Economic benefits of flood mitigation investments

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Executive summary

Australia's largest natural disaster risks are from floods, particularly in eastern Australia. Indeed, the flood events across wide parts of Queensland (including Brisbane) and New South Wales in 2010 and 2011 highlight the sheer scale and severity of these risks. Flooding disasters have been and will remain a fundamental part of Australia's climate.

Investments in flood mitigation infrastructure, such as flood levees and water storage systems, can provide a cost effective and proven means of reducing the community's long term exposure to the risk of floods — often with relatively modest financial outlays.

Case study analysis of flood protection investments in the regional Queensland towns of Roma and St George, and the New South Wales town of Grafton, highlight the strong economic gains which can be achieved. As part of the study, Urbis worked with local governments to obtain a range of economic and technical data for the three towns.

Based on their protective capacities and underlying weather risks, the recent flood mitigation investments in Roma and St George showed a net benefit of $64.7 million and $25.7 million respectively over the next 50 years. The legacy flood mitigation structures in Grafton show a long term net economic gain of $59.2 million (see Figure E.1 and Table E.1).

Cost benefit ratios for the three levee systems were in the order of 2.2-5.4 indicating a robust economic return on investment for the community. Importantly, this compares well with many other infrastructure projects which are often candidates for limited allocations of regional development funding from governments.

The estimated cost benefit ratios for the recently commissioned Roma (4.9) and St George (5.4) levee structures are relatively higher than for the legacy flood mitigation assets in Grafton (2.2). This is driven by some key technical factors. The Grafton assets are older, larger and more complex, requiring higher annual maintenance expenditures and some major capital repair to rectify damage from recent floods. The levee structures in Roma and St George also provide a higher flood protection rating, in large part reflecting more modern design and hydrology standards.

Elements of a business case on flood mitigation investment

This policy brief provides decision-makers with a systematic and forward-looking way of developing a business case for flood mitigation investments. The three regional case studies are used to showcase the business case framework and how it can demonstrate the capacity of flood mitigation investments to protect communities and build economic resilience.

Because of its community-wide protections and public financing, the business case of natural disaster mitigation is that of a *public* business case. This rests on evaluating the full range of economic benefits and the costs of respective mitigation options.

The framework utilises a cost-benefit approach to evaluate infrastructural flood mitigation measures based on three core modules:

- **Climate risk** — The approach examines total flood risk encompassing current weather patterns at the three towns and surrounding areas. The analysis is made over the long term and some aspects of the future risk may deviate from current patterns such as the frequency and severity of heavy rainfall events.

- **Elements at risk** — Extreme weather events impact people, assets and productive activities. This economic base differs between towns and regions and changes over time due to development and population growth. In general terms, the more people and physical infrastructure exposed to a weather event, the greater the risk. It is important to establish a clear view of a regions' 'value at risk' across different asset classes such as residential houses, commercial buildings and public infrastructure, and its economic structure.

- **Protective capacity of mitigation** — The extent to which a flood mitigation measure protects a community and how much it costs to build and maintain form a foundation of the business case. Larger scale and more protective structures are more expensive but generally provide better protection in terms of their flood rating or coverage (or both). Examining this capacity essentially involves measuring the long term capital and operating expenditures against total economic benefit, predominantly represented as avoided losses from expected disaster events and potential improvements in insurance coverage.

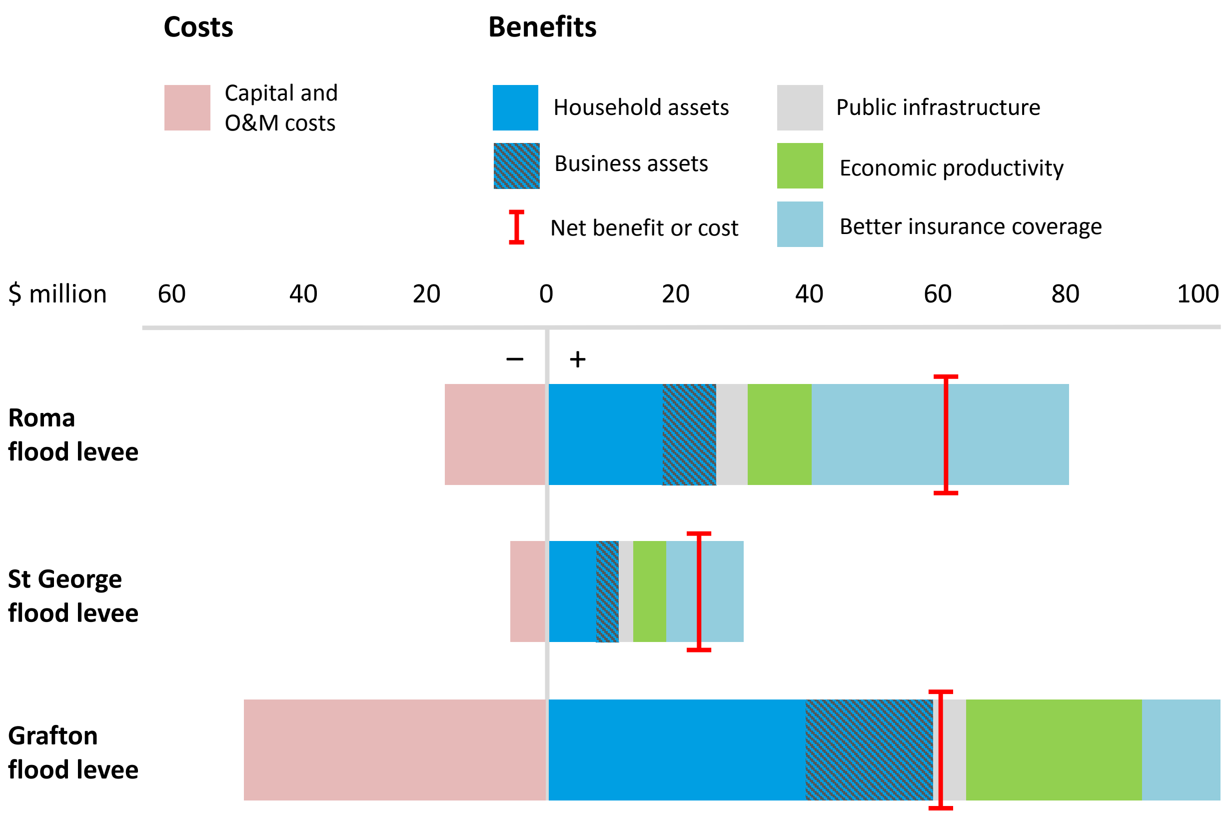
Overall, the strongest business cases for new flood mitigation works being considered by local government will establish clearly the scale and dimensions of these factors within the context of local and regional settings, and how they may change over the long term (say over a 20-50 year time horizon).

Some key exposures will be difficult to quantify. Issues such as loss of heritage value, emotional trauma from disaster events and death and injury constitute some of the most devastating impacts from natural disasters. This analysis has concentrated on the economic costs and benefits and more detailed qualitative aspects are ideally considered as part of evaluations of specific proposals.

The Productivity Commission's *Natural Disaster Funding Arrangements* draft report (September 2014) sets out a range of accepted principles for the cost benefit analysis of mitigation options which have been reflected in this study.

A particular matter identified by the Commission concerns the double counting of benefits from natural disaster mitigation options. This can occur, for example, in assessing avoided damages to assets in conjunction with future reductions in insurance premiums. A few issues should be noted. First, the risk of natural disasters and avoided damages from mitigation are not always fully reflected in the pricing of insurance premiums. Business and public assets, in particular, may be uninsured or self-insured, and residential insurance pricing is often unable to be tailored to individual properties. Second, in a related sense, reductions in premiums for residential insurance products can also extend well beyond the more direct protective influence of levee assets — effectively enhancing accessibility of coverage and providing more wholesale benefits for local townships and immediate surrounds. These issues, which were emphasised in discussions with insurers, mean that avoided infrastructure damage or residential pricing reductions can often be somewhat incomplete measures of the potential economic gains from levee investments, especially in more localised settings such as those examined in this study.

FIGURE E.1 – COST AND BENEFITS OF FLOOD MITIGATION INVESTMENTS



Indicative analysis of flood mitigation benefits

TABLE E.1

	ROMA	ST GEORGE	GRAFTON
Impacts (NPV, $ millions)			
Costs			
Total capital costs (including O&M)	$16.4	$5.9	$49
Protective benefits (avoided costs)			
Household assets	$18.4	$7.6	$41.6
Business assets and stock	$7.6	$3.8	$20.8
Public infrastructure	$4.5	$2.3	$5.3
Economic productivity	$10.9	$5.4	$29
Better insurance coverage	$39.7	$12.6	$11.4
Total benefits	$81.1	$31.6	$108.2
Net benefit	**$64.7**	**$25.7**	**$59.2**
Benefit cost ratio	**4.9**	**5.4**	**2.2**

Note: Columns may not total precisely due to rounding.
Source: Urbis estimates

Three key points stand out from the case studies:

- ***There are strong protective benefits from flood levees.*** The benefits arising from these investments are heavily weighted on the avoided flood damage to residential properties and minimised disruption to economic activity based around town centres. Better insurance coverage is also a dominant feature of the composition of economic benefits. For Roma, St George and Grafton townships, this benefit was estimated in the order of $39.7 million, $12.6 million and $11.4 million respectively on an NPV basis. These savings provide a regular ongoing benefit for residents, both current and future policyholders, because of the levee. This price differential will endure over time even in circumstances where insurance pricing may increase in forward years. Premiums would simply be higher in the absence of flood mitigation protection. It may also allow insurance to be made more available where coverage has been limited and prohibitively expensive in high risk areas.

