BRITISH COLUMBIA TSUNAMI NOTIFICATION METHODS

"A Toolkit for Community Planning"

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EXECUTIVE SUMMARY

The Emergency Program Act of British Columbia requires all local authorities (Municipalities and Regional Districts) to develop emergency plans for their jurisdiction. The Local Authority Emergency Management Regulation, enabled by the Act, requires that those local authority emergency plans, *"establish procedures by which those persons who may be harmed or suffer loss are notified of an emergency or impending disaster."* There is not one right solution or strategy for emergency notification that works in all communities equally. The unique features of each community require unique solutions.

The purpose of this toolkit is to provide British Columbia local authorities and their communities with information that will allow them to evaluate the many options available to provide notification and warning to the public of a potential or impending Tsunami wave. In general, notification options fall into 2 categories:

1. Mass Notification Methods - common alerting to an area, such as sirens
2. Addressable Notification Methods - targeted alerting, such as email and Weatheradio

While this toolkit was developed specifically with tsunami hazards in mind, it may also be applicable to many other hazards that could impact communities.

Large tsunami waves are incredibly powerful and destructive. Early warning and notification are key to the successes in preventing injury and loss of life. The tsunami events in South Asia in December 2004 and Japan in March 2011 created renewed awareness worldwide of the potential of tsunami waves. It also led to significant discussion about the need to warn those people who may be at risk from future events.

British Columbia has had a Tsunami Warning System in place for a number of years. Tsunami warning notifications for Coastal British Columbia are initiated by the U.S. National Tsunami Warning Center (NTWC). Emergency Management British Columbia, upon receipt of a warning from NTWC, notifies local authorities, coastal communities, the media and stakeholders by a combination of warning methods, including telephone, fax, Internet and emergency broadcast interrupts. These authorities are then required to implement their warning plans to advise their populations at risk.

This toolkit provides descriptions of notification methods and options, brief discussions of their advantages and disadvantages relative to other methods, implementation considerations and costs. The type of method(s) of notification that each local area uses will be shaped by several factors, including: the physical location and nature of the population (e.g. residents vs. non-residents), time of day, budget, geographic location, available supporting infrastructure, local customs, economic and social activities, etc. To achieve effective warning there should be complete and timely coverage, redundancy, and seamless meshing of new and existing systems.

Regardless of the warning method(s) used, it is critical that there be consistency in application and messaging, widespread public knowledge of the potential local area risks and emergency procedures, as well as continuous education about the warning practices. No matter how expensive or sophisticated, a warning system can never be totally effective without education. Whatever methods are chosen, all groups that are part of the notification process should be involved in the planning, implementation and operation of their systems.

It is important to recognize that a warning is the trigger for all of the subsequent activities that will occur during the emergency period, including response, rescue, relief and recovery. The warning portion (initial alert to the all-clear) may be relatively short or could go on for a prolonged period depending upon the nature of the hazard incident. Investing wisely in flexible, robust, redundant, multi-purpose communication system can yield dividends for all emergency needs.

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LIST OF ACRONYMS

2G	Second Generation
3G	Third Generation
4G	Fourth Generation
AOR	Area of Responsibility
ARES	Amateur Radio Emergency Service (Radio Amateurs of Canada)
BCAS	B.C. Ambulance Service
BDU	Broadcast Distribution Undertaking
CAP	Common Alerting Protocol
CB	Citizen's Band Radio
CEMCN	Central Emergency Management Communication Network
CCG	Canadian Coast Guard
CHS	Canadian Hydrographic Service
CLC	Canadian Location Codes
CMB	Continuous Marine Broadcast
CRTC	Canadian Radio-Television and Telecommunications Commission
DCS	Digital Calling Service
DMAC	Deputy Municipal Amateur Radio Coordinator
DSC	Digital Selective Calling
DTH	Direct-to-home
DTMF	Dual Tone Multi-Frequency
EAS	Emergency Alert System (US)
EC	Environment Canada
ECC	Emergency Coordination Centre
EIDS	Earthquake Information Distribution System
EMBC	Emergency Management British Columbia
ENS	Earthquake Notification Service
EOC	Emergency Operations Centre
ERMS	Emergency Response Management System
ERP	Effective Radiated Power
FIPS	Federation Information Processing Standards (US)
FRS	Family Radio Service
FSA	Forward Sortation Area
GEO	Geostationary Orbit
GIS	Geographic Information Systems
GMDSS	Global Maritime Distress and Safety System
GMRS	General Mobile Radio Service
GOC	Government Operations Centre
GPRS	General Packet Radio Service
GPS	Global Positioning Satellite
HF	High Frequency
HSPA	High-Speed Packet Access
IM	Instant Messaging
IOC	International Oceanographic Commission

IP	Internet Protocol
IPTV	Internet Protocol Television
IRLP	Internet Radio Linking Project
INAC	Ministry of Indian and Northern Affairs (Canada)
ISP	Internet Service Provider
JRCC	Joint Rescue Co-ordination Centre
LAN	Local Area Network
LAP	Local Area Paging
LCW	Letter Carrier Walk
LED	Light Emitting Diode
LEO	Low Earth Orbit Satellite
LOS	Line-of-Sight
LTE	Long-Term Evolution
MCTS	Marine Communications and Traffic Services (Canadian Coast Guard)
MERC	Municipal Emergency Radio Coordinator
MMSI	Maritime Mobile Service Identity
MOH	Ministry of Health
MSAT	Mobile Satellite System
NAADS	National Aggregation And Dissemination System
NAVTEX	Navigational Telex
NAWAS	National Warning System (US)
NOAA	National Oceanic and Atmospheric Association (US)
NOS	National Ocean Survey
NWS	National Weather Service (US)
NWPTAC	Northwest Pacific Tsunami Advisory Center
OCC	Operational Communications Centre
OTA	Over-the-air
PA	Public Address
PBX	Private Branch Exchange
PCS	Personal Communications Service
PECC	Provincial Emergency Coordinator Centre
PENS	Provincial Emergency Notification System
PERAC	Provincial Emergency Radio Advisory Committee
PERCS	Provincial Emergency Radio Communications Service
PPV	Pay Per View
PREOC	Provincial Regional Emergency Operations Centre
PSC	Public Safety Canada
PSTN	Public Switched Telephone Network
PTT	Push-to-Talk
PTWC	Pacific Tsunami Warning Centre
PTWS	Pacific Tsunami Warning and Mitigation System
QoS	Quality of Service
RCMP	Royal Canadian Mounted Police
RO	Regional Office
RSS	Rich Site Summary or Real Simple Syndication
S.A.M.E.	Specific Area Message Encoding

SEND	Satellite Emergency Notification Device
SIP	Session Initiation Protocol
SMS	Short Message Service
SMS-SG	SMS Special Gateway
SNU	Social Media Unit
TTY/TDD	Text Telephone/Telecommunications Device for the Deaf
UHF	Ultra High Frequency
URL	Uniform Resource Locator
USGS	U.S. Geological Survey
UTC	Coordinated Universal Time
VHF	Very High Frequency
VLPFM	Very Low Power Frequency
VLPTV	Very Low Power Television
VMS	Variable Message Sign
VOD	Video-on-demand
VoIP	Voice-over-Internet-Protocol
WAN	Wide Area Network
WAP	Wide Area Paging

INTRODUCTION

Tsunamis are among the most destructive forces in nature and can cause much loss of life, injury, and property damage. The term "tsunami", pronounced, "soo-nah-mee", is a Japanese word that embodies two characters: "tsu" and "nami". The character "tsu" means harbour, and the character "nami" denotes wave. Tsunamis are a series of unusually big waves formed by a large-scale disturbance of the surface of a water body. One of the primary causes of tsunamis is earthquakes, but tsunamis can also be caused by near-shore and underwater landslides, near-shore and underwater volcanoes, human-induced explosions on or underwater, and even by space objects impacting water bodies.

In deep, open-ocean water, these waves are often less than a metre high and can travel at speeds up to 1,000 kilometres per hour. However, as they reach shallow water and approach shorelines, the leading edge of the waves begin to slow down, and the wave begins to "pile up" behind, causing the wave to grow in height. The crests of these waves can be many metres high by the time they reach the shoreline. Sometimes, however, the crest of the wave isn't the first to arrive, the trough is. In this case, instead of very high water levels, the first sign of a tsunami is what appears to be a very, very low tide exposing unusually wide or unprecedented stretches of the seabed. It is important to note that the largest of the tsunami waves is often not the first wave and there can be anywhere from a few tens of minutes, to more than an hour between wave crests.

Most tsunamis are created in the Pacific Ocean, because the largest number of subduction zones is found there. Along the western coast of North America, tsunamis generally are divided into two threat categories: distant (far-field) and local (near-field), depending on the point of origin of the earthquake and size of the area affected. Distant tsunamis are classified as those generated 1,000 kilometres or farther away in the Pacific Ocean, and can severely impact British Columbia's outer coastal regions. The second threat is from tsunamis that are generated in local waters. These tsunamis can be triggered by earthquakes and shoreside and submarine landslides within a 1000 kilometre range and can have an impact on other B.C. coastal areas.

Several factors make tsunami hazard prediction and risk mitigation especially challenging along B.C.'s coast. These include the broad geographical scope of Pacific Ocean originated tsunamis that can affect B.C., the complex characteristics of B.C.'s coastline, the diversity of coastal populations and infrastructures and the varying options and capabilities for warning those at-risk.

The last destructive tsunami to significantly affect the west coast of B.C. was caused by the 1964 Alaskan earthquake. As the tsunami waves moved along the coast, they swept into the inlets of the islands and mainland. Several locations reported damage including Port Alberni, Hot Springs Cove, Gold River, Zeballos, Fair Harbour, Amai Inlet, Winter Harbour, Port Alice and Port McNeil.

Injury and loss of life can be minimized if coastal populations at-risk are warned that a tsunami is approaching. Under current notification arrangements, it is expected that a distant tsunami should allow sufficient time for an official tsunami message to be given to populations at-risk, but a local tsunami can reach the shoreline within minutes and may not allow for any official warning to take place. In such a case, natural signs, such as the strong shaking from the earthquake, a receding ocean, or a loud roaring sound, may be the only local warnings to allow for appropriate action. However, even in these instances and depending upon local conditions, people on floating marine platforms or vessels may not feel the shaking or witness other signs and may remain unaware of the hazard.

Warning methods fall into two basic categories:

1. **Mass Notification Methods** that are not individually addressable and generally provide the same alert or message to everyone within a particular geographic area, regardless of level of individual risk. Examples include:

Outdoor Systems	Fixed sirens and public address systems Mobile sirens Electronic signs
Broadcasting Systems	Conventional over-the-air radio and television Cable and satellite television Local low power radio
Internet	Social media RSS and special apps Audio and video streaming

2. **Addressable Notification Methods** that can tailor and target alerts and messages only to those at risk or to specific groups (such as emergency responders). Some newer, addressable technologies are also flexible enough to support many of the same functions as traditional mass notification systems. Examples include:

Broadcasting Systems	Amateur radio Canadian Coast Guard radio Weatheradio (Environment Canada)
Telecommunication Systems	Automated notification Telephone trees Paging and tone-alert radio Agency radio SMS Text messaging
Internet	VoIP Email Social media Instant messaging and special apps
Personal Systems	Door-to-Door Residential Route-warning

Each method has benefits and drawbacks and is discussed in more detail later in this document.

The type of methods that each area uses will be shaped by several factors, including: the physical location and nature of the population (e.g., residents vs. non-residents), time of day and year, budget, geographic location, available supporting infrastructure, local customs, economic and social activities, etc. To achieve effective warning there should be complete and timely coverage, redundancy and seamless meshing of new and existing systems. Regardless of the method, it is critical that there be consistency in warning application and messaging, widespread and current public knowledge of both the potential risks, as well as continuous education about the alerts.

A warning system can never be totally effective without education, no matter how expensive or sophisticated. Whatever methods are chosen, all groups that are part of the notification process should be involved in the planning, implementation and operation of their systems.

The main purpose of this toolkit is to provide community and other coastal authorities with information about various warning methods and procedures to assist them with planning and developing tsunami warning methods and procedures for their own areas.

Information incorporated into this document was gathered from a variety of sources. The document, in part, is based on a previous document produced by the SFU Telematics Research Lab in 2005, with extensive revisions and updates to reflect contemporary notification practices and underpinning infrastructures. A substantial amount of the supporting background research was carried out under two previous phases of the CSSP supported project involving 1) a comprehensive review of B.C. populations-at-risk, institutional tsunami notification arrangements, dissemination methods, coverage and gaps (2014) and 2) the conducting of a series of pilot projects to assess new mobile and broadcasting notification techniques, especially in rural and remote coastal regions with challenging terrain (2015).

Several methods were employed to gather additional information. A series of Internet and online journal searches were conducted concerning warnings systems, lessons learned and recommended good practices. Provincial and federal programs were reviewed and information was gathered from other jurisdictions through interviews and other personal contact, a visit to the U.S. National Oceanic and Atmospheric Association's National Tsunami Warning Center and participation in the U.S. National Tsunami Mitigation Program. A B.C. coastal community survey was conducted in 2014 to identify local tsunami practices and issues. Additional information was gathered through participation in Emergency Management British Columbia (EMBC), regional and local workshops, planning meetings and exercises (especially Tsunami Notification Networking Group and rural/remote coastal community), and interviews with communication service providers, vendors and other supply organizations. Other information was derived from data collected and analyzed during the conducting of pilot projects and mapping and visualization of compiled coastal data sets.

This document is divided into three sections.

Section One Provides a brief overview of tsunami causes and characteristics, how they are detected, and a brief description of the current West Coast Tsunami Warning System and its components.

Section Two Describes various approaches to warning, including concepts, definitions, procedures, planning, and incorporating the experience of communities participating in the U.S. TsunamiReady Program and other regions.

Section Three Examines various notification methods available to B.C. coastal communities, including advantages and disadvantages, design and implementation considerations.

Scope and Limitations

Collectively, today, B.C. coastal emergency authorities and partner agencies are required to employ an array of methods to receive official tsunami event notifications and disseminate alerts and messages to populations-at-risk (including telephone, facsimile, email, radio, SMS, Twitter, WWW, sirens, personal contact, etc.). Their choices of methods are influenced by several factors, including: institutional and jurisdictional arrangements, budgets, available supporting infrastructures, the physical location and nature of the population (e.g. residents vs. non-residents), local customs and economic and social activities. In more rural and remote regions, communication with populations-at-risk can be challenged even further because of limited modes of transportation and widely dispersed populations that fluctuate according to seasonal variations and economic circumstances (tourism, fishing, logging, aquaculture, etc.). Regardless of the method, additional critical considerations are consistency in application and messaging, timeliness, as well as ensuring widespread public knowledge of the nature of the risks, methods of notification and expected actions.

From an electronic communication perspective, particularly in rural areas, there are widely varying levels of access to services (especially basic fixed and cellular telephone, Internet and local broadcasting services) due to higher infrastructure costs, smaller supporting populations and greater distances from larger centres. Even where two-way radio (marine, commercial and public safety) and satellite communication systems are employed, access to and reliability of service can be influenced by line-of- sight coverage issues due to mountainous terrain.

While many communications challenges persist, advances in information and communication technology (ICT) increasingly offer a range of new options for integrating and standardizing notification arrangements. Among the potentially more useful ICTs are Internet Protocol-based fixed and mobile terrestrial and satellite systems. These systems are more addressable and becoming more affordable and widespread in use, including data exchange schemes, such as the Common Alerting Protocol (CAP), that offer opportunities better to manage, integrate and target warning messages simultaneously across a wide variety of fixed and mobile dissemination systems, with exponentially-growing communication capacity. Further, considerable experience is being gained in innovative community-based last-mile ICT projects in other locations, especially in the post-tsunami regions of South Asia and Japan, which could help to inform the development of new initiatives in the Canadian West Coast region.

Consequently, to remain relevant, tsunami and other emergency notification arrangements now must draw upon and integrate a broad mixture of traditional and contemporary systems to support timely communication with all potentially affected populations (fixed and transient). At the same time, this mix of legacy, contemporary and seemingly ever-emerging next-generation 'disruptive' technologies incessantly affects almost every aspect of personal, interpersonal and mass communication that underpins emergency notification. One of the most significant paradigm shifts is the rapid movement away from the use of fixed single mode technologies (such as landline telephone and over-the air broadcasting) towards personalized and globally connected mobile communication technologies (such as wireless smart devices) which combine all of the attributes of traditional mass and personalized services with new forms of social communication and networking.

In this regard, this toolk is intended to primarily serve as a “snapshot-in-time” to record and discuss those notification methods that we have identified in the course of this project, as being applicable to B.C. coastal areas and, thus, should be viewed chiefly as a contribution to a continuous work-in-progress. Information presented in this document, therefore, is not guaranteed to be fully current or accurate. Further, while this document may reveal new options for communicating warnings and other critical information, they are not intended to replace or supercede any existing notification guidelines or protocols published and/or recommended by EMBC and the US NTWC.

SECTION ONE

Public Tsunami Warning Systems

1.1 Basics of Public Warning Systems

Experience has shown that people at risk from disasters, whether natural or human-induced, can take actions that save lives, reduce losses, speed response, and reduce human suffering when they receive and act upon accurate warnings in a timely manner. Scientists and emergency management programs continue to develop more accurate warnings as they deploy better sensors to measure key variables, employ better models, and expand their understanding of the causes of disasters, while today's communication revolution enable populations-at-risk to receive these warnings more efficiently and quickly regardless of location or time of day.

The result is that warnings are becoming much more useful to society as lead-times and reliability improve, and as society devises ways to respond more effectively.[1]

Warning systems typically involve the installation of a range of instruments and technologies to enable early detection and monitoring of hazards. They also involve scientific and organizational programs for analyzing the collected data to determine the extent of associated risk exposure, probable impacts, and processes for notifying those at risk in a timely fashion. For Pacific tsunamis, these arrangements include the installation of a network of seismometers, sea level gauges and deep-sea sensors that provide around-the-clock, real-time data for detecting earthquakes and ocean water movements. Scientists use this data to predict the possibility of tsunami waves and to model their anticipated arrival times and onshore impacts.

Advanced telecommunications networks enable this data to be shared worldwide almost instantaneously and notifications to be transmitted to designated national warning authorities. It is the responsibility of the national authority to determine whether or not to issue a tsunami warning applicable to its own territory and population(s), tailor the content of the warning, target those at risk and disseminate the warning message(s). For Canada's West Coast, this authority is the Emergency Management British Columbia (EMBC*).* **However, it is the responsibility of local authorities to issue local warning and evacuation orders and to ensure that warnings can be accessible to, understood by, and acted upon by local populations under their jurisdictions most directly affected by tsunami threats.**

1.1.1 Warning as a System

Warning should be viewed not simply as a technology, but rather as a unified system made up of several critical and inter-related elements:

- Hazard identification, risk assessment and vulnerability analysis;
- Detection and monitoring;

[1] National Science and Technology Council. (2000).

- Emergency management structure;
- Local dissemination, and
- Public education.

Further, in addition to warning the public, an effective warning system also should provide information about how to prevent and mitigate against disasters, as well as information and knowledge to aid timely response, relief and recovery efforts.

For public warning to be effective a number of key planning tasks should first be understood, accepted and completed within the local context:[2]

1. Establishing a **tsunami warning planning group** to conduct necessary background research, consult and work with all affected interests and contribute to the development of a tsunami warning plan and system.
2. Conducting and updating over time a **hazard and risk analysis** to identify hazards and to determine coastal areas most at risk from tsunamis.
3. Completing a **vulnerability analysis** to determine populations and critical facilities that are potentially exposed and likely to be impacted.
4. Developing **tsunami inundation maps** to identify and designate areas expected to be damaged by flooding or waves.
5. Identifying and mapping **evacuation plans and routes** to enable populations to reach higher ground or move inland safely.
6. Selecting appropriate **notification methods and install appropriate means** to ensure all populations at risk can be alerted and given instruction at any time, regardless of physical location.
7. Establishing **emergency plans and procedures** for when warnings will be issued and how they will be widely disseminated, for initiating evacuations, for establishing and managing shelters, and for coordinating search and rescue and emergency relief operations. These plans and procedures should be tested regularly with public involvement.
8. Developing an **education program** to ensure the public is knowledgeable about the nature of hazards and their effects, who and what is at risk, how populations will be warned, what the warnings mean and what actions should be taken.
9. Ensuring **regular testing and assessment** of the warning system both to ensure that the system works and that the public understands its purpose and messages.

It is also important to recognize that populated areas, hazard conditions and notification methods change over time so planning needs to be an on-going process.

[2] Samarajiva, et al. (2005).

1.2 THE BRITISH COLUMBIA TSUNAMI WARNING SYSTEM

British Columbia's Tsunami Warning System comprises three basic subsystems:[3]

1. Detection subsystem
2. Emergency management subsystem
3. Public response subsystem

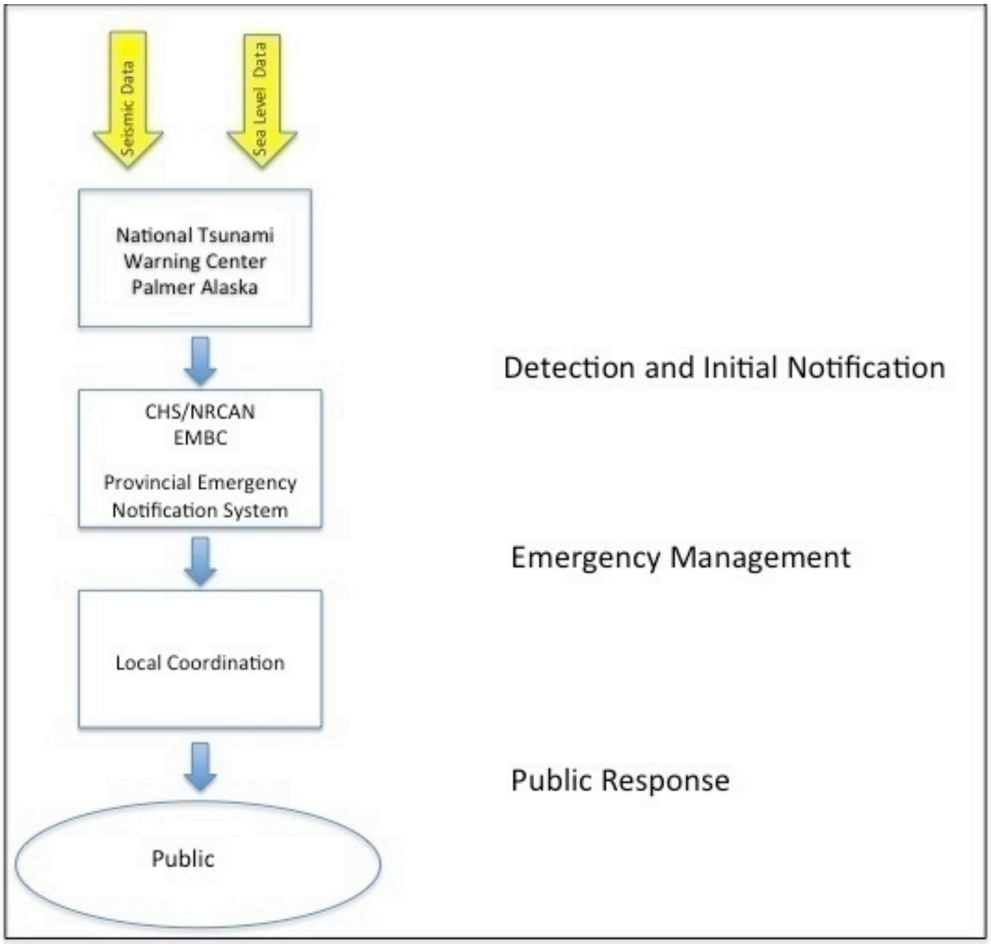

Figure 1: Components of the B.C. Tsunami Warning System

1.2.1 Stage 1: The Detection and Initial Notification Subsystem

The function of the detection and initial notification subsystem is to identify and communicate the presence of a hazard or the existence of hazardous conditions. In the case of a tsunami detection, this involves: the monitoring and detection of certain seismic events, the anticipation and detection of tsunami generation, the tracking and monitoring of any generated waves, and the forecasting of wave arrival times and estimated wave heights.

Since 1965 the detection subsystem supporting the B.C. Tsunami Warning System has been coordinated at an international level by a group under the auspices of the International

[3] Adapted from: Anderson,P. and Gow, G. (2003).

Oceanographic Commission (IOC). The present name of this group is the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (IGC/PTWS). Canada is a member of this group, along with 46 other member states located within the Pacific Rim.

The Pacific Tsunami Warning Center (PTWC), located in Hawaii, serves as the operational warning headquarters for the Pacific Tsunami Warning and Mitigation System (PTWS). PTWC works closely with other international, sub-regional and national centres in monitoring seismic and sea level stations around the Pacific Ocean for large earthquakes and tsunami waves. The PTWS makes use of a worldwide network of seismic stations to locate potentially tsunami generating earthquakes, as well as deep-ocean sensors and coastal sea level stations to verify the generation and evaluate the severity of a tsunami. The system disseminates tsunami information and warning messages to designated national authorities in more than 100 locations throughout the Pacific. Sub-regional centres such as Japan's Northwest Pacific Tsunami Advisory Center (NWPTAC) and NOAA's US National Tsunami Warning Center (NTWC) provide regional alerts to the northwest Pacific and South China Sea regions and the U.S.A. west coast, Alaska and Canada, respectively[4].

Tsunami Detection and Initial Notification for the Western Canada/U.S. Region

The U.S. National Tsunami Warning Center operated by the Alaska Region of NOAA's National Weather Service, in Palmer, Alaska, has the responsibility for issuing Tsunami Warnings, Advisories, Watches, Cancellations and Information Statements and interpretive information to civilian emergency and military officials in Alaska, Washington, Oregon, California and British Columbia (EMBC and the Canadian Armed Forces Joint Task Force Pacific). The Center collaborates with the Pacific Tsunami Warning Center to provide tsunami warning service, and mutual backup, to United States coastal regions and many other countries throughout the world. NTWC's area-of-responsibility (AOR) is Puerto Rico, the Virgin Islands, Canada, and the east and west coasts of all U.S. states except Hawaii. More specifically for the Pacific Coast, it includes the U.S. States of Alaska, Washington, Oregon, California and the Province of British Columbia. The PTWC in Hawaii serves as a backup to NTWC and is responsible for notification to the remaining areas of the Pacific.

To accomplish its mission of providing accurate and timely tsunami bulletins to its AOR, the NTWC detects, locates, sizes, and analyzes earthquakes throughout the world. Earthquakes that activate the center's alarm system initiate an earthquake and tsunami investigation which includes the following four basic steps: 1) automatic locating and characterizing the earthquake; 2) earthquake analysis and review; 3) sea level data analysis and tsunami forecasting, and 4) disseminating information to the appropriate emergency management officials.

NTWC's goal is to issue tsunami warnings within five minutes of an earthquake. Since the Center has implemented 24x7 on-site operations, average response time has dropped to approximately three minutes for events within its AOR.

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[4] Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (2016).

To accomplish this, the first tsunami bulletins issued (whether Tsunami Warning, Advisory, Watch or Information Statement – described in more detail below) are based solely on pre-set criteria and analysis of seismic data from approximately 750 seismic stations recorded at NTWC.

Once a significant event has occurred, the nearest tide gauges and deep ocean tsunami detectors (DARTs) are monitored to confirm the existence or nonexistence of a tsunami, and its degree of severity. NTWC has access to approximately 900 tide sites and 50 DARTs. Many of these sites are maintained by NOAA's National Ocean Survey (NOS). For North America's Pacific Northwest coastal sub-region, in addition to the NOS sites, sea level information is provided by the Canadian Hydrographic Service and Ocean Networks Canada to the Center.

If a tsunami has been generated, the sea level data is critical for use in calibrating forecast models. Following the first message, the tsunami is analyzed using observed sea level data, forecast models, historic data, and further seismic processing. Based on this analysis, supplemental messages are issued if a Warning, Advisory, or Watch was originally issued. Areas with forecasts of 1m or greater in zero-to-peak amplitude are generally put in a tsunami Warning; those with forecasts 0.3m to 1m in an Advisory, and for those less than 0.3m Warning, Watch, and/or Advisory messages are cancelled. Historical information has shown that tsunamis can cause damage due to strong currents when amplitudes reach 0.5m or greater.

Message Targeting

NTWC Warning, Watch, and Advisory regions are based on distance from the earthquake epicentre, tsunami travel time, or pre-computed threat estimates. British Columbia is divided into five tsunami inundation risk zones A, B, C, D and E[5]. These were developed taking into account wave height, run-up, subsidence and adding a safety margin, and to ensure timeliness in notification. [6]

Each of the five designated zones includes all islands and inlets within the location description. For purposes of its messaging, the NTWC also uses these same zones.

Table 1: Recommended Tsunami Run-up Planning Levels

ZONE	WAVE HEIGHT (m)	RUN-UP (x2.0) (m)	SAFETY (X1.5) (m)	SUBSID-ENCE (m)	PLANNING LEVEL (m)
Zone A (North Coast and Haida Gwaii)	2.0	4.0	6.0		6
Zone B (Central Coast)	2.0	4.0	6.0		6
Zone C (W. Vancouver Island)	3.0	6.0	9.0	1.0	10
Zone D (Juan De Fuca Strait)	1.3	2.7	4.1		4
Zone E (Strait of Georgia)	0.5	1.0	1.5		2

[5] PEP (2006); British Columbia, (2013a); British Columbia, (2013b)
[6] PEP (2006); British Columbia, (2013a); British Columbia, (2013b)

Zone A: The North Coast and Haida Gwaii

Beginning on the Alaska/B.C. border near Stewart, B.C. and moving in a southward direction along the coast to the southern tip of Banks Island, including the Queen Charlotte Islands.

Zone B: The Central Coast and Northeast Vancouver Island Coast including Kitimat, Bella Coola and Port Hardy

Beginning on the southern tip of Banks Island to the northern tip of Vancouver Island (the western limit of the eastern boundary of Cape Scott Provincial Park.) This zone has a southern limit of a line running from the convergence of the Tsitika River and Johnstone Strait (in Robson Bight Provincial Park) on Vancouver Island in the south to the most eastern point of Broughton Island in the north.

Zone C: The Outer West Coast of Vancouver Island from Cape Scott to Port Renfrew

Beginning on the eastern boundary of Cape Scott Provincial Park on the northern tip of Vancouver Island and running in a south-easterly direction along the outer coast of Vancouver Island to Sombrio Point southeast of Port Renfrew.

Zone D: The Juan de Fuca Strait from Jordan River to Greater Victoria including the Saanich Peninsula

Beginning at Sombrio Point southeast of Port Renfrew and running in an easterly direction to the most northerly point of the Saanich Peninsula.

