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Auditor-General Report No.39 2018–19
Performance Audit

The Bureau of Meteorology's Delivery of Extreme Weather Services

Bureau of Meteorology

Australian National Audit Office

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Australian National Audit Office

Canberra ACT

22 May 2019

Dear Mr President
Dear Mr Speaker

In accordance with the authority contained in the *Auditor-General Act 1997*, I have undertaken an independent performance audit in the Bureau of Meteorology. The report is titled *The Bureau of Meteorology's Delivery of Extreme Weather Services.* Pursuant to Senate Standing Order 166 relating to the presentation of documents when the Senate is not sitting, I present the report of this audit to the Parliament.

Following its presentation and receipt, the report will be placed on the Australian National Audit Office's website — http://www.anao.gov.au.

Yours sincerely

Grant Hehir
Auditor-General

The Honourable the President of the Senate
The Honourable the Speaker of the House of Representatives
Parliament House
Canberra ACT

AUDITING FOR AUSTRALIA

The Auditor-General is head of the Australian National Audit Office (ANAO). The ANAO assists the Auditor-General to carry out his duties under the *Auditor-General Act 1997* to undertake performance audits, financial statement audits and assurance reviews of Commonwealth public sector bodies and to provide independent reports and advice for the Parliament, the Australian Government and the community. The aim is to improve Commonwealth public sector administration and accountability.

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Summary and recommendations

Background

1. The Bureau of Meteorology (the Bureau) is responsible for 'enabling a safe, prosperous, secure and healthy Australia through the provision of weather, water, climate and ocean services'.[1] The Bureau's weather forecasts, warnings and analyses support decision-making by governments, industry and the community. Australian sectors which rely heavily on timely and accurate weather services include emergency management, aviation, maritime, defence, agriculture, energy and resources.

2. The *Meteorology Act 1955* and the *Water Act* 2007 defines the Bureau's functions and the powers of the Director of Meteorology. The Bureau is a non-corporate Commonwealth entity under the *Public Governance, Performance and Accountability Act 2013* within the Environment and Energy Portfolio. The Bureau plays a key role in fulfilling a range of Australia's international obligations, including under the Convention of the World Meteorological Organization (WMO) and Convention on International Civil Aviation.

3. The Bureau delivers forecast and warning services for all meteorological events. Extreme weather services are a core function of the Bureau which is integrated with its delivery of routine weather services. During complex events the Bureau undertakes specific activities aimed at ensuring its staff and systems are able to operate effectively under pressure.

Rationale for undertaking the audit

4. Effective forecasts and warnings are important in allowing the Bureau's stakeholders, customers and the public to prepare for extreme events, reducing the potential for loss of life and damage to infrastructure and property. The cost of natural disasters to the economy has been assessed as $18.2 billion per year, equivalent to 1.2 per cent of gross domestic product.[2]

Audit objective and criteria

5. The audit's objective was to determine if the Bureau's processes support the delivery of effective extreme weather services. To form a conclusion against the audit objective, the ANAO adopted the following high-level criteria:

- Does the Bureau's planning appropriately support its ability to provide extreme weather services?
- Does the Bureau manage its operational resources effectively in responding to extreme weather events?
- Is the Bureau's assessment and reporting on the performance of its extreme weather services fit for purpose?

6. The Bureau's provision of extreme weather services is an integral part of its ongoing operational activities. This audit has therefore included an analysis of key elements associated

1 Department of the Environment and Energy *Portfolio Budget Statements 2018–19*. Budget Related Paper No. 1.6 Environment and Energy Portfolio, Australian Government, Canberra, 2018, p. 118.

2 Australian Business Roundtable for Disaster Resilience & Safer Communities (ABRDRSC) and Deloitte Access Economics, Building resilience to natural disasters in our states and territories, ABRDRSC, 2017, p.16.

with the Bureau's delivery of general weather services in order to examine its ability to escalate operational activity, when required, to deliver extreme weather services.

Conclusion

7. The Bureau has established largely effective processes to support its delivery of extreme weather services.

8. Appropriate planning and governance structures have been implemented to underpin extreme weather services. Planning processes, including extensive stakeholder engagement activities, support the implementation of the Bureau's corporate strategy. Planning for changes to the delivery of aviation and associated services is being appropriately coordinated and managed at the strategic and operational levels. The Bureau's design of new policies and governance frameworks for risk management and resilience planning is appropriate, however improvement is required in the efficacy of controls to reduce residual risk.

9. The Bureau's operational processes and activities, including its management of resources, have allowed it to prepare for and respond effectively to extreme weather events. To ensure the sustainability of its operations, improvements are required in the planning of asset investment and maintenance, rostering and workforce management.

10. The Bureau undertakes verification work to monitor its performance in specific areas of forecasting in order to improve accuracy and reliability. An overall program for the verification of all types of extreme weather has not yet been implemented. Reporting to the Parliament and the public is generally fit for purpose, however coverage of the Bureau's performance in delivering extreme weather services could be expanded.

Supporting findings

Planning and governance

11. The Bureau has formal planning processes in place which enable it to respond to extreme weather effectively. The Bureau's performance planning framework identifies priorities for operational activity, showing clear links between planned actions and expected performance outcomes. Extensive participation in stakeholder planning forums supports the Bureau in planning its investments and operations and contributes to national capabilities in responding to extreme weather. Cost recovery arrangements support relationships with key stakeholders, such as the aviation industry and the Department of Defence, and contribute to the rigour of the Bureau's planning frameworks. Planning for changes to operational models for the delivery of aviation and associated services is being appropriately coordinated and managed.

12. The Bureau's governance frameworks have the potential to support the effective delivery of extreme weather services, but implementation could be improved. The Bureau's executive structure and changes to its committee system have enhanced its capacity to plan and monitor the implementation of its corporate strategy, however committee processes for investment decisions and the commitment of funds would benefit from further refinement. The Bureau has established risk management frameworks which require improvement in the efficacy of controls to reduce residual risk, and has established crisis and incident management capabilities which require improvement in training and testing processes.

Management of operational resources

13. The Bureau is appropriately engaging government, media and public stakeholders in relation to extreme weather events. Operational forecasting centres have developed effective liaison structures with state government stakeholders, and forecasters have established processes to provide timely and relevant advice to decision-makers before and during extreme weather events. The Bureau is progressing a project with the emergency management sector aimed at increasing the effectiveness of forecasts and warnings through a greater focus on communicating the potential impacts of weather to communities.

14. The Bureau's operational policies and processes are largely effective in supporting extreme weather services. Cross-jurisdictional cooperation and the introduction of enterprise-wide forecasting systems have increased standardisation in forecasting policies and processes. Initiatives have commenced to standardise state and territory processes for rostering, pre-season asset checks and manual record-keeping. The recent use of standard crisis and incident management processes supports effective decision-making during extreme events, however there is improvement required in the recording of operational judgements and decisions.

15. The Bureau has established partially effective processes for the planning and management of assets to facilitate the delivery of extreme weather services. Nine of the Bureau's 12 key business risks relate to asset management. Work is in progress to address identified risks through the introduction of new frameworks to manage the Bureau's asset base and prioritise associated investments. It is not evident that the capability requirements of the Bureau are yet being formally considered in planning processes to support asset investment decisions.

16. Bureau staffing and surge arrangements are effective in meeting existing increases in demand for flood support, and a national approach to scaling up regional staffing levels for other types of extreme weather was trialled during the 2018–19 season. The Bureau's Extreme Weather Desk provides additional surge capacity. The Bureau's systems for recording work effort do not readily allow for the analysis of information at an aggregate level to support longer term planning.

Performance assessment and reporting

17. The Bureau commenced implementation of a formal post event review management methodology in early 2018 to capture and apply operational lessons after significant weather events. The methodology is appropriate, but it is unclear whether identified improvements are being implemented.

18. The Bureau undertakes activity to assess the accuracy of forecasts and warnings, and this information is used to improve models and forecaster ability on an ongoing basis. An overall program for the verification of all types of extreme weather has not yet been implemented.

19. The Bureau has established a performance reporting framework which aligns with Australian Government requirements in most respects. The performance criteria contained in the Bureau's 2017–18 Corporate Plan lack baselines or targets, reducing the line of sight between its criteria and reporting of performance in its Annual Report. The Bureau's external performance reporting could be expanded to better enable public visibility of performance in the delivery of extreme weather services.

Recommendations

Recommendation no.1 **Paragraph 3.32**	The Bureau of Meteorology develop a nationally consistent approach to govern the recording of decisions and judgements before and during extreme weather events. **Bureau of Meteorology's response:** *Agreed*.
Recommendation no.2 **Paragraph 3.50**	The Bureau of Meteorology establish a capability-based planning process to support the management of its existing asset base and prioritise associated investments. **Bureau of Meteorology's response:** *Agreed.*
Recommendation no.3 **Paragraph 3.70**	The Bureau of Meteorology establish a process to analyse the operational effort involved in responding to extreme weather events on a national basis in order to inform long term workforce management and financial planning. **Bureau of Meteorology's response:** *Agreed.*
Recommendation no.4 **Paragraph 4.37**	The Bureau of Meteorology expand performance reporting to include information about the accuracy and timeliness of forecasts and warnings for extreme weather services. **Bureau of Meteorology's response:** *Agreed.*

Summary of entity response

20. The proposed audit report was provided to the Bureau of Meteorology, which provided a summary response that is set out below. Its full response is reproduced at Appendix 1.

> The Bureau of Meteorology (the Bureau) "agrees" with the ANAO's recommendations and has committed to a number of relevant actions as follows:
>
> The Bureau will adopt a nationally consistent approach to govern the recording of decisions incorporating automated systems, situation reports, log-sheets/books in accordance with standard operating procedures, incident and crisis management plans.
>
> Since the Audit, the Bureau has adopted an Enterprise Asset Policy and a Strategic Asset Management Plan in accordance with ISO 55000 Asset Management and ISO 19770 IT Asset Management. The Bureau has also committed $40.9 million to a Radar Sustainment and Modernisation program. The Bureau will continue to uplift its asset management practices in accordance with recognised standards.
>
> Since the Audit, the Bureau has adopted an organisation-wide workforce planning framework and capability development plan to better inform our future workforce requirements. This along with rolling four-year budgets and Group and Program plans will inform the allocation of human and financial resources, including provisions for extreme weather events. The Bureau's capacity to respond to multiple and simultaneous extreme weather events will be enhanced as part of the Public Services Transformation Program.

The Bureau will accelerate its verification work and enhance public reporting on the accuracy and timeliness of extreme weather services. The Bureau notes that existing reporting of severe and extreme weather uses accepted World Meteorological Organization categories.

Through these and other continuous improvement actions, the Bureau remains committed to providing the Australian community with national weather, climate and water services second to none.

Key messages from this audit for all Australian Government entities

21. Below is a summary of key messages, including instances of good practice, which have been identified in this audit that may be relevant for the operations of other Australian Government entities.

Stakeholder engagement

- The Bureau established stakeholder engagement as a key platform of its Strategy 2017–22. This has ensured that effective stakeholder engagement is seen as a priority by all Bureau staff. The Bureau's relationships with key stakeholder groups are often the foundation for the coordinated or joint delivery of services.

Fit for purpose policies, procedures and systems

- Clear and up-to-date guidance for entity staff is important for ensuring consistency in operational decision-making and outcomes. Processes and procedures should clearly align with policy guidance. Any variations between different business areas should be on the basis of a clear rationale and take account of risk.
- Operational entities should ensure they have fit for purpose systems in place for recording key operational judgements and decisions.

Governance and risk management

- Entities should regularly monitor the implementation of planned risk treatments to ensure that risk ratings and the effectiveness of treatments are appropriate.
- It is important that the implementation of recommendations arising from internal and external reviews, where accepted by an entity, are appropriately overseen to ensure the full benefits of change are realised.

Performance statements

- Performance criteria should enable the Parliament and the public to form a view about how well an entity has performed in delivering on its purpose. This requires an entity to establish metrics relevant to the key activities it undertakes to achieve its purpose. Metrics should enable the entity to measure and report on performance over time.

Management support systems

- Establishing four year budgets can be an effective strategy in planning and maintaining critical capabilities.
- Frameworks for planning and managing future assets should include the consideration of all factors which contribute to capability, such as the availability of skilled staff, support systems, and maintenance resourcing for the life of the asset.

Audit findings

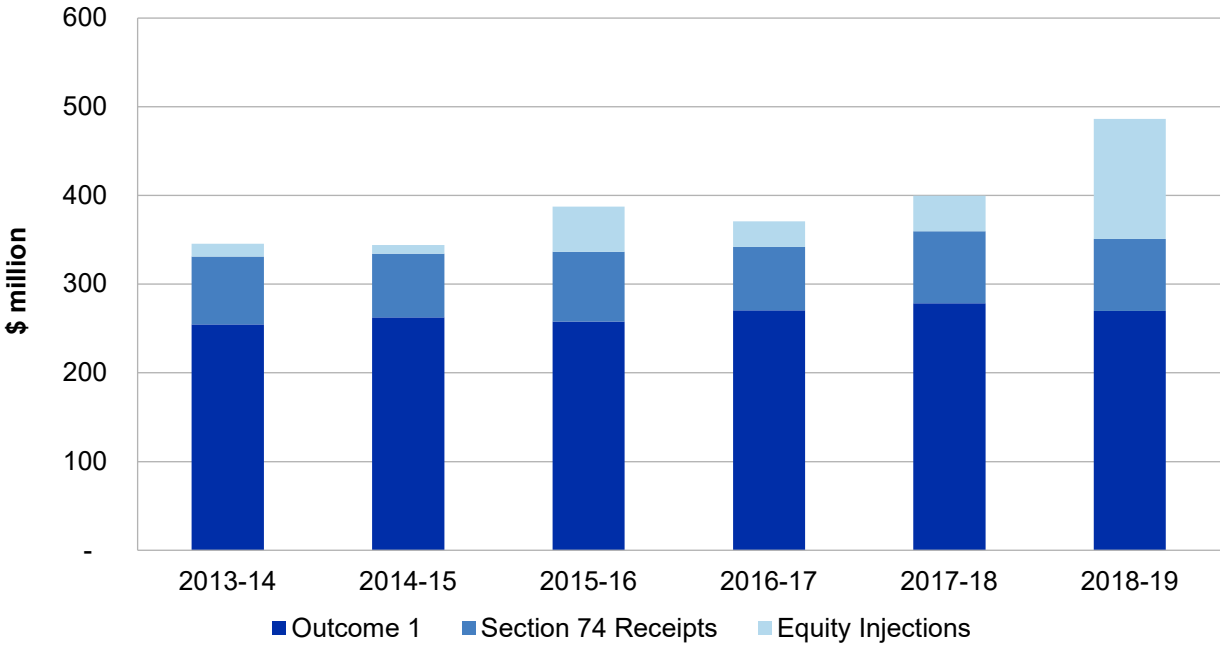
1. Background

The Bureau of Meteorology

1.1 The Bureau of Meteorology (the Bureau) is responsible for 'enabling a safe, prosperous, secure and healthy Australia through the provision of weather, water, climate and ocean services'.[3] The Bureau's weather forecasts, warnings and analyses support decision-making by governments, industry and the community. Australian sectors which rely on timely and accurate weather services include emergency management, aviation, maritime, defence, agriculture, energy and resources.

1.2 The *Meteorology Act 1955* and the *Water Act 2007* define the Bureau's functions and the powers of the Director of Meteorology. The Bureau is a non-corporate Commonwealth entity under the *Public Governance, Performance and Accountability Act 2013* (PGPA Act) within the Environment and Energy Portfolio. The Bureau plays a key role in fulfilling a range of Australia's international obligations, including under the Convention of the World Meteorological Organization (WMO) and Convention on International Civil Aviation.

