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INVENTORY OF CRITICAL AND ESSENTIAL FACILITIES VULNERABLE TO EARTHQUAKE OR TSUNAMI HAZARDS ON THE OREGON COAST

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DISCLAIMER

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EXECUTIVE SUMMARY

Scientific discoveries of the last several years strongly suggest that the Oregon coast will some day experience a magnitude 8 to 9 undersea earthquake and accompanying large tsunami. The coast will be shaken severely and then, about 5 to 30 minutes later, a series of large tsunami waves will strike. The Oregon Department of Geology and Mineral Industries (DOGAMI) has completed this study to get a gross estimate of how many of the critical and essential facilities such as schools, hospitals, and fire stations on the Oregon coast are vulnerable to this catastrophic event. These facilities are particularly important because they are the centers for emergency response and recovery.

Owing to limitations of time and funding, the study was based on rapid reconnaissance techniques conducted over a six month period and covering 47 communities on shorelines within about 9 miles of the open coast. The results are therefore intended only as a general guide to potential problems that need further, more definitive study. The vulnerability of structures to severe damage from earthquake shaking was estimated using a standard rapid screening technique developed by the Applied Technology Council. There is no recognized standard reconnaissance technique for estimating tsunami flooding hazard in areas without a long historical record of tsunamis, so a very crude method was developed which predicts a theoretical open coastal run-up elevation that is assumed to extend inland at that same height through each study area. This technique probably exaggerates the tsunami run-up in communities like Tillamook and Reedsport that are far enough inland for any open coastal tsunami wave to decrease in height as it attenuates up estuaries and spreads out into bays. Future studies will combine complex numerical modeling of the waves and detailed field mapping of tsunami sediment deposits to more accurately estimate potential tsunami inundation and run-up. DOGAMI is pursuing a pilot study of this kind in the Lincoln City-Siletz Bay area.

Even as crude as this reconnaissance study is, it is apparent that over half of the critical and essential facilities on the coast could possibly be vulnerable to collapse during shaking. This is particularly worrisome with respect to schools. Should a great earthquake occur during class time, children in as many as 64 of the 117 schools might find themselves in collapsing buildings. When the additional hazard of tsunami inundation is added to the earthquake threat, 86 of the 117 schools (74 percent) may be vulnerable. With possibly 10 of the 13 hospitals (84 percent) potentially vulnerable to collapse or tsunami flooding, treatment of the seriously injured may well be impossible in most areas. An entire generation of children in many communities could be at risk. Similar statistics apply to the other facilities studied: fire and police stations, major public assembly structures, hazardous sites, communication centers, emergency preparedness centers, and emergency vehicle shelters. In many of the smallest communities with limited critical facilities, all of their emergency response resources could be vulnerable to the combined earthquake and tsunami hazard. This is true of even some larger communities like Seaside which lie almost entirely in low lying areas potentially vulnerable to tsunami flooding.

The bad news is that the Oregon coast is at present poorly prepared for a great undersea earthquake. The majority of public facilities appear to be constructed of materials such as unreinforced masonry that can be subject to severe damage, even collapse, when shaken. In most communities tsunami flooding and evacuation problems from local earthquakes have not influenced the siting of schools and other essential facilities.

The good news is that current estimates of the likelihood of a great earthquake and locally generated tsunami are on the order of 10-20 percent in the next 50 years. This means that there is an 80 to 90 percent chance that we have those fifty years to prepare by planning our emergency response, retrofitting of some structures, constructing new facilities to resist collapse, and siting them away from zones of dangerous soil and potential tsunami flooding. A thoughtful program of education and detailed mapping of earthquake and tsunami hazard zones will provide the most cost effective means of mitigation. DOGAMI, in cooperation with other state, federal, and local agencies is coordinating this effort state wide.

INVENTORY OF CRITICAL AND ESSENTIAL FACILITIES VULNERABLE TO EARTHQUAKE OR TSUNAMI HAZARDS ON THE OREGON COAST

1.0 INTRODUCTION

Scientific findings of the last several years have shown that the Oregon coast is vulnerable to shaking and tsunami flooding from great (M 8-9) undersea earthquakes that can occur on the Cascadia subduction zone fault system (see Madin, 1992, for a summary). The chance in the next 50 years of a great subduction zone earthquake is between 10 and 20 percent (Adams, 1990; Peterson and Darienzo, 1991). The Oregon Department of Geology and Mineral Industries (DOGAMI) is assessing the current level of vulnerability of the coastal population to these hazards. The investigation presented here is a very preliminary assessment of the vulnerability of critical and essential facilities to ground shaking and tsunami inundation. The results will help to evaluate the state of preparedness and to set priorities for hazard mitigation efforts.

The study is not a definitive assessment of the level of seismic or tsunami risk for the coastal region as a whole or of individual facilities. The time and resources available necessarily limited the scope of work to a reconnaissance level that is completely inappropriate for site specific decisions. These preliminary results can only be used to help direct further, more definitive assessments.

The scope of the study was limited geographically to 47 towns and cities located along shorelines within about 9 miles of the open coast (see Appendix C, Table C-1, for complete list of municipalities). The municipal boundaries of each such city or town defined the extent of the individual study areas. Nearby inland municipalities, while vulnerable to ground shaking, are not at risk from tsunami inundation and so were not included.

The study was limited with respect to the structures investigated. It includes only those facilities which house emergency management and response agencies, public and larger private schools, day care establishments, and industrial sites with hazardous materials.

Finally, the scope of the investigation was limited with respect to the hazards investigated. Only tsunami flooding and the structural vulnerability of buildings to shaking were investigated. Other earthquake hazards such as liquefaction, slope instability, subsidence, and fire were not considered.

2.0 PROJECT OBJECTIVES

1. Identification of critical and essential facilities.
2. Preliminary assessment of the vulnerability of each facility's buildings to ground shaking.
3. Preliminary assessment of the vulnerability of facilities to tsunami flooding.
4. Preliminary assessment of the vulnerability of these facilities to the combined effects of ground shaking and tsunami flooding.

3.0 METHODOLOGY

The definition of critical and essential facilities used in this study follows closely the definitions found in the Uniform Building Code (Table 23-K, 1991) and Oregon Revised Statutes (ORS 455.447, 1993). Briefly, facilities such as schools, hospitals, fire and police stations, and emergency vehicle shelters were the primary focus of the study. Appendix A gives a full description of the types of facilities included in the survey. Appendix C lists all cities studied.

3.1 Earthquake Vulnerability

The structural assessment of a facility's buildings is based on the Applied Technology Council's (ATC) "ATC-21, Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook" (Applied Technology Council, 1988a). This methodology provides a rational basis for rapidly assessing the likelihood of a building sustaining severe damage during a major earthquake. A copy of the inspection form and a full description of the method are given in Appendices B and D

Using the ATC guideline (p. VI, Applied Technology Council, 1988a), a building was listed as at risk and in need of more detailed evaluation if it had an ATC structural score of 2 or less. This score translates to a 1 percent or more chance of sustaining major life-threatening structural damage. Life-threatening damage is defined as a potential loss of 60 percent or more of the total value of the structure during an earthquake.

3.2 Tsunami Vulnerability

There is no generally accepted standard procedure for rapid screening for tsunami hazards in areas without an extensive historical record of tsunami flooding. The current historical record is limited to distant tsunamis. On average, distant earthquakes will produce maximum 100-year and 500-year tsunami flooding elevations in Oregon below 15 ft (typically 6-10 ft) and 26 ft (typically 12-16 ft), respectively (Houston and Garcia, 1978). Appendix C, Table C-1, lists estimated 100-year and 500-year flooding elevations at all municipalities studied here.

The 1964 Alaskan tsunami probably approximated a 500-year distant event. Nine Oregon observation sites had recorded maximum flooding elevations at the open coast of 7-14 ft (typically 10-12 ft) above mean high water (Schatz and others, 1964). This corresponds to maximum flooding elevations above mean sea level of about 10-17 ft (typically 13-15 ft). An example is Seaside where the first wave arrived at about mean high water, flooding up to about 18 ft above mean sea level on the open coast and about 12 ft in the lower parts of the estuaries (Tom Horning, 1995, personal communication). While there was damage on the Oregon coast from this event, very few critical or essential facilities were in the flooding zone.

Compared to distant tsunamis, flooding from locally generated tsunamis will be much worse, but essentially all of these events occurred before written records in Oregon. They are only known through study of poorly preserved tsunami deposits and, in the case of the last tsunami, from Japanese harbor records which apparently recorded the 1700 AD event (Satake and others, 1995; see Kerr, 1995, for discussion). Satake and others (1995) estimated that this Cascadia earthquake could have been as large as magnitude 9. In the Pacific Basin magnitude 8-9 earthquakes like those thought to occur on the Cascadia subduction zone are capable of producing tsunamis with maximum run-up heights on the order of 6-100 ft (mean of about 28 ± 22 ft)[1] near the epicenters, depending on local factors (Lockridge and Smith, 1984). The 1993 Hokkaido Nansei-Oki earthquake demonstrated that even a magnitude 7.8 event can produce run-up heights on the order of 15 to 100 ft (typically 20-60 ft) in areas 30-50 miles from the epicenter (Bernard and Gonzales, 1993; run-up surveys of the Hokkaido event by G. R. Priest, A. M. Baptista, and Y. Tanioka, 1993). If the earthquake rupture is slow (so called "slow" earthquakes), like in the 1992 Nicaraguan event, then a magnitude 7 (surface wave magnitude) or 7.6 (moment magnitude) event can produce tsunamis up to 30 ft high (typically 17-22 ft) on nearby shorelines (Baptista and others, 1993). In order to gain a sense of the tsunami threat, an ad hoc technique was developed that could be applied rapidly and uniformly to each study area. The results are meant to set priorities for more detailed studies.

For the purposes of this reconnaissance study, a large local undersea earthquake was assumed to be the source of the scenario tsunami. A facility was considered to be potentially vulnerable to tsunami inundation if it sat below a predicted tsunami run-up elevation. Rigorous numerical modeling of each area for tsunami flooding is beyond the scope of this study, so a crude approximation of the inundation was used. Wave height at the open coastal shoreline was estimated from an interim numerical model provided by the Oregon Graduate Institute of Science and Technology (OGI) based on a scenario undersea earthquake of magnitude 8.8 with rupture zone extending along the Cascadia subduction zone from southern Washington to northern California (see Myers, 1994, for a detailed description of the numerical technique).

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[1] This mean was calculated from the maximum run-up elevations listed in the table of Lockridge and Smith (1984) for each of the thrust-type magnitude 8-9 earthquakes that occurred on subduction zone fault systems of the Pacific Basin. This is the faulting thought to occur on the Cascadia subduction zone. Since the type of fault mechanism was not listed in Lockridge and Smith (1984), a judgement was made regarding a thrust-type subduction zone source based on the regional geology of the area and the tsunami height If a negligible near-field tsunami was generated, it is unlikely to be a thrust mechanism. Where a range was listed, the highest value was used. The ±22 ft error is the one sigma error (68 percent confidence), assuming a normal Guassian probability distribution.

This regional model, while reasonably sophisticated, is still being modified as part of an ongoing Oregon State University Sea Grant investigation; hence, the interim status. The wave heights predicted by OGI are not significantly different from those predicted by the Alaska Tsunami Warning Center (Whitmore, 1993; 1994) for essentially the same scenario earthquake.

The regional wave height model does not provide run-up heights or inundation, so the model does not predict how high or how far inland the waves get as they wash up over beach slopes onto dry land. Rather, the model assumes that the wave hits a vertical wall and reflects off of it. Run-up elevation was estimated by multiplying this open coastal tsunami wave height by 2 and adding the height of the mean higher high tide (about 4 ft above mean sea level). U. S. Geological Survey (USGS) 7.5 minute topographic maps were then utilized to map inundation, assumed to be all terrain below the run-up elevation. Doubling of the wave height was done to help compensate for the observed tendency of numerically modeled wave height at the open coast to be too low by a factor of 2 from field surveyed run-up elevations (Imamura and others, 1994). In some cases the nearest modeled wave height was used where there was no model data exactly at the site. Estimated run-up elevations for all studied municipalities are given in Appendix C, Table C-1. The 47 run-up elevations ranged from 12 to 53 ft, averaging 33±10 ft (error range at 68 percent confidence), so they are reasonable with respect to the world wide data discussed above.

As explained below, run-up heights for some inland estuaries and bays are probably overestimated by this technique, but available time and resources prevented a more detailed inundation analysis. In order to address these inaccuracies, detailed inundation and wave height studies are in progress for a pilot hazard mapping project being conducted by DOGAMI in the Siletz Bay-Lincoln City area. Likewise, preliminary inundation and run-up studies have been done for Seaside and Cannon Beach by a local citizen's group. While valuable, the Seaside and Cannon Beach studies use a method different from that used for Siletz Bay and for this project. To produce some uniformity of the data, the crude method described above has been applied to all areas, including Siletz Bay, Seaside, and Cannon Beach.

3.3 Data Collection

The assessment was conducted by visiting each site where a critical or essential facility was identified. A brief structural assessment of the buildings at the site was made in accordance with the ATC visual inspection procedure described in Appendix B. Data on the terrain (e.g. elevation) immediately surrounding the facility was also collected for the tsunami portion of the database. Visits lasted between 5 and 30 minutes, depending on the number, size and complexity of the buildings located on the site. The inspection procedure is described in detail in Appendix D.

3.4 Data Presentation

The data collected are presented in the accompanying digital database. The database provides the name, address, type of facility, and the results of the structural and tsunami flooding assessment. The database fields are described in Appendix E. The data are also summarized below in bar graphs and narratives.

4.0 LIMITATIONS OF THE DATA

When using the data presented in this report, the superficiality of the structural inspection, the short time available to search for facilities in each area, and the great uncertainty in the tsunami inundation estimate should be kept firmly in mind. As such, the results presented here, while useful at a reconnaissance level, should be used only as a guide for further, more concrete studies.

4.1 Facility Selection

The facilities included in this report probably omit many fitting the criteria for inclusion. In particular, private schools and day care centers are difficult to identify and locate. Emergency power generating facilities as well as command and communication centers are challenging to inventory, because they change periodically, and many different agencies have these capabilities. Emergency vehicles may be parked at a variety of locations, and all possible storage sites are almost surely not accounted for here. Emergency vehicles not owned by fire departments, private ambulance companies and hospitals (e.g., fire fighting equipment owned by the U. S. Forest Service) are not well accounted for in this study. Every effort was made to find all facilities within the scope of the study given the limited time and resources, and no facility was intentionally ignored.

4.2 The Applied Technology Council (ATC) Survey

The ATC survey methodology is intended to screen buildings for a later detailed evaluation of their risk of collapse during a major earthquake. It is not possible to make an authoritative statement about a building's structural integrity based solely on a visual inspection. The condition of the load bearing members, in particular the lateral support system, the quality of the connections, and the presence and extent of steel reinforcement in masonry and concrete are just examples of important pieces of information not available during a visual inspection of the exterior. The procedure was developed in California. Applicability to the Oregon coast is questionable, because the analysis anticipates earthquakes which may be weaker than great earthquakes on the Cascadia subduction zone fault system. The result of the structural portion of the survey therefore only provides an indication of relative risk.

It should also be noted that the survey procedure is designed only to identify buildings at risk of collapse. The serviceability of a structure in the aftermath of an earthquake, while related to its structural condition, is not addressed.

4.3 Map Coordinate Data

Location data for facilities is based on standard USGS 7.5-minute topographic maps. For longitude and latitude, these maps are referenced to the 1927 North American Datum. Longitude, latitude, and distance from water bodies is accurate to within 100 ft. The elevations are referenced to the National Geodetic Vertical Datum of 1929. The elevation of a particular location is often difficult to determine from these maps. Contour lines are generally drawn at 40-foot intervals, so the elevation data is accurate only to 40 ft.

4.4 Tsunami Modeling

Numerical modeling of tsunami run-up height and inundation in bays, estuaries, and beaches is very complex, requiring detailed data on terrain elevation, water depth, wave height at the open shore, and the extent of coseismic subsidence. Wave height depends on a detailed knowledge of the causative earthquake, particularly the exact shape of the sea floor deformation, including any submarine landslides. Also needed is a highly detailed digital map of the shape of the seafloor and terrain to be flooded. None of these things were known with precision for this reconnaissance study. In fact, even with all of these factors at hand, a detailed numerical model for flooding at each bay would have to be run utilizing specialized software different from that used for regional wave height modeling. This was completely beyond the scope of this study. Therefore, the estimated run-up height and inundation is only a very preliminary estimate based on the regional wave height model explained above.