- ***Significant economic value is at risk.*** Changes in weather risks can have a major influence on the payoffs from levee investments. Any increase in underlying natural disaster risks over the next few decades would effectively increase the returns from investments put in place today. Accordingly, these investments can play a key role in meeting Australia's future climate change adaptation agenda.

- ***Effective flood mitigation can be delivered at low cost.*** Flood mitigation investments are major forward-looking commitments that typically involve shared funding from several levels of government. Crucially, investments can involve relatively modest upfront expenditures with incremental additions and enhancements into the future. This pattern of gradually building up community level resilience can help address more immediate funding constraints.

Natural disaster policy frameworks

Australia’s natural disaster policy framework has many elements, including support by governments in disaster recovery and assistance payments, efficient insurance markets, land use planning and building codes, and programs to mitigate severe weather risks. Each of these elements has an important role for establishing an efficient and coordinated approach for natural disaster risk management — one which recognises that a balance of responsibilities between individuals, businesses and government (as both asset owners and policymakers) is needed.

A greater focus on protecting the community from extreme weather events has been shown in these case studies to be cost effective and contribute to safer, more resilient communities.

Analysis highlights that flood mitigation assets have the potential to provide economic payoffs which exceed $2.20 for each dollar spent.

Given the demands on government spending and in ensuring taxpayers’ money is well spent, establishing a robust business case is a vital pre-condition for council’s seeking to advance specific flood mitigation investments.

Introduction

A key factor driving the costs of natural disasters on Australian communities is the increased exposure of physical assets to natural disaster. Assets at risk such as buildings and infrastructure are growing in value as a result of economic development and population growth. Much of this exposure occurs along Australia's inland river systems affecting both regional towns and major urban centres.

Due to the large, and growing, costs of natural disasters and the devastating impact they have on communities, there is increasing awareness of the role of mitigation investments to address the risks of floods and other forms of natural disasters, particularly as a complement to disaster support and recovery.

In this context, Urbis has been engaged by Suncorp to examine the economic benefits of flood mitigation investments. This policy brief proposes a systematic and forward-looking framework for considering new flood mitigation activities. The framework is applied to three regional flood mitigation levees, highlighting how these investments can cost-effectively protect communities and build economic resilience, both now and well into the future when climate risks may become more pronounced.

Structure of the brief

This brief is structured in the following chapters. **Chapter One** discusses the nature and degree of flood risks in Australia and the damage which can be inflicted. This essentially sets out the baseline risks being faced by many regional towns. Simply, floods are an ever-present risk to regional populations and their economies. And these risks may also be changing — for the worse — because of climate change.

Chapter Two examines the role of mitigation investments in reducing community-wide vulnerabilities to floods. There are many aspects to these impacts, including to the built infrastructure and to the accessibility and pricing of insurance coverage for flood risks. Building on this examination, a framework for assessing such impacts, together with the costs of mitigation investments, is put forward. The framework provides for changing climate risks to be integrated in the analysis as specific scenarios.

Applying the business case framework, **Chapters Three, Four and Five** assess two specific regional mitigation investments in the Queensland towns of Roma and St George, and the New South Wales town of Grafton. The analyses shows that these mitigation investments have wide-ranging and long term protective attributes for the towns which provide a strong net benefit. Some policy implications for business case development of new mitigation options in other town centres are also discussed.

1 Flood risks in eastern Australia

Flood risks are an enduring feature of the Australian landscape and there is extensive history of devastating and economically costly floods in many towns and cities.

Queensland and NSW, due to their large inland waterways, are two states which are particularly prone to wide scale riverine flooding. In the case of Queensland, this is further compounded by its major exposure to tropical cyclones and related flooding events.

These weather events are exacerbated by the El Nino Southern Oscillation (ENSO) climate phenomenon which influences underlying weather patterns in Australia over long periods. This results in alternating cyclical patterns of El Nino and La Nina conditions, with the latter typically increasing the intensity and frequency of rainfall over much of the continent.

This chapter discusses the major aspects of flood risks in Australia, how these can damage economies and how underlying risks may be increasing because of changes in the climate.

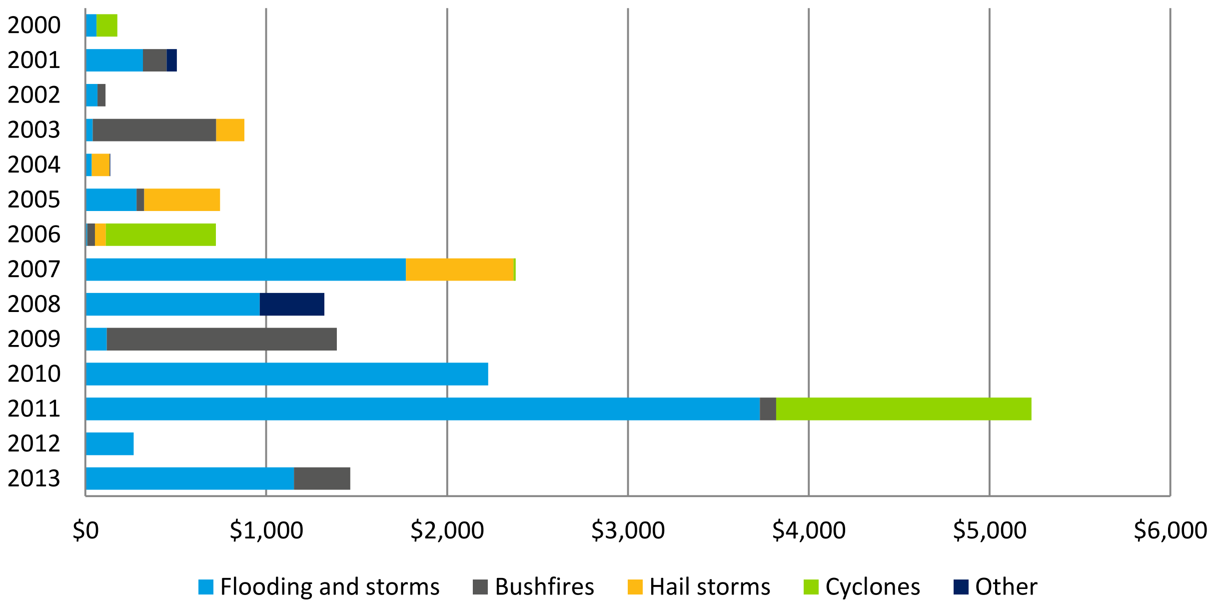
1.1 THE EXTENT AND NATURE OF FLOOD RISKS

Floods are the most expensive natural hazard in Australia. Figure 1.1 below shows the insured losses associated with floods and other natural disasters. These estimates are partial indicators of cost, and it should be noted that other forms of damage are also relevant. For instance, wider economic disruptions to agricultural productivity and other sectors, uninsured public and private assets and intangible costs such as those related to injuries, deaths and psychological stress are major cost components.

Some reports have estimated that insurance costs generally account for around 16% to 33% of the total costs of natural disasters. And in the case of flooding events, insurance costs can account for fewer than 20% of total costs (Bureau of Transport Economics 2001). Consequently, the total costs of flooding can be up to five times higher than the insured costs.

In a broader evaluation of the cost of severe flooding, the World Bank estimates the total cost of the 2010-11 Queensland floods was in excess of US$15 billion. These floods resulted in evacuations of over 70 towns, and washed away roads, railways, destroyed crops and halted Queensland's $20 billion coal export industry, making the flooding one of Australia's most expensive natural disasters. Although this flood was considered to be an extreme and low probability event, it clearly demonstrates the exposures of many population centres to catastrophic flooding events.

FIGURE 1.1 – INSURED COSTS OF SEVERE NATURAL DISASTERS ($ MILLIONS, 2011 PRICES)



Note: 2013 and 2012 figures have been adjusted for inflation
Source: Insurance Council of Australia

Flood risks and behaviour

There are four key means by which flooding events occur: heavy rainfall, storm surges, tsunamis and dam failures. Floods associated with heavy rainfall are the most frequent cause of flooding in Australia.

Because of their situation along waterways, regional communities in inland Australia are particularly exposed to riverine flood risks (many as a result of 'east coast low' and tropical cyclone weather patterns). Such floods tend to be slower rising but longer lasting events than storm surge and coastal flood events.

Flood risks are relatively localised and depend on the frequency of flooding and associated consequences to the community. Settlement issues are crucial.

Changing demographics within floodplains, such as the expansion and consolidation of town centres, and development of the built environment affect the scale of impacts on people, property and local economies. This is not to say that such development is a detriment — to the contrary, exposures are magnified because communities have become larger and more prosperous and have invested in greater physical assets. That said, it means locational risks need to be properly understood and, where exposures have increased, new ways of mitigating these risks evaluated and managed locally.

1.2 THE ECONOMIC IMPACT OF FLOODS

Floods, especially inland floods, can cover an incredibly large area, sometimes thousands of square kilometres. The floods in Queensland and NSW over the summer of 2010-11 affected an area larger than France and Germany combined. As noted, inland floods also tend to be longer duration events compared to coastal river flooding.

These characteristics have a number of economic dimensions. It can make post-disaster recovery and emergency responses more complex, requiring resources to cover substantial areas of inundation. It can also disrupt a greater range of economic activities such as mining and agriculture, and for longer. The 2010-11 Queensland floods affected coal supply chains for several months. Around 85% of Queensland coal mines were either restricted or closed entirely (Queensland Flood Commission). Many mines needed to be dewatered at a time when access to specialised equipment was highly constrained and physical access was difficult.

All types of disasters cause disruption or damage to capital stocks, the labour force and natural resources. In particular, the effects can be classified as direct, indirect and intangible impacts (see Table 1.1).

- Direct effects are the immediate physical damage caused by the disaster. This includes the damage which is immediately visible (for instance inundation of a house) and that which takes longer to appear (such as water damage which accelerates road deterioration).
- Indirect impacts are those financial costs which are not directly caused by the natural disaster. These impacts include the disruption to the community, households and businesses. They also cover clean up and repair costs, the costs of securing alternative accommodation and transport, and lost business production.

