MovingAhead

STREETS AND PLACES REIMAGINED

DRAFT FINAL Energy and Sustainability 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 Energy and Sustainability 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
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Acronyms, Abbreviations, and Terms

Acronyms and Abbreviations	Definitions
AA	Alternatives Analysis
AASHTO	American Association of State Highway and Transportation Officials
ATR	Automated Traffic Recording
BAT	Business Access and Transit
BPA	Bonneville Power Administration
BRT	Bus Rapid Transit
Btu	British thermal unit
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DKS	DKS Associates
Draft Eugene 2035 TSP	*DRAFT Eugene 2035 Transportation System Plan* (City of Eugene, 2016)
EC	Enhanced Corridor
EmX	Emerald Express, Lane Transit District's Bus Rapid Transit System
EPA	U. S. Environmental Protection Agency
EV	electric vehicle
EWEB	Eugene Water & Electric Board
FTA	Federal Transit Administration
FTN	Frequent Transit Network
GHG	greenhouse gas
I-5	Interstate 5
LCC	Lane Community College
LCOG	Lane Council of Governments
LOS	Level of Service
mpg	miles per gallon
MPO	Metropolitan Planning Organization
n.d.	no date
NEPA	National Environmental Policy Act
OAR	Oregon Administrative Rule
OHP	Oregon Highway Plan
RTP	Central Lane Metropolitan Planning Organization Regional Transportation Plan (adopted November 2007). (The RTP includes the Financially Constrained Roadway Projects List)
SUB	Springfield Utility Board
TDM	Transportation Demand Management
VMT	Vehicle Miles Traveled
WEEE	West Eugene EmX Extension

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."
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	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.
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.
Business Access and Transit Lane (BAT)	In general, a BAT lane is a concrete lane, separated from general-purpose lanes by a paint stripe and signage. A BAT lane provides 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.
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 Rapid Transit (BRT)	A transit mode that combines the quality of rail transit and the flexibility of buses. It can operate on bus lanes, HOV lanes, expressways, or ordinary streets. The vehicles are designed to allow rapid passenger loading and unloading, with more doors than ordinary buses.
Capital Improvements Program	A Capital Improvement Plan or Program (CIP) is a short-range plan, usually four 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	A Categorical Exclusion (CE) means a category of actions which 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.

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.
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.
Documented Categorical Exclusion (DCE)	A Documented Categorical Exclusion (DCE) means a group of actions that may also qualify as 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 Documented Categorical Exclusions. Such actions require some NEPA 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.
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).
EmX	Lane Transit District's Bus Rapid Transit System, pronounced "MX," short for Emerald Express.
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.
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; statements are required by the National Environmental Policy Act (NEPA).
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.

Terms	Definitions
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 probably of meeting the community's needs (e.g., environmentally acceptable, economically efficient, implementable).
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.
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.
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).
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
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)	Level of service (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.
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.

Terms	Definitions
Locally Preferred Alternative (LPA)	The Locally Preferred Alternative is the alternative selected through the Alternatives Analysis process completed prior to or concurrent with NEPA analysis. This term is also used to describe the proposed action that is being considered for New Starts or Small Starts funds.
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.
Mitigation	A means to avoid, minimize, rectify, or reduce an impact, and in some cases, to compensate for an impact.
Mode	A particular form or method of travel distinguished by vehicle type, operation technology and right of way separation from other traffic.
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.
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.
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 (EIS) 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 (NEPA) action. The No-Build alternative consists of the existing conditions, plus any improvements which have been identified in the Statewide Transportation Improvement Program (STIP).
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.

Terms	Definitions
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.
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.
Ridership	The number of rides taken by people using a public transportation system in a given time period.
Right of Way	Publicly owned land that can be acquired and used for transportation purposes.
Strategy	An intended action or series of actions which when implemented achieves the stated goal.
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.
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.
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.
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.

Energy and Sustainability Summary

This Energy and Sustainability Technical Report presents the results of analyses conducted for the Lane Transit District (LTD) and 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 are ready to advance to capital improvements programming in the near term. LTD and the City of Eugene 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 of Eugene. A main theme of the City's vision is to concentrate new growth along and near the City's key transit corridors and in 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. The Energy and Sustainability analysis uses energy and greenhouse gas (GHG) emissions as a framework for evaluating the sustainability of the various alternatives under study. Additionally, the sustainability analysis qualitatively evaluates the alignment of the proposed alternatives with the sustainability policies of the City of Eugene and LTD.

The City of Eugene and LTD examined multimodal transit alternatives in five key transit corridors identified in the *Draft Envision Eugene Comprehensive Plan* (Envision Eugene, 2016) 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 corridor location is shown on Figure S.1-1. The *Level 2 Definition of Alternatives* (CH2M et al., 2016) contains a detailed description of the project alternatives. The following items summarize the project alternatives evaluated.

- The **No-Build Alternative** serves as a reference point to gauge the benefits, costs, and effects of the Enhanced Corridor and EmX Alternatives in each corridor. The 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, the *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.

- **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. EmX service is intended to improve transit speed, reliability, and ridership.

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 technical report focuses on estimating the variations in the type and amount of energy that would be consumed to build and operate the Enhanced Corridor and EmX Alternatives as compared to the No-Build Alternative. The report provides information on the methods used for the analysis and identifies the potential significant adverse and beneficial effects of each project alternative on direct energy consumption (systemwide British thermal units (Btu) consumed and greenhouse gas (GHG) emissions for automobiles, trucks, and buses on an average weekday), indirect impacts (Btu consumed and GHG emissions associated with vehicle repair and maintenance), and short-term, construction-related impacts (Btu consumed and GHG emissions associated with construction of the project). This information was useful in determining if shifts in transportation system energy usage would occur and how energy used for the alternatives would affect regional energy supply and demand.

The energy impact analysis addressed several main issues, including:

- The existing use and demand for energy resources in the region
- The current energy use for transportation
- The available and forecast supply of energy
- Projected energy consumption for operation of the study alternatives
- Projected energy consumption for vehicle maintenance resulting from miles traveled for each of the study alternatives
- Projected energy consumption during construction of the study alternatives
- Measures to reduce energy consumption for operation and during construction of the study alternatives

This report also addressed the alternatives' ability to support the City of Eugene's and LTD's sustainability policies, particularly the reduction in energy used and GHGs generated to operate the transit system and ability of the transit district to attract riders to transit services and away from single occupant vehicles (i.e., a reduction in regional vehicle miles traveled), which in general would lead to reduced energy use and GHG emissions.

This report provided a summary of the existing energy usage in the Eugene area including the type, source, and utilization rates for various energy sources. In particular, the discussion of current energy use focuses on electrical and fossil fuel use and the demand for these resources. This report characterized existing energy consumption by various transportation types, including the existing transit system and related facilities such as park and ride lots and maintenance facilities.

Figure S.1-1. Enhanced Corridor Alternatives Overview

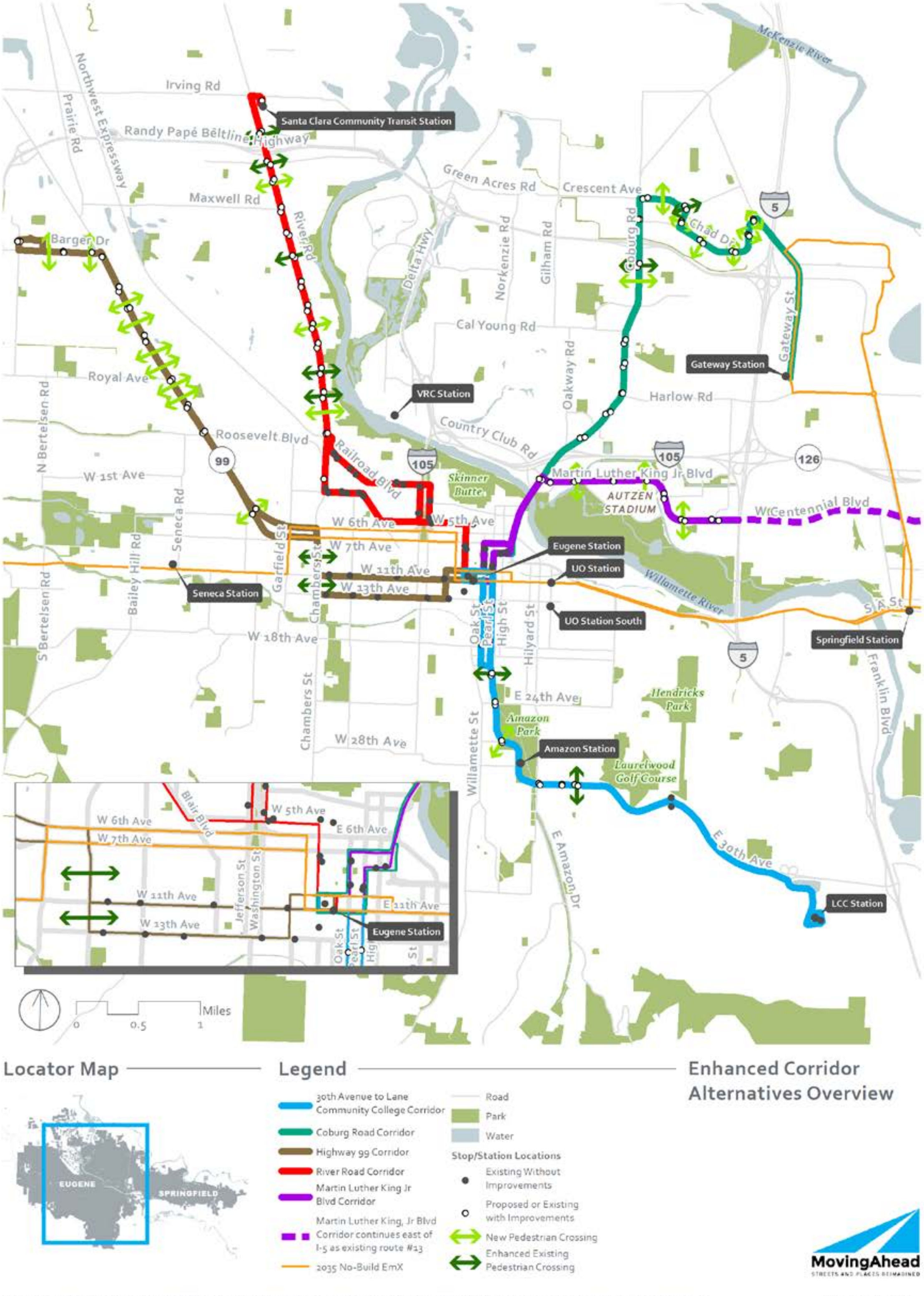
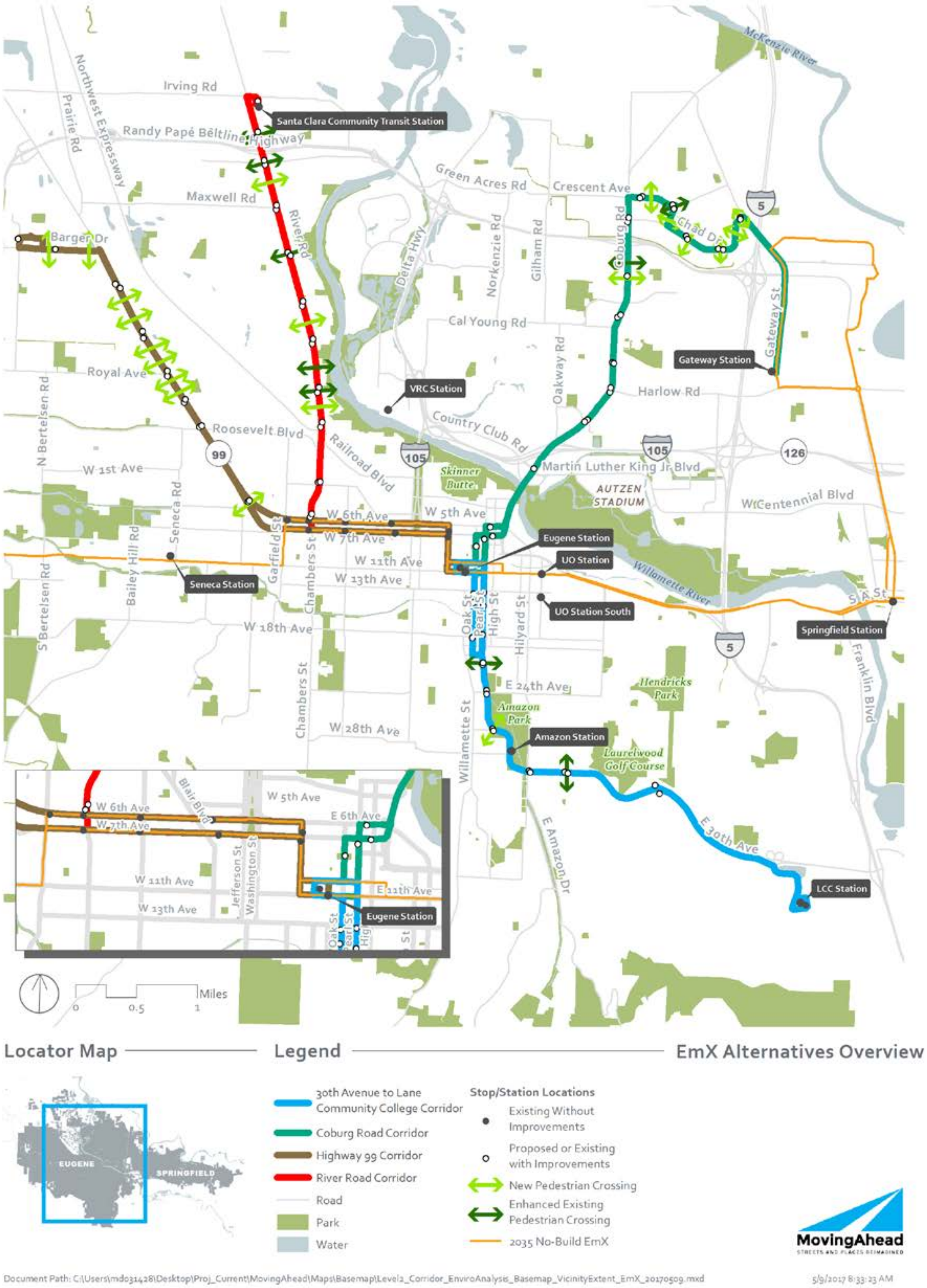


Figure S.1-2. EmX Alternatives Overview



The estimated direct and indirect impact on energy consumption and project alternatives as well as identifying sustainable transportation factors were the main focus of this analysis. For the energy consumption analysis, Btu and GHG emissions were calculated for each alternative based on projected changes in automobile, truck, and bus vehicle miles traveled (VMT). Energy used by LTD, outside of direct and indirect energy related to bus VMT (such as energy consumed at Glenwood Headquarters) was not assessed in this report. Cumulative effects of the alternatives were addressed by qualitatively assessing their impacts in the context of the forecast energy supply and consumption at a regional level. Mitigation measures to conserve energy during construction and operation of the study alternatives were also considered in this analysis.

This report was prepared in compliance with the National Environmental Policy Act (NEPA) and applicable state environmental policy legislation, as well as local and state planning and land use policies and design standards.

S.1. Affected Environment

The project's five corridors are primarily located within the City of Eugene, with a portion of the River Road and 30th Avenue to Lane Community College (LCC) Corridor located within unincorporated Lane County, and a portion of the Coburg Road Corridor located in the City of Springfield. The sustainability analysis qualitatively addresses LTD's Long-Range Transit Plan, adopted in March 2014, and the City of Eugene's Sustainability Policy, adopted November 13, 2006. These policies demonstrate the City's and LTD's commitment to advancing the social, economic and environmental sustainability of the Eugene-Springfield metropolitan area.

The City of Eugene has committed to pursue the following actions:

- All city-owned facilities and city operations shall be carbon neutral by 2020, either by reducing GHGs to zero, funding local GHG reduction projects and programs, or purchasing verifiable carbon offsets.
- By 2030, the City organization shall reduce its use of fossil fuels by 50 percent compared to 2010 usage.
- By 2030, all businesses and individuals working or living in Eugene shall collectively reduce the total use of fossil fuels by 50 percent compared to 2010 usage.
- By 2100, total community GHG shall be reduced to Eugene's average share of a global atmospheric GHG level of 350 parts per million.

The benchmarks set to meet these goals are to decrease GHGs from city operations by 15 percent each year and to reduce GHGs from fossil fuel use by 2.5 percent each year.

Lane Transit District has developed policies to advance the social, economic and environmental sustainability of the Eugene-Springfield metropolitan area. In the policy, LTD commits to pursue action in the following six areas:

- Improve connectivity throughout LTD service area
- Ensure equitable and accessible transit service
- Maintain and enhance safety and security
- Use resources sustainably in adapting to future conditions
- Engage the regional community in short-term and long-term planning
- Sustain and enhance prosperity through investment in transit service and infrastructure.

LTD's headquarters is in Glenwood, an unincorporated part of Lane County situated between Eugene and Springfield. While the postal address of Glenwood is considered Eugene, it is within the City of

Springfield's annexation and is served by the Springfield Utility Board (SUB) for its electricity needs. Most of the stops and stations for the corridors included in this project are powered by the Eugene Water & Electric Board (EWEB). The Bonneville Power Administration (BPA) is the largest energy supplier to both EWEB and SUB, which are publicly owned municipal utilities. (EWEB, 2012 and *Where Power Comes From* [SUB, 2015]). The BPA's fuel mix in 2015 consisted of 83.6% large hydroelectric, 9.9% nuclear, 4.8% non-specified, 0.9% small hydroelectric, 0.6% wind, 0.1% biomass and waste, and 0.1% natural gas (SUB, 2015). EWEB and SUB electricity rates are low compared with the U.S. average, which is typical for the Northwest region.

For petroleum, approximately 80 percent of Oregon's crude oil originates from Alaska, and is refined in Washington State (U.S. Energy Information Administration, 2016). Generally, over the past several decades, fuel efficiency in vehicles has increased, while fuel prices have been volatile, rising significantly in 2008 and again in 2012, and declining significantly in 2015 (U.S. Energy Information Administration, 2015). However, gasoline sales and vehicle miles traveled in the Central Lane County area have been steadily declining since 2003; in October 2015, fuel usage was about 92 percent of usage in October 2005 (Lane Council of Governments [LCOG], 2016, February).

Alternative fuels used for transportation include ethanol, biodiesel, compressed natural gas, renewable diesel, and electricity. The number of hybrid and electric vehicles has risen significantly since 2000, and is expected to continue growing. Oregon has installed fast electric vehicle (EV) charging stations along Interstate 5 and many scenic byways throughout the state in order to support this growth (U.S. Department of Energy, 2014).

S.2. Environmental Consequences

The construction of a frequent bus (used on Enhanced Corridor – or EC – Alternatives) or EmX system has both positive and negative effects on the transportation energy consumption. All build alternatives would consume energy due to construction and maintenance of the system. A positive effect is that people who formerly used a single-occupancy automobile as their primary means of transportation may shift to using transit. As a result of this capture of new riders, the average daily VMT by automobile should decline. This decline should result in less congestion on the roadways, thus reducing the direct energy demands of other vehicles as well. The reduction in VMT typically translates to a net energy benefit and reduction in GHG emissions. Additionally, the buses used in the EC Alternatives and the BRT vehicles used in the EmX Alternatives provide more efficient means of transportation as compared to passenger cars. Even as a bus or BRT vehicle consumes more energy than a passenger car, the average amount of energy utilized per passenger is usually less.

The EC and EmX Alternatives also have the potential to decrease the need for constructing more transportation infrastructure due to increasing congestion, as well as reducing energy consumption associated with the manufacture of new vehicles, as more travelers make a mode shift to transit. The build alternatives – EC with more frequent buses and EmX with frequent BRT vehicles – have the potential to increase road safety, increase the health of transit users, improve air quality, and increase community livability.

The long-term direct impacts of the proposed alternatives include changes to direct energy consumption. Energy measures include consumption, measured in Btu, and GHG emissions, measures in grams of carbon dioxide equivalent (CO_2e). Indirect energy effects involve ongoing vehicle maintenance and repair energy. Indirect energy is calculated by determining the energy equivalent of all of the material products and operations necessary to keep the transportation system operable. Construction energy effects involve the one-time, non-recoverable energy costs associated with construction of roadways and structures. It should be noted that the energy consumption associated with construction could be highly variable, depending on the source, manufacturing, and transport of materials.

The total long-term energy use (sum of direct impacts and maintenance energy) for the EC Alternatives is shown in Table S.2-1.

Table S.2-1. 2035 Total Long-Term Regionwide Energy Impacts, EC Alternatives

Corridor	Energy Type	No-Build Energy Use (Btu)	EC Alternative Energy Use (Btu)	Change from No-Build (Btu)	Percent Change from No-Build
Highway 99	**Direct Energy (Btu)**	49,352,300,000	49,352,700,000	400,000	0.001%
	CO_2e Equivalent Energy (Btu)	62,830,600,000	62,832,400,000	1,800,000	0.003%
	Maintenance Energy (Btu)	11,574,200,000	11,576,000,000	1,800,000	0.016%
	Total	**123,757,100,000**	**123,761,100,000**	**4,000,000**	**0.003%**
River Road	**Direct Energy (Btu)**	49,352,300,000	49,348,700,000	-3,600,000	-0.007%
	CO_2e Equivalent Energy (Btu)	62,830,600,000	62,826,600,000	-4,000,000	-0.006%
	Maintenance Energy (Btu)	11,574,200,000	11,573,900,000	-300,000	-0.003%
	Total	**123,757,100,000**	**123,749,200,000**	**-7,900,000**	**-0.006%**
30th Avenue	**Direct Energy (Btu)**	49,352,300,000	49,350,400,000	-1,900,000	-0.004%
	CO_2e Equivalent Energy (Btu)	62,830,600,000	62,829,600,000	-1,000,000	-0.002%
	Maintenance Energy (Btu)	11,574,200,000	11,575,200,000	1,000,000	0.009%
	Total	**123,757,100,000**	**123,755,200,000**	**-1,900,000**	**-0.002%**
Coburg Road	**Direct Energy (Btu)**	49,352,300,000	49,341,600,000	-10,700,000	-0.022%
	CO_2e Equivalent Energy (Btu)	62,830,600,000	62,816,100,000	-14,500,000	-0.023%
	Maintenance Energy (Btu)	11,574,200,000	11,570,800,000	-3,400,000	-0.029%
	Total	**123,757,100,000**	**123,728,500,000**	**-28,600,000**	**-0.023%**
Martin Luther King, Jr. Boulevard	**Direct Energy (Btu)**	49,352,300,000	49,353,800,000	1,500,000	0.003%
	CO_2e Equivalent Energy (Btu)	62,830,600,000	62,835,400,000	4,800,000	0.008%
	Maintenance Energy (Btu)	11,574,200,000	11,577,500,000	3,300,000	0.029%
	Total	**123,757,100,000**	**123,766,700,000**	**9,600,000**	**0.008%**

Source: DKS. (2016).

The total long-term energy use (sum of direct impacts and maintenance energy) for the EC Alternatives is shown in Table S.2-2.

Table S.2-2. 2035 Total Long-Term Regionwide Energy Impacts, EmX Alternatives

Corridor	Energy Type	No-Build Energy Use (Btu)	EC Alternative Energy Use (Btu)	Change from No-Build (Btu)	Percent Change from No-Build
Highway 99	**Direct Energy (Btu)**	49,352,300,000	49,343,600,000	-8,700,000	-0.018%
	CO_2e Equivalent Energy (Btu)	62,830,600,000	62,823,700,000	-6,900,000	-0.011%
	Maintenance Energy (Btu)	11,574,200,000	11,576,800,000	2,600,000	0.022%
	Total	**123,757,100,000**	**123,744,100,000**	**-13,000,000**	**-0.011%**
River Road	**Direct Energy (Btu)**	49,352,300,000	49,363,500,000	11,200,000	0.023%
	CO_2e Equivalent Energy (Btu)	62,830,600,000	62,850,100,000	19,500,000	0.031%
	Maintenance Energy (Btu)	11,574,200,000	11,582,300,000	8,100,000	0.070%
	Total	**123,757,100,000**	**123,795,900,000**	**38,800,000**	**0.031%**
30th Avenue	**Direct Energy (Btu)**	49,352,300,000	49,350,400,000	-1,900,000	-0.004%
	CO_2e Equivalent Energy (Btu)	62,830,600,000	62,829,600,000	-1,000,000	-0.002%
	Maintenance Energy (Btu)	11,574,200,000	11,575,200,000	1,000,000	0.009%
	Total	**123,757,100,000**	**123,755,200,000**	**-1,900,000**	**-0.002%**
Coburg Road	**Direct Energy (Btu)**	49,352,300,000	49,352,100,000	-200,000	0.000%
	CO_2e Equivalent Energy (Btu)	62,830,600,000	62,832,100,000	1,500,000	0.002%
	Maintenance Energy (Btu)	11,574,200,000	11,576,300,000	2,100,000	0.018%
	Total	**123,757,100,000**	**123,760,500,000**	**3,400,000**	**0.003%**

Source: DKS. (2016).

S.3. Mitigation Measures

Overall, the impacts of the EC and EmX Alternatives on direct and indirect energy consumption are not large enough in relation to the No-Build Alternatives to warrant additional mitigation measures.

All required mitigation measures related to sustainability, such as preserving or replanting trees and minimizing traffic obstructions, would be specified in LTD's construction contracting documents.

S.4. Conclusions

Overall, the EC and EmX Alternatives are expected to have energy consumption rates that are very similar to the No-Build Alternatives (see Table S.4-1). The changes in regionwide energy consumption are negligible for the Alternatives due to continued increases in fuel efficiency over the next 20 years. Given the continued gains in technology for increasing energy efficiency, energy consumption is not expected to be a factor for determining the preferred alternatives.

Table S.4-1. Summary of Energy and Sustainability Environmental Consequences by Corridor and Alternative

Alternatives	Temporary / Short-Term Construction Related Impacts / Benefits	Long-Term Direct Impacts / Benefits	Indirect / Cumulative Effects	Mitigation Measures	Unavoidable Adverse Effects
Highway 99 Corridor					
No-Build Alternative	• None	• Limited potential for sufficient mode shifts away from motor vehicle travel to transit to improve energy use and sustainability.	• Limited potential for future reduction in indirect energy consumption	• None	• None
Enhanced Corridor Alternative	• Construction-related energy use and emissions • Jobs creation and related economic benefits • The cement used for bus stops will require less maintenance than asphalt over time	• Systemwide reduction in VMT of less than 0.02% as compared to No-Build Alternative	• Systemwide increase in maintenance and repair energy (<0.02%) compared to No-Build	• None	• None
EmX Alternative	• Construction-related energy use and emissions • Jobs creation and related economic benefits • The cement used for bus / BRT vehicle lanes and stations will require less maintenance than asphalt over time	• Systemwide reduction in VMT of 0.05% as compared to No-Build Alternative • Systemwide reduction in energy consumption of 0.02% as compared to No-Build • Systemwide reduction in GHG emissions of less than 0.02% as compared to No-Build center of activity	• Systemwide increase in maintenance and repair energy (<0.03%) compared to No-Build	• None	• None

Table S.4-1. Summary of Energy and Sustainability Environmental Consequences by Corridor and Alternative

Alternatives	Temporary / Short-Term Construction Related Impacts / Benefits	Long-Term Direct Impacts / Benefits	Indirect / Cumulative Effects	Mitigation Measures	Unavoidable Adverse Effects
River Road Corridor					
No-Build Alternative	• Same as Highway 99 Corridor No-Build	• Same as Highway 99 Corridor No-Build	• Same as Highway 99 Corridor No-Build	• None	• None
Enhanced Corridor Alternative	• Same as Highway 99 Corridor EC	• Limited potential for regionwide reduction in VMT, energy use, or GHG emissions as compared to No-Build Alternative	• Limited potential for decreasing indirect energy compared to No-Build Alternative	• None	• None
EmX Alternative	• Same as Highway 99 Corridor EmX	• Systemwide reduction in VMT of less than 0.02% as compared to No-Build Alternative • Systemwide energy consumption and GHG emissions increase of less than 0.04% compared to No-Build	• Systemwide increase in maintenance and repair energy (<0.08%) compared to No-Build	• None	• None
30th – LCC Corridor					
No-Build Alternative	• Same as Highway 99 Corridor No-Build	• Same as Highway 99 Corridor No-Build	• Same as Highway 99 Corridor No-Build	• None	• None
Enhanced Corridor Alternative	• Same as Highway 99 Corridor EC	• Limited potential for regionwide reduction in VMT, energy use, or GHG emissions as compared to No-Build Alternative	• No potential for decreasing indirect energy compared to No-Build Alternative	• None	• None

Table S.4-1. Summary of Energy and Sustainability Environmental Consequences by Corridor and Alternative

Alternatives	Temporary / Short-Term Construction Related Impacts / Benefits	Long-Term Direct Impacts / Benefits	Indirect / Cumulative Effects	Mitigation Measures	Unavoidable Adverse Effects
EmX Alternative	• Same as Highway 99 Corridor EmX	• Limited potential for regionwide reduction in VMT, energy use, or GHG emissions as compared to No-Build Alternative	• No potential for decreasing indirect energy compared to No-Build Alternative	• None	• None
Coburg Road Corridor					
No-Build Alternative	• Same as Highway 99 Corridor No-Build	• Same as Highway 99 Corridor No-Build	• Same as Highway 99 Corridor No-Build	• None	• None
Enhanced Corridor Alternative	• Same as Highway 99 EC	• Systemwide VMT reduction of less than 0.02% compared to No-Build Alternative • Systemwide reduction in average weekday energy consumption and GHG emissions (<0.03%) compared to No-Build	• Systemwide reduction in maintenance and repair energy (<0.03%) compared to No-Build	• None	• None
EmX Alternative	• Same as Highway 99 EmX	• Systemwide VMT reduction of less than 0.02% compared to No-Build Alternative	• Systemwide increase in maintenance and repair energy (<0.02%) compared to No-Build	• None	• None

Table S.4-1. Summary of Energy and Sustainability Environmental Consequences by Corridor and Alternative

Alternatives	Temporary / Short-Term Construction Related Impacts / Benefits	Long-Term Direct Impacts / Benefits	Indirect / Cumulative Effects	Mitigation Measures	Unavoidable Adverse Effects
Martin Luther King, Jr. Blvd. Corridor					
No-Build Alternative	• Same as Highway 99 Corridor No-Build	• Same as Highway 99 Corridor No-Build	• Same as Highway 99 Corridor No-Build	• None	• None
Enhanced Corridor Alternative	• Construction-related energy use and emissions • Jobs creation and related economic benefits • The cement used for bus lanes and stops will require less maintenance than asphalt over time	• Systemwide VMT reduction of less than 0.02% compared to No-Build Alternative	• Potential for slight increase in systemwide indirect energy (<0.03%) compared to No-Build Alternative	• None	• None

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, June)
- Affected environment
- Adverse and beneficial effects including short-term, direct, indirect and cumulative
- Mitigation measures
- Permits and approvals
- References

1.2. Energy and Sustainability Technical Report and Purpose

The purpose of this technical report is to present the results of the energy and sustainability analysis for the MovingAhead corridor alternatives. Energy consumption calculated includes average weekday direct energy consumption (measured in Btu), average weekday greenhouse gas (GHG) emissions (measured in grams of carbon dioxide equivalents (CO_2e), maintenance and repair energy (measured in Btu), and short-term construction energy (measured in Btu/2016 dollar. The results of the energy and sustainability calculations and potential mitigation measures to offset both short-term and long-term impacts are considered in the selection of corridor preferred alternatives.

