US 97 Facility Plan

US 97 South Redmond Corridor Project

Redmond, Oregon

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Acronyms and Abbreviations

BNSF	Burlington Northern Santa Fe
BPSIP	Oregon Bicycle and Pedestrian Safety Implementation Plan
GEH	Statistical formula used to compare two sets of traffic volumes
HDM	Highway Design Manual
ISIP	Oregon Intersection Safety Implementation Plan
LQ	location quotient
MSA	Metropolitan Statistical Area
NHS	National Highway System
OAP	Oregon Aviation Plan
OAR	Oregon Administrative Rule
ODOT	Oregon Department of Transportation
OHP	Oregon Highway Plan
OPTP	Oregon Public Transportation Plan
ORP	Oregon Resilience Plan
ORS	Oregon Revised Statute
OTP	Oregon Transportation Plan
PHF	peak hour factor
PMT	Project Management Team
RDSIP	Oregon Roadway Departure Safety Implementation Plan
ROW	Right-of-Way
SAC	Stakeholder Advisory Committee
SC	Steering Committee
SRC	South Redmond Corridor
STIP	Statewide Transportation Improvement Program
TAC	Technical Advisory Committee
TPR	Transportation Planning Rule
TSAP	Transportation Safety Action Plan
TSP	Transportation System Plan
UGB	urban growth boundary
v/c	v/c ratio
vph	vehicles per hour

1 Background

1.1 Purpose

The purpose of the US 97 South Redmond Corridor (SRC) Facility Plan is to provide a brief history of the planning process along the US 97 SRC; describe the existing conditions found along the corridor, including economic and traffic conditions; outline the planning and decision making process, including a description of all concepts considered and evaluated; and finally, present the recommended concept for improvements along the corridor.

The US 97 SRC Facility Plan is intended to help address existing shortcomings of the current corridor, including:

- Lacking or substandard pedestrian facilities.
- Lacking or substandard bicycle facilities.
- Limited crossing opportunities of US 97 for pedestrians and bicyclists.
- Limited east-west connectivity between the corridor and the neighborhoods to the west.
- Untapped development potential due to a multitude of vacant or underdeveloped parcels along the corridor.
- Challenging corridor aesthetics, dominated by automobile-serving facilities (roadways, driveways, parking) and auto-oriented businesses with associated signage.
- The project is intended to provide improvements to maximize the function of US 97 and the connecting transportation system by addressing traffic mobility efficiencies, safety, and local development needs.
- The project will also provide the opportunity to enhance economic development, community urban design, and business vitality along the corridor.
- Travel times along US 97 are also improved with the recommended concept, with a 28 percent improvement in the northbound travel time and a six percent improvement in the southbound travel time compared to No Build.
- If no improvements are made within the US 97 corridor, crashes are predicted to increase from approximately 43 per year today to 76 per year by 2040.

The recommended concept described below addresses these shortcomings and includes benefits that range from operational and safety improvements to access improvements and aesthetic enhancements. Proposed improvements include:

- Three new signalized intersections along US 97 that provide protected U-turns.
- Three new road connections that cross the canal and connect US 97 to Redmond neighborhoods on the west side of US 97.

- Traffic separators between the northbound and southbound lanes on US 97 that allow protected left-hand turning movements and U-turns at signalized intersections.

1.2 Corridor Planning History

US 97 Corridor Plan/Redmond Reroute

The US 97 Corridor Plan and Redmond Reroute study evaluated alternatives to address congested conditions on US 97 through the south end of the City of Redmond (City). The study corridor extended from the central area of the City, where Phase 1 of a highway reroute terminates, and ended at the south of the Redmond urban growth boundary (UGB). This included both urban and rural environments, as well as undeveloped and fully developed areas. The plan considered options for enhancing truck and auto mobility through the corridor, ranging from enhancements for the existing route to multiple reroute extension and bypass alignments. The evaluation of alternatives used criteria such as congestion relief, safety, railroad conflicts, environmental impacts, property access, property impacts, construction costs, canal impacts, airport conflicts, and compatibility with planned development.

Charrette

On October 28th and 29th, 2013, the City hosted a Design Charrette to help property and business owners, stakeholders, and interested members of the public envision the future of the US 97 SRC as depicted in Figure 1 and Figure 2. This interactive, two-day session built on the June 2010 plan for the corridor and helped to better determine the overall design concept for US 97 SRC regarding street frontage, access management, and urban design. The plans and drawings that resulted from this effort provide the foundation for an implementation and funding strategy for the US 97 Facility Plan.

Figure 1. Charrette Concept

Source: SERA Architects

Figure 2. Charrette Meeting

Corridor Vision

The 2013 Charrette helped define three distinct “character” areas along US 97 – Village Commercial near downtown between Veterans Way and Odem Medo Way, Urban Commercial between Odem Medo Way and Yew Avenue / Airport Way, and Gateway District south of Yew Avenue / Airport Way. Subsequently, a group of students from the University of Oregon explored these character areas further and developed a series of conceptual ideas, ranging from modifications to the roadway configuration to landscape enhancements and added street furnishings.

1.3 Facility Plan Process

Previous planning efforts along US 97 were studied as a starting point for the US 97 SRC Facility Plan. Identifying public needs was an important part of the planning process. As the project team learned more information about previous concepts, the gained knowledge filtered into the decision making process to arrive at a hybrid of various concepts that culminated in the recommended concept.

2 Existing and Future Conditions

2.1 Policy, Plans, and Standards

As of spring 2019, there is an on-going update to the Redmond Transportation System Plan (TSP). The TSP and US 97 SRC project teams have coordinated closely, and the US 97 SRC project is consistent with the current draft TSP.

This section provides a review of current transportation related plans, standards, rules, regulations, and policies in place by the state, county, and local jurisdictions that pertain to the update of the TSP This summary serves as a reference for the Project Management Team (PMT) and the Project Advisory Committee and identifies key issues for consideration as part of the TSP Update.

Some documents reviewed herein document existing transportation-related standards, targets, and guidelines with which the TSP shall coordinate and be consistent; other documents contain identified transportation improvements to include in the year 2040 analyses of potential projects. Some City policy and regulatory documents described in this review may require amendments following the adoption of the TSP to ensure implementation of the identified TSP policies and projects, as well as compliance with Oregon’s Transportation Planning Rule (TPR).

2.2 State and Regional Plans

OAR Chapter 734 Division 051

Commonly referred to as Division 51, Oregon Department of Transportation (ODOT) adopted Oregon Administrative Rule (OAR) 734-051 to establish procedures and criteria to govern highway approaches, access control, spacing standards, traffic separators/medians, and restriction of turning movements. This is intended to comply with statewide planning goals, acknowledged comprehensive plans, state law, and the Oregon Transportation Plan (OTP).

The 2008 TSP outlines the guiding principles used in the adoption of new access management standards consistent with OAR 734-051 and the Oregon Highway Plan (OHP). The TSP Update will incorporate the amendments to OAR 734-051 through the adoption of Senate Bill 264 when establishing revised street design guidelines.

Within Redmond, three state facilities connect the city's residents, employees, and visitors with other areas in Central Oregon as well as throughout the state as shown in Table 1. These highways also provide connections between areas within the city and, at the same time, can present a barrier to walking and cycling. In addition, per the Oregon Resilience Plan (ORP), US 97 is a Tier I, Phase I Lifeline Route that would serve as a critical statewide route in the event of a catastrophic emergency, such as a Cascadia Subduction Zone earthquake. A summary of the three facilities and the applicable standards are shown in Table 1 below.

Table 1. ODOT Access Management Spacing Standards

Route Name	Facility Extents	Facility Designation	2015 ADT	Posted Speed Limit (mph)	Access Spacing Standard (feet)
OR 126	Entire Section within City Limits	Statewide Highway	>5,000	25/35/45/50	350/500/800/1320
US 97	Entire Section within City Limits	Statewide Highway	>5,000	40/50/55	800/1100/1320

Oregon Highway Plan

The OHP is the modal plan of the OTP to guide ODOT in the planning, operations, and financing of its highway system. Policies in the OHP emphasize the efficient management of the highway system to increase safety, partner with local and regional jurisdictions, and employ new techniques to improve operations in the existing lanes before expanding capacity. The OHP's policies provide a link between land use and transportation; provide standards and targets for highway performance; design, and access management; and emphasize the multimodal relationship between state highways; local and regional streets; bicycle; pedestrian; transit, rail; and air systems.

The following are examples of OHP policies that are relevant to the US 97 SRC Facility Plan.

Policy 1A: State Highway Classification

ODOT classifies its highways into four levels of importance: Interstate, Statewide, Regional, and District. This classification system guides ODOT's management of the highway system; informs decisions about investments in the highway system; guides the development of facility plans; informs the agency's review of local plans and zoning amendments; and guides facility management decisions, such as road approach permits.

As noted above, there are three ODOT highways within Redmond City limits, including US 97 and OR 126. The purpose and management objectives of these highways are provided in Policy 1A, as summarized below.

- Statewide highways (US 126 and US 97) are intended to provide inter-urban and inter-regional mobility and to connect larger urban areas, ports, and major recreation areas that are not directly served by Interstate Highways. A secondary function is to connect regional trips. ODOT's management objective of these highways is to provide safe and efficient operations with minimal interruptions to flow within urban areas.
- District highways typically function as county and city arterials and collectors. These facilities link urban and rural areas within a region. ODOT's management objective of these highways is to provide for safe and efficient operations in an environment that reflects the urban character and multimodal modes of the highway.

Within the City Limits, US 97 has both an expressway and non-expressway designation. Both US 97 and OR 126 have a freight route designation.

Policy 1B: Land Use and Transportation

Policy 1B provides clarification on ODOT and other agencies to establish the linkage between land use and transportation in transportation plans, facility and corridor plans, plan amendments, access permitting and project development. Policy 1B also recognizes that state highways can serve as the main street in some communities, and as such, this policy provides for a balance between serving a local community's needs and through traffic.

Policy 1C: State Highway Freight System

To support the continued vitality of local and state economies, the designated state's freight system facilitates efficient and reliable interstate, intrastate, and regional truck movement. This freight system includes routes that carry significant tonnage by truck and serve as the primary interstate and intrastate highway connections to ports, intermodal terminals, and urban areas. Highways included in this designation have higher highway mobility standards than other statewide highways. Within the city, both US 97 and US 126 are designated freight routes.

Policy 1F: Highway Mobility Policy

This policy establishes mobility targets that implement the objectives of the OTP and other OHP policies. The policy, as revised, offers the flexibility to the state and local jurisdictions to collaboratively implement mobility targets that support and reflect land use, transportation, and economic development priorities.

The mobility targets are a measure of state highway performance based on a volume-to-capacity (v/c) ratio. The targets are intended to make initial assessment of measures needed to maintain acceptable and reliable mobility but also to recognize that alternative mobility targets (including measures that are not v/c-based) can be effective in identifying solutions that "better balance state and local community needs and objectives."

Within Redmond, the following targets are applicable:

- Statewide Expressway outside of a Metropolitan Planning Organization area (US 97 and OR 126): 0.85 if the speeds are less than or equal to 35 miles per hour and 0.80 for speeds greater than 35 miles per hour.

Policy 1G: Major Improvements

This policy establishes a three-tier process related to evaluating major improvements to the state highway system. The first priority is to improve the safety and management of the existing system prior to adding roadway capacity. Transportation system management and transportation demand management measures (including land use changes) can be used to determine ways to better manage the efficiency of the existing system. The second priority is to make minor improvements to the state highway system and/or improvements to the local street network. The third priority is to add lanes to increase capacity or make other major improvements.

Policy 2F: Traffic Safety

This policy priorities improvements to enhance the safety of all users of the highway system. Action 2F.4 provides for the implementation of the Safety Management System to allocate resources to areas with the most significant safety issues.

Policy 3A: Classification and Spacing Standards

As discussed above, ODOT manages location, spacing, and intersections along state highways to ensure the safe and efficient operations for the traveling public. These management tools recognize the intended function and classification of the highways (as discussed in action 3A.2). The applicable access management spacing standards for the City, as established in the OHP, are implemented by access management rules in OAR 734, Division 51 and highlighted in the above section.

Policy 4A: Efficiency of Freight Movement

The City is bisected by two important statewide freight routes: US 97 and US 126. Policy 4A recognizes the need to maintain and improve the efficiency of freight movement on the state system. The City and ODOT will work together to identify needed improvements to each highway, consistent with this policy.

Policy 4B: Alternative Passenger Modes

This policy supports the development and enhancement of "alternative passenger services and systems" that help preserve the performance and function of the state highway system.

Oregon Freight Plan (2011)

The Oregon Freight Plan is the modal plan of the OTP that supports the movement of goods and commodities in the state. Per this policy, it is the state's intent "to improve freight connections to local, Native American, state, regional, national and global markets in order to increase trade-related jobs and income for workers and businesses." This plan prioritizes strategic investments in existing freight facilities (including rail, marine, air, and pipeline infrastructure).

Within the City, US 97 and OR 126 are part of the state's freight network. The following policies in the Freight Plan can help shape the projects evaluated as part of the US 97 SRC.

- Strategy 1.2: Strive to support freight access to the Strategic Freight System. This includes proactively protecting and preserving corridors designated as strategic.
- Action 1.2.1. Preserve freight facilities included as part of the Strategic Freight System from changes that would significantly reduce the ability of these facilities to operate as efficient components of the freight system unless alternate facilities are identified, or a safety-related need arises.
- Strategy 2.4: Coordinate freight improvements and system management plans on corridors comprising the Strategic Freight System with the intent to improve supply chain performance.

Oregon Public Transportation Plan (OPTP)

The OPTP provides guidance to the development and maintenance of public transportation systems. The vision that guides this element of the OPTP is summarized below.

- "A comprehensive, interconnected, and dependable public transportation system, with stable funding, that provides access and mobility in and between communities of Oregon in a convenient, reliable, and safe manner that encourages people to ride.
- A public transportation system that provides appropriate service in each area of the state, including service in urban areas that is an attractive alternative to the single-occupant vehicle, and high-quality, dependable service in suburban, rural, and frontier (remote) areas.
- A system that enables those who do not drive to meet their daily needs.
- A public transportation system that plays a critical role in improving the livability and economic prosperity for Oregonians."

For Redmond, the OPTP Implementation Plan would encourage the collaboration between ODOT, Cascades East Transit, and the City to enhance city and regional transit services. The OPTP is currently being updated.

Oregon State Rail Plan (2014)

This modal plan addresses long-term freight and passenger rail planning in the state and includes policies and planning processes to maintain and enhance rail service, integrate freight and passenger elements into the land use and transportation planning processes, and provide for collaboration between state, regional and local jurisdictions.

The Burlington Northern Santa Fe (BNSF) Railway in Redmond is a significant driver of economic opportunity for the community. This system interfaces with the community between US 97 and the industrial area near the airport. Within the city, BNSF carries a wide variety of commodities. Today, there are seven at-grade crossings of the railroad within the city. In addition, the Project Advisory Committee includes ODOT representatives that will advise on rail and freight interests.

Oregon Aviation Plan (OAP, 2007)

The OAP provides strategies and policies for investment in the maintenance and enhancement of the state public aviation system. The plan provides for collaboration between the Oregon Department of Aviation, other state and local agencies (like the City), and the Federal Aviation Administration.

The Redmond Municipal Airport is a Category I – Commercial Service Airport and is located immediately to the east of the US 97 SRC. The commercial service airport categorization applies to airports that provide scheduled commercial passenger service in addition to general aviation aircraft. The Airport serves as the primary facility for commercial aviation passenger travel in the region. The Airport, in collaboration with the City, County, and ODOT, is currently updating its Master Plan. This airport also serves an important function as emergency operation center in the event of a Cascadia earthquake.

Oregon Bicycle and Pedestrian Plan (2016)

The vision of the Oregon Bicycle and Pedestrian Plan is:

> *"In Oregon, people of all ages, incomes, and abilities can access destinations in urban and rural areas on comfortable, safe, well connected biking and walking routes. People can enjoy Oregon's scenic beauty by walking and biking on a transportation system that respects the needs of its users and their sense of safety. Bicycle and pedestrian networks are recognized as integral, interconnected elements of the Oregon transportation system that contribute to our diverse and vibrant communities and the health and quality of life enjoyed by Oregonians."*

The plan recognizes that walking and biking support economic growth, health, environmental quality, and mobility. The plan outlines the following goals that are applicable to Redmond:

1. **Safety.** Eliminate pedestrian and bicyclist fatalities and serious injuries and improve the overall sense of safety of those who bike or walk.
2. **Accessibility and Connectivity**. Provide a complete bicycling and pedestrian network that reliably and easily connects to destinations and other transportation modes.
3. **Mobility and Efficiency**. Improve the mobility and efficiency of the entire transportation system by providing high quality walking and biking options for trips of short and moderate distances. Support the ability of people who bike, walk or use mobility devices to move easily on the system.
4. **Community and Economic Vitality.** Enhance community and economic vitality through walking and biking networks that improve people's ability to access jobs, businesses, and other destinations, as well as to attract visitors

and tourists, new residents, and new business to the state, opening new opportunities for Oregonians.

5. **Equity.** Provide opportunities and choices for people of all ages, abilities, races, ethnicities, and incomes in urban, suburban, and rural areas across the state to bike or walk to reach their destinations and to access transportation options, assuring transportation disadvantaged communities are served and included in decision making.
6. **Health.** Provide Oregonians opportunities to become more active and healthier by walking and biking to meet their daily needs.
7. **Sustainability.** Help to meet federal, state, and local sustainability and environmental goals by providing zero emission transportation options like walking and biking.
8. **Strategic Investment.** Recognize Oregon's strategic investments in walking and biking as crucial components of the transportation system that provide essential options for travel, and can help reduce system costs, and achieve other important benefits.
9. **Coordination, Cooperation, and Collaboration**. Work actively and collaboratively with federal, state, regional, local, and private partners to provide consistent and seamless walking and biking networks that are integral to the transportation system.

Oregon Transportation Safety Action Plan (TSAP, 2016)

The TSAP establishes goals to achieve the vision that there will be "no deaths or life-changing injuries on Oregon's transportation system by 2035." These goals foster a safety culture, provide infrastructure to enhance safety, support healthy communities, leverage technology, and coordinate agencies and stakeholders to work together. The TSAP prioritizes improvements related to four areas:

- Risky behaviors, such as impaired driving, distracted driving, unbelted driving, speeding.
- Infrastructure, such as intersection improvements.
- Protections for vulnerable users, such as pedestrians, bicyclists, and older road users.
- Improved facility management, such as data collection, training, enforcement, licensing, and emergency response.

The TSAP identifies several actions in support of these priorities. Some of these action items that are relevant to Redmond include:

- **Action 6.3.2**: Continue work between ODOT, cities, and counties to consider and revise, as appropriate, regulations and programs for establishing speed limits to achieve safety goals, improve balance among multimodal interests, and support community objectives.
- **Action 6.3.6**: Focus facility design and redesign to achieve operating speeds consistent with safety goals, context, users, and land use.

- **Action 6.5.1**: Implement design treatments to achieve appropriate speeds and manage sight distance consistent with context, users, and community goals.
- **Action 6.5.3**: Support multimodal safety considerations during local TSP development, and other planning efforts (e.g., local TSAP's) to guide project planning, operations, and maintenance for safer transportation facilities.
- **Action 6.6.1**: Implement low-cost systemic safety improvements at intersections.
- **Action 6.8.1**: Evaluate the safety performance of innovative pedestrian facilities and continue implementing the most effective.
- **Action 6.8.2**: Provide safe facilities and crossings in areas where pedestrians are present, or access is needed. Prioritize transit corridors, school areas, multilane streets and highways, and other high risk areas and facilities.
- **Action 6.10.1**: Evaluate the safety impacts of innovative bicycle facilities and continue implementing the most effective.

ODOT Highway Design Manual (HDM)

The HDM establishes design standards and procedures for the state highway system. The HDM has been coordinated with the American Association of State Highway and Transportation Officials' policies. The HDM provides guidance on the location and design of new construction, major reconstruction, and resurfacing, restoration or rehabilitation projects. The standards in the HDM are specified by functional classification. Therefore, the standards relevant to US 97 and OR 126 (statewide freight facilities) are different than for the O'Neill Highway (a district highway).

Transportation Planning Rule (OAR 660-012)

Oregon defines 19 statewide planning goals; of which Goal 12 is Transportation. The TPR, OAR Division 12, defines how to implement this goal and requires, amongst other areas, that counties and cities work with ODOT to prepare local TSP's that are consistent with the OTP.

The TPR recognizes the role that a safe, convenient, and economical transportation system plays in supporting local and state economic vitality. It also requires the integration of comprehensive land use planning with transportation needs and the promotion of multi-modal systems that make it more convenient for people to walk, bicycle, use transit, and drive less.

In compliance with the TPR, Redmond will need to adopt and/or amend land use regulations consistent with state and federal requirements "to protect transportation facilities, corridors and sites for their identified functions (OAR 660-012-0045(2))." These may include:

- Standards to protect future operations of roads;
- A process for coordinated review of future land use decisions affecting transportation facilities, corridors, or sites;
- A process to apply conditions to development proposals to minimize impacts and protect transportation facilities, corridors, or sites;

- Regulations to provide notice to ODOT of land use applications that require public hearings, involve land divisions, or affect private access to roads; and
- Regulations assuring that amendments to land use designations, densities, and design standards are consistent with the functions, capacities, and performance standards of facilities identified in the TSP. (See OAR 660-012-0060.)

The TPR, as amended, allows local governments to exempt a zone change from the “significant effect” determination if the proposed zoning is consistent with the comprehensive plan map designation and the TSP. As well as a “balancing test” to weigh land use amendments that will create industrial or traded-sector jobs and/or provide other benefits.

Statewide Transportation Improvement Program (STIP, 2018 – 2021)

The STIP serves as the state’s four-year capital improvement program for multimodal projects, as well as for projects in the National Parks, National Forests, and Native American tribal lands. The STIP is updated every two years in accordance with federal requirements. The 2018 – 2021 STIP identifies one project in the study area for the US 97 SRC that will rehabilitate pavement throughout the corridor:

- Project 21166 US 97: Yew Avenue – Veterans Way: $1 Million to develop engineering plans for grinding and overlaying the pavement

Oregon Roadway Departure Safety Implementation Plan (RDSIP)

The RDSIP was developed in conjunction with the TSAP (described in the above sections). Per the TSAP vision and priority areas, the objective of the RDSIP is to reduce statewide roadway departure fatalities by 20 percent. None of the facilities in Redmond are identified in the RDSIP as high roadway departure crash locations. However, as described above, one of the key goals of the US 97 SRC is to provide a safe and efficient transportation system for all users.

Oregon Intersection Safety Implementation Plan (ISIP)

The ISIP was also developed in conjunction with the TSAP and provides for intersection-related safety measures to reduce fatal crashes. The ISIP requires an analysis of crash trends, cost effective countermeasures and the pairing of low cost improvements with education and enforcement.

Oregon Bicycle and Pedestrian Safety Implementation Plan (BPSIP)

The BPSIP was also developed in conjunction with the TSAP with the intent of reducing the frequency and severity of pedestrian and bicycle related crashes. Like the ISIP, the BPSIP identifies priority locations and countermeasure options. The BPSIP identifies the US 97 corridor for improved cyclist travel.

Oregon Resilience Plan

The ORP was developed in 2013 in response to a House Resolution that directed the Oregon Seismic Safety Policy Advisory Commission to prepare a plan that “reviews policy options, summarizes relevant reports and studies by state agencies and makes recommendations on policy direction to protect lives and keep commerce flowing during and after a Cascadia earthquake and tsunami.” The plan’s goal is to improve the infrastructure reliability to reduce the social and economic impact associated with these events.

Redmond plays a key role in the implementation of the ORP. The Redmond Municipal Airport is identified as the primary state FEMA emergency response airport in Central Oregon. In addition, US 97 is identified as a primary corridor for statewide connectivity during a Cascadia event. In recognition of the City's important role, the TSP includes the following goal:

- *TSP Goal 2.* Advance community and statewide emergency preparedness efforts through support of the Oregon Resiliency Plan.

This report provides guidance for implementing local transit systems. The primer outlines recommended coordination and planning activities, transit design considerations, community involvement and livability, and case studies of past successful small city transit plans.

2.2.2 Regional and Local Plan Policies

ODOT Region 4 Active Transportation Needs Inventory

ODOT Region 4 is working to create "safer, more walkable and bikeable networks in and between communities across Central Oregon, in alignment with the direction recently set out in ODOT's Statewide Bicycle and Pedestrian Plan. The Region has completed an initial phase of project to understand pedestrian and bicycle-related needs." As a part of the US 97 SRC, the project team assessed existing facilities within the study area.

The evaluation of the gaps and deficiencies as part of the existing facilities assessment is intended to be used in future project selection, project design, and identifying locations most in need of dedicated pedestrian or bicycle projects.

Deschutes County 2012 TSP

The Deschutes County TSP identifies policies and improvements that support the County's transportation system through the year 2030. The Deschutes County 2012 TSP highlights the importance of providing a safe and efficient system for all users, and recognizes the type of the highways that provide statewide roles in providing for regional and statewide freight movement. Key goals from the Deschutes County 2012 TSP include:

- Coordinating with the plans and policies established by adjacent counties and the State.
- Providing a safe and efficient network for residential and non-residential mobility.
- Enhancing the opportunity for intermodal connections and public transportation throughout the County.
- Support a safe and convenient bicycle and pedestrian system that is integrated within the transportation system.
- Maintain the existing level and intensity of freight and rail activity throughout the County, and encourage the expansion of private industry.

The TSP identified the following projects within the City:

- An interchange at the US 97/O'Neil Highway intersection;
- Evaluation of a rerouting of US 97 within Redmond (this has been superseded); and
- Developing a concept for an interchange at US 97/Quarry Road including the regional connections to Quarry Road.

The City, ODOT, and County are working together on the Redmond TSP development and will ensure consistency of the plans and policies.

City of Redmond Transit Master Plan (TMP, 2009)

The TMP was developed with the goal of exploring the feasibility of a fixed-route transit system within the City and to provide a "conceptual service plan" that outlines implementation steps. The primary purposes of the TMP were to:

- Prepare for future community growth and changes in the economy and demographics.
- Anticipate the need for new transit facilities so that future development plans can integrate with these needs.
- Promote multi-modal transportation options that help to reduce reliance on single-occupant vehicles.
- Allow for a system that is fully accessible for persons with disabilities and that is in compliance with the Americans with Disabilities Act (ADA).
- Identify partner opportunities.

The TMP was intended to be integrated into the City's TSP update. The City will work in collaboration with Cascades East Transit and ODOT to continue to explore the feasibility of providing fixed route transit in the future.

Redmond Service Alternatives (2013)

Recommended service alternatives were developed for Central Oregon communities as part of the 2013 Central Oregon Intergovernmental Council Regional Transit Plan update, including the City of Redmond. The City is currently served through dial-a-ride service and the Community Connector System.

The following highlights recommendations from the preferred Redmond service plan. Alternatives are categorized by Short-Term (1-3 years), Mid-Term (3-10 years), and Long-Term (beyond 10 years) options. Specific recommendations are included in the Service Plan.

- Short-Term:
  - Provide improvements and efficiencies to the Community Connector System.
  - Implement a basic fixed-route service network.
- Mid-Term:
  - Provide continued improvements and enhancements to the Community Connector System, including additional time of day service.
  - Implement a complete fixed-route service network.

- Long-term:
  - Consider more expanded service for the Community Connector System, including Sunday service.
  - Implement an additional service route to the fixed-route service system.

The Service Alternative is strong in its finding that a fixed-route service would be beneficial for the City of Redmond and its residents.

Redmond Comprehensive Plan

The City's Comprehensive Plan includes goals and policies that "support good jobs and affordable homes, protect natural resources, and preserve historic buildings." These goals and policies are intended to guide City decision making on programs, major capital projects, and other funding decisions for the future. Chapter 12 includes goals and policies related to transportation. The four primary goals identified in this chapter include:

- Reduce through traffic, congestion, and improve circulation along Highway 97, especially along the 5th and 6th Street couplet.
- Enhance east-west circulation.
- Identify roadway systems needs to serve undeveloped areas so that steps can be taken to preserve rights-of-ways and maintain adequate traffic circulation.
- Increase the use of alternative travel modes through improved safety and service.

The Comprehensive Plan includes 55 policies in support of these goals as well as the 2008 TSP map. The US 97 SRC will be consistent with the overall goals of all elements of the Comprehensive Plan and will recommend changes to implementation of the Plan, including the adoption of a new Transportation Map consistent with the ongoing City of Redmond TSP update (2019).

Redmond Development Code

The Redmond Development Code is located within Chapter 8 of the Redmond City Code. It establishes the zoning standards and land use procedures for the City. The following sections, amongst others, will be reviewed as part of the City of Redmond TSP update (2019) for compliance with the TPR as well as to help implement the TSP:

- Sections 8.0500 – 8.0515: off-street parking and loading requirements.
- Section 8.07: variances and amendments, including zone changes.
- Section 8.1: processes for legislative procedures, development actions, land use actions, appeals, and declaratory rulings.

Redmond 2008 Transportation System Plan

The City last updated its TSP in 2008, in recognition of key changes that had occurred since the 1999 TSP was adopted, and is currently working on the 2019 City of Redmond TSP. The 2008 TSP's primary focus was to:

- Address how the new re-route of US 97 north of Highland Avenue will affect city street circulation and related access to growing industrial areas to the east.
- Confirm that the plan is consist with latest Statewide Plans and Policies.

- Ensure that multimodal system could adequately serve Redmond growth to nearly 60,000 people as well as additional development outside the City's limits that influence local conditions (e.g., rural lands and destination resorts).

The TSP includes a Master Plan project map and Action Plans to support the City's transportation goals and policies through the year 2030.

The updated TSP will guide future multimodal system needs and decision-making regarding priorities, policies, and projects through the year 2040. As part of the evaluation of potential projects to address identified deficiencies, the updated TSP will include those projects previously recommended within the Action Plans of the 2008 TSP.

Ongoing Amendments or Updates to 2008 TSP Project Lists and Costs

The City maintains a capital improvement program that prioritizes five-year funding related to transportation system investments. The TSP will incorporate the five-year capital improvement program projects into the "No Build" scenario evaluation.

Redmond Airport Master Plan

In 2017, the City began updating its Airport Master Plan to assess facility and service needs of the Redmond Municipal Airport ("the Airport") throughout the next 20 years. The Master Plan will provide strategic direction regarding the Airport's 20-year capital development plan and investment of resources related to airfield, airspace, terminal area, and landside facilities.

The key questions the Master Plan seeks to address include:

- How will Central Oregon's growth continue in the future, and what will the impact be on aviation activity?
- What role will General Aviation and United States Forest Service activities play in the future?
- Is a runway extension justified and, if so, how long should it be, and in what direction?
- What is the viability of runway and terminal improvements previously depicted on the ALP?
- How can the passenger terminal and associated facilities accommodate continued passenger growth and additional carriers?
- What are the opportunities for increased airport revenue generation?
- How much property will be needed to satisfy the demand for future aviation use?
- What future changes in critical aircraft should the Airport plan for?
- Are aviation facilities adequate to meet the needs of the growing community?

The TSP PMT also includes members of the Airport Master Planning team to ensure collaboration between the two efforts. The TSP will incorporate key recommendations for adoption related to the Airport Master Plan update.

City's Current and Past Budget for Transportation

For the fiscal year 2017/2018, the City anticipated a beginning fund balance of $46.9 million, $13.2 million of which were in the Transportation Fund. The budget notes that a number of capital improvement projects are being funded by the System Development Charge and other capital project dollars, such as the general fund. The budget report notes the South Canal Boulevard Reconstruction project and maintenance activities as significant priorities for transportation.

The budget includes an increase in the annual investment in road maintenance at $850,000, particularly to support improving roadway pavement conditions. It also notes that the Airport is undertaking major runway rehabilitation for its secondary runway (11-29) to help ensure continuity and safety of air travel for Central Oregon over the next several decades.

City Parks and Recreation District Master Plan Update (2018)

The City updated its 2008 Master Plan to reflect current community choices and opportunities related to renewed economic development and downtown revitalization efforts, including the development of Centennial Park. This Master Plan creates a vision for "an innovative, inclusive and interconnected system of parks, trails and open spaces that promotes outdoor recreation, health and environmental conservation as integral elements of a thriving, livable Redmond."

The Parks Master Plan Update provides updated inventories of park resources, demographic conditions, a needs analysis, management considerations, and capital project phasing - including an implementation plan for developing, conserving and maintaining high-quality parks, trails, facilities and open spaces across the City.

2.3 Regional Economy

US Highway 97 serves as the primary connection between Redmond and Bend, its larger neighbor to the south. Together, the two cities comprise the urban heart of Deschutes County, which in turn is the economic hub for the larger Central Oregon region. This report section outlines the economic conditions and trends across this region, focusing on the Bend-Redmond urban environment, with additional attention to the City of Redmond and the project corridor itself. This economic context plays an important role in how the proposed roadway improvements stand to benefit the area, not just in terms of safety and traffic flow, but also in terms of economic development and business activity.

2.3.1 Context and Trends

The City of Redmond lies some 15 miles northeast of its larger neighbor, Bend, in northeastern Deschutes County as depicted in Figure 3. Thanks in part to Oregon's urban growth boundary requirements, the two cities remain independent entities with a clear rural separation between them. However, as the short commute distance separating them appears increasingly tolerable to bigger-city migrants, the already strong economic ties between Redmond and Bend now feature a largely blended housing market.

This trend is partly a function of the escalating housing affordability challenge facing Deschutes County and similar areas across the country where desirable quality-of-life attributes attract migrants - often well-educated working-age movers from comparatively affluent urban markets - driving up home prices while putting pressure on local supply chains.

Figure 3. Regional Context Map

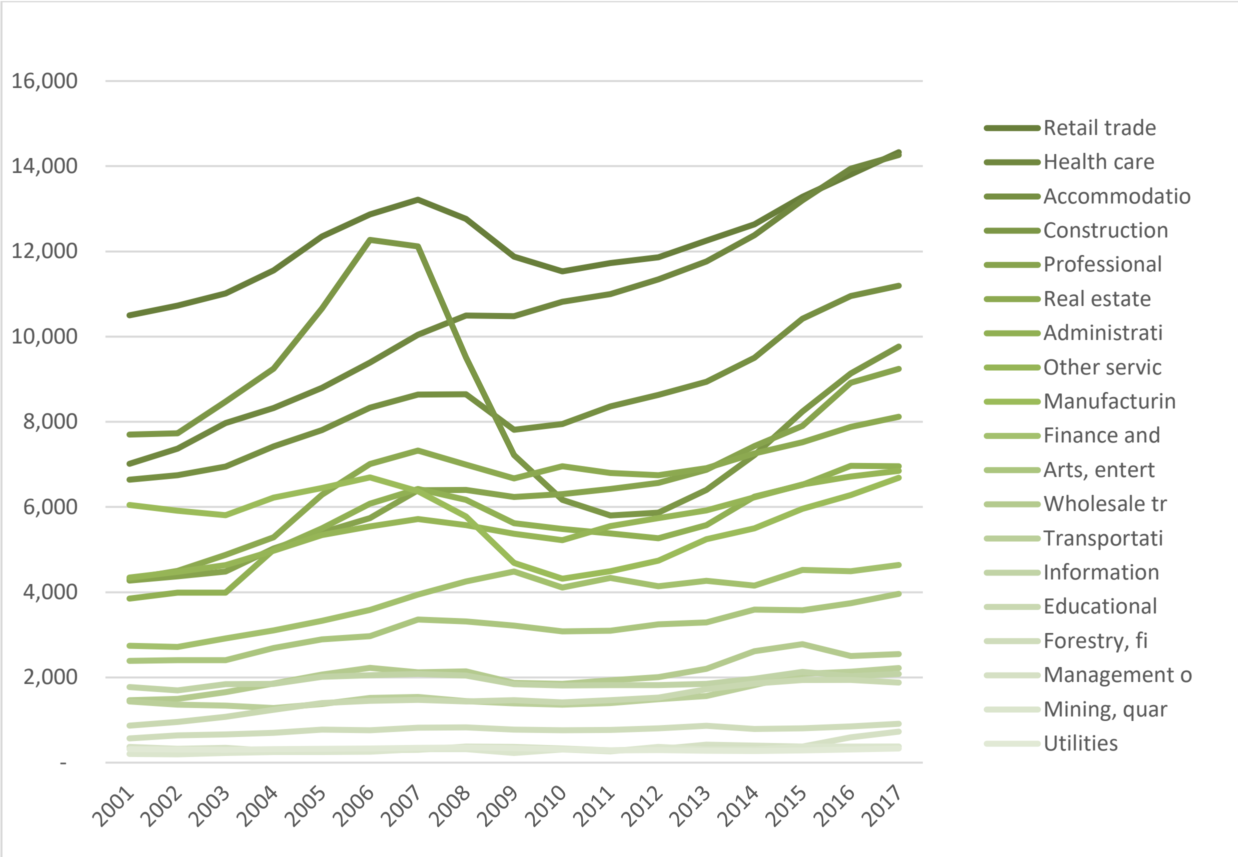
**Source: Leland Consulting Group*

2.3.2 Regional Employment and Industry Performance

In terms of total full- and part-time employment, the top industry sectors in the Bend-Redmond Metropolitan Statistical Area (MSA) (Deschutes County) are retail, healthcare, hospitality (accommodation and food service), and construction as shown in Figure 4. These four sectors account for one half of the approximately 100,000 private sector jobs in the region. Government jobs account for another 10,000.

Of these, construction has been the most highly cyclical and heavily tied to the residential market. Retail and hospitality are also cyclical, but to a lesser extent. Both the healthcare (approximately 14,000 jobs) and professional/technical services (9,000 jobs) sectors have the distinctions of being less prone to boom-bust patterns.

Figure 4. Bend-Redmond Employment Trends by Industry



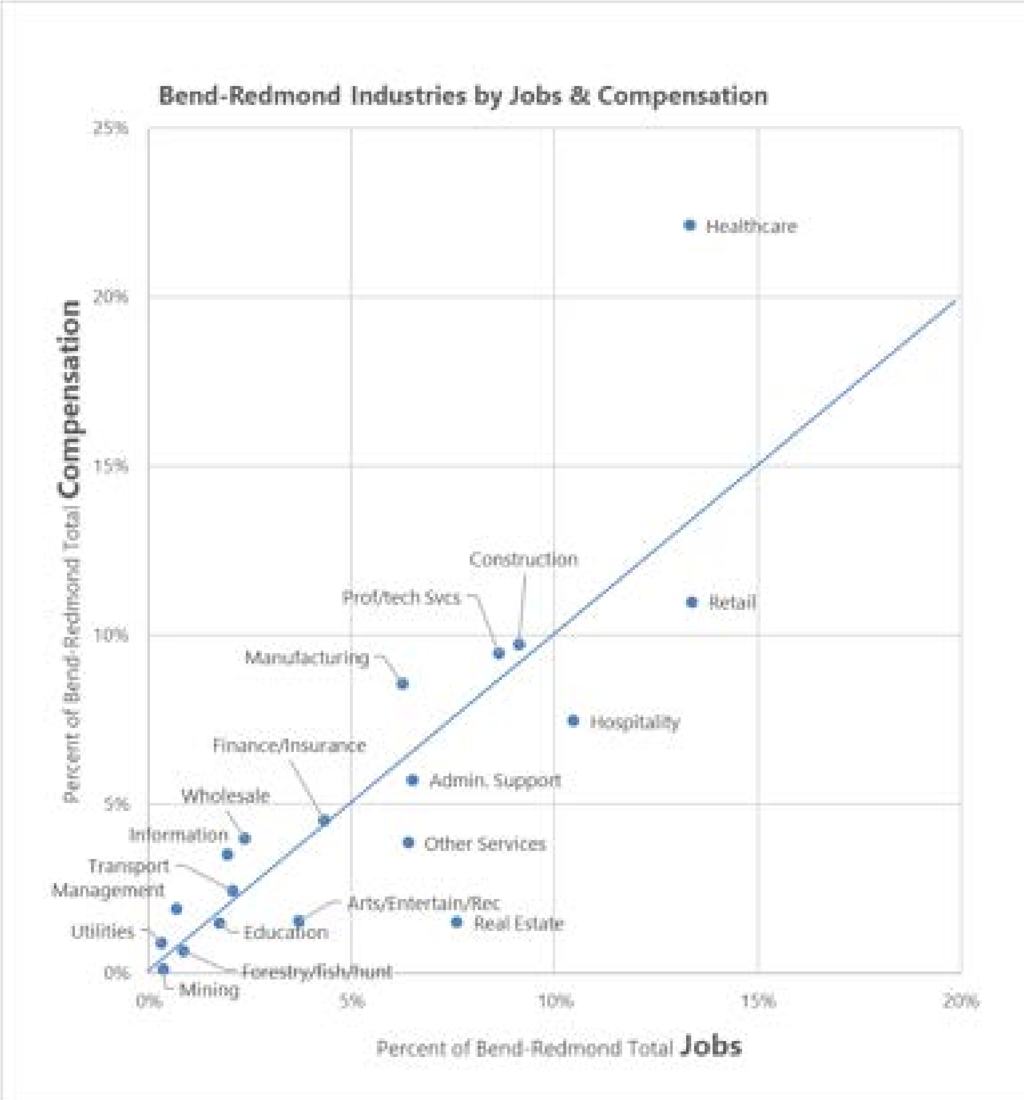
Source: U.S. Bureau of Economic Analysis, Leland Consulting Group

2.3.3 Compensation

Figure 5 shows countywide industry groupings by both total job count and total compensation. Higher-paying industries above the blue line account for a greater share of total (private-sector) compensation than their share of county jobs.

Healthcare services are an outlier, accounting for about 22 percent of all compensation paid out in the county but just 13 percent of the jobs. Manufacturing is the other positive standout, with nearly nine percent of countywide compensation from just over six percent of the jobs. Wholesalers pay out 4 percent of all compensation with just 2.4 percent of jobs. Management sector compensation is also disproportionately high compared to the average, but with far fewer jobs. Some lower-wage standouts include hospitality, retail, and non-professional services. In this market, jobs in the real estate/leasing sector in this market, jobs in the real estate/leasing sector (normally at or above average wage) appear to be surprisingly low-paying.

Figure 5. Jobs vs. Total Compensation



2.3.4 Locational Advantage

Although relatively low paying, Bend-Redmond metro jobs in accommodations represent a good example of a sector that is distinctively important to the local area. Accommodation jobs make up 2.1 percent of the local Deschutes County economy (as measured in total compensation), but just 1.0 percent at the national level. This ratio (2.1 divided by 1.0) gives the “location quotient[1]”, or LQ, for the accommodations industry in Bend-Redmond. Activities with LQs higher than 1.0 are attention-worthy as they represent industries that are disproportionately important to the local economy as compared to the U.S. as a whole.

[1] Location quotients are commonly calculated based on share of jobs comparisons, but share-of-compensation can also be used, improving sensitivity to the importance of higher-wage employment.

Looking at LQs, especially when zooming in beyond the broad industry sector groupings, can be especially helpful in identifying locational advantages that may help steer future economic development recruiting efforts.

Table 2 details more specific industry classifications with both high LQ scores and significant employment levels in the Bend-Redmond area – loosely grouped into related clusters:

Table 2. Location Quotients of Key Industries, Bend and Redmond Region

Industry	Total Compensation	LQ	Comments
Beverage product manufacturing	$45.8 million	5.3	Primarily local craft brewing industry
Forestry & fishing-related	$26 million	2.2	Mainly forestry, related to the two following manufacturing industries
Wood products manufacturing	$37.8 million	3.6	
Furniture manufacturing	$14.9 million	1.7	
Amusement & recreation	$55.2 million	2.2	Somewhat diverse cluster but all driven by central Oregon's role as a regional and super-regional mecca for outdoor recreation and related tourism
Accommodation	$82.9 million	2.1	
Food service & drinking	$137 million	1.6	
Sporting goods & hobby retail	$22.7 million	3.1	
Publishing (non-internet)	$90.0 million	2.0	Largely a Bend phenomenon – driven by concentration of local news media.
Broadcasting (non-internet)	$22.6 million	1.7	
Healthcare & social assistance	$882 million	1.6	Healthcare in Bend and Redmond draws patients from a wide catchment area, largely rural, with few health services
Building materials & garden retail	$49.4 million	2.0	This cluster is closely tied to the region's migration-fueled population growth. It is also quite cyclical – sensitive to fluctuations in growth rates.
Construction of buildings	$126 million	1.6	

Source: Bureau of Economic Analysis and Leland Consulting Group

2.3.5 Redmond versus Bend

Redmond and Bend share many of the same leading and locally-defining industries (roughly in proportion to their difference in population). For example, in both cities, just over 13 percent of citywide jobs are in the retail sector. Bend has a higher absolute job count than Redmond in every major industry sector.

2.3.6 Bend Strengths

As home to the region's main medical center, Bend has a greater per-capita share of healthcare jobs. Information sector jobs, primarily in broadcasting and publishing, are almost all confined to Bend.

2.3.7 Redmond Strengths

Although most manufacturing jobs are in Bend, Redmond actually has a disproportionately higher share of the overall workforce in this sector – possibly due in part to lower overall labor and construction costs in Redmond.

The largest private-sector discrepancy in per-capita industry presence is in transportation and warehousing, where 5.5 percent of all Redmond jobs are found, versus just 1.7 percent of Bend jobs.

2.3.8 Some Industry Conclusions

- In terms of targeting any future industry recruitment efforts to attract prospective new users to the Redmond US 97 SRC, manufacturing and logistics (transportation and warehousing) and any industry that already shows a strong countywide local advantage (high LQs) should be near the top of the list. Not only has the region already shown an ability to support those industries, but their disproportionate representation indicates that they likely draw spending support from outside the county (thus importing new dollars into the local economy). That said, adding new retail businesses has limited economic development benefit, especially in Oregon, since retail jobs tend to be low-paying and cities do not receive sales tax revenues from their presence.
- Although not a high LQ-scoring industry, logistics businesses may be an attractive target for the corridor since they pay average wage levels and already show a tendency to disproportionately locate in Redmond versus Bend.
- Manufacturing also appears to be a good corridor target given the presence of major manufacturers in Redmond.
- **Beverage manufacturing** (largely based in Bend) pays well and already has a strong LQ for the metro.
- **BASX Solutions** (manufacturing data center cooling solutions and cleanroom systems), a recent addition to Redmond, further demonstrates the ability of the subject corridor in particular to accommodate major manufacturing sector site needs, even in the high-tech sector (making computer network cooling systems).

- **Wood products (and related) manufacturing** is not heavily represented on the corridor, but also appears to enjoy a strong regional advantage countywide. Wages should be strong too, although caution should be paid to the fact that this is one of the few industry groups currently shrinking in size.

While Redmond's interdependence with Bend is significant, Bend remains the primary economic hub for the region, resulting in greater housing affordability for Redmond homes and lower payrolls burdens on Redmond employers.

Redmond presents an increasingly favorable cost environment relative to Bend with lower land prices, yet similar ability to draw workers from a countywide labor pool.

The construction market is leaving prospective Redmond developers exposed to development cost escalations largely driven by Bend's rapid growth. The bottom-line impact of this phenomenon may contribute to less risk taking among Redmond builders, whose projects must succeed with lower rents than are attainable in Bend.

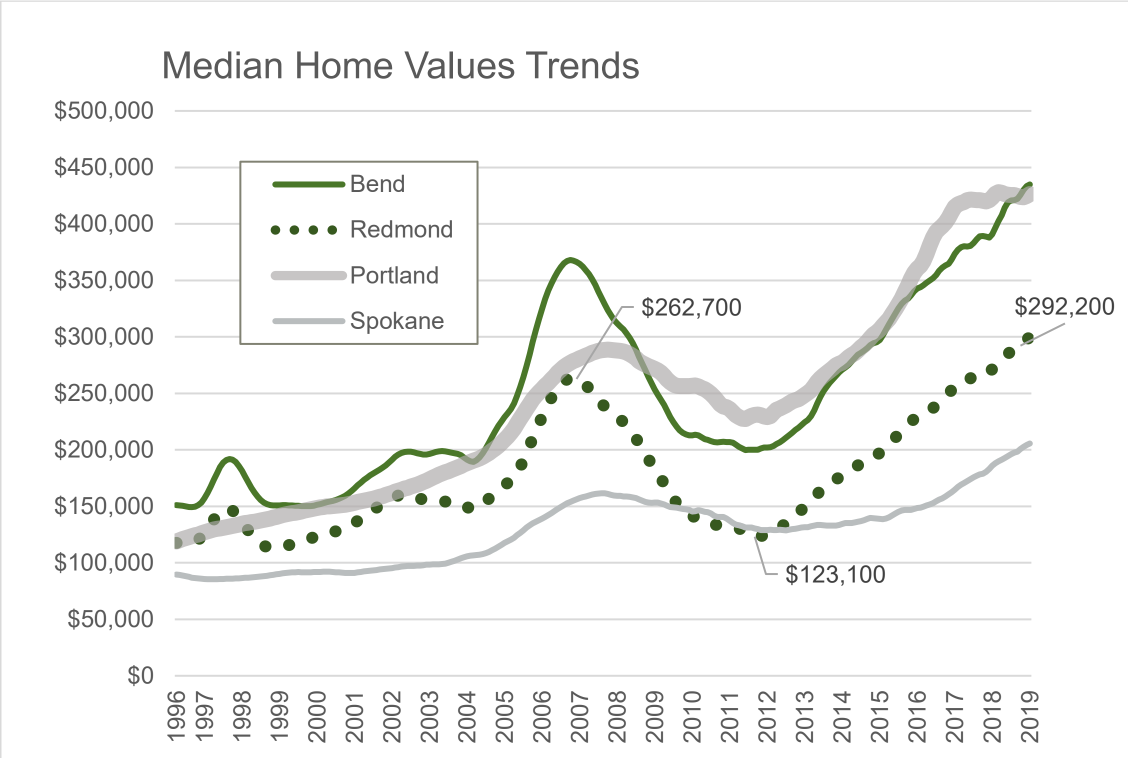
For Deschutes County, food manufacturing (primarily in the form of breweries), tech (especially smaller-scale software development and design), and tourism/recreation are the primary traded-sector engines of job creation. Construction (especially during booms) is a major employment industry.

A recent (2017) study of the Bend-Redmond MSA by the Milken Institute described the shared economy as…

> "…characterized by concentrations in the leisure, hospitality, retail, and, to a lesser extent, construction industries. Like its peers, the Bend-Redmond MSA has benefited from the natural beauty of its setting, attracting tourists and residents interested in outdoor recreation to the region. Situated in central Oregon, east of the Cascade mountain range, its high desert location yields more dry days than the Oregon coast, drawing in vacationers from Portland and beyond. A portion of these visitors choose to make a permanent move, citing the lifestyle, the landscape, schools, and home prices as reasons for leaving more expensive coastal metros."

Both Redmond and Bend have proven especially vulnerable to boom-bust market cycles, best illustrated in Figure 6, where the steep swings in Bend and Redmond home values stand in contrast to more subdued cycles in Portland and Spokane (yet in nearly perfect sync with one another). Redmond home values fell by more than half between the past recession's peak and trough and are now on their way to tripling that 2011 low point. Continued volatility has potential negative consequences: upward price and rent movement stokes labor market supply problems, given the limited choices available to people employed in this relatively remote urban center, while another steep crash would create other equity and public welfare concerns for those unable to afford existing mortgages.

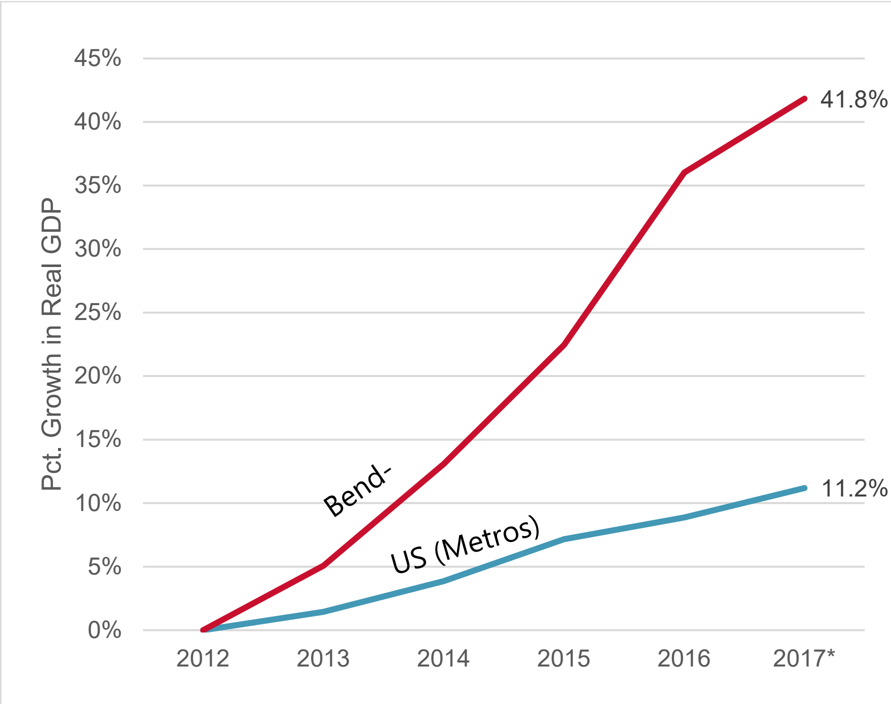
Figure 6. Housing Market Cycles, Redmond, Bend and Comparison Cities



Source: Zillow Home Value Estimates; and Leland Consulting Group

A local economy is not defined by the housing market alone, of course. Figure 7 shows the remarkable post-recession performance of the Bend-Redmond economy, with real GDP (overall economic output, adjusted for inflation), expanding at nearly four times the rate as the national economy from 2012 to 2017.

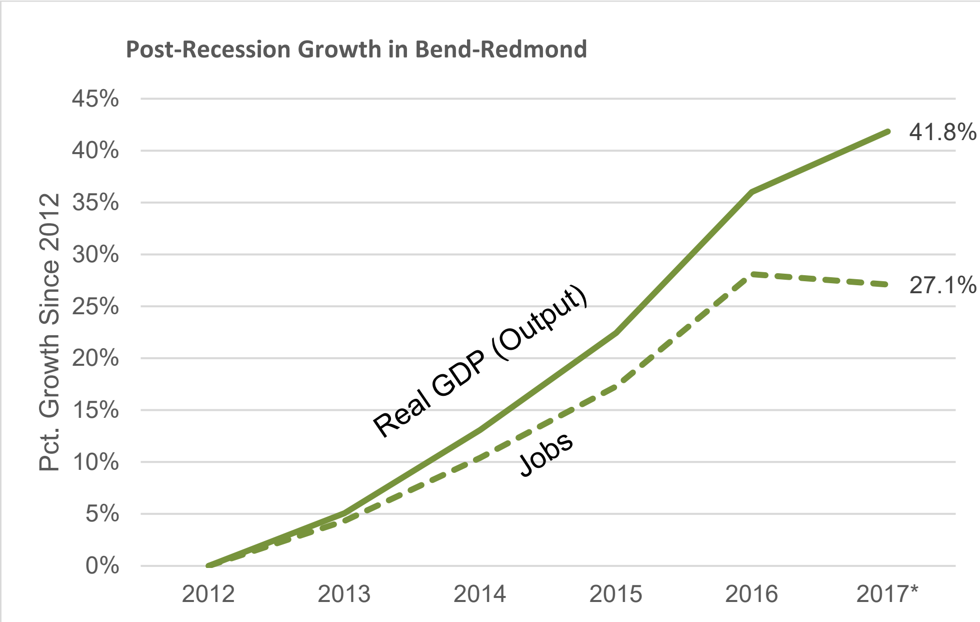
Figure 7. Real GDP Growth, Post-Recession Comparison



Source: Bureau of Economic Analysis and Leland Consulting Group

Figure 8 focuses on Bend-Redmond only, showing output growth compared with job growth. This illustrates that employment (an important economic priority for Redmond and a success metric identified for this project in particular) has not grown in direct proportion to rising output (essentially, sales of goods and services). This is an increasingly common phenomenon as many job functions are becoming automated or globally outsourced. The local significance to this project is that development of new facilities on the corridor, while desirable from a property tax and construction employment standpoint, may not necessarily translate into as many permanent jobs as was once the case.