It is possible that a facility that is located near the open coast and listed as invulnerable in this report may be found to be vulnerable owing to errors in the predicted wave height and the crude elevation data available from topographic maps. In fact, it is well known that local effects such as submarine landslides and "V"-shaped valleys can amplify wave height by factors of 2 or 3. According to field observations of coseismically buried prehistoric soils (Darienzo, 1991; Darienzo and others, 1993, 1994; Darienzo and Peterson, 1990; Gallaway and others, 1992; Peterson and Darienzo, 1989, 1991; Peterson and Priest, 1995; Peterson and others, 1991), coseismic subsidence, particularly on the northern Oregon coast and in local structures of the south coast, can be up to 5 ft, whereas the regional numerical model generally predicted much lower values of subsidence. This factor will increase wave height above that predicted by the regional model.

It is certain that the crude constant elevation model used here may overestimate inundation and run-up height for inland areas such as Tillamook, Toledo, and Reedsport. Run-up height generally decreases inland for most tsunamis, owing to normal dissipation of their energy with distance traveled. Therefore, an inland facility listed as vulnerable to a tsunami in this report may be found not to be vulnerable once a detailed inundation study is done. This is amply demonstrated by preliminary results of detailed inundation mapping at Siletz Bay where DOGAMI, OGI, and Portland State University are collaborating on a detailed study. In addition to the normal decrease of run-up with distance, the height is dramatically attenuated by Siletz Spit, especially for scenario tsunamis that overtop only part of the barrier spit. Jetties and other barriers at the mouths of most of the port cities will have similar dramatic effects on tsunami wave propagation. Two barrier-guarded bays deserve more discussion, since they contain highly developed areas that influence significantly the estimates of tsunami vulnerability for the respective counties.

The city of Reedsport, which contains most of the facilities identified as vulnerable to tsunami flooding in Douglas County, lies 9 miles up the Umpqua River. The Umpqua River estuary and the associated man made and natural barriers can be expected to significantly attenuate tsunami waves. For example, the 1964 tsunami wave was 14 ft high at the open coast but negligible at Reedsport (Schatz and others, 1964). Sands possibly deposited by larger prehistoric tsunamis in the Umpqua River basin have been found as much as 14 miles up-river from the coast (Briggs, 1994). However, these sands were located at low elevations in marshes fringing the estuary and do not prove that significantly high waves flooded the area. These prehistoric sands were also deposited before the extensive man made barriers were constructed at the mouth of the estuary.

Likewise, the City of Tillamook contains the majority of the critical and essential facilities identified as vulnerable to tsunami flooding in Tillamook County. Tillamook has a low elevation but is located several kilometers inland behind Tillamook Bay. Tillamook Bay and the barrier system guarding the bay will very significantly attenuate a tsunami before it reaches the City (Whitmore, 1994). The 1964 Alaskan tsunami, although 10 ft high at the open coast, was negligible at Tillamook (Schatz and others, 1964).

5.0 DATABASE SUMMARY

The data for each county and the entire coastal area of the state are summarized in the text, as well as in the tables and figures below. For convenience, all bar graphs and tables are together immediately after this section. A narrative for each county follows the tables and figures. For each geographic entity the following information is given:

1. The total number of each type of facility.
2. The number of facilities at risk of sustaining major damage from ground shaking.
3. The number of facilities at risk from tsunami flooding.
4. The total number at risk from either ground shaking or tsunami flooding.

Totals of facilities from the entire coast are presented first (Table 1; Figure 1), followed by totals for each county, presented alphabetically (Tables 2-8; Figures 2-8). Data includes only the studied incorporated and unincorporated municipalities.

Data for each incorporated and unincorporated municipality are listed alphabetically by the name of the municipality in Tables 9 through 54 and in the multi-page Figure 9. Detailed structural and tsunami survey data for each facility are given in the digital database arranged in separate files corresponding to each county.

Many facilities studied in this survey serve two or more purposes. A city hall may be a town's fire and police station, or a county courthouse may serve as the sheriff's office, 911 dispatch center, and emergency preparedness office. In these cases, the building is listed only under its primary or most prevalent use. This is done to avoid the confusion of listing the same building many times. All known uses for each facility are indicated in the database.

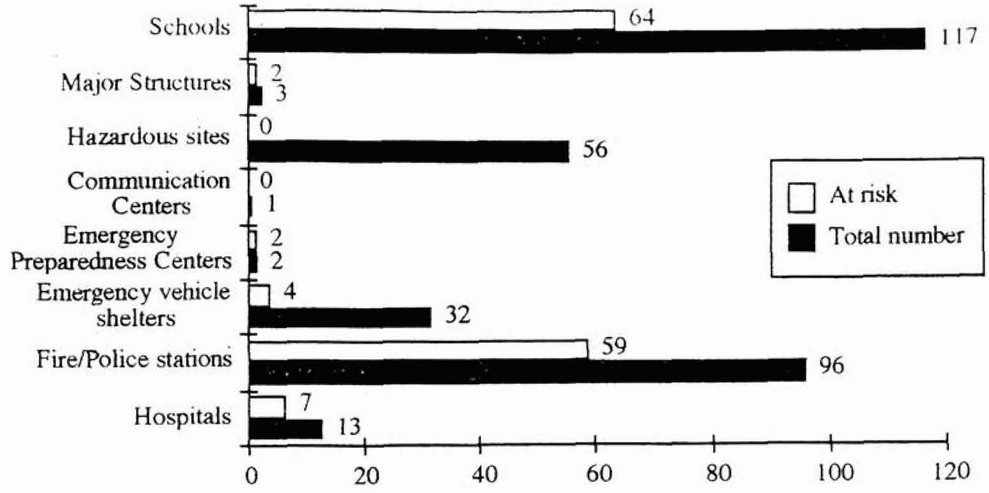


Figure 1a. Summary of critical and essential facilities at risk from ground shaking in coastal areas of Oregon.

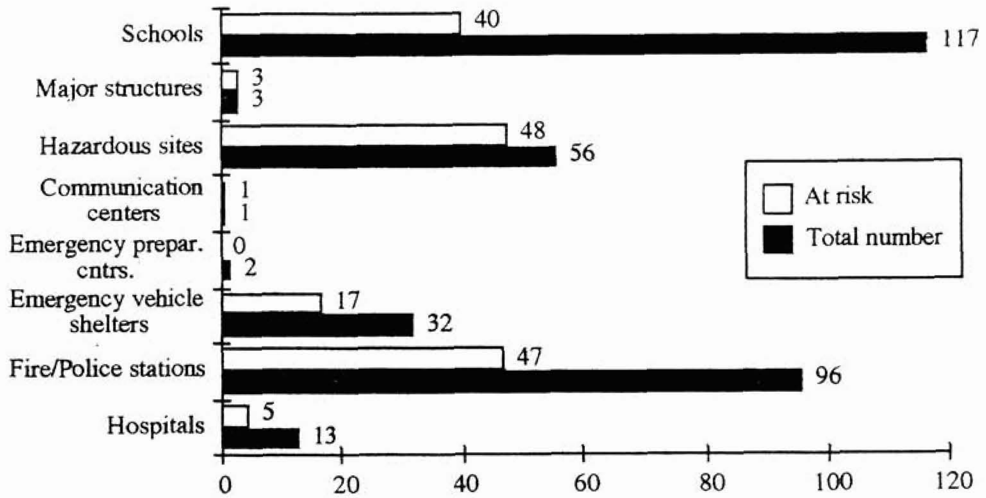


Figure 1b. Summary of critical and essential facilities at risk from tsunami inundation in coastal areas of Oregon.*

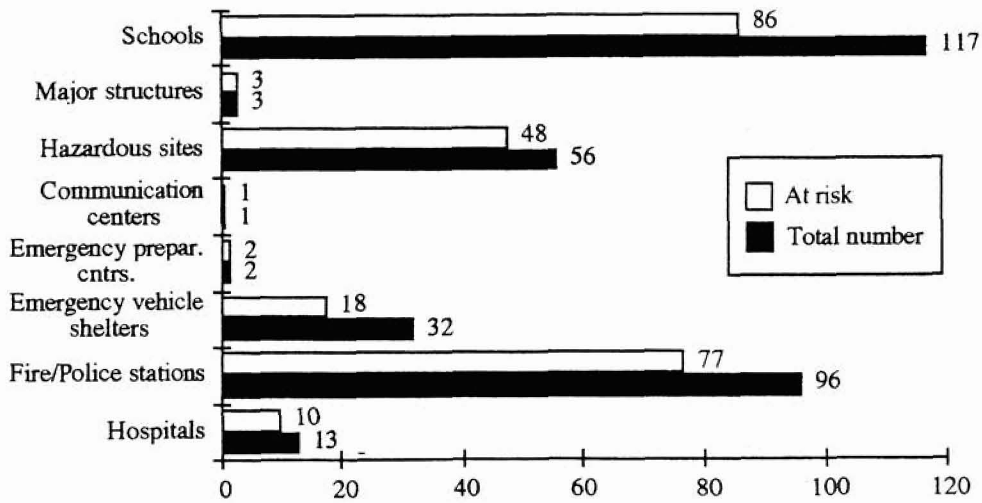


Figure 1c. Summary of critical and essential facilities at risk from ground shaking or tsunami inundation in coastal areas of Oregon.*

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

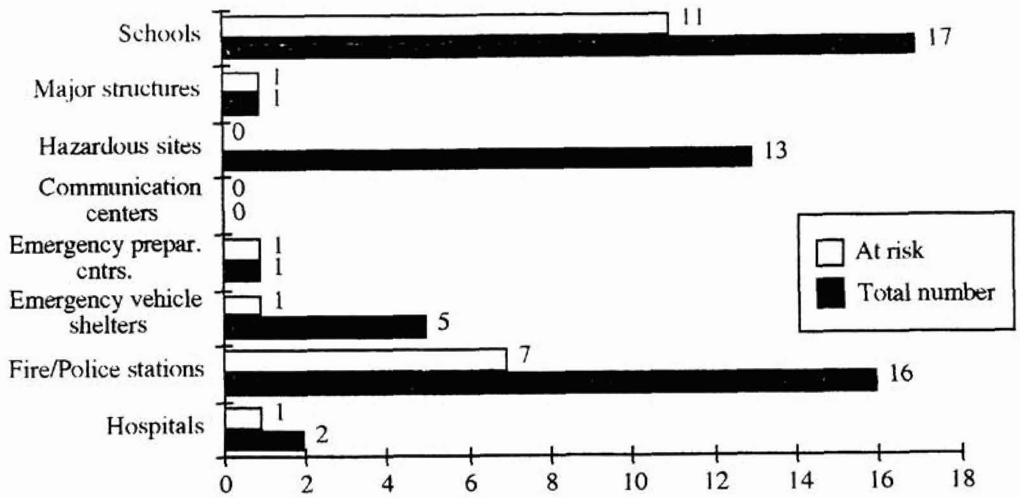


Figure 2a. Summary of critical and essential facilities at risk from ground shaking in coastal areas of Clatsop County.

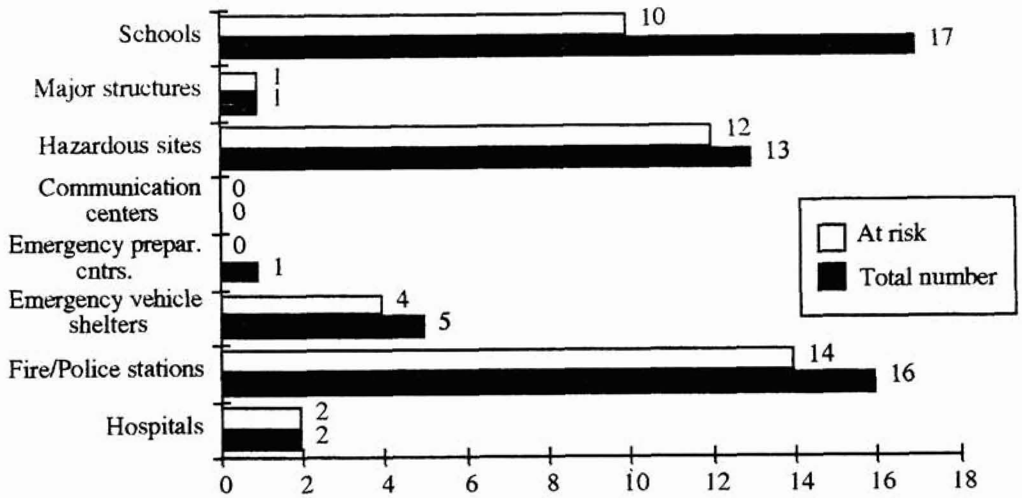


Figure 2b. Summary of critical and essential facilities at risk from tsunami inundation in coastal areas of Clatsop County.*

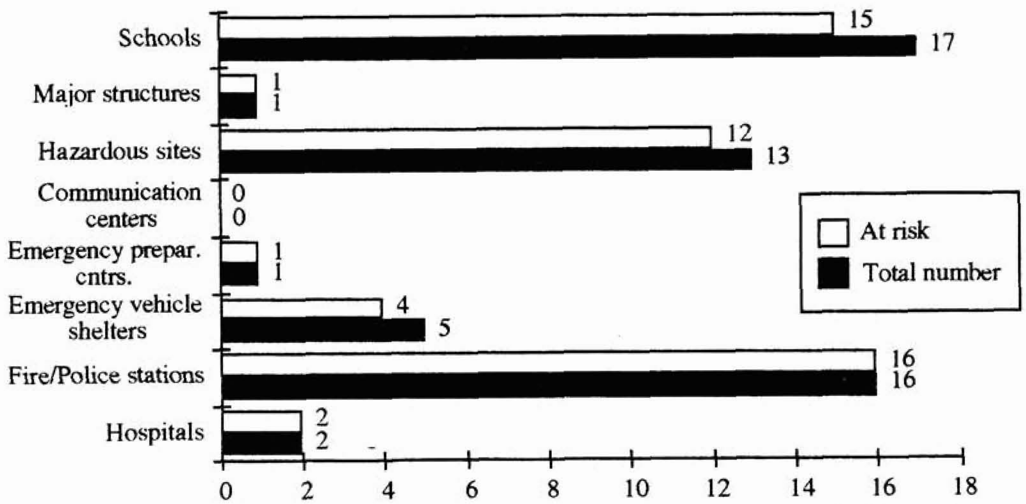


Figure 2c. Summary of critical and essential facilities at risk from ground shaking or tsunami inundation in coastal areas of Clatsop County.*

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

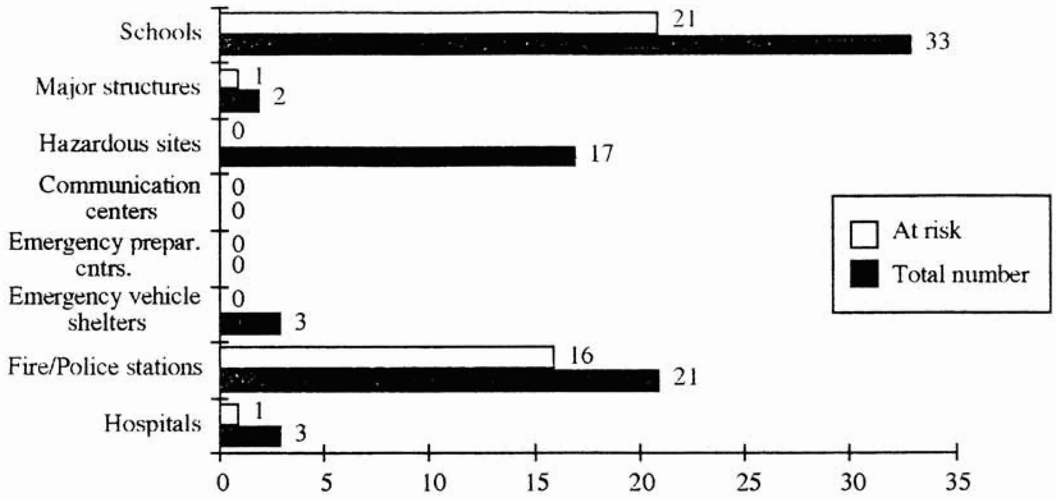


Figure 3a. Summary of critical and essential facilities at risk from ground shaking in coastal areas of Coos County.