Zone E: The Strait of Georgia including the Gulf Islands, Greater Vancouver and Johnstone Strait

Beginning at the most northerly point of the Saanich Peninsula, including Brentwood Bay and all the Gulf Islands within the Georgia Basin to one of two points at the northern limit. The northern limit is a line running from the convergence of the Tsitika River and Johnstone Strait (in Robson Bight Provincial Park) on Vancouver Island in the south to the most eastern point of Broughton Island in the north.

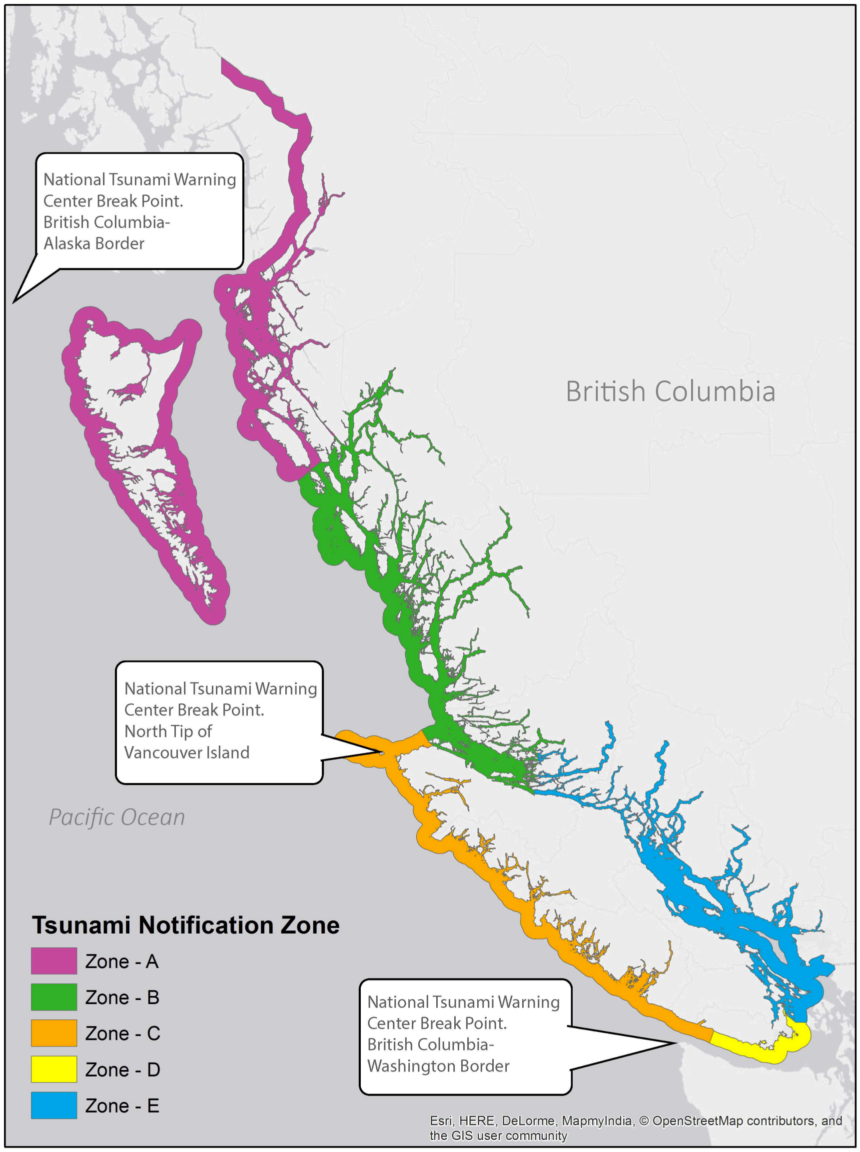

Figure 2: British Columbia Tsunami Notification Zones

Populations-at-Risk

Fixed Locations

Some 280 settled location place names have been identified in the tsunami notification zones. Of these, 88 are incorporated municipalities, 61 are First Nations territories and the remaining 131 are rural unincorporated places that fall within the jurisdictions of one of the 15 coastal regional district authorities.[7]

[7] Anderson, P. (2014)

Table 2: Estimates of Fixed Location Populations Residing Within B.C. Tsunami Zones

Tsunami Notification Zone	Population 2011
Zone A	19,804
Zone B	13,407
Zone C	18,075
Zone D	192,511
Zone E	727,128
TOTAL	**970,925**

Transient Populations

Other populations at-risk are those that reside temporarily in or traverse through coastal areas. There are many varieties whose numbers vary according to economic, socio-cultural, seasonal and other factors. Examples include logging, commercial fishing and aquaculture workers, recreational land and marine populations, tourists, etc., and they travel throughout all of B.C's sub-regions, including the most remote locations where communication and tsunami notification services are marginal at best.

1.2.2 Stage 2: Initiating the Emergency Management Subsystem

The function of the emergency management subsystem is to determine the extent and magnitude of the tsunami threat to B.C. and carry out necessary actions. This includes assessment of public safety threat, property loss potential, environmental damage potential, and economic loss potential and informing authorities in order to activate plans and notify populations-at-risk. Emergency Management British Columbia is the receiving authority for NTWC bulletins and the provincial lead for tsunami notification within the B.C. Emergency Management Subsystem. Upon receipt of a NTWC bulletin indicating a threat to British Columbia, EMBC consults with the Canadian Hydrographic Service (CHS) of Fisheries and Oceans Canada to assess the local tsunami threat based on ocean and tidal conditions at the time bulletins were issued. Seismologists at Natural Resources Canada's Pacific Geoscience also provide input. EMBC tsunami messages are issued through the Provincial Emergency Notification System (PENS). PENS relies on multiple methods and partner agencies to facilitate timely and accurate tsunami messaging. These arrangements are described in more detail later in this document.

It is important to note, however, that this subsystem is most effective in the case of distant tsunamis, where there is sufficient time to determine possible tsunami risk and mobilize an appropriate response along the B.C. Coast. Tsunamis generated locally (1000 km or less) within a B.C. Coast sub-region, may pre-empt activation of this subsystem for nearby locations. Little can be done to warn of local tsunamis because their travel time is so short. Persons living in coastal areas need to assume that a tsunami may have been generated if a large earthquake has occurred off the coast or in inner waters, and react accordingly.

Tsunami messages issued by NTWC and EMBC use the same alert levels. From the highest to the lowest threat, the alert levels are: Warning, Advisory, Watch, Information Statement and

Cancellation.[8] Each has a distinct meaning relating to recommended local emergency response activities. The following table and descriptions below outline the meaning of each alert level and recommended action. It is important to note that during a tsunami, updated information may result in a change in the alert levels.

Table 3: NTWC and EMBC Tsunami Alert Levels

Warning	Inundating wave possible	Full evacuation suggested
Advisory	Strong currents likely	Stay away from the shore
Watch	Danger level not known yet	Stay alert for more information
Information Statement	Minor waves at most	No action required
Cancellation	Tide gauges show no wave activity	Confirm safety of local areas

Warning - A "Warning" is the highest level of tsunami alert. Warnings are issued due to the imminent threat of a tsunami from a large undersea earthquake, or following confirmation that a potentially destructive tsunami is underway. They may be based initially only on seismic information as a means of providing the earliest possible alert. Warnings indicate that flooding up to the maximum expected limit accompanied by powerful currents is possible and may continue for several hours after initial arrival. Residents should follow their local emergency management instructions, including evacuation of coastal areas within the area. Mariners may be encouraged to reposition ships to deep waters when there is time to safely do so. Warnings may be updated, adjusted geographically, downgraded, or cancelled.

Advisory - An "Advisory" is the second highest level of tsunami alert. Advisories are issued when a tsunami with the potential to generate strong currents or waves dangerous to those in or very near the water is imminent, expected, or occurring. The threat may continue for several hours or even up to a day after initial arrival, but significant inundation is not expected for areas under an advisory. Appropriate actions by local emergency management personnel may include closing beaches, evacuating harbours and marinas and alerting and instructing boaters, kayakers and others on the water. Advisories are updated to continue the advisory, expand/contract affected areas, upgrade to a warning, or cancel the advisory.

Watch - A "Watch" is the third highest level of tsunami alert. A tsunami watch is an early alert issued to areas that may later be impacted by a tsunami. Watches are normally issued based on seismic information without confirmation that a destructive tsunami is underway. Tsunami impact is normally at least three hours away for regions within a tsunami watch. When watches are issued, emergency management officials and the public should prepare to take timely action, especially in case the Watch is upgraded to an Advisory or Warning.

Information Statement - An "Information" statement is issued to inform emergency management officials and the public that an earthquake has occurred, or that a tsunami warning, watch or advisory has been issued for another section of the ocean. In most cases, information statements are issued to indicate there is no threat of a destructive tsunami and to prevent

[8] NTWC, 2014a; NTWC, 2014b; British Columbia, 2013b

unnecessary concern when an earthquake has occurred but there is no tsunami threat.

Cancellation - A “Cancellation” cancels any previously issued tsunami messages. It is issued when there is no longer observed evidence of tsunami waves at tide gauge stations. Local conditions may differ from those at tide gauge stations and local authorities need to determine the safety of their coastlines. Cancellations are the final tsunami messages issued by NTWC and EMBC.

Notification Criteria, Protocols, Methods and Message Flows

NTWC bulletins are given the initial highest message priority and receipt of a NTWC tsunami message from EMBC or directly from NTWC should be observed until such time as EMBC bulletins are issued[9].

Earlier, B.C. tsunami messages were tailored to first go to emergency authorities to ensure a coordinated and consistent message flow from NTWC to EMBC and then from EMBC to local emergency management stakeholders and the public. However, advances in information and communication technology now enable both emergency managers and the public to obtain NTWC messages directly via email, SMS and WWW services. Also appearing on the digital landscape are new social media applications, in particular, Twitter, that enable rapid duplication and public redistribution of tsunami messages.

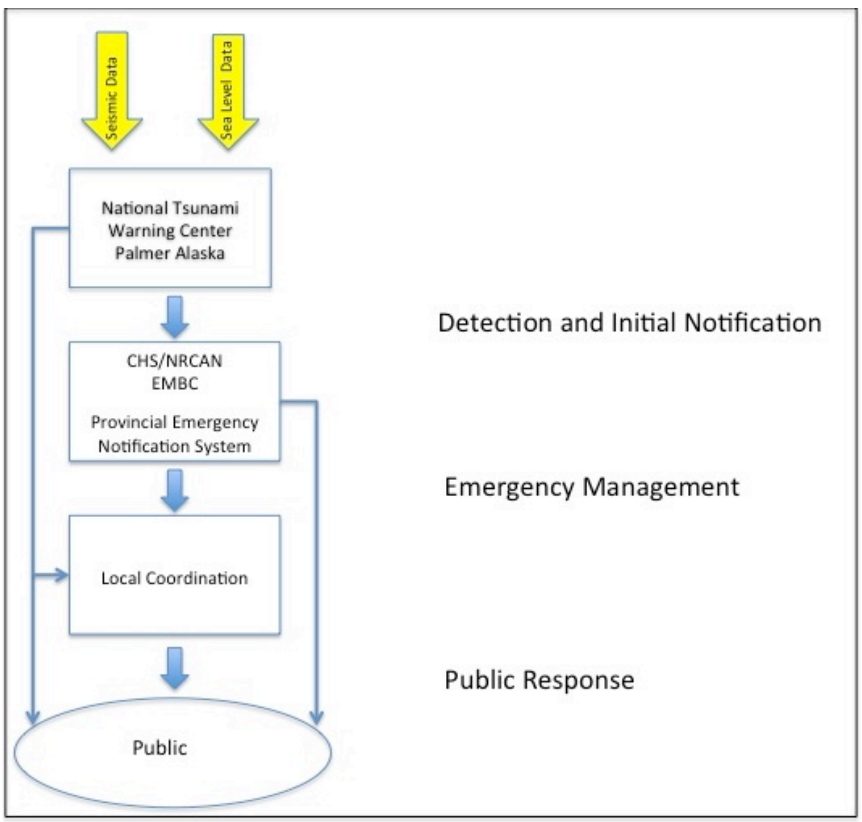

Figure 3: Flow of Tsunami Messages

[9] British Columbia, 2013b

The combined effects of these changes are such that emergency managers, critical service providers and the public now all possess a wide array of methods for receiving and distributing NTWC and EMBC tsunami notifications, both directly and indirectly through multiple dissemination routes at approximately the same time. These arrangements are outlined below and described in more detail in Section Three.

NTWC Bulletins

While the primary recipients of NTWC tsunami messages are intended to be coastal state/provincial lead emergency services, the U.S. Federal Emergency Management Agency, weather service offices, Coast Guards, and military offices, as mentioned, the bulletins are also available through a variety of means to local emergency managers and the general public.

As indicated earlier, initial NTWC Warning, Advisory and Watch messages are generated based solely on seismic event data and will contain the following information:

- Geographic areas covered by the message;
- Recommended actions;
- Preliminary earthquake parameters, and
- Estimated tsunami start times for selected sites.

Updated messages will include tsunami impact forecasts and measurements of tsunami activity from DART and tide stations and/or other reports of activity. Samples of NTWC messages are available at: http://wcatwc.arh.noaa.gov/?page=product_list

NTWC messages are disseminated to British Columbia emergency management agencies and members of the public through a multitude of systems. The table below summarizes message output devices used at the Center. An asterisk (*) in the table indicates messages are transmitted directly from the operational software.

Table 4: Message Dissemination Methods at the National Tsunami Warning Center

Service	Owner or Operating Agency	Primary User Audience
NOAA Weather Wire *	NWS	National Weather Service forecast subscribers and U.S./state – Canada/province emergency management agencies
NAWAS	FEMA	U.S./state – Canada/province emergency management agencies
EIDS *	USGS	Emergency management officials
INTERNET * (web site, email, RSS, and cell phone text messaging)	Public Telecommunications	International and domestic government agencies, academic institutions and the public in general

NOAA Weather Wire - The NOAA Weather Wire is a satellite broadcast service maintained by the NWS to disseminate weather products domestically. Users of the NWW system consist of Weather Service Offices, state and provincial emergency management agencies, and the U.S. Coast Guard.

NAWAS - The NAational WArning System is a nationwide dedicated voice telephone system connecting selected defence, National Weather Service, emergency management, and Coast Guard agencies.

EIDS – Earthquake Information Distribution System is an earthquake information dissemination tool operated by the United States Geological Survey. The Internet is used to transmit earthquake information to USGS servers where it is disseminated to various web sites and agencies.

Internet - NTWC maintains a public web site and a set of group email lists for emergency managers for disseminating Warning, Advisory and Watch messages and Tsunami Information Statements. Shortened cell phone text (SMS) messages are also transmitted via an Internet-to-SMS gateway to emergency managers. Presently, NTWC does not provide email or SMS service directly to the public, but does enable access via third party providers. NTWC sends out automated shortened Warning, Advisory, Watch and Information messages on its Twitter account, @NWS_NTWC. *Additional details are available in Section Three.*

British Columbia Tsunami Notification Arrangements

NTWC tsunami messages are received by the 24/7 Emergency Coordination Centre (ECC) located at EMBC Headquarters in Saanichton (Victoria) via NTWC email and the NOAA Weatherwire, and may be followed by a NAWAS conference call between NTWC and EMBC for situational updates during a tsunami event. Upon receiving a NTWC Warning, Advisory or Watch for B.C., the ECC will initiate steps to notify key partners and the public through its enhanced Provincial Emergency Notification System and activate EMBC's management structure as described further below.

B.C.'s tsunami notification protocol is based on the following key considerations:[10]

- EMBC's focus is on notifying its audience of possible or actual impacts to public safety.
- The science that governs the NTWC tsunami notifications determines whether the public is at any risk. If no Warning, Advisory or Watch is issued, the public can be assured there is no risk.
- This risk level associated with notification is the same threshold used in a number of west coast U.S. states.
- With over 2,000 earthquakes off the B.C. coast in any given year - or more than five per day on average - sending notifications of non-threats may cause a level of complacency that would negatively impact awareness should a tsunami threat actually occur.

[10] https://news.gov.bc.ca/factsheets/factsheet-criteria-for-provincial-tsunami-notification

EMBC Provincial Emergency Notification System Activation Process

British Columbia's Tsunami Notification Process Plan[11] identifies and briefly describes the roles, responsibilities and general procedures used by international, federal, provincial and key stakeholder agencies in the dissemination of tsunami messages within B.C. Beyond the general roles and responsibilities outlined in the Plan, each identified stakeholder has its own internal standard operating procedures that detail its activities during a tsunami.

EMBC's notification criteria are as follows:[12]

- If NTWC issues a tsunami Warning, Advisory and Watch, EMBC's enhanced notification process will be immediately initiated.
- If NTWC issues an earthquake notification that does not result in any tsunami threat, EMBC may not issue a notification to its greater audience or via social media.
- The ECC forwards the NTWC notification, via email, to its pre-established tsunami alert distribution list. Concurrently, the EMBC Social Media Unit (SMU) is notified directly by NTWC via email, SMS and Twitter and is to communicate the tsunami message via its Twitter account, @EmergencyInfoBC.
- EMBC activates the emergency management structure, both provincially and regionally. This may involve activation of its Provincial Emergency Coordination Centre (PECC) at EMBC HQ and those EMBC Provincial Regional Emergency Operations Centres (PREOCs) that have populations and communities at risk within their zones. The four associated B.C. EMBC Regions are: Northeast, Northwest, Vancouver Island, and Southwest.
- The affected PREOCs contact, via phone call, the necessary local authorities, placing priority on those communities at highest risk.
- Notification is also sent out through B.C.'s provincial emergency notification system (PENS) to reach local authorities, public safety agencies and key media via landline, fax or email. Additional NTWC notifications will also be sent out through PENS.
- As new updates arrive, EMBC's social media unit posts the latest verified information to the www.EmergencyInfoBC.gov.bc.ca site. Links to these posts will be tweeted.
- Activation of the provincial and regional emergency management structure will continue until the cancellation of all tsunami alerts is communicated via PENS. This will also be conveyed via social media.
- Local authorities have overall responsibility for notifying their residents of any risk or evacuation plans, which may employ a variety of methods.

[11] British Columbia, 2013b
[12] British Columbia, 2012

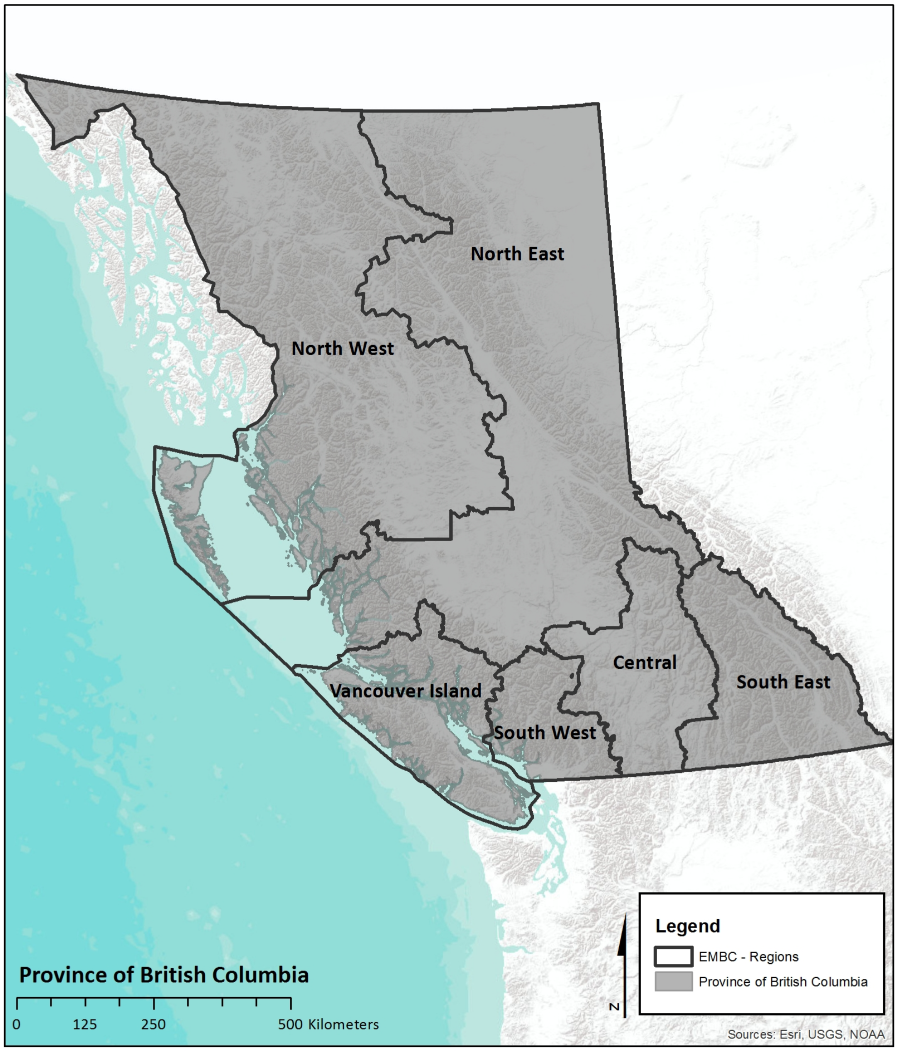

Figure 4: EMBC Regions

PENS Message Targeting and Content

To ensure all coastal populations receive appropriate tsunami messages, EMBC uses the five tsunami notification zones discussed earlier. If known, the PENS tsunami message will contain the following information:

- A brief description of the event including location;
- Whether or not it is known that a tsunami has been generated;
- The B.C. tsunami zone(s) placed in Warning, Advisory, Watch, Information Only or Cancellation, and
- Recommended actions.

Technical Components of PENS

Although EMBC is the Provincial lead for tsunami notification to emergency management stakeholders in B.C., as briefly outlined above, many organizations collaborate both formally and informally to disseminate tsunami messages to as many people as possible in as short a time as possible. Formally, the Provincial Emergency Notification System consists of a set of core EMBC methods, supplemented by partner agency methods to ensure timely and accurate tsunami messaging. These methods include:

- EMBC email;
- EMBC interactive voice telephone;
- EMBC fax;
- EMBC social media twitter feed and EmergencyInfoBC blog;
- EMBC ECC and PREOC direct telephone calls;
- Provincial Emergency Radio Communications Service (PERCS);
- Environment Canada Weatheradio, EC Alert me email and Weather website;
- Marine Communication and Traffic Services/Canadian Coast Guard - Channel 16 marine radio transmissions, and
- B.C. Emergency Alerting System.

EMBC Email - EMBC uses email messaging to contact emergency managers and key agencies, health authorities, media, and critical service and infrastructure providers. Emails are relayed through three different methods:

1. The Emergency Coordination Centre comprehensive and pre-established tsunami alert distribution list. This list includes provincial ministries, crown corporations, federal agencies, local authorities, key media and first responders.
2. Provincial Regional Emergency Operations Centres email lists that serve specific coastal regions.
3. The Provincial Emergency Notification System automated email distribution list.

Fax - While advances in ICT, such as email, have superceded the general use of facsimile (fax), for many rural communities, where cellular and Internet is unreliable or unavailable, fax remains a valuable form of communication. In some cases, fax also complements other forms of alerting. For example, many rural fire departments are paged when a tsunami event occurs and are then instructed to check their fax machines for full message details.

Interactive Telephone System - EMBC disseminates B.C.-specific pre-recorded tsunami voice messages through an automated phone system to predetermined emergency management stakeholders. This web-based system can be accessed both at the EMBC and remotely and can simultaneously dial multiple phone numbers in a short period of time. Although it may be slower to be activated and received than email methods, it is the most intrusive alert method and allows for modification of the messages to provide customized information specific to B.C.

PREOC Direct Phone Calls - EMBC Regional offices have established contact lists with emergency management personnel in B.C. coastal communities. Phone calls are prioritized based on the arrival time of the tsunami and historical tsunami impacts. This is a reliable person-to-person system that allows for confirmation that the tsunami message is received and reporting about actions taken. PREOCs also facilitate conference calls to enable regional coordination.

Social Media, Blog and RSS - EMBC utilizes social media to alert British Columbians to a tsunami threat by amplifying messages and verified information from NTWC and EMBC officials. The primary channels used are the @EmergencInfoBC Twitter account, an Emergency Info BC blog and a RSS feed. *Additional details are available in Section Three*.

A second account, @PreparedBC, provides preparedness & recovery information. Two features that differentiate @EmergencyInfoBC from @NWS_NTWC messages are that @EmergencyInfoBC messages are not generated automatically and are not always tsunami specific. @EmergencyInfoBC is used to disseminate all provincial and other hazard alerts. However, due to the near real-time nature of Twitter, tsunami messages and updates can often be received via @EmergencyInfoBC before the other PENS notification methods.

B.C. Emergency Alerting System - The B.C. Emergency Alerting System is the B.C.-specific name for the national Alert Ready program and is expected to come into operation in 2016. Alert Ready is a new, standardized Canada-wide program that allows authorized government officials in each province and territory to issue emergency alerts through major television and local radio broadcasters and licensed satellite and cable program distributors. For tsunami notification purposes, where lives are at risk, the system will be used to interrupt television and local radio broadcasts with information on Warnings and Advisories. *A more detailed description of these arrangements is contained in Section Three.*

Key PENS Partners

NTWC and EMBC messages are redistributed and amplified further by other organizations through their own networks in order to ensure widespread notification of their members and/or the public according to their own established plans.

Environment Canada

Environment Canada (EC) utilizes its infrastructure and expertise in national weather alerting to further disseminate tsunami messages in B.C. On behalf of EMBC, it issues B.C. specific tsunami messages through a number of key channels, including WWW, Weatheradio and subscription media and emergency management web platforms. *A more detailed description of these arrangements is contained in Section Three.*

Canadian Coast Guard – Marine Communication and Traffic Services[13]

Canadian Coast Guard's Marine Communication and Traffic Services (MCTS) provides both internal CG alerting and a broadcast and communications warning service for the marine community. MCTS is responsible for broadcasting NTWC and EMBC Warnings, Advisories, Watches and Cancellations to ships at sea. MCTS will begin broadcasting messages received from NTWC but stop broadcasting and replace them with EMBC PENS messages once they are received. Presently Prince Rupert MCTS functions as the primary Coast Guard liaison between the NTWC, Coast Guard operational sites, the Canadian Hydrographic Service (CHS) of Fisheries and Oceans Canada and the EMBC Provincial Emergency Coordination Centre. In the event that

[13] Based, in part, on excerpts from CCG, 2014a and CCG, 2014b

Comox is unable to perform this function, Victoria MCTS is the liaison alternate. *A more detailed description of these arrangements is contained in Section Three.*

Royal Canadian Mounted Police

The Royal Canadian Mounted Police (RCMP) "E" Division, which serves British Columbia, is the largest Division in the RCMP, with approximately one-third of the entire force located in British Columbia (RCMP, 2014). 51 of its detachment offices are located along the Coast within the five B.C. tsunami notification zones.

NTWC and EMBC tsunami messages are received by the Royal Canadian Mounted Police (RCMP) and relayed to affected detachments through its extensive network of District and E Division Headquarters Operational Communications Centres. NTWC messages are received directly via email and EMBC messages may originate from the ECC and automated PENS. District OCCs and local detachments may also receive them directly via PREOCs in the affected areas.

B.C. Ambulance Service

B.C. Ambulance Service (BCAS) operates as an agency under BC Emergency Health Services (BCEHS). BCAS provides emergency medical services 24 hours a day, seven days a week to more than 4.4 million British Columbia residents and millions of visitors. BCAS responds to calls from 184 ambulance stations and five aircraft bases located throughout the province. 57 of the ambulance stations are located along the Coast within the five B.C. tsunami notification zones.

Similar to RCMP, BCAS receives NTWC messages directly via email and messages received from EMBC may originate from the ECC and automated PENS, or PREOCs. When BCAS receives a NTWC or EMBC Tsunami Advisory, Warning or Watch notification it activates its Major Incident Notification Matrix using E-Team and Emergency Response Management System (ERMS) automated notification system tools to notify operational directors, the BCAS Communications Branch, impacted area managers and unit chiefs at ambulance stations.

Fire Department Dispatch

In many of the coastal sub-regions, fire department dispatch centres may also receive NTWC and EMBC PENS tsunami Warnings, Advisories, Watches and Cancellations and alert fire departments in affected areas via pager and/or radio.

Ministry of Health

The primary role of the Ministry of Health (MoH) for tsunami notification is to ensure that health system partners, including its Emergency Management Unit, regional health authorities, BCAS and coastal hospitals have received relevant tsunami messages and have activated plans, as appropriate.

Public Safety Canada

The primary role of Public Safety Canada is to provide support to the Province and national Government Operations Centre (GOC), and to coordinate situational awareness and requests for federal assistance. For tsunamis, the GOC in Ottawa receives messages from NTWC and the B.C. Regional Office (RO) and redistributes them as appropriate to federal and other departments and agencies. The RO receives B.C. tsunami messages from EMBC, the GOC and NTWC, and distributes notices and reports as appropriate to other regional federal departments and agencies.

Media

Media are important partners in the delivery of tsunami messages and public safety information. Media, both traditional and social outlets, play a role that includes public messaging, province-wide awareness and the notification of the general public. Their role is extremely important regardless of their target audience (provincial, regional and local) or chosen mode of communication (television, radio, online or print).

1.2.3 Stage 3: Public Response Subsystem: Reaching the Last Mile/Person

The roles of the public response subsystem are to inform local populations of a potential or imminent threat to the area and to initiate and coordinate protective response measures, such as evacuation. It is important to note that local governments (local authorities and First Nations) are primarily responsible for local notification and evacuation arrangements. However, to be effective, local notification activities need to be undertaken and coordinated by a range of organizations and agencies, depending on the plan established within each local authority community or region. Designated emergency program members will be responsible for issuing warnings and evacuation orders to members of the public within their jurisdictions. They may be aided by police, search and rescue groups, fire departments, amateur radio and others in accordance with their plans. Where there is a large employer in the area, warning and other notifications may be issued at the worksite. Others who share local area responsibilities for notification include provincial and federal parks authorities.

Once local emergency managers and program staff receive NTWC and EMBC tsunami messages, and are made aware of a tsunami risk to their populations, they need to begin notifying response agencies, the public and media in their jurisdiction according to their emergency plans.

The public response subsystem can be extended to include planning and mitigation measures taken *well in advance* of a tsunami event. In fact, there are several identifiable stages of local warning:

1. **Stop Entry or Evacuate an Area:** Residents and visitors first need to know if they are in or about to enter into an area at risk of tsunami.
2. **Receiving the Warnings:** Individuals and other groups need to know how they should expect to receive tsunami warnings (there may be more than one method depending on their location) and how to obtain additional information and interpret the messages that accompany them.

