Oregon Seismic Lifeline Routes Identification Project

Lifeline Selection Summary Report

Prepared for
Oregon Department of Transportation

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Contents

1.0 Introduction

1.1 Project Background

The Oregon Department of Transportation mission is "(t)o provide a safe, efficient transportation system that supports economic opportunity and livable communities for Oregonians." To fulfill that mission, the Oregon Transportation Commission makes decisions about how best to maintain transportation facilities for multiple purposes including public safety and resilience in the case of natural disasters. This study is the latest addition to ongoing efforts to maintain transportation system resilience, this time focused on earthquakes and associated hazards.

Specifically, the Oregon Seismic Lifeline Routes (OSLR) identification project has produced this study which includes recommendations for designation of a Seismic Lifelines System. The study was designed to address Policy 1E, Lifeline Routes, of the 1999 Oregon Highway Plan, which states: "It is the policy of the State of Oregon to provide a secure lifeline network of streets, highways, and bridges to facilitate emergency services response and to support rapid economic recovery after a disaster." This project advances ODOT's commitment to support a secure lifeline network by addressing system vulnerability issues within the right of way of existing highway facilities.

This report is not an emergency response plan. ODOT participates in emergency response planning statewide as a First Responder for Transportation and Public Works functions and has a formal Emergency Operations Plan, administered in the Maintenance Division, which includes agreements with other emergency service providers statewide. This current effort is to develop **a strategy for the state highway system to support emergency response and recovery efforts by providing the best connecting infrastructure practicable** between service providers, incident areas and essential supply lines to allow emergency service providers to do their jobs with minimum disruption. It is also intended to support community and regional economic recovery after a disaster event.

The Oregon Highway Plan Lifeline Routes policy also states that "ODOT's investment strategy should recognize the critical role that some highway facilities, particularly bridges, play in emergency response and evacuation." ODOT Bridge section has taken the lead on identifying system vulnerabilities and connecting vulnerable bridges with available funding to increase system resiliency. This report summarizes a newly developed study method to help prioritize system management measures at a systems level. It includes data beyond the facility and geophysical data addressed in earlier studies and adds new considerations including population areas, locations of hospitals, fire stations, energy utilities, fuel storage facilities and other essential services, and connections to other modes that will be important in a major emergency such as airports, ports and freight routes. In this way, the study looks at vulnerabilities, key connections, and road capacity to identify routes that need to be made more resilient to facilitate response and recovery after a disaster.

While the OHP policy identifies earthquakes, flooding, landslides, wild fires, and other natural and man-made disasters as the types of events that ODOT plans will address, the "design event" for this study is a major Cascadia Subduction Zone (CSZ) earthquake with likely related events including tsunami, landslides, liquefaction of soils and dam failures. **The reason for focusing on a Cascadia Subduction Zone event is that it would have regional to multi-state impacts and would require a multi-state and federal response.** A CSZ event would also have significant impacts on the surface transportation system, requiring mobilization of many levels of emergency response and having far-reaching economic impacts. The result of this work can be built upon over time to address issues not included here, including other natural hazards and interoperability with local transportation networks

1.2 Report Overview

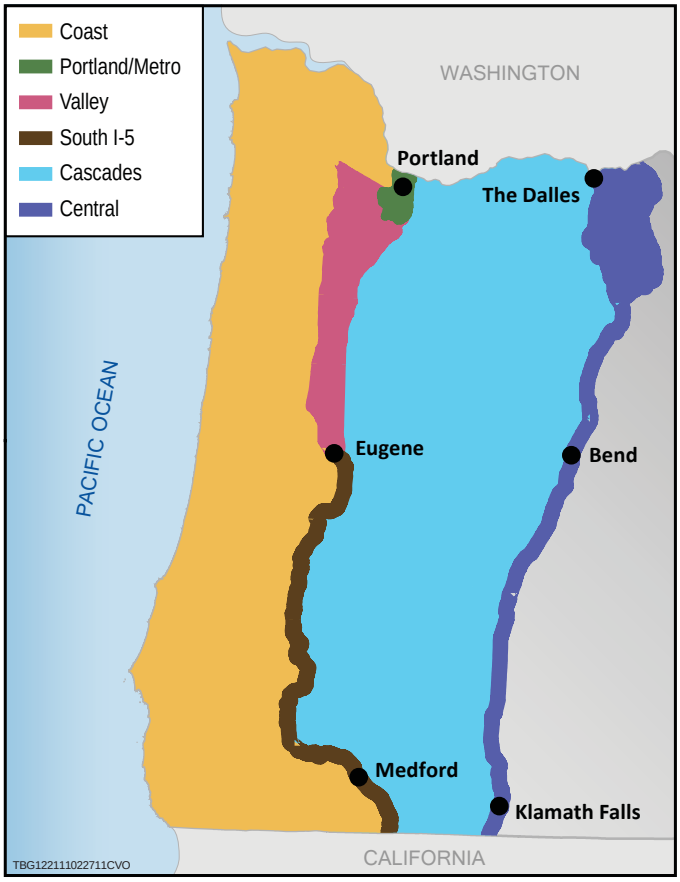
This report provides a high-level overview of the project to identify Oregon Seismic Lifeline Routes, summarizing the processes conducted and conclusions reached. Many more details about the data and methodology used, as well as the specific results of the OSLR project, can be found in the *Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification* report (CH2M HILL, 2012).