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
Energy and Sustainability	Kate Petak	DKS Associates	Transportation Associate / 4 years
Editors			
	Lynda Wannamaker	Wannamaker Consulting	President / 33 years
	Scott Richman	CH2M	Senior Project Manager / 24 years
	Rob Rodland	CH2M	Project Manager / 20 years
	Peter Coffey	DKS Associates	Senior Transportation Engineer / 31 years
	Mat Dolata	DKS Associates	Transportation Engineer / 11 years
	Kelly Hoell	LTD	Transit Development Planner / 12 years

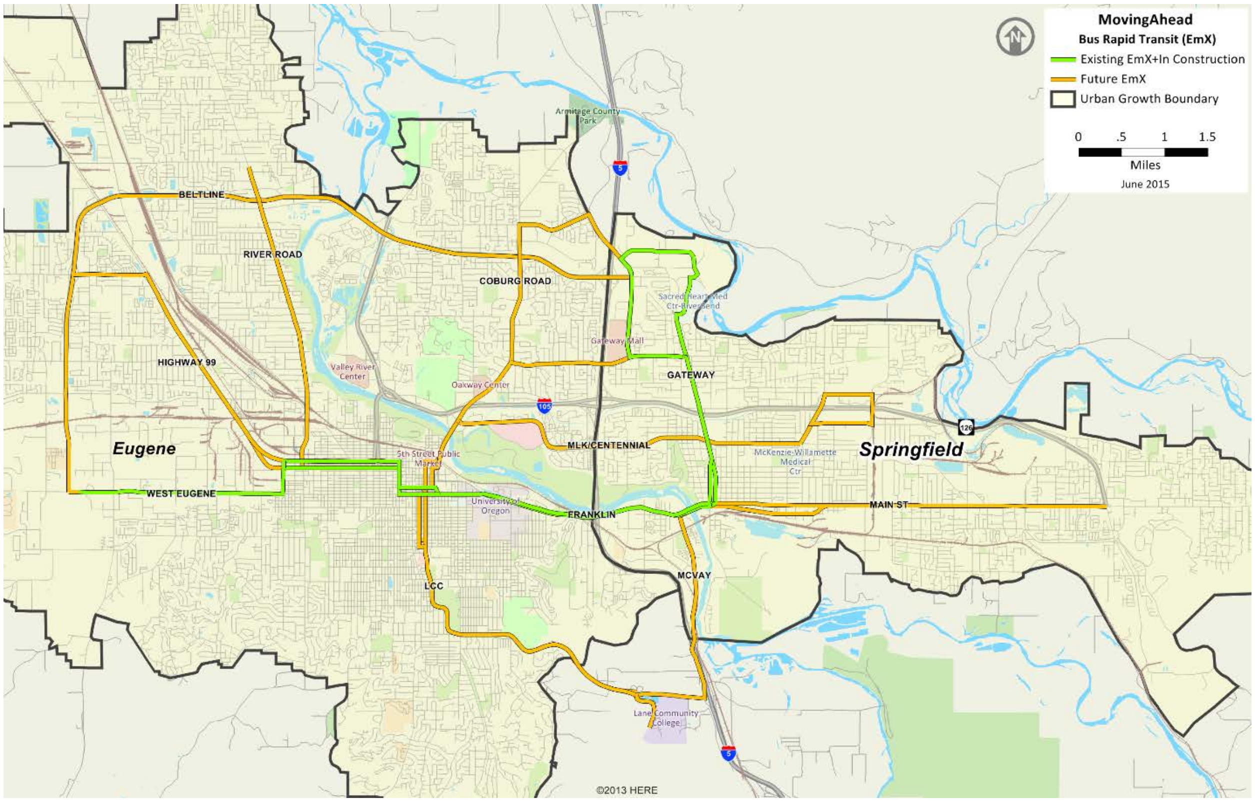
Source: MovingAhead Project Team. (2017).

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], 2014) 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, 2014) 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).

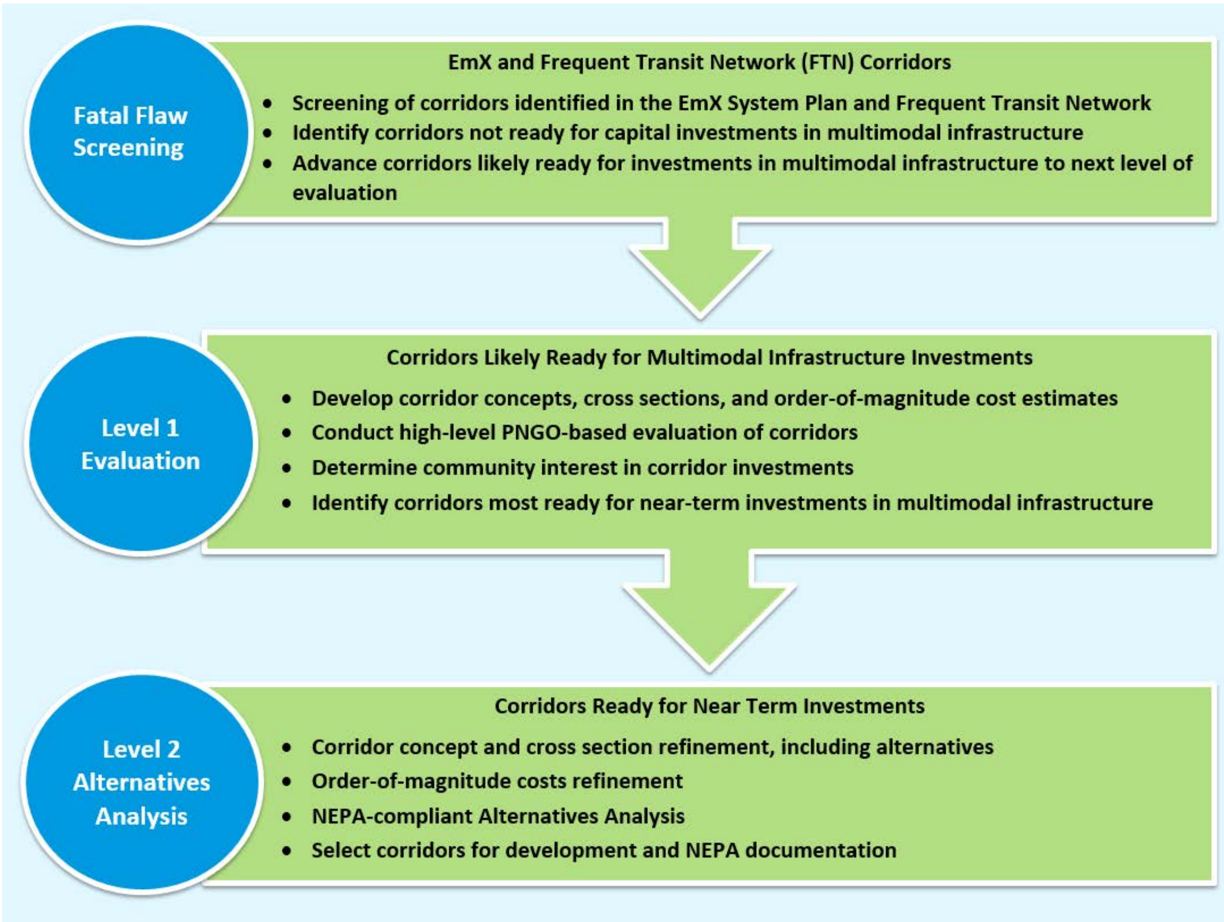
1.5. Screening and Evaluation of Multimodal Options

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, June).

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).

BRT = bus rapid transit
FTA = Federal Transit Administration
LOS = level of service
LTD = Lane Transit District

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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

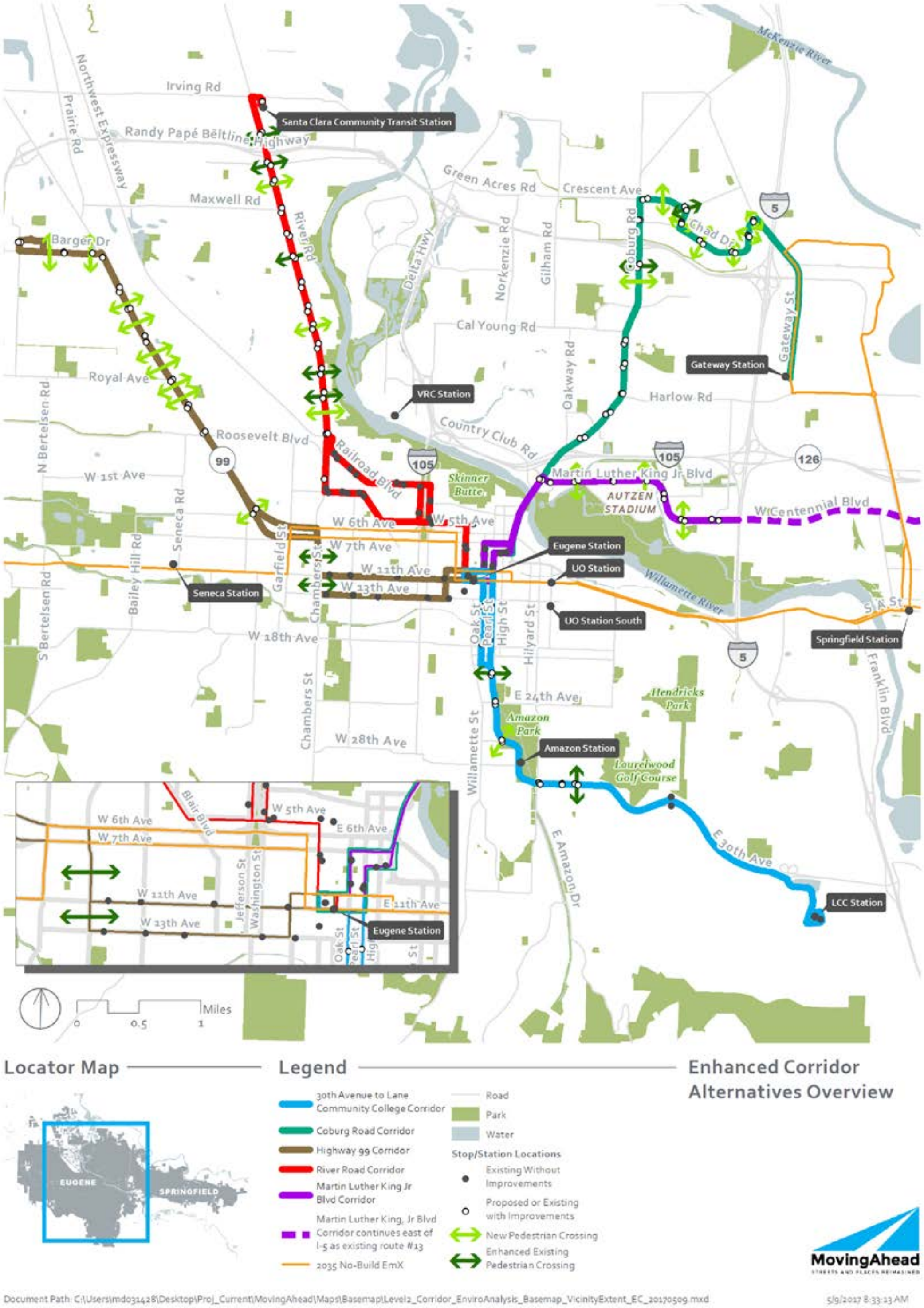
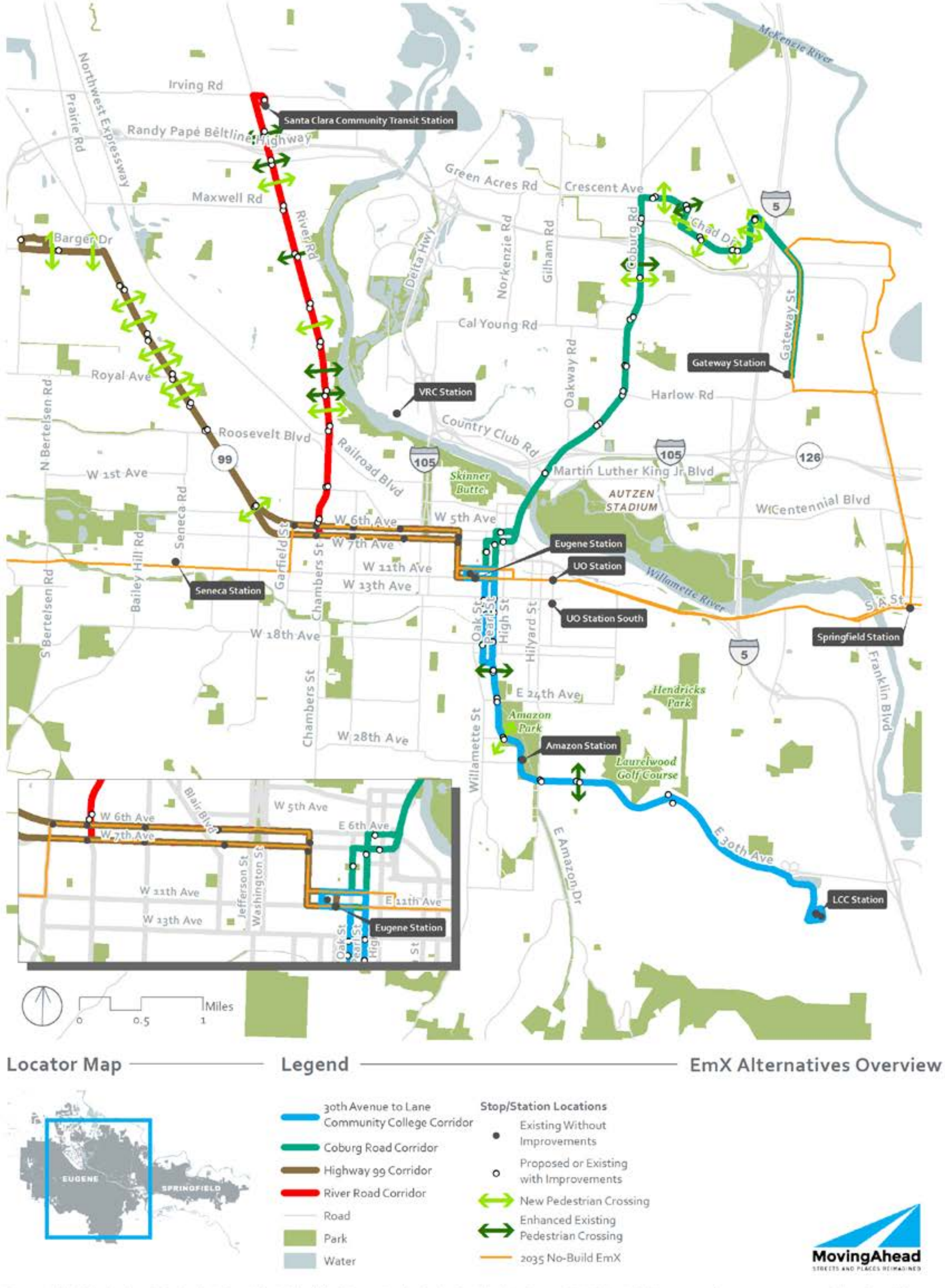


Figure 2.1-2. EmX Alternatives Overview



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 report addresses the methods and data that were used to assess potential affects to energy use, GHG emissions, and alignment with adopted sustainability policies as a result of the project's various alternatives under study in the LTD MovingAhead Project.

The purpose of the energy and GHG emissions evaluation is to identify potential adverse impacts and beneficial effects of the various alternatives on energy use and GHGs for LTD's MovingAhead Project and evaluate alignment with the City of Eugene's and LTD's adopted policies regarding sustainability. At a basic level, energy use is a process where raw materials are converted into energy to power transit, personal vehicles, and construction equipment, as well as to produce materials for transportation facilities. As a byproduct of energy use and the conversion process, outputs are created such as carbon dioxide (CO_2). As the effects of CO_2 (and other heat-trapping gases) are better understood in terms of climate change, more efforts are focused on energy conservation and reduction of emissions output. Reducing the amount of energy and CO_2 production in transportation can be accomplished by reducing vehicle miles traveled, increasing the number of people in a vehicle, increasing the number of trips made by non-emitting vehicles (bicycle, skateboard, mobility device) or on foot, increasing public transportation use, utilizing alternative fuel types, increasing the fuel efficiency of vehicles, or by reducing delay and vehicle idling created by congestion. The Energy and Sustainability analysis uses energy and greenhouse gas (GHG) emissions as a framework for evaluating sustainability of the various alternatives under study. Additionally, the sustainability analysis qualitatively addresses LTD's Sustainability Policy, adopted September 18, 2013, and the City of Eugene's Sustainability Policy, adopted November 13, 2006. These policies demonstrate the City's and LTD's commitment to advancing the social, economic and environmental sustainability of the Eugene-Springfield metropolitan area.

The City of Eugene has committed to pursue the following actions:

- Reduce community-wide GHG emissions 10 percent below 1990 levels by 2020
- Reduce community-wide fossil fuel use 50 percent by 2030
- Identify strategies that will help the community adapt to a changing climate and increasing fossil fuel prices

LTD has committed to pursue action in four areas:

- Providing quality transit service
- Using environmentally-friendly vehicles
- Constructing earth-friendly projects
- Implementing sustainable operating practices

3.1. Methods

Energy use and supply in the project area is generally characterized for gasoline, diesel and electricity, including supply sources, rates of energy use, and demand forecasts. For example, existing energy consumption and supply data were provided by documents such as the State of Oregon's Energy Plan.

Energy use for operation and construction was determined for each of the project alternatives and the baseline (present day) condition. Operational energy use includes the amount of fuel energy used to operate buses and BRT vehicles for each alternative including the anticipated background traffic for each scenario. This estimate is based on estimated vehicle miles traveled (VMT) and average fuel efficiency (miles per gallon) of motor vehicles and the bus and BRT vehicle fleet.

A carbon footprint analysis estimated GHG emissions for the alternatives based on operational fuel energy, using forecasts of added / reduced vehicle-miles resulting from the proposed alternative. GHG emissions used in the calculations only included tailpipe emissions, rather than a full life-cycle analysis of well-to-wheels emissions.

Indirect energy was analyzed for each alternative, based on VMT and the estimated energy required for vehicle maintenance and repair by mode.

Construction energy impacts involve the one-time, non-recoverable energy costs associated with construction of roadways and structures. The construction energy analysis was conducted using the input / output method, a method developed by Caltrans to estimate the amount of energy used in the manufacture of materials and construction of projects (Talaga et al., 1983). The input / output method consists of multiplying construction costs by a Btu/dollar conversion factor to estimate the Btu required to construct a project. Three factors are considered in estimating the amount of construction energy expended for a project: energy used in mining and processing of raw materials and manufacturing of building materials; energy used to transport materials to the job site; and energy used at the job site during construction.

Construction energy was calculated based on the construction and permanent footprint provided in the *Conceptual Designs Set*. For this energy report, construction energy in Btu was estimated, converted to 1977 dollars (using conversion factors provided by Caltrans), then converted to 2016 dollars using the United States Consumer Price Index inflation calculator.

The energy benefits were determined by monetizing direct energy and GHG emissions for each alternative. This monetized energy value was divided by the anticipated annual capital and operating cost of the project and presented as a percentage.

3.2. Relevant Laws and Regulations

No local, state or federal laws constrain energy use or regulate sustainability practices; however, some policies do address energy use and sustainability, mainly in terms of conserving energy or providing means to improve the efficiency of energy use or setting goals for GHG reductions. Policies applicable to this Energy and Sustainability analysis are discussed in the section below.

3.2.1. Federal

National Environmental Policy Act of 1969 (NEPA). 42 of the United States Code (U.S.C.) 4332. NEPA requires that federal agencies consider environmental impacts before taking actions that could affect the human environment. As interpreted by the Council on Environmental Quality, NEPA requires that "reasonably foreseeable" direct, indirect, and cumulative effects of a proposed action be considered in the decision-making process. As defined by NEPA, the term "effects" includes "aesthetic, historic, cultural, economic, social, or health" effects. Energy use is one of the environmental elements typically assessed in NEPA documentation.

Title 42 of U.S.C. 42 U.S.C. 6201, 13401, and 13431. Title 42 of the U.S.C. focuses on energy conservation, reduced reliance on foreign energy sources (mainly petroleum), use of alternative fuels, and increased efficiency in energy use. Policies related to energy include:

- Providing for improved energy efficiency in motor vehicles (42 U.S.C. 6201)
- Increasing economic efficiency by meeting future needs for energy services at the lowest cost considering technologies that improve the efficiency of energy end use, while conserving energy supplies such as oil (42 U.S.C. 13401)
- Reducing air, water, and other environmental impacts (including emissions of GHGs) related to energy production, distribution, transportation, and use by development of an environmentally sustainable energy system (42 U.S.C. 13401)
- Reducing demand for oil in the transportation sector for all motor vehicles (42 U.S.C. 13431)

3.2.2. State

State of Oregon Energy Plan 2013-2015. The Oregon Energy Plan includes an energy action plan with goals and recommendations to help ensure that Oregon has an adequate supply of affordable and reliable energy. Goals related to transportation energy include the following:

- Implement Oregon's Energy Incentive Program, which includes allocation of credits for transit and creation of alternative fuel vehicle infrastructure.
- Implement strategy for reducing GHGs (this includes emissions from transportation sources).

Oregon State Transportation Plan. 2006. The proposed 2006-2030 State Transportation Plan continues an emphasis on efficient energy use for transportation. The plan has seven main goals, two of which relate to energy. Goal 3, Economic Vitality, promotes the expansion and diversification of Oregon's economy through the energy efficient movement of people, goods, services and information. Goal 4, Sustainability, focuses on "providing a transportation system that meets present needs without compromising the ability of future generations to meet their needs . . ." Goal 4 addresses energy: "It is the policy of the State of Oregon to support efforts to move to a more diversified and cleaner energy supply, promote fuel efficiencies, and prepare for possible fuel shortages."

Oregon Highway Plan (OHP). (ODOT, 2006). The OHP defines policies and investment strategies for Oregon's state highway system for the next 20 years and further refines the goals and policies of the Oregon Transportation Plan. Several of these relate to energy use and are similar to those found in the Oregon Transportation Plan. For example, Goal 4 is "to optimize the overall efficiency and utility of the state highway system through the use of alternative modes and travel demand management strategies." Travel demand management (TDM) techniques are discussed under Policy 4.D. These TDM measures have the goals of decreasing energy consumption, congestion, and VMT.

Oregon Statewide Planning Goals. Oregon Administrative Rules (OAR) 660-14. Oregon has developed and maintained a strong statewide program of land use planning since the early 1970s. The core of this program consists of 19 statewide planning goals. Two of these goals, 12 and 13, relate to energy. Goal 12, Transportation, is to provide and encourage a safe, convenient and economic transportation system. It states that transportation plans must encourage the conservation of energy. In addition, transportation systems shall, to the fullest extent possible, be planned to utilize existing facilities and rights-of-way within the state, provided that such use is not inconsistent with the environmental, energy, land use, economic or social policies of the state.

Section 35 of OAR 660-12 relates to evaluation and selection of transportation system alternatives. It states "the transportation system shall minimize adverse economic, social, environmental and energy consequences."

Goal 13, Energy Conservation, states that land and uses developed on the land shall be managed and controlled so as to maximize the conservation of all forms of energy, based on sound economic principles (OAR 660-015).

Oregon Revised Statutes 2013 Edition. Oregon Revised Statute 469.010 states that "energy- efficient modes of transportation for people and goods shall be encouraged, while energy-inefficient modes of transportation shall be discouraged."

Oregon Sustainable Transportation Initiative, 2010. This is a "statewide effort to reduce GHG emissions from transportation while creating healthier, more livable communities and greater economic opportunity." It is designed to help the state meets its goal of reducing GHG emissions by 75 percent below 1990 levels by 2050.

Oregon House Bill 3543. 2007. Oregon House Bill 3543 establishes GHG reduction goals for the State:

- 2010: Stabilize emissions and begin reduction
- 2020: Achieve 10 percent reduction below 1990 levels
- 2050: Achieve 75 percent reduction below 1990 levels

House Bill 2001, the Jobs and Transportation Act. 2009. The following GHG reduction strategies are included in this bill:

- New Funding. HB 2001 directs the Oregon Department of Transportation (ODOT) to participate in and finance the development of transportation plans needed to reduce GHG emission by light vehicles by working with multiple agencies, local governments, and other partners.
- New Criteria for Funding. HB 2001 calls for updating the criteria used to select projects programmed in the Statewide Transportation Improvement Program to ensure that project selection is consistent with GHG reduction goals.
- Scenario Planning. HB 2001 directs Portland Metro and the Central Lane MPO to each develop two or more land use/transportation scenarios reducing GHG from cars while planning for population growth. Achieving the preferred scenario of reducing per capita GHG emissions from light vehicles by 20 percent would require substantial additional funding for transit operations and maintenance. Current funding mechanisms focus on capital development rather than operations, leaving LTD with little budget for existing operations. Should LTD identify funding for system expansion, additional funding would be needed to operate and maintain that system (LCOG, 2015).
- Other. HB 2001 also directs ODOT to create a provision for medium speed electric vehicles so that when they are manufactured to meet federal passenger car safety standards ODOT can be ready. In addition, HB 2001 directs ODOT to work with the Travel Information Council and the private sector to develop a plan for installing electric motor vehicle charging stations at rest areas.

House Bill 2186. 2009. The following GHG strategies are included in this bill:

- Low carbon fuel standards for fuel that is used for transportation. The aim of Oregon's low carbon fuel standard will be to reduce the average carbon intensity of the mix of transportation fuels used in Oregon by 10 percent by 2020.
- Establishment of a MPO GHG Emissions Task Force. The charge to the Task Force was to recommend legislation to interim Legislative assembly committees to establish a process for adopting and implementing GHG emissions reductions plans, including a schedule for the planning process and an

estimate of necessary funding. The focus is on reducing GHG emissions from light motor vehicles of 10,000 pounds or less and must consider contributions of improved vehicle technologies and fuels.

- Requirements to maintain or retrofit medium-duty and heavy-duty trucks in order to reduce aerodynamic drag and otherwise reduce GHG emissions from those trucks.
- Restrictions and prohibitions on the sale and distribution of after-market motor vehicle parts, including but not limited to tires, if alternatives are available that decrease GHG emissions from motor vehicles.
- Requirements for motor vehicle service providers to check and inflate tire pressure according to manufacturer recommended specifications.
- Restrictions on engine use by parked commercial vehicles, including but not limited to medium-duty trucks and heavy-duty trucks, and by commercial ships while at port, and requirements that truck stops and ports provide alternatives to engine use such as electric power.