3. **Responding to Warnings:** Individuals and other groups need to know what to do after receiving a warning.
4. **Getting Information**: Local dissemination points should be capable of receiving, possibly editing, and then issuing tsunami warnings (notifications) in a timely and consistent manner through appropriate (possibly multiple) channels.
5. **Giving the Right Information**: Communities should be prepared to answer questions and respond to requests for additional information from members of the public.

SECTION TWO

Considerations for Effective Warning

Ultimately, the success of a warning is measured by what actions people take. Once authorities have decided to issue a public warning and have prepared the message, the challenge is to deliver the message to everyone who needs to be warned. There are numerous methods available for delivering public warnings and related information, but many factors can affect their overall warning effectiveness. Among others, these factors include:

- identifying who needs to be informed;
- where they are located;
- what they are doing;
- time of day, week and even season;
- what they rely upon to receive local news and information;
- what special needs they may have, and
- how well they understand and accept the warning in order to take action.

Further, since people often seek multiple sources of information to confirm a threat, every means for getting information to the public should be utilized, including recognizing that, through personal and social media, the public can also be a messenger as well as a receiver of information. As such, an effective public warning system should use as many information dissemination channels as possible to ensure no portion of the public is left out. **The specific methods and technologies to be used will depend upon the requirements and capacities of the local communities involved and, therefore, will need to be tailored accordingly.**

Whatever methods are chosen, there is a need to ensure a fully functioning system through continued maintenance, upgrading and installation of back up procedures. For public safety purposes, it should have as close to 100 per cent reliability as technically and economically feasible.

2.1 Warning System Parameters

In designing and implementing a warning capability, consideration should be given to choosing a combination of methods and technologies that achieves an overall capability to meet the following criteria:

Reliability

- accurate;
- redundant and secure;
- available in the absence of normal electricity and telecommunications services;
- always operational and ready to warn, and
- fast transmission, with assured delivery and confirmation.

Coverage

- addressable to populations in affected locations;
- reaches all people within an area-at-risk (including transient populations);
- scalable to enable expansion of warning area and recipients;
- accessible to people with special needs, including various language requirements, and
- familiar, understood and accepted by population.

Messaging

- enables only those authorized to insert messages;
- easily modifiable to suit changing conditions;
- able to convey essential information, regardless of length;
- adaptable to different dissemination and communication interfaces;
- employs messaging terminology that is clearly understood by recipients, and
- provides location for obtaining more information.

Other Requirements

- readily accessible to authorized users;
- supports multiple distribution technologies (e.g., Internet, sirens/public address, fixed and mobile telephone, radio, television, signage, etc.);
- intrusive;
- supports and enhances existing local practices;
- adaptive to technological and end-user change;
- supports strategies for evacuation, response and recovery plans;
- applies to multiple types of hazards;
- doesn't put message provider or recipient at risk, and
- cost effective.

An effective notification system always requires continuous public education and awareness about the purpose and capabilities of the system (see Section 2.3). A system can never be totally effective without education, no matter how expensive or sophisticated. Whatever methods are chosen, all groups that are part of the notification process should be involved in the planning, implementation and operation of their systems.

2.1.1 Factors to Consider in Developing a Warning Capability

A public warning is comprised of two essential components: 1) an alert and 2) a message with instruction. An alert is intended to sufficiently intrusive to interrupt people from whatever they are doing at the time and secure their utmost attention. It can also be delivered audibly, visually and/or physically (e.g. through vibrating devices). The message should convey what, where, and how severe the hazard is, how likely the hazard is to occur and when, and what action(s) needs to be taken by the recipients of the message.

Alerts and messages are not always delivered by the same method or technology. For example, a siren may be used to alert the public as a signal to follow social media or tune to a local broadcast station to receive a corresponding message.

There are a number of important relationships between alerting, messaging and chosen delivery methods[14]:

Alerts and messages can be broadcast to all people:

- Who are using a specific medium.

Alerts and messages can be delivered to:

- Specific locations (e.g., beaches);
- Specific devices, wherever they may be (e.g., mobile cellular);
- Specific lists of people falling within a specific area (e.g., all schools within the flood inundation zone), and
- Specific lists of people using multiple methods (e.g., social media, email, SMS, group fax, telephone voice, public address, pagers, etc.).

An alert can be:

- Audible;
- Visual;
- Physical (e.g., vibrating device, including wearable technology such as smart watches and fitness devices);
- Distinctive (e.g., specific tone or flashing light), and
- Non-distinctive (e.g., telephone ring, email notification).

A message can be:

- Audible (e.g., spoken, tones);
- Visual (e.g., text, lights);
- Physical (e.g., Braille);
- Distinctive (e.g., text crawler across a TV screen), and
- Non-distinctive (e.g., imbedded in a regular news broadcast).

Some methods are specific to:

- The range of the transmitter;
- A particular technology (e.g., sirens, voice telephone, two-way radio);
- Social media characteristics;
- A human-determined geographic boundary (e.g., a municipal or regional district boundary);
- An event driven geographic area (e.g., a flood inundation zone);
- An individual location;
- Outdoors;
- Indoors;
- An individual facility (e.g. a school, marketplace or shopping centre), and
- A specific person, authority or agency.

[14] Adapted from Partnership for Public Warning. (2004).

Some methods include the ability to confirm that a message has been delivered to:

- A person or device at a specific location;
- A person or device wherever currently located, and
- A specific person.

With respect to the timing of the message, some methods offer alert and/or message delivery:

- To all recipients at the same time;
- To recipients over a period of time, and
- To recipients within specific geographic areas or specific lists, at specific times or during specific periods of time.

With respect to capacity, some methods:

- Have substantial capacity to reach recipients;
- Have a capacity to reach recipients within specific time frames, and
- Have capacities that are affected by other uses of the networks they utilize.

When it comes to security and reliability, some methods are more or less:

- Vulnerable to hacking than others;
- Easily mimicked than others;
- Perform better under the challenges associated with various hazardous events;
- Dependent on electrical grids being operational;
- Dependent on local communication infrastructures (e.g., landline versus satellite);
- Remain operational throughout the entire duration of the emergency;
- Affected by terrain or physical structures, and
- Weather and other environmental conditions.

With respect to targeting populations-at-risk, alerts and messages should take into account:

- Who are the recipients:

Emergency responders	Elected officials
Media	Elders
Children	Local residents
People with special needs	Tourists
(e.g., visually, hearing or physically	Transient populations
challenged, infirm, illiterate, don't	Special workplace situations
peak the primary local language, etc.)	(e.g., noisy environments)

- Where they are located:

Home	Work
Outside	Onboard a boat or plane
School	Shopping centre, commercial area
Hospital	Restaurant
Theatre	Recreational centre
Wharf	Hiking trail
Floating lodge	In transit

- What they are doing:

Driving	Sleeping

Listening to streamed music on smart device	Watching TV
Listening to radio	Talking on the telephone
Texting	Updating social media page
Sea kayaking	Working in a mill
Playing sports	Walking/running
Diving	Camping/hiking

- Time of day.
- Season (e.g., peak tourist season).

Even taking all of these factors into account, the effectiveness of warning requires not only that the message is received, but also that it is based on accurate assumptions about human behavior in times of crisis, and:

- The warning needs to be capable of interrupting whatever people are doing, compelling them to understand the threat, and to act as instructed;
- People need to believe that the warning is truthful and accurate;
- People need to personalize the message as being relevant to them, and
- People need to decide to act and overcome any constraints to taking that action(s) advised.

Again, prior public education is needed for familiarity and acceptance.

2.1.2 Message Content

It is imperative that the message contains correct, precise, up-to-date, and unambiguous information about:

- **What** protective action can be taken to best protect health and safety, and how will it be done;
- **When** protective action should be performed, when it should be completed, and when the threat has ended;
- **Where** - locations that are at risk and who should take protective action;
- **Why** *(hazard and consequences).* What the impending hazard is, what the potential consequences of the hazard are, and how the protective action can reduce harm, and
- **Who** *(source).* Who is providing the message—which should be selected based on who would be viewed as the most credible source for the affected population, often several sources.[15]

2.1.3 Dissemination Methods

Dissemination methods fall basically into two categories which align with the different categories of intendant warning message recipient:

1. **General methods** are less targeted and mainly represented by the mass media (broadcasting).

[15] Mileti, D. and Sorensen, J.

2. **Specific methods** are mainly represented by addressable (personalized) technologies or are those used to reach smaller groups (narrowcasting). They provide warnings to particular householders, businesses, industries, agencies or other clearly identifiable individuals, social groups or organizations.

   Depending upon location and available supporting infrastructure, many different general and specific methods may be available and each should be assessed for its relative merits and applicability.

In most tsunami events, both types of method will need to be used to increase the likelihood of the message getting through to all-at-risk. For example, in cases where a tsunami may affect rural or remote segments of the population, it is appropriate to convey warnings by the broadcast media, as well as by phoning or texting individuals who can then alert their neighbours in-person if necessary.

While the major goal is to direct messages to those most at-risk in order to reduce over-warning, many outside the affected areas, especially emergency organizations, may also rely on the same messaging for situational awareness and to initiate support preparations.

Further, not all methods carry the same detail of content or disseminate all categories of tsunami notifications. Some methods are restricted to disseminating short text messages, while others may carry full text details, as well as imbedded images, maps or electronic links to additional information. Some methods may only broadcast messages (Warnings, Advisories and Cancellations) to those in situations where there are imminent threats to life and safety, while others disseminate a complete and continuous range of messages (Warnings, Advisories, Watches, Cancellations and Information Statements) to any willing recipient, regardless of their location or severity of risk faced.

Consequently, during tsunami events, it is usually necessary to employ a layered selection of different methods to increase the likelihood that the messages will reach all relevant stakeholders.

It is also vitally important to recognize that each method of dissemination may differ in the speed by which it can deliver messages. Timeliness of delivery can be critical, especially during near shore or regional tsunami events when time is truly of the essence in warning local and regional area populations-at-risk. Any delay in warning means less time to take local action before the tsunami arrives. Conversely, through employment of the most efficient and reliable methods, every minute the warning time can be reduced provides an extra minute for populations-at-risk to take necessary actions.

POTENTIAL METHODS OF TUSNAMI WARNING	
GENERAL *More quickly disseminated* ↓ *More slowly disseminated*	**Sirens, public address and automated electronic signs** **Social media – Twitter** **Radio and television:** message: break-in community announcements **Social media – Facebook** **Radio and television**: phone-in interviews with emergency officials **Radio and television:** scheduled news bulletin **Agency web sites** **Community notice boards** **Newspapers**
SPECIFIC *More quickly disseminated* ↓ *More slowly disseminated*	**Two-way radio – group call:** Coast Guard, commercial, marine, private, FRS/GMRS, amateur radio **Agency pagers:** fire departments, search and rescue **Tone alert activated radios**: Weatheradio **Social media:** following/retweeting specific accounts/hashtags **Email:** automated lists **Telephone:** automated mass dialing systems with pre-recorded messages **Facsimile**: group lists **SMS:** individual and automated lists **Loud hailers**: mobile public address systems using route warning **Door-to-Door**

Figure 5: Potential Methods of Public Warning

2.1.4 Location: Outdoor and Indoor Warning Methods

Knowing the location of target populations is crucial in identifying the type(s) of method to be used – specifically whether they are located indoors or outdoors. A number of methods may be used for both, as the case with voice telephones which can be used inside a building or residence, or outside via a mobile cellular device. It is also crucial to understand and take into account the limitations each method has when being used.

Outdoor Warning Methods - Many different sounds can be used as mass audible warnings. The basic requirements are that the sound should be clearly audible and the listener should know what it means.

The most effective sound for warning is commonly a sound generated for that specific purpose. As such, it is frequently a distinctive sound. However, presently, there are no nationally or internationally established universal warning sounds for floods or tsunamis.

Two crucial factors that affect the ability of a warning sound to reach a potential listener are barriers to sound in the listener's immediate vicinity and background or masking noise. These factors are discussed in more detail in Section Three.

Indoor Warning Methods - While sirens, electronic billboards and other mass notification methods can reach large segments of the outdoor population, the biggest challenge is warning people who are indoors. Structures can easily block sounds as well as sighting of visual objects. Dwellings, public and commercial facilities and work places are usually well insulated (and hence sound-proofed). Community bylaws often require large billboard and other mass messaging systems to be sighted away from residential and public spaces (e.g., parks).

Indoor warning methods, therefore, should rely upon technologies that are: 1) capable of penetrating inside spaces; 2) wide-spread enough to ensure that they can reach any space where people may be residing; 3) sufficiently disruptive to capture undivided attention, and 4) are capable of disseminating messages any time of day or night.

From the most basic methods (door-to-door, indoor public address systems) to the more sophisticated (emergency broadcasting), all methods must rely upon an external source to trigger the alert and messaging system. Contemporary indoor warning methods rely upon some form of electronic communication for this purpose (telephone, radio, television, Weatheradio). Depending upon what activities people are engaged in at the time of the warning or if they are sensory impaired, it will be necessary to rely upon methods that cater to different senses (e.g., hearing, sight) to ensure that everyone is alerted and informed.

Some methods provide limited, one-way message delivery capability (e.g., broadcast radio) while others support two-way and/or interactive messaging (e.g., telephone, SMS text messaging, social media). These features become important considerations when confirmation of message reception is required. Further, many public telecommunication systems (telephone, voice cellular, SMS) are not scaled for community-wide use during emergency situations and experience has demonstrated that they can degrade rapidly because of excessive demand and resulting congestion. As a result, limited public access should be anticipated once public warning has been initiated.

The combination of all of these factors can affect the overall effectiveness of warning devices dramatically, so it is important to take them into consideration in the design of a warning system.

2.2 Warning and Communication System Preparedness

To ensure effective response, communities carefully need to consider what warning and communication functions need to be supported before, during and immediately after emergency events. This is especially true in tsunami emergencies where there is little or no time to put into place any special notification arrangements that have not already been pre-planned. The following communications functions and supporting arrangements based upon lessons drawn from U.S. TsunamiReady communities and other experience from around the Pacific and Indian Ocean have been identified as essential for ensuring effective public warning. Details about the relative advantages of suggested communication options are discussed in Section Three.

2.2.1 Local Tsunami Warning Reception and Community Activation[16]

An established 24-hour Warning Reception Point should be able to receive NTWC and EMBC Tsunami Messages, and provide local reports and advice. Typically, this might be a police or fire department dispatching point. For communities without a local dispatching point, a neighbouring agency or team of trained local officials might be able to act for them in that capacity. The warning point needs to have:

- 24-hour accessibility;
- Warning reception capability;
- Communication/dissemination capability to alert local emergency managers, and
- Ability and authority to activate local public warning system(s).

In accordance with local emergency plans, an **Emergency Operations Centre (EOC)** should be established in the community, in order to execute and coordinate tsunami warning functions. Tsunami-related roles of an EOC can be summarized as:

- Activation to be based on predetermined guidelines related to NTWC and EMBC Tsunami messages and/or local tsunami events;
- Staffed by trained emergency managers;
- Ability to communicate with adjacent EOCs/Warning Points, and
- Ability to communicate with EMBC Emergency Coordination Centre and Provincial Regional Emergency Operations Centre.

2.2.2 Communications and Coordination

NTWC and EMBC Tsunami Warning Message reception - The Warning Point, key emergency officers and agencies and the EOC require a number of alternative methods to ensure the greatest possibility to receive any NTWC or EMBC PENS and Alert Ready tsunami messages. To protect against delivery failure, *at a minimum*, at least three methods of communication access need to operate on completely different network infrastructures. Depending upon local availability, the following are possible options:

- Device(s) capable of receiving social media - @NWS_NTWC and @EmergencyinfoBC;
- Fixed landline telephone;
- Mobile telephone;
- Voice-over-IP telephone with public network telephone number;
- Satellite phone;
- Facsimile;
- Email;
- Monitoring NTWC and EmergencyInfoBC websites;

[16] Adapted from: National Ocean and Atmospheric Administration. National Weather Service. (2015).

- Monitoring NTWC and EmergencyInfoBC RSS feeds;
- Monitoring Coast Guard Marine Radio Channel 16;
- Environment Canada Weatheradio receiver;
- Environment Canada ECAlertMe email account;
- Alert Ready connected radio or television receiver ;
- MSAT EmergNet;
- Amateur Radio;
- Agency radio, and
- Monitoring traditional and social media.

Local Warning Dissemination - Upon receipt of NTWC and EMBC tsunami warnings or other reliable information suggesting a local tsunami is imminent, local emergency officials need to be able to communicate the threat to as much of the population as possible. This requires having at least two or more means of ensuring timely dissemination of warnings to indoor and outdoor populations (based on population and local resources). Methods for consideration include:

- Fixed sirens, public address systems and horns;
- Local broadcasting stations;
- Vehicle and boat sirens and public address systems;
- Social media, including Twitter, Facebook and Blogs;
- Automated telephone voice, email and SMS notification systems;
- Indoor public address systems;
- Tone alert activated radios placed in public facilities and workplaces;
- Outdoor mobile electronic signs;
- Fixed signage with flashing lights and instructions (e.g., "Emergency Info when Flashing: Proceed Inland and away from Water");
- Door-to-door verbal notification and leafleting;
- Marine and local agency two-way radio;
- FRS/GMRS radios set to a designated channel;
- HTML Push and smart phone/device apps;
- Amateur radio, and
- Community web page.

For Regional Warning Point - A regional communication network will be required that ensures information flow to rural and remote populations. Because of widespread variations in service coverage, several different methods may need to be incorporated. Depending upon rural availability, the following are potential options:

- Social media, including Twitter, Facebook and Blogs;
- Automated telephone voice, email and SMS notification systems;
- Email lists;
- SMS and other mobile instant messaging;
- Marine and other two-way radio;
- Amateur radio;
- Satellite telephone and text messaging;
- Satellite Emergency Notification devices;

- Regional broadcasting stations;
- HTML Push and smart phone/device apps;
- Door-to-door notification, and
- Vehicle and boat sirens and public address systems.

Agency Response and Recovery Coordination (local and regional)

- Two-way radio and agency dispatch;
- Amateur radio (VHF and HF);
- Telephone and cellular;
- Social media;
- Crowdsourcing;
- SMS and other mobile instant messaging;
- Telephone conferencing;
- Internet conferencing (e.g., webinar, Skype);
- On-line file sharing;
- Email – one-to-one and specialized distribution lists;
- Facsimile;
- MSAT EmergNet;
- Marine radio, and
- Satellite Emergency Notification devices.

2.3 Public Education Considerations

Anyone interviewing emergency coordinators will find that the most consistent advice they give is: "educate your community". The warning process includes the planning and installation of warning devices and methods and also the assurance that the public (residents and tourists) and government officials (first responders, and other agency employees) are aware of these plans and what the warning devices do.

There are at least two major steps in educating the public about tsunami warning methods. The first is to identify the educational information that is needed to ensure the public's safety; the second is to determine the methods that would work best in disseminating this information to the public.

2.3.1 Educational Information

When educating the public, the community will need to have certain information. Suggestions follow about what types of information can be most beneficial:

What is a Tsunami and what are the hazards associated with them? - Provide a brief description of what a tsunami is, specifically focusing on wave actions and other hazards. People may not understand that tsunami events usually have more than one wave action, and that after the first wave, succeeding waves may become larger and more devastating. Also, it may be appropriate to indicate the other hazards that may be associated with these waves (e.g., debris, collapsing structures, and surges). The matter of the destructive force of waves needs to be emphasized as well.

What is the difference between a "local" and a "distant" tsunami? - Provide a brief description focusing on the differing time periods between a local and a distant tsunami. Inform that when strong ground shaking from an earthquake is felt, people in areas-at-risk should move inland or to higher ground (as specified in local plans) immediately, as a tsunami may occur within minutes. Once people understand more about the risks, they will be better prepared to focus on evasive actions.

What can people do to protect themselves from a tsunami? - Highlight the need for pre-planning, focusing on the preparation of family disaster plans, becoming familiar with local earthquake and tsunami plans, and preparing 72-hours+ emergency kits. It is important that the population understand that help may not reach the community for an extended period of time in some areas, depending on the nature of the disaster impacts.

How will people be warned and when do people evacuate? - It is important to explain all the warning methods used by your community, ensuring that the public knows what the various evacuation signs, sirens, broadcasting messages, etc. mean. People need to know how and when they should expect to receive evacuation orders, noting particularly that they can only return after receiving clearance from emergency officials.

How and where do people evacuate to? - A picture is worth a thousand words and a good map indicating evacuation routes and staging areas accompanied by a brief explanation on how to get to higher ground or inland (e.g., walking vs. driving a car) can greatly assist safe evacuation. Some communities publish this information in telephone books, brochures and on-line. The description of staging areas and details about the support that will be provided there are also important, along with the need for individuals to have portable emergency kits.

What are the community plans? - Provide information on what the community plan entails, describing emergency services, self-sufficiency, community boundaries, and staging areas. The point should be emphasized that if a near-shore tsunami event is possible, emergency responders may not be able to enter a threatened area, so people need to be prepared to evacuate on their own.

Concise instructions - Instructions need to be clear and concise about what to do, be accessible in different languages and be conveyed by communication to suit the needs of the audience.

Where to get more information? - Provide contact information on where individuals can obtain more information. This is for provincial and other contacts (including web-sites) as well as community contacts.

Emergency Management British Columbia also provides a range of public tsunami-specific and other warning notification information through its two websites:

1. http://www.emergencyinfobc.gov.bc.ca/resources/ and
2. https://twitter.com/PreparedBC

2.3.2 Information Disseminating Methods

After key information has been identified and prepared, the next step is to decide on the best ways to disseminate it to the public, and the most appropriate time to do so. A good dissemination system involves many participants. Partnerships with local community businesses, government agencies and broadcasting stations will help in covering a larger audience.

Workshops can be organized involving different interest groups such as those associated with schools, hospitals, seniors' centres, town hall meetings, library, recreational centres, neighbourhood centres, churches, businesses (hotels, restaurants, bookstores, and mills). Private organizations (Red Cross, environmental groups, clubs) or recreational venues such as parks (registration centres or campsites) can also be utilized. Training materials are needed to help deliver the right message and to make it easy for emergency managers and others (e.g. first responders or volunteers) to deliver.

Pamphlets and brochures can be prepared to educate the public about tsunamis and how individuals can act to remain safe. These can be distributed through various means, using such mechanisms as the community's emergency Facebook or website, handed out at workshops, posting or emailing to residents. They can be placed in tourist sites (visitor centres, rest stops, hotels, restaurants); transportation sites (airports, ferries, marinas, cruise ships); business sites (shopping malls, factories); or included as inserts or articles in local newspapers or delivered door-to-door with volunteers.

If a region has a number of different communities, it can develop a brochure template containing generic information (listed in the above section) and only change information that is specific to each community (e.g., the evacuation map).

Information signage can be in the form of evacuation signs showing evacuating routes and tsunami staging areas. General information posters can be placed in potential inundation areas where many people often congregate (shopping malls, hotels, restaurants, workplaces, trail heads, beach access points).

Media materials can also help raise general public awareness. These can include background material and media kits, education videotapes distributed to all coastal jurisdictions, broadcast shows on radio and television, or be distributed to school districts in all coastal areas. A good location for these materials would be local public or school libraries.

Emergency Preparedness Week and Shakeout BC activities can include workshops, evacuation exercises, the introduction and public discussions about new warning systems (such as signage, sirens), etc.

Public Service Announcements can provide information before and during a crisis. Consider developing broadcast shows with local emergency coordinators and creating pre-scripted emergency announcements/warnings with local broadcasters.

Other methods which can be both developed within or provided to communities include**:**

- Mobile Apps;
- Social Media;
- Placing information at the front of a phone book;
- Working with local hospitality associations or hotels to place information in books found in hotel rooms or putting evacuation posters on the inside of guest rooms, and
- Working with local merchants to manufacture memorabilia items such as heat sensitive coffee mugs that demonstrate how to survive a tsunami, magnets, place mats, bookmarks, tee-shirts, and other things that popularize safety slogans or illustrate ways to survive.

SECTION THREE

Warning Methods and Selection Considerations

Among the most important considerations in designing and implementing local warning systems are to ensure that adopted methods correspond to local circumstances and that they also have the most effective coverage for the most affordable cost. Therefore, it is critical to have local needs properly evaluated since costs of implementing new systems often can be relatively high. They include not only systems costs, but costs for other component systems (such as radios or other remote access systems for activation), installation of supporting equipment (e.g., poles, racks, cabinets, etc.), labour, maintenance, and training. However, the high costs associated with acquiring new systems may be offset by eliminating even higher costs of maintaining older systems. In addition, if adjacent communities decide to use the same system approach, costs may be reduced further by purchasing equipment and services in quantity.[17]

For warning systems to be effective and locally appropriate, the benefits and limitations of available notification methods need to be properly understood, evaluated and factored into the system design and selection. There is a great selection of methods available, but no one method is perfect and no method can be guaranteed never to fail. Very reliable communication systems need to be in place to ensure that the notification and information sharing can occur without delay. By relying on one single method, such as the sounding of the sirens or the receiving of information solely from broadcasts, populations risk missing a warning if that system technically fails or physically fails to reach everyone. To ensure people can get warning information, at a minimum, at least two independent methods of simultaneous communication should be available to protect against the possibility of failure.

The following review of warning techniques represents a best effort to identify and summarize those notification methods that are currently available and/or being used within British Columbia's coastal region, along with a preview of other emerging methods and their underpinning technologies which might help to expand, enhance or eventually replace existing practices. However, as will be shown below, while a variety of potentially suitable notification options already exist for consideration, Canada's communications landscape is now changing very rapidly and these changes have enormous implications for how and where tsunami messages can be delivered. Further, the previously unique attributes of many systems (one-way broadcasting, two-way telephony, fixed and mobile communication) continue to merge through digital convergence producing new hybrid approaches. Consequently, today's communication environment makes it difficult to easily group and evaluate notification methods in a coherent fashion that neatly intersects with specific community warning needs.

For purposes of presentation, where possible, methods discussed below have been grouped into traditional notification categories, but with other characteristics noted. It is also important to

[17] Adapted from: Beaulieu, J. D. (2001).

recognize that due to this rapidly changing field, it is highly probable that not all options may have been identified and fully evaluated in this toolkit, especially with regard to Internet-based methods. In this regard, this toolkit should be viewed as a work-in-progress.

3.1 Types of Warning Methods

Warning methods traditionally fall into two basic categories:

1. Mass Notification Methods

These systems are not individually addressable and generally provide the same alert or message to everyone within a particular geographic area, regardless of level of individual risk. Examples include:

- Outdoor systems – sirens, mobile sirens, mobile electronic signs;
- Mass broadcasting systems – conventional radio, television and cable television, and
- Social media – Twitter.

2. Addressable Notification Methods

These systems can tailor and target alerts and messages only to those at risk or to specific groups (such as emergency responders). Some newer addressable technologies are also flexible enough to support many of the same functions of traditional mass notification systems. Examples include:

- Broadcasting systems – Canadian Coast Guard and marine radio, Weatheradio (Environment Canada) and amateur radio, Alert Ready;
- Telecommunication systems – telephone voice and facsimile, paging and tone-alert radio, Internet, VoIP, cellular voice, Short Message Service and data apps, and satellite, and
- Personal systems – door-to-door and residential route-warning (using mobile public address systems).

3.2 Which Method is Best Suited for My Community?

Communities today regularly need to use a multi-faceted system consisting of a combination of different methods in order to reach everybody. For example, they might use outdoor sirens for the alert signal, tone alert monitors at schools, hospitals, and industries and radio, TV, billboards and social media for the message. However, as previously outlined, there are many factors (including affordability, accessibility, demographics, usage behavior and coverage) to consider when choosing a particular selection of methods that best suits your community's or region's needs.

Ultimately, public warning needs to be assessed within the context of the community's overall emergency communications needs since much of the supporting telecommunications infrastructure will be the same. It is important to recognize that a warning is the trigger for all of the subsequent activities that will occur throughout the emergency period, including response, rescue, relief and recovery. The warning portion (initial alert to the all-clear) may be very short or could go on for a day or more depending upon the nature of the hazard (storm, tsunami, flood, hazardous materials incident). Investing wisely in flexible, robust, redundant, multi-purpose communication infrastructure can yield dividends for all emergency needs.

The following pages provide descriptions of many potential methods along with brief discussions of their advantages and disadvantages relative to other methods, implementation considerations and potential costs. It should be noted that this document does not implicitly endorse or recommend any vendor, imply that these are the only suppliers of equipment or services, or accept responsibility for the quality of products reviewed or their availability and continuance. Indicated costs are intended to serve only as approximations and may not accurately reflect current market conditions. Readers are strongly encouraged to conduct their own research and evaluations.

3.3 MASS NOTIFICATION METHODS

3.3.1 OUTDOOR SYSTEMS

Sirens
Mobile Sirens
Electronic Signs

MASS NOTIFICATION METHODS
Outdoor Systems: Sirens

Sirens are designed to provide a rapid alert to potentially threatened populations. They are currently one of the most widely used mass notification means of alerting outdoor populations. When sirens are properly located, they can reach most populations, including those in isolated areas (e.g., beaches). They can also reach populations that have limited access to other warning devices, such as telephones, cell phones and commercial television and radio.

However, in Canada, there are no uniform standards for tsunami-siren warning systems. As such, lack of uniform warning can result in inconsistent warning signals and confusion about proper actions to be taken during a tsunami warning. It is also important to note that many sirens have limited broadcasting and messaging capabilities. When activated, people may be expected to turn to another source such as a radio or television station for further instructions. Therefore, for sirens to be effective, populations should be continuously educated about their purposes and intended reactions, and systems need to be tested regularly.

The following description provides a brief overview of general characteristics, and advantages and disadvantages for using this type of warning system. For more detailed information concerning acoustic properties, considerations for design and installation, and maintenance of sirens, a highly recommended source is FEMA's 2006 Outdoor Warning Systems Technical Bulletin.

The siren system a community adopts will depend on the amount of funds available, and the type and area of coverage a community needs and wants. This will require an on-site assessment by a specialist. (Note: some siren manufacturers and vendors offer this service to communities). The signal or voice message from the siren should be clear, concise, and distinct. The alarm or message should be uniform over as broad an area as possible.

General Characteristics

Sirens are devices that transmit different sounds and/or voice messages. They are either electro-mechanical or electronic. Some may also employ a visual warning in conjunction with sirens such as a co-located strobe or flashing light. Sirens can be triggered locally or centrally and automatically[18]. Siren controls can activate any single particular station, groups of stations, or all the system's stations. Critical factors to be considered in the initial planning stages of a public warning system are: 1. defining the purpose and choosing which type of siren to use (includes - structure, coverage, broadcasting, power source, testing and maintenance); 2. identifying siren placement; and 3. costs.

