

**Community understanding of tsunami risk in  
Coastal Washington: 2015 focus group study**

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## CONTENTS

<b>ABSTRACT</b> .....	<b>ii</b>
<b>KEYWORDS</b> .....	<b>ii</b>
<b>1.0 INTRODUCTION</b> .....	<b>1</b>
<b>2.0 METHOD</b> .....	<b>3</b>
<b>3.0 FOCUS GROUP RESULTS</b> .....	<b>5</b>
3.1 PREPAREDNESS AND AWARENESS .....	5
3.2 VULNERABLE GROUPS IN THE COMMUNITY .....	6
3.3 EVACUATION PLANNING .....	6
3.4 WARNING SYSTEMS .....	7
3.5 TOURISM .....	8
3.6 RESPONSE AND WELFARE .....	9
3.7 COMMUNITY-LED IDEAS AND SOLUTIONS .....	9
<b>4.0 QUESTIONNAIRE RESULTS</b> .....	<b>12</b>
<b>5.0 CONCLUSIONS</b> .....	<b>18</b>
5.1 OPPORTUNITIES – IDEAS AND SOLUTIONS .....	19
<b>6.0 REFERENCES</b> .....	<b>20</b>

## FIGURES

<b>Figure 1</b>	The Cascadia Subduction Zone, Pacific Northwest USA (Source: USGS).....	1
<b>Figure 2</b>	Map of western Washington, showing the focus group meeting locations of Long Beach, Tokeland and Aberdeen. ....	3
<b>Figure 3</b>	Image taken with the beach/dune on the right, and a tourist resort building on the left, the tallest structure for many miles in Long Beach. ....	10
<b>Figure 4</b>	Perceptions of when a future tsunami might affect the participants' communities.....	13
<b>Figure 5</b>	Sources of tsunami preparedness information (shown as per cent).....	14
<b>Figure 6</b>	Warnings expected for a distant source tsunami, shown as per cent.....	15
<b>Figure 7</b>	Warnings expected for a near source tsunami, shown as per cent.....	16
<b>Figure 8</b>	Pre-evacuation behaviours (shown as per cent). ....	17

## TABLES

<b>Table 1</b>	Six themes and 13 subthemes identified from the focus groups meetings.....	5
<b>Table 2</b>	Natural hazards perceived by participants as most likely to affect communities. ....	12
<b>Table 3</b>	Tsunami awareness and preparedness statements, shown as per cent (N=35). ....	13

## APPENDICES

<b>A1.0 APPENDIX 1: TSUNAMI AWARENESS SURVEY– WASHINGTON</b> .....	<b>22</b>
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## **ABSTRACT**

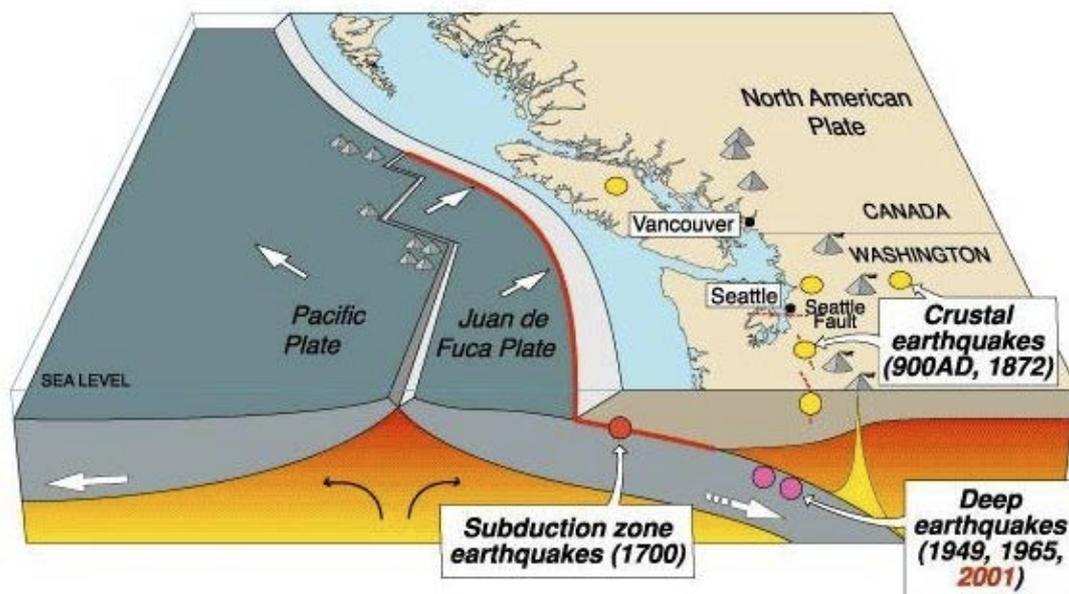
This report presents recent findings from focus group interviews conducted with communities at risk of earthquake/tsunami hazards associated with the Cascadia subduction zone in Washington State, USA. The communities were found to have varying degrees of engagement with preparedness and planning activities in their community. There was significant doubt about the effectiveness of tsunami warning sirens. Many community-led ideas and solutions for improving local tsunami awareness and preparedness were described by participants. Efforts at State- and County-level to support local initiatives were noted by participants, with mutual support, trust and respect between key stakeholders seen as important for developing tsunami preparedness in at-risk communities.

## **KEYWORDS**

Earthquake, tsunami, hazards, community preparedness, Cascadia Subduction Zone, Washington State.

## 1.0 INTRODUCTION

Worldwide, tsunamis have been responsible for the deaths of many hundreds of people in recent decades, destroying coastal communities and livelihoods in many places (Wood, Jones, Spielman & Schmidlein, 2015). Most recently, the Tohoku earthquake and tsunami in Japan resulted in 16,000 deaths, and with direct economic losses of between US\$171–183 billion (Norio, Ye, Kajitani, Shi & Tatano, 2011). There are many more communities at risk, including the US Pacific Northwest. Coastal Washington is vulnerable to Cascadia Subduction Zone earthquakes, which are capable of generating a destructive tsunami. The close proximity of the Cascadia Subduction Zone to the coast of Washington and Oregon (~30km offshore) means that destructive waves could inundate the coast within a period of less than half an hour (Figure 1). The most recently recorded tsunami in this area was in 1700 AD. Oral histories around this event were passed down through the Native American Indian community, and illustrate that there was widespread destruction at the time (Satake, Shimazaki, Tsuji & Ueda, 1996). No pre-1700AD Indian artefacts have ever been found.



**Figure 1** The Cascadia Subduction Zone, Pacific Northwest USA (Source: USGS).

A recent study of tsunami vulnerability in Washington and Oregon coastal communities by Wood et al. (2015) highlighted the relative vulnerability of different communities to tsunami inundation. These communities were grouped into high, moderate, and low risk, based on population exposure and location and risk to life. Grays Harbor County and Pacific County communities represent the most at-risk populations anywhere along the Washington, Oregon and northern Californian coasts with respect to evacuation timeframes and access to high ground. Aberdeen (Grays Harbor County) has the highest number of residents living in tsunami hazard zones, while Ocean Shores (Pacific County) has the largest proportion of residents with insufficient time to evacuate a near source tsunami event (Wood et al., 2015).

