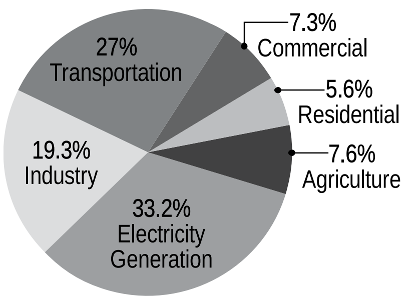
Greenhouse Gases

Greenhouse gases generally include six types of gas. Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perflourocarbons (PFCs), and sulfur hexafluoride (SF_6).

Exhibit 3.19-1
Source of U.S. Greenhouse Gas Emissions, 2004[a]



Source: EPA 2006.

[a] Excluding emissions in U.S., territories, which accounted for 0.88% of total emissions.

What is included in the transportation sector?

The transportation sector includes domestic air transport, road vehicles, rail, pipeline transport, national navigation, and non-specific transport. Consistent with IPCC guidelines, it does not include international aviation or marine bunker fuels.

3.19.8 Climate Change

This section summarizes potential cumulative impacts associated with climate change and discusses future uncertainty and risk associated with climate change. Climate change, also referred to as global warming, is an increase in the overall average atmospheric temperature of the earth. The Intergovernmental Panel on Climate Change (IPCC) stated: “Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations.”[48] In the coming decades, scientists anticipate that as atmospheric concentrations of greenhouse gases continue to rise, average global temperatures and sea levels will continue to rise as a result and precipitation patterns will change.

Virtually all human activities have an impact on our environment, and transportation is no exception (Exhibit 3.19-1). Transportation is a substantial source of greenhouse gas emissions, and contributes to global warming through the burning of petroleum-based fuel. Any process that burns fossil fuel releases carbon dioxide into the air. Carbon dioxide is the primary greenhouse gas emitted by vehicles, and therefore it is the focus of this analysis.

Changes in CO_2 emissions from fossil fuel combustion are influenced by many long-term and short-term factors, including population and economic growth, energy price fluctuations, technological changes, and seasonal temperatures. On an annual basis, the overall consumption of fossil fuels in the United States generally fluctuates in response to changes in general economic conditions, energy prices, weather, and the availability of non-fossil alternatives.[49] Over time, carbon emissions increase with population growth. The population, as well as the number of miles being driven, has grown and is expected to continue growing, but standards for vehicle fuel efficiency have not changed since 1991.

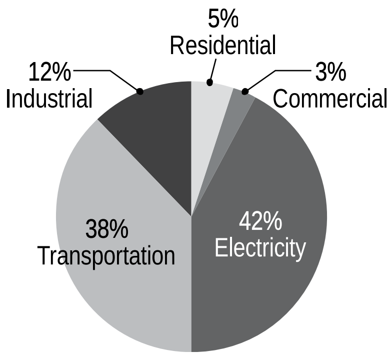
Transportation accounts for an estimated 38 percent of Oregon’s carbon dioxide emissions, with vehicle CO_2 emissions predicted to increase by 33 percent by 2025 because of increased driving (Exhibit 3.19-2).

Washington State predicts that, with the state’s reliance on in-state hydropower for electricity generation, the transportation sector accounts for almost 50 percent of greenhouse gas emissions in Washington (Exhibit 3.19-3).

[48] IPCC, 2007.

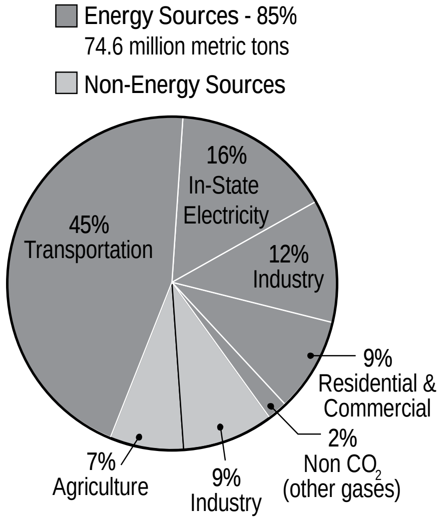
[49] Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks. 1990-2006 February 2008).

Exhibit 3.19-2
Greenhouse Gas Emissions in Oregon, 2008



Source: Oregon Department of Energy January 2008.

