Western Australia
Post Flood Social Research

Prepared for the Department of Fire and Emergency Services

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Executive Summary

Background
The Western Australia Department of Fire and Emergency Services (DFES) manages and delivers a broad range of operational services to coordinate incident response and conduct hazard and special risk planning. During the summer and wet season at the beginning of 2017, Western Australia (WA) experienced significant flooding resulting in four fatalities. Risk Frontiers were engaged to conduct social research to assist DFES to develop an understanding of community and key stakeholder perspectives on flood risks and behaviours and to provide a sound evidence base for community engagement initiatives to reduce flood fatalities in WA.

Methodology
The methodology for this research project involved the following:

- Analysis of flood deaths in Western Australia between 1960 and 2017
- Analysis of flood rescues since 2012/13
- Literature review
- Telephone and online survey of 287 individuals
- Six focus groups consisting of 43 participants
- Interviews with key stakeholder organisations.

Summary of Key Findings

Flood fatalities
Between 1960 and 2017 there have been at least 22 flood fatalities in Western Australia and some 457 nationwide between 1960 and 2015. Around 49% of flood fatalities in Australia are vehicle-related (Haynes et al., 2017a, FitzGerald et al., 2010b), with some 229 vehicle-related flood fatalities having occurred between 1960 and 2015 (Haynes et al., 2017a). Over the last 15 years there has been an equal share of fatalities associated with sedans and 4WD vehicles (Haynes et al., 2017a). Queensland-focused research has identified that young males who drive 4WDs are most likely to enter floodwater (Prevention of flood related deaths working group, 2016).

Research into the dynamics of vehicles in floodwater has found that in fast-flowing floodwater of three metres per second or greater, it can take just 15 centimetres of floodwater for a small vehicle to become unstable and only 30 centimetres for 4WDs (Smith et al., 2017). Once a vehicle is washed or driven from a roadway into deep floodwater it may take only a few minutes for the vehicle to submerge (Molenaar et al., 2014, McDonald and Giesbrecht, 2013a), reflecting the short time available for emergency crews to successfully rescue vehicle occupants.

Most vehicle-related flood victims were either travelling to their home, a friend’s place, work or an appointment (Peden et al., 2017). Factors influencing driver behaviour have been found to include past experiences, individual perceptions (e.g., pressure to arrive at a destination), social and environmental factors (e.g., social influences and other motorists driving through) and self-efficacy judgements (e.g., perceived ability to assess and mitigate risk) (Hamilton et al., 2016a).

Research into the possible influence of road characteristics on flood fatalities has concluded that the risk to drivers during floods is not uniform across roadways. Characteristics that influence the level of risk include small upstream catchment size; the absence of road barricades; depth of
flooding adjacent to the roadway; absence of lighting; dipping road grade; lack of curb and guttering and an inability of motorists to easily turn around (Gissing et al., 2017).

Post Flood Research

People driving through floodwater

Though people recognise that driving through floodwater is dangerous and, when doing so, often feel some degree of danger, drivers are able to identify circumstances when it might be okay to drive through floodwater.

It is clear that entering floodwater is a frequent and entrenched behaviour, often a deliberate choice by drivers, as shown by the large number who had entered floodwater but had chosen not to enter in a different circumstance. The majority of those who had entered floodwater had done so on multiple occasions and intended to do so in the future if faced with the same circumstances.

Decision-making by those who attempt to drive through floodwater appears to consider four key elements: 1) the urgency of the need; 2) the perceived flood and road conditions at the time of the decision; 3) the perceived level of self-efficacy; and 4) the social context. It is possible that emotion also plays an important role in decision making. This element requires further research.

There are no precise methods of measuring many of the decision-making factors available to drivers identified in this study (e.g., assessing the relative hazard of floodwater based upon depth and velocity) and it must be considered that people are making judgements in environments that lack absolute certainty. Although many motorists have previously entered floodwater, they lack a sound knowledge of the limitations of their vehicles with respect to floodwater. It was indicated that, when drivers are uncertain, the behaviour would not be performed or that further actions would be performed to obtain further certainty, such as walking into the floodwater to assess the depth and velocity of the water before deciding to enter, or watching another driver drive across.

Results from this research show that more males drive through floodwater than females and that males appear to drive through floodwater on a more frequent basis and through floodwater that is likely to be more dangerous. Males younger than 60 and females younger than 40 are most likely to drive through floodwater. Those who are employed outdoors and who have confidence in their swimming abilities are also more likely to enter floodwater. The most common vehicle type to be driven into floodwater is 4WDs, with 4WDs also most likely to be driven through more dangerous floodwater.

Key concerns of drivers considering entering floodwater were the drivers’ personal safety, the safety of passengers, the possibility of damaging the vehicle and the possibility of requiring rescue.

Sixty-eight percent of vehicles entered floodwater with passengers also in the vehicle. Although the majority of passengers were said to have agreed with the drivers’ assessment to enter floodwater, over 30% indicated that they were either concerned or very concerned about the decision.

People swimming or walking in floodwater

People do not walk or swim in floodwater as frequently as driving into floodwater, with the majority of adults having not swum or walked in floodwater over the last ten years. Swimming in floodwater was regarded by 95% of respondents as dangerous or very dangerous, recognising that there is a strong social norm that reflects the absence of this behaviour amongst the majority of
the community. The main concerns people shared about swimming or walking in floodwater were that people might drown, become injured or become sick.

Swimming in floodwater appears in at least some instances to be a social or group activity, with some influence on the choice of whether to do so occurring as a result of other people also doing it or being in the vicinity.

It is clear that decision-making by adults, in the vast majority of situations, is deliberate and involved at least the assessment of flooding conditions. It would appear that most people walk or swim into floodwater to check if conditions are suitable for a vehicle to cross or to reach a destination.

Participants were commonly concerned about children swimming in floodwater and could identify spots where this activity regularly occurred. Adult males were more likely to have walked or swum through floodwater, and were more likely to undertake these actions more frequently. Adults engaging in the behaviour were between the ages of 18 and 60. People with a high confidence in their swimming ability, those who worked outdoors and those living in northern WA were all more likely to have walked or swum in floodwater.

**Future Management Strategies**

Future management strategies are identified and outlined within the report including:

- Conducting engagement campaigns
- Developing strategic partnerships with likeminded organisations
- Promoting safer driving through work, health and safety policies
- Improving the provision of roads information
- Reviewing flood signage
- Engaging with children
- Engaging with media organisations
- Promoting key messages in emergency warnings
- Evaluation.
Background

The Western Australia Department of Fire and Emergency Services (DFES) manages and delivers a broad range of operational services to coordinate incident response and conduct hazard and special risk planning. During the summer and wet season at the beginning of 2017, Western Australia (WA) experienced significant flooding resulting in four fatalities. Risk Frontiers were engaged to conduct social research to assist DFES to develop an understanding of community and key stakeholder perspectives on flood risks and behaviours and to provide a sound evidence base for community engagement initiatives to reduce flood fatalities in WA.

Western Australian Floods 2017

Significant flooding occurred across the northern section of WA starting from December 2016. Only one named tropical cyclone impacted the region: however, a large number of tropical lows affected the Kimberley and Pilbara Region. Summer rainfall averaged across the Kimberley was over 940mm, making it the wettest summer on record (Bureau of Meteorology, 2017c). Areas most affected included the Fitzroy River, Ord River, Northern Kimberley and the De Gray River.

In February 2017, significant flooding occurred across the southern portion of Western Australia as a result of heavy rainfall between the 8th and 11th of February. Major flooding was recorded in the Avon River, with minor flooding occurring downstream in the Swan River. Major flooding occurred in the Upper Blackwood River catchment with minor to moderate flooding recorded downstream. Significant flooding also occurred in the Esperance coastal district (Bureau of Meteorology, 2017a), however, there are no detailed flood warning networks in this area. Figure 1 illustrates the flood severity experienced across the flood warning gauge network. Areas reported as being significantly impacted were:

- Ravensthorpe, having become isolated and with significant damage to surrounding farms and roads
- Northam, where some residents were warned to evacuate their homes
- Swan Valley, with several vineyards and parks being inundated
- Gnowangerup, which became isolated
- Wagin, where six homes and shops were reported as flooded
- Gibson and Jerdacuttup, where two males died as a consequence of entering floodwater.
A number of rainfall measurement sites in the southwest registered record high January daily and monthly rainfall totals as a result of the event (Bureau of Meteorology, 2017b). At Yorkrakine, observed rainfall intensities had a probability of occurrence of less than 1% annually on average.

**Methodology**

The methodology for the completion of the research has included the following components:

**Flood Fatality Analysis**

Utilising Risk Frontiers’ PerilAUS, a database that records damage and fatalities from natural hazard events Australia-wide, an analysis of flood fatalities between 1960 and 2017 was performed. Data to inform PerilAUS has been collected over the last 30 years, utilizing media reports and coronial records. Coronial records have been sourced from the National Coronial Information System. A recent Australia-wide analysis of flood fatalities has been completed as part of research for the Bushfire and Natural Hazards Cooperative Research Centre (Haynes et al., 2017a).

**Rescue Analysis**

Flood rescue data for the last five years beginning with 2012/13 was analysed to provide insights into the number and location of flood rescues.

**Literature review**

A desktop review of Australian and international research on flood fatalities, risk perception and education about safety around floodwaters was undertaken to identify findings and insights relevant to the WA context. Literature for the review was sourced from the previous ANZEMC report on the prevention of flood related fatalities (2015), and through searching Google Scholar to identify additional publications.
Telephone and online survey

A survey of residents targeting the southern and Kimberley regions of WA was undertaken to understand people's attitudes and decision-making in respect to entering floodwater. The survey was conducted via telephone and online between September and October, 2017. DFES promoted the survey online through its digital media channels and through local media. Local community networks were also utilised to promote the survey. The content and format of the questionnaire was finalised after feedback from DFES. The questionnaire was then submitted to and approved by the Macquarie University Ethics Committee. The survey data was collected through Survey Monkey and was analysed to identify key themes.

Survey response profile

A total of 287 individuals responded to the survey. Respondents were evenly distributed across most age groups of less than 60 years of age. The distribution of respondents’ ages is shown in Figure 2. Gender was also relatively evenly distributed, with 55% females and 43% males responding.

Most respondents were employed and mainly worked indoors (39%; n=108), followed by those who were employed and worked mainly outdoors (26%; n=71) and those who were retired (16%; n=43). Half (50% n=139) of the respondents had lived in their current town or suburb for more than ten years. Only 9% of respondents (n=24) had lived in their current town or suburb for less than a year.

![Figure 2: Respondents' ages](image)

Interviews and focus groups

Interviews were held with key stakeholders, including representatives from various government agencies, local councils and peak bodies, to understand their perspectives on issues related to people entering floodwaters. Thematic analysis was undertaken to identify key themes arising. Specific stakeholder organisations interviewed included:

- Department of Water
• Mainroads Western Australia (Mainroads WA)
• WA Police
• Red Cross
• Royal Life Saving Society
• City of Swan
• Shire of Esperance
• Bureau of Meteorology
• Department of Fire and Emergency Services
• Shire of Katanning
• Shire of York
• Shire of Derby West Kimberley.

Focus groups were conducted in York, Ravensthorpe, Esperance, Broome and Fitzroy Crossing. In total, six focus groups were conducted involving some 43 people (24 males and 19 females from a variety of age groups). Two focus groups were conducted at Fitzroy Crossing.

Focus groups in York, Ravensthorpe, Esperance and Broome consisted of community representatives who were recruited through local Community Resource Centres. At Fitzroy Crossing, for one of the focus groups, participants were recruited through Marra Worra Worra; the other consisted of participants from the local DFES Brigade. Focus groups were recorded and transcribed. Thematic analysis was undertaken to identify key themes.

Approval was granted by the Macquarie University Ethics Committee to undertake the interviews and focus groups including those with indigenous community members.
Western Australia Flood Fatalities

At least 22 flood fatalities have occurred in WA from 1960 to June 2017. The most fatal event was the 1989 Emu Mine flash flood near Leinster, in which six people died. Due to the relatively few people killed in WA during the period under study, this multiple-fatality event will influence some of the results. Note: an additional fatality was reported by DFES at Carlton Gorge, Ord River, 11 December 2016: however, on examination of the news media reports it has been determined that this death was not due to flood conditions.

Year, month, time of day

Table 1 shows that, from 1960-2017, relatively few flood deaths have occurred in WA. Annual death totals have ranged from zero to six, with an annual average of around one death every two and a half years. However, after 12 years of no flood fatalities, 2017 has seen four.

Table 1: Number of fatalities against year of occurrence

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of fatalities</th>
<th>Year</th>
<th>No. of fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>1</td>
<td>1999</td>
<td>1</td>
</tr>
<tr>
<td>1980</td>
<td>1</td>
<td>2000</td>
<td>1</td>
</tr>
<tr>
<td>1988</td>
<td>1</td>
<td>2003</td>
<td>3</td>
</tr>
<tr>
<td>1989</td>
<td>6</td>
<td>2004</td>
<td>1</td>
</tr>
<tr>
<td>1995</td>
<td>1</td>
<td>2017</td>
<td>4</td>
</tr>
<tr>
<td>1997</td>
<td>2</td>
<td>Total</td>
<td>22</td>
</tr>
</tbody>
</table>
Table 2 shows the month of death. Aside from June, when the Emu Mine disaster occurred, the majority of deaths (55%) have occurred in late summer/early autumn: in January, February and March.

Table 2: Number of fatalities against month of occurrence

<table>
<thead>
<tr>
<th>Month</th>
<th>No. of fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>4</td>
</tr>
<tr>
<td>February</td>
<td>5</td>
</tr>
<tr>
<td>March</td>
<td>3</td>
</tr>
<tr>
<td>April</td>
<td>1</td>
</tr>
<tr>
<td>June</td>
<td>7</td>
</tr>
<tr>
<td>October</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>22</strong></td>
</tr>
</tbody>
</table>

The time of day of the fatality was known for 18 out of the 22 cases. Of those, the majority of deaths (8, or 44%) occurred in the afternoon – this includes the six fatalities from the Emu Mine disaster. A substantial number (7, or 39%) of fatalities occurred during the night or very early morning. Table 3 shows the full results.

Table 3: Number of fatalities against time of day of incident

<table>
<thead>
<tr>
<th>Time of day</th>
<th>No. of fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early morning (night)</td>
<td>2</td>
</tr>
<tr>
<td>morning</td>
<td>1</td>
</tr>
<tr>
<td>noon</td>
<td>1</td>
</tr>
<tr>
<td>afternoon</td>
<td>8</td>
</tr>
<tr>
<td>evening</td>
<td>1</td>
</tr>
<tr>
<td>night</td>
<td>5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>18</strong></td>
</tr>
</tbody>
</table>
Indigeneity

Two (10%) at least of the 22 decedents were indigenous in origin. However, often indigeneity was not stated in the news media articles: thus, the proportion of indigenous flood deaths may be greater than that stated.

Age and Gender

Of the 19 cases where gender was known, 17 (89%) were males.

Amongst the 22 fatalities there were two infants, two children and 16 adults. Table 4 gives a breakdown by ten-year age range, which was known for 16 cases out of the 22. The greatest number of fatalities has occurred amongst those aged 0-9 years, 30-39 years and 40-49 years.

Table 4: Number and proportion of fatalities against age of flood fatalities

<table>
<thead>
<tr>
<th>Age range</th>
<th>No. of fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9</td>
<td>4</td>
</tr>
<tr>
<td>10-19</td>
<td>0</td>
</tr>
<tr>
<td>20-29</td>
<td>2</td>
</tr>
<tr>
<td>30-39</td>
<td>3</td>
</tr>
<tr>
<td>40-49</td>
<td>4</td>
</tr>
<tr>
<td>50-59</td>
<td>1</td>
</tr>
<tr>
<td>60-69</td>
<td>1</td>
</tr>
<tr>
<td>70-79</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>16</td>
</tr>
</tbody>
</table>

The Emu Mine disaster

Unseasonally heavy rain dumped 90mm within 48 hours in the area surrounding the Emu Mine (now known as Agnew Mine), 20km from Leinster and 320km north of Kalgoorlie, on 13 June 1989. A nearby creek system burst its banks, first flooding an old pit, then sending a torrent of water into the main open-cut mine and the shaft (decline) below. The mine manager saw there was going to be a massive flood and made a heroic but virtually suicidal attempt to warn the other five miners by driving into the mine. He was engulfed by the massive flash flood and resultant landslide: the flood came as a torrent of water straight into the shaft where the men were (this was a tunnel sloping 500m down from the base of the pit). The whole area (550m by 50m) was covered with water and the entrance was covered by 10m of water.
Location

The drainage basin in which the flood fatalities occurred is shown in Table 5. Figure 3 shows that fatalities are distributed approximately equally amongst the north and the south of the state.

**Table 5: Number and proportion of fatalities against drainage basin**

<table>
<thead>
<tr>
<th>Drainage basin</th>
<th>No. of fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashburton River</td>
<td>1</td>
</tr>
<tr>
<td>Blackwood River</td>
<td>2</td>
</tr>
<tr>
<td>Collie River</td>
<td>1</td>
</tr>
<tr>
<td>Esperance Coast</td>
<td>2</td>
</tr>
<tr>
<td>Fitzroy River</td>
<td>2</td>
</tr>
<tr>
<td>Gascoyne River</td>
<td>1</td>
</tr>
<tr>
<td>King Edward River</td>
<td>1</td>
</tr>
<tr>
<td>Mackay</td>
<td>1</td>
</tr>
<tr>
<td>Ord River</td>
<td>3</td>
</tr>
<tr>
<td>Port Hedland Coast</td>
<td>2</td>
</tr>
<tr>
<td>Salt Lake</td>
<td>6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>22</strong></td>
</tr>
</tbody>
</table>
Circumstances of death
The varying levels of detail available for each fatality sometimes required a small number of assumptions to be made to balance the usefulness of the information extracted without diminishing the accuracy of the interpretation of the data.

Activity prior to death
Nine (47%) of the 19 cases for which this data was known were attempting to cross a watercourse, via either a bridge, causeway, crossing, culvert, ford or road and one was attempting to cross floodwaters along a road (not across a watercourse). Six (33%) were engaged in an activity not near a usual watercourse. Two were engaged in an activity in the water and one was engaged in an activity near the water.

Detailed location of fatality
Fourteen (70%) of the 20 cases for which this data was known were near, on or in a natural or man-made watercourse (including dry creek beds and stormwater drains). Six (30%) were in a mine (“Other”, in this coding field).
Reason behind action prior to death

The same six (32%) of the 19 cases for which this data was known were working. Ten (53%) decedents were en route to a destination: the two of those known were visiting (i.e. a non-essential trip). One decedent was engaged in a rescue, which was unconnected with the flood event, and two had been undertaking recreational swimming – one of whom then attempted (successfully, but to his own demise) to rescue another.

Occupation

The occupation of a decedent can sometimes shed some light on the reason behind the activity being carried out. Information on occupation was known for 14 cases. Six (43%) were miners, four (29%) were children, two were involved in farming and one was a labourer. In one other case the decedent was a mine worker, but it was his voluntary SES work that led to death.

Transport at the time of death

Eight (40%) of the 20 known cases were in a vehicle that was crossing at a causeway or similar. A ninth was in a vehicle but en route to warn the five miners (26%) who were in the mine shaft. A tenth was involved in a vehicle accident due to the wet conditions but was washed out of the upturned vehicle and down a stormwater drain.

Four of those in vehicles were in 4WDs and a fifth was in a ute. One was in a van; one in a car and the type of vehicle involved in three of the fatalities was unknown.

Three were on foot and two of the decedents had been swimming in the floodwater.

Familiarity with death location

Information was sparse concerning how familiar the decedents were with the place of the fatal flood incident. Some information was available for eleven out of the 22 deaths. In only one of those eleven cases was the decedent not a local. In at least five and possibly six cases the decedents were local; in two and possibly three cases the decedents’ parents/driver of vehicles were familiar with the area and in one case the decedent was probably familiar with the area (the SES volunteer). No tourists, from the data available, were amongst the fatalities found in this study.
Flood Rescue Analysis

Flood rescue data was provided by DFES to inform the research. Over the last five years since 2012/13 there have been 36 flood and swift rescue incidents. The largest number of these, as shown in Table 6, have been performed in the Kimberley and Pilbara regions. Some 22 incidents were recorded in 2016/17, with 11 of these occurring in the Kimberley Region.

Table 6:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Goldfields Midlands Region</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Great Southern Region</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Kimberley Region</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>Metro</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Pilbara Region</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>22</strong></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>

Flood rescues in total are likely to be underreported as a consequence of community members performing rescues and system reporting restrictions prior to 2014.
Literature Review

Flood Fatality Research

Globally, flooding is the most common of all natural disasters (Doocy S, 2013) and drowning is the leading cause of death during floods (Di Mauro M, 2012). The World Health Organization (WHO) estimates that globally, between 1980 and 2009, floods have claimed the lives of over 500,000 people (World Health Organization, 2014). With the likelihood of floods increasing in the future (Doocy S, 2013, Patz et al., 2000), there is a need for dedicated research and the implementation and evaluation of prevention strategies to reduce loss of life during times of flood.

Most commonly, the circumstances of the fatality involve people taking risks and entering floodwater either on foot or in a vehicle, of which vehicle related fatalities are most frequent (Ashley and Ashley 2008, Diakakis and Deligiannakis 2013, Jonkman and Kelman 2005, Jonkman and Vrijling 2008). Other circumstances include being trapped within a building, being in a boat or a failed rescue attempt (Jonkman and Kelman, 2005).

A significant number of flood fatalities have been attributed to unnecessary risk taking behaviors (Jonkman and Kelman 2005). Where people have deliberately entered floodwaters, reasons for doing so have been to continue their intended travel; engage in recreational pursuits; continue their work and evacuate or carry out a rescue of a person or pet (Haynes et al. 2009).

In Australia, between 1900 and 2015, some 1859 flood fatalities were recorded, with the majority of these being male (Haynes et al., 2017a). The death rate from flooding in Australia has been decreasing since the 1960’s in all jurisdictions apart from the Northern Territory. Most deaths have occurred in Queensland and NSW. The greatest portion of all flood fatalities have been less than the age of 29. Fatalities associated with victims attempting to cross a watercourse have been most prevalent. Being engaged in an activity near the water was the second most frequent activity at the time of death for males and third for women, with many of these victims engaging in recreation (Haynes et al., 2017a).