Johnston et al. (2014) reviewed and evaluated tsunami public education activities in the western Washington area over the period 2001–2012. The multiple forms of outreach and education used by County and State authorities have been positive, but do not always equate to improved preparedness by residents for a future tsunami event. The inclusion of Washington in the ShakeOut exercise has had a measureable impact on improving awareness of

earthquake and tsunami risks in the state, particularly in communities where residents took the opportunity to exercise for tsunami evacuation as well as for earthquake (Johnston et al., 2014). School education programmes were also found to be particularly successful, with student knowledge of the correct actions to take during an earthquake and tsunami found to be high.

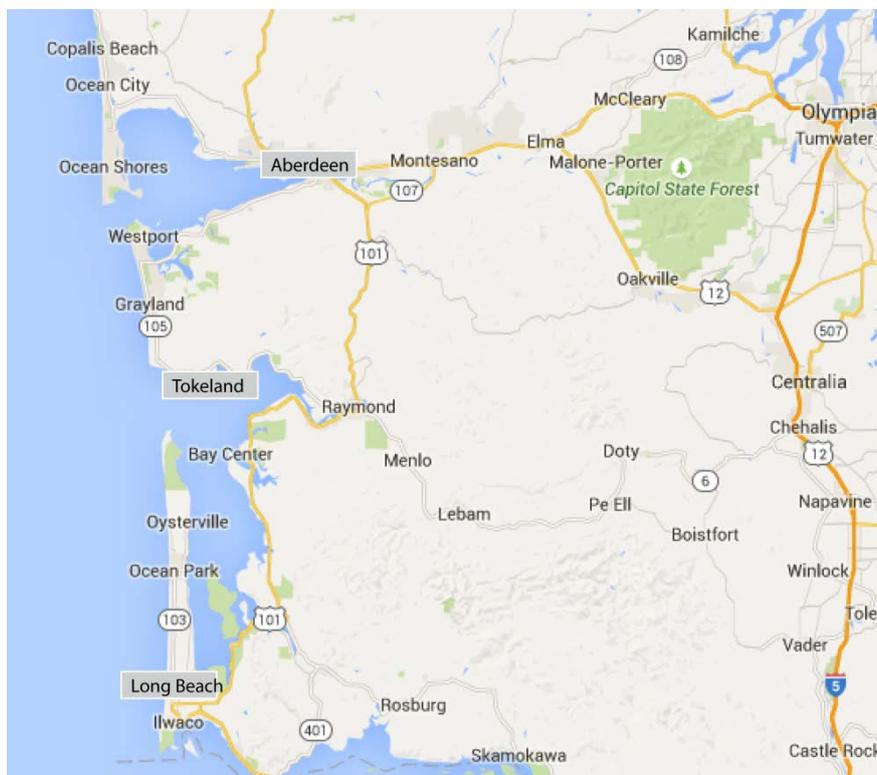
This report documents the results of a series of focus group with communities at risk from tsunami hazards in Pacific County and Grays Harbor County in western Washington state. Preliminary results from six focus groups are presented below, together with results from a questionnaire investigating tsunami awareness in the focus group participants. The questionnaire was designed to gather additional information from focus group participants with specific reference to tsunami and earthquake hazard awareness, preparedness and evacuation behaviours.

The aim of this research was threefold:

1. To investigate current awareness and understanding of tsunami risk by local residents in high risk communities;
2. To have conversations with communities about their ideas and solutions towards mitigating some of the risks they face, and to feed these ideas back to county emergency managers;
3. To investigate perceptions of appropriate behaviours during evacuation.

## 2.0 METHOD

Scott McDougall (Deputy Director, Pacific County Emergency Management) based in Long Beach, and Chuck Wallace (Deputy Director of Grays Harbor County Emergency Management) in Aberdeen were key contacts, and assisted in recruiting local citizens and stakeholders to attend the focus groups by using social media invitations and word-of-mouth. The locations of the focus groups are shown in Figure 2. Four focus groups were held in Long Beach, with numbers of participants per group ranging from 3–8. Another focus group was held in Tokeland with six participants, and one focus group was held in Aberdeen with 10 participants. A total of 37 people attended the six focus groups, which were held on May 11th and 12th 2015.



**Figure 2** Map of western Washington, showing the focus group meeting locations of Long Beach, Tokeland and Aberdeen.

Most of the individuals in attendance were concerned citizens, while others worked for key stakeholders including emergency services, and community organisations, e.g., churches and libraries. Most had a particular interest in tsunami hazards for a variety of reasons, including:

- A personal awareness of the tsunami risk and a motivation to get themselves, and in some cases those around them, better prepared.
- Local leaders wanting to learn more and feed it out to their neighbours, families and communities.
- Concern at their own lack of understanding about tsunami hazards, and a thirst to learn more.
- Community Emergency Response Team (CERT) volunteers who attend a number of training sessions which include tsunami hazard and preparedness training.

- Cascadia Earthscope Earthquake and Tsunami Education Program (CEETEP) attendees. This National Science Foundation (NSF) funded program is organised by a collaboration between university science faculty and state/local emergency management agencies. There were three individuals who had attended these workshops and they were clearly knowledge-leaders in their communities and were spreading the word on tsunami hazard awareness and preparedness within their communities.

We asked all focus group participants to complete a two-page survey before the focus group began, investigating their knowledge, awareness and preparedness for a future tsunami in their community. We chose to distribute the survey before the focus group to understand their perceptions prior to being influenced by the opinions of other participants. While this survey is not a representative sample of the community as a whole, it offers useful insights into how the participants understand the tsunami hazards that they live with in Pacific County and Grays Harbor County.

To contextualise recent local damaging natural hazard events, in 2007 there was a very severe winter storm, which caused extensive power cuts for 4–5 days, and made transport around the area very challenging. Fallen trees and landslides closed several roads. In addition, many people remembered the Nisqually earthquake in 2001, however there wasn't much damage in the local area.

We used a digital recorder at each focus group with the expressed permission of all participants. Ethical approval was granted through Massey University, and all participants were informed of their rights of anonymity and their freedom of involvement in the study from the outset.

Participants were asked to describe three key areas of interest a) their awareness of the tsunami hazard, and whether they had received any information from local, state or federal agencies, b) their expectations of the warnings and/or information they would receive during a tsunami event, c) and their thoughts around tsunami evacuation. The conversations flowed naturally, and other subjects of specific interest to these participants were covered where necessary. All the interviews were transcribed, and thematic analyses was conducted to identify key themes. Six preliminary themes, comprising 13 sub-themes were identified. The analysis was triangulated within the research team and with County emergency managers, and is presented in Table 1.

### 3.0 FOCUS GROUP RESULTS

The focus groups generated a great deal of detailed qualitative data on tsunami hazard and the understanding and preparedness of participants for a future tsunami event. Thirteen sub-themes have been identified from the data, ranging from the use and effectiveness of evacuation sirens, to neighbourhood support and preparedness, and to post-disaster community recovery (presented in Table 1). Tourism and tourist issues were most prominent in Long Beach due to the popularity of the town with visitors during the high season. Many issues were discussed about the ability of the local community to assist and care for visitors to their community, as well as the preparedness of tourism businesses.