[18] Adapted from: Beaulieu, J. D. (2001) and DHA-FEMA (2006)

Electro-mechanical Sirens

Electro-mechanical siren units generate sound mechanically. They are driven by an electric motor and are available in various types of design and output power engineered for various uses. They sound by forcing compressed air through a narrowed opening, or “vortex,” in much the same way a musician blows air through the mouthpiece of an instrument. A motor driven device then chops the forced air into a stream of pulses that is converted into high-pressure airflow as it passes through the exterior “horn” section of the siren that often resembles a megaphone. Electro-mechanical sirens cannot transmit voice.

Electronic Sirens

Electronic siren units are powerful loudspeaker systems that can broadcast amplified electronically generated standard tone patterns, such as a “Wail”, “Attack”, “Hi-Lo”, “Alert”, “Whoop”, “Air Horn”, etc. Some versions of electronic siren units offer public address messaging and other sound broadcasting. This is a valuable feature, making it possible to communicate local emergency information quickly and efficiently to the public, especially more transient populations. Announcements can be generated live from microphone or from pre-messages stored on disks or memory devices.

Structure

There are three principal parts of a siren system: the siren, controller, and actuator. The siren produces the noise, the controller controls the signal type, duration, etc., and the actuator triggers the controller either remotely or directly.

Actuator control units may transmit signals either via radio or landlines. Currently most sirens are controlled by radio frequency. Encoders transmit a Dual Tone Multi-Frequency (DTMF) signal over the radio system, which takes approximately ½ a second. The encoder produces the DTMF signal and the radio transmitter sends the signal to the sirens. Each siren has a radio receiver and a decoder that receives the DTMF signal and decodes the information. The decoder decodes the command and the siren’s microprocessor then selects the intended command that was sent from the encoder.

Siren units, whether electro-mechanical or electronic, are essentially of three basic types: 1) those designed to send out a highly focused cone of sound in the direction they are pointed (fixed-directional), 2) those designed to project sound at once in a 360-degree pattern (fixed-omnidirectional), or 3) those designed to project sound in one direction while the unit rotates or oscillates through 360 degrees.

Coverage

The main difference between fixed and rotating sirens is the amount of coverage area. A rotating siren increases the coverage area. For example, where the coverage area for a fixed siren would be a 300 to 450-metre radius from the siren; a rotating siren would increase the coverage to a 1.6-kilometre radius. For a stationary listener, the sound from a rotating siren goes up and down in loudness, while sending out the sound wave in all directions. The coverage area for an electronic siren can be increased by adding more amplification and/or additional units that are networked.

Power Source

Sirens rely on electricity and would be of limited use should the main area power system be disrupted by a local tsunami-generating earthquake. Backup systems or systems that do not rely on the main power system, such as solar, are possible, provided they survive the earthquake. Solar energy collectors will add costs to the siren system. However, costs of solar panels have dropped significantly and allow placement in areas where there are no power lines, such as isolated beaches and parks. A solar powered system, free from commercial connection, would provide service if commercial power were to be disrupted by earthquakes and would protect the system from power surges. There are also new wind-powered sources available.

Testing

Although testing is important to keep residents and tourists aware and educated, the public may also object to repeat testing. Testing can be done without sounding the actual siren, thus reducing public complaints, or it can be scheduled at specific times. For example, some communities perform silent tests weekly and an audible test once a month for residents to hear. Some areas also use less offensive and distinct sounds such as a mooing cow at Cannon Beach. Whatever testing method communities choose, manufacturers all recommend testing at least once a month.

Maintenance

Modern units require less maintenance because they are electronic with few moving parts. Testing the sirens will help to identify maintenance needs and it is recommended that sirens have a bi-annual maintenance scheduled.

Placement

When placing the siren it is important to identify locations that will provide optimum coverage of the sound for the population. Besides the distance over which the warning sound is to be heard, many other important factors need to be considered in the placement of sirens. Any of these other factors may in some circumstances become as important as the size of the intended coverage area.

Natural Terrain - The topography around a siren station's location can deflect the sound away from an area expected to be covered. The terrain around the siren unit site can be so important that a siren station properly placed to take advantage of the terrain's features can 'bounce' or reflect the sound to an area otherwise blocked by a hill. Types of ground surface, including different kinds of foliage and their coverage, can significantly influence sound reflectance or absorption. Seasonal changes to vegetation also can be critical in this regard.

Human-made Terrain - Structure sizes, heights, outer wall surfaces, types of roofs and their angles can all affect passage of the projected alarm sound throughout the area and reduce its effectiveness. Consideration is needed concerning the effectiveness of the 80 decibel loudness level range in awakening people asleep at night inside insulated homes.

Ambient Noise - Often referred to as background noise, ambient noise is the composite of all sounds (natural and human-made) in a given environment travelling from many directions and distances that can mask or affect the propagation of warning sounds. Ambient noises change continuously in loudness and pitch and by time of day.

Weather - Prevailing seasonal wind patterns can deflect projected sound from reaching its targeted area. Air temperature and humidity are also important considerations. Projected sound tends to rise in warm air. A siren's metal parts can corrode in coastal areas and can be damaged by windblown sand in beachfront areas if not designed specifically for those conditions. During heavy rains or stormy weather, the percentage of people who hear a warning siren is greatly reduced because of the noise associated with the storm, and because more people are indoors.

Hazard Zones - Hazards that can destroy the siren should be identified. Structures such as buildings or cliffs tend to crumble during earthquakes. When placing sirens within tsunami zone areas, such as beaches, the system controls should be located above the potential water line, but still allow easy access for maintenance.

Convenience - A common problem in site selection is locating sirens next to pre-existing and convenient AC power sources. Convenience is often the determining factor rather than whether the location provides maximum effectiveness for the siren.

Public Opinion - Public objection to a technically ideal location may occur. An ideal site may be avoided because of public criticism concerning the aesthetics of the location or the belief that the proposed siren could negatively impact property values.

Poor selection of placement sites for sirens can lead to expensive alternatives, for example: having to install more units than otherwise necessary, or investing in inappropriately designed equipment. Such problems can be addressed through public education about the hazard and incorporation of the public in the planning process. Once accomplished, the location and effectiveness of the notification system will likely be considered a necessity to minimize casualties in the community.

System Selection and Implementation Considerations

In summary, the selection of the appropriate types of siren units and their effective placement is best realized when:

1. There is acceptance within the community that the hazard, for which the siren system is designed, is very real, and
2. There has been full and comprehensive research conducted before final system selection. Communities will need to map out structures and terrain challenges, background noise

levels, locations with good line-of-sight, noise sensitive locations, hazard zones, etc. Communities may consider hiring the services of a professional specialist, who is experienced in acoustic surveys and siren equipment. A properly designed system can avoid costly errors made by poor placement and/or investment in siren equipment that is inappropriate to the local need.

Other factors to be considered when selecting sirens are:

- Ensure corrosion resistance of the components that will be exposed to the weather;
- Water-resistance of the parts that shield the non-exposed components;
- Number of moving parts – more moving parts requires more maintenance;
- Sound projection and voice/sound quality and capabilities;
- Operational and maintenance ease and accessibility;
- Repair parts availability and warranty issues, and
- Get references from other users.

Community Examples

A number of communities on the West Coast of North America use sirens along their shorelines and within their communities. B.C. examples include: Port Alberni, Tofino, Tseshaht First Nation, Zeballos, Gitga'at First Nation, Bella Bella, Bamfield and the Village of Queen Charlotte. Many of the U.S. TsunamiReady communities such as Tillamook County in Oregon, Delnorte County in California and the Kenai Peninsula Borough in Alaska also have sirens. Many of these communities recommend broadcasting capabilities, especially in those areas in which there is a heavy tourist flow. The initial cost may be substantial but communities may find sponsors to support the installation of sirens.

Cost

Sirens are expensive and can cost from $25,000 to $60,000+. Main cost features are: installation, control devices, and sirens. Maintenance budgets also will need to be considered, especially if sirens are located in very rural communities and access is limited (air or water). Sirens can be a cost-effective warning means for large areas such as public beaches, both for local residents and tourists.

WHY USE SIRENS?

Advantages

- Effective method to warn populations-at-risk in a short amount of time.
- Sirens with live public address or pre-recorded message capabilities can also be used before (testing, training, exercising) at minimal additional cost and throughout the incident. Sirens are frequently used before electrical power is restored to notify affected populations about reception centres, shelters, first aid stations, etc.
- Wide area outdoor coverage, especially in areas with no other form of alerting.
- Do not discriminate amongst recipients.
- Can awake/alert indoor residents near sirens and thus supplement indoor alerting systems.
- No cost to receive alerts/messages.

- Units may already be in common use in community for volunteer fire departments or other purposes.
- Can be part of an integrated system using external sirens and small alerting receivers for inside of buildings.
- Widely recognized and have a single focus.
- Public address versions can broadcast in different languages.
- Can have a large number of pre-recorded messages.
- Low current draw required to operate from integral batteries and can be charged by solar panels or other alternative systems (e.g., wind generators) as protection from utility power disruptions.
- Radio controlled and, therefore, can be independent of landline utilities.
- Full time conditioning/monitoring reducing the need for live testing required solely for maintenance purposes.
- Great flexibility in placement of battery powered and radio controlled units. Can be centrally controlled and remotely accessed.
- System controllers that can initiate individual, groups or all sirens.
- System is available 24/7.

Disadvantages

- Devices cannot always be heard in buildings or vehicles or in areas that have high background noise levels.
- Audio messages not always clearly audible during high wind events.
- For non-public address versions, public needs to be educated to turn to an additional source to gain more information.
- Public may have to be able to distinguish several different signals for different hazards or intended use.
- Siren soundings need to be coordinated with other alerting methods.
- Large numbers of sirens may be needed to cover populated areas and to be loud enough to be heard indoors by most people.
- Poorly protected units can be damaged by waves, wind, sand and salty air.

MASS NOTIFICATION METHODS
Outdoor Systems: Mobile Sirens

As indicated above, siren systems are designed to provide a rapid alert and are currently one of the most effective mass notification means of alerting outdoor populations. When sirens are properly situated and scaled for coverage, they can reach all targeted areas, including those in isolated areas (e.g., beaches). However, it may not be feasible to place sirens everywhere people need to be alerted. A key factor for mobile community sirens is that they can be quickly moved to different locations.

GENERAL CHARACTERISTICS

The primary difference between mobile and fixed sirens is that these sirens can be placed on trailers, vehicles and vessels and moved to different locations. Ease of moving the mobile sirens is also a key feature. They are lightweight and portable, and set-up time is usually only a few minutes. They can be moved to locations where they are most needed: evacuation areas, large intersections and evacuation routes. They are also useful in terms of avoiding possible destruction from the disaster itself. However, the public may not be expecting these sirens in certain locations. Emergency personnel will need to ensure that prior education is given for recognizing the siren tones. For these reasons, it is important to consider including public address broadcasting capabilities with the sirens.

WHY USE MOBILE SIRENS?

Advantages

- Good to use in situations when there is a long warning period.
- Can be moved to where information is most needed.
- Public address versions can broadcast in different languages.
- Can have a large number of pre-recorded messages.
- Solar or battery powered.
- May be more cost effective than fixed signs – because allows for flexibility in moving the sign.

Disadvantages

- Not good in situations when there is a short warning period.
- Takes time to move to a location.
- May be difficult to deploy if roads are destroyed and there is no access.
- Public may have to distinguish between several different signals for different hazards or intended use.
- Siren soundings need to be coordinated with other alerting methods.
- May be vandalized if left in public spaces.

MASS NOTIFICATION METHODS
Outdoor Systems: Electronic Signs

An important visual outdoor warning system, often overlooked, but widely available in most regions, are electronic message boards. You may notice them along many B.C. highways and at many highway construction sites. Motorists today already see most of these signs as providing cautionary simple text messages or symbols regarding roadway conditions (e.g., severe weather conditions, roadway constructions, roadway closures). Mobile systems are usually trailer-mounted, can be easily moved from location to location and are often self-powered by solar energy.

Emergency signage systems can be very useful during and after emergency events. These systems form an important supplement to acoustic outdoor systems, especially for motorists and others that may not hear sirens or audio alerts, be tuned to an alerting radio station or have access to any other alerting device. The messages may contain information such as: "Tsunami Warning, Proceed North Immediately", "Flood Risk Area, No Entry, Tune to AM 1160 for Info" or "Warning, Hazard Ahead, Turn Around Now". Electronic signs can also be utilized to show pedestrian evacuation routes and give emergency status updates.

Many communities, institutions and businesses are also actively using electronic signage for other purposes. Among the many locations, they can be easily spotted outside and inside churches, schools, recreational centres, financial institutions, retail outlets and auto dealerships, transportation centres and other public and high occupancy areas. Many of these can easily be integrated into community notification programs. Further, schools, colleges and universities and other public institutions have been among the most rapid adopters of automated signage systems, and local expertise may already be available.

Fixed vs. Mobile Signs

Fixed signs are usually larger than mobile signs giving them more of a capability in displaying longer messages. Another advantage is, when placed in a permanent position, the public tends to rely on that sign for key local information and will look for it. Signs need to be placed in strategic locations where they will be most useful. (Example: main road used as the major evacuation route from an area). Commercial marking firms are experts at locating electronic commercial signage for maximum exposure.

Mobile signs are flexible and can be placed where they are most needed (rural evacuation routes or staging areas). These signs have less message capability and should be placed according to their viewing cone areas.

GENERAL CHARACTERISTICS

The main characteristics of an electronic signage system are: the control system, message capabilities, and fixed or mobile structure. Also referred to as variable message signs (VMS), state-of-the-art signs use reflective disc message displays with fiber optic lighting or light-emitting diode (LED) displays. In addition, current VMS have features that increase visibility in bright ambient light conditions and are modular in design, producing character heights that can be read as far as a kilometre away.

They can also generate and transmit messages from a desktop or mobile computer device. Messages can be transmitted to each sign in a system using a wide variety of telecommunications systems, including cellular, satellite, telephone lines, coaxial cable, microwave, radio, broadband wireless, Ethernet or fiber optic cable. Maintenance personnel can centrally monitor subsystems such as power supply voltages, LED pixels, temperature and humidity.

Message Capabilities

The message capabilities of these systems rely on a number of factors: size of the sign and characters, resolution of the sign, the viewing cone and the changeability of the message. All of these factors focus on the need to get a clear message to motorists who may be traveling at high speeds or to pedestrian traffic.

Size of Signs

Signs vary in size. The bigger the sign the more message capability it will have and the longer it may be able to be viewed while mobile. Usually signs will display three to four lines of text and offer options on the size and number of characters that can be displayed. For example, manufacturers recommend that character sizing should be normally 508 mm (20") for traffic exceeding 90 km/h which will allow for an approximate viewing distance of .25 kms (1000 feet) and capable of being viewed for 12.4 seconds.[19]

Sign Resolution

Resolutions of the signs vary. Full-colour, high-resolution LED full-matrix variable message signs usually allow choice of monochrome amber or full-colour. These signs can also display graphics such as road signs (e.g., closures, turns, speeds) and, some, even video.

Viewing Cone

The viewing cone is the angle at which the sign is read. Proper location for the sign is important. Both fixed and mobile signs have different viewing angles ranging from 15° to 70° typically for roadside and up to 140° for permanent installations.

Changeability of Message

Modern sign systems are capable of storing hundreds of preprogrammed messages. These messages may be changed from a central location or on-site. Messages can only be a certain length and should be short and concise, and can be in different languages.

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[19] Suncoast LED. (2016).

Local Policies

Check with your local community about existing bylaws or policies that may affect the type, size and use of signage.

Cost

The cost of mobile units is approximately $25,000 each while fixed units may be as high as $250,000 (depending on the structure the unit is placed on).

Consider:

- Conducting an area survey to determine most suitable locations for their deployment;
- Identifying existing systems and determining their availability during emergencies, including access arrangements, remote interconnection and interoperability prospects;
- Establishing agreements with local highways maintenance, construction firms and others who own and operate systems;
- Establishing a local emergency signage policy to encourage adoption of messaging standards and protocols;
- Pre-scripting messages.
- Using them at major public events and in local emergency exercises so populations become more familiar with their usage.

WHY USE ELECTRONIC SIGNAGE SYSTEMS?

Advantages

- Can be quickly updated as the emergency situation develops.
- Newer digital signs can be much more than text and can display images, graphics, video as well as broadcast audio.
- Unlike SMS text messages and emails, which can take several minutes or more to arrive at their intended output devices, a digital signage system may take only seconds to deliver an alert.
- Highly visible – many LED models can be seen up to 1500 feet and are visible both during the day and night.
- Fixed signs – public know to look for information.
- Mobile signs – can be moved to where information is most needed.
- No need for users to register.
- No cost to receive messages.
- Can be repeated and/or updated.
- Remote and central programmability.
- Can be preprogrammed with many messages and in different languages.
- Solar or battery powered.
- System maintenance – can be done centrally or remotely.
- Available 24/7.

- Visual alerts can be turned on for longer time than voice messages, repeating the message as long as needed for better warning, and do not require special receivers or subscription.

Disadvantages

- Weather conditions may affect visibility of sign.
- May depend on target audience passing by, taking time to read and understand messages.
- Distance and speed of vehicles are a factor in clear visibility.
- Varying capability depending on size of sign.
- May not be able to program remotely due to model.
- Large letters limit message length capability.
- May be vandalized if left in public spaces.

3.3 MASS NOTIFICATION METHODS

3.3.2 BROADCASTING SYSTEMS

Conventional Radio and Television
Cable Television
Low Power Radio

MASS NOTIFICATION METHODS
Broadcasting Systems: Conventional Radio and Television

Conventional radio and television have been among the best mass media for distributing general information to a wide area, including emergency instructions and updates. But mass media might not be best for first level intrusive notification. For emergency broadcasting to be effective as an alerting tool, it is essential for the intended audience to be tuned to, or live streaming a designated radio or television channel or to be situated within hearing and/or viewing range.

Market research has indicated that there are considerable differences between the use of radio and TV at different times of the day. During the day more people listen to the radio; far fewer watch TV. This pattern changes in the late afternoon and evening when TV becomes the principal broadcast medium that the public uses to receive information. During the night, when most people are sleeping, most broadcast technologies are ineffective. These challenges make it necessary to use other means (sirens, telephones, mobile apps, etc.) to first alert populations and to direct them to tune to designated stations or, increasingly on-line sources, for instructions.

GENERAL CHARACTERISTICS

Local Operations

Over the past decade, in addition to changing listener/viewing behavior, many changes have taken place concerning how stations are managed, staffed and programmed. Traditionally, private stations were locally operated and programmed, with on-air staff usually residing in the local community. Today, with the advent of networking, many commercial stations are programmed from other locations with limited or no local on-air staff or limited hours when staff is available at the station. Many community transmitters are simply re-broadcasting the entire programming content of another station located out-of-area and have no local program facilities. In other cases, there may be no local over-the-air station service at all, but programming is available via cable television, satellite or Internet stream. Another trend is the licensing of small low-power private or community-owned FM stations that provide an alternative source of local or regional programming. Establishing and maintaining regular contact with station managers is important to ensure emergency personnel are familiar with station operations, points of contact and broadcast coverage arrangements.

EMBC and Broadcasters

Broadcasters throughout British Columbia routinely broadcast official weather-related Warnings, Advisories, Watches and Statements issued by Environment Canada and often use standard procedures for receipt and broadcast of these messages. As part of the B.C. Tsunami Warning System, stations may also be notified by EMBC of Tsunami Warnings, Advisories, Watches and Cancellations via its Provincial Emergency Notification System (PENS) and, most recently, can be required to immediately broadcast specific alerts for hazard threats that pose an imminent threat to life or property via an emergency program interruption system known as Alert Ready.

Many stations also operate local web and Facebook sites, RSS and Twitter feeds that provide up-to-date local news and weather information, as well as live or pre-recorded audio and/or video programming data streams.

Local Warnings

Some communities, as part of their ongoing preparedness planning, have made prior arrangements with program originating stations to broadcast notifications to residents during emergencies, such as floods, urban-wildland interface fires, dangerous goods incidents, etc. Similar arrangements should be considered for tsunami warning. While content may need to be tailored and submitted on a just-in-time basis to suit immediate emergency circumstances, standardized instructions, such as how to personally prepare for evacuation, how to locate safe areas and reception centres, can be pre-scripted and stored with stations' news departments. When stations receive emergency messages, they will require some form of authentication, which should be in place before emergencies occur.

Arrangements for how to contact the stations should also be pre-planned. Most stations rely upon email, telephone, SMS and fax for notification. But, such arrangements could quickly become complicated if the station serves more than one community and/or is not programmed from a local facility. In such cases, arrangements will need to be coordinated on a regional basis.

Emergency Program Interruption – Alert Ready

In Canada, licensed broadcasting and program distribution operators have recently installed special equipment to enable authorized emergency organizations to provide warning messages directly to listeners and viewers as part of a new National Public Alert System. The system opens significant new opportunities to reach a number of otherwise underserved rural coastal populations, especially through the use of Direct-to-home (DTH) satellite broadcast services that can reach even many of the most remote locations.

Emergency alerts are distributed through the use of a single national aggregation and dissemination system (NAADS) that is operated by Pelmorex Communications Inc. (The Weather Network) that links to transmitters and other program distribution systems. For selecting the appropriate areas to notify, the alerting authority will first determine what areas are affected by an incident, weather or environmental situation. They will then use a standard system that corresponds with census divisions and sub-divisions, which also usually correspond to municipal and regional district boundaries, to allow participating radio, television, cable and satellite companies to taper the broadcast of alerts to those that are specifically at risk.

In 2014, the Canadian Radio-television and Telecommunications Commission (CRTC) ruled that all Canadian broadcasters, including over-the-air television broadcasters, radio broadcasters, and broadcast distribution undertakings, must begin participating in the new National Public Alert

System.[20] *The ruling, however, does not currently apply to broadcast programming streamed over the Internet.* Further, use of the system is restricted to emergency alert messages relating to imminent or unfolding dangers to life and for which an immediate public call to action is required.

The National Public Alert System was formally launched on March 31, 2015 under the brand *Alert Ready*. As of March 31, 2016, the following types of undertakings are required to participate:

- All CBC originating and rebroadcasting over-the-air AM, FM and television stations.
- Private over-the-air AM, FM radio broadcasters and television broadcasters.
- Campus, community and native over-the-air AM and FM radio and television stations.
- Tourist information FM radio stations.
- Broadcasting distribution (BDU) and video-on-demand (VOD) undertakings, including cable, fibre, digital subscriber line or radiocommunication multi-point distribution systems and satellite distributors.
- For terrestrial BDUs serving more than 2,000 subscribers but fewer than 20,000 subscribers, the requirements will only apply to digital systems. For BDUs that only use older analog technology, distribution of emergency alert messages is voluntary.

Ensuring successful implementation of Alert Ready in B.C. requires coordination between critical stakeholders, such as provincial and local emergency management officials and broadcasters. Beginning in 2015, and continuing through 2016, EMBC has commenced a series of province-wide pilot alert tests of the British Columbia Emergency Alerting System part of Alert Ready with an initial priority focus on enhancing tsunami notification in B.C. coastal areas. These tests will enable EMBC and communities to establish a baseline for identifying which coastal regions are able to receive alerts via Alert Ready and to increase public and emergency authority awareness of the service. It is expected that these new arrangements will serve as a common system to reach out to virtually any coastal location, urban or remote, and potentially represents one of the first ubiquitous tsunami notification delivery systems for notification in fixed locations.

For local notification and other emergency communication purposes, communities should continue to promote cooperation with stations serving their areas.

Additional information is available at:

Alert Ready
http://www.theweathernetwork.com/alert-ready

B.C. Emergency Alerting System
http://www.emergencyinfobc.gov.bc.ca/resources/

[20] Canadian Radio-television and Telecommunications Commission. (2014).

Why Use Local Radio?

Advantages

- Instant communication to all affected people if tuned in.
- Gives detailed information, and can keep people up to date.
- Generally, universally available and affordable (most people have a radio receiver).
- Respected medium. Local radio stations usually have close ties with the local community; at their best, they are a valued part of the local social structure.
- Can be used indoors, outdoors and in moving vehicles and watercraft.
- Alert Ready specific messages will be received regardless of which local over-the-air station people are listening to.
- Battery operated receivers can work during power outages with battery operated radios and can reach people inside their cars and outside of their homes.
- No cost to receive messages.

Disadvantages

- Have to be tuned in to receive warning.
- Limited usefulness during periods of the day - and especially in the late evening/early morning if turned off.
- May reach people not affected by the emergency, potentially causing unnecessary concern and/or unwarranted actions.
- Fewer people listening to conventional radio, so becoming more supplementary.
- Many may be listening to the station via an Internet stream rather than-over-the air and may not get Alert Ready messages.
- Alert Ready is restricted to emergency alert messaging relating to imminent or unfolding dangers to life and for which an immediate public call to action is required. Other arrangements need to be made for all other warning (slower onset) or emergency broadcast messaging.
- Depending upon staffing and program scheduling may not be accessible during late evening/early morning periods.
- Poor over-the-air reception or no local radio service in smaller communities and/or many rural coastal areas.

Why Use Television?

Advantages

- Instant communication to all affected people if watching.
- Gives detailed information, and can keep people up to date.
- Can reach people indoors.
- Generally, universally available (majority of households have a TV).
- Respected medium, especially with utilization of a local or regional newscaster (e.g., a "familiar face").

- Television is an excellent source of emergency information. Graphics, such as maps, can be used to describe the event in detail.
- Alert Ready specific messages will be received regardless of which broadcast station or channel people are viewing.
- No cost to receive messages.

Disadvantages

- Limited usefulness during daytime when most people are at work or school and in the late evening/early morning when TV is turned off.
- Limited usefulness outside of the house.
- Fewer people viewing conventional television, so becoming more supplementary.
- Many may be viewing station programming via an Internet stream rather than-over-the air and may not get Alert Ready messages.
- Alert Ready is restricted to emergency alert messaging relating to imminent or unfolding dangers to life and for which an immediate public call to action is required. Other arrangements need to be made for all other warning (slower onset) or emergency broadcast messaging.
- May reach people not affected by the emergency, potentially causing unnecessary concern and/or unwarranted actions.
- Poor over-the-air reception or no local programming service in smaller communities and many rural regions.
- May require cable television or satellite reception to receive programming.
- Not available during power outages.

MASS NOTIFICATION SYSTEMS
Broadcasting Systems: Low Power Radio

In addition to mainstream radio broadcasting, in the late 1990s, a new form of local Canadian broadcasting emerged: low power radio. Low power broadcasting stations take advantage of relatively inexpensive programming insertion and transmission equipment and transmitters. Stations can range in power from less than one to upwards of 50 Watts. Extremely low power stations are operated for many purposes including from real estate, car dealership drive-by promotion and special outdoor events. Slightly more powerful stations are often operated by local commercial not-for-profit and commercial enterprises, especially in rural and remote communities. Some provide a full range of programming services while others serve as network rebroadcast stations.

GENERAL CHARACTERISTICS

Special low power AM and FM stations are also used by communities for temporary emergency broadcasting purposes. The equipment is similar to that used by community stations, with fixed or portable transmitters. Program insertion (studio) equipment can be integrated with the basic transmitter or separated and operated as a remote unit. Some communities have purchased their own equipment to be able to broadcast to their residents on a specific broadcast frequency. Depending upon the transmitter power, topography and any other physical obstructions, type of antenna and location, coverage may range from a few hundred metres to about 10 kilometres. Most units permit battery operation. Costs range from about $3,500 to $10,000.

Licensing and Regulation

Depending upon the system chosen and intended use, some systems are fully exempt from requiring government authorization to operate, while others are partially exempt. These requirements are discussed in more detail below.

All forms of broadcasting in Canada are regulated by two government organizations, Industry Canada and the Canadian Radio-television and Telecommunications Commission (CRTC). To operate an FM broadcasting transmitter, one needs to apply for a Broadcasting Certificate from Industry Canada and a Broadcasting Licence from the CRTC. Industry Canada, the Radio Frequency Spectrum Manager, determines if the proposed transmission is compatible with other broadcasting transmissions, as well as non-broadcasting transmissions. The CRTC regulates programming content and ownership issues. Under certain circumstances, low power radio may be exempt from CRTC licensing requirements.

CRTC exemption order respecting public emergency radio undertakings

For emergency broadcasting purposes, the CRTC has chosen to exempt certain classes of low power AM and FM stations from licensing. Communities or emergency agencies may be exempt from licensing if they meet the following criteria, as set out in Public Notice CRTC 2000-11:

- The undertaking meets all technical requirements of the Department of Industry and has acquired all authorizations or certificates prescribed by that Department.
- The undertaking operates between 525 and 1705 kHz in the AM frequency band or between 88 and 107.5 MHz in the FM frequency band.
- The undertaking broadcasts at a power of 5 watts or less transmitter power for AM or with an Effective Radiated Power (ERP) of 5 watts or less for FM.
- The undertaking is operated by a member of a police department, fire department or any organization designated by a federal, provincial or municipal government as being responsible for the coordination of emergency relief.
- The programming provided by the undertaking is information and instruction regarding a public emergency.
- The programming provided by the undertaking contains no music or advertising material.
- The programming is live or pre-recorded and, if the latter, is broadcast within 24 hours of the original recording.
- The undertaking broadcasts its programming over a period of not more than seven consecutive days.
- The undertaking does not broadcast programming that is religious or political in nature.

Industry Canada Authorization

Because Industry Canada and the CRTC are responsible for different aspects of broadcasting, a broadcasting transmitter exempt from CRTC's licensing is not automatically exempt from Industry Canada's authorization requirement. Most transmitters may still need to meet authorization requirements from Industry Canada. Industry Canada, which also has a role to play in facilitating emergency telecommunications, is prepared to work with emergency organizations during an actual emergency to streamline authorization and to give access to radio spectrum as soon as possible. It is not prepared to give blanket exemption to all low power transmitters.

Additional information about regulation is available at:

Canadian Radio-television and Telecommunications Commission (CRTC)

Home page
http://www.crtc.gc.ca

Exemption order respecting public emergency radio undertakings**,** CRTC 2000-11
http://www.crtc.gc.ca/eng/archive/2000/PB2000-11.htm

Community radio policy, Public Notice CRTC 2000-13
http://www.crtc.gc.ca/eng/archive/2000/PB2000-13.htm

Industry Canada

Frequently Asked Questions on Low Power FM Broadcasting
http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/en/sf02087e.html

Application for a Broadcasting Certificate Very Low Power FM (VLPFM) or Very Low Power Television (VLPTV) in Small Remote Communities
http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09867.html

WHY USE LOW POWER RADIO?

Advantages

- Instant communication to all affected people if tuned in.
- Gives detailed information, and can keep people up to date.
- Generally, available and affordable technology (most people have a radio receiver).
- If community owns its own station, it can be used at any time.
- Can be used indoors, outdoors and in moving vehicles and watercraft.
- Battery operated receivers can work during power outages with battery operated radios and can reach people inside their cars and outside of their homes.
- No cost to receive messages.