Senate Bill 1059. 2010. On March 18, 2010, Governor Ted Kulongoski signed House Bill 1059. This legislation directs Oregon Transportation Commission to adopt statewide transportation strategies on GHG emissions to aid in achieving emission reduction goals in Oregon Revised Statute 468A.205. In addition, the legislation requires:

- ODOT and the Oregon Department of Land Conservation and Development (DLCD) to coordinate and consult with MPOs and other state agencies to develop a state-level strategy to reduce GHGs from transportation
- Development of a toolkit to assist local governments and MPOs in reducing GHGs from transportation
- Development of guidelines for scenario planning
- Information to be provided to DLCD to set transportation-related GHG reduction targets for major metropolitan areas
- Outreach and education to the public and work with local governments within urban areas served by an MPO in order to consider how they may reduce GHGs short-term in the transportation sector

3.2.3. Local

Eugene Climate Recovery Ordinance. 2016 Update. (City of Eugene, 2016) The City of Eugene Climate Recovery goals specified in this ordinance include the following:

- All city-owned facilities and city operations shall be carbon neutral by 2020, either by reducing GHGs to zero, funding local GHG reduction projects and programs, or purchasing verifiable carbon offsets.
- By 2030, the City organization shall reduce its use of fossil fuels by 50 percent compared to 2010 usage.
- By 2030, all businesses and individuals working or living in Eugene shall collectively reduce the total use of fossil fuels by 50 percent compared to 2010 usage.
- By 2100, total community GHG shall be reduced to Eugene’s average share of a global atmospheric GHG level of 350 parts per million.

The benchmarks set to meet these goals are to decrease GHGs from city operations by 15 percent each year and to reduce GHGs from fossil fuel use by 2.5 percent each year.

Eugene-Springfield Metropolitan Area General Plan. 2010 Update. The Metro Plan includes an energy element in section III.J. This section discusses conservation and strategies to increase energy efficiency in areas such as transportation.

Lane Transit District Long-Range Transit Plan: Draft Goals, Policies, and Actions. 2014 Lane Transit District has developed policies to advance the social, economic and environmental sustainability of the Eugene-Springfield metropolitan area. In the policy, LTD commits to pursue action in the following six areas:

- Improve connectivity throughout LTD service area.
- Ensure equitable and accessible transit service.
- Maintain and enhance safety and security.
- Use resources sustainably in adapting to future conditions.
- Engage the regional community in short-term and long-term planning.
- Sustain and enhance prosperity through investment in transit service and infrastructure.

Eugene Community Climate and Energy Action Plan. 2013 Progress Report. In September 2010, Eugene City Council adopted the Community Climate and Energy Action Plan. The plan contains three separate but overlapping goals:

- Reduce community-wide GHG emissions 10 percent below 1990 levels by 2020.
- Reduce community-wide fossil fuel use 50 percent by 2030.
- Identify strategies that will help the community adapt to a changing climate and increasing fossil fuel prices.

City Council of Eugene Resolution No 4618. On February 28, 2000, the City Council adopted Resolution No 4618 adopting a definition and statement of intent regarding the application of sustainability principles to the City of Eugene and affirmed the commitment of City elected officials and staff to uphold these principles.

City Council of Eugene Resolution No 4893. On November 13, 2006, the City Council adopted Resolution No 4893 committing the City of Eugene to sustainable practices and to businesses that produce sustainable products and services. This resolution further states that the City Council will cooperate with other public agencies to promote sustainable practices and the use of sustainable products and services to achieve the long-term outcomes in the report prepared by the Sustainable Business Initiative Task Force Report as accepted by the City Council on October 23, 2006. The intent of the declaration by the City is to spur the adoption of sustainable practices and the growth of sustainable industries within the private and non-profit sectors of the community and make it clear to City employees and other public agencies that incorporating sustainability into planning, policy permitting and all forms of decision making is a City priority.

City of Eugene Ordinance 20540. In July 2014, the City of Eugene adopted Ordinance No 20540 adopting goals for climate action, climate assessment, climate benchmarks, and climate reporting. The goals related to climate action were:

- By the year 2020, all city-owned facilities and city operations shall be carbon neutral.
- By the year 2030, the city shall reduce its use of fossil fuels by 50 percent compared to 2010 usage.
- By the year 2030, all businesses, individuals, and others living or working in the city shall reduce the total (not per capita) use of fossil fuels by 50 percent compared to 2010 usage.

3.3. Contacts and Coordination

Project staff coordinated with Hart Migdal, Planning Technician at Lane Transit District.

3.4. Analysis Areas

In general, the analysis area for the energy and sustainability assessment includes the entire Eugene-Springfield region.

Generally, the Energy and Sustainability analysis evaluated the differences in energy consumption and GHG emissions between the project's various alternatives including the No-Build Alternatives, based on the following:

- The forecast year is the "horizon" year of the 20-year planning period, in this case, 2035.
- VMT data are estimated in the LCOG regional travel demand model.
- The project area consisted of the regionwide transportation network modeled for air quality and travel demand purposes.
- Energy consumption in British thermal units (Btus) is based on estimated changes in VMT. Energy consumption was estimated based on factors reported in the *New and Small Starts Evaluation and Rating Process Final Policy Guidance* (FTA, 2013, August).
- The GHG emissions were estimated from the Btu estimates developed for the energy consumption estimate multiplied by standard tons of CO_2/million Btu conversion template, provided in the *New and Small Starts Evaluation and Rating Process Final Policy Guidance* (FTA, 2013, August).
- The indirect energy consumption in Btus was estimated based on Caltrans factors (Talaga et al., 1983).
- The construction energy consumption in Btus was estimated based on the Caltrans Input-Output Method (Talaga et al., 1983).

Project staff collected regional and project specific data related to energy use and sustainability practices including the availability and existing use of energy in the Eugene-Springfield metropolitan area, and forecasts of future energy demand for various transportation-related fuels types, particularly petroleum and electricity. The supply and demand for existing energy resources (natural gas, electricity and petroleum) was documented.

Project staff obtained the following from other team members: BRT vehicle assumptions, baseline and operational conditions (ADT, VMT), linear mileage of site work and new lanes, and estimated number of new bus stations, terminals, and traffic signals. This was used to determine operational fuel energy use carbon output and short-term construction energy in the corridor for the specific project alternatives as well as anticipated background traffic.

The LCOG regional travel demand was the primary source of VMT data used in the energy analysis. The model generated estimates of regional travel behavior for the base 2010 scenario and future year 2035 alternatives. The model used household travel survey data, land use estimates that considers population growth and expected development, and representations of the transportation network and programmed transportation improvements as inputs. The outputs of the travel demand model included travel times between origins and destinations across the region, expected mode choices (e.g., traveling by bus or car) and traffic volumes on the regional roadway network. These traffic volumes were used to calculate regional VMT for cars, trucks, and buses, which served as the basis for estimated impacts related to energy use and emissions.

3.4.1. Energy

Calculations for direct energy, GHG emissions, indirect energy, and construction energy are included in this report. The systemwide VMT, which was used for each calculation, was separated into passenger miles, heavy truck miles, and bus miles to account for differences in energy consumption levels. The

Btu(s) per VMT for each mode were taken from the FTA New Starts program standardized evaluation criteria (Table 3.4-1).

Table 3.4-1. Change in Energy Use Factors (Btu/VMT)

Mode	Current Year	10-year Horizon	20-year Horizon
Automobile	7,559	6,167	5,633
Bus – Diesel	41,436	35,635	33,978
Bus – Hybrid	33,149	28,508	27,182
Heavy Truck*	21,542*	21,542*	17,544*

Source: Federal Transit Administration New and Small Starts Evaluation and Rating Process Final Policy Guidance. (2013, August).

*Source: Calculation from data in U.S. Energy Information Administration Annual Energy Outlook 2015 With Projections to 2040 (2015, April).

The energy use factors for heavy trucks were calculated by dividing energy consumption by VMT. Both of these values are reported in the Annual Energy Outlook 2015 document for 2010 and 2035. The 2010 values were used to calculate both current year and 10-year horizon factors (since heavy truck energy standards have not been established yet for the near future); the 2035 values were used to calculate the 20-year horizon factor.

The operational fuel energy used by vehicles (auto, bus, and heavy truck) was determined by multiplying VMT by the energy consumption levels estimated by vehicle type. Vehicle fuel energy use was calculated for the design year for all alternatives.

The energy use is monetized based on the economic dependence on imported petroleum for fuels. FTA uses a value of $0.20 per gallon of petroleum fuel. To convert from Btu to gallons of petroleum fuel, FTA uses conversion factors of 116,090 Btu per gallon of gasoline and 128,450 Btu per gallon of diesel fuel. The resulting monetization factors are $1.72 per million Btu for gasoline and $1.56 per million Btu for diesel fuel. Gasoline is assumed to be the sole fuel for changes in automobile VMT and diesel is assumed to be the sole fuel for changes in heavy truck and hybrid bus VMT for simplicity.

3.4.2. Greenhouse Gas

The units associated with GHG calculations are CO_2e. This is a factor that converts all GHG emissions (including, but not limited to, CO_2), which have different rates of affecting global warming, into CO_2 terms. The change in GHG emissions factors is listed in Table 3.4-2.

Table 3.4-2. Change in Greenhouse Gas (g CO_2e/VMT) Emissions Factors over Time

Mode	Current Year[a]	10- Year Horizon	20-year Horizon
Automobile	532	434	397
Bus – Diesel	3,319	2,854	2,721
Bus – Hybrid	2,655	2,283	2,177
Bus – CNG	2,935	2,524	2,406

Table 3.4-2. Change in Greenhouse Gas (g CO_2e/VMT) Emissions Factors over Time

Mode	Current Year[a]	10- Year Horizon	20-year Horizon
Bus – Electric	2,934	2,441	2,303
Heavy Truck	1,485[b]	1,211[b]	1,108[b]

Source: *New and Small Starts Evaluation and Rating Process Final Policy Guidance* (FTA, 2013, August)

Operational fuel energy use for an alternative was translated into carbon output using CO_2 emissions standards published by the Transportation Energy Data Book.

CO_2 emissions from a gallon of gasoline = 8,887 grams = 19.6 pounds/gallon CO_2 emissions from a gallon of diesel = 10,180 grams = 22.4 pounds/gallon.

(Note that many factors may affect these calculations, such as temperature and specific fuel blend, but for the purposes of this project the calculations were used as the general standard.)

[a] The STA defines "current year" as: as close to today as the data will permit.

[b] Source: *Emissions Factors 2014* (U.S. Environmental Protection Agency [EPA], 2015). 20 Year Horizon calculating using reduction ratio of automobile.

The social cost of carbon is "an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change" (Interagency Working Group, 2013).To capture the monetary value of change in GHG emissions, FTA guidance is to use the $57 per Metric ton CO_2e midrange estimate of the social cost of carbon in 2035 obtained from the *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866* (Interagency Working Group: 2013). The $57/Metric ton CO_2e value is the 2035 midrange estimate based on a 3 percent discount rate.

Once the energy consumption and GHG emission data were calculated, the sums of the monetized values were added together and divided by the annualized capital and operating cost of each project alternative. That ratio was multiplied by 100 to express the energy benefit as a percentage.

Construction energy was calculated based on the input / output method developed by the California Department of Transportation (Talaga et al., 1983). This was used to calculate energy use based on energy factors for manufacturing, processing and placement of construction materials.

Using results from other analyses, project staff qualitatively assessed the project alternatives for consistency with the City of Eugene and LTD's adopted sustainability policies and programs in place at the time of the analysis.

3.5. Significance Thresholds

Project staff compared costs of energy use and GHG emissions among the alternatives using FTA guidance. Once this cost is combined with the air quality, transportation safety, and capital cost estimates, the environmental benefit is determined by comparing the total to the following thresholds provided by FTA for New and Small Start projects (Table 3.5-1).

Table 3.5-1. FTA Environmental Benefits Thresholds

Rating	Range
High	>10%
Medium-High	5 to 10%
Medium	0 to 5%
Low-Medium	0 to -10%
Low	<-10%

Source: FTA. (2013).

The energy benefits percentages only represent a piece of these total percentages; therefore, significance ratings cannot be determined from this report alone.

3.6. Impact Analysis

3.6.1. Long-Term Impacts Analysis Approach

Direct impacts for energy use were measured by the estimated amount of fuel and GHG emissions consumed under the project alternatives. Estimated fuel consumption and GHG emissions of project alternatives were compared to the No-Build Alternatives. These impacts were quantified by Btus and monetary costs and represented in data tables within this technical report.

Sustainability impacts of the project alternatives were qualitatively evaluated in terms of general consistency of the alternatives with sustainability policies and programs adopted by LTD and the City of Eugene in place at the time of the analysis. If project alternatives are not consistent with these adopted policies, this analysis identified any necessary changes to LTD and City of Eugene policies.

3.6.2. Alternative Short-Term Impacts Approach

Construction of the proposed LTD MovingAhead Project may cause short-term impacts, such as increases in energy consumption. Design drawings for alternatives and construction management plans were used to identify direct construction related impacts to energy and determine if construction management plans are consistent with sustainability policies adopted by LTD and the City of Eugene.

3.6.3. Indirect Impact Analysis Approach

In addition to analyzing potential direct impacts to energy use, the analysis includes potential indirect impacts to energy consumption and sustainability policies resulting from each of the alternatives. This evaluation includes qualitatively determining if 2035 traffic volume forecasts and anticipated land use changes may potentially impact energy consumption, GHG emissions, and sustainability policies.

3.6.4. Cumulative Impact Analysis Approach

Cumulative impacts result from the combined impacts of the proposed project with those occurring in the past, present, and reasonably foreseeable future. A cumulative impact is the impact on the environment resulting from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions.

Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Cumulative impacts may include the effects of natural processes and events, depending on the specific resource in question. Cumulative impacts include the total of all impacts to a particular resource that have occurred, are occurring, and would likely occur as a result of any action or influence. The cumulative impact analysis for energy and sustainability compared the past, present, and reasonably foreseeable energy consumption impacts within a larger area of potential impact.

The Council on Environmental Quality provides an 11-step process for cumulative impact analysis in their report, Considering Cumulative Effects under the National Environmental Policy Act, which is documented on the American Association of State Highway and Transportation Officials (AASHTO) Center for Environmental Excellence's site for Indirect Effects / Cumulative Impacts:

1. Identify the significant cumulative effects associated with the proposed action and define the assessment goals.
2. Establish the geographic scope for the analysis.
3. Establish the time frame for the analysis.
4. Identify other actions affecting the resources, ecosystems, and human communities of concern.
5. Characterize the resources, ecosystems, and human communities identified during scoping in terms of their response to change and capacity to withstand stresses.
6. Characterize the stresses affecting these resources, ecosystems, and human communities and their relation to regulatory thresholds.
7. Define a baseline condition for the resources, ecosystems, and human communities.
8. Identify the important cause and effect relationships between human activities and resources, ecosystems, and human communities.
9. Determine the magnitude and significance of cumulative effects.
10. Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects.
11. Monitor the cumulative effects of the selected alternative and adapt management.

Cumulative impacts were qualitatively analyzed and were based on comprehensive land use and transportation elements that are components of all build alternatives. This contextual analysis included past, present and reasonably foreseeable future projects or actions occurring in the project area or the broader community which when combined with the project build alternatives, may lead to significant increases in energy consumption, GHG emissions, or conflicts with LTD's and the City of Eugene's adopted sustainability policies.

3.7. Mitigation Measures Approach

A qualitative analysis of likely impacts was used to determine appropriate mitigation measures and to evaluate the cost of measures and their potential effectiveness. Mitigation measures were also prioritized to respond to the greatest land use impacts and coordinated with affected jurisdictions.

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4. System-Level Environmental Consequences

4.1. Affected Environment

4.1.1. Existing Energy Consumption Overview

4.1.1.1. Electricity

LTD's headquarters is located in Glenwood, an unincorporated part of Lane County situated between Eugene and Springfield. Although the postal address of Glenwood is considered Eugene, Glenwood is within the City of Springfield's annexation and is served by the Springfield Utility Board (SUB) for its electricity needs. Most of the stops and stations for the corridors included in this project are powered by the Eugene Water & Electric Board (EWEB). As publicly owned municipal utilities, the Bonneville Power Administration (BPA) is the largest energy supplier to both EWEB and SUB.

The EWEB provides energy and water services to the residents and businesses of the City of Eugene and adjacent suburban areas. The total service area is approximately 238 square miles. In 2012, EWEB served approximately 89,011 electricity and 51,998 water customers in a community of approximately 158,000 persons (EWEB, 2012). The SUB provides energy and water services to the residents and businesses in the City of Springfield and adjacent areas. In 2015, SUB served approximately 31,201 electricity and 19,960 water customers (SUB, 2015).

EWEB serves its customers with power it generates in its facilities as well as power it purchases from other sources. EWEB's owned and co-owned electricity generation facilities are dominated by hydroelectric, wind, and biomass cogeneration sources. EWEB's single largest electric power supplier is the BPA, and SUB purchases all of its electricity from BPA. In 2015, the BPA's fuel mix consisted of 83.6 percent large hydroelectric, 9.9 percent nuclear, 4.8 percent non-specified, 0.9 percent small hydroelectric, 0.6 percent wind, 0.1 percent biomass and waste, and 0.1 percent natural gas (SUB, 2015). EWEB and SUB energy rates are low ($0.07 per kilowatt-hour for residential electric) compared with the U.S. average (about $0.12 per kilowatt-hour), and typical for the Northwest.

4.1.1.2. Petroleum

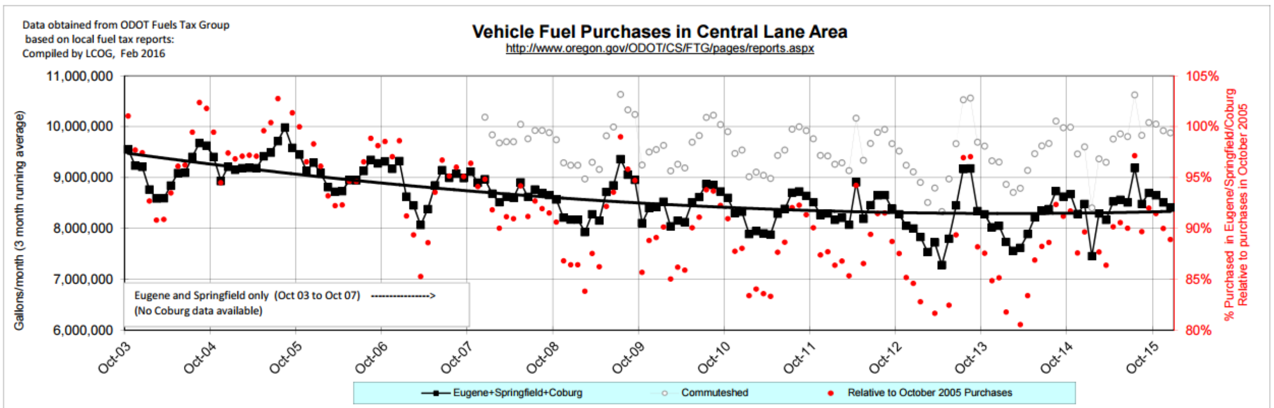
Nationally, the fuel efficiency of new vehicles has increased since the 1970s. From 1970 to 2013, U.S. auto fuel economy increased 87 percent, from 13.5 miles per gallon (mpg) (in 1970) to 25.2 mpg (in 2013). Within this period, there were times when fuel efficiency declined, but since 2003 fuel economy has increased by 2.8 mpg, or 1.2 percent per year, resulting in an overall efficiency increase. At the same time, vehicle ownership increased (registrations increased at an annual average rate of 0.6 percent between 1970 and 2013) and vehicle miles travelled increased up until 2005, and decreased from 2005 to 2013 (resulting in an increase at an annual average rate of 0.6 percent per year between 1970 and 2007, and a decrease of 1.8 percent per year between 2003 and 2013).

Currently, transportation is the highest use of petroleum in Oregon. In 2010, statewide gasoline use was 60 percent of transportation energy and 33 percent of total energy use. Statewide gasoline use increased by 8 percent between 1990 and 2003. The statewide average number of miles driven per capita has declined from a peak of 10,218 miles in 1999 to 8,651 in 2011, a decrease of 15 percent. (State of Oregon Office of Economic Analysis, 2013).

Oregon imports all of its petroleum with most of its petroleum coming from domestic sources. Close to 80 percent of the crude oil destined for Oregon originates from Alaska. Oregon does not have any refineries and approximately 90 percent of Oregon's refined oil is imported from Washington State (U.S. Energy Information Administration [EIA], 2016).

Based upon local fuel sales tax receipts, gasoline sales in the Central Lane County area have been steadily declining since 2003 (Figure 4.1-1). In October 2015, fuel usage was about 92 percent of usage in October 2005 (LCOG, 2016, February).

Figure 4.1-1. Gasoline Usage in Central Lane County Area



Source: LCOG. (2016, February).

4.1.1.3. Other Transportation Fuel Sources

Alternative fuels used for transportation in Oregon include ethanol, biodiesel, compressed natural gas, liquefied natural gas, liquefied petroleum gas (propane), renewable diesel, and electricity. These alternative fuels are used in place of diesel and gasoline, although some of them are either blended with, or partially derived from, petroleum products. All fuel sold in Oregon currently consists of 5 percent biodiesel and 10 percent ethanol.

At present, ethanol and biodiesel are the main alternatives to gasoline and diesel, and comprise 7 percent and 1 percent of Oregon's total road use fuel, respectively. Biomass can be used to produce biofuels for transportation or stationary equipment. In 2013, Oregonians used more than 170 million gallons of alternative fuels, up from 60 million gallons in 2002. This represents just less than 10 percent of Oregon's gasoline supply.

As of 2013, ethanol production in Oregon is about 40 million gallons / year, with most being produced from corn at the Pacific Ethanol plant in Boardman, Oregon. The remainder is shipped by rail to local terminals from the Midwest.

Estimated use of biodiesel is 25.7 million gallons / year, with Oregon producing about 7 million gallons / year. The remainder is shipped by rail to local terminals from the Midwest.

Other alternative fuel types comprise less than 1 percent of Oregon's total road use fuel. When converted into gallons, compressed natural gas usage is about 2 million gallons / year (about 0.1 percent of total road use fuel), liquid petroleum gas usage is about 600,000 gallons / year (about 0.03 percent of total road use fuel), and electricity usage is about 120,000 gallons / year (about 0.01 percent of total road use fuel).

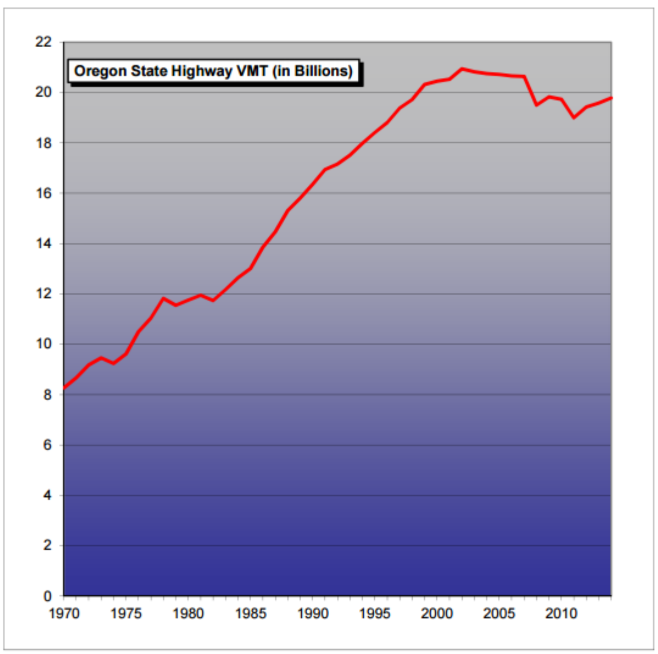
Nationwide, there are nearly 21.5 million alternative fuel vehicles, and this is expected to grow to 29.3 million vehicles in 2021. The number of hybrid vehicles, a type of alternative fuel vehicle, registered in Oregon has risen from zero in 2000 to more than 26,000 at the beginning of 2008. The DMV says the number of hybrids being registered is nearly doubling every year. Electric vehicles account for a little over 1 percent of all vehicle sales in Oregon, and there were about 6,000 registered electric vehicles in the state as of April 2015. According to the U.S. Department of Energy, there are 1,091 public electric vehicle-charging outlets in Oregon, including many direct current fast charging stations located along Interstate 5 and several Oregon Scenic Byways (U.S. Department of Energy, 2016).

Other types of alternative fuel vehicles are becoming more common in Oregon and are likely to increase in numbers due to volatile fuel prices and environmental concerns. About 90,000 of all registered passenger vehicles in Oregon (approximately 3 percent), are capable of using ethanol fuels of up to 85 percent alcohol content (E-85 flex fuel). Which of these alternative fuels become prominent in the future depends on the total impacts of production, marketability and economic forces.

Vehicle Miles Traveled

For more than a decade, the rate of growth of VMT in Oregon has been declining, as Figure 4.1-2 shows. Per capita VMT on Oregon's state highways has declined by about 5.5 percent from 2002 to 2014 (ODOT, 2016).

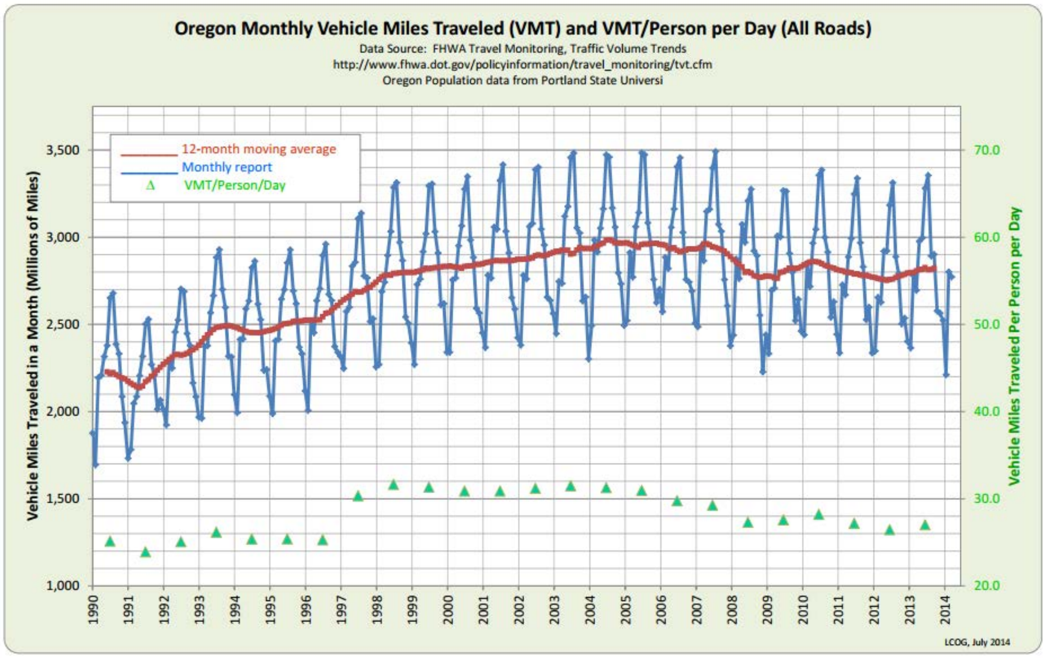
Figure 4.1-2. Oregon State Highway VMT (in Billions): 1970 through 2014



Source: *Oregon Vehicle Miles Traveled (VMT)*. ODOT. (2016). Retrieved from https://www.oregon.gov/ODOT/TD/TDATA/pages/tsm/vmtpage.aspx.

Figure 4.1-3 shows a 12-month running average of monthly VMT on all roads in Oregon, which is reported by the Federal Highway Administration based on automatic recorders and statistical analysis. As of 2013, the reported miles were 5 percent lower than the VMT estimated for 2005.

Figure 4.1-3. Oregon Monthly VMT and VMT Per Person Per Day (All Roads): 1990 through 2014



Source: LCOG. (2014, July).

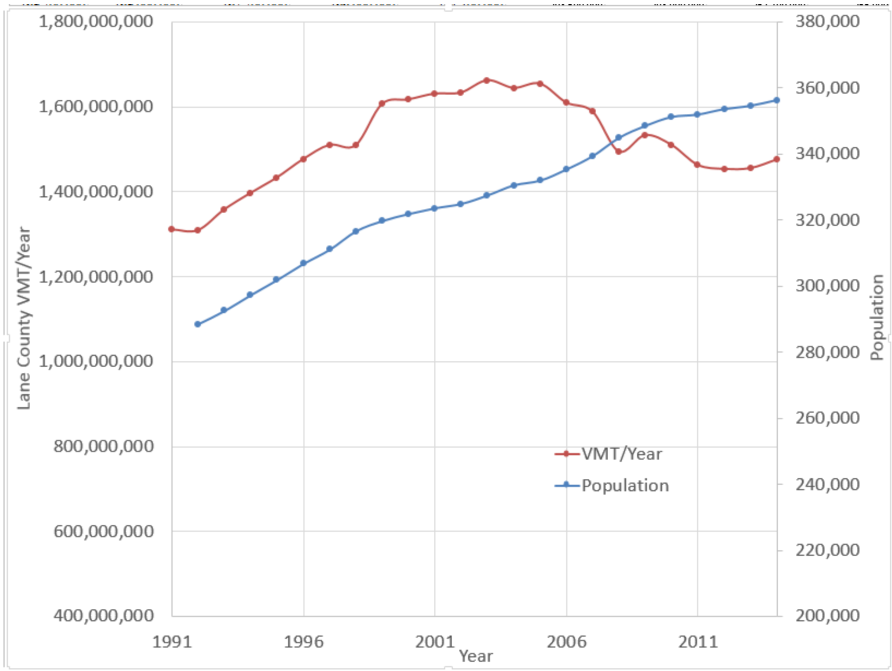
Commuters who work in metropolitan areas but live outside that area produce almost half of the total GHG emissions of all metropolitan area commuters; these commuters produce disproportionate quantities of GHG emissions because their work trips are three to six times longer (ODOT, 2009).