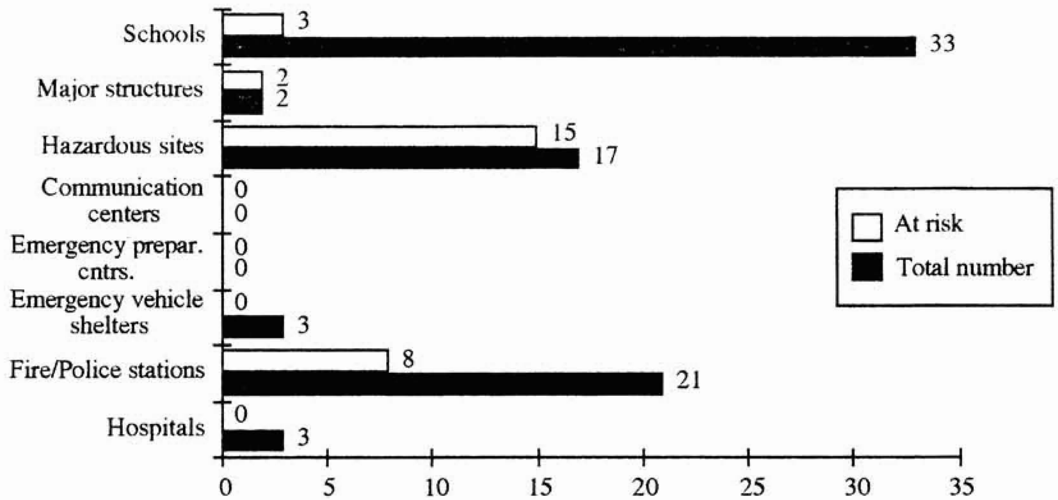


Figure 3b. Summary of critical and essential facilities at risk from tsunami inundation in coastal areas of Coos County.*

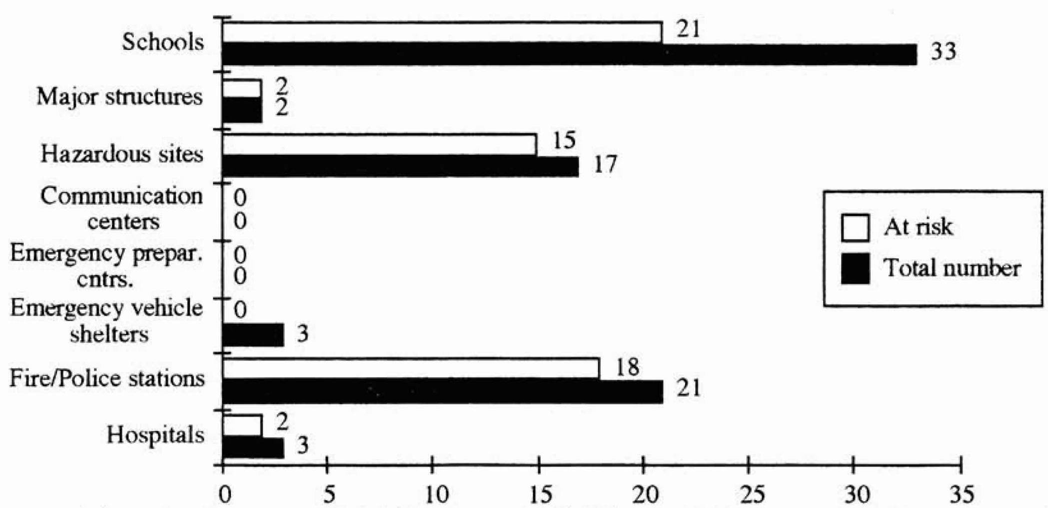


Figure 3c. Summary of critical and essential facilities at risk from ground shaking or tsunami inundation in coastal areas of Coos County.*

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

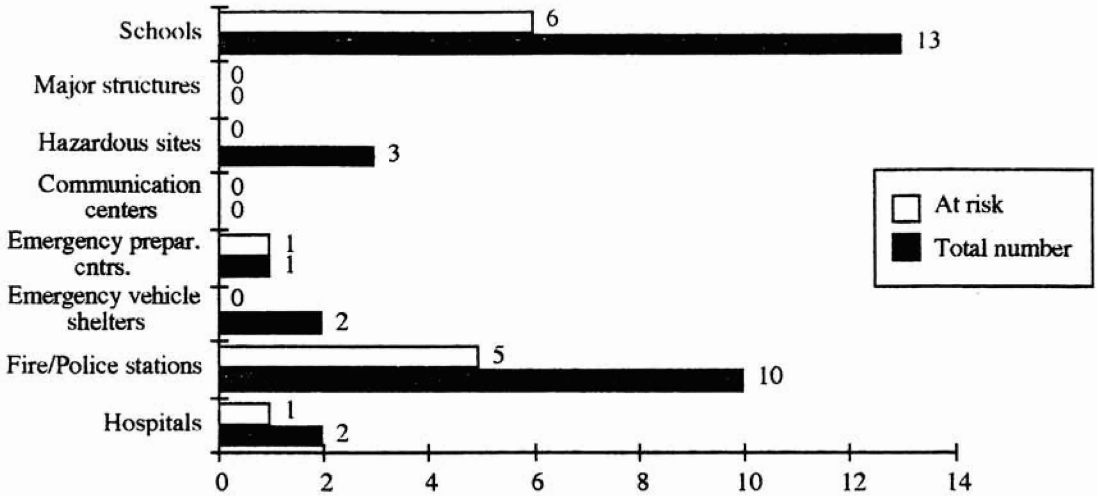


Figure 4a. Summary of critical and essential facilities at risk from ground shaking in coastal areas of Curry County.

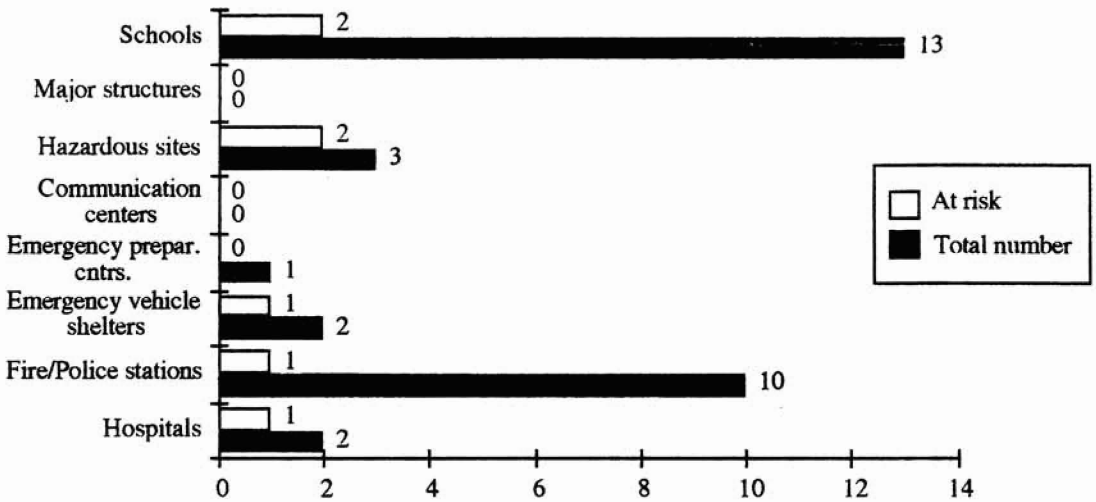


Figure 4b. Summary of critical and essential facilities at risk from tsunami inundation in coastal areas of Curry County.*

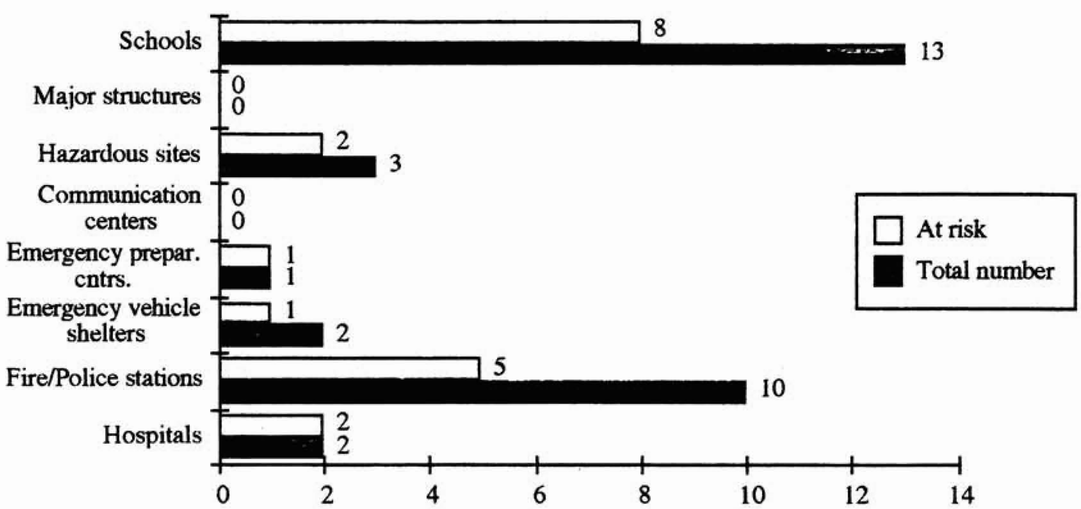


Figure 4c. Summary of critical and essential facilities at risk from ground shaking or tsunami inundation in coastal areas of Curry County.*

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

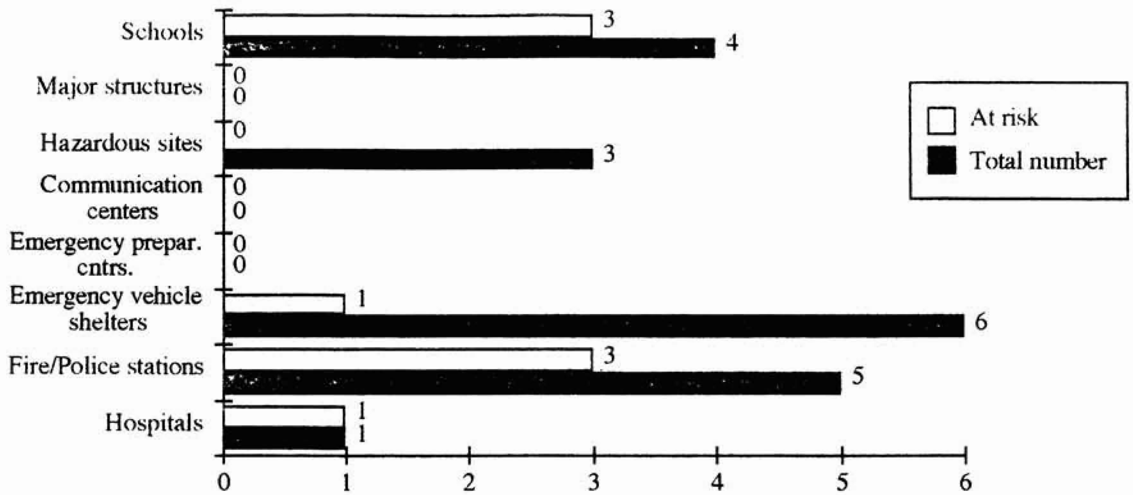


Figure 5a. Summary of critical and essential facilities at risk from ground shaking in coastal areas of Douglas County.

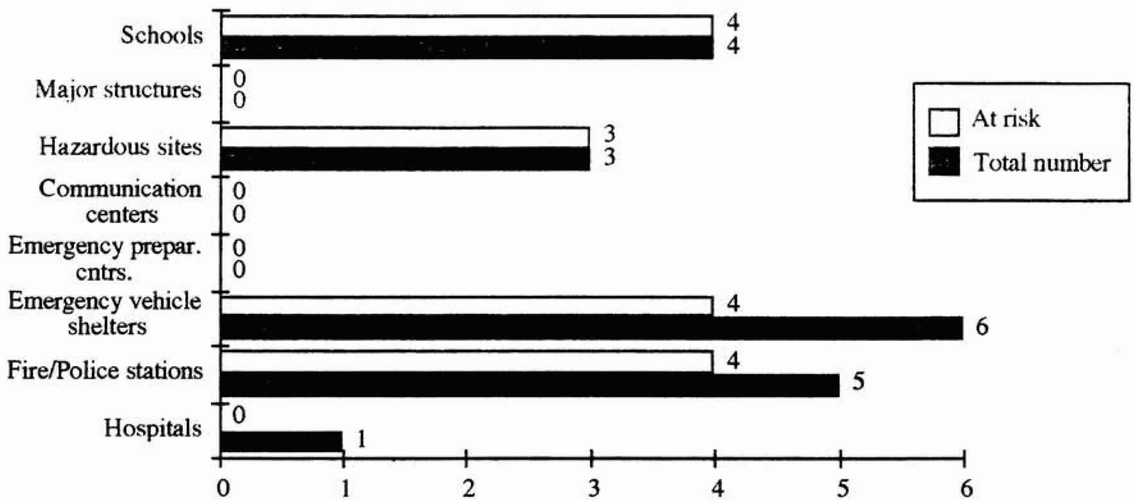


Figure 5b. Summary of critical and essential facilities at risk from tsunami inundation in coastal areas of Douglas County.*

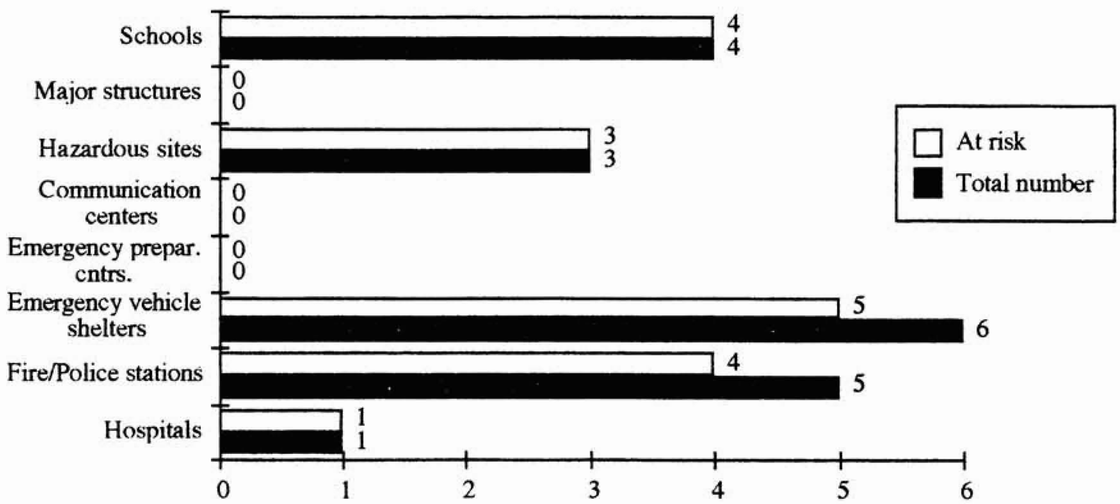


Figure 5c. Summary of critical and essential facilities at risk from ground shaking or tsunami inundation in coastal areas of Douglas County.*

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

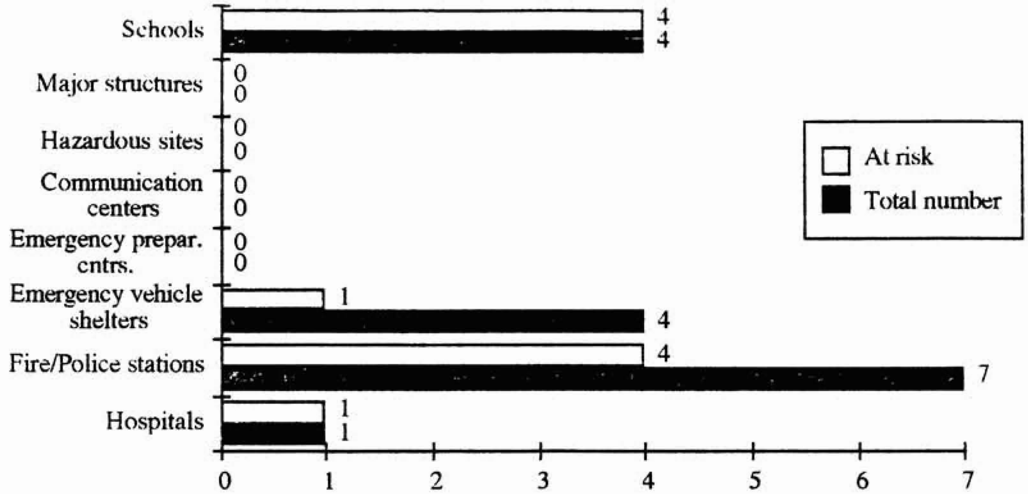


Figure 6a. Summary of critical and essential facilities at risk from ground shaking in coastal areas of Lane County.

