



**ACT**  
Government

Chief Minister and Cabinet

# Climate Change Vulnerability Assessment Framework for Infrastructure

August 2012



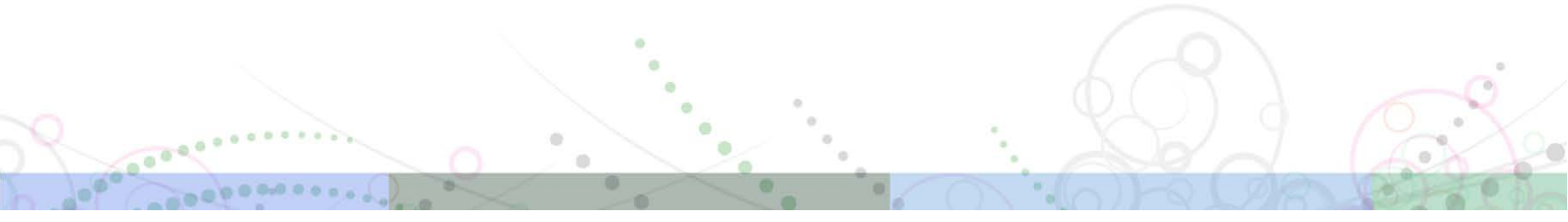
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## List of Abbreviations

<b>ACT</b>	Australian Capital Territory
<b>ACTPLA</b>	ACT Planning and Land Authority
<b>CMCD</b>	Chief Minister and Cabinet Directorate
<b>COAG</b>	Council of Australian Governments
<b>CSIRO</b>	Commonwealth Scientific and Industrial Research Organisation
<b>DA</b>	Development Application
<b>EIS</b>	Environmental Impact Statement
<b>GIS</b>	Geographical Information System
<b>IPCC</b>	International Panel on Climate Change
<b>MCA</b>	Multi-Criteria Analysis
<b>NCA</b>	National Capital Authority
<b>NSW</b>	New South Wales
<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>PAF</b>	Performance and Accountability Framework
<b>SAMF</b>	Strategic Asset Management Framework
<b>SAMP</b>	Strategic Asset Management Plans

## Executive Summary

This document sets out a framework for assessing the vulnerability of Australian Capital Territory's infrastructure to climate change, developed by AECOM in collaboration with the Chief Minister and Cabinet Directorate. The framework builds on work undertaken by AECOM for ACTPLA in 2010 which examined the climate change risks associated with human settlement in the Territory.

The framework is a further step in systematically embedding climate change risk assessment at important junctures of government decision making and planning. The framework recognises that infrastructure has a long life span or 'design life'. In the future most infrastructure will experience climatic conditions that are likely to be different to those for which they have been designed.

It also recognises that climate change assessment, at strategic points in the decision making process, will be vital to the delivery of effective and efficient infrastructure over the coming decades.

The framework is intended to supplement, rather than replace any element of the existing risk management framework used by the ACT Government. Both frameworks follow the steps described in the Risk Management Standards (AS/NZS ISO 31000:2009).

### Focus of the framework

The framework is intended to provide Government with a diagnostic tool to assist in considering climate change and its impacts during the planning, development, renewal, maintenance and management of public infrastructure. Its core focus is on the risks associated with managing infrastructure across all phases of the infrastructure life-cycle and within the context of a policy implementation cycle. Over time this framework may be further developed to ensure integration with broader climate change policies, including mitigation strategies.

### Framework principles

The proposed framework is based on the principles of:

- *An integrated and flexible approach to infrastructure planning.* The adoption of a framework should ensure that social, environmental, financial and economic factors are considered when undertaking climate change vulnerability assessment. The framework should also allow changes in infrastructure, information technology, government plans and priorities to be reflected in the outcomes of the assessment process.
- *A risk management approach to infrastructure planning.* The adoption of a framework should ensure that climate change risks can be accurately determined and provide the nature and timing of responses to climate change to ensure that optimum infrastructure outcomes are achieved by agencies. The infrastructure risks associated with climate change should be managed in a prudent and efficient way.
- *A shared responsibility approach to planning and risk assessment.* The adoption of a framework should recognise the responsibilities of multiple agencies for the management of infrastructure.
- *A life-cycle approach to infrastructure development and renewal.* The adoption of a framework should recognise the basic life-cycle of public infrastructure and the key steps in managing infrastructure projects.

### Framework logic

The framework logic is based on a:

- Clearly articulated relationship between aspects of climate change vulnerability, risk and adaptive capacity.
- Recognition that risk assessment processes differ between new and existing infrastructure projects, and therefore different methodologies and approaches are necessary for each type of project.
- Recognition that the entry points for climate change assessment can occur equally at a strategic whole of government level as well as at an operational agency level.