Disadvantages

- Have to be tuned in to receive warning.
- Limited usefulness during periods of the day - and especially in the late evening/early morning if turned off
- Fewer people listening to conventional radio, so becoming more supplementary.
- Requires trained staff to operate who need to be available at all times.
- Limited coverage, especially in outlying rural areas.
- Unless specific arrangements are made, not linked to Alert Ready.

MASS NOTIFICATION METHODS
Broadcasting Systems: Conventional Cable Television

Residents in many coastal communities receive radio and television as well as Internet and other services through local cable providers. Like radio and television, most CRTC licensed cable providers are now required to participate in Alert Ready that enables interruption of regular programming to provide audio and video warning messages on all programmed channels. However, not all providers are required to participate. Currently, older smaller analog systems (2,000-20,000 subscribers) are exempt, but are encouraged to voluntarily participate. Further, Alert Ready is restricted to emergency alert messaging relating only to "imminent or unfolding dangers to life and for which an immediate public call to action is required".

Consequently, it may be practical to explore how existing cable facilities can be used to support broader local public warning needs. Some of the most obvious services include the local message/bulletin board and community programming channels. Message channels, like mobile outdoor message signs, often can be programmed from a remote location and enhanced with graphics such as maps, familiar emergency logos, etc. The community-programming channel can provide a means to broadcast live emergency messages and ongoing coverage throughout the emergency period if power is available and the cable system infrastructure is not impacted by the emergency.

WHY CABLE TELEVISION?

Advantages (locally programmed channels)

- Widely available for indoor use.
- Gives detailed local information, and can keep people up-to-date.
- Messages can be repeated until emergency is over.
- Messages can be regularly updated.
- Full programming service channels can carry a wide variety of live and pre-recorded information, including a message "crawl" over video programming.

Disadvantages (locally programmed channels)

- Need to subscribe to use service.
- Need to have receiver turned on.
- Need to be tuned to specific channel.
- Outside Alert Ready, may not be suitable for initial alert, but could be used to provide additional instructions if people know in advance to turn to the channel.
- Limited usefulness during periods of the day - and especially in the late evening/early morning if turned off.
- Fewer people watching conventional television.
- Not available during power outages.
- Programming staff not generally available on a 24/7 basis.
- Poor service coverage outside communities and/or in rural areas.

3.4 ADDRESSABLE NOTIFICATION METHODS

3.4.1 BROADCASTING SYSTEMS

Amateur Radio
Canadian Coast Guard
Weatheradio (Environment Canada)

ADDRESSABLE NOTIFICATION METHODS
Broadcasting Systems: Amateur Radio

Amateur radio, often referred to as "ham radio", is a hobby enjoyed by many thousands of people throughout the world. Amateur radio operators use two-way radios to communicate with each other. Unlike other personal radio services such as CB radio, Family Radio Service (FRS) or General Mobile Radio Service (GMRS), amateur radio operators are required to pass an examination and be government certified.

Amateur radio operators have access to special frequencies throughout the entire radio frequency spectrum. Choice of frequency allows for effective communication across a community, region, country, continent or the entire world, regardless of season, time of day or night. The use of shortwave frequency bands, or HF bands, can facilitate worldwide and inter-regional communication, the use of VHF and UHF bands, local and regional communication and the use of microwave bands can provide enough bandwidth for television and high-speed data transmissions.

EMERGENCY COMMUNICATION CHARACTERISTICS

Amateur radio has a long history of public emergency communication service. This is particularly true during natural disasters that cripple public telecommunications and broadcasting services, and where amateur radio is often the only surviving means of communication.

Amateur radio operators have the skill, equipment and experience to provide immediate support when other communication methods are unavailable. Amateur radio is suitable for emergency activities because most of the radio equipment used is battery powered, highly portable and capable of operating on a wide variety of frequencies. This enables interoperability across frequency bands and rapid deployment of networks within and outside communities. Operators are also generally well versed in improvising and restoring communications under primitive conditions (as may be found during disasters) because they practice this skill as a key part of their hobby. An annual international contest event called "Field Day" gives amateur radio clubs an opportunity to practice emergency preparedness by establishing emergency stations using temporary antennas and emergency power.

Organization of Emergency Amateur Radio Services in British Columbia

Within British Columbia, the Provincial Emergency Radio Communications Service (PERCS) operates in support of the Emergency Management British Columbia and local communities. The PERCS concept was developed to create a unique sense of identity and source of information for amateur radio volunteers. A Provincial Emergency Radio Advisory Committee (PERAC), composed of amateur radio operators, provides advice on issues relating to emergency radio communications.

At the national level, emergency amateur radio services are organized and coordinated through the national Radio Amateurs of Canada Amateur Radio Emergency Service (RAC/ARES). Where applicable, PERCS endeavours to integrate RAC/ARES appointees into B.C.'s emergency amateur radio system.

In partnership, PERCS and ARES organizations support the continuing development of an emergency radio communications capability within the British Columbia amateur radio community. This is achieved through a number of coordinating functions and is not limited to the following:

- sharing of resources;
- development of training materials and conduct of training activities, and
- development, conduct and evaluation of emergency amateur radio exercises.

At the local authority level, a Municipal Amateur Radio Coordinator (MARC) and deputy are responsible for developing a local Amateur Radio Communications Plan.

Many operational functions are supported by local and regional amateur radio emergency networks including:

- Voice and data messaging and
- Surveillance and notification

Voice communication allows the user agency to pass messages over voice networks connecting several locations inside and outside the impacted area. The messages may be pre-written and forwarded using a standardized format (similar to telegrams), or unwritten where personnel of the user agencies may talk with each other.

Data communication allows the user agency the ability to pass messages over a digital radio network connecting several locations inside and outside the impacted area or region. These messages are entered by computer keyboard and transmitted to another location. Typically these messages contain lists of items or details of such complexity and length that using the voice traffic service is impractical.

Surveillance allows the user agency to monitor and control activities in an area using a voice network. Monitoring is carried out by amateurs, using hand-held radios, either working by themselves or in conjunction with representatives of the user agency. Typically the amateurs monitor parking lots, roadways, special facilities and crowds to report any problems that arise.

In some cases, amateurs are trained and help in early warning phases as trained spotters and observers (storm and flood watchers, and even tsunami wave observers when situated in safe locations). With today's available technology, many amateur groups can also install remote wireless camera systems to enhance these activities, especially in high-risk areas. They can incorporate many of the features of commercial notification systems into their infrastructures, including paging and tone-alert radio, radio-activated alarms and sirens, hazard detection and monitoring equipment, etc.

EMBC HF Amateur Net

The primary intention of the EMBC Amateur Net is to establish and maintain communications between the Provincial Emergency Coordination Centre and the six Provincial Regional Emergency Operations Centres. The Net is tested every third Wednesday evening of the month on 3735 KHz**.**

Regional Networks

Many regions in the British Columbia operate HF and VHF networks to provide emergency communication support to and between communities and their associated Provincial Regional Emergency Operations Centres. EMBC operates amateur stations at each PREOC, as do most communities at their EOCs. Many of the voice VHF and UHF local area repeaters are now networked across the province, enabling several individual sites to be quickly linked together to form wide area regional networks. An example is the Vancouver Island Trunk Radio System that links amateur radio repeaters all the way up the East Coast of Vancouver Island and inland as far as Port Alberni, as well as to Tofino on the West Coast.

Traditionally, linkages between sites have been provided through radio-based backbone networks. Today, they are supplemented by the use of Internet connections (utilizing Voice-over-IP) in two associated projects: Internet Radio Linking Project (IRLP) and EchoLink.

Many of the regional networks also support packet data transmission capable of sending information such as electronic mail, to and from the Internet from HF, VHF and UHF radio systems. Using the Winlink system, any amateur with a properly equipped radio can quickly establish a data pathway to the Internet via a participating WinLink radio station, without having to rely on satellites or other terrestrial Internet services.

WHY USE AMATEUR RADIO?

Advantages

- Can play an important backup communications role between EOCs and strategic community locations during emergency events.
- Most equipment is portable and can operate independently from the main electrical system.
- The wide variety of available amateur radio frequencies enables multiple networks to be established to serve different emergency support functions.
- Many communities have certified amateur radio operators.
- Equipment is often already in place and maintained by local and regional clubs.
- Increasingly, amateur radio is becoming interoperable with other communication systems (e.g., Internet email, VoIP, etc.).

Disadvantages

- Roles for amateur radio in public warning in B.C. have not been clearly defined by most jurisdictions.

- Not a public warning system. Amateur radio operators utilize radio frequencies that are not intended for general public broadcast purposes, but can be used for relaying warning messages among radio operators who may be affiliated with emergency organizations.
- Operators of amateur radio need to hold certificates of proficiency.
- Due to the volunteer nature of the hobby, not always possible to recruit and train enough operators to support a lengthy emergency operation.
- Limited VHF radio repeater coverage on West Coast of Vancouver Island and in Central Coast Region.
- Limited number of established provincial and regional voice emergency networks. Can be difficult to coordinate large numbers of operators during wider area disaster events.
- Message and information exchange capacity is severely limited compared to other contemporary non-amateur systems.

ADDRESSABLE NOTIFICATION METHODS
Broadcasting Systems: Canadian Coast Guard Radio

The Canadian Coast Guard (CCG) Marine Communications and Traffic Services serves a broad stakeholder group ranging from the general public, to commercial shippers, ferry operators, fishers, recreational boaters, coastal communities, other government departments, other levels of government and international organizations. Its primary objective is to ensure safe, efficient and accessible waterways as well as protecting our marine areas from environmental damage

For tsunami warning purposes, the Marine Communications and Traffic Services (MCTS) is particularly crucial in providing aid in the warning and recovery stages.

The Canadian Coast Guard's extensive communications network offers one of the most practical mass notification methods to alert marine and some land (especially remote) populations along most of the B.C. Coast.

MCTS provides marine safety communications co-ordination with rescue resources and the Joint Rescue Co-ordination Centre Victoria (JRCC) - one of three JRCCs in Canada operated by the Canadian Armed Forces in conjunction with CCG. MCTS also supports vessel traffic services and broadcasts marine safety information such as weather bulletins, Tsunami Messages and notices to shipping.

In the Western region, there are 2 centres located at Victoria and Prince Rupert. These centres are connected to an extensive network of remote communications sites located to provide continuous coverage of almost the entire B.C. coastal region in VHF, HF and MF frequencies. Two systems used to broadcast safety, navigational and marine weather are:

1. Continuous Marine Broadcast (CMB) is an automated recorder used to disseminate marine weather information provided by Environment Canada and is updated several times a day (MF and VHF);
2. Navigational Telex (NAVTEX) is an international automated medium frequency direct-printing service for delivery of navigational and meteorological warnings and forecasts, as well as urgent marine safety information to ships and is effective 40 to 300 nautical miles offshore (518Khz)

Digital Selective Calling - As part of a Global Maritime Distress and Safety System (GMDSS) initiative, newer marine VHF and MF radio models are equipped with a Digital Selective Calling (DSC) feature that allows selective calling on VHF Marine Channel 70 and MF 2187.5 kHz. Normally, after establishing contact on the DSC channel, both parties will change to an agreed voice channel to communicate. To make a digital call each radio must have an identity, a 9-digit Maritime Mobile Service Identity (MMSI) number that can be obtained free of charge, by Industry Canada. An important safety feature of a DSC radio is that it can initiate a special Distress Alert which will tell the Coast Guard and other boaters in the area that the caller requires immediate assistance and, if equipped with a Geographical Positioning Satellite (GPS) device, will automatically let rescuers know the radio's exact location. Although a DSC receiver will normally only respond to its individual Maritime Mobile Service Identity number call, all

DSC receivers in a given area can be mass alerted by an "All Ships" DSC call. Some VHF models have a DSC watch function that monitors Channel 70 while receiving another channel. Upon receiving a distress call it will automatically switch to the International Calling and Distress Channel 16 to receive follow-on voice communication.

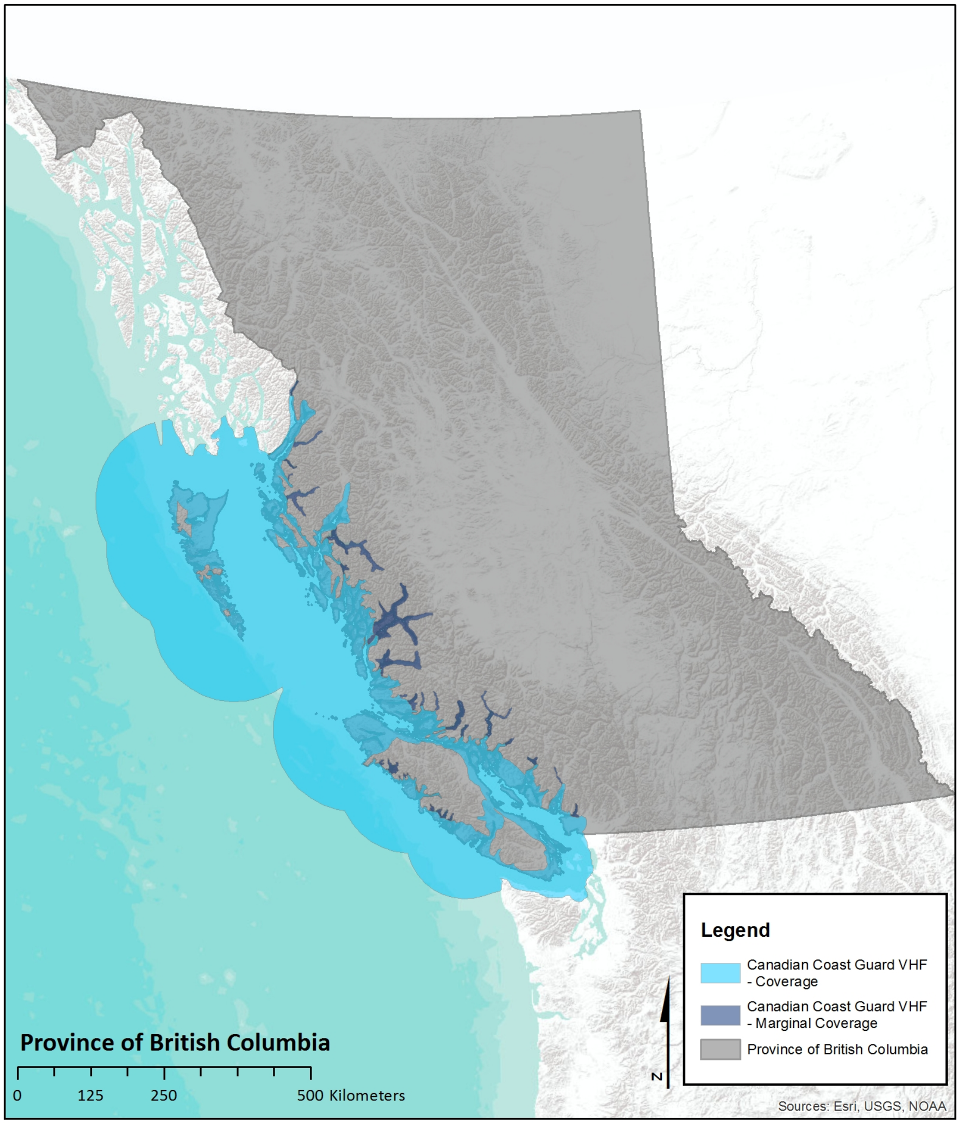

Figure 6: Canadian Coast Guard Pacific Coast VHF Coverage

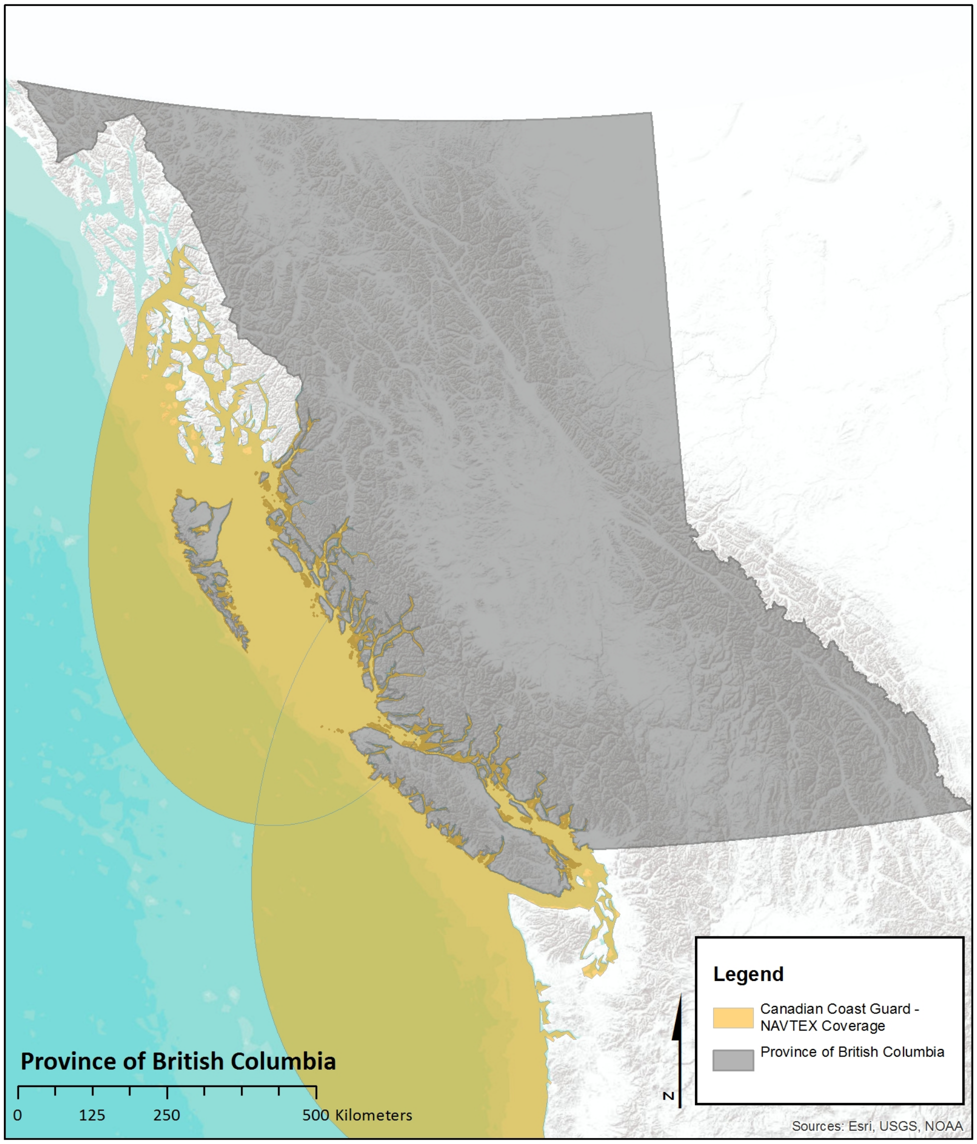

Figure 7: Canadian Coast Guard Pacific Coast NAVTEX Coverage

Coast Guard MCTS Western Tsunami Notification Procedures - MCTS is responsible for broadcasting NTWC and EMBC Warnings, Advisories, Watches and Cancellations to ships at sea. MCTS will begin broadcasting messages received from NTWC but stop broadcasting and replace them with EMBC PECC PENS messages once they are received. Presently Prince Rupert MCTS functions as the primary Coast Guard liaison between the NTWC, Coast Guard operational sites, the Canadian Hydrographic Service (CHS) of Fisheries and Oceans Canada and the EMBC Provincial Emergency Coordination Centre. In the event that Prince Rupert is unable to perform this function, Victoria MCTS is the liaison alternate.

Broadcast Priority

- Tsunami Watch and Advisory messages for general marine traffic are designated as URGENT.
- Tsunami Watch messages are designated as SAFETY.

Centres will use the highest broadcast priority based on the tsunami activity within the notification zone for the centre's Area of Responsibility. Further, although Warning, Advisory or Watch tsunami messages will specify the geographical area of concern, all MCTS centres will broadcast the complete tsunami message to ensure the widest possible coverage. Broadcasts will be made via DSC, 2054 KHz, 4125 KHz, the CMB and NAVTEX.

Once MCTS initiates a tsunami broadcast, centres can expect calls from ships at sea, anchored or alongside, and from other agencies (e.g., police, shipping agents, etc.). Centres may also establish local community fan-out lists where necessary.

Canadian Vessel and Portable Radio Licensing

Radio licences for Canadian vessel and portable maritime radios are no longer required, provided their operations meet the following criteria:

- they are not operated in the sovereign waters of a country other than Canada.
- the radio equipment is only capable of operating on frequencies that are allocated for maritime mobile communications or marine radio navigation.
- The radio equipment is not used on land.

Further, any person who uses a marine radio to transmit is required to possess a Restricted Radio Operator's Certificate. More information is available at: https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08764.html

Costs

Costs will vary depending upon type of communication system. Basic commercial VHF radios typically range from $150 to $400. MF radios with DCS range from $2000 and up and NAVTEX receivers from $600-800. Most commercial marine radio dealers carry these products.

WHY USE CCG MCTS?

Advantages

- Easy for mariners to receive.
- Equipment installation and operation is mandated for larger classes of vessels and generally in widespread use by pleasure craft operators.
- Radio operators are trained and certified in use of emergency communications procedures.
- Several different modes of warning message reception available.
- Digital Selective Calling feature allows radios to be left in stand-by mode and be activated when Coast Guard issues an "All Ships" DSC call.
- For non-marine radio operators, inexpensive VHF Weatheradio receivers used by Environment Canada are capable of tuning to most of the Continuous Marine Broadcast Service channels.
- Messages can be received both outside and indoors.

- No cost to use.

Disadvantages

- Messages are aimed at maritime populations and do not specifically cover land-based populations.
- Because of topography and antenna orientations, VHF coverage may be marginal in some on-land locations.
- Similar marine coverage issues may apply inside narrow channels due to poor line-of-sight between VHF receivers and transmitters.
- Continuous Marine Broadcast Service does not support tone alert activation features of Weatheradio.

ADDRESSABLE NOTIFICATION METHODS
Broadcasting Systems: Environment Canada Weatheradio

Utilizing the same technology as NOAA's Weather Radio service in the U.S., Environment Canada (EC) operates its own "Weatheradio Canada" nationwide network of radio stations broadcasting weather and environmental information 24 hours a day in both official languages on 7 dedicated frequencies within the VHF public service band.

The enhanced Specific Area Message Encoding (SAME) capable Weatheradio receivers use digital SAME codes as the trigger that activates the alarm features ahead of a warning message and alert users to an incoming important message. Users who use a SAME-capable Weatheradio will be able to receive the full suite of weather and non-weather related emergency messages that include Warnings, Advisories, Watches and Cancellations. In addition, they will be able to access the full functionality of the warning device unit, with features like the ability to pre-select which warnings to receive, and for which region(s).

All Weatheradios with the SAME decode feature can be preset to activate only in a local geographic area by programming the appropriate Canadian Location Code (CLC) code. CLCs correspond to EC's weather forecast regions. There are also options that permit the receiving of alerts for more than one location in the broadcast area and, with some models, an additional option to disable the alerting feature for certain types of warning messages. This enables the receivers to be used as distinct tsunami alerting devices if desired. Also, because these codes are standard across Canada and the U.S., receivers can work in either country; a useful feature for maritime travelers.

Older Weatheradios do not have the SAME decode feature. These units will continue to receive the full range of Warnings, Advisories, Watches and Cancellations as in the past. However, they will not be able to take advantage of the enhanced options offered by a Weatheradio with SAME decoding capability. Upgrading to newer receivers is strongly recommended.

For coastal British Columbia, 10 transmitters provide Weatheradio service. The average range for reception of the broadcast signal is approximately 60 km from the transmitter site, but this can vary considerably depending on the terrain. At one location (Port Hardy) a low power broadcast without the alert tone or SAME code is transmitted on the regular FM and can be heard using an ordinary radio. Figure 8 illustrates current radio coverage.

For those areas served by Weatheradio, receivers could be standard equipment for:

- Hospitals
- Schools
- Marinas
- Dispatch Offices
- Work places
- Campgrounds
- Beaches
- Trails
- Homes
- Emergency Preparedness groups
- First Responders
- Local Government

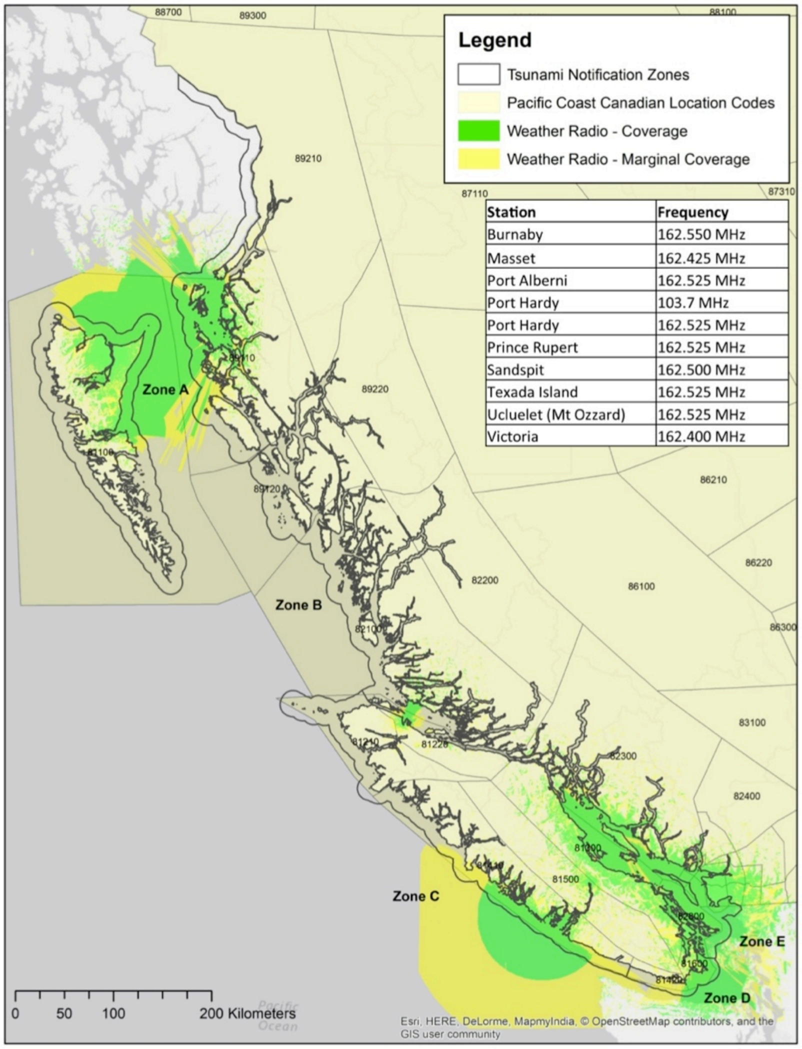

Figure 8: Environment Canada Weatheradio Coverage

Costs

Receivers are relatively inexpensive and widely available. When purchasing a Weatheradio receiver, look for models that have the 7 weather channels (often referred to as NOAA Weather channels) with the S.A.M.E/FIPS alert feature. FIPS is the US equivalent of the CLC codes and is compatible with the CLC codes. Not all receivers have this feature.

There are many models to choose from, including desktop versions and handheld versions about the size of an FRS radio. Many two-way radios now carry Weatheradio features. The desktop versions typically are AC powered with a battery backup; however, regular battery checks are critical. Various models are now solar and/or hand crank self powered as well. Many of the radios provide voice, siren, and tone alerting, but in addition possess a strobe light or some other form of visual alerting. Costs of receivers typically range from about $25 to $100, and are often included in two-way radios as a bonus feature. There is no additional cost to receive messages.

Additional information is available at: http://www.ec.gc.ca/meteo-weather/default.asp?lang=En&n=792F2D20-1

WHY USE WEATHERADIO?

Advantages

- Can be tuned to specific geographic locations, warning only those people who are directly at risk.
- Can be used to alert populations that are beyond the reach of other local warning methods or are too far away to be reached in-person.
- Can be used both indoors and outdoors.
- System can broadcast messages in both official languages.
- In coordination with EMBC, EC activates tsunami messages.
- No cost to use.
- Battery backed/self-powered receivers can operate during a limited power outage.
- Available 24/7.

Disadvantages

- Equipment needs to be kept in a location where it can be heard and monitored.
- Weatheradio coverage is limited along B.C. Coast.
- Topography can interfere with reception and create local dead spots.
- Some locations, including indoor, may require an external antenna to improve reception.
- Device needs to be powered all the time.
- Receivers need to be set to correct frequency and S.A.M.E. Code (all warnings are done by default).
- Some receivers can be used to tune to Canadian Coast Guard Continuous Marine Broadcast frequencies that also broadcast EMBC/NTWC tsunami messages.
- Older models need to be left on and monitored all the time.

3.4 ADDRESSABLE NOTIFICATION METHODS

3.4.2 TELECOMMUNICATION SYSTEMS

Telephone
Paging and Tone-Alert Radio
Internet
VoIP
Cellular and Mobile Messaging Services
Satellite

ADDRESSABLE NOTIFICATION METHODS
Telecommunication Systems: Telephone

Various types of addressable mass notification methods exist for sending the same message to select groups of people, large and small; for example, a population within a specific geographic area or a restricted list of recipients (e.g., all members of a fire department). A popular messaging system is the dial-out telephone voice notification system in which a computer server is used to deliver a pre-recorded voice message to a list of telephone numbers.
The importance of this type of method is that the public uses telephones (both landlines and cellular) and are very reliant on this type of communication for information.

General Characteristics

Characteristics of a notification system are: speed and calling capacity, GIS capabilities, and community control. Telephone voice notification systems dial each number in a pre-established list and then play a pre-recorded message when the call is answered. Multiple numbers can be dialed simultaneously, which is dependent upon the number of ports available on the server. If there is no answer, the system moves on to the next number and will periodically re-try the no-answer telephone number. The system continues to dial the numbers until the message has been delivered to all numbers in the list (or until a specified time-out period has expired). Such systems are in common use by organizations to transmit information to selected groups, ranging from public libraries notifying members that ordered books have arrived to public safety organizations issuing evacuation orders.

Speed and Calling Capacity

The number of calls a system can place within a given time period is determined by the call completion time and the number of available outgoing phone lines. The call completion time is the sum of the call setup time (dialing and connection to a called number) and the time it takes for a person to answer the call, listen to the message and hang-up the phone.