Framing the economic impacts of natural disasters

TABLE 1.1

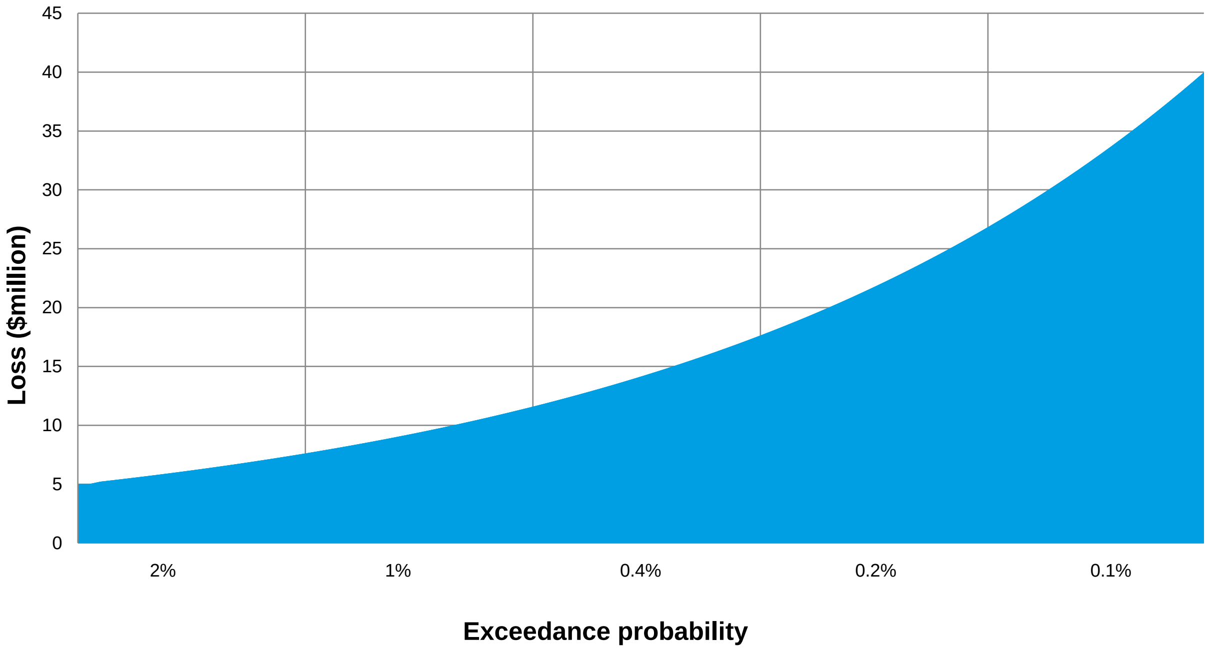
COSTS	DIRECT	INDIRECT
Tangible	• Damage to residential and commercial property • Damage to public infrastructure • Damage to crops and livestock	• Disruptions to transport and essential services networks • Disruptions to industrial production and other forms of productivity • Emergency responses and clean-up costs
Intangible	• Death and injuries • Ecological damage • Damage to cultural and heritage sites	• Emotional stress and anxiety • Disruptions to daily life • Cultural and heritage losses

At specific locations, such as towns and cities, flood risk is measured in terms of precise probabilities. These are expressed as a function of frequency and severity. Minor floods are more likely than the most severe and catastrophic events.

The relationship between probabilities and potential losses or damages is shown through an annual exceedance probability curve (AEP) (see Figure 1.2 below). This describes the probability that various levels of loss will be exceeded. A 1% AEP flood event shows expected flood losses with a 1% chance of being exceeded annually.

The shape of the exceedance curve has implications for structural flood mitigation measures. The sharper it rises, the greater the potential losses from higher probability flood events, and thus the greater the protective capacity of a mitigation investment at a given flood rating.

FIGURE 1.2 – RELATIONSHIP BETWEEN FLOOD DAMAGE AND LIKELIHOOD



The changing nature of natural disaster risks

Australia's climate has a high degree of natural variability. Fluctuations in annual rainfall are greater than any other continent, leading to extended periods of drought and periodic flooding events. In many ways, this fundamental variability can mask changes in the climate, with perceptions that natural variations are much more significant.

Over the next hundred years, some aspects of Australia's climate such as rainfall patterns and average temperatures are projected to change.

The analysis was undertaken on the basis of current weather patterns.

Looking forward, climate change could compound the risks of disruption from flooding and more frequent and intense storms. A key implication is that any increase in underlying natural disaster risks in the decades ahead would effectively increase the returns from mitigation investments made today. Accordingly, these investments can play a key role in meeting Australia's future climate change adaptation agenda.

2 The benefits of flood mitigation

Australia's recurring history with riverine and coastal floods has, understandably, led to longstanding attention on different approaches to flood management and protection.

While various major flood mitigation investments to protect communities from severe flood events have occurred, other approaches to mitigating flood risks have been somewhat haphazard. For instance, substantial development across jurisdictions has occurred in highly flood prone areas (some of which was made under incomplete information about the underlying flood risk). There remains substantial areas where better ways to protect the communities can be put in place.

Disaster mitigation measures encompass a broad range of structural and non-structural activities:

- Public infrastructure to reduce the community-wide exposures to catastrophic damage such as flood levees, storm embankments and fire breaks.
- Private modifications to reduce the potential damage to individual assets such as clearing yards and raising the height of homes. They can involve both retro-fitted structural measures and building regulations for new homes.
- Response measures which enable faster, earlier and more widespread pre-emptive actions ahead of and during a disaster event. Weather monitoring and sms-based warning systems for cyclone, flood and bushfire threats are an example of such measures.

This brief centres on large-scale public flood mitigation investments to reduce the economic cost of natural disasters.

What risks are involved?

Disaster mitigation measures seek to reduce the underlying risk of a natural hazard to a community. Risk is fundamentally a function of two elements: likelihood and consequence. The former relates to the probability of disaster event occurring and the latter concerns the damage and cost an event could impose. Simply, risks are higher when there is a greater probability of a disaster occurring and if these events are likely to have devastating consequences.

The likelihood of disaster events is largely a natural phenomenon. Even in instances where human activities have a bearing, such as climate change, the policy avenues for altering weather patterns are very long term. Accordingly, policy attention is focused on mitigating the impacts of disaster events rather than their prevalence.

There are several development factors which influence the economic consequences of natural disasters. Increasing population and growth of the built environment — typical outcomes from economic progress — increase the 'value at risk' from a given disaster event. In effect, there are more people and more assets exposed to disaster risk. The Brisbane floods of 1974 and 2011 highlight this development change, with population in the city roughly doubling in the period between these events. In fact, the 2011 flood was lower than that in 1974 but caused much more residential asset damage due to increased population and density.

These changing issues highlight an important time dimension to risk. The risks today and the risks into the future are different.

Mitigation measures, which are almost all very long term investments, thus provide a level of protection on the basis of current settlement patterns and the stock and quality of built infrastructure, as well as those that will exist many years and decades from now.

This capacity to address both present and future risks is a crucial aspect in any mitigation investment decision (as discussed below).

It should be noted that these measures do not protect against all flood risks. Mitigation infrastructure, and its costs, needs to reflect community standards on appropriate risk reduction measures.

In terms of the community's overall risk exposure to natural hazards, it should be noted that it is neither practical nor economically feasible to eliminate all risk. Rather, the aim is to reduce risks to a socially acceptable level — one which is proportionate to the balance of probability and the costs of protection. Indeed, this is a factor in many facets of policymaking, such as road safety, tax compliance and border security, where the payoffs from eliminating residual risks are substantially outweighed by the costs.

What factors influence the potential benefits from flood mitigation investments?

Mitigation investments, as in all forms of investment, are ideally made by examining their benefits and costs. The benefits here predominantly involve the protective capacity of respective structures, which are measured in terms of the costs which are effectively avoided by mitigation works.

A few generalisations can be made in terms of the cost benefit calculus. First, cost effectiveness is typically enhanced when structural works protect a larger number of people and properties. This helps spread the costs and compound the benefits from a given investment. Second, when natural hazard exposures are higher at both a severe and extreme level, the potential payoffs from mitigation increase. Where such events are a recurrent feature of the environment, such as the experience with floods in many Australian waterways, measures to limit damage yield more constant economic returns.

Flood mitigation can improve insurance coverage

A key aspect of flood mitigation is its impact on insurance markets. Private insurance markets provide a means of addressing the risks of natural hazards by spreading or ‘pooling’ the costs of losses across a wider group (e.g. policyholders, insurers, reinsurers). Insurance does not reduce the risks to the community or mitigate the actual damages of a natural disaster, it redistributes the costs — simply, many people pay to cover the losses of a few.

In some parts of Australia, the availability and/or affordability of flood insurance has been a major issue for households and small businesses. In some cases, insurers facing high and uncertain risk have entirely withdrawn coverage for flood exposures, or are pricing flood insurance at levels many consumers find prohibitive.

Exclusions and pricing are rightful commercial decisions by insurers. However, coverage for specific risks has implications for consumers, government and the industry. And reduced private risk management can increase overall reliance on government disaster assistance (as an ‘insurer of last resort’). Crucially, this can affect immediate post-disaster costs for taxpayers and entrench community attitudes on a greater role for government in disaster assistance over the longer term, thus placing pressure on future costs.

In this context, flood mitigation provides several benefits for insurance markets. By reducing inherent risk exposures for towns and regions, it can facilitate the entry of insurers into the market where they were previously absent, and it can put downward pressure on premiums. Both of these matters, in isolation and together, will encourage increased levels of risk management across a community, thereby improving levels of uninsurance and underinsurance.