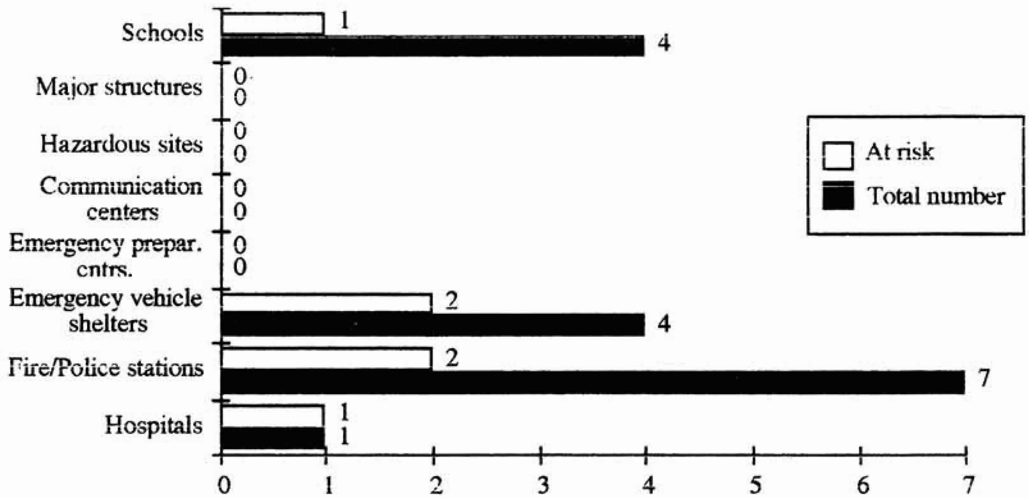


Figure 6b. Summary of critical and essential facilities at risk from tsunami inundation in coastal areas of Lane County.*

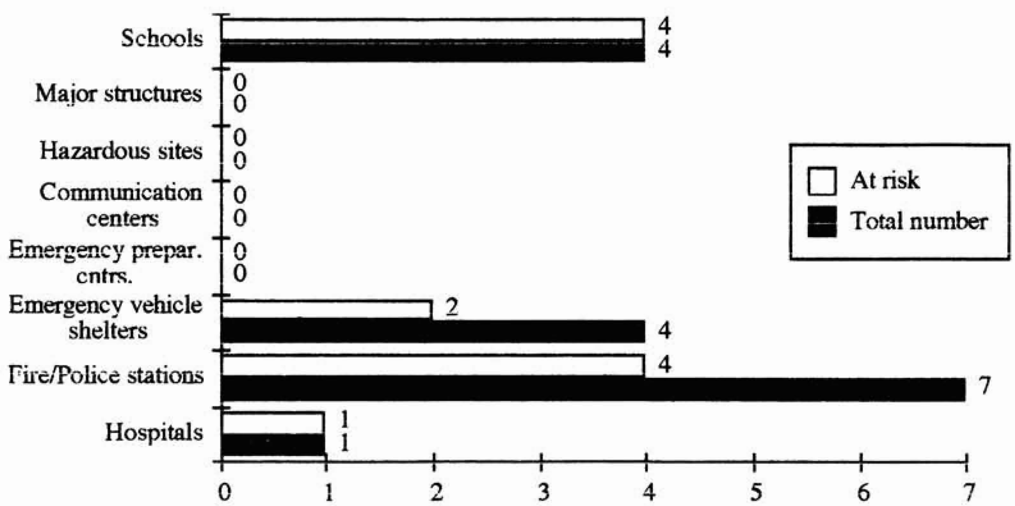


Figure 6c. Summary of critical and essential facilities at risk from ground shaking or tsunami inundation in coastal areas of Lane County.*

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

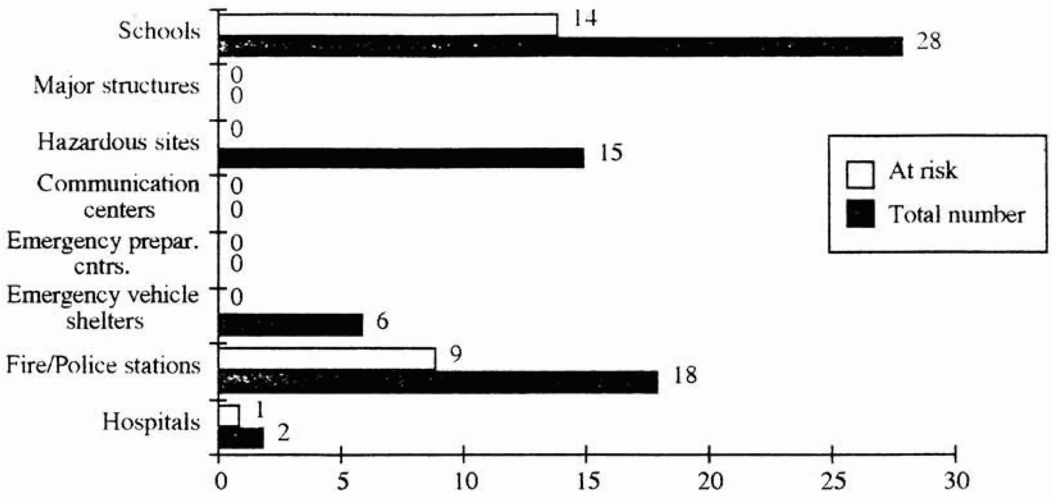


Figure 7a. Summary of critical and essential facilities at risk from ground shaking in coastal areas of Lincoln County.

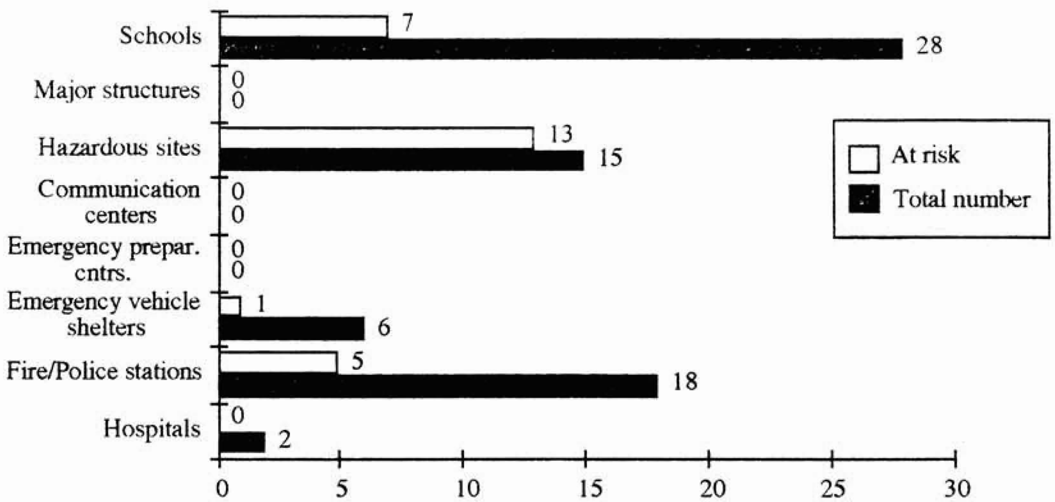


Figure 7b. Summary of critical and essential facilities at risk from tsunami inundation in coastal areas of Lincoln County.*

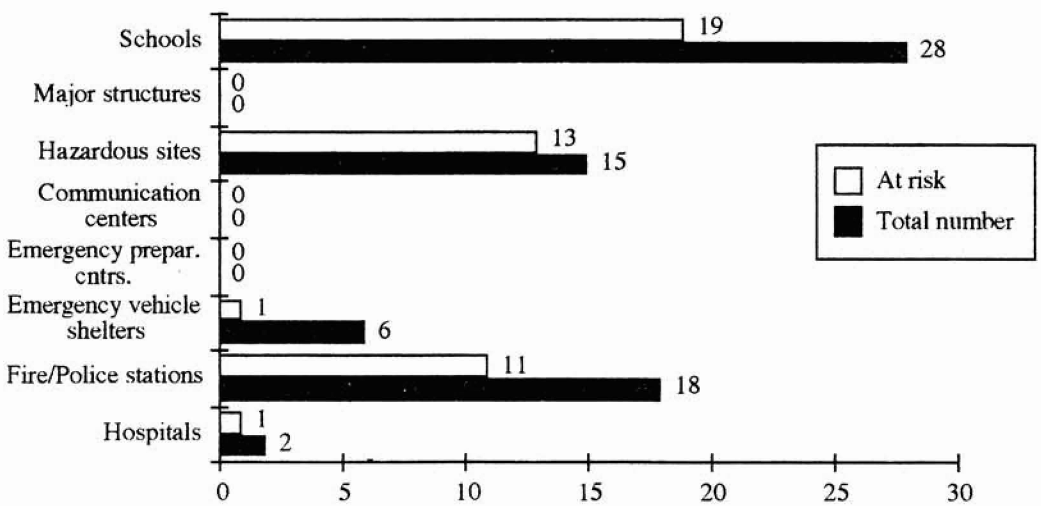


Figure 7c. Summary of critical and essential facilities at risk from ground shaking or tsunami inundation in coastal areas of Lincoln County.*

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

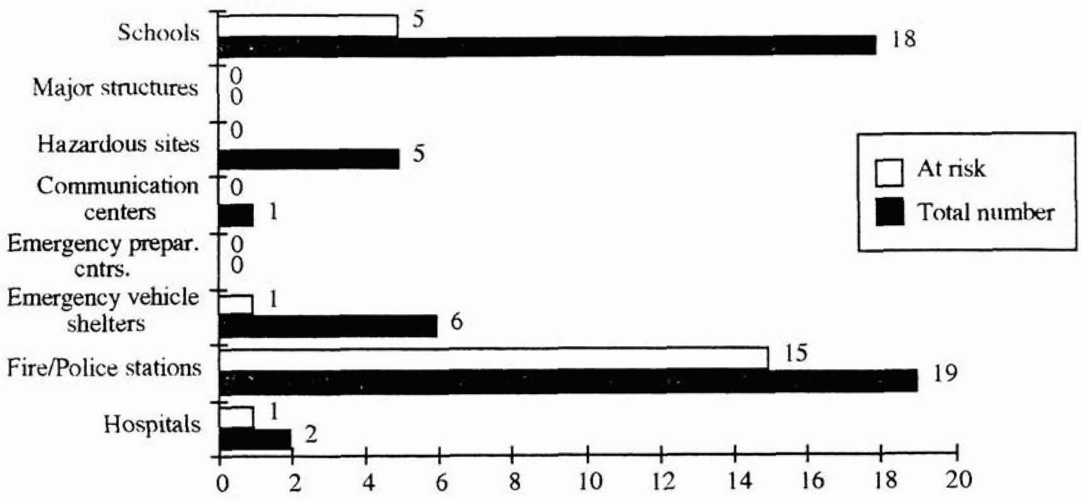


Figure 8a. Summary of critical and essential facilities at risk from ground shaking in coastal areas of Tillamook County.

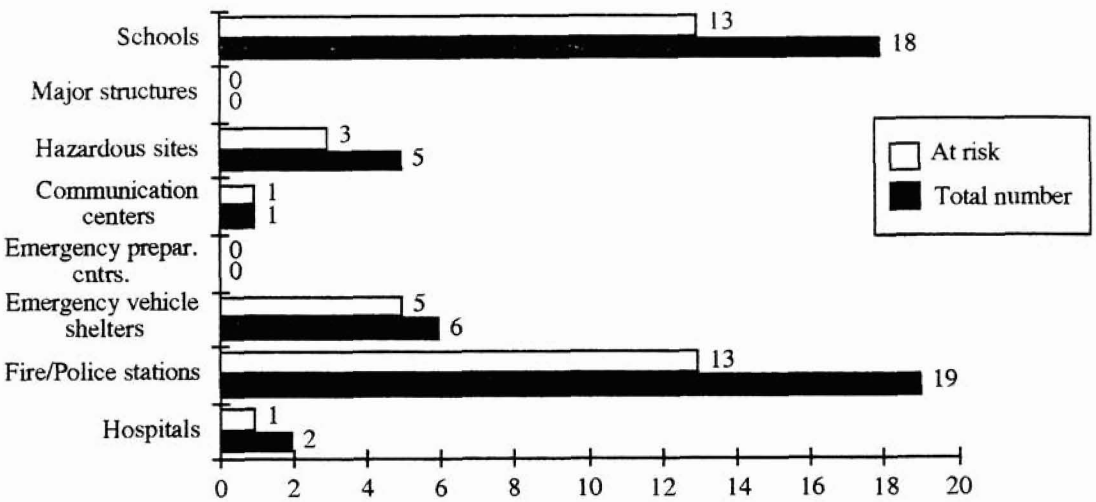


Figure 8b. Summary of critical and essential facilities at risk from tsunami inundation in coastal areas of Tillamook County.*

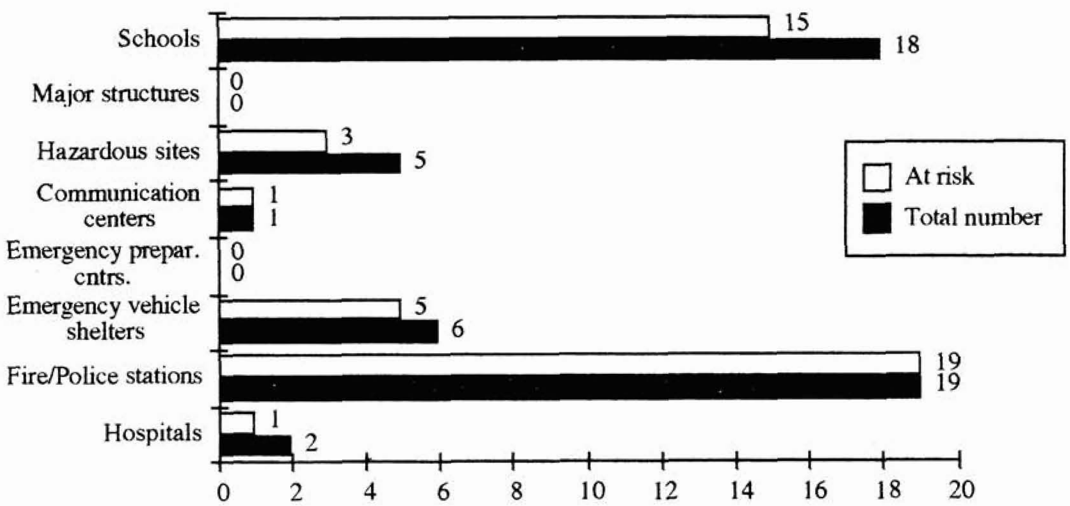
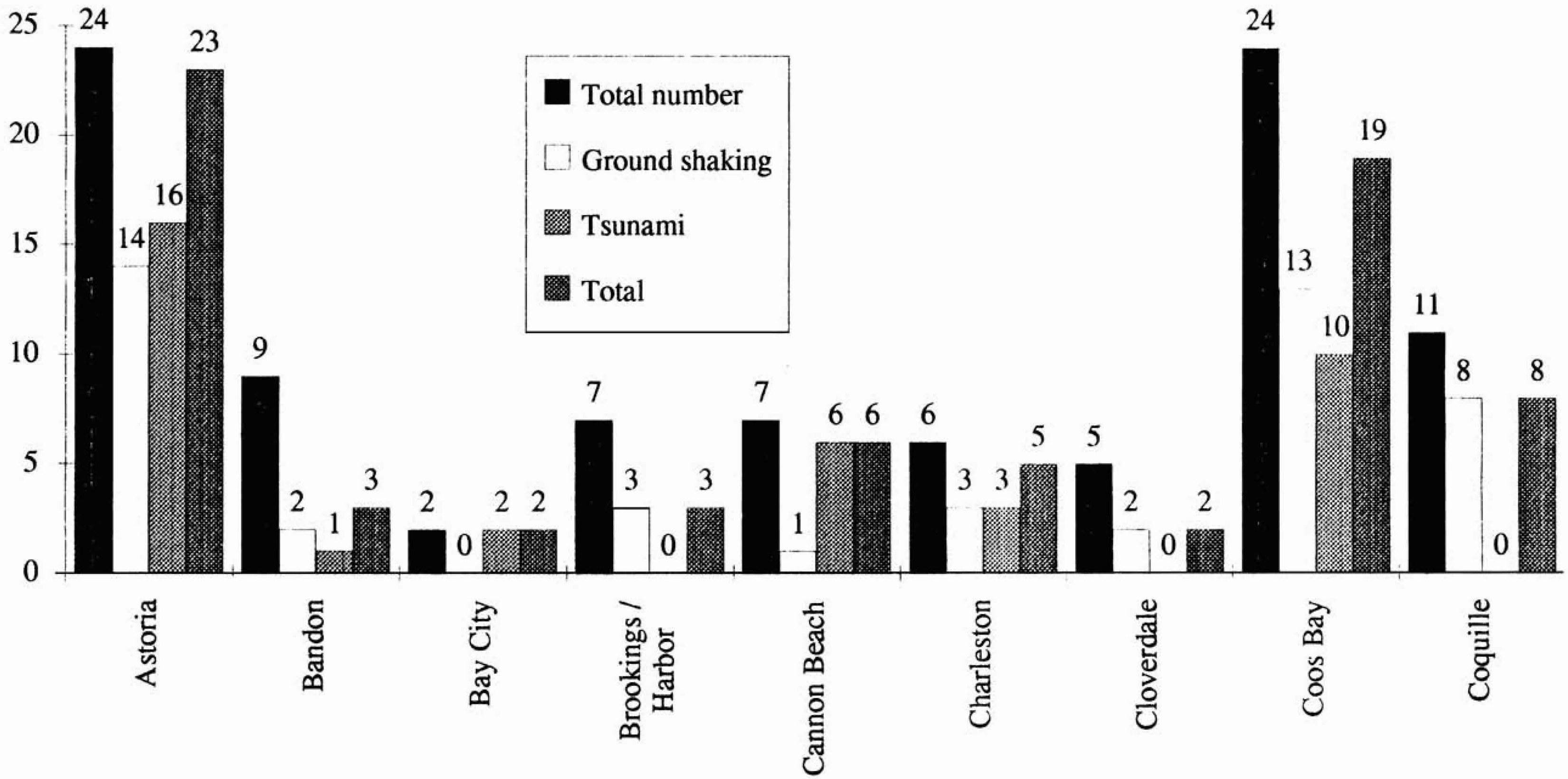