Most telephone systems take an average of about 20 seconds between the time the call is placed and when it is answered (a call being answered after 3-4 ringing cycles). This time needs to be added to the length of messaging and hang-up time (1-2 seconds). Thus a call with a 30 second message would take a little over 50 seconds to complete. The messaging time can be even longer if the system uses interactive voice recognition (IVR) or a touch-tone response system in which the called person is requested to respond before the message begins. The person is prompted for responses during the message, and afterwards is offered choices of having the message repeated or leaving a return message. To increase the chances of reaching populations quickly, additional outgoing lines are added to the notification server. For example, using an average call completion time of 60 seconds over a 30-minute warning duration time, a system using different calling capacities could deliver notifications at the following rates:

Number of lines	Potential number of calls
10	300
100	3,000
1000	30,000
10,000	300,000

The number of calls successfully completed will depend whether or not people answered the telephone call; the line was busy; people remained on-line until the message was fully delivered; there was telephone network congestion encountered, etc.

Availability during an Emergency

Almost all emergency telephone notification systems use the public telephone network for message delivery. During times of emergency, the network's local switching facility in the affected area can be expected to receive a high volume of both internal and external calls, often quickly exceeding its capacity to connect all requested circuits. Unless the telephone notification system has priority access to local circuits and/or can access inbound external trunks, it may be affected in the same manner as other regular calls and will receive "all circuits are busy" messages. High incoming call volumes from the notification system may actually add to local network congestion during the response phase. For these reasons, telephone notification systems are most useful during a Watch period or at the beginning of the Warning phase for disseminating initial warnings when there is likely to be less public loading of the telephone system.

GIS Capabilities

A variation of the dial-out telephone voice notification system uses the same general technology but adds digital mapping (GIS) and database features that enable specific geographic areas to be selected quickly and numbers listed in a database to be automatically dialed. This feature can be very useful for tsunami hazards. For example, a system can enable a municipality to pre-identify all residences and businesses below the projected inundation elevation and store this as a GIS file. To activate the system upon receiving a tsunami warning, the emergency official simply opens the file, and clicks on the appropriate button which automatically sends the GIS map layer to the alerting company's operations centre. Upon confirming the message the municipality wishes to send, the alerting company operator, with a keystroke, extracts all numbers within this shape and the dialing begins. This entire activation process takes only a minute or two.

The municipality can also create custom shapes "on the fly", simply with the cursor, and can create additional alerting areas or shapes; for example, areas up-slope of the inundation zone where a simple advisory might be useful. Alerting such areas would be an additional activation, where the alerting company operator is given a separate message to deliver to different areas. The inundation zone shape can also be divided into smaller units for separate messages; for example, to give different evacuation directions or routes to minimize traffic congestion.

Community Control Systems

For very modest requirements, several PC-based products are available that enable people to set up and manage their own systems. If an organization operates their own local telephone switch (PBX), they may be able to interface a server with it and set up an internal notification system.

System Selection and Implementation Considerations

Telephone notification systems are very useful, especially for warning people indoors. However, many factors need to be considered before a final decision is made concerning which system may be appropriate for your needs, how much it will enhance your area's overall warning capacities, what it will cost and during which stage of the warning process will it be most effective. Some of the key factors are:

- **Size and geographical locations of population** to be notified. How many people need to be notified and will a telephone notification system reach all identified populations?
- **Daytime versus nighttime contact periods**. Will a telephone notification system be able to target populations at all appropriate times of the day?
- **Capacity of dial-out system**. Will the system be able to connect to all pre-listed numbers within the required time?
- **Capacity of local telephone network** to handle volume of notification calls. Can the notification system be scaled to an appropriate rate of calling so it does not overload the local telephone switching system? It is important to consult with the telephone network's engineers for appropriate system sizing recommendations, as opposed to taking a "plug-and-play" approach.
- **Service coverage in remote regions**. For those without regular telephone service, can the system easily interface with other systems such as satellite phones?
- **Operational accessibility**. Can the vendor demonstrate that your community will have priority access to the required system capacity?
- **Redundancy of system components**. Is the vendor's supporting infrastructure operationally and geographically (located in more than one region) redundant?
- **Reliability of service provider**. Is the vendor primarily dedicated to emergency notification and will they provide copies of system performance reports?
- **Technical support**. Does the vendor offer technical and operational support with trained staff on a 24x7x365 basis?
- **Maintenance of outbound calling database.** Does the system allow easy and secure access to updating and editing of the calling database?
- **Privacy.** Does the storage of personal information (including phone numbers) meet federal and provincial privacy requirements?

Provincial Systems: EMBC Provincial Emergency Notification System

EMBC uses a telephone based notification service for issuing tsunami warning, advisory, cancellation and other critical information to local authorities, agencies and media outlets in British Columbia. Notification methods include facsimile, voice landline telephone, cellular and satellite phone. The system is not intended for general public notification. When there is critical emergency information to be issued, EMBC will use the system to immediately contact local emergency officials in communities/areas at risk so they will be able to react quickly to initiate local emergency plans and notification arrangements.

Community Use of Telephone Notification Systems

Several communities in British Columbia are also using telephone notification systems for public warning purposes for specific areas at-risk or broader notification purposes. Often calls are delivered to phone numbers generated from white pages data and are delivered in the form of voice messages. In some cases, the entire service is dependent on opt-in, self-registration. Self-registration can also enable recipients to receive voice or text messages on their cell phones, or by email.

Costs

Commercial services range in price, depending upon the population to be reached, the degree to which subscribers will maintain their own databases and the notification features selected, including use of GIS. It is best to contact providers directly to discuss your community size and alerting needs. Annual contracts for basic non-GIS systems can range from around $2,100 to over $10,000, which includes a minimum specified number of records to be included in a “notification list”, and should allow records to be organized in separate groups, such as key response personnel or facilities for emergency notification (fire, emergency social services, care facilities, fish farms, logging camps, etc.). GIS-based system contacts are more expensive yet. Calling costs are from $0.25 per call and upwards. For small communities, high entry costs can be a significant barrier to use, but a possible work-around solution might be to encourage several communities to band together to share costs or subscribe on a pay-as-you-need basis.

For stand-alone systems, basic systems start at $800 for simple stand-alone single dialers to $5,000 or more for a fully integrated basic entry-level server. Small systems likely will not be effective for community-wide notification, but may be useful for limited emergency personnel notification. Additional costs will be incurred for adding redundant capacity, including an out-of-area backup system.

Why Use a Telephone System?

Advantages

- Multi-purpose; can be used for other purposes during emergencies (e.g., call-out of employees) or outside emergencies (e.g., staff updates, important event notification, etc.).
- Can create lists of individuals or organizations with common characteristics (such as emergency responder teams or populations in flood inundation zones) and contact them as needed.
- Can be configured to target specific geographic locations, warning only those people who are directly at risk.
- Can be used to target populations that are beyond the reach of other local warning methods or are too far away to be reached in-person.

- Called parties can be logged to determine whether or not a call was answered and length of time to complete the calls.
- Messages can be pre-scripted, recorded and stored on server for future use.
- Messages can be pre-recorded in different languages as required.
- An optional protocol allows text messages to be delivered to Text Telephone/Telecommunications Device for the Deaf (TTY/TDD) and other devices. This feature has the potential to greatly enhance ability to warn citizens who are hearing impaired as well as those carrying pagers.
- Can operate during a limited power outage.
- Can be supplemented with cellular and satellite phones.
- Can operate 24/7.

Disadvantages

- Cannot reach people without telephones.
- Generally cannot reach people outdoors (unless they are carrying a cellular or satellite telephone).
- Cannot notify people inside unless they answer the telephone.
- Not available during telephone/cellular outages.
- May be necessary to make a trade-off between content and speed. Delivery of messages will be slowed if the message length is too long and/or if the system has limited call-out capacity.
- May not verify that call receivers have understood the message.
- Effectiveness decreases rapidly as public telephone network becomes congested.
- Fewer people are using landline telephones so residential/office contact is increasingly dependent on cellphone contact which may require pre-self-registration.

GIS Enhanced Systems

Advantages

- Can be used to support warning for a variety of hazards that may have different geographical area impacts.
- Very effective for making notifications within a well-defined geographic area.
- Using a GIS interface, emergency organizations can quickly select areas affected by an incident and immediately include all telephone numbers stored in the associated calling database for the selected area.
- Can quickly modify warning and notification target areas during rapidly changing conditions.

Disadvantages

- Due to privacy concerns and CRTC regulations, telephone number notification databases often contain only telephone numbers listed in the White Pages or commercially supplied databases. However, not all listed telephones are located at the same address listed in the White Pages; some listed addresses may be simply billing addresses.
- Unless manually added to the database, systems will not automatically notify people with unlisted numbers. To minimize this, many jurisdictions have provided a means for

populations to voluntarily provide contact information for addition to the database through self-registration.

- Cannot override “call blocking” features used by subscribers. Subscribers may have to request to remove the feature from their phone in order to receive notification messages.
- Cell phone numbers are not automatically included in the database, nor are nomadic Voice-over-IP telephone numbers (used on PCs and mobile devices). They can be manually entered into the system either as part of a notification list or linked to a specific address.
- A mobile phone, tablet and PC are mobile and users may be well out of the affected area. Or conversely, the situation where the user is mobile, is in the affected area, but is not notified because the registered fixed location of the number is in an unaffected area.

ADDRESSABLE NOTIFICATION METHODS
Telecommunication Systems: Paging and Tone-Alert Radio

General Paging

With the increased use of cellular voice and text messaging, paging is viewed as being at the end of its lifespan. However, paging still remains an important mobile method of alerting, and should be considered as a valid alerting concept beyond its traditional method of transmission.

GENERAL CHARACTERISTICS

Traditional paging is a method that allows people to send messages via the telephone network, radio systems, and more frequently via the Internet. The pager receiver constantly monitors a specific radio frequency dedicated to pager use. It remains silent until it 'hears' a specific identification (ID) string that tells it to display the sent message. The pager radio transmitter is constantly sending out pages, but a unit will only activate when it hears its own ID over the air. Most models operate in a tone alert or vibrate mode.

Some indoor voice pagers have built in loud speakers and some form of visual component such as a red or orange flashing light to further attract attention.

Types of Pager Receivers

There are five basic types of pager receivers:

1. **Tone (beeper) Pagers -** These devices only send out a tone.
2. **Numeric Pagers -** These devices permit a string of numbers (usually up to 20) to be displayed on the pager.
3. **Alphanumeric Pagers** - These devices allow messages of characters (letters and numbers) to be displayed so more complex messages can be sent. Callers can send you a message (from 240-300 characters) by typing it themselves (usually via an Internet web page or email client) or by calling an answering service number.
4. **Voice/tone Pagers** - These devices receive and announce spoken messages. When someone calls and leaves a voice message the pager will beep and the subscriber will hear their message right away.
5. **Two-way Pagers -** These devices have a built-in keyboard allowing the user to send and receive email messages (some including file attachments), write notes to other pagers and even retrieve information via the Internet. Many are operated on the same network as cellular telephones and are described in more detail in the Section entitled, "Telecommunication Systems: Cellular and Mobile Messaging Services".

Service Provision

Service providers offer group or mass calling services where pre-designated groups of subscribers can be sent (multicast) the same message at the same time, rather than transmitting a separate copy of the message to each individual subscriber. This allows for mass notification, and is often used by fire departments, search and rescue groups.

For coastal B.C., commercial paging service coverage is restricted primarily to the B.C. Lower Mainland/Sunshine Coast, eastern and southern coasts of Vancouver Island and through the Alberni Valley into the Ucluelet-Tofino areas of the west coast.

Community Paging System

An alternative for communities to ensure coverage is to implement their own service. The method chosen will need to consider population size, topography, and budget. The most effective type would include voice paging or a system that combined voice and alphanumeric paging. There are two types of paging systems that a community may consider investing in: “Local Area Paging” (LAP) and “Wide Area Paging” (WAP). Local area paging utilizes one single transmitter site that typically has line-of-sight (LOS) to the rest of the community. Wide area paging utilizes multiple transmitters in order to maximize coverage.

LAP - The costs of implementing a local area paging system can vary depending upon the overall desired method of paging, available supporting infrastructure and extent of coverage penetration. A community with LOS to all of the schools, hospitals, and other public facilities in the area may be able to install a single transmitter and each facility may want to install receivers in a number of key locations. As an example, depending upon terrain, a 40-watt transmitter can cover approximately 10 square kilometres. Smaller indoor systems are also available to expand coverage within and between buildings. To reduce overall costs communities could co-locate on an existing radio system, such as a fire service.

WAP - Wide area paging systems are much more versatile in covering larger terrains than LAP systems, but are more costly to implement and maintain. Although they are still LOS dependent, the radio signal can be repeated for greater coverage. An alternative approach is to network a series of existing two-way radio systems to enable wide area paging. Many fire departments along the West Coast use paging from a central dispatch location to receive tsunami Warnings, Advisories, Watches and Cancellations. Pages are overlaid on the existing radio networks.

Cost

Subscription services - To a large extent, the paging market mirrors the cellular telephone market. Depending on the plan, monthly service fees can range from $10 to $40 per month. Service fees will vary depending on whether pagers are owned or rented. Purchasing units range from $50 to $150. Pagers can be leased for a minimal monthly fee.

Equipment - The costs of LAP systems vary dramatically. A basic LAP voice pager system with a 40-watt transmitter will cost around $3,000-$4,000 (this will provide approximately 10 square kilometres of coverage) and the pager speaker/receivers are approximately $300 per unit.

Licensing

Pager transmitters will require Industry Canada authorization and licensing. Additional information is available at: http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/en/h_sf01847e.html

Tone-Alert Radio

Tone alert is a radio that receives a signal from a transmitter that delivers a message to the listener. The radios operate on standby condition and only when the transmitter sends a specific signal to the radio will it be activated. Often these radios can be pre-programmed so only specific events trigger the activation of the radio. This technology can be found in Environment Canada and NOAA weather radios described earlier and some local private paging/warning systems.

General Characteristics

Tone alert radio is similar to the local area paging services described above. The receivers typically operate at VHF 150-170MHz or UHF 850-870MHz and deliver an alert tone that is followed by a live or recorded message. Optional strobe lights and LED displays for the hearing impaired are also available.

Why Use Paging/Tone-Alert Systems?

Advantages

- Depending on how the system is developed, it can provide overall coverage throughout the community and surrounding area.
- There are several options for message delivery (examples: pagers, speakers etc.).
- Tone alert capability to capture attention.
- Vibrating mode useful for hearing impaired.
- The technology could be utilized for everyday situations rather than being an entirely emergency system. (This could possibly include some cost recovery mechanisms).
- Can generally reach people indoors and outside.
- Can target subscribers through group paging.
- Mobile phone/IP-based pagers can reach people beyond normal radio paging reception areas.
- IP-based paging can leverage existing Internet distribution infrastructure.

Disadvantages

- Land-based commercial paging services have limited coverage areas.
- Reception may be impaired by poor line-of-sight to transmitter.

- Need to be a subscriber (or network member) to be reached.
- Need to be used and/or carried at all times to ensure messages will be received.
- Need to be regularly maintained (e.g., batteries are regularly replaced).
- Maintenance of receivers cannot be monitored by local warning authority.
- Indoor units need to have a reliable power source.
- Extra cost to buy or rent pagers/tone-alert receivers.
- Missed terrestrial pages may not be rebroadcast or recovered (e.g., out of reception area or pager is turned off when paged).
- High cumulative cost to use specialized pagers, especially if only for warning purposes.
- For IP-based paging systems, lessening of warning diversity as other local methods are also dependent on using same network infrastructure.

System operated by the community

- The initial costs of implementing service can be expensive.
- Additional technical and administrative support required, including licensing.
- If it is not used and maintained regularly it can quickly fall into a state of disrepair.

ADDRESSABLE NOTIFICATION METHODS
Telecommunication Systems: Internet

In addition to distributing tsunami alerts and warnings through radio, TV, mobile devices, Environment Canada Weatheradios, sirens, reverse 9-1-1, and digital road signs, etc., notifications can also be sent via Internet-connected services and systems.

In fact, the Internet is rapidly replacing other traditional technologies as the most universal and ubiquitous means for disseminating information. Trends point towards the rapid uptake of Internet-based services by the general population with an associated decreased time spent on television and radio and even voice telephony. Additionally, social networking services such as Twitter, Facebook, YouTube, Instagram and Flickr have created new ways to interact and socialize. Users are able to add a wide variety of information to pages and messages to pursue common interests and to connect and maintain communication with others individually or in groups. Increasingly, these services also allow users to connect their various accounts enabling them to share uploaded information to those sites.

The Internet has proven to be particularly suitable for emergency notification since information flows are continuously updateable and can be provided concurrently in different formats (e.g. text, maps, video, audio), both in push and pull modes, across a global network of different types of interoperable devices and applications. For tsunami warning, the Internet has become the key technological infrastructure for integrating virtually all of the key end-to-end arrangements including the detection, emergency management and public response subsystems described in Section One.

GENERAL CHARACTERISTICS

Internetworked devices use the Internet Protocol (IP) to communicate with each other over networks. The Internet is not a single network, but rather a *network of networks* that consists of millions of private, public, academic, business, and government networks of local to global scope. A major strength of the Internet is its increasing general accessibility and the multiple ways in which IP access can be provided, from copper wire and fiber-optic to wireless and satellite communication systems. Small messages to large files can be transmitted, with one-way or two-way communication, and can send/receive anything from text documents to audio and video information.

The Internet supports many network services, such as the World Wide Web, electronic mail, multiplayer online games and other peer-to-peer networking, Internet telephony, file sharing, syndication, audio and video streaming and most prominently, mobile applications such as social media apps.

The following sub-sections outline many of the Internet-based applications used in present B.C. West Coast tsunami warning arrangements, along with some additional applications that may be suitable for notification consideration.

Coastal Internet Coverage

In Canada, Internet accessibility and capacity is closely tied to population densities, geographic location and proximity to telecommunications network infrastructures. This is especially true for B.C. coastal areas where population densities and infrastructure distributions vary widely. For fixed locations, all now have some potential access to Internet-based services. However, generally only the more urbanized regions or locations within proximity to them have multiple choices of provider and infrastructure type (e.g., ADSL, Cable, Cellular). The most remote regions have to rely primarily on service from a satellite-based provider, which typically is more expensive, may have data usage caps and may not have the necessary quality of service to support the same two way voice and video services associated with urban wireline broadband services. Service connections are also affected by mountainous topography influencing the ability to achieve line-of-sight visibility with the orbiting satellites. Conversely, other than power, satellite service does not depend upon other local or regional technical infrastructure to operate.

Internet access over mobile cellular service tends to follow a similar pattern, with coverage and level of service determined by population density and/or higher volume highway transportation routes. While, High Speed Packet Access (HSPA) has become the standard mobile Internet service offering, higher capacity Long Term Evolution (LTE) service remains tied to more urban centres or rural corridors that have higher capacity out-of-region networking provisions. Areas without cellular service may still be able to access many of the same mobile smart phone IP applications via Wi-Fi on local IP networks.

Why Use Internet?

Advantages

- Generic infrastructure.
- Cross-platform.
- Low-cost.
- Many possible applications and media possible.

Disadvantages

- Some applications require high-quality networks, and possibly network experts in community.
- Software installation may be required on community member computers, with user support personnel required.
- Servers may be required, and server management personnel required.

Email

Email is based on a set of protocols that allows for sending mail to a mail server, transmission across the network, and delivery to, or retrieval by, the user. Email has become the most ubiquitous means of electronic messaging and has extensively replaced facsimile for interpersonal and inter-organizational communication.

U.S. Geological Survey Earthquake Notification Service (ENS) - ENS is a free customizable service that sends automated notification emails whenever earthquakes happen in specified areas. New accounts default to receiving notifications about earthquakes with magnitude 6.0 or greater. However, ENS can be customized to only deliver messages for certain areas, at specified times, and to multiple addresses. ENS allows users to associate up to 15 email addresses with each account.

Subscription instructions are available via: https://earthquake.usgs.gov/ens/

NTWC Email Notification - NTWC maintains a set of restricted group email lists primarily for U.S. State, county, community and selected B.C. emergency management organizations. Presently, NTWC does not provide email service directly to the public, but does enable access via the Intergovernmental Oceanographic Commission which redistributes bulletins from National Tsunami Warning Center, Pacific Tsunami Warning Center and North West Pacific Tsunami Advisory Center in Japan.

Subscription instructions are available via:
https://lists.unesco.org/wws/info/tsunami-information-ioc

EMBC Email Notification - EMBC uses email messaging to contact emergency managers and key agencies, health authorities, media, and critical service and infrastructure providers. Emails are relayed through three different methods:

1. The Emergency Coordination Centre (ECC) comprehensive and pre-established tsunami alert distribution list. This list includes provincial ministries, Crown corporations, federal agencies, local authorities, key media and first responders.
2. Provincial Regional Emergency Operations Centres (PREOCs) email lists that serve specific coastal regions.
3. The Provincial Emergency Notification System automated email distribution list.

Local authorities and other emergency organizations should contact their EMBC Regional Office for more information about these services and which ones they may be eligible to use. See Appendix A for a list of offices.

Environment Canada EC Alert Me - EC Alert Me is an experimental notification service that allows Canadian emergency management subscribers to custom-define their alert areas, types and conduit options. The service is not intended for general public use.

The client management interface is a web application that serves as the primary gateway for creating and managing customized weather and tsunami alerts. Alerts can be viewed on-line or as email messages. Through the client web interface, registered subscribers can create a new alert when they wish to be informed of certain conditions/events occurring in a designated area. They can create as many alerts as they want.

The types of messages for which they might want to be alerted include warnings, advisories, watches and special statements for a full range of weather-related events, as well as NTWC and EMBC tsunami Warning, Advisory, Watch and Cancellation messages. Once alert types are selected, subscribers are allowed to select the area (s) for which they wish to be alerted during specific conditions. Desired sub-regions can be selected by using an on-line interactive map, entering the name(s) or specific CLC tab(s). For tsunami alerts, CLCs have been grouped to correspond with the B.C. Tsunami Notification Zones.

- Zone A - the North Coast and Haida Gwaii, B.C. (081100-089110-089210)
- Zone B - the Central Coast and Northeast Vancouver Island Coast including Kitimat, Bella Coola and Port Hardy, B.C. (081220-082100-082200-089120-089220)
- Zone C - the Outer West Coast of Vancouver Island from Cape Scott to Port Renfrew, B.C. (081210-081410-081500)
- Zone D - the Juan de Fuca Strait from Jordan River to Greater Victoria including the Saanich Peninsula, B.C. (081420-081600)
- Zone E - the Strait of Georgia including the Gulf Islands, Greater Vancouver and Johnstone Strait, B.C. (081300-082300-082500-082600-082800)

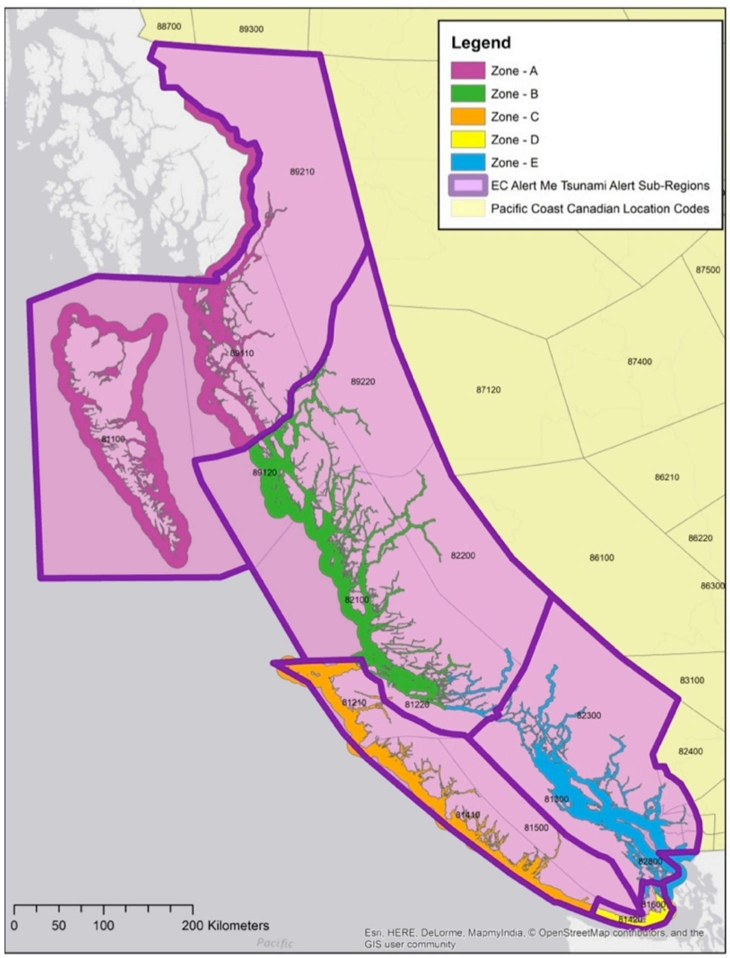

Figure 9: EC Alert Me Tsunami Alert Sub-Regions

Subscription and other information about EC Alert Me is available at:
https://ecalertme.weather.gc.ca/

The Weather Network Alerts - The Weather Network, operated by Pelmorex Media Inc., offers a similar email-based public safety alerting service to the general public. While primarily focused on weather-related notification, this service is also connected to Alert Ready and redistributes EMBC emergency broadcast alerts. Users require an account and can sign up through the Weather Network web site. Similar to EC Alert Me, users can create their own profiles to customize and filter notifications by location.

Subscription and other information is available at:
https://www.theweathernetwork.com/ca/my-account/sign-in?pgref=my_alerts

Why Use Email?

Advantages

- Widely supported on PC and mobile device operating systems and IP network infrastructures.
- Very low cost.
- Available 24/7.
- Every personal device with Internet access features usually has an email program.
- Easy way to disseminate information, ranging from text files to maps, sound and video files and imbedded web links.
- Large amounts of information can be quickly disseminated over vast areas to large groups if bandwidth and server processing is sufficient.
- Distribution lists can be predefined and targeted.
- Easy interface for message senders and receivers – minimal specialized knowledge needed.
- Can provide easy feedback return communication path.
- Can operate over low quality of service networks.
- Short length emails can be sent to mobile devices such as SMS messages.

Disadvantages

- Not everyone has constant access to email.
- Requires centralized email servers – specialized knowledge needed to set up and manage, and potential single point of failure.
- Does not scale well to transmission of messages to a large number of users without extra server capacity.
- No guarantee of delivery time.
- Requires operating network return path for forward delivery.
- Can be secure to users (on both sides) if set up with the correct technology; otherwise can be easily faked.

Syndication - RSS

Rich Site Summary or Really Simple Syndication, often simply called "RSS" is a primary pull-based mechanism for automated Internet news distribution. RSS uses a set of standardized web feed formats to publish frequently updated information such as news headlines, blog entries, and even audio and video. RSS fed documents can include full or summarized text, along with other information such as publishing date and author's name.

The use of a standard XML file format (Common Alerting Protocol - CAP and Atom) ensures compatibility and interoperability across many different platforms and application programs. RSS feeds provide a convenient means for users to receive timely updates from favourite websites or to aggregate data from many sites. Browsers are available for all types of computers and mobile devices and can constantly monitor the feeds and alert and inform the user of any updates. Browsers can also automatically "pull down" the new data for the user.

USGS ENS Syndication - The USGS provides customizable direct Internet RSS feeds of past hour, past day, past 7 days and past 30 days earthquake event data. Subscription instructions are available via: http://earthquake.usgs.gov/earthquakes/feed/v1.0/atom.php

Natural Resources Canada Recent Earthquakes Syndication - Natural Resources Canada (NRCAN) provides summary of all recent Canadian earthquakes via a RSS feed available at: http://www.earthquakescanada.nrcan.gc.ca/index-eng.php?tpl_region=canada&tpl_output=rss

NTWC Syndication - NTWC provides direct Internet RSS feeds of messages to the public via RSS available at: http://ntwc.arh.noaa.gov/events/xml/PAAQAtom.xml and an XML/CAP format product maintained at: http://ntwc.arh.noaa.gov/events/xml/PAAQCAP.xml

EMBC Syndication - EMBC's Emergency Information British Columbia also feeds of its tsunami and other emergency notifications via a RSS feed maintained at: http://www.emergencyinfobc.gov.bc.ca/atom.xml.

Environment Canada - RSS feeds of Environment Canada's Public Weather Alerts for British Columbia service are available for each of its Forecast Regions. Subscription information is available at: http://weather.gc.ca/warnings/index_e.html?prov=bc

Some local authorities are also offering RSS feeds for multi-hazard and other notification purposes.

The Weather Network - The Weather Network provides general weather RSS feeds, including alerts and warnings for each community location in B.C. Subscription information is available at: http://legacyweb.theweathernetwork.com/rss/

Why Use Syndication?

Advantages

- Available across numerous operating systems and platforms (PCs, mobile devices, etc.).
- Automated checking systems built into standard software platforms.
- Easily interconnected to other networking and warning infrastructure.
- Can operate behind almost any firewall or NAT infrastructure.
- Can operate on low-QoS networks.
- Scales moderately well for medium-sized communities.

Disadvantages

- Pull-based, not push-based, so warnings only available upon checking.
- Some browser applications have lengthy delays in checking intervals (15 minutes and greater).
- Requires 2-way networking for forward delivery.
- Browsers can use up a lot of bandwidth checking for updates during non-event times (especially on mobile networks).
- RSS may soon become a legacy technology.

Web Sites and Blogs

Conventional web sites, web logs (blogs) sites and social networking sites such as Facebook, allow users to manually retrieve or automatically recover data. Such systems provide large amounts of backup information and can be quickly updated and supply an almost unlimited number of users with a large variety of information. Many now imbed content from other sources such as Twitter. However, web sites don't function as an efficient first-stage alerting or notification tool since users usually have to be prompted first about updates and then actively open the website. Despite this, today, that process can happen very quickly; for example, users can now be alerted by a Tweet, SMS text message, RSS feed or one of numerous smartphone apps containing a brief summary with an imbedded URL to link to the warning centre's site. These web sites provide additional vital information that is not supported by short messaging systems.

The following is a brief summary of current sites that are specific to earthquake and tsunami notification.

USGS ENS Web Sites - Latest earthquake reports are available at: http://earthquake.usgs.gov/earthquakes/map/

Additional information is available at: https://sslearthquake.usgs.gov/ens/

Natural Resources Canada (NRCAN) Recent Earthquake Web Site - NRCAN also provides information about recent Canadian earthquakes. Additional information is available at: http://www.earthquakescanada.nrcan.gc.ca/index-eng.php

NTWC Web Site - NTWC public web site provides current tsunami notification messages as well as maps of earthquake locations, energy dispersal and tsunami wave estimated times of arrival. Email and Twitter tsunami bulletins often point to this site for full event details. The web site also provides a large amount of educational, safety, and scientific information. Additional information about the site is available at: http://ntwc.arh.noaa.gov/

EMBC Emergency Info BC Web Site - Similar to NTWC, Emergency Info BC maintains a web site that posts the latest B.C. related major tsunami event details when Warnings, Advisories, Watches and Cancellations are issued. EMBC email and EmergencyInfoBC Twitter tsunami bulletins also point to this site for additional event details. The site is also used for other B.C. hazard notification purposes. Additional information about the site is available at: http://www.emergencyinfobc.gov.bc.ca

Environment Canada Web Site - Environment Canada offers public access to alerts through its website. While the primary focus is on issuing weather related alerts and warnings, as a supplement Environment Canada also distributes tsunami Warning, Watch, Advisory and Cancellation notifications. Notifications can be viewed at Provincial or specific forecast area levels.