Exhibit 3.19-3
Greenhouse Gas Emissions in Washington, 2004
TOTAL=88.3 million metric tons of CO_2 equivalent



Source: Washington Department of Community, Trade and Economic Development (Preliminary Estimate)

Future carbon emissions for the CRC project are difficult to estimate precisely because such a wide variety of factors could influence carbon emissions by 2030. Some of the factors that could change between now and 2030 include government regulations, price and availability of fuel and alternative energy sources, and vehicle technology (such as electric hybrid or fuel cell vehicles).

The National Highway Traffic and Safety Administration (NHTSA), which is part of U.S. DOT, establishes and amends the Corporate Average Fuel Economy (CAFE) standards for vehicles. The CAFE program gives manufacturers an incentive to sell more fuel-efficient light trucks and automobiles. Congress sets CAFE standards for cars. EPA reports the CAFE results for each manufacturer to NHTSA annually, and NHTSA determines if they comply with CAFE standards and assesses penalties as required. A tax is imposed on makers of new model year cars that fail to meet the minimum fuel economy level of 22.5 mpg. In 2011, the standard will change to include many larger vehicles.

A discussion of greenhouse gas emissions, as well as the calculations of emissions by alternative, are found in Section 3.12, Energy.

On December 19, 2007, President Bush signed into law the Clean Energy Act of 2007, which requires in part that automakers boost fleetwide gas mileage to 35 mpg by the year 2020. The current CAFE standard for cars, set in 1984, requires manufacturers to achieve an average of 27.5 miles per gallon, while a second CAFE standard requires an average of 22.2 miles per gallon for light trucks such as minivans, sport utility vehicles, and pickups. The new rules require that these standards be increased such that, by 2020, the new cars and light trucks sold each year deliver a combined fleet average of 35 miles per gallon. It is unclear how the phase-in of these new cars will impact the overall fuel efficiency of the fleet mix between now and 2030. It is partially dependent on the economy; for example, how many people buy new vehicles before 2030.

If historic and recent transportation trends continue, CO_2 emissions will continue to increase. By 2030, CO_2 emitted from vehicles on all regional roadways, including I-5 and I-205, are expected to increase over existing conditions. For example, the population is expected to increase in Clark County by 66 percent between 2005 and 2030, which could have a dramatic effect on vehicle miles traveled in the region. Without the CRC improvements, the highway crossing would produce 40 percent more greenhouse gas emissions by 2030 than under existing conditions and the regional transit system would produce 30 percent more.

Several jurisdictions in the project area have goals to reduce greenhouse gases. The Washington legislature passed a statute that aims to achieve 1990 greenhouse gas levels by 2020, and a 50 percent reduction below 1990 levels by 2050. The goals of the Oregon Climate Change Integration Act seek to reduce emissions 10 percent below 1990 levels by 2020 and achieve a 75 percent reduction below 1990 levels by 2050. Regulations implementing these goals have not been issued yet. Both Oregon and Washington are members of the Western Climate Initiative, which announced a regional, economy-wide greenhouse gas emissions target of 15 percent below 2005 levels by 2020, or approximately 33 percent below business-as-usual levels.[50]

In 1993, Portland was one of the first U.S. cities to adopt a plan to address global warming. In 2001, Multnomah County joined Portland in adopting a revised plan, the Local Action Plan on Global Warming, outlining more than 100 short- and long-term actions to reduce emissions 10 percent below 1990 levels by 2010.[51] In addition, mayors of Portland and Vancouver signed the U.S. Mayors' Climate Protection Agreement committing to reduce carbon emissions in cities below 1990 levels.

[50] See Western States Initiative webpage at http://www.westernclimateinitiative.org/Index.cfm.

[51] See 2005 Global Warming Progress Report by City of Portland and Multnomah County on more information regarding CO2 reductions in the metro region.