Figure 1.1: Bureau of Meteorology agency resourcing 2013–14 to 2018–19



Source: Based on Commonwealth of Australia data, Agency Resourcing Budget Paper No. 4 2013–14 to 2018–19.

1.3 The Bureau's total resourcing in 2018–19 is $486.4 million (Figure 1.1). Equity funding for major information communication technology (ICT) programs has driven recent increases in total agency resourcing. Other elements of the Bureau's resourcing, including government funding to achieve its core outcome, its external revenue flows and staffing levels have remained relatively stable.

3 Department of the Environment and Energy, *Portfolio Budget Statements 2018–19*. Budget Related Paper No. 1.6 Environment and Energy Portfolio, Australian Government, Canberra, 2018, p. 118.

1.4 The Bureau's organisational structure consists of six groups (Appendix 2). There are three key groups with responsibilities relating to extreme weather services.

- National Forecast Services Group delivers weather, climate, hydrological, oceanographic forecasting services and public communications;
- Data and Digital Group is responsible for managing assets, including physical components of the observations network, as well as relevant ICT, software and data.
- Business Solutions Group is responsible for aviation and space weather services.

1.5 The Bureau's staff with key forecasting responsibilities include:

- 268 meteorologists in operational roles who deliver weather forecasts and warning services from the Bureau's National Operations Centre in Melbourne and State and Territory Forecasting Centres located in each state and territory capital city;[4]
- 50 hydrologists in operational roles who deliver flood forecast and warning services from four Flood Warning Centres with staff located in each of the forecasting centres;
- eight space weather services forecasters in operational roles who deliver services from the Space Weather Forecasting Centre in the Bureau's Sydney office; and
- seven meteorologists on the Extreme Weather Desk (located in the Bureau's Melbourne office).

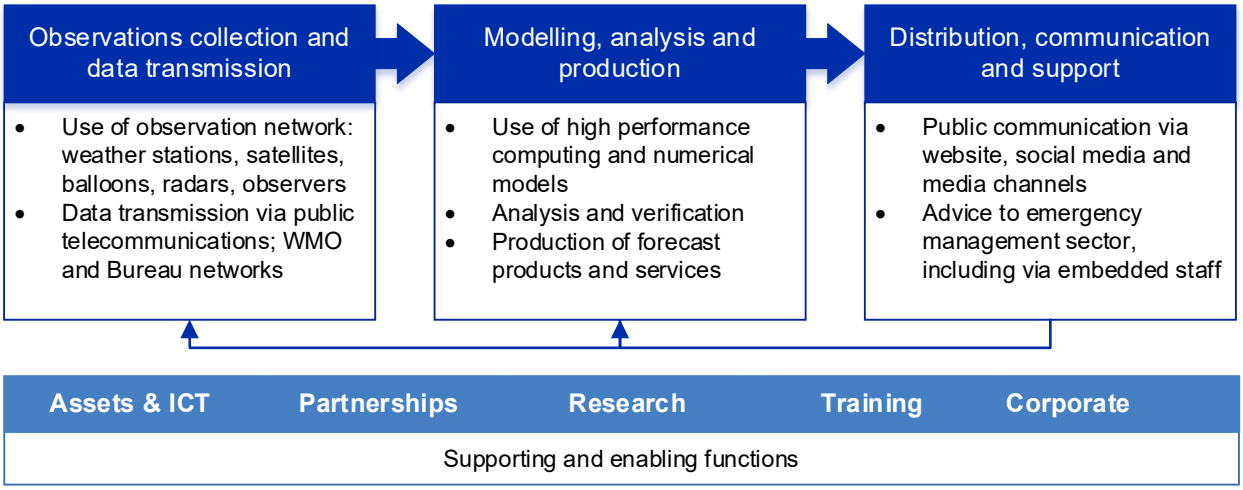
Severe and extreme weather services

1.6 The Bureau delivers domestic forecast and warning services for a wide range of extreme weather events. These include: flood, thunderstorms, fire, tropical cyclones, storm surge, hazardous surf and storm tides, tsunami and heatwave. The Bureau's Space Weather Service monitors events such as solar flares which can result in damage to power networks and satellites. The Bureau also meets a range of international forecasting and warning commitments.

1.7 The process of producing and communicating forecasts and warnings occurs continuously across the Bureau. A representation of the key stages of the forecasting process and the functions supporting this are shown in Figure 1.2.

4 Services are also delivered through the Sydney Airport Meteorological Unit, offices in Cairns and Townsville and Department of Defence offices around the country. Forecast services to support the activities of the Australian Antarctic Division are delivered from the Bureau's Antarctic bases at Casey, Mawson and Davis.

Figure 1.2: Forecasting process and supporting functions



Source: Adapted by the ANAO from Bureau of Meteorology and World Meteorological Organization documents.

1.8 The Bureau's access to observations data is essential for delivering extreme weather services. Data is generated through assets, networks and facilities owned by the Bureau and third parties:

- surface, marine, upper air and satellite equipment collecting data from the Earth's surface, atmosphere and space;
- ICT assets — including high performance computing capability and data networks;
- the use of Numeric weather prediction (NWP) models — the Bureau operates around 50 NWP models which use current observations of weather, as well as historical weather and climate data, to forecast future conditions; and
- facilities — the Bureau maintains state and territory offices and 24 field stations (currently being consolidated into eight observing operations hubs).

1.9 In 2017–18 the Bureau estimated the value of its assets at over $700 million. Approximately $82 million was invested in asset acquisition and construction during this financial period. The Bureau's participation in WMO arrangements allows it to access significant international capabilities.

1.10 The provision of extreme weather services is an integral part of the Bureau's ongoing operational activities. In delivering these services it relies on the same underpinning meteorological capabilities as are required for the provision of general weather services. However, before and during extreme weather events, the Bureau uses a range of specific strategies and processes to ensure its staff and systems are able to operate effectively under pressure. Actions undertaken as part of these processes include:

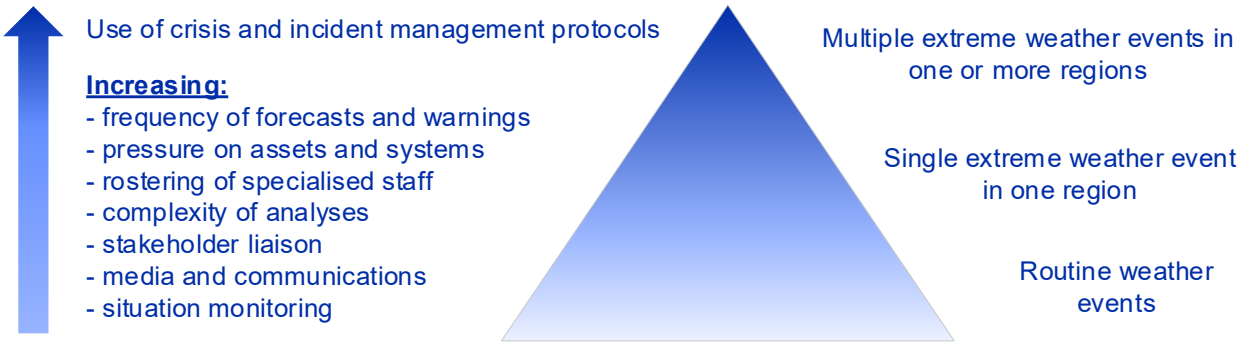
- pre-season[5] preparations to ensure infrastructure, processes and staff are ready to respond to severe events;

5 Different types of extreme weather occur more frequently at certain times in different regions. These periods are referred to as seasons. In parts of northern Australia, for example, the fire weather season is considered to be the winter months. In parts of southern Australia the fire weather season occurs during summer months. Extreme weather conditions in a region can still occur outside of these seasons.

- monitoring events to determine if and when the Bureau's response should escalate;
- scaling up staff effort and mobilising additional resources; and
- enacting crisis and incident protocols to manage increases in the need for liaison, coordination and public communications.

1.11 The Bureau's ability to escalate activities during extreme events is an important part of its capacity to respond effectively to extreme weather (see Figure 1.3).

Figure 1.3: Escalation of activities during extreme weather events



Source: ANAO based on Bureau of Meteorology information.

1.12 An example of this escalation process in practice is provided at Case study 1, which details activities undertaken by the Bureau in response to multiple extreme events during the summer of 2018–19.

Case study 1. Bureau response to multiple extreme weather events, December 2018 to February 2019

From late January to early February 2019 the Bureau responded to flooding around the Townsville area in north Queensland[a] and bushfires across Tasmania[b] During this period, the Bureau also monitored high fire danger across parts of Victoria.

In response to these weather events, the Bureau activated crisis and incident management protocols on 31 January 2019. This included the stand-up of a crisis management team (CMT) led by a member of the Executive Team and incident management teams. A key feature of the Bureau's approach to handling these events was a significant increase in its communications effort.

- Public communications in Queensland consisted of flood watches; warnings; and emergency warning signals; hourly radio updates to affected communities, as well as news interviews, social media and videos.
- The Bureau's Brisbane office communicated with Queensland Fire and Emergency Services (QFES), including via a meteorologist embedded in its control centre. Bureau spokespeople participated in daily QFES media conferences. There was also ongoing communication with the Australian Government Crisis Coordination Centre.
- Communication with other stakeholders included briefings to ministers and other parliamentarians; liaison with operators of Ross River Dam[c] and the Australian Defence Force's 5th Aviation Regiment to support rescue and response operations.

Noting on 31 January that weather events in Queensland were increasing meteorologist and management fatigue, the Bureau's CMT activated national flood surge arrangements. Support was provided by the Extreme Weather Desk (EWD) and other state and territory offices in relation to incident managers, communications and hydrologists. The EWD also provided support to the Bureau's Tasmanian office to assist with spot fire forecasts. Support to state fire agencies was bolstered by placing a meteorologist in state crisis management arrangements. Incident managers monitored potential impacts of poor air quality in Hobart.

During the period of its activation, the CMT monitored the performance of key observations assets. It noted that flood technicians from Brisbane and Cairns would be redirected to support flood network continuity, with the rain and flood warning network to be regularly reviewed.

Note a: North tropical, central coast and Gulf areas. Major flooding occurred overnight on 3 February 2019, with the peak level reached at the Aplin Weir in Townsville on 4 February 2019.

Note b: Dry lightning resulted in fires on 28 December 2018, with seventy fires still active toward the end of January.

Note c: Key water storage and flood control infrastructure in the Townsville region.

Source: ANAO based on Bureau of Meteorology information.

Reviews of the Bureau's services

1.13 The Auditor-General has conducted two performance audits of the Bureau of Meteorology in the past two decades: *Weather Services in the Bureau of Meteorology* (1999);[6] and *Administration of the Improving Water Information Program* (2014).[7] These reports identified the need for the Bureau to strengthen its monitoring and reporting of performance information and to improve its governance and arrangements for managing projects.

1.14 Four key reviews have informed the development of the Bureau's operating model and contributed to its capacity to respond to extreme events.

- Review of the Bureau of Meteorology's capacity to respond to future extreme weather and natural disaster events and to provide seasonal forecasting services (the Munro Review). The review was commissioned by the Parliamentary Secretary for Sustainability and Urban Water in 2011.
- Review of Aviation Weather Services, undertaken by the Bureau in response to a request from the aviation industry in 2015.[8]
- A Bureau-commissioned business process baselining and analysis activity in 2015 and 2016 (the Reimagining Project).
- An organisational Functional and Efficiency Review in 2016, undertaken as part of a government-wide process (Efficiency through Contestability Program) to identify opportunities for greater efficiency and contestability in government activity.

1.15 These reviews highlighted the importance of the Bureau keeping pace with the expectations of stakeholders for high quality forecasting, whilst ensuring operations remain sustainable. Recommendations have included the need to:

6 Auditor-General Report No.22 1999–2000 *Weather Services in the Bureau of Meteorology.*

7 Auditor-General Report No.22 2013–14 *Administration of the Improving Water Information Program*.

8 The review was undertaken with input from an international aviation weather expert and an aviation industry representative in 2015.

- better define the range, standard and cost of routine weather services;
- achieve greater efficiency in operations through more effective planning and management of Australia's observation network;
- increase the use of automated forecasting for routine weather, and to direct forecaster effort to specialised analysis, particularly of extreme weather;
- implement systematic and consistent ways of gaining customer feedback on performance and service expectations; and
- engage with business and government clients to ensure products are relevant to their needs and appropriately costed.

1.16 The 2011 Munro Review highlighted the need for the Bureau to be able to provide a greater volume of accurate forecasts, particularly during multiple extreme weather events. The Bureau's workforce and ageing infrastructure were identified as risks to the sustainability of its operations. The review also observed that the Bureau, as a large scale service provider, lacked a necessary focus on process development and documentation. The 2011 Munro review made 13 recommendations for 'Priority Action'.

1.17 The Government's response to the 2011 Munro Review (issued in 2013) agreed with 10 of the recommendations, with one recommendation 'Agreed In-Principle' and two recommendations 'Agreed In Part'. The Government's response included funding of $58.5 million over four years[9] for additional frontline meteorologists and hydrologists, and the establishment of an Extreme Weather Desk aimed at providing a flexible and targeted capacity to respond to extreme weather events across Australia. [10] This funding also provided for new flood forecasting and storm tide prediction systems, and included $3.7 million for essential infrastructure repairs and upgrades.

1.18 The 2016 Functional and Efficiency Review of the Bureau made 35 recommendations, several of which reiterated those of earlier reports. Thirteen recommendations were directed at strengthening the Bureau's processes and systems for allocating resources and making capital investment decisions.[11]

Organisational developments

1.19 Over the past decade the Bureau has implemented a range of corporate initiatives aimed at improving the effectiveness and efficiency of its service provision. Current internal reforms are being driven by increasing domestic and international demand for timely, reliable and localised weather prediction.

1.20 As part of a broader program of reform, the Bureau is implementing changes to its delivery of services to the aviation industry and is planning to redevelop its model for the provision of public weather services. These reforms are aimed at implementing more efficient arrangements for

9 Funding commenced 1 July 2013, with ongoing funding following implementation.

10 Bureau of Meteorology, *Australian Government Response to the review of the Bureau of Meteorology's capacity to respond to future extreme weather and national disaster events and to provide seasonal forecasting services*, Australian Government, 2013, pp.1–2.

11 The Bureau advised that these recommendations were implemented between 30 June 2017 and 30 June 2018.

delivering weather services, and making better use of specialist forecaster skills to meet the emerging needs of industry, government and community.

1.21 Following the discovery of critical cyber vulnerabilities in the Bureau's ICT infrastructure in 2015,[12] the Australian Government committed funds to a five-year program of remediation (termed ROBUST).[13] The program aims to improve the security of the Bureau's ICT systems, applications and processes and increase the resilience of its observations network. The program's delivery streams include: ICT security; resilience and service management; infrastructure; observations network; data and integration; applications; delivery channels; and an overall framework for managing the delivery of ICT capability.

1.22 A program of work to provide an initial response to cyber vulnerabilities was funded in the 2016–17 Budget and has involved expenditure of $35.8 million. Further funding to ensure the long term security of ICT infrastructure has been delivered in two tranches from 2017–18 (ROBUST T1) and 2018–19 (ROBUST T2). Expenditure, to date, has been $41.2 million and $18.8 million respectively, with further funds committed to the value of around $20 million.[14] Work under the two tranches of ROBUST is not expected to be completed until 2021–22. A business case for funding to undertake a final phase of remediation (ROBUST T3) was in development at the time of this audit.

Rationale for the audit

1.23 Effective forecasts and warnings are important in allowing the Bureau's stakeholders, customers and the public to prepare for extreme weather events, reducing the potential for loss of life and damage to infrastructure and property. The cost of natural disasters to the economy has been assessed as $18.2 billion per year, equivalent to 1.2 per cent of gross domestic product.[15] This audit was selected to provide assurance about the effectiveness of the Bureau's arrangements for forecasting and warning on extreme weather events.