A logic map and a detailed explanation of the framework are provided in the body of the document.

## 1.0 Why a framework?

### 1.1 Introduction

Climate change is very likely to place increasing pressures on the community and its supporting infrastructure over the coming decades. Warmer temperatures, changes in precipitation patterns, increased climate variability and more extreme weather events are expected to pose a potential risk to the owners, managers, regulators and operators of public infrastructure.

Infrastructure can be defined as the technical structures that support society, such as roads, water supply, sewers, electrical grids, telecommunications, etc. In the context of climate change, the principle focus is on 'hard' infrastructure, such as roads, sewers, fire roads, stormwater drains, natural reserves, etc. However, consideration also needs to be given to 'soft' forms of infrastructure where appropriate, such as emergency services management arrangements.

Climate change will potentially impact infrastructure through either a change in the pattern of extreme events such as storms, bushfires, floods, drought or through gradual changes such as air temperature, rainfall, and solar radiation. Most infrastructure projects have long life spans varying from a couple of decades for a road up to a century for a bridge or a tunnel. However, infrastructure is usually designed on the basis of past climate conditions and generally does not consider possible future climate. Therefore ACT's infrastructure is likely to experience future climate conditions different to the one they have been designed for.

This document proposes a framework for assessing the degree of climate change vulnerability for Australian Capital Territory (ACT) infrastructure. It is a further step in systematically embedding climate change risk assessment at important junctures of Government decision making and planning.

### 1.2 Climate change in the ACT

Worldwide industrial development has caused greenhouse gases to be released into the atmosphere in great volumes. Changes in land use have occurred with increasing surfaces being cleared for urban and agricultural development. Concurrently, substantial increases in air temperature have been observed during the 20<sup>th</sup> and 21<sup>st</sup> centuries.

Computer models representing the climate system have been used to estimate the relative contribution of various factors such as changes in radiation from the sun, dust from volcanic eruptions, etc. The Intergovernmental Panel on Climate Change (IPCC, 2007) has concluded that "warming of the climate system is unequivocal [...and that], anthropogenic warming and sea level rise is likely to continue for centuries [...] even if greenhouse gas concentrations are stabilised".

The position of world leading scientists is clear – climate change is happening and the emissions of greenhouse gases from human activities are largely responsible. The case for action is compelling and State, Territory and Local Governments have a critical role to play in preparing communities for future climate change. Numerous reports and studies, especially *Weathering the Change* (2007) and the *Garnaut Review* (2009), have highlighted the particular vulnerability of the ACT to climate change impacts.

Recent work carried out by AECOM for ACTPLA included findings by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) on a tailored climate scenario for the ACT. This tailored climate scenario suggests that a 2°C warming is expected by the mid 21<sup>st</sup> Century for ACT. Further modelling prepared by the CSIRO suggests that the future climate in the Canberra region is most likely to be hotter with some minor variance in rainfall.

This 50th percentile modelling of likely climate change impact suggests annual air temperatures that are between 1.8°C and 2.9°C warmer compared to current values; summer temperatures that are between 1.8°C and 3.1°C warmer, and mean rainfall changes between -4.6% and + 4.4%<sup>1</sup>. Additionally the number of hot days (>35°C) and very hot days (>40°C) could increase significantly (respectively from 5 days to 20 days and from 0.1 day to 2 days per year). Extreme rainfall events are also projected to increase.

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<sup>1</sup> It should be noted that rainfall projections are associated with high level of uncertainty and should be considered with great care.

The work also suggests that the Canberra region could experience even hotter temperatures with drier conditions than those stated. The most extreme climate change model scenarios would have profound implications for the ACT Government, the ACT community as well as the broader ACT/NSW region. Examples of potential impacts identified include:

- **Infrastructure** – changed rates of deterioration (roads/pavement), changing sizing requirements (stormwater), operational cost changes (buildings) and loss of amenity.
- **Health** – positive and negative effects from increased temperatures, changes in vector borne disease, heat wave frequency.
- **Natural resource management** – shifts in distribution of species (possible increase in local species extinction), changes to wetlands and waterways, decreased freshwater resources, increased pressure from pests, weeds and disease.
- **Emergency management** – changes in the pattern (intensity, frequency, seasonality and location) of extreme climatic events such as bushfire, storms and floods.
- **Agriculture** – change in productivity and crop selection, changes in seasonal activities, reduced water availability, greater pressure from weeds and disease.
- **Economic** – increased insurance costs, displacement of economic activity, uncertain budgeting environment, changes to amortisation schedules.
- **Social** – the increased cost of essential goods and services brought about by climate change may have a disproportionately greater effect on the budgets of lower income households, with consequent mitigation implications, such as the possible introduction of lifeline tariff pricing policies for essential services for lower income households.