Additional information about the site is available at:
https://weather.gc.ca/warnings/index_e.html?prov=bc

The Weather Network Website - The Weather Network also operates its web service for public alerts. This service is also connected to Alert Ready and redistributes EMBC emergency broadcast alerts.

Additional information about the site is available at:
http://www.theweathernetwork.com/maps/alerts

Google Public Alerts Web Site - Google Public Alerts is a web map service that displays warnings from Environment Canada and Public Safety Canada (in English and French), and from the U.S. National Weather Service (NWS) and the U.S. Geological Survey (USGS). It also provides links to more detailed information about the warning, including full text from the issuing authority, Tweets related to the warning, related news stories and safety tips.

Additional information about the site is available at:
http://google.org/publicalerts

WHY USE WEB SITES?

Advantages

- Large, complex data can be provided.
- Servers can be located and updated locally or out-of-area.
- Public access possible by all users on all operating systems.
- Easily interconnected to other networking and warning infrastructure.

- Can be accessed behind almost any firewall or NAT infrastructure.
- Can operate on low Quality of Service networks.

Disadvantages

- Supplementary to warning. If not continuously monitored for updated information, usually requires a 2 step process for supporting warning – an alert and redirection to website.
- Requires 2-way networking for forward delivery.

Social Media – Twitter Feeds

Social Media broadly refers to a set of Internet-based tools that support social interaction through many-to-many communications. It encompasses a variety of technologies including online social networks, examples of which include Twitter, Facebook, Flickr and Instagram, as well as weblogs and crowdsourcing tools like Ushahidi that were built specifically for use in crises. Social media are now actively used across all sectors of societies throughout the world to facilitate communication, collaboration, and information collection and dissemination.[21]

Social media have proven particularly useful in emergencies both to officials seeking to deliver warnings and other information directly to the public and to citizens seeking to personally communicate with officials and each other. One of the most widely used social networking services for rapid dissemination of emergency information is Twitter that enables users to send and read short 140-character messages called "tweets". Registered users can read and post tweets, while those who are unregistered generally can still read them. Users can access Twitter messaging through numerous platforms including Twitter's web site interface, smart mobile wireless device apps and even older mobile phone SMS text messaging.

Despite its versatility, Twitter is not used by everyone and not always monitored by its subscribers. It also relies on Internet access that is not accessible to everyone along B.C.'s coast. For these and other reasons, it should be viewed as a complementary network to distribute and amplify tsunami warnings and not to replace other emergency notification systems.

A Few Tips from the Field[22]

- It is important to build social networks before emergencies occur.
- The more people who see your Tweets, the more people who will benefit.
- Point people to relevant accounts and coordinate the use of #Hashtags with other organizations or efforts.
- Use hashtags to broadcast information more widely beyond your followers.
- Hashtags can be used to connect and share information about emergency response both locally and around the world.
- As a guide, Emergency Info BC has compiled a list of evolving, trending and most-used emergency hashtags in British Columbia which is available at: http://www.emergencyinfobc.gov.bc.ca/resources/. Its partners at the Ministry of

[21] NAS (2013).
[22] NAS Ibid., Twitter (2016), Emergency Info B.C. (2016)

Transportation and Infrastructure also oversee a list of the most popular hashtags for B.C. communities which is available at http://tranbc.ca/tranbc-social-media-hash-tags/

- Sometimes it's important to retweet important information from another trusted source. When you do, use the official Retweet feature marked by the Retweet icon . This helps Twitter know that the Tweet is important, so it can rank it higher in search results.
- Monitor trending topics for relevant regions to help identify rumors that might be spreading. When you know a rumor is unfounded, counter it with accurate, verified information**.**

Twitter for Good Program

During emergencies and disasters, Twitter has offered tools and programs that help with communication tools and humanitarian response mechanisms. Additional details are available at: https://about.twitter.com/company/twitter-for-good

Twitter and Tsunami Notification

The following is a brief summary of current sites that are specific to earthquake and tsunami notification. Users can also sign up for a SMS version (See: Cellular and Mobile Messaging Services below).

US Geological Survey Tweet Earthquake Dispatch

The USGS offers earthquake alerts via two twitter accounts.

@USGSted

@USGSted distributes alerts for earthquakes worldwide with magnitudes of 5.5 and above. These tweets also contain location, origin time, a magnitude descriptor and link to the USGS webpage with the most recent information about the event. Tweets can also include the frequency of tweets in a region surrounding the event containing the hashtag "#quake" or its equivalent in several other languages which often originate from people who have experienced the shaking effects of the earthquake. After some significant earthquakes, @USGSted will also tweet supplementary information about the event.

@USGSBigQuakes

@USGS Big Quakes is a simplified version for those users who are only interested in seismically derived earthquakes worldwide with magnitudes of 5.5 and above. The tweets do not include the frequency of tweets containing the word "earthquake".

NRCAN Earthquakes Canada Twitter Feed

@CANADAquakes

@CANADAquakes distributes alerts for all significant earthquakes considered relevant to Canada. Tweets contain a magnitude descriptor, location and URL link to NRCAN's website for more details about the event including a map and any reported effects.

National Tsunami Warning Center

@NWS_NTWC

NTWC sends out automated shortened Tsunami Warning, Advisory, Watch and Information messages on its Twitter account, @NWS_NTWC. Messages also contain earthquake magnitude, approximate location and the hashtag “#NTWC” which allows viewers to comment (tweet) about the event.

EMBC - Emergency Info B.C.

@EmergencyInfoBC

EMBC utilizes Twitter to alert British Columbians to a tsunami threat by amplifying messages and verified information from NTWC and EMBC officials through its Twitter account, @EmergencyInfoBC. Due to the near real-time nature of Twitter, tsunami messages and updates often can be received via @EmergencyInfoBC before the other PENS notification methods.

Two features that differentiate @EmergencyInfoBC from @NWS_NTWC Twitter messages are that @EmergencyInfoBC messages are not generated automatically and are not always tsunami specific as @EmergencyInfoBC is used to disseminate all provincial hazard alerts. Hence, messages also contain hashtags for location of the event, and hazard type.

A second account, @PreparedBC, provides preparedness & recovery information.

WHY USE TWITTER?

Advantages

- Quick notes that are easy to read.
- Cross-platform.
- Much faster to distribute than emails.
- Free to use.
- Widely adopted for social networking.
- For senders, convenient way to connect with followers.
- All key regional tsunami warning centres use it.
- Users can follow specific agency accounts as trusted sources of information.
- Offers a partnership through which officials can provide the best information they have available at the moment and their followers can help disseminate the information.
- Messages can be easily redistributed through re-tweeting and cross-linking with other social networking services.
- Can reduce the gap between the time individuals receive warning information and when they need to take action.
- Useful as a feedback medium for confirming warning information.
- Can provide links to more detailed information via imbedded URLs.

Disadvantages

- Each tweet is limited to 140 characters.

- Not specifically designed or scaled for emergency use.
- No priority access.
- No guaranteed delivery.
- Dependency on third party provider. Not managed by emergency management community.
- Requires a fixed or mobile Internet connection.
- Citizens have to register to use the service (opt in).
- Without alerts set up on browser apps, warnings can remain in background and unnoticed.
- Without following specific accounts and hashtags, event data may be difficult to locate.
- Messages can be readily altered as they are spread.
- Messages that may no longer be accurate can continue to propagate through social media long after they are no longer current.
- Without establishing prior arrangements with Twitter, users and senders can exceed Twitter default message downloading and uploading caps.
- Timeline histories are short, making event document and preservation difficult, unless organizations are willing to pay for access to archived tweets.

Note about Twitter Alerts

Twitter recently announced a beta Twitter Alerts program to support local, national, and international institutions that provide critical information to the general public. Twitter Alerts are intended for crisis situations that include warnings for imminent dangers, preventive instructions, evacuation directions, urgent safety alerts and information about access to essential resources. What distinguishes Twitter Alerts from regular Twitter service is that tweets are delivered instantly as push notifications or text messages to subscribers' phones and tablets and are designed to stand out from other Tweets on followers' Timelines and across twitter.com and the Twitter mobile apps.[23]

Several U.S., U.K., Australian and Japanese emergency organizations are participating in the trial program. Presently, no Canadian organizations are registered. However, at time of preparing this guide, Twitter has indicated that it has stopped accepting any additional registrations. It is hoped that the program will resume accepting registrations in the near future.

Details about this initiative are available at: https://about.twitter.com/products/alerts

[23] Twitter (2016) Twitter Alerts.

Voice-over-Internet Protocol (VoIP), also known as Internet Telephony is another way Canadians can make telephone calls. However, instead of using the traditional telephone system, calls are routed to switches over the Internet. VoIP in its earlier forms was mainly set up for computer-to-computer communication (e.g., early Skype, Yahoo Chat, etc.) within closed user groups. [24] As VoIP became more mainstream, cable, telephone, satellite and third party service providers began offering their own services to the public, and many consumers have now replaced their traditional wireline service with VoIP. Mobile cellular operators are also moving towards IP networks for voice communications, thus encouraging direct IP-connectivity, rather than linking back into traditional circuit-switched networks via gateways.

GENERAL CHARACTERISTICS

The sets of telecommunication rules that enable voice signals to be carried over the Public Internet (or other IP-based networks) are commonly referred to as Voice-over-IP or VoIP protocols. Using VoIP protocols, voice communications can be delivered over any IP network regardless of whether it is the public Internet, an Intranet or a Local Area Network (LAN). In a VoIP-enabled network, the voice signal is digitized, compressed and converted to IP packets and then transmitted (streamed) over the IP network. The key benefits of VoIP are very low costs and the integration of data and voice in a single network. VoIP can be used to carry virtually any type of audio, and is being used as a means to trunk between voice radio, paging and other wireless and landline communication systems to extend coverage and enable them to work together.

There are some major differences between VoIP telephone and regular telephone systems. VoIP voice content is chopped up into small packets of data, each numbered and encoded with an address for the packet to be sent to. Unlike a traditional telephone call with a continuous flow of electronic communication over a dedicated circuit between sender and receiver, VoIP voice data flows over a general-purpose network where information can flow over different network routes before reaching the final destination. Because of this, VoIP systems need to adjust for out-of-order packet delivery, late packets, and lost packets.

In order to interconnect users, a method of switching and user addressing is required. Some VoIP systems use simple computer software applications to facilitate this, while others provide all of the same call features of modern advanced telephone switches (caller ID, call forwarding, voice mail, etc.). In order to place a call from a VoIP phone to someone on the main public switched telephone network (PSTN), VoIP switches must be interconnected to the PSTN. Some switches now combine both traditional and VoIP features to enable additional redundancy, using both the Internet and PSTN to route calls.

[24] Schulzrinne, et al.

Setting up a VoIP System

Setting up a VoIP system requires a number of components:

> **A central device to manage the calls** like a telephone switch (PBX) does in traditional phone systems. This can be a dedicated piece of equipment such as an IP PBX (a regular PBX that has been IP-enabled), or a server running specialized software. IP PBX's are available through all major telecommunications manufacturers, as well as IP equipment manufacturers such as Cisco. Prices range from around $1,000. PBX systems are becoming more popular as a lower cost option to traditional mainstream PBXs. A low cost option is an open source software implementation, such as Asterisk, a free software version that supports many features only available in expensive proprietary PBX systems.
>
> **Telephones and a data network** refer to existing digital phones and computer networks. Depending on the setup, internal calls are routed over the existing phone or computer network. Calls within the same office will typically be routed over the phone network, while calls to other locations get routed over the computer network. Calls to external phone numbers get sent through the network to a gateway, which connects to the public switched telephone network. To the phone user, all calls connect seamlessly.

Current Commercial VoIP Offerings in Canada

Virtually any land-based Internet service provider in Canada can support some form of VoIP service, either directly or as a carrier for third party providers. Canada's four largest cable companies and dozens of smaller competitors now offer Canadian consumers their own version of VoIP service. The main telephone companies such as Telus and Bell are also moving to implement VOIP. Eventually, it is likely that almost all voice telecommunications systems will be employing VoIP, including cell phone systems.

Currently, Canadian commercial VoIP offerings are offered in two forms:

- Cable telephony, now beginning to be offered by the major cable companies such as Shaw and Rogers.
- Nomadic VoIP telephony, which is being offered by companies like Primus, Vonage.

Both Cable telephony and Nomadic VoIP telephony use the same technologies to send and receive calls. The difference between Cable and Nomadic VoIP is the network they use to relay the phone call to the PSTN or to another Digital Network. For Cable telephony, the subscriber switching generally takes place within the cable company's own physical sub-network. For Nomadic VoIP, the switch can be located virtually anywhere on the Internet. Subscribers attach an adapter or install a software program (client) on a computer (equipped with a microphone and speakers or a headset) and then plug them into any broadband Internet connection.

Cost

Cost savings are largely due to using a single network to carry voice and data. There is a basic cost for accessing Internet service, but using VoIP over this service usually does not involve any extra charges. If insufficient capacity (bandwidth) is available, the voice communication will become unintelligible. A dial-up Internet connection may have just enough capacity for low level voice quality if the link isn't being used for other applications, but a cable or DSL broadband connection will enable better service.

Cost for commercial VoIP services vary. Larger providers offer full PSTN interconnectivity including a telephone adapter, a regular telephone number and choice of area code, as well as numerous call features, including web-based management. Prices range from approximately $15 to $60 per month.

There are many service providers that offer free VoIP service with no sign up or monthly fees but charge for interconnection to the main PSTN or other VoIP providers. Examples are Skype and Vonage.

WHY USE A VOIP SYSTEM?

For public warning, VoIP offers advantages and disadvantages. General advantages are low cost, off-the-shelf availability of VoIP products and services and flexibility. General disadvantages include quality of service, reliability, electricity dependency and security issues. These advantages and disadvantages are discussed in more detail below.

Advantages

- **Cost** - VoIP takes advantage of unused capacity of IP networks and supporting equipment to enable extremely low cost voice communications.
- **Extension and integration of warning services** - VoIP provides one or two-way voice communications to terminals or devices in virtually any location that possesses an IP connection (wired or wireless) with reasonable bandwidth. These locations can include small remote communities or businesses that have broadband Internet service through new national and provincial satellite, landline and cellular programs. Connected systems and devices could include telephone notification systems, local and remote sirens, paging and other tone-alerting transmitters and receiving devices, radio transmitters, etc.
- **Mitigating effects of local telephone network congestion** - VoIP provides a potential solution to local telephone network congestion. Because VoIP telephones use IP networks, they can operate independently of the local PSTN (but be interconnected as required). They can continue to function when regular phone service is unavailable.
- **Transitioning** - Many existing office telephone systems can be adapted for VoIP. Existing phone wires can be used within offices and VoIP for calls between locations. This combination will work well, especially if offices have relatively new telecom equipment - many office switches (PBXs) can be IP-enabled with software upgrades and minor hardware additions. Vendors may also be able to set up systems that use only traditional lines and extensions at first, but support expansion to VoIP at a later stage.
- **Mobility and functionality** - VoIP phones and server switches can be moved and located anywhere in the network, and with full Internet operability, can be located almost anywhere in Canada or the world. This provides flexibility in placing key critical communications components out of hazard zones.
- **User friendliness** - VoIP adapters are easy to install and use.

Disadvantages

- **Reliability** - Many systems are only as good as their weakest links. IP networks on which VoIP applications depend consist of a number of interdependent components (modems, routers, domain name and other servers, cable and other physical connections, etc.). A failure of any of these components can disrupt services. A major issue is the requirement for reliable power needed for all of the network components, including end-user phone adapters. Unlike conventional telephones that are connected directly to telephone company phone lines, which in the event of a power failure are kept functioning by batteries and back-up generators located at the telephone exchange, there are no such arrangements for connections on the public Internet. For assured networking, all IP components need to be provided with some form of uninterruptible power supply.
- **Quality of service** - As IP was originally designed for carrying data, it does not provide real time guarantees to support the Quality of Service (QoS) standards required for VoIP. Common QoS issues include latency (delays in data packets arriving at a destination, often when satellite circuits are involved), and jitter (variations in the delay of the packets) and packet loss. Networks can be designed to address these issues, but the problem can resurface when connecting to the public Internet or other outside networks. Over the public Internet, the quality of VoIP connections can rapidly deteriorate with the number of hops across the network. Different implementations can be sensitive to different aspects of QoS. For instance, the nomadic services are often designed for the public Internet, and trade less overall performance for increased steady performance under a wide range of QoS conditions. Conversely, many low-end solutions, such as Asterisk, and even commercial-grade VoIP solutions, often cannot easily handle QoS issues, and rapidly fail over extended networks, or networks under stress. Thus, there are complex issues around the use of VoIP in public warning applications. This may make other audio over network technologies, such as Streamed Audio or distributed Audio (Syndicated Podcasting, Peer to Peer networking, etc.) more appropriate for alert communication.
- **Interoperability** - Not all VoIP products from different vendors will operate with each other. This necessitates putting in place gateway technologies to bridge the networks.
- **Security** - Operating in an open network such as the Internet exposes VoIP applications to all of the vulnerabilities of general public IP networking (viruses, denial-of-service attacks, hacking, etc.).
- **Firewalls** - As a security precaution, most organizations have set up firewalls to insulate their own networks from unauthorized access from the outside. Firewalls can present obstacles for enabling VoIP connections between internal and external networks. Often additional configuration and network management tools are required to enable interconnection. This can present problems in times of crisis when network links may need to be rapidly extended.
- **Scalability** - VoIP systems need to be flexible enough to grow to meet increased user demand as services become more accepted. Some network management, user management technologies and products may not be sufficiently developed to address these issues. Similarly, networks supporting the applications will require the necessary bandwidth to ensure QoS.

- **Emergency calls** - Many VoIP services allow subscribers to select a telephone number whose area code and exchange belong to an area or region they don't live in. When 911 calls are placed via the Internet, the call is routed to the 911 centre designated to the area code and exchange people are dialing from, which may not correspond to the area they live in. CRTC now has regulations for fixed (non-nomadic) VoIP services. Where end-users are assigned a regular public telephone number, the VoIP is required to provide 911 or enhanced 911 services within regions where it is provided by incumbent telephone companies. However, nomadic VoIP remains problematic as end-users can be located virtually anywhere in the world.

ADDRESSABLE NOTIFICATION METHODS

Telecommunication Systems: Cellular and Mobile Messaging Services

People rely heavily on cellular communication due to its portability and convenience. However, the system is not yet 100% reliable or accessible. Within British Columbia, many coastal areas remain underserved and unserved due to a lack of transmitters or geography restricting coverage.

GENERAL CHARACTERISTICS

A cellular or mobile network is basically a telecommunication network where the last segment is wireless. As such, a cellular mobile phone is essentially a two-way radio that establishes the final network connection. Mobile phones operate over a network of transceivers called "cell sites". By breaking the airspace down into many smaller cells, cellular networks are able to use their frequencies much more efficiently and it allows for more usage than one single high-powered transceiver. When linked together these sites provide radio coverage over wide geographic areas. This enables a large number of portable transceivers such as mobile phones and data terminals, to communicate via cellular base stations, with each other and with fixed transceivers and telephones anywhere in the network, even if some of the transceivers are moving through more than one cell during transmission. This also enables mobile phones and mobile computing devices to be connected to the public switched telephone network, the public Internet and private networks. To facilitate voice and data interexchange, however, the local cell traffic must be trunked or "backhauled" to centralized switches, routers and servers often located out-of-area. In this regard, the backhaul infrastructure is as critical to facilitating communication as the actual last-mile connections. Further, cellular networks have a limited amount of radio spectrum for which operators receive licences from the federal government, and each cell site, therefore, has a limited number of frequencies available. In emergency situations it is very easy to exceed this capacity. Consequently, cellular is not an assured method for delivering time sensitive and life critical warnings.

In the past two decades, cellular networks have gone through several major transformations from basic analogue voice-only to digital voice, text and low speed data to high-speed data. Today's mobile phones incorporate all of the traditional and contemporary cellular digital features and more. In fact, the modern phone is comprised of many radio systems operating on different cellular frequency bands, as well as other bands, such as Wi-Fi and Bluetooth that interoperate through the phone's operating system and applications software. This integration enables users to access and even share connections to the Internet. In cases where local Wi-Fi services exist, users can switch over from cellular data connections to reduce usage charges and/or access higher speed service. This also enables use of mobile Internet-based applications in areas that are outside cellular signal range.

Consequently, in addition to traditional circuit based voice telephony, modern mobile phones can support a variety of other services, such as text messaging, multimedia messaging services (MMS), email, Internet access, short-range wireless communications, GPS, gaming, photography, video and audio recording and streaming, as well as a host of third party applications (apps) including VoIP and social media. Mobile phones that offer these and more general computing capabilities are typically referred to as "smartphones". Other "smart user devices", such as tablets, also support many of these same features.

Coinciding with mobile device evolution are advances in high-speed digital networking. Beginning in the 1990s, when expected data speeds ranged from 1.2 to 9.6 kbps, by 2010 data speeds grew to 21 Mbps with High-Speed Packet Access (HSPA) networks, and even higher today with latest generation Long-Term Evolution (LTE) networks that are engineered to speeds over 200 Mbps, with average expected speeds in the range of 12 to 65 Mbps depending upon supporting telecommunication network design and capacity.

The cost of creating, continuously upgrading and maintaining these cellular networks is very high and, consequently, service coverage is concentrated in more populated areas. In British Columbia, cellular service coverage tends to mirror population densities and associated higher usage transportation corridors. For B.C.'s coastal region, it is not surprising then, that coverage is greatest within the South West Mainland, Southern and Eastern Vancouver Island areas with additional coverage in the Tofino, Bella Bella/Bella Coola, Prince Rupert/Kitimat and North Western Haida Gwaii sub-regions.

Coverage maps for B.C.'s main cellular operators are available at:

- Bell Canada http://tinyurl.com/ke5yotr
- Rogers Communications http://tinyurl.com/zb29ugv
- Telus Communications http://tinyurl.com/zawsmjk
- Wind Mobile http://tinyurl.com/kgtn26k

Impact of Mobile Communications and Smartphones on Alerting

Today, Canada's fastest growing telecommunications contributor is the mobile wireless sector with over 19 million Canadians subscribing to mobile broadband services and more Canadian households now subscribing exclusively to mobile wireless services than to wireline (landline) telephone services.

Mobile communications networking, generally through the use of smartphone user devices, is rapidly becoming the primary path for Internet-based communication. Increasingly, Instant Messaging (IM) technology is replacing SMS for most text-based communication with users. Modern smartphones often have a consistent interface that does not distinguish between IM and SMS, thus providing the same level of audio and/or vibration alert to the user. IM can also function over Wi-Fi, even when a cellular signal isn't available. In contrast, with present commercial implementations, SMS only functions where the corresponding 2G (or, for satellite phone SMS, satellite coverage) signal is available, and does not function directly over present 3G (HSPA) and 4G Long Term Evolution (LTE) networks. Future LTE networks may enable SMS via use of the LTE IP Multimedia System (IMS), or via a special SMS Gateway (SMS-SG) method, neither presently in general implementation in commercial networks. It is uncertain whether or not SMS will be a major function in future mobile networks as they transition to fully IP 4G and beyond systems. Thus, it is important to consider other forms of IM as potential alerting mechanisms.

Below is a brief discussion of mobile applications used to support current tsunami notification practices, as well as an introduction to emerging next-generation mobile notification opportunities. However, it is beyond the scope of the present guide to fully explore all of the IM options, and it is hoped that future revisions will better reflect these developments.

WHY USE CELLULAR?

Advantages

Traditional Cellular

- Wide spread usage.
- Can be used indoors or outdoors.
- Can be more effective than voice service during emergencies.
- Portable and mobile.
- Many different types of devices can use these networks (older 2G and newer smart phones, modems).
- It is a technology that is familiar to people.
- Most subscribers keep devices close by.
- Relatively affordable depending upon service options.

High-speed Data

- Can largely support same applications as any fixed wireline or wireless network.
- Devices can serve as Internet gateways for other devices and applications (sensors, mobile hotspot, electronic signs, sirens, etc.).
- Coverage is being expanded along major coastal highway corridors in Southern B.C. Mainland and Eastern Vancouver Island.
- Can support a variety of Internet-based applications for pushing or pulling notifications.

Disadvantages

- During emergency events cellular voice channels are easily overloaded.
- Unlike simple 2-way radios, cell phones and mobile data devices often require connections to both local and out-of-area infrastructure to enable people to communicate with each other.
- Lack of rural and remote coverage in less populated coastal regions, both for permanent and transient populations.
- Not everyone can share the same benefits, based on affordability and inequitable network deployment.
- Most cell sites have limited backup power.

Short Messenger Service (SMS)

As mentioned above, modern Cellular networks incorporate current 3G and 4G, as well as legacy 2G services, including SMS. SMS allows users to send and receive short textual messages directly via their PCS cellular phones. SMS uses the handset keypad and menus to write, format, send and receive text. SMS messages can be sent from a PC over the Internet, from other Internet capable cellular devices and a range of portable satellite devices. SMS has been around since circa 1991 and was first widely adopted in Europe and Asia, and later in North America. Virtually all Canadian cell phones are now capable of SMS at a relatively low cost.

SMS can be a very efficient way of sending quick short (usually under 160 characters) messages. It uses a different portion of the cellular network and can be an alternative to voice communications. SMS messaging can continue to function on congested networks, although often at a slower rate of exchange. Since the post-2004 Indian Ocean tsunami, SMS has become a widely adopted method to communicate with people when there is an emergency situation. For example, during the 2010/2011 earthquakes in Christchurch, New Zealand, high traffic volumes made it extremely difficult to connect cellular voice calls, but SMS text messaging continued to operate and provided a communications means for people who understood how to use it. Both free and commercial subscription-based service SMS are available. Subscribers can pre-register and then be sent a text message giving them a warning or information concerning a potential hazard.

Many mass notification vendors have devised server systems that, upon being triggering by an event, will send out large numbers of SMS messages for delivery to mobile terminals. However, timeliness of message delivery cannot be guaranteed. SMS messages are sent separately to each individual subscriber and delivery times can be dramatically affected by the capacity of servers, the infrastructure used to link to the cellular SMS service, the cellular SMS receiving and processing capacity and the traffic loading on the cellular. Because subscription service providers can also access cellular SMS subscribers through the open public Internet, cellular network operators don't know how many such systems there are, or have a way to control how many subscribers are signed up. Therefore, there is no current method to ensure priority access for public SMS emergency messaging.

Delivery of SMS messages can also be greatly affected by distribution of messages from one carrier to another through gateways that may have limited capacity or are affected by sudden traffic spikes during special events. It is not uncommon to witness delays of several hours.

"Cell broadcasting" is another method of relaying short messages to cell phones. Cell broadcasting allows a single text message to be broadcast to all mobile handsets in a given geographical area at the same time. This area can range from the radius covered by a single cell to the entire network. Because cell broadcasting targets cell sites and all phones linked to them at the time, no pre-registration of mobile telephone numbers is required, although phones must possess this feature and it needs to be enabled. Cell broadcasting places very little loading on the network as a cell broadcast to every subscriber on the network is the same as sending an SMS message to a single phone. Cell broadcasting is not yet available in Canada, although it is in pilot test phase in various locations.

Earthquake and Tsunami Subscription-based SMS

Subscription-based SMS text systems are used by many jurisdictions and institutions to send text messages that provide alerts about hazards and other items of interest. Although these systems typically allow users to sign up for particular geographical areas of interest, the technology does not support delivery based on the recipient's current location. As opt-in systems, they reach only people who sign up for the service.

The following services have been identified as supporting earthquake and tsunami notification. ***Given the limitations discussed above, these services should be treated as informational tools and not robust warning systems.***

U.S. Geological Survey Earthquake Notification Service (ENS) - In addition to electronic mail delivery, ENS can send SMS notifications about earthquakes as an email to SMS service. The short message format contains magnitude time (UTC), date, latitude and longitude, descriptive location, an event ID and email ID. Through their ENS accounts, users can tailor their messages by selecting the geographical area of interest, and even daytime and nighttime magnitudes. Subscription instructions are available via: https://sslearthquake.usgs.gov/ens/

NTWC SMS - NTWC does not directly offer a public SMS service. However, as discussed earlier, NTWC sends out automated shortened Warning, Advisory, Watch and Information messages through its Twitter account, @NWS_NTWC.

B.C. followers can also sign up for a SMS version, simply by sending "**Follow NWS_NTWC "** to 21212 which is the shortcode mobile number supported by Bell, Rogers, Telus and Wind. Further, users do not have to have a Twitter account to use this service.

EMBC SMS - Similarly, to NTWC, EMBC does not directly offer a Public or emergency management SMS service. Instead, B.C. followers of EMBC's @EmergencyInfoBC Twitter account can also sign up for a SMS version, simply by sending "**Follow EmergencyInfoBC"** to 21212.

WHY USE SHORT MESSAGE SERVICE SYSTEMS?

Advantages

- Can target specific groups of subscribers (e.g., emergency personnel).
- Can often pass messages even when voice side of cellular service is congested.
- Can originate SMS messages from any Internet email client (phone or other mobile two-way messaging device, email program, web page, etc.).
- Can be used over other devices, including satellite phones and Satellite Emergency Notification Devices.
- Alternate way of reaching hearing impaired.
- Alternate method of receiving Twitter messages.

Disadvantages

- Not all cellular users use SMS.
- Short message length (160 characters) restricts content to short alerts with limited instruction.
- Lack of rural and remote coverage in less populated coastal regions requires use of more expensive mobile satellite options.
- Each SMS message is processed separately by the server. Messages sent between users on the same network are usually exchanged fairly quickly. Reliability of network

connections on servers will significantly affect timeliness of message delivery, especially if sender and receiver are on different networks.

- It is necessary to know the individual SMS address of each mobile that needs to be contacted. This information is not freely available and has to be obtained by subscribers 'signing up' to the service. Since the service is voluntary, it is also difficult to determine how many local area users are not signed up.
- Difficult for subscribers to differentiate between a normal SMS message and an emergency alert, possibly resulting in messages being unread.
- The location from where the subscriber signed up may not have any relationship to where the subscriber is at time of warning.
- No priority access for SMS warnings.
- No message validation. Method is not hoax proof.

Today mobile devices can communicate with the majority of IP-based services through conventional Internet connections, even when those devices are not connected to cellular infrastructures.