The purpose of the OSLR project is to facilitate the implementation of Policy 1E, Lifeline Routes, in the *Oregon Transportation Plan*, which states, "It is the policy of the State of Oregon to provide a secure lifeline network of streets, highways, and bridges to facilitate emergency services response and to support rapid economic recovery after a disaster" (Oregon Department of Transportation [ODOT], 2006). The OSLR project helps to implement that policy by establishing the specific list of highways and bridges that comprise the seismic lifeline network. Further, it establishes a three-tiered system of seismic lifelines to help prioritize seismic retrofits on state-owned highways and bridges. The three tiers are described in some detail below. The OSLR project was conducted by the ODOT Transportation Development Division (TDD) from September 2011 through April 2012, in coordination and consultation with Bridge, Maintenance, Geotechnical, and other impacted divisions within the agency, as well as with other state agencies including the Oregon Department of Geological and Mineral Industries (DOGAMI) and the Public Utility Commission (PUC) through a Project Management Team (PMT) and Steering Committee (SC).

2.0 Process for Identifying Lifeline Routes

The study area was considered to be the geographic region of the State most susceptible to a seismic event and related impacts, that being, generally, the populated areas along the Interstate 5 corridor and locations west of I-5. The area east of Interstate 5 to US 97 was also included in the study area, because access to the east side of Interstate 5 was critical to key emergency response services and to widespread economic recovery. Figure 2-1 highlights the study area and the six geographic zones within the study area.

FIGURE 2-1
Project Study Area and Geographic Zones



Within the study area, Oregon highways were considered. The process started with the selection of Oregon highways that were good candidates as lifeline routes for further evaluation, as identified by ODOT staff. This step was done to increase the efficiency of the OSLR project and to decrease the effort required to analyze the data along each route. State highways west of US 97 were selected for inclusion in the evaluation because they meet one or more of the following characteristics:

- Likely ability to promote safety and survival through connections to major population centers with survival resources
- Current use as a strategic freight and/or commerce route
- Connection to one or more of the following key destinations of statewide significance identified by ODOT Maintenance as critical for surface connection to interstate resources:
  - I-84 east of Biggs Junction
  - US 20 east of Bend
  - The California border on I-5
  - The California border on US 97
  - A crossing of the Columbia River into southwest Washington
  - A port on the Columbia or Willamette River
  - A port on the coast
  - Portland International Airport
  - Redmond Municipal Airport

State highways in western Oregon that were not selected are considered important to the overall transportation system and local emergency response and recovery. However, for the purposes of this study, they were found not to be good candidates for identification as regional lifeline routes because they do not connect major population centers, or do not connect to destinations of statewide significance, or, in downtown Portland, are not considered primary facilities. Figure 2-2 depicts the highways that were included in the evaluation.