### 1.3 Focus of the framework

The potential impact of climate change on the Territory's physical and natural infrastructure is the focus of this framework. The framework is intended to provide ACT Government with a diagnostic tool that can assist in considering climate change and its impacts during the planning, development, renewal, maintenance and management of public infrastructure. Its core focus is on the risks associated with managing infrastructure across all phases of the infrastructure life-cycle and within the context of a policy implementation cycle.

By focusing on the infrastructure risks associated with climate change the framework:

- Promotes good practice risk-based approaches to infrastructure planning, development, renewal, maintenance and management. Such good practices are anticipated to help agencies achieve enhanced value-for-money from infrastructure investment decisions.
- Promotes sustainable and longer term infrastructure outcomes through a deeper understanding of climate change vulnerability and possible adaptation options.
- Enhances the alignment between whole-of-government planning and decision making about public infrastructure through a common understanding of climate change. It also enhances the connections between infrastructure planning, strategic planning and resource allocation across Government.

### 1.4 Linkages with planning arrangements

Currently agencies are required to undertake a range of planning activities that assess the costs and benefits, risks and investments of infrastructure decisions. These activities must account for a number of ACT policies and frameworks that currently operate.

The climate change assessment framework will be embedded within the ACT Infrastructure Planning Process. It is anticipated to assist Government and directorates in the development of high quality infrastructure to further enhance the economic prosperity of community and support effective delivery of services. It will also provide decision makers with a set of assessment practices and processes that allow for a rolling program of climate change assessments that complement annual planning processes.

The framework will also be closely linked with the ACT's climate change strategy (*Weathering the Change*) as well as the broader objectives of the *Canberra Plan and Spatial Plan*.

Additional detail about these linkages can be found in Section 3.0 of this report.

## 2.0 Overview of the framework

### 2.1 Framework principles

The principles of the climate change vulnerability assessment framework are in part derived from previous climate change projects undertaken by AECOM for the ACT Government and are also in part derived from the key themes of the ACT Government's emerging *Performance and Accountability Framework (PAF)*.

The principles of the framework are:

- *An integrated and flexible approach.* The adoption of a framework should ensure that social, environmental, financial and economic factors are considered when undertaking climate change vulnerability assessment. The framework should also allow changes in infrastructure, information technology, government plans and priorities to be reflected in the outcomes of the assessment process.
- *A risk management approach.* The adoption of a framework should ensure that climate change risks can be accurately determined and provide the nature and timing of responses to climate change to ensure that optimum infrastructure outcomes are achieved by agencies. The infrastructure risks associated with climate change should be managed in a prudent and efficient way.
- *A shared responsibility approach.* The adoption of a framework should recognise the responsibilities of multiple agencies for the management of single infrastructure.
- *A project life-cycle approach.* The adoption of a framework should recognise the basic life-cycle of public infrastructure and the key steps in managing infrastructure projects. Project life-cycle management insights and practices can then be used by infrastructure investors and managers as part of existing management techniques.

The climate change assessment framework is intended to provide a broader strategic context for existing codes and standards for infrastructure. The strategic decision making decision-making process should apply the four principles mentioned above in the context of infrastructure planning and the application of the codes and standards.

### 2.2 Links to ACT Risk Management Framework

The climate change vulnerability assessment framework is intended to supplement, rather than replace any element of the existing risk management framework used by the ACT Government. Both frameworks follow the steps described in the Risk Management Standards (AS/NZS ISO 31000:2009). Ultimately, the climate change vulnerability assessment framework may be fully integrated into the broader risk management framework used by the ACT Government.



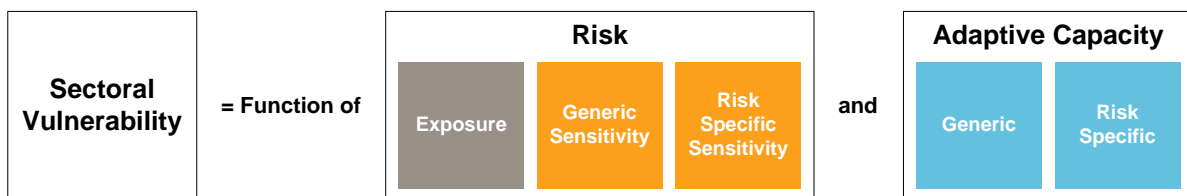


Figure 1 The risk management process

### 2.3 Framework logic

It is proposed that the ACT use a similar logic to assess ACT infrastructure vulnerability to climate change as that used in the ACTPLA study (AECOM 2010). Under this logic vulnerability is analysed as a function of risk exposure and sensitivity and adaptive capacity. The relationship between these different aspects is outlined in figure 1. below.

