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Guideline for construction of new levees or the modification of existing levees

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Version history

Version	Date	Comments
1.00	May 2014	New document
2.00	December 2018	Updated department reference. Amendments to be consistent with current water and planning legislation.
2.01	22 November 2022	Updated document to remove reference to self-assessable code to align with water and planning legislation. Updated departmental template and branding.

Approval

Position	Name	Date
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1. Purpose

Category 1 levees are either constructed or modified on a rural property to have no off-property impacts on people, property or the environment beyond the property.

This guideline is to be read in conjunction with the *Accepted development requirements for the construction of new levees or the modification of existing levees* (the requirements for levees).

This guideline provides information to help proponents:

- meet the requirements under the Planning Regulation 2017 (Planning Regulation) for the construction of new levees or modification of existing levees
- better understand the issues involved in design and management of levees.

This guideline is designed to be used by:

- landholders interested in constructing a new levee or modifying an existing levee
- suitably qualified persons engaged to design and construct a levee.

1.1 Use of the guideline

The guideline is designed to assist in the interpretation of the accepted development requirements for levees.

This guideline does not provide technical standards or detailed methodologies for the design, construction, modification or maintenance of levees. The detailed design and construction or modification of levees is recommended to be undertaken by suitably qualified persons with relevant professional experience and knowledge.

It is important to note that the guideline does not have any legal authority. The accepted development requirements override any information that is contained in this guideline.

2. Definition of a levee

2.1 Inclusion

The *Water Act 2000* (Water Act) defines a levee as:

an artificial embankment or structure which prevents or reduces the flow of overland flow water onto or from land.

A levee includes levee-related infrastructure, which is defined as infrastructure that is:

- a. connected with the construction or modification of the levee; or
- b. used in the operation of the levee to prevent or reduce the flow of overland flow water onto or from land.

2.2 Exclusion

The Water Act lists a number of activities that are excluded from the definition of a levee, such as:

- a. prescribed farming activities
- b. fill that is
 - i. deposited at a place for gardens or landscaping, including for example, landscaping for the purposes of visual amenity or acoustic screening
 - ii. less than the volume of material prescribed under a regulation (Note: section 100 of the Water Regulation 2016 prescribes this volume to be 50m³).
- c. infrastructure used to safeguard life and property from the threat of coastal hazards.
- d. a structure regulated under another Act including, for example, the following:
 - i. a levee constructed as emergency work under the *Planning Act 2016* (Planning Act), section 166
 - ii. a structure constructed under an approved plan under the *Soil Conservation Act 1986*
 - iii. a structure whose design takes into account the impacts of flooding or flood mitigation but which is not primarily designed for flood mitigation
Example—a public road within the meaning of the *Transport Infrastructure Act 1994*.
 - iv. a structure constructed within the bed, or across a bank, of a watercourse, including, for example, a weir or barrage, the construction of which was carried out under this Act and for which a development permit under the Planning Act was given
 - v. an embankment or other structure constructed for long-term storage of water under the *Water Supply (Safety and Reliability) Act 2008* (Water Supply Act).
Example—a ring tank or dam.
- e. irrigation infrastructure that is not levee-related infrastructure.

Appendix B provides more information on the activities that are excluded from the definition of levees and where these activities may be captured by other legislation or regulations. Where there is uncertainty around whether an activity or structure is defined as a levee, the levee proponent should contact the assessment manager.

2.3 Levees that are constructed as emergency works

A levee is exempt from the regulation if it is constructed or modified because of an emergency endangering:

- a. the life or health of a person
- b. the structural safety of a building
- c. the operation or safety of community infrastructure that is not a building.

The person must give written notice to the assessing authority as soon as practicable after starting the development. This does not apply if the person is required by an enforcement notice or order to stop carrying out the development or use (Planning Act section 166).

3. Construction or modification of levee

The guideline and requirements for levees applies to the construction of new levees or the modification of existing levees. A new levee is a structure that is built where no pre-existing levees are in place for flood mitigation or other purposes.

An existing levee means a levee that:

- was under construction when section 967 of the Water Act commenced
- has not been modified since the construction of the levee was completed or otherwise came to an end
- or
- was existing on the commencement and has not been modified since.

Modify, for an existing levee, means any or all of the following:

- to raise or lower the height of the levee
- to extend or reduce the length of the levee
- to make another change to the levee that affects the flow of water.

3.1 Calculating off-property impacts

An off-property impact means an impact caused by flooding as a result of the levee being constructed or modified. Off-property impacts are measured in terms of the hydraulic effects of the levee under a range of flood events that may include impacts on people, property or the environment beyond the property.

The level of off-property impacts will determine whether a proposed levee is subject to self-assessment or code/impact assessment. In calculating the off-property impacts requirements, category of levee will determine the type and level of assessment required as shown in table 1.

Table 1: Calculating off-property impact

Off property impact	Category	Assessment type	Assessor
A levee in rural area that has no off-property impact	Category 1	Accepted development (with requirements)– self assessment	Applicant
A levee that has an off-property impact and for which the affected population is less than 3	Category 2	Assessable development - code assessment	Local Government
A levee that has an off-property impact and for which the affected population is at least 3 or more	Category 3	Assessable development - impact assessment	Local Government with Queensland Government as referral agency.

When conducting levee assessment for a range of flood events, the following issues need to be considered:

- potential changes to the flow path, flow velocity, flooded area or flood height of floodwaters or overland flow waters
- any incremental flood impacts
- other potential risks such as levee failure and climate change impacts.

If the assessment outcome of a construction or modification of a levee indicates no change under a range of flood events, the levee is considered to have no off-property impacts and is subject to the requirements for levee.

If the assessment determines that the levee will have off-property impact, refer to the development assessment system code for development applications for construction or modification of particular levees for category 2 and 3 levees.

3.2 Engagement of a suitably qualified person

It is recommended that the levee proponent engage a suitably qualified person early in the process to assist with levee assessment to meet the legislative requirements.

A suitably qualified person is a person with the necessary qualifications and experience to undertake risk assessments, hydrologic/hydraulic studies or the design and construction of a levee. This person will have access to relevant Australian and international standards, and the expertise necessary to meet legislative requirements.

An example of this person is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the *Professional Engineers Act 2002*, such as a civil engineer who has demonstrated competency and relevant experience in the design and construction of levee banks or other flood infrastructure.

4. Meeting the accepted development requirements for levees

In conducting self-assessment of category 1 levees, the proponent needs to determine if it meets the accepted development requirements specified in table 2.

Table 2: Accepted development requirements for the construction of new levee or modification of existing levee

Accepted development requirements
<p>The levee is located in a rural area and is designed to protect part of an individual’s property.</p> <ul style="list-style-type: none"> • The levee is located in a rural zone. <p>Note: rural zone refers to a zone in a local government planning scheme that is equivalent to the “rural zone” of the Queensland Planning Provisions.</p>
<p>The levee does not alter the flow of overland flow water or floodwaters in a way that results in off-property impacts.</p> <ul style="list-style-type: none"> • There must be no change in the hydraulic effects beyond the boundaries of the property as a result of levee construction or modification. Hydraulic effects that must not change are: <ul style="list-style-type: none"> – the flow path of overland flow water or floodwater where it enters or exits the property and – the flow velocity off-property and – the flooded area off-property and – the flood height off-property.