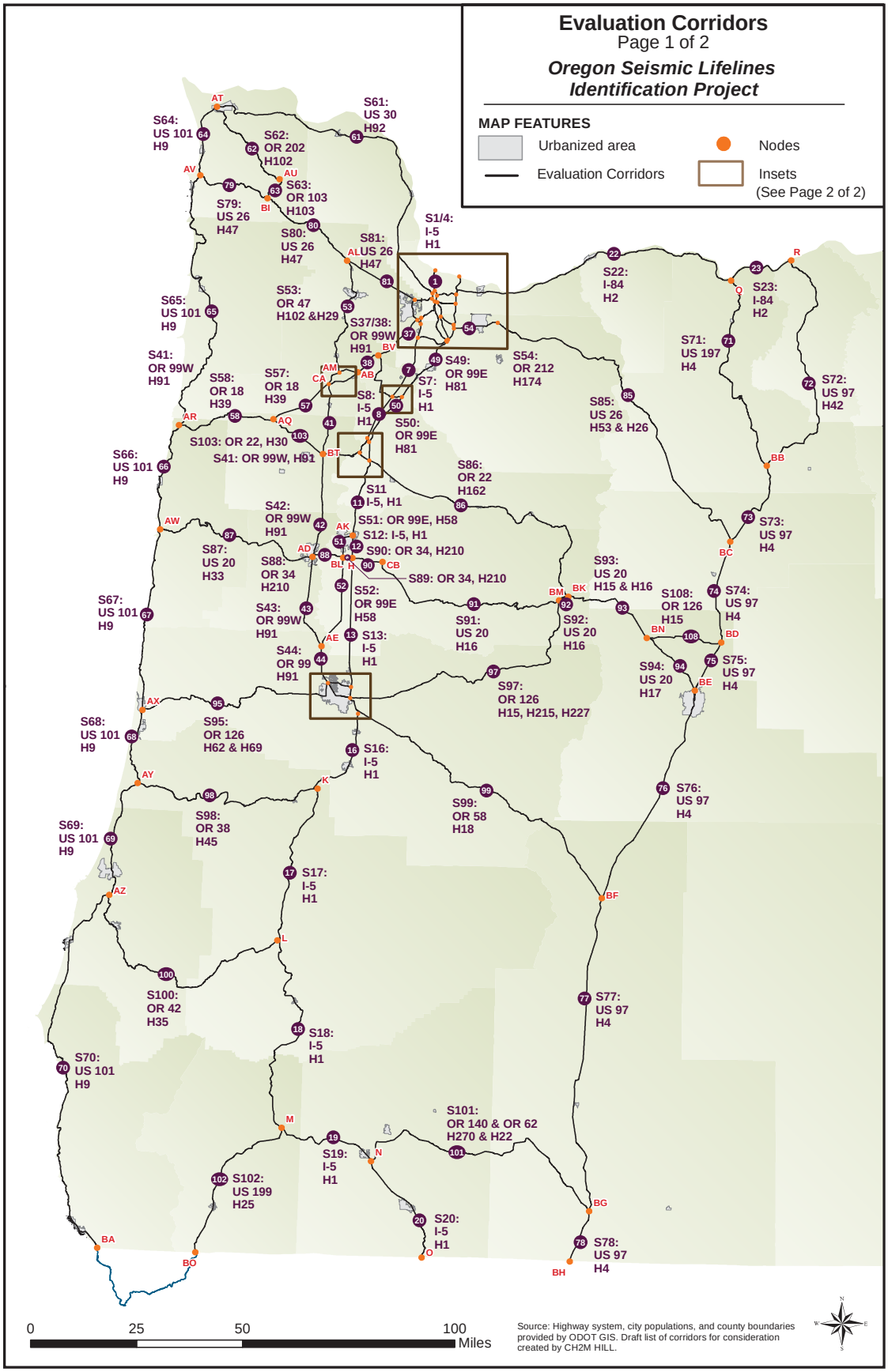
Each highway in the study was divided into segments, which can be grouped geographically into the following six geographic zones (shown in Figure 2-1) within the western half of the state:

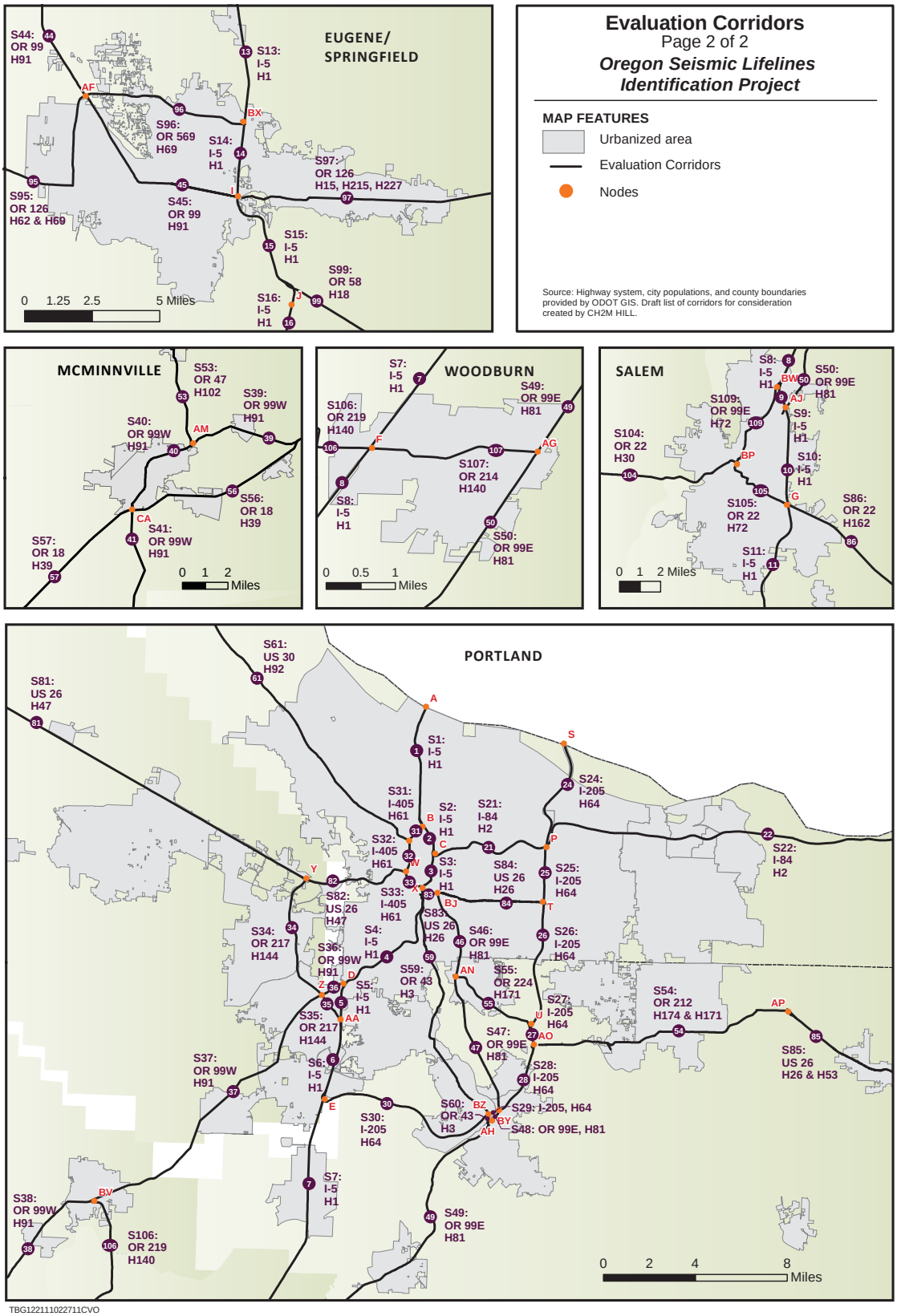
- Coast (US 101 and connections to US 101 from the Willamette Valley)
- Portland Metro (highways within the Portland metro region)
- Valley (circulation between the Portland metro area and other major population centers in the Willamette Valley)
- South I-5 (the section of I-5 south of Eugene/Springfield)
- Cascades (highways crossing the Cascades mountain range)
- Central (the US 97/US 197 corridor from Washington to California)

After selecting the highways for evaluation, an evaluation framework was established that includes goals, objectives, criteria, and parameters. **Goals** are the guiding principles for what the set of lifeline routes are meant to accomplish before, during, and after a seismic event. There are three main goals for Oregon seismic lifeline routes:

1. Support survivability immediately following the event
2. Provide transportation facilities critical to life support for an interim period following the event
3. Support statewide economic recovery