Research globally has highlighted risks to motorists during flood events and has been the key focus of flood fatality literature. In Australia, Haynes et al. (2017a) found that 49% of flood fatalities were vehicle-related and Fitzgerald et al. (2010a) found that 48.5% of flood deaths between 1997 and 2008 were vehicle-related. Similarly, Peden (2017), in conducting an analysis of unintentional fatal drowning in Australian rivers, identified that 55% of all flood-related deaths in Australian rivers between 2002 and 2012 were as a result of driving through floodwaters.

In total, some 229 flood fatalities were associated with vehicles between 1960 and 2015 (Haynes et al., 2017a). Some 64% of vehicle-related flood fatalities have been associated with sedans and 19% with 4WDs in Australia (Haynes et al., 2017a). Since 1960, the prevalence of fatalities associated with sedans has decreased, whilst fatalities involving 4WDs has increased (Haynes et al., 2017a). In the last fifteen years they have contributed an equal share (Haynes et al., 2017a). This change may also be reflective of the proportion of 4WDs driven in Australia.

In the United States, Ashley and Ashley (2008) found that 63% of flood fatalities were vehicle-related. Similarly, Špitalar et al. (2014) found that 68% of flash flood fatalities were vehicle-related and Terti et al. (2016) 68%. Jonkman and Vrijling (2008), in a study of flood fatalities across Europe and the United States, identified that 32% of deaths were associated with vehicles. In Greece, some 40% of flood fatalities have been associated with vehicles (Diakakis and Deligiannakis, 2015a), with this proportion growing over-time (Diakakis and Deligiannakis, 2016). In other countries the
proportions have been lower though yet significant, with France 30% (Vinet et al., 2016) and Portugal, 14% (Pereira et al., 2017).

Floodwaters can submerge vehicles or sweep them away. Motorists may deliberately enter floodwaters, enter flood water unexpectedly (Yale et al., 2003) or find themselves in circumstances where floodwaters rise around their vehicle (Diakakis and Deligiannakis, 2015b). Smith et al. (2017) tested the impact of various flood conditions on vehicles, with results indicating that in fast-flowing floodwater of three metres per second it can take just 15 centimetres of floodwater for a small passenger vehicle to become unstable and only 30 centimetres for a 4WD vehicle. Information on various flood hazard safety thresholds for vehicles and people is summarised in Figure 4 (Australian Institute of Disaster Resilience, 2017).

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure4.png}
\caption{Safety thresholds for pedestrians, motorists and vehicles (Source: Australian Institute of Disaster Resilience, 2017)}
\end{figure}

Once vehicles enter water they undertake a three-phase process of floating, sinking and submersion (Molenaar et al., 2014). Empirical studies have demonstrated that the floating phase may last from 30 to 120 seconds, followed by the sinking phase which is typically completed within two to four minutes of contact with the water (Molenaar et al., 2014, McDonald and Giesbrecht, 2013b). Vehicles may enter floodwater upright or roll into the stream (Smith et al., 2017). Occupants may experience difficulty in escaping their vehicles due to flood conditions, physical trauma, failure of electric windows, automatic locking doors or the activation of airbags (Molenaar et al., 2014). Vehicles entering deeper water have been associated with lower survival rates (McDonald and Giesbrecht, 2013a).

Research indicates that people drown in their vehicle as a result of the vehicle being inundated, being washed away (Drobot et al., 2007, Kellar and Schmidlin, 2012, Yale et al., 2003), attempting
to escape a vehicle by trying to swim or walk to safety (Drobot et al., 2007, Kellar and Schmidlin, 2012, Yale et al., 2003) or by being ejected from a vehicle (Kellar and Schmidlin, 2012).

Research by Peden (2017) into the causal factors of drowning deaths associated with driving through floodwaters have identified that two thirds of those who drowned were the drivers of the vehicle and were alone in the car when they drove into floodwaters. Almost two thirds (60.6%) occurred on roads that were known to be open at the time of the incident. Drivers were alone in the vehicle in 58.3% of road open cases: the remaining 41.7% of drivers drove through floodwaters with passengers in the vehicle. Almost a third (30.2%) of vehicle-related flood victims on open roads were intending to travel to their own home or a friend's home, most commonly in cars (38.5%), utilities (30.8%) and 4WDs (23.1%). Just over a fifth (25.6%) of those who drowned on open roads were intending to travel to work/appointments. All victims driving heavy vehicles or machinery were undertaking paid employment at the time of their drowning. All incidents (100.0%) involving motorbikes/ATVs occurred when the victim was riding for recreation (Peden, 2017).

Analysis of vehicle related fatalities in the United States and Greece has shown that most fatalities have occurred at night (Diakakis and Deligiannakis, 2013, Maples and Tiefenbacher, 2009, Špitalar et al., 2014, Haynes et al., 2017a). It is hypothesised that drivers are not able to see flooded roads and possibly enter floodwater by accident (Špitalar et al., 2014), or that drivers are not able to assess the depth and velocity of water due to poor visibility (Maples and Tiefenbacher, 2009). Drugs and alcohol may also contribute (Jonkman and Kelman, 2005).

A large percentage of flood rescues undertaken by emergency services are also vehicle related. Haynes et al. (2009) analysed flood rescue incident reports following flooding in the Hunter River Catchment, Australia in June 2007 and found that 36% of rescues had been from vehicles. Further, approximately a third of the some 300 flood rescues performed by New South Wales State Emergency Service during flooding around Sydney in June, 2016 were from vehicles (Smith et al., 2017). Such rescues place emergency services personnel at high risk.

Prevalence of motorists entering floodwater

Gissing (2016) observed a section of flooded road that had been closed using barricades on the NSW South Coast in 2015. Results showed that 84% of motorists chose to ignore road closure signs and barricades, and drove through floodwater. Though the types of vehicles being driven varied, the largest proportion was 4WDs and SUVs (48%). The majority of drivers were male (Gissing et al., 2016).

Some studies have considered the prevalence of motorists entering floodwater. Wright et al. (2010) documented a survey of residents in Richmond, Windsor, Woronora and Lismore, where some 50% of respondents noted that it was safe to walk or drive through six inches of floodwater. In a different survey of eight NSW communities, 49% of respondents suggested that they would turn around if faced with a flooded road, with 22% indicating that they would travel on with care (Wright et al., 2010). The majority of those involved in focus groups supporting the study recognised that floodwater could be dangerous and that it should not be underestimated. Some admitted that they had driven on flooded roads before though they recognised the dangers. People had developed their own criteria for assessing the dangers. For example, some would not drive across a flooded road if they thought the water was fast flowing; others would get out of their vehicle to test the depth and speed by walking into it (Wright et al., 2010). It was concluded that males between 18 to 35 years of age and drivers of SUVs and trucks were most at-risk of driving into floodwater (Wright et al., 2010).
A further NSW survey conducted by Campbell (2014) identified that 93% of respondents had encountered floodwater and that 50% had entered floodwater, primarily through driving (67%).

Research to inform the Queensland “if its flooded forget it” campaign (Prevention of Flood Related Deaths Working Group, 2016) identified that 29% of respondents had driven through floodwater. This rate was higher amongst males and those who drove 4WDs, in particular young males aged 18-24 years who drove 4WDs. A total of 49% of respondents indicated that they would never drive through floodwater. The most significant deterrents for people not to enter floodwater were nominated as the presence of police/officials, the sight of another vehicle in trouble, the presence of road closed signs, their own judgement and being asked to stop by a passenger in their vehicle (Prevention of flood related deaths working group, 2016).

In the United Kingdom (UK), a joint survey by the Environment Agency and the Automobile Association (2014) found that 60% of UK drivers would risk driving through floodwater. Twice as many men said they would risk entering floodwaters when compared to women (Automobile Association, 2014).

In Arizona, United States, a study by Coles et al. (2009) found that some 61% of drivers had driven through floodwater. It was found that larger vehicles were more likely to be driven into floodwater than smaller vehicles. Education levels were not found to be a significant determinant of behaviour.

It is important to note that in some cases motorists may not have chosen to enter floodwater and may have simply become overwhelmed by the rapid rise of floodwater or been unaware of the presence of floodwater prior to entry (Martin, 2010).

**Reasons for entering floodwater**

Explanations for motorists deliberately entering floodwater include: not taking warnings seriously (Drobot et al., 2007), underestimating the risk (Diakakis and Deligiannakis, 2013, Maples and Tiefenbacher, 2009, Drobot et al., 2007), being impatient and thinking that they are invincible (Franklin et al., 2014). Drivers may develop a false sense of security whilst inside a vehicle (Diakakis and Deligiannakis, 2013, Maples and Tiefenbacher, 2009, Jonkman and Kelman, 2005) and it is possible that motorists may not fully appreciate flood conditions such as the depth and speed of floodwaters, and the influence such conditions may have on safety (Diakakis and Deligiannakis, 2013, Yale et al., 2003). It has also been suggested that motorists may recognise the risk but fail to personalise it, believing that the risk does not apply to them (Pearson and Hamilton, 2014). Hamilton et al. (2016a) identify factors possibly influencing decision making including past experience; pressures to arrive at a destination; perception that a situation is different to warnings; avoiding isolation; lack of motivation to take alternate options; pressure from other drivers; encouragement by passengers; behaviour of other motorists; security of others being present if rescue was needed; believing they had the knowledge and skills; belief in their ability to accurately assess the risk and belief in their vehicle.

Coles et al. (2009) identified similar factors including the fact that the car ahead made it through; their family are on the other side; they didn’t know another possible route and the floodwater didn’t look that deep. Deterrents not to enter floodwater were identified as the presence of a barricade or sign; the risk of damage to their vehicle; that it was against the law; an alternative route was available and known and that passengers were present (Coles et al., 2009). It was found that decisions to enter floodwater did not differ significantly between men and women (Coles et al., 2009).
Social influences have been explored in other road safety research in the context of speeding. Fleiter et al. (2010) found that passengers generally had an effect of slowing speeds and that drivers reported increasing their speeds whilst alone. Other social influences included speeding up to maintain pace with the traffic flow and a perceived pressure to drive faster (Fleiter et al., 2010).

**Influence of road characteristics**

Austroads (2015), a peak body for road management in Australia, has stated that the vast majority of the approximately 20,000 floodways in Australia and New Zealand were not constructed in accordance with required design and hydraulic standards, lack appropriate signage and have depth gauges that can be misinterpreted. Further, they propose that implementation of safety measures at floodways should consider the level of risk, appropriate treatments and resources necessary for implementation.

Gissing et al. (2017) investigated the influence of road characteristics on flood fatalities based on a site analysis of 21 road sections where fatalities had occurred. The results of this research indicated that some characteristics are common among sites where flood fatalities have occurred. These characteristics variously influence the risk that motorists knowingly or unknowingly enter floodwater, the ability of motorists to turn around upon seeing floodwaters and the likely survivability of entering floodwaters. Key risk factors identified through the research are summarised in Table 7.

**Table 7: Road-related risk factors (Source: Gissing et al. (2017))**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factors that may influence a motorist to enter floodwater</strong></td>
<td></td>
</tr>
<tr>
<td>Presence of signage</td>
<td>Signage is aimed at informing motorists of the likely presence of water over a roadway.</td>
</tr>
<tr>
<td>Road alignment</td>
<td>A tight bend in a roadway directly before a floodway may result in little to no chance for a motorist to take action to avoid entering floodwater.</td>
</tr>
<tr>
<td>Road grade</td>
<td>The falling grade of a road may result in a motorist entering shallow water before progressing into much deeper water.</td>
</tr>
<tr>
<td>Road pavement</td>
<td>Gravel road surfaces have been shown to have a lower friction co-efficient when compared to sealed road pavements, therefore making it easier for motorists to slide off.</td>
</tr>
<tr>
<td>Presence of lighting</td>
<td>Lighting of a roadway allows motorists to observe floodwater during evening hours.</td>
</tr>
<tr>
<td>Traffic volume</td>
<td>Traffic volume represents the number of motorists that may be at risk of entering floodwater whilst travelling a specific road section. Large volumes of traffic may also hinder the ability of a motorist to turn a vehicle around.</td>
</tr>
<tr>
<td>Speed limit</td>
<td>Speed limit may influence the speed a motorist was travelling whilst observing signage and in making decisions to enter floodwater.</td>
</tr>
<tr>
<td>Ease of turning around</td>
<td>The width and lane structure of a road (i.e. one-way or two-way) influences the ability of a motorist to turn a vehicle around.</td>
</tr>
<tr>
<td><strong>Factors that may influence whether a vehicle is washed from a road</strong></td>
<td></td>
</tr>
<tr>
<td>Depth and velocity of floodwaters</td>
<td>Particular thresholds of floodwater increase the likelihood of a vehicle being washed from a road (Smith et al., 2017).</td>
</tr>
<tr>
<td>Factor</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Rate of rise (catchment size)</td>
<td>Rate of rise reflects the speed at which floodwater may rise or fall. Fast rates of rise are associated with smaller catchment sizes.</td>
</tr>
<tr>
<td>Absence of roadside barriers</td>
<td>Roadside barricades provide protection against a motorist leaving a roadway.</td>
</tr>
<tr>
<td>Curb and guttering</td>
<td>Curb and guttering provides some degree of protection against a motorist leaving a roadway.</td>
</tr>
<tr>
<td>Distance water was over the road</td>
<td>Water covering a long distance of a roadway may result in motorists becoming disorientated.</td>
</tr>
</tbody>
</table>

**Factors that may influence survivability of motorists once washed from the road**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate of rise (catchment size)</td>
<td>Fast rising floodwater enhances the dynamic nature of downstream conditions.</td>
</tr>
<tr>
<td>Flood depths downstream</td>
<td>Vehicles will sink in deep floodwater directly downstream of roadway.</td>
</tr>
<tr>
<td>Downstream flood velocities</td>
<td>Fast flowing floodwaters may rapidly sweep a vehicle downstream.</td>
</tr>
</tbody>
</table>

Of the measures assessed by Gissing et al. (2017), small upstream catchment size (fast rate of rise), the absence of road barricades, depth of flooding adjacent to the roadway, absence of lighting, dipping road grade, lack of curb and guttering and the inability of motorists to easily turn around were the most frequently observed factors. Each of these factors were observed in at least fifty percent of cases studied. In addition, the probability of a roadway being flooded and exceeding vehicle stability criteria must be considered a precursor condition.

**Prevention strategies**

Strategies to prevent flood fatalities associated with vehicles and people entering floodwater can be categorised into engagement, engineering, enforcement/ incentive and emergency response. Research has highlighted the importance of adopting a systems approach to changing behaviour. Peden et al. (2004), in a World Health Organisation review of road traffic injury prevention, concluded that road safety campaigns were able to influence behaviour when used in conjunction with legislation and law enforcement. However, the authors found that, in isolation, education, information and publicity generally did not deliver tangible and sustained reductions in deaths and serious injuries. An example of the use of a multitude of strategies can be found in efforts to reduce rates of smoking that have included publicising the health risks, raising taxes, banning smoking indoors, restrictions on marketing, advertising the dangers of smoking and providing support for those trying to quit. Pierce et al. (2012) outlined that, in Australia and California, comprehensive community-wide programs using multiple strategies have resulted in large declines in smoking initiation.

**Engagement**

Australian emergency services in Queensland, New South Wales and Victoria have conducted major campaigns aimed at reducing the incidence of individuals entering floodwater. These have included “If it’s flooded forget it” (Queensland), “15 to float” and “You don't know what you're getting into” (Victoria). These campaigns have involved a combination of television, radio or print advertising, accompanied by promotion through social media.
NSW SES have utilised a series of social media videos exhibiting real world stories of those who have entered floodwater\(^1\). During recent flood operations in 2017 they also utilised the hashtag “floodwit” to discourage people from entering floodwater (Figure 5). VICSES have also previously conducted an online campaign called “Whose poo”, focused on communicating that floodwater is contaminated\(^2\).

Figure 5: NSW SES social media graphic

Nationally, the Royal Life Saving Society deliver a campaign titled “Respect the river”. This campaign focuses on the reduction of drowning on inland waterways, including those incidents that result from flooding. Further, the Royal Life Saving Society, in partnership with NRMA, have developed a social media campaign using video infographics called “For Life’s Sake – The Dangers of Driving Through Floodwater”\(^3\).

In the United States, the National Weather Service runs a campaign with the slogan “Turn around don’t drown”. The National Weather Service has provided standard signage, public safety announcements and printed materials (Figure 6). State agencies have further promoted the campaign within their communities. In Oklahoma the Association of Floodplain Managers has used the campaign to engage with year four children through a poster design contest (Figure 7). In North Carolina, contests have been conducted to develop memorable jingles that are associated with the “Turn around don’t drown” tag line. Though no formal evaluations of these efforts could be identified, Martin (2010) stated that the results of the campaign have been mixed.

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\(^1\) [www.youtube.com/watch?v=iZ_d9r1Pckg](https://www.youtube.com/watch?v=iZ_d9r1Pckg)

\(^2\) [www.youtube.com/watch?v=ONu1DMKLIUk](https://www.youtube.com/watch?v=ONu1DMKLIUk)

\(^3\) [www.youtube.com/watch?v=ZtlXpDBjUIQ](https://www.youtube.com/watch?v=ZtlXpDBjUIQ)
The Clark County Regional Flood Control District (United States) has conducted an annual campaign surrounding public design of billboards to discourage motorists from entering floodwater through humorous messages (Figure 8). Whilst regular social research indicates a drop in motorists entering floodwater it is difficult to attribute it to the billboard campaign alone (Wright et al., 2010).

The UK Environment Agency and the Automobile Association undertook a joint media and digital campaign utilising the “#thinkdontsink” hashtag (Figure 9). Other UK initiatives include the twitter account The Coast Guard Team (Figure 10) and the Northamptonshire Local Government “don’t be...
a numpty” campaign\(^4\) (Figure 11). Both of these initiatives engage with the community utilising humour to demonstrate the key message of not driving through floodwater.

![Floods Destroy Be Prepared](image)

Figure 9: UK Environment Agency and the Automobile Association Campaign

![The Coastguard Team social media message](image)

Figure 10: The Coast Guard Team social media message

\(^4\) [www.youtube.com/watch?v=C1qf8elpeo](http://www.youtube.com/watch?v=C1qf8elpeo)
Figure 11: Northamptonshire Local Government social media video

Research to inform the “if it’s flooded forget it campaign” identified three different audience segments, including “the novice” (who had no experience, was usually caught off guard, had thought little of the consequences and had driven through floodwater to get somewhere), “the cautious risk taker” (experienced in driving through floodwater, will attempt to avoid it, but will assess the risk, see the risk as part of life and regard themselves as safe drivers) and “the reckless risk taker” (will deliberately engage with the risk, is full of bravado, mostly regional and male) (Prevention of flood related deaths working group, 2016).

Key Messages

Key messages across Australia do vary slightly and sometimes compete with “how to” messages provided by 4WD groups. Table 8 shows key messages by each Australian jurisdiction.

Table 8: Key Messages

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>Key Message</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qld</td>
<td>Stay out of floodwater.</td>
<td>Queensland Government</td>
</tr>
<tr>
<td>NSW</td>
<td>Never drive, ride or walk through floodwater.</td>
<td>NSW SES</td>
</tr>
<tr>
<td>WA</td>
<td>Driving on roads during or after a flood is extremely hazardous. Roads may be damaged, bridges destroyed and communities may be isolated by floodwaters for days, weeks or months. Do not drive into water of unknown depth and current.</td>
<td>DFES</td>
</tr>
<tr>
<td>Vic</td>
<td>Floodwater is dangerous – never drive, walk or ride through floodwater.</td>
<td>VICSES</td>
</tr>
<tr>
<td></td>
<td>Floodwater is toxic – never play or swim in floodwater.</td>
<td></td>
</tr>
<tr>
<td>Jurisdiction</td>
<td>Key Message</td>
<td>Source</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------------------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>SA</td>
<td>Never attempt to drive in floodwaters.</td>
<td>SA SES</td>
</tr>
<tr>
<td></td>
<td>Never enter floodwaters and in particular do not allow children to play in or near them.</td>
<td></td>
</tr>
<tr>
<td>TAS</td>
<td>Never drive, ride or walk through floodwater – this is the main cause of death during floods. Floodwater may be deeper and faster flowing than you think and may contain hidden snags and debris. This includes causeways and low-lying roads.</td>
<td>TAS SES</td>
</tr>
<tr>
<td>NT</td>
<td>Do not let children play in or near floodwater.</td>
<td>NT SES</td>
</tr>
<tr>
<td></td>
<td>Do not walk through floodwater.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Do not drive through floodwater.</td>
<td></td>
</tr>
<tr>
<td>ACT</td>
<td>Never enter or travel through floodwater.</td>
<td>ACT SES</td>
</tr>
</tbody>
</table>

Though seen as appropriate, how practical flood safety messages are has been challenged given that, in many cases, motorists have in the past successfully crossed flooded roadways (Austroads, 2015). Messages promoted within the 4WD community commonly encourage motorists to check the depth of an inundated roadway by walking the flooded section of a road or river crossing. As shown in Figure 4 in some instances it may be possible for an adult to safely wade across a flooded road, but not to drive across the same section due to the increased vulnerability of vehicles in the specific circumstance (Australian Institute of Disaster Resilience, 2017).

**Campaign Evaluation**

Despite campaigns, people in Australia still enter floodwater. For example, in NSW, research following flooding in March 2017 identified that 47% of community members surveyed had entered floodwater on foot and 4% had driven through floodwater (Haynes et al., 2017b). Campaigns have not been well evaluated. Limited evaluation evidence regarding the Queensland “If it’s flooded forget it” campaign indicated that around 70% of those surveyed recalled the campaign, mostly through television advertising. Only 58% of respondents indicated that it was enough to stop them from entering floodwater and only 56% thought it was relevant to them. Evaluation results also indicated that there was ambiguity around the meaning of “flooded”(Prevention of flood related deaths working group, 2016).

