

Workers on the frontline of climate change

Strategic insights for NSW workforce impacts and adaptation

July 2026

Acknowledgement of Country



Department of Climate Change, Energy, the Environment and Water acknowledges the traditional custodians of the land and pays respect to Elders past, present and future.

We recognise Australian Aboriginal and Torres Strait Islander peoples' unique cultural and spiritual relationships to place and their rich contribution to society.

Artist and designer Nikita Ridgeway from Aboriginal design agency – Boss Lady Creative Designs, created the People and Community symbol.

Workers on the frontline of climate change

Published by NSW Department of Climate Change, Energy, the Environment and Water

First published: July 2026

ISBN: 978-1-76186-217-5

EH 2026/0182 July 2026

Acknowledgements

The department acknowledges the contribution of Andrew Glover, Claudine Moutou and Andrew Tice in the production of this report. The report's authors would like to acknowledge SafeWork NSW key role in identifying the initial need for the research, informing its scope and providing expert advice and review. The report also benefited from review by colleagues in NSW Department of Climate Change, Energy, the Environment and Water, Department of Primary Industries and Regional Development, and researchers based at La Trobe University.

Copyright and disclaimer

© State of New South Wales through Department of Climate Change, Energy, the Environment and Water 2026. Information contained in this publication is based on knowledge and understanding at the time of writing in 2025 and is subject to change. For more information, please visit the following websites:

For ECCS documents: <https://www.energy.nsw.gov.au/copyright>

For Water and Environment <https://www.environment.nsw.gov.au/about-us/copyright-and-disclaimer>

For General NSW Government <https://www.nsw.gov.au/nsw-government/copyright>

Contents

Acknowledgement of Country	ii
1 Research summary	1
2 Introduction	3
2.1 Report scope and limitations.....	4
2.2 Methodological approach.....	5
2.3 How to read this report.....	5
3 What are the hazards?	6
3.1 High ambient temperature, heatwaves and humidity.....	6
3.2 Air quality degradation: Bushfire smoke, dust and ozone.....	8
3.3 Extreme weather events: storms, floods, and bushfires.....	9
Storms and heavy rainfall.....	10
Flooding.....	11
Bushfires.....	11
3.4 Transition risks from new technologies and infrastructure.....	12
3.5 Longer-term health effects of climate exposure.....	13
3.6 Psychosocial and mental well-being effects.....	16
Impacts related to extreme heat.....	16
Impacts related to drought and economic stress.....	17
Impacts related to climate-related disasters.....	17
Impacts from climate awareness and uncertainty.....	18
Community-level mental health and social impacts	18
4 Who is most at risk?	19
4.1 Exposure by work type: outdoor vs. indoor work	19
4.2 Industry and occupation.....	20
Potential scale of outdoor workforce exposure to climate risks	23
4.3 Geographic and regional differences within NSW.....	25
4.4 Demographic and social vulnerability	30
Age-related vulnerability to climate impacts.....	31
Gender and climate vulnerability	31
Pregnancy and heat risk.....	31
Religious and cultural practices.....	32
Socioeconomic factors.....	32

	Indigenous workers and cultural impacts.....	32
	Precarious work: casual, seasonal, and gig workers.....	33
4.5	Compound vulnerabilities and example case studies	34
5	Impacts on worker safety and productivity.....	37
5.1	Workplace incidents, injuries, and near misses.....	37
	Higher injury rates in hot conditions.....	37
	Heat illness as recordable incidents	38
	Overexertion injuries and ergonomic issues.....	38
5.2	Productivity losses due to heat and disruptions.....	38
5.3	Workplace disruptions affecting productivity	40
6	Risk reduction and adaptation strategies	42
6.1	Adjusting work hours and schedules.....	42
6.2	Enhanced rest breaks and hydration practices.....	44
6.3	Clothing, protective equipment and cooling gear	45
6.4	Training, monitoring, and early warning systems.....	47
	Training and awareness.....	48
	Monitoring systems.....	48
	Early warning systems	49
6.5	Workplace design, infrastructure and planning improvements	49
7	Co-benefits of adaptation for worker wellbeing.....	51
7.1	Improving long-standing workplace conditions.....	51
7.2	Community co-benefits of a climate-resilient workforce.....	54
8	Conclusion.....	56
9	References	57

1 Research summary

This report provides a comprehensive analysis for policymakers, planners, unions, and industry stakeholders on the impacts of climate change on workers in New South Wales (NSW).

The report begins by identifying major climate-related hazards in NSW and discussing their direct and secondary impacts on workers' health and well-being. This includes both immediate effects, such as heatstroke and injuries, and longer-term consequences, like chronic illnesses and mental health strain.

Table 1: List of climate-related hazards considered in the report

Climate hazard	Example impacts on workers
Extreme heat	Heat exhaustion, dehydration, reduced productivity, increased injury risk
Poor air quality (e.g. bushfire smoke, dust)	Respiratory issues, eye irritation, fatigue
Extreme weather (e.g. storms, floods, bushfires)	Physical injury, trauma, work disruption
New technologies (e.g. hydrogen, batteries)	Safety risks from unfamiliar or volatile materials
Long-term exposure	Chronic illness (e.g. kidney disease), mental health strain
Psychosocial stressors	Anxiety, burnout, PTSD, job insecurity

Next, it analyses how risk is distributed across different groups of workers, considering factors such as the nature of work, industry sector, geographic location, demographic differences, and work arrangements. This section highlights disparities and projects nominal future exposure levels for outdoor workers.

The report then reviews evidence on how climate change is already affecting workplace safety, including incident rates and near misses, as well as productivity, such as efficiency losses and sick days. It underscores the occupational health and economic implications if these challenges are not addressed.

Strategies to reduce and manage climate risks to workers are outlined, including adapting work schedules, enhancing protective measures, redesigning workplaces, and broader urban planning and policy interventions. Global best practices are examined for their relevance to NSW, along with potential implementation challenges.

The report also discusses how responding to climate change can yield positive outcomes for workers. Adaptation efforts can improve working conditions, address existing inequities, and offer broader social benefits, positioning NSW as a leader in this area.

Finally, a range of recommendations are identified to help adapt the NSW workforce to current and future climate hazards. These include policy and regulatory reforms, strategic planning and infrastructure integration, workforce preparedness and support, stakeholder engagement and partnerships, and investment in foresight and research.

Overall, this report aims to provide a detailed, evidence-based resource for decision-makers to understand the nature and extent of climate change impacts on NSW workers and to guide effective adaptation strategies.

2 Introduction

Climate change is no longer a distant projection – its impacts are being felt now, and they are poised to intensify in the coming decades. In New South Wales (NSW), projections indicate significant shifts in climate patterns that will affect virtually every aspect of life. By mid-century (2040–2059), under a high-emissions scenario, NSW’s average annual temperature is expected to increase by about 1.9°C (central estimate) above late-20th-century levels.

This overall warming will be accompanied by more frequent and intense extreme events. Heatwaves are becoming more frequent and lasting longer, with the number of hot days over 35°C projected to increase significantly by 2050 and double by 2090. Bushfire danger is also anticipated to increase significantly, with the number of severe fire weather days expected to double or triple in many NSW regions by 2090 under a high-emissions scenario. Fire weather danger is on the rise, with the fire season lengthening and more very high fire danger days anticipated. This will increase the number of poor air quality days, both from bushfires and the need for hazard reduction burns. Heavy rainfall events are also projected to become more intense in some parts of the state, and seasonal rainfall patterns are anticipated to shift. These environmental changes are already evident: all of NSW has warmed significantly since the early 20th century, with inland areas warming the most (about 1.4°C since 1910), and recent decades have seen record-breaking heat, drought, and catastrophic bushfires across the state.

While climate change affects the entire population, its impacts on workers merit special attention. Several factors make the workplace context distinct in how climate change impacts are felt:

- **Duration and intensity of exposure:** Workers typically spend longer periods in a given environment than in other contexts. With sustained exposure to heat or poor air quality conditions, the body’s ability to cope can be overwhelmed, leading to heat strain or other health issues more readily than in shorter, casual exposure scenarios.
- **Physical activity:** Many jobs involve physical exertion which raises the body’s core temperature. This means that even moderate heat can become dangerous faster for an active worker than for a resting individual. The combination of high ambient temperatures and metabolic heat from physical labour can push workers into heat stress conditions that would not affect people working in more sedentary roles as severely (Cheveldayoff 2023).
- **Protective gear and work attire:** Some safety measures can exacerbate climate exposures. Construction and emergency workers often must wear heavy personal protective equipment (PPE) or uniforms (e.g. helmets, boots, or hazmat suits) that trap heat and body generated humidity. This can impede the body’s cooling (sweat evaporation), increasing heat strain. Similarly, firefighters or disaster clean-up crews may wear respirators or masks that make breathing harder in hot, smoky conditions.
- **Obligations and routines:** Workers might have less flexibility to avoid exposure than people in other contexts. While an individual could choose to avoid exercising on an extremely hot afternoon, a municipal road crew might not have the option to delay their scheduled work without employer approval. Although workplace health and safety legislation requires employers to do all that is reasonably practicable to prevent harm – and workers have the legal right to refuse unsafe work – economic necessity or lack of awareness may still lead some workers to continue working in unsafe conditions. This highlights the importance of ensuring that legal protections are not only in place but actively enforced and communicated.

- **Environment control (or lack thereof):** Many workplaces, especially outdoor sites but also certain indoor settings like warehouses, factory floors, or non-air-conditioned workshops and sheds, do not have the climate controls that are standard in modern homes or offices. This means workers in those settings are at greater risk of exposure to dangerous environmental conditions.
- **Intersecting hazards while working:** Work often entails using tools, machinery, or being in situations where the consequences of heat stress or weather events can be immediately dangerous. Operating heavy machinery or driving vehicles in extreme heat, for example, can involve elevated risk if the operator becomes dizzy or fatigued in these conditions. This can add to the existing risk profile of work situations due to ambient environmental conditions.

Given these factors it's clear that climate change can affect workers in ways that are qualitatively and quantitatively different from how it affects the general population.

2.1 Report scope and limitations

This report focuses on how climate change affects workers during their time at work – that is, in their workplace and during work hours. However, it also recognises that some climate-related impacts extend beyond the workplace and can influence workers' health and performance. For example, heat stress experienced on the job may continue to affect workers during their commute or at home, while poor sleep due to high overnight temperatures can increase vulnerability during the next workday. Similarly, climate hazards experienced while commuting to or from their workplace may impact worker's ability to perform their roles. These interactions are considered where they meaningfully amplify workplace risks.

The analysis is centred on the current experiences of workers in industries operating in NSW. It does not attempt to forecast how the broader structure of the workforce or the scale of different industries may evolve in response to climate change. While climate trends are expected to reshape where and how industries operate, these systemic shifts are considered out of scope. Instead, the report focuses on the day-to-day impacts of climate hazards on individual workers as they perform their roles.

Although the report discusses several ways climate change affects productivity – such as through absenteeism, presenteeism, and workplace disruptions – it does not include a full economic modelling of these impacts. Broader macroeconomic and systemic effects, including sectoral costings and implications for GDP, are beyond the scope of this review. However, these are significant and warrant further investigation to support adaptation planning and to demonstrate the economic benefits of proactive climate action.

Terminology note: While the term *Person Conducting a Business or Undertaking (PCBU)* is the technically correct designation under NSW Workplace Health and Safety legislation, this report uses the term *employer* throughout for the sake of readability and accessibility. This choice reflects the report's aim to communicate clearly with a broad audience, including policymakers, industry stakeholders, and workers themselves.

2.2 Methodological approach

This report was developed through a structured process that began with identifying climate hazards relevant to NSW using the Adapt NSW website. This resource provided a comprehensive overview of projected climate trends, including increased temperatures, more frequent bushfires, changing rainfall patterns, and sea level rise. These hazards were mapped visually using a Miro board to trace their downstream consequences – such as bushfires leading to degraded air quality or storms resulting in flood-related disruptions – and then linked to plausible impacts on workers.

A key distinction was made between:

- **Direct climate hazards** likely to affect workers during their duties (e.g. extreme heat, poor air quality, storms, and flooding), and
- **Indirect or systemic hazards** (e.g. ocean acidification, reduced snowfall) that are more likely to affect industries or economic sectors rather than workers directly.

This distinction helped narrow the scope of the report to focus on hazards with the most immediate and observable impacts on workers' health, safety, and productivity, while acknowledging broader systemic risks where relevant. Following this scoping exercise, a targeted literature review was conducted using Google Scholar. Search strings included:

- 'Occupational safety climate risks Australia'
- 'Climate change mental health workplace compensation'
- 'Occupational hazards Australia "climate change"'
- 'Climate worker report Australia "occupational hazards"'

Relevant references were imported into Zotero reference management software, and Research Rabbit was used to identify additional literature through citation mapping and AI-based relevance suggestions. This iterative process formed the evidence base for the report, ensuring that findings were grounded in both peer-reviewed research and emerging insights from the field.

2.3 How to read this report

This report has been designed to support a wide range of readers – from policymakers and planners to industry stakeholders and frontline workers – by offering both high-level insights and detailed analysis. To make the content accessible and navigable, each major section begins with a summary table that outlines the key issues, risks, or findings relevant to that topic.

These summary tables are intended to provide a quick-scan overview for readers who wish to grasp the core messages without reading the full prose. They highlight the most important climate hazards, worker vulnerabilities, health impacts, and adaptation strategies in a concise format.

Following each summary table, the report presents more detailed narrative content that explores the evidence base, contextual factors, and implications in greater depth. This structure allows readers to engage with the material at their preferred level, whether scanning for strategic insights or delving into the full analysis.

Readers are encouraged to use the summary tables as entry points into each section, and to refer to the detailed content for further clarification, case studies, and supporting evidence.

3 What are the hazards?

Climate change introduces or exacerbates a range of hazards that directly impact workers' health and safety. In NSW, key climate-related hazards anticipated to impact workers include extreme heat, poor air quality (from bushfire smoke, dust storms, and increased ground-level ozone), extreme weather events (such as storms, floods, and bushfires themselves), and indirect effects like changes in disease patterns. These hazards can have immediate impacts on workers (such as causing acute illness or injury during a shift) as well as secondary or long-term impacts (such as contributing to chronic health conditions or mental health issues over time).

This section provides a comprehensive overview of the risks, organised by the type of hazard and nature of impact.

3.1 High ambient temperature, heatwaves and humidity

Heat is one of the most pervasive and dangerous climate-related hazards for workers, and the risk that is most prevalent in the research literature on this topic. When ambient temperatures rise beyond the body's comfort zone (especially above 30°C, and more so above 35°C), it becomes progressively harder for individuals to maintain a safe core body temperature while working. Consequently, heatwaves have large impacts on the utilisation of healthcare services in NSW (Jegasothy 2017:1368).

In this report, we distinguish between several heat-related climate hazards that affect workers in NSW:

- **Extreme heat** refers to any single day where ambient temperatures exceed safe thresholds for human health and productivity – typically above 30°C, and especially above 35°C.
- **Heatwaves**, by contrast, are defined by the Bureau of Meteorology (BoM) as 3 or more days of unusually high maximum and minimum temperatures compared to the local climate norm (Nairn and Fawcett 2013). These events are particularly dangerous because they involve sustained heat exposure, often with high overnight temperatures that prevent physiological recovery and disrupt sleep.
- **Extreme weather events**, such as bushfires, floods, and storms, are distinct from heatwaves but may co-occur. For example, bushfires often coincide with heatwaves, compounding risks through radiant heat and poor air quality.
- **Humidity** is also a critical factor in heat stress. High humidity can act as a force multiplier for heat stress by impeding sweat evaporation, limiting the body's natural cooling mechanism.

This section focuses on both acute heat exposure and multi-day heatwave events, recognising that their impacts on workers differ in intensity, duration, and recovery time. Workers exposed to such conditions face the risk of heat-related illnesses which occur on a spectrum:

- **Heat exhaustion:** marked by heavy sweating, weakness, dizziness, nausea, headache, and if not addressed, can progress to
- **Heat stroke:** a life-threatening condition where the body's temperature regulation fails, leading to extremely high core temperature, confusion, loss of consciousness, and potentially organ damage or death.