Figure 8. GDP Growth Outpacing Job Growth in Bend-Redmond

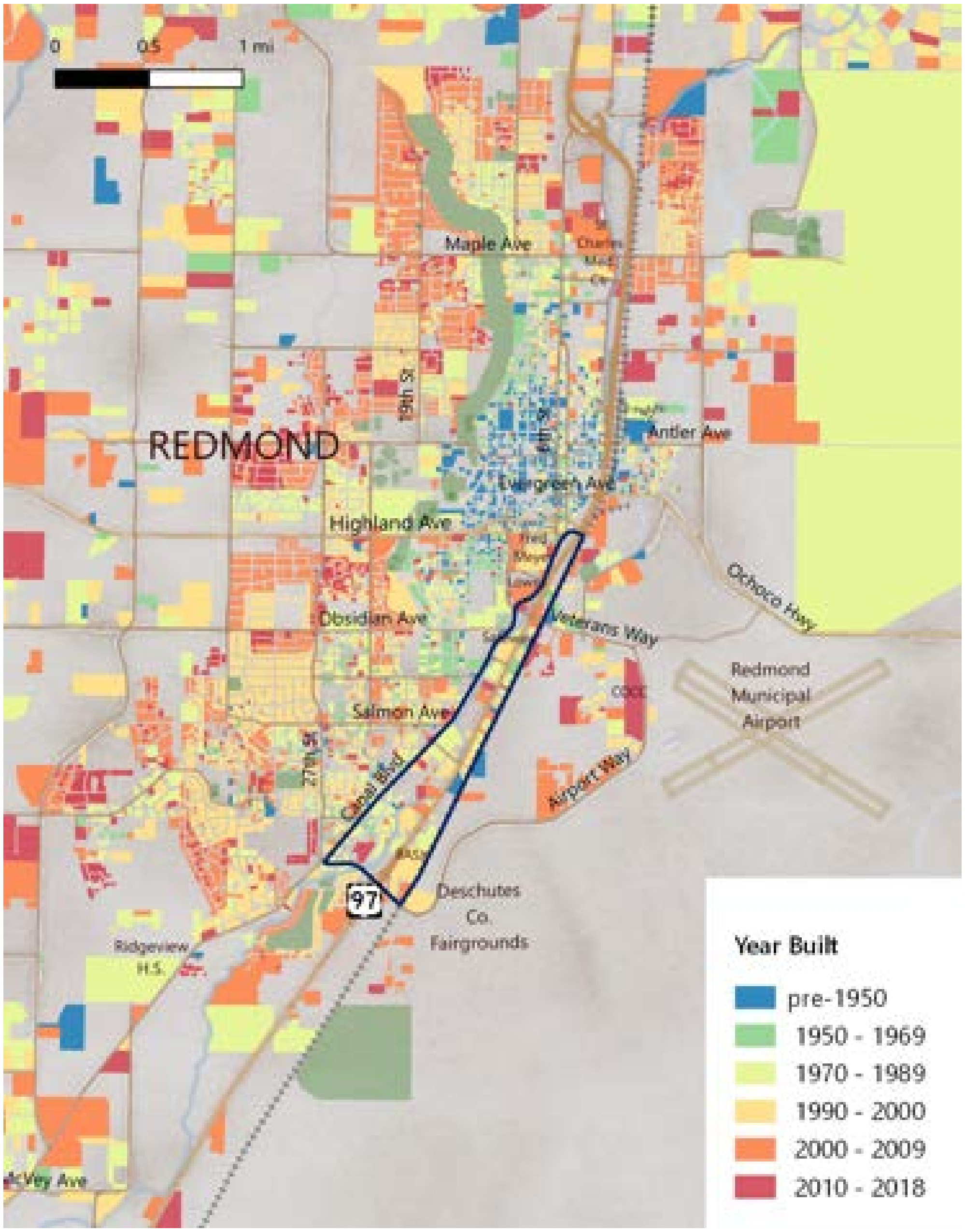


*Source: Bureau of Economic Analysis and Leland Consulting Group

Zooming into the City of Redmond area, we get a clearer picture of the US 97 SRC role in the surrounding development context. As shown in Figure 9, there has been some recent scattered development fronting the US 97 SRC, but activity has been fairly limited in scope since Fred Meyer, Safeway, and Lowe's opened in the mid-2000s. Most post-recession construction citywide (parcels shown in red) has been along Redmond's western and northern edges. The new Central Oregon Community College (COCC) Redmond Campus, located between the corridor and the airport, is the most significant new development in the corridor vicinity since 2010.

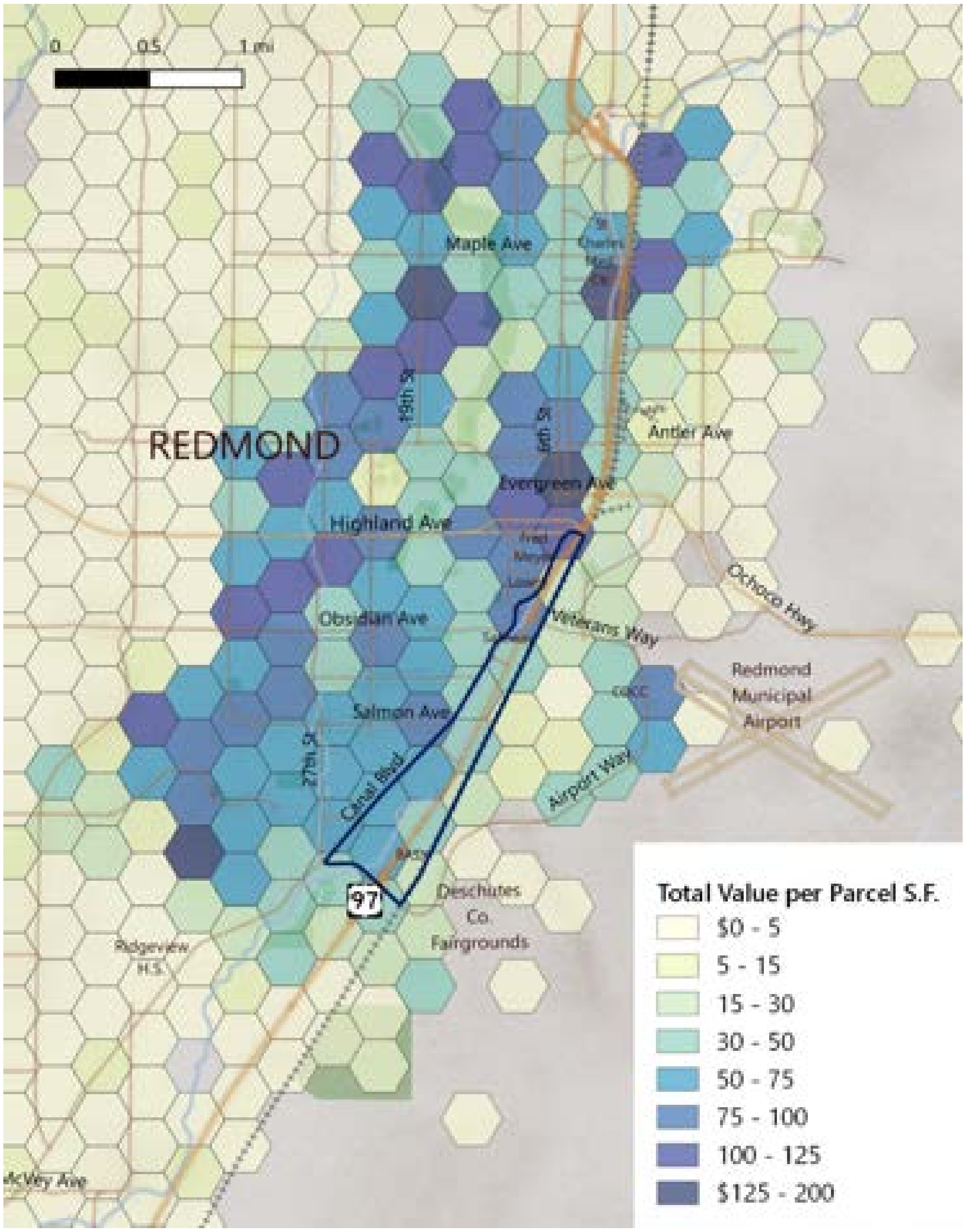
Figure 10 shows a shaded hex grid over the city with darker/bluer shading indicating a higher concentration of development value (assessor's total real market value, including improvements, per parcel square foot). The central takeaway of this map is the relatively low value density along the US 97 SRC relative to downtown, Redmond's west side, and the area around St. Charles Medical Center. This value disparity will be an important initial challenge for any attempts to build development and redevelopment momentum along the highway.

Figure 9. Developed Redmond Parcels by Year Built



Source: Deschutes County Assessor and Leland Consulting Group

Figure 10. Development Value Density in Redmond



Source: Deschutes County Assessor and Leland Consulting

2.3.9 Corridor Economics and Potential to Respond to Roadway Changes

We first look at an initial screening to roughly quantify and locate areas where land may be available, either immediately or over a longer term, for land use and real estate activity in order to respond to positive changes in the corridor environment. Figure 11 and Figure 12 illustrate areas of vacancy or potential underutilization, where development or redevelopment opportunities may be more likely (and needed). The southern half of the immediate (fronting) corridor has far more underutilized or vacant acreage relative to the north. Both north and south segments have considerable quantities of underutilized land east of the railroad.

Based on the underutilized land screening and professional judgment guided by location, potential for assembly, acreage, access and zoning, we identified 31 corridor parcels that have short-term development or redevelopment potential. These are:

- Primarily vacant parcels, or those with currently low value improvements, with the exception of one case with a medium value improvement but high vacancy.
- Not in use as major RV, auto, or rental equipment lots.
- Sufficiently large for development, either individually or as part of an assembly of adjacent parcels.
- Sufficiently accessible.

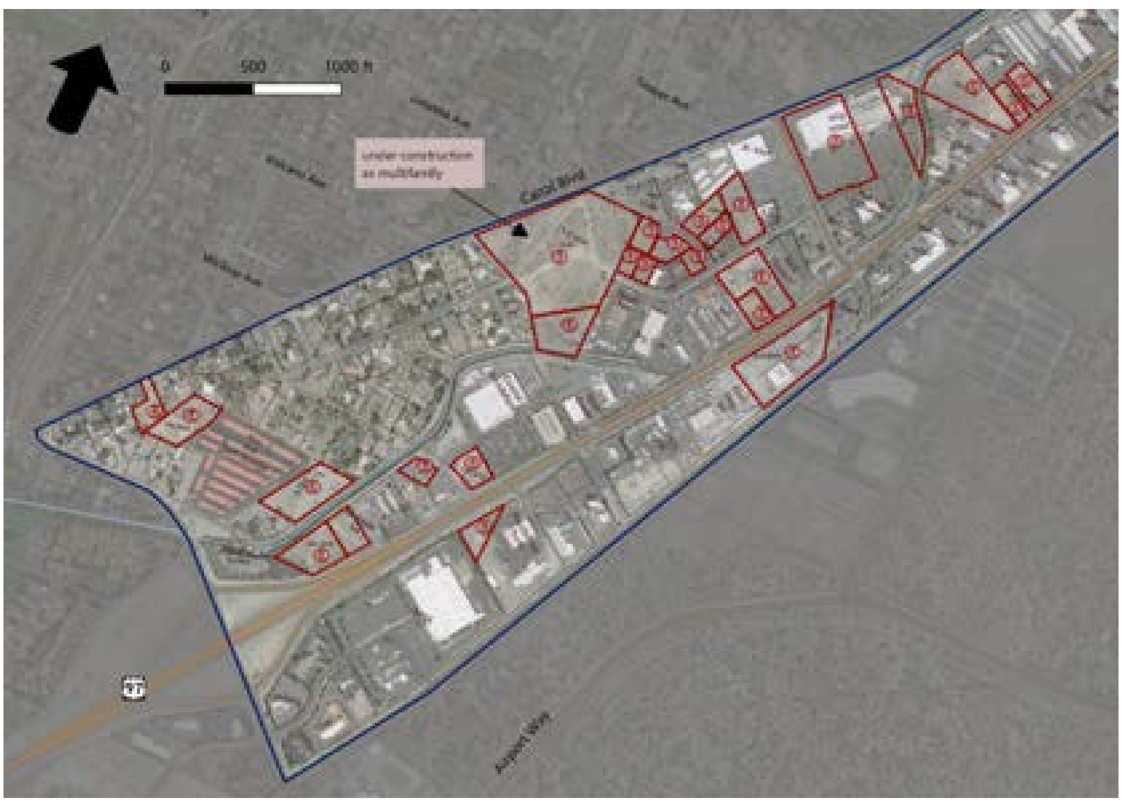
In total, the 31 identified parcels comprise 44.3 acres. This includes a 9.2-acre parcel with construction already underway. All zoning is C-1 (Strip Commercial) except for two parcels zoned R-4 (General Residential) totaling 2.1 acres.

This is not a recommendation for redevelopment of any of the identified parcels, but simply a current estimate of likely redevelopment candidates for purposes of assessing short-term economic development under a roadway improvement scenario.

The parcels in question are outlined on the following two maps, with acreages labeled.

Figure 11. Corridor Land Utilization, North Segment

Figure 12. Corridor Land Utilization, South Segment



2.3.10 Development Types

Based on this hypothetical development potential, the prevailing C-1 zoning, and assumptions of modest land value growth and increased developer interest due to the proposed roadway improvements, the following mix of land uses could develop over 10-20 years along the study area as shown in Table 3.

Table 3. Potential Long-Term Economic Development Changes*

Land Use	Acres	Est. Building s.f.	FAR	Notes
86-room hotel	1.7	45,000	0.63	Similar size to Comfort Suites
86-room hotel	1.7	45,000	0.63	
Lodging Subtotal	**3.3**	**90,000**		
Manufacturing building	3.7	40,000	0.25	
R&D/flex building	0.9	10,000	0.25	
R&D/flex building	0.9	10,000	0.25	
Light industrial service	0.9	10,000	0.25	
Light industrial service	0.8	9,000	0.25	
Light industrial service	0.8	9,000	0.25	
Industrial/Employment Subtotal	**8.1**	**88,000**		
Junior box retail	2.3	25,000	0.25	
Grocery-anchored center	9.2	100,000	0.25	
Free-standing restaurant	0.5	5,000	0.25	
Free-standing restaurant	0.5	5,000	0.25	
Strip retail	1.1	12,000	0.25	
Strip retail	1.1	12,000	0.25	
Retail Subtotal	**14.6**	**159,000**		
Walk-up apartments (50 units)	2.5	50,000	0.46	20 du/a

Land Use	Acres	Est. Building s.f.	FAR	Notes
Walk-up apartments (50 units)	2.5	50,000	0.46	21 du/a
Walk-up apartments (50 units)	2.5	50,000	0.46	20 du/a
Walk-up apartments (50 units)	2.5	50,000	0.46	21 du/a
Walk-up apartments (50 units)	2.5	50,000	0.46	22 du/a
Walk-up apartments (50 units)	2.5	50,000	0.46	20 du/a
Residential Subtotal	**15**	**300,000**		includes 9 acres under construction
Additional roads & Infrastructure	*3.3*			*assuming some minimal additional roads may be needed*
Total	**44.3**			

**Source: Leland Consulting Group*

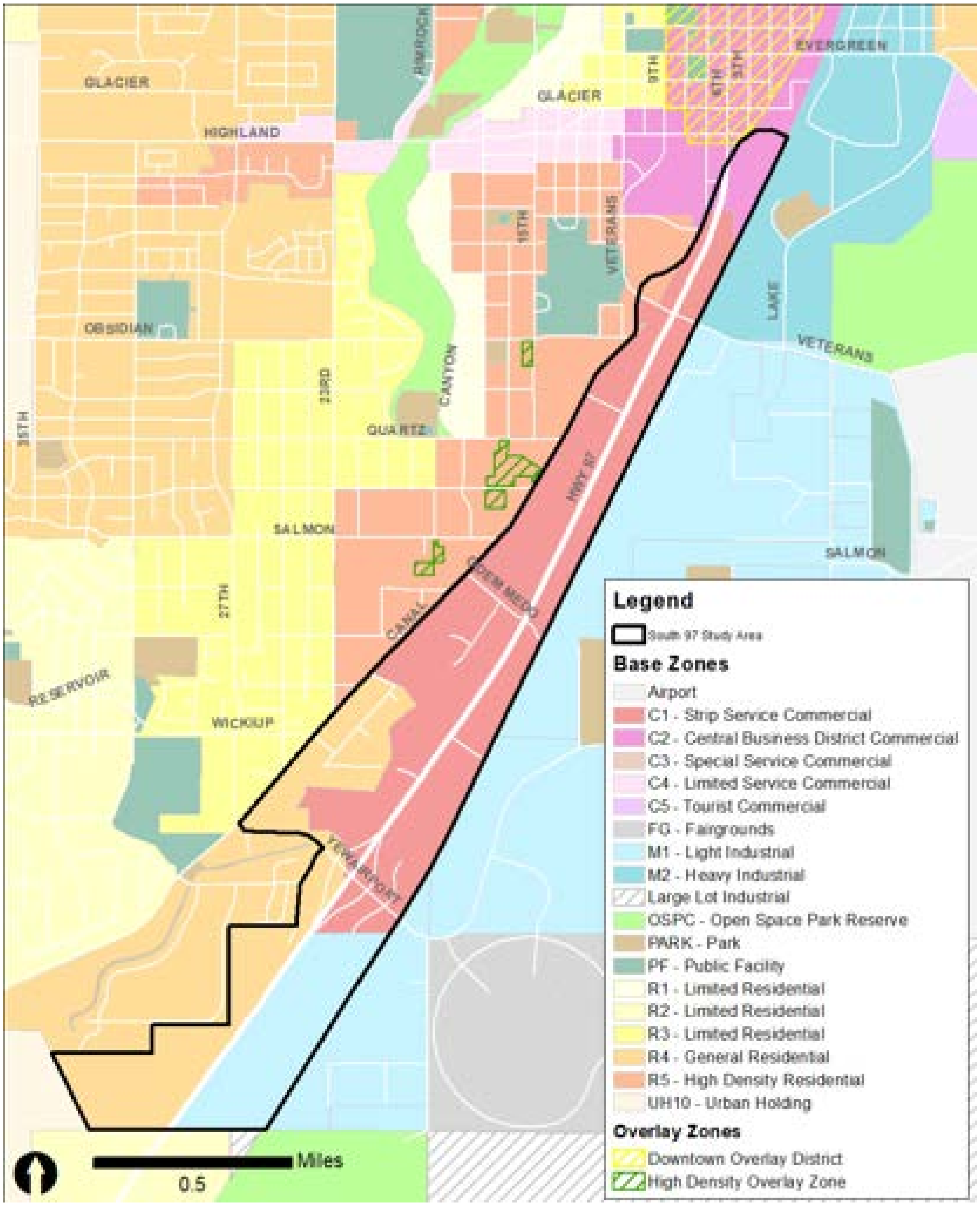
This development program would accommodate up to 300 units of new housing, almost 90,000 square feet of new employment space, two new hotels, and approximately 160,000 square feet of new retail services. With the proposed infrastructure improvements, these uses would serve Redmond’s ongoing growth needs as well as provide more accessible and safe commercial services and employment opportunities for the neighborhoods west of Canal Boulevard. This potential economic investment is further incentivized by the corridor’s location within a designated Opportunity Zone. Opportunity Zones are designated census tracts that are eligible to receive significant investment tax treatment as provided by the 2017 Tax Cuts and Jobs Act. Because of the special tax treatment that investors in real estate and businesses will receive (namely deferred and potentially eliminated capital gains), it is expected that significant amounts of investment will be driven to eligible Opportunity Zones before the law expires in 2026.

2.4 Land Use

To develop an understanding of the project area, a land-use inventory was prepared. Existing land uses, as identified by base zoning and overlay districts, are shown in Figure 13. Existing land uses directly along the US 97 SRC consist mostly of C1 Strip Service Commercial. R4 General Residential and M1 Light Industrial zones cover land at the southern end of the study area; a small pocket of C2 Central Business District Commercial covers the north end where the study area abuts Downtown Redmond. The C1 zone includes most of the businesses (ranging from drive-thru dining to regional grocery stores to agricultural supply vendors) that face Highway 97. These parcels range from roughly 0.3 to over 5.0 acres.

Areas to the east (across the railroad tracks) are primarily M1 Light Industrial, Airport, FG Fairgrounds, and Park-zoned land. Areas to the west are mostly suburban singlefamily residential uses, with associated schools and parks, and are covered by R2 and R3 Limited Residential, R4 General Residential, and R5 High Density Residential zones.

Figure 13. Land Use Map



2.5 Transportation Conditions

The Project study area is approximately three miles of US 97 from Highland Avenue to south of the Yew Avenue / Airport Way interchange. The project area is shown in Figure 14.The project goal is to improve function and safety along US 97 and provide a facility plan that aligns with previously established goals and principles from the 2010 Redmond South US 97 Corridor Plan and City of Redmond Resolution 2014-02.

2.5.1 Traffic

The project team forecasted 2040 traffic volumes in the US 97 SRC. The Traffic Volume Forecasts Memo (Appendix A) provides more detail into the windowed subarea travel demand modeling.

Future traffic volumes for the year 2040 were forecast for the No-Build and Build conditions based on a windowed subarea model of the regional Bend-Redmond Model (BRM). The windowed subarea modeling approach provides more sensitivity to local traffic control and circulation changes and allowed for the ability to better estimate changes in travel patterns associated with new traffic signals, roundabouts, street connections, and local access changes. The same demand matrix was used for analysis of the No-Build and Build models.

Most of the land use growth in the study area forecast by the year 2040 is related to employment (i.e., commercial and industrial businesses), with a net increase of about 700 workers in the areas immediately adjacent to US 97 (a 97 percent increase over 2010). The distribution of this employment growth varies along the corridor, ranging from slight decreases in some mostly built out areas to substantial increases at the southern end of the corridor where new development is expected on vacant parcels as shown in Figure 15. The employment growth, coupled with housing growth elsewhere in the City of Redmond and regional travel growth on US 97, will increase traffic activity with average daily traffic volumes increasing from approximately 28,000 vehicles in 2017 to approximately 36,000 vehicles in 2040. This corresponds to an average annual growth rate of 1.24 percent.

Figure 14. Study Area

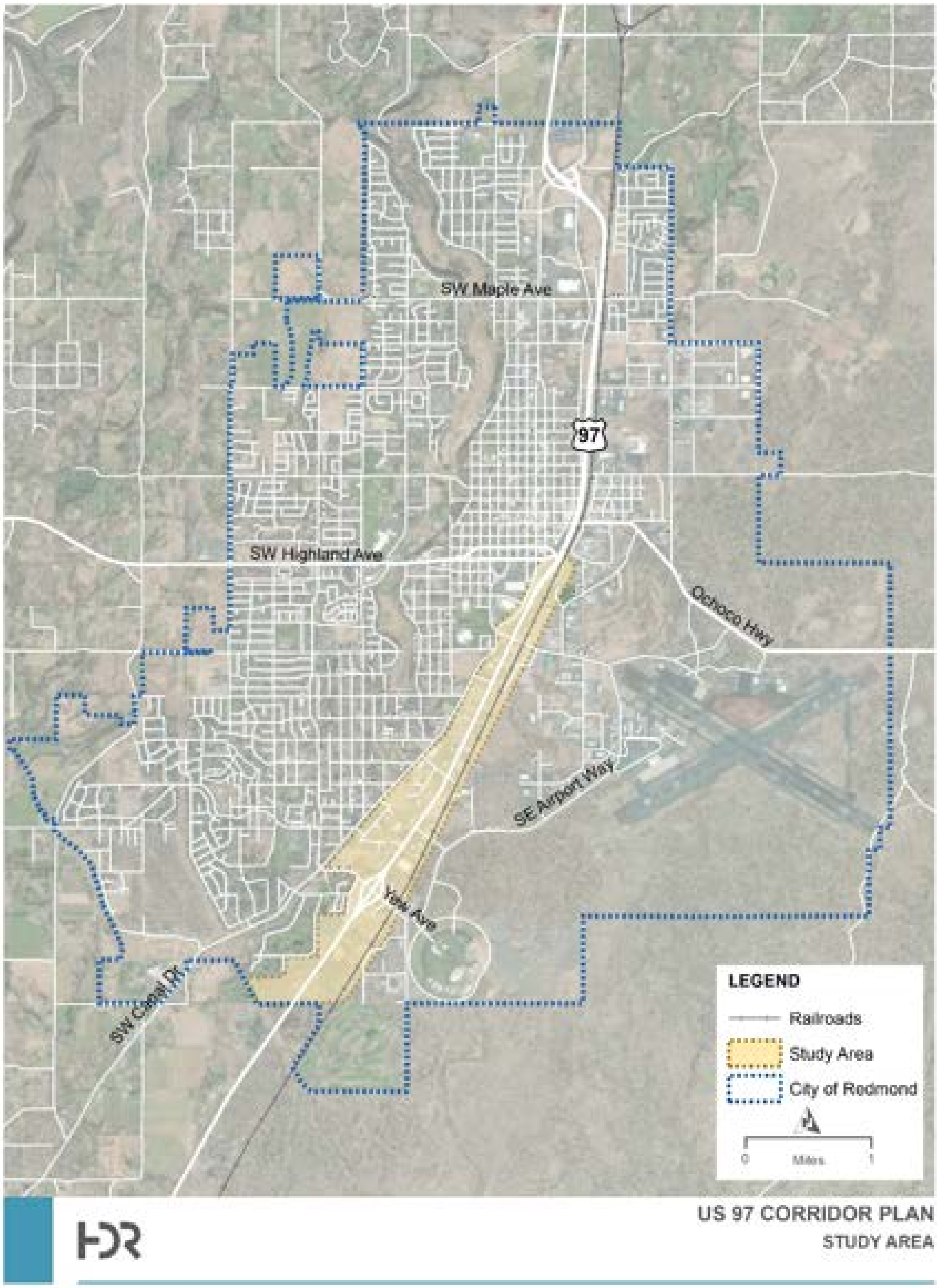
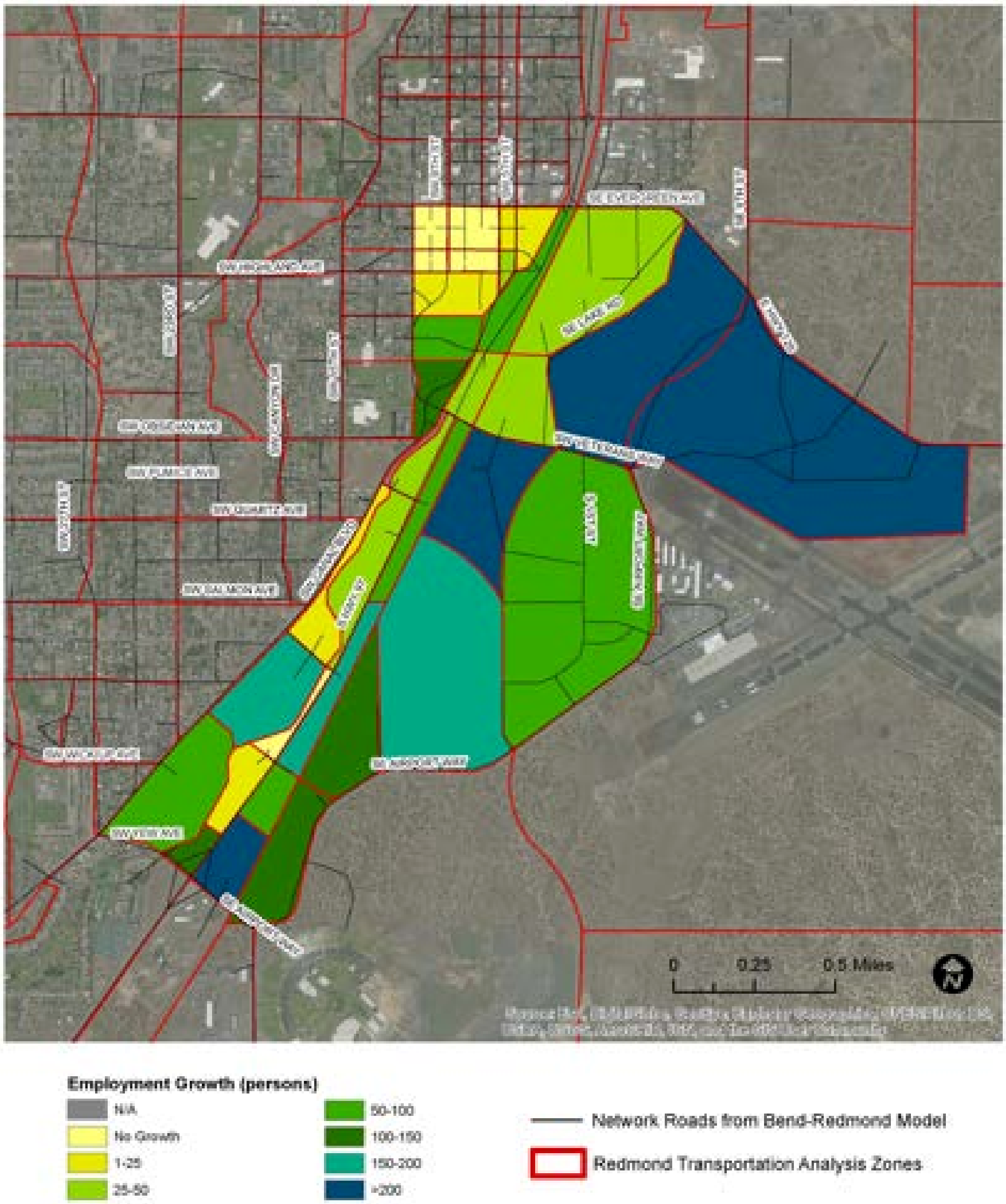


Figure 15. Employment Growth



The 2040 No-Build network included one new street connection, the Quartz Avenue extension between Canal Boulevard and US 97. This new facility provided a more direct connection for some trips within the study area. The diversion created by the Quartz Avenue extension resulted in future traffic volume forecasts that were lower than the existing traffic counts at intersections as listed below:

- US 97 / Odem Medo Way westbound left movement.
- Canal Boulevard / Quartz Avenue northbound through, eastbound left, and eastbound right movements.

- Canal Boulevard / Pumice Avenue northbound through, northbound right, and westbound left movements.
- US 97 / Pumice Avenue eastbound left and eastbound right movements.
- Canal Boulevard / Veterans Way northbound left, northbound through, northbound right, and southbound left movement.
- US 97 / Veterans Way eastbound left and eastbound right movements.

The types of trips using the US 97 SRC were sampled between Glacier Avenue / Highland Avenue and Yew Avenue in the No-Build and Build networks. Trips beginning (entering the subarea network) or ending (leaving the subarea network) at driveways along US 97 were classified as “access” trips. Those beginning and/or ending at other external roads, such as Canal Boulevard or Veterans Way, using US 97 for a portion of the trip but not accessing any business along US 97, are classified as “local”. Those trips driving through the study area on US 97, without stopping, are classified as “regional”.

The Microsimulation Model Development and Calibration Memo (Appendix B) documents the development of a calibrated traffic simulation model for the PM peak hour that is capable of replicating existing traffic conditions and best suited to evaluate future operations of the No-Build and Build alternatives. It includes the Existing Conditions simulation model development and calibration results.

The results of the Vissim calibration process were used to validate queue lengths, traffic volumes, and travel times. Visual audits were also performed to check the consistency of the model with field conditions. In general, the study area is not congested, and visual observations of the Vissim model were consistent with field conditions. Table 4 below displays traffic volume during the PM peak hour.

Table 4. Traffic Volume Summary – PM Peak Hour

Intersection	Measured Volume	Simulated Volume	GEH	Difference		Volume Measure
				VPH	%	
SW Highland Ave & SW 6th St	1404	1404	0.0	0	0.0%	+/- 15%
SW Highland Ave & SW 5th St	1201	1204	0.1	3	0.2%	+/- 15%
SW Veterans Way & SW Canal Blvd	1922	1917	0.1	-5	-0.3%	+/- 15%
US 97 off Ramp & Yew Ave	1361	1332	0.8	-29	-2.1%	+/- 15%
US 97 On Ramp & Yew Ave	1320	1304	0.4	-16	-1.2%	+/- 15%
US 97 & Odem Medo Way	3543	3392	2.6	-151	-4.3%	+/- 400 VPH
US 97 & Veterans Ave	3782	3655	2.1	-127	-3.4%	+/- 400 VPH
US 97 & Highland Ave/Glacier Ave	3346	3275	1.2	-71	-2.1%	+/- 400 VPH
Glacier Ave & SW 5th St	1203	1218	0.4	15	1.2%	+/- 15%
Glacier Ave & 6th St	1286	1274	0.3	-12	-0.9%	+/- 15%
Canal Blvd & Odem Medo Way	1547	1536	0.3	-11	-0.7%	+/- 15%

As shown below, the average travel times, estimated using Vissim, correlate well with the historic and field-collected travel times. For US 97 northbound, the differences in average travel time between the simulation and the field data (Bluetooth or iPeMS) is 45 seconds or less. For US 97 southbound, the differences are even less, with only 22 seconds for the iPeMS data (Table 4) and two seconds for the Bluetooth data (Table 5). It is important to note that the existing SCATS timing was not used, and that fixed timing plans were optimized for the simulation. Despite these modifications, the travel time results show that the Vissim model provides a good representation of existing conditions.

Table 5. Travel Time Summary – Bluetooth

Travel Time Segments		Field Measured	VISSIM	Difference (minutes)
Direction	Segment	Travel Time (minutes)	Travel Time (minutes)	
SB	South of Evergreen Avenue to North of Yew Avenue	3.94	3.98	0.04
NB	North of Yew Avenue to South of Evergreen Avenue	4.27	3.54	-0.74

Table 6. Travel Time Summary – iPeMS

Travel Time Segments		Field Measured	VISSIM	Difference (minutes)
Direction	Segment	Travel Time (minutes)	Travel Time (minutes)	
SB	South of Evergreen Avenue to North of Yew Avenue	4.35	3.98	-0.37
NB	North of Yew Avenue to South of Evergreen Avenue	4.13	3.54	-0.59

The Vissim model development and calibration effort for the existing (2017) PM peak period hour serves as the basis for the future No-Build and Build alternatives analysis. Overall, the calibration of the existing conditions Vissim model produced simulation output that replicated existing traffic operations and field observed driver behavior for the PM peak period. In addition, it is anticipated that some of the calibration parameters may be modified when analyzing various alternatives if geometric improvements warrant changes in vehicle speeds or capacity.

Traffic analysis for both the Build and No-Build alternative is explored in the Traffic Analysis Memorandum (Appendix B). The No-Build alternative maintains the existing lane configurations of the current facility but includes an extension of Quartz Avenue between Canal Boulevard and US 97. The intersection of Quartz Avenue and US 97 is signalized under the No-Build alternative.

The results of this analysis show that the Build alternative operates significantly better than the No-Build alternative at most of the study area intersections along US 97 and Canal Boulevard. The existing roundabout at Yew Avenue and Canal Boulevard operates poorly (LOS F) in both the No-Build and Build (2040) alternatives, and the Yew Avenue and northbound US 97 ramp terminal intersection experiences more delay in the Build alternative due to a shift in travel patterns. Travel times along US 97 are also improved with the recommended concept, with a 30 percent improvement in the northbound travel time and a 12 percent improvement in the southbound travel time (Table 7).

Table 7. Future 2040 PM Peak Hour Travel Time Summary

Travel Time Segments	Distance (miles)	No-Build	Build
		Travel Time (minutes)	Travel Time (minutes)
US 97 Northbound from Yew Ave to Highland/Glacier Ave	2.5	8.2	6.0
US 97 Southbound from Highland/Glacier Ave to Yew Ave	2.5	6.8	6.5

2.5.2 Safety

A Transportation Safety Evaluation (Appendix D) was conducted within the study area for existing conditions and future (year 2040) conditions with and without the proposed improvements to the US 97 SRC. Key findings from the safety analysis of the study area include:

- Along the US 97 SRC, there were 214 crashes between the years 2011 and 2015.
- Crash types vary, but the majority involved rear-end, turning movements, and sideswipe crashes.
- There were three crashes resulting in fatalities, two of which were located along the segment portions of US 97 near the Yew Avenue interchange. Two of the fatalities involved pedestrians.
- There were four pedestrian and four bicycle crashes within the study area.
- Approximately 48 percent of crashes resulted in only property damage.
- The segments of US 97 between Evergreen Avenue and Veterans Way and between Veterans Way/Wickiup Avenue have recently experienced crash rates higher than the statewide average.
- Four of the 16 study intersections were flagged as safety focus locations, including the one top 10 percent SPIS site at Veterans Way. Table 8 demonstrates which study intersections were flagged as safety focus areas and why.
- If no improvements are made within the US 97 SRC, crashes are predicted to increase from approximately 43 per year today to 76 per year by 2040.
- The proposed improvements will improve safety in the US 97 SRC. In 2040, the Build scenario is predicted to reduce crashes by 12 per year and would lessen the severity of many of the crashes that do occur.
- Key contributing factors to the predicted crash reduction and overall improvement in safety, resulting from the Build scenario, include:
    - the addition of a raised median island (reduces the frequency and severity of crashes and provides a pedestrian crossing refuge);
    - new signalized intersections (lessens the severity of crashes and provides for controlled pedestrian crossings); and

- Improved east-west connectivity therefore reducing traffic volumes on US 97.

Table 8. Safety Focus Area

Int. No.	Intersection Name	Reason Intersection was Flagged as Safety Focus Area			
		High Intersection Crash Rate	Overrepresentation of a Crash Type	Top 10% SPIS Site	High Segment Crash Rate
1	US 97 / Glacier/Highland	Yes			Yes
2	US 97 / Veterans Way			Yes	Yes
3	US 97 / Pumice Avenue				Yes
4	US 97 / Odem Medo Way		SS-O		Yes
5	US 97 / Wickiup Avenue				Yes
6	US 97 SB / Yew Avenue		Turn		
7	US 97 NB / Yew Avenue		Angle		
8	Canal Boulevard / Veterans Way		Turn		
9	Canal Boulevard / Pumice Avenue	Yes			
10	Canal Boulevard / Quartz Avenue				
11	Canal Boulevard / Odem Medo Way				
12	Canal Boulevard / Yew Avenue				
13	5th Street / Highland Avenue		Angle		
14	5th Street / Glacier Avenue		Angle		
15	6th Street / Highland Avenue	Yes	Angle		
16	6th Street / Glacier Avenue	Yes	Angle		

2.5.3 Active Transportation

Circulation for all modes of travel is constrained by physical barriers along both sides of US 97, resulting in limited east-west connectivity. Along the west side, the canal limits connections between the US 97 SRC and adjoining neighborhoods with only four existing canal crossings at Veterans Way, Pumice Ave, Odem Medo Way, and Yew Avenue. Along the east side of US 97, the railroad tracks are a substantial barrier with only two at-grade crossings at Veterans Way and Airport Way, effectively disconnecting the corridor from east side development.

Within the US 97 SRC, accommodations for people on foot or bicycle are substandard with substantial gaps in the network, forcing people to walk or bike along the unprotected shoulder for significant distances. Crossing opportunities are limited to three existing signals at Highland Ave, Veterans Way, and Odem Medo Way, which effectively prevents walking or biking access to destinations across the street for much of the corridor and results in long walking distances between signalized crossings (see Table 9). An underpass at Airport Way provides a grade separated crossing of US 97, however, it does not provide access to and from the corridor for people on foot or bike.

The Dry Canyon Trail's southern end at Reindeer Avenue and 19th Street is less than a half mile west of the corridor. The Homestead Canal Trail provides a largely uninterrupted, paved path of about 3.7 miles for pedestrians and cyclists that extends north beyond downtown Redmond. An unpaved trail along the canal of about three quarters of a mile extends south from Yew Avenue.

Table 9. Existing walk times

Roadway segment	Approx. distance	Approx. walk time (4 ft/sec)
	(feet)	(minutes)
Evergreen Avenue to Highland Avenue*	1,100	4.58
Highland Avenue to Veterans Way	2,800	11.67
Veterans Way to Odem Medo Way	4,600	19.17
Odem Medo Way to Yew Avenue/Airport Way	4,100	17.08
Average	**3,833**	**15.97**

**Listed for comparison – not included in average.*

Mode specific existing conditions are described in the Active Transportation Memo (Appendix E).

3 Alternatives Evaluation

3.1 Evaluation Process

Alternatives developed for the Plan were analyzed using the 20-year planning horizon traffic volumes and analysis procedures. The alternative evaluation goals provide a shared vision on the corridor and demonstrate stakeholder input from the public and business owners who live and work along the corridor. The Bend/Redmond area has been growing at a substantial rate and Deschutes County is one of the fastest growing regions in the nation. As the region continues to grow, there is a desire and need for a safer corridor and more connections along US 97 to the larger transportation network.

The team developed goals, objectives and criteria, developed alternatives, evaluated alternatives using those criteria.

3.1.1 Goals, Objectives, Evaluation Criteria

The City adopted a resolution (No. 2014-02) to partner with ODOT to refine, design, and implement a corridor improvement project for the US 97 South Corridor in 2014. The project study area extends along approximately three miles of US 97 South from Highland Avenue to the southern border of the Redmond urban growth boundary (aligned with Elkhorn Avenue). The adopted resolution was the result of a multi-year collaborative planning process that included the City, ODOT, and a stakeholder group consisting of impacted business and property owners, and community representatives. The outcome of the process was a corridor plan that included a series of conceptual design solutions to improve safety and operations for state, regional, and local traffic, access management and connectivity, development potential, and community character of the study corridor. The project is also expected to take into account the need to repair existing pavement conditions along US 97.

As part of the adoption of the 2014 resolution, the City and ODOT agreed upon the following vision for the corridor:

"The South US 97 Corridor is a vibrant business district that is safe and accessible to shoppers traveling by car, bus, bike, or on foot. The corridor is aesthetically pleasing and provides opportunities for business and community interaction. Traffic moves efficiently and at a reasonable speed in both the north-south and east-west directions."

In addition, the resolution established the following goals and guiding principles for the corridor:

Goals

1. Create a shared vision for the future of the corridor.
2. Garner significant public involvement.
3. Identify needed public infrastructure improvements.
4. Develop recommendations for transportation and safety improvements.
5. Establish an urban design plan and development standards to create a visually appealing business district.
6. Identify high crash locations, crash types that are most common, and risk factors, to develop and implement appropriate safety countermeasures.
7. Explore options for improving local traffic circulation and reduce local trips on US 97, including implementation of the City's SE 9th Street Arterial Link Project.
8. Improve east-west neighborhood connectivity.
9. Address local and regional transportation needs.
10. Create an access plan with significant solutions for locations of concern with realistic strategies for implementation.
11. Develop a prioritized implementation strategy/action plan.

Guiding Principles

1. Property owners and public are engaged.
2. Public input is respected and considered.
3. Public funds are invested efficiently and effectively.

4. Recommendations are flexible enough to allow for future development and redevelopment.
5. East-west connectivity is improved.
6. Corridor aesthetics are improved.
7. Implementation and maintenance plans have clear roles and responsibilities.
8. The resulting plan and capital program improves corridor conditions.
9. Business vitality of the corridor is protected and enhanced.
10. Safety is improved for drivers, bicyclists and pedestrians.
11. All modes of travel, including transit, are accommodated.

3.2 Project Decision Making Process

The following presents a basic outline of the steps included in the proposed decision making process for the US 97: South Redmond Corridor Improvement Project.

- Refine and establish a set of Project Goals based on the previously established vision, goals, and principles identified in the City's 2014 resolution. Develop a set of objectives and evaluation criteria designed to achieve the Project Goals and evaluate refined corridor design alternatives. The draft set of Goals and Objectives are presented in Table 10.
- Present the draft goals, objectives, and evaluation criteria to the Technical Advisory Committee (TAC), Stakeholder Advisory Committee (SAC), and Project Steering Committee (SC). The TAC and SAC will provide input into the final list of goals, objectives, and evaluation criteria, whereas the SC will approve the final list to be used in the concept evaluation. (Completed in October 2017)
- Obtain concurrence on the evaluation scoring of conceptual design treatments (e.g. frontage road versus backage road, additional cross street connectivity, and active transportation facilities on frontage road as compared to U.S. 97) through the application of the evaluation criteria. The outcome of these scores are Design Variables.
- Develop two build alternatives designed to achieve the project goals and objectives. Table 10 includes a draft set of Design Variables that describe aspects of the corridor design where build alternatives may differ. The Design Variables were considered during the build alternative design and refinement process. Table 10 also provides an initial set of pros and cons for each design variable, intended to facilitate the alternatives evaluation.
- Assess the two build alternatives utilizing the evaluation criteria to select a preferred concept using the future no-build as a baseline for comparison.
- Present the results of the evaluation to the TAC, SAC, and SC for input, refinement, and approval.

3.3 Goals, Objectives and Evaluation Criteria

Table 10 below summarizes the stakeholder goals and principles put forward in the Council resolution and establishes refined draft Project Goals organized in four categories as follows:

- Community Character (focus on economic development and urban design).
- Process (focus on public/stakeholder involvement).
- Safety/Operations (focus on US 97).
- Access/Connectivity (focus on local access and east/west connectivity).

Table 10 introduces Objectives and preliminary Evaluation Criteria designed to support and implement the Project Goals. The project Objectives and Evaluation Criteria was instrumental in the comparative evaluation of the alternatives in order to select a preferred corridor design concept, which was incorporated into the Corridor Facility Plan. The project Objectives and Evaluation Criteria will also be helpful in informing the following key decisions in the alternative selection process:

- What character should the improved corridor have and what is the desired experience for people traveling through the corridor?
- Which types of improvements are needed over the 20-year planning horizon to maximize economic development opportunities, enhance the business vitality of the corridor, and improve corridor aesthetics?
- Should the project focus on improving conditions for existing businesses or on maximizing values for property owners leading to gradual conversion towards higher-value land uses?
- What types of land uses/businesses is the project trying to preserve and/or attract?
- Which types of improvements are needed for the 2040 planning horizon to ensure safe and efficient travel in the corridor?
- What is the right balance between accommodating regional through-traffic and creating a vibrant multi-modal commercial area connected to the local community?
- What implementation steps need to be taken to ensure effective corridor operations and maintenance?

3.4 Application of Evaluation Criteria

The decision making framework is fundamentally the application of evaluation criteria in two stages. The first stage involves Typology and Design Variables, the second stage involves Alternative Design Evaluation. The purpose of the first stage of the evaluation is to compare the design concepts (for example, frontage road versus backage road) to inform the Design Variables and help direct project designers to achieve the project goals and objectives. For the first stage of the evaluation, each typology will be compared against the no-build scenario. Each major project element will be compared against each criteria as compared to no-build. The second stage will feature more detailed designs, broken out into segments, and compared against a no-build condition using the same project evaluation criteria applied during the first stage.

This will allow a consistent evaluation and a focused design effort. The end result will be a preferred alternative that responds to the goals, objectives, and evaluation criteria developed and applied by the TAC, SAC, and SC. The manner in which the preferred alternative responds to evaluation criteria will be documented in the evaluation scoring matrix to help build a defensible, robust record for why project decisions were made to help inform future design efforts during final design.

Table 10. Objectives and preliminary Evaluation Criteria

Category	Resolution Goals (G) and Principles (P)	Draft Project Goals	Draft Objectives	Draft Preliminary Evaluation Criteria
Community Character	*G1: Create a Shared Vision for the Future of the Corridor* *G5: Establish an urban design plan and development standards to create a visually appealing business district* *P4: Recommendations are flexible enough to allow for future development and redevelopment* *P6: Corridor aesthetics are improved* *P9: Business vitality of the corridor is protected and enhanced*	1. Develop a corridor design that improves aesthetics and establishes a flexible urban design framework for the creation of an economically vital and visually appealing business district	• Improve corridor aesthetics and provide a unique visual identity • Provide a sense of entry, a clear sequence or progression of movement, and create a variety of public spaces • Preserve and enhance business vitality by improving conditions for existing businesses or by maximizing values for property owners leading to gradual conversion towards higher-value land uses • Incentivize private sector improvements to business repair and aesthetics • Accommodate future development or redevelopment • Provide design standards that support development types, forms, and intensities supportive of the project vision	• Degree of consistent building frontage • Degree of consistent landscape treatment along corridor, including aligned street trees • Business visibility • Number of required property takings • Degree to which existing buildings contribute to the desired character • Development or redevelopment potential of parcels along the corridor • Ease of wayfinding • Number of facade and other improvements • Clear understanding of signage • Ability to accommodate existing businesses • Community connectivity and comfortable public space provided
Process	*G1: Create a Shared Vision for the Future of the Corridor* *G2: Garner significant public involvement* *G11: Develop a prioritized implementation strategy/action plan* *P1: Property owners and public are engaged* *P2: Public input is respected and considered* *P3: Public funds are invested efficiently and effectively* *P8: The resulting plan and capital program improves corridor conditions*	2. Develop a corridor design based on the established shared vision with significant public and stakeholder involvement in order to utilize public funds effectively and efficiently	• Keep the project vision in mind • Involve stakeholders and public in a meaningful manner in the decision making process throughout the project • Develop a prioritized implementation strategy/action plan • Ensure public funds are invested efficiently and effectively	• Level of public and stakeholder support • Degree to which recommendations can be implemented in phases • Cost effectiveness • Degree to which recommendation requires special approvals or agreements • Consistency with local, regional and statewide policy • Ability for City and ODOT to maintain improvement (e.g. plowing and landscaping) • Identified ROW or environmental impacts • Forward compatibility to potential future improvements
Safety/ Operations	*G3: Identify needed public infrastructure improvements* *G4: Develop recommendations for transportation and safety improvements* *G6: Identify high crash locations, crash types that are most common, and risk factors, to develop and implement appropriate safety countermeasures* *G9: Address local and regional transportation needs* *P10: Safety is improved for drivers, bicyclists, and pedestrians* *P11: All modes of travel, including transit, are accommodated*	3. Develop a corridor design that improves safety and provides for efficient travel for all modes	• Improve safety for drivers, bicyclists, and pedestrians • Implement appropriate safety countermeasures at identified high crash and high risk locations • Evaluate safety through analysis of crash data and identification of risk factors • Maintain or enhance efficient travel for regional traffic along US 97 • Maintain or enhance efficient travel for local trips • Improve or add facilities for people walking or bicycling along the corridor • Accommodate transit operations in facility designs	• Reduction of risk factors • Encourage reasonable traffic speeds for facility context • Reduction of conflict points on US 97 • Reduction of predicted crash frequency on US 97 • Improved safety for people walking • Improved safety for people bicycling • Average travel time through the US 97 corridor • Improved travel time reliability • Intersection volume/capacity ratio • Intersection level of service • Side street delay • Degree of low-stress bike accommodation and network connectivity • Degree of low-stress pedestrian accommodation and network connectivity • Degree and efficiency of transit accommodation
Access/ Connectivity	*G3: Identify needed public infrastructure improvements* *G7: Explore options for improving local traffic circulation and reduce local trips on US 97, including implantation of the City's SE 9th Street Arterial Link Project* *G8: Improve east-west neighborhood connectivity* *G9: Address local and regional transportation needs* *G10: Create an access plan with significant solutions for locations of concern with realistic strategies for implementation* *P5: East-west connectivity is improved* *P11: All modes of travel, including transit, are accommodated*	4. Develop a corridor design that improves local access and east-west connectivity for all modes of travel	• Add or enhance opportunities to cross US 97 for all modes of travel • Improve east-west connectivity between the US 97 corridor and neighborhoods west of the canal • Provide adequate access to businesses along the US 97 corridor for both customers and freight/delivery • Reduce the number of local trips on US 97 • Minimize out-of-direction travel	• Number of destinations within walking or biking distance • Frequency, quality, and location of crosswalks across US 97 • Frequency, quality, and location of connections to neighborhoods across the canal • Ease of access to businesses along the corridor from either direction • Level of connectivity providing for alternate routes for local traffic • ADA accessibility achieved

Table 11 provides an overview of initial Design Variables that describe aspects of the corridor design where build alternatives may differ. The intent is to provide a toolbox for the development, refinement, and evaluation of the build alternatives. Table 11 also includes an initial set of pros and cons for each design variable, assessing to what extent each variable in isolation addresses the project goals and objectives.

