MovingAhead

STREETS AND PLACES REIMAGINED

DRAFT FINAL Geology and Seismic Technical Report

Lane Transit District
City of Eugene

In cooperation with
Lane Council of Governments
Lane County
Oregon Department of Transportation

July 7, 2017

DRAFT FINAL Geology and Seismic Technical Report

MovingAhead Project

Prepared in accordance with the
National Environmental Policy Act of 1969, as amended 42 U.S.C. 4322
and the
Federal Transit Act of 1964, as amended 49 U.S.C. 1601 et seq.

July 7, 2017

Prepared for
Federal Transit Administration
Lane Transit District
City of Eugene

Prepared by
CH2M HILL, Inc.

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Sasha Luftig, Project Manager for the MovingAhead Project, at
(541) 682-6135 or (800) 735-2900 TTY or Sasha.Luftig@ltd.org.

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(541) 682-6135 or Sasha.Luftig@ltd.org.

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Acronyms, Abbreviations, and Terms

Acronyms and Abbreviations	Definitions
AA	Alternatives Analysis
AASHTO	American Association of State Highway and Transportation Officials
API	area of potential impact
BAT	business access and transit lanes
BMP	best management practice
BRT	bus rapid transit
CH2M	CH2M HILL, Inc.
City	City of Eugene
CSZ	Cascadia Subduction Zone
Draft Eugene 20135 TSP	Draft Eugene 2035 Transportation System Plan (City of Eugene, 2016)
DOGAMI	Oregon Department of Geology and Mineral Industries
EmX	Emerald Express, Lane Transit District's Bus Rapid Transit System
FTA	Federal Transit Administration
FTN	frequent transit network
I-105	Interstate 105
I-5	Interstate 5
LCC	Lane Community College
LCOG	Lane Council of Governments
LTD	Lane Transit District
MMA	Michael Minor and Associates, Inc.
MPO	metropolitan planning organization
Mw	earthquake moment magnitude
NAVD88	North American Vertical Datum of 1988
NEPA	National Environmental Policy Act
NRCS	Natural Resources Conservation Service
ODOT	Oregon Department of Transportation
ROW	right of way
TSP	Transportation System Plan
U.S.C.	United States Code
RTP	Regional Transportation Plan (Central Lane MPO, 2011); the RTP includes the Financially Constrained Roadway Projects List
USGS	U.S. Geological Survey
WEEE	West Eugene EmX Extension
WEG	wind erodibility group

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Geology and Seismic Summary

This Geology and Seismic Technical Report presents the results of the geology and seismic assessment for the Lane Transit District (LTD) and the City of Eugene's MovingAhead Project in Eugene, Oregon. The purpose of the MovingAhead Project is to determine which high-capacity transit corridors identified in the adopted *Emerald Express (EmX) System Plan, Lane Transit District Long-Range Transit Plan* (LTD, 2014) and the Frequent Transit Network (FTN) are ready to advance to capital improvements programming in the near term. LTD and the City of Eugene (City) initiated the MovingAhead Project in 2014 to identify and examine alternatives for improving multimodal safety, mobility, and accessibility in key transit corridors in the City. A main theme of the City's vision is to concentrate new growth along and near the City's key transit corridors and core commercial areas while protecting neighborhoods and increasing access to services for everyone. LTD and the City are jointly conducting the project to facilitate a more streamlined and cost-efficient process through concurrent planning, environmental review, and design and construction of multiple corridors.

LTD and the City of Eugene examined multimodal transit alternatives in five key transit corridors identified in *Draft Envision Eugene Comprehensive Plan* (Envision Eugene, 2016, July) and the *DRAFT Eugene 2035 Transportation System Plan* (City of Eugene, 2016; Draft Eugene 2035 TSP), the region's highest growth centers, and downtown Eugene:

- Highway 99 Corridor
- River Road Corridor
- 30th Avenue to Lane Community College (LCC) Corridor
- Coburg Road Corridor
- Martin Luther King, Jr. Boulevard Corridor

No-Build, Enhanced Corridor, and EmX Alternatives were developed for each corridor, except the Martin Luther King, Jr. Boulevard Corridor, for which only No-Build and Enhanced Corridor Alternatives were developed. Each proposed corridor location is shown on Figures S.1-1 and S.1-2 for the Enhanced Corridor Alternatives and the EmX Alternatives, respectively. The *MovingAhead Level 2 Definition of Alternatives* (CH2M HILL, Inc. [CH2M] et al., 2016) contains a detailed description of the project alternatives. The following is a summary of the project alternatives evaluated.

- The **No-Build Alternatives** serve as a reference point to gauge the benefits, costs, and effects of the Enhanced Corridor and EmX Alternatives in each corridor. Each No-Build Alternative is based on the projected conditions in 2035. Capital projects are derived from the financially constrained project lists in the Draft Eugene 2035 TSP, *Lane County Transportation System Plan* (Lane County Public Works, Engineering Division Transportation Planning, 2004, update in progress), the *Lane Transit District Capital Improvement Plan* (LTD, 2015), and the *Lane Transit District Long-Range Transit Plan* (LTD, 2014).
- **Enhanced Corridor Alternatives** are intended to address the project's Purpose, Need, Goals, and Objectives without major transit capital investments, instead focusing on lower-cost capital improvements, operational improvements, and transit service refinements, including 15-minute service frequency. Features can include transit queue jumps (lanes for buses that allow the bus to "jump" ahead of other traffic at intersections using a separate signal phase), stop consolidation, and enhanced shelters. These features can improve reliability, reduce transit travel time, and increase passenger comfort, making transit service along the corridor more attractive.

Figure S.1-1. Enhanced Corridor Alternatives Overview

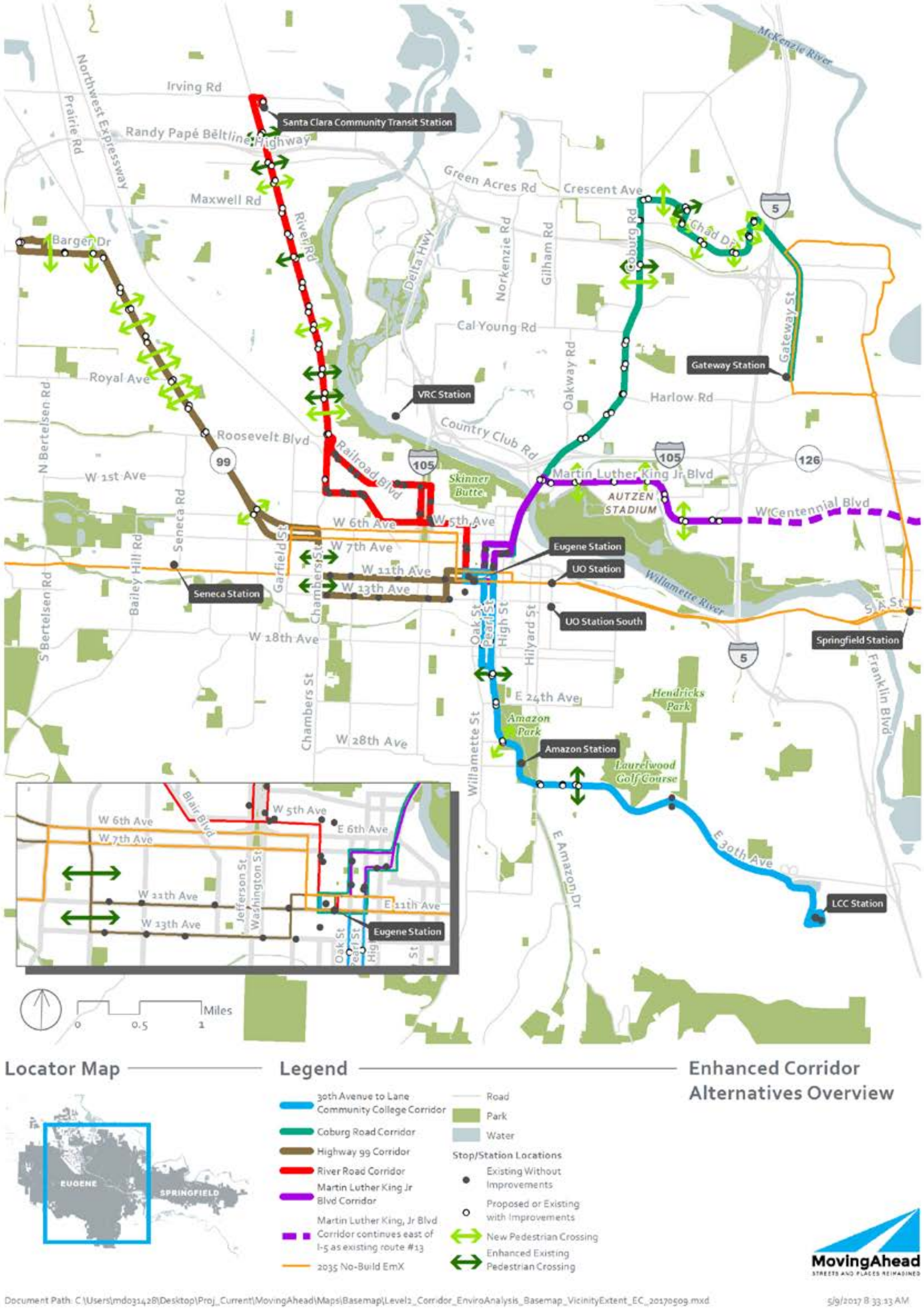
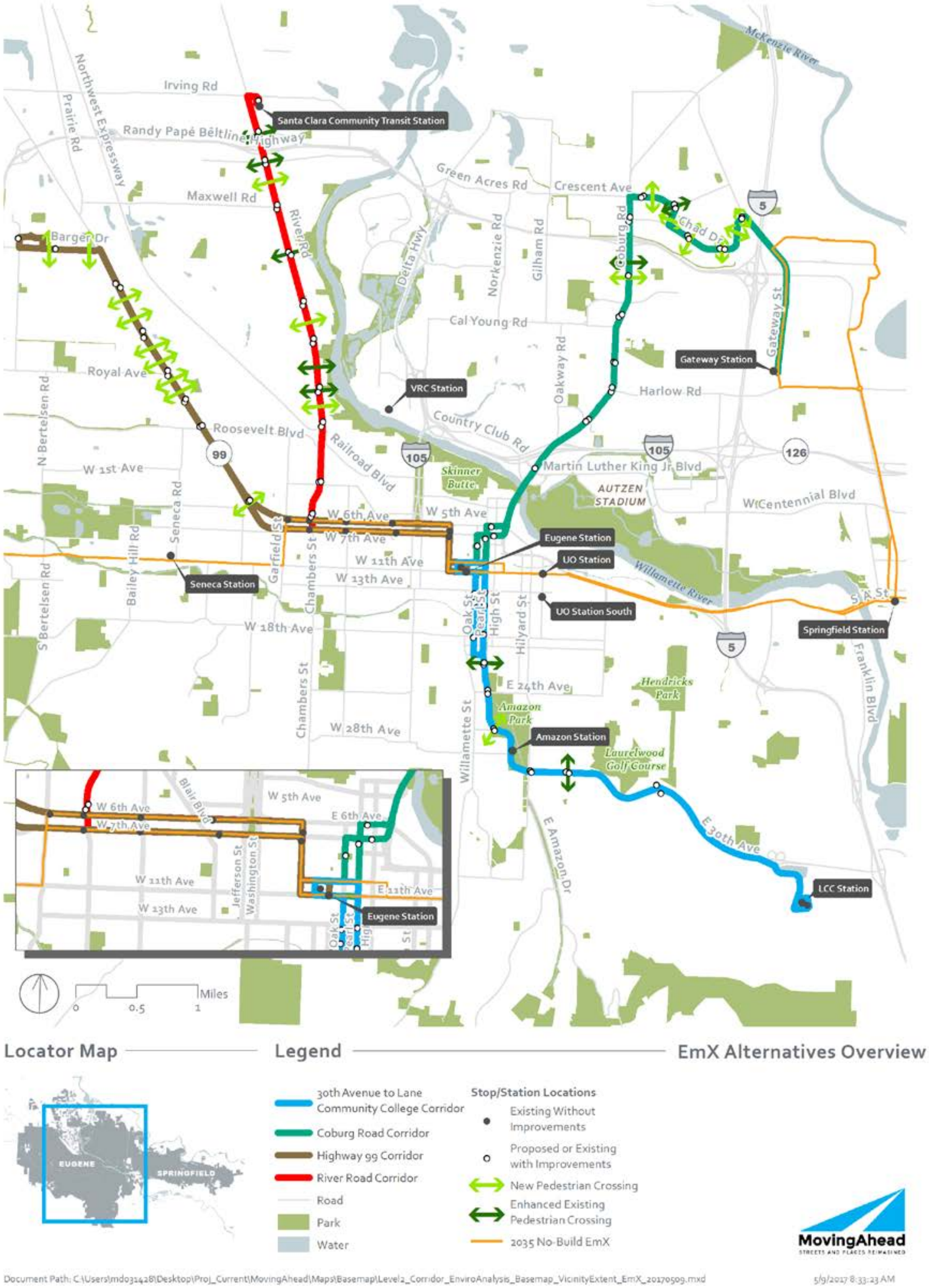


Figure S.1-2. EmX Alternatives Overview



- **EmX Alternatives** are characterized by sections of exclusive guideway, branded multi-door 60-foot-long bus rapid transit (BRT) vehicles, and enhanced stations with level boarding platforms instead of bus stops; off-board fare collection; transit signal priority; wider stop spacing; and 10-minute service frequencies. In general, EmX is a transit mode positioned between fixed-route bus service operating in mixed traffic and urban rail service operating in a separate right of way (ROW). EmX service is intended to improve transit speed, reliability, and ridership.

This report, prepared to support the MovingAhead Project Alternatives Analysis (AA), addresses potential adverse and beneficial effects that the project alternatives would have on geology and seismicity. It describes how the proposed project alternatives would affect geology and seismicity in the five study corridors. It bases the assessments on how the alternatives would have potential adverse impacts to geology and seismicity in the area of potential impact (API) and identifies potential mitigation measures to reduce impacts to geology and seismicity.

Figure S.1-1 shows the proposed corridors for the Enhanced Corridor Alternatives and Figure S.1-2 shows the proposed corridors for the EmX Alternatives.

This report was prepared in compliance with the National Environmental Policy Act (NEPA), 42 United States Code (U.S.C.) 4321-4347, applicable state environmental policy legislation, as well as local and state planning and land use policies and design standards.

This technical report provides detailed discussions on existing geologic and seismic hazards that could have potential impacts to the LTD and City of Eugene's MovingAhead Project (affected environment), and the potential impacts of the project to the geology resources (environmental consequences).

S.1. Affected Environment

The project team assessed geologic and seismic hazards along each corridor and each alternative within the area of potential impact (API) to determine whether project construction for any of the alternatives under consideration would occur in areas identified as significant geologic hazard zones or pass within close proximity (within approximately 6 miles) of potentially active crustal faults or fault zones. The API for geologic and seismic hazards is defined as the area within 100 feet from either edge of the existing corridor for each alternative and associated facilities.

CH2M assessed geologic units and soil characteristics using maps (including topographic maps, surficial soils maps, geologic maps, and geologic hazard maps) published by governmental agencies, including the Oregon Department of Geology and Mineral Industries (DOGAMI). Geologic hazards (including erosion, problematic soil properties, landslide, volcano, ground motion, fault rupture, liquefaction, and tsunamis or seiches) were evaluated along each corridor and alternative.

Table S.1-1 summarizes the geologic hazards for each corridor and alternative. It includes erosion, problematic soil properties, landslide, volcano, ground motion, faults rupture, liquefaction hazards, and tsunami or seiche. According to the U.S. Geological Survey (USGS) Quaternary Fault and Fold Database (USGS, 2014), the Owl Creek Fault near Corvallis is the closest active "Class A" fault[1] to the project. It is approximately 26 miles north of the project. Therefore, because no mapped active faults or fault zones are close to the project, fault rupture is not a concern. The MovingAhead Project is located too far and at an elevation too high above the Oregon coast for tsunami inundation to be a concern and there are no significant waterbodies near any of the corridors where seiche inundation could be a concern. There

[1] Geologic evidence demonstrates the existence of a Quaternary fault of tectonic origin, whether the fault is exposed for mapping or inferred from liquefaction or other deformational features.

is a remote potential that a seismic event could lead to failure of upstream dams near the Willamette River, causing uncontrolled release of water, raising water levels in the Willamette River, and causing inundation to portions of the River Road Corridor, Coburg Road Corridor, and Martin Luther King, Jr. Boulevard Corridor in lower-lying areas and near stream crossings. Based on the recent volcanic hazard maps that DOGAMI prepared (Oregon HazVu: Statewide Geohazards Viewer, DOGAMI, 2016a), volcanic activity (which includes pyroclastic flows, landslides, lava flows, and tephra falls generated by volcanic eruptions) is not considered a significant hazard to the project. Appendix C includes Figures C-1 through C-12 present geologic maps and Natural Resources Conservation Service (NRCS) soil survey maps of the project area. Figures C-13 through C-20 present landslide and seismic hazard maps.

Table S.1-1. Summary of Existing Geologic Hazards by Corridor and Alternative

Hazard	No-Build Alternative	Enhanced Corridor Alternative	EmX Alternative
Highway 99 Corridor			
Erosion Hazard	Low wind erosion susceptibility Low to moderate water erosion susceptibility	Low wind erosion susceptibility Low to moderate water erosion susceptibility	Low wind erosion susceptibility Low to moderate water erosion susceptibility
Problematic Soil Properties	High shrink-swell and hydric soils: • From the Wagner Street and Cubit Street intersection to the Altamont Street and Aerial Way intersection • Along W. 7th Avenue from Garfield Street to Chamber Street	High shrink-swell and hydric soils: • From the Wagner Street and Cubit Street intersection to the Altamont Street and Aerial Way intersection • Along W. 7th Avenue from Garfield Street to Chamber Street • From the W. 12th Avenue and Chamber Street intersection to the W. 11th Avenue and Taylor Street intersection	High shrink-swell and hydric soils: • From the Wagner Street and Cubit Street intersection to the Altamont Street and Aerial Way intersection • Along W. 7th Avenue from Garfield Street to Chamber Street
Relative Landslide Hazard	Moderate (landsliding possible) to high (landsliding likely) • Highway 99 between W. 5th Avenue and Roosevelt Boulevard south	Moderate (landsliding possible) to high (landsliding likely) • Highway 99 between W. 5th Avenue and Roosevelt Boulevard south	Moderate (landsliding possible) to high (landsliding likely) • Highway 99 between W. 5th Avenue and Roosevelt Boulevard south
Volcanic Activity Hazard	Pyroclastic flows, lava flows, and lahars are not expected to come within 8.5 miles	Pyroclastic flows, lava flows, and lahars are not expected to come within 8.5 miles	Pyroclastic flows, lava flows, and lahars are not expected to come within 8.5 miles
Relative Ground Motion	Strong to very strong ground-shaking zone	Strong to very strong ground-shaking zone	Strong to very strong ground-shaking zone
Fault Rupture Hazard	No mapped active faults pass through the site	No mapped active faults pass through the site	No mapped active faults pass through the site

Table S.1-1. Summary of Existing Geologic Hazards by Corridor and Alternative

Hazard	No-Build Alternative	Enhanced Corridor Alternative	EmX Alternative
Relative Liquefaction Hazard	Moderate liquefaction hazard zone: • From the W. 6th Avenue and Adams Street intersection Eugene Station • From the W. 7th Avenue and Blair Boulevard intersection to Eugene Station	Moderate liquefaction hazard zone: • From the W. 12th Avenue and Chambers Street intersection to Eugene Station • From the W. 11th Avenue and Taylor Street intersection to Eugene Station	Moderate liquefaction hazard zone: • From the W. 6th Avenue and Adams Street intersection to Eugene • From the W. 7th Avenue and Blair Boulevard intersection to Eugene Station
Tsunami or Seiche Hazard	No earthquake-generated water waves could reach the site	No earthquake-generated water waves could reach the site	No earthquake-generated water waves could reach the site
River Road Corridor			
Erosion Hazard	Low wind and water erosion susceptibility	Low wind and water erosion susceptibility	Low wind and water erosion susceptibility
Problematic Soil Properties	None	None	None
Relative Landslide Hazard	Moderate (landsliding possible) to high (landsliding likely): • Chambers Street between W. 2nd Avenue and Northwest Expressway • River Road at Randy Papé Beltline Highway	Moderate (landsliding possible) to high (landsliding likely): • Chambers Street between W. 2nd Avenue and Northwest Expressway • River Road at Randy Papé Beltline Highway • Jefferson Street and Washington Street, between W. 5th Avenue and W. 1st Avenue	Moderate (landsliding possible) to high (landsliding likely): • Chambers Street between W. 2nd Avenue and Northwest Expressway • River Road at Randy Papé Beltline Highway
Volcanic Activity Hazard	Pyroclastic flows, lava flows, and lahars are not expected to come within 8.5 miles	Pyroclastic flows, lava flows, and lahars are not expected to come within 8.5 miles	Pyroclastic flows, lava flows, and lahars are not expected to come within 8.5 miles
Relative Ground Motion	Strong to very strong ground-shaking zone	Strong to very strong ground-shaking zone	Strong to very strong ground-shaking zone

Table S.1-1. Summary of Existing Geologic Hazards by Corridor and Alternative

Hazard	No-Build Alternative	Enhanced Corridor Alternative	EmX Alternative
Fault Rupture Hazard	No mapped active faults pass through the site	No mapped active faults pass through the site	No mapped active faults pass through the site
Relative Liquefaction Hazard	Moderate liquefaction hazard zone: • From Irving Road to the Roosevelt Boulevard and Chambers Street intersection • From the W. 6th Avenue and Adams Street intersection to Eugene Station • From the W. 7th Avenue and Blair Boulevard intersection to Eugene Station	Moderate liquefaction hazard zone: • From Irving Road to the Roosevelt Boulevard and Chambers Street intersection • From the W. 5th Avenue and Adams Street intersection to Eugene Station • From the W. 1st Avenue and Jefferson Street intersection to Eugene Station • From the W. 1st Avenue and Washington Street intersection to Eugene Station	Moderate liquefaction hazard zone: • From Irving Road to the Roosevelt Boulevard and Chambers Street intersection • From the W. 6th Avenue and Adams Street intersection to Eugene Station • From the W. 7th Avenue and Blair Boulevard intersection to Eugene Station
Tsunami or Seiche Hazard	No earthquake-generated water waves could reach the site	No earthquake-generated water waves could reach the site	No earthquake-generated water waves could reach the site
30th Avenue to Lane Community College Corridor			
Erosion Hazard	Low to moderate wind erosion susceptibility Low water erosion susceptibility	Low to moderate wind erosion susceptibility Low water erosion susceptibility	Low to moderate wind erosion susceptibility Low water erosion susceptibility

Table S.1-1. Summary of Existing Geologic Hazards by Corridor and Alternative

Hazard	No-Build Alternative	Enhanced Corridor Alternative	EmX Alternative
Problematic Soil Properties	High shrink-swell and hydric soils: • From the Oak Street and E. 14th Avenue intersection, and from the Pearl Street and E. 15th Avenue intersection to the E. 30th Avenue and Kincaid Street intersection • Approximately 800 feet north of the E. 30th Avenue and Forest Boulevard intersection • Along Gonyea Road to LCC	High shrink-swell and hydric soils: • From the Oak Street and E. 14th Avenue intersection, and from the Pearl Street and E. 15th Avenue intersection to the E. 30th Avenue and Kincaid Street intersection • Approximately 800 feet north of the E. 30th Avenue and Forest Boulevard intersection • Along Gonyea Road to LCC	High shrink-swell and hydric soils: • From the Oak Street and E. 14th Avenue intersection, and from the Pearl Street and E. 15th Avenue intersection to the E. 30th Avenue and Kincaid Street intersection • Approximately 800 feet north of the E. 30th Avenue and Forest Boulevard intersection • Along Gonyea Road to LCC
Relative Landslide Hazard	Moderate (landsliding possible) to high (landsliding likely): • Between the Amazon Parkway and E. 29th Avenue intersection and LCC Station Very high (existing landslide): • Along E. 30th Avenue at the Spring Boulevard interchange	Moderate (landsliding possible) to high (landsliding likely): • Between the Amazon Parkway and E. 29th Avenue intersection and LCC Station Very high (existing landslide): • Along E. 30th Avenue at the Spring Boulevard interchange	Moderate (landsliding possible) to high (landsliding likely): • Between the Amazon Parkway and E. 29th Avenue intersection and LCC Station Very high (existing landslide): • Along E. 30th Avenue at the Spring Boulevard interchange
Volcanic Activity Hazard	Pyroclastic flows, lava flows, and lahars are not expected to come within 6 miles	Pyroclastic flows, lava flows, and lahars are not expected to come within 6 miles	Pyroclastic flows, lava flows, and lahars are not expected to come within 6 miles
Relative Ground Motion	Strong ground-shaking zone	Strong ground-shaking zone	Strong ground-shaking zone
Fault Rupture Hazard	No mapped active faults pass through the site	No mapped active faults pass through the site	No mapped active faults pass through the site

Table S.1-1. Summary of Existing Geologic Hazards by Corridor and Alternative

Hazard	No-Build Alternative	Enhanced Corridor Alternative	EmX Alternative
Relative Liquefaction Hazard	Moderate liquefaction hazard zone: • From Eugene Station to the E. 30th Avenue and Alder Street intersection High liquefaction hazard zone: • From 0.5 mile before to 0.3 mile after the E. 30th Avenue and Spring Boulevard intersection	Moderate liquefaction hazard zone: • From Eugene Station to the E. 30th Avenue and Alder Street intersection High liquefaction hazard zone: • From 0.5 mile before to 0.3 mile after the E. 30th Avenue and Spring Boulevard intersection	Moderate liquefaction hazard zone: • From Eugene Station to the E. 30th Avenue and Alder Street intersection High liquefaction hazard zone: • From 0.5 mile before to 0.3 mile after the E. 30th Avenue and Spring Boulevard intersection
Tsunami or Seiche Hazard	No earthquake-generated water waves could reach the site	No earthquake-generated water waves could reach the site	No earthquake-generated water waves could reach the site
Coburg Road Corridor			
Erosion Hazard	Low to moderate wind and water erosion susceptibility	Low to moderate wind and water erosion susceptibility	Low to moderate wind and water erosion susceptibility
Problematic Soil Properties	High shrink-swell and hydric soils: • At the Chad Drive and Shadow View Drive intersection • Between the Coburg Road and Crescent Avenue intersection and the Old Coburg Road and Chad Drive intersection • At the Coburg Road and Bailey lane intersection • At approximately 200 feet south of the Coburg Road and Willakenzie Road intersection	High shrink-swell and hydric soils: • At the Chad Drive and Shadow View Drive intersection • Between the Coburg Road and Crescent Avenue intersection and the Old Coburg Road and Chad Drive intersection • At the Coburg Road and Bailey lane intersection • At approximately 200 feet south of the Coburg Road and Willakenzie Road intersection	High shrink-swell and hydric soils: • At the Chad Drive and Shadow View Drive intersection • Between the Coburg Road and Crescent Avenue intersection and the Old Coburg Road and Chad Drive intersection • At the Coburg Road and Bailey lane intersection • At approximately 200 feet south of the Coburg Road and Willakenzie Road intersection

Table S.1-1. Summary of Existing Geologic Hazards by Corridor and Alternative

Hazard	No-Build Alternative	Enhanced Corridor Alternative	EmX Alternative
Relative Landslide Hazard	Moderate (landsliding possible) to high (landsliding likely): • Coburg Road at the Randy Papé Beltline Highway interchange • Coburg Road at the I-105 Highway interchange • Coburg Road from E. 4th Avenue to Martin Luther King, Jr. Boulevard ramp	Moderate (landsliding possible) to high (landsliding likely): • Coburg Road at the Randy Papé Beltline Highway interchange • Coburg Road at the I-105 Highway interchange • Coburg Road from E. 4th Avenue to Martin Luther King, Jr. Boulevard ramp	Moderate (landsliding possible) to high (landsliding likely): • Coburg Road at the Randy Papé Beltline Highway interchange • Coburg Road at the I-105 Highway interchange • Coburg Road from E. 4th Avenue to Martin Luther King, Jr. Boulevard ramp
Volcanic Activity Hazard	Pyroclastic flows, lava flows, and lahars are not expected to come within 7.5 miles	Pyroclastic flows, lava flows, and lahars are not expected to come within 7.5 miles	Pyroclastic flows, lava flows, and lahars are not expected to come within 7.5 miles
Relative Ground Motion	Strong to very strong ground-shaking zone	Strong to very strong ground-shaking zone	Strong to very strong ground-shaking zone
Fault Rupture Hazard	No mapped active faults pass through the site	No mapped active faults pass through the site	No mapped active faults pass through the site
Relative Liquefaction Hazard	Moderate liquefaction hazard zone: • From Eugene Station to Pioneer Pike • Along N. Game Farm Road • Along Gateway Street	Moderate liquefaction hazard zone: • From Eugene Station to Pioneer Pike • Along N. Game Farm Road • Along Gateway Street	Moderate liquefaction hazard zone: • From Eugene Station to Pioneer Pike • Along N. Game Farm Road • Along Gateway Street
Tsunami or Seiche Hazard	No earthquake-generated water waves could reach the site	No earthquake-generated water waves could reach the site	No earthquake-generated water waves could reach the site

Table S.1-1. Summary of Existing Geologic Hazards by Corridor and Alternative

Hazard	No-Build Alternative	Enhanced Corridor Alternative	EmX Alternative
Martin Luther King, Jr. Boulevard Corridor			
Erosion Hazard	Low to moderate wind and water erosion susceptibility	Low to moderate wind and water erosion susceptibility	Not applicable
Problematic Soil Properties	Hydric soils: • Along the Martin Luther King, Jr. Boulevard from driveway of PK Park to Leo Harris Parkway	Hydric soils: • Along the Martin Luther King, Jr. Boulevard from driveway of PK Park to Leo Harris Parkway	
Relative Landslide Hazard	Low (landsliding unlikely) to moderate (landsliding possible)	Low (landsliding unlikely) to moderate (landsliding possible)	
Volcanic Activity Hazard	Pyroclastic flows, lava flows, and lahars are not expected to come within 6.5 miles	Pyroclastic flows, lava flows, and lahars are not expected to come within 6.5 miles	
Relative Ground Motion	Strong to very strong ground-shaking zone	Strong to very strong ground-shaking zone	
Fault Rupture Hazard	No mapped active faults pass through the site	No mapped active faults pass through the site	
Relative Liquefaction Hazard	Moderate liquefaction hazard zone	Moderate liquefaction hazard zone	
Tsunami or Seiche Hazard	No earthquake-generated water waves could reach the site	No earthquake-generated water waves could reach the site	

I-105 = Interstate 105

S.2. Environmental Consequences

The project team assessed long-term direct impacts, short-term construction-related impacts, and cumulative impacts of the LTD and City of Eugene's MovingAhead Project to geology resources within the API. The Draft *Level 2 Definition of Alternatives* (CH2M et al., 2016) and the conceptual design roll plots along each alternative were reviewed to evaluate the extent of the construction. The majority of the construction activities in all the corridors are minor structures, such as transit queue jumps, enhanced corridor bus stops, EmX stations, utility trenches, concrete pavement, traffic signs and sidewalks. The construction activities associated with these structures are expected to be minor and the impacts from geology and seismicity as related to the environmental consequences are expected to be very minor. In addition to minor construction activities, the following construction activities would be anticipated along each corridor.

S.2.1. Highway 99 Corridor

Along the Highway 99 Corridor Enhanced Corridor Alternative, the following construction activities would be anticipated:

- A pedestrian bridge across the freight railroad line, from Highway 99 just north of Side Street east to Trainsong Park
- Embankment fill (about 5 feet) and regrading at the intersection of Highway 99 and Roosevelt Boulevard to develop a 500-foot right-turn pocket

Along the Highway 99 Corridor EmX Alternative, the following construction activities would be anticipated:

- A pedestrian bridge across the freight railroad line, from Highway 99 just north of Side Street east to Trainsong Park
- Embankment fill (about 5 feet) and regrading at the intersection of Highway 99 and Roosevelt Boulevard to develop a 500-foot right-turn pocket

S.2.2. River Road Corridor

Along the River Road Corridor Enhanced Corridor Alternative, the following construction would be anticipated:

- Construction of a turn pocket at the intersection of the River Road and Railroad Boulevard ramp; grading impacts and potential structural impacts would limit the length of the turn pocket

Along the River Road Corridor EmX Alternative, the following construction would be anticipated:

- Construction of a turn pocket at the intersection of the River Road and Railroad Boulevard ramp; grading impacts and potential structural impacts would limit the length of the turn pocket
- Widening the roadway under the Randy Papé Beltline Highway Bridge; reviewing the design criteria and as-built drawings of the Randy Papé Bridge during the final design phase will confirm the feasibility of this improvement and will determine the extent of the construction

S.2.3. 30th Avenue to LCC Corridor

Along the 30th Avenue to LCC Corridor Enhanced Corridor Alternative, the following construction activities would be anticipated:

- Decommission pedestrian bridge and convert to enhanced pedestrian crossing on Amazon Parkway at the Civic Stadium development site
- New road construction on E. 20th Avenue from Oak Street to Amazon Parkway as a 60-foot-wide cross section

Along the 30th Avenue to LCC Corridor EmX Alternative, the following construction activities would be anticipated:

- Decommission pedestrian bridge and convert to enhanced pedestrian crossing on Amazon Parkway at the Civic Stadium development site
- New road construction on E. 20th Avenue from Oak Street to Amazon Parkway as a 60-foot-wide cross section
- A new EmX station at Spring Boulevard westbound and E. 30th Avenue that might need considerable fill and regrading

S.2.4. Coburg Road Corridor

Along the Coburg Road Corridor Enhanced Corridor Alternative, no major construction activities would be anticipated.

Along the Coburg Road Corridor EmX Alternative, the following construction activity would be anticipated:

- Widening the roadway under the Randy Papé Beltline Highway Bridge; reviewing the design criteria and as-built drawings of the Randy Papé Bridge during the final design phase will confirm the feasibility of this improvement and will determine the extent of the construction

S.2.5. Martin Luther King, Jr. Boulevard Road Corridor

Along the Martin Luther King, Jr. Boulevard Corridor Enhanced Corridor Alternative, no major construction activities would be anticipated.

S.2.6. No-Build Alternative – All Corridors

Under the No-Build Alternative in each corridor, the existing transportation system would continue to operate and other committed transportation and development projects would be implemented as separate actions from the MovingAhead Project. The No-Build Alternative would not impact geologic and seismic hazards related to construction, operation, or maintenance of the MovingAhead Project.

S.2.7. Impacts Common to All Build Alternatives

Long-term impacts would be related to geologic and seismic hazards that already exist. These would include the potential for slope instability and landslides, and seismic hazards. Insufficient long-term stability of earth slopes and retaining wall structures could endanger on-site and off-site properties. This risk would be greater if a large seismic event were to occur. The consequences of a seismic event during operations would be strong to very strong ground shaking, which could lead to:

- Liquefaction of loose, saturated, cohesionless soils that could cause settlement and potential lateral movement of liquefied and overlying soil
- Settlement from densification of loose soils
- Instability of steep slopes
- Increased earth pressures on retaining walls and buried structures

These effects could damage the constructed facilities. The overall risk of impacts from slope instability, landslides, and seismic hazards would be higher in the areas with higher relative landslide hazard and higher relative liquefaction hazard (as summarized in Table S.1-1). These effects would be considered during the design phases of the project, and various mitigation or minimization measures could be implemented. The MovingAhead Project would address seismic design hazards to meet seismic design standards to minimize the long-term risks to the system. Designing new structures to meet the current seismic design standards would provide opportunities to mitigate existing slope instability and to mitigate liquefaction hazards through ground-improvement techniques.

Impacts during construction would be associated with the equipment used to perform the construction, as well as the direct and indirect impacts of the construction activities. Such activities would have the potential to cause a number of short-term impacts and benefits on the environment related to geology; these might include the following:

- Erosion hazards
- Slope instability and landslide hazards
- Seismic hazards
- Construction-induced vibrations and noises
- Settlements from new earth loads
- Excavations for foundations and removal of unsuitable material
- Dewatering

The severity or frequency of the hazard or impact could be avoided or minimized using conventional design and construction methods.

No increase in significant indirect or cumulative impacts would be expected. Prior activities along the corridors have affected the surficial geologic units, and future developments would also affect the surficial geologic units. The small changes that would occur because of the MovingAhead Project would include the reworking of disturbed soil, localized minor grade changes, minor changes in slope stability, and ground improvements. These activities would have little or no meaningful impacts to geology or soils. Such activities would be expected to benefit any areas where previous development activity included poorly compacted artificial fill, or structures that were not designed to current standards.

S.2.8. Highway 99 Corridor

S.2.8.1. Enhanced Corridor Alternative Impacts

- The overall risk of impacts from slope instability and landslide would be low. For the section of Highway 99 from Roosevelt Boulevard south to W. 5th Avenue, risks are moderate (landsliding possible) to high (landsliding likely).

- The major source of construction vibration and noises would be pile driving, if a pile system would be considered for the foundation of the proposed pedestrian bridge across the freight railroad line during the project's final design phase.
- An area of embankment fill and regrading would be anticipated at the intersection of Highway 99 and Roosevelt Boulevard. During final design, detailed evaluations would be conducted and, where appropriate, methods of stabilization would be developed.

S.2.8.2. EmX Alternative Impacts

- The overall risk of impacts from slope instability and landslide would be low. For the section of Highway 99 from Roosevelt Boulevard south to W. 5th Avenue, risks are moderate (landsliding possible) to high (landsliding likely).
- The major source of construction vibration and noises would be pile driving, if a pile system would be considered for the foundation of the proposed pedestrian bridge across the freight railroad line during the project's final design phase. Other sources of construction vibration would include vibratory rollers and jack hammers.
- An area of embankment fill and regrading would be anticipated at the intersection of Highway 99 and Roosevelt Boulevard. During final design, detailed evaluations would be conducted and, where appropriate, methods of stabilization would be developed.

S.2.9. River Road Corridor

S.2.9.1. Enhanced Corridor Alternative Impacts

- The overall risk of impacts from slope instability and landslide would be low. The long-term impacts from slope instability and landslide would be limited for the following locations that have been mapped as moderate (landsliding possible) to high (landsliding likely):
  - Chambers Street between W. 2nd Avenue and the Northwest Expressway
  - River Road at the Randy Papé Beltline Highway interchange
  - Jefferson Street and Washington Street, between W. 5th Avenue and W. 1st Avenue
- Because of constructing in landslide hazard areas, the short-term impacts would be limited for the following locations, which have been mapped as moderate (landsliding possible) to high (landsliding likely):
  - Chambers Street between W. 2nd Avenue and the Northwest Expressway
  - River Road at the Randy Papé Beltline Highway interchange

S.2.9.2. EmX Alternative Impacts

- The overall risk of impacts from slope instability and landslide would be low. The long-term impacts from slope instability and landslide, and short-term impacts because of constructing in landslide hazard areas would be limited for the following locations that have been mapped as moderate (landsliding possible) to high (landsliding likely):
  - Chambers Street between W. 2nd Avenue and the Northwest Expressway
  - River Road at the Randy Papé Beltline Highway interchange
- Widening the roadway under the Randy Papé Beltline Highway Bridge might have structural impacts. Reviewing the design criteria and as-built drawings of the Randy Papé Beltline Highway

Bridge during the final design phase will confirm the feasibility of this improvement and will determine the extent of the construction.

S.2.10. 30th Avenue to Lane Community College Corridor

S.2.10.1. Enhanced Corridor Alternative Impacts

- The long-term impacts from slope instability and landslide, and short-term impacts because of constructing in landslide hazard areas would be limited for the section of the 30th Avenue to LCC Corridor between the Amazon Parkway and E. 29th Avenue intersection and LCC Station that have been mapped as moderate (landsliding possible) to very high (existing landslide).

S.2.10.2. EmX Alternative Impacts

- The long-term impacts from slope instability and landslide, and short-term impacts because of constructing in landslide hazard areas would be limited for the section of the 30th Avenue to LCC Corridor between the Amazon Parkway and E. 29th Avenue intersection and LCC Station that have been mapped as moderate (landsliding possible) to very high (existing landslide).
- The new EmX station at Spring Boulevard westbound and E. 30th Avenue might need considerable fill and regrading. During final design, detailed evaluations would be conducted and, where appropriate, methods of stabilization would be developed.

S.2.11. Coburg Road Corridor

S.2.11.1. Enhanced Corridor Alternative Impacts

- The overall risk of impacts from slope instability and landslide would be low. The long-term impacts from slope instability and landslide, and short-term impacts because of constructing in landslide hazard areas would be limited for the following sections of Coburg Road that have been mapped as moderate (landsliding possible) to high (landsliding likely):
    - Coburg Road at the Randy Papé Beltline Highway interchange
    - Coburg Road at the I-105 Highway interchange
    - Coburg Road from E. 4th Avenue to the Martin Luther King, Jr. Boulevard ramp

S.2.11.2. EmX Alternative Impacts

- The overall risk of impacts from slope instability and landslide would be low. The long-term impacts from slope instability and landslide, and short-term impacts because of constructing in landslide hazard areas would be limited for the following sections of Coburg Road that have been mapped as moderate (landsliding possible) to high (landsliding likely):
    - Coburg Road at the Randy Papé Beltline Highway interchange
    - Coburg Road at the I-105 Highway interchange
    - Coburg Road from E. 4th Avenue to the Martin Luther King, Jr. Boulevard ramp
- Widening the roadway under the Randy Papé Beltline Highway Bridge might have structural impacts. Reviewing the design criteria and as-built drawings of the Randy Papé Beltline Highway Bridge during the final design phase will confirm the feasibility of this improvement and will determine the extent of the construction.