In the Eugene-Springfield MPO area, approximately 80 percent of workers with workplaces within the metropolitan area reside in the area, while 20 percent commute in from areas outside the metro area. The average round trip travel distance of workers residing within the metropolitan area is 8 miles and 48 miles for workers residing outside the MPO (ODOT, 2009).

As a result, the highest percentage of vehicle miles traveled is made by workers who reside outside of the MPO and travel to workplaces located within the MPO (approximately 60 percent of VMT). Similarly, the GHG emissions for these workers are greater than that for workers residing within the MPO boundaries.

Figures 4.1-4 shows annual data reported by ODOT for state highways in Lane County based on automatic recorders and statistical analysis. As of 2013, the reported miles were 86 percent of the 2005 VMT. During that same period, population in the county increased by 6.3 percent (LCOG, 2014).

Figure 4.1-4. Lane County VMT Per Year (State Highways) and Population: 1991 through 2014



Source: LCOG. (2014, July).

4.1.1.4. Greenhouse Gas Emissions

Nationwide, CO_2 emissions in 2014 were 7 percent higher than in 1990 (6,870 metric tons CO_2e versus 6,397 metric tons CO_2e). CO_2 accounts for the majority of GHGs (U.S. Environmental Protection Agency [EPA], 2016, April).

Highway vehicles are responsible for the majority of GHG emissions in the transportation sector. Highway vehicles were responsible for over 80 percent of all transportation energy use in 2014. Light duty highway vehicles, which include passenger cars and light duty trucks (sport utility vehicles, pickup trucks, and minivans) accounted for 61 percent of the on-road emissions, while heavy duty vehicles (primarily freight trucks) contributed 23 percent (the remaining 16 percent was from non-highway modes).

Most U.S. transportation sector CO_2 emissions come from petroleum fuels (98 percent). Motor gasoline has been responsible for about 60 percent of U.S. CO_2 emissions over the last twenty years.

Between 1997 and 2014, it is estimated that CO_2 emissions for cars and light trucks have increased 10.9 percent, and medium and heavy trucks have increased 76.3 percent, for an average increase of 24.1 percent for highway uses (EPA, 2016, April).

Between 1975 and 2014, the carbon footprint for light vehicles sold in the United States dropped dramatically, due to increases in fuel efficiency, as shown in Figure 4.1-5. The carbon footprint for cars decreased by 46.8 percent, while the carbon footprint for light trucks decreased by 46.0 percent (Davis et al., 2015).

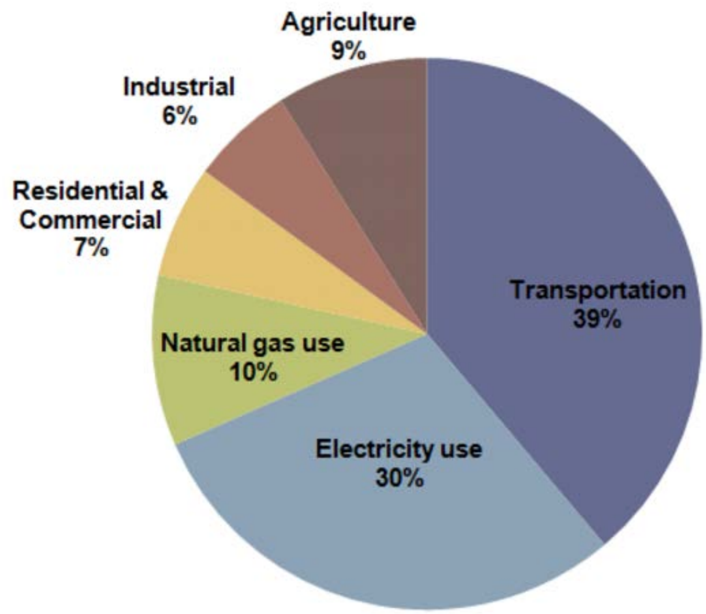
Figure 4.1-5. Production-Weighted Annual Carbon Footprint of New Domestic and Import Cars, Model Years 1975-2014 (Metric Tons of CO_2)

Model Year	Car	Car SUV
1975	12.6	15.2
1980	8.5	11.6
1981	7.9	11.5
1982	7.6	8.6
1983	7.7	8.2
1984	7.6	8.8
1985	7.4	8.4
1986	7.1	8.9
1987	7.1	8.7
1988	7.0	8.8
1989	7.2	8.9
1990	7.3	9.0
1991	7.2	9.3
1992	7.3	9.5
1993	7.2	9.9
1994	7.3	9.4
1995	7.2	9.5
1996	7.3	9.2
1997	7.3	8.8
1998	7.3	9.3
1999	7.4	9.1
2000	7.4	9.5
2001	7.4	9.0
2002	7.3	8.8
2003	7.3	8.5
2004	7.3	8.5
2005	7.2	8.4
2006	7.3	8.3
2007	7.0	8.2
2008	7.0	8.0
2009	6.7	7.7
2010	6.5	7.4
2011	6.5	7.2
2012	6.1	7.2
2013	6.0	6.9
2014	5.9	7.0
Average annual percentage change		
1975–2014	-1.9%	-2.0%
2004–2014	-2.1%	-1.9%

Source: *Transportation Energy Data Book*. (Davis et al., 2015).

Gross total emissions from all sectors of the Oregon economy amount to about 60.1 million metric tons of CO_2e for the year 2014. Figure 4.1-6 shows the percent of total GHG emissions by major sector of Oregon's economy in 2015. The transportation sector accounts for about 39 percent of the GHG emissions (Oregon Department of Environmental Quality, 2015).

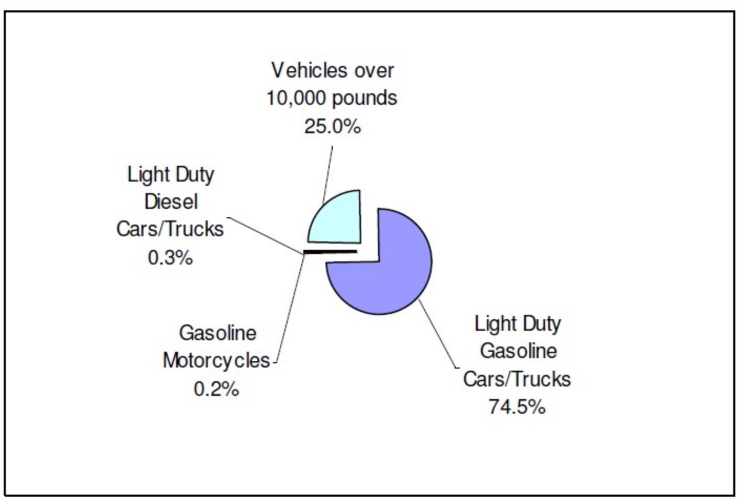
Figure 4.1-6. Total GHG by Major Economic Sector in Oregon



Source: *Greenhouse Gas Inventory Report.* (Oregon Department of Environmental Quality, 2012).

All of the GHG emissions from on-road vehicles (cars, trucks, buses, etc.) account for about 80 percent of transportation sector emissions (the remaining 20 percent is from aviation, farm vehicles, locomotives, and boats). Of these emissions, light vehicles (those less than 10,000 pounds) account for 75 percent, as shown in Figure 4.1-7 (ODOT, 2009).

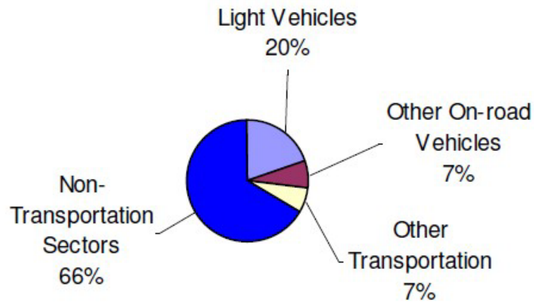
Figure 4.1-7. On-Road Vehicle Contributions to CO_2 Emissions in Oregon



Source: ODOT. (2009).

Additionally, light vehicles account for about 20 percent of all GHG emissions in Oregon (Figure 4.1-8).

Figure 4.1-8. Contribution of Transportation to Total GHG Emissions in Oregon



Source: ODOT. (2009).

Recently, the EPA, the Portland Metro area, and the Eugene-Springfield Metro region have separately evaluated an alternative systems-based view of GHG emissions, where each system represents and comprises all the parts of the economy to fulfill a particular need. For instance, in a systems-based analysis, food production would include all emissions from the electric power, transportation, industrial and agricultural sectors associated with growing, processing, transporting and disposing of food. Under this approach, emissions across an entire system can be evaluated. These studies have found that materials management, or the emissions associated with the production, manufacture and disposal of materials, goods and food, comprises the largest share of emissions (42 percent of nationwide emissions, 48 percent of Portland Metro emissions, and 58 percent of Eugene-Springfield Metro region emissions). Under this revised approach, the role of local passenger transport is reduced, and comprises just 15 percent of overall U.S. emissions, 14 percent of Portland Metro emissions, and 17 percent of Eugene-Springfield Metro region emissions (City of Eugene, 2015).

4.1.2. Future Energy Consumption Overview

4.1.2.1. National Trends

The EIA prepares an annual energy outlook that forecasts the energy market into the future (the 2015 version forecasts to the year 2040) (EIA, 2016a).

This report looks at trends in energy supply and demand linked to the projected performance of the U.S. economy, advances in energy production and consumption technologies, annual weather pattern changes, and future public policy decisions. It is important to note that the report establishes a reference case, against which future changes may be compared. The report is based on the assumption that current laws and regulations remain unchanged throughout the projections and therefore would provide a basis for examination and discussion of energy market trends if changes are considered in the future.

Key results highlighted in the EIA's Annual Energy Outlook 2015 report include growth in U.S. energy production, modest growth in energy consumption, increased use of renewables, declining reliance on imported liquid fuels, and projected stabilization in energy-related CO_2 emissions due to improved efficiency in end-use sectors and a shift away from more carbon-intensive fuels.

The report notes that global economic growth and trade will weaken after 2025, which will slow growth in U.S. exports and cause some trade-sensitive industries to level off. In the reference case, dry natural gas production remains the largest contributor to total U.S. energy production through 2040. Continued strong growth in domestic production of crude oil from tight formations leads to a decline in net imports of crude oil and petroleum products.

Energy consumption is forecast to grow at a modest rate, averaging 0.3 percent a year from 2013 to 2040 in the reference case. Increasingly stringent fuel economy standards can cause gasoline consumption in the transportation sector to be 21 percent lower in 2040 than in 2013. Industrial energy use is expected to rise with the growth of shale gas supply, which has increased markedly over the past few years and continues to have an upward production trend. Due to increased dry natural gas production, the price will be driven lower, and consumption will increase. Electricity prices increase in the reference case by 18 percent between 2013 and 2040, due to rising fuel costs and expenditures on electric transmission and distribution infrastructure and slow growth of consumption.

Renewable energy sources are expected to meet much of the growth in electricity demand; in the reference case, renewable electricity generation increases by 72 percent from 2013 to 2040, accounting for more than one-third of new generation capacity. The share of renewable energy grows from 13 percent in 2013 to 18 percent in 2040 in the reference case. Wind and solar generation account for nearly two-thirds of the increase, and solar photovoltaic technology is the fastest-growing energy source, growing at an annual average rate of 6.8 percent.

Energy-related CO_2 emissions stabilize in the reference case, declining modestly are the transportation (-0.2 percent / year) and residential (-0.2 percent / year) sectors and increasing modestly are the electric power (0.2 percent / year), industrial (0.5 percent / year), and commercial (0.3 percent / year) sectors.

The following summarizes some of these trends as they relate to the transportation sector:

- Decrease in fuel consumption. Transportation-related consumption of fuels is anticipated to decrease, while other sectors experience modest growth over the projection period. Diesel fuel consumption is expected to grow by 0.8 percent per year from 2013 to 2040, but gasoline consumption is expected to decrease by 21 percent between 2013 and 2040 due to increasing fuel efficiency standards. Because the U.S. consumes more gasoline than diesel fuel, the pattern of gasoline consumption strongly influences the overall trend of energy consumption in the transportation sector.
- Transportation energy consumption declines between 2013 and 2040, falling most rapidly through 2030, primarily due to improvements in light-duty vehicle fuel economy. This projection is a significant departure from the historical trend. Transportation energy consumption grew by an average of 1.3 percent / year from 1973 to 2007, when it peaked, as a result of increases in demand for personal travel and movement of goods that outstripped gains in fuel efficiency. Total VMT for light-duty trucks is expected to increase 36 percent from 2013 to 2040, and the average VMT per licensed driver is expected to increase from about 12,200 miles in 2013 to 13,300 miles in 2040. The fuel economy of new vehicles is expected to increase from 32.8 mpg in 2013 to 48.1 mpg in 2040, as more stringent Corporate Average Fuel Economy and GHG emissions standards take effect. Alternative fuel vehicles and hybrids are expected to gain significant market shares, and motor gasoline-only vehicles are expected to account for 46 percent of new sales in 2040, declining from 83 percent of new sales in 2013. Energy use by all heavy-duty vehicles is expected to increase, and travel is expected to grow by 48 percent between 2013 and 2040.

- New Corporate Average Fuel Economy and emissions standards boost vehicle fuel efficiency. Since 1975, the fuel economy of the combined car and light truck fleet has moved through several phases:
    1. A rapid increase from 1975 through 1981
    2. A slow increase until reaching its peak in 1987
    3. A gradual decline until 2004
    4. An increase beginning in 2005

Light trucks (pickups, SUVs, and vans) have claimed a rising share of U.S. light duty vehicle sales since the 1970s, peaking at over 55 percent of new light duty sales in 2004 before dropping to just over 47 percent in 2009. Thus, despite technology improvements, average fuel economy for new light duty vehicles ranged between 24 and 26 mpg from 1995 to 2006 after peaking at 26.2 mpg in 1987, then rose to 30 mpg in 2013 with higher fuel prices and the introduction of tighter fuel economy standards. In the reference case, the average fuel economy of new light duty vehicles rises from 30 mpg in 2013 to 54 mpg in 2040.

4.1.2.2. Oregon State Trends

Electricity

Earthquakes and drought pose the greatest natural risks for Oregon's electricity supply. In the year 2000, the Northwest Power Planning Council completed a comprehensive study to evaluate electricity system adequacy in the region. The study simulated the operation of the regional power system under varying conditions of river stream flows and weather conditions. The Council concluded that the region has an increasing probability of power supply problems in coming winters. These events are typically the result of some combination of adverse hydro stream flows, colder weather, and higher than expected outages of generation facilities. Climate change therefore may pose additional strain on Oregon's electricity supply.

EWEB maintains an Integrated Electric Resource Plan that is updated every few years to evaluate what energy resources it will need in the future. This plan sets two priorities: continue an aggressive energy conservation effort, and acquire renewable power to meet any increase in demand that cannot be offset by conservation efforts. Diversification is focused on renewables, local cogeneration and distributed generation opportunities.

SUB also maintains an Integrated Resource Plan, updated every few years, that presents a long-term forecast of the lowest reasonable cost combination of resources necessary to meet the needs of their customers. The plan is based on a dynamic power-supply marketplace and integrates these options with forecasted energy demands of customers expected to be served by SUB over the next several years. The purpose is aimed at finding the resource portfolio with the best combination of cost and risk, providing balance between the least expensive power-supply portfolio and the most desirable way to meet energy needs.

It is also anticipated that there will be continued federal investment in smart grid technologies, which will enhance the ability for electricity suppliers to respond to load demands. It is anticipated that load demands may increase from the charging load for plug-in hybrid vehicles.

Petroleum

Petroleum demand, particularly for gasoline, is not expected to slow appreciably because population and vehicle travel continue to increase. However, newer vehicles are more fuel efficient, and it is expected that this will increase even more because of recent government requirements for higher fuel efficiency and use of alternate sources of fuel for transportation (such as ethanol, bio-diesel, compressed natural gas, liquefied petroleum gas, and electricity).

There is some concern over the supply of petroleum to Oregon. As stated above, most of the oil originates from the North Slope of Alaska and is transported through a 600-mile pipeline. The pipeline is located in a harsh environment, and there is the potential for an accident to upset the flow of crude oil to refineries in Washington and other states that supply Oregon. In addition, there is little storage of petroleum in Oregon (Oregon Department of Energy, 2005).

Peak Oil and Gas

Oil accounts for about 40 percent of the energy we use, and natural gas accounts for another 25 percent. Oil provides most of our transportation energy; natural gas heats nearly half our building space and generates around 13 percent of Oregon's electricity. In addition, oil and natural gas are used for numerous industrial processes, including as a feedstock for thousands of products such as asphalt, fertilizers, pesticides, plastics, chemicals, paints, medical products, vinyl, and shoes and apparel. Opinions differ as to when production will peak.

Some experts believe the peak is imminent or has already happened. Many believe it will occur before 2020. The most optimistic opinions place the peak around 2030. The primary difference revolves around estimates of the Earth's recoverable reserves and the effect of prices in stimulating advanced recovery and development of unconventional resources. When peak oil and gas occur, it is likely to have a profound impact on energy production. Oil and natural gas have been cheap and easy to produce, but the alternatives will be difficult and expensive to produce. As a result, more capital and energy will have to be allocated to produce alternative sources. In addition, many of the alternatives produce electricity rather than liquid transportation fuels. It could take decades to replace a significant amount of declining oil and natural gas reserves.

In addition to alternative supplies, it will be necessary to increase the efficiency of the energy used. It is anticipated that this will result in major investments in the energy efficiency of cars, homes and buildings, lights, appliances, and industrial processes.

Vehicle Miles Traveled

Based upon the 2006 Oregon Transportation Plan, total VMT in Oregon is expected to increase at approximately 1.35 percent annually over the plan period (2006 to 2030). This increase is primarily due to population growth and increases in economic activity. Oregon's added capacity on the major road system has not matched traffic growth.

It is anticipated that there will be increases in fuel prices, though the amount may be difficult to predict. Increases in fuel prices will discourage the use of less fuel-efficient transportation modes such as the single-occupancy vehicle. At the same time, as it becomes more expensive to operate a private vehicle, Eugene will see an increase in demand for mass transit and other transportation options. As transportation becomes more expensive, demand for housing nearer to employment will likely increase. Over time, this economic pressure on the transportation systems will likely lead to denser land use patterns to meet the changing demand.

Greenhouse Gas Emissions

State of Oregon Goals:

Oregon HB 3543 (adopted in 2007) established GHG reduction goals for the State, which are also those most likely to be applied to our region:

- 2010: stabilize emissions and begin reduction
- 2020: achieve 10 percent reduction below 1990 levels
- 2050: achieve 75 percent reduction below 1990 levels

Meeting Reduction Goals:

Brian Gregor of the Oregon Department of Transportation recently highlighted the reduction in fuel use per capita that would be needed to achieve the State's goals (Table 4.1-1) (ODOT, 2009):

Table 4.1-1. 1990 Fuel Use Per Capita and 2050 Fuel Use Per Capita Needed to Achieve State Goals

Year	Statewide Fuel Use (billion gallons)	Population (millions)	Avg. Fuel Use per Capita (gallons)
1990	1.6	2.8	567
2050	0.4	5.9	68

Source: Brian Gregor, ODOT. (2009).

In order to achieve the reduction goals set out by the State, fuel use would need to drastically reduce from an average use of 567 gallons per person in 1990 to 68 gallons per person in 2050, a reduction of more than 88 percent from 1990 levels. It is important to note that state-level inventory work reports that transportation GHG emissions have grown since 1990, further complicating this challenge.

Transportation emissions are influenced by three main factors:

1. Vehicle technology
2. Fuel characteristics
3. VMT

Advances in vehicle and fuel technologies are anticipated to be major factors in reducing GHG emissions. In the case of GHG emissions, fleet-wide vehicle emission rates have been essentially stagnant since 1991 while VMT has grown over the same period. As a result, growth in driving has so far outpaced the emissions benefits of vehicle technology improvements. Yet, given the magnitude of change in fuel consumption that is projected to be needed, improvements in vehicle technology and fuel may not be sufficient, particularly if VMT continues its pattern of long-term growth.

In order to achieve the reduction while accommodating a doubling of the population, the State would need to reduce the transportation related emissions to around 1 ton of CO_2e / capita. This is equivalent to driving a 25-mpg car using gasoline about 2,700 miles per year per capita.

ODOT analysis has shown that for the State to meet its goals, all strategies have to be employed: demand management, low carbon fuels, electric vehicles, and alternative modes including transit.

Gail Achterman, Chair of the Oregon Transportation Commission, recently addressed the issue of VMT growth, recognizing that while Oregon's land use policies have curtailed sprawl as a key factor in increasing VMT, VMT growth in Oregon is still being realized and is therefore being influenced by other factors.

Factors affecting the number of vehicle trips and each trip's distance (and thus VMT) made each day include (but are not limited to) age, income, population, household size, workers per household, auto ownership, access to transit, economic health/activity, and individual choice.

There are a number of studies that have begun to evaluate the effectiveness of different VMT reduction strategies.

4.1.3. Sustainability Overview

LTD has developed policies to advance the social, economic and environmental sustainability of the Eugene/Springfield metropolitan area. In the environmental sustainability policy, LTD commits to pursue action in the following four areas: Providing quality transit service, using environmentally friendly vehicles, constructing earth-friendly projects, and implementing sustainable operating practices.

Sustainable transportation systems generally address the impacts of transportation systems on three primary interconnected fronts: economic development, environmental preservation, and social development.

LTD is currently one of 13 transit agencies in the U.S. to achieve certification of a high international sustainability standard known as International Organization Standardization's 14001, which is a family of standards related to environmental management that helps organizations minimize how their operations negatively affect the environment, comply with requirements, and continually improve. Additionally, LTD developed and adopted an Environmental and Sustainability Management System, which is a set of management processes and procedures that allows an organization to analyze, control, and reduce the environmental impact of its activities, products and services and operate with greater efficiency and control. LTD also voluntarily signed on to the American Public Transportation Association's Sustainability Commitment, which helps transit agencies bring sustainability to the forefront of everyday practices by managing employee awareness, utility consumption, and internal prioritization of sustainability initiatives. LTD has achieved a Silver level of recognition for its efforts in utility reduction and employee training and engagement.

Transportation facilities and activities have significant sustainability impacts, including the following (Table 4.1-2):

Table 4.1-2. Transportation Impacts to Sustainability

Economic	Social	Environmental
Traffic congestion	Inequity of impacts and benefits	Air and water pollution
Mobility barriers	Human health impacts	Habitat loss
Facility costs	Community interaction	Hydrological impacts
Consumer costs	Community livability	Depletion of resources
	Aesthetics	

A number of factors suggest that increased transit use is a more sustainable transportation option, as compared to roadway modernization and capacity increases. The EC and EmX Alternatives being proposed for near term capital improvements programming on five corridors can play an important role in addressing sustainability by addressing these three areas of impact, both directly (e.g. by reducing operational energy consumption) and indirectly (e.g. by facilitating compacting development, conserving land and decreasing travel demand).

4.2. Effects Common to Most or All Build Alternatives

4.2.1. Energy

The construction of an EmX corridor has both positive and negative effects on transportation energy consumption. A positive effect is that people who formerly used a single-occupancy auto as their primary means of transportation may shift to using the EmX. As a result of this capture of new riders, the average daily VMT by auto should decline as compared to No-Build Alternatives, thereby saving fuel and GHGs. This decline in VMT would also result in less congestion on the roadways. The reduction in VMT could translate to a net energy benefit if enough automobile trips are shifted to transit trips. The same trends could apply to the EC Alternatives as compared to the No-Build, although at a smaller scale.

In addition, the EC and EmX Alternatives provide a more efficient means of transportation, as compared to passenger cars. Even as a bus or BRT vehicle consumes more energy than a passenger car, the average amount of energy utilized per passenger is far less. As an example, if the average vehicle occupancy of BRT vehicles is 15.7 passengers (based upon - The EmX Franklin Corridor BRT Project Evaluation [FTA, 2009]), and of passenger car vehicles is 1.67 in 2009, it would take an average of approximately 9.4 passenger cars to carry the average load of a BRT vehicle (15.7 / 1.67). The greatest advantage of buses and BRT vehicles over passenger vehicles is during peak hour trips, when buses and EmX vehicles tend to be at their highest occupancy and passenger cars tend to be at their lowest. There is far more peak hour utilization of buses and EmX vehicles than of autos as a percentage of total seat availability. Further, the roadway system at the peak hour commute times would be congested, impacting the emissions from passenger vehicles while BRT vehicles, which would generally operate outside of the congested lanes, would not be impacted. As a result of these factors, the amount of GHG emissions savings achieved is also most prominent during peak commuting times. Additionally, the project proposes to use hybrid-diesel powered BRT vehicles, and diesel motor fuel has approximately 12 percent more Btu's per gallon than gasoline (Transportation Energy Data Book, 2015). LTD has purchased five all-electric buses for regular and enhanced service (not BRT vehicles) and has been awarded a grant that will allow for the purchase of five more buses in the near future. The net effect of shifting a portion of the fleet from hybrid-diesel buses to electric buses would be a decrease in direct energy use and a decrease in GHG emissions.

Additionally, buses and BRT vehicles have "deadhead" miles, such as driving from the operating yard to the beginning of the first trip in the morning, and then back at the end of the day. Even though the buses and BRT vehicles are not carrying any passengers while deadheading, they are using fuel for such movements, which must be accounted for in the calculation of energy usage. The connectivity offered by the EmX system may have an advantage over typical bus routes in this regard. Typically, a bus has a very small passenger load when it begins a route, picks up passengers more-or-less constantly as it approaches its peak load point, most commonly the leading edge of the central business district, and then has a steadily decreasing passenger load as it nears the end of the route. The EmX system, which connects to other regional transportation systems and has terminus locations at major commercial and employment centers, is likely to have a greater number of passengers throughout the route during more times of the day in both directions.

Higher ridership levels result in less energy use per passenger, and therefore are a metric for evaluating the efficiency of the energy use of the EC and EmX Alternatives. A study of transit capacity indicated that operational improvements and BRT service have the potential to show a 30 to 200 percent increase in transit ridership (Rutsch 2008). Ridership studies on the Franklin Boulevard EmX Corridor show significant percentage increases over the average ridership on the Route 11 that existed prior to implementing EmX service. Between February 2007 and April 2008, the number of passengers per revenue hour increased from approximately 70 to 94 within 14 months, an increase of approximately 34 percent over the ridership on the fixed route bus service of Route 11 (FTA, 2009). After implementing EmX service on Franklin Boulevard, average weekday ridership rates rose substantially, from approximately 2,500 average weekday boardings on buses operating on Route 11 in 2006 to over 11,017 average weekday boardings on EmX in 2013.

In addition to potentially reducing direct energy consumption, the EC and EmX Alternatives have the potential to decrease the need for constructing more transportation infrastructure to reduce increasing congestion.

This potential for direct and indirect reduction in energy consumption must be balanced against the negative effects of the energy consumed by construction and maintenance of the EmX system. Manufacturing, maintaining and operating the BRT vehicles would also consume additional energy.

4.2.2. Sustainability

4.2.2.1. Climate Change Emissions

By moving more people with greater efficiency, the proposed EC and EmX Alternatives have the potential to reduce GHG emissions. A recent report funded through the Transit Cooperative Research Program found that public transportation reduces CO_2 emissions by 7.4 million metric tons annually (Gallivan, 2010). Davis and Hale (2007, September) estimate that at current levels of use public transit services avoid emissions of at least 6.9 million metric tons of CO_2 equivalent by substituting for automobile travel and reducing traffic congestion, and possibly much more by creating more accessible land use patterns. They estimate that a typical household could reduce its total greenhouse emissions by 25-30 percent by shifting from two vehicles to one vehicle, as can occur if they move from an automobile-dependent community to a transit-oriented development. One study estimated that by reducing vehicle travel, easing congestion and supporting more efficient land use patterns, public transportation reduces about 37 million metric tons of CO_2e emissions annually (Bailey et al., 2008).

Reductions in emissions are anticipated to be achieved by some of the EmX Alternatives through direct reductions in energy consumption, as riders choose public transportation in lieu of private vehicles, as well as indirect effects achieved through savings from improved traffic flow due to transit's impact on reducing congestion and secondary land use and travel reduction impacts, as the types and intensity of businesses and commercial areas along the corridor transition from current lower-intensity, more dispersed uses focused on the convenience of auto accessibility and toward more pedestrian-oriented centers of activity. For the EC Alternatives, the anticipated reduction in motor vehicle VMT may not be large enough to offset the increase in energy use due to operating more buses.