Audit approach

Audit objective, criteria and scope

1.24 The audit's objective was to determine if the Bureau of Meteorology's processes support the delivery of effective extreme weather services. To form a conclusion against the audit objective, the ANAO adopted the following high-level criteria:

- Does the Bureau's planning appropriately support its ability to provide extreme weather services?

12 Australian Cyber Security Centre, *ACSC Threat Report 2016*, Australian Government, 2016, p 11.

13 The Bureau of Meteorology – improved security and resilience measure (the ROBUST program) is part of the Bureau's equity injection funding shown in Figure 1.1.

14 A mid-term Gateway Review of the ROBUST Program led by the Department of Finance is scheduled for April 2019. The purpose of a Gateway Review is to provide assurance and advice on the delivery and implementation of policies, programmes, projects, and services, as well as early identification of areas requiring corrective action. See Department of Finance, *Gateway Reviews* [Internet], Finance, Canberra, 2017, available from www.finance.gov.au/assurance-reviews/review-process/, [accessed 20 March 2019].

15 Australian Business Roundtable for Disaster Resilience & Safer Communities (ABRDRSC) and Deloitte Access Economics, Building resilience to natural disasters in our states and territories, ABRDRSC, 2017, p.16.

- Does the Bureau manage its operational resources effectively in responding to extreme weather events?
- Is the Bureau's assessment and reporting on the performance of its extreme weather services fit for purpose?

1.25 The Bureau's provision of extreme weather services is an integral part of its ongoing operational activities. This audit has therefore included an analysis of key elements associated with the Bureau's delivery of general weather services in order to examine its ability to escalate operational activity, when required, to deliver extreme weather services.

Audit methodology

1.26 In undertaking the audit between July 2018 and February 2019, the ANAO audit team:

- examined the Bureau's records and interviewed the Bureau's personnel at its Victorian state office in Melbourne, the NSW/ACT office in Sydney and the Northern Territory office in Darwin; and
- gathered feedback from the Bureau's stakeholders via interviews with emergency management organisations and other customer groups (see Appendix 4) and considered submissions from members of the public.

1.27 The audit was conducted in accordance with the ANAO Auditing Standards at a cost to the ANAO of approximately $571,100.

1.28 The team members for this audit were Judy Lachele, Joshua Francis, Kate Wilson and Paul Bryant.

2. Planning and governance arrangements

Areas examined

This chapter examines whether the Bureau of Meteorology's (the Bureau) planning processes, including governance arrangements and relationships, appropriately support its delivery of extreme weather services.

Conclusion

Appropriate planning and governance structures have been implemented to underpin extreme weather services. Planning processes, including extensive stakeholder engagement activities, support the implementation of the Bureau's corporate strategy. Planning for changes to the delivery of aviation and associated services is being appropriately coordinated and managed at the strategic and operational levels. The Bureau's design of new policies and governance frameworks for risk management and resilience planning is appropriate, however improvement is required in the efficacy of controls to reduce residual risk.

Areas for improvement

There have been no recommendations identified.

Suggestions for improvement have been noted in relation to the implementation of the Bureau's revised resilience framework; the consideration of risk in conjunction with partner agencies; and the reduction of risk levels through the use of management controls. Further suggestions relate to the role of committees in informing the development of the Bureau's budget and the expenditure of available funds.

Has the Bureau established formal planning to ensure it is able to respond to extreme weather effectively?

The Bureau has formal planning processes in place which enable it to respond to extreme weather effectively. The Bureau's performance planning framework identifies priorities for operational activity, showing clear links between planned actions and expected performance outcomes. Extensive participation in stakeholder planning forums supports the Bureau in planning its investments and operations and contributes to national capabilities in responding to extreme weather. Cost recovery arrangements support relationships with key stakeholders, such as the aviation industry and the Department of Defence (Defence), and contribute to the rigour of the Bureau's planning frameworks. Planning for changes to operational models for the delivery of aviation and associated services is being appropriately coordinated and managed.

2.1 As the Bureau's provision of extreme weather services is an integral part of its ongoing operational activities, this section examines key strategies, planning processes, stakeholder management, commercial relationships and reform activities relevant to the delivery of both general and extreme weather services.

Strategy and planning

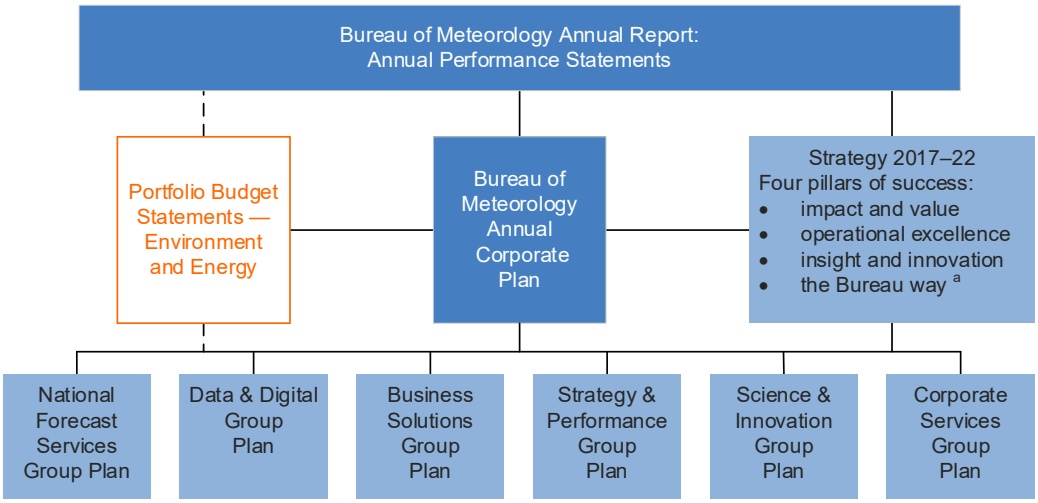
2.2 The Bureau's Strategy 2017–22 (Strategy), which is also the basis of its corporate plan, outlines the Bureau's key strategic goals and deliverables, as well as actions for improving its performance. It cites key drivers of change in the Bureau's operating environment as:

- increased expectations of service;
- developments in technology and international forecasting policy and practice; and
- continuing pressure to deliver services more efficiently.

Group Planning

2.3 In 2017–18 the Bureau revised its business planning documentation to align with its Strategy. Cascading from Strategy 2017–22 are Group Plans which set out actions for achieving the Bureau's strategic outcomes. There is clear alignment between the content of Group Plans and the objectives, key directions and principles set out in its strategy. The Bureau's performance planning framework is shown in Figure 2.1.

Figure 2.1: The Bureau of Meteorology's performance planning framework



Note a: 'The Bureau way' describes key features of the organisational culture the Bureau is aiming to foster.[16]
Source: ANAO based on Bureau of Meteorology information.

2.4 The Bureau implemented a new budgeting process in 2018 and established a four year budget at the Group level. This process and its outcomes are documented in the Bureau's Budget Book 2018–19. The budget book provides Group Executives with an understanding of the resources available to deliver Group Plans, and information to assist them to avoid over-committing resources.

Stakeholder relationships

2.5 The Bureau's Strategy 2017–22 emphasises the need to increase the relevance and value of the Bureau's services to stakeholders.[17] As well as helping to define priorities, the Bureau's relationships with key stakeholder groups are often the foundation for the coordinated or joint delivery of services.

16 Bureau of Meteorology, *Strategy 2017–22*, 2017, p. 7.
17 Ibid., p.6.

International cooperation arrangements

2.6 Australia's membership of the World Meteorological Organisation (WMO) enables the Bureau to access weather information from across the globe. The WMO's World Weather Watch (WWW) links observing systems, telecommunication facilities, and data processing and forecasting centres. Operated by members, the WWW allows the Bureau to access global data and avoid duplicating investments in its observations network.

2.7 International engagement supports the development and maintenance of important arrangements for operational redundancy and continuity. Tsunami advisories for the Indian Ocean are provided by Australia, Indonesia and India. Formal mutual back-up arrangements for volcanic ash advisories are in place with Japan and New Zealand in the event a centre is unable to fulfil its function. The Bureau is also a member of the Intergovernmental Coordination Group of the Pacific Tsunami Warning System which establishes arrangements for sharing seismic and sea level data and warnings advisories.

2.8 The Bureau's cooperative arrangements reflect wider trends toward the provision of meteorological information services for high impact weather across national boundaries. There is planning underway to combine a number of meteorological centres — at local, regional or global levels — to provide integrated extreme weather services in the future.[18]

Partnering with emergency services organisations

Arrangements within the Australian Government

2.9 The Bureau participates in coordination arrangements for responding to natural disasters on a national and international level. Emergency Management Australia (EMA) coordinates support to the states and the territories through the Australian Government Crisis Coordination Centre (AGCCC).[19] The AGCCC advises Australian Government decision-makers on the management of all hazards. This involves drawing on the input of multiple agencies, including daily meteorological reports from the Bureau.

2.10 AGCCC stakeholders regard the Bureau as a critical and effective participant in crisis coordination arrangements. The Bureau's day-to-day contact with emergency services contributes to coordinated national decision-making.

Intergovernmental Agreement on the Provision of Hazard Services

2.11 There is recognition at the Australian and state and territory government level that nationally coordinated efforts enhance Australia's capacity to withstand and recover from emergencies and disasters.

2.12 In 2013, Australia's national consultative emergency management forum[20] tasked the Bureau and EMA with leading the development of recommendations to establish a sustainable basis

18 The International Civil Aviation Organization has undertaken work to determine global requirements for information about hazardous meteorological conditions. It anticipates continued expansion of world-wide information sharing through regional and global centres delivering forecasts on behalf of individual countries. See International Civil Aviation Organization (ICAO), *Seventeenth Meeting of the Asia/Pacific Meteorological Information Exchange Working Group WP/05 Introduction of Space Weather Advisories*, ICAO, 7 March 2019.

19 EMA is a part of the Australian Government Department of Home Affairs. While state and territory governments are responsible for emergency management in their jurisdictions, EMA coordinates Australian Government physical and financial support.

20 The Australia-New Zealand Emergency Management Committee (ANZEMC).

for the provision of weather services to the states and territories. In May 2015, a taskforce, co-chaired by the Director-General EMA and Head of the Hazards, Warnings and Forecasts Division of the Bureau, with senior representatives from the states and territories, reached agreement on the standardisation of 117 of 129 Bureau services to state and territory emergency services.

2.13 The Council of Australian Government's *Intergovernmental Agreement on the Provision of Bureau of Meteorology Hazard Services to the States and Territories* (the IGA) was signed in February 2017 by the Australian Government Ministers for Justice and for the Environment and Energy; and responsible ministers from state-level jurisdictions.[21] The IGA:

- formalises and standardises services provided to state and territory emergency services agencies; and
- clarifies responsibilities of the Australian Government, the states, territories and local governments for flood, fire weather and other forms of extreme weather.

2.14 The IGA recognises that jurisdictions do not have uniform requirements for weather services and products. Queensland, for example, makes extensive use of cyclone products, whereas Tasmania may rely heavily on frost warnings. When states or territories receive the same service, it is now delivered in accordance with an agreed standard. The IGA also identifies supplementary services to be provided on a cost-recovered basis.

2.15 Senior emergency management stakeholders cited the IGA process as an effective example of Australian Government leadership that has promoted a nationally consistent approach to emergency management in a historically contested area of cooperation.

2.16 To oversee the full implementation of the IGA, and resolve outstanding matters, jurisdictions agreed to establish an ongoing Hazard Services Forum (HSF). A set of 133 actions were developed to standardise the 117 services agreed under the IGA. Detailed action plans for standardising flood, fire weather and extreme weather services are being progressed. As of March 2019, HSF members had completed 98 of a total of the 133 standardisation actions.[22]

Cost recovery and commercial relationships

2.17 The Bureau provides specialised services under cost recovery and commercial funding arrangements for a range of industry sectors such as aviation, marine, energy and resources, and agriculture.[23] The Bureau's Business Solutions Group is responsible for these services.

2.18 The Bureau has projected $98.4 million in revenue from external sources in 2018–19, almost 30 per cent of the Bureau's total operational revenue for the year.[24] The largest individual sources of income are from the provision of services to the aviation industry ($38.9 million), followed by services to Defence ($8.3 million).

21 Council of Australian Governments, *Intergovernmental Agreement on the Provision of Bureau of Meteorology Hazard Services to the States and Territories*, 2017.

22 An additional four items were added after the conclusion of the 2015 taskforce.

23 Section 74 of the *Public Governance, Performance and Accountability Act 2013* (Cth), Compilation No. 4, Office of Parliamentary Counsel, Canberra.

24 Excludes Australian Government equity injections (Figure 1.1).

2.19 Remaining income is own-source income and gains, primarily from the sales of goods and rendering of services. These include projects such as an agreement with the Victorian Government for the installation of a new radar in the Wimmera region; and the upgrading of the Tindal radar, partly funded by Defence. Other initiatives include the delivery of services to energy and resources companies and the development of climate information services for the Pacific region, funded by the Department of Foreign Affairs and Trade.[25]

2.20 As commercial and cost-recovery agreements extend to delivering extreme weather services, this audit examined the Bureau's two most significant relationships — with Defence and the aviation industry.

Defence

2.21 The Bureau has a statutory obligation to support the Australian Defence Force (ADF).[26] It delivers aviation observation and forecast services to the Army, Navy and Air Force. Bureau meteorologists are embedded in a joint operational command centre and support operational activities and military exercises at a number of bases. These services support the ADF's ability to plan and operate in hazardous or extreme conditions.

2.22 A framework for managing the relationship between the Bureau and Defence has been in place since 2011 in the form of an overarching agreement, subordinate Memoranda of Understanding (MOU) and service arrangements. Overall responsibility for the relationship resides with the Director of Meteorology and the Vice Chief of the Defence Force.

2.23 Defence stakeholders described a close and effective relationship at an operational level. The Bureau has obtained feedback on the quality of some of its services through surveys and site visits, however performance information has not been collected for all Defence services. For the seven MOUs and eight service agreements in place with ADF, basic performance specifications appear to exist only for the Air Force and for ocean forecasting. This limits the Bureau's ability to determine the effectiveness of all services or to identify trends over time.

2.24 A new agreement and structure for dialogue at senior levels is being established, reflecting a shared interest in expanding the service relationship. Terms of reference for the Defence Weather Service Consultative Group, which provides advice to the Director of Meteorology and the Vice Chief of the Defence Force, are being revised to increase the level of representation and the monitoring and review of the Bureau's services across different areas of Defence.

2.25 Improvements to the Bureau's ICT data security are likely to support a greater range and depth of cooperation. The Bureau is aiming to maintain its provision of bespoke data in support of ADF missions, while also enhancing its ability to contribute expertise to Defence's planning of military capability. Options for centralising the secure transmission of data are being considered by the Defence Geospatial-Intelligence Executive Board, chaired by the Director of the Australian Geospatial Intelligence Organisation.

25 The Climate and Oceans Support Program supports 14 Pacific Island Countries to collect and analyse sea level data, store meteorological records and provide climate and ocean monitoring and prediction services for Pacific governments, communities and the private sector.

26 Paragraph 6(2)(a) of the *Meteorology Act 1955* (Cth).

Aviation

2.26 The Bureau's relationship with the aviation sector is extensive and governance arrangements are mature. The Aviation Weather Services Cost Recovery Implementation Statement 2015–20 is the primary framework governing the relationship. It sets the costs, fees and relevant stakeholder engagement arrangements. Costs are for forecasters, training, management and research staff and aviation regulation. Also included are costs associated with the installation and maintenance of new and current equipment.[27]

2.27 The Bureau issues aerodrome forecasts at 207 civil and military aerodromes across Australia including warnings for 38 aerodromes. Aerodrome warnings are issued for tropical cyclones, strong winds, thunderstorms, sand and dust storms, frost and volcanic ash deposition. Reports about weather that may affect the safety of aircraft operations are provided for two transnational Flight Information Regions covering approximately 11 per cent of the globe. The Volcanic Ash Advisory Centre based in the Bureau's Melbourne office is one of nine centres worldwide.