FIGURE 2-2
Evaluation Corridors




EUGENE/
SPRINGFIELD
S44: OR 99 H91
S13: I-5 H1
S96: OR 569 H69
S14: I-5 H1
S97: OR 126 H15, H215, H227
S95: OR 126 H62 & H69
S45: OR 99 H91
S15: I-5 H1
S99: OR 58 H18
S16: I-5 H1
0 1.25 2.5 5 Miles
Evaluation Corridors
Page 2 of 2
Oregon Seismic Lifelines Identification Project
MAP FEATURES
Urbanized area
Evaluation Corridors
Nodes
Source: Highway system, city populations, and county boundaries provided by ODOT GIS. Draft list of corridors for consideration created by CH2M HILL.
MCMINNVILLE
S53: OR 47 H102
S39: OR 99W H91
S40: OR 99W H91
S56: OR 18 H39
S41: OR 99W H91
S57: OR 18 H39
0 1 2 Miles
WOODBURN
S7: I-5 H1
S49: OR 99E H81
S106: OR 219 H140
S107: OR 214 H140
S8: I-5 H1
S50: OR 99E H81
0 0.5 1 Miles
SALEM
S8: I-5 H1
S50: OR 99E H81
S109: OR 99E H72
S9: I-5 H1
S104: OR 22 H30
S10: I-5 H1
S105: OR 22 H72
S86: OR 22 H162
S11: I-5 H1
0 1 2 Miles
PORTLAND
S61: US 30 H92
S81: US 26 H47
S1: I-5 H1
S24: I-205 H64
S31: I-405 H61
S2: I-5 H1
S21: I-84 H2
S22: I-84 H2
S32: I-405 H61
S3: I-5 H1
S84: US 26 H26
S25: I-205 H64
S82: US 26 H47
S33: I-405 H61
S83: US 26 H26
S34: OR 217 H144
S4: I-5 H1
S46: OR 99E H81
S26: I-205 H64
S36: OR 99W H91
S59: OR 43 H3
S55: OR 224 H171
S5: I-5 H1
S27: I-205 H64
S54: OR 212 H174 & H171
S35: OR 217 H144
S47: OR 99E H81
S85: US 26 H26 & H53
S37: OR 99W H91
S6: I-5 H1
S28: I-205 H64
S30: I-205 H64
S60: OR 43 H3
S29: I-205, H64
S48: OR 99E, H81
S7: I-5 H1
S38: OR 99W H91
S106: OR 219 H140
S49: OR 99E H81
0 2 4 8 Miles
TBG122111022711CVO

These goals capture the need for seismic lifeline routes during three distinct time periods after a seismic event. Goal 1 refers to short term needs after an event, Goal 2 refers to mid-term needs after an event, and Goal 3 refers to long term needs after an event. **Objectives** are the specific actions that can be implemented to achieve each goal. Each goal has two or three specific objectives. **Criteria** are categories of measurements for which data was available to support the evaluation of how well each segment can achieve the related objectives and goal. Table2-1 lists the goals, objectives, and criteria within the evaluation framework.

TABLE 2-1
Evaluation Framework

Goals	Objectives	Criteria
1. Support survivability immediately following the event *(short term)*	1A: Retain routes necessary to bring emergency responders to the emergency location	· Bridge seismic resilience · Roadway seismic resilience · Dam safety · Roadway width · Route provides critical non-redundant access to a major area · Access to fire stations · Access to hospitals · Access to ports and airports · Access to population centers · Access to ODOT maintenance facilities · Ability to control access during response and recovery
	1B: Retain routes necessary to (a) transport injured people from the damaged area to hospitals and other critical care facilities and (b) transport emergency response personnel (police, firefighters, and police), equipment, and materials to damaged areas	· Route provides critical non-redundant access to a major area · Bridge seismic resilience · Dam safety · Roadway seismic resilience · Access to hospitals · Access to emergency response staging areas
2. Provide transportation facilities critical to life support for an interim period following the event *(mid-term)*	2A: Retain the routes critical to bring life support resources (food, water, sanitation, communications, energy, and personnel) to the emergency location	· Access to ports and airports · Bridge seismic resilience after short term repair · Dam safety · Roadway seismic resilience · Access to critical utility components (such as fuel depots and critical communication facilities) · Access to ODOT maintenance facilities · Freight access

TABLE 2-1
Evaluation Framework

Goals	Objectives	Criteria
	2B: Retain regional routes to hospitals	· Access to hospitals
	2C: Retain evacuation routes out of the affected region	· Access to central Oregon · Access to ports and airports · Importance of route to freight movement
3. Support statewide economic recovery *(long-term)*	3A: Retain designated critical freight corridors	· Freight access · Bridge seismic resilience after short-term repair · Roadway seismic resilience after short-term repair · Route provides critical non-redundant access to a major area · Access to ports and airports · Access to railroads
	3B: Support statewide mobility for connections outside of the affected region	· Access to central Oregon · Access to ports and airports · Access to railroads
	3C: Retain transportation facilities that allow travel between large metro areas	· Route provides critical non-redundant access to a major area · Connection to centers of commerce

ODOT = Oregon Department of Transportation

Each segment was assigned a rating of high, moderate, or low with respect to its performance for each criterion. Once the results of the evaluation of each segment were established, weightings were assigned to each goal, objective, and criteria based on relative importance of the criteria and/or relative value of the available data, as assessed by the project teams. This allowed routes to be compared to each other in order to arrive at an overall rating. That rating was then used to help identify the most favorable seismic lifeline routes. These overall ratings, along with several other criteria discussed below, were then used to define the seismic lifelines as Tier 1, 2, and 3, as described in the next section.