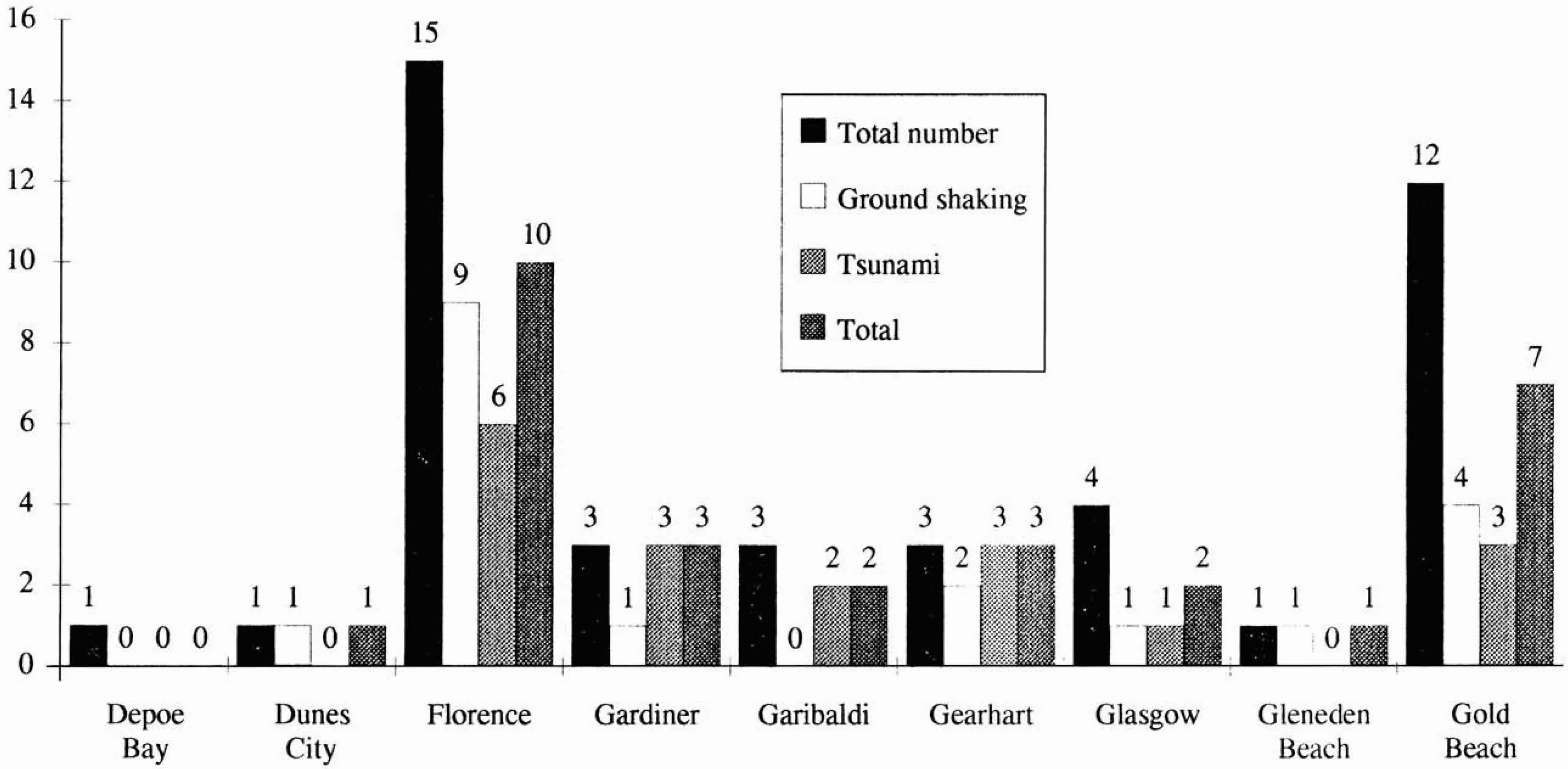
Figure 8c. Summary of critical and essential facilities at risk from ground shaking or tsunami inundation in coastal areas of Tillamook County.*

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.



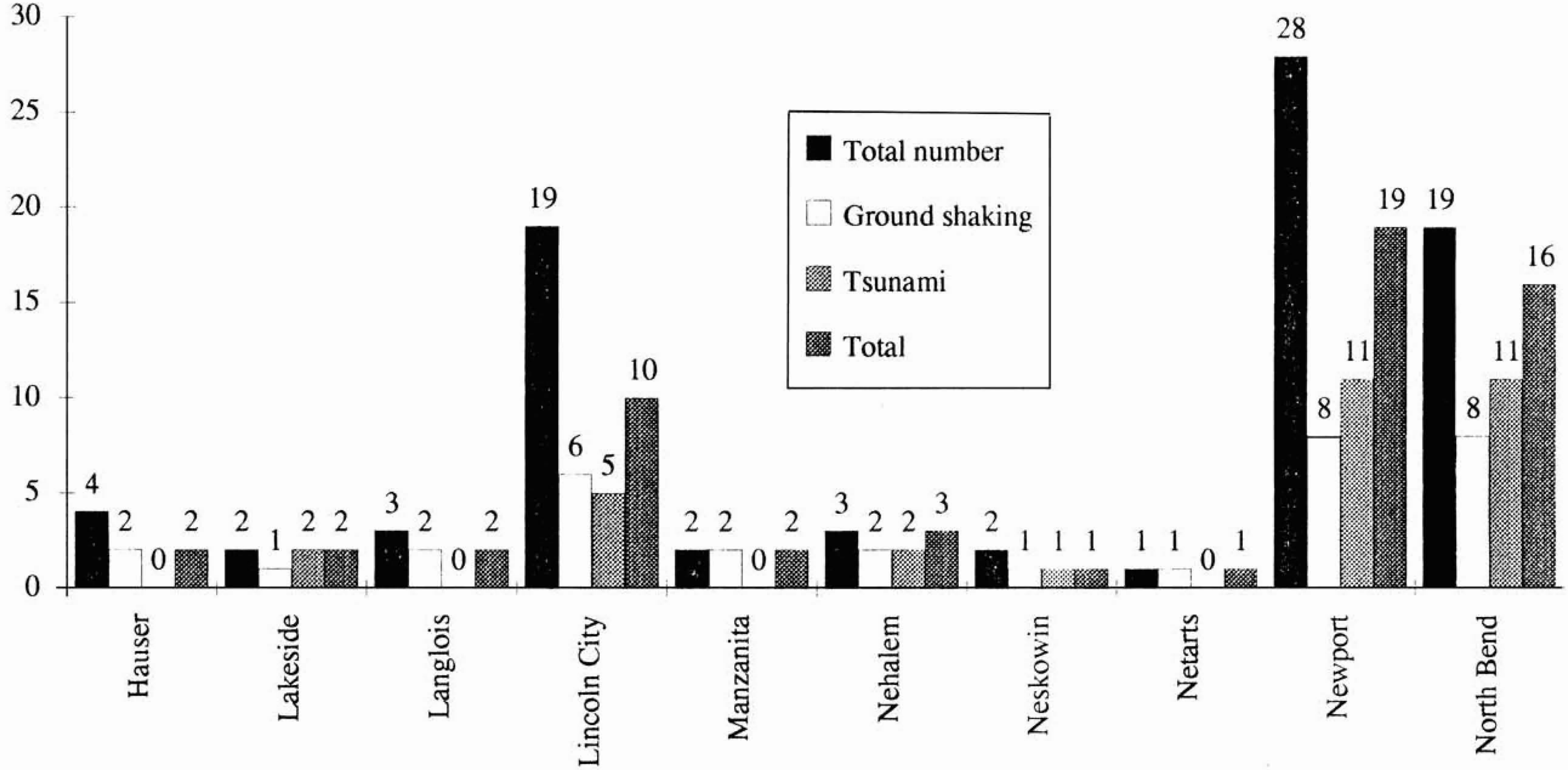
Note: The tsunami estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Figure 9. Total number of critical and essential facilities at risk from ground shaking and tsunami inundation in Oregon's coastal communities.



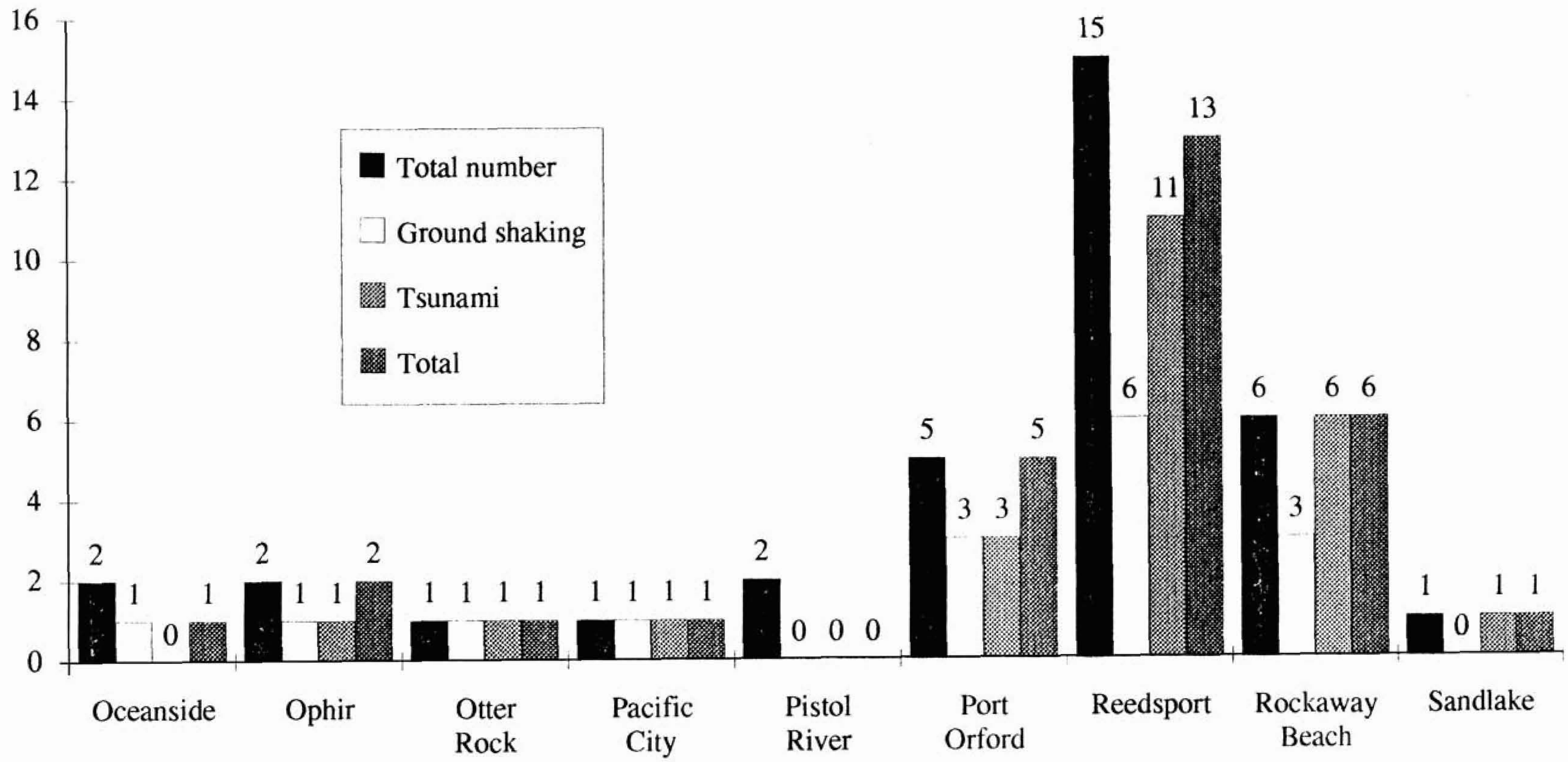
Note: The tsunami estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Figure 9. Total number of critical and essential facilities at risk from ground shaking and tsunami inundation in Oregon's coastal communities (continued).



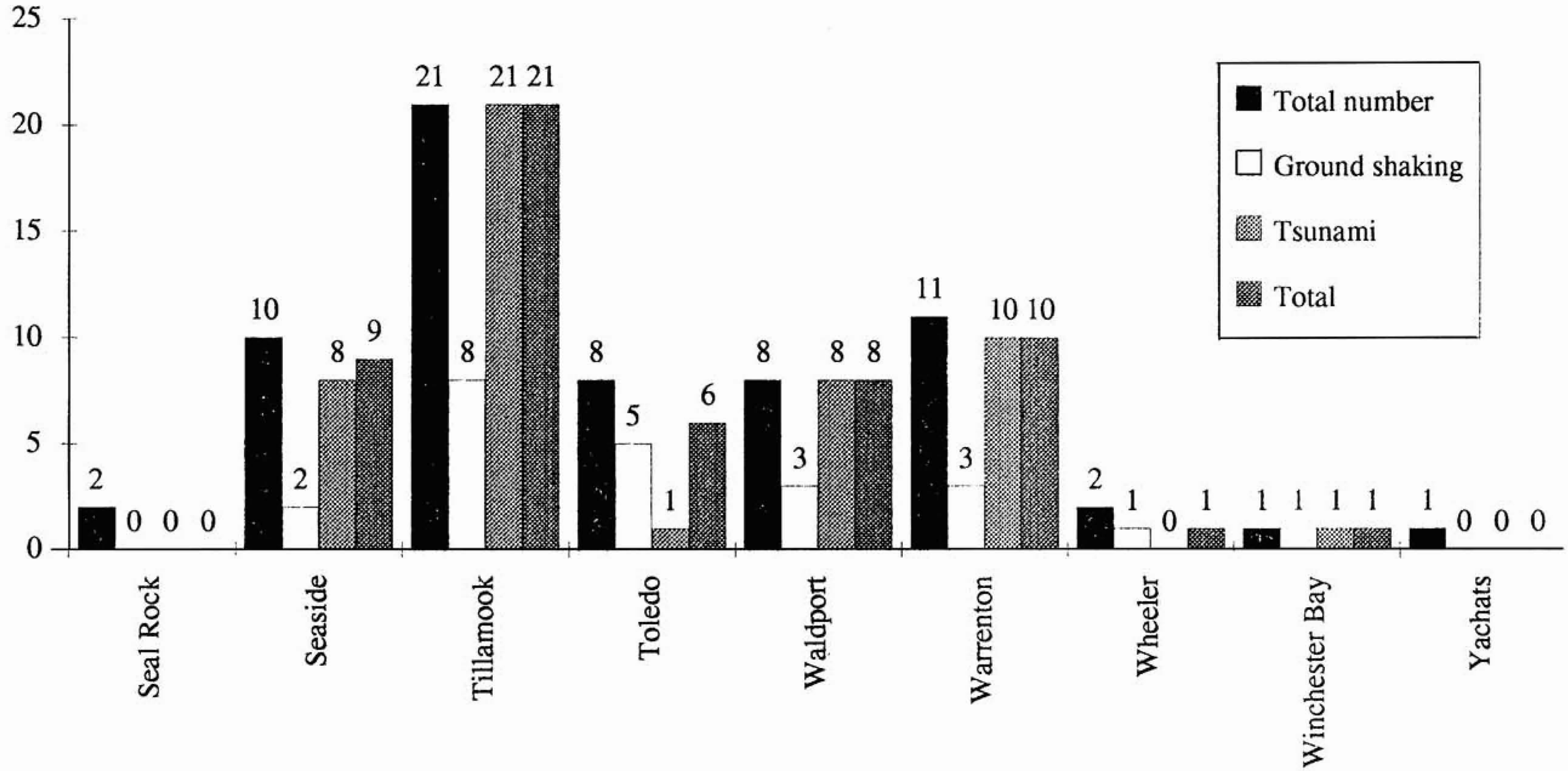
Note: The tsunami estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Figure 9. Total number of critical and essential facilities at risk from ground shaking and tsunami inundation in Oregon's coastal communities (continued).