2.28 Aviation meteorological functions are delivered from 12 forecasting centres. Both public weather and aviation forecasting services are provided from seven capital city offices.[28] At these locations meteorologists are assigned to either a public weather or an aviation forecasting function on a shift-by-shift basis.[29]

2.29 The standards and recommended practices for the Bureau's delivery of aviation weather services are detailed in Annex 3 to the *Convention on International Civil Aviation* (the Convention).[30] The Bureau's Aeronautical Services Handbook provides detailed guidance to forecasters on standards for the delivery of services, including defined tolerances for accuracy and the prioritisation of services in specific circumstances.

2.30 The Bureau's systems of quality assurance include monitoring by the Meteorological Authority Office (MetAuthority) which operates within the Bureau, but separately from its aviation services arm. The MetAuthority is responsible for ensuring that services are provided in accordance with the provisions of the Convention. Both the MetAuthority and the Bureau's aviation services maintain certification under ISO 9001:2015 Quality Management Systems, a requirement of the International Civil Aviation Organisation (ICAO).

2.31 Verification of operational performance against standards occurs through aerodrome forecast verification reports. More broadly, the Bureau's performance in service provision is overseen by a number of forums, including a six-monthly high-level consultative group meeting attended by industry and government stakeholders, as well as seven technical services groups which meet one to two times a year.

27 The charge also includes related support costs, overheads and depreciation.

28 These are: Brisbane, Sydney, Melbourne, Hobart, Adelaide, Perth and Darwin.

29 The Bureau's average staffing level for operational meteorological forecasters delivering public weather and aviation functions is around 270 in 2018–19.

30 The Convention established the International Civil Aviation Organisation (ICAO) and gave it the power to set international standards and practices for international air navigation. These are set out in the ICAO document *Meteorological Service for International Air Navigation Meteorological Service for International Air Navigation*, also known as Annex 3 to the Convention. The sixteenth edition of Annex 3 was published in 2007.

Aviation Meteorological Services Transformation

2.32 A Review of Aviation Services (RAWS) was undertaken in 2015. This has provided the basis of the Bureau's current planning for future service delivery. To deliver on the objectives of RAWS, the Bureau commenced planning in 2017 for the implementation of a three-year Aviation Meteorological Services Transformation (AMST) program. The program envisages transitioning most aviation forecast production to two Aviation Forecasting Centres in Brisbane and Melbourne by June 2020. Aviation functions will continue to be delivered by around 80 forecasting positions funded by the aviation industry.

2.33 Benefits the Bureau aims to realise from AMST include increased specialisation and the ability to meet demands for a greater volume and range of aviation services. This includes a greater capacity to redirect forecaster attention from routine aviation forecasting to high impact weather, when necessary.

2.34 The total cost of AMST is $13.34 million with the aviation industry contributing $10.29 million and the Bureau $3.06 million. Appropriate governance arrangements have been developed, including implementation and change management plans, risk and issue management processes, detailed staffing arrangements and regular executive reporting.

2.35 The Bureau has identified and monitored potential risks to both its aviation and public weather service provision arising from planned changes to its operating model. Key implementation risks identified by the Bureau are: the possibility of delays if major ICT changes are not implemented on time, or that public weather services are compromised by the transfer of resources away from state and territory offices.

2.36 The Bureau's public February 2019 quarterly implementation status report assesses risk mitigations for 'ensuring public weather services are not compromised' as 'Green' on a traffic light scale.[31] This was an improvement from 'Amber' status in previous quarterly reports. Measures driving this improvement in the short term include scheduling functional transitions outside peak times, close management of release agreements for staff commencing in the new centres and the further development of national surge guidelines (refer to paragraph 3.61).

Proposed improvements to public weather services

2.37 To deliver on its Strategy 2017–22, the Bureau is seeking to make changes to its model for delivering public weather services, including for severe and extreme weather. A business case was in development throughout 2018 and approved by the Executive Team in February 2019. Key operational outcomes of the initiative are expected to be:

- increased capacity, reliability and flexibility in responding to customer expectations;
- more staff operating in severe weather decision-support and frontline media roles; and
- less requirement for shift-work.

The detailed design of an integrated national approach to operations, supported by greater specialisation at specific state and territory locations commenced in March 2019. Full transition

31 Bureau of Meteorology, *RAWS Implementation Quarterly Status Report (February 2019)* [Internet], available from http://www.bom.gov.au/aviation/aviation-transformation/aviation-transformation.pdf, [accessed 8 May 2019].

to a new public weather operating model through its Public Services Transformation Program is proposed for 2022 (refer to paragraph 2.41).

2.38 Through the second half of 2018, emergency services stakeholders sought clarification from the Bureau on whether the organisational changes under consideration would affect the delivery of high impact weather services at the local level. Following parliamentary and media interest in September and October 2018, briefings were provided to the Prime Minister and other parliamentarians. In October 2018, the CEO presented at Senate Estimates and explained that quality control processes would ensure forecasts to communities are appropriately informed by an understanding of local weather and its likely consequences.[32] The CEO also wrote to concerned stakeholders about the aims of the program, emphasising the importance of fully utilising national capabilities to better respond to the needs of local community and industries.

2.39 In February 2019 the Bureau commissioned the development of a stakeholder engagement plan, which is expected to be implemented from July 2019. The Bureau also developed guidance for its managers to support them in communicating the objectives of public weather reforms to their staff and external stakeholders, and to provide details about planned processes of consultation and decision-making.

Coordination and oversight of major initiatives

2.40 The Bureau has appropriate governance arrangements in place to support its planning for the implementation of major initiatives — aviation, public weather, as well as its significant ICT and physical infrastructure upgrades through the ROBUST program. A set of policy and planning principles have been established to inform decision-making, and the operational implications of planned changes are considered at appropriate levels.

2.41 The Public Services Transformation Program (PST Program) will be delivered progressively in four phases, commencing from 1 July 2019 and delivered over three years, with a preparation phase prior to delivery. The phased approach, including the use of trials and end to end testing of the operational approach, is aimed at ensuring key risks and interdependencies are appropriately managed and services are not compromised during transition.

2.42 The Executive Team monitors the status of concurrent portfolio-level major initiatives at each monthly meeting. It reviews dependencies between initiatives and establishes expectations of collaboration across the organisation. ROBUST program progress reporting to the Bureau's governance committees, including to the Executive Team and audit committee, has provided a model for reporting on other major initiatives. Reporting on current programs appropriately informs the executive of the status of implementation; the management of risks; and the use of financial and non-financial resources.

2.43 Each program has a senior executive level program control group. Responsibility for implementing program elements are incorporated into Group Plans. Further Bureau actions to ensure the appropriate coordination of major initiatives include:

- strengthening the role of its Enterprise Project Management Office;
- implementing an enterprise-wide project management software platform;

32 Commonwealth, *2018-19 Supplementary Budget Estimates*, Senate, Environment and Communications Committee, 22 October 2018, Dr Johnson, CEO and Director of the Bureau of Meteorology, p.20.

- establishing an enterprise-wide project delivery model; and
- developing the project management capabilities of its staff.

Do the Bureau's governance frameworks support the effective delivery of extreme weather services?

The Bureau's governance frameworks have the potential to support the effective delivery of extreme weather services, but implementation could be improved. The Bureau's executive structure and changes to its committee system have enhanced its capacity to plan and monitor the implementation of its corporate strategy, however committee processes for investment decisions and the commitment of funds would benefit from further refinement. The Bureau has established risk management frameworks which require improvement in the efficacy of controls to reduce residual risk, and has established crisis and incident management capabilities which require improvement in training and testing processes.

2.44 As the Bureau delivers extreme weather services as part of its ongoing operational activities, this section includes an examination of those elements within the Bureau's governance structure and policies for general weather services that also support its ability to escalate operational activity for extreme weather events.

Governance structure

2.45 The Bureau's Chief Executive Officer (CEO), who is also the Director of Meteorology, is the accountable authority for the Bureau within the meaning of the *Public Governance, Performance and Accountability Act 2013* (PGPA Act).

2.46 Six group executives report to the CEO. The CEO and group executives make up the Executive Team, the Bureau's highest level management committee. In July 2017 the Executive Team established three sub-committees with terms of references and delegations — the Investment Committee, the Major Transactions Committee and the Security, Risk and Business Committee. The other major committee, the Audit Committee, already existed before this point.

Investment Committee

2.47 The Investment Committee's charter states that its role is to make recommendations to the Executive Team regarding the allocation of Bureau resources to meet operational, capability, capital, and support services requirements. Minutes of its first meeting in July 2018 indicate members envisaged the Investment Committee being a 'control room with a view over the entire investment landscape'. It was to align its work with the Bureau's planning and budget cycle and establish a framework for determining priorities from the top down in line with Strategy 2017–22.

2.48 Following several meetings of the Investment Committee, the Executive Team decided to directly perform its functions, including consideration of resource allocation and capital budgeting. This pausing of its operation was largely due to time pressures associated with concluding Group Plans and the need to meet budget deadlines. The Bureau advised that the Executive Team expects to re-instate the Investment Committee from 1 July 2019.

2.49 Improvements to the Bureau's budgeting processes (refer to paragraph 2.4) and asset planning and management (refer to paragraphs 3.34 to 3.49) are likely to provide the frameworks

and information the Investment Committee requires to apply a strategic perspective to investment, and to deliver on its charter more broadly. This is discussed further in the context of Recommendation no.2 (see paragraph 3.50).

Major Transactions Committee

2.50 A Major Transactions Committee (MTC) was established, chaired by the Chief Operating Officer, to support the CEO in directing and controlling the Bureau's involvement in the commitment of funds through transactions with other parties. These include commercial arrangements, procurement and capital spending such as for property or major equipment. The committee considers proposed commitments that meet defined risk and financial thresholds.[33] The Bureau is aiming through the committee to instil a more rigorous approach to the consideration of significant transactions.[34]

2.51 The MTC has issued guidance on key information to be submitted by business areas to enable committee members to appropriately assess transactions. Information relates to alignment with strategy; expected benefits; capability needed to deliver outcomes; opportunity costs; dependencies; risks; whole of life costs and the soundness of proposed commercial arrangements.

2.52 In its first year of operation, the MTC considered transactions relating to the installation of new radar systems; fee for service arrangements; pilot forecast services; international cooperation; and office refurbishment. The Bureau has adopted a generally sound approach to ensuring all transactions meeting defined thresholds are reviewed by the committee before consideration by the delegate. The ANAO observed that some proposals meeting these thresholds have been directly considered by the CEO or the Executive Team. While the MTC is advisory in nature, the circumstances under which a proposal is to be considered by either the MTC or, outside the established governance framework, by members of the Executive Team is not made clear. There is a risk that the purpose and intended outcomes of the committee's functioning will be weakened by the existence of separate pathways for the consideration of financial commitments.

2.53 Both the Investment Committee and Major Transactions Committee have charters defining roles and responsibilities. There would be benefit in the charters articulating the role of the Investment Committee in providing advice to the Executive Team on strategic priorities to inform the development of the budget, and the role of the Major Transactions Committee in endorsing the release of funds allocated through the budget process.

Security, Risk and Business Continuity Committee

2.54 The role of the Security, Risk and Business Continuity Committee (SRBCC) is to provide assurance to the CEO and Executive Team that the Bureau is effectively managing risk at both a strategic and operational level. The committee has played an important role in overseeing development of standard contingency planning and resilience frameworks.

2.55 In line with its charter, the SRBCC can make recommendations to the Executive Team on the allocation of resources, both operational and capital, in support of security and business continuity

33 This includes transactions which have been assessed as having a risk rating of 'high' or greater and/or transactions with a whole-of-life cost greater than $2 million. Risk ratings pertain to intellectual property or partnership arrangements; financial loss or fraud; reputation; stakeholder or customers; safety or environment; national security and security of data and information.

34 As of December 2018, the MTC had met 23 times and considered 32 transactions.

needs and in response to risk assessments. Cyber measures are an important element of security, and the committee has received regular updates on the status of these measures.

Audit Committee

2.56 In accordance with the PGPA Act, the Bureau's audit committee provides ongoing oversight of its risk management framework, and contributes to its internal system of control, including through its audit program. The internal audit program for 2017–18 comprised five audits, with ten planned for the 2018–19 financial year. Four of the planned audits are 'mid-flight' or 'health check reviews' and five will examine whole of enterprise processes.[35] While none of the planned audits will directly examine the Bureau's extreme weather capabilities, the majority are intended to provide assurance on key foundations of the Bureau's service provision.

Risk Management Framework

2.57 The Bureau's Enterprise Risk Management Framework 2017–20 (ERMF) has been developed under its Strategy 2017–22. Group and program plan risks were identified in 2018 through a series of leadership workshops. The framework includes an overall risk appetite statement and appetite statements by risk category. Accountabilities and responsibilities for implementing the ERMF have been identified at each level of the organisation. Application of the EMRF is evident in the Bureau's Groups Plans and Budget Book 2018–19.

2.58 The Bureau assesses the risk of an ineffectual warning or forecast impacting on public safety or key customers as 'extreme'. On the basis that the Bureau regards extreme weather services to be part of standard service provision, it does not explicitly refer to risks associated with the delivery of these services. Noting that demands on operational meteorologists and communication staff can escalate significantly during severe weather events, the Bureau could consider identifying risks and treatments which are specifically linked to the delivery of extreme weather services.

2.59 Warnings are often developed in conjunction with emergency services organisations and communicated via media or other external channels. The risk of ineffectual warnings could be considered a shared risk under the *Commonwealth's Risk Management Policy* and the ERMF. The ERMF includes a requirement to identify risks that impact on other entities and sectors and provides information to assist with treating and reporting shared risks. The Bureau should ensure that risk and mitigation strategies are formally and regularly considered with partner agencies through existing governance arrangements, such as relevant forums and agreements.[36]

2.60 The ERMF identifies a range of detailed controls for reducing the effect of individual risks.[37] None of these (rated mostly as 'fair') are considered to reduce the overall risk ratings (rated 'high' or 'extreme'). The Executive Team and audit committee regularly receive a Key Business Risk Report with mitigation strategies rated by risk control owners. The Bureau should aim through these

35 As at March 2019 the Bureau advised that two internal audits were complete; four were in progress; and four were in the process of being procured.

36 Department of Finance, *Commonwealth Risk Management Policy*, Australian Government, 2014. P.21 'Shared risk — a risk with no single owner, where more than one entity is exposed to or can significantly influence the risk'.

37 ibid., p. 20 — an internal control is any process, policy, device, practice or other actions within the internal environment of an organisation which modifies the likelihood or consequences of a risk.

arrangements to drive improvements to the efficacy of controls in order to reduce risks currently rated as 'high' or 'extreme'.

Resilience Framework

2.61 In August 2018 the Executive Team endorsed a Resilience Framework (the Framework). The Framework details the scope of work needed to strengthen the Bureau's arrangements to minimise the impact of events on service provision. It also outlines a requirement to update and align policies for: crisis management; incident control; business continuity, including state continuity plans; ICT disaster recovery; and security and communications.

2.62 Some elements of this framework have been completed, as discussed below. The revision of policies is scheduled to be completed by the end of 2018–19, with further implementation supported by a three-year exercise schedule.

2.63 Uninterrupted operations are critical to the Bureau's ability to deliver services, including during extreme events. The *Protective Security Policy Framework* also requires entities to implement measures to minimise or remove the risk of assets or resources being made inoperable.[38] The Bureau has a low risk appetite in relation to interruptions in the operation of critical assets and systems.