Table 2: Summary of heat-related health conditions for workers

Condition	Symptoms/signs	Notes
Heat rash	Skin irritation in sweaty areas	Early warning sign of heat stress
Heat cramps	Painful muscle cramps due to salt imbalance	Often occurs during or after intense physical activity
Heat exhaustion	Heavy sweating, weakness, dizziness, nausea, headache	Can progress to heat stroke if untreated
Heat stroke	Core temp > 40°C, confusion, unconsciousness, dry/hot skin, slurred speech	Life-threatening; requires immediate medical attention
Rhabdomyolysis	Muscle weakness, dark tea-coloured urine	Can lead to kidney failure if untreated
Fainting (syncope)	Dizziness, temporary loss of consciousness	Dangerous in high-risk environments (e.g. working at heights)
Exacerbated illness	Chest pain, shortness of breath, blood sugar irregularities	Especially affects workers with heart disease, diabetes or hypertension
Mental illness	Increased hospital admissions for mental health issues during heatwaves	Includes elevated suicide risk

On worksites, signs of heat stress can include workers looking pale, clammy or conversely very hot and dry (if they have stopped sweating), disorientation, or collapsing. If not caught early, heat stress can be fatal. Between 2001 and 2013, 13 workers have died in Australia due to extreme environmental heat exposure on the job (SafeWork NSW 2024). All but one of these deaths occurred in outdoor work contexts, underscoring that working under direct sun and heat is a severe risk. Coroners investigating these fatalities found common themes: workers (or nearby colleagues) often failed to recognise the early signs of heat illness, and many victims were working alone without a means to call for help. This highlights that the onset of heat illness can be difficult to detect, as workers may not realise they are in danger until it's too late.

Physiological strain: Under high heat conditions, the human body diverts blood to the skin to dissipate heat and sweats out fluids for evaporative cooling. This leads to dehydration through loss of water and electrolytes through sweat, and cardiovascular strain as the heart rate increases to pump blood for cooling.

The immediate health impacts of heat on workers include:

- **Heat cramps and heat rash:** Early signs include painful muscle cramps (due to salt imbalances from sweating) and skin rashes in sweaty areas. These may be minor in themselves but are warning flags of heat stress (Cheveldayoff 2023).

- **Rhabdomyolysis:** In some cases of extreme exertion in heat, workers can suffer muscle breakdown (signalled by weakness and dark tea-coloured urine) which can lead to kidney failure if untreated (ILO 2024).
- **Fainting (syncope):** Heat can cause blood pressure drops leading to dizziness and fainting, which are particularly dangerous in many workplaces scenarios such as operating machinery or working at heights.
- **Exacerbation of medical conditions:** Workers with underlying conditions like heart disease, high blood pressure, or diabetes might experience worsening of these (e.g., chest pain, shortness of breath, blood sugar irregularities) in hot conditions. Workers who are older, overweight, or have chronic health conditions face higher risk in high heat environments.
- **Mental illness:** Hospital admissions for mental illness increase during heatwaves, particularly for suicide risk (Thompson et al. 2018).

3.2 Air quality degradation: Bushfire smoke, dust and ozone

Climate change in NSW is contributing to conditions that worsen air quality episodically, notably bushfire smoke during severe fire seasons - and increased controlled hazard reduction burning in more mild conditions - and dust storms during droughts. Additionally, higher temperatures can increase ground-level ozone formation on still, sunny days. Poor air quality is a significant health hazard for workers, particularly those outdoors. Table 3 provides a summary of health impacts faced by workers from air quality hazards. These are expanded on in the rest of the section.

Table 3: Summary of air quality hazards and worker health impacts

Hazard	Source/trigger	Primary health impacts	Notes
Bushfire smoke	Severe fire seasons, hazard reduction burns	• Respiratory irritation (coughing, throat, eyes) • Headaches, dizziness • Reduced oxygen uptake	Contains PM2.5 and toxic gases; worsens asthma; long-term exposure linked to COPD
Dust and allergens	Drought, agricultural activity, wind-blown dust	• Breathing difficulties • Airway irritation • Allergic reactions (e.g. hay fever, asthma flare-ups)	Dust particles clog airways; pollen seasons may lengthen with warming
Ground-level ozone	High temperatures, still air, vehicle/ industrial emissions	• Coughing, chest pain • Temporary lung function reduction	Forms during heatwaves; exacerbates respiratory conditions

Bushfire smoke contains a mixture of harmful gases and fine particulate matter (PM2.5) that are akin to very high pollution levels and can have serious health impacts. The immediate effects on workers inhaling smoke include:

- **Respiratory irritation:** Coughing, throat irritation, stinging eyes, and shortness of breath are common acute responses. Workers with asthma or other respiratory conditions can have severe flare-ups, resulting in the need to use inhalers or take sick leave due to breathing difficulties.
- **Reduced oxygen uptake:** Even healthy individuals may experience chest tightness or slight breathing difficulty after prolonged smoke exposure. Tasks that are already physically demanding become harder as the body struggles with smoke inhalation.
- **Headaches and dizziness:** Due to carbon monoxide and other toxins in thick smoke.

The secondary impacts of smoke include potential longer-term health consequences. Chronic exposure to fine particles can reduce lung function and is linked to higher risks of respiratory diseases. Those exposed to bushfire smoke are at risk of suffering inflammation of airways that lingers, increasing susceptibility to bronchitis or even reducing overall lung capacity over time. Repeated intense smoke exposures raise concern about long-term respiratory issues for outdoor workers. In the case of chronic obstructive pulmonary disease (COPD), this can also reduce people's ability to subsequently withstand heat stress due to physiological impairment (Kenny et al. 2010).

Dust and allergens: Climate change is projected to increase the frequency and severity of droughts across NSW and other parts of Australia. These dry conditions create environments where dust and particulates can more easily become airborne, particularly in areas without adequate irrigation. Wind-driven movement of soil, along with agricultural activities such as tilling and harvesting, contributes to elevated dust levels that pose respiratory risks for workers (Applebaum 2016). Outdoor workers exposed to dust storms or persistently dusty environments may experience breathing difficulties similar to those caused by smoke. Although dust particles are generally larger than PM2.5 found in bushfire smoke, they can still obstruct airways and irritate respiratory tissues. Additionally, a warming climate may extend pollen seasons and promote the growth of allergenic plants, intensifying respiratory symptoms for individuals with asthma, hay fever, or other sensitivities (Katelaris and Beggs 2018).

Ground-level ozone and pollution: Ozone is a lung irritant, causing coughing and chest pain, and can reduce lung function temporarily. Ground-level ozone (a component of smog) forms when sunlight triggers reactions involving pollutants from vehicles and industry. Heatwaves often come with high solar radiation and still air that allows pollution to accumulate. Climate change is likely to increase the frequency of days where ozone levels exceed health guidelines, creating health impacts for those affected (Knowlton et al. 2004).

3.3 Extreme weather events: storms, floods, and bushfires

This section discusses 3 major types of extreme weather events – storms, floods and bushfires – and the distinct risks they pose to workers. While these hazards often overlap, each has unique characteristics and consequences that require tailored responses.

Table 4: Summary of extreme weather events and key risks to workers

Hazard type	Onset speed	Typical duration	Key risks to workers
Storms and heavy rainfall	Rapid (minutes to hours)	Short term (hours to days)	- Physical injury from debris and lightning - Electrical hazards (e.g. downed powerlines) - Public transport disruptions - Flash flooding (drowning and mobility risks)
Flooding	Gradual (hours to days)	Extended (days to weeks)	- Riverine and coastal inundation stranding workers and animals - Contamination and disease from floodwaters - Mould exposure after water recedes - Physical injury during clean-up
Bushfires	Rapid (hours)	Variable (days to weeks)	- Burn injuries, heat exhaustion, smoke inhalation - Evacuation and work disruption - Post-fire recovery hazards

Storms and heavy rainfall

Sudden severe storms and intense rainfall events are expected to become more frequent and intense in NSW due to climate change. These events pose a range of risks to workers, particularly those outdoors or reliant on infrastructure and transport systems:

- **Physical injury risk:** Outdoor workers can be struck by falling tree branches or debris in high winds. Lightning strikes are a threat for those caught in storms in open areas – such as park rangers, farm workers, or construction crews on scaffolding – especially if proper lightning safety protocols are not followed. After storms, debris and unstable structures can continue to pose physical risks during clean-up and recovery.
- **Electrical hazards:** Storms and high winds can damage electrical infrastructure, leading to downed powerlines or exposed wiring that may remain live. Workers in utilities, emergency services, and clean-up crews face elevated risks of electric shock or electrocution when operating in or near storm-damaged areas. These hazards may persist for hours or days after the initial event.
- **Public transport disruptions:** Storms and heavy rainfall can severely impact public transport systems, leading to delays, cancellations or breakdowns. Workers who rely on trains, buses, or ferries may be stranded en route to or from work, or stuck on halted services for extended periods. These disruptions can increase stress, anxiety, and fatigue, particularly for shift workers or those in precarious employment who may fear income loss or disciplinary action due to

lateness. Extended delays can also reduce rest and recovery time, compounding vulnerability to other climate-related hazards.

- **Flash flooding and mobility risks:** Storms can trigger flash flooding – rapid-onset inundation caused by intense rainfall overwhelming drainage systems. These events are highly unpredictable and can occur within minutes, posing immediate danger to workers caught in low-lying areas, basements, or near stormwater channels. Flash floods can block roads and transport routes, isolate workers, and delay emergency response. The speed and force of flash flooding make it particularly hazardous for workers attempting to cross water or evacuate quickly.

Flooding

Flooding refers to longer-duration inundation caused by river overflow, coastal storm surge, or sustained rainfall over large catchments. While it may follow storm events, flooding is a distinct hazard with slower onset and broader geographic impact.

- **Riverine and coastal inundation risks:** Workers in regional areas or near floodplains may face prolonged disruptions due to rising river levels or coastal flooding. These events can inundate worksites, homes, and transport corridors for days or weeks, affecting access to work and continuity of operations. Unlike flash floods, these events often allow more time for evacuation but can result in longer-term displacement and economic loss.
- **Contamination and disease:** Floodwaters often carry sewage, industrial chemicals, and other hazardous substances. Workers involved in clean-up or restoration may be exposed to pathogens, leading to gastrointestinal illness, skin infections, or respiratory issues. Prolonged exposure to damp environments also increases the risk of mould-related health problems, particularly in indoor recovery settings.
- **Physical injury risk:** Navigating flooded environments can involve unstable surfaces, hidden debris, and slippery conditions. Workers may suffer sprains, cuts, or falls during flood response or recovery efforts. These risks are heightened when personal protective equipment is compromised or unavailable.

Bushfires

Bushfires are projected to become more frequent and intense in NSW, with longer fire seasons and more severe fire weather conditions. Workers in certain sectors – particularly emergency services, utilities, agriculture, environmental services (e.g. park rangers, ecologists) and outdoor trades – face direct and indirect risks from bushfire events.

- **Direct exposure risks:** Firefighters and emergency responders are at high risk of burn injuries, heat exhaustion, and smoke inhalation due to combined exposure to radiant heat and ambient high temperatures. Utility workers, farmers and others may also be exposed while protecting infrastructure, property or animals, sometimes without adequate training or equipment.
- **Evacuation and work disruption:** For many workers, bushfires mean sudden evacuation or cessation of work. While necessary for safety, these disruptions can result in lost income, project delays, and logistical challenges. Workers may also face uncertainty about when and how work will resume, adding to stress and economic strain.
- **Post-fire recovery hazards:** After a bushfire, many workers are involved in clean-up and rebuilding efforts. These tasks carry risks such as handling sharp debris, inhaling ash and dust, and exposure to unstable structures. Psychological trauma from witnessing destruction –

- especially in familiar or culturally significant areas – can also affect workers’ mental health and long-term wellbeing.
- **Air quality and respiratory impacts:** Even workers not directly in fire zones may be affected by bushfire smoke, which can travel long distances. Smoke exposure can lead to respiratory irritation, reduced oxygen uptake, and fatigue, particularly for outdoor workers or those with pre-existing conditions.

3.4 Transition risks from new technologies and infrastructure

As NSW takes steps toward mitigating climate change, workers will also face challenges arising from the transition to a low-carbon economy and society. These ‘transition risks’ primarily emerge from shifts in energy sources, technologies, and industrial processes that are central to climate action. While these changes are essential for reducing emissions and building climate resilience, they can introduce new occupational hazards, unfamiliar materials, and altered work environments. Workers in emerging sectors may encounter risks that are not yet fully understood or regulated.

This section explores the safety implications of these technological transitions and highlights the need for proactive adaptation to ensure that climate solutions do not inadvertently compromise worker health and safety.

Table 5: Summary of transition risks to NSW workers

Technology	Key characteristics	Worker safety risks	Considerations for adaptation
Hydrogen	Odourless, colourless, invisible flame; embrittles materials; flammable and explosive	Difficult leak detection; risk of explosion; material degradation; unfamiliar chemical properties	Requires specialised sensors, safety training, and updated protocols for handling and storage
Batteries	Used across grid, transport, and machinery; risk of overheating and combustion	Fire hazards; need for specialised suppression; exposure across diverse workplace contexts	Safety awareness, fire response planning, and integration into workplace hazard assessments

Hydrogen is a key part of the NSW’s decarbonisation strategy, particularly in sectors like transportation, heavy industry, and energy production (NSW Hydrogen Strategy 2021). However, hydrogen also presents a number of safety risks for workers who may be involved in its production, distribution, and use – with a recent review claiming that hydrogen infrastructure growth is outpacing safety knowledge and standards (Hoseyni et al. 2024). Unlike other commonly used fuels, hydrogen is odourless, colourless, and whose flames are invisible to the naked eye. This makes leaks difficult to detect without specialised sensors. It also has an ‘embrittling’ characteristic, making

certain materials it comes into contact with more brittle, creating the potential for leaks in pipelines and storage tanks (Queensland WHS, 2025). Risk profiles of various blends of hydrogen (with LPG) are also not well established, creating risks for those who are unaware of its chemical properties. These characteristics, combined with its flammability and explosive potential, pose potential risks to workers that will need to be planned for as part of adapting workplaces for climate change.

Batteries: As NSW’s energy system transitions to more reliance on intermittent renewable sources, batteries are an essential technology to maintain grid stability and energy reliability. These might be large scale batteries maintained by electricity network operators, or smaller scale household and commercial batteries. Batteries also increasingly serve as an energy source to a range of mobile transport and machinery, from e-bikes to e-ships. The proliferation of batteries through a range of workplace contexts means that workers need to be aware of their hazard potential.

While generally deemed safe in most contexts, batteries have been linked to incidents of overheating and combustion (SafeWork NSW 2025). The nature and intensity of these fires requires specialised fire suppression measures. Given these industries and technologies are relatively new, and still in the process of being rolled out, it is important to prioritise the safety and risk awareness of those working in and around.

3.5 Longer-term health effects of climate exposure

In addition to the immediate, acute effects discussed above, climate change can also have more insidious long-term health impacts on workers. These can arise from chronic or repeated exposures and cumulative physical and psychological strain. Health impacts of this kind are important to understand because there may be a significant lag between exposure and impact, creating an accumulated impact on the healthcare system in the future.

Table 6: Summary of longer-term health impacts of climate exposure on workers

Health Impact	Associated climate hazard(s)	Description of risk	Groups most affected
Chronic kidney disease (CKD)	Heat	Repeated dehydration and heat stress can cause kidney injury over time.	Outdoor workers, manual labourers
Cardiovascular disease	Heat	Chronic heat exposure stresses the cardiovascular system, increasing risk of heart events.	Workers with pre-existing conditions, older workers
Chronic respiratory illness	Bushfire smoke, air pollution	Long-term exposure to bushfire smoke and PM2.5 has been linked to reduced lung function, chronic bronchitis, and increased risk of respiratory disease.	Outdoor workers, workers with pre-existing respiratory issues

Health Impact	Associated climate hazard(s)	Description of risk	Groups most affected
Cognitive decline	Heat	Cumulative heat exposure may accelerate cognitive decline due to neurological stress.	Older adults, vulnerable populations
Musculoskeletal wear-and-tear	Heat	Heat-related fatigue and dehydration can lead to poor lifting technique and joint stress.	Manual labourers, physically active workers
Reproductive health impacts	Heat, pollution	Chronic heat and pollutant exposure may reduce fertility and increase pregnancy risks.	Pregnant workers, reproductive-age workers
Vector-borne diseases	Heat, rainfall	Expanded habitats for mosquitoes and ticks increase disease risk.	Agricultural workers, outdoor workers, animal handlers
Chemical exposure	Changing pest pressure	Increased pesticide use raises long-term exposure risks.	Agricultural workers
Skin cancer and UV exposure	Solar radiation	Warmer climate may increase UV exposure due to lighter / short sleeved clothing worn in outdoor work.	Outdoor workers

Chronic kidney disease (CKD): There is growing evidence globally linking occupational heat stress to a form of chronic kidney disease. Repeated episodes of dehydration and heat stress can cause kidney injury over time. In parts of Central America and South Asia, epidemics of CKD have been observed among outdoor manual labourers (sugarcane workers, rice farmers) in hot climates. The International Labour Organization warns that globally over 26 million people may already be suffering chronic kidney disease due to workplace heat stress (ILO 2024). In the NSW context, outdoor workers who year after year endure extreme summers (without adequate hydration and rest) could be at risk of subclinical kidney damage.

