Moira Shire Flood Emergency Plan

A Sub-Plan of the Municipal Emergency Management Plan

For Moira Shire Council
And
VICSES
North East Region and the
Cobram, Numurkah and Yarrawonga Units
December 2020 Version 1.2

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Document Transmittal Form / Amendment Certificate

This Municipal Flood Emergency Plan (MFEP) will be amended, maintained and distributed as required by VICSES in consultation with Moira Shire Council.

Suggestions for amendments to this Plan should be forwarded to:

Regional Manager
North East Region
Victoria State Emergency Service
27 Wedge Street
Benalla Victoria 3672

Amendments listed below have been included in this Plan and promulgated to all registered copyholders.

Amendment Number	Date of Amendment	Amendment Entered By	Summary of Amendment
0	xx/xx/2013		Preparation and distribution of Version 1 of this MFEP
1	May 2014	Moira Shire Council, VicSES	Full review of the Municipal Flood Emergency Plan following the March 2012 flood event
2	December 2014	MCA	Added Numurkah intel from the Floodplain Management Study
3	September 2020	Moira Shire Council, VicSES	Added / Reviewed local information and updated terminology
4	December 2020	BOM and CMA	The Proposed Moderate and Major levels for Numurkah have been removed, pending consultation with BOM and all required parties on final declared flood class levels

This Plan will be maintained on the (www.ses.vic.gov.au and / or www.moira.vic.gov.au) websites.

List of Abbreviations & Acronyms

The following abbreviations and acronyms are used in the Plan:

AEP	Annual Exceedance Probability (is the inverse of ARI expressed as a percentage)
AHD	Australian Height Datum (the height of a location above mean sea level in metres)
AIIMS	Australasian Inter-service Incident Management System
AoCC	Area of Operations Control Centre / Command Centre
ARI	Average Recurrence Interval (is the inverse of AEP)
ARMCANZ	Agricultural & Resource Management Council of Australia & New Zealand
AV	Ambulance Victoria
BoM	Bureau of Meteorology
CALD	Culturally and Linguistically Diverse (communities).
CEO	Chief Executive Officer
CERM	Community Emergency Risk Management
CFA	Country Fire Authority
CMA	Catchment Management Authority
DH	Department of Health
DHHS	Department of Health & Human Services
DoI	Department of Infrastructure
AGVIC	Agriculture Victoria Department of DJPR
EAS	Emergency Alert System
EHO	Environmental Health Officer
EMLO	Emergency Management Liaison Officer
EMMV	Emergency Management Manual Victoria
EMT	Emergency Management Team
EO	Executive Officer
FO	Floodway Overlay
FW	Flood Warning
FWS	Flood Warning System
FZ	Floodway Zone
GBCMA	Goulburn Broken Catchment Management Authority
GMW	Goulburn Murray Water
GVW	Goulburn Valley Water
HACC	Home and Community Care
IAP	Incident Action Plan
IC	Incident Controller
ICC	Incident Control Centre
IFD	Intensity-Frequency-Duration (applies to rainfall data)
ICC	Incident Control Centre
IMT	Incident Management Team
IMS	Incident Management System
LSIO	Land Subject to Inundation Overlay
LHQ	Local Head Quarters
MECC	Municipal Emergency Coordination Centre
MEMP	Municipal Emergency Management Plan
MEMPC	Municipal Emergency Management Planning Committee
MERC	Municipal Emergency Response Coordinator
MERO	Municipal Emergency Resource Officer
MFB	Metropolitan Fire and Emergency Services Board
MFEP	Municipal Flood Emergency Plan
MFPC	Municipal Flood Planning Committee

MRM	Municipal Recovery Manager
MSC	Moira Shire Council
NEW	North East Water
NSW	New South Wales
OIC	Officer in Charge
OSOM	One Source, One Message
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PWD	Public Works Department
RCC	Regional Control Centre
RDO	Regional Duty Officer
REMI	Regional Emergency Management Inspector
RERC	Regional Emergency Response Coordinator
RERCC	Regional Emergency Response Coordination Centre
RIA	Rapid Impact Assessment
SBO	Special Building Overlay
SCC	State Control Centre
SEWS	Standard Emergency Warning System
SHERP	State Health Emergency Response Plan
SitRep	Situation Report
SOP	Standard Operating Procedure
VFD	Victorian Flood Data
VicPol	Victoria Police
VICSES	Victoria State Emergency Service

Part 1. INTRODUCTION

1.1 Municipal Endorsement

This Municipal Flood Emergency Plan (MFEP) has been prepared by Moira Shire with the authority of the Municipal Emergency Management Planning Committee (MEMPC) – (refer to Section 1.6 endorsement of plan) pursuant to Section 20 of the Emergency Management Act 1986 (as amended).

This MFEP is a sub plan to the Moira Shire Municipal Emergency Management Plan (MEMP). It is consistent with the Emergency Management Manual Victoria (EMMV) and the Victoria Flood Management Strategy (DNRE, 1998a) and takes into account the outcomes of the Community Emergency Risk Assessment (CERA) process undertaken by the MEMPC.

This MFEP is consistent with the VICSES North East Region Flood Emergency Plan and the State Flood Emergency Plan.

This MFEP is a result of the cooperative efforts of the Moira Shire Municipal Flood Planning Committee (MFPC) and its member agencies.

Minor and administrative amendments will be made to this MFEP from time to time without re-presenting the plan to the MFPC or the MEMPC. Any major structural or policy changes will be considered before adoption.

This Plan is endorsed by the Moira Shire MEMPC as a sub-plan to the MEMP.

Endorsement

Mayor, Councillor Peter Mansfield……Date……../…../……..

State Emergency Service – Regional Manager ……Date……../…../…….

1.2 The Municipality

An outline of Moira Shire in terms of its location, demography and other general matters is provided in the MEMP. An outline of the flood threat is provided in Appendix A of this Plan.

1.3 Purpose and Scope of this Flood Emergency Management Plan

The purpose of this MFEP is to detail arrangements agreed for the planning, preparedness/prevention, response and recovery from flood incidents within Moira Shire.

As such, the scope of the Plan is to:

- Identify the flood risk within Moira Shire;
- Support the implementation of measures to minimise the causes and impacts of flood incidents within Moira Shire;
- Detail response and recovery arrangements including preparedness, incident management, command and control;
- Identify linkages with local, regional and state emergency and wider planning arrangements with specific emphasis on those relevant to flood.

1.4 Municipal Flood Planning Committee (MFPC)

Membership of the Moira Shire Municipal Flood Planning Committee (MFPC) will comprise of the following representatives from the following agencies and organisations:

- VICSES
- Moira Shire
- Victoria Police (ie. Municipal Emergency Response Coordinator) (MERC)
- Goulburn Broken Catchment Management Authority
- Department of Health (DH)
- Department of Health & Human Services (DHHS)
- Country Fire Authority
- Goulburn Murray Water
- Department of Environment & Primary Industry (AGVIC)
- Bureau of Meteorology
- North East Water
- Goulburn Valley Water
- Local community representatives and
- Other agencies as required

1.5 Responsibility for Planning, Review & Maintenance of this Plan

This MFEP must be maintained in order to remain effective.

VICSES through the MFPC has responsibility for preparing, reviewing, maintaining and distributing this plan.

The MFPC will meet at least once per year.

The MFEP should be reviewed and where necessary, arrangements and information contained in it should be amended:

- Following any new flood or stormwater drainage study;
- Following a change in non-structural and/or structural flood mitigation measures;
- After the occurrence of a significant flood event within the municipality.

Part 2. PREVENTION / PREPAREDNESS ARRANGEMENTS

2.1 Community Awareness for all Types of Flooding

Details of this MFEP will be released to the community through local media, the FloodSafe program, and Councils website upon formal adoption by Moira Shire Council.

VICSES with the support of Moira Shire and in-principle support from the GBCMA will coordinate community education programs for flooding within the council area (eg. FloodSafe/StormSafe).

A FloodSafe Community Education/Communication Plan has not yet been developed. When available, details will be included as an Appendix to this MFEP.

2.2 Structural Flood Mitigation Measures

2.2.1 Existing measures

The following is a summary of structural flood mitigation measures that exist within Moira Shire:

Formal flood protection levees existing within the municipality are as follows:

Nathalia:
Key elements of the town levee scheme include:

- Along both banks of the Broken Creek and around parts of the town (see maps at Appendices C and F) noting that while the majority of the levee comprises a series of engineered earthen banks; road openings and the foreshore area are protected by a demountable aluminium panel system which is erected ahead of an approaching flood.
- A small section of the levee on a Draper Street also needs to be completed using sandbags.
- GMW's No 12 channel acts as a levee on the south side of town.

Cobram:
Key elements of the town levee scheme include:

- Dick's spillway.
- Levee adjacent to Wyatt Road (Cavagna's Levee): A short section (300m) of earthen levee prevents breakout towards Pullar Road.
- River Road: Elevated allotments act as a levee to the north and east of Scenic Drive. A concrete wall (Densons Levee) is landscaped as the property fence and provides flood protection between Scenic Drive and Mookarii Street. Temporary flood barriers are required across Mookarii Street.
- Town Levee: This levee extends from Mookarii Street to near Harris Road and adjoins the PWD levee.

Barmah:
Key elements of the town levee scheme include:

- A study has been conducted to work out the best protection strategy for Barmah Township. This plan has been adopted by Council at its ordinary meeting in August 2013. Implementation of the study recommendations is not known at this time as it is subject to funding.

Numurkah
Key elements of the town levee scheme include:

- A study is being conducted to determine the best early warning and protection strategy for Numurkah. Completion of this study is expected in 2014.

Numerous rural flood protection levees exist within the municipality as follows:

- Across the Broken Creek floodplain in order to protect farming assets.
- Adjacent to the lower reaches of the Goulburn River.
- Across the Murray floodplain in order to protect farming and other assets.

Refer to Appendix C for detailed information on existing structural flood mitigation measures.

2.2.2 Protection of private dwellings

To reduce the risk of flooding, landholders in rural areas are encouraged to construct an earthen bank around their dwelling and immediate curtilages to provide flood protection up to at least the 1% AEP flood level. Properly planned banks can be drained and controlled when a flood occurs, works of this nature are exempt from a planning permit from the Moira Shire provided only the dwelling is involved. Moira Shire can assist with typical design drawings.

2.2.3 Levees

Levees by definition interrupt the natural flow of water, any person or organisation strengthening, raising or creating any levee other than those approved under formal flood mitigation schemes could be legally liable for all damages. The Control Agency (VICSES) may however approve such works after appropriate consideration,

2.3 Non-structural Flood Mitigation Measures

2.3.1 Exercising the Plan

Arrangements for exercising this Plan will be at the discretion of the MEMPC. This Plan should be regularly exercised, on an annual basis. Refer to Section 4.7 of the EMMV for guidance.

2.3.2 Flood Warning

Arrangements for flood warnings are contained within the State Flood Emergency Plan and the EMMV (Part 3.7) and on the Bureau of Meteorology (BoM) website.

Specific details of local flood warning system arrangements within the Municipality are provided in Appendix E.

2.3.3 Flood Observers

The need to incorporate local knowledge into planning and community education has been recognised through the Victorian Floods Review which states in Recommendation 22:

“VICSES takes the necessary measures to require that local knowledge is considered in flood risk planning, including the verification of flood maps and flood response plans. The need for community involvement in flood planning, flood plain management and emergency response is accepted.”

The Victorian Emergency Management Reform White Paper further highlights the need to incorporate local knowledge, stating:

“Local knowledge on people, history risks, vulnerability, operational requirements, infrastructure and services significantly enhances emergency preparation, response and recovery.”

Local knowledge can be obtained from a variety of sources including VICSES units, CFA Brigades, Police Stations, Water Authorities, CMAs, Local Government and observer networks. Once collected, local knowledge information needs to be processed, validated and assessed.

A local knowledge policy is being developed by VICSES to ensure the incorporation of local knowledge in decision making before, during and after incidents. For further detail please refer to www.ses.vic.gov.au

Part 3. RESPONSE ARRANGEMENTS

3.1 Introduction

3.1.1 Activation of Response

Flood response arrangements may be activated by the Regional Duty Officer (RDO) VICSES North East Region or the Incident Controller (IC).

The IC/VICSES RDO will activate agencies as required and document the State Flood Emergency Management Plan.

3.1.2 Responsibilities

There are a number of agencies with specific roles that act in support of VICSES and provide support to the community in the event of a serious flood within Moira Shire. These agencies will be engaged through the Incident EMT (Emergency Management Team).

The general roles and responsibilities of supporting agencies are as agreed within the Moira Shire MEMP, EMMV (Part 7 'Emergency Management Agency Roles'), the State Flood Emergency Plan and the VICSES North East Region Flood Emergency Plan.

3.1.3 Municipal Emergency Coordination Centre (MECC)

Liaison with the MECC will be through the established Division/Sector Command and through municipal involvement in the Incident EMT, in particular the Municipal Emergency Response Coordinator (MERC). The IC / VICSES RDO will liaise with the MECC directly if no Division/Sector Command is established.

The function, location, establishment and operation of the MECC will be as detailed in the Moira Shire MEMP – Councils primary MECC location is at its municipal offices at 44 Station Street Cobram.

3.1.4 Escalation

Most flood incidents are of local concern and an appropriate response can usually be coordinated using local resources. However, when these resources are exhausted, the State's arrangements provide for further resources to be made available, firstly from neighbouring municipalities (on a regional basis) and then on a state-wide basis.

Resourcing and event escalation arrangements are described in the EMMV ('State Emergency Response Plan).

3.2 Strategic Control Priorities

To provide guidance to the Incident Management Team (IMT), the following strategic control priorities, consistent with the State and Regional Flood Emergency Plans, shall form the basis of incident action planning processes:

- Protection and preservation of life is paramount - this includes:
    - Safety of emergency services personnel,
    - Safety of community members including vulnerable community members and visitors/tourist located within the incident area, and
    - Safety and welfare of displaced community members.
- Issuing of community information and warnings detailing incident information that is timely, relevant and tailored to assist community members make informed decisions about their safety;

- Protection of community essential infrastructure and essential services that support community resilience;
- Protection of residential property as a place of primary residence;
- Protection of assets supporting economic production and individual livelihoods;
- Protection of environmental and conservation values; and
- Effective transition to recovery.

Circumstances may arise where the IC is required to vary these priorities, with the exception being that the protection of life should remain the highest. This shall be done in consultation with the State Flood Controller and relevant stakeholders based on sound incident predictions and risk assessments.

3.3 Command, Control & Coordination

The Command, Control and Coordination arrangements in this Municipal Flood Emergency Plan must be consistent with those detailed in the State Flood Emergency Plans and the North East Region Flood Emergency Plan. For further information, refer to the State Emergency Response Plan, Part 3 of the EMMV.

The specific details of the Command, Control and Coordination arrangements for this plan are as provided in Appendix C.

3.3.1 Control

Functions 5(a) and 5(c) at Part 2 of *the Victoria State Emergency Service Act 1986 (as amended)* detail the authority for VICSES to plan for and respond to flood.

Part 7.1 of the EMMV prepared under the *Emergency Management Act 1986 (as amended)*, identifies VICSES as the Control Agency for flood. It identifies DEPI as the Control Agency responsible for "*dam safety, water and sewerage asset related incidents*" and other emergencies.

All flood response activities within Moira Shire including those arising from a dam failure or retarding basin/levee bank failure incident will therefore be under the control of the appointed IC, or his/her delegated representative.

3.3.2 Incident Controller (IC)

An IC will be appointed by the VICSES (as the Control Agency) to command and control available resources in response to a flood event on the advice of the BoM (or other reliable source) that a flood event will occur or is occurring, the IC responsibilities are as defined in Part 3.5 of the EMMV

3.3.3 Incident Control Centre (ICC)

As required, the IC will establish an ICC from which to initiate incident response command and control functions. The decision as to if and when the ICC should be activated, rests with the Control Agency (ie. VICSES).

Pre-determined ICC locations are listed in Appendix 1 of the VICSES North East Region Flood Emergency Plan.

3.3.4 Divisions and Sectors

To ensure that effective command and control are in place, the IC may establish divisions and sectors depending upon the complexity of the event and resource capacities.

Divisions and sectors may be established to assist with the management of flooding within the municipality. A pre-determined list of divisional command locations and sector command locations are summarised, by catchment, in Appendix 8 of the VICSES North East Region Flood Emergency Plan.

3.3.5 Incident Management Team (IMT)

The IC will form an IMT.

Refer to 3.5 of the EMMV for guidance on IMTs and Incident Management Systems (IMSs).

3.3.6 Emergency Management Team (EMT)

The IC will establish a multi-agency EMT to assist the flood response. The EMT will consist of key personnel (with appropriate authority) from stakeholder agencies and relevant organisations who need to be informed of strategic issues related to incident control and who are able to provide high level strategic guidance and policy advice to the IC for consideration in developing incident management strategies.

Organisations, including Moira Shire are required within the EMT and will provide an Emergency Management Liaison Officer (EMLO) to the ICC if and as required as well as other staff and/or resources identified as being necessary, within the capacity of the organisation.

Refer to 3.5 of the EMMV for guidance on EMTs-

3.3.7 On Receipt of a Flood Watch/Severe Weather Warning

The IC (or VICSES RDO until an IC is appointed) will undertake actions as defined within the flood intelligence cards (Appendix C). General considerations by the IC/VICSES RDO will be as follows:

- Review flood intelligence to assess likely flood consequences.
- Monitor weather and flood information/situation (eg. through the BoM website at www.bom.gov.au/vic/flood/).
- Assess Command and Control requirements.
- Review local resources and consider needs for further resources regarding personnel, property protection, flood rescue and air support.
- Notify and brief appropriate officers. This includes Regional Control Centre (RCC) (if established), State Control Centre (SCC) (if established), Council, other emergency services through the EMT.
- Assess ICC readiness (including staffing of IMT and EMT) and open if required.
- Ensure flood bulletins and community information is prepared and issued to the community.
- Monitor watercourses and undertake reconnaissance of low-lying areas.
- Develop media and community information management strategy.
- Ensure flood mitigation works are being checked by owners.
- Develop, issue and maintain an Incident Action Plan (IAP), if required.
- Develop and issue Situation Report(s) (SitReps), if and as required.

3.3.8 On Receipt of the First and Subsequent Flood Warnings

The IC (or VICSES RDO until an IC is appointed) will undertake actions as defined within the flood intelligence cards (Appendix C). General considerations by the IC/VICSES RDO will be as follows:

- Develop an appreciation of current flood levels and predicted levels - are floodwaters rising, peaking or falling?
- Review flood intelligence to assess likely flood consequences.

Consider:

  - What areas may be at risk of inundation;
  - What areas may be at risk of isolation;
  - What areas may be at risk of indirect affects as a consequence of power, gas, water, telephone, sewerage, health, transport or emergency service infrastructure interruption;
  - The characteristics of the populations at risk.

- Determine what the at-risk community need to know and advise as the flood develops.
- Warn the at-risk community including ensuring that an appropriate warning and community information strategy is implemented including details of:
  - The current flood situation;
  - Flood predictions;
  - What the consequences of predicted (or expected or actual) levels may be;
  - Public safety advice;
  - Who to contact for further information;
  - Who to contact for emergency assistance.
- Liaise with relevant asset owners as appropriate (ie. water and power utilities).
- Implement response strategies as required based on flood consequence assessment.
- Continue to monitor the flood situation (eg. through the BoM website www.bom.gov.au/vic/flood/).
- Continue to conduct reconnaissance of low-lying areas.

3.4 Community Information and Warnings

Guidelines for the distribution of community information and warnings are contained in the State Flood Emergency Plan.

Community information and warning communication methods available include:

- Emergency Alert;
- Phone messages (including SMS);
- Radio and television;
- Two-way radio;
- Mobile and fixed public address systems;
- Sirens;
- Verbal Messages (ie. Doorknocking);
- Agency websites;
- VICSES Flood/Storm Information Line;

- Variable Message Signs (ie. road signs);
- Community meetings;
- Newspapers;
- Email;
- Telephone trees;
- Community flood wardens;
- Fax stream;
- Newsletters;
- Letter drops;
- Social media and/or social networking sites (ie. twitter and/or facebook).

The release of flood bulletins and information with regard to response activities at the time of a flood event is the responsibility of VICSES as the Control Agency.

Council has the responsibility to assist VICSES to warn individuals within the community including activation of flood warning systems, where they exist. Responsibility for public information, including media briefings, rests with VICSES as the Control Agency.

Other agencies such as CFA, AGVIC and VicPol may be requested to assist VICSES with the communication of community flood warnings.

In cases where severe flash flooding is predicted, dam failure is likely or flooding necessitating evacuation of communities is predicted, the IC may consider the use of the Emergency Alert System (EAS) and/or the Standard Emergency Warning System (SEWS).

DHHS will coordinate information regarding public health and safety precautions.

Refer to Appendices C and E for any specific details regarding how community information and warnings are to be provided within Moira Shire.

3.5 Media Communication

The IC through the Information Unit established at the ICC will manage media communication. If the ICC is not established, the VICSES RDO will manage all media communication.

3.6 Rapid Impact Assessment (RIA)

A RIA can be conducted to assess and record the extent and nature of damage caused by flooding. This information may then be used to provide the basis for further needs assessment and recovery planning by DH & DHS and recovery agencies.

VicPol is responsible for coordinating the collection, collation and dissemination of RIA information on a whole-of government basis. The IC is responsible for activating VicPol to undertake this function.

The purpose, function and conduct of RIAs are outlined in the State Flood Emergency Plan. All RIAs should be conducted in accordance with Part 3 of the EMMV.

3.7 Preliminary Deployments

When flooding is expected to be severe and access to townships cut, suburbs and /or communities, the IC will consult with relevant agencies to ensure that resources are in place if required to provide emergency response. These resources might include emergency service personnel, food items and non-food items such as medical supplies, shelter, assembly areas, relief centres, etc.

3.8 Response to Flash Flooding

Emergency management response to flash flooding should be consistent with the guideline contained as Appendix 6 in the State Flood Emergency Plan.

Planning for flash flooding should commence with an assumption that evacuation is the most effective strategy. However, given that a proportion of the population is unlikely to evacuate, either by choice or impediment, a rescue contingency plan must also be contemplated.

When conducting pre-event planning for flash floods the following steps should be followed and in the order as given:

1. Determine if there are impediments to for evacuation by considering warning time, safe routes, resources available and etc;
2. If evacuation is possible, then evacuation should be the adopted strategy and it must be supported by a public information capability and a rescue contingency plan;
3. Where it is likely people will become trapped by due to limited evacuation options, safety advice needs to be provided to people at risk advising not to attempt to flee by entering floodwater, if they become trapped it may be safer to seek the highest point within the building and to telephone 000 if they require rescue. This advice needs to be provided even when evacuation may be possible, due to the likelihood that not all community members will evacuate.
4. For buildings known to be structurally unsuitable an earlier evacuation trigger will need to be established (return to step 1 of this cycle).
5. If an earlier evacuation is not possible then specific preparations must be made to rescue occupants trapped in structurally unsuitable buildings either pre-emptively or as those people call for help.

During a flash flood it is difficult to development and establish an evacuation centre ahead of triggering the evacuation, as is normal practice, but this is insufficient justification for not adopting evacuation.

Refer to Appendix C for response arrangements for flash flood events within the Municipality.

3.9 Evacuation / Relocation

In Victoria evacuation is largely voluntary, however in particular circumstances legislation provides some emergency service personnel with authority to remove people from areas or prohibit their entry.

The decision to recommend or warn people to prepare to evacuate or to evacuate immediately rests with the IC. It is the choice of individuals as to how they respond to this recommendation.

Once the decision is made VicPol are responsible for the management of the evacuation process where possible. VICSES and other agencies will assist where practical and are responsible for the development and communication of evacuation warnings.

VicPol and/or Australian Red Cross will take on the responsibility of registering people affected by a flood emergency including those who have been evacuated.

Refer to Section 3.8 of the EMMV and the Evacuation Guidelines for guidance on evacuations for flood emergencies.

Refer to Appendix C of the Moira Shire MEMP for guidance on evacuation arrangements for specific areas of the Municipality and to Appendix D of this MFEP for detailed evacuation arrangements in the event of flooding.

3.10 Flood Rescue

VicPol as the designated Control Agency for water rescue will coordinate rescues undertaken during flood events.

In order to activate water rescue services, VICSES as control agency for overall flood response, will identify areas at risk of requiring rescue and notify the Officer in Charge of the Water Police Search and Rescue Squad to request pre-deployment of rescue resources to those areas.

In conducting rescues, VicPol may require the assistance of appropriately trained and equipped personnel. In these circumstances appropriately trained and equipped VICSES units or other agencies that have appropriate training, equipment and support may carry out rescues.

Rescue operations may be undertaken where voluntary evacuation is not possible, has failed or is considered too dangerous for an at-risk person or community. An assessment of available flood rescue resources (if not already done prior to the event) should be undertaken prior to the commencement of rescue operations.

Rescue is considered a high-risk strategy to both rescuers and persons requiring rescue and should not be regarded as a preferred emergency management strategy. Rescuers should always undertake a dynamic risk assessment before attempting to undertake a flood rescue.

Resources available for rescues carried out within Moira Shire are detailed in the MEMP.

3.11 Animal Welfare

Animal management guidelines are provided in the MEMP along with the location and contact details for appropriate animal welfare entities.

Matters relating to the welfare of livestock, companion animals and wildlife (including feeding and rescue) are to be referred to AGVIC. This includes requests for emergency supply and/or delivery of fodder to stranded livestock or for livestock rescue.

Matters relating to the welfare of wildlife are to be referred to AGVIC.

3.12 Aircraft Management

Aircraft can be used for a variety of purposes during flood operations including evacuation, resupply, reconnaissance, intelligence gathering, rescue, logistics and emergency travel.

Air support operations will be conducted under the control of the IC.

The IC may request aircraft support through the State Air Desk located at the SCC. The SCC will establish priorities.

Suitable airbase facilities are located at:

- Shepparton;
- Yarrawonga;
- Tocumwal;
- Benalla.

Note that various ovals and sporting fields may be suitable but encumbrances such as powerlines and light towers would need to be logged and an appropriate risk assessment completed.

3.13 Resupply

Communities, neighbourhoods or households can become isolated during floods as a consequence of road closures or damage to roads, bridges and causeways. Under such circumstances, the need may arise to resupply isolated communities/properties with essential items.

When predictions/intelligence indicates that communities, neighbourhoods and/or households may become isolated, VICSES will advise businesses and/or households that they should stock up on essential items.

After the impact, VICSES can support isolated communities through assisting with the transport of essential items to isolated communities and assisting with logistics functions.

Resupply operations are to be included as part of the emergency relief arrangements. VICSES will work with the relief agencies to service communities that are isolated.

3.14 Essential Community Infrastructure and Property Protection

3.14.1 General

Essential community infrastructure and property (eg. residences, businesses, roads, power supplies, communications, etc.) may be affected in the event of a flood.

DEPI will work with VICSES to identify key energy assets (ie. power, gas and liquid fuels) in floodplains. Providers of other essential services may need to be contacted in the event of concerns about service continuity.

The IC will ensure that owners of essential community infrastructure are kept advised of the flood situation. Essential community infrastructure providers must keep the Incident Controller informed of their status and ongoing ability to provide services.

The IC will determine the priorities related to the use of sandbags which will be consistent with the strategic control priorities and with VICSES Sandbag Policy.

Property may be protected by:

- Sandbagging to minimise entry of water into buildings;
- Encouraging businesses and households to lift or move contents;
- Construction of temporary levees in consultation with the GBCMA, local government and VicPol and within appropriate approval frameworks.

Sandbag collection points will be established at easily accessible community facilities or locations within or near threatened communities as appropriate.

Refer to Appendix C for further specific details of essential infrastructure requiring protection.

3.14.2 Moira Shire Sandbag Policy – Stores, Procedure and Measures

Moira Shire retains sufficient sandbags to protect those assets which are the statutory responsibility of Council. Residents who are located in areas that have a history of flooding or are shown on the Moira Planning Scheme as subject to inundation are encouraged to provide more permanent protection for themselves and their assets.

Moira Shire will keep on hand a minimum of:

Cobram – approximately 10,000 sandbags

- 1,000 sandbags are to be available for Council to enable protection of public assets (ie. those assets that are the statutory responsibility of Council);

- The remaining 9,000 sandbags are to be made available to residents within the Municipality.

Nathalia - approximately 10,000 sandbags

- 1,000 sandbags must be kept in reserve to enable any gaps in the levee at Nathalia to be blocked as required.
- 1,000 sandbags are to be available for Council to enable protection of public assets (ie. those assets that are the statutory responsibility of Council);
- The remaining sandbags are to be made available to residents outside the levees.

Numurkah approximately - 10,000 sandbags

- 1,000 sandbags are to be available for Council to enable protection of public assets (ie. those assets that are the statutory responsibility of Council);
- The remaining 9,000 sandbags are to be made available to residents outside the levees.
- In addition, 10,000 Sandbags stored at the Numurkah SES LHQ.

Yarrawonga approximately - 10,000 sandbags

- 1,000 sandbags are to be available for Council to enable protection of public assets (ie. those assets that are the statutory responsibility of Council);
- The remaining 9,000 sandbags are to be made available to residents outside the levees.
- In addition, 8,000 Sandbags stored at the Yarrawonga SES LHQ

Tungamah approximately -10,000 sandbags

- 1,000 sandbags are to be available for Council to enable protection of public assets (ie. those assets that are the statutory responsibility of Council);
- The remaining 9,000 sandbags are to be made available to residents outside the levees.

Back-up supplies of sandbags are available through the VICSES Regional Headquarters at Benalla and/or from neighbouring municipalities.

If VICSES sandbags are becoming limited in supply, priority will be given to protection of essential community infrastructure (eg. water supplies, wastewater facilities and essential services). Other high priorities may include for example the protection of historical buildings.

Suppliers of sandbags and/or sand are not listed in the MEMP.

Applications from residents and businesses for sandbags and sand are to be made to VICSES.

Sandbags and sand will be made available free of charge to residents but only on the basis of protecting dwellings and their immediate vicinity. Council cannot guarantee that the requested number of sandbags or sand will be available or will be able to be supplied.

Additional sandbags and sand requested by residents other than approved as above may be supplied, if available in Council's store, at Council's sole discretion.

Council will not sandbag private houses or business. All requests for assistance in sandbagging individual houses must be made to VICSES. Each request for assistance will be treated on its own individual merits.

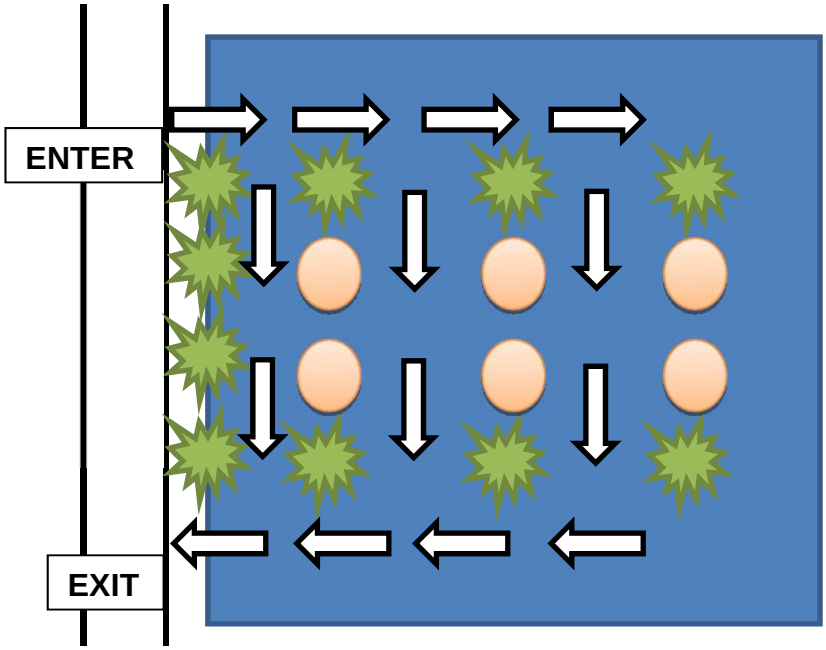
Sand bag filling areas

In the March 2012 flood event, sandbag filling took place at the following locations;

- Yarrawonga Depot, Sharp Street Yarrawonga. (Yarrawonga Showgrounds / Victoria Park as an alternative)
- Cobram Depot, Shubert Street Cobram.
- Tungamah Depot, Boyd Street Tungamah

- Numurkah Depot, Brennion Street Numurkah. This was relocated to the St Johns Catholic Church car park, Tocumwal Rd Numurkah due to inundation of the Depot.
- Nathalia Depot and Sports and Community Centre car park, Gifford Street Nathalia
- Picola Silo, Moran Street Picola
- Sandbags were also filled at Dhurringile Prison as well as in the townships of Wunghnu, Katamatite, Barmah and other locations for the purposes of residential protection.

Suggested traffic flow for public access in and around designated sandbag areas



This will ensure a consistent flow of traffic and enable a safe system to deliver sand when required.

During a flood emergency most homes built on a concrete slab after 1974 can be protected with approximately 25 sandbags. During large flooding events sandbags maybe in limited supply, see appendix I for draft SES brochure on sandbagging and how to protect your home.

		Distance in metres										
		10	20	30	40	50	100	200	300	400	500	1000
Course	**Height**	**Cubic meters required** (assuming 1 bag holds 0.021 cubic metres of sand)										
1	100 mm	0.42	.0.84	1.26	1.68	2.1	4.2	8.4	12.6	16.8	21	42
2	200 mm	0.84	1.68	2.52	3.36	4.2	8.4	16.8	25.2	33.6	42	84
3	300 mm	1.26	2.52	3.78	5.044	6.3	12.6	25.2	37.8	50.4	63	126
4	400 mm	1.68	3.36	5.04	6.72	8.4	16.8	33.6	50.4	67.2	844	168
5	500 mm	2.1	4.2	6.3	8.4	10.5	21	442	63	84	105	210
6	600 mm	2.52	5.04	7.56	10.08	12.6	25.2	50.4	75.6	100.8	126	252

- 1 cubic metre of sand weighs approx. 1700kg (dry) 1900kg (wet).
- 1 cubic metre of sand fills about 47 sandbags (2/3 full).
- Five people take 1 hour to fill by hand and lay about 60 sandbags.

3.15 Disruption to Services

Disruption to services other than essential community infrastructure and property can occur in flood events. Refer to Appendix C for specific details of likely disruption to services and proposed arrangements to respond to service disruptions in Moira Shire.

3.16 Waste Water related Public Health Issues and Critical Sewerage Assets

Inundation of sewerage assets including sewerage pump stations during surface flooding may result in water quality problems within the municipality. Where this is likely to or has occurred, the responsible agency (ie. G-MW, GVW or NEW depending on location within the Municipality[1]) is responsible for:

- Identification and monitoring critical assets to assist preparedness and response activities in the event of a flood.
- Advising VICSES/ICC of any potential or current security threats to critical sewerage infrastructure Developing action plan(s) in consultation with the IC to protect critical sewage infrastructure
- Advising the IC whether town water (potable)supply is at risk, NEW or GVW in consultation with the IC and Department of Health will notify consumers if the water is not safe to drink, including issuing the necessary advice (e.g. Boil Water Advisory Notice).
- The IC will develop drinking water warnings in consultation with the relevant Water Corporation
- Inundation of septic tank systems may also result in similar water quality problems. In the event of flood waters contaminated by septic tank systems the MSC senior EHO is to advise the ICC and the relevant Water Corporation. Assessment and actions are detailed above.

3.17 Preventing Illness from Contaminated Water

Drinking water potable reticulated water supply systems) have the capacity to deal with flood situations due to protective barriers such as positive pressures and chlorine unless there is damage to key infrastructure or the system experiences a mains failure during the flood event. The relevant Water Corporation will be responsible for:

- Monitoring the performance and capacity of their respective supply system.
- Providing advice to the IC whether a town water (potable) supply is at risk, either NEW or GVW in consultation with the IC and department of Health will notify consumers if the water is not safe to drink, including issuing the necessary advice (e.g. Boil Water Advisory Notice)
- Developing an action plan in consultation with the IC to secure and protect critical water supply assets.

The IC will develop drinking water warnings in consultation with relevant Water Corporation. NEW and GVW for urban supplies and G-MW for non-town users (e.g. Stock and domestic)

[1] North East Water has responsibilities for towns in the Municipality to the east of a line drawn from Benalla to Tungamah to Yarrawonga and including Bundalong, St James, Tungamah and Yarrawonga. Other townships in the Municipality are serviced by Goulburn Valley Water. All rural water is the responsibility of Goulburn Murray Water.

3.18 Levee Management

Levee owners/operators are responsible for the maintenance, operation and monitoring of their levees.

Levee owners/operators must keep the IC informed of levee status and be prepared to provide expert advice to the IC about the design and construction of their levees.

In accordance with the strategic control priorities, the IC may assist levee owners to coordinate resources, both technical and physical, to provide advice and affect temporary repairs to or augmentation of levees.

3.19 Road Closures

VicRoads are responsible for designated main roads and highways, Council are responsible for the designated local and regional road network.

Road closures caused by flooding within the municipality will be managed by Moira Shire and VicRoads as part of their normal formal functions. This will include necessary observations and the placement of warning signs, road blocks, etc to local and regional roads, bridges, walking and bike trails, etc. Moira Shire staff may also liaise with and advise VicRoads as to the need or advisability of erecting warning signs and/or of closing roads and bridges under its jurisdiction.

VicRoads and Moira Shire will communicate information regarding road closures to the ICC. The VicRoads website will be updated and maintained for current road closures. These can be viewed at www.VicRoads.vic.gov.au

3.20 Dam Failure

DEPI is the control agency for dam safety incidents (eg. breach, failure or potential breach/failure of a dam). Water Corporations who manage dams will manage any potential dam safety incident in accordance with the Ministerial Statement of Obligations and Protocols between DEPI and Victorian Water Corporations.

VicSES is however the Control Agency for any flooding that may result from a dam failure incident. In the result of any dam safety incident during a flood event the VICSES, the Dam Manager and DEPI will develop a suitable Command and Control Plan to manage the combined flood and dam safety incident. While there are a number of private dams within the municipality, there are no substantial dams whose failure is likely to cause direct significant structural and community damage within Moira Shire. North East Water identifies the Yarrawonga Waste Water Storage on its Dam Safety Register. This dam has a low consequence category. However, a breach of this dam may create a public health risk and impact nearby road and rail assets.

3.21 After Action Review

VICSES will coordinate the after action review arrangements of flood response operations (ie. debrief) as soon as practical following an event.

All agencies involved in the flood incident should be represented at the after action review.

3.22 Recording of Flood Information

During and immediately after a flood it is important that key aspects of the event are recorded.

Arrangements for the collection/recording of flood related information is the responsibility of the municipality although GBCMA and VICSES will assist where possible. The MERO should ensure that there is no duplication of data collection activities and efforts, and that efforts are integrated as far as possible with post-impact assessment activities.

Data to be collected includes:

- The date/time on the reference river gauge when key infrastructure (eg. drains, roads, buildings, etc) is first affected by rising flood waters (refer to the Shire's Director of Shire Development and Liveability, Executive Manager of Construction & Assets or the Shire's Executive Engineer);
- The extent and depth of the peak of the flood within the precinct(s) affected as well as at strategic locations within the Municipality (in conjunction with GBCMA);
- As part of and in preparation for the above, actively encourage residents to mark the flood peak with a permanent marker on a permanent structure within their property and to note the date/time of its occurrence;
- Flood damage – in both qualitative and quantitative terms (refer to the Shire's Manager Town Planning and Building or to the MAV's Resource Sharing Agreement, VICSES/VicPol[2] and GBCMA);
- Flood warning service performance, particularly in relation to the service level agreement and the progressive implementation of the actions outlined in this Plan; and
- A summary of the development, progression and impact of the flood event (see Appendix A) (in conjunction with GBCMA).

[2] The IC is responsible for activating a rapid impact/damage assessment during flooding events.

Part 4. EMERGENCY RELIEF & RECOVERY ARRANGEMENTS

4.1 General

Arrangements for recovery from a flood incident within Moira Shire are detailed in the Moira Shire MEMP.

4.2 Emergency Relief

The IC should ensure that the MERC, the RRC and the MRM are kept informed of the need for relief.

The decision to recommend the opening of an emergency relief centre rests with the IC. The IC is responsible for ensuring that relief arrangements have been considered and implemented where required under the State Emergency Relief and Recovery Plan (Part 4 of the EMMV).

The range and type of emergency relief services to be provided in response to a flood event will be dependent upon the size, impact, and scale of the flood. Refer to Section 4.4 of the EMMV for details of the range of emergency relief services that may be provided.

Suitable relief facilities identified for use during floods, including details of relief arrangements, are detailed in the MEMP.

4.3 Animal Welfare

See Section 3.11 of this MFEP.

4.4 Transition from Response to Recovery

VICSES as the control agency is responsible for ensuring effective transition from response to recovery. This transition will be conducted in accordance with existing arrangements as detailed in Part 3 of the EMMV.

APPENDIX A - FLOOD THREATS FOR MOIRA SHIRE

General

Moira Shire is located within the catchments of the Murray, Goulburn and Ovens Rivers and Broken and Boosey Creeks, all of which have substantial floodplains. Ground slopes are generally low with the result that during large floods, a significant part of the Shire can be inundated by one or more of these watercourses.

The municipality is bound by the Murray to the north, the lower Ovens to the east and the lower Goulburn to the west. Broken Creek with its many tributary creeks, watercourses and drainage lines including Boosey Creek and the Muckatah Depression (situated between the Murray and Ovens Rivers and the Broken and Boosey Creeks), transects the municipality. The Broken Creek catchment covers a major portion of the shire.

Flooding within the municipality can affect as many as 23 communities and usually follows local heavy rainfall or a prolonged rainfall event such as occurred in October 1993 in the Broken River catchment and March 2012 in the Broken–Boosey catchments. The risk of flooding has been reduced at Cobram and Nathalia by structural flood mitigation works.

The Yarrawonga Weir (Lake Mulwala) on the Murray River at Yarrawonga is the only substantial Dam/Weir structure within the Moira municipality.

Riverine Flooding

Rainfall of 25mm or more across the Broken Creek catchment results in rises in the Nine Mile and lower Broken Creek as these are the main outfalls for the many drains within the catchment. General rain of 100mm or more is required to produce more substantial runoff. A wet catchment is required to produce flooding.

Large severe floods within the municipality generally occur as a result of either:

- Very heavy rainfall occurring when warm moist air from a decaying tropical cyclone from north west or northern Australia is dragged down and across north east Victoria (eg. March 2012); or
- Moderate to heavy rainfall after a prolonged period of general rainfall which can result from sequences of cold fronts during winter and spring.

In the former scenario, the rainfall is sufficiently heavy and prolonged to rapidly fill the natural floodplain storage and generate runoff.

In the latter scenario, the period of general rainfall “wets” the catchments and also partially fills the natural floodplain storage. This is particularly important in the Muckatah Depression and across the upper and middle reaches of the Broken and Boosey Creek system, as these areas provide substantial floodplain storage. These two effects combine to increase the runoff generated during the subsequent period of rainfall resulting in a large flood within one or more of the municipalities’ watercourses.

Major flooding in the Murray, Goulburn and Ovens Rivers is usually the result of heavy rainfall in their upper catchments, outside the municipality. Flooding in the Broken and Boosey Creek catchments tends to be caused by local heavy rainfall within the municipality and further upstream including across the Muckatah Depression and/or inter-catchment flows from the Broken River outside and to the south of the shire.

Water level rises within the municipalities’ watercourses tend to be quite slow, particularly in the lower reaches; this is a direct consequence of the low grades and generally flat nature of the floodplains.

Flash Flooding and Overland Flows

Short duration, high intensity rainfall (usually associated with severe thunderstorms or small scale weather systems that are locally intense and slow moving) can cause localised flooding along the creeks within the Municipality and within urban areas when the local drainage system surcharges. Such events, which are mainly confined to the summer months do not generally create widespread flooding since they only last for a short time and affect limited areas. Flooding from these storms occurs with little warning and localised damage can be severe.

High intensity rainfall associated with thunderstorms with average rainfall rates of typically more than 20 mm/hour for 2 hours or more, is likely to lead to high flows in the creeks as well as flash flooding and / or overland flows, particularly in the urbanised parts of the Municipality.

If drains become blocked or catchment exceeds the capacity of stormwater drains localised flooding and overland flows in urban areas can be observed. Under these circumstances the drain surcharges and excess water flows above ground. The location of such flooding is hard to predict other than in cases where a drain has a past history of surcharging. Council maintenance records may provide some guidance in such cases.

Overview of Catchments and Flood Behaviours

Broken Creek

The Broken Creek catchment slopes generally to the west-north-west with the Broken Creek joining the Murray River 12km upstream of the Barmah township, adjacent to the Barmah Forest and approx. 18km upstream of the Barmah Choke. It has an area of approximately 3,050km^2. Around 67% of the catchment (approximately 2,038km^2) is upstream of Numurkah. Boosey Creek and the upper sections of Broken Creek account for 1,311km^2, Major Creek 510km^2 and the Muckatah Depression 217km^2.

The Warby Ranges and hill extensions to the east define the eastern boundary of the catchment and the lower Dookie Hills lie alongside part of the southern boundary. Elsewhere the catchment boundaries are indistinct and ground slopes are typically quite flat. As a result, and under natural conditions, flood waters could transfer across catchment boundaries from the Murray River (to the north) and Broken River (to the south) and to and from the Goulburn River system (to the west). However, many of these overflow paths have been restricted or blocked by levees, irrigation channels or roads.

The upper part of the Broken Creek system comprises of Sandy Creek, Boosey Creek, Major Creek and Broken Creek upstream of Katandra Weir near Katamatite. Tungamah and Katamatite are the main towns within this system.

The middle reach extends from Katandra Weir to Walsh's Bridge, 5km downstream from the Broken Creek – Nine Mile Creek confluence and includes many tributary creeks and depressions[3]. The most significant of these are the Muckatah Depression and Guilfus, Congupna, Nine Mile and Pine Lodge creeks[4]. The lower reaches of many of these creeks and depressions have been modified and function as surface water drains (eg. Shepparton Drains 11 and 12). Wild Dog Creek and Box Creek near Numurkah are minor anabranches which also flood during major events. Numurkah and Wunghnu are the main towns.

Flows from the Muckatah Depression travel more slowly than the main creek flows and join with the Broken Creek to the east of Numurkah, via Kinnaird's wetlands. Levels at Naring (CFA station) provide an indication of timings. During a large regional event with significant rain across the

[3] There are a number of significant wetlands within the Municipality including Tungamah Swamp, Lake Rowan, Moodies Swamp, Muckatah Depression, Dowdles Swamp and Kinnaird's Swamp and the Barmah Forest.

[4] Receive water from the Dookie Hills.

Muckatah Depression (eg. at Yarrawonga), the water from the Muckatah Depression comes into the Broken Creek behind the main peak (Depression water gets held back) resulting in a very slow recession at Numurkah – but no second rise.

The Shepparton – Numurkah railway line acts as a levee. This along with the natural topography of the floodplain facilitates the transfer of water from Numurkah to the south towards Wunghnu where water can be still rising after the level has peaked at Numurkah. It should be noted that the railway line does act to raise water levels upstream in the near vicinity, but does not have any real impact on peak water levels in Numurkah township.

Note that flood waters that feed into the Guilfus, Congupna, Pine Lodge and Nine Mile creeks affect Tallygaroopna, Katunga and Congupna.

A natural sand ridge runs transversely across the floodplain in the vicinity of Walsh's Bridge downstream from the Broken–Nine Mile confluence and creates a natural restriction to floodplain flows. Downstream from Walsh's Bridge the creek assumes the course of an ancient route of the Goulburn River and is bordered by small natural levees which along with numerous public and private levees, roads and irrigation channels; confine the extent of inundation during moderate floods. Their influence on the extent of larger (major) floods is much less and the spread of flood waters is significant.

A formal system of levees protects the Nathalia township from flooding. During large floods, a significant breakout and flow path occurs from the creek on the east side of town from near the water treatment plant, threatening a number of houses outside the levee system and cutting the Murray Valley Highway. This is shown on the flood inundation maps for Nathalia.

Drain 13 joins the Broken Creek immediately downstream from Nathalia. During large flow events, the Creek backs up the Drain which carries drainage water from upstream. A newly installed spillway west of the Murray Valley Highway, causes a flow path to the north which quickly inundates a section of the Murray Valley Highway between Horner's Road and Peter Clay Road. Flows continue north to the Picola-Barmah Road (Picola-Katunga Road) inundating a large area by up to 500mm. Flows are picked up by a depression (No 11 Drain) and returned to the Broken Creek in a generally westerly direction to the south of the Picola township. This is shown on the flood inundation maps for Nathalia.

The east GMW channel No 12 is located along the ridge on the southern side (left back) of the Creek near Nathalia for a good distance downstream. The ridge and channel restrict the transfer of flows across the Barmah-Shepparton Road; there are a few low points along the road which can get wet.

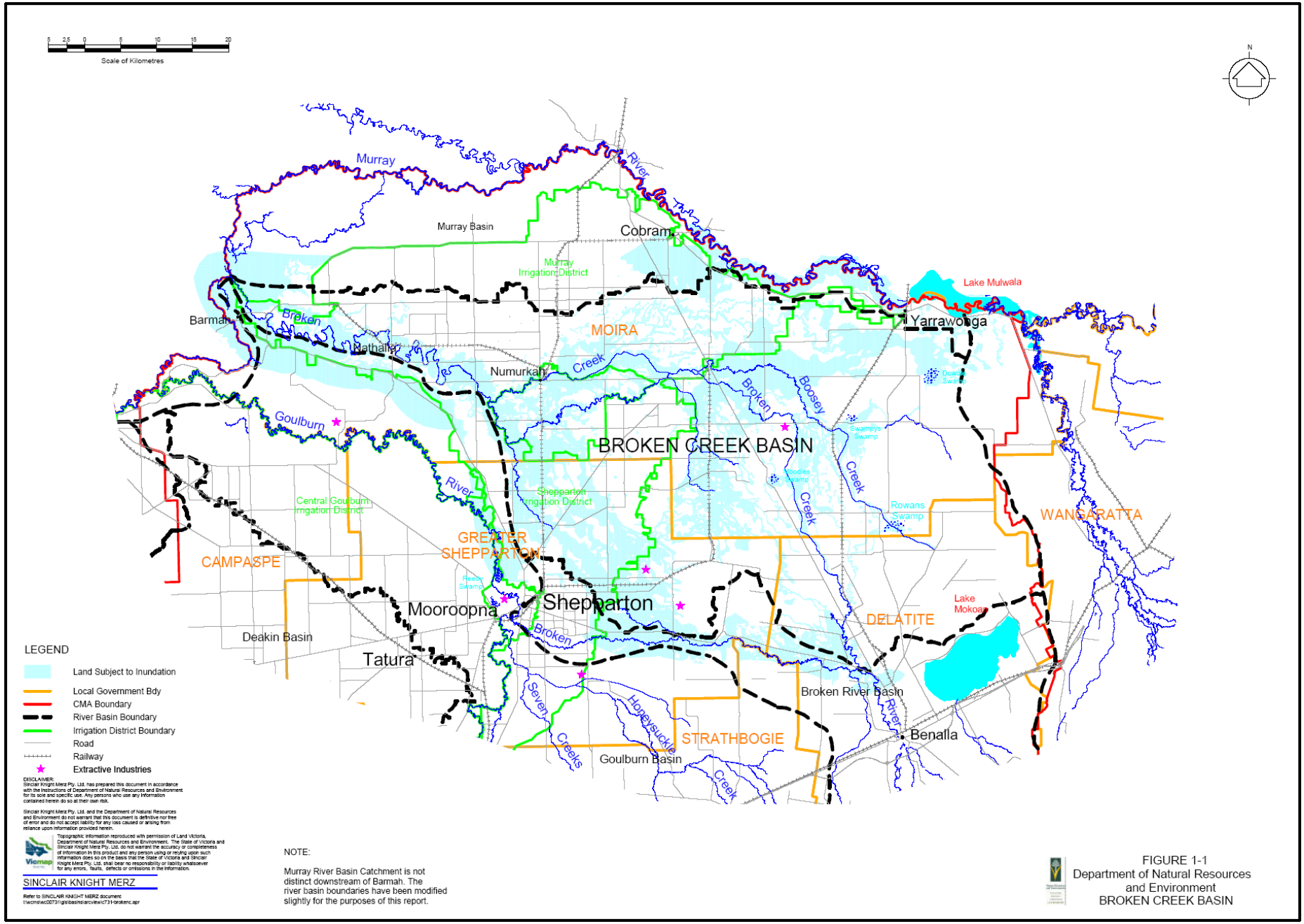
If Loch Garry is operating the Goulburn River flows will be present on the west (left hand) side of the Barmah-Shepparton Road and may flow across it.

During floods, water spreads out along the natural anabranches and effluent flow paths and fills large flood storage areas in the lower reaches. Natural high-level breakaways to the Goulburn River exist near Prentice Road and Nathalia and to Green Swamp and the Barmah Forest to the north.

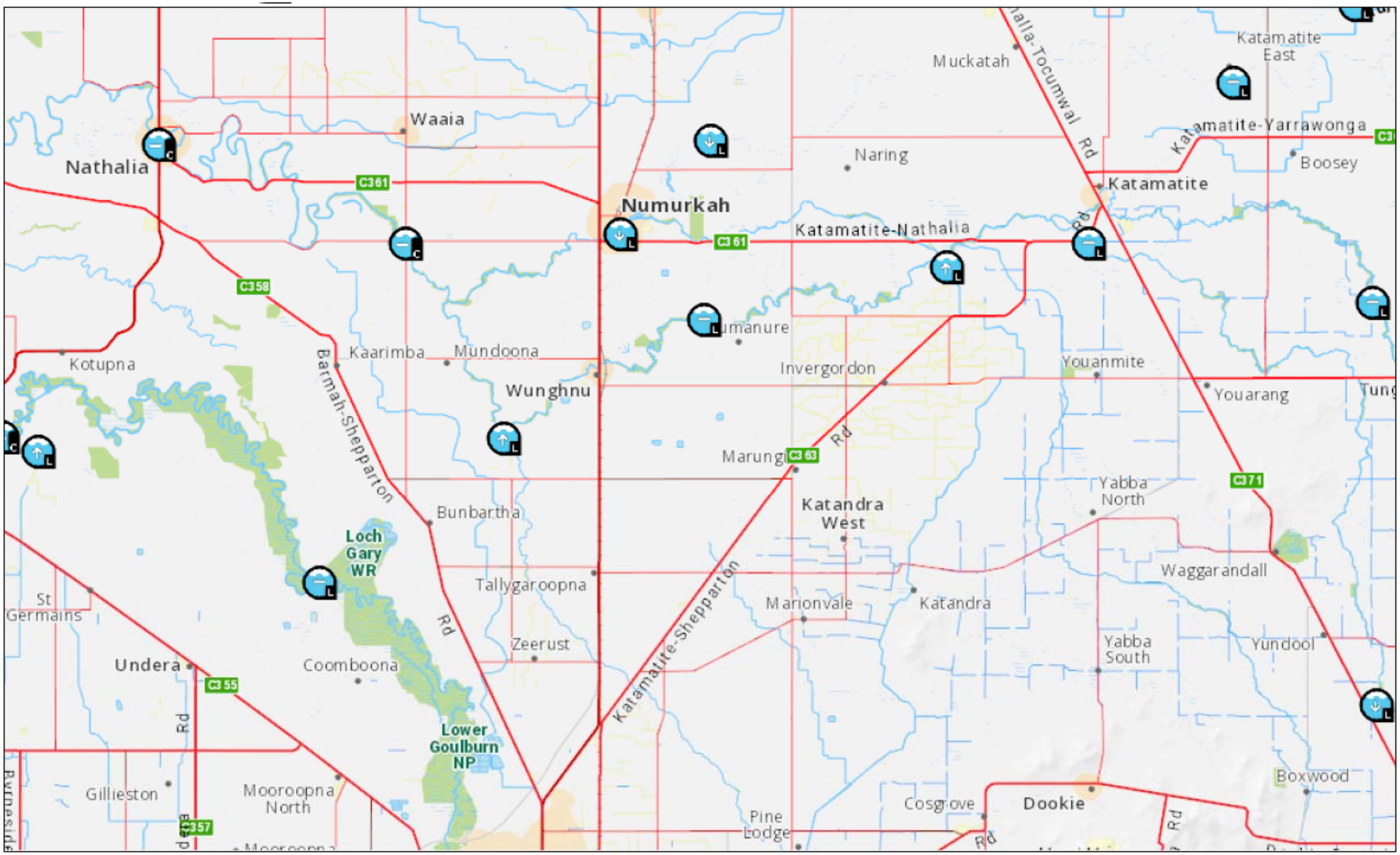
Nearer to Barmah, the creek is capacity constrained with very little slope; floodwaters move slowly. If the Murray River is not in flood, Barmah will not be threatened by flooding as breakouts occur to the north east downstream from Picola and into the Barham Forest.

During major floods (eg. 1974 and 1993 but not 2012), flows spill into the Broken Creek catchment from the Broken River near Casey's Weir and upstream of Gowangardie Weir, through minor watercourses such as Guilfus, Congupna, Danton's, Pine Lodge and O'Keefe creeks (note that the excavated, regulated diversion channel that connects to the top end of Broken Creek as part of the Casey's Weir/Major Creek water supply system is not a major connector) and move north across a broad area west of Gowangardie (see diagram in Section 2.3.1.1 in Appendix C). The channel capacity of these minor watercourses is not sufficient to accommodate flood flows and extensive

inundation of the surrounding land results. These creeks discharge into Nine Mile Creek and then into the Broken Creek between Numurkah and Walsh's Bridge.


Scale of Kilometres
Murray River
Murray Basin
Cobram
Murray Irrigation District
Lake Mulwala
Barmah
Broken Creek
Nathalia
MOIRA
Yarrawonga
Numurkah
Broken Creek
Boosey Creek
Goulburn
BROKEN CREEK BASIN
Swampys Swamp
Shepparton Irrigation District
Central Goulburn Irrigation District
Rowans Swamp
WANGARATTA
GREATER SHEPPARTON
CAMPASPE
Mooroopna
Shepparton
Lake Mokoan
DELATITE
Deakin Basin
Tatura
Broken River Basin
Seven Creeks
Honeysuckle Creek
STRATHBOGIE
Benalla
Goulburn Basin
LEGEND
Land Subject to Inundation
Local Government Bdy
CMA Boundary
River Basin Boundary
Irrigation District Boundary
Road
Railway
Extractive Industries
DISCLAIMER:
SINCLAIR KNIGHT MERZ
NOTE:
Murray River Basin Catchment is not distinct downstream of Barmah. The river basin boundaries have been modified slightly for the purposes of this report.
FIGURE 1-1
Department of Natural Resources and Environment
BROKEN CREEK BASIN

Live Water Height Gauges both NON FCL and with FCL



May 27, 2020

1:288,895

0 2.5 5 10 mi

0 4 8 16 km

Murray River

The contributing catchment for the Murray River to Yarrawonga is approximately 27,300km^2 and can be broken into three sub-catchments: the Upper Murray River (above Lake Hume), the Kiewa River and the Ovens River. Murray River flood flows within Moira Shire can arise from various contributions from these three sub-catchments.

Between the confluence of the Ovens and Murray Rivers to around 5km upstream of Cobram, the floodplain is relatively well defined by a series of sand hills. Downstream from Cobram however, the floodplain is much broader and unconfined. A system of levees on the Victorian side of the river, extending from just upstream of Cobram to Barmah protects rural areas from flooding. These levees as well as irrigation channels and drains, road and railway infrastructure influence flood behaviour in this area.

Once river channel capacity is exceeded, significant flow breaks out of the river across the section of floodplain adjacent to Dicks Levee (see figure below). Under natural conditions, these flows are likely to extend to the west and north-west affecting Yarroweyah and Strathmerton as well as the Murray Valley Highway. This area was flooded during the 1917 event. During the 1975 event, extensive sandbagging was required along Dicks Levee to prevent overflow. As part of subsequent flood mitigation works for Cobram, Dicks Levee was raised and reinforced.

The Barmah Choke is a natural obstruction just upstream from Barmah adjacent to where the Broken Creek joins the Murray River. This limits Murray River flood flows immediately downstream to around 35,000ML/d. The balance of flood waters is forced northwards into NSW along the Edwards River and its tributaries.

Between the Barmah Choke and Echuca, flood behaviour in the Murray is dominated by flooding from the Goulburn River. From around Tocumwal to Echuca, the floodplain is characterised by large areas of natural flood storage including the Barmah Forest.

Townships within Moira Shire at risk of flooding from the Murray include Barmah, Cobram, Koonoomoo, Yarroweyah and parts of Yarrawonga. Strathmerton flooded in 1917 but the development of irrigation infrastructure since then is now thought to protect the town.

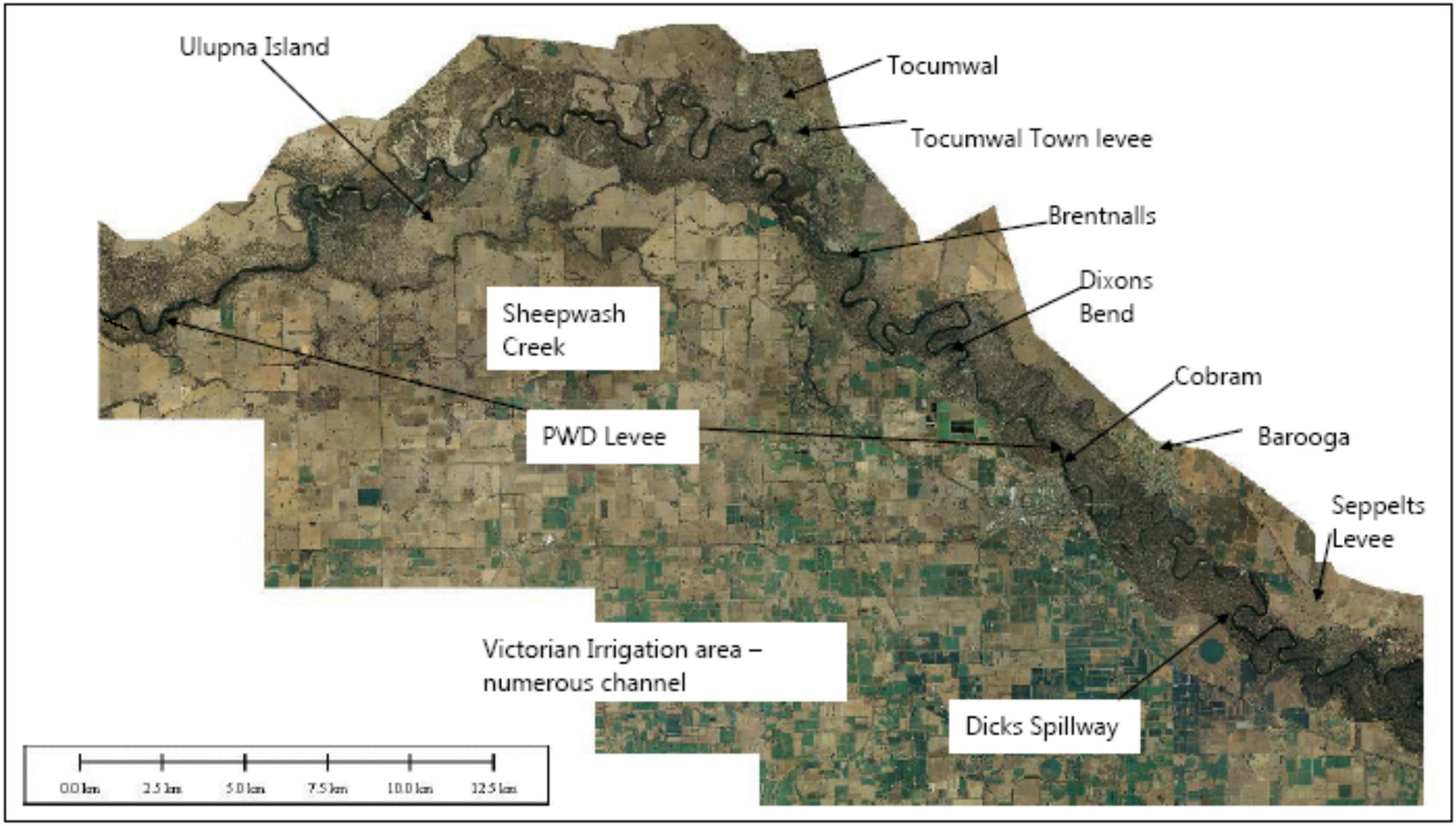
History suggests that flood events with similar peak flows but different flood volumes and durations can result in significantly different flood behaviour. Thus consideration of peak flow, flood volume and duration (ie. the shape of the hydrograph) is essential in determining flood behaviour and likely impacts.

Goulburn River

The Goulburn River rises upstream of Lake Eildon, flows through Seymour and Shepparton, enters the Shire near McCoy's Bridge and joins the Murray River about 15km upstream of Echuca. The majority of effluent flows from the Goulburn River spill northwards into Moira Shire, although breaching of levees during major flooding can cause inundation of the Goulburn River floodplain in the adjoining Campaspe Shire. The flood height and timing at which effluent flows begin and/or levees are breached (ie. into the Deep, Wakiti, Sheepwash and Skeleton Creeks), has a significant bearing on flood behaviour across the Goulburn River floodplain. **Note that any flooding above the September 2010 level (11.1m at Shepparton and 10.2m at McCoy's Bridge) is likely to breach some levees along the lower Goulburn River, probably on both the northern and southern side of the river.**

Ovens River

The Ovens and King Rivers rise on the northern slopes of the Great Dividing Range, join at Wangaratta and enter the Shire a little downstream from Wangaratta. The Ovens joins the Murray River at Bundalong at the upstream end of Lake Mulwala. Farm land, the Wangaratta–Yarrawonga Road and a number of minor roads are affected by large floods.


Ulupna Island
Tocumwal
Tocumwal Town levee
Brentnalls
Dixons Bend
Sheepwash Creek
PWD Levee
Cobram
Barooga
Seppelts Levee
Victorian Irrigation area – numerous channel
Dicks Spillway
0.0 km
2.5 km
5.0 km
7.5 km
10.0 km
12.5 km

Drainage Hot Spots within the Shire

The following areas have a high risk of flooding during heavy rain events.

As at July 2012				
Town Name	Streets	Spatial Vision's VICMap Book Reference	Catchment	Notes
Yarrawonga	Cahill's Road South Road Havenstock Drive Reilly's Road Leah Drive LaBamba Drive Zorro Drive Kathryn Crescent	8416 A14 8415 J14 224 K10 224 J10 8416 C9 8416 C9 8416 B10 8416 B9	Murray River	Refer to Moira Shire Operations Pump and Drainage booklet.
Numurkah	Tunnock Road Melville Street Rowe Street Newby Street Brennion Street Katamatite-Nathalia Road Knox Street Brooke Court Ashley Court Shaw Court Reed Court Harding Court	8371 F7 8371 E6 8371 F7 8371 F7 8371 D6 8371 E8 8371 E6 8371 J4 8371 J3 8371 E8 8371 D8 8371 E8	Broken – Boosey and Muckatah Depression	Refer to Moira Shire Operations Pump and Drainage booklet.
Nathalia	Lancaster Avenue Ryan's Road Cemetery road Ball Street	8370 J13 8370 J14 8370 H14 8370 J13	Broken - Boosey	Refer to Moira Shire Operations Pump and Drainage booklet.
Wunghnu	Carlisle Street Taylor Street Welch Street Walter Street	8412 D3 8412 C3 8412 D3 8412 D3	Broken - Boosey	Refer to Moira Shire Operations Pump and Drainage booklet.
Cobram	Catona Crescent High Street Sledmere Avenue Broadway Street	8325 D11 8325 E8 8325 G8 8325 E7	Murray River	Refer to Moira Shire Operations Pump and Drainage booklet.
Tungamah	Middleton Street Barr Street	8397 H5 8397 H6	Broken - Boosey	Refer to Moira Shire Operations Pump and Drainage booklet.

Overview of Levees within the Shire

The Cobram and Nathalia levees and associated stormwater drainage systems that are managed and routinely maintained by Council were extended to their current level plus freeboard as part of formal Flood Mitigation Schemes[5].

Nathalia

The levee at Nathalia was extended in 2010 and now provides protection from the 1% AEP flood plus freeboard which varies between 450mm and 600mm. The levee is mostly earthen although road openings and the foreshore area need to be completed ahead of an approaching flood using a system of demountable aluminium panels. A section of the levee also needs to be completed at Draper Street using sandbags (see Appendix C). GMW's No 12 channel acts as a levee on the south side of town.

Cobram

The Cobram town levee was raised and strengthened in 2000/2001 and now provides protection for Cobram from the 1% AEP flood with freeboard which varies from 250mm to more than 600mm.

Key elements of the Cobram town levee scheme include:

- Dick's spillway: This spillway allows flooding to breakout to a natural lower lying floodplain. The breakout reduces the flow in the river and in turn the flood levels along the river through Cobram. The spillway has been reinforced to withstand overtopping, with a non-erodible top layer.
- Levee adjacent to Wyatt Road (Cavagna's Levee): A short section (300m) of earthen levee prevents breakout towards Pullar Road.
- River Road: Elevated allotments act as a levee to the north and east of Scenic Drive. A concrete wall (Densons Levee), landscaped as the front property fence, provides flood protection between Scenic Drive and Mookarii Street. Temporary flood barriers are required across Mookarii Street.
- Town Levee: This levee extends from Mookarii Street to near Harris Road and adjoins the PWD levee.

Murray River – Victorian side

Overview

A system of levees on the Victorian side of the Murray River (known as the Public Works Department "PWD" levee) extends from just downstream of the Cobram town levee to Barmah and protects rural areas from flooding. The level of protection provided by the PWD levee varies considerably along its length. Under 100 year ARI flood conditions, some sections have a freeboard greater than 300mm, while other sections are overtopped by less than 300mm.

The levees from Yielima to Barmah are designated private levees.

Construction of the PWD levees commenced in 1895 and was completed in 1910. They were breached and re-instated following major events in 1916, 1917, 1956 and 1975. During the 1975 flood, major levee breaches occurred at Brentnalls Beach, Cleaves Beach and Dixons Bend. Failures have also occurred at numerous locations around Ulupna Island. In recent times, the GBCMA has strengthened the PWD levees at a number of locations that were identified as major priorities from a levee audit in 1996. This included those locations of major levee breaches that occurred in the 1975 flood and an 8km length of levee from the Cobram town levee to Greens Lane at Koonoomoo.

[5] Operations and Maintenance Manuals were prepared for the Cobram and Nathalia levees and outline appropriate triggers. for closing gate valves, for erecting the demountable sections of the levee at Nathalia, for erecting temporary barriers within the levee at Cobram and for operating and maintaining stormwater pumps, amongst other things. Copies of the manuals are available from Moira Shire.

Cobram to Cleave's

Major strengthening of the PWD levee has been undertaken at Dixons Bend and Cleaves Beach by the GBCMA since 2000. At Cleaves Beach, the PWD levee abuts a natural sand hill.

Cleaves Beach to Ulupna Creek confluence

The PWD levee abuts a natural sand hill adjacent to Torgannah Road, with Cleaves Beach located to the east and Brentnalls Beach to the west. A number of effluent streams once exited the main river channel near Brentnalls Beach. These effluent streams have been in-filled with sand. The presence of sand provides a preferential flow path under the levee and reduces the levee's integrity. Major strengthening of the PWD levee has been undertaken at Brentnalls Beach by the GBCMA since 2000.

Ulupna Island

A 14km levee around Ulupna Island provides protection against flood events up to and including the 10 year ARI event (193,000 ML/d at Yarrawonga). Generally, this level of protection is lower than provided by the PWD levees. The levee was overtopped in the 1974 and 1975 events but not in the 1993 flood (183,000 ML/d Yarrawonga).

Murray River – NSW side

Adjacent to Dick's Levee, a natural low floodplain occurs on the New South Wales side at Seppelt's Levee. This levee marks the upstream end of the Barooga Cowal Depression. The depression flows generally parallel to the Murray River. Effluent flows in the depression can give rise to flooding in Barooga and Tocumwal.

The Barooga levee between Barooga and Tocumwal provides protection to both rural areas and to Tocumwal, this is a substantial levee and is up to 4 m in height.

The Tocumwal town levee consists of several levee segments extending downstream from the golf course to the river crossing. The levee was designed to protect the town from a 100 year ARI flood with a 600mm freeboard.

Downstream of Tocumwal on the NSW side of the river, two significant effluent flow paths leave the Murray River: Tuppal and Bullatale Creek. Both flow to the Edwards River. Extensive private and public levees that influence the distribution of overbank flows have been constructed in this area.

Goulburn River

Levees have been constructed adjacent to the lower Goulburn River. These levees are not constructed to the 1% AEP standard and are generally neither well-constructed nor well maintained: their structural integrity and the protection provided are unknown. They were constructed as part of Government sponsored employment schemes following the depression of the 1890s and have no identifiable owner. Flooding above the September 2010 level (11.1m at Shepparton and 10.2m at McCoy's Bridge) is likely to breach some of these levees along both sides of the lower Goulburn River.

Irrigation, road and railway infrastructure as well as the many channels and related irrigation infrastructure act as levees and influence flood behaviour within the shire. The Shepparton–Tocumwal railway line is an example. It runs perpendicular to the direction of flow (ie. across the flow), which creates a head of up to 500mm and encourages water towards Wunghnu.

Broken Creek

A small levee runs along the northern bank of Broken Creek at Numurkah. This levee was complimented in the March 2012 event with significant temporary works, including levees, sandbags, blockage of some pits, etc. An irrigation channel bank along Kinnairds Road provides protection to the town.

There are also a significant number of private levees within the shire, particularly within the Broken Creek catchment. Some are mapped in the VFD. Their influence is difficult to determine but is

considered to be minimal during large floods.

Infrastructure

Overview

The network of roads, irrigation channels, railway lines and levees that cross the municipality intersect many of the natural flow paths. The many levees, weirs and bridges lead to confinement of flow, reduction in natural flood storage, raised flood levels and increased flood velocities. All have some impact on flood extents and the period of inundation.

A dominant feature in the region is the East Goulburn Main Channel. Flood flows are obstructed by the channel resulting in ponding and some flow re-distribution although syphons do allow the passage of small to medium flood flows.

In addition to Lake Mulwala, there are eight weirs on Broken Creek between Nathalia and the Murray River. The highest of these is Rices Weir (2m high) which is located at the most downstream point of the Creek on the edge of the Barmah Forest near the Murray River. The weir controls dominate flow and water levels for minor to moderate floods. These weirs have no significant effect during major floods, however creek levels at the weirs can be affected by backwater from the Murray River when it is high.

Major Roads

The following is a list of major roads that may be inundated in a flood dependant on the magnitude of the flood. Note that many minor roads will also be inundated.

- Murray Valley Highway – at Nathalia and to the east of town.
- Murray Valley Highway to the east of Nathalia through Strathmerton and Yarroweyah although the location and depth of flooding will depend on whether it is a Broken Creek or Murray River flood.
- Murray Valley Highway between Cobram and Yarrawonga
- Goulburn Valley Highway north of Shepparton to Numurkah
- Goulburn Valley Highway north through Koonoomoo to Tocumwal although the location and depth of flooding will depend on whether it is a Broken Creek or Murray River flood.
- Cobram–Koonoomoo Road
- Mywee-Bearii Road
- Mywee–Koonoomoo Road
- Most of the roads to the north of the Murray Valley Highway will inundated to a depth of 1m or more in the event of a large Murray River flood.
- Shepparton–Barmah Road/Nathalia–Barmah Road
- Picola-Barmah Road
- Katamatite-Nathalia Road, between Nathalia and Numurkah and between Numurkah and Katamatite
- Most of the roads that cross the Muckatah Depression
- Most of the roads that are adjacent to the Broken and Boosey creeks that cross the floodplain upstream of Numurkah are likely to be flooded and for some distance to a depth of 500mm or so.

Other infrastructure

The railway line from Shepparton to Strathmerton and then to Tocumwal is likely to be compromised during large Broken Creek floods (between Wunghnu and Numurkah) and in Murray River floods from south of Strathmerton to the river. This railway line was seriously damaged during the March 2012 event with numerous blowouts observed between Wunghnu and Numurkah.

Mobile network telephone towers are primarily located on high ground and appear to be unaffected by flooding.

Water treatment plants are either protected from flooding (eg. at Nathalia, Numurkah and Cobram) or above flood level (eg. Tungamah).

Wastewater treatment plants are either located out of the floodplain or protected by levees to 1% AEP level plus freeboard.

A number of **electrical power kiosk/zone sub-stations (cabinets)** are in areas affected by flooding. The electrical distribution companies all have sub-stations flagged.

Historic Floods

Across the Municipality

Significant floods have occurred within the Municipality as follows:

Murray River	Goulburn River	Ovens River	Broken Creek
1867			
1870	1870		
September 1916	September 1916		
1917		1917	1917
1931			
			1939
1956	1956		
May 1974	May 1974	May 1974	May 1974
October / November 1975			
July 1981	July 1981		
	September 1983		
October 1993	October 1993	October 1993	October 1993
			July 1995
January 2011			
	March 2012		March 2012

Murray River

Murray River – peak flood levels (m) and flows (in ML/d)					
Month / Year	Yarrawonga	Cobram	Tocumwal		
1917	390,000				
1931	210,000				
1955	181,000				
1956	204,000				
1958	157,000				
1970	184,000				
1973	142,000				
1974	196,000	193,000	193,000		
1975	234,000	248,000	248,000		
1993	183,000	205,000	205,000		

Broken Creek – peak flood levels

The May 1974, October 1993 and March 2012 floods are the three largest floods in the Broken Creek system in recent times. Based on anecdotal and media reports, a flood in 1917 is believed to have been comparable in size to the 1974 event. The May 1974 and October 1993 events resulted from local runoff and substantial overflows from the Broken River into the Broken Creek system. The March 2012 event was caused solely by heavy rain and runoff in the Broken Creek catchment without any contribution (overflow) from the Broken River.

Broken Creek – peak flood levels					
Month / Year	Tungamah	Katamatite	Numurkah	Walsh's Bridge	Nathalia
May 1974	2.60m 122.561mAHD	2.81m 115.674mAHD		3.25m 104.32mAHD	2.89m 101.89mAHD
October 1993	2.73m 122.691mAHD	2.74m 115.604mAHD	107.67mAHD at Melville St	3.50m 104.455mAHD	3.09m 102.095mAHD
July 1995	2.31m 122.27mAHD	2.36m 115.22AHD		3.13m 104.085mAHD	2.63m 101.635mAHD
September 2010				1.61m 102.565mAHD	0.98m 99.955mAHD
March 2012	2.88m 122.841mAHD	3.10m 115.964mAHD	107.96mAHD at Melville St 107.591mAHD at rail bridge 107.58mAHD at GV Highway	3.57m 104.525mAHD	3.26m 102.265mAHD

November 1870 flood
The largest flood along the Murray River since European settlement occurred in 1870. A large flood also occurred along the Goulburn River: approximately 2% AEP event at Shepparton. At Echuca the gauge reached 96.20mAHD which is about 0.6m higher than the 1% AEP flood level (95.63mAHD at Echuca Wharf).

September 1916 flood
The 1916 flood is the highest recorded along the Goulburn River (about a 1% AEP event at Shepparton) while it was a significant event along the Murray River (3-5% AEP at Echuca). It is likely that the levee system would have been overtopped on both sides of the Goulburn River upstream of McCoy's Bridge. It was also a significant event along Broken Creek with levels estimated to be similar to those experienced in March 2012.

1917 flood
The 1916 event was followed in 1917 by another large flood (4% AEP at Echuca and Shepparton). Although details are not available, this flood on the Murray River at Albury, Corowa and Yarrawonga was among this areas highest known. Murray River floodwater spread into the Broken Creek system. This would be unlikely to occur today with the works completed for the Murray Valley Irrigation area.

August 1956 flood
This event was the fourth largest along the Murray River at Echuca since 1870 (4% AEP) and about the seventh largest along the Goulburn River (5% AEP at Shepparton).

May 1974 flood
Widespread flooding occurred in May and October 1974. This flood was more significant along the Murray River (~6% AEP at Echuca), Goulburn River (1.5% AEP at Shepparton) with numerous levee breaches occurring along the lower Goulburn.