3.19.9 Long-Term Impacts

The CRC project constitutes small section of I-5; nevertheless, the consumption of fuel for the movement of people and goods on I-5 across the Columbia River could potentially cause cumulative long-term impacts on the environment. CRC project could reduce greenhouse gas emissions in the project area with the build alternatives. The guidelines set out by international, national, and state organizations primarily focus on improving vehicle efficiency and low-carbon fuel[52]; however, they do suggest measures for infrastructure that could reduce greenhouse gas emissions, such as:

- **Providing bicycle and pedestrian infrastructure**. The build alternatives include a bicycle and pedestrian multi-use path across the river, completely separated from vehicle traffic.
- **Providing transit options**. Currently, the only transit option from Portland to Vancouver or vice-versa is on buses that flow and stop with traffic. The build alternatives will provide high capacity transit (light rail or bus rapid transit) that will operate on a separate guideway, unaffected by vehicle congestion.
- **Implementing tolls**. The CRC project is considering a wide-range of scenarios for tolling the build alternatives, including increasing tolls during peak-periods to encourage off-peak driving. Traffic modeling shows that variable tolls would cause mode shift to transit and non-motorized transit (bicycle and pedestrian), or encourage people to not make certain trips.
- **Increasing efficiency of transportation systems**. The elimination of bridge lifts, variable pricing with tolls, the addition of auxiliary lanes between closely spaced interchanges in the project area, and the intersection improvements proposed for the CRC project will minimize congestion and stop-and-go conditions, which lead to inefficient use of energy.
- **Supporting transit orientated development**. The build alternatives provide an opportunity for transit-oriented development, consistent with existing land use plans for the City of Portland and the City of Vancouver.
- **Replacing aging infrastructure in existing corridors**. The build alternatives will upgrade an existing structure in an urban area instead creating a new transportation corridor.

The project team estimated greenhouse gas emissions for the CRC alternatives. The methodology for estimating long-term energy use was based on methodologies outlined in the Oregon Energy Manual, and CO_2 emissions were estimated using data provided by the Environmental Protection Agency (EPA). Other factors taken into account were:

- Vehicle trips[53]
- Expected advancements in vehicle technology

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[52] IPCC (2007), The State of Oregon Governor's Climate Change Integration Group (January 2008).

[53] Vehicle demand and transit demand is based on the regional, system-wide demand for people to drive their cars or take transit in the project area, including I-5 and I-205 river crossings.

- Expected advancements in fuel technology
- Current and future transit technology (electric for light rail and bio-diesel for buses)

The analysis shows that all build alternatives are projected to reduce personal vehicle travel demand over No-Build conditions and improve the operations of the I-5 crossing, as described in the Traffic section of this DEIS.

CO_2 emissions account for 94 to 95 percent of greenhouse gases emitted by the transportation sector.[54] As a result, the EPA uses CO_2 emission estimates as a representative indicator of greenhouse gas emissions. The general equation for estimating CO_2 emissions can be expressed as:

$$EM = FC \times EF$$

EM = Emissions of CO_2 (lbs)
FC = Fuel consumed (gallons)
EF = Emission factor (lbs of CO_2/gallon) (based on fuel type)

The CRC Energy Technical Report has more information on CO_2 emissions, and the methodology for calculating alternatives' potential affect on climate change

The fuel consumed (FC) is the amount of fuel that would be used to operate a vehicle or bus. The emission factor (EF) is the amount of CO_2 that would be emitted during combustion of a gallon of fuel. Based on data from the EPA, the emission factors used in this analysis were 19.4 pounds of CO_2 per one gallon of gasoline and 22.2 pounds for one gallon of diesel.[55] The emission factor for biodiesel can vary slightly depending on the blend, but was assumed to be equal to diesel (22.2 lbs of CO_2/gallon of biodiesel) for this analysis, which is consistent with EPA conclusions that biodiesel emits the same amount of CO_2 compared to diesel.[56]

When fuel burns, the carbon and hydrogen separate. The hydrogen combines with oxygen to form water and carbon combines with oxygen to form carbon dioxide (CO_2). The carbon content of fuel assumed in this analysis is the recommended EPA quantities for the amount of carbon in a typical gallon of gasoline or diesel.[57]

Light rail is operated by electricity. Although light rail vehicles do not individually emit CO_2 during travel, the process of converting fuel to electricity does. The electricity used to operate light rail would most likely come from sources available in the project area. Approximately 40 percent of the total electricity needed for light rail would be provided by Portland General Electric, based on the location of two substations in the Portland area. From these substations, 42 percent would come from coal and 13.9 percent would come from natural gas (the remaining portions would come from non-CO_2 emitting sources, such as hydropower, nuclear, wind, etc). Approximately 60 percent of the total electricity needed would be provided by Clark County Public Utilities, based on the location of three substations in the Vancouver area. From

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[54] EPA (2005). Other greenhouse gases cover a broad array of gases other than CO2, principally methane (CH4), nitrous oxide (N2O) and sulfur hexaflouride (SF6).