S.2.12. Martin Luther King, Jr. Boulevard Corridor

S.2.12.1. Enhanced Corridor Alternative Impacts

- The overall risk of impacts from slope instability and landslide would be low.

S.3. Mitigation Measures

Mitigation measures would be common for all build alternatives.

- Detailed study during final design would confirm the degree of geologic risk. At sites where geologic conditions are not suitable (as summarized in Table S.1-1), appropriate design and construction measures would be implemented to avoid potential effects and geologic risks during operations.
- Engineering design standards and best management practices would be used to avoid and minimize potential construction impacts. Based on the review of potential impacts, the design and construction process would address seismic hazards, settlement, landslide hazards, erosion and sediment control, vibrations, and groundwater.

S.4. Conclusions

The majority of the construction activities in all the corridors are minor structures, such as transit queue jumps, enhanced corridor bus stops, EmX stations, utility trenches, concrete pavement, traffic signs, and sidewalks. The construction activities associated with these structures are expected to be minor and the potential impacts would be very minor. The severity or frequency of the hazards or impacts from construction activities associated with other improvements could be avoided or minimized using conventional design and construction methods. Where impacts are identified as being moderate to high, generally more effort would be required during design to evaluate the severity of the impact and identify an adequate avoidance and minimization method.

1. Introduction

1.1. MovingAhead Technical Reports

A total of 20 technical reports have been prepared for the MovingAhead Project. The technical reports have been prepared to support the selection of preferred alternatives for the MovingAhead Project and subsequent environmental documentation. The technical reports assume that any corridors advanced for environmental review will require a documented categorical exclusion under the National Environmental Policy Act (NEPA). Any corridors requiring a higher level of environmental review would be supported by the technical evaluation but might not be fully covered by the technical evaluation.

Technical reports have been prepared for the following disciplines:

- Acquisitions and Displacements
- Air Quality
- Capital Cost Estimating
- Community Involvement, Agency and Tribal Coordination
- Community, Neighborhood, and Environmental Justice
- Cultural Resources
- Ecosystems (Biological, Fish Ecology, Threatened and Endangered Species, Wetlands and Waters of the U.S. and State)
- Energy and Sustainability
- Geology and Seismic
- Hazardous Materials
- Land Use and Prime Farmlands
- Noise and Vibration
- Operating and Maintenance Costs
- Parklands, Recreation Areas, and Section 6(f)
- Section 4(f)
- Street and Landscape Trees
- Transportation
- Utilities
- Visual and Aesthetic Resources
- Water Quality, Floodplain, and Hydrology

In general, each technical report includes the following information for identifying effects:

- Relevant laws and regulations
- Contacts and coordination
- Summary of data sources and analysis methods described in the *MovingAhead Environmental Disciplines Methods and Data Report* (CH2M HILL, Inc. [CH2M] et al., 2015)
- Affected environment
- Adverse and beneficial effects including short-term, direct, indirect and cumulative
- Mitigation measures
- Permits and approvals
- References

1.2. Geology and Seismic Technical Report and Purpose

This Geology and Seismic Technical Report provides detailed discussions on existing geologic and seismic hazards that could have potential impacts to the Lane Transit District (LTD) and City of Eugene's MovingAhead Project (affected environment), and the potential impacts of the project to the geology resources (environmental consequences).

1.3. Discipline Experts

Table 1.3-1 identifies discipline experts who contributed to the preparation of this report. This table includes their areas of expertise, affiliated organizations, titles, and years of experience.

Table 1.3-1. Discipline Experts

Discipline	Technical Expert	Affiliated Organization	Title / Years of Experience
Geology and Seismic	Maddie Heidari	CH2M	Geotechnical Engineer / 10 years
	Todd Cotten	CH2M	Senior Geotechnical Engineer / 21 years
Editors			
	Scott Richman	CH2M	Senior Project Manager / 24 years
	Ryan Farncomb	CH2M	Senior Transportation Planner / 7 years
	Sasha Luftig	LTD	Development Project Manager / 9 years

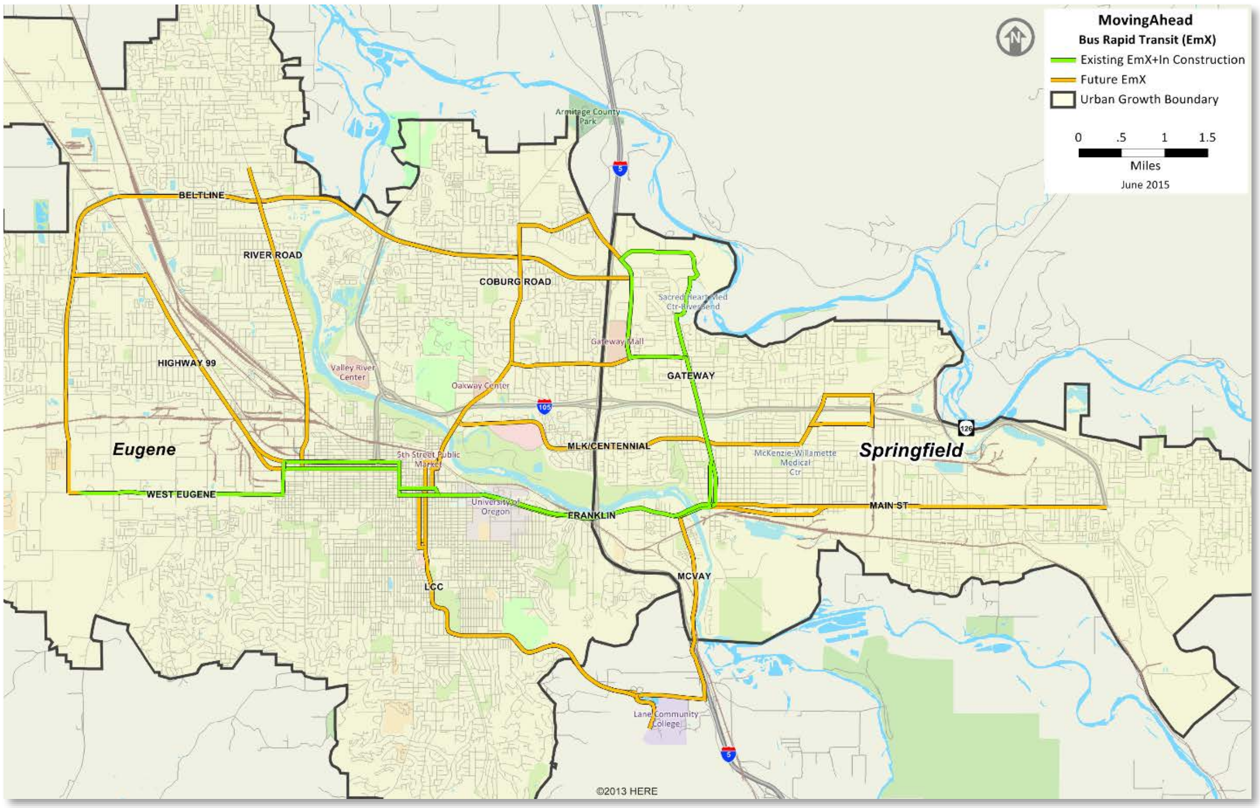
Source: MovingAhead Project Team. (2017).

1.4. Study Background

The purpose of the MovingAhead Project is to determine which high-capacity transit corridors identified in the adopted *Central Lane Metropolitan Planning Organization Regional Transportation Plan* (Lane Council of Governments [LCOG], 2011, December; RTP) and the *Lane Transit District Long Range Transit Plan* (Lane Transit District [LTD], 2014b) as part of the Frequent Transit Network (FTN) are ready to advance to capital improvements programming in the near term. The study is being conducted jointly with the City of Eugene and LTD to facilitate a streamlined and cost-efficient process through concurrent planning, environmental review, and design and construction of multiple corridors. The study area includes Eugene and portions of unincorporated Lane County.

The *Lane Transit District Long-Range Transit Plan* (LTD, 2014b) identifies the full Martin Luther King, Jr. Boulevard / Centennial Boulevard Corridor as a future part of the FTN. Initially, MovingAhead considered options on Centennial Boulevard to serve Springfield as part of this corridor. Because Springfield does not have the resources available to consider transit enhancements on Centennial Boulevard at this time, MovingAhead will only develop Emerald Express (EmX) and Enhanced Corridor Alternatives within Eugene. Figure 1.4-1 presents LTD's existing and future bus rapid transit (BRT) system.

Figure 1.4-1. Lane Transit District's Bus Rapid Transit (BRT) System



Source: LTD. (2015 Amended 2015, June).

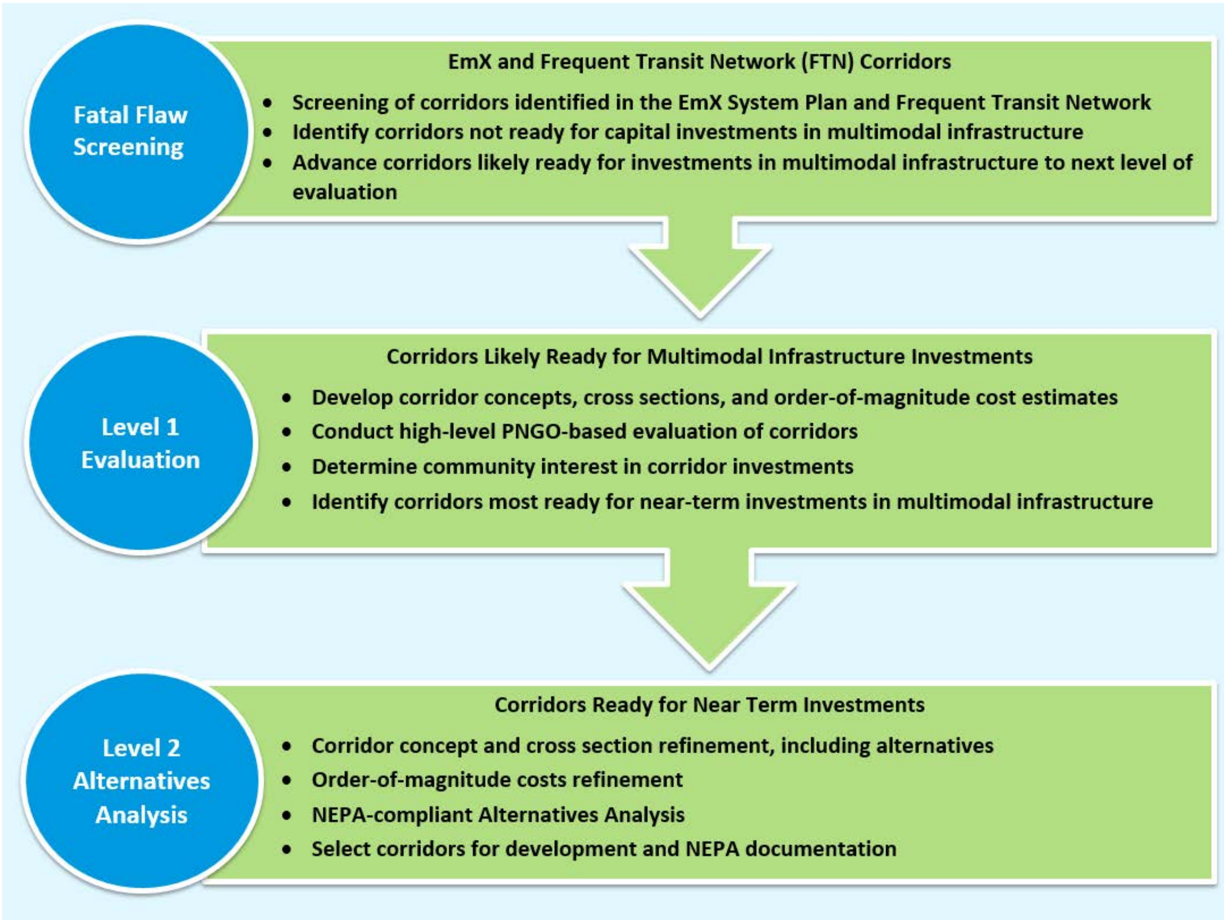
1.5. Screening and Evaluation of Multimodal Options

The MovingAhead Project process includes two phases. This first phase has three discrete but closely related tasks: identifying transit improvements; identifying improvements for bicyclists, pedestrians, and users of mobility devices; and preparing a NEPA-compliant evaluation of alternatives focused on the region's transportation system. Corridor options identified as part of the first phase were developed using multimodal cross sections that include variations on automobile, truck, and bus travel lanes; bicycle lanes; landscaping strips; and sidewalks. At the end of the first phase, the City of Eugene and LTD will select the corridors that are most ready for near-term capital improvements and prioritize improvements for funding. The selected corridors will be advanced to the second phase, which will focus on preparing NEPA environmental reviews (Documented Categorical Exclusions), and initiating the Federal Transit Administration (FTA) project development process.

1.5.1. Fatal Flaw Screening

The project team conducted a fatal flaw screening in February 2015 to identify which of the 10 corridors should not move forward to the Level 1 Screening Evaluation (Figure 1.5-1). This high-level evaluation used criteria based on MovingAhead's Purpose, Need, Goals, and Objectives (LTD, 2015, Amended 2015, June) and existing data to determine which corridors were not ready for capital investment in BRT or multimodal infrastructure in the next 10 years. The screening was conducted with local, regional, and state agency staff. Of the 10 corridors identified, the following three corridors were not advanced from the fatal flaw screening to the Level 1 Screening Evaluation: 18th Avenue, Bob Straub Parkway, and Randy Papé Beltline Highway. Table 1.5-1 shows the results of the fatal flaw screening.

Figure 1.5-1. MovingAhead Phase 1 Steps



Source: Wannamaker Consulting. (2015).

Although originally advanced from the fatal flaw screening, the Main Street-McVay Highway Corridor was also not advanced to the Level 1 Screening Evaluation because the Springfield City Council (on May 18, 2015) and LTD Board (on May 20, 2015) determined that the corridor is ready to advance to a study to select a locally preferred transit solution. At the time (May 2015), the Main Street-McVay Highway Corridor was on a schedule ahead of the MovingAhead Project schedule. If the Main Street-McVay Highway Corridor study schedule is delayed and its progress coincides with this project, the corridor could be reincorporated back into MovingAhead.

Table 1.5-1. Results of the Fatal Flaw Screening

Corridor	Advanced to Level 1	Consider Later
Highway 99	✓	
River Road	✓	
Randy Papé Beltline		✓
18th Avenue		✓
Coburg Road	✓	
Martin Luther King Jr. Boulevard / Centennial Boulevard	✓	
30th Avenue to Lane Community College	✓	
Main Street-McVay Highway	✓	
Valley River Center	✓	
Bob Straub Parkway		✓

Source: LTD and City of Eugene. (2015).

The six remaining multimodal corridors were advanced to the Level 1 Screening Evaluation to determine how they compared with each other in meeting the Purpose, Need, Goals, and Objectives.

1.5.2. Level 1 Screening Evaluation

The Level 1 Screening Evaluation assessed how each corridor would perform according to the Purpose, Need, Goals, and Objectives of MovingAhead. The Level 1 Screening Evaluation used existing studies and readily available data to evaluate each corridor. Based on community input and technical analysis, the following corridors and alternatives were advanced from the Level 1 Screening Evaluation to the Level 2 Alternatives Analysis (AA) (Table 1.5-2):

- No-Build Alternatives: all corridors
- Enhanced Corridor and EmX Alternatives:
    - Highway 99 Corridor
    - River Road Corridor
    - 30th Avenue to Lane Community College (LCC) Corridor
    - Coburg Road Corridor
- Enhanced Corridor Alternative:
    - Martin Luther King Jr. Boulevard Corridor

The Valley River Center Corridor received the least public support during public outreach and was not carried forward to the Level 2 AA.

Table 1.5-2. Corridors and Transit Alternatives Advanced to the Level 2 Alternatives Analysis

Corridor	No-Build	Enhanced Corridor	EmX
Highway 99	✓	✓	✓
River Road	✓	✓	✓
30th Avenue to Lane Community College	✓	✓	✓
Coburg Road	✓	✓	✓
Martin Luther King, Jr. Boulevard	✓	✓	

Source: CH2M. (2016).

For a detailed discussion of alternatives and design options considered for each corridor, but not carried forward to the Level 2 AA, please refer to the *Alternatives and Design Options Considered but Eliminated Technical Memorandum* (CH2M, 2016).

1.5.3. Level 2 Alternatives Analysis

To guide the Level 2 AA, LTD prepared new ridership forecasts and related evaluation measures using the LCOG regional model. Base-year and future-year forecasts were prepared for corridor alternatives based upon updated inputs and transit networks specific to each corridor. The planning horizon year used for the Level 2 AA is 2035. The built and natural environments, transit operations, traffic, finance, historical resources, and other areas were also evaluated as part of the Level 2 AA. The findings from the Level 2 AA will aid LTD and the City of Eugene in determining how corridors should be prioritized for capital investments over the next 5 years. Selected corridors will be advanced to Phase 2.

1.6. Purpose and Need

The prioritization of capital investments in multimodal transit corridors is a powerful tool for implementing local and regional comprehensive land use and transportation plans, agency strategic plans, and other community planning documents. Capital investments in multimodal transit corridors can have a substantial impact on patterns of growth and development. By coordinating the timing of, and prioritizing the funding for, strategic multimodal capital investments, the MovingAhead Project (a multimodal transit corridor study) helps ensure that future development is consistent with our region's plans and vision.

The Purpose and Need Statement was refined based on public and agency input.

1.6.1. Purpose

The purpose of the MovingAhead Project is to:

- Develop a Capital Improvements Program that forecasts and matches projected revenues and capital needs over a 10-year period
    - Balance desired multimodal transit corridor improvements with the community's financial resources
    - Ensure the timely and coordinated construction of multimodal transit corridor infrastructure
    - Eliminate unanticipated, poorly planned, or unnecessary capital expenditures

- Identify the most economical means of financing multimodal transit corridor capital improvements
- Establish partnerships between LTD, City of Eugene, and other local agencies that prioritize multimodal transit infrastructure needs and promote interagency cooperation
- Ensure that multimodal transit corridor investments are consistent with local comprehensive land use and transportation plans

1.6.2. Need

The need for the MovingAhead Project is based on the following factors:

- LTD's and the region's commitment to implementing the region's vision for BRT in the next 20 years consistent with the RTP that provides the best level of transit service in a cost-effective and sustainable manner.
- Need for streamlined environmental reviews to leverage systemwide analysis.
- Need to build public support for implementation of the systemwide vision.
- Selection of the next EmX / FTN corridors is based on long-range operational and financial planning for LTD's service.

1.6.3. Goals and Objectives

Goal 1: Improve multimodal transit corridor service

- Objective 1.1: Improve transit travel time and reliability
- Objective 1.2: Provide convenient transit connections that minimize the need to transfer
- Objective 1.3: Increase transit ridership and mode share in the corridor
- Objective 1.4: Improve access for people walking and bicycling, and to transit
- Objective 1.5: Improve the safety of pedestrians and bicyclists accessing transit, traveling in and along the corridor, and crossing the corridor

Goal 2: Meet current and future transit demand in a cost-effective and sustainable manner

- Objective 2.1: Control the increase in transit operating cost to serve the corridor
- Objective 2.2: Increase transit capacity to meet current and projected ridership demand
- Objective 2.3: Implement corridor improvements that provide an acceptable return on investment
- Objective 2.4: Implement corridor improvements that minimize impacts to the environment and, where possible, enhance the environment
- Objective 2.5: Leverage funding opportunities to extend the amount of infrastructure to be constructed for the least amount of dollars

Goal 3: Support economic development, revitalization, and land use redevelopment opportunities for the corridor

- Objective 3.1: Support development and redevelopment as planned in other adopted documents
- Objective 3.2: Coordinate transit improvements with other planned and programmed pedestrian and bicycle projects
- Objective 3.3: Coordinate transit improvements with other planned and programmed roadway projects
- Objective 3.4: Minimize adverse impacts to existing businesses and industry
- Objective 3.5: Support community vision for high capacity transit in each corridor
- Objective 3.6: Improve transit operations on state facilities in a manner that is mutually beneficial to vehicular and freight traffic flow around transit stops and throughout the corridor
- Objective 3.7: Improve transit operations in a manner that is mutually beneficial to vehicular traffic flow for emergency service vehicles

1.6.4. Evaluation Criteria

Evaluation criteria will be used during the Trade-off Analysis, which is part of the Level 2 AA, to aid in determining how well each of the corridor alternatives would meet the project's Purpose, Need, Goals, and Objectives. The evaluation criteria require a mix of quantitative data and qualitative assessment. The resulting data will be used to measure the effectiveness of each proposed corridor alternative and to assist in comparing and contrasting the alternatives and options. In Table 1.6-1, evaluation criteria are listed for each of the project's objectives. Some objectives have only one criterion for measuring effectiveness, while others require several criteria.

Table 1.6-1. Evaluation Criteria

Goals and Objectives		Evaluation Criteria
Goal 1: Improve multimodal transit corridor service		
Objective 1.1:	Improve transit travel time and reliability	• Round trip p.m. peak transit travel time between select origins and destinations • On-time performance (no more than 4 minutes late) of transit service
Objective 1.2:	Provide convenient transit connections that minimizes the need to transfer	• Number of transfers required between heavily used origin-destination pairs
Objective 1.3:	Increase transit ridership and mode share in the corridor	• Average weekday boardings on corridor routes • Transit mode share along the corridor • Population within 0.5 mile of transit stop • Employment within 0.5 mile of transit stop
Objective 1.4:	Improve access for people walking and bicycling, and to transit	• Connectivity to existing pedestrian facilities • Connectivity to existing bicycle facilities
Objective 1.5:	Improve the safety of pedestrians and bicyclists accessing transit, traveling in and along the corridor, and crossing the corridor	• Opportunity to provide a safe and comfortable environment for pedestrians and bicyclists in the corridor
Goal 2: Meet current and future transit demand in a cost-effective and sustainable manner		
Objective 2.1:	Control the increase in transit operating cost to serve the corridor	• Cost per trip • Impact on LTD operating cost • Cost to local taxpayers
Objective 2.2:	Increase transit capacity to meet current and projected ridership demand	• Capacity of transit service relative to the current and projected ridership
Objective 2.3:	Implement corridor improvements that provide an acceptable return on investment	• Benefit / cost assessment of planned improvements
Objective 2.4:	Implement corridor improvements that minimize impacts to the environment and, where possible, enhance the environment	• Results of screening-level assessment of environmental impacts of transit solutions

Table 1.6-1. Evaluation Criteria

Goals and Objectives		Evaluation Criteria
Objective 2.5:	Leverage funding opportunities to extend the amount of infrastructure to be constructed for the least amount of dollars	• Number and dollar amount of funding opportunities that could be leveraged • Meet the FTA's Small Starts funding requirements
Goal 3:	**Support economic development, revitalization and land use redevelopment opportunities for the corridor**	
Objective 3.1:	Support development and redevelopment as planned in other adopted documents	• Consistent with the BRT System Plan and FTN concept • Consistent with the *Regional Transportation System Plan* (Central Lane Metropolitan Planning Organization [MPO], 2007) • Consistent with local comprehensive land use plans
Objective 3.2:	Coordinate transit improvements with other planned and programmed pedestrian and bicycle projects	• Capability of transit improvement to coordinate with other planned and programmed pedestrian and bicycle projects identified in adopted plans and Capital Improvements Programs
Objective 3.3:	Coordinate transit improvements with other planned and programmed roadway projects	• Capability of transit improvement to coordinate with other planned and programmed roadway projects identified in adopted plans and Capital Improvements Programs
Objective 3.4:	Minimize adverse impacts to existing businesses and industry	• Impacts to businesses along the Corridor measured in number and total acres of properties acquired, parking displacements, and access impacts. • Impact on freight and delivery operations for Corridor businesses
Objective 3.5:	Support community vision for high capacity transit in corridor	• Community vision includes high capacity transit in corridor
Objective 3.6:	Improve transit operations on state facilities in a manner that is mutually beneficial to vehicular and freight traffic flow around transit stops and throughout the corridor	• Impact on current and future year intersection level of service (LOS) on state facilities • Impact on current and future year p.m. peak hour auto / truck travel times on state facilities
Objective 3.7:	Improve transit operations in a manner that is mutually beneficial to vehicular traffic flow for emergency service vehicles	• Qualitative assessment of potential impacts to emergency service vehicle traffic flow and access

Source: LTD and City of Eugene. (2015, June).

LOS = level of service

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2. Alternatives Considered

This section briefly reviews the major features of the alternatives considered in the Level 2 AA. For full details on each alternative and the five corridors described in this technical report – Highway 99, River Road, 30th Avenue to LCC, Coburg Road, and Martin Luther King, Jr. Boulevard – refer to the *MovingAhead Level 2 Definition of Alternatives* (CH2M et al., 2016). Each corridor location is shown on Figures 2.1-1 and 2.1-2 for the Enhanced Corridor Alternatives and the EmX Alternatives, respectively.

Figure 2.1-1. Enhanced Corridor Alternatives Overview

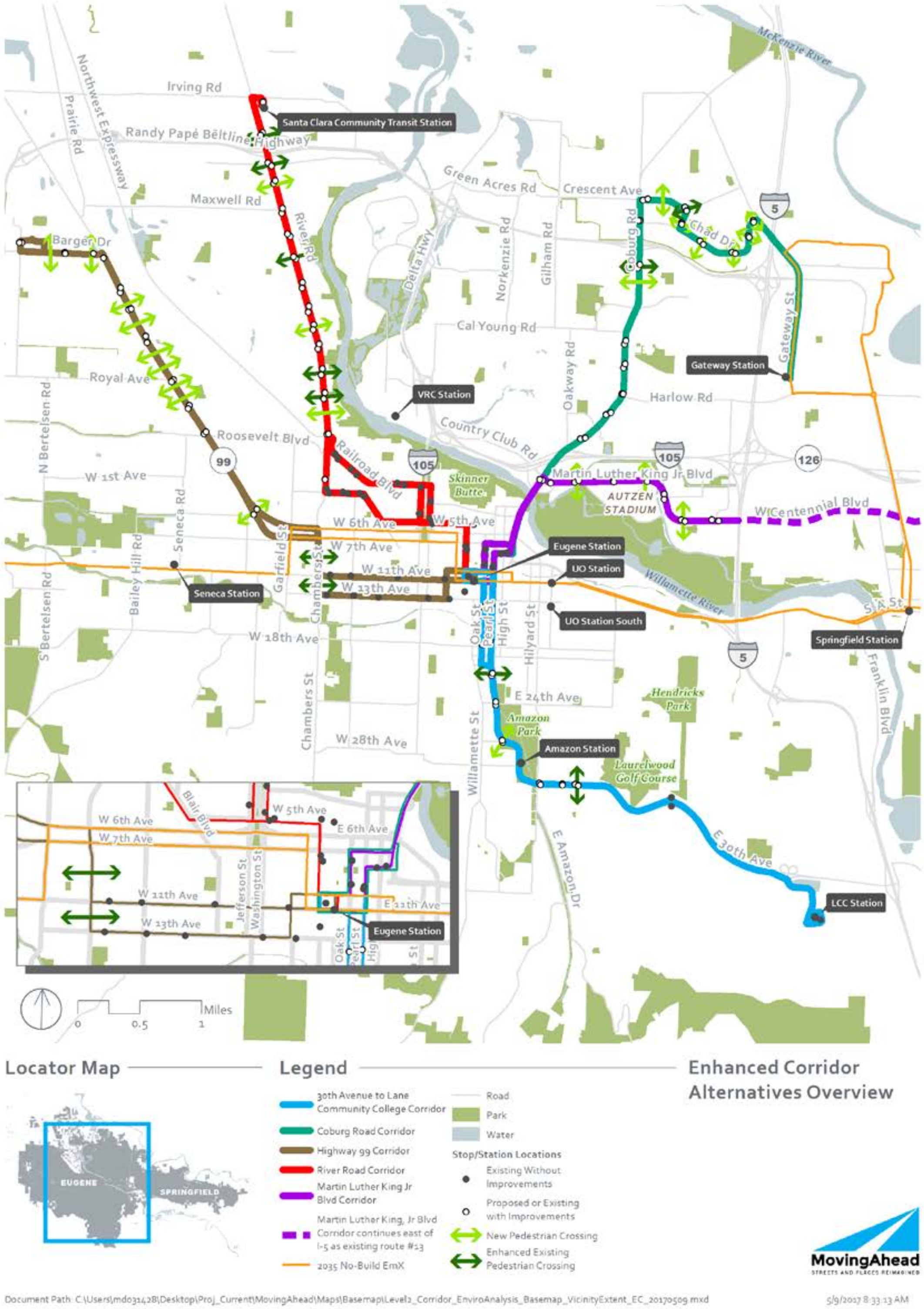
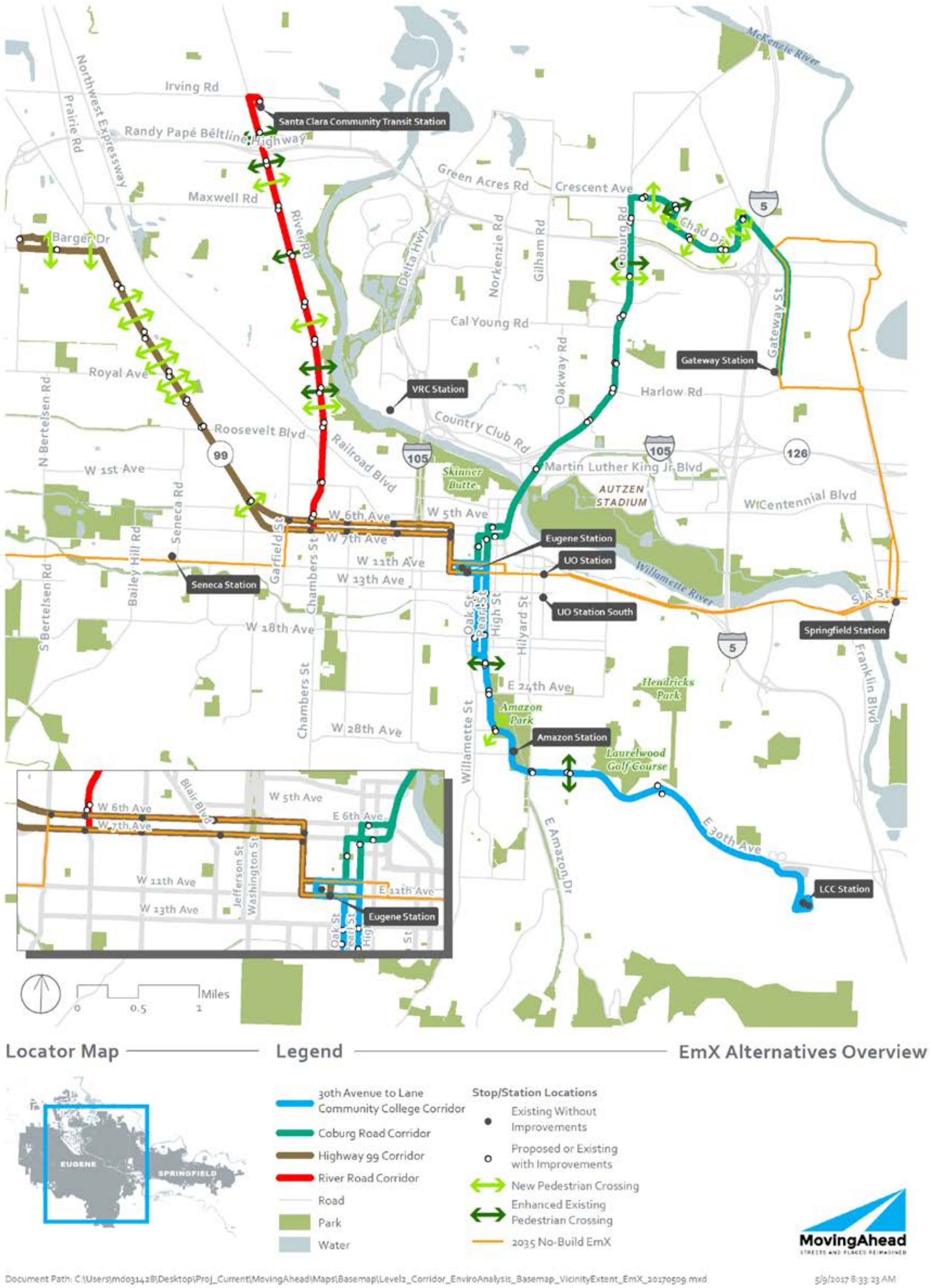


Figure 2.1-2. EmX Alternatives Overview



2.1. No-Build Alternative Transit Network

This section describes the No-Build Alternative transit network, which is based on projected conditions in the year 2035, the project's environmental forecast year. For each corridor, the No-Build Alternative serves as a reference point to gauge the benefits, costs, and effects of the build alternatives.

2.1.1. Capital Improvements

Under the No-Build Alternative, the following capital improvements are anticipated by 2035:

- **West Eugene EmX Extension**. Currently under construction, the West Eugene EmX Extension (WEEE) project and its associated capital improvements will be completed in 2017.
- **Santa Clara Community Transit Center**. The existing River Road Station is located at the southeast corner of the River Road / Randy Papé Beltline Highway interchange between the eastbound on-ramp and River Avenue. To meet growing demand and avoid the impacts of increasing congestion, LTD plans to relocate the River Road Station to a site north of the Randy Papé Beltline Highway at the southeast corner of River Road and Hunsaker Lane. Once relocated to the new site, the River Road Station would be renamed the Santa Clara Community Transit Center. This new transit center is planned to include a mix of uses including a park and ride lot, residential housing, community space, and commercial uses. The River Road Station relocation to the new site is anticipated to be completed by the end of 2018.
- **Main Street EmX Extension**. Included in the RTP and currently under study, the extension of the existing Franklin EmX line on Main Street from Springfield Station to Thurston Station and associated capital improvements (e.g., stations, bicycle and pedestrian facilities, and signal modifications) is anticipated to be completed within the 20-year planning horizon (2035). The No-Build Alternative transit network assumes EmX service on Main Street. However, the outcome of this study, and the ultimate improvements chosen, are uncertain at this time.
- **McVay Highway Enhanced Corridor**. Included in the RTP and currently under study, Enhanced Corridor service from Springfield Station on McVay Highway to LCC and associated capital improvements (e.g., improved stops, transit queue jumps, and improved bicycle and pedestrian crossings) is anticipated to be completed within the 20-year planning horizon (2035).

2.1.2. Transit Operations

The No-Build Alternatives for each corridor include changes to transit service anticipated as a result of the WEEE project, Main Street EmX Extension project, development of the Santa Clara Community Transit Center, and other changes to fixed route service. The following changes to the existing 2016 fixed route services are anticipated by 2035:

- Eliminated routes:
    - Route 11 (replaced by Main Street EmX service)
    - Route 32 (replaced by WEEE service)
    - Route 76 (replaced by WEEE service)
    - Route 85 (replaced by Enhanced Corridor service on the McVay Highway)
    - Route 43 (replaced by WEEE service)
- Other route modifications:
    - Add WEEE service (replaces Route 43 service on W. 11th Avenue) as extension of existing EmX service

- Add Main Street EmX service from Springfield Station to Thurston Station
  - Add Route 2 with service from Barger Drive / Echo Hollow Road to Eugene Airport
  - Add Route 16 to connect north and south of Main Street with EmX service
  - Add Enhanced Corridor service on McVay Highway from Springfield Station to LCC (replaces Route 85)
  - Reroute Route 33 and extend to Amazon Parkway
  - Reroute Route 36 to extend north of W. 11th Avenue to Barger Drive (replaces Route 43)
  - Reroute Route 41 via Highway 99 / Royal Avenue / W. 11th Avenue
  - Reroute Route 40 via Royal Avenue / Elmira Road / Roosevelt Boulevard / Chambers Street / W. 2nd Avenue / Oak and Pearl Streets
  - Add Route 44 paralleling Route 40 above to serve West Eugene
  - Reroute Route 55 to extend to Santa Clara Community Transit Center
  - Reroute Route 93 with service continuing to Eugene Station via Seneca Station and service terminating at the WEEE terminus
- Change in service frequencies:
  - Increase service on Route 24 from 30-minute peak frequencies to 15-minute peak frequencies
  - Increase service on Route 28 from approximately 30-minute peak frequencies (varying 20- to 30-minute intervals) to 15-minute peak frequencies
  - Increase service on Route 41 from 30- and 15-minute peak frequencies to 15-minute peak frequencies
  - Increase service on Route 51 from 60-minute off-peak frequencies to 30-minute off-peak frequencies
  - Increase service on Route 52 from 60-minute off-peak frequencies to 30-minute off-peak frequencies
  - Increase service on Route 66 from 30- and 15-minute weekday a.m. peak, off-peak, and p.m. peak frequencies to 15-minute weekday a.m. peak, off-peak, and p.m. peak frequencies
  - Increase service on Route 67 from approximately 30-minute weekday a.m. peak, off-peak, and p.m. peak frequencies to 15-minute weekday a.m. peak, off-peak, and p.m. peak frequencies
  - Increase service on Route 78 from approximately 60-minute frequencies from 8 a.m. to 6 p.m. to 30-minute weekday a.m. peak, off-peak, and p.m. peak frequencies
  - Increase service on Route 79x from 30-minute peak frequencies to 10-minute peak frequencies, and modify off peak frequencies to 15 minutes from between 10 and 30 minutes currently
  - Decrease a.m. peak service on Route 93 from 60-minute frequencies to 120-minute frequencies during a.m. peak hours, and increase from no service between Veneta and the WEEE terminus to 120-minute frequencies during p.m. peak hours (off-peak service is 120-minute frequencies between Veneta and the WEEE terminus)
  - Decrease a.m. peak service on Route 96 from 30-minute frequencies to 60-minute frequencies, and increase off-peak service from no service between 8:20 a.m. and 3:40 p.m. to 60-minute off-peak frequencies

Key transportation improvements specific to each corridor are described under each corridor's No-Build Alternative.

2.2. Enhanced Corridor Alternatives

Enhanced Corridor Alternatives are intended to address the project's Purpose, Need, Goals, and Objectives without major transit capital investments, instead focusing on lower-cost capital improvements, operational improvements, and transit service refinements. Features could include transit queue jumps (lanes for buses that allow the bus to “jump” ahead of other traffic at intersections using a separate signal phase), stop consolidation, enhanced shelters, and redesigned service to improve cross-town connectivity. These features improve reliability, reduce transit travel time, and increase passenger comfort.

Enhanced Corridor service would run from 6:45 a.m. to 11:30 p.m. weekdays, 7 a.m. to 11 p.m. Saturdays, and 8 a.m. to 8 p.m. Sundays. Service frequencies are assumed to be 15 minutes during all periods.

2.3. EmX Alternatives

EmX (BRT) Alternatives are characterized by exclusive guideways (business access and transit lanes [BAT] or bus-only lanes); branded, multi-door 60-foot-long BRT vehicles; enhanced stations with level boarding platforms instead of stops; off-board fare collection; signal priority; wider stop spacing; and frequent and redesigned service to improve cross-town connectivity.

EmX service is assumed to run from 6:45 a.m. to 11:30 p.m. weekdays, 7 a.m. to 11 p.m. Saturdays, and 8 a.m. to 8 p.m. Sundays. Service frequencies are assumed to be 10 minutes during all periods.

2.4. Highway 99 Corridor

The Highway 99 Corridor begins at the Eugene Station, travels through downtown, then extends northwest along Highway 99 to Barger Drive, turning west at Barger Drive to terminate on Cubit Street north of the intersection of Barger Drive and Cubit Street east of the Randy Papé Beltline Highway. This corridor is approximately 10.5 round-trip miles.

2.4.1. No-Build Alternative

The Highway 99 Corridor No-Build Alternative includes existing roadway, bicycle, pedestrian, and transit facilities in the corridor, as well as planned improvements in the DRAFT *Eugene 2035 Transportation System Plan* (City of Eugene, 2016; Draft Eugene 2035 TSP). The No-Build Alternative would not include capital improvements on Highway 99. As part of the Draft Eugene 2035 TSP, the following transportation improvements are planned along or adjacent to the corridor:

- Upgrade Bethel Drive, from Highway 99 to Roosevelt Boulevard, to a two-lane urban facility with sidewalks on both sides of the road, bicycle lanes, and planting strips
- Widen Barger Drive immediately west of the Randy Papé Beltline Highway interchange to include an additional travel lane in each direction
- Add a shared-use path on the west side of Highway 99 from Roosevelt Boulevard south to the intersection of W. 7th Avenue and Garfield Street (the section of this project from Roosevelt to W. 5th Avenue has been completed)
- Add bicycle lanes on Garfield Street from Roosevelt Boulevard south to W. 6th Avenue
- Add a bicycle lane on W. 6th Avenue from Garfield Street to W. 5th Avenue
- Complete the sidewalk network on Highway 99 from Roosevelt Boulevard south to Garfield Street
- Add a shared-use path on Roosevelt Boulevard from Maple Street to Highway 99
- Add a bicycle lane on Roosevelt Boulevard from Highway 99 east to railroad tracks

Under the No-Build Alternative, Highway 99 Corridor service would remain at 15-minute headways during peak periods and 30-minute headways during off-peak periods and evenings. Under the No-Build

Alternative, a slight change is also made to Route 93, which would stop at the Pearl Buck Center in the absence of Route 44.

2.4.2. Enhanced Corridor Alternative

Capital improvements under the Highway 99 Corridor Enhanced Corridor Alternative would include enhanced bicycle and pedestrian crossings; improvements to existing bus stops and the construction of new stops; construction of queue jumps at some intersections; traffic signal reconstruction; construction of bus-only left turn lanes; and roadway widening at some locations in the corridor.

Existing conventional fixed-service routes would remain the same as with the No-Build Alternative, with the exception of the elimination of Route 41. Service west of WinCo would also remain the same or be improved.