Developing the business case for flood mitigation investments

Local governments generally lead the implementation of mitigation measures within their jurisdictions. Because of the larger scale of structural mitigation works, funding from state and federal governments is often required — as is the case with many forms of infrastructure investment. These funding arrangements reflect the broader economic ramifications of natural disasters. Damage from catastrophic weather events extends far more broadly than those regions suffering actual physical loss. This includes impacts to agricultural and mining production, and the provision of government-sponsored disaster relief, which are borne by all taxpayers.

Because of the public policy issues and government funding requirements, the business case of natural disaster mitigation options becomes a *public* business case. This rests on evaluating the full range of economic and social benefits and costs of respective mitigation options.

Costs tend to be easier to identify, and mostly involve the direct financial costs of investments (although there can be other costs such as a loss of natural amenity). Evaluating benefits is often less straightforward and involves identifying the avoided costs from limiting future economic losses.

These avoided costs or the protective capacity of mitigation works fall into three main categories:

- direct financial impacts such as structural damage and loss of agricultural productivity
- indirect financial impacts involving costs not directly caused by the disaster, such as those associated with business disruptions, clean-up costs and emergency responses
- intangible (non-monetary) costs such as those arising from environmental damage, deaths and loss of health and heritage assets.

In addition, the potential for mitigation investments to secure other economic payoffs such as better functioning insurance markets (and reduced insurance premiums) and an investment environment more conducive to productive commercial enterprise needs to be recognised.

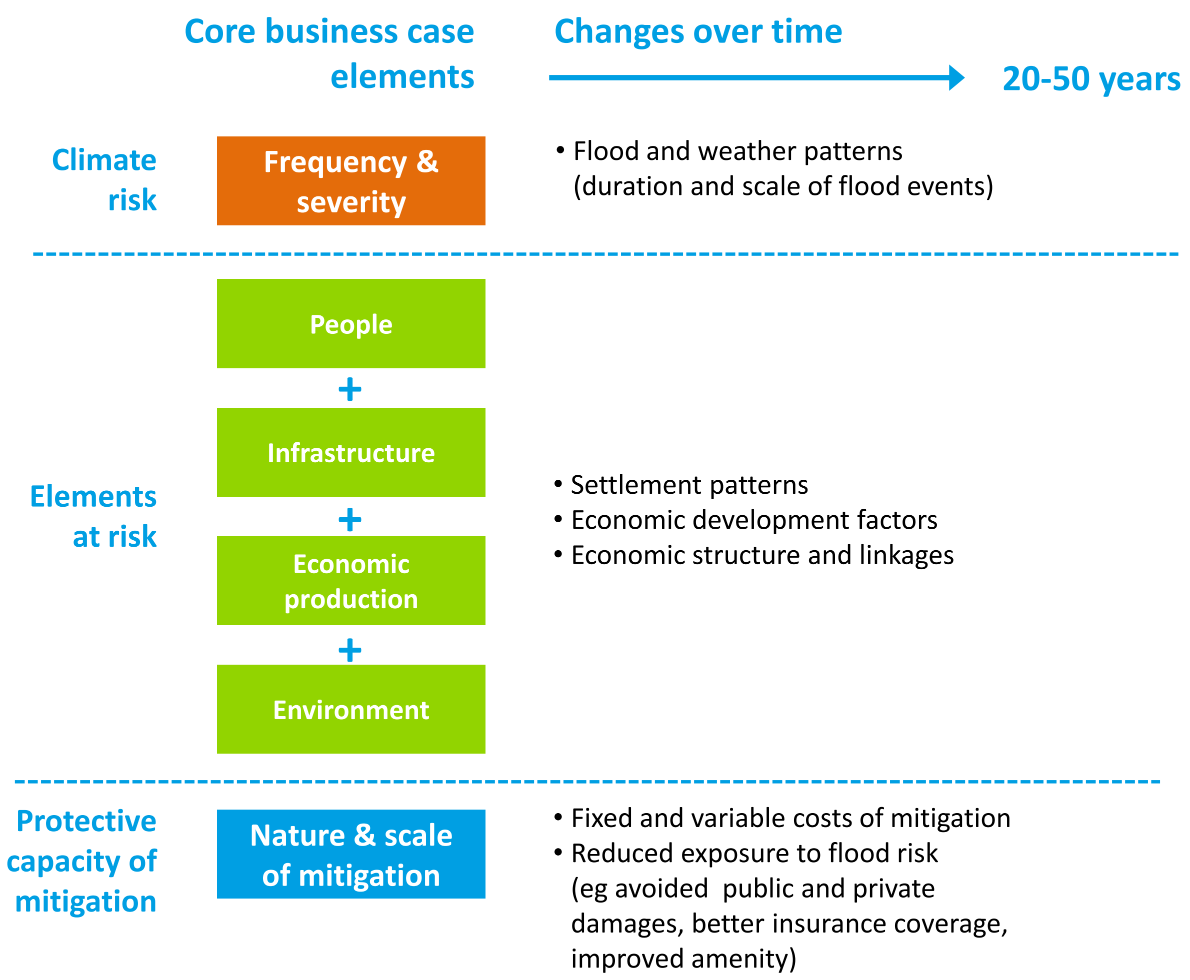
The core elements of this evaluation are set out in Figure 2.1. These align with accepted principles of cost benefit analysis of mitigation options which were recently reinforced in the Productivity Commission's *Natural Disaster Funding Arrangements* draft report (September 2014).

The extent and quality of project evaluation in Australia is varied. While there are instances of very good decision making processes, many significant infrastructure investments have been made in the absence of systematic cost benefit analysis. Indeed, the risks of suboptimal investment decisions can be greater when they involve large projects offering highly concentrated benefits but with diffuse costs.

As highlighted, the issues of 'how likely and how bad' are the threats from natural disasters underpin the economic case for flood mitigation investments. The strongest business cases for new flood mitigation works will establish clearly the scale and dimensions of these factors within the context of local and regional settings, and how they may change over the very long term (say over a 20-50 year time horizon).

The case studies discussed below highlight the elements which should underpin the development of robust business cases for new flood mitigation investments.

FIGURE 2.1 – ELEMENTS OF A BUSINESS CASE ON FLOOD MITIGATION INVESTMENTS



3 Case Study: The Roma flood levee

Roma is a rural town in South West Queensland. It is situated between the junction of the Warrego and Carnarvon highways which serve as the main entry points into the town. Roma is the largest town in the broader region of Maranoa.

The town is traversed by Bungil Creek which joins the Balonne River 7 kilometres west of Surat. Roma has a long history of flood events and has recently completed a flood levee to protect the town.

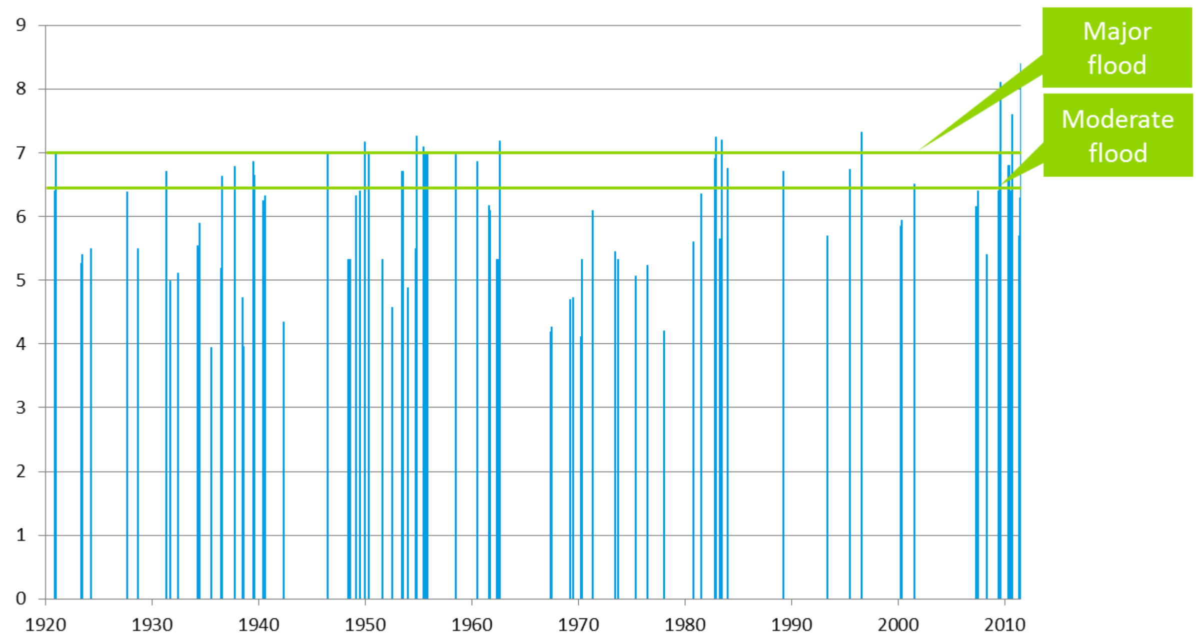
3.1 ROMA'S FLOOD HISTORY

The Bungil Creek catchment has an extensive history of high river level peaks, which lead to serious and prolonged flooding events. As illustrated in the Chart 3.1 below, annual peaks at Bungil Creek show regular peaks above 6 metres over the last one hundred years, including a recent period of major flood events since 2010.

- In 2010, the Bungil Creek in the Condamine-Balonne catchment overflowed several times. It peaked at 7.0 metres in February 2010 and 8.1 metres in March 2010.
- In April 2011, Roma was again inundated after heavy rainfalls. Bungil Creek peaked at 7.65 metres, leading to dozens of people being evacuated from their homes.
- In February 2012, a very significant rainfall event occurred over southern inland Queensland and northern NSW. This occurred over catchments that were already saturated from flooding rains the previous month. This rainfall led to record to levels of 8.40 metres in February. This was Roma's worst flood in its history, eclipsing the 2010 floods. Within the town, 444 homes were inundated, twice as many in previous years.
- Over the last 50 years, there have been 18 moderate and 8 major flooding events in Roma.