Figure 2 Relationship between vulnerability, risk and adaptive capacity



Source AECOM 2010

Central to the issue of vulnerability (or risk) assessment is the concept of the likelihood of risk and the consequences of events. Specifically in relation to infrastructure, a very relevant consideration is the adequacy of the construction standards (e.g. built to withstand a 1 in 100 year flood). Analysis of whether the risk of such an event will increase due to climate change, and whether the consequence of such an event would be any greater than it currently is, are very real considerations. It may be possible that current construction standards already more than adequately allow for any changes due to climate change. However, without a focus on likelihood and consequence, construction standards may increase, adding cost to cover an event for which the likelihood may not have materially increased, or the consequence be of marginal difference to the current situation.

Exposure can be described as the nature and degree to which a system is exposed to significant climatic variations (IPCC 2001). This aspect of vulnerability mainly encompasses climate variables and biophysical elements strongly influenced by changes in the climate.

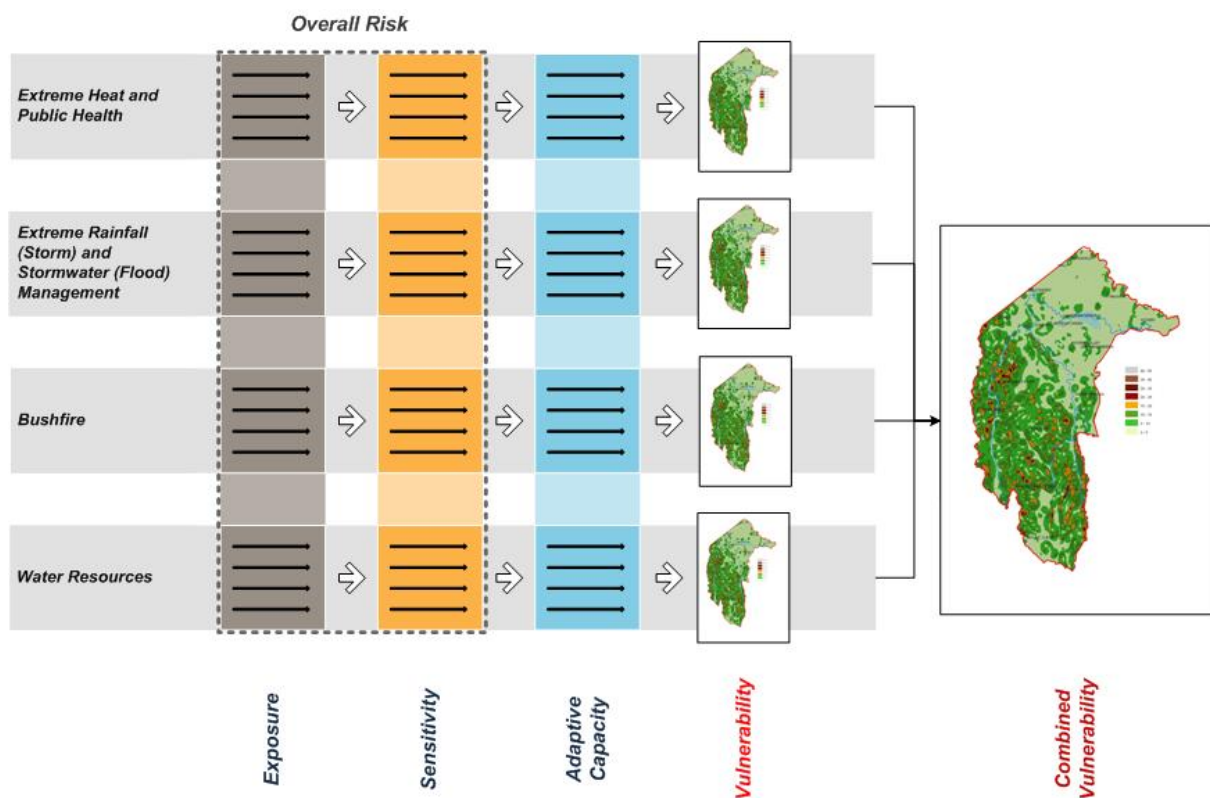
Sensitivity refers to the degree to which a system is affected, either adversely or beneficially, by climate related variables including means, extremes, gradual changes and variability. Sensitivity is influenced by biophysical

elements such as ground slope or aspects, infrastructure elements (e.g. drainage infrastructure) and socio-economic elements (e.g. importance of this infrastructure service for the ACT population as a whole). Some aspects of the sensitivity are generic across all risks while others are specific to a particular risk or combination of risks.