4.1 The levee is located in a rural area and is designed to protect part of an individual’s property

The requirements for levees is only applicable to levees located in a rural zone. Levees in zones other than rural will be category 2 or 3 levees and will therefore require code or impact assessment.

4.2 The levee does not alter the flow of overland flow water or floodwaters in a way that results in off-property impacts

To meet the accepted development requirements, the proponent needs to assess the potential off-property impacts of the levee to ensure that the acceptable outcomes are achieved.

Generally, this will require a hydraulic assessment by a suitably qualified person that demonstrates that flooding caused by the levee will not have off-property impacts.

As an alternative to the formal hydraulic assessment, a compelling case may be developed by applying some of the floodplain parameters as described in section 4.4. Methodology used is at the discretion of the proponent, however sufficient analysis should be undertaken to allow the proponent to be confident that no off-property impacts will result from the proposed levee and that this could be justified, if necessary, to a third party.

4.2.1 Hydraulic effect

Hydraulics is the study of the flow of water, in particular, the evaluation of flow parameters such as water level, extent and velocity.

Hydraulic effect in relation to accepted development of levees are measured by examining the variation between the before and after scenarios of:

- the flow path of overland flow water or floodwater where it enters or exits the property
- the flow velocity
- the flooded area
- the flood height.

It is expected that in the decision to embark on the construction or modification of a levee, the proponent has a general sense of the levee size, location and configuration, as well as an estimation of the flood height that the levee will protect against and the area that is to be protected by the levee. This information, in combination with the considerations listed below, will provide an indication of the potential impacts of the levee. Using the information gathered, the proponent must be able to reasonably determine if there are potential off-property impacts that will cause damage to people, property or the environment. It is recommended that the basis of this assumption should be documented and records kept by the levee proponent in case of any future concerns being raised by third parties with regards to the impact of the levee.

It is recommended that, to the extent possible, proponents consider the following issues and use the checklist in Appendix C to ensure that the appropriate issues are accounted for:

- property size
- the size of the property area to be protected by the levee
- levee design details, including:
 - total length
 - maximum height
 - width at top of levee
 - width at base of levee
 - estimated volume of fill in cubic metres
- fill material that is used to construct the levee
- soil on which the levee is built on and other in-situ conditions
- type of levee (earthen, concrete, crib wall, other)
- proximity of the levee to:
 - property boundary
 - watercourses, including rivers, lakes, wetlands and dams
 - occupied buildings on-property
 - occupied buildings off-property
 - urban or residential areas
 - community infrastructure
 - other levees and ringtanks
 - roads and other access infrastructure
- known flood heights (can be based on local knowledge of historical levels, flood levels at nearby gauging stations, or design flood heights where available, such as q100 or the 2011 flood)
- the flood protection height of the levee in relation to the known flood heights, i.e. the maximum flood height that the levee is designed to protect
- volume of water that is being displaced during flood events
- predicted flow path of floodwaters or overland flow when the flood height reaches the flood protection height of the levee
- predicted flow path of floodwaters or overland flow when the levee is overtopped
- estimated life of the levee
- maintenance requirements, including a proposed schedule
- applicable design standards to which the levee is constructed or modified
- levee location and configuration in relation to:
 - floodplain
 - overland flow paths
- the proportion of the floodplain that will be blocked by the levee structure
- set-back distance of the levee from the watercourse.

4.3 Determining off-property impacts: hydraulic assessments

Conducting a formal hydraulic assessment is the most effective way to identify the hydraulic effects of the levee and off-property impacts under a set of flood events. The types of hydraulic assessments that may be undertaken include, from simplest to most complex:

- Mannings formula, which estimates the average velocity of water flowing in an open channel.
- One-dimensional steady state hydraulic modelling, such as HEC-RAS, models water flows in an open channel.
- Two-dimensional fully hydrodynamic modelling, such as MIKE-21, TUFLOW and RMA-2.

Off-property impacts of accepted development levees are based on whether there are hydraulic effects from the levee that extend beyond the property boundary on which the levee is located. This is based on the assumption that if the hydraulic effects off-property do not change as a result of the levee construction or modification, then there will be no impacts on people, property or the catchment.

The off-property impacts of a levee can vary depending on the type of flood event. To ensure accepted development requirements are met, the proponent should consider a set of flood events, which includes events up to the design height of the levee as well as events that overtop the levee. The proponent should also consider the impacts if the levee fails structurally.

Flood events can be selected on historical flood levels or in line with design floods, such as Q100 or the 2011 Queensland floods, where available. Assessment of off-property impacts should also consider risks due to potential climate change impacts.

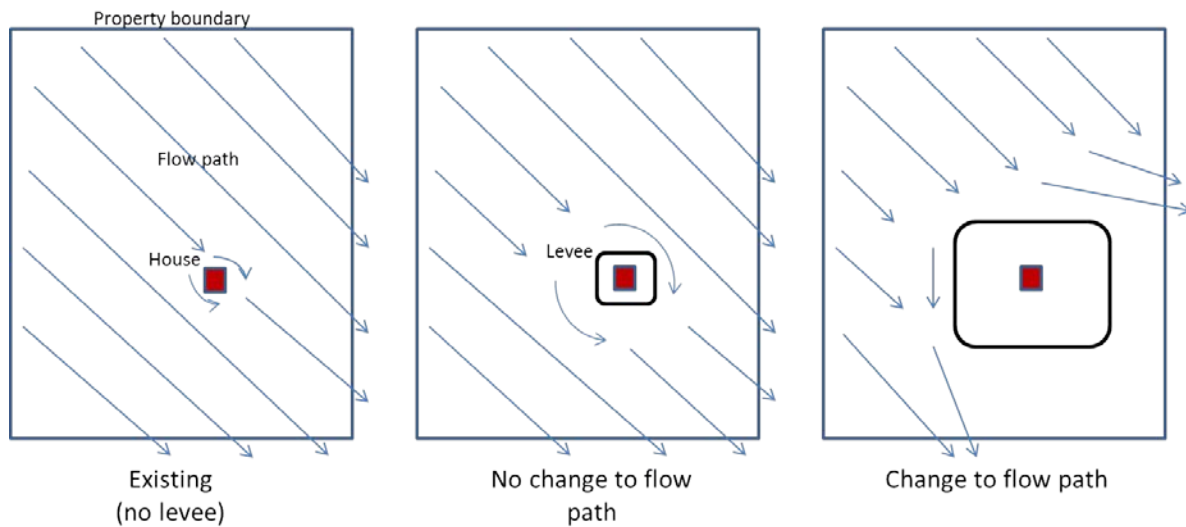
The four types of hydraulic effects that will need to be measured in a hydraulic assessment by the proponent are explained below. Each hydraulic effect is illustrated in a simplistic manner to help explain how the building or modification of a levee can lead to off-property impacts.

4.3.1 Flow path alteration

Prior to the construction or modification of the levee, proponents should have a reasonable knowledge of how water flows across their property during rain or flood events. The construction or modification of the levee should not change the flow path of overland flow water or floodwaters where it enters or exits the property.

Levees have the potential to influence the flow of water upstream or downstream from where it is located. The extent of flow alteration will depend on a number of factors, including, but not limited to, levee length and height, proximity to the property boundary or watercourse and proportion of the floodplain blocked.