HISTORICAL ANNUAL PEAK (METRES) AT BUNGIL CREEK, 1920–2014

CHART 3.1



Source: Bureau of Meteorology

3.2 NEW FLOOD MITIGATION INVESTMENTS IN ROMA

To address the ongoing risk of flooding in Roma, an extensive flood mitigation system has recently been completed in the town (see Figure 3.1). Stage 1 of the project comprises a 5.2 kilometre levee, which reaches a maximum height of 4 metres, to protect the town centre and surrounding community from rising river levels. It has been built to withstand a 0.1% AEP event and about 500 homes and businesses will be protected from over-the-floor flooding by the levee structure. The capital costs of Stage 1 were approximately $16 million with minimal operating and maintenance costs per year.

Stage 2 is still in concept stage, but is intended to provide additional protection by further fortifying the existing flood infrastructure.

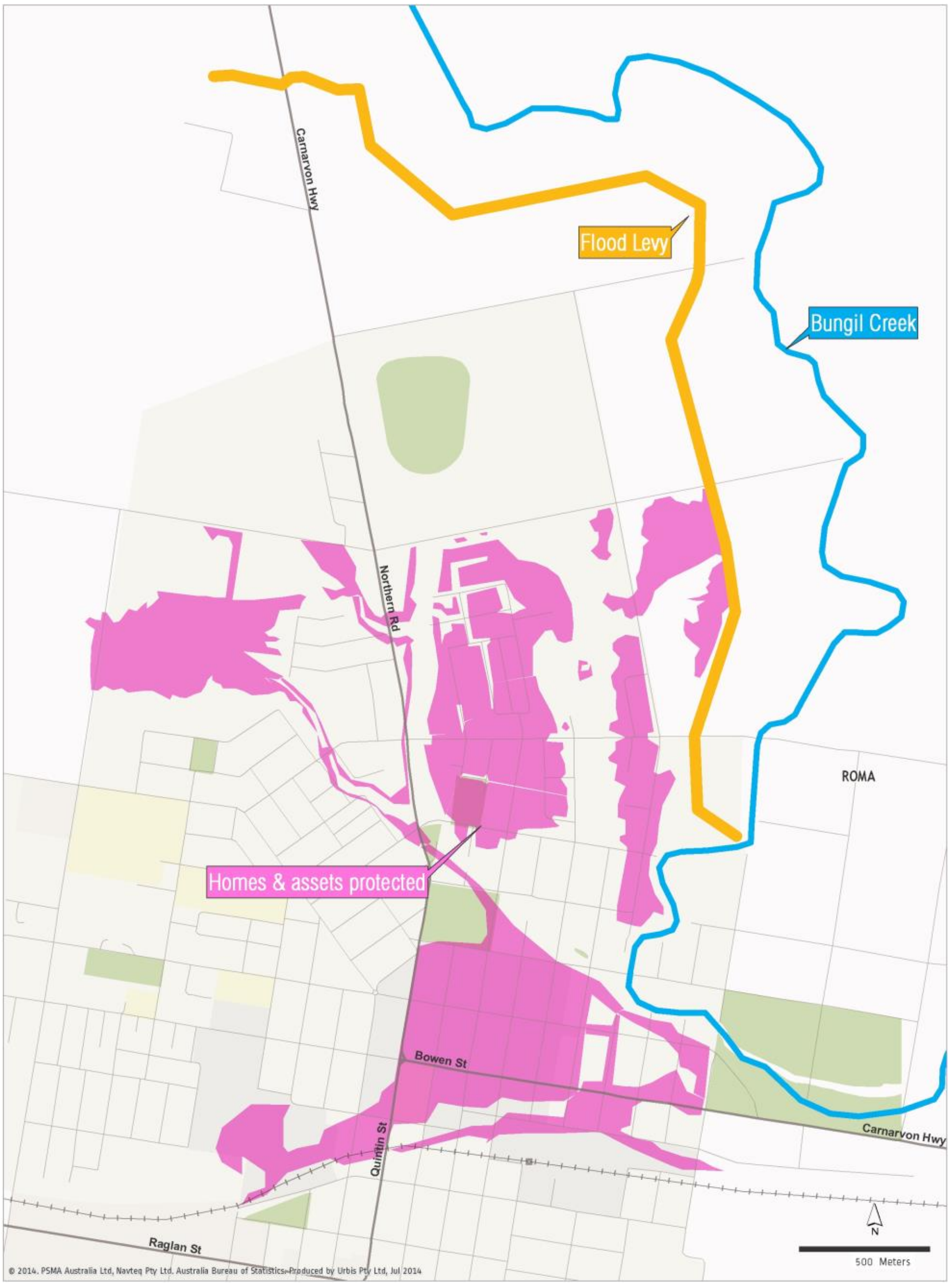
The latest proposed elements for Stage 2 protections include:

- over 3 km of new levees, including an extension of the existing stage 1 levee
- 5.2 km of new and upgraded two floodway channel diversions
- widening and deepening a 3.4 km long drain at Bungil Creek
- expansion of the Roma Railway Dam
- 1.6 km of new storm water drainage systems.

Detailed costings for these options are still being finalised and will depend on the specific features of each component. The economic feasibility of Stage 2 will thus be subject to ongoing consideration.

The assessment has incorporated the Stage 1 mitigation project only. Further analysis of Stage 2 could be undertaken applying the framework outlined in this report, which has been designed to assist Councils with their evaluation of new flood mitigation investment options.

FIGURE 3.1 – MAP OF ROMA'S FLOOD LEVEE SYSTEM



SNAPSHOT OF ROMA AND THE MARANOA REGION

TABLE 3.1

REGION SNAPSHOT	
Population	6,906
Average number of people per household	2.6
Number of residential properties	Occupied – 2,244 Unoccupied – 329
Number of businesses	1,173
Key industries (% of Gross Regional Product)	Mining – 27.8% Agricultural, forestry and fishing – 14.9% Public administration and safety – 6.5% Construction – 5.9% Health care and social assistance – 4.8% Industry composition is for the Maranoa LGA. Roma functions as the region's major service centre and business hub.
Current flood mitigation system	• A 5.2 km levee embankment levee runs from north of the Roma airport across the Carnarvon Highway and follows Bungil creek (along the eastern side of the town). • Protection against over-the-floor flood risk for approximately 483 homes. • Designed to protect against a 0.1% AEP flood. • Cost $16 million to construct.

Source: ABS, Maranoa Regional Council

3.3 THE ECONOMIC BENEFITS OF ROMA'S FLOOD LEVEE

An analysis of Stage 1 of the Roma flood mitigation system was undertaken based on the framework outlined in Chapter 2.

This framework was structured around three modules: climate risk, elements at risk (or 'value at risk'), and the protective capacity of mitigation investments. Evaluation was conducted over a 50 year period going forward, reflecting the long term nature of the levee structure.

The analysis adopted a conservative financial-based approach and did not consider the additional social and environmental costs associated with flooding.

Climate risk

A general climate risk scenario was examined, based on a continuation of current weather patterns for the region.

This was overlayed onto technical assessments of flood risks for Roma which projected expected damages for different scale flood events.

Elements at risk

The study evaluated the town's current economic composition, namely its industry profile, residential housing and public infrastructure profile. These figures were based on information obtained from Maranoa Regional Council and Australian Bureau of Statistics. As evaluations were conducted over a 50 year period going forward, the study incorporates longer term structural change.

For example, according to the Queensland Treasury, the population of Roma is projected to grow at an annual average rate of 1.0% over 50 years. This growth was factored into the analysis with attendant increases in the scale and value of physical assets within the town.

Urbis' analysis of flood damage to households was based on available technical assessments of property damage by Maranoa Council, prepared by GHD and Engeny Water Management. These assessments stressed the limitations of existing property data, including the form and type of residential properties likely to be impacted.

Protective capacity of mitigation

The analysis examined major direct and indirect tangible costs resulting from flooding, such as damage to private and public assets, regional production and productivity losses.

Reductions in insurance premiums were included on the basis that construction of a flood levee reduces uncertainty and therefore provides greater ability by insurers to adequately and appropriately price premiums based on risk. Discounts to risk premiums were calculated on the basis of average premiums paid in 2014. A 60% reduction in insurance premiums is expected in Roma based on market information from insurers. This discount was applied to households and businesses considered at risk of flooding.

The main costs of the flood mitigation investment examined were the initial capital investment, as well as ongoing maintenance and operating costs. These totalled around $16.4 million on a present value basis. It should be noted that the annual upkeep requirements for the mitigation structures are minimal.

On the basis of current weather patterns and flood risks, the flood levee is expected to provide a broad range of protective benefits:

- Benefits to physical assets comprise around $18.4 million in avoided damages to residential property, $7.6 million to business assets and $4.5 million in public infrastructure.
- About $10.9 million in avoided productivity losses from disruption to services and business access in the town and immediate surrounds.
- Better insurance coverage for residents of approximately $39.7 million.

These benefits have a total present value of around $81.1 million.