[55] EPA, 2005a.

[56] The reduction in CO2 emissions from using biodiesel comes from the energy saved in harvesting the fuel, which was not computed in this analysis.

[57] EPA, 2005b.

these substations, 7 percent would come from coal and 28 percent would come from natural gas. The remaining portions would come from non-CO_2 emitting sources, primarily hydropower.

Exhibit 3.19-4 summarizes the potential daily energy use and CO_2 emissions for the alternatives in 2030.

Exhibit 3.19-4
Full Alternatives Summary of Daily Energy Use and CO_2 Emissions

Alternative	Energy Consumed (mBtu)	Electricity Consumed (kWh)	Gasoline Consumed (gal)	Bio/Diesel Consumed (gal)	CO_2e Emissions (tons)
Existing	4,014.4	77,355.3	8,343.0	19,585.2	342.5
Alternative 1 (No-Build)	5,384.2	152,628.0	10,661.0	25,536.6	463.3
Alternative 2 (Replacement, BRT)	5,248.1	152,628.0	9,598.0	25,520.9	452.3
Alternative 3 (Replacement, LRT)	5,242.3	162,063.3	9,598.0	25,231.8	452.4
Alternative 4 (Supplemental, BRT)	5,729.2	160,645.6	9,622.0	28,790.3	493.7
Alternative 5 (Supplemental, LRT)	5,687.1	172,053.3	9,622.0	28,172.0	490.7

Source: CRC Cumulative Effects Technical Report.

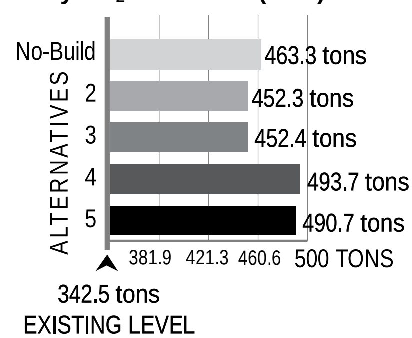
The replacement crossing with associated highway improvements, a toll on I-5, and light rail or bus rapid transit (Alternative 2 or 3) would reduce CO_2 emissions about two to three percent lower than the No-Build Alternative. This reduction is due to fewer auto trips over the river, more people riding on public transit, and reduced traffic congestion, which improves fuel efficiency.

Alternatives 4 and 5 were estimated to increase CO_2 emissions relative to No-Build, primarily because they include aggressive increases in the frequency of light rail or bus rapid transit and other bus routes without realizing proportional decreases in auto travel. Buses powered by petroleum diesel or bio-diesel emit CO_2, and a portion of the electricity that powers light rail comes from power plants that emit CO_2.

It is important to note that the total CO_2 emission estimates do not capture all of the potential reductions in CO_2 emissions associated with the highway improvements. They capture only the reductions associated with changes in highway travel speeds and the number of vehicles on the crossing itself. It is likely that the decreased congestion both north and south of the river, due to the replacement crossing and to a lesser extent the supplemental crossing, would further reduce CO_2 emissions compared to No-Build. In addition, the model does not capture a potential mode shift to bicycle and pedestrian that is expected with a toll and an improved bicycle and pedestrian path.

Carbon emissions will tend to be lower with a higher toll, or by tolling both I-5 and I-205, because tolling decreases the number of cars driving over the crossing and increases the number of people riding transit or carpooling.

Exhibit 3.19-5
Daily CO_2 Emissions (tons)



Source: CRC Energy Technical Report

According to the U.S. Department of Energy, the average American household produces 59 tons of carbon per year, and 11.7 tons of it is related to transportation

TERMS & DEFINITIONS

Adaptation

The intergovernmental Panel on Climate Change (IPCC 2001) defines adaptation as "adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in human processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change."