Table 11. Draft Design Variables

Draft Design Variables			Pros	Cons
Corridor Width	Consistent along corridor extent		• Aesthetics • Consistent operations • Greater clarity in wayfinding • Consistent conditions for business along corridor • Driver expectancy maintained	• Property takings required • Likely more expensive
	Varies, adjusting to existing constraints and project needs		• Minimized property impacts/takings • Potential cost savings	• Aesthetically challenging • Possible wayfinding difficulties • Possible operational challenges • Some safety risk factors may remain • Driver expectancy degraded
Intersection Spacing	Unchanged		• No additional cost	• No improvement for east-west connectivity • No improvement for pedestrian and bike access • Possible bypass/cut-through traffic on access road
	Reduced spacing with additional signals		• Improvement for pedestrian and bike access and safety • Potential to manage traffic speeds • Improvement for businesses access • Provides opportunity for additional east-west connectivity	• Cost
Local Street Network	Additional local streets and bridges		• Improvement for east-west connectivity • Potential for reduction of local traffic on US 97 • Increase in size of walk and bike shed • Possible improvement of business environment	• Cost (roadway and canal bridge structures) • Potential for cut-thru traffic
Access roads	Location	Front	• Access/parking near business frontages	• Possible conflicts with existing buildings
		Rear (“backage road”)	• Ingress/egress poses fewer difficulties	• Difficult wayfinding due to lack of visibility • Business access/viability may be adversely impacted • Increase likelihood of cut-through traffic within parking lots
	Traffic flow	One-way traffic	• Less width needed • Simpler operations and ingress/egress	• Limited local access • Out-of-direction travel and U-turns required • Possible adverse impact on businesses
		Two-way traffic	• Better local access • Minimized need for out-of-direction travel • Possible reduction of local access traffic on US 97	• Ingress/egress may be complicated • More width required
		One-way contraflow	• Improves business access to pass-by traffic in contraflow direction	• Limited access and out-of-direction travel required for opposite direction
	Ingress/egress	At intersections parallel to mainline	• No out-of-direction travel • Potential for parallel local access route without impacting mainline US 97 traffic operations and/or capacity • Consistent corridor width	• Signal phasing may be more complicated • Access road traffic may cause conflict with right turning mainline traffic
		At cross streets set back from mainline intersections	• Conventional intersections at US 97 with local access separated • Access road does not add conflicts to mainline intersection	• Out of direction travel required • Potential adverse impact on business visibility and wayfinding
		Driveways from/to mainline near intersections	• Conventional intersection operations • Minimizes driveway interruptions between intersection	• Local access limited between intersections • Access road doesn’t add capacity or syphon off local traffic • Increase in conflict points
		Intermittent/mid-block driveways	• More access opportunities closer to destinations • Improved circulation and channelization along access roads	• More frequent driveway interruptions and potential mainline conflicts
	Parking	None	• Minimal space requirements	• No contribution to pedestrian-friendly environment or other benefit • Tendency for higher speeds
		One side	• Limited width needed • Parking near business frontages • If on building side, limited exposure of people to US 97 traffic • If on building side, parked cars provide buffer for pedestrians	• Less efficient use of access road • Less parking than two-sided configuration

Draft Design Variables			Pros	Cons
		Both sides	• Maximized use of access road • Parking near business frontages • Parked cars provide buffer for pedestrians	• More width needed • Places people between US 97 and access road
		Parallel	• Less width needed • Resembles city street rather than parking lot	• More difficult operations • Less efficient use of space • Potential ADA challenges
		Angled	• Easier operations • More efficient	• More width needed
	In-street	Bike lanes on mainline	• Consistent route, especially for confident cyclists • Limited conflicts with vehicular traffic	• Near high-speed vehicles • High stress environment for less confident cyclists
		Bike lanes on access road	• Bike route near likely destinations • Bikes adjacent to slower vehicle traffic	• Frequent conflicts with parking maneuvers and driveway access • Potential out-of-direction travel
		Sharrows on access road	• Efficient space usage	• Bike and vehicular traffic mixed • Frequent conflicts with parking maneuvers and driveway access • Less suited for less confident cyclists
	Separated	Cycle tracks	• Limited conflicts between bikes and other modes • Physical separation between fast traffic and bikes • Low stress environment for cyclists	• Additional width required • Potential for more complex intersections
		Two-way cycle track on one side	• Two-way business access on one side • Conflicts between modes limited to one side of corridor	• Bike access limited to one side of corridor
Pedestrian Accommodation	Sidewalks	Along building frontage	• Pedestrian route near destinations • Building orientation to sidewalk encouraged	• Possible out-of-direction travel if corridor frontage is inconsistent
		Between mainline and access road	• Consistent alignment	• Safety challenge when crossing access road • Likely duplicate pedestrian walkways
	Crossings	Additional signalized crossings	• Improvement for east-west connectivity • Increased size of walk and bike shed • Potential improvement for business environment	• Cost • Impacts to signal progression along US 97
		Additional unsignalized crossings	• East-west connectivity improvement with modest cost	• Questionable pedestrian comfort and safety crossing US 97 • Uncontrollable traffic operations and delays along US 97
		Median refuges at signalized crossings	• Increased pedestrian comfort • Allows two-stage pedestrian crossing, improving throughput and signal progression along US 97	• May encourage pedestrians to cross in one-stage and leave standing in the median waiting to cross in an unprotected situation

3.5 Stakeholder Input

3.5.1 Intro and Strategy

As outlined in the Public Involvement Memorandum (Appendix F), the purpose of public involvement in this project was to fully understand stakeholder issues in regards to the US 97 SRC. It also sought to engage stakeholders in alternative evaluations, development, and selection of the project design.

Prior to reaching out to stakeholders about the project, the team developed key messages and identified crucial stakeholders who would be most interested in and impacted by this project. Coordinating with business and property owners along the corridor was crucial, so much of the project's outreach was targeted to these stakeholders. Other key stakeholders included nearby residents, the City of Redmond, Deschutes County, the freight community, as well as multimodal users and general highway users. Identifying key stakeholders early on helped inform the formation of the SAC.

3.5.2 Stakeholder Advisory Committee

The SAC met five times throughout the project to discuss the goals of the process, approve evaluation criteria, and evaluate potential alternatives. SAC members are identified in Table 12. In forming the SAC, the project team ensured that a variety of interests were represented, from business owners and managers to planners to influential members of the community. Business and property owners made up a large part of this group, as they would directly benefit from or be impacted by changes to US 97 SRC in the short and long term.

Table 12. Members of the Committee

Name	Affiliation
Gill Platt	Mindstate Power Sports
Charley Miller	Miller Lumber
Lindsay Greco	Wilson's Furniture
Paul Rodby	McDonald's
James Westcoat	McDonald's
Frank Bowen	Napa Auto Parts
Jeff Nordstrom	Safeway
Mark Malott	Central Oregon Ranch Supply
Laura Garcia	Mazatlan | Mexican Restaurant
Scott Carlson	Hooker Creek Construction Materials
Jon Stark	Economic Development for Central Oregon
Ed Fitch	Fitch Law Group

Name	Affiliation
Bill Hilton	Redmond Urban Area Planning Commission
Joseph Zika	Redmond Urban Area Planning Commission
Roger Lee	Economic Development for Central Oregon
Bill Braly	Redmond Bicycle and Pedestrian Advisory Committee

Stakeholder Committee Voting

The project team combined the best elements from the five previous concepts to prepare a recommended concept.

Concept A (multi-way boulevard) had one of the most expensive right-of-way costs and construction costs since it required significant right-of-way acquisition to construct the wide footprint. Concept B (channelized access and circulation) required less right-of-way, but limited the access to businesses on the opposite side of the street. Concept C (signalized protected access) limited traffic mobility since it allowed access at signals but not U-turns. Concept D (super street mobility) allowed some U-turns, but limited the access since they were not allowed at all signals. Concept E, the recommended concept, allows U-turns at each signal as well as incorporating a center median for safety

For the committee meetings in November 2018, the project team divided the recommended concept into four sections to make it easier for the stakeholders to identify areas of concern. The sections are identified in Figure 16. After reviewing each section, committee members voted using a red, yellow, and green color system. Red indicated the committee member did not prefer the recommendation in that section; yellow indicated the committee member required more specifics; and green indicated the committee member had no concerns. The results are displayed in Table 13.

Figure 16. Recommended Concept

Table 13. Results for Recommended Concept

	Section 1	Section 2	Section 3	Section 4
Green	6	7	7	0
Yellow	1	0	0	7
Red	0	0	0	0

3.5.3 Recommended Concept

The recommended concept introduces three new signals and introduces U-turns at each signal that reduce conflicts and movements at intersections.

Key features of this concept include:

- Three new signalized intersections along US 97 SRC that allow protected U-turns.
- Three new roads connecting US 97 to Canal Boulevard to enhance access to businesses on US 97 from the community.
- Traffic separators between the northbound and southbound lanes on US 97 allowing protected left-hand turning movements and U-turns at signalized intersections.
- Areas for safe pedestrian refuge halfway across US 97 to enhance pedestrian crossings.

- New sidewalks and cycle track treatments throughout the length of the corridor and along east/west connecting roads to provide a more well connected active transportation network.
- Connections to the new, already planned, shared-use path along Canal Boulevard and the canal.
- A limited number of new access roads or alleyways to provide alternative access where new connections provide safe ingress and egress nearby.

3.5.4 Public Engagement Methods and Tools

The project team utilized a variety of tools to inform and seek input from the public, including:

- **Project Website.** A website (www.southredmond97.org) was developed to provide information to the public about the purpose and background of the project and potential concepts for improvements. The site encouraged feedback on potential concepts through a comment form, as well as contact information for project team members. It also provided up-to-date information about upcoming events and ways to participate in the project.
- **Open House.** On February 7, 2018, the project hosted an open house in partnership with the City of Redmond's TSP. The US 97 SRC station was attended by 16 people. To notify the public about the open house in February 2018, an invite to the open house was included in the City's newsletter. Input was provided from a broad part of the Redmond community. The need to improve US 97 was a common comment at this event.
- **Business and Property Owner Site Sessions.** Once potential design alternatives were identified, the project team organized two rounds of site sessions with business and property owners to discuss opportunities and concerns for each alternative. Site sessions were held at businesses along the corridor and were open to the public. Business and property owners were notified through a mailer for the first round and an email for the second round.

Figure 17. Site Session at Chevron Station

- **Mailers.** To notify the public about the open house in February 2018, an invite to the open house was included in the City's water bills prior to the event (Appendix G). Prior to the first round of site sessions in June 2018, a mailer was sent to business and property owners in the project area describing the project and inviting them to the site sessions and the upcoming Stakeholder Advisory Committee Meeting (Appendix H).
- **Fact Sheets.** In February 2018 the project team developed a fact sheet describing the project, its purpose, and alternatives A and B, to be used for discussion at the site sessions as well as at the SAC, TAC and SC meetings (Appendix I). For the committee meetings in November 2018, the team created five fact sheets, one for each alternative (A, B, C, D and E), that describe the features of each alternative, as well as their potential benefits and impacts and how they scored against the evaluation criteria (Appendix J)
- **Stakeholder Interviews.** In fall 2017, the project team conducted stakeholder interviews with a sampling of property owners, real estate professionals (brokers, developers), business owners, economic development officials, and adjacent neighborhood representatives (Appendix K). Twelve individuals were interviewed, and feedback received helped to inform evaluation criteria, initial design concepts, and public outreach efforts going forward.
- **Individual Site Sessions** a few one on one interviews were conducted at business sites along the corridor:
  - McDonalds: June 2018, visited site location and reviewed parking, driveway, and landscaping.

  - Abby's Pizza: June 2018, visited site location and reviewed design options, discussed parking, driveway, and landscaping.
  - Madeline's Grill: June 2018, visited site location and discussed sign location, landscaping, and driveway.
  - Chevron: April 2019, visited site location and reviewed shared driveway alleyway behind the business and site circulation for freight trucks.
  - Wilson's Furniture: April 2019, visited site location and reviewed alleyway and backage road.
  - BAS-X: April 2019; visited site location and discussed freight access and circulation.

- **Stakeholder Tracking.** In spring of 2017, the project team contacted business owners throughout the corridor. This stakeholder tracking was used to send out mailing information about site sessions and project information. Figure 18 identifies the properties whose owners engaged with the project team in green. The team didn't hear back from owners of properties indicated in red although communication was provided to property and business owners.

Figure 18. Stakeholder Tracking Map

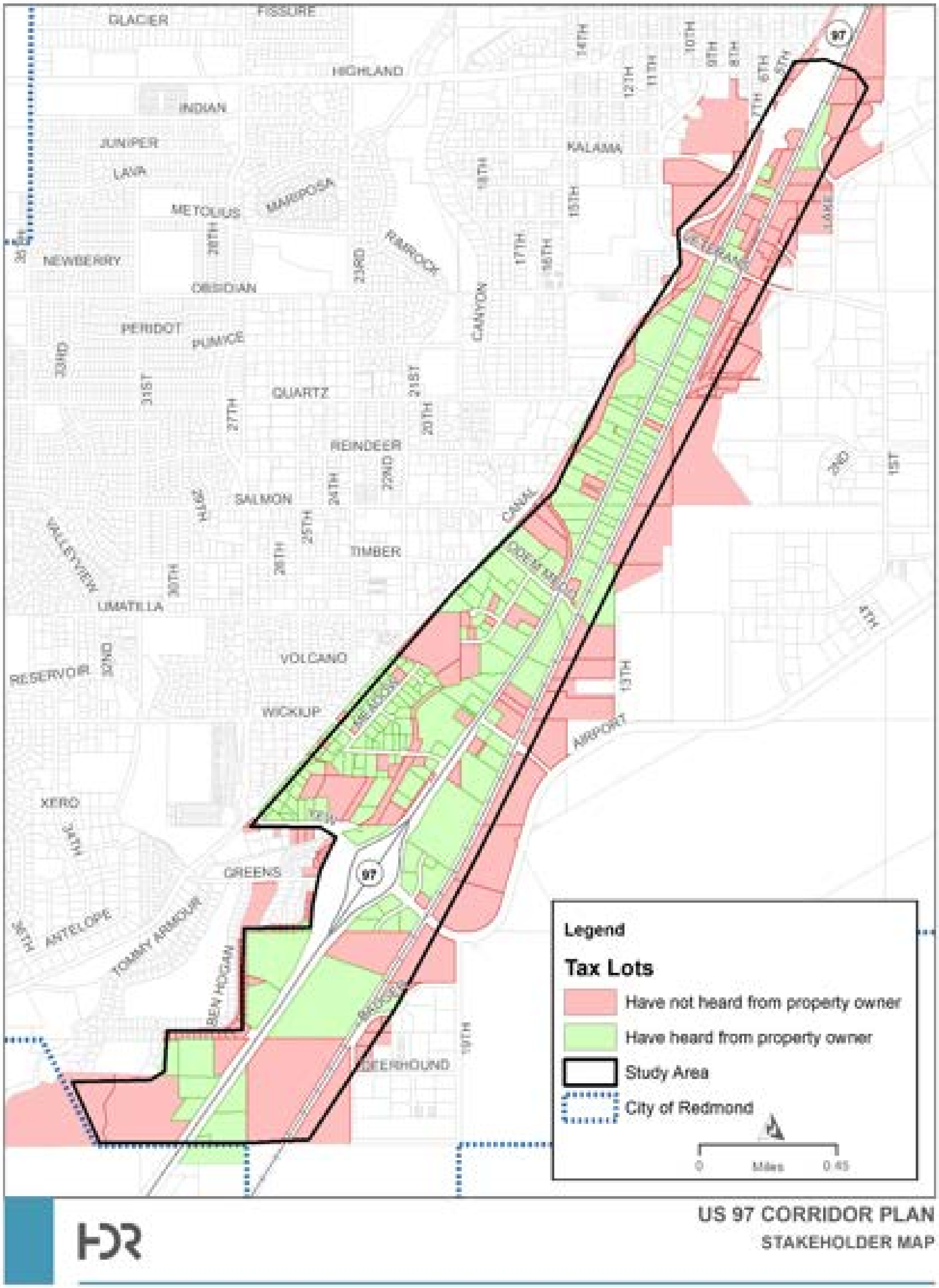
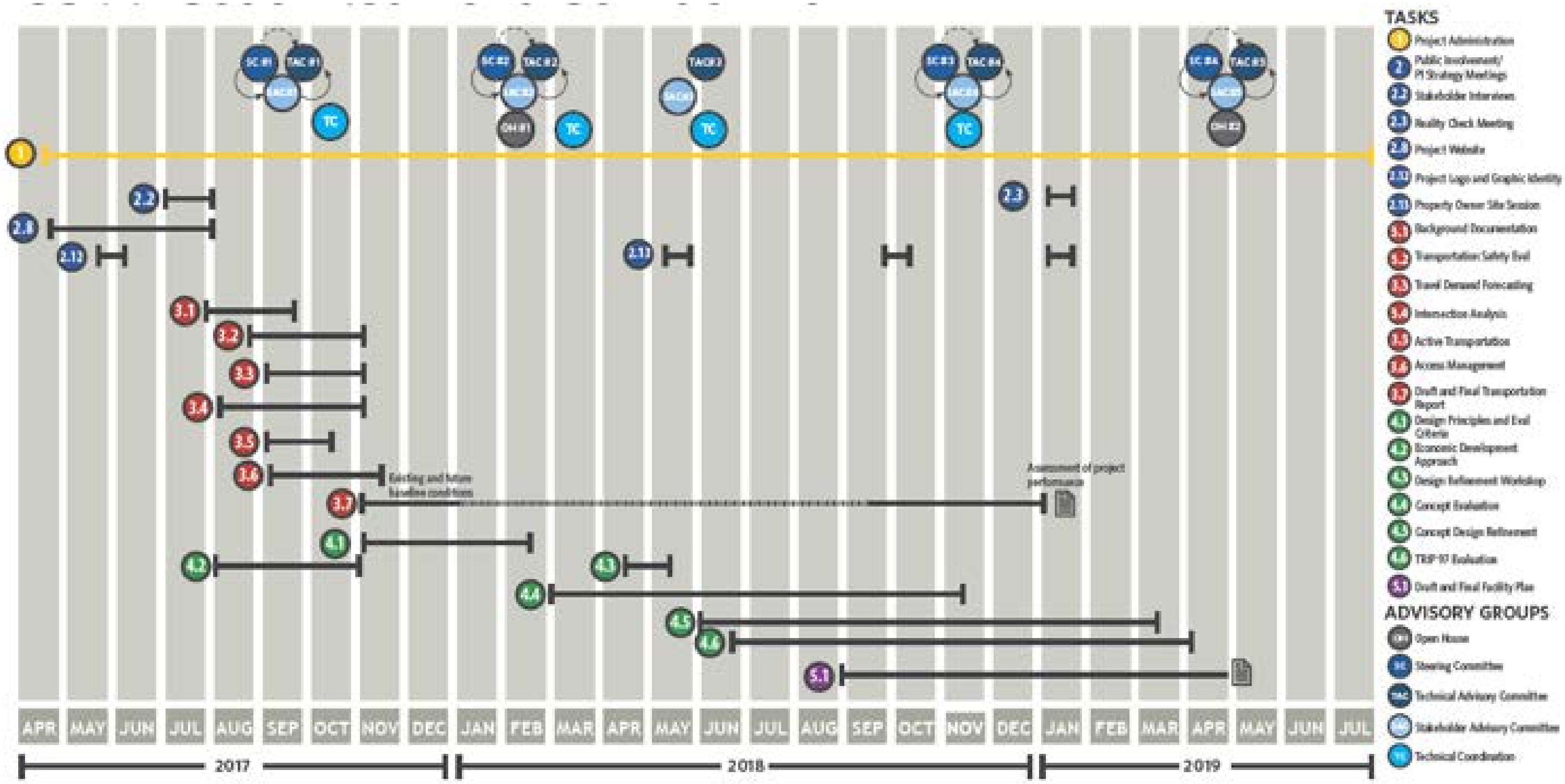


Figure 19 shows the project timeline. The project kicked off in April 2017 and ended in July 2019. The project included five TAC meetings, five SAC meetings, and four SC meetings.

Figure 19. US 97 SRC Schedule Overview



3.6 Concepts Considered

A total of five concepts were considered throughout the project. Concept A (multi-way boulevard) had one of the most expensive right-of-way costs and construction costs since it required significant right-of-way acquisition to construct the wide footprint. Concept B (channelized access and circulation) required less right-of-way, but limited the access to businesses on the opposite side of the street. Concept C (signalized protected access) limited traffic mobility since it allowed access at signals but not U-turns. Concept D (super street mobility) allowed some U-turns, but limited the access since they were not allowed at all signals. Concept E, the recommended concept, allows U-turns at each signal as well as incorporating a center median for safety. The detailed concept scorecard in shown in Figure 20.

Figure 20. Concept Scorecard

CRITERIA	CONCEPT A: Multi-Way Boulevard	CONCEPT B: Channelized Access and Circulation	CONCEPT C: Signalized Protected Access	CONCEPT D: Super Street Mobility	CONCEPT E: Recommended Concept
ROW Cost / Impact	Poor	Good	Average	Average	Good
Construction Cost	Poor	Good	Average	Average	Good
Access	Average	Poor	Average	Poor	Average
Safety	Average	Good	Good	Good	Good
Community Character*	Good	Average	Average	Poor	Average
Phaseability	Poor	Good	Good	Average	Good
Traffic Mobility	Poor	Average	Poor	Good	Average
Active Transportation	Good	Good	Good	Good	Good

Qualitative ranking: ● Poor ● Average ● Good

*Note: improvement in Community Character under all options requires the involvement of private property and/or business owners

3.6.1 Initial concepts (A and B)

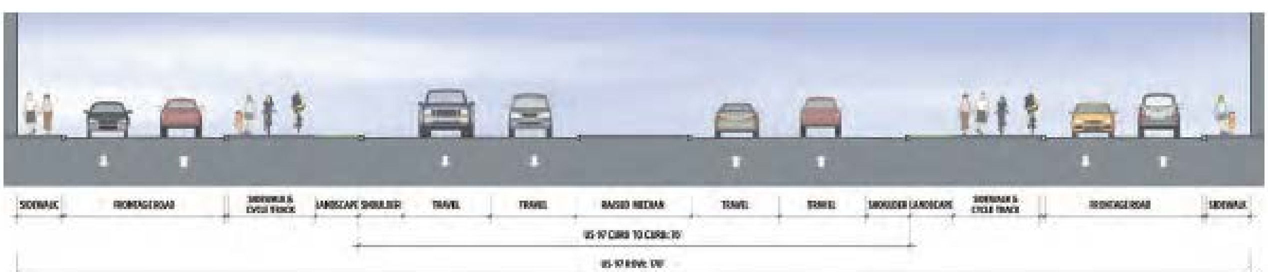
Concept A: Multi-way Boulevard

This concept introduces a multi-way boulevard to the corridor as a way of managing access to businesses and creating safer access points. A multi-way boulevard includes through lanes and local access lanes that run parallel to the highway and can be located in front of businesses along the highway (frontage road) or behind businesses (back access road). In this concept, several frontage roads would be constructed on either side of the highway with designated points of access, along with three areas of back access road as depicted in Figure 21 and Figure 22. Once on a frontage road, drivers are able to turn in and out of business parking lots at a slower speed, without having to pull directly onto the highway upon exiting.

Key features of this concept include:

- Frontage roads and some back access roads that allow safer access to businesses.
- Three new roads that cross the canal and one other additional road that connects US 97 to neighborhoods on the west side.
- Traffic separators that allow for additional pedestrian crossings.
- New sidewalks and multi-use paths throughout the length of the corridor and along new connecting roads.
- Additional landscaping along multi-use paths and new multi-way boulevards.
- A new multi-use path trail along Canal Boulevard and the canal (already planned).

Figure 21. Concept A: Multi-way Boulevard cross section



ROW Cost / Impact	Construction Cost	Access	Safety	Community Character	Phaseability	Traffic Mobility	Active Transportation
Poor	Poor	Average	Average	Good	Poor	Poor	Good

Qualitative ranking: ● Poor ● Average ● Good

Figure 22. Concept A: Multi-way Boulevard

Concept B: Channelized Access and Circulation

- Concept B proposes traffic separators between the northbound and southbound lanes on US 97, as well as U-turns at signalized intersections. These combined elements allow for safer turning movements into businesses along the corridor without adding a significant amount of new roadway, making it a lower-cost option than Concept A. Concept B is shown in Figure 23

Figure 23 and Figure 24.

Key features of this concept include:

- Traffic separators between the northbound and southbound lanes on US 97 allowing protected left-hand turning movements and U-turns at signalized intersections.
- Short segments of frontage road between Veterans Way and Odem Medo Way.
- Three new roads that cross the canal and one other additional road that connects US 97 to neighborhoods on the west side.
- New sidewalks and multi-use paths throughout the length of the corridor and along new connecting roads.
- A new multi-use path trail along Canal Boulevard and the canal (already planned).

Figure 23. Concept B: Channelized Access and Circulation cross section

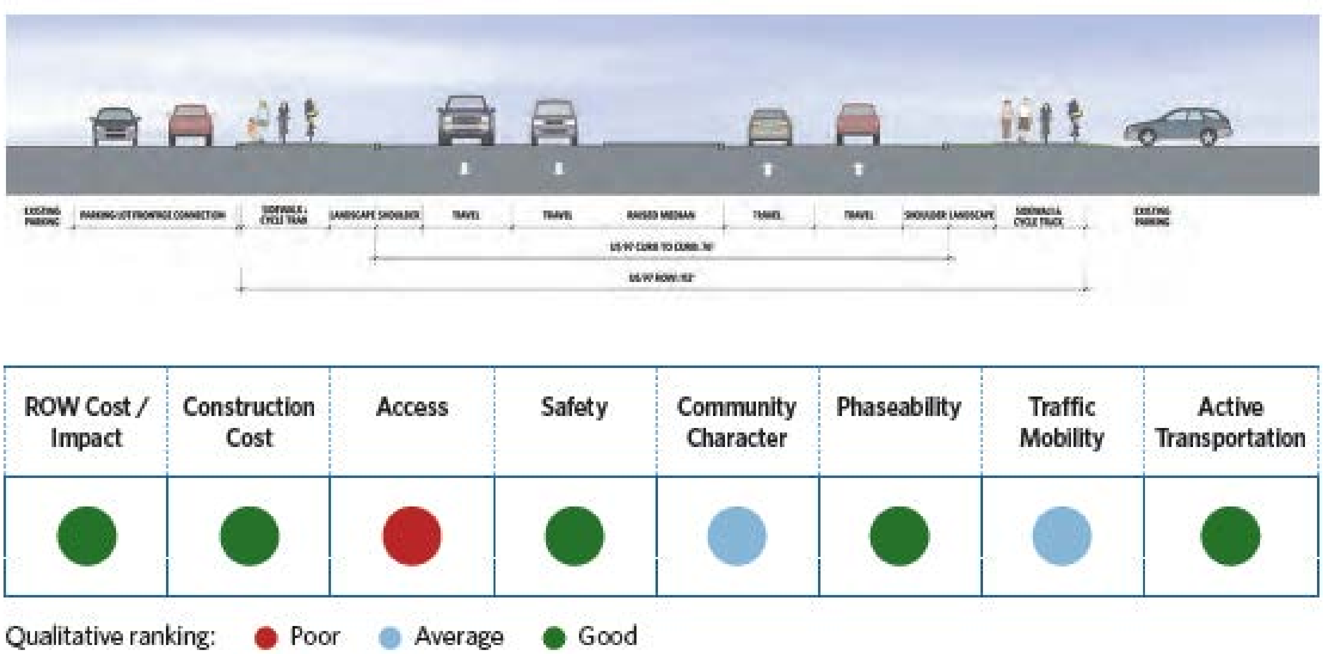


Figure 24. Concept B: Channelized Access and Circulation

3.6.2 Additional concepts (C and D)

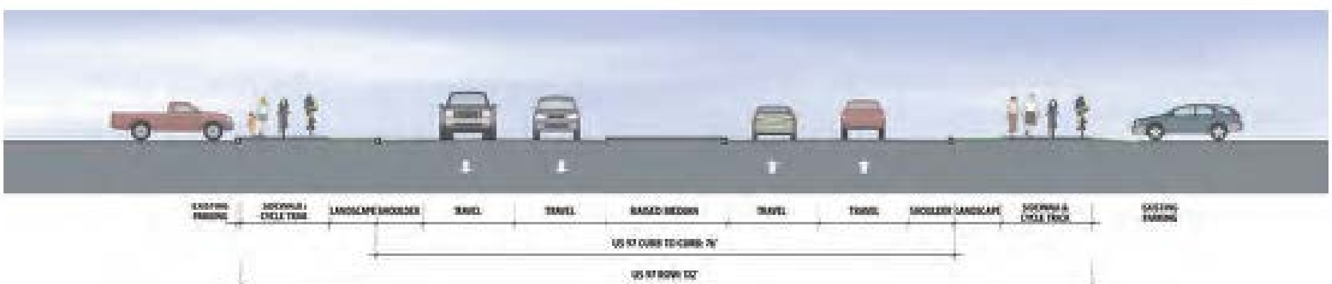
Concept C: Signalized Protected Access

Concept C introduces five new signals as a way to provide safe turns at intersections. In this concept, additional signals slow traffic and offer additional safer crossing areas to connect sidewalks and multi-use paths and shown in Figure 26 and Figure 26.

Cost and impacts for this concept are estimated to be lower than concepts A and B. Key features of this concept include:

- Three new partial signals (protected movement) and two new full signals along US 97.
- Three new roads that cross the canal and one other additional road that connects US 97 to neighborhoods on the west side.
- Areas for safe pedestrian refuge halfway across the street, where crossing the entire road without delay is difficult.
- New sidewalks and multi-use path paths throughout the length of the corridor and along east/west connecting roads.
- A new multi-use path trail along Canal Boulevard and the canal (already planned).

Figure 25. Signalized Protected Access cross section



ROW Cost / Impact	Construction Cost	Access	Safety	Community Character	Phaseability	Traffic Mobility	Active Transportation
Average	Average	Average	Good	Average	Good	Poor	Good

Qualitative ranking: ● Poor ● Average ● Good

Figure 26. Concept C: Signalized Protected Access

September 27, 2019

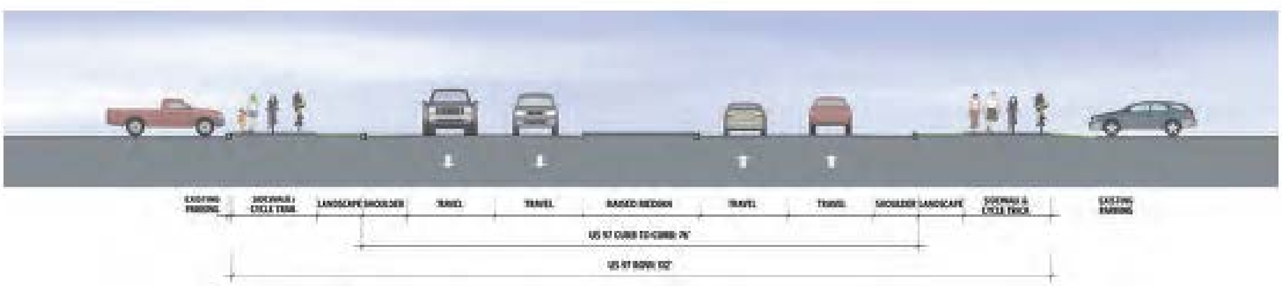
Concept D: Super Street Mobility

This concept introduces U-turns that reduce the number of conflicts by limiting movements at intersections. To make a left-turn, drivers must proceed to a designated U-turn area. This concept includes a two-phase signal versus the standard four-phase signal, increasing traffic flow and auto mobility along the corridor. These combined elements reduce congestion without adding new roadway. This concept would best provide mobility for US 97 and minimize delay at the intersections and shown in Figure 27 and Figure 28. The costs and new impacts for this concept is estimated to be lower than concepts A and B.

Key features of this concept include:

- Signalized U-turns to reduce conflicts at intersections and reduce delay while accessing businesses.
- Three new roads that cross the canal and one additional road that connects US 97 to neighborhoods on the west side.
- Additional pedestrian crosswalks.
- New sidewalks throughout the length of the corridor and along new east/west connecting roads.
- A new multi-use path trail along Canal Boulevard and the canal (already planned).Removal of left turn movements at Veterans Way.

Figure 27. Super Street Mobility Access cross section



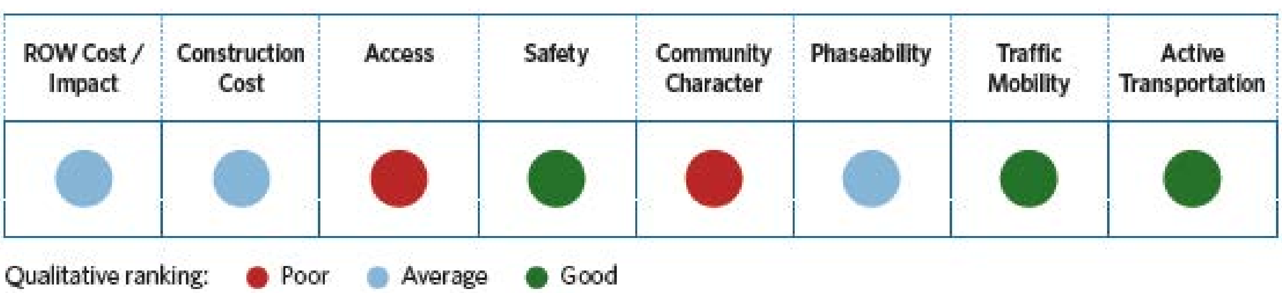


Figure 28. Concept D: Super Street Mobility Access

3.7 Recommended Concept

The recommended concept was selected by the three Committees by applying the evaluation criteria. The concept introduces three new signals located at Wickiup Avenue, north of Salmon Avenue, and Quartz Avenue. It introduces U-turns at each signal to reduce the number of conflicts and movements at intersections. To make a left-turn, drivers must proceed to a designated U-turn area. The recommended concept includes additional signals that slow traffic and offer additional safer crossing areas to connect sidewalks and multiuse paths as shown in the cross section in Figure 29. The recommended concept scores are the best of all five concepts and are shown in Figure 30.

Key features of this concept include:

- Three new signalized intersections along US 97 that allow protected U-turns.
- Three new roads connecting US 97 to Canal Boulevard to enhance access to businesses on US 97 from the community.
- Traffic separators between the northbound and southbound lanes on US 97 allowing protected left-hand turning movements and U-turns at signalized intersections.
- Areas for safe pedestrian refuge halfway across US 97 to enhance pedestrian crossings.
- New sidewalks and cycle track treatments throughout the length of the corridor and along east/west connecting roads to provide a more well-connected active transportation network.
- Connections to the new, already planned shared-use path along Canal Boulevard and the canal.
- A limited number of new access roads or alleyways to provide alternative access where new connections provide safe ingress and egress nearby.

Figure 29. Scorecard Recommended Concept Cross section

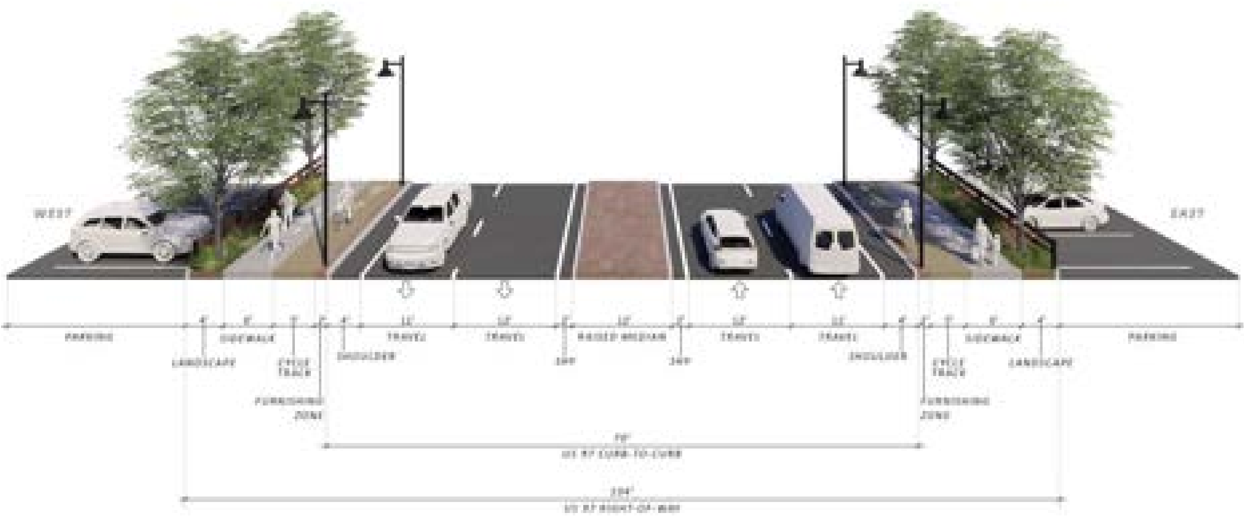


Figure 30. Scorecard Recommended Concept scorecard

ROW Cost / Impact	Construction Cost	Access	Safety	Community Character	Phaseability	Traffic Mobility	Active Transportation
Good	Good	Average	Good	Average	Good	Average	Good

Qualitative ranking: Poor Average Good

4 Recommended Concept

4.1 Project Purpose and Vision

The purpose of the US 97 SRC project is to enhance transportation safety, improve corridor travel reliability and operations, and enhance the corridor business environment through balanced transportation improvements to US 97 between Yew Avenue and the Glacier-Highland intersections. The need for the project stems from growing traffic volumes and congestion, high severity crashes in the study area, and the desire to provide safer and better access to business and property owners in the corridor.

The framework for the US 97 SRC: arose from the City's adoption of the 2014 resolution agreed to by the City and ODOT as the following vision for the corridor:

"The South US 97 Corridor is a vibrant business district that is safe and accessible to shoppers traveling by car, bus, bike, or on foot. The corridor is aesthetically pleasing and provides opportunities for business and community interaction. Traffic moves efficiently and at a reasonable speed in both the north-south and east-west directions."

4.2 Policy Context

According to the OHP, US 97 is a Statewide Highway, National Highway System (NHS) Route, National Network (federally designated truck route),OHP Freight Route, Reduction Review Route (as per (Oregon Revised Statute [ORS] 366.215) and south of Yew Avenue is also an Expressway. These designations reflect the importance of US 97 to freight travel for the States of Oregon, Washington and California.

The TSP classifies US 97 as a Major Arterial, the top classification in proposed road hierarchy in the Plan. Yew Avenue and Veterans Way are classified as a Minor Arterials, SW Odem Medo Way is classified as a Major Collector, and the future Quartz Avenue is classified as a Proposed Major Collector.

The proposed improvements in the corridor are consistent with the adopted functional classifications in the TSP. As of spring 2019, there is an on-going update to the TSP. The TSP and US 97 South Redmond Corridor project teams have coordinated closely, and the US 97 South Redmond Corridor project is consistent with the current draft TSP.

The OHP also has proposed mobility targets for facilities in different classifications this includes v/c targets (as shown on page 84 of the OHP). The mobility target for this facility is 0.85.

For signalized intersections, the overall intersection v/c ratio is provided from the HCM 2000 signalized reports in Synchro. For unsignalized intersections, the v/c ratio for the worst movement on US 97 is provided from the HCM 2000 unsignalized reports in Synchro. As shown highlighted in red below, multiple intersections on US 97 exceed the Oregon Highway Plan mobility threshold of 0.85 during the PM peak period. The Yew Avenue northbound ramp terminal, Wickiup Avenue, and Odem Medo Way intersections have a higher v/c ratio in the Build condition due to the addition of protected U-turn movements or a shift in traffic volumes. It is important to note that the recommended concept does not add capacity to the existing network. An alternative mobility standard will be set in the Oregon Highway Plan for the v/c achieved with the project as the new future standard for those intersections where the standard is not met. This includes US 97 and Wickiup Avenue, US 97 and Odem Medo Way, US 97 and Reindeer/Salmon Avenues, US 97 and Veterans Way and the US 97 NB entrance ramp at Yew Avenue.

Table 14. Future 2040 Synchro Analysis Summary

Intersection	No-Build		Build	
	Analysis Type	v/c	Analysis Type	v/c
Yew Avenue & US 97 Northbound	Signalized	0.84	Signalized	1.00
Yew Avenue & US 97 Southbound	Signalized	0.63	Signalized	0.71
Wickiup Avenue & US 97	Unsignalized	0.88	Signalized	0.91
Odem Medo Way & US 97	Signalized	1.01	Signalized	1.05
Reindeer Avenue/Salmon Avenue & US 97	N/A	N/A	Signalized	0.83
Quartz Street & US 97	Signalized	0.95	Signalized	0.75
Pumice Avenue & US 97	Unsignalized	0.90	Signalized	0.81
Veterans Way & US 97	Signalized	1.12	Signalized	1.06
Highland Avenue/Glacier Avenue & US 97	Signalized	0.83	Signalized	0.79

Note:

1. For signalized intersections, the overall intersection v/c ratio is provided from the HCM 2000 signalized reports in Synchro.
2. For unsignalized intersections, the v/c ratio for the worst movement on US 97 is provided from the HCM 2000 unsignalized reports in Synchro.
3. Intersections not meeting the OHP mobility standard of 0.85 are represented in red text, except where an alternative mobility standard is being proposed.
4. The City and ODOT are proposing alternative mobility targets for US 97 Veterans Way, US 97 Odem Medo Way, and US 97 NB Ramp Terminal at Yew Avenue at 1.0 v/c as a part of adoption of this plan. For US 97 at Wickiup Avenue the target is 0.95 v/c as a part of adoption of this plan.

SW Veterans Way is the most capacity constrained point on the corridor. The limited number of crossings of the BNSF railroad east of US 97 forces traffic from the employment and industrial area via a limited number of crossings, resulting in heavy cross traffic. The recommended concept optimizes the intersection to the extent feasible without larger transportation system changes or more expensive grade separation options on US 97. Additional options could be considered to improve intersection performance and reduce delay at the intersection, which include: 1) eliminating turning movements at the intersection that will route traffic to use U-turns or indirect lefts at nearby intersections, 2) grade separation of the whole intersection or certain intersection movements or 3) additional crossing of the rail line to allow for traffic volumes to be balanced across additional crossings.

Coordination with BNSF was conducted in the winter of 2019 with ODOT, the City of Redmond, and the City of Bend. It is likely that additional crossing closures would need to be considered to allow for a future at-grade crossing of the rail line. The likely new BNSF railroad crossings would occur at either Quartz Avenue or SW Odem Medo Way. The SW Quartz Avenue crossing would be more effective at reducing the delay at SW Veterans Way due to the closer proximity of the corridor.

4.3 Final Recommended Concept

4.3.1 Concept Overview

The recommended concept introduces three new signals and introduces U-turns at each signal that reduce conflicts and movements at intersections. To make a left-turn, drivers must proceed to a designated U-turn area. The concept includes these additional signals to slow traffic and offer additional safer crossing areas to connect sidewalks and multi-use paths. The recommended concept is shown in Figure 32 and Figure 33.

Key features of this concept include:

- Three new signalized intersections along US 97 that allow protected U-turns.
- Three new road connections that cross the canal and connect US 97 to Redmond neighborhoods on the west side of US 97.
- Traffic separators between the northbound and southbound lanes on US 97 allowing protected left-hand turning movements and U-turns at signalized intersections.
- Areas for safe pedestrian refuge halfway across US 97 to enhance pedestrian crossings.
- New sidewalks and cycle track facilities throughout the length of the corridor and along east/west connecting roads to provide a well-connected active transportation network.
- A new multi-use path trail along Canal Boulevard and the canal (already planned).
- A limited number of new access roads or alleyways to provide alternative access where new connections provide safe ingress and egress nearby.

The recommended concept as show in Figure 31 is the most cost effective in terms of construction costs and ROW costs. It allows access to driveways while still providing safety with the center median. The concept scorecard is displayed in Figure 32.

Figure 31. Recommended Concept

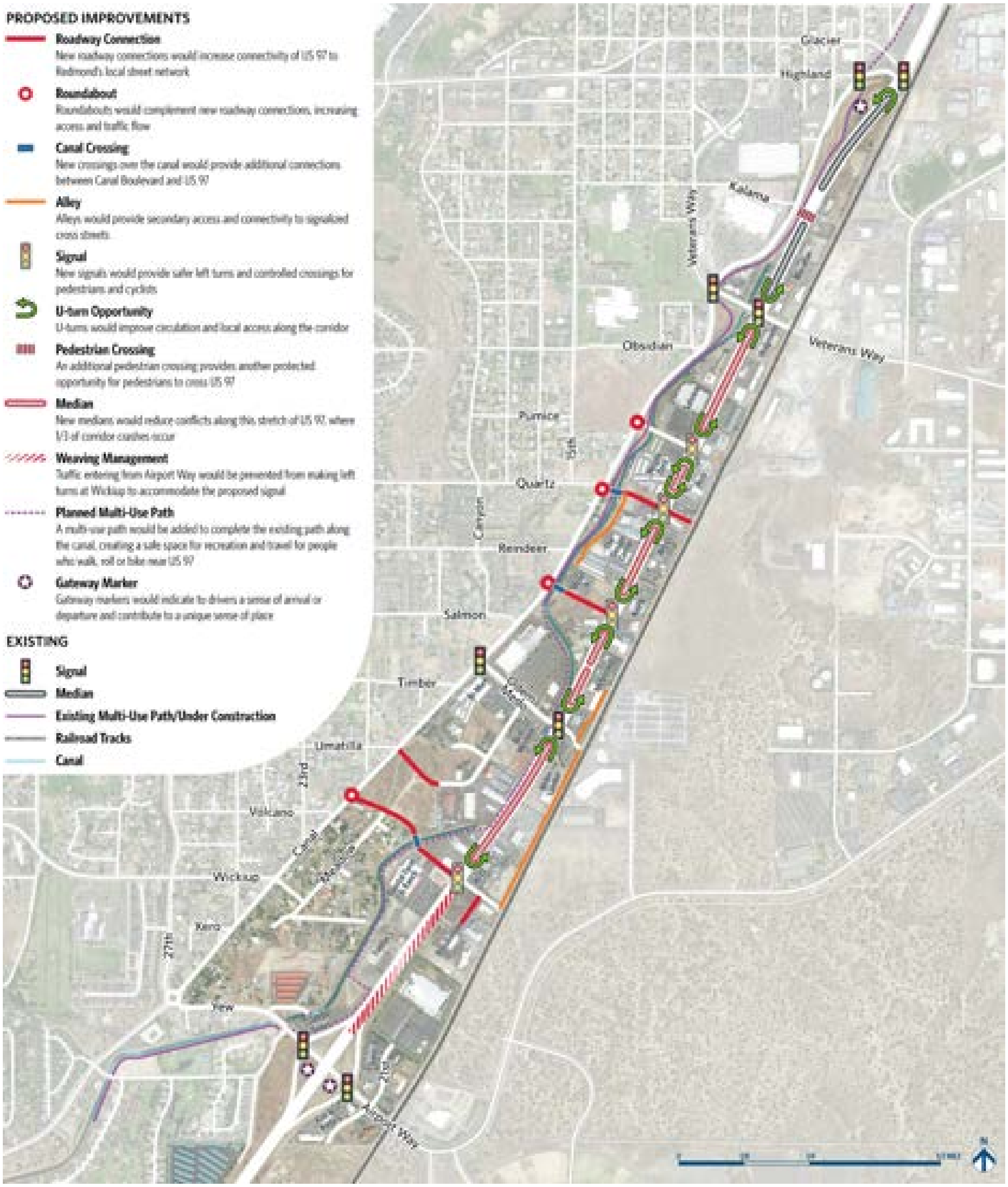


Figure 32. Scorecard Overview of Concepts

CRITERIA	CONCEPT A: Multi-Way Boulevard	CONCEPT B: Channelized Access and Circulation	CONCEPT C: Signalized Protected Access	CONCEPT D: Super Street Mobility	CONCEPT E: Recommended Concept
ROW Cost / Impact	Poor	Good	Average	Average	Good
Construction Cost	Poor	Good	Average	Average	Good
Access	Average	Poor	Average	Poor	Average
Safety	Average	Good	Good	Good	Good
Community Character*	Good	Average	Average	Poor	Average
Phaseability	Poor	Good	Good	Average	Good
Traffic Mobility	Poor	Average	Poor	Good	Average
Active Transportation	Good	Good	Good	Good	Good

Qualitative ranking: ● Poor ● Average ● Good

*Note: improvement in Community Character under all options requires the involvement of private property and/or business owners

4.3.2 US 97 SRC Streetscape

The recommended highway facility design provides opportunities for streetscape enhancements along the length of the US 97 SRC as it transitions from an urban highway setting at the north to rural at the south. The recommended streetscape improvements support several key project goals, including promoting active transportation, improving vehicular safety and access, supporting commercial businesses, and enlivening community character. These recommended streetscape improvements generally fit within the existing ROW throughout the project area.

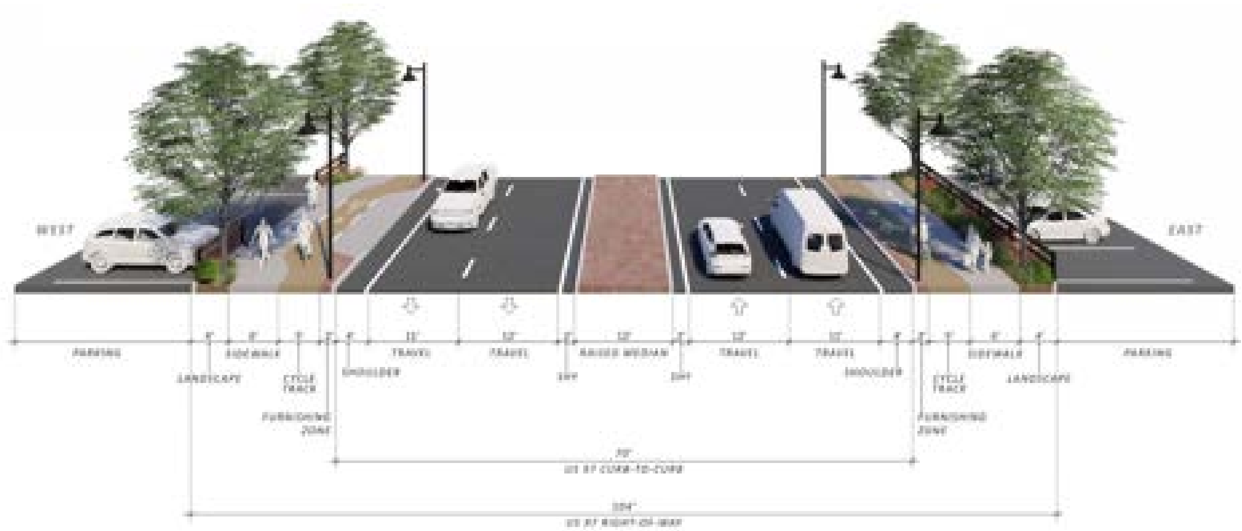
The recommended streetscape concept shown in Figures 33 - 36 uses a variety of elements to provide users with a safe and dedicated route along US 97 SRC:

- A two-foot furnishing zone with special surface materials helps physically separate the road lanes from the walking and bicycle route. The furnishing zone features pedestrian-scale, pendant street lights that reference the agricultural heritage of the community.

- A five-foot wide, one-way cycletrack (northbound on the east side; southbound on the west side), grade-separated from motor vehicle traffic.
- A six-foot wide sidewalk adjacent to the cycletrack on both sides of the street. Together, the sidewalk and cycletrack facilities provide continuous walking and biking paths along US 97 SRC to businesses, destinations, connecting side streets, and the Homestead Trail.
- Alignment shifts to the sidewalk and cycletrack at driveways to create additional safety and visibility protections. Shifting the bike/ped facilities outboard at driveways will reduce turning conflicts between cars and people walking and biking.
- A four-foot landscape zone of native plants and drought-tolerant trees. The landscape area will provide shade, screen adjacent parking lots and properties, improve the walking and biking environment, help identify driveway locations, and provide natural traffic-calming by enclosing the street environment and creating visual interest. This zone includes fencing at the back edge of the sidewalk to help enclose the street and define the boundary between right-of-way and private property. See Section 4.3.3 for a preliminary plant, materials, lighting, and furnishing palette.
- A basalt-pattern stamped concrete is recommended in the median and the furnishing zone to further enhance the streetscape by referencing both the geology of the region and elements of the Gateway designs (see Section 4.3.4).

Figure 33 illustrates the typical South Highway 97 street cross section used in the Recommended Concept showing configuration of space for walking, bicycling, landscape planting, driving, and roadway median.

Figure 33. Typical South Highway 97 Cross-Section



The furnishing zone and landscape areas illustrated in Figure 34 provide a protection buffer for people walking and biking along US 97 and enhance the overall streetscape with planting and lighting. The landscape area currently will separate people from site parking lots, but if properties redevelop, there may also be opportunities for buildings and/or outdoor plaza spaces to be located closer to the sidewalk rather than a parking lot.

Figure 34. Furnishing zone and landscape areas

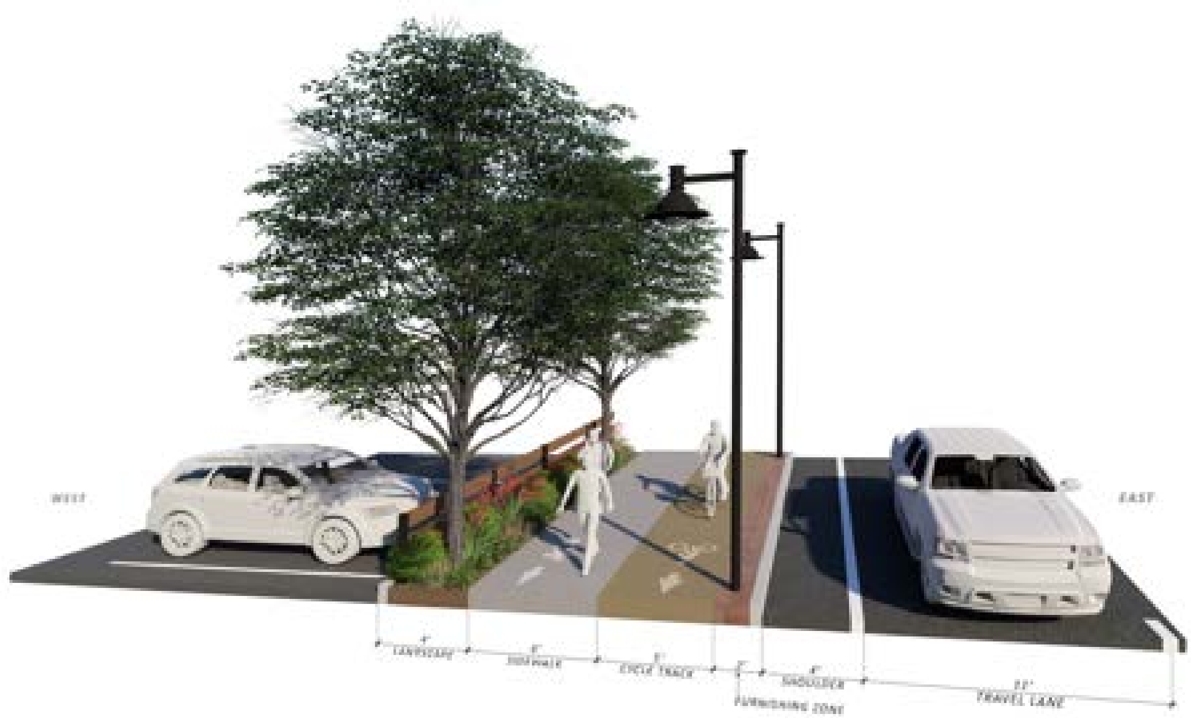


Figure 35 illustrates the roadway configuration, median and turn lane, U-turn pockets, cycletrack, sidewalk, and landscaped street edge.

Figure 35. Roadway Configuration

The overall configuration of US 97 at a typical intersection location with an east-west running street is shown below in Figure 36.

Figure 36. Typical Intersection

4.3.3 Recommended Streetscape and Landscape Materials, Furnishings, and Plant Palette

The recommended US 97 South project area streetscape is defined not only by its configuration of facilities and routes, but also by the use of regionally-appropriate surface materials, furnishings, lighting, plants, and trees to define the character and quality of the roadway.

Figure 38 shows how various materials, furnishings, and landscaping can be deliberately located along different segments of US 97 South to help define gateways, street segments, and key intersections. Figures 38 - 41 show additional detail and sample treatments that can help establish the character of the roadway.

The materials and palette used in the streetscape and landscape are intended to:

- Define spaces and locations for walking, biking, driving, and other modes;
- Provide shade and enclosure to the street;
- Calm vehicle traffic speeds;
- Highlight important character and operational locations throughout the project area;
- Use similar and complementary materials and palette – such as native plants, stone and rock, and a muted color schedule – to create relationships between the gateways and the full roadway in the project area.

Figure 37 illustrates the US 97 South Framework Diagram of project areas gateways, highway segments, and intersections. Materials and planting palettes assigned to each area help define character and varying qualities of the roadway environment as illustrated in Figures 38 - 41.