One way to compare the EC and EmX Alternatives to the No-Build Alternatives is to consider the amount that VMT is reduced. In this method, equivalent CO_2 production will be used to evaluate GHG emissions.

Different fuels emit different amounts of CO_2 in relation to the energy they produce. To compare emissions across fuels, the amount of equivalent CO_2 emitted per unit of energy output or heat content is evaluated. According to the EIA, the following pounds of CO_2 are emitted per million Btu of energy for the following fuels (EIA, 2016b):

- Diesel fuel and heating oil 161.3 pounds of CO_2
- Gasoline 157.2 pounds of CO_2

The U.S. national average annual output emission rate for generating electricity is 1,122.9 pounds of CO_2 per megawatt-hour, and the Northwest Power Pool Regional average (the region covering Oregon) is 907.0 pounds of CO_2 per megawatt-hour (EPA, 2014).

Calculation of CO_2e emissions reduced is based on auto VMT and subsequent energy use reductions. Because the EmX Alternatives have significant benefits over the No-Build Alternatives in terms of reductions in systemwide annual VMT, they have the potential to create a reduction in future air pollutants (CO_2e emissions) as more passengers shift from automobile trips to transit, bicycling, and walking. All of the EmX and EC Alternatives have negligible impacts to systemwide CO_2e pollutants over the No-Build Alternative because the reduction in motor vehicle VMT and CO_2e emissions is not usually large enough to offset the increase in bus VMT and CO_2e emissions.

Finally, transit can minimize its own GHG emissions by using efficient vehicles, alternative fuels, and decreasing the impact of capital project construction and service operations.

4.2.2.2. Air Quality

The EC and EmX Alternatives may impact air quality. For impacts to air quality, refer to the MovingAhead Air Quality Technical Report (MMA, 2017).

4.2.2.3. Water Quality

The EC and EmX Alternatives may impact water quality. For impacts to water quality, refer to the Water Quality, Floodplain, and Hydrology Technical Report.

4.2.2.4. Land Use Impacts

The EC and EmX Alternatives may impact land use. For impacts to land use, refer to the Land Use and Prime Farmlands Technical Report.

4.2.2.5. Ecosystems

The EC and EmX Alternatives may impact local ecosystems. For impacts to ecosystems, refer to the Ecosystems Technical Report.

4.2.2.6. Street and Landscape Trees

The EC and EmX Alternatives may impact street and landscape trees. For impacts to trees, refer to the Street and Landscape Trees Technical Report.

4.3. Long-Term Direct Impacts

Direct energy consumption involves energy used by the operation of vehicles. In assessing the direct energy impact, consideration was given to the following factors:

- Vehicle mix, including light-duty vehicles, medium trucks, and heavy trucks
- Annual VMT
- Variation of fuel consumption rates by vehicle type

The direct energy analysis for each alternative was based on projected year 2035 systemwide traffic volumes and VMT. The 2035 average daily traffic volumes for the system were obtained from the project-specific traffic analysis.

Direct energy consumption was calculated for the following factors:

- Change in energy use
- Change in GHG emissions

The factors are calculated from estimates of changes in automobile and transit VMT. All measures are converted from VMT into units using national level standard conversion factors. Units are monetized based on standard dollar values. Corridor VMT was separated into passenger miles, heavy truck miles, and bus miles to account for differences in energy consumption levels. Table 4.3-1 shows the Btus per VMT for each mode were taken from the FTA New Starts program standardized evaluation criteria.

Table 4.3-1. Change in Energy Use Factors, Current Year (Approx. 2015) and 20 Year Horizon (Approx. 2035) (Btu/VMT)

Mode	Current Year (Approx. 2015) (Btu/VMT)	20-year Horizon (Approx. 2035) (Btu/VMT)
Automobile	7,559	5,633
Bus – Diesel	41,436	33,978
Bus – Hybrid	33,149	27,182
Commuter Rail – Diesel (new) and DMU	96,138	96,138
Commuter Rail – Diesel (Used)	96,138	96,138
Heavy Truck[a]	21,542[a]	17,54[a]

Source: *New and Small Starts Evaluation and Rating Process Final Policy Guidance.* (FTA, 2013, August).

[a] Calculated for 2035 from data in EIA Annual Energy Outlook (EIA, 2015).

For application of these energy use factors, FTA defines "current year" as close to today as the data will permit. For these purposes, the current year factors apply to 2015 and the 20-year horizon factors apply for 2035 data.

The operational fuel energy used by vehicles (auto, bus, and heavy truck) was determined by multiplying VMT by the energy consumption levels estimated by vehicle type. Vehicle fuel energy use was calculated for the design year for all alternatives.

The energy use is monetized based on the economic dependence on imported petroleum for fuels. FTA uses a value of $0.20 per gallon of petroleum fuel. To convert from Btu to gallons of petroleum fuel, FTA uses conversion factors of 116,090 Btu per gallon of gasoline and 128,450 Btu per gallon of diesel fuel. The resulting monetization factors are $1.72 per million Btu for gasoline and $1.56 per million Btu for diesel fuel. Gasoline is assumed to be the sole fuel for changes in automobile VMT and diesel is assumed to be the sole fuel for changes in heavy truck and hybrid bus VMT for simplicity.

As described in Chapter 4 of this report, the calculation of the proposed unit rates for GHG emissions uses CO2e. This is a factor that converts all GHG emissions (including, but not limited to, CO2), which have different rates of affecting global warming, into CO2 terms. Table 4.3-2 shows the change in GHG emissions factors.

Table 4.3-2. Change in Greenhouse Gas (grams of CO_2e/VMT) Emissions Factors

Mode	Current Year	20-year Horizon
Automobile[a]	532	397
Bus – Diesel[a]	3,319	2,721
Bus – Hybrid[a]	2,655	2,177
Bus – Electric[a]	2,934	2,303
Heavy Truck[b]	1,485	1,108

[a] Source: *New and Small Starts Evaluation and Rating Process Final Policy Guidance* (FTA, 2013, August).
[b] Source: EPA. *Emissions Factors 2014*. 20 Year Horizon calculating using reduction ratio of automobile.

Operational fuel energy use for an alternative was translated into carbon output using CO_2 emissions standards published by the Transportation Energy Data Book, Table 11-11.

CO_2 emissions from a gallon of gasoline = 8,887 grams = 19.6 pounds / gallon

CO_2 emissions from a gallon of diesel = 10,180 grams = 22.4 pounds / gallon

(Note that many factors may affect these calculations, such as temperature and specific fuel blend, but for the purposes of this project the calculations will be used as the general standard.)

Once all of the energy consumption and GHG emission data were calculated, the various alternatives were compared to each other, including comparison to the No-Build Alternatives.

4.3.1. No-Build Alternative

Under the No-Build Alternatives, there are expected to be impacts due to the continued increase in automobile VMT and congestion. Additionally, the existing roadway system may eventually have to be renovated to meet future traffic demands. Should land use patterns and travel behavior continue as they exist today, it is anticipated that congestion would rise dramatically, increasing the cost of travel and reducing the efficiency of the region's roadway network, with resulting adverse impacts to energy use as well as to social and economic factors, such as worker accessibility and employers' ability to find employees. There are also anticipated higher user costs, including lost time and vehicle expenses.

4.3.2. Enhanced Corridor Alternative

Under the EC Alternatives, the VMT could continue to increase with congestion, but may be lower than the No-Build Alternative; the existing roadway system may eventually still have to be renovated to meet future traffic demands. Additionally, EC buses would also be affected by an increase in VMT and congestion because the buses mainly run in general purpose lanes in these corridor alternatives.

4.3.3. EmX Alternative

Under the EmX Alternatives, the increase in transit ridership is expected to cause a decrease in VMT and congestion when compared with the No-Build and EC Alternatives. BRT vehicles could be affected by changes in VMT and congestion in the segments of the corridors where it runs in mixed traffic.

4.4. Indirect and Cumulative Effects

Potential indirect impacts to energy consumption and sustainability policies were assessed for the No-Build, EC, and EmX Alternatives. This evaluation includes determining if future 2035 traffic volume forecasts and anticipated land use changes may potentially impact energy consumption and sustainability policies.

Cumulative impacts were qualitatively analyzed and based on comprehensive land use and transportation elements that are components of all build alternatives. This contextual analysis includes past, present and reasonably foreseeable future projects or actions occurring in the project area or the broader community which when combined with the project build alternatives, may lead to significant increases in energy consumption or conflicts with LTD's and the City of Eugene's adopted sustainability policies.

Construction and operation of any of the EC or EmX Alternatives is not expected to affect local or regional energy supplies or consumption. Compared to the No-Build Alternative, operation of most of the EC and EmX Alternatives would better support LTD's and the City of Eugene's adopted sustainability policies by reducing automobile VMT and increasing transit ridership.

4.5. Short-Term Construction-Related Impacts

Construction energy effects involve the one-time, non-recoverable energy costs associated with construction of roadways and structures. The construction energy analysis was conducted using the input / output method, a method developed by Caltrans to estimate the amount of energy used in the manufacture of materials and construction of projects (Talaga et al., 1983). The input / output method consists of multiplying construction costs by a Btu/dollar conversion factor to estimate the Btu required to construct a project. Three factors are considered in estimating the amount of construction energy expended for a project: energy used in mining and processing of raw materials and manufacturing of building materials; energy used to transport materials to the job site; and energy used at the job site during construction.

For this energy report, construction energy in Btu was estimated, converted to 1977 dollars (using conversion factors provided by Caltrans), then converted to 2016 dollars using the United States Consumer Price Index inflation calculator.

4.5.1. No-Build Alternative

Since construction work associated with the proposed project would not occur, the No-Build Alternatives are expected to consume the least amount of indirect energy.

4.5.2. Enhanced Corridor Alternative

The EC Alternatives would require some construction, but in general it would be significantly less than the amount of construction associated with the EmX Alternatives. The construction energy for the EC Alternatives was estimated from best available preliminary information. A lack of detailed information precluded a more thorough life cycle cost analysis. The construction energy for the EC Alternatives includes the manufacturing energy of the materials and estimates on the direct energy necessary to transport materials and place those materials. It should be noted that the energy consumption associated with construction could be highly variable, depending upon the source, manufacturing and transport of materials.

The cement used for bus-only lanes in all build alternatives would be much stronger than asphalt and would require less maintenance over time. Removing buses from the asphalt lanes could extend the life of those sections of the roadway.

4.5.3. EmX Alternative

The construction energy requires for the different EmX Alternatives was estimated from best available preliminary information. The EmX Alternatives contain the most sitework and construction, so are expected to have higher short-term energy costs than the No-Build and EC Alternatives. A lack of detailed information precluded a more thorough life cycle cost analysis. The construction energy required for the EmX Alternatives includes the manufacturing energy of the materials and estimates on the direct energy necessary to transport materials and place those materials. It should be noted that the energy consumption associated with construction could be highly variable, depending upon the source, manufacturing and transport of materials.

The cement used for bus-only lanes in the EmX Alternatives (as well as the Martin Luther King, Jr. Boulevard EC Alternative) is much stronger than asphalt and will require less maintenance over time. Removing buses from the asphalt lanes could extend the life of those sections of the roadway.

4.6. Potential Mitigation Measures

4.6.1. No-Build Alternative

4.6.1.1. Long-Term Impacts

Should land use patterns and travel behavior continue as they exist today, it is anticipated that congestion would continue to rise, increasing the cost of travel and reducing the efficiency of the region's roadway network, with possible adverse impacts to energy use and social and economic factors, such as worker accessibility and employers' ability to find employees. There are also anticipated higher user costs, including lost time and vehicle expenses. These impacts are further discussed in the Socioeconomics Technical Memo.

The increased congestion is expected to have a negative effect on air quality and ecosystems. These impacts are further discussed in the Air Quality Technical Memo and the Ecosystems Technical Memo.

4.6.1.2. Short-Term Impacts

No mitigation measures are assumed for short-term impacts in the No-Build Alternative for energy and sustainability; however, increases in traffic volumes over time would add to congestion in the system, and the existing roadway system may eventually have to be renovated to meet future traffic demands.

4.6.2. Enhanced Corridor and EmX Alternative

4.6.2.1. Long-Term Impacts

Several of the goals of the project are directed at reducing demand for energy and GHG emissions. There are negligible changes in overall energy consumption with the EC and EmX Alternatives as compared to the No-Build Alternative (less than 0.05 percent). As it is becoming increasingly important to reduce dependence on fossil fuels, overall energy needs, and GHG emissions, the following are some measures that could be incorporated into the project design to provide additional energy savings, in response to local and regional sustainability policies:

- Incorporate green building practices and design elements, such as, but not limited to:
  - Light colored (high-albedo) roofing materials, high-volume fly-ash concrete pavements, and sustainably harvested wood products
  - Use water-efficient and low maintenance landscaping
  - Use low carbon intensity building materials
  - Use locally sourced and reused building materials
  - Use energy efficient bulbs and appliances in traffic signals, street lights, and other electrical uses
  - Reduce unnecessary outdoor lighting
- Where streets are modified during construction, install street improvements that are bicycle and pedestrian friendly
- Implement low-impact development practices that maintain the existing hydrology of the site to manage storm water and protect the environment, where feasible
- Ensure that the project enhances, and does not disrupt or create barriers to, non-motorized transportation

In addition to energy and sustainability impacts, the following long term impacts are further discussed in other technical memos:

- New impervious area (see Water Quality Technical Memo)
- Wetland impacts (see Wetlands Technical Memo)
- Street and landscape tree removal and planting (see Street and Landscape Tree Technical Memo)
- Displaced businesses and employees (see Socioeconomics Technical Report)
- Lost tax revenue (see Socioeconomics Technical Report)
- Connectivity between employment centers, communities, and community resources (see Socioeconomics Technical Report)
- Social impacts (see Socioeconomics Technical Report)

4.6.2.2. Short-Term Impacts

Energy used in construction would be partially mitigated by operation of the system, which generally reduces the demand for energy in comparison with the No-Build Alternatives. During construction activities, potential mitigation measures to reduce energy and sustainability impacts include:

- Conserve and restore natural areas, where practicable
- Sort construction and demolition waste materials for reusable or recyclable materials
- Provide on-site collection and storage of recycled materials
- Institute procurement practices that: 1) require reuse of products and materials whenever possible, 2) avoid use of disposable goods in favor of durable goods whenever possible, 3) use locally sourced materials whenever possible, 4) reduce consumption of carbon-intensive good, and 5) use low carbon shipping methods
- Institute construction best management practices, such as, but not limited to:
  - Ensure that all construction equipment is properly tuned and maintained prior to and for the duration of onsite operation
  - Enforce and follow limits for idling time for vehicles, including delivery and construction vehicles
  - Use existing power sources or clean fuel generators rather than temporary power generators. Use on=site renewable energy production if possible

- Develop a traffic plan to minimize traffic flow interference from construction activities. The plan may include advance public notice of routing, use of public transportation, and satellite parking areas with a shuttle service
    - Minimize construction workforce travel to the project, by promoting travel demand management strategies and use of local workforces
    - Schedule operations affecting traffic for off-peak hours whenever possible
    - Minimize obstruction of through-traffic lanes

- Preserve or replant trees that are removed during development as a means of providing/maintaining carbon storage and shade for buildings

4.7. Permits and Approvals

No permits or approvals are required for potential impacts evaluated in this report. Permits and approvals are more specifically addressed in other technical reports for this project.

5. Highway 99 Corridor Environmental Consequences

5.1. Affected Environment

The following section evaluates the Highway 99 Corridor for future year No-Build, EC, and EmX Alternatives. Along this corridor, energy is consumed primarily for residential, commercial, and transportation purposes. Transportation energy for motor vehicles is primarily provided by direct combustion of petroleum fuels, with lesser contributions from compressed natural gas and electricity. Energy consumption is increased at heavily congested intersections. Several intersections in the study area are already heavily congested and traffic volumes are forecast to increase by 2035.

Bus rapid transit vehicles and frequent service buses operating within the corridor could help reduce reliance on private vehicles while typically providing a more efficient use of energy. These services provide more attractive alternatives to the automobile than regular service buses, and also tend to have higher ridership, which could reduce energy consumption per passenger.

5.2. Long-Term Direct Impacts

The long-term direct impacts of the proposed alternatives include changes to direct energy consumption. Energy measures include consumption, measured in Btu, and GHG emissions, measures in grams of CO_2e. The direct energy analysis for each alternative was based on projected year 2035 traffic volumes and regionwide VMT for cars, combination trucks, and buses.[1] Direct energy and GHG emissions consumption were calculated by multiplying energy use factors developed by the Federal Transit Administration (FTA, 2013) by average weekday VMT values.

5.2.1. No-Build Alternative

VMT is expected to increase as compared to existing conditions under the No-Build Alternative, with congestion increasing accordingly. The average weekday VMT, average energy use factors, and average weekday energy consumption are shown in Table 5.2-1.

Table 5.2-1. 2035 No-Build Alternative Regionwide Transportation Energy Consumption

Vehicle Type	Average Weekday VMT	Average Energy Use Factors (Btu/VMT)	Average Weekday Energy Consumption (Btu)
Automobile	5,044,992	5,633	28,418,400,000
Combination Truck	1,169,234	17,544	20,513,100,000
Buses / BRT Vehicles	15,482	27,182	420,800,000
Total	**6,229,708**		**49,352,300,000**

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016)
Average Energy Use and Cost Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013)

[1] Regionwide VMT provided to DKS Associates by Randy Parker, John Parker Consulting. Traffic modeling for alternatives was performed by Jennifer John, CH2M, and model data were provided to DKS Associates.

The average weekday VMT, CO_2e emissions factors, and total CO_2e emissions are shown in Table 5.2-2.

Table 5.2-2. 2035 No-Build Alternative Regionwide GHG Emissions

Vehicle Type	Average Weekday VMT	CO_2e Emissions Factors (grams CO_2e/VMT)	Total grams CO_2e
Automobile	5,044,992	397	2,002,900,000
Combination Truck	1,169,234	1,108	1,295,500,000
Buses / BRT Vehicles	15,482	2,177	33,700,000
Total	**6,229,708**		**3,332,100,000**

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

5.2.2. Enhanced Corridor Alternative

The EC Alternative would provide modest increases in bus services and facility enhancements such as new bus pullouts. Roadways and active transportation facilities would otherwise remain largely unchanged. The average weekday VMT, average energy use factors, and average weekday energy consumption are shown in Table 5.2-3.

The EC Alternative shows the potential to produce a modest decrease in VMT compared to the No-Build Alternative. However, the alternative does not indicate a potential to reduce energy consumption. This is because of the increase in bus VMT. Buses use more energy than automobiles per mile travelled. Even though buses consume a lot more energy than automobiles, they can transport a lot more people too. The data shown do not take into account that buses are associated with a lower energy use per person than automobiles and trucks. The automobile trips taken off the road by the increased transit service in this alternative do not create enough energy savings to offset the increase in energy from increased bus VMT.

Table 5.2-3. 2035 EC Alternative Regionwide Transportation Energy Consumption

Vehicle Type	Average Weekday VMT	Average Energy Use Factors (Btu/VMT)	Average Weekday Energy Consumption (Btu)
Automobile	5,043,693	5,633	28,411,100,000
Combination Truck	1,169,259	17,544	20,513,500,000
Buses / BRT Vehicles	15,749	27,182	428,100,000
Total	**6,228,701**		**49,352,700,000**
Change from No-Build	-1,007		500,000
Percent change from No-Build	-0.016%		0.001%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

The same average weekday VMT values were used to estimate the GHG emissions, measured in CO_2e, as shown in Table 5.2-4. Similar to the result for average weekday energy consumption, the EC Alternative does not show a potential to reduce GHG emissions.

Table 5.2-4. 2035 EC Alternative Regionwide GHG Emissions

Vehicle Type	Average Weekday VMT	CO_2e Emissions Factors (grams CO_2e/VMT)	Total grams CO_2e
Automobile	5,043,693	397	2,002,400,000
Combination Truck	1,169,259	1,108	1,295,500,000
Buses / BRT Vehicles	15,749	2,177	34,300,000
Total	**6,228,701**		**3,332,200,000**
Change from No-Build	-1,007		100,000
Percent change from No-Build	-0.016%		0.003%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016)
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August)

5.2.3. EmX Alternative

Significant improvements to transit facilities, including BAT lanes and queue jumps, would be provided in the EmX Alternative. Vehicle, pedestrian and bicycle facilities would also be enhanced in some locations. The average weekday VMT, average energy use factors, and average weekday energy consumption are shown in Table 5.2-5.

Total VMT has the potential to decrease more than in the No-Build and EC Alternatives because of more significant improvements to transit services. The EmX Alternative indicates the potential to reduce direct energy consumption, as total VMT could decrease enough to offset the increase in bus/BRT vehicle energy consumption. Buses / BRT vehicles use more energy than automobiles per mile travelled. Even though buses / BRT vehicles consume a lot more energy than automobiles, they can transport a lot more people too. The data shown do not take into account that buses / BRT vehicles are associated with a lower energy use per person than automobiles and trucks.

Table 5.2-5. 2035 EmX Alternative Regionwide Transportation Energy Consumption

Vehicle Type	Average Weekday VMT	Average Energy Use Factors (Btu/VMT)	Average Weekday Energy Consumption (Btu)
Automobile	5,041,568	5,633	28,399,200,000
Combination Truck	1,168,755	17,544	20,504,600,000
Buses / BRT Vehicles	16,181	27,182	439,800,000
Total	**6,226,504**		**49,343,600,000**
Change from No-Build	-3,204		-8,600,000
Percent change from No-Build	-0.05%		-0.02%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

The same average weekday VMT values were used to calculate the GHG emissions, measured in CO_2e, as shown in Table 5.2-6. The EmX Alternative shows the potential to slightly reduce GHG emissions relative to the No-Build Alternative. The automobile trips taken off the road by the increased transit service in this alternative have the potential to create enough of an emissions reduction to offset the increase in emissions from increased BRT vehicle VMT.

Table 5.2-6. 2035 EmX Alternative Regionwide GHG Emissions

Vehicle Type	Average Weekday VMT	CO_2e Emissions Factors (grams CO_2e/VMT)	Total grams CO_2e
Automobile	5,043,693	397	2,001,500,000
Combination Truck	1,169,259	1,108	1,295,000,000
Buses / BRT Vehicles	15,749	2,177	35,200,000
Total	**6,228,701**		**3,331,700,000**
Change from No-Build	-3,204		-400,000
Percent change from No-Build	-0.05%		-0.01%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August)

5.2.4. Annualized Impacts & Costs

The total annualized costs associated with energy consumption and GHG emissions are shown in Table 5.2-7, and will be incorporated into a total environmental benefit analysis using data from the Air Quality Technical Report, Transportation Technical Report, Capital Cost Estimating Report, and Operations and Maintenance Costs Technical Report.

The annualized impacts were based on the assumption that all buses would be hybrid-diesel buses. If LTD were to convert a portion of their fleet to electric buses, the energy consumption and GHG emissions costs would be reduced for all alternatives, including the No-Build Alternative. If additional electric buses were acquired for the EC Alternative, the total value of the EC Alternative improvement could increase slightly, as both the energy consumption and the GHG emissions would be expected to decrease.

Table 5.2-7. 2035 Estimated Regionwide Annual Costs Compared to No-Build Alternative

Annual Value	EC Alternative	EmX Alternative
Decrease (Increase) in Energy Consumption, million Btu	160	3,651
Energy Value of Improvement	$649.01	$6,749.63
Decrease (Increase) in GHG Emissions, metric tons CO_2e	(9)	180
GHG Emissions Value of Improvement	-$496.68	$10,277.97
Total Value of Improvement	**$152.34**	**$17,027.61**

Source: DKS. (2016).

Cost Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

The energy consumption and GHG emissions costs were developed using the following cost factors from FTA's New Starts and Small Starts Final Policy Guidance document (FTA, 2013):

- $1.72 per million Btu for gasoline (assumed as sole fuel for auto VMT)
- $1.56 per million Btu for diesel fuel (assumed as sole fuel for heavy truck and diesel-hybrid bus VMT)
- $57 per metric ton of CO_2e as the midrange 2035 estimate of the social cost of carbon

An annualization factor[2] of 342 was used to estimate annual automobile and heavy truck VMT based on average weekday VMT data. Annualized bus VMT was provided by LTD.

5.3. Long-Term Indirect Impacts

Indirect energy impacts involve ongoing vehicle maintenance and repair energy. Indirect energy is calculated by determining the energy equivalent of all of the material products and operations necessary to keep the transportation system operable. The indirect energy analysis was conducted by converting regionwide VMT for each alternative into energy consumption.

While not quantified here, roadway maintenance may increase for higher bus service, except when cement improvements are made to the roadway that could result in lower maintenance and energy associated with maintenance for the roadways repairs over the long term.

5.3.1. No-Build Alternative

The regionwide indirect energy associated with vehicle maintenance and repair energy is shown in Table 5.3-1.

Table 5.3-1. 2035 No-Build Alternative Regionwide Maintenance and Repair Energy

Vehicle Type	Maintenance / Repair Energy (Btu / mile)	Tires (Btu / mile)	Oil (Btu / mile)	VMT	Maintenance / Repair Energy (Btu)
Automobile	815	316	308	5,044,992	7,259,700,000
Combination Truck	1,592	725	1,199	1,169,234	4,111,000,000
Bus / BRT Vehicle	13,142	-	-	15,482	203,500,000
Total				**6,229,708**	**11,574,200,000**

Source: DKS. (2016).

5.3.2. Enhanced Corridor Alternative

The regionwide indirect energy associated with vehicle maintenance and repair energy is shown in Table 5.3-2. The EC Alternative does not indicate the potential to decrease in maintenance and repair

[2] The annualization factor was calculated based on 2015 traffic volume data from ODOT's Automated Traffic Recording (ATR) stations. An average value was applied based on the six ATR stations located in the Eugene-Springfield region.

energy as compared to the No-Build Alternative. This is due to the more intensive energy required for maintaining buses as compared to other vehicles.

Table 5.3-2. 2035 EC Alternative Regionwide Maintenance and Repair Energy

Vehicle Type	Maintenance / Repair Energy (Btu / mile)	Tires (Btu / mile)	Oil (Btu / mile)	VMT	Maintenance / Repair Energy (Btu)
Automobile	815	316	308	5,043,693	7,257,900,000
Combination Truck	1,592	725	1,199	1,169,259	4,111,100,000
Bus / BRT Vehicle	13,142	-	-	15,749	207,000,000
Total				**6,228,701**	**11,576,000,000**
Change from No-Build				-1,007	2,000,000
Percent change from No-Build				-0.016%	0.015%

Source: DKS. (2016).

5.3.3. EmX Alternative

The regionwide indirect energy associated with vehicle maintenance and repair energy is shown in Table 5.3-3. The EmX alternative does not indicate the potential to decrease maintenance and repair energy compared to the No-Build Alternative. This is due to more intensive energy required for maintaining BRT vehicles as compared to other vehicles.

Not reflected in Table 5.3-3 for vehicle maintenance is the maintenance for roadways. The cement used for bus-only lanes in the EmX Alternative is much stronger than asphalt and will require less maintenance over time. Removing buses from the asphalt lanes could extend the life of those sections of the roadway.

Table 5.3-3. 2035 EmX Alternative Regionwide Maintenance and Repair Energy

Vehicle Type	Maintenance / Repair Energy (Btu / mile)	Tires (Btu / mile)	Oil (Btu / mile)	VMT	Maintenance / Repair Energy (Btu)
Automobile	815	316	308	5,041,568	7,254,800,000
Combination Truck	1,592	725	1,199	1,168,755	4,109,300,000
Bus / BRT Vehicle	13,142	-	-	16,181	212,700,000
Total				**6,226,504**	**11,576,800,000**
Change from No-Build				-3,204	2,600,000
Percent change from No-Build				-0.05%	0.02%

Source: DKS. (2016).

5.4. Total Long-Term Impacts

Total energy impacts account for direct energy consumed by vehicles, vehicle emissions, and vehicle maintenance and repair energy. Energy impacts are assessed based on the projected future VMT, which is influenced by projected changes in land use patterns, population growth, and programmed transportation improvements.

5.4.1. No-Build Alternative

The total long-term energy use (sum of direct impacts and maintenance energy) is shown in Table 5.4-1.

Table 5.4-1. 2035 Total Long-Term Regionwide Energy Impacts

Energy Type	No-Build Energy Use (Btu)
Direct Energy (Btu)	49,352,300,000
CO_2e Equivalent Energy (Btu)[a]	62,830,600,000
Maintenance Energy (Btu)	11,574,200,000
Total	**123,757,100,000**

Source: DKS. (2016).

[a] CO_2e energy was converted from grams CO_2 to Btu by multiplying grams by 18.856 Btu / gram (1 therm = 5,302 grams CO_2; 99,976.1 Btu = 1 therm) to calculate total energy use.

5.4.2. Enhanced Corridor Alternative

The total long-term energy use (sum of direct impacts and maintenance energy) is shown in Table 5.4-2. The EC Alternative does not indicate potential to decrease total energy use in the region as compared to the No-Build Alternative.