Note: The tsunami estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Figure 9. Total number of critical and essential facilities at risk from ground shaking and tsunami inundation in Oregon's coastal communities (continued).



Note: The tsunami estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Figure 9. Total number of critical and essential facilities at risk from ground shaking and tsunami inundation in Oregon's coastal communities (concluded).

Facility Type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	13	7	5	10
Fire/Police stations	455.447 (a)(B)	96	59	47	77
Emergency vehicle shelters	455.447 (a)(D)	32	4	17	18
Emergency prepar. cntrs.	455.447 (a)(E)	2	2	0	2
Communication centers	455.447 (a)(G)	1	0	1	1
Hazardous sites	455.447 (b)	56	na	48	48
Major structures	455.447 (c)	3	2	3	3
Schools	455.447 (e)(B)	117	64	40	86
Total		320	138	161	245

Table 1. Summary of critical and essential facilities in coastal areas of Oregon.

Facility Type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	2	1	2	2
Fire/Police stations	455.447 (a)(B)	16	7	14	16
Emergency vehicle shelters	455.447 (a)(D)	5	1	4	4
Emergency prepar. cntrs.	455.447 (a)(E)	1	1	0	1
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	13	na	12	12
Major structures	455.447 (c)	1	1	1	1
Schools	455.447 (e)(B)	17	11	10	15
Total		55	22	43	51

Table 2. Summary of critical and essential facilities in coastal Clatsop County.

Facility Type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	3	1	0	2
Fire/Police stations	455.447 (a)(B)	21	16	8	18
Emergency vehicle shelters	455.447 (a)(D)	3	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	17	na	15	15
Major structures	455.447 (c)	2	1	2	2
Schools	455.447 (e)(B)	33	21	3	21
Total		79	39	28	58

Table 3. Summary of critical and essential facilities in coastal Coos County.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility Type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	2	1	1	2
Fire/Police stations	455.447 (a)(B)	10	5	1	5
Emergency vehicle shelters	455.447 (a)(D)	2	0	1	1
Emergency prepar. cntrs.	455.447 (a)(E)	1	1	0	1
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	3	na	2	2
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	13	6	2	8
Total		31	13	7	19

Table 4. Summary of critical and essential facilities in coastal Curry County.

Facility Type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	1	1	0	1
Fire/Police stations	455.447 (a)(B)	5	3	4	4
Emergency vehicle shelters	455.447 (a)(D)	6	1	4	5
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	3	na	3	3
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	4	3	4	4
Total		19	8	15	17

Table 5. Summary of critical and essential facilities in coastal Douglas County.

Facility Type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	1	1	1	1
Fire/Police stations	455.447 (a)(B)	7	4	2	4
Emergency vehicle shelters	455.447 (a)(D)	4	1	2	2
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	4	4	1	4
Total		16	10	6	11

Table 6. Summary of critical and essential facilities in coastal Lane County.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility Type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	2	1	0	1
Fire/Police stations	455.447 (a)(B)	18	9	5	11
Emergency vehicle shelters	455.447 (a)(D)	6	0	1	1
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	15	na	13	13
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	28	14	7	19
Total		69	24	26	45

Table 7. Summary of critical and essential facilities in coastal Lincoln County.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	2	1	1	1
Fire/Police stations	455.447 (a)(B)	19	15	13	19
Emergency vehicle shelters	455.447 (a)(D)	6	1	5	5
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	1	0	1	1
Hazardous sites	455.447 (b)	5	na	3	3
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	18	5	13	15
Total		51	22	36	44

Table 8. Summary of critical and essential facilities in coastal Tillamook County.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	1	1	1	1
Fire/Police stations	455.447 (a)(B)	5	4	3	5
Emergency vehicle shelters	455.447 (a)(D)	3	1	2	2
Emergency prepar. cntrs.	455.447 (a)(E)	1	1	0	1
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	7	na	7	7
Major structures	455.447 (c)	1	1	1	1
Schools	455.447 (e)(B)	6	6	2	6
Total		24	14	16	23

Table 9. Summary of critical and essential facilities in the City of Astoria.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	1	0	0	1
Fire/Police stations	455.447 (a)(B)	2	1	0	1
Emergency vehicle shelters	455.447 (a)(D)	1	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	1	na	1	1
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	4	1	0	1
Total		9	2	1	3

Table 10. Summary of critical and essential facilities in the City of Bandon.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	0	1	1
Emergency vehicle shelters	455.447 (a)(D)	1	0	1	1
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	na	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	0	0	0	0
Total		2	0	2	2

Table 11. Summary of critical and essential facilities in Bay City.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	2	1	0	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	1	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	4	2	0	2
Total		7	3	0	3

Table 12. Summary of critical and essential facilities in the Cities of Brookings and Harbor.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	4	0	4	4
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	1	na	1	1
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	2	1	1	1
Total		7	1	6	6

Table 13. Summary of critical and essential facilities in the City of Cannon Beach.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	3	2	2	3
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	1	na	1	1
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	2	1	0	1
Total		6	3	3	5

Table 14. Summary of critical and essential facilities in the City of Charleston.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	0	1
Emergency vehicle shelters	455.447 (a)(D)	1	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	1	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	2	1	0	1
Total		5	2	0	2

Table 15. Summary of critical and essential facilities in Cloverdale.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	1	1	0	1
Fire/Police stations	455.447 (a)(B)	6	5	4	6
Emergency vehicle shelters	455.447 (a)(D)	1	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	5	na	4	4
Major structures	455.447 (c)	1	1	1	1
Schools	455.447 (e)(B)	10	7	1	7
Total		24	13	10	19

Table 16. Summary of critical and essential facilities in the City of Coos Bay.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	1	0	0	0
Fire/Police stations	455.447 (a)(B)	3	3	0	3
Emergency vehicle shelters	455.447 (a)(D)	1	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	1	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	5	5	0	5
Total		11	8	0	8

Table 17. Summary of critical and essential facilities in the City of Coquille.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	0	0	0
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	0	0	0	0
Total		1	0	0	0

Table 18. Summary of critical and essential facilities in Depoe Bay.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	0	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	0	0	0	0
Total		1	1	0	1

Table 19. Summary of critical and essential facilities in Dunes City.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	1	1	1	1
Fire/Police stations	455.447 (a)(B)	6	3	2	3
Emergency vehicle shelters	455.447 (a)(D)	4	1	2	2
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	4	4	1	4
Total		15	9	6	10

Table 20. Summary of critical and essential facilities in Florence.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	0	1	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	1	na	1	1
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	1	1	1	1
Total		3	1	3	3

Table 21. Summary of critical and essential facilities in Gardiner.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	0	1	1
Emergency vehicle shelters	455.447 (a)(D)	1	0	1	1
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	1	0	0	0
Total		3	0	2	2

Table 22. Summary of critical and essential facilities in Garibaldi.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	2	1	2	2
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	1	1	1	1
Total		3	2	3	3

Table 23. Summary of critical and essential facilities in Gearhart.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	0	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	1	na	1	1
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	2	0	0	0
Total		4	1	1	2

Table 24. Summary of critical and essential facilities in Glasgow.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	0	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	0	0	0	0
Total		1	1	0	1

Table 25. Summary of critical and essential facilities in Gleneden Beach.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	1	1	0	1
Fire/Police stations	455.447 (a)(B)	4	1	0	1
Emergency vehicle shelters	455.447 (a)(D)	2	0	1	1
Emergency prepar. cntrs.	455.447 (a)(E)	1	1	0	1
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	1	na	1	1
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	3	1	1	2
Total		12	4	3	7

Table 26. Summary of critical and essential facilities in Gold Beach.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	2	0	0	0
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	2	2	0	2
Total		4	2	0	2

Table 27. Summary of critical and essential facilities in Hauser.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	1	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	1	na	1	1
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	0	0	0	0
Total		2	1	2	2

Table 28. Summary of critical and essential facilities in Lakeside.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	0	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	0	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	2	1	0	1
Total		3	2	0	2

Table 29. Summary of critical and essential facilities in Langlois.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	1	0	0	0
Fire/Police stations	455.447 (a)(B)	4	3	1	3
Emergency vehicle shelters	455.447 (a)(D)	2	0	0	missing data
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	1	na	1	1
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	11	3	3	6
Total		19	6	5	10

Table 30. Summary of critical and essential facilities in Lincoln City.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	2	2	0	2
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	0	0	0	0
Total		2	2	0	2

Table 31. Summary of critical and essential facilities in Manzanita.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	1	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	1	na	1	1
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	1	1	0	1
Total		3	2	2	3

Table 32. Summary of critical and essential facilities in Nehalem.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	1	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	1	0	0	0
Total		2	1	1	1

Table 33. Summary of critical and essential facilities in Neskowin.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	0	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	0	0	0	0
Total		1	1	0	1

Table 34. Summary of critical and essential facilities in Netarts.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	1	1	0	1
Fire/Police stations	455.447 (a)(B)	4	2	0	2
Emergency vehicle shelters	455.447 (a)(D)	3	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	12	na	11	11
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	8	5	0	5
Total		28	8	11	19

Table 35. Summary of critical and essential facilities in Newport.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	3	3	1	3
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	7	na	7	7
Major structures	455.447 (c)	1	0	1	1
Schools	455.447 (e)(B)	8	5	2	5
Total		19	8	11	16

Table 36. Summary of critical and essential facilities in North Bend.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	0	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	1	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	0	0	0	0
Total		2	1	0	1

Table 37. Summary of critical and essential facilities in Oceanside.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	0	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	0	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	1	0	1	1
Total		2	1	1	2

Table 38. Summary of critical and essential facilities in Ophir.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	1	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	0	0	0	0
Total		1	1	1	1

Table 39. Summary of critical and essential facilities in Otter Rock.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	1	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	0	0	0	0
Total		1	1	1	1

Table 40. Summary of critical and essential facilities in Pacific City.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	0	0	0
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	1	0	0	0
Total		2	0	0	0

Table 41. Summary of critical and essential facilities in Pistol River.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	1	0	1	1
Fire/Police stations	455.447 (a)(B)	1	1	1	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	1	na	1	1
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	2	2	0	2
Total		5	3	3	5

Table 42. Summary of critical and essential facilities in Port Orford.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	1	1	0	1
Fire/Police stations	455.447 (a)(B)	3	2	2	2
Emergency vehicle shelters	455.447 (a)(D)	6	1	4	5
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	2	na	2	2
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	3	2	3	3
Total		15	6	11	13

Table 43. Summary of critical and essential facilities in Reedsport.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	2	2	2	2
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	1	na	1	1
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	3	1	3	3
Total		6	3	6	6

Table 44. Summary of critical and essential facilities in Rockaway Beach.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	0	1	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	0	0	0	0
Total		1	0	1	1

Table 45. Summary of.critical and essential facilities in Sandlake.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	2	0	0	0
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	0	0	0	0
Total		2	0	0	0

Table 46. Summary of critical and essential facilities in Seal Rock.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	1	0	1	1
Fire/Police stations	455.447 (a)(B)	2	0	2	2
Emergency vehicle shelters	455.447 (a)(D)	1	0	1	1
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	2	na	1	1
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	4	2	3	4
Total		10	2	8	9

Table 47. Summary of critical and essential facilities in Seaside.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	1	1	1	1
Fire/Police stations	455.447 (a)(B)	5	4	5	5
Emergency vehicle shelters	455.447 (a)(D)	3	1	3	3
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	1	0	1	1
Hazardous sites	455.447 (b)	1	na	1	1
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	10	2	10	10
Total		21	8	21	21

Table 48. Summary of critical and essential facilities in Tillamook.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	0	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	2	na	1	1
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	5	4	0	4
Total		8	5	1	6

Table 49. Summary of critical and essential facilities in Toledo.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	3	1	3	3
Emergency vehicle shelters	455.447 (a)(D)	1	0	1	1
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	4	2	4	4
Total		8	3	8	8

Table 50. Summary of critical and essential facilities in Waldport.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	3	2	3	3
Emergency vehicle shelters	455.447 (a)(D)	1	0	1	1
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	3	na	3	3
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	4	1	3	3
Total		11	3	10	10

Table 51. Summary of critical and essential facilities in Warrenton.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	1	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	0	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	0	0	0	0
Total		2	1	0	1

Table 52. Summary of critical and essential facilities in Wheeler.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	1	1	1
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	0	0	0	0
Total		1	1	1	1

Table 53. Summary of critical and essential facilities in Winchester Bay.

Facility type	Building class	Total number	Ground shaking risk	Tsunami risk *	Total at risk
Hospitals	455.447 (a)(A)	0	0	0	0
Fire/Police stations	455.447 (a)(B)	1	0	0	0
Emergency vehicle shelters	455.447 (a)(D)	0	0	0	0
Emergency prepar. cntrs.	455.447 (a)(E)	0	0	0	0
Communication centers	455.447 (a)(G)	0	0	0	0
Hazardous sites	455.447 (b)	0	na	0	0
Major structures	455.447 (c)	0	0	0	0
Schools	455.447 (e)(B)	0	0	0	0
Total		1	0	0	0

Table 54. Summary of critical and essential facilities in Yachats.

* Tsunami risk estimates in this report may be exaggerated by ignoring the effects of bays and estuaries.

5.1 Oregon Coast

The data for all studied municipalities on the Oregon coast appears in Table 1 and Figure 1. Figure 1a summarizes the vulnerability to ground shaking of critical and essential facilities on the coast. There are thirteen hospitals in coastal communities, six of which may be at risk from ground shaking (46 percent). Fifty-nine of ninety-six fire/police facilities in coastal counties could be at risk from ground shaking (61 percent), along with four of thirty-two emergency vehicle shelters (13 percent). There are two facilities which serve exclusively as emergency preparedness centers, and both are potentially at risk from ground shaking. There are three major structures on the coast, two of which might be at risk from ground shaking (67 percent). The other major structure, a planned casino in North Bend, has not yet been built. Sixty-four of 117 schools on the coast may be at risk from ground shaking (55 percent).

Figure 1b summarizes the risk from tsunami inundation for critical and essential facilities on the coast. Of the thirteen hospitals in coastal communities, five may be at risk from tsunami inundation (38 percent). Forty-six of ninety-six fire/police facilities in coastal counties could be at risk from tsunami inundation (48 percent), along with seventeen of thirty-two emergency vehicle shelters (53 percent). One of three dedicated communications facilities may be at risk from tsunami inundation (33 percent). There are three major structures on the coast, two of which might be at risk from tsunami inundation (67 percent). The proposed site for the other major structure, a planned casino in North Bend, may be at risk from tsunami inundation. Forty of 117 schools on the coast might be at risk from tsunami inundation (34 percent). As mentioned above, estimates of tsunami inundation for the Oregon coast do not include possible tsunami wave attenuating effects of bays, estuaries, and bay mouth barriers along the coast. These effects may significantly reduce the tsunami threat to cities and towns which lie near these waterways.

Figure 1c illustrates the potential risk from combined ground shaking and tsunami inundation. It is possible that 74 percent of the schools, 80 percent of the fire and police stations, 77 percent of the hospitals, 84 percent of the hazardous sites, 56 percent of the emergency vehicle shelters, and virtually all of the identified major structures, communication centers, and emergency preparedness centers could be at risk. These facilities need further hazard assessment.

5.2 Clatsop County

The data for Clatsop County appears in Table 2 and Figure 2. Figure 2a summarizes the vulnerability to ground shaking of critical and essential facilities in the county. There are two hospitals in Clatsop County, one of which may be at risk from ground shaking (50 percent). Seven of sixteen fire/police facilities in Clatsop County could be at risk from ground shaking (44 percent), along with one of five emergency vehicle shelters (20 percent). The one emergency preparedness center, the Clatsop County Courthouse, might be at risk from ground shaking. There is one major structure in the county, and it may be at risk from ground shaking. Eleven of seventeen schools in the county could be at risk from ground shaking (65 percent).

Figure 2b summarizes the risk from tsunami inundation for critical and essential facilities in Clatsop County. Both hospitals in Clatsop County may be at risk from tsunami inundation. Fourteen of 16 fire/police facilities in Clatsop County could be at risk from tsunami inundation, along with four of five emergency vehicle shelters (80 percent). Twelve of thirteen hazardous materials sites could be at risk from tsunami inundation. The one major structure in Clatsop County might be at risk from tsunami inundation. Ten of seventeen schools in the county may be at risk from tsunami inundation (59 percent).

Figure 2c illustrates the potential risk from combined ground shaking and tsunami inundation. It is possible that 88 percent of the schools, 80 percent of the emergency vehicle shelters, 92 percent of the hazardous sites, and all of the fire and police stations, hospitals, major structures, communication centers, and emergency preparedness centers could be at risk. These facilities need further hazard assessment

5.3 Coos County

The data for Coos County appears in Table 3 and Figure 3. Figure 3a summarizes the vulnerability to ground shaking of critical and essential facilities in the county. Sixteen of twenty-one fire/police facilities in Coos County may be at risk from ground shaking (76 percent). There is one major structure in the county, and it could be at risk from ground shaking. The other major structure in the county is a planned casino in North Bend which has not yet been built. Twenty-one of thirty-three schools in the county might be at risk from ground shaking (64 percent).