Figure 37. US 97 South Framework Diagram

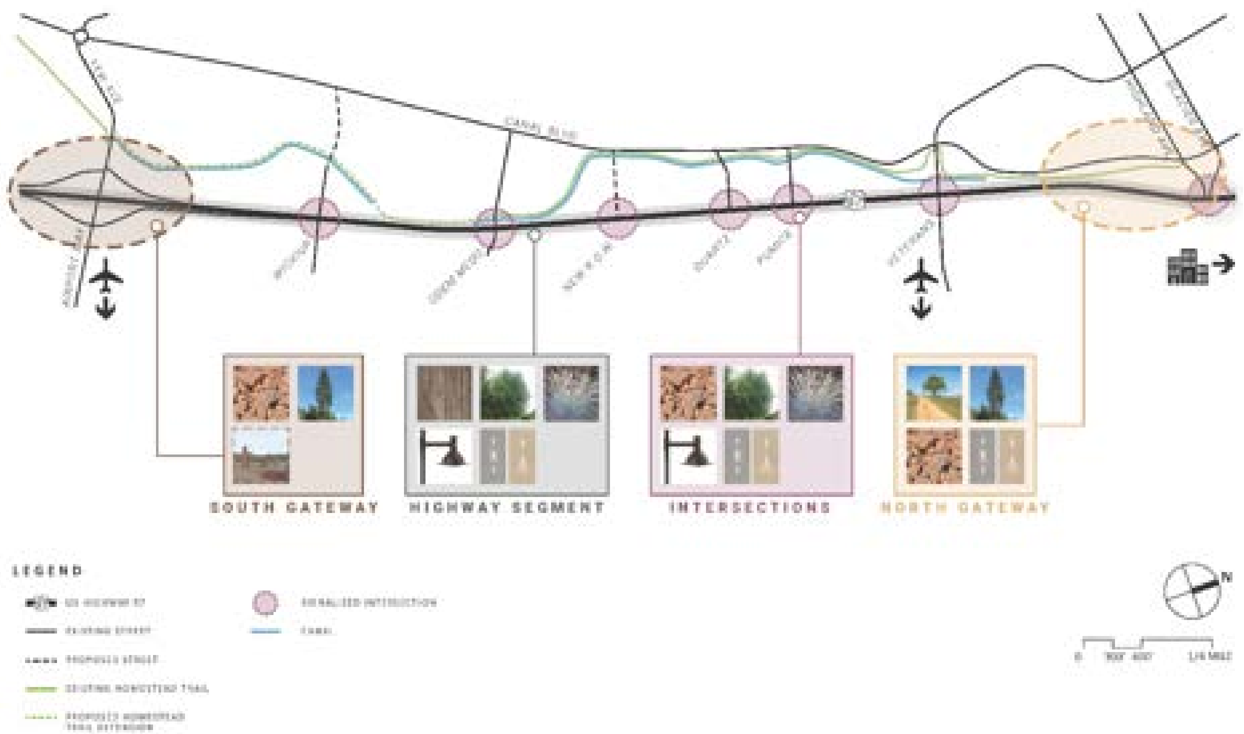


Figure 38. Materials and Furnishings Palette

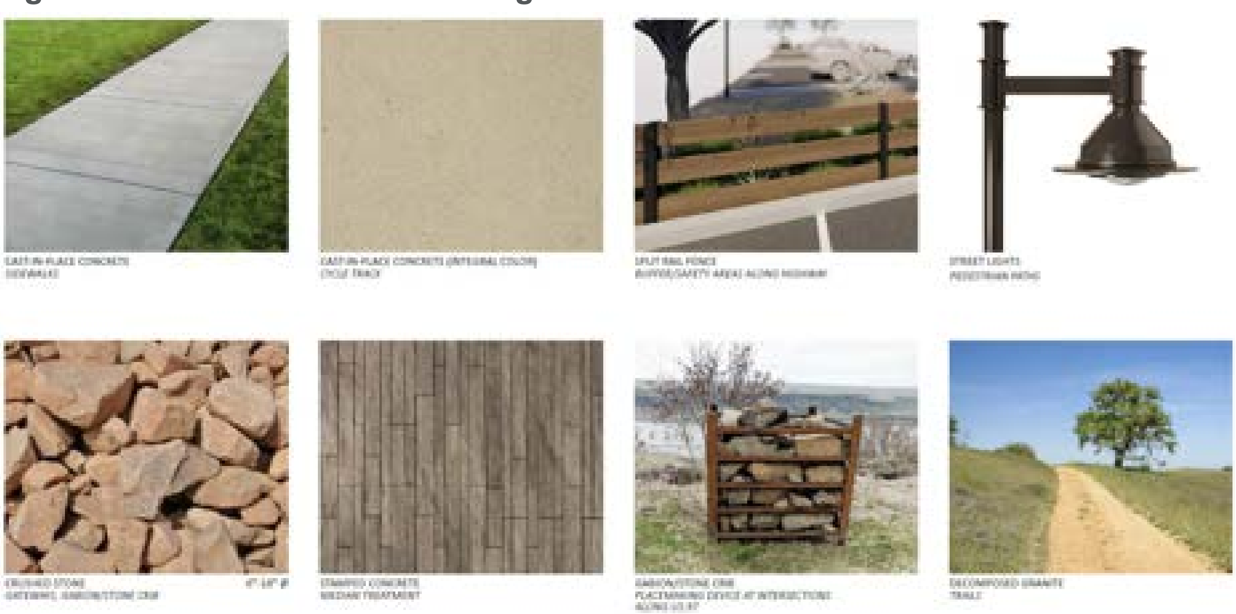


Figure 39. Plant Palette (Street Trees)

*GREENSPIRE LITTLELEAF LINDEN
TILIA CORDATA 'GREENSPIRE'

*NORTHERN RED OAK
QUERCUS RUBRA

PATRIOT ELM
ULMUS 'PATRIOT'

*= Redmond approved street tree

Figure 40. Plant Palette (Gateway Trees)

PONDEROSA PINE
PINUS PONDEROSA

EASTERN TAMARACK
LARIX LARICINA

Figure 41. Plant Palette (Understory)

4.3.4 US 97 SRC Gateway Treatments

Major opportunities for signature gateway designs exist at both the north and south ends of the US 97 SRC. The project seeks to improve these gateways both to enhance the corridor as a regional destination and to improve the corridor as a welcoming route and entryway to Downtown Redmond, local neighborhoods, the Redmond Municipal Airport, Deschutes County Fairgrounds, and areas further south in Central Oregon. The concepts shown here include some foundational improvements to the gateways that could be included as part of the corridor project, with ample opportunity for additional enhancements to be completed separately in the future.

North Gateway

The North Gateway location is the oblong-shaped, undeveloped land bound by US 97 SRC on the east, Canal Boulevard on the west, and Highland Avenue to the north. The east edge of the site contains the City's Flag Monument, which includes numerous flag poles, landscaping, and a monument wall facing US 97 SRC. The northernmost segment of the Homestead Trail was recently paved on this site running along the east side of Canal Boulevard.

The North Gateway recommendations build off these features to improve trail and path facilities, add layers of landscaping throughout the site's ridges and bowls, and make the Flag Monument a safer and more inviting local destination. Figure 42 below shows a view of the North Gateway site looking east, with US 97 SRC running left-to-right.

Recommended improvements include:

- A trailhead kiosk at the Homestead Trail near Highland Avenue.
- Enhancements to the Flag Monument, including a seating carve out and space for additional signs and plaque on the interior, west-facing side of the Monument berm.

This new view of the Monument would be accessed by a gravel trail wrapping the north and east sides of the site.

- Additional landscaping - including new trees - along the berms and trails surrounding the site. As these new trees grow over the decades, they will provide a vertical stature to the site that will help mark this gateway as a key connection point between Downtown, US 97 SRC, and the region.

These improvements will work with, and complement, “Thoughts of Flight,” the more formal, brushed stainless-steel sculpture nearby at Glacier/Highland.

Figure 42 is a concept illustration of the North Gateway, looking west with Highway 97 at the back side of the image, showing Flag Monument enhancements, new trails, and tree plantings.

Figure 42. North Gateway Concept

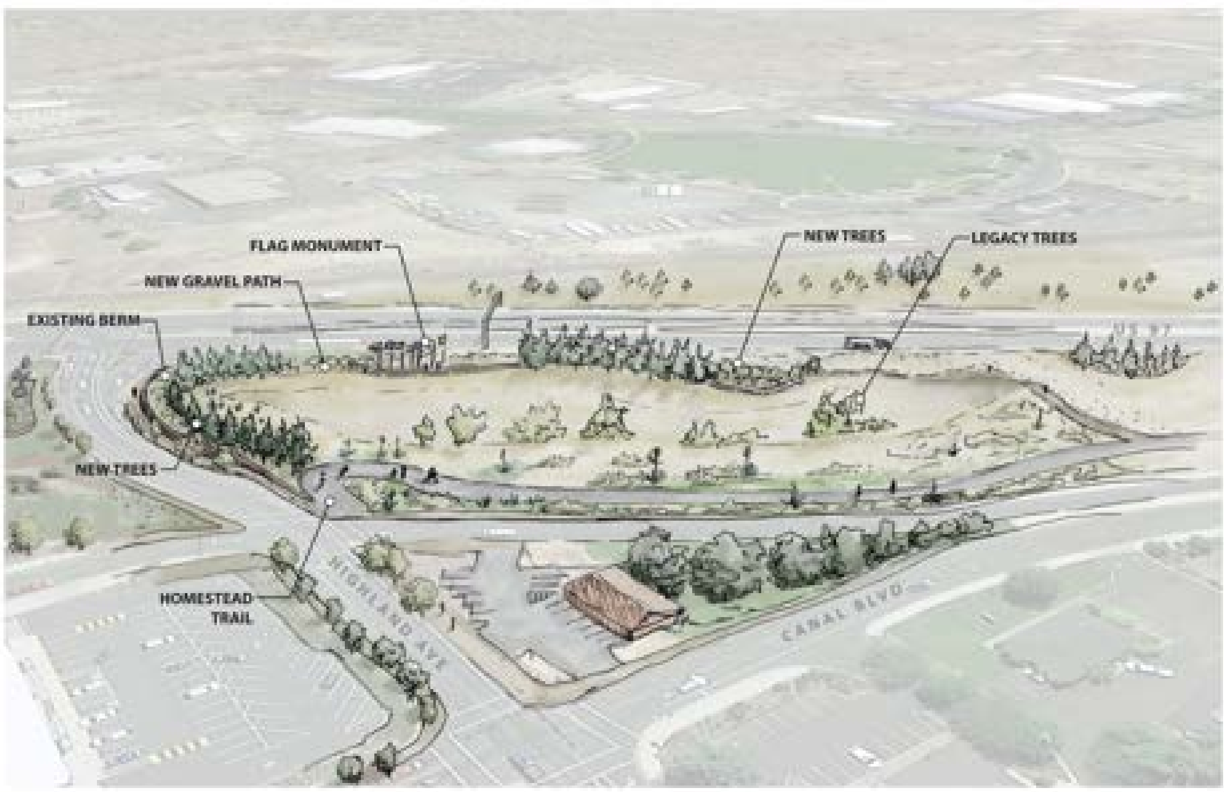


Figure 43 illustrates the North Gateway, viewed from inside the “bowl” of the site, showing the Flag Monument improvements, new trails, and seating areas.

Figure 43. Inside the North Gateway Concept

South Gateway

The South Gateway comprises the four large, triangular pieces of ROW within the US 97 SRC interchange at Airport Way and Yew Avenue. Each of these remnant wedges is nearly two acres in size, with significant berm and bowl terrain, and offers ample opportunity for large gateway features. Figure 44 depicts landscape and landform improvements that could be initiated through the corridor construction project.

Recommended improvements include:

- Large-growing native trees to add a distinct, natural, vertical element to the gateway site.
- Patterned stone mounds – referencing the region's lava flows and alluvial fans – that follow the terrain's existing ridges and bowls. The stone could be relocated excavation spoils from the road construction project, which would reflect a compelling story about the reuse of natural, regional materials, and would highlight the existing stone wall faces that were exposed during previous excavation for the interchange ramps.
- Future projects to add large-scale art and sculpture in the gateway to further define the area as an entryway to Redmond.

This location is a true, four-way gateway, marking passage not just along US 97 SRC but also east and west for travelers on Airport Way and Yew Avenue. The trees and stone-forms would take on different characteristics of scale, color, and form throughout various times of day and as people approached the gateway from different directions. The use of trees and stone is mimicked at the North Gateway as shown in Figure 45 and along the corridor streetscape through the basalt concrete pattern.

Figure 44. Southwest Gateway Concept / Rock Landforms and Tree Plantings

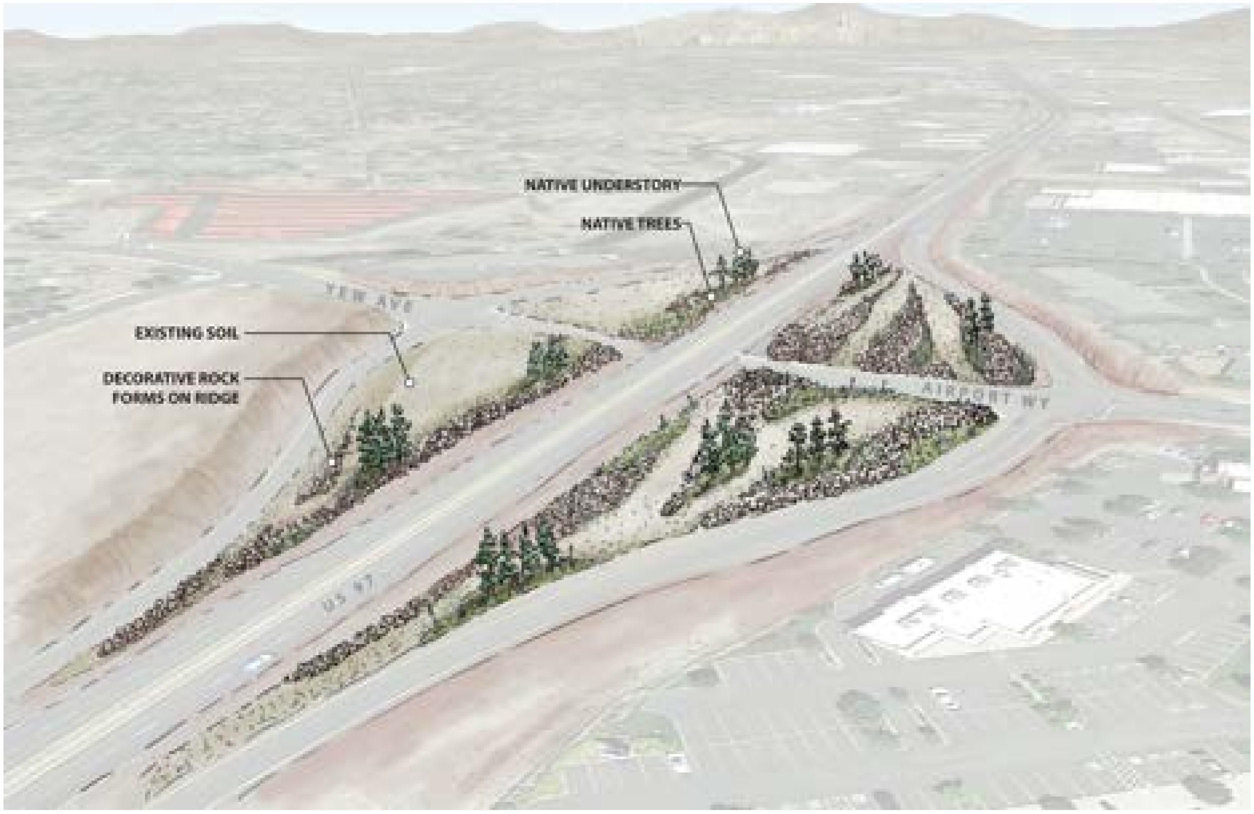


Figure 45. Southwest Gateway Concept Highway Interchange Area

5 Facility Plan

5.1 Project Purpose and Vision

The purpose of the US 97 South Redmond Corridor project is to enhance transportation safety, improve corridor travel reliability and operations, and enhance the corridor business environment through balanced transportation improvements to US 97 between Yew Avenue and the Glacier-Highland intersections. The need for the project stems from growing traffic volumes and congestion, high severity crashes in the study area and the desire to provide certainty to business and property owners in the corridor.

The framework for the US 97: South Redmond Corridor plan arose from the City of Redmond adoption of the 2014 resolution agreed to by the City and ODOT as the following vision for the corridor:

"The South US 97 Corridor is a vibrant business district that is safe and accessible to shoppers traveling by car, bus, bike or on foot. The corridor is aesthetically pleasing and provides opportunities for business and community interaction. Traffic moves efficiently and at a reasonable speed in both the north-south and east-west directions."

5.2 Policy Context

According to the Oregon Highway Plan (OHP), US 97 is a Statewide Highway, NHS Route, National Network (federally designated truck route),OHP Freight Route, Reduction Review Route (as per (Oregon Revised Statute [ORS] 366.215) and south of Yew Avenue is also an Expressway. These designations reflect the importance of US 97 to freight travel to the States of Oregon, Washington and California.

The Redmond TSP classifies US 97 as a Major Arterial, the top classification in proposed road hierarchy in the Plan. Yew Avenue and Veterans Way are classified as a Minor Arterials, SW Odem Medo Way is classified as a Major Collector, and the future Quartz Avenue is classified as a Proposed Major Collector.

The proposed improvements in the corridor are consistent with the adopted functional classifications in the Redmond TSP. As of spring 2019, there is an on-going update to the TSP, the TSP and US 97 South Redmond Corridor project teams have coordinated closely, and the US 97 South Redmond Corridor project is consistent with the current draft TSP.

The OHP also has proposed mobility targets for facilities in different classifications outlined in Table 14 Volume-to-Capacity (v/c) targets (page 84 of the OHP). The mobility target in the OHP for this facility is 0.85. All existing and future intersections meet this standard except for where alternative mobility standards are being proposed at the following locations:

- **US 97/SW Veterans Way** - proposed alternative mobility target equal to a v/c ratio of 1.0 with a peak hour factor (PHF) of 1.0 during annual average weekday traffic. This standard is not being met due to physical limitations and the incompatibility of potential solutions with current funding and planned land uses in the area. The proposed solution improves the v/c at the intersection to the maximum extent feasible with a v/c ratio of 1.06;

- **US 97/Odem Medo Way** - proposed alternative mobility target equal to a v/c ratio of 1.0 with a PHF of 1.0. This standard is not being met due to an inability to achieve the target due to physical limitations and the incompatibility of potential solutions with current funding and planned land uses in the area. The proposed solution improves the v/c at the intersection to the maximum extent feasible with a v/c ratio of 1.05;
- **US 97 NB Ramp Terminal/Yew Avenue** - proposed alternative mobility target equal to a v/c ratio of 1.0 with a PHF of 1.0. The project results in a v/c ratio at the intersection of 1.0 thus meeting the alternative mobility target; and,
- **US 97/Wickiup Avenue** - proposed alternative mobility target equal to a v/c ratio of 0.95 with a PHF of 1.0 during annual average weekday traffic. The project results in a v/c ratio at the intersection of 0.91 thus meeting the alternative mobility target.

SW Veterans Way is the most capacity constrained point on the corridor. The limited number of crossings of the BNSF railroad east of US 97 forces traffic from the employment and industrial area from the east via a limited number of crossings, resulting in heavy cross traffic. The recommended concept optimizes the intersection to the extent feasible without larger transportation system changes or more expensive grade separation options on US 97. Additional options could be considered to improve intersection performance and reduce delay at the intersection, which could include: 1) eliminating turning movements at the intersection that will route traffic to use U-turns or indirect lefts at nearby intersections, 2) grade separation of the whole intersection or certain intersection movements or 3) additional crossing of the rail line to allow for traffic volumes to be balanced across additional crossings. These solutions were considered but dismissed during this study due to the high cost of such improvements, physical limitations at the intersection, lack of support from businesses and residents, transportation safety considerations and anticipated difficulty permitting

Coordination with BNSF was conducted in the winter of 2019 with ODOT, the City of Redmond, and the City of Bend. It is likely that additional crossing closures would need to be considered to allow for an additional at-grade crossing of the rail line. The likely new BNSF railroad crossings would occur at either Quartz Avenue or SW Odem Medo Way. The SW Quartz Avenue crossing would be more effective at reducing the delay at SW Veterans Way due to the closer proximity and travel desire lines of travel crossing the corridor.

5.3 Recommended Concept

5.3.1 Concept Overview

The recommended concept introduces three new signals and introduces U-turns at each signal that reduce conflicts and movements at intersections. To make a left-turn, drivers must proceed to a designated U-turn area. The concept includes additional signals that slow traffic and offer additional safer crossing areas to connect sidewalks and multiuse paths. The recommended concept is shown in Figure 46.

Key features of this concept include:

- Three new signalized intersections along US 97 that allow protected U-turns.
- Three new road connections that cross the canal and connect US 97 to Redmond neighborhoods on the west side of US 97.
- Traffic separators between the northbound and southbound lanes on US 97 allowing protected left-hand turning movements and U-turns at signalized intersections.
- Areas for safe pedestrian refuge halfway across US 97 to enhance pedestrian crossings.
- New sidewalks and cycle track treatments throughout the length of the corridor and along east/west connecting roads to provide a more well connected active transportation network.
- These treatments will provide connections to the new, already planned shared-use path along Canal Boulevard and the canal.
- A limited number of new access roads or alleyways to provide alternative access where new connections provide safe ingress and egress nearby.

Figure 46. Recommended Concept

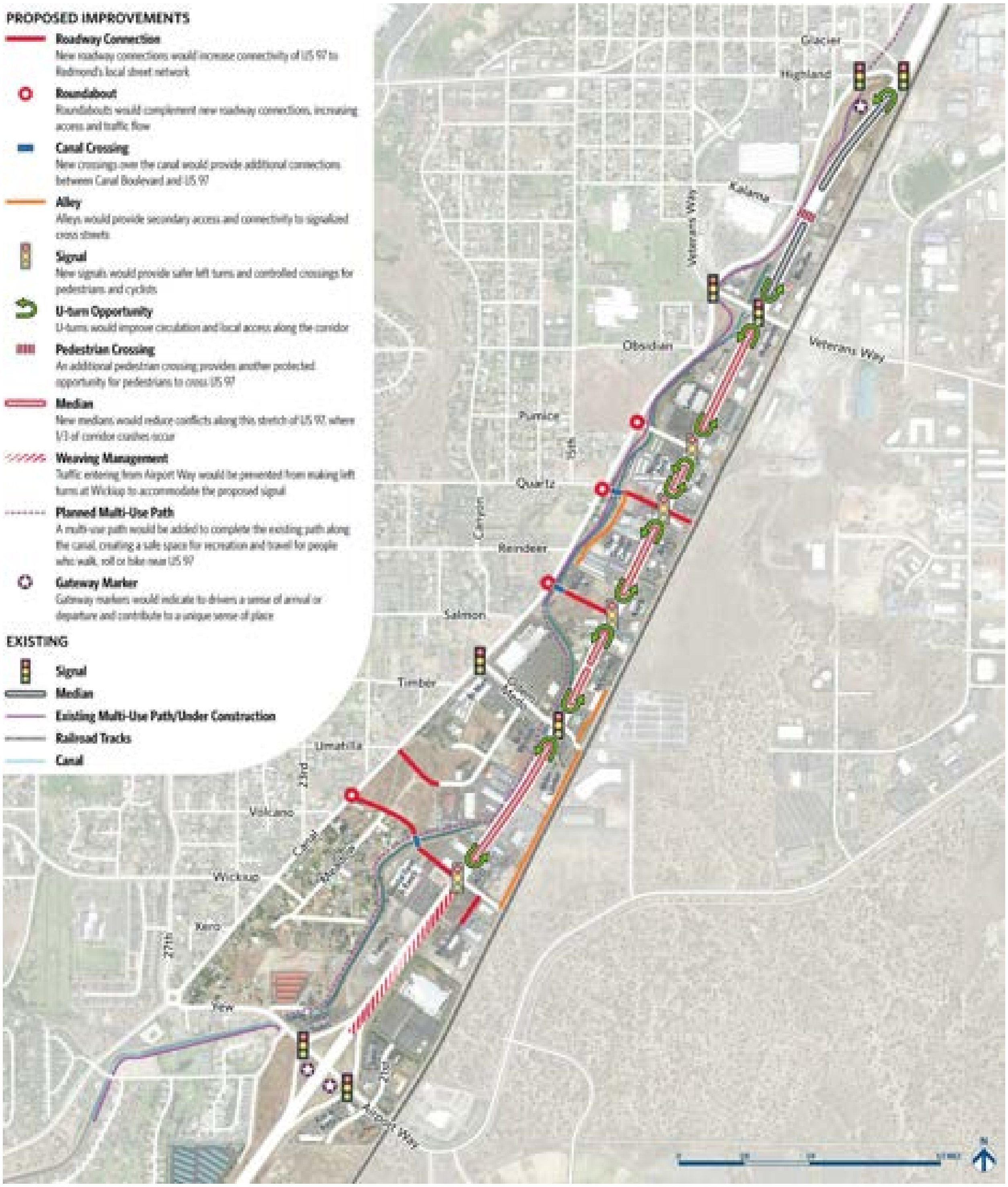
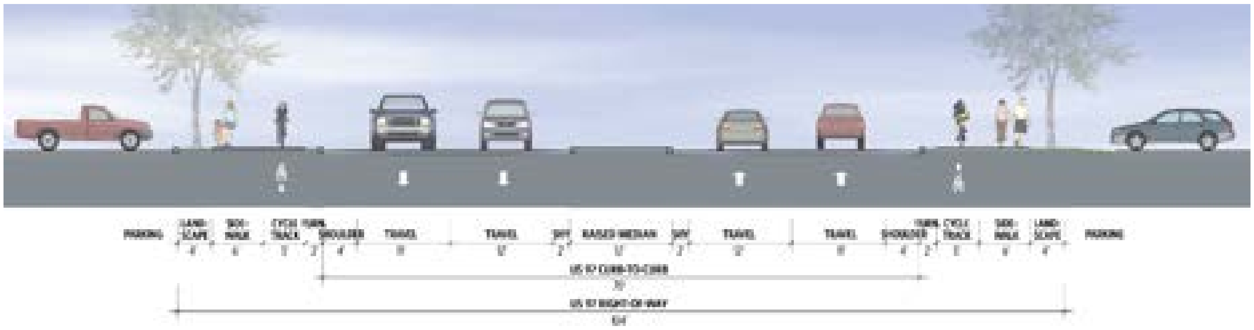


Figure 47. Recommended Concept Cross Section



5.3.2 US 97 South Redmond Corridor Gateway Treatments

Major opportunities for signature gateway designs exist at both the north and south ends of the South US 97 corridor. The project seeks to improve these gateways both to enhance the corridor as a regional destination and to improve the corridor as a welcoming route and entryway to downtown Redmond, local neighborhoods, the airport and fairgrounds, and areas further south in Central Oregon. The concepts shown here include some foundational improvements to the gateways that could be included as part of the corridor project, with ample opportunity for additional enhancements to be completed separately in the future.

North Gateway

The North Gateway location is oblong-shaped unbuilt land bound by South US 97 on the east, Canal Boulevard on the west, and Highland Avenue to the north. The east edge of the site contains the Flag Monument, which includes numerous flag poles, landscaping, and a monument wall facing South US 97. The northernmost segment of the Homestead Trail was recently paved on this site running along the east side of Canal Boulevard.

The North Gateway recommendations build off these features to improve trail and path facilities, add layers of landscaping throughout the ridges and bowls of the sites, and make the Flag Monument a safer and more inviting city destination. Figure 48 below shows a view of the North Gateway site looking east, with South US 97 at the back side of the gateway.

Proposed improvements include:

- A **trailhead kiosk** at the Homestead Trail near Highland Avenue
- Enhancements to the **Flag Monument**, including a seating carve out and space for additional signs and plaque on the interior, west-facing side of the Monument berm. This new view of the Monument would be accessed by a new gravel trail wrapping the north and east sides of the site.
- Additional **landscaping** - including new trees - along the berms and trails surrounding the site. As these new trees grow over the decades, they will provide a vertical stature to the site that helps mark this gateway as a key connection point between downtown, South US 97, and the region.

These improvements will work with, and complement, the more formal brushed stainless-steel sculpture nearby at Glacier/Highland (*Thoughts of Flight* by Jerry Werner).

Figure 48. Concept illustration of the North Gateway

South Gateway

The South Gateway comprises the four large triangular remnant parcels within the South US 97 interchange at Airport Way and Yew Avenue. These triangle wedges are nearly two acres in size each, with significant berm and bowl terrain, and offer ample opportunity for large gateway features. Figure 49 depicts landscape and landform improvements that could be initiated through the corridor construction project.

Proposed improvements include:

- Large-growing **native trees** to add a distinct natural, vertical element to the gateway site.
- Shaped **stones mounds and berms** following the existing ridges and bowls of the terrain. The stone could be relocated excavation spoils from the road construction project and would reflect a compelling story about the reuse of natural, regional materials, and would highlight the existing stone wall faces that were exposed during previous excavation for the interchange ramps.
- Future projects to add large-scale **art and sculpture** in the gateway to further define the area as an entryway to Redmond.

This location is a true four-way gateway, marking passage not just along South US 97 but also east and west for travelers on Airport Way and Yew Avenue. The trees and stone-forms would take on different characteristics of scale, color, and form throughout various times of day and as people approached the gateway from different locations. The use of trees and stone is mimicked at the North Gateway and along the corridor streetscape through the basalt concrete pattern.

Figure 49. Concept illustration of the South Gateway

5.3.3 US 97 South Redmond Corridor Streetscape

The recommended highway facility design provides opportunities for streetscape enhancements along the length of the South US 97 corridor as it transitions from an urban highway setting at the north to rural at the south. The streetscape improvements support several key project goals, including promoting active transportation, improving vehicular safety and access, and enlivening community character. Additionally, these recommended streetscape improvements generally fit within the existing right-of-way (ROW) throughout the project area.

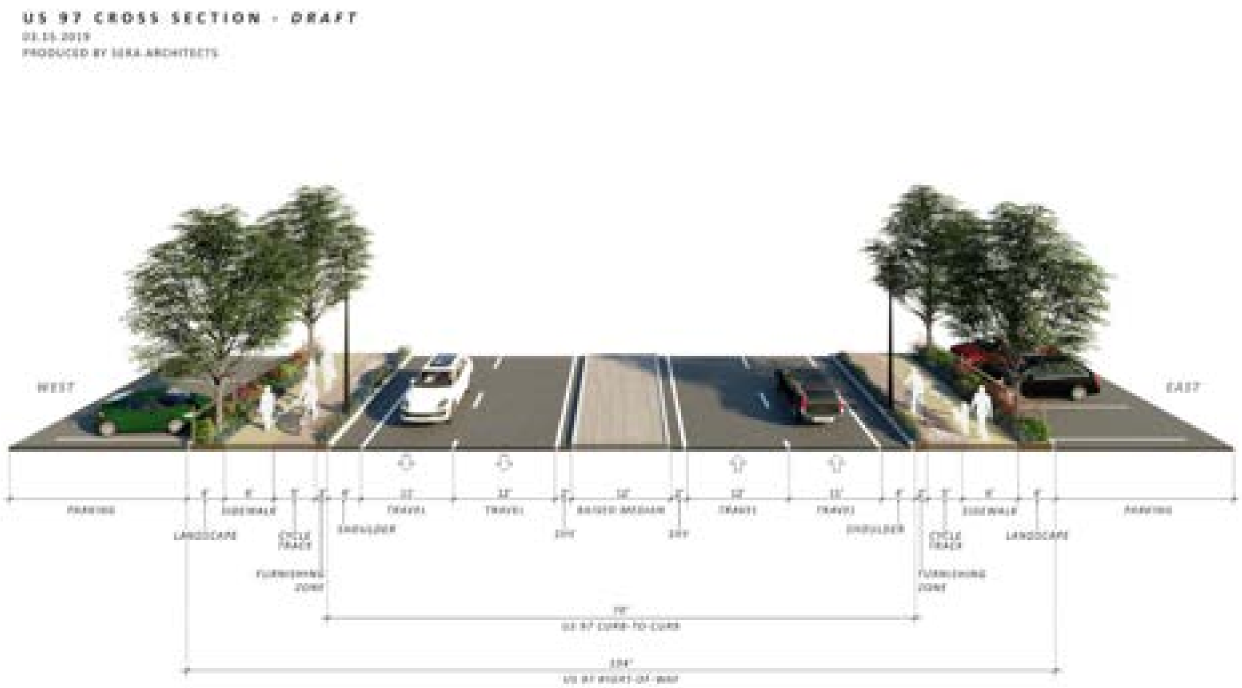
The streetscape concept uses a variety of elements to provide users with a safe and dedicated route along South US 97:

- A two-foot **furnishing zone** contains hearty native plantings to help physically separate the road lanes from the walking and bicycle route. The furnishing zone also features pedestrian-scale, pendant street lights that reference the agricultural heritage of the community.
- A five-foot wide, one-way, grade-separated **cycletrack** (northbound on the east side; southbound on the west side) with special pavement markings at driveways and intersections to help warn of crossing conflicts.
- A six-foot wide **sidewalk** sits next to the cycletrack on both sides of the street. Together, the sidewalk and cycletrack facilities provide continuous walking and biking paths along South US 97 to businesses and destinations and connecting to side streets and the Homestead Trail.
- A four-foot **landscape zone** of native plants and drought-tolerant trees. The landscape area provides shade, screens adjacent parking lots and properties, improves the walking and biking environment, helps identify driveway locations, and

provides natural traffic-calming by enclosing the street environment and creating visual interest. This zone includes split-rail fencing at the back edge of the sidewalk to help enclose the street and separate right-of-way from properties.

A basalt-pattern stamped concrete is used in the median and selectively in the furnishing zone to further excite the streetscape by recalling both the geology of the region and elements of the Gateway designs.

Figure 50. Typical South Highway 97 street cross section



5.4 US 97 South Redmond Concept Phasing and Cost

The recommended concept has an estimated cost of approximately $55,000,000. The cost estimate is based on industry standards for development of planning-level estimates, using historical bid information from recently constructed ODOT projects. It includes a combination of the costs that are measurable at the current level of design, including paving materials (asphalt, aggregate base), sidewalks, curbs, retaining walls, traffic signal systems and stormwater facilities. At this planning level, a stormwater analysis has not been completed, so the quantity and costs of the stormwater facilities was calculated using the length and width of the project and assumed a quantity of structures and length of pipe based on standard practice for collecting and treating surface water in Central Oregon. Assumptions were made on type, size and location of retaining walls, as the cost of retaining walls is greatly impacted by the height and type of wall, which is also dictated by location and right-of-way space available. This project will include the acquisition of ROW, which has been included in this estimate. The need for ROW includes cost for the physical land that will be acquired at $15 per square foot, in addition to a cost to complete the appraisal and acquisition process at $15,000 for each impacted property.

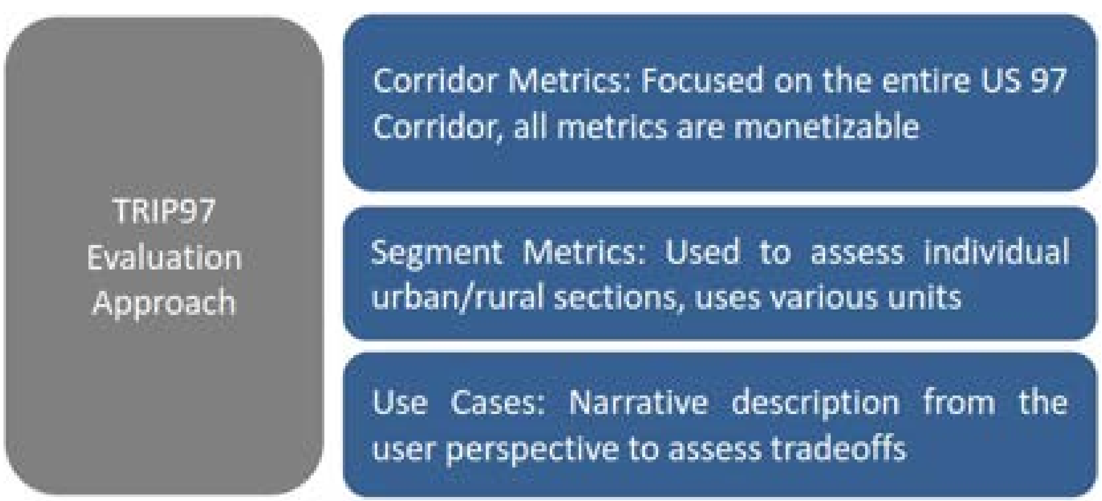
In addition to the measurable costs, the estimate also includes services required for construction of the project, including design-engineering fees, engineering support during construction, and services that will be provided by the contractor including mobilization, construction survey, and temporary control of traffic. These costs are derived based on a percentage of the total material costs (the measurable costs as discussed above), a typical process in development of engineering estimates.

Project phasing is a critical component of the plan. There are several logical segments to building out the recommended concept. Generally, ROW for the project, where needed, can be acquired over time through a ROW dedication process concurrent with obtaining permits through the City of Redmond at the time of redevelopment. If only partial funding is available, logical termini would include building out between signalized intersections. U-turns at the intersections should be built concurrent with implementation of the center median to ensure that adequate access can be provided. Similarly, the additional connections between SW Canal Blvd and US 97 should be implemented at the time when those intersections are constructed, although they could be constructed as a first stage to provide additional travel options while US 97 is being reconstructed.

5.4.1 TRIP97 Evaluation

The plan establishes an evaluation approach for how the performance measures are analyzed and how the results of that analysis are combined and summarized into meaningful direction for transportation investment and decision-making. The intent of this evaluation approach is to ensure the results can inform decision-makers as to which projects provide the greatest return on investment. Figure 51 provides the TRIP97 Evaluation Approach Overview.

Figure 51. TRIP97 Evaluation Approach Overview



For this evaluation, an urban segment-level analysis methodology will be used. The segment performance measures consider the operations of specific sections of the corridor and provide more detail with an emphasis on management goals within the segment.

Performance Measures

Performance measures are indicators of how the transportation system is operating, and collectively they represent how well a proposed strategy satisfies goals. The TRIP97 methodology establishes the link between goal areas and the performance measures, and how each measure is derived. The selected Urban Segment performance measures and goals are outlined in Table 15.

Table 15. Applied Urban Segment Selected Performance Measures

Goal Area	Performance Measure Applied
Mobility	• Average Travel Time • Travel Time Reliability • Side-Street Delay
Safety	• Predicted Crash Frequency and Severity
Network Redundancy	• Percent of north-south travel on US 97
Accessibility	• Public street turning movement opportunities per mile
Travel Options	• Multimodal Level of Service

Performance measures are selected based on their ability to independently assess the different goal areas that were identified. However, it is important to note that each of the performance measures do correlate with one another although they address different goal areas. Table 16 provides a brief description of each performance measure and proposed evaluation tools.

Table 16. Summary of Corridor Performance Measure Analysis Methods and Outputs

Performance Measure	Evaluation Tool	Output for Analysis	Comments
Average Travel Time	HERS-ST – used by ODOT to derive performance measures for average travel time	Average Annual PM peak period Directional Travel Time (minutes)	The consultant team will provide data inputs for the HER-ST tool to ODOT's TPAU.[2] TPAU will complete analysis and provide results.
Travel Time Reliability	HERS-ST - used by ODOT to derive performance measures for average travel time	Directional Travel Time Standard Deviation during the weekday PM peak period (minutes)	The consultant team will provide data inputs for the HER-ST tool to ODOT's TPAU.[2] TPAU will complete analysis and provide results.
Side Street Delay	Corridor Vissim model	Weighted Measured Average Delay (seconds)	The result of this analysis is a weighted sum of side-street delay based on total side-street delay and side-street volume. The result is a singular delay number.
Predicted Crashes	Highway Safety Manual	Expected crashes by severity	This metric focuses on expected crashes which are informed by predicted and observed crashes. Crash severity (severe injury/fatal and property damage only further influence this metric.
Percent of N-S Traffic on US 97	Travel Demand Model	Percent travel on US 97	This method is designed to determine how the highway is being utilized for regional or local travel. If local alternatives are available, more travel will likely occur on the local street network for north-south movements.
Turning Movement Opportunities per Mile	Turning Movement Index Approach	Turning Movement Index Score	The method presented for calculating this metric is intended to provide an evaluation of the public street connectivity to US 97.
Multimodal Level of Service	HCM2010	MMLOS Index Score for each of the pedestrian, bicycle, and transit modes.	These methods are consistent with the HCM2010.

5.4.2 Project Benefits

The US 97 South Redmond Corridor project developed goals, objectives and evaluation criteria. These goals, objectives and evaluation criteria were adopted by each of our committees to help guide project design decisions. The recommended concept provided the optimum balance of these criteria. The project benefits include:

- **Improved corridor travel times and travel time reliability**. It is anticipated southbound travel times on US 97 will experience a 9 percent reduction, while northbound travel times will see a 30 percent reduction.

[2] Transportation Planning Analysis Unit

- **Reduced delay at project area intersections**. All intersections will operate with less delay, but for the intersection at Veterans Way and Canal Boulevard that experiences a slight increase. Overall, the study area operates with less delay to the travelling public.
- **Improved safety performance in the study area**. The recommended concept will reduce crash severity, greatly reduce risky driving maneuvers, and increase the safety and comfort of bicycles and pedestrians.
- **Increased connectivity to the neighborhoods**. The added connections at Wickiup Avenue, Reindeer-Salmon Avenue and Quartz Avenue will improve business access from the neighborhoods, reduce reliance on US 97 for local trips, increase multi-modal access to the corridor and provide additional travel options during weather or crash events for all travelers.
- **Provide a unique experience for travelers on the corridor including gateway treatments and streetscape design that will create a vibrant business district**. The proposed trees behind the sidewalk, consistent design elements and application of natural, low maintenance roadside treatments will enhance both the travel and business experience in South Redmond.

Appendix A US97 SRC Traffic Volume Forecasts Memorandum

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TECHNICAL MEMORANDUM

DATE: September 6, 2019

TO: Project Team and Stakeholders

FROM: John Bosket, PE; Aaron Berger, PE; Dock Rosenthal, EIT

SUBJECT: US 97 Redmond South Corridor Area Facility Plan
Traffic Volume Forecasts

This memorandum describes the process followed for forecasting future traffic volumes in the US 97 Redmond study corridor for the year 2040 and the traffic volumes resulting from that process. The Origin-Destination matrix developed in this process was used to forecast future traffic volumes in the No-Build and Build condition road networks. This memorandum provides more detail into the windowed subarea travel demand modeling process outlined in the "Traffic Volume Modeling Methodology Memo" for this project.

EXECUTIVE SUMMARY

Future traffic volumes for the year 2040 were forecast for the No-Build and Build conditions based on a windowed subarea model of the regional Bend-Redmond Model (BRM). The windowed subarea modeling approach provides more sensitivity to local traffic control and circulation changes and allowed for the ability to better estimate changes in travel patterns associated with new traffic signals, roundabouts, street connections, and local access changes. The same demand matrix was used for analysis of the No-Build and Build models.

Most of the land use growth in the study area forecast by the year 2040 is related to employment (i.e., commercial and industrial businesses), with a net increase of about 700 workers in the areas immediately adjacent to US 97 (a 97% increase over 2010). The distribution of this employment growth varies along the corridor, ranging from slight decreases in some mostly built out areas to substantial increases at the southern end of the corridor where new development is expected on vacant parcels. The employment growth coupled with housing growth elsewhere in the City of Redmond and regional travel growth on US 97 will increase traffic activity, with average daily traffic volumes increasing from approximately 28,000 vehicles in 2017 to approximately 36,000 vehicles in 2040. This corresponds to an average annual growth rate of 1.24%.

The 2040 No-Build network included one new street connection: the Quartz Avenue extension between Canal Boulevard and US 97. This new facility provided a more direct connection for

some trips within the study area. The diversion created by the Quartz Avenue extension resulted in future traffic volume forecasts that were lower than the existing traffic counts at intersections as listed below:

- US 97 & Odem Medo Way eastbound left movement
- Canal Boulevard & Quartz Avenue northbound through, eastbound left, eastbound right and southbound right movements
- Canal Boulevard & Pumice Avenue northbound through, northbound right, and westbound left movements
- US 97 & Pumice Avenue eastbound left and eastbound right movements
- Canal Boulevard & Veterans Way northbound left, northbound through, northbound right, and southbound left movements
- US 97 & Veterans Way eastbound left and eastbound right movements

The 2040 Build network included new traffic signals on US 97, new roundabouts on Canal Boulevard, and three additional connections between Canal Boulevard and US 97 at Wickiup Avenue, Umatilla Avenue, and a connection between Reindeer Avenue and Salmon Avenue. These new connections and intersection traffic controls cause changes in trip routing that moves trips move off US 97. In addition, travel demand on existing connections between Canal Boulevard and US 97 is redistributed across the new street extensions, decreasing trips on existing east-west connections compared to the No-Build scenario. The most significant traffic volume changes on the study area street network caused by the Build scenario are described below.

Volume Increases:

- Eastbound and westbound Quartz Avenue – Southbound to westbound demand from US 97 shifts to westbound Quartz Avenue instead of using Veterans Way. This shift is likely due to reduced intersection delay caused by the construction of a roundabout at the intersection of Quartz Avenue and Canal Boulevard (in contrast with No-Build). This reduced delay coupled with additional signals along US 97 results in a faster travel time for these vehicles. Eastbound Quartz Avenue also attracts additional trips headed to northbound US 97.
- Eastbound and Westbound connection between Reindeer Avenue and Salmon Avenue – The westbound connection primarily attracts northbound US 97 trips headed west to Salmon Avenue. The eastbound connection primarily attracts northbound trips from Canal Boulevard headed to northbound US 97. This connection in the central area of the US 97 corridor provides a more direct route for vehicles from Salmon Avenue that

previously accessed US 97 via Odem Medo Way or Quartz Avenue in the No-Build network.

- Eastbound and westbound Umatilla Avenue – Westbound Umatilla Avenue serves as a cut-through route from US 97 via Odem Medo Way to Canal Boulevard. The reduction of eastbound volume along Odem Medo Way makes the unsignalized left turn accessing this cut-through route a faster option compared with the signal at Odem Medo Way and Canal Boulevard. Eastbound Umatilla Avenue also serves as access to the adjacent commercial properties. With no left northbound left turn allowed the intersection with US 97 vehicles headed to those properties either turn left at Wickiup Avenue to access via Quartz Boulevard or make a U-turn at Odem Medo Way.
- Westbound Wickiup Avenue – Serves northbound US 97 traffic headed to local destinations along Canal Boulevard. This new connection serves volume that formerly traveled further north on US 97 and turned at Odem Medo Way.

Volume Decreases:

- Eastbound and westbound Odem Medo Way – Volume on this link decreases significantly because of the new east-west connections. In the No-Build network, Odem Medo Way provides the main east-west connection in the southern portion of the US 97 corridor. With additional connections at Wickiup Avenue and Umatilla Avenue, the volume is more evenly distributed on these other routes.
- US 97/ Yew Avenue southbound off-ramp – With connections available at Wickiup Avenue and Umatilla Avenue to the north, volume on the US 97/ Yew Avenue southbound off-ramp headed to northbound Canal Boulevard decreases in the Build scenario. This volume is headed west and the new connections provide a more direct route for these vehicles' ultimate destinations.
- US 97 southbound – Additional delay from signals along US 97 makes the southbound travel time along Airport Way a faster path for regional trips headed south from OR 126. Improved street connectivity between US 97 and Canal Boulevard allows some trips to leave the highway sooner, leading to further reductions in volume.

In general, the new traffic signals on US 97 increase delay, while the new street connections reduce trip lengths for drivers coming from and going to Canal Boulevard. This results in a reduction of volume along US 97 as trips shift to the new connections that provide faster and more direct access to drivers' ultimate destinations.

The types of trips using the US 97 corridor were sampled between Glacier Avenue/Highland Avenue and Yew Avenue in the No-Build and Build networks. Trips beginning (entering the subarea network) or ending (leaving the subarea network) at driveways along US 97 were classified as "access" trips. Those beginning and/or ending at other external roads, such as

Canal Boulevard or Veterans Way, using US 97 for a portion of the trip, but not accessing any business along US 97, are classified as “local”. Those trips driving through the study area on US 97, without stopping, are classified as “regional”.

A comparison between No-Build and Build showed that all traffic volumes along US 97 reduce by approximately 6% in the Build network. Looking at specific trip types, regional trip volumes remain identical in the two networks. Intuitively, these long-distance, through trips will continue to use US 97 as it provides the most direct route. The volume reduction along US 97 in the Build network results from lower relative volumes of local and access trips. The same trips are still being made in the Build network, however, they are leaving US 97 earlier and using new connections to avoid congestion and reach their destination faster. More information about the impact to access trips from the Build network changes can be found in the Existing Access Conditions Technical Memorandum.

INTRODUCTION

The overall model process is shown below. Further detail into each step of the process is provided in the subsequent sections.

MODELING APPROACH

This section provides an overview of the modeling approach used for this analysis. More detailed information can be found in the Traffic Volume Modeling Methodology Memorandum.

The 2010 Bend-Redmond (BRM) regional travel demand model was used as a basis for this analysis. A windowed subarea was created from this regional model for the corridor of US 97 contained within OR 126, Veterans Way, and Airport Way to the east, Evergreen Avenue to the north, 11th Street, Veterans Way, and Canal Boulevard to the west and Yew Avenue and Airport Way to the south.

The windowed approach typically holds volumes constant at the boundaries for consistency with the larger regional model while adding street network density to achieve a more detailed model of local circulation. In this case, the street network density was increased by adding all the driveway access points that are located within the US 97 corridor.

Extract 2010 Subarea Demand

The year 2010 demand was extracted from the 2010 BRM Emme model for the windowed subarea containing the study area. This demand was then imported as a matrix into the detailed Visum network for the windowed subarea. This step resulted in an uncalibrated 2010 average weekday subarea model.

Land Use and Demand Refinements

The next step in the modeling process focused on filling in the gaps in the model data between the BRM base year (2010) and the windowed subarea base year (2017). As expected, some Traffic Analysis Zone's (TAZ's) from the 2010 base year model did not reflect existing development in 2017. Therefore, prior to any interpolation to reach a year 2017 estimate, the following adjustments were added or subtracted from the 2010 demand to help develop a reasonable Origin-Destination (O-D) distribution for 2017.

A BRM TAZ between Veterans Way and Canal Boulevard now includes a home improvement store that was not constructed in 2010 and therefore is not included in the base year demand matrix, which models the TAZ as nearly vacant. For this TAZ, the 2017 (existing) land use was calculated based on a similar TAZ in the Bend area of the regional model, using a linear regression of regional model data to estimate the 2017 demand. This demand adjustment was added to the 2010 demand as part of the 2010 to 2017 demand adjustment process. This change was only made to develop the 2017 calibrated windowed subarea model, as the BRM 2040 land use data contained reasonable land use for this specific TAZ.

Another BRM TAZ contained an overestimate of existing employment for 2010 (but not 2040) due to the presence of the school district administration office. All school district employment was associated with the district office address in the 2010 land use dataset, leading to the TAZ employment overestimate. This overestimate was corrected using a linear regression equation developed from existing BRM model land use and re-calculating the base year demand for this TAZ based on school district office employment information from the 2040 land use.

External TAZ's are zones that access roads outside of the study area boundary and are included in a model to provide a link to the larger region outside of the model boundary. Demand accessing the external zone at SW Juniper Avenue and SW 11th Street was adjusted to correct the vehicles that were routing through the model. SW 11th Street is a one-way southbound link but is coded as a two-way connection in the regional model. The regional impact of this error is insignificant but in the more refined subarea model (with 11th Street coded as a one-way road) the discrepancy was resulting in significant volume looping through 9th Street to Glacier Avenue to access 11th Street southbound. To correct this issue the demand accessing SW Juniper and SW 11th Street was shifted south, shifting demand to the left at SW Kalama Avenue and bypassing the loop from 9th Street to 11th Street.

Estimate 2017 Demand and Seasonal Adjustment

Significant growth has occurred in the model area since the 2010 base year and therefore the initial model assignments were well below actual 2017 traffic counts. To develop a more reasonable 2017 demand, a demand matrix was extracted from the 2040 BRM model. The 2040 and 2010 matrices were linearly interpolated to generate an estimated 2017 demand.

As the BRM is an average weekday model, the 2017 counts were also seasonally factored to an average weekday. As the counts were collected in June, the seasonal adjustment factor (based off Automatic Traffic Recorders (ATR) located along US 97 in the Redmond area) was 0.91, or 91% of the 2017 counts. The average weekday on the corridor represents typically April/October conditions.

Origin-Destination Matrix Estimation Adjustments

Following the 2017 demand estimation, the assigned windowed subarea model volumes were closer to the seasonally adjusted average weekday count totals, but significant discrepancies remained, with differences ranging between 300 and 500 vehicles for through movements on US 97 and up to 150 vehicles for turning movements. To correct for these discrepancies a demand matrix correction procedure was run using the TFlowFuzzy Origin-Destination Matrix Estimation (ODME) tool in Visum. The ODME adjustments were saved in a trip adjustment matrix, representing the inherent O-D distributive differences between the BRM demand, which is calibrated to link volumes on higher classification streets, and the windowed subarea demand, which is calibrated to turns volumes in a much smaller area with more network detail. Therefore, this demand correction trip matrix was also applied to the 2040 data extracted from the BRM model.

US 97 Driveway TAZ and Pass-By Trip Adjustments

Travel demand in the BRM entering and exiting US 97 was low compared to the driveway counts, as the BRM models pass-by trips as through trips. Count volumes into and out of all zones along US 97 were approximately 150 higher than the assigned volume from the calibrated 2017 demand matrix. Therefore, these additional trips entering and exiting US 97 TAZs were assumed to be pass-by trips, allowing a demand pairs to be split into two demand pairs (the original origin zone to a US 97 driveway and the US 97 driveway to the original destination zone) without influencing the trip generation basis for the model. Movement volumes from major origins and destinations to the north and south corridor were calculated using screenlines. The pass-by trip volume was calculated from the difference between the counted and assigned volume into or out of the zones along US 97. This fixed pass-by adjustment was also applied to the future year demand matrix.

2017 Subarea Model Calibration and Validation

Demand matrix circulation within the subarea was calibrated to match counted traffic volumes. Modeled traffic volumes were compared to counted and seasonally factored volumes obtained for the major intersections in the model area. One tool used in the calibration process was adjusting the delay incurred by traffic control devices, specifically traffic signals. Signals in the study area use SCATS, an adaptive timing system. The subarea modeling tool can use green time data from the signal timing to generate a more intelligent traffic assignment but cannot replicate the flexibility of an adaptive system. Therefore, the initial model runs used fixed cycles from the base SCATS timing provided by ODOT. Some of the modeled routes deviated from the actual routes used (e.g., traffic using local streets rather than arterials). The green time allocated to problematic movements was adjusted to create more or alleviate delay and therefore adjust the route selection within the model.

Model circulation is also influenced by segment speed. Model speeds were inventoried from speed limits identified through field work and modeled appropriately. When certain routes attracted a disproportionate share of the volume and intersection signal delay was reasonable, particularly in the downtown grid network, link speeds were adjusted based on roadway characteristic (neighborhood streets, downtown streets with lots for parking activity, higher than posted prevailing speeds on mainline links, etc.) to shift that volume back to the preferred path based on count information. Table 1 identifies the locations where link speed in the windowed subarea model deviates from that in the regional model.