Figure 1: flow path alteration into and out of the property



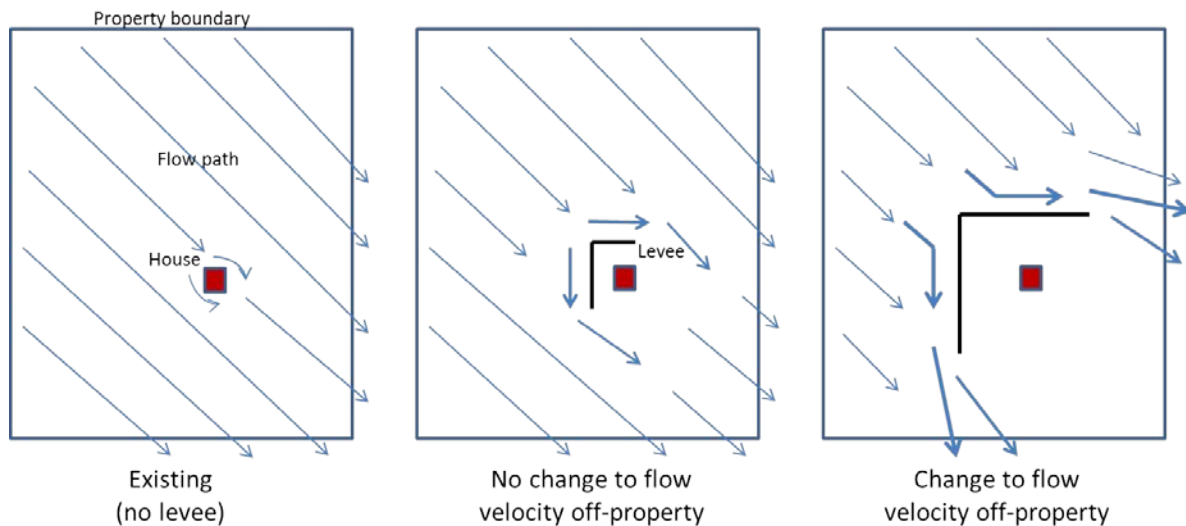
4.3.2 Flow velocity

Flow velocity can be qualitatively estimated using key indicators such as observable erosion, vegetation and soil conditions. For a given soil type, the greater the erosion, it is reasonable to assume the greater the flow velocity; the less vegetation, the less resistance there is to flow, and so the greater its velocity.

The construction or modification of the levee should not change overland flow water velocity where it enters or exits the property. A levee restricts flood water flow which causes an associated change in velocity. The magnitude of these changes depends on the new flow area, reduced in width by the imposed levee, however also increased in height, and the amount of water passing through the floodplain.

Velocity also has a direction component, and this should be considered in determining flow path alteration.

Figure 2: flow velocity into and out of the property

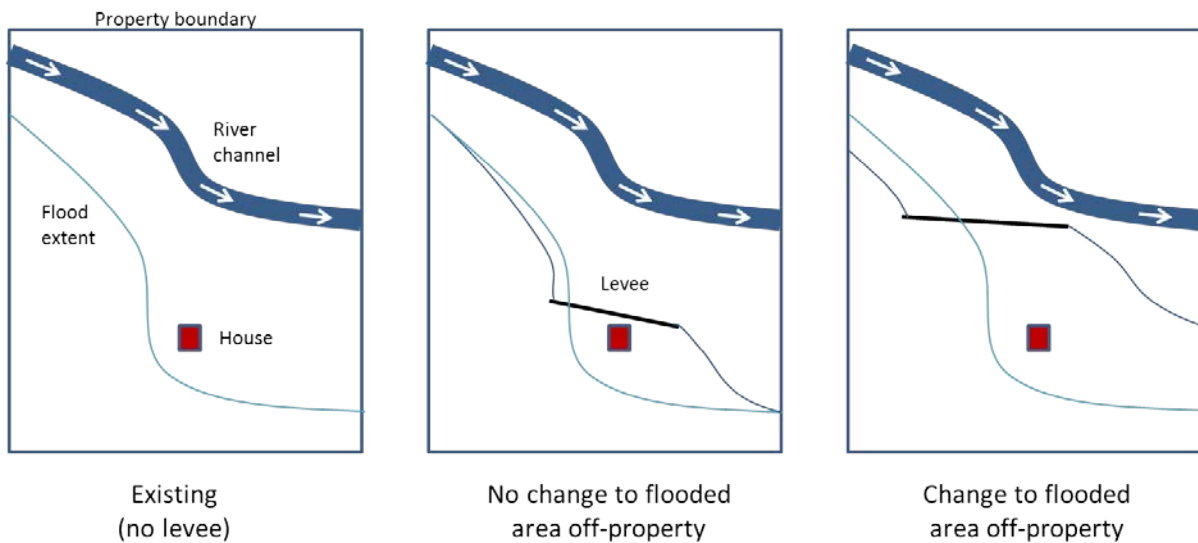


4.3.3 Flooded area

Topographical maps may be useful as a guideline to determine floodwater extent for a given flood height. The construction or modification of the levee should not change floodwater extent on external properties. A levee restricts flood water flow which causes, with variation due to unique floodplain parameters, water to backup upstream. Downstream of a restriction caused by a levee, floodwaters spread out.

These changes protrude away from a levee for a distance which is influenced by floodplain characteristics such as slope and flow resistance, and how these are changed by construction or modification of the levee. The more the levee imposes on the natural floodplain, the further floodwater changes will result. It is useful to consider floodplain extent at the same time as flood height as they are inextricably linked.