Cardiovascular disease: Experiencing high ambient heat places additional stress on the heart, as mentioned previously. Workers with high heat exposure over years might have an increased risk of developing heart conditions or experiencing events like heart attacks or arrhythmias, especially if they have other risk factors. While immediate triggers are acute (e.g. a worker with a hidden heart condition collapsing in a heatwave), there is also concern that climate stress could contribute to the overall wear of a person's cardiovascular system. This, in turn, is likely to make them more vulnerable to heat stress, as evidenced by mortality rates from the 2003 European heatwave that found a 30% increase in deaths of people with cardiovascular disease (Kenny et al. 2010).

Chronic respiratory impacts: Long-term exposure to bushfire smoke has been associated with persistent respiratory health effects, including reduced lung function and increased incidence of

chronic bronchitis. Studies following major bushfire events in Indonesia found significant declines in lung capacity and forced expiratory volume (FEV1/FVC) over one to two years post-exposure, with more pronounced effects in men. Additional research from Canada and the United States projects rising cases of chronic and acute bronchitis linked to PM2.5 exposure from bushfires, particularly among children and outdoor workers. Occupationally exposed individuals may also face elevated risks of lung cancer, though further longitudinal research is needed to fully understand these outcomes (Grant and Runkle 2022).

Cognitive decline: Emerging research suggests that cumulative exposure to extreme heat might have effects on cognitive function. A recent study in the U.S. found that older adults with high lifetime exposure to extreme heat showed faster cognitive decline, potentially due to repeated heat stress causing subtle neurological damage (Shin et al. 2024). This finding was more pronounced in vulnerable populations and poor neighbourhoods, likely due to compounding factors (Choi et al. 2023).

Musculoskeletal wear-and-tear: There is an indirect effect where climate-related fatigue can lead workers to use their bodies improperly (like poor lifting technique when tired). Over years, this can contribute to chronic back injuries or joint issues. Also, dehydration can reduce the fluid in joints and spine slightly, potentially increasing susceptibility to injury. While these can be considered standard workplace ergonomics concerns, they are amplified by changing climatic conditions and may become more pronounced in the future (Lundgren 2013).

Reproductive health impacts: Beyond pregnancy, climate change induced impacts could potentially affect reproductive health more generally. These concerns include reduced fertility in both men and women from chronic heat exposure and increased exposure to pollutants (Papadiouchou et al. 2024).

Exposure to vector-borne diseases: Climate change expands the habitat of disease vectors like mosquitoes and ticks. Workers in certain outdoor jobs may face new health risks from these. For example, warmer temperatures and changed rainfall could increase the range of mosquito-borne diseases such as Ross River virus in NSW (Lee et al. 2023). Agricultural and outdoor workers might have higher exposure to mosquito bites around stagnant water that persist after flood events. Likewise, tick and leech borne diseases could become more common if populations grow due to more favourable climate conditions. Those workers who interact with animals on a regular basis may also have higher risk of infection for certain diseases, such as abattoir workers, livestock farmers, and veterinarians (Applebaum 2016:18).

Increased use of chemicals: Another indirect effect – as pest pressures change with climate, the use of pesticides or other chemicals may increase in agriculture (Balbus et al. 2013). This means workers would likely have higher exposure to these chemicals, with long-term health implications such as poisoning, cancer, neurotoxicity, endocrine disruption, reproductive disorders, cardiovascular disease, cardiopulmonary disease, and immune suppression (ILO 2024:85).

Skin cancer and UV exposure: Australia already has high UV levels and outdoor workers have elevated risk of skin cancer (Carey et al. 2014). While climate change's effect on UV is complex, a warmer climate may mean more time with skin exposed (if workers wear lighter clothing) or different patterns of outdoor work.

3.6 Psychosocial and mental well-being effects

Climate change can significantly affect the mental health and social well-being of workers. This section explores the psychological stressors induced by key climate-related hazards, including extreme heat, natural disasters, and the broader uncertainties associated with a changing climate. These impacts are grouped below by the primary climate driver or context in which they arise.

Table 7: Summary of psychosocial and mental health impacts of climate change on workers

Impact category	Climate driver	Key effects on workers	Notes
Heat stress and mental health	Extreme heat	Irritability, aggression, reduced job satisfaction, depression	May lead to increased workplace conflict and long-term mood decline
Economic stress and drought impacts	Drought, excess rainfall	Anxiety, job insecurity, increased suicide risk, trauma from livestock culling	Mental health strain linked to financial stress and traumatic decisions
Disaster-related trauma and fatigue	Bushfires, floods, storms	PTSD, acute stress disorder, burnout, 'hero fatigue'	Long recovery periods and repeated exposure can lead to workforce strain
Climate awareness and eco-anxiety	General climate uncertainty	Chronic stress, anxiety, reduced concentration and motivation	Emerging theme; relevant across sectors
Community-level social impacts	Drought, disasters	Substance abuse, domestic violence, family breakdown, reduced workforce cohesion	Observed in rural communities; compounding effects noted
Compounded stressors	Interaction of multiple hazards	Amplified interpersonal conflict, mental health decline at work and home	Stressors may interact with non-climate factors, worsening outcomes

Impacts related to extreme heat

Occupational (workplace) heat stress and mental health: Researchers have explored how heat itself affects mental well-being and behaviour on the job. Heat can increase irritability and aggression, which could potentially lead to more workplace conflicts or even violence (Applebaum 2016:18). Moreover, if someone feels physically miserable from heat at work, day after day, it can erode overall mood and job satisfaction, contributing to depression and mental health decline in the long run.

Impacts related to drought and economic stress

Job insecurity and economic stress: Certain industries will face more volatility due to climate change, creating chronic stress and anxiety about job stability. For example, rural populations and particularly farmers experience drought conditions most directly, as extended dry conditions impact their livelihoods through reduced agricultural productivity. Anxiety and distress about crop failure and poor livestock health are widely recognised impacts on farmers and rural populations that arise from drought conditions. Similar economic impacts can also occur from too much rain, such as excess moisture ruining crop harvesting or floods destroying infrastructure and livestock.

Rural populations have been found to experience an increase in psychological distress for the first 2.5–3 years of a drought, even whilst controlling for demographic, social and environmental factors (Luong et al. 2021:1). Such declines in mental health can also result in increased rates of suicide amongst these parts of the community. A longitudinal study of rural populations in NSW between 1970 and 2007 found an increased relative risk of suicide of 15% for rural males aged 30–49 years as drought conditions set in (Hanigan et al. 2012:13950).

Trauma from livestock culling and crop failure: Drought conditions may also require farmers to undertake trauma-inducing activities that further contribute to a decline in their mental health. For example, being forced to personally cull livestock due to an inability to feed them is a situation that many drought-affected farmers have had to face during periods of sustained drought (ABC 2024). As drought conditions become more frequent with climate change, it's reasonable to expect that the impacts on farmers' mental health will also increase.

Mental health impacts can be experienced by workers and can also be experienced by managers and others who are responsible for workers exposed to climate induced hazards.

Impacts related to climate-related disasters

Overwork and fatigue during crises: During climate-related disasters, some workers – especially emergency services, healthcare staff, and utility repair crews – may be required to work extended hours under high-stress conditions. In NSW, emergency response operations such as those involving Rural Fire Service staff and volunteers typically follow structured shift patterns. While these schedules are designed to manage fatigue, they can still be gruelling when sustained over long periods, particularly during prolonged or repeated events like bushfire seasons or flood recovery. Even within these guidelines, cumulative fatigue can lead to exhaustion, burnout, and longer-term mental health strain – sometimes referred to as 'hero fatigue' (Zhang et al. 2022). As extreme events become more frequent, the recovery time between deployments may shrink, increasing the psychological toll on frontline workers.

Trauma from disaster experiences: Workers who directly experience disasters – whether as responders or victims – can develop acute stress disorder and PTSD. For instance, emergency service workers who rescued people during bushfires, or workers who survived a flash flood at their workplace, may experience symptoms of PTSD which can lead to avoiding anything reminding them of it. A study on firefighters in Australia found a significant proportion reported psychological issues even up to 2–7 years after major fire events (Zhang et al. 2022). For volunteer firefighters who often have day jobs in addition to their fire duties, this trauma can spill over into their regular work and personal life. A review of health impacts in Northern NSW highlighted that mental health issues (like

PTSD, anxiety, depression) surged in communities after climate-related disasters such as floods (Lee et al. 2023). These mental health impacts tend to become more severe with successive disasters, with people experiencing greater impacts when disaster events occurred in close succession (Li and Leppold 2025).

Solastalgia and grief: This refers to the sense of loss and grief workers may feel if environments and ecosystems they frequently work in are damaged or destroyed – such as a park ranger experiencing grief after a bushfire. Such emotional impacts can affect one's commitment to work or even lead to early retirement or exit from the profession (Richardson 2025).

Climate-related stress and exposure may lead to workforce shortages in high-risk sectors. Evidence from emergency services and education shows that burnout and health concerns are prompting early exits, with nearly 40% of Australian teachers considering leaving the profession due to stress (AITSL 2025; Zhang et al. 2022).

Impacts from climate awareness and uncertainty

Stress and anxiety (eco-anxiety): Many workers are increasingly aware of climate change and its potential to disrupt their lives and jobs. This awareness can manifest as climate anxiety or stress. For instance, farmers may live with constant stress about more frequent droughts or heatwaves and what it means for their livelihood. Even urban workers might feel 'eco-anxiety' reading about extreme events or worrying about what the future holds. Unlike sudden trauma, this is a chronic, simmering stress that can affect concentration, motivation, and overall mental health.

Community-level mental health and social impacts

Community and social cohesion impacts: Workers and their colleagues are not the only ones that experience these impacts; the communities in which they are embedded are also affected. Communities can be disrupted by climate events, affecting social well-being. In rural areas, when multiple farms or businesses struggle due to drought, entire communities feel the strain – this can lead to social issues like increased substance abuse, family problems, domestic violence, and broader social dysfunction. This subsequently impacts the productivity and wellbeing of the workforce in communities that are adversely impacted.

Compounded stressors: These climate change induced stressors often don't act in isolation and can interact with other 'non-climate' related phenomena. For example, during a heatwave, we often see increased interpersonal tensions and also sometimes increased incidence of issues like domestic violence. A worker might be dealing with stress at work from the heat and then go home to a family also stressed, exacerbating the chance for interpersonal conflict and family breakdown.

Public facing workers that interact with people who may be prone to heat induced violence and aggression are likely to be impacted most.

The next section will discuss which groups of workers are most at risk, recognising that not all face these hazards equally. Understanding vulnerability is key to tailoring interventions and protections.

4 Who is most at risk?

All workers in NSW will feel some effects of climate change, but the magnitude and severity of impacts vary greatly across different groups. Vulnerability depends on multiple factors:

- the nature of the work (outdoor versus indoor)
- the industry sector
- geographic location
- population characteristics (e.g. socioeconomic status, age, gender, health)
- type of work (e.g. permanent vs. casual).

This section examines these factors and identifies who is most at risk, providing examples to illustrate disparities.

4.1 Exposure by work type: outdoor vs. indoor work

The nature of a worker's environment plays a critical role in determining their exposure to climate-related hazards. Whether a role is performed primarily outdoors or indoors can significantly influence the level and type of risk faced, particularly in relation to heat, air quality, and extreme weather. While indoor settings may offer some protection, not all are equally equipped to manage rising temperatures or poor ventilation. Understanding these distinctions is essential for tailoring adaptation strategies that reflect the realities of different work contexts across NSW.

Table 8: Summary of work types and key climate risks

Work type	Exposure characteristics	Examples of roles	Key risks
Outdoor work	Direct exposure to climate hazards such as heat, solar radiation, wind, rain, and air pollution	Construction, agriculture, mining, utilities, transport, emergency services	Heat stress, poor air quality, limited access to shade or cooling, increased injury risk
Non climate controlled indoor workplaces	Generally more shielded than outdoor, but risk varies depending on building design and ventilation	Factories, warehouses, kitchens, workshops	Heat accumulation in poorly ventilated spaces, exposure to heat-generating machinery
Hybrid exposure	Indoor roles with frequent outdoor transitions or variable cooling environments	Warehouse loaders, healthcare workers conducting home visits	Intermittent exposure to heat and poor air quality, inconsistent thermal comfort

- **Outdoor workers** are on the front lines of climate exposure. By virtue of working outside they directly experience high temperatures, solar radiation, rain, wind, and air pollution. Examples of jobs that operate in such environments include:
 - **Construction and trades:** Builders, roofers, road crews, carpenters working on outdoor sites.
 - **Agriculture and farming:** Fruit pickers, farmers, stock hands, irrigators.
 - **Mining and extraction:** Many mining operations in NSW are open-cut, exposing workers to heat and dust.
 - **Maintenance and utilities:** Council workers doing park maintenance, powerline repair crews, water utility workers fixing outdoor infrastructure.
 - **Transport and delivery:** Truck drivers (in non-air-conditioned vehicles), postal delivery on foot or bike, couriers, traffic police.
 - **Emergency services:** Firefighters, paramedics, police on duty outdoors – often have to operate outside.

These outdoor occupations have a higher risk of exposure to extremes in temperature and weather, and poor air quality. Outdoor work leaves little refuge from climate conditions – shade can be scarce or less easily accessed, and cooling or shelter options may be limited while performing their work.

- **Indoor workers** are generally more shielded, especially those in climate-controlled environments like offices or shopping centres. However, not all indoor work is free from climate hazards:
 - **Non-air-conditioned indoor workplaces:** Factories, warehouses, workshops, sheds (including packing and shearing), kitchens, and some small businesses may lack air conditioning or have inadequate ventilation. These can become heat traps in heatwave conditions. The Western Sydney / Moorebank intermodal area has a particularly high concentration of warehouses that would fall into this category. Manufacturing plant workers around heat-generating machinery (smelters, bakeries, commercial laundries with steamers) also face very high heat exposure.
 - **Hybrid exposure:** Some indoor jobs require frequent trips outside (e.g. a warehouse loader moving in and out of trucks), requiring exposure to the elements. Similarly, some worker's roles take them into spaces that may have highly varied levels of cooling available, such as healthcare workers conducting visits into homes that may not have air conditioning.

4.2 Industry and occupation

Climate change does not affect all industries equally. The nature of work – whether it is performed indoors or outdoors, physically demanding or sedentary, remote or urban – plays a critical role in determining a worker's exposure to climate hazards. This section outlines the key industries and occupations in NSW that are most vulnerable to climate-related risks, highlighting the specific environmental exposures and operational contexts that shape their risk profiles. Understanding these differences is essential for tailoring climate adaptation strategies to the realities of each sector.

Table 9: Summary of industry exposure to climate hazards

Industry / occupation	Primary climate hazards	Key exposure factors
Agriculture and forestry	Extreme heat, drought, bushfires, storms	Outdoor work, physical exertion, isolation, dust, smoke, economic stress
Construction and infrastructure	Extreme heat, storms, bushfires	Outdoor work, heavy labour, scaffolding, machinery, limited shade
Emergency services	Bushfires, floods, storms, extreme heat	High-stress roles, prolonged exposure, smoke inhalation, trauma, shift fatigue
Environmental services	Extreme heat, bushfires, storms, poor air quality	Remote terrain, strenuous fieldwork, limited infrastructure, solo work risks
Marine workers	Heat, UV, storms, cyclones, humidity	Reflective heat, sea-state hazards, isolation, equipment degradation
Transport and delivery	Extreme heat, poor air quality, storms	Vehicle exposure, long hours, urban heat, roadside pollution, limited cooling
Manufacturing and warehousing	Extreme heat, poor air quality	Poor ventilation, heat-trapping buildings, machinery, repetitive physical tasks
Healthcare and aged care	Extreme heat, poor air quality, bushfires	Home visits to non-cooled environments, PPE use, stress from vulnerable clients
Education	Extreme heat, poor air quality	Outdoor supervision, older buildings, limited cooling, student wellbeing concerns
Hospitality	Extreme heat, poor air quality	Hot kitchens, outdoor service areas, fast-paced work, limited cooling
Mining (surface and underground)	Extreme heat, dust, poor air quality	High ambient and underground temperatures, dust exposure, remote locations

- Agriculture and forestry:** This includes roles such as farmers, farmhands, fruit pickers, and forestry workers. These workers spend long hours outside, often in physically demanding tasks such as harvesting, planting, mustering cattle, and operating heavy machinery. Risks in these roles include extreme heat, sun exposure (skin cancer risk), variable rainfall (drought leading to dust), storm exposure, and bushfire (grassfires have potential to threaten farms). Furthermore, workers are often working in isolation, where incidents such as a collapse from heat may not be able to be helped immediately. Prolonged drought can cause psychological stress for farm

owners and workers, sometimes reflected in higher rates of depression and even suicide in farming communities during drought periods – as discussed previously.