Table 1: Link Speed Deviations between US 97 Subarea Model and Bend-Redmond Model

Road	From	To	Subarea Model Speed (MPH)	Bend-Redmond Model Speed (MPH)
SW Highland Ave	SW 11th St	SW 6th St	30	25
SW Veterans Wy	US 97	SW Highland	35	30
SW Kalama Ave	SW Veterans Wy	SW Canal Blvd	35	20-25
SW Canal Blvd	SW Pumice Dr	SW 6th St Fork	35	30
SW 6th St	SW Highland Ave	SW Evergreen Ave	20	25-35
SW 5th St	SW Highland Ave	SW Evergreen Ave	20	25-35
SW Evergreen Ave	SW 11th St	SW 6th St	25	20
US 97	SW Glacier/ SW Highland	SW Evergreen Ave	50	45
US 97	SW Wickiup	SW Veterans	40	45
US 97	Yew Ave North Ramps	SW Wickiup	50	55
Pumice Ave	SW Canal Blvd	US 97	20	30
SW Odem Medo Way	SW Canal Blvd	US 97	35	25

2040 Horizon Year

The 2040 horizon year subarea demand matrix was calculated from the extracted Bend-Redmond model 2040 demand matrix, the ODME demand correction adjustments, and the pass-by adjustment matrix. The two adjustment matrices were identical to those used to calibrate the 2017 subarea model demand matrix. Future 2040 Average Weekday turn volumes at the study intersections were post-processed from the windowed subarea model link volumes and the seasonally adjusted average weekday counts using NCHRP 765 methodology. The forecasted 2040 turn volumes were then seasonally adjusted to the 30th highest hour (30HV), using a seasonal adjustment factor of 1.13 (derived from ATR data on US 97 in Redmond). This seasonal factoring method ensured that the seasonal portion of the traffic growth also increased between 2017 and 2040, along with the more typical weekday traffic. The post-processed 30HV volumes were balanced where appropriate, such as between intersections where there are no other routes available (e.g., US 97/ Yew Avenue interchange).

To ensure consistency with the BRM regional model, the post-processed volumes from the subarea assignment were compared with post-processed volumes derived from the BRM using the same counts. The BRM post-processed total intersection volumes were within 2% for the southern subarea boundary and 3% for the northern subarea boundary. The discrepancy between the volumes from the BRM and windowed subarea models was due entirely to the NCHRP methodology. Post-processing BRM volumes involves a model base year of 2010 and a count year of 2017, while the subarea model base year (2017) and count year (also 2017) are identical. The most prevalent NCHRP method using either model is the Average method which uses an average of the Modified Ratio and Difference methods. However, due to the greater difference in count volume and base model assignment the Difference method is far more prevalent when using the BRM (this is net model growth plus counts), while the subarea model post-processing is more likely to trigger the Ratio or Modified Ratio, which incorporate a growth rate component, opposed to a net growth.

2040 No-Build

The BRM Financially Constrained model was used as the basis for the 2040 No-Build forecasts. This model included the following projects, which are assumed to be reasonably likely to be constructed by the year 2040:

- Quartz Avenue Extension between Canal Boulevard and Airport Way

The BRM 2040 land use was used to estimate TAZ level trip growth. The BRM 2040 land use matches the growth projections developed for Redmond by Portland State University. As shown in Figure 1 below, most TAZs in the US 97 subarea model are expected to experience employment growth from 2010 to 2040, with a net increase of about 700 workers in the TAZs immediately adjacent to US 97 (a 97% increase over 2010). The distribution of this employment growth varies along the corridor, ranging from slight decreases in some mostly built out areas to substantial increases at the southern end of the corridor where new development is expected on vacant parcels. The employment growth coupled with housing growth elsewhere in the City of Redmond and regional growth on US 97 at the study area gateways will increase traffic activity in 2040.

No-Build Traffic Volumes

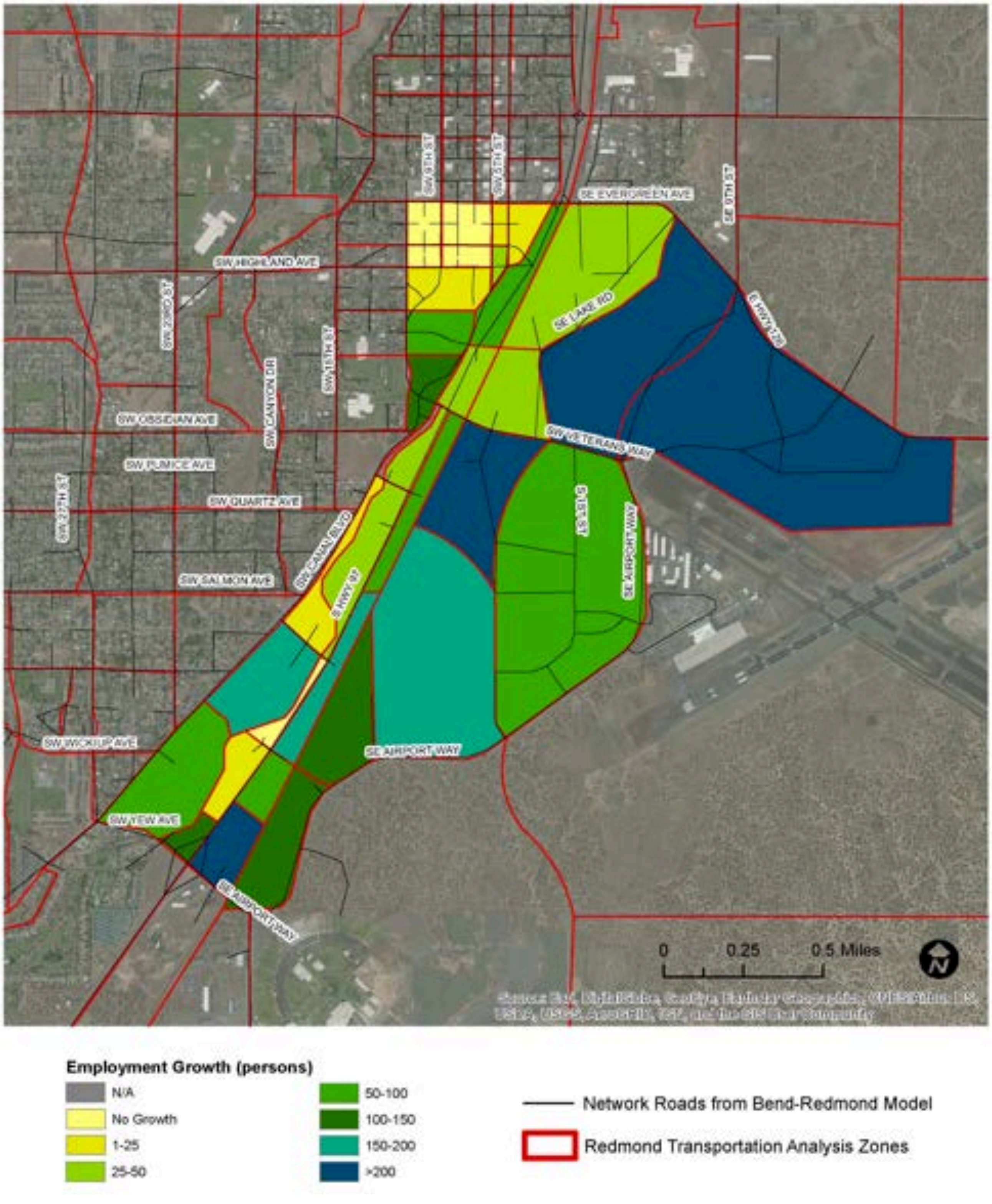
Figure 2 below shows the study intersections within the boundary of the subarea model and the 2040 No-Build 30HV traffic volumes at each intersection. These traffic volumes will be used to establish baseline future traffic conditions without proposed improvements in place.

Negative growth occurs at the following locations in the subarea network due to the additional east-west connection provided at Quartz Avenue:

- US 97 & Odem Medo Way eastbound left movement
- Canal Boulevard & Quartz Avenue northbound through, eastbound left, eastbound right and southbound right movements
- Canal Boulevard & Pumice Avenue northbound through, northbound right, and westbound left movements
- US 97 & Pumice Avenue eastbound left and eastbound right movements
- Canal Boulevard & Veterans Way northbound left, northbound through, northbound right, and southbound left movements
- US 97 & Veterans Way eastbound left and eastbound right movements

The decrease of these movements generally follows a volume shift off of northbound Canal Boulevard between Quartz Avenue and Veterans Way. This shift was made possible by the additional connection at Quartz Avenue.

Figure 1: Employment Growth in the US 97 Subarea Model (2010 to 2040)



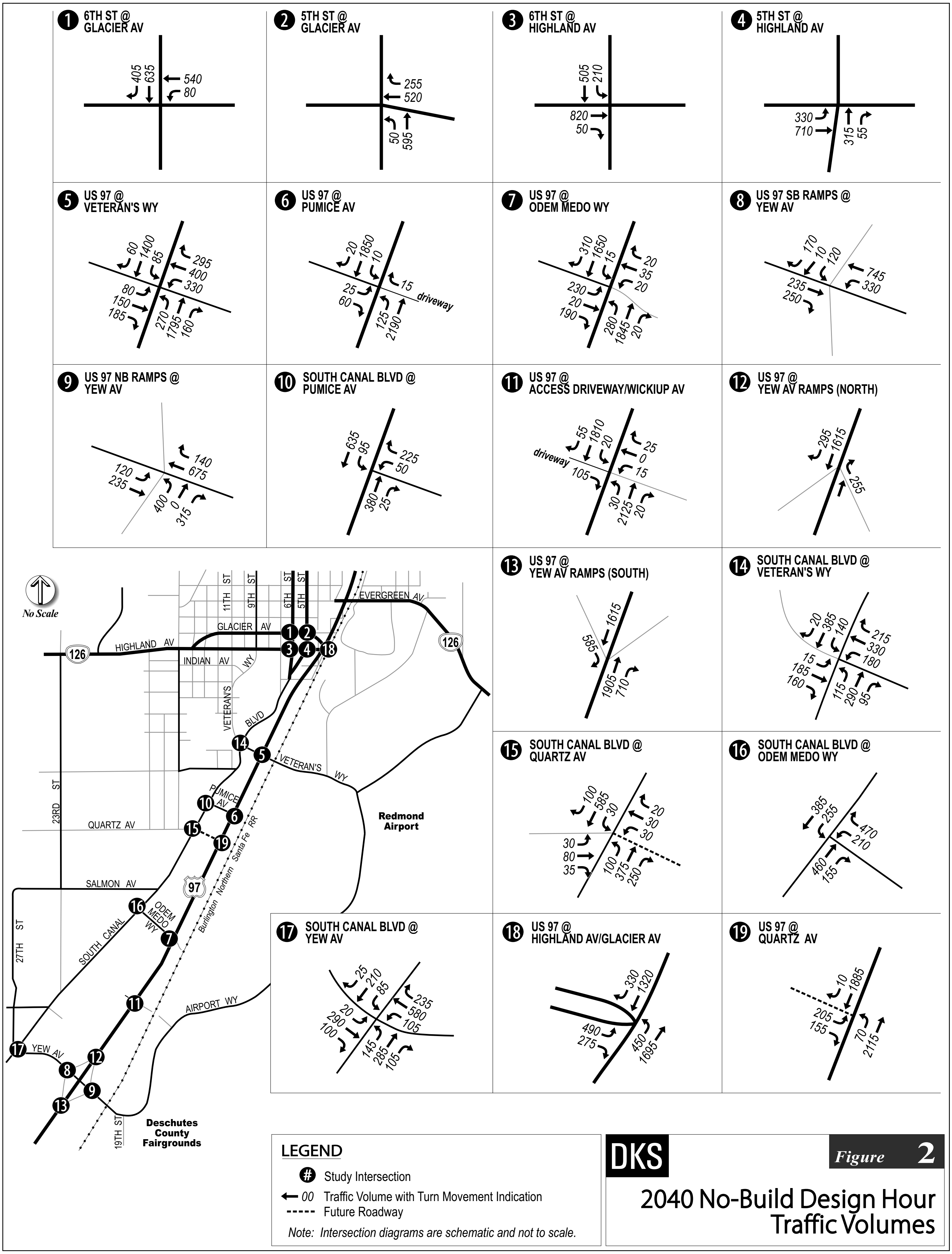


Figure 2

2040 No-Build Design Hour Traffic Volumes

2040 BUILD

For the evaluation of the Build network the assumptions in the BRM model remained the same as the No-Build analysis. Sensitivity testing of the projects included in the Build network indicated negligible regional impact from the additional east-west connections. Future turn forecasts were then based on the same demand matrix as the No-Build turn forecasts with the additional road network including three new east-west connections between US 97 and Canal Boulevard as described below and shown in Figure 3.

- The extension of SW Wickiup Avenue
- The extension of SW Umatilla Avenue
- A new roadway connection between SW Salmon Avenue and SW Reindeer Avenue

US 97 Corridor Volumes in Build and No-Build

The types of trips using the US 97 corridor were sampled between Glacier Avenue/Highland Avenue and Yew Avenue in the No-Build and Build networks. Trips beginning (entering the subarea network) or ending (leaving the subarea network) at driveways along US 97 were classified as “access” trips. Those beginning and/or ending at other external roads, such as Canal Boulevard or Veterans Way, using US 97 for a portion of the trip, but not accessing any business along US 97, are classified as “local”. Those trips driving through the study area on US 97, without stopping, are classified as “regional”.

A comparison between No-Build and Build showed that all traffic volumes along US 97 reduce by approximately 6% in the Build network. Looking at specific trip types, regional trip volumes remain identical in the two networks. Intuitively, these long-distance, through trips will continue to use US 97 as it provides the most direct route. The volume reduction along US 97 in the Build network results from lower relative volumes of local and access trips. The same trips are still being made in the Build network, however, they are leaving US 97 earlier and using new connections to avoid congestion and reach their destination faster. More information about the impact to access trips from the Build network changes can be found in the Existing Access Conditions Technical Memorandum.

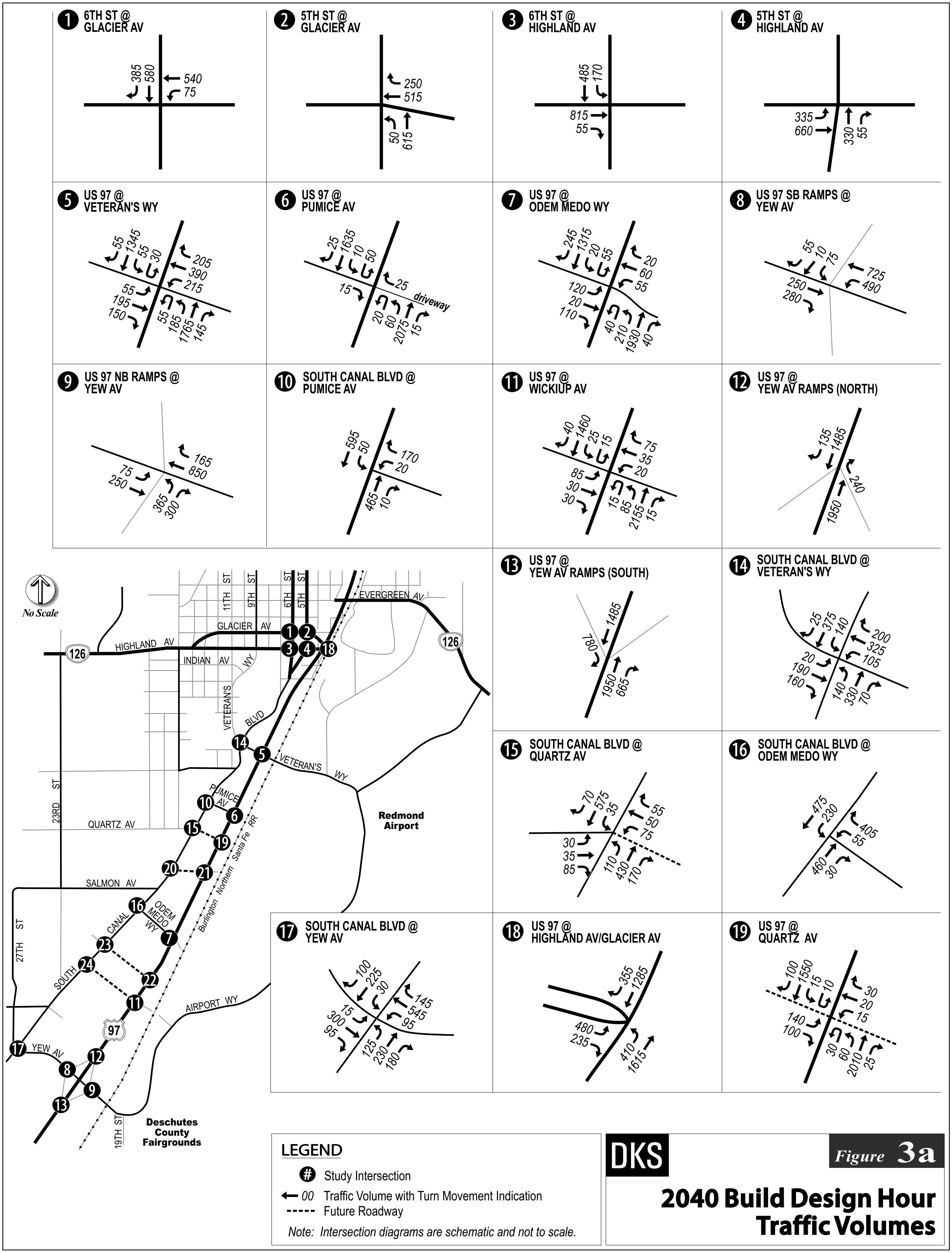
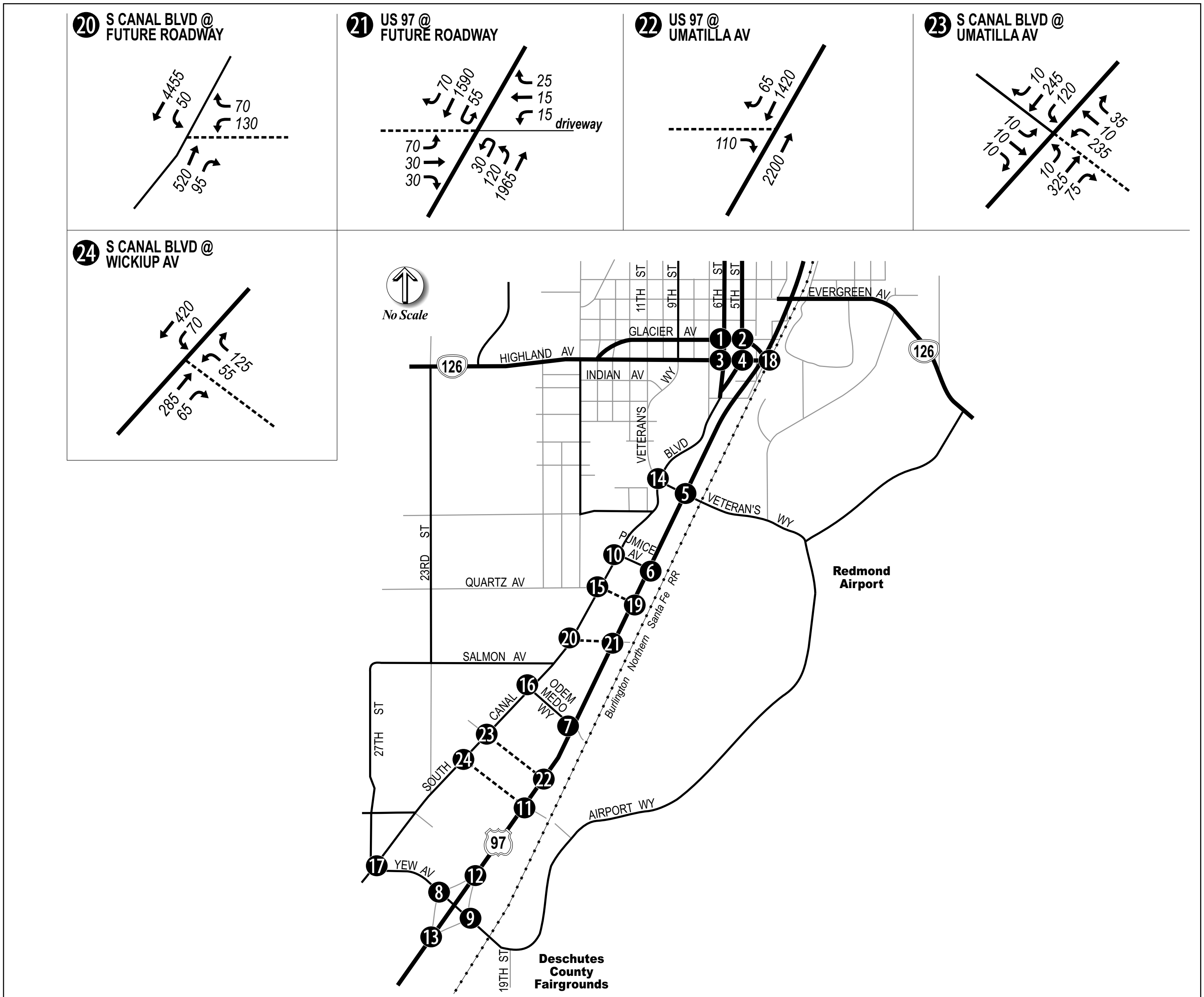


Figure 3a

2040 Build Design Hour Traffic Volumes



LEGEND

\# Study Intersection

← 00 Traffic Volume with Turn Movement Indication

----- Future Roadway

Note: Intersection diagrams are schematic and not to scale.

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Figure **3b**

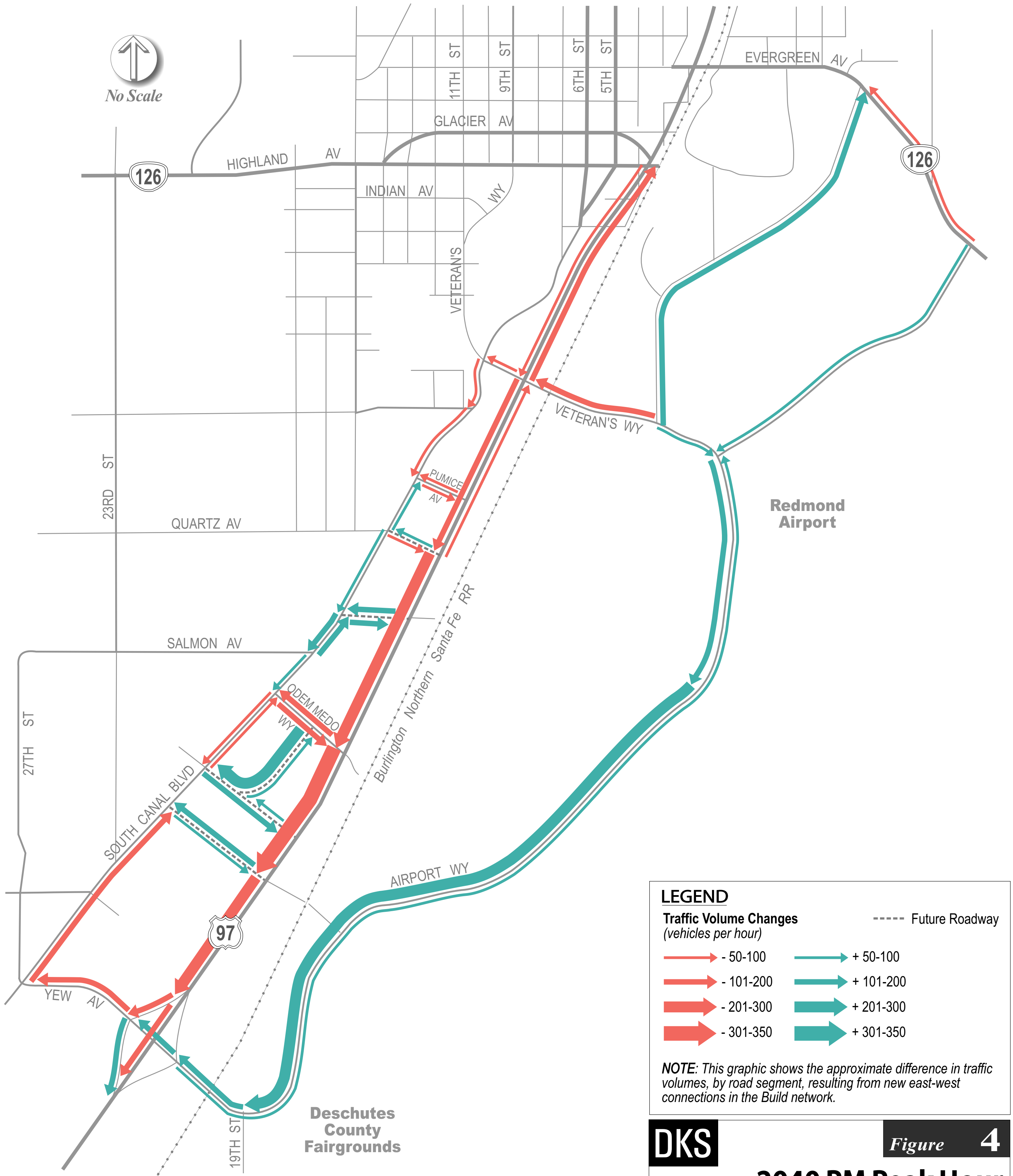
2040 Build Design Hour Traffic Volumes

Build Traffic Volumes

In general, trips move off US 97 in the Build scenario. This shift is related to the three additional signals along the US 97 corridor (resulting in delay and travel time increases) and new roundabouts along Canal Boulevard that reduce the delay for left turns onto and off this facility. Demand on connections west of US 97 is distributed across the new roadway extensions, decreasing demand on existing east-west connections compared to the No-Build scenario. Figure 4 illustrates how traffic volumes change on the street network during the weekday p.m. peak hour if the Build scenario is implemented. The most significant traffic volume changes on the study area street network caused by the Build scenario are described below.

Volume Increases:

- Eastbound and westbound Quartz Avenue – Southbound to westbound demand from US 97 shifts to westbound Quartz Avenue instead of using Veterans Way. This shift is likely due to reduced intersection delay caused by the construction of a roundabout at the intersection of Quartz Avenue and Canal Boulevard (in contrast with No-Build). This reduced delay coupled with additional signals along US 97 results in a faster travel time for these vehicles. Eastbound Quartz Avenue also attracts additional trips headed to northbound US 97.
- Eastbound and Westbound connection between Reindeer Avenue and Salmon Avenue – The westbound connection primarily attracts northbound US 97 trips headed west to Salmon Avenue. The eastbound connection primarily attracts northbound trips from Canal Boulevard headed to northbound US 97. This connection in the central area of the US 97 corridor provides a more direct route for vehicles from Salmon Avenue that previously accessed US 97 via Odem Medo Way or Quartz Avenue in the No-Build network.
- Eastbound and westbound Umatilla Avenue – Westbound Umatilla Avenue serves as a cut-through route from US 97 via Odem Medo Way to Canal Boulevard. The reduction of eastbound volume along Odem Medo Way makes the unsignalized left turn accessing this cut-through route a faster option compared with the signal at Odem Medo Way and Canal Boulevard. Eastbound Umatilla Avenue also serves as access to the adjacent commercial properties. With no left northbound left turn allowed the intersection with US 97 vehicles headed to those properties either turn left at Wickiup Avenue to access via Quartz Boulevard or make a U-turn at Odem Medo Way.
- Westbound Wickiup Avenue – Serves northbound US 97 traffic headed to local destinations along Canal Boulevard. This new connection serves volume that formerly traveled further north on US 97 and turned at Odem Medo Way.



***NOTE**: This graphic shows the approximate difference in traffic volumes, by road segment, resulting from new east-west connections in the Build network.*

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Figure 4

2040 PM Peak Hour Build vs. No-Build Traffic Volume Shifts

Volume Decreases:

- Eastbound and westbound Odem Medo Way – Volume on this link decreases significantly because of the new east-west connections. In the No-Build network, Odem Medo Way provides the main east-west connection in the southern portion of the US 97 corridor. With additional connections at Wickiup Avenue and Umatilla Avenue, the volume is more evenly distributed on these other routes.
- US 97/ Yew Avenue southbound off-ramp – With connections available at Wickiup Avenue and Umatilla Avenue to the north, volume on the US 97/ Yew Avenue southbound off-ramp headed to northbound Canal Boulevard decreases in the Build scenario. This volume is headed west and the new connections provide a more direct route for these vehicles' ultimate destinations.
- US 97 southbound – Additional delay from signals along US 97 makes the southbound travel time along Airport Way a faster path for regional trips headed south from OR 126. Improved street connectivity between US 97 and Canal Boulevard allows some trips to leave the highway sooner, leading to further reductions in volume.

Appendix B US97 SRC Model Development and Calibration Memorandum

Memo

Date:	Wednesday, July 24, 2019
Project:	ODOT US 97 South Redmond Corridor
To:	Project Team
From:	Andy Johnson, HDR, Jeremy Jackson, HDR
Subject:	**Micro Simulation Model Development and Calibration Memo (Task 3.4)**

Introduction

US 97 is a critical part of the state's transportation system and is the primary north-south transportation corridor in Central Oregon. The US 97 South Corridor in Redmond serves a mix of state, regional, and local traffic traveling to, from and within a variety of different destinations in Redmond. Redmond itself is a destination which not only is the hub for transportation serving Central Oregon, but also has regional attractors, including a commercial airport, fairgrounds, and many industrial and commercial areas. The City of Redmond (City) adopted a resolution (No. 2014-02) to partner with the Oregon Department of Transportation (ODOT) to refine, design, and implement a corridor Refinement Plan and improvement project for the US 97 South Corridor in 2014. The Project study area extends along approximately three miles of US 97 South from Highland Avenue to the southern border of the Redmond urban growth boundary (aligned with Elkhorn Avenue). The adopted resolution was the result of a multi-year collaborative planning process that included the City, ODOT, and a stakeholder group consisting of impacted business and property owners and community representatives. The outcome of the process was a corridor plan that included a series of conceptual design solutions to improve safety and operations for state, regional, and local traffic, access management and connectivity, development potential, and community character of the study corridor.

The Project is intended to provide improvements to maximize the function of US 97 and the connecting transportation system by addressing traffic mobility efficiencies, safety, and local development needs. The Project will also provide the opportunity to enhance economic development, community urban design, and business vitality along the corridor.

The purpose of this memorandum is to document the development of a calibrated traffic simulation model for the PM peak hour that is capable of replicating existing traffic conditions and best suited to evaluate future operations of the No-Build and Build alternatives. This document presents the Existing Conditions simulation model development and calibration results to support the US 97 Redmond Corridor project.

Project Area

The Project study area is approximately three miles of US 97 from Highland Avenue to south of the Yew Avenue interchange and includes segments of SW Canal Boulevard. The Project area and extents of the simulation model is shown in Figure 1.

Figure 1. Study Area and Simulation Network

Traffic Data Collection

Traffic data collection occurred in early June 2017 and consisted of intersection turning movement and driveway counts, 72-hour vehicle classification counts, Bluetooth travel time data, and vehicle queue lengths. Turning movement counts were consistent with ODOT *Analysis Procedure Manual* (APM) requirements; including a 15-minute breakdown of pedestrians, bicyclists, passenger vehicles, and heavy vehicles.

Weekday, 16-hour turning movement counts were collected between 6:00 AM and 10:00 PM at the following intersections:

- US 97 at Glacier/Highland Ave (signal)
- US 97 at Veterans Way (signal)
- US 97 at Pumice Ave (unsignalized)
- US 97 at Odem Medo Way (signal)
- US 97 at Wickiup Ave (unsignalized)
- US 97 SB at Yew Ave (signal)
- US 97 NB at Yew Ave (signal)
- Canal Blvd at Veterans Way (signal)
- Canal Blvd at Pumice Ave (unsignalized)
- Canal Blvd at Quartz (unsignalized)
- Canal Blvd at Odem Medo Way (signal)
- Canal Blvd at Yew Ave (roundabout)
- 5th St at Highland Ave (signal)
- 5th St at Glacier Ave (signal)
- 6th St at Highland Ave (signal)
- 6th St at Glacier Ave (signal)

Weekday, 72-hour classification counts were collected on US 97 between Glacier/Highland Avenue and Veterans Way and between Odem Medo Way and Yew Avenue interchange (north of ramps). In addition, seventy driveway counts within the study area were collected during the weekday PM peak period between 4:00 PM and 6:00 PM.

For calibration of the microsimulation model, data collection included weekday, 72-hour Bluetooth travel time measurements on both directions of US 97 and intersection queue lengths. Bluetooth data was collected between Tuesday and Thursday, June 6, 2017 to June 8, 2017. One Bluetooth unit was located between Evergreen Avenue and Glacier/Highland Avenue and one was located at or near Yew Avenue. Historic iPeMS data between June and August 2017 (Tuesday through Friday, excluding holidays) was also collected to validate travel times and speeds along US 97. Queue lengths, measured as number of vehicles, were recorded in two-minute intervals during the PM (4:00 PM to 6:00 PM) peak period on US 97 at the Odem Medo Way and Veterans Way intersections.

Model Development

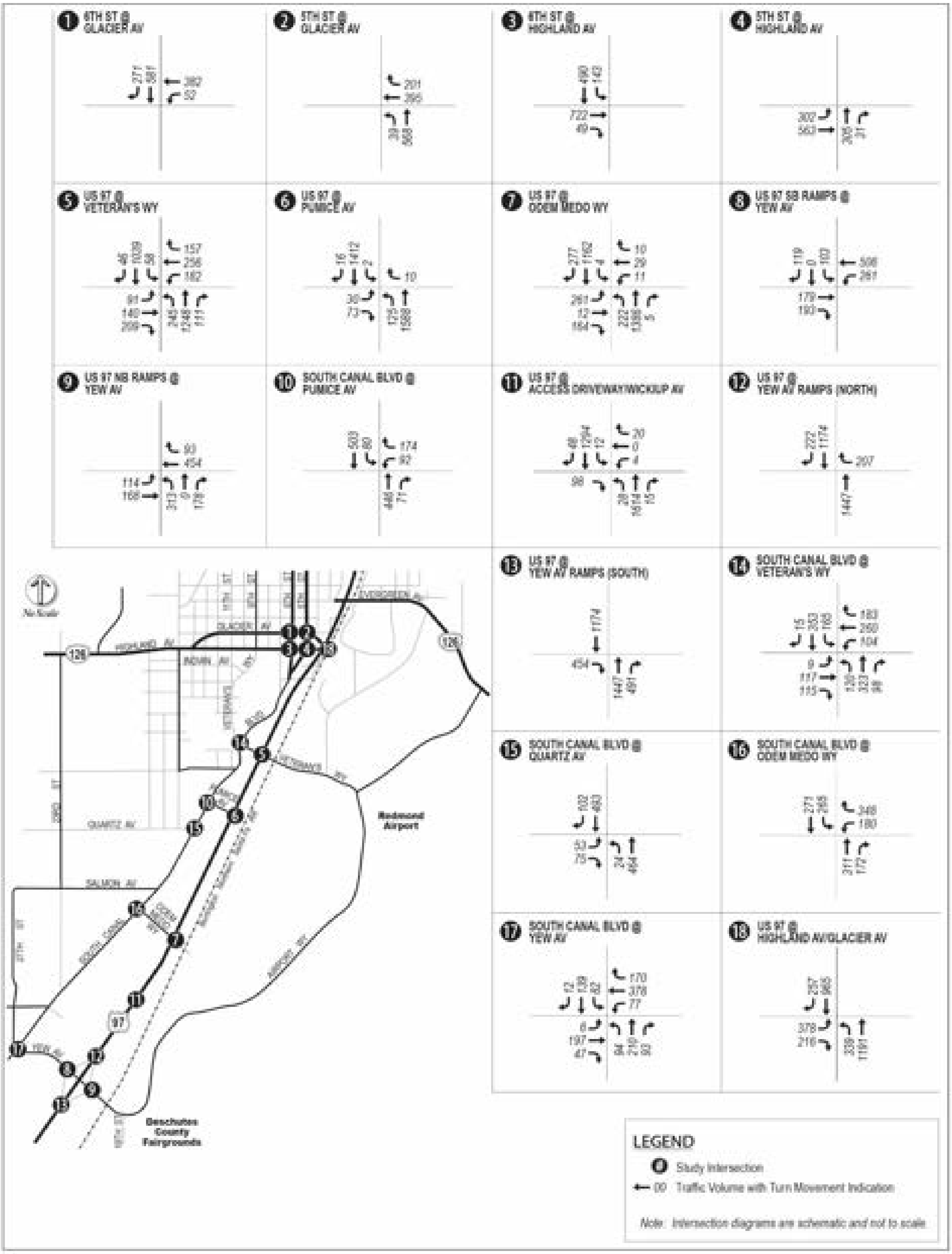
The existing conditions simulation model for the study area was developed using Vissim version 9.00-11, a widely-used, behavior-based multi-purpose traffic microsimulation program. Vissim tracks individual vehicle movements and interactions with more detail than typical Highway Capacity Manual (HCM) methods and quantifies the performance of individual movements and overall delays and queue lengths for highways, ramps, and intersections. Model assumptions, parameters, and network coding techniques are discussed in the following subsections. All assumptions are based on the traffic conditions collected in the field in early June 2017.

Existing Year Volumes

All existing year (2017) volumes were collected in early June 2017. Existing year PM peak hour volumes were seasonally adjusted to the 30th highest hour (30HV) using the on-site automatic traffic recorder (ATR) method consistent with the APM. The on-site ATR method uses five years of historic ATR data to determine an average adjustment factor, eliminating the lowest and highest percent of ADT and averaging the remaining values. There are two ATR's on US 97 within or near the study area; the Redmond-Hemlock ATR and the Redmond ATR. The Redmond ATR (#09-020) is primarily a commuter trend and is located on US 97 at milepost (MP) 124.39, 0.79 miles south of Yew Avenue. The Redmond-Hemlock ATR (#09-022) is primarily a summer trend and is located on US 97 at MP 120.92, 0.04 miles north of Antler Avenue. The seasonal adjustment factors were determined to be 1.04 for the Redmond ATR and 1.05 for the Redmond-Hemlock ATR.

Given the characteristics of US 97 within the study area, the Redmond-Hemlock ATR was used for the Glacier/Highland intersection, including Glacier Avenue and Highland Avenue at 5th Street and 6th Street due to the proximity to US 97. The Redmond ATR was used for the study area intersections from Veterans Way to south of Yew Avenue, including the adjacent City intersections on Canal Boulevard. The PM peak hour balanced, existing year design hour volumes for the study area are provided in Figure 2.

Figure 2. 2017 Existing Design Hour Traffic Volumes



Data Inputs

Multiple data sources were used to develop the data inputs and calibration targets used in the Vissim models for the US 97 corridor improvement project. The Vissim model data inputs, sources, and what they were used for are shown in Table 1 below.

Table 1. Vissim Model Data Inputs

Data	Source	Use
Traffic Volumes	HDR	Input and Calibration
Signal Timing	ODOT	Input
Travel Time	HDR/iPeMS	Calibration
Queue Length	HDR	Calibration

Model Geometrics

Scaled aerial photography was utilized to develop the base Vissim network and establish intersection lane configurations, stop bar locations, and turn pocket lengths. The high-resolution aerials were also used to accurately model merge and diverge sections on US 97 at the Yew Avenue interchange.

Vehicle Inputs

Balanced traffic volumes were summarized in 15-minute intervals using existing count data to represent the traffic fluctuations during the simulated peak hour, which allowed the Vissim model to more closely represent traffic arrival patterns and queuing on US 97 and at study area intersections. The Vissim models included a 30-minute seeding period prior to the start of the peak hour using 100 percent of the peak hour flow rate. The seeding period allows for vehicles to be loaded into the network before recording simulation results. A global peak hour of 4:30 PM to 5:30 PM was determined for the study area based on the turning movement counts collected throughout the study area.

Driveways

There are approximately 70 driveways within the study area, most of which are located on US 97. Major driveways that generate a substantial amount of traffic were modeled as unsignalized intersections, while low volume driveways were grouped together and modeled as sink/sources (right-in right-out intersections) for volume balancing.

Vehicle Routing

Traffic patterns in Vissim were modeled using static routes and routing decisions. Vehicle routing through the study area was achieved through the development of Origin-Destination (OD) matrices. The OD matrices were estimated by evaluating permitted/prohibited movements and calculating the ratios of individual turn movements at each intersection. The OD matrices were developed using Visum's OD matrix estimation feature, TFlowFuzzy[1]. Based on the land uses within the study area, the same traffic patterns were assumed for both cars and trucks, resulting in routing decisions that were applied to all vehicle types.

Traffic Compositions

Traffic compositions (car and truck percentages) were derived from existing count data for all model inputs. Peak hour truck percentages for each input ranged between 1 and 8 percent within the study area. Car and heavy vehicle distributions were based on the Vissim North American default vehicle fleet developed by PTV America in January 2010.

Speed Distributions

In general, speed limits were used to define the speed distributions on all roadways within the study area, with the 85th percentile speeds set to approximately 5 mph over the posted speed. The speed distribution curves are generally linear and provided a good match for the observed travel times. Speed decisions were used in the models to generate desired vehicle speeds at various roadway segments and reduced speed areas were strategically placed in locations where vehicles need to reduce their speed due to roadway alignment or for turning movements at intersections.

Lane Change Distance and Emergency Stop Distance

The look-back or lane change distance defines the distance at which vehicles attempt to change lanes. The longer the distance, the farther back the driver prepares for their next turning movement before making the movement, thus resulting in better lane utilization. Lane change distances were initially set to a value of 1,500 feet and adjusted, where necessary, to match field conditions. Emergency stop is the last possible position where a vehicle can change lanes. The default value for emergency stops is 16.4 feet and was increased to 50 feet to allow enough space for vehicles to make decisions prior to being too close to an intersection or diverge location, especially at higher speeds.

Signal Operations and Stop Control

The signalized intersections within the study area run on an adaptive system called SCATS by TransCore. For modeling purposes, fixed timing plans (cycle lengths, splits, and offsets) were used. Synchro models used in the development of the base timing plans for SCATS were provided by ODOT and were used to establish coordinated signal timing plans in Vissim. Since SCATS was not used, fixed timing plans were optimized for existing conditions. All intersections were coded with an individual signal controller using Vissim's ring barrier controller (RBC) module. Stop control was also coded in the model for unsignalized intersections.

Multiple Model Runs and Simulation Output

Due to the varying nature of the simulations between runs with different random seed numbers, Vissim results can differ from one run to the next. To improve model accuracy, multiple runs are

[1] TFlowFuzzy is a matrix estimation method in VISUM used to adjust an OD matrix so that the result of the assignment more closely matches the observed volumes within the network.

required, and the results should be calculated using an average of these runs. Ten runs were performed for the existing conditions model, with random seed numbers ranging from 1111 to 11110 with increments of 1111.

Model Calibration

Calibration is an iterative process that involves adjusting model parameters until the simulation reasonably replicates driver behavior, traffic flow patterns, and field-measured data. The calibration process used for the Vissim model followed ODOT and FHWA guidelines for determining the acceptability of model results as compared to existing operations.

Visual Checking and Error Correction

The visual checking and error correction process focused on addressing coding errors before the calibration process began. This process involved reviewing data inputs, Vissim error reports, and model animations. Although primarily performed during model development, visual checking and error correction is still an important process that should be performed during calibration. When making changes to driver behavior or other model parameters, this step helps ensure that unintended consequences are minimized in the model.

Data inputs included network geometry, traffic volumes, signal timing, and route choices, and were reviewed by the model developer as well as a quality control reviewer. Vissim produces an error file after each simulation run. This can include vehicle removal, signal issues, end of link errors, and various others. Critical errors in the model were accounted for and corrected during this step. Reasonableness checks included visual checking of the animation file to check for abnormal driving behavior or irregular queuing within the network and to identify coding parameters that may have been overlooked.

Calibration Targets

The objective of model calibration is to match model performance estimates and the field performance measurements. However, there is a limit to the accuracy that results from an extensive process of matching the model to the field conditions, since observations on different days will naturally yield different results due to normal fluctuations in traffic patterns. The following calibration targets were used based on the *ODOT Vissim Protocol* and the *FHWA Traffic Analysis Toolbox*:

1. Hourly Flows (Model Versus Observed)
    a. Simulated and measured link volumes for more than 85% of links to be:
        i. Within 100 vph for volumes less than 700 vph
        ii. Within 15% for volumes between 700 vph and 2700 vph
    b. Simulated and measured link volumes for more than 85% of links to have a GEH statistic value of five (5) or lower.

c. Simulated and measured link volumes to be within a GEH value of five (5) or lower for all entry and exit locations and all intersection turn movements greater than 100 vehicles per hour.

2. Travel Time

a. Simulated travel time within +/- 1 minute for routes with observed travel times less than 7 minutes.

b. Simulated travel time within +/- 15% for routes with observed travel times greater than 7 minutes.

3. Visual Audits

a. Check consistency with field conditions of the following: weaving maneuvers; patterns and extent of queues at intersections and congested links; lane utilization/choice; location of bottlenecks; etc.

b. Critical queue lengths are visually acceptable to the satisfaction of analysts and reviewers.

Volume Validation

The GEH statistic used for traffic volume calibration compares expected or measured volumes with volume output from the microsimulation model and is calculated using the following formula:

$$GEH = \sqrt{\frac{2(m-c)^2}{m+c}}$$

Notes:
m = output traffic volume from the simulation model (vph)
c = input traffic volume (vph)

The GEH is scored using the following classification:

GEH < 5.0	**Acceptable fit**
5.0 <= GEH <= 10.0	Caution: possible model error or bad data
GEH > 10.0	Unacceptable

Using GEH instead of difference percentages allows for a better acceptance over a wider range of volumes. GEH is not linear and places less importance on links with low expected volumes while allowing for variation at high volume locations. GEH values higher than 5 should warrant investigation and values over 10 indicate there may be an error with the model.

Travel Time Validation

Bluetooth travel time measurements were collected on both of directions of US 97 for three consecutive weekdays. One Bluetooth unit was located between Evergreen and

Glacier/Highland and one was located at or near Yew Avenue. Historic travel time data from iPeMS (June 2017 through August 2017) was also used to validate travel times along US 97.

Calibration Parameters

Calibration parameters for US 97 and the adjacent arterials are based on the default "Urban Motorized" driver behavior with a few modifications to better replicate existing conditions. The following car following parameters were modified:

- Look ahead distance: The number of observed vehicles was increased to 6 from the default value of 4.

In addition to the car following parameters described above, the following lane change parameters were adjusted:

- Cooperative lane change: This parameter was enabled (checked) to enhance merging and lane changing, with a maximum speed difference of 10.00 mph and a maximum collision time of 10.00 seconds.

These changes resulted in traffic conditions on US 97 and the adjacent arterials that were generally consistent with field observed conditions.

Calibration Results

The results of the Vissim calibration process were used to validate queue lengths, traffic volumes, and travel times. Visual audits were also performed to check the consistency of the model with field conditions. In general, the study area is not congested, and visual observations of the Vissim model were consistent with field conditions.

Queue Length Validation

The modeled maximum approach queue lengths were compared to field observed queue lengths on US 97 at the Odem Medo Way and Veterans Way intersections. The field observed queues at both locations included up to 15 vehicles (+/-) and varied throughout the peak hour. Assuming an average distance of 25 to 30 feet from the front end of one vehicle to the rear of the next, the queue lengths ranged from 375 to 450 feet (+/-). The Vissim results show an average maximum approach queue length at Odem Medo of approximately 450 feet for northbound US 97 and 300 feet for southbound US 97. At the Veterans Way intersection, the average maximum approach queue lengths from Vissim were approximately 400 feet for northbound US 97 and 500 feet for southbound US 97.

It is important to note that the existing SCATS timing was not used, and that fixed timing plans were optimized for the simulation. Given that queue lengths are dependent on signal timing as well as vehicle length, the queue lengths in the Vissim simulation model were within acceptable limits when compared to the queue lengths observed in the field.

Traffic Volume Validation

The PM peak hour modeled traffic volumes and balanced field-collected volumes at each intersection are provided in Table 2. The traffic volume summaries are based on total volume (sum of all turning movements) at the intersections. Individual movement results for each intersection are provided in Appendix A. As shown below, the PM peak hour traffic volumes, as measured in the Vissim simulation models, correlate well with the balanced field-collected volumes, with a calculated GEH of 2.6 or less for all intersections. The individual turning movements also had a calculated GEH of 2.6 or less for all movements.

Table 2. Traffic Volume Summary – PM Peak Hour

Intersection	Measured Volume	Simulated Volume	GEH	Difference		Volume Measure
				vhp	%	
SW Highland Ave & SW 6th St	1404	1404	0.0	0	0.0%	+/- 15%
SW Highland Ave & SW 5th St	1201	1204	0.1	3	0.2%	+/- 15%
SW Veterans Way & SW Canal Blvd	1922	1917	0.1	-5	-0.3%	+/- 15%
US 97 off Ramp & Yew Ave	1361	1332	0.8	-29	-2.1%	+/- 15%
US 97 On Ramp & Yew Ave	1320	1304	0.4	-16	-1.2%	+/- 15%
US 97 & Odem Medo Way	3543	3392	2.6	-151	-4.3%	+/- 400 vph
US 97 & Veterans Ave	3782	3655	2.1	-127	-3.4%	+/- 400 vph
US 97 & Highland Ave/Glacier Ave	3346	3275	1.2	-71	-2.1%	+/- 400 vph
Glacier Ave & SW 5th St	1203	1218	0.4	15	1.2%	+/- 15%
Glacier Ave & 6th St	1286	1274	0.3	-12	-0.9%	+/- 15%
Canal Blvd & Odem Medo Way	1547	1536	0.3	-11	-0.7%	+/- 15%

Travel Time Validation

The PM peak hour modeled travel times and field-collected travel times for US 97 are shown below in Table 3 and Table 4 for both the Bluetooth and iPeMS travel times. As shown below, the average travel times, estimated using Vissim, correlate well with the historic and field-collected travel times. For US 97 northbound, the differences in average travel time between the simulation and the field data (Bluetooth or iPeMS) is 45 seconds or less. For US 97 southbound, the differences are even less, with only 22 seconds for the iPeMS data and 2 seconds for the Bluetooth data. It is important to note that the existing SCATS timing was not used, and that actuated timing plans with fixed cycle lengths were optimized for the simulation. Despite these modifications, the travel time results show that the Vissim model provides a good representation of existing conditions. The raw Bluetooth and iPeMS data used for calibration is provided in Appendix B.

Table 3. Travel Time Summary – Bluetooth

Travel Time Segments		Field Measured	VISSIM	
Direction	Segment	Travel Time (mins)	Travel Time (min)	Difference (minutes)
SB	South of Evergreen Ave to North of Yew Ave	3.94	3.98	0.04
NB	North of Yew Ave to South of Evergreen Ave	4.27	3.54	-0.74

Table 4. Travel Time Summary – iPeMS

Travel Time Segments		Field Measured	VISSIM	
Direction	Segment	Travel Time (mins)	Travel Time (min)	Difference (minutes)
SB	South of Evergreen Ave to North of Yew Ave	4.35	3.98	-0.37
NB	North of Yew Ave to South of Evergreen Ave	4.13	3.54	-0.59

Conclusion

This report documented the Vissim model development and calibration effort for the existing (2017) PM peak period hour, which will serve as the basis for the future No-Build and Build alternatives analysis. Overall, the calibration of the existing conditions Vissim model produced simulation output that replicated existing traffic operations and field observed driver behavior for the PM peak period. In addition, it is anticipated that some of the calibration parameters may be modified when analyzing various alternatives if geometric improvements warrant changes in vehicle speeds or capacity.