2.64 The Munro Review reported in 2011 that the Bureau was carrying significant risk with respect to business continuity. Following two radar outages in January and May 2016, the Bureau strengthened its arrangements.[39] All state and territory offices received scenario-based training in business continuity processes at the end of 2016. An internal evaluation of this training concluded that arrangements were largely effective in supporting staff to prioritise forecasts and manage stakeholders. Common issues identified were the lack of standardised media and communication procedures and the need to strengthen incident management procedures. Business continuity plans for state and territory offices continued to be updated between 2016 and February 2019.

2.65 In November 2017 the Executive Team noted the need for the Bureau to urgently uplift its crisis management arrangements and to implement a systematic and comprehensive business continuity framework across the entity. In August 2018 an internal audit of surge capacity identified that additional efforts were required to fully implement incident management procedures as part of a national surge response model.

2.66 In October 2018, the Bureau introduced national level crisis and incident management plans based on standard incident management approaches consistent with those used by emergency service agencies.[40] The Bureau conducted a planned scenario-based exercise to test the new plans and 'triggers' in these and business continuity plans. The Bureau advised that these plans were enacted on nine occasions between November 2018 and February 2019 to respond to extreme

38 Attorney-General's Department, *Protective Security Policy Framework* [Internet], Australian Government, 2019, available from www.protectivesecurity.gov.au/Pages/default.aspx, [accessed 24 January 2019].

39 On 8 January 2016 the Bureau's forecasting service was affected for several hours as a result of a major network fault, with radar imagery, including for aviation services, unable to be updated. Further outages occurred in May of that year.

40 A system commonly used by state emergency services is the Australasian Inter-Service Incident Management System.

weather events and unplanned business disruptions.[41] The Bureau also enacted business continuity procedures to respond to at least one planned and one unplanned business disruption during 2018.

2.67 Observations from recent business continuity and incident management exercises indicate there is an ongoing need for training, as well as regular and rigorous testing to properly embed capabilities across all groups. Particular emphasis should be placed on 'surprise' exercises.

ICT Disaster Recovery

2.68 The focus of the ROBUST program is to ensure security and resilience risks are addressed. In March 2017 the Bureau's audit committee noted delays in achieving a redundant ICT disaster recovery capability. The Bureau advised that some ICT disaster recovery arrangements are in place, but that a complete ICT disaster recovery plan has not been finalised. Current infrastructure constraints also prevent ICT teams performing formal ICT disaster recovery testing.

2.69 In January 2019 the residual risk rating for ICT interruption or outages impacting on the delivery of meteorology services was reduced from 'extreme' to 'high' based on improved documentation and processes used in recent events.

2.70 The Bureau's executive recognises the importance of establishing a widely understood and well-practised whole of enterprise approach to ICT disaster recovery and business continuity. The full implementation of the ROBUST Program and the Resilience Framework is critical to addressing this area of vulnerability.

41 As at March 2019, post-event reviews of the operation of crisis and management plans during the 2018–19 summer had not been completed.

3. Management of operational resources

Areas examined

The ANAO examined whether Bureau's operational processes and activities support it to prepare for, and respond effectively to extreme weather. These include its engagement with community and emergency management stakeholders; its business and information management processes; and asset and staffing strategies.

Conclusion

The Bureau's operational processes and activities, including its management of resources, have allowed it to prepare for and respond effectively to extreme weather events. To ensure the sustainability of its operations, improvements are required in the planning of asset investment and maintenance, rostering and workforce management.

Areas for improvement

The ANAO made has three recommendations aimed at improving the Bureau's recording of decisions during extreme events, planning for asset investments and analysis of operational effort for long term workforce management.

Suggestions for improvement have been noted in relation to reviewing the currency of the Bureau's memorandum of understanding with the Australian Broadcasting Commission; ensuring appropriate surge support for the space weather function; and optimising the use of the Extreme Weather Desk in the context of broader changes to its operating model.

Are relevant stakeholders appropriately engaged before and during extreme weather events?

The Bureau is appropriately engaging government, media and public stakeholders in relation to extreme weather events. Operational forecasting centres have developed effective liaison structures with state government stakeholders, and forecasters have established processes to provide timely and relevant advice to decision-makers before and during extreme weather events. The Bureau is progressing a project with the emergency management sector aimed at increasing the effectiveness of forecasts and warnings through a greater focus on communicating the potential impacts of weather to communities.

Preparing for extreme weather

3.1 Effective warnings allow the Bureau of Meteorology's (Bureau) stakeholders, customers and the public to prepare for extreme events. It is estimated that a community well prepared for a flood could reduce potential damage by up to 80 per cent.[42] The Bureau communicates warning messages, agreed with state emergency services, as part of its forecast service. In 2017–18 the Bureau issued 16,000 warnings in relation to extreme weather for the marine and land environments, as well as over 1000 flood warnings.

42 N Comrie, *Review of the 2010–11 Flood Warnings and Response: Final Report*, Victorian Government, Melbourne, 2011, p. 31.

3.2 Reviews of extreme weather events over the past decade have concluded that the success of warnings depends in large part on the quality of information provided to the community before warnings are issued. Equally important is public trust in warnings. If members of the community do not have confidence in the reliability of a warning, they may ignore them.[43]

3.3 The National Forecast Services Group (NFS) within the Bureau delivers two communications programs[44] to disseminate general public information, and provide information to emergency services agencies to support their planning.[45] Formal pre-season briefings to government, the emergency management and industry sectors[46] enable planners to judge risks associated with the season ahead, as well as longer-term trends.[47]

3.4 There is close interaction between the Bureau and Australian, state and territory government authorities throughout extreme weather seasons. Most forecasting centres participate in state-level forums or reference groups that enable the quality of Bureau services to be discussed.

3.5 The Bureau undertook a program to enhance its communications capabilities between 2014 and 2017 by appointing specialist media officers to perform functions previously the responsibility of forecasters. NFS Media and Communication Managers attached to forecast centres in capital cities[48] are responsible for maintaining links with the media; preparing and distributing media products; and providing training to forecasters. State-based media staff coordinate their activities with a National Media Team responsible for liaising with the media, ministerial offices; the Australian Government Crisis Coordination Centre; and stakeholders across government and industry.

3.6 Media and Communication Managers and representatives of the Australian Broadcasting Corporation (ABC), a key emergency broadcaster,[49] reported a generally effective working relationship. A memorandum of understanding (MoU) was established with the ABC in 2013 to govern this relationship. The Bureau should consider reviewing this MoU to ensure its ongoing relevance.

Flood warning services

3.7 Flooding is a key type of extreme weather event in Australia. A number of insights and operating principles that have emerged from reviews of the Bureau's response to flooding events.

- The quality of the Bureau's flood warning services depends on data from state and territory, local government and regional authorities. This requires ongoing cooperation

43 N Comrie, *Review of the 2010-11 Flood warnings and Response: Final Report,* Victorian Government, Melbourne, 2011, p. 33.

44 National Operations, Community Forecasts; and Public Safety and Community Outreach.

45 Examples are: the intensity of heat events in recent years; typical impacts of El Nino cycles; and analyses of the extent to which lack of rainfall in specific parts of Australia contributes to extreme fire conditions.

46 Primarily energy, resources, water, agriculture and transport.

47 Briefings include seasonal, monthly and/or multi-week forecasts. Specific products are: Tropical Cyclone Seasonal Outlook and Southern Australia Seasonal Bushfire Outlook. Videos produced by the Bureau are used by government entities and companies to efficiently communicate key messages to staff.

48 With the exception of Canberra.

49 The ABC is one of a number of media broadcasters that transmit emergency warnings and information to the public in consultation with emergency services organisations.

between all parties responsible for maintaining and updating rainfall and flood monitoring infrastructure.

- Warning processes integrate specialist input from a number of agencies. State incident control centres rely on the Bureau updating data on its website frequently and making staff available to verify or update weather predictions. The community also expects to have access to relevant, real-time observations.[50]
- Warnings should enable local users to make decisions about how best to protect their interests. This depends on the Bureau and first responders understanding local conditions, events and demographics, as well as local networks for disseminating information.

3.8 In response to review recommendations, the Bureau has led or participated in processes aimed at improving elements of the national flood emergency response system. Key developments are listed below.

- The clarification of roles and responsibilities for flood management, including the provision of relevant flood information by states and territories to the Bureau, through the 2017 *Intergovernmental Agreement on the Provision of Hazard Services*.[51]
- Cross-jurisdictional work to develop a national framework for flood warnings in order to have consistent, formalised flood forecast and warning products for state emergency services and other users; as well as data sharing agreements.
- Ongoing work to develop a national flood warning infrastructure plan to improve processes associated with river level and rainfall monitoring infrastructure.[52]

3.9 At a regional level, the Bureau chairs Flood Warning Consultative Committees (FWCC) in each state and territory. FWCCs are attended by representatives from key stakeholder organisations such as state agencies, local government and catchment authorities. Their role is to advise the Bureau on improving the provision of its flood forecasting services in the respective jurisdiction.

3.10 Representatives indicated that FWCCs are an effective mechanism for consulting on flood forecasting and warning services, including the setting and reporting on standards in service level agreements, and the sharing and interpretation of data. FWCCs are also well placed to identify needs for improvement at state, regional and local levels.

Embedded forecasters

3.11 The Bureau has embedded meteorologists in all state emergency services, with the exception of the ACT, Northern Territory and Tasmania — where extra meteorological support can be provided on request. This arrangement began in Victoria in the 2007–08 summer, and has gradually been extended to other states. Having a meteorologist operating in state crisis management centres helps incident controllers to interpret the content and certainty of forecasts; understand risks; and make critical decisions during intense periods of operations.

50 Bureau of Meteorology*, National Arrangements for Flood Forecasting and Warning*, Australian Government, 2018.

51 ibid.

52 The Bureau's 2018 Flood Warning (hydrometric) Network Infrastructure Strategic Study states that the national flood data network includes around 7500 observation sites measuring river levels and rainfall — 46 per cent of which are owned by the Bureau.

3.12 Emergency management personnel expressed a high degree of confidence in the judgements of embedded forecasters about the potential impact of a forecasted event, as this is often based on long professional experience in the particular type of weather or local area. Emergency management authorities in the ACT, Northern Territory and Tasmania have chosen not to embed forecasters, citing cost as a reason for not having this arrangement in place.

Local warnings

3.13 A consistent theme of past reviews is the need for state emergency response agencies to better engage with communities to improve the relevance, reliability and impact of warnings. A national review of warnings and information by Emergency Management Victoria in 2014 concluded that warnings need to be closely linked to the situation and community for which they are provided.[53] In 2016 the Burns Review of extreme weather in South Australia found that emergency warnings had not adequately conveyed the potential consequences of the event. The Local Government Association of South Australia observed that communities did not fully comprehend warning messages or understand what was expected of them.[54] The review of the 2018 Cyclone Debbie response recommended that emergency warning information be more explicit.[55]

3.14 While a warning may previously have been assessed as effective based on its accuracy in predicting the onset of an extreme event, the 2018 review of Cyclone Debbie noted that local communities now expect to understand what a forecast warning means at an individual, household and neighbourhood level[56] and for forecasts to take account of the amount of time the community needs to carry out mitigation actions, such as evacuation.[57]

Future Warnings Services Project

3.15 In 2017 the Bureau initiated a four year collaborative project with emergency services aimed at addressing concerns raised in the 2014 Emergency Management Victoria review and the 2016 Burns Review that forecasts were providing insufficient detail about the significance and possible consequences of an event. The Future Warnings Services Project takes as its starting point that warnings should communicate the impact of weather rather than simply forecasting an event. The Bureau observed that this requires a shift from the current issuing of standard, broad warning messages to wording tailored to specific locations and communities.

3.16 The project identified a need for future warning services to reflect a more dynamic understanding of circumstances in cities and communities and their channels of communication, and for the Bureau to:

53 Emergency Management Victoria*, National Review of Warnings and Information: Final Report November 2014*, Victorian Government, Melbourne, 2014, p.10.

54 G Burns, L Adams, G Buckley. *Independent Review of the Extreme Weather Event South Australia 28 September 5 October 2016*, 2017, p.20.

55 Office of the Inspector-General Emergency Management, *The Cyclone Debbie Review*, Report 1: 2017–18, Queensland Government, Brisbane, 2017, p.22.

56 ibid., p.37.

57 M Cawood, C Keys, C Wright. *The Total Flood Warning System: what have we learnt since 1990 and where are the gaps*, Australian Journal of Emergency Management, Volume 33, No.2, April 2018, p.50.

- develop a deeper understanding of communities by engaging both formally and informally with a broader spectrum of stakeholders, for example, local governments, than it has to date;
- overcome technical limitations in sharing real-time information between systems operated by it and emergency services; and
- increase its capacity to issue forecasts more frequently so that users are able to make judgements about when and how to respond.

3.17 The project draws on information obtained through a series of workshops commissioned by the Bureau to develop its understanding of the operational and decision-making processes and requirements of emergency services organisations.

3.18 Whilst the emergency management sector is able to draw on multiple sources of weather information, discussions with representatives indicate that they see value in the Bureau investing in capabilities that allow it to act as a central and authoritative source of truth. Weather information issued by the Bureau remains a preferred basis for operational planning in the sector. The Bureau has planned work to improve warnings, hazards information and data and to reconfigure its website as a more effective communications platform.

3.19 Interviews conducted by the Bureau with emergency services stakeholders in 2018 as part of the project indicated that these stakeholders value their operational relationships with the Bureau's regional staff. They also expressed a view that the implementation of solutions by all jurisdictions to increase interoperability between critical systems appears slow. The Bureau could consider whether there is scope for the Hazard Services Forum to address these concerns following agreement on the standardisation of policies and arrangements.

Do the Bureau's operational policies and processes support effective extreme weather services?

The Bureau's operational policies and processes are largely effective in supporting extreme weather services. Cross-jurisdictional cooperation and the introduction of enterprise-wide forecasting systems have increased standardisation in forecasting policies and processes. Initiatives have commenced to standardise state and territory processes for rostering, pre-season asset checks and manual record-keeping. The recent use of standard crisis and incident management processes supports effective decision-making during extreme events, however there is improvement required in the recording of operational judgements and decisions.

Standardisation of business processes

3.20 The Bureau's introduction of new national forecasting and warning systems has assisted in standardising forecast processes, making it easier for forecasters to operate out of any office.[58] National arrangements and common processes are in place for the delivery of flood services (see paragraph 3.58).

58 Systems include the Next Generation Forecast and Warning System (NexGenFWS); the Australian Digital Forecast Database (AFDF); and the Australian Community Climate and Earth-System Simulator (ACCESS). Standard systems are used for flood, spot fire forecasts and cyclones.

3.21 For other types of extreme weather, the Bureau's state and territory guidance and instructions for operations indicates there are differing approaches to activities such as rostering, pre-season asset checks and recording significant decisions and actions.[59] Processes and procedures for recording minimum required meteorological data from an event vary across offices.

Documentation of policies and processes

3.22 The Bureau's operational policy and procedure documents for extreme weather generally contain a requirement that they be updated annually prior to each extreme weather season. This audit reviewed thirty-five policy and procedure documents used by operational staff. The documents contained inconsistencies in instructions for the recording of descriptive information such as document approver and versioning. The ability of forecasters to respond quickly and effectively during extreme events could be compromised when key information such as contact details; hyperlinks; user names and passwords; and roles and responsibilities change.

Documenting critical operational decisions

3.23 The 2011 Munro Review and 2016 Functional Efficiency Review identified the importance of recording key decisions during extreme events. The Munro Review observed:

> Bureau advice can lead to the decision to initiate large scale operations, such as evacuations, in circumstances where costs are high and lives are at risk. The gravity of these decisions places significant pressure on the accuracy of Bureau information. Some stakeholders consulted during the Review commented on the growing need for advice that will stand up to intense scrutiny in post event enquiries.