It is a common misbelief that people choose to enter floodwater because of a lack of knowledge around the dangers of driving through floodwater (Franklin et al., 2014). In fact, given the increased attention of this risky driving behaviour in the media, Hamilton et al. (Under Review) found that the dangers are known to many Australians and that individuals can recall and understand the risks of driving through floodwaters yet continue to ignore safety messages and drive through - results supported by others (Taylor et al., 2016, Shevellar and Riggs, 2015). Even though drivers commended safety campaigns and messages, some drivers perceive them as not relevant to their own circumstances, believing their specific situation to be different from those in the warnings (Shevellar and Riggs, 2015). This highlights that having knowledge does not always translate into behaviour, suggesting that the behavioural decision-making in vehicles around floodwater is based on more than knowledge acquisition alone (Gissing, 2016, Pearson and Hamilton, 2014, Taylor et al., 2016).
**Additional Engagement Avenues**

Concerns have been expressed about the impact of television advertising and media footage that provides imagery of 4WD vehicles driving through floodwater or reporters engaging in unsafe behaviours (Campbell, 2014). No research exists regarding the impact of advertisements on driver behaviour: however, research into the influence of advertising that illustrates other forms of risky driving behaviour concluded that there was no immediate effect of brief exposure to such advertisements on risk-taking behaviour, though the risks associated with accumulated exposure were unknown (Vingilis et al., 2015). Motor vehicle advertising in Australia is governed by a voluntary code of practice. This code states that motor vehicle advertisements cannot promote illegal driving behaviours or show motorists driving in an unsafe manner (Kaye et al., 2015). Campbell (2014) researched the influence of media imagery through a public survey, finding that some 17% of respondents had been significantly or somewhat influenced to enter floodwater as a result of imagery shown by the media.

Gissing (2016) identified that emergency service vehicles also entered floodwater along a closed section of road, possibly sending the wrong message to other motorists that driving along a flooded road that had been closed was safe. Further work is required in this area to identify the level of influence such actions have on general motorist behaviour, but it is likely to undermine engagement efforts to modify behaviour.

Work-related flood fatalities and rescues do occur. There is scope to further encourage businesses as part of their work health and safety systems to adopt policies that discourage motorists from entering floodwater. In the broader road safety context, work-related road safety has grown in importance and has been recognised as a possible conduit for improving broader community road safety (Wallington et al., 2014). A case study of British Telecommunications showed that improving organisational road safety practices and culture resulted in more than halving collision rates and costs (Wallington et al., 2014). In the Australian context, research has concluded that organisations need to place greater priority on road safety risk management practices (Warmerdam et al., 2017).

Other possible methods of engaging with communities may include inclusion of materials in safer driver programs or licence testing and inclusion of activities in schools programs.

**Engineering**

A floodway is defined as a longitudinal depression in a roadway specifically designed to accommodate the passage of floodwater (Austroads, 2015). Floodways are typically utilised in situations where there are no other practical alternatives to provide a bridge or culvert (Austroads, 2015). Most floodways are located on rural roads (Austroads, 2015). A large portion of floodways in Australia are found to be inadequate in terms of design and signage standards (Austroads, 2015). Floodways though similar to Fords are different in that they attempt to provide a dry crossing environment, where as a Ford is typically a wet crossing within a stream. Specific guidelines for the construction of floodways are outlined in Austroads (2013) and further detailed in Austroads (2015), including the following safety considerations:

- Adequate approach sight distance should be provided to allow motorists time to recognise flooded roads
- The depth of water over the floodway should be as uniform as possible
- Road closure should be considered when floodwater reaches 300mm or more over the road surface
• Floodways should not be placed on horizontal curves and design should resist scour and washouts
• The length of a floodway should not exceed 300m so that motorists do not become disorientated
• Motorists should be able to turn vehicles around and seek alternative routes
• Signage consistent with Australian standards (including AS 1742.2) should be provided including road subject to flooding signs, floodway or ford signs and depth markers.

In the context of reducing the incidence of motorists entering floodwater, engineering interventions might include improved signage, lighting, barricades, road raising and vehicle design. Engineering options can often be expensive to implement and also are commonly associated with ongoing maintenance costs. In Australia at present, there is no accepted process for prioritisation or planning for floodway upgrades to reduce the incidence of motorists entering floodwater.

**Signage**

Current signage standards for water crossings are based on AS 1742.2 (2009). Austroads (2015) state that:

> Given that all designated floodways will at some time have water flowing over the road with varying flood levels, all water crossings must have in place a ford or floodway sign, depth indicator and water over road sign. (Austroads, 2015)

The effectiveness of the use of signage as a strategy to reduce the incidence of motorists and people entering floodwater is mixed. Even where signage exists, it still needs to be accurately interpreted for an informed decision to be made. Depth markers also require knowledge of critical flood thresholds, which motorists and other individuals may not have (Austroads, 2015). Common flood signage also tends to warn motorists of the possibility of a flooded road rather than the actuality of a road being flooded (Martin, 2010). Austroads (2015) conclude that existing signage does not provide the most important information, this being, in their view, the product of water depth and velocity for a given vehicle. Although technology exists to measure the product of depth and velocity, it is not considered cost effective for low volume roads (Austroads, 2015).

Austroads (2015) found that it was uncommon to find all required signs and guideposts present at floodways, therefore placing motorists at greater risk. Gissing et al. (2017) identified that signage was present at only twelve of twenty one different sites where flood fatalities had occurred. Further, where road barricades and closure signage were present, Gissing (2016) identified that some 84% of motorist chose to ignore them. The fact that motorists continue to enter floodwater where signage is present suggests that motorists either ignore, misinterpret or simply do not see signage. Coles et al. (2009) found that 90% of survey respondents would be strongly influenced by signage in their decision not to enter floodwater. Similarly, 90% of respondents thought signs indicated the likelihood of flood danger: however, only 44% thought signs indicated the degree of danger (Coles et al., 2009). It has also been found that leaving road closed signs up after floodwater recedes has a negative effect by reducing the trust motorists have in this advice (Wright et al., 2010).

Similar results and challenges have been found in the context of beach safety. Matthews et al. (2014) found that, when beachgoers were asked about the safety signage that was present prior to their entry on to the beach, only 45% of them had observed any signage. In terms of safe swimming behaviour, people at the beach with children were more likely to swim between the flags (Sherker et al., 2010). Those swimmers with a basic knowledge of rip currents are significantly
more likely to avoid them (Sherker et al., 2010). This may indicate that motorists and individuals who have an understanding of the dangers of floodwater maybe more likely to avoid entering floodwater. However, people may overestimate their ability to assess the dangers of entering floodwater: for example, research by Surf Life Saving Australia (2016) showed that two out of three people who think they can identify a rip cannot.

Flood signage is largely passive. Research in the context of railway crossings has shown that active controls - for example flashing lights, gate controls and sound signals (including in vehicle audio) - are more effective than passive stop signs (Rudin-Brown et al., 2012, Liu et al., 2016, Tey et al., 2013, Tey et al., 2011). Rumble strips on roadways have been proven to be less effective than active controls (Tey et al., 2013). Despite the effectiveness of active controls, vehicle collisions still occur at railway crossings with active controls (Tey et al., 2011).

Further, research in the context of school zones has shown mixed results, with some researchers identifying a positive effect from utilizing signs, whilst others argue that signs have little to no effect on driver behaviour (Strawderman et al., 2015). The combination of text signs and flashing lights has been shown to be more effective than flashing lights or text signs in isolation in reducing speeding (Gregory et al., 2016).

Active controls have also been utilised in health care. D’egidio et al. (2014) and Rashidi et al. (2016) found that installing flashing lights on alcohol gel dispensers increased their use in maintaining hygiene by around two hundred percent.

Some examples utilising a combination of active measures with flood signage do exist, including road subject to flooding signs combined with a flashing road flooded sign in Logan City Council (Qld) (Figure 12), and commercial systems similar to railway crossings with boom gates and signs with flashing lights. Many of these systems are connected to stream level gauges, and signage can be automatically activated once trigger levels are exceeded.

NSW SES, in partnership with NRMA Insurance, is currently trialling flood detection equipment known as ‘Dipstick’ at 18 locations across NSW. This technology has the ability to send alerts to local SES Units and Local Government. In addition, it is equipped with a flashing light to warn when flooding is detected. This technology is also being utilised at a small number of sites by Local Councils in Victoria (Rasmussen, 2017), including Cardinia Shire in the area surrounding the Beaconsfield Railway Station (Figure 13). Here the dipstick technology provides alerts to the Council in regard to when to close and reopen the road (Tuftec, 2017). To date, no robust evaluative evidence exists regarding the effectiveness of these measures.

Austroads (2015) concluded that:

“For low-water crossings with a history of repeated flooding and accidents, automatic systems that provide flashing warning beacons provide a timely and effective notification to motorists and road agencies. Effectiveness can be further improved with the use of automatic gates, similar to that used at railway crossings which most motorists will heed as a warning” (Austroads, 2015).

Despite this statement, Austroads (2015) do call for further trialling and evaluation in the Australian context.

Variable message signs have also been utilised historically to promote flood safety messages along major traffic routes during floods. However, due to limitations in the amount of text they can contain, messages have been restricted to largely generic flood safety advice.
The level of sign saturation may also influence the effectiveness of signage. Strawderman et al. (2015) studied the impacts of sign saturation on school zones based on the hypothesis that if a driver observes too many of the same signs, they no longer respond to the sign with same level of attention. The results of the research found that sign saturation did not result in lower compliance with speed signage displayed in school zones. Research is needed to confirm the impacts of sign saturation in the context of compliance with signage related to flooding.

Recent Chinese research has investigated the use of roadside flood markers and found that a revised colour gauge design which utilised colour to communicate the level of risk was superior to commonly utilised digit style flood markers, through reducing response times and allowing risk to be clearly distinguished (Jing et al., 2017).

**Flood Gates**

The most commonly used method of closing roads in Australia consists of utilising barricades, which are placed across the road surface. Experience with the use of barricades has shown that
motorists attempt to drive around them; that they have been removed and, in circumstances where flooding occurs quickly, there is little opportunity for authorities to put them in place. Road operators maintain a limited stock of barriers and on occasions have run out. The effectiveness of barriers could be improved by manning them by emergency service or road operator personnel: however, during episodes of significant flooding, such crews are limited and are unable to man every crossing (Gissing, 2016).

A method receiving more attention is the use of automatic gates to close roads. Automatic flood gates have been piloted by Gladstone Regional Council (Figure 14). When activated, the system unlocks, alerts are sent to emergency services, warning lights switch on and gates close the road. Another example of a specialised flood gate was identified from Bexar County, US (Figure 15), which combines a boom gate with signage and flashing lights.

In other areas, manual gates have been fixed to the roadside to enable rapid closure of roads by operations crews during flood events (Figure 16). A mixed approach utilising automated warning beacons triggered by water level gauging at the site and manual gates has been utilised in Cardinia Shire, Victoria by Melbourne Water (Figure 17). The automated process sends an SMS to the council to prompt them to close the manual gates. Manual gates were preferred as there were fears that an automated system could be vandalised. The infrastructure costs associated with the Cardinia system are estimated at $20,000, with ongoing annual maintenance of $1500 (Rasmussen, 2017).
Figure 15: Boom gate control (Source: Bexar County, Texas)

Figure 16: Manual gate (Source: Somerset Rivers Authority)
Roadside Barriers (Guard Rails)

There has been no specific research conducted regarding the effectiveness of different types of road barriers in improving the safety of motorists during floods. It is noted by Gissing et al. (2017) that the absence of barriers may increase the risk of vehicles either being swept from the road or accidently driven from the road.

Vehicle design

Vehicle design has proved to be a key factor in reducing the overall road death toll, with innovations such as seatbelts and air bags now commonplace. Existing vehicle design, however, would seem to have few, if any, elements incorporated to reduce flood-related motorist fatalities. Future innovations may make vehicles safer, including the introduction of autonomous vehicles. If these vehicles were programmed to avoid flooded roads, this would be helpful in reducing flood-related deaths (Gissing et al., 2015). There is no knowledge currently available regarding manufacturer designs in this area.

Enforcement/Incentive

Regulation is frequently utilised to change behaviour: for example, reducing speeding and drink driving, and eliminating smoking from public spaces. There are specific examples of motorists being charged with dangerous driving offences in Queensland and in NSW as a result of driving into floodwater. In 2012, a Queensland man was convicted of manslaughter and jailed after driving into a flood after his action was responsible for a passenger’s death (Gissing et al., 2015).
In the United States, the State of Arizona in 1995 passed the “Stupid Motorist Law”, which holds a person who recklessly enters floodwater in a vehicle liable for the cost of their rescue. A similar law was voted on in the State of Virginia in 2016, but was not passed. No such specific legislation exists in Australia.

It has been suggested that motorists who require rescue as a consequence of entering floodwater should be liable for the costs of the rescue efforts. However, it has been suggested that this may result in a resistance by those in need to seek emergency assistance from rescue agencies, placing them at greater risk (Prevention of flood related deaths working group, 2016).

The central premise of deterrence theory is that crime can be prevented when punishment is certain, quick and severe (Eassey and Boman, 2016). General deterrence is aimed at reducing a certain action by directing threat of sanction at all possible offenders. Specific deterrence is aimed at reducing a certain action by applying a sanction to a specific offender (Sentencing Advisory Council, 2011).

The effectiveness of deterrence mechanisms has been well studied in the context of road safety. The enforcement of drink driving laws has been shown to be effective both in Australia and internationally. The introduction of random breath testing in New South Wales in 1982 led to a 48 percent decrease in fatal crashes over an initial four and half month period and a decrease in fatal crashes over a subsequent ten year period (Terer and Brown, 2014). Further random breath testing led to reductions in fatal crashes of 28 percent in Western Australia and 35 percent in Queensland (Terer and Brown, 2014). In Canada, the introduction of laws targeting speeding and drink driving were attributed in the two year period after their implementation to reducing fatal vehicle crashes by 21% (Brubacher et al., 2014).

In the context of criminal justice it has been concluded that the threat of imprisonment has a small general deterrent effect. The certainty of apprehension and punishment has been consistently found to be associated with the greatest impacts (Sentencing Advisory Council, 2011).

Another method of influencing behaviour might be for insurance companies to promote that they will not cover claims for motorists that deliberately enter floodwater, or to reward safe driving practices with discounts.

Emergency operations

Warnings

The purpose of a flood warning system is to provide information to inform decision making of emergency response agencies and the community to enable proactive actions to mitigate the impacts of flooding. The Total Flood Warning System consists of the following components:

- Monitoring of rainfall and river level conditions that may result in flooding
- Prediction of flood severity and time of onset of particular flood levels
- Interpretation of flood predictions to determine the likely consequences on the community
- Construction of warning messages
- Communication of warning messages to communities
- Response to the warnings by communities and emergency response agencies
- Review of the warning system after flood events.
In the context of reducing the number of people entering floodwater warning, messages contain specific advice messages to people not to or to avoid entering floodwater.

Several different types of flood warning products exist. These include:

- Flood Watch
- Flood Warning
- Severe Weather Warning.

At many sites where flood-prone roads exist there are unlikely to be specific flood warning systems. The advice to individuals contained in more generalised severe weather warning and flood watch products should be to encourage motorists to check local road conditions before embarking on a journey.

**Road Information**

Road information is typically in high demand during floods. This information is commonly provided via websites, radio stations, phone hotlines and social media. Commonly utilised sources include local government and road operator webpages. There can be some challenges in collating up to date road information and, in some cases, there is no single source of road information, with road information being supplied by different road operators.

Examples exist of attempts to specifically communicate road information in relation to floods. The City of San Antonio and Bexar County in the United States has developed a web-based mapping portal to display alternative routes around flood-prone road crossings. Information on the website is supported by sensors (High Water Alert Lifesaving Technology) at each site that detect when floodwater is present (Figure 18). Information can also be sent by text message or email alerts for certain sites that subscribers may be interested in. Bexar County has installed some 150 flood sensors (Bexar County, 2017). Similar information regarding flooded road crossings is also provided by the City of Austin in Texas (Figure 19).

![Figure 18: Bexar County road information website](image-url)
The Queensland Government, as part of their “If It’s Flooded Forget It” campaign, have also developed and operate a website to crowd-source road closure information (see http://floodwatersafety.initiatives.qld.gov.au/flooded-roads-map/) (Figure 20). In recent flooding, Tweed Shire Council utilised social media as a source of information to identify flooded roads (Rose, 2017).

Modern car GPS systems can provide advice to motorists based upon up-to-date traffic information. Most recently during Hurricane Irma it was reported that emergency management officials were working with Google to ensure real time road closure information was available through Google Maps to assist with resident evacuations (Kaser, 2017). Google specifically stated:

To provide access to accurate and useful transportation information, we use algorithmic and manual methods to account for everyday and emergency road closures. We’re working directly with Florida officials to help provide up-to-date information to those affected by the storm. These road closures will also appear on our Irma Crisis Map, embedded as part of our SOS Alert on Search (Kaser, 2017).
Google Maps also enables the crowd-sourcing of road closure information by allowing users to report road closures.
Research Results

The following section outlines the results of the survey, focus groups and stakeholder interviews.

What is floodwater?

Respondents were asked how they would define floodwater. Responses (n=268) varied, indicating that flooding is not seen as a phenomenon with standard parameters and that there is some individual interpretation as to what flooding is. The most popular definitions of flooding included water outside its normal course or where it is not usually (n=61); and water that was described as either dangerous, fast, deep or flowing, or a combination of these terms (n=61). Some respondents recognised that flooding was associated with water levels that were above normal (n=13) or excessive rain or water level events; and sometimes described floodwater as overflowing or spilling out (n=13). Some recognised that flooding was a result of drainage systems becoming overwhelmed (n=12) and in other cases that flooding was associated with water left over from heavy rain that had not drained (n=11). Some respondents defined floodwater by its consequences such as water coming in or threatening homes (n=10) and inundating roads (n=11). Some respondents nominated a height to define floodwater including anything deeper than 10cm (n=2), anything deeper than a foot (30cm) (n=3), or anything knee deep or higher (n=6).

Similarly, focus group participants provided explanations such as excess water, a lot of water, water that goes higher than it usually is, water in areas where it is not meant to be and a rapid rise of water. Some indicated explanations that reflect the severity of flooding such as not being able to see the bottom of the water and that it is greater than ankle depth.

Flood experience

Respondents were asked if and how they may have previously experienced flooding. The results are shown in Figure 21. Of the 276 respondents who completed the question, 84% (n=232) had experienced flooding on the road when driving, making it by far the most frequent impact by flooding experienced by the community. Other experiences included flooding of home (31%; n=87), workplace (29%; n=79) or farm (26%; n=72). Some 9% indicated that they had not previously experienced flooding.
Respondents were also asked to identify how floods may have impacted them during the previous (2017) summer or wet season. Responses were very similar to previous historic experiences with 66% (n=173) indicating they were impacted by the flooding of local roads. Other impacts noted by respondents included flooding of farmland (20%; n=52), isolation (18%; n=48), flooding of place of employment (13%; n=33) and disruption to business (13%; n=34). Twelve respondents indicated that their vehicle had been flooded and 24% of respondents stated that they had not been impacted by flooding (n=62). Results are summarised in Figure 22.

Feedback from focus group participants in Esperance and Ravensthorpe reflected the magnitude of the flooding that occurred in February 2017 and impacts on agriculture. Participants said:

*In my mind and I’ve been living on the river out there for 60 years in the one spot for 60 years and I’ve seen the river flood plenty of times. But this was just absolutely enormous you know, right across the paddocks and took 19.9 kilometres of fences. Three tractors under water, a silo with 15 tonne of barley in it and it went four kilometres down the river. We had a ute turn over three times, we had a truck under water full of grain, another silo hooked up to a tractor, the tractor spun right around in a circle. Numerous other damage and whatnot that is just indescribable and every farmer copped it.*
Figure 22: During last summer or wet season how were you impacted by flooding? (n=263)

The greatest proportion of respondents indicated that they had previously encountered flooded roads once or twice over more than a year (35%; n=92), followed by those who had encountered flooded roads once or twice per year (32%; n=84). Overall results regarding how often respondents had encountered flooded roads in the past are summarised in Figure 23.

Figure 23: How often have you encountered flooded roads (i.e. driving in the areas you live or work)? (n=265)

Focus group participants noted their experiences of flooded roads in the past:
When it actually is pouring you really can’t drive around… especially around town here it floods from the mangroves to around Coles…it is ankle deep I walked through it… little cars look like little boats driving around town (Broome participant).

One time when I travelled up to Darwin we had to wait on the side of the road for seven hours just for the water to go down (Broome participant).

In addition to flooded roads, participants noted risks associated with boggy roads following heavy rains - in particular, in the north of the state where motorists could become stranded in remote areas.

**Stakeholder and community concerns regarding flooding**

State and local level stakeholders expressed concerns regarding people entering floodwater and the dangers associated with doing so, including those who took risks to view floodwaters. Views were expressed about the differences in previous flood experiences between the northern and southern sections of WA. In the north of WA, stakeholders stated that local communities experience regular flooding: however, in the southern part of WA, floods had not occurred for some time prior to February 2017, and there were concerns regarding lack of community experience and apathy. Stakeholders stated:

*People are just not used to flooding. Up north, people have a lot of experience. In the Great South, I don’t know that a lot of people have experienced floods. People were just not aware of what flooding could do (local emergency service stakeholder in south of WA).*

*Really it is about community awareness especially in the southwest, where we haven’t had any [floods] for a while…….People don’t know how to drive through floodwater or not to drive through it (State Government stakeholder).*

*We don’t have flood literacy. We are very impacted by bushfires, but not by floods. (NGO stakeholder).*

*We were well prepared as much as we can for flooding. The amount of water though caught us by surprise. Our public warnings were a little late in getting out. The biggest issue was people were not following warnings not to enter floodwater. People just were not prepared for the scale of flooding that was experienced. I have never seen so much water in 35 years (local emergency service stakeholder in south of WA).*

*The local people, some of them just didn’t expect it to be like that. To have roads flooded and bridges washed away (local emergency service stakeholder in south of WA).*

It was noted by focus group participants in the south of the state that flooding is not an issue of day to day concern. In the north, however, adjustment to annual flooding from the wet season was seen as part of the culture of communities. Participants said:

*Yeah, it’s not something you go around thinking about, what if you get a flood, obviously it doesn’t really cross your mind until the heavy rain comes and you realise that things are getting cut off (Broome resident).*

*The biggest problem is it was 2002 to through 2017, that is a long time to go without any flood problems…, people come and go from the town, may not have remembered, people may not have seen prior levels and how it was going to impact them, and what roads are going to be flooded (survey respondent).*
Despite the flooding in February, stakeholders stated that people were already forgetting about the experiences, with motorists observed entering floodwater during minor flooding in the south of WA later in the year⁵. Community forums held in the Swan Valley immediately after the floods about flood preparedness were also said to have been poorly attended.