Table 5.4-2. 2035 Total Long-Term Regionwide Energy Impacts

Energy Type	No-Build Energy Use (Btu)	EC Alternative Energy Use (Btu)	Change from No-Build (Btu)	Percent Change from No-Build
Direct Energy (Btu)	49,352,300,000	49,352,700,000	400,000	0.001%
CO_2e Equivalent Energy (Btu)[a]	62,830,600,000	62,832,400,000	1,800,000	0.003%
Maintenance Energy (Btu)	11,574,200,000	11,576,000,000	1,800,000	0.016%
Total	**123,757,100,000**	**123,761,100,000**	**4,000,000**	**0.003%**

Source: DKS. (2016).

[a] CO_2e energy was converted from grams CO_2 to Btu by multiplying grams by 18.856 Btu / gram (1 therm = 5,302 grams CO_2; 99,976.1 Btu = 1 therm) to calculate total energy use.

5.4.3. EmX Alternative

The total long-term energy use (sum of direct impacts and maintenance energy) is shown in Table 5.4-3. The EmX Alternative indicates the potential to slightly decrease total energy use in the region as compared to the No-Build Alternative.

Table 5.4-3. 2035 Total Long-Term Regionwide Energy Impacts

Energy Type	No-Build Energy Use (Btu)	EmX Alternative Energy Use (Btu)	Change from No-Build (Btu)	Percent Change from No-Build
Direct Energy (Btu)	49,352,300,000	49,343,600,000	-8,700,000	-0.018%
CO_2e Equivalent Energy (Btu)[a]	62,830,600,000	62,823,700,000	-6,900,000	-0.011%
Maintenance Energy (Btu)	11,574,200,000	11,576,800,000	2,600,000	0.022%
Total	**123,757,100,000**	**123,744,100,000**	**-13,000,000**	**-0.011%**

Source: DKS. (2016).

[a] CO_2e energy was converted from grams CO_2 to Btu by multiplying grams by 18.856 Btu / gram (1 therm = 5,302 grams CO_2; 99,976.1 Btu = 1 therm) to calculate total energy use.

5.5. Short-Term Construction-Related Impacts

Construction energy effects involve the one-time, non-recoverable energy costs associated with construction of roadways and structures. It should be noted that the energy consumption associated with construction could be highly variable, depending on the source, manufacturing, and transport of materials. The construction energy analysis was conducted using the Input-Output Method, which converts Year 1977 construction dollars into energy consumption.

5.5.1. No-Build Alternative

There are no construction activities associated with the No-Build Alternative. No construction energy use was assumed for the No-Build Alternative.

5.5.2. Enhanced Corridor Alternative

The estimated construction energy for the EC Alternative is shown in Table 5.5-1. The estimate considers only construction for new lanes, new stations and terminals, sitework, and new traffic signals. All of the values listed reflect increases as compared to the No-Build Alternative.

Table 5.5-1. EC Alternative Construction Energy Use (Btu x 10^9)

	Construction Energy Measure / $1977	Quantity	Total Construction Energy (Btu x 10^9 / $1977)	Total Construction Energy (Btu x 10^9)
Bus and Turning Lanes	2.46 Btu x 10^9 per lane mile	1.5	3.69	14.6
Stations and Terminals	3.25 Btu x 10^9 per station	0	0	0
Sitework	0.88 Btu x 10^9 per lane mile	4.0	3.56	14.1
Traffic Signals	5,000,000 Btu / signal	8	0.04	0.16
Total			**7.29**	**28.9**

Source: Calculated based on factors provided in *West Eugene EmX Extension Project Energy and Sustainability Technical Memo*, Table 6-5

5.5.3. EmX Alternative

The estimated construction energy for the EmX Alternative is shown in Table 5.5-2. The estimate considers only construction for new lanes, new stations and terminals, sitework, and new traffic signals. All of the values listed reflect increases as compared to the No-Build Alternative. The one-time energy use associated with the EmX Alternative is expected to be approximately 10 times greater than the one-time energy use associated with the EC Alternative.

Table 5.5-2. EmX Alternative Construction Energy Use (Btu x 10^9)

	Construction Energy Measure / $1977	Quantity	Total Construction Energy (Btu x 10^9 / $1977)	Total Construction Energy (Btu x 10^9)
Bus and Turning Lanes	2.46 Btu x 10^9 per mile	2.8	6.89	27.3
Stations and Terminals	3.25 Btu x 10^9 per station	16	52	206.44
Sitework	0.88 Btu x 10^9 per mile	4.3	3.78	15.0
Traffic Signals	5,000,000 Btu / signal	8	0.04	0.16
Total			**62.7**	**249**

Source: Calculated based on factors provided in *West Eugene EmX Extension Project Energy and Sustainability Technical Memo*, Table 6-5

5.6. Potential Mitigation Measures

Potential mitigation measures for the No-Build, EC, and EmX Alternatives are detailed in Section 4.6.

5.7. Permits and Approvals

No permits or approvals are required for potential impacts evaluated in this report. Permits and approvals are more specifically addressed in other technical reports for this project.

5.8. Summary of Findings

5.8.1. Long-Term Direct Impacts

The following long-term direct impacts are expected for the No-Build Alternative:

- Limited potential for sufficient mode shifts away from motor vehicle travel to transit to improve energy use and sustainability
- Adverse impacts to sustainability compared to build alternatives, including air quality, safety, health, vehicle costs, and mobility options for Title VI and environmental justice populations
- Inconsistent with applicable goals and policies related to GHG reductions and sustainability

The following long-term direct impacts are expected for the EC Alternative:

- Potential for regionwide reduction in VMT as compared to No-Build Alternative
- Not potential to reduce fossil fuel consumption and GHG emissions as compared to No-Build Alternative, due to increase in bus VMT but not a large enough reduction in auto VMT

The following long-term direct impacts are expected for the EmX Alternative:

- Potential for regionwide reduction in VMT as compared to No-Build Alternative
- Potential to reduce fossil fuel consumption and GHG emissions as compared to No-Build Alternative, as total VMT could decrease enough to offset the increase in transit energy consumption
- Support nodal development, resulting in gradual transition from current lower-intensity, auto-oriented land use pattern, toward more pedestrian-oriented center of activity, with resulting benefits including:
    - Decrease in the distances people need to travel to reach destinations
    - Fewer automobile trips and emissions
    - Preservation of open space and resource lands
    - Ancillary sustainability benefits, including:
        - Increased safety
        - Health benefits
        - Vehicle cost savings
    - Improved mobility and transportation options for Title VI and environmental justice populations
    - Increased property values
    - Deferred costs for roadway capacity improvements
    - Increase in pollution generating surfaces

The direct energy calculations are covered in Section 5.2.

5.8.2. Long-Term Indirect Impacts

There would be limited potential for future reduction in indirect energy consumption for the No-Build Alternative.

For the EC and EmX Alternatives, there would not be potential for decreasing indirect energy compared to No-Build Alternative due to the more intensive energy required for maintaining transit vehicles.

The indirect energy calculations are covered in Section 5.3.

5.8.3. Short-Term Construction-Related Impacts

For the No-Build Alternative, there would be no short-term construction-related impacts.

The following short-term construction-related impacts are expected for the EC and EmX Alternatives:

- Construction-related energy use and emissions
- Jobs creation and related economic benefits

The short-term construction-related impact calculations are covered in Section 5.5.

5.8.4. Mitigation Measures

For the No-Build Alternative, there would be no mitigation measures.

The following mitigation measures could be achieved for the EC and EmX Alternatives:

- Energy-related best management practices during construction
- Sustainable procurement practices
- Recycling and reuse of construction and demolition materials
- Preserve or replant trees

The mitigation measures are covered in greater detail in Section 4.6.

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6. River Road Corridor Environmental Consequences

6.1. Affected Environment

The following section evaluates the River Road Corridor for future year No-Build, EC, and EmX Alternatives. In this corridor, energy is consumed primarily for residential, commercial, and transportation purposes. Transportation energy for motor vehicles is primarily provided by direct combustion of petroleum fuels, with lesser contributions from compressed natural gas and electricity. Energy consumption is increased at heavily congested intersection. Several intersections in the study area are already heavily congested and traffic volumes are forecasted to increase by 2035.

Bus rapid transit vehicles and frequent service buses operating within the corridor could help reduce reliance on private vehicles while typically providing a more efficient use of energy. These services provide more attracted alternatives to the automobile than regular service buses, and tend to have higher ridership, which could reduce energy consumption per passenger.

6.2. Long-Term Direct Impacts

The long-term direct impacts of the proposed alternatives include changes to direct energy consumption. Energy measures include consumption, measured in Btu, and GHG emissions, measures in grams of CO_2e. The direct energy analysis for each alternative was based on projected year 2035 traffic volumes and regionwide VMT for cars, combination trucks, and buses.[3] Direct energy and GHG emissions consumption were calculated by multiplying energy use factors developed by the Federal Transit Administration (FTA, 2013) by average weekday VMT values.

6.2.1. No-Build Alternative

VMT is expected to increase as compared to existing conditions under the No-Build Alternative, with congestion increasing accordingly. The average weekday VMT, average energy use factors, and average weekday energy consumption are shown in Table 6.2-1.

Table 6.2-1. 2035 No-Build Alternative Transportation Energy Consumption

Vehicle Type	Average Weekday VMT	Average Energy Use Factors (Btu / VMT)	Average Weekday Energy Consumption (Btu)
Automobile	5,044,992	5,633	28,418,500,000
Combination Truck	1,169,234	17,544	20,513,000,000
Buses / BRT Vehicles	15,482	27,182	420,800,000
Total	**6,229,708**		**49,352,300,000**

Source: DKS. (2016).

[3] Regionwide VMT provided to DKS Associates by Randy Parker, John Parker Consulting. Traffic modeling for alternatives was performed by Jennifer John, CH2M, and model data were provided to DKS Associates.

The average weekday VMT, CO_2e emissions factors, and total CO_2e values are shown in Table 6.2-2.

Table 6.2-2. 2035 No-Build Alternative Regionwide GHG Emissions

Vehicle Type	Average Weekday VMT	CO_2e Emissions Factors (grams CO_2e / VMT)	Total Grams of CO_2e
Automobile	5,044,992	397	2,002,900,000
Combination Truck	1,169,234	1,108	1,295,500,000
Buses / BRT Vehicles	15,482	2,177	33,700,000
Total	**6,229,708**		**3,332,100,000**

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016)
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August)

6.2.2. Enhanced Corridor Alternative

The EC Alternative would provide modest increases in bus services and facility enhancements such as new bus pullouts. Roadways and active transportation facilities would otherwise remain largely unchanged. The average weekday VMT, average energy use factors, and average weekday energy consumption are shown in Table 6.2-3.

The EC Alternative shows the potential to produce a modest decrease in VMT compared to the No-Build Alternative. Additionally, the alternative shows the potential to slightly reduce energy consumption. This is the automobile trips potentially taken off the road by the increased transit service in this alternative create enough energy savings to offset the increased bus energy. Buses use more energy than automobiles per mile travelled. Even though buses consume a lot more energy than automobiles, they can transport a lot more people too. The data shown do not take into account that buses are associated with a lower energy use per person than automobiles and trucks.

Table 6.2-3. 2035 EC Alternative Transportation Energy Consumption

Vehicle Type	Average Weekday VMT	Average Energy Use Factors (Btu / VMT)	Average Weekday Energy Consumption (Btu)
Automobile	5,044,445	5,633	28,415,400,000
Combination Truck	1,169,088	17,544	20,510,400,000
Buses / BRT Vehicles	15,557	27,182	422,900,000
Total	**6,229,090**		**49,348,700,000**
Change from No-Build	-618		-3,600,000
Percent change from No-Build	-0.010%		-0.007%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

The same average weekday VMT values were used to calculate the GHG emissions, measured in CO_2e, as shown in Table 6.2-4. The EC Alternative shows the potential to slightly reduce GHG emissions relative to the No-Build Alternative. The automobile trips taken off the road by the increased transit service in this alternative have the potential to create enough of an emissions reduction to offset the increase in emissions from increased bus VMT.

Table 6.2-4. 2035 EC Alternative GHG Emissions

Vehicle Type	Average Weekday VMT	CO_2e Emissions Factors (grams CO_2e/VMT)	Total Grams of CO_2e
Automobile	5,044,445	397	2,002,600,000
Combination Truck	1,169,088	1,108	1,295,400,000
Buses / BRT Vehicles	15,557	2,177	33,900,000
Total	**6,229,090**		**3,331,900,000**
Change from No-Build	-618		-200,000
Percent change from No-Build	-0.010%		-0.006%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

6.2.3. EmX Alternative

Significant improvements to transit facilities, including BAT lanes and queue jumps, would be provided in the EmX Alternative. Vehicle, pedestrian and bicycle facilities would also be enhanced in some locations. The average weekday VMT, average energy use factors, and average weekday energy consumption are shown in Table 6.2-5.

The EmX Alternative does not indicate a potential to reduce energy consumption as compared to the No-Build Alternative. This is because of the increase in BRT vehicle VMT. BRT vehicles use more energy than automobiles per mile travelled. Even though BRT vehicles consume a lot more energy than automobiles, they can transport a lot more people too. The data shown do not take into account that BRT vehicles are associated with a lower energy use per person than automobiles and trucks. The automobile trips taken off the road by the increased transit service in this alternative do not create enough energy savings to offset the increase in energy from increased bus VMT.

Table 6.2-5. 2035 EmX Alternative Transportation Energy Consumption

Vehicle Type	Average Weekday VMT	Average Energy Use Factors (Btu / VMT)	Average Weekday Energy Consumption (Btu)
Automobile	5,043,776	5,633	28,411,600,000
Combination Truck	1,169,008	17,544	20,509,000,000
Buses / BRT Vehicles	16,293	27,182	442,900,000
Total	**6,229,077**		**49,363,500,000**

Table 6.2-5. 2035 EmX Alternative Transportation Energy Consumption

Vehicle Type	Average Weekday VMT	Average Energy Use Factors (Btu / VMT)	Average Weekday Energy Consumption (Btu)
Change from No-Build	-631		11,223,975
Percent change from No-Build	-0.010%		0.023%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).

The same average weekday VMT values were used to estimate the GHG emissions, measured in CO_2e, as shown in Table 6.2-6. Similar to the result for average weekday energy consumption, the EmX Alternative does not show a potential to reduce GHG emissions.

Table 6.2-6. 2035 EmX Alternative GHG Emissions

Vehicle Type	Average Weekday VMT	CO_2e Emissions Factors (grams CO_2e/VMT)	Total Grams of CO_2e
Automobile	5,043,776	397	2,002,379,072
Combination Truck	1,169,008	1,108	1,295,260,449
Buses / BRT Vehicles	16,293	2,177	35,469,861
Total	**6,229,077**		**3,333,109,382**
Change from No-Build	-631		1,032,032
Percent Change from No-Build	-0.010%		0.031%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).

6.2.4. Annualized Impacts and Costs

The total annualized costs associated with energy consumption and GHG emissions are shown in Table 6.2-7, and will be incorporated into a total environmental benefit analysis using data from the Air Quality Technical Report, Transportation Technical Report, Capital Cost Estimating Report, and Operations and Maintenance Costs Technical Report.

The annualized impacts were based on the assumption that all buses would be hybrid-diesel buses. If LTD were to convert a portion of their fleet to electric buses, the energy consumption and GHG emissions costs would be reduced for all alternatives, including the No-Build Alternative. If additional electric buses were acquired for the EC Alternative, the total value of the EC Alternative improvement could increase slightly, as both the energy consumption and the GHG emissions would be expected to decrease.

Table 6.2-7. 2035 Estimated Regionwide Annual Costs for All Alternatives

Annual Value	EC Alternative	EmX Alternative
Decrease (Increase) in Energy Consumption, million Btu	1,192	(2,398)
Energy Value of Improvement	$2,028.04	($3,367.09)
Decrease (Increase) in GHG Emissions, metric tons CO_2e	70	(238)
GHG Emissions Value of Improvement	$4,016.91	($13,542.33)
Total Value of Improvement	**$6,044.95**	**($16,909.42)**

Source: DKS. (2016).

Cost Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August)

The energy consumption and GHG emissions costs were developed using the following cost factors from FTA's New Starts and Small Starts Final Policy Guidance document (FTA, 2013):

- $1.72 per million Btu for gasoline (assumed as sole fuel for auto VMT)
- $1.56 per million Btu for diesel fuel (assumed as sole fuel for heavy truck and diesel-hybrid bus VMT)
- $57 per metric ton of CO_2e as the midrange 2035 estimate of the social cost of carbon

An annualization factor[4] of 342 was used to estimate annual VMT based on average weekday VMT data. Annualized bus VMT was provided by LTD.

6.3. Long-Term Indirect Impacts

Indirect energy effects involve ongoing vehicle maintenance and repair energy. Indirect energy is calculated by determining the energy equivalent of all of the material products and operations necessary to keep the transportation system operable. The indirect energy analysis was conducted by converting regionwide VMT for each alternative into energy consumption.

While not quantified here, roadway maintenance may increase for higher bus service, except when cement improvements are made to the roadway which could, in the long-term, result in lower maintenance and energy associate with maintenance for the roadways repairs.

6.3.1. No-Build Alternative

The regionwide indirect energy associated with vehicle maintenance and repair is shown in Table 6.3-1.

[4] The annualization factor was calculated based on 2015 traffic volume data from ODOT's ATR stations. An average value was applied based on the six ATR stations located in the Eugene-Springfield region.

Table 6.3-1. 2035 No-Build Alternative Regionwide Maintenance and Repair Energy

Vehicle Type	Maintenance / Repair Energy (Btu / mile)	Tires (Btu / mile)	Oil (Btu / mile)	VMT	Maintenance / Repair Energy (Btu)
Automobile	815	316	308	5,044,992	7,259,700,000
Combination Truck	1,592	725	1,199	1,169,234	4,111,000,000
Bus/BRT Vehicle	13,142	-	-	15,482	203,500,000
Total				**6,229,708**	**11,574,200,000**

Source: DKS. (2016).

6.3.2. Enhanced Corridor Alternative

The regionwide indirect energy associated with vehicle maintenance and repair energy is shown in Table 6.3-2. The EC Alternative indicates the potential for decrease in maintenance and repair energy as compared to the No-Build Alternative.

Table 6.3-2. 2035 EC Alternative Regionwide Maintenance and Repair Energy

Vehicle Type	Maintenance / Repair Energy (Btu / mile)	Tires (Btu / mile)	Oil (Btu / mile)	VMT	Maintenance / Repair Energy (Btu)
Automobile	815	316	308	5,044,445	7,258,900,000
Combination Truck	1,592	725	1,199	1,169,088	4,110,500,000
Bus/BRT Vehicle	13,142	-	-	15,557	204,500,000
Total				**6,229,090**	**11,573,900,000**
Change from No-Build				-618	-300,000
Percent change from No-Build				-0.010%	-0.003%

Source: DKS. (2016).

6.3.3. EmX Alternative

The regionwide indirect energy associated with vehicle maintenance and repair energy is shown in Table 6.3-3. The EmX alternative does not indicate the potential to decrease maintenance and repair energy compared to the No-Build Alternative. This is due to more intensive energy required for maintaining BRT vehicles as compared to other vehicles.

Not reflected in Table 6.3-3 for vehicle maintenance is the maintenance for roadways. The cement used for bus-only lanes in the EmX Alternative is much stronger than asphalt and will require less maintenance over time. Removing buses from the asphalt lanes could extend the life of those sections of the roadway.

Table 6.3-3. 2035 EmX Alternative Regionwide Maintenance and Repair Energy

Vehicle Type	Maintenance / Repair Energy (Btu / mile)	Tires (Btu / mile)	Oil (Btu / mile)	VMT	Maintenance / Repair Energy (Btu)
Automobile	815	316	308	5,043,776	7,258,000,000
Combination Truck	1,592	725	1,199	1,169,008	4,110,200,000
Bus/BRT Vehicle	13,142	-	-	16,293	214,100,000
Total				**6,229,077**	**11,582,300,000**
Change from No-Build				-631	8,100,000
Percent change from No-Build				-0.010%	0.070%

Source: DKS. (2016).

6.4. Total Long-Term Impacts

Total energy impacts account for direct energy consumed by vehicles, vehicle emissions, and vehicle maintenance and repair energy. Energy impacts are assessed based on the projected future VMT, which is influenced by projected changes in land use patterns, population growth, and programmed transportation improvements.

6.4.1. No-Build Alternative

The total long-term energy use (sum of direct impacts and maintenance energy) is shown in Table 6.4-1.[5]

Table 6.4-1. 2035 Total Long-Term Regionwide Energy Impacts

Energy Type	No-Build Energy Use (Btu)
Direct Energy (Btu)	49,352,300,000
CO_2e Equivalent Energy (Btu)[a]	62,830,600,000
Maintenance Energy (Btu)	11,574,200,000
Total	**123,757,100,000**

Source: DKS. (2016).

[a] CO_2e energy was converted from grams CO_2 to Btu by multiplying grams by 18.856 Btu / gram (1 therm = 5,302 grams CO_2; 99,976.1 Btu = 1 therm) to calculate total energy use.

[5] CO_2e energy was converted from grams CO_2 to Btu by multiplying grams by 18.856 Btu/ gram (1 therm = 5,302 grams CO_2; 99976.1 Btu = 1 therm).

6.4.2. Enhanced Corridor Alternative

The total long-term energy use (sum of direct impacts and maintenance energy) is shown in Table 6.4-2. The EC Alternative indicate the potential to decrease total energy use in the region as compared to the No-Build Alternative.

Table 6.4-2. 2035 Total Long-Term Regionwide Energy Impacts

Energy Type	No-Build Energy Use (Btu)	EC Alternative Energy Use (Btu)	Change from No-Build (Btu)	Percent Change from No-Build
Direct Energy (Btu)	49,352,300,000	49,348,700,000	-3,600,000	-0.007%
CO2e Equivalent Energy (Btu)[a]	62,830,600,000	62,826,600,000	-4,000,000	-0.006%
Maintenance Energy (Btu)	11,574,200,000	11,573,900,000	-300,000	-0.003%
Total	**123,757,100,000**	**123,749,200,000**	**-7,900,000**	**-0.006%**

Source: DKS. (2016).

[a] CO_2e energy was converted from grams CO_2 to Btu by multiplying grams by 18.856 Btu / gram (1 therm = 5,302 grams CO_2; 99,976.1 Btu = 1 therm) to calculate total energy use.

6.4.3. EmX Alternative

The total long-term energy use (sum of direct impacts and maintenance energy) is shown in Table 6.4-3. The EmX Alternative does not indicate the potential to decrease total energy use in the region as compared to the No-Build Alternative.

Table 6.4-3. 2035 Total Long-Term Regionwide Energy Impacts

Energy Type	No-Build Energy Use (Btu)	EmX Alternative Energy Use (Btu)	Change from No-Build (Btu)	Percent Change from No-Build
Direct Energy (Btu)	49,352,300,000	49,363,500,000	11,200,000	0.023%
CO2e Equivalent Energy (Btu)[a]	62,830,600,000	62,850,100,000	19,500,000	0.031%
Maintenance Energy (Btu)	11,574,200,000	11,582,300,000	8,100,000	0.070%
Total	**123,757,100,000**	**123,795,900,000**	**38,800,000**	**0.031%**

Source: DKS. (2016).

[a] CO_2e energy was converted from grams CO_2 to Btu by multiplying grams by 18.856 Btu / gram (1 therm = 5,302 grams CO_2; 99,976.1 Btu = 1 therm) to calculate total energy use.

6.5. Short-Term Construction-Related Impacts

Construction energy effects involve the one-time, non-recoverable energy costs associated with construction of roadways and structures. It should be noted that the energy consumption associated with construction could be highly variable, depending on the source, manufacturing, and transport of materials. The construction energy analysis was conducted using the Input-Output Method, which converts Year 1977 construction dollars into energy consumption.

6.5.1. No-Build Alternative

There are no construction activities associated with the No-Build Alternative. No construction energy use was assumed for the No-Build Alternative.

6.5.2. Enhanced Corridor Alternative

The estimated construction energy for the EC Alternative is shown in Table 6.5-1. The estimate considers only construction for new lanes, new stations and terminals, sitework, and new traffic signals. All of the values listed reflect increases as compared to the No-Build Alternative.

Table 6.5-1. EC Alternative Construction Energy Use (Btu x 10^9)

	Construction Energy Measure / $1977	Quantity	Total Construction Energy (Btu x 10^9 / $1977)	Total Construction Energy (Btu x 10^9)
Bus and Turning Lanes	2.46 Btu x 10^9 per mile	1.9	4.67	18.6
Stations and Terminals	3.25 Btu x 10^9 per station	0	0	0
Sitework	0.88 Btu x 10^9 per mile	1.6	1.42	5.65
Traffic Signals	5,000,000 Btu/signal	1	0.005	0.02
Total			**6.10**	**24.2**

Source: Calculated based on factors provided in West Eugene EmX Extension Project Energy and Sustainability Technical Memo, Table 6-5

6.5.3. EmX Alternative

The estimated construction energy for the EC Alternative is shown in Table 6.5-2. The estimate considers only construction for new lanes, new stations and terminals, sitework, and new traffic signals. All of the values listed reflect increases as compared to the No-Build Alternative. The one-time energy use associated with the EmX Alternative is expected to be approximately 17 times greater than the one-time energy use associated with the EC Alternative.

Table 6.5-2. EmX Alternative Construction Energy Use (Btu x 10^9)

	Construction Energy Measure / $1977	Quantity	Total Construction Energy (Btu x 10^9 / $1977)	Total Construction Energy (Btu x 10^9)
Bus and Turning Lanes	2.46 Btu x 10^9 per mile	14.4	35.4	141
Stations and Terminals	3.25 Btu x 10^9 per station	20	65.0	258
Sitework	0.88 Btu x 10^9 per mile	3.6	3.18	12.6
Traffic Signals	5,000,000 Btu / signal	5	0.03	0.10
Total			**104**	**411**

Source: Calculated based on factors provided in West Eugene EmX Extension Project Energy and Sustainability Technical Memo, Table 6-5

6.6. Potential Mitigation Measures

Potential mitigation measures for the No-Build, EC, and EmX Alternatives are detailed in Section 4.6.

6.7. Permits and Approvals

No permits or approvals are required for potential impacts evaluated in this report. Permits and approvals are more specifically addressed in other technical reports for this project.

6.8. Summary of Findings

6.8.1. Long-Term Direct Impacts

The following long-term direct impacts are expected for the No-Build Alternative:

- Limited potential for sufficient mode shifts away from motor vehicle travel to transit to improve energy use and sustainability
- Adverse impacts to sustainability compared to build alternatives, including air quality, safety, health, vehicle costs, and mobility options for Title VI and environmental justice populations
- Inconsistency with applicable goals and policies related to GHG reductions and sustainability

The following long-term direct impacts are expected for the EC Alternative:

- Potential for regionwide reduction in VMT as compared to No-Build Alternative
- Potential to reduce fossil fuel consumption and GHG emissions as compared to No-Build Alternative, as total VMT could decrease enough to offset the increase in transit energy consumption

The following long-term direct impacts are expected for the EmX Alternative:

- Potential for regionwide reduction in VMT as compared to No-Build Alternative
- Not a potential to reduce fossil fuel consumption and GHG emissions as compared to No-Build Alternative, due to increase in BRT vehicle VMT but not a large enough reduction in auto VMT
- Support nodal development, resulting in gradual transition from current lower-intensity, auto-oriented land use pattern, toward more pedestrian-oriented center of activity, with resulting benefits including:
    - Decrease in the distances people need to travel to reach destinations
    - Fewer automobile trips and emissions
    - Preservation of open space and resource lands
    - Ancillary sustainability benefits, including:
    - Increased safety
    - Health benefits
    - Vehicle cost savings
    - Improved mobility and transportation options for Title VI and environmental justice populations
    - Increased property values
    - Deferred costs for roadway capacity improvements
    - Increase in pollution generating surfaces

The direct energy calculations are covered in Section 6.2.

6.8.2. Indirect and Cumulative Effects

There would be limited potential for future reduction in indirect energy consumption for the No-Build Alternative.

For the EC Alternative, there would be potential for decreasing indirect energy compared to No-Build Alternative.

For the EmX Alternative, there would not be potential for decreasing indirect energy compared to No-Build Alternative due to the more intensive energy required for maintaining transit vehicles.

The indirect energy calculations are covered in Section 6.3.

6.8.3. Short-Term Construction-Related Impacts

For the No-Build Alternative, there would be no short-term construction-related impacts.

The following short-term construction-related impacts are expected for the EC and EmX Alternatives:

- Construction-related energy use and emissions
- Jobs creation and related economic benefits

The short-term construction-related impact calculations are covered in Section 6.5.

6.8.4. Mitigation Measures

For the No-Build Alternative, there would be no mitigation measures.

The following mitigation measures could be achieved for the EC and EmX Alternatives:

- Energy-related best management practices during construction
- Sustainable procurement practices
- Recycling and reuse of construction and demolition materials
- Preserve or replant trees

The mitigation measures are covered in greater detail in Section 4.6.

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7. 30th Avenue to Lane Community College Corridor Environmental Consequences

7.1. Affected Environment

The following section evaluates the 30th Avenue to LCC Corridor for future year No-Build, EC, and EmX Alternatives. In this corridor, energy is consumed primarily for residential, commercial, and transportation purposes. Transportation energy for motor vehicles is primarily provided by direct combustion of petroleum fuels, with lesser contributions from compressed natural gas and electricity. Energy consumption is increased at heavily congested intersection. Several intersections in the study area are already heavily congested and traffic volumes are forecasted to increase by 2035.