3.0 Identification of Seismic Lifeline Routes

The results of the evaluation framework and a review of system connectivity and key geographical features were used to identify a three-tiered seismic lifeline system. The routes identified as Tier 1 are considered to be the most significant and necessary to ensure a functioning statewide transportation network. A functioning Tier 1 lifeline system provides traffic flow through the state and to each region. The characteristics of a sufficient Tier 1 system included:

· A contiguous network (all Tier 1 segments are connected to all other Tier 1 segments so that there are no isolated Tier 1 segments)

- Penetration of each geographic region of the study area with access to the most populous areas in those regions
- Access to the most critical facilities required for statewide response and recovery (facilities required for electrical generation and distribution, road building materials, communications, fuel delivery, etc)
- Access from the east to the most seismically vulnerable regions of the state
- Redundant crossings of the Willamette River in Portland (more than one crossing so that all traffic is not constrained to a single crossing)
- The Tier 1 system should be as small as possible to both meet the needs listed above and minimize the cost of retrofit and/or repair (provide the most important services for the least cost)

The Tier 2 lifeline routes provide additional connectivity and redundancy to the Tier 1 lifeline system. The Tier 2 system allows for direct access to more locations, increased traffic volume capacity, and alternate routes in high-population regions in the event of outages on the Tier 1 system.

The Tier 3 lifeline routes provide additional connectivity and redundancy to the lifeline systems provided by Tiers 1 and 2.

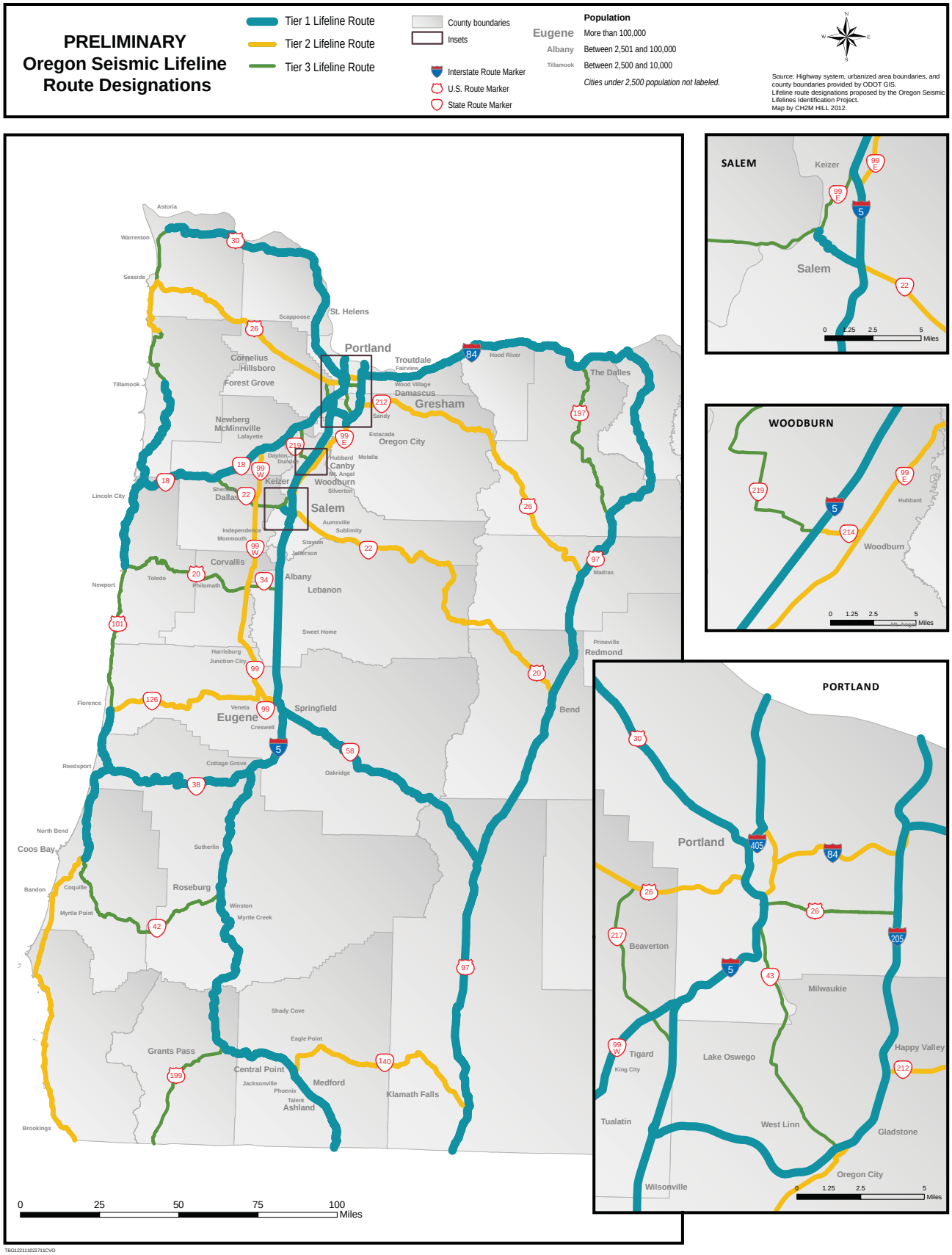
Together, the Tiers 1, 2, and 3 lifelines comprise the Oregon Seismic Lifeline System and are intended to accomplish the following:

- Include all of US 101 to provide access to all of the Oregon coast
- Include routes that have been identified as providing access to the most critical utilities
- Include all routes that have been identified as providing access to the nine State of Oregon emergency staging areas identified by the Oregon Office of Emergency Management.
- Include all routes that have been designated as strategic freight corridors or freight facilities

Figure 3-1 depicts Tier 1, 2, and 3 seismic lifeline routes. The sections that follow list the lifeline routes within each geographic zone.

In the discussion below, the roadways selected to serve as lifeline routes are referred to as corridors since it is not intended that the identified state highways be utilized as seismic lifeline routes to the exclusion of other alternatives in the same vicinity. Future seismic vulnerability evaluation and remediation prioritization efforts are likely to identify least cost alternatives for providing a seismically resilient route that include detours off of the identified roadway to bypass critical seismic vulnerabilities. Therefore the term “corridor” is used to denote that the identified highway, along with easily accessed adjacent roadways as necessary, are intended to serve as the seismic lifeline route.

FIGURE 3-1
Lifeline Routes



3.1 Coast Geographic Zone

The Coast Geographic Zone is the most seismically vulnerable of all the geographic zones and the most difficult to access due to geographic constraints. While one could argue that the region's critical post earthquake needs should dictate that all routes be Tier 1, the reality is that the vulnerabilities in the Coast Geographic Zone are so extensive that the majority of the cost to make the entire lifeline system resilient would be incurred for repairs done within this region. Furthermore, because of the high vulnerability of the zone, it is paramount that emergency services and recovery resources are able to reach this zone from other zones. Consequently, the Consensus of the PMT and SC was that all needs are best served with a conservative Tier 1 backbone system, selected according to the criteria described in Section 3.0, above.

The Tier 1 system in the Coast Geographic Zone consists of three access corridors:

- OR 30 from Portland to Astoria
- OR 18 from the Valley to US 101 and north and south on US 101 from Tillamook to Newport
- OR 38 from I-5 to US 101 and north and south on US 101 from Florence to Coos Bay

The Tier 2 system in the Coast Geographic Zone consists of three access corridors:

- US 26 from OR-217 in Portland to US 101 and north and south on US 101 from Seaside to Nehalem
- OR 126 from the Valley to US 101 at Florence
- US 101 from Coos Bay to the California border

The Tier 3 system in the Coast Geographic Zone consists of the following corridors:

- US 101 from Astoria to Seaside
- US 101 from Nehalem to Tillamook
- OR 22 from its junction with OR 18 to the Valley
- OR 20 from Corvallis to Newport
- OR 42 from I-5 to US 101
- US 199 from I-5 to the California border

3.2 Portland Metro Geographic Zone

In addition to encompassing the largest population concentration in the state, the Portland Metro Geographic Zone contains facilities (such as transportation, communication, and fuel depots) that are critical to statewide earthquake response and recovery. For these reasons, it has a higher concentration of lifeline routes than the other geographic zones and redundant Tier 1 crossings of the Willamette River.