2.4.3. EmX Alternative

The Highway 99 Corridor EmX Alternative would include creating BAT lanes on segments of W. 7th Avenue and Highway 99; reconstructing the Highway 99 / Roosevelt Boulevard intersection (traffic signal, turn lanes, and queue jump); completing other intersection modifications in the corridor; roadway widening at some locations; and constructing nine new enhanced pedestrian and bicycle crossings, new sidewalks, and a pedestrian bridge across the railroad line from Highway 99 to the Trainsong neighborhood. Four existing bus stop locations would be improved to EmX stations, in addition to constructing new stations. Some existing EmX stations would be used for the Highway 99 Corridor EmX service.

Route 44 is a conventional service line added to this alternative only, providing coverage on 11th and 13th Avenues as well as service to the Pearl Buck Center on W. 1st Avenue, with 30-minute headways during all periods. This would be a decrease in service for the 11th and 13th Avenue corridors that currently have 15-minute peak service. Route 44 is primarily intended to replace conventional service lost with the removal of the existing Route 41. Route 41 would be replaced with the Highway 99 Corridor EmX service described in this alternative.

2.5. River Road Corridor

The River Road Corridor begins at the Eugene Transit Center, travels through downtown and then north to the Santa Clara Community Transit Center (intersection of Hunsaker Lane and River Road). This corridor is approximately 10.3 round-trip miles.

2.5.1. No-Build Alternative

The River Road Corridor No-Build Alternative would include existing roadway, bicycle, pedestrian, and transit facilities in the corridor, as well as planned improvements in the Draft Eugene 2035 TSP. There would be no additional major bus capital improvements under the No-Build Alternative.

As part of the Draft Eugene 2035 TSP, the following transportation improvements are planned adjacent to and along the River Road Corridor:

- Upgrade the Hunsaker Lane / Beaver Street intersection to urban collector standards, including two travel lanes, a center turn lane, bicycle lanes, sidewalks on both sides of the road, and planting strips from River Road to Division Avenue
- Provide bicycle boulevards on Ruby Avenue, Horn Lane, Arbor Drive, and Park Avenue

- Include sidewalks on Hunsaker Lane, Howard Avenue, and Hilliard Lane
- Provide protected bicycle lanes on River Road from the Northwest Expressway to Division Avenue

Under the No-Build Alternative, River Road Corridor service would remain at 30-minute headways for both Routes 51 and 52 (which together effectively provide 15-minute service during peak periods) and off-peak periods. After 6:15 p.m., there is no longer a combined 15-minute frequency, and headways return to 30 minutes.

2.5.2. Enhanced Corridor Alternative

Capital improvements constructed as part of the River Road Corridor Enhanced Corridor Alternative would include BAT lanes on River Road approaching the Randy Papé Beltline Highway and other roadway improvements, like traffic signal reconstruction at certain locations along the corridor. Improvements to existing bus stops and the construction of new stops would also occur.

Routes 51 and 52 would be eliminated, and Enhanced Corridor service for River Road includes a split alignment in order to serve portions covered by those routes at 30-minute headways. In this arrangement, the area from Railroad Boulevard to W. 1st Avenue is served by one Enhanced Corridor service as a replacement for the Route 51 service, while the area along Blair Boulevard and W. 2nd Avenue is served by the other alignment to replace service lost with removal of Route 52. Those alignments meet at Railroad Boulevard and River Road to serve the River Road Corridor with consistent 15-minute headways.

2.5.3. EmX Alternative

New construction under the River Road Corridor EmX Alternative would include lane repurposing on River Road for BAT lanes, constructing short sections of exclusive bus lanes near the Randy Papé Beltline Highway, reconstructing traffic signals and intersections at several locations, constructing new bicycle and pedestrian crossings, improving existing stops to EmX stations, and constructing new stations. Some existing EmX stations would be used with the River Road EmX service.

Transit service changes would also include modifying headways on Route 40 during the a.m. and p.m. peak hours to 15 minutes, developing a new Route 50 "River Road Connector" with 30-minute headways all day, and eliminating Routes 51, 52, and 55. These replacements ensure no loss in existing coverage or service.

2.6. 30th Avenue to Lane Community College Corridor

The 30th Avenue to LCC Corridor begins at Eugene Station and travels south along Pearl Street (outbound) to Amazon Parkway, then on E. 30th Avenue to its terminus at the LCC Station. The return trip travels on Oak Street (inbound), which is the northbound couplet to Pearl Street. This corridor is approximately 10.2 round-trip miles.

2.6.1. No-Build Alternative

The 30th Avenue to LCC Corridor No-Build Alternative would include existing roadway, bicycle, pedestrian, and transit facilities in the corridor, as well as planned improvements in the Draft Eugene 2035 TSP. There would be no additional major bus capital improvements to the 30th Avenue to LCC Corridor under the No-Build Alternative.

The Draft Eugene 2035 TSP identifies the following transportation improvements along or adjacent to the corridor:

- Bicycle boulevard on Alder Drive

For the portion of E. 30th Avenue in unincorporated Lane County, Lane County does not plan to improve bicycle facilities along the road.

Under the No-Build Alternative, 30th Avenue to LCC Corridor service would remain at 30-minute headways on Route 81. The Route 82 service would remain at 10-minute headways during the a.m. peak, 15-minute headways during off-peak periods, and 20-minute headways during the p.m. peak, with no weekend service.

2.6.2. Enhanced Corridor Alternative

Capital improvements as part of the 30th Avenue to LCC Corridor Enhanced Corridor Alternative would include the construction of new bus stops, capital improvements to some existing bus stops, a new traffic signal on Amazon Parkway at E. 20th Avenue, and new bike facilities on Oak and Pearl Streets.

Under the 30th Avenue to LCC Corridor Enhanced Corridor Alternative, service to LCC provided by Routes 81 and 82 would be eliminated and replaced by Enhanced Corridor service. The direct connection between LCC and the University of Oregon Station along Route 81 would be eliminated. It would be replaced by connecting the 30th Avenue to LCC Corridor Enhanced Corridor Alternative to the Franklin EmX line with a transfer at Eugene Station.

2.6.3. EmX Alternative

The 30th Avenue to LCC Corridor EmX Alternative would include repurposing parking and general-purpose lanes to BAT lanes on Oak and Pearl Streets, constructing queue jumps, extending E. 20th Avenue, adding a new traffic signal on Amazon Parkway, and adding a new cycle track on High Street. In addition to constructing new EmX stations, existing bus stops would be improved to EmX stations in certain locations.

Service to LCC provided by Routes 81 and 82 would be replaced with EmX service. The direct connection between LCC and the University of Oregon Station along Route 81 would be eliminated. It would be replaced by connecting the 30th Avenue to LCC Corridor EmX Alternative to the Franklin EmX line with a transfer at Eugene Station.

2.7. Coburg Road Corridor

The Coburg Road Corridor begins at Eugene Station and continues to Coburg Road using the Ferry Street Bridge. The corridor continues north on Coburg Road to Crescent Avenue, east on Crescent Avenue and Chad Drive to N. Game Farm Road, and south on N. Game Farm Road and Gateway Street to the existing Gateway Station at the Gateway Mall. Although service extends from N. Game Farm Road to the Gateway Station, capital improvements for the corridor terminate at Interstate 5 (I-5). This corridor is approximately 11.2 round-trip miles.

2.7.1. No-Build Alternative

The Coburg Road Corridor No-Build Alternative includes existing roadway, bicycle, pedestrian, and transit facilities in the corridor, as well as planned improvements in the Draft Eugene 2035 TSP. There would be no additional major transportation improvements to the Coburg Road Corridor under the No-Build Alternative.

Under the No-Build Alternative, the Coburg Road Corridor service would remain at 15-minute headways on Routes 66 and 67 at all weekday times, 30-minute headways on Saturdays, and 60-minute headways on Sundays.

2.7.2. Enhanced Corridor Alternative

The Coburg Road Corridor Enhanced Corridor Alternative would include new traffic signal construction, intersection reconstruction at several locations on Coburg Road, the addition of queue jumps, and the addition of BAT lanes south of the Interstate 105 (I-105) interchange. New crossings for bicyclists and pedestrians would be constructed. Existing bus stops would be improved and new stops would also be constructed.

Route 12 would be altered to serve Valley River Center and Marcola Road. A new route (Route 60) would be added to serve Valley River Center, and Routes 66 and 67 would be eliminated. This change would provide new service and coverage to the Cal Young neighborhood and along Hayden Bridge Way in Springfield. It would require current passengers along Harlow Road to transfer in order to get downtown.

2.7.3. EmX Alternative

Improvements to the corridor under the Coburg Road Corridor EmX Alternative would include construction of exclusive transit lanes at several locations on Coburg Road and intersection reconstruction at multiple locations. New bicycle and pedestrian crossings and EmX stations would be constructed, and some existing bus stops would be improved to EmX stations.

As in the Coburg Road Corridor Enhanced Corridor Alternative, Route 12 would be altered to serve Valley River Center and Marcola Road, and Route 60 would be added to serve Valley River Center, while Routes 66 and 67 would be eliminated. This change would provide new service and coverage to the Cal Young neighborhood and along Hayden Bridge Way in Springfield. It would require current passengers along Harlow Road to transfer in order to get downtown.

2.8. Martin Luther King, Jr. Boulevard Corridor

The Martin Luther King, Jr. Boulevard Corridor begins at Eugene Station and travels through downtown Eugene on Oak and Pearl Streets and on 7th and 8th Avenues. The corridor uses the Ferry Street Bridge to reach Martin Luther King, Jr. Boulevard and continues east on Martin Luther King, Jr. Boulevard past Autzen Stadium to Centennial Boulevard. Although transit service continues along Centennial Boulevard, capital improvements for the corridor terminate at I-5. The corridor is approximately 6.0 round-trip miles.

2.8.1. No-Build Alternative

The Martin Luther King, Jr. Boulevard Corridor No-Build Alternative includes existing roadway, bicycle, pedestrian, and transit facilities in the corridor, as well as planned improvements in the Draft Eugene 2035 TSP. The Draft Eugene 2035 TSP identifies the following transportation improvements along or adjacent to the Martin Luther King, Jr. Corridor:

- Add a center turn lane along sections of Martin Luther King, Jr. Boulevard from Club Road to Leo Harris Parkway

Under the No-Build Alternative, the Martin Luther King, Jr. Boulevard Corridor service would remain at 30-minute headways.

2.8.2. Enhanced Corridor Alternative

Capital improvements associated with the Martin Luther King, Jr. Boulevard Corridor Enhanced Corridor Alternative would include reconstructing traffic signals at the intersections of Coburg Road and Martin Luther King, Jr. Boulevard and of Martin Luther King, Jr. Boulevard and Centennial Loop; repurposing existing outside general-purpose lanes to BAT lanes on Martin Luther King, Jr. Boulevard; adding a new traffic signal at the intersection of Martin Luther King, Jr. Boulevard and Leo Harris Parkway; enhancing pedestrian crossings; constructing new bus stops; and improving existing bus stops. Existing Route 13 would be eliminated.

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3. Methods and Data

This section describes the analysis methodologies and data used for the geology and seismic evaluation for the MovingAhead Project.

3.1. Relevant Laws and Regulations

Local and state design codes for public streets and related facilities apply to the design and construction of facilities within the City and state rights-of-ways (ROW), respectively, including addressing geologic hazards that could result from or affect the project facilities. A full inventory of those standards will be prepared during the project's final design phase, and all applicable standards would be met to receive construction permits from the applicable jurisdiction or agency.

For geotechnical design, including earthquake design standards, the current applicable guidance that would be met includes the following documents. These current standards may be superseded by updated versions or other guidance adopted by federal, state, or local agencies. The current geotechnical design standards include the *Geotechnical Design Manual* (Oregon Department of Transportation [ODOT], 2011). Seismic design of the pedestrian bridge across the freight railroad line, from Highway 99 just north of Side Street east to Trainsong Park along the Highway 99 Corridor Enhanced Corridor and EmX Alternatives, would follow the *Guide Specifications for Load and Resistance Factor Design Seismic Bridge Design* (American Association of State Highway and Transportation Officials [AASHTO], 2009), as supplemented by the *Bridge Design and Drafting Manual* (ODOT, 2014), with all applicable updates and revisions through 2014.

The guidance in the following two documents provides the current standards for completing liquefaction analysis.

- Dickenson, S., et al. (2002, November). *Assessment and Mitigation of Liquefaction Hazards to Bridge Approach Embankments in Oregon*.
- Dickenson, S. (2005, June). *Recommended Guidelines for Liquefaction Evaluations Using Ground Motions from Probabilistic Seismic Hazard Analysis*.

3.2. Area of Potential Impact

In general, the API for the geologic and seismic assessment is within 100 feet from either edge (ROW line) of existing corridor for each corridor alternative.

3.3. Contacts and Coordination

The project team did not contact external people or organizations when completing the geologic and seismic assessments.

3.4. Level 1 Screening Analysis

No data were collected for the Level 1 Screening.

3.5. Level 2 Alternatives Analysis

The first step in assessing the potential impact of geology and geologic hazards to the project was to determine whether project construction for any of the alternatives would occur in areas identified as significant geologic hazard zones or that would pass close to potentially active crustal faults and folds. A final consideration was whether project construction would require significant cup or fill slopes be developed.

Geology/geologic hazard maps were used to assess whether the project alternative would pass through a significant geologic hazard zone. The U.S. Geological Survey (USGS) Fault and Fold Database (USGS, 2014) was used to assess whether a project alternative would cross or be located close to a significant geologic hazard zone. The alternative would be considered close if it was located within approximately 6 miles (10 kilometers) of a Class A fault (AASHTO, 2009).

If the alternative would not occupy areas identified as significant geologic hazard zones and would not be located within approximately 6 miles of a Class A fault, the finding was documented and no further analysis was performed.

If construction would occur within significant geologic hazard zones close to a Class A fault, then a further assessment of the geologic conditions present in the area would be conducted. The assessment included a review of published geology and geologic hazard maps, Natural Resources Conservation Service (NRCS) soil surveys, water well logs, and past geotechnical reports for the area. These available data were used to assess whether the project facilities would impact the geologic hazards or potentially increase the risk of slope instability or seismically induced lateral spread.

3.5.1. Data Collection

Data sources for the geology and seismic assessment included the following:

- MovingAhead Project conceptual designs
- NRCS web soil survey for Lane County, Oregon
- Oregon Department of Geology and Mineral Industries (DOGAMI) maps for the City of Eugene and Lane County, including:
    - Geologic mapping
    - Geologic hazard maps
    - Relative earthquake hazard maps
    - Landslide inventory maps
- *National Seismic Hazard Maps* (USGS, 2008)
- *Quaternary Fault and Fold Database for the United States* (USGS, 2014)

3.5.2. Significance Thresholds

If one or more of the project alternatives would be constructed within an area identified as a significant geologic hazard zone or would cross or be located within 6 miles of a Class A fault as identified on the USGS Fault and Fold Database, then additional analysis would be prepared to assess whether the project would be at risk from and/or create a geologic hazard. A geologic hazard would be deemed significant if that hazard would put improvements and/or persons at risk and if the hazard could not be avoided (through design modifications) and/or mitigated.

3.5.3. Impact Analysis

The project team assessed the potential for geology and geologic hazards to impact the short- and long-term performance of the project alternatives using historic observations and geologic mapping reviewed for the project.

3.5.3.1. Long-Term Impacts Analysis Approach

The potential for long-term impacts was evaluated for the alternatives that pass through geologic hazard zones.

Long-term impacts to geologic and seismic hazards could result if significant cut or fill slopes are required, especially if they were located in areas where they could increase risk of slope instability. Long-term settlement resulting in poor performance and increased maintenance could result if construction occurs in areas identified as having highly organic or compressible soils.

Crossing a potentially active fault would increase the potential for fault rupture and associated ground displacement that could have a significant impact on the project. There is also a risk of increased ground shaking associated with construction in the vicinity of existing Class A faults where there is some evidence of recent (Quaternary) activity. In the event that an alternative crosses or is located within close proximity to a Class A fault, within 6 miles (AASHTO, 2009), an assessment of the slip rate, fault length, and fault type was made to evaluate the relative risk to the project associates with the potential for future rupture of the fault.

The risk of liquefaction and corresponding lateral spread is greater in areas where subsurface conditions consist of loose, saturated soil.

3.5.3.2. Short-Term Impacts Analysis Approach

Short-term impacts could be associated with project elements that require construction practices that could increase the potential for slope instability. Such practices could include large temporary excavations or fills. Depending on the alternatives evaluated, a general assessment was made related to the potential that project elements could require construction practices that might impact slope stability temporarily.

Short-term impacts could also be associated with soils that have high potential for erosion if the existing ground and ground cover is disturbed during construction. An assessment of the alternatives was made for the potential that the project elements could require grading that would increase the potential for short-term impacts to soil erosion.

3.5.3.3. Indirect Impacts Analysis Approach

Indirect impacts are not applicable.

3.5.3.4. Cumulative Impacts Analysis Approach

If any alternatives would include new or altered bridges, retaining walls, or other similar structures, an indirect and cumulative impact analysis would be required. If an alternative included these features, these methods would be updated, as appropriate.

3.5.3.5. Mitigation Measures Analysis Approach

The primary mitigation measure is avoidance of geologic hazard zones. In the event that geologic hazard zones cannot be avoided, the following mitigation measures were evaluated for effectiveness:

- Slope stabilization
- Excavation of problematic soils and replacement using suitable fill material
- Ground improvement
- Development of post construction monitoring and maintenance procedures

4. Environmental Consequences

This section describes the environmental consequences of geology and seismicity related to the MovingAhead Project.

4.1. Effects Common to Most or All Alternatives

4.1.1. Affected Environment

Geologic units, soil characteristics, and geology and seismic hazards along each alternative were assessed within the API to establish the affected environment for geology and seismicity. The API for geology and seismicity is defined as the area within 100 feet from either edge of the existing corridor for each alternative and associated facilities.

CH2M assessed geologic units and soil characteristics using maps — including topographic maps, surficial soils maps, geologic maps, and geologic hazard maps—published by governmental agencies, including the DOGAMI. No geotechnical borings were drilled during the Level 2 AA.

4.1.1.1. Geologic Setting

The project site is located within the southern portion of the Willamette Valley physiographic province, a broad alluvial plain bordered by the Cascade Mountains on the east and the younger Coast Range along the west. Extending north towards the Columbia River, the valley is approximately 130 miles long and ranges from 20 to 40 miles wide. Elevations along the valley floor range from approximately 400 feet in the south near Eugene to near sea level in the vicinity of Portland in the north. The Willamette River is the major waterway within the valley, flowing south to north and connecting with smaller tributaries within its 11,200-square-mile watershed (Orr and Orr, 1997).

This project site is located in a fore arc basin developed by the Cascadia subduction zone, with bedrock units consisting of Tertiary rocks ranging in age from Eocene to Miocene that consist of volcanic flows and intrusions, tuffaceous sediments, and sedimentary rocks. As a topographic low for the last 15 million years, the basins of the Willamette Valley have collected up to 1500 feet of Neogene and Quaternary fill from the surrounding uplands, deposited by creek and river processes. The basin fill consists of fine-grained Miocene and Pliocene fluvial-lacustrine deposits at the basin bottoms, to coarse-grained fluvial Quaternary sediment deposits in the upper 300 feet that are primarily derived from the Cascade Range and Missoula Flood sediment (O'Conner et al., 2001). The catastrophic Missoula flood events that occurred approximately 12,000 years ago resulted in fine to coarse-grained sediments to be deposited through the valley floor, overlying the coarse-grained sand and gravel deposits distributed along the alluvial plain of the Willamette River.

Figures C-1 and C-2 show the surficial geologic units mapped within the Eugene area. The following geologic units are within API (DOGAMI, 2010):

- Artificial fill (af), which consists of man-made deposits of gravel, sand, and clay, including road embankments.
- Holocene alluvium (Ha), which consists of gravel, sand, silt and clay deposited in active stream channels
- Holocene older alluvium (Hoa), which consists of unconsolidated deposits that formed on low terraces (above Ha), on high river benches along major streams, and along older abandoned stream channels that post-date withdrawal of the last Missoula Flood

- Quaternary landslide and debris avalanche deposits (Qls) which consist of unconsolidated, chaotically mixed and deformed rock, colluvium, and soil deposited by landslides
- Quaternary terrace and fan deposits (Qtg) which consist of deeply dissected, unconsolidated to semi-consolidated gravel, sand, silt and clay that form upper alluvial terraces along the Willamette River
- Late Eocene-early Oligocene siliciclastic marine sedimentary rocks (Teoe) (Eugene Formation), which consists of shallow marine sandstone and siltstone with local / minor thin conglomerate beds; this unit may be susceptible to landslide where bedding planes are moderately to steeply dipping

4.1.1.2. Seismicity

The Willamette Valley physiographic province is directly related to the plate tectonic setting associated with the Cascadia Subduction Zone. The Cascadia Subduction Zone is the region extending from northern California to southern British Columbia, where the oceanic Juan de Fuca plate is subducting beneath the continental North American plate. This has caused formation, uplift, tilting, and folding of the Coast Range and the volcanic formation of the Cascade Mountains, with the Willamette Valley located in between.

The *Earthquake Archive* database (USGS, 2016a) has records for three earthquakes above an earthquake moment magnitude (Mw) of 3.0 occurring within 60 miles of Eugene. The largest magnitude earthquake (Mw 4.1) occurred on July 4, 2015, near Walterville, approximately 13 miles east-northeast of Eugene (USGS, 2016a).

The most recent earthquake of engineering interest (Mw>5.0) to occur near the project was the 1993 Scotts Mills earthquake (Mw 5.6). The epicenter for this earthquake was located approximately 75 miles north-northeast of the project site. According to the *ShakeMap* database (USGS, 2016b), ground shaking associated with this event as recorded in the Eugene area was weak to light.

4.1.1.3. Geologic Hazards

Erosion

Erosion hazards occur where soils may experience severe to very severe water or wind erosion. Certain types of soil (such as silts) are more prone to erosion hazards. The potential for erosion also increases as the slope steepness increases. Surficial soils and topographic maps can be used to identify areas that are particularly susceptible to erosion.

The NRCS, an agency of the U.S. Department of Agriculture, maintains a national database of soils information that includes soil erosion factors (NRCS, 2016). Figure C-12 presents descriptions of the NRCS soil units. NRCS assigns each soil unit into one of eight wind erodibility groups (WEGs). Each WEG consists of soils having similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible.

The NRCS erosion factor, K, indicates the susceptibility of a soil to sheet and rill erosion by water. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the K value, the more susceptible the soil is to sheet and rill erosion by water.

Problematic Soil Properties

Organic soil is soil that contains significant amounts of decaying plant or animal material. This soil tends to have less strength and is more susceptible to compression than ordinary soils. Organic soils are generally unsuitable for most engineering projects. Peat is a specific type of organic soil that contains primarily decaying plant matter. Peat is often found in marsh or swamp areas where water has covered the decaying plant material, preventing oxidation and attack by most organisms. Peat soil is often acidic and can cause corrosion in structures such as steel pipelines. According to the NRCS database, no organic/peat soils were identified in the API.

High shrink-swell soils are primarily clay soils that swell when moisture is absorbed. These soils typically occur in poorly drained bottomland. They can exert pressure on solid structures and cause severe damage. Sites that have a moderate or high shrink/swell potential as identified by the Soil Survey of Lane County are shown. Construction in these areas requires a licensed design professional to evaluate the soils during excavation.

Hydric soils or wet soils are described as having a groundwater table within 1.5 feet of the ground surface, a condition that likely occurs during the wetter months of the year. The high water table creates areas of standing water, which can fill excavation sites.

Landslides

Landslide hazard areas are typically defined as areas that, because of a combination of slope inclination, soil type, geologic structure, and presence of water, are susceptible to failure and subsequent downhill movement. According to the landslide inventory map (DOGAMI, 2016b), historically active landslides have been identified within the API (Figures C-13 and C-14).

Volcano

The Pacific Northwest region is home to a large number of active volcanoes along the Cascade Mountain Range. These volcanoes are the result of active subduction taking place along the Cascadia Subduction Zone (CSZ). As the Juan de Fuca plate is actively subducted beneath the North American plate, rock is melted into the molten magma that fuels the large number of volcanoes in the Cascade Range. The closest major volcano to the project is the cluster of glaciated stratovolcanoes called the Three Sisters. The Three Sisters extend for 12 miles along the crest of the Cascade Range, approximately 60 miles east of Eugene.

Large volcanic eruptions often cause damaging pyroclastic flows (avalanches of hot, dry, volcanic ash, gas, and fragmented rock), landslides, lahars (rapidly moving mudflow of water and volcanic ash), lava flows, glacial-outburst floods, and ash deposits. Large eruptions can also create a lateral blast hazard in the immediate vicinity of a volcano. Volcanic flow hazards generally travel downhill, and the damage they cause typically decreases the farther they travel from the volcanic source. Lahars can travel significant distances from the eruption source through river valleys or other geographic channels before they dissipate.

The USGS (2014) and DOGAMI (2016a) have prepared volcanic hazard maps that evaluate each of these hazards for each of the Cascade volcanoes. These maps indicate that volcanic eruptions of Three Sisters are capable of producing lahars that could reach the intersection of Highway 126 and Bob Straub Parkway (approximately 8.5 miles east of the City of Eugene). Pyroclastic flows, landslides, or lava flows generated by volcanic eruptions would remain even farther away from Eugene.

A volcanic eruption could also distribute volcanic ash (referred to as tephra) across the region. The ash could cause minor health hazards, damage certain types of equipment, and disrupt social and economic activities. The USGS has prepared maps that show the annual probabilities of tephra accumulation resulting from the combined contributions of major Cascade volcanoes (USGS, 2013). According to these maps, the annual probability that the project might experience 0.4 inch or more of tephra accumulation would be less than 0.1 percent.

Ground Motion

The severity of future ground shaking within the API would be influenced by many factors, including the proximity of the project alignment to the location of the causative earthquake; the duration and intensity of the earthquake; and the type of geologic materials underlying the site.

Fault Rupture

According to the Quaternary Fault and Fold Database (USGS, 2014), the closest active fault Class A to the project is the Owl Creek Fault near Corvallis, approximately 26 miles north of the project. No mapped active faults pass through the project site.

Liquefaction

Liquefaction occurs when loose, saturated, sandy soils lose strength because of increased pore water pressure and behave like a viscous liquid. Liquefaction commonly occurs as a result of ground shaking during earthquakes and can results in ground settlement, lateral spreading, landslides, localized disruption because of sand boils, and reduced support for structural foundations. Buildings, bridges, piles, and other structures founded on or in liquefied soils may settle, tilts, move laterally, or collapse.

Tsunamis or Seiches

Tsunamis or seiches are possible secondary effects from seismic events. Both mechanisms involve water waves that are created by an earthquake. According to the Tsunami Inundation map (DOGAMI, 2013), the maximum wave elevation triggered by a magnitude 9.1 Cascadia earthquake would be about 90 feet (North American Vertical Datum of 1988 [NAVD88]) at Heceta Head on the Oregon coast. Eugene is about 50 miles from the Heceta Head, with an approximate elevation of 430 feet. In general, the MovingAhead Project would be located too far from and too high above the Oregon coast for a tsunami inundation. In addition, no significant water bodies where seiche inundation might be a concern would be near any of the corridors.

There is a remote potential that a seismic event could lead to failure of upstream dams near the Willamette River, causing uncontrolled release of water, raising water levels in the Willamette River, and causing inundation to portions of the River Road Corridor, Coburg Road Corridor and Martin Luther King, Jr. Boulevard Corridor in lower-lying areas and near stream crossings.

4.1.2. Long-Term Direct Impacts

4.1.2.1. No-Build Alternative

The long-term impacts of the No-Build Alternative related to geologic hazards that already exist would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the area, even without building the MovingAhead Project. Transportation infrastructure, including transit, within the corridor would be affected by slope instability and seismic hazards identified for the build alternatives below.

4.1.2.2. Enhanced Corridor and EmX Alternatives

Long-term impacts would be related to geologic and seismic hazards that already exist. For example, there would be a risk of seismic events during the period of operation, and this risk could cause other related geologic hazards (such as liquefaction and seismic-induced slope failures). The following list identifies potential long-term operational impacts associated with geology.

- **Slope Instability and Landslides.** Insufficient long-term stability of earth slopes and retaining wall structures could endanger on-site and off-site properties. This risk would be greater if a large seismic event were to occur. Slope stability would be considered during the design phases of the project and various minimization measures could be implemented to stabilize areas of potential risk.
- **Seismic Hazards.** The project would be within a seismically active area. The consequences of a seismic event during operations would be strong ground shaking, which could lead to:
    - Liquefaction of loose, saturated, cohesionless soils that could cause settlement and potentially lateral movement of liquefied and overlying soil
    - Settlement from densification of loose soils
    - Instability of steep slopes
    - Increased earth pressures on retaining walls and buried structures

  These effects could damage the constructed facilities. The overall risk of impacts from slope instability, landslides, and seismic hazards would be higher in the areas with higher relative landslide hazard and higher relative liquefaction hazard (as summarized in Table S.1-1 and the following sections). These effects would be considered during the design phases of the project, and various mitigation or minimization measures could be implemented. The MovingAhead Project would meet seismic design standards to minimize the long-term risks to the system. Designing new structures to meet the current seismic design standards would provide opportunities to mitigate existing slope instability and to mitigate liquefaction hazards through ground-improvement techniques.

4.1.3. Indirect and Cumulative Effects

4.1.3.1. No-Build Alternative

The indirect and cumulative impacts of the No-Build Alternative related to geologic hazards that already exist would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the area, even without building the MovingAhead Project.

4.1.3.2. Enhanced Corridor and EmX Alternatives

Prior activities within the corridors have affected the surficial geologic units, as will future development activities. The small changes that would occur because of the MovingAhead Project would include the reworking of disturbed soil, localized minor grade changes, minor changes in slope stability, and ground improvements. These activities would have little or no meaningful impacts to geology or soils. Such activities would be expected to benefit any areas where previous development activity included poorly placed or compacted artificial fill, or structures that were not designed to current standards. No increase in significant cumulative impacts would be expected.

4.1.4. Short-Term Construction-Related Impacts

4.1.4.1. No-Build Alternative

The short-term construction-related impacts of the No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the area, even without building the MovingAhead Project.

4.1.4.2. Enhanced Corridor and EmX Alternatives

Impacts during construction would be associated with the equipment used to perform the construction, as well as the direct and indirect impacts of the construction activities. Construction activities would have the potential to cause a number of short-term impacts on the environment related to geology, which might include the following.

- **Erosion Hazards.** Clearing of protective vegetation, fill placement, and soil removal or stockpiling during construction allows rainfall and runoff to erode soil particles. The severity of potential erosion is a function of the quantity of vegetation removed, site topography, rainfall, types of soils, and the volume and configuration of soils stockpiled. Erosion of soils could be minimized by completing construction in the summer and fall months when rainfall is less significant. In addition, best management practices (BMPs) would be used to help minimize erosion hazards. These BMPs include, but would not be limited to, the following:
    - Maintaining vegetative growth and providing adequate surface water runoff systems
    - Constructing silt fences downslope of all exposed soil and using plastic covers over exposed earth
    - Using temporary erosion control blankets and mulching to minimize erosion prior to vegetation establishment
- **Slope Instability and Landslide Hazards.** Construction of the proposed improvements would potentially involve grade changes, including cuts and fills that could increase the potential for landsliding or slumping of hillsides.

    During final design, detailed slope stability evaluations would be conducted and, where appropriate, methods of stabilization developed. Methods that could help minimize landslide hazards for both static and seismic conditions would include, but would not be limited to, the following:
    - Using retaining structures that are designed for the loads from retained soils
    - Using mechanical slope reinforcement such as soil nailing
    - Providing construction specifications and quality assurance programs that prohibit over-steepened slopes
- **Seismic Hazards.** An earthquake could occur during construction, resulting in embankment slope failures, liquefaction, or ground settlement. The risk of seismic hazards to construction is considered low because there is a low probability that an earthquake would occur during the actual construction period. If a large earthquake were to occur, the major risk would be to the ongoing construction activities. Work schedules would likely be delayed as efforts were made to repair damaged components of the construction work. Some disruption could also occur to utilities or nearby structures from the damage to exposed cuts or fills.
- **Construction-Induced Vibrations and Noises.** The use of heavy equipment during construction causes ground vibrations. The level of vibrations depends on the type of heavy equipment, distance from the source, and ability of the soil to transmit vibrations. The main concern for construction vibration is potential damage to structures.

- **Settlements from New Earth Loads.** The new earth loads would compress soft soils below and adjacent to the new construction. The extent of compression beyond the footprint of the new earth load could extend at an angle of about 45 degrees down and out from the load. The impacts on adjacent areas could include the following:
    - Settlement of existing utilities
    - Damage to roadways and sidewalks, resulting in additional maintenance work
- **Excavations for Foundations and Removal of Unsuitable Material.** If excavations for structure foundations and the relocation of utilities are not supported correctly, the ground next to the excavations could fail and collapse. This could damage buried utilities, structures, or roadways located adjacent to the excavations. Methods that could help minimize utility and buried structure impacts would include, but would not be limited to, the following:
    - Relocating or protecting utilities where ground settlement could not be avoided
    - Constructing a pile-supported embankment to transfer earth loads to incompressible layers

  Existing soils excavated during construction that cannot be used as structural fill or for landscape material would require removal from the project footprint and disposal elsewhere. Disposal of the material at off-site locations would result in additional truck traffic, dust, and other construction-related impacts.
- **Dewatering.** If proper consideration is not given to the effects of water level changes, dewatering of excavations located below the groundwater table during construction could cause nearby structures to settle. The impact of dewatering would be considered low for the entire alignment if proper avoidance and minimization measures were used. Methods that could help minimize soil settlement include, but are not limited to, the following:
    - Controlling the changes in groundwater elevation near critical structures through the use of localized dewatering and groundwater injection methods
    - Using sheet pile or other groundwater barrier systems to control the horizontal extent of groundwater withdrawal
- **Summary.** The severity or frequency of the hazard or impact could be avoided or minimized using conventional design and construction methods. Where impacts were identified as being moderate to high, more effort would be required during design to evaluate the severity of the impact and to identify an adequate avoidance and minimization method.

4.2. Highway 99 Corridor Environmental Consequences

The project team reviewed the Draft *Level 2 Definition of Alternatives* and the conceptual design roll plots along the Highway 99 Corridor to evaluate the extent of the construction.

No construction activities would be anticipated along the Highway 99 Corridor Enhanced Corridor Alternative between Chambers Street and Eugene Station (downtown area). No construction activities would be anticipated along the EmX Alternative between Garfield Street and Eugene Station (downtown area). The majority of the construction activities would be minor structures such as transit queue jumps, enhanced corridor bus stops, EmX stations, utility trenches, concrete pavement, traffic signs and sidewalks. The construction activities associated with these structures are expected to be minor and the impacts from geology and seismicity as related to the environmental consequences are expected to be very minor. In addition to minor construction activities, the following construction activities that may have potential impact would be anticipated along the Highway 99 Corridor Enhanced Corridor and EmX Alternatives:

- A pedestrian bridge across the freight railroad line, from Highway 99 just north of Side Street east to Trainsong Park
- Embankment fill (about 5 feet) and regrading at the intersection of Highway 99 and Roosevelt Boulevard to develop a 500-foot right-turn pocket

4.2.1. Affected Environment

4.2.1.1. No-Build Alternative

Geologic Setting

Figures C-1 and C-2 show the surficial geologic units mapped within the Highway 99 Corridor, which are Holocene alluvium (Ha) and Quaternary terrace and fan deposits (Qtg) (DOGAMI, 2010).

Geologic Hazards

Erosion

Figures C-3 and C-4 show the NRCS Soil Survey Map in the vicinity of the Highway 99 Corridor No-Build Alternative. The NRCS database (NRCS, 2016) indicates that the surficial soils mapped in the API (unit symbols of 5, 31, 32, 76, 87, 118, and 119) are classified as WEG 6. Therefore, they have low susceptibility to erosion by wind.

The NRCS database indicates that the erosion factor K of surficial soils mapped in the Highway 99 Corridor No-Build Alternative ranges from 0.15 to 0.43. Therefore, they are considered to have low to moderate susceptibility to erosion by water.

Problematic Soil Properties

According to the NRCS database, organic/peat soils were not identified in the Highway 99 No-Build Alternative.

NRCS soil unit 87 has been identified as having high shrink-swell capacity, and NRCS soil units 5 and 87 have been identified as hydric soils.

Along the Highway 99 Corridor No-Build Alternative, NRCS soil unit 5 is located:

- From the Wagner Street and Cubit Street intersection to the Altamont Street and Aerial Way intersection

Along the Highway 99 Corridor No-Build Alternative, NRCS soil unit 87 is located:

- Along W. 7th Avenue from Garfield Street to Chamber Street

Landslides

According to the landslide inventory map (DOGAMI, 2016b), no historically active landslides have been identified within the Highway 99 Corridor No-Build Alternative (Figures C-13 and C-14).

As shown in Figures C-15 and C-16, for the most part, landslide hazard along the Highway 99 Corridor No-Build Alternative is mapped as low (landsliding unlikely). The following location is mapped as moderate (landsliding possible) to high (landsliding likely):

- Highway 99 between W. 5th Avenue and Roosevelt Boulevard south

Volcano

Volcanic activity is not considered a significant hazard to the Highway 99 Corridor No-Build Alternative. According to the recent volcanic hazard maps that DOGAMI prepared (2016a), pyroclastic flows, lava flows, and lahars are not expected to come within 8.5 miles of the Highway 99 Corridor.

Ground Motion

According to the expected earthquake shaking map (DOGAMI, 2016a), the Highway 99 Corridor No-Build Alternative is located in a strong to very strong ground-shaking zone (Figures C-17 and C-18).

Fault Rupture

No mapped active faults pass through the Highway 99 Corridor.

Liquefaction

According to the recent relative earthquake liquefaction hazard map that DOGAMI prepared (2016a), as shown in Figures C-19 and C-20, the following locations in the Highway 99 Corridor No-Build Alternative are within a moderate liquefaction hazard zone:

- From the W. 6th Avenue and Adams Street intersection to Eugene Station
- From the W. 7th Avenue and Blair Boulevard intersection to Eugene Station

Tsunamis or Seiches

No earthquake-generated water waves would be a concern for the Highway 99 Corridor.

4.2.1.2. Enhanced Corridor Alternative

Geologic Setting

Figures C-1 and C-2 show the surficial geologic units mapped within the Highway 99 Corridor, which are Holocene alluvium (Ha) and Quaternary terrace and fan deposits (Qtg) (DOGAMI, 2010).

Geologic Hazards

Erosion

Figure C-3 shows the NRCS Soil Survey Map in the vicinity of the Highway 99 Corridor Enhanced Corridor Alternative. The NRCS database (NRCS, 2016) indicates that the surficial soils mapped in the API (unit symbols of 5, 31, 32, 76, 87, 118, and 119) are classified as WEG 6. Therefore, they have low susceptibility to erosion by wind.

The NRCS database indicates that the erosion factor K of surficial soils mapped in the Highway 99 Corridor Enhanced Corridor Alternative ranges from 0.15 to 0.43. Therefore, they are considered to have low to moderate susceptibility to erosion by water.

Problematic Soil Properties

According to the NRCS database, organic/peat soils were not identified in the Highway 99 Corridor Enhanced Corridor Alternative.

NRCS soil unit 87 has been identified as having high shrink-swell capacity, and NRCS soil units 5 and 87 have been identified as hydric soils.

Along the Highway 99 Corridor Enhanced Corridor Alternative, NRCS soil unit 87 soils are located:

- Along W. 7th Avenue from Garfield Street to Chamber Street
- From the W. 12th Avenue and Chamber Street intersection to the W. 11th Avenue and Taylor Street intersection

Along the Highway 99 Corridor Enhanced Corridor Alternative, NRCS soil units 5 is located:

- From the Wagner Street and Cubit Street intersection to the Altamont Street and Aerial Way intersection

Landslides

According to the landslide inventory map (DOGAMI, 2016b), no historically active landslides have been identified within the Highway 99 Corridor Enhanced Corridor Alternative (Figure C-13).

As shown in Figure C-15, for the most part, landslide hazard along the Highway 99 Corridor Enhanced Corridor Alternative is mapped as low (landsliding unlikely). The following location is mapped as moderate (landsliding possible) to high (landsliding likely):

- Highway 99 between W. 5th Avenue and Roosevelt Boulevard south

Volcano

Volcanic activity is not considered a significant hazard to the Highway 99 Corridor Enhanced Corridor Alternative. According to the recent volcanic hazard maps that DOGAMI prepared (2016a), pyroclastic flows, lava flows, and lahars are not expected to come within 8.5 miles of the Highway 99 Corridor.

Ground Motion

According to the expected earthquake shaking map (DOGAMI, 2016a), the Highway 99 Corridor Enhanced Corridor Alternative is located in a strong to very strong ground-shaking zone (Figure C-17).

Fault Rupture

No mapped active faults pass through the Highway 99 Corridor.

Liquefaction

According to the recent relative earthquake liquefaction hazard map that DOGAMI prepared (2016a), as shown in Figure C-19, the following locations in the Highway 99 Corridor Enhanced Corridor Alternative are within a moderate liquefaction hazard zone:

- From the W. 12th Avenue and Chambers Street intersection to Eugene Station
- From the W. 11th Avenue and Taylor Street intersection to Eugene Station

Tsunamis or Seiches

No earthquake-generated water waves would be a concern for the Highway 99 Corridor.

4.2.1.3. EmX Alternative

Geologic Setting

Figures C-1 and C-2 show the surficial geologic units mapped within the Highway 99 Corridor, which are Holocene alluvium (Ha) and Quaternary terrace and fan deposits (Qtg) (DOGAMI, 2010).