- **Construction and infrastructure:** A range of construction workers – from large infrastructure projects to home building – are often outdoors or in partially built structures that may not offer shade or insulation. They also generally engage in heavy labour, placing additional stress on the body. Moreover, construction involves hazards like scaffolding and machinery, where heat-induced lapses can be more consequential if they occur. Storms and high winds also pose risks in these scenarios.
- **Emergency services:** Firefighters, both urban and rural, face direct climate disaster risks such as bushfires. They often work in the most exposed outdoor conditions by the nature of their job. Paramedics and police can also be required to operate in extreme heat, such as responding to spikes in heat-related call-outs during heatwaves. State Emergency Service (SES) volunteers / workers dealing with floods and storms also have high exposure during these events.
- **Environmental services:** Workers in environmental services – including park rangers, field scientists, ecological consultants, and conservation staff – often operate in remote and ecologically diverse settings such as deserts, alpine zones, wetlands, and bushland. These roles typically involve strenuous physical activity across rugged terrain, often with limited access to shelter, water, or emergency support. Climate hazards for these workers include extreme heat, bushfires, storms, and degraded air quality from smoke or dust. The remoteness of their work can amplify risks, particularly when operating alone or in areas with poor communication infrastructure. Additionally, the emotional toll of witnessing environmental degradation – such as species loss or habitat destruction – may contribute to mental health strain, especially for workers with strong ecological or cultural ties to the land.
- **Marine industries:** Workers in fishing, marine tourism, and shipping face unique climate exposures due to their time spent on or near water. Heat and UV radiation are intensified by reflection off the ocean surface, while storms and cyclones pose serious safety risks. High humidity and salt air can affect both health and equipment. These roles often involve long hours in isolated conditions, with limited access to shelter or emergency support, making rapid response to climate hazards more difficult.
- **Transport and delivery:** This includes truck drivers, delivery drivers (including gig economy couriers on bikes or scooters), mail carriers, railway workers (track maintenance crews). Many in this industry spend a lot of time on the road in vehicles that might not be well-cooled or outside while loading/unloading. Vehicle breakdowns in remote areas may render them particularly vulnerable in extreme conditions.
- **Manufacturing and warehousing:** People working in large warehouses, distribution centres, and factories have elevated exposure over other indoor roles. If these facilities lack proper climate control, they can become extremely hot inside, creating dangerous working environments. Even workers in cold-storage units can experience heatwaves if they are required to move between extreme cold (freezers) to extreme hot ambient conditions repeatedly, which can cause its own stress on the body.
- **Healthcare and aged care:** Healthcare workers in hospitals during heatwaves may face overcrowded emergency rooms, high stress, and if hospital cooling systems struggle under peak energy demand, may be required to work in hot, uncomfortable conditions whilst wearing PPE. While hospitals and healthcare centres in NSW are typically climate controlled, many aged and homecare workers are required to undertake home visitations to clients that may be unable to

afford to use air conditioning, increasing their exposure to heat on the job (Humphrys et al. 2022).

- **Education:** Teachers supervising children in playgrounds, or in older classrooms without air conditioning, may suffer heat stress. Sports coaches and outdoor education instructors also face high heat exposure. Reduced opportunities for student's outdoor play and recreation may also have flow on effects, both for student and teacher wellbeing.
- **Hospitality:** Chefs and kitchen staff often work near hot ovens/stoves in cramped conditions. Wait staff in outdoor sections also face exposure. These work environments also tend to be fast paced, high pressure settings that are physically demanding, particularly as ambient temperature increases.
- **Mining:** Workers on outdoor (surface) mining sites face many of the same challenges as other outdoor workers in terms of heat exposure and dust pollution. Underground mining workers may also face high temperatures – often higher than ambient temperatures at the surface - as these sites are not necessarily cooled naturally or artificially. Cooling may be limited to select spaces such as vehicle cabins or offices.

Potential scale of outdoor workforce exposure to climate risks

This section takes the employment sectors identified in table 9 as its basis to provide an indication of the numbers of workers exposed to climate related risks by virtue of industry and work type. A desktop exercise was conducted to align the profiles with the Australian and New Zealand Standard Industrial Classification (ANZSIC) (2006 (Revision 2.0)) using the detailed classification resources available at Australian Bureau of Statistics (2006-revision-2.0).

The desktop exercise is both subjective (defined by the profiles identified in the preceding sections) and **very conservative**. No assessment was made on potential exposure to climate during journey to work, for example. Further, the approach does not incorporate sectoral impacts that might arise due to current and ongoing mechanisation or automation.

To undertake the classification, a sequential method was applied. Firstly, broad groupings at the Group (3-digit level) were removed from the exercise if the constituent classes aligned with forms of work conducted, for majority of the time, in an office environment. Secondly, the remaining employment forms were then assessed at the 4-digit level to remove instances of support and service roles.

Table 10 sets out the relative scale of exposed employment forms in NSW as of 2021.

Table 10: Scale of exposed jobs by Industry Division (ABS Census 2021) – rounded to nearest 100 jobs

Construction	Agriculture, forestry and fishing	Transport, postal and warehousing	Accommodation and food services	Public administration and safety	Health care and social assistance	Arts and recreation services
Building installation services (67,900)	Sheep, beef cattle and grain farming (41,700)	Road freight transport (38,000)	Accommodation (30,000)	Public order and safety services (29,100)	Other health care services (5,800)	Parks and Gardens operations (3,900)
Building completion services (49,600)	Fruit and tree nut growing (5,300)	Postal and courier pick-up and delivery services (13,800)				
Residential building construction (48,000)	Mushroom and vegetable growing (3,600)	Road passenger transport (1,000)				
Non-residential building construction (44,800)	Nursery and floriculture production (3,300)	Scenic and sightseeing transport (1,000)				
Building construction services (34,500)	Other livestock farming (3,100)					
Heavy and civil engineering construction (31,800)	Dairy cattle farming (2,900)					
Other construction services (26,500)	Poultry farming (2,700)					
Land development and site preparation services (12,500)	Other crop growing (2,300)					
	Aquaculture (1,000)					
	Fishing (900)					
315,600	66,800	53,800	30,000	29,100	5,800	3,900

Current levels of worker exposure also need to be situated in future projections for how these industries are anticipated to grow going forward. This is necessary for understanding the scale of worker exposure that NSW will experience in future decades. Table 11 below provides the total numbers of exposed positions as of 2024, 2044 and 2064 based on sector specific 20- and 40-year compound annual growth rates (CAGR). As shown, construction positions dominate the projections, tied to assumptions around both housing and major engineering projects. Under current conditions there are projected to be over 500,000 climate-exposed positions in the industry by 2064, exceeding that of all other sectors combined.

Table 11: Forecast growth of exposed positions by main Industry grouping (TZP 2024)

Industry	2024	2044	2064	20-year CAGR	40-year CAGR
Construction	397,666	464,233	519,439	0.8%	0.7%
Transport, postal and warehousing	73,769	94,070	101,605	1.2%	0.8%
Agriculture, forestry and fishing	69,166	83,457	92,792	0.9%	0.7%
Accommodation and food services	38,577	48,100	53,453	1.1%	0.8%
Public administration and safety	36,824	40,314	41,028	0.5%	0.3%
Health care and social assistance	7,195	9,367	10,777	1.3%	1.0%
Arts and recreation services	6,059	7,344	8,127	1.0%	0.7%

It should be noted that for these projections, each industry is held to be constant as a proportion of the overall NSW economy. Should certain industries grow or contract proportionally (not just numerically), these figures would require revision to align with those changes. Another limitation is that the age representation of workers in each industry is also assumed to remain constant. Given demographic assumptions about the ageing workforce, there is likely to be differences in worker exposure that will likely have a higher representation of older workers than is currently the case.

4.3 Geographic and regional differences within NSW

Workers, including exposed workers, are more prevalent and numerous in certain NSW regions than others. Understanding the spatial extent of current and future worker exposure is important for planning for adaptation.

This section utilises the Transport for NSW Travel Zone Projections for the year 2024 and considers the distribution of exposed work forms across the state based on place of work. It does this by applying the ratios derived from the previous work to the main industry groupings on the ABS SA4 geography.

Overall, it is estimated that in 2024, 619,000 - or about 1 in 7 NSW workers - were employed in occupations that involve spending a substantial proportion of their working time outdoors. This includes workers in the industries listed in Table 11, as well as those in other roles that require working outdoors.

The overall distribution of potential exposed jobs by region are presented in the following two tables, ranked from highest to lowest concentrations. Table 12 presents the number of jobs that can be classified as directly exposed jobs within regions of Greater Sydney, including Central Coast while Table 13 presents those for regional NSW.

Table 12: Distribution of exposed Greater Sydney jobs in 2024 by SA4 region (ranked on total jobs) – Source: Transport for NSW - TZP24 Employment Projections • The share of potentially exposed workers was calculated at the 4-digit ANZSIC level. These shares have been applied to the 1-digit industry level to provide this summary

SA4	Exposed jobs (2024)	Total positions	Percent exposed
Outer South West	20,780	115,330	18.0%
Outer West and Blue Mountains	24,870	144,410	17.2%
Blacktown	25,830	154,120	16.8%
South West	30,010	178,250	16.8%
Baulkham Hills and Hawkesbury	19,600	117,880	16.6%
Sutherland	14,990	91,590	16.4%
Central Coast	23,790	145,970	16.3%
Inner South West	31,300	195,400	16.0%
Northern Beaches	17,670	125,700	14.1%
Parramatta	37,800	285,680	13.2%
Inner West	16,930	131,130	12.9%
Eastern Suburbs	12,580	120,780	10.4%
North Sydney and Hornsby	26,290	281,580	9.3%
Ryde	11,010	127,590	8.6%
City and Inner South	60,230	750,670	8.0%
Total	373,680	2,966,080	12.6%

Table9 13: Distribution of exposed Regional NSW jobs in 2024 by SA4 region (ranked on total jobs) – Source: Transport for NSW - TZP24 Employment Projections • The share of potentially exposed workers was calculated at the 4-digit ANZSIC level. These shares have been applied to the 1-digit industry level to provide this summary

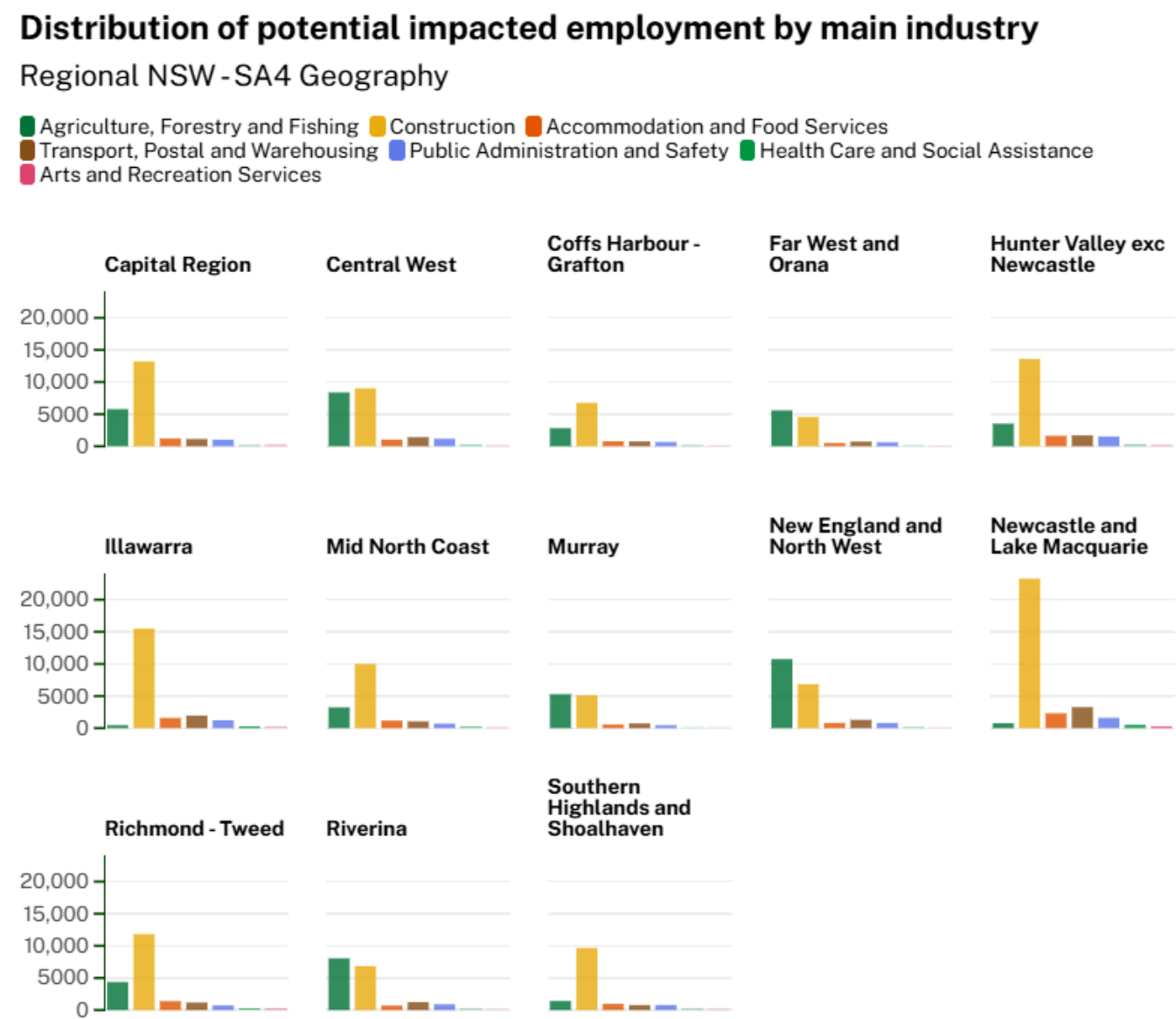
SA4	Exposed Jobs (2024)	Total positions	Percent exposed
Murray	12,330	51,300	24.0%
Capital Region	22,730	97,510	23.3%
New England and North West	20,790	91,490	22.7%
Far West and Orana	12,200	56,610	21.6%
Riverina	17,970	83,670	21.5%
Central West	21,340	110,000	19.4%
Coffs Harbour - Grafton	12,030	64,940	18.5%
Southern Highlands and Shoalhaven	13,890	75,010	18.5%
Mid North Coast	16,530	93,610	17.7%
Richmond - Tweed	19,900	113,580	17.5%
Hunter Valley excluding Newcastle	22,340	141,620	15.8%
Illawarra	21,240	144,180	14.7%
Newcastle and Lake Macquarie	32,070	226,260	14.2%
Total	245,360	1,349,780	18.2%

Urban locations, the CBDs of Sydney and Parramatta, contain numerically the most climate exposed positions. However, over 1 in every 5 positions (>20%) in the Murray, Capital Region, New England and Northwest, Far West and Orana and the Riverina can be identified as most exposed on a proportional basis. Further to this, any impacts in the mining sector are not included in this assessment. Adding positions within this sector into the mix of work increases the range of exposed jobs to well over 1 in 4.

Figures 1 and 2 present the numbers of exposed positions by the Australian Bureau of Statistics SA4 geography, split between Regional NSW (Figure 1) and Greater Sydney (Figure 2). Whilst the construction sector dominates across all regions, the sheer concentration of different work forms based around inner Sydney is evident. The role of Parramatta as Sydney's second CBD is also evident with a wide range of potential exposed work forms across all the key industries.

An understanding of how climate change is changing the risk profiles of workers across all sectors in NSW is an important input for climate change risk and opportunity assessments, as well as economic forecasting.

Figure 1: Distribution of potential impacted employment by main industry – Regional NSW



Source: Transport for NSW - TZIP24 Employment Projections • The share of potentially exposed workers was calculated at the 4 digit ANZSIC level. These shares have been applied to the 1 digit industry level to provide this summary

Figure 2: Distribution of potential impacted employment by main industry – Greater Sydney

Distribution of potential impacted employment by main industry

Greater Sydney - SA4 Geography

■ Agriculture, Forestry and Fishing
 ■ Construction
 ■ Accommodation and Food Services
 ■ Transport, Postal and Warehousing
 ■ Public Administration and Safety
 ■ Health Care and Social Assistance
 ■ Arts and Recreation Services



Source: Transport for NSW - TZP24 Employment Projections • The share of potentially exposed workers was calculated at the 4 digit ANZSIC level. These shares have been applied to the 1 digit industry level to provide this summary

4.4 Demographic and social vulnerability

Workers are also differentially vulnerable to climate impacts due to a range of inherent characteristics and socially mediated differences. These differences mean that certain natural hazards will not be experienced in the same way across the NSW working population. Understanding this variation is important for climate adaptation planning, to ensure that certain demographic and cultural groups are not disproportionately disadvantaged by climate impacts whilst working.