3.24 Logging systems are commonly used by first response agencies to record key decisions, their rationale and actions taken during complex incidents. The Bureau uses a range of automated systems to capture forecast decisions, as well as situational reports and log sheets. However, analysis of the Bureau's guidance indicates there is no clear, organisation-wide policy, procedure or system for maintaining a record of why specific operational decisions were taken during extreme events. Examples of operational decisions involving management judgement or discretion include whether and when to issue a Standard Emergency Warning Signal, or when to move from three hourly warnings to one hourly warnings. Higher-level decision-making may relate to coordination activities between tropical cyclone warning centres to manage workloads and the management of national resources deployed into state emergency coordination centres.

3.25 National policies refer to a requirement to record information, but are not consistent when detailing the type of information that should be captured. One third of the thirty-five national operational policy documents reviewed did not state any requirement to maintain operational decisions. In documents that do, the specification of the type of information to be recorded varied. The purpose of recording information during an event — such as enabling others to understand after the event why particular decisions were taken and by whom — is not always clearly explained.

3.26 The rationale for operational decisions taken during extreme weather events may be captured by a range of systems and tools. This includes: electronic notes, forms and wiki pages; systems logs; hand written, paper based records; emails; and automatically recorded phone calls.

59 Work to standardise business processes commenced in 2015, however, this was put on hold pending an organisational restructure in 2017.

The use of multiple, unconnected systems for capturing operational information increases the risk that information may not be able to be readily located after an event.

3.27 The emergency nature of extreme weather events creates challenges for staff in the real-time recording of decisions. Operational staff advised that they often spent a significant amount of time after each major event retrieving and integrating data from a range of sources.

3.28 The Bureau advised that its incident and crisis management plans, operationalised in November 2018, provide a standard approach to recording decisions. However, these protocols only apply during the stand-up of formal incident and crisis management teams. An examination of records relating to extreme weather events during the 2018–19 summer identified instances where senior managers had been required to instruct incident management teams on the type of decisions and supporting data to be recorded, and on how to develop inventories of interaction with stakeholders. Decisions were logged in accordance with incident and crisis management plans. There is an ongoing need, however, to establish organisation-wide guidance on the types of decisions to be recorded by different areas of the Bureau.

3.29 In 2018 the Bureau reviewed its approach to documenting policies, processes and procedures. It identified inconsistent approaches to naming conventions and formatting, version control and the lack of a central repository.[60] In August 2018 the Bureau adopted a Policy Governance Framework. The framework covers the development, approval and management of the Bureau's policies, processes, procedures and guidelines. A number of transformation programs, including ROBUST and public weather, are intended be used to implement the new Policy Governance Framework.

3.30 The Bureau's Strategy 2017–22 sets clear objectives for standardising enterprise systems and processes; and adopting a single set of enterprise information and technology standards. The Bureau holds certification to ISO 9001:2015 Quality Management Systems for Aviation Meteorological Services (Darwin, Canberra and Sydney); its Meteorological Authority and Marine Weather Services.

3.31 The Bureau advised it is developing quality management systems for certification for further programs between 2019 and 2020.[61] New Aviation Forecasting Centres in Melbourne and Brisbane will require processes and documentation consistent with ISO 9001:2015.

Recommendation no.1

3.32 The Bureau of Meteorology develop a nationally consistent approach to govern the recording of decisions and judgements before and during extreme weather events.

Bureau of Meteorology response: *Agreed.*

3.33 The Bureau will adopt a nationally consistent approach to govern the recording of decisions incorporating automated systems, situation reports, log-sheets/books in accordance with standard operating procedures, incident and crisis management plans.

60 The review included a stocktake that identified that the Bureau had more than 986 policy-related documents. This did not take complete account of the National Forecast Services Group's operational service documents.

61 National Security Program (2019); Space Weather Services (2019); Joint Tsunami Warning Centre (2020); Automatic Weather Station Observing Networks (2020).

Does the Bureau's management of assets facilitate the effective delivery of extreme weather services?

The Bureau has established partially effective processes for the planning and management of assets to facilitate the delivery of extreme weather services. Nine of the Bureau's 12 key business risks relate to asset management. Work is in progress to address identified risks through the introduction of new frameworks to manage the Bureau's asset base and prioritise associated investments. It is not evident that the capability requirements of the Bureau are yet being formally considered in planning processes to support asset investment decisions.

Asset management and planning

3.34 A 1999–2000 Auditor-General's report highlighted the importance of the Bureau determining the 'optimal combination of observation sources that meets all the statutory requirements and adequately balances the capabilities of meteorological science with the costs to the taxpayer.'[62] Findings from subsequent reviews indicate continuing challenges.

3.35 In August 2018 nine of the Bureau's 12 'high' or 'extreme' rated key business risks relate to operating, managing or funding the Bureau's assets. Risks relate to:

- failures in ICT, observation assets, or supply of services from third parties;
- financial management issues, including the sustainability of funding for operations and assets;
- staff and executive skills, retention and safety, including staff with relevant ICT expertise and
- the management of assets and projects.

An additional key business risk regarding ineffective warnings or forecasts to the public is directly linked to the risk of asset failure.

3.36 The Bureau has historically lacked a mature capital framework for translating the intent of the Bureau's corporate strategy into high-level investment priorities. Four asset management frameworks have been developed since 2014 to plan and manage the observations network:

- Observing System Strategy 2014–2020 and Beyond.
- ROBUST program, a major upgrade of the Bureau's ICT and observational assets from 2017–18 to 2021–22.
- Asset Management Framework, (2018) which consists of an Asset Management Policy, a Strategic Asset Management Plan, and yet to be developed individual asset management plans.
- Investment Prioritisation Framework (2018).

Observing System Strategy 2014–2020 and Beyond

3.37 The Observing System Strategy 2014–2020 and Beyond (the OSS) identifies 38 outcomes to ensure the 'observation system is future fit to enable the Bureau to deliver on its mission in a

62 1999–2000 Auditor-General's Report No.22 1999–2000, *Weather Services in the Bureau of Meteorology*, p.17.

responsive, effective and efficient manner.' It describes the broad technology, governance, business process and staffing changes needed to deliver services more efficiently and effectively.

3.38 The strategy and associated initiatives are regarded by the Bureau as having continuing relevance to the development of its capabilities. A number of individual initiatives are now incorporated into the Group Plan for the Data and Digital Group. There is no high-level implementation plan clearly covering all of the 38 OSS outcomes, and the status of implementation has not been regularly reported to the executive. A report prepared in October 2017 for the Executive Team listed the status of 327 recommended actions.

3.39 Without an implementation plan and means of clearly tracking the status of outcomes under the OSS, and associated expenditure, it is difficult for the Bureau to demonstrate that the intended benefits of the strategy are being realised, and that this is occurring according to an established schedule and within allocated resources. One OSS activity involves developing strategies for individual categories of asset (refer to paragraph 3.45). Until this has been completed, it may not be possible to reliably report on improvements to capability.

3.40 A key initiative under the OSS is the consolidation of over 175 technical positions from 24 staffed field stations, some in remote locations, into eight 'observing operations hubs'. As well as increasing the efficiency of collecting and communicating observations and maintaining and upgrading assets, the new model aims to better utilise staffing resources and expertise.

3.41 The Bureau's 2017 business case states the cost of operations as approximately $31.7 million per annum and estimates the new model will reduce operational expenditure by up to $38.9 million over ten years when compared to the current operating mode. The project involves the purchasing of assets to transition from manual observations to fully automated weather observations and the installation of nine automated balloon release systems.[63] New hub premises are being established with staff planned to be relocated before 2022.

3.42 Four hubs have been implemented to date — Adelaide in 2015, Darwin in 2016, Melbourne in 2017 and Cairns in 2018. The delivery of hubs in Hobart and Brisbane is delayed, creating risks for remaining hubs in Perth, Hobart and Sydney, scheduled for delivery by 2020.

3.43 To instil greater discipline in the initiation and delivery of initiatives, the Bureau introduced a new model in August 2018 for implementing technology projects. The model aims to promote a whole of life perspective by building in consideration of supporting systems, sustainment costs and ongoing monitoring of performance against expectation. Implementation of the model commenced with its use by the Data and Digital Group, and is now being used on a whole of organisation basis. If implemented consistently across the Bureau, the model is effectively oriented towards clarifying accountabilities, reducing duplication between projects, and allowing failing projects to be quickly identified and ceased.

Asset management framework

3.44 The Bureau is developing an asset management framework under the ROBUST program based on international standards.[64] This framework includes an Asset Management Policy and a

63 Balloon release systems are used for upper air measurement.

64 The international standard for organisational asset management is provided in *ISO 550001:2014 Asset Management Systems*.

Strategic Asset Management Plan (SAMP) that were approved in 2018. The SAMP identified a range of issues that the Bureau is seeking to address:

- Most of the Bureau's assets are technically at the end of their useful life. Planning on a whole of life basis is limited and does not include resourcing considerations.
- The Bureau has poor visibility of its asset portfolio and of the performance of individual assets, and it lacks the necessary information to be able to prioritise maintenance and disposal of assets.
- Only two classes of asset are supported by plans (radar and upper air measurement) and these are out of date.
- There is a need for clear leadership and allocation of roles and responsibilities for planning and execution.

3.45 The Bureau has recently undertaken planning to develop class-based asset management plans under this framework with the intention of fully implementing a strategic and integrated asset management framework. .

Prioritisation of investments

3.46 In November 2018 the Bureau's Executive Team endorsed a new Investment Prioritisation Framework to guide the allocation of Department Capital Budget (DCB) funds.[65] This framework requires all proposals to be ranked using criteria that include consideration of legal obligation; risk and value; and capacity to deliver as is, or to modify.

3.47 In 2018–19 the Bureau has used this framework to prioritise 43 capital investments — 34 existing projects and nine new proposals. Implementation of the framework has been an important first step in establishing the capacity to identify and address existing pressures. The Executive Team has approved the final DCB allocations for 2019–20 through to 2022–23, noting that further work would be needed to determine outer year funding allocations.

3.48 Optimising investments in the observations network requires an ability for the Bureau to identify core capability requirements from a whole of enterprise perspective. As an example, the ability to collect data relevant to forecasting severe thunderstorms is enhanced by having an upper air measurement capability. This capability can be delivered through a range of options, such as a radio sonde upgrade program, satellite or ingestion of data generated by aircraft. An investment framework should enable the suitability of specific individual proposals (for example, the acquisition of specific equipment) to be assessed from the point of view of their potential contribution to defined current and future enterprise capabilities.

3.49 A capability-based approach to planning to underpin the Bureau's decision-making on capital investments is in development as part of the implementation of the SAMP. The SAMP is a high-level framework which establishes an expectation that broad organisational aims will inform the setting of asset management objectives. This provides a potentially appropriate basis for capability-based planning. Plans for individual classes of asset are scheduled for development under the framework between January and September 2019. These are to identify specific assets capable of delivering the functions, capacity and levels of service needed to satisfy current and

65 Departmental capital budget (DCB) is provided to non-corporate Commonwealth entities that receive government funding to meet costs associated with the replacement of minor assets ($10 million or less) or maintenance costs that are eligible to be included in the asset's cost base.

future requirements. Until the full suite of individual asset plans are in place, the scope for capability based asset investment decisions is likely to remain limited.

Recommendation no.2

3.50 The Bureau of Meteorology establish a capability based planning process to support the management of its existing asset base and prioritise associated investments.

Bureau of Meteorology response: *Agreed.*

3.51 Since the Audit, the Bureau has adopted an Enterprise Asset Policy and a Strategic Asset Management Plan in accordance with ISO 55000 Asset Management and ISO 19770 IT Asset Management. The Bureau has also committed $40.9 million to a Radar Sustainment and Modernisation program. The Bureau will continue to uplift its asset management practices in accordance with recognised standards.

Does the Bureau employ effective staffing strategies to respond to extreme weather events?

Bureau staffing and surge arrangements are effective in meeting existing increases in demand for flood support, and a national approach to scaling up regional staffing levels for other types of extreme weather was trialled during the 2018–19 season. The Bureau's Extreme Weather Desk provides additional surge capacity. The Bureau's systems for recording work effort do not readily allow for the analysis of information at an aggregate level to support longer term planning.

Surge capacity

3.52 Extreme weather events necessitating a rapid increase (or surge) in forecaster activities can significantly increase demands on forecasters and frontline staff to issue additional forecasts and warning products; provide briefings to media; and liaise with emergency services or other key stakeholders. The Bureau's four-day national forecast for extreme weather (the National Hazard Outlook) is a key process used to determine whether forecast high impact weather events are likely to require the activation of local or national contingency procedures.

3.53 To ensure an effective response to extreme weather events, managers in Flood Warning Centres and State and Territory Forecasting Centres undertake a number of actions in preparation for, and at the onset of a surge event. This includes developing rosters with additional positions and scheduling forecasters with relevant skills. In cases where local resources are likely to be insufficient, managers can access forecasting and media support from other offices, as well as the Extreme Weather Desk (EWD) located at the Bureau's Melbourne office, for a limited range of extreme weather types.

Surge response for floods

3.54 The 2011 Munro Review recommended the establishment of a National Flood Desk. Four teams now provide flood forecasting for north, south, east and west regions of Australia. These arrangements support the Bureau's ability to flexibly meet highly variable demands for flood forecasting across Australia, and to manage the risk of fatigue during protracted flood events.

3.55 The Bureau uses a national register to record the competency of individual hydrologists to undertake specific forecasting roles in each state and territory, as well as their most recent operational experience. A gap analysis undertaken in 2016 compared the number of hydrologists and competencies against the number and type of roles required by each centre to respond to both routine and extreme weather events. It found that staffing and competency levels were within requirements for the majority of positions. The analysis was repeated in 2018, and reflects that the Bureau adopts an evidence-based approach to resource and competency planning for flood operations.

3.56 Guidelines for assigning hydrologists during flood events are well defined. Staffing needs are assessed by dedicated Flood Monitoring Leads in each team. Twice weekly 'National Situational Review' meetings led by a National Flood Operational Coordinator help to determine overall resourcing strategies and plan for staff shortages or system outages.

3.57 Teams assigning staff use well-defined rostering principles that take account of the need to minimise fatigue. A standard flood rostering tool, configured for each operational centre, monitors individual hours worked during flood events and alerts managers to potential fatigue breaches or errors in rostering.

Surge response for non-flood extreme weather

3.58 Unlike the nationally standardised approach in place for flood operations, procedures for responding to other types of extreme weather (for example, thunderstorms, tropical cyclones, and fire weather) are documented in individual directives developed and maintained by each of the State and Territory Forecasting Centres. Directives generally refer to the discretion of senior managers to assign additional staff, as necessary.

3.59 In early 2017 the Bureau responded to significant flooding caused by Cyclone Debbie. Over a two week period the Bureau's surge response involved over 30 staff to support flood operations in Queensland and New South Wales, with a mix of staff from these and other jurisdictions. In addition to surge support for flood operations, surge was also provided for cyclone and other weather. The Bureau subsequently undertook an analysis which identified a need for better rostering tools.

3.60 In August 2018 the Bureau compiled a national competency register which enables managers to more efficiently assess the availability of staff and to request assistance from a national 'pool', when surge support is needed. Regular gap analyses to determine the number and competencies of meteorologists for extreme events, similar to that undertaken for flood operations, would enhance the Bureau's planning and workforce management for future surge events.

3.61 Draft Operational Surge and Response Guidelines developed in October 2018 for all weather types were tested during the 2018–19 severe weather season — these are yet to be finalised. The guidelines codify several existing processes to invoke national surge support when regional offices require additional assistance, such as twice-weekly contingency meetings. National surge considerations are informed by a four-day national forecast of extreme weather (the National Hazard Outlook) produced by the Extreme Weather Desk.