Figure 3: flooded area off-property



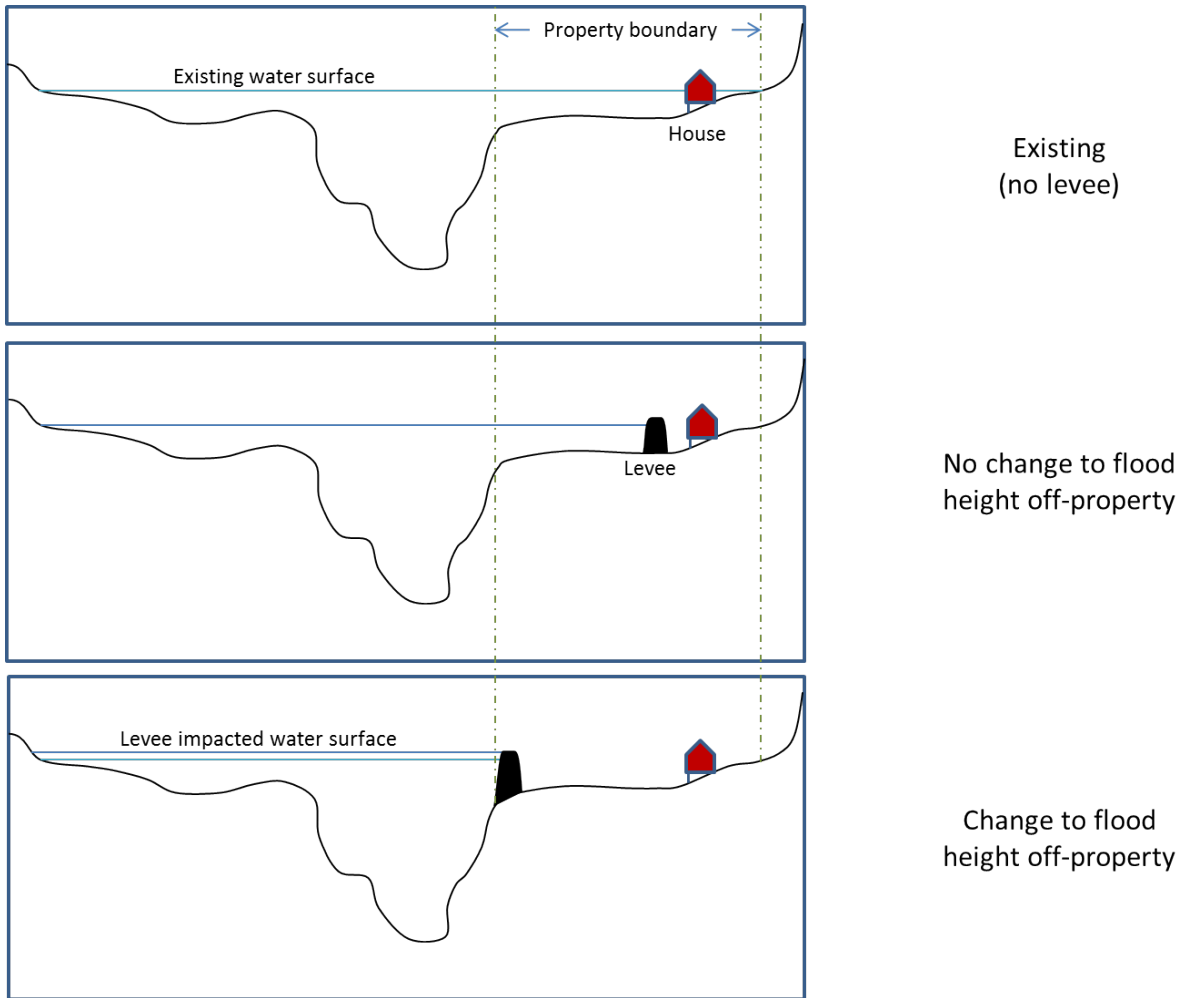
4.3.4 Flood height

Construction or modification of the levee should not change floodwater height off-property. A levee restricts flow, yet the amount of water going through a floodplain does not change. For this to occur, a change must occur to flow velocity, flow height, or a combination of both. The latter almost always happens in practice.

If the restriction is in a region of relatively high flow rate, as is the case closer to the main channel, the change to flow height will be greater. By identifying flow paths and velocities, the region of low flow rate can be determined and the flood height impact of a levee minimised.

Large vegetation and areas protected by topography from high velocity flows are indications of this minimised impact region. Reducing the levee size will further reduce flood height impacts.

Figure 4: flood height off-property



4.4 Determining off-property impacts—floodplain parameters

In the absence of a suitably qualified person to verify the hydraulic effects of a levee, various prescriptive requirements have been investigated to give proponents guidance in determining whether the levee is a category 1 levee. It should be noted that these should not be considered as rules when determining whether a levee has off-property impacts or not but can be used to provide guidance.

Three simple geometric parameters were identified as being the most representative of the distinction between category 1 (no off-property impacts) and category 2 (off-property impacts) levees. These are explained below and a case study of how the impact of a levee could be assessed using these parameters is provided in appendix D. The example in appendix D is included for indicative purposes only and provides some context that may be useful for proponents to see the characteristics of a typical category 1 levee.

4.4.1 Floodplain blocked

This is the percentage of the entire floodplain that is blocked by a levee for the given levee protection height. The greater this value, the more the flow is restricted and so the greater the impact will be.

This is evaluated as:

$$\text{Floodplain blocked (\%)} = \frac{\text{Levee width}}{\text{Floodplain width}} \times 100\%$$

The levee width required by this equation is the projected width of the levee in the direction of flow. Similarly the floodplain width is the width of a cross section that passes through the levee, perpendicular to flow.

A percentage is required to ensure this value is standardised between floodplains of all different sizes; the impact of a 500m wide levee in a 2km floodplain is invariably different to the same size levee in a 5km wide floodplain. For a given levee size, the proportion of floodplain blocked is a constant, regardless of its location in the floodplain. By extension this means the impact is the same regardless of levee location in the floodplain. This is an oversimplification, however it is a useful guide.

Appendix D provides an example of a levee that was deemed to be category 1 levee. In this example, the proportion of floodplain blocked by the levee was estimated to be five per cent.

4.4.2 Floodplain behind levee

This parameter addresses part of the issue identified as a shortcoming of floodplain blocked —levee position on floodplain. It is assumed here that the closer to the main river channel a levee is, the bigger its impact will be. Unfortunately, this is only the case for very specific geometric arrangements, however it serves as a useful approximation in most cases.

It is evaluated as:

$$\text{Floodplain behind levee(\%)} = \frac{\text{Overbank width} - \text{Levee setback}}{\text{Overbank width}} \times 100\%$$

The overbank width is the floodplain width, perpendicular to flow, on the side of the river the levee is located. Levee setback is the distance, perpendicular to flow, from the main river bank to the levee. A percentage is again used to standardise between floodplains of differing sizes.

In the example in appendix D, the floodplain behind the levee was estimated to be 55 per cent.

4.4.3 Flood volume displaced

A functioning levee protects an area by displacing water. The greater the volume of this water, the more restricted floodwaters are, and so the greater the impact. Unfortunately this does not consider the location of the levee, and in doing so, how critical this displaced volume is to flow. If a levee was built in an area where, during flood flows, the water conveyance is negligible, there would be little impact. Yet if a levee is built in an area where, during flood, conveyance is high, the impact would be significant.

Flood volume displaced is difficult to determine accurately without elevation data. It can however, be approximated using several assumptions. First the levee height is assumed to be a constant for the length of its perimeter. Secondly it is assumed the levee height is equal to the flood inundation depth for the area protected by the levee, before the levee was built.

It is then calculated as:

$$\text{Flood volume displaced} = (\text{Levee plan area}) \times (\text{Levee height})$$

In the example in appendix D, the flood volume displaced was estimated to be 3000m³.

4.4.4 Notification and consultation

As part of the self-assessment process, the proponent is required to send a notification form to the local council. The notification form provides information to the council on the details of the levee developed, including the location, completion date, a description of the works, the process undertaken to determine off-property impacts and consultation. If no consultation was undertaken, the proponent can provide an explanation. The form is required to be submitted within 10 business days of completing the works. The form is located in *Accepted development requirements for the construction of new levees or the modification of existing levees* on www.business.qld.gov.au.

Notification of the works does not constitute an approval by local council for the works or agreement on the determination of off-property impacts.

It is recommended that the proponent consult with neighbours about the intention to build a levee. Although not mandatory for category 1 levees, the consultation can be used to provide details of the levee to neighbours and assurance that off-property impacts have been considered.

The proponent can also contact their local government with details of the proposed works and to discuss the assumptions on which the impact assessment of the levee are based.

It should be noted that any agreement with the neighbours or local government does not reduce potential liability of the proponent if off-property impacts are caused by the levee. It is therefore recommended that the proponent contact the local government and neighbours notifying them of intent to develop a levee and share initial ideas about proposed levee as soon as a decision to embark on the construction or modification of a levee has been made.

The proponent may be able to find out initial feedback and concerns, if any, as well as useful information such as local floodplain management plan, flood study, design standards and local expertise available.

5. Liability for impacts

The proponent bears full responsibility for any impacts that the levee may cause under any flood event scenario including possible overtopping or failure. It is recommended that any records or information created as part of the self-assessment be maintained by the proponent.

In the case where a self-assessed levee is located on a property that is subsequently sold, the liability for any impacts is transferred to the new owners.