The following section presents the results from the focus group meetings, using direct quotes from participants to illustrate key points. This section describes findings related to each of the six themes, followed by a section outlining community-led solutions that were described during the focus groups.

**Table 1** Six themes and 13 subthemes identified from the focus groups meetings.

Sub-themes	Themes
Difference between near and far source tsunami	Warning systems
Use of tsunami warning sirens	
Evacuation routes	Evacuation planning
Ability of community to evacuate	
Evacuation method (car/foot)	
Location of high ground	
Community preparedness efforts, neighbourhood support	Preparedness and Awareness
Wave height and inundation potential	
Vulnerable people in the community (disabled/elderly)	Vulnerable groups
Tourist/tourism issues	Tourism
Public education about tsunami issues	Response and Welfare
School information and education about tsunami issues	
Community response and welfare post-disaster	

### 3.1 PREPAREDNESS AND AWARENESS

There was generally a high level of awareness of tsunami hazard across the focus group participants, but many still stated they didn't know what to do to prepare: *"I'm aware of the danger, but I'm not aware of what we're supposed to do"*. Some were particularly concerned about a certain proportion of the local community, as well as non-residents in the community: *"I still think there is a head in the sand attitude, even from the year-rounders, but especially around the seasonal people, like it's not going to happen when I'm around here on vacation"*.

Others were more realistic: *"We are basically on our own, the government is not going to come and save you."* Some took care to purchase property outside of tsunami inundation areas: *"When we were purchasing a house recently we were looking for houses that would be away from the tsunami zones"* Participants mentioned their experience of the 2007 storm as a way to imagine what post-tsunami impacts on roading and lifelines might be like for their community in future events. Those who could remember the storm had been motivated to get more prepared for future events.

Several participants mentioned the negative impact of local myths about tsunami hazard, and that these myths had the effect of reducing people's concern about the risk. Specifically, people mentioned the geomorphology of the coastline. *"There are these myths that there is a continental shelf that will stop the wave"* and that *"The fisherman say there is a reef out there so the tsunami won't get us."*

For some, they were confident in their own level of preparedness, but concerned about the lack of preparedness in others. *"One of my fears is that my wife and I, and even our dog, are well prepared, but I worry about the 500 other people that will show up at the same evacuation point, injured with no food and water, and they show up with an A15 and 100 rounds of ammunition. I'm much more concerned about that."* Others were well prepared, and had made sure they had access to emergency kits in several locations, in the car, home and workplace, just in case they are not home when an earthquake occurs.

There was concern about the effectiveness of preparedness actions in the event of a large and destructive local earthquake due to the scale of damage that would likely result. *"I don't mind getting prepared, but the place is built on sand, the roads are going to crack, there is no way you could use a car, I have no clue where the high ground is."*

### **3.2 VULNERABLE GROUPS IN THE COMMUNITY**

Many participants were concerned about members of the community who would be physically unable to evacuate. *"We have a nursing home next door to our church. What are you going to do with the people who can't help themselves?"* Another individual remarked that there were many elderly in his community *"You're talking about a lot of older people who couldn't get very far, and sure as hell couldn't do any climbing."*

Others described that some members of the community were more fatalistic than others. *"I fear there is a fatalistic view in the older portion of the community."* Younger people were often considered to be more proactive in their mindset. *"The younger generation is more in tune with it than some of our elderly residents."* Some commented also about the minority populations in the community, with 15–20% of the population comprising Spanish-speaking people (anecdotally).

### **3.3 EVACUATION PLANNING**

Discussion about evacuation differed across the communities we visited. For those with high ground close by, they were mainly clear about their intentions. *"Our evacuation plan was to walk up the hill", "I can get myself and my family up the hill within three minutes of an earthquake". "I live on the ridge in Surfside...50–60ft above sea level, so we are going to stay where we're at"*

Others were concerned about damage to local roads and bridges that would prevent them from evacuating by road. *“If [the earthquake] blows a couple of bridges, we are stuck here... it’s a joke”*. *“People would get very frustrated when we said that a local tsunami could damage roads and they wouldn’t be able to drive out”*. *“We have a lot of high ground here, but I’d say probably 95% of it is gated, its either private, corporate or tribal land”*, illustrating the misconception some individuals have about being able to evacuate in their car, rather than having to travel on foot. In reality, damage to roads from a local earthquake/tsunami event will make car travel impossible.

In other communities, such as Tokeland and Ocean Shores, the lack of high ground within close walking distance was a cause of significant stress for some people, and had the effect of making people angry, upset and fatalistic about their chances of survival. One woman commented *“I’m sorry, but what I’m hearing is that you may as well bend over and kiss your butt goodbye.”* Another man commented that in the event of a major local earthquake *“I would probably roll over and go back to sleep.”* Proactive efforts to test evacuation routes had led to some despondency within participants, for example *“As part of the CEETEP workshop exercise down in Ocean Shores, we were all on the beach and gave ourselves 20 mins to walk to high ground, and we didn’t make it. And we were all mostly healthy people, and that’s the scary reality”*. Another person commented *“How do we all get to high ground... it’s a long walk. It’s about two miles”*. The lack of evacuation options was highlighted by a comment from a local woman who was knowledgeable about tsunami after taking the CEETEP course said *“In the event of that, your only options are to climb the tallest building or the tallest tree and hang on”*.

The issue of how to try to motivate people to get prepared when their location is at extreme risk poses a very significant challenge to local emergency managers. For example, one Aberdeen resident noted that in the event of a large, near source tsunami *“The Peninsula is a speed bump if we have a tsunami, and so how to get past that when you are educating people about the threat, without scaring the crap out of them?”*

Some were concerned about what they would do when they are not in their own community when a tsunami occurs. *“There are places on the Peninsula that I don’t even feel comfortable going because if something happened locally [local-source tsunami] there is nowhere to go”*. *“My biggest concern is that if I am home I know what to do, but what if I am at the grocery store? If I feel an earthquake and I only have a few minutes, what do I do, where do I go?”*

In addition, there was some discussion around the misconception about how quickly external help will be available, particularly in terms of evacuating, for example *“People don’t have a good grasp of what could happen in a local tsunami, [and think] that they’ll get warnings and there will be buses to pick them up.”*

### **3.4 WARNING SYSTEMS**

A total of 20 sirens exist in Pacific County (managed and funded by 18 County and 2 Shoalwater Bay Indian Tribe), and these are all hazard broadcast sirens used for a range of hazards, not just to warn about tsunami threats. This was identified as a problem in itself, because participants noted there was confusion about whether a siren warning was for a tsunami (near or far source), or for a local fire event. One comment illustrated this confusion: *“On Mondays at noon are they testing the near tsunami siren or the far tsunami siren?”*

There was also an issue with people being able to hear the sirens. *“We have the sirens, sometimes you can hear them, sometimes you can’t depending on how the wind is blowing.”*

Another commented *“Those sirens may warn the people who live right underneath them...but I don’t think the sirens do much of anything, especially if it is evening when people are indoors.”* Overall there was a widespread scepticism about the effectiveness of warning sirens. However, it was clear for some that they still expected to receive a warning siren, and would not evacuate until this happened.