The adaptive capacity can be defined as the ensemble of resources (human, natural, institutional, financial and technical) available to a group or an individual to cope with climate change risks or to realise benefits, through changes in characteristics or behaviour. Adaptive capacity can be an inherent property or it may have been developed as a result of previous policy, planning or design decisions of the organisation. Additionally the adaptive capacity may be generic (i.e. common across all climate change risks) or risk specific, at the local, regional and national level.

In the ACTPLA study, the scoring for each element was combined and weighted depending on data availability and its ability to represent the element of the considered risk. For each available variable, maps were developed using a Geographical Information System (GIS) framework. Figure 2 illustrates the approach to estimating the relative vulnerability of ACT human settlements to particular climate change risks and the combined effect of climate change.

Figure 3 Conceptual representation of the approach taken to assess vulnerability to climate change in the ACT



Source AECOM 2010

It is proposed that the exposure elements of the ACTPLA study be applied to the infrastructure framework, with some amendments and additions. The ACTPLA exposure risk included the risks of bushfire, extreme heat, heavy precipitation and reduced water availability. Other risks such as extreme winds were not analysed and would require additional work.

The following sections describe a logic map that can be used to consider the likely impact of climate change and to enable managers to understand the sensitivity and adaptive capacity of the infrastructure systems they manage. By combining an estimate of the particular exposures (derived from the ACTPLA study), and a self assessment of the sensitivity and adaptive capacity of the ACT infrastructure management system, it is possible to identify the overall vulnerability of ACT infrastructure to climate change.

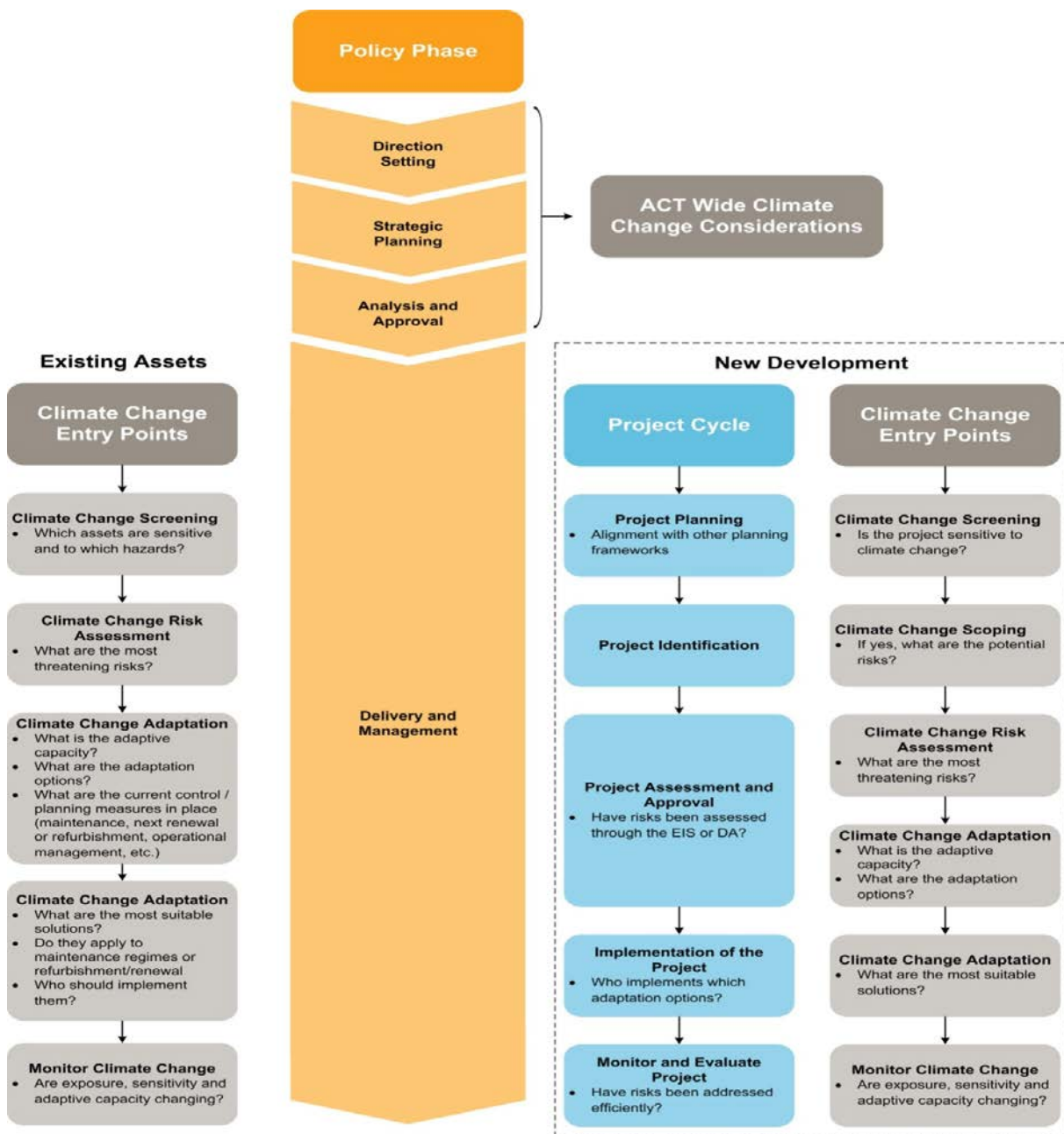
## 2.4 Entry points for climate change consideration