Surge for space weather

3.62 Following a severe space weather event in September 2017, the Bureau's Space Weather Forecasting Centre (the centre) identified a need to increase its capacity to respond to requests for briefings to customers, media and government. The Bureau advised in February 2019 that the centre is able to readily access support from other parts of the Bureau. However, current competency registers do not identify staff readily able to relieve space weather staff during a surge event. In light of the small number of forecasters in the centre and the specialised nature of its forecasting, the Bureau should consider implementing training to ensure that surge staff are able to appropriately support the centre.

Role of the Extreme Weather Desk in surge support

3.63 The Australian Government response in 2013 to the Munro Review committed to establishing a single National Centre for Extreme Weather to be staffed by eight meteorologists.[66] This centre, known as the Extreme Weather Desk (EWD), commenced operations in late 2015 with four meteorologists. It became fully operational in 2017 with a pool of seven meteorologists.[67]

3.64 A key role of the EWD is to provide weather forecasting and media surge support to state and territory offices during sustained periods of extreme weather.[68] Given the limited number of meteorologists, the EWD acts as one source of surge support. The Bureau does not record the number or frequency of surge responses within an office, between offices or from the EWD. Upon request, the EWD determined that it had provided additional forecasting and media support for more than 30 weather events between March 2017 and April 2018.

3.65 Because the Bureau does not systematically record or analyse information about demand for surge support, it cannot reliably determine its expenditure on surge activity. While this may not impact on the Bureau's practical ability to surge in response to specific events, it is likely to detract from its ability in the longer term to reliably evaluate and plan activity; and to confidently advise government on its use of resources or its future funding requirements.

3.66 Current daily tasks for the EWD include briefing the media, the Australian Government Crisis Centre and other stakeholders; assisting with post-event reviews; verifying severe weather; and trialling new products and systems. The more flexible national surge capacity envisaged by the Bureau's transformation programs could reduce the need for the EWD to support regional operations, creating greater scope for it to lead and coordinate the development of enterprise-wide policies, arrangements and processes. The Bureau should consider reviewing the role of the EWD to determine how its resources and capabilities can best support the Bureau's broader goals for enhanced service provision at the national level.

Rostering and fatigue management during surge activity

3.67 During surge events rosters need to be updated frequently. Managers use spreadsheets for planning which do not have inbuilt guards against shift conflicts or potential non-adherence to

66 Bureau of Meteorology, *Australian Government Response to the review of the Bureau of Meteorology's capacity to respond to future extreme weather and national disaster events and to provide seasonal forecasting services*, Australian Government, 2013, p4.

67 This is one short of the eight specified by the Australian Government Response. The desk is staffed by one meteorologist during winter, and two meteorologists during the severe weather season and operates 7am to 6:30pm seven days per week.

68 The EWD does not provide support for flood or space weather forecasting.

fatigue or other guidelines. The Bureau has undertaken improvements for flood forecasting operations, however, further work is needed to embed these guidelines and tools into the Bureau's operations.

3.68 For most types of weather, rostering or actual work effort data is not readily available for the purposes of analysing trends and costs or for identifying future staffing requirements, including capacity to respond to extreme events. The Bureau does not systematically collect information at a national level about actual or potential incidences of breaches of fatigue guidelines.

Workforce planning

3.69 In 2011, the Munro Review recommended that the Bureau develop and implement a long term workforce planning strategy, including succession plans for all frontline weather services positions. In January 2017 the Bureau prepared a draft enterprise level workforce plan which identified the need for information about actual and budgeted employee expense reports, as well as succession planning for critical roles. However, a workforce strategy, regular reporting of trends and an understanding of staffing cost drivers is not in place.

Recommendation no.3

3.70 The Bureau of Meteorology establish a process to analyse the operational effort involved in responding to extreme weather events on a national basis in order to inform long term workforce management and financial planning.

Bureau of Meteorology's response: *Agreed.*

3.71 Since the Audit, the Bureau has adopted an organisation-wide workforce planning framework and capability development plan to better inform our future workforce requirements. This along with rolling four-year budgets and Group and Program plans will inform the allocation of human and financial resources, including provisions for extreme weather events. The Bureau's capacity to respond to multiple and simultaneous extreme weather events will be enhanced as part of the Public Services Transformation Program.

4. Performance assessment and reporting

Areas examined

This chapter examines whether the Bureau has effective arrangements for assessing, improving and reporting on its performance in delivering extreme weather services.

Conclusion

The Bureau undertakes verification work to monitor its performance in specific areas of forecasting in order to improve accuracy and reliability. An overall program for the verification of all types of extreme weather has not yet been implemented. Reporting to the Parliament and the public is generally fit for purpose, however coverage of the Bureau's performance in delivering extreme weather services could be expanded.

Area for improvement

The ANAO has made one recommendation aimed at ensuring the Parliament and the public receive appropriately comprehensive information about the Bureau's performance in delivering extreme weather services.

Suggestions for improvement have been noted in relation to the implementation of the Bureau's Post Event Review Methodology; specifying and reporting against targets and baselines for performance criteria; and including contextual information in the Bureau's annual report about efficiency measures relevant to the delivery of extreme weather.

Does the Bureau systematically capture and apply operational learnings after significant weather events?

The Bureau commenced implementation of a formal post event review management methodology in early 2018 to capture and apply operational lessons after significant weather events. The methodology is appropriate, but it is unclear whether identified improvements are being implemented.

4.1 The Bureau's forecasters have an established operational practice of undertaking extreme weather event reviews with a meteorological or hydrological focus. These reviews build understanding of complex weather phenomena and help the Bureau and key stakeholders to improve their operations and planning for future events.

4.2 Before 2018 the Bureau lacked a consistent approach to conducting reviews and to recording and applying lessons to improve its forecasting and business performance. The Bureau has since introduced a Post-Event Review Management (PERM) methodology which provides a standard framework for conducting reviews and for systematically improving performance through learning from operational experience. The PERM governance framework identifies who within the organisation is responsible for following through on actions identified in reviews, and whether these apply only to a state or territory office or should be addressed at an organisational level.

4.3 Responsibility for implementing the PERM resides with the Group Executive of National Forecast Services (NFS), and the methodology is being applied by NFS staff. PERM roles and responsibilities have been incorporated into individual performance agreements for 2018–19, champions have been established and training is occurring across the NFS Group.

4.4 While the PERM policy envisages the involvement of all relevant operational staff in review processes, this is yet to occur. The policy does not reference the Corporate Services (responsible for training) or Data and Digital Groups (responsible for the performance of assets). Aviation and Space Weather Services have their own review methodologies, which are intended to be incorporated in the PERM framework in time. The benefits of the PERM as a tool for organisational learning are likely to be reduced if the policy is not implemented on an organisation-wide basis.

4.5 An internal review in 2018 showed that while the policy has been well integrated in NFS standard operating procedures and performance agreements, the effectiveness of the policy has been limited by lessons learnt not being sufficiently shared across regions. A centralised Lessons and Actions Register has now been established but is yet to be fully implemented.

4.6 The effectiveness of the register within and across state and territory offices will need to be carefully monitored and reviewed. It is not clear, for example, whether specific actions relevant to all regional offices identified in a post-event review conducted in March 2018 have been progressed. The Bureau advised that there were nine significant events from the summer of 2018–19 where the PERM requires post-event reviews to be conducted. These are yet to be completed.

4.7 Whilst the PERM policy and procedures set appropriate accountability arrangements for tracking the implementation of agreed actions, such as quarterly reporting to the executive, it is too early to determine the effectiveness of these arrangements. In implementing the PERM, the Bureau should ensure deadlines are adhered to and systemic issues are clearly identified and addressed across its state and territory offices.

Is there evidence that the Bureau is using performance information to improve its performance over time?

The Bureau undertakes activity to assess the accuracy of forecasts and warnings, and this information is used to improve models and forecaster ability on an ongoing basis. An overall program for the verification of all types of extreme weather has not yet been implemented.

4.8 The performance of weather services can be judged in terms of the quality of forecasts and warnings (that is, accuracy and timeliness); and how well services meet user requirements (for example, relevance and accessibility). This audit examined whether the Bureau is using information about the accuracy and timeliness of its extreme weather forecasts and warnings to improve its performance over time. The Bureau's responsiveness to the broader needs of key users of forecast and warnings was discussed in Chapter 3.

Verification of forecasts and warnings

4.9 Verification of weather services refers to the process of assessing the accuracy and timeliness of forecasts and warnings compared to the conditions that eventuated. The World Meteorology Organization states the main goal of a verification process is to continuously improve the quality of weather services.[69] Verification activity supports meteorological organisations to monitor and report on the performance of their services in order to improve operational decision-making and maintain public trust.

69 World Meteorological Organization, *Verification* [Internet], available from www.wmo.int/pages/prog/amp/pwsp/qualityassuranceverification_en.htm [accessed 19 November 2018].

4.10 In relation to general weather forecasting, the Bureau's verification work over the period 2014 to 2018 has focused on comparing the accuracy of models producing automated forecasts with that of manual forecasting. Verification results have enabled the Bureau to improve its modelling and increase the use of automated forecasts. This has contributed to steady increases in the accuracy of forecasts. As an example, maximum temperature forecasts in 2017 for a point in time four days from the present were as accurate as next day forecasts in 2003.

Verification across extreme weather services

4.11 Forecasting, policy and research staff undertake data analysis and publish their results in peer-reviewed literature across a range of forecasting activities, including those with a specific focus on extreme weather. In 2015 the Bureau commissioned an international expert in meteorology to undertake a review (the 2015 review) of its verification processes. The review endorsed the Bureau's overarching verification policy, but identified issues in relation to the ability of the public to access verification information, and limited internal reporting and accountability for verification measures. The Bureau's 2017–18 performance statement included verification results for one type of extreme weather (the accuracy of floodwater-level predictions). By comparison, its 2016–17 performance statements included the accuracy of forecasts or warnings for five types of extreme weather.

4.12 The 2015 review found that the Bureau's verifications of tropical cyclones and severe thunderstorms were out of date and recommended this be updated. The Bureau responded by updating the tropical cyclone track verification on its website. The Bureau acknowledges that further work is required in verifying tropical cyclone intensity forecasts and severe thunderstorm forecasts. As many forms of extreme weather are inherently difficult to predict, there would be benefit in the Bureau providing alternative information and context to enable performance to be assessed over time.

Coordination of verification activities

4.13 In response to the 2015 review the Bureau committed to verifying all types of forecast, warning and analysis products. It established a verification board to coordinate and prioritise verification activities; and to review and report on verification activities and results. The board, and the Verification Reference Group which replaced it in 2017–18, have not developed an implementation plan to respond to the review's recommendations.

4.14 Responsibility for resourcing, designing and undertaking verification activities is devolved to each of the Bureau service areas. As a consequence there has been insufficient oversight of verification activities across the various weather services. The development of a 'roadmap' to guide implementation of review recommendations and other actions has been discussed by the Verification Reference Group and members of the executive since late 2016. The roadmap indicates that, as of November 2018, three of the 38 review recommendations had been implemented.

4.15 The Bureau is yet to set internal performance indicators, baselines and targets for all extreme weather products and services. In February 2019 the Bureau advised that the Verification Reference Group is overseeing the development of a framework for verifying and reporting on the quality of key forecasts and warnings services.

4.16 For forecasts and warnings for which verification is not currently occurring, or when new forecasting products are released (for example, heatwave assessments), it may take several years

of monitoring before achievable targets can be set. This underlines the need for the Bureau to review its current range of verification activities to establish a basis for future target setting.

Does the Bureau have an appropriate performance reporting framework?

The Bureau has established a performance reporting framework which aligns with Australian Government requirements in most respects. The performance criteria contained in the Bureau's 2017–18 Corporate Plan lack baselines or targets, reducing the line of sight between its criteria and reporting of performance in its Annual Report. The Bureau's external performance reporting could be expanded to better enable public visibility of performance in the delivery of extreme weather services.

Australian Government performance framework — reporting on extreme weather services

4.17 The performance measurement and reporting requirements for Australian Government entities are established under the *Public Governance, Performance and Accountability Act 2013* (PGPA Act) and the *Public Governance, Performance and Accountability Rule 2014* (PGPA Rule). The performance framework requires an entity's purpose, activities, and performance measures to be clearly aligned. This provides the Parliament and the public with information to assess its progress towards achieving planned outcomes.

4.18 Entities prepare three key documents annually to provide a line of sight between their use of public resources and the results they have achieved — the Portfolio Budget Statements, Corporate Plan, and Annual Report, incorporating audited financial statements and Annual Performance Statements (performance statements).[70]

4.19 The Bureau's stated purpose is: 'To provide trusted, reliable and responsive weather, water, climate and ocean services for Australia — all day, every day.' The purpose aligns with the functions of its governing Act,[71] and describes the intended quality of its service provision.

4.20 The Bureau's 2017–18 Corporate Plan describes the Bureau's purpose and the results it is intending to achieve over a four year period (2017–2021) organised under four strategic themes (referred to as 'pillars').[72] Performance criteria are described in the Bureau's 2017–18 performance statements as 19 Strategic Success Measures (SSMs).[73]

4.21 The characteristics of appropriate performance criteria are relevance, reliability and completeness[74], and are defined as follows:

- relevant — where they clearly indicate who will benefit from the entity's activities and how; address a significant aspect/s of the entity's purposes via its activities; and provide sufficient information in a clear and concise manner;

70 The Bureau's 2017–18 Annual Report was provided to the Minister for the Environment and Energy on 3 October 2018 and tabled in Parliament out-of-session on 24 October 2018.

71 Section 6 of the *Meteorology Act 1955* (Cth), Compilation No. 6 Office of Parliamentary Counsel, Canberra.

72 Bureau of Meteorology, *Corporate Plan 2017–18,* p. 5.

73 Bureau of Meteorology, *Annual Performance Statements 2017–18,* pp. 10-21.

74 Department of Finance, *Quick Reference Guide RMG 131: Developing Good Performance Information,2016*.

- reliable — use and disclose information sources and methodologies that are fit for purpose (including a basis or baseline for measurement or assessment, for example a target or benchmark); and are free from bias; and
- Complete — provide a balanced examination of the overall performance story, and collectively address the entity's purpose.

Relevance

4.22 As the Bureau's core capabilities underpin its ability to deliver extreme weather forecasts and warnings, its performance criteria do not explicitly reference the delivery of extreme weather services. This audit therefore reviewed the ten performance criteria which could be considered of direct relevance to the delivery of these services (listed in Appendix 3).

4.23 Performance information provided against these criteria would assist the reader to understand those particular aspects of the Bureau's operations most relevant to it fulfilling its purpose with respect to the provision of hazard services. The criteria are expressed in plain language; indicated who would benefit; and are relevant to meeting the Bureau's purpose.

Reliability

4.24 Department of Finance (Finance) guidance states that an entity's corporate plan should include a description of performance measures, when they will be reported on, the data collection techniques to be used and any targets the performance measures will be assessed against.[75] This information can then be used by the Parliament and the public to assess the results presented by the entity in its performance statements at year-end.

4.25 A review commissioned by the Bureau in 2016 recommended the establishment of a baseline of current forecast and warning performance regarding quality, on-time delivery and customer satisfaction, and relevant targets. Whilst targets for some activities, such as the accuracy of forecasting models and flood warnings, are referred to in the performance statements section of the Bureau's 2017–18 annual report, the Bureau's corporate plan does not specify targets or baselines for assessing the performance criteria. To adhere to Finance's guidance, the Bureau should firstly specify the targets and baselines for its performance criteria in its corporate plan, and then report against these in the performance statements section of its annual report.

4.26 In relation to the performance information reported in the Bureau's 2017–18 annual report, SSM6 provides information about the Bureau's performance in floodwater-level prediction against an externally set target. However there is no specific reporting on other forms of extreme weather against targets or baselines for the remaining nine performance criteria relevant to the delivery of extreme weather services.