Some noted that they did not rely on siren warnings for a tsunami and said *“I’m taking care of myself, no one is going to let me know”* and *“Don’t hesitate, evacuate.”* Others were concerned about the wider community relying on the siren before taking action: *“My fear is that people won’t do anything until they hear that siren, that’s my concern.”*

The National Oceanic and Atmospheric Administration (NOAA) weather radios were thought to be very useful, and many people had these in their homes and/or workplaces. These radios have weekly tests on a Wednesday, giving people reassurance that they continue to work over periods of time without use during an emergency. Many business owners mentioned having these in their workplace.

Reverse 911 automated calls to warn people about tsunami events had been received by many participants during the Japan tsunami warning, however, some slept through the phone call or simply didn’t receive one. These calls require a particular type of phone system, and also require individuals to register to receive them, hence they do not reach all local residents.

There was very little reference to any form of ‘warning fatigue’, in respect to past tsunami warnings that were not followed by an actual event. Several people talked about the Japan/Tohoku warning in 2011, but they didn’t seem to perceive that the warning was unjustified. However, one participant described: *“I’ve gone through several warnings, and the first few times we’ve evacuated when we’ve had some warning, and the third time we figured “To hell with it, nothing’s going to happen so we went down to the tavern and drank and waited it out.”* On the whole, however, participants took tsunami warnings seriously and planned to evacuate if they were able to.

### **3.5 TOURISM**

Pacific County has a permanent population of 21,500 people, and is a popular tourist area during the summer months, when up to 80,000 people can visit the area. Other major events on the tourist calendar include the Rod Run car show in September, which is estimated to attract 125,000 people, and the popular Clam Dig weekends that bring many thousand visitors to the beaches.

There was clearly some concern about the large number of visitors in the area during the peak summer months, and the feeling that a) tourists are typically unaware of the risk of tsunami, and b) that these individuals would collectively present a major challenge during the response/recovery. *“For us [local residents] one of the danger areas is having lots of tourists and non-permanent residents, and they not having a clue as to what to do.”* *“On the 4th of July, you would not believe the crowds we get here.”* This was of particular concern to smaller communities that received large influxes of tourists that would overwhelm their local resources in the event of a major disaster.

The lack of awareness was a challenge some thought should be addressed. *“The people who grew up here feel more comfortable (in terms of tsunami evacuation), but there is a lot of tourism here in the summer, how do you educate people who are here for a week?”* Another

person commented, *“We have a huge influx of tourists for 3 and a half months, and if something happens a lot of us have an idea of what is going to happen in our own home and community, but if I am going to have 14,000 tourists turning up on any given day that is going to intensify things. I don’t believe the tourist lodging establishments have any plans.”*

Two tourism operators were present at the focus group meetings in Long Beach, and they described some of the efforts they were making to get better prepared. These included making information available to their guests, such as tsunami information on the back of guest bedroom doors, evacuation planning and storing extra food and water. *“Their preparations are mainly around who is going to be staying in their facilities and how to keep their guests safe.”* One resort manager mentioned *“They are also starting to store food to last 3 days for the number of guests that they have.”* There was also some discussion around using their multi-level buildings as vertical evacuation structures, however there was doubt over their engineering and whether they would withstand the force of a tsunami.

There was some mention that visitors could be frightened by hazard warnings and might decide not to visit the area, however, one resort manager countered this by saying *“When our guests come and see the tsunami evacuation route posted on the door, it makes them feel more comfortable.”*

Some believe it was up to local tourism officials (e.g., State Park managers) to educate tourists. For example, one individual living next door to a State Park was concerned about the number of tourists and their lack of awareness, and asked the local park manager *“What information do you give visitors to inform them about the risk that they have, and they said nothing, and they can put 3000 people there at the park, where there is only one way into the park ... Do you make any preparations, and they said no, everybody is on their own... this is a challenge”.*

### **3.6 RESPONSE AND WELFARE**

*“You’ve made it to high ground, you’ve survived the tsunami... now what?”* commented a local Long Beach resident. There was talk of the need to survive for three weeks, with potentially little access to food and water. Many thought there was a real need to store provisions and install water facilities at evacuation sites. There were many examples of community-driven initiatives to place stores of food, clothing and water in 55 gallon barrel drums. Others described the efforts of a local school to place ‘go-packs’ of essential items for children at evacuation sites. Several individuals were concerned about non-permanent residents turning up at their homes in need of help, and questioned whether they would have enough supplies to share with others.

### **3.7 COMMUNITY-LED IDEAS AND SOLUTIONS**

Community-led solutions for mitigating tsunami and earthquake hazard are a powerful means to enable local people to feel as though they can make a difference. There are several current projects that are leading the way. For example, the community in Westport voted to tax themselves and build a vertical evacuation structure as part of their new Ocosta School building. Once completed, this will be the first vertical evacuation tower in North America, and it was a community initiative that would not have happened without significant local support. In addition, the Long Beach community is working with Federal Emergency Management Agency (FEMA) to construct a berm at Long Beach school for children to be evacuated to, which is another project with the potential to save many lives.

Participants at all of the focus groups had a range of ideas and potential solutions to improve community preparedness, awareness and recovery from a future tsunami event. These are outlined below.

- Relax the building height restrictions and allow taller buildings that can be engineered for vertical evacuation.
- Use existing tall buildings (e.g., tourist resorts in Long Beach) as vertical evacuation structures (Figure 3). This might require structural strengthening of these buildings, but once this was done, many people would be able to evacuate along areas of the Peninsula where there was no high ground close by.



**Figure 3** Image taken with the beach/dune on the right, and a tourist resort building on the left, the tallest structure for many miles in Long Beach.

- There was a lot of support for CERT all-hazards training. *“I just went through a CERT class and I found that very informative, it also made me aware, it also made me more proactive as well as my mindset goes, I want to prepare. So more of these CERT classes.” “The people that go through the 20 hours of CERT training feel enabled to do something, and it changes the whole mindset.”* Growing the CERT programme would indirectly spread the word and build awareness about tsunami.
- Provide maps for local people to show them where areas of high ground are located nearby. It was also suggested that CERT volunteers could help with disseminating this information door-to-door in communities.
- Leverage off the annual ShakeOut event as a way to test tsunami evacuation routes.
- Provide a hazards information pamphlet together with the Discover Pass (State Park entry pass) or Clam Dig license to target visitors to the area and give them information about tsunami evacuation and other local hazards.
- Make NOAA weather alert radios more available to people.
- Walk the tsunami evacuation route to see how long it takes to get there. *“When the kids and me are in town we’ll be at Subway and we’ll just say ‘Time’ and we’ll give ourselves 15 mins to get away from the ocean”*

- High school seniors could do disaster preparedness projects for their senior project. *“So many times the kids are the ones that teach the parents.”*
- Use the range of smart phones apps that are available, such as elevation apps to help people plan where high ground is, to help people identify their evacuation routes. One particular computer program that was mentioned is called *Map your neighbourhood*.
- A current community board initiative involved placing 55 gallon drums at evacuation points filled with essential supplies for the days following an event. This could be investigated for other locations.
- Provide school go-packs for kids, with stores of essential supplies for children at evacuation points.
- Ensure that wave height (tsunami inundation) data is described in feet, and not in metres because people noted this was causing confusion. (However, to assist foreign visitors to the area, including both units would be useful.)
- To improve communication, invite interns from College to come to Long Beach to the Farmers market, and set up a table for the students to hand out information to educate the public.
- Install a water supply at evacuation points.