Geologic Hazards

Erosion

Figure C-4 shows the NRCS Soil Survey Map in the vicinity of the Highway 99 Corridor EmX Alternative. The NRCS database (NRCS, 2016) indicates that the surficial soils mapped in the API (unit symbols of 5, 31, 32, 76, 87, 118, and 119) are classified as WEG 6. Therefore, they have low susceptibility to erosion by wind.

The NRCS database indicates that the erosion factor K of surficial soils mapped in the Highway 99 Corridor EmX Alternative ranges from 0.15 to 0.43. Therefore, they are considered to have low to moderate susceptibility to erosion by water.

Problematic Soil Properties

According to the NRCS database, organic/peat soils were not identified in the Highway 99 Corridor EmX Alternative.

NRCS soil unit 87 has been identified as having high shrink-swell capacity, and NRCS soil units 5 and 87 have been identified as hydric soils.

Along the Highway 99 Corridor EmX Alternative, NRCS soil units 5 is located:

- From the Wagner Street and Cubit Street intersection to the Altamont Street and Aerial Way intersection

Along the Highway 99 Corridor EmX Alternative, NRCS soil unit 87 is located:

- Along W. 7th Avenue from Garfield Street to Chamber Street

Landslides

According to the landslide inventory map (DOGAMI, 2016b), no historically active landslides have been identified within the Highway 99 Corridor EmX Alternative (Figure C-14).

As shown in Figure C-16, for the most part, landslide hazard along the Highway 99 Corridor EmX Alternative is mapped as low (landsliding unlikely). The following location is mapped as moderate (landsliding possible) to high (landsliding likely):

- Highway 99 between W. 5th Avenue and Roosevelt Boulevard south

Volcano

Volcanic activity is not considered a significant hazard to the Highway 99 Corridor EmX Alternative. According to the recent volcanic hazard maps that DOGAMI prepared (2016a), pyroclastic flows, lava flows, and lahars are not expected to come within 8.5 miles of the Highway 99 Corridor.

Ground Motion

According to the expected earthquake shaking map (DOGAMI, 2016a), the Highway 99 Corridor EmX Alternative is located in a strong to very strong ground-shaking zone (Figure C-18).

Fault Rupture

No mapped active faults pass through the Highway 99 Corridor.

Liquefaction

According to the recent relative earthquake liquefaction hazard map that DOGAMI prepared (2016a), as shown in Figure C-20, the following locations in the Highway 99 Corridor EmX Alternative are within a moderate liquefaction hazard zone:

- From the W. 6th Avenue and Adams Street intersection to Eugene Station
- From the W. 7th Avenue and Blair Boulevard intersection to Eugene Station

Tsunamis or Seiches

No earthquake-generated water waves would be a concern for the Highway 99 Corridor.

4.2.2. Long-Term Direct Impacts

4.2.2.1. No-Build Alternative

The long-term direct impacts of the No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the Highway 99 Corridor, even without building the MovingAhead Project. Transportation infrastructure, including transit, within the corridor would be affected by slope instability and seismic hazards identified for the build alternatives below.

4.2.2.2. Enhanced Corridor Alternative

The following list identifies potential long-term operational impacts associated with geology along the Highway 99 Corridor Enhanced Corridor Alternative.

- **Slope Instability and Landslides.** The overall risk of impacts from slope instability and landslide would be low. For the section of Highway 99 between W. 5th Avenue and Roosevelt Boulevard south, the risk would be moderate (landsliding possible) to high (landsliding likely).
- **Seismic Hazards.** The project would be within a seismically active area. The MovingAhead Project would meet seismic design standards to minimize the long-term risks to the system.

4.2.2.3. EmX Alternative

The following list identifies potential long-term operational impacts associated with geology along the Highway 99 Corridor EmX Alternative.

- **Slope Instability and Landslides.** The overall risk of impacts from slope instability and landslide would be low. For the section of Highway 99 between W. 5th Avenue and Roosevelt Boulevard south, the risk would be moderate (landsliding possible) to high (landsliding likely).
- **Seismic Hazards.** The project would be within a seismically active area. The MovingAhead Project would meet seismic design standards to minimize the long-term risks to the system.

4.2.3. Indirect and Cumulative Effects

4.2.3.1. No-Build Alternative

The cumulative impacts of the Highway 99 Corridor No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the area, even without building the MovingAhead Project.

4.2.3.2. Enhanced Corridor Alternative

With the Highway 99 Corridor Enhanced Corridor Alternative, no increase in significant cumulative impacts would be expected.

4.2.3.3. EmX Alternative

With the Highway 99 Corridor EmX Alternative, no increase in significant cumulative impacts would be expected.

4.2.4. Short-Term Construction-Related Impacts

4.2.4.1. No-Build Alternative

The short-term construction-related impacts of the Highway 99 Corridor No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the area, even without building the MovingAhead Project.

4.2.4.2. Enhanced Corridor Alternative

Construction activities would have the potential to cause a number of short-term impacts on the environment related to geology, which might include the following along the Highway 99 Corridor Enhanced Corridor Alternative.

- **Slope Instability and Landslide Hazards.** Overall risk of impacts because of constructing in landslide hazard areas would be limited for the section of Highway 99 between W. 5th Avenue and Roosevelt Boulevard south that has been mapped as moderate (landsliding possible) to high (landsliding likely).
- **Construction-Induced Vibrations and Noises.** The major source of construction vibration and noises would be pile driving, if a pile system would be considered for the foundation of the proposed pedestrian bridge across the freight railroad line during the project's final design phase. Other sources of construction vibration would include vibratory rollers and jack hammers. The *Noise and*

Vibration Technical Report (Michael Minor and Associates, Inc. [MMA] and CH2M, 2017) provides a more detailed review of these potential impacts.

- **Settlements from New Earth Loads.** The project team would anticipate that retained fill would be used at some locations in the Highway 99 Corridor Enhanced Corridor Alternative for construction of new stops, turn lanes, queue jumps, and widening of roadways. It is not anticipated, however, that these retained fills would be more than a couple of feet tall. As a result, the settlement that the placement of new fills might cause would be expected to be negligible.

  An area of embankment fill and regrading would be anticipated at the intersection of Highway 99 and Roosevelt Boulevard. During final design, detailed evaluations would be conducted and, where appropriate, methods of stabilization would be developed.

- **Excavations for Foundations and Removal of Unsuitable Material.** The risk of impact to utilities and buried structures would be considered low during construction. After reviewing design drawings, it is anticipated that the potential soil excavation volumes would be minor.

4.2.4.3. EmX Alternative

Construction activities would have the potential to cause a number of short-term impacts on the environment related to geology, which might include the following along the Highway 99 Corridor EmX Alternative.

- **Slope Instability and Landslide Hazards.** Overall risk of impacts because of constructing in landslide hazard areas would be limited for the section of Highway 99 between W. 5th Avenue and Roosevelt Boulevard south that has been mapped as moderate (landsliding possible) to high (landsliding likely).
- **Construction-Induced Vibrations and Noises.** The major source of construction vibration and noises would be pile driving, if a pile system would be considered for the foundation of the proposed pedestrian bridge across the freight railroad line during the project's final design phase. Other sources of construction vibration would include vibratory rollers and jack hammers. The *Noise and Vibration Technical Report* (MMA and CH2M, 2017) provides a detailed review of these potential impacts.
- **Settlements from New Earth Loads.** The project team would anticipate that retained fill would be used at some locations in the Highway 99 Corridor for construction of new stops, turn lanes, queue jumps, and widening of roadways. It is not anticipated, however, that these retained fills would be more than a couple of feet tall. As a result, the settlement that the placement of new fills might cause would be expected to be negligible.

  An area of embankment fill and regrading would be anticipated at the intersection of Highway 99 and Roosevelt Boulevard. During final design, detailed evaluations would be conducted and, where appropriate, methods of stabilization would be developed.

- **Excavations for Foundations and Removal of Unsuitable Material.** The risk of impact to utilities and buried structures would be considered low during construction. After reviewing design drawings, it is anticipated that the potential soil excavation volumes would be minor.

4.3. River Road Corridor Environmental Consequences

The project team reviewed Draft *Level 2 Definition of Alternatives* and the conceptual design roll plots along the River Road Corridor to evaluate the extent of the construction.

No construction activities would be anticipated along the Enhanced Corridor Alternative between Eugene Station and the intersection of W. 1st Avenue and Chambers Street. No construction activities would be anticipated along the EmX Alternative between Eugene Station and the intersection of W. 6th Avenue and Chambers Street (downtown area). The majority of the construction activities are minor structures such as transit queue jumps, enhanced corridor bus stops, EmX stations, utility trenches, concrete pavement, traffic signs, and sidewalks. The construction activities associated with these structures are expected to be minor and the impacts from geology and seismicity as related to the environmental consequences are expected to be very minor. In addition to minor construction activities, the following construction activity would be anticipated along the River Road Corridor Enhanced Corridor and EmX Alternatives:

- Construction of turn pocket at the intersection of River Road and Railroad Boulevard ramp; length of turn pocket limited by grading impacts and potential structural impacts

The River Road Corridor EmX Alternative would include widening the roadway under the Randy Papé Beltline Highway Bridge. Reviewing the design criteria and as-built drawings of the Randy Papé Beltline Highway Bridge during the final design phase will confirm feasibility of this improvement and will determine the extent of the construction.

4.3.1. Affected Environment

4.3.1.1. No-Build Alternative

Geologic Setting

Figures C-1 and C-2 show the surficial geologic units mapped within the River Road Corridor, which are Holocene alluvium (Ha), Holocene older alluvium (Hoa), and Quaternary terrace and fan deposits (Qtg) (DOGAMI, 2010).

Geologic Hazards

Erosion

Figures C-5 and C-6 show the NRCS Soil Survey Map in the vicinity of the River Road Corridor No-Build Alternative. The NRCS database indicates that the surficial soils mapped in the API (unit symbols of 25, 32, and 76) are classified as WEG 6. Therefore, they have low susceptibility to erosion by wind.

The NRCS database indicates that the erosion factor of surficial soils mapped in the River Road Corridor No-Build Alternative ranges from 0.24 to 0.32. Therefore, they are considered to have low susceptibility to erosion by water.

Problematic Soil Properties

According to the NRCS database, organic/peat soils, high-shrink/swell capacity soils, and hydric soils were not identified in the River Road Corridor No-Build Alternative.

Landslides

According to the landslide inventory map (DOGAMI, 2016b), no historically active landslides have been identified within the River Road Corridor No-Build Alternative (Figures C-13 and C-14).

As shown in Figures C-15 and C-16, for the most part, landslide hazard along the River Road Corridor No-Build Alternative is mapped as low (landsliding unlikely). The following locations are mapped as moderate (landsliding possible) to high (landsliding likely):

- Chambers Street between W. 2nd Avenue and Northwest Expressway
- River Road at the Randy Papé Beltline Highway interchange

Volcano

Volcanic activity is not considered a significant hazard to the River Road Corridor No-Build Alternative. According to the recent volcanic hazard maps prepared by DOGAMI (2016a), pyroclastic flows, lava flows, and lahars are not expected to come within 8.5 miles of the River Road Corridor.

Ground Motion

According to the expected earthquake shaking map (DOGAMI, 2016a), the River Road Corridor No-Build Alternative is located in a strong to very strong ground-shaking zone (Figures C-17 and C-18).

Fault Rupture

No mapped active faults pass through the River Road Corridor.

Liquefaction

According to the recent relative earthquake liquefaction hazard map prepared by DOGAMI (2016a), as shown in Figures C-19 and C-20, the following locations in the River Road Corridor No-Build Alternative are within a moderate liquefaction hazard zone:

- From Irving Road to the Roosevelt Boulevard and Chambers Street intersection
- From the W. 6th Avenue and Adams Street intersection to Eugene Station
- From the W. 7th Avenue and Blair Boulevard intersection to Eugene Station

Tsunamis or Seiches

No earthquake-generated water waves would be a concern for the River Road Corridor. There is a remote potential that a seismic event could lead to failure of upstream dams near to the Willamette River, causing uncontrolled release of water, raising water levels in the Willamette River, and causing inundation to portions of the River Road Corridor in lower-lying areas and near stream crossings.

4.3.1.2. Enhanced Corridor Alternative

Geologic Setting

Figures C-1 and C-2 show the surficial geologic units mapped within the River Road Corridor, which are Holocene alluvium (Ha), Holocene older alluvium (Hoa), and Quaternary terrace and fan deposits (Qtg) (DOGAMI, 2010).

Geologic Hazards

Erosion

Figure C-5 shows the NRCS Soil Survey Map in the vicinity of the River Road Corridor Enhanced Corridor Alternative. The NRCS database indicates that the surficial soils mapped in the API (unit symbols of 25, 32, and 76) are classified as WEG 6. Therefore, they have low susceptibility to erosion by wind.

The NRCS database indicates that the erosion factor of surficial soils mapped in the River Road Corridor Enhanced Corridor Alternative ranges from 0.24 to 0.32. Therefore, they are considered to have low susceptibility to erosion by water.

Problematic Soil Properties

According to the NRCS database, organic/peat soils, high-shrink/swell capacity soils, and hydric soils were not identified in the River Road Corridor Enhanced Corridor Alternative.

Landslides

According to the landslide inventory map (DOGAMI, 2016b), no historically active landslides have been identified within the River Road Corridor Enhanced Corridor Alternative (Figure C-13).

As shown in Figure C-15, for the most part, landslide hazard along the River Road Corridor Enhanced Corridor Alternative is mapped as low (landsliding unlikely). The following locations are mapped as moderate (landsliding possible) to high (landsliding likely):

- Chambers Street between W. 2nd Avenue and the Northwest Expressway
- River Road at the Randy Papé Beltline Highway interchange
- Jefferson Street and Washington Street, between W. 5th Avenue and W. 1st Avenue

Volcano

Volcanic activity is not considered a significant hazard to the River Road Corridor Enhanced Corridor Alternative. According to the recent volcanic hazard maps prepared by DOGAMI (2016a), pyroclastic flows, lava flows, and lahars are not expected to come within 8.5 miles of the River Road Corridor.

Ground Motion

According to the expected earthquake shaking map (DOGAMI, 2016a), the River Road Corridor Enhanced Corridor Alternative is located in a strong to very strong ground-shaking zone (Figure C-17).

Fault Rupture

No mapped active faults pass through the River Road Corridor.

Liquefaction

According to the recent relative earthquake liquefaction hazard map prepared by DOGAMI (2016a), as shown in Figure C-19, the following locations in the River Road Corridor Enhanced Corridor Alternative are within a moderate liquefaction hazard zone:

- From Irving Road to the Roosevelt Boulevard and Chambers Street intersection
- From the W. 5th Avenue and Adams Street intersection to Eugene Station
- From the W. 1st Avenue and Jefferson Street intersection to Eugene Station

- From the W. 1st Avenue and Washington Street intersection to Eugene Station

Tsunamis or Seiches

No earthquake-generated water waves would be a concern for the River Road Corridor.

4.3.1.3. EmX Alternative

Geologic Setting

Figures C-1 and C-2 show the surficial geologic units mapped within the River Road Corridor, which are Holocene alluvium (Ha), Holocene older alluvium (Hoa), and Quaternary terrace and fan deposits (Qtg) (DOGAMI, 2010).

Geologic Hazards

Erosion

Figure C-6 shows the NRCS Soil Survey Map in the vicinity of the River Road Corridor EmX Alternative. The NRCS database indicates that the surficial soils mapped in the API (unit symbols of 25, 32, and 76) are classified as WEG 6. Therefore, they have low susceptibility to erosion by wind.

The NRCS database indicates that the erosion factor of surficial soils mapped in the River Road Corridor EmX Alternative ranges from 0.24 to 0.32. Therefore, they are considered to have low susceptibility to erosion by water.

Problematic Soil Properties

According to the NRCS database, organic/peat soils, high-shrink/swell capacity soils, and hydric soils were not identified in the River Road Corridor EmX Alternative.

Landslides

According to the landslide inventory map (DOGAMI, 2016b), no historically active landslides have been identified within the River Road Corridor EmX Alternative (Figure C-14).

As shown in Figure C-16, for the most part, landslide hazard along the River Road Corridor EmX Alternative is mapped as low (landsliding unlikely). The following locations are mapped as moderate (landsliding possible) to high (landsliding likely):

- The section of Chambers Street between W. 2nd Avenue and the Northwest Expressway
- The section of River Road at the Randy Papé Beltline Highway interchange

Volcano

Volcanic activity is not considered a significant hazard to the River Road Corridor EmX Alternative. According to the recent volcanic hazard maps prepared by DOGAMI (2016a), pyroclastic flows, lava flows, and lahars are not expected to come within 8.5 miles of the River Road Corridor.

Ground Motion

According to the expected earthquake shaking map (DOGAMI, 2016a), the River Road Corridor EmX Alternative is located in a strong to very strong ground-shaking zone (Figure C-18).

Fault Rupture

No mapped active faults pass through the River Road Corridor.

Liquefaction

According to the recent relative earthquake liquefaction hazard map prepared by DOGAMI (2016a), as shown in Figure C-20, the following locations in the River Road Corridor EmX Alternative are within a moderate liquefaction hazard zone:

- From Irving Road to the Roosevelt Boulevard and Chambers Street intersection
- From the W. 6th Avenue and Adams Street intersection to Eugene Station
- From the W. 7th Avenue and Blair Boulevard intersection to Eugene Station

Tsunamis or Seiches

No earthquake-generated water waves would be a concern for the River Road Corridor.

4.3.2. Long-Term Direct Impacts

4.3.2.1. No-Build Alternative

The long-term direct impacts of the No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the River Road Corridor, even without building the MovingAhead Project. Transportation infrastructure, including transit, within the corridor would be affected by slope instability and seismic hazards identified for the build alternatives below.

4.3.2.2. Enhanced Corridor Alternative

The following list identifies potential long-term operational impacts associated with geology along the River Road Corridor Enhanced Corridor Alternative:

Slope Instability and Landslides. The overall risk of impacts from slope instability and landslide would be low. For the following locations, the risk would be moderate (landsliding possible) to high (landsliding likely):

- The section of Chambers Street between W. 2nd Avenue and Northwest Expressway
- The section of River Road at Randy Papé Beltline Highway interchange
- The section of Jefferson Street and Washington Street, between W. 5th Avenue and W. 1st Avenue

Seismic Hazards. The project would be within a seismically active area. The MovingAhead Project would meet seismic design standards to minimize the long-term risks to the system.

4.3.2.3. EmX Alternative

The following list identifies potential long-term operational impacts associated with geology along the River Road Corridor EmX Alternative:

Slope Instability and Landslides. The overall risk of impacts from slope instability and landslide would be low. For the following locations, the risk would be moderate (landsliding possible) to high (landsliding likely):

- The section of Chambers Street between W. 2nd Avenue and Northwest Expressway
- The section of River Road at Randy Papé Beltline Highway interchange

Seismic Hazards. The project would be within a seismically active area. The MovingAhead Project would meet seismic design standards to minimize the long-term risks to the system.

4.3.3. Indirect and Cumulative Effects

4.3.3.1. No-Build Alternative

The cumulative impacts of the River Road Corridor No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the area, even without building the MovingAhead Project.

4.3.3.2. Enhanced Corridor Alternative

With the River Road Corridor Enhanced Corridor Alternative, no increase in significant cumulative impacts would be expected.

4.3.3.3. EmX Alternative

With the River Road Corridor EmX Alternative, no increase in significant cumulative impacts would be expected.

4.3.4. Short-Term Construction-Related Impacts

4.3.4.1. No-Build Alternative

The short-term construction-related impacts of the River Road Corridor No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the area, even without building the MovingAhead Project.

4.3.4.2. Enhanced Corridor Alternative

Construction activities have the potential to cause a number of short-term impacts on the environment related to geology, which might include the following along the River Road Corridor Enhanced Corridor Alternative.

- **Slope Instability and Landslide Hazards.** Overall risk of impacts because of constructing in landslide hazard areas would be limited for the following sections of River Road that have been mapped as moderate (landsliding possible) to high (landsliding likely):
    - Chambers Street between W. 2nd Avenue and the Northwest Expressway
    - River Road at the Randy Papé Beltline Highway interchange
- **Construction-Induced Vibrations and Noises.** The major sources of construction vibration include vibratory rollers and jack hammers. The *Noise and Vibration Technical Report* (MMA and CH2M, 2017) provides a detailed review of these potential impacts.
- **Settlements from New Earth Loads.** The project team anticipates that retained fill would be used at some locations in the River Road Corridor Enhanced Corridor Alternative for construction of new stops, turn lanes, queue jumps, and widening of roadways. It is not anticipated, however, that these retained fills would be more than a couple of feet tall. As a result, the settlement that the placement of new fills might cause would be expected to be negligible.

- **Excavations for Foundations and Removal of Unsuitable Material.** The risk of impact to utilities and buried structures would be considered low during construction. After reviewing design drawings, it is anticipated that the potential soil excavation volumes would be minor.

4.3.4.3. EmX Alternative

Construction activities would have the potential to cause a number of short-term impacts on the environment related to geology, which might include the following along the River Road Corridor EmX Alternative.

- **Slope Instability and Landslide Hazards.** Overall risk of impacts because of constructing in landslide hazard areas would be limited for the section of Chambers Street between W. 2nd Avenue and Northwest Expressway, and the section of River Road at the Randy Papé Beltline Highway interchange that has been mapped as moderate (landsliding possible) to high (landsliding likely).
- **Construction-Induced Vibrations and Noises.** The major sources of construction vibration include vibratory rollers and jack hammers. The *Noise and Vibration Technical Report* (MMA and CH2M, 2017) provides a detailed review of these potential impacts.
- **Settlements from New Earth Loads.** The project team anticipates that retained fill would be used at some locations in the River Road Corridor EmX Alternative for construction of new stops, turn lanes, queue jumps, and widening of roadways. It is not anticipated, however, that these retained fills would be more than a couple of feet tall. As a result, the settlement that the placement of new fills might cause would be expected to be negligible.
- **Excavations for Foundations and Removal of Unsuitable Material.** The risk of impact to utilities and buried structures would be considered low during construction. After reviewing design drawings, it is anticipated that the potential soil excavation volumes would be minor.

4.4. 30th Avenue to Lane Community College Corridor Environmental Consequences

The project team reviewed the *Level 2 Definition of Alternatives* and the conceptual design roll plots along the 30th Avenue to LCC Corridor to evaluate the extent of the construction.

No construction activities would be anticipated along the Enhanced Corridor and EmX Alternative between the intersection of University Street and E. 30th Avenue and LCC. The majority of the construction activities are minor structures such as transit queue jumps, enhanced corridor bus stops, EmX stations, utility trenches, concrete pavement, traffic signs and sidewalks. The construction activities associated with these structures are expected to be minor and the impacts from geology and seismicity as related to the environmental consequences are expected to be very minor. In addition to minor construction activities, the following construction activities would be anticipated along the 30th Avenue to LCC Corridor Enhanced Corridor and EmX Alternatives:

- Decommission pedestrian bridge and convert to enhanced pedestrian crossing on Amazon Parkway at the Civic Stadium development site
- New road construction on E. 20th Avenue from Oak Street to Amazon Parkway as a 60-foot-wide cross section

The 30th Avenue to LCC Corridor EmX Alternative includes a new EmX station at Spring Boulevard westbound and E. 30th Avenue which may need considerable fill and regarding.

4.4.1. Affected Environment

4.4.1.1. No-Build Alternative

Geologic Setting

Figures C-1 and C-2 show the surficial geologic units mapped within the 30th Avenue to LCC Corridor, which are artificial fill (af), Holocene alluvium (Ha), Quaternary landslide and debris avalanche deposits (Qls), Quaternary terrace and fan deposits (Qtg), and late Eocene-early Oligocene siliciclastic marine sedimentary rocks (Teoe) (DOGAMI, 2010).

Geologic Hazards

Erosion

Figures C-7 and C-8 show the NRCS Soil Survey Map in the vicinity of the 30th Avenue to LCC Corridor No-Build Alternative. The NRCS database indicates that most of the surficial soils mapped in the API (unit symbols of 8, 9, 11D, 11E, 41F, 42E, 43C, 43E, 76, 87, 102C, 103C, and 127C) are classified as WEG 4 to WEG 6. Therefore, they have low to moderate susceptibility to erosion by wind.

The NRCS database indicates that the erosion factor of surficial soils mapped in the 30th Avenue to LCC Corridor No-Build Alternative range from 0.1 to 0.37. Therefore, they are considered to have low susceptibility to erosion by water.

Problematic Soil Properties

According to the NRCS database, organic/peat soils were not identified in the 30th Avenue to LCC Corridor No-Build Alternative.

NRCS soil units 8, 9 and 87 has been identified as having high shrink-swell capacity and, NRCS soil units 8, 9, 87, 102C, and 103C have been identified as hydric soils.

Along the 30th Avenue to LCC Corridor No-Build Alternative, NRCS soil units 8, 9, and 87 are located:

- From the Oak Street and E. 14th Avenue intersection, and from the Pearl Street and E. 15th Avenue intersection to the E. 30th Avenue and Kincaid Street intersection

Along the 30th Avenue to LCC Corridor No-Build Alternative, NRCS soil units 102C, and 103C are located:

- Approximately 800 feet north of the E. 30th Avenue and Forest Boulevard intersection
- Along Gonyea Road to LCC

Landslides

According to the landslide inventory map (DOGAMI, 2016b), historically active landslides have been identified within the 30th Avenue to LCC Corridor No-Build Alternative along E. 30th Avenue east of the Spring Boulevard intersection (Figures C-13 and C-14).

As shown in Figures C-15 and C-16, the following locations are mapped as low (landsliding unlikely):

- For the most part, between Eugene Station and Amazon Parkway and E. 29th Avenue intersection

The following locations are mapped as moderate (landsliding possible) to high (landsliding likely)

- Between the Amazon Parkway and E. 29th Avenue intersection and LCC Station.

The following location is mapped as very high (existing landslide):

- Along E. 30th Avenue at the Spring Boulevard interchange

Volcano

Volcanic activity is not considered a significant hazard to the 30th Avenue to LCC Corridor No-Build Alternative. According to the recent volcanic hazard maps prepared by DOGAMI (2016a), pyroclastic flows, lava flows, and lahars are not expected to come within 6 miles of the 30th Avenue to LCC Corridor.

Ground Motion

According to the expected earthquake shaking map (DOGAMI, 2016a), the 30th Avenue to LCC Corridor No-Build Alternative is located in a strong ground-shaking zone (Figures C-17 and C-18).

Fault Rupture

No mapped active faults pass through the 30th Avenue to LCC Corridor.

Liquefaction

According to the recent relative earthquake liquefaction hazard map prepared by DOGAMI (2016a), as shown in Figures C-19 and C-20, the following location in the 30th Avenue to LCC Corridor No-Build Alternative is within a moderate liquefaction hazard zone:

- From the Eugene Station to the E. 30th Avenue and Alder Street intersection

The following location is within a high liquefaction hazard zone:

- From 0.5 mile before to 0.3 mile after the E. 30th Avenue and Spring Boulevard intersection

Tsunamis or Seiches

No earthquake-generated water waves would be a concern for the 30th Avenue to LCC Corridor.

4.4.1.2. Enhanced Corridor Alternative

Geologic Setting

Figures C-1 and C-2 show the surficial geologic units mapped within the 30th Avenue to LCC Corridor, which are artificial fill (af), Holocene alluvium (Ha), Quaternary landslide and debris avalanche deposits (Qls), Quaternary terrace and fan deposits (Qtg), and late Eocene-early Oligocene siliciclastic marine sedimentary rocks (Teoe) (DOGAMI, 2010).

Geologic Hazards

Erosion

Figure C-7 shows the NRCS Soil Survey Map in the vicinity of the 30th Avenue to LCC Corridor Enhanced Corridor Alternative. The NRCS database indicates that most of the surficial soils mapped in the API (unit symbols of 8, 9, 11D, 11E, 41F, 42E, 43C, 43E, 76, 87, 102C, 103C, and 127C) are classified as WEG 4 to WEG 6. Therefore, they have low to moderate susceptibility to erosion by wind.

The NRCS database indicates that the erosion factor of surficial soils mapped in the 30th Avenue to LCC Corridor Enhanced Corridor Alternative range from 0.1 to 0.37. Therefore, they are considered to have low susceptibility to erosion by water.

Problematic Soil Properties

According to the NRCS database, organic/peat soils were not identified in the 30th Avenue to LCC Corridor Enhanced Corridor Alternative.

NRCS soil units 8, 9, and 87 has been identified as having high shrink-swell capacity and, NRCS soil units 8, 9, 87, 102C, and 103C have been identified as hydric soils.

Along the 30th Avenue to LCC Corridor Enhanced Corridor Alternative, NRCS soil units 8, 9, and 87 are located:

- From the Oak Street and E. 14th Avenue intersection, and from the Pearl Street and E. 15th Avenue intersection to the E. 30th Avenue and Kincaid Street intersection

Along the 30th Avenue to LCC Corridor Enhanced Corridor Alternative, NRCS soil units 102C, and 103C are located:

- Approximately 800 feet north of the E. 30th Avenue and Forest Boulevard intersection
- Along Gonyea Road to LCC

Landslides

According to the landslide inventory map (DOGAMI, 2016b), historically active landslides have been identified within the 30th Avenue to LCC Corridor Enhanced Corridor Alternative along E. 30th Avenue east of the Spring Boulevard intersection (Figure C-13).

As shown in Figure C-15, the following location is mapped as low (landsliding unlikely):

- For the most part, between Eugene Station and Amazon Parkway and E. 29th Avenue intersection

The following location is mapped as moderate (landsliding possible) to high (landsliding likely)

- Between the Amazon Parkway and E. 29th Avenue intersection and LCC Station

The following location is mapped as very high (existing landslide):

- Along E. 30th Avenue at the Spring Boulevard interchange

Volcano

Volcanic activity is not considered a significant hazard to the 30th Avenue to LCC Corridor Enhanced Corridor Alternative. According to the recent volcanic hazard maps prepared by DOGAMI (2016a), pyroclastic flows, lava flows, and lahars are not expected to come within 6 miles of the 30th Avenue to LCC Corridor.

Ground Motion

According to the expected earthquake shaking map (DOGAMI, 2016a), the 30th Avenue to LCC Corridor Enhanced Corridor Alternative is located in a strong ground-shaking zone (Figure C-17).

Fault Rupture

No mapped active faults pass through the 30th Avenue to LCC Corridor.

Liquefaction

According to the recent relative earthquake liquefaction hazard map prepared by DOGAMI (2016a), as shown in Figure C-19, the following location in the 30th Avenue to LCC Corridor Enhanced Corridor Alternative is within a moderate liquefaction hazard zone:

- From the Eugene Station to the E. 30th Avenue and Alder Street intersection

The following location is within a high liquefaction hazard zone:

- From 0.5 mile before to 0.3 mile after the E. 30th Avenue and Spring Boulevard intersection

Tsunamis or Seiches

No earthquake-generated water waves would be a concern for the 30th Avenue to LCC Corridor.

4.4.1.3. EmX Alternative

Geologic Setting

Figures C-1 and C-2 show the surficial geologic units mapped within the 30th Avenue to LCC Corridor, which are artificial fill (af), Holocene alluvium (Ha), Quaternary landslide and debris avalanche deposits (Qls), Quaternary terrace and fan deposits (Qtg), and late Eocene-early Oligocene siliciclastic marine sedimentary rocks (Teoe) (DOGAMI, 2010).

Geologic Hazards

Erosion

Figure C-8 shows the NRCS Soil Survey Map in the vicinity of the 30th Avenue to LCC Corridor EmX Alternative. The NRCS database indicates that most of the surficial soils mapped in the API (unit symbols of 8, 9, 11D, 11E, 41F, 42E, 43C, 43E, 76, 87, 102C, 103C, and 127C) are classified as WEG 4 to WEG 6. Therefore, they have low to moderate susceptibility to erosion by wind.

The NRCS database indicates that the erosion factor of surficial soils mapped in the 30th Avenue to LCC Corridor EmX Alternative range from 0.1 to 0.37. Therefore, they are considered to have low susceptibility to erosion by water.

Problematic Soil Properties

According to the NRCS database, organic/peat soils were not identified in the 30th Avenue to LCC Corridor Enhanced Corridor Alternative.

NRCS soil units 8, 9 and 87 has been identified as having high shrink-swell capacity and, NRCS soil units 8, 9, 87, 102C, and 103C have been identified as hydric soils.

Along the 30th Avenue to LCC Corridor EmX Alternative, NRCS soil units 8, 9, and 87 are located:

- From the Oak Street and E. 14th Avenue intersection, and from the Pearl Street and E. 15th Avenue intersection to the E. 30th Avenue and Kincaid Street intersection

Along the 30th Avenue to LCC Corridor EmX Alternative, NRCS soil units 102C, and 103C are located:

- Approximately 800 feet north of the E. 30th Avenue and Forest Boulevard intersection
- Along Gonyea Road to LCC

Landslides

According to the landslide inventory map (DOGAMI, 2016b), historically active landslides have been identified within the 30th Avenue to LCC Corridor EmX Alternative along E. 30th Avenue east of the Spring Boulevard intersection (Figure C-14).

As shown in Figure C-16, the following locations are mapped as low (landsliding unlikely):

- For the most part, between Eugene Station and Amazon Parkway and E. 29th Avenue intersection

The following locations is mapped as moderate (landsliding possible) to high (landsliding likely)

- Between the Amazon Parkway and E. 29th Avenue intersection and LCC Station

The following location is mapped as very high (existing landslide):

- Along E. 30th Avenue at the Spring Boulevard interchange

Volcano

Volcanic activity is not considered a significant hazard to the 30th Avenue to LCC Corridor EmX Alternative. According to the recent volcanic hazard maps prepared by DOGAMI (2016a), pyroclastic flows, lava flows, and lahars are not expected to come within 6 miles of the 30th Avenue to LCC Corridor.

Ground Motion

According to the expected earthquake shaking map (DOGAMI, 2016a), the 30th Avenue to LCC Corridor EmX Alternative is located in a strong ground-shaking zone (Figure C-18).

Fault Rupture

No mapped active faults pass through the 30th Avenue to LCC Corridor.

Liquefaction

According to the recent relative earthquake liquefaction hazard map prepared by DOGAMI (2016a), as shown in Figure C-20, the following location in the 30th Avenue to LCC Corridor EmX Alternative is within a moderate liquefaction hazard zone:

- From the Eugene Station to the E. 30th Avenue and Alder Street intersection

The following location is within a high liquefaction hazard zone:

- From 0.5 mile before to 0.3 mile after the E. 30th Avenue and Spring Boulevard intersection

Tsunamis or Seiches

No earthquake-generated water waves would be a concern for the 30th Avenue to LCC Corridor.

4.4.2. Long-Term Direct Impacts

4.4.2.1. No-Build Alternative

The long-term direct impacts of the No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the 30th Avenue to LCC Corridor, even without building the MovingAhead Project. Transportation infrastructure, including transit, within the corridor would be affected by slope instability and seismic hazards identified for the build alternatives below.

4.4.2.2. Enhanced Corridor Alternative

The following list identifies potential long-term operational impacts associated with geology along the 30th Avenue to LCC Corridor Enhanced Corridor Alternative.

Slope Instability and Landslides. For the section of the 30th Avenue to LCC Corridor between the Amazon Parkway and E. 29th Avenue intersection and LCC Station, the overall risk of impacts from slope instability and landslide would be moderate (landsliding possible) to high (landsliding likely). For the section of the 30th Avenue to LCC Corridor along E. 30th Avenue and the Spring Boulevard intersection, the risk would be mapped as very high (existing landslide).

Seismic Hazards. The project would be within a seismically active area. The MovingAhead Project would meet seismic design standards to minimize the long-term risks to the system.

4.4.2.3. EmX Alternative

The following list identifies potential long-term operational impacts associated with geology along the 30th Avenue to LCC Corridor EmX Alternative.

Slope Instability and Landslides. For the section of the 30th Avenue to LCC Corridor between the Amazon Parkway and E. 29th Avenue intersection and LCC Station, the overall risk of impacts from slope instability and landslide would be moderate (landsliding possible) to high (landsliding likely). For the section of the Corridor along E. 30th Avenue and the Spring Boulevard intersection, the risk would be mapped as very high (existing landslide).

Seismic Hazards. The project would be within a seismically active area. The MovingAhead Project would meet seismic design standards to minimize the long-term risks to the system.

4.4.3. Indirect and Cumulative Effects

4.4.3.1. No-Build Alternative

The cumulative impacts of the 30th Avenue to LCC Corridor No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the area, even without building the MovingAhead Project.

4.4.3.2. Enhanced Corridor Alternative

With the 30th Avenue to LCC Corridor Enhanced Corridor Alternative, no increase in significant cumulative impacts would be expected.

4.4.3.3. EmX Alternative

With the 30th Avenue to LCC Corridor EmX Alternative, no increase in significant cumulative impacts would be expected.

4.4.4. Short-Term Construction-Related Impacts

4.4.4.1. No-Build Alternative

The short-term construction-related impacts of the 30th Avenue to LCC Corridor No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the area, even without building the MovingAhead Project.

4.4.4.2. Enhanced Corridor Alternative

Construction activities have the potential to cause a number of short-term impacts on the environment related to geology, which might include the following along the 30th Avenue to LCC Corridor Enhanced Corridor Alternative.

- **Slope Instability and Landslide Hazards.** Overall risk of impacts because of constructing in landslide hazard areas would be limited for the section of the 30th Avenue to LCC Corridor between the Amazon Parkway and E. 29th Avenue intersection and LCC Station that have been mapped as moderate (landsliding possible) to very high (existing landslide).
- **Construction-Induced Vibrations and Noises.** The major sources of construction vibration include vibratory rollers and jack hammers. The *Noise and Vibration Technical Report* (MMA and CH2M, 2017) provides a detailed review of these potential impacts.
- **Settlements from New Earth Loads.** The project team would anticipate that retained fill would be used at some locations in the 30th Avenue to LCC Corridor for construction of new stops, turn lanes, queue jumps, and widening of roadways. It is not anticipated, however, that these retained fills would be more than a couple of feet tall. As a result, the settlement that the placement of new fills might cause would be expected to be negligible.
- **Excavations for Foundations and Removal of Unsuitable Material.** The risk of impact to utilities and buried structures would be considered low during construction. After reviewing design drawings, it is anticipated that the potential soil excavation volumes would be minor.

4.4.4.3. EmX Alternative

Construction activities would have the potential to cause a number of short-term impacts on the environment related to geology, which might include the following along the 30th Avenue to LCC Corridor EmX Alternative.

- **Erosion Hazards.**
- **Slope Instability and Landslide Hazards.** Overall risk of impacts because of constructing in landslide hazard areas would be limited for the section of the 30th Avenue to LCC Corridor between the Amazon Parkway and E. 29th Avenue intersection and LCC Station that has been mapped as moderate (landsliding possible) to very high (existing landslide).
- **Construction-Induced Vibrations and Noises.** The major sources of construction vibration include vibratory rollers and jack hammers. The *Noise and Vibration Technical Report* (MMA and CH2M, 2017) provides a detailed review of these potential impacts.
- **Settlements from New Earth Loads.** The project team would anticipate that retained fill would be used at some locations in the 30th Avenue to LCC Corridor for construction of new EmX stations, turn lanes, queue jumps, and widening of roadways. It is not anticipated, however, that these retained fills would be more than a couple of feet tall. As a result, the settlement that the placement of new fills might cause would be expected to be negligible.

- **Excavations for Foundations and Removal of Unsuitable Material.** The risk of impact to utilities and buried structures would be considered low during construction. After reviewing design drawings, it is anticipated that the potential soil excavation volumes would be minor.

4.4.5. Potential Mitigation Measures

4.4.5.1. No-Build Alternative

The No-Build Alternative would include existing roadway, bicycle, pedestrian, and transit facilities in the corridor, as well as planned improvements in the Eugene TSP. No potential mitigation measures were evaluated for this alternative.

4.4.5.2. Enhanced Corridor Alternative

Detailed study during final design would confirm the degree of geologic risk. At sites where geologic conditions are not suitable, appropriate design and construction measures would be implemented to avoid potential effects and geologic risks during operations.

Engineering design standards and best management practices would be used to avoid and minimize potential construction impacts. Based on the review of potential impacts, the design and construction process would address seismic hazards, settlement, landslide hazards, erosion and sediment control, vibrations, and groundwater.

4.4.5.3. EmX Alternative

Detailed study during final design would confirm the degree of geologic risk. At sites where geologic conditions are not suitable, appropriate design and construction measures would be implemented to avoid potential effects and geologic risks during operations.

Engineering design standards and best management practices would be used to avoid and minimize potential construction impacts. Based on the review of potential impacts, the design and construction process would address seismic hazards, settlement, landslide hazards, erosion and sediment control, vibrations, and groundwater.

4.5. Coburg Road Corridor Environmental Consequences

The project team reviewed Draft *Level 2 Definition of Alternatives* and the conceptual design roll plots along the Coburg Road Corridor to evaluate the extent of the construction.

No construction activities would be anticipated along the Enhanced Corridor between Eugene Station and the intersection of Coburg Road and Martin Luther King Jr. Boulevard except a proposed new signal south of the Ferry Street Bridge. The majority of the construction activities are minor structures such as transit queue jumps, enhanced corridor bus stops, EmX stations, utility trenches, concrete pavement, small retaining walls, regrading, traffic signs and sidewalks. The construction activities associated with these structures are expected to be minor and the impacts from geology and seismicity as related to the environmental consequences are expected to be very minor.

In addition to minor construction activities, the Coburg Road Corridor EmX Alternative would include widening the roadway under the Randy Papé Beltline Highway Bridge. Reviewing the design criteria and as-built drawings of the Randy Papé Bridge during final design phase would confirm the feasibility of this improvement and would determine the extent of the construction.