In May 1974 event, heavy rain fell across the Muckatah Depression, the Boosey, Broken, Nine Mile, Wild Dog and Box Creeks. The Broken, Nine Mile and Box Creeks all merged and flooding lasted nearly two months. Overflows from the Broken River contributed to Broken Creek flows. Wild Dog and Box Creeks significantly added to flooding upstream of Numurkah. Parts of the commercial and residential areas in Numurkah flooded. Major sandbagging efforts by locals saved the town from more damage.

October / November 1975 flood
The 1975 flood peaked at Yarrawonga at approximately 234,000 ML/d (~17 year ARI). Significant levee failures occurred at Brentnalls Beach, Cleaves Beach and Dixons Bend which resulted in considerable flow across the Victorian floodplain. At Echuca, this flood was the third largest since 1870 (~3% AEP).

July 1981 flood
This was a major but less severe flood along the Goulburn River (12% AEP at Shepparton) and Murray River.

September and October 1993 floods
In September 1993 a major flood substantially reduced flood storage along the lower reaches of the Goulburn River floodplain. Consequently, a larger flood in October 1993 along the Goulburn (3% AEP at Shepparton) and Murray Rivers (~4% AEP at Echuca) produced a peak a little higher than the 1916 event. Levees on both sides of the Goulburn River breached at numerous locations between Loch Garry and McCoy's Bridge.

More rain fell in the upper Broken Creek catchment than over the Boosey Creek catchment during October. Significant flooding occurring in the Broken Creek system with overflows from the Broken River.

The October 1993 flood peak at Yarrawonga was approximately 183,000 ML/d (~9 year ARI). The flood was contained between the Cobram/PWD levee and the Barooga/Tocumwal levee in New South Wales. No overflow occurred at Dick's levee.

January 2011 flood

This flood followed an extended wet weather period with major flooding along the lower Goulburn River in September 2010 and moderate flooding in December. While minor flood flows occurred along the lower Goulburn and higher than normal flows (but less than minor flood flow) were experienced in the Murray River and in the Broken Creek, it was catchments to the west of Shepparton that experienced major flooding.

March 2012

Minor flooding occurred in the Goulburn River downstream from Shepparton while severe major flooding (indicative of a 1% AEP event) occurred across the Broken Creek catchment. The flooding was the result of a period of very heavy rain from a warm moist airflow from a decaying tropical cyclone that originated over north-west Australia and persisted from 27 February to 4 March. Many rainfall records were broken. More rain fell in the Boosey Creek catchment than in the upper Broken Creek catchment. The initial burst of rain "wetted up" the catchment and initiated flooding. During the second burst of rainfall, significant flows originated in the upper Broken and Boosey creek catchments and in the Muckatah Depression. Record flooding resulted at Tungamah (23,300ML/d), Katamatite (12,000ML/d), Numurkah (est 27,500ML/d) and Nathalia as well as at Wunghnu, Katunga and St James. Many houses were flooded over-floor and large areas of farm land were inundated for an extended period. In Numurkah, more than 90 buildings were damaged above floor level, including the hospital and other community facilities. The Shepparton - Numurkah Railway line was badly damaged. 130 local roads were damaged and closed including the Goulburn Valley Highway, Katamatite Road and Numurkah - Nathalia Road. Many properties were isolated. Some local flooding occurred at Yarrawonga and Cobram, a result in some instances of flash flooding.

Dam Failure

Major Dams

Yarrawonga Weir (Lake Mulwala) is the only major dam within Moira Shire. Failure would not cause any flooding concern to the community. The weir is operated by GMW. Formal plans and procedures that cover the full range of credible potential failures are maintained by GMW.

There are a number of significant reservoirs upstream of the municipality. These are:

- Dartmouth Dam on the Mitta Mitta River,
- Hume Dam on the Murray River upstream of Albury-Wodonga,
- Lake Buffalo on the Buffalo River near Myrtleford,
- Lake William Hovell in the upper parts of the King River,
- Loombah and McCallsey Reservoirs on Ryan's Creek upstream of Benalla,
- Lake Eildon at Eildon,
- Goulburn Weir near Nagambie on the Goulburn River, and
- Storages associated with hydro-power generation in the upper reaches of the Kiewa River.

Only a failure at either Dartmouth and/or Hume is considered to have the potential to cause significant structural and community damage within Moira Shire. Both these storages are operated by GMW. Formal plans and procedures that cover the full range of credible potential failures are maintained by GMW.

While DEPI is the Control Agency for all dam safety incidents, VICSES is the Control Agency for any flooding that may result.

Retardation Basins

Moira Shire has several retardation basins to assist in large rain events. The basins are located in the larger towns and are located:

Cobram

- Catona Crescent
- Campbell Road
- Apex Reserve, Campbell Road
- Schubert Street/Karook Street
- Gemmill Street
- Wondah Street
- Bisogni Drive

Numurkah

- Numurkah Lake
- Goulburn Valley Highway
- Patterson Street
- Rowe Street
- Station Street

Yarrawonga

- Weston Close
- Hazelle Court
- Madden Drive/Shannon Court
- Parsons Road
- Woods Road
- Lakeview Circuit
- Freddy Court
- Adoni Green

Nathalia

- Park Street
- Gifford/Manifold Street

Wunghnu

- Taylor Street/Woodhouse Street

Flood Inundation Mapping

Murray River

Flood inundation maps have been produced by Water Technology (November 2011) for the Murray River from Dicks/Seppelt's levees to downstream of the Ulupna Creek confluence for the 10, 20, 50, 100, 200 and 500 year ARI flood events. The mapping covers a number of scenarios as follows:

- Levee overtopping without failure (no levee failure)
- Victorian levee failure
- NSW levee failure
- Victorian irrigation channel removal

A subset of these maps is included in this MFEP at Appendix F.

Broken Creek

Water Technology delivered flood inundation maps for the Broken Creek at Nathalia and the surrounding floodplain in 2012 for the 5, 10, 20, 50, 100 and 500 year ARI flood events. A subset of those maps is included in this MFEP at Appendix F.

In 2014, Water Technology also delivered flood inundation maps for the Broken Creek at Numurkah and the surrounding floodplain upstream to near the confluence of the Nine Mile Creek and downstream to Nathalia for the 5, 10, 20, 50, 100, 200 and 500 year ARI flood events. A subset of those maps is included in this MFEP at Appendix F.

Planning Scheme

For areas of the municipality not covered in detailed flood maps, the Moira Planning Scheme shows areas along the watercourses within the municipality likely to be inundated by a 1% AEP (100-year ARI) flood event as LSIO. While it is not practical to reproduce the LSIO as an attachment to this Plan, hard copies are available from Moira Shire. The planning scheme maps are also available in hard copy form and as PDF digital copies at the Moira Shire MECC and in digital form at the AGVIC website www.dpcd.vic.gov.au/planningschemes.

At Nathalia, Cobram and Koonoomoo, the Planning Scheme refers to designated 1% AEP flood levels. These are the 1% AEP flood levels across land designated as subject to inundation within the Planning Scheme.

Flood Data Transfer Project Mapping

Coarse flood extent maps were also developed for the whole of the Moira municipality in 2000 as part of a state-wide Flood Data Transfer Project (FDTP) (DNRE, 2000). Although this flood extent mapping has a low level of accuracy, the maps can be a useful guide to highlight areas subject to flooding where detailed mapping is not yet available. The associated reports provide guidance on likely accuracies and associated confidence in delineations.

Floor Level Information

Flood studies have been completed for Cobram, Nathalia, Numurkah and the Murray River from Dicks/Seppelt's levees to downstream of the Ulupna Creek confluence. All studies conducted delivered a series of flood inundation and extent maps for a range of different sized flood events (see Appendix F). The study for Nathalia delivered a list of properties likely to experience below and above-floor inundation for a series of design flood events. This information is included in Appendix C. It should be noted that additional properties to those listed may also be flooded depending on the severity of the event.

Digital Flood Extent Datasets and Aerial Flood Photography

The Victorian Flood Data (VFD) datasets (available from GBCMA) contain a significant quantity of flood information in GIS format. For example:

- Historic flood levels for a range of events as listed in the table below;
- Historic flood extents taken from aerial photography as listed in the table below; and
- 1% AEP flood extents for the Murray and Goulburn Rivers and for the Broken Creek at Nathalia.

The original aerial flood photography mentioned above is also available from the GBCMA (see table below).

Information	Area	Events
Statistical & Historic Flood Levels	Moira Shire Council Broken / Boosey creeks	1956, 1974, 1993, 2012
Flood Photography		1974, 1992, October 1993, March 2012
Statistical & Historic Flood Levels	Moira Shire Council Goulburn River	1956, 1974, 1993
Flood Photography		1956, May 1974, October 1993
Statistical & Historic Flood Levels	Moira Shire Council Murray River	1974, 1975, 1993
Flood Photography		1973, May 1974, November 1975, October 1992, October 1993
Statistical & Historic Flood Levels	Moira Shire Council Ovens River	1974, 1993
Flood Photography		1974, 1993

Notes:
1. Line scans and other datasets are available for the 2011 and 2012 flood events.
2. A selection of still photographs of the March 2012 flood event is available from GBCMA.

Flood inundation maps for the Murray River and the Numurkah and Nathalia areas are available digitally through the VFD and in hard copy form from Moira Shire and GBCMA.

Flood Intelligence Cards – see Appendix C

All flood intelligence records are approximations. This is because no two floods at a location, even if they peak at the same height will have identical impacts. Flood intelligence cards detail the relationship between flood magnitude and flood consequences. More details about flood intelligence and its use can be found in the Australian Emergency Management Manuals flood series.

APPENDIX B - TYPICAL FLOOD RISE, RECESSION AND PEAK TRAVEL TIMES

Parts of Moira Shire are subject to flash flooding as a result of stormwater being unable to drain through the underground drainage system following heavy rainfall. Definitive information on the time it takes flash flooding to develop (ie. arrive at a location) following the start of heavy rain and the time it takes for the maximum water depth/extent to be reached is not available. **Timing is however likely to be short: approx. 30 minutes or so**.

In the case of riverine flooding, the time of travel of a flood peak will be influenced by antecedent conditions. A flood on a 'dry' watercourse will generally travel slower than a flood on a 'wet' watercourse (eg. the first flood after a dry period will travel slower than the second flood in a series of floods) and big floods tend to travel faster than small floods. Hence, the size of the flood, recent flood history, soil moisture and forecast weather conditions all need to be considered when using the following information to direct flood response activities.

Floods in the Broken Creek system travel slowly – the rate of rise is slow, peaks are long and flat and the rate of fall is around 3 to 5 times the rate of rise (see below).

The rate of rise for big floods in the Murray River is generally around 50 to 100 mm per hour with the peak travelling at up to ~1 km/h. Smaller floods will rise somewhat more slowly and travel at about half this rate (ie. around 0.5 km/h). Recessions are generally slower with the rate of fall around 2 times the rate of rise.

Note that Murray River flooding only occurs if there is flooding in tributary streams and / or very high flows through Lake Hume. Big floods generally only occur if there is major flooding on a number of the tributary streams. Flood peaks travel relatively slowly. Travel times reduce quite markedly for large floods.

Location From	Location To	Typical Travel Time	Comments
RIVERINE FLOODNG – Murray River			
Hume	Yarrawonga	3 -4 days	
Corowa	Yarrawonga	1 – 1.5 day	
Yarrawonga	Cobram	~17 – 24 hours	A dry floodplain may extend travel time while it may be shorter for a flood following an earlier recent flood that filled floodplain storage.
Tocumwal	Barmah	5 – 7 days	Bigger floods may come through as quickly as 3 days
Yarrawonga	Echuca	4 to 6 days	Larger floods Inundation can remain for 30 days or more
		~ 12 days	Smaller floods

Location From	Location To	Typical Travel Time	Comments
RIVERINE FLOODNG – Ovens River			
Wangaratta	Yarrawonga	~2 days - first flood and with flows up to about 60,000ML/d ~1.5 days - 60,000ML/d to 120,000ML/d ~1 day - >150,000ML/d	Yarrawonga Weir is usually operated to FSL which means that flood flows are passed Through the storage (what comes in goes out). It has limited capacity but does assist in reducing flood peaks.
RIVERINE FLOODNG – Goulburn River			
Shepparton	McCoy's Bridge	~24 hours	
	Echuca Wharf	> 4.5 days	
RIVERINE FLOODNG – Broken Creek			
Floods are characterised by long flat peaks and slow recessions although the rise can be quite sharp, particularly at Numurkah and upstream. The further down the catchment the longer the peak and the slower the recession.			
Start of rainfall (upper catchment)	Tungamah	24 hours	Begin to rise from normal levels on a dry catchment
		9 to 12 hours	Begin to rise from normal levels on a wet catchment
Start of rainfall (upper catchment	Katamatite	24 hours	Begin to rise from normal levels on a dry catchment
		10 to 15 hours	Begin to rise from normal levels on a wet catchment
Start of rainfall (upper catchment)	Tungamah	4 days	To peak with major flooding
From beginning of upstream flooding	To beginning of flooding at Numurkah	24 hours or so	Beginning of flooding.
From Tungamah	To Katamatite	24 to 30 hours	Peak to peak with major flooding. Recession at Tungamah is approx. 3 times rate of rise.
From Katamatite	To Numurkah	36 to 40 hours	
From Dip Bridge		5 days	Peak to peak with major flooding. Recession at Katamatite is approx. 3 times rate of rise.

Location From	Location To	Typical Travel Time	Comments
Box Creek		2 days	Time from when Box Creek breaks out to the south over the Katamatite Road near Gordon Road
Naring		~20 hours	Based on March 2012 event. May be two peaks with second a little (300mm?) higher than the first.
Numurkah	Walsh's Bridge	65 to 75 hours	Peak to peak with major flooding
Walsh's Bridge	Nathalia	40 to 48 hours	Peak to peak with major flooding. For moderate flooding and above. Subsequent rises tend to travel faster than the first rise. Recession at Walsh's Bridge is approx. four times the rate of rise probably due to the effect of the railway line at Numurkah and flows from Pine Lodge and other creeks.
Nathalia	Rices Weir/Barmah	4 to 5 days	Peak to peak with major flooding. Recession at Nathalia is between 3.5 to 4.5 times rate of rise. Slower rate applying for lower gauge levels.

October 1993 event timeline

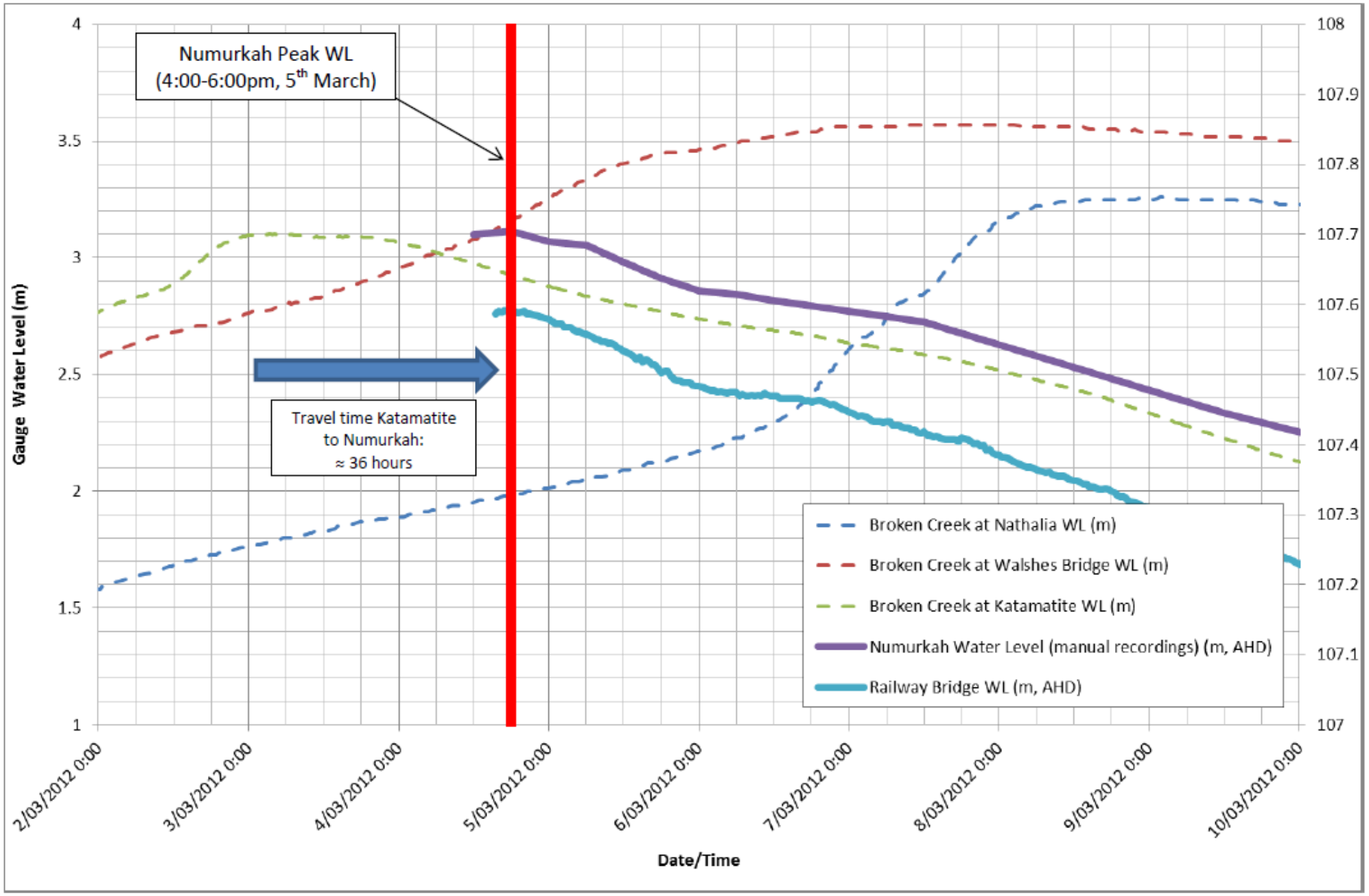
Location	Peak Level / Flow	Time and Date
Tungamah	15,300 ML/d	4 am 6 October 1993
Katamatite	8,751 ML/d	10.25pm 7 October 1993
Congupna Creek at Shepparton – Katamatite Road	2,971 ML/d	3.40am-9.40am 7 October 1993
Pine Lodge Creek at Shepparton – Katamatite Road	8,751 ML/d	3.40am-9.40am 7 October 1993
Walshs Bridge	3.50m (104.45mAHD): 10,100 ML/d	12 October 1993
Nathalia	3.09m (102.09mAHD): 9,740 ML/d	15 October 1993

March 2012 event timeline

The following timeline (table and chart) was constructed using anecdotal reports, temporary gauge records, photos and videos. A couple of points to note:

- Travel time of the flood peak from Katamatite to Numurkah was approximately 36 hours.
- During the event, levels immediately upstream of the railway bridge were recorded by a temporary gauge installed by professional surveyors. The gauge was installed at approximately 3pm on 4th March 2012 just prior to the peak of the event. Manually recorded levels recorded by a local resident, located on the Katamatite-Nathalia Road near the lower end of the hospital depression, show very similar behaviour in terms of timing of the peak and the slow rate of recession. While both records don't commence until the Sunday afternoon the timings of the recorded flood peak are consistent with anecdotal reports.
- The gauge record shows that after the peak of the event water levels at the railway bridge slowly receded at a steady rate of approximately 3.5 mm/h for 24 hours. The rate then slowed for another 24 hour period before increasing again.
- Given that the exact time of the railway blowout is unknown, it is difficult to ascertain the impact it had on upstream water levels. However, given the relatively steady and slow recession rate of flood levels, it seems unlikely to have had a large impact. The hydrograph is very flat in shape with the peak flood level occurring over several hours and then levels gradually receding. There is no evidence of a rapid drop in levels at either of the water level records.

Time	Date	Event
3:15am-5:30am	Saturday 3rd March 2012	Peak at Katamatite Gauge
8:00pm-8:00am: (varies depending on location)	Saturday 3rd/Sunday 4th March 2012	Broken Creek breaks it's banks in Numurkah
6:00am	Sunday 4th March 2012	Floodwaters entered the Numurkah Hospital
4:00-6:00pm	Sunday 4th March 2012	Peak at Numurkah (107.591m AHD at railway bridge)
Evening: (exact time unknown)	Sunday 4th March 2012	Blow-out at railway bridge
Midnight (12:00am)	Monday 5th March 2012	Levels have dropped by 12mm (107.579m AHD at railway bridge)
8:00am	Monday 5th March 2012	Levels have dropped by 42mm (107.549, AHD at railway bridge)
8:00pm	Monday 5th March 2012	Levels have dropped by 97mm (107.494m AHD at railway bridge)
8:30am-12:00pm	Wednesday 7th March 2012	Peak at Walsh's Bridge gauge
10:45pm-3:45am	Thursday 8th/Friday 9th March 2012	Peak at Nathalia


Numurkah Peak WL
(4:00-6:00pm, 5th March)
Travel time Katamatite
to Numurkah:
≈ 36 hours
Gauge Water Level (m)
Date/Time
4
3.5
3
2.5
2
1.5
1
108
107.9
107.8
107.7
107.6
107.5
107.4
107.3
107.2
107.1
107
2/03/2012 0:00
3/03/2012 0:00
4/03/2012 0:00
5/03/2012 0:00
6/03/2012 0:00
7/03/2012 0:00
8/03/2012 0:00
9/03/2012 0:00
10/03/2012 0:00
Broken Creek at Nathalia WL (m)
Broken Creek at Walshes Bridge WL (m)
Broken Creek at Katamatite WL (m)
Numurkah Water Level (manual recordings) (m, AHD)
Railway Bridge WL (m, AHD)

APPENDIX C – MOIRA SHIRE COMMUNITY FLOOD EMERGENCY MANAGEMENT PLAN

Overview

The flooding of floodplains within river and creek corridors is much easier to predict than flash flooding and overland flows in existing urban areas. The latter tends to be relatively localised, not necessarily in contiguous areas and occur when heavy rainfall (usually associated with severe thunderstorms or small scale weather systems that are locally intense and slow moving) is concentrated in some part of or across a small catchment. Other factors can significantly affect the extent and depth of inundation in a given area: for example, blocked drains; silted, blocked or insufficient number of side entry pits; no entry to drains from low points; undersized drains (insufficient capacity – both piped and table); inappropriate road and footpath cross-falls; footpaths not high enough to contain flow in roadway and/or roadside drainage not sufficiently sized; the extent of inspection and maintenance etc. Fences and other obstructions can block overland flow paths in urban areas resulting in flooding that may otherwise not have been expected. These factors can result in the inundation of properties by overland flows, even for storms of much less intensity than the 1% AEP or design event. The likely location of such flooding is hard to predict other than perhaps in cases where there is a history.

In urban areas, localised intense rainfall often leads to flash flooding due to the resulting volume of runoff being greater than the capacity of the existing underground stormwater drainage system. The excess stormwater moves along overland flow paths. As formalised overland flow paths have generally not been delineated across the Shire, properties in or close to local drainage lines may flood unexpectedly.

Overview of Flooding and Consequences

Introduction

Moira Shire is subject to riverine flooding along the main waterways within the municipality as well as flash flooding in urbanised areas (eg. Cobram) where the stormwater drainage system may surcharge after local heavy rainfall.

Once the PWD levees are overtopped or breached along the Murray River (20 year ARI event or larger), water spreads over a large area (see mapping at Appendix F). Many roads are affected and access is severely impacted.

It is not known at what level houses begin to be flooded over-floor or how many houses are at risk of over-floor flooding in a 1% AEP event. Properties in Koonoomoo, Yarroweyah and Strathmerton would be affected and it is considered likely that a number of houses would be flooded over-floor. Access would be severely compromised with flooding across roads generally between 250 mm and 500 mm deep.

Isolation

Due to the generally flat nature of the municipality, isolation is a significant risk for many areas during large and widespread flooding. Major roads can be closed for extended periods with flood waters more than 300mm deep for extended distances within the Broken Creek catchment and more than a metre deep in areas affected by Murray River flooding. The Goulburn Valley Highway and Murray Valley Highway are susceptible to flooding.

The railway line from Shepparton / Numurkah through Strathmerton to Cobram and Tocumwal will be compromised by large Broken Creek floods (between Wunghnu and Numurkah) and Murray River floods (from south of Strathmerton to the river).

Essential Infrastructure

Vulnerable establishments (eg. hospitals, aged care facilities, schools etc) within the municipality are detailed in the MEMP and are also identified on flood inundation maps (see Appendix F).

Areas Affected

Maps at Appendix F provide guidance on where riverine flooding is likely in the event of heavy rainfall.

Broken Creek - Flooding and Consequences

The upper part of the Broken Creek system comprises Sandy Creek, Boosey Creek, Major Creek and the Broken Creek upstream of Katandra Weir near Katamatite. Tungamah and Katamatite are the main towns in this part of the catchment.

The middle reach extends from Katandra Weir to Walsh's Bridge, 5km downstream from the Broken Creek – Nine Mile Creek confluence and includes many tributary creeks and depressions[6]. The most significant of these are the Muckatah Depression and Guilfus, Congupna, Nine Mile and Pine Lodge creeks. The lower reaches of many of these creeks and depressions have been modified to function as surface water drains (eg. Shepparton Drains 11 and 12). Wild Dog Creek and Box Creek near Numurkah are minor anabranches which also flood during major events. Numurkah and Wunghnu are the larger towns in the middle section of the Brocken Creek catchment.

Note that flood waters that feed into the Guilfus, Congupna, Pine Lodge and Nine Mile creeks affect Tallygaroopna, Katunga and Congupna.

Downstream from Walsh's Bridge, the Broken Creek assumes the course of an ancient route of the Goulburn River. It is bordered by small natural levees along with numerous public and private levees as well as roads and irrigation channels, which confine the extent of inundation during moderate floods. The influence of these levees on larger (major) floods is much less and the spread of flood waters is significant. Nathalia is the main town in this part of the catchment. Picola township is not directly affected by Broken Creek floods.

There are many Drains through the Broken Creek catchment. They are often depressions that have sometimes been enhanced and include waterway area under any road crossings and other obstructions. During heavy rain events this can result in localised 'flooding' of farm land and at road crossings along these drainage lines. It can also result in concern from locals that flooding is more widespread and severe than it is. Air observations and consideration of topographic maps can assist in confirming the phenomena.

During major floods in the Broken River (eg. 1974 and 1993 but not 2012 as the Broken River was not in major flood), flows spill into the Broken Creek catchment from the Broken River near Casey's Weir and downstream from Gowangardie Weir through minor watercourses such as Guilfus, Congupna, Danton's, Pine Lodge and O'Keefe Creeks (note that the excavated, regulated diversion channel that connects to the top end of Broken Creek as part of the Casey's Weir/Major Creek water supply system is not a major connector) and moves north across a broad area west of Gowangardie Weir (see Figures C1, C2, C3 and C4 below). The channel capacity of these minor watercourses is not sufficient to accommodate flood flows. Extensive inundation of the surrounding land results. These creeks discharge into Nine Mile Creek and then into the Broken Creek between Numurkah and Walsh's Bridge.

Breakouts from near Casey's Weir occur when flow in the Broken River reaches approximately 200 m^3/s or at a water surface elevation of 158.73 m AHD (or around 1.81m at the gauge) at Casey's Weir. See Figure C5 below.

[6] There are a number of significant wetlands within the Municipality including Tungamah Swamp, Lake Rowan, Moodies Swamp, Muckatah Depression, Dowdles Swamp and Kinnairds Swamp and the Barmah Forest.

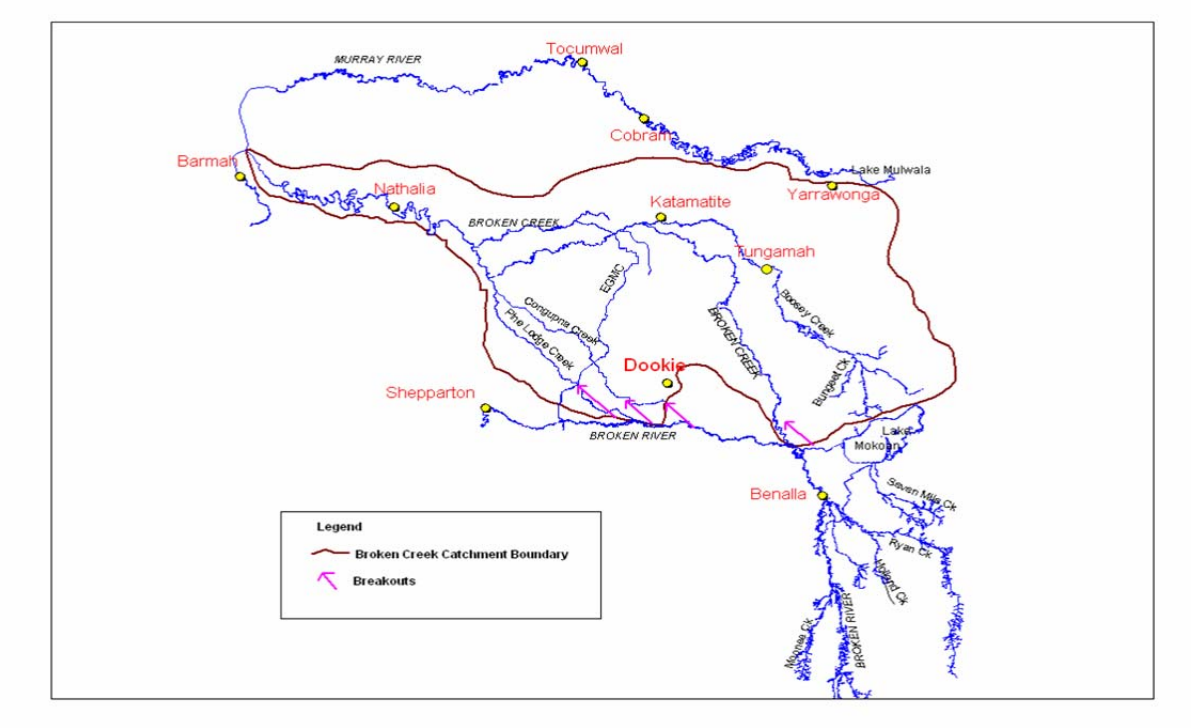


Figure C1: Overview of the connections between the Broken River and Broken Creek catchments

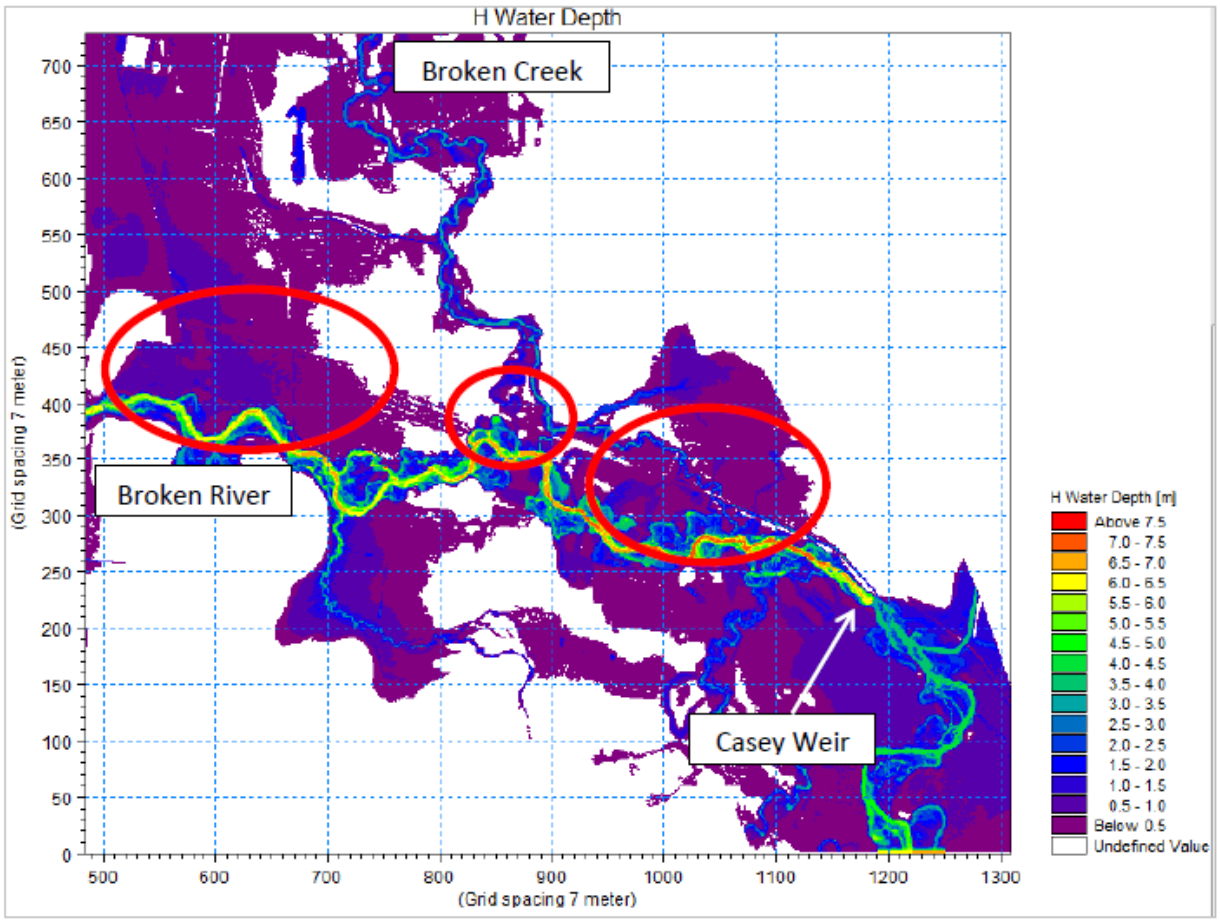


Figure C2: Broken River near Casey's Weir with breakouts to Broken Creek indicated by red circles (Water Technology, 2014)

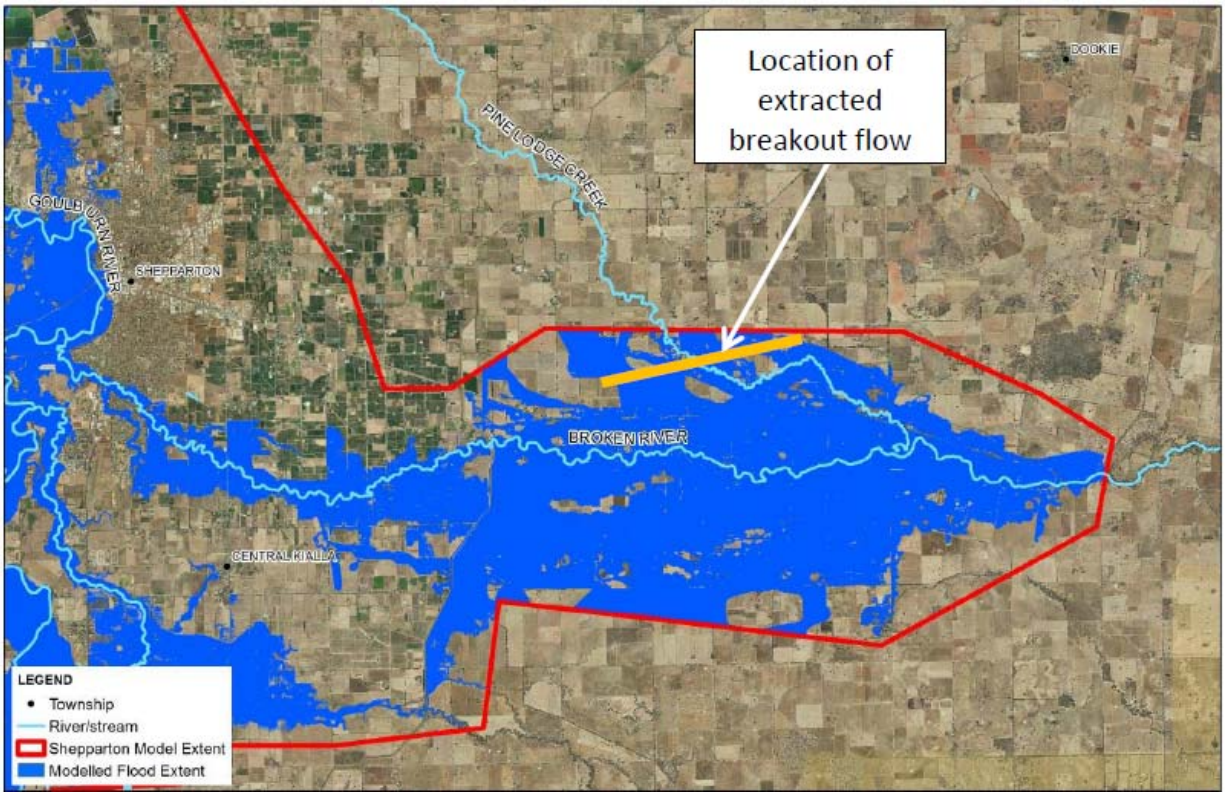


Figure C3: Broken River breakouts to Broken Creek downstream from Gowangardie Weir (Water Technology, 2014)

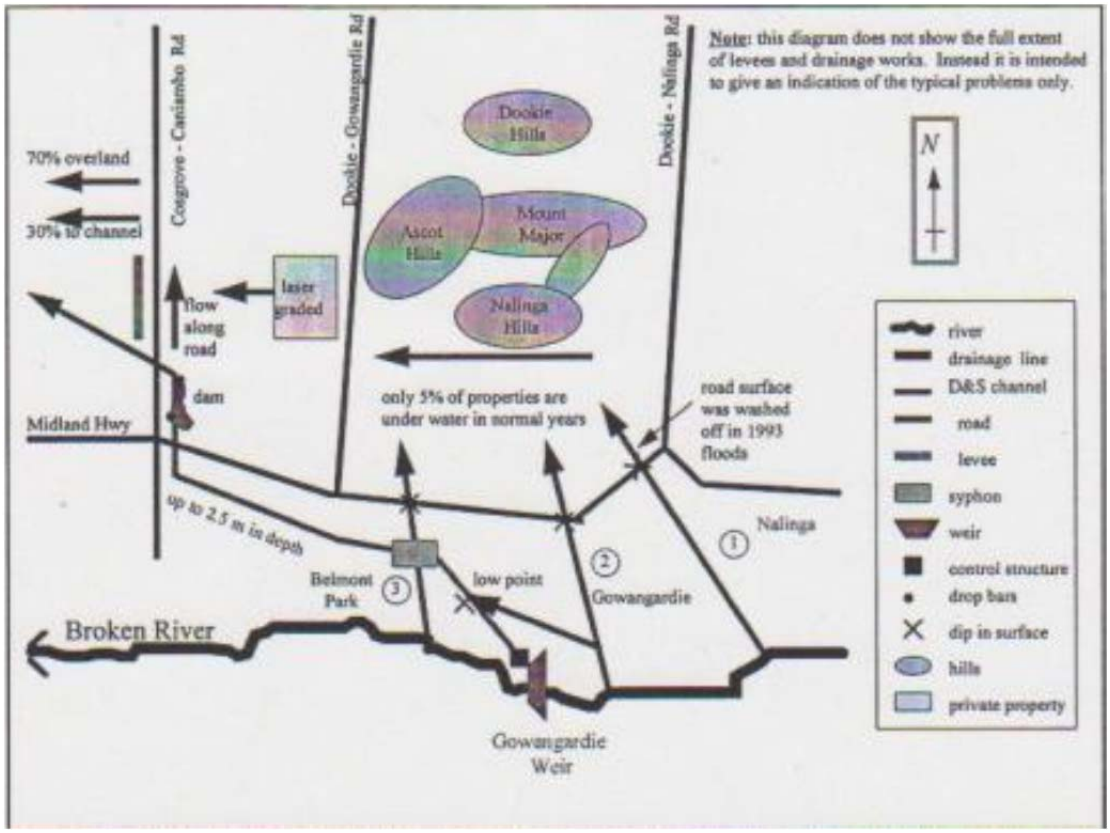


Figure C4: Overview of Broken River breakouts to Broken Creek downstream from Gowangardie Weir

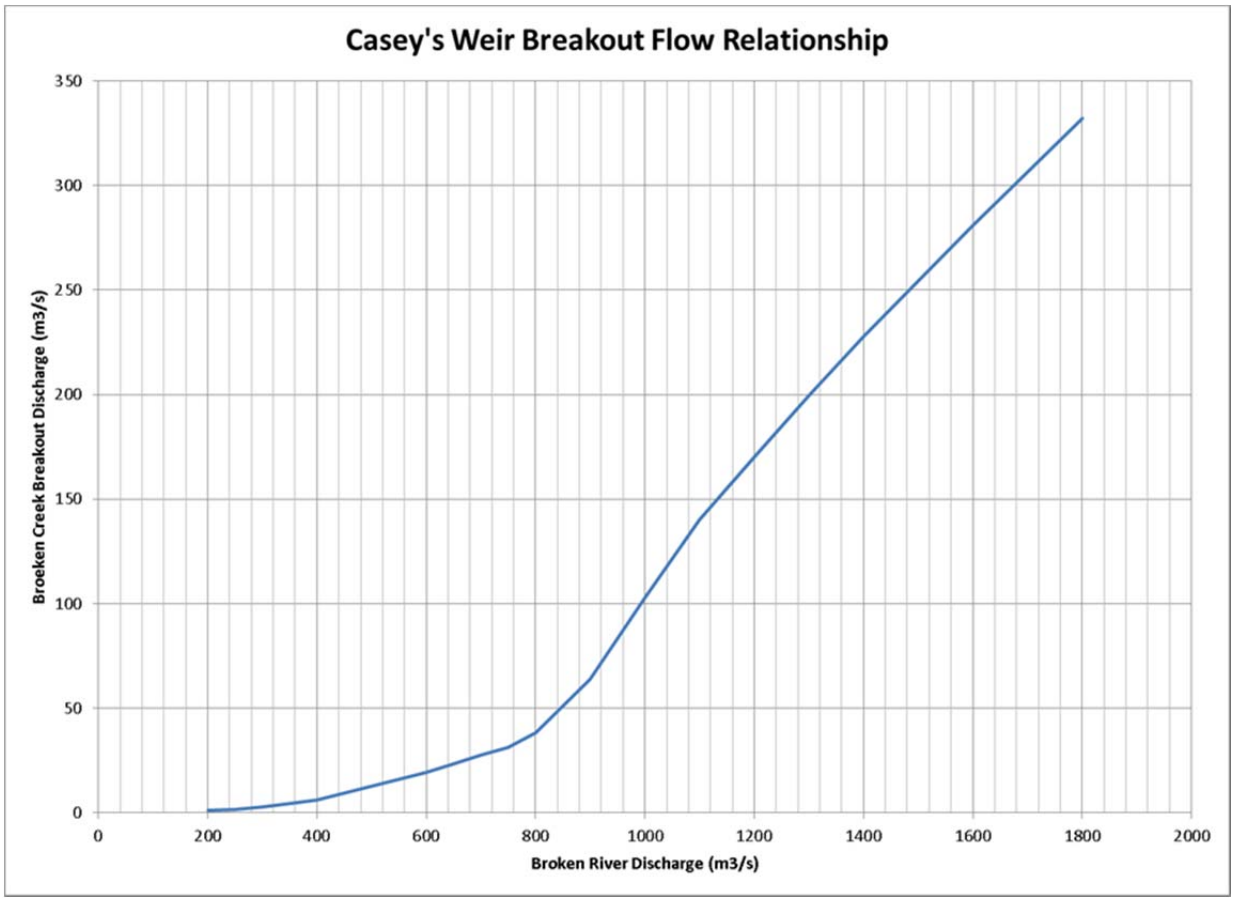


Figure C5: Casey's Weir breakout – Broken River / Broken Creek flow relationship (Water Technology, 2014)

In addition to inflows from the Broken River, transfer of flood waters between tributary catchments is common. It is possible for flood waters from the upper Broken Creek to flow to the north into Boosey Creek upstream of Katamatite. Boosey Creek can also overflow to the north-west into the Boosey-Burramine anabranch, which is connected to the Muckatah Depression. This transfer also operates in reverse and occurred in March 2012. Downstream of Katamatite, the Broken Creek can overflow into Wild Dog Creek and then to the west into the lower Muckatah Depression. To the south, the overflow is into Box Creek which enters Nine Mile Creek downstream from Wunghnu.

Broken Creek - Design Floods

AEP (%)	ARI (years)	Peak Design Flow (m^3/sec & ML/d)		Peak Design Levels (m & mAHD)	
		Boosey Creek at Tungamah	Broken Creek at Katamatite	Broken Creek at Numurkah	Broken Creek at Nathalia
50	2	8.97 (775)	1.31 (113)	-	-
20	5	43.6 (3,769)	7.26 (627)	107.412	2.27 (101.27)
10	10	88.2 (7,617)	18.1 (1,566)	107.593	2.63 (101.63)
5	20	148 (12,823)	39.0 (3,366)	107.714	2.87 (101.87)
2	50	251 (21,665)	93.2 (8,052)	107.830	3.12 (102.12)
1	100	343 (29,687)	168 (14,496)	107.934	3.29 (102.29)
0.5	200	448 (38,700)	289 (24,940)	108.048	-
0.2	500	600 (51,876)	560 (48,420)	108.239	3.49 (102.49)

Murray River - Flooding and Consequences

Townships within Moira Shire at risk of flooding from the Murray include Barmah, Cobram, Koonoomoo, Yarroweyah and Strathmerton. In addition, parts of Yarrawonga and Bundalong are at risk from flooding.

Substantial flooding of rural land from the Murray River only occurs in major events (say larger than 20% AEP) when the levee system is either overtopped or fails. The character of the flooding will depend on both the location of the breach or overtop and the size and duration of the flood peak.

The extent of flooding from high flows in the Murray River is very dependent on the status and integrity of the many levees and irrigation channels and drains within the Shire. Refer to Appendix F for flood inundation mapping for existing and a variety of levee failure conditions (Water Technology, 2011).

Goulburn River – Flooding and Consequences

The floodplain below Shepparton has a well-developed road system and the river is bridged at three locations. The regulating structure at Loch Garry is perhaps the most important feature in this section of the floodplain.

Kotupna and the surrounding rural areas including the Loch Garry Flood Protection District are subject to flooding from the naturally occurring flows in the local creeks (Deep, Sheepwash, Skeleton, Wakiti and Hancocks creeks – the latter are fed directly from the Goulburn River and flow in the direction of Yambuna) as well as when the Loch is operated.

If Loch Garry is operating (Loch Garry Regulator operating rules come into effect 24 hours after the Shepparton gauge reaches 10.36m), Goulburn River flows will be present on the west (left hand) side of the Nathalia –Barmah Road and may flow across it into the lower reaches of Broken Creek as well as into the Murray immediately downstream from Barmah.

The majority of effluent flows from the lower reaches of the Goulburn River spill northwards into Moira Shire, although breaching of levees during major flooding can cause inundation of the Goulburn River floodplain in the adjoining Campaspe Shire. The flood height and timing at which effluent flows begin and / or levees are breached (i.e. into Deep, Wakiti, Sheepwash and Skeleton Creeks), has a significant bearing on flood behaviour across the Goulburn River floodplain. **Note that any flooding above the September 2010 level (11.1m at Shepparton and 10.2m at McCoys Bridge) is likely to**

breach some levees along the lower Goulburn River, probably on both the northern and southern side of the river.

For major floods exceeding 10.7m at the Shepparton gauge, the Shepparton - Barmah Road may need to be closed and the Murray Valley Highway may be cut by flood waters and need to be closed.

The 1% AEP flood at Shepparton is 12.30m at the gauge. The 1974 flood peak was 12.00m while the 1993 peak was 11.72m.

At McCoys Bridge the 1% AEP flood level is 11.28m on the gauge. The 1974 flood peaked at 10.85m while the 1993 flood peak was 11.015m. The difference in peak rank compared with Shepparton may be related to levees.

Ovens River – Flooding and Consequences

Within Moira Shire, farm land, the Wangaratta – Yarrawonga Road and a number of minor roads are affected by large floods. It is thought that the floors of most houses at Bundalong are above the 1% AEP flood level but access does become problematic.

During a 1% AEP Ovens River flood (127.9mAHD - 127.2mAHD from upper to lower Bundalong) or an event similar to 1993 (~200,000ML/d), the following impacts are likely:

- At Bundalong, residential development on the Ovens and Murray frontages (Phalaras Lane, Bailey Street / Nicholson Court and William Street) would require protection;
- Other areas in this vicinity may require close monitoring including the floodway section of the Murray Valley Highway at the Ovens River crossing, the East Peechelba Road, which has to be closed at the Ovens River, and the old Bethumi Township area which may be at risk in a major event;
- A further area of concern is the likely non-functioning of many of the septic systems in the Bundalong area creating a potential health hazard;
- At Yarrawonga, frontage flooding of lawns, parkland, etc could be expected.

APPENDIX C1 – BUNDALONG FLOOD EMERGENCY PLAN

Overview of Flooding Consequences

Bundalong is directly affected by high flows from either the Murray or Ovens Rivers although flooding impacts within the municipality are minimal and limited to a few specific locations.

1% AEP flood levels at Yarrawonga vary from 125.82mAHD upstream of the Weir to 124.0mAHD downstream.

At Bundalong, residential development on the Ovens and Murray River frontages (Phalaris Lane, Bailey Street, Nicholson Street and William Street) would require protection. Other areas in this vicinity may require close monitoring including:

- The floodway section of the Murray Valley Highway at the Ovens River (Parola's Bridge);
- The Peechelba Road which has to be closed at the Ovens River crossing; and
- The old Bathumi township area which may be at risk in a major event.

A further area of concern is the likelihood of non-functioning septic tank systems in the Bundalong area creating a potential health hazard.

What areas are affected

Problems in the Bundalong area only arise when major floods occur on the Murray River or Ovens River upstream of Yarrawonga. A major flood on either of these streams or a combined flow at their junction of equivalent size or greater will create flooding problems in the township of Bundalong.

The most likely strategy to be employed in a major flood is to closely monitor upstream levels and at the appropriate time sandbag houses known to be at risk.

Supplies of sand will be required at Bundalong prior to sandbagging operations. The proposed location for these operations is at the Dan Cronin Reserve in Pyke Street, where lights, power and other required facilities are available.

During a 1% AEP event in the Murray River:

- Foreshore flooding plus potential flooding of residential property at the upper end of development on the Ovens River at Bundalong could occur if the ponding effect of Lake Mulwala was great enough. Effects would be similar at Yarrawonga in the case of a 1% AEP (127.9 - 127.2mAHD from upper to lower Bundalong) Ovens River flood or an event similar to 1993 (~200,000ML/d).

Caravan parks likely to be affected

- There is one caravan park in Bundalong located on the Murray Valley Highway.
- Campers along the Ovens River edge must also be considered.

How many properties

The Bundalong flooding profile is confined to Phalaris Lane, Bailey Street, Nicholson Street and William Street houses likely to require protection are shown on plans attached and included VICSES plans.

How much warning time

- Flooding in Bundalong will come from the Murray River, Ovens River or large rain events such as in 2012.
- Contact BoM for warnings to do with this town.

Impacts on essential community infrastructure

- Munro's Road sewage pond infrastructure may be affected; however it has been built on high ground.

Isolation risks

N/A

Major road closures

- Murray Valley Highway at the Ovens River crossing
- Yarrawonga-Wangaratta Road
- Peechelba Road

Locations where evacuation difficulties may occur for example low flood islands

N/A

Flood Mitigation

Flood mitigation systems/measures:

- Upstream gauges on the Murray River and Ovens River must be monitored as the flood event approaches. To follow development of a flood, there are two (2) gauge locations on the Murray and two (2) on the Ovens which require to be monitored. These are as follows with detail of flood event to be expected:

Murray River at Lake Hume downstream gauge.

- 5.50m major flood (approx. 139,000 ML/d)
- 4.90m moderate flood (approx. 71,000 ML/d)
- 1975 flood (171,580 ML/d)

Murray River at Corowa gauge

- 8.10m major flood
- 7.60m moderate flood
- 8.52m 1975 flood (194,809 ML/d)

Ovens River at Wangaratta gauge

- 12.99m 1993 flood (record flood, approx.200,000ML/d)
- 12.93m 1974 flood
- 12.70m major flood
- 12.40m moderate flood

Peechelba gauge

This gauge is presently only a local observation gauge used by GMW for Yarrawonga Weir and others to monitor trends and peak. Yarrawonga SES are taking steps to formally include this gauge in their monitoring arrangements.
No rating exists for the Peechelba gauge and no data exists for 1975, however, 1993 peak level was 132.62AHD.

Where do levees and retarding basins exist?

No levees or retardations basis exist in Bundalong

Flood Impacts and Required Actions

Deliverables from flood, drainage and other studies;

- Bundalong has limited urban drainage infrastructure and has not been the focus of a flood study to this time.

Hydraulic modelling/flood inundation animations;

- N/A

Past flood experience – gleaned from Council files, records and reports of previous floods including nature and severity of floods (ie. flash floods, riverine floods, major floods etc), newspaper accounts, post-event funding submissions, etc;

Community or agency flood awareness material - particularly in relation to FloodSafe or StormSafe material - make sure information / intelligence is shared and consistent;

Community and agency knowledge;

- Following the March 2012 flood event, a review of this flood emergency plan included local knowledge from members of the Yarrawonga SES unit, Bundalong Action Group and the Bundalong CFA.
- As part of planning and response to future flood emergencies, local groups such as those listed above should be considered for the knowledge they can provide for specific events.

Any known or possible community infrastructure impacts:

- There is a large number of septic tank systems used within and around the Bundalong community. Coordination of pumping these systems will need to be carried out after the flood event.

Any sewer pumps likely to be inundated;

- The new housing estates in Bundalong have town sewage infrastructure.

Any groundwater wells are likely to be inundated;

If ground water bores exist it will be the responsibility of the operator to ensure water is tested and is safe, bore water should be monitored if used for domestic purposes, test should be undertaken periodically. More information can be obtained from the Department of Health.

Water treatment plants and water storage areas to be affected;

- The Bundalong water treatment plant is located in Pasley Street and is not expected to be affected in a flood event.

Pumps and other service equipment etc. likely to be inundated;

- Nil

Community and agency knowledge;

Look to agencies – BoM FW directives, Council's MEMP, GBCMA FW directive and associated information, etc, etc.

Flood inundation maps (including LSIO, SBO and FZ delineations from the Planning Scheme);

Bundalong

NOTE – intelligence MUST have regard for changes within catchments that modify likely flood behaviour (eg. Mitigation works that reduce the severity of a flood risk)

This intelligence can be presented in a number of ways – on the Y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs. VICSES to complete actions column

Note – In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Command, Control and Coordination

VICSES will assume overall control of the response to flood incidents. Other agencies will be requested to support operations as detailed in this Plan. Control and coordination of a flood incident shall be carried out at the lowest effective level and in accordance with the State Emergency Response Plan (EMMV Part 3). During significant events, VICSES will conduct incident management using multi-agency resources.

Divisional Command will be located at the Hume Region Divisional Command Centre Yarrawonga to manage the Murray River above and below Yarrawonga, The upper Broken and Boosey Creek catchments.

The Sectors will be established in towns affected by flooding, utilising local emergency service personnel where possible.

Station Number: 409002. Gauge Location: Murray River at Corowa

River Height (m) And or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible
5.90m	Moderate Flood Level x% AEP (xx year ARI)		
7.59m / 34,796ML/d		October 1996	
8020m / 74,328ML/d		October 1974	
8.54m / ML/d 65,482ML/d		October 1975	
8.60m	Major Flood Level x% AEP (xx year ARI)		
158,000ML/d	5% AEP (20 year ARI)		
219,000ML/d	2% AEP (50 year ARI)		
274,000ML/d	1% AEP (100 year ARI)		
x.xxm	Probable Maximum Flood (PMF)		

Note: flood intelligence records are approximations. This is because no two floods at a location, even if they peak at the same height, will have identical impacts. Flood intelligence cards detail the relationship between flood magnitude and flood consequences. More details about flood intelligence and its use can be found in the Australian Emergency Management Manuals flood series.

Station Number: 403200. Gauge Location: Ovens River at Wangaratta

River Height (m) And or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible
11.90m / 25,300ML/d	Minor Flood Level x% AEP (xx year ARI)		
12.40m / 40,500ML/d	Moderate Flood Level x% AEP (xx year ARI)		
12.70m / 98,000ML/d	Major Flood Level 5% AEP (20 year ARI)		
142,000ML/d	2% AEP (50 year ARI)		
180,00ML/d	1% AEP (100 year ARI)		
12.93m/ X,GBML/d		1974 Flood	
12.98m / 187,000ML/d		October 1993 Flood	
x.xxm	Probable Maximum Flood (PMF)		

Note: flood intelligence records are approximations; this is because no two floods at a location, even if they peak at the same height, will have identical impacts. Flood intelligence cards detail the relationship between flood magnitude and flood consequences. More details about flood intelligence and its use can be found in the Australian Emergency Management Manuals flood series.

APPENDIX C2 YARRAWONGA FLOOD EMERGENCY PLAN

Overview of Flooding Consequences

This area is directly affected by high flows in either the Murray or Ovens Rivers although flooding impacts within the municipality are minimal and are limited to a specific location.

1% AEP flood levels at Yarrawonga vary from 125.82mAHD upstream of the Weir to 124.0mAHD downstream.

What areas are affected

The Yarrawonga & Border Golf Club (NSW), immediately downstream of the weir's northern gate structure, begins to become affected when outflows reach around 68,000ML/d.

Minor problems may occur immediately downstream of the weir at the caravan park to the south of the Murray River. Problems may also occur at the bottom end of Cullens Road and Tregany Court. The houses in this area may be marooned in a large flood but are otherwise not affected.

During a major Murray River flood, it would be practical to be prepared to block drains and sandbag off in order to prevent any minor intrusions into Yarrawonga.

During a 1% AEP event in the Murray:

- Frontage flooding of lawns, parkland, etc at Yarrawonga could be expected.
- Frontage flooding plus potential flooding of residential property at the upper end of development on the Ovens River at Bundalong could occur if the ponding effect of Lake Mulwala was great enough. Effects would be similar at Yarrawonga in the case of a 1% AEP (127.9 - 127.2mAHD from upper to lower Bundalong) Ovens River flood or an event similar to 1993 (~200,000ML/d).

Problems in the Yarrawonga area only arise when major floods occur on the Murray River or Ovens River. Upstream of Yarrawonga a major flood on either of these streams or a combined flow at their junction of equivalent size or greater, will create flooding problems with the Yarrawonga drainage system and frontage areas.

Caravan parks likely to be affected:

- Yarrawonga Caravan Park is the only park to be affected. Westside and Jelara Caravan Parks would not be affected by flood waters.

How many properties:

- In the 2012 floods, localised heavy rainfall was the prominent cause of flooding at a number of urban properties. Overland flooding from the upper reaches of the Muckatah Depression affected properties in Reilly's Road, parts of Havenstock Drive, Cahill's Road and Parsons Crescent area.

How much warning time:

- Riverine flooding Murray River travel time from Corowa to Yarrawonga is approximately 1.5 days.
- Riverine flooding Ovens River travel time from Wangaratta to Yarrawonga is approximately 2 days.

Impacts on essential community infrastructure:

- Minor risk to infrastructure flooding.

Isolation risks:

- Yarrawonga township would not be isolated due to flood waters. Individual isolation may occur to some properties.

Major road closures

- Benalla-Yarrawonga Road at Lake Rowan floods 2-3 times a year and all traffic is diverted through Tungamah.
- Katamatite-Yarrawonga Road west of Yarrawonga near O'Dwyers Road floods in heavy rain events.
- Murray Valley Highway remains clear during major floods or rain events in both directions.

Locations where evacuation difficulties may occur for example low flood islands

Not Applicable

Flood Mitigation

Flood mitigation systems/measures:

Key Warning/Trigger Gauges

- Upstream gauges on both the Murray River and Ovens Rivers are required to be monitored on the approach of a flood event. To follow development of a flood, there are two (2) gauge locations on the Murray River and two (2) on the Ovens River which require monitoring.

These are as follows:

Murray River at Lake Hume - downstream gauge.

- 5.50m major flood (approx. 139,000 ML/d)
- 4.90m moderate flood (approx. 71,000 ML/d)
- 1975 flood (171,580 ML/d)

Murray River at Corowa gauge

- 8.10m major flood
- 7.60m moderate flood
- 8.52m 1975 flood (194,809 ML/d)

Ovens River at Wangaratta gauge

- 12.99m 1993 flood (record flood, approx.200,000ML/d)
- 12.93m 1974 flood
- 12.70m major flood
- 12.40m moderate flood

Peechelba gauge

- This gauge is presently only a local observation gauge and used by GMW at Yarrawonga Weir and others to monitor trends and peak. Yarrawonga SES is presently taking steps to formally include this gauge in their monitoring arrangements.
- No rating exists for the Peechelba gauge and no data exists for 1975, however,
- 1993 peak level was 132.62 AHD

Where do levees and retarding basins exist?

- There are no levees in Yarrawonga.
- There are eight retardation basins in Yarrawonga, these are situated at:
    - Weston Close south
    - Hazelle Court
    - Madden Drive/Shannon Court nth east
    - Parsons Crescent

- Woods Road
- Lakeview Circuit
- Freddy Court and
- Adoni Green

What communities do they protect?

- The mentioned retardation basins protect residents in the south and north east areas of Yarrawonga

Who manages them?

- Moira Shire manages all retardation basins within the municipality. .

Details of any levee closure points such as railway crossing etc., which may need to be sandbagged.

- Nil

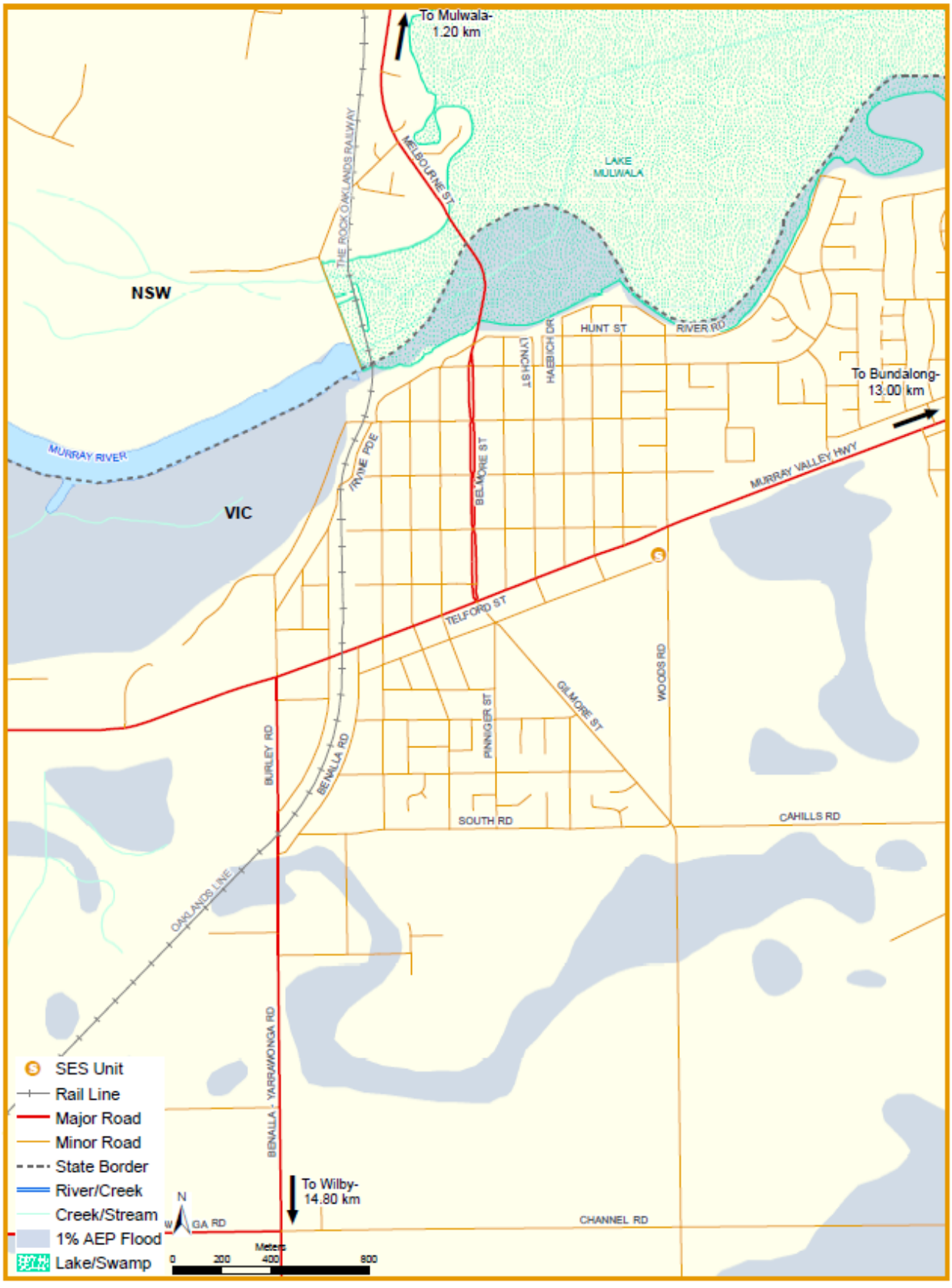
Flood Impacts and Required Actions

Municipal Task List

- In a moderate rain events, clearing of storm water pits in Belmore Street.
- Prepare to close roads if required at Duffield Street, Dunlop Street, Gilmore Street, South Road, Murphy Street, Hume Street and Sharp Street.
- Regularly check retardation ponds and pumps. In major rain events or floods, ensure sand for sandbagging is available.
- An internal access track running approximately 600 meters from East to West on the property on the south side of the Yarrawonga-Katamatite in-between Reilly's Road and the Benalla-Yarrawonga Road may contribute to protection of Havenstock Drive. This track needs to be monitored in anticipation of flood waters. If necessary (as determined by the IC in consultation with GBCMA) this track may be strengthened either by sandbagging or earth. Such action would require consultation between the property owner and the IC.
- Also to be considered and determined as appropriate is the removal of sections of the Railway line. The IC may consider this only after consultation with VicTrack and GBCMA.
- Whilst not identified in the 1% flood event overlay, a number of properties in urban fringe settlements such as Havenstock Drive and Cahill's Road were impacted in the March 2012 flood event. Residents in these areas need to be alerted of potential impact. Furthermore and relevant to the Havenstock Drive and Reilly's Road area, in major rain / flood events, SES may request of GMW that the Reilly's Road Channel be opened to release water into if appropriate.

Flood inundation maps (including LSIO, SBO and FZ delineations from the Planning Scheme);

Yarrawonga



Deliverables from flood, drainage and other studies;

Hydraulic modelling / flood inundation animations;

- N/A

Past flood experience – gleaned from Council files, records and reports of previous floods including nature and severity of floods (ie. flash floods, riverine floods, major floods etc), newspaper accounts, post-event funding submissions, etc;

Community or agency flood awareness material - particularly in relation to FloodSafe or StormSafe material - make sure information / intelligence is shared and consistent;

- SES and the Moira Shire Council are in the process in writing the Flood Safe guide for Yarrawonga. The mapping has been completed and the wording for the guide is being compiled.

Community and agency knowledge;

- Following the March 2012 flood event, a review of this flood emergency plan included local knowledge from members of the Yarrawonga SES unit and Yarrawonga CFA.

As part of planning and response to future flood emergencies, local groups such as those listed above should be considered for the knowledge they can provide for specific events.

Any known or possible community infrastructure impacts including:

Any sewer pumps likely to be inundated;

There is a large number of septic tank systems used within and around Cahill's Road, Reilly's Road and Havenstock Drive. Coordination of pumping work is to be carried out after a major flood event.

Any groundwater wells likely to be inundated;

There are bore water wells around Reilly's Road, Havenstock Drive and Cahill's Road, If ground water bores exist it will be the responsibility of the operator to ensure water is tested and is safe, bore water should be monitored if used for domestic purposes, testing should be undertaken periodically. More information can be obtained from the Department of Health.

Water treatment plants and water storage areas to be affected;

- NA

Pumps and other service equipment likely to be inundated;

- Moira Shire has many pumps through Yarrawonga, please refer to MSC's operation manual for Drains and Pumps.

Community and agency knowledge;

Look to agencies – BoM FW directives, Council's MEMP, GBCMA FW directive and associated information

NOTE – intelligence MUST have regard for changes within catchments that modify likely flood behaviour (eg. Mitigation works that reduce the severity of a flood risk)

This intelligence can be presented in a number of ways – on the Y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked.

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs. VICSES to complete actions column

Note – In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Command, Control and Coordination

VICSES will assume overall control of the response to flood incidents. Other agencies will be requested to support operations as detailed in this Plan. Control and coordination of a flood incident shall be carried out at the lowest effective level and in accordance with the State Emergency Response Plan (EMMV Part 3). During significant events, VICSES will conduct incident management using multi-agency resources.

Divisional Command will be located at the Hume Region Divisional Command Centre Yarrawonga to manage the Murray River above and below Yarrawonga, the upper Broken and Boosey Creek catchments.

The Sectors will be established in towns affected by flooding, utilising local emergency service personnel where possible.

Station Number: 409025 Gauge Location: Murray River at Yarrawonga

River Height (m) And or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible
6.40m	Minor Flood Level x% AEP (xx year ARI)		
x.xxm			
x.xxm			
x.xxm			
6.70m	Moderate Flood Level x% AEP (xx year ARI)		
x.xxm 235,000mlAHD	5% AEP (20 year ARI)		
7.80m	Major Flood Level x% AEP (xx year ARI)		
x.xxm 325,000mlAHD	2% AEP (50 year ARI)		
x.xxm 390,000mlAHD	1% AEP (100 year ARI)		
x.xxm	Probable Maximum Flood (PMF)		

Note: flood intelligence records are approximations; this is because no two floods at a location, even if they peak at the same height, will have identical impacts. Flood intelligence cards detail the relationship between flood magnitude and flood consequences. More details about flood intelligence and its use can be found in the Australian Emergency Management Manuals flood series.

APPENDIX C3 – COBRAM FLOOD EMERGENCY PLAN

Overview of Flooding Consequences

The 1% AEP flood adopted for Yarrawonga Weir is 387,000ML/d. It is around 355,000ML/d and 340,000ML/d for Cobram and Tocumwal respectively.

The levee system in the vicinity of Cobram commenced in 1895 and was completed in 1910 and became known as the Public Works Department (PWD) levees. The levees were breached in the 1916/17 flood events (approx. a 1% event) and substantial breakout flows occurred upstream of Cobram through a natural low point now protected by Dick's levee.

The 1975 flood (rated at 3%, or about 1 in 30) provided the highest river levels since the PWD levees were constructed. Significant sandbagging was required at Dicks, Cavagna's and the PWD levees and major breaches occurred at Brentnalls Beach, Cleaves Beach and Dixons Bend. Following the 1975 event, the levees were reinstated and upgraded and Dick's levee was strengthened and set at the 1975 flood level. More recently, the Goulburn Broken Catchment Management Authority (GBCMA) has strengthened the PWD levees at a number of locations that were identified as major priorities from a levee audit in 1996. This included locations of major levee breaches that occurred in the 1975 flood and an 8km length of levee from the Cobram town levee to Greens Lane at Koonoomoo.

Unless flows are above major flood level there are few problems in the river reach between Cobram and Barmah.

Catchment response is generally slow. Large floods generally only occur after the catchment has been 'wetted up'. Due to the size of the catchment, it's generally flat nature, the many depressions, tributary creeks and drainage lines, the estimation of flood travel and peak timings may vary depending on variables. Nevertheless, indicative timings for creek levels to rise and fall at key locations and peak travel times are provided in Appendix B.

Maps delivered by Water Technology (2011) show flood extents and depths for a range of scenarios that include existing levees remaining in place and breaching.

Flooding Behaviour In and Around Cobram

The 100 year flood mapping with the Cobram Town levees in place (refer to the100 year ARI flood mapping delivered by Water Technology, 2011), indicates flow paths along the Murray Valley Highway towards the southern limits of Cobram with two flow paths through Cobram. The flow path along the Murray Valley Highway affects residential properties in the vicinity of William, High, Sydney, Station, Murray and Punt Streets. A second path crosses Campbell Road adjacent to Dudley Park Lane and then continues north along Acacia, Gregory and Thomson Avenue, through Cobram Secondary College grounds, across Karook Street and affects Gorton, Nicolina, Irene Streets and Grasso Drive.

The threat of flooding in the vicinity of Cobram will come from:

- Overtopping of the town levees by flow in excess of the 1% AEP event (there is very little freeboard available at this flow);
- Flows from an upstream breakout near Dairy Paddock Lane along the Murray Valley Highway towards the southern limits of Cobram and two flow paths through Cobram;
- Overtopping of or breakout flows through natural low points upstream, such as Dicks and Cavagna's levees.

During a 1% AEP flood with Dicks Levee set at the 1975 level, no sandbagging or an overtopping (not breaching) scenario, it is expected that approximately 340m^3/sec (29,300 ML/d) would escape from the Murray River at Dicks levee and join with water from the breakout that occurs about 1.5km upstream near Dairy Paddock Lane. This water would pond for a short period (less than 1 day)

between Barnes Road to the east, Langan Road to the west and the No 1 Channel, before building up sufficiently to move westerly towards Cobram. If the channel did not breach, the highest level reached between the channel and the sand hill to the north would be about 117.7mAHD.

To stop water entering Cobram from the Murray Valley Highway, a temporary levee is required to be constructed across the Murray Valley Highway (at Collie's). The balance of flow, some 24,000 ML/d, would have overtopped the No 1 Channel by 400mm or so over a length of about 5km. This flow would move firstly south westerly towards the Cobram South and Benalla–Tocumwal Road intersection, then in a north westerly direction towards Yarroweyah, where it would overtop the Murray Valley Highway and continue towards Koonoomoo. In larger floods, water from the breakout spreads quite widely and would affect Strathmerton. See 2011 mapping.

In the event of the channel breaching or being breached, it is expected that there would be a drop in the level upstream of the channel and a reduction in the flow towards Cobram accompanied by an increase in the flow moving southward. Close monitoring of river levels and the flow moving southward is essential in order to assist detection of a breach.

It should be noted that in the event of a major (1% AEP) flood it may be necessary, in order to minimise damage to property on the south side of the No 1 Channel, to deliberately breach the channel rather than wait until it breaches. This strategy would provide some opportunity to control flows and reduce the likelihood of inundating higher ground.

If flood waters were to overtop the levees protecting Cobram to the north, the town would experience some flooding (see mapping). The extent of the flooding would depend on whether overtopping occurred upstream or downstream from the Warkil Street–Manse Road area. Upstream overtopping would be partly confined by the higher ground between the two streets and possibly pond to the south and flow generally along Karook Street to the west. Water overtopping to the west of Manse Road would generally move to the west until ponded between the levee and the No 1 Channel. The impact of this ponding would depend on the volume of overtopping. It may be necessary to breach a section of the channel to relieve the situation.

Overtopping as described in the preceding paragraph would create an extremely serious situation in Cobram. It is difficult to predict where the main flow of water would travel given the effect of street kerbs and other barriers on the flow. However, the obvious strategy would be to keep the water as far as possible to the north of Karook Street (funnel it between the No 1 Channel and the levee) and pump flood water over the levee to the river as soon as is possible. Flooding of this type would necessitate evacuation of residents in the affected area.

Breaches further to the west (ie. west of Racecourse Road) provide only a minor threat to the town and could in the main be dealt with by temporary measures including sandbagging and a temporary low bank in Racecourse Road. This water will mainly flow to the west and be a problem to any low lying land or buildings in the Koonoomoo area and further west.

It is essential that:

- Sand supplies be arranged early for the Green Lane and Weiss Road locations given the potential for access problems;
- The communications system between the IC and FO in the Cobram to Labuan Road reach of river is activated early in any event;
- The position of the Time Out Resort (roads are closed at 6.25m on the Tocumwal gauge) and the low sand saddles upstream of Seppelt's Road Barooga (NSW) are monitored;
- A temporary levee is constructed on Murray Valley Highway (near Collie's) from about the 20 year ARI flood level (8.5m on the gauge at Yarrawonga and a flow of 251,000 ML/d) in order to prevent the progress of water along the Highway and into Cobram;

- During 100 year ARI flood conditions:
    - Place temporary barriers (gates) across allotment access routes along River Road;
    - Place temporary barriers at Mookarii Street in order to achieve required freeboard.

What areas are affected?

- If the Murray River diversion at Dicks and Cavanagh levees were to be compromised this water would be diverted south through rural areas at the corner of Pullar Road and the Murray Valley Highway using the irrigation channels.
- Catona Crescent can be affected by flash floods following large rainfall event.
- Rural areas south of Cobram are most likely to be affected in large rainfall/flood event as water is directed away from Cobram to the south.

Caravan parks likely to be affected

- Cobram has 5 Caravan Parks in and around the town. 4 of the caravan parks are in the Cobram township and are free from floodwaters. Cobram East Caravan Park is outside the levee on the Murray Valley Highway.

How many properties

- During a major Murray River flood properties west of Racecourse Road to Koonoomoo could be affected by over-floor flooding.
- Many more rural properties to the south of Cobram will be affected if Dicks or Cavanaghs levee is compromised.
- During large rainfall events the entire town drainage system can be overwhelmed with water visible in many streets and reserves, houses in Catona Crescent are at high risk of flooding.

How much warning time

- Generally, 24 hours warning from Yarrawonga Weir.

Impacts on essential community infrastructure

- Damage to road infrastructure in and around Cobram would be significant.

Isolation risks

- The entire township of Cobram is at risk of isolation in a major Murray River flood event. Isolated to the south and east by the Muckatah Depression, and isolated to the west by flows overtopping the old levee west of Racecourse Road.

Major road closures

- Murray Valley Highway
- Goulburn Valley Highway
- Cobram-Koonoomoo Road
- Cobram South Road and
- Benalla-Tocumwal Road.

Locations where evacuation difficulties may occur for example low flood islands

Nil

Flood Mitigation

The river reach between Cobram and Barmah incur few problems during a flood unless flows are above major flood level.

The levee system in the vicinity of Cobram commenced in 1895 and was completed in 1910 and became known as the Public Works Department (PWD) levees. The levees were raised and strengthened in 2000/01 and now provides protection for Cobram from the 1% AEP flood with freeboard which varies from 250mm to more than 600mm.

The levee scheme is made up of earth and concrete levees and includes a spillway upstream. Earthen levees begin at River Road Cobram and run along the east of the township to Harris Road.

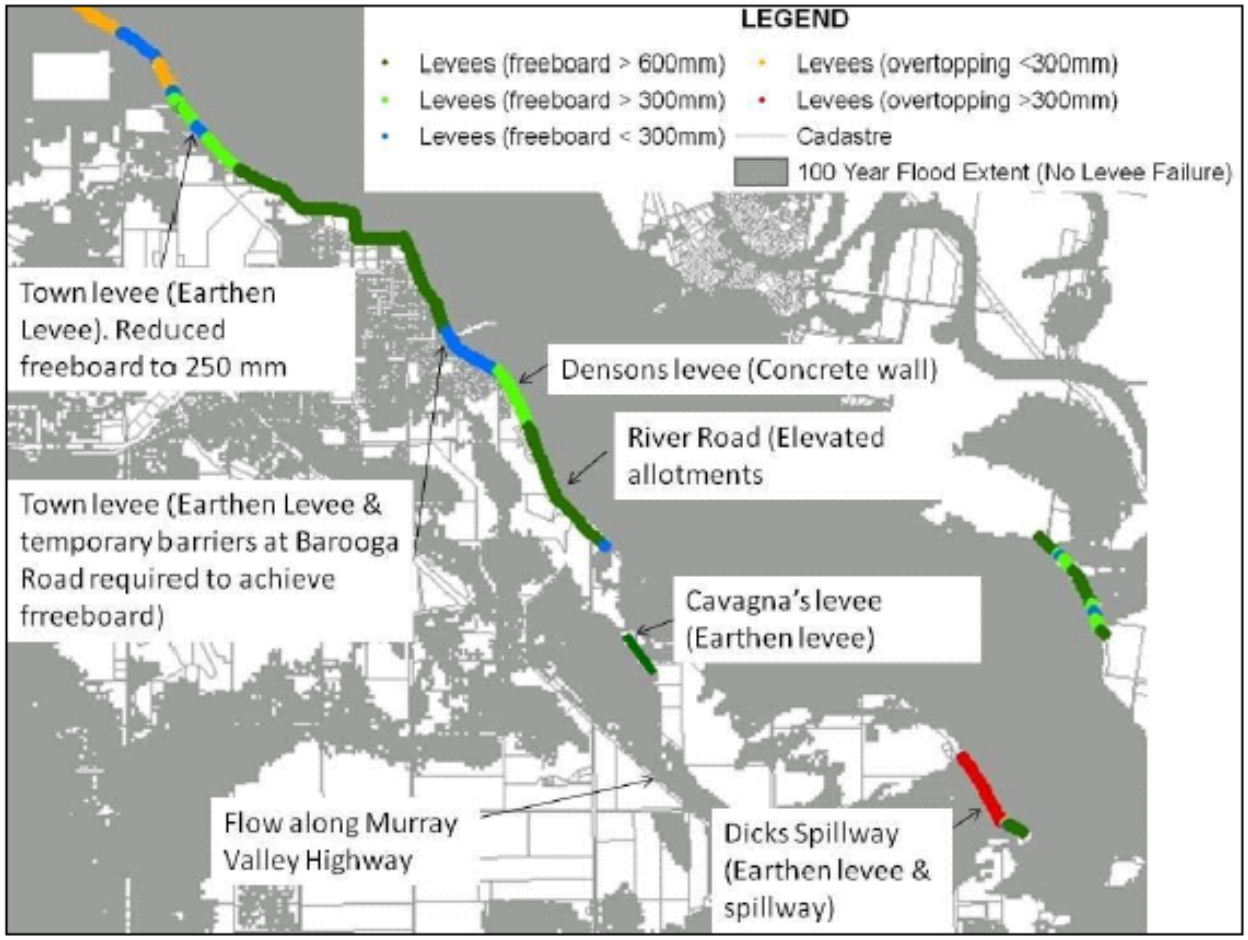
The key elements of the **Cobram Town Levee Scheme** (see diagram below) include:

- Dick's Spillway
- Cavagna's Levee
- River Road
- Densons Levee
- Town Levee
- PWD Levee

Dick's Spillway

Dicks Spillway is located adjacent to Cemetery Road to the east of Cobram Township. This spillway design allows flooding to break out to a natural lower lying floodplain which reduces the flow in the river and the flood levels along the river through Cobram. The spillway has been reinforced to withstand overtopping, with a non-erodible top layer.