Survey respondents were asked to rate their concerns about flooding based upon a series of predefined concerns. The most significant concerns identified were the threat to motorists on local roads and to people swimming or walking in floodwater. This result reflects that of all flood issues, the issue of entering floodwater by driving, walking or swimming is likely to generate the most interest amongst communities. Other high rating concerns included the threat to family, neighbours or friends and threat to pets and livestock. Responses are summarised in Table 9.

Table 9: Community concerns regarding flooding (n=264)

<table>
<thead>
<tr>
<th>Concern</th>
<th>Score out of 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threat to your health and safety</td>
<td>3.71</td>
</tr>
<tr>
<td>Threat to your property</td>
<td>3.31</td>
</tr>
<tr>
<td>Threat to your family, neighbours or friends</td>
<td>3.86</td>
</tr>
<tr>
<td>Threat to your place of employment</td>
<td>2.61</td>
</tr>
<tr>
<td>Threat to pets and livestock</td>
<td>3.79</td>
</tr>
<tr>
<td>Threat to crops</td>
<td>3.31</td>
</tr>
<tr>
<td>Threat to motorists on local roads</td>
<td>4.08</td>
</tr>
<tr>
<td>Threat to people swimming or walking in floodwater</td>
<td>4.08</td>
</tr>
<tr>
<td>Threat of isolation</td>
<td>3.33</td>
</tr>
<tr>
<td>Threat of losing power, water or sewage</td>
<td>3.58</td>
</tr>
</tbody>
</table>

At Fitzroy Crossing, specific concern was raised about children jumping into and swimming in the Fitzroy River when it was flooded (see, for example, Figure 24) and their level of knowledge about how to be safe. An example was raised that last wet season there had been an incident when a child had been reported missing but was later accounted for. It was noted that some community members from outside the local area did not have flood experience and could be more susceptible to flood dangers (for example, indigenous community members who had travelled from the desert). Sharks, crocodiles, snakes, debris and rubbish were said to be in the floodwater. Others thought that children swimming in the river was just part of growing up in Fitzroy Crossing. Though there is now a swimming pool established at Fitzroy Crossing, which is operated by the Royal Life Saving Society, focus group participants saw that children were attracted by the strong current of the river and the chance to swing from trees. The local swimming pool manager noted that scenarios of river swimming were incorporated into children’s swimming lessons. Focus group participants also noted that children were taught swimming by their parents in the river.

At Fitzroy Crossing, flooding was said to bring fish that were good for hunting, and that traditional owners welcomed flooding for this reason. It was noted, however, that there is a lack of formal plans for floods in remote indigenous communities.

Concerns were also raised at Fitzroy Crossing about people being isolated in remote communities during floods, and people from remote communities travelling through floodwater to Fitzroy Crossing to obtain supplies and to attend licensed premises. It was mentioned that on occasions people become stuck between different floodways whilst making their journey as well as risking being washed from floodways whilst crossing them. One story shared involved people travelling between remote communities who had successfully crossed four flooded road sections but had eventually lost both of their vehicles and had become stranded some 70km away from Fitzroy Crossing, and required rescue. To further illustrate the issue focus group participants said:

*People want to come [into town]. If water is on the road they will swim to get to town (Fitzroy Crossing resident).*

*Their absolute desire that “I have to get into Fitzroy Crossing”. People who started to walk from Yakanarra because they just wanted to get into Fitzroy Crossing. They were in safe spot because there had been a food drop out there. They had blow-up pool mattresses and they wanted to put them into the helicopters. And their absolute desire of “I have to go into Fitzroy Crossing” (Fitzroy Crossing resident).*

**How safe is it to enter floodwater?**

Survey respondents were asked to rate how safe it was to undertake different actions in different flood conditions on a scale of very dangerous, dangerous, neutral, somewhat safe and completely safe. 264 respondents responded to the question.

Walking through knee-deep still floodwater was seen by 47% (n=123) of respondents as either very dangerous or dangerous. Twenty-two percent (n=59) rated it neutral but of concern was that 31% (n=82) of respondents thought that it would be somewhat or completely safe to do so. When
asked how safe it would be to walk through knee-deep fast flowing water, responses showed that significantly more people believed that these conditions were dangerous, with 96% (n=254) of respondents indicating that it would be very dangerous or somewhat dangerous to do so.

Driving through knee-deep still floodwater was seen as dangerous or somewhat dangerous by 50% (n=133) of respondents. Twenty-four percent (n=63) rated it as neutral. Again, of concern, 26% (n=68) believed that it would be somewhat safe or completely safe to drive through knee-deep still floodwater. When asked how safe it would be to drive through knee-deep fast flowing floodwater, 96% (n=253) of respondents believed it would be very dangerous or dangerous to do so, again showing a significant increase when floodwater is described as fast flowing.

In both the cases of walking or driving through floodwater, the speed of the water appears to be a contributing factor to decision making. Interviews with subject matter experts and the views of Austroads (2015) suggest that it is often difficult to judge the velocity of floodwater.

Swimming in floodwater was considered to be a very dangerous or dangerous activity by 95% (n=252) of respondents, suggesting that people view swimming in floodwater as dangerous an activity as walking or driving through knee-deep fast flowing floodwater.

**Frequency of people entering floodwater by vehicle**

The frequency with which respondents indicated they had previously driven through floodwater is summarised in Figure 25. Some 245 respondents answered the question, with 76% (n=186) indicating that they had previously driven a vehicle though floodwater in the last ten years and 24% (n=59) stating that they had not. Some 20% (n=50) of respondents indicated that they had driven through floodwater more than ten times over the last ten years. These results indicate that many motorists have experience driving through floodwater in the past, and that those with experience often enter floodwater again.

![Figure 25: Approximately how many times have you driven a vehicle through floodwater in the last ten years? (n=245)](image-url)
Respondents (n=266) were also asked if they had entered floodwater over the last (2017) summer or wet season as a driver or a passenger. Fifty-seven percent (n=151) of respondents confirmed that they had entered floodwater. Of those who had entered floodwater, 46% (n=69) did so solely as the driver, 19% (n=28) solely as a passenger and 35% (n=52) both as a driver and passenger at different times.

Who drives through floodwater?

In general, a greater percentage of males have driven a vehicle through floodwater at least once (n=88/104, 85%) when compared to females (n=96/138, 70%). Males also appear to drive through floodwater on a more frequent basis, with 31% (n=32/104) of males reporting to have driven through floodwater more than ten times in the last ten years compared with only 13% of females (n=18/138).

Males less than the age of 60 were most likely to have driven through floodwater in the last ten years, whilst females less than the age of 40 were more likely to have driven through floodwater in the last ten years (Table 10). Overall, the distribution of the frequency of those who have entered floodwater in the last ten years is relatively even between the ages of 18 and 60 when gender totals are combined.

Table 10: Age and gender vs. driving into floodwater at-least once over the last ten years

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Male and entered floodwater at least once in the last ten years (%)</th>
<th>Female and entered floodwater at least once in the last ten years (%)</th>
<th>Total (%) entered floodwater at least once in the last ten years.</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-30</td>
<td>19 (22%)</td>
<td>24 (25%)</td>
<td>43 (23%)</td>
</tr>
<tr>
<td>31-40</td>
<td>18 (20%)</td>
<td>25 (26%)</td>
<td>43 (23%)</td>
</tr>
<tr>
<td>41-50</td>
<td>18 (20%)</td>
<td>16 (17%)</td>
<td>34 (18%)</td>
</tr>
<tr>
<td>51-60</td>
<td>20 (23%)</td>
<td>17 (18%)</td>
<td>37 (20%)</td>
</tr>
<tr>
<td>61-70</td>
<td>9 (10%)</td>
<td>9 (9%)</td>
<td>18 (10%)</td>
</tr>
<tr>
<td>71-80</td>
<td>3 (3%)</td>
<td>4(4%)</td>
<td>7 (4%)</td>
</tr>
<tr>
<td>81-90</td>
<td>1 (1%)</td>
<td>1 (1%)</td>
<td>2 (1%)</td>
</tr>
<tr>
<td>Total</td>
<td>88</td>
<td>96</td>
<td>184</td>
</tr>
</tbody>
</table>

Those who worked mainly outdoors were most likely to drive through floodwater at-least once and to also more frequently drive into floodwater, as shown in Table 11.

Table 11: Occupation vs. driving into floodwater at-least once over the last ten years

<table>
<thead>
<tr>
<th>What best describes your occupation?</th>
<th>Approximately how many times have you driven a vehicle through floodwater in the last ten years?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never</td>
</tr>
<tr>
<td>Employed and work mainly indoors</td>
<td>22 (22%)</td>
</tr>
<tr>
<td>Employed and work mainly outdoors</td>
<td>4 (7%)</td>
</tr>
<tr>
<td>Other</td>
<td>9 (26%)</td>
</tr>
<tr>
<td>Retired</td>
<td>18 (45%)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>3 (27%)</td>
</tr>
<tr>
<td>Total</td>
<td>56</td>
</tr>
</tbody>
</table>
Of the 118 respondents who answered what type of vehicle they had driven through floodwater, 83, or 70%, had driven a 4WD, as shown in Table 12. The majority of these drivers had driven through floodwaters four times or more. A further eight (7%) had driven a bus, truck or combination of truck and high-set 4WD [this latter within the “Other” category]. 17, or 14%, had driven a hatchback or sedan/ station wagon and the majority of these drivers had driven through floodwaters less than four times. The high percentage of drivers entering floodwater in 4WDs may reflect the large proportion of 4WD ownership in the areas surveyed.

Table 12: Number of responses times driven through floodwater vs. vehicle type

<table>
<thead>
<tr>
<th>Type of vehicle driven into floodwaters</th>
<th>Approximately how many times have you driven a vehicle through floodwater in the last ten years?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Once only</td>
</tr>
<tr>
<td>2WD Ute</td>
<td>0</td>
</tr>
<tr>
<td>4WD</td>
<td>5</td>
</tr>
<tr>
<td>All wheel drive</td>
<td>0</td>
</tr>
<tr>
<td>Bus or truck</td>
<td>0</td>
</tr>
<tr>
<td>Hatchback</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
</tr>
<tr>
<td>Sedan/ Station Wagon</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
</tr>
</tbody>
</table>

Fairly similar trends are seen amongst males and females when the gender of drivers is analysed with respect to vehicle type and the number of times the drivers have driven into floodwater. Forty percent of males and 32% of females driving 4WDs had driven through floodwater more than ten times.

The influence of length of residence in their local area on the likelihood of people driving into floodwater was examined. Results as shown in Table 13 reveal that relatively similar percentages of those who had entered floodwater exists across the lengths of time of motorists had lived in their current town or suburb, the exception being those who were very new to the area, having lived in the area for less than a year, who were the least likely to have driven through floodwater.

Focus group participants commented that they would not travel though floodwater on roads that they did know. One stated:

*I wouldn't like to go through floodwaters anywhere outside of my district. I believe I know my crossings and my roads and whatnot in my district and what depth of water it's likely to be. Then you gauge whether you're going to have a go or not but, yes, I wouldn't like to try it in another district where I didn't know what was going on (Ravensthorpe resident).*
Focus group participants expressed concerns about residents who had not lived in communities for very long and may not understand how to deal with the local environment. One focus group participant said:

The ones who are school teachers who have absolutely no idea... there was one the other day who went out and got bogged and didn’t know how to 4WD, there are people like that that come up, who are not conversant with the environment (Fitzroy Crossing resident).

Focus group participants raised concerns also about tourists entering floodwater and about the suitability and preparation of vehicles driven by many tourists when travelling through flooded areas. Focus group participants said:

Having a good vehicle as well to travel around... most just come up with four door sedans... there are some that are smart and come up with 4WDs; most just come up with every day sedans (Broome Resident).

We worry more about the outsiders, people do not sit down and talk to them (Fitzroy Crossing resident).

Local police in the south of WA suggested that tourists had been the worst when it came to entering floodwater. In another area the local council raised concerns in relation to vehicles travelling to the area specifically to find flooded rivers to ford.

Survey results have found that there is a correlation between confidence in swimming ability and willingness to drive through floodwater, as shown in Table 14. Very few respondents with very low or low swimming confidence had ever driven in floodwater of any depth. Most who rated their swimming confidence as high had driven through floodwater 4-10 (14; 25%) or >10 (15; 27%) times. The number of respondents who had driven through more rapid flows of floodwater also increased with confidence in their swimming ability.
Residents in the north of WA, in general, tend to drive through floodwater more often. 178 respondents were identified as living either north of Onslow or from Kalgoorlie southwards who gave a positive response to this question. Of the 40 respondents in the north of WA, 21 (53%) had driven through floodwater more than ten times in the past ten years and 31 (78%) had driven through floodwater more than three times in the past ten years. On the other hand, the majority of residents in the south of WA responded that they had driven through floodwaters two to three times (n=49 or 36%); with 108 (79%) having driven through floodwaters two to ten times in the past ten years.

As shown in Table 15, 31% (n=46) of those who recalled receiving flood information previously did drive through floodwater, whilst 51% (n=77) who did drive through floodwater did not previously recall receiving any flood information.

**Table 15: Relationship between those who enter floodwater and the receipt of flood information**

<table>
<thead>
<tr>
<th>Have you received flood safety information in the past?</th>
<th>Did you at any time drive through floodwater last summer/ wet season?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Both a driver and passenger at different times</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>Yes</td>
<td>12</td>
</tr>
<tr>
<td>No</td>
<td>27</td>
</tr>
<tr>
<td>Unsure</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
</tr>
</tbody>
</table>

**Driver Behaviour**

Survey respondents were asked what precautionary actions were undertaken prior to driving into floodwater. Results are summarised in Figure 26. Of the 120 respondents who answered the question, the most frequently reported precaution was checking the depth and speed of floodwater (88%; n=105). Other frequently reported precautions included checking the state of the road (58%; n=70), checking for debris (53%; n=63), checking if an alternate route was available (50%; n=60), waiting to see if others successfully crossed (44%; n=53) and consulting with passengers (43%; n=51).
When respondents were asked what prompted them to take precautions, most commonly they were motivated by their own safety and the safety of others in the vehicle \((n=35)\). Complementing this were those who took precautions because it was dangerous. Others were motivated by the fear of damage to their vehicle and its material contents \((n=9)\). Some respondents noted that they did not know the state of the road \((n=11)\), or were unsure of the depth or velocity of the floodwater \((n=7)\). A few were motivated as a consequence of seeing other vehicles previously being washed away \((n=3)\). Others responded that it was common sense \((n=18)\), they had some experience or knowledge \((n=9)\) or they had received some form of training or advice from others to do so \((n=3)\).

Assessing Flood Safety

Focus group participants were asked how safe it was to drive through floodwater. Almost all participants recognised that it was dangerous to enter floodwater and explained that the level of safety was dependent on a variety of different factors summarised in Table 16.
Table 16 – Factors nominated by focus group participants used to decide if floodwater is safe to cross

<table>
<thead>
<tr>
<th>Safe to enter</th>
<th>Unsafe to enter</th>
</tr>
</thead>
<tbody>
<tr>
<td>When someone is a confident and experienced driver</td>
<td>When no one else is around</td>
</tr>
<tr>
<td>When a vehicle in front has made it through</td>
<td>The road has been damaged</td>
</tr>
<tr>
<td>When water is still</td>
<td>Water is too deep</td>
</tr>
<tr>
<td>When the driver can see the road beneath the floodwater</td>
<td>When you can’t see the road beneath the floodwater</td>
</tr>
<tr>
<td>When you can walk through it</td>
<td>When crossing a gravel road</td>
</tr>
<tr>
<td>When crossing a sandy crossing</td>
<td>When the water is fast flowing</td>
</tr>
<tr>
<td>When the water is shallow</td>
<td>When there is debris</td>
</tr>
<tr>
<td>Someone else is around</td>
<td>When you can’t see how far the floodwater stretches for</td>
</tr>
<tr>
<td>When the water is dropping</td>
<td>When the water is rising</td>
</tr>
</tbody>
</table>

Regarding the factors used to assess the safety of floodwaters, participants stated:

- **Depends upon what it is. Every bit of floodwater is different** (York resident).

- **In that decision to drive through you think you’ll be right. Like when it's not rushing, obviously you see rushing water you don't go near it but when it's just like still it is ok** (Ravensthorpe resident).

- **Pretty much you just look at the road and you just know if it's not safe. We've had to cross one flood zone where it was going over our bonnet. We looked at the road and we saw it was a bitumen road and you could still see, because it wasn’t flowing too quickly, but you could still see the verge of the road, it wasn’t eroded out. So we went through it. It was fine. But if we couldn’t see the base, or if we could see ripples in the water, wouldn’t touch it** (Esperance resident).

- **Depends on what type of car you have, its height and how quickly the water is running** (York resident).

- **We know that when the water is dropping it is crossable. When it is rising I don’t think anyone will. We will get someone to walk through and check the current** (Fitzroy Crossing resident).

- **Yes, it’s just water and you can see the bottom and you think you're okay but obviously you don't know what's underneath there and things like that** (Ravensthorpe resident).

- **Yes, the flow is important, you must understand the flow** (Ravensthorpe resident).

- **Usually if there's no other car around to help you if something went wrong. Or if you look at the river and go, “If I get washed off, what’s going to happen to me?” If it’s too dangerous, I wouldn’t even touch it. But most of the time if it looks sort of all right, I'll go for it nice and slowly. But you’d want to know that there’s someone out there that could help you if you did accidentally get washed off** (Esperance resident).

- **My experience has been when there's a car in front of you that I've observed them get through, then I would attempt to go through. If I got to there and I was the only one there, yeah I probably wouldn’t attempt it** (Esperance resident).
It depends how confident driver you are as well and how experienced you are and, you'll probably find a lot more of the farmers would be more experienced in that sort of thing. You spend all your life driving just on town roads, you're not so experienced (Esperance resident).

Many focus group participants thought they had the skills and knowledge to judge when it was safe to enter floodwater. This was illustrated by the following statements by focus group participants:

For us we know when to cross, we live out there. We see floods every year. Water becomes but of life and survival (Fitzroy Crossing resident).

But we know when to get across and what level the river will be – last year there was a group of blokes you know trying to cross the river and their car ended up right down, they could have drowned, they lost their car and everything... They were told by local people not to cross the water because the current underneath was really strong (Fitzroy Crossing resident).

Focus group participants were asked how they would judge the depth and speed of floodwater. Responses included utilising depth markers and road side posts to assess depths, dropping a stick in the water, observing foam, churning or ripples, watching the speed of debris in the water and walking through it first to assess velocity. Other risk indicators were identifying dangerous animals or if other vehicles were safely crossing. Focus group participants illustrated these factors when stating:

There were other cars going through, so I guess we saw that they were getting through safely, so we thought it would be fine to go through as well (York resident).

Well we came across where the Meridian was flooded and everyone was like you can't get into town and we couldn't go down earlier, we got to the Meridian and realised it was flooded. I said I thought it would be a good idea if I got out and walked to see how far I could get and I probably only got three metres, that was just gushing so fast. I was like, no, and I got in the car and just went home, it's not worth it (Ravensthorpe resident).

Personal advice, don’t go doing it unless you know what is underneath. Being SES trained we will walk a flooded track, down one side and back the other where there are wheel tracks, before we will take a unit through. I think the training that we have had covers us (York resident).

So if you can see the bubbles and stuff and a bit of foam and whatnot that means it's got a fair bit of power and quite often it pays to roll your strides up above your knee and go and just see how much power there is there and gauge it from there and then make a decision when you get back to your vehicle (Ravensthorpe resident).

Participants across numerous focus groups indicated that they did not know what depth of floodwater their car could safely drive through. Some provided general guides such as the vehicle hood or tyres. In some instances discussion reflected the difficulty apparent in assessing flood conditions. For example:

Because again the water looks pretty calm on top, but it’s ripping underneath (Ravensthorpe resident).

There will be times when you know you can easy get across, but it is the times when you’re unsure (Esperance resident).
Other participants noted the dynamic nature of flooding and that the conditions at a particular road could change quickly:

Yeah, I think that’s experience, sometimes it can look so safe, being involved in flash flooding in Queensland, so you know. I know how scary it can get pretty quick, so I don’t think you read what you thought was going on and what the need was. If it was an emergency you might give it a go, but if not, I’d be waiting for a farmer or someone, a big vehicle to go first. But no, yeah, it can change really quick. It’s like fire really, it’s unpredictable, it might look tame and it might only look seven metres across, but it can change pretty quick (Esperance resident).

In some instances communication between motorists was noted about the flood risks including:

If somebody came through it my way heading towards to me and as he's coming past me I’d wind me window down and say, what’s it like mate? (Ravensthorpe resident)

I would either check to see how fast it's flowing or ask someone else who's been through it recently and see what they think of it (Esperance resident).

Focus group participants spoke of how previous experience in driving through floodwater can bias decision making:

I think if you take the recent experiences, or it's complacency, you know, “I've done that before, I've got through before”, there's always back stories though isn't there. So, you increase your risk if you've already taken a risk. So, if your judgment’s impaired because of what happened before. So, I think that's still an important message. Like if you decided forget it, but if your judgment's impaired then that needs to be a reminder for people as well (Esperance resident).

You know, “I've done it before, I'm experienced”. But I guess you can't always just think that that's going to be safe enough (Esperance resident).

No matter how much knowledge you got, it might not be your knowledge, it could be a different conditions, different car... (Fitzroy Crossing resident).

Some focus group participants spoke of actions that would reduce the risks involved in driving into floodwater including following in the wake of a larger vehicle and placing rocks in the vehicle to increase its weight. One participant related their belief that the type of tyre on a vehicle influenced vehicle flotation, saying that large tyres easily floated. To illustrate these practices one participant said:

Well I went through in a 4WD and there was a little car sitting there waiting and I said well if you get right up close to my backside I'll create the wake for you and that will push the water away for you so you can get through (Ravensthorpe resident).