4.5.1. Affected Environment

4.5.1.1. No-Build Alternative

Geologic Setting

Figures C-1 and C-2 show the surficial geologic units mapped within the Coburg Road Corridor, which are Holocene alluvium (Ha), Holocene older alluvium (Hoa), and Quaternary terrace and fan deposits (Qtg) (DOGAMI, 2010).

Geologic Hazards

Erosion

Figures C-9 and C-10 show the NRCS Soil Survey Map in the vicinity of the Coburg Road Corridor No-Build Alternative. The NRCS database indicates that the surficial soils mapped in the API (unit symbols of 5, 8, 23, 25, 31, 32, 34, 75, 76, 97, 118, and 119) are classified as WEG 3 to WEG 6. Therefore, they have low to moderate susceptibility to erosion by wind.

The NRCS database indicates that the erosion factor of surficial soils mapped in the API ranges from 0.15 to 0.43. Therefore, they are considered to have low to moderate susceptibility to erosion by water.

Problematic Soil Properties

NRCS soil unit 8 has been identified as having high shrink-swell capacity, and NRCS soil units 5, 8, and 34 have been identified as hydric soils. Along the Coburg Road Corridor No-Build Alternative, NRCS soil unit 8 is located:

- At the Chad Drive and Shadow View Drive intersection

Along the Coburg Road Corridor No-Build Alternative, NRCS soil units 5 and 34 are located:

- Between the Coburg Road and Crescent Avenue intersection and the Old Coburg Road and Chad Drive intersection
- At the Coburg Road and Bailey Lane intersection
- At approximately 200 feet south of the Coburg Road and Willakenzie Road intersection

Landslides

According to the landslide inventory map (DOGAMI, 2016b), no historically active landslides have been identified within the Coburg Road No-Build Alternative (Figures C-13 and C-14).

As shown in Figures C-15 and C-16, for the most part, landslide hazard along the Coburg Road Corridor No-Build Alternative is mapped as low (landsliding unlikely). The following locations are mapped as moderate (landsliding possible) to high (landsliding likely):

- Coburg Road at the Randy Papé Beltline Highway interchange
- Coburg Road at the I-105 Highway interchange
- Coburg Road from E. 4th Avenue to the Martin Luther King, Jr. Boulevard ramp

Volcano

Volcanic activity is not considered a significant hazard to the Coburg Road Corridor No-Build Alternative. According to the recent volcanic hazard maps prepared by DOGAMI (2016a), pyroclastic flows, lava flows, and lahars are not expected to come within 7.5 miles of the Coburg Road Corridor.

Ground Motion

According to the expected earthquake shaking map (DOGAMI, 2016a), the Coburg Road Corridor No-Build Alternative is located in a strong to very strong ground-shaking zone (Figures C-17 and C-18).

Fault Rupture

No mapped active faults pass through the Coburg Road Corridor.

Liquefaction

According to the recent relative earthquake liquefaction hazard map prepared by DOGAMI (2016a), as shown in Figures C-19 and C-20, the following locations in the Coburg Road Corridor No-Build Alternative are within a moderate liquefaction hazard zone:

- From the Eugene Station to Pioneer Pike
- Along N. Game Farm Road
- Along Gateway Street

Tsunamis or Seiches

No earthquake-generated water waves would be a concern for the Coburg Road Corridor. There is a remote potential that a seismic event could to failure of upstream dams near the Willamette River, causing uncontrolled release of water, raising water levels in the Willamette River, and causing inundation to portions of the Coburg Road Corridor in lower-lying areas and near stream crossings.

4.5.1.2. Enhanced Corridor Alternative

Geologic Setting

Figures C-1 and C-2 show the surficial geologic units mapped within the Coburg Road Corridor, which are Holocene alluvium (Ha), Holocene older alluvium (Hoa), and Quaternary terrace and fan deposits (Qtg) (DOGAMI, 2010).

Geologic Hazards

Erosion

Figure C-9 shows the NRCS Soil Survey Map in the vicinity of the Coburg Road Corridor Enhanced Corridor Alternative. The NRCS database indicates that the surficial soils mapped in the API (unit symbols of 5, 8, 23, 25, 31, 32, 34, 75, 76, 97, 118, and 119) are classified as WEG 3 to WEG 6. Therefore, they have low to moderate susceptibility to erosion by wind.

The NRCS database indicates that the erosion factor of surficial soils mapped in the Coburg Road Corridor Enhanced Corridor Alternative ranges from 0.15 to 0.43. Therefore, they are considered to have low to moderate susceptibility to erosion by water.

Problematic Soil Properties

NRCS soil unit 8 has been identified as having high shrink-swell capacity, and NRCS soil units 5, 8, and 34 have been identified as hydric soils. Along the Coburg Road Corridor Enchance Corridor Alternative, NRCS soil unit 8 is located:

- At the Chad Drive and Shadow View Drive intersection

Along the Coburg Road Corridor No-Build Alternative, NRCS soil units 5 and 34 are located:

- Between the Coburg Road and Crescent Avenue intersection and the Old Coburg Road and Chad Drive intersection
- At the Coburg Road and Bailey Lane intersection
- At approximately 200 feet south of the Coburg Road and Willakenzie Road intersection

Landslides

According to the landslide inventory map (DOGAMI, 2016b), no historically active landslides have been identified within the Coburg Road Enhanced Corridor Alternative (Figure C-13).

As shown in Figure C-15, for the most part, landslide hazard along the Coburg Road Corridor Enhanced Corridor Alternative is mapped as low (landsliding unlikely). The following locations are mapped as moderate (landsliding possible) to high (landsliding likely):

- Coburg Road at the Randy Papé Beltline Highway interchange
- Coburg Road at the I-105 Highway interchange
- Coburg Road from E. 4th Avenue to the Martin Luther King, Jr. Boulevard ramp

Volcano

Volcanic activity is not considered a significant hazard to the Coburg Road Corridor Enhanced Corridor Alternative. According to the recent volcanic hazard maps prepared by DOGAMI (2016a), pyroclastic flows, lava flows, and lahars are not expected to come within 7.5 miles of the Coburg Road Corridor.

Ground Motion

According to the expected earthquake shaking map (DOGAMI, 2016a), the Coburg Road Corridor Enhanced Corridor Alternative is located in a strong to very strong ground-shaking zone (Figure C-17).

Fault Rupture

No mapped active faults pass through the Coburg Road Corridor.

Liquefaction

According to the recent relative earthquake liquefaction hazard map prepared by DOGAMI (2016a), as shown in Figure C-19, the following locations in the Coburg Road Corridor Enhanced Corridor Alternative are within a moderate liquefaction hazard zone:

- From the Eugene Station to Pioneer Pike
- Along N. Game Farm Road
- Along Gateway Street

Tsunamis or Seiches

No earthquake-generated water waves would be a concern for the Coburg Road Corridor.

4.5.1.3. EmX Alternative

Geologic Setting

Figures C-1 and C-2 show the surficial geologic units mapped within the Coburg Road Corridor, which are Holocene alluvium (Ha), Holocene older alluvium (Hoa), and Quaternary terrace and fan deposits (Qtg) (DOGAMI, 2010).

Geologic Hazards

Erosion

Figure C-10 shows the NRCS Soil Survey Map in the vicinity of the Coburg Road Corridor EmX Alternative. The NRCS database indicates that the surficial soils mapped in the API (unit symbols of 5, 8, 23, 25, 31, 32, 34, 75, 76, 97, 118, and 119) are classified as WEG 3 to WEG 6. Therefore, they have low to moderate susceptibility to erosion by wind.

The NRCS database indicates that the erosion factor of surficial soils mapped in the Coburg Road Corridor EmX Alternative ranges from 0.15 to 0.43. Therefore, they are considered to have low to moderate susceptibility to erosion by water.

Problematic Soil Properties

NRCS soil unit 8 has been identified as having high shrink-swell capacity, and NRCS soil units 5, 8, and 34 have been identified as hydric soils. Along the Coburg Road Corridor No-Build Alternative, NRCS soil unit 8 is located:

- At the Chad Drive and Shadow View Drive intersection

Along the Coburg Road Corridor No-Build Alternative, NRCS soil units 5 and 34 are located:

- Between the Coburg Road and Crescent Avenue intersection and the Old Coburg Road and Chad Drive intersection
- At the Coburg Road and Bailey Lane intersection
- At approximately 200 feet south of the Coburg Road and Willakenzie Road intersection

Landslides

According to the landslide inventory map (DOGAMI, 2016b), no historically active landslides have been identified within the Coburg Road EmX Alternative (Figure C-14).

As shown in Figure C-16, for the most part, landslide hazard along the Coburg Road Corridor EmX Alternative is mapped as low (landsliding unlikely). The following locations are mapped as moderate (landsliding possible) to high (landsliding likely):

- Coburg Road at the Randy Papé Beltline Highway interchange
- Coburg Road at the I-105 Highway interchange
- Coburg Road from E. 4th Avenue to the Martin Luther King, Jr. Boulevard ramp

Volcano

Volcanic activity is not considered a significant hazard to the Coburg Road Corridor EmX Alternative. According to the recent volcanic hazard maps prepared by DOGAMI (2016a), pyroclastic flows, lava flows, and lahars are not expected to come within 7.5 miles of the Coburg Road Corridor.

Ground Motion

According to the expected earthquake shaking map (DOGAMI, 2016a), the Coburg Road Corridor EmX Alternative is located in a strong to very strong ground-shaking zone (Figure C-18).

Fault Rupture

No mapped active faults pass through the Coburg Road Corridor.

Liquefaction

According to the recent relative earthquake liquefaction hazard map prepared by DOGAMI (2016a), as shown in Figure C-20, the following locations in the Coburg Road Corridor EmX Alternative are within a moderate liquefaction hazard zone:

- From the Eugene Station to Pioneer Pike
- Along N. Game Farm Road
- Along Gateway Street

Tsunamis or Seiches

No earthquake-generated water waves would be a concern for the Coburg Road Corridor.

4.5.2. Long-Term Direct Impacts

4.5.2.1. No-Build Alternative

The long-term direct impacts of the No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the Coburg Road Corridor, even without building the MovingAhead Project. Transportation infrastructure, including transit, within the corridor would be affected by slope instability and seismic hazards identified for the build alternatives below.

4.5.2.2. Enhanced Corridor Alternative

The following list identifies potential long-term operational impacts associated with geology along the Coburg Road Corridor Enhanced Corridor Alternative.

Slope Instability and Landslides. The overall risk of impacts from slope instability and landslide would be low. For the following sections of Coburg Road, the risk would be moderate (landsliding possible) to high (landsliding likely):

- Coburg Road at the Randy Papé Beltline Highway interchange
- Coburg Road at the I-105 Highway interchange
- Coburg Road from E. 4th Avenue to the Martin Luther King, Jr. Boulevard ramp

Seismic Hazards. The project would be within a seismically active area. The MovingAhead Project would meet seismic design standards to minimize the long-term risks to the system.

4.5.2.3. EmX Alternative

The following list identifies potential long-term operational impacts associated with geology along the Coburg Road Corridor EmX Alternative.

Slope Instability and Landslides. The overall risk of impacts from slope instability and landslide would be low. For the following sections of Coburg Road, the risk would be moderate to high:

- Coburg Road at the Randy Papé Beltline Highway interchange
- Coburg Road at the I-105 Highway interchange
- Coburg Road from E. 4th Avenue to the Martin Luther King, Jr. Boulevard ramp

Seismic Hazards. The project would be within a seismically active area. The MovingAhead Project would meet seismic design standards to minimize the long-term risks to the system.

4.5.3. Indirect and Cumulative Effects

4.5.3.1. No-Build Alternative

The cumulative impacts of the Coburg Road Corridor No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the area, even without building the MovingAhead Project.

4.5.3.2. Enhanced Corridor Alternative

With the Coburg Road Corridor Enhanced Corridor Alternative, no increase in significant cumulative impacts would be expected.

4.5.3.3. EmX Alternative

With the Coburg Road Corridor EmX Alternative, no increase in significant cumulative impacts would be expected.

4.5.4. Short-Term Construction-Related Impacts

4.5.4.1. No-Build Alternative

The short-term construction-related impacts of the Coburg Road Corridor No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the area, even without building the MovingAhead Project.

4.5.4.2. Enhanced Corridor Alternative

Construction activities have the potential to cause a number of short-term impacts on the environment related to geology, which might include the following along the Coburg Road Corridor Enhanced Corridor Alternative.

- **Slope Instability and Landslide Hazards.** Overall risk of impacts because of constructing in landslide hazard areas would be limited for the following sections of Coburg Road that have been mapped as moderate (landsliding possible) to high (landsliding likely):
  - Coburg Road at the Randy Papé Beltline Highway interchange
  - Coburg Road at the I-105 Highway interchange
  - Coburg Road from E. 4th Avenue to the Martin Luther King, Jr. Boulevard ramp

- **Construction-Induced Vibrations and Noises.** The major sources of construction vibration include vibratory rollers and jack hammers. The *Noise and Vibration Technical Report* (MMA and CH2M, 2017) provides a detailed review of these potential impacts.
- **Settlements from New Earth Loads.** The project team anticipate that retained fill would be used at some locations in the Coburg Road Corridor Enhanced Corridor Alternative for construction of new stops, turn lanes, queue jumps, and widening of roadways. It is not anticipated, however, that these retained fills would be more than a couple of feet tall. As a result, the settlement that the placement of new fills might cause would be expected to be negligible.
- **Excavations for Foundations and Removal of Unsuitable Material.** The risk of impact to utilities and buried structures would be considered low during construction. After reviewing design drawings, it is anticipated that the potential soil excavation volumes would be minor.

4.5.4.3. EmX Alternative

Construction activities have the potential to cause a number of short-term impacts on the environment related to geology, which might include the following along the Coburg Road Corridor EmX Alternative.

- **Slope Instability and Landslide Hazards.** Overall risk of impacts because of constructing in landslide hazard areas would be limited for the following sections of Coburg Road EmX Alternative that have been mapped as moderate (landsliding possible) to high (landsliding likely):
  - Coburg Road at the Randy Papé Beltline Highway interchange
  - Coburg Road at the I-105 Highway interchange
  - Coburg Road from E. 4th Avenue to the Martin Luther King, Jr. Boulevard ramp
- **Construction-Induced Vibrations and Noises.** The major sources of construction vibration include vibratory rollers and jack hammers. The *Noise and Vibration Technical Report* (MMA and CH2M, 2017) provides a detailed review of these potential impacts.
- **Settlements from New Earth Loads.** The project team anticipate that retained fill would be used at some locations in the Coburg Road Corridor EmX Alternative for construction of new stops, turn lanes, queue jumps and widening of roadways. It is not anticipated, however, that these retained fills would be more than a couple of feet tall. As a result, the settlement that the placement of new fills might cause would be expected to be negligible.
- **Excavations for Foundations and Removal of Unsuitable Material.** The risk of impact to utilities and buried structures is considered low during construction. After reviewing design drawings, it is anticipated that the potential soil excavation volumes would be minor.

4.6. Martin Luther King, Jr. Boulevard Corridor Environmental Consequences

The project team reviewed the Draft *Level 2 Definition of Alternatives* and the conceptual design roll plots along the Martin Luther King, Jr. Boulevard Corridor to evaluate the extent of the construction.

No construction activities would be anticipated along the Enhanced Corridor between Eugene Station and the intersection of Coburg Road and Martin Luther King Jr. Boulevard. The majority of the construction activities are minor structures such as enhanced corridor bus stops, concrete pavement, traffic signs, and sidewalks. The construction activities associated with these structures are expected to be minor and the impacts from geology and seismicity as related to the environmental consequences are expected to be very minor.

4.6.1. Affected Environment

4.6.1.1. No-Build Alternative

Geologic Setting

Figures C-1 and C-2 show the surficial geologic units mapped within the Martin Luther King, Jr. Boulevard Corridor, which are Holocene alluvium (Ha) and Holocene older alluvium (Hoa) (DOGAMI, 2010).

Geologic Hazards

Erosion

Figure C-11 shows the NRCS soil survey map in the vicinity of the Martin Luther King, Jr. Boulevard Corridor No-Build Alternative. The NRCS database indicates that most of the surficial soils mapped in the API (unit symbols of 23, 25, 26, 27, 29, 30, 48, 76, and 97) are classified as WEG 3 to WEG 6. Therefore, they have low to moderate susceptibility to erosion by wind.

The NRCS database indicates that the erosion factor of surficial soils mapped in the Martin Luther King, Jr. Boulevard Corridor No-Build Alternative ranges from 0.15 to 0.43. Therefore, they are considered to have low to moderate susceptibility to erosion by water.

Problematic Soil Properties

NRCS soil unit 48 (Fluvents, nearly level) has been identified as hydric soil. Along the Martin Luther King, Jr. Boulevard Corridor No-Build Alternative, NRCS soil unit 48 is located:

- Along Martin Luther King, Jr. Boulevard from the driveway of PK Park to Leo Harris Parkway

Landslides

According to the landslide inventory map (DOGAMI, 2016b), no historically active landslides have been identified within the Martin Luther King, Jr. Boulevard Corridor No-Build Alternative (Figure C-13). As shown in Figure C-15, landslide hazard along the Martin Luther King, Jr. Boulevard Corridor No-Build Alternative is mapped as low (landsliding unlikely) to moderate (landsliding possible).

Volcano

Volcanic activity is not considered a significant hazard to the Martin Luther King, Jr. Boulevard Corridor No-Build Alternative. According to the recent volcanic hazard maps prepared by DOGAMI (2016a), pyroclastic flows, lava flows, and lahars are not expected to come within 6.5 miles of the Martin Luther King, Jr. Boulevard Corridor.

Ground Motion

According to the expected earthquake shaking map (DOGAMI, 2016a), the Martin Luther King, Jr. Boulevard Corridor No-Build Alternative is located in a strong to very strong ground-shaking zone (Figure C-17).

Fault Rupture

No mapped active faults pass through the Martin Luther King, Jr. Boulevard Corridor.

Liquefaction

According to the recent relative earthquake liquefaction hazard map prepared by DOGAMI (2016a), as shown in Figure C-19, the Martin Luther King, Jr. Boulevard Corridor is located within a moderate liquefaction hazard zone.

Tsunamis or Seiche

No earthquake-generated water waves would be a concern for the Martin Luther King, Jr. Boulevard Corridor. There is a remote potential that a seismic event could lead to failure of upstream dams near the Willamette River, causing uncontrolled release of water, raising water level in Willamette River, and causing inundation to portions of the Martin Luther King, Jr. Blvd Corridor in lower-lying areas and near stream crossings.

4.6.1.2. Enhanced Corridor Alternative

Geologic Setting

Figures C-1 and C-2 show the surficial geologic units mapped within the Martin Luther King, Jr. Boulevard Corridor, which are Holocene alluvium (Ha) and Holocene older alluvium (Hoa) (DOGAMI, 2010).

Geologic Hazards

Erosion

Figure C-11 shows the NRCS soil survey map in the vicinity of the Martin Luther King, Jr. Boulevard Corridor Enhanced Corridor Alternative. The NRCS database indicates that most of the surficial soils mapped in the API (unit symbols of 23, 25, 26, 27, 29, 30, 48, 76, and 97) are classified as WEG 3 to WEG 6. Therefore, they have low to moderate susceptibility to erosion by wind.

The NRCS database indicates that the erosion factor of surficial soils mapped in the Martin Luther King, Jr. Boulevard Corridor Enhanced Corridor Alternative ranges from 0.15 to 0.43. Therefore, they are considered to have low to moderate susceptibility to erosion by water.

Problematic Soil Properties

NRCS soil unit 48 (Fluvents, nearly level) has been identified as hydric soil.

Along the Martin Luther King, Jr. Boulevard Corridor Enhanced Corridor Alternative, NRCS soil unit 48 is located:

- Along Martin Luther King, Jr. Boulevard from the driveway of PK Park to Leo Harris Parkway

Landslides

According to the landslide inventory map (DOGAMI, 2016b), no historically active landslides have been identified within the Martin Luther King, Jr. Boulevard Corridor Enhanced Corridor Alternative (Figure C-13). As shown in Figure C-15, landslide hazard along the Martin Luther King, Jr. Boulevard Corridor No-Build Alternative is mapped as low (landsliding unlikely) to moderate (landsliding possible).

Volcano

Volcanic activity is not considered a significant hazard to the Martin Luther King, Jr. Boulevard Corridor Enhanced Corridor Alternative. According to the recent volcanic hazard maps prepared by DOGAMI (2016a), pyroclastic flows, lava flows, and lahars are not expected to come within 6.5 miles of the Martin Luther King, Jr. Boulevard Corridor.

Ground Motion

According to the expected earthquake shaking map (DOGAMI, 2016a), the Martin Luther King, Jr. Boulevard Corridor Enhanced Corridor Alternative is located in a strong to very strong ground-shaking zone (Figure C-17).

Fault Rupture

No mapped active faults pass through the Martin Luther King, Jr. Boulevard Corridor.

Liquefaction

According to the recent relative earthquake liquefaction hazard map prepared by DOGAMI (2016a), as shown in Figure C-19, the Martin Luther King, Jr. Boulevard Corridor is located within a moderate liquefaction hazard zone.

Tsunamis or Seiche

No earthquake-generated water waves would be a concern for the Martin Luther King, Jr. Boulevard Corridor.

4.6.2. Long-Term Direct Impacts

4.6.2.1. No-Build Alternative

The long-term direct impacts of the No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the Martin Luther King, Jr. Boulevard Corridor, even without building the MovingAhead Project. Transportation infrastructure, including transit, within the corridor would be affected by slope instability and seismic hazards identified for the build alternatives below.

4.6.2.2. Enhanced Corridor Alternative

The following list identifies potential long-term operational impacts associated with geology along the Martin Luther King, Jr. Boulevard Corridor Enhanced Corridor Alternative.

Slope Instability and Landslides. The overall risk of impacts from slope instability and landslide would be low.

Seismic Hazards. The project would be within a seismically active area. The MovingAhead Project would meet seismic design standards to minimize the long-term risks to the system.

4.6.3. Indirect and Cumulative Effects

4.6.3.1. No-Build Alternative

The cumulative impacts of the Martin Luther King, Jr. Boulevard Corridor No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the area, even without building the MovingAhead Project.

4.6.3.2. Enhanced Corridor Alternative

With the Martin Luther King, Jr. Boulevard Corridor Enhanced Corridor Alternative, no increase in significant cumulative impacts would be expected.

4.6.4. Short-Term Construction-Related Impacts

4.6.4.1. No-Build Alternative

The short-term construction-related impacts of the No-Build Alternative would be associated with the planned improvements in the Eugene TSP that are expected to be developed in the area, even without building the MovingAhead Project.

4.6.4.2. Enhanced Corridor Alternative

Construction activities have the potential to cause a number of short-term impacts on the environment related to geology, which might include the following along the Martin Luther King, Jr. Boulevard Corridor the Enhance Corridor Alternative.

- **Construction-Induced Vibrations and Noises.** The major sources of construction vibration include vibratory rollers and jack hammers. The *Noise and Vibration Technical Report* (MMA and CH2M, 2017) provides a detailed review of these potential impacts.
- **Settlements from New Earth Loads.** The project team would anticipate that retained fill would be used at some locations in Martin Luther King, Jr. Boulevard Corridor Enhanced Corridor Alternative for construction of new stops, turn lanes, queue jumps and widening of roadways. It is not anticipated, however, that these retained fills would be more than a couple of feet tall. As a result, the settlement that the placement of new fills might cause would be expected to be negligible.
- **Excavations for Foundations and Removal of Unsuitable Material.** The risk of impact to utilities and buried structures would be considered low during construction. After reviewing design drawings, it is anticipated that the potential soil excavation volumes would be minor.

5. Potential Mitigation Measures

5.1. No-Build Alternative

The No-Build Alternative would include existing roadway, bicycle, pedestrian, and transit facilities in the corridor, as well as planned improvements in the Eugene TSP. No potential mitigation measures were evaluated for this alternative.

5.2. Enhanced Corridor Alternative

Detailed study during final design would confirm the degree of geologic risk. At sites where geologic conditions were not suitable, appropriate design and construction measures would be implemented to avoid potential effects and geologic risks during operations.

Engineering design standards and best management practices would be used to avoid and minimize potential construction impacts. Based on the review of potential impacts, the design and construction process would address seismic hazards, settlement, landslide hazards, erosion and sediment control, vibrations, and groundwater.

5.3. EmX Alternative

Detailed study during final design would confirm the degree of geologic risk. At sites where geologic conditions are not suitable, appropriate design and construction measures would be implemented to avoid potential effects and geologic risks during operations.

Engineering design standards and best management practices would be used to avoid and minimize potential construction impacts. Based on the review of potential impacts, the design and construction process would address seismic hazards, settlement, landslide hazards, erosion and sediment control, vibrations, and groundwater.

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6. References

American Association of State Highway and Transportation Officials (AASHTO). (2009). *Guide Specifications for Load and Resistance Factor Design Seismic Bridge Design*. 1st Edition.

Central Lane Metropolitan Planning Organization (MPO). (2007). *Regional Transportation System Plan.*

Central Lane Metropolitan Planning Organization (MPO). (2011, December). *Regional Transportation Plan.* (RTP)

CH2M HILL, Inc. (CH2M). (2016). *MovingAhead Alternatives and Design Options Considered but Eliminated Technical Memorandum.*

CH2M HILL, Inc. (CH2M), Environmental Science & Assessment, Heritage Research Associates, Michael Minor & Associates, and Wannamaker Consulting. (2015). *MovingAhead Environmental Disciplines Methods and Data Report*.

CH2M HILL, Inc. (CH2M), Wannamaker Consulting, DKS Associates, and John Parker Consulting. (2016). *Moving Ahead Level 2 Definition of Alternatives*. Draft.

City of Eugene. (2016). *DRAFT Eugene 2035 Transportation System Plan.* (Draft Eugene 2035 TSP).

Dickenson, S. (2005, June). *Recommended Guidelines for Liquefaction Evaluations Using Ground Motions from Probabilistic Seismic Hazard Analysis*. Oregon State University, Department of Civil, Construction and Environmental Engineering. Report to ODOT.

Dickenson, S.E., N.J. McCullough, M.G. Barkau, B.J. Wavra. (2002, November). *Assessment and Mitigation of Liquefaction Hazards to Bridge Approach Embankments in Oregon*. Oregon State University, Department of Civil, Construction and Environmental Engineering. SPR Project 361.

Envision Eugene. (2016, July). Draft *Envision Eugene Comprehensive Plan*. Draft. (Draft Envision Eugene)

Lane Council of Governments (LCOG). (2011, December). *Central Lane Metropolitan Planning Organization Regional Transportation Plan.*

Lane County Public Works, Engineering Division Transportation Planning. (2004, June 4; update in progress). *Lane County Transportation System Plan*.

Lane Transit District (LTD). (2014). *Lane Transit District Long-Range Transit Plan*.

Lane Transit District (LTD). (2015, Amended 2015, June). *Lane Transit District Capital Improvement Plan*.

Lane Transit District (LTD) and City of Eugene. (2015, June). *MovingAhead Fatal Flaw Screening Technical Memorandum*.

Michael Minor and Associates, Inc. (MMA) and CH2M HILL, Inc. (CH2M). (2017). *MovingAhead Noise and Vibration Technical Report*.

Natural Resources Conservation Service (NRCS). (2016). *Web Soil Survey*. Accessed at: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

O'Conner J. E., A. Sarna-Wojcicki, K.C. Wozniak, D.J. Polette, and R.J. Fleck. (2001). *Professional Paper No. 1620 – Origin, Extent, and Thickness of Quaternary Geologic Units in the Willamette Valley, Oregon*. U.S. Geological Survey.

Oregon Department of Geology and Mineral Industries (DOGAMI). (2010). *Open-File Report O-10-03, Digital geologic map of the southern Willamette Valley, Benton, Lane, Linn, Marion, and Polk Counties, Oregon*. By Jason D. McClaughry, Thomas J. Wiley, Mark L. Ferns, and Ian P. Madin.

Oregon Department of Geology and Mineral Industries (DOGAMI). (2013). *Local Source (Cascadia Subduction Zone) Tsunami Inundation Map, Heceta Head, Oregon*.

Oregon Department of Geology and Mineral Industries (DOGAMI). (2016a). *Oregon HazVu: Statewide Geohazards Viewer*.

Oregon Department of Geology and Mineral Industries (DOGAMI). (2016b). *Open-File Report O-16-02, Landslide susceptibility overview map of Oregon*. By William J. Burns, Katherine A. Mickelson, and Ian P. Madin.

Oregon Department of Transportation (ODOT). (2011, April). *Geotechnical Design Manual*.

Oregon Department of Transportation (ODOT). (2014). *Bridge Design and Drafting Manual*.

Orr, William N. and Elizabeth L., Orr. (1997). *Geology of Oregon*. Kendall Hunt. 254 pp.

U.S. Geological Survey (USGS). (2008). *National Seismic Hazard Maps*. http://earthquake.usgs.gov/hazards/products/conterminous/2008.

U.S. Geological Survey (USGS). (2013). *Tephra Fall Hazards at Three Sisters*. http://volcanoes.usgs.gov/volcanoes/three_sisters/three_sisters_hazard_101.html.

U.S. Geological Survey (USGS). (2014). *Quaternary Fault and Fold Database for the United States*. http://earthquake.usgs.gov/hazards/qfaults/.

U.S. Geological Survey (USGS). (2016a). *Earthquake Archive.* www.earthquake.usgs.gov/earthquakes/search/. Accessed August 22, 2016.

U.S. Geological Survey (USGS). (2016b). *ShakeMap*. http://earthquake.usgs.gov/earthquakes/shakemap/atlas/shake/199303251334/. Accessed August 22, 2016.

Wannamaker Consulting. (2015). *MovingAhead Phase 1 Steps.*

Appendix A: Glossary and Naming Conventions

This appendix includes a detailed list of acronyms, abbreviations, and technical terms used throughout this report. It also includes naming conventions used in the MovingAhead Project.

Acronyms and Abbreviations

Table A-1. Acronyms and Abbreviations

Acronyms and Abbreviations	Definitions
/H-RCP	Historic Structures or Sites Combine Zone
/WP	Waterside Protection
/WQ	Water Quality
°C	degree(s) Celsius
μg/L	microgram(s) per liter
μg/m^3	microgram(s) per cubic meter
AA	Alternatives Analysis
AAC	all aluminum conductor
AASHTO	American Association of State Highway and Transportation Officials
AAI	All Appropriate Inquiry
ACS	American Community Survey
ADA	Americans with Disabilities Act
AEO	Annual Energy Outlook
APE	Area of Potential Effect
API	Area of Potential Impact
approx.	approximately
ARTS	All Roads Transportation Safety Program
ATR	Automated Traffic Recording
BAT	business access and transit
BEST	Better Eugene Springfield Transit
BFE	Base Flood Elevation
BMP	best management practice
BPA	Bonneville Power Administration
BRT	bus rapid transit
Btu	British thermal unit
c	circa
CAA	Clean Air Act
CAFE	Corporate Average Fuel Economy
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980

Table A-1. Acronyms and Abbreviations

Acronyms and Abbreviations	Definitions
CERCLIS	Comprehensive Environmental Response Compensation and Liability Information System
CFR	Code of Federal Regulations
CFU	Colony-Forming Unit
CH2M	CH2M HILL, Inc.
CIG	Capital Investment Grant
CIP	Capital Improvements Program
City	City of Eugene
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COGP	County Opportunity Grant Program
Corps	U.S. Army Corps of Engineers
CRL	Confirmed Release List
CSZ	Cascadia Subduction Zone
CTR	commute trip reduction
CWA	Clean Water Act
CY	cubic yard
dB	decibel
dBA	A-weighted decibel
DBE	Disadvantaged Business Enterprise
DEIS	Draft Environmental Impact Statement. Also referred to as Draft EIS.
DEQ	Oregon Department of Environmental Quality
DKS	DKS Associates
DLS	Donation Land Claim
DOE	Determination of Eligibility
DOGAMI	Oregon Department of Geology and Mineral Industries
DOT	Department of Transportation
Draft EIS	Draft Environmental Impact Statement. Also referred to as DEIS.
Draft Envision Eugene	*Draft Envision Eugene Community Vision* (Envision Eugene, 2016, July)
Draft Eugene 2035 TSP	*DRAFT Eugene 2035 Transportation System Plan* (City of Eugene, 2016)
DSL	Oregon Department of State Lands
DU	dwelling unit
EA	Environmental Assessment or each
EC	City of Eugene Code
EC	eligible contributing

Table A-1. Acronyms and Abbreviations

Acronyms and Abbreviations	Definitions
EC	Enhanced Corridor Alternative (in some tables)
ECLA	*Eugene Comprehensive Lands Assessment* (ECONorthwest, 2010, June)
ECSI	Environmental Cleanup Site Information database (Oregon DEQ, 2016)
EFH	essential fish habitat
EIS	Environmental Impact Statement
EJ	Environmental Justice
EmX	Emerald Express, Lane Transit District's Bus Rapid Transit System
EmX	EmX Alternative (in some tables)
EOA	Equity and Opportunity Assessment
EPA	U. S. Environmental Protection Agency
ES	eligible significant
ES NR	eligible significant NRHP
ESA	Endangered Species Act or Environmental Site Assessment
ESH	essential indigenous anadromous salmonid habitat
ESU	Evolutionarily Significant Unit
EWEB	Eugene Water & Electric Board
FAST Act	Fixing America's Surface Transportation Act
FEIS	Final Environmental Impact Statement. Also referred to as Final EIS.
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act of 1974
Final EIS	Final Environmental Impact Statement. Also referred to as FEIS.
FOE	Finding of Effect
FPPA	Farmland Protection Policy Act, 7 U.S.C. 4201-4209 and 7 CFR 658
FRA	Federal Railroad Administration
ft	foot (feet)
ft^2	square foot (feet)
FTA	Federal Transit Administration
FTN	Frequent Transit Network
FY	fiscal year
GAN	Grant Anticipation Note
GARVEE	Grant Anticipation Revenue Vehicle
GHG	greenhouse gas
GIS	geographic information system
GLO	General Land Office
Heritage	Heritage Research Associates, Inc.

Table A-1. Acronyms and Abbreviations

Acronyms and Abbreviations	Definitions
HGM	Hydro-geomorphic
HMTA	Hazardous Materials Transport Act of 1975, with amendments in 1990 and 1994
HOV	high-occupancy vehicle
HPNW	Historic Preservation Northwest
I-5	Interstate 5
I-105	Interstate 105
IOF	Immediate Opportunity Fund
ISA	International Society of Arboriculture
ISTEA	Intermodal Surface Transportation Efficiency Act
kV	kilovolt(s)
LaneACT	Lane Area Commission on Transportation
LCC	Lane Community College
LCDC	Land Conservation and Development Commission
LCOG	Lane Council of Governments
Ldn	day-night sound level
LE	Listed Endangered
LEP	limited English proficiency
L_{eq}	equivalent sound level
LF	lineal foot (feet)
LGAC	Local Government Affairs Council
LGGP	Local Government Grant Program
LID	Local Improvement District
L_{max}	maximum sound level
L_{min}	minimum sound level
LNG	liquefied natural gas
LOS	level of service
LPA	Locally Preferred Alternative
LRAPA	Lane Regional Air Protection Agency
LRFP	LTD's Long-Range Financial Plan
LRT	Light Rail Transit
LRTP	LTD's Long-Range Transit Plan
LT	Listed Threatened
LTD	Lane Transit District
LUST	leaking underground storage tank
LWCF	Land and Water Conservation Fund
m	meter(s)

Table A-1. Acronyms and Abbreviations

Acronyms and Abbreviations	Definitions
MAP-21	Moving Ahead for Progress in the 21st Century
MBTA	Migratory Bird Treaty Act
Metro Plan	*Metro Plan, Eugene-Springfield Metropolitan Area General Plan* (LCOG et al., 1987, as updated on 2015, December 31)
mg/kg	milligram(s) per kilogram
MI	mile(s)
mL	milliliter(s)
MMA	Michael Minor and Associates, Inc.
MOA	Memorandum of Agreement
MOE	Measure of Effectiveness
MPC	Metropolitan Policy Committee
mpg	miles per gallon
mph	miles per hour
MPO	Metropolitan Planning Organization
MTIP	*Metropolitan Transportation Improvement Program Federal FY 2015 to Federal FY 2018* (Central Lane MPO, adopted 2014, October, as amended)
Mw	Earthquake moment magnitude
N/A	not applicable
NA	not applicable; no data available
NAAQS	National Ambient Air Quality Standards
NAC	Noise Abatement Criteria
NAVD88	North American Vertical Datum of 1988
ND	nodal development
NEPA	National Environmental Policy Act of 1969, as amended, 42 U.S.C. 4321-4347
NFA	no further action
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO_2	nitrous dioxide
NO_x	nitrous oxides
NPDES	National Pollutant Discharge Elimination System
NPMS	National Pipeline Mapping System
NPS	Department of Interior's National Park Service
NR	Natural Resource
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NS	no standard established

Table A-1. Acronyms and Abbreviations

Acronyms and Abbreviations	Definitions
NW Natural	Northwest Natural
O_3	ozone
O&M	operations and maintenance
OAR	Oregon Administrative Rule
OARRA	Oregon Archaeological Records Remote Access
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODOE	Oregon Department of Energy
ODOT	Oregon Department of Transportation
OHP	Oregon Highway Plan
OPA	Oil Pollution Act of 1990
OPRD	Oregon Parks and Recreation Department
OR	Oregon
ORBIC	Oregon Biodiversity Information Center
ORS	Oregon Revised Statutes
OTIB	Oregon Transportation Infrastructure Bank
Pb	lead
PCB	polychlorinated biphenyl
PEM	Palustrine Emergent Wetland
PM	particulate matter
PM_{10}	particulate matter – 10 microns in diameter
$PM_{2.5}$	particulate matter – 2.5 microns in diameter
PMT	Project Management Team
ppb	parts per billion
PPE	personal protective equipment
ppm	parts per million
PROS	Parks, Recreation, and Open Space
PUC	Public Utilities Commission
Qls	landslide and debris avalanche deposits
Qtg	terrace and fan deposits
Qty	quantity
RCRA	Resource Conservation and Recovery Act of 1976
RFFA	reasonably foreseeable future action
ROW	right of way
RRFB	Rectangular Rapid Flash Beacon

Table A-1. Acronyms and Abbreviations

Acronyms and Abbreviations	Definitions
RTP	*Central Lane Metropolitan Planning Organization Regional Transportation Plan* (LCOG, adopted 2007, November; 2011, December). (The RTP includes the Financially Constrained Roadway Projects List)
SARA	Superfund Amendments and Reauthorization Act of 1986
SARA III	Emergency Planning and Community Right to Know Act of 1986; part of the SARA amendments
SC	sensitive critical
SCC	Standard Cost Categories
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SDC	Systems Development Charge
SDWA	Safe Drinking Water Act
sec	second(s)
Section 4(f)	Section 4(f) of the Department of Transportation Act of 1966
Section 6(f)	Section 6(f) of the LWCF Act of 1965
Section 106	Section 106 of the National Historic Preservation Act of 1966 (36 CFR 800.5)
SF	square foot (feet)
SHPO	Oregon State Historic Preservation Office
SIP	State Implementation Plan
SMU	Species Management Unit
SO_2	sulfur dioxide
SOC	species of concern
SSGA	Small Starts Construction Grant Agreement
STA	Special Transportation Area
STIP	Statewide Transportation Improvement Program
SV	Sensitive Vulnerable
SY	square yard(s)
TAP	Transportation Alternatives Program
TAZ	transportation analysis zone
TCE	Temporary Construction Easement
TD	transit-oriented development
TDM	Transportation Demand Management
TEA-21	Transportation Equity Act for the 21st Century
Teoe	siliciclastic marine sedimentary rocks
TESCP	Temporary Erosion and Sediment Control Plan
TIF	Tax Increment Financing
TIP	Transportation Improvement Program
TMDL	total maximum daily load

Table A-1. Acronyms and Abbreviations

Acronyms and Abbreviations	Definitions
TOD	transit-oriented development
TPAU	Department of Transportation – Transportation Planning Analysis Unit
TPR	Transportation Planning Rule
TransPlan	*Eugene-Springfield Transportation System Plan* (City of Eugene et al., adopted 2002, July)
TRB	Transportation Research Board
TSI	Transportation System Improvement
TSM	Transportation System Management
TSP	Transportation System Plan
UGB	Urban Growth Boundary
UMTA	Urban Mass Transit Administration
Uniform Act	Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended, 42 U.S.C. 4601 et. seq., 49 CFR Part 24
URA	Urban Renewal Area
U.S.C.	United States Code
USDOT	U.S. Department of Transportation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
v/c	volume-to-capacity
VHT	vehicle hours traveled
VMT	vehicle miles traveled
VOC	volatile organic compound
WEEE	West Eugene EmX Extension
WEG	wind erodibility group
YOE	year of expenditure

Terms

Table A-2. Terms

Terms	Definitions
Accessibility	The extent to which facilities are barrier-free and useable for all persons with or without disabilities.
Action	An “action,” a federal term, is the construction or reconstruction, including associated activities, of a transportation facility. For the purposes of this Handbook, the terms “project,” “proposal,” and “action” are used interchangeably unless otherwise specified. An action may be categorized as a “categorical exclusion” or a “major federal action.”
Agricultural / Forest / Natural Resource	AG, EFU-25, EFU-30, EFU-40, F-1, F-2, and NR
Alignment	Alignment is the street or corridor that the transit project would be located within.
Alternative Fuels	Low-polluting fuels which are used to propel a vehicle instead of high-sulfur diesel or gasoline. Examples include methanol, ethanol, propane or compressed natural gas, liquid natural gas, low-sulfur or "clean" diesel and electricity.
Alternatives Analysis (AA)	The process of evaluating the costs, benefits, and impacts of a range of transportation alternatives designed to address mobility problems and other locally-defined objectives in a defined transportation corridor, and for determining which particular investment strategy should be advanced for more focused study and development. The Alternatives Analysis (AA) process provides a foundation for effective decision making.
Area of Potential Effect	A term used in Section 106 to describe the area in which historic resources may be affected by a federal undertaking.
Area of Potential Impact	An assessment’s Area of Potential Impact for the project is defined separately for each discipline.
Auxiliary Lanes	Lanes designed to improve safety and reduce congestion by accommodating cars and trucks entering or exiting the highway or roadway, and reducing conflicting weaving and merging movements.
Base Fare	The price charged to one adult for one transit ride; excludes transfer charges, and reduced fares.
Base Period	The period between the morning and evening peak periods when transit service is generally scheduled on a constant interval. Also known as "off-peak period."
Boarding	Boarding is a term used in transit to account for passengers of public transit systems. One person getting on a transit vehicle equals one boarding. In many cases, individuals will have to transfer to an additional transit vehicle to reach their destination and may well use transit for the return trip. Therefore, a single rider may account for several transit boardings in one day.
Bus Phase	An exclusive traffic signal phase for buses and/or BRT vehicles.
Bus Rapid Transit (BRT)	A transit mode that combines the quality of rail transit and the flexibility of buses. It can operate on bus lanes, high-occupancy vehicle (HOV) lanes, expressways, or ordinary streets. The vehicles are designed to allow rapid passenger loading and unloading, with more doors than ordinary buses.