Table 14: Demographic and social vulnerability factors affecting climate risk

Vulnerability factor	Climate-related risks	Key exposure considerations
Age (older workers)	Reduced heat tolerance, cardiovascular strain, chronic illness exacerbation	Declining thermoregulation, higher prevalence of comorbidities
Age (younger workers)	Risk-taking behaviour, low experience, limited voice in workplace	May ignore early signs of heat stress or hesitate to speak up
Gender (women)	Menopausal heat sensitivity, social pressure, underreporting discomfort	Often in care giving, cleaning, or hospitality roles with indirect but high exposure
Gender (men)	Overexertion, reluctance to report symptoms due to masculinity norms	Overrepresented in outdoor manual labour roles
Pregnancy	Increased core temperature, dehydration, foetal risk	Higher risk of pre-term birth, miscarriage, and heat-related complications
Religious and cultural factors	Heat stress from religious clothing; dehydration and fatigue from fasting	Garments may reduce heat dissipation; fasting (e.g. Ramadan) limits hydration during hot work
Socioeconomic status	Poor housing, energy hardship, limited healthcare access	Reduced recovery at home, longer commutes, fewer workplace protections
Indigenous workers	Higher exposure, cultural grief (solastalgia), health disparities	Often in regional areas, strong connection to Country, higher rates of chronic illness

Age-related vulnerability to climate impacts

- **Older workers:** Age plays a significant role in heat vulnerability. Older workers (age 55 and above) generally have reduced cardiovascular and thermoregulatory capacity. The body's sweat response and circulation efficiency decline with age, making it harder to dissipate heat. Older individuals are also more likely to have chronic conditions or be on medications that impair heat tolerance. While advanced age is strongly associated with reduced heat tolerance, it is unclear whether ageing itself or other factors associated with the ageing process are the primary cause of this change (Lundgren et al 2013).
- Workers aged 65 or older are at even greater risk from extreme heat. In physically demanding jobs, it's often the case that older workers either move to lighter duties or retire; however, with ageing populations and later retirement ages, we may see more older workers in these roles. These workers may experience the impact of heat exposure more than their younger colleagues.
- **Younger workers:** In contrast, very young workers (teens, early 20s) may be physically more resilient, but they often lack experience to gauge their limits and may take more risks or ignore early signs of heat stress. They may also be a greater risk due to low 'voice' – limited experience or confidence to speak up about unsafe conditions.

Gender and climate vulnerability

Gender differences in vulnerability can be physiological and social in nature:

- **Physiological differences:** research indicates women handle heat slightly differently to men. Women generally sweat less than men and have a higher surface-area-to-mass ratio, which can be an advantage in dry heat (better dissipation) but a disadvantage in humid heat as less sweating means less cooling from sweat evaporating. Older women in particular are more vulnerable to heat stress than older men (Leach et al. 2024). Menopausal symptoms in women can also compound vulnerability to high ambient temperatures (Humphrys et al. 2022).
- **Occupational exposure:** Men make up the majority in industries like construction, mining, and many outdoor manual jobs in Australia that have the highest expected heat exposure. Given this, it appears that more men are exposed to extreme heat and physical hazards at work. Women, however, are highly represented in other sectors such as healthcare, aged care, cleaning, some manufacturing, and hospitality. Many of these roles may not be nominally classified as 'exposed', but nevertheless involve frequent exposure to high heat conditions when they occur.
- **Social context** can also play a role in how workers respond to climate impacts on the job. For instance, women workers might be less inclined to speak up about discomfort in traditionally male-dominated workplaces for fear of seeming 'weak' in harsh environments. Men might similarly feel pressure to 'tough it out', as masculinity norms may discourage acknowledging heat illness until it becomes severe, or poor air quality impacting their work.

Pregnancy and heat risk

- **Pregnant workers** are particularly sensitive to heat. Pregnancy already raises core body temperature slightly and heat tolerance is lower. Heat stress can cause dehydration and divert blood flow away from the uterus, and extreme maternal body temperature can distress the fetus. Research from NSW indicates that pregnant women exposed to high temperatures have a higher risk of adverse outcomes such as preterm birth (Ye et al. 2024). This is particularly important as it will place additional burden on the healthcare system going forward, as pre-term

births are associated with higher rates of engagement with healthcare services. Heat exposure has also been found to increase the risk of miscarriage and other adverse pregnancy and foetal outcomes (Jiao et al. 2023).

Religious and cultural practices

- Certain religious or cultural customs may increase vulnerability to climate hazards in the workplace. For example, some workers wear conservative clothing that covers most or all of the body for religious reasons – such as long robes, hijabs, or turbans – which can reduce heat dissipation and increase the risk of heat stress in hot environments.
- Additionally, fasting for religious observances such as Ramadan – during which Muslim workers may refrain from consuming food and water during daylight hours – may heighten vulnerability to dehydration and fatigue, particularly in physically demanding or outdoor roles. Other practices, such as prayer times or dietary restrictions, may also intersect with workplace routines and climate-related risks. It is important that adaptation strategies – such as hydration access, rest breaks, uniform design, and scheduling – are inclusive and sensitive to these needs to ensure equitable protection for all workers.

Socioeconomic factors

- **Low-income workers:** Constrained access to socioeconomic resources generally means workers are generally less able to handle climate impacts. Those workers earning lower incomes are vulnerable in a range of ways that higher incomes may not be. For instance, those workers living in energy hardship situations may be less able to afford to install and run air conditioning while at home during heatwaves, reducing the quality of their rest and sleep after tiring workdays. This fatigue may lead to ongoing health impacts, as well as increase the chance of mishaps and incidents on the job. Low-income workers may be more likely to be commuting longer distances due to being unable to afford housing in locations near their work, further compounding the fatigue they may experience.
- **Healthcare and leave access:** Those in lower paying jobs often have less flexibility or leave entitlements, making it less likely that they will be given leave during circumstances that may impact their health at work. They may be less likely to be able to afford quality healthcare in response to certain climate impacts experienced on the job, such as treatment for respiratory issues triggered by working in poor air quality.
- **Comorbidities:** Those on lower incomes are also more likely to experience a range of comorbidities and health conditions that make them less resilient to climate impacts that are experienced while at work.

Indigenous workers and cultural impacts

- **Geographic and occupational exposure:** Indigenous workers are particularly vulnerable to climate impacts at work due to a range of socioeconomic and cultural factors. Indigenous workers are disproportionately located in regional and remote areas, where many climate impacts are expected to be more severe. They are more likely to be in roles that involve working outdoors, subjecting them to high ambient temperatures and other impacts.
- **Housing and health:** As with socioeconomic disadvantaged workers more generally, Indigenous people are more likely to live in lower quality housing with less effective climate control, making

them more vulnerable to heatwaves and diminished potential for rest and recovery. Indigenous people experience higher rates of health conditions that are likely to be exacerbated by climate impacts on the job – particular respiratory and cardiovascular diseases.

- **Cultural impacts:** Experiences of ‘solastalgia’ (grief for the loss of home environments, discussed earlier) may be more common and profound in Indigenous workers, given the connection to country that many of them have. This may require dedicated, culturally appropriate mental health support for these workers following extreme weather events and damage to culturally significant sites and natural environments.

Additional research can provide deeper understanding of specific risks associated with roles that might not be classified as ‘exposed’.

Precarious work: casual, seasonal, and gig workers

Workers in precarious employment arrangements – such as casual labourers, seasonal pickers, gig economy participants, and migrant visa holders – often face heightened vulnerability to climate hazards. These roles typically lack the protections and flexibility afforded to permanent staff, making it more difficult for workers to refuse unsafe conditions or take necessary precautions. Economic pressure, limited access to leave, and undertraining can compound exposure to extreme heat, poor air quality, and other climate-related risks. This section outlines the key groups within precarious work and the specific factors that increase their susceptibility to harm.

Table 15: Vulnerability of precarious workers to climate hazards

Worker type	Climate-related risks	Key exposure considerations
Migrant workers (PALM, WHV)	Heat stress, dehydration, exploitation	Outdoor roles, long hours, limited cooling, language barriers, fear of reporting
Casual and gig workers	Heat illness, smoke exposure, lack of leave	No paid sick leave, economic pressure to work in unsafe conditions
Piece-rate and seasonal workers	Overexertion, heat illness, kidney strain	Paid by output, discouraged from taking breaks, intense physical labour
Contract and labour hire workers	Heat stress, undertraining, reluctance to report	May receive less safety training, fear of losing future contracts
Informal economy workers	Lack of protection, unregulated exposure	Not covered by formal safety systems, invisible to regulators

- **Migrant workers:** such as those participating in the Pacific Australia Labour Mobility (PALM) scheme – often from Pacific Island nations – are employed in sectors such as agriculture, aged care, and hospitality (Pacific Islands Forum Secretariat 2022). These roles frequently involve outdoor work in hot conditions, long hours, and limited access to climate-controlled environments. PALM workers may also face language barriers, isolation, and limited ability to advocate for safer conditions, increasing their vulnerability to heat stress and exploitation. Similarly, young travellers on working holiday visas often take up farm work to extend their stay in Australia. These workers may be inexperienced, undertrained, and financially pressured to continue working in unsafe conditions, with documented cases of exploitation occurring (SBS 2024).
- **Casual and gig workers** often lack paid sick leave or the security to decline work. A casual construction labourer might fear losing future shifts if they don't show up on a hot day, even if feeling unwell. Gig workers (such as food delivery riders) are typically paid per delivery, so they have a strong incentive to keep working even in unsafe heat or smoke. This precariousness means they are more likely to continue working in weather conditions that a full-time worker (who could ask for accommodations or take leave) would avoid.
- **Piece-rate and seasonal workers:** Many agricultural labourers are paid by the amount picked (piece-rate) and are seasonal. They are known to work intensely to maximise earnings, which can lead to overexertion especially in heat. Research conducted internationally found sugarcane cutters working piece-rate did not take rest breaks or hydrate enough because that cut into their pay, thereby increasing heat illness and kidney disease risk (Wesseling 2016). Similar dynamics for fruit pickers may be followed in NSW, although it is unclear whether this is the case.
- **Contract and labour hire workers** might not have had the same training on heat safety as permanent staff, and might be given the more laborious tasks that increase the likelihood of heat stress. If they do experience heat stress or any other climate induced impact, they may be reluctant to report it due to a fear of losing subsequent contracts.
- **Informal economy workers:** Workers doing cash-in-hand jobs are less visible in the regulatory system, so unlikely to benefit from official guidance or support during climate induced hazards.

4.5 Compound vulnerabilities and example case studies

Often, the highest risk is where multiple of these factors intersect. Here we consider six different fictional worker archetype case studies to illustrate experiences of working in climate change affected environments with different vulnerabilities.

Case Study 1: The regional farmhand

- John is a 60-year-old farmhand in the Riverina region of NSW. He's been working in agriculture all his life. The region has faced back-to-back summers of drought and heatwaves. John works outdoors repairing fences and tending to livestock. The air around the paddocks and muster yards is dusty, and he finds himself coughing a lot. As an older worker, the heat hits him harder than it used to – last summer he had an episode of dizziness and almost fainted while working alone in a paddock on a 39°C day. He also feels stress because the farm's finances are tight due to drought losses, and he pushes himself to work the hours asked. He does not have the luxury of retiring or taking summers off, due to a lack of savings to support him later in life. John's risk

factors include outdoor work, extreme heat region, older age, rural isolation. He exemplifies how an aging rural workforce may suffer more heat illnesses and potentially be at risk of serious outcomes like heat stroke or heart attacks in heat.

Case Study 2: The urban construction apprentice

- Ali is a 23-year-old apprentice carpenter working on a large construction project in Western Sydney. It's summer, and heatwaves are hitting 40°C+. As the junior member of the team he often gets tasked with the more physically demanding work (hauling timbers, moving materials across the site). Ali is fit and eager to prove himself, so he tends to push through even when exhausted. He's aware of heat risks but does not want to be seen as the one who slows the team down. On one particularly hot afternoon, he starts feeling light-headed. His supervisor, also feeling the heat, fails to notice Ali's condition until he sees him vomiting from heat exhaustion. They get Ali to shade and hydrate him, but this near-miss shows how young male workers, even those in good physical condition, can be affected by heat. Ali's risk factors include outdoor heavy work, urban heat island exposure, cultural pressure not to complain, and being a relatively inexperienced worker.

Case Study 3: The mobile health care worker

- Sarah is a home healthcare worker in Wollongong, NSW. She visits elderly clients in their homes, providing essential care such as administering medications, assisting with mobility and showering, and performing routine health checks. During summer heatwaves, temperatures often soar above 35°C, and many of her clients do not have air conditioning in their homes. Sarah's job involves physical activity including assisting and moving clients. She is deeply concerned about the welfare of her elderly clients, who are particularly vulnerable to heat-related illnesses. She often finds them in overheated homes, struggling to stay cool. This adds to her stress, as she feels responsible for their well-being and worries about the potential for heat stroke or dehydration. Sarah's case highlights how nominally 'indoor' roles can nevertheless involve exposure to high ambient temperatures, and how stress burdens from climate impacts affect workers in the care economy.

Case Study 4: The emergency responder

- Dave is a firefighter (volunteer with the RFS and also a self-employed tradesman). During a harsh bushfire season he spent weeks fighting fires in his area. He was exposed to extreme radiant heat, smoke, and worked in shifts that left him exhausted. Months after, he finds himself anxious and having flashbacks about approaching flames in windy conditions. He also feels physically drained – smoke inhalation and heat took a toll and he breathes harder when doing anything physically demanding at work now. Dave's example shows how physical climate exposure and mental trauma can result from climate induced natural hazards, diminishing worker's productivity and well-being.

Case Study 5: The parcel delivery worker:

- Sarah is a parcel delivery worker in Sydney who makes her daily suburban runs on her e-scooter. Her delivery route takes her several hours to complete, usually during the hottest parts of the day in summer. Her route takes her along busy roads and beside cars idling at traffic lights. On a few occasions she has become dizzy while driving the scooter in very hot conditions and narrowly avoided collisions with cars and people. She notices her asthma becomes worse on hot

days. She is also planning to start a family soon and worries about the impact that the heat and fumes might have on her baby if she keeps doing her job. Sarah's example highlights the challenges of working outside in heatwaves for extended periods of time, proximity to sources of airborne pollution, and the risks associated with operating a vehicle in these conditions. It also highlights the longer-term health effects for current and future generations.

Case Study 5: The migrant gig worker

- Chen is a recent international student in Sydney who works part-time as a food delivery bicyclist for a food delivery app. During summer heatwaves, he cycles out in traffic with hot asphalt, no shade, and carries a thermal bag on his back. On other occasions he notices a burning smell when he opens his front door, and the air in his neighbourhood seems hazy. He pulls up cotton scarf over his mouth and nose as a makeshift face mask and heads out anyway. He cannot afford to skip these shifts because he needs the income to pay for his rent and electricity bill, which just went up recently. Chen is an example of a migrant gig worker at high risk: he may not be fully aware of health protections, and he's financially pressured to work in unsafe conditions without direct supervision. Such workers might also lack social support or insurance if they do suffer health impacts.

These cases underscore that vulnerability is often multi-dimensional. Geography, job type, personal factors (age/gender/health), and economic/job security factors all intersect.

In summary, those most at risk in NSW include:

- outdoor workers in hot inland or urban heat island regions (construction labourers, farmers, etc.), or indoor roles that are not climate controlled
- workers in physically demanding roles that magnify heat stress
- workers with personal vulnerabilities (older age, pregnancy, certain health conditions)
- those in precarious work with less ability to protect themselves (casual, gig, migrant workers)
- industry-specific groups like emergency responders and agricultural workers who face both environmental and mental health stressors
- regions like Western Sydney and northwest NSW for propensity for extremely high temperatures.

Understanding who is most at risk allows targeted adaptation measures – which the next section of this report will address, focusing on safeguarding these vulnerable groups through improved safety measures and policies.

5 Impacts on worker safety and productivity

Climate change does not just pose a health risk to workers; it also has effects on workplace safety and overall productivity. In NSW and globally, the evidence indicates that as temperatures increase, poor air quality events become more frequent, and extreme weather disrupts routines, workplaces see more incidents, more downtime, and reduced work output.

This section explores how climate change is impacting work safety and productivity, and discusses what these mean for businesses, organisations and the economy.