Assessing specific situations

Focus group participants were shown six images of different flooded roadways illustrating different flood and road conditions to identify what circumstances may be considered safe to drive through and which were too hazardous (illustrated below in figures 27-32).

The results of the exercise identified that, although almost all participants believed that driving through floodwater is dangerous, almost all could identify a situation where they would drive through floodwater: that is, when floodwater with some certainty appeared shallow and with low velocity, and the road surface appeared undamaged. The exercise results further support the
factors identified by participants that are used to judge the safety of floodwater before entry (Table 16).

Uncertainty was also seen as a key decision-making factor when deciding whether or not to enter floodwater in a vehicle. In an attempt to reduce uncertainty, participants would often suggest entering floodwater by foot to test conditions.

*Image 1 – Straight section of road with shallow flooding*

Participants commented that the flow of the water in the image in figure 27 was largely still and that the road centrelines could clearly be seen underneath the floodwater. One commented on use of the roadside posts to assist in assessing the depth of the water. The majority of participants indicated that they would drive through such floodwater, in a 4WD, with some indicating that they would keep to the middle of the road to avoid possible soft edges. Some indicated that they would walk through the water first or would drive down the centre where the centrelines could be seen beneath the water. One stakeholder expressed concern about upstream conditions and that the situation could change, one thought the water was dropping so was okay. Some stakeholders said that they would consider not driving through the water if they were in a small vehicle, and others noted that the road surface could have been washed out beneath the water and not be visible in the image.
Participants commented that they could not see the end of the water or ascertain how deep it was in image 2 (see figure 28). Participants were also uncertain as to what was in the water. Some participants suggested that they would walk through the floodwater first to assess the level of safety, including the depth and velocity of the water. Some tried to assess the depth of the water based upon the roadside marker on the right-hand side of the road. Most participants indicated, after some thought, that they would not enter: however, a small number thought that they would enter in a 4WD, especially if they had to get somewhere urgently. One who said they would not enter thought they might change their decision if they knew the local area.
Participants commented that the floodwater in image 3 (see figure 29) looked fast-flowing due to its “choppy nature”, that it was difficult to ascertain the depth of the water and that the crossing was steep. Mud on the opposite roadside was observed and was said to indicate an unstable or slippery road surface. Participants were also uncertain as to what might be present beneath the floodwater or if it had been washed out. Participants said that they would not drive through it, though one suggested that they might if they were familiar with the area.
Participants commented that there was debris in the water of image 4 (see figure 30), that the water looked quite fast-flowing and that it was possible that part of the road had collapsed. One participant stated:

> It’s strong enough to take out a tree so it’s certainly going to shift a vehicle (Ravensthorpe stakeholder).

Most participants said that they would not attempt to cross. However, one participant suggested that they would attempt the crossing in a 4WD but not a sedan, this suggestion being based upon the depth being only half a metre.
Participants commented that half of the road in image 5 (see figure 31) was missing and that they didn't know if the other side was in danger of collapse. Most suggested that they would not cross the roadway. One suggested that they would if it was an emergency situation, noting that the water was not very deep, that it was just fast-moving and that they could see where the erosion had occurred. Others suggested that, if they could walk through safely on the side that had not been eroded, they would attempt to cross in a vehicle. Another suggested that they would attempt to cross on a motor bike.
Participants noted the speed and volume of floodwater in image 6 (see figure 32) and the absence of depth indicators to identify the depth of floodwaters. Others noted the length of the flooded road section and questioned the integrity of the road surface underneath. All participants said that they would not enter.

**Reasons for Driving into Floodwater**

Respondents (n=116) were asked their purpose for entering floodwater. Results are summarised in Figure 33. The most popular reasons for entering floodwater were to get home (59%; n=69), or to get to work or for work (54%; n=63). Other frequently-mentioned responses included to check on property (22%; n=26) and to reach a safer location (19%; n=22).

![Figure 33: In general, what was the purpose for driving through floodwater? (n=116)](image)

The majority of males, of all age groups, drove through floodwater to either get home (26%; n=34) or to get to work (23%; n=32). A slightly higher percentage of females than males, across most age ranges, drove through floodwater to get home (32%; n=35), and a slightly lower percentage to get to work (19%; n=21). As expected, a greater percentage of females than males drove into floodwater in order to collect children/ family members.

Some focus group participants provided insights as to their purpose in driving into floodwater:

*Because you want to be somewhere or you’ve got to be somewhere. If you’ve got an appointment or you travel so far and it’s either like turn around and go back, which is a pain in the arse, or just risk it to get to where you want to go (Esperance resident).*

*Yeah for like emergencies or something, if it happened during the day and the kids are at school or something, you know. You’ve got to try and find a way to get them if you’re a farm person or something. You’ve got to try and fetch them from school or something (Esperance resident).*
Decision influences to drive into floodwater

Respondents (n=116) were asked to rate the extent to which a list of possible predefined influences had had on their decision making. Respondents rated each of these on a scale of one to five, where one indicated no influence at all and five indicated a great deal of influence. Results are summarised in Table 17. The most significant influences were found to be that no practical alternate routes were available; the driver had confidence in their vehicle; the floodwater was only shallow; the driver knew the road well; the floodwater was not flowing fast and the driver had driven through floodwater before.

Table 17: Influences on decision making (n=116)

<table>
<thead>
<tr>
<th>Possible Influence</th>
<th>Average score out of 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>No practical alternate routes were available</td>
<td>4.22</td>
</tr>
<tr>
<td>I was close to home or work</td>
<td>2.59</td>
</tr>
<tr>
<td>It was urgent that I got somewhere</td>
<td>2.66</td>
</tr>
<tr>
<td>The floodwater was only shallow</td>
<td>3.89</td>
</tr>
<tr>
<td>I have driven through floodwater before</td>
<td>3.46</td>
</tr>
<tr>
<td>Floodwater was not flowing fast</td>
<td>3.75</td>
</tr>
<tr>
<td>I knew the road well</td>
<td>3.76</td>
</tr>
<tr>
<td>Others were driving through it</td>
<td>2.81</td>
</tr>
<tr>
<td>It was difficult to turn around</td>
<td>1.86</td>
</tr>
<tr>
<td>There were barricades on the road side</td>
<td>1.55</td>
</tr>
<tr>
<td>Felt pressured by passengers</td>
<td>1.14</td>
</tr>
<tr>
<td>Felt pressured by other motorists</td>
<td>1.18</td>
</tr>
<tr>
<td>I had confidence in my vehicle</td>
<td>3.95</td>
</tr>
<tr>
<td>It was fun to do</td>
<td>1.72</td>
</tr>
<tr>
<td>Alcohol or drugs made me feel more confident to do it</td>
<td>1.03</td>
</tr>
<tr>
<td>I feared becoming isolated</td>
<td>1.54</td>
</tr>
</tbody>
</table>

Respondents (n=117) were also asked how many other drivers they believed also drove through floodwater, to assess to the extent to which those who drove through floodwater associated the practice as being part of a wider group norm. Some 55% (n=65) of respondents felt that between 61 and 100 percent of other drivers also drove through floodwater, reflecting that there is a perception that the majority of other drivers also enter floodwater. This perception is consistent with results outlining how many drivers actually do enter floodwater. Overall results are summarised in Figure 34.
Of those who reported driving through floodwater, some 88% (n=101) said that they would drive through floodwater if faced with the same circumstances in the future. Eleven percent (n=13) said that they were unsure and only one respondent said that they would not, that respondent noting that it was because their experience had been “scary”. Ninety-five percent (n=61) of males would drive through floodwater if faced with the same situation compared to 78% of females (n=40).

Those who had driven through floodwater were also asked if there had been an occasion when they had chosen not to drive through floodwater. Some 83% (n=96) responded that there had been a time when they had chosen not to enter floodwater, indicating that they likely used some judgement to decide whether to enter floodwater. Responses did not vary by gender.

All of those who had at any time over the last summer or wet season chosen not to enter floodwater (n=173) were asked for their reasons why. The main reasons nominated included the depth of floodwater (60%; n=103), the speed of the floodwater (55%; n=95), damage to the road (38%; n=65) and the existence of an alternate route (31%; n=54). Other less popular reasons nominated included debris in the water (17%; n=30), that the driver did not know the road (16%; n=28) and that the driver was in a small vehicle (15%; n=23). Of interest was that only 6% (n=10) nominated that they were influenced in their decision by passengers being in the vehicle. Overall results are summarised in Figure 35. Reasons provided by focus group participants were similar to those surveyed, including that the water was deeper, faster and contained debris.
Figure 35: Why did you choose not to enter floodwater? (n=173)

Focus group participants spoke of their actions when they chose not to enter floodwater:

*Sometimes I've travelled and it's been flooding I've either delayed my trip or taken the roads that have been designated as safe detour roads. Or have gone the way that they say you should go on detours and things like that* (Esperance resident).

*If I see water, even the last floods where I was going along the road where there's water, if I didn't have to go through I wouldn't. Especially with kids in the car* (Esperance resident).

Survey respondents who did not enter floodwater at any time during the last summer or wet season were also asked what concerned them most about entering floodwater. The largest concern expressed was the risk to their own health and safety (91%; n=158), followed by the risks to the health and safety of passengers (68%; n=118), the possibility of damaging their vehicle (57%; n=100) and the possibility of requiring rescue (55%; n=96). Overall results are summarised in Figure 36.
Survey respondents expressed concern about complacency and that people needed to use their common sense, saying:

You can’t combat stupidity/ natural selection; people are also very complacent about things they shouldn’t be, you cannot help that. I strongly believe that people need to take more responsibility for their own actions. Lives were only lost due to their irresponsibility of entering floodwaters.

It’s more of a common sense issue. Some people that have lived here their whole life or a while might think ‘she’ll be right mate’ and are willing to take silly chances.

Stories of people that drove through floodwater

Focus group participants who had entered floodwater shared some of their stories of when they had entered floodwater. Many stories reflected changing flood conditions that often caught drivers off-guard; that experiences of driving through floodwater are not transferable and that conditions at the same floodway can differ between floods. Others illustrated self-efficacy judgements involving assessing levels of confidence in vehicles and driver capabilities. Some stories included:

Well I can tell you driving through water, when I first looked at the water and I knew the road, I’ve been here most of my life and the water was probably about eight inches deep. I thought well that’s all right for my van, my car will take that easily and I started into there and it was probably a 200 metre stretch. Then all of a sudden that water rose up to nearly three feet instantaneously. My car stalled and if it wasn’t for his wife behind... I put my head out and said, “[Lenny] push me, push me”, because my car was going - it would all have ended up in the bloody water because from there instantaneously my car starting to shift on the road (Ravensthorpe resident).
I've been into the flooded river before; got cut off before. I used to go everywhere in the old Nissan. This time it fell in a hole which had never been in this crossing before in the river out here, and fell into the hole and then it stalled and then the dog was in the back, got washed out through the window. When I let the window down Andy climbed out the window and got on the roof and climbed down and then he ran home, which is about four kilometres. Even with my expertise and part of my job is to control these tracks that we've got and I'm going through water quite a bit. But that is one time I got caught and I was actually bloody frightened too (Ravensthorpe resident).

Because we'd gone out to the bridge on the Sunday and we drove through it and it was fine and then coming back through we actually had a moment of crap because it had changed so quickly (Ravensthorpe resident).

After all the flooding was on the way down, it was predictable that the flood’s going to get better, but it's not going to be worse. When we went straight back to work, we were still driving through deep puddles. Because we worked one week on one weekend off, we decided drive from Albany all the way to the mine sites, and through all the rivers and back crossings. But because we were all quite experienced in four-wheel driving and stuff, we knew we can do it, no one else can do it. But like all the little city cars that are going down, you’d see a bunch of people parked on the side. We’d say we could tow you through if you want, but it’s probably not worth it, because there’s about four or five crossings five k’s down the road you have to deal with too. The only time we’d go through flood waters is if we wanted to do a week worth of work, because there’s nothing else to do. For us it was, we deemed it safe to cross so we thought to ourselves, well we’re capable of doing it and we’ve got the gear and the help, that if we do something wrong, we’ve got another car that can help us (Esperance resident).

Once you go in, you’ve got to know if you can come back out. If there’s something in front of you, like if you feel your wheels sink down, you want to know that you can go back. We’d look at the crossing and go oh well, it looks quite washed out from the gravel road, we’ll slowly creep forward and then go oh, it’s too dangerous. If there was no way out, and you can’t see in front of you, you’re pretty much stuck there. Pretty much you’d come up to a crossing and look at it and go, we probably can’t get out of that, so we’ll not go through that crossing (Esperance resident).

Yeah, we drove through, not the recent floods, but a few years ago. I guess when the weather system was actually occurring at the time, before roads were closed off and it was towards Corrigin or just out of Corrigin. We got to a place where the road was flat, but really I guess low and just open paddocks on either side. The water was just flowing over quite an expanse through paddocks, across the road. The traffic had slowed down and there were people waiting to cross. I think we were probably the last vehicle to get across. Yeah you just certainly waited to see what was going to happen ahead before you took on ‘cross the flood water. But I remember at the time, and the water, it was really flat land, so it didn’t feel like we were going to drop off the edge of anything. But it was still concerning as to how fast the water was rising, as you were crossing through. Although as you entered it might have seemed shallow when you got to the next point, was it still going to be that. Then by then, I think we were the last ones through, then the police arrived and closed it (Esperance resident).

Our family does a lot of off-roading, so during all the flooding, half of us were back at Albany having a break. When we tried to cross some of the crossings, we’d look at it and go, “well
that looks deep”, and if we've got little petrol cars or something that needs to get through, we'll switch them off and tow them through with a bigger diesel car. But every now and then accidents happen and one of our mates decided it would be a great idea to go through by himself, and swamped his car. Two weeks later we towed it out, but if the water was flowing, which it was for a little bit, his car actually started going sideways. We were quite concerned, because if it was anywhere else, his car would have just been taken downstream. He said he couldn't actually get out with the water flowing on his doors, he couldn't push hard enough to open it. He had to wind his window down and crawl out as the cars on the side in the bush. He said it was quite scary, he said he would never cross a river again, unless someone else is there to help him, if he got on his side or something. I haven't actually crossed flash flood water before, so I don't know what it's like. But crossing flowing streams, if you're not experienced, you'll see everyone else do it and go I'm good, I can do that. You do it and you get all nervous and you tense up and it's a bit of a different experience if you've never done it before (Esperance resident).

It's usually a flat, one of the crossings - on the detour road between Jerramungup and Ravey, across the Philips River wash out. You go down two gravel roads, ... All the detours say you keep going and you go all the way around up to Lake King or something. If you know your stuff, you take a few shortcuts and cross a few rivers, that are still flooding and still technically closed off. But you'll just cross them anyway because it cuts off three hours off your drive. At night time, we usually tow a trailer to our workshop, up in the dark, about two tonnes on the trailer, so it was quite a hefty drive. We usually drive at night time through just the standard bitumen road that was flooded. You just look at all the reflectors down the road and just keep your car in the middle of the road the whole way, and just trust that there's no big pothole or something you can get stuck in. Just hope, just hope that you can just keep going down the road and not get stuck. We did that quite a few times. After the first time, you get used to it and I guess if it kept changing, you would think that it's still good. But if something changed like the water level went up or the speed of the water increased, you would probably still think it's all right and just go for it anyway. I guess one of the guys who got washed out and didn't end up too well for him: he went through one crossing, got to the next one and went oh can't go that way, so we'll go back. Then apparently, he didn't survive that one too long (Esperance resident).

I've driven through the Ord River when water was just lapping over the door. Managed to get behind a truck, one truck came behind me and got washed away. We were going to Wyndham, there were a lot of cars there, but you could see the pegs and the water was dropping. We had been crossing the river all the time to and from work, so I am used to it. Bit silly at that time, wanted to go to a party. Just lucky to make it through. Everyone was yelling, “Go back you silly bastard”. But there was only one little section of strong current there (Fitzroy Crossing resident).

We were out in the community all together, the road ... we managed to get the old Falcon across to the other side and drove into Fitzroy... I was driving and the water up to here [points to neck]. Just to get to the pub. We were not worried about anything (Fitzroy Crossing resident).
Characteristics of flood environment when driving through floodwater

Respondents (n=116) nominated the greatest depth of floodwater that they had driven through over the last (2017) summer and wet season. The most frequently nominated depth was 45 to 60cm (28%; n=33), followed by 30 to 45cm (27%; n=31). Overall results are shown in Figure 37.

Figure 37: What was the greatest depth of floodwater you drove through last summer or wet season? (n=116)

Respondents were asked what was the fastest flowing floodwater they had driven through. The majority had driven through water that was described as moderate flow (41%; n=47) or slight flow (38%; n=44). No respondents answered that they had travelled through water described as raging, though 12% (n=14) said that they had driven through water described as having a rapid flow. These results show that, although motorists will take the risk of entering flowing water, they do moderate their decisions based on the velocity of the water flow. Overall results are presented in Figure 38.
Drivers of 4WDs and bus/trucks tended to drive through deeper water than those of other vehicles, as shown in Table 18. Drivers of hatchbacks, non-4WD SUVs and sedans/station wagons rarely attempted anything deeper than 45cm. 4WD drivers frequently drove through floodwater of 45-60cm (32%; n=27), 60-95cm (21%; n=18) and some, over 95cm (8%; n=7). A similar pattern is seen when looking at the velocity of floodwater: drivers of sedans/station wagons/hatchbacks often drove through a slight flow and sometimes a moderate flow but never a rapid flow (see Table 19). 4WD drivers most frequently drove through slight or moderate flows also, but 12 (14%) drove through rapidly flowing floodwater. There was a greater frequency of males driving through deeper floodwater than females, as shown in Table 20. The majority of both male and female respondents drove mainly through slight to moderate flows of floodwater. A greater proportion of males (n= 11; 17%) entered rapid flows when compared to females (n=3; 6%).

Table 18: Number of responses depth of floodwater driven through vs. vehicle type

<table>
<thead>
<tr>
<th>Type of vehicle driven through floodwater</th>
<th>Depth of floodwater driven through (in cm):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;15</td>
</tr>
<tr>
<td>2WD Ute</td>
<td>0</td>
</tr>
<tr>
<td>4WD</td>
<td>3</td>
</tr>
<tr>
<td>All wheel drive</td>
<td>0</td>
</tr>
<tr>
<td>Bus or truck</td>
<td>1</td>
</tr>
<tr>
<td>Hatchback</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
</tr>
<tr>
<td>Sedan/ Station Wagon</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7</td>
</tr>
</tbody>
</table>
Table 19: Number of responses velocity of floodwater vs. vehicle type

<table>
<thead>
<tr>
<th>Type of vehicle driven through floodwater</th>
<th>Velocity of floodwater driven through:</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Still</td>
<td>Slight flow</td>
<td>Moderate flow</td>
<td>Rapid flow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2WD Ute</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4WD</td>
<td>5</td>
<td>32</td>
<td>36</td>
<td>12</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>All wheel drive</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Bus or truck</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Hatchback</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Sedan/ Station Wagon</td>
<td>2</td>
<td>7</td>
<td>4</td>
<td>0</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>44</td>
<td>47</td>
<td>14</td>
<td>116</td>
<td></td>
</tr>
</tbody>
</table>

Table 20: Gender vs. depth of floodwater

<table>
<thead>
<tr>
<th>Gender</th>
<th>Depth of floodwater driven through (in cm):</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;15</td>
<td>15-30</td>
<td>30-45</td>
<td>45-60</td>
<td>60-95</td>
<td>&gt;95</td>
</tr>
<tr>
<td>Female</td>
<td>4</td>
<td>10</td>
<td>16</td>
<td>17</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Male</td>
<td>3</td>
<td>8</td>
<td>15</td>
<td>16</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>18</td>
<td>31</td>
<td>33</td>
<td>19</td>
<td>8</td>
</tr>
</tbody>
</table>

The majority (79%; n=92) of the 117 respondents who provided information as to when they drove through had driven through floodwater whilst it was daylight. A further 15% of respondents (n=18) had entered floodwater at dawn or dusk. Of concern was that some 9% (n=10) had entered floodwater at night time without street lighting present, making it difficult to assess flood conditions before entering. Overall results are presented in Figure 39.

Figure 39: Generally did you drive through floodwater when it was? (n=117)
It is clear that drivers did not enter floodwater without feeling some sense of danger. Respondents (n=117) were asked to rate the greatest level of danger they felt when they drove through floodwater. Forty percent (n=47) reported that they felt low danger, whilst 33% (n=39) reported feeling medium danger. Some 10% (n=11) felt a level of danger that was either high or extreme. Results are summarised in Figure 40.

![Figure 40: What was the greatest level of danger you felt when you drove through floodwater? (n=117)](image)

Relatively few 4WD drivers (14%; n=12) reported that the greatest danger they felt was insignificant – so even in a 4WD the drivers rarely felt completely safe whilst crossing floodwaters and, in nine cases (11%), reported feeling a high to extreme level of danger.

**Driver reaction to road closures and signage**

Respondents (n=117) were asked if they recalled any depth markers or flood danger signs when they drove through floodwater. Half (50%; n=58) of the respondents indicated that they did recall depth markers and signs. The results indicate that, although depth markers and signs in some instances may inform driver decision making, they do not prevent drivers from entering floodwater. Depth markers and signs may not be present at all floodways, as also concluded by Austroads (2015).

Road owners closed roads to minimise risks to road users and to protect the road infrastructure. Road operators reported closing roads once they became flooded. In some instances, road closures were manned but, in others, due to insufficient resources, they could not be. Of considerable concern to incident management staff were occurrences of people ignoring road closure signs. One stakeholder said:

*Greatest concern was people driving through road closed signs. A lot of people were driving through road closed signs. There was concern that local property owners had tractors at road crossings pulling cars through floodwater. There didn’t seem to be much thought given to the consequences if things went wrong (local emergency service stakeholder in the south of WA).*
Some 17% (n=20) of respondents (n=117) indicated that they had driven around road closure signs or barricades. Observations of people driving around road closure barricades and signs were also supported by road operators and police. Police said that if resources had been available they would have fined motorists observed ignoring road closure signs. Focus group participants also commented on the use of road closure signage:

Unless it was physically a barrier put up across the whole thing they still go around it (Ravensthorpe resident).