Appendix A. Intersection GEH Summary

Intersection	Movement	Measured Volume	Simulated Volume	GEH	Difference		Volume Measure	Meets Measure?	Meets GEH?
					vph	%			
SW Highland Ave and SW 6th St	EBT	722	710	0.4	-12	-1.7%	+/- 15%	Yes	Yes
	EBR	49	61	1.6	12	24.5%	+/- 100 vph	Yes	Yes
	SBL	143	159	1.3	16	11.2%	+/- 100 vph	Yes	Yes
	SBT	490	474	0.7	-16	-3.3%	+/- 100 vph	Yes	Yes
SW Highland Ave and SW 5th St	EBL	302	316	0.8	14	4.6%	+/- 100 vph	Yes	Yes
	EBT	563	553	0.4	-10	-1.8%	+/- 100 vph	Yes	Yes
	NBT	305	304	0.1	-1	-0.3%	+/- 100 vph	Yes	Yes
	NBR	31	31	0.0	0	0.0%	+/- 100 vph	Yes	Yes
SW Veterans Way and SW Canal Blvd	EBL	9	8	0.3	-1	-11.1%	+/- 100 vph	Yes	Yes
	EBT	177	171	0.5	-6	-3.4%	+/- 100 vph	Yes	Yes
	EBR	115	118	0.3	3	2.6%	+/- 100 vph	Yes	Yes
	SBL	165	173	0.6	8	4.8%	+/- 100 vph	Yes	Yes
	SBT	353	344	0.5	-9	-2.5%	+/- 100 vph	Yes	Yes
	SBR	15	14	0.3	-1	-6.7%	+/- 100 vph	Yes	Yes
	WBL	104	109	0.5	5	4.8%	+/- 100 vph	Yes	Yes
	WBT	260	252	0.5	-8	-3.1%	+/- 100 vph	Yes	Yes
	WBR	183	190	0.5	7	3.8%	+/- 100 vph	Yes	Yes
	NBL	120	129	0.8	9	7.5%	+/- 100 vph	Yes	Yes
	NBT	323	309	0.8	-14	-4.3%	+/- 100 vph	Yes	Yes
	NBR	98	100	0.2	2	2.0%	+/- 100 vph	Yes	Yes
US 97 Off Ramp and Yew Ave	EBT	179	163	1.2	-16	-8.9%	+/- 100 vph	Yes	Yes
	EBR	193	198	0.4	5	2.6%	+/- 100 vph	Yes	Yes
	SBL	103	98	0.5	-5	-4.9%	+/- 100 vph	Yes	Yes
	SBR	119	103	1.5	-16	-13.4%	+/- 100 vph	Yes	Yes
	WBL	261	291	1.8	30	11.5%	+/- 100 vph	Yes	Yes
	WBT	506	479	1.2	-27	-5.3%	+/- 100 vph	Yes	Yes
US 97 On Ramp and Yew Ave	EBL	114	103	1.1	-11	-9.6%	+/- 100 vph	Yes	Yes
	EBT	168	158	0.8	-10	-6.0%	+/- 100 vph	Yes	Yes
	WBT	454	441	0.6	-13	-2.9%	+/- 100 vph	Yes	Yes
	WBR	93	106	1.3	13	14.0%	+/- 100 vph	Yes	Yes
	NBL	313	329	0.9	16	5.1%	+/- 100 vph	Yes	Yes
	NBR	178	167	0.8	-11	-6.2%	+/- 100 vph	Yes	Yes
US 97 and Odem Medo Rd	EBL	261	264	0.2	3	1.1%	+/- 100 vph	Yes	Yes
	EBT	12	12	0.0	0	0.0%	+/- 100 vph	Yes	Yes
	EBR	164	157	0.6	-7	-4.3%	+/- 100 vph	Yes	Yes
	SBL	4	2	1.2	-2	-50.0%	+/- 100 vph	Yes	Yes
	SBT	1162	1085	2.3	-77	-6.6%	+/- 15%	Yes	Yes
	SBR	277	278	0.1	1	0.4%	+/- 100 vph	Yes	Yes
	WBL	11	12	0.3	1	9.1%	+/- 100 vph	Yes	Yes
	WBT	29	28	0.2	-1	-3.4%	+/- 100 vph	Yes	Yes
	WBR	10	9	0.3	-1	-10.0%	+/- 100 vph	Yes	Yes
	NBL	222	211	0.7	-11	-5.0%	+/- 100 vph	Yes	Yes
	NBT	1386	1330	1.5	-56	-4.0%	+/- 15%	Yes	Yes
	NBR	5	4	0.5	-1	-20.0%	+/- 100 vph	Yes	Yes
US 97 and Veterans Ave	EBL	91	90	0.1	-1	-1.1%	+/- 100 vph	Yes	Yes
	EBT	140	136	0.3	-4	-2.9%	+/- 100 vph	Yes	Yes
	EBR	209	216	0.5	7	3.3%	+/- 100 vph	Yes	Yes
	SBL	58	56	0.3	-2	-3.4%	+/- 100 vph	Yes	Yes
	SBT	1039	958	2.6	-81	-7.8%	+/- 15%	Yes	Yes
	SBR	46	54	1.1	8	17.4%	+/- 100 vph	Yes	Yes
	WBL	182	186	0.3	4	2.2%	+/- 100 vph	Yes	Yes
	WBT	256	258	0.1	2	0.8%	+/- 100 vph	Yes	Yes
	WBR	157	151	0.5	-6	-3.8%	+/- 100 vph	Yes	Yes
	NBL	245	239	0.4	-6	-2.4%	+/- 100 vph	Yes	Yes
	NBT	1248	1200	1.4	-48	-3.8%	+/- 15%	Yes	Yes
	NBR	111	111	0.0	0	0.0%	+/- 100 vph	Yes	Yes
US 97 and Highland Ave/Glacier Ave	EBL	378	372	0.3	-6	-1.6%	+/- 100 vph	Yes	Yes
	EBR	216	212	0.3	-4	-1.9%	+/- 100 vph	Yes	Yes
	SBT	965	936	0.9	-29	-3.0%	+/- 15%	Yes	Yes
	SBR	257	283	1.6	26	10.1%	+/- 100 vph	Yes	Yes
	NBL	339	318	1.2	-21	-6.2%	+/- 100 vph	Yes	Yes
	NBT	1191	1154	1.1	-37	-3.1%	+/- 15%	Yes	Yes

Intersection	Movement	Measured Volume	Simulated Volume	GEH	Difference		Volume Measure	Meets Measure?	Meets GEH?
					vph	%			
Glacier Ave and SW 5th St	WBT	395	371	1.2	-24	-6.1%	+/- 100 vph	Yes	Yes
	WBR	201	229	1.9	28	13.9%	+/- 100 vph	Yes	Yes
	NBL	39	50	1.6	11	28.2%	+/- 100 vph	Yes	Yes
	NBT	568	568	0.0	0	0.0%	+/- 100 vph	Yes	Yes
Glacier Ave and 6th St	SBT	581	576	0.2	-5	-0.9%	+/- 100 vph	Yes	Yes
	SBR	271	274	0.2	3	1.1%	+/- 100 vph	Yes	Yes
	WBL	52	56	0.5	4	7.7%	+/- 100 vph	Yes	Yes
	WBT	382	368	0.7	-14	-3.7%	+/- 100 vph	Yes	Yes
Canal Blvd and Odem Medo Way	SBL	265	266	0.1	1	0.4%	+/- 100 vph	Yes	Yes
	SBT	271	271	0.0	0	0.0%	+/- 100 vph	Yes	Yes
	WBL	180	179	0.1	-1	-0.6%	+/- 100 vph	Yes	Yes
	WBR	348	341	0.4	-7	-2.0%	+/- 100 vph	Yes	Yes
	NBT	311	302	0.5	-9	-2.9%	+/- 100 vph	Yes	Yes
	NBR	172	177	0.4	5	2.9%	+/- 100 vph	Yes	Yes
Yew Ave and Canal Blvd (Roundabout)	EBL	6	5	0.4	-1	-16.7%	+/- 100 vph	Yes	Yes
	EBT	197	193	0.3	-4	-2.0%	+/- 100 vph	Yes	Yes
	EBR	47	51	0.6	4	8.5%	+/- 100 vph	Yes	Yes
	SBL	82	82	0.0	0	0.0%	+/- 100 vph	Yes	Yes
	SBT	139	140	0.1	1	0.7%	+/- 100 vph	Yes	Yes
	SBR	12	11	0.3	-1	-8.3%	+/- 100 vph	Yes	Yes
	WBL	77	71	0.7	-6	-7.8%	+/- 100 vph	Yes	Yes
	WBT	378	347	1.6	-31	-8.2%	+/- 100 vph	Yes	Yes
	WBR	170	162	0.6	-8	-4.7%	+/- 100 vph	Yes	Yes
	NBL	94	88	0.6	-6	-6.4%	+/- 100 vph	Yes	Yes
	NBT	210	220	0.7	10	4.8%	+/- 100 vph	Yes	Yes
	NBR	93	86	0.7	-7	-7.5%	+/- 100 vph	Yes	Yes

Appendix B. Travel Time Data

US97 SB Bluetooth
Length 1.97 miles

			Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
Day	Start	End	**Sample Size**	**Mean Travel Time**	**Standard Deviation**	**Mean Speed**	**85th PCT Speed**	**Median**	**Min**	**Max**	**25th PCT**	**75th PCT**	**95th PCT**
1	4:30 PM	4:45 PM	11	3.83	0.68	30.91	38.55	3.53	2.88	4.73	3.34	4.47	4.72
	4:45 PM	5:00 PM	10	4.59	0.52	25.81	27.75	4.57	3.68	5.73	4.32	4.80	5.73
	5:00 PM	5:15 PM	6	3.47	0.75	34.08	40.38	3.04	2.87	4.51	3.02	4.37	4.51
	5:15 PM	5:30 PM	13	3.96	1.34	29.87	41.08	3.20	2.77	7.40	3.00	4.53	7.07
2	4:30 PM	4:45 PM	12	3.99	0.73	29.65	38.66	4.18	2.97	4.92	3.11	4.56	4.91
	4:45 PM	5:00 PM	12	3.86	0.63	30.68	39.86	4.15	2.80	4.69	3.39	4.30	4.66
	5:00 PM	5:15 PM	8	4.00	0.57	29.57	37.48	4.19	3.04	4.53	3.65	4.38	4.53
	5:15 PM	5:30 PM	7	4.21	0.72	28.15	37.13	4.51	3.04	4.84	3.60	4.64	4.84
3	4:30 PM	4:45 PM	11	3.85	0.67	30.74	38.95	3.93	2.99	4.83	3.11	4.36	4.82
	4:45 PM	5:00 PM	8	3.84	0.71	30.83	39.32	4.05	2.78	4.64	3.17	4.42	4.64
	5:00 PM	5:15 PM	6	3.51	0.74	33.71	41.66	3.25	2.81	4.52	2.89	4.35	4.52
	5:15 PM	5:30 PM	14	3.90	0.60	30.32	37.35	4.18	3.02	4.63	3.23	4.41	4.61
Average	**4:30 PM**	**5:30 PM**	**118**	**3.94**	**0.73**	**30.17**	**38.10**	**3.92**	**2.97**	**5.09**	**3.32**	**4.47**	**5.04**

US97 NB Bluetooth
Length 1.97 miles

			Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
Day	Start	End	**Sample Size**	**Mean Travel Time**	**Standard Deviation**	**Mean Speed**	**85th PCT Speed**	**Median**	**Min**	**Max**	**25th PCT**	**75th PCT**	**95th PCT**
1	4:30 PM	4:45 PM	9	4.17	0.40	28.39	31.58	4.17	3.60	4.77	3.91	4.39	4.77
	4:45 PM	5:00 PM	14	4.17	0.58	28.39	33.47	4.20	3.00	5.05	4.07	4.62	4.99
	5:00 PM	5:15 PM	19	4.48	0.92	26.45	33.24	4.31	3.19	7.17	3.99	4.75	6.44
	5:15 PM	5:30 PM	9	3.73	0.49	31.77	36.36	3.61	2.87	4.42	3.44	4.09	4.42
2	4:30 PM	4:45 PM	7	3.84	0.65	30.84	37.12	3.64	3.17	4.62	3.24	4.51	4.62
	4:45 PM	5:00 PM	14	4.45	0.83	26.59	34.57	4.36	2.97	5.67	4.05	5.15	5.65
	5:00 PM	5:15 PM	6	3.93	0.47	30.15	35.39	4.05	3.09	4.37	3.73	4.28	4.37
	5:15 PM	5:30 PM	11	4.44	0.48	26.67	30.84	4.47	3.62	5.03	4.11	4.86	5.03
3	4:30 PM	4:45 PM	11	4.13	0.76	28.70	37.65	4.04	3.01	5.43	3.77	4.53	5.42
	4:45 PM	5:00 PM	16	4.55	1.09	26.03	33.79	4.24	3.41	7.32	3.81	4.82	6.96
	5:00 PM	5:15 PM	8	4.35	0.58	27.20	32.15	4.40	3.41	5.11	3.95	4.81	5.11
	5:15 PM	5:30 PM	14	4.34	0.45	27.25	30.94	4.32	3.73	5.13	3.99	4.75	5.10
Average	**4:30 PM**	**5:30 PM**	**138**	**4.27**	**0.68**	**27.79**	**33.71**	**4.19**	**3.26**	**5.60**	**3.88**	**4.68**	**5.44**

TRAVEL TIME DATA

15 MINUTE STATISTICAL SUMMARY

ROUTE INFORMATION
Name / Number:
Label: North of Yew to South of Evergreen
Length of Segment: 1.973156732 miles
Direction:

Beginning Station: BA7 North of Yew
Latitude: 44.24565667
Longitude: -121.1901833
Ending Station: A0C South of Evergreen
Latitude: 44.27072833
Longitude: -121.171095

Date: 6-Jun-17
Day of Week: Tuesday

Project Name: Redmond Bluetooth

	Begin Time	End Time	Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
Time			**Sample Size**	**Mean Travel Time**	**Standard Deviation**	**Mean Speed**	**85th PCT Speed**	**Median**	**Min**	**Max**	**25th PCT**	**75th PCT**	**95th PCT**
Midnight	12:00 AM	12:15 AM	5	3.07	0.20	38.52	41.12	3.04	2.87	3.38	2.90	3.22	3.38
	12:15 AM	12:30 AM	2	3.03	0.06	39.08	39.68	3.03	2.98	3.07	2.98	3.07	3.07
	12:30 AM	12:45 AM	2	2.96	0.04	40.02	40.36	2.96	2.93	2.98	2.93	2.98	2.98
	12:45 AM	1:00 AM	0										
	1:00 AM	1:15 AM	1	2.87	0.00	41.30	41.30	2.87	2.87	2.87	2.87	2.87	2.87
	1:15 AM	1:30 AM	1	3.01	0.00	39.35	39.35	3.01	3.01	3.01	3.01	3.01	3.01
	1:30 AM	1:45 AM	0										
	1:45 AM	2:00 AM	0										
	2:00 AM	2:15 AM	0										
	2:15 AM	2:30 AM	1	3.18	0.00	37.19	37.19	3.18	3.18	3.18	3.18	3.18	3.18
	2:30 AM	2:45 AM	2	3.08	0.05	38.45	38.92	3.08	3.04	3.12	3.04	3.12	3.12
	2:45 AM	3:00 AM	1	2.90	0.00	40.82	40.82	2.90	2.90	2.90	2.90	2.90	2.90
	3:00 AM	3:15 AM	1	2.98	0.00	39.68	39.68	2.98	2.98	2.98	2.98	2.98	2.98
	3:15 AM	3:30 AM	0										
	3:30 AM	3:45 AM	1	2.87	0.00	41.30	41.30	2.87	2.87	2.87	2.87	2.87	2.87
	3:45 AM	4:00 AM	0										
	4:00 AM	4:15 AM	2	3.01	0.15	39.30	40.71	3.01	2.91	3.12	2.91	3.12	3.12
	4:15 AM	4:30 AM	3	3.13	0.28	37.78	40.36	3.02	2.93	3.45	2.95	3.34	3.45
	4:30 AM	4:45 AM	4	2.98	0.22	39.68	42.34	2.94	2.79	3.27	2.81	3.15	3.27
	4:45 AM	5:00 AM	1	3.11	0.00	38.09	38.09	3.11	3.11	3.11	3.11	3.11	3.11
	5:00 AM	5:15 AM	4	2.62	0.14	45.24	47.12	2.57	2.51	2.82	2.53	2.70	2.82
	5:15 AM	5:30 AM	0										
	5:30 AM	5:45 AM	0										
	5:45 AM	6:00 AM	2	4.26	2.23	27.77	44.12	4.26	2.68	5.84	2.68	5.84	5.84
	6:00 AM	6:15 AM	3	3.26	0.70	36.30	48.16	3.64	2.46	3.68	2.75	3.67	3.68
	6:15 AM	6:30 AM	0										
	6:30 AM	6:45 AM	4	2.49	0.48	47.51	55.06	2.32	2.13	3.19	2.22	2.77	3.19
	6:45 AM	7:00 AM	5	3.39	0.39	34.89	40.33	3.40	2.84	3.86	3.12	3.70	3.86
	7:00 AM	7:15 AM	1	3.86	0.00	30.68	30.68	3.86	3.86	3.86	3.86	3.86	3.86
	7:15 AM	7:30 AM	5	2.79	0.29	42.43	45.68	2.68	2.58	3.28	2.61	2.91	3.28
	7:30 AM	7:45 AM	10	3.04	0.42	38.97	45.10	3.03	2.54	4.05	2.75	3.17	4.05
	7:45 AM	8:00 AM	8	3.61	0.51	32.79	40.73	3.70	2.88	4.28	3.15	4.00	4.28
	8:00 AM	8:15 AM	8	3.05	0.53	38.76	46.58	3.03	2.48	3.83	2.59	3.44	3.83
	8:15 AM	8:30 AM	9	3.48	0.59	33.98	40.59	3.50	2.63	4.64	3.04	3.75	4.64
	8:30 AM	8:45 AM	9	3.19	0.33	37.11	41.96	3.28	2.80	3.61	2.84	3.47	3.61
	8:45 AM	9:00 AM	8	3.84	0.51	30.81	35.75	3.97	2.95	4.41	3.47	4.25	4.41
	9:00 AM	9:15 AM	9	3.54	0.53	33.43	40.05	3.31	2.85	4.27	3.13	4.03	4.27
	9:15 AM	9:30 AM	6	3.04	0.34	38.89	43.47	3.01	2.65	3.60	2.83	3.17	3.60
	9:30 AM	9:45 AM	12	3.45	0.62	34.32	41.78	3.28	2.65	4.66	3.14	3.63	4.65
	9:45 AM	10:00 AM	6	3.18	0.29	37.19	40.94	3.14	2.77	3.62	3.07	3.36	3.62
	10:00 AM	10:15 AM	4	3.74	0.44	31.68	36.64	3.76	3.18	4.25	3.45	4.02	4.25
	10:15 AM	10:30 AM	8	4.64	1.25	25.54	33.71	4.42	3.03	6.32	3.74	5.71	6.32
	10:30 AM	10:45 AM	6	3.84	0.54	30.83	34.48	3.60	3.37	4.82	3.53	4.13	4.82
	10:45 AM	11:00 AM	8	4.01	0.40	29.50	32.71	3.95	3.57	4.63	3.67	4.33	4.63
	11:00 AM	11:15 AM	16	4.31	0.69	27.44	33.27	4.23	3.17	5.61	3.74	4.79	5.52
	11:15 AM	11:30 AM	9	3.84	0.42	30.80	33.07	3.84	2.85	4.27	3.74	4.15	4.27
	11:30 AM	11:45 AM	8	3.83	0.54	30.88	36.66	3.83	3.02	4.68	3.44	4.20	4.68
	11:45 AM	12:00 PM	7	4.16	0.72	28.49	34.90	4.45	3.25	5.17	3.52	4.62	5.17
Noon	12:00 PM	12:15 PM	7	3.77	0.50	31.37	35.63	3.73	2.93	4.59	3.65	3.98	4.59
	12:15 PM	12:30 PM	15	4.71	1.00	25.13	33.65	4.82	2.82	6.75	4.39	5.30	6.50
	12:30 PM	12:45 PM	10	4.23	0.39	27.99	31.22	4.15	3.73	4.93	3.92	4.50	4.93
	12:45 PM	1:00 PM	8	3.95	0.64	30.00	35.70	3.86	2.97	4.98	3.55	4.40	4.98
	1:00 PM	1:15 PM	9	4.35	1.05	27.23	35.22	4.26	2.86	5.93	3.52	4.93	5.93
	1:15 PM	1:30 PM	5	4.79	0.61	24.73	28.09	4.55	4.18	5.52	4.29	5.40	5.52
	1:30 PM	1:45 PM	10	4.95	1.10	23.90	32.89	4.72	3.43	6.60	4.28	5.96	6.60
	1:45 PM	2:00 PM	14	4.21	0.52	28.10	31.21	4.23	3.23	5.63	3.98	4.37	5.40
	2:00 PM	2:15 PM	9	4.31	1.39	27.49	37.31	3.92	3.07	7.68	3.61	4.52	7.68
	2:15 PM	2:30 PM	12	3.85	0.37	30.79	34.42	3.80	3.42	4.50	3.47	4.12	4.48
	2:30 PM	2:45 PM	8	3.79	0.85	31.22	40.08	3.67	2.87	4.89	3.03	4.58	4.89
	2:45 PM	3:00 PM	6	4.02	0.54	29.48	34.99	4.09	3.20	4.77	3.66	4.27	4.77
	3:00 PM	3:15 PM	5	6.17	5.04	19.19	33.77	4.07	3.39	15.17	3.74	7.07	15.17
	3:15 PM	3:30 PM	6	6.11	4.00	19.36	27.07	4.53	4.27	14.28	4.53	4.53	14.28
	3:30 PM	3:45 PM	9	8.72	8.12	13.58	27.04	4.82	3.50	23.27	4.69	9.59	23.27
	3:45 PM	4:00 PM	13	7.38	6.28	16.04	30.87	5.06	3.58	21.47	4.39	5.76	21.46
	4:00 PM	4:15 PM	10	3.70	0.71	31.97	39.03	3.86	2.43	4.58	3.13	4.25	4.58
	4:15 PM	4:30 PM	11	5.07	0.85	23.33	28.02	5.07	3.28	6.18	4.75	5.70	6.18
	4:30 PM	4:45 PM	9	4.17	0.40	28.39	31.58	4.17	3.60	4.77	3.91	4.39	4.77
	4:45 PM	5:00 PM	14	4.17	0.58	28.39	33.47	4.20	3.00	5.05	4.07	4.62	4.99
	5:00 PM	5:15 PM	19	4.48	0.92	26.45	33.24	4.31	3.19	7.17	3.99	4.75	6.44
	5:15 PM	5:30 PM	9	3.73	0.49	31.77	36.36	3.61	2.87	4.42	3.44	4.09	4.42
	5:30 PM	5:45 PM	12	4.43	0.48	26.70	30.32	4.61	3.37	4.88	4.09	4.79	4.88
	5:45 PM	6:00 PM	11	4.06	0.32	29.16	31.19	4.03	3.62	4.73	3.88	4.13	4.71
	6:00 PM	6:15 PM	8	4.19	0.58	28.23	33.47	4.26	3.39	5.09	3.67	4.60	5.09
	6:15 PM	6:30 PM	14	5.09	1.44	23.25	33.41	5.39	2.90	8.03	3.93	5.98	7.72
	6:30 PM	6:45 PM	7	4.10	0.92	28.85	36.62	3.83	3.23	5.84	3.36	4.53	5.84
	6:45 PM	7:00 PM	17	3.72	0.53	31.79	40.79	3.90	2.70	4.50	3.43	4.09	4.44
	7:00 PM	7:15 PM	3	3.35	0.50	35.34	42.54	3.55	2.78	3.72	2.97	3.67	3.72
	7:15 PM	7:30 PM	9	3.64	0.48	32.56	38.16	3.62	2.78	4.22	3.44	4.13	4.22
	7:30 PM	7:45 PM	7	3.19	0.45	37.11	43.05	3.14	2.75	3.91	2.77	3.54	3.91
	7:45 PM	8:00 PM	8	3.73	0.52	31.75	37.60	3.68	3.13	4.43	3.25	4.21	4.43
	8:00 PM	8:15 PM	4	3.59	0.41	33.00	37.33	3.56	3.15	4.08	3.26	3.92	4.08
	8:15 PM	8:30 PM	7	3.37	0.37	35.17	41.17	3.39	2.87	3.86	3.01	3.60	3.86
	8:30 PM	8:45 PM	10	3.41	0.40	34.72	39.79	3.28	2.95	4.07	3.12	3.80	4.07
	8:45 PM	9:00 PM	6	3.34	0.63	35.47	42.28	3.20	2.77	4.38	2.85	3.62	4.38
	9:00 PM	9:15 PM	5	2.92	0.31	40.57	45.98	3.11	2.57	3.17	2.59	3.15	3.17
	9:15 PM	9:30 PM	5	3.26	0.21	36.37	39.44	3.32	2.97	3.48	3.07	3.42	3.48
	9:30 PM	9:45 PM	3	2.75	0.03	43.05	43.31	2.73	2.73	2.78	2.73	2.77	2.78
	9:45 PM	10:00 PM	5	2.95	0.26	40.11	43.28	2.81	2.73	3.28	2.76	3.20	3.28
	10:00 PM	10:15 PM	7	2.81	0.21	42.17	45.87	2.75	2.56	3.11	2.62	3.00	3.11
	10:15 PM	10:30 PM	7	3.26	0.26	36.33	39.91	3.25	2.87	3.67	3.07	3.41	3.67
	10:30 PM	10:45 PM	6	2.95	0.18	40.19	43.74	3.02	2.63	3.13	2.82	3.07	3.13
	10:45 PM	11:00 PM	2	3.10	0.54	38.19	43.58	3.10	2.72	3.48	2.72	3.48	3.48
	11:00 PM	11:15 PM	4	3.02	0.24	39.25	42.41	2.99	2.78	3.30	2.82	3.21	3.30
	11:15 PM	11:30 PM	4	2.83	0.30	41.78	48.00	2.90	2.43	3.10	2.60	3.07	3.10
	11:30 PM	11:45 PM	4	2.70	0.04	43.85	44.40	2.70	2.67	2.73	2.67	2.73	2.73
Midnight	11:45 PM	12:00 AM	2	3.25	0.61	36.43	42.03	3.25	2.82	3.68	2.82	3.68	3.68

SUMMARY

			Total Number of Samples	Averages of the 15 Minutes periods		
				Mean Travel Time	Standard Deviation	Mean Speed
AM Peak Period	**7:00 AM**	**9:00 AM**	58	3.36	0.40	35.69
Midday Period	**12:00 PM**	**2:00 PM**	78	4.37	0.73	27.31
PM Peak Period	**4:00 PM**	**6:00 PM**	95	4.23	0.59	28.27
Daily	**12:00 AM**	**12:00 AM**	597	3.73	0.72	33.38

TRAVEL TIME DATA

15 MINUTE STATISTICAL SUMMARY

ROUTE INFORMATION
Name / Number:
Label: North of Yew to South of Evergreen
Length of Segment: 1.973156732 miles
Direction:

Beginning Station: BA7 North of Yew
Latitude: 44.24565667
Longitude: -121.1901833
Ending Station: A0C South of Evergreen
Latitude: 44.27072833
Longitude: -121.171095

Date: 7-Jun-17
Day of Week: Wednesday

Project Name: Redmond Bluetooth

	Begin Time	End Time	Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
Time			**Sample Size**	**Mean Travel Time**	**Standard Deviation**	**Mean Speed**	**85th PCT Speed**	**Median**	**Min**	**Max**	**25th PCT**	**75th PCT**	**95th PCT**
Midnight	12:00 AM	12:15 AM	1	2.92	0.00	40.48	40.48	2.92	2.92	2.92	2.92	2.92	2.92
	12:15 AM	12:30 AM	2	3.05	0.24	38.82	41.06	3.05	2.88	3.22	2.88	3.22	3.22
	12:30 AM	12:45 AM	2	2.43	0.38	48.65	54.64	2.43	2.17	2.70	2.17	2.70	2.70
	12:45 AM	1:00 AM	4	3.04	0.09	38.90	40.25	3.06	2.93	3.12	2.97	3.11	3.12
	1:00 AM	1:15 AM	1	3.44	0.00	34.40	34.40	3.44	3.44	3.44	3.44	3.44	3.44
	1:15 AM	1:30 AM	1	2.63	0.00	44.96	44.96	2.63	2.63	2.63	2.63	2.63	2.63
	1:30 AM	1:45 AM	0										
	1:45 AM	2:00 AM	2	2.83	0.13	41.78	43.18	2.83	2.74	2.93	2.74	2.93	2.93
	2:00 AM	2:15 AM	0										
	2:15 AM	2:30 AM	0										
	2:30 AM	2:45 AM	0										
	2:45 AM	3:00 AM	0										
	3:00 AM	3:15 AM	1	3.18	0.00	37.19	37.19	3.18	3.18	3.18	3.18	3.18	3.18
	3:15 AM	3:30 AM	1	2.72	0.00	43.58	43.58	2.72	2.72	2.72	2.72	2.72	2.72
	3:30 AM	3:45 AM	1	2.56	0.00	46.28	46.28	2.56	2.56	2.56	2.56	2.56	2.56
	3:45 AM	4:00 AM	1	2.97	0.00	39.79	39.79	2.97	2.97	2.97	2.97	2.97	2.97
	4:00 AM	4:15 AM	2	2.75	0.23	42.99	45.68	2.75	2.59	2.92	2.59	2.92	2.92
	4:15 AM	4:30 AM	0										
	4:30 AM	4:45 AM	2	3.01	0.14	39.30	40.59	3.01	2.92	3.11	2.92	3.11	3.11
	4:45 AM	5:00 AM	1	2.92	0.00	40.48	40.48	2.92	2.92	2.92	2.92	2.92	2.92
	5:00 AM	5:15 AM	1	3.55	0.00	33.35	33.35	3.55	3.55	3.55	3.55	3.55	3.55
	5:15 AM	5:30 AM	2	3.33	0.03	35.56	35.79	3.33	3.31	3.35	3.31	3.35	3.35
	5:30 AM	5:45 AM	5	3.25	0.46	36.41	41.78	3.02	2.78	3.86	2.93	3.67	3.86
	5:45 AM	6:00 AM	2	2.70	0.34	43.78	48.00	2.70	2.47	2.94	2.47	2.94	2.94
	6:00 AM	6:15 AM	1	2.63	0.00	44.96	44.96	2.63	2.63	2.63	2.63	2.63	2.63
	6:15 AM	6:30 AM	5	2.87	0.34	41.20	48.57	3.03	2.35	3.17	2.61	3.13	3.17
	6:30 AM	6:45 AM	2	2.76	0.39	42.92	47.67	2.76	2.48	3.03	2.48	3.03	3.03
	6:45 AM	7:00 AM	7	3.26	0.32	36.35	40.11	3.18	2.93	3.78	3.00	3.51	3.78
	7:00 AM	7:15 AM	1	3.27	0.00	36.24	36.24	3.27	3.27	3.27	3.27	3.27	3.27
	7:15 AM	7:30 AM	5	2.74	0.25	43.16	48.08	2.75	2.40	3.08	2.59	2.90	3.08
	7:30 AM	7:45 AM	5	3.17	0.40	37.31	43.65	3.23	2.65	3.62	2.84	3.50	3.62
	7:45 AM	8:00 AM	8	3.29	0.44	35.93	42.01	3.31	2.55	3.92	3.04	3.59	3.92
	8:00 AM	8:15 AM	5	3.26	0.43	36.35	39.63	3.11	2.97	4.02	3.03	3.36	4.02
	8:15 AM	8:30 AM	7	3.27	0.31	36.16	41.57	3.38	2.82	3.58	2.97	3.52	3.58
	8:30 AM	8:45 AM	9	3.88	0.83	30.52	38.87	3.97	2.64	5.56	3.35	4.18	5.56
	8:45 AM	9:00 AM	7	3.80	0.47	31.12	36.37	4.09	3.02	4.22	3.47	4.19	4.22
	9:00 AM	9:15 AM	11	3.34	0.51	35.42	42.53	3.50	2.32	4.03	2.95	3.62	4.02
	9:15 AM	9:30 AM	6	3.69	0.45	32.05	36.82	3.63	3.03	4.27	3.50	4.10	4.27
	9:30 AM	9:45 AM	7	3.67	0.38	32.25	36.27	3.54	3.11	4.08	3.43	4.03	4.08
	9:45 AM	10:00 AM	7	3.61	0.30	32.79	36.22	3.63	3.20	4.11	3.39	3.72	4.11
	10:00 AM	10:15 AM	11	3.55	0.36	33.38	35.23	3.49	3.02	4.52	3.43	3.57	4.48
	10:15 AM	10:30 AM	9	3.64	0.48	32.48	37.51	3.52	3.00	4.24	3.25	4.13	4.24
	10:30 AM	10:45 AM	9	3.65	0.34	32.47	37.56	3.73	3.07	4.02	3.40	3.91	4.02
	10:45 AM	11:00 AM	12	3.54	0.51	33.44	39.52	3.63	2.52	4.23	3.17	3.87	4.22
	11:00 AM	11:15 AM	6	3.96	0.50	29.93	34.25	3.89	3.30	4.72	3.69	4.25	4.72
	11:15 AM	11:30 AM	6	3.46	0.26	34.25	37.19	3.40	3.05	3.77	3.38	3.73	3.77
	11:30 AM	11:45 AM	9	3.70	0.47	32.04	37.03	3.72	3.18	4.48	3.20	3.92	4.48
	11:45 AM	12:00 PM	11	4.08	0.77	29.02	33.52	3.93	3.00	5.91	3.66	4.16	5.86
Noon	12:00 PM	12:15 PM	7	3.87	0.44	30.56	35.34	4.06	3.17	4.45	3.55	4.16	4.45
	12:15 PM	12:30 PM	9	3.57	0.45	33.17	39.53	3.69	2.92	4.06	3.07	3.95	4.06
	12:30 PM	12:45 PM	6	4.48	0.55	26.46	30.36	4.48	3.90	5.25	3.90	4.83	5.25
	12:45 PM	1:00 PM	10	3.86	0.69	30.69	38.61	3.74	2.83	5.07	3.53	4.40	5.07
	1:00 PM	1:15 PM	11	4.46	0.72	26.55	34.63	4.42	3.23	5.40	4.29	4.99	5.40
	1:15 PM	1:30 PM	8	4.30	0.64	27.55	31.26	4.27	3.25	5.57	4.09	4.43	5.57
	1:30 PM	1:45 PM	8	3.97	0.42	29.80	31.99	3.85	3.62	4.95	3.73	4.02	4.95
	1:45 PM	2:00 PM	16	4.12	0.35	28.72	31.26	4.15	3.26	4.57	3.93	4.41	4.54
	2:00 PM	2:15 PM	11	3.84	0.44	30.82	35.12	3.85	3.14	4.57	3.55	3.99	4.56
	2:15 PM	2:30 PM	5	3.75	0.46	31.57	35.52	3.67	3.25	4.49	3.50	3.94	4.49
	2:30 PM	2:45 PM	6	3.61	0.78	32.81	42.66	3.53	2.76	4.56	2.80	4.47	4.56
	2:45 PM	3:00 PM	12	4.98	0.86	23.79	29.50	5.02	3.65	6.65	4.30	5.63	6.55
	3:00 PM	3:15 PM	12	4.45	1.64	26.60	34.79	3.92	2.95	8.95	3.46	4.79	8.64
	3:15 PM	3:30 PM	7	4.52	0.58	26.22	30.02	4.30	3.83	5.29	4.06	5.07	5.29
	3:30 PM	3:45 PM	11	4.41	0.98	26.87	32.96	4.16	3.26	6.77	3.67	4.91	6.69
	3:45 PM	4:00 PM	11	4.12	0.39	28.75	31.99	4.10	3.46	4.57	3.80	4.51	4.57
	4:00 PM	4:15 PM	10	3.64	1.08	32.48	39.25	3.11	2.80	5.63	3.02	3.87	5.63
	4:15 PM	4:30 PM	18	4.14	0.85	28.58	37.58	3.93	3.01	5.70	3.42	4.93	5.56
	4:30 PM	4:45 PM	7	3.84	0.65	30.84	37.12	3.64	3.17	4.62	3.24	4.51	4.62
	4:45 PM	5:00 PM	14	4.45	0.83	26.59	34.57	4.36	2.97	5.67	4.05	5.15	5.65
	5:00 PM	5:15 PM	6	3.93	0.47	30.15	35.39	4.05	3.09	4.37	3.73	4.28	4.37
	5:15 PM	5:30 PM	11	4.44	0.48	26.67	30.84	4.47	3.62	5.03	4.11	4.86	5.03
	5:30 PM	5:45 PM	9	4.50	0.74	26.29	31.09	4.77	2.72	5.10	4.45	4.87	5.10
	5:45 PM	6:00 PM	8	4.24	0.49	27.90	31.09	4.13	3.63	5.18	3.93	4.50	5.18
	6:00 PM	6:15 PM	6	3.67	0.47	32.25	37.00	3.56	3.10	4.30	3.35	4.15	4.30
	6:15 PM	6:30 PM	12	4.08	0.50	29.01	33.55	4.08	3.43	4.97	3.64	4.32	4.96
	6:30 PM	6:45 PM	7	4.37	0.27	27.08	28.93	4.45	3.81	4.59	4.32	4.56	4.59
	6:45 PM	7:00 PM	7	4.27	0.34	27.76	30.75	4.35	3.85	4.62	3.91	4.57	4.62
	7:00 PM	7:15 PM	11	4.48	2.21	26.44	34.86	3.78	3.23	11.02	3.52	4.35	10.69
	7:15 PM	7:30 PM	13	3.89	0.59	30.41	36.06	3.84	3.25	5.43	3.42	4.19	5.25
	7:30 PM	7:45 PM	5	3.59	0.21	32.98	35.65	3.70	3.27	3.80	3.43	3.73	3.80
	7:45 PM	8:00 PM	8	3.52	0.64	33.68	40.66	3.41	2.90	4.72	2.96	3.88	4.72
	8:00 PM	8:15 PM	6	3.92	0.57	30.19	37.21	4.22	3.11	4.41	3.29	4.27	4.41
	8:15 PM	8:30 PM	6	3.24	0.51	36.52	42.28	3.12	2.80	4.04	2.80	3.57	4.04
	8:30 PM	8:45 PM	5	3.62	0.43	32.67	37.12	3.57	3.09	4.29	3.39	3.84	4.29
	8:45 PM	9:00 PM	7	3.47	0.67	34.16	42.88	3.33	2.68	4.52	2.92	3.99	4.52
	9:00 PM	9:15 PM	8	3.24	0.44	36.50	40.95	3.25	2.50	4.09	3.10	3.33	4.09
	9:15 PM	9:30 PM	3	2.97	0.26	39.87	42.54	2.86	2.78	3.27	2.80	3.16	3.27
	9:30 PM	9:45 PM	0										
	9:45 PM	10:00 PM	4	2.77	0.30	42.76	48.44	2.79	2.42	3.07	2.52	3.02	3.07
	10:00 PM	10:15 PM	2	3.52	0.07	33.67	34.15	3.52	3.47	3.57	3.47	3.57	3.57
	10:15 PM	10:30 PM	4	3.23	0.16	36.66	39.17	3.30	2.99	3.33	3.15	3.31	3.33
	10:30 PM	10:45 PM	4	2.86	0.37	41.36	46.20	2.76	2.54	3.39	2.65	3.08	3.39
	10:45 PM	11:00 PM	4	3.49	0.22	33.89	36.84	3.58	3.17	3.64	3.37	3.62	3.64
	11:00 PM	11:15 PM	1	3.42	0.00	34.65	34.65	3.42	3.42	3.42	3.42	3.42	3.42
	11:15 PM	11:30 PM	3	2.81	0.28	42.07	44.96	2.68	2.63	3.13	2.64	3.02	3.13
	11:30 PM	11:45 PM	2	2.72	0.16	43.58	45.53	2.72	2.60	2.83	2.60	2.83	2.83
Midnight	11:45 PM	12:00 AM	1	3.24	0.00	36.52	36.52	3.24	3.24	3.24	3.24	3.24	3.24

SUMMARY

			Total Number of Samples	Averages of the 15 Minutes periods		
				Mean Travel Time	**Standard Deviation**	**Mean Speed**
AM Peak Period	**7:00 AM**	**9:00 AM**	47	3.34	0.39	35.85
Midday Period	**12:00 PM**	**2:00 PM**	75	4.08	0.53	29.19
PM Peak Period	**4:00 PM**	**6:00 PM**	83	4.15	0.70	28.69
Daily	**12:00 AM**	**12:00 AM**	560	3.54	0.42	34.31

TRAVEL TIME DATA

15 MINUTE STATISTICAL SUMMARY

ROUTE INFORMATION
Name / Number:
Label: North of Yew to South of Evergreen
Length of Segment: 1.973156732 miles
Direction:

Beginning Station: BA7 North of Yew
Latitude: 44.24565667
Longitude: -121.1901833
Ending Station: A0C South of Evergreen
Latitude: 44.27072833
Longitude: -121.171095

Date: 8-Jun-17
Day of Week: Thursday

Project Name: Redmond Bluetooth

Time	Begin Time	End Time	Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
			Sample Size	Mean Travel Time	Standard Deviation	Mean Speed	85th PCT Speed	Median	Min	Max	25th PCT	75th PCT	95th PCT
Midnight	12:00 AM	12:15 AM	1	2.89	0.00	40.94	40.94	2.89	2.89	2.89	2.89	2.89	2.89
	12:15 AM	12:30 AM	2	3.77	0.00	31.43	31.43	3.77	3.77	3.77	3.77	3.77	3.77
	12:30 AM	12:45 AM	2	3.07	0.85	38.61	48.00	3.07	2.47	3.67	2.47	3.67	3.67
	12:45 AM	1:00 AM	2	2.84	0.31	41.72	45.24	2.84	2.62	3.06	2.62	3.06	3.06
	1:00 AM	1:15 AM	3	3.30	0.22	35.88	38.82	3.38	3.05	3.47	3.13	3.45	3.47
	1:15 AM	1:30 AM	0										
	1:30 AM	1:45 AM	0										
	1:45 AM	2:00 AM	0										
	2:00 AM	2:15 AM	2	3.73	0.04	31.78	32.00	3.73	3.70	3.75	3.70	3.75	3.75
	2:15 AM	2:30 AM	0										
	2:30 AM	2:45 AM	3	2.99	0.07	39.57	40.13	2.95	2.95	3.07	2.95	3.04	3.07
	2:45 AM	3:00 AM	0										
	3:00 AM	3:15 AM	0										
	3:15 AM	3:30 AM	1	2.57	0.00	46.13	46.13	2.57	2.57	2.57	2.57	2.57	2.57
	3:30 AM	3:45 AM	0										
	3:45 AM	4:00 AM	0										
	4:00 AM	4:15 AM	0										
	4:15 AM	4:30 AM	3	2.84	0.08	41.62	42.41	2.81	2.79	2.93	2.80	2.90	2.93
	4:30 AM	4:45 AM	1	2.71	0.00	43.71	43.71	2.71	2.71	2.71	2.71	2.71	2.71
	4:45 AM	5:00 AM	2	2.75	0.38	42.99	47.67	2.75	2.48	3.03	2.48	3.03	3.03
	5:00 AM	5:15 AM	2	3.05	0.12	38.82	39.91	3.05	2.97	3.13	2.97	3.13	3.13
	5:15 AM	5:30 AM	0										
	5:30 AM	5:45 AM	1	3.10	0.00	38.19	38.19	3.10	3.10	3.10	3.10	3.10	3.10
	5:45 AM	6:00 AM	5	3.26	0.49	36.28	42.89	3.27	2.75	3.77	2.78	3.75	3.77
	6:00 AM	6:15 AM	4	2.92	0.14	40.56	42.82	2.92	2.75	3.08	2.82	3.01	3.08
	6:15 AM	6:30 AM	2	3.23	0.19	36.71	38.29	3.23	3.09	3.36	3.09	3.36	3.36
	6:30 AM	6:45 AM	4	3.40	0.25	34.80	36.71	3.31	3.22	3.77	3.26	3.55	3.77
	6:45 AM	7:00 AM	10	3.13	0.33	37.80	41.30	2.97	2.87	3.82	2.90	3.37	3.82
	7:00 AM	7:15 AM	6	3.01	0.57	39.35	47.23	2.92	2.50	3.83	2.52	3.37	3.83
	7:15 AM	7:30 AM	6	3.45	0.32	34.30	37.74	3.40	3.05	3.95	3.27	3.64	3.95
	7:30 AM	7:45 AM	7	2.87	0.21	41.21	43.61	2.82	2.69	3.32	2.74	2.89	3.32
	7:45 AM	8:00 AM	8	3.40	0.48	34.83	40.78	3.44	2.72	4.00	2.98	3.81	4.00
	8:00 AM	8:15 AM	7	3.75	0.75	31.58	42.54	4.00	2.78	4.63	2.97	4.38	4.63
	8:15 AM	8:30 AM	8	3.33	0.36	35.58	39.97	3.31	2.66	3.78	3.15	3.63	3.78
	8:30 AM	8:45 AM	9	3.70	1.07	31.96	44.33	3.38	2.60	6.18	3.06	4.09	6.18
	8:45 AM	9:00 AM	7	4.35	0.60	27.19	32.25	4.45	3.35	4.98	3.97	4.91	4.98
	9:00 AM	9:15 AM	9	3.55	0.63	33.31	41.18	3.36	2.73	4.40	3.04	4.16	4.40
	9:15 AM	9:30 AM	4	3.83	1.05	30.92	40.31	3.55	2.88	5.33	3.15	4.51	5.33
	9:30 AM	9:45 AM	6	3.28	0.24	36.07	39.55	3.33	2.97	3.55	3.03	3.48	3.55
	9:45 AM	10:00 AM	10	4.68	1.74	25.31	35.17	3.85	2.93	8.15	3.47	5.60	8.15
	10:00 AM	10:15 AM	10	3.74	0.51	31.63	35.34	3.78	2.68	4.39	3.49	4.09	4.39
	10:15 AM	10:30 AM	11	3.73	1.01	31.70	39.46	3.43	2.91	6.12	3.02	4.35	6.06
	10:30 AM	10:45 AM	10	4.07	0.82	29.05	37.09	3.94	3.12	5.38	3.40	4.87	5.38
	10:45 AM	11:00 AM	7	3.74	0.25	31.62	34.43	3.82	3.38	4.12	3.55	3.83	4.12
	11:00 AM	11:15 AM	8	4.05	0.54	29.25	33.66	3.98	3.21	4.88	3.69	4.47	4.88
	11:15 AM	11:30 AM	12	3.57	0.44	33.17	39.14	3.60	2.89	4.32	3.25	3.79	4.31
	11:30 AM	11:45 AM	7	4.58	1.33	25.82	34.00	4.47	3.27	7.38	3.78	4.61	7.38
	11:45 AM	12:00 PM	9	4.47	0.87	26.48	34.93	5.01	3.23	5.57	3.51	5.05	5.57
Noon	12:00 PM	12:15 PM	8	3.81	0.61	31.05	38.45	3.87	2.82	4.68	3.38	4.25	4.68
	12:15 PM	12:30 PM	7	3.93	0.45	30.12	33.72	3.86	3.34	4.81	3.70	4.04	4.81
	12:30 PM	12:45 PM	8	4.04	0.69	29.33	36.45	4.00	2.93	5.04	3.64	4.51	5.04
	12:45 PM	1:00 PM	7	4.01	0.48	29.54	34.69	4.05	3.37	4.69	3.56	4.31	4.69
	1:00 PM	1:15 PM	12	4.90	0.67	24.17	27.16	4.90	3.43	5.96	4.62	5.21	5.94
	1:15 PM	1:30 PM	9	4.71	0.62	25.12	30.28	4.78	3.77	5.94	4.48	4.88	5.94
	1:30 PM	1:45 PM	9	4.56	1.56	25.96	31.73	4.08	3.63	8.67	3.98	4.29	8.67
	1:45 PM	2:00 PM	8	4.60	0.68	25.71	29.57	4.42	3.82	5.93	4.16	4.97	5.93
	2:00 PM	2:15 PM	4	4.73	0.14	25.02	25.87	4.75	4.57	4.85	4.62	4.85	4.85
	2:15 PM	2:30 PM	9	3.98	0.35	29.75	32.27	3.88	3.49	4.63	3.76	4.18	4.63
	2:30 PM	2:45 PM	9	4.36	0.60	27.15	32.31	4.49	3.46	5.52	3.94	4.62	5.52
	2:45 PM	3:00 PM	8	4.10	0.71	28.85	36.86	4.17	2.97	5.02	3.62	4.64	5.02
	3:00 PM	3:15 PM	8	4.38	0.21	27.06	28.45	4.41	3.99	4.71	4.28	4.46	4.71
	3:15 PM	3:30 PM	12	4.42	0.32	26.79	27.92	4.32	4.01	5.18	4.29	4.40	5.16
	3:30 PM	3:45 PM	12	4.19	0.62	28.25	32.77	4.23	3.01	5.42	3.79	4.57	5.34
	3:45 PM	4:00 PM	10	4.41	0.37	26.87	30.10	4.45	3.85	4.84	4.07	4.76	4.84
	4:00 PM	4:15 PM	9	4.63	0.45	25.59	28.06	4.62	4.18	5.68	4.30	4.76	5.68
	4:15 PM	4:30 PM	5	3.67	0.42	32.27	36.15	3.48	3.23	4.22	3.36	4.06	4.22
	4:30 PM	4:45 PM	11	4.13	0.76	28.70	37.65	4.04	3.01	5.43	3.77	4.53	5.42
	4:45 PM	5:00 PM	16	4.55	1.09	26.03	33.79	4.24	3.41	7.32	3.81	4.82	6.96
	5:00 PM	5:15 PM	8	4.35	0.58	27.20	32.15	4.40	3.41	5.11	3.95	4.81	5.11
	5:15 PM	5:30 PM	14	4.34	0.45	27.25	30.94	4.32	3.73	5.13	3.99	4.75	5.10
	5:30 PM	5:45 PM	7	4.09	0.47	28.98	32.75	3.98	3.40	4.70	3.80	4.53	4.70
	5:45 PM	6:00 PM	17	4.35	0.66	27.20	31.33	4.17	3.44	5.63	3.92	4.74	5.62
	6:00 PM	6:15 PM	9	3.96	0.74	29.88	41.50	4.21	2.78	4.84	3.44	4.54	4.84
	6:15 PM	6:30 PM	9	4.15	1.07	28.54	34.06	3.75	3.06	6.76	3.58	4.35	6.76
	6:30 PM	6:45 PM	12	4.67	0.40	25.36	28.19	4.66	4.07	5.37	4.41	4.87	5.35
	6:45 PM	7:00 PM	11	4.65	0.75	25.45	29.27	4.63	3.08	5.78	4.26	5.22	5.76
	7:00 PM	7:15 PM	10	3.56	0.38	33.29	36.90	3.40	3.19	4.25	3.23	3.88	4.25
	7:15 PM	7:30 PM	12	4.15	0.50	28.52	33.55	4.32	3.22	4.83	3.75	4.51	4.81
	7:30 PM	7:45 PM	10	3.90	0.43	30.38	32.58	3.95	2.93	4.48	3.68	4.22	4.48
	7:45 PM	8:00 PM											
	8:00 PM	8:15 PM											
	8:15 PM	8:30 PM											
	8:30 PM	8:45 PM											
	8:45 PM	9:00 PM											
	9:00 PM	9:15 PM											
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	10:15 PM	10:30 PM											
	10:30 PM	10:45 PM											
	10:45 PM	11:00 PM											
	11:00 PM	11:15 PM											
	11:15 PM	11:30 PM											
	11:30 PM	11:45 PM											
Midnight	11:45 PM	12:00 AM											

SUMMARY

			Total Number of Samples	Averages of the 15 Minutes periods		
				Mean Travel Time	Standard Deviation	Mean Speed
AM Peak Period	**7:00 AM**	**9:00 AM**	58	3.48	0.55	34.50
Midday Period	**12:00 PM**	**2:00 PM**	68	4.32	0.72	27.62
PM Peak Period	**4:00 PM**	**6:00 PM**	87	4.26	0.61	27.90
Daily	**12:00 AM**	**12:00 AM**	511	3.81	0.51	31.93

TRAVEL TIME DATA

15 MINUTE STATISTICAL SUMMARY

ROUTE INFORMATION
Name / Number:
Label: South of Evergreen to North of Yew
Length of Segment: 1.973156732 miles
Direction:

Beginning Station: A0C South of Evergreen
Latitude: 44.27072833
Longitude: -121.171095
Ending Station: BA7 North of Yew
Latitude: 44.24565667
Longitude: -121.1901833