The diagram below illustrates the conceptual logic underpinning the framework. The flow chart shows how climate change assessment fits within a policy and infrastructure project life-cycle, and can augment existing tools and frameworks to improve infrastructure decision making across Government.

The framework has been adapted from the Risk Management Standard AS/NZS ISO 31000:2009 to meet the requirements of the ACT. This is based on previous analysis undertaken for ACTPLA (2010) on human settlement across the ACT. This is to provide consistency with previous studies.

An understanding of the policy environment should guide how and when climate change assessment is undertaken. The discussion, below, illustrates how the project cycle and risk assessment elements of climate change vulnerability assessment will need to be applied across the various policy phases of the ACT's broader Infrastructure Assessment Framework (2010).

Figure 4 Logic map of the Climate Change Vulnerability Assessment Framework



Source Adapted from ACT Government Infrastructure Framework and AECOM 2010

## 3.0 Framework phases

This section provides a more detailed explanation of the framework and its elements.

### 3.1 Direction setting phase

#### Objective

The objective of this phase is to ensure that climate change risk and adaptation options are clearly identified at a whole-of-government and community level.

#### Planning context

This phase represents the highest level of infrastructure planning and priority setting, and the aggregation of planning activities across Government. It typically involves the infrastructure planning activities of individual Ministers, Cabinet Members of the Government and Legislative Assembly, Directors-General, Directorate representatives and the community of the ACT (through Territory-wide consultation).

The planning activities at this phase should reflect the seven priority areas of the Canberra Plan and short and medium-term priorities of elected governments, as well as the ACT's intergovernmental obligations under Council of Australian Governments (COAG). Ideally, the planning activities should help Governments to develop whole-of-government infrastructure priorities that are longer term.

For this reason, there is considerable scope for climate change assessment tools, such as longer-term trend and demand analysis and scenario planning, to be implemented across Government. The addition of such diagnostic tools can provide the technical and strategic data that is necessary to effectively manage future infrastructure investment risks.

#### Entry point for climate change assessment

A co-ordinated approach between the different ACT Government directorates through whole-of-government climate change risk assessment and adaptation planning should be embedded at the direction setting phase. This could be facilitated by the creation of an ACT Government working group on climate change representing the different branches of government. This working group would be most active in the lead up to a refresh of the *Canberra Plan* and the *Spatial Plan*.

Such an approach or working group could also play a liaison role with other State and Territory Governments (e.g. through the COAG group on adaptation) and other relevant organisation such as the National Capital Authority (NCA) or ActewAGL.

### 3.2 Strategic planning phase

#### Objective

The objective of this phase is to ensure that climate change risk assessment is undertaken at a whole-of-government level and the strategies for reducing the ACT vulnerability have been adopted across each Government directorate.

#### Planning context

The ACT Infrastructure Plan provides a link between the longer-term objectives set out in the *Canberra Plan* and *Spatial Plan*, the priorities in the Annual Budget, and the operational strategies outlined in the Strategic Asset Management Plans (SAMPs) of individual agencies. The planning activities at this stage are a consequence of the feedback from Community Roundtables, and the technical/operational information collected by individual agencies.

The infrastructure planning activities at this phase are intended to deliver:

- A clearly articulated medium (5 year) and long-term (10 year) infrastructure program encompassing investment in new infrastructure, as well as existing and ageing infrastructure.
- The integration of infrastructure programs and projects with other planning activities – such as the social and service delivery responsibilities of Government.

- A strong basis for improving Government services to the ACT community and the region, by ensuring that infrastructure development is aligned with community needs.