Figure 3b summarizes the risk from tsunami inundation for critical and essential facilities in Coos County. Nine of twenty-one fire/police facilities in Coos County may be at risk from tsunami inundation (43 percent). Fifteen of seventeen hazardous materials sites could be at risk from tsunami inundation (88 percent). Both major structures in the county may be at risk from tsunami inundation. Three of thirty-three schools in Coos County are potentially at risk from tsunami inundation (9 percent). As mentioned above, estimates of tsunami inundation for Coos County do not include possible tsunami wave attenuating effects of Coos Bay and the Coquille River estuaries and associated bay mouth barriers. These effects may significantly reduce the tsunami threat to the Coos Bay area and Bandon.

Figure 3c illustrates the potential risk from combined ground shaking and tsunami inundation. It is possible that 63 percent of the schools, 88 percent of the hazardous sites, 86 percent of the fire and police stations, 67 percent of the hospitals and all of the major structures could be at risk. These facilities need further hazard assessment

5.4 Curry County

The data for Curry County appears in Table 4 and Figure 4. Figure 4a summarizes the vulnerability to ground shaking of critical and essential facilities in the county. There are two large medical facilities (one hospital and one large doctor's office) in Curry County, one of which may be at risk from ground shaking (50 percent). Five of ten fire/police facilities in Curry County could be at risk from ground shaking (50 percent). The one emergency preparedness center, the Curry County Courthouse, is possibly at risk from ground shaking. Six of thirteen schools in the county might be at risk from ground shaking (46 percent).

Figure 4b summarizes the risk from tsunami inundation for critical and essential facilities in Curry County. There are two large medical facilities (one hospital and one large doctor's office) in Curry County, one of which may be at risk from tsunami inundation (50 percent). One of ten fire/police facilities in Curry County could be at risk from tsunami inundation (10 percent), along with one of two emergency vehicle shelters (50 percent). Two of three hazardous materials sites may be vulnerable to tsunami inundation (67 percent). Two of thirteen schools in the county may be at risk from tsunami inundation (15 percent).

Figure 4c illustrates the potential risk from combined ground shaking and tsunami inundation. It is possible that 62 percent of the schools, 50 percent of the emergency vehicle shelters, 66 percent of the hazardous sites, 50 percent of the fire and police stations and all hospitals and emergency preparedness centers could be at risk. These facilities need further hazard assessment

5.5 Douglas County

The data for Douglas County appears in Table 5 and Figure 5. Figure 5a summarizes the vulnerability to ground shaking of critical and essential facilities in the county. There is one hospital in Douglas County, and it may be at risk from ground shaking. Three of five fire/police facilities in Douglas County could be at risk from ground shaking (60 percent). Three of four schools in the county may be at risk from ground shaking (75 percent).

Figure 5b summarizes the risk from tsunami inundation for critical and essential facilities in Douglas County. Four of five fire/police facilities may be at risk from tsunami inundation (80 percent), along with four of six emergency vehicle shelters (67 percent). All three hazardous materials sites could be at risk from tsunami inundation. All four schools in Douglas County may be at risk from tsunami inundation. As mentioned above, estimates of tsunami inundation for Douglas County do not include possible tsunami wave attenuating effects of the Umpqua River estuary and bay mouth barriers. These effects will greatly reduce the tsunami threat to Reedsport and Gardiner, which are about 2½ and 3¾ miles inland, respectively, inland from the open coast. Only a detailed study of potential inundation will provide an accurate estimate of the vulnerability of these areas.

Figure 5c illustrates the potential risk from combined ground shaking and tsunami inundation. It is possible that 80 percent of the fire and police stations, 83 percent of the emergency vehicle shelters, and all of the schools, hospitals, and hazardous sites could be at risk. These facilities need further hazard assessment

5.6 Lane County

The data for Lane County appears in Table 6 and Figure 6. Figure 6a summarizes the vulnerability to ground shaking of critical and essential facilities in the county. There is one hospital in Lane County, and it may be at risk from ground shaking. Four of seven fire/police facilities in Lane County could be at risk from ground shaking (57 percent). There are four emergency vehicle shelters in Lane County, one of which may be at risk from ground shaking (25 percent). All four schools in the county may be at risk from ground shaking (100 percent).

Figure 6b summarizes the risk from tsunami inundation for critical and essential facilities in Lane County. The hospital in Lane County may be at risk from tsunami inundation. Two of seven fire/police facilities in Lane County may be vulnerable to tsunami inundation (29 percent), along with two of four emergency vehicle shelters (50 percent). One of four schools could be vulnerable to tsunami inundation (25 percent). As mentioned above, estimates of tsunami inundation for Lane County do not include possible tsunami wave attenuating effects of the Siuslaw River estuary. These effects may significantly reduce the tsunami threat to Florence.

Figure 6c illustrates the potential risk from combined ground shaking and tsunami inundation. It is possible that 57 percent of the fire and police stations, 50 percent of the emergency vehicle shelters, and all of the schools and hospitals could be at risk. These facilities need further hazard assessment

Figure 6c summarizes the risk from ground shaking and tsunami inundation for critical and essential facilities in Lane County. Facilities included in these totals may be at risk from ground shaking, tsunami inundation, or both.

5.7 Lincoln County

The data for Lincoln County appears in Table 7 and Figure 7. Figure 7a summarizes the vulnerability to ground shaking of critical and essential facilities in the county. There are two hospitals in Lincoln County, one of which may be at risk from ground shaking (50 percent). Nine of eighteen fire/police facilities in Lincoln County could be at risk from ground shaking (50 percent). Fourteen of twenty-eight schools in the county might be at risk from ground shaking (50 percent).

Figure 7b summarizes the risk from tsunami inundation for critical and essential facilities in Lincoln County. Five of eighteen fire/police facilities in Lincoln County may be vulnerable to tsunami inundation (28 percent), along with one of six emergency vehicle shelters (17 percent). Thirteen of fifteen hazardous materials sites could be vulnerable to tsunami inundation (87 percent). Seven of twenty-eight schools in Lincoln County may be vulnerable to tsunami inundation (25 percent). As mentioned above, estimates of tsunami inundation for Lincoln County do not include possible tsunami wave attenuating effects of Yaquina Bay, Alsea Bay, and other estuaries. These effects may significantly reduce the tsunami threat to Waldport and other towns in Lincoln County.

Figure 7c illustrates the potential risk from combined ground shaking and tsunami inundation. It is possible that 68 percent of the schools, 17 percent of the emergency vehicle shelters, 87 percent of the hazardous sites, 55 percent of the fire and police stations, and 50 percent of the hospitals could be at risk. These facilities need further hazard assessment

5.8 Tillamook County

The data for Tillamook County appears in Table 8 and Figure 8. Figure 8a summarizes the vulnerability to ground shaking of critical and essential facilities in the county. There are two hospitals in Tillamook County, both of which may be at risk from ground shaking (100 percent). Fifteen of nineteen fire/police facilities in Tillamook County are possibly at risk from ground shaking (79 percent). There are six emergency vehicle shelters in Tillamook County, one of which might be at risk from ground shaking (17 percent). Five of eighteen schools in the county may be at risk from ground shaking (28 percent).

Figure 8b summarizes the risk from tsunami inundation for critical and essential facilities in Tillamook County. One of two hospitals in Tillamook County may be at risk from tsunami inundation. Thirteen of nineteen fire/police facilities in the county may be at risk from tsunami inundation (68 percent), along with five of six emergency vehicle shelters (83 percent). The one communication facility in the county may be vulnerable to tsunami inundation. Three of five hazardous materials sites could be vulnerable to tsunami inundation (60 percent). Thirteen of eighteen schools in Tillamook County may be vulnerable to tsunami inundation (72 percent). As mentioned above, estimates of tsunami inundation for Tillamook County do not include possible tsunami wave attenuating effects of Tillamook Bay and other estuaries. These effects may significantly reduce the tsunami threat to Tillamook and other towns in Tillamook County. These factors will be particularly effective at reducing the run-up and inundation at the City of Tillamook. Tillamook is more than 6¾ miles inland behind a bay guarded by a significant barrier at the open coast. It is entirely possible that a detailed study of tsunami wave propagation would show that none of the critical facilities in Tillamook are at risk.

Figure 8c illustrates the potential risk from combined ground shaking and tsunami inundation. It is possible that 83 percent of the schools, 83 percent of the emergency vehicle shelters, 60 percent of the hazardous sites, 50 percent of the hospitals and all of the communication centers, fire stations, and police headquarters could be at risk. These facilities need further hazard assessment

6.0 CONCLUSIONS AND RECOMMENDATIONS

Overall, the critical and essential facilities of the Oregon coast are not prepared to withstand a major earthquake and tsunami. A large percentage of the structures are of older cinder block or other unreinforced masonry construction and may not survive significant ground shaking. This is particularly true of older fire stations, county courthouses, and school buildings. In fact, it is apparent that over half of the critical and essential facilities on the coast could possibly be vulnerable to collapse during shaking. This is particularly worrisome with respect to schools. Should a great earthquake occur during class time, children in as many as 64 of the 117 schools might find themselves in collapsing buildings. When the additional hazard of tsunami inundation is added to the earthquake threat, 86 of the 117 schools (74 percent) may be vulnerable. With possibly 10 of the 13 hospitals (84 percent) potentially vulnerable to collapse or tsunami flooding, treatment of the seriously injured may well be impossible in most areas. An entire generation of children in many communities could be at risk. Similar statistics apply to the other facilities studied: fire and police stations, major public assembly structures, hazardous sites, communication centers, emergency preparedness centers, and emergency vehicle shelters. In many of the smallest communities with limited critical facilities, all of their emergency response resources could be vulnerable to one or the other hazard. This is true of even some larger communities like Seaside which lie almost entirely in low lying areas potentially vulnerable to tsunami flooding. When one considers that many of these communities, especially the smaller ones, are likely to be isolated by road and bridge destruction following a great earthquake, the emergency response consequences are very serious.

Since the probability of a great earthquake is on the order of 10 to 20 percent in the next 50 years, there is an 80 to 90 percent likelihood that the coast has fifty years in which to prepare for this event. The following are some of the most pressing problems and the actions which will help to mitigate them.

With regard to earthquake shaking, the most important issue is the retrofitting or replacement of outdated fire stations and school buildings. Cinder block fire stations, which score very low on the ATC survey, are probably at very high risk of collapse. Older masonry school buildings also tend to score very low on the survey. Of additional concern for schools are large windows which could shatter during even a mild earthquake and create a serious safety hazard.

Many local 911 dispatch centers and police departments, with the exception of the Oregon State Police (OSP), are generally housed in older masonry buildings, most often city halls and county courthouses. County emergency preparedness offices, along with their communication equipment and plans, are also generally located in the basements of county courthouses. County courthouses along the coast are large, old unreinforced masonry structures which do not score well on the ATC survey and could be at risk of collapse during an earthquake. Many city halls housing police departments, while much smaller than courthouses, are also generally older unreinforced masonry buildings which may be at risk of collapse.

Several hospitals, though newer than courthouses, are composed of unreinforced masonry which can suffer collapse. Architectural facades and other portions of the structures located around hospital entrances could fall, causing an immediate hazard to those nearby and a continuing problem for those wishing access. Examples of this include apartments or decorative arches located over the street entrance to the emergency room.

A variety of mitigation strategies are available to counter these problems. Fire houses and schools could be reinforced or replaced to increase their resistance to earthquake forces, either by steel reinforcement of existing walls or selective replacement of older walls with reinforced masonry or steel walls, or in the case of some fire stations complete replacement of the older structure. A much more detailed evaluation of a structure and the underlying soil is required before refitting could be undertaken. Replacing structures would also provide the opportunity of moving them away from areas of potential tsunami flooding and from dangerous soils apt to slide, amplify, or liquefy during shaking. School windows could have a clear coating placed on both sides to prevent shattering and wide dispersal of glass shards. Coverings for play areas and other outdoor coverings should be analyzed and replaced or refitted as necessary to ensure that they can resist collapse. Police agencies, county emergency managers, and 911 dispatch centers should be moved to newer facilities designed to withstand earthquake forces and located outside of tsunami threatened areas. Hospitals should be modified to increase their resistance to earthquakes, and the structures or facades which could fall and block the entrances should be removed or more securely fastened. Older masonry hospital buildings should also be reinforced or replaced, as with schools and fire stations, to enhance their survivability. Special attention should also be paid to any structure which could house large numbers of displaced people in an emergency. Experience from past earthquakes has shown that school gymnasiums are particularly useful in this regard.

The tsunami threat to the Oregon coast is not known with precision, because of uncertainties about the size and shape of bottom deformation accompanying a great earthquake and limitations of the resources available to do detailed inundation modeling for each community. Even so, a great many critical facilities are clearly vulnerable to even modest tsunamis. Indeed, every type of critical and essential facility inventoried was in danger from tsunami flooding in one or more localities. Evacuation and emergency response planning is the first mitigation step. The second step, where feasible, is relocation of facilities, especially if new construction is contemplated.

The most effective way to reduce the lives lost during a great earthquake in a coastal zone is to mitigate the tsunami threat, since, historically, most coastal people are killed by this hazard. The most cost effective mitigation strategy is education. Residents of low-lying coastal areas need to be informed about the nature of the tsunami hazard and how to prepare for and respond to that threat. For public agencies this means compiling and distributing accurate information about tsunamis and making sure people know what to do in the event of a tsunami warning or earthquake. **Teaching coastal visitors and residents to get to high ground or inland in the event of an earthquake is essential**. Installation of warning and evacuation signs is an effective first step. DOGAMI, in cooperation with Travel Information Council and a number of other agencies, is installing educational signs at sites such as Newport (entrance to the Aquarium), Reedsport (Visitors Information Center), and Seaside (on the boardwalk) where large numbers of visitors can be expected to see them. The department has also spearheaded design of standard tsunami warning and evacuation signs. To obtain these signs contact:

Orville Gaylor
Traffic Section, Oregon Dept. of Transportation
132 Transportation Bldg.
Salem, Oregon 97310
Phone: 503-986-3603

Ultimately, evacuation and land use planning will have to be guided by accurate maps of the tsunami flooding and of dangerous soils that are subject to liquefaction, landsliding, and amplification of shaking. While expensive, these maps will serve as the only rational basis for crucial decisions, especially in low lying areas underlain by unconsolidated soils where choosing low risk sites and evacuation routes is complex. The DOGAMI pilot study of the Siletz Bay-Lincoln City area is an important first step in providing these maps to targeted municipalities.

7.0 ACKNOWLEDGMENTS

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APPENDIX A
TYPES OF FACILITIES COVERED BY THE SURVEY

Hospitals, per 455.447(a)(A)*. Some larger private clinics which were mentioned by local officials as being significant health care providers in rural areas were included as well.

Fire stations, municipal and rural, per 455.447(a)(B). Municipal and rural fire department and district fire stations. Federal and state fire suppression equipment associated with state parks and national parks and forests were not included.

Police stations, per 455.447(a)(B). These included municipal police departments, county sheriff's departments, and offices of the Oregon State Police.

Emergency vehicle shelters, per 455.447(a)(D). Facilities falling exclusively under this category are private ambulance companies and ambulance services housed near hospitals. Road maintenance facilities of cities, counties, and the state are also included.

Road maintenance facilities' structures are generally light wood or steel frame garages or other small structures. The ATC methodology does not apply well to these types of structures, so they were not inspected.

Emergency preparedness offices, per 455.447(a)(E). These are generally in the offices of the county emergency managers, which are housed in county courthouses.

Government communication centers, per 455.447(a)(G). Facilities such as emergency management offices and ***911 dispatch centers*** were included under this category.

Hazardous industrial sites, per 455.447(b). Large industrial sites and petroleum storage tanks as well as municipal wastewater treatment plants are included under this category.

Major structures, per 455.447(c).

Day care centers, per 455.447(e)(B). All such institutions with student populations over 30. Some smaller day care facilities were included when they were the only ones in small towns.

Private schools, per 455.447(e)(B). The minimum population for inclusion is 30, not 50 as specified by statute.

Public schools, per 455.447(e)(B).

* A proposed amendment to Oregon Regulatory Statute 455.447 currently under consideration provides definitions of critical and essential facilities. Section (a) defines types of "Essential facilities." Section (b) defines "Hazardous Facilities." Section (c) defines "Major Structures." Section (e) defines "Special occupancy structures." Within section (a) there are seven specific types of essential facilities, labeled (A) through (G). Within section (e) there are six specific types of special occupancy structures, labeled (A) through (F). These classifications are used in this report and in the accompanying database.