Date: 6-Jun-17
Day of Week: Tuesday

Project Name: Redmond Bluetooth

			Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
Time	Begin Time	End Time	**Sample Size**	**Mean Travel Time**	**Standard Deviation**	**Mean Speed**	**85th PCT Speed**	**Median**	**Min**	**Max**	**25th PCT**	**75th PCT**	**95th PCT**
Midnight	12:00 AM	12:15 AM	5	2.83	0.41	41.81	51.52	3.08	2.18	3.13	2.54	3.11	3.13
	12:15 AM	12:30 AM	4	3.18	0.74	37.24	52.64	3.39	2.15	3.78	2.65	3.71	3.78
	12:30 AM	12:45 AM	5	3.02	0.33	39.16	43.35	2.85	2.71	3.45	2.78	3.34	3.45
	12:45 AM	1:00 AM	3	3.17	0.39	37.39	42.16	3.12	2.81	3.58	2.89	3.46	3.58
	1:00 AM	1:15 AM	2	2.71	0.15	43.71	45.53	2.71	2.60	2.82	2.60	2.82	2.82
	1:15 AM	1:30 AM	3	2.99	0.35	39.57	44.82	2.99	2.64	3.34	2.73	3.25	3.34
	1:30 AM	1:45 AM	2	3.27	0.54	36.24	41.06	3.27	2.88	3.65	2.88	3.65	3.65
	1:45 AM	2:00 AM	1	2.88	0.00	41.06	41.06	2.88	2.88	2.88	2.88	2.88	2.88
	2:00 AM	2:15 AM	1	3.42	0.00	34.65	34.65	3.42	3.42	3.42	3.42	3.42	3.42
	2:15 AM	2:30 AM	2	2.86	0.06	41.42	42.03	2.86	2.82	2.90	2.82	2.90	2.90
	2:30 AM	2:45 AM	3	2.82	0.26	41.99	45.39	2.73	2.61	3.12	2.64	3.02	3.12
	2:45 AM	3:00 AM	0										
	3:00 AM	3:15 AM	1	2.67	0.00	44.40	44.40	2.67	2.67	2.67	2.67	2.67	2.67
	3:15 AM	3:30 AM	1	3.18	0.00	37.19	37.19	3.18	3.18	3.18	3.18	3.18	3.18
	3:30 AM	3:45 AM	2	3.23	0.46	36.71	40.82	3.23	2.90	3.55	2.90	3.55	3.55
	3:45 AM	4:00 AM	0										
	4:00 AM	4:15 AM	0										
	4:15 AM	4:30 AM	2	2.51	0.09	47.12	48.32	2.51	2.45	2.57	2.45	2.57	2.57
	4:30 AM	4:45 AM	1	3.07	0.00	38.61	38.61	3.07	3.07	3.07	3.07	3.07	3.07
	4:45 AM	5:00 AM	2	2.96	0.30	39.96	43.05	2.96	2.75	3.18	2.75	3.18	3.18
	5:00 AM	5:15 AM	1	2.81	0.00	42.16	42.16	2.81	2.81	2.81	2.81	2.81	2.81
	5:15 AM	5:30 AM	3	2.65	0.23	44.68	48.65	2.63	2.43	2.89	2.48	2.83	2.89
	5:30 AM	5:45 AM	4	2.85	0.25	41.51	46.93	2.95	2.47	3.03	2.71	2.99	3.03
	5:45 AM	6:00 AM	3	3.50	0.60	33.85	41.06	3.53	2.88	4.08	3.04	3.94	4.08
	6:00 AM	6:15 AM	1	3.23	0.00	36.62	36.62	3.23	3.23	3.23	3.23	3.23	3.23
	6:15 AM	6:30 AM	6	2.96	0.40	40.04	44.68	2.80	2.57	3.68	2.77	3.12	3.68
	6:30 AM	6:45 AM	7	3.40	0.64	34.84	44.26	3.30	2.54	4.22	2.90	4.03	4.22
	6:45 AM	7:00 AM	7	3.02	0.34	39.23	44.99	3.12	2.52	3.37	2.74	3.33	3.37
	7:00 AM	7:15 AM	6	2.96	0.38	40.04	48.00	3.12	2.35	3.30	2.64	3.22	3.30
	7:15 AM	7:30 AM	13	2.99	0.33	39.64	45.19	3.05	2.43	3.56	2.71	3.21	3.53
	7:30 AM	7:45 AM	10	2.82	0.42	41.97	46.43	2.76	2.38	3.92	2.63	2.80	3.92
	7:45 AM	8:00 AM	11	3.11	0.46	38.01	45.90	3.29	2.48	3.77	2.68	3.48	3.76
	8:00 AM	8:15 AM	12	3.28	0.59	36.13	45.83	3.37	2.40	4.28	2.68	3.74	4.24
	8:15 AM	8:30 AM	14	5.27	3.17	22.45	38.82	4.19	2.64	12.81	3.11	4.38	12.26
	8:30 AM	8:45 AM	4	3.02	0.32	39.25	43.77	2.97	2.68	3.45	2.79	3.24	3.45
	8:45 AM	9:00 AM	15	3.62	0.52	32.69	39.16	3.55	2.74	4.42	3.24	4.12	4.37
	9:00 AM	9:15 AM	7	3.54	0.56	33.45	39.50	3.26	2.98	4.25	3.04	4.07	4.25
	9:15 AM	9:30 AM	9	3.22	0.59	36.73	43.31	2.88	2.73	4.23	2.76	3.86	4.23
	9:30 AM	9:45 AM	12	3.71	1.44	31.94	44.89	3.04	2.48	6.52	2.71	4.20	6.52
	9:45 AM	10:00 AM	9	3.57	0.88	33.18	43.22	3.27	2.58	4.86	2.89	4.41	4.86
	10:00 AM	10:15 AM	9	3.64	0.72	32.52	42.09	4.07	2.60	4.36	2.85	4.22	4.36
	10:15 AM	10:30 AM	7	4.37	1.46	27.10	39.44	4.57	2.84	7.13	3.21	4.79	7.13
	10:30 AM	10:45 AM	6	3.45	0.63	34.27	39.68	3.13	2.97	4.42	3.01	4.08	4.42
	10:45 AM	11:00 AM	12	3.61	0.48	32.76	38.54	3.52	3.00	4.31	3.16	4.10	4.30
	11:00 AM	11:15 AM	7	4.43	1.02	26.71	35.95	4.72	2.82	5.96	3.76	4.97	5.96
	11:15 AM	11:30 AM	10	3.81	0.77	31.08	40.36	3.78	2.79	5.07	3.02	4.47	5.07
	11:30 AM	11:45 AM	5	4.20	0.48	28.15	32.96	4.40	3.37	4.52	4.04	4.48	4.52
	11:45 AM	12:00 PM	9	3.56	0.65	33.28	42.00	3.82	2.78	4.29	2.92	4.14	4.29
Noon	12:00 PM	12:15 PM	5	3.43	0.95	34.52	43.98	2.88	2.68	4.77	2.71	4.27	4.77
	12:15 PM	12:30 PM	10	3.77	0.61	31.41	37.19	3.85	2.75	5.01	3.47	4.03	5.01
	12:30 PM	12:45 PM	4	3.52	0.57	33.65	41.16	3.62	2.83	4.01	3.05	3.99	4.01
	12:45 PM	1:00 PM	10	3.99	0.65	29.69	36.90	4.12	2.95	4.79	3.28	4.52	4.79
	1:00 PM	1:15 PM	9	3.56	0.83	33.23	40.02	3.09	2.91	5.31	3.03	4.10	5.31
	1:15 PM	1:30 PM	11	4.49	0.78	26.38	35.00	4.68	2.98	5.62	4.26	4.82	5.60
	1:30 PM	1:45 PM	9	3.66	0.60	32.35	37.37	3.25	3.03	4.78	3.24	4.05	4.78
	1:45 PM	2:00 PM	11	4.10	1.12	28.86	40.71	4.03	2.73	6.68	3.34	4.57	6.59
	2:00 PM	2:15 PM	6	3.34	0.60	35.41	41.54	3.05	2.75	4.22	3.00	3.99	4.22
	2:15 PM	2:30 PM	5	4.01	0.62	29.56	36.85	4.27	2.98	4.55	3.69	4.36	4.55
	2:30 PM	2:45 PM	7	3.68	1.06	32.14	41.18	2.97	2.78	5.57	2.95	4.34	5.57
	2:45 PM	3:00 PM	8	4.40	1.25	26.91	41.06	4.56	2.88	6.69	3.36	4.90	6.69
	3:00 PM	3:15 PM	14	4.25	0.57	27.83	34.50	4.45	3.12	4.83	4.02	4.77	4.82
	3:15 PM	3:30 PM	10	3.51	0.57	33.73	40.25	3.49	2.83	4.37	3.00	4.03	4.37
	3:30 PM	3:45 PM	8	4.36	0.94	27.14	31.70	4.18	3.02	6.34	4.09	4.50	6.34
	3:45 PM	4:00 PM	2	3.04	0.09	38.98	39.79	3.04	2.97	3.10	2.97	3.10	3.10
	4:00 PM	4:15 PM	14	3.72	0.55	31.79	37.00	3.45	3.07	4.50	3.28	4.28	4.50
	4:15 PM	4:30 PM	11	3.95	0.78	30.00	39.33	3.90	2.88	5.09	3.27	4.67	5.08
	4:30 PM	4:45 PM	11	3.83	0.68	30.91	38.55	3.53	2.88	4.73	3.34	4.47	4.72
	4:45 PM	5:00 PM	10	4.59	0.52	25.81	27.75	4.57	3.68	5.73	4.32	4.80	5.73
	5:00 PM	5:15 PM	6	3.47	0.75	34.08	40.38	3.04	2.87	4.51	3.02	4.37	4.51
	5:15 PM	5:30 PM	13	3.96	1.34	29.87	41.08	3.20	2.77	7.40	3.00	4.53	7.07
	5:30 PM	5:45 PM	17	4.15	0.58	28.55	36.51	4.33	2.97	4.81	3.80	4.51	4.76
	5:45 PM	6:00 PM	16	3.88	0.65	30.53	38.78	4.25	2.92	4.68	3.28	4.41	4.63
	6:00 PM	6:15 PM	20	3.87	0.77	30.61	37.99	3.68	3.04	5.60	3.13	4.49	5.28
	6:15 PM	6:30 PM	12	3.44	0.75	34.45	41.00	3.02	2.67	4.80	2.92	4.17	4.77
	6:30 PM	6:45 PM	7	3.52	0.71	33.64	40.56	3.18	2.80	4.72	3.05	4.08	4.72
	6:45 PM	7:00 PM	11	3.72	0.90	31.87	40.23	3.63	2.68	5.80	2.99	4.17	5.72
	7:00 PM	7:15 PM	11	3.06	0.57	38.69	45.07	2.72	2.62	4.23	2.69	3.29	4.22
	7:15 PM	7:30 PM	19	3.48	0.83	34.02	42.89	3.09	2.53	5.50	2.85	4.16	5.04
	7:30 PM	7:45 PM	14	3.09	0.84	38.28	45.80	2.82	2.38	5.70	2.72	3.19	5.33
	7:45 PM	8:00 PM	5	3.39	1.34	34.97	45.14	2.69	2.61	5.73	2.65	3.85	5.73
	8:00 PM	8:15 PM	4	3.65	0.65	32.47	41.52	3.77	2.75	4.29	3.26	4.03	4.29
	8:15 PM	8:30 PM	2	2.43	0.12	48.65	50.38	2.43	2.35	2.52	2.35	2.52	2.52
	8:30 PM	8:45 PM	6	3.56	1.56	33.25	45.68	2.81	2.57	6.55	2.62	4.00	6.55
	8:45 PM	9:00 PM	11	3.25	0.68	36.43	46.11	2.88	2.54	4.57	2.69	3.73	4.55
	9:00 PM	9:15 PM	8	3.11	0.32	38.04	42.34	3.10	2.65	3.72	2.93	3.23	3.72
	9:15 PM	9:30 PM	6	3.14	0.57	37.68	45.65	3.01	2.52	3.83	2.71	3.78	3.83
	9:30 PM	9:45 PM	4	3.08	0.48	38.45	41.91	2.85	2.83	3.80	2.83	3.33	3.80
	9:45 PM	10:00 PM	9	3.41	0.44	34.73	39.80	3.59	2.64	4.03	3.11	3.69	4.03
	10:00 PM	10:15 PM	4	3.15	0.35	37.58	42.79	3.14	2.73	3.58	2.90	3.40	3.58
	10:15 PM	10:30 PM	3	2.69	0.15	44.07	46.13	2.63	2.57	2.86	2.58	2.80	2.86
	10:30 PM	10:45 PM	2	3.12	0.94	37.99	48.32	3.12	2.45	3.78	2.45	3.78	3.78
	10:45 PM	11:00 PM	3	4.04	0.97	29.33	40.36	4.44	2.93	4.73	3.31	4.66	4.73
	11:00 PM	11:15 PM	2	2.85	0.32	41.60	45.24	2.85	2.62	3.07	2.62	3.07	3.07
	11:15 PM	11:30 PM	4	3.41	0.55	34.74	40.67	3.29	2.88	4.17	3.02	3.80	4.17
	11:30 PM	11:45 PM	3	3.82	0.69	31.02	38.82	4.00	3.05	4.40	3.29	4.30	4.40
Midnight	11:45 PM	12:00 AM	3	2.70	0.12	43.89	45.39	2.65	2.61	2.83	2.62	2.79	2.83

SUMMARY

			Total Number of Samples	Averages of the 15 Minutes periods		
				Mean Travel Time	**Standard Deviation**	**Mean Speed**
AM Peak Period	**7:00 AM**	**9:00 AM**	85	3.38	0.77	36.27
Midday Period	**12:00 PM**	**2:00 PM**	69	3.81	0.76	31.26
PM Peak Period	**4:00 PM**	**6:00 PM**	98	3.94	0.73	30.19
Daily	**12:00 AM**	**12:00 AM**	659	3.43	0.60	35.29

TRAVEL TIME DATA

15 MINUTE STATISTICAL SUMMARY

ROUTE INFORMATION
Name / Number:
Label: South of Evergreen to North of Yew
Length of Segment: 1.973156732 miles
Direction:

Beginning Station: A0C South of Evergreen
Latitude: 44.27072833
Longitude: -121.171095
Ending Station: BA7 North of Yew
Latitude: 44.24565667
Longitude: -121.1901833

Date: 7-Jun-17
Day of Week: Wednesday

Project Name: Redmond Bluetooth

			Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
Time	Begin Time	End Time	Sample Size	Mean Travel Time	Standard Deviation	Mean Speed	85th PCT Speed	Median	Min	Max	25th PCT	75th PCT	95th PCT
Midnight	12:00 AM	12:15 AM	0										
	12:15 AM	12:30 AM	1	3.16	0.00	37.48	37.48	3.16	3.16	3.16	3.16	3.16	3.16
	12:30 AM	12:45 AM	2	3.28	0.44	36.10	39.91	3.28	2.97	3.59	2.97	3.59	3.59
	12:45 AM	1:00 AM	3	2.83	0.25	41.83	46.43	2.92	2.55	3.02	2.64	2.99	3.02
	1:00 AM	1:15 AM	4	2.74	0.04	43.15	43.92	2.75	2.69	2.77	2.71	2.77	2.77
	1:15 AM	1:30 AM	2	2.75	0.12	43.05	44.40	2.75	2.67	2.83	2.67	2.83	2.83
	1:30 AM	1:45 AM	0										
	1:45 AM	2:00 AM	0										
	2:00 AM	2:15 AM	0										
	2:15 AM	2:30 AM	0										
	2:30 AM	2:45 AM	0										
	2:45 AM	3:00 AM	0										
	3:00 AM	3:15 AM	0										
	3:15 AM	3:30 AM	1	2.78	0.00	42.54	42.54	2.78	2.78	2.78	2.78	2.78	2.78
	3:30 AM	3:45 AM	2	2.66	0.06	44.54	45.24	2.66	2.62	2.70	2.62	2.70	2.70
	3:45 AM	4:00 AM	1	2.76	0.00	42.92	42.92	2.76	2.76	2.76	2.76	2.76	2.76
	4:00 AM	4:15 AM	4	2.68	0.52	44.19	53.81	2.68	2.19	3.17	2.23	3.13	3.17
	4:15 AM	4:30 AM	1	2.83	0.00	41.78	41.78	2.83	2.83	2.83	2.83	2.83	2.83
	4:30 AM	4:45 AM	0										
	4:45 AM	5:00 AM	0										
	5:00 AM	5:15 AM	2	2.78	0.58	42.66	50.02	2.78	2.37	3.18	2.37	3.18	3.18
	5:15 AM	5:30 AM	4	2.92	0.45	40.50	44.80	2.73	2.64	3.58	2.65	3.20	3.58
	5:30 AM	5:45 AM	5	2.66	0.17	44.54	46.89	2.65	2.53	2.94	2.53	2.72	2.94
	5:45 AM	6:00 AM	1	2.75	0.00	43.05	43.05	2.75	2.75	2.75	2.75	2.75	2.75
	6:00 AM	6:15 AM	2	2.88	0.45	41.18	46.28	2.88	2.56	3.19	2.56	3.19	3.19
	6:15 AM	6:30 AM	3	2.81	0.39	42.11	48.65	2.78	2.43	3.22	2.52	3.11	3.22
	6:30 AM	6:45 AM	2	3.04	0.25	38.92	41.30	3.04	2.87	3.22	2.87	3.22	3.22
	6:45 AM	7:00 AM	12	2.94	0.43	40.29	45.98	2.84	2.33	3.88	2.67	3.25	3.82
	7:00 AM	7:15 AM	9	2.81	0.16	42.06	44.42	2.82	2.52	3.07	2.72	2.90	3.07
	7:15 AM	7:30 AM	9	2.98	0.29	39.70	42.60	2.92	2.57	3.63	2.83	3.08	3.63
	7:30 AM	7:45 AM	13	2.89	0.47	41.01	47.36	2.75	2.40	3.95	2.56	3.03	3.90
	7:45 AM	8:00 AM	6	2.93	0.27	40.40	44.62	2.91	2.63	3.35	2.68	3.10	3.35
	8:00 AM	8:15 AM	8	3.12	0.56	37.94	48.99	3.16	2.42	4.22	2.77	3.24	4.22
	8:15 AM	8:30 AM	11	3.28	0.69	36.10	45.24	3.12	2.53	4.28	2.63	3.99	4.28
	8:30 AM	8:45 AM	12	3.77	0.54	31.43	38.75	3.92	2.88	4.33	3.19	4.23	4.33
	8:45 AM	9:00 AM	11	3.55	0.85	33.39	42.78	3.03	2.63	4.93	2.82	4.16	4.92
	9:00 AM	9:15 AM	13	3.69	1.02	32.09	43.01	3.25	2.57	5.98	2.85	4.45	5.77
	9:15 AM	9:30 AM	13	3.42	0.67	34.59	41.40	3.27	2.46	4.88	2.97	3.86	4.79
	9:30 AM	9:45 AM	8	3.31	0.71	35.81	46.28	3.06	2.50	4.38	2.76	3.97	4.38
	9:45 AM	10:00 AM	13	3.41	0.61	34.68	42.09	3.26	2.68	4.48	2.95	3.89	4.46
	10:00 AM	10:15 AM	3	2.73	0.10	43.31	44.96	2.74	2.63	2.82	2.66	2.80	2.82
	10:15 AM	10:30 AM	15	3.21	0.43	36.93	42.19	2.98	2.72	3.86	2.83	3.57	3.85
	10:30 AM	10:45 AM	9	3.49	0.42	33.96	38.90	3.43	2.82	4.10	3.21	3.81	4.10
	10:45 AM	11:00 AM	7	3.73	1.12	31.71	42.21	3.10	2.75	5.83	2.91	4.36	5.83
	11:00 AM	11:15 AM	11	2.95	0.56	40.15	47.91	2.78	2.30	4.30	2.68	3.22	4.26
	11:15 AM	11:30 AM	6	4.75	0.75	24.95	28.99	4.46	3.98	5.91	4.23	5.43	5.91
	11:30 AM	11:45 AM	5	2.97	0.19	39.93	43.02	2.98	2.72	3.22	2.82	3.09	3.22
	11:45 AM	12:00 PM	12	3.91	0.66	30.30	39.25	4.11	2.86	4.78	3.39	4.40	4.76
Noon	12:00 PM	12:15 PM	5	3.33	0.47	35.61	42.25	3.27	2.71	3.87	2.99	3.74	3.87
	12:15 PM	12:30 PM	11	3.47	0.72	34.14	40.94	3.06	2.85	4.86	2.90	4.16	4.83
	12:30 PM	12:45 PM	11	3.34	0.52	35.46	40.71	3.26	2.83	4.23	2.92	3.70	4.23
	12:45 PM	1:00 PM	11	3.47	0.54	34.17	39.74	3.23	2.72	4.29	3.07	3.93	4.29
	1:00 PM	1:15 PM	7	3.26	0.36	36.36	41.52	3.19	2.79	3.82	2.97	3.50	3.82
	1:15 PM	1:30 PM	4	4.03	0.70	29.38	37.30	4.16	3.08	4.72	3.54	4.52	4.72
	1:30 PM	1:45 PM	13	4.14	0.76	28.61	41.12	4.46	2.77	4.72	3.89	4.69	4.72
	1:45 PM	2:00 PM	11	4.00	0.58	29.62	37.62	4.07	2.78	4.66	4.03	4.36	4.65
	2:00 PM	2:15 PM	8	3.43	0.63	34.49	40.26	3.09	2.90	4.45	2.97	3.99	4.45
	2:15 PM	2:30 PM	6	3.95	0.83	30.00	38.31	3.89	3.00	4.88	3.22	4.79	4.88
	2:30 PM	2:45 PM	11	4.32	0.64	27.41	30.46	4.26	3.10	5.40	4.00	4.77	5.38
	2:45 PM	3:00 PM	11	4.70	0.95	25.16	33.16	4.98	2.85	6.12	4.10	5.30	6.08
	3:00 PM	3:15 PM	11	4.07	1.67	29.11	39.78	3.34	2.91	8.81	3.28	4.35	8.60
	3:15 PM	3:30 PM	8	3.94	0.93	30.06	40.28	3.95	2.93	5.47	3.02	4.57	5.47
	3:30 PM	3:45 PM	11	3.94	0.76	30.08	38.57	4.27	2.83	5.05	3.11	4.52	5.03
	3:45 PM	4:00 PM	10	4.06	1.23	29.14	36.43	3.56	3.06	7.24	3.33	4.37	7.24
	4:00 PM	4:15 PM	7	3.82	0.78	31.02	41.65	3.75	2.83	4.77	3.04	4.49	4.77
	4:15 PM	4:30 PM	11	3.92	0.70	30.20	39.49	4.01	2.83	4.96	3.22	4.42	4.93
	4:30 PM	4:45 PM	12	3.99	0.73	29.65	38.66	4.18	2.97	4.92	3.11	4.56	4.91
	4:45 PM	5:00 PM	12	3.86	0.63	30.68	39.86	4.15	2.80	4.69	3.39	4.30	4.66
	5:00 PM	5:15 PM	8	4.00	0.57	29.57	37.48	4.19	3.04	4.53	3.65	4.38	4.53
	5:15 PM	5:30 PM	7	4.21	0.72	28.15	37.13	4.51	3.04	4.84	3.60	4.64	4.84
	5:30 PM	5:45 PM	13	4.27	0.70	27.70	33.81	4.14	2.85	5.07	4.04	4.79	5.07
	5:45 PM	6:00 PM	13	4.10	0.89	28.88	39.75	4.28	2.70	5.23	3.34	4.82	5.22
	6:00 PM	6:15 PM	13	4.19	0.52	28.25	33.39	4.21	3.13	4.76	3.97	4.60	4.75
	6:15 PM	6:30 PM	14	4.20	0.68	28.16	38.56	4.54	2.98	4.82	4.00	4.70	4.82
	6:30 PM	6:45 PM	10	3.97	0.70	29.83	39.46	4.21	2.75	4.76	3.31	4.54	4.76
	6:45 PM	7:00 PM	12	3.36	0.71	35.24	41.18	3.05	2.75	5.13	2.97	3.62	5.03
	7:00 PM	7:15 PM	9	2.90	0.20	40.82	43.14	2.89	2.62	3.22	2.77	3.00	3.22
	7:15 PM	7:30 PM	8	3.62	0.66	32.72	38.77	3.32	2.87	4.50	3.13	4.34	4.50
	7:30 PM	7:45 PM	8	3.39	0.74	34.88	44.96	3.07	2.63	4.56	2.84	4.07	4.56
	7:45 PM	8:00 PM	6	2.85	0.18	41.56	45.16	2.93	2.61	3.00	2.64	2.98	3.00
	8:00 PM	8:15 PM	4	2.74	0.31	43.18	46.13	2.60	2.57	3.21	2.57	2.92	3.21
	8:15 PM	8:30 PM	5	3.08	0.33	38.38	43.98	3.10	2.60	3.49	2.88	3.32	3.49
	8:30 PM	8:45 PM	5	3.58	0.60	33.09	41.60	3.73	2.70	4.23	3.14	4.01	4.23
	8:45 PM	9:00 PM	7	3.40	0.78	34.81	41.11	3.18	2.82	5.07	2.93	3.48	5.07
	9:00 PM	9:15 PM	7	3.68	0.65	32.14	41.36	3.71	2.82	4.56	3.07	4.18	4.56
	9:15 PM	9:30 PM	3	3.17	0.30	37.35	40.82	3.11	2.90	3.50	2.95	3.40	3.50
	9:30 PM	9:45 PM	6	4.23	0.72	27.98	33.62	4.20	3.37	5.48	3.74	4.38	5.48
	9:45 PM	10:00 PM	6	3.64	0.49	32.52	37.48	3.63	3.14	4.48	3.18	3.78	4.48
	10:00 PM	10:15 PM	3	4.34	0.93	27.25	31.36	3.84	3.77	5.42	3.79	5.02	5.42
	10:15 PM	10:30 PM	9	3.98	0.43	29.71	33.63	3.90	3.35	4.54	3.61	4.42	4.54
	10:30 PM	10:45 PM	0										
	10:45 PM	11:00 PM	5	3.69	0.52	32.07	38.42	3.67	2.90	4.32	3.44	4.04	4.32
	11:00 PM	11:15 PM	2	4.64	0.11	25.51	25.92	4.64	4.57	4.72	4.57	4.72	4.72
	11:15 PM	11:30 PM	2	5.20	0.48	22.77	24.37	5.20	4.86	5.54	4.86	5.54	5.54
	11:30 PM	11:45 PM	6	4.02	0.41	29.46	32.78	3.93	3.43	4.65	3.89	4.28	4.65
Midnight	11:45 PM	12:00 AM	5	3.38	0.22	34.99	38.14	3.47	2.98	3.51	3.35	3.49	3.51

SUMMARY

			Total Number of Samples	Averages of the 15 Minutes periods		
				Mean Travel Time	Standard Deviation	Mean Speed
AM Peak Period	**7:00 AM**	**9:00 AM**	79	3.17	0.48	37.75
Midday Period	**12:00 PM**	**2:00 PM**	73	3.63	0.58	32.92
PM Peak Period	**4:00 PM**	**6:00 PM**	83	4.02	0.71	29.48
Daily	**12:00 AM**	**12:00 AM**	633	3.49	0.53	34.81

TRAVEL TIME DATA

15 MINUTE STATISTICAL SUMMARY

ROUTE INFORMATION
Name / Number:
Label: South of Evergreen to North of Yew
Length of Segment: 1.973156732 miles
Direction:

Beginning Station: A0C South of Evergreen
Latitude: 44.27072833
Longitude: -121.171095
Ending Station: BA7 North of Yew
Latitude: 44.24565667
Longitude: -121.1901833

Date: 8-Jun-17
Day of Week: Thursday

Project Name: Redmond Bluetooth

	Begin Time	End Time	Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
Time			**Sample Size**	**Mean Travel Time**	**Standard Deviation**	**Mean Speed**	**85th PCT Speed**	**Median**	**Min**	**Max**	**25th PCT**	**75th PCT**	**95th PCT**
Midnight	12:00 AM	12:15 AM	3	4.00	0.02	29.60	29.78	4.01	3.98	4.02	3.98	4.01	4.02
	12:15 AM	12:30 AM	3	3.41	0.34	34.76	37.00	3.22	3.20	3.80	3.20	3.65	3.80
	12:30 AM	12:45 AM	0										
	12:45 AM	1:00 AM	4	3.64	0.50	32.53	36.54	3.49	3.22	4.36	3.33	3.95	4.36
	1:00 AM	1:15 AM	1	3.05	0.00	38.82	38.82	3.05	3.05	3.05	3.05	3.05	3.05
	1:15 AM	1:30 AM	2	3.18	0.42	37.19	41.06	3.18	2.88	3.48	2.88	3.48	3.48
	1:30 AM	1:45 AM	0										
	1:45 AM	2:00 AM	0										
	2:00 AM	2:15 AM	5	3.03	0.48	39.03	48.95	3.24	2.19	3.37	2.87	3.29	3.37
	2:15 AM	2:30 AM	1	3.16	0.00	37.48	37.48	3.16	3.16	3.16	3.16	3.16	3.16
	2:30 AM	2:45 AM	1	2.78	0.00	42.54	42.54	2.78	2.78	2.78	2.78	2.78	2.78
	2:45 AM	3:00 AM	3	3.15	0.26	37.55	40.48	3.09	2.93	3.44	2.97	3.35	3.44
	3:00 AM	3:15 AM	1	2.61	0.00	45.39	45.39	2.61	2.61	2.61	2.61	2.61	2.61
	3:15 AM	3:30 AM	2	3.50	0.04	33.79	34.07	3.50	3.47	3.53	3.47	3.53	3.53
	3:30 AM	3:45 AM	3	3.57	0.44	33.12	37.48	3.53	3.16	4.03	3.25	3.91	4.03
	3:45 AM	4:00 AM	0										
	4:00 AM	4:15 AM	1	2.72	0.00	43.58	43.58	2.72	2.72	2.72	2.72	2.72	2.72
	4:15 AM	4:30 AM	3	2.88	0.22	41.06	43.58	2.80	2.72	3.13	2.74	3.05	3.13
	4:30 AM	4:45 AM	0										
	4:45 AM	5:00 AM	0										
	5:00 AM	5:15 AM	2	3.39	0.76	34.95	41.54	3.39	2.85	3.92	2.85	3.92	3.92
	5:15 AM	5:30 AM	3	2.82	0.04	41.91	42.54	2.82	2.78	2.87	2.79	2.86	2.87
	5:30 AM	5:45 AM	0										
	5:45 AM	6:00 AM	1	2.65	0.00	44.68	44.68	2.65	2.65	2.65	2.65	2.65	2.65
	6:00 AM	6:15 AM	5	3.07	0.35	38.52	42.79	3.00	2.75	3.63	2.80	3.28	3.63
	6:15 AM	6:30 AM	3	2.79	0.45	42.41	51.10	2.85	2.32	3.21	2.45	3.12	3.21
	6:30 AM	6:45 AM	9	3.20	0.43	37.01	43.38	3.37	2.52	3.80	2.77	3.45	3.80
	6:45 AM	7:00 AM	6	3.12	0.49	37.94	44.96	3.08	2.53	3.77	2.78	3.47	3.77
	7:00 AM	7:15 AM	9	2.92	0.43	40.59	48.57	2.82	2.37	3.65	2.52	3.22	3.65
	7:15 AM	7:30 AM	7	2.95	0.49	40.13	46.62	2.98	2.43	3.93	2.64	3.03	3.93
	7:30 AM	7:45 AM	20	2.89	0.47	40.97	46.35	2.76	2.32	4.17	2.57	3.04	3.94
	7:45 AM	8:00 AM	10	3.16	0.58	37.49	43.05	2.85	2.51	4.38	2.80	3.62	4.38
	8:00 AM	8:15 AM	3	3.23	0.69	36.68	47.04	3.28	2.52	3.88	2.71	3.73	3.88
	8:15 AM	8:30 AM	17	3.58	0.58	33.11	41.00	3.63	2.78	4.33	3.03	4.07	4.33
	8:30 AM	8:45 AM	15	3.71	0.71	31.91	42.60	4.00	2.59	4.56	3.20	4.43	4.55
	8:45 AM	9:00 AM	17	4.38	1.35	27.01	38.22	4.02	2.72	7.27	3.69	4.55	7.27
	9:00 AM	9:15 AM	7	5.97	4.38	19.81	45.01	4.45	2.48	14.88	2.83	7.25	14.88
	9:15 AM	9:30 AM	17	4.69	3.67	25.23	44.10	2.93	2.33	14.09	2.75	4.20	13.35
	9:30 AM	9:45 AM	10	3.45	0.56	34.31	43.18	3.42	2.62	4.15	3.12	4.11	4.15
	9:45 AM	10:00 AM	14	3.34	0.44	35.50	41.27	3.27	2.76	4.07	2.97	3.63	4.04
	10:00 AM	10:15 AM	6	3.20	0.48	37.00	42.87	3.02	2.64	3.83	2.94	3.75	3.83
	10:15 AM	10:30 AM	11	3.20	0.56	37.04	42.92	2.99	2.54	4.62	2.90	3.45	4.56
	10:30 AM	10:45 AM	9	3.53	0.61	33.52	44.02	3.60	2.58	4.20	3.00	4.00	4.20
	10:45 AM	11:00 AM	9	4.16	2.68	28.48	42.25	3.18	2.77	11.15	2.81	4.12	11.15
	11:00 AM	11:15 AM	12	3.77	1.13	31.39	43.63	3.93	2.43	6.38	2.78	4.24	6.22
	11:15 AM	11:30 AM	6	3.37	0.54	35.18	41.78	3.34	2.80	4.17	2.88	3.66	4.17
	11:30 AM	11:45 AM	9	3.27	0.57	36.23	42.65	3.03	2.59	4.08	2.91	3.90	4.08
	11:45 AM	12:00 PM	10	3.94	0.97	30.07	41.78	4.03	2.75	6.04	3.17	4.18	6.04
Noon	12:00 PM	12:15 PM	17	3.89	1.17	30.43	40.53	3.78	2.79	7.98	3.11	4.09	6.71
	12:15 PM	12:30 PM	5	4.28	1.66	27.64	42.00	4.22	2.77	6.91	2.92	5.14	6.91
	12:30 PM	12:45 PM	12	4.32	1.63	27.39	39.41	4.28	2.78	8.68	3.04	5.00	8.32
	12:45 PM	1:00 PM	7	4.76	1.53	24.89	31.67	4.43	3.32	8.10	4.17	4.47	8.10
	1:00 PM	1:15 PM	11	3.55	0.63	33.36	39.62	3.33	2.90	4.57	3.03	4.24	4.56
	1:15 PM	1:30 PM	10	4.20	0.52	28.20	32.14	4.38	3.00	4.72	3.94	4.42	4.72
	1:30 PM	1:45 PM	5	4.87	0.35	24.29	26.13	4.81	4.49	5.40	4.61	5.11	5.40
	1:45 PM	2:00 PM	9	4.30	0.63	27.54	31.48	4.48	2.73	4.82	4.32	4.60	4.82
	2:00 PM	2:15 PM	9	5.84	5.76	20.27	38.04	4.38	2.99	21.10	3.34	4.68	21.10
	2:15 PM	2:30 PM	8	6.30	6.65	18.79	35.22	3.96	3.23	22.69	3.47	4.81	22.69
	2:30 PM	2:45 PM	11	3.91	0.66	30.25	35.52	3.82	3.08	5.26	3.34	4.33	5.23
	2:45 PM	3:00 PM	9	4.36	0.44	27.15	29.77	4.48	3.33	4.82	4.23	4.61	4.82
	3:00 PM	3:15 PM	8	4.95	0.38	23.92	26.21	4.92	4.40	5.47	4.66	5.28	5.47
	3:15 PM	3:30 PM	10	3.71	0.69	31.87	38.40	3.37	2.87	4.73	3.18	4.42	4.73
	3:30 PM	3:45 PM	17	4.23	0.70	27.96	37.00	4.52	3.11	5.03	3.52	4.79	5.02
	3:45 PM	4:00 PM	9	4.10	0.61	28.90	37.12	4.45	3.08	4.67	3.56	4.53	4.67
	4:00 PM	4:15 PM	12	5.09	0.89	23.27	25.19	4.84	3.47	6.73	4.78	5.28	6.72
	4:15 PM	4:30 PM	11	3.62	0.77	32.74	40.58	3.20	2.81	4.73	3.04	4.49	4.73
	4:30 PM	4:45 PM	11	3.85	0.67	30.74	38.95	3.93	2.99	4.83	3.11	4.36	4.82
	4:45 PM	5:00 PM	8	3.84	0.71	30.83	39.32	4.05	2.78	4.64	3.17	4.42	4.64
	5:00 PM	5:15 PM	6	3.51	0.74	33.71	41.66	3.25	2.81	4.52	2.89	4.35	4.52
	5:15 PM	5:30 PM	14	3.90	0.60	30.32	37.35	4.18	3.02	4.63	3.23	4.41	4.61
	5:30 PM	5:45 PM	16	3.78	0.68	31.33	38.29	3.54	2.92	4.67	3.15	4.51	4.67
	5:45 PM	6:00 PM	14	4.10	0.94	28.84	41.23	4.36	2.78	5.67	3.12	4.82	5.60
	6:00 PM	6:15 PM	13	3.78	0.54	31.35	37.34	3.84	2.91	4.54	3.30	4.34	4.54
	6:15 PM	6:30 PM	19	3.82	0.77	31.02	40.48	3.91	2.88	4.85	3.10	4.53	4.81
	6:30 PM	6:45 PM	9	3.73	0.86	31.76	43.58	4.04	2.72	4.72	2.73	4.44	4.72
	6:45 PM	7:00 PM	11	3.32	0.87	35.68	42.31	2.98	2.61	5.52	2.84	3.28	5.46
	7:00 PM	7:15 PM	8	3.14	0.50	37.71	43.26	2.98	2.67	4.24	2.82	3.31	4.24
	7:15 PM	7:30 PM	11	3.78	1.19	31.30	42.89	3.12	2.68	5.85	2.87	4.30	5.85
	7:30 PM	7:45 PM	3	2.98	0.26	39.68	44.12	3.13	2.68	3.13	2.80	3.13	3.13
	7:45 PM	8:00 PM											
	8:00 PM	8:15 PM											
	8:15 PM	8:30 PM											
	8:30 PM	8:45 PM											
	8:45 PM	9:00 PM											
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	10:00 PM	10:15 PM											
	10:15 PM	10:30 PM											
	10:30 PM	10:45 PM											
	10:45 PM	11:00 PM											
	11:00 PM	11:15 PM											
	11:15 PM	11:30 PM											
	11:30 PM	11:45 PM											
Midnight	11:45 PM	12:00 AM											

SUMMARY

			Total Number of Samples	Averages of the 15 Minutes periods		
				Mean Travel Time	**Standard Deviation**	**Mean Speed**
AM Peak Period	**7:00 AM**	**9:00 AM**	98	3.35	0.66	35.99
Midday Period	**12:00 PM**	**2:00 PM**	76	4.27	1.02	27.97
PM Peak Period	**4:00 PM**	**6:00 PM**	92	3.96	0.75	30.22
Daily	**12:00 AM**	**12:00 AM**	603	3.70	0.86	33.17

iPeMS - US 97 NB

Hour	Average Speed (n	Avg Travel Time (mins)
6/1/2017 16:00	26.89	4.47
6/1/2017 17:00	29.60	4.08
6/6/2017 16:00	29.60	4.08
6/6/2017 17:00	30.64	3.94
6/7/2017 16:00	29.17	4.16
6/7/2017 17:00	30.55	3.93
6/8/2017 16:00	30.65	3.92
6/8/2017 17:00	30.39	3.96
6/13/2017 16:00	30.59	3.94
6/13/2017 17:00	27.75	4.35
6/14/2017 16:00	32.24	3.72
6/14/2017 17:00	30.28	3.97
6/15/2017 16:00	26.96	4.49
6/15/2017 17:00	28.65	4.21
6/20/2017 16:00	29.97	4.01
6/20/2017 17:00	30.61	3.94
6/21/2017 16:00	29.89	4.08
6/21/2017 17:00	31.92	3.79
6/22/2017 16:00	26.11	4.72
6/22/2017 17:00	28.56	4.24
6/27/2017 16:00	32.38	3.71
6/27/2017 17:00	29.06	4.15
6/28/2017 16:00	32.39	3.76
6/28/2017 17:00	28.82	4.20
6/29/2017 16:00	30.50	3.96
6/29/2017 17:00	30.34	3.99
7/5/2017 16:00	26.82	4.49
7/5/2017 17:00	29.37	4.17
7/6/2017 16:00	28.98	4.18
7/6/2017 17:00	27.41	4.42
7/11/2017 16:00	29.02	4.15
7/11/2017 17:00	26.00	4.64
7/12/2017 16:00	32.35	3.73
7/12/2017 17:00	26.67	4.51
7/13/2017 16:00	28.40	4.24
7/13/2017 17:00	28.85	4.19
7/18/2017 16:00	27.07	4.46
7/18/2017 17:00	31.01	3.90
7/19/2017 16:00	30.16	4.04
7/19/2017 17:00	28.89	4.17
7/20/2017 16:00	28.17	4.30
7/20/2017 17:00	30.74	3.92
7/25/2017 16:00	30.56	3.93
7/25/2017 17:00	28.97	4.15
7/26/2017 16:00	26.56	4.55
7/26/2017 17:00	30.11	4.00
7/27/2017 16:00	29.75	4.05
7/27/2017 17:00	31.57	3.80
8/1/2017 16:00	27.21	4.42
8/1/2017 17:00	26.26	4.58
8/2/2017 16:00	31.46	3.83
8/2/2017 17:00	27.70	4.36
8/3/2017 16:00	25.39	4.74
8/3/2017 17:00	27.46	4.39
8/8/2017 16:00	28.66	4.21
8/8/2017 17:00	31.26	3.86
8/9/2017 16:00	26.92	4.47
8/9/2017 17:00	31.95	3.79
8/10/2017 16:00	27.80	4.36
8/10/2017 17:00	30.97	3.90
8/15/2017 16:00	28.73	4.21
8/15/2017 17:00	28.53	4.24
8/16/2017 16:00	26.20	4.61
8/16/2017 17:00	30.19	4.04
8/17/2017 16:00	28.91	4.17
8/17/2017 17:00	34.06	3.53
8/22/2017 16:00	28.08	4.34
8/22/2017 17:00	30.74	3.92
8/23/2017 16:00	29.80	4.03
8/23/2017 17:00	28.29	4.28
8/24/2017 16:00	29.16	4.15
8/24/2017 17:00	28.44	4.30
8/29/2017 16:00	27.68	4.36
8/29/2017 17:00	32.63	3.68
8/30/2017 16:00	29.62	4.06
8/30/2017 17:00	31.39	3.83
8/31/2017 16:00	30.69	3.93
8/31/2017 17:00	29.78	4.06

iPeMS - US 97 SB

Hour	Average Speed	Avg Travel Time (mins)
6/1/2017 16:00	30.40	4.39
6/1/2017 17:00	37.20	3.57
6/2/2017 16:00	27.74	4.79
6/2/2017 17:00	31.33	4.26
6/6/2017 16:00	35.50	3.77
6/6/2017 17:00	29.95	4.44
6/7/2017 16:00	31.24	4.32
6/7/2017 17:00	32.90	4.14
6/8/2017 16:00	32.69	4.06
6/8/2017 17:00	29.58	4.55
6/9/2017 16:00	25.04	5.33
6/9/2017 17:00	30.25	4.56
6/13/2017 16:00	27.99	4.76
6/13/2017 17:00	30.83	4.37
6/14/2017 16:00	28.78	4.63
6/14/2017 17:00	32.92	4.06
6/15/2017 16:00	26.35	5.04
6/15/2017 17:00	26.99	4.94
6/16/2017 16:00	29.19	4.56
6/16/2017 17:00	26.66	5.11
6/20/2017 16:00	33.23	4.02
6/20/2017 17:00	36.06	3.69
6/21/2017 16:00	30.69	4.35
6/21/2017 17:00	27.18	4.98
6/22/2017 16:00	30.56	4.36
6/22/2017 17:00	31.88	4.18
6/23/2017 16:00	27.65	4.81
6/23/2017 17:00	28.36	4.69
6/27/2017 16:00	33.56	3.99
6/27/2017 17:00	31.76	4.18
6/28/2017 16:00	30.69	4.34
6/28/2017 17:00	30.19	4.44
6/29/2017 16:00	32.82	4.05
6/29/2017 17:00	28.00	4.84
6/30/2017 16:00	28.21	4.72
6/30/2017 17:00	27.60	4.84
7/5/2017 16:00	30.36	4.38
7/5/2017 17:00	33.87	3.94
7/6/2017 16:00	29.90	4.45
7/6/2017 17:00	29.40	4.56
7/7/2017 16:00	30.06	4.44
7/7/2017 17:00	32.76	4.06
7/11/2017 16:00	31.48	4.23
7/11/2017 17:00	34.06	3.90
7/12/2017 16:00	35.69	3.75
7/12/2017 17:00	33.92	3.95
7/13/2017 16:00	27.70	4.83
7/13/2017 17:00	32.48	4.10
7/14/2017 16:00	29.88	4.44
7/14/2017 17:00	31.23	4.30
7/18/2017 16:00	33.64	3.96
7/18/2017 17:00	29.20	4.58
7/19/2017 16:00	35.27	3.77
7/19/2017 17:00	31.76	4.22
7/20/2017 16:00	28.83	4.68
7/20/2017 17:00	30.95	4.33
7/21/2017 16:00	22.66	5.87
7/21/2017 17:00	25.04	5.31
7/25/2017 16:00	32.96	4.04
7/25/2017 17:00	33.49	3.99
7/26/2017 16:00	33.14	4.01
7/26/2017 17:00	33.42	3.98
7/27/2017 16:00	28.48	4.68
7/27/2017 17:00	31.23	4.27
7/28/2017 16:00	32.56	4.15
7/28/2017 17:00	32.93	4.06
8/1/2017 16:00	29.85	4.47
8/1/2017 17:00	30.34	4.39
8/2/2017 16:00	28.53	4.73
8/2/2017 17:00	27.55	4.93
8/3/2017 16:00	25.87	5.30
8/3/2017 17:00	29.06	4.58
8/4/2017 16:00	30.30	4.45
8/4/2017 17:00	25.06	5.53
8/8/2017 16:00	33.13	4.02
8/8/2017 17:00	32.48	4.11
8/9/2017 16:00	27.33	4.87
8/9/2017 17:00	32.52	4.08
8/10/2017 16:00	28.06	4.84
8/10/2017 17:00	32.26	4.12
8/11/2017 16:00	25.38	5.31
8/11/2017 17:00	29.97	4.43
8/15/2017 16:00	31.03	4.29
8/15/2017 17:00	32.78	4.13
8/16/2017 16:00	31.41	4.23
8/16/2017 17:00	37.56	3.55
8/17/2017 16:00	31.02	4.29
8/17/2017 17:00	36.81	3.61
8/18/2017 16:00	38.96	3.41
8/18/2017 17:00	34.39	3.91
8/22/2017 16:00	33.94	3.94
8/22/2017 17:00	35.29	3.80
8/23/2017 16:00	34.70	3.86
8/23/2017 17:00	34.35	3.87
8/24/2017 16:00	33.29	3.99
8/24/2017 17:00	28.72	4.67
8/25/2017 16:00	31.99	4.15
8/25/2017 17:00	28.05	4.78
8/29/2017 16:00	34.33	3.88
8/29/2017 17:00	35.95	3.70
8/30/2017 16:00	34.60	3.84
8/30/2017 17:00	35.94	3.69
8/31/2017 16:00	30.75	4.33
8/31/2017 17:00	30.03	4.49

Appendix C US 97 SRC Traffic Analysis Memorandum

Memo

Date:	Wednesday, August 21, 2019
Project:	ODOT US97 Redmond South Corridor
To:	Project Team
From:	Andy Johnson and Jeremy Jackson, HDR
Subject:	**Final Project Traffic Analysis Summary Memo**

1.0 Introduction

Highway 97 is a critical part of the Oregon transportation system and is the primary north-south transportation corridor in Central Oregon. The US 97 South Corridor in Redmond serves a mixture of state, regional, and local traffic traveling to, from and within a variety of different destinations in Redmond. The City of Redmond (City) is a destination which not only is the hub for transportation serving Central Oregon, but also has regional attractors, including a commercial airport, fairgrounds, and many industrial and commercial areas. The City adopted a resolution (No. 2014-02) to partner with the Oregon Department of Transportation (ODOT) to refine, design, and implement a corridor Refinement Plan and improvement project for the US 97 South Corridor in 2014. The project study area extends along approximately three miles of US 97 South from Highland Avenue to the southern border of the Redmond urban growth boundary (aligned with Elkhorn Avenue). The adopted resolution was the result of a multi-year collaborative planning process that included the City, ODOT, and a stakeholder group consisting of impacted business and property owners and community representatives. The outcome of the process was a corridor plan that included a series of conceptual design solutions to improve safety and operations for state, regional, and local traffic, access management and connectivity, development potential, and community character of the study corridor.

The project is intended to provide improvements to maximize the function of US 97 and the connecting transportation system by addressing traffic mobility efficiencies, safety, and local development needs. The project will also provide the opportunity to enhance economic development, community urban design, and business vitality along the corridor. The purpose of this document is to present the results of the analysis for existing and future traffic conditions along US 97 and Canal Boulevard.

2.0 Study Area

The project study area is approximately three miles of US 97 from Highland Avenue to south of the Yew Avenue interchange. The project area is shown in Figure 1. The project goal is to improve function and safety along US 97 and provide a facility plan that aligns with previously established goals and principles from the 2010 Redmond South US 97 Corridor Plan and City of Redmond Resolution 2014-02.

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(503) 423-3700

Figure 1. Study Area

3.0 Methodology

3.1 Operational Criteria

Operational criteria analyzed for the project include volume-to-capacity (v/c) ratios, level of service (LOS) and 95th percentile queuing.

3.1.1 Volume-to-Capacity Ratio

A comparison of intersection demand to capacity is one method of evaluating how an intersection is operating or expected to operate for motor vehicles. This comparison is presented as a v/c ratio. A v/c ratio of less than 1.00 indicates that the motor vehicle volume is less than the available capacity. As the v/c approaches 0.00, traffic conditions are better, with little congestion or delays for most intersection movements. As the v/c ratio approaches 1.00, traffic becomes more congested and unstable with longer delays. A v/c over 1.00 means the demand exceeds the available capacity of the intersection.

3.1.2 Level of Service

Level of Service is another measure for evaluating motor vehicle traffic capacity and quality of service of roadways. LOS results supplement the v/c ratio to gain a better understanding of how motor vehicles operate at the intersections. LOS is a function of control delay, which includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. Six service levels have been established ranging from LOS A, where there is insignificant or no motor vehicle delay, to LOS F, where the delay is more than 50 seconds at unsignalized intersections or more than 80 seconds at signalized intersections.

It should be noted that at signalized intersections, some motor vehicle movements, particularly side street approaches or left turns onto side streets, might experience longer delays because they receive only a small portion of the effective green time during a signal cycle, but their v/c ratio may be relatively low. For this reason, it is worthwhile to examine both v/c ratio and LOS when evaluating overall intersection motor vehicle operations. Although LOS is not a mobility target, both LOS and v/c were evaluated.

3.1.3 95th Percentile Queuing

Queuing estimates help provide a more complete assessment of how an intersection is operating for motor vehicles in congested conditions, but they cannot capture the potential additional delays at other intersections within the analysis. To be consistent with ODOT procedures, 95th percentile queue lengths were used for this analysis.

3.2 Mobility Standards

For the existing and future conditions analysis, the mobility target in the updated 1999 Oregon Highway Plan (OHP) apply to the intersections along US 97 and the Yew Avenue ramp terminal intersections. This version of the OHP defines mobility targets in terms of v/c ratios, which are dependent upon the roadway classification and area type. US 97 within the study area is classified as a Freight Route on a Statewide Highway inside a Metropolitan Planning

Organization urban growth boundary. According to OHP Table 6, the mobility target for this portion of US 97 is a v/c of 0.85. In February 2021 an alternative mobility standard was set for 1.0 at US 97 and Veteran's Way.

3.3 Traffic Operations Software

The project area was modeled and analyzed using Vissim (version 11) and followed the recommendations and procedures included in the ODOT *Analysis Procedures Manual* (APM), the *ODOT Vissim Protocol*, and *FHWA's Traffic Analysis Toolbox*. Vissim was used to determine intersection delay, estimated LOS, and 95th percentile queue lengths. In addition to the microsimulation analysis using Vissim, the study area was also analyzed using Synchro (version 10) and Highway Capacity Software (HCS). Synchro uses the general characteristics of an intersection to evaluate how it will operate based on the *2000 Highway Capacity Manual* (HCM)[1] and was primarily used to determine intersection v/c ratios along US 97 for comparison to ODOT mobility thresholds. HCS was used to evaluate the Yew Avenue interchange merge and diverge areas on US 97 to determine v/c ratios for comparison to ODOT mobility thresholds.

3.4 Data Collection

Data collection for the traffic analysis included existing traffic volumes, traffic control data, and calibration data.

3.4.1 Traffic Volumes

Existing traffic count data was collected for the study area on a Tuesday in early June 2017 and consisted of intersection turning movement and driveway counts, and 72-hour vehicle classification counts. The intersection turning movement volumes included a 15-minute breakdown of pedestrians, bicyclists, passenger vehicles, and heavy vehicles and were collected on a typical weekday between 6:00 AM and 10:00 PM at the following intersections:

- US 97 at Glacier/Highland Avenue (signal)
- US 97 at Veterans Way (signal)
- US 97 at Pumice Avenue (unsignalized)
- US 97 at Odem Medo Way (signal)
- US 97 at Wickiup Avenue (unsignalized)
- US 97 SB at Yew Avenue (signal)
- US 97 NB at Yew Avenue (signal)
- Canal Boulevard at Veterans Way (signal)

[1] HCM 2010 or HCM 6 analysis currently does not provide all output needed using Synchro.

- Canal Boulevard at Pumice Avenue (unsignalized)
- Canal Boulevard at Quartz Avenue (unsignalized)
- Canal Boulevard at Odem Medo Way (signal)
- Canal Boulevard at Yew Avenue (roundabout)
- 5th Street at Highland Avenue (signal)
- 5th Street at Glacier Avenue (signal)
- 6th Street at Highland Avenue (signal)
- 6th Street at Glacier Avenue (signal)

Weekday, 72-hour classification counts were collected on US 97 between Glacier Avenue/Highland Avenue and Veterans Way and between Odem Medo Way and Yew Avenue interchange (north of ramps). In addition, 70 driveway counts within the study area were collected during the weekday PM peak period between 4:00 PM and 6:00 PM.

3.4.2 Traffic Control Data

The signalized intersections within the study area run on an adaptive system called SCATS by TransCore. For analysis purposes, fixed timing plans (cycle lengths, splits, and offsets) were used. Synchro models used in the development of the base timing plans for SCATS were provided by ODOT and used to establish coordinated signal timing plans for analysis. Since SCATS will not be used, fixed timing plans will be optimized for each analysis year. SCATS is not an ODOT standard operations program and is not anticipated to be used in the future.

3.4.3 Calibration Data

For calibration of the microsimulation models, data collection included travel time measurements and intersection queue lengths. Weekday travel time measurements on both directions of US 97 were collected using a combination of Bluetooth units and iPEMS data (a 3rd Party HERE data aggregator tool). Travel time measurements were collected on US 97 from south of Evergreen Avenue to north of the Yew Avenue interchange. Intersection queue lengths, measured as number of vehicles, were recorded in two-minute intervals during the PM (4:00 PM to 6:00 PM) peak period on US 97 at the Odem Medo Way and Veterans Way intersections.

3.5 Existing Year Volume Development

All existing year (2017) volumes were collected in early June 2017. Existing year PM peak hour volumes were seasonally adjusted to the 30th highest hour (30HV) using the on-site automatic traffic recorder (ATR) method consistent with the APM. The on-site ATR method uses five years of historic ATR data to determine an average adjustment factor, eliminating the lowest and highest percent of ADT and averaging the remaining values. There are two ATR’s on US 97 within or near the study area; the Redmond-Hemlock ATR and the Redmond ATR. The Redmond ATR (#09-020) is primarily a commuter trend and is located on US 97 at milepost (MP) 124.39, 0.79 miles south of Yew Avenue. The Redmond-Hemlock ATR (#09-022) is primarily a summer trend and is located on US 97 at MP 120.92, 0.04 miles north of Antler Avenue. The seasonal adjustment factors were determined to be 1.04 for the Redmond ATR and 1.05 for the Redmond-Hemlock ATR.

Given the characteristics of US 97 within the study area, the Redmond-Hemlock ATR was used for the Glacier Avenue/Highland Avenue intersection, including Glacier Avenue and Highland Avenue at 5th Street and 6th Street due to the proximity to US 97. The Redmond ATR was used for the study area intersections from Veterans Way to south of Yew Avenue, including the adjacent City intersections on Canal Boulevard.

A global peak hour of 4:30 PM to 5:30 PM was determined for the study area based on the turning movement counts collected throughout the study area. The PM peak hour was chosen as the analysis time period to coincide with the large number of driveway counts that were collected as part of the study. Access to and from local businesses along US 97 is also highest during the PM peak period. The PM peak hour balanced, existing year design hour volumes for the study area are provided in Figure 2.

3.6 Analysis Years and Scenarios

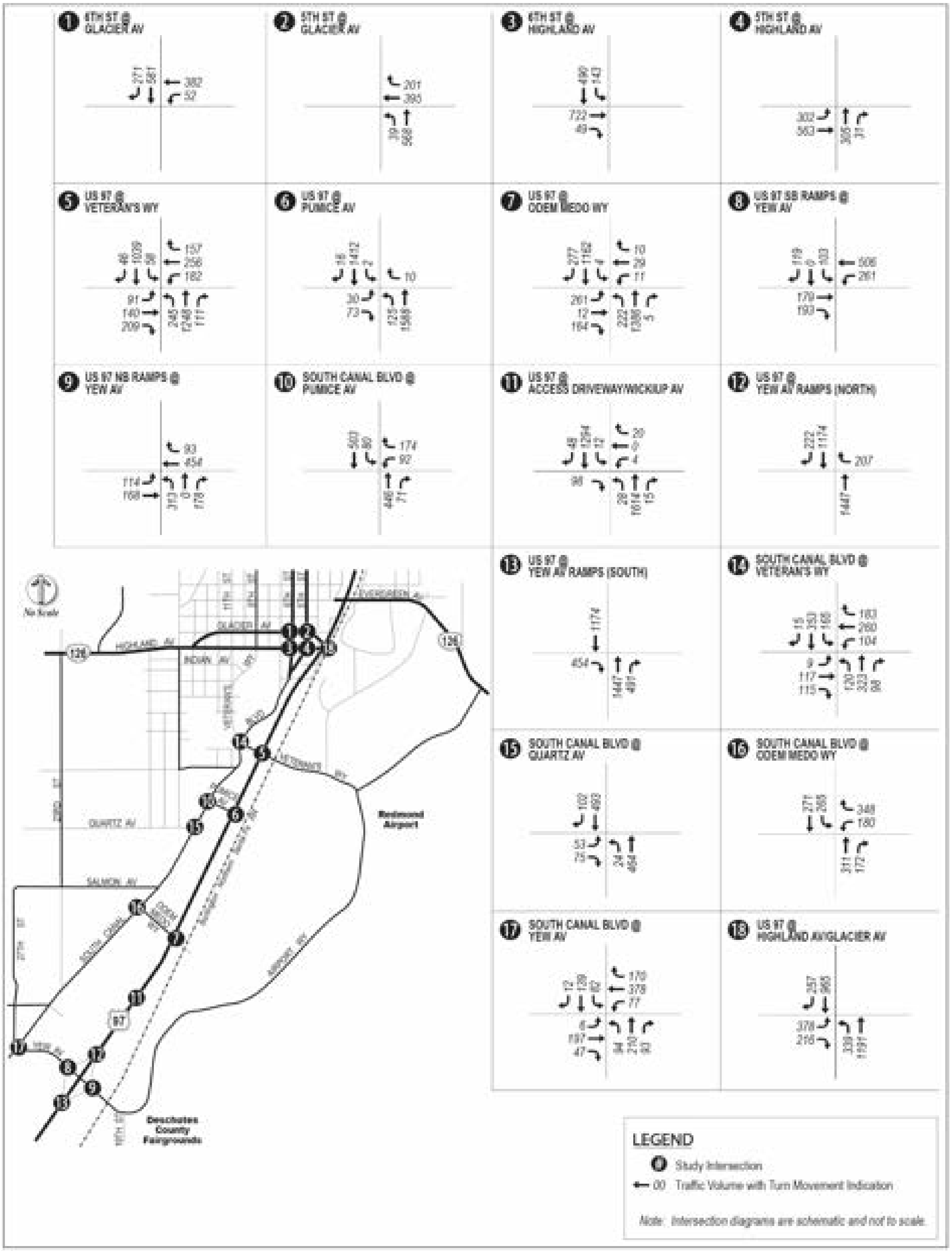
To support the traffic operational analyses for the project, a balanced network of existing and forecasted volumes was prepared for the PM peak period for:

- Existing Year = 2017
- Horizon Year = 2040

The horizon year of 2040 is consistent with the ODOT planning horizon and design year for US 97. The scenarios that will be analyzed for the project include:

- Existing Year = Calibrated, existing year conditions.
- Horizon Year No-Build = Future year conditions with Transportation System Plan (TSP) identified improvements.
- Horizon Year Build = Future year conditions with TSP identified improvements and recommended Build alternative.