Several people mentioned Project Safe Haven, a community-led initiative to develop a vertical evacuation strategy, to identify high ground and/or build vertical evacuation structures for communities. However, people acknowledge the expensive nature of these structures and the lack of local financial resource available to build them. *“We need vertical evacuation structures... the Peninsula is a death trap if you don’t get some here.”*

## 4.0 QUESTIONNAIRE RESULTS

At each focus group, participants were asked to complete a short two-page survey about tsunami preparedness and awareness. Ten people completed the survey in Aberdeen, eighteen in Long Beach and seven in Tokeland. Male respondents totalled 48% and female 52%. There were 11 questions that addressed awareness, preparedness, tsunami warning systems and social behaviours during evacuation. The survey is attached in Appendix 1.

### Question 1: Which two natural hazards are mostly likely to affect your community?

Participants were asked which natural hazards are most likely to affect their community from a multiple choice list. Storm with high winds (71%), tsunami (46%), flooding (40%) and earthquakes (26%) were the most likely perils identified (Table 2).

**Table 2** Natural hazards perceived by participants as most likely to affect communities.

Natural hazard	Per cent (N=35)
Storm with high winds	71
Tsunami	46
Flooding	40
Earthquake	26
Coastal erosion	20
Landslide	11
Wildfire	6
Ashfall from a volcano	0

### Question 2: Statements about tsunami hazard and preparedness

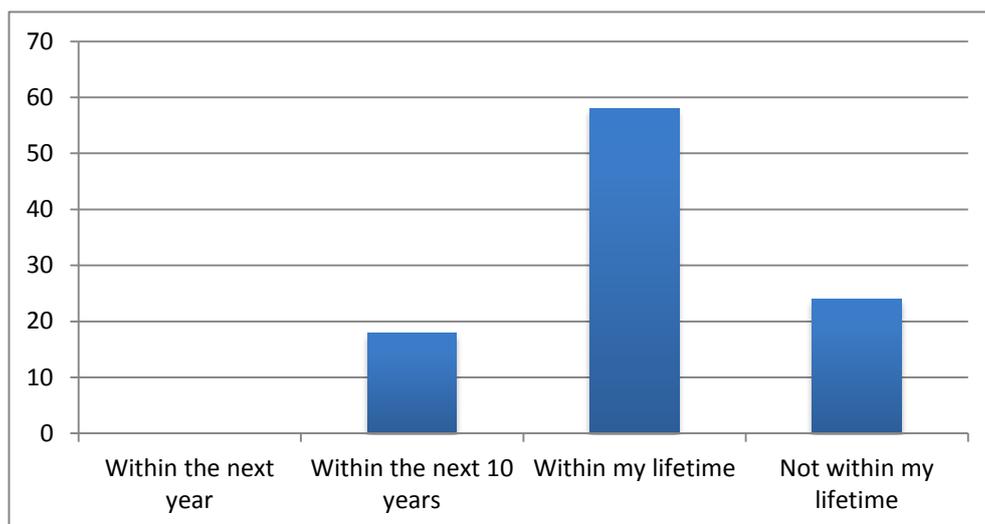
Participants were asked to describe their views on a number of statements, on a Likert scale from 1 = strongly disagree to 5 = strongly agree. The first statement about the likelihood of a damaging tsunami occurring during their lifetime did not generate a strong point of view. (Table 3). Forty per cent believed a damaging tsunami is unlikely to occur during their lifetime, while 28% thought a tsunami could happen. Very few people agreed that external help would be provided during a tsunami crisis. 54% of the sample disagreed that their property would never be damaged as a result of a tsunami, while 22% were neutral and the remainder thought no damage would ever occur. 62% of participants agreed or strongly agreed that preparing for a tsunami will improve their everyday living conditions, and only 9% disagreed. The statement that 'Tsunami are too destructive to bother to prepare for' produced very strong disagreement, with 91% of participants disagreeing or strongly disagreeing. 'Preparing for tsunami will help save lives' again produced a strong positive response, with 97% in agreement. Most participants believe they know how to get prepared for a tsunami, with 74% disagreeing or strongly disagreeing with the statement 'I do not know how I can prepare for tsunami'.

**Table 3** Tsunami awareness and preparedness statements, shown as per cent (N=35).

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
A damaging tsunami is unlikely to occur during my lifetime	6	34	31	17	11
It is unnecessary to prepare for tsunami as assistance will be provided by local organisations or Government agencies	83	11	3	3	0
My property will never be damaged by a tsunami	34	20	23	17	6
Preparing for tsunami will improve my everyday living conditions	0	9	29	41	21
Tsunami are too destructive to bother preparing for	67	23	3	6	0
Preparing for tsunami will help save lives	3	0	0	26	71
I do not know how I can prepare for tsunami	37	37	9	17	0

**Question 3: When do you think the next damaging tsunami might affect your community?**

There is a high level of awareness about tsunami hazard, with most individuals believing their community will be affected by one during their lifetime (58%, Figure 4). They do, however, place the risk relatively far into the future (>10 years), with no one thinking it could happen within 12 months. Almost a quarter of the sample does not believe a tsunami will affect them during their lifetime (24%). In this question, participants were asked to tick only one of these multi-choice answers.