Table A-2. Terms

Terms	Definitions
Business Access and Transit (BAT) Lane	In general, a BAT lane is a concrete lane, separated from general-purpose lanes by a paint stripe and signage. A BAT lane provides Bus Rapid Transit (BRT) priority operations, but general-purpose traffic is allowed to travel within the lane to make a turn into or out of a driveway or at an intersecting street. However, only the BRT vehicle is allowed to use the lane to cross an intersecting street.
Busway	Exclusive freeway lane for buses and carpools.
Capital Improvements Program (CIP)	A CIP is a short-range plan, usually 4 to 10 years, which identifies capital projects and equipment purchases, provides a planning schedule, and identifies options for funding projects in the program.
Categorical Exclusion (CE)	A CE means a category of actions that do not individually or cumulatively have a significant effect on the human environment and for which, therefore, neither an environmental assessment nor an environmental impact statement is required.
Chambers Special Area Zone	S-C
Charter Tree	A tree defined by the Eugene Charter (City of Eugene, 2002, updated 2008) as "…(a living, standing, woody plant having a trunk 25 inches in circumference at a point 4-½ feet above mean ground level at the base of the trunk) of at least fifty years of age within publicly owned rights of way for streets, roads, freeways, throughways, and thoroughfares and within those portions of the city which were in the incorporated boundaries of the city as of January 1, 1915, shall be designated historic street trees and recognized as objects of high historic value and significance in the history of the city and deserving of maintenance and protection." These trees have special historic importance to the City and require special processes be followed if their removal is proposed, including a public vote on the project proposing the removal.
Charter Tree Boundary	Defined by the Eugene Charter (City of Eugene, 2002, updated 2008) as "…those portions of the city which were in the incorporated boundaries of the city as of January 1, 1915." Trees within this boundary may, if they meet certain criteria, be granted the special title and protective status of a Charter Tree, defined above.
City of Eugene Zoning Classifications	Industrial (I-2 and I-3), Commercial (C-3), Mixed-Use (C-1, C-2, GO, S-C, S-CN, S-DR, S-DW, S-E, S-F, S-HB, S-JW, S-RN, S-W, and S-WS), Single-Family Residential (R-1), Multi-Family Residential (R-2 and R-3), Institution (PL and PRO), Agricultural / Forest / Natural Resource (AG, EFU-25, EFU-30, EFU-40, F-1, F-2, and NR), Office (E-1 and E-2), Special Area Zone (Non-Mixed Use) (S-H and S-RP), Downtown Westside Special Area Zone (S-DW), Chambers Special Area Zone (S-C)
Clean Air Act Amendments of 1990	The comprehensive federal legislation that establishes criteria for attaining and maintaining the federal standards for allowable concentrations and exposure limits for various air pollutants; the act also provides emission standards for specific vehicles and fuels.
Collector Streets	Collector streets provide a balance of both access and circulation within and between residential and commercial/industrial areas. Collectors differ from arterials in that they provide more of a citywide circulation function, do not require as extensive control of access, and are located in residential neighborhoods, distributing trips from the neighborhood and local street system.
Commercial	C-3

Table A-2. Terms

Terms	Definitions
Commuter Rail	Commuter rail is a transit mode that is a multiple car electric or diesel propelled train. It is typically used for local, longer-distance travel between a central city and adjacent suburbs, and can operate alongside existing freight or passenger rail lines or in exclusive rights of way.
Compressed Natural Gas (CNG)	An alternative fuel; compressed natural gas stored under high pressure. CNG vapor is lighter than air.
Conformity	The ongoing process that ensures the planning for highway and transit systems, as a whole and over the long term, is consistent with the state air quality plans for attaining and maintaining health-based air quality standards; conformity is determined by metropolitan planning organizations (MPOs) and the U.S. Department of Transportation (U.S. DOT), and is based on whether transportation plans and programs meet the provisions of a State Implementation Plan.
Congestion Mitigation and Air Quality (CMAQ)	Federal funds available for either transit or highway projects that contribute significantly to reducing automobile emissions, which cause air pollution.
Cooperating Agency	Regulations that implement the National Environmental Policy Act define a cooperating agency as any federal agency, other than a lead agency, which has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal (or a reasonable alternative) for legislation or other major federal action significantly affecting the quality of the human environment.
Coordination Plan	Required under Moving Ahead for Progress in the 21st Century (MAP-21), the coordination plan contains procedures aimed at achieving consensus among all parties in the initial phase of environmental review and to pre-empt disagreements that can create delays later on in a project.
Corridor	A broad geographical band that follows a general directional flow connecting major sources of trips that may contain a number of streets, highways, and transit route alignments.
Corridor Transit Service Characteristics	The amount of transit service provided in each corridor, measured by daily vehicle hours traveled, daily vehicle miles traveled, and daily place-miles of service.
Demand Responsive	Non-fixed-route service utilizing vans or buses with passengers boarding and alighting at pre-arranged times at any location within the system's service area. Also called "Dial-a-Ride."
Diesel Multiple Unit (DMU)	Each unit carries passengers and can be self-powered by a diesel motor; no engine unit is required.
Documented Categorical Exclusion (DCE)	A DCE means a group of actions that may also qualify as Categorical Exclusions (CEs) if it can be demonstrated that the context in which the action is taken warrants a CE exclusion; i.e., that no significant environmental impact will occur. Thus, these actions are referred to as DCEs. Such actions require some National Environmental Policy Act documentation, but not an Environmental Assessment or a full-scale Environmental Impact Statement. DCEs documentation must demonstrate that, in the context(s) in which these actions are to be performed, they will have no significant environmental impact or that such impacts will be mitigated.

Table A-2. Terms

Terms	Definitions
Downtown Westside Special Area Zone	S-DW
Draft Environmental Impact Statement (DEIS)	The DEIS is the document that details the results of the detailed analysis of all of the projects alternatives. The DEIS contains all information learned about the impacts of a project and alternatives.
Earmark	A federal budgetary term that refers to the specific designation by Congress that part of a more general lump-sum appropriation be used for a particular project; the earmark can be designated as a minimum and/or maximum dollar amount.
Effects	Effects include ecological, aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions that may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial. Effects include: (1) direct effects that are caused by the action and occur at the same time and place, and (2) indirect effects that are caused by the action and are later in time or farther removed in distance but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use; population density or growth rate; and related effects on air and water and other natural systems, including ecosystems (40 CFR 1508.8).
Electrical Multiple Unit (EMU)	The EMU is heavier than a light rail vehicle, but it is powered in the same way by an overhead electrical system.
EmX	Lane Transit District’s Bus Rapid Transit System, pronounced “MX,” short for Emerald Express.
Environmental Assessment (EA)	A report subject to the requirements of the National Environmental Policy Act (NEPA) demonstrating that an Environmental Impact Statement (EIS) is not needed for a specific set of actions. The EA can lead to a Finding of No Significant Impact (FONSI).
Environmental Impact Statement (EIS)	A comprehensive study of likely environmental impacts resulting from major federally-assisted projects; EISs are required by the National Environmental Policy Act.
Environmental Justice	A formal federal policy on environmental justice was established in February 1994 with Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations." There are three fundamental environmental justice principles: • To avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority populations and low-income populations. • To ensure the full and fair participation by all potentially affected communities in the transportation decision-making process. • To prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority and low-income populations.
Envision Eugene	The City of Eugene’s Comprehensive Plan (latest draft or as adopted). Envision Eugene includes a determination of the best way to accommodate the community’s projected needs over the next 20 years.

Table A-2. Terms

Terms	Definitions
Evaluation Criteria	Evaluation criteria are the factors used to determine how well each of the proposed multimodal alternatives would meet the project's Goals and Objectives. The Evaluation Criteria require a mix of quantitative data and qualitative assessment. The resulting data are used to measure the effectiveness of proposed multimodal alternatives and to assist in comparing and contrasting each of the alternatives to select a preferred alternative.
Exclusive Right of Way	A roadway or other facility that can only be used by buses or other transit vehicles.
Fatal Flaw Screening	The purpose of a Fatal Flaw Screening is to identify alternatives that will not work for one reason or another (e.g., environmental, economic, community). By using a Fatal Flaw Screening process to eliminate alternatives that are not likely to be viable, a project can avoid wasting time or money studying options that are not viable and focus on alternatives and solutions that have the greatest probability of meeting the community's needs (e.g., environmentally acceptable, economically efficient, implementable).
Finding of No Significant Impact (FONSI)	A document prepared by a federal agency showing why a proposed action would not have a significant impact on the environment and thus would not require preparation of an Environmental Impact Statement (EIS). A FONSI is based on the results of an Environmental Assessment (EA).
Fixed Guideway System	A system of vehicles that can operate only on its own guideway constructed for that purpose (e.g., rapid rail, light rail). Federal usage in funding legislation also includes exclusive right of way bus operations, trolley coaches, and ferryboats as "fixed guideway" transit.
Fixed Route	Service provided on a repetitive, fixed-schedule basis along a specific route with vehicles stopping to pick up and deliver passengers at set stops and stations; each fixed-route trip serves the same origins and destinations, unlike demand responsive and taxicabs.
Geographic Information System (GIS)	A data management software tool that enables data to be displayed geographically (i.e., as maps).
Goals and Objectives	Goals and objectives define the project's desired outcome and reflect community values. Goals and objectives build from the project's Purpose and Need Statement. • Goals are overarching principles that guide decision making. Goals are broad statements. • Objectives define strategies or implementation steps to attain the goals. Unlike goals, objectives are specific and measurable.
Guideway	A transit right of way separated from general purpose vehicles.
Headway	Time interval between vehicles passing the same point while moving in the same direction on a particular route.

Table A-2. Terms

Terms	Definitions
Heritage Tree	The *City of Eugene Urban Forest Management Plan* (City of Eugene Public Works Department Maintenance Division, 1992) defines "Heritage Trees" as: "Any tree of exceptional value to our community based on its size (relative to species), history, location, or species, or any combination of these criteria." Such a tree cannot be removed "except when otherwise necessary for the public health, safety, or welfare."
Hydrology	Refers to the flow of water including its volume, where it drains, and how quickly it flows.
Impacts	A term to describe the positive or negative effects upon the natural or built environments as a result of an action (i.e., project).
In-vehicle Travel Time	The amount of time it takes for a transit vehicle to travel between an origin and a destination.
In-vehicle Walk and Wait Travel Time	The amount of in-vehicle travel time plus time spent walking to transit, initial wait time, transfer wait time (if any), and time walking from transit to the destination.
Independent Utility	A project or section of a larger project that would be a usable and reasonable expenditure even if no other projects or sections of a larger project were built and/or improved.
Industrial	I-2 and I-3
Institution	PL and PRO
Intergovernmental Agreement	A legal pact authorized by state law between two or more units of government, in which the parties contract for, or agree on, the performance of a specific activity through either mutual or delegated provision.
Intermodal	Those issues or activities that involve or affect more than one mode of transportation, including transportation connections, choices, cooperation, and coordination of various modes. Also known as "multimodal."
Jefferson Westside Special Area Zone	S-JW
Joint Development	Ventures undertaken by the public and private sectors for development of land around transit stations or stops.
Key Transit Corridors	Key Transit Corridors are mapped in Envision Eugene and are anticipated to be significant transit corridors for the City and the region
Kiss & Ride	A place where commuters are driven and dropped off at a station to board a public transportation vehicle.
Land and Water Conservation Fund (LWCF) Act of 1965	16 U.S.C. 4601-4 et seq. The Land and Water Conservation Fund (LWCF) State Assistance Program was established by the LWCF Act of 1965 to stimulate a nationwide action program to assist in preserving, developing, and providing assurance to all citizens of the United States (of present and future generations) such quality and quantity of outdoor recreation resources as may be available, necessary, and desirable for individual active participation. The program provides matching grants to states and through states to local units of government, for the acquisition and development of public outdoor recreation sites and facilities.
Landscape Tree	A living, standing, woody plant having a trunk that exists on private property.

Table A-2. Terms

Terms	Definitions
Lane Regional Air Protection Agency (LRAPA)	LRAPA is responsible for achieving and maintain clean air in Lane County using a combination of regulatory and non-regulatory methods
Layover Time	Time built into a schedule between arrival at the end of a route and the departure for the return trip, used for the recovery of delays and preparation for the return trip.
Lead Agency	The organization that contracts and administers a study. For transit projects, FTA would typically fill this role. The lead agency has the final say about the project's purpose and need, range of alternatives to be considered, and other procedural matters.
Level of Detail	The amount of data collected, and the scale, scope, extent, and degree to which item-by-item particulars and refinements of specific points are necessary or desirable in carrying out a study.
Level of Service (LOS)	LOS is a measure used by traffic engineers to determine the effectiveness of elements of transportation infrastructure. LOS is most commonly used to analyze highways, but the concept has also been applied to intersections, transit, and water supply.
Light Rail Transit (LRT)	Steel wheel/steel rail transit constructed on city streets, semi-private right of way, or exclusive private right of way. Formerly known as "streetcar" or "trolley car" service, LRT's major advantage is operation in mixed street traffic at grade. LRT vehicles can be coupled into trains, which require only one operator and often are used to provide express service.
Limited (or Controlled) Access	Restricted entry to a transportation facility based upon facility congestion levels or operational condition. For example, a limited access roadway normally would not allow direct entry or exit to private driveways or fields from said roadway.
Liquefaction	A phenomenon associated with earthquakes in which sandy to silty, water saturated soils behave like fluids. As seismic waves pass through saturated soil, the structure of the soil distorts, and spaces between soil particles collapse, causing ground failure.
Liquefied Natural Gas (LNG)	An alternative fuel; a natural gas cooled to below its boiling point of 260 degrees Fahrenheit so that it becomes a liquid; stored in a vacuum bottle-type container at very low temperatures and under moderate pressure. LNG vapor is lighter than air.
Local Streets	Local streets have the sole function of providing direct access to adjacent land. Local streets are deliberately designed to discourage through-traffic movements.
Locally Preferred Alternative (LPA)	The LPA is the alternative selected through the Alternatives Analysis process completed prior to or concurrent with National Environmental Policy Act analysis. This term is also used to describe the proposed action that is being considered for New Starts or Small Starts funds.
Low-Income Persons	Those whose median household income is at or below the Department of Health and Human Services poverty guidelines. For a four-person household with two related children, the poverty threshold is $24,300 (year 2016 dollars).

Table A-2. Terms

Terms	Definitions
Maintenance area	An air quality designation for a geographic area in which levels of a criteria air pollutant meet the health-based primary standard (national ambient air quality standard, or NAAQS) for the pollutant. An area may have on acceptable level for one criteria air pollutant, but may have unacceptable levels for others. Maintenance/attainment areas are defined using federal pollutant limits set by EPA.
Maintenance facility	A facility along a corridor used to clean, inspect, repair and maintain bus vehicles, as well as to store them when they are not in use.
Major Arterial	Major arterial streets should serve to interconnect the roadway system of a city. These streets link major commercial, residential, industrial, and institutional areas. Major arterial streets are typically spaced about one mile apart to assure accessibility and reduce the incidence of traffic using collectors or local streets for through traffic in lieu of a well-placed arterial street. Access control, such as raised center medians, is a key feature of an arterial route. Arterials are typically multiple miles in length.
Major Investment Study (MIS)	An alternatives analysis study process for proposed transportation investments in which a wide range of alternatives is examined to produce a smaller set of alternatives that best meet project transportation needs. The purpose of the study is to provide a framework for developing a package of potential solutions that can then be further analyzed during an Environmental Impact Statement process.
Metro Plan Designations	Commercial, Commercial / Mixed Use, Government and Education, Heavy Industrial, High Density Residential / Mixed-Use, High Density Residential, Light-Medium Industrial, Low Density Residential, Medium Density Residential, Medium Density Residential / Mixed-Use, Mixed-Use, Parks and Open Space, Major Retail Center, Campus Industrial, University Research
Metropolitan Planning Organization (MPO)	The organization designated by local elected officials as being responsible for carrying out the urban transportation and other planning processes for an area.
Minimum Operable Segment	A stand-alone portion of the alternative alignment that has independent utility, allowed by FTA to be considered as interim termini for a project. A minimum operable segment (MOS) provides flexibility to initiate a project with available funding while pursuing additional funding to complete the remainder of the project.
Minor Arterial	A minor arterial street system should interconnect with and augment the urban major arterial system and provide service to trips of moderate length at a somewhat lower level of travel mobility than major arterials. This system also distributes travel to geographic areas smaller than those identified with the higher system. The minor arterial street system includes facilities that allow more access and offer a lower traffic mobility. Such facilities may carry local bus routes and provide for community trips, but ideally should not be located through residential neighborhoods.

Table A-2. Terms

Terms	Definitions
Minority	A person who is one or more of the following: • Black: a person having origins in any of the black racial groups of Africa • Hispanic or Latino: a person of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race • Asian American: a person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent • American Indian and Alaskan Native: a person having origins in any of the original people of North America, South America (including Central America), and who maintains cultural identification through tribal affiliation or community recognition • Native Hawaiian and Other Pacific Islander: a person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands
Mitigation	A means to avoid, minimize, rectify, or reduce an impact, and in some cases, to compensate for an impact.
Mixed-Use	C-1, C-2, GO, S-C, S-CN, S-DR, S-DW, S-E, S-F, S-HB, S-JW, S-RN, S-W, and S-WS
Modal Split	A term that describes how many people use different forms of transportation. Frequently used to describe the percentage of people using private automobiles as opposed to the percentage using public transportation, walking, or biking. Modal split can also be used to describe travelers using other modes of transportation. In freight transportation, modal split may be measured in mass.
Mode	A particular form or method of travel distinguished by vehicle type, operation technology, and right-of-way separation from other traffic.
Moving Ahead for Progress in the 21st Century (MAP-21)	Moving Ahead for Progress in the 21st Century (MAP-21) was signed by President Obama on July 6, 2012, reauthorizing surface transportation programs through FY 2014. It includes new and revised program guidance and regulations with planning requirements related to public participation, publication, and environmental considerations.
MovingAhead Project	The City of Eugene and LTD are working with regional partners and the community to determine which improvements are needed on some of our most important transportation corridors for people using transit, and facilities for people walking and biking. MovingAhead will prioritize transit, walking, and biking projects along these corridors so that they can be funded and built in the near-term. The project will focus on creating active, vibrant places that serve the community and accommodate future growth. During Phase 1, currently underway, the community will weigh in on preferred transportation solutions for each corridor and help prioritize corridors for implementation. When thinking about these important streets, LTD and the City of Eugene refer to them as corridors because several streets may work as a system to serve transportation needs.
Multi-Family Residential	R-2 and R-3
Multimodal	Multimodal refers to various modes. For the MovingAhead project, multimodal refers to Corridors that support various transportation modes including vehicles, buses, walking and cycling.

Table A-2. Terms

Terms	Definitions
National Environmental Policy Act of 1969 (NEPA)	A comprehensive federal law requiring analysis of the environmental impacts of federal actions such as the approval of grants; also requiring preparation of an Environmental Impact Statement for every major federal action significantly affecting the quality of the human environment.
New Starts	Federal funding granted under Section 3(i) of the Federal Transit Act. These discretionary funds are made available for construction of a new fixed guideway system or extension of any existing fixed guideway system, based on cost-effectiveness, alternatives analysis results, and the degree of local financial commitment.
No Action or No-Build Alternative	An alternative that is used as the basis to measure the impacts and benefits of the other alternative(s) in an environmental assessment or other National Environmental Policy Act action. The No-Build Alternative consists of the existing conditions, plus any improvements that have been identified in the Statewide Transportation Improvement Program.
Nonattainment Area	Any geographic region of the United States that the U.S. Environmental Protection Agency (EPA) has designated as not attaining the federal air quality standards for one or more air pollutants, such as ozone and carbon monoxide.
Notice of Intent	A federal announcement, printed in the *Federal Register*, advising interested parties that an Environmental Impact Statement will be prepared and circulated for a given project
Off-Peak Period	Non-rush periods of the day when travel activity is generally lower and less transit service is scheduled. Also called "base period."
Office	E-1 and E-2
Oregon Statewide Comprehensive Outdoor Recreation Plan (SCORP)	The 2013-2017 Oregon Statewide Comprehensive Outdoor Recreation Plan (SCORP), entitled *Ensuring Oregon's Outdoor Legacy* (OPRD, No Date), constitutes Oregon's basic 5-year plan for outdoor recreation. The plan guides the use of LWCF funds that come into the state; provides guidance for other OPRD-administered grant programs; and provides recommendations to guide federal, state, and local units of government, as well as the private sector, in making policy and planning decisions.
Park and Ride	Designated parking areas for automobile drivers who then board transit vehicles from these locations.
Participating Agency	A federal or non-federal agency that may have an interest in the project. These agencies are identified and contacted early-on in the project with an invitation to participate in the process. This is a broader category than "cooperating agency" (see Cooperating Agency).
Passenger Miles	The total number of miles traveled by passengers on transit vehicles; determined by multiplying the number of unlinked passenger trips times the average length of their trips.
Peak Hour	The hour of the day in which the maximum demand for transportation service is experienced (refers to private automobiles and transit vehicles).
Peak Period	Morning and afternoon time periods when transit riding is heaviest.
Peak/Base Ratio	The number of vehicles operated in passenger service during the peak period divided by the number operated during the base period.

Table A-2. Terms

Terms	Definitions
Place-miles	Place-miles refers to the total carrying capacity (seated and standing) of each bus and is calculated by multiplying vehicle capacity of each bus by the number of service miles traveled each day. Place-miles highlight differences among alternatives caused by a different mix of vehicles and levels of service.
Preferred Alternative	An alternative that includes a major capital improvement project to address the problem under investigation. As part of the decision making process, the Preferred Alternative is compared against the No Action or No-Build Alternative from the standpoints of transportation performance, environmental consequences, cost-effectiveness, and funding considerations.
Purpose and Need	The project Purpose and Need provides a framework for developing and screening alternatives. The purpose is a broad statement of the project's transportation objectives. The need is a detailed explanation of existing conditions that need to be changed or problems that need to be fixed.
Queuing	Occurs when traffic lanes cannot fit all the vehicles trying to use them, or if the line at an intersection extends into an upstream intersection.
Record of Decision (ROD)	A decision made by FTA as to whether the project sponsor receives federal funding for a project. The Record of Decision follows the Draft EIS and Final EIS.
Regulatory Agency	An agency empowered to issue or deny permits.
Resource Agency	A federal or state agency or commission that has jurisdictional responsibilities for the management of a resource such as plants, animals, water, or historic sites.
Revenue Hours	Hours of transit service available for carrying paying riders.
Ridership	The number of people using a public transportation system in a given time period.
Ridesharing	A form of transportation, other than public transit, in which more than one person shares the use of the vehicle, such as a van or car, to make a trip. Also known as "carpooling" or "vanpooling."
Right of Way	Publicly owned land that can be acquired and used for transportation purposes.
Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU)	SAFETEA-LU was passed by Congress July 29, 2005, and signed by the President August 10, 2005. Includes new and revised program guidance and regulations (approximately 15 rulemakings) with planning requirements related to public participation, publication, and environmental considerations. SAFETEA-LU covers FY 2005 through FY 2009 with a total authorization of $45.3 billion.
Scoping	A formal coordination process used to determine the scope of the project and the major issues likely to be related to the proposed action (i.e., project).
Screening Criteria	Criteria used to compare alternatives.
Section 4(f) of the Department of Transportation Act of 1966	23 U.S.C. 138 and 49 U.S.C. 303. Parks are subject to evaluation in the context of Section 4(f) of the Department of Transportation Act of 1966, which governs the use of publicly-owned/open to the public park and recreation lands, government-owned wildlife lands, and historic resources.
Section 4(f) resources	(i) any publicly owned land in a public park, recreation area, or wildlife and waterfowl refuge of national, state, or local significance, or (ii) any land from a historic site of national, state, or local significance

Table A-2. Terms

Terms	Definitions
Section 6(f) of the LWCF Act of 1965	The LWCF's most important tool for ensuring long-term stewardship is its "conversion protection" requirement. Section 6(f)(3) strongly discourages conversions of state and local park, and recreational facilities to other uses. Conversion of property acquired or developed with assistance under the program requires approval of the Department of Interior's National Park Service (NPS) and substitution of other recreational properties of at least equal fair market value, and of reasonably equivalent usefulness and location.
Section 106	Section 106 of the National Historic Preservation Act of 1966 requires that federal agencies take into account the effect of government-funded construction projects on property that is included in, or eligible for inclusion in, the NRHP.
Shuttle	A public or private vehicle that travels back and forth over a particular route, especially a short route or one that provides connections between transportation systems, employment centers, etc.
Single-Family Residential	R-1
Special Area Zone (Non-Mixed Use)	S-H and S-RP
Springfield 2030	Currently underway, this update to the City of Springfield's Comprehensive Plan will guide and support attainment of the community's livability and economic prosperity goals and redevelopment priorities.
Springfield Transportation System Plan (TSP)	The City of Springfield's Transportation System Plan looks at how the transportation system is currently used and how it should change to meet the long-term (20-year) needs of the City of Springfield's residents, businesses, and visitors. The Plan, which identifies improvements for all modes of transportation, will serve as the City of Springfield's portion of the Regional Transportation System Plan prepared by Lane Council of Governments (LCOG). It was prepared in coordination with Oregon Department of Transportation, LCOG, and the Oregon Department of Land Conservation and Development. The TSP was adopted March 11, 2014.
State Implementation Plan (SIP)	A state plan mandated by the Clean Air Act Amendments of 1990 that contains procedures to monitor, control, maintain, and enforce compliance with national standards for air quality.
Strategy	An intended action or series of actions which when implemented achieves the stated goal.
Street Tree	A living, standing, woody plant having a trunk that exists in the public right of way.
Study Area	The area within which evaluation of impacts is conducted. The study area for particular resources will vary based on the decisions being made and the type of resource(s) being evaluated.
Throughput	The number of users being served at any time by the transportation system.
Title VI	This Title declares it to be the policy of the United States that discrimination on the ground of race, color, or national origin shall not occur in connection with programs and activities receiving federal financial assistance and authorizes and directs the appropriate federal departments and agencies to take action to carry out this policy.

Table A-2. Terms

Terms	Definitions
Transit Oriented Development (TOD) or Nodal Development	A strategy to build transit ridership, while discouraging sprawl, improving air quality and helping to coordinate a new type of community for residents. TODs are compact, mixed-use developments situated at or around transit stops. Sometimes referred to as Transit Oriented Communities, or Transit Villages.
Transit System	An organization (public or private) providing local or regional multi-occupancy-vehicle passenger service. Organizations that provide service under contract to another agency are generally not counted as separate systems.
Transitway	A Bus Rapid Transit (BRT) priority lane generally with a concrete lane, with or without concrete tracks with grass-strip divider, and a curb separation, traversable by general-purpose vehicles at signalized intersections.
Transportation Demand Management (TDM)	Strategies to attempt to reduce peak period automobile trips by encouraging the use of high occupancy modes through commuter assistance, parking incentives, and work policies that alter the demand for travel in a defined area in terms of the total volume of traffic, the use of alternative modes of travel, and the distribution of travel over different times of the day.
Transportation Improvement Program (TIP)	A program of intermodal transportation projects, to be implemented over several years, growing out of the planning process and designed to improve transportation in a community. This program is required as a condition of a locality receiving federal transit and highway grants.
Travel Shed	Synonymous with “corridor” (see Corridor). A subarea in which multiple transportation facilities are experiencing congestion, safety, or other problems.
urban plaza	An urban plaza is a place that can be used for socializing, relaxation, and/or events.
v/c ratio	Used as a principal measure of congestion. The “v” represents the volume or the number of vehicles that are using the roadway at any particular period. The “c” represents the capacity of a roadway at its adopted level of service (LOS). If the volume exceeds the capacity of the roadway (volume divided by capacity exceeds 1.00), congestion exists.
Vehicle Hours of Delay	Cumulative delay experiences by transit vehicles during high traffic periods.
Water Quality	Refers to the characteristics of the water, such as its temperature and oxygen levels, how clear it is, and whether it contains pollutants.
Whiteaker Special Area Zone	S-W

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Appendix B: Construction Activities

General Construction Methods

The following section describes how construction of the Locally Preferred Alternative (LPA) would likely be staged and sequenced. This description is based on Lane Transit District's (LTD's) experience with the Franklin, Gateway, and West Eugene EmX Corridors. The final plan for construction methods, sequencing, and staging will be determined in coordination with the contractor and permitting authorities.

Utility work will generally be completed before the transportation infrastructure is constructed. Utility work, often conducted by local utility companies, occurs separately from project-related construction. After completing required utility relocation and other preparatory site work, the contractor will begin with construction of new transit lanes, bike lanes, sidewalks, and any other "flatwork." The contractor will modify existing signals or construct new traffic signals as part of this work. In some cases, the contractor may construct the signal footings but install signal arms after initial work is complete. Flatwork for stations, including curbs, ramps, and station footings, will be completed as the work progresses along the alignment. Streets and street segments will be restored to normal operations after this work is complete. The contractor is expected to progress approximately two blocks every 2 weeks, with additional time required – up to 2 weeks – for each enhanced stop or EmX station. Additional time will be required at intersections that require new or substantially modified traffic signals. The construction sequencing will be determined through coordination between the contractor and local residents, businesses, and property owners regarding construction scheduling preferences. It is expected that, for each major segment, the work would start at one end of the segment and progress to the other end of the segment. All flatwork is expected to be completed in two construction seasons.

Stations will be fabricated during the second construction season and installed during the subsequent (final) construction season, along with landscaping, fare machines, real-time passenger information, enhanced stop or EmX station amenities, and other similar items.

The contractor and LTD will coordinate closely with the Oregon Department of Transportation (ODOT) and with the City of Eugene (as appropriate to the jurisdiction) on traffic control. Depending on the segment, ODOT or the City will review and approve traffic plans for construction.

On streets with multiple lanes in each direction (or multiple lanes in one direction for one-way streets), at least one lane of traffic will be open at all times. Flaggers will coordinate travel at intersections and other points of congestion, as necessary. On streets with a single lane, it may be necessary to close one direction of traffic for certain periods. In those situations, flaggers will be used to manage the traffic flow safely. The contractor and LTD will also coordinate with businesses to ensure that the project maintains access for patrons and deliveries.

Coordination with Businesses and Residents

LTD's Franklin, Gateway, and West Eugene EmX projects demonstrated LTD's commitment to communicating with impacted businesses, residences, and travelers, both before and during construction. As with those projects, LTD will contact all businesses and residents along the alignment well before construction begins to solicit local concerns, issues, and scheduling preferences. Businesses and residents will also be able to communicate with the contractor and LTD during construction. LTD's construction liaison will provide e-mail updates and serve as an ongoing point of contact to address concerns and to provide information to affected businesses, residents, and other interested persons. LTD will provide a 24-hour hotline to quickly address construction concerns from businesses and residences.

LTD will also work to enhance activity at businesses affected by construction. This can be done through attractive signage, direct communications with the public (e.g., direct mail and advertising), and community events (e.g., street fairs). These techniques succeeded in keeping business areas active during previous EmX projects.

Appendix C: Figures

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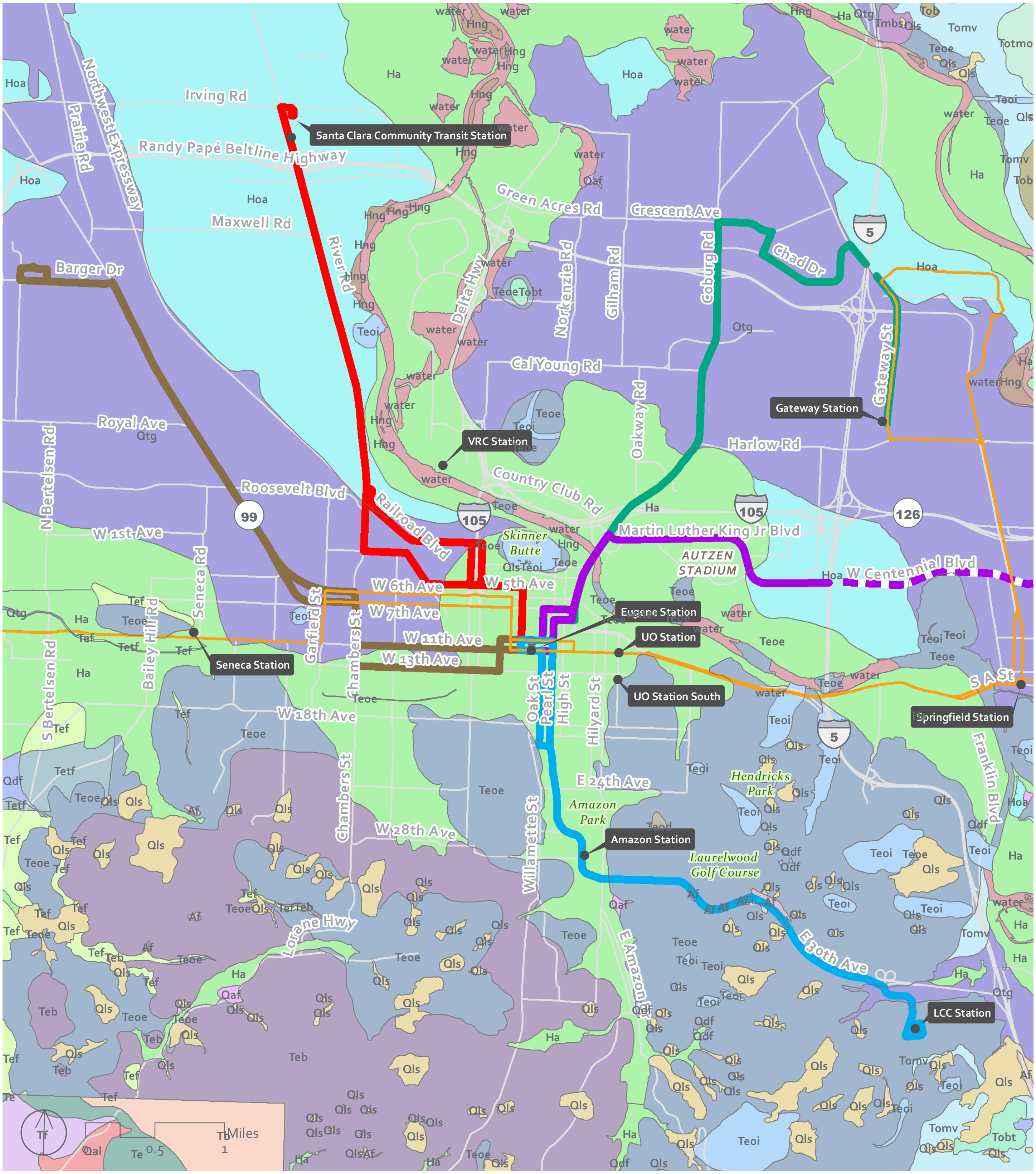
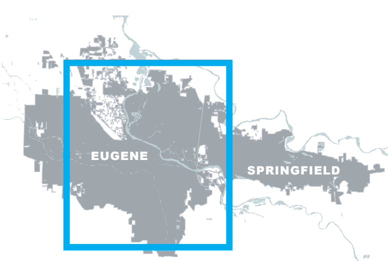


Legend

- 30th Avenue to Lane Community College Corridor
- Coburg Road Corridor
- Highway 99 Corridor
- River Road Corridor
- Martin Luther King Jr Blvd Corridor
- Martin Luther King, Jr Blvd Corridor continues east of I-5 as existing route #13
- 2035 No-Build EmX

Geologic Units Along Corridors

- Af - Artificial Fill
- Ha - Alluvium
- Hoa - Older Alluvium
- Qls - Landslide and Debris Avalanche Deposits
- Qtg - Terrace and Fan Deposits
- Teoe - Siliciclastic Marine Sedimentary Rocks



Geologic Map of the Project Area

Enhanced Corridor Alternatives

Figure C-1

MovingAhead
STREETS AND PLACES REIMAGINED

Data Source: Oregon Department of Geology and Mineral Industries (DOGAMI). Open-File Report 0-10-03, Digital geologic map of the southern Willamette Valley, Benton, Lane, Linn, Marion, and Polk Counties, Oregon, by Jason D. McClaughry, Thomas J. Wiley, Mark L. Ferns, and Ian P. Madin.

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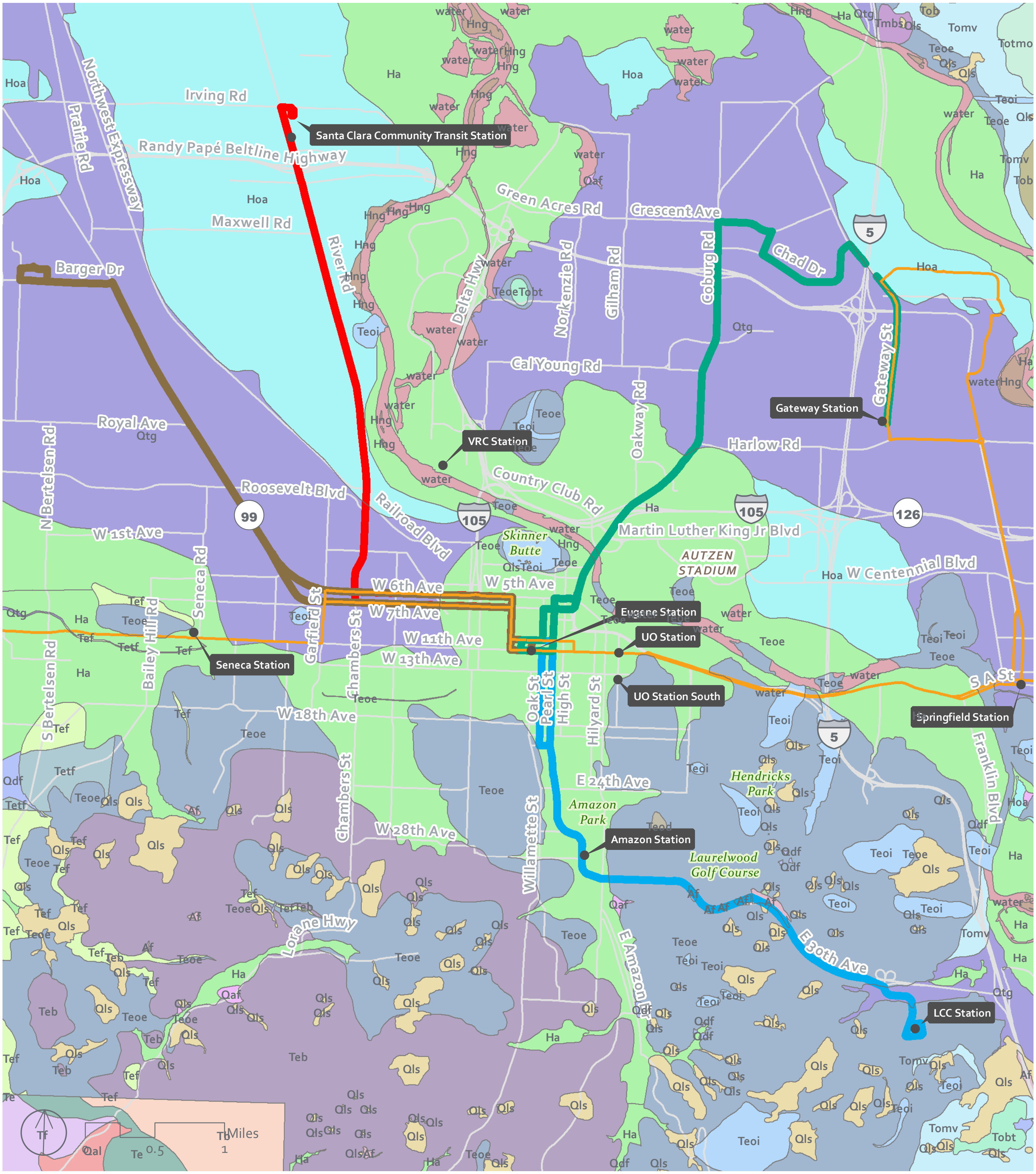

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- Coburg Road Corridor
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- River Road Corridor
- 2035 No-Build EmX

Geologic Units Along Corridors

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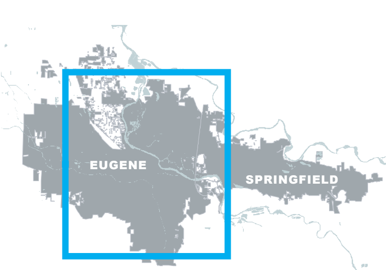

Geologic Map of the Project Area

EmX Alternatives

Figure C-2

MovingAhead
STREETS AND PLACES REIMAGINED

Data Source: Oregon Department of Geology and Mineral Industries (DOGAMI). Open-File Report 0-10-03, Digital geologic map of the southern Willamette Valley, Benton, Lane, Linn, Marion, and Polk Counties, Oregon, by Jason D. McClaughry, Thomas J. Wiley, Mark L. Ferns, and Ian P. Madin.