6. Further information

Further information that may assist self-assessment includes:

- Guidelines for the construction and modification of category 2 and 3 levees, available at www.business.qld.gov.au
- applicable standards and manuals, such as:
 - Floodplain Management in Australia. Best Practice Principles and Guidelines (SCARM, 2000)
 - Managing the floodplain: A guide to best practice in flood risk management in Australia (Emergency Management Australia, 2013)
 - Levee Design, Construction and Maintenance Manual (Victoria State Government, 2002)
 - International Levees Handbook (CIRIA, 2013)
 - Floodplain Development Manual (NSW State Government, 2005)
 - Queensland Urban Drainage Manual (Queensland State Government Department of Natural Resources and Water, 2007)
 - Planning for stronger, more resilience floodplains (Queensland State Government Queensland Reconstruction Authority, 2011)
 - Emergency Management Practice Guide 3: Managing the Floodplain (Emergency Management Australia, 1999).
- available reports and historical information on floods for the local area and catchment
- Queensland Reconstruction Authority mapping, aerial photography, satellite imagery and other applicable local knowledge at www.qldreconstruction.org.au
- consultation with Bureau of Meteorology, Department of Transport and Main Roads, Department of Regional Development, Manufacturing and Water, Department of Environment and Science, Department of State Development, Infrastructure, Local Government and Planning
- Consultation with local government as well as local residents who have experienced flood events.
- interim floodplain assessment overlay by Queensland Government (Queensland Globe)
- relevant Australian and international standards
- topographic information from aerial imagery or field survey.

Levee proponents should contact their local council for additional guidance in relation to these accepted development requirements.

7. Definitions

Affected population: for a levee means the total number of persons occupying all buildings on which the levee has a significant impact.

Annual exceedance probability (AEP): probability of exceeding a specified flow or level in any one year (CIRIA, 2013).

Average recurrence interval (ARI): the average period in years between the occurrence of a flood of a given size or larger (SCARM, 2000).

Category 1 levee: a levee that has no off-property impact.

Category 2 levee: a levee—

- a. that has an off-property impact; and
- b. for which the affected population is less than 3.

Category 3 levee: a levee—

- a. that has an off-property impact; and
- b. for which the affected population is at least 3.

Defined flood event (DFE): the flood event selected for the management of flood hazard to new development. This is generally determined in floodplain management studies and incorporated in floodplain management plans. Selection of DFEs should be based on an understanding of flood behaviour, and the associated likelihood and consequences of flooding. It should also take into account the social, economic, environmental and cultural consequences associated with floods of different severities (SPP: State interest guideline: natural hazards, risk and resilience).

Existing levee: means a levee—

- a. that
 - i. was under construction when section 967 of the *Water Act 2000* commenced; and
 - ii. has not been modified since the construction of the levee was completed or otherwise came to an end or
- b. that was existing on the commencement and has not been modified since.

Flood: relatively high water levels caused by excessive rainfall, storm surge, dam break or a tsunami that overtop the natural or artificial banks of a stream, creek, river, estuary, lake or dam (SCARM, 2000).

Flood hazard area: refer to State Planning Policy (Queensland State Government Department of State Development, Infrastructure, Local Government and Planning, 2013a).

Flood protection height: the height of the maximum flood that the levee is designed to protect against. The flood protection height should not include the freeboard.

Floodways: areas where a significant volume of water flows during floods and are often aligned with obvious natural channels. They are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, which may in turn adversely affect other areas. They are often, but not necessarily, areas with deeper flow or areas where higher velocities occur (adopted from NSW Floodplain Management Manual, 2001).

Flood storage areas: the area of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood (adopted from NSW Floodplain Management Manual, 2001).

Flood fringe: the remaining area of land affected by flooding, after floodway and flood storage areas have been defined. Development in flood fringe areas would not have any significant effect on the pattern of flood flows and/or flood levels (adopted from NSW Floodplain Management Manual, 2001).

Freeboard: the height above a defined flood level, typically used to provide a factor of safety. Freeboard compensates for effects such as wave action, localised hydraulic behaviour and settlement of levees, which increase flood levels or reduce the level of protection provided by levees. Freeboard should not be relied upon to provide protection for flood events larger than the DFE (SCARM, 2000).

Hydraulic assessment: the study of the flow of water in waterways, in particular, the evaluation of flow parameters such as water level, extent and velocity (SCARM, 2000).

Hydrologic assessment: the study of water and its constituents as they move through the natural processes that constitute the hydrological cycle (i.e. rainfall, runoff, evaporation, infiltration) (SCARM, 2000).

Irrigation infrastructure: water infrastructure or other infrastructure constructed, erected or installed for the supply of water or the storage and distribution of water for the irrigation of crops or pastures. Examples of irrigation infrastructure - a supply channel, head ditch or tailwater drain

Landholder: includes owners or lessees of the land on which the levee is proposed to be constructed or modified. Also referred to as levee proponent.

Levee: an artificial embankment or structure which prevents or reduces the flow of overland flow water onto or from land. A levee includes levee-related infrastructure.

Levee property:

- a. means the lot or parcel of land on which a levee is situated; and
- b. includes another lot or parcel of land that is contiguous with the lot or parcel mentioned in paragraph (a) and owned by the same entity.

Levee-related infrastructure: for a levee, means infrastructure, including irrigation infrastructure, that is—

- a. connected with the construction or modification of the levee or
- b. used in the operation of the levee to prevent or reduce the flow of overland water onto or from land.

Examples of infrastructure for paragraph (b) a channel, drain, outfall or pipe

Modify, for an existing levee, means any or all of the following:

- to raise or lower the height of the levee
- to extend or reduce the length of the levee
- to make another change to the levee that affects the flow of water.

Off-property impact: for a levee, means an impact the levee has on a people, property or the environment outside the levee property.

Overland flow water: Refer to Schedule 4 of the *Water Act 2000*.

Overtopping: passing of water over the top of a structure as a result of a water level higher than the crest of the structure (CIRIA, 2013).

Prescribed farming activities means—

- a. cultivating soil or

Examples—clearing, replanting and broadacre ploughing

- b. disturbing soil to establish non-indigenous grasses, legumes or forage cultivars or
- c. using land for horticulture or viticulture or
- d. laser levelling or contouring soil.

Probable maximum flood (PMF): the largest flood that could conceivably occur at a particular location. The PMF defines the extent of flood-prone land.

Property: refer to levee property definition

Registered Professional Engineer Queensland (RPEQ): means a person registered as a registered professional engineer under the *Professional Engineers Act 2002*.

Resilience: the ability to adapt to changing conditions and prepare for, withstand and rapidly recover from disruption.

Rural zone: refers to a zone in a local government planning scheme that is equivalent to the 'rural zone' of the Queensland Planning.

Significant impact, of a levee on a building, means each of the following:

- a. an increase, caused by the levee, of more than 5cm in the flow height of water over the floorboards of the building
- b. an increase, caused by the levee, of more than 0.2m/s in the flow velocity of water over the floorboards of the building.

Suitably qualified person: refer to section 3.2 of this guideline.

Watercourse: refer to the *Water Act 2000* section 5.

Vulnerability: the degree of susceptibility of individual persons, the community and the environment to natural hazards, such as floods.