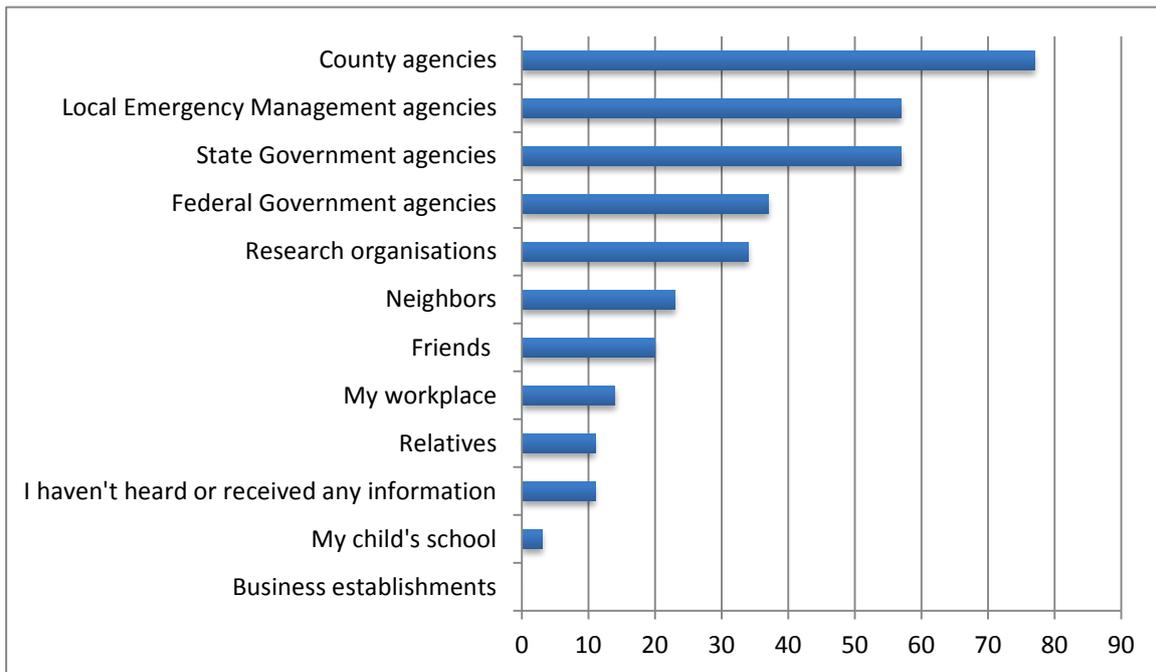


**Figure 4** Perceptions of when a future tsunami might affect the participants' communities (shown as per cent).

#### Question 4: Sources of information about preparing for tsunami

The participants were asked 'Have you heard or received any information about preparing for tsunami hazards from any of the following?' They could tick all options that applied.

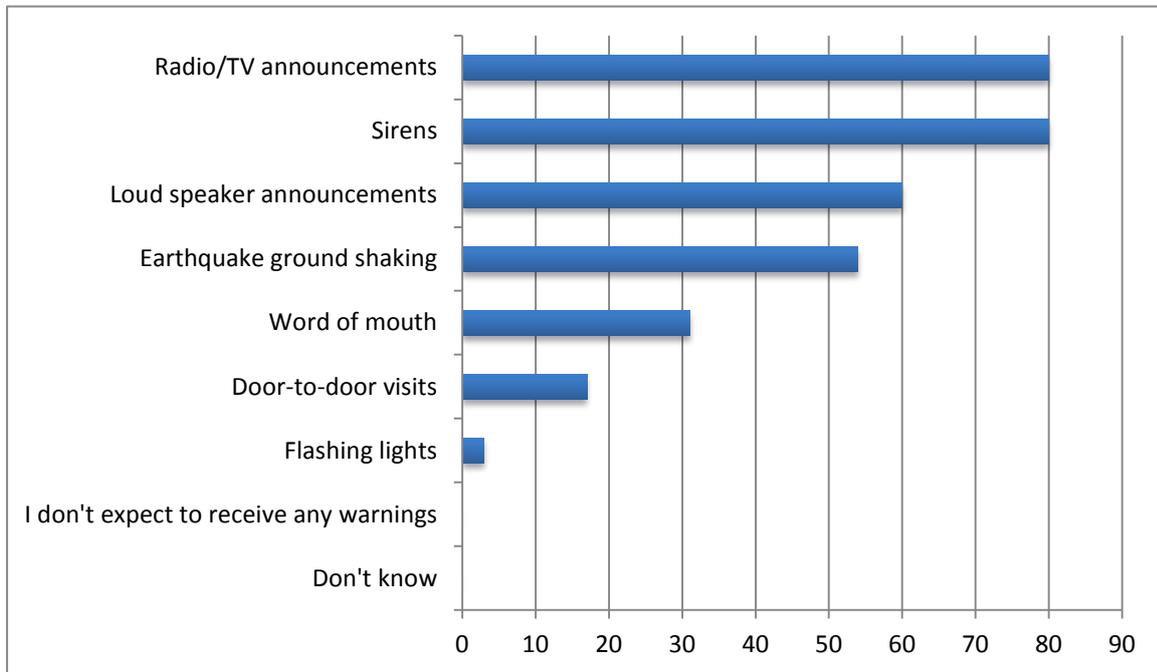
County and local emergency management agencies are the most popular source of tsunami preparedness information (Figure 5). State and Federal agencies, and research organisations are also used relatively frequently. 11% of the sample had not heard or received any information about preparing for a tsunami event.



**Figure 5** Sources of tsunami preparedness information (shown as per cent).

### Question 5: Likely warnings for a tsunami arriving within the next 12 hours

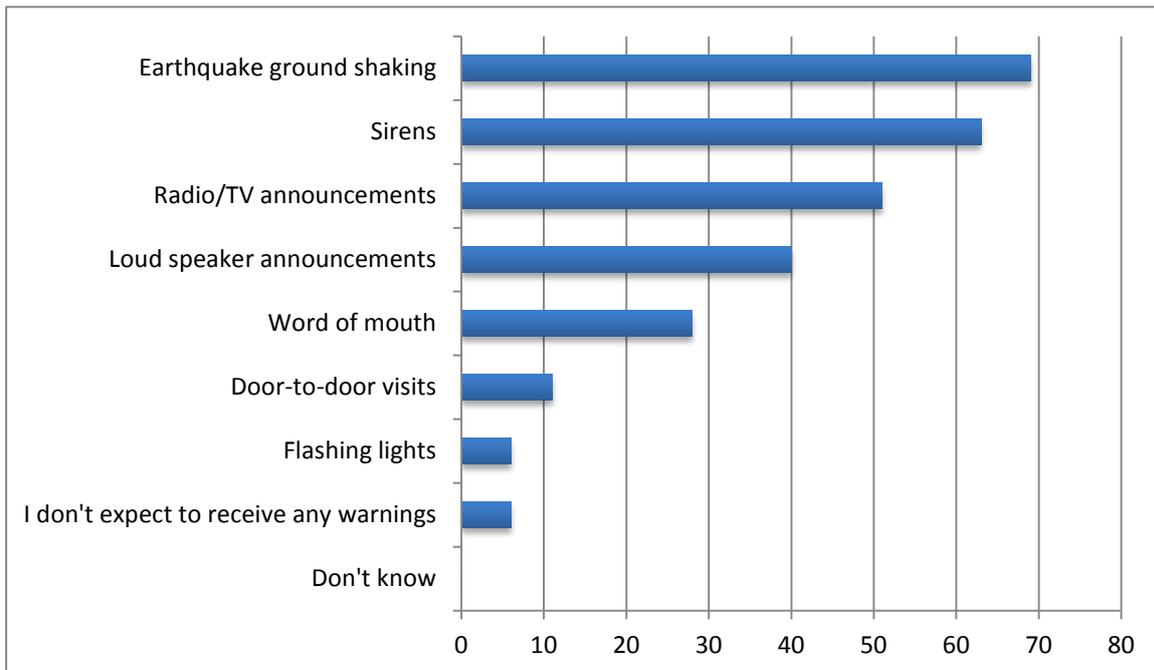
Radio and TV announcements, as well as sirens are considered the most likely warnings that people will get if a tsunami is due to arrive within 12 hours (Figure 6). Loud speaker announcements, ground shaking and word-of-mouth were also identified as potential warnings. 17% expected to receive a visit from emergency services to warn them.