5.1 Workplace incidents, injuries, and near misses

Higher injury rates in hot conditions

Multiple studies across different contexts find a correlation between higher temperatures and increased workplace injuries. The reasons, as discussed, include heat-induced fatigue and impaired cognition, sweaty palms or dizziness affecting physical tasks, and sometimes rushing to finish work before it gets ‘too hot’ leading to mistakes. In Australia, a retrospective observational study of Safe Work Australia databases estimated that 2.3% of the entire occupational injury burden nationally was attributable to high ambient temperatures alone – with the figure for NSW being among the highest at 2.9% (Varghese et al. 2023).

In practical terms, what do these injuries look like? The following are some typical scenarios likely to be encountered:

- **Construction incidents:** On extremely hot days, construction sites report more minor injuries like cuts or tool mishaps, and occasionally major ones like falls.
- **Manufacturing and warehousing incidents:** Factories and warehouses without proper cooling see workers making more errors around machinery. Hot weather has been found to significantly increase the risk of incidents and injuries on the job, regardless of whether that work takes place indoors or outdoors (Park et al. 2021).
- **Vehicle crashes:** Drivers in heat may suffer drowsiness and fatigue, particularly if the air conditioning in the vehicle is not functioning or insufficient. Similarly, more tyre blowouts happen in extreme heat, which can cause vehicle incidents.
- **Agricultural injuries:** Farm workers in heat might mishandle animals, mishandle equipment or miscontrol vehicles that result in injury.
- **Firefighter injuries:** In extreme bushfires, many firefighters get minor burns, smoke inhalation or sprains. As bushfires become more frequent and intense, the number of such injuries and fatalities could rise.

It is important to note that not all impacts will show up as formal injury claims. Near-misses often go unreported but are likely to increase. For every incident that happens, there may be several close shaves – such as a worker nearly falling but catching themselves. A hotter environment likely multiplies those close calls, creating an overall less safe work environment.

Heat illness as recordable incidents

When a worker gets heat exhaustion, it is typically treated as a work-related incident. These count against safety performance and are a direct indicator of climate's toll on safety. If climate change causes longer or more intense heatwaves, we can expect a rising trend of such incidents unless appropriate adaptation and mitigation measures are implemented.

Overexertion injuries and ergonomic issues

Heat can force workers to adopt awkward body movements or to work faster than normal (e.g. to avoid rising temperatures), which can cause overexertion injuries like muscle strains, back injuries, and other physical impacts.

5.2 Productivity losses due to heat and disruptions

One of the most well-documented impacts of climate on work is reduced labour productivity in high heat. Productivity can be measured in various ways – output per hour, self-rated performance, or economic output. Numerous studies indicate that as workplace heat rises beyond certain thresholds, work output drops (Han et al. 2024). This can be due to:

- **Slower pace:** Workers intentionally or unintentionally slow down to cope with heat (self-pacing to prevent exhaustion).
- **More breaks:** Either formally required or informally taken as micro-breaks (standing in front of a fan, grabbing water, etc.).
- **Cognitive slowdown:** Mental tasks are performed more slowly or with more errors, requiring rework.
- **Absenteeism:** Workers may take sick leave or not show up due to heat stress or related illness.
- **Presenteeism:** Workers show up but perform below capacity due to feeling unwell (e.g. attending work with a heat headache or after a night of poor sleep from high overnight temperatures).

A comprehensive Australian study of self-reported reductions in work performance due to heat translated to an average of US\$655 (approximately A\$800–\$900) per employed person per year, when accounting for both absenteeism and presenteeism in the 2013/14 summer. Extrapolated, this translates to an annual economic burden of around US\$6.2 billion (\$9.5 billion AUD) for Australia – roughly equivalent to 0.33–0.47% of GDP (Zander et al. 2015).

Extreme climate events causing lost work days can include:

- **Heatwaves:** During particularly high ambient temperatures work simply cannot continue. There have been cases where employers send workers home early for safety, causing lost work hours. If such decisions become more frequent overall productivity declines if it cannot be made up later.
- **Bushfire smoke days:** In Sydney 2019, some outdoor workplaces shut down when air quality index reached hazardous levels. Construction sites paused work when visibility was too low or workers were getting ill, creating project delays. Outdoor events may be cancelled due to poor air quality, which may or may not be able to be held at a later date.

- **Floods and storms:** If a workplace is flooded or damaged, workers are often unable to perform their work. Workplaces may require prolonged periods of clean up and drying out before work can resume. Mould growth following flooding may also affect workplace health of those working indoors.

Productivity vs safety trade-off: It is worth noting that productivity losses often occur as a side-effect of trying to keep workers safe (like taking breaks, slowing pace). There's an inherent tension in this regard: pushing to maintain output in extreme conditions can jeopardise safety, but protecting workers (which is paramount) can mean accepting some productivity loss.

Economic estimates and projections: It's important to recognise the scale of the productivity decline that will result from working hours lost to high ambient temperatures. The International Labour Organization projected that by 2030, in a scenario of continued global warming, the world could see 2.2% of total working hours lost to heat – an equivalent of 80 million full-time jobs gone (ILO 2019).

More relevant to Australia, the Arisht-Rockefeller Hot Cities report for Sydney estimated current heat exposure already costs Sydney's economy about A\$432 million per year in lost productivity. If no adaptation measures are implemented this could double to nearly A\$974 million per year in 2050 due to more frequent high-heat days. These figures exclude broader economic ripple effects, so they focus largely on the lost labour output itself (Atlantic Council Climate Resilience Centre 2024).

It is important to acknowledge that the productivity figures cited in this section are likely to be highly conservative. Most estimates focus on direct labour output losses and do not account for broader systemic disruptions, second-order effects (such as supply chain delays or infrastructure strain), or third-order impacts (such as long-term workforce attrition or reduced economic resilience). These ripple effects can significantly amplify the true economic burden of climate-related productivity loss. A more comprehensive modelling approach would be needed to fully capture the cascading consequences of climate disruptions on the NSW workforce and economy.

The economic impacts are likely to vary across **industry sectors**. The following industries appear to be more vulnerable due to their more direct exposure to climate induced hazards:

- **Construction and outdoor projects:** Deadlines may be missed or extended, potentially leading to financial penalties or overtime costs. For example, if a highway build was scheduled for summer, a string of heatwaves might force delays or night work, which is more expensive due to lighting, shift allowances.
- **Agriculture:** Climate change is increasingly disrupting agricultural operations by affecting the safety, timing, and quality of both crop and livestock work. Rising temperatures and shifting seasonal patterns can compress harvest windows, causing fruits and vegetables to ripen simultaneously and placing intense pressure on workers to pick quickly before spoilage. This urgency often leads to longer hours, reduced rest, and heightened risk of heat stress. During heatwaves or poor air quality conditions, crops may go unharvested if workers are physically unable to meet demands, while livestock tasks – such as shearing – may be deferred, impacting productivity, wool quality, and animal health.

Livestock, particularly dairy cattle, are highly vulnerable to heat stress, which can reduce milk yield, feed intake, growth, fertility, and increase susceptibility to disease. These effects vary by species, breed, age, and physiological condition, with some breeds (e.g., *Bos indicus* and certain beef cattle) showing greater heat tolerance (Meat and Livestock Australia 2025). Recognising livestock as climate-exposed workers encourages a more compassionate and strategic approach

to adaptation, including shade provision, water access, cooling infrastructure, and modified handling schedules to reduce stress. This not only supports animal welfare but also alleviates emotional and economic burdens on human workers.

- **Service sector:** Some services like outdoor tourism and outdoor dining are forced to shut during extremely high temperatures – a loss of income for those businesses and wages for workers, particularly if they occur during peak tourism/business periods. Indoor retail can also slow if customers do not go out in extreme weather as much as they otherwise would.

5.3 Workplace disruptions affecting productivity

Climate change is reshaping the conditions under which work is performed, introducing new challenges that can disrupt operations and reduce productivity across sectors. These disruptions stem from both direct environmental stressors and broader systemic vulnerabilities, affecting everything from infrastructure reliability to workforce capacity. As these pressures grow, workplaces must adapt not only to safeguard health and safety but also to maintain economic resilience.

Table 16: Summary of workplace disruptions affecting productivity

Disruption	Effect on workplace	Impact on productivity
Power outages	Increased electricity demand during extreme heat leading to blackouts or load shedding	Halts to workplace operations; limited functionality with backup generators
Infrastructure hazards	Heat damage to roads, railways, and airports	Delays in commuting and freight; constrained air travel; reduced operational efficiency
Cascading supply chain impacts	Climate events in other regions disrupting global supply chains	Material shortages, increased costs, and delays affecting NSW workplaces

Power outages: During extreme heat, electricity demand surges driven by increased air conditioning use, sometimes resulting in blackouts or load shedding. If workplaces lose power, many workplace activities halt. Backup generators may be designed to cover critical functions but not full productivity. NSW has recently experienced strain on grids in heatwaves - though large-scale blackouts have been relatively limited in recent years. As climate events intensify, the reliability of infrastructure will be further pressured and demand management measures may be implemented, particularly in high energy consuming workplaces (e.g. steel production).

Infrastructure hazards: Heat can impact key infrastructure and limit core economic activities, such as road tar melting or railway tracks buckling and overhead cables drooping. This can also lead to increased commute times for workers, as trains may have to travel slower or alternative modes offered. In certain extreme dry heat situation planes are unable to take off, constraining air travel

(World Economic Forum 2017). While this is primarily experienced in the Middle East, heat vulnerable airports in NSW may experience such conditions as climate change progresses. Each of these impacts reduces the productivity of workers in those industries, impacting their overall viability.

Cascading impacts of climate hazards in global supply chains: It's important to recognise that climate impacts affecting workers in regions outside of NSW can also affect productivity within NSW due to the interconnected nature of global supply chains. Extreme weather events in major exporting countries can disrupt the supply of goods and materials to NSW, leading to shortages and increased costs. By diversifying supply sources, investing in resilient infrastructure through the supply chain, and implementing advanced risk management strategies, NSW could lead by example to help ameliorate these impacts and protect workers outside of its immediate jurisdiction.

Understanding these impacts underlines why investing in adaptation and protective measures is not just a health imperative, but an economic one. The next section will discuss into how NSW can reduce these safety incidents and productivity losses by making changes at the workplace and policy level.

6 Risk reduction and adaptation strategies

Adapting workplaces and work practices to a changing climate is essential to protect workers and maintain productivity. A variety of strategies and best practices have emerged globally to reduce the impacts of extreme heat, poor air quality, and other climate hazards on workers. This section reviews those strategies, examining their effectiveness and relevance to NSW. It also critically discusses how broader planning and policy decisions can either alleviate or exacerbate climate risks for workers.

6.1 Adjusting work hours and schedules

Adjusting work hours and schedules is one of the most direct and widely adopted strategies to reduce worker exposure to climate-related hazards. While traditionally focused on heat, this approach is increasingly relevant for managing risks from a broader range of environmental stressors, including poor air quality, storms, and extreme weather variability.

Table 17: Summary of adjusting work hours and schedules to minimise exposure to climate hazards

Strategy	Purpose	Benefits	Challenges
Shifting work to safer hours	Avoid peak heat and poor air quality periods	Reduces exposure to extreme temperatures and airborne pollutants; improves safety and productivity	Requires lighting for night work; may disrupt sleep and family life; noise restrictions may apply
Midday or hazard-based breaks	Pause work during the most hazardous parts of the day	Protects workers during peak heat or pollution; aligns with international best practices	Extends overall workday; may be difficult to enforce consistently
Seasonal scheduling	Plan work around seasonal climate risks	Avoids peak hazard periods (e.g., summer heat, storm seasons); improves long-term planning	Limited flexibility in some industries (e.g., agriculture); requires advanced scheduling
Effectiveness	Reduce health risks and improve resilience	Substantial benefits for workers with respiratory conditions; lowers risk of heat illness and fatigue	Requires real-time hazard monitoring and responsive scheduling systems

- **Shifting work to safer hours:** Outdoor industries in hot or high-risk regions have long adopted early start times (e.g., 6 AM or earlier), with work concluding by early afternoon. As climate extremes intensify, these shifts may need to move even earlier – or into the evening or night – to avoid not only peak heat but also periods of poor air quality, such as those caused by bushfire smoke or dust storms. In NSW, some construction companies have already implemented dawn shifts and occasional night work during summer heatwaves and smoke events. Similar adaptations may be necessary in other sectors, especially during periods of high pollen count, ozone levels, or storm activity.
- **Midday or hazard-based breaks:** In addition to time-of-day shifts, some regions enforce or recommend extended mid-day breaks during hazardous conditions. This is common in tropical and subtropical countries, where siesta-like breaks help workers avoid the most dangerous hours. In the Middle East, midday work bans are legally enforced during the hottest months. Spain has introduced restrictions during extreme temperature alerts, and in Greece, the government ordered heavy outdoor work – including construction and agriculture – to pause from midday to 5 pm during heatwaves in 2023 and 2024 (Reuters, 2024).
- **Seasonal and hazard-aware scheduling:** Planning work around seasonal climate patterns can also reduce exposure. For example, major infrastructure projects or outdoor training exercises could be scheduled in spring or autumn to avoid summer extremes or storm seasons. In agriculture, while crop cycles often dictate timing, some flexibility may be possible in planting, harvesting, or shearing to avoid periods of high heat, smoke, or flood risk. Similarly, industries reliant on transport may need to avoid scheduling critical operations during seasons prone to rail buckling, road closures, or flight disruptions.

Effectiveness: These scheduling adjustments are highly effective in reducing exposure to multiple climate hazards. Avoiding peak-risk hours can significantly lower the likelihood of heat illness, respiratory distress, or injury from sudden weather events. For individuals with respiratory conditions such as asthma or COPD, avoiding work during poor air quality periods – especially those driven by bushfire smoke or high ozone levels – can substantially reduce the risk of exacerbations and long-term respiratory harm. Even modest shifts in timing can improve air quality exposure profiles and enhance overall worker health.

Challenges: Despite their benefits, adjusting work hours presents logistical and social challenges. Night work requires lighting and may disrupt sleep or family life, potentially trading one risk (heat or air quality) for another (fatigue). Split shifts can extend the overall workday, and not all tasks can be performed at night due to noise restrictions or reliance on daylight. Additionally, responding to rapidly changing conditions, such as sudden storms or smoke plumes, requires flexible systems and real-time communication. Adoption and enforcement remain key hurdles, particularly in sectors with rigid schedules or limited resources.

6.2 Enhanced rest breaks and hydration practices

As climate conditions intensify, particularly during heatwaves, ensuring workers have adequate opportunities to rest and rehydrate becomes a critical component of workplace safety. Even when work hours cannot be shifted away from peak heat periods, these strategies can significantly reduce the risk of heat-related illness and improve overall wellbeing. This section outlines practical approaches and challenges associated with these measures, highlighting their importance in adapting workplaces to a warming climate.

Table 18: Summary of enhanced rest breaks and hydration practices

Strategy	Purpose	Key practices	Challenges
Mandated break schedules	Reduce heat stress through structured rest periods	15 mins/hour for moderate heat; 30 mins/hour for high heat; increase frequency as temperature rises	Enforcement in fast-paced or understaffed environments; resistance from workers/employers
Cool/shaded rest environments	Improve recovery during breaks	Shade structures, air-conditioned rooms, cool sheds	Limited infrastructure in small operations
Hydration strategies	Prevent dehydration and heat illness	Scheduled water breaks; hydration packs; urine colour charts; electrolyte drinks	Workers may delay hydration; need for education and reminders
Cooldown aids	Accelerate cooling during breaks	Cool towels, misting fans, ice vests, ice-slurry drinks	Cost, logistics, and availability
Cultural and operational barriers	Address resistance and enable safe practices	Promote safety culture valuing breaks; plan for staff coverage	Cultural norms (e.g. 'push through' mentality); lack of resources

- **Mandated break schedules:** WHS guidelines often suggest a certain proportion of each hour worked to be spent resting: e.g. for moderate heat stress, 15 minutes rest each hour; for high heat stress, 30 minutes rest each hour, etc. (SafeWork NSW 2025). These can be formalised in company policy or industry codes. Ensuring these are followed is key to worker protection. In NSW, SafeWork recommends to increase frequency of breaks as temperature rises – as opposed to longer breaks less often.
- **Rest in cool/shaded environments:** A break is most effective if the worker more able to cool down. Providing shade structures on outdoor sites and cool rooms or air-conditioned break areas facilitate this. Some large construction sites now have an air-conditioned shed or site office where overheated workers can recover.
- **Hydration strategies:** Drinking water is a pillar of heat mitigation. Workplaces should provide ample cool drinking water (or electrolyte drinks where needed) and actively remind/encourage

workers to drink. Some use scheduled water breaks (e.g., everyone stops for a drink every 20 minutes). Personal water bottles or hydration packs that workers wear, have been adopted in some outdoor jobs to allow sipping without stopping work. Workers should also be educated not to wait until thirsty, as by then mild dehydration has set in. One practice is the urine colour chart – some worksites put posters of a chart encouraging workers to check their urine colour as a gauge of hydration.