APPENDIX B
DISCUSSION OF ATC SURVEY METHODOLOGY

The structural survey methodology used on this project, the Applied Technology Council's (1988a) "ATC-21, Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook" is intended to be the first phase in "a multi-phase procedure for identifying hazardous buildings" (Applied Technology Council, 1988a, p. vi). The intent of the procedure is limited to "[providing] a standard rapid visual screening" of buildings to find those which may pose a threat to life in the event of a major earthquake (Applied Technology Council, 1988a, p. v). The inspection performed under this methodology is extremely superficial and merely identifies types of buildings which may present a problem. **It cannot state with certainty whether or not a building will sustain damage or collapse during an earthquake.**

The results of the inspection are reduced to a single number, the Structural Score, "S." This number appears in the facilities database. It is related directly to the probability of a building sustaining major life-threatening structural damage (greater than 60 percent of total value) during an earthquake by the relation:

$$probability = (10^{-S} x100)\%$$

Thus a building with a score (S) of 2.0 has a 1 percent chance of sustaining major damage during a severe earthquake. This is only a rough estimate. It should be emphasized that "[t]he type of damage to be expected is a complex issue that depends on the structural type and age of the building, its configuration, construction materials, the site conditions, the proximity of the building to neighboring buildings, and the type of non-structural elements" (Applied Technology Council, 1988a, p. 9). ***Using the ATC guideline (p. VI, Applied Technology Council, 1988), a building was listed as at risk and in need of more detailed evaluation if it had an ATC structural score of 2.0 or less.***

Damage resulting in loss of life can also result from facades and other portions of buildings falling to the ground, even if the structure itself survives. This eventuality is considered in a superficial way by the ATC procedure. A check-off box indicating the presence of a "Non Structural Falling Hazard" appears on the form (Figure B-1). The purpose of this portion of the survey is to identify facades, awnings, or other features which may fall independently of the structure. This is a wholly qualitative assessment on the part of the inspector.

The Structural Score is based on a compilation of the experiences of expert structural engineers. Engineers were surveyed on their opinions and experience with various types of structures and structural features in areas of high seismicity. Their responses were analyzed to produce the Structural Score matrix seen on the survey form (Figure B-1). Thus the scores reflect the average expected performance for certain broad categories of structures.

In some cases where two or more types of materials were used to construct a building, two or more final scores may apply to that building. Because this survey procedure is intended to be only a screening prior to a more detailed analysis of the more at risk buildings, uncertainty of this kind is not inconsistent with the intent of the survey.

For more details about this structural survey, the reader is referred to Applied Technology Council (1988a), "ATC-21, Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook" and Applied Technology Council (1988b), " ATC 21-1, Rapid Visual Screening of Buildings for Potential Seismic Hazards: Supporting Documentation."

ATC-21/ (NEHRP Map Areas 5,6,7 High)

Rapid Visual Screening of Seismically Hazardous Buildings

Address ______________________

______________________ Zip ______

Other Identifiers ______________________

No. Stories ____________ Year Built ________

Inspector ____________ Date ________

Total Floor Area (sq. ft) ______________________

Building Name ______________________

Use ______________________

(Peel-off label)

Scale:

INSTANT PHOTO

OCCUPANCY	
Residential	No. Persons
Commercial	0–10
Office	11–100
Industrial	100+
Pub. Assem.	
School	
Govt. Bldg.	
Emer. Serv.	
Historic Bldg.	

Non Structural Falling Hazard ☐

DATA CONFIDENCE

* = Estimated, Subjective, or Unreliable Data

DNK = Do Not Know

STRUCTURAL SCORES AND MODIFIERS

BUILDING TYPE	W	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	C1 (MRF)	C2 (SW)	C3/S5 (URM INF)	PC1 (TU)	PC2	RM	URM
Basic Score	**4.5**	**4.5**	**3.0**	**5.5**	**3.5**	**2.0**	**3.0**	**1.5**	**2.0**	**1.5**	**3.0**	**1.0**
High Rise	N/A	-2.0	-1.0	N/A	-1.0	-1.0	-1.0	-0.5	N/A	-0.5	-1.0	-0.5
Poor Condition	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.6	-0.5	-0.5	-0.5
Vert. Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-1.0	-0.5	-0.5	-1.0	-1.0	-0.5	-0.5
Soft Story	-1.0	-2.5	-2.0	-1.0	-2.0	-2.0	-2.0	-1.0	-1.0	-2.0	-2.0	-1.0
Torsion	-1.0	-2.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Plan Irregularity	-1.0	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-1.0	-1.0	-1.0	-1.0
Pounding	N/A	-0.5	-0.5	N/A	-0.5	-0.5	N/A	N/A	N/A	-0.5	N/A	N/A
Large Heavy Cladding	N/A	-2.0	N/A	N/A	N/A	-1.0	N/A	N/A	N/A	-1.0	N/A	N/A
Short Columns	N/A	N/A	N/A	N/A	N/A	-1.0	-1.0	-1.0	N/A	-1.0	N/A	N/A
Post Benchmark Year	+2.0	+2.0	+2.0	+2.0	+2.0	+2.0	+2.0	N/A	+2.0	+2.0	+2.0	N/A
SL2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
SL3	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
SL3 & 8 to 20 stories	N/A	-0.8	-0.8	N/A	-0.8	-0.8	-0.8	-0.8	N/A	-0.8	-0.8	-0.8

FINAL SCORE

COMMENTS

ATC8PM
30032.01

Detailed Evaluation Required?

YES NO

Figure B-1. An ATC building survey form.

APPENDIX C
PRELIMINARY ESTIMATES OF TSUNAMI RUN-UP ELEVATIONS

Table C-1. Modeled shoreline tsunami wave heights and estimated preliminary run-up elevations for a local M8.8 Cascadia earthquake (EQ). Listed for comparison are run-up elevations for tsunamis from distant earthquakes that are likely to occur every 100 or 500 years. The estimates are no substitute for site specific mapping of inundation.

	Cascadia EQ	Cascadia EQ	Cascadia EQ	Cascadia EQ		Distant EQ	Distant EQ
Location	**Wave height (ft)**	**MHH tide (ft)**	**Total run-up (ft)[0]**	**Footnotes**	**°N. Latitude**	**Run-up[13] 100-yr (ft)**	**Run-up[13] 500-yr (ft)**
Astoria	3	4	***12***	[1]	46.18	7	12
Bandon	9	4	***22***	[1]	43.12	8	14
Bay City	15	4	***34***	[1], [3]	45.52	7	13
Brookings	10	4	***24***	[1]	42.06	7	12
Cannon Beach	22	4	***48***	[1]	45.90	8	14
Charleston	11	4	***26***	[1], [4]	43.34	8	14
Cloverdale	15	4	***35***	[2], [5]	45.19	8	14
Coos Bay	11	4	***26***	[1], [4]	43.35	8	16
Coquille	9	4	***22***	[1], [6]	43.18	8	14
Depoe Bay	10	4	***26***	[2]	44.81	8	13
Dunes City	11	4	***26***	[1], [7]	43.90	7	12
Florence	11	4	***26***	[1], [7]	43.99	9	15
Gardiner	24	4	***53***	[2], [8]	43.75	9	16
Garibaldi	15	4	***34***	[1], [3]	45.56	7	13
Gearhart	21	4	***46***	[2]	46.02	11	19
Glasgow	11	4	***26***	[1], [4]	43.44	7	11
Gleneden Beach	13	4	***30***	[1], [9]	44.88	7	13
Gold Beach	15	4	***33***	[2]	42.41	8	14
Harbor	10	4	***24***	[1], [10]	42.04	7	12
Hauser	11	4	***26***	[1], [4]	43.50	8	13
Lakeside	24	4	***53***	[2], [8]	43.57	8	14
Langlois	9	4	***22***	[1], [6]	42.92	7	12
Lincoln City	13	4	***30***	[1], [9]	44.94	8	14
Manzanita	16	4	***36***	[1]	45.72	8	14
Nehalem	14	4	***32***	[1]	45.72	8	14
Neskowin	18	4	***39***	[2]	45.11	7	12
Netarts	24	4	***53***	[2]	45.44	7	13
Newport	15	4	***34***	[1]	44.64	8	14
North Bend	11	4	***26***	[1], [4]	43.40	8	16
Oceanside	15	4	***35***	[2]	45.46	7	13
Ophir	12	4	***29***	[2]	42.56	12	20
Otter Rock	13	4	***31***	[2]	44.75	7	12
Pacific City	15	4	***35***	[2]	45.20	8	14
Pistol River	8	4	***20***	[2]	42.28	6	10
Port Orford	7	4	***18***	[1]	42.75	7	12

Location	Cascadia EQ Wave height (ft)	Cascadia EQ MHH tide (ft)	Cascadia EQ Total run-up (ft)[0]	Cascadia EQ Footnotes	°N. Latitude	Distant EQ Run-up[13] 100-yr (ft)	Distant EQ Run-up[13] 500-yr (ft)
Reedsport	24	4	***53***	[2], [8]	43.70	7	13
Rockaway Beach	18	4	***39***	[2]	45.60	8	13
Sandlake	17	4	***39***	[2]	45.29	8	13
Seal Rock	15	4	***34***	[2]	44.50	11	19
Seaside	20	4	***45***	[2]	45.99	11	19
Tillamook	15	4	***34***	[1], [3]	45.46	7	13
Toledo	15	4	***34***	[1], [11]	44.62	9	16
Waldport	12	4	***28***	[2]	44.43	11	20
Warrenton	16	4	***36***	[2]	46.16	8	12
Wheeler	14	4	***32***	[1], [12]	45.69	9	16
Winchester Bay	24	4	***53***	[2]	43.68	7	13
Yachats	10	4	***25***	[2]	44.31	11	19

Footnotes:

[0] Total Run-up from a local M 8.8 Cascadia earthquake = Mean Higher High Tide (MHH Tide) + 2 X Wave Height.

[1] Source: Myers (1994).

[2] Source: Ed Myers (1994, personal. communication) from OGI interim wave height model.

[3] Based on modeled wave at Barview (Tillamook Bay entrance).

[4] Based on modeled wave at Barview (Coos Bay entrance).

[5] Based on modeled wave at Pacific City.

[6] Based on modeled wave at Bandon (Coquille River mouth).

[7] Based on modeled wave at Heceta Beach.

[8] Based on modeled wave at Winchester Bay.

[9] Based on modeled wave at Siletz Bay entrance.

[10] Based on modeled wave at Brookings.

[11] Based on modeled wave at Newport (Yaquina Bay entrance).

[12] Based on modeled wave at Nehalem (Nehalem Bay).

[13] Statistically derived run-up elevations from Houston and Garcia (1978) for distant tsunamis which can be expected to recur every 100 or 500 years. They assumed that the most significant tsunamis would be from South American and Aleutian Trench earthquake sources. They superimposed possible tsunamis on typical tides for a 24-hour period to derive the run-up elevations with a probability equal to the 100- and 500-year recurrence. Elevations listed in the table were determined by plotting the listed latitude of the individual cites on Plates 18 through 26 of Houston and Garcia (1978). Elevations are for open coastal run-up and do not imply that these are accurate flooding elevations for inland areas like Tillamook. and Reedsport. Complex inundation modeling must be done to accurately predict actual flooding elevations at all sites. The Houston and Garcia (1978) numerical model had significantly less bathymetric data for the Oregon coast than that used by the Oregon Graduate Institute of Science and Technology for the Cascadia tsunami model. Numerical modeling techniques for the two studies also differed, so they are not directly comparable.

APPENDIX D
FACILITY INSPECTION PROCEDURE

The survey procedure for this project was planned around completing the structural survey described in Appendix B and obtaining data for the other fields in the database. An inspection typically lasted from 5 to 30 minutes, depending on the size and complexity of the structure. The on-site portion of the survey required the completion of the basic data about the facility and inspection, taking a photograph of the facility, completing a rough sketch of the facility, defining its occupancy category, and determining its structural score. The immediate terrain and physical location were noted for the tsunami portion of the database.

The structural score is based on two things: the type of material used in constructing the building, and what features of a building may diminish the building's capacity to resist seismic forces. These can be determined to a greater or lesser degree by carefully observing the exterior walls and roof of a structure. The primary material is usually obvious. On occasion facades or thick paint may obscure the walls sufficiently to make determining the material impossible. In this case, the material may be guessed, or all but two possible choices eliminated. Gross architectural and other features which affect the score are readily apparent from the outside. Entrance into the building and inspection of its structure from within, while very useful in determining a building's strength and capacity to resist earthquakes, are not intended in the survey methodology.

The building sketch is intended to show special features not indicated in the photograph or the structural score. For this project, the sketch was most useful for determining the rough layout of a building. The layout has implications to the structural score and also gives a good estimate of the size of a building. The sketch is also intended to ensure careful observation of the building. In this it can be quite effective, since sketching the layout and composition of the walls provides a natural opportunity to note special details in a logical format. Observations were keyed to establishing the structural score and to finding special features which present a particular hazard during an earthquake. Examples of this are large windows and heavy facades or other overhanging features which could fall and create a hazard during or after an earthquake.

One or more photographs of the structure were taken with a 35-mm camera. The survey calls for an "instant photo," i.e. a Polaroid, to be taken. In the author's experience, these types of photos do not convey sufficient information to be of use to an observer who has never seen the structure first-hand. The occupancy section of the survey form is self-explanatory. Space is also provided for additional comments about the structure. These comments are reflected in the comment space of the database where appropriate.

APPENDIX E
DESCRIPTION OF THE DATABASE

Digital Files

Subdirectory *Charfigs* has all spreadsheet figures in Microsoft Excel 4.0 format.

Subdirectory *Chardat* has data files for individual facilities within each county. Data files have all data on individual facilities for each coastal zone within a county; file names are the names of the counties. Files with extension *.xls* are Microsoft Excel 4.0 spreadsheet files. Files with extension *.dbf* are in dBase file format, generally dBaseIII or IV.

The database was originally created as Excel spreadsheets, so the data is best viewed in spreadsheet format. dBase files have some comment fields truncated during file conversion. Footnotes were also lost during conversion to dbase files, but are listed in the *Readme.txt* file in the *Explantn* subdirectory. Revised dBase field labels are also listed in *Readme.txt*. The following are explanations of the original spreadsheet field labels.

Basic Data

Name	Building or facility name or identification.
Use	The use of the facility which qualifies it for inclusion in this survey.
Owner	Publicly owned or privately owned.
Address	The street address of the facility. In some cases a street number could not be found, so the nearest intersection or simply the street alone is indicated. This situation is most common in smaller towns.
City	The city, town, or locale where the facility is located.
County, ZIP	The county in which the facility is located, and the ZIP code.
Location (2 fields)	The longitude and latitude of the facility.
Brief description	The basic type of material used in constructing the building or buildings of the facility (e.g. wood or cinder blocks).
Building class	The section(s) of ORS 455.447 which applies to the facility.
Structural Score	The Structural Score for a facility. In cases where a building is composed of two distinct sections, two scores may be indicated. Two scores may also result from uncertainty about the makeup of a building. For a discussion of the meaning of the score, see Appendix B.
Non structural falling hazard	This field indicates the apparent presence or absence of facades or other portions of the structure which may fall and create a hazard during an earthquake.
Survey sheet number	The survey form for every facility included in the structural portion of the survey is on file. Survey forms are numbered sequentially for each town and city.
Surface soil type	A qualitative assessment of the predominant soil type at the surface was made where possible.

Tsunami Data

Elevation (MSL)	The elevation of a facility, read off USGS 7.5-minute topographical maps, above mean sea level (MSL). On some maps, the elevation is often difficult to determine with precision, so a range, maximum or minimum is indicated.
Distance from shoreline	The distance from the open ocean to the facility. For inland towns and cities, this is not significant and is not reported. In the North Bend/Coos Bay area, this field is replaced by a distance from Coos Bay. In the Astoria area, the field may be replaced by a distance from the Columbia River.
Distance from nearest water	The distance from the nearest body of water to the facility.
Type of nearest waterbody	The name and type of the nearest water body. For rivers, the river mile at the closest approach is indicated if available.
Terrain slope	The topography of the surrounding area. This data is intended to reflect the potential for long-term flooding of the facility in the event of inundation.
Surrounding geography	A qualitative assessment of the immediate area surrounding the facility. Five types of terrain are listed: • Open - No or few surrounding structures, little or no significant vegetation. • Open residential - A few houses or other light structures in the vicinity. • Dense residential - Many houses or other light structures in the vicinity. • Open business - A few buildings or other large structures in the vicinity. • Dense business - Many buildings or other large structures in the vicinity.
At risk?	Yes, the facility is found to be in potential danger from tsunami inundation, or No, the facility is not found to be in danger.
USGS map	The name of the USGS 7.5 minute topographical map containing the facility.
Comments	Space for any special information or comment about the facility.