Hydraulic modelling (Water Technology, 2011) demonstrates that overflow at Dicks Spillway (crest level is 117.30mAHD) commences for flows greater than a 20 year ARI event (flow at Yarrawonga of 251,000 ML/d and a gauge height of 8.5m – Water Technology, 2011).



Cobram Town Levees

In floods larger than the 20 year ARI event, water from this breakout flows towards Cobram along the Murray Valley Highway alignment and also to the west and then north west towards Yarroweyah (and also Strathmerton in larger floods) and Koonoomoo. A more detailed description of this flow is provided in the following section.

Overtopping of up to 370mm in depth occurs at Dicks Spillway during a 100 year ARI flood event.

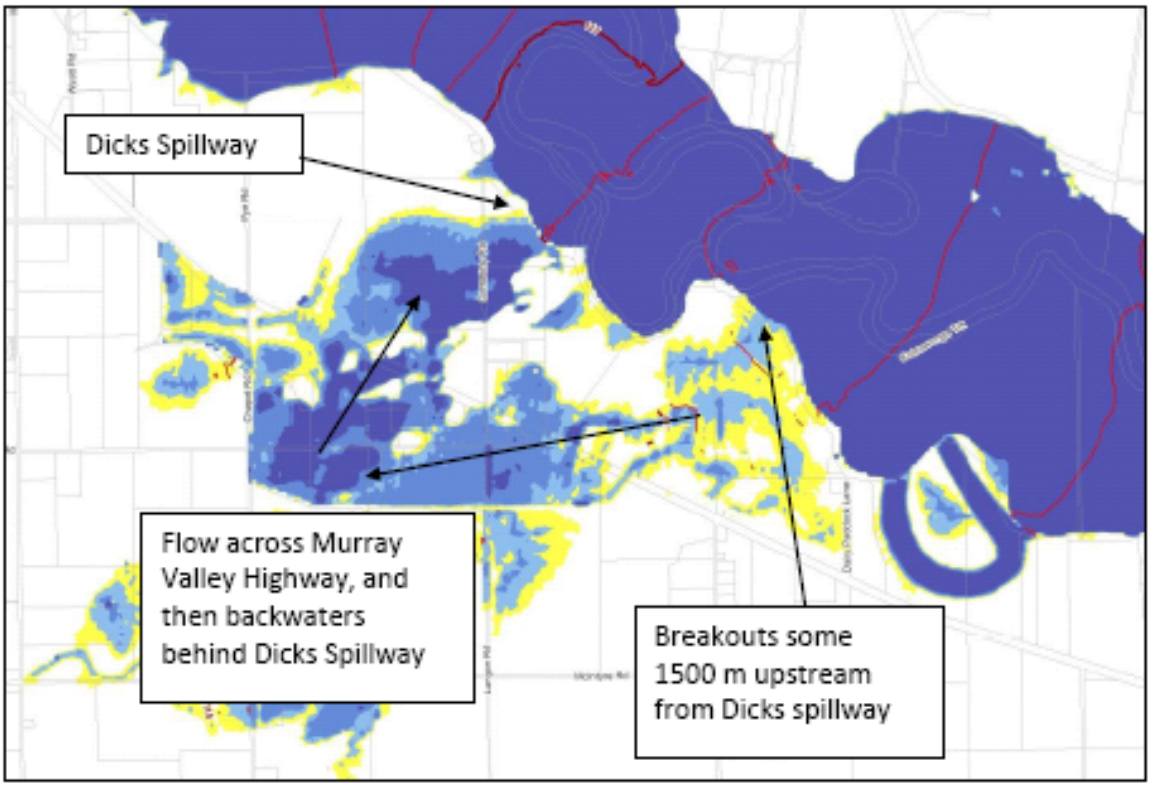
Sandbagging the spillway to prevent overflow does not provide any benefit as a breakout occurs (from about the 20 year ARI event) some 1.5km upstream from Dick's Spillway (near Dairy Paddock Lane), flows across the Murray Valley Highway and fills the area behind the spillway adjacent to Cemetery Road. This flooding occurs regardless of whether the spillway is sandbagged. There is no significant change (less than 0.005m) in flood levels from Dicks Spillway to the Cobram–Barooga Bridge, and no change in flood behaviour in the Murray River or in the area behind Dicks Spillway. **There is no benefit in sandbagging Dicks Spillway** (see figure below).

Cavagna's Levee (adjacent to Wyatt Road)

A short section (some 300 m) of earthen levee that prevents breakout towards Pullar Road.

River Road

Along River Road, elevated allotments act as a levee to the north and east of Scenic Drive. These allotments are greater than 600 mm above the 100 year ARI flood level.



Flood behaviour at Dicks Spillway during a 20 year ARI event

Densons Levee

A concrete wall landscaped as the front property fence and provides flood protection between Scenic Drive and Mookarii Street. Freeboard during the 1% AEP flood is greater than 300 mm. Temporary flood barriers are required across Mookarii Street.

Town Levee

This levee extends from Mookarii Street to near Harris Road and adjoins the PWD levee. The town levee downstream of Mookarii Street has a freeboard generally above the 100 year ARI flood levels of greater than 600mm. However, the freeboard is reduced to about 250 mm for the segment from Harris Road to approximately 500 m upstream of Harris Road, adjacent to the GVW treatment plant. This means that while the Town Levee should withstand a 100 year ARI flood (albeit with very little freeboard), it provides protection against a 20 year event with 600 mm freeboard. A figure and table in Appendix D of Water Technology (2011) provides details. **See below also.**

PWD Levee

Freeboard on the PWD levee under the 100 year ARI flood conditions varies considerably, with some sections having a freeboard greater than 300mm while others are overtopped by greater than 300mm. Sandbagging the levee would not be practical; the focus is to be on the safety of people and stock with individual sandbagging activities as required.

Cobram to Cleaves Beach Levee

Cleaves Beach is around 4km upstream of Tocumwal.

From the end of the Cobram town levee near Harris Road to the Dixons Bend (near Smith Road), the freeboard is less than 300mm under the 100 year ARI flood conditions. The levee is overtopped by up to 300mm for a 1.3km section upstream of Dixons Bend and a short section of levee at Cleaves Beach is overtopped by up to 300mm.

Overtopping of the PWD levee upstream of Dixons Bend commences for flow greater than a 20 year ARI flood (251,000 ML/d) at Yarrawonga. At Cleaves levee the overtopping commences for flows greater than a 50 year ARI flood (328,000 ML/d) at Yarrawonga. There are five sections along this levee ranging in length from 250m up to 2km that will be overtopped by up to 500mm in a 100 year ARI event. A figure and table in Appendix D of Water Technology (2011) provides details.

Breakouts at Dixon Bend travel via (and fill) Torgannah Lagoon across the Goulburn Valley Highway near Koonoomoo, continue via Sheepwash Creek and return to the Murray River via Ulupna Creek on the southern side of Ulupna Island.

The 1% AEP flood level at Koonoomoo is 112.3mAHD.

Cleaves Levee to Ulupna Creek confluence

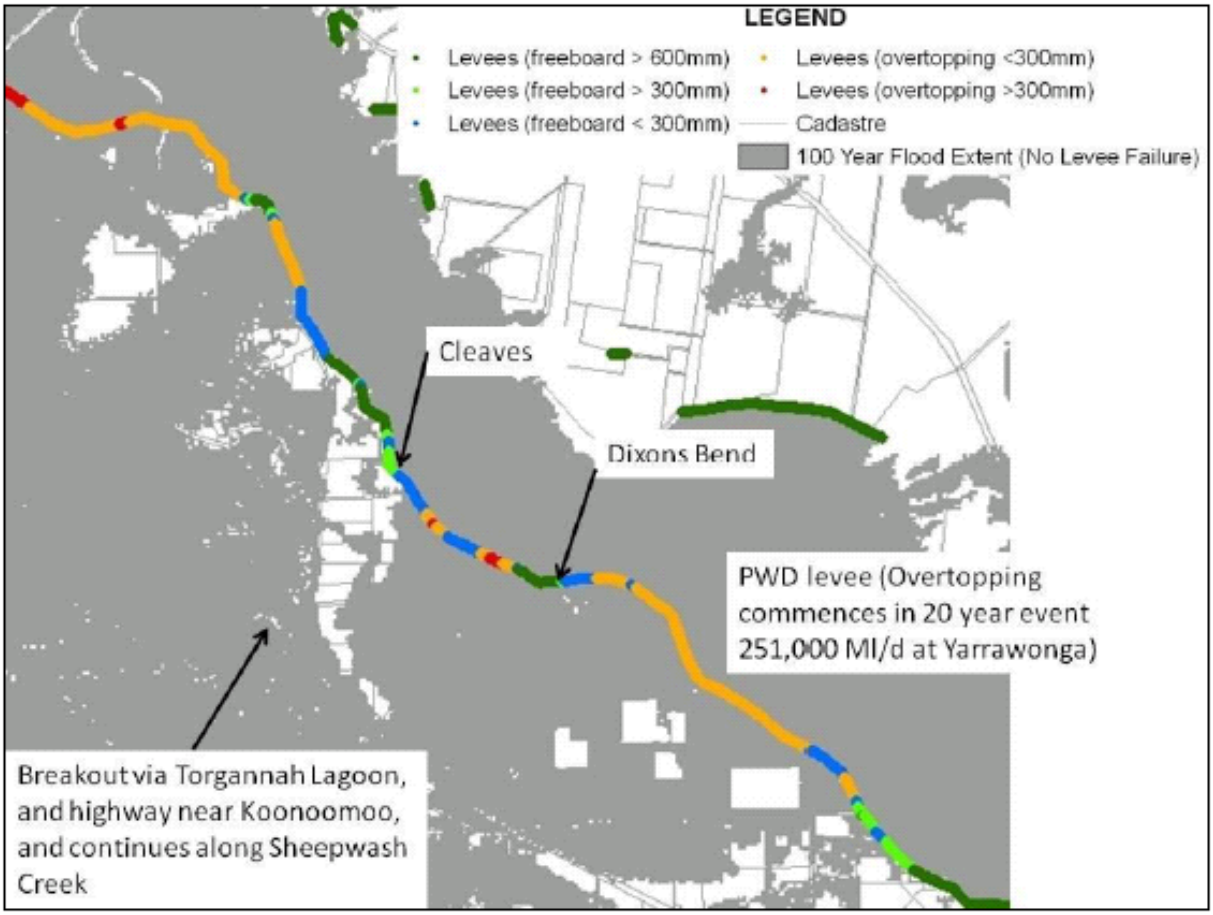
This section of the PWD levee provides protection for the 20 year ARI flood event (251,000 ML/d at Yarrawonga). In larger events, upstream levee overtopping/failure results in flooding behind the PWD levee through this section.

There 14 sections of this levee that will be overtopped by up to 800mm by a 10 year ARI event. Zeach section ranges in length from 250m to 4.25km. A figure and table in Appendix D of Water Technology (2011) provides details.

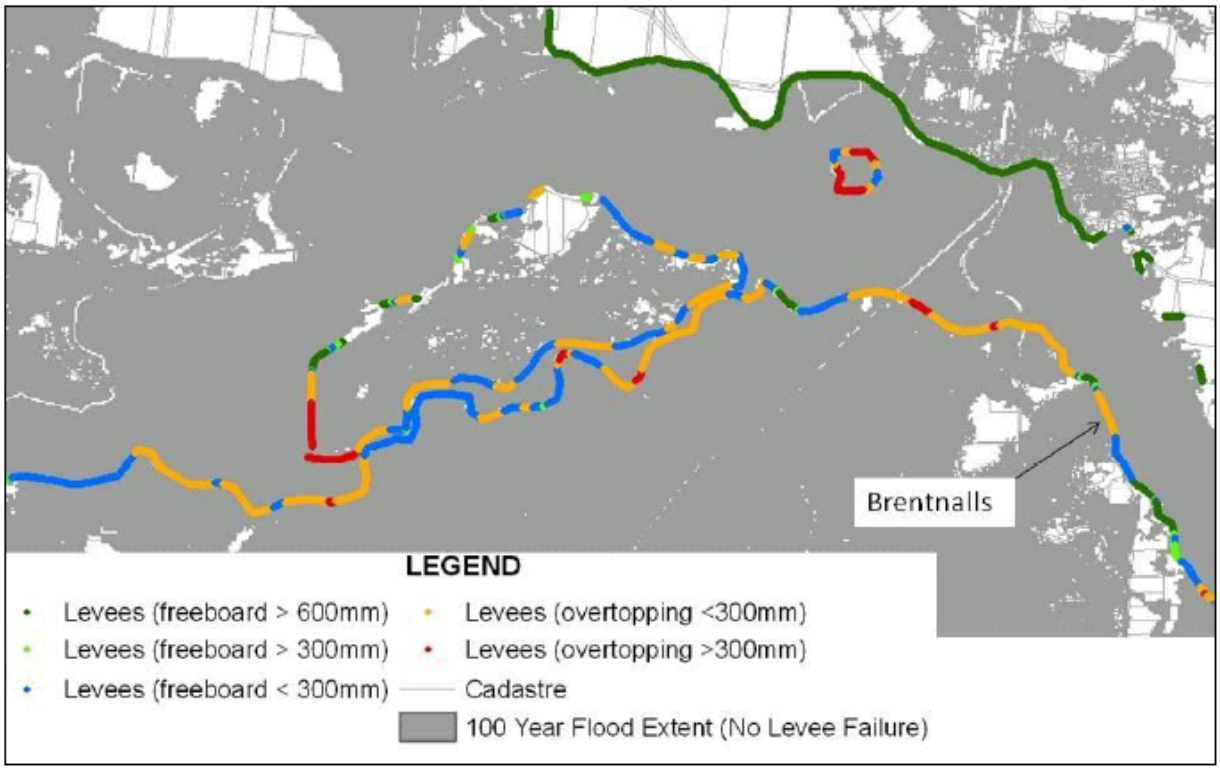
NOTE re TOCUMWAL

The 1975 peak level at Tocumwal was 7.54m.

There is little increase in gauge height at Tocumwal as the flow increases beyond about 240,000 ML/d. This reflects the overtopping of the upstream PWD levee and the additional flow across the Victorian floodplain. It also highlights the relative insensitivity of flood levels along the river downstream of Cleaves as the PWD levees overtop.



PWD levee – Harris Road to Cleaves Beach (4km upstream of Tocumwal)



PWD levee – Cleaves to Ulupna Island

Retarding basins:

- Schubert/Karook Street,
- Campbell Road,
- Catona Crescent,
- Gemmill Street,
- Bisogni Drive,
- Wondah Street,
- Campbell Road Apex Reserve basin

What communities do they protect?

- Levees protect the whole of the Cobram township.
- The retardation basins are designed to help protect the community in those areas from local heavy rainfall events.

Who manages them?

- Moira Shire Council manages the town earthen levees and retardation basins.

Details of any levee closure points such as railway crossing which may need to be sandbagged.

- Barrier or a clay bank will be installed across Mookarii Street at River Road.
- Levee built over Murray Valley Highway.
- The driveway entrance at 22 River Road will require sandbagging to complete the levee.

Flood Impacts and Required Actions

The following is a compilation of the various tasks which must be undertaken with the approach of a major flood. I t is assumed that triggering advice has been received from upstream sites such as Yarrawonga or Wangaratta and that the situation is being monitored.

These tasks should be carried out when the Cobram River gauge is in the range 6.6m to 6.8m.

- Erect water over road signs at River Road.
- Erect road closed signage at Thomson's Beach entrance.
- Sunrise Crescent - drain to be closed by balloon inflation.
- Bourke Court -drain to river, close valve on River Road.
- Lirrk Street/Churr Street corner drain under levee to be closed by balloon inflation on water side.
- North of Lirrk Street, drain under levee to be closed off by balloon inflation.
- Martinvale Court, drain under levee to be closed by balloon inflation.
- Corner Brepbir and Boorin Streets, drain under levee to be sandbagged off on the water side and side entry pit on the north-west corner of the intersection to be sealed by balloon.
- Manse Road, north of Sims Road drain to be sealed off.
- North end of Racecourse Road, one (1) drain to the east and two (2) drains to the west of the road to be sealed off.
- Consider blocking off irrigation channel located between Harris and Manse Roads. There is an outlet that protrudes under the levee to the river (not a shire asset) uncertain of ownership of asset.
- Install clay bank or sandbag across Mookarii Street at River Road.
- Sandbag driveway entrance to #22 River Road Cobram.

Past flood experience – gleaned from Council files, records and reports of previous floods including nature and severity of floods (ie. flash floods, riverine floods, major floods etc), newspaper accounts, post-event funding submissions, etc;

Community or agency flood awareness material - particularly in relation to FloodSafe or StormSafe material - make sure information / intelligence is shared and consistent;

- SES and Moira Shire Council are in the process in writing the Flood Safe guide for Cobram. The mapping has been completed and the wording for the guide is being compiled.

Community and agency knowledge;

- Following the March 2012 flood event, a review of this flood emergency plan included local knowledge from members of the Cobram SES unit, and the Cobram CFA.

As part of planning and response to future flood emergencies, local groups such as those listed above should be considered for the knowledge they can provide for specific events.

Pumps and other service equipment likely to be inundated;

Refer to Cobram section of Moira Shire Pumps and Drains Operations Manual.

Community and agency knowledge;

Look to agencies – BoM FW directives, Council's MEMP, GBCMA FW directive and associated information, etc.

NOTE – intelligence MUST have regard for changes within catchments that modify likely flood behaviour (eg. Mitigation works that reduce the severity of a flood risk)

This intelligence can be presented in a number of ways – on the Y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs. VICSES to complete actions column

Note – In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Station Number 409202 Gauge Location: Murray River at Tocumwal

River Height (m) And or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible
6.40m / 82,000ML/d	Minor Flood Level 25% AEP (4 year ARI)		
6.71m / 98,000ML/d	Moderate Flood Level 20% AEP (5 year ARI)		
6.90m/ 115,000Ml/d	Moderate Flood Level	August 2010 Flood	
7.02m/ 138,000ML/d	Moderate Flood Level 10% AEP (10 year ARI)		
x.GBm/ 210,000ML/d	5% AEP (20 year ARI)		
7.30m / 190,00ML/d	Major Flood Level x4.2% AEP (24 year ARI)	July 1917 Flood	
7.32m/ 205,000ML/d	Major Flood Level x4% AEP (25 year ARI)	May 1974 Flood	
7.37m/ 205,000ML/d	31 year ARI	October 1993 Flood	
7.49m/ 237,000ML/d	2% AEP (50 year ARI)		
7.53m/ 248,000ML/d	5 year ARI	October 1975 Flood	
7.66m/ 285,000/d	1% AEP (100 year ARI)		
x.xxm	Probable Maximum Flood (PMF)		

Note: flood intelligence records are approximations. This is because no two floods at a location, even if they peak at the same height, will have identical impacts. Flood intelligence cards detail the relationship between flood magnitude and flood consequences. More details about flood intelligence and its use can be found in the Australian Emergency Management Manuals flood series.

Command, Control and Coordination

VICSES will assume overall control of the response to flood incidents. Other agencies will be requested to support operations as detailed in this Plan. Control and coordination of a flood incident shall be carried out at the lowest effective level and in accordance with the State Emergency Response Plan (EMMV Part 3). During significant events, VICSES will conduct incident management using multi-agency resources.

Divisional Command will be located at the Hume Region Divisional Command Centre Numurkah to manage the Goulburn River downstream of Shepparton and or the Broken Creek catchment.

The Sectors will be established in towns affected by flooding, utilising local emergency service personnel where possible.

MURRAY RIVER AT COBRAM				
River Height and Flow at Yarrawonga (ML/d & m)	River Height at Cobram (m)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible	Comments
If a large Murray River flood it is a possibility most roads including the Murray Valley Highway and the Goulburn Valley Highway will close, sand and sandbags should be stockpiled where thought to be needed, supplies will be either cut off or severely restricted. As required, drain outfalls should be monitored and closed-off, stormwater pumps should also be monitored as required. A number of portable pumps should be available for use during any flood event which occurs within the Shire. The Cobram levee is in good condition and provides protection (albeit with variable freeboard) up to a little over the 100 year ARI event. The PWD levees provide a much lower level of protection (around 20-year ARI) to the rural areas and are generally not as well maintained. Flood inundation mapping exists for a variety of scenarios, levee or channel breach's or overtopping, have the potential to change flood behaviour quite remarkably. The scenarios are not detailed in this Flood Intelligence Card. Users are referred to the appropriate mapping delivered by Water Technology (2011). Available mapping scenarios comprise: • Levee overtopping without failure (no levee failure); • Victorian levee failure; • NSW levee failure; and • Victorian irrigation channel removal				
6.4m 82,000ML/d			Shut valve at North East Drainage Dam. Once river reaches pipe turn pump to auto.	Minor flood level for downstream Yarrawonga
	6.6m – 6.8m	Need to close off drains	On gravel section of River Road, "water over road" signs required. Continue to monitor remainder of sealed section. Thomson's Beach, access closed. Bourke Court, drain to river, close valve on River Road Lirrk Street / Churr Street, drain under levee to be closed by valve. Martinvale Court, close valve drain under levee. (Shut valve and pump as required)	There are further drains located along the remaining length of the levee to Yielima. These drains are located on the levee plans and are closed by adjacent landholders or local groups.

MURRAY RIVER AT COBRAM				
River Height and Flow at Yarrawonga (ML/d & m)	River Height at Cobram (m)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible	Comments
			Brepbir Court and Boorin Street, drain under levee to be sandbagged off on the water side and side entry pit on the NW corner of the intersection to be sealed by balloon. (Shut valve on road side of levee then pump when water builds up in pit) Manse Road, north of Sims Road, drain to be sealed off. (Shut valve and pump when water builds up in pit) North end of Racecourse Road, 1 x drain to the east of the road and 2 x drains to the east of the road to be sealed off. (Put balloon in drain to the west. Put balloon in drain to the east of racecourse road)	
6.7m 98,000ML/d				Moderate flood level for downstream Yarrawonga
7.3m 153,400ML/d	7.67m		Close monitoring required for bigger floods. Is equivalent to around 7.10m on the Tocumwal gauge.	
183,000ML/d	8.20m			1993 flood level
7.8m 182,000ML/d				Major flood level for downstream Yarrawonga
7.9m 193,000ML/d		Water confined to the river channel except to the north of the Mywee–Koonoomoo Road and the Bearii–Mywee Road where shallow flooding occurs along Ulupna Creek and other drainage		10% AEP event

MURRAY RIVER AT COBRAM				
River Height and Flow at Yarrawonga (ML/d & m)	River Height at Cobram (m)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible	Comments
		lines – see mapping. Old Coach Road flooded near Tocumwal.		
234,000ML/d	8.59m		Monitor depth of water flowing over the Murray Valley Highway near Dicks Spillway. Prepare to advise VicRoads on need to close the road. (Water will begin to flow over the well at North East Drainage dam). This will need engineering assessment.	1975 flood level
8.5m 251,000ML/d		Breakout has occurred ~1.5km upstream of Dicks Spillway near Dairy Paddock Lane. Flow across the Murray Valley Highway is generally up to 500mm deep but up to 1m deep in places. Cemetery Road flooded to depth. Flooding not expected at Cobram. North of Mywee–Koonoomoo and Bearii–Mywee Roads, flooding is generally up to 500mm deep but up to 1m deep in some areas – see mapping. Most local roads flooded.	If further rises, prepare to block the flow path along the Murray Valley Highway with a temporary levee. If this is not done or fails, residential properties in the vicinity of William, High, Sydney, Station, Murray and Punt Streets will be impacted along with properties in Campbell Road adjacent to Dudley Park Lane, Acadia, Gregory, Thomson, Karook, Gorton, Nicolina and Irene Streets and Grasso Drive as well as the grounds of the Cobram Secondary College. Consider 4000 sandbags as emergency measure in case Murray Valley Highway needed a levee	5% AEP event
9.0m 328,000ML/d		Many rural roads impassable. Murray Valley and Goulburn Valley Highways impassable. Railway line may be flooded. Flow over Dicks Spillway is ~20mm deep. Flow from breakout near Dairy Paddock Lane	Maintain temporary levee on the Murray Valley Highway to the east of Cobram in order to prevent flooding of the town. Consider installing temporary barriers on property access routes on River Road.	2% AEP event

MURRAY RIVER AT COBRAM				
River Height and Flow at Yarrawonga (ML/d & m)	River Height at Cobram (m)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible	Comments
		heads west then north west to Yarroweyah and Koonoomoo.		
9.3m 387,000ML/d	9.21m	Large area of the Shire flooded with many properties and communities either isolated or evacuated. Many roads impassable. Railways likely to be compromised. Flow over Dicks Spillway is ~370mm deep. Flow from breakout near Dairy Paddock Lane affecting a wider area including Yarroweyah and Strathmerton.	Monitor temporary barriers and levees. Install temporary barriers at Mookarii Street in order to maintain required freeboard.	1% AEP flood level
9.5m 448,000ML/d		Flow over Dicks Spillway is ~400mm deep.		0.5% AEP (200 year ARI)
9.7m 528,000ML/d		Flow over Dicks Spillway is ~600mm deep.		0.2% AEP (500 year ARI)

YARROWEYAH – MURRAY RIVER FLOODING				
River Height and Flow at Yarrawonga (ML/d & m)	River Height at Cobram (m)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible	Comments
6.4m 82,000ML/d				Minor flood level for downstream Yarrawonga
6.7m 98,000ML/d				Moderate flood level for downstream Yarrawonga
183,000ML/d	8.20m			1993 flood level
7.8m 182,000ML/d				Major flood level for downstream Yarrawonga
7.9m 193,000ML/d				10% AEP event
234,000ML/d	8.59m			1975 flood level
8.5m 251,000ML/d			If further rises, begin to think about Murray Valley Highway access and need to supply and/or evacuate Yarroweyah, having regard for the shrinking island at the north east end of town.	5% AEP event
9.0m 328,000ML/d		Murray Valley Highway impassable in both directions with water up to 500mm deep. Intersection of Kokoda Road, Kenny Road and Murray Valley Highway flooded to 500mm. Properties fronting Murray Valley Highway, Gooley Street and Kenny Road flooded up to 250mm or more. Higher parts of town (north east – Centre, Amos		2% AEP event

YARROWEYAH – MURRAY RIVER FLOODING				
River Height and Flow at Yarrawonga (ML/d & m)	River Height at Cobram (m)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible	Comments
		and North Streets) form a shrinking island. Railway line may be flooded.		
9.3m 387,000ML/d	9.21m	All properties in Yarroweyah flooded to up to 250mm and dry island at NE end of town is continuing to shrink. More extensive flooding of the Murray Valley Highway. Railway line likely to be flooded with some damage.		1% AEP flood level
9.5m 448,000ML/d		Very little of the dry island to NE of town remaining. Most properties in town flooded by up to 500mm with those fronting the Murray Valley Highway flooded by up to a metre.		0.5% AEP (200 year ARI)
9.7m 528,000ML/d		A metre or more of water through most of the town.		0.2% AEP (500 year ARI)

STRATHMERTON – MURRAY RIVER FLOODING				
River Height and Flow at Yarrawonga (ML/d & m)	River Height at Cobram (m)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible	Comments
6.4m 82,000ML/d				Minor flood level for downstream Yarrawonga
6.7m 98,000ML/d				Moderate flood level for downstream Yarrawonga
183,000ML/d	8.20m			1993 flood level
7.8m 182,000ML/d				Major flood level for downstream Yarrawonga
7.9m 193,000ML/d				10% AEP event
234,000ML/d	8.59m			1975 flood level
8.5m 251,000ML/d			If further rises, begin to think about Murray Valley Highway access and the need to supply and/or evacuate Strathmerton.	5% AEP event
9.0m 328,000ML/d		Murray Valley Highway impassable to the east (Cobram) and west (Nathalia) with water up to 500mm deep. Railway line from Numurkah and to Cobram and Tocumwal may be flooded.		2% AEP event
9.3m 387,000ML/d	9.21m	Most properties and roads in Strathmerton flooded up to 250mm including the fire station.		1% AEP flood level

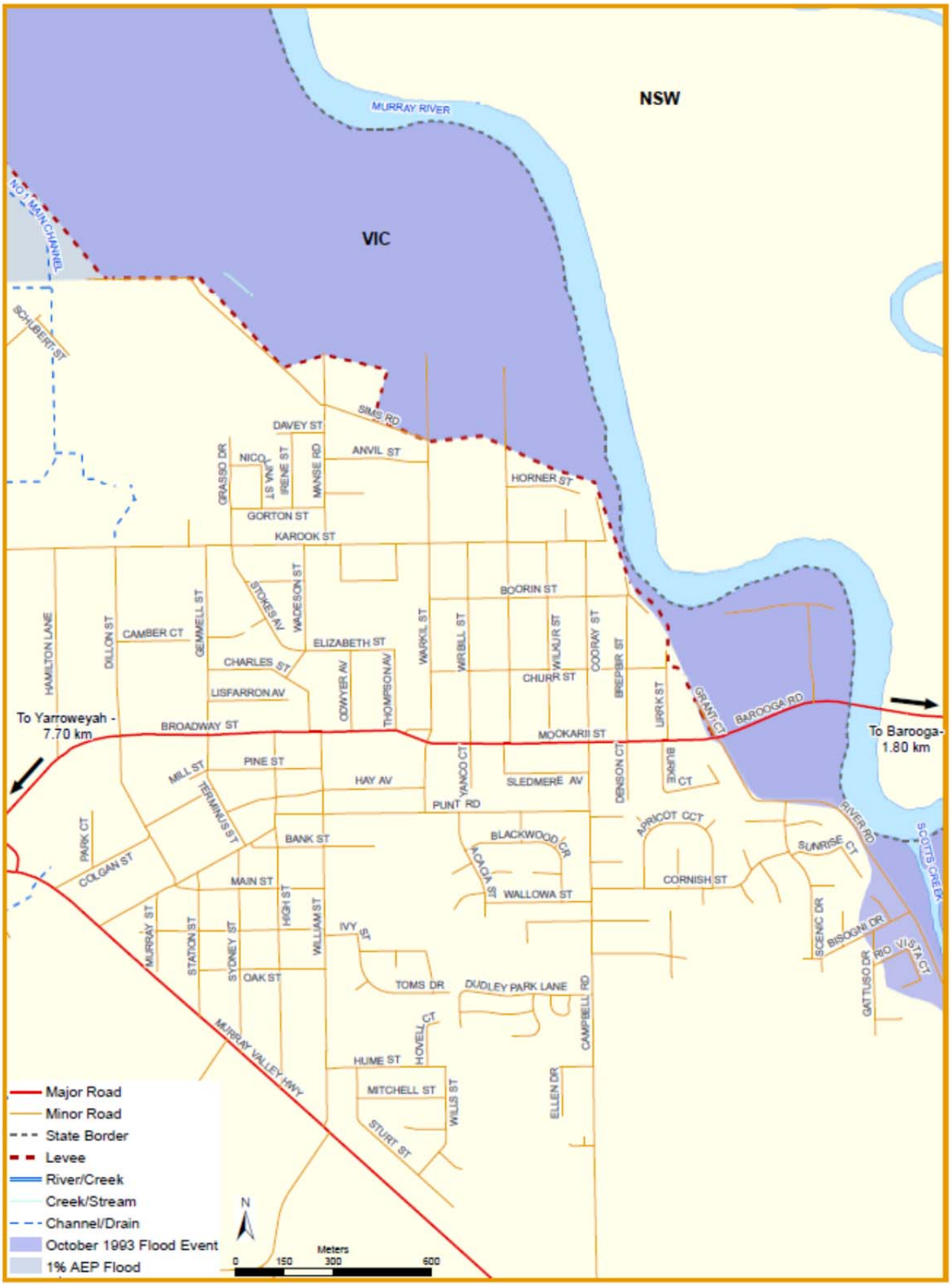
STRATHMERTON – MURRAY RIVER FLOODING				
River Height and Flow at Yarrawonga (ML/d & m)	River Height at Cobram (m)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible	Comments
		More extensive flooding of the Murray Valley Highway. Railway line from Numurkah and to Cobram and Tocumwal likely to be flooded with some damage.		
9.5m 448,000ML/d		Flooding through Strathmerton up to 500mm deep.		0.5% AEP (200 year ARI)
9.7m 528,000ML/d		Flooding through Strathmerton up to 1m deep.		0.2% AEP (500 year ARI)

KOONOOMOO – MURRAY RIVER FLOODING				
River Height and Flow at Yarrawonga (ML/d & m)	River Height at Cobram (m)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible	Comments
6.4m 82,000ML/d				Minor flood level for downstream Yarrawonga
6.7m 98,000ML/d				Moderate flood level for downstream Yarrawonga
183,000ML/d	8.20m			1993 flood level
7.8m 182,000ML/d				Major flood level for downstream Yarrawonga
7.9m 193,000ML/d				10% AEP event
234,000ML/d	8.59m			1975 flood level
8.5m 251,000ML/d			Begin to think about access to Koonoomoo and the rural area to the north and west and the need to supply and/or evacuate the township and rural properties.	5% AEP event
9.0m 328,000ML/d		Koonoomoo flooded with water up to 500mm deep through the town. Goulburn Valley Highway impassable in both directions with water up to 1m deep. Cobram - Koonoomoo Road and Mywee Road impassable with water more than 1m deep in places.		2% AEP event
9.3m	9.21m	More extensive flooding of the town and		1% AEP flood level

KOONOOMOO – MURRAY RIVER FLOODING				
River Height and Flow at Yarrawonga (ML/d & m)	River Height at Cobram (m)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible	Comments
387,000ML/d		surrounding area.		
9.5m 448,000ML/d				0.5% AEP (200 year ARI)
9.7m 528,000ML/d				0.2% AEP (500 year ARI)

Flood inundation maps (including LSIO, SBO and FZ delineations from the Planning scheme);

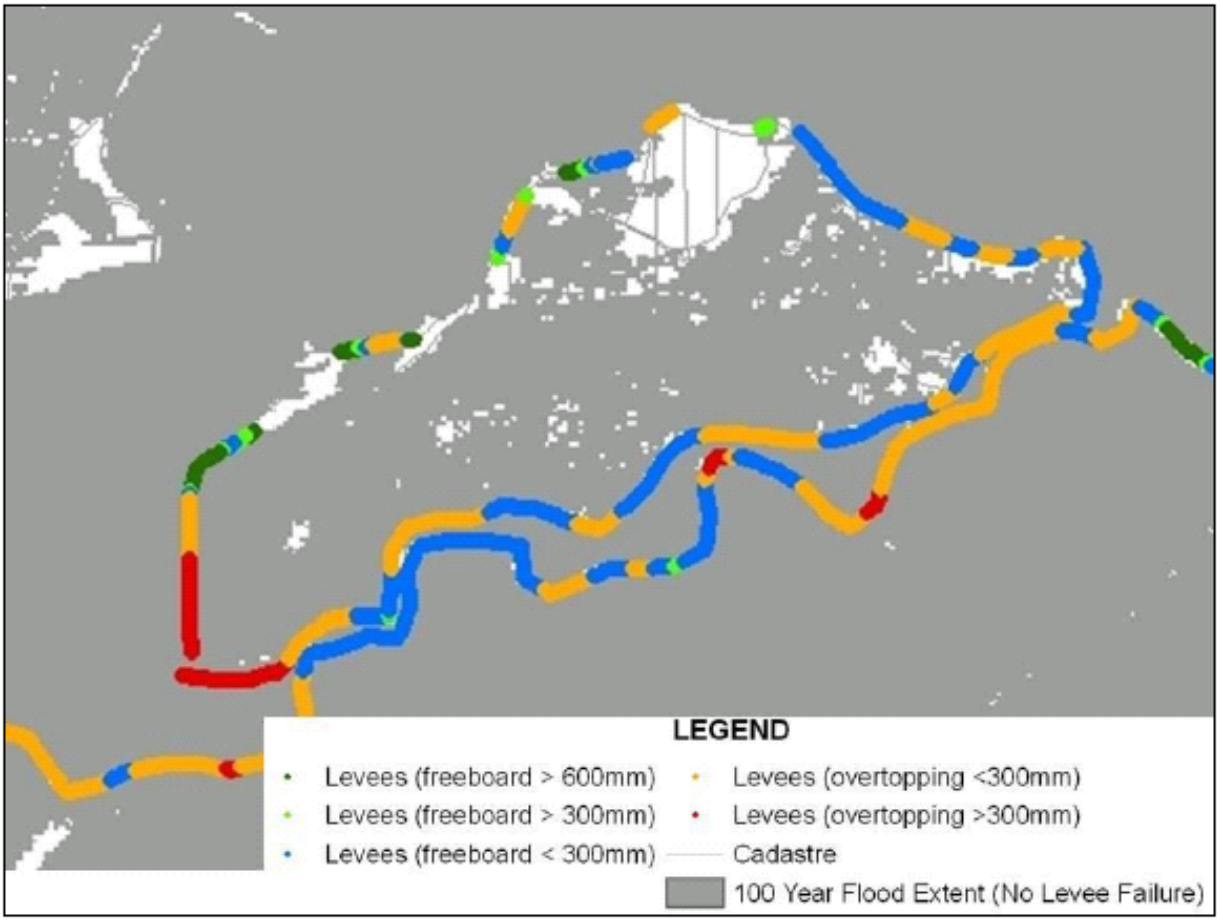
Cobram



APPENDIX C4 – ULUPNA ISLAND FLOOD EMERGENCY PLAN

The Ulupna Island levee provides protection for floods up to and including the 10 year ARI event (193,000 ML/d at Yarrawonga). Overtopping of the levee commences at the north east end of the island during a 20 year ARI flood event (251,000 ML/d at Yarrawonga). There are 14 sections of this levee that will be overtopped by up to 400 mm during a 100 year ARI event. The sections range in length from 250m to 1,750m. A figure and table in Appendix D of Water Technology (2011) provides details.

The levee was not overtopped in the 1993 flood (183,000 ML/d at Yarrawonga) but significant failures/overtopping occurred during the 1975 event.



Ulupna Island Levee

APPENDIX C5 – BEARII / MORGANS BEACH FLOOD EMERGENCY PLAN

Broad sheet flooding occurs around Bearii and generally ranges from 150mm to 500mm in depth, although there will be some areas that are flooded up to 1m deep.

Flooding at Morgan's Beach is not generally regarded to be a problem.

In the event of a levee failure or overtopping, the Drain 6 outfall should be monitored closely to allow water to be returned to the river at this point as soon as possible.

APPENDIX C6 - BARMAH FLOOD EMERGENCY PLAN

Flooding at Barmah is complex and can occur in a variety of ways:

- From Murray flooding due to levee breach or overtopping;
- From Murray flooding as a result of major breakouts upstream moving across country behind the levees;
- From Goulburn River flooding and Loch Garry releases causing a backup of water to Barmah.

If the Murray River is not in flood, **Barmah will not be threatened by Broken Creek flooding**, as breakouts occur to the north east downstream from Picola and into the Barham Forest, as happened in March 2012. Silting of the Broken Creek channel near Barmah can however elevate levels but the upstream breakouts will operate before flood waters threaten the town. Remnant levees and subtle rises in ground level also act to protect the Barmah township from Broken Creek floods.

This 1% AEP flood level at Barmah is estimated at 96.9mAHD, about 0.4m above the 1975 flood level or about the average level of the top of the levees from Barmah upstream to Corry's Mill Road.

The Barmah levees provide protection from about a 3% AEP Murray River flood. Considerable sandbagging was carried out in 1993 to protect the town (the 1975 and 1993 floods are rated at about 3 to 4% AEP (about 30 year ARI) events at Barmah) and as a result it is considered unlikely that a 1% AEP flood could be withstood. The levees would be overtopped or possibly breached and, based on 1994 study results, it is expected that some 51 of the 106 buildings in the town would be flooded.

In view of the above, protective efforts should concentrate on the levees which directly protect the town and if necessary abandon any efforts to hold the Moira Lakes Road levee past Racecourse Road or any other levees of a similar nature.

The town drainage system requires attention prior to the arrival of a flood (see below).

Access to Barmah should remain possible via the Picola-Barmah Road during a 1993 or 1975 size event provided the road has not been cut by Broken Creek flooding. In a 1% AEP flood, Barmah would most likely be isolated to all but boat or air (helicopter) traffic. Required resources, including sand and bags would need to be in place ahead of isolation.

Between the Barmah choke and Echuca, flood behaviour in the Murray River is dominated by flooding from the Goulburn River.

What areas are affected

In a major Murray River flood the Caravan Park to the north of the Murray River crossing and areas directly north of town including Corry's Street and Moira Lakes Road are most at risk. In a major Murray River and Broken Creek flood the above areas plus areas to the east of town could be impacted.

Contact: Mick Caldwell local and works for AGVIC 0427 808 501 for more details on Barmah.

Caravan parks likely to be affected

- As above, the Barmah Caravan Park at the Murray River crossing is likely to be affected by a major Murray River flood, low lying areas in this Caravan Park could also be affected by a high river event.

How many properties

- In a major flood that overtops the levees at Barmah most of the township is at risk of over-floor inundation.

How much warning time

- Murray River: 5-7 days based on height information received from the Tocumwal gauge.
- Conditions need to be monitored that take into consideration flooding or large flows from the Broken Creek and Goulburn River. Both these water courses can impact flooding in the Barmah township depending on timing.

Impacts on essential community infrastructure

- Road infrastructure would be impacted cutting access to township.

Isolation risks

- In a major flood that overtops the levees at Barmah, most of the township is at risk of isolation. Low lying section of Caravan Park at the River crossing may also become isolated in a high river event.

Major road closures

- Barmah Road (NSW to Echuca-Moama)
- Shepparton-Barmah Road
- Picola-Barmah Road
- James Bridge Road

Locations where evacuation difficulties may occur for example low flood islands

N/A

Flood Mitigation

Where do levees and retarding basins exist?

- Barmah Caravan Park north of Murray River crossing.
- The entire length of Moira Lakes Road
- Murray Street along the Murray River to Swan Court behind properties on Riverview Drive.
- Corry Street from Picola-Barmah Road to in-between Tinkler and Rice Streets
- No retardation basins exist in Barmah

Location of any spillways? Details of any levee closure points such as railway crossing etc., which may need to be sandbagged.

- Barmah Caravan Park levee near Murray River crossing requires sandbagging to complete levee.

Flood Impacts and Required Actions

Deliverables from flood, drainage and other studies;

Flood inundation maps (including LSIO, SBO and FZ delineations from the Planning Scheme);

Hydraulic modelling / flood inundation animations;

- N/A

Past flood experience – gleaned from Council files, records and reports of previous floods including nature and severity of floods (ie. flash floods, riverine floods, major floods etc), newspaper accounts, post-event funding submissions, etc;

Community or agency flood awareness material - particularly in relation to FloodSafe or StormSafe material - make sure information / intelligence is shared and consistent;

Community and agency knowledge;

- Local knowledge from long term residents, Barmah CFA, AGVIC, Parks Victoria, Moira Shire staff past and present.

Any sewer pumps likely to be inundated;

- The Caravan Park sewer maybe inundated. New sewer system in low lying area close to Murray River.

Any groundwater wells likely to be inundated;

Water treatment plants and water storage areas to be affected;

Pumps and other service equipment etc. likely to be inundated;

Community and agency knowledge;

Look to agencies – BoM FW directives, Council's MEMP, GBCMA FW directive and associated information, etc, etc.

NOTE – intelligence MUST have regard for changes within catchments that modify likely flood behaviour (eg. Mitigation works that reduce the severity of a flood risk)

This intelligence can be presented in a number of ways – on the y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs. VICSES to complete actions column

Note – In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Command, Control and Coordination

VICSES will assume overall control of the response to flood incidents. Other agencies will be requested to support operations as detailed in this Plan. Control and coordination of a flood incident shall be carried out at the lowest effective level and in accordance with the State Emergency Response Plan (EMMV Part 3). During significant events, VICSES will conduct incident management using multi-agency resources.

Divisional Command will be located at the Hume Region Divisional Command Centre Numurkah to manage the Goulburn River downstream of Shepparton and or the Broken Creek catchment.

The Sectors will be established in towns affected by flooding, utilising local emergency service personnel where possible.

Barmah and surrounding area

MURRAY RIVER AT BARMAH			
River Height at Barmah (m)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Action[7]	Comments
The 1993 flood level is marked on the gauge board in blue. At this level there is approximately 100mm. of freeboard on the adjacent roadway.			
▪ The indicator for likely flooding at Barmah is around 7.30m at Yarrawonga Weir (140,000 -150,000ML/d) or 7.67m at Cobram or 7.10m at Tocumwal. ▪ If there is a major flood in the Goulburn River, levels at Barmah will be a little higher than perhaps expected as there will be some back-up in the Murray from the confluence downstream.			
5.4m		▪ Caravan Park - 1 x main drain to be blocked	Installation of non-return flap at end of culvert
5.8m	Drains in all levees must be closed before this level.	▪ Moira Lakes Road from town to Racecourse Road, 3 x drains which have to be blocked and pumped as required. ▪ Moira Lakes Road from Racecourse Road to the end, further 3 x drains which have to be blocked. ▪ Murray Street, 6 x drains to be blocked and pumped as required, including the 450mm pump located near the Water Treatment Plant. Power for this unit is located inside the plant building now operated by GV Water.	Will also need to place marker posts so they are more easily located.
6.00m			Minor Flood Level
6.2m		▪ Caravan Park - further 4 x main drains to be blocked	
6.50m			Moderate Flood Level
6.80m	Expect some flooding issues around Barmah.		Corresponds to ~7.10m at Tocumwal or 7.30m at Yarrawonga.
7.00m		Need to monitor drains	Major Flood Level

[7] All references to unsafe driving depths have been extracted from Appendix J of *Floodplain Management in Australia, Best Practice Principles and Guidelines* (ARMCANZ, 2000)

MURRAY RIVER AT BARMAH			
River Height at Barmah (m)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Action[7]	Comments
		Monitor levees for limit of protection	
7.21m			1975 flood
7.22m	Levee likely to be close to overtopping.	Sandbagging required to protect some houses.	1993 flood
7.61m	Extensive flooding. Town cut off		

Note: flood intelligence records are approximations. This is because no two floods at a location, even if they peak at the same height, will have identical impacts. Flood intelligence cards detail the relationship between flood magnitude and flood consequences. More details about flood intelligence and its use can be found in the Australian Emergency Management Manuals flood series.

APPENDIX C7 – MUCKATAH DEPRESSION FLOOD EMERGENCY PLAN

The Muckatah Depression is a natural shallow, flat and wide drainage basin (approx. 280km^2) that starts upstream of Dowdles Swamp (south of Yarrawonga and west of Bundalong), follows along the Muckatah Creek and then joins the Broken Creek via Kinnaird's Swamp upstream of Numurkah, around Naring. Levels taken at Naring (CFA station) provide an indication of flow timings.

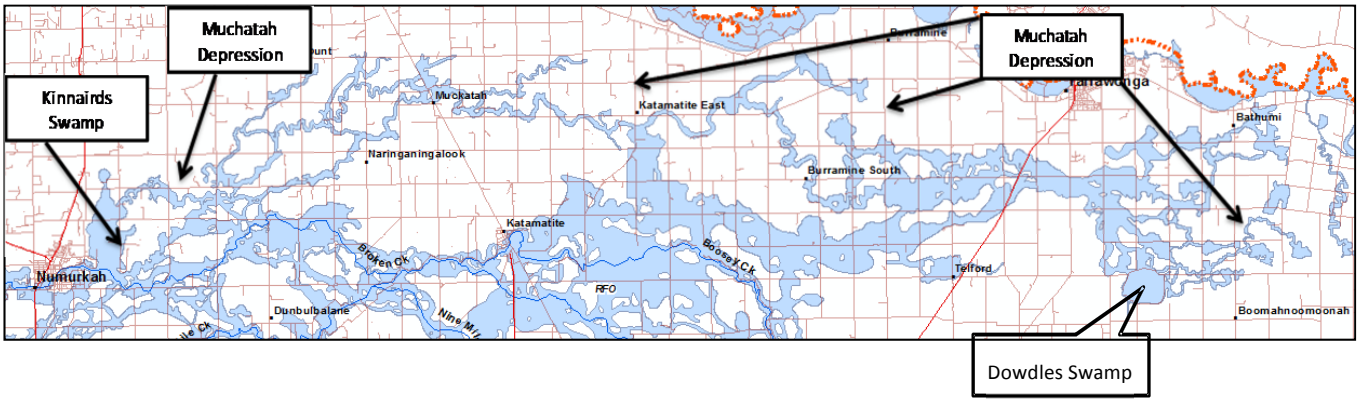
Water draining from this basin can cause high water levels to stay around longer or add to flooding in the Broken Creek in and around Numurkah.

No 4 Main Channel has a significant influence on flow paths and flood routing in the lower sections of the Muckatah Depression (ie. closest to Numurkah).

During big floods (eg. like March 2012) the movement of floodwater along the Muckatah Depression floodplain is slower than the floodwater in the Broken Creek system. There may also be a transfer of flows between the Muckatah Depression and Boosey Creek. The transfer can occur both ways.

During a large regional event with significant rain across the Muckatah Depression (eg. at Yarrawonga), the water from the Muckatah Depression comes into the Broken Creek behind the main peak (Depression water gets held back) resulting in a very slow recession at Numurkah – but no second rise.

1% AEP flood levels at Muckatah vary from 114.3mAHD on the upper side of town to 114.0mAHD on the lower.



Overview of Flooding Consequences

- During big floods, floodwater from the Muckatah Depression can impact areas south of Yarrawonga, the Muckatah township and farms along the length of the Depression.
- Floodwater travels along the Muckatah Depression more slowly than floodwater travels along the Broken Creek.
- During a large regional flood with significant rain across the Broken Creek basin, floodwater in the Muckatah Depression is held back by the main body of floodwater travelling along the Broken Creek. In Numurkah, this results in flood heights dropping more slowly or staying around for longer.
- Floodwater from the Muckatah Depression does not usually cause a second rise in flood levels at Numurkah or create a higher flood peak. Some flow from the Muckatah Depression is also known to breakout to the west and flow north of Numurkah.

What areas are affected

The Muckatah Depression.

How many properties

- Unknown

How much warning time

- It is unknown of warning times in large rainfall events. Residents must be prepared to be isolated if large rain events occur.

Impacts on essential community infrastructure

- The Naring Hall/CFA Station will require sandbagging in a large flood.

Isolation risks

- Many residents will be isolated during a large flood or large rail event until the depression drains into the Broken Creek.

Major road closures

- Benalla-Tocumwal Road
- Yarrawonga-Benalla Road
- Katamatite-Yarrawonga Road
- Goulburn Valley Highway
- Numerous sealed links and collector roads that run north-south will also be closed.

Locations where evacuation difficulties may occur for example low flood islands

- unknown

The Muckatah Surface Water Management Scheme

The Muckatah drainage scheme covers approx. 280km^2 of farm land from Dowdles Swamp to Numurkah and incorporates the areas of Wilby, Tungamah, Burramine, Boosey, Katamatite, Naring, Invergordon and Numurkah.

The Muckatah Surface Water Management System provides outfall for surface water from small to medium rain events and thus slows and reduces outflows into the Broken Creek upstream from Numurkah (downstream from Naring). In other words, it aims to remove (drain) excess water from farm land caused by minor storms through a series of drains. It is not a flood mitigation scheme and thus the system has limited impact on flows from the Depression during large rain events, such as occurred in March 2012.

Flood Mitigation

- Nil

Flood Impacts and Required Actions

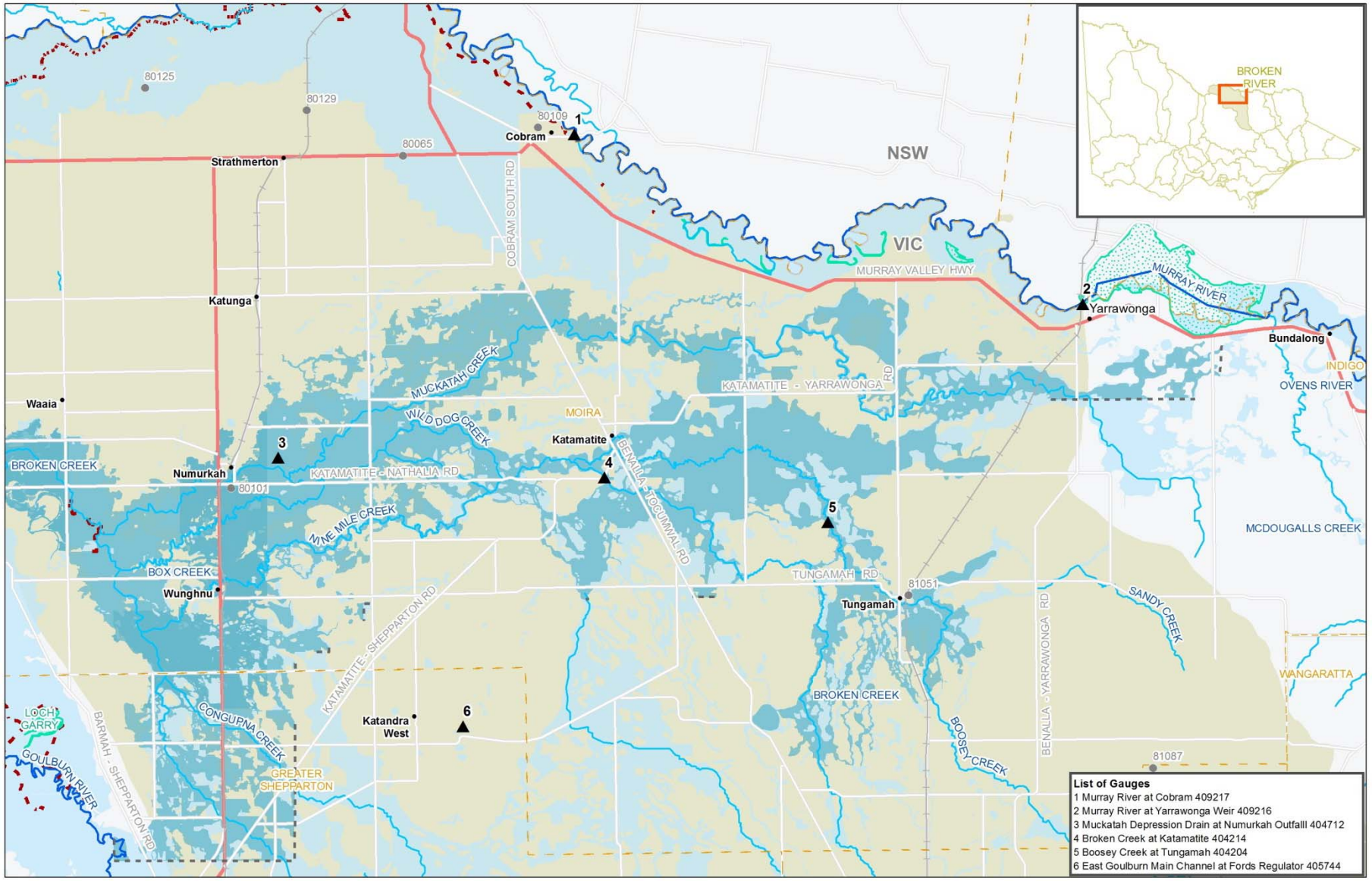
Deliverables from flood, drainage and other studies;

Flood inundation maps (including LSIO, SBO and FZ delineations from the Planning Scheme);

Hydraulic modelling / flood inundation animations

- N/A

Broken River and Boosey Creek Catchment - Muckatah Depression



DISCLAIMER
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Past flood experience – gleaned from Council files, records and reports of previous floods including nature and severity of floods (ie. flash floods, riverine floods, major floods etc), newspaper accounts, post-event funding submissions, etc;

Community or agency flood awareness material - particularly in relation to FloodSafe or StormSafe material - make sure information / intelligence is shared and consistent;

Community and agency knowledge;

Look to agencies – BoM FW directives, Council's MEMP, GBCMA FW directive and associated information, etc, etc.

NOTE – intelligence MUST have regard for changes within catchments that modify likely flood behaviour (eg. Mitigation works that reduce the severity of a flood risk)

This intelligence can be presented in a number of ways – on the y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs. VICSES to complete actions column

Note – In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Command, Control and Coordination

VICSES will assume overall control of the response to flood incidents. Other agencies will be requested to support operations as detailed in this Plan. Control and coordination of a flood incident shall be carried out at the lowest effective level and in accordance with the State Emergency Response Plan (EMMV Part 3). During significant events, VICSES will conduct incident management using multi-agency resources.

Divisional Command will be located at the Hume Region Divisional Command Centre Numurkah and Yarrawonga to manage the Muckatah Depression.

There are currently no automated gauges located within the Muckatah Depression.

APPENDIX C8 – TUNGAMAH FLOOD EMERGENCY PLAN

Overview of Flooding Consequences

Tungamah is flooded by the Boosey Creek which is a result of rainfall across the upper catchment.

No major problems were experienced during the 1974 and 1993 floods although flood water entered the hotel cellar via the footpath in 1973. In March 2012, a number of houses were flooded as well and the town was isolated. Many surrounding roads were flooded to depth and impassable.

1% AEP flood levels vary from 126.2mAHD on the upper side of town to 125.4mAHD on the lower.

Drains within town are not normally a problem.

What areas are affected?

- Areas to the south of Spry Street can be affected in a major flood.

Caravan parks likely to be affected?

- Nil

How many properties?

- In a major flood event 10-20 properties are at risk of over-floor flooding.

How much warning time?

- If a significant amount of rain occurs in the upper catchment (300mm+) it generally takes 2 – 3 days to reach a peak at Tungamah. Warnings are provided from water heights taken at Sandy Creek, Wilby. Sandy creek enters the Boosey creek 3km's east of Tungamah.
- During the February/March 2012 rain/flood event, Tungamah did not have any warning time.

Impacts on essential community infrastructure?

- In a major flood the new sewer system in Tungamah maybe inundated, the impact of this is unknown at this stage as the sewer has not been flooded.
- Limited access to the Town Hall in Barr Street and Maternal &Child Health Centre in Middleton Street.

Isolation risks?

- The township of Tungamah is at risk of being isolated for 4-7 days.
- 10-20 rural properties are at risk of major isolation for 4-7 days during a major flood event.
- Deliveries to the township may be cut during a major flood.

Major road closures?

- Devenish Road
- Tungamah Road
- Tungamah Main Road

Locations where evacuation difficulties may occur for example low flood islands?

- N/A

Flood Mitigation

- No retardation basins, spillways or levees exist in Tungamah.

Flood Impacts and Required Actions

- If upstream information indicates a large Boosey Creek flood, sand and sandbags should be stockpiled at the Depot, 20,000 sandbags are stored at the Tungamah depot as a minimum at all times
- Water over road signs will be required at Boyd Street, Devenish Road, Tungamah Road and west end of Spry Street.
- Refer to section two of the MSC Operations Manual for pumps and drains.

Hydraulic modelling/flood inundation animations;

- N/A

Past flood experience – gleaned from Council files, records and reports of previous floods including nature and severity of floods (ie. flash floods, riverine floods, major floods etc), newspaper accounts, post-event funding submissions, etc;

Community or agency flood awareness material - particularly in relation to FloodSafe or StormSafe material - make sure information / intelligence is shared and consistent;

- Following the March 2012 flood event, a review of this flood emergency plan included local knowledge from members of the Yarrawonga SES unit and Tungamah CFA.
- As part of planning and response to future flood emergencies, local groups such as those listed above should be considered for the knowledge they can provide for specific events.

Any known or possible community infrastructure impacts including:

- It is unknown at this time; a new sewage scheme is being installed in Tungamah currently.
- The Tungamah Recreation Reserve may be inundated in large flood events.

Any groundwater wells likely to be inundated;

- It is unknown how many ground water wells are in operation, If ground water bores exist it will be the responsibility of the owner/landlord to ensure water is tested and safe, bore water should be monitored if used for domestic purposes, testing should be undertaken periodically. More information can be obtained from the Department of Health.

Community and agency knowledge;

Look to agencies – BoM FW directives, Council's MEMP, GBCMA FW directive and associated information.

NOTE – intelligence MUST have regard for changes within catchments that modify likely flood behaviour (eg. Mitigation works that reduce the severity of a flood risk)

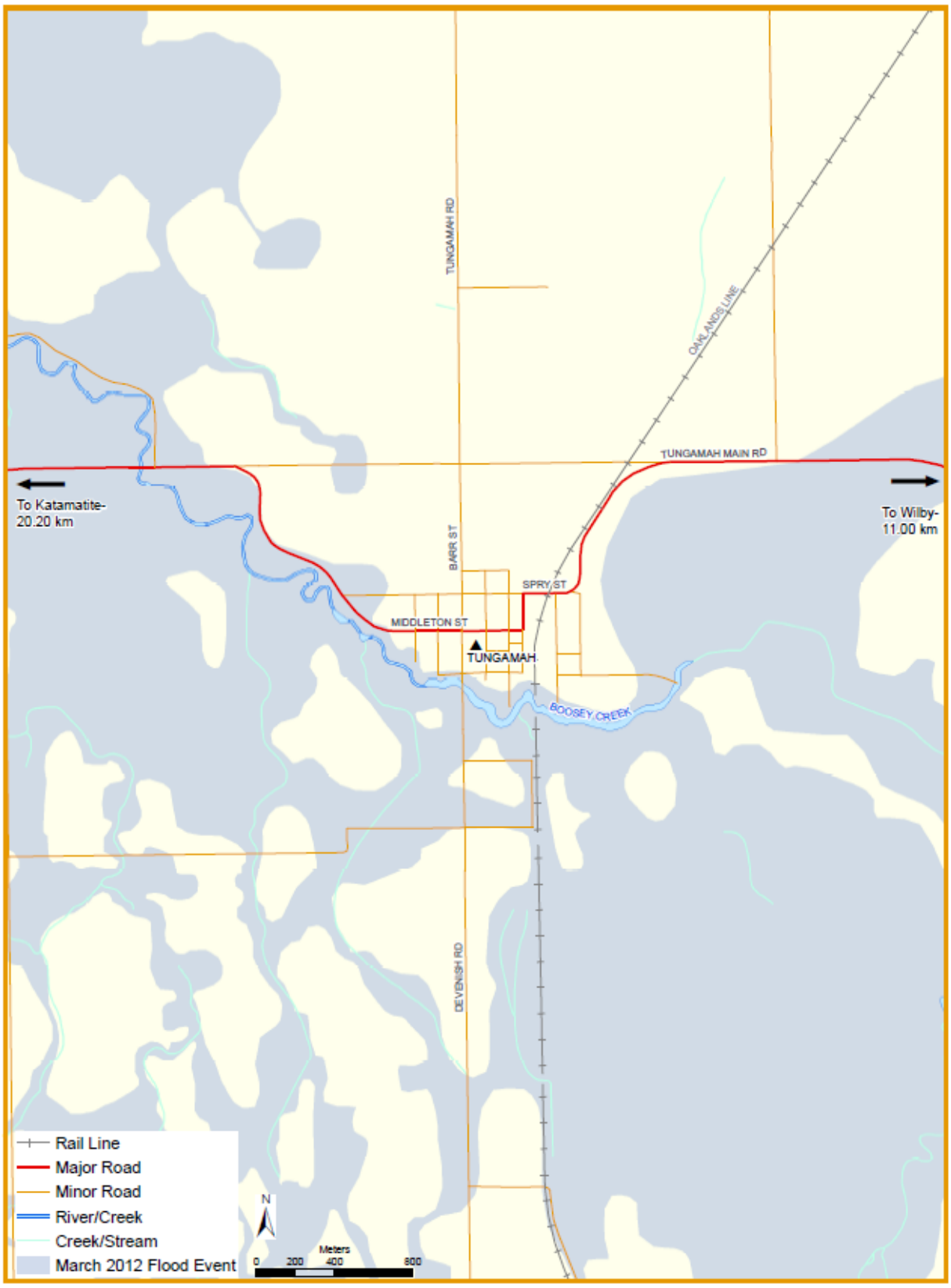
This intelligence can be presented in a number of ways – on the y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs. VICSES to complete actions column

Note – In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Flood inundation maps (including LSIO, SBO and FZ delineations from the Planning Scheme);

Tungamah



Command, Control and Coordination

VICSES will assume overall control of the response to flood incidents. Other agencies will be requested to support operations as detailed in this Plan. Control and coordination of a flood incident shall be carried out at the lowest effective level and in accordance with the State Emergency Response Plan (EMMV Part 3). During significant events, VICSES will conduct incident management using multi-agency resources.

Divisional Command will be located at the Hume Region Divisional Command Centre Numurkah to manage the Goulburn River downstream of Shepparton and or the Broken Creek catchment.

The Sectors will be established in towns affected by flooding, utilising local emergency service personnel where possible.

Station Number 404204 Gauge Location: Boosey Creek at Tungamah

River Height (m) and/or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible
x.xxm	Minor Flood Level x% AEP (xx year ARI)		
2.31m/ 8,810ML/d	x% AEP (5 year ARI)	July 1995 flood	
x.xxm			
2.35m/ 3,980ML/d	x% AEP (5 year ARI)	July 1981 flood	
2.35m / 4,070ML/d	20% AEP (5 year ARI)		
2.43m/ 4,760ML/d	x% AEP (6 year ARI)	August 1973 flood	
2.46m/ 5,250ML/d	x% AEP (7 year ARI)	October 1975 flood	
2.54m / 7,220ML/d	10% AEP (10 year ARI)		
2.66m / 11,900ML/d	4% AEP (25 year ARI)		
2.73m / 15,700ML/d	2% AEP (50 year ARI)		
2.73m/ 15,700ML/d	x% AEP (53 year ARI)	October 1993 flood	
2.81m / 19,400ML/d	1% AEP (100 year ARI)		
2.88m/ 24,000ML/d	unknown% AEP (unknown year ARI)	March 2012 flood	
x.xxm	Probable Maximum Flood (PMF)		

Note: flood intelligence records are approximations. This is because no two floods at a location, even if they peak at the same height, will have identical impacts. Flood intelligence cards detail the relationship between flood magnitude and flood consequences. More details about flood intelligence and its use can be found in the Australian Emergency Management Manuals flood series.

FLOOD LEVELS RESPONSE GUIDE –TUNGAMAH TOWNSHIP

Likely Flooding Scenario

Flooding of areas within and surrounding Tungamah generally occur following heavy rains (>100mm.) in the catchment upstream of the township and can be exacerbated by inflows from a flooded Broken River at Casey's Weir. Tungamah was substantially free from floods in the 1974 and 1993 events, when flooding does occur in the town; problems are generally minor and are managed locally because the town is isolated.

However, the flood of 2012 caused major damage to property in Tungamah with 10-20 houses inundated and the Recreation Reserve inundated. Flood waters remained in the township for 4-7 days.

Large areas of rural land in the vicinity of town are inundated and many of the roads in the area are cut by floodwaters making road closures and signing a critical task. Access to the town is generally maintained from the North (but in major Muckatah depression flows, the north access can also be cut) many of the roads to the east and west will be closed.

The strategy used in Tungamah is based on close monitoring of the position in the catchment regarding rainfall and catchment condition.

Key Warning/Trigger Gauge
No upstream gauge exists which would provide a clear warning to the town. Monitoring of rainfall within the area and local knowledge may give pre-warning advice to the township.

APPENDIX C9 - KATAMATITE FLOOD EMERGENCY PLAN

Overview of Flooding Consequences

The Victorian town of Katamatite is located on the Boosey Creek about 200km north-northeast of Melbourne with a population of around 200.

The upper catchment of the Broken Creek is bound to the east and south by hills with flatter country on the east, north and west. The majority of the catchment features flat to very flat slopes.

Boosey Creek joins Broken Creek downstream of Katamatite below Gilmour's Bridge. Parts of the town were flooded in March 2012 and access was cut to the township.

There are two main results which follow from the relatively flat landscape of the catchment:

- When flooding occurs it can be very extensive and last for some considerable time;
- Cross-catchment flows of water can occur

Transfer of water can occur either into or away from the Broken Creek and adjoining catchments (ie. From the Broken River and to (and from) the Muckatah Depression).

1% AEP flood levels vary from 116.2mAHD on the upper side of town to 115.9mAHD on the lower.

What areas are affected

- Areas to the east and south of town are most susceptible to flooding in a major event. These areas include houses along Beek Street, Hotchin Street and Cemetery Road, with the Katamatite Recreation Reserve liable to inundate during a major flood.

Caravan parks likely to be affected

- One in a large flood

How many properties

- Approx. 19 properties flooded above floor level

How much warning time

- Typically Katamatite has up to 5 days warning if the rain falls in the foothills east and south of Tungamah.

Impacts on essential community infrastructure

- The Katamatite Recreation Reserve oval is liable to flooding in a major event.

Isolation risks

- The township of Katamatite has a high risk of isolation in a major flood event. The town is likely to be cut off/isolated for more than a week in a major flood event.

Major road closures

- Benalla-Tocumwal Road (North and South of town), Katamatite-Nathalia Road and Yarrawonga-Katamatite Road

Locations where evacuation difficulties may occur for example low flood islands

- Unknown

Flood Mitigation

There are levees in Katamatite. Sandbagging is the only measure of protecting property and infrastructure.

Katamatite has no retardation basins.

Flood Impacts and Required Actions

Deliverables from flood, drainage and other studies;

Refer to Katamatite section of MSC Pumps and Drainage Operations Manual.

Hydraulic modelling/Flood inundation animations;

- N/A

Past flood experience – gleaned from Council files, records and reports of previous floods including nature and severity of floods (ie. flash floods, riverine floods, major floods etc), newspaper accounts, post-event funding submissions, etc;

Community or agency flood awareness material - particularly in relation to FloodSafe or StormSafe material - make sure information / intelligence is shared and consistent;

- Local Residents, Katamatite CFA past and present members and Lions club members.

Any known or possible community infrastructure impacts including:

- Katamatite does not have a sewage scheme and operate only by septic tank system.
- It is unknown the number of residents that have wells and bores; the operation of these rests with the owner to ensure water is safe for domestic purposes. Contact the Department of Health for further information.

Pumps and other service equipment etc. likely to be inundated;

Community and agency knowledge;

Look to agencies – BoM FW directives, Council's MEMP, GBCMA FW directive and associated information, etc,

NOTE – intelligence MUST have regard for changes within catchments that modify likely flood behaviour (eg. Mitigation works that reduce the severity of a flood risk)

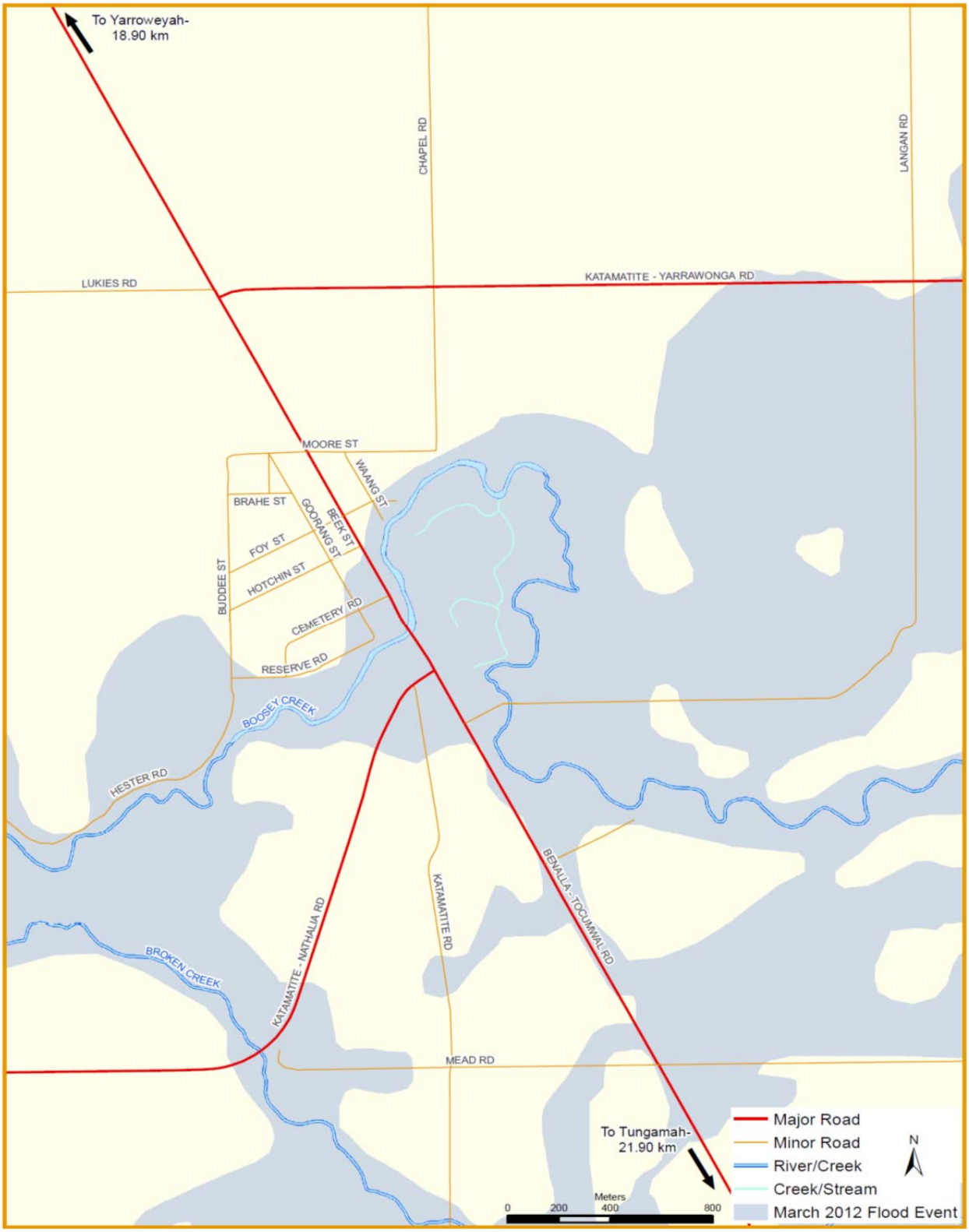
This intelligence can be presented in a number of ways – on the Y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs. VICSES to complete actions column

Note – In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Flood inundation maps (inc. LSIO, SBO and FZ delineations from the Planning Scheme:

Katamatite



Command, Control and Coordination

VICSES will assume overall control of the response to flood incidents. Other agencies will be requested to support operations as detailed in this Plan. Control and coordination of a flood incident shall be carried out at the lowest effective level and in accordance with the State Emergency Response Plan (EMMV Part 3). During significant events, VICSES will conduct incident management using multi-agency resources.

Divisional Command will be located at the Hume Region Divisional Command Centre Numurkah to manage the Goulburn River downstream of Shepparton and or the Broken Creek catchment.

The Sectors will be established in towns affected by flooding, utilising local emergency service personnel where possible.

Station Number 404214 Gauge Location: Broken Creek at Location Katamatite

River Height (m) And or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible
x.xxm			
2.00m / 998ML/d	20% AEP (5 year ARI)		
2.39m / 2,310ML/d	10% AEP (10 year ARI)		
2.71m / 5,700ML/d	4% AEP (25 year ARI)		
2.74m/ 6,250ML/d	28 year ARI	October 1993	
2.81m/ 7,540ML/d	35 year ARI	May 1974 Level: Flood water reached the top step of the Catholic church.	All roads entering to the township to be closed. Sandbagging in Hotchin St, Beek St, Wang St and Goorang St as Flood Water will reach these Properties this will include the CFA Fire Station and Police Station
2.93m / 10,200ML/d	2% AEP (50 year ARI)		
3.10m/ 12,000ML/d		February/March 2012: Flood water reach past the post office in Beek St.	
17,200ML/d	1% AEP (100 year ARI)		
x.xxm	Probable Maximum Flood (PMF)		

Note: flood intelligence records are approximations. This is because no two floods at a location, even if they peak at the same height, will have identical impacts. Flood intelligence cards detail the relationship between flood magnitude and flood consequences. More details about flood intelligence and its use can be found in the Australian Emergency Management Manuals flood series.

APPENDIX C10 - NUMURKAH FLOOD EMERGENCY PLAN

Overview of Flooding Consequences

Numurkah is located on the Broken Creek floodplain about 200km north-northeast of Melbourne and is approximately 111m above sea level. It is the largest town in the Broken Creek catchment with a population of around 4,800. It is located in the middle reach of the catchment, downstream from the Broken Creek – Muckatah Creek confluence.

The Warby Ranges and hill extensions to the north define the eastern boundary of the Broken Creek catchment and the lower Dookie Hills lie alongside part of the southern boundary. Elsewhere the catchment boundaries are indistinct and ground slopes are typically quite flat. As a result and under natural conditions, when flooding occurs it can be quite extensive. Further, flood waters can transfer across catchment boundaries from the Murray River (to the north) and Broken River (to the south). While many of the overflow paths have been restricted or blocked by levees, irrigation channels or roads, a number activate under high flows.

It is well established that breakout flows occur during large floods from the Broken River into Broken Creek downstream from Casey's Weir and further west between Gowangardie and Shepparton into Guilfus, Congupna, Danton's, Pine Lodge and O'Keefe Creeks and move north. Note that the excavated, regulated diversion channel that connects to the top end of Broken Creek is part of the Casey's Weir/Major Creek water supply system, is not a major connector.

The channel capacity of these minor watercourses is not sufficient to accommodate flood flows and extensive inundation of the surrounding land results. These creeks discharge into Nine Mile Creek and then into the Broken Creek between Numurkah and Walsh's Bridge. Transfer of flood waters between tributary catchments is common. It is possible for flood waters from the upper Broken Creek to flow to the north into Boosey Creek upstream of Katamatite. Boosey Creek can also overflow to the northwest into the Boosey – Burramine anabranch, connected to the Muckatah Depression. This transfer also operates in reverse, as occurred in March 2012. Downstream of Katamatite, Broken Creek can overflow into Wild Dog Creek and then to the west into the lower Muckatah Depression. To the south, the overflow is into Box Creek which enters Nine Mile Creek downstream from Wunghnu

Breakouts from near Casey's Weir occur when flow in the Broken River reaches approximately 200 m^3/s or at a water surface elevation of 158.73 mAHD (or around 1.81m at the gauge) at Casey's Weir (Water Technology 2014). A relationship that provides guidance on likely flows based on actual Broken River flows / levels at Casey's Weir is provided in Appendix A of this MFEP.