A road closed sign means absolutely nothing to everybody (Fitzroy Crossing resident).

Some effort to educate motorists about not driving through road closure signs was observed at the Derby Tourist Information Centre, where a poster encouraging motorists not to drive through road closures signs was displayed (Figure 41).

Figure 41: Road closure education post at Derby Tourist Information Centre

Focus group participants were asked how they react to “road subject to flooding” and “floodway” signs. Participants commented that they pay attention to such signs when it has been raining and
that the signs communicate the message that the road section can flood. Some noted that they would slow down and that signs were important for tourists. Others indicated that they were largely ignored, especially outside of flood events. Participants stated:

That if it’s raining, to watch out, because could be some water on the road.

Out at farmland usually you just ignore them, you go oh, well it’s a dip in the road, oh well there’s a sign there. Usually in rain, heavy rain it’s maybe the creek crossing on the road is actually flowing. But usually on your daily drive to work, you cross four or five and you just go oh, it’s just a dip, it’s nothing to worry about. Yeah it comes flood time, and you go oh, that’s why they’re there. But usually we just... out in the bush... just ignore them, just another sign (Esperance resident).

A local resident in Lake Grace reported that the community’s trust in road closure signage had previously been eroded when signs were left up for some time after a flood had passed.

Vehicle passenger dynamics

Respondents (n=117) who had driven through floodwater were asked if passengers were also ever in the vehicle. 68% (n=79) responded that passengers had been present. In 66% (n=50) of cases, passengers were male and in 57% (n=43) passengers were female. The average number of passengers in the vehicle when entering floodwater was two. The majority of passengers were aged between 21 and 50 years of age. In 23% (n=18) of cases there were children as passengers that were 11 years or less. The overall age distribution of passengers is summarised in Figure 42.

![Figure 42: Age distribution of passengers (n=117)](image)

Males were more likely to drive through floodwater whilst carrying passengers than females when considering those who did so during last (2017) summer/ wet season (see table 21). Both males and females beneath the age of sixty were most likely to drive through floodwater whilst carrying
passengers (table 19). Passengers overwhelmingly reported that the driver of the vehicle at the time was male (86%; n=24).

**Table 21 age vs. gender of those drivers who carried passengers through floodwater during last (2017) summer/ wet season**

<table>
<thead>
<tr>
<th>Drivers’ age</th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-30 years</td>
<td>9 (26%)</td>
<td>7 (17%)</td>
<td>16 (21%)</td>
</tr>
<tr>
<td>31-40 years</td>
<td>11 (31%)</td>
<td>8 (19%)</td>
<td>19 (25%)</td>
</tr>
<tr>
<td>41-50 years</td>
<td>6 (17%)</td>
<td>12 (29%)</td>
<td>18 (23%)</td>
</tr>
<tr>
<td>51-60 years</td>
<td>6 (17%)</td>
<td>9 (21%)</td>
<td>15 (19%)</td>
</tr>
<tr>
<td>61-70 years</td>
<td>2 (6%)</td>
<td>4 (10%)</td>
<td>6 (8%)</td>
</tr>
<tr>
<td>71-80 years</td>
<td>1 (3%)</td>
<td>1 (2%)</td>
<td>2 (3%)</td>
</tr>
<tr>
<td>81-90 years</td>
<td>0 (0%)</td>
<td>1 (2%)</td>
<td>1 (1%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>35 (45%)</td>
<td>42 (55%)</td>
<td>77 (100%)</td>
</tr>
</tbody>
</table>

Respondents were then asked what the passengers said about driving through floodwater. Seventy-five percent (n=59) said that the passengers had agreed with their assessment and in a small number of cases (n=7) it was reported that passengers had encouraged the driver to drive through. In only one case was it reported that the passenger said to not enter floodwater. This response was illustrated through the story of a focus group participant:

> I think we certainly did discuss it, “Should we, shouldn’t we, we’ve got a bigger car then them, they got through, do we risk it, and I think we should, we will, yeah” (Esperance resident).

Respondents who said they had been passengers in a vehicle that had driven through floodwater last (2017) summer or wet season were asked how concerned they had been during the experience. The level of concern varied, with the largest number of respondents (n=11) indicating that they had been a little concerned, whilst 9 respondents indicated that they had been concerned or very concerned. Figure 43 illustrates the overall spread of results. Passengers indicated that they had been most concerned about their own health and safety (n=13), the health and safety of others in the vehicle (n=11) and the possibility of damaging the vehicle (n=9). The age of the driver ranged almost evenly across all age groups between 21 and 70 years of age.

Whilst the vehicle was driven through floodwater, respondents recalled staying quiet to allow the driver to concentrate (n=12) or taking an active role in assisting to cross the water such as keeping a look out for debris (n=9) and helping to direct the driver (n=6).
Figure 43: How concerned were you as a passenger about driving through floodwater? (n=28)

Frequency of people walking or swimming in floodwater

Respondents (n=265) were asked how many times they may have walked or swum in floodwater in the last ten years. The majority (57%; n=150) indicated that they had never walked or swum in floodwater over the last ten years. However, 43% (n=115) of respondents indicated that they had done so. Overall results are shown in Figure 44. These results show that people have been less likely, in the past, to swim or walk through floodwater than to drive through it. Although the majority of people have not walked or swum through floodwater, a large number have engaged in these activities.

Figure 44: Approximately how many times have you walked or swum in floodwater in the last ten years? (n=265)
Respondents were asked if they had entered floodwater on foot or by swimming during the last (2017) summer or wet season. Thirty-six percent (n=81) of respondents who had encountered floodwater indicated that they had, whilst 64% (n=144) indicated that they had not.

Those who had entered floodwater by walking or swimming last (2017) summer or wet season were asked if there was a time when they had chosen not to walk or swim in floodwater. Seventy-eight percent of respondents indicated that there had been a time when they had chosen not to thus enter floodwater.

Of all those who, at any time, choose not to walk or swim though floodwater, the most common reasons for not doing so were that it was not necessary (57%; n=116) and that water was flowing too fast (44%; n=90) or too deep (42%; n=85). Some respondents had also chosen not to enter floodwater on the basis that there was debris in the water (24%; n=49). Overall results are illustrated in Figure 45.

![Figure 45: Why did you choose not to walk or swim in floodwater? (n=205)](image)

People were most concerned, regarding swimming or walking through floodwater, with the possibility of drowning (73%; n=150), becoming injured (69%; n=142) or becoming sick (42%; n=86).

A focus group participant spoke of risks associated with contaminants in floodwater:

*Then you actually didn't consider, yes you knew there had been floodwater and everything, but you still let your kids go and swim and be part of the swimming lessons because you needed that certificate and then for them to have a skin condition that followed because of it wasn't sea water they were swimming in.*

**Who walks or swims in floodwater?**

A higher proportion of males (54%; n=61) than females (36%; n=53) had walked or swum through floodwater over the last ten years (Table 22). Males were also likely to have walked or swum through floodwater more frequently, with 12% (n=14) of males compared to 3% (n=3) of females having walked or swum through floodwater more than ten times in the last ten years.
When considering age, the majority of those from both sexes who had walked or swum through floodwater at least once over the last ten years were between the ages of 18 and 60, as shown in Table 22. These results, however, do not report on the prevalence of those younger than 18 as the survey was restricted to adults.

**Table 22: Age and gender vs. walking or swimming in floodwater over the last ten years**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Male and entered floodwater at least once in the last ten years (%)</th>
<th>Female and entered floodwater at least once in the last ten years (%)</th>
<th>Total (%) entered floodwater at least once in the last ten years.</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-30</td>
<td>12 (20%)</td>
<td>15 (28%)</td>
<td>27 (23%)</td>
</tr>
<tr>
<td>31-40</td>
<td>12 (20%)</td>
<td>14 (26%)</td>
<td>26 (22%)</td>
</tr>
<tr>
<td>41-50</td>
<td>10 (16%)</td>
<td>7 (13%)</td>
<td>17 (15%)</td>
</tr>
<tr>
<td>51-60</td>
<td>17 (28%)</td>
<td>12 (23%)</td>
<td>29 (25%)</td>
</tr>
<tr>
<td>61-70</td>
<td>6 (10%)</td>
<td>2 (4%)</td>
<td>8 (7%)</td>
</tr>
<tr>
<td>71-80</td>
<td>3 (5%)</td>
<td>3 (6%)</td>
<td>6 (5%)</td>
</tr>
<tr>
<td>81-90</td>
<td>1 (2%)</td>
<td>0 (0%)</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>Total</td>
<td>61</td>
<td>53</td>
<td>117</td>
</tr>
</tbody>
</table>

There tended to be a greater number of people who had some confidence (medium, high or very high) in their swimming ability amongst those who had walked or swum through floodwater (Table 23).

**Table 23: Number of responses times walked/swum through floodwater vs. confidence in swimming ability**

<table>
<thead>
<tr>
<th>Approximately how many times have you walked/swum in floodwater in the last ten years?</th>
<th>How would you rate your confidence to swim 50 metres?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Low</td>
</tr>
<tr>
<td>Never</td>
<td>14</td>
</tr>
<tr>
<td>&gt; ten times</td>
<td>0</td>
</tr>
<tr>
<td>At least once or more</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
</tr>
</tbody>
</table>

Similarly to the analysis of who drives through floodwater, residents in the north of WA, in general, tended to walk or swim in floodwater more often (Table 24). 109 respondents were identified as living either north of Onslow or from Kalgoorlie southwards who gave a positive response to this question. Of the 25 residents in the north of WA, 14 (56%) had walked through or swum in floodwater more than three times in the past ten years. On the other hand, the majority (n=43 or 51%) of the 84 residents in the south of WA responded that they had walked through or swum in floodwaters only two to three times in the past ten years.
Table 24: The influence of geography on the likelihood of walking or swimming in floodwater

<table>
<thead>
<tr>
<th>Approximately how many times have you walked/swum in floodwater in the last ten years?</th>
<th>North or south of Western Australia?</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N from Onslow</td>
<td>S from Kalgoorlie</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Only once</td>
<td>5 (20%)</td>
<td>22 (26%)</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>2-3 times</td>
<td>6 (24%)</td>
<td>43 (51%)</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>4-10 times</td>
<td>5 (20%)</td>
<td>11 (13%)</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>more than 10 times</td>
<td>9 (36%)</td>
<td>8 (10%)</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>84</td>
<td>109</td>
<td></td>
</tr>
</tbody>
</table>

Those who worked mainly outdoors were more likely to have walked or swum in floodwater at least once over the last ten years (n=39/68, 57%) when compared with those respondents that worked mainly indoors (n=40/105, 38%). Those who worked mainly outdoors were also more likely to enter floodwater more frequently than those who worked mainly indoors (Table 25).

Table 25: The influence of occupation on the likelihood of walking or swimming in floodwater

<table>
<thead>
<tr>
<th>What best describes your occupation?</th>
<th>Approximately how many times have you walked/swum in floodwater in the last ten years?</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never</td>
<td>At-least once</td>
<td>&gt; ten times</td>
</tr>
<tr>
<td>Employed and work mainly indoors</td>
<td>65 (62%)</td>
<td>40 (38%)</td>
<td>4 (4%)</td>
</tr>
<tr>
<td>Employed and work mainly outdoors</td>
<td>29 (43%)</td>
<td>39 (57%)</td>
<td>8 (12%)</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>14 (44%)</td>
<td>18 (56%)</td>
<td>5 (16%)</td>
</tr>
<tr>
<td>Retired</td>
<td>28 (66%)</td>
<td>14 (33%)</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>11 (85%)</td>
<td>2 (15%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Total</td>
<td>147</td>
<td>113</td>
<td>18</td>
</tr>
</tbody>
</table>

Walker or swimmer behaviour

Respondents were asked what precautions they had taken, in general, before walking or swimming through floodwater. The most frequently nominated precautions included checking depth of floodwater (84%; n=52), assessing how fast the water was flowing (82%; n=51) and looking for debris (61%; n=38). Other less frequent precautions undertaken included assessing water quality (27%; n=17), telling someone where they were going (24%; n=15) and swimming or walking with another person (19%; n=12). Overall results are summarised in Figure 46. One focus group participant spoke of conditions when it might be safe to walk through floodwater:

Anything waist below it is doable, but then up to your neck and swimming, water is cold, we have had a lot of drowning (Fitzroy Crossing resident).
Reasons for walking or swimming in floodwater

Respondents were asked their purpose for entering floodwater. The most frequent responses were to reach a destination (35%; n=27) or to check conditions before driving a vehicle across (31%; n=24). Overall results are illustrated in Figure 47.

A drowning prevention stakeholder stated that air temperature and boredom possibly played a part in people deciding to swim and play in floodwater. Provision of safe areas for children to swim...
such as swimming pools was seen as critical, where supervision can be provided and the water is clean. Specifically, it was stated:

*The kids love the rivers, especially when they are swollen. When the pool is closed, kids will swim in the river. They will take risks (drowning prevention stakeholder).*

The majority of males (29%; n=16) entered floodwater on foot in order to check the suitability for a vehicle to cross. In general, this activity was most common across the 31-60 year age groups. The next most common reason was to reach a destination (25%; n=14) and then for work (18%; n=10).

The most common reason for females entering floodwater on foot was in order to reach a destination (25%; n=13), then recreation (22%; n=10) and then to check the suitability for a vehicle to cross (13%; n=6).

One story by a focus group participant illustrated the reasoning and decision-making behind walking or swimming in floodwater:

*Our farm flooded back ages ago to the point where we had a harvester parked on the [plateau], and that's underwater. You could see the auger floating. That's about it. But because it was such a big vast area covered in water, you could see it flowing out there. But right in front of you it was calm so we just like played around in the water. Like some of us would stand in there and walk as far as we can go until we start losing traction. We had fun out there but we didn't realise what could happen. We just didn't care really. We just had fun.*

Factors influencing decision-making in walking or swimming in floodwater

Respondents were asked, from a series of pre-defined choices, to rate what the level of influence each choice had on their decision to enter floodwater. Seventy-nine respondents answered the question. Factors were rated on a scale of one to five, where one was “not at all” and five was “a great deal”. The most highly rated factors in the decision making were: “I know the area well” (3.11); “needed to get somewhere urgently” (2.72) and “there were others around” (2.45). These factors are summarised in Table 26.

**Table 26: Factors influencing decision-making factors in walking or swimming in floodwater (n=79)**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Average score</th>
</tr>
</thead>
<tbody>
<tr>
<td>It was hot</td>
<td>1.38</td>
</tr>
<tr>
<td>Needed to get somewhere urgently</td>
<td>2.72</td>
</tr>
<tr>
<td>There were others around</td>
<td>2.45</td>
</tr>
<tr>
<td>I was bored</td>
<td>1.24</td>
</tr>
<tr>
<td>I always do</td>
<td>1.59</td>
</tr>
<tr>
<td>Others were doing it</td>
<td>1.82</td>
</tr>
<tr>
<td>I know the area well</td>
<td>3.11</td>
</tr>
</tbody>
</table>

Entry of children and youths into floodwater

A small number of respondents (6%; n=15/251) reported that children or youths from their family had entered floodwater. These respondents were asked what precautions had been taken. Those most commonly nominated included regular supervision (n=11), assessing water speed (n=12), checking the floodwater depth (n=9) and checking of the water quality (n=7).
The most common influences on allowing children to walk or swim in floodwater included that it was easy to supervise and that the respondent was also doing it.

In one case on social media, when an image was posted depicting children water-skiing, with the aid of a 4WD, through what was interpreted as floodwater (Figure 48), there were conflicting views as to how safe the activity was. Firstly comments were made such as:

*Making the most of a bad situation.*

*Best dad ever.*

*A day they will always remember. Great to see a parent making special memories out of a unusual and damaging event. Love it.*

These comments were followed by:

*Unless that water is clear that is one easy way to injure or lose a kid in water that’s going to be full of debris and who knows what else that poses a hazard.*

![Children playing in water](Source: Ravensthorpe Agricultural Initiative Network)

*Figure 48: Children playing in water (Source: Ravensthorpe Agricultural Initiative Network)*

Similar debate was also mentioned by focus group participants:

*Well we got ridiculed too for - we took our kids down well after the flood if you could get down there. There were some photos of the kids standing on the thing, oh, you shouldn’t let kids stand that close. But we could see exactly where - what was underneath us. We wouldn’t have put our kids in that situation but because they just saw a photo and assumed, they were thinking how stupid (Ravensthorpe resident).*
The role of parents in discouraging children from entering floodwater was commonly raised by focus group participants, although participants noted that, on occasions, children may take little notice of advice provided by their parents. Participants stated:

I think if you’re a parent you’re going to tell your kids when there’s a big flood, listen I’ve seen it, I don’t want you going anywhere near it (Ravensthorpe resident).

The parents they know no swimming, but the kids don’t listen. But having that parental control with your kids. I am sure the police have done the same, checking the floods and telling kids not to swim. But you can’t tell over 50 kids jumping off the bridge (Fitzroy Crossing resident).

Warnings and community information

Participants mentioned checking websites, including the Bureau of Meteorology weather radar and the Elders website, listening to radio stations and observing local environmental cues in order to obtain information on flooding and heavy rain.

Stakeholders and focus group participants provided mixed feedback about warnings that were provided during the event. Though emergency service stakeholders reported receiving little feedback from the community across southern areas, focus group participants and some stakeholders expressed that they received little to no warning of the possibility of severe flooding occurring and that it was difficult to identify the possible magnitude and local consequences that might occur as a result of the heavy rainfall. Despite receiving little warning, some acknowledged that there was little that could have been done to prepare anyway. Participants in southern WA said:

Not enough. The ramp-up doesn’t reflect what is going to happen, you get the weather waning, but you don’t realise all the water coming off the upper catchment and what that will equate to (Esperance resident).

Yes, we got nothing, it just randomly starting raining and it didn’t stop raining (Ravensthorpe resident).

Well there wasn’t something to say, oh, you’re going to get a big rain was there? (Ravensthorpe resident).

Just came from nowhere. The only warning we had, they did say that we were likely to get fairly heavy rain because of something or other (Ravensthorpe resident).

There wasn’t enough warning. It can stop raining, you don’t understand that floods happen after the rain finishes, when it builds up (Esperance resident).

It’s hard with rain because it rains all the time, you can really tell from a weather warning if it is going to be enough to cause a flood, often in Esperance they say it is going to rain, but it never does (Esperance resident).

Minor floodwater, people just listen to the word minor. It means nothing to me. People don’t understand the different flood classifications (NGO stakeholder).

It was said, by focus group participants, that warnings were largely issued from Perth, containing information mainly provided by the BoM and that few local specific warnings were issued to communities in the southern parts of the state. Stakeholders spoke of the need to improve local flood intelligence as a priority to enable more proactive and specific local information provision.
and planning. It was noted that some local governments were already reviewing flood plans. A local government stakeholder expressed concern with people's apathy to warnings.

Systems issues were also identified: in one case, it was identified that local government did not have a social media presence to distribute emergency information and was reliant on a local community organisation; there were also some concerns that some could not access information from the internet or smartphones. Focus group participants said:

*The Shire did the media releases, which was great, but they had no way of getting them apart from us, if we weren’t on call that weekend the information wouldn’t have gotten out... all they were putting out what roads were impacted... no other real safety information or anything.*

*We were logging on to get that information, but not everyone has the internet... some of the older generation probably wouldn’t... they don't like to embrace the smart phone technology (York resident).*

A first-pass assessment of messages promoted in warnings and information provided by stakeholders also identified some inconsistent messaging regarding driving through floodwater. Some messages urged people not to enter floodwater, whilst others left motorists to make their own decisions by stating do not drive into water of unknown depth and velocity. On some occasions it was reported that messages suggested that motorists should first walk the flooded road section to assess the depth and speed of water.

**Local Roads Information**

Information about main roads is provided by Mainroads Western Australia (Mainroads WA) through the Mainroads WA website, social media, traditional media, engagement with road houses and VMS boards (Figure 49). Local roads information is generally managed by councils, which was reported by stakeholders to be promoted by links on the Mainroads WA website. Some affected councils mentioned communicating information about local road closures through social media and their website, sometimes through a third-party community organisation such as the Community Resource Centre. Focus group participants reported utilising social media, local council or Mainroads WA websites, word of mouth, emails from road organisations and calling the police or Mainroads WA to get roads information. Local government also mentioned posting information at tourist information centres (Figure 50). It was also recognised that community members shared road information between themselves, utilising social media, based upon their own observations of road conditions.

Participants recommended that weather, flood and road information should be linked together and available from the one website. Two-way radio was recognised as a method of communicating roads information to remote communities.
Figure 49: Mainroads WA road closure information sign in the Kimberley

Figure 50: Roads information at the Fitzroy Crossing Tourist Information Centre
Feedback was provided about roads information. In some instances it reflected that roads information could be confusing or out of date. Some stakeholders questioned the reliability of the information: “Will it be like that when I get there?”. It was recognised that, often, members of the public do not understand who the road owner is and often believe that Mainroads WA owns and operates all roads. Participants said:

There was often some confusion when roads were flooded. Which roads are they? How long are they going to be cut off? What are the alternatives? Sometimes you needed to go looking (Esperance resident).

I think the [web] site you went to, not that I remember what it was, you got on, it said the road was still closed or if it was open… it said there was detour, but didn’t exactly tell you. What if I missed the detour?… Wasn’t as clear as what it possibly could be (Esperance resident).

If I am thinking of going somewhere I look up the Department of Transport website, to see if there are any roads that have been closed. Usually it is up to date but not always up to date. The Shire is probably better than the Department of Transport (Broome resident).

We get tourists come through, how are they going to find the information… people don’t know Australia… most are elderly tourists so they are not very computer literate (Broome resident).

Once LEMAC got their hands on how bad the communication was in regard to the roads and got that sorted out then there was a bit of a plan put out. But that took about six days from memory, took about six days to let people know what was going on (Ravensthorpe resident).

Some focus group discussion reflected on how quickly road information can change. For example:

Everyone on Facebook four hours ago said this road was fine, you rock up and there’s a big rut in it, you can’t drive past, there’s no sign, because they can’t get there. A bit of information on where things, because it changes so quickly, it’s very hard to figure out things, like which roads are safe, which roads are rutted out. How severe it is, because you could cross it if you had a bigger car. Yeah, because it’s happened so quickly it’s hard to know (Esperance resident).