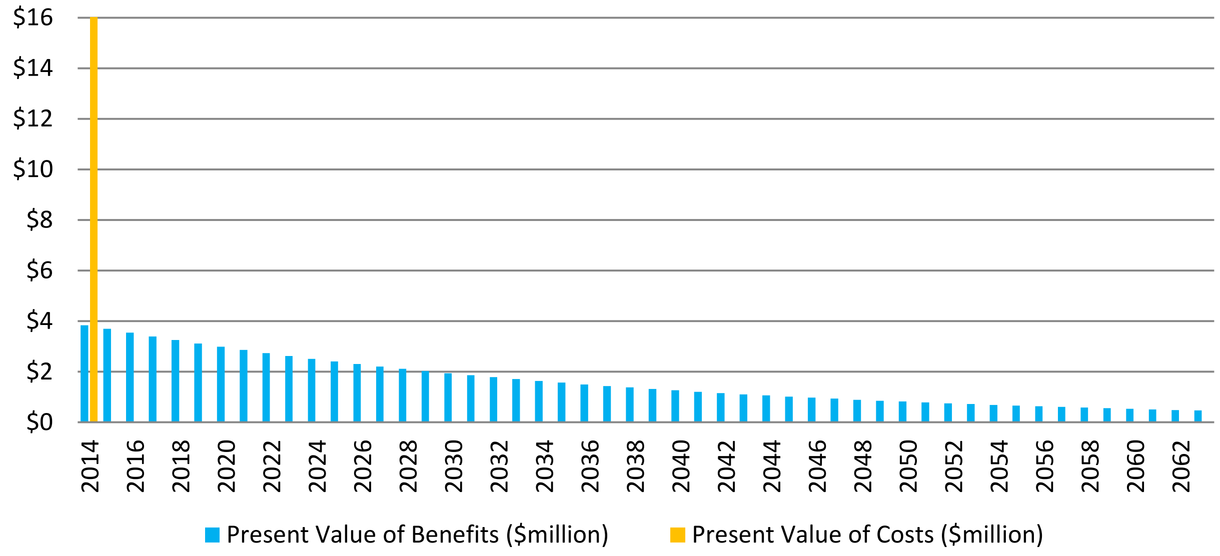
Flood mitigation investments involve large front loaded costs, but from that point are very long lived assets with little ongoing maintenance requirements. They effectively 'lock in' the costs from commissioning and provide ongoing benefits gradually and cumulatively for many decades. The general pattern of these net impacts is shown in Chart 3.2.

That said, local government experiences in managing flood levee investments indicate that some potentially more significant capital repairs are sometimes required over a 20-30 year period. This is especially driven by periods of intense flooding which can stress and damage levee systems. These costs, which are more difficult to anticipate, reflect the underlying hazards they are designed to protect.

While the Roma, St George and Grafton levee structures will be exposed to these longer term risks, they are unlikely to materially alter the projected cost profile of the investments.

Roma flood levee — sequencing of impacts

CHART 3.2



Note: Annual operating and maintenance costs are minimal and are not shown on the chart scale.
Source: Urbis

The analysis shows a strong net benefit based on the protective capacity of the region's mitigation system. The levee investment is estimated to have an indicative benefit cost ratio (BCR) of 4.9, indicating a return on investment for the community of $4.90 for each dollar spent.

The results of the analysis are summarised in Table 3.2 below.

TABLE 3.2 – SUMMARY OF ESTIMATED BENEFITS OF ROMA'S FLOOD MITIGATION SYSTEM

Appraisal period	50 years
Capital costs	$16 million
Whole of life costs	$18 million
Discount rate	7%
Inflation rate	2.5%
Cost-benefit analysis ($ million)	
	Present value over 50-years
Present value of benefits (avoided costs)	
Household	$18.4
Businesses	$7.6
Public infrastructure	$4.5
Productivity	$10.9
Better insurance coverage	$39.7
Present value of benefits	$81.1
Present value of costs	
Flood mitigation capital investment	$16
Maintenance	$0.4
Present value of costs	$16.4
Cumulative Net Present Value	$64.7
Benefit Cost Ratio	**4.9**

Note: Columns may not total precisely due to rounding.
Source: Urbis estimates

4 Case Study: The St George flood levee

St George is rural town located in South West Queensland. It is situated between the junction of several main highways (Carnarvon Highway, Balonne Highway, Castlereagh highway and Moonie Highway). St George is the largest town in the broader region of Balonne Shire.

The Balonne River passes through the town of St George and is a continuation the Condamine River at Surat. St George has a long history of flood events and has recently completed a flood levee to protect the town.

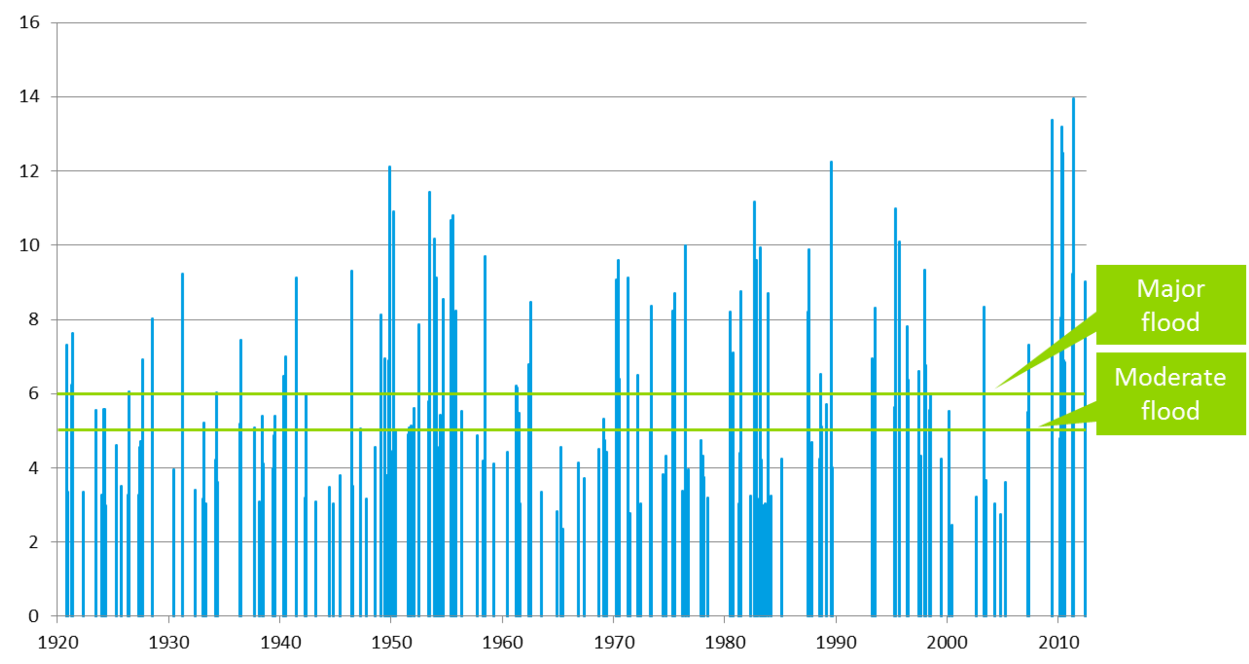
4.1 ST GEORGE'S FLOOD HISTORY

The Balonne River catchment has an extensive history of high river level peaks, which lead to serious and prolonged flooding events. As illustrated in Chart 4.1 below, annual peaks at Balonne River show regular peaks above 8 metres over the last one hundred years. This includes a recent period of acute flooding, where heights of 13.95 metres were reached.

- In March 2010 heavy rainfall was recorded at the Condamine/Balonne catchment, producing widespread major flooding. Flood levels at St George peaked at 13.39 metres.
- In December 2010 – January 2011 the area suffered another flood following heavy rainfalls. The floods peaked in St George at 13.2 metres.
- In February 2012, significant rainfall occurred over southern inland Queensland, into catchments that were already saturated from the previous month. This event led to record flooding, which peaked at 13.95 metres at St George.
- Over the last 50 years there have been 74 moderate and 57 major flooding events in St George.

HISTORICAL ANNUAL PEAK (METRES) AT BALONNE RIVER, 1920–2014

CHART 4.1



Source: Bureau of Meteorology

4.2 NEW FLOOD MITIGATION INVESTMENTS IN ST GEORGE

To address the ongoing risk of flood in St George, an extensive flood mitigation system has recently been competed in the town (see Figure 4.1). Stage 1 of the project comprised of a 4.7 km levee to protect the town centre and surrounding community from rising river levels. The capital costs of Stage 1 were approximately $5.7 million with minimal operating and maintenance costs per year. Stage 2 of the flood mitigation system has recently been completed. The flood levee system is able to withstand flooding up to a height of 14.5 metres. Through the levee and other supporting mitigation measures, about 90% of the St George township will be protected from future flood events.

FIGURE 4.1 – MAP OF ST GEORGE'S FLOOD LEVEE SYSTEM

TABLE 4.1 – SNAPSHOT OF ST GEORGE AND THE BALONNE SHIRE

REGION SNAPSHOT	
Population	3,292
Average number of people per household	2.7
Number of residential properties	Occupied – 1,108 Unoccupied – 249
Number of businesses	433
Key industries	Agriculture Retail Health and community services Transport Business services
Current flood mitigation system	• 4.7 km levee that protects homes and the aged care facility at the southern and northern ends of the town (stage one). Stage two consists of a wall that joins the levees in the middle to protect the main part of town. • Cost of $5.7 million to construct the mitigation system. The project was funded through State and Federal funding and a partnership between the Balonne Shire Council and the Churches of Christ, owners of the Warrawee Aged Care facility. • Current flood mitigation systems protect the town from flood heights up to 14.5 metres.

Source: ABS, Balonne Regional Council

4.3 THE ECONOMIC BENEFITS OF ST GEORGE'S FLOOD LEVEE

An analysis of St George's flood mitigation system was undertaken based on the framework outlined in Chapter 2.

This framework was structured around three modules: climate risk, elements at risk (or 'value at risk'), and the protective capacity of mitigation investments. Evaluation was conducted over a 50 year period going forward, reflecting the long term nature of the levee structure.

The analysis adopted a conservative financial-based approach and did not consider the additional social and environmental costs associated with flooding.

Climate risk

A general climate risk scenario was examined, based on a continuation of current weather patterns for the region.

This was overlayed onto technical assessments of flood risks for St George which projected expected damages for different scale flood events.