Figure 2. 2017 Existing Design Hour Traffic Volumes



4.0 Existing Conditions Analysis

4.1 Base Model Development and Calibration

The existing conditions simulation model for the study area was developed using Vissim (version 11), an ODOT approved, behavior-based multi-purpose traffic microsimulation program developed by PTV. Vissim tracks individual vehicle movements and interactions and thus provides a more robust and detailed analysis than typical Highway Capacity Manual (HCM) methods and quantifies the performance of individual movements and overall delays and queue lengths for highways, arterials, and intersections.

The calibration process used for the Vissim models followed ODOT and FHWA guidelines for determining the acceptability of model results as compared to existing operations. Calibration targets included comparing modeled volumes and travel times to existing traffic counts and field measured travel times, queue length validation, and overall observations of driver behavior. The Vissim model development and calibration report for the project is provided in Attachment A. Overall, the calibration of the existing conditions Vissim models produced simulation output that replicated traffic volumes, travel times, and field observed driver behavior for the PM peak period; with a calculated GEH Statistic of 2.6 or less for all movements and travel times within one minute for all travel time segments.

4.2 Vissim Analysis Results

A summary of overall intersection delays for existing PM peak hour conditions is provided in Table 1. In Vissim, the intersection LOS is computed from a microsimulation analysis and is therefore reported as an “estimated LOS.” Vissim tracks individual vehicle movements and interactions and quantifies overall intersection delays more realistically than typical equation-based HCM methods. The estimated LOS is based on HCM criteria and thresholds for signalized and unsignalized intersections. The overall intersection delay and LOS for all signalized intersections is based on the total control delay of all movements. The overall intersection delay and LOS for all unsignalized intersections is based on the worst stop-controlled movement per HCM standards..

For queuing, Vissim reports queue length from the stop bar along any path until it reaches an upstream study intersection. Per the ODOT Vissim Protocol, the 95th percentile queue length is manually calculated as the average of maximum queues plus 1.65 times the standard deviation. This methodology tends to report 95th percentile queue lengths that are greater than the average maximum queue measured in Vissim. The results of the Vissim analysis indicate that all intersections are operating at LOS D or better in the existing PM peak period. Detailed operational results for each intersection, including delay, LOS, and queuing for all movements, is provided in Attachment B.

Table 1. Existing 2017 PM Peak Hour Vissim Analysis Summary

Intersection	Existing		
	Analysis Type	Delay (sec/veh)	LOS
SW Highland Avenue & SW 6th Street	Signalized	9.1	A
SW Highland Avenue & SW 5th Street	Signalized	7.2	A
SW Glacier Avenue & SW 6th Street	Signalized	13.9	B
SW Glacier Avenue & SW 5th Street	Signalized	14.7	B
US 97 & SW Highland Ave/SW Glacier Avenue	Signalized	17.2	B
US 97 & SW Veterans Way	Signalized	22.6	C
US 97 & SE Pumice Avenue	Unsignalized	22.5	C
US 97 & SW Odem Medo Way	Signalized	19.0	B
US 97 & SW Wickiup Avenue	Unsignalized	18.1	C
SW Canal Boulevard & SW Odem Medo Way	Signalized	18.8	B
SW Canal Boulevard & SE Pumice Avenue	Unsignalized	28.2	D
SW Canal Boulevard & SW Veterans Way	Signalized	29.1	C
SW Yew Avenue & US 97 SB Ramps	Signalized	7.9	A
SW Yew Avenue & US 97 NB Ramps	Signalized	16.2	B
SW Yew Avenue & SW Canal Boulevard	Unsignalized	11.5	B

Note:

1. The overall intersection delay and LOS for all unsignalized intersections is based on the worst stop-controlled movement per HCM standards.
2. The overall intersection delay and LOS for all signalized intersections is based on the total control delay of all movements per HCM standards.

4.3 Synchro Analysis Results

Synchro was used for the analysis of the US 97 intersections to supplement the Vissim analysis. The Synchro analysis results for the existing PM peak hour are presented in Table 2 and include v/c ratios that compare to OHP mobility standards. For signalized intersections, the overall intersection v/c ratio is provided from the HCM 2000 signalized reports in Synchro. For unsignalized intersections, the v/c ratio for the worst movement on US 97 is provided from the HCM 2000 unsignalized reports in Synchro. As shown highlighted in red below, the US 97 and Odem Medo Way intersection exceeds the existing conditions OHP mobility threshold of 0.85 during the PM peak period. Detailed HCM reports from Synchro are provided in Attachment C.

Table 2. Existing 2017 PM Peak Hour Synchro Analysis Summary

Intersection	Analysis Type	V/C
Yew Avenue & US 97 Northbound	Signalized	0.69
Yew Avenue & US 97 Southbound	Signalized	0.48
Wickiup Avenue & US 97	Unsignalized	0.64
Odem Medo Way& US 97	Signalized	0.90
Pumice Avenue & US 97	Unsignalized	0.66
Veterans Way & US 97	Signalized	0.81
Highland Avenue/Glacier Avenue & US 97	Signalized	0.62

Note:
1. For signalized intersections, the overall intersection v/c ratio is provided from the HCM 2000 signalized reports in Synchro.
2. For unsignalized intersections, the v/c ratio for the worst movement on US 97 is provided from the HCM 2000 unsignalized reports in Synchro.

4.4 HCS Analysis Results

HCS was used for the analysis of the merge and diverge areas along US 97 at the Yew Avenue interchange. The HCS analysis results for the existing PM peak hour are presented in Table 3 and include v/c ratios that compare to OHP mobility standards. As shown below, all merge and diverge areas along US 97 are operating below capacity and do not exceed the existing conditions OHP mobility threshold of 0.85 during the PM peak period. Detailed HCS reports for all merge and diverge areas are provided in Attachment D.

Table 3. Existing 2017 PM Peak Hour HCS Analysis Summary

Intersection	Analysis Type	V/C
US 97 Northbound Off-Ramp to Yew Avenue	Diverge	0.41
US 97 Northbound On-Ramp from Yew Avenue	Merge	0.49
US 97 Southbound Off-Ramp to Yew Avenue	Diverge	0.35
US 97 Southbound On-Ramp from Yew Avenue	Merge	0.46

5.0 Traffic Forecasting

Future traffic volumes for the horizon year 2040 were forecast for the No-Build and Build conditions based on a windowed subarea model of the regional Bend-Redmond Model (BRM). The windowed subarea modeling approach provides more sensitivity to local traffic control and circulation changes and allowed for the ability to better estimate changes in travel patterns associated with new traffic signals, roundabouts, street connections, and local access changes. The same demand matrix was used for analysis of the No-Build and Build models.

Most of the land use growth in the study area forecast by the year 2040 is related to employment (i.e., commercial and industrial businesses), with a net increase of approximately 700 workers in the areas immediately adjacent to US 97 (a 97 percent increase over 2010). The distribution of this employment growth varies along the corridor, ranging from slight decreases in some mostly built out areas to substantial increases at the southern end of the corridor where new development is expected on vacant parcels. The employment growth coupled with housing growth elsewhere in the City of Redmond and regional travel growth on US 97 will increase traffic activity, with average daily traffic volumes increasing from approximately 28,000 vehicles in 2017 to approximately 36,000 vehicles in 2040. This corresponds to an average annual growth rate of 1.24 percent.

The Traffic Volume Forecasts Memo (Attachment E) provides more detail into the travel demand forecasting and model refinement process and includes the 2040 No-Build and 2040 Build volume figures.

6.0 Alternatives Analysis

The alternatives analysis included an evaluation of a No-Build and Build alternative within the study area. The No-Build alternative includes only TSP identified improvements, while the Build alternative includes additional improvements along US 97 and Canal Boulevard.

6.1 No-Build Alternative

The No-Build alternative maintains the existing lane configurations of the current facility but includes an extension of Quartz Avenue between Canal Boulevard and US 97. The intersection of Quartz Avenue and US 97 is signalized under the No-Build alternative.

6.2 Build Alternative

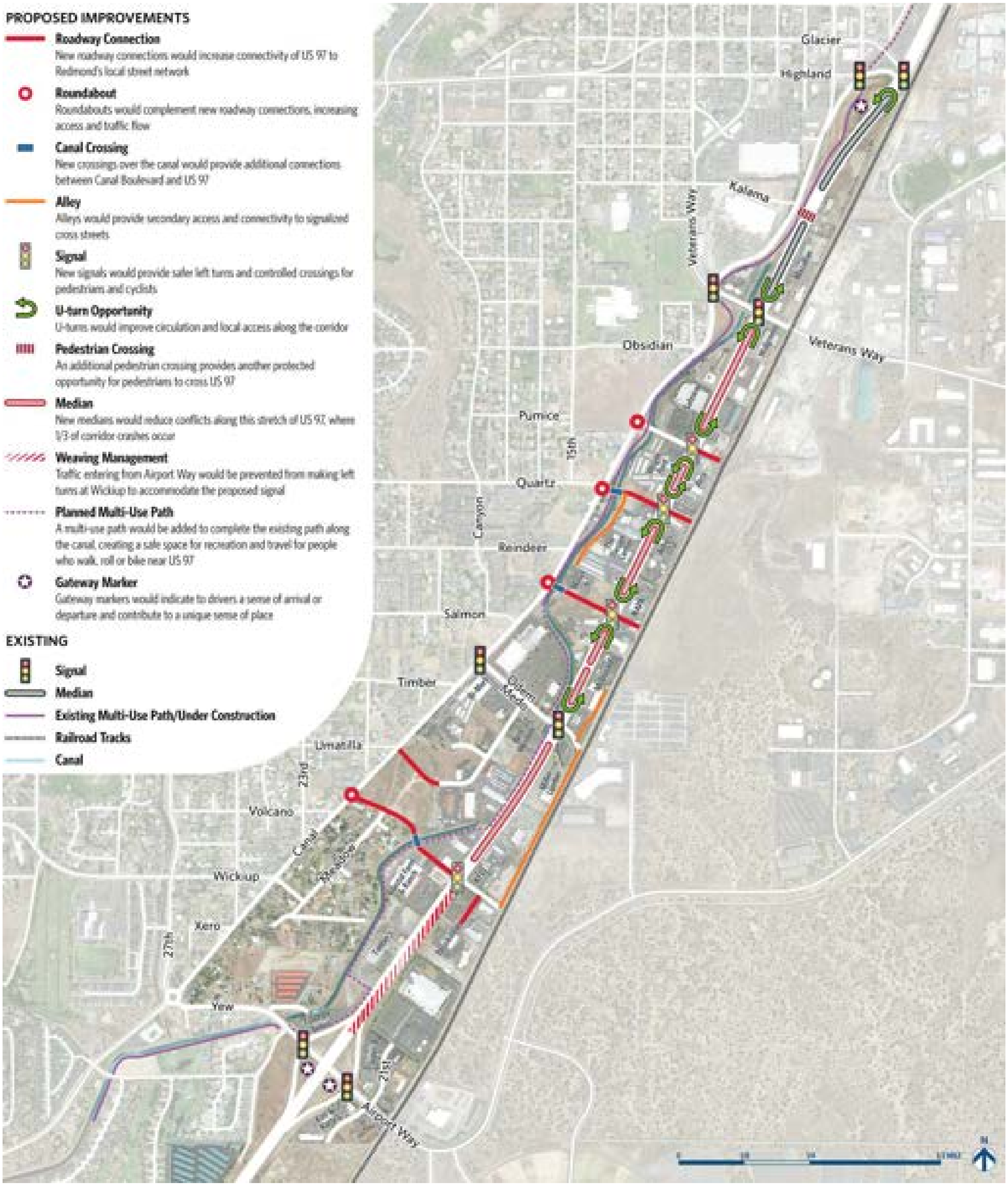
The Build alternative includes improvements to US 97 and Canal Boulevard that address operational challenges due to growth and provide more accessibility, not only north and south but also east and west along the corridor for all modes of transportation. One of the major design features is a center running median that allows for crossing US 97 at key intersections. In addition, U-turns are provided at certain intersections to maintain access to businesses along US 97. Access between US 97 and Canal Boulevard is also improved with more connections between the two facilities and multiple roundabout intersections on Canal Boulevard.

The recommended concept introduces three additional signals and introduces U-turns at each signal that reduce turning conflicts from the median along US 97. The U-turns will require State Traffic Engineer approval. To make a left-turn, drivers must proceed to a designated U-turn area. The concept includes additional signals that slow traffic and offer additional safer crossing areas to connect sidewalks and multiuse paths. The recommended concept also includes three additional road connections that cross the canal and connect US 97 to Redmond neighborhoods on the west side of US 97. These connections provide more route choice for drivers and redistribute traffic volumes between US 97 and Canal Boulevard, resulting in less traffic at most of the intersections along the US 97 corridor. The additional signals provide protected crossings at these locations, making the new connections more effective. The recommended concept is shown in Figure 3.

Key features of this concept include:

- Three additional signalized intersections along US 97 that allow protected U-turns.
- Three additional road connections that cross the canal and connect US 97 to Redmond neighborhoods on the west side of US 97.
- Traffic separators between the northbound and southbound lanes on US 97 allowing protected left-hand turning movements and U-turns at signalized intersections.
- Areas for safe pedestrian refuge halfway across US 97 to enhance pedestrian crossings.
- New sidewalks and cycle track treatments throughout the length of the corridor and along east/west connecting roads to provide a more well-connected active transportation network.
- These treatments will provide connections to the new, already planned, shared-use path along Canal Boulevard and the canal.
- A limited number of new access roads or alleyways to provide alternative access where new connections provide safe ingress and egress nearby.

Figure 3. Recommended Concept



6.3 Vissim Analysis Results

The No-Build and Build alternative Vissim models were developed using the calibrated existing conditions model and revised with updated roadway geometry and future year traffic volumes. The results from the Vissim analysis include intersection delay and LOS as well as travel time along US 97. Table 4 summarizes the PM peak hour delay and LOS for the study area intersections. The estimated LOS is based on HCM criteria and thresholds for signalized and unsignalized intersections. The overall intersection delay and LOS for all signalized intersections is based on the total control delay of all movements. The overall intersection delay and LOS for all unsignalized intersections is based on the worst stop-controlled movement per HCM standards.

As shown in Table 4, the Build alternative operates better than the No-Build alternative at key study area intersections along US 97 between Veterans Way and Wickiup Avenue. By providing additional east-west connections between US 97 and Redmond neighborhoods on the west side of the canal, traffic volumes are redistributed, resulting in less traffic at most of the intersections along the US 97 corridor. Heavy turn volumes at the limited locations where traffic could cross the canal are now reduced as traffic has additional options to access the west side of US 97. The Build alternative also adds signals to the US 97 and Wickiup Avenue and US 97 and Pumice Avenue intersections, improving operations for the movements that were stop-controlled. The additional traffic signals along the corridor provide protected crossings at both the new and existing connections, improving accessibility on and off US 97.

There are two intersections that are operating worse in the Build alternative, however, due to the shift in traffic patterns between alternatives. The Yew Avenue and US 97 northbound ramp terminal are operating at LOS C and LOS E in the No-Build and Build alternatives, respectively. In addition, the existing roundabout at the Yew Avenue and Canal Boulevard intersection experiences significant congestion and queuing in both alternatives, operating at LOS F with delays exceeding three minutes. Detailed operational results for each intersection, including delay, LOS, and queuing for all movements, is provided in Attachment F.

Table 4. Future 2040 PM Peak Hour Vissim Analysis Summary

Intersection	Existing 2017		No-Build 2040		Build 2040	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
SW Highland Avenue & SW 6th Street	9.1	A	11.1	B	10.8	B
SW Highland Avenue & SW 5th Street	7.2	A	7.8	A	8.7	A
SW Glacier Avenue & SW 6th Street	13.9	B	17.0	B	15.1	B
SW Glacier Avenue & SW 5th Street	14.7	B	20.6	C	21.6	C
US 97 & SW Highland Avenue/SW Glacier Avenue	17.2	B	24.1	C	23.4	C
US 97 & SW Veterans Way	22.6	C	79.0	E	55.1	E
US 97 & SE Pumice Avenue	***22.5***	***C***	***86.5***	***F***	13.1	B
US 97 & SW Quartz Avenue	N/A	N/A	26.7	D	16.7	B
US 97 & SW Reindeer Avenue/Salmon Avenue	N/A	N/A	N/A	N/A	17.8	B
US 97 & SW Odem Medo Way	19.0	B	74.2	E	30.4	C
US 97 & SW Wickiup Avenue	***18.1***	***C***	***55.9***	***F***	12.0	B
SW Canal Boulevard & SW Wickiup Avenue	N/A	N/A	N/A	N/A	***15.6***	***C***
SW Canal Boulevard & SW Odem Medo Way	18.8	B	23.6	C	22.1	C
SW Canal Boulevard & SW Reindeer Avenue/Salmon Avenue	N/A	N/A	N/A	N/A	***19.9***	***C***
SW Canal Boulevard & SW Quartz Avenue	N/A	N/A	***37.6***	***D***	***32.2***	***C***
SW Canal Boulevard & SE Pumice Avenue	***28.2***	***D***	***26.8***	***D***	***14.0***	***B***
SW Canal Boulevard & SW Veterans Way	29.1	C	39.6	D	46.7	D
SW Yew Avenue & US 97 SB Ramps	7.9	A	12.3	B	17.2	B
SW Yew Avenue & US 97 NB Ramps	16.2	B	27.2	C	62.9	E
SW Yew Avenue & SW Canal Boulevard	***11.5***	***B***	***180.1***	***F***	***248.8***	***F***

Note:

Blue **=** Unsignalized intersection, overall intersection delay and LOS is based on the worst stop-controlled movement per HCM standards.

A comparison of travel times on northbound and southbound US 97 between Yew Avenue and Highland Avenue/Glacier Avenue is provided in Table 5. The travel time summary shows a significant improvement in travel time between the No-Build and Build alternatives, particularly on northbound US 97. There is a 30 percent improvement in the northbound travel time and a 12 percent improvement in the southbound travel time.

Table 5. Future 2040 PM Peak Hour Travel Time Summary

Segment	Distance (miles)	No-Build	Build
		Travel Time (min)	Travel Time (min)
US 97 Northbound from Yew Ave to Highland/Glacier Ave	2.5	8.2	6.0
US 97 Southbound from Highland/Glacier Ave to Yew Ave	2.5	6.8	6.5

6.4 Synchro Analysis Results

The Synchro analysis results for the 2040 No-Build and Build alternatives are presented in Table 6 and include v/c ratios that compare to OHP mobility standards. For signalized intersections, the overall intersection v/c ratio is provided from the HCM 2000 signalized reports in Synchro. For unsignalized intersections, the v/c ratio for the worst movement on US 97 is provided from the HCM 2000 unsignalized reports in Synchro.

As shown highlighted in red below, multiple intersections on US 97 exceed the future conditions mobility threshold of 0.85 during the PM peak period. The Yew Avenue northbound ramp terminal, Wickiup Avenue, and Odem Medo Way intersections have a higher v/c ratio in the Build condition due to the addition of protected U-turn movements or a shift in traffic patterns. It is important to note that the recommended concept does not add capacity to the existing network. Four ODOT facilities do not meet the OHP mobility standard; 1) US 97 NB Ramp Terminal, 2) US 97 and Wickiup Avenue, 3) US 97 and Odem Medo Way, and 4) US 97 and Veterans Way. Detailed HCM reports from Synchro are provided in Attachment G.

Table 6. Future 2040 PM Peak Hour Synchro Analysis Summary

Intersection	No-Build		Build	
	Analysis Type	V/C	Analysis Type	V/C
Yew Avenue & US 97 Northbound	Signalized	0.84	Signalized	1.00
Yew Avenue & US 97 Southbound	Signalized	0.63	Signalized	0.71
Wickiup Avenue & US 97	Unsignalized	0.88	Signalized	0.91
Odem Medo Way & US 97	Signalized	1.01	Signalized	1.05
Reindeer Avenue/Salmon Avenue & US 97	N/A	N/A	Signalized	0.83

Intersection	No-Build		Build	
	Analysis Type	V/C	Analysis Type	V/C
Quartz Street & US 97	Signalized	0.95	Signalized	0.75
Pumice Avenue & US 97	Unsignalized	0.90	Signalized	0.81
Veterans Way & US 97	Signalized	1.12	Signalized	1.06
Highland Avenue/Glacier Avenue & US 97	Signalized	0.83	Signalized	0.79

Note:
1. For signalized intersections, the overall intersection v/c ratio is provided from the HCM 2000 signalized reports in Synchro.
2. For unsignalized intersections, the v/c ratio for the worst movement on US 97 is provided from the HCM 2000 unsignalized reports in Synchro.

6.5 HCS Analysis Results

HCS was used for the analysis of the merge and diverge areas along US 97 at the Yew Avenue interchange. The HCS analysis results are presented in Table 7 and include v/c ratios that compare to OHP mobility standards (v/c of 0.85). As shown below, all merge and diverge areas along US 97 are operating below capacity and do not exceed the future conditions OHP mobility threshold of 0.85 during the PM peak period. Detailed HCS reports for all merge and diverge areas are provided in Attachment H.

Table 7. Future 2040 PM Peak Hour HCS Analysis Summary

Intersection	Analysis Type	No-Build	Build
		V/C	V/C
US 97 Northbound Off-Ramp to Yew Avenue	Diverge	0.54	0.54
US 97 Northbound On-Ramp from Yew Avenue	Merge	0.64	0.65
US 97 Southbound Off-Ramp to Yew Avenue	Diverge	0.48	0.43
US 97 Southbound On-Ramp from Yew Avenue	Merge	0.63	0.64

7.0 Conclusion

Partnering with ODOT, the City adopted a resolution to refine, design, and implement a corridor Refinement Plan and improvement project for the US 97 South Corridor in 2014. The project study area extends along approximately three miles of US 97 South from Highland Avenue to the southern border of the Redmond urban growth boundary. The project is intended to provide improvements to maximize the function of US 97 and the connecting transportation system by addressing traffic mobility efficiencies, safety, and local development needs. The project will also provide the opportunity to enhance economic development, community urban design, and business vitality along the corridor.

The recommended concept includes improvements to US 97 as well as Canal Boulevard that improve operations and provide safer crossings for all modes of transportation. One of the major design features is a center running median that allows for crossing US 97 at key intersections. The recommended concept introduces three new signals and provides U-turns at each signal that reduce conflicts and movements and maintain access to businesses along US 97. Access between US 97 and Canal Boulevard is also improved with more connections between the two facilities and multiple roundabout intersections on Canal Boulevard.

The results of the traffic analysis show that the Build alternative operates better than the No-Build alternative at most of the study area intersections along US 97 and Canal Boulevard while addressing operational challenges due to growth and providing more accessibility along the corridor for all modes of transportation. The existing roundabout at Yew Avenue and Canal Boulevard operates poorly (LOS F) in both the No-Build and Build alternatives, and the Yew Avenue and northbound US 97 ramp terminal intersection experiences more delay in the Build alternative due to a shift in travel patterns. Travel times along US 97 are also improved with the recommended concept, with a 28 percent improvement in the northbound travel time and a six percent improvement in the southbound travel time.

Attachment A. Vissim Model Development and Calibration Report

Memo

Date:	Wednesday, July 24, 2019
Project:	ODOT US 97 South Redmond Corridor
To:	Project Team
From:	Andy Johnson, HDR, Jeremy Jackson, HDR
Subject:	**Micro Simulation Model Development and Calibration Memo (Task 3.4)**

Introduction

US 97 is a critical part of the state's transportation system and is the primary north-south transportation corridor in Central Oregon. The US 97 South Corridor in Redmond serves a mix of state, regional, and local traffic traveling to, from and within a variety of different destinations in Redmond. Redmond itself is a destination which not only is the hub for transportation serving Central Oregon, but also has regional attractors, including a commercial airport, fairgrounds, and many industrial and commercial areas. The City of Redmond (City) adopted a resolution (No. 2014-02) to partner with the Oregon Department of Transportation (ODOT) to refine, design, and implement a corridor Refinement Plan and improvement project for the US 97 South Corridor in 2014. The Project study area extends along approximately three miles of US 97 South from Highland Avenue to the southern border of the Redmond urban growth boundary (aligned with Elkhorn Avenue). The adopted resolution was the result of a multi-year collaborative planning process that included the City, ODOT, and a stakeholder group consisting of impacted business and property owners and community representatives. The outcome of the process was a corridor plan that included a series of conceptual design solutions to improve safety and operations for state, regional, and local traffic, access management and connectivity, development potential, and community character of the study corridor.

The Project is intended to provide improvements to maximize the function of US 97 and the connecting transportation system by addressing traffic mobility efficiencies, safety, and local development needs. The Project will also provide the opportunity to enhance economic development, community urban design, and business vitality along the corridor.

The purpose of this memorandum is to document the development of a calibrated traffic simulation model for the PM peak hour that is capable of replicating existing traffic conditions and best suited to evaluate future operations of the No-Build and Build alternatives. This document presents the Existing Conditions simulation model development and calibration results to support the US 97 Redmond Corridor project.

Project Area

The Project study area is approximately three miles of US 97 from Highland Avenue to south of the Yew Avenue interchange and includes segments of SW Canal Boulevard. The Project area and extents of the simulation model is shown in Figure 1.

Figure 1. Study Area and Simulation Network

Traffic Data Collection

Traffic data collection occurred in early June 2017 and consisted of intersection turning movement and driveway counts, 72-hour vehicle classification counts, Bluetooth travel time data, and vehicle queue lengths. Turning movement counts were consistent with ODOT *Analysis Procedure Manual* (APM) requirements; including a 15-minute breakdown of pedestrians, bicyclists, passenger vehicles, and heavy vehicles.

Weekday, 16-hour turning movement counts were collected between 6:00 AM and 10:00 PM at the following intersections:

- US 97 at Glacier/Highland Ave (signal)
- US 97 at Veterans Way (signal)
- US 97 at Pumice Ave (unsignalized)
- US 97 at Odem Medo Way (signal)
- US 97 at Wickiup Ave (unsignalized)
- US 97 SB at Yew Ave (signal)
- US 97 NB at Yew Ave (signal)
- Canal Blvd at Veterans Way (signal)
- Canal Blvd at Pumice Ave (unsignalized)
- Canal Blvd at Quartz (unsignalized)
- Canal Blvd at Odem Medo Way (signal)
- Canal Blvd at Yew Ave (roundabout)
- 5th St at Highland Ave (signal)
- 5th St at Glacier Ave (signal)
- 6th St at Highland Ave (signal)
- 6th St at Glacier Ave (signal)

Weekday, 72-hour classification counts were collected on US 97 between Glacier/Highland Avenue and Veterans Way and between Odem Medo Way and Yew Avenue interchange (north of ramps). In addition, seventy driveway counts within the study area were collected during the weekday PM peak period between 4:00 PM and 6:00 PM.

For calibration of the microsimulation model, data collection included weekday, 72-hour Bluetooth travel time measurements on both directions of US 97 and intersection queue lengths. Bluetooth data was collected between Tuesday and Thursday, June 6, 2017 to June 8, 2017. One Bluetooth unit was located between Evergreen Avenue and Glacier/Highland Avenue and one was located at or near Yew Avenue. Historic iPeMS data between June and August 2017 (Tuesday through Friday, excluding holidays) was also collected to validate travel times and speeds along US 97. Queue lengths, measured as number of vehicles, were recorded in two-minute intervals during the PM (4:00 PM to 6:00 PM) peak period on US 97 at the Odem Medo Way and Veterans Way intersections.

Model Development

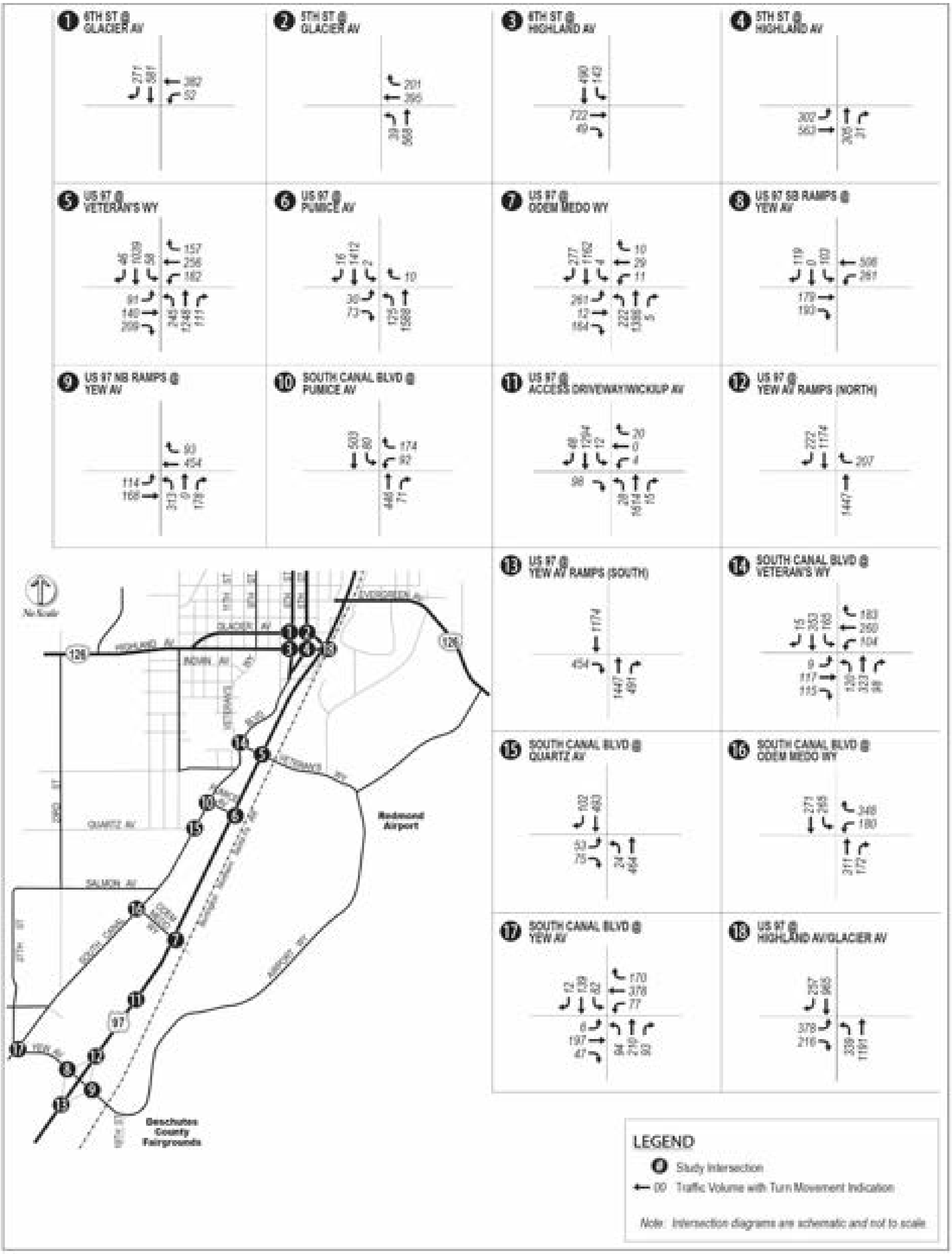
The existing conditions simulation model for the study area was developed using Vissim version 9.00-11, a widely-used, behavior-based multi-purpose traffic microsimulation program. Vissim tracks individual vehicle movements and interactions with more detail than typical Highway Capacity Manual (HCM) methods and quantifies the performance of individual movements and overall delays and queue lengths for highways, ramps, and intersections. Model assumptions, parameters, and network coding techniques are discussed in the following subsections. All assumptions are based on the traffic conditions collected in the field in early June 2017.

Existing Year Volumes

All existing year (2017) volumes were collected in early June 2017. Existing year PM peak hour volumes were seasonally adjusted to the 30th highest hour (30HV) using the on-site automatic traffic recorder (ATR) method consistent with the APM. The on-site ATR method uses five years of historic ATR data to determine an average adjustment factor, eliminating the lowest and highest percent of ADT and averaging the remaining values. There are two ATR's on US 97 within or near the study area; the Redmond-Hemlock ATR and the Redmond ATR. The Redmond ATR (#09-020) is primarily a commuter trend and is located on US 97 at milepost (MP) 124.39, 0.79 miles south of Yew Avenue. The Redmond-Hemlock ATR (#09-022) is primarily a summer trend and is located on US 97 at MP 120.92, 0.04 miles north of Antler Avenue. The seasonal adjustment factors were determined to be 1.04 for the Redmond ATR and 1.05 for the Redmond-Hemlock ATR.

Given the characteristics of US 97 within the study area, the Redmond-Hemlock ATR was used for the Glacier/Highland intersection, including Glacier Avenue and Highland Avenue at 5th Street and 6th Street due to the proximity to US 97. The Redmond ATR was used for the study area intersections from Veterans Way to south of Yew Avenue, including the adjacent City intersections on Canal Boulevard. The PM peak hour balanced, existing year design hour volumes for the study area are provided in Figure 2.

Figure 2. 2017 Existing Design Hour Traffic Volumes



Data Inputs

Multiple data sources were used to develop the data inputs and calibration targets used in the Vissim models for the US 97 corridor improvement project. The Vissim model data inputs, sources, and what they were used for are shown in Table 1 below.

Table 1. Vissim Model Data Inputs

Data	Source	Use
Traffic Volumes	HDR	Input and Calibration
Signal Timing	ODOT	Input
Travel Time	HDR/iPeMS	Calibration
Queue Length	HDR	Calibration

Model Geometrics

Scaled aerial photography was utilized to develop the base Vissim network and establish intersection lane configurations, stop bar locations, and turn pocket lengths. The high-resolution aerials were also used to accurately model merge and diverge sections on US 97 at the Yew Avenue interchange.

Vehicle Inputs

Balanced traffic volumes were summarized in 15-minute intervals using existing count data to represent the traffic fluctuations during the simulated peak hour, which allowed the Vissim model to more closely represent traffic arrival patterns and queuing on US 97 and at study area intersections. The Vissim models included a 30-minute seeding period prior to the start of the peak hour using 100 percent of the peak hour flow rate. The seeding period allows for vehicles to be loaded into the network before recording simulation results. A global peak hour of 4:30 PM to 5:30 PM was determined for the study area based on the turning movement counts collected throughout the study area.

Driveways

There are approximately 70 driveways within the study area, most of which are located on US 97. Major driveways that generate a substantial amount of traffic were modeled as unsignalized intersections, while low volume driveways were grouped together and modeled as sink/sources (right-in right-out intersections) for volume balancing.

Vehicle Routing

Traffic patterns in Vissim were modeled using static routes and routing decisions. Vehicle routing through the study area was achieved through the development of Origin-Destination (OD) matrices. The OD matrices were estimated by evaluating permitted/prohibited movements and calculating the ratios of individual turn movements at each intersection. The OD matrices were developed using Visum's OD matrix estimation feature, TFlowFuzzy[1]. Based on the land uses within the study area, the same traffic patterns were assumed for both cars and trucks, resulting in routing decisions that were applied to all vehicle types.

Traffic Compositions

Traffic compositions (car and truck percentages) were derived from existing count data for all model inputs. Peak hour truck percentages for each input ranged between 1 and 8 percent within the study area. Car and heavy vehicle distributions were based on the Vissim North American default vehicle fleet developed by PTV America in January 2010.

Speed Distributions

In general, speed limits were used to define the speed distributions on all roadways within the study area, with the 85th percentile speeds set to approximately 5 mph over the posted speed. The speed distribution curves are generally linear and provided a good match for the observed travel times. Speed decisions were used in the models to generate desired vehicle speeds at various roadway segments and reduced speed areas were strategically placed in locations where vehicles need to reduce their speed due to roadway alignment or for turning movements at intersections.

Lane Change Distance and Emergency Stop Distance

The look-back or lane change distance defines the distance at which vehicles attempt to change lanes. The longer the distance, the farther back the driver prepares for their next turning movement before making the movement, thus resulting in better lane utilization. Lane change distances were initially set to a value of 1,500 feet and adjusted, where necessary, to match field conditions. Emergency stop is the last possible position where a vehicle can change lanes. The default value for emergency stops is 16.4 feet and was increased to 50 feet to allow enough space for vehicles to make decisions prior to being too close to an intersection or diverge location, especially at higher speeds.

Signal Operations and Stop Control

The signalized intersections within the study area run on an adaptive system called SCATS by TransCore. For modeling purposes, fixed timing plans (cycle lengths, splits, and offsets) were used. Synchro models used in the development of the base timing plans for SCATS were provided by ODOT and were used to establish coordinated signal timing plans in Vissim. Since SCATS was not used, fixed timing plans were optimized for existing conditions. All intersections were coded with an individual signal controller using Vissim's ring barrier controller (RBC) module. Stop control was also coded in the model for unsignalized intersections.

Multiple Model Runs and Simulation Output

Due to the varying nature of the simulations between runs with different random seed numbers, Vissim results can differ from one run to the next. To improve model accuracy, multiple runs are

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[1] TFlowFuzzy is a matrix estimation method in VISUM used to adjust an OD matrix so that the result of the assignment more closely matches the observed volumes within the network.

required, and the results should be calculated using an average of these runs. Ten runs were performed for the existing conditions model, with random seed numbers ranging from 1111 to 11110 with increments of 1111.

Model Calibration

Calibration is an iterative process that involves adjusting model parameters until the simulation reasonably replicates driver behavior, traffic flow patterns, and field-measured data. The calibration process used for the Vissim model followed ODOT and FHWA guidelines for determining the acceptability of model results as compared to existing operations.

Visual Checking and Error Correction

The visual checking and error correction process focused on addressing coding errors before the calibration process began. This process involved reviewing data inputs, Vissim error reports, and model animations. Although primarily performed during model development, visual checking and error correction is still an important process that should be performed during calibration. When making changes to driver behavior or other model parameters, this step helps ensure that unintended consequences are minimized in the model.

Data inputs included network geometry, traffic volumes, signal timing, and route choices, and were reviewed by the model developer as well as a quality control reviewer. Vissim produces an error file after each simulation run. This can include vehicle removal, signal issues, end of link errors, and various others. Critical errors in the model were accounted for and corrected during this step. Reasonableness checks included visual checking of the animation file to check for abnormal driving behavior or irregular queuing within the network and to identify coding parameters that may have been overlooked.

Calibration Targets

The objective of model calibration is to match model performance estimates and the field performance measurements. However, there is a limit to the accuracy that results from an extensive process of matching the model to the field conditions, since observations on different days will naturally yield different results due to normal fluctuations in traffic patterns. The following calibration targets were used based on the *ODOT Vissim Protocol* and the *FHWA Traffic Analysis Toolbox*:

1. Hourly Flows (Model Versus Observed)
    a. Simulated and measured link volumes for more than 85% of links to be:
        i. Within 100 vph for volumes less than 700 vph
        ii. Within 15% for volumes between 700 vph and 2700 vph
    b. Simulated and measured link volumes for more than 85% of links to have a GEH statistic value of five (5) or lower.

c. Simulated and measured link volumes to be within a GEH value of five (5) or lower for all entry and exit locations and all intersection turn movements greater than 100 vehicles per hour.

2. Travel Time

   a. Simulated travel time within +/- 1 minute for routes with observed travel times less than 7 minutes.

   b. Simulated travel time within +/- 15% for routes with observed travel times greater than 7 minutes.

3. Visual Audits

   a. Check consistency with field conditions of the following: weaving maneuvers; patterns and extent of queues at intersections and congested links; lane utilization/choice; location of bottlenecks; etc.

   b. Critical queue lengths are visually acceptable to the satisfaction of analysts and reviewers.

Volume Validation

The GEH statistic used for traffic volume calibration compares expected or measured volumes with volume output from the microsimulation model and is calculated using the following formula:

$$GEH = \sqrt{\frac{2(m-c)^2}{m+c}}$$

Notes:
m = output traffic volume from the simulation model (vph)
c = input traffic volume (vph)

The GEH is scored using the following classification:

GEH < 5.0	**Acceptable fit**
5.0 <= GEH <= 10.0	Caution: possible model error or bad data
GEH > 10.0	Unacceptable

Using GEH instead of difference percentages allows for a better acceptance over a wider range of volumes. GEH is not linear and places less importance on links with low expected volumes while allowing for variation at high volume locations. GEH values higher than 5 should warrant investigation and values over 10 indicate there may be an error with the model.

Travel Time Validation

Bluetooth travel time measurements were collected on both of directions of US 97 for three consecutive weekdays. One Bluetooth unit was located between Evergreen and

Glacier/Highland and one was located at or near Yew Avenue. Historic travel time data from iPeMS (June 2017 through August 2017) was also used to validate travel times along US 97.

Calibration Parameters

Calibration parameters for US 97 and the adjacent arterials are based on the default “Urban Motorized” driver behavior with a few modifications to better replicate existing conditions. The following car following parameters were modified:

- Look ahead distance: The number of observed vehicles was increased to 6 from the default value of 4.

In addition to the car following parameters described above, the following lane change parameters were adjusted:

- Cooperative lane change: This parameter was enabled (checked) to enhance merging and lane changing, with a maximum speed difference of 10.00 mph and a maximum collision time of 10.00 seconds.

These changes resulted in traffic conditions on US 97 and the adjacent arterials that were generally consistent with field observed conditions.

Calibration Results

The results of the Vissim calibration process were used to validate queue lengths, traffic volumes, and travel times. Visual audits were also performed to check the consistency of the model with field conditions. In general, the study area is not congested, and visual observations of the Vissim model were consistent with field conditions.

Queue Length Validation

The modeled maximum approach queue lengths were compared to field observed queue lengths on US 97 at the Odem Medo Way and Veterans Way intersections. The field observed queues at both locations included up to 15 vehicles (+/-) and varied throughout the peak hour. Assuming an average distance of 25 to 30 feet from the front end of one vehicle to the rear of the next, the queue lengths ranged from 375 to 450 feet (+/-). The Vissim results show an average maximum approach queue length at Odem Medo of approximately 450 feet for northbound US 97 and 300 feet for southbound US 97. At the Veterans Way intersection, the average maximum approach queue lengths from Vissim were approximately 400 feet for northbound US 97 and 500 feet for southbound US 97.

It is important to note that the existing SCATS timing was not used, and that fixed timing plans were optimized for the simulation. Given that queue lengths are dependent on signal timing as well as vehicle length, the queue lengths in the Vissim simulation model were within acceptable limits when compared to the queue lengths observed in the field.

Traffic Volume Validation

The PM peak hour modeled traffic volumes and balanced field-collected volumes at each intersection are provided in Table 2. The traffic volume summaries are based on total volume (sum of all turning movements) at the intersections. Individual movement results for each intersection are provided in Appendix A. As shown below, the PM peak hour traffic volumes, as measured in the Vissim simulation models, correlate well with the balanced field-collected volumes, with a calculated GEH of 2.6 or less for all intersections. The individual turning movements also had a calculated GEH of 2.6 or less for all movements.

Table 2. Traffic Volume Summary – PM Peak Hour

Intersection	Measured Volume	Simulated Volume	GEH	Difference		Volume Measure
				vhp	%	
SW Highland Ave & SW 6th St	1404	1404	0.0	0	0.0%	+/- 15%
SW Highland Ave & SW 5th St	1201	1204	0.1	3	0.2%	+/- 15%
SW Veterans Way & SW Canal Blvd	1922	1917	0.1	-5	-0.3%	+/- 15%
US 97 off Ramp & Yew Ave	1361	1332	0.8	-29	-2.1%	+/- 15%
US 97 On Ramp & Yew Ave	1320	1304	0.4	-16	-1.2%	+/- 15%
US 97 & Odem Medo Way	3543	3392	2.6	-151	-4.3%	+/- 400 vph
US 97 & Veterans Ave	3782	3655	2.1	-127	-3.4%	+/- 400 vph
US 97 & Highland Ave/Glacier Ave	3346	3275	1.2	-71	-2.1%	+/- 400 vph
Glacier Ave & SW 5th St	1203	1218	0.4	15	1.2%	+/- 15%
Glacier Ave & 6th St	1286	1274	0.3	-12	-0.9%	+/- 15%
Canal Blvd & Odem Medo Way	1547	1536	0.3	-11	-0.7%	+/- 15%

Travel Time Validation

The PM peak hour modeled travel times and field-collected travel times for US 97 are shown below in Table 3 and Table 4 for both the Bluetooth and iPeMS travel times. As shown below, the average travel times, estimated using Vissim, correlate well with the historic and field-collected travel times. For US 97 northbound, the differences in average travel time between the simulation and the field data (Bluetooth or iPeMS) is 45 seconds or less. For US 97 southbound, the differences are even less, with only 22 seconds for the iPeMS data and 2 seconds for the Bluetooth data. It is important to note that the existing SCATS timing was not used, and that actuated timing plans with fixed cycle lengths were optimized for the simulation. Despite these modifications, the travel time results show that the Vissim model provides a good representation of existing conditions. The raw Bluetooth and iPeMS data used for calibration is provided in Appendix B.

Table 3. Travel Time Summary – Bluetooth

Travel Time Segments		Field Measured	VISSIM	
Direction	Segment	Travel Time (mins)	Travel Time (min)	Difference (minutes)
SB	South of Evergreen Ave to North of Yew Ave	3.94	3.98	0.04
NB	North of Yew Ave to South of Evergreen Ave	4.27	3.54	-0.74

Table 4. Travel Time Summary – iPeMS

Travel Time Segments		Field Measured	VISSIM	
Direction	Segment	Travel Time (mins)	Travel Time (min)	Difference (minutes)
SB	South of Evergreen Ave to North of Yew Ave	4.35	3.98	-0.37
NB	North of Yew Ave to South of Evergreen Ave	4.13	3.54	-0.59

Conclusion

This report documented the Vissim model development and calibration effort for the existing (2017) PM peak period hour, which will serve as the basis for the future No-Build and Build alternatives analysis. Overall, the calibration of the existing conditions Vissim model produced simulation output that replicated existing traffic operations and field observed driver behavior for the PM peak period. In addition, it is anticipated that some of the calibration parameters may be modified when analyzing various alternatives if geometric improvements warrant changes in vehicle speeds or capacity.

Appendix A. Intersection GEH Summary

Intersection	Movement	Measured Volume	Simulated Volume	GEH	Difference		Volume Measure	Meets Measure?	Meets GEH?
					vph	%			
SW Highland Ave and SW 6th St	EBT	722	710	0.4	-12	-1.7%	+/- 15%	Yes	Yes
	EBR	49	61	1.6	12	24.5%	+/- 100 vph	Yes	Yes
	SBL	143	159	1.3	16	11.2%	+/- 100 vph	Yes	Yes
	SBT	490	474	0.7	-16	-3.3%	+/- 100 vph	Yes	Yes
SW Highland Ave and SW 5th St	EBL	302	316	0.8	14	4.6%	+/- 100 vph	Yes	Yes
	EBT	563	553	0.4	-10	-1.8%	+/- 100 vph	Yes	Yes
	NBT	305	304	0.1	-1	-0.3%	+/- 100 vph	Yes	Yes
	NBR	31	31	0.0	0	0.0%	+/- 100 vph	Yes	Yes
SW Veterans Way and SW Canal Blvd	EBL	9	8	0.3	-1	-11.1%	+/- 100 vph	Yes	Yes
	EBT	177	171	0.5	-6	-3.4%	+/- 100 vph	Yes	Yes
	EBR	115	118	0.3	3	2.6%	+/- 100 vph	Yes	Yes
	SBL	165	173	0.6	8	4.8%	+/- 100 vph	Yes	Yes
	SBT	353	344	0.5	-9	-2.5%	+/- 100 vph	Yes	Yes
	SBR	15	14	0.3	-1	-6.7%	+/- 100 vph	Yes	Yes
	WBL	104	109	0.5	5	4.8%	+/- 100 vph	Yes	Yes
	WBT	260	252	0.5	-8	-3.1%	+/- 100 vph	Yes	Yes
	WBR	183	190	0.5	7	3.8%	+/- 100 vph	Yes	Yes
	NBL	120	129	0.8	9	7.5%	+/- 100 vph	Yes	Yes
	NBT	323	309	0.8	-14	-4.3%	+/- 100 vph	Yes	Yes
	NBR	98	100	0.2	2	2.0%	+/- 100 vph	Yes	Yes
US 97 Off Ramp and Yew Ave	EBT	179	163	1.2	-16	-8.9%	+/- 100 vph	Yes	Yes
	EBR	193	198	0.4	5	2.6%	+/- 100 vph	Yes	Yes
	SBL	103	98	0.5	-5	-4.9%	+/- 100 vph	Yes	Yes
	SBR	119	103	1.5	-16	-13.4%	+/- 100 vph	Yes	Yes
	WBL	261	291	1.8	30	11.5%	+/- 100 vph	Yes	Yes
	WBT	506	479	1.2	-27	-5.3%	+/- 100 vph	Yes	Yes
US 97 On Ramp and Yew Ave	EBL	114	103	1.1	-11	-9.6%	+/- 100 vph	Yes	Yes
	EBT	168	158	0.8	-10	-6.0%	+/- 100 vph	Yes	Yes
	WBT	454	441	0.6	-13	-2.9%	+/- 100 vph	Yes	Yes
	WBR	93	106	1.3	13	14.0%	+/- 100 vph	Yes	Yes
	NBL	313	329	0.9	16	5.1%	+/- 100 vph	Yes	Yes
	NBR	178	167	0.8	-11	-6.2%	+/- 100 vph	Yes	Yes
US 97 and Odem Medo Rd	EBL	261	264	0.2	3	1.1%	+/- 100 vph	Yes	Yes
	EBT	12	12	0.0	0	0.0%	+/- 100 vph	Yes	Yes
	EBR	164	157	0.6	-7	-4.3%	+/- 100 vph	Yes	Yes
	SBL	4	2	1.2	-2	-50.0%	+/- 100 vph	Yes	Yes
	SBT	1162	1085	2.3	-77	-6.6%	+/- 15%	Yes	Yes
	SBR	277	278	0.1	1	0.4%	+/- 100 vph	Yes	Yes
	WBL	11	12	0.3	1	9.1%	+/- 100 vph	Yes	Yes
	WBT	29	28	0.2	-1	-3.4%	+/- 100 vph	Yes	Yes
	WBR	10	9	0.3	-1	-10.0%	+/- 100 vph	Yes	Yes
	NBL	222	211	0.7	-11	-5.0%	+/- 100 vph	Yes	Yes
	NBT	1386	1330	1.5	-56	-4.0%	+/- 15%	Yes	Yes
	NBR	5	4	0.5	-1	-20.0%	+/- 100 vph	Yes	Yes
US 97 and Veterans Ave	EBL	91	90	0.1	-1	-1.1%	+/- 100 vph	Yes	Yes
	EBT	140	136	0.3	-4	-2.9%	+/- 100 vph	Yes	Yes
	EBR	209	216	0.5	7	3.3%	+/- 100 vph	Yes	Yes
	SBL	58	56	0.3	-2	-3.4%	+/- 100 vph	Yes	Yes
	SBT	1039	958	2.6	-81	-7.8%	+/- 15%	Yes	Yes
	SBR	46	54	1.1	8	17.4%	+/- 100 vph	Yes	Yes
	WBL	182	186	0.3	4	2.2%	+/- 100 vph	Yes	Yes
	WBT	256	258	0.1	2	0.8%	+/- 100 vph	Yes	Yes
	WBR	157	151	0.5	-6	-3.8%	+/- 100 vph	Yes	Yes
	NBL	245	239	0.4	-6	-2.4%	+/- 100 vph	Yes	Yes
	NBT	1248	1200	1.4	-48	-3.8%	+/- 15%	Yes	Yes
	NBR	111	111	0.0	0	0.0%	+/- 100 vph	Yes	Yes
US 97 and Highland Ave/Glacier Ave	EBL	378	372	0.3	-6	-1.6%	+/- 100 vph	Yes	Yes
	EBR	216	212	0.3	-4	-1.9%	+/- 100 vph	Yes	Yes
	SBT	965	936	0.9	-29	-3.0%	+/- 15%	Yes	Yes
	SBR	257	283	1.6	26	10.1%	+/- 100 vph	Yes	Yes
	NBL	339	318	1.2	-21	-6.2%	+/- 100 vph	Yes	Yes
	NBT	1191	1154	1.1	-37	-3.1%	+/- 15%	Yes	Yes

Intersection	Movement	Measured Volume	Simulated Volume	GEH	Difference		Volume Measure	Meets Measure?	Meets GEH?
					vph	%			
Glacier Ave and SW 5th St	WBT	395	371	1.2	-24	-6.1%	+/- 100 vph	Yes	Yes
	WBR	201	229	1.9	28	13.9%	+/- 100 vph	Yes	Yes
	NBL	39	50	1.6	11	28.2%	+/- 100 vph	Yes	Yes
	NBT	568	568	0.0	0	0.0%	+/- 100 vph	Yes	Yes
Glacier Ave and 6th St	SBT	581	576	0.2	-5	-0.9%	+/- 100 vph	Yes	Yes
	SBR	271	274	0.2	3	1.1%	+/- 100 vph	Yes	Yes
	WBL	52	56	0.5	4	7.7%	+/- 100 vph	Yes	Yes
	WBT	382	368	0.7	-14	-3.7%	+/- 100 vph	Yes	Yes
Canal Blvd and Odem Medo Way	SBL	265	266	0.1	1	0.4%	+/- 100 vph	Yes	Yes
	SBT	271	271	0.0	0	0.0%	+/- 100 vph	Yes	Yes
	WBL	180	179	0.1	-1	-0.6%	+/- 100 vph	Yes	Yes
	WBR	348	341	0.4	-7	-2.0%	+/- 100 vph	Yes	Yes
	NBT	311	302	0.5	-9	-2.9%	+/- 100 vph	Yes	Yes
	NBR	172	177	0.4	5	2.9%	+/- 100 vph	Yes	Yes
Yew Ave and Canal Blvd (Roundabout)	EBL	6	5	0.4	-1	-16.7%	+/- 100 vph	Yes	Yes
	EBT	197	193	0.3	-4	-2.0%	+/- 100 vph	Yes	Yes
	EBR	47	51	0.6	4	8.5%	+/- 100 vph	Yes	Yes
	SBL	82	82	0.0	0	0.0%	+/- 100 vph	Yes	Yes
	SBT	139	140	0.1	1	0.7%	+/- 100 vph	Yes	Yes
	SBR	12	11	0.3	-1	-8.3%	+/- 100 vph	Yes	Yes
	WBL	77	71	0.7	-6	-7.8%	+/- 100 vph	Yes	Yes
	WBT	378	347	1.6	-31	-8.2%	+/- 100 vph	Yes	Yes
	WBR	170	162	0.6	-8	-4.7%	+/- 100 vph	Yes	Yes
	NBL	94	88	0.6	-6	-6.4%	+/- 100 vph	Yes	Yes
	NBT	210	220	0.7	10	4.8%	+/- 100 vph	Yes	Yes
	NBR	93	86	0.7	-7	-7.5%	+/- 100 vph	Yes	Yes

Appendix B. Travel Time Data

US97 SB Bluetooth
Length 1.97 miles

			Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
Day	Start	End	**Sample Size**	**