The Tier 1 system in the Portland Metro Geographic Zone consists of the following corridors:

- I-5, excluding the section between the northern and southern I-405 interchanges
- I-405
- I-205
- OR 99W from I-5 to OR 217

The Tier 2 system in the Portland Metro Geographic Zone consists of three access corridors:

- I-84
- I-5 between the northern and southern I-405 interchanges
- US 26 from OR 217 to I-405

The Tier 3 system in the Portland Metro Geographic Zone consists of the following corridors:

- OR 217
- US 26 from I-5 to I-205
- OR 43

3.3 Valley Geographic Zone

The Valley Geographic Zone generally consists of two or three north-south routes through the Willamette Valley and a variety of east-west connectors between those routes. It was desired to designate seismic lifeline routes that provide redundant north-south movement.

The Tier 1 system in the Valley Geographic Zone consists of the following corridors:

- I-5
- OR 99W from I-5 to OR 18 near Dayton
- OR 18 from OR 99W near Dayton to McMinnville
- OR 22 from I-5 to OR 99E in Salem

The Tier 2 system in the Valley Geographic Zone consists of the following corridors:

- US 26 from OR 47 to OR 217
- OR 99W from McMinnville to Junction City
- OR 99 from Junction City to I-5 in Eugene
- OR 99E from Oregon City to I-5 in Salem
- OR 214 in Woodburn from I-5 to OR 99E

The Tier 3 system in the Valley Geographic Zone consists of the following corridors:

- OR 219 from Newberg to Woodburn
- OR 99E in Salem from I-5 to OR 22
- OR 22 from OR 99W to Salem
- OR 34 from Corvallis to I-5

3.4 South I-5 Geographic Zone

The only roadway included in the evaluation in the South I-5 Geographic Zone is I-5 from Eugene to the California border. All of I-5 in this zone has been designated Tier 1 due to its importance in the region and the lack of alternate corridors.

3.5 Cascades Geographic Zone

The Cascades Geographic Zone consists of five crossings of the cascades from western to central Oregon. These routes connect the highly seismically impacted western portion of the state to the central portion of the state that is expected to have less impact from a Cascadia Subduction Zone event. In addition, the southernmost route can serve as a connection from Medford to the Klamath Falls area in the event of a seismic event in the Klamath Falls area.

The Tier 1 system in the Cascades Geographic Zone consists of two corridors:

- I-84
- OR 58

The Tier 2 system in the Cascades Geographic Zone consists of two corridors:

- OR 212 and US 26
- OR 22 from Salem to Santiam Junction and US 20 from Santiam Junction to Bend

There are no corridors designated as Tier 3 in the Cascades Geographic Zone.

3.6 Central Geographic Zone

The Tier 1 system in the Central Geographic Zone consists of the following corridors:

- I-84 from The Dalles to Biggs Junction
- US 97

There are no Tier 2 corridors in the Central Geographic Zone

One Tier 3 corridor is in the Central Geographic Zone:

- US 197

4.0 Conclusion

This report provides ODOT with guidance about which roadways are most important for response and recovery following a major earthquake and which roadways are most easily prepared for, and repaired after, a major seismic event. Tier 1 lifeline routes are the most critical highways identified to provide statewide coverage; Tiers 2 and 3 lifeline routes would increase the usability of the system and add access to other areas. The next step in the process of planning for a seismic event is to prioritize mitigation and retrofit projects on these lifelines. Although this study has provided comparative results for seismic vulnerability on roadways, it does not provide sufficient detail to actually prioritize bridge and roadway seismic retrofits on a given highway. Additional engineering evaluations are needed to determine the needs for bridge and roadway seismic retrofit projects.

The information developed through this study will be used to update the Oregon Highway Plan, Lifelines Policy 1E by providing additional detail in the background section and by supporting revisions to policy actions that have been addressed by this and other activities since the policy was last amended. In addition, the Oregon Seismic Lifelines Map is expected to be adopted as part of the OHP.

5.0 References

CH2M HILL. 2012. *Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification*. May 15.

Oregon Department of Transportation. 2006. *Oregon Transportation Plan*. http://www.oregon.gov/ODOT/TD/TP/ortransplanupdate.shtml. Accessed September 2011.