Elements at risk

The study evaluated the town's current economic composition, namely its industry profile, residential housing and public infrastructure profile. These figures were based on information obtained from Balonne Shire council and Australian Bureau of Statistics. As evaluations were conducted over a 50 year period going forward, the study incorporates longer term structural change.

For example according to the Queensland Treasury, the population of St George is projected to decline at an annual average rate of -0.02% over 50 years. This decline was factored into the analysis, especially in terms of future growth in the scale and value of the town's physical assets.

Protective capacity of mitigation

The analysis examined major direct and indirect tangible costs resulting from flooding, such as damage to private and public assets, regional production and productivity losses.

Reductions in insurance premiums were included on the basis that construction of a flood levee reduces uncertainty and therefore provides greater ability by insurers to adequately and appropriately price premiums based on risk. Discounts to risk premiums were calculated on the basis of average premiums paid in 2014. A 30% reduction in insurance premiums is expected in St George based on market information from insurers. This discount was applied to households and businesses considered to be at risk of flooding.

The main costs of the flood mitigation investment examined were the initial capital investment, as well as ongoing maintenance and operating costs. These totalled around $5.9 million on a present value basis.

On the basis of current weather patterns and flood risks, the flood levee is expected to provide a broad range of protective benefits:

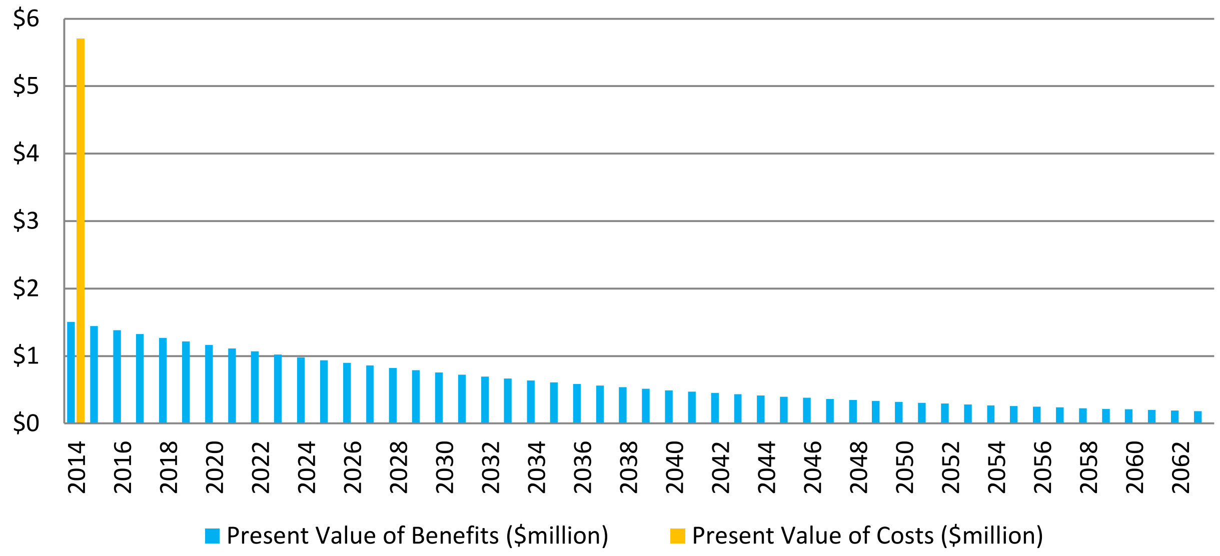
- Benefits to physical assets comprise around $7.6 million in avoided damages to residential property, $3.8 million to business assets and $2.3 million in public infrastructure.
- About $5.4 million in avoided productivity losses from disruption to services and business access in the town and immediate surrounds.
- Better insurance coverage for residents of approximately $12.6 million.

These benefits have a total present value of around $31.6 million.

As in the case of Roma, St George's flood mitigation investment involves large front loaded costs and are very long lived assets with little ongoing maintenance requirements. They effectively 'lock in' the costs from commissioning and provide ongoing benefits gradually and cumulatively for many decades. The general pattern of these net impacts is shown in Chart 4.2.

St George flood levee — sequencing of impacts

CHART 4.2



Note: Annual operating and maintenance costs are minimal and are not shown on the chart scale.
Source: Urbis

The analysis shows a strong net benefit based on the protective capacity of the region's mitigation system. The levee investment is estimated to have an indicative BCR of 5.4, indicating a return on investment for the community of $5.40 for each dollar spent.

The results of the analysis are summarised in Table 4.2 below.

TABLE 4.2 – SUMMARY OF ESTIMATED BENEFITS OF ST GEORGE'S FLOOD MITIGATION SYSTEM

Appraisal period	50 years
Capital costs	$5.7 million
Whole of life costs	$6.7 million
Discount rate	7%
Inflation rate	2.5%
Cost-benefit analysis ($ million)	
	Present value over 50-years
Present value of benefits (avoided costs)	
Household	$7.6
Businesses	$3.8
Public infrastructure	$2.3
Productivity	$5.4
Better insurance coverage	$12.6
Present value of benefits	$31.6
Present value of costs	
Flood mitigation capital investment	$5.7
Maintenance	$0.2
Present value of costs	$5.9
Cumulative Net Present Value	$25.7
Benefit Cost Ratio	**5.4**

Note: Columns may not total precisely due to rounding.
Source: Urbis estimates

5 Case Study: The Grafton flood levee

Grafton is a town situated along the Clarence River in north-east New South Wales. The town encompasses an intersection between the Pacific Highway, the primary north-south route in Eastern Australia, and the Gwydir Highway, a major east-west route. Grafton serves as a commercial centre for regional agribusiness due to the area's abundance of fertile river-flats for sugarcane plantations and mixed-farming activities.

The town is bisected by the Clarence River, one of the most extensive river systems in New South Wales which acts as the main stem for 24 tributaries of varying sizes.

Following a series of damaging floods in the 1940s and 1950s, the Clarence River County Council was formed in 1959 to execute flood mitigation plans for all shires in the floodplain.

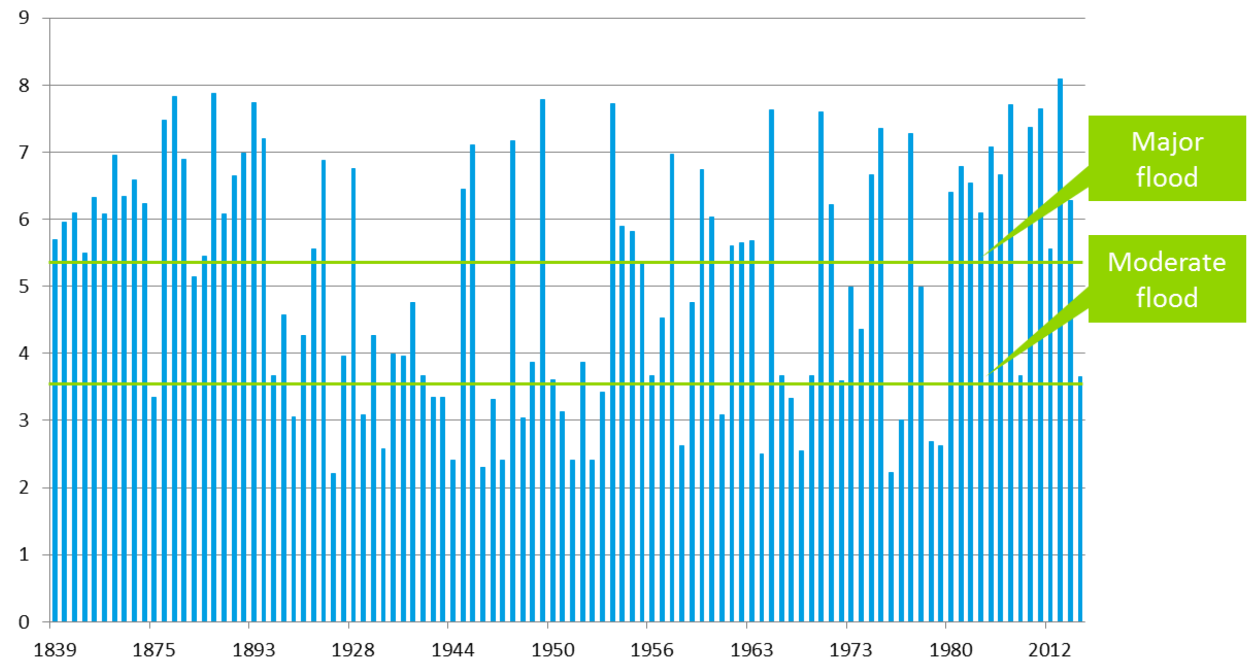
5.1 GRAFTON'S FLOOD HISTORY

Grafton has an extensive history of flooding dating back to 1839 (see Chart 5.1). Over the last 50 years there have been 26 moderate and 19 major floods at Grafton. Most recent major floods occurred in 2001, 2009, 2011 and 2013 in which peak river levels reached above 7.3m.

The January 2013 flood was one of the largest floods on record, peaking at a new record height of 8.1m, surpassing the previous record of 7.9m set in 1980.

HISTORICAL ANNUAL PEAK (METRES) AT CLARENCE RIVER (PRINCE ST), 1839–2014

CHART 5.1



Source: Clarence Valley Council

5.2 GRAFTON'S FLOOD MITIGATION INVESTMENTS

To address ongoing flood risks in Grafton, flood mitigation systems were installed periodically over several decades (see Figure 5.1). The Grafton levee was constructed in the late 1970s and South Grafton levee was completed in 1997.

Current valuations of the flood mitigation system are approximately $42.6 million. The system offers protection rated at 5% AEP. While it was initially built to withstand a 1% AEP flood, its risk rating was subsequently downgraded following more recent hydrology and flood modelling.