**Figure 6** Warnings expected for a distant source tsunami, shown as per cent (arrival time within 12 hours).

### Question 6: Likely warnings for a tsunami arriving within an hour

For a near-source Cascadia-generated tsunami, 69% of people expect the ground to shake (Figure 7), which is a correct assumption. However, a large proportion still believed that sirens will warn them, even though local emergency management authorities cannot guarantee there will be enough time for a siren to be activated for a near-source event. People do not rely as heavily on radio and TV announcements for near-source tsunami warnings as for distant-source tsunami (51% and 80% respectively).



**Figure 7** Warnings expected for a near source tsunami, shown as per cent (arrival time within one hour).

### Question 7: Evacuation behaviour

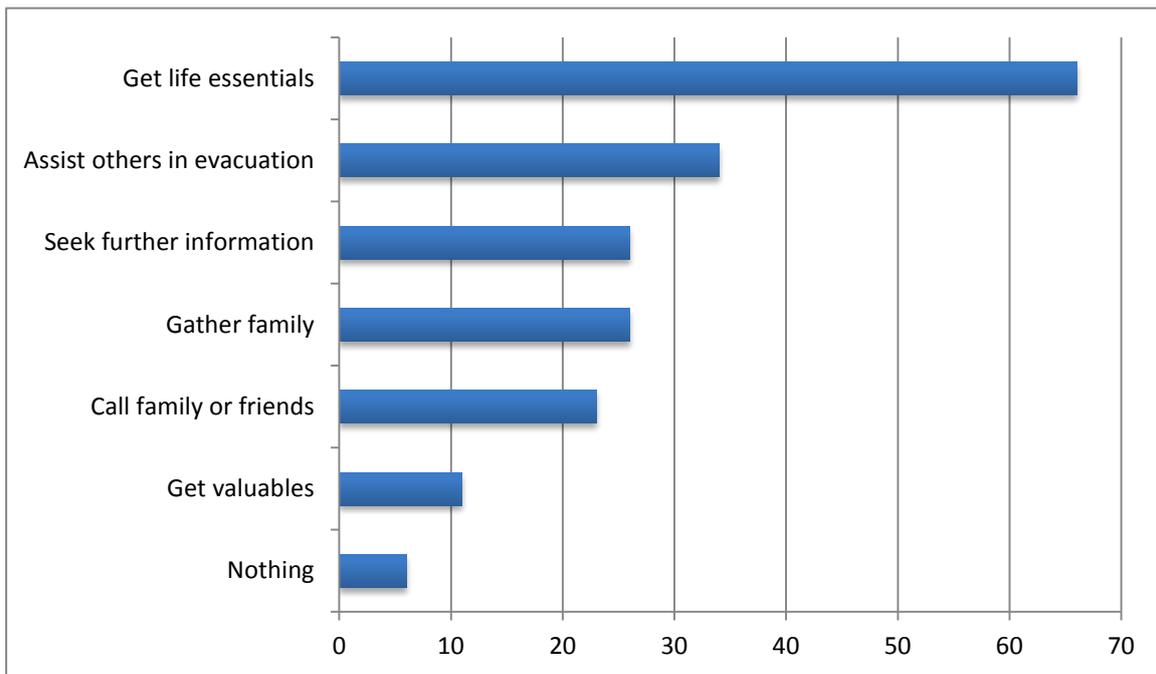
86% of respondents said they would evacuate if they felt a strong earthquake while at the beach or anywhere on the coast. If they did choose to evacuate, all respondents believed they would have either a few minutes (25%) or 10–30 mins (75%) to move to safety. No one selected any of the longer timeframes to evacuate (i.e., 30 mins–1 hour, 1–3 hours or more than 3 hours).

### Question 8/9: Evacuation destination

86% said they do have a specific place to evacuate to. A range of specific evacuation locations were offered, with most people describing areas of high ground, by following evacuation routes, or simply heading inland.

### Question 10: Pre-evacuation behaviours

Two thirds of respondents said they would collect essential supplies (e.g., food, water or medicines) prior to evacuating (Figure 8). 34% would help assist others to evacuate, and 26% would gather family prior to evacuating, with the same number reporting that they would seek further information. All of these are very natural responses and may be appropriate for a distant-source tsunami, however, any delay in people leaving their property can have negative consequences in the event of a near-source tsunami, when there may only be minutes to get to safety.



**Figure 8** Pre-evacuation behaviours (shown as per cent).

## 5.0 CONCLUSIONS

- In general, there was a high awareness of tsunami risk, however, it must be recognised that these results are not representative of the wider population, and that most people attending the meetings had specific interests in disaster preparedness and tsunami and earthquake issues.
- Tsunami, storms, earthquakes and flooding are considered by the participants to be the top four most likely hazards to affect communities in the area.
- There was a strong belief that the local community would not receive immediate external help from state or federal agencies following a tsunami event, and that preparing themselves and their communities for a tsunami was important both for making their own lives more comfortable and also for saving lives after the event. Many people were making collective community plans for how they would manage after a tsunami event.
- The results of the questionnaire indicate that timeframes of less than 30 mins to evacuate are widely accepted for a near source tsunami, which is promising. But most concerning was the perceived lack of immediacy for the evacuation, given the short timeframe they would have to initiate and carry out this response. From both survey results and focus group discussions it was clear that many participants do not fully understand how little time they will have to react, and suggested they would delay their departure to collect essential items, seek information and assist others in evacuation. This is consistent with previous studies (Johnston et al., 2014).
- Evacuation sirens are perceived to be confusing and ineffective, and many described how hearing them was highly dependent on their location and the weather (wind) conditions, with the net outcome being that the sirens are inaudible for many people. However, many still rely on evacuation sirens to warn them, even for a near source event.
- Many people noted they are not aware of where the nearest high ground is, particularly when they are away from their homes.
- There continues to be a lack of awareness about the potential damage to roads and infrastructure from a local Cascadia earthquake. Focus group participants frequently described their plans to evacuate by road, however, a local earthquake will almost certainly render roads and bridges impassable.
- Where high ground was nearby, much of the discussion focussed on the means to get to evacuation points, and also some of the issues around damage to bridges, roads and lack of signage and awareness of evacuation routes. But in areas where moving to high ground was more challenging or impossible, i.e., Tokeland, due to much bigger distances to travel on foot, their concerns focussed on the lack of options for themselves and for other vulnerable members of their community. For some, the lack of options to evacuate led to feelings of hopelessness and fatalism about their chances of survival.

- Tourism issues were most prominent in Long Beach and Ocean Shores communities, with many people feeling concerned at the prospect of having large numbers of visitors in town during a crisis. These issues included how to effectively educate short-stay visitors and non-permanent residents, and how tourism operators could plan effectively for their own response to an event. Some tourism-led initiatives were outlined, including evacuation plans for guests, and tsunami information being placed in guest rooms.
- County and local emergency management agencies were identified as the most frequent source of tsunami and earthquake preparedness information and education for local people to date.