Planning activities at the strategic phase should help Government to develop strong linkages between risk assessment and the emerging and changing needs of the community. A consolidated *ACT Infrastructure Plan* will, over time, assist in the delivery of infrastructure projects that meet the major plans and priorities of directorates.

#### **Entry point for climate change assessment**

The strategic setting phase provides the opportunity to consider the broader climate change impacts not only in the ACT but also in the NSW surrounding region. Issues faced by NSW areas surrounding the ACT (such as shortage of water in Yass or Murrumbateman or flooding in Queanbeyan which have the potential to be exacerbated by climate change) can have significant implications for the ACT.

At this phase a multi-risk approach is recommended to capture the “larger picture” for the ACT. This consideration can be delivered through an inter-directorate workshop involving all ACT directorates engaged in this program. The key findings for the four risks considered in the Spatial Plan Evaluation (AECOM 2010) could constitute the basis for this discussion (bushfire, extreme heat and public health, extreme rainfall and flooding and reduction in water availability). They could be complemented by additional risks such as storms and extreme winds and natural areas/biodiversity vulnerability.

The outcomes of this phase would be an identification of ACT-wide impacts to inform Territory-wide master planning for large development programs such as sub-division or critical urban infrastructure.

### **3.3 Analysis and approval phase**

#### **Objective**

The objective of this phase is to ensure that climate change assessment is an integral part of the design and approval of all types of infrastructure projects. The current ACT requirement to consider climate change (both mitigation and adaptation) as part of an ACT Environmental Impact Statement (EIS) ensure that climate change is considered for all large infrastructure projects. This needs to be complemented by tools and regulations not triggering an EIS.

#### **Planning context**

Prior to the allocation of budget funding and the commissioning of programs and projects, a range of analytical and approval processes for infrastructure occur within directorates to determine the costs and benefits of infrastructure investments. The ACT Treasury’s Strategic Asset Management Framework (SAMF), provides directorate managers that are involved in the management of physical infrastructure and the delivery of Government services that are infrastructure dependent, with a set of consistent policies to work from. Under the SAMF, agency personnel are required to consider:

- A four year forward program of infrastructure.
- Government objectives with respect to the management of assets and infrastructure.
- Social, environmental and economic delivery needs of the ACT community and associated asset management decisions.

Within this context directorates are required to develop business cases and undertake feasibility studies of individual projects or programs of infrastructure. They are also required to follow policies on the physical and financial recording of assets, the use and performance of infrastructure, and the accountabilities for the management of assets and infrastructure. The outcomes of these activities (in particular, business cases and feasibility studies) will shape and be shaped by the annual budget process of Government. The Budget Papers provide a whole of government record of the decision making that has occurred at this phase of the framework.

#### **Entry point for climate change assessment**

As previously mentioned, a consideration of climate change is incorporated into the ACT approval process through the analysis contained in ACT EISs. However this needs to be reinforced by requiring similar and comparable analysis for smaller infrastructure projects.

### 3.4 Delivery and management phase

#### Objective

The objective of this phase is to ensure that infrastructure project delivery is managed with ongoing consideration of key climate change risks. This may include implementing appropriate measures to ensure ACT infrastructure projects continue to be “climate ready”.<sup>2</sup> The ongoing management of infrastructure should also reflect evolving best practice in climate change risk assessment and adaptation.

#### Planning context

The delivery and management of infrastructure projects will be shaped by the Strategic Asset Management Plans (SAMPs) prepared by agencies. SAMP's are used by directorates to identify the optimum mix and form of assets needed so that the agency can deliver the outcomes sought by Government.

The development of procurement plans and various project related plans assist directorates to manage the operation and maintenance, acquisition, disposal and financial aspects of infrastructure delivery. The detail and complexity of these plans is subject to the size and scope of infrastructure and risks associated with infrastructure failure.

#### Entry point for climate change assessment

This phase is where consideration of climate change needs to be presented with greater detail. To achieve this it is helpful for the project cycle to be broken down into a series of tasks. The tasks may relate to the development of new assets or the management of existing assets. These different types of tasks may require different types of activities.

#### *New Development*

##### 1. Project Planning / Climate Change Screening

At this step the project manager and other core decision makers would screen for climate change vulnerability. This can be translated in the following question: *is the project sensitive to climate change?* Not all projects are sensitive to climate change and not all climate change risks are relevant to every project. Some of the key factors to be considered are the proposed location and service to be delivered by the infrastructure project, the budget and the design life of the proposed project.