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Appendix B Activities excluded from the definition of levees

Activity	Definition	How activity is currently managed
1. Prescribed farming activities	<p>a. cultivating soil or Examples— clearing, replanting and broadacre ploughing</p> <p>b. disturbing soil to establish non-indigenous grasses, legumes or forage cultivars or</p> <p>c. using land for horticulture or viticulture or</p> <p>d. laser levelling or contouring soil. Common or Dictionary definition applies to laser levelling.</p>	<ul style="list-style-type: none"> • Prescribed farming activities are managed as in accordance with best practice guidelines. • Check with the relevant codes and best practices applicable in your Local Government area. Refer to the planning scheme of your council for further details.
2. Fill that is used in landscaping /visual amenity / acoustic screening.	<p>Fill is not considered as a levee, if it uses less than a volume of 50m³ of fill material.</p>	<p>Cut and fill is often used to improve access, to provide useable outdoor spaces, to improve visual amenity and provide acoustic screening as in accordance with the best practice guidelines. For example 'Landscape Design requirements for Education Queensland School grounds'.</p> <p>Check with the relevant codes and best practices applicable in your Local Government area. Refer to the Planning Scheme of your Council for further details.</p>
3. Infrastructure used to safeguard life and property from the threat of coastal hazards.	<p>The infrastructure used to safeguard life and property from the threat of coastal hazards within coastal management district, includes coastal protection structures like seawalls and groynes. Dictionary definition applies for seawalls and groynes in <i>Coastal Protection and Management Act 1995</i>.</p>	<p>The primary purpose of such infrastructure is to prevent bank or beach erosion.</p> <p>Such infrastructure is assessed under Prescribed Tidal Works Code for development applications as assessable development.</p> <p>State Code 8 – Coastal development and tidal works, or development in a coastal management district code also applies here for the assessment of applications on such infrastructure construction.</p>
4. Structures constructed for emergency work.	<p>Levees or levee like structures could be constructed as emergency work by an applicant because of an emergency endangering:</p> <p>(i) the life or health of a person; or</p> <p>(ii) the structural safety of a building; or</p> <p>(iii) the operation or safety of community infrastructure that is not a building; and notify (written) the assessing authority as soon as practicable after starting the construction.</p> <p>However, above provisions do not apply if the applicant is required by an</p>	<p>The primary purpose of the constructed structures (levees or levee-like) as emergency work is to protect life and property under emergency situations. Levees or levee like structures may be constructed as emergency work as in accordance with the best available engineering standards.</p> <p>An applicant undertaking an emergency development or use, would only be required to give written notice to the assessing authority as soon as practicable after starting the development or use (refer s.166 of the Planning Act 2016). An enforcement notice or order to stop carrying out the</p>

	enforcement notice or order to stop carrying out the development or use.	levee construction could be applied by the assessing authority, if a levee constructed under an emergency is not up to the engineering standards or non-complying with the code provisions.
5. A structure constructed under <i>Soil Conservation Act 1986 (SC Act)</i>.	Structures under the SC Act are designed for the purpose of controlling erosion. Structures include contour banks, diversion banks and waterways.	A property plan details soil conservation works/measures required for an individual landholding. A property plan may be approved by delegated officers. A project plan consists of several properties within a defined catchment and coordinates runoff control works across land within a catchment including road/rail infrastructure. Chief Executive advertises a proposed project plan, review objections and make recommendations to the Governor-in-Council who then may approve the plan. Appeal provisions are available for both project and property plans.
6. A structure whose design takes into account the impacts of flooding or flood mitigation but which is not primarily designed for flood mitigation such as public roads	Roads and associated engineering structures designed and constructed under <i>Transport Infrastructure Act 1994</i> and Planning schemes of the local government.	The roads designed and constructed under <i>Transport Infrastructure Act 1994</i> , are being assessed under chapter 1 of the Department of Main Roads and Transport's Road Drainage Manual (RDM) for flood impacts. Council roads are assessed under the relevant codes of the Planning schemes, for flood impacts. The provisions of the Queensland Urban Drainage Manual (QUDM) are also being applied to assess the flood impacts of these roads.
7. Structure regulated under <i>Environmental Protection Act 1994 (EP Act)</i>.	Dams or levees relating to resources operations are regulated structures constructed as part of environmentally relevant activities. Protecting human life and the environment requires that the standards used for the design, construction, operation, modification and decommissioning of regulated structures mitigate the consequences arising from potential failure or collapse of those structures. Notes: The term regulated structures includes land-based containment structures, levees, bunds and voids, but not a tank or container designed and constructed to an Australian Standard that deals with strength and structural integrity.	An environmental impact statement (EIS) is required for an environmentally relevant activity. Generic terms of reference for EIS provides for the description of current flood risk for a range of annual exceedance probabilities up to the probable maximum flood, for potentially affected waterways, and the assessment of (through flood modelling) how the project may potentially change flooding characteristics. The assessment should consider all infrastructure associated with the project including levees, roads and linear infrastructure and all proposed measures to avoid or minimise impacts. (Ref-section 8.6 of ToR). EIS lists and describe all dams or levees proposed on the project site and undertake an assessment to determine the hazard category of each dam or levee (low, significant, or high), according to the criteria in the EHP 'Manual for Assessing Hazard Categories and Hydraulic Performance of Dams'. Further, the potential risks to people and property that may be associated with the project in the form of a preliminary risk assessment for all components of

		the project under section 8.13 – ‘Hazard and Safety’ in the ToR of EIS.
8. Structures constructed within the bed, or across a bank of a water course under <i>Water Act 2000</i>	<p>Construction of weirs, barrages and dams across a water course that hinder or obstruct the flow of water in the watercourse.</p> <p>Notes: A watercourse is a river, creek or other stream, including a stream in the form of an anabranch or a tributary, in which water flows permanently or intermittently, regardless of the frequency of flow events (Ref: Chapter 1 Part 2). The bed and banks of the watercourse typically consist of bedrock and very coarse material, including boulders, cobbles and gravel (Water Regulation 2016 Schedule 1).</p> <p>Weir means a barrier constructed across a watercourse below the outer banks of the watercourse that hinders or obstructs the flow of water in the watercourse weir means a barrier constructed across a watercourse below the outer banks of the watercourse that hinders or obstructs the flow of water in the watercourse.</p>	The construction of weirs, barrages and dams are code assessed (Ref: State Code 10 Water) unless operations are mentioned as accepted development in a Water Plan or Water Management Protocol. It may be an exempt activities under the Riverine Protection Permit Exemption Requirements.
9. Waterway barrier works	Waterway includes a river, creek, stream, watercourse or inlet of the sea. Waterway barrier works means a dam, weir or other barrier across a waterway if the barrier limits fish stock access and movement along a waterway (Ref- <i>Fisheries Act 1994</i>).	Operational work that is the construction or raising of waterway barrier works, other than operational work that is accepted development or carried out on premises to which structure plan arrangements apply. The document is <i>Accepted development requirements for operational work that is constructing or raising waterway barrier works</i> .
10. A structure constructed for long term storage of water under the <i>Water Supply Act</i>	<p><i>Water Supply (Safety and Reliability) Act 2008</i> (WSA) provides for the regulation of referable dams constructed and maintained for the safety and reliability of water supply. Under section 341 of this Act:</p> <p>A dam is, or a proposed dam after its construction will be, a referable dam (dam is considered referable if it would threaten life if it failed.) if—</p> <ol style="list-style-type: none"> (a) a failure impact assessment of the dam, or the proposed dam, is required to be carried out under this part; and (b) the assessment states the dam has, or the proposed dam after its construction will have, a category 1 or category 2 failure impact rating; and (c) the chief executive has, under section 349, accepted the assessment 	<p>Construction of a dam is subject to a development permit under the Planning Act 2016. The Water Supply Act provides for a determination of whether the proposed dam is referable or not.</p> <p>The failure assessment must be undertaken by a Registered Professional Engineer and is required for all dams exceeding the following criteria:</p> <ul style="list-style-type: none"> more than ten metres high, and a storage capacity exceeding 1500 megalitres <p>OR</p> <ul style="list-style-type: none"> more than ten metres high, and a storage capacity exceeding 750 megalitres, and a catchment area which is more than three times the reservoir surface area at full supply level.
11. Irrigation Infrastructure that is not levee-related infrastructure	Irrigation infrastructure means water infrastructure or other infrastructure constructed, erected or installed for the supply of water or the storage, distribution and application of water for	Irrigation infrastructure is managed at property level and the responsibility being on a landholder to carry out works and measures for flood mitigation.