How do you estimate the impact of climate change on river levels?

Studies that have modeled future climate and river flow used existing data about the Columbia River Basin to predict trends over the next 50 to 100 years, taking into account the effects of global warming and other emergent conditions in the basin. These studies suggest that in the next century the flow pattern of the Columbia River could be transformed from a primarily snow-melt fed river to one supported by a mix of rainfall and diminished snow-melt.

Potential Mitigation and Adaptation

Currently no local, state, or federal regulations identify a threshold for CO_2 emissions for transportation projects. However, potential measures for reducing adverse impacts to climate change from all alternatives could include:

- Implement programs that further encourage use of public transit
- Promote compact and transit-oriented development which encourages walking
- Provide safe and well-lighted sidewalks to encourage walking
- Provide safe and more accessible connections to paths for bicyclists and pedestrians
- Offer ride-share and commute choice programs
- Construct with materials and build systems that meet efficiency standards for equipment and lighting design
- Recycle building materials, such as concrete, from project
- Use sustainable energy to provide electricity for lighting and other operational demands
- Plant vegetation to absorb or offset carbon emissions
- Promote fuel-efficiency improvements, such as a low carbon fuel standard
- Promote diesel engine emission reduction
- Consider clean energy certificates or other carbon offsets for energy used

In addition to reducing CO_2 emissions, the CRC project may need to adapt to the effects brought about by climate change. The IPCC defines adaptation as "adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. Adaptation refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change."[58] In October 2002 the U.S. DOT Center for Climate Change and Environmental Forecasting, with the support of the EPA, Department of Energy, and the U.S. Global Change Research Program sponsored an interdisciplinary workshop to define research priorities regarding the potential impacts of climate variability and change on transportation. The priority areas identified at the workshop include: 1) assessment of potential impacts on critical infrastructure locations and facilities, 2) development of improved tools for risk assessment and decision-making, and 3) assessment of response strategies. The CRC project is proposed infrastructure that could be impacted by climate change.

The CRC project team considered some of the potential risks that could be caused by climate change, and potential adaptation measures to mitigate risk. The CRC project's location relative to the Columbia River

[58] IPCC, 2001.

raises special concerns related to climate change. The Columbia River's water levels are affected by the amount of snow that falls during the winter and the amount of precipitation that falls as rain year round. The factor that affects these precipitation patterns most is the temperature of the atmosphere.

The effects of climate change on the river's flow and peak flow cycle have been the focus of several climate prediction models[59] over the last 10 years. Studies conclude that the increase in winter rain (which would historically fall as snow) will lead to increased winter flow of the Columbia River and a weaker snow-melt increase during the spring and summer. Under the worst case scenario, the water level of the Columbia River would rise another 5 feet during winter flow in 2030 compared to existing conditions.

Based on the information available, potential adaptation measures could include:

- Raising the height of the crossing to account for potential rise in the Columbia River water level
- Ensuring that the design and the materials used to build the crossing can withstand major storms and droughts
- Avoiding and minimizing construction in 100-year or 500-year floodplains

3.19.10 Electric and Magnetic Fields

Standards for electric and magnetic field (EMF) exposure guidelines are established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the American Conference of Governmental Industrial Hygienists. A survey conducted under the National Institutes of Health characterizes the personal magnetic field exposure in the general population.[60] The results indicate that approximately 14 percent of the general population is exposed to a 24-hour average magnetic field strength exceeding 2 mG. About 25 percent of people spend more than one hour at fields greater than 4 mG, and 9 percent spend more than one hour at fields greater than 8 mG. Approximately 1.6 percent of people experience at least one gauss (1,000 mG) during a 24-hour period.

Any of the CRC alternatives that involve extending light rail would add to EMF exposure. However, EMF levels from the light rail system are well below the ICNIRP exposure standards. There would be a slight cumulative increase for those persons riding or working on the light rail system. However, it is not anticipated that human health would be adversely affected by light rail-generated EMF.

3.19.11 Energy and Peak Oil

Cumulative effects related to energy use are partially incorporated into the long-term energy demand estimates prepared for the CRC project. Those estimates are based on travel demand forecasts that factor in

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[59] Hamlet and Lettenmaier, 1999.

[60] Enertech Consultants, 1998.