In large flows, flooding of land in and around Numurkah causes isolation and property damage in the south, south west and east of the township. However, the waterway through Numurkah and the timely operation of the town weir doors can help reduce the impacts of minor and moderate flooding. It is important therefore that the upstream position is monitored and that in the event of an expected significant flood, the Melville Street and Stockyard Weirs are removed early with the co-operation of GMW. This will minimise the ponding of inflows. Other tasks need also to be completed in a timely manner prior to water entering (back-flowing into) the town via the drainage system. Not that in large slow moving floods like March 2012, the operation of these structures may not have a big influence on the peak flood levels.

Downstream from Numurkah, a large area of mainly agricultural land is inundated during major floods. This creates a large volume of flood storage and further slows peak travel times.

Flood Behaviour - Summary

The Broken Creek catchment is relatively slow to react to rain until it wets up. Flow travel times are similarly affected by antecedent conditions. Nevertheless, for a catchment-wide rather than local rain event, the time from the start of upstream flooding to the start of flooding at Numurkah is generally of the order of 24 hours or more. See Appendix B.

Numurkah has been flooded numerous times in the past, including the significant floods of 1917, May 1974, March 2012 and to a lesser extent October 1993.

Flooding at Numurkah is generally caused by significant rainfall over the upstream catchment. Breakout flows from the Broken River downstream from Casey's Weir and also downstream from Gowangardie Weir can also contribute to flows and flooding in the Broken Creek catchment – in the Broken River itself or via Nine Mile Creek.

Flows travel relatively slowly in the Broken Creek catchment: rises are slow and recessions even slower. This means that hydrographs are typically long and flat, although the final shape depends very heavily on where the bulk of rain fell and the main contributing areas (e.g. Broken Creek, Majors Creek, Boosey Creek, Muckatah Depression). That means that the consequences of flooding begin to occur at Numurkah long before the peak is reached. Warning lead time is initially far more important in the Broken Creek catchment than accuracy.

Flows from the Muckatah Depression travel more slowly than flows in other parts of the Broken Creek system and join with the Broken Creek upstream and to the east of Numurkah, via Kinnaird's wetlands. Levels at Naring (CFA station) provide an indication of timings. During a large regional event with significant rain across the Broken Creek catchment, including the Muckatah Depression, water from the Depression generally comes into the Broken Creek behind the main peak resulting in a very slow (extended) recession at Numurkah – but no second rise.

Structures such as drains, irrigation channels, roads and railway lines have a significant impact on flooding in the Broken Creek catchment in terms of slowing the passage of flood water through the catchment and causing water to build up behind those structures. At Numurkah, they have a significant role in protecting properties from inundation, particularly the irrigation channel to the east of the town adjacent to Kinnaird's Road. It holds flood water back and protects much of the eastern part of the town.

Breakouts occur from the Broken Creek at Numurkah in relatively small events with even the 20% AEP (5 year ARI) event breaking out across the floodplain to the south of town. Properties are inundated from the 20% AEP (5 year ARI) event with inundation initially occurring in the southern part of the town. As the flow in the creek increases, water levels rise and the extent of inundation widens significantly.

There are four constriction points at Numurkah that have an impact on flood behaviour because they can hold up water in large events:

- At a narrowing of the waterway adjacent to the golf course;
- At the Melville Street bridge;
- The railway bridge; and
- The Goulburn Valley Highway Bridge.

The Shepparton–Numurkah railway line acts as a levee: water backs-up on the upstream side although the impact on water levels only extends upstream as far as Melville Street. Flood levels in central Numurkah including the business district and southern residential area are not impacted by the railway line. The presence of the railway line and the natural floodplain slope can assist the transfer of water from Numurkah to the south to Wunghnu where water can be still rising after the level has peaked at Numurkah.

The drainage systems to the north of Numurkah cross the Goulburn Valley Highway and, in large floods, carry quite a lot of water to Broken Creek. In March 2012 there were breakouts as drain capacity was not sufficient to carry the volume of runoff. While some locals claimed the flooding resulted from backflow from Broken Creek, the modelling undertaken by Water Technology (2014) proved otherwise.

While a natural sand ridge runs transversely across the floodplain in the vicinity of Walshs Bridge downstream from the Broken – Nine Mile confluence and creates a natural restriction to floodplain flows, it has no influence on flooding at Numurkah.

Design Events – Flood Behaviour

20% AEP Event

- Flooding generally well-contained in Broken Creek through central Numurkah.
- Breakouts occur upstream of Numurkah resulting in inundation of parts of the golf course and some flow through the hospital depression.
- Approximately 12 (Check the number?) properties are inundated at the eastern end of Madeleine Street and Tunnock Road in south-eastern Numurkah with depths up to 300 mm.
- Breakout near Station Street inundates the wetland area as well as one commercial property on Station Street.
- Inundation of Kinnaird Wetlands and low-lying areas around Brooke Court to the east of Numurkah. Partial inundation of approximately 15 properties on Brooke Court/Kinnaird's Road (all below floor flooding).
- The Numurkah-Katamatite Road is overtopped as a result of flows from the hospital depression.
- Some low-lying areas in the floodplain to south of Numurkah are inundated.
- Inundation of a number of paddocks downstream of the highway and railway bridges.
- Properties inundated above floor level: 2
- Properties inundated below floor level: 69

10% AEP Event

- Breakouts begin to occur from Broken Creek in central Numurkah. 15 properties are inundated near the corner of Melville Street and Tunnock Road. The Numurkah Caravan Park is also inundated.
- Additional properties inundated in south-east Numurkah including several properties along the Numurkah- Katamatite Road (below floor flooding).
- Water starts backing up behind the railway line resulting in water flowing south across the Numurkah-Katamatite Road and engaging the secondary railway and highway culverts located 400m further south.
- Increased engagement of the floodplain to the south of Numurkah.
- Flood levels approximately 200 mm higher than the 20% AEP (5 year) event in central Numurkah.
- Properties inundated above floor level: 6
- Properties inundated below floor level: 110

5% AEP Event

- All properties on Brooke Court inundated (all below floor).
- More properties inundated in south Numurkah including several on Newby and Thornton Streets.
- Additional commercial properties inundated on Station Street with water backing up behind the railway line in that area.
- Significantly more inundation of the floodplain to the south of Numurkah.

- Walsh's Bridge Road begins to overtop to the west of Sloleys Bridge.
- Flood levels approximately 140 mm higher than the 10% AEP (10 year) event in central Numurkah.
- Properties inundated above floor level: 8
- Properties inundated below floor level: 151

2% AEP Event

- Significantly more breakouts from the north bank of Broken Creek leading to overtopping into Lake Numurkah and inundation of approximately 10 commercial properties in central Numurkah. Raised levels in Lake Numurkah lead to inundation of 7-8 properties on Reynolds Drive.
- An additional 25 properties flooded in southern Numurkah.
- Water begins flowing along Pine Street over the irrigation channel adjacent to Kinnaird's Road resulting in inundation of approximately 25 properties in east Numurkah in the vicinity of Maple Crescent.
- Significantly more flooding in south Numurkah and inundation of another 40 residential properties.
- Flooding to rear grounds of Lakeside Country Club. The hospital grounds begin to flood.
- Flood water flows north across Saxton Street West to the west side of the Highway towards the proposed industrial area.
- Widespread inundation across the floodplain to the south of town. Highway and railway begin to overtop to the south of the Numurkah-Katamatite Road intersection.
- Flood levels approximately 140 mm higher than the 5% AEP event in central Numurkah.
- Properties inundated above floor level: 50
- Properties inundated below floor level: 294

1% AEP Event

- Inundation of additional 20 commercial properties in central Numurkah.
- More flooding in south Numurkah leading to inundation of an additional 25 residential properties.
- An additional 35 properties inundated in east Numurkah as a result of overtopping of Lake Numurkah and flows from Pine Street. Much of the Lakeside Country Club is inundated.
- Railway begins to overtop in central Numurkah near Orchard Street.
- Flood levels approximately 110 mm higher than the 2% AEP event in central Numurkah.
- Properties inundated above floor level: 108
- Properties inundated below floor level: 436

0.5% AEP Event

- Flood levels approximately 100 mm higher than the 1% AEP event in central Numurkah.
- Significantly worse flooding through central and eastern township areas with approximately 60 additional properties inundated compared with the 1% AEP event.
- An additional 50 properties inundated in west Numurkah in the vicinity of Nelson Street, Saxton Street and Cullen Court as a result of water flowing back across the Highway and the railway overtopping near Orchard Street.
- Widespread inundation across the floodplain to the south and south-east of Numurkah.
- Properties inundated above floor level: 297
- Properties inundated below floor level: 592

0.2% AEP Event

- Widespread inundation across the floodplain and through the town. 90% of central Numurkah inundated with flood depths of 200-250 mm through the central business area on Melville Street.
- Flood levels approximately 180 mm higher than the 0.5% AEP event in central Numurkah.

Likely Flooding Scenario

Advice of potential high flows in the Broken Creek at Numurkah has traditionally been received from Tungamah and Katamatite. When heavy rain of 100mm of more has been received in the area of Tungamah, Katamatite and Yarrawonga, a high creek flow can be expected at Numurkah. By monitoring rainfall and flows and using the guidance and indicative flood / no-flood tools provided below, an estimate of the likely severity of expected flooding at Numurkah can be made that links with relevant flood inundation mapping.

Note that flows at the Dip Bridge (the 1993 flood level was 113.56mAHD) provide a reasonable indication of likely flows at Numurkah some 4-5 days later. Further, when Box Creek breaks out to the south over the Katamatite-Nathalia Road near Gordons Road, a high level usually occurs at Numurkah 2 days later. However, no two floods are the same. In March 2012 the flood peak occurred in Numurkah much earlier than would normally be expected.

It is important that the upstream position is monitored and that in the event of an expected significant flood, the Melville Street and Stockyard Weirs are removed early with the co-operation of GMW. This will minimise the ponding of inflows. Completing the tasks on the municipal task list (see first row of the Numurkah Flood Intelligence Card below) is vital as is the timing. These tasks **must** be carried out prior to water entering the town via the underground stormwater drainage system.

Lessons from the March 2012 Flood

- The low-lying areas to the east of Numurkah around Kinnaird Wetland and Brookes Court filled quickly and early in the event.
- Breakouts from Broken Creek occurred upstream of Numurkah early in the event leading to inundation of the hospital depression and floodplain to the south of Numurkah.
- The irrigation channel banks adjacent to Kinnaird's Road and the temporary levees placed across Pine Street and Wattle Drive provided significant protection to the eastern parts of Numurkah.
- Temporary levees placed near the Lakeside Country Club and south-eastern shore of Lake Numurkah also provided significant protection to properties in that area.
- Extensive inundation through southern Numurkah resulted in inundation of approximately 60 properties including the Numurkah Hospital and aged care facility.
- Caravan Park and Cemetery inundated.
- Significant inundation of properties around Brooke Court in east Numurkah occurred but due to raised building pads, only 1 or 2 were flooded above-floor.
- Breakouts from the northern bank of Broken Creek in the vicinity of Melville Street inundated a number of commercial properties in that area including the El Toro Motel. Local accounts described stormwater backing up and surcharging prior to overland flows breaking out from the creek.
- Water backed-up against the Shepparton-Numurkah railway line and overtopped both it and the Goulburn Valley Highway at multiple locations. A significant number of washouts occurred between Numurkah and Wunghnu.
- Approximately 93 residential buildings and 10 businesses were inundated across the town.
- Peak was approximately 180 mm higher than the 1993 event immediately upstream of the Melville Street Bridge.

Lessons from the October 1993 Flood

- Engagement of the floodplain and hospital depression to the south of Numurkah township but to a much smaller extent than the March 2012 event.
- Inundation of approximately 25 properties mainly south of the Broken Creek channel in the region of Melville Street and Tunnock Road.
- Several commercial properties inundated north of the Melville Street Bridge but flood extents and depths much less than the 2012 event through the central township.
- Water backed up behind the Goulburn Valley Highway and railway but no overtopping of either.
- Irrigation channel banks to the east of Numurkah adjacent to Kinnaird's Road held water back thereby protecting a number of properties in that area.
- Water overtopped and flowed into Lake Numurkah. Some properties on the north shore of the lake inundated. Temporary levees were not used in that area so additional inundation occurred there compared with the 2012 event.

Flood Consequences

Motels and Caravan Parks likely to be affected:

- Numurkah Caravan Park
- El Toro Motel
- Numurkah Golf and Bowls Club

How many properties are affected in Numurkah?

- In 2012, 77 homes and 10 businesses where affected by above-floor inundation.
- See summary and detailed property inundation tables later in this Appendix

How much warning time:

- Varies depending on the flood, but generally between 3-5 days. See Appendix B.

Key Warning/Trigger Gauge

- The Dip Bridge Gauge gives the first indication of a potentially large event. The 1993 flood at this gauge registered 113.56mAHD.
- The Muckatah depression has limited water flow gauges and no automated sites. Ground observation and local knowledge is required to verify flows.
- Install PALS gauges at locations identified later in this Appendix.
- The indicative flood / no-flood tools provided in this MFEP.

Melville Street Gauge at Numurkah

- **Proposed** flood class levels: Minor 107.40mAHD, Moderate and Major are pending consultation with BOM and all required parties on final declared flood class levels
- May 1974 flood level 107.8mAHD
- October 1993 flood level 107.77mAHD
- March 2012 flood level 107.96mAHD
- Peaks can be observed 3–5 days after the peak at Dip Bridge

NOTE that the March 2012 peak at the rail bridge was 107.591mAHD and at the GVH 107.58mAHD.

Impacts on essential community infrastructure:

- In 2012, Numurkah District Health Service was inundated. The floor level of the redeveloped hospital is at 108.3mAHD, which is approx. 450mm above the 2012 flood level at site. The older part of the hospital along the eastern boundary has floor levels around the 2012 flood level (ie. approx. 107.85mAHD at site without freeboard).
- Gwandalan Court aged care independent living units was inundated in 2012.
- Community Health Centre was isolated in 2012.
- Numurkah Pioneers Memorial Lodge (high and low care facility) was isolated in 2012.

Isolation risks for Numurkah are:

- Numurkah Hospital.
- Properties south of the Broken Creek in Numurkah may be inundated and or isolated. Residents in Brooke and Ashley Court near Kinnaird's wetland will be isolated in a major flood event.
- The Numurkah Aged Care facility will be isolated.
- Karinya Nursing Home may be isolated

Major road closures around Numurkah are:

- Goulburn Valley Highway
- Katamatite-Nathalia Road to the east
- Katamatite–Nathalia Road
- Kaarimba Road
- Naring Road
- (KD) Walshs Bridge Road
- Labuan Road

Locations where evacuation difficulties may occur, for example low flood islands:

- Properties south of the Broken Creek and east of Kinnaird's Road in Numurkah.

Numurkah Flood Mitigation and potential areas of concern with 2012 sandbagging guide

Legend for potential areas of concern during major flood events. (**see map on page 109**)

1. Hospital (refer to the Hospital flood plan).
2. Pioneer Lodge (was isolated during 2012 flood).
3. Communications tower -sandbag to protect telecommunications infrastructure.
4. GVW Pump - Thornton Street – sandbagging to protect.
5. Retardation pump - Rowe Street.
6. Retardation pump - near Rockcliffs Bridge.
7. Table drains near Trengrove Street and Rockcliffs Bridge.
8. Block drains - corner of Knox and Goulburn Valley Highway.
9. Lakeside Resort - golf driving range embankment to be construct to channel level.
10. North side of Broken Creek - sandbags are required to be 2 high.
11. Pine Street embankment - needs to be at least 500mm high.
12. Utilise the channel embankment between Pine Street and Wattle Drive and along Kinnaird's Road.
13. Close Numurkah Lake flood/storm water slide doors.

Where do levees and retarding basins exist?

The lake at Numurkah receives stormwater from the town drainage system. As some of the outfall pipes are not fitted with flap-gates this can create potential flooding issues as lake levels rise during large rain events. Problems occur when local heavy rainfall is combined with a high creek level (refer to Moira Shire Pumps and Drainage Manual).

The Shepparton–Numurkah railway line runs parallel on the upstream side of the Goulburn Valley Highway between Wunghnu and Numurkah. The railway line acts as a levee and restricts the natural water flow pushing flood water towards Wunghnu. When flood water starts spilling over the railway line, levels in town do not rise significantly (although further rises can occur) due to the water getting away and spreading towards Wunghnu. Discussions will need to occur early for possible mitigation solutions.

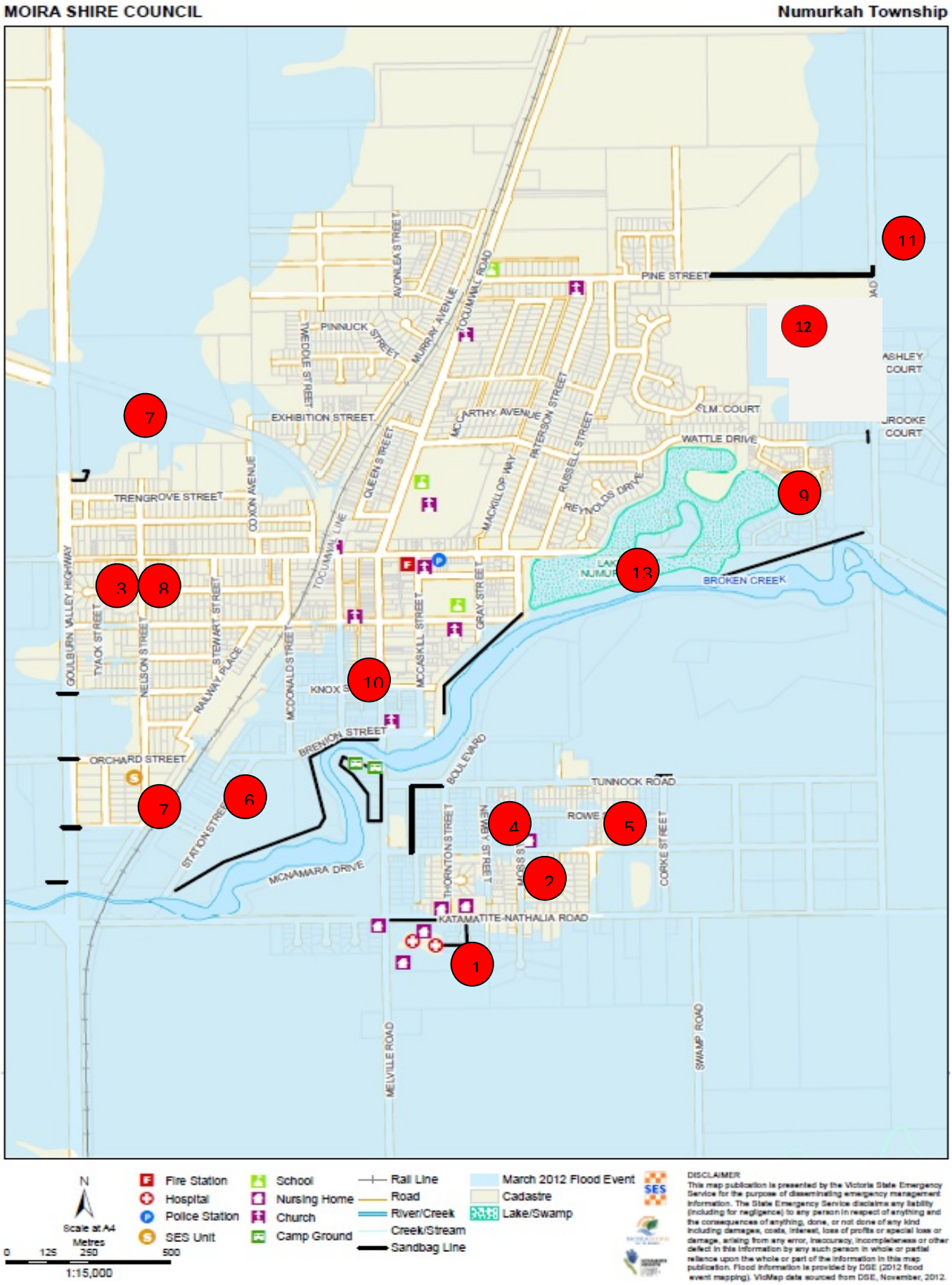
Sandbagging should be undertaken in gaps to the channel alongside Kinnaird's Road to prevent flood water flowing into the lake and north east part of Numurkah.

Access into Ashley and Brooke Courts will be difficult due to flooding from the direction of Kinnaird's Swamp, houses are unlikely to be affected as floor levels are higher than the roads. The 2012 flood saw one house affected in Brooke Court due to a under house heating/cooling system. Access and egress should be considered for residents of Brooke and Ashley Court.

The Cemetery (old) is levied on three (3) sides, but needs work along Corke Street to protect a pump well that exists to pump area out should be blocked.

Flood inundation map:

Numurkah Flood Mitigation and potential areas of concern with 2012 sandbagging plan



What communities do they protect or impact on?

- The Numurkah township (particularly south side of the Broken Creek) is affected by the flow of water as a result of the pooling caused by the Shepparton–Numurkah railway during a major flood.
- V/Line reporting of Emergencies and Immediate actions: (03) 9619 4778 or (03) 9619 1077.

Immediately Downstream from Numurkah

In major floods, the Katamatite Road to the east is closed and significant areas south of the Numurkah - Nathalia Road and west almost to Karimba Road are flooded. This is in part due to the constriction just upstream of Walshs Bridge. There are a number of houses in this area.

Flood Impacts and Required Actions

The Flood Intelligence Card for Numurkah lists the tasks which must be carried out with the approach of a significant flood event. It is assumed that a) triggering advice has been received from upstream sites such as Dip Bridge and Box Creek, b) that the indicative flood no-flood tools provided herein have been used and that c) the situation is being monitored.

The 1% AEP flood level at Melville Street is 107.934mAHD.

Community and agency knowledge;

- Following the March 2012 flood event, a review of this flood emergency plan included knowledge from past and present members of the Numurkah SES, Moira Shire Council, Numurkah CFA and Numurkah Flood Action group (formed after the 2012 flood event), to obtain local knowledge.
- This MEFP includes intelligence and flood related information arising from the 2014 Numurkah Floodplain Management Study (Water Technology, 2014).

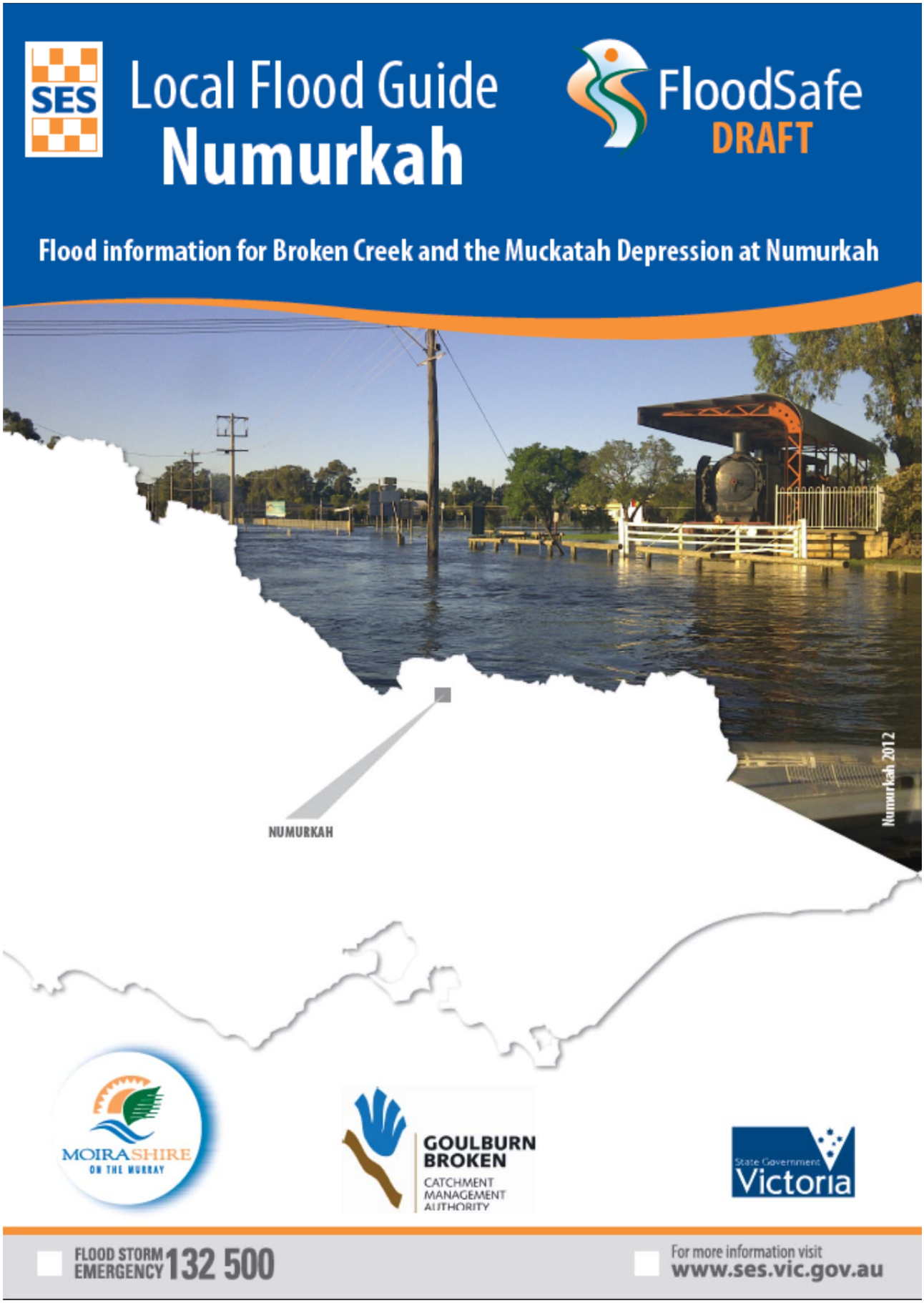
Any known or possible community infrastructure impacts including:

- There are a large number of septic tank systems used within and around the Numurkah community. Coordination of pumping work will need to be carried out after a major flood event.
- The communications tower on the Goulburn Valley Highway will need to be considered for protection. (Not the communications tower in Melville Street)

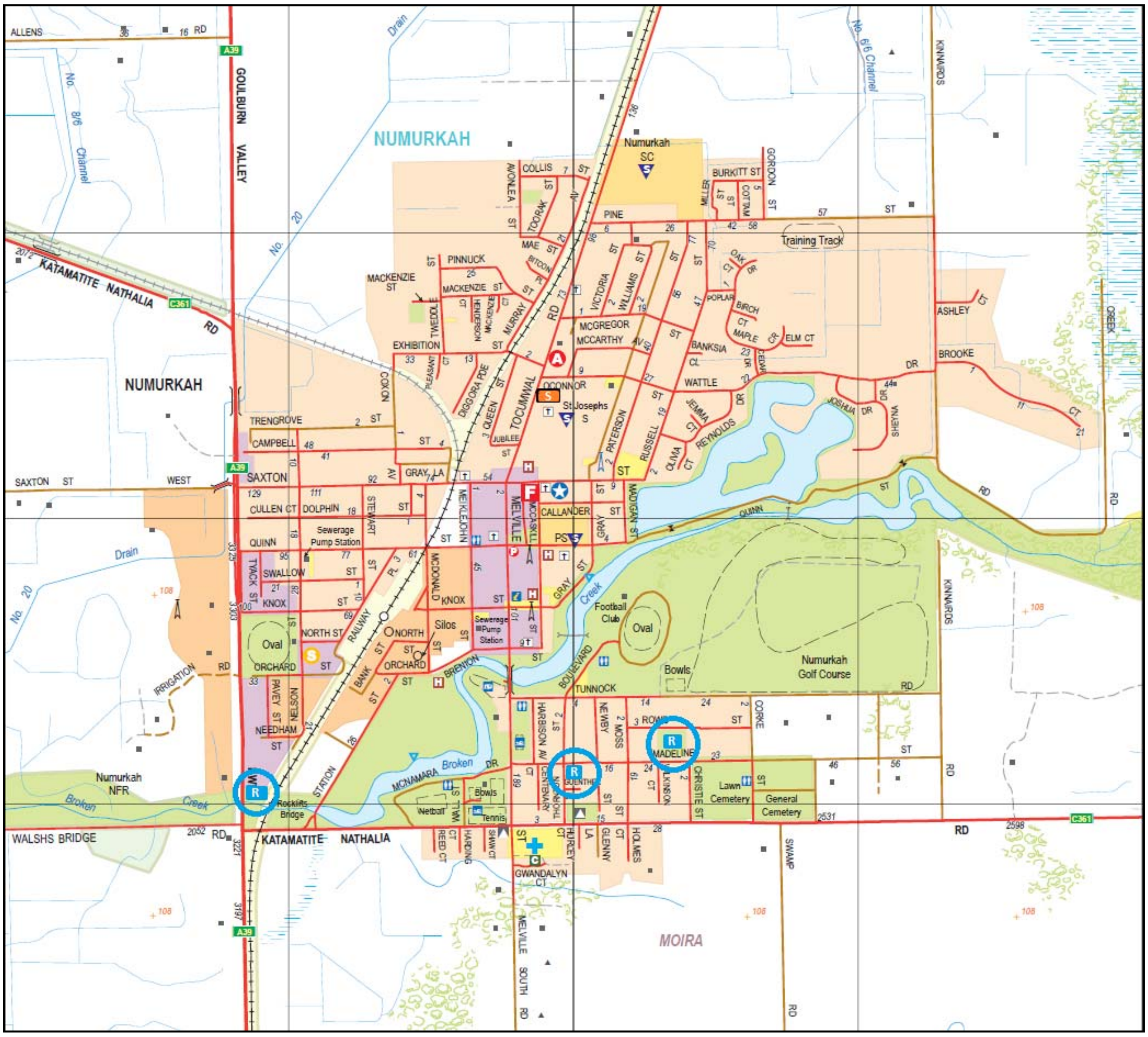
Water treatment plants and water storage areas affected;

- During the 2012 flood event the Water Treatment Plant on the corner of Gray and McCaskill Streets remained dry (~108.2mAHD).

Community or agency flood awareness material - particularly in relation to FloodSafe or StormSafe material - make sure information / intelligence is shared and consistent



Pumps and other service equipment likely to be inundated;



1. Madeline Street / Rowe Street retardation basin pump
2. GVW pump Thornton Street
3. Retardation Pump near Rockcliffs Bridge

Command, Control and Coordination

VICSES will assume overall control of the response to flood incidents. Other agencies will be requested to support operations as detailed in this Plan. Control and coordination of a flood incident shall be carried out at the lowest effective level and in accordance with the State Emergency Response Plan (EMMV Part 3). During significant events, VICSES will conduct incident management using multi-agency resources.

Divisional Command will be located at the Hume Region Divisional Command Centre Numurkah to manage the Goulburn River downstream of Shepparton and or the Broken Creek catchment.

The Sectors will be established in towns affected by flooding, utilising local emergency service personnel where possible.

Flood Intelligence Card for Numurkah and immediate area

BROKEN CREEK at NUMURKAH			
Creek level at Numurkah (mAHD)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Action	Comments
Prior to flood	In conjunction with GMW, lower the level of the Melville Street and Station Street regulator pools in advance of the flood. The 450mm pipe draining the Train Park to the Creek should be closed off when necessary and pumped from the pit as required. Check operation of the non-return valve at the Rowe Street retardation basin pump well (prevents entry of backwater from the Creek). Close the non-return valve (held open under normal conditions) at the Rowe Street pipe from Tunnock Road into retardation basin. The Cemetery (old) is levied on three (3) sides, but needs sandbagging along Corke Street to seal from flood water. A pump well exists to pump area and should be blocked. Check the non-return flap on the Shaw Court and Harding Court drain behind the Hospital. Although flooding can occur in this area, houses have previously been above flood levels. Station Street flooding tends to flow backwards along Station Street into residences around the Oil Seed Factory. Block the western table drain from the Broken Creek Bridge (Goulburn Valley Highway - Rockcliffs Road) adjacent to the Concrete factory to prevent water flowing north and entering the town drainage system. Refer to the west Numurkah drainage plan. Also block the eastern table drain from the Broken Creek adjacent the Numurkah Youth Club oval to prevent water flowing North.Ashley Street and Brooke Court experience access problems due to flooding from the Kinnaird's Swamp direction. Banking off at Pine Street and Wattle Drive to the GMW outfall channel is required to avoid flows entering the top end of the town. This should be achieved by the construction of a drivable levee. Residents are to be notified of this action and asked to consider evacuation. Block the Goulburn Valley Highway culvert on the eastern side (north of Trengrove Street) with a truck load of sand. Consider establishing sandbagging stations north and south of Broken Creek in Numurkah: at the St Johns Catholic Church car park to the north and Numurkah Golf and Bowls Club to the south. Sandbags will be required prior to flooding in Numurkah. Construction of a levee from the Southern end of the Kinnairds Road channel across to the vehicle track which runs along the North of the Broken Creek. (need a map describing the route used last time) . Close the box culverts that connect Broken Creek and Lake Numurkah – located on the south western edge of the lake. Security of this closure will need to be monitored to protect residents in Wattle Drive and Elm Court unless permenant solution is in place. Sandbags placed in all pits leading to creek along McNamara Dr , Wall St to prevent creek water levels from entering streets. Refer to the MSC Pumps and Drainage Manual for more detail.		Undertake these tasks when flooding is likely at Numurkah. The heads-up of likely flooding may come from: ▪ BoM warnings. ▪ Local information (eg. from Tungamah and/or Katamatite, Dip Bridge and Box Creek, etc). ▪ Application of the indicative flood / no-flood tools contained in this MFEP. ▪ On-going monitoring.

BROKEN CREEK at NUMURKAH			
Creek level at Numurkah (mAHD)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Action	Comments
107.01			Estimated level of the 1956 flood
107.18			Estimated level of the 1939 flood
107.40		Arrange for deployment of PALS with due regard for likely flood characteristics and previously identified locations – see below	PRELIMINARY Minor Flood Level
107.412	Through central Numurkah, water generally confined to creek channel. Breakouts upstream inundate parts of the golf course and result in some flow through the hospital depression. Breakout near Station Street inundates the wetland area as well as one commercial property on Station Street. Approx 12 properties inundated at the eastern end of Madeleine and Tunnock Streets in south-east Numurkah with depths up to 300 mm. Kinnaird Wetlands and low-lying areas around Brooke Court to east of Numurkah are inundated. Partial inundation of approximately 15 properties on Brooke Court / Kinnaird's Road (all below floor flooding). Flows from hospital depression overtop Numurkah-Katamatite Road. Low-lying areas of floodplain to the south of Numurkah are inundated. Inundation of a number of paddocks downstream of the Highway and railway bridges. 71 properties wet, 12 against the building, 2 flooded above floor level.	Block side-entry pits to the underground stormwater drainage system to prevent backflow. This will extend the time for preparation as it will delay initial inundation within the lower / older part of town, including Melville Street.	20% AEP (5-year ARI) event
		Moderate and Major are pending consultation with BOM and all required parties on final declared flood class levels	PRELIMINARY Moderate Flood Level
107.593	Breakouts begin to occur from Broken Creek in central Numurkah with flood levels approx 200 mm higher than during the 20% AEP (5 year) event. 15 properties are inundated near the corner of Melville Street and Tunnock Road.	Prepare for flooding in Melville Street.	10% AEP (10-year ARI) event

BROKEN CREEK at NUMURKAH			
Creek level at Numurkah (mAHD)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Action	Comments
	Numurkah Caravan Park in Melville Street inundated. Additional properties inundated in south-east Numurkah including several properties along the Numurkah- Katamatite Road (below floor flooding). Water starts backing up behind the railway line resulting in water flowing south across the Numurkah-Katamatite Road and engaging the secondary railway and highway culverts located 400m further south. Increased engagement of the floodplain to the south of Numurkah. 110 properties wet, 31 against the building, 6 flooded above floor level.		
		Moderate and Major are pending consultation with BOM and all required parties on final declared flood class levels	PRELIMINARY Major Flood Level
107.714	All properties on Brooke Court inundated (all below floor). More properties inundated in south Numurkah including several on Newby and Thornton Streets. Additional commercial properties inundated on Station Street with water backing up behind the railway line in that area. Significantly more inundation of the floodplain to the south of Numurkah. Walsh's Bridge Road begins to overtop to the west of Sloleys Bridge. The Cemetery begins to be inundated. Flood levels approximately 140 mm higher than the 10% AEP (10 year) event in central Numurkah. 151 properties wet, 51 against the building, 8 flooded above floor level.	Prepare for more extensive flooding in Melville Street and associated buildings (see property flooded table below).	5% AEP (20-year ARI) event
107.77			October 1993 flood

BROKEN CREEK at NUMURKAH			
Creek level at Numurkah (mAHD)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Action	Comments
107.80	7 buildings damaged by flood.		May 1974 flood
107.830	Significantly more breakouts from the north bank of Broken Creek leading to overtopping into Lake Numurkah and inundation of approximately 10 commercial properties in central Numurkah. Raised levels in Lake Numurkah lead to inundation of 7-8 properties on Reynolds Drive. An additional 25 properties flooded in southern Numurkah. Water begins flowing along Pine Street over the irrigation channel adjacent to Kinnaird's Road resulting in inundation of approximately 25 properties in east Numurkah in the vicinity of Maple Crescent. Significantly more flooding in south Numurkah and inundation of another 40 residential properties. The Vet Clinic at 106 Knox Street within 100mm of flooding over-floor. Flooding to rear grounds of Lakeside Country Club. Hospital grounds begin to flood. Show Grounds on Tunnock Road are beginning to flood. Flood water flows north across Saxton Street West to the west side of the Highway towards the proposed industrial area. Widespread inundation across the floodplain to the south of town. Highway and railway begin to overtop to the south of the Numurkah-Katamatite Road intersection. Flood levels approximately 140 mm higher than the 5% AEP event in central Numurkah. 294 properties wet, 161 wet against the building, 50 flooded above floor level.		2% AEP (50-year ARI) event
107.934	Inundation of additional 20 commercial properties in central Numurkah.	If peak will be another 150mm or so higher, consider protecting the Water Treatment Plant at the corner of Gray	1% AEP (100-year ARI) event

BROKEN CREEK at NUMURKAH			
Creek level at Numurkah (mAHD)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Action	Comments
	More flooding in south Numurkah leading to inundation of an additional 25 residential properties. An additional 35 properties inundated in east Numurkah as a result of overtopping of Lake Numurkah and flows from Pine Street. Much of the Lakeside Country Club is inundated. VICSES depot at 36 Nelson Street is wet but not flooded over-floor. Railway begins to overtop in central Numurkah near Orchard Street. Flood levels approximately 110 mm higher than the 2% AEP event in central Numurkah. 436 properties wet, 285 wet against the building, 108 flooded above floor level.	and McCaskill. Review health service availability – clinic at 207 Melville Street, Red Cross at 27 Quinn Street and hospital – access and likelihood of over-floor flooding (see property flooded table below).	
107.96	Numurkah Hospital and aged care facility inundated. 11 patients and 32 residents were evacuated. Note that ground floor in the redeveloped hospital is 450mm higher than this level. Town sewerage system damaged. Caravan Park, 77 houses, 10 businesses and Cemetery inundated.		March 2012 event (and ~1916 flood). Flood damage to farms totalled ~$75mil. Over $40mil damage to roads, bridges and community facilities.
108.048	Flood levels approximately 100 mm higher than the 1% AEP event in central Numurkah. Significantly worse flooding through central and eastern township areas with approximately 60 additional properties inundated compared with the 1% AEP event. An additional 50 properties inundated in west Numurkah in the vicinity of Nelson Street, Saxton Street and Cullen Court as a result of water flowing back across the Highway and the railway overtopping near Orchard Street. Widespread inundation across the floodplain to the south and south-east of Numurkah. 592 properties wet, 494 wet against the building, 297 flooded above	Consider evacuating hospital if further rises likely. Consider how to maintain water supply if further rises likely as the Water Treatment Plant at the corner of Gray and McCaskill is within 100mm of flooding over-floor. Prepare Shire Offices at 95 Melville Street for over-floor flooding.	0.5% AEP (200-year ARI) event

BROKEN CREEK at NUMURKAH			
Creek level at Numurkah (mAHD)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F	Action	Comments
	floor level.		
108.200		Check the electrical Substation at 35 Knox Street.	Numurkah water treatment plant level.
108.239	Widespread inundation across the floodplain and through the town. 90% of central Numurkah inundated with flood depths of 200-250 mm through the central business area on Melville Street. Flood levels approximately 180 mm higher than the 0.5% AEP event in central Numurkah.	Evacuate hospital	0.2% AEP (500-year ARI) event
108.300			Floor level of hospital redevelopment. Is approx. 450mm above the 2012 flood level at site. Older part of hospital along the eastern boundary has floor levels around the 2012 flood level (ie. approx. 107.85mAHD at site without freeboard)

Note: flood intelligence records are approximations. This is because no two floods at a location, even if they peak at the same height, will have identical impacts. Flood intelligence cards detail the relationship between flood magnitude and flood consequences. More details about flood intelligence and its use can be found in the Australian Emergency Management Manuals flood series

Properties Likely to be Flooded at Numurkah

The following is a list of properties expected to experience inundation (and the depth of that flooding) as a result of riverine flooding within the municipality, along with an indication of the likely depth of over-floor inundation**. It is strongly recommended that the following list be used in conjunction with the flood inundation maps (see Appendix F)**.

The list of properties likely to be flooded (with corresponding levels and indication of over-floor flood depth) should be updated within twelve (12) weeks of a flood with information collected as part of post-flood information recording activities as well as may be collected as a consequence of the event debrief and from the collective experience of the IMT.

Summary of number of flood affected properties in Numurkah (ref Water Technology,2014) EXISTING CONDITIONS						
	Design Flood ARI (years)					
	5	10	20	50	100	200
Level at the Numurkah gauge (Melville St) (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048
Number of properties flooded above floor	2	6	8	50	108	296
Number of floor within 100mm of being inundated	1	0	2	32	87	236
Number of properties flooded below floor only	12	31	51	161	285	494
Number of properties within 100mm of being inundated against the building	3	12	24	52	146	192
Total number of flooded properties	14	37	59	211	393	791

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
1 ASHLEY COURT	-	-	-		0.02	0.16	-	-	-	-	-		
2 ASHLEY COURT	-	0.07	0.18	0.32	0.44	0.57	-	-	-	-	-	-	
3 ASHLEY COURT	-	-	-	-	-		-	-	-	-	-		
5 ASHLEY COURT	-		0.08	0.22	0.33	0.47	-	-	-	-	-		
6 ASHLEY COURT	-	-	-	-		0.06	-	-	-	-	-	-	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
7 ASHLEY COURT	0.08	0.21	0.32	0.46	0.57	0.71	-	-	-	-	-	-	
8 ASHLEY COURT	0.03	0.16	0.27	0.41	0.53	0.66	-	-	-	-	-	-	
2 BANK STREET	-	-	-	0.09	0.19	0.28	-	-	-	0.08	0.18	0.26	
2 BANKSIA CLOSE	-	-	-	-		0.14	-	-	-	-	-		
3 BANKSIA CLOSE	-	-	-	0.00	0.07	0.18	-	-	-	-	-		
4 BANKSIA CLOSE	-	-	-	0.03	0.12	0.21	-	-	-	-		0.02	
1 BIRCH COURT	-	-	-	0.10	0.21	0.28	-	-	-		0.02	0.09	
2 BIRCH COURT	-	-	-	0.19	0.30	0.37	-	-	-	0.00	0.11	0.18	
3 BIRCH COURT	-	-	-	0.20	0.31	0.38	-	-	-		0.10	0.17	
4 BIRCH COURT	-	-	-	0.07	0.17	0.25	-	-	-	-		0.04	
5 BIRCH COURT	-	-	-	0.07	0.17	0.25	-	-	-		0.02	0.09	
6 BIRCH COURT	-	-	-	0.18	0.28	0.36	-	-	-		0.07	0.15	
8 BIRCH COURT	-	-	-	0.18	0.29	0.36	-	-	-		0.03	0.11	
BOULEVARD	-	-	-	-		0.09	-	-	-	-	-	-	Football Club
BRENION STREET	-	-	0.11	0.25	0.35	0.46	-	-	0.10	0.24	0.34	0.45	Scout Hall
BRENION STREET	-	-	-	0.15	0.25	0.36	-	-	-	0.13	0.23	0.34	
1 BRENION STREET	-	-	-	-	-		-	-	-	-	-	-	
1A BRENION STREET	-	-	-	-		0.07	-	-	-	-		0.02	
2 BRENION STREET	-	-	-	0.15	0.26	0.37	-	-	-	-	-		
1/5 BRENION STREET	-	-	-	0.03	0.11	0.21	-	-	-	-		0.01	
2/5 BRENION STREET	-	-	-	0.04	0.10	0.20	-	-	-	-	-		
3/5 BRENION STREET	-	-	-	-		0.07	-	-	-	-	-		
4/5 BRENION STREET	-	-	-		0.05	0.15	-	-	-	-	-		
5/5 BRENION STREET	-	-	-		0.05	0.14	-	-	-	-	-		
9 BRENION STREET	-	-	-	0.17	0.29	0.41	-	-	-	-	-		
1 BROOKE COURT	0.29	0.43	0.54	0.67	0.79	0.92	-	-	-	-	-	-	
2 BROOKE COURT		0.10	0.21	0.35	0.47	0.60	-	-	-	-	-	-	
3 BROOKE COURT	-	-	-	-	-		-	-	-	-	-	-	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth							Comments
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
4 BROOKE COURT	-	-		0.12	0.24	0.37	-	-	-	-	-	-	
5 BROOKE COURT	0.19	0.32	0.44	0.57	0.69	0.82	-	-	-	-	-	-	
6 BROOKE COURT	-	0.01	0.12	0.25	0.37	0.50	-	-	-	-	-		
7 BROOKE COURT	0.08	0.22	0.33	0.46	0.58	0.71	-	-	-	-	-	-	
8 BROOKE COURT	-	-	0.01	0.15	0.26	0.40	-	-	-	-	-		
9 BROOKE COURT	-	-	-	-	-		-	-	-	-	-	-	
10 BROOKE COURT	-	-	-	-	-	0.03	-	-	-	-	-	-	
11 BROOKE COURT	-	-	-	-	-		-	-	-	-	-	-	
12 BROOKE COURT	-	0.11	0.22	0.36	0.47	0.60	-	-	-	-	-		
15 BROOKE COURT		0.10	0.21	0.34	0.46	0.59	-	-	-	-	-	-	
19 BROOKE COURT		0.06	0.17	0.30	0.42	0.55	-	-	-	-	-	-	
20 BROOKE COURT	-	-	-	-		0.06	-	-	-	-	-	-	
21 BROOKE COURT	0.00	0.14	0.25	0.39	0.50	0.63	-	-	-	-	-	-	
22 BROOKE COURT	-	-	-	-	-		-	-	-	-	-	-	
24 BROOKE COURT	-	-	-	-		0.04	-	-	-	-	-	-	
2 CALLANDER STREET	-	-	-	-	-	0.19	-	-	-	-	-		
6 CALLANDER STREET	-	-	-	-	-	0.06	-	-	-	-	-	0.02	
8 CALLANDER STREET	-	-	-	-	-	0.09	-	-	-	-	-	0.09	
17 CALLANDER STREET	-	-	-	-	-	0.31	-	-	-	-	-		
3/17 CALLANDER STREET	-	-	-	-	-	0.33	-	-	-	-	-		
19 CALLANDER STREET	-	-	-	-	-	0.12	-	-	-	-	-	0.11	
4/24 CALLANDER STREET	-	-	-	-	-	0.06	-	-	-	-	-	0.06	
39 CAMPBELL STREET	-	-	-	-	-		-	-	-	-	-	-	
41 CAMPBELL STREET	-	-	-	-	-		-	-	-	-	-	-	
43 CAMPBELL STREET	-	-	-	-	-	0.01	-	-	-	-	-	-	
45 CAMPBELL STREET	-	-	-	-	-	0.04	-	-	-	-	-	-	
46 CAMPBELL STREET	-	-	-	-	-		-	-	-	-	-	-	
47 CAMPBELL STREET	-	-	-	-	-	0.10	-	-	-	-	-	-	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth		Comments

Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
48 CAMPBELL STREET	-	-	-	-	-		-	-	-	-	-	-	
49 CAMPBELL STREET	-	-	-	-	-	0.08	-	-	-	-	-	-	
49A CAMPBELL STREET	-	-	-	-	-	0.07	-	-	-	-	-	-	
50 CAMPBELL STREET	-	-	-	-	-	0.11	-	-	-	-	-	-	
51 CAMPBELL STREET	-	-	-	-	-		-	-	-	-	-	-	
53 CAMPBELL STREET	-	-	-	-	-	0.00	-	-	-	-	-	-	
55 CAMPBELL STREET	-	-	-	-	-	0.07	-	-	-	-	-	-	
57 CAMPBELL STREET	-	-	-	-	-	0.16	-	-	-	-	-	-	
2 CENTENARY COURT	-	-	-	0.12	0.16	0.27	-	-	-	-		0.03	
2A CENTENARY COURT	-	-	-	-	-		-	-	-	-	-	-	
4 CENTENARY COURT	-	-	-	-	-		-	-	-	-	-	-	
6 CENTENARY COURT	-	-	-		0.09	0.22	-	-	-	-		0.08	
8 CENTENARY COURT	-	-	-	0.06	0.16	0.29	-	-	-		0.02	0.14	
9 CENTENARY COURT	-	-	-	-	-		-	-	-	-	-		
12 CENTENARY COURT	-	-	-	0.08	0.19	0.32	-	-	-	-	-	-	
2-4 CORKE STREET	-	-	-	-	-		-	-	-	-	-		
6 CORKE STREET	-	-	-		0.01	0.11	-	-	-	-	-	-	
8 CORKE STREET	-	-	-	-	-		-	-	-	-	-	-	
12 CORKE STREET	-	-	-	-		0.03	-	-	-	-	-		
14 CORKE STREET	-	-	-	-	0.04	0.14	-	-	-	-	-	-	
16-18 CORKE STREET	-	-	-	-	-		-	-	-	-	-	-	
95 CREEK ROAD	-		0.08	0.22	0.33	0.46	-	-	-	-		0.09	
1-2 CULLEN COURT	-	-	-	-	-	0.10	-	-	-	-	-	0.08	
3 CULLEN COURT	-	-	-	-	-	0.46	-	-	-	-	-	0.18	
4 CULLEN COURT	-	-	-	-	-	0.34	-	-	-	-	-	0.04	
5 CULLEN COURT	-	-	-	-	-	0.44	-	-	-	-	-	0.18	
6 CULLEN COURT	-	-	-	-	-	0.32	-	-	-	-	-	0.12	
7 CULLEN COURT	-	-	-	-	-	0.18	-	-	-	-	-		

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth		Comments

Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
8 CULLEN COURT	-	-	-	-	-		-	-	-	-	-	-	
9 CULLEN COURT	-	-	-	-	-	0.23	-	-	-	-	-	-	
10 CULLEN COURT	-	-	-	-	-	0.15	-	-	-	-	-	-	
11 CULLEN COURT	-	-	-	-	-	0.29	-	-	-	-	-	0.18	
12 CULLEN COURT	-	-	-	-	-	0.30	-	-	-	-	-	0.08	
13 CULLEN COURT	-	-	-	-	-	0.22	-	-	-	-	-	0.05	
14 CULLEN COURT	-	-	-	-	-	0.24	-	-	-	-	-	0.13	
15 CULLEN COURT	-	-	-	-	-	0.55	-	-	-	-	-	0.55	
16 CULLEN COURT	-	-	-	-	-	0.04	-	-	-	-	-		
17 CULLEN COURT	-	-	-	-	-	0.04	-	-	-	-	-	-	
18 CULLEN COURT	-	-	-	-	-	0.02	-	-	-	-	-	-	
26 DOLPHIN STREET	-	-	-	-	-	0.01	-	-	-	-	-	-	
30 DOLPHIN STREET	-	-	-	-	-		-	-	-	-	-	-	
31 DOLPHIN STREET	-	-	-	-	-	0.12	-	-	-	-	-	-	
32 DOLPHIN STREET	-	-	-	-	-	0.17	-	-	-	-	-	-	
2 ELM COURT	-	-	-	0.61	0.72	0.79	-	-	-	0.05	0.16	0.23	
3 ELM COURT	-	-	-	0.62	0.72	0.80	-	-	-	0.05	0.16	0.23	
6 ELM COURT	-	-	-	0.60	0.71	0.78	-	-	-	0.01	0.11	0.19	
8 ELM COURT	-	-	-	0.64	0.75	0.82	-	-	-	0.22	0.32	0.40	
9 ELM COURT	-	-	-	0.65	0.75	0.83	-	-	-	0.07	0.17	0.25	
10 ELM COURT	-	-	-	0.63	0.73	0.81	-	-	-	0.20	0.30	0.38	
11 ELM COURT	-	-	-	0.59	0.69	0.77	-	-	-	0.20	0.30	0.38	
12 ELM COURT	-	-	-	0.55	0.65	0.73	-	-	-	0.18	0.28	0.36	
5 GLENNY LANE	-	-	-		0.09	0.19	-	-	-	-		0.03	
2 GOLDEN MEWS	-	-	-	0.54	0.66	0.80	-	-	-	-	-	-	
6 GOLDEN MEWS	-	-	-	0.62	0.75	0.88	-	-	-	-	-	-	
3221 GOULBURN VALLEY HWAY	-	-	-	-	0.15	0.24	-	-	-	-	0.15	0.24	
GRAY STREET	-	-	-	-	-		-	-	-	-	-		

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
GRAY STREET	-	-	-	-	0.02	0.14	-	-	-	-		0.09	Water Treatment Plant
5 GRAY STREET	-	-	-	-	-	0.09	-	-	-	-	-		
7 GRAY STREET	-	-	-	-	0.04	0.17	-	-	-	-	-		
1/9 GRAY STREET	-	-	-	-		0.10	-	-	-	-	-		
2/9 GRAY STREET	-	-	-	-	-		-	-	-	-	-		
5/9 GRAY STREET	-	-	-	-	-	0.26	-	-	-	-	-		
11 GRAY STREET	-	-	-	-	-		-	-	-	-	-		
13 GRAY STREET	-	-	-	-	-	0.06	-	-	-	-	-	-	
15 GRAY STREET	-	-	-	-	-		-	-	-	-	-	-	
20 GRAY STREET	-	-	-	-	-		-	-	-	-	-	-	
22 GRAY STREET	-	-	-	-	-	0.36	-	-	-	-	-	-	
1/26 GRAY STREET	-	-	-	-	-	0.18	-	-	-	-	-	0.09	
2/26 GRAY STREET	-	-	-	-	-	0.15	-	-	-	-	-		
3/26 GRAY STREET	-	-	-	-	-	0.11	-	-	-	-	-	0.04	
4/26 GRAY STREET	-	-	-	-	-	0.18	-	-	-	-	-	0.03	
2/28 GRAY STREET	-	-	-	-	-	0.09	-	-	-	-	-	0.06	
3/28 GRAY STREET	-	-	-	-	-	0.15	-	-	-	-	-	0.11	
4/28 GRAY STREET	-	-	-	-	-	0.19	-	-	-	-	-	0.04	
5/28 GRAY STREET	-	-	-	-	-	0.10	-	-	-	-	-	0.07	
30 GRAY STREET	-	-	-	-	-	0.09	-	-	-	-	-	0.06	
32 GRAY STREET	-	-	-	-	-	0.27	-	-	-	-	-	-	
34 GRAY STREET	-	-	-	-	-	0.30	-	-	-	-	-	0.21	
36 GRAY STREET	-	-	-	-	0.01	0.41	-	-	-	-	-	0.13	
38 GRAY STREET	-	-	-	-	-	0.22	-	-	-	-	-	0.05	
1 GWANDALAN COURT	-	-	-	-		0.05	-	-	-	-	-		
2 GWANDALAN COURT	-	-	-	-	0.01	0.12	-	-	-	-	-	0.00	
3 GWANDALAN COURT	-	-	-	-	0.05	0.17	-	-	-	-		0.07	
4 GWANDALAN COURT	-	-	-	-	0.09	0.21	-	-	-	-		0.06	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth		Comments

Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
5 GWANDALAN COURT	-	-	-	-		0.07	-	-	-	-	-	0.00	
6 GWANDALAN COURT	-	-	-	-	-		-	-	-	-	-		
7 GWANDALAN COURT	-	-	-	-		0.00	-	-	-	-	-		
8 GWANDALAN COURT	-	-	-	-	-		-	-	-	-	-		
9 GWANDALAN COURT	-	-	-	-		0.04	-	-	-	-	-	0.01	
10 GWANDALAN COURT	-	-	-	-	-		-	-	-	-	-	0.01	
11 GWANDALAN COURT	-	-	-	-	-	0.00	-	-	-	-	-		
1 HARBISON AVENUE	-	0.25	0.38	0.50	0.61	0.73	-	-	-		0.08	0.19	
2 HARBISON AVENUE	-	-	0.00	0.13	0.23	0.35	-	-		0.06	0.17	0.28	
3 HARBISON AVENUE	-	0.01	0.14	0.27	0.37	0.49	-	-	-	-		0.02	
1/4 HARBISON AVENUE	-	-	-		0.06	0.18	-	-	-	-	-		
2/4 HARBISON AVENUE	-	-	-		0.02	0.14	-	-	-	-	-	0.00	
3/4 HARBISON AVENUE	-	-	-	-		0.06	-	-	-	-		0.06	
5 HARBISON AVENUE	-	-	-	0.24	0.34	0.46	-	-	-	0.12	0.23	0.34	
6 HARBISON AVENUE	-	-	-	0.09	0.19	0.30	-	-	-	-	-	-	
7 HARBISON AVENUE	-	-	-		0.07	0.18	-	-	-	-	-		
8 HARBISON AVENUE	-	-	-		0.08	0.18	-	-	-	-		0.03	
1-2 HARDING COURT	-	-	-	-	-		-	-	-	-	-	-	
4 HARDING COURT	-	-	-	-	-		-	-	-	-	-		
5 HARDING COURT	-	-	-	-	-		-	-	-	-	-		
7 HARDING COURT	-	-	-	0.02	0.13	0.25	-	-	-	-	-	-	
8 HARDING COURT	-	-		0.19	0.30	0.42	-	-	-	-	-		
1 HOLMES COURT	-	-	-	-	-	0.05	-	-	-	-	-		
1A HOLMES COURT	-	-	-	-	-		-	-	-	-	-	-	
1B HOLMES COURT	-	-	-	-	0.05	0.16	-	-	-	-	-	-	
2 HOLMES COURT	-	-	-	-	-		-	-	-	-	-	-	
3 HOLMES COURT	-	-	-	-		0.05	-	-	-	-	-		
4-5 HOLMES COURT	-	-	-	-	-		-	-	-	-	-		

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
8 HOLMES COURT	-	-	-	-	-	0.09	-	-	-	-	-		
9 HOLMES COURT	-	-	-	-	-		-	-	-	-	-		
1 HURLEY COURT	-	-	-	-	-	0.09	-	-	-	-	-	-	
2 HURLEY COURT	-	-	-	-	-	0.04	-	-	-	-	-		
3 HURLEY COURT	-	-	-	-		0.03	-	-	-	-	-	-	
4 HURLEY COURT	-	-	-	-	-	0.19	-	-	-	-	-	-	
5 HURLEY COURT	-	-	-	-	-	0.04	-	-	-	-	-		
6 HURLEY COURT	-	-	-	-	-	0.19	-	-	-	-	-		
7 HURLEY COURT	-	-	-	-	-	0.12	-	-	-	-	-	-	
6 IRRIGATION ROAD	-	-				0.16	-	-	-	-	-	-	
2 JEMMA COURT	-	-	-	-	0.03	0.26	-	-	-	-	-	0.04	
3 JEMMA COURT	-	-	-	-	0.11	0.33	-	-	-	-	-	-	
4 JEMMA COURT	-	-	-	-	0.11	0.33	-	-	-	-		0.16	
2 JOSHUA DRIVE	-	-	-	-	0.08	0.23	-	-	-	-	0.00	0.15	
4 JOSHUA DRIVE	-	-	-	-	0.05	0.19	-	-	-	-	0.03	0.17	
5 JOSHUA DRIVE	-	-	-	-	0.05	0.19	-	-	-	-	0.03	0.17	
6 JOSHUA DRIVE	-	-	-	-	0.01	0.15	-	-	-	-	0.03	0.17	
7 JOSHUA DRIVE	-	-	-	-	-		-	-	-	-	-	-	
10 JOSHUA DRIVE	-	-	-	-		0.09	-	-	-	-	-	-	
11 JOSHUA DRIVE	-	-	-	-	-		-	-	-	-	-	-	
12 JOSHUA DRIVE	-	-	-	-		0.04	-	-	-	-	-	-	
14 JOSHUA DRIVE	-	-	-	-	0.03	0.15	-	-	-	-	0.03	0.15	
16 JOSHUA DRIVE	-	-	-	-	0.03	0.15	-	-	-	-	0.02	0.13	
18 JOSHUA DRIVE	-	-	-	-	0.03	0.14	-	-	-	-	0.02	0.13	
20 JOSHUA DRIVE	-	-	-	-	0.02	0.14	-	-	-	-	0.02	0.14	
23 JOSHUA DRIVE	-	-	-	-		0.06	-	-	-	-	-	-	
24 JOSHUA DRIVE	-	-	-	-	-		-	-	-	-	-	-	
25 JOSHUA DRIVE	-	-	-	-		0.07	-	-	-	-	-	-	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
KATAMATITE-NATHALIA ROAD	-	-	0.15	0.27	0.36	0.48	-	-	0.15	0.27	0.36	0.48	Cemetery Shelter (toilets remain dry)
1 KATAMATITE-NATHALIA RD	-	-		0.10	0.20	0.31	-	-	-	-	-		
1/2 KATAMATITE-NATHALIA RD	-	-	-	-	-		-	-	-	-	-	-	
3/2 KATAMATITE-NATHALIA RD	-	-	-	-	-		-	-	-	-	-		
7 KATAMATITE-NATHALIA RD	-	-	-	-	-		-	-	-	-	-	-	
9 KATAMATITE-NATHALIA RD	-	-	-	-	-		-	-	-	-	-	-	
10 KATAMATITE-NATHALIA RD	-	-	-	-	-	0.03	-	-	-	-	-	-	
11 KATAMATITE-NATHALIA RD	-	-	-	-			-	-	-	-	-	-	
12 KATAMATITE-NATHALIA RD	-	-	-	-	-		-	-	-	-	-	-	
14 KATAMATITE-NATHALIA RD	-	-	-	-	-		-	-	-	-	-	-	
18 KATAMATITE-NATHALIA RD	-	-	-	-	-		-	-	-	-	-		
19 KATAMATITE-NATHALIA RD	-	-	-	-	-	0.09	-	-	-	-	-		
20 KATAMATITE-NATHALIA RD	-	-	-	-	-		-	-	-	-	-	-	
21 KATAMATITE-NATHALIA RD	-	-	-	-	-	0.00	-	-	-	-	-	0.00	
22 KATAMATITE-NATHALIA RD	-	-	-	-	-		-	-	-	-	-		
28 KATAMATITE-NATHALIA RD	-	-	-	-		0.04	-	-	-	-	-	-	
30 KATAMATITE-NATHALIA RD	-	-	0.13	0.30	0.43	0.55	-	-	-	-	-	-	
36 KATAMATITE-NATHALIA RD	-	-	-	-	0.04	0.16	-	-	-	-	-	-	
38 KATAMATITE-NATHALIA RD	-	-	-	0.05	0.17	0.29	-	-	-	-	-	0.00	
40 KATAMATITE-NATHALIA RD	-	-		0.10	0.22	0.34	-	-	-	-	-		
42-44 KATAMATITE-NATHALIA RD	-	-	-	-		0.12	-	-	-	-	-		
46 KATAMATITE-NATHALIA RD	-	-	-	-	-		-	-	-	-	-	-	
2531 KATAMATITE-NATHALIA RD	0.18	0.23	0.31	0.42	0.53	0.65	-	-	-	-	-		
2547 KATAMATITE-NATHALIA RD	-	-	-	-		0.06	-	-	-	-		0.06	
2551 KATAMATITE-NATHALIA RD	0.15	0.21	0.29	0.42	0.52	0.64	-	-	-	-	-	-	
KINNAIRDS ROAD	0.21	0.34	0.45	0.58	0.69	0.82	0.09	0.22	0.33	0.46	0.57	0.70	
KINNAIRDS ROAD	-	-		0.04	0.16	0.29	-	-	-		0.10	0.23	
LOT 4 KINNAIRDS ROAD	-	-	-	-		0.05	-	-	-	-	-	-	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
87 KINNAIRDS ROAD	-	-	-	-	-		-	-	-	-	-	-	
135 KINNAIRDS ROAD	-	-	-	-		0.12	-	-	-	-	-	-	
137 KINNAIRDS ROAD	-	-	-		0.06	0.19	-	-	-	-	-	-	
161 KINNAIRDS ROAD	-	-	-		0.05	0.18	-	-	-	-	-	-	
165 KINNAIRDS ROAD	-	0.08	0.19	0.33	0.44	0.58	-	-	-	-	-	-	
169 KINNAIRDS ROAD	-	0.01	0.13	0.26	0.38	0.51	-	-	-	-	-	-	
183 KINNAIRDS ROAD	0.14	0.27	0.38	0.52	0.63	0.76	-	-	-	-	-	-	
23-29 KNOX STREET	-	-	-	-	-		-	-	-	-	-		Car Wash
38 KNOX STREET	-	-	-	-	0.00	0.12	-	-	-	-	-		
40-42 KNOX STREET	-	-	-	-	0.06	0.17	-	-	-	-	-		
44 KNOX STREET	-	-	-	-	0.09	0.20	-	-	-	-	-		
46 KNOX STREET	-	-	-	-	0.15	0.26	-	-	-	-	-		
48 KNOX STREET	-	-	-	-	0.12	0.22	-	-	-	-	-		
50 KNOX STREET	-	-	-	-	0.10	0.20	-	-	-	-	0.10	0.20	Mens Shed
52-64 KNOX STREET	-	-	-	-	0.02	0.11	-	-	-	-	0.02	0.11	Doug Small Auto Elec
53 KNOX STREET	-	-	-	-		0.06	-	-	-	-	-	-	
55 KNOX STREET	-	-	-	-	-		-	-	-	-	-	-	
57 KNOX STREET	-	-	-	-	0.24	0.34	-	-	-	-	0.24	0.34	
59 KNOX STREET	-	-	-	-	0.00	0.10	-	-	-	-		0.01	
61 KNOX STREET	-	-	-	-	0.17	0.27	-	-	-	-	0.17	0.27	
69 KNOX STREET	-	-	-	-		0.12	-	-	-	-	-	-	
70 KNOX STREET	-	-	-	-	-	0.05	-	-	-	-	-	-	
71 KNOX STREET	-	-	-	-		0.08	-	-	-	-	-	-	
72 KNOX STREET	-	-	-	-	-	0.08	-	-	-	-	-	-	
73 KNOX STREET	-	-	-	-		0.11	-	-	-	-	-	-	
74 KNOX STREET	-	-	-	-	0.04	0.17	-	-	-	-	-	-	
75 KNOX STREET	-	-	-	-	0.11	0.23	-	-	-	-	-	-	
76 KNOX STREET	-	-	-	-		0.07	-	-	-	-	-	-	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
77 KNOX STREET	-	-	-	-		0.10	-	-	-	-	-	-	
78 KNOX STREET	-	-	-	-	0.01	0.12	-	-	-	-	-	-	
79 KNOX STREET	-	-	-	-		0.07	-	-	-	-	-	-	
80 KNOX STREET	-	-	-	-	-		-	-	-	-	-	-	
81 KNOX STREET	-	-	-	-		0.10	-	-	-	-	-	-	
82 KNOX STREET	-	-	-	-	0.02	0.14	-	-	-	-	-	-	
83 KNOX STREET	-	-	-	-	0.05	0.18	-	-	-	-	-	-	
84 KNOX STREET	-	-	-	-	0.06	0.19	-	-	-	-	-		
1/86 KNOX STREET	-	-	-			0.11	-	-	-	-	-		
2/86 KNOX STREET	-	-	-	-		0.07	-	-	-	-	-		
3/86 KNOX STREET	-	-	-	-		0.06	-	-	-	-	-		
4/86 KNOX STREET	-	-	-	-		0.07	-	-	-	-	-		
90-92 KNOX STREET	-	-	-	0.09	0.17	0.30	-	-	-	-		0.10	
94 KNOX STREET	-	-	-	0.02	0.10	0.22	-	-	-	-	-	-	
98 KNOX STREET	-	-	-	-		0.10	-	-	-	-	-	-	
100 KNOX STREET	-	-	-	0.18	0.26	0.38	-	-	-	0.18	0.26	0.38	
106 KNOX STREET	-	-	-	0.15	0.23	0.35	-	-	-		0.05	0.17	Numurkah Vet Clinic
154 LYONS ROAD	0.07	0.09	0.12	0.16	0.20	0.25	-	-	-	-	-	-	
2 MACKILLOP WAY	-	-	-	-	-	0.02	-	-	-	-	-		
3 MACKILLOP WAY	-	-	-	-	-	0.02	-	-	-	-	-	0.02	
4 MACKILLOP WAY	-	-	-	-	-	0.06	-	-	-	-	-	0.06	
5 MACKILLOP WAY	-	-	-	-	-	0.08	-	-	-	-	-	0.06	
6 MACKILLOP WAY	-	-	-	-	-	0.24	-	-	-	-	-	0.24	
7 MACKILLOP WAY	-	-	-	-	-	0.22	-	-	-	-	-	0.22	
2 MADELINE STREET	-	-	-	-	0.02	0.12	-	-	-	-	-	-	
2/2 MADELINE STREET	-	-	-	-		0.09	-	-	-	-	-		
3 MADELINE STREET	-	-	-	0.11	0.17	0.31	-	-	-	-	-		
1/4 MADELINE STREET	-	-	-	0.03	0.10	0.23	-	-	-	-	-		

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
2/4 MADELINE STREET	-	-	-	-		0.03	-	-	-	-	-	-	
3/4 MADELINE STREET	-	-	-	-	-	0.01	-	-	-	-	-	-	
5 MADELINE STREET	-	-	-		0.09	0.21	-	-	-	-	-		
6 MADELINE STREET	-	-	-	-	-		-	-	-	-	-	-	
7 MADELINE STREET	-	-	-	-		0.05	-	-	-	-		0.02	
1/8 MADELINE STREET	-	-	-	-	-		-	-	-	-	-	-	
2/8 MADELINE STREET	-	-	-	-	-		-	-	-	-	-	-	
3/8 MADELINE STREET	-	-	-	-	-	0.01	-	-	-	-	-	-	
8A MADELINE STREET	-	-	-	-		0.11	-	-	-	-	-	-	
9 MADELINE STREET	-	-	-	-		0.07	-	-	-	-		0.02	
1/10 MADELINE STREET	-	-	-	-	-	0.01	-	-	-	-	-	-	
2/10 MADELINE STREET	-	-	-	-	-	0.00	-	-	-	-	-	-	
3/10 MADELINE STREET	-	-	-	-		0.09	-	-	-	-	-	-	
11 MADELINE STREET	-	-	-	0.11	0.23	0.35	-	-	-	-		0.09	
1/12 MADELINE STREET	-	-	-	-	-	0.02	-	-	-	-	-	-	
2/12 MADELINE STREET	-	-	-	-	-		-	-	-	-	-	-	
3/12 MADELINE STREET	-	-	-	-		0.06	-	-	-	-	-	-	
14 MADELINE STREET	-	-	-		0.07	0.20	-	-	-	-	-	-	
16 MADELINE STREET	-	-	-	0.03	0.16	0.29	-	-	-	-	-		
18 MADELINE STREET	-	-	-	0.04	0.16	0.29	-	-	-	-	-	0.03	
20 MADELINE STREET	-	-	-	-	0.02	0.15	-	-	-	-	-	0.01	
21 MADELINE STREET	-	-	-			0.09	-	-	-			0.09	
23 MADELINE STREET	-	-	-	-		0.08	-	-	-	-		0.08	
24 MADELINE STREET	-	-	-	-	-		-	-	-	-	-	-	
25 MADELINE STREET	-	-	-	-		0.03	-	-	-	-	-	-	
27 MADELINE STREET	-	-	-	-	-		-	-	-	-	-		
29 MADELINE STREET	-	-	-	-		0.04	-	-	-	-	-	-	
31 MADELINE STREET	-	0.07	0.16	0.26	0.34	0.43	-	-	-	-	-	-	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
33 MADELINE STREET	-	-	-	-	-		-	-	-	-	-	-	
46-48 MADELINE STREET	-	-	-	-		0.08	-	-	-	-	-	-	
47-49 MADELINE STREET	-	-		0.05	0.15	0.26	-	-	-	-	-	-	
51-53 MADELINE STREET	-	-	-	-	-		-	-	-	-	-		
52-54 MADELINE STREET	-	-		0.05	0.15	0.27	-	-	-	-	-	-	
55-57 MADELINE STREET	-	-		0.07	0.17	0.29	-	-	-	-	-		
59-61 MADELINE STREET	-	-	-	0.02	0.12	0.24	-	-	-	-	-	-	
60-62 MADELINE STREET	-			0.12	0.23	0.35	-	-	-	-	-	-	
7 MADIGAN STREET	-	-	-	-	-	0.29	-	-	-	-	-	0.11	
11 MADIGAN STREET	-	-	-	-	-	0.17	-	-	-	-	-	-	
13 MADIGAN STREET	-	-	-	-	-	0.11	-	-	-	-	-	-	
15 MADIGAN STREET	-	-	-	-	-	0.46	-	-	-	-	-	0.46	
17 MADIGAN STREET	-	-	-	-	-	0.57	-	-	-	-	-	0.12	
2 MAPLE CRESCENT	-	-	-	-			-	-	-	-	-	-	
3 MAPLE CRESCENT	-	-	-	-		0.06	-	-	-	-	-		
4 MAPLE CRESCENT	-	-	-		0.04	0.11	-	-	-	-		0.02	
5 MAPLE CRESCENT	-	-	-	-	0.03	0.10	-	-	-	-	-		
6 MAPLE CRESCENT	-	-	-	0.11	0.21	0.29	-	-	-	-		0.07	
7 MAPLE CRESCENT	-	-	-	-		0.07	-	-	-	-	-		
8 MAPLE CRESCENT	-	-	-	0.15	0.26	0.33	-	-	-		0.07	0.15	
9 MAPLE CRESCENT	-	-	-	-		0.04	-	-	-	-	-		
11 MAPLE CRESCENT	-	-	-	-		0.01	-	-	-	-	-	-	
10-12 MAPLE CRESCENT	-	-	-	0.30	0.40	0.48	-	-	-	0.12	0.22	0.29	
13 MAPLE CRESCENT	-	-	-	-		0.06	-	-	-	-	-	-	
14 MAPLE CRESCENT	-	-	-	0.23	0.34	0.41	-	-	-	0.13	0.24	0.31	
15 MAPLE CRESCENT	-	-	-	0.00	0.11	0.18	-	-	-	-			
16 MAPLE CRESCENT	-	-	-	0.28	0.38	0.46	-	-	-	0.05	0.15	0.23	
17 MAPLE CRESCENT	-	-	-	0.09	0.19	0.27	-	-	-	-	-	-	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
18 MAPLE CRESCENT	-	-	-	0.26	0.36	0.44	-	-	-	0.17	0.27	0.35	
19 MAPLE CRESCENT	-	-	-	0.10	0.21	0.28	-	-	-	-		0.06	
20 MAPLE CRESCENT	-	-	-	0.26	0.36	0.44	-	-	-	0.09	0.19	0.26	
21 MAPLE CRESCENT	-	-	-	0.15	0.25	0.33	-	-	-	0.04	0.15	0.22	
23 MAPLE CRESCENT	-	-	-	0.01	0.11	0.19	-	-	-	-			
25 MAPLE CRESCENT	-	-	-	0.11	0.21	0.29	-	-	-		0.02	0.09	
27 MAPLE CRESCENT	-	-	-	-		0.00	-	-	-	-	-	-	
29 MAPLE CRESCENT	-	-	-	0.42	0.52	0.59	-	-	-	-	-	-	
33 MAPLE CRESCENT	-	-	-	0.58	0.69	0.76	-	-	-	0.22	0.32	0.40	
35 MAPLE CRESCENT	-	-	-	0.43	0.54	0.61	-	-	-	0.10	0.21	0.28	
37 MAPLE CRESCENT	-	-	-	0.53	0.63	0.71	-	-	-		0.05	0.12	
MCCASKILL STREET	-	-	-	-		0.12	-	-	-	-	-		Seniors Hub
25 MCCASKILL STREET	-	-	-	-	-		-	-	-	-	-		
1/27 MCCASKILL STREET	-	-	-	-	-		-	-	-	-	-	-	
1/29 MCCASKILL STREET	-	-	-	-	-	0.01	-	-	-	-	-	-	
31 MCCASKILL STREET	-	-	-	-	-		-	-	-	-	-	-	
1/33 MCCASKILL STREET	-	-	-	-	-	0.04	-	-	-	-	-	0.03	
2/33 MCCASKILL STREET	-	-	-	-	-		-	-	-	-	-		
3/33 MCCASKILL STREET	-	-	-	-	-	0.07	-	-	-	-	-		
4/33 MCCASKILL STREET	-	-	-	-	-	0.07	-	-	-	-	-		
39 MCCASKILL STREET	-	-	-	-		0.10	-	-	-	-		0.03	Water Treatment Plant
41-43 MCCASKILL STREET	-	-	-	0.10	0.23	0.37	-	-	-	-	-	0.02	
1/42 MCCASKILL STREET	-	-	-	-	0.05	0.19	-	-	-	-	-		
2/42 MCCASKILL STREET	-	-	-	-	-		-	-	-	-	-	-	
3/42 MCCASKILL STREET	-	-	-	-	-		-	-	-	-	-	-	
4/42 MCCASKILL STREET	-	-	-	-	0.11	0.25	-	-	-	-	-		
44 MCCASKILL STREET	-	-	-	0.08	0.22	0.35	-	-	-		0.06	0.20	
45 MCCASKILL STREET	-	-	-	0.11	0.24	0.38	-	-	-	-		0.13	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
46 MCCASKILL STREET	-	-	-	0.27	0.40	0.53	-	-	-	0.16	0.29	0.42	
1/47 MCCASKILL STREET	-	-	-	0.07	0.20	0.33	-	-	-	-	-	0.03	
2/47 MCCASKILL STREET	-	-	-	0.07	0.19	0.33	-	-	-	-	-		
3/47 MCCASKILL STREET	-	-	-		0.04	0.17	-	-	-	-	-	0.00	
49 MCCASKILL STREET	-	-	-	-		0.12	-	-	-	-		0.05	
51 MCCASKILL STREET	-	-	-	0.05	0.18	0.31	-	-	-	0.02	0.15	0.28	
MCDONALD STREET	-	-	-	-		0.12	-	-	-	-		0.12	Gordan Cardwell
MCDONALD STREET	-	-	-	-	0.21	0.36	-	-	-	-	0.21	0.36	
21 MCDONALD STREET	-	-	-	-	-	0.01	-	-	-	-	-	0.01	Rob Board Auto Electrics
23 MCDONALD STREET	-	-	-	-	-		-	-	-	-	-		Davies Garages
25 MCDONALD STREET	-	-	-	-	-		-	-	-	-	-		Commercial
29 MCDONALD STREET	-	-	-	-	-		-	-	-	-	-	-	
31 MCDONALD STREET	-	-	-	-	-	0.04	-	-	-	-	-	-	
33 MCDONALD STREET	-	-	-	-		0.11	-	-	-	-		0.11	Commercial
46 -50 MCDONALD STREET	-	-	-	-	-		-	-	-	-	-	-	Commercial
52-54 MCDONALD STREET	-	-	-	-	0.04	0.15	-	-	-	-	-	-	Riverland Oil Seeds Production Office
57 MCDONALD STREET	-	-	-	-	0.03	0.13	-	-	-	-		0.07	
57A MCDONALD STREET	-	-	-	-	0.17	0.27	-	-	-	-	0.17	0.27	Storage Shed 2
58 MCDONALD STREET	-	-	-	0.02	0.13	0.24	-	-	-	-		0.10	
59 MCDONALD STREET	-	-	-	-		0.06	-	-	-	-		0.06	
65 MCDONALD STREET	-	-	-	0.18	0.29	0.41	-	-	-	-		0.11	
67 MCDONALD STREET	-	-	-	0.26	0.38	0.50	-	-	-	0.23	0.34	0.46	
67A MCDONALD STREET	-	-	-	0.16	0.27	0.39	-	-	-	0.15	0.26	0.38	Derelict House
69 MCDONALD STREET	-	-	-	0.04	0.15	0.27	-	-	-	-	-	0.02	Numurkah Building Supplies
31 MCGREGOR STREET	-	-	-	-	0.16	0.33	-	-	-	-	0.13	0.29	
33 MCGREGOR STREET	-	-	-	-	0.16	0.33	-	-	-	-	0.14	0.31	
34-36 MCGREGOR STREET	-	-	-	-		0.13	-	-	-	-	-	-	
38 MCGREGOR STREET	-	-	-	-	0.02	0.19	-	-	-	-		0.09	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
40 MCGREGOR STREET	-	-	-	-	0.00	0.17	-	-	-	-	-		
MEIKLEJOHN STREET	-	-	-	0.04	0.14	0.24	-	-	-	0.04	0.14	0.24	DP and JA Greness
13 MEIKLEJOHN STREET	-	-	-	-	-	0.08	-	-	-	-	-	-	
14-16 MEIKLEJOHN STREET	-	-	-	-	-	0.09	-	-	-	-	-	-	
15 MEIKLEJOHN STREET	-	-	-	-	-		-	-	-	-	-	-	
22 MEIKLEJOHN STREET	-	-	-	-	-	0.05	-	-	-	-	-	-	
43 MEIKLEJOHN STREET	-	-	-	-	-	0.01	-	-	-	-	-		
45 MEIKLEJOHN STREET	-	-	-	-	-	0.10	-	-	-	-	-	-	
46 MEIKLEJOHN STREET	-	-	-	-	-	0.05	-	-	-	-	-		
47-49 MEIKLEJOHN STREET	-	-	-	-	-		-	-	-	-	-		Wheelers Auto Elec
48-58 MEIKLEJOHN STREET	-	-	-	-	-	0.05	-	-	-	-	-	0.00	Diverse Builders Workshop
53-55 MEIKLEJOHN STREET	-	-	-	-	0.09	0.21	-	-	-	-	-	0.01	Commercial
57 MEIKLEJOHN STREET	-	-	-	-	-	0.01	-	-	-	-	-	-	
59-61 MEIKLEJOHN STREET	-	-	-	-	-	0.14	-	-	-	-	-	0.14	Danielles Massage
60 MEIKLEJOHN STREET	-	-	-	-	0.08	0.19	-	-	-	-	0.06	0.17	Gospel
62 MEIKLEJOHN STREET	-	-	-	-	0.08	0.19	-	-	-	-	-	-	
63 MEIKLEJOHN STREET	-	-	-	-		0.06	-	-	-	-		0.06	
64 MEIKLEJOHN STREET	-	-	-	-	0.07	0.19	-	-	-	-	-	-	Breretons Bakery
65 MEIKLEJOHN STREET	-	-	-	-	0.02	0.15	-	-	-	-		0.08	
67 MEIKLEJOHN STREET	-	-	-	-	0.03	0.15	-	-	-	-	-		
68-70 MEIKLEJOHN STREET	-	-	-	-		0.09	-	-	-	-		0.09	Numurkah Milk Supply
72 MEIKLEJOHN STREET	-	-	-	-	0.03	0.14	-	-	-	-	0.03	0.14	Barbarros Engineering Workshop
74-76 MEIKLEJOHN STREET	-	-	-	0.20	0.32	0.43	-	-	-	-		0.11	
80 MEIKLEJOHN STREET	-	-	-	0.23	0.34	0.45	-	-	-	-		0.04	
82-84 MEIKLEJOHN STREET	-	-	-	0.09	0.21	0.32	-	-	-		0.08	0.19	Rural and Plumbing
86 MEIKLEJOHN STREET	-	-	-	-	0.06	0.17	-	-	-	-	0.03	0.14	
95 MEIKLEJOHN STREET	-	-	-		0.05	0.16	-	-	-	-	-		
MELVILLE STREET	-	-	-	-		0.02	-	-	-	-	-		Sports Complex