Bus rapid transit vehicles and frequent service buses operating within the corridor could help reduce reliance on private vehicles while typically providing a more efficient use of energy. These services provide more attracted alternatives to the automobile than regular service buses, and also tend to have higher ridership, which could reduce energy consumption per passenger.

7.2. Long-Term Direct Impacts

The long-term direct impacts of the proposed alternatives include changes to direct energy consumption. Energy measures include consumption, measured in Btu, and GHG emissions, measures in grams of CO_2e. The direct energy analysis for each alternative was based on projected year 2035 traffic volumes and regionwide VMT for cars, combination trucks, and buses.[6] Direct energy and GHG emissions consumption were calculated by multiplying energy use factors developed by the Federal Transit Administration (FTA, 2013) by average weekday VMT values.

7.2.1. No-Build Alternative

VMT is expected to increase as compared to existing conditions under the No-Build Alternative, with congestion increasing accordingly. The average weekday VMT, average energy use factors, and average weekday energy consumption are shown in Table 7.2-1.

Table 7.2-1. 2035 No-Build Alternative Regionwide Transportation Energy Consumption

Vehicle Type	Average Weekday VMT	Average Energy Use Factors (Btu / VMT)	Average Weekday Energy Consumption (Btu)
Automobile	5,044,992	5,633	28,418,400,000
Combination Truck	1,169,234	17,544	20,513,100,000
Buses / BRT Vehicles	15,482	27,182	420,800,000
Total	**6,229,708**		**49,352,300,000**

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

[6] Regionwide VMT provided to DKS Associates by Randy Parker, John Parker Consulting. Traffic modeling for alternatives was performed by Jennifer John, CH2M, and model data were provided to DKS Associates.

The average weekday VMT, CO_2e emissions factors, and total CO_2e emissions are shown in Table 7.2-2.

Table 7.2-2. 2035 No-Build Alternative Regionwide GHG Emissions

Vehicle Type	Average Weekday VMT	CO_2e Emissions Factors (grams CO_2e/VMT)	Total Grams of CO_2e
Automobile	5,044,992	397	2,002,900,000
Combination Truck	1,169,234	1,108	1,295,500,000
Buses / BRT Vehicles	15,482	2,177	33,700,000
Total	**6,229,708**		**3,332,100,000**

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

7.2.2. Enhanced Corridor Alternative

The EC Alternative would provide modest increases in bus services and facility enhancements such as new bus pullouts. Roadways and active transportation facilities would otherwise remain largely unchanged. The average weekday VMT, average energy use factors, and average weekday energy consumption are shown in Table 7.2-3.

The EC Alternative does not show potential to produce a decrease in VMT compared to the No-Build Alternative. Additionally, the alternative does not indicate a potential to reduce energy consumption. This is because bus VMT is decreased in this alternative, which causes automobile VMT to increase as compared to the No-Build Alternative. The automobile energy increase contributes to the overall energy consumption increase as compared to the No-Build Alternative. Buses use more energy than automobiles per mile travelled. Even though buses consume a lot more energy than automobiles, they can transport a lot more people too. The data shown do not take into account that buses are associated with a lower energy use per person than automobiles and trucks.

Table 7.2-3. 2035 EC Alternative Regionwide Transportation Energy Consumption

Vehicle Type	Average Weekday VMT	Average Energy Use Factors (Btu / VMT)	Average Weekday Energy Consumption (Btu)
Automobile	5,045,668	5,633	28,422,200,000
Combination Truck	1,169,309	17,544	20,514,400,000
Buses / BRT Vehicles	15,349	27,182	417,200,000
Total	**6,230,326**		**49,353,800,000**
Change from No-Build	618		1,500,000
Percent Change from No-Build	0.010%		0.003%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

The same average weekday VMT values were used to estimate the GHG emissions, measured in CO_2e, as shown in Table 7.2-4. Similar to the result for average weekday energy consumption, the EC Alternative does not show a potential to reduce GHG emissions.

Table 7.2-4. 2035 EC Alternative Regionwide GHG Emissions

Vehicle Type	Average Weekday VMT	CO_2e Emissions Factors (grams CO_2e/VMT)	Total Grams of CO_2e
Automobile	5,045,668	397	2,003,100,000
Combination Truck	1,169,309	1,108	1,295,600,000
Buses / BRT Vehicles	15,349	2,177	33,500,000
Total	**6,230,326**		**3,332,200,000**
Change from No-Build	618		100,000
Percent Change from No-Build	0.010%		0.002%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).

Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

7.2.3. EmX Alternative

Significant improvements to transit facilities, including BAT lanes and queue jumps, would be provided in the EmX Alternative. Vehicle, pedestrian and bicycle facilities would also be enhanced in some locations. The average weekday VMT, average energy use factors, and average weekday energy consumption are shown in Table 7.2-5.

Total VMT has the potential to decrease more than in the No-Build and EC Alternatives because of more significant improvements to transit services. The EmX Alternative indicates the potential to reduce direct energy consumption, as total VMT could decrease enough to offset the increase in bus/BRT vehicle energy consumption. Buses / BRT vehicles use more energy than automobiles per mile travelled. Even though buses / BRT vehicles consume a lot more energy than automobiles, they can transport a lot more people too. The data shown do not take into account that buses / BRT vehicles are associated with a lower energy use per person than automobiles and trucks.

Table 7.2-5. 2035 EmX Alternative Regionwide Transportation Energy Consumption

Vehicle Type	Average Weekday VMT	Average Energy Use Factors (Btu / VMT)	Average Weekday Energy Consumption (Btu)
Automobile	5,044,129	5,633	28,413,600,000
Combination Truck	1,169,073	17,544	20,510,200,000
Buses / BRT Vehicles	15,696	27,182	426,600,000
Total	**6,228,898**		**49,350,400,000**
Change from No-Build	-810		-1,900,000
Percent change from No-Build	-0.013%		-0.004%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).

Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

The same average weekday VMT values are used to calculate the GHG emissions, measured in CO_2e, as shown in Table 7.2-6. The EmX Alternative shows the potential to slightly reduce GHG emissions relative to the No-Build Alternative. The automobile trips taken off the road by the increased transit service in this alternative have the potential to create enough of an emissions reduction to offset the increase in emissions from increased BRT vehicle VMT.

Table 7.2-6. 2035 EmX Alternative Regionwide GHG Emissions

Vehicle Type	Average Weekday VMT	CO2e Emissions Factors (grams CO_2e / VMT)	Total Grams CO2e
Automobile	5,044,129	397	2,002,500,000
Combination Truck	1,169,073	1,108	1,295,300,000
Buses	15,696	2,177	34,200,000
Total	**6,228,898**		**3,332,000,000**
Change from No-Build	-810		-100,000
Percent change from No-Build	-0.013%		-0.002%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

7.2.4. Annualized Impacts & Costs

The total annualized costs associated with energy consumption and GHG emissions are shown in Table 7.2-7, and will be incorporated into a total environmental benefit analysis using data from the Air Quality Technical Report, Transportation Technical Report, Capital Cost Estimating Report, and Operations and Maintenance Costs Technical Report.

The annualized impacts were based on the assumption that all buses would be hybrid-diesel buses. If LTD were to convert a portion of their fleet to electric buses, the energy consumption and GHG emissions costs would be reduced for all alternatives, including the No-Build Alternative. If additional electric buses were acquired for the EC Alternative, the total value of the EC Alternative improvement could increase slightly, as both the energy consumption and the GHG emissions would be expected to decrease.

Table 7.2-7. 2035 Estimated Regionwide Annual Costs for All Alternatives

Annual Value	EC Alternative	EmX Alternative
Decrease (Increase) in Energy Consumption, million Btu	(2,978)	(1,558)
Energy Value of Improvement	($4,853.89)	($2,164.27)
Decrease (Increase) in GHG Emissions, metric tons CO_2e	(218)	(157)
GHG Emissions Value of Improvement	($12,449.51)	($8,952.25)
Total Value of Improvement	**($17,303.40)**	**($11,116.52)**

Source: DKS. (2016).

Cost Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

The energy consumption and GHG emissions costs were developed using the following cost factors from FTA's New Starts and Small Starts Final Policy Guidance document (FTA, 2013):

- $1.72 per million Btu for gasoline (assumed as sole fuel for auto VMT)
- $1.56 per million Btu for diesel fuel (assumed as sole fuel for heavy truck and diesel-hybrid bus VMT)
- $57 per metric ton of CO_2e as the midrange 2035 estimate of the social cost of carbon

An annualization factor[7] of 342 was used to estimate annual VMT based on average weekday VMT data. Annualized bus VMT was provided by LTD.

7.3. Long-Term Indirect Impacts

Indirect energy effects involve ongoing vehicle maintenance and repair energy. Indirect energy is calculated by determining the energy equivalent of all of the material products and operations necessary to keep the transportation system operable. The indirect energy analysis was conducted by converting regionwide VMT for each alternative into energy consumption.

While not quantified here, roadway maintenance may increase for higher bus service, except when cement improvements are made to the roadway that could result in lower maintenance and energy associate with maintenance for the roadways repairs over the long term.

7.3.1. No-Build Alternative

The regionwide indirect energy associated with vehicle maintenance and repair energy is shown in Table 7.3-1.

Table 7.3-1. 2035 No-Build Alternative Regionwide Maintenance and Repair Energy

Vehicle Type	Maintenance / Repair Energy (Btu / mile)	Tires (Btu / mile)	Oil (Btu / mile)	VMT	Maintenance / Repair Energy (Btu)
Automobile	815	316	308	5,044,992	7,259,700,000
Combination Truck	1,592	725	1,199	1,169,234	4,111,000,000
Bus / BRT Vehicle	13,142	-	-	15,482	203,500,000
Total				**6,229,708**	**11,574,200,000**

Source: DKS. (2016).

7.3.2. Enhanced Corridor Alternative

The regionwide indirect energy associated with vehicle maintenance and repair energy is shown in Table 7.3-2. The EC Alternative indicates the potential to slightly decrease maintenance and repair energy as compared to the No-Build Alternative. This is due to the decrease in bus VMT as compared to

[7] The annualization factor was calculated based on 2015 traffic volume data from ODOT's ATR stations. An average value was applied based on the six ATR stations located in the Eugene-Springfield region.

the No-Build Alternative, as more intensive energy use is required for maintaining buses as compared to other vehicles.

Table 7.3-2. 2035 EC Alternative Regionwide Maintenance and Repair Energy

Vehicle Type	Maintenance / Repair Energy (Btu / mile)	Tires (Btu / mile)	Oil (Btu / mile)	VMT	Maintenance / Repair Energy
Automobile	815	316	308	5,045,668	7,260,700,000
Combination Truck	1,592	725	1,199	1,169,309	4,111,300,000
Bus / BRT Vehicle	13,142	-	-	15,349	201,700,000
Total				**6,230,326**	**11,573,700,000**
Change from No-Build				618	-500,000
Percent change from No-Build				0.010%	-0.004%

Source: DKS. (2016).

7.3.3. EmX Alternative

The regionwide indirect energy associated with vehicle maintenance and repair energy is shown in Table 7.3-3. The EmX alternative does not indicate the potential to decrease maintenance and repair energy compared to the No-Build Alternative. This is due to more intensive energy required for maintaining BRT vehicles as compared to other vehicles.

Not reflected in Table 7.3-3 for vehicle maintenance is the maintenance for roadways. The cement used for bus-only lanes in the EmX Alternative is much stronger than asphalt and will require less maintenance over time. Removing buses from the asphalt lanes could extend the life of those sections of the roadway.

Table 7.3-3. 2035 EmX Alternative Maintenance and Repair Energy

Vehicle Type	Maintenance / Repair Energy (Btu / mile)	Tires (Btu / mile)	Oil (Btu / mile)	VMT	Maintenance / Repair Energy (Btu)
Automobile	815	316	308	5,044,129	7,258,500,000
Combination Truck	1,592	725	1,199	1,169,073	4,110,400,000
Bus / BRT Vehicle	13,142	-	-	15,696	206,300,000
Total				**6,228,898**	**11,575,200,000**
Change from No-Build				-810	1,000,000
Percent Change from No-Build				-0.013%	0.009%

Source: DKS. (2016).

7.4. Total Long-Term Impacts

Total energy impacts account for direct energy consumed by vehicles, vehicle emissions, and vehicle maintenance and repair energy. Energy impacts are assessed based on the projected future VMT, which is influenced by projected changes in land use patterns, population growth, and programmed transportation improvements.

7.4.1. No-Build Alternative

The total long-term energy use (sum of direct impacts and maintenance energy) is shown in Table 7.4-1.[8]

Table 7.4-1. 2035 Total Long-Term Regionwide Energy Impacts

Energy Type	No-Build Energy Use (Btu)
Direct Energy (Btu)	49,352,300,000
CO_2e Equivalent Energy (Btu)[a]	62,830,600,000
Maintenance Energy (Btu)	11,574,200,000
Total	**123,757,100,000**

Source: DKS. (2016).

[a] CO_2e energy was converted from grams CO_2 to Btu by multiplying grams by 18.856 Btu / gram (1 therm = 5,302 grams CO_2; 99,976.1 Btu = 1 therm) to calculate total energy use.

7.4.2. Enhanced Corridor Alternative

The total long-term energy use (sum of direct impacts and maintenance energy) is shown in Table 7.4-2. The EC Alternative does not indicate potential to decrease total energy use in the region as compared to the No-Build Alternative.

Table 7.4-2. 2035 Total Long-Term Regionwide Energy Impacts

Energy Type	No-Build Energy Use (Btu)	EC Alternative Energy Use (Btu)	Change from No-Build (Btu)	Percent Change from No-Build
Direct Energy (Btu)	49,352,300,000	49,353,800,000	1,500,000	0.003%
CO2e Equivalent Energy (Btu)[a]	62,830,600,000	62,831,800,000	1,200,000	0.002%
Maintenance Energy (Btu)	11,574,200,000	11,573,700,000	-500,000	-0.004%
Total	**123,757,100,000**	**123,759,300,000**	**2,200,000**	**0.002%**

Source: DKS. (2016).

[a] CO2e energy was converted from grams CO2 to Btu by multiplying grams by 18.856 Btu / gram (1 therm = 5,302 grams CO2; 99,976.1 Btu = 1 therm) to calculate total energy use.

[8] CO_2e energy was converted from grams CO_2 to Btu by multiplying grams by 18.856 Btu / gram (1 therm = 5302 g CO_2; 99976.1 Btu = 1 therm).

7.4.3. EmX Alternative

The total long-term energy use (sum of direct impacts and maintenance energy) is shown in Table 7.4-3. The EmX Alternative indicates the potential to slightly decrease total energy use in the region as compared to the No-Build Alternative.

Table 7.4-3. 2035 Total Long-Term Energy Impacts

Energy Type	No-Build Energy Use (Btu)	EmX Alternative Energy Use (Btu)	Change from No-Build (Btu)	Percent Change from No-Build
Direct Energy (Btu)	49,352,300,000	49,350,400,000	-1,900,000	-0.004%
CO2e Equivalent Energy (Btu)[a]	62,830,600,000	62,829,600,000	-1,000,000	-0.002%
Maintenance Energy (Btu)	11,574,200,000	11,575,200,000	1,000,000	0.009%
Total	**123,757,100,000**	**123,755,200,000**	**-1,900,000**	**-0.002%**

Source: DKS. (2016).

[a] CO2e energy was converted from grams CO2 to Btu by multiplying grams by 18.856 Btu / gram (1 therm = 5,302 grams CO2; 99,976.1 Btu = 1 therm) to calculate total energy use.

7.5. Short-Term Construction-Related Impacts

Construction energy effects involve the one-time, non-recoverable energy costs associated with construction of roadways and structures. It should be noted that the energy consumption associated with construction could be highly variable, depending on the source, manufacturing, and transport of materials. The construction energy analysis was conducted using the Input-Output Method, which converts Year 1977 construction dollars into energy consumption.

7.5.1. No-Build Alternative

There are no construction activities associated with the No-Build Alternative. No construction energy use was assumed for the No-Build Alternative.

7.5.2. Enhanced Corridor Alternative

The estimated construction energy for the EC Alternative is shown in Table 7.5-1. The estimate considers only construction for new lanes, new stations and terminals, sitework, and new traffic signals. All of the values listed reflect increases as compared to the No-Build Alternative

Table 7.5-1. EC Alternative Construction Energy Use (Btu x 10^9)

	Construction Energy Measure / $1977	Quantity	Total Construction Energy (Btu x 10^9 / $1977)	Total Construction Energy (Btu x 10^9)
Bus and Turning Lanes	2.46 Btu x 10^9 per mile	3.4	8.36	33.2
Stations and Terminals	3.25 Btu x 10^9 per station	0	0	0
Sitework	0.88 Btu x 10^9 per mile	1.9	1.71	6.79
Traffic Signals	5,000,000 Btu / signal	4	0.02	0.08
Total			**10.1**	**40.1**

Source: Calculated based on factors provided in *West Eugene EmX Extension Project Energy and Sustainability Technical Memo*, Table 6-5

7.5.3. EmX Alternative

The estimated construction energy for the EmX Alternative is shown in Table 7.5-2. The estimate considers only construction for new lanes, new stations and terminals, sitework, and new traffic signals. All of the values listed reflect increases as compared to the No-Build Alternative. The one-time energy use associated with the EmX Alternative is expected to be approximately 9 times greater than the one-time energy use associated with the EC Alternative.

Table 7.5-2. EC Alternative Construction Energy Use (Btu x 10^9)

	Construction Energy Measure / $1977	Quantity	Total Construction Energy (Btu x 10^9 / $1977)	Total Construction Energy (Btu x 10^9)
Bus and Turning Lanes	2.46 Btu x 10^9 per mile	7.1	17.5	69.3
Stations and Terminals	3.25 Btu x 10^9 per station	21	68.3	271
Sitework	0.88 Btu x 10^9 per mile	3.4	2.97	11.8
Traffic Signals	5,000,000 Btu / signal	4	0.02	0.08
Total			**88.7**	**352**

Source: Calculated based on factors provided in West Eugene EmX Extension Project Energy and Sustainability Technical Memo, Table 6-5

7.6. Potential Mitigation Measures

Potential mitigation measures for the No-Build, EC, and EmX Alternatives are detailed in Section 4.6.

7.7. Permits and Approvals

No permits or approvals are required for potential impacts evaluated in this report. Permits and approvals are more specifically addressed in other technical reports for this project.

7.8. Summary of Findings

7.8.1. Long-Term Direct Impacts

The following long-term direct impacts are expected for the No-Build Alternative:

- Limited potential for sufficient mode shifts away from motor vehicle travel to transit to improve energy use and sustainability
- Adverse impacts to sustainability compared to build alternatives, including air quality, safety, health, vehicle costs, and mobility options for Title VI and environmental justice populations
- Inconsistent with applicable goals and policies related to GHG reductions and sustainability

The following long-term direct impacts are expected for the EC Alternative:

- Not potential for regionwide reduction in VMT as compared to No-Build Alternative
- Not potential to reduce fossil fuel consumption and GHG emissions as compared to No-Build, due to decrease in bus VMT and increase in auto VMT

The following long-term direct impacts are expected for the EmX Alternative:

- Potential for regionwide reduction in VMT as compared to No-Build Alternative
- Potential to reduce fossil fuel consumption and GHG emissions as compared to No-Build Alternative, as total VMT could decrease enough to offset the increase in transit energy consumption
- Support nodal development, resulting in gradual transition from current lower-intensity, auto-oriented land use pattern, toward more pedestrian-oriented center of activity, with resulting benefits including:
    - Decrease in the distances people need to travel to reach destinations
    - Fewer automobile trips and emissions
    - Preservation of open space and resource lands
    - Ancillary sustainability benefits, including:
        - Increased safety
        - Health benefits
        - Vehicle cost savings
    - Improved mobility and transportation options for Title VI and environmental justice populations
    - Increased property values
    - Deferred costs for roadway capacity improvements
    - Increase in pollution generating surfaces

The direct energy calculations are covered in Section 7.2.

7.8.2. Long-Term Indirect Impacts

There would be limited potential for future reduction in indirect energy consumption for the No-Build Alternative.

For the EC Alternative, there would be potential for decreasing indirect energy compared to No-Build Alternative.

For the EmX Alternative, there would not be potential for decreasing indirect energy compared to No-Build Alternative due to the more intensive energy required for maintaining transit vehicles.

The indirect energy calculations are covered in Section 7.3.

7.8.3. Short-Term Construction-Related Impacts

For the No-Build Alternative, there would be no short-term construction-related impacts.

The following short-term construction-related impacts are expected for the EC and EmX Alternatives:

- Construction-related energy use and emissions
- Jobs creation and related economic benefits

The short-term construction-related impact calculations are covered in Section 7.5.

7.8.4. Mitigation Measures

For the No-Build Alternative, there would be no mitigation measures.

The following mitigation measures could be achieved for the EC and EmX Alternatives:

- Energy-related best management practices during construction
- Sustainable procurement practices
- Recycling and reuse of construction and demolition materials
- Preserve or replant trees

The mitigation measures are covered in greater detail in Section 4.6.

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8. Coburg Road Corridor Environmental Consequences

8.1. Affected Environment

The following section evaluates the Coburg Road corridor for future year No-Build, EC, and EmX Alternatives. In this corridor, energy is consumed primarily for residential, commercial, and transportation purposes. Transportation energy for motor vehicles is primarily provided by direct combustion of petroleum fuels, with lesser contributions from compressed natural gas and electricity. Energy consumption is increased at heavily congested intersection. Several intersections in the study area are already heavily congested and traffic volumes are forecasted to increase by 2035.

Bus rapid transit vehicles and frequent service buses operating within the corridor could help reduce reliance on private vehicles while typically providing a more efficient use of energy. These services provide more attracted alternatives to the automobile than regular service buses, and tend to have higher ridership, which could reduce energy consumption per passenger.

8.2. Long-Term Direct Impacts

The long-term direct impacts of the proposed alternatives include changes to direct energy consumption. Energy measures include consumption, measured in Btu, and GHG emissions, measures in grams of CO_2e. The direct energy analysis for each alternative was based on projected year 2035 traffic volumes and regionwide VMT for cars, combination trucks, and buses.[9] Direct energy and GHG emissions consumption were calculated by multiplying energy use factors developed by the Federal Transit Administration (FTA, 2013) by average weekday VMT values.

8.2.1. No-Build Alternative

VMT is expected to increase as compared to existing conditions under the No-Build Alternative, with congestion increasing accordingly. The average weekday VMT, average energy use factors, and average weekday energy consumption are shown in Table 8.2-1.

Table 8.2-1. 2035 No-Build Alternative Regionwide Transportation Energy Consumption

Vehicle Type	Average Weekday VMT	Average Energy Use Factors (Btu / VMT)	Average Weekday Energy Consumption (Btu)
Automobile	5,044,992	5,633	28,418,400,000
Combination Truck	1,169,234	17,544	20,513,100,000
Buses / BRT Vehicles	15,482	27,182	420,800,000
Total	**6,229,708**		**49,352,300,000**

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

[9] Regionwide VMT was provided to DKS Associates by Randy Parker, John Parker Consulting. Traffic modeling for alternatives was performed by Jennifer John, CH2M; model data were provided to DKS Associates.

The average weekday VMT, CO_2e emissions factors, and total CO_2e emissions are shown in Table 8.2-2.

Table 8.2-2. 2035 No-Build Alternative Regionwide GHG Emissions

Vehicle Type	Average Weekday VMT	CO_2e Emissions Factors (grams CO_2e / VMT)	Total Grams CO_2e
Automobile	5,044,992	397	2,002,900,000
Combination Truck	1,169,234	1,108	1,295,500,000
Buses / BRT Vehicles	15,482	2,177	33,700,000
Total	**6,229,708**		**3,332,100,000**

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

8.2.2. Enhanced Corridor Alternative

The EC Alternative would provide modest increases in bus services and facility enhancements such as new bus pullouts. Roadways and active transportation facilities would otherwise remain largely unchanged. The average weekday VMT, average energy use factors, and average weekday energy consumption are shown in Table 8.2-3.

The EC Alternative shows the potential to produce a modest decrease in VMT compared to the No-Build Alternative. The alternative also indicates a potential to reduce direct energy consumption, as total VMT could decrease enough to offset the increase in bus energy consumption. Bus VMT is decreased in this alternative compared to the No-Build Alternative. Buses use more energy than automobiles per mile travelled. Even though buses consume a lot more energy than automobiles, they can transport a lot more people too. The data shown do not take into account that buses are associated with a lower energy use per person than automobiles and trucks.

Table 8.2-3. 2035 EC Alternative Regionwide Transportation Energy Consumption

Vehicle Type	Average Weekday VMT	Average Energy Use Factors (Btu / VMT)	Average Weekday Energy Consumption (Btu)
Automobile	5,044,288	5,633	28,414,500,000
Combination Truck	1,169,068	17,544	20,510,100,000
Buses / BRT Vehicles	15,341	27,182	417,000,000
Total	**6,228,696**		**49,341,600,000**
Change from No-Build	-1,012		-10,700,000
Percent change from No-Build	-0.016%		-0.022%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

The same average weekday VMT values were used to calculate the GHG emissions, measured in CO_2e, as shown in Table 8.2-4. The EC Alternative shows the potential to slightly reduce GHG emissions relative to the No-Build Alternative. However, the bus VMT is decreased in this alternative as compared to the No-Build Alternative.

Table 8.2-4. 2035 EC Alternative Regionwide GHG Emissions

Vehicle Type	Average Weekday VMT	CO_2e Emissions Factors (grams CO_2e / VMT)	Total Grams of CO_2e
Automobile	5,044,288	397	2,002,600,000
Combination Truck	1,169,068	1,108	1,295,300,000
Buses / BRT Vehicles	15,341	2,177	33,400,000
Total	**6,228,696**		**3,331,300,000**
Change from No-Build	-1,012		-800,000
Percent change from No-Build	-0.016%		-0.023%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

8.2.3. EmX Alternative

Significant improvements to transit facilities, including BAT lanes and queue jumps, would be provided in the EmX Alternative. Vehicle, pedestrian and bicycle facilities would also be enhanced in some locations. The average weekday VMT, average energy use factors, and average weekday energy consumption are shown in Table 8.2-5.

Total VMT has the potential to decrease more than in the No-Build and EC Alternatives because of more significant improvements to transit services. The EmX Alternative indicates the potential to reduce direct energy consumption, as total VMT could decrease enough to offset the increase in bus / BRT vehicle energy consumption. Buses / BRT vehicles use more energy than automobiles per mile travelled. Even though buses / BRT vehicles consume a lot more energy than automobiles, they can transport a lot more people too. The data shown do not take into account that buses / BRT vehicles are associated with a lower energy use per person than automobiles and trucks.

Table 8.2-5. 2035 EmX Alternative Regionwide Transportation Energy Consumption

Vehicle Type	Average Weekday VMT	Average Energy Use Factors (Btu / VMT)	Average Weekday Energy Consumption (Btu)
Automobile	5,043,713	5,633	28,411,300,000
Combination Truck	1,169,130	17,544	20,511,200,000
Buses / BRT Vehicles	15,805	27,182	429,600,000
Total	**6,228,647**		**49,352,100,000**
Change from No-Build	-1,061		-200,000
Percent change from No-Build	-0.017%		-0.001%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

The same average weekday VMT values were used to estimate the GHG emissions, measured in CO_2e, as shown in Table 8.2-6. Similar to the result for average weekday energy consumption, the EmX Alternative does not show a potential to reduce GHG emissions.

Table 8.2-6. 2035 EmX Alternative GHG Emissions

Vehicle Type	Average Weekday VMT	CO_2e Emissions Factors (grams CO_2e/VMT)	Total Grams of CO_2e
Automobile	5,043,713	397	2,002,400,000
Combination Truck	1,169,130	1,108	1,295,400,000
Buses / BRT Vehicles	15,805		34,400,000
Total	**6,228,647**		**3,332,200,000**
Change from No-Build	-1,061	2,177	100,000
Percent change from No-Build	-0.017%		0.002%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

8.2.4. Annualized Impacts & Costs

The total annualized costs associated with energy consumption and GHG emissions are shown in Table 8.2-7, and will be incorporated into a total environmental benefit analysis using data from the Air Quality Technical Report, Transportation Technical Report, Capital Cost Estimating Report, and Operations and Maintenance Costs Technical Report.

The annualized impacts were based on the assumption that all buses would be hybrid-diesel buses. If LTD were to convert a portion of their fleet to electric buses, the energy consumption and GHG emissions costs would be reduced for all alternatives, including the No-Build Alternative. If additional electric buses were acquired for the EC Alternative, the total value of the EC Alternative improvement could increase slightly, as both the energy consumption and the GHG emissions would be expected to decrease.

Table 8.2-7. 2035 Estimated Regionwide Annual Costs for All Alternatives

Annual Value	EC Alternative	EmX Alternative
Decrease (Increase) in Energy Consumption, million Btu	3,235	16
Energy Value of Improvement	$5,263.99	$418.42
Decrease (Increase) in GHG Emissions, metric tons CO_2e	229	(33)
GHG Emissions Value of Improvement	$13,062.55	($1,883.37)
Total Value of Improvement	**$18,326.54**	**($1,464.96)**

Source: DKS, 2016.