	<p>the irrigation of crops or pastures. Examples of irrigation infrastructure— a supply channel, head ditch or tail water drain.</p> <p>Irrigation channel means an artificial channel in which there is only water that is intended to be used for irrigation (Ref: Chemical Usage (Agricultural and Veterinary) Control Regulation 2017- Div 3 Sub Div 1 –Interpretation)</p>	<p>More information on certification of irrigation professionals is available on Irrigation Australia website</p>
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Appendix C Checklist for category 1 levees

C-1 Levee design

Design element	Details
Property size	
Total length	
Maximum height	
Width at top of levee	
Width at base of levee	
Estimated volume of fill (in m³)	
Fill material that is used to construct the levee	
Soil type on which the levee is constructed	
Type of levee (earthen, concrete, crib wall, other)	

C-2 Levee location and configuration

C-2-1 Site map showing location and alignment of levee and identifiers (property boundary, watercourses, roads, other landmarks, address) and map series number and coordinates



C-2-2 The proximity of the levee to the following (distances should be measured from the point of the levee that is closest to the object or landmark):

Object or landmark	Distance (in metres)
Property boundary	
Watercourses, including rivers, lakes, wetlands and dams	
Occupied buildings on-property	
Occupied buildings off-property	
Urban or residential areas	
Community infrastructure	
Other levees and ringtanks	
Roads and other access infrastructure	
Other	

C-3 Details on levee design and potential impacts

C-3-1 What are the known flood heights that are being used to set the levee height?

C-3-2 What is the flood protection height of the levee in relation to the known flood heights?

C-3-3 What is the size of the area to be protected by the levee?

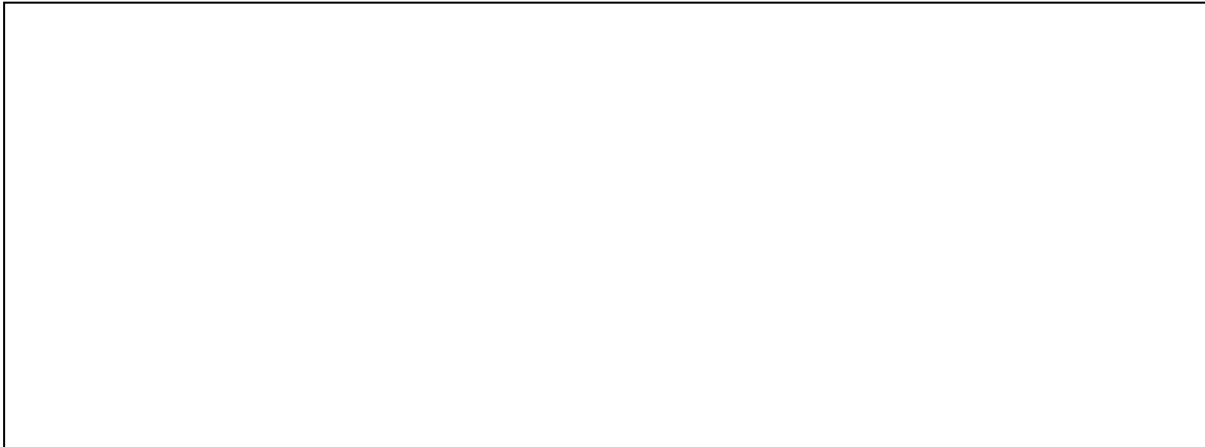
C-3-4 What is the average slope of the land on which the levee is located?

C-3-5 What is the estimated volume of water that is being displaced during flood events?

C-3-6 What is the predicted flow path of floodwaters or overland flow when the flood height reaches the flood protection height of the levee?



C-3-7 What is the predicted flow path of floodwaters or overland flow when the levee is overtopped?



C-3-8 What is the estimated life of the levee and what are the maintenance requirements over the life of the levee?



Appendix D Example of category 1 levee

This example is provided as an illustration of a potential category 1 levee that is subject to self-assessment.

In this example the proponent has decided to look at protecting a small 2,000m² area of their 40ha property using a levee. The height of the levee is to be an average of 1.5m, determined from historical flood events. In order to better understand how flood waters flow through the floodplain, the proponent accessed Queensland Globe available on Queensland Government website and turned on the Queensland Topographic Map layer.

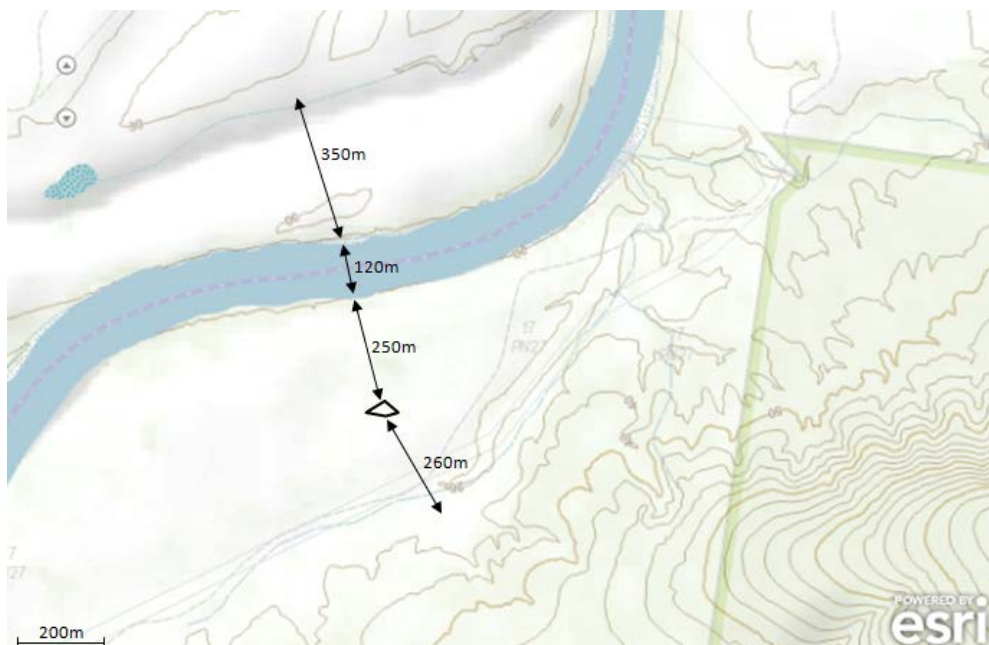
After navigating to their private rural lot, the proponent was then able to measure the levee width *perpendicular to flow* of 50m and length in the *direction of flow* of 75m

As well as key floodplain widths (perpendicular to flow), including:

- The ground elevation where the levee is to be located is approximately 25m AHD
- The flood protection height of the levee is 26.5m AHD
- Distance of the main channel to the levee is 250m
- Distance from the levee to the floodplain boundary is 260m
- Main channel width is 120m
- Total floodplain width is $350 + 120 + 250 + 260 + 50 = 1030\text{m}$

Note that for some of the above information, some intermediate contour lines had to be estimated/linearly interpolated. The proponent is also able to determine lengths from a physical survey of their property.