4.27 While the Bureau provides monthly reporting to the Executive Team on weather model accuracy, this is not published in its annual report. There may be scope to identify appropriate international benchmarks for the purposes of reporting publicly. As discussed at paragraph 4.16, the Bureau's planning for verification activities could also include a focus on establishing baselines for different types of extreme weather to support public reporting.

75 Department of Finance, *Resource Management Guide No. 132: Corporate plans for Commonwealth entities*, January 2017, p. 7.

4.28 For five of the 10 criteria reviewed it is not evident how achievements will be measured. These relate to determining the contribution of the Bureau to social and economic value; international benchmarking and verification; and the assessment of benefits derived from international collaboration.

4.29 In relation to the targets for performance criteria which are reported in the Bureau's 2017–18 annual report, the basis of these targets is not always apparent. An example of this is: 'The Bureau's website was the most trusted weather information source for 39 per cent of respondents, compared to the target of 35 per cent.' Without further information validating 35 per cent as a reasonable expectation of performance, the reader is unable to judge the Bureau's achievement. A description of the rationale for targets in the corporate plan would further improve the reliability of performance measures and ensure more meaningful information is provided to the reader.

Completeness

4.30 The Bureau's performance criteria are generally balanced and collectively address the Bureau's overarching purpose. They provide a foundation for developing a meaningful account of performance against its purpose.

4.31 The Bureau's performance criteria overall are suitable for an entity whose central purpose is the delivery of services. They envisage reporting of both quantitative and qualitative information about the extent to which its products and services are used; customer satisfaction; and some aspects of operational capability.

4.32 Reporting on the quality of the weather services, such as the accuracy and timeliness of forecasts and warnings for all types of extreme weather would provide a more meaningful story of the Bureau's performance in regard to this particular function. This is discussed further in the following section.

General reporting on extreme weather services

4.33 Extreme weather services are of critical interest to government and industry stakeholders and the general public. The Bureau's Annual Report 2017–18 contains information throughout the report (outside of the performance statements section) that gives account of the quality, timeliness and customer satisfaction of its weather forecasts. This includes summary information on the cyclone season, gale and severe frost warnings and trend graphs on the provision, uptake and quality of its services.[76]

4.34 The Bureau's 2017–2022 Group Plans specify outcomes and performance criteria which align with its corporate plan. The National Forecast Services (NFS) Group is described as 'providing highly valued and resilient forecast and warning services to the Australian community and emergency services customers'.[77] Analysis of measures contained in the NFS and other Group Plans indicates that, if appropriately baselined and supported by evidence of achievement, these measures would generally improve public reporting on the quality of its severe and extreme weather service provision.

76 *Bureau of Meteorology Annual Report 2017–18*, p.23.

77 Bureau of Meteorology, *Corporate Plan 2017–18,* p. 10.

4.35 Performance statements are intended to be the primary location for all public data on the actual performance of an entity.[78] Results reported in the Bureau's performance statements are limited to flood warnings. While it would not be practical to include detail about all aspects of performance on severe and extreme weather in the annual performance statement, clear references to relevant information contained elsewhere in the report could be provided.

4.36 Establishing a direct link between the funding reported in the Portfolio Budget Statements and the performance information presented in the Bureau's corporate plans and performance statements is challenging for the Bureau as it has a single outcome and program. A significant proportion of the Bureau's annual budget supports its observing infrastructure network which does not distinguish between routine, severe and extreme weather. Similarly, operation of the Bureau's computing infrastructure is used on a full time basis to support the full range of its forecasting operations. For the large majority of the Bureau's service delivery activities, the apportioning of costs between routine, severe and extreme weather services would be based on judgement.

Recommendation no.4

4.37 The Bureau of Meteorology expand performance reporting to include information about the accuracy and timeliness of forecasts and warnings for extreme weather services.

Bureau of Meteorology's response: *Agreed.*

4.38 The Bureau will accelerate its verification work and enhance public reporting on the accuracy and timeliness of extreme weather services. The Bureau notes that existing reporting of severe and extreme weather uses accepted World Meteorological Organization categories.

4.39 The Bureau should consider including contextual information about efficiency measures in its annual report that contribute to the delivery of severe and extreme weather.

Grant Hehir
Auditor-General

Canberra ACT
22 May 2019

78 Department of Finance, *Resource Management Guide No. 134 Annual performance statements for Commonwealth entities*, Australian Government, Canberra, 2017.

Appendices

Appendix 1 Entity response

Australian Government
Bureau of Meteorology

Office of the CEO and Director of Meteorology
Bureau of Meteorology
GPO Box 413, Brisbane QLD 4001 Australia

In reply please quote

DIR 19 0172

3 May 2019

Mr Grant Hehir
Auditor General
Australian National Audit Office
GPO Box 707
CANBERRA ACT 2601

Dear Mr Hehir

The Bureau of Meteorology's Delivery of Extreme Weather Services Audit

Thank you for providing the Australian National Audit Office's (ANAO) report under s.19 of the Auditor-General Act 1997 on the Bureau of Meteorology's delivery of extreme weather services.

The six-month audit was undertaken during a demanding severe weather season where the Bureau served Australians through multiple events - unprecedented flooding in north Queensland occurring concurrently with extreme fires in Tasmania and Victoria, followed by Severe Tropical Cyclones Owen, Trevor, Oma and Veronica.

Via an integrated national response our meteorologists, hydrologists, climatologists and communications experts from across Australia delivered high impact and valued services to the community. Our front-line operational staff were well supported by enterprise crisis and incident management systems and processes. Their outstanding efforts received consistently strong positive feedback and appreciation from key stakeholders, customers and partners.

The Bureau of Meteorology (the Bureau) “agrees” with the ANAO’s recommendations and has committed to a number of relevant actions as follows:

1. *Nationally consistent approach to govern recording of decisions pertaining to extreme weather*. The Bureau will adopt a nationally consistent approach to govern the recording of decisions incorporating automated systems, situation reports, log-sheets/books in accordance with standard operating procedures, incident and crisis management plans.

2. *Establish a capability-based asset planning process and prioritise asset investments.* Since the Audit, the Bureau has adopted an Enterprise Asset Policy and a Strategic Asset Management Plan in accordance with ISO 55000 Asset Management and ISO 19770 IT Asset Management. The Bureau has also committed $40.9 million to a Radar Sustainment and Modernisation program. The Bureau will continue to uplift its asset management practices in accordance with recognised standards.

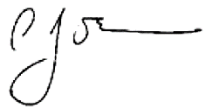
Australia’s National Meteorological Service
Level 16, 32 Turbot Street, Brisbane QLD 4000 | T: +61 7 3239 8700 | www.bom.gov.au | ABN 92 637 533 532

3. *Establish and analyse the operational effort responding to extreme weather to inform workforce management and financial planning.*
   Since the Audit, the Bureau has adopted an organisation-wide workforce planning framework and capability development plan to better inform our future workforce requirements. This along with rolling four-year budgets and Group and Program plans will inform the allocation of human and financial resources, including provisions for extreme weather events. The Bureau's capacity to respond to multiple and simultaneous extreme weather events will be enhanced as part of the Public Services Transformation Program.

4. *Performance reporting to include accuracy and timeliness of forecasts and warnings.*
   The Bureau will accelerate its verification work and enhance public reporting on the accuracy and timeliness of extreme weather services. The Bureau notes that existing reporting of severe and extreme weather uses accepted World Meteorological Organization categories.

Through these and other continuous improvement actions, the Bureau remains committed to providing the Australian community with national weather, climate and water services second to none.

Yours sincerely



Dr Andrew Johnson FTSE FAICD
CEO and Director of Meteorology

Australia's National Meteorological Service
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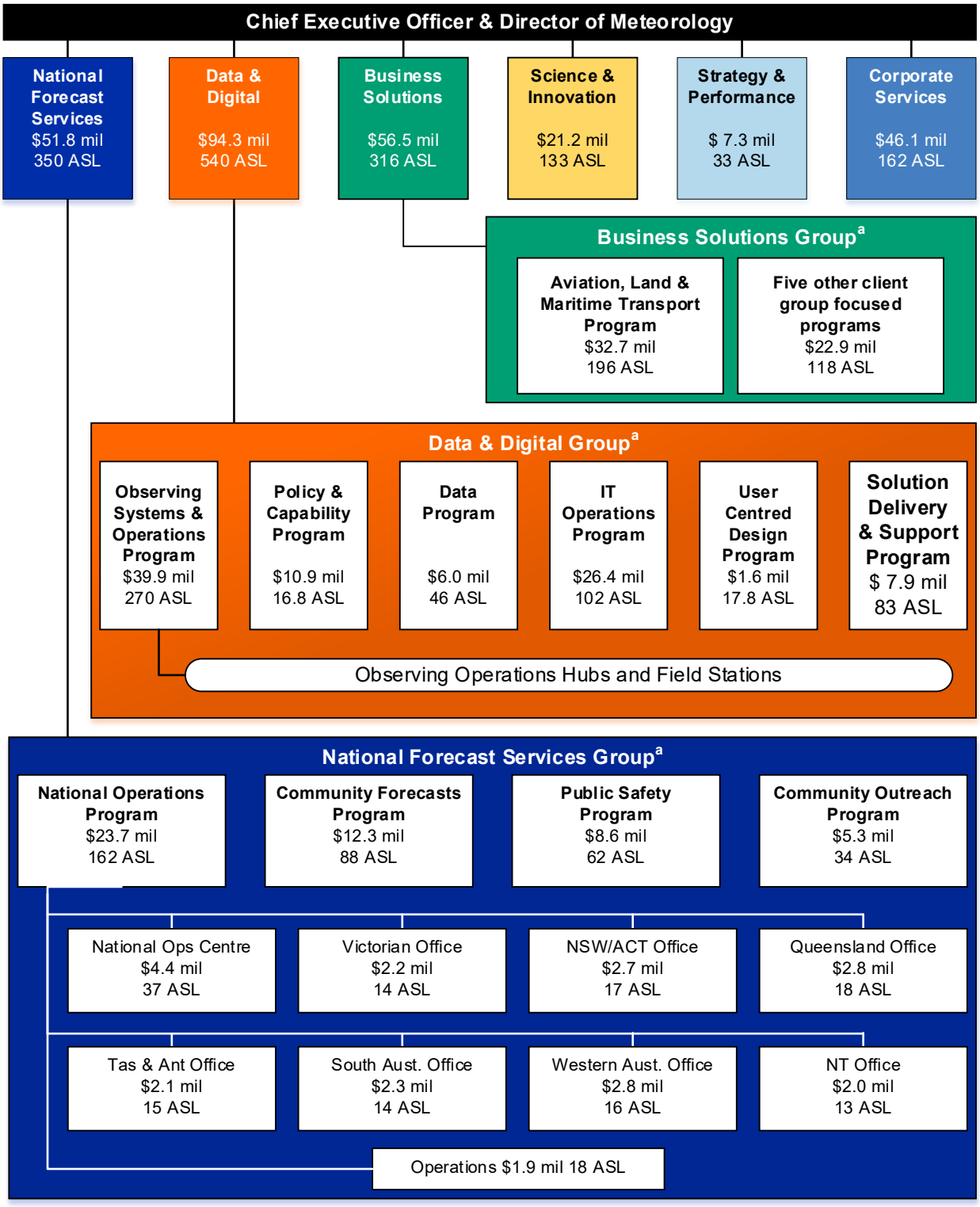
Appendix 2 Organisational structure and resourcing

Figure A. 1: Bureau of Meteorology organisational structure and resourcing



Note a: Some activities, such as resourcing for executive staff, are not shown under each group.

Source: Adapted by ANAO from Bureau of Meteorology information.

Appendix 3 Criteria for the assessment of the appropriateness of performance information

1. To undertake an assessment against the Department of Finance's *Quick Reference Guide – RMG 131 Developing good performance information*, the ANAO has applied the following audit criteria. This criteria has been applied for audits of performance information since Auditor-General Report No.58 2016–17 *Implementation of the Annual Performance Statements Requirements 2015–16.* The assessment characteristics and explanations have been updated over time to reflect the ANAO's methodology development.

Table A.1: Criteria for the assessment of the relevance, reliability and completeness of performance information

		Characteristics	Explanation
Relevant	Individual assessment	**Benefit** The performance criterion clearly indicates who will benefit and how they will benefit from the entity's activities.	The performance criterion should explain who will benefit from the activity and how the recipient benefitted.
		Focus The performance criterion should address a significant aspect/s of the purpose, via the activities.	The performance criterion should assist significantly in informing whether the purpose is being achieved, and the attribution of the entity's activities to it is clear.
		Understandable The performance criterion should provide sufficient information in a clear and concise manner.	The performance criterion should be stated in plain English and signal the impacts of activities to inform users.
Reliable		**Measurable** The performance criterion should use information sources and methodologies that are fit for purpose	The performance criterion should be capable of being measured to demonstrate the progress of fulfilling the purpose. This includes documenting a basis or baseline for measurement or assessment, for example a target or benchmark.
		Free from Bias The performance criterion should be free from bias and where possible, benchmarked against similar activities.	The performance criterion should allow for clear interpretation of results and provide an unbiased basis for assessment.
Complete	Overall assessment	**Balanced** The performance criteria should provide a balanced examination of the overall performance story.	The performance criteria should reflect a balance of measurement types (effectiveness and efficiency), bases (quantitative and qualitative) and timeframes (short, medium and long term).
		Collective The performance criteria should collectively address the purpose	The performance criteria should demonstrate the extent of achievement against the purpose through the activities identified in the corporate plan.

Appendix 4 Performance criteria reviewed by the ANAO

Table A2: Bureau of Meteorology Strategic Success Measures

Measure	Description	Responsible Group/s
SSM1	The financial and social value we deliver to Government, industry and the Australian community.	National Forecast Services Business Solutions
SSM2	The levels of satisfaction and trust our customers and partners have in us and the way we interact with them.	National Forecast Services Business Solutions
SSM3	Our reputation among our customers and partners, and within the Australian community.	National Forecast Services Business Solutions
SSM4	The level of uptake of our services by new customers and the return rate from existing customers.	Business Solutions
SSM6	Our delivery to customer requirements.	National Forecast Services Business Solutions
SSM7	Internationally benchmarked levels of capacity utilisation, product and service performance, system reliability, resilience and speed to market	Data and Digital Strategy and Performance
SSM9	Independent verification of the quality of our services.	National Forecast Services Strategy and Performance
SSM10	The levels of workforce skill and competency benchmarked with our peers and against accepted international standards.	Corporate Services
SSM11	The depth, breadth and quality of our external partnerships and collaborations.	Science and Innovation
SSM15	Feedback from staff, customers and partners on our capacity to innovate.	Data and Digital

Source: Bureau of Meteorology's *Strategy 2017–2022*

Appendix 5 List of external stakeholders interviewed

- AFAC — National Council for Fire and Emergency Services
- Animal Health Australia
- Australian Broadcasting Corporation (ABC)
- Australian Capital Territory Rural Fire Service, ACT Emergency Services Agency
- Australian Energy Market Operator (AEMO)
- Australian Government Crisis Coordination Centre, Department of Home Affairs
- City of Darwin
- Current Operations Head Quarters Joint Operations Command, Department of Defence
- Deloitte (Bureau of Meteorology internal auditors)
- Director Emergency Recovery, Northern Territory Department of the Chief Minister
- Emergency Management Victoria
- Geoscience Australia
- Goulburn-Murray Water Rural Water Corporation
- INPEX Operations Australia Pty Ltd
- Local Government Association of the Northern Territory
- National Resilience Taskforce, Department of Home Affairs
- Northern Territory Cattlemen's Association
- Northern Territory Emergency Service, Northern Territory Police, Fire and Emergency Services
- Northern Territory Police Commissioner
- Power and Water Corporation, Northern Territory
- South Australian State Emergency Services
- State Emergency Service Tasmania, Department of Police, Fire and Emergency Management
- Tasmanian State Emergency Services
- Victorian State Emergency Services