- **Cooldown aids during breaks:** Providing cool towels, misting fans, or even ice vests during breaks can accelerate cooling. Some mining sites in Western Australia use small ice-slurry drinks (slushies) during breaks to quickly reduce core body temp – a creative measure from sports science now entering workplaces.

Challenges: Enforcing breaks can be difficult in certain work environments, particularly where the tempo of the work is externally paced, or where there are insufficient staff available to relieve people while they take breaks (Humphrys et al. 2022). There may be worker resistance (e.g. ‘I just want to get it done, not stop and start’) or employer resistance (‘we’ll lose time’). Successfully practicing breaks requires a safety culture that values breaks as necessary, not as slacking off. In smaller operations, providing a cool space might be more difficult, as there may not be a staffing capacity to arrange it.

6.3 Clothing, protective equipment and cooling gear

Instead of cooling spaces and insulating them from heat and other hazards, another strategy is to use worn equipment and clothing to protect workers. There are a range of options here, some of which are already widely used in various contexts but could be expanded further, while others are more novel.

Table 19: Summary of clothing, protective equipment and cooling gear to protect workers

Strategy	Purpose	Benefits	Challenges / considerations
Heat-appropriate clothing	Reduce heat absorption and improve airflow	Keeps workers cooler; prevents sunburn; improves comfort	May conflict with safety gear requirements; limited availability of advanced fabrics
Cooling vests	Actively cool the body during or after work	Reduces core temperature; aids recovery in extreme conditions	Limited cooling duration; may be bulky or require recharging/freezing
Sun protection gear	Minimize solar exposure and UV damage	Prevents sunburn, skin cancer, and eye damage; supports skin’s cooling function	Not cooling directly; may be underused without enforcement

Strategy	Purpose	Benefits	Challenges / considerations
Respiratory protection (e.g. P2 masks)	Protect against smoke, dust, and airborne particles	Reduces respiratory illness and exposure to pollutants and pathogens	Can increase heat stress; requires stockpiling and timely distribution
Enhanced PPE for extreme conditions	Protect against fire, chemicals, and heat	Maintains safety while reducing heat burden; supports hazardous industry workers	Needs innovation to balance protection and breathability; may be costly
Insect protection gear	Prevent bites from disease-carrying insects	Reduces risk of vector-borne diseases; improves comfort in warmer climates	May require regular reapplication or special clothing treatments

- **Heat-appropriate clothing:** Lightweight, breathable, light-coloured fabrics help reduce the heat absorbed by the body and allow for air flow next to the skin. Natural fibres or technical moisture-wicking fabrics can keep workers cooler than heavy cotton or non-breathable synthetics. Loose-fitting long sleeves can protect from sun and keep a bit cooler than direct sun on skin (plus prevent sunburn). There has been development in artificially cooling clothing, such as vests with built-in fans that have been used internationally for factory workers.
- **Cooling vests:** These can be ice-pack vests or those with phase-change material that stays cool for several hours. Workers can wear them during work or just on breaks. Firefighters often recover with cooling vests in extreme conditions.
- **Sun protection gear:** Wide-brim hats or flap caps, neck shades, UV-filtering safety glasses – these reduce solar load and reduce risk of skin cancer and eye damage. While not cooling per se, they prevent sunburn which impairs the skin's cooling ability and overall health.
- **Respiratory protection:** For smoke and dust, providing N95/P2 masks or more advanced respirators to outdoor workers can prevent inhalation of harmful particles. During the bushfires, many outdoor workers started using P2 masks when available. Such masks may also benefit workers by reducing the inhalation of airborne diseases. Employers of outdoor workers should stock these for bad air days, noting that wearing a mask in heat is another stress, but necessary in certain conditions.
- **Enhanced PPE for extreme conditions and chemical hazards:** Firefighters are now exploring lighter gear for bushfire situations to reduce heat stress while still protecting from flames (traditional structural fire gear is too insulating and heavy for bushfires). Similarly, hazmat suits with cooling underlayers can help hazardous industry workers in heat. PPE should also be worn to protect agricultural workers exposed to the increased impact of pesticides in a changing climate, albeit only where it is not possible or practicable to control exposure by other measures (ILO 2024).

- **Insect protection:** If warmer climate increases the prevalence of disease carrying insects, tick or mosquitos, workers in more areas may require repellents or permethrin-treated clothing to prevent them from being bitten.
- **Footwear and gloves:** Breathable versions of these can help to reduce heat sweat issues, since sweaty feet and hands can lead to blisters or slipping. However, safety sometimes requires less breathable items (e.g. steel-toe boots). Moisture wicking socks may help reduce heat impacts in these areas of the body.

Modifications can also be made to the workplace itself to ensure that workers are operating in a more comfortable environment:

- **Ventilation and fans:** For indoor workplaces, installing or improving ventilation is critical. Even if full air-conditioning is not feasible, large fans, roof ventilators, or evaporative coolers can significantly drop temperature and create air movement that makes sweating more effective. In outdoor or semi-outdoor sites, portable misting fans that blow fine mist that evaporates and cools the air reduce heat burden. These are commonly used in mines, sports sidelines, outdoor events, but more widespread use may be beneficial.
- **Equipment modifications:** Using machinery or mechanisation to reduce physical labour in heat can reduce worker impacts. Remote-controlled equipment such as drones can also be used to keep workers away from particularly hottest environments.
- **Maintenance of HVAC (heating, ventilation and air conditioning) :** For indoor workplaces, air-con systems need to be robust and have backup in case of power failure. Backup generators may be necessary for critical cooling of indoor spaces where staff work, to prevent sudden heat exposure if power fails.

6.4 Training, monitoring, and early warning systems

Adapting workplaces to climate hazards requires a multi-layered approach that includes worker education, real-time monitoring, and proactive early warning systems. Each plays a distinct role in reducing risk and improving safety outcomes.

Table 20: Summary of training, monitoring and early warning systems and their impacts

Component	Purpose	Key practices / tools	Impact on worker safety
Training and awareness	Equip workers with knowledge to self-monitor and respond to climate hazards	Heat stress recognition, hydration guidance, PPE use, emergency procedures, ergonomic techniques	Reduces risk of injury and illness; empowers workers to act safely and confidently

Component	Purpose	Key practices / tools	Impact on worker safety
Monitoring systems	Track environmental and physiological conditions in real time	WBGT meters, thermometers, wearable sensors, buddy systems, AQI/PM2.5 checks	Enables timely interventions; supports decision-making for breaks, relocation, or escalation
Early warning systems	Provide advance notice of hazardous conditions	Heatwave alerts, weather forecasts, pre-planned operational adjustments	Allows proactive scheduling changes and preparedness; reduces exposure before hazards occur

Training and awareness

Worker training is foundational to climate adaptation, especially in roles where direct supervision is limited and self-monitoring is essential. Education empowers workers and supervisors to recognise and respond to climate-related risks before they escalate. Key areas of training should include:

- recognising signs of heat or respiratory stress in oneself and others (e.g. excessive fatigue, cessation of sweating, confusion)
- understanding proper hydration practices (e.g. avoiding caffeine or alcohol during work hours)
- administering first aid for heat exhaustion, including moving the person to shade, gradual cooling, offering water if conscious, and calling emergency services for heat stroke
- awareness of personal risk factors such as illness, medication use, or low fitness levels, which may increase vulnerability to heat
- emergency procedures for events like lightning storms or bushfires
- correct use of personal protective equipment (PPE), such as fitting and maintaining P2 masks
- ergonomic techniques to prevent injury when fatigued, including proper lifting and using buddy systems.

SafeWork NSW and other agencies provide resources on working in heat and poor air quality (SafeWork NSW 2024). However, training must also address how these hazards can interact – such as bushfires coinciding with heatwaves – and should be delivered in multiple languages to ensure accessibility for migrant workers.

Monitoring systems

Monitoring plays a critical role in identifying hazardous conditions and ensuring timely interventions. It includes both environmental and physiological tracking:

- **Environmental monitoring:** Tools such as onsite thermometers, humidity sensors, and Wet-Bulb Globe Temperature (WBGT) meters help assess heat stress levels. Some workplaces use smartphone apps or automated alerts when thresholds are exceeded, prompting supervisors to initiate extra breaks or halt work. Onsite monitoring is especially important where localised conditions (e.g. heat radiating from dark road surfaces) differ from broader weather station data.
- **Worker monitoring:** In high-risk settings, wearable sensors can track heart rate and skin temperature, alerting workers or supervisors when physiological strain becomes dangerous.

Buddy systems are also recommended to help detect early signs of heat illness, particularly in isolated work environments.

- **Air quality monitoring:** On days with poor air quality, checking the Air Quality Index (AQI) or PM2.5 levels is essential – especially for outdoor workers. If thresholds are exceeded, workplaces may need to implement mask use or relocate work indoors.

Early warning systems

Early warning systems provide advance notice of hazardous conditions, enabling workplaces to adjust operations before risks materialise. For example, heatwave alerts from the Bureau of Meteorology can trigger pre-planned responses such as rescheduling work to cooler hours or postponing labour-intensive tasks. Effective use of these systems requires reliable forecasting and clear communication channels to inform workers promptly.

Even when conditions do not meet formal thresholds for cancellation, preparatory measures should be in place. This includes ensuring first aid kits are stocked with cooling packs and that staff are trained in emergency response protocols. Advanced first aid training – particularly for managing heat stroke and respiratory distress – can further reduce risk and improve outcomes.

6.5 Workplace design, infrastructure and planning improvements

Workplaces are not all equal in their ability to protect workers from harsh environmental conditions. While certain workplaces will generally be less exposed to these risks by virtue of the type of building they are (e.g. an office building vs a warehouse), certain building and planning decisions can also improve the resilience of the places that people work. Where possible locating workplaces or designing them with climate in mind can bring multiple benefits going forward.

- **Workplace design:** New warehouses and other buildings can be built with better insulation and ventilation to keep them cool during hot temperatures. Avoiding materials that exacerbate heat (such as using light-coloured roofing on facilities instead of dark metal) also reduces the heat absorption of the building. For warehouses that have large open roller doors that let hot air in, redesigning workflow to minimise doors open time or adding air curtains can also reduce heat impacts.
- **Urban design to reduce heat:** Modifications can also be made to the broader environment in which many workplaces are situated. The Urban Heat Island effect means many urban worksites are likely to be hotter on average than regional areas in the same climatic zones. Addressing this by creating more tree canopy coverage and green spaces, using reflective surfaces rather than dark ones that absorb heat, and ventilation corridors that can lower ambient temps in work environments. These are longer-term strategies, but important for planning for climate change in the decades to come.
- **Urban planning decisions** can also affect people's day to day work routines, creating challenges or benefits for workers that may be exacerbated by climate impacts. For instance, many workers in Sydney are forced to undertake long daily commutes due to unaffordable housing costs in the city. These workers may already be heat-stressed or fatigued by the time they start work, and even more so for the return homeward journey. Reducing commute times by improving housing

affordability and transport commuting times would benefit many workers' ability to perform their jobs in harsh conditions.

Implementing a combination of these strategies can significantly reduce the risk to workers and help maintain productivity even as climate extremes become more common. However, it is acknowledged that the adequacy of these strategies has not been stress tested under climate change scenarios – and there is therefore a degree of uncertainty about their effectiveness going forward. As climate change progresses, it's important these strategies are monitored and evaluated by employers, regulators, and policymakers to ensure worker impacts are properly understood and reduced. The next section will discuss how, beyond just preventing harm, adapting to climate change can also present opportunities to improve work conditions and create new avenues for work.

7 Co-benefits of adaptation for worker wellbeing

While much of the discourse around climate change and work focuses on risks and challenges, it is equally important to recognise the opportunities and potential co-benefits that proactive climate action can bring for workers. Climate adaptation and mitigation efforts can serve as a catalyst to improve working conditions, create new jobs, and address longstanding workplace issues.

This section explores these more positive aspects, demonstrating that building a climate-resilient economy in NSW can be a win-win for workers and employers alike.

7.1 Improving long-standing workplace conditions

Climate adaptation strategies offer more than just protection from emerging environmental hazards – they present a timely opportunity to address long-standing issues in workplace design, culture, and wellbeing. By investing in measures that mitigate the impacts of heat, smoke, and other climate-related risks, employers can enhance worker resilience to climate extremes but also foster healthier, more inclusive, and more productive work environments year-round.

Table 21: Summary of potential improvements to long-standing workplace conditions

Improvement area	Purpose / benefit	Key practices / examples	Broader impact
Thermal comfort and air quality	Enhance indoor climate resilience and year-round comfort	Roof insulation, mechanical ventilation, improved airflow	Reduces temperature extremes, dust, fumes, headaches, and allergies
Hydration and facilities	Promote health and hygiene through better amenities	Clean drinking water, electrolyte supplements, improved rest areas	Reduces fatigue and injury risk
Safety culture	Foster proactive safety practices and climate awareness	Daily safety briefings, weather monitoring, integrated hazard management	Strengthens overall workplace safety and engagement
Worker empowerment	Encourage worker voice and rights in climate adaptation	Right to stop work in dangerous heat, inclusive safety policies	Supports 'just transition' and collaborative workplace culture

Improvement area	Purpose / benefit	Key practices / examples	Broader impact
Mental health support	Address climate-related stress and trauma	Counselling, peer support, stress management resources	Benefits all mental health challenges, not just climate-related
Schedule flexibility	Improve work-life balance and reduce exposure during extreme conditions	Remote work options, variable hours, split shifts	Enhances job satisfaction and adaptability
Technology and innovation	Reduce exposure and improve efficiency through modern tools	Drones for inspections, digitised tasks, sensor data analysis	Opens up higher-skilled roles and upskilling opportunities
Reduced physical strain	Minimise exertion and injury risk, especially in heat	Mechanisation, ergonomic tools (e.g. powered wheelbarrows)	Benefits workers year-round, not just during heat events
Inclusive planning	Support vulnerable workers and promote equity	Adjusted duties, accommodations for health conditions or disabilities	Fosters inclusive and supportive work environments

- **Thermal comfort and indoor air quality:** By installing better cooling and ventilation systems to deal with heatwaves or smoke, workplaces inadvertently create healthier, more comfortable environments year-round. For example, a warehouse that invests in roof insulation and mechanical ventilation to keep summer temperatures down will also be warmer in winter and have fresher air generally. Workers benefit from fewer temperature extremes in both directions and reduced exposure to dust or fumes due to improved airflow. Improved indoor air quality can reduce incidences of headaches and allergies, thereby boosting overall well-being and productivity beyond just the extreme climate events.
- **Hydration and facilities:** Emphasis on hydration means worksites provide better basic amenities including clean drinking water, and electrolyte supplements. In the past, worksites may have lacked easy access to drinking water; climate adaptation provides additional impetus to make these improvements, improving general health and hygiene. Likewise, improving rest areas for heat means workers have a proper place to take breaks – which can improve morale and reduce general fatigue or injury rates even in normal conditions.
- **Safety culture:** Heightened awareness and planning for climate risks can spill over into a stronger overall safety culture. If a company makes daily safety briefings due to weather monitoring when conditions warrant it, they may also catch other safety issues in those meetings. Workers who feel their employer cares about their heat safety might be more engaged in other safety programs too. This fosters a more proactive and caring environment. A climate-safe workplace is often a safer workplace in general, as heat is one of many hazards that need management.

- **Worker empowerment:** Introducing policies like the right to stop work in dangerous heat can empower workers to speak up about other hazards too. This reinforces the principle that workers' health comes first. This empowerment is a facet of the 'just transition' – ensuring labour rights and safety are central as we adapt and respond to climate change. Over time, this could lead to more collaborative employer-worker relationships on a range of issues, not just climate.
- **Mental health support:** With climate change causing anxiety and trauma, many employers will need to bolster mental health services for workers – such as counselling, stress management resources, or peer support programs. These supports, once in place, benefit workers facing any mental health challenge, not only climate-related.
- **Schedule flexibility and work-life balance:** Adaptation may necessitate more flexible scheduling (such as remote work options on very hot days, or variable hours). This could encourage a more flexible work culture generally, which workers value. The COVID-19 pandemic taught many industries how to work remotely effectively; applying that lesson for extreme weather (e.g., letting non-essential staff work from home during a heatwave) could both reduce heat exposure and improve work-life balance. Once flexibility is shown to work, workers might negotiate more of it for other reasons too, improving job satisfaction.
- **Technology and innovation at work:** Adapting to climate can drive technological upgrades, for example digitising some tasks to avoid sending people out in dangerous conditions, or using drones to inspect infrastructure on extremely hot days instead of a worker climbing. Those innovations can also improve efficiency and open up higher-skilled job roles (like drone operators, data analysts to interpret sensor data). Workers can be upskilled to use these new tools, improving their qualifications and career prospects.
- **Reduced physical strain:** Many climate adaptations involve mechanisation or ergonomic improvements to reduce physical strain in heat. These can reduce physical exertion and injury risk overall. For example, if a landscaping crew starts using powered wheelbarrows to move heavy loads in summer (to reduce exertion), they may keep using them in cooler months too – meaning less physically demanding labour and fewer musculoskeletal injuries all year.
- **Inclusive planning:** A focus on vulnerable workers means employers might pay more attention to workers individual health needs and offer accommodations like lighter duties in heat. This habit of adjusting work to individual needs can foster a more inclusive workplace for people with various health conditions or disabilities even apart from climate issues.