Emerging Smartphone Notification Methods

Modern mobile devices, plus laptop and fixed personal computers, support various forms of instant messaging (IM) protocols, the most used being the Extensible Messaging and Presence Protocol (XMPP), which is often known by the original name Jabber. Many IM systems, such as Google Hangouts, use XMPP, and other IM systems such as Skype and Facebook chat have XMPP interfaces.

XMPP can provide for one-to-one and multi-user chat, text-based messaging, including user presence signaling, but also allows for certain clients to support audio and video via the *Jingle* protocol. Users can be combined into groups for combined messaging and management. Plugins can be added for a wide range of services. XMPP allows for a wide range of clients, some integrated to Session Initiation Protocol (SIP) voice-based services.

An example is *Xabber,* a cross-platform, free, XMPP client. The client provides good presence indication and allows multiple servers to be used simultaneously, indicating which users/devices are available. The client also provides for multi-user (one-to-many and many-to-many) chat, thus allowing alert notification and other multiple-user services, and reception of control message chat.

Jitsi is an experimental but highly sophisticated client that can support many SIP and XMPP capabilities, including video and audio in XMPP, user presence, file transfer, and more, across multiple platforms. It can also support encrypted communications, secure DNS and other mission-critical requirements important for future emergency management and alerting applications. Jitsi is an open source application and can be deployed on mobile devices as well as on laptops.

Various modes of XMPP can be used for alerting. The first mode is simple one-to-one messaging. This allows a directed message to be sent to a user by an alerting user, without requiring the alerted user to have any special registration with the alerting user, apart from having an account on the system. Although this service is only one-to-one, as in conventional non-broadcast SMS, it is possible to write server application systems and corresponding apps that can use such messages to alert many users by sequential message sends.

The second mode is the creation of a chat room, in which one user can send a message to the chat room. This requires the alerted users to join the chat room, created by the alerting user. This is appropriate to small user groups, in which registration requirements, and the ability for all users to send messages, is not considered a problem, and has the benefit of providing one-to-many communications without extra infrastructure. For a larger community, or even major response team, this approach may not be appropriate, given registration requirements. However, dedicated apps can use these same protocols to build a corresponding alert system.

A third mode is an actual relayed one-to-many message mode, implemented via plug-in services on the server. In this mode, using direct one-to-one messages, a given user list receives messages from one source. For example, this can be linked to incoming email alerts, received via a wireline, satellite or cellular connection to a mail server, to ensure that an entire group of users, with no further registration requirements, receives the alerts. The test has been successful, but it is generally found that the plug-in is not stable enough. It should be noted that email is the slowest method of receiving a Tsunami alert over the Internet, and thus, without a dedicated high-speed, high-priority connection from an alerting authority, this approach would not be directly appropriate. However, other connections, such as a modified plug-in receiving data from a *Twitter* account, or via a direct call from the alerting authority, could be used as a variant of this approach.

Alerting via non-XMPP Messaging Services

XMPP is not the only method to provide Internet IM services. Major commercial messaging servers are emerging, based on both standards (such as XMPP) for internal communication, and on custom protocols, especially since mobile (smartphone) communications have become dominant. An example is the emerging Canadian messaging service *Slack* that allows for creation of complex one-to-many group communications, with various extents of alerting, and is regarded as a potential replacement for both IM and email alerting in the future.

SIP and other standard protocols also allow for IM applications, and thus, there is a wide range of options for building alerting infrastructure via modern IP-enabled techniques.

Alerting via Voice Services

Many-to-one voice services provide a method of alerting users. An example is *Zello* that integrates a traditional two-way radio Push-to-Talk (PTT) mode, and provides audio, text and image messaging on both a private (one-to-one) and group (one-to-many broadcast) communication level. All these modes can be supported and interoperate over cellular and conventional Internet networks

WHY USE SMARTPHONE APPLICATIONS?

Advantages

- Public has bought into and supports use of the technology.
- Almost always with people.
- If not silenced, can be available 24/7.
- Widely used and many applications and notification services are available at no additional cost beyond the device hardware and connection costs.
- Can incorporate almost all traditional wireline and emerging mobile services.
- Unlike earlier times, once people are alerted, there is a far greater chance that users can access detailed, and often real-time, information, via multiple methods (e.g., social media, TV and news apps, etc.) combined on their mobile devices.
- Highly adaptable to personal requirements.
- Cellular data usage charges can be offset by off-loading data exchange onto less expensive Wi-Fi Internet connections.

Disadvantages and other implications

- Always need connectivity.
- Traditional warning methods such as dialup voice telephone notification are being forced into obsolescence or marginalized as fewer telecommunications users are using voice to communicate. In fact many cellular personal devices such as tablets do not include a basic telephone function, and have to be added as a special application that may or may not be interconnected to the traditional public telephone system.
- Becoming so personalized that emergency managers may need to get citizens to inform the rest of the community, because only a small fraction (far smaller than before) may get an alert.
- May need to use sirens, electronic signs and other traditional methods to alert public and signal them to check their mobile devices for further information posted on web, Facebook, and other sites.
- Increased interdependency among notification methods and potential mass scale vulnerability from congestion or network failures during emergencies.
- Through digital convergence backhaul trucking, if there is a lack of diversity, vulnerable can be extended to all community communication services (including digital broadcast program distribution, mobile and landline phone, mobile land radio dispatch and trunking, and general Internet) that may be using the same infrastructure to connect local users within and outside their regions.
- A lot of the new media are not real-time (as in they may be on-demand or download), and thus, right now, they cannot deliver alerts (unless the user is on a device receiving alerts some other way).

ADDRESSABLE NOTIFICATION METHODS
Telecommunication Systems: Satellite

Satellite technology plays an important role in extending services to regions unreachable by traditional wireline communications services, or where the costs of providing wireline services are considered prohibitive. Broadcasters and other program providers also use satellite systems to distribute content or as backup to their land-based networks. Many cable television and terrestrial radio and TV stations use satellite feeds to obtain programming. Direct-to-home satellite TV has become an alternative method for receiving broadcasting services in both urban and rural homes, and telephone and Internet links are provided by satellite as a more affordable means for reaching the "last mile" rural and remote populations, both on land and at sea.

Coastal British Columbians, who rely mostly on satellite services for some or all of their telecommunications needs, are located in some of the most remote areas of Canada, where roads or terrestrial telecommunications transmission facilities are often non-existent. As such, fixed satellite services have become extremely important lifeline gateway services for rural and remote regions. However, parity with other more populated regions remains an issue. While the Canadian telecommunications services continue to expand rapidly in urban and accessible rural areas, in remote communities, a single incumbent telephone company usually remains as the primary service provider for traditional wireline voice services. For broadband Internet and mobile wireless services, despite the entry by alternative telecommunications services providers, Internet speeds in satellite-dependent communities still remain considerably below those available in communities served by terrestrial facilities. Similarly, mobile wireless services offered in satellite-dependent communities, if available, typically use older generation technology with lower data speeds compared to what is available elsewhere in Canada. [25] Despite these inequities, increasingly, there are many innovative ways to harness satellite services to improve coastal tsunami and other hazard warning and emergency communication.

General Characteristics

Communication satellite systems are generally available in two forms, fixed and mobile. Fixed satellite ground systems usually employ a satellite antenna focused on a satellite in a fixed geostationary orbit (GEO) around the Earth's equator. These systems typically relay television and radio broadcasting network feeds, direct-to-home broadcasting, telephone voice, fax and high-speed data services. Over the past two decades, costs for data services have decreased and government-led initiatives have enabled services such as high speed Internet to be extended to rural and remote communities.

Mobile satellite systems generally support switched voice and slower speed data communications. Two types of systems support mobile satellite services: 1. GEO satellites that communicate with mobile self-tracking end-user terminals and/or fixed antennas; 2. Low earth orbit satellite (LEO) systems that deploy global constellations of small satellites that orbit in a

[25] CRTC (2004) Satellite Inquiry Report.

grid-like formation around the world. Both GEOs and LEOs also support the use of handheld phones and other devices. An advantage of using LEO satellites, however, is that there is minimal voice delay.

Examples of GEO mobile communication system providers are Lightsquared (MSAT) and Inmarsat. LEO service providers include Iridium and Globalstar. All of these systems support access to public telephone networks and slow speed data interconnection. Iridium and Inmarsat also support SMS mobile phone text messaging.

Mobile systems offer opportunities to extend telephone warning notification to rural and remote regions, as well as to serve as vital community backup systems for voice, fax, text message and limited data communication.

All satellite terminals require clear line-of-sight paths to orbiting satellites. For many coastal areas of B.C., mountainous terrain can pose serious challenges for ensuring reliable connections. If satellite communications are to be considered for public warning purposes, proper site assessment and extensive testing should first be conducted to ensure that terminals are situated in appropriate locations. Even mobile terminals may be restricted in practical use if they are not properly tested in the most strategic locations.

Fixed Satellite Systems

Fixed satellite systems can be used for delivering broadcast and other television services as well as telecommunications services. Satellite systems used for broadcast service delivery are licensed by the CRTC as Broadcasting Distribution Undertakings (BDUs). The two nationally licensed BDUs are Bell TV (formally ExpressVu) and Shaw Direct. Both enable access to services in urban and rural/remote regions of Coastal B.C. through the use of small fixed satellite antennas on land or motorized antennas onboard vessels. With the recent mandating of BDUs to carry Alert Ready messages, it is becoming more technically possible for EMBC tsunami notifications to reach even the most remote coastal populations residing in fixed locations.

Fixed satellite systems that are used for providing telecommunications services primarily to locations in stationary remote areas can be delivered in 2 different ways. One method is via a community aggregator model in which satellite capacity (usually C-band) is relayed via satellite to and from a community ground station that, in turn, is connected to a local access distribution network, and then to individual households, businesses, and government buildings. The second approach uses a direct-to-home model through which service is delivered directly to households. In British Columbia coastal regions the direct-to-home model (using Ka-band capacity) is the primary means of providing Internet based services, including email, streaming, VoIP, RSS, etc. Two key service providers are Xplornet and Galaxy Broadband.

GEO Mobile Satellite Systems

MSAT EmergNet

MSAT, owned and operated by Lightsquared, Inc., is North America's longest running geostationary mobile satellite service, offering both a telephone and a two-way voice-radio capability (called dispatch radio). Many remote coastal fire departments use MSAT for backing up communication between local transmitters and out-of-area dispatching centres.

Of particular value to coastal community networking is MSAT's dispatch radio feature. This two-way radio feature functions much like a terrestrial trunking radio system and offers talk-groups that can be pre-configured for different groups of agencies. Because the system is satellite-based, other than requiring use of a local DC power source, it can operate without relying on local terrestrial infrastructure and can be used over vast geographic areas. In the mountainous BC coastal region this service has proven to be more reliable for acquiring and maintaining a network connection than mobile services that rely upon low earth orbit satellite services.

The main terminal technology uses a transceiver with a motorized satellite antenna that supports both stationary and mobile communication. The handsets combine both the standard satellite Public Switched Telephone Network and 'push-to-talk' two-way radio features. The antenna can be physically extended away from the base unit by using a coax extension cable. Similarly, the handset can be extended away from the base by using a category 5 Ethernet cable. Magnetic feet attached to the antenna enable easy positioning and securing them to vehicle rooftops, portable tripods with base plates and marine vessels.

In B.C., a special service package configured specifically for emergency preparedness and response agencies has been developed called "EmergNet" and is offered by Infosat Communications LP and its dealers. This service package includes two radio talk-groups (general and private one-to-one) as well as voice telephone capability. EMBC has EmergNet terminals installed at its Emergency Coordination Centre and at all of its Provincial Regional Emergency Operations Centres. A number of coastal emergency management, health and public safety agencies, including local authorities, have joined EmergNet. Agencies are encouraged to regularly test their units and EMBC has established a bi-monthly schedule (first Wednesday – daytime and third Wednesday – evening) to facilitate this. Contact your EMBC regional office for further information.

Cost

Prices for terminals range from approximately $5,000 to $6,500 depending upon added accessories. Outgoing and incoming phone calls are $.99 per minute, and a monthly access fee of about $50, plus system access fees. EmergNet two-way radio time is included in the monthly subscription. Additional fees apply for terminal activation and annual system access. Other fees apply for value added services such as voice mail, call forwarding, etc.

Inmarsat

Inmarsat is an international satellite telecommunications service provider, offering telephone and data services to users worldwide, via portable or mobile terminals that communicate with ground stations through geostationary telecommunications satellites.

Services available in B.C. coastal areas include the "BGAN" set of IP-based shared-carrier services, and IsatPhone portable and fixed phone services.

The *Broadband Global Area Network* (BGAN) is a global satellite internet network with telephony intended for use on land utilizing portable terminals. *FleetBroadband* is a maritime service based on BGAN technology and offers similar services.

BGAN terminals are normally used to connect a smart device (phone, tablet) or laptop to access broadband Internet services in remote locations. BGAN supports two-way Internet data speeds up to 492 kbit/s, telephone voice and mobile phone SMS text messaging. A key feature is that, unlike other fixed satellite Internet services that require bulky satellite dishes to connect, BGAN terminals are about the size of a laptop and can be carried easily in a backpack. They are also battery operated and can be placed in an always-on mode. Depending on terminal type, users can connect their computers and/or smart mobile devices via Bluetooth, Wi-Fi, Ethernet or USB connection(s). Many also come equipped with a regular RJ11 phone jack for making calls using an ordinary telephone handset. Most BGAN terminals can support a router or switch device so users can connect multiple computers, VOIP phones and other IP devices. Utilities and other industries are using BGAN for long term fixed location operation to support a variety of outdoor remote connection needs, including utility smart meter backhaul, weather, environmental and seismic monitoring, and alerting. Some terminals permit mobile use via a motorized satellite antenna similar to that used by MSAT.

IsatPhone Pro is Inmarsat's mobile satellite phone including SMS mobile phone text messaging, short message emailing and GPS look-up-and-send. It also supports a data service of up to 20kbit/s.

Both BGAN (voice and email) and IsatPhone (voice) are suitable for use with EMBC's Provincial Emergency Notification Service. Both can also be used to receive NTWC and EMBC tsunami notification Tweets via SMS.

Cost

Most portable BGAN terminals cost between $1,500 and $6,000 depending on class and capabilities of the supported systems. Monthly subscriptions begin around $75 per month. Data charges are expensive, and depending upon plan, begin at about $8.50 per megabyte. Outgoing phone calls are approximately $1.10/min to any landline or cellphone worldwide with free incoming calls. SMS texting is billed at approximately $0.50 per outgoing text with free incoming texts.

IsatPhones range between approximately $800 and $1,200. Monthly subscriptions are approximately $40 per month. Outgoing phone calls are approximately $1.10 per minute to any landline or cellphone and SMS messages are approximately $0.50 per outgoing text with free incoming texts.

LEO Mobile Satellite Services

Globalstar

Globalstar, Inc. (Globalstar) owns and operates a collection of 40 low earth orbit satellites whose signals cover 80% of the Earth's surface; everywhere but the extreme polar regions and some mid-ocean regions. Service offerings to more than 120 countries world-wide include public switched voice telephone, data at 9.6 kbps (express data available up to 19 kbps), and SMS mobile phone text messaging (limited to 35 characters on the basic handsets and up to 160 characters on the Sat-Fi device).

Globalstar offers a portable handset, fixed phone and Wi-Fi enabled devices and specialized modem products for data applications.

Cost

Portable phones retail beginning at around $700, with fixed units at approximately $1,500. Basic monthly service fees start at approximately $40 per month. Activation and monthly system fees also apply as do value added fees for voice mail, SMS, etc. Phone calls are approximately $1.00 per minute for both outbound and inbound.

All phone units may be appropriate for EMBC's Provincial Emergency Notification Service (voice). The Sat-Fi device could also be used to receive NTWC and EMBC tsunami notification Tweets via SMS.

Iridium

The Iridium Satellite System is owned and operated by Iridium Satellite LLC. Iridium operates its own constellation of LEO satellites (66 satellites) whose signals cover all regions of the earth (including polar). Its service offerings include public switched voice telephone, low speed data at 4.8 kbps, SMS mobile telephone (160 characters) and text-to-email services.

Cost

Iridium's range of hardware includes fixed and handheld/portable satellite phone units. Prices for phones range from approximately $1,350 for handhelds to $1,400 for Wi-Fi connected versions to $3,700 for fixed units. Monthly subscription fees are $40 for phones, plus activation and system access fees. Other charges apply for voice mail and other value added services. SMS messages are $.60 each and voice airtime charges range from $1.99 to $1.19 per minute, depending upon rate plan.

A more recent development is the use of Iridium to support Satellite Emergency Notification Devices discussed below.

Satellite-based Emergency Notification Devices

One of the most significant West Coast communication challenges is notifying populations on-the-move both on land and water. Currently, there is no ubiquitous means of reaching transient populations. Even where two-way radio (marine, commercial and public safety) and mobile satellite communication systems are employed, access to and reliability of service are significantly influenced by line-of- sight coverage issues due to mountainous terrain and other obstructions.

Notwithstanding these challenges, over the past decade a number of mobile satellite systems and services have emerged that may help to expand mobile notification. These include Short Message System (SMS) enabled mobile satellite phones, mobile IP based satellite devices and two-way Satellite Emergency Notification Devices (SENDs). These devices operate on different platforms employing both low earth and geostationary orbital satellite systems and support various forms of messaging.

Examples include: Iridium-based SEND devices such as inReach (SMS/short message), Iridium Go (SMS/email/voice), Iridium satellite phone (SMS/voice) and Inmarsat iSATPhone (SMS/voice). Many of these devices can be paired with mobile smartphones, PCs and tablets. Each supports its own mobile handset devices to provide short messaging and GPS tracking, but through different software applications and user features. They are all commercially available and, in particular, the inReach devices are now widely sold through outdoor, sporting and electronics outlets, and are increasingly being used to support a wide variety of recreational and outdoor work safe activities.

For mobile two-way messaging purposes, all of these devices support SMS and short email-based text messaging. The inReach, however, generally requires the device user to initiate the connection and outbound messages are sent immediately if there is available GPS and Iridium reception. When there is poor satellite signal coverage, users may be prompted to wait until reception is satisfactory or try to send anyway. Depending upon signal conditions, messaging can be delayed for significant periods. Replies to inReach messages can be sent back to inReach devices directly from cellphones if they are SMS messages. Messages sent to devices are first stored on the inReach server and the next time the inReach device connects to it via the Iridium satellite network, the device will receive the reply.

Consequently, external messages and notifications usually are not delivered in real-time but, rather, are more often stored and forwarded. A function called the “Listen Interval” enables this reconnection period to be set from a range of 20 minutes to continuous. Unless set to “Continuous”, important messages will not be pushed on-demand to the devices, but only delivered when the device has successfully reconnected. Line-of-sight visibility with orbiting satellites, of course, also significantly affects connectivity and timeliness of messaging, as does any latency on the connected networks.

Further, network addresses are not permanently assigned to inReach devices and may expire when devices have not been used regularly or have been turned off for a while. These addresses can be reassigned to other inReach devices in the meantime. This makes it difficult to push SMS notifications to the devices, especially from a mobile phone or automated SMS server, such as Twitter-to-SMS. However, messages can always be sent manually to devices via a web portal which can manage messaging to single or multiple devices but, again, the Listen Interval will affect delivery times.

Although these features reduce the capabilities for mass instant notification, the service can still be useful for smaller inter-organizational or intra-organizational purposes and support a variety of users such as outdoor recreationalists, search and rescue, CCG, emergency management, and parks staff and others working alone or travelling in areas with no other established communications means.

Similar to inReach, Iridium and Iridium satellite phones also support SMS messaging, but use a different satellite connection method. They use a circuit-based approach in which the phones, when in view of the satellites, can be continuously registered on the network, making them potentially more suitable for instant-type messaging. In this regard, users can pre-register their telephone numbers to receive regular cellular telephone SMS feeds, especially for tsunami Tweet-to-SMS notifications from NTWC and Emergency Info BC. Instructions are as follows:

@NWS_NTWC

Iridium followers can sign up for a SMS version, simply by sending "**Follow NWS_NTWC "** to 40404

Inmarsat followers can sign up for a SMS version, simply by sending "**Follow NWS_NTWC "** to 898

@EmergencyinfoBC

Iridium followers can also sign up for a SMS version, simply by sending "**Follow @EmergencyinfoBC**" to 40404

I**nmarsat** followers can sign up for a SMS version, simply by sending "**Follow @EmergencyinfoBC**" to 898

WHY USE A SATELLITE SYSTEM?

Advantages

General

- Can be operated independently of local terrestrial communications infrastructure.
- Only wide area technology that is available everywhere and at the same cost, as long as the user is within the signal beam (footprint) of the satellite and has a clear line-of-sight view to orbiting satellite.

- Satellite's inherent strength is point to multipoint transmission of data, video or audio.
- Satellites can simultaneously broadcast information to virtually an unlimited number of receivers within their footprints at high speeds.
- Satellite terminals can be interconnected to terrestrial community networks to enable sharing of inbound and outbound satellite links.
- Satellite networks can be deployed in locations relatively quickly because of their wireless nature and minimal need for local infrastructure support (mostly electricity).

Mobile

- Fast deployment and installation.
- Doesn't require a trained technician to install or operate.
- Enables access to telephone voice and short messaging beyond mobile cellular coverage.
- Lightweight.

Disadvantages

General

- Fixed broadband systems require a trained technician to install.
- Fixed satellite dishes can be easily thrown out of alignment by earthquakes and aftershocks requiring technicians to realign each time unless antenna is automated and self-aligning model (more expensive).
- Fixed broadband systems requires reliable AC electricity to operate
- Require clear line-of-sight with satellite to operate.

Mobile

- Devices without external antenna options generally can only be used outdoors.
- Limited data communication capacity.
- Limited SMS text length makes it difficult to provide remote users with sufficient warning information if this is their only source.
- Installation and configuration of some devices and associated smartphone interface apps can be complex.
- Poor clear line-of-sight with satellite will result in loss of service and/or significant delays in reception of warning and other messages.
- Poor placement of device when carrying on-person (e.g., inside a packsack) can significantly affect performance.
- Interconnection charges between satellite service providers and with terrestrial telephone providers (especially for voice calls) vary significantly and should be identified in advance of using satellite devices. These charges should be available from all providers.

3.4 ADDRESSABLE NOTIFICATION METHODS

3.4.3 PERSONAL SYSTEMS

Door-to-Door
Residential Route-warning
Canada Post

ADDRESSABLE NOTIFICATION METHODS
Personal Systems: Door-to-Door

Personal notification uses emergency personnel or trained volunteers to go door-to-door or to groups of people to deliver a personalized warning message. Personal contact has an advantage in that people may be more willing to respond to a warning especially when given by people who are already known throughout the area. Local knowledge is also important to ensure no-one is missed, especially in areas where other means of warning are lacking and door-to-door warning may be the only working option. A disadvantage is that it is time consuming and may require the commitment of many vehicles, boats and on-foot personnel.

SYSTEM SELECTION AND IMPLEMENTATION CONSIDERATIONS

The Door-to-Door method of warning people is very useful but there are important factors to be considered when deciding whether or not to choose this method:

- **Notification time and safety** - Door-knocking may need to be carried out if radical action, including evacuation, is necessary and if time permits. Because the safety of the door-knockers and the population that needs to be evacuated are at risk, door-knocking should only be used when there is enough time and personnel available, and when it is safe to do so.
- **What message to deliver -** Door-knockers should deliver printed material giving advice on what to do immediately. The message should include information on evacuation routes and evacuation centres, should specify what people should do before leaving home and what they should take with them. It is important that the information is clear and concise.
- **Size and geographic locations of population to be notified** - If the number of people to be contacted is ***small*** and the door-knocking can be planned before tsunami flooding begins, locally trained volunteers may be used. Volunteers need to be recruited and trained by a response agency and should be known to the residents. In a number of communities, local search and rescue teams are used. Within some communities, trained block watch coordinators may be able to perform such a task.

Where the population to be personally notified is ***large or spread out over large areas*, ** trained emergency service personnel are likely to be required to carry out the task. In these instances the number of doorknockers required may be many and much planning will be necessary.

- **Commercial and industrial zones** - For commercial properties, trained door-knockers might include local Chamber of Commerce officials or managers of industrial estates who can pass warnings by door-knock or telephone ‘cascade’ to shopkeepers, hotels and managers of industrial premises in at-risk areas.

- **Time needed to implement method** - Planning needs to take into consideration how long it will take to assemble and brief the door-knockers, how long it will take to door-knock each building and how long each door-knocker can safely remain in an at-risk area. Experience suggests that it takes at least four-to-six minutes to door-knock at each house. Using two person teams, ten teams (20 personnel) plus control personnel will be required to door-knock approximately 100 homes in one hour. This rate can vary considerably, depending upon the time of day (e.g., weekday – people may be at work or late at night – people first need to be woken), how far apart properties are situated and how they can be reached (e.g., rural back road, paths or by water).

WHY USE DOOR-TO-DOOR?

Advantages

- High degree of credibility.
- Provides all necessary information and instructions.
- Very strategic notification.
- Can reach all people at home or at a specific location.
- One of the few methods to ensure everyone at location has been notified and understands what actions need to be taken.
- Cost effective if using trained volunteers.
- Can verify who has received the notification.

Disadvantages

- Very time consuming and slow.
- Requires recruiting and training large numbers of personnel who could be used possibly for other valuable purposes.
- May require a large amount of logistics support (cars, boats and other transportation, accurate maps and route information, etc.).
- Requires timely coordination.
- Unable to reach a very wide area quickly.
- Expensive in terms of labor costs, if using paid personnel.
- Can place personnel delivering messages at-risk.

ADDRESSABLE NOTIFICATION METHODS
Personal Systems: Residential Route-warning

Residential route warning can be a very efficient warning method, especially in densely populated areas and much faster than door-to-door warning. It can also be effective where there are not enough people or there is not enough time to carry out door-to-door notification.

General Characteristics

The common features of these systems are that they are mobile and usually found on some type of vehicle or boat. The entire system is easy to install and is comprised of a controller, an amplifier, a microphone and a siren speaker. Systems can permit users a hands-free operation, cycling through two or three siren tones or giving public address (PA) repeats. There is a PA over-ride in all functions.

System Selection and Implementation Considerations

The Residential Route Warning method is very useful but there are some considerations which need to be included when deciding to choose this method:

- **Range of warning** - It is important to note the type of PA system being used and its capacity. Standard range of typical vehicle PA systems is about 300 metres. The vehicle needs to stop about every 600 metres, and the message has to be re-read or re-played, or the vehicle should be traveling slowly enough for people within the vicinity to hear the entire message.
- **Type of message** - To cover a large area within a timely period, messages should be kept short and may require instructing people to turn to another source for further instructions. If there is a time constraint, the main message should be to indicate evacuation routes and centres.
- **Size and geographical locations of population to be notified** - This method is useful where the population is either dense or spread out. Pre-planning these routes is recommended but it is important to remember that routes may be destroyed or blocked if a hazard has already occurred.
- **Personnel and resources needed** -This method is reliant on vehicles having a mobile public address system and will also require personnel to run this system.
- **Sirens only -** Police, fire and other agencies may use vehicles and marine craft equipped with sirens to notify nearby area populations. Most individuals recognize these types of sirens as an isolated emergency signal. The public may not respond appropriately to such a signal without receiving further information. There should be another source for further instructions regarding what actions to take.

Costs

The entire system is relatively inexpensive, ranging from $1,500 to $2,000 per unit.

WHY USE RESIDENTIAL ROUTE WARNING?

Advantages

- System is more time efficient compared to door-to-door system.
- Highly credible if emergency vehicles are used.
- Can be moved from area to area quickly.
- Can target notification (e.g., warn specific homes or streets affected).
- Can reach people indoors if loud enough.
- Messages can be changed easily and repeated.
- Easy to install and on many different types of vehicles.
- Can have hands-free operation.
- Usually already installed on police cars, fire trucks and ambulances.
- Cost-effective for large areas such as public beaches and parks.

Disadvantages

- Only good if vehicles/personnel available.
- Could place emergency personnel in danger during the event.
- Road damage and traffic jams can hinder vehicles from entering or leaving.
- Limited in area covered – sound heard within less than a ½ km radius.
- May not work well in some areas, including rural areas where residences are some distance from the road ,or for penetrating large buildings with few external windows.
- Limitations of loud speaker systems are often demonstrated when people go to their front doors to ascertain the nature of the noise only to find that the vehicle has disappeared and are only able to hear bits of what is now being broadcast elsewhere.
- May require a large amount of logistics support (cars, boats and other transportation, accurate maps and route information, etc.).
- Difficult to confirm who has received and understood notification.

ADDRESSABLE NOTIFICATION METHODS
Personal Systems: Canada Post

Most people probably don't realize it, but Canada Post has the capacity to play a support role in post-disaster relief.

With advance planning, Canada Post's experience with message delivery could be an asset to community warning, especially for getting educational and awareness materials to residences and businesses before events occur and helping communities plan routes for door-to-door notification and route alerting during events. To target specific populations within a specific geographical area, Canada Post's Householder Counts and Maps provide information on the counts of houses, apartments, farms and businesses throughout Canada, along with associated Forward Sortation Area (FSA) and Letter Carrier Walk (LCW) maps.

Householder count information is updated monthly on Canada Post's web site (http://www.canadapost.ca/cpc2/addrm/hh/default-e.asp) and changes to householder counts are frequently updated (available on its Householder Count Page).

Canada Post and Disaster Relief

Canada Post's service obligations extend to delivering mail in cases of disaster. During relief and recovery phases, Canada Post can provide alternate mail delivery to individuals who were temporarily displaced from their residences. The same holds for public and commercial organizations.

In case of disaster, and when other emergency response resources are unavailable, Canada Post vehicles and drivers could assist communities to aid in recovery. Emergency authorities should check with their local post offices for further information.

APPENDIX A

Emergency Management British Columbia Offices

South West Region 14292 Green Timbers Way Surrey, B.C. V3T 0J4 Tel: 604 586-4390 Fax: 604 586-4334	**Central Region** 1255-D Dalhousie Drive Kamloops, B.C. V2C 5Z5 Tel: 250 371-5240 Fax: 250 371-5246
South East Region 403 Vernon Street Nelson, B.C. V1L 4E6 Tel: 250 354-5904 Fax: 250 354-6561	**North East Region** 3235 Westwood Drive Prince George, B.C. V2N 1S4 Tel: 250 612-4172 Fax: 250 612-4171
North West Region Suite 1B - 3215 Eby Street Terrace, B.C. V8G 2X8 Tel: 250 615-4800 Fax: 250 615-4817	**Vancouver Island Region** Block A - Suite 200 2261 Keating Cross Road Saanichton B.C. V8M 2A5 Tel: 250 952–5848 Fax: 250 952-4304
Headquarters Block A - Suite 200 2261 Keating Cross Road Saanichton B.C. V8M 2A5 Tel: 250 952-4913 Fax: 250 952-4888	

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