Typically, infrastructure with very long design life (such as bridges and tunnels) are likely to be sensitive to climate change. Any risks to critical infrastructure (such as water storage, supply and distribution, electricity transmission, and major roads) should also be considered for these projects. Some temporary infrastructure or infrastructure providing non critical services might not require climate change vulnerability assessment.

The exposure elements of the ACTPLA project can be used to direct climate change assessment.

Whether climate change is considered or not, it is important to document with a clear rationale explaining why particular elements of analysis were or were not undertaken.

##### 2. Project Identification / Climate Change Scoping

Once it has been determined that the project is sensitive to climate change a scoping approach should help identify which elements of the infrastructure project are sensitive to what climate related variables. This scoping should include consideration of maintenance objectives and decisions to commission or decommission infrastructure.

The scoping phase should also determine the different stakeholders involved in the climate change risk assessment, who will be conducting the assessment and the possible budget to deliver the assessment. If the project is likely to trigger an EIS, a scoping brief should be included in the EIS requirement.

It is possible that some risks and elements of the infrastructure project included in the scoping brief may not be relevant when the detailed assessment is performed. It is equally possible that additional risks and infrastructure elements are found to be relevant during the detailed assessment.

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<sup>2</sup> Ideally this should include consideration of climate variability as well as climate change.

### 3. Project Assessment and Approval / Climate Change Risk Assessment and Adaptation Planning

The key objective of this step is to identify, analyse and prioritise the different climate change risks to the infrastructure project. To ensure consistency between different projects assessed and delivered in the ACT the same methodology should be used for all assessment.

For instance the methodology detailed in the risk management standards (ASNZ 4360 and ISO 31 000) could be selected. The risks would then be analysed as a function of their likelihood and consequences.

More detailed elements of risk exposure derived from the ACTPLA framework could be used to underpin the assessment for relevant variables (including mean and extreme temperature, mean and extreme rainfall, bushfire). Other risks such as flooding, that are partially covered in the ACTPLA framework, could be augmented by specialist studies such as local flood modelling.

The risk assessment would result in a list of prioritised risks. It is important that the rationale explaining the ranking of each risk is well documented. High and extreme risks would typically be the focus of the adaptation response.

Once the risks have been prioritised the second objective of this phase is to identify relevant adaptation options to address them. At this stage the range of adaptation options would be relatively wide and dependent on the infrastructure project in question.

### 4. Implementation of the Project / Climate Change Adaptation<sup>3</sup>

During this step, the range of adaptation options previously identified need to be first assessed to analyse which options are the most suitable to the project from an efficiency as well as from a suitability point of view. The aim is to prioritise a long list of options into a small number of options. Such prioritisation can be done using a Multi-Criteria Analysis framework (MCA). Criteria such as cost, efficiency, speed of implementation, technical feasibility, human capacity and acceptance can be used for the MCA.

Identified options can then be incorporated into the relevant phases of the project implementation. This can include the construction, maintenance, refurbishment and decommissioning phases. Funding should also be considered to ensure that climate change assessment activities are reflected in the final outcomes of infrastructure projects.

### 5. Monitor and Evaluate Project / Monitor Climate Change

As with any other environmental and risk management process it is relevant to monitor and re-evaluate the risks and the measures in place to reduce risk over time. Depending on the size of the infrastructure project and its projected life-cycle climate change monitoring can be an ongoing activity or undertaken at key junctures in a project's design life. Critical thresholds can be established at the beginning of the project to trigger specific actions (e.g. temperature thresholds resulting in change of materials, rainfall thresholds resulting in sizing requirements).

#### **Existing Assets**

The actions described for new developments can be applied to existing assets. The ability of Government to consider current risks and control measures for the assessment of existing assets is equally important. This is because the assets already exist and the services are already being delivered to the ACT community, and the risk of existing infrastructure failures can have more immediate and direct implications for the health and well being of individuals.

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<sup>3</sup> As the ACT regulation requires all Environmental Impact Studies (EIS) to consider climate change (both mitigation and adaptation aspects), such concerns will be included in the EIS scope for each project triggering this process. In this instance, the main requirement would be to ensure that the process is followed thoroughly (both in terms of risk identification and adaptation options implementation). For projects which do not require an EIS it is important to follow the process described above (which may or may not result in a full assessment depending on the sensitivity of the proposed project to climate variability and climate change).

## 4.0 Application of the Framework

The Climate Change Vulnerability Assessment Framework for Infrastructure is intended to provide government with a diagnostic tool that can assist in considering climate change and its impacts during the planning, development, renewal, maintenance and management of public infrastructure. It is therefore a useful complement to the existing risk management framework used by the ACT Government and follows the Risk Management Standards (AS/NZS ISO 31000:2009) as part of infrastructure planning.



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