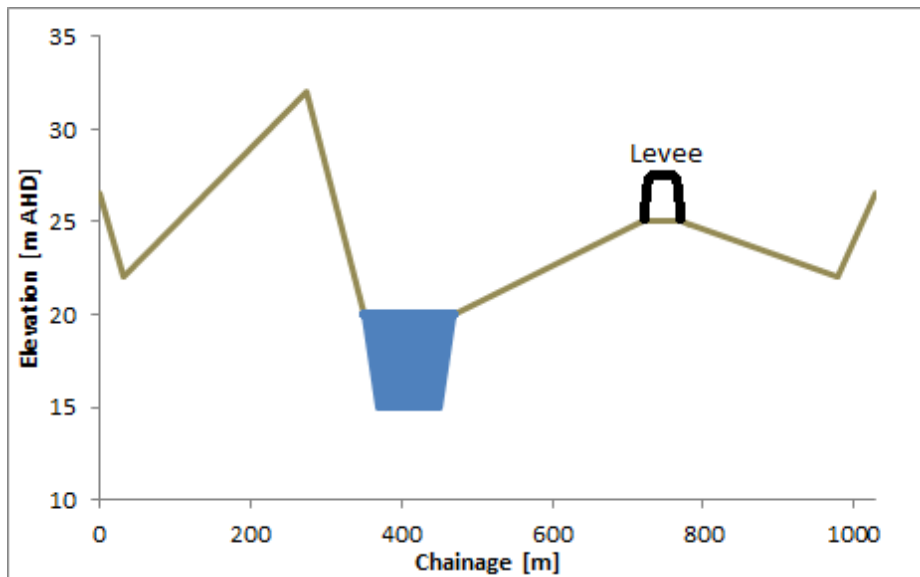
The following figure illustrates this information, where the river flows from left to right. The levee is located on the right overbank (looking downstream as is standard convention).



The proponent then calculates the percentage of the floodplain the levee design blocks as

$$\text{Floodplain blocked (\%)} = \frac{\text{Levee width}}{\text{Floodplain width}} \times 100\% = \frac{50}{1030} \times 100 \cong 5\%$$

This value is low, indicating that the levee does not significantly restrict flood waters. However this alone does not guarantee that the proposed design is category 1. The right overbank is relatively flat and wide, and so it may convey a large amount of flood flow. Ideally the levee should be located in a position where flow conveyance is minimal. The contours provide a rough guide in this respect—if they indicate a trench where water can flow, it is prudent to avoid this area. To look at this, the applicant plotted an approximate cross section using the topographic information above. This is done by measuring elevation information along the black dimension lines.



Note that the channel is shown for illustrative purposes only—it is not known from the input data.

Since the proponent is constructing the levee to protect their main dwellings, moving the levee to minimise impacts may not be an option.

The percentage of the floodplain behind the levee can be useful in this example because, generally, the further the levee is set back into the floodplain, the lesser its impact. This is especially true for floodplains that have elevation profiles that gradually rise from the channel to the edge of the floodplain, as approximately shown in this example.

This is calculated as:

$$\begin{aligned} \text{Floodplain behind levee(\%)} &= \frac{\text{Overbank width} - \text{Levee setback}}{\text{Overbank width}} \times 100\% \\ &= \frac{(250 + 50 + 260) - (250)}{(250 + 50 + 260)} \times 100\% = 55\% \end{aligned}$$

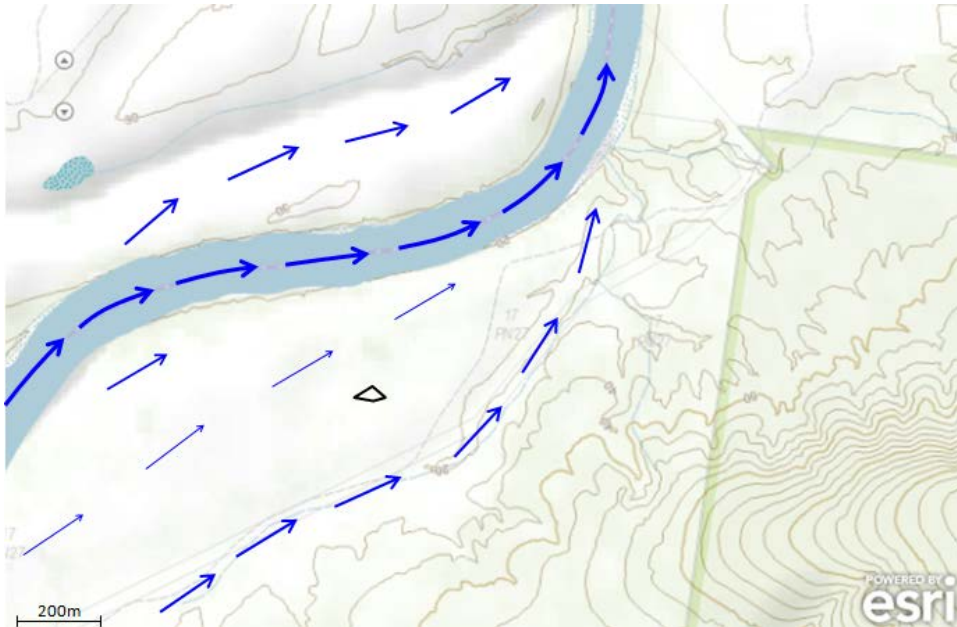
The lower the value for the above calculation, the better. While 55 per cent is high, coupled with the consideration of a low floodplain blocked, this design is likely to have no impact.

A further consideration is to look at the flood volume displaced.

This is calculated as:

$$\text{Flood volume displaced} = (\text{Levee plan area}) \times (\text{Levee height}) = (2000) \times (26.5 - 25) = 3000\text{m}^3$$

Theoretically the more volume displaced, the more water is forced through the remainder of the cross section, and so the greater the levee impact. A more sophisticated approach is to also consider how critical the protected area was to flow. If the levee was built in a channel, this is very important to flow, whereas if it was at a high water mark level, it may not be so important. Again with reference to the cross section, the levee is located on a small ridge, and so it likely is not in a region of particular importance to flow conveyance. This is confirmed using the flow path diagram below, which indicated flow paths do not flow around the levee with a high velocity.



This example illustrates a design that will likely have no off-property impacts, especially considering the large 40ha property size. Using the information above and considering other factors in line with section 4.2 of the guidelines, the proponent can reasonably assume that given the large size of the property and the relatively small size of the levee, the levee will not have any off-property impacts.

In this example, it can be reasonably assumed that the building of the level would not impact on:

- the flow of water where it enters and exits the property
- the velocity of flood flow beyond the boundaries of the property
- ponding beyond the boundaries of the property
- flood heights beyond the boundaries of the property.

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