Focus group participants raised the need for more signage during floods to provide early notification of flooded roads. In some instances in southern WA, local councils and Mainroads WA reported difficulty in closing roads as they were difficult to access or as they simply ran out of road closure barricades and signs. Mainroads WA and local emergency services raised issues relating to communicating roads information to tourists.

Detours were provided to encourage motorists to take alternate routes. It was reported, however, that not all motorists chose to follow detours and, when they did, a small number of drivers became lost on roads that they were not familiar with. Focus group participants in the southern section of WA complained of detours being poorly signposted and that the condition of some roads that were part of detours was poor. Detours could also be very long, adding hours to the length of trips. A participant said:

I found that detour was really bad too. We went on there to - obviously everyone has to use it and the amount of dust… you can't see in front of you, you can't see what's coming next to
you. The amount of times you'd be driving and it'd just be full of dust and the next thing a truck goes past I'm like, oh x?zt!! (Ravensthorpe resident).

Stakeholders in the south of the state stated their concern that people were not accessing roads information during the floods to plan their journeys, whilst in the north it was reported that tourists were mainly proactive in seeking roads information. It was suggested that, if possible, information be provided about the likely lengths of time a road section may be closed. Another suggestion was that, when communicating roads information to tourists, consideration also be given to the possibility that English may not be their first language.

Future management strategies

The majority of all survey respondents would encourage others not to enter floodwater in the future (74%; n=179).

Respondents (n=242) were asked to rate the extent to which they agreed with possible management solutions to reduce the number of people entering floodwater. Respondents were asked to rate on a scale of strongly agree (5), agree (4), neither agree or disagree (3), disagree (2) and strongly disagree (1). Based upon these ratings, respondents most clearly agreed with strategies of improving flood safety education (4.1/5) and providing improved information about what roads are flooded (4/5). Respondents showed some degree of agreement with improving information in warnings about possible impacts (3.8/5), development of workplace-based policies to discourage employees from entering floodwater (3.7/5) and building roads higher so motorists do not need to drive through floodwater (3.1/5). Respondents were largely neutral in their support for the installation of barricades on road edges to prevent vehicles from being washed away (3/5), participation as part of a local project to raise flood safety awareness (2.7/5) and fining of people who drive though floodwater (2.6/5).

Some respondents specifically commented on road signage and road information, saying:

The person that gets the information first, I believe should act on it. By the time they tell other people, it’s usually too late. We got stock 30km away at a road that had 1.2 metre deep raging floodwater and got stuck for hours. Sometimes I get stuck for days. This is because information hasn’t been shared to surrounding areas (Esperance resident).

We got stuck on a flooded road. There was no signage, so we were stuck and had no choice but to go through it. It was a very scary experience. Afterwards we found out that there was a detour but there was no signage at the time and we hadn’t heard of it. There were no depth markers and there was a dip in the road, so it wasn’t possible to judge the depth (Esperance resident).

There needs to be signage at intersections quite a while before flooded roads so people are aware and don’t get stuck in dangerous situations. There also needs to be depth markers (Esperance resident).

Better advertising of alternate routes. Country people on isolated roads with no signs and no other way of getting home will risk the floodwaters to get home otherwise there can be no phone signal and nowhere to sleep or wait. No rescue when you are hundreds of kilometres away from Perth (Esperance resident).

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[6] Score based on 17 responses only
Last summer was one of the worst floods I’ve seen. I don’t think the road the man died on was closed. During that flood, none of the roads were closed. None were closed for at least 24 hours. So we need someone that monitors roads in flood events that can provide updates and close roads when they are unsafe. We had people in trucks and with caravans that were stuck because the roads were open and they had no way of turning around (Esperance resident).

The black and white posts marking the depth of the water on the water on the side of the road are the best thing for people during a flood event. With these, people can see what the actual depth of water is so they can make an informed decision. Without these, not everyone knows how to judge the depth of the water (such as utilising the surrounding vegetation depth). These should be placed in a lot of places (Esperance resident).

Need more signage.. obviously more road closed signs for the shire (Esperance resident).

Focus group participants noted experiences where their employer had encouraged them not to enter floodwater.

The organisation I worked for told people not to come in, so no point coming in you’re not going to make it, it was flooded in town. (Broome resident).

We got kicked off the mine site because we knew rain was coming. In our job any rain would cause the roads where we were working to be unsafe. Because we were out in a paddock. As soon as the rain was on the radar we left site, travelled back to Albany. Fortunately, I was on the way to Perth when all the flooding was happening, but some of our workmen had to get helicoptered out. We weren’t expecting much, we were just expecting some sloppy rain, some sloppy mud sorry, and it turns out all the bridges and all the roads to get to the mine site, were so destroyed that we had to get airlifted out, or some of us did (Esperance resident).

At Fitzroy Crossing, community members called for improved signage at known swimming spots and programs focused on the education of children regarding the dangers of swimming in floodwater. A stakeholder said:

Mainly building that skill about how to swim, when they are in that sort of situation with flood and a strong current coming through like they need to survive... It is more about survival then having a good swim. You can have a good swim in the swimming pool, but when you go into the river it is about survival. What do you know, having that knowledge, because we have floods every year, they train themselves so they know what to do (Fitzroy Crossing).

Figure 51 shows existing signage on a floodway outside of Fitzroy Crossing: no specific signage, however, was observed at the main bridge.
Preferred communication

Respondents (n=243) were asked who they most trust to receive advice about flood safety. Most trusted sources included the SES (65%; n=159), police (49%; n=121) and local council (44%; n=108). Overall results are summarised in Figure 52.
Focus group participants provided several suggestions as to who should provide safety messages. Some thought that government road agencies should provide messages to motorists, as the roads are owned and operated by government, and that such messages should form part of their safety campaigns. It was acknowledged that the tourism industry would be best placed to engage with tourists. For indigenous remote communities, it was suggested that community leaders such as chairpersons were likely the best people to provide safety messages to communities.

Survey respondents (n=241) were asked how they would most prefer to receive information about flood safety. The most common channels overall included social media (58%; n=140), television advertising (51%; n=122), websites (43%; n=103) and radio advertising (38%; n=92). Overall results are summarised in Figure 53.
When considering communication channels specifically to target males of various age groups who had previously driven through floodwater, similar results were found, as shown in Table 27.

Table 27: Number of responses communication channels to target males who had previously driven through floodwater

| How those who drove through floodwater last wet season prefer to receive flood safety information | Male age group (years) |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 18-30 | 31-40 | 41-50 | 51-60 | 61-70 | 71-80 | 81-90 | Total |
| Television advertising | 5 | 5 | 7 | 5 | 1 | 1 | 1 | 26 |
| Television news program | 2 | 2 | 7 | 3 | 3 | 1 | 1 | 19 |
| Radio advertising | 4 | 4 | 5 | 5 | 1 | 1 | 0 | 20 |
| Radio news program | 3 | 4 | 7 | 7 | 4 | 1 | 0 | 26 |
| Visit by SES | 4 | 4 | 2 | 2 | 0 | 0 | 0 | 12 |
| Mail (Postal) | 2 | 4 | 1 | 2 | 1 | 1 | 0 | 11 |
| Social Media | 8 | 7 | 7 | 5 | 5 | 1 | 0 | 33 |
| Attendance at a community meeting | 1 | 1 | 3 | 1 | 0 | 0 | 0 | 6 |
| Website | 5 | 5 | 7 | 4 | 4 | 0 | 0 | 25 |
| Newspaper advertising | 0 | 0 | 5 | 1 | 0 | 0 | 1 | 7 |
| Newspaper article | 1 | 2 | 2 | 2 | 1 | 0 | 1 | 9 |
| Programs at schools | 3 | 4 | 5 | 4 | 0 | 0 | 0 | 16 |
| Family and friends | 1 | 3 | 3 | 0 | 0 | 0 | 0 | 10 |
| Your employer | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 8 |

Focus group participants raised the need to use multiple channels to communicate flood safety messages. Participants mentioned the need for television advertising that focused on actual stories or hard-hitting real images. For example:
Why not do some real-life stuff where there's a flood and have a bloke on a rope with a harness and then on there watching him go down the bloody river (Ravensthorpe resident).

So definitely bringing life stories into a campaign would hit - I think would - yes, like they've done with the smoking ads (Ravensthorpe resident).

Some participants said that they would be happy to share their real-life experiences.

Some thought advertisements similar to existing fire ads would help, as they said that they had taken notice of them.

The need for improved signage to communicate flood safety messages was also highlighted. Roadhouses were identified as being a possible distribution channel for road and safety information during floods, as were text messages from local government to residents. It was noted that participants would likely access web-based information by first accessing an internet search engine such as Google.

Indigenous community focus group participants noted that Facebook and local radio were good communication channels as well as direct communication. Community leaders were viewed as the most appropriate to deliver messages. It was also mentioned that school teachers and the owners of local shops could be utilised to communicate messages. It was recognised that these people were present in the community and largely understood it. Though social media was considered effective, other focus group feedback identified challenges in communicating to households that do not have internet and that there is a need to also provide messages through noticeboards.

Specific feedback included:

The biggest complaint that we get up here is that we don’t have internet; we don’t have a computer; why aren’t you putting a sign on the notice board... many of the locals here do not have a computer in their house... they will go to the notice board outside the supermarket or the BP Roadhouse (Fitzroy Crossing resident).

It was noted that imagery was key to communicating with indigenous populations and that messages need to be simple and short. A focus on family was also seen as necessary, as family is important in indigenous communities. Materials, it was suggested, should be locally tailored and relevant, using local language where possible. It was noted that lessons could be learnt from previous indigenous public health campaigns in forming engagement strategies. Some specific feedback included:

The pamphlets that they send up here are absolutely useless for our local people... we need to put out stuff that people can connect with (Fitzroy Crossing resident).

People want pictorial stuff... Words mean nothing... there are different language groups, so one language may not be appropriate to another... it is the visual stuff that this community with look at (Fitzroy Crossing resident).

Schools programs were noted by focus group participants as being an important opportunity to promote safety messages with children. It was suggested that such programs should also include first aid and lifesaving skills. Other stakeholders also raised the need to engage with the media to minimise the use of imagery that may promote unsafe behaviours.

Thirty-six percent of respondents (n=87) indicated they had received flood safety information in the past, with this information largely being provided by local council (53%; n=46), SES (45%;
n=39) and Bureau of Meteorology (44%; n=38). Overall results regarding sources of previous flood information are summarised in Figure 54. It should be noted that in WA SES is part of DFES.

Focus group participants provided feedback about learning about flood risk through discussions with neighbours and other in the community either face to face or through social media. Several communities noted sharing information and images of the 2017 floods through social media.

**Figure 54: Source of previous flood information (n=86)**

**Engagement campaigns**

Focus group participants were shown a variety of images and slogans (“creatives”) used previously by other jurisdictions, including NSW, Qld and Victoria, to reduce the incidence of motorists entering floodwater. Participant feedback is summarised below.

**VICSES - “15 to float”**

**Figure 55: “15 to float” creative (Source VICSES)**
Focus group participants said that the key messages derived from the image and slogan (see Figure 55) included:

- No level of water is safe to drive in.
- To be aware of water and to stay out of it.
- That just a small amount of water can wash a small vehicle away.
- So, if there was even a little bit and you're in a small car, they don't do it.

Participants recognised that small cars are very light and that it does not take too much for them to float. One participant, however, believed that opening the doors of the vehicle would increase the weight of the vehicle and hence the amount of water the vehicle could drive through.

Some participants noted that the car in the image was not floating and suggested that it might actually encourage people to enter floodwater. Then again, other participants noted that they did not know previously that a small vehicle could float in 15cm of floodwater and hence had been informed. Some participants, though, questioned the validity of the message, stating “it has to get up to the doors to float, it rarely floats just up to the wheels”. Others thought that the message did not apply to them as they drove 4WDs or were experienced and had driven through more than 15cm of floodwater in the past without concern. Some saw the image and message as promoting people to enter floodwater.

NSWSES - “If it’s flooded, forget it”

Figure 56: NSW SES “If it’s flooded, forget it” creative

Focus group participants said that the key messages derived from the image and slogan (see Figure 56) included:

- Don’t go through the floodwater. It is dangerous. Keep yourself and your family safe.
Turn around get out of there.
Better to be safe than sorry.

Some participants said the graphic compelled people to turn around and avoid the water; others thought that the imagery was in conflict with the message, some thinking that the utility vehicle was doing a burnout that was dangerous. Participants felt that the image did not portray the dangers associated with floodwater and that the road did not look realistic. Others stated that they simply did not like the poster.

The bright colours were said to bring attention to the image.

Queensland – “If it’s flooded forget it” – with child, at night

Figure 57: Queensland Government – “If it’s flooded, forget it” creative – with child, at night

Focus group participants said that the key messages derived from the image and slogan (see Figure 57) included:

- Don’t risk yourself and your family. It is not worth it.
- Is it worth your life going into this?

Participants suggested that they would not be attempting to walk through the floodwater at night with children. Participants raised questions about what might be in the water and the risk that the adult could fall, placing the child at-risk. There seemed to be some confusion created by the message of not driving through floodwater and the image of a parent carrying a child whilst walking through the floodwater. Others were confused as to how the vehicle had driven into the floodwater in relation to the give way sign behind the vehicle and also commented that it appeared that the gentleman was walking into floodwater and not headed back where he had come from. For some the image was also too dark.
A participant commented about the terrifying nature of the image, commenting that they could not imagine anything worse than carrying out a couple of kids through floodwater at night. Further, the participant declared that it would be terrible to actually feel your car start to float.

Participants suggested that the darkness of the image meant that it may not standout as much as other advertisements and that it was actually preferable to see the image fully.

Queensland – “If it’s flooded, forget it” – 4WD on causeway

Focus group participants commented that the key message of the image and slogan (see Figure 58) were:

- Not to drive through floodwater.
- That a small amount of floodwater can wash a vehicle away.
- It is unsafe and it doesn’t matter what type of car you have it will be swept away by some sort of water.

Focus group participants thought the image and slogan communicated the message its creators were trying to get across.
Focus group participants said that the key messages derived from the image and slogan (see Figure 59) included:

- **You might as well drive into a river as you will achieve the same affect driving into floodwater.**
- **That you don’t know what’s underneath. You don’t know how deep it is, that sort of thing.**
- **Floodwaters are unpredictable.**
- **Makes you quickly realise that, yes, it can be quite dangerous.**

The image raised thoughts about the safety of the surface under the floodwater. Participants thought that the image stood out and communicated the message clearly. They mentioned that they observed the SES logo. People said that it was “scary” and “in your face”, and that it communicated that water can actually get deep enough to submerge a vehicle. There was some feedback that there may be too much wording on the image, but that the image itself is very powerful. Some comments reflected the fact that the vehicle was only a small car and that it was unsuitable to be near floodwater in any case.
Out of the five tested creatives, those most preferred by focus group participants were the Queensland “If it’s flooded, forget it” – 4wd on causeway (Figure 58) and the VICSES “You don’t know what you’re getting into” (Figure 59).

**DFES Brochure**

![DFES Preparing for storms brochure](image)

*Figure 60: DFES Preparing for storms brochure*

A historical DFES storm safety brochure (Figure 60) was also tested. This brochure was on display in York and was tested as an example of the style of publication commonly used by emergency services across Australia to engage with communities. More recent versions of this brochure are now available.

Participants did not feel that the design of the brochure compelled them to engage with it or to read it. Participants noted that there were a lot of words in the brochure and that key messages needed to be highlighted so that they stood out.

**Nominated safety messages**

Focus group participants were asked to nominate messages to dissuade people from entering floodwater. Messages included:

*Floods can kill.*

*Think about depth, flow and condition of the road.*

*Is your life worth this?*
It’s not worth driving, just stay out of the water.

Flooding is unpredictable.

Don’t risk your or your family’s life.

You could lose your family and friends driving through floodwater.

It can take a long period of time if you get washed from the road.

If you don’t know it don’t go.

If you are unsure just don’t do it.

No you don’t enter floodwater.

Is it really worth the risk?

Saving yourself ten minutes is not worth your life.
Discussion and Conclusions

Threats to those who drive, through or swim or walk in floodwater were seen as the community’s greatest concerns with respect to flooding. To bring about behavioural change in order to reduce these behaviours, it will be essential to adopt a multifaceted strategy consisting of measures that consider engagement, enforcement and incentives, engineering and emergency response. The discussion in this section is framed to inform the development of engagement strategies.

Development of strategies to reduce the number of motorists entering floodwater

Although almost all focus group participants recognised that driving through floodwater was dangerous and that, when doing so, survey respondents often felt some degree of danger, drivers were able to identify circumstances when it might be okay to drive through floodwater. For example, 26% of survey respondents indicated that it would be safe or somewhat safe to enter knee-deep still floodwater.

It is clear that entering floodwater is a frequent and entrenched behaviour, often a deliberate choice by drivers, as shown by the large number who had entered floodwater but had chosen not to enter in a different circumstance. The majority of those who had entered floodwater had done so on multiple occasions and intended to do so in the future if faced with the same circumstances.

Decision-making by those who attempt to drive through floodwater appears to consider four key elements: 1) the urgency of the need; 2) the perceived flood and road conditions at the time of the decision; 3) the perceived level of self-efficacy; and 4) the social context. This decision-making process is outlined in Figure 6.1. Interestingly, similar overall conceptual factors were also identified by Hamilton et al. (2016b), including outcomes assessment (similar to assessing flood and road conditions), social influences and self-efficacy, although individual elements described between the two studies do vary. It is possible that emotion also plays an important role in decision making. This element requires further research.

There are no precise methods of measuring many of the decision-making factors available to drivers identified in this study (e.g., assessing the relative hazard of floodwater based upon depth and velocity) and it must be considered that people are making judgements in environments that lack absolute certainty. Although many motorists have previously entered floodwater, they lack a sound knowledge of the limitations of their vehicles with respect to floodwater. It was indicated that, when drivers are uncertain, the behaviour would not be performed or that further actions would be performed to obtain further certainty, such as walking into the floodwater to assess the depth and velocity of the water before deciding to enter, or watching another driver drive across.

Results from this research show that more males drive through floodwater than females and that males appear to drive through floodwater on a more frequent basis and through floodwater that is likely to be more dangerous. Males younger than 60 and females younger than 40 are most likely to drive through floodwater. Those who are employed outdoors and who have confidence in their swimming abilities are also more likely to enter floodwater. The most common vehicle type to be driven into floodwater is 4WDs, with 4WDs also most likely to be driven through more dangerous floodwater.
Figure 6: Driving into floodwater decision making model

- **Perceived need**
  Emergency situation; to get home; for work; to get to work; to collect children; to check property; to reach a safer location; to visit friends and family; and for fun. There is no practical alternative route available.

- **Perceived flood conditions**
  Water depth is shallow; water velocity is slight; road surface is undamaged; no debris; and falling flood level. Little uncertainty in the assessment.

- **Perceived self-efficacy**
  Confident and experienced driver; confidence in vehicle; good knowledge of roads; confident around water and there are other people around. Can take measures to increase self-efficacy such as follow another vehicle through or increase weight of vehicle.

- **Perceived social context**
  Others are observed entering water; and passengers agree with assessment to enter floodwater.

**Decision**

**Driver encounters floodwater**
Key concerns of drivers considering entering floodwater were the drivers’ personal safety, the safety of passengers, the possibility of damaging the vehicle and the possibility of requiring rescue.

Sixty-eight percent of vehicles entered floodwater with passengers also in the vehicle. Although the majority of passengers were said to have agreed with the drivers’ assessment to enter floodwater, over 30% indicated that they were either concerned or very concerned about the decision.

Key audience segments

The target audience can be broken into a series of audience groups to target through engagement campaigns. These include:

- The worker or local resident: those who travel through floodwater to travel to and from work, or for work, to attend appointments or to collect supplies. These people are locals and are likely to be aware of and experienced with local flood conditions. It is likely that they have entered floodwater before, and believe they have the skills to assess the safety of floodwater and will enter if there is a need to do so.
- The thrill seeker: those who will actively seek out the risk for fun. They may or may not be local to the area. It is likely that they have entered river crossings and floodwater before.
- The newbies: those who are new or unfamiliar with an area and have little to no knowledge of the local flood environment. They are unlikely to have driven through floodwater before, especially in the area they are driving in, and may not understand their local environment. These may be tourists or new residents to a flood-prone area.

Development of strategies to reduce the number of people swimming or walking in floodwater

Our research was limited to adults. Those who participated in the research indicated that they did not engage in this behaviour as frequently as driving into floodwater, with the majority of adults having not swum or walked in floodwater over the last ten years. Swimming in floodwater was regarded by 95% of respondents as dangerous or very dangerous, recognising that there is a strong social norm that reflects the absence of this behaviour amongst the majority of the community. The main concerns people shared about swimming or walking in floodwater were that people might drown, become injured or become sick.

Swimming in floodwater appears in at least some instances to be a social or group activity, with some influence on the choice of whether to do so occurring as a result of other people also doing it or being in the vicinity.

It is clear that decision-making by adults, in the vast majority of situations, is deliberate and involved at least the assessment of flooding conditions. It would appear that most people walk or swim into floodwater to check if conditions are suitable for a vehicle to cross or to reach a destination.