The flood events in Grafton over the last decade were effectively mitigated by the town's levee system, with minimal external damage to business and residential assets. This successive series of floods resulted in some damage to the levee system itself (for sure, a much better outcome than the alternative) and repair works to the levee structures has been scheduled over the next few years. The cost of these works is approximately $3.7 million.

FIGURE 5.1 – MAP OF GRAFTON'S FLOOD LEVEE SYSTEM

TABLE 5.1 – SNAPSHOT OF GRAFTON AND CLARENCE VALLEY

REGION SNAPSHOT	
Population	18,359 (approximately 10,200 residents are directly protected by the Grafton flood mitigation system)
Average number of people per household	2.4
Number of residential properties	Occupied – 7,086 Unoccupied – 678
Number of businesses	1,317
Key industries	Retail Health care and social assistance Manufacturing Public administration and safety Financial and insurance services
Current flood mitigation systems (includes structural projections for central Grafton and across the Clarence Valley LGA)	• 110 km of levee • 18 km rock protection • 50 bridges • 500 floodgates • 250 flood mitigation drains

Source: ABS, Clarence Valley Council

5.3 THE ECONOMIC BENEFITS OF GRAFTON'S FLOOD LEVEE

An analysis of Grafton's flood mitigation system was undertaken based on the framework outlined in Chapter 2.

This framework was structured around three modules: climate risk, elements at risk (or 'value at risk'), and the protective capacity of mitigation investments. Evaluation was conducted over a 50 year period going forward, reflecting the long term nature of the levee structure, coupled with an additional historical perspective (see below).

The analysis adopted a conservative financial-based approach and did not consider the additional social and environmental costs associated with flooding.

The Grafton flood levy system is a longstanding community asset which has been in place for several decades in some form or another (different stages and extensions to the system occurred over many years). This legacy element has an impact on a forward looking cost benefit analysis. Essentially, the largest capital costs have already occurred and the analysis captures the future stream of protective benefits and O&M costs only. In this way, it can paint a somewhat exaggerated picture of the economic merits of the flood mitigation system.

To incorporate the historical capital costs of the levee system, the 'starting point' of the analysis has been drawn back to 1990. This timeframe reflects the period in which the Grafton levee system was substantially completed. It also incorporates the benefits to the town over the period, including substantial protection from major flood events during the previous decade.

While cost benefit analysis is almost always forward-looking, integrating these legacy elements (both benefits and costs) provides a more complete picture of the economic merits of the Grafton flood mitigation system. Importantly, it captures the substantial front loaded nature of the infrastructure investment.

Climate risk

A general climate risk scenario was examined, based on a continuation of current weather patterns for the region.

This was overlayed onto technical assessments of flood risks for Grafton which projected expected damages for different scale flood events.

Elements at risk

The study evaluated the town's current economic composition, namely its industry profile, residential housing and public infrastructure profile. These figures were based on information obtained from Clarence Valley Council and Australian Bureau of Statistics. As evaluations were conducted over a 50 year period going forward, the study incorporates longer term structural change.

For example according to Clarence Valley Council, the population of Grafton is projected to decline at an annual average rate of -0.02% over 50 years. This decline was factored into the analysis, especially in terms of future growth in the scale and value of the town's physical assets.

Urbis' analysis of flood damage to households was based on available technical assessments of property damage by Clarence Valley Council, prepared by Bewsher Consulting. These assessments stressed the limitations of existing property data, including the form and type of residential properties likely to be impacted.

Protective capacity of mitigation

The analysis examined major direct and indirect tangible costs resulting from over the flooding, such as damage to private and public assets, regional production and productivity losses.

The analysis incorporated future decreases in insurance premiums of around 30% for the highest risk households in Grafton. This has been informed by recent pricing decisions by Suncorp in the town. It should be noted that these benefits could be substantially higher and broader based going forward if contemporary flood risk data was available to insurers. It is understood Clarence Valley Council is considering undertaking a detailed floor height mapping profile of Grafton which would support insurers' future flood risk assessments.

The main costs of the flood mitigation investment examined were the ongoing maintenance and operating costs. These totalled around $5.4 million on a present value basis.

On the basis of current weather patterns and flood risks, the flood levee is expected to provide a broad range of protective benefits:

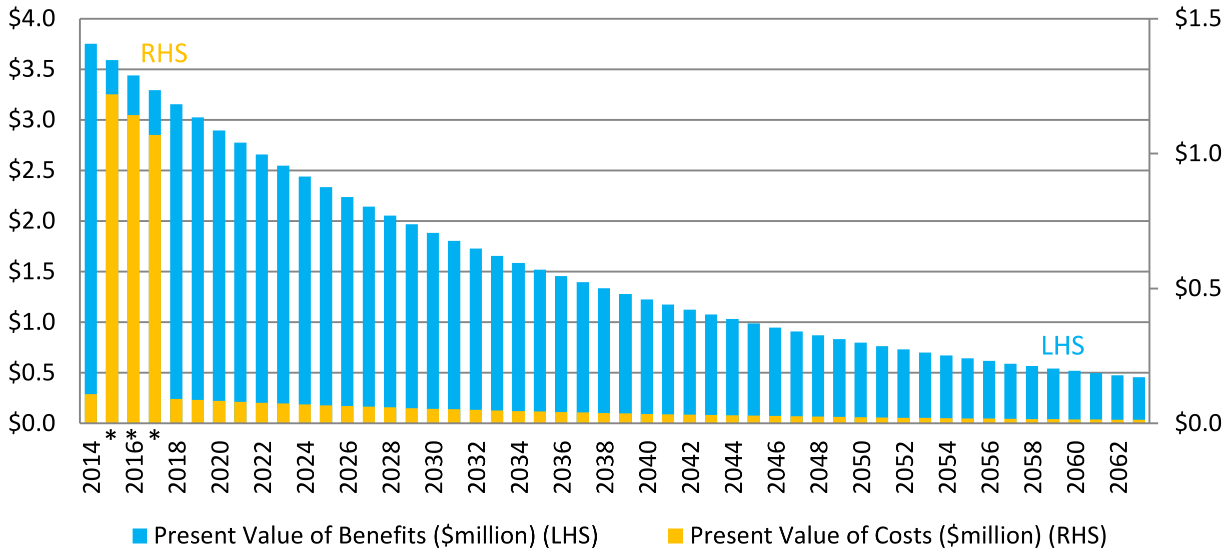
- Benefits to physical assets comprise around $29 million in avoided damages to residential property, $14.5 million to business assets and $3.7 million in public infrastructure.
- About $20.2 million in avoided productivity losses from disruption to services and business access in the town and immediate surrounds.
- Better insurance coverage for residents of approximately $11.4 million.

These benefits have a total present value of around $78.8 million.

Flood mitigation investments involve large front loaded costs, but from that point are very long lived assets with little ongoing maintenance requirements (although some more substantial irregular work is planned for Grafton to repair damage to the levee). They effectively 'lock in' the costs from commissioning and provide ongoing benefits gradually and cumulatively for many decades. The general pattern of these net impacts is shown in Chart 5.2.

Grafton flood levee — sequencing of impacts

CHART 5.2



Note: *indicates the cost of one-off repair works to the levee structure.
Source: Urbis

As the Grafton flood mitigation system has been in place for several decades, the analysis included an additional component incorporating the cost and benefits in a historical perspective (from 1990 to 2013), in conjunction to the 50 year forward looking focus of the analysis. As noted, this provides a more complete picture of the levee's economic impact as it captures the front loaded nature of the infrastructure investment.

Accounting for both historical and projected costs and benefits, the levee structure demonstrates a strong net economic payoff for the community. The BCR for the Grafton flood levee is estimated at 2.2, indicating an economic return of $2.20 for each dollar spent.

Essentially, this highlights the substantial future long term benefits to the town from the prudent investment decisions made in the past.

The results of the analysis are summarised in Table 5.2 below.

TABLE 5.2 – SUMMARY OF ESTIMATED BENEFITS OF GRAFTON'S FLOOD MITIGATION SYSTEM

Appraisal period	50 years, plus historical profile of levee
Capital costs	$42.6 million
Whole of life costs	$59.1 million
Discount rate	7%
Inflation rate	2.5%
Cost-benefit analysis ($ million)	
Analysis over the period 2014-63 (excludes historical legacy costs)	
Present value of benefits (avoided costs)	
Household	$29
Businesses	$14.5
Public infrastructure	$3.7
Productivity	$20.2
Better insurance coverage	$11.4
Present value of benefits	$78.8
Present value of costs	
Maintenance	$5.4
Present value of costs	$5.4
Cumulative Net Present Value	$73.4
Benefit Cost Ratio	**14.6**
Analysis incorporating historical capital costs of levee assets	
Present value of benefits (1990-2013)	$29.4
Present value of benefits (2014-2063)	$78.8
Total present value of benefits	$108.2
Present value of costs (1990-2013)	$43.6
Present value of costs (2014-2063)	$5.4
Total present value of costs	$49
Cumulative Net Present Value	$59.2
Benefit Cost Ratio	**2.2**

Note: Columns may not total precisely due to rounding.
Source: Urbis estimates

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This report is dated 09 October 2014 and incorporates information and events up to that date only and excludes any information arising, or event occurring, after that date which may affect the validity of Urbis Pty Ltd's (**Urbis**) opinion in this report. Urbis is under no obligation in any circumstance to update this report for events occurring after the date of this report. Urbis prepared this report on the instructions, and for the benefit only, of AAI Limited (Suncorp Group) (**Instructing Party**). To the extent permitted by applicable law, Urbis expressly disclaims all liability, whether direct or indirect, to the Instructing Party which relies or purports to rely on this report for any purpose other than the Purpose, and to any other person which relies or purports to rely on this report for any purpose whatsoever (including the Purpose).

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