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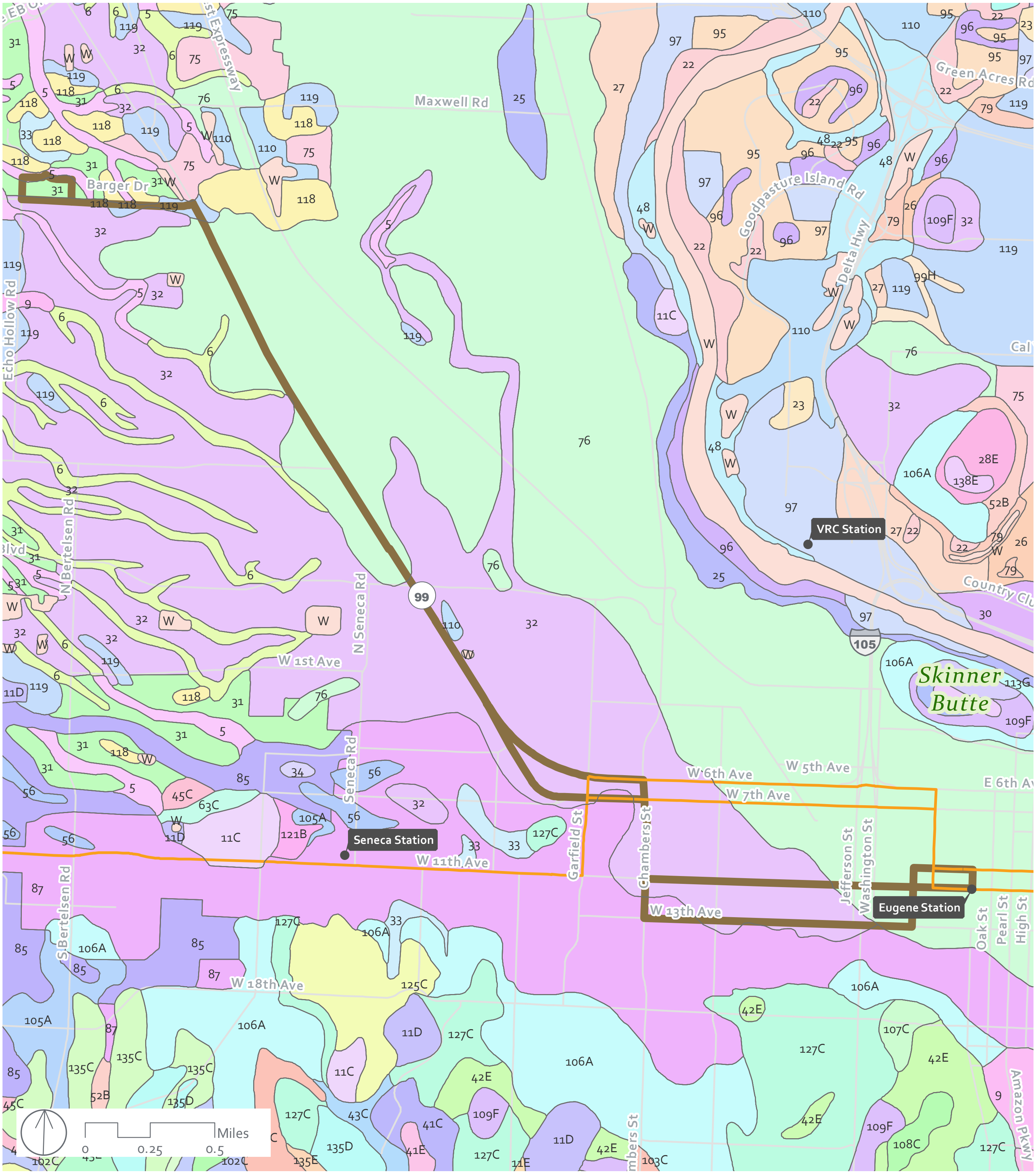

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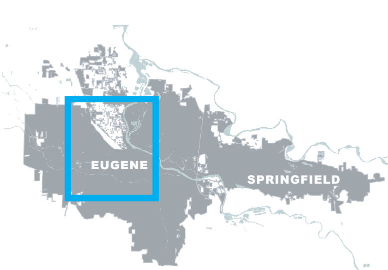

- 30th Avenue to Lane Community College Corridor
- Coburg Road Corridor
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- River Road Corridor
- Martin Luther King Jr Blvd Corridor
- Martin Luther King, Jr Blvd Corridor continues east of I-5 as existing route #13
- 2035 No-Build EmX

Note: Refer to NRCS Soils Legend figure for description of each soil unit

NRCS Soil Survey Map

Highway 99 Corridor Enhanced Corridor Alternative

Figure C-3

MovingAhead
STREETS AND PLACES REIMAGINED

Data Sources: City of Eugene, Lane Transit District, United State Department of Agriculture, Natural Resources Conservation Services

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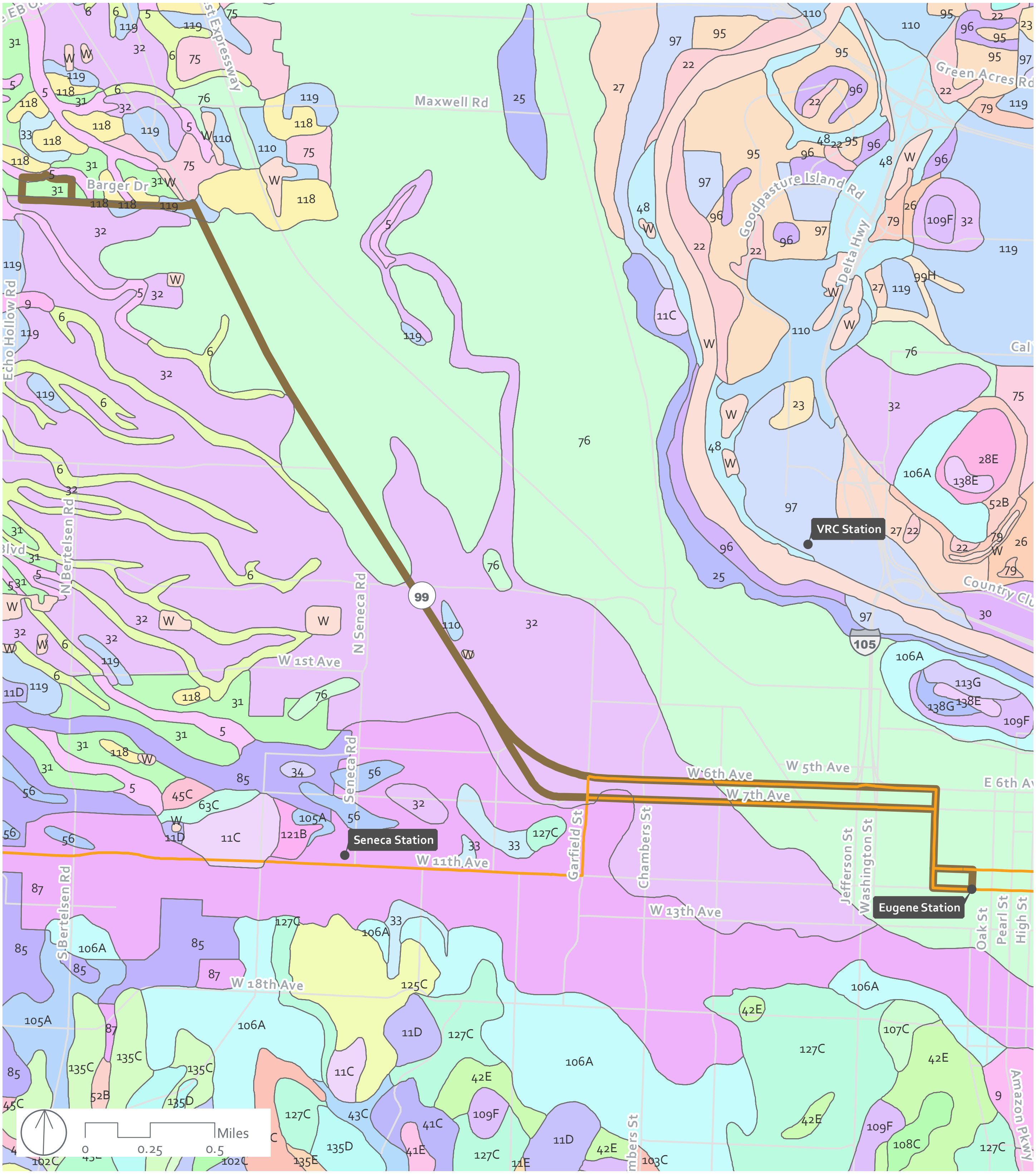

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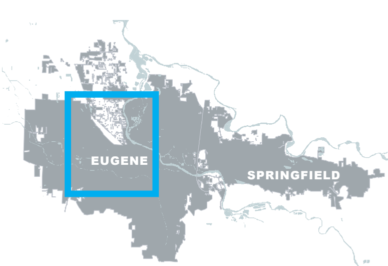

- 30th Avenue to Lane Community College Corridor
- Coburg Road Corridor
- Highway 99 Corridor
- River Road Corridor
- 2035 No-Build EmX

Note: Refer to NRCS Soils Legend figure for description of each soil unit

NRCS Soil Survey Map

Highway 99 Corridor EmX Alternative

Figure C-4

MovingAhead
STREETS AND PLACES REIMAGINED

Data Sources: City of Eugene, Lane Transit District, United State Department of Agriculture, Natural Resources Conservation Services

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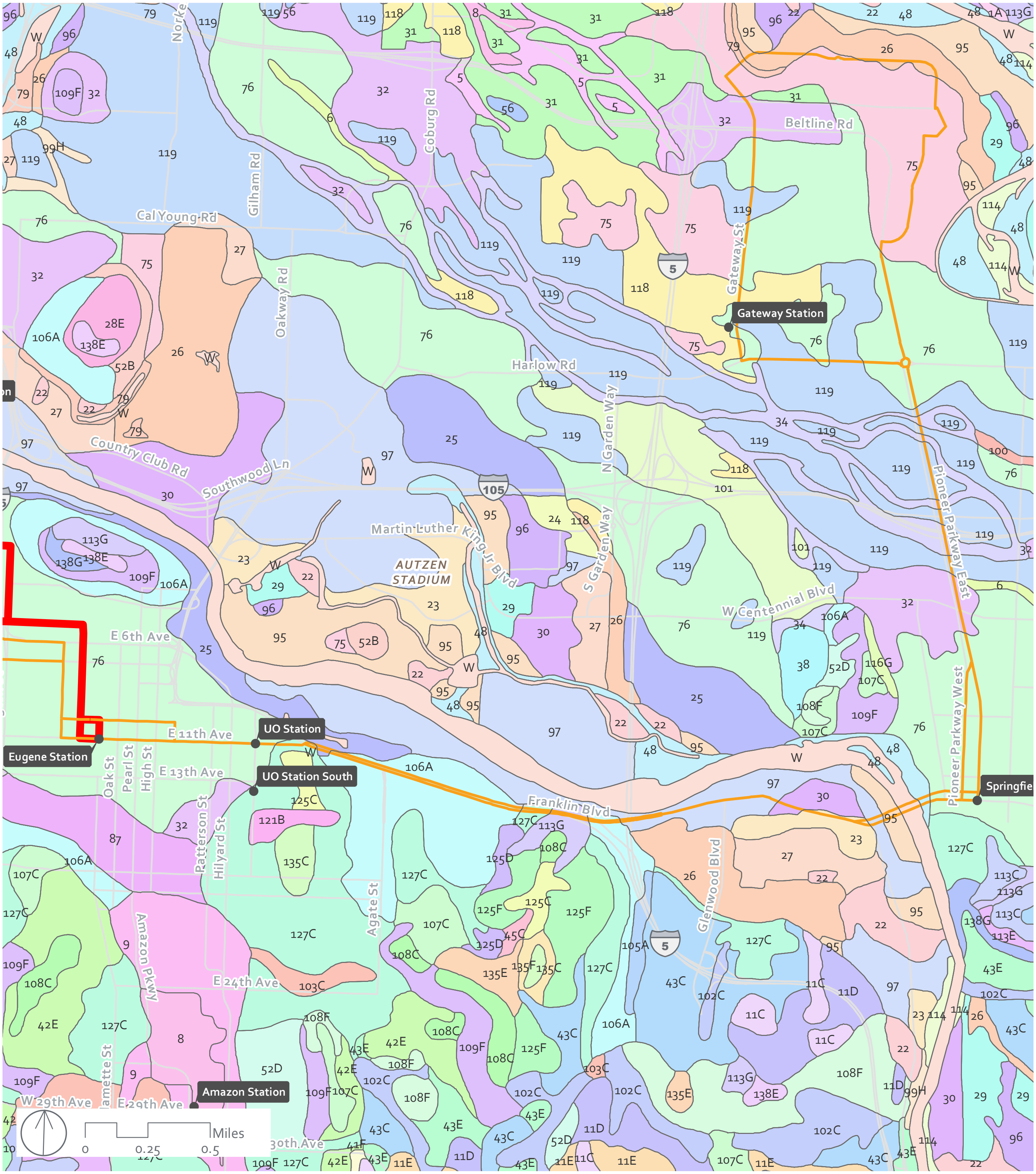

Legend

- 30th Avenue to Lane Community College Corridor
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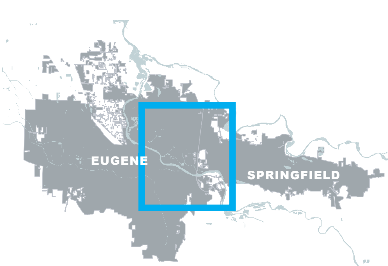
- 2035 No-Build EmX

Note: Refer to NRCS Soils Legend figure for description of each soil unit



NRCS Soil Survey Map

River Road Corridor Enhanced Corridor Alternative

Figure C-5

MovingAhead
STREETS AND PLACES REIMAGINED

Data Sources: City of Eugene, Lane Transit District, United State Department of Agriculture, Natural Resources Conservation Services

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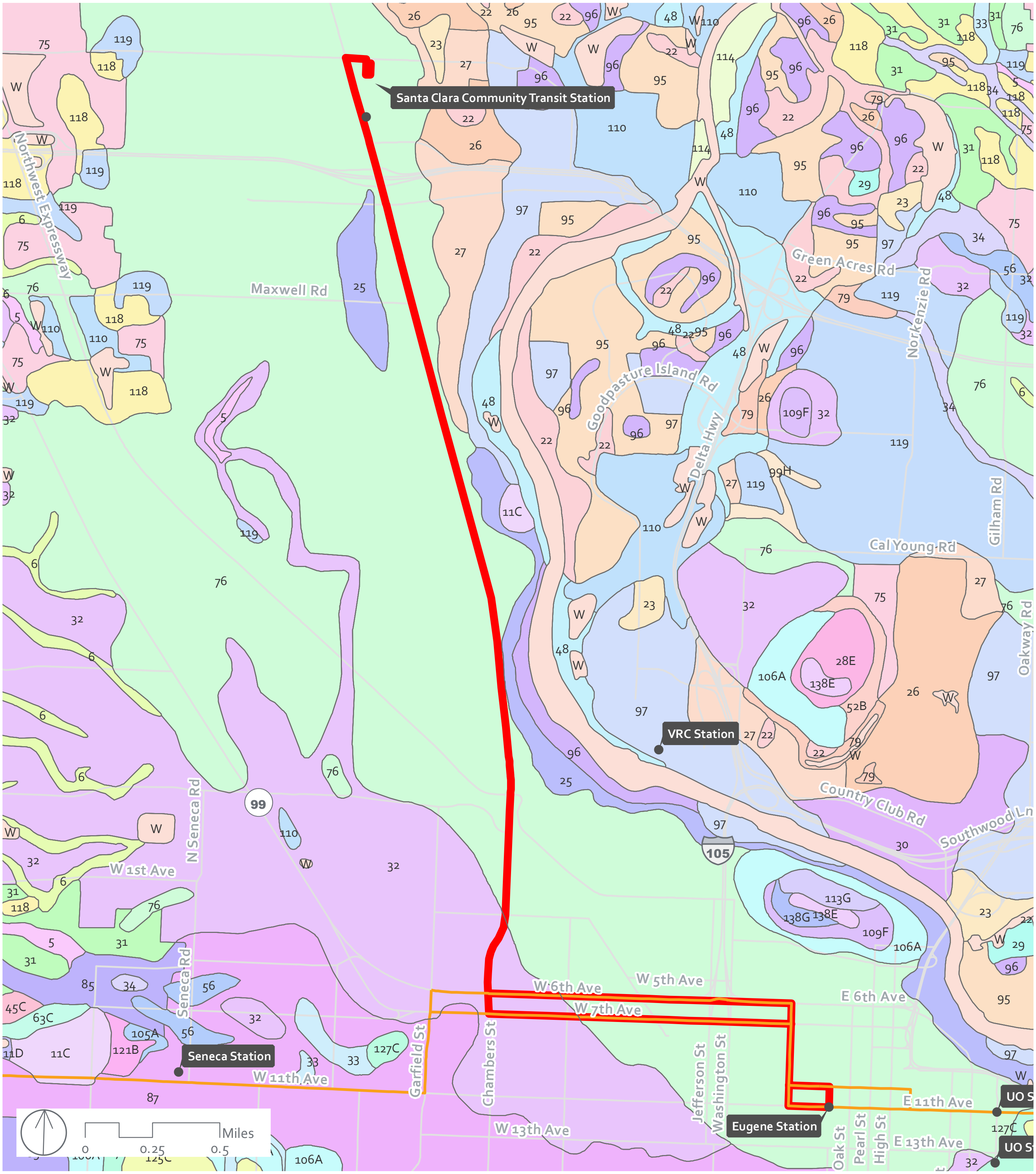

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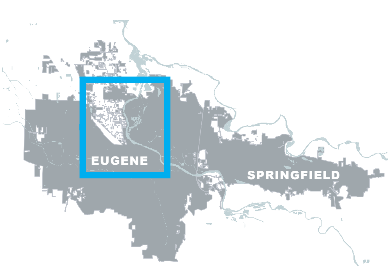


- 30th Avenue to Lane Community College Corridor
- Coburg Road Corridor
- Highway 99 Corridor
- River Road Corridor
- 2035 No-Build EmX

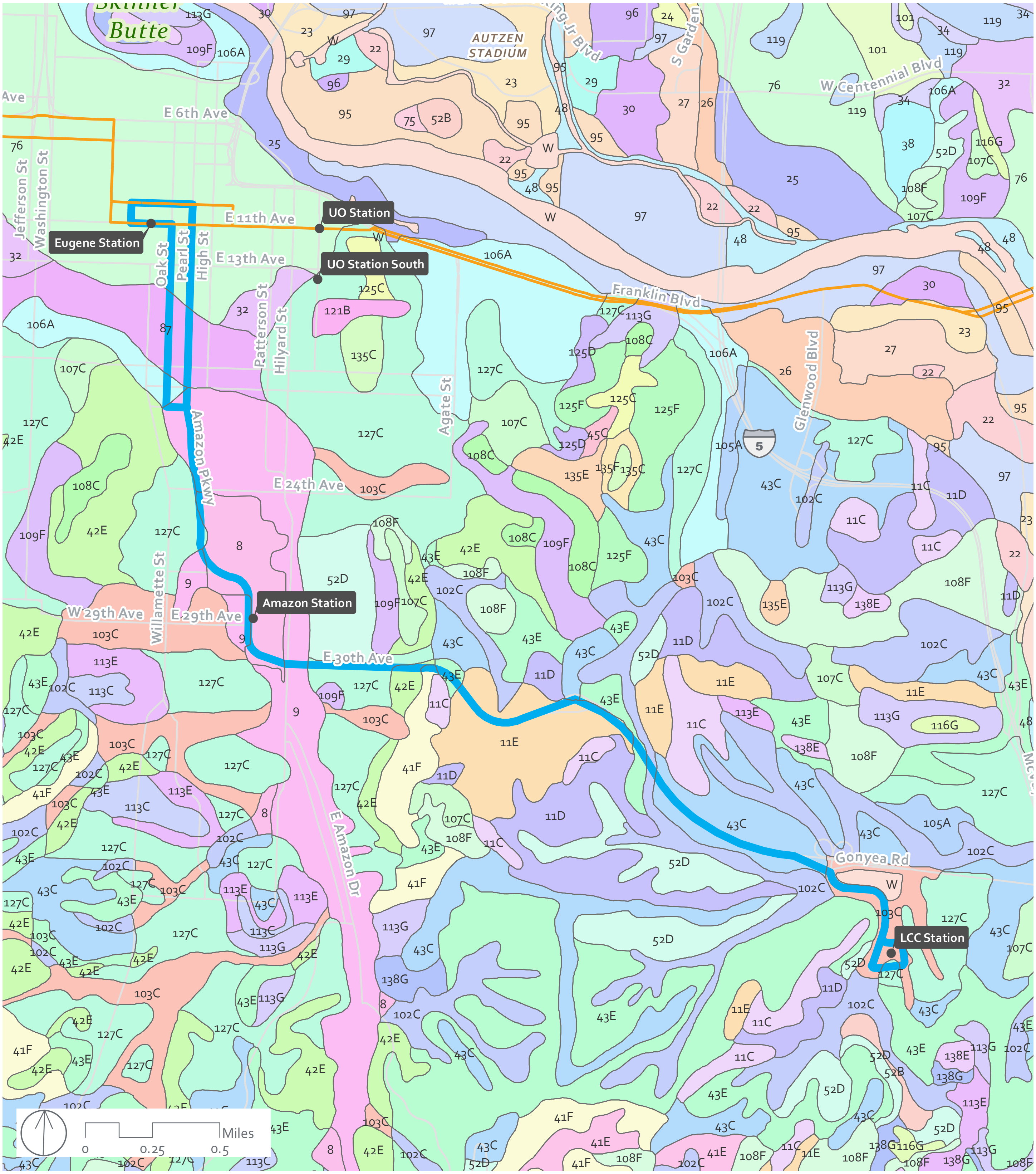
Note: Refer to NRCS Soils Legend figure for description of each soil unit

NRCS Soil Survey Map

River Road Corridor EmX Alternative

Figure C-6

MovingAhead
STREETS AND PLACES REIMAGINED



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- 30th Avenue to Lane Community College Corridor
- Coburg Road Corridor
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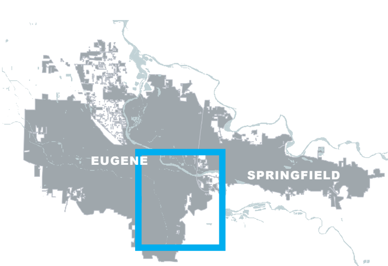
Note: Refer to NRCS Soils Legend figure for description of each soil unit



NRCS Soil Survey Map

30th Avenue to LCC Corridor Enhanced Corridor Alternative

Figure C-7

MovingAhead
STREETS AND PLACES REIMAGINED

Data Sources: City of Eugene, Lane Transit District, United State Department of Agriculture, Natural Resources Conservation Services

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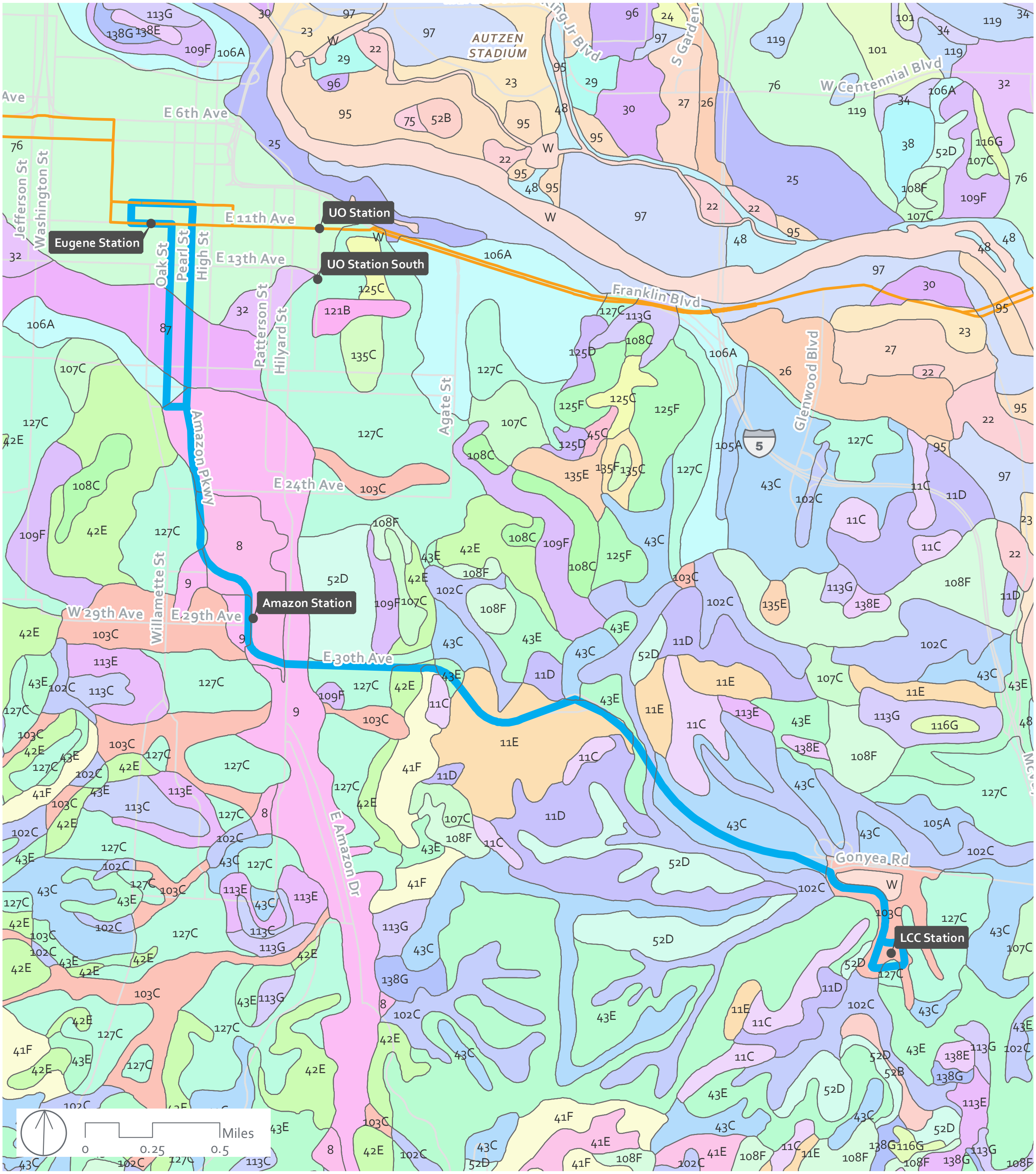

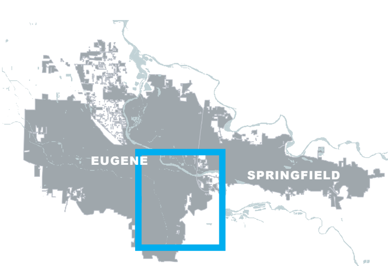

Legend

30th Avenue to Lane Community College Corridor

Coburg Road Corridor

Highway 99 Corridor

River Road Corridor

2035 No-Build EmX

Note: Refer to NRCS Soils Legend figure for description of each soil unit

NRCS Soil Survey Map

30th Avenue to LCC Corridor EmX Alternative

Figure C-8

MovingAhead
STREETS AND PLACES REIMAGINED

Data Sources: City of Eugene, Lane Transit District, United State Department of Agriculture, Natural Resources Conservation Services

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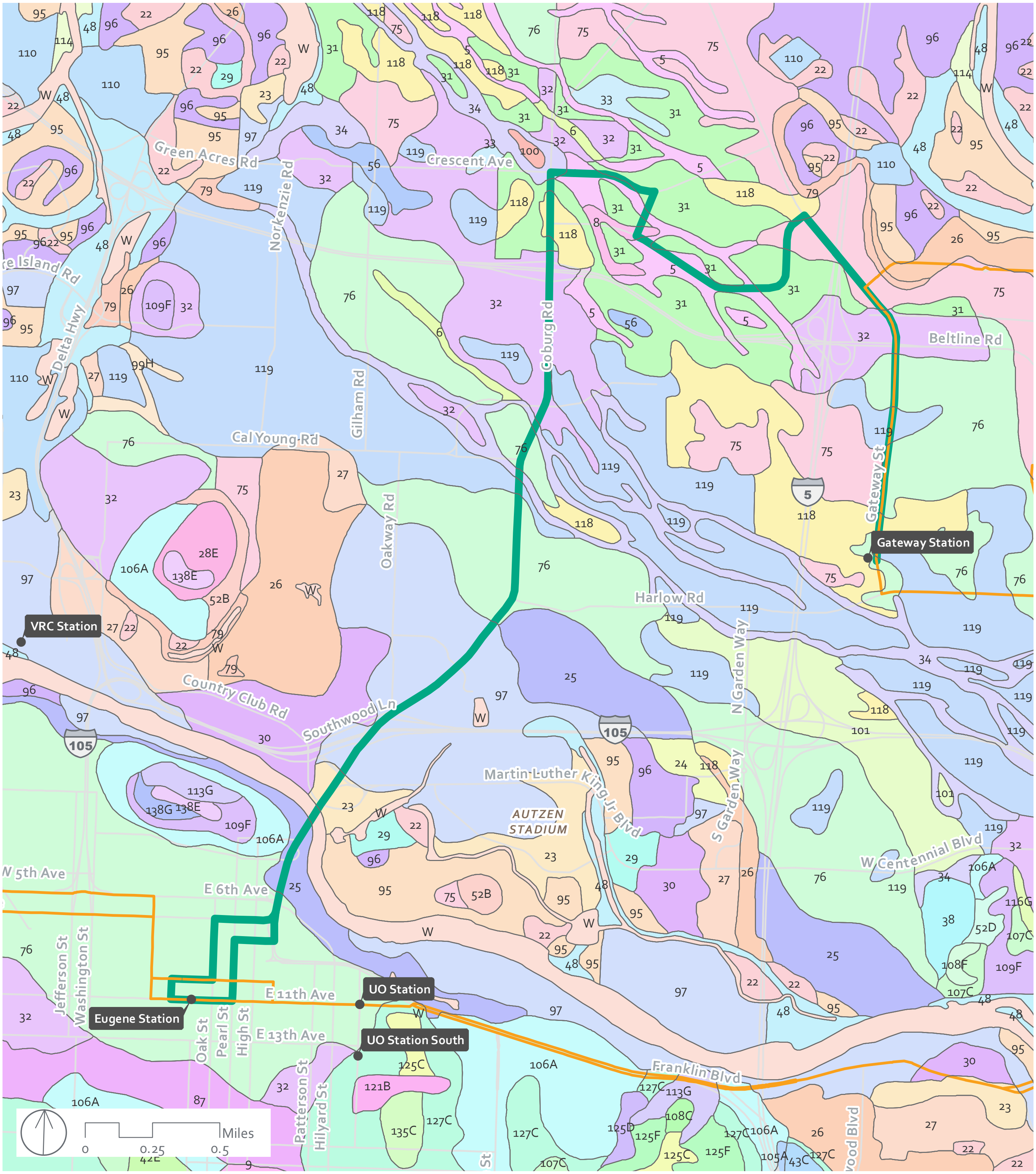

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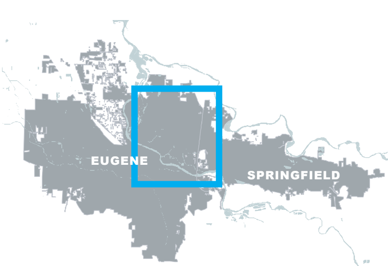
Note: Refer to NRCS Soils Legend figure for description of each soil unit



NRCS Soil Survey Map

Coburg Road Corridor Enhanced Corridor Alternative

Figure C-9

MovingAhead
STREETS AND PLACES REIMAGINED

Data Sources: City of Eugene, Lane Transit District, United State Department of Agriculture, Natural Resources Conservation Services

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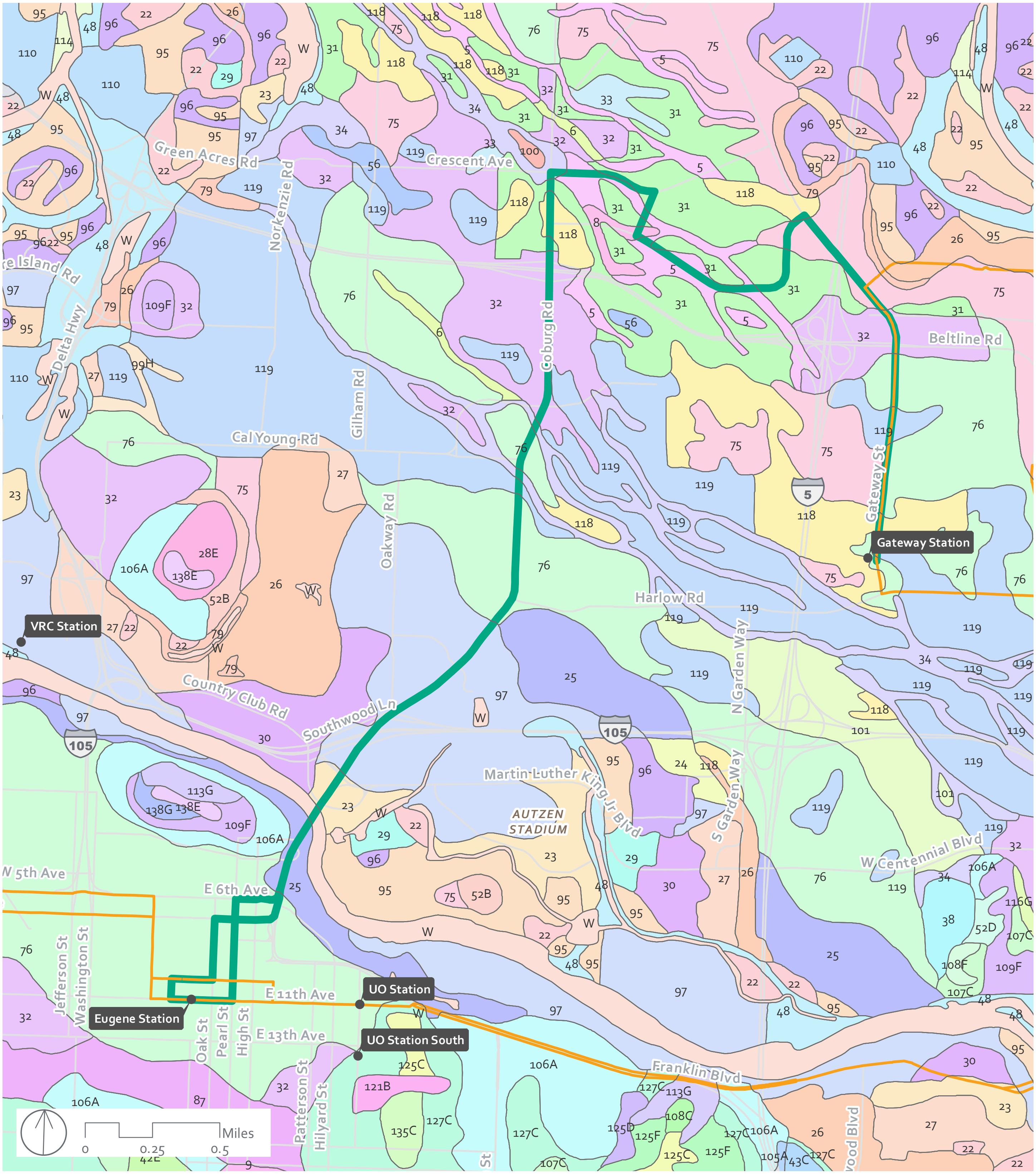
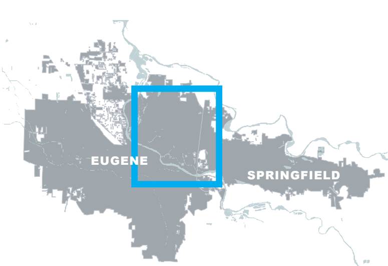


Legend

- 30th Avenue to Lane Community College Corridor
- Coburg Road Corridor
- Highway 99 Corridor
- River Road Corridor
- 2035 No-Build EmX

Note: Refer to NRCS Soils Legend figure for description of each soil unit



NRCS Soil Survey Map

Coburg Road Corridor EmX Alternative

Figure C-10

MovingAhead
STREETS AND PLACES REIMAGINED

Data Sources: City of Eugene, Lane Transit District, United State Department of Agriculture, Natural Resources Conservation Services

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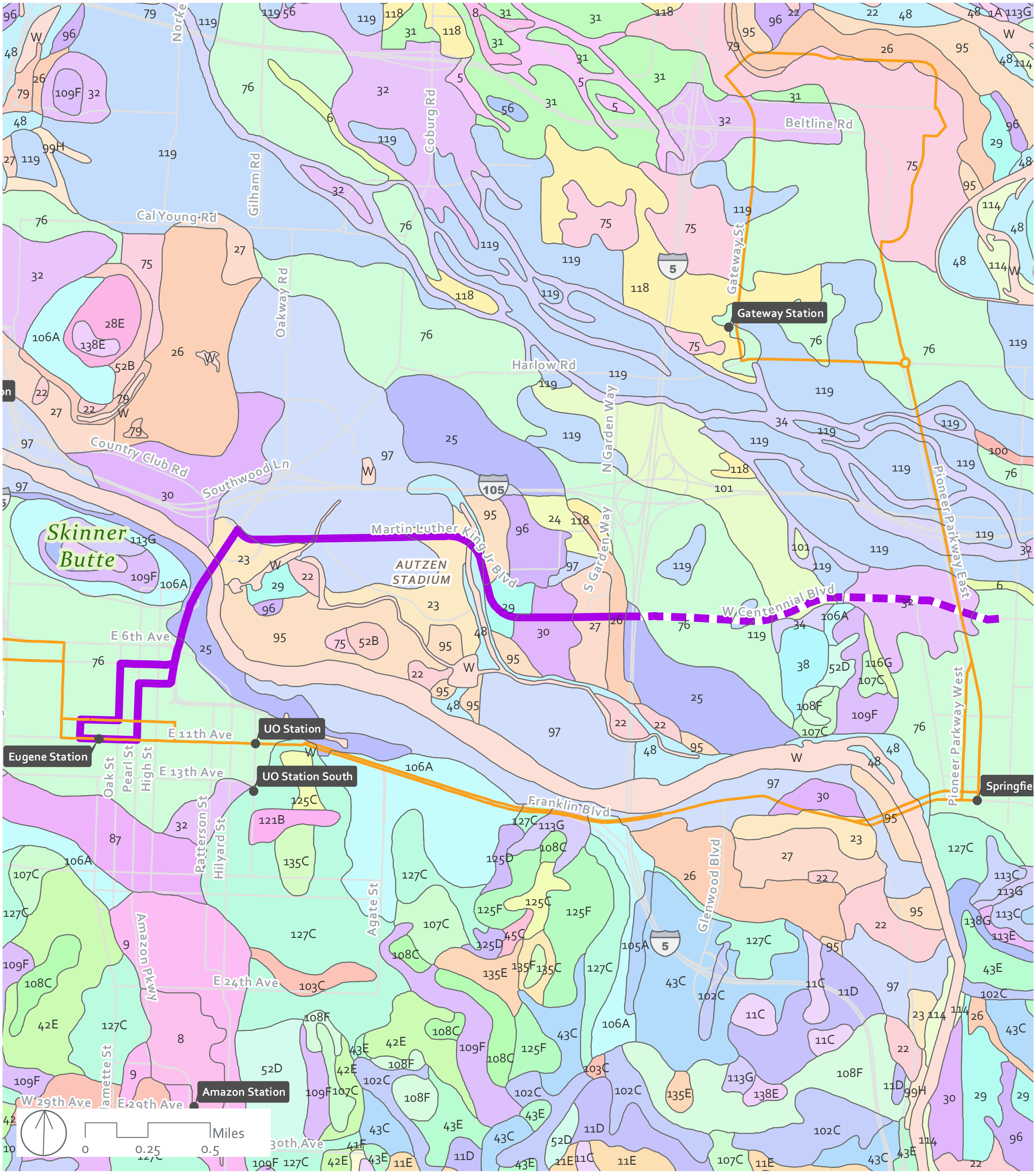

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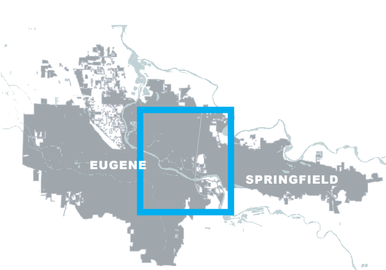

- 30th Avenue to Lane Community College Corridor
- Coburg Road Corridor
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- River Road Corridor
- Martin Luther King Jr Blvd Corridor
- Martin Luther King, Jr Blvd Corridor continues east of I-5 as existing route #13
- 2035 No-Build EmX

Note: Refer to NRCS Soils Legend figure for description of each soil unit

NRCS Soil Survey Map

Martin Luther King, Jr. Boulevard Corridor Enhanced Corridor Alternative

Figure C-11

MovingAhead
STREETS AND PLACES REIMAGINED

Data Sources: City of Eugene, Lane Transit District, United State Department of Agriculture, Natural Resources Conservation Services