Creating a means to identify and certify climate ready employers and workplaces could help workers make informed decisions about which jobs will prioritise their safety from climate impacts.

7.2 Community co-benefits of a climate-resilient workforce

Adapting workplaces to climate change is not only a matter of risk mitigation for the organisation involved, it also presents a powerful opportunity to deliver broader social, economic, and environmental benefits. This section explores how climate adaptation can serve as a catalyst for positive transformation, supporting a more equitable and future-ready workforce.

Table 22: Summary of co-benefits for a resilient workforce

Co-benefit area	Description	Impact on workers and communities
Health outcomes	Reducing exposure to heat and pollution lowers chronic illness rates	Improves long-term wellbeing, reduces healthcare costs, and boosts productivity
Reduced inequality	Targeted adaptation efforts in vulnerable regions and industries	Enhances protection for low-income workers and creates new local employment opportunities
Stronger communities	Climate adaptation projects can strengthen social cohesion and local capacity	Empowers communities, supports recovery, and fosters collaboration across sectors
Economic resilience	Protecting workers helps maintain business continuity and job security	Stabilises output, revenue, and workforce participation during climate disruptions
Leadership opportunity	NSW can lead by integrating climate adaptation into workplace safety	Sets a benchmark for others, attracts investment, and enhances global reputation
Schedule flexibility	Remote work options, variable hours, split shifts	Enhances job satisfaction and adaptability
Technology and innovation	Drones for inspections, digitised tasks, sensor data analysis	Opens up higher-skilled roles and upskilling opportunities
Reduced physical strain	Mechanisation, ergonomic tools (e.g. powered wheelbarrows)	Benefits workers year-round, not just during heat events
Inclusive planning	Adjusted duties, accommodations for health conditions or disabilities	Fosters inclusive and supportive work environments

- **Health outcomes:** Reducing heat and pollution exposure not only prevents immediate injuries, but it can also lower chronic illness rates like cardiovascular and respiratory diseases. Healthier workers mean lower healthcare costs and higher productivity for society in the long term.
- **Reduced inequality:** Many climate-vulnerable workers are low-income. By targeting adaptation efforts to, say, Western Sydney or to industries like agriculture where wages are lower, it can help reduce health and economic inequalities. Those workers gain more protection and possibly new job opportunities in their communities, such as upgrading workplaces, or tree-planting programs providing income. The UN Global Compact (2022) emphasises that a just transition with strong worker protections can avoid exacerbating inequalities and instead promote decent work.
- **Stronger communities:** When workers are safe and secure, communities are more stable. Adaptation projects like community microgrids (for stable power in heatwaves) or local water projects can empower communities and often involve local workers. There is a social cohesion that can come from collectively tackling climate challenges – for instance, after disasters, communities often bond through rebuilding, and that includes multi-sector collaboration (government, NGOs, businesses, unions).
- **Economic resilience:** Protecting workers means the economy is more able to handle climate shocks. For example, if heat adaptation keeps workers productive, businesses lose less output, tax revenues remain steadier, and jobs are more secure. A resilient workforce is a foundation for a resilient economy.
- **Leadership opportunity:** NSW could set an example by integrating climate adaptation into workplace safety comprehensively. This could influence standards in other jurisdictions and position NSW as a leader, potentially attracting global events knowledge exchange events or investments.

In essence, addressing climate change about more than just avoiding harm; it's an opportunity to modernise our work environments to ensure workers are able to thrive going forward. As climate policies are implemented, it will be crucial to ensure they are done in consultation with workers to harness these opportunities fully.

8 Conclusion

Climate change is no longer a distant forecast for NSW – it is a present reality that is already reshaping the working environment. This report has detailed how rising temperatures, more extreme weather, and shifting climate patterns will increasingly affect workers' health, safety, and productivity in NSW.

Our State is experiencing significant warming and more frequent extremes like heatwaves, bushfires and floods. These translate into harsher conditions for workers, especially those outdoors or in non-climate-controlled settings. Days that were once considered extreme are becoming the new normal, requiring adaptation in how work is conducted.

Workers face immediate dangers such as heat-related illnesses (heat exhaustion, heat stroke), injuries exacerbated by heat fatigue, respiratory problems from bushfire smoke, and physical threats from storms and floods. Heat stress has already caused worker fatalities and is linked to higher incident rates. Climate change also poses long-term health risks – repeated heat exposure can contribute to chronic kidney disease, accelerate cognitive decline, and increase reproductive complications. Mental health impacts, including heightened stress, anxiety, and trauma after extreme events, are significant concerns for worker well-being.

These impacts are not evenly distributed. Outdoor workers, by virtue of exposure, are generally the most at risk, along with those in physically demanding jobs. Certain industries – notably agriculture, construction, emergency services, and transport – see higher risk levels. Within these, young, fit workers may incur injuries by pushing too hard, whereas older workers and those with health conditions may suffer severe health consequences. Women have distinct vulnerabilities that emerge from both physiological and social causes. NSW's Indigenous population are likely to experience many of these impacts more severely than other groups. Casual, migrant, and gig economy workers often have the least protection or ability to refuse dangerous work. Regional disparities – in both climate impacts and workers in exposed jobs – mean certain areas will experience higher rates of exposure to these impacts.

Heat and extreme weather are already reducing work output. One survey has suggested up to 70% of Australian workers report that heat has affected their productivity (The Australia Institute 2023). Economically, heat-related productivity losses are costing Australia due to heat-weakened labour output. Injuries and illnesses also impose costs through workers' compensation, healthcare, and lost workdays. If unaddressed, these trends threaten to undermine economic growth and workers' livelihoods.

The findings above underscore that climate change is fundamentally a workplace issue as much as it is an environmental one. It demands integration into occupational health and safety planning, labour policy, and business risk management. The traditional separation between environmental policy and workplace policy is no longer tenable. For NSW policymakers and planners, this means treating extreme heat and climate hazards with the same urgency and structured approach as other workplace hazards. Recognising that protecting workers from climate impacts also protects the broader economy. The costs of inaction – in health, compensation, lost productivity – are likely to far outweigh the costs of adaptation measures. Ensuring that climate adaptation efforts are inclusive is also paramount, to cover vulnerable workers such as those in the gig economy or small businesses who might otherwise fall through the cracks of regulation. Doing so will ensure NSW has a 'just transition' to climatically adapted economy and society.

9 References

ABC News (17 August 2024) [“It’s bad out there”: Farmer shoots cows as hay shortage, dry conditions plague Tasmania](#), ABC website, accessed 16 January 2025.

Applebaum KM et al. (2016) [‘An overview of occupational risks from climate change’](#), *Current Environmental Health Reports*, 3(1):13–22, doi: 10.1007/s40572-016-0081-4, doi: 10.1007/s40572-016-0081-4.

Atlantic Council Climate Resilience Centre (n.d.) [‘Hot cities, chilled economies Sydney, Australia’](#), Rockefeller Hot Cities report, One Billion resilient website, accessed 12 May 2025.

Australian Bureau of Statistics (2006-revision-2.0), [The detailed classification](#), ABS Website, accessed 26 June 2026.

Australian Institute for Teaching and School Leadership (June 2025) [National Trends Teacher Workforce](#), Australian Teacher Workforce Data, AITSL website, accessed 17 July 2025.

Balbus JM et al. (2013) ‘Implications of global climate change for the assessment and management of human health risks of chemicals in the natural environment’, *Environmental Toxicology and Chemistry*, 32(1):62–78, doi:10.1002/etc.2046.

Carey RN et al. (2014) ‘Occupational exposure to solar radiation in Australia: who is exposed and what protection do they use?’, *Australian and New Zealand Journal of Public Health*, 38(1):54–59, doi: 10.1111/1753-6405.12174.

Cheveldayoff P et al. (2023) ‘Considerations for occupational heat exposure: A scoping review’, *PLOS Climate*, 2(9), doi: 10.1371/journal.pclm.0000202.

Choi EY, Lee H and Chang VW (2023) ‘Cumulative exposure to extreme heat and trajectories of cognitive decline among older adults in the USA’, *Journal of Epidemiology and Community Health*, 77(11):728–735, doi: 10.1136/jech-2023-220675.

Forner DV (2023) ‘Building resilience to climate change: the role of volunteers’, [Building resilience to climate change](#), *AJEM* October 2023, accessed 26 June 2026.

Grant E and Runkle JD (2022) ‘Long-term health effects of wildfire exposure: A scoping review’, *The Journal of Climate Change and Health*, 6:100110, doi:10.1016/j.joclim.2021.100110.

Han S et al. (2024) ‘Heat exposure and productivity loss among construction workers: a meta-analysis’, *BMC Public Health*, 24(1):3252, doi: 10.1186/s12889-024-20744-x.

Hanigan IC et al. (2012) ‘Suicide and drought in New South Wales, Australia, 1970–2007’, *Proceedings of the National Academy of Sciences of the United States of America*, 109(35):13950–13955, doi: 10.1073/pnas.1112965109.

Hoseyni SM, Mesbah Mostafa MO and Cordiner J (2024) ‘Mitigating risks in hydrogen-powered transportation: A comprehensive risk assessment for hydrogen refuelling stations, vehicles, and garages’, *International Journal of Hydrogen Energy*, 91:1025–1044, doi: 10.1016/j.ijhydene.2024.10.074.

Humphrys E, Goodman J and Newman F (2022) [“Zonked the hell out”: Climate change and heat stress at work](#), *The Economic and Labour Relations Review*, 33(2):256–271, doi: 10.1177/10353046221092414.

International Labour Organization (2024) [Ensuring safety and health at work in a changing climate: global report](#), International Labour Organization website.

- Jegasothy E et al. (2017) 'Extreme climatic conditions and health service utilisation across rural and metropolitan New South Wales', *International Journal of Biometeorology*, 61(8):1359–1370, doi: 10.1007/s00484-017-1313-5.
- Jiao A et al. (2023) 'Analysis of heat exposure during pregnancy and severe maternal morbidity', *JAMA Network Open*, 6(9):e2332780, doi: 10.1001/jamanetworkopen.2023.32780.
- Katellaris CH and Beggs PJ (2018) 'Climate change: allergens and allergic diseases', *Internal Medicine Journal*, 48(2):129–134, doi: 10.1111/imj.13699.
- Kenny GP et al. (2010) 'Heat stress in older individuals and patients with common chronic diseases', *Canadian Medical Association Journal*, accessed 30 June 2026.
- Knowlton K et al. (2004) 'Assessing ozone-related health impacts under a changing climate', *Environmental Health Perspectives*, 112(15):1557–1563, doi: 10.1289/ehp.7163. Available at: [NASA GISS: Knowlton et al. 2004: Assessing ozone-related health impacts under a changing climate](#).
- Leach OK, Cottle RM, Fisher KG, Wolf TS and Kenney L (2024) 'Sex differences in heat stress vulnerability among middle-aged and older adults (PSU HEAT Project)', *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, 327(3):R320–R327, doi: 10.1152/ajpregu.00114.2024.
- Li A and Leppold C (2025) 'Long-term mental health trajectories across multiple exposures to climate disasters in Australia: a population-based cohort study', *The Lancet Public Health*, 10(5):e391–e400, doi: 10.1016/S2468-2667(25)00068-4.
- Lundgren K et al. (2013) 'Effects of heat stress on working populations when facing climate change', *Industrial Health*, 51(1):3–15, doi: 10.2486/indhealth.2012-0089.
- Luong TT et al. (2021) 'New insights into the relationship between drought and mental health emerging from the Australian Rural Mental Health Study', *Frontiers in Psychiatry*, 12, doi: 10.3389/fpsyt.2021.719786.-
- Meat and Livestock Australia (2025) [Heat stress](#), Meat and Livestock Australia website, accessed 16 July 2025.
- Nairn J and Fawcett R (2013.) 'Defining heatwaves: heatwave defined as a heat- impact event servicing all community and business sectors in Australia', The Centre for Australian Weather and Climate Research, CAWCR Technical Report No. 060, <https://nla.gov.au/nla.obj-2968723484/view>, accessed 26 June 2026.
- NSW Climate and Energy Action (2025) [NSW Hydrogen Strategy](#), NSW Climate and Energy Action website, accessed 26 June 2026.
- NSW Health (1 December 2017) 'Study finds heatwaves in NSW cause 10 per cent increase in deaths', [NSW Health website](#), accessed 1 July 2026.
- Pacific Islands Forum Secretariat (December 2022) [Comprehensive Assessment of Regional and Sub-Regional Labour Mobility Arrangements in the Pacific](#), accessed 26 June 2026.
- Papadiochou A et al. (2024) 'Impact of climate change on reproductive health and pregnancy outcomes: A systematic review', *Cureus*, 16(8): e68221, doi: 10.7759/cureus.68221.
- Park J, Pankratz NMC and Behrer, A (2021) 'Temperature, workplace safety, and labor market inequality', *SSRN Electronic Journal* [Preprint], doi: 10.2139/ssrn.3892588.
- Queensland Work Health and Safety (2023) [Hydrogen](#), Worksafe Queensland Government website, accessed 23 April 2025.
- Reuters (2024) 'Greece restricts outdoor work as temperatures soar again', reporting by Valentini Anagnostopoulou and Angeliki Koutantou, Reuters website, accessed 26 June 2026.

- Richardson A (2025) 'Solastalgia: Missing home while being home', Climate Psychiatry Alliance website, accessed 12 May 2025.
- SafeWork NSW (2020) Working in extreme heat: the facts, SafeWork NSW website, accessed 27 February 2025.
- SafeWork NSW (2024) Lithium-ion batteries, SafeWork NSW website, accessed 23 April 2025.
- SBS News (2024) 'Pacific workers face 'appalling' housing, fear deportation if they seek medical care, inquiry told', SBS website, accessed 17 July 2025.
- Shin SH et al. (2024) 'Performance under fire: Older adult cognitive risks and protections under heat strain', *The Gerontologist*, 64(11):gnae116, doi: 10.1093/geront/gnae116.
- The Australia Institute (2023) 'Climate of the nation 2023', research report author Morison E, The Australia Institute website, accessed 12 May 2025.
- Thompson R et al. (2018) 'Associations between high ambient temperatures and heat waves with mental health outcomes: a systematic review', *Public Health*, 161:171–191, doi: 10.1016/j.puhe.2018.06.008.
- Transport for NSW (2020) Travel zone projections 2024 (TZP24), Transport for NSW website interactive resource, accessed 21 May 2025.
- UNGNA (2022) *2022 Annual Report*. Available at: <https://unglobalcompact.org.au/wp-content/uploads/2023/04/UNGCNA-Annual-Report-2022.pdf>, accessed 26 June 2026.
- US EPA O. (2022) *Climate Change and the Health of Workers*. Available at: Climate Change and the Health of Occupational Groups, accessed 1 July 2026.
- Varghese BM et al. (2023) 'The burden of occupational injury attributable to high temperatures in Australia, 2014–19: a retrospective observational study', *Medical Journal of Australia*, 219(11), accessed 27 February 2025.
- Wesseling C et al. (2016) 'Kidney function in sugarcane cutters in Nicaragua – a longitudinal study of workers at risk of Mesoamerican nephropathy', *Environmental Research*, 147:125–132, doi: 10.1016/j.envres.2016.02.002.
- World Economic Forum (2017) 'Extreme heat makes it harder for planes to take off - this is why', World Economic Forum website, accessed 16 July 2025.
- Ye T, Guo Y, Huang W, Zhang Y, Abramson MJ, Li S (2024) 'Heat exposure, preterm birth, and the role of greenness in Australia', *JAMA Pediatr.* 2024 Apr 1; 178(4):376–383. doi: 10.1001/jamapediatrics.2024.0001. PMID: 38407915; PMCID: PMC10897824.
- Zander KK et al. (2015) 'Heat stress causes substantial labour productivity loss in Australia', *Nature Climate Change*, 5(7):647–651, doi: 10.1038/nclimate2623.
- Zhang Y et al. (2022) 'The long-term impact of bushfires on the mental health of Australians: a systematic review and meta-analysis', *European Journal of Psychotraumatology*, 13(1):2087980, doi: 10.1080/20008198.2022.2087980.