## **5.1 OPPORTUNITIES – IDEAS AND SOLUTIONS**

- There was much support for working collectively within the community to develop solutions. It is important for emergency managers to identify local leaders with the ability to build momentum for projects locally, or to leverage off current community-led initiatives to assist them to achieve their preparedness goals.
- Vertical evacuation structures were identified as important, and many suggested that existing buildings could be strengthened so they could protect lives during a tsunami. Others believed external federal funding should be sought to build new structures.
- On-going public education highlighting the difference between near and far source tsunami events is necessary, with particular focus on the short timeframe to evacuate from a Cascadia event, and the potential for damage to road networks resulting in cars not being an option for evacuation.
- Individuals who had been through either the CERT or CEETEP training were much more aware of the risks, and frequently played a leadership role in educating others in their community about tsunami risks, including the need to evacuate quickly, and to prepare for such events. These programmes should be supported and developed into the future. The network of CERT volunteers could be recruited for some public education tasks.

## 6.0 REFERENCES

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## **APPENDICES**

## A1.0 APPENDIX 1: TSUNAMI AWARENESS SURVEY– WASHINGTON

**1. Which are the TWO natural hazards that you think are most likely to affect your community? (Check only two)**

- |  |   |
|--|---|
| <input type="checkbox"/> 1 Flooding              | <input type="checkbox"/> 5 Ashfall from a volcanic eruption |
| <input type="checkbox"/> 2 Storm with high winds | <input type="checkbox"/> 6 Tsunami                          |
| <input type="checkbox"/> 3 Wildfire              | <input type="checkbox"/> 7 Coastal erosion                  |
| <input type="checkbox"/> 4 Earthquake            | <input type="checkbox"/> 8 Landslide                        |

**2. To what extent do you agree or disagree with the following statements? Please use the scale below to show how each statement matches your views:**

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
A damaging tsunami is unlikely to occur during my lifetime	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
It is unnecessary to prepare for tsunami as assistance will be provided by local organisations or Government agencies	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
My property will never be damaged by a tsunami	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
Preparing for tsunami will improve my everyday living conditions	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
Tsunami are too destructive to bother preparing for	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
Preparing for tsunami will help save lives	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
I do not know how I can prepare for tsunami	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

**3. When do you think the next damaging tsunami might affect your community? (Check only one)**

- |   |   |
|---|---|
| <input type="checkbox"/> 1 Within the next year     | <input type="checkbox"/> 4 Not within your lifetime |
| <input type="checkbox"/> 2 Within the next 10 years | <input type="checkbox"/> 3 Within your lifetime     |

**4. Have you heard or received any information about preparing for tsunami hazards from any of the following? (Check all that apply)**

- |  |   |
|--|---|
| <input type="checkbox"/> 1 I haven't heard or received any information | <input type="checkbox"/> 8 Local Emergency Management group           |
| <input type="checkbox"/> 2 Friends                                     | <input type="checkbox"/> 9 Business establishments                    |
| <input type="checkbox"/> 3 Neighbours                                  | <input type="checkbox"/> 10 Research organisations (e.g., USGS, NOAA) |
| <input type="checkbox"/> 4 Relatives                                   | <input type="checkbox"/> 11 My workplace                              |
| <input type="checkbox"/> 5 Federal Government agencies                 | <input type="checkbox"/> 12 My child's school                         |
| <input type="checkbox"/> 6 State Government                            | <input type="checkbox"/> 13 Other, please specify _____               |
| <input type="checkbox"/> 7 County agencies                             | _____   |

**5. How do you expect to be warned that a tsunami is coming within the next 12 hours? (Check all that apply)**

- |  |   |
|--|---|
| <input type="checkbox"/> <sub>1</sub> Earthquake ground shaking                | <input type="checkbox"/> <sub>6</sub> Radio and TV announcements                    |
| <input type="checkbox"/> <sub>2</sub> Sirens                                   | <input type="checkbox"/> <sub>7</sub> Word of mouth                                 |
| <input type="checkbox"/> <sub>3</sub> Loud speaker announcements               | <input type="checkbox"/> <sub>8</sub> Don't know                                    |
| <input type="checkbox"/> <sub>4</sub> Flashing lights                          | <input type="checkbox"/> <sub>9</sub> I don't expect to receive any kind of warning |
| <input type="checkbox"/> <sub>5</sub> Door-to-door visit by emergency services | <input type="checkbox"/> <sub>10</sub> Other (please specify) _____                 |
- 

**6. How do you expect to be warned that a tsunami is coming within an hour? (Check all that apply)**

- |  |   |
|--|---|
| <input type="checkbox"/> <sub>1</sub> Earthquake ground shaking                | <input type="checkbox"/> <sub>6</sub> Radio and TV announcements                    |
| <input type="checkbox"/> <sub>2</sub> Sirens                                   | <input type="checkbox"/> <sub>7</sub> Word of mouth                                 |
| <input type="checkbox"/> <sub>3</sub> Loud speaker announcements               | <input type="checkbox"/> <sub>8</sub> Don't know                                    |
| <input type="checkbox"/> <sub>4</sub> Flashing lights                          | <input type="checkbox"/> <sub>9</sub> I don't expect to receive any kind of warning |
| <input type="checkbox"/> <sub>5</sub> Door-to-door visit by emergency services | <input type="checkbox"/> <sub>10</sub> Other (please specify) _____                 |
- 

**7. If you feel a strong earthquake while at the beach (or anywhere on the coast),**

**a. Would you evacuate?**

- <sub>1</sub> Yes  
 <sub>2</sub> No

**b. If yes, after feeling a strong earthquake how much time do you think will you have to move to safety from a possible tsunami? (Check only one)**

- |  |   |
|--|---|
| <input type="checkbox"/> <sub>1</sub> A few minutes            | <input type="checkbox"/> <sub>4</sub> 1 – 3 hours       |
| <input type="checkbox"/> <sub>2</sub> 10 minutes to 30 minutes | <input type="checkbox"/> <sub>5</sub> More than 3 hours |
| <input type="checkbox"/> <sub>3</sub> 30 minutes to 1 hour     | <input type="checkbox"/> <sub>6</sub> Don't know        |

**8. Do you have a specific evacuation destination in mind if you had to evacuate after a tsunami warning?**

- <sub>1</sub> Yes  
 <sub>2</sub> No

**9. If yes, where do you plan to go?**

---

**10. What would you do before evacuating? (Check all that apply)**

- <sub>1</sub> Nothing
- <sub>2</sub> Assist others in evacuation
- <sub>3</sub> Get life essentials (Food, water, medicine, etc.)
- <sub>4</sub> Get valuables (jewellery, money, etc.)
- <sub>5</sub> Call family or friends
- <sub>6</sub> Gather family
- <sub>7</sub> Seek further information (from radio, TV...)
- <sub>8</sub> Other (please specify) \_\_\_\_\_

**1. What is your gender?**

- <sub>1</sub> Male
- <sub>2</sub> Female
- <sub>3</sub> Prefer not to say

**2. In what year were you born? \_\_\_\_\_**

- decline to answer

**3. Where are you living? (Town/city and state)**

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