Cost Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

The energy consumption and GHG emissions costs were developed using the following cost factors from FTA's New Starts and Small Starts Final Policy Guidance document (FTA, 2013):

- $1.72 per million Btu for gasoline (assumed as sole fuel for auto VMT)
- $1.56 per million Btu for diesel fuel (assumed as sole fuel for heavy truck and diesel-hybrid bus VMT)
- $57 per metric ton of CO_2e as the midrange 2035 estimate of the social cost of carbon

An annualization factor[10] of 342 was used to estimate annual VMT based on average weekday VMT data. Annualized bus VMT was provided by LTD.

8.3. Long-Term Indirect Impacts

Indirect energy effects involve ongoing vehicle maintenance and repair energy. Indirect energy is calculated by determining the energy equivalent of all of the material products and operations necessary to keep the transportation system operable. The indirect energy analysis was conducted by converting regionwide VMT for each alternative into energy consumption.

While not quantified here, roadway maintenance may increase for higher bus service, except when cement improvements are made to the roadway that could result in lower maintenance and energy associate with maintenance for the roadways repairs over the long term.

8.3.1. No-Build Alternative

The regionwide indirect energy associated with vehicle maintenance and repair energy is shown in Table 8.3-1.

Table 8.3-1. 2035 No-Build Alternative Regionwide Maintenance and Repair Energy

Vehicle Type	Maintenance / Repair Energy (Btu / mile)	Tires (Btu / mile)	Oil (Btu / mile)	VMT	Maintenance / Repair Energy (Btu)
Automobile	815	316	308	5,044,992	7,259,700,000
Combination Truck	1,592	725	1,199	1,169,234	4,111,000,000
Bus / BRT Vehicle	13,142	-	-	15,482	203,500,000
Total				**6,229,708**	**11,574,200,000**

Source: DKS. (2016).

8.3.2. Enhanced Corridor Alternative

The regionwide indirect energy associated with vehicle maintenance and repair energy is shown in Table 8.3-2. The EC Alternative indicates the potential for decrease in maintenance and repair energy as compared to the No-Build Alternative.

[10] The annualization factor was calculated based on 2015 traffic volume data from ODOT's ATR stations. An average value was applied based on the six ATR stations located in the Eugene-Springfield region.

Table 8.3-2. 2035 EC Alternative Regionwide Maintenance and Repair Energy

Vehicle Type	Maintenance / Repair Energy (Btu / mile)	Tires (Btu / mile)	Oil (Btu / mile)	VMT	Maintenance / Repair Energy (Btu)
Automobile	815	316	308	5,044,288	7,258,700,000
Combination Truck	1,592	725	1,199	1,169,068	4,110,500,000
Bus / BRT Vehicle	13,142	-	-	15,341	201,600,000
Total				**6,228,696**	**11,570,800,000**
Change from No-Build				-1,012	-3,400,000
Percent change from No-Build				-0.016%	-0.030%

Source: DKS. (2016).

8.3.3. EmX Alternative

The regionwide indirect energy associated with vehicle maintenance and repair energy is shown in Table 8.3-3. The EmX alternative does not indicate the potential to decrease maintenance and repair energy compared to the No Build Alternative. This is due to more intensive energy required for maintaining BRT vehicles as compared to other vehicles.

Not reflected in Table 8.3-3 for vehicle maintenance is the maintenance for roadways. The cement used for bus-only lanes in the EmX Alternative is much stronger than asphalt and will require less maintenance over time. Removing buses from the asphalt lanes could extend the life of those sections of the roadway.

Table 8.3-3. 2035 EmX Alternative Regionwide Maintenance and Repair Energy

Vehicle Type	Maintenance / Repair Energy (Btu / mile)	Tires (Btu / mile)	Oil (Btu / mile)	VMT	Maintenance / Repair Energy (Btu)
Automobile	815	316	308	5,043,713	7,257,900,000
Combination Truck	1,592	725	1,199	1,169,130	4,110,700,000
Bus / BRT Vehicle	13,142	-	-	15,805	207,700,000
Total				**6,228,647**	**11,576,300,000**
Change from No-Build				-1,061	2,100,000
Percent change from No-Build				-0.017%	0.018%

Source: DKS. (2016).

8.4. Total Long-Term Impacts

Total energy impacts account for direct energy consumed by vehicles, vehicle emissions, and vehicle maintenance and repair energy. Energy impacts are assessed based on the projected future VMT, which is influenced by projected changes in land use patterns, population growth, and programmed transportation improvements.

8.4.1. No-Build Alternative

The total long-term energy use (sum of direct impacts and maintenance energy) is shown in Table 8.4-1.[11]

Table 8.4-1. 2035 Total Long-Term Regionwide Energy Impacts

Energy Type	No-Build Energy Use (Btu)
Direct Energy (Btu)	49,352,300,000
CO_2e Equivalent Energy (Btu)[a]	62,830,600,000
Maintenance Energy (Btu)	11,574,200,000
Total	**123,757,100,000**

Source: DKS. (2016).

[a] CO2e energy was converted from grams CO2 to Btu by multiplying grams by 18.856 Btu/gram (1 therm = 5,302 grams of CO2; 99,976.1 Btu = 1 therm) to calculate total energy use.

8.4.2. Enhanced Corridor Alternative

The total long-term energy use (sum of direct impacts and maintenance energy) is shown in Table 8.4-2. The EC Alternative indicate the potential to decrease total energy use in the region as compared to the No-Build Alternative.

Table 8.4-2. 2035 Total Long-Term Regionwide Energy Impacts

Energy Type	No-Build Energy Use (Btu)	EC Alternative Energy Use (Btu)	Change from No-Build (Btu)	Percent Change from No-Build
Direct Energy (Btu)	49,352,300,000	49,341,600,000	-10,700,000	-0.022%
CO_2e Equivalent Energy (Btu)[a]	62,830,600,000	62,816,100,000	-14,500,000	-0.023%
Maintenance Energy (Btu)	11,574,200,000	11,570,800,000	-3,400,000	-0.030%
Total	**123,757,100,000**	**123,728,500,000**	**-28,600,000**	**-0.023%**

Source: DKS. (2016).

[a] CO_2e energy was converted from grams CO_2 to Btu by multiplying grams by 18.856 Btu/gram (1 therm = 5,302 grams of CO_2; 99,976.1 Btu = 1 therm) to calculate total energy use.

[11] CO_2e energy was converted from grams CO_2 to Btu by multiplying grams by 18.856 BTU/gram (1 therm = 5302 g CO_2; 99976.1 Btu = 1 therm).

8.4.3. EmX Alternative

The total long-term energy use (sum of direct impacts and maintenance energy) is shown in Table 8.4-3. The EmX Alternative does not indicate the potential to decrease total energy use in the region as compared to the No-Build Alternative.

Table 8.4-3. 2035 Total Long-Term Regionwide Energy Impacts

Energy Type	No-Build Energy Use (Btu)	EmX Alternative Energy Use (Btu)	Change from No-Build (Btu)	Percent Change from No-Build
Direct Energy (Btu)	49,352,300,000	49,352,000,000	-200,000	-0.001%
CO2e Equivalent Energy (Btu)[a]	62,830,600,000	62,832,100,000	1,500,000	0.002%
Maintenance Energy (Btu)	11,574,200,000	11,576,300,000	2,100,000	0.018%
Total	**123,757,100,000**	**123,760,500,000**	**3,400,000**	**0.003%**

Source: DKS. (2016).

[a] CO2e energy was converted from grams CO2 to Btu by multiplying grams by 18.856 Btu/gram (1 therm = 5,302 grams of CO2; 99,976.1 Btu = 1 therm) to calculate total energy use.

8.5. Short-Term Construction-Related Impacts

Construction energy effects involve the one-time, non-recoverable energy costs associated with construction of roadways and structures. It should be noted that the energy consumption associated with construction could be highly variable, depending on the source, manufacturing, and transport of materials. The construction energy analysis was conducted using the Input-Output Method, which converts Year 1977 construction dollars into energy consumption.

8.5.1. No-Build Alternative

Under the No-Build Alternative, there are no construction activities associated with the proposed project. No construction energy use is assumed for the No-Build Alternative.

8.5.2. Enhanced Corridor Alternative

The estimated construction energy for the EC Alternative is shown in Table 8.5-1. The estimate considers only construction for new lanes, new stations and terminals, sitework, and new traffic signals. All of the values listed reflect increases as compared to the No-Build Alternative.

Table 8.5-1. EC Alternative Construction Energy Use (Btu x 10^9)

	Construction Energy Measure / $1977	Quantity	Total Construction Energy (Btu x 10^9 / $1977)	Total Construction Energy (Btu x 10^9)
Bus and Turning Lanes	2.46 Btu x 10^9 per mile	8.2	20.2	80.1
Stations and Terminals	3.25 Btu x 10^9 per station	0	0	0
Sitework	0.88 Btu x 10^9 per mile	3.1	2.71	10.8
Traffic Signals	5,000,000 Btu / signal	12	0.06	0.24
Total			**22.9**	**91.1**

Source: Calculated based on factors provided in West Eugene EmX Extension Project Energy and Sustainability Technical Memo, Table 6-5

8.5.3. EmX Alternative

The estimated construction energy for the EC Alternative is shown in Table 8.5-2. The estimate considers only construction for new lanes, new stations and terminals, sitework, and new traffic signals. All of the values listed reflect increases as compared to the No-Build Alternative. The one-time energy use associated with the EmX Alternative is expected to be approximately 6 times greater than the one-time energy use associated with the EC Alternative.

Table 8.5-2. EmX Alternative Construction Energy Use (Btu x 10^9)

	Construction Energy Measure / $1977	Quantity	Total Construction Energy (Btu x 10^9 / $1977)	Total Construction Energy (Btu x 10^9)
Bus and Turning Lanes	2.46 Btu x 10^9 per mile	11.6	28.5	113
Stations and Terminals	3.25 Btu x 10^9 per station	30	97.5	387
Sitework	0.88 Btu x 10^9 per mile	5.5	4.84	19.2
Traffic Signals	5,000,000 Btu / signal	16	0.08	0.32
Total			**131**	**520**

Source: Calculated based on factors provided in West Eugene EmX Extension Project Energy and Sustainability Technical Memo, Table 6-5

8.6. Potential Mitigation Measures

Potential mitigation measures for the No-Build, EC, and EmX Alternatives are detailed in Section 4.6.

8.7. Permits and Approvals

No permits or approvals are required for potential impacts evaluated in this report. Permits and approvals are more specifically addressed in other technical reports for this project.

8.8. Summary of Findings

8.8.1. Long-Term Direct Impacts

The following long-term direct impacts are expected for the No-Build Alternative:

- Limited potential for sufficient mode shifts away from motor vehicle travel to transit to improve energy use and sustainability
- Adverse impacts to sustainability compared to build alternatives, including air quality, safety, health, vehicle costs, and mobility options for Title VI and environmental justice populations
- Inconsistent with applicable goals and policies related to GHG reductions and sustainability

The following long-term direct impacts are expected for the EC Alternative:

- Potential for regionwide reduction in VMT as compared to No-Build Alternative
- Potential to reduce fossil fuel consumption and GHG emissions as compared to No-Build Alternative, as total VMT could decrease enough to offset the increase in transit energy consumption

The following long-term direct impacts are expected for the EmX Alternative:

- Potential for regionwide reduction in VMT as compared to No-Build Alternative
- Potential to reduce fossil fuel consumption compared to No-Build Alternative, as total VMT could decrease enough to offset the increase in transit energy consumption
- Not a potential to reduce GHG emissions as compared to No-Build Alternative, due to increase in BRT vehicle VMT but not a large enough reduction in auto VMT
- Support nodal development, resulting in gradual transition from current lower-intensity, auto-oriented land use pattern, toward more pedestrian-oriented center of activity, with resulting benefits including:
    - Decrease in the distances people need to travel to reach destinations
    - Fewer automobile trips and emissions
    - Preservation of open space and resource lands
    - Ancillary sustainability benefits, including:
        - Increased safety
        - Health benefits
        - Vehicle cost savings
    - Improved mobility and transportation options for Title VI and environmental justice populations
    - Increased property values
    - Deferred costs for roadway capacity improvements
    - Increase in pollution generating surfaces

The direct energy calculations are covered in Section 8.2.

8.8.2. Indirect and Cumulative Effects

There would be limited potential for future reduction in indirect energy consumption for the No-Build Alternative.

For the EC Alternative, there would be potential for decreasing indirect energy compared to No-Build Alternative.

For the EmX Alternative, there would not be potential for decreasing indirect energy compared to No-Build Alternative due to the more intensive energy required for maintaining transit vehicles.

The indirect energy calculations are covered in Section 8.3.

8.8.3. Short-Term Construction-Related Impacts

For the No-Build Alternative, there would be no short-term construction-related impacts.

The following short-term construction-related impacts are expected for the EC and EmX Alternatives:

- Construction-related energy use and emissions
- Jobs creation and related economic benefits

The short-term construction-related impact calculations are covered in Section 8.5.

8.8.4. Mitigation Measures

For the No-Build Alternative, there would be no mitigation measures.

The following mitigation measures could be achieved for the EC and EmX Alternatives:

- Energy-related best management practices during construction
- Sustainable procurement practices
- Recycling and reuse of construction and demolition materials
- Preserve or replant trees

The mitigation measures are covered in greater detail in Section 4.6.

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

9.1. Affected Environment

The following section evaluates the Martin Luther King, Jr. Boulevard corridor for future year No-Build and EC Alternatives. In this corridor, energy is consumed primarily for residential, commercial, and transportation purposes. Transportation energy for motor vehicles is primarily provided by direct combustion of petroleum fuels, with lesser contributions from compressed natural gas and electricity. Energy consumption is increased at heavily congested intersection. Several intersections in the study area are already heavily congested and traffic volumes are forecasted to increase by 2035.

Frequent service buses operating within the corridor could help reduce reliance on private vehicles while typically providing a more efficient use of energy. These services provide more attracted alternatives to the automobile than regular service buses, and also tend to have higher ridership, which could reduce energy consumption per passenger.

9.2. Long-Term Direct Impacts

The long-term direct impacts of the proposed alternatives include changes to direct energy consumption. Energy measures include consumption, measured in Btu, and GHG emissions, measures in grams of CO_2e. The direct energy analysis for each alternative was based on projected year 2035 traffic volumes and regionwide VMT for cars, combination trucks, and buses.[12] Direct energy and GHG emissions consumption were calculated by multiplying energy use factors developed by the Federal Transit Administration (FTA, 2013) by average weekday VMT values.

9.2.1. No-Build Alternative

VMT is expected to increase as compared to existing conditions under the No-Build Alternative, with congestion increasing accordingly. The average weekday VMT, average energy use factors, and average weekday energy consumption are shown in Table 9.2-1.

Table 9.2-1. 2035 No-Build Alternative Regionwide Transportation Energy Consumption

Vehicle Type	Average Weekday VMT	Average Energy Use Factors (Btu / VMT)	Average Weekday Energy Consumption (Btu)
Automobile	5,044,992	5,633	28,418,400,000
Combination Truck	1,169,234	17,544	20,513,100,000
Buses	15,482	27,182	420,800,000
Total	**6,229,708**		**49,352,300,000**

Source: DKS. (2016).
Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

[12] Regionwide VMT provided to DKS Associates by Randy Parker, John Parker Consulting. Traffic modeling for alternatives was performed by Jennifer John, CH2M, and model data were provided to DKS Associates.

The average weekday VMT, CO_2e emissions factors, and total CO_2e emissions are shown in Table 9.2-2.

Table 9.2-2. 2035 No-Build Alternative Regionwide GHG Emissions

Vehicle Type	Average Weekday VMT	CO_2e Emissions Factors (grams CO_2e/VMT)	Total Grams of CO_2e
Automobile	5,044,992	397	2,002,900,000
Combination Truck	1,169,234	1,108	1,295,500,000
Buses	15,482	2,177	33,700,000
Total	**6,229,708**		**3,332,100,000**

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

9.2.2. Enhanced Corridor Alternative

Significant improvements to transit facilities, including BAT lanes, would be provided in the EC Alternative. Vehicle, pedestrian and bicycle facilities would also be enhanced in some locations. The average weekday VMT, average energy use factors, and average weekday energy consumption are shown in Table 9.2-3.

The EC Alternative shows the potential to produce a modest decrease in VMT compared to the No-Build Alternative. However, the alternative does not indicate a potential to reduce energy consumption. This is because of the increase in bus VMT. Buses use more energy than automobiles per mile travelled. Buses use more energy than automobiles per mile travelled. Even though buses consume a lot more energy than automobiles, they can transport a lot more people too. The data shown do not take into account that buses are associated with a lower energy use per person than automobiles and trucks. The automobile trips taken off the road by the increased transit service in this alternative do not create enough energy savings to offset the increase in energy from increased bus VMT.

Table 9.2-3. 2035 EC Alternative Regionwide Transportation Energy Consumption

Vehicle Type	Average Weekday VMT	Average Energy Use Factors (Btu / VMT)	Average Weekday Energy Consumption (Btu)
Automobile	5,044,110	5,633	28,413,500,000
Combination Truck	1,168,952	17,544	20,508,100,000
Buses	15,902	27,182	432,200,000
Total	**6,228,964**		**49,353,800,000**
Change from No-Build	-743		1,500,000
Percent Change from No-Build	-0.012%		0.003%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

The same average weekday VMT values were used to estimate the GHG emissions, measured in CO_2e, as shown in Table 9.2-4. Similar to the result for average weekday energy consumption, the EC Alternative does not show a potential to reduce GHG emissions.

Table 9.2-4. 2035 EC Alternative Regionwide GHG Emissions

Vehicle Type	Average Weekday VMT	CO_2e Emissions Factors (grams CO2e/VMT)	Total Grams of CO_2e
Automobile	5,044,110	397	2,002,500,000
Combination Truck	1,168,952	1,108	1,295,200,000
Buses	15,902	2,177	34,600,000
Total	**6,228,964**		**3,332,300,000**
Change from No-Build	-743		200,000
Percent Change from No-Build	-0.012%		0.008%

Source: DKS. (2016).

Bus VMT: *MovingAhead Draft Level 2 Definition of Alternatives* (CH2M et al., 2016).
Average Energy Use Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

9.2.3. Annualized Impacts & Costs

The total annualized costs associated with energy consumption and GHG emissions are shown in Table 9.2-5, and will be incorporated into a total environmental benefit analysis using data from the Air Quality Technical Report, Transportation Technical Report, Capital Cost Estimating Report, and Operations and Maintenance Costs Technical Report.

The annualized impacts were based on the assumption that all buses would be hybrid-diesel buses. If LTD were to convert a portion of their fleet to electric buses, the energy consumption and GHG emissions costs would be reduced for all alternatives, including the No-Build Alternative. If additional electric buses were acquired for the EC Alternative, the total value of the EC Alternative improvement could increase slightly, as both the energy consumption and the GHG emissions would be expected to decrease.

Table 9.2-5. 2035 Estimated Regionwide Annual Costs for All Alternatives

Annual Value	EC Alternative
Decrease (Increase) in Energy Consumption, million Btu	(222)
Energy Value of Improvement	($75.20)
Decrease (Increase) in GHG Emissions, metric tons CO_2e	(63)
GHG Emissions Value of Improvement	($3,576.18)
Total Value of Improvement	**($3,651.38)**

Source: DKS. (2016).

Cost Factors: New and Small Starts Evaluation and Rating Process Final Policy Guidance (FTA, 2013, August).

The energy consumption and GHG emissions costs were developed using the following cost factors from FTA's New Starts and Small Starts Final Policy Guidance document (FTA, 2013):

- $1.72 per million Btu for gasoline (assumed as sole fuel for auto VMT)
- $1.56 per million Btu for diesel fuel (assumed as sole fuel for heavy truck and diesel-hybrid bus VMT)
- $57 per metric ton of CO_2e as the midrange 2035 estimate of the social cost of carbon

An annualization factor[13] of 342 was used to estimate annual VMT based on average weekday VMT data. Annualized bus VMT was provided by LTD.

9.3. Long-Term Indirect Impacts

Indirect energy effects involve ongoing vehicle maintenance and repair energy. Indirect energy is calculated by determining the energy equivalent of all of the material products and operations necessary to keep the transportation system operable. The indirect energy analysis was conducted by converting regionwide VMT for each alternative into energy consumption.

While not quantified here, roadway maintenance may increase for higher bus service, except when cement improvements are made to the roadway that could result in lower maintenance and energy associate with maintenance for the roadways repairs over the long term.

9.3.1. No-Build Alternative

The regionwide indirect energy associated with vehicle maintenance and repair energy is shown in Table 9.3-1.

Table 9.3-1. 2035 No-Build Alternative Regionwide Maintenance and Repair Energy

Vehicle Type	Maintenance / Repair Energy (Btu / mile)	Tires (Btu / mile)	Oil (Btu / mile)	VMT	Maintenance / Repair Energy (Btu)
Automobile	815	316	308	5,044,992	7,259,700,000
Combination Truck	1,592	725	1,199	1,169,234	4,111,000,000
Bus / BRT Vehicle	13,142	-	-	15,482	203,500,000
Total				**6,229,708**	**11,574,200,000**

Source: DKS. (2016).

9.3.2. Enhanced Corridor Alternative

The regionwide indirect energy associated with vehicle maintenance and repair energy is shown in Table 9.3-2. The EC Alternative does not indicate the potential to decrease in maintenance and repair energy as compared to the No-Build Alternative. This is due to the more intensive energy required for maintaining buses as compared to other vehicles.

[13] The annualization factor was calculated based on 2015 traffic volume data from ODOT's ATR stations. An average value was applied based on the six ATR stations located in the Eugene-Springfield region.

Not reflected in Table 9.3-2 for vehicle maintenance is the maintenance for roadways. The cement used for EC Alternative stations is much stronger than asphalt and will require less maintenance over time. Removing buses from the asphalt lanes could extend the life of those sections of the roadway.

Table 9.3-2. 2035 EC Alternative Maintenance and Repair Energy

Vehicle Type	Maintenance / Repair Energy (Btu / mile)	Tires (Btu / mile)	Oil (Btu / mile)	VMT	Maintenance / Repair Energy (Btu)
Automobile	815	316	308	5,044,110	7,258,500,000
Combination Truck	1,592	725	1,199	1,168,952	4,110,000,000
Bus / BRT Vehicle	13,142	-	-	15,902	209,000,000
Total				**6,228,964**	**11,577,500,000**
Change from No-Build				-743	3,300,000
Percent Change from No-Build				-0.012%	0.028%

Source: DKS. (2016).

9.4. Total Long-Term Impacts

Total energy impacts account for direct energy consumed by vehicles, vehicle emissions, and vehicle maintenance and repair energy. Energy impacts are assessed based on the projected future VMT, which is influenced by projected changes in land use patterns, population growth, and programmed transportation improvements.

9.4.1. No-Build Alternative

The total long-term energy use (sum of direct impacts and maintenance energy) is shown in Table 9.4-1.[14]

Table 9.4-1. 2035 Total Long-Term Regionwide Energy Impacts

Energy Type	No-Build Energy Use (Btu)
Direct Energy (Btu)	49,352,300,000
CO_2e Equivalent Energy (Btu)[a]	62,830,600,000
Maintenance Energy (Btu)	11,574,200,000
Total	**123,757,100,000**

Source: DKS. (2016).

[a] CO2e energy was converted from grams CO2 to Btu by multiplying grams by 18.856 Btu/gram (1 therm = 5,302 grams of CO2; 99,976.1 Btu = 1 therm) to calculate total energy use.

[14] CO_2e energy was converted from grams CO_2 to Btu by multiplying grams by 18.856 Btu/gram (1 therm = 5,302 grams of CO_2; 99976.1 Btu = 1 therm).

9.4.2. Enhanced Corridor Alternative

The total long-term energy use (sum of direct impacts and maintenance energy) is shown in Table 9.4-2.[15] The EC Alternative does not indicate potential to decrease total energy use in the region as compared to the No-Build Alternative.

Table 9.4-2. 2035 Total Long-Term Regionwide Energy Impacts

Energy Type	No-Build Energy Use (Btu)	EC Alternative Energy Use (Btu)	Change from No-Build (Btu)	Percent Change from No-Build
Direct Energy (Btu)	49,352,300,000	49,353,800,000	1,500,000	0.003%
CO_2e Equivalent Energy (Btu)[a]	62,830,600,000	62,835,400,000	4,800,000	0.008%
Maintenance Energy (Btu)	11,574,200,000	11,577,500,000	3,300,000	0.028%
Total	**123,757,100,000**	**123,766,700,000**	**9,600,000**	**0.008%**

Source: DKS. (2016).

[a] CO2e energy was converted from grams CO2 to Btu by multiplying grams by 18.856 Btu/gram (1 therm = 5,302 grams of CO2; 99,976.1 Btu = 1 therm) to calculate total energy use.

9.5. Short-Term Construction-Related Impacts

Construction energy effects involve the one-time, non-recoverable energy costs associated with construction of roadways and structures. It should be noted that the energy consumption associated with construction could be highly variable, depending on the source, manufacturing, and transport of materials. The construction energy analysis was conducted using the Input-Output Method, which converts Year 1977 construction dollars into energy consumption.

9.5.1. No-Build Alternative

There are no construction activities associated with the No-Build Alternative. No construction energy use was assumed for the No-Build Alternative.

9.5.2. Enhanced Corridor Alternative

The estimated construction energy for the EC Alternative is shown in Table 9.5-1. The estimate considers only construction for new lanes, new stations and terminals, sitework, and new traffic signals. All of the values listed reflect increases as compared to the No-Build Alternative

[15] CO_2e energy was converted from grams CO_2 to Btu by multiplying grams by 18.856 Btu/gram (1 therm = 5,302 grams of CO_2; 99976.1 Btu = 1 therm).

Table 9.5-1. EC Alternative Construction Energy Use (Btu x 10^9)

	Construction Energy Measure / $1977	Quantity	Total Construction Energy (Btu x 10^9 / $1977)	Total Construction Energy (Btu x 10^9)
Bus and Turning Lanes	2.46 Btu x 10^9 per mile	14.1	34.7	138
Stations and Terminals	3.25 Btu x 10^9 per station	0	0	0
Sitework	0.88 Btu x 10^9 per mile	2.0	1.74	6.92
Traffic Signals	5,000,000 Btu / signal	1	0.01	0.02
Total			**36.4**	**145**

Source: Calculated based on factors provided in West Eugene EmX Extension Project Energy and Sustainability Technical Memo, Table 6-5

9.6. Potential Mitigation Measures

Potential mitigation measures for the No-Build and EC Alternatives are detailed in Section 4.6.

9.7. Permits and Approvals

No permits or approvals are required for potential impacts evaluated in this report. Permits and approvals are more specifically addressed in other technical reports for this project.

9.8. Summary of Findings

9.8.1. Long-Term Direct Impacts

The following long-term direct impacts are expected for the No-Build Alternative:

- Limited potential for sufficient mode shifts away from motor vehicle travel to transit to improve energy use and sustainability
- Adverse impacts to sustainability compared to build alternatives, including air quality, safety, health, vehicle costs, and mobility options for Title VI and environmental justice populations
- Inconsistent with applicable goals and policies related to GHG reductions and sustainability

The following long-term direct impacts are expected for the EC Alternative:

- Potential for regionwide reduction in VMT as compared to No-Build Alternative
- Not potential to reduce fossil fuel consumption and GHG emissions as compared to No-Build Alternative, due to increase in bus VMT but not a large enough reduction in auto VMT
- Support nodal development, resulting in gradual transition from current lower-intensity, auto-oriented land use pattern, toward more pedestrian-oriented center of activity, with resulting benefits including:
  - Decrease in the distances people need to travel to reach destinations
  - Fewer automobile trips and emissions
  - Preservation of open space and resource lands
  - Ancillary sustainability benefits, including:
    - Increased safety

    - Health benefits
    - Vehicle cost savings
  - Improved mobility and transportation options for Title VI and environmental justice populations
  - Increased property values
  - Deferred costs for roadway capacity improvements
  - Increase in pollution generating surfaces

The direct energy calculations are covered in Section 9.2.

9.8.2. Long-Term Indirect Impacts

There would be limited potential for future reduction in indirect energy consumption for the No-Build Alternative.

For the EC Alternative, there would not be potential for decreasing indirect energy compared to No-Build Alternative due to the more intensive energy required for maintaining transit vehicles.

The indirect energy calculations are covered in Section 10.3.

9.8.3. Short-Term Construction-Related Impacts

For the No-Build Alternative, there would be no short-term construction-related impacts.

The following short-term construction-related impacts are expected for the EC Alternative:

- Construction-related energy use and emissions
- Jobs creation and related economic benefits

The short-term construction-related impact calculations are covered in Section 9.5.

9.8.4. Mitigation Measures

For the No-Build Alternative, there would be no mitigation measures.

The following mitigation measures could be achieved for the EC Alternative:

- Energy-related best management practices during construction
- Sustainable procurement practices
- Recycling and reuse of construction and demolition materials
- Preserve or replant trees

The mitigation measures are covered in greater detail in Section 4.6.

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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* (Central Lane MPO, 2016, May)
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
NW Natural	Northwest Natural

Table A-1. Acronyms and Abbreviations

Acronyms and Abbreviations	Definitions
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.