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NRCS Soil Unit Data

- 100 - Oxley gravelly silt loam
- 101 - Oxley-Urban land complex
- 102C - Panther silty clay loam, 2 to 12 percent slopes
- 103C - Panther-Urban land complex, 2 to 12 percent slopes
- 105A - Pengra silt loam, 1 to 4 percent slopes
- 106A - Pengra-Urban land complex, 1 to 4 percent slopes
- 107C - Philomath silty clay, 3 to 12 percent slopes
- 108C - Philomath cobbly silty clay, 3 to 12 percent slopes
- 108F - Philomath cobbly silty clay, 12 to 45 percent slopes
- 109F - Philomath-Urban land complex, 12 to 45 percent slopes
- 110 - Pits
- 113C - Ritner cobbly silty clay loam, 2 to 12 percent slopes
- 113E - Ritner cobbly silty clay loam, 12 to 30 percent slopes
- 113G - Ritner cobbly silty clay loam, 30 to 60 percent slopes
- 114 - Riverwash
- 116G - Rock outcrop-Witzel complex, 10 to 70 percent slopes
- 118 - Salem gravelly silt loam
- 119 - Salem-Urban land complex
- 11C - Bellpine silty clay loam, 3 to 12 percent slopes
- 11D - Bellpine silty clay loam, 12 to 20 percent slopes
- 11E - Bellpine silty clay loam, 20 to 30 percent slopes
- 11F - Bellpine silty clay loam, 30 to 50 percent slopes
- 121B - Salkum silty clay loam, 2 to 8 percent slopes
- 125C - Steiwer loam, 3 to 12 percent slopes
- 125D - Steiwer loam, 12 to 20 percent slopes
- 125F - Steiwer loam, 20 to 50 percent slopes
- 127C - Urban land-Hazelair-Dixonville complex, 3 to 12 percent slopes
- 130 - Waldo silty clay loam
- 135C - Willakenzie clay loam, 2 to 12 percent slopes
- 135D - Willakenzie clay loam, 12 to 20 percent slopes
- 135E - Willakenzie clay loam, 20 to 30 percent slopes
- 135F - Willakenzie clay loam, 30 to 50 percent slopes
- 138E - Witzel very cobbly loam, 3 to 30 percent slopes
- 138G - Witzel very cobbly loam, 30 to 75 percent slopes
- 1A - Abiqua silty clay loam, 0 to 3 percent slopes
- 22 - Camas gravelly sandy loam, occasionally flooded
- 23 - Camas-Urban land complex
- 24 - Chapman loam
- 25 - Chapman-Urban land complex
- 26 - Chehalis silty clay loam, occasionally flooded
- 27 - Chehalis-Urban land complex
- 28C - Chehulpum silt loam, 3 to 12 percent slopes
- 28E - Chehulpum silt loam, 12 to 40 percent slopes
- 29 - Cloquato silt loam
- 30 - Cloquato-Urban land complex
- 31 - Coburg silty clay loam
- 32 - Coburg-Urban land complex
- 33 - Conser silty clay loam
- 34 - Courtney gravelly silty clay loam
- 38 - Dayton silt loam, clay substratum
- 41C - Dixonville silty clay loam, 3 to 12 percent slopes
- 41E - Dixonville silty clay loam, 12 to 30 percent slopes
- 41F - Dixonville silty clay loam, 30 to 50 percent slopes
- 42E - Dixonville-Hazelair-Urban land complex, 12 to 35 percent slopes
- 43C - Dixonville-Philomath-Hazelair complex, 3 to 12 percent slopes
- 43E - Dixonville-Philomath-Hazelair complex, 12 to 35 percent slopes
- 45C - Dupee silt loam, 3 to 20 percent slopes
- 48 - Fluvents, nearly level
- 5 - Awbrig silty clay loam
- 52B - Hazelair silty clay loam, 2 to 7 percent slopes
- 52D - Hazelair silty clay loam, 7 to 20 percent slopes
- 56 - Holcomb silty clay loam
- 6 - Awbrig-Urban land complex
- 63C - Jory silty clay loam, 2 to 12 percent slopes
- 75 - Malabon silty clay loam
- 76 - Malabon-Urban land complex
- 78 - McAlpin silty clay loam
- 79 - McBee silty clay loam
- 8 - Bashaw clay
- 81D - McDuff clay loam, 3 to 25 percent slopes
- 85 - Natroy silty clay loam
- 87 - Natroy-Urban land complex
- 89C - Nekia silty clay loam, 2 to 12 percent slopes
- 89D - Nekia silty clay loam, 12 to 20 percent slopes
- 9 - Bashaw-Urban land complex
- 95 - Newberg fine sandy loam
- 96 - Newberg loam
- 97 - Newberg-Urban land complex
- 99H - Ochrepts and Umbrepts, very steep
- W - Water

Legend for NRCS Soil Survey Maps

Enhanced Corridor and EmX Alternatives

Figure C-12

Data Sources: City of Eugene, Lane Transit District, United State Department of Agriculture, Natural Resources Conservation Services

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MovingAhead
STREETS AND PLACES REIMAGINED

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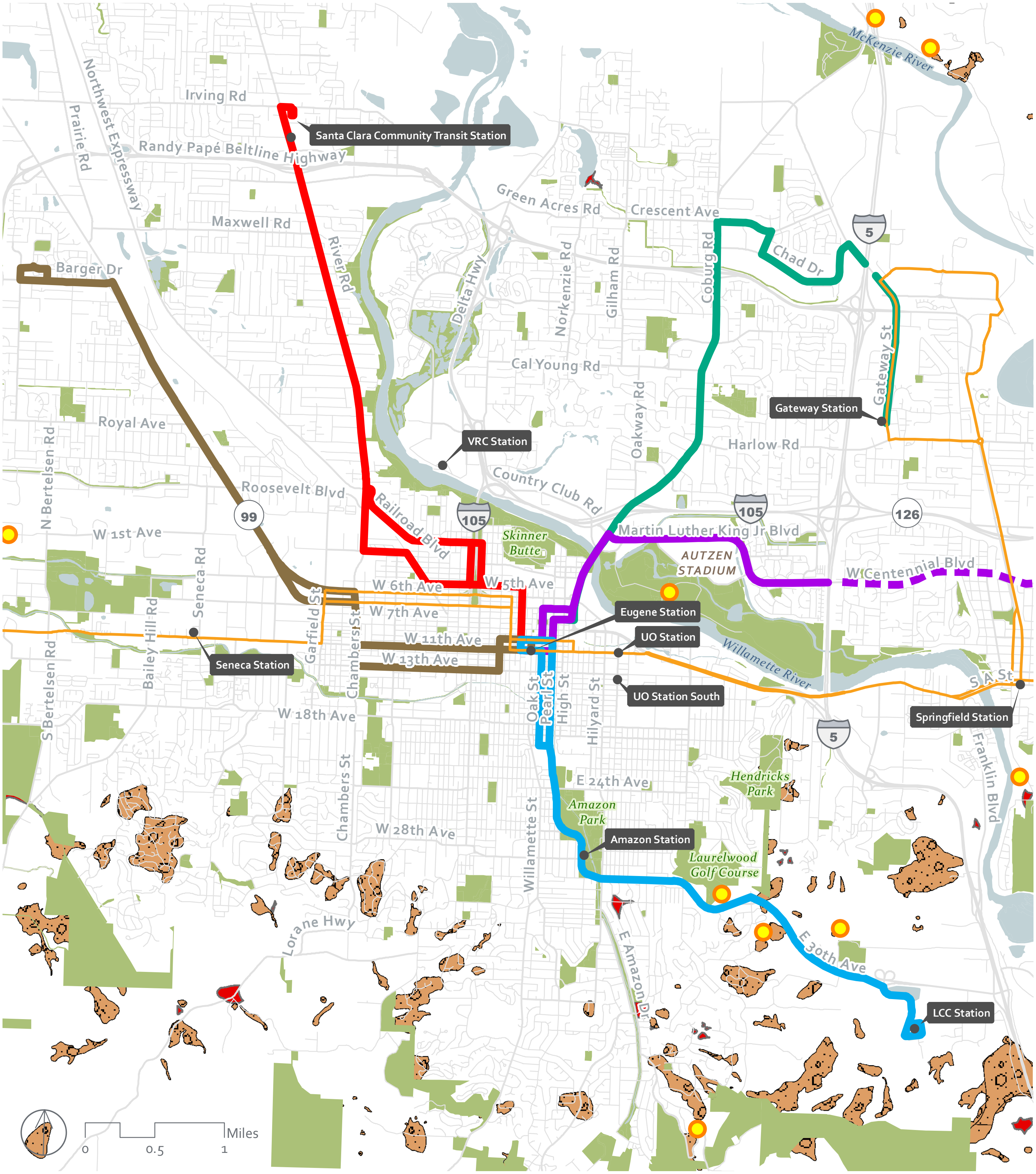

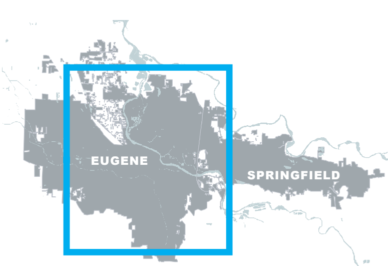

Legend

- 30th Avenue to Lane Community College Corridor
- Coburg Road Corridor
- Highway 99 Corridor
- River Road Corridor
- Martin Luther King Jr Blvd Corridor
- Martin Luther King, Jr Blvd Corridor continues east of I-5 as existing route #13
- 2035 No-Build EmX
- Water
- Park
- Historic Landslide

Mapped Deposits

- Fan
- Landslide

Historic Landslides Data Inventory

Enhanced Corridor Alternatives

Figure C-13

MovingAhead
STREETS AND PLACES REIMAGINED

Data Resources: City of Eugene, Lane Transit District, Oregon Department of Geology and Mineral Industries (DOGAMI), Open-File Report O-16-02, Landslide Susceptibility Overview Map of Oregon, by William J. Burns, Katherine A. Mickelson, and Ian P. Madin

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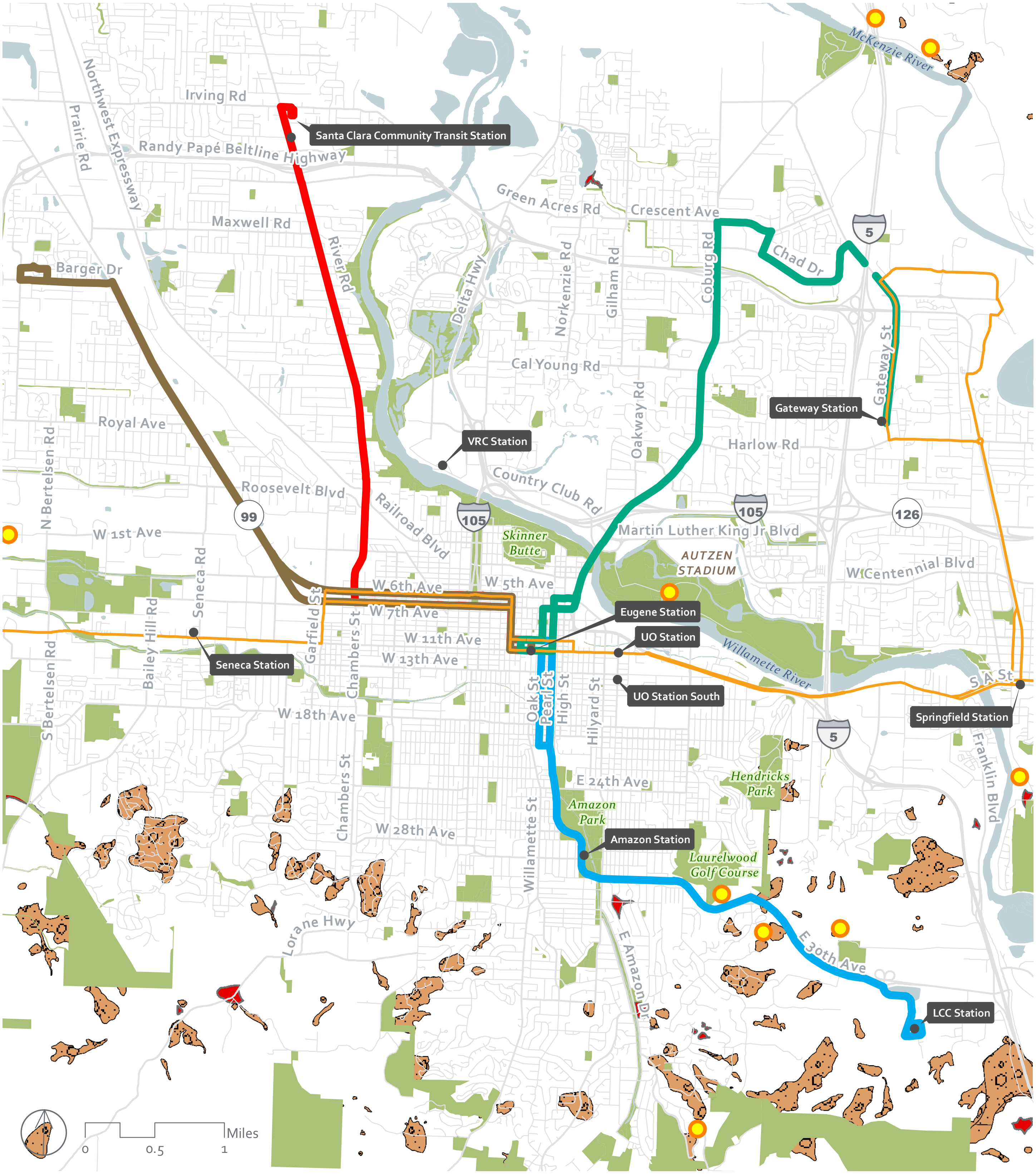

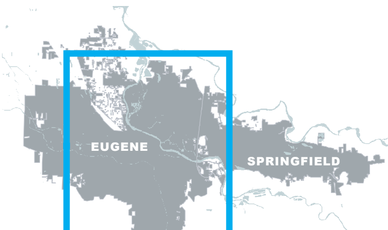

Legend

- 30th Avenue to Lane Community College Corridor
- Coburg Road Corridor
- Highway 99 Corridor
- River Road Corridor
- 2035 No-Build EmX
- Water
- Park
- Historic Landslide

Mapped Deposits

- Fan
- Landslide

Historic Landslides Data Inventory

EmX Alternatives

Figure C-14

MovingAhead
STREETS AND PLACES REIMAGINED

Data Resources: City of Eugene, Lane Transit District, Oregon Department of Geology and Mineral Industries (DOGAMI), Open-File Report O-16-02, Landslide Susceptibility Overview Map of Oregon, by William J. Burns, Katherine A. Mickelson, and Ian P. Madin

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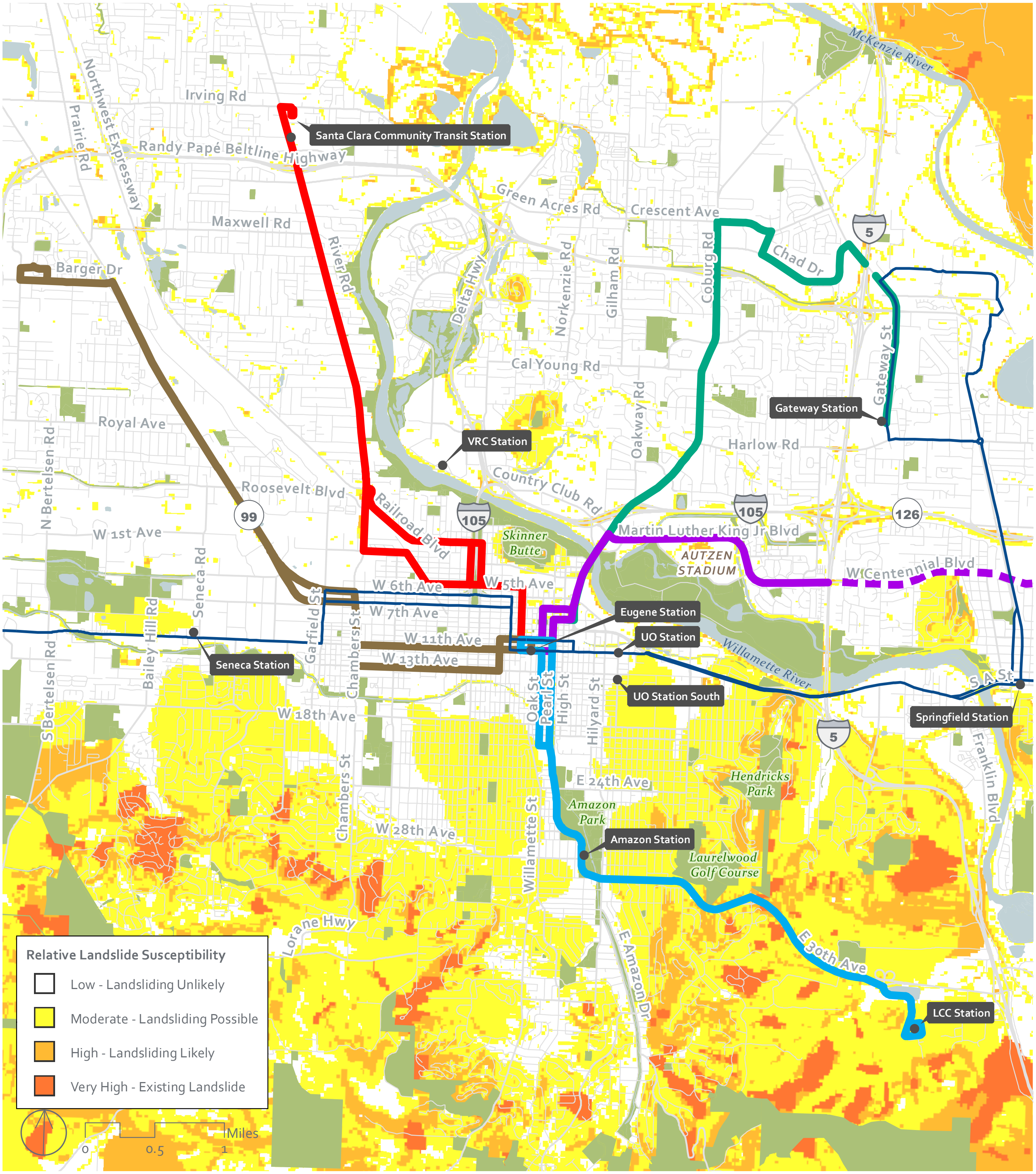

Legend

- 30th Avenue to Lane Community College Corridor
- Coburg Road Corridor
- Highway 99 Corridor
- River Road Corridor
- Martin Luther King Jr Blvd Corridor
- Martin Luther King, Jr Blvd Corridor continues east of I-5 as existing route #13
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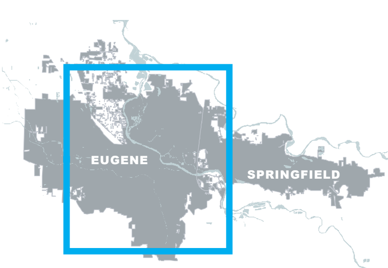
- Water
- Park



Landslide Susceptibility

Enhanced Corridor Alternatives

Figure C-15

MovingAhead
STREETS AND PLACES REIMAGINED

Data Resources: City of Eugene, Lane Transit District, Oregon Department of Geology and Mineral Industries (DOGAMI), Open-File Report O-16-02, Landslide susceptibility overview map of Oregon, by William J. Burns, Katherine A. Mickelson, and Ian P. Madin.
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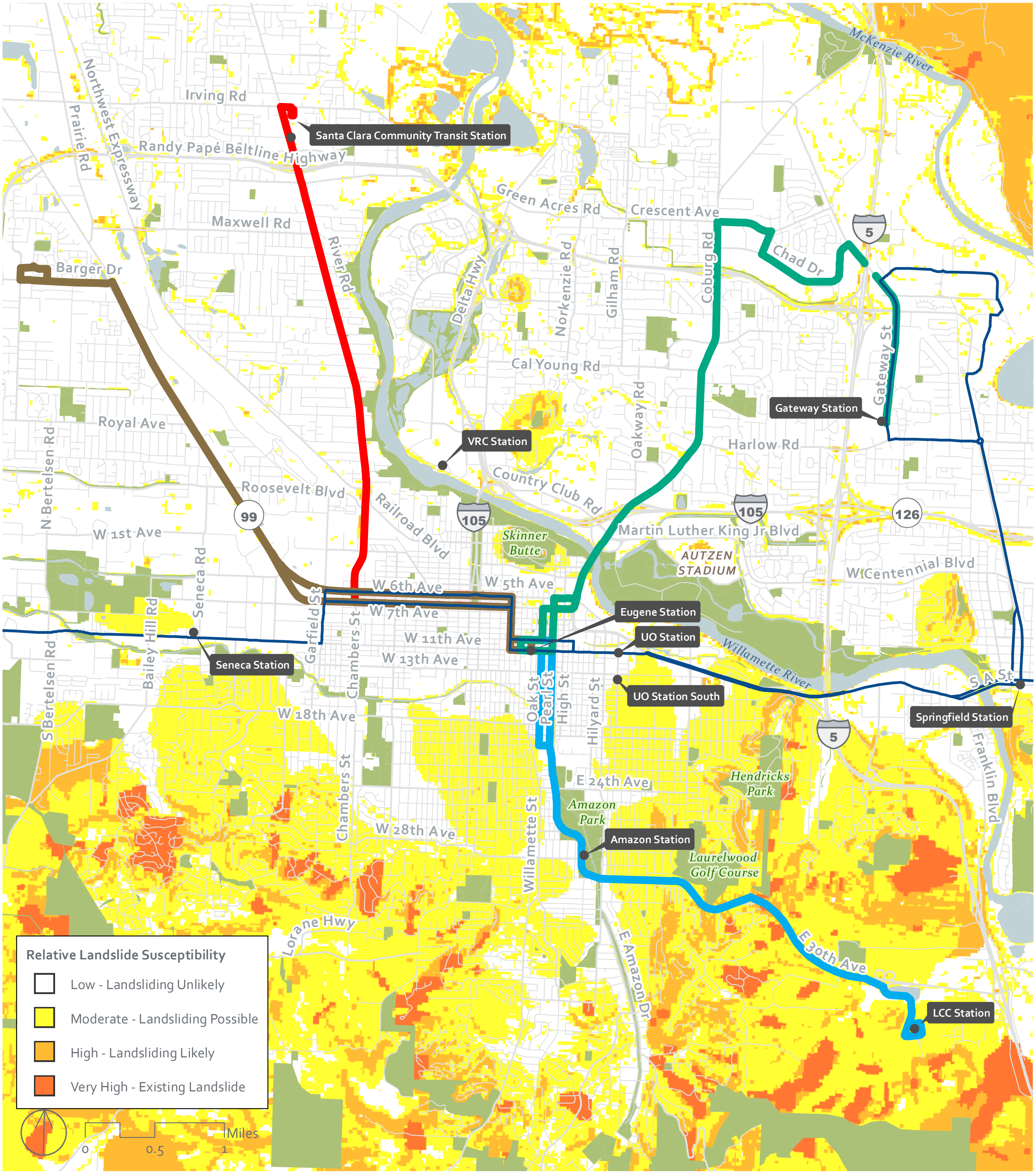

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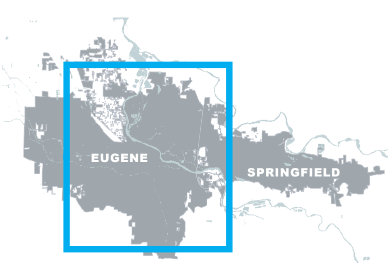

- 30th Avenue to Lane Community College Corridor
- Coburg Road Corridor
- Highway 99 Corridor
- River Road Corridor
- 2035 No-Build EmX
- Water
- Park

Landslide Susceptibility

EmX Alternatives

Figure C-16

MovingAhead
STREETS AND PLACES REIMAGINED

Data Resources: City of Eugene, Lane Transit District, Oregon Department of Geology and Mineral Industries (DOGAMI), Open-File Report O-16-02, Landslide susceptibility overview map of Oregon, by William J. Burns, Katherine A. Mickelson, and Ian P. Madin.

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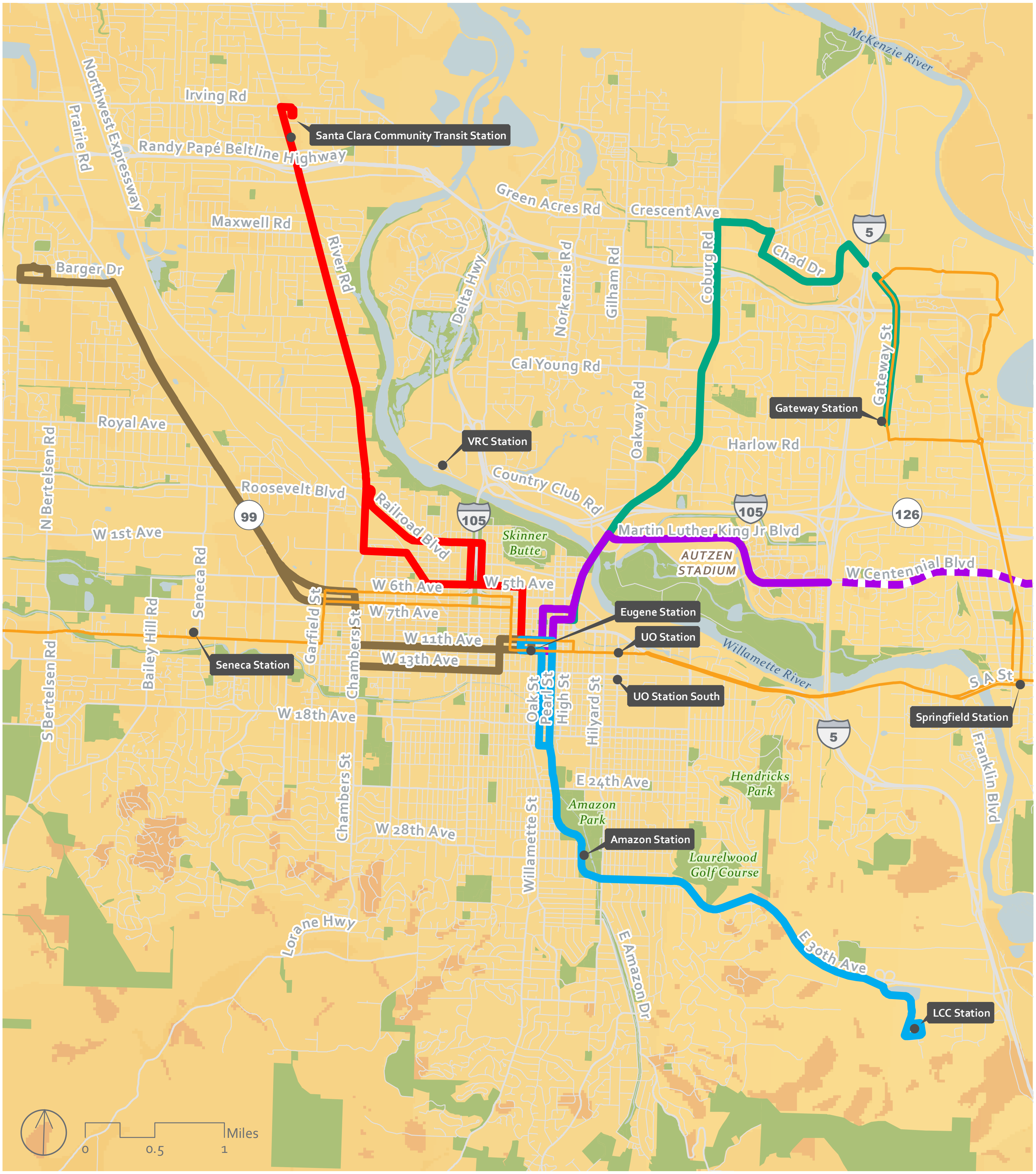

Legend

- 30th Avenue to Lane Community College Corridor
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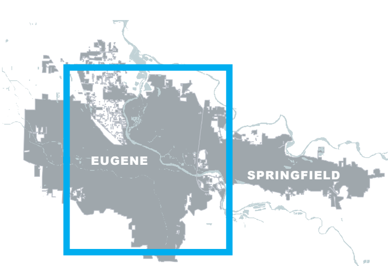
- Martin Luther King, Jr Blvd Corridor continues east of I-5 as existing route #13
- 2035 No-Build EmX
- Water
- Park

Peak Ground Acceleration

Severe

Low

No Known Active Faults Mapped within Approximately 26 miles of Project Area.



Earthquake Hazards

Enhanced Corridor Alternatives

Figure C-17

MovingAhead
STREETS AND PLACES REIMAGINED

Data Sources: City of Eugene, Lane Transit District, Oregon Department of Geology and Mineral Industries
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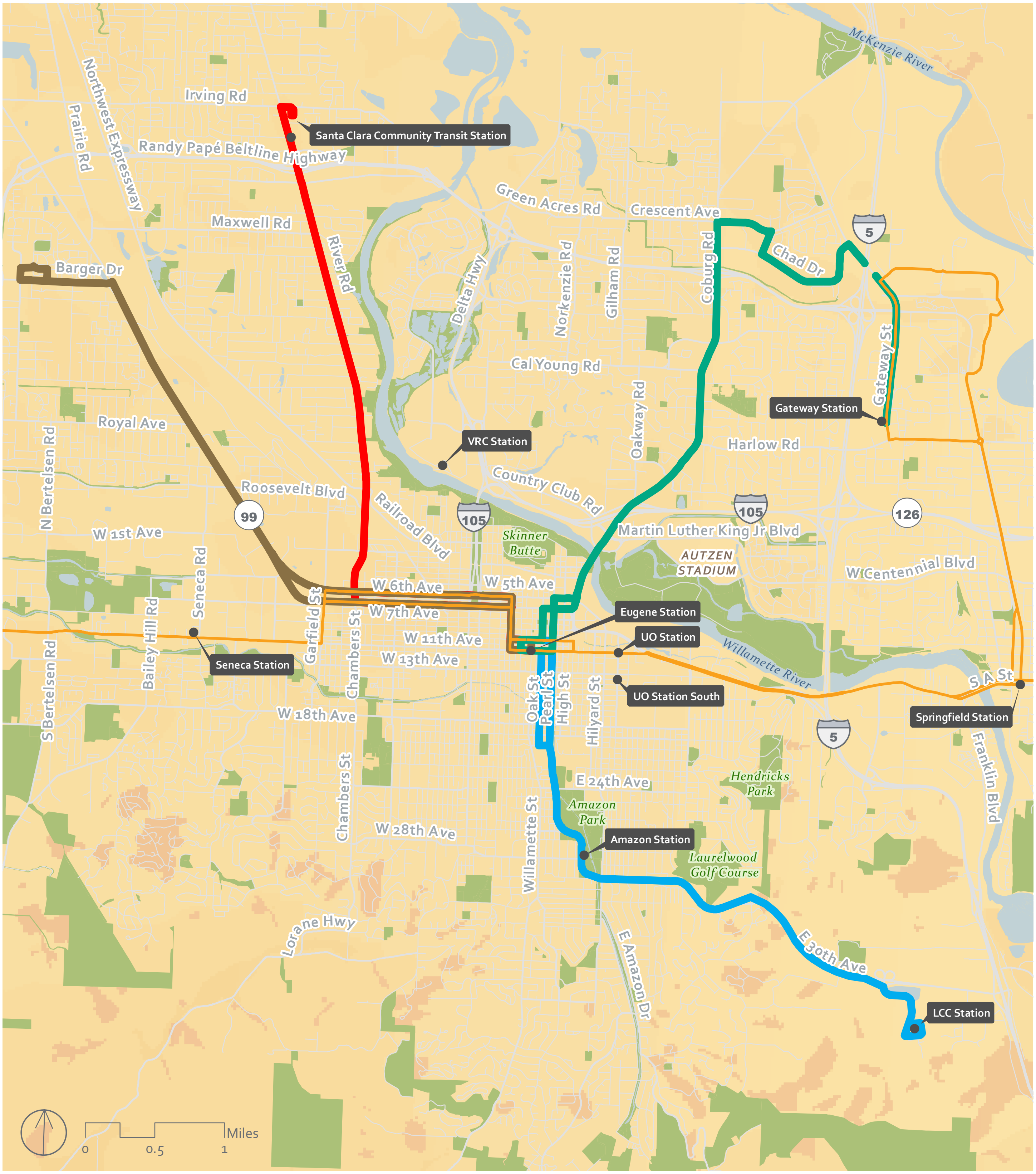

Legend

- 30th Avenue to Lane Community College Corridor
- Coburg Road Corridor
- Highway 99 Corridor
- River Road Corridor
- 2035 No-Build EmX
- Water
- Park

Peak Ground Acceleration
Severe
Low

No Known Active Faults Mapped within Approximately 26 miles of Project Area.

Earthquake Hazards
EmX Alternatives

Figure C-18

MovingAhead
STREETS AND PLACES REIMAGINED

Data Sources: City of Eugene, Lane Transit District, Oregon Department of Geology and Mineral Industries
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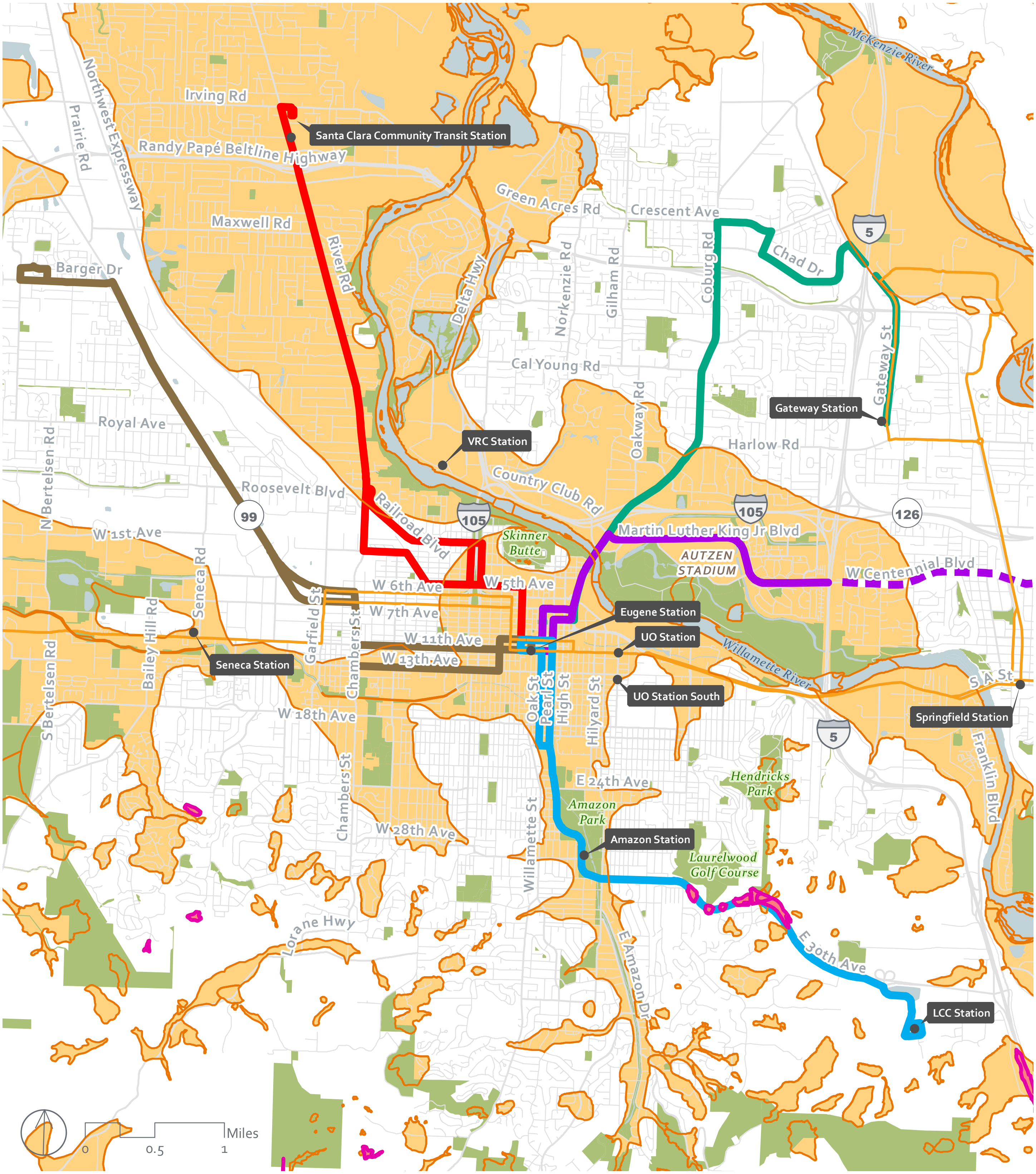

Legend

- 30th Avenue to Lane Community College Corridor
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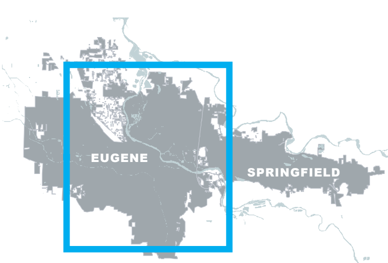
- 2035 No-Build EmX
- Water
- Park

Liquefaction Susceptibility

- Moderate
- High

No Known Active Faults Mapped within Approximately 26 miles of Project Area.



Liquefaction Susceptibility

Enhanced Corridor Alternatives

Figure C-19

MovingAhead
STREETS AND PLACES REIMAGINED

Data Sources: City of Eugene, Lane Transit District, Oregon Department of Geology and Mineral Industries
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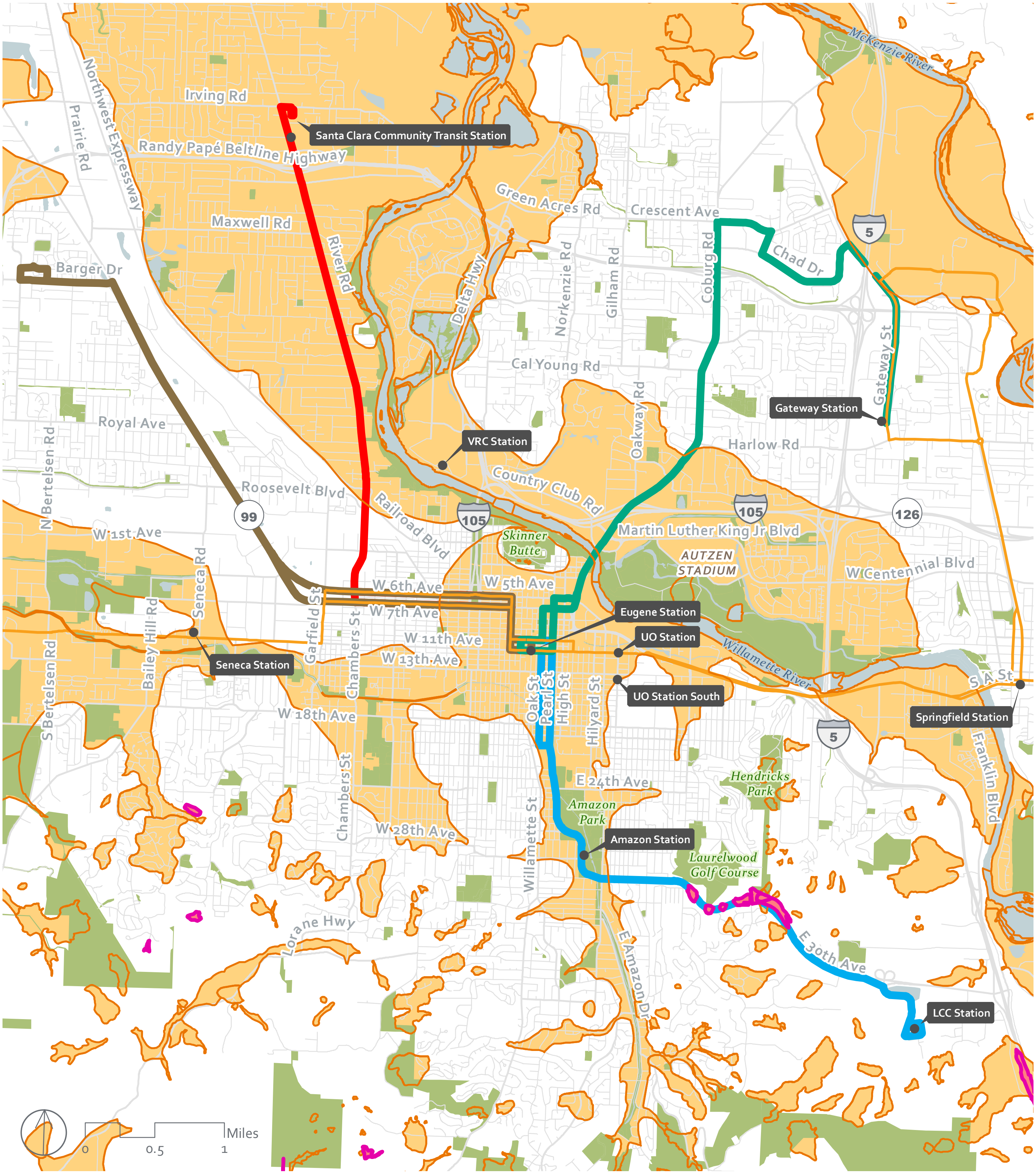

Legend

- 30th Avenue to Lane Community College Corridor
- Coburg Road Corridor
- Highway 99 Corridor
- River Road Corridor
- 2035 No-Build EmX
- Water
- Park

Liquefaction Susceptibility

- Moderate
- High

No Known Active Faults Mapped within Approximately 26 miles of Project Area.

Liquefaction Susceptibility

EmX Alternatives

Figure C-20

MovingAhead
STREETS AND PLACES REIMAGINED

Data Sources: City of Eugene, Lane Transit District, Oregon Department of Geology and Mineral Industries

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