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
MELVILLE STREET	-	-	-	-	-	0.08	-	-	-	-	-	-	Numurkah Hardware
MELVILLE STREET S	-		0.07	0.23	0.34	0.44	-	-	-		0.04	0.14	
MELVILLE STREET	-	-	-	-	-	0.05	-	-	-	-	-	-	Laundrette
MELVILLE STREET	-	-	-	-	-	0.09	-	-	-	-	-	-	Numurkah Hotel
MELVILLE STREET	-	0.05	0.15	0.29	0.40	0.50	-	-	-	-	-	-	Caravan Park
43 MELVILLE STREET	-	-	-	-	-		-	-	-	-	-	-	Craft Shop
53-57 MELVILLE STREET	-	-	-	-	-	0.09	-	-	-	-	-	-	Australia Post
54 MELVILLE STREET	-	-	-	-	-	0.05	-	-	-	-	-	-	ANZ Bank
56 MELVILLE STREET	-	-	-	-	-		-	-	-	-	-	-	Real Estate - First National
59 MELVILLE STREET	-	-	-	-	-		-	-	-	-	-	-	Storage
59 MELVILLE STREET	-	-	-	-	-		-	-	-	-	-		Commercial
63-69 MELVILLE STREET	-	-	-	-	-	0.04	-	-	-	-	-		Murray Goulburn
64 MELVILLE STREET	-	-	-	-	-		-	-	-	-	-		Commercial
66 MELVILLE STREET	-	-	-	-	-	0.02	-	-	-	-	-	0.02	Numurkah Travel & Cruise
68 MELVILLE STREET	-	-	-	-	-		-	-	-	-	-		Freedom Independence
70-72 MELVILLE STREET	-	-	-	-	-	0.02	-	-	-	-	-	0.02	Hairdresser
71 MELVILLE STREET	-	-	-	-	-	0.11	-	-	-	-	-	-	Flowers on Melville
72A MEIKLEJOHN STREET	-	-	-	-	0.12	0.23	-	-	-	-		0.08	Barros Engineering
73 MELVILLE STREET	-	-	-	-	-	0.11	-	-	-	-	-	-	Hair Societe
74 MELVILLE STREET	-	-	-	-	-	0.22	-	-	-	-	-	0.03	The Common Thread
75 MELVILLE STREET	-	-	-	-	-	0.07	-	-	-	-	-		Butcher
76-78 MELVILLE STREET	-	-	-	-	-	0.13	-	-	-	-	-		Newsagent
77 MELVILLE STREET	-	-	-	-	-	0.08	-	-	-	-	-	-	Hot Bread
79 MELVILLE STREET	-	-	-	-	-	0.08	-	-	-	-	-		Coffee Shop
80 MELVILLE STREET	-	-	-	-	-	0.08	-	-	-	-	-	0.08	Chemist
81 MELVILLE STREET	-	-	-	-	-	0.04	-	-	-	-	-	-	Telegraph Hotel
82-84 MELVILLE STREET	-	-	-	-	-	0.04	-	-	-	-	-	0.04	Solicitors
83 MELVILLE STREET	-	-	-	-	-		-	-	-	-	-		Bottle Shop

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
92-96 MELVILLE STREET	-	-	-	-	-	0.21	-	-	-	-	-	0.17	Video/Furniture
95 MELVILLE STREET	-	-	-	-	-		-	-	-	-	-		Shire Offices
97-99 MELVILLE STREET	-	-	-	-	-	0.09	-	-	-	-	-	-	Foodworks
98-100 MELVILLE STREET	-	-	-	-	-	0.21	-	-	-	-	-	0.12	St Vincent
101 MELVILLE STREET	-	-	-	-	0.11	0.22	-	-	-	-	0.05	0.16	Stranut
102 MELVILLE STREET	-	-	-	-	-	0.21	-	-	-	-	-	0.21	Credit Union
103 MELVILLE STREET	-	-	-	-	0.13	0.25	-	-	-	-	0.00	0.12	Sport
104-106 MELVILLE STREET	-	-	-	-	-	0.26	-	-	-	-	-	0.26	Chinese Restaurant
105-111 MELVILLE STREET	-	-	-	-	-		-	-	-	-	-		Nursery
108-110 MELVILLE STREET	-	-	-	-	-	0.17	-	-	-	-	-	0.15	Netball
112 MELVILLE STREET	-	-	-	-	0.01	0.13	-	-	-	-	0.01	0.13	Pizza
113 MELVILLE STREET	-	-	-	-	-		-	-	-	-	-		
114-116 MELVILLE STREET	-	-	-	-	-	0.15	-	-	-	-	-	0.11	Diverse Building
115 MELVILLE STREET	-	-	-	0.05	0.16	0.27	-	-	-	-		0.07	
118-120 MELVILLE STREET	-	-	-	-	0.21	0.31	-	-	-	-	-	-	Numurkah Historical Society
122-124 MELVILLE STREET	-	-	-	-	0.08	0.19	-	-	-	-	0.08	0.19	Christmas Shop
126-128 MELVILLE STREET	-	-	-	-	0.32	0.43	-	-	-	-	0.13	0.24	Pizza Shop
130 MELVILLE STREET	-	-	-	0.02	0.12	0.23	-	-	-		0.07	0.18	Tool
130-132 MELVILLE STREET	-	-	-		0.06	0.17	-	-	-	-		0.10	
134 MELVILLE STREET	-	-	-	0.04	0.14	0.25	-	-	-		0.05	0.16	Accountant
138-140 MELVILLE STREET	-	-	-	0.17	0.26	0.36	-	-	-	-	-	-	
142 MELVILLE STREET	-	-	-	0.23	0.33	0.44	-	-	-	0.09	0.19	0.30	
146 MELVILLE STREET	-	-	-	0.23	0.33	0.43	-	-	-	0.12	0.22	0.33	
158 MELVILLE STREET	-	0.01	0.14	0.25	0.33	0.42	-	0.01	0.14	0.25	0.33	0.42	Caravan Park
160 MELVILLE STREET	-	-	-	-	-		-	-	-	-	-	-	
162 MELVILLE STREET	-	-		0.00	0.09	0.20	-	-	-	-		0.02	
164-166 MELVILLE STREET	-			0.11	0.20	0.30	-	-	-	-	-	-	
168 MELVILLE STREET	-	0.11	0.18	0.28	0.37	0.48	-	-		0.07	0.16	0.26	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
170 MELVILLE STREET	-	0.04	0.12	0.22	0.32	0.42	-	-	-		0.00	0.11	
172 MELVILLE STREET	-	0.24	0.32	0.44	0.53	0.63	-	-	-		0.09	0.19	
174 MELVILLE STREET	-	0.23	0.32	0.44	0.53	0.63	-	0.05	0.14	0.26	0.35	0.45	
185 MELVILLE STREET	-	-	-	-		0.05	-	-	-	-	-		
2/185 MELVILLE STREET	-	-	-	-	-		-	-	-	-	-		
3/185 MELVILLE STREET	-	-	-	-	-	0.01	-	-	-	-	-		
4/185 MELVILLE STREET	-	-	-	-		0.03	-	-	-	-		0.03	
187 MELVILLE STREET	-	-	-	0.13	0.16	0.27	-	-	-	-	-		
189 MELVILLE STREET	-	-	-	0.02	0.07	0.17	-	-	-	-	-	-	
191 MELVILLE STREET	-	-	-	0.04	0.10	0.21	-	-	-			0.10	
193 MELVILLE STREET	-	-	-	0.07	0.15	0.26	-	-	-	-		0.03	
195 MELVILLE STREET	-	-	-	0.09	0.18	0.30	-	-	-	-		0.04	
197 MELVILLE STREET	-	-	-	0.09	0.18	0.30	-	-	-			0.12	
201-203 MELVILLE STREET	-	-	-	0.17	0.25	0.36	-	-	-	-	-		
4/202 MELVILLE STREET	-	-	-	-	-		-	-	-	-	-		
204 MELVILLE STREET	-	-	-	0.23	0.33	0.43	-	-	-		0.08	0.18	
206 MELVILLE STREET	-	-	-	0.15	0.25	0.35	-	-	-	0.01	0.11	0.21	
207 MELVILLE STREET	-	-	-	-		0.07	-	-	-	-	-		Community Health
208 MELVILLE STREET	-	-	-	-		0.06	-	-	-	-		0.06	
226 MELVILLE ROAD	-	-	-	-	-		-	-	-	-	-	-	
232 MELVILLE ROAD	-	-	-		0.05	0.15	-	-	-	-	-		
233 MELVILLE ROAD	-	-	-	-	0.01	0.11	-	-	-	-		0.01	
1A MOSS STREET	-	-	-	-	-	0.04	-	-	-	-	-	-	
1B MOSS STREET	-	-	-	-		0.04	-	-	-	-	-	-	
2 MOSS STREET	-	-	-	-	0.14	0.27	-	-	-	-	-	-	
3 MOSS STREET	-	-	-	0.11	0.23	0.37	-	-	-	-	-	-	
4 MOSS STREET	-	-	-	-	0.08	0.22	-	-	-	-	-	-	
6 MOSS STREET	-	-	-	-	0.10	0.23	-	-	-	-	-		

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
7 MOSS STREET	-	-	-		0.03	0.16	-	-	-	-	-	-	
8 MOSS STREET	-	-	-	-	0.10	0.23	-	-	-	-	-	0.01	
10 MOSS STREET	-	-	-	-	0.12	0.25	-	-	-	-	0.05	0.18	
12 MOSS STREET	-	-	-	0.04	0.16	0.29	-	-	-	-	-	0.00	
14 MOSS STREET	-	-	-	0.25	0.37	0.50	-	-	-	0.04	0.16	0.30	
15-17 MOSS STREET	-	-	-	-	-		-	-	-	-	-	-	
16 MOSS STREET	-	-	-	0.22	0.35	0.48	-	-	-		0.06	0.20	
18 MOSS STREET	-	-	-	0.28	0.41	0.54	-	-	-	-		0.08	
21 MOSS STREET	-	-	-	-	-		-	-	-	-	-	-	
27 MOSS STREET	-	-	-	-	-		-	-	-	-	-	-	
31 MOSS STREET	-	-	-	-	-	0.01	-	-	-	-	-		
33 MOSS STREET	-	-	-	-	-	0.10	-	-	-	-	-	-	
35 MOSS STREET	-	-	-	-	-	0.02	-	-	-	-	-	-	
36 MOSS STREET	-	-	-	-	-	0.08	-	-	-	-	-	0.08	
2 NEEDHAM STREET	-	-	-		0.07	0.25	-	-	-		0.07	0.25	Commercial
2 NELSON STREET	-	-	-	-	-	0.10	-	-	-	-	-	-	
4 NELSON STREET	-	-	-	-	-	0.12	-	-	-	-	-	-	
6 NELSON STREET	-	-	-	-	-	0.19	-	-	-	-	-		
8 NELSON STREET	-	-	-	-	-	0.12	-	-	-	-	-	-	
10 NELSON STREET	-	-	-	-	-		-	-	-	-	-	-	
14 NELSON STREET	-	-	-	-	-	0.11	-	-	-	-	-		
16 NELSON STREET	-	-	-	-	-		-	-	-	-	-	-	
21 NELSON STREET	-	-	-	0.01	0.07	0.19	-	-	-	0.01	0.07	0.19	Commercial
21 NELSON STREET	-	-	-	0.02	0.12	0.29	-	-	-		0.07	0.24	
24 NELSON STREET	-	-	-	0.11	0.20	0.32	-	-	-	-	-	0.00	
26 NELSON STREET	-	-	-		0.04	0.16	-	-	-	-	-	-	
32 NELSON STREET	-	-	-	0.27	0.35	0.48	-	-	-	0.04	0.12	0.25	
36 NELSON STREET	-	-	-	-	0.01	0.18	-	-	-	-	-		SES

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
38 NELSON STREET	-	-	-	-	-	0.15	-	-	-	-	-	0.15	Braybons Auto Repair
39 NELSON STREET	-	-	-	0.12	0.22	0.40	-	-	-	-		0.11	
39 NELSON STREET	-	-	-	-	-		-	-	-	-	-		Riverland Graincorp
40 NELSON STREET	-	-	-	-	-	0.01	-	-	-	-	-	0.01	Braybons Auto Repair
42 NELSON STREET	-	-	-	0.02	0.12	0.30	-	-	-	-		0.14	Goju Ryu Aus
44-46 NELSON STREET	-	-	-	-	-	0.06	-	-	-	-	-		Rich Valley Soft Drinks
48 NELSON STREET	-	-	-	0.12	0.22	0.40	-	-	-	-		0.15	Nelson Street Self Storage
1 NEWBY STREET	-	-	-		0.05	0.18	-	-	-	-	-		
2 NEWBY STREET	-	-	0.07	0.20	0.32	0.45	-	-	-	-	-		
3 NEWBY STREET	-	-	-	0.03	0.15	0.28	-	-	-	-	-	-	
4 NEWBY STREET	-	-	0.04	0.18	0.30	0.43	-	-	-	-	-	0.00	
5 NEWBY STREET	-	-	-	-		0.05	-	-	-	-	-	-	
6 NEWBY STREET	-	-		0.06	0.18	0.31	-	-	-	-	-		
7 NEWBY STREET	-	-	-	-	0.02	0.15	-	-	-	-	-	-	
8 NEWBY STREET	-	-	-	-		0.11	-	-	-	-	-	-	
9 NEWBY STREET	-	-	-	0.08	0.20	0.33	-	-	-	-	-	-	
10 NEWBY STREET	-	-	-		0.09	0.22	-	-	-	-	-	-	
11 NEWBY STREET	-	-	-	0.10	0.22	0.35	-	-	-	-	-		
12 NEWBY STREET	-	-	-	-	0.05	0.18	-	-	-	-	-	-	
14 NEWBY STREET	-	-	-	-	0.07	0.20	-	-	-	-	0.01	0.13	
15 NEWBY STREET	-	-	-	0.30	0.42	0.55	-	-	-	0.28	0.40	0.53	
16 NEWBY STREET	-	-	-	0.07	0.19	0.32	-	-	-	-	-	-	
18 NEWBY STREET	-	-	-	0.12	0.24	0.37	-	-	-	-	-	0.01	
19A NEWBY STREET	-	-	-	-		0.09	-	-	-	-	-	-	
1/21 NEWBY STREET	-	-	-	-	-		-	-	-	-	-	-	
3/21 NEWBY STREET	-	-	-	-	-		-	-	-	-	-		
25 NEWBY STREET	-	-	-	-	-	0.08	-	-	-	-	-		
1/25-27 NEWBY STREET	-	-	-	-	-		-	-	-	-	-	-	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth		Comments

Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
2/25-27 NEWBY STREET	-	-	-	-	-		-	-	-	-	-	-	
4/25-27 NEWBY STREET	-	-	-	-	-		-	-	-	-	-		
29 NEWBY STREET	-	-	-	-	-		-	-	-	-	-	-	
31 NEWBY STREET	-	-	-	-	-		-	-	-	-	-		
1 NORTH STREET	-	-	-	-		0.07	-	-	-	-	-	-	
2 NORTH STREET	-	-	-	-	-		-	-	-	-	-		
3 NORTH STREET	-	-	-	-		0.07	-	-	-	-	-	-	
4-6 NORTH STREET	-	-	-	-	0.03	0.13	-	-	-	-	-	-	
5 NORTH STREET	-	-	-	-	-		-	-	-	-	-		
7 NORTH STREET	-	-	-	-	-		-	-	-	-	-	-	
8-10 NORTH STREET	-	-	-	-		0.09	-	-	-	-		0.09	
25 OCONNOR STREET	-	-	-	-	0.09	0.49	-	-	-	-	-		
27-29 OCONNOR STREET	-	-	-	-	0.02	0.35	-	-	-	-	-	0.03	
28-30 OCONNOR STREET	-	-	-	-	-	0.27	-	-	-	-	-		
31 OCONNOR STREET	-	-	-	-	-	0.05	-	-	-	-	-	-	
32 OCONNOR STREET	-	-	-	-	-	0.06	-	-	-	-	-	-	
34 OCONNOR STREET	-	-	-	-	-	0.12	-	-	-	-	-		
1 OLIVIA COURT	-	-	-	-	-	0.17	-	-	-	-	-	0.14	
1/2 OLIVIA COURT	-	-	-	-	-	0.07	-	-	-	-	-	-	
2/2 OLIVIA COURT	-	-	-	-	-	0.05	-	-	-	-	-		
3 OLIVIA COURT	-	-	-	-	-	0.08	-	-	-	-	-		
3A OLIVIA COURT	-	-	-	-	-	0.11	-	-	-	-	-		
4 OLIVIA COURT	-	-	-	-	-	0.02	-	-	-	-	-	-	
5 OLIVIA COURT	-	-	-	-	-		-	-	-	-	-	-	
7 OLIVIA COURT	-	-	-	-	-		-	-	-	-	-	-	
8 OLIVIA COURT	-	-	-	-	-	0.01	-	-	-	-	-		
9 OLIVIA COURT	-	-	-	-	-	0.00	-	-	-	-	-	-	
10 OLIVIA COURT	-	-	-	-	-	0.09	-	-	-	-	-		

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
11 OLIVIA COURT	-	-	-	-	-	0.13	-	-	-	-	-		
4-6 ORCHARD STREET	-	-	-	0.25	0.36	0.47	-	-	-	-	-		Riverland Graincorp
12 ORCHARD STREET	-	-	-	0.20	0.31	0.42	-	-	-	-	-	-	Weigh Bridge
33 ORCHARD STREET	-	-	-	-	0.07	0.18	-	-	-	-		0.10	Stonehouse Bus lines
2 PATERSON STREET	-	-	-	-	0.23	0.63	-	-	-	-		0.30	
4 PATERSON STREET	-	-	-	-	0.20	0.60	-	-	-	-	-		
6 PATERSON STREET	-	-	-	-	0.19	0.59	-	-	-	-	-	0.23	
8 PATERSON STREET	-	-	-	-	0.24	0.64	-	-	-	-	-	0.27	
10 PATERSON STREET	-	-	-	-	0.15	0.55	-	-	-	-	-	0.04	
12 PATERSON STREET	-	-	-	-	0.09	0.50	-	-	-	-	-	0.15	
14 PATERSON STREET	-	-	-	-	0.31	0.71	-	-	-	-	-	0.29	
5/15 PATERSON STREET	-	-	-	-	-		-	-	-	-	-	-	
16 PATERSON STREET	-	-	-	-	0.27	0.67	-	-	-	-		0.33	
1/17 PATERSON STREET	-	-	-	-	-	0.09	-	-	-	-	-	-	
2/17 PATERSON STREET	-	-	-	-	-	0.02	-	-	-	-	-	-	
3/17 PATERSON STREET	-	-	-	-	-		-	-	-	-	-	-	
4/17 PATERSON STREET	-	-	-	-	-		-	-	-	-	-	-	
6/17 PATERSON STREET	-	-	-	-	-	0.06	-	-	-	-	-	-	
18 PATERSON STREET	-	-	-	-	0.14	0.54	-	-	-	-	-	0.19	
1/19 PATERSON STREET	-	-	-	-	-	0.19	-	-	-	-	-		
2/19 PATERSON STREET	-	-	-	-	-	0.04	-	-	-	-	-		
3/19 PATERSON STREET	-	-	-	-	-	0.12	-	-	-	-	-		
4/19 PATERSON STREET	-	-	-	-	-		-	-	-	-	-	-	
5/19 PATERSON STREET	-	-	-	-	-		-	-	-	-	-	-	
6/19 PATERSON STREET	-	-	-	-	-	0.02	-	-	-	-	-		
7/19 PATERSON STREET	-	-	-	-	-	0.02	-	-	-	-	-		
8/19 PATERSON STREET	-	-	-	-	-	0.06	-	-	-	-	-		
20 PATERSON STREET	-	-	-	-	0.16	0.56	-	-	-	-	-	0.12	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
9/21 PATERSON STREET	-	-	-	-	-	0.09	-	-	-	-	-		
10/21 PATERSON STREET	-	-	-	-	-	0.13	-	-	-	-	-		
11/21 PATERSON STREET	-	-	-	-	-	0.14	-	-	-	-	-		
12/21 PATERSON STREET	-	-	-	-	-		-	-	-	-	-	-	
13/21 PATERSON STREET	-	-	-	-	-		-	-	-	-	-	-	
14/21 PATERSON STREET	-	-	-	-	-	0.03	-	-	-	-	-		
15/21 PATERSON STREET	-	-	-	-	-	0.02	-	-	-	-	-	-	
16/21 PATERSON STREET	-	-	-	-	-	0.11	-	-	-	-	-		
22 PATERSON STREET	-	-	-	-	-	0.30	-	-	-	-	-	0.17	
1/23 PATERSON STREET	-	-	-	-	-		-	-	-	-	-	-	
2/23 PATERSON STREET	-	-	-	-	-	0.00	-	-	-	-	-	-	
24 PATERSON STREET	-	-	-	-	0.08	0.49	-	-	-	-	-	0.04	
25 PATERSON STREET	-	-	-	-	-	0.04	-	-	-	-	-		
26 PATERSON STREET	-	-	-	-	0.13	0.54	-	-	-	-	-	0.24	
27 PATERSON STREET	-	-	-	-	-		-	-	-	-	-	-	
1/27 PATERSON STREET	-	-	-	-	-	0.14	-	-	-	-	-	-	
28 PATERSON STREET	-	-	-	-	0.09	0.50	-	-	-	-		0.35	
29 PATERSON STREET	-	-	-	-		0.35	-	-	-	-	-		
30 PATERSON STREET	-	-	-	-	0.26	0.67	-	-	-	-	-	0.13	
31 PATERSON STREET	-	-	-	-	-	0.19	-	-	-	-	-	0.07	
32 PATERSON STREET	-	-	-	-	0.06	0.47	-	-	-	-		0.34	
33 PATERSON STREET	-	-	-	-	-	0.14	-	-	-	-	-	-	
1/34 PATERSON STREET	-	-	-	-	0.11	0.50	-	-	-	-	-		
2/34 PATERSON STREET	-	-	-	-	0.10	0.48	-	-	-	-	-	0.00	
35 PATERSON STREET	-	-	-	-		0.18	-	-	-	-	-	-	
1/36 PATERSON STREET	-	-	-	-	0.13	0.46	-	-	-	-	-		
2/36 PATERSON STREET	-	-	-	-	-	0.44	-	-	-	-	-		
3/36 PATERSON STREET	-	-	-	-	-	0.47	-	-	-	-	-		

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
4/36 PATERSON STREET	-	-	-	-	-	0.47	-	-	-	-	-	-	
37 PATERSON STREET	-	-	-	-	0.01	0.20	-	-	-	-	-	-	
38 PATERSON STREET	-	-	-	-	0.16	0.40	-	-	-	-	-	0.12	
39 PATERSON STREET	-	-	-	-	0.02	0.21	-	-	-	-	-		
41 PATERSON STREET	-	-	-	-	0.21	0.39	-	-	-	-	-		
43 PATERSON STREET	-	-	-	-	0.08	0.26	-	-	-	-	-		
45 PATERSON STREET	-	-	-	-	0.08	0.26	-	-	-	-	-	-	
1 PAVEY STREET	-	-	-	-	-		-	-	-	-	-	-	Numurkah Nu-Genes
3 PAVEY STREET	-	-	-	-		0.09	-	-	-	-	-	0.01	Commercial
5 PAVEY STREET	-	-	-	-	-	0.10	-	-	-	-	-	0.10	Hendersons Fertilizer
7-9 PAVEY STREET	-	-	-	-		0.13	-	-	-	-	-	0.11	DS Kendall Waste Services
11 PAVEY STREET	-	-	-	-	0.05	0.22	-	-	-	-	-		Commercial
15 PAVEY STREET	-	-	-	-	-		-	-	-	-	-	-	Commercial
2 POPLAR DRIVE	-	-	-	-		0.04	-	-	-	-	-		
4 POPLAR DRIVE	-	-	-	-	-		-	-	-	-	-	-	
6 POPLAR DRIVE	-	-	-	-	0.05	0.13	-	-	-	-	-		
QUINN STREET	-	-	-	-	-	0.07	-	-	-	-	-	-	Commercial
25 QUINN STREET	-	-	-	-	-	0.07	-	-	-	-	-		Hair Designs
26 QUINN STREET	-	-	-	-	-		-	-	-	-	-		Eagle Café
27 QUINN STREET	-	-	-	-	-	0.14	-	-	-	-	-	0.14	Red Cross
28 QUINN STREET	-	-	-	-	-	0.13	-	-	-	-	-	0.13	Toilet Block
29 QUINN STREET	-	-	-	-	-		-	-	-	-	-		
31 QUINN STREET	-	-	-	-		0.07	-	-	-	-	-	-	Funeral
33 QUINN STREET	-	-	-	-	0.01	0.16	-	-	-	-		0.08	Parloor
37 QUINN STREET	-	-	-	-	-		-	-	-	-	-	-	
43 QUINN STREET	-	-	-	-	-		-	-	-	-	-	-	
91 QUINN STREET	-	-	-	-		0.08	-	-	-	-	-		
92 QUINN STREET	-	-	-	-	-	0.07	-	-	-	-	-	0.07	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
93 QUINN STREET	-	-	-	0.04	0.12	0.25	-	-	-	-	-		
94 QUINN STREET	-	-	-	-		0.11	-	-	-	-	-	-	
95 QUINN STREET	-	-	-	0.09	0.18	0.30	-	-	-	-	-	-	
96 QUINN STREET	-	-	-	-	0.07	0.20	-	-	-	-		0.08	
97 QUINN STREET	-	-	-	0.13	0.22	0.34	-	-	-	-	-	-	
98 QUINN STREET	-	-	-	-	-		-	-	-	-	-	-	
99 QUINN STREET	-	-	-		0.01	0.13	-	-	-		0.01	0.13	New name Electric Motor Services
100 QUINN STREET	-	-	-	-	-		-	-	-	-	-	-	
102 QUINN STREET	-	-	-	-	-		-	-	-	-	-	-	
104 QUINN STREET	-	-	-	-		0.09	-	-	-	-	-		
106 QUINN STREET	-	-	-	-	-		-	-	-	-	-		
108 QUINN STREET	-	-	-	-	-	0.23	-	-	-	-	-	-	
110 QUINN STREET	-	-	-	-	-		-	-	-	-	-	-	
112-114 QUINN STREET	-	-	-	-	-		-	-	-	-	-	-	
1 RACHAEL BOULEVARD	-	-	-	-	-		-	-	-	-	-	-	
2 RACHAEL BOULEVARD	-	-	-	-	-		-	-	-	-	-	-	
8 RACHAEL BOULEVARD	-	-	-	-	-		-	-	-	-	-	-	
16 RAILWAY PLACE	-	-	-	-		0.07	-	-	-	-	-	-	
18 RAILWAY PLACE	-	-	-	-		0.09	-	-	-	-	-	-	
20 RAILWAY PLACE	-	-	-	-		0.12	-	-	-	-	-	-	
50-60 REILYS PIT ROAD	0.04	0.04	0.05	0.10	0.16	0.22	-	-	-	-	-	-	
1 REED COURT	-	-	-	0.05	0.16	0.27	-	-	-	-	-	-	
3 REED COURT	-	-	-	-		0.10	-	-	-	-	-		
4 REED COURT	-	-	-	-	0.04	0.16	-	-	-	-	-	-	
7 REED COURT	-	-	-		0.05	0.15	-	-	-	-	-		
8 REED COURT	-	-	-		0.04	0.14	-	-	-	-	-		
9 REED COURT	-	-	-		0.06	0.17	-	-	-	-	-	-	
10 REED COURT	-	-	-		0.05	0.15	-	-	-	-	-		

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
1 REYNOLDS DRIVE	-	-	-	-	-	0.10	-	-	-	-	-	0.01	
2 REYNOLDS DRIVE	-	-	-	-	-	0.22	-	-	-	-	-	0.08	
3 REYNOLDS DRIVE	-	-	-	-	-	0.15	-	-	-	-	-	-	
4 REYNOLDS DRIVE	-	-	-	-	-	0.18	-	-	-	-	-	0.07	
5 REYNOLDS DRIVE	-	-	-	-	-	0.07	-	-	-	-	-	-	
6 REYNOLDS DRIVE	-	-	-	-	-	0.20	-	-	-	-	-		
7 REYNOLDS DRIVE	-	-	-	-	-	0.06	-	-	-	-	-		
8 REYNOLDS DRIVE	-	-	-	-	-	0.10	-	-	-	-	-		
9 REYNOLDS DRIVE	-	-	-		0.08	0.25	-	-	-	-		0.08	
10 REYNOLDS DRIVE	-	-	-	-	-	0.07	-	-	-	-	-	-	
2/10 REYNOLDS DRIVE	-	-	-	-	-	0.03	-	-	-	-	-	-	
12 REYNOLDS DRIVE	-	-	-	-		0.15	-	-	-	-		0.10	
13 REYNOLDS DRIVE	-	-	-	-		0.13	-	-	-	-	-	0.01	
14 REYNOLDS DRIVE	-	-	-		0.09	0.26	-	-	-	-	-		
16 REYNOLDS DRIVE	-	-	-	-		0.14	-	-	-	-	-		
18 REYNOLDS DRIVE	-	-	-	-		0.09	-	-	-	-	-	-	
19 REYNOLDS DRIVE	-	-	-		0.16	0.33	-	-	-	-	-	-	
20 REYNOLDS DRIVE	-	-	-	-	-		-	-	-	-	-		
21 REYNOLDS DRIVE	-	-	-		0.16	0.33	-	-	-	-		0.15	
1 ROWE STREET	-	-	-		0.09	0.22	-	-	-	-		0.08	
3 ROWE STREET	-	-	-	-		0.10	-	-	-	-	-		
5 ROWE STREET	-	-	-	-	-	0.07	-	-	-	-	-		
7 ROWE STREET	-	-	-	-	-	0.03	-	-	-	-	-	-	
9 ROWE STREET	-	-	-	-	-		-	-	-	-	-	-	
11 ROWE STREET	-	-	-	-	-	0.03	-	-	-	-	-	-	
13 ROWE STREET	-	-	-	-	0.01	0.05	-	-	-	-	-	-	
15 ROWE STREET	-	-	-	-			-	-	-	-	-	-	
17 ROWE STREET	-	-	-	-		0.08	-	-	-	-	-	-	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
21 ROWE STREET	-	-	-	-	0.22	0.26	-	-	-	-	-	-	
23 ROWE STREET	-	-	-	-	-	0.07	-	-	-	-	-	-	
27 ROWE STREET	-	-	-	-	0.02	0.11	-	-	-	-	-		
28 ROWE STREET	-	-	-		0.07	0.16	-	-	-	-	-	-	
30 ROWE STREET	-		0.04	0.15	0.24	0.34	-	-	-	-	-	-	
31 ROWE STREET	-	-	-	-		0.03	-	-	-	-	-		
32 ROWE STREET	-		0.05	0.16	0.25	0.35	-	-	-	-	-		
33 ROWE STREET	-	-		0.08	0.17	0.26	-	-	-	-	-		
34 ROWE STREET	-		0.07	0.18	0.27	0.37	-	-	-	-	-	-	
38 ROWE STREET	-	0.07	0.16	0.27	0.36	0.46	-	-	-	-	-		
12 RUSSELL STREET	-	-	-	-	-		-	-	-	-	-	-	
13 RUSSELL STREET	-	-	-	-	-	0.14	-	-	-	-	-	-	
14 RUSSELL STREET	-	-	-	-	-	0.00	-	-	-	-	-	-	
15-17 RUSSELL STREET	-	-	-	-	-	0.01	-	-	-	-	-	-	
16 RUSSELL STREET	-	-	-	-	-		-	-	-	-	-		
2/16 RUSSELL STREET	-	-	-	-	-	0.01	-	-	-	-	-		
18 RUSSELL STREET	-	-	-	-	-	0.12	-	-	-	-	-		
19 RUSSELL STREET	-	-	-	-	-	0.11	-	-	-	-	-		
20 RUSSELL STREET	-	-	-	-	-	0.11	-	-	-	-	-		
21 RUSSELL STREET	-	-	-	-	-	0.10	-	-	-	-	-	-	
22 RUSSELL STREET	-	-	-	-	-	0.11	-	-	-	-	-	-	
23 RUSSELL STREET	-	-	-	-	-	0.04	-	-	-	-	-	-	
2/23 RUSSELL STREET	-	-	-	-	-	0.02	-	-	-	-	-	-	
24 RUSSELL STREET	-	-	-	-	-	0.07	-	-	-	-	-		
26 RUSSELL STREET	-	-	-	-	0.17	0.39	-	-	-	-		0.22	
27 RUSSELL STREET	-	-	-	-	-		-	-	-	-	-	-	
28 RUSSELL STREET	-	-	-	-	-	0.03	-	-	-	-	-	-	
32 RUSSELL STREET	-	-	-	-	0.01	0.16	-	-	-	-	-		

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth		Comments

Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
33 RUSSELL STREET	-	-	-	-	-	0.02	-	-	-	-	-	-	
34 RUSSELL STREET	-	-	-	0.01	0.07	0.19	-	-	-	-	-		
1/35 RUSSELL STREET	-	-	-	-		0.13	-	-	-	-	-	-	
2/35 RUSSELL STREET	-	-	-	-		0.10	-	-	-	-	-	-	
3/35 RUSSELL STREET	-	-	-	-		0.09	-	-	-	-	-	-	
37 RUSSELL STREET	-	-	-	-	0.23	0.39	-	-	-	-		0.15	
38 RUSSELL STREET	-	-	-	-	-		-	-	-	-	-	-	
39 RUSSELL STREET	-	-	-	-	0.22	0.38	-	-	-	-	-	-	
42 RUSSELL STREET	-	-	-	-		0.07	-	-	-	-	-	-	
44 RUSSELL STREET	-	-	-	-		0.01	-	-	-	-	-	-	
46 RUSSELL STREET	-	-	-	-		0.06	-	-	-	-	-	-	
48 RUSSELL STREET	-	-	-	-	-	0.01	-	-	-	-	-	-	
40 SAMPSONS ROAD	-	-	-				-	-	-	-	-	-	
70 SAMPSONS ROAD	-	-	-			0.01	-	-	-			0.01	
7 SAXTON STREET	-	-	-	-		0.34	-	-	-	-	-	0.03	
9 SAXTON STREET	-	-	-	-		0.38	-	-	-	-	-	-	
11 SAXTON STREET	-	-	-	-		0.35	-	-	-	-	-		
107 SAXTON STREET	-	-	-	-	-		-	-	-	-	-	-	
109 SAXTON STREET	-	-	-	-	-	0.08	-	-	-	-	-	-	
110 SAXTON STREET	-	-	-	-	-		-	-	-	-	-	-	
111 SAXTON STREET	-	-	-	-	-	0.26	-	-	-	-	-	0.02	
112 SAXTON STREET	-	-	-	-	-	0.17	-	-	-	-	-	-	
113 SAXTON STREET	-	-	-	-	-	0.11	-	-	-	-	-	-	
114 SAXTON STREET	-	-	-	-	-	0.18	-	-	-	-	-	-	
115 SAXTON STREET	-	-	-	-	-	0.29	-	-	-	-	-	-	
116 SAXTON STREET	-	-	-	-	-	0.05	-	-	-	-	-	-	
117 SAXTON STREET	-	-	-	-	-	0.05	-	-	-	-	-	-	
2/117 SAXTON STREET	-	-	-	-	-		-	-	-	-	-	-	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
3/117 SAXTON STREET	-	-	-	-	-		-	-	-	-	-	-	
118 SAXTON STREET	-	-	-	-	-	0.07	-	-	-	-	-	0.03	The Flower & Function Studio
119 SAXTON STREET	-	-	-	-	-	0.17	-	-	-	-	-	0.05	
120 SAXTON STREET	-	-	-	-	-		-	-	-	-	-	-	
121 SAXTON STREET	-	-	-	-	-	0.05	-	-	-	-	-		
122-124 SAXTON STREET	-	-	-	-	-	0.19	-	-	-	-	-		
123 SAXTON STREET	-	-	-	-	-		-	-	-	-	-		
125 SAXTON STREET	-	-	-	-	-	0.14	-	-	-	-	-	-	
127 SAXTON STREET	-	-	-	-	-	0.03	-	-	-	-	-		
128 SAXTON STREET	-	-	-	-	-	0.24	-	-	-	-	-	-	
129 SAXTON STREET	-	-	-	-	-	0.21	-	-	-	-	-		
130 SAXTON STREET	-	-	-	-	-		-	-	-	-	-	-	
131-133 SAXTON STREET	-	-	-	-	-		-	-	-	-	-	-	Good Start Early Learning
1/132 SAXTON STREET	-	-	-	-	-		-	-	-	-	-	-	
2/132 SAXTON STREET	-	-	-	-	-		-	-	-	-	-	-	
3/132 SAXTON STREET	-	-	-	-	-		-	-	-	-	-	-	
134 SAXTON STREET	-	-	-	-	-	0.30	-	-	-	-	-	-	
1 SHAW COURT	-	-	-	-	-		-	-	-	-	-	-	
2 SHAW COURT	-	-	-	-	0.01	0.15	-	-	-	-	-		
3 SHAW COURT	-	-	-	-		0.07	-	-	-	-	-	-	
4 SHAW COURT	-	-	-	-		0.12	-	-	-	-	-		
5 SHAW COURT	-	-	-	-	0.02	0.14	-	-	-	-	-		
6 SHAW COURT	-	-	-	-		0.08	-	-	-	-	-		
7 SHAW COURT	-	-	-	-		0.09	-	-	-	-	-		
8 SHAW COURT	-	-	-	-		0.05	-	-	-	-	-		
9 SHAW COURT	-	-	-	0.21	0.35	0.47	-	-	-	-	-	-	
2 SHEYNA DRIVE	-	-	-	-	-		-	-	-	-	-	-	
4 SHEYNA DRIVE	-	-	-	-	-		-	-	-	-	-	-	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
7 SHEYNA DRIVE	-	-	-	-	-		-	-	-	-	-	-	
1/9 SHEYNA DRIVE	-	-	-	-	-		-	-	-	-	-	-	
6/9 SHEYNA DRIVE	-	-	-	-	-		-	-	-	-	-	-	
LOT 19 SHEYNA DRIVE	-	-	0.01	0.14	0.24	0.36	-	-	-	-		0.07	
LOT 19 SHEYNA DRIVE	-	-	-	-	0.01	0.13	-	-	-	-		0.08	Country Club Rec Room
1908 SHINNICKS ROAD	-	-	-				-	-	-	-	-	-	
1910 SHINNICKS ROAD	-	-	-	-	-		-	-	-	-	-	-	
1924 SHINNICKS ROAD	-	0.20	0.26	0.32	0.34	0.37	-	-	-	-	-	-	
2 SINCLAIR DRIVE	-	-	-	0.03	0.07	0.14	-	-	-	-	-	-	
3 SINCLAIR DRIVE	-	-	-	-	-		-	-	-	-	-	-	
4 SINCLAIR DRIVE	-	-		0.06	0.10	0.18	-	-	-	-	-	-	
63 SLOLEYS BRIDGE ROAD	-	-	-		0.03	0.13	-	-	-	-	-	-	
89 SLOLEYS BRIDGE ROAD	-	-	-		0.04	0.13	-	-	-	-	-	-	
STATION STREET	-	-	-	0.03	0.14	0.24	-	-	-	0.03	0.14	0.24	Old Toilets
6 STATION STREET	-	-	-	0.13	0.23	0.33	-	-	-	0.08	0.18	0.28	Commercial
18 STATION STREET	-	-	0.14	0.34	0.44	0.53	-	-	-	-	-		Bunker
20-24 STATION STREET	-	-	-		0.06	0.15	-	-	-		0.06	0.15	Stainless Steel
26 STATION STREET	-	-	-	-		0.05	-	-	-	-		0.05	
28 STATION STREET	-	-	-	-	0.03	0.13	-	-	-	-	0.03	0.12	Commercial
30-40 STATION STREET	-	-		0.14	0.25	0.34	-	-	-	-	-	-	
14 STEWART STREET	-	-	-	-	-		-	-	-	-	-	-	
3 SWALLOW STREET	-	-	-	-	-		-	-	-	-	-	-	
5 SWALLOW STREET	-	-	-	-	-		-	-	-	-	-	-	
9 SWALLOW STREET	-	-	-	-	-	0.03	-	-	-	-	-	-	
17 SWALLOW STREET	-	-	-	-	0.04	0.16	-	-	-	-	-	-	
18 SWALLOW STREET	-	-	-	-	-		-	-	-	-	-		
19 SWALLOW STREET	-	-	-	-		0.10	-	-	-	-		0.06	
21-25 SWALLOW STREET	-	-	-	0.10	0.18	0.31	-	-	-	0.07	0.15	0.27	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
751 SWAMP ROAD	0.03	0.16	0.31	0.47	0.59	0.72	0.01	0.14	0.30	0.46	0.58	0.70	
1 THORNTON STREET	-	-	0.04	0.17	0.29	0.41	-	-	-	-		0.11	
2 THORNTON STREET	-	-		0.05	0.16	0.28	-	-	-		0.08	0.20	
3 THORNTON STREET	-	0.08	0.22	0.36	0.47	0.60	-	-	-	-		0.08	
4 THORNTON STREET	-	-		0.11	0.23	0.35	-	-	-	-		0.10	
5 THORNTON STREET	-	-	0.03	0.16	0.28	0.40	-	-	-	-	-		
1/6 THORNTON STREET	-	-	-	-		0.08	-	-	-	-		0.03	
2/6 THORNTON STREET	-	-	-	-		0.05	-	-	-	-	-	0.01	
3/6 THORNTON STREET	-	-	-		0.08	0.20	-	-	-	-		0.03	
7 THORNTON STREET	-	-	-	0.05	0.17	0.30	-	-	-	-	-	-	
8 THORNTON STREET	-	-	-	0.12	0.24	0.36	-	-	-	-	-	-	
9 THORNTON STREET	-	-	-		0.11	0.23	-	-	-	-	-	-	
10 THORNTON STREET	-	-	-	-		0.03	-	-	-	-	-	-	
11 THORNTON STREET	-	-	-	-	-	0.01	-	-	-	-	-	-	
12 THORNTON STREET	-	-	-	0.17	0.28	0.40	-	-	-	0.17	0.28	0.40	
13 THORNTON STREET	-	-	-		0.03	0.15	-	-	-	-		0.08	
14 THORNTON STREET	-	-	-	-		0.06	-	-	-	-	-		
15 THORNTON STREET	-	-	-	0.06	0.18	0.29	-	-	-	-	-	-	
17 THORNTON STREET	-	-	-	0.17	0.29	0.40	-	-	-	-	-		
1/19 THORNTON STREET	-	-	-	-	-		-	-	-	-	-	-	
2/19 THORNTON STREET	-	-	-	-	-		-	-	-	-	-	-	
3/19 THORNTON STREET	-	-	-	-	-		-	-	-	-	-	-	
30 TRENGROVE STREET	-	-	-	-	-		-	-	-	-	-	-	
32 TRENGROVE STREET	-	-	-	-	-		-	-	-	-	-	-	
34 TRENGROVE STREET	-	-	-	-	-	0.01	-	-	-	-	-	-	
36 TRENGROVE STREET	-	-	-	-	-	0.10	-	-	-	-	-	-	
38-40 TRENGROVE STREET	-	-	-	-	-	0.09	-	-	-	-	-	-	
42 TRENGROVE STREET	-	-	-	-	-	0.15	-	-	-	-	-	-	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
44-46 TRENGROVE STREET	-	-	-	-	-	0.07	-	-	-	-	-	-	
48 TRENGROVE STREET	-	-	-	-	-		-	-	-	-	-	-	Commercial
TUNNOCK ROAD	-	-		0.11	0.23	0.37	-	-	-	0.01	0.14	0.27	Show Ground Shed
TUNNOCK ROAD	-	-	-			0.08	-	-	-	-	-	-	Golf Club
TUNNOCK ROAD	0.22	0.33	0.43	0.54	0.64	0.75		0.08	0.17	0.29	0.39	0.50	Rifle Range
TUNNOCK ROAD	-	0.12	0.21	0.33	0.43	0.53	-	0.12	0.21	0.33	0.43	0.53	Golf Club Shed
1 TUNNOCK ROAD	-		0.07	0.20	0.31	0.43	-	-	-		0.07	0.19	
2 TUNNOCK ROAD	-	-		0.09	0.20	0.33	-	-	-	0.03	0.14	0.26	
3 TUNNOCK ROAD	-	0.03	0.17	0.31	0.42	0.55	-	-	-	-		0.12	
4 TUNNOCK ROAD	-	0.04	0.19	0.33	0.45	0.57	-	-	-	-	-		
5 TUNNOCK ROAD	-	-		0.08	0.20	0.32	-	-	-	-	-	-	
5A TUNNOCK ROAD	-		0.10	0.23	0.35	0.48	-	-	-	-	-	-	
6 TUNNOCK ROAD	-	-	-		0.06	0.19	-	-	-	-	-		
7 TUNNOCK ROAD	-	-	-	-		0.09	-	-	-	-	-	-	
9 TUNNOCK ROAD	-	-	-	-	0.03	0.17	-	-	-	-	-		
1/9A TUNNOCK ROAD	-	-	-	-	0.07	0.20	-	-	-	-	-	-	
2/9A TUNNOCK ROAD	-	-	-	-	0.05	0.18	-	-	-	-	-	-	
3/9A TUNNOCK ROAD	-	-	-	-	0.12	0.25	-	-	-	-	-	-	
10 TUNNOCK ROAD	-	-	-	-	-		-	-	-	-	-	-	
11 TUNNOCK ROAD	-	-	-	0.25	0.37	0.51	-	-	-	-	-	-	
12 TUNNOCK ROAD	-	-	-	-	-		-	-	-	-	-	-	
13 TUNNOCK ROAD	-	-	-	-		0.06	-	-	-	-	-	-	
14 TUNNOCK ROAD	-	-	-	-		0.05	-	-	-	-	-	0.03	
15 TUNNOCK ROAD	-	-	-	-		0.06	-	-	-	-	-	-	
16 TUNNOCK ROAD	-	-	-	-	0.00	0.05	-	-	-	-	-	-	
17 TUNNOCK ROAD	-	-	-	-	0.11	0.17	-	-	-	-	-	-	
18 TUNNOCK ROAD	-	-	-	-		0.04	-	-	-	-	-	-	
19 TUNNOCK ROAD	-	-	-	-	0.04	0.09	-	-	-	-		0.01	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
1/20 TUNNOCK ROAD	-	-	-	-	-		-	-	-	-	-		
2/20 TUNNOCK ROAD	-	-	-	-	-		-	-	-	-	-	-	
3/20 TUNNOCK ROAD	-	-	-	-	-		-	-	-	-	-	-	
4/21 TUNNOCK ROAD	-	-	-	-	-	0.01	-	-	-	-	-	-	
5/21 TUNNOCK ROAD	-	-	-	-	-		-	-	-	-	-	-	
6/21 TUNNOCK ROAD	-	-	-	-	-		-	-	-	-	-		
22 TUNNOCK ROAD	-	-	-	-		0.03	-	-	-	-	-	-	
22A TUNNOCK ROAD	-	-	-	-	-		-	-	-	-	-	-	
2/22 TUNNOCK ROAD	-	-	-	-	-	0.04	-	-	-	-	-	-	
24 TUNNOCK ROAD	-	-	-	-		0.04	-	-	-	-	-	-	
25 TUNNOCK ROAD	-	-	0.09	0.21	0.30	0.40	-	-	-	-	-	-	
26 TUNNOCK ROAD	-	-		0.02	0.11	0.21	-	-	-	-	-	-	
27 TUNNOCK ROAD	-	-	-	-	-		-	-	-	-	-	-	
29 TUNNOCK ROAD	-		0.07	0.19	0.28	0.38	-	-	-	-	-	-	
30-36 TUNNOCK ROAD	-	-	-	-		0.01	-	-	-	-	-		
37-40 TUNNOCK ROAD	-	-		0.04	0.13	0.24	-	-	-	-		0.04	
41-44 TUNNOCK ROAD	-	-	-	-	-		-	-	-	-	-		
45-50 TUNNOCK ROAD	-	-	-		0.03	0.14	-	-	-	-	-		
51-54 TUNNOCK ROAD	-	-	-	-		0.06	-	-	-	-	-		
1 TYACK STREET	-	-	-	-		0.06	-	-	-	-	-		W.Poad & Partners
6 TYACK STREET	-	-	-	-	-		-	-	-	-	-		Commercial
8 TYACK STREET	-	-	-	-	-		-	-	-	-	-		Commercial
10 TYACK STREET	-	-	-	-	0.05	0.17	-	-	-	-	0.00	0.13	Pacific Seeds
12 TYACK STREET	-	-	-	-	0.05	0.17	-	-	-	-	0.05	0.17	Commercial
14 TYACK STREET	-	-	-	-	0.14	0.26	-	-	-	-	0.14	0.26	Commercial
16 TYACK STREET	-	-	-		0.05	0.17	-	-	-			0.10	
1853 WALSHS BRIDGE ROAD	-	-	-	-	-		-	-	-	-	-	-	
1932 WALSHS BRIDGE ROAD	-	-	-	-		0.03	-	-	-	-	-	-	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
1939 WALSHS BRIDGE ROAD	-			0.06	0.10	0.17	-	-	-	-	-	-	
2052 WALSHS BRIDGE ROAD	-	-	0.01	0.09	0.18	0.27	-	-	-	-	-		
1 WATTLE DRIVE	-	-	-	-	-	0.03	-	-	-	-	-	-	
2 WATTLE DRIVE	-	-	-	-	-	0.09	-	-	-	-	-		
3 WATTLE DRIVE	-	-	-	-	-	0.05	-	-	-	-	-		
4 WATTLE DRIVE	-	-	-	-	-	0.05	-	-	-	-	-	-	
5 WATTLE DRIVE	-	-	-	-	-	0.08	-	-	-	-	-		
6 WATTLE DRIVE	-	-	-	-	-	0.02	-	-	-	-	-	-	
7 WATTLE DRIVE	-	-	-	-	-	0.04	-	-	-	-	-	-	
8 WATTLE DRIVE	-	-	-	-	-	0.39	-	-	-	-	-	0.39	
9 WATTLE DRIVE	-	-	-	-	-	0.05	-	-	-	-	-		
10 WATTLE DRIVE	-	-	-	-	-	0.13	-	-	-	-	-	-	
12 WATTLE DRIVE	-	-	-	-	-	0.01	-	-	-	-	-	-	
1/13 WATTLE DRIVE	-	-	-	-		0.10	-	-	-	-	-	-	
2/13 WATTLE DRIVE	-	-	-	-		0.09	-	-	-	-	-	-	
14 WATTLE DRIVE	-	-	-	0.00	0.07	0.19	-	-	-	-	-		
15 WATTLE DRIVE	-	-	-	-	-		-	-	-	-	-	-	
16 WATTLE DRIVE	-	-	-		0.00	0.12	-	-	-	-	-	-	
20 WATTLE DRIVE	-	-	-	-		0.07	-	-	-	-	-	-	
1/22-26 WATTLE DRIVE	-	-	-	-	-		-	-	-	-	-	-	
8/22-26 WATTLE DRIVE	-	-	-	-	-		-	-	-	-	-	-	
30 WATTLE DRIVE	-	-	-	-	-	0.02	-	-	-	-	-	-	
34 WATTLE DRIVE	-	-	-	-	-		-	-	-	-	-	-	
36 WATTLE DRIVE	-	-	-	-	-		-	-	-	-	-	-	
38 WATTLE DRIVE	-	-	-	-	-		-	-	-	-	-	-	
40 WATTLE DRIVE	-	-	-	-	-	0.02	-	-	-	-	-	-	
42 WATTLE DRIVE	-	-	-	-	-		-	-	-	-	-	-	
44 WATTLE DRIVE	-	-	-	-	-	0.07	-	-	-	-	-	-	

NUMURKAH – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

LEGEND		Within ~100mm of being flooded		Over-ground flood depth		Over-floor flood depth						
Location (Number & Street)	Depth of flooding against building						Depth of over-floor flooding						Comments
	5y	10y	20y	50y	100y	200y	5y	10y	20y	50y	100y	200y	
Numurkah gauge (mAHD)	107.412	107.593	107.714	107.830	107.934	108.048	107.412	107.593	107.714	107.830	107.934	108.048	
46 WATTLE DRIVE	-	-	-	-	-	0.06	-	-	-	-	-	-	
1/48 WATTLE DRIVE	-	-	-	-	-	0.13	-	-	-	-	-	-	
2/48 WATTLE DRIVE	-	-	-	-		0.04	-	-	-	-	-	-	
3/48 WATTLE DRIVE	-	-	-	-		0.01	-	-	-	-	-	-	
4/48 WATTLE DRIVE	-	-	-	-	-	0.12	-	-	-	-	-	-	
52 WATTLE DRIVE	-	-	-	0.09	0.19	0.26	-	-	-	0.03	0.13	0.21	
56 WATTLE DRIVE	-	-	-	-	0.12	0.23	-	-	-	-	-	-	
57 WATTLE DRIVE	-	-	-	-		0.08	-	-	-	-	-	-	
58 WATTLE DRIVE	-	-	-	-	0.00	0.21	-	-	-	-	-	-	
59 WATTLE DRIVE	-	-	-	-		0.05	-	-	-	-	-	-	
60 WATTLE DRIVE	-	-	-	-		0.15	-	-	-	-	-	-	
61 WATTLE DRIVE	-	-	-	-	-	0.03	-	-	-	-	-	-	
63 WATTLE DRIVE	-	-	-	-	-		-	-	-	-	-	-	
64 WATTLE DRIVE	-	-	-	-	0.05	0.18	-	-	-	-	-	-	
65 WATTLE DRIVE	-	-	-	-	-		-	-	-	-	-	-	
66 WATTLE DRIVE	-	-	-	-	0.07	0.19	-	-	-	-	-	-	
69 WATTLE DRIVE	-	-	-	-	-		-	-	-	-	-	-	
70 WATTLE DRIVE	-	-	-	-	0.18	0.30	-	-	-	-	-	-	
71 WATTLE DRIVE	-	-	-	-	-		-	-	-	-	-	-	
72 WATTLE DRIVE	-	-	-	-	0.00	0.12	-	-	-	-	-	-	
73 WATTLE DRIVE	-	-	-	-	-		-	-	-	-	-	-	
74 WATTLE DRIVE	-	-	-	-	0.14	0.26	-	-	-	-	-	-	
75 WATTLE DRIVE	-	-	-	-		0.03	-	-	-	-	-	-	
78 WATTLE DRIVE	-	-	-	-	-	0.24	-	-	-	-	-	-	
80 WATTLE DRIVE	-	-	-	0.01	0.12	0.25	-	-	-	-	-	-	
82 WATTLE DRIVE	-	-	-	-		0.02	-	-	-	-	-	-	

Approximate Severity of Flooding Tools for Numurkah

Introduction

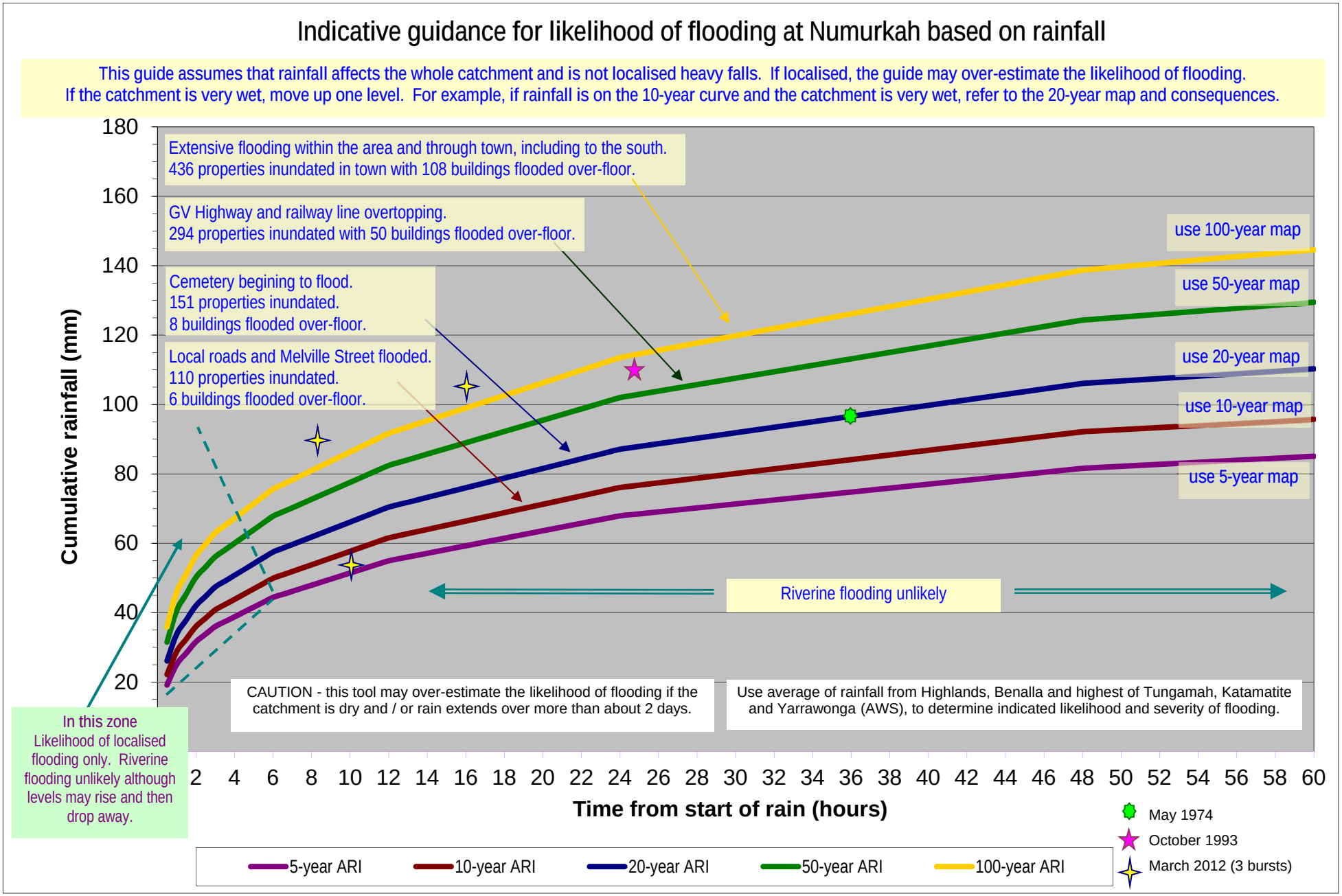
The BoM does not currently provide flood forecasts for Numurkah. All actions must therefore be driven by rain and / or river level observations.

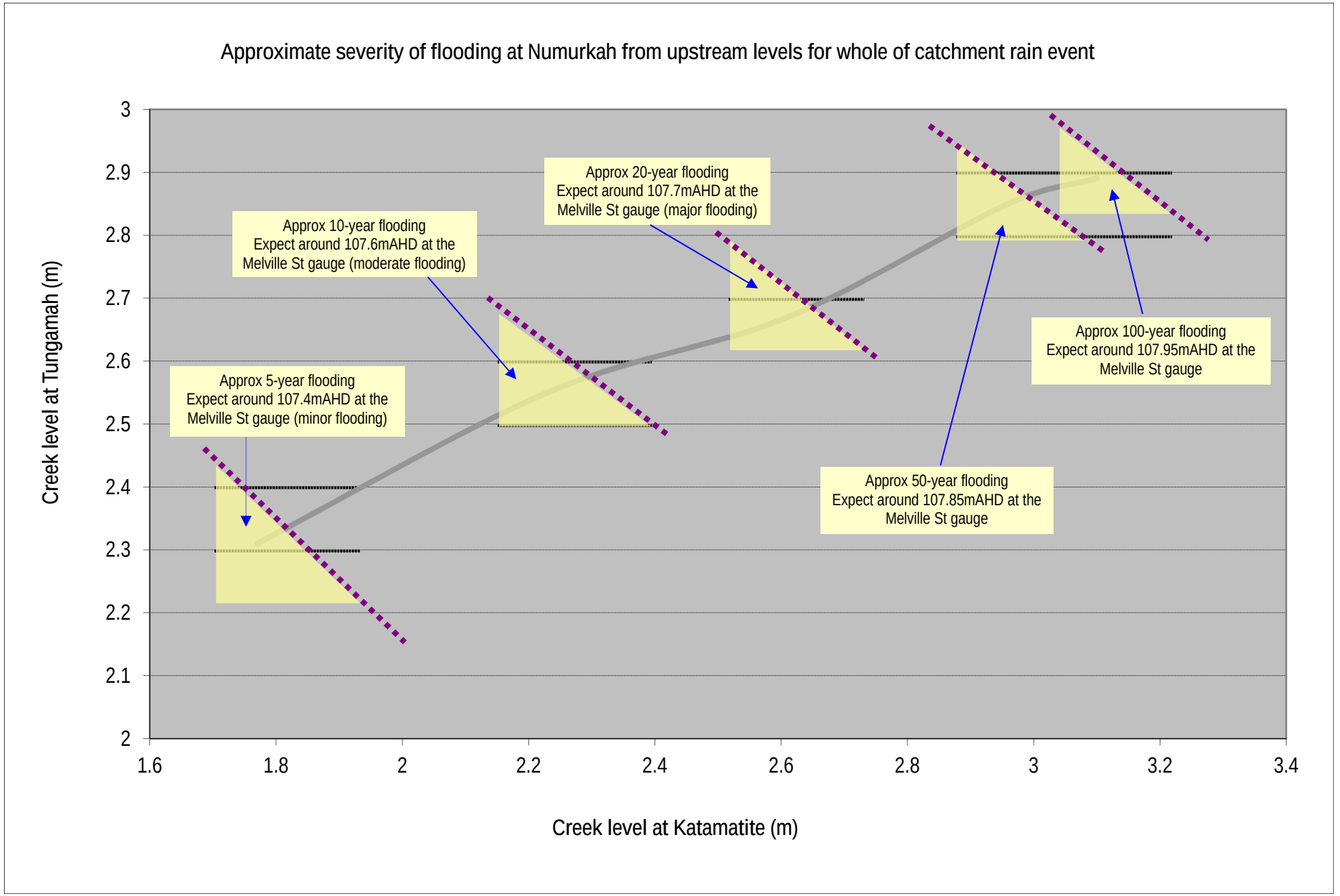
Using the Approximate Severity of Flooding Tools

The following tools can be used with some lead time to provide a heads-up of the likelihood and scale of possible flooding at Numurkah. They use rainfall from across the catchment and creek levels at Tungamah and Katamatite. This data is available from the BoM website.

It is suggested that the indicative quick look 'flood / no-flood' tool developed for Numurkah (see below) will provide an initial heads-up of the likelihood and scale of possible flooding. The approximate severity of flooding at Numurkah tool (see below) will enable this heads up to be verified to some extent as the event develops using levels from the Tungamah and Katamatite river gauge sites. In addition to providing initial indications of the likely scale of flooding in and around Numurkah, the tools will provide guidance on the need to install the PALS at the locations detailed below. It should be noted that the tools do not provide a prediction of expected flood height. They provide indicative guidance only that can then be related to the flood inundation maps produced by Water Technology (2014), a sub-set of which is provided in Appendix F.

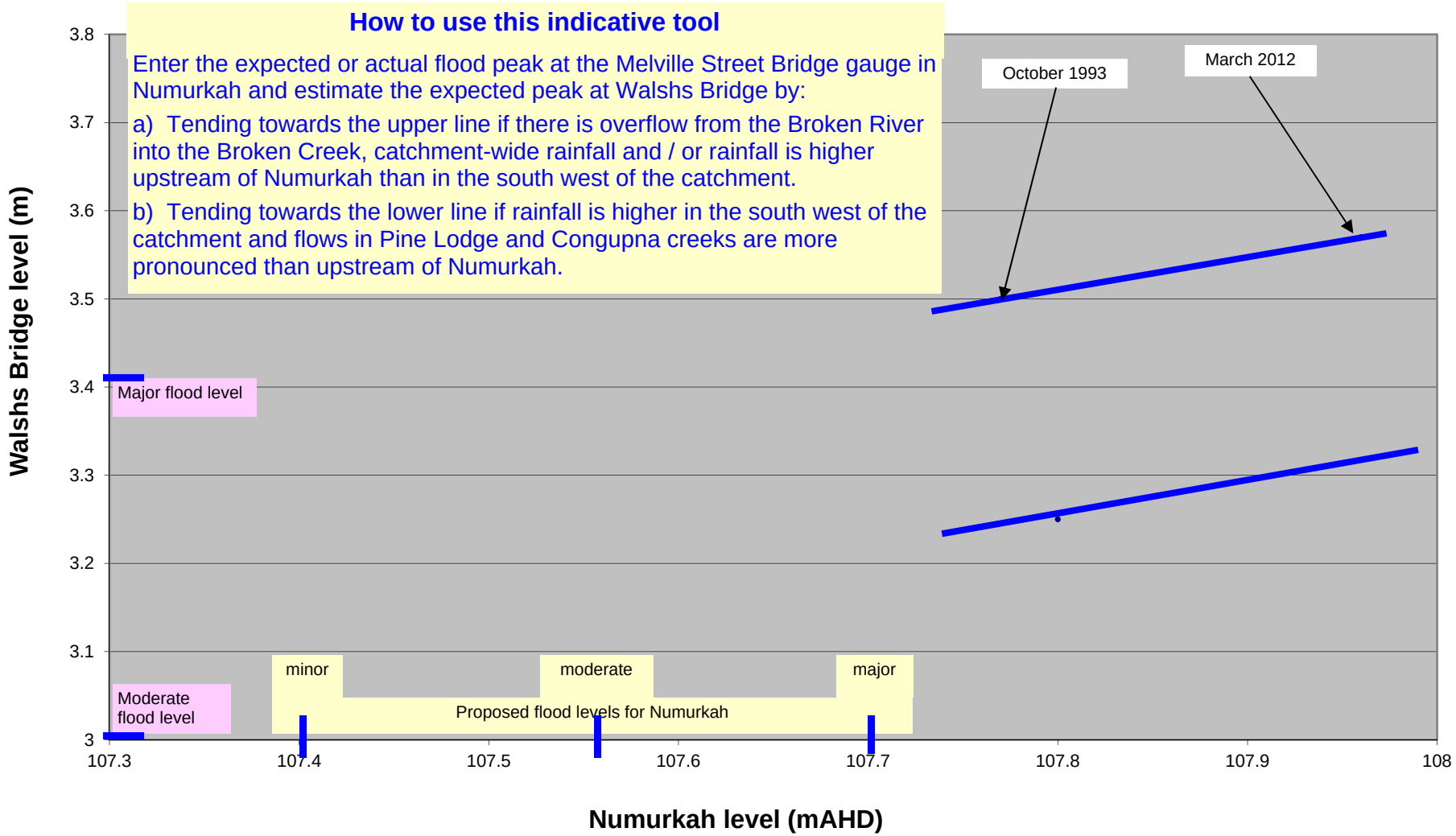
The third tool is very preliminary and simplistic whereas the hydrology upstream of Numurkah is complex. The tool provides an indication of the expected peak level at Walshs Bridge based on an expected peak level at Numurkah. That level will probably need to be inferred as there are no tools currently available to provide a firm forecast of flood levels for Numurkah. While this tool should therefore be used with extreme caution, when used in conjunction with the forecast tool for Nathalia provided in Appendix C12, it does provide preliminary guidance on expected conditions at Nathalia. In turn that should enable work to commence to install the demountable barriers well ahead of them needing to be in place.


Indicative guidance for likelihood of flooding at Numurkah based on rainfall
This guide assumes that rainfall affects the whole catchment and is not localised heavy falls. If localised, the guide may over-estimate the likelihood of flooding.
If the catchment is very wet, move up one level. For example, if rainfall is on the 10-year curve and the catchment is very wet, refer to the 20-year map and consequences.
Extensive flooding within the area and through town, including to the south.
436 properties inundated in town with 108 buildings flooded over-floor.
GV Highway and railway line overtopping.
294 properties inundated with 50 buildings flooded over-floor.
Cemetery begining to flood.
151 properties inundated.
8 buildings flooded over-floor.
Local roads and Melville Street flooded.
110 properties inundated.
6 buildings flooded over-floor.
use 100-year map
use 50-year map
use 20-year map
use 10-year map
use 5-year map
Riverine flooding unlikely
CAUTION - this tool may over-estimate the likelihood of flooding if the catchment is dry and / or rain extends over more than about 2 days.
Use average of rainfall from Highlands, Benalla and highest of Tungamah, Katamatite and Yarrawonga (AWS), to determine indicated likelihood and severity of flooding.
In this zone
Likelihood of localised flooding only. Riverine flooding unlikely although levels may rise and then drop away.
Cumulative rainfall (mm)
180
160
140
120
100
80
60
40
20
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60
Time from start of rain (hours)
May 1974
October 1993
March 2012 (3 bursts)
5-year ARI
10-year ARI
20-year ARI
50-year ARI
100-year ARI


Approximate severity of flooding at Numurkah from upstream levels for whole of catchment rain event
Creek level at Tungamah (m)
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
Creek level at Katamatite (m)
Approx 5-year flooding
Expect around 107.4mAHD at the
Melville St gauge (minor flooding)
Approx 10-year flooding
Expect around 107.6mAHD at the
Melville St gauge (moderate flooding)
Approx 20-year flooding
Expect around 107.7mAHD at the
Melville St gauge (major flooding)
Approx 50-year flooding
Expect around 107.85mAHD at the
Melville St gauge
Approx 100-year flooding
Expect around 107.95mAHD at the
Melville St gauge

Indication of peak level at Walshs Bridge from peak at Numurkah

CAUTION: this tool is very approximate



Locations for PALS Gauges In and Around Numurkah

Two potential gauge (PALS or permanent) sites have been identified – a primary (preferred) location and an alternative location. This has been done so that if a flood event occurs before a gauge is installed at the Highway Bridge, a PALS (or similar) can be installed and maximum value can be extracted from the intelligence contained in this MFEP.

A total of eight (8) sites have been identified for installation of Portable Automated Logger System (PALS) equipment to assist flood forecasting and warning activities at Numurkah. The locations have been selected on the basis of ease of access during the early stages of a flood, the lead time that would be available during an event for flooding at Numurkah, the 'representativeness' in terms of flood severity, and the ability to relate levels at those sites to flood inundation mapping delivered as part of the Numurkah flood study (Water Technology, 2014).

It is not suggested that all 8 sites must be instrumented during a future flood, although if they were, the data collected would greatly assist local flood response and inform update of the Moira Shire MFEP. It is suggested that locations should be instrumented in the early stages of a flood event on a priority basis depending on the number of PALS units available and the likely flow contributions from the Muckatah Depression and other parts of the Broken Creek catchment.

The table below provides location details for each of the eight PALS sites while the **red dots** on the accompanying maps provide a visual description of those locations.

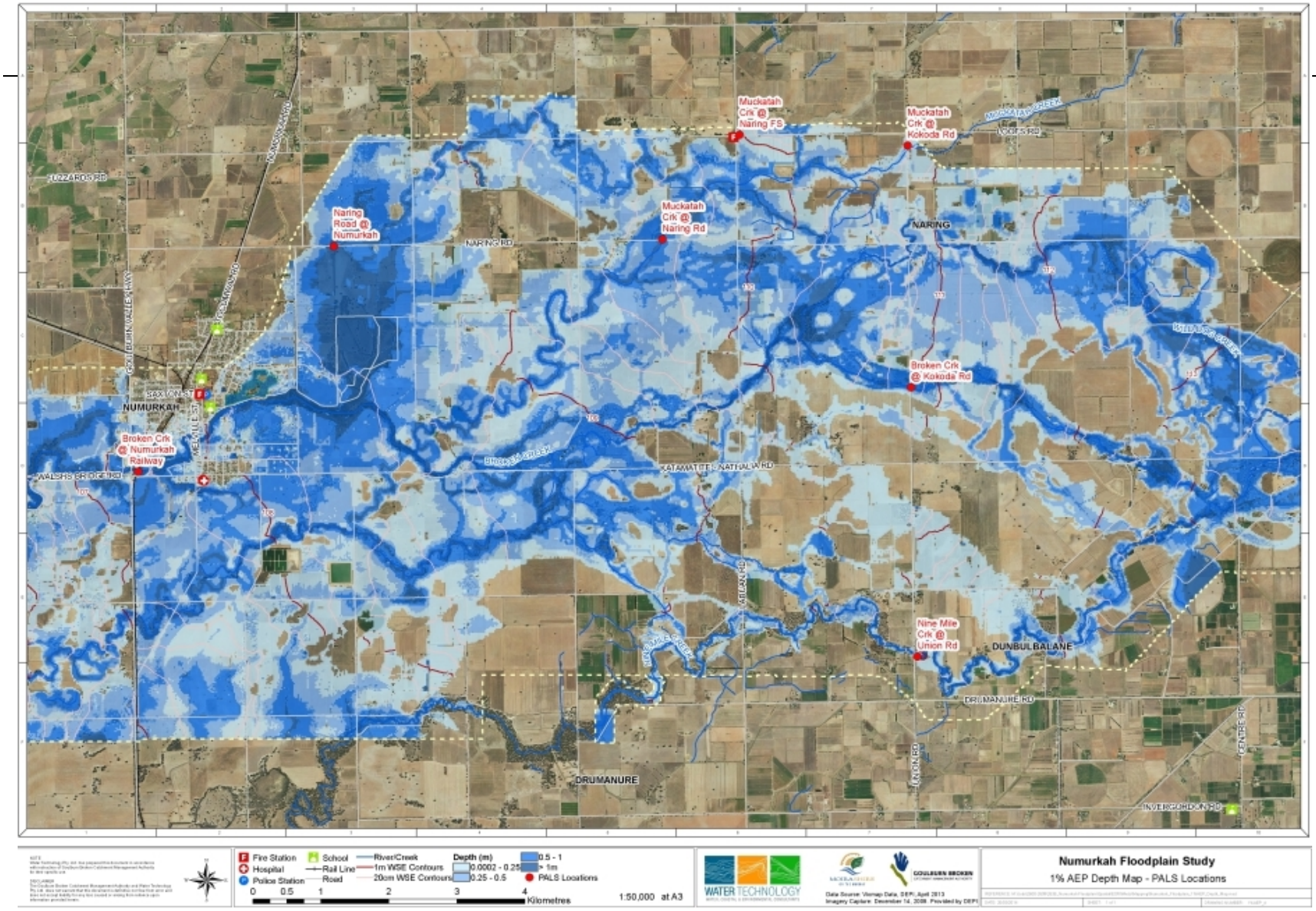
Table C10-1 Potential PALS locations, gauge zeros and applicable design flood levels

Location							
Gauge zero for PALS unit (mAHD)	20% AEP (mAHD)	10% AEP (mAHD)	5% AEP (mAHD)	2% AEP (mAHD)	1% AEP (mAHD)	0.5% AEP (mAHD)	0.2% AEP (m AHD)
370317E 6005220N	Broken Creek immediately upstream of the southern crossing at Kokoda Road						
109.854	109.989	110.076	110.249	110.512	110.715	110.890	111.058
370414E 6001255N	Nine Mile Creek immediately upstream of Union Road						
109.969	110.645	110.702	110.846	110.946	110.983	111.022	111.092
366656E 6007390N	Muckatah Creek at Naring Road around 1km west of Labuan Road						
108.721	109.170	109.373	109.515	109.664	109.772	109.859	109.959
367794E 6008934N	Muckatah Creek at the Naring Fire Station (on the opposite corner) – see Note 3 below						
109.175	N/A	109.823	109.882	109.928	109.945	109.989	110.126
370270E 6008780N	Muckatah Creek immediately upstream of Kokoda Road – see Note 3 below						
110.287	N/A	N/A	N/A	110.489	110.598	110.698	110.822

Location							
Gauge zero for PALS unit (mAHD)	20% AEP (mAHD)	10% AEP (mAHD)	5% AEP (mAHD)	2% AEP (mAHD)	1% AEP (mAHD)	0.5% AEP (mAHD)	0.2% AEP (m AHD)
361816E 6007290N	Muckatah Creek at Naring Road immediately upstream of Numurkah						
107.764	107.904	108.037	108.148	108.248	108.405	108.544	108.853
359792E 6004482N	Broken Creek at the Melville Street Bridge gauge upstream of the bridge in Numurkah						
107.264	107.412	107.593	107.714	107.830	107.934	108.048	108.239
358935E 6003970N	Broken Creek immediately upstream of the railway line at Numurkah						
106.082	106.96	107.15	107.25	107.40	107.49	107.59	107.86

Important notes:

1. It is not suggested that all 8 site must be instrumented during a future flood. Rather, locations should be instrumented in the early stages of a flood event on a priority basis depending on the number of PALS units available and the likely flow contributions from the Muckatah Depression and other parts of the Broken Creek and Nine Mile Creek catchments.
2. N/A indicates that flood water will not wet the proposed PALS location for this sized flood – the location will be dry. However, it is likely that water will be approaching the location. Refer to inundation mapping.
3. Flood levels provided for Muckatah Creek at the Naring Fire Station and upstream of Kokoda Road are approximate only as both locations are close to the upstream boundary of the hydraulic model.
4. The Melville Street Bridge location may need to be instrumented permanently.
5. Maps showing the proposed PALS locations are provided below.