Participants were commonly concerned about children swimming in floodwater and could identify spots where this activity regularly occurred. Adult males were more likely to have walked or swum through floodwater, and were more likely to undertake these actions more frequently. Adults engaging in the behaviour were between the ages of 18 and 60. People with a high confidence in their swimming ability, those who worked outdoors and those living in northern WA were all more likely to have walked or swum in floodwater.
Suggested strategies for behaviour change

Key strategies to promote behaviour change based upon the findings of this research are outlined below:

- **Design engagement campaigns to target motorists entering floodwater.** Simply communicating about the dangers and possible consequences of the behaviour is unlikely to be successful, as those undertaking the behaviour already acknowledge the dangers. It is suggested that traditional messaging such as “never enter flood water” requires further context, as many responding to the message have undertaken the behaviour before without severe consequence. Engagement campaigns should:
  - Question the ability of a driver to accurately interpret flood conditions and their ability to successfully cross the floodwater. This would include utilising imagery and messages that focus on the level of uncertainty associated with engaging in the behaviour. For example, “floodwaters can be difficult to judge no matter how experienced you are”; “do you really know how fast the water is flowing/what is underneath the water”; “floodwaters can change quickly: best not to take the risk”
  - Emphasise that the margin for error in decision-making can be very small: misjudging the depth of floodwater by a few centimetres can mean the difference between life and death
  - Question the transferability of experience. Messages that refute the transfer of previous experience should be promoted: for example, “it doesn’t matter how many times you have done it before, floodwaters are always different even at the same location: best not to take the risk”
  - Promote risks to others including the impacts on family. This could utilise a story line where a motorist decides to take an alternate route and makes it home safely with their family
  - Explore the specific risk in northern WA of being at risk in isolated and remote locations
  - Promote consistent actions including:
    - Always check road conditions before travelling when heavy rain or floods are forecast; don’t drive when you know roads may be flooded
    - If you encounter floodwater it is always the best decision never to enter; it can be difficult to assess the dangers posed by flooding, no matter how experienced you are; conditions are uncertain and can change rapidly
    - Avoid encouraging motorists to walk through the water to check conditions: this action promotes that it is safe to enter floodwater by walking, which may place people at risk. The message is also inconsistent with research into vehicle dynamics in floodwater, which suggests that it may be possible to walk a section of flooded road, but not possible to drive along the same section under the same flood conditions. Conditions can also rapidly change from what was assessed placing vehicle occupants in danger.
  - Use clear imagery and little text
  - Consider utilising real world stories of people who have experienced driving through floodwater and required rescue
  - Tailor messages, where possible, to the local flood risk and community
  - Provide messages to reinforce driving laws, such as motorists not only risk their life, but a fine if they travel through road closure signs
- Utilise digital media, including social media and websites
- Provide stories for 4WD magazines and actively engage with the industry, including 4WD training providers.

**Design engagement campaigns to target those who may walk or swim in floodwater.** Again, simply communicating the dangers of this behaviour are unlikely to be sufficient, as the danger is largely appreciated amongst adults. Engagement programs should:
  - Provide further context to the message of never to swim or walk through floodwater. Messages should promote the presence of factors that may not be easily seen or assessed, like debris in the water, such as broken glass or barbed wire; the presence of contaminants such as chemicals, oil and sewerage; hazardous currents; deep holes; and the presence of animals such as snakes or crocodiles. Messages should question the ability of an adult to assess these before swimming or walking, or allowing someone else to swim or walk
  - Encourage adults to communicate to children the dangers of entering floodwater
  - Discourage people from entering floodwaters to assess flood conditions for the reasons stated previously
  - Swimming in floodwater appears to be a social or group activity and people appear influenced by others also undertaking the activity. Promote the fact that the vast majority of people think that swimming in floodwaters is very dangerous and not to do it, in order to reinforce the social norm
  - Promote safe swimming locations and identify incentives for children and adults to swim at these locations rather than in floodwater.

- **Develop partnerships to spread the message.** Numerous partners exist for DFES to collaborate with to help promote the message. These include: Royal Life Saving; Mainroads WA; WA Police; local government; tourism operators; roadhouses; Red Cross, Bureau of Meteorology; trucking peak bodies, 4WD associations and trainers, RAC; Community Resource Centres and Aboriginal corporations

- **Promote safer driving through workplace policies.** With the high prevalence of people entering floodwater to get to work, to get home and for work there is an opportunity to promote safer driving during floods and severe weather through workplace safe driving and work, health and safety (WHS) policies. DFES could engage with peak business bodies and WHS regulators to achieve this

- **Make obtaining roads information easier.** Ensure processes are in place to obtain information about flooded roads from a single state-wide website, even if this involves linking to information made available on third party sites such as local government, as was reported as already occurring by some stakeholders interviewed. This website should be promoted as the most up to date and comprehensive site to obtain roads information. Where possible, also provide information about the possible length of closure so that motorists undertaking long journeys can plan ahead. DFES has begun the process of integrating roads information with the emergency.wa.gov.au website, which will have significant benefit when completed

- **Review flood risk signage.** Existing flood risk signage could more clearly articulate the risk of entering floodwater and provide advice to avoid doing so. Further collaborative research should be considered to identify the most effective design of revised signage. Signage should also be considered in known local areas where people may swim and play in floodwater
• **Engage with Children.** Seek to engage with children to promote safe swimming behaviours through swimming lessons and school programs. Children may also be important advocates in vehicles to express their fears when travelling through floodwater.

• **Engage with media organisations.** Engage with media organisations to discourage them from promoting unsafe behaviours.

• **Promote key messages in warning and emergency information.** Key messages should be prompted in warnings and emergency information products and be communicated through traditional and social media. Use imagery if possible to communicate messages. Tailor warning messages to the local community by providing information on possible local flood consequences. When incidents occur, promote these, when sensible to do so, and reinforce safe behaviours. When flooding is likely or occurring, people are most likely to engage about the issue.

• **Evaluation.** It is important to continually evaluate programs to ensure they are effective and that lessons are being identified and integrated into future engagement practices. Further simple research can be undertaken by DFES to support an ongoing knowledge base, by incorporating some fields within incident management reporting that capture the sex and approximate age of a person requiring assistance; type of vehicle being driven; and characteristics of the rescue environment.

In addition to these strategies, wider law enforcement and strategies to consider the design of flood prone roads should be considered.
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PREVENTION OF FLOOD RELATED DEATHS WORKING GROUP 2016. Preventing flood related fatalities: a focus on people driving through floodwater. Canberra: Commonwealth Attorney-General’s Department


SURF LIFE SAVING AUSTRALIA 2016. The Ripping Truth.


Questionnaire

Help us to understand your experiences during recent flooding

We invite you to participate in a survey about your experience of the floods that occurred last summer and wet season. We are inviting residents in the Southern, Swan Valley and Kimberley Regions. We are interested in your perceptions of the local flood risk and your actions during recent floods.

We recognise that people may have experienced significant losses as a result of the flooding and we sincerely apologise for any distress receiving and completing this survey may cause. If you require support, you can access free counselling and support services through Lifeline (ph: 13 11 14).

This survey is being conducted by Risk Frontiers in conjunction with the Department of Fire and Emergency Services. By telling us about your experience, expectations, and knowledge of flooding, you will be making an important contribution to improving community safety during future flooding events. The results of this survey will help improve community engagement and emergency management policy, and will be available publicly.

Participation in this survey is voluntary and you are free to withdraw at anytime. All information will remain confidential. This project has been approved by the Macquarie University Human Research Ethics Committee. The survey should take 10 to 15 minutes to complete.

If you have any questions or concerns about this survey, please contact Risk Frontiers at info@riskfrontiers.com.

1. Are you willing to complete this survey?
   - Yes
   - No
2. What suburb or town do you live at?

3. What is your age?
   - 18-30 years
   - 31-40 years
   - 41-50 years
   - 51-60 years
   - 61-70 years
   - 71-80 years
   - 81-90 years
   - 91 years or over
4. What is your gender?
   - Male
   - Female
   - Transgender
   - Prefer not to say

5. What best describes your occupation?
   - Employed and work mainly outdoors
   - Employed and work mainly indoors
   - Unemployed
   - Other (please specify)

6. How long have you lived in your current town or suburb?
   - Less than 1 year
   - More than 1 year but less than 5 years
   - More than 5 years but less than 10 years
   - More than 10 years

7. How would you rate your confidence to swim 50 metres?
   - Very high
   - High
   - Medium
   - Low
   - Very Low

8. How would you define floodwater?
9. Have you ever experienced flooding at any of the following locations before?

- [ ] Home
- [ ] Place of work
- [ ] On the road when driving
- [ ] Farm
- [ ] I have not experienced flooding
- [ ] Other (please specify)

______________________________
### About your perceptions of flood risk

10. What concerns you most about flooding? (Please rate on scale of 1 to 5)

<table>
<thead>
<tr>
<th>Concern</th>
<th>(1) Not concerned</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5) Very concerned</th>
<th>Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threat to your health and safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Threat to your property</td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>Threat to your family, neighbors or friends</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Threat to your place of employment</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Threat to pets and livestock</td>
<td></td>
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<td></td>
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<tr>
<td>Threat to crops</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Threat to motorists on local roads</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Threat to people swimming or walking in floodwater</td>
<td></td>
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<tr>
<td>Threat of isolation</td>
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<td></td>
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<tr>
<td>Threat of losing power, water or sewage</td>
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<td></td>
</tr>
</tbody>
</table>

11. How safe do you believe the following to be?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Very dangerous</th>
<th>Dangerous</th>
<th>Neutral</th>
<th>Somewhat safe</th>
<th>Completely safe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking through knee deep still floodwater</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking through knee deep fast flowing floodwater</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swimming through floodwater</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driving through knee deep still floodwater</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driving through knee deep fast flowing floodwater</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
12. During last summer or wet season how were you impacted by flooding?
- Flooding of your home
- Flooding of your place of employment
- Flooding of farmland
- Disruption to your business
- Other (please specify)

13. How often have you encountered flooded roads (i.e. driving in the areas you live or work)?
- Very often - more than half a dozen times per year
- Often - three to six times per year
- Sometimes - once or twice per year
- Rare - once or twice over more than one year
- Never
14. Approximately how many times have you driven a vehicle through floodwater in the last 10 years?
- Never
- Once only
- 2-3 times
- 4-10 times
- More than 10 times

15. Approximately how many times may you have walked or swam in floodwater in the last 10 years?
- Never
- Only once
- 2-3 times
- 4-10 times
- More than 10 times

16. During last summer or wet season did you at anytime drive through floodwater of any depth as either the driver or passenger?
- Yes
- No
- Did not encounter flooded roads
17. Were you the driver or passenger of the vehicle?

- Driver
- Passenger
- Both a driver and passenger at different times
18. In general before driving through floodwater did you

- Consult with passengers
- Check for alternate routes
- Check the depth and speed of floodwater
- Check to see if others were around in case rescue was needed
- Wait to see if others successfully crossed
- Check the state of the road
- Check for any debris
- Contacted family, friends or neighbours
- Did nothing
- Other (please specify)
19. What prompted you to take precautions before driving through floodwater?
20. In general what was the purpose for driving through floodwater?

- To reach a safer location
- To visit friends, neighbours or family
- To rescue people
- To rescue pets or livestock
- To rescue or secure property
- Other (please specify)

- For fun or recreation
- To check on property
- To collect children or family members
- To get home
- To get to work
21. To what extent did the following influence your decisions to drive into floodwater? (Please rate on scale of 1 to 5)

<table>
<thead>
<tr>
<th></th>
<th>(1) Not at all</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5) A great deal</th>
</tr>
</thead>
<tbody>
<tr>
<td>No practical alternate routes were available</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I was close to home or work</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>It was urgent that I got somewhere</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The floodwater was only shallow</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I have driven through floodwater before</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Floodwater was not flowing fast</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I knew the road well</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Others were driving through it</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>It was difficult to turn around</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>There were barricades on the road side</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Felt pressured by passengers</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Felt pressured by other motorists</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I had confidence in my vehicle</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>It was fun to do</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Alcohol or drugs made me feel more confident to do it</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I feared becoming isolated</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Other (please specify)
22. What was the greatest depth of floodwater you drove through last summer or wet season?
   (a) less than 15 cm 
   (b) 15 to 30 cm 
   (c) 30 to 45 cm 
   (d) 45 to 60 cm 
   (e) 60 to 95 cm 
   (f) 95 cm or above

23. What was the fastest flowing floodwater you drove through last summer or wet season?
   (a) Still 
   (b) Slight flow 
   (c) Moderate flow 
   (d) Rapid flow 
   (e) Raging flow

24. What was the greatest level of danger you felt when you drove through floodwater?
   (a) Insignificant 
   (b) Low 
   (c) Medium 
   (d) High 
   (e) Extreme

25. Generally did you drive through floodwater when it was?
   [ ] Daylight
   [ ] Dawn or dusk
   [ ] Nighttime and there were no streetlights
   [ ] Nighttime and there were streetlights
   [ ] All of the above
   [ ] Other (please specify)

26. Generally do you recall any signs or depths markers where you drove through floodwater?
   (a) Yes 
   (b) No 
   (c) Unsure
27. Did you ever drive through road closure signs or barricades?
- Yes
- No
- Unsure

28. How many other drivers do you believe also drive through floodwater?
- Almost everyone (61 to 100 percent)
- Most (61 to 80 percent)
- Some (41 to 60 percent)
- Few (21 to 40 percent)
- Very few (20 percent or less)

29. Generally what type of vehicle were you driving when you encountered floodwater?
- Hatchback
- Sedan / Station Wagon
- 2WD 4x4
- 4WD
- Other (please specify)
- Bus or truck
- Tractor
- Motorcycle
- All wheel drive

30. When you drove through floodwater were passengers ever also in the vehicle?
- Yes
- No
- Unsure
31. Think of the most memorable time you drove through floodwater last summer or wet season what did passengers say about driving through the floodwater?

☐ Encouraged me to do it  
☐ Said not to do it  
☐ Were unsure of if it was safe  
☐ Agreed with my assessment that it was safe  
☐ Did not express an opinion  
☐ Other (please specify) 

32. Think of the most memorable time you drove through floodwater last summer or wet season what was the gender of the passengers?

☐ Male  
☐ Female  
☐ Transgender  
☐ Prefer not to say  

33. Think of the most memorable time you drove through floodwater last summer or wet season how many passengers were there in the vehicle?

☐ 1  
☐ 2  
☐ 3  
☐ 4  
☐ 5  
☐ More than 5  

34. Think of the most memorable time you drove through floodwater last summer or wet season what age (s) were the passengers?

☐ 0 to 11 years  
☐ 11 to 20 years  
☐ 21 to 30 years  
☐ 31 to 40 years  
☐ 41 to 50 years  
☐ 51 to 60 years  
☐ 61 to 70 years  
☐ 71 to 80 years  
☐ 81 to 90 years  
☐ 91 years plus
35. If faced by the same circumstances in the future, would you drive through floodwater again?

- Yes
- No
- Unsure
36. Why wouldn’t you drive through floodwater again?

37. Was there ever a time when you chose not to drive through floodwater?
   - ☐ Yes
   - ☐ No
   - ☐ Did not encounter floodwater on the road
   - ☐ Unsure
38. Why did you choose not to drive through floodwater?
- [ ] The depth of floodwater
- [ ] The speed of the floodwater
- [ ] Damage to the road
- [ ] There was an alternative route
- [ ] I had passengers in the vehicle with me
- [ ] I didn’t know the road
- [ ] I was driving a small vehicle
- [ ] Other (please specify)

39. What concerns you about driving through floodwater?
- [ ] Possibility of damaging your vehicle
- [ ] Possibility of damaging the road
- [ ] Possibility of requiring rescue
- [ ] My own health and safety
- [ ] Health and safety of passengers
- [ ] Possible embarrassment
- [ ] Nothing
- [ ] Other (please specify)
40. Think of the most memorable time in the past summer or wet season as a passenger how concerned were you about driving through floodwater?

- Not concerned
- Concerned
- A little concerned
- Very concerned
- Neutral

41. Think of the most memorable time in the past summer or wet season as a passenger what actions did you take when you were driven through floodwater?

- Encouraged driver to enter floodwater
- Discouraged driver from entering floodwater
- Helped to direct the driver
- Walked across the floodwater whilst driver drove vehicle
- Kept a look out for debris
- Stayed quiet to allow driver to concentrate
- Nothing
- Other (please specify)

42. Think of the most memorable time in the past summer or wet season as a passenger what concerned you most about being driven through floodwater?

- Possible damage to the vehicle
- My own health and safety
- Possibility of damaging the road
- Health and safety of others in the vehicle
- Possibility of requiring rescue
- Nothing
- Other (please specify)
43. Think of the most memorable time in the past summer or wet season what type of vehicle were you in when you encountered floodwater?

- Hatchback
- Sedan / Station Wagon
- 2WD Ute
- 4WD
- Other (please specify)

44. Think of the most memorable time in the past summer or wet season when you drove through floodwater what was the gender of the driver?

- Male
- Female
- Transgender
- Prefer not to say

45. Think of the most memorable time in the past summer or wet season when you drove through floodwater what age was the driver?

- 16 to 21 years
- 21 to 30 years
- 31 to 40 years
- 41 to 50 years
- 51 to 60 years
- 61 to 70 years
- 71 to 80 years
- 81 to 90 years
- 91 years plus

46. Did you at anytime enter floodwaters on foot or by swimming?

- Yes
- No
- Did not encounter floodwater
- Unsure
47. In general before walking or swimming in floodwater what precautions did you take?
- [ ] Checked depth of floodwater
- [ ] Looked upstream for any dead animals
- [ ] Assessed how fast the water was flowing
- [ ] Looked for debris
- [ ] Swam or walked with another person
- [ ] Told someone where I was going
- [ ] Assessed the quality of the water (e.g. sewage, smell, oil)
- [ ] Checked official sources for water quality information
- [ ] Checked for crocodiles
- [ ] Checked for snakes, spiders and other insects
- [ ] Wore a flotation device
- [ ] Other (please specify)

48. In general what was the purpose for walking or swimming in floodwater?
- [ ] Fun or recreation
- [ ] To cool down
- [ ] To reach a destination
- [ ] Accidentally entered floodwater
- [ ] To work
- [ ] Other (please specify)
49. In general to what extent did the following influence your decision to walk or swim through floodwater? (Please rate on a scale of 1 to 5)

<table>
<thead>
<tr>
<th>Factor</th>
<th>(1) Not at all</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5) A great deal</th>
</tr>
</thead>
<tbody>
<tr>
<td>It was hot</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needed to get somewhere urgently</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There were others around</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I was bored</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I always do</td>
<td></td>
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<tr>
<td>Others were doing it</td>
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<tr>
<td>I know the area well</td>
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</tbody>
</table>

50. Was there a time when you chose not to walk or swim in floodwater?

- [ ] Yes
- [ ] No
- [ ] Unsure
51. Why did you choose not to walk or swim in floodwater?

- Too deep
- Water was fast flowing
- Crocodiles in the water
- Sewage, chemical and other pollutants in the water
- Debris in the water
- Was told not to by relative or friend
- I had consumed drugs or alcohol
- Snakes, spiders or other insects in the water
- Was not necessary
- Other (please specify)

52. What concerns you most about walking or swimming in floodwater?

- Possibility of drowning
- Possibility of becoming injured
- Possibility of becoming sick
- Nothing
- Other (please specify)

53. Did any young children or youth in your family enter floodwaters?

- Yes
- No
- No young children or youth in my family
- Unsure
54. What precautions did you take when children or youth in your family walked or swam in floodwater?

- Regularly supervised
- Occasionally checked
- Ensured they wore a flotation device
- Checked water quality (e.g. sewage/mellboli)
- Asked oldest child to supervise
- Other (please specify)

55. To what extent did the following influence your decision to allow children to walk or swim through floodwater? (Please rate on scale of 1 to 5)

<table>
<thead>
<tr>
<th></th>
<th>(1) Not at all</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5) A great deal</th>
</tr>
</thead>
<tbody>
<tr>
<td>It was not</td>
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<tr>
<td>Children would do it anyway</td>
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<tr>
<td>I was doing it to</td>
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<tr>
<td>Was easy to supervise</td>
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<td>It was an emergency</td>
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<tr>
<td>I did it when I was their age</td>
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</tbody>
</table>

56. Would you encourage others not to enter floodwater in the future?

- Yes
- No
- Unsure
57. To what extent do you agree with the following statements

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neither agree or disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
<th>Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood safety education is required to reduce the number of people entering floodwater</td>
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<tr>
<td>People who drive through floodwater should be fined</td>
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<tr>
<td>There needs to be better information about what roads are flooded</td>
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<tr>
<td>Roads need to be built higher so motorists do not need to drive through floodwater</td>
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<tr>
<td>Barricades need to be built on the edge of roads to prevent vehicles from being washed away</td>
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<tr>
<td>Workplaces should have policies to discourage their employees from entering floodwater</td>
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<td>I would be willing to be part of a local project to raise awareness about flood safety</td>
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<tr>
<td>Flood warnings need to be improved to provide more information about possible impacts</td>
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</tbody>
</table>
58. Who do you most trust in your community to receive advice about flood safety?
- SES
- Fire brigade
- Police
- Teachers
- Elders
- Friends or family
- Neighbours
- Doctor or nurse
- Local Council
- Other (please specify)

59. What ways would you prefer to receive information about flood safety
- Television advertising
- Television news program
- Radio advertising
- Radio news program
- Visit by SES
- Mail (Postal)
- Social Media
- Other (please specify)

60. Have you received flood safety information in the past?
- Yes
- No
- Unsure
61. Who provided the flood safety information?

- Local Council
- State Emergency Service
- Police
- Fire Brigade
- Bureau of Meteorology
- Media
- Family and friends
- Neighbours
- Employer
- Other (please specify)

62. Do you have any feedback about flood warnings or information you have previously received?
63. Is there anything further you would like to add?

Thanks for completing the survey.
Focus Group Discussion Guide

What issues are of greatest concern in your community?

What do you define as flooding?

What makes flooding dangerous?

How concerned are you about flooding in your local community?

If anything, what would concern you most about flooding?

How safe do you all think it is to drive through floodwater?

Has anyone ever driven through floodwater before as a driver or passenger?

- What was the situation?
- Why did you drive through the water?
- What type of vehicle were you driving?
- Where passengers in the vehicle?
- Did you take any precautions?
- What concerned you most about driving through floodwater?
- Had you driven through floodwater before?
- Did you see any signs warning about floodwater?
- Did you drive around any barriers?
- If you were a passenger, who was driving and what did you say to the driver?

Has anyone ever decided not to drive through floodwater?

- What was the situation?
- Why did you decide not to drive through floodwater?
- What type of vehicle were you driving?
- Where passengers in the vehicle?

How safe do you think it is to walk or swim in floodwater?
Has anyone ever walked or swam in floodwater?

- What was the situation?
- Why did you decide to walk or swim in floodwater?
- What precautions did you take?

Has anyone ever chosen not to swim or walk in floodwater?

- What was the situation?
- Why did you decide not to?
- What precautions did you take?

How can flood safety be improved in your community?

- What strategies could be undertaken?
- What should be the key messages?
- Who should deliver safety messages?
- What is the best method of sharing messages?
- How should the community be involved?