Overview of proposed PALS locations

Broken Creek immediately upstream of the southern crossing at Kokoda Road

Nine Mile Creek immediately upstream of Union Road

Muckatah Creek at Naring Road around 1km west of Labuan Road

Muckatah Creek at the Naring Fire Station (on the opposite corner)

Muckatah Creek immediately upstream of Kokoda Road

Muckatah Creek at Naring Road immediately upstream of Numurkah

Broken Creek at the Melville Street Bridge gauge upstream of the bridge in Numurkah

Broken Creek immediately upstream of the railway line at Numurkah

APPENDIX C11 - WUNGHNU FLOOD EMERGENCY PLAN

Overview of Flooding Consequences

Flooding at Wunghnu is not usually considered a major problem. However, in March 2012, high flows in the Broken Creek system (including Nine Mile Creek) backed up against the Shepparton – Numurkah railway line and flowed south from Numurkah. In October 1993, the town was affected by high flows in Pine Lodge and Congupna creeks as a result of overflows from the Broken River.

Levels at Payne's Bridge (112.46mAHD in 1993) provide an indication of likely flows/levels at Wunghnu (106.08mAHD in 1993).

In 1974, flood levels ranged from 106.8mAHD upstream of the railway line to 106.1mAHD downstream of the town. The peak level recorded at the Goulburn Valley Highway was 106.7mAHD.

1% AEP flood levels vary from 106.7mAHD on the upper side of town to 106.4mAHD on the lower.

What areas are affected

- In March 2012, 11 properties were flooded above floor level, the Goulburn Valley Highway was closed, a channel breached and water was still rising after the peak had passed at Numurkah.

Caravan parks likely to be affected

- There are no caravan parks in Wunghnu, but the recreation reserve can accommodate caravans and camper trailers.
- The northern end of the Wunghnu Recreation Reserve is liable to inundation during a major flood; it was flooded in the 2012.

How many properties

- 11 properties in Wunghnu township were flooded above flood level.

How much warning time

- No official data has been collected

Impacts on essential community infrastructure

- Wunghnu Recreation Reserve is the only community infrastructure that was affected.

Isolation risks

- In the 2012 floods the town was cut off from flood waters to the north and south on the Goulburn Valley Highway

Major road closures

- In 2012 the Goulbourn Valley Highway was flooded north and south of Wunghnu for normal traffic.

Locations where evacuation difficulties may occur for example low flood islands

- Not applicable.

Flood Mitigation

Flood mitigation systems/measures

Refer to the Wunghnu section in the Moira Shire Drainage and Pump Operations Manual, council manages the infrastructure in this town.

Deliverables from flood, drainage and other studies;

- No flood study has been done in Wunghnu. Information about the Drains and pumps refer to the councils “Drainage and Pump Operations Manual”.

Community and agency knowledge;

Look to agencies – BoM FW directives, Council’s MEMP, GBCMA FW directive and associated information, etc, etc.

NOTE – intelligence MUST have regard for changes within catchments that modify likely flood behaviour (eg. Mitigation works that reduce the severity of a flood risk)

This intelligence can be presented in a number of ways – on the y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs. VICSES to complete actions column

Note – In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

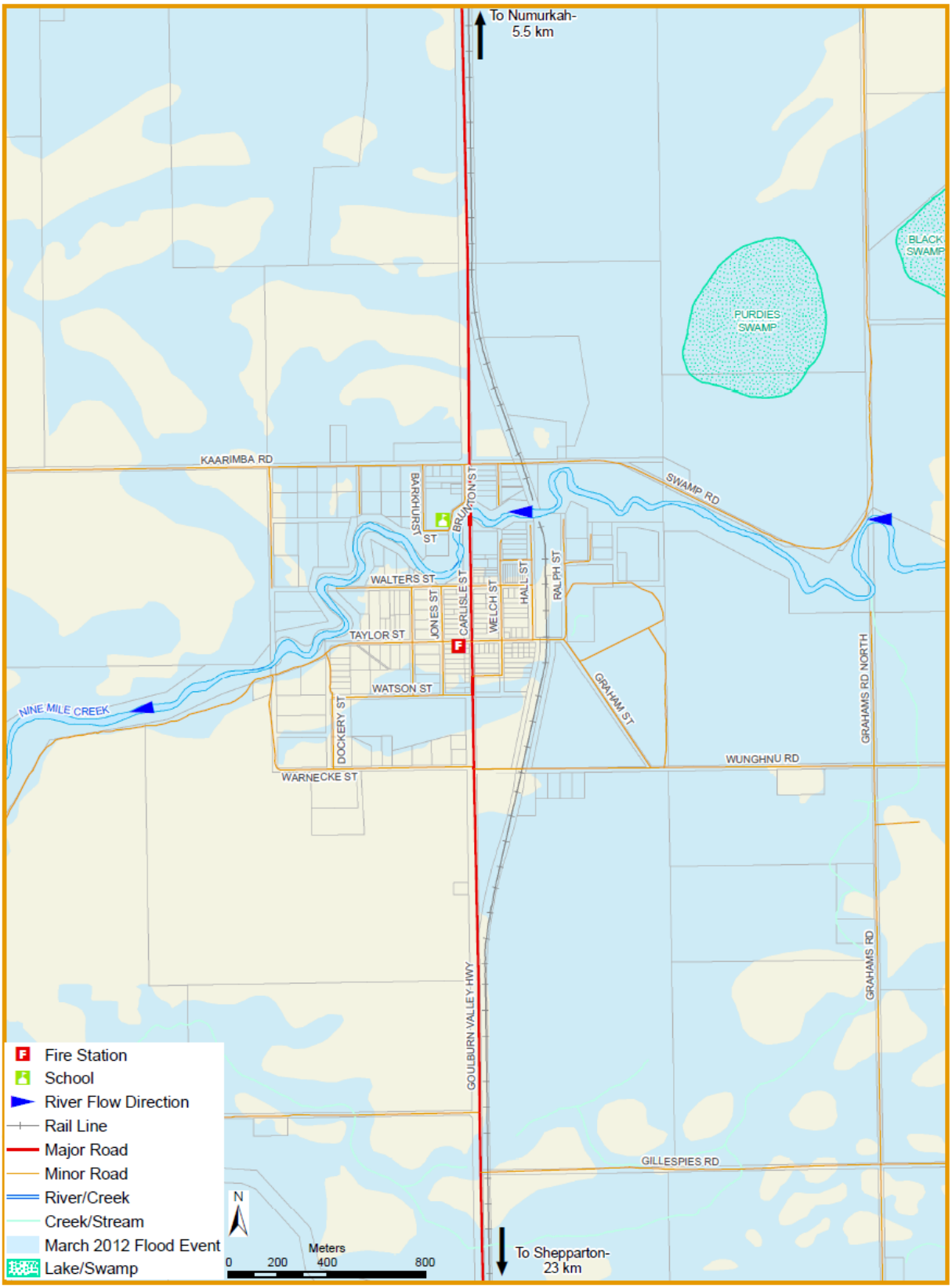
Command, Control and Coordination

VICSES will assume overall control of the response to flood incidents. Other agencies will be requested to support operations as detailed in this Plan. Control and coordination of a flood incident shall be carried out at the lowest effective level and in accordance with the State Emergency Response Plan (EMMV Part 3). During significant events, VICSES will conduct incident management using multi-agency resources.

Divisional Command will be located at the Hume Region Divisional Command Centre Numurkah to manage the Goulburn River downstream of Shepparton and or the Broken Creek catchment.

The Sectors will be established in towns affected by flooding, utilising local emergency service personnel where possible.

Wunghnu



No automated gauges are currently located at Wunghnu

River Height (m) And or River Flow (ML/d)	Annual Exceedance Probability	Consequence / Impact	Action Actions may include (but not limited to) Evacuation, closure of road, sandbagging, issue warning and who is responsible
x.xxm	Minor Flood Level x% AEP (xx year ARI)		
x.xxm	Moderate Flood Level x% AEP (xx year ARI)		
x.xxm	5% AEP (20 year ARI)		
x.xxm	Major Flood Level x% AEP (xx year ARI)		
x.xxm	2% AEP (50 year ARI)		
x.xxm	1% AEP (100 year ARI)		
x.xxm	Probable Maximum Flood (PMF)		

Note: Flood intelligence records are approximations; this is because no two floods at a location, even if they peak at the same height, will have identical impacts. Flood intelligence cards detail the relationship between flood magnitude and flood consequences. More details about flood intelligence and its use can be found in the Australian Emergency Management Manuals flood.

APPENDIX C12 – NATHALIA & DOWNSTREAM FLOOD EMERGENCY PLAN

A formal system of levees protects the Nathalia township from flooding. The levees provide protection from the 1% AEP flood plus freeboard. Freeboard ranges from 450mm on those parts of the levee with a sealed crest to 600mm elsewhere. The levee is mostly earthen although road openings and the foreshore area needs to be completed ahead of an approaching flood using a system of demountable aluminium panels. A section of the levee also needs to be completed at Draper Street using sandbags. G-MW's No 12 Channel acts as a levee on the south side of town.

During large flood events a significant breakout and flow path occurs from the creek on the east side of town from near the water treatment plant, threatening a number of houses outside the levee system and cutting the Murray Valley Highway to the north. This is shown on the flood inundation maps for Nathalia.

There is a slope between the by-passing flow and the creek at the Broken Creek Bridge in the township. Levels tend to be higher in town than on the floodplain (near the Murray Valley Highway just outside the north levee) on the rising limb and lower on the falling limb. In a large flood the slope can be up to 400mm.

The Murray Valley Highway floods at around 2.5km and 3.4km north of Nathalia at Centre Road forcing the Murray Valley Highway closure.

Drain 13 joins the Broken Creek immediately downstream from Nathalia. During large flow events, the creek backs up the drain which carries drainage water from upstream. Historically this would cause the channel bank to breach at the bend at the Murray Valley Highway. However in 2013 a spillway was installed at this location to relieve pressure from the drainage infrastructure. The spillway causes a flow path to the North West which quickly inundates a section of the Highway between Horner's Road and Peter Clay Road. Flows continue north to the Katunga-Picola Road inundating a large area by up to 500mm. A number of houses may need to be sandbagged in this area to prevent inundation. Flows are picked up by a depression (No 11 Drain) and returned to the Broken Creek in a generally westerly direction to the south of the Picola township in the vicinity of the Picola South Road (Greens Swamp). This is shown on the flood inundation maps for Nathalia.

Low-lying areas including Greens Swamp and local roads between the Broken Creek and the Katunga-Picola and Picola-Barmah Roads become affected by floodwater. Some become impassable.

The East Goulburn Channel No 12 is located along the ridge on the southern side (left back) of the Creek downstream from near Nathalia. The ridge and channel restrict the transfer of flows across the Nathalia–Barmah Road although there are a few low points along the road which may have flooding. **If Loch Garry is not and is unlikely to operate, there may be some benefit in breaching the No 12 Channel to provide some relief to houses on the floodplain, but in reality it is unlikely to have a noticeable impact due to the slack grades and relative volumes.**

If Loch Garry is operating (Loch Garry Regulator operating rules come into effect 24 hours after the Shepparton gauge reaches 10.36m), Goulburn River flows will be present on the west (left hand) side of the Nathalia–Barmah Road and may flow across it.

During floods, water spreads out along the natural anabranches and effluent flow paths and fills large flood storage areas in the lower reaches. Natural high-level breakaways to the Goulburn River exist near Prentices Road and Nathalia, and to Green Swamp and the Barmah Forest to the north.

Nearer to Barmah the creek is capacity constrained with very little slope. Flood waters move slowly. If the Murray is not in flood, Barmah will not be threatened by flooding as breakouts occur to the north

east downstream from Picola and into the Barham Forest. The IC may consider releasing water, by breaching the levee at Goose Swamp, when water levels on the Broken Creek side are higher. This will give some relief to residents in the local area.

See Appendix C6 for flood behaviours at Barmah.

If there has been a significant period between high flows in the bottom end of Broken Creek, the creek is likely to have silted up a bit which will result in initial elevated water levels (similar to 1974 and 2012) in the reach upstream of Rices Weir. As flows increase, the creek bed will begin to scour and levels will rise slowly until the breakout into the Barmah Forest becomes established. Levels will then stabilise at Rices Weir.

In the event of a flood that causes closure of the Shepparton–Barmah Road and the Murray Valley Highway, any sand needed at Nathalia needs to be stockpiled in the town before access is lost. Generally this is only a significant threat if the Goulburn River is in flood and Loch Garry is operated.

1% AEP flood levels at Nathalia vary from 102.6mAHD on the upper side of town to 102.2mAHD on the lower.

Overview of Flooding Consequences

Nathalia is a rural town in northern Victoria. The township is located on the banks of Broken Creek on the Murray Valley Highway, approximately 40kms north west of Shepparton. At the 2011 census, Nathalia had a population of 1,902.

The main industries in Nathalia are cropping, dairy farming and grazing. Some of the town's major businesses are Rex James Stockfeed, Rapidspray Tank Factory, Remax Products and Ryan's Abattoir's.

The town has five schools, a government High School and Primary School as well as a Regional Catholic College and a Catholic Primary School. There is also an independent combined Primary and Secondary School.

General overview of flooding consequence.

Advice of potential floods in Nathalia is generally received well in advance from a variety of sources including Tungamah, Numurkah, Congupna and Wunghnu. Flooding may arise from heavy rainfall upstream of Tungamah or from the Broken River. In 1993 general flooding across the catchment and from the Goulburn River downstream of Shepparton, including Loch Garry. Large areas of rural land are inundated in a major event from any of the above sources.

The Nathalia Township is protected to a level of approximately 1-% providing the required actions which form part of the protection plan to be carried out. These actions include closing the levee north of the town on the Murray Valley Highway and Railway Street levee closing various roads, installation of temporary steel barriers at the Broken Creek Bridge, town drains and pumping is required.

Monitoring the situation as the flood approaches is vital. Early closure of the Murray Valley Highway deprives the town access to the north and the residents from the north are unable to obtain services and or supplies from the township.

In addition, early closure of the town drains involves unnecessary pumping costs in periods of rain.

The Shepparton-Barmah Road may be closed in any major Goulburn River flood and with the closure of the Murray Valley Highway any sand needed requires to be stockpiled in the town prior to the flood before access to the pits is lost.

Key Warning/Trigger Gauge

Although advance warnings may be received from sites well upstream such as Tungamah, Shepparton, Wunghnu, etc., the key upstream guide is at (KD) Walsh's Bridge.

The close monitoring of this gauge provides an indication of the size of the flood and duration of the peak and following assessment of an event; the main focus is on the rate of rise and the timing of carrying out the various tasks.

The peak reading at (KD) Walsh's Bridge in the 1993 flood was 3.50m (to current gauge zero and equivalent to 104.45 mAHD), which is a little less than the 2% AEP (50-year ARI) flood level at this location.

Drain 13 joins the Broken Creek immediately downstream from Nathalia. During large flow events, the creek backs up the drain which carries drainage water from upstream. Historically this would cause the channel bank to breach at the bend at the Murray Valley Highway. However in 2013 a spillway was installed at this location to relieve pressure from the drainage infrastructure. The spillway causes a flow path to the north west which quickly inundates a section of the Highway between Horner's Road and Peter Clay Road. Flows continue north to the Katunga-Picola Road inundating a large area by up to 500mm. A number of houses may need to be sandbagged in this area to prevent inundation. Flows are picked up by a depression (No 11 Drain) and returned to the Broken Creek in a generally westerly direction to the south of the Picola township in the vicinity of the Picola South Road (Greens Swamp). This is shown on the flood inundation maps for Nathalia.

Nathalia Gauge

Nathalia's Broken Creek Bridge gauge usually peaks about 2 – 4 days after (KD) Walsh's Bridge. The peak reading at this gauge in the 1993 flood was 3.09m (to current gauge zero and equivalent to 102.09mAHD), which is a little less than the 2% AEP (50-year ARI) flood level at this location.

The areas are affected

- Maps at Appendix F provide guidance on where flooding is likely in the event of heavy rainfall.

Motels and Caravan parks likely to be affected

- There are two (2) caravan parks and one (1) Motel inside the Nathalia levee system. The Nathalia Motel and Holiday Park is on Blake Street, Riverbank Caravan Park in Park Street and the Coach Stop Caravan Park on Elizabeth Street.
- All venues have an evacuation plan for flood emergencies. Copies of these plans are held at Moira Shire Municipal office.

How many properties are affected at Nathalia

- There are a number of properties affected outside the Nathalia levee system that will require protected. In March 2012, 17 properties were inundated and/or isolated.

How much warning time

- Catchment response is generally slow. Large floods generally only occur after the catchment has had soaking rain. Due to the size of the catchment, it's flat nature, the many depressions, tributaries, creeks and drainage lines, the estimated flood travel and peak timings are difficult to predict. Nevertheless, indicative timings for creek levels to rise and fall at key locations and peak travel times are provided in Appendix B.

Impacts on essential community infrastructure at Nathalia are

- Vulnerable establishments (eg. hospitals, aged care facilities, schools, etc) within the municipality are detailed in the MEMP and are identified on flood inundation maps (see Appendix F).

Isolation risks for Nathalia

- Due to the flat nature of the municipality, isolation is a significant risk for many areas during large and widespread flooding; major roads can be closed for extended periods with flood waters more than 300mm deep for long distances.

Major road closures around Nathalia

Major roads that may be affected by flooding are:

- Murray Valley Highway,
- Katamatite–Nathalia Road,
- Nathalia–Waaia Road,
- Barmah-Shepparton Road,
- Katunga-Picola Road and
- Picola-Barmah Road.

Locations where evacuation difficulties may occur for example low flood islands

- All areas outside of the Nathalia flood levee system may have difficulties in evacuating once the temporary (demountable) metal barriers are installed, this could mean isolation for residents during a large flood event.

Flood Mitigation

Information about the permanent earthen levees and the temporary (demountable) metal barriers are available from the Moira Shire municipal office.

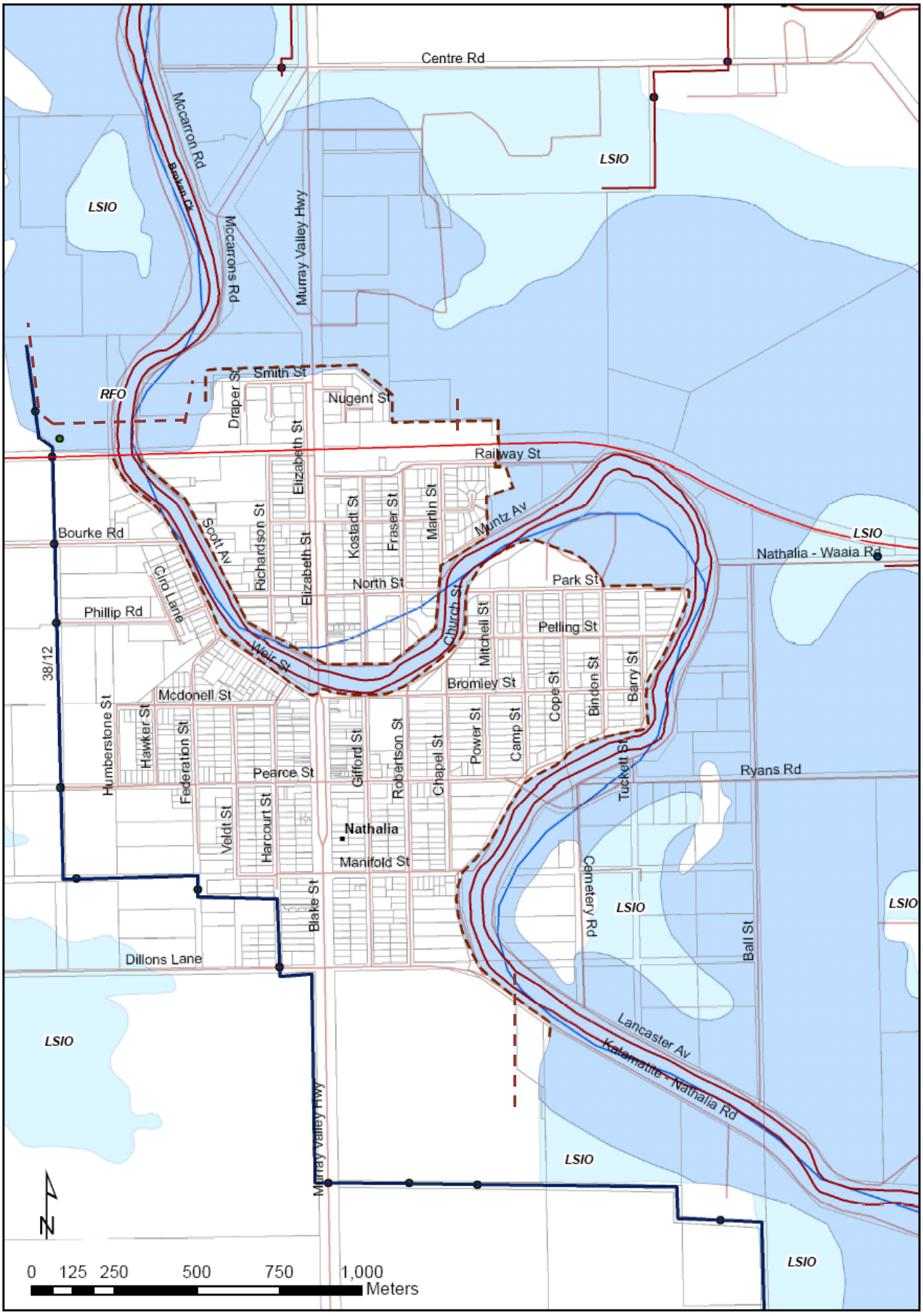
Where do levees and retarding basins exist at Nathalia?

What communities do they protect and who manages them?

The earthen levees and the temporary (demountable) metal barriers protect the township of Nathalia; these are maintained by the Moira Shire Council.

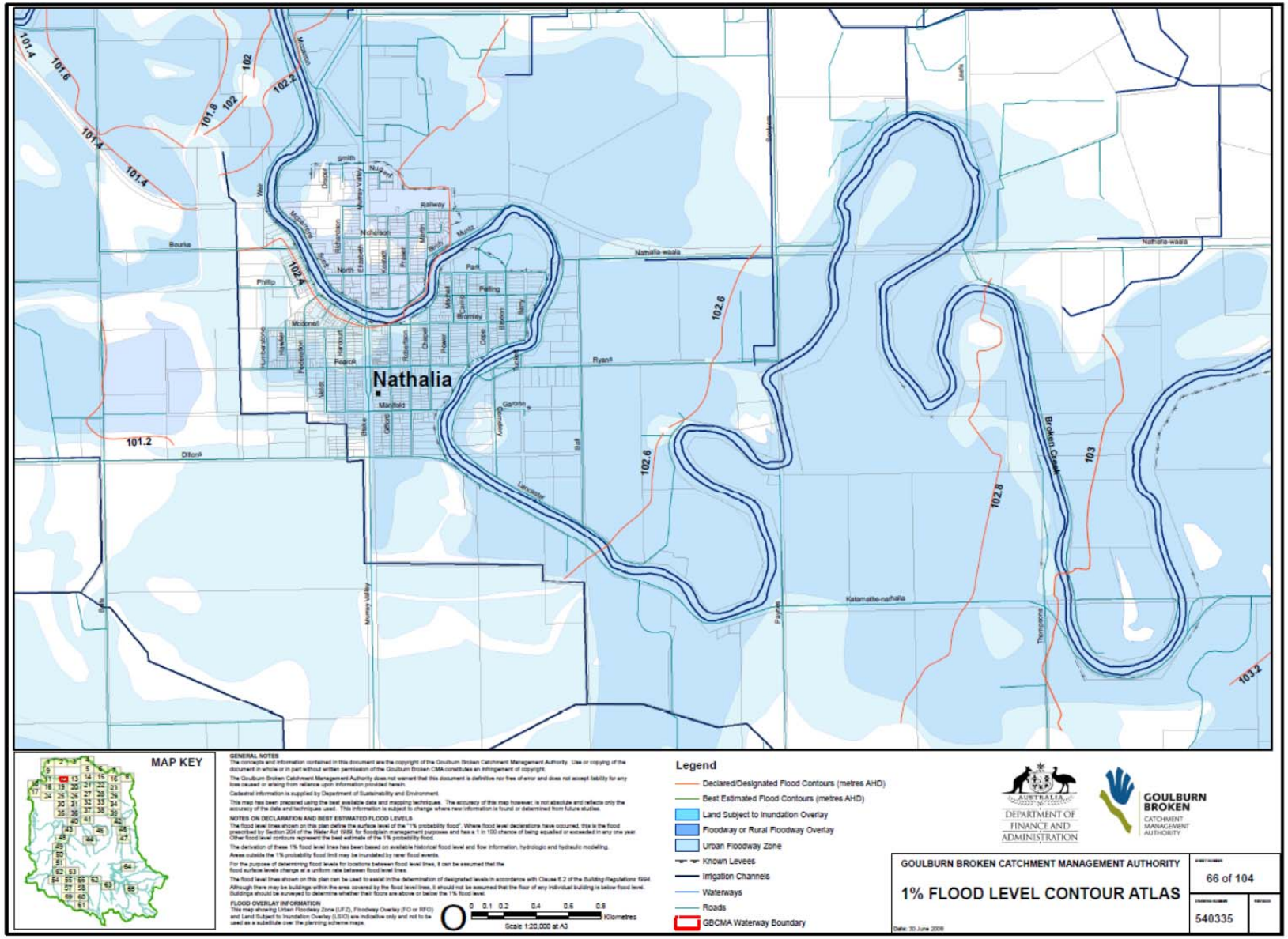
Details of any levee closure points such as railway crossing etc., which may need to be sandbagged.

Sandbagging is required at the unfinished section of levee in Draper Street Nathalia, Katamatite–Nathalia Road at the water treatment plant and the end of Weir Street next to the irrigation channel (60 Weir Street).


Centre Rd
Mccarron Rd
Broken Ck
Mccarrons Rd
Murray Valley Hwy
LSIO
RFO
Smith St
Draper St
Nugent St
Railway St
Elizabeth St
Kostadt St
Fraser St
Martin St
Muntz Av
Bourke Rd
Scott Av
Richardson St
Elizabeth St
North St
Park St
Nathalia - Waaia Rd
Phillip Rd
Clrd Lane
Church St
Mitchell St
Pelling St
Weir St
Bromley St
Cope St
Binden St
Barry St
38/12
Mcdonell St
Humberstone St
Hawker St
Federation St
Gifford St
Robertson St
Chapel St
Power St
Camp St
Tuckett St
Pearce St
Ryans Rd
Veldt St
Harcourt St
Nathalia
Manifold St
Cemetery Rd
Ball St
Blake St
Dillons Lane
Lancaster Av
Katamatite - Nathalia Rd
Murray Valley Hwy
N
0 125 250 500 750 1,000
Meters

Flood inundation maps (including LSIO, SBO and FZ delineations from the Planning Scheme);

Nathalia township with no flood barriers



Broken River and Boosey Creek Catchment - Lower

Rain Gauge
Combined Gauge
River Gauge
Township
Rail Line
Major Road
River/Creek
1% AEP Flood
Broken Creek Catchment
Lake/Swamp
LGA Boundary

Scale at A4
Kilometers
0 2.5 5 10
1:400,000

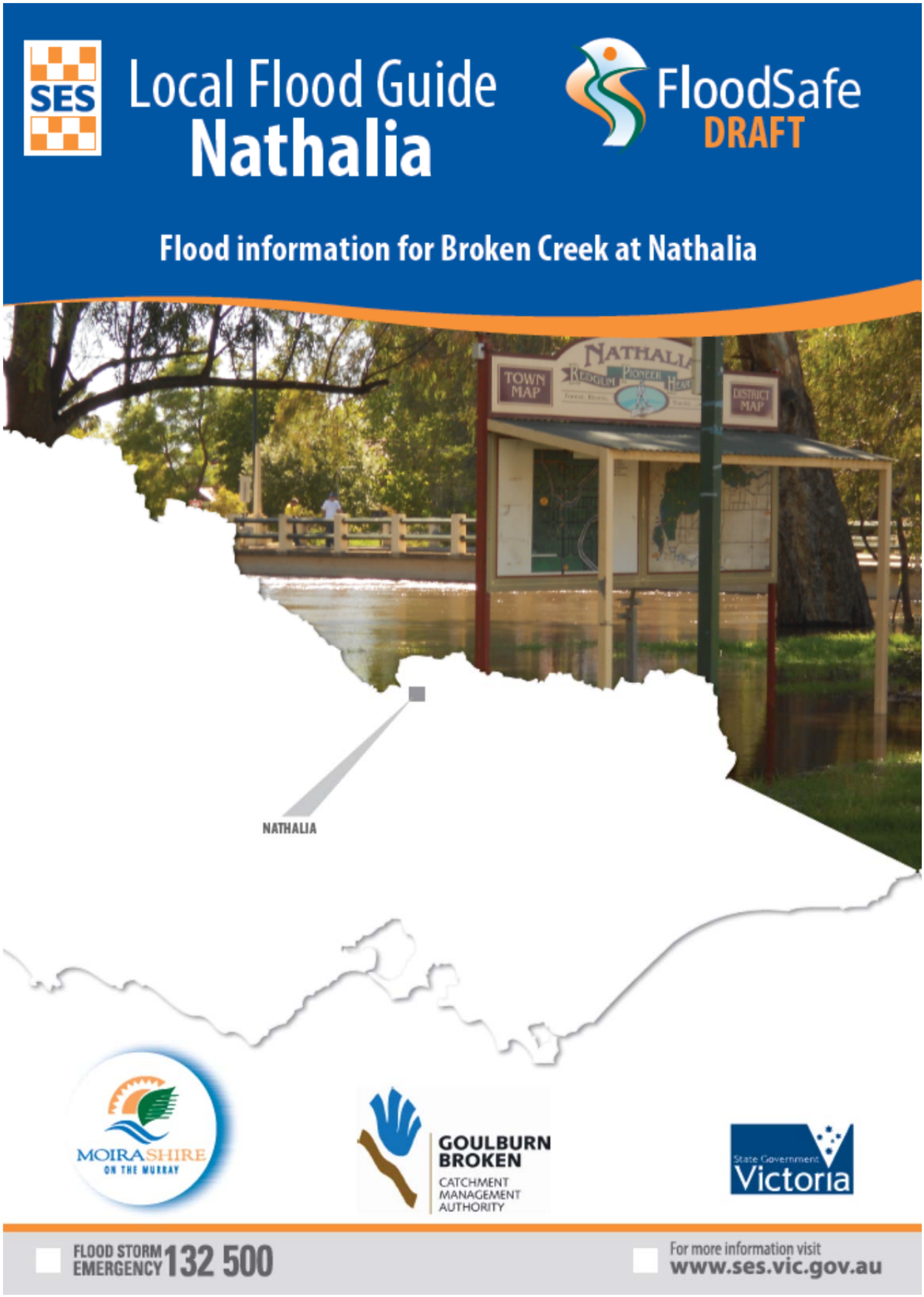
N

GOULBURN BROKEN

SES

DISCLAIMER
This map publication is presented by the Victoria State Emergency Service for the purpose of disseminating emergency management information. The State Emergency Service disclaims any liability (including for negligence) to any person in respect of anything and the consequences of anything, done, or not done of any kind including damages, costs, interest, loss of profits or special loss or damage, arising from any error, inaccuracy, incompleteness or other defect in this information. by any such person in whole or partial reliance upon the whole or part of the information in this map publication. Flood information is provided by Goulburn River CMA. VicMap data sourced from DSE, November, 2012.

Community or agency flood awareness material (particularly in relation to FloodSafe or StormSafe material – make sure information / intelligence is shared and consistent)



Community and agency knowledge;

- Past and present members of the Moira Shire Council can provide local knowledge.
- Past and present members of the Nathalia CFA can provide local knowledge.

Any known or possible community infrastructure impacts including:

- During the 2012 flood event the water treatment plant remained dry at Nathalia.

Flood Impacts and Required Actions

The following is a compilation of the various known tasks which must be undertaken with the approach of a significant flood event. It is assumed that triggering advice has been received from BoM, from sites such as Numurkah and Walsh's Bridge and that the situation is being monitored. The flood prediction tool contained in this MFEP will also assist in the determination of the likely severity of expected flooding.

Further information can be found in MSC's Pumps and Drainage Manual.

Water treatment plants and water storage areas to be affected;

- Waste treatment plant on Katamatite–Nathalia Road will require sandbagging.

Pumps and other service equipment likely to be inundated;

- A guide to the drainage and pump operations is available in a booklet from Moira Shire Council.

Community and agency knowledge;

Look to agencies – BoM FW directives, Council's MEMP, GBCMA FW directive and associated information, etc, etc.

NOTE – intelligence MUST have regard for changes within catchments that modify likely flood behaviour (eg. Mitigation works that reduce the severity of a flood risk)

This intelligence can be presented in a number of ways – on the y axis of a hydrograph, against a graphic of a staff gauge, etc. At this stage, tables as follows are considered best but other presentation may be added provided they do not lead to confusion or result in critical information being overlooked

CMAs can assist with population of the following three tables – in terms of consequences, flows, levels and AEPs.

Note – In Flash Flood areas without gauges, it will only be possible to provide a general description of likely flood impacts.

Command, Control and Coordination

VICSES will assume overall control of the response to flood incidents. Other agencies will be requested to support operations as detailed in this Plan. Control and coordination of a flood incident shall be carried out at the lowest effective level and in accordance with the State Emergency Response Plan (EMMV Part 3). During significant events, VICSES will conduct incident management using multi-agency resources.

Divisional Command will be located at the Hume Region Divisional Command Centre Numurkah to manage the Goulburn River downstream of Shepparton and or the Broken Creek catchment.

The Sectors will be established in towns affected by flooding, utilising local emergency service personnel where possible.

3.1.1 Nathalia

Use forecast or actual levels at Walshs Bridge to drive response at Nathalia. Gives a minimum of approximately 36 - 48 hours lead time at Nathalia.
Refer also to the graphs after this table.

<table>
<tr><th colspan="4">BROKEN CREEK at NATHALIA</th></tr>
<tr><th>River Height at Walshs Bridge (m)</th><th>River Height at Nathalia (m)</th><th>Consequence / Impact within Moira Shire
Refer to maps and lists at Appendix F (includes levee break maps)</th><th>Action[8]</th><th>Comments</th></tr>
<tr><td colspan="4">

If a large Goulburn River flood is a possibility (Shepparton – Barmah Road and MV Highway closed), sand should be stockpiled if necessary because access to sand supplies will be cut off.
As required, drain outfalls should be monitored and closed-off. Stormwater pumps should also be monitored as required.
Flow in the underground drainage system should be monitored at the Motel Corner. When the flow first begins to move backwards, the drain outfall should be closed and the pump started.

When water can be heard flowing at the Robertson / Pearce Street intersection, the Cope Street drain should be shut off and the pump started.
The Riverview Caravan Park has a retardation basin. With the basin full, the inspection pit upstream of the basin should be checked and if necessary the basin shut off and a pump used.
The Weir Street drain can be closed and the pump started when necessary based on the situation at an inspection pit about 40metres up the road.
Mitchell Street (Muntz Avenue pump). Drain can be closed off and pumped when the drain on the north side of the creek bridge flows over the inspection box.
Scott's Avenue can be closed when convenient. The inspection pit at Richardson Street going north about half way down will be a guide.
Murray Goulburn (temporary pump). Drain should be watched at the box just north of MG. The drain has a flap at the outfall near Chinaman's Weir which is usually blocked by farmers to avoid problems. This is not a worry.
Weir Street at the Railway Bridge. The door into the G-MW outfall should be closed.
Bogan Street (Numurkah Road.) near Hawker's Court. Door to be closed.

Two (2) portable pumps should be available for use during any flood event which occurs in Nathalia.
The slope between water levels on the floodplain near the Murray Valley Highway north of town and at the Highway Bridge in town can be up to 400mm with the town level being higher on the rise and lower on the recession. This has implications for when the barriers can be removed and the Highway re-opened.

</td></tr>
<tr><td>Prior to flood</td><td colspan="2">In a major event the levee north of the town on the Murray Valley Highway and at Railway Street will need to be joined with temporary (demountable) metal barriers to complete the levee system. Timing of closure will be based on the situation – see below. Sand for sandbagging will need to be imported before closure.

Temporary (demountable) metal barriers will also need to be erected along Weir Street from the Bridge to Federation Street and along Bromley Street from Gifford Street to Blake Street. See below for timing.

The Shepparton-Barmah Road will need to be monitored. If the Goulbourn River is in flood and Loch Gary bars activated, inundation over Barmah-Shepparton Road will occur.

In a large flood, the Shepparton-Barmah Road will be closed from the Murray Valley Highway to Kaarimba Hall Road to the east and to the irrigation channel east side of Oaks Road in the west.</td><td>Undertake these tasks when flooding is likely at Nathalia.

The heads-up of likely flooding may come from:
▪ BoM warnings.
▪ Local information from Tungamah, Katamatite, Numurkah, Walshs</td></tr>
</table>

[8] All references to unsafe driving depths have been extracted from Appendix J of *Floodplain Management in Australia, Best Practice Principles and Guidelines* (ARMCANZ, 2000)

BROKEN CREEK at NATHALIA				
River Height at Walshs Bridge (m)	River Height at Nathalia (m)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F (includes levee break maps)	Action[8]	Comments
		If upstream information indicates that a large Goulburn River flood is possible, sand is required to be stockpiled at the Moira Shire Depot in Gifford Street, the Community Centre car park in Robertson Street and the old railway land behind Rex James Stockfeed off Elizabeth Street if necessary, as access to sand supplies may be cut off. Flow in the underground drainage system should be monitored at the Nathalia Motel and Holiday Park on Blake Street. When the flow first begins to move backwards the drain outfall should be closed and the pump started. When water can be heard flowing at the Robertson/Pearce Street intersection, the Cope Street drain should be shut off and the pump started. The Riverview Caravan Park has a retardation basin. When the basin is full the drainage pit upstream of the basin should be checked and, if necessary, the basin shut off and a trailer pump used to pump water into the Broken Creek. The Weir Street drain can be closed and the pump started when necessary based on the situation at the drainage pit about 40m up the road. The Muntz Avenue pump drain can be closed off and pumped when the drain on the north side of the Broken Creek Bridge flows over the drainage pit. The Scott's Avenue pump can be closed when convenient. A drainage pit at Richardson Street from Scott Avenue half way down will be a guide. The Smith Street pump should be watched at the box just north of Murray Valley Highway. The drain has a flap at the outfall near Chinaman's Weir which is usually blocked by farmers to avoid problems. This is not a worry. Weir Street at the Railway Bridge. The door into the Broken Creek outfall should be closed before water runs back through pipe. Boaden Street corner of Chapel Street door is to be closed before water runs back through pipe. During the 2012 March flood event, the IC placed a 'no-fly' area over Nathalia Township to all media outlets. The IC may need to consider in future flood events the effects of low flying aircraft when barriers are in place. The additional pressure of aircraft wake may cause water spilling over and adding additional pressure to demountable barriers. Further information can be found in MSC's Pumps and Drainage Manual.		Bridge). ▪ Application of the indicative flood prediction tool contained in this MFEP. ▪ On-going monitoring.
1.61	0.98	No impacts.		September 2011 event
2.00	1.50			Minor Flood Level
2.55	1.72	Very little impact – minor roads and some land beside the creek.		December 2011 event

BROKEN CREEK at NATHALIA				
River Height at Walshs Bridge (m)	River Height at Nathalia (m)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F (includes levee break maps)	Action[8]	Comments
2.95	2.20	Lowest part of Weir Street near the Williams Street intersection starting to get wet.	Put up "water over road" signs in Weir Street. Barriers to be put up when water gets deeper and likely to affect properties along Weir Street.	
2.99	2.27			20% AEP (5-yr ARI)
3.00	2.50			Moderate Flood Level
3.10m	2.52m	Water across the Murray Valley Highway 3.4km north of town up to 100mm deep. Will also flood at around 2.5km north of town. On the recession as a large flood falls, this is about when water will be completely off the Highway pavement near the levee: it will be dry.	Advise VicRoads that will need to close the Murray Valley Highway soon if further rises likely.	
	2.60	The Drain 13 channel spillway will begin operating around this level with a flow path to the north west. The Murray Valley Highway will be inundated between Horners Road and Peter Clay Road. Flows will continue north to the Picola – Katunga Road inundating a large area by up to 500mm. Some houses may need to be sandbagged. Flows are picked up by the Drain 11 depression and returned to the creek south west of Picola in the Picola South Road / Greens Swamp area.	Refer to G-MW but remedial action unlikely to be desirable until positive flows observed from the drain to the spillway and negative flows from the creek to the spillway (i.e. both are putting water onto the floodplain, rather than just the creek).	
3.13	2.63 7,440ML/d			July 1995 flood
3.21	2.63			10% AEP (10-yr ARI)
3.30	2.80	Water across parts of Weir Street and lowest gardens starting to get inundated.	Start putting flood barriers up along Weir Street and consider pumping water off Weir Street.	
3.35	2.82	Water approaching gap in levee at Railway Street.	Put up “Road closed signs on Railway Street and start putting flood barriers up across the Railway Street opening in the levee.	

BROKEN CREEK at NATHALIA				
River Height at Walshs Bridge (m)	River Height at Nathalia (m)	Consequence / Impact within Moira Shire Refer to maps and lists at Appendix F (includes levee break maps)	Action[8]	Comments
3.36	2.87	Water across the Murray Valley Highway just outside the levee likely to be around 400mm deep.		5% AEP (20-yr ARI)
3.40	2.90			Major Flood Level
3.40	2.90	Water approaching gap in the levee at the Murray Valley Highway.	Install flood barriers across the Murray Valley Highway opening in the levee to the north of town.	
3.41	2.92	Water likely to begin wetting Bromley Street between the levee and the Highway Bridge.	Install flood barriers along Bromley Street between the Highway Bridge and the levee end wall.	
3.50	3.09			October 1993 flood
3.50	3.09	Water approaching the ground level gap in the levee at 3 Draper Street.	Start building sandbag levee across the gap in the levee at 3 Draper Street. See diagram below.	
3.54	3.12			2% AEP (50 yr ARI)
3.57	3.26	17 houses were damaged / habitable		March 2012 flood
3.66	3.29	Note that 1% AEP planning level is 102.39mAHD (3.385m)	.	1% AEP (100 yr ARI)
3.82	3.49	Flood waters likely to overtop the road edge levee on the Katamatite Road near Town Weir. Likely to overtop at Katamatite Road	Consider initiating evacuation of the town and / or build a sandbag levee along the top of the road edge levee and check that the sandbag levee at 3 Draper Street is strong and high enough.	0.2% AEP (500 yr ARI)
3.96	3.65	Water will overtop the concrete wing wall on the southern upstream side of the Murray Valley Highway Bridge. This signals the beginning of a potential serious overtopping of the levee system	Consider initiating an evacuation of the town and / or add sandbags to the top of the wing wall and check that the sandbag levee at 3 Draper Street is strong and high enough.	
4.05	3.78	Water will overtop the capped sections of the main levee in the vicinity of the Murray Valley Highway. This signals the beginning of a potential failure of the levee system.	Consider directing an evacuation of the town and / or add sandbags to the top of the levee and check that the sandbag levee at 3 Draper Street is strong and high enough.	

Note: flood intelligence records are approximations. This is because no two floods at a location, even if they peak at the same height, will have identical impacts. Flood intelligence cards detail the relationship between flood magnitude and flood consequences. More details about flood intelligence and its use can be found in the Australian Emergency Management Manuals flood series.

Properties likely to be flooded

Introduction

The following is a list of properties expected to experience inundation (and the depth of that flooding) as a result of riverine flooding within the municipality, along with an indication of the likely depth of over-floor inundation**. It is strongly recommended that the following list be used in conjunction with the flood inundation maps (see Appendix F)** particularly if inundation mapping has identified the location of each floor level lower than the expected flood height (ie. where over-floor flooding is likely).

List of Properties Likely to be Flooded

The list of properties likely to be flooded (with corresponding levels and indication of over-floor flood depth) should be updated within twelve (12) weeks of a flood with information collected as part of post-flood information recording activities and as may be collected as a consequence of the event debrief as well as from the collective experience of the IMT.

Summary of number of flood affected properties: NATHALIA – EXISTING CONDITIONS						
	Design Flood ARI (years)					
	5	10	20	50	100	500
Level in Broken Creek at Walsh's Bridge	2.99	3.21	3.36	3.54	3.66	3.82
Level in the Broken Creek at Nathalia	2.27	2.63	2.87	3.12	3.29	3.49
Number of properties flooded	10	19	20	22	25	
Number of building flooded over-floor	4	10	10	15	17	

NATHALIA – EXISTING CONDITIONS

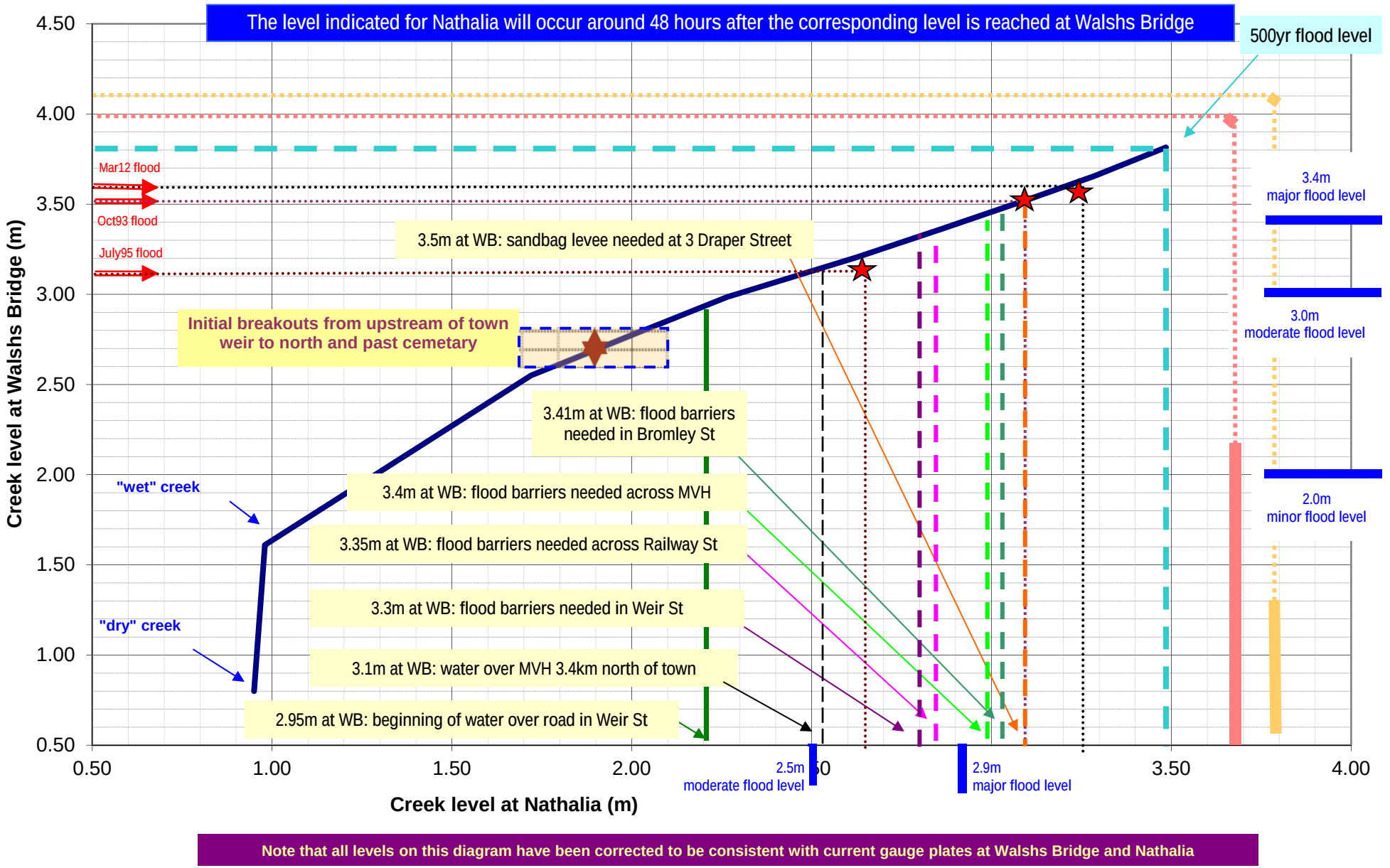
It is suggested that this table be used in conjunction with the flood inundation maps

Location (Number & Street)	Floor level on Nathalia gauge (m) without correction for flood slope	Depth of flooding at property for selected river heights on the Nathalia gauge					Depth of over-floor flooding for selected river heights on the Nathalia gauge					Comments
		5yr	10yr	20yr	50yr	100yr	5yr	10yr	20yr	50yr	100yr	
		2.27m	2.63m	2.87m	3.12m	3.29m	2.27m	2.63m	2.87m	3.12m	3.29m	
Convert local gauge levels to AHD by adding 99.005m												
60 Bourke Road	3.46	---	---	---	---	---	---	---	---	---	---	
63 Bourke Road	2.91	---	---	---	---	---	---	---	---	---	---	
Cemetery Road	3.10	0.15m	0.42m	0.50m	0.66m	0.75m	---	0.17m	0.25m	0.41m	0.50m	
12 Cemetery Road	3.53	---	---	---	0.05m	0.14m	---	---	---	---	0.07m	
20 Cemetery Road	4.21	---	---	---	---	---	---	---	---	---	---	
24 Cemetery Road	4.02	---	---	---	---	---	---	---	---	---	---	
32 Cemetery Road	3.95	---	---	---	---	---	---	---	---	---	---	
46 Cemetery Road	4.13	---	0.03m	0.09m	0.25m	0.34m	---	---	---	---	---	
50 Cemetery Road	3.87	---	---	---	---	0.18m	---	---	---	---	0.00m	Over-floor flooding likely above 3.39m
57 Cemetery Road	3.41	---	0.10m	0.14m	0.28m	0.37m	---	---	---	0.11m	0.20m	
17 Lancaster Ave	3.59	---	0.00m	0.03m	0.26m	0.35m	---	---	---	---	---	
21 Lancaster Ave	3.49	---	0.04m	0.07m	0.19m	0.28m	---	---	---	0.02m	0.11m	
39 Lancaster Ave	3.59	0.12m	0.38m	0.41m	0.64m	0.73m	---	---	---	---	---	Over-floor flooding likely above 3.40m
49 Lancaster Ave	3.18	0.10m	0.36m	0.39m	0.62m	0.71m	---	0.06m	0.09m	0.32m	0.41m	
73 Lancaster Ave	2.53	0.57m	0.82m	0.86m	1.09m	1.18m	0.46m	0.71m	0.75m	0.98m	1.07m	Private levee top=102.4mAHD, entry=102.2mAHD
5 McCarrons Road	2.96	0.42m	0.65m	0.70m	0.79m	0.87m	---	0.08m	0.13m	0.22m	0.30m	
3717 Murray Valley Hwy	2.84	0.18m	0.43m	0.51m	0.59m	0.68m	---	0.22m	0.30m	0.39m	0.47m	Private levee top=101.8mAHD, entry=101.7mAHD

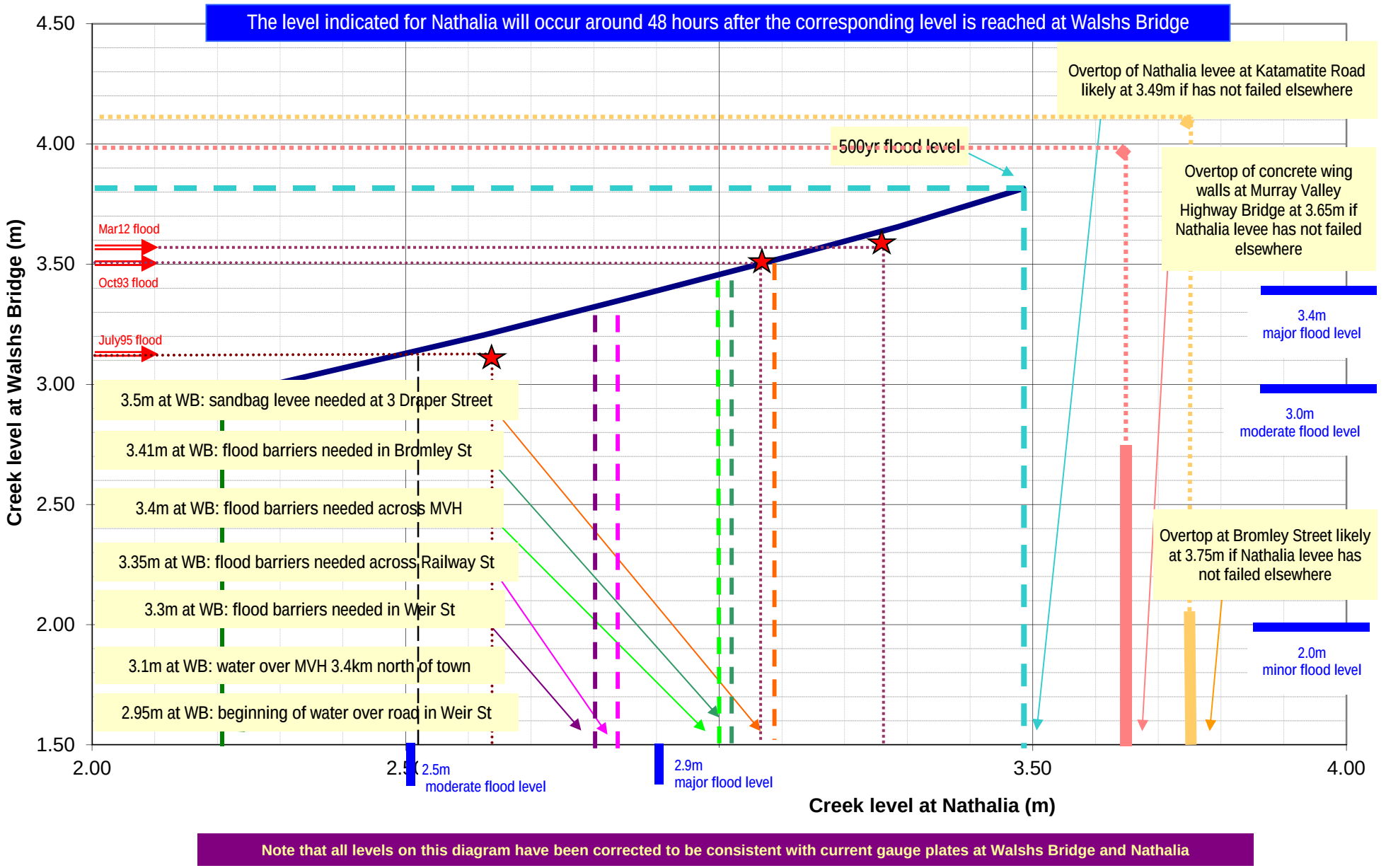
NATHALIA – EXISTING CONDITIONS

It is suggested that this table be used in conjunction with the flood inundation maps

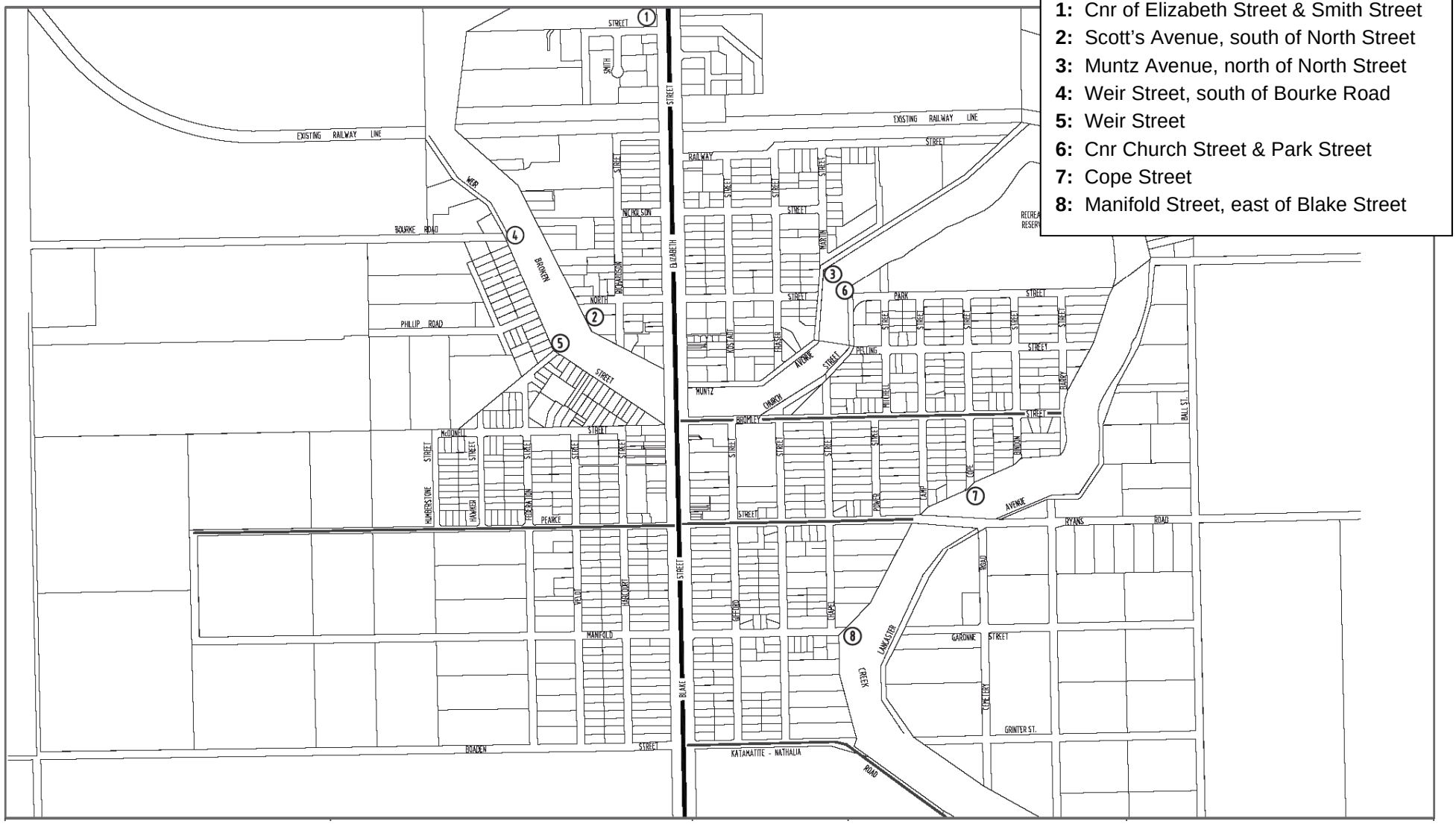
Location (Number & Street)	Floor level on Nathalia gauge (m) without correction for flood slope	Depth of flooding at property for selected river heights on the Nathalia gauge					Depth of over-floor flooding for selected river heights on the Nathalia gauge					Comments
		5yr	10yr	20yr	50yr	100yr	5yr	10yr	20yr	50yr	100yr	
		2.27m	2.63m	2.87m	3.12m	3.29m	2.27m	2.63m	2.87m	3.12m	3.29m	
Convert local gauge levels to AHD by adding 99.005m												
29 Railway Street	3.63	---	0.08m	0.23m	0.28m	0.35m	---	---	---	---	---	Private levee top=102.2mAHD, entry=101.8mAHD
70 Railway Street	2.77	0.80m	1.00m	1.15m	1.20m	1.27m	0.13m	0.33m	0.48m	0.53m	0.60m	Private levee top=102.2mAHD, entry=102.1mAHD
34 Ryan's Road	4.08	---	---	---	---	0.04m	---	---	---	---	---	
39 Ryan's Road	3.29	0.11m	0.36m	0.40m	0.63m	0.72m	---	---	---	0.21m	0.30m	Private levee top=102.2mAHD, entry=101.7mAHD
42 Ryan's Road	3.42	---	0.11m	0.16m	0.37m	0.45m	---	---	---	0.09m	0.17m	
44 Ryan's Road	2.86	---	0.39m	0.44m	0.65m	0.73m	---	0.39m	0.44m	0.65m	0.73m	Pad on vacant block
52 Ryan's Road	2.58	---	0.67m	0.72m	0.93m	1.01m	---	0.67m	0.72m	0.93m	1.01m	Pad on vacant block
54 Ryan's Road	3.98	---	---	---	---	0.06m	---	---	---	---	---	
58 Ryan's Road	3.79	---	0.06m	0.11m	0.33m	0.41m	---	---	---	---	---	
62 Ryan's Road	3.77	---	---	0.01m	0.22m	0.31m	---	---	---	---	---	
Waaia Road	2.55	0.41m	0.64m	0.68m	0.88m	0.97m	0.41m	0.64m	0.68m	0.88m	0.97m	Galvanised iron shed on slab on ground
14 Waaia Road	3.33	---	---	---	0.13m	0.22m	---	---	---	0.10m	0.19m	Private levee top=102.1mAHD, entry=101.9mAHD
89 Waaia Road	2.85	0.10m	0.30m	0.40m	0.55m	0.64m	0.10m	0.30m	0.40m	0.55m	0.64m	

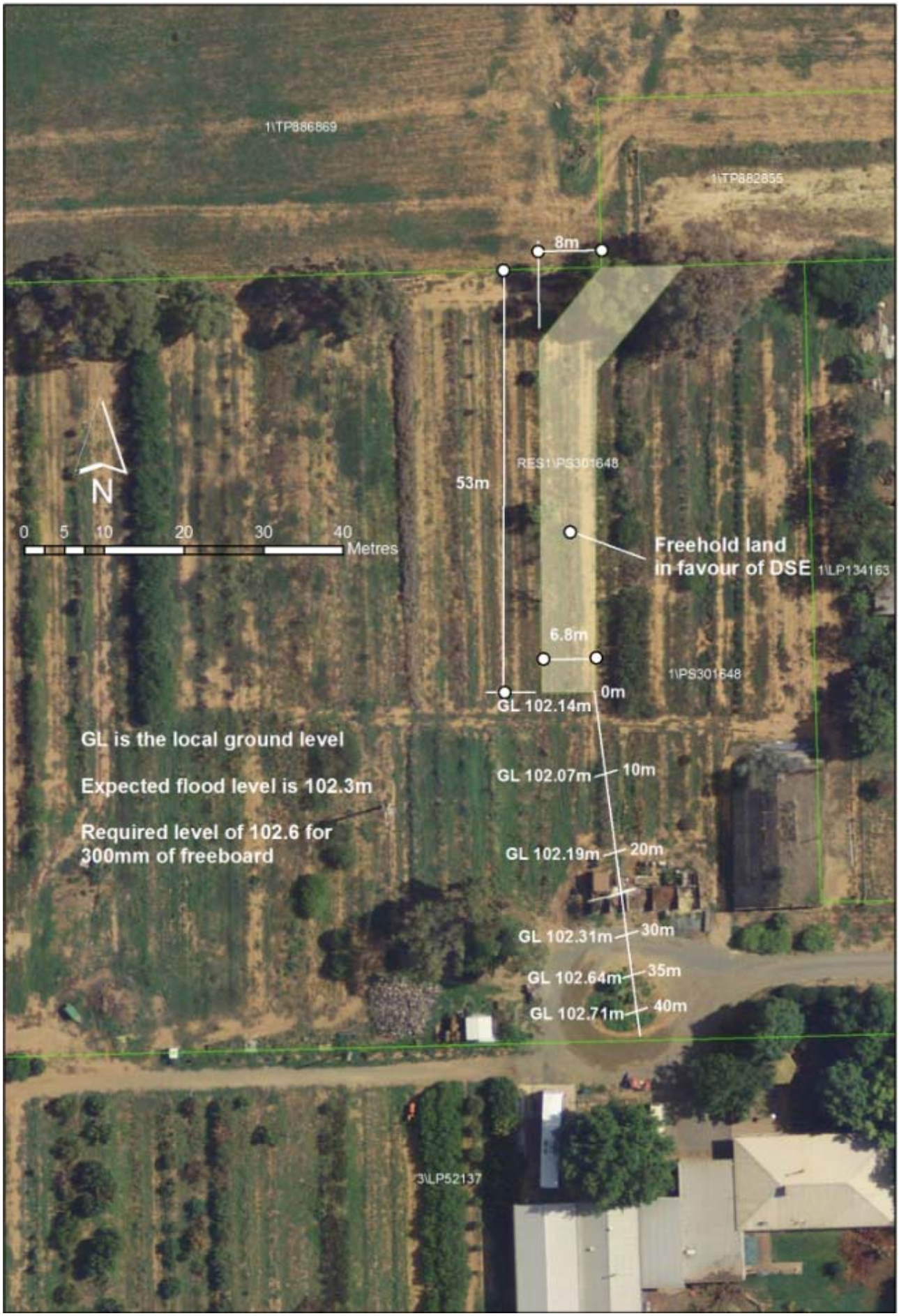


Note that all levels on this diagram have been corrected to be consistent with current gauge plates at Walshs Bridge and Nathalia

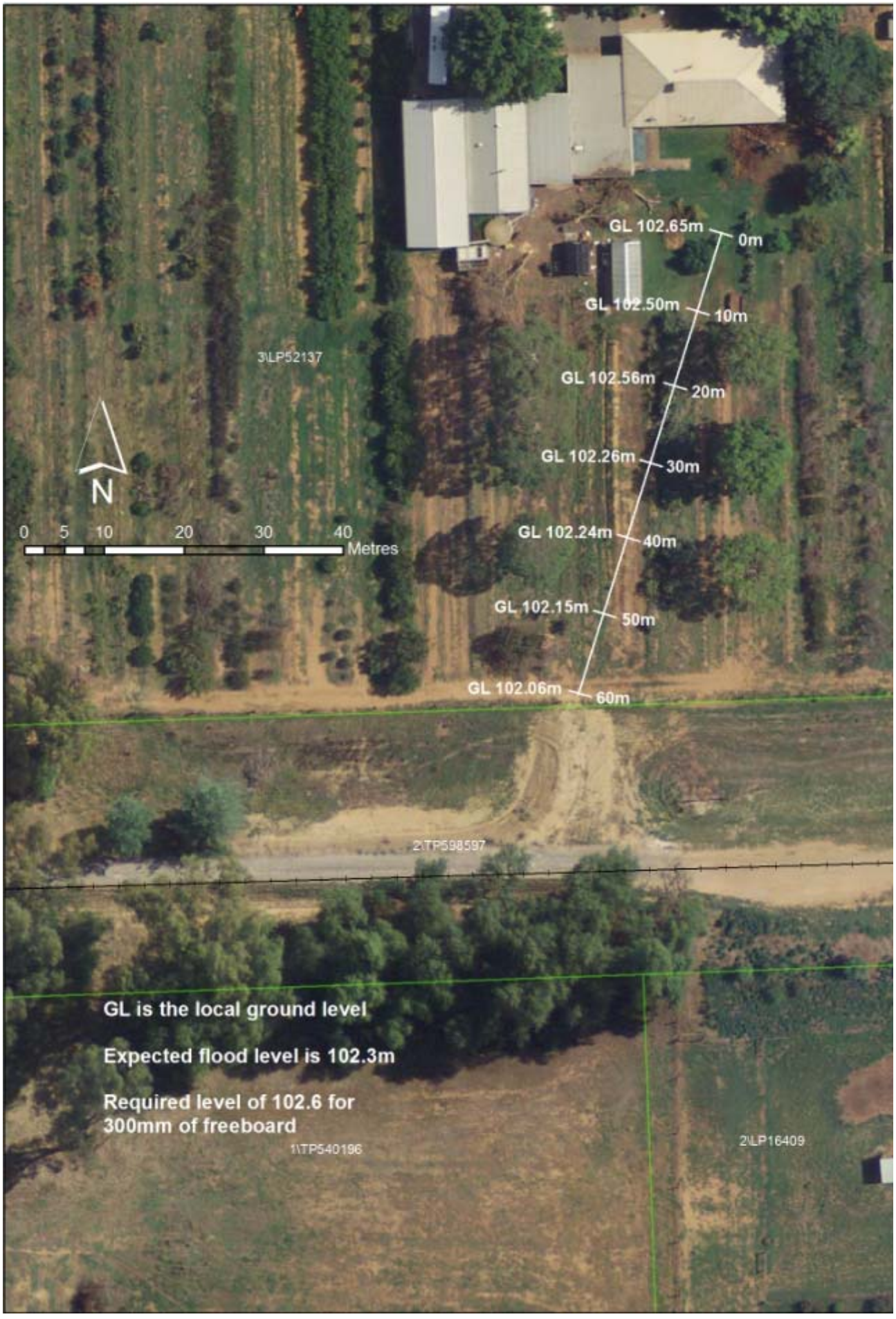

The level indicated for Nathalia will occur around 48 hours after the corresponding level is reached at Walshs Bridge
Overtop of Nathalia levee at Katamatite Road likely at 3.49m if has not failed elsewhere
500yr flood level
Overtop of concrete wing walls at Murray Valley Highway Bridge at 3.65m if Nathalia levee has not failed elsewhere
Mar12 flood
Oct93 flood
July95 flood
3.4m major flood level
3.0m moderate flood level
3.5m at WB: sandbag levee needed at 3 Draper Street
3.41m at WB: flood barriers needed in Bromley St
3.4m at WB: flood barriers needed across MVH
3.35m at WB: flood barriers needed across Railway St
3.3m at WB: flood barriers needed in Weir St
3.1m at WB: water over MVH 3.4km north of town
2.95m at WB: beginning of water over road in Weir St
Overtop at Bromley Street likely at 3.75m if Nathalia levee has not failed elsewhere
2.0m minor flood level
2.5m moderate flood level
2.9m major flood level
Creek level at Walshs Bridge (m)
Creek level at Nathalia (m)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
2.00
3.50
4.00
Note that all levels on this diagram have been corrected to be consistent with current gauge plates at Walshs Bridge and Nathalia

Location of Flood Pumps at Nathalia – September 2007





Levee extension to the north of the house on 3 Draper Street Nathalia is to be sandbagged



Levee extension to the south of the house at 3 Draper Street Nathalia is to be sandbagged

APPENDIX D – Flood Evacuation Arrangements

There are five stages in the evacuation process: decision, warning, withdrawal, shelter and return.

Phase 1 - Decision to Evacuate

The Incident Controller may make the decision to evacuate an at-risk community under the following circumstances:

- When life and safety are at risk;
- Properties are likely to become inundated;
- Properties are likely to become isolated and occupants are not suitable for isolated conditions;
- Public health is at threat as a consequence of flooding and evacuation is considered the most effective risk treatment. This is the role of the Health Commander of the incident to assess and manage. Refer to the State Health Emergency Response Plan (SHERP) for details);
- Buildings have been made uninhabitable;
- Essential services have been damaged and are not available to a community and evacuation is considered the most effective risk treatment.

The following should be considered when planning for evacuation:

- Anticipated flood consequences and their timing and reliability of predictions;
- Size and location of the community to be evacuated;
- Likely duration of evacuation;
- Forecast weather;
- Flood models;
- Predicted timing of flood consequences;
- Time required to conduct the evacuation;
- Time available to conduct the evacuation;
- Evacuation priorities and evacuation planning arrangements;
- Access and egress routes available and their potential flood liability;
- Current and likely future status of essential infrastructure;
- Resources required to conduct the evacuation;
- Resources available to conduct the evacuation;
- Shelter including Emergency Relief Centres, Assembly Areas etc.;
- Vulnerable people and facilities;
- Transportation;
- Registration;
- People of CALD background and transient populations;
- Safety of emergency service personnel;
- Different stages of an evacuation process.

The decision to evacuate should be made in consultation with the MERO, MERC, DHS, Health Commander and other key agencies and expert advice (GBCMA and Flood Intelligence specialists) unless time constraints prevent this consultation. VicPol are the lead agency coordinating evacuation.

The following **Evacuation Checklist** can be used as a guide when evaluating the need for evacuation in a particular area as a result of flooding.

Key Questions	Answers
Are there any existing Flood Evacuation Plans within Moira Shire?	
Name of area(s) at risk.	
How many people are at risk (including special needs groups)?	
When and where are access routes likely to be disrupted?	
Is the area a flood island, accessible by road, accessible overland or land locked?	
How much time is available to warn the area? Where Flash Flooding risks exist adopt the strategy detailed in Section 3.8 of this MFEP.	
Under what circumstances and in what areas is shelter in place and not evacuation the best option?	
Where are Flood Relief Centres located?	
What are the triggers for evacuation? (ie. a particular area at a specified gauge height?) – refer to Appendix C of this MFEP.	
How will evacuation warning messages be communicated to people? (ie. OSOM, Emergency Alert, etc.)	
Have standard evacuation messages been developed for predicted or likely flood scenarios?	
What forms of transport are needed to assist with evacuation?	
Where are airbase facilities located?	
Where are animal shelter compounds located? Any other arrangements for management and accommodation of pets / animals?	
What are the local command and control arrangements for evacuation?	

Other Confirmations and Clarifications:

Clarify and confirm local arrangements and responsibilities for evacuation at the local level. This includes:

- Confirming and facilitating local awareness of responsibilities for the decision to evacuate (ie. Incident Controller), the management of evacuation (ie. VicPol) and the tasks to be undertaken for evacuation (ie. development and communication of evacuation warnings).
- The role of agencies at the local level involved in evacuation (ie. VicPol, VICSES, Australian Red Cross etc.)

Local arrangements must be consistent with arrangements as set out in Section 3.8 of the EMMV and the Evacuation Guidelines.

The table below details triggers for evacuation. If these circumstances are predicted or are likely to occur, evacuation should be considered.

Sector	Gauge	Trigger

The table below details time required to evacuate established areas.

Sector	Likely time required for evacuation (including resource assumptions)

Phase 2 – Warning or Recommendation

Messages to the community will comprise of either a warning to affected people that they prepare to evacuate or a recommendation that they evacuate immediately.

Evacuation messages can be disseminated via methods listed in Part 3 of this plan.

Evacuation messages will be developed and issued by the Incident Controller in consultation with the MERO, MERC, DHS and other key agencies and expert advice (GBCMA and flood intelligence specialists).

The Incident Controller is responsible for authorising and issuing evacuation messages.

Phase 3 – Withdrawal

Withdrawal will be controlled by the VicPol Evacuation Manager. The Evacuation Manager is responsible for managing the withdrawal which will include developing an evacuation plan which clearly identifies activities and timelines as well as the roles and responsibilities of any agencies involved.

VICSES will provide advice regarding the most appropriate evacuation routes and locations for at-risk communities to evacuate to, etc.

VICSES, MFB, AV and Local Government will provide resources where available to support VicPol / VicRoads with route control and may assist VicPol in arranging evacuation transportation.

VICPOL will control security of evacuated areas.

Evacuees will be encouraged to move using their own transport where possible. Transport for those without vehicles or other means will be arranged – refer to the MEMP.

Possible evacuation routes to be used are as detailed in the MEMP:

Sector	Evacuation Route	Evacuation route closure point or circumstances

Landing zones for helicopters are located at:

Shepparton;

Yarrawonga;

Tocumwal;

Benalla;

Various ovals and sporting fields – while these may be suitable, encumbrances such as power lines and light towers would need to be logged and an appropriate risk assessment completed before being used.

Special needs groups and vulnerable residents likely to need help may be identified via the Home and Community Care (HACC) database, via Council's ''vulnerable persons' register or through community network organisations. Refer to the MEMP.

Phase 4 – Shelter

Relief Centres and /or assembly areas which cater for people's basic needs may be established to meet the immediate needs of people affected by flooding. Flood Emergency Relief / Recovery Centres and /or Assembly Areas are listed in the MEMP.

Moira Shire is responsible for the provision of emergency shelter and for managing emergency relief centres.

The Incident Controller is responsible for activating emergency relief services.

VicPol in consultation with VICSES will liaise with Local Government and DHS (where regional coordination is required) via the relevant control centre to plan for the opening and operation of relief centres, this can best be achieved through the Emergency Management Team (EMT).

Animal Shelter

Animal management guidelines are provided in the MEMP along with the location and contact details for appropriate animal welfare entities.

Matters relating to the welfare of livestock, companion animals and wildlife (including feeding and rescue) are to be referred to AGVIC. This includes requests for emergency supply and / or delivery of fodder to stranded livestock or for livestock rescue.

Matters relating to the welfare of wildlife are to be referred to AGVIC.

Caravans

No arrangements exist for the evacuation of caravans, refer to caravan park evacuation plan that may be found at the caravan park or at the Moira shire.

Levee Environments

None identified other than those identified in township emergency plans

Isolated Properties

None identified other than those identified in township emergency plans

Phase 5 – Return

Return will be consistent with the Strategic Plan for the Return of Community.

The Incident Controller in consultation with VicPol and other relevant agencies will determine when it is safe for evacuees to return to the affected area / their properties and will arrange for the notification of the community.

VicPol will manage the return of evacuated people with the assistance of other agencies as required.

Considerations for deciding whether to evacuate may return to the affected area include:

- Current flood situation;
- Status of flood mitigation systems;
- Size and location of the community;
- Access and egress routes available and their status;
- Resources required to coordinate the return;
- Special needs groups;
- Forecast weather;
- Transportation particularly for people without access to transport.

Disruption to Services

Disruption to a range of services can occur in the event of a flood. This may include road closures affecting school bus routes, damage to water treatment plant affecting potable water supplies, etc. [List facilities, trigger point for action and strategy to be employed]

Service	Impact	Trigger point for action	Strategy / Temporary Measures

Essential Community Infrastructure and Property Protection

Essential Community Infrastructure and properties (eg. residences, businesses, roads, power supply, etc) that require protection are as follows: [List facilities, trigger point for action and strategy to be employed]

Facility	Impact	Trigger Point for action	Strategy / Temporary Measures

Sandbag collection points will be established at easily accessible community facilities or locations within or near threatened communities as appropriate.

Rescue

Resources available within Moira Shire to assist with rescue operations are as listed in the MEMP.

While there are no formal resource sharing arrangements establishing by Moira Shire with other municipalities and / or other agencies other than the MAV's Resource Sharing Agreement, Victorian incident management arrangements established for flood facilitate such sharing.

There are no known high-risk areas / communities (ie. low-lying islands) where rescues might be required.

APPENDIX E - FLOOD WARNING SYSTEMS

1 Flood Warning Products

Flood Warning products and Flood Class Levels can be found on the BoM website. Flood Warning Products include Severe Thunderstorm Warnings, Severe Weather Warnings, Flood Watches and Flood Warnings.

2 Severe Thunderstorm and Severe Weather Warnings

The BoM can forecast the environment in which severe thunderstorms or small scale weather systems that are locally intense and slow moving may occur and provides a generalised service to that effect. However, it is not yet scientifically possible to predict individual flash flooding events except on time scales of tens of minutes at the very best.

The BoM issues warnings of flash flooding when it becomes apparent that an event has commenced which may lead to flash flooding or when flash flooding has commenced. However, the BoM does not provide warnings for flash flooding for specific creeks and locations.

Flood Watches

Flood watches are issued by the BoM to notify communities and other stakeholders within broad areas (rather than specific catchments) of the potential flood threat from a developing weather situation. They provide a 'heads up' of likely flooding.

Flood watches are based on an assessment of the developing weather situation and indicators of current catchment wetness. They provide generalised statements about expected forecast rainfall totals, the current state of the catchments within the target area and the streams at risk from flooding. Instructions for obtaining rain and stream level observations and access to updated Watches and Warnings are also included.

Normally, the BoM would issue a Flood Watch 24 to 36 hours in advance of any likely flooding and issue updates as required. If at any time during that period there was an imminent threat of floods occurring, the Flood Watch would be upgraded to a Flood Warning.

3 Flood Warnings

Flood Warnings are firm predictions of flooding based on actual rainfall and river height information as well as the results of stream flow based models of catchment behaviour that take account of antecedent conditions (i.e. the 'wetness' of the catchment, storage levels within dams, etc) and likely future rainfall. Releases from dams are an essential input to such models.

To assist the description of the flood warning service it provides; BoM are in the process of categorising the locations where river height data is obtained into three types as follows.

- **Forecast locations:** BoM provides a forecast of future water level as the class of predicted flooding ('minor', 'moderate' or 'major' - see BoM website for an explanation of these terms and current flood class levels) or as a predicted level and associated class of flooding for these locations.
- **Information locations:** BoM does not provide a forecast for these locations but as flood class levels are defined, does provide current water levels and trends.
- **Data locations:** BoM only provides data for these locations: no forecasts and no indication of the class (or severity) of flooding.

These locations will be further designated as either "key" or "secondary" in relation to flood forecasting activities.

- **Key locations:** may be a forecast location and the real-time data collected at site are critical to the provision of a flood forecasting service to a downstream site.
- **Secondary locations:** data from these sites are used to support hydrological modelling and flood prediction activities although their loss during an event is considered unlikely to affect BoM ability to provide a flood forecasting service.

Flood forecasts provided by the BoM are categorised as either:

- **Qualitative:** the forecast includes information about the expected class of flooding ('minor', 'moderate' or 'major' - see BoM website for an explanation of these terms and current flood class levels) and the timing of expected flooding at the location. The forecast may also include information about the expected class of flooding during the peak.
- **Quantitative:** the forecast includes the expected class of flooding ('minor', 'moderate' or 'major' - see BoM website for an explanation of these terms and current flood class levels) together with more specific information about the height and time of future water levels at the location.
- **Generalised:** the forecast comprises generalised statements advising that flooding is expected and are usually issued for areas where no locations exist for which quantitative or qualitative forecasts are provided, in the developing stages of a flood and / or when there is insufficient data available to make a specific prediction.

Not all sites for which flood class levels exist will automatically be provided with a quantitative flood forecast. It is understood that sites will be classified on the basis of flood risk and consequence. The lower rated sites will receive a qualitative warning service only. For these sites, BoM will issue warnings that advise only of the exceedance (or likely exceedance) of flood class levels along with the class of flooding expected: a detailed flood forecast will not be provided.

4 Existing Flood Warning System

Flood warning systems currently exists for selected locations and streams within the Shire. They comprise:

- A number of telemetered rain and river flow / level monitoring stations within relevant catchments;
- Access to data from these sites through the tables and maps available on the BoM website;
- All data sites covered by robust on-going operation and maintenance arrangements;
- Flood class levels established for river forecast and information sites;
- A rainfall – runoff model that is used by the BoM to forecast flood levels and times at selected locations (i.e. quantitative forecasts);
- Qualitative flood forecasts (in terms of the class of flooding only) along with current river levels for other forecast locations;
- Current river levels for other selected sites in relevant catchments;
- Standard direct from BoM to media, VICSES and other stakeholder agency warning distribution arrangements;
- VICSES messaging during flood events;
- Access through VICSES to the Emergency Alert during severe flood situations;
- A Municipal Flood Emergency Plan (MFEP) that acts as a repository for flood intelligence and associated mapping and which is used to guide response during periods of flooding;
- Post-event reviews held as and when considered necessary consistent with the EMMV.

Flood Watches and Warnings are issued by the BoM to the media, VICSES and a range of other stakeholder organisations including Moira Shire. Council will receive a follow up communication from

VICSES.

Council has the responsibility for alerting individuals within the community including activation of flood warning systems if they exist (eg. Nathalia). Council is also expected to monitor the situation and take appropriate action within its areas of responsibility, ensuring that at all times, VICSES as the Control Agency for flood, is kept appraised of developments and that any actions taken accord with the overall strategy adopted by VICSES to respond to the event and as reflected in this Plan.

Flood Watches and Warnings, along with all available rain and river level / flow data (updated hourly), radar and satellite imagery and other related information, are also posted to the Bureau's website.

Flood warnings are categorised as 'minor', 'moderate' or 'major' (see BoM website for an explanation of these terms and current flood class levels – see also table below) and indicate the expected severity of the flood for agreed key locations along the river. Flood warnings usually include:

- Rainfall amounts for selected locations within and adjacent to the catchment;
- River heights and trends (rising, steady, falling) at key locations within the catchment;
- Outflows (in ML/d) from major storages within the catchment;
- Forecasts of the height and time of flood peaks at key locations;
- A weather outlook and the likely impact of expected rainfall on flooding; and
- A warning re-issue date and time.

Note 1: The term "local flooding" or "flash flooding" may be used for localised flooding resulting from intense rainfall over a small area.

Note 2: The term "significant rises" may be used in the early stages of an event when it is clear that river levels will rise but it is too early to say whether they will reach flood level.

Additional information (eg. weather radar and satellite images, updated rain and river level information, details of current watches and warnings) can be obtained from the BoM's website (www.bom.gov.au/hydro/flood/vic) and the VICSES website (www.ses.vic.gov.au).

Rainfall data is available from the BoM website for twelve sites considered relevant to the Broken Creek catchment - Benalla, Cobram, Dookie, Greta West, Gowangardie Weir, Highlands (Bungeet), Katamatite, Nathalia, Tocumwal, Tungamah, Wangaratta and Yarrawonga (see table below).

Rainfall station	Rainfall and river height data (by catchment) map	Rainfall total tables			Daily rainfall bulletin	Latest observations table (30 minute)
		1-hour	3-hour	24-hour		
Benalla (AWS)					Lower NE X	North East X
Benalla (ERTS)	X	Broken River catchment X	X	X		
Cobram		Broken catchment		X		
Dookie		Broken catchment		X	Upper North X	
Greta West (ERTS)	X	15 Mile Creek catchment X	X	X		
Gowangardie Weir (ERTS)		Broken catchment	X	X	Upper North X	
Highlands	X	Broken catchment				

Rainfall station	Rainfall and river height data (by catchment) map	Rainfall total tables			Daily rainfall bulletin	Latest observations table (30 minute)
		1-hour	3-hour	24-hour		
(Bungeet) (ERTS)		X	X	X		
Katamatite (logger)	X					
Nathalia		Broken catchment				
				X		
Tocumwal	X				NSW Riverina X	
Tungamah (logger)		Broken catchment			Upper North	
				X	X	
Wangaratta (AWS)	X	Ovens catchment			Lower NE	North East
		X	X	X	X	X
Yarrawonga (AWS)	X	Ovens catchment			Upper North	Northern
		X	X	X	X	X

Table F1: Availability for rainfall data relevant to the Broken Creek catchment

Stream flow data is available from the BoM website for four locations within the Broken Creek catchment:

Stream gauge site	Location
Boosey Creek at Tungamah (404204)	Around 42km upstream of Numurkah and 21km upstream of the Boosey Creek - Broken Creek confluence
Broken Creek at Katamatite (404214)	Around 11km upstream of Numurkah and 2km upstream of the Boosey Creek - Broken Creek confluence
Broken Creek at Walshs Bridge (404238)	Around 11km downstream from Numurkah
Broken Creek at Nathalia (404237)	Around 24km downstream from Numurkah

A staff gauge is also located on the Broken Creek at the Melville Street Bridge in Numurkah. However, there are no formal arrangements for reading this gauge during flood events.

While there are a few additional water monitoring sites and a number of additional staff gauges within the Broken Creek catchment, there are no formal arrangements for reading the staff gauges and no automated near real-time transfer of data from instrumented sites to the BoM.

FLOOD CLASS LEVELS for river gauges relevant to Moira Shire				
River Station	Minor	Moderate	Major	Gauge Zero
Broken Creek at Tungamah				119.961mAHD
Broken Creek at Katamatite				112.864mAHD
Broken Creek at Numurkah @ the Melville Street Bridge[1]	107.40mAHD[1]	107.55mAHD[1]	107.70mAHD[1]	0.00
Broken Creek at Walsh's Bridge	2.00m	3.00m	3.40m	100.955mAHD

FLOOD CLASS LEVELS for river gauges relevant to Moira Shire				
River Station	Minor	Moderate	Major	Gauge Zero
Broken Creek at Nathalia	1.50m	2.50m	2.90m	99.005mAHD
Broken River at Benalla	2.50m	3.70m	4.50m	164.859mAHD
Broken River at Casey Weir	2.10m	2.60m	3.00m	156.914mAHD
Broken River at Goomalibee	No longer available from BoM website. Old values are provide below:			
	6.30m	6.60m	6.75m	
Broken River at Nalinga	No longer available from BoM website. Old values are provide below:			
	4.80m	5.30m	6.15m	
Broken River at Orrvale	6.80m	7.20m	7.90m	108.339mAHD
Murray River at Albury	4.30m	4.90m	5.50m	147.435mAHD
Murray River at Corowa	4.60m	5.90m	8.60m	126.017mAHD
Murray River at Yarrawonga D/S	6.40m 82,000ML/d	6.70m 98,000ML/d	7.80m 182,000ML/d	115.035mAHD
Murray River at Tocumwal	6.40m	6.70m	7.30m	103.830mAHD
Murray River at Barmah	No longer available from BoM website. Old values are provide below:			
	6.00m	6.50m	7.00m	89.287mAHD
Goulburn River at Shepparton	9.50m	10.70m	11.00m	100.127mAHD
Goulburn River at McCoy's Bridge	9.00m	10.00m	10.20m	91.443mAHD
Ovens River at Wangaratta	11.90m	12.40m	12.70m	130.426mAHD

NOTES

1 Preliminary flood class levels proposed for Numurkah in 2014

2 Other flood class levels as extracted from the Bureau of Meteorology's website (www.bom.gov.au) on 14 December 2014 and as advised by Moira Shire.

3 It is emphasised that the flood levels quoted in the table above refer to that part of the river where the flood effects can be related to the gauge reading.

4 The occurrence of a certain class of flooding at one point in a catchment will not necessarily lead to the same class of flooding at other points – for example along the main river and its tributary creeks or along a drainage network's overland flow paths. This is because the floodplain physiography and use (and thus flood impact) varies along the river or flow path and also because antecedent conditions combined with where and how rainfall occurs (both in time and space) will drive how a flood develops and progresses.

5 Flood impact is dependent on more than the peak height or flow. The rate of rise, duration, extent and season of flooding are also important. For this reason, flood class levels can only be considered as a guide to flood severity.

6 Not all sites for which flood class levels exist will automatically be provided with a quantitative flood forecast by the BoM in the future. It is understood that sites will be classified on the basis of flood risk and consequence. The lower rated sites will receive a quantitative warning service only. For these sites, BoM will issue warnings that advise only of the exceedance (or likely exceedance) of

flood class levels along with the class of flooding expected: a detailed flood forecast will not be provided.

5 Flood Bulletins

VICSES distributes flood emergency information to the media through “Flood Bulletins”. Flood Bulletins provide BoM Flood Warning information as well as information regarding possible flood consequences and safety advice, not contained in BoM Flood Warning products. VICSES uses the title Flood Bulletin to ensure emphasis is placed on BoM Flood Warning product titles.

The relevant VICSES Region Headquarters or the established ICC will normally be responsible for drafting, authorizing and issuing Flood Bulletins, using the One Source, One Message (OSOM) system.

Flood Bulletins should refer to the warning title within the Bulletin header.

Flood Bulletins should follow the following structure:

- What is the current flood situation;
- What is the predicted flood situation;
- What are the likely flood consequences;
- What should the community do in response to flood warnings;
- Where to seek further information;
- Who to call if emergency assistance is required.

It is important that the description of the predicted flood situation is consistent with and reflects the relevant BoM Flood Warning.

Flood Bulletins should be focused on specific gauge (or in the absence of gauges, catchment) reference areas, that is the area in which flood consequences specifically relate to the relevant flood gauge.

Flood Bulletins should be prepared and issued after receipt of each Flood Watch and Flood Warning from the BoM, or after Severe Weather or Thunderstorm Warnings indicating potential for severe flash flooding.

To ensure Flood Bulletins are released in a timely manner, standardised Flood Bulletins may be drafted based on different scenarios, prior to events occurring. The standardised Flood Bulletins can then be adapted to the specifics of the event occurring or predicted to occur.

6 Local Flood Warning System Arrangements

Nathalia

As part of the Nathalia Flood Warning Project, Moira Shire Council in conjunction with project partners, implemented a flood emergency alerting system. The system comprises “State of the Art” telephone technology “Voice Reach” and utilises Moira Shire’s Nathalia Tourist Information FM Radio FM-88, which will operate as a “Municipal Emergency Radio”.

As an event builds all community members in the vicinity of Nathalia who have not “opted-out” of the system will receive a telephone alert initiated by Moira Shire through Xpedite. Information will also be loaded to and be available via FM-88. Continuous updates will be broadcast on FM-88 until the flood event subsides.

The Flood Alert Operation Procedures Manual for FM Radio and VoiceREACH are not included in this MFEP but are available as a separate document from Moira Shire Council.

It is essential that routinely (ie. at least once per year) each procedure detailed in the Manual is tested by activation and that the (original) database is updated.

Numurkah

The BoM does not currently provide flood warning services for the town. However, the tools provided in Appendix C10 of this MFEP do however provide some indicative guidance on the likelihood and severity of flooding at Numurkah. The tools use rainfall from across the catchment and creek levels at Tungamah and Katamatite. However, the tools do not provide a prediction of expected flood height. They provide indicative guidance only that can then be related to the flood inundation maps produced by the flood study (Water Technology, 2014).

Other locations

There are no other specific local flood warning systems or arrangements in place within Moira Shire.

APPENDIX F – MAPS

Overview

Maps considered useful to flood response are listed in this Appendix. These maps are available in hard copy form and as PDF digital copies from Moira Shire and include:

- Catchment maps - Broken Creek map included herein.
- For Numurkah, flood inundation maps for the 5, 10, 20, 50, 100, 200 and 500-year ARI events for both the township (inner) and surrounding floodplain (outer) areas.
- For Nathalia, flood inundation maps for the 5, 10, 20, 50, 100 and 500-year ARI events for the township (inner) area, and from Walsh's Bridge South Road to Dohnts Road (outer) area as well as levee break maps for the 100 and 500-year ARI events for the township area.
- For the Murray floodplain, flood inundation maps for the 10, 20, 50, 100, 200 and 500 year ARI events for a number of scenarios as follows:
  - Levee overtopping without failure (no levee failure);
  - Victorian levee failure;
  - New South Wales levee failure; and
  - Victorian irrigation channel removal.
- For all towns in the Municipality 1% flood extents and flood level contours (available from GBCMA).
- Maps produced as part of the Flood Data Transfer project (AGVIC, 2000) and now updated for more recent data and study results (available through the VFD).

Note that:

- Maps showing 100-year ARI (1% AEP) flood extent and floodway's (together with volume, height and water quality data) are shown at the Victorian Water Resources website (see the list of references in Appendix H).
- The Moira Planning Scheme shows all delineated FZ, LSIO and FO within the Shire and is available from the DCPI website (see the list of references in Appendix H).

Pedigree of maps included herein

Numurkah

The Numurkah maps delivered by Water Technology (2014) have been produced using the revised hydrology and updated hydraulic model developed post the March 2012 flood event. They therefore recognise and accommodate the March 2012 flood event.

Nathalia

Inner Area Maps

Water Technology (2012) reran the hydraulic model developed as part of the Nathalia Floodplain Management Plan (SMEC, 2005) to produce post-levee flood inundation maps for Nathalia for the 5, 10, 20, 50, 100 and 500-year ARI events. The maps reflect the correct gauge zeros at Nathalia and Walsh's Bridge and include the current cadastre.

Outer Area Maps

Water Technology (2012) produced post-levee flood inundation maps for the floodplain from Walsh's Bridge South Road to a little downstream of Dohnts Road, south of Picola.

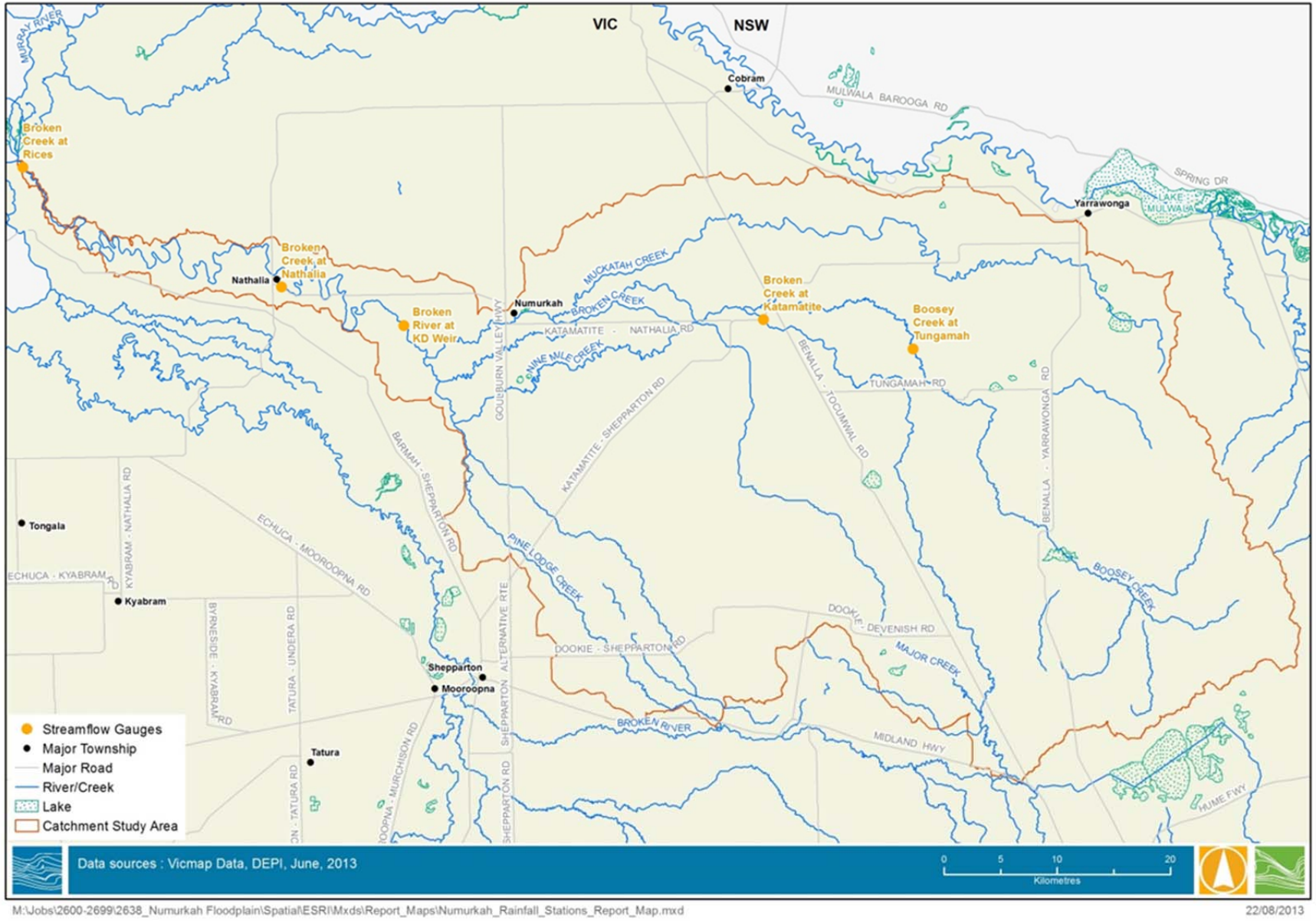
Levee Break Maps

The 100-year and 500-year ARI flood inundation maps prepared as part of the Nathalia Floodplain Management Plan (SMEC, 2005) and as subsequently reworked by Water Technology in 2012 to reflect correct gauge zeros at Nathalia and Walsh's Bridge and include the current cadastre are provided herein as typical levee break flood inundation scenarios.

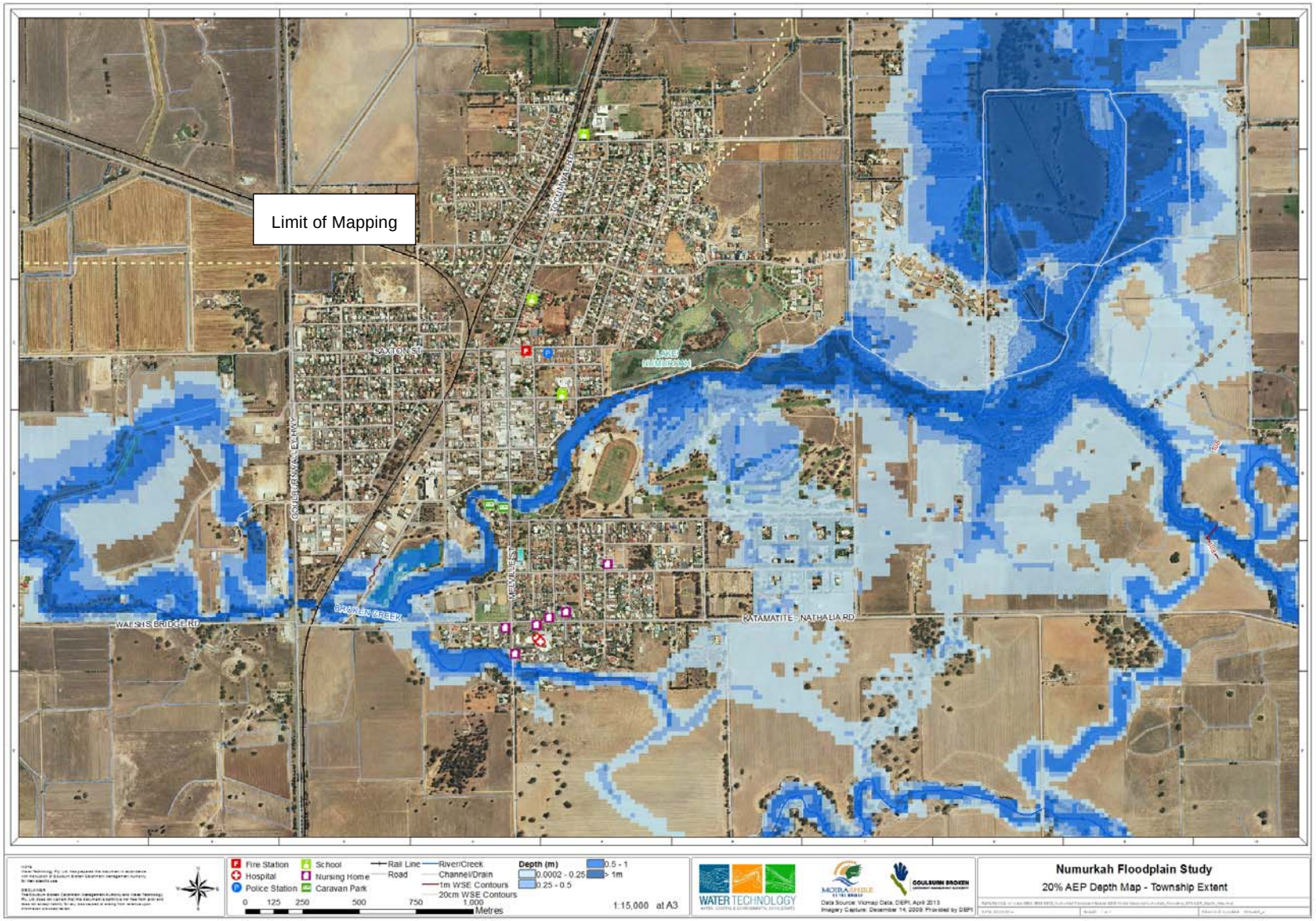
Murray River and Floodplain

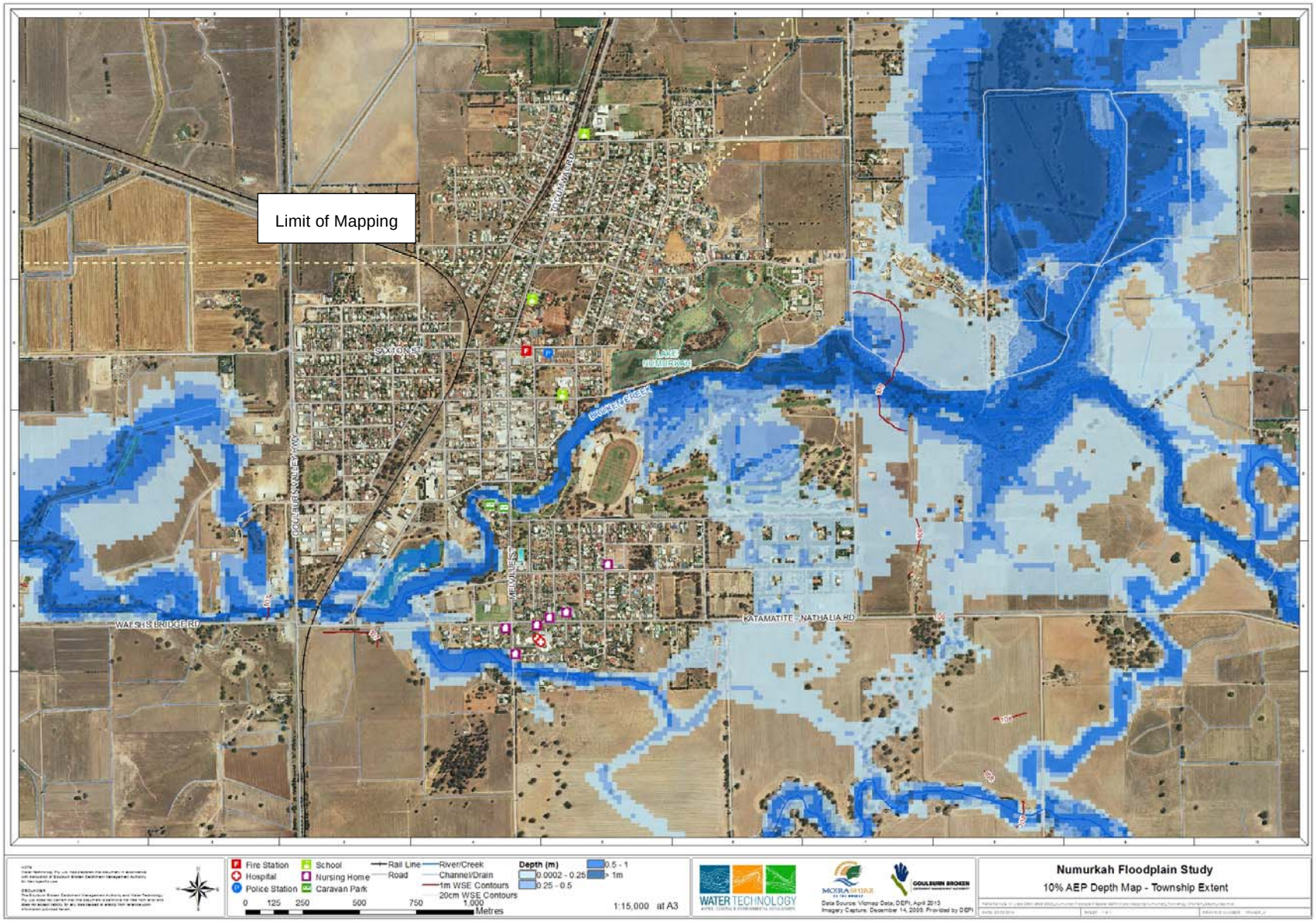
A selection of the flood inundation maps produced by Water Technology (2011) as part of the Murray River Regional Flood Study: Dicks / Seppelt's Levee to downstream, of the Ulupna Creek confluence for the 10, 20, 50, 100, 200 and 500 year ARI events under a number of scenarios involving the levees on both the Victorian and NSW side of the river are provided herein.

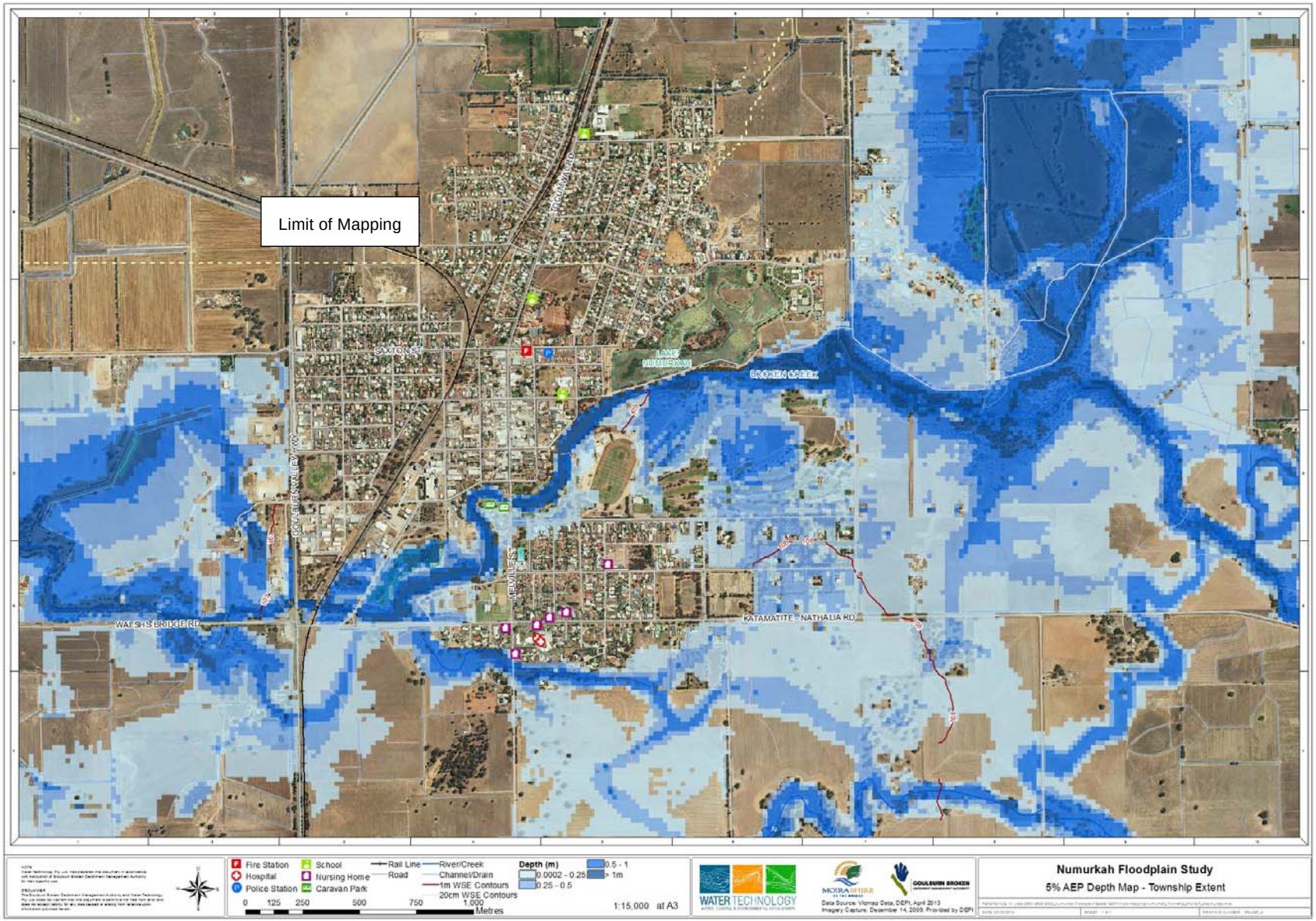
2 Broken Creek catchment

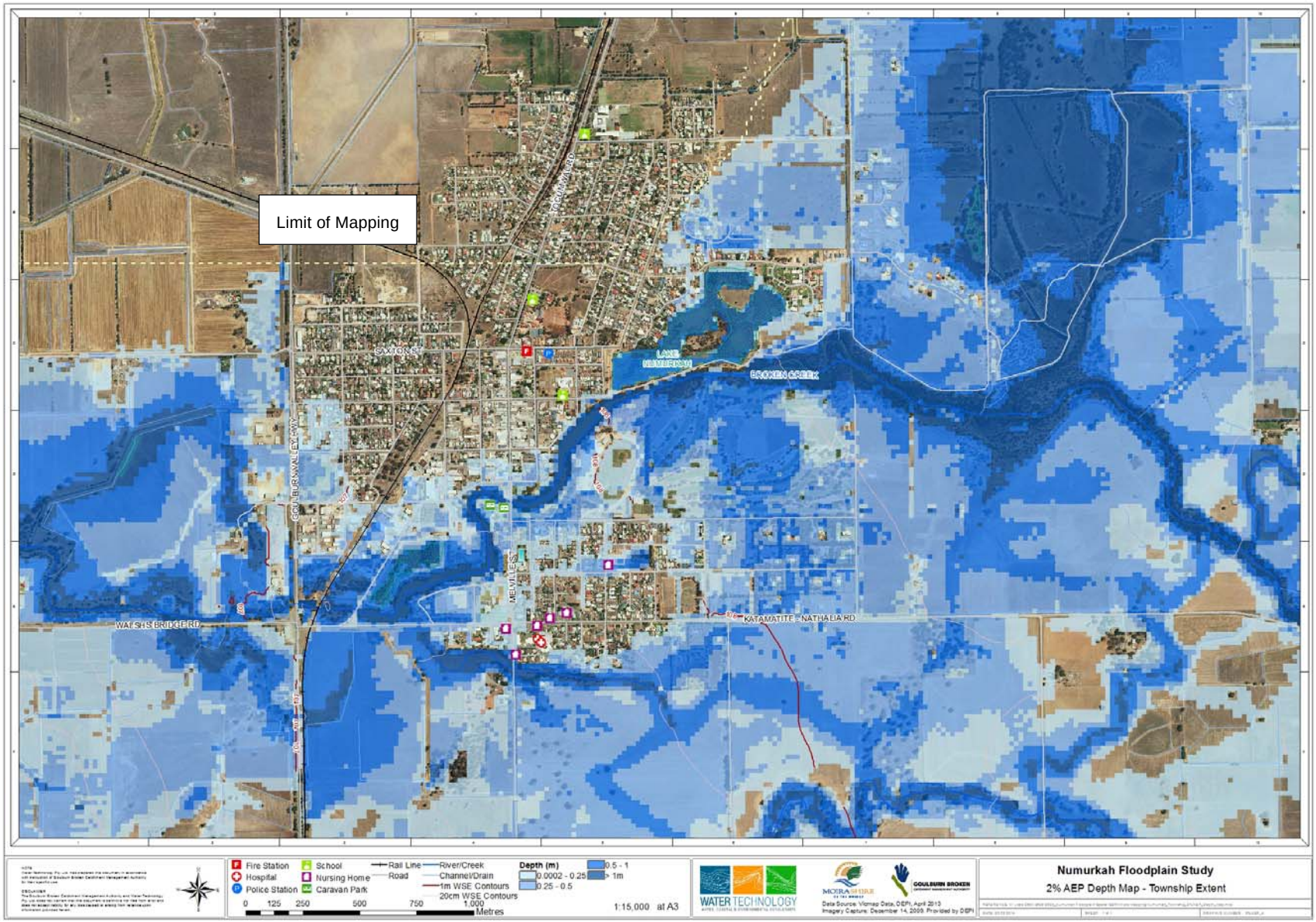


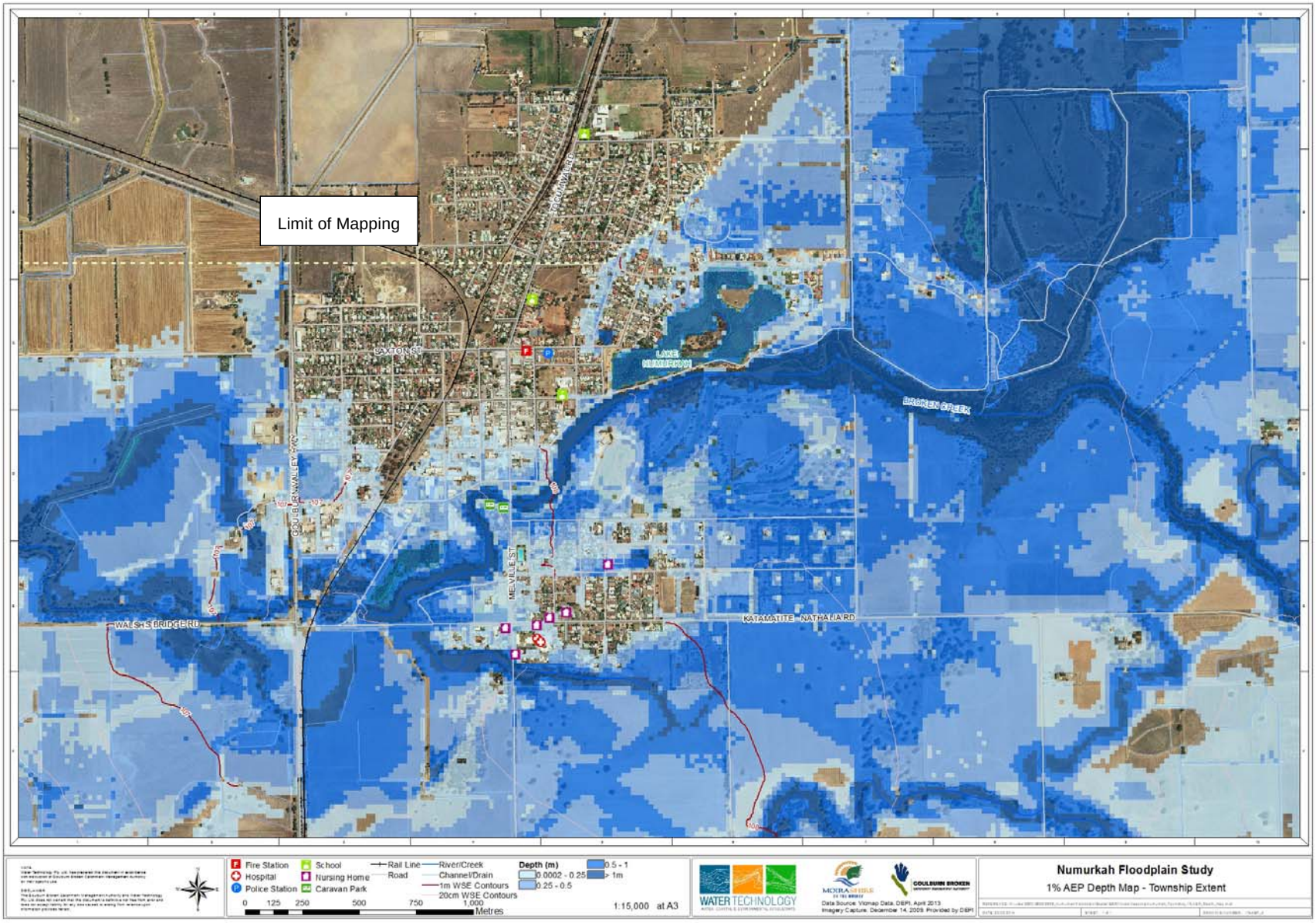
3 Numurkah - township

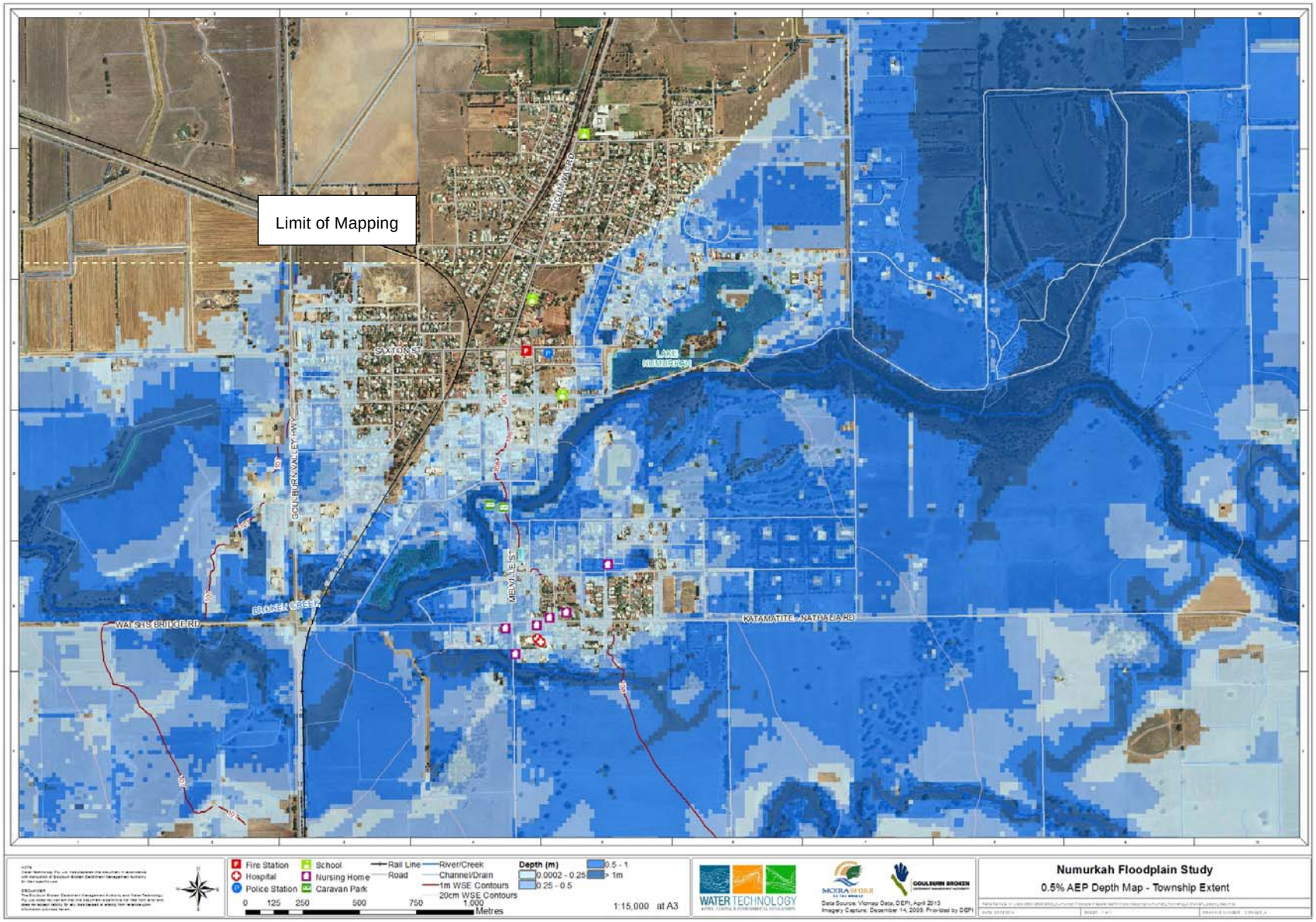


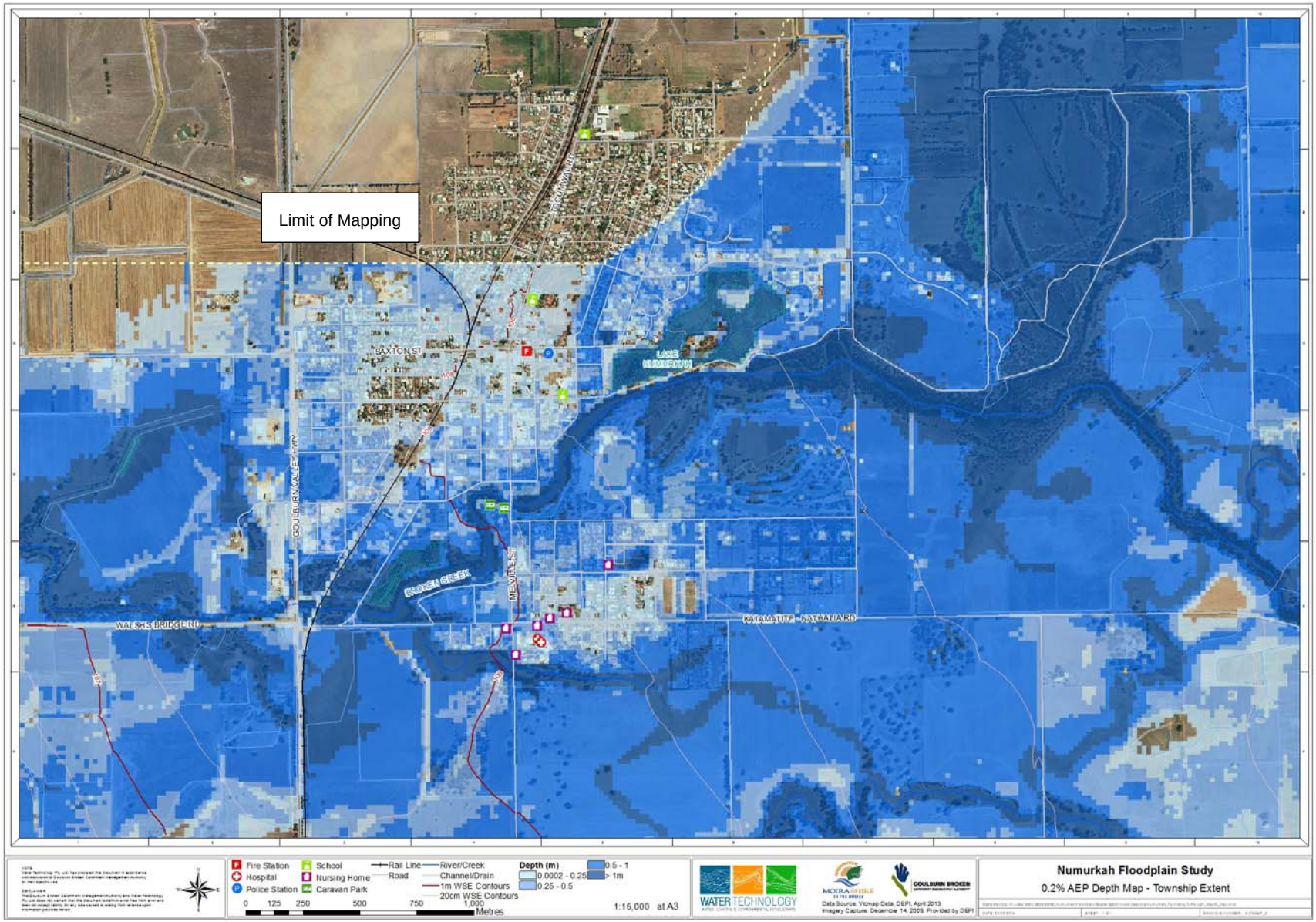

Limit of Mapping
BROKEN CREEK
LAKE NUMURKAH
EXTONS RD
GOULBURN VALLEY HWY
MELVILLES RD
WALSHS BRIDGE RD
KATAMATITE - NATHALIA RD
Fire Station
Hospital
Police Station
School
Nursing Home
Caravan Park
Rail Line
Road
River/Creek
Channel/Drain
1m WSE Contours
20cm WSE Contours
Depth (m)
0.0002 - 0.25
0.25 - 0.5
0.5 - 1
> 1m
0 125 250 500 750 1,000
Metres
1:15,000 at A3
WATER TECHNOLOGY
Data Source: Vicmap Data, DEPI, April 2013
Imagery Capture: December 14, 2009. Provided by DEPI
Numurkah Floodplain Study
10% AEP Depth Map - Township Extent


Limit of Mapping
EATONS
LAKE
BROKEN CREEK
GOULBURN VALLEY HWY
MERRILEES
WAISH'S BRIDGE RD
KATAMATITE - NATHALIA RD
Fire Station
Hospital
Police Station
School
Nursing Home
Caravan Park
Rail Line
Road
River/Creek
Channel/Drain
1m WSE Contours
20cm WSE Contours
Depth (m)
0.0002 - 0.25
0.25 - 0.5
0.5 - 1
> 1m
0 125 250 500 750 1,000
Metres
1:15,000 at A3
WATER TECHNOLOGY
MOIRA SHIRE
GOULBURN BROKEN
Numurkah Floodplain Study
5% AEP Depth Map - Township Extent

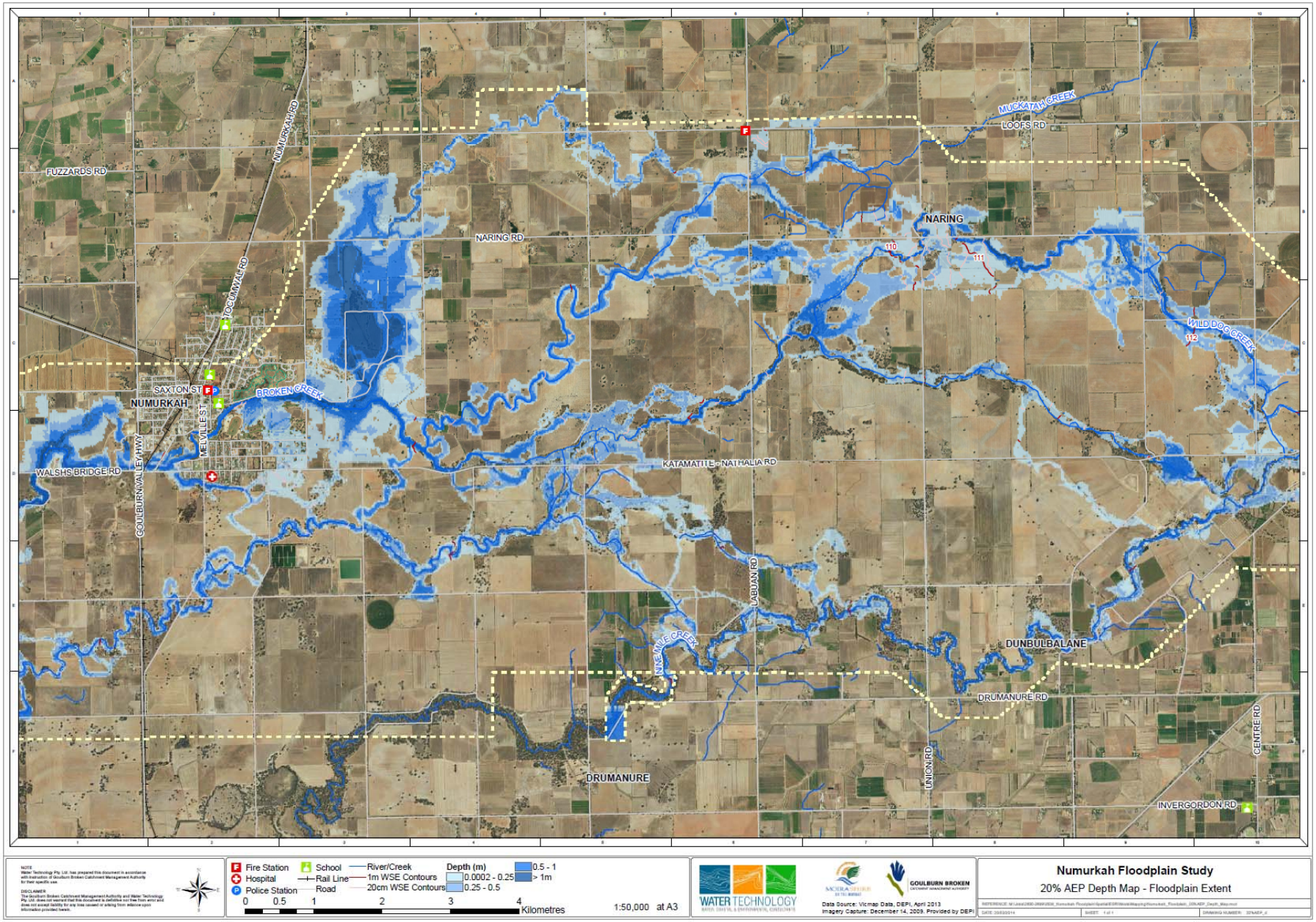

Limit of Mapping
SAXONS
LAKE NUMURKAH
BROKEN CREEK
GOULBURN VALLEY HWY
MELVILLES
WALSHS BRIDGE RD
KATAMATITE - NATHALIA RD
Fire Station
Hospital
Police Station
School
Nursing Home
Caravan Park
Rail Line
Road
River/Creek
Channel/Drain
1m WSE Contours
20cm WSE Contours
Depth (m)
0.0002 - 0.25
0.25 - 0.5
0.5 - 1
> 1m
0 125 250 500 750 1,000
Metres
1:15,000 at A3
WATER TECHNOLOGY
Data Source: Vicmap Data, DEPI, April 2013
Imagery Capture: December 14, 2009. Provided by DEPI
Numurkah Floodplain Study
2% AEP Depth Map - Township Extent

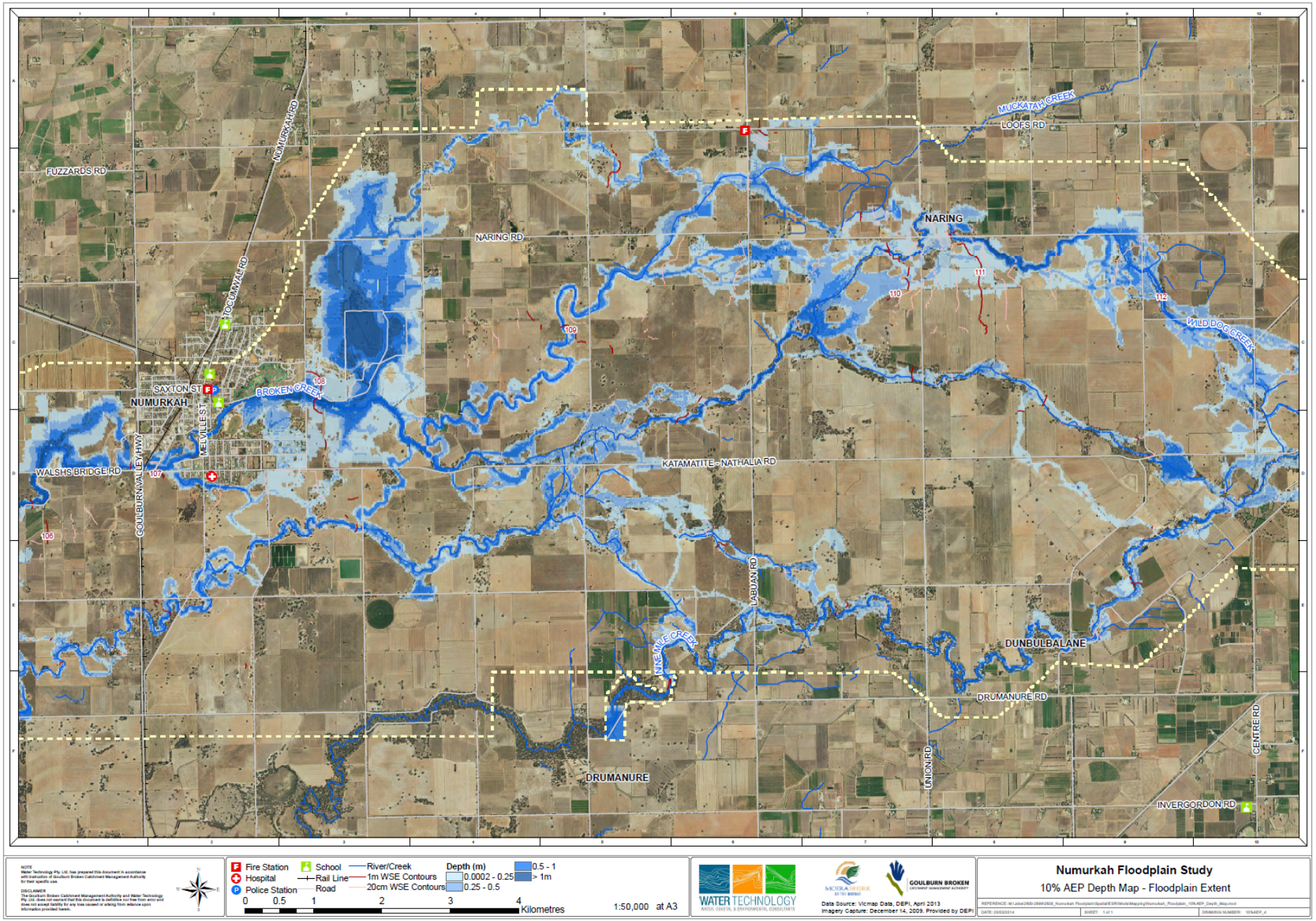

Limit of Mapping
BROADWAY
BAXTON ST
LAKE
HUMEPOW
BROKEN CREEK
GOULBURN VALLEY HWY
MELVILLE ST
WALSHS BRIDGE RD
KATAMATITE - NATHALIA RD
Fire Station
Hospital
Police Station
School
Nursing Home
Caravan Park
Rail Line
Road
River/Creek
Channel/Drain
1m WSE Contours
20cm WSE Contours
Depth (m)
0.0002 - 0.25
0.25 - 0.5
0.5 - 1
> 1m
0 125 250 500 750 1,000
Metres
1:15,000 at A3
WATER TECHNOLOGY
Data Source: Vicmap Data, DEPI, April 2013
Imagery Capture: December 14, 2009 Provided by DEPI
Numurkah Floodplain Study
1% AEP Depth Map - Township Extent

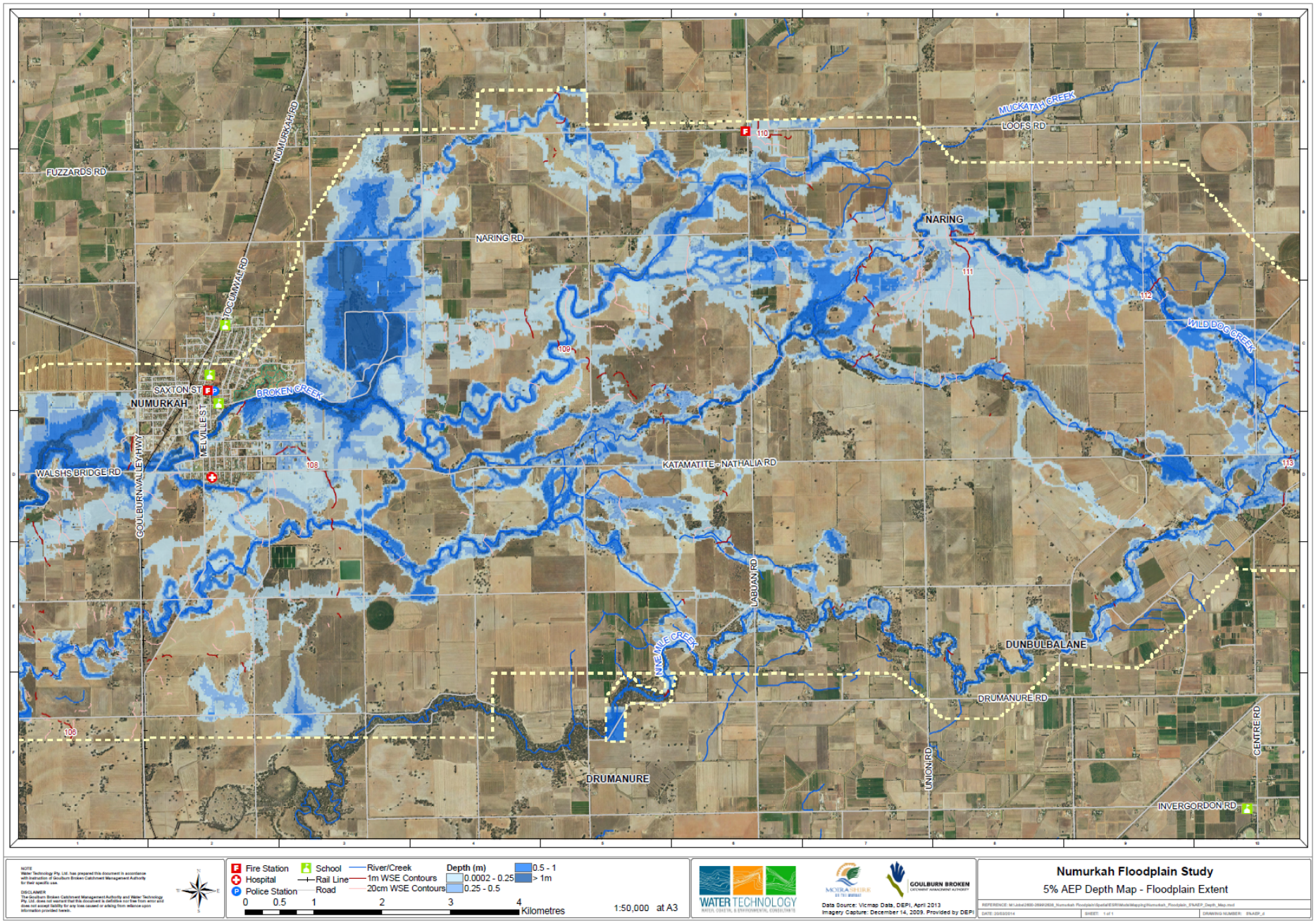

Limit of Mapping
GOULBURN VALLEY HWY
BROKEN CREEK
WALSH'S BRIDGE RD
MELVILLE ST
KATAMATITE - NATHALIA RD
LAKE KATAMATITE
SAXONS
Fire Station
Hospital
Police Station
School
Nursing Home
Caravan Park
Rail Line
Road
River/Creek
Channel/Drain
1m WSE Contours
20cm WSE Contours
Depth (m)
0.0002 - 0.25
0.25 - 0.5
0.5 - 1
> 1m
0 125 250 500 750 1,000
Metres
1:15,000 at A3
WATER TECHNOLOGY
Numurkah Floodplain Study
0.5% AEP Depth Map - Township Extent

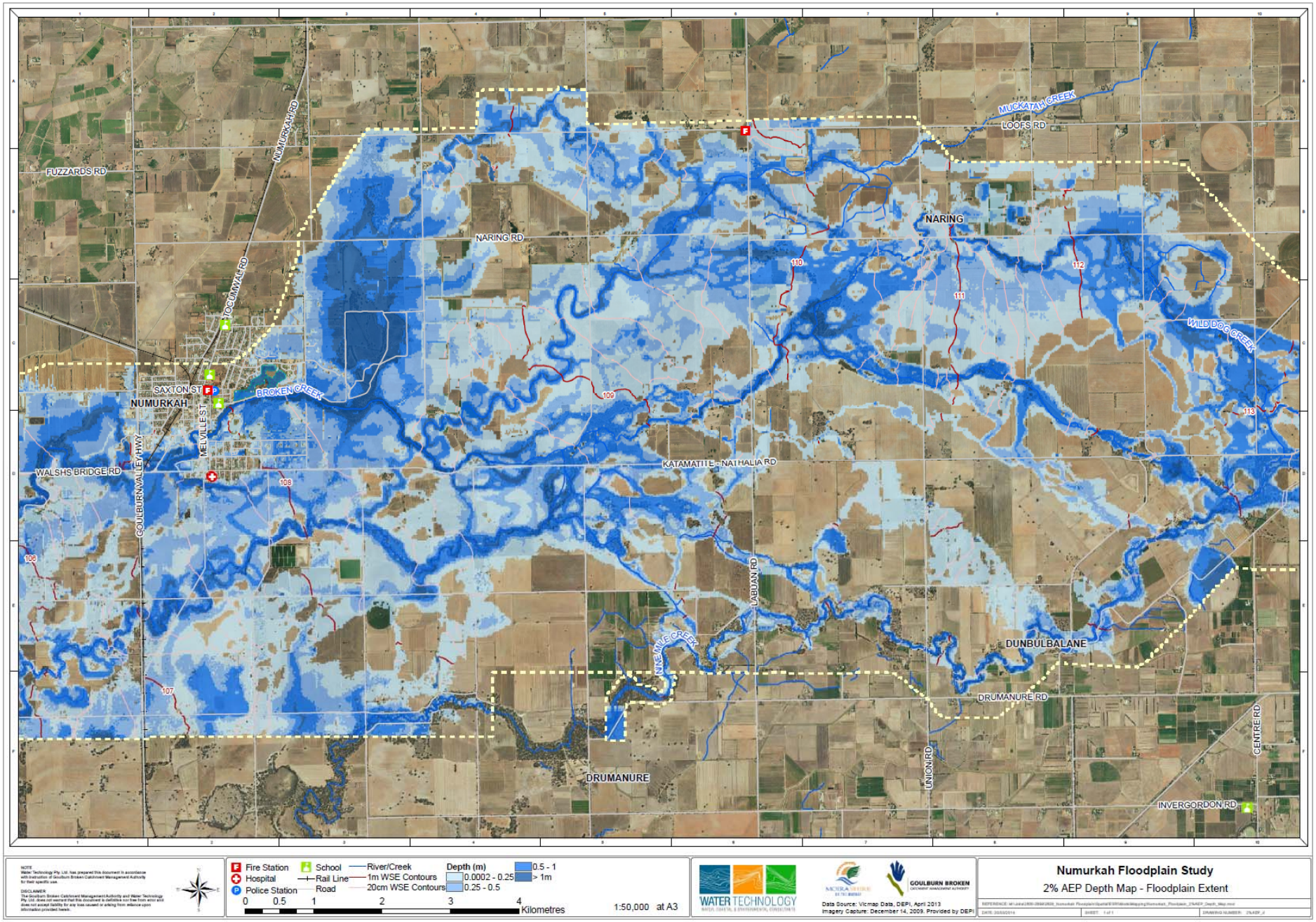

Limit of Mapping
BAXTON ST
LAKE NUMERUNK
GOULBURN VALLEY HWY
MELVILLE ST
BROKEN CREEK
WALSHS BRIDGE RD
KATAMATITE - NATHALIA RD
Fire Station
Hospital
Police Station
School
Nursing Home
Caravan Park
Rail Line
Road
River/Creek
Channel/Drain
1m WSE Contours
20cm WSE Contours
Depth (m)
0.0002 - 0.25
0.25 - 0.5
0.5 - 1
> 1m
0 125 250 500 750 1,000
Metres
1:15,000 at A3
WATER TECHNOLOGY
Data Source: Vicmap Data, DEPI, April 2013.
Imagery Capture: December 14, 2009. Provided by DEPI
Numurkah Floodplain Study
0.2% AEP Depth Map - Township Extent

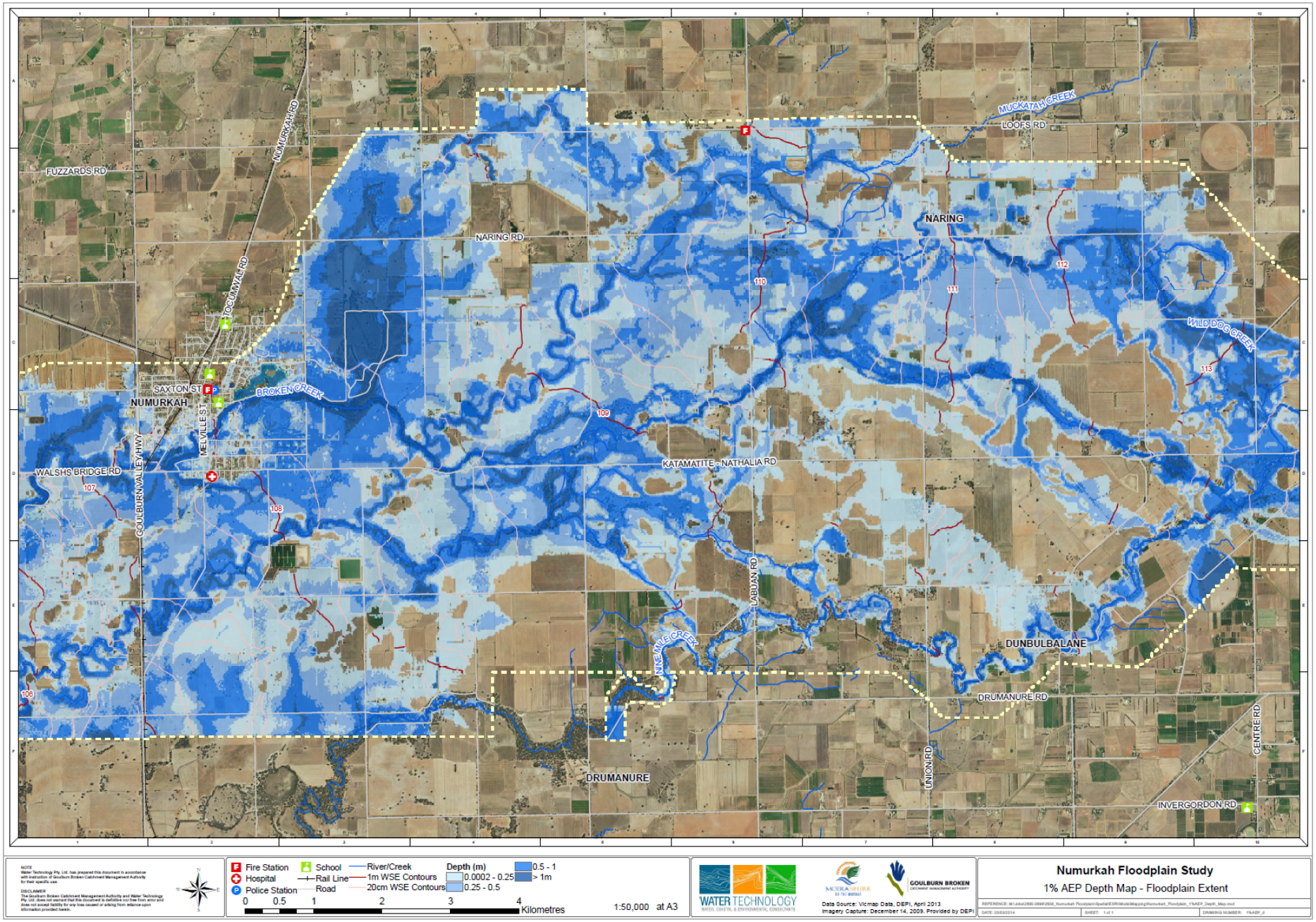
4 Numurkah – surrounding floodplain

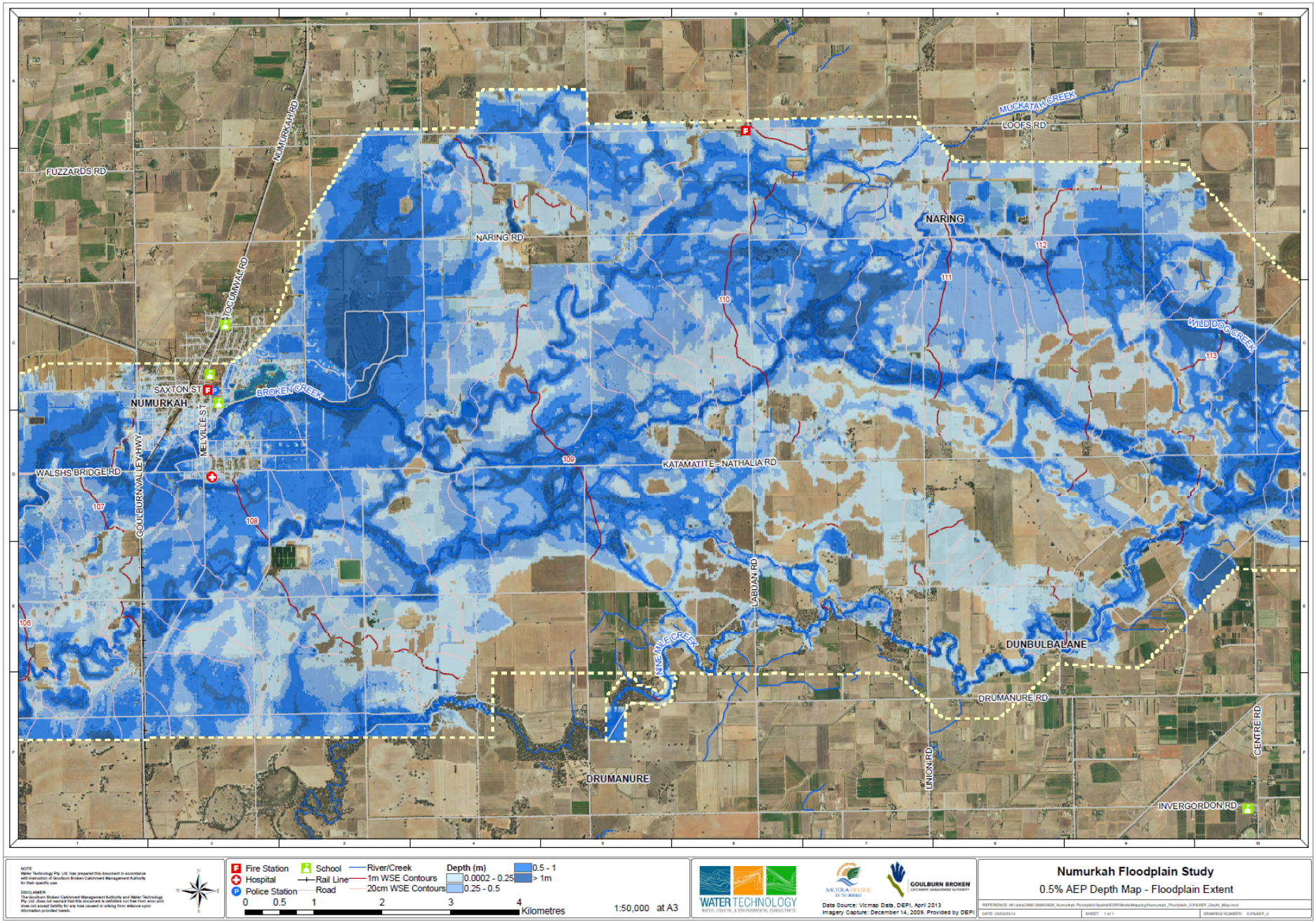


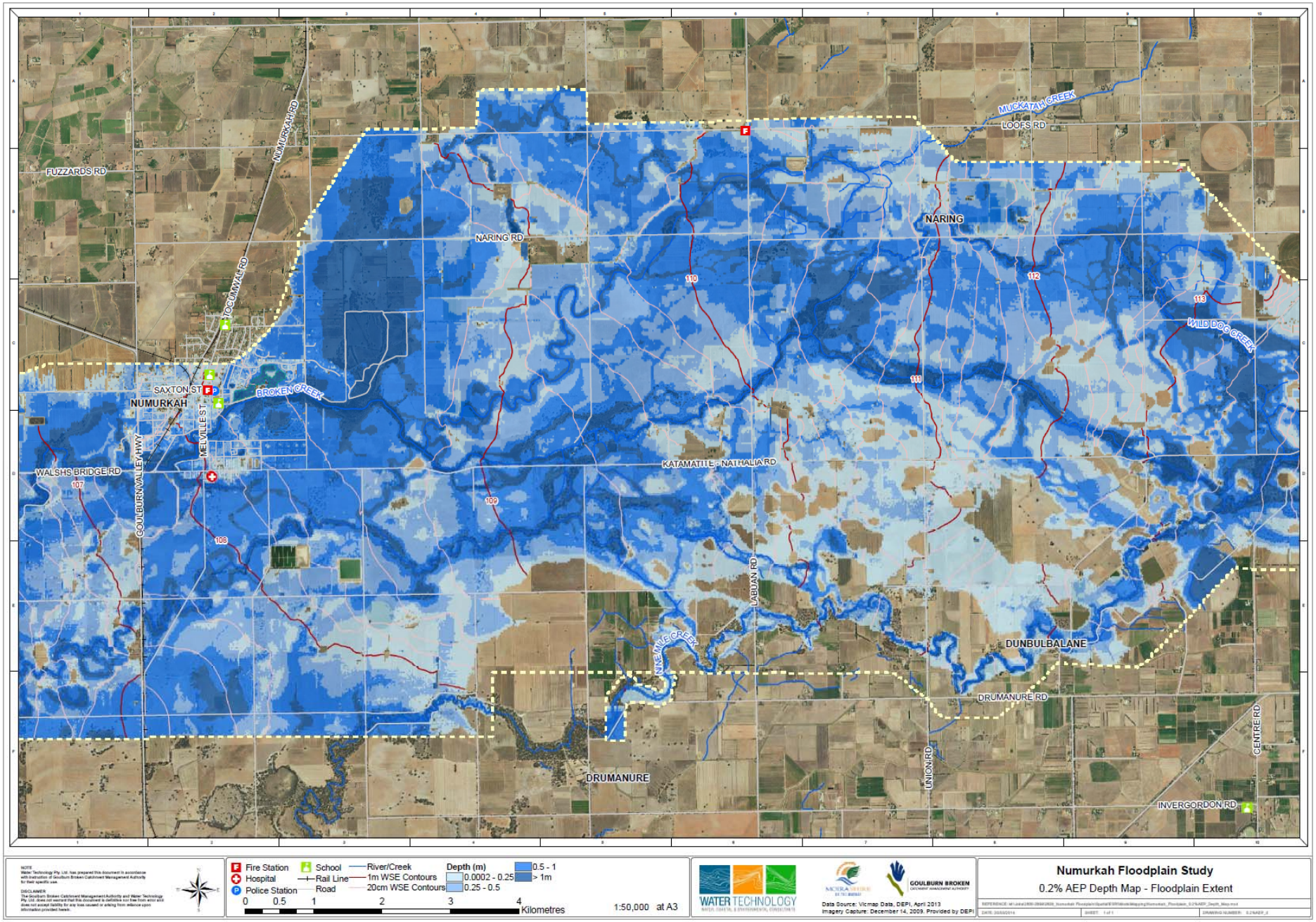

FUZZARDS RD
NUMURKAH RD
TOCUMWAL RD
NARING RD
NARING
MUCKATAH CREEK
LOOFS RD
WILD DOG CREEK
SAXTON ST
NUMURKAH
BROKEN CREEK
MELVILLE ST
GOULBURN VALLEY HWY
WALSHS BRIDGE RD
KATAMATITE - NATHALIA RD
LABUAN RD
NINE MILE CREEK
DUNBULBALANE
DRUMANURE RD
DRUMANURE
UNION RD
CENTRE RD
INVERGORDON RD
Fire Station
Hospital
Police Station
School
Rail Line
Road
River/Creek
1m WSE Contours
20cm WSE Contours
Depth (m)
0.0002 - 0.25
0.25 - 0.5
0.5 - 1
> 1m
0 0.5 1 2 3 4 Kilometres
1:50,000 at A3
WATER TECHNOLOGY
Data Source: Vicmap Data, DEPI, April 2013
Imagery Capture: December 14, 2009. Provided by DEPI
Numurkah Floodplain Study
10% AEP Depth Map - Floodplain Extent


FUZZARDS RD
NUMURKAH RD
TOOLAMAH RD
NARING RD
MUCKATAH CREEK
LOOFS RD
NARING
WILD DOG CREEK
SAXTON ST
NUMURKAH
BROKEN CREEK
MELVILLE ST
GOULBURN VALLEY HWY
WALSHS BRIDGE RD
KATAMATITE - NATHALIA RD
LABUAN RD
NINE MILE CREEK
DUNBULBALANE
DRUMANURE RD
DRUMANURE
UNION RD
CENTRE RD
INVERGORDON RD
106
108
109
110
111
112
113
Fire Station
Hospital
Police Station
School
Rail Line
Road
River/Creek
1m WSE Contours
20cm WSE Contours
Depth (m)
0.0002 - 0.25
0.25 - 0.5
0.5 - 1
> 1m
0 0.5 1 2 3 4
Kilometres
1:50,000 at A3
WATER TECHNOLOGY
Data Source: Vicmap Data, DEPI, April 2013
Imagery Capture: December 14, 2009. Provided by DEPI
Numurkah Floodplain Study
5% AEP Depth Map - Floodplain Extent

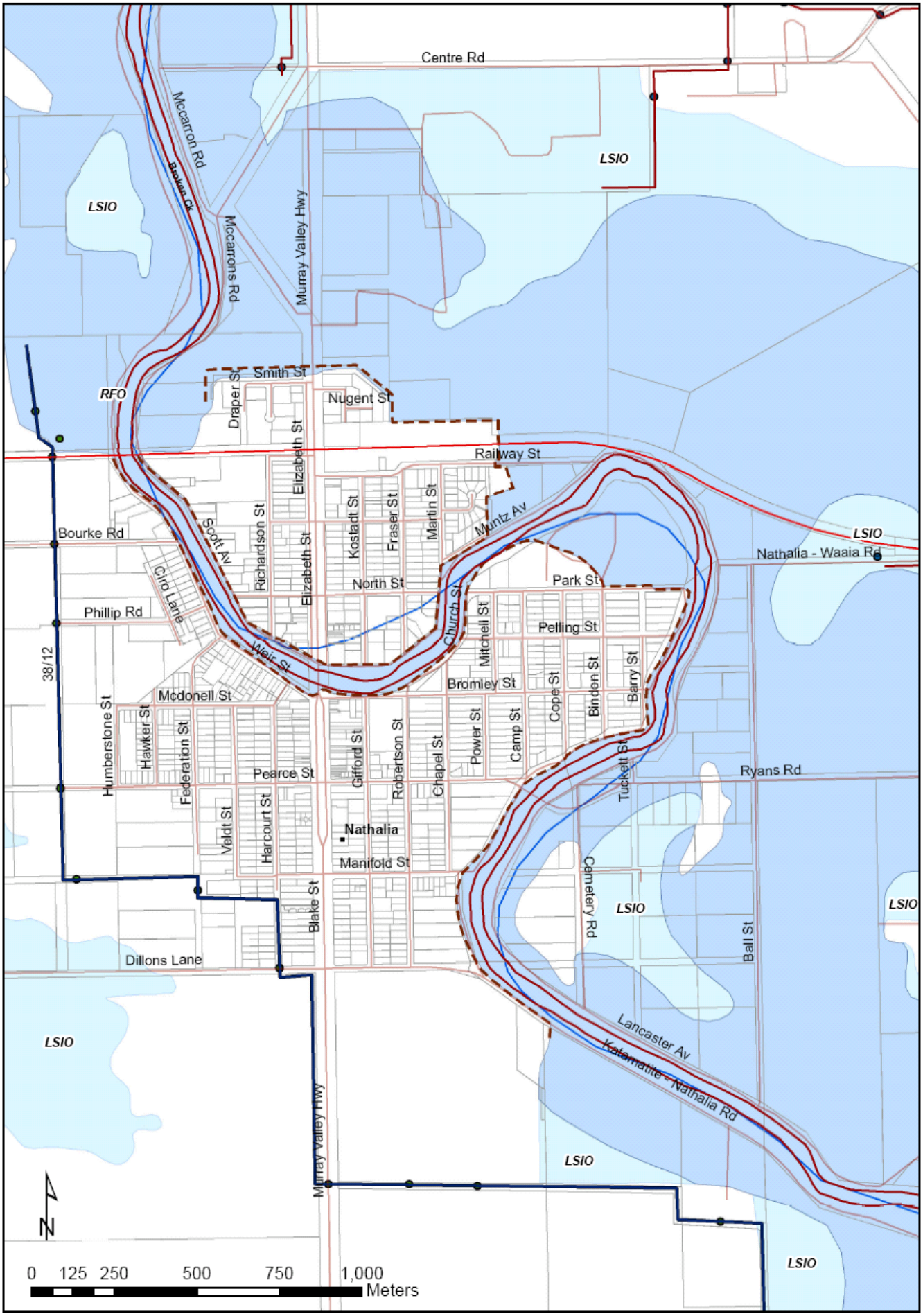

FUZZARDS RD
NUMURKAH RD
NARING RD
NARING
MUCKATAH CREEK
LOOFS RD
WILD DOG CREEK
HOCKINGS RD
SAXTON ST
NUMURKAH
BROKEN CREEK
MELVILLE ST
GOULBURN VALLEY HWY
WALSHS BRIDGE RD
KATAMATITE - NATHALIA RD
LABUAN RD
NINE MILE CREEK
DUNBULBALANE
DRUMANURE RD
DRUMANURE
UNION RD
CENTRE RD
INVERGORDON RD
110
112
111
109
113
108
106
107
Fire Station
Hospital
Police Station
School
Rail Line
Road
River/Creek
1m WSE Contours
20cm WSE Contours
Depth (m)
0.0002 - 0.25
0.25 - 0.5
0.5 - 1
> 1m
0 0.5 1 2 3 4 Kilometres
1:50,000 at A3
WATER TECHNOLOGY
Data Source: Vicmap Data, DEPI, April 2013
Imagery Capture: December 14, 2009. Provided by DEPI
Numurkah Floodplain Study
2% AEP Depth Map - Floodplain Extent


FUZZARDS RD
NUMURKAH RD
TOCUMWAL RD
NARING RD
LOOFS RD
MUCKATAH CREEK
NARING
WILD DOG CREEK
SAXTON ST
NUMURKAH
BROKEN CREEK
MELVILLE ST
GOULBURN VALLEY HWY
WALSHS BRIDGE RD
KATAMATITE - NATHALIA RD
LABUAN RD
NINE MILE CREEK
DUNBULBALANE
DRUMANURE RD
CENTRE RD
UNION RD
DRUMANURE
INVERGORDON RD
107
108
109
110
111
112
113
Fire Station
Hospital
Police Station
School
Rail Line
Road
River/Creek
1m WSE Contours
20cm WSE Contours
Depth (m)
0.0002 - 0.25
0.25 - 0.5
0.5 - 1
> 1m
0 0.5 1 2 3 4 Kilometres
1:50,000 at A3
WATER TECHNOLOGY
Data Source: Vicmap Data, DEPI, April 2013
Imagery Capture: December 14, 2009. Provided by DEPI
GOULBURN BROKEN
Numurkah Floodplain Study
1% AEP Depth Map - Floodplain Extent

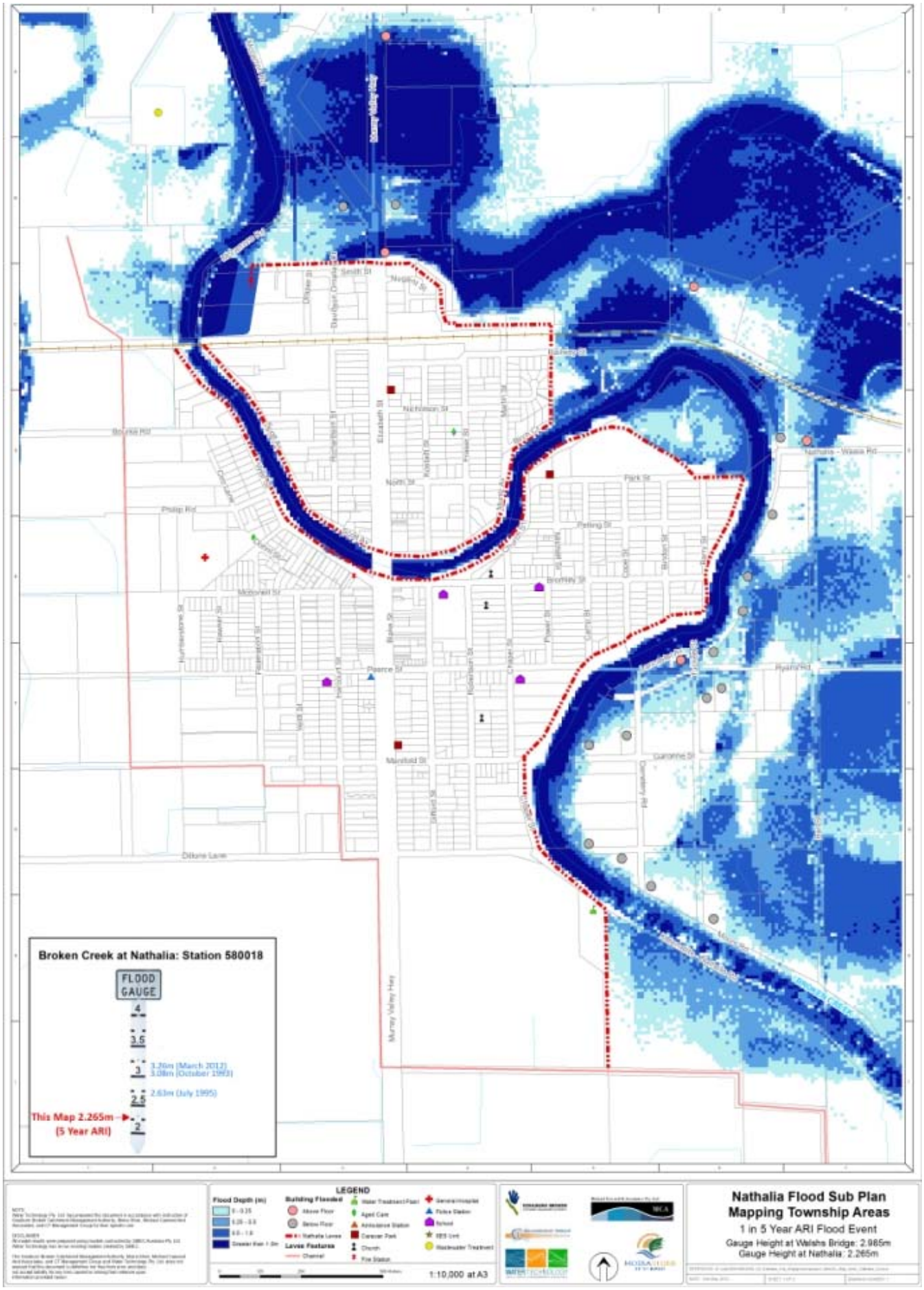

FUZZARDS RD
NUMURKAH RD
TOCUMWAL RD
NARING RD
LOOFS RD
MUCKATAH CREEK
NARING
WILD DOG CREEK
SAXTON ST
NUMURKAH
MELVILLE ST
BROKEN CREEK
GOULBURN VALLEY HWY
WALSHS BRIDGE RD
KATAMATITE – NATHALIA RD
LABUAN RD
NINE MILE CREEK
DUNBULBALANE
DRUMANURE RD
DRUMANURE
UNION RD
CENTRE RD
INVERGORDON RD
106
107
108
109
110
111
112
113
Fire Station
Hospital
Police Station
School
Rail Line
Road
River/Creek
1m WSE Contours
20cm WSE Contours
Depth (m)
0.0002 - 0.25
0.25 - 0.5
0.5 - 1
> 1m
0 0.5 1 2 3 4 Kilometres
1:50,000 at A3
WATER TECHNOLOGY
MOIRA SHIRE
GOULBURN BROKEN
Data Source: Vicmap Data, DEPI, April 2013
Imagery Capture: December 14, 2009. Provided by DEPI
Numurkah Floodplain Study
0.5% AEP Depth Map - Floodplain Extent

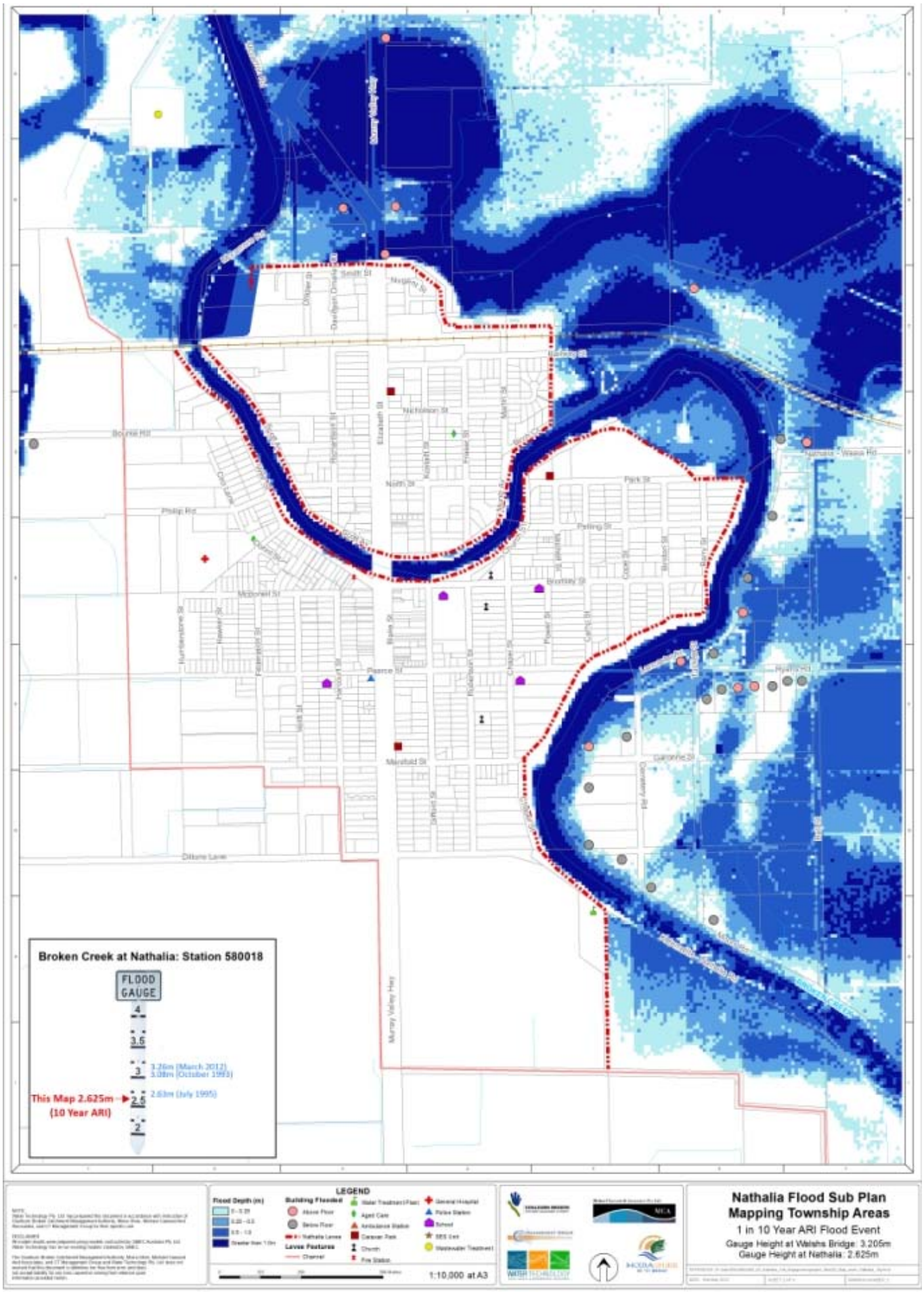

FUZZARDS RD
NUMURKAH RD
TOCUMWAL RD
LOOFS RD
MUCKATAH CREEK
NARING
NARING RD
WILD DOG CREEK
SAXTON ST
NUMURKAH
BROKEN CREEK
MELVILLE ST
GOULBURN VALLEY HWY
WALSHS BRIDGE RD
KATAMATITE - NATHALIA RD
LABUAN RD
NINE MILE CREEK
DUNBULBALANE
DRUMANURE RD
CENTRE RD
UNION RD
DRUMANURE
INVERGORDON RD
107
108
109
110
111
112
113
119
Fire Station
Hospital
Police Station
School
Rail Line
Road
River/Creek
1m WSE Contours
20cm WSE Contours
Depth (m)
0.0002 - 0.25
0.25 - 0.5
0.5 - 1
> 1m
0 0.5 1 2 3 4 Kilometres
1:50,000 at A3
WATER TECHNOLOGY
Data Source: Vicmap Data, DEPI, April 2013
Imagery Capture: December 14, 2009. Provided by DEPI
GOULBURN BROKEN
Numurkah Floodplain Study
0.2% AEP Depth Map - Floodplain Extent

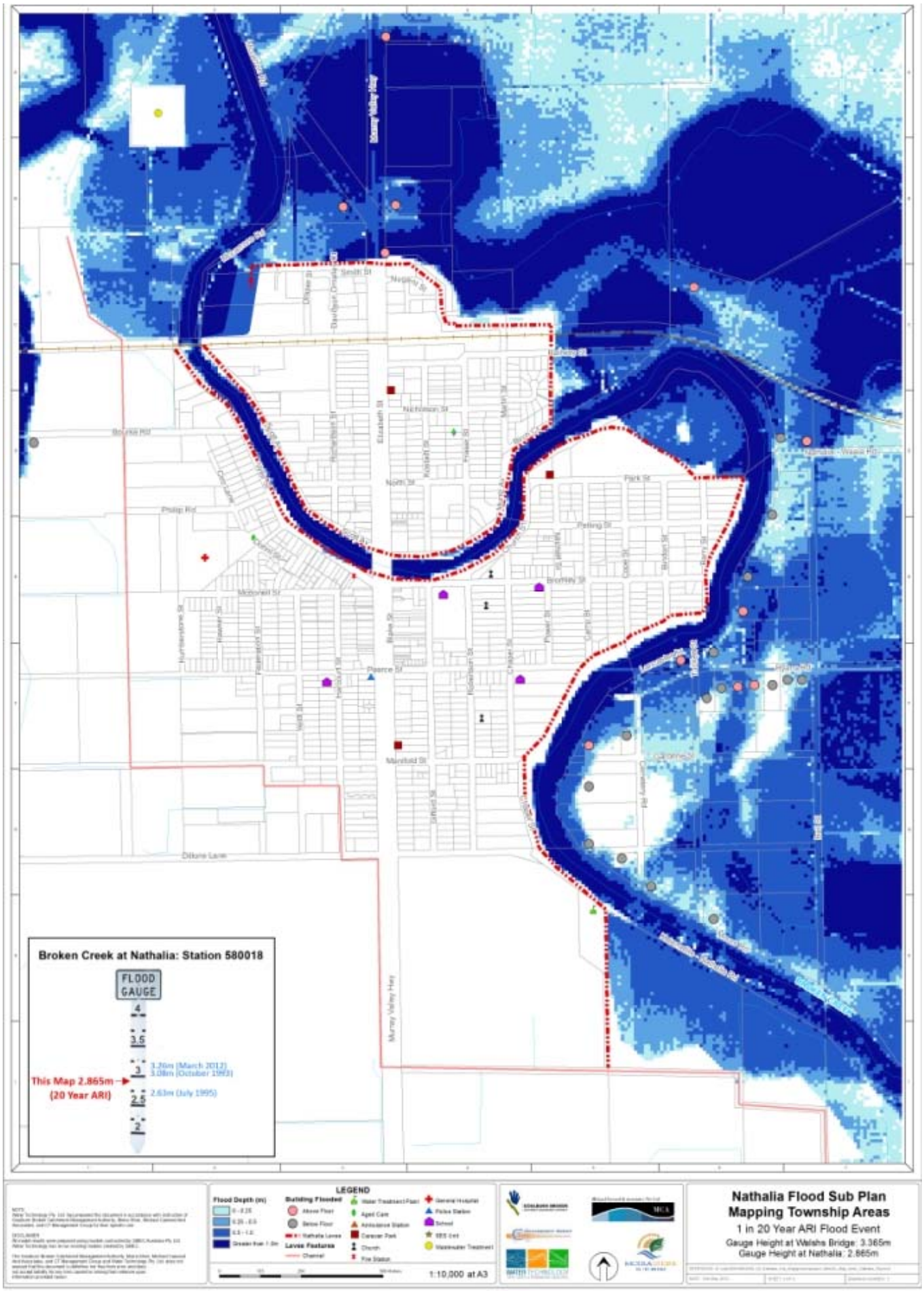
5 Nathalia – levee

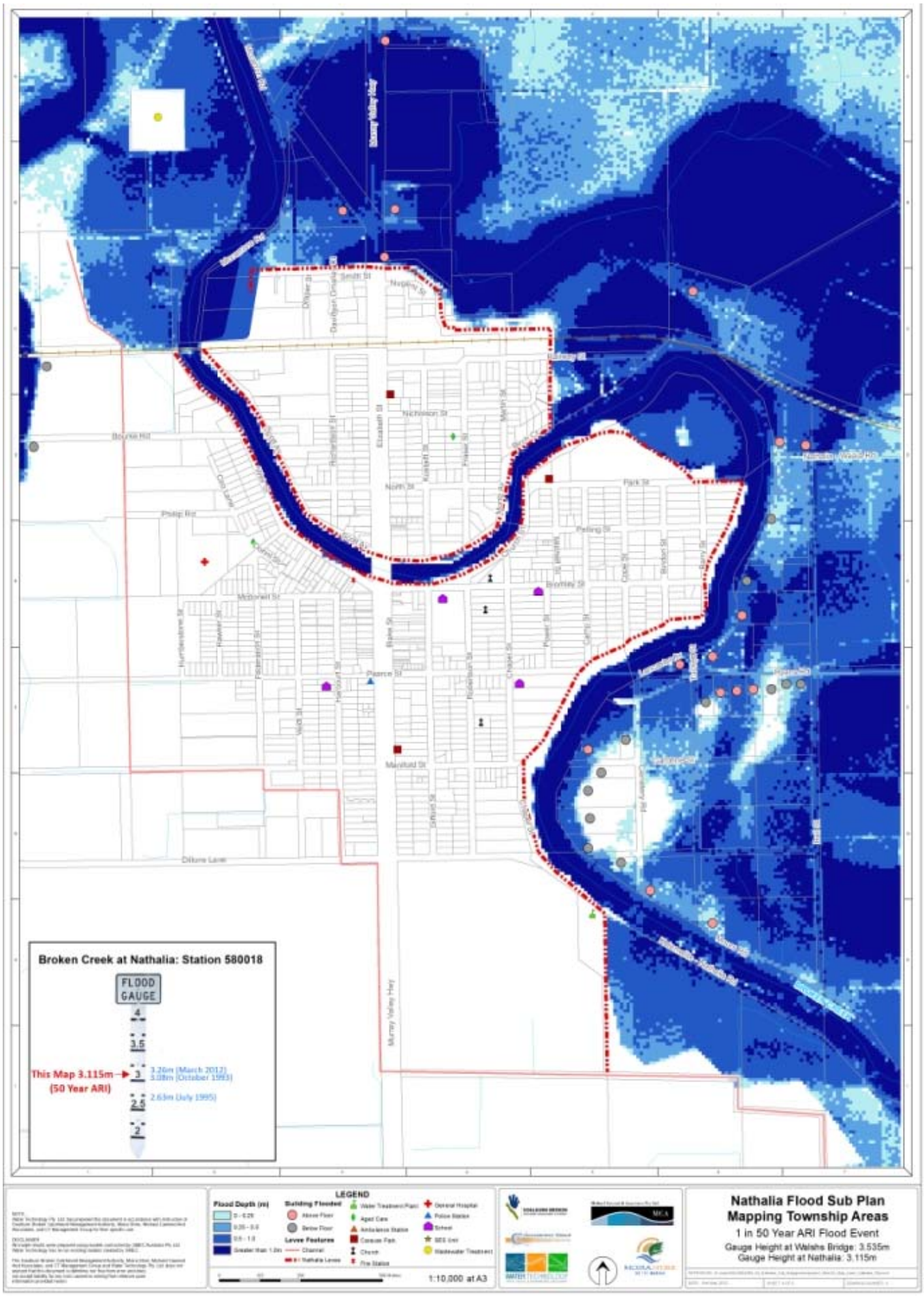


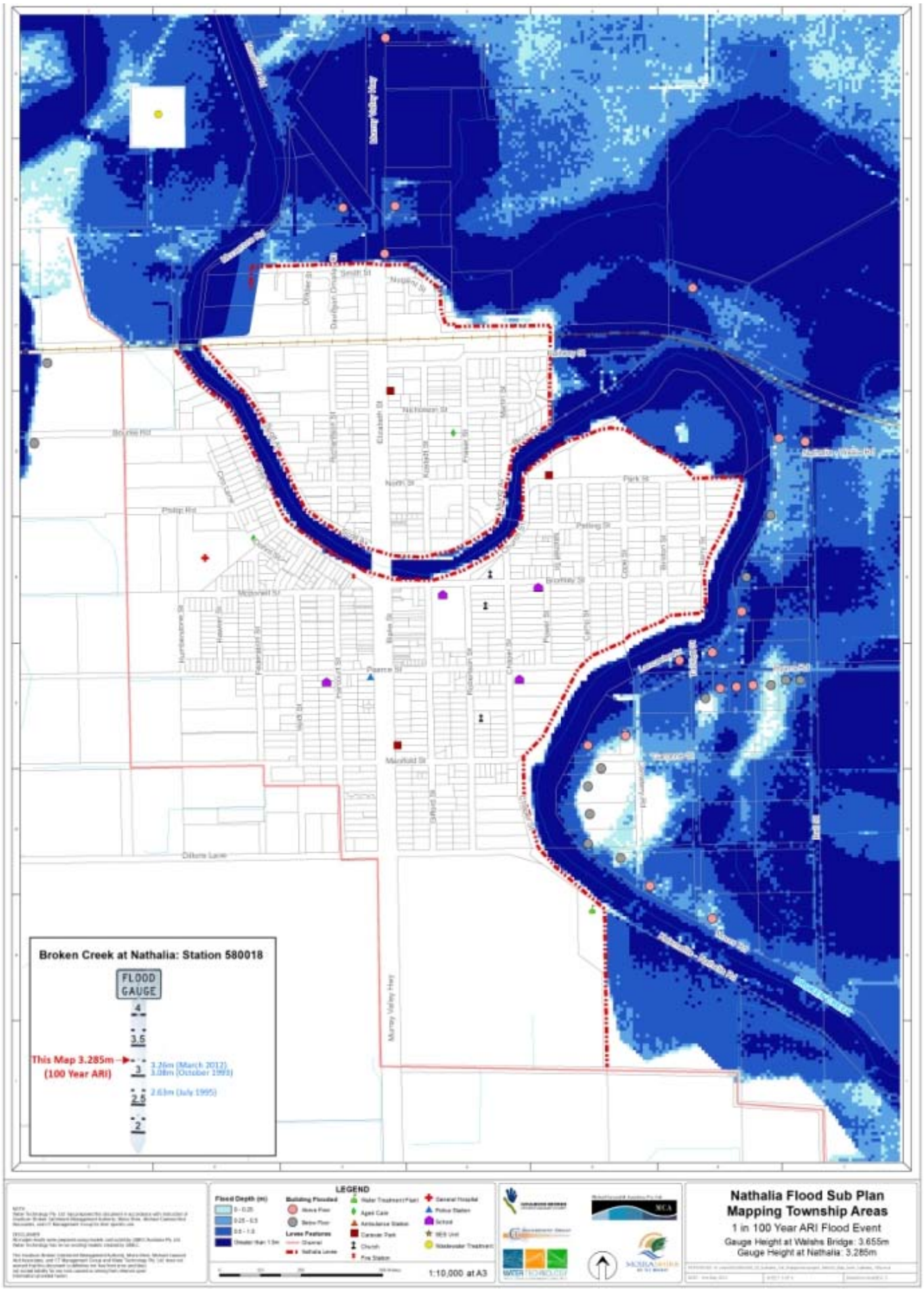
6 Nathalia – inner area maps

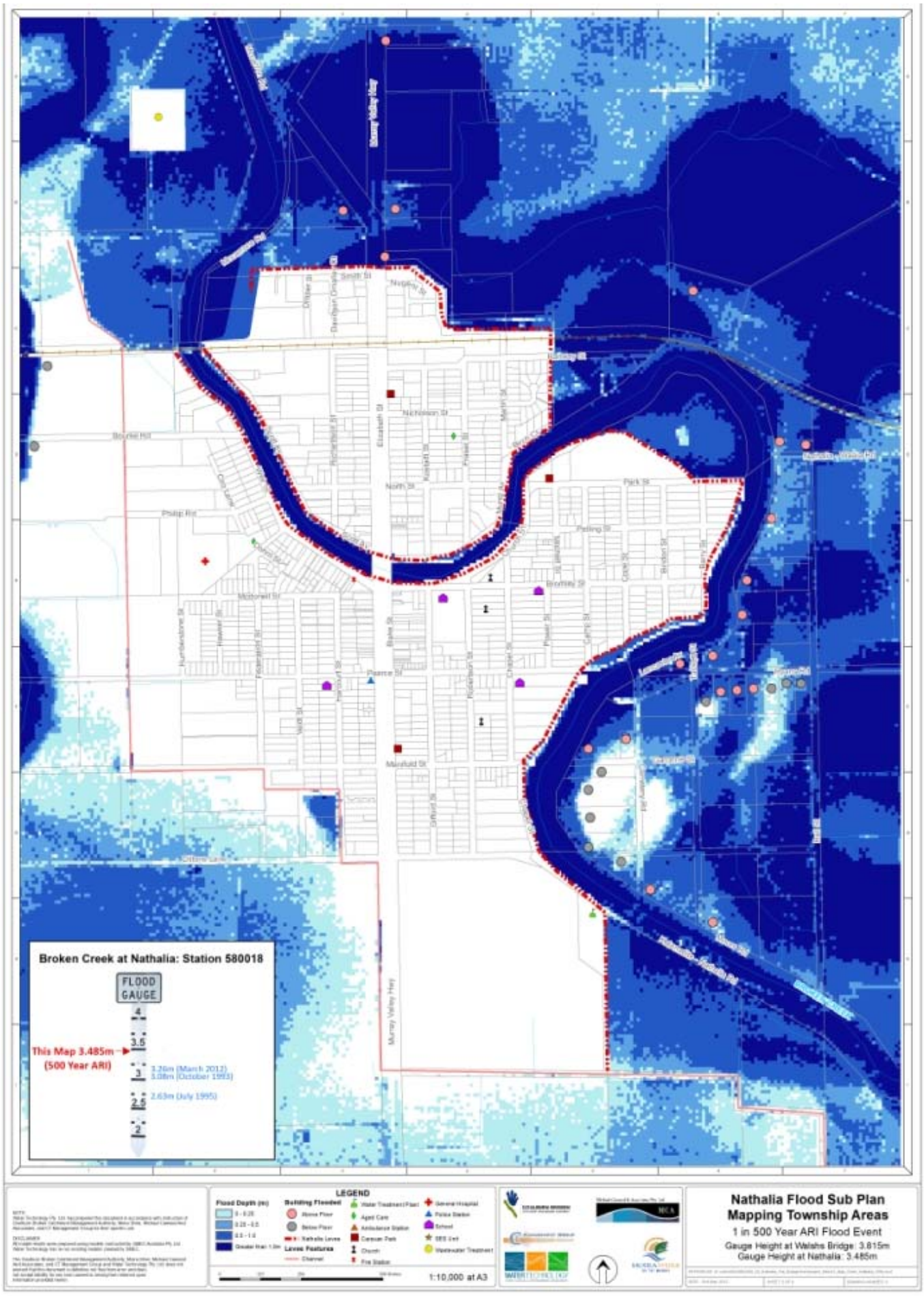



Broken Creek at Nathalia: Station 580018
FLOOD GAUGE
4
3.6
3
3.26m (March 2012)
3.08m (October 1993)
This Map 2.625m
(10 Year ARI)
2.6
2.63m (July 1995)
2
LEGEND
Flood Depth (m)
Building Flooded
Above Floor
Below Floor
Levee Features
Channel
1:10,000 at A3
Nathalia Flood Sub Plan
Mapping Township Areas
1 in 10 Year ARI Flood Event
Gauge Height at Welshs Bridge: 3.205m
Gauge Height at Nathalia: 2.625m

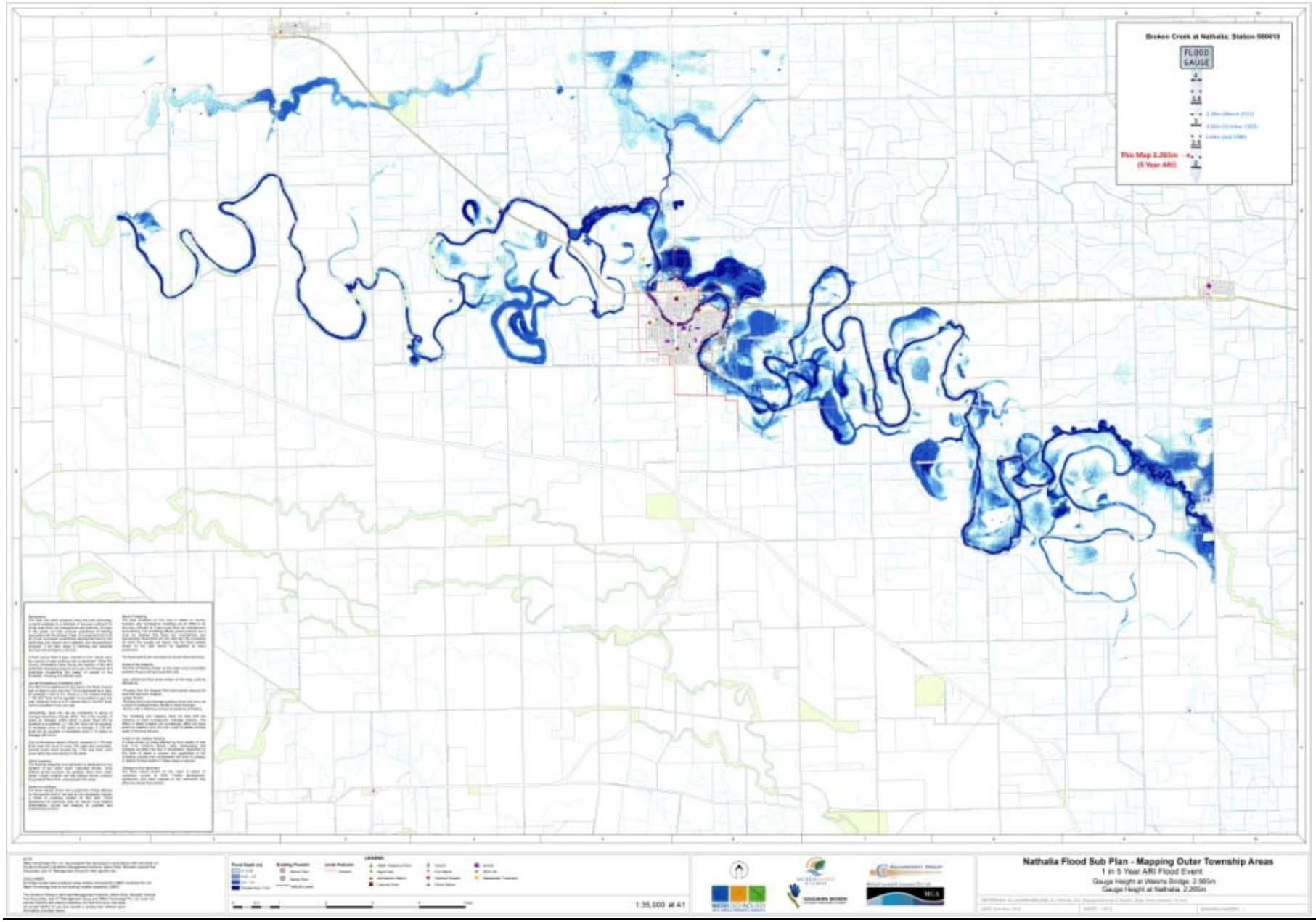

Broken Creek at Nathalia: Station 580018
FLOOD GAUGE
4
3.5
3
This Map 2.865m
(20 Year ARI)
2.5
2
3.70m (March 2012)
3.08m (October 1993)
2.63m (July 1995)
LEGEND
Flood Depth (m)
Building Flooded
Above Floor
Below Floor
Levee Features
Nathalia Levee
Channel
Water Treatment Plant
Aged Care
Ambulance Station
Caravan Park
Church
Fire Station
General Hospital
Police Station
School
SES Unit
Wastewater Treatment
1:10,000 at A3
Nathalia Flood Sub Plan
Mapping Township Areas
1 in 20 Year ARI Flood Event
Gauge Height at Walshs Bridge: 3.365m
Gauge Height at Nathalia: 2.865m

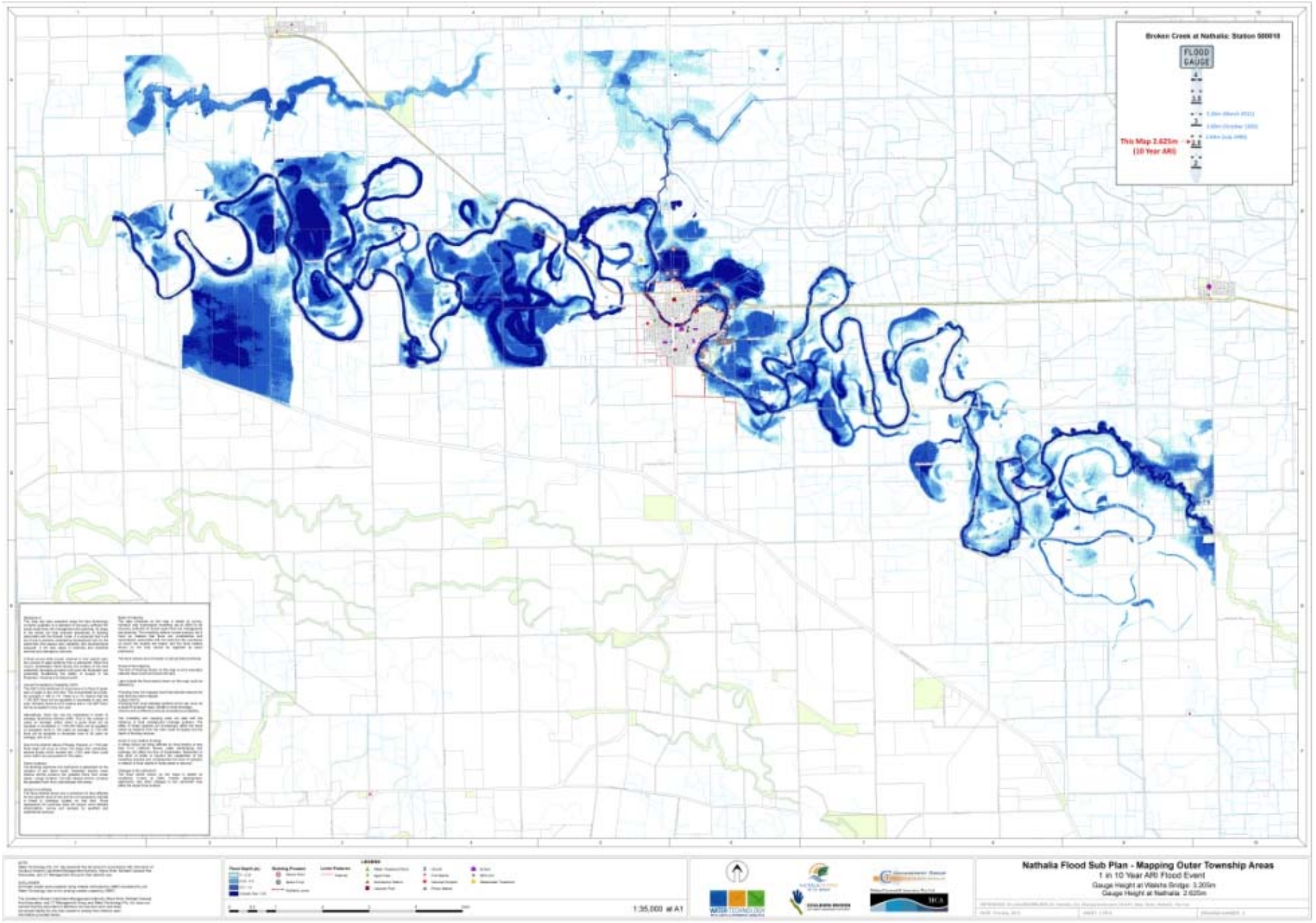

Broken Creek at Nathalia: Station 580018
FLOOD GAUGE
4
3.5
This Map 3.115m
(50 Year ARI)
3
3.20m (March 2012)
3.08m (October 1993)
2.5
2.63m (July 1995)
2
LEGEND
Flood Depth (m)
Building Flooded
Above Floor
Below Floor
Levee Features
Channel
Nathalia Levee
Water Treatment Plant
Aged Care
Ambulance Station
Caravan Park
Church
Fire Station
General Hospital
Police Station
School
SES Unit
Wastewater Treatment
1:10,000 at A3
Nathalia Flood Sub Plan
Mapping Township Areas
1 in 50 Year ARI Flood Event
Gauge Height at Walshs Bridge: 3.535m
Gauge Height at Nathalia: 3.115m

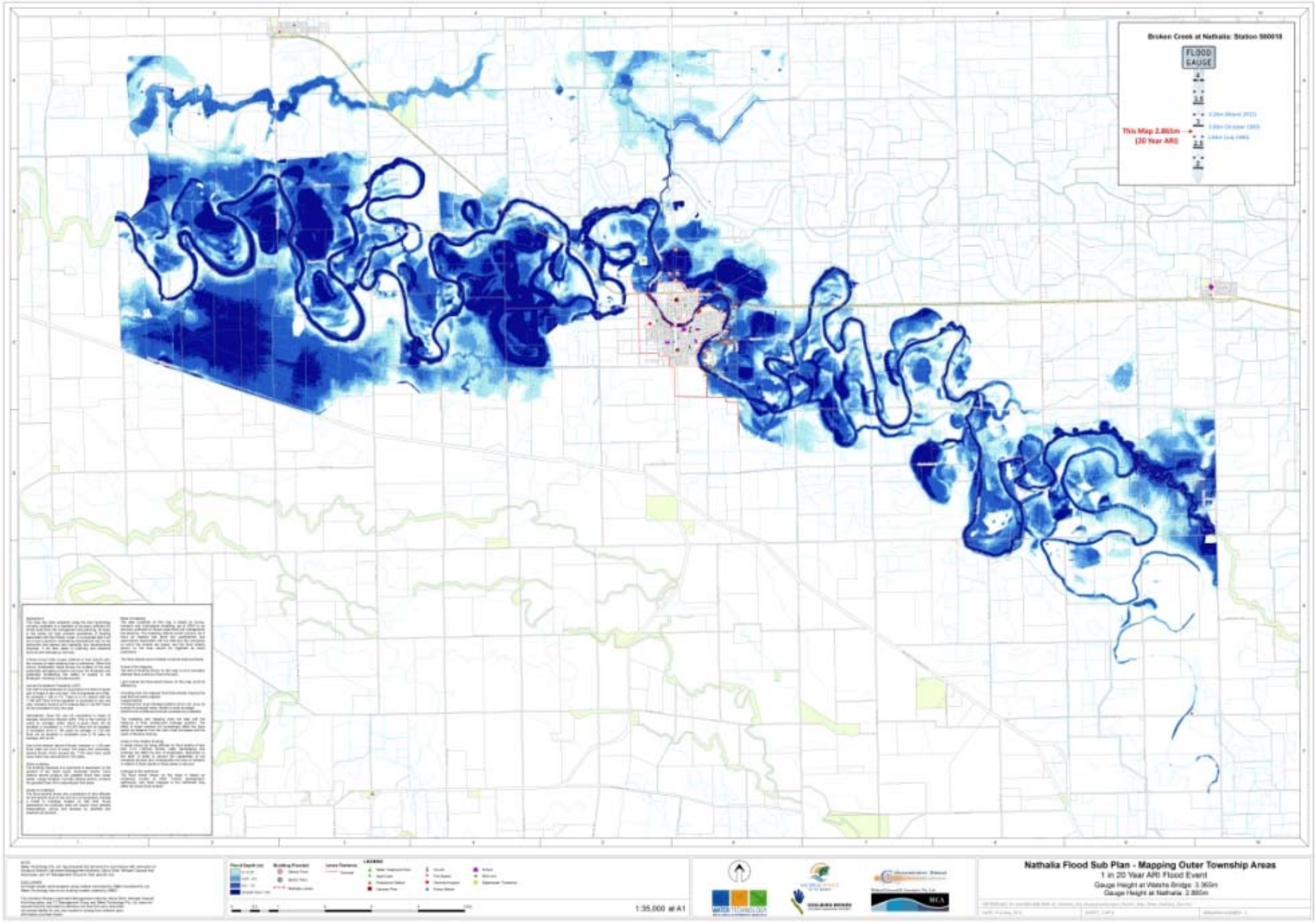

Broken Creek at Nathalia: Station 580018
FLOOD GAUGE
4
3.5
This Map 3.285m
(100 Year ARI)
3
3.26m (March 2012)
3.08m (October 1993)
2.5
2.63m (July 1995)
2
LEGEND
1:10,000 at A3
Nathalia Flood Sub Plan
Mapping Township Areas
1 in 100 Year ARI Flood Event
Gauge Height at Walshs Bridge: 3.655m
Gauge Height at Nathalia: 3.285m

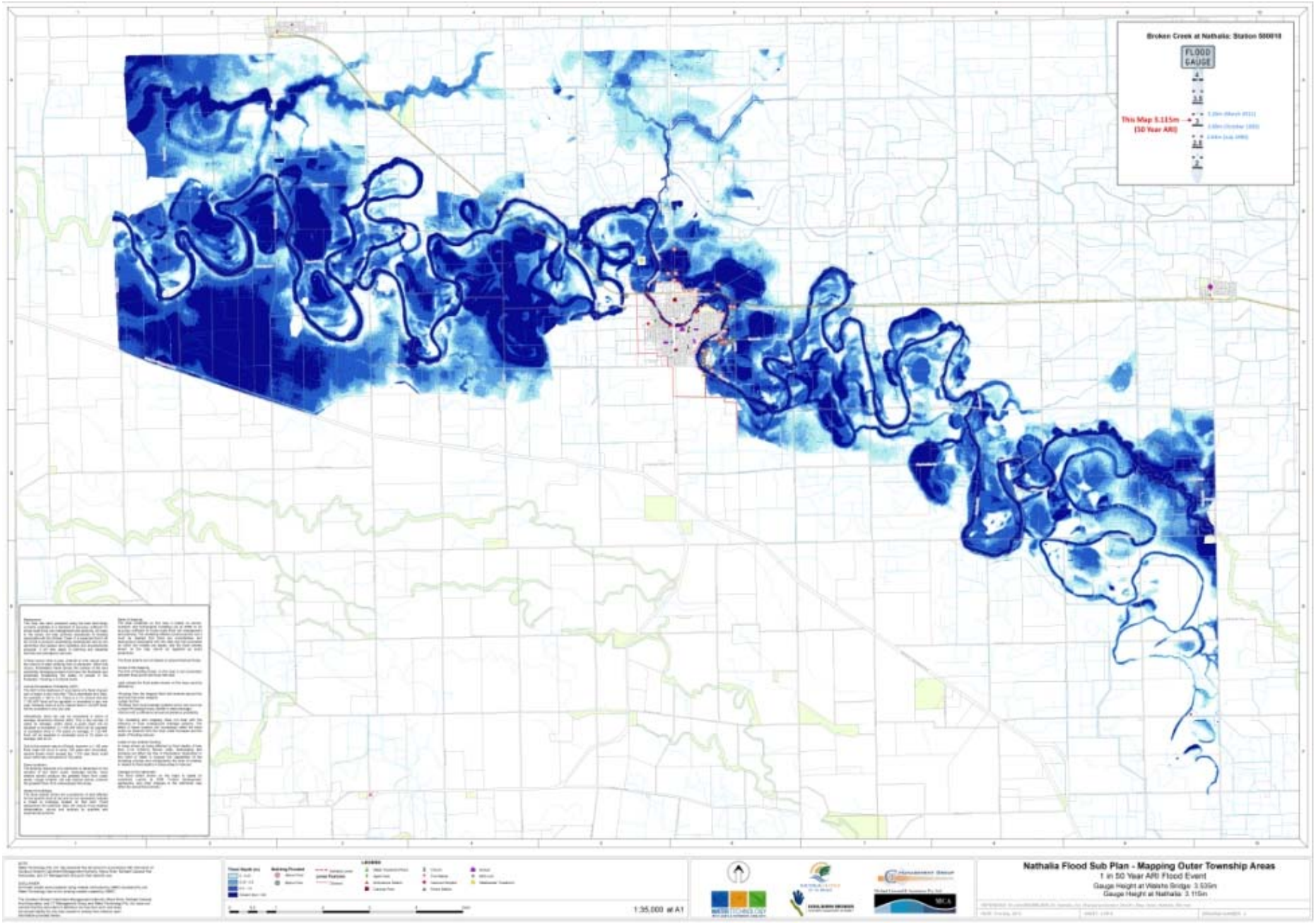

Broken Creek at Nathalia: Station 580018
FLOOD GAUGE
4
3.6
This Map 3.485m
(500 Year ARI)
3
3.26m (March 2012)
3.08m (October 1993)
2.63m (July 1995)
2.5
2
LEGEND
Flood Depth (m)
Building Flooded
Above Floor
Below Floor
Levee Features
Nathalia Levee
Channel
Water Treatment Plant
Aged Care
Ambulance Station
Caravan Park
Church
Fire Station
General Hospital
Police Station
School
SES Unit
Wastewater Treatment
1:10,000 at A3
Nathalia Flood Sub Plan
Mapping Township Areas
1 in 500 Year ARI Flood Event
Gauge Height at Walshs Bridge: 3.815m
Gauge Height at Nathalia: 3.485m

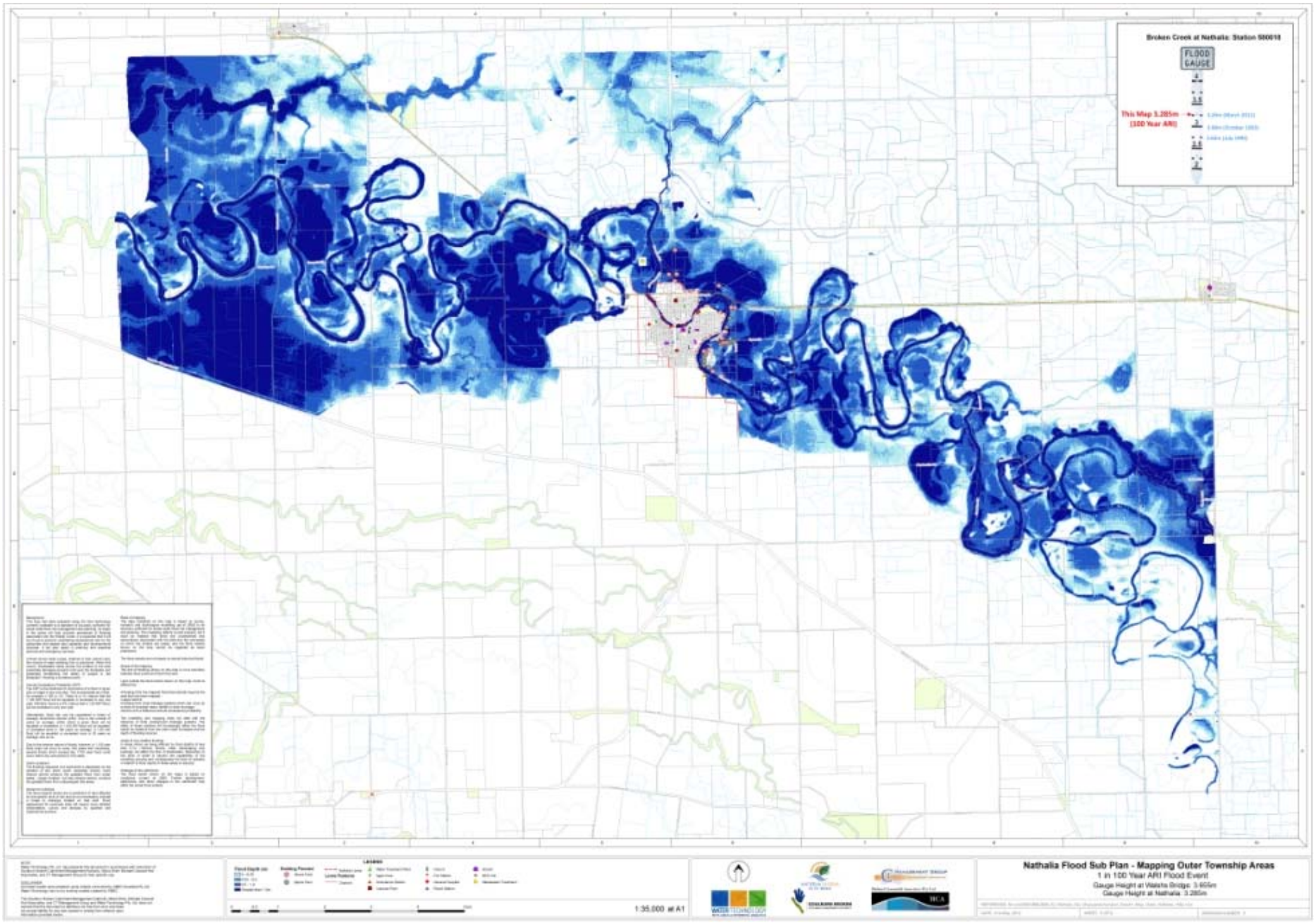
7 Nathalia – outer area maps

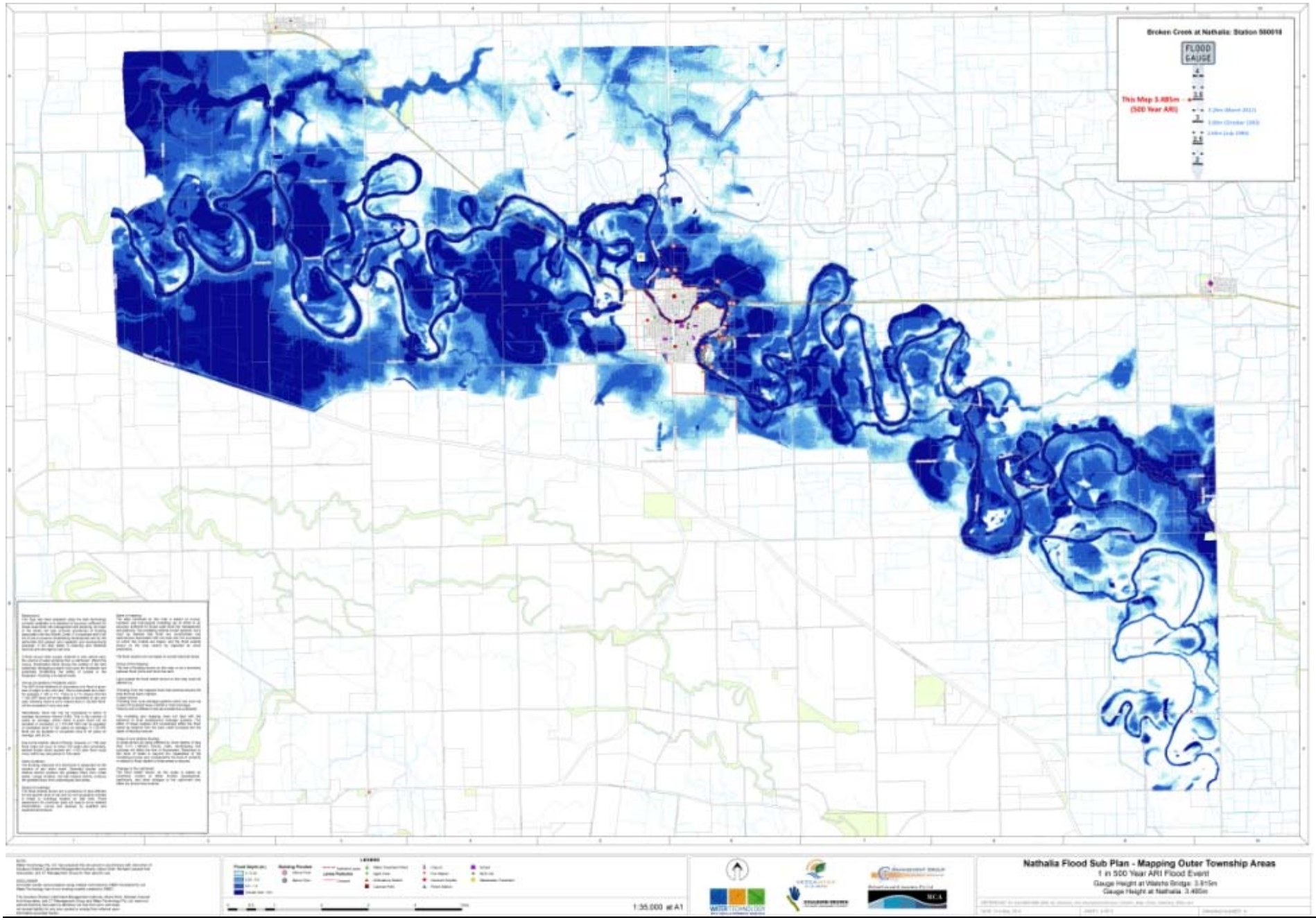



Broken Creek at Nathalia: Station 000010
FLOOD GAUGE
This Map 2.625m (10 Year ARI)
Nathalia Flood Sub Plan - Mapping Outer Township Areas
1 in 10 Year ARI Flood Event
Gauge Height at Waiohs Bridge: 3.205m
Gauge Height at Nathalia: 2.625m
1:35,000 at A1

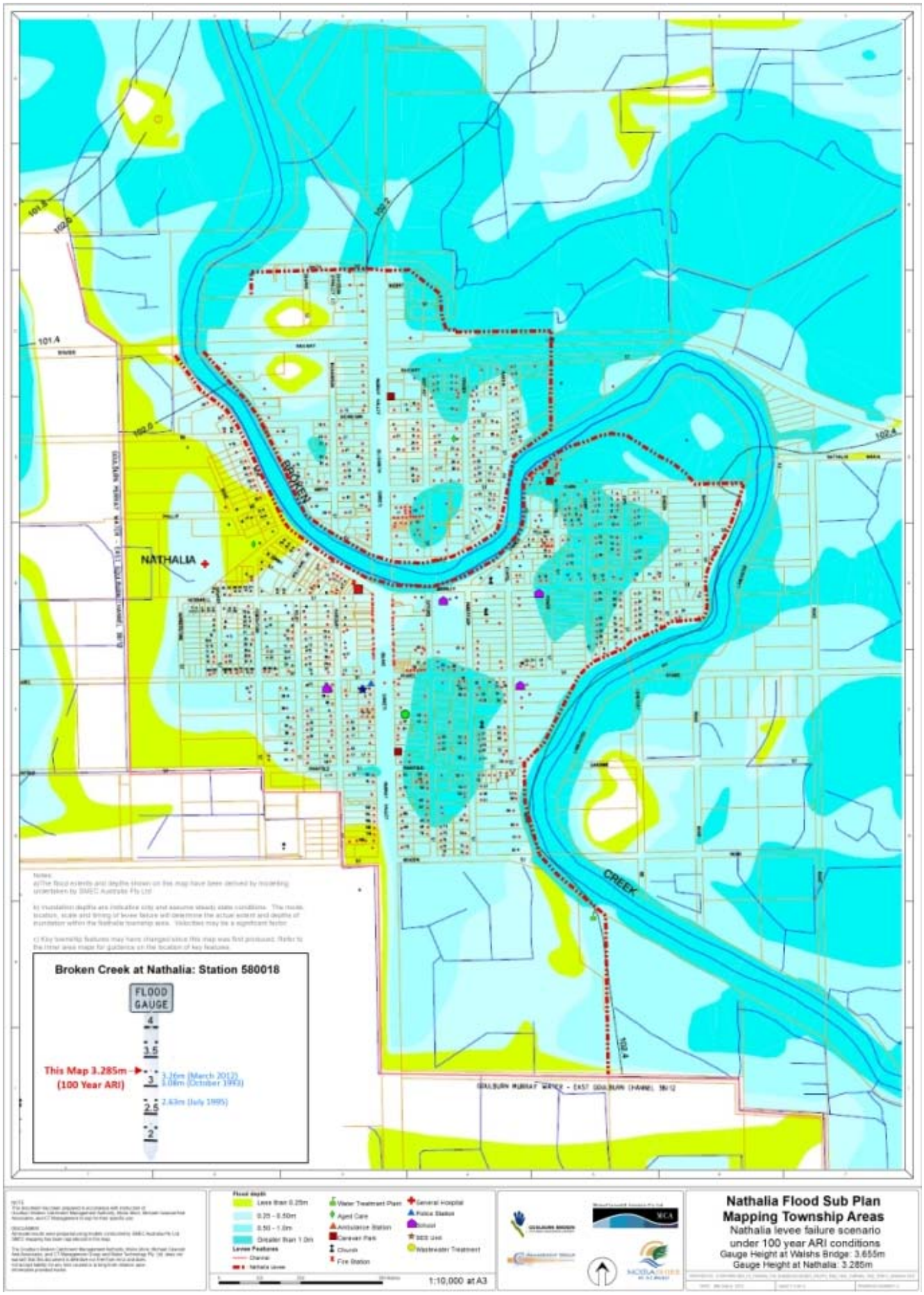

Broken Creek at Nathalia: Station 580018
FLOOD GAUGE
This Map 2.865m
(20 Year ARI)
Nathalia Flood Sub Plan - Mapping Outer Township Areas
1 in 20 Year ARI Flood Event
Gauge Height at Waisha Bridge: 3.365m
Gauge Height at Nathalia: 2.865m
1:35,000 at A1

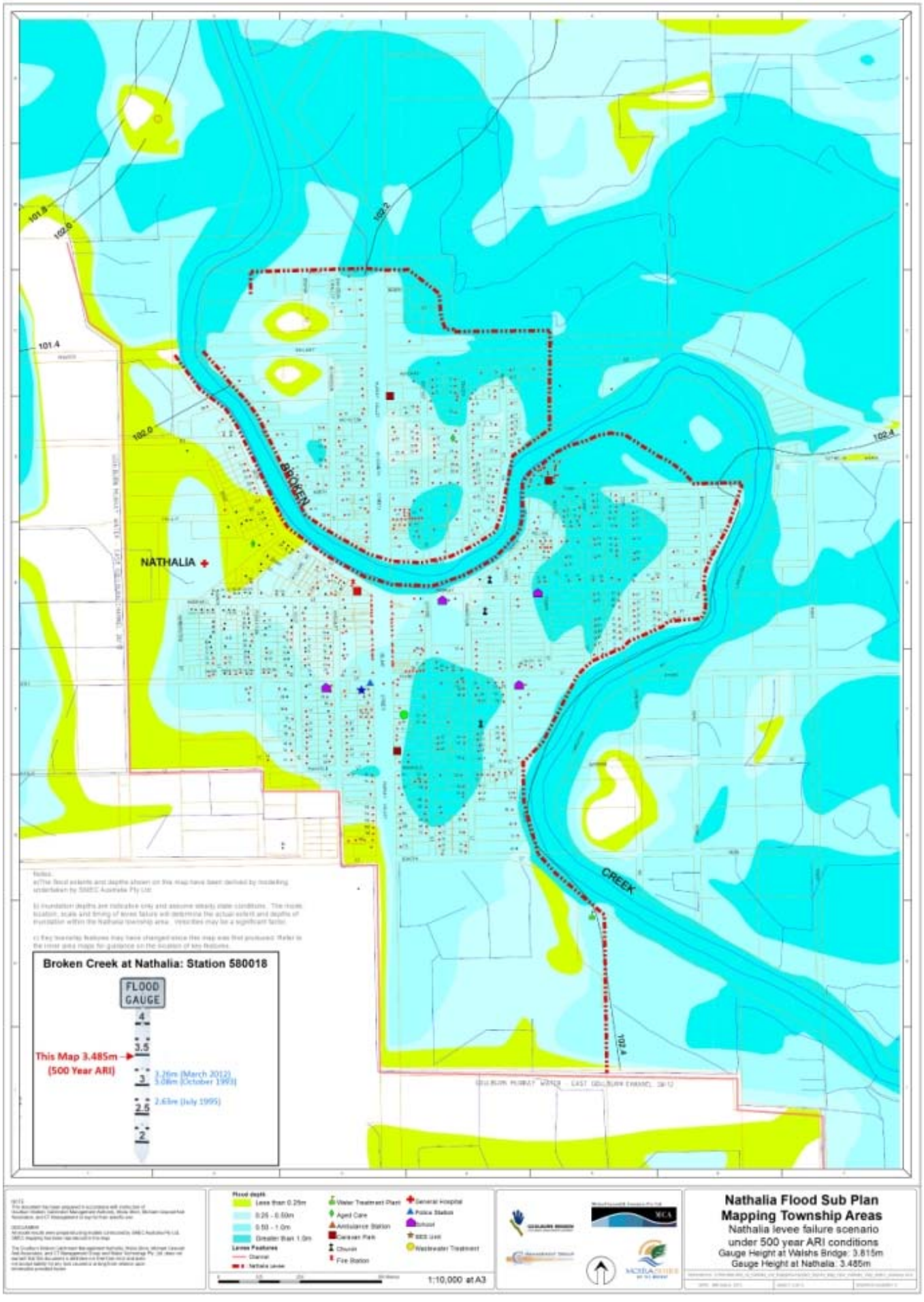

Broken Creek at Nathalia: Station 000010
FLOOD GAUGE
This Map 5.115m
(50 Year ARI)
Nathalia Flood Sub Plan - Mapping Outer Township Areas
1 in 50 Year ARI Flood Event
Gauge Height at Waisha Bridge: 3.535m
Gauge Height at Nathalia: 3.115m
1:35,000 at A1


Broken Creek at Nathalia: Station 980618
FLOOD GAUGE
This Map 3.285m
(100 Year ARI)
Nathalia Flood Sub Plan - Mapping Outer Township Areas
1 in 100 Year ARI Flood Event
Gauge Height at Waiaka Bridge: 3.955m
Gauge Height at Nathalia: 3.285m
1:35,000 at A1


Broken Creek at Nathalia: Station 580010
FLOOD GAUGE
This Map 3.485m
(500 Year ARI)
1:35,000 at A1
Nathalia Flood Sub Plan - Mapping Outer Township Areas
1 in 500 Year ARI Flood Event
Gauge Height at Wards Bridge: 3.915m
Gauge Height at Nathalia: 3.485m

8 Nathalia – levee break maps




BROKEN
NATHALIA
CREEK
101.8
102.0
102.2
101.4
102.4
Broken Creek at Nathalia: Station 580018
FLOOD GAUGE
4
3.5
This Map 3.485m
(500 Year ARI)
3
3.26m (March 2012)
3.08m (October 1993)
2.5
2.63m (July 1995)
2
Flood depth
Less than 0.25m
0.25 - 0.50m
0.50 - 1.0m
Greater than 1.0m
Levee Features
Channel
Nathalia Levee
Water Treatment Plant
Aged Care
Ambulance Station
Caravan Park
Church
Fire Station
General Hospital
Police Station
School
SES Unit
Wastewater Treatment
1:10,000 at A3
Nathalia Flood Sub Plan
Mapping Township Areas
Nathalia levee failure scenario
under 500 year ARI conditions
Gauge Height at Walshs Bridge: 3.815m
Gauge Height at Nathalia: 3.485m

APPENDIX G – LOCAL KNOWLEDGE ARRANGEMENTS

As control agency for flood in Victoria, VICSES is committed to ensuring the incorporation of local knowledge in decision making before, during and after incidents.

Information from community sources including but not limited to observations, historical information and information about current and possible consequences of an incident may be utilised to help inform the process of incorporating local knowledge into decision making during an incident. Community observers, Local Information Officers (LIOs) and other agency networks identified in Moira Municipal Flood Emergency Plan will help support this process.

LIOs provide a key communication interface to community observers and other sources of local knowledge.

For the Moira Municipality community observers identified are:

Community Observer Name	**Community Observer contact details**	**LIO Contact**	**Key Areas of local knowledge expertise**
Craig Prescot	0428 554 030	Yarrawonga Unit	Bosey System Wilby
John Pettigrew	03 58269557	Numurkah Unit	Loch Garry / Lower Goulburn area. Lives 10klms from Shepparton and passed GBCMA board member.
Bob Watters	0428655485	Numurkah Unit	Wunghnu East/9 Mile Creek area. He has an established network of other farmers he regularly has “flood” contact with.
Geoff Crapper	0407 354 254	Numurkah Unit	An ex Molino Stewart employee
Peter Newman	0429 683 283	Numurkah Unit	Bearii - good local knowledge
Jane Waser	0408 563 498	Numurkah Unit	Waaia - good local knowledge

For the Numurkah, Cobram and Yarrawonga the Local Information Officer identified is:

LIO Name	LIO contact details	Community Observer contacts
Rod Hill	0408 570 769	
John Stava	0409 257 025	
Des O'Meara	0408 239 593	

For the Broken Creek, Boosie Creek, Lower Goulburn and Murray River other agency networks identified are:

- CFA Brigades
- GBCMA
-

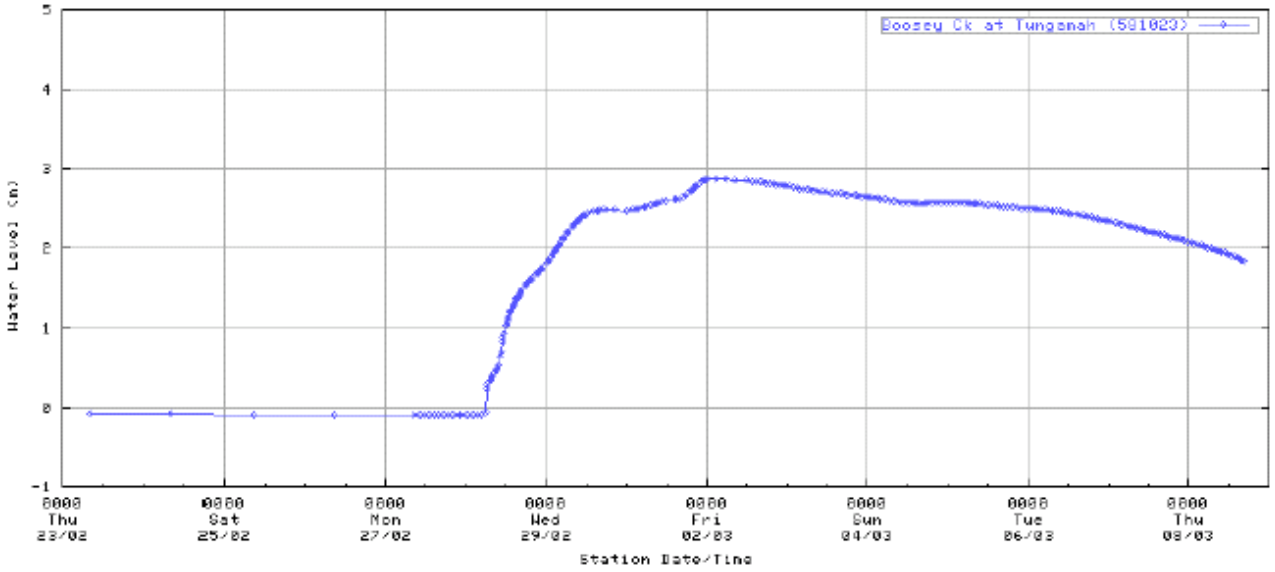
Important Notes:

These arrangements do not permit community observers and existing agency networks any responsibility for operational decisions and do not permit community observers and existing agency networks to direct operational activity, including the management of flood levees.

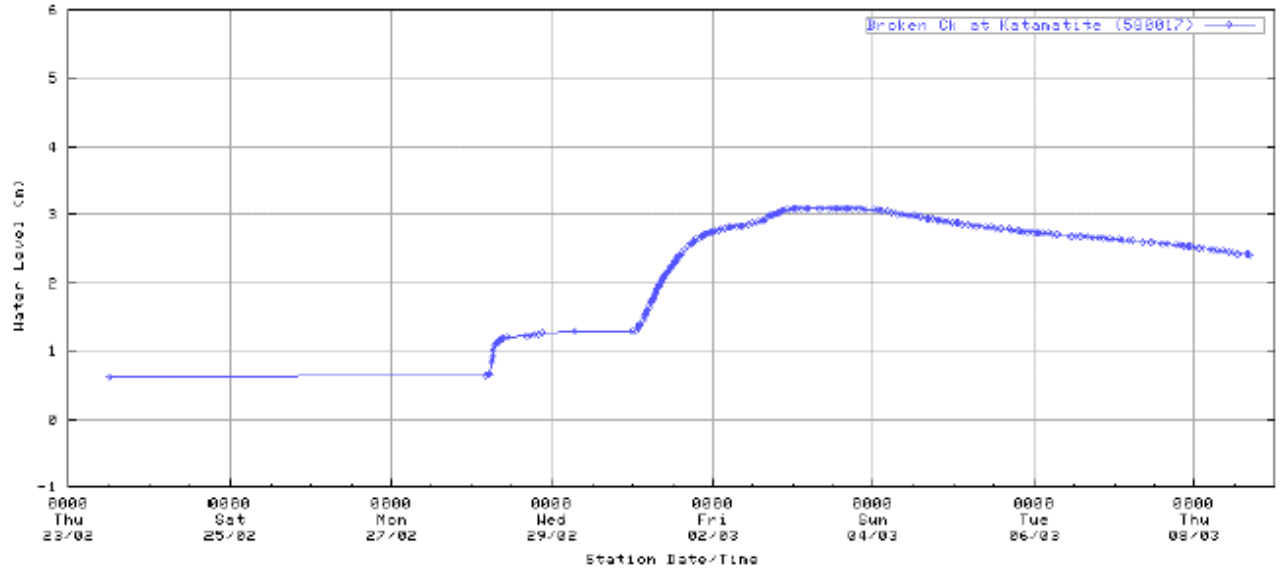
Information provided from sources of local knowledge must be processed and validated before it can become intelligence to inform decision making.

APPENDIX H – BROKEN CREEK – MARCH 2012

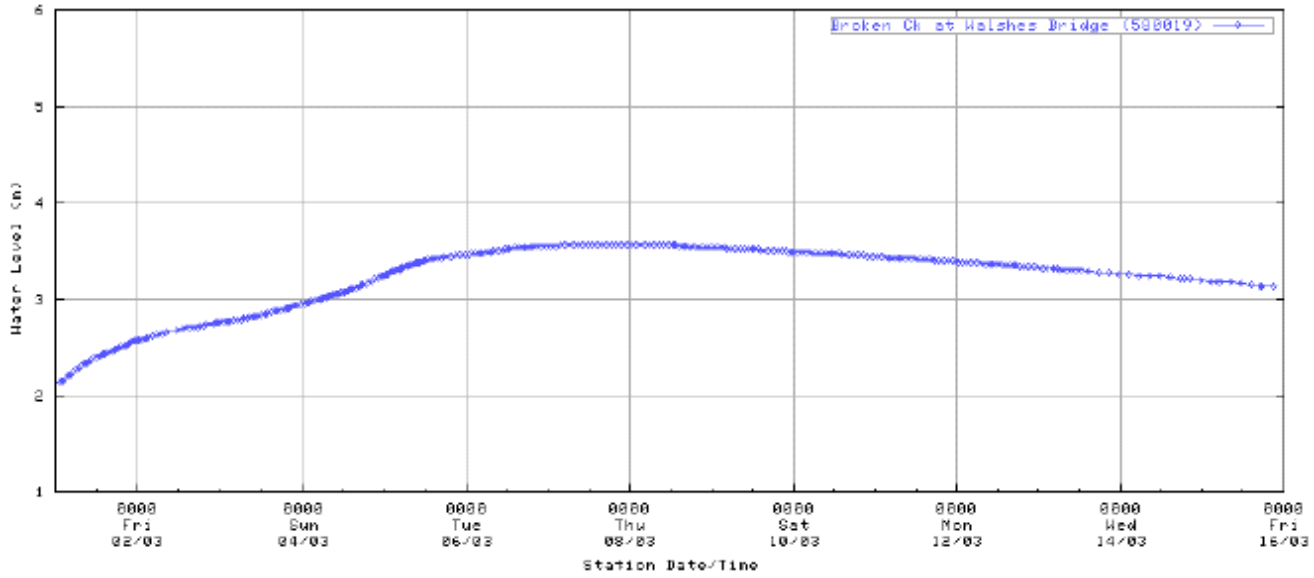
Tungamah



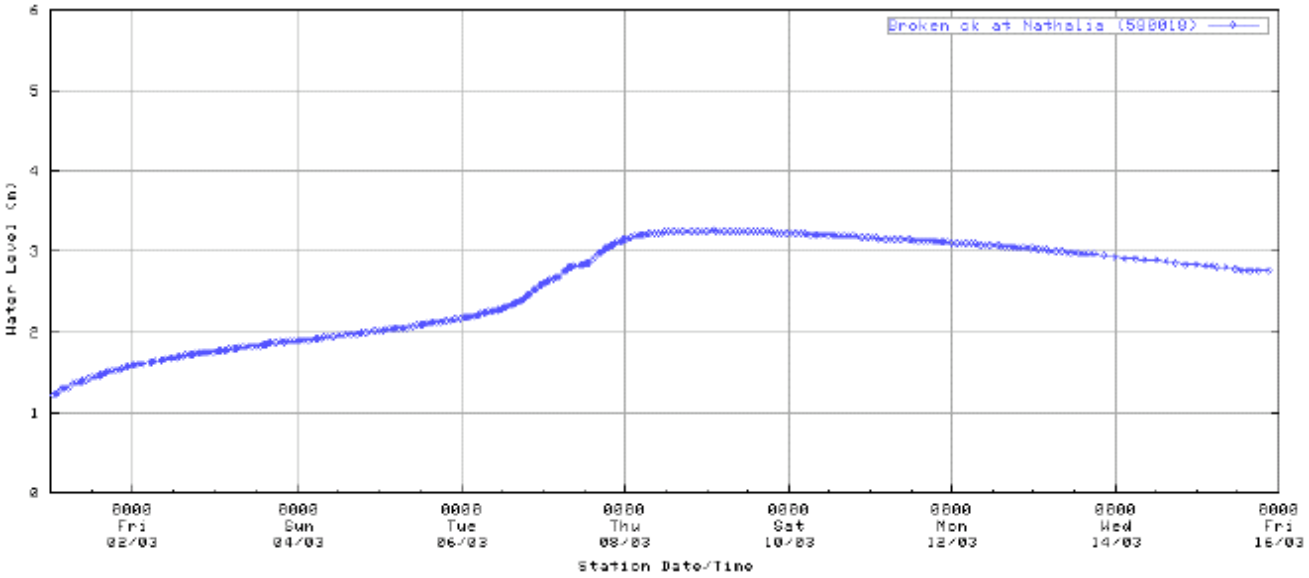
Katamatite



Walsh's Bridge



Nathalia



APPENDIX H – REFERENCES AND INTEL SOURCES

The following studies may be useful in understanding the nature of flooding within Moira Shire.

- Shepparton-Mooroopna Flood Study Main Report June 1982
- Cameron McNamara (1987) *Lower Goulburn Flood Plain Management Study, Shepparton To Kanyapella*. October 1987
- GHD (1986) *Murray River Floodplain Management Study*. December 1986.
- GHD (1994) *Barmah Flood Mitigation Study*. 1994.
- HydroTechnology (1995) *Broken River Catchment Floods: October 1993, Volume 4.* March 1995.
- SKM (2002) *Shepparton Mooroopna Floodplain Management Study.* October 2002.
- SMEC (2005): *Nathalia Floodplain Management Plan*. November 2005.
- Water Technology (2007) *Shepparton Mooroopna Flood Warning and Emergency Management Project: Project.* Report for Greater Shepparton City Council. January 2007.
- Water Technology (2011) *Murray Regional Flood Study: Dicks / Seppelt's levees to downstream of the Ulupna Creek confluence*. Report for Goulburn Broken Catchment Management Authority, Berrigan Shire and Moira Shire. November 2011.
- Water Technology (2014) *Numurkah Floodplain Management Study and Plan*. Report for Moira Shire and Goulburn Broken Catchment Management Authority
- http://planningschemes.dpcd.vic.gov.au/index.html Department of Planning and Community Development for planning scheme flood maps
- http://www.vicwaterdata.net/vicwaterdata/home.aspx for historical data on water quality, river heights and flows
- http://www.bom.gov.au Bureau of Meteorology for river gauge readings and flood warnings
- http://www.floodvictoria.vic.gov.au for information on historic floods in Victoria – VERY USEFUL
- http://www.ses.vic.gov.au Victoria State Emergency Service
- http://www.ema.gov.au Emergency Management in Australia
- http://www.delwp.vic.gov.au/fire-and-other-emergencies Department of Environment, Land, Water and Planning emergency management.
- COUNCIL, GBCMS and VICSES Geographical Information System (GIS) – these contain layers showing drainage assets, flooding extents, flood related call-out locations, roads, title boundaries and other useful information.

Relevant but more general references include:

- Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000), Standing Committee on Agriculture and Resource Management (SCARM) Report No 73: *Floodplain Management in Australia, Best Practice Principles and Guidelines*.
- Bureau of Meteorology (1996): *Bureau of Meteorology Policy on the Provision of the Flash Flood Warning Service.* May 1996.
- Department of Natural Resources and Environment (DNRE) (2000): *Flood Data Transfer Project* – – Flood Data and Flood Planning Maps as well as Flood Mapping and River Basin Reports.
- Department of Environment, Land, Water and Planning (AGVIC) (2008): *Victoria Caravan Parks Flood Emergency Management Plan Template and Guidelines*. (Two documents) March 2008.

- Emergency Management Australia (EMA) (2009a): *Managing the Floodplain*. Australian Emergency Manual Series Part 3 (Emergency Management Practice) Volume 3, Guide 3, Manual 19.
- Emergency Management Australia (EMA) (2009b): *Flood Response*. Australian Emergency Manual Series Part 3 (Emergency Management Practice) Volume 3, Guide 6, Manual 22.
- Emergency Management Australia (EMA) (2009c): *Flood Warning – 3rd edition*. Australian Emergency Manual Series Part 3 (Emergency Management Practice) Volume 3, Guide 5, Manual 21.
- Emergency Management Australia (EMA) (2009d): *Flood Preparedness*. Australian Emergency Manual Series Part 3 (Emergency Management Practice) Volume 3, Guide 4, Manual 20.
- Emergency Management Australia (EMA) (2009e): *Emergency Management Planning for Flood Affected by Dams*. Australian Emergency Manual Series Part 3 (Emergency Management Practice) Volume 3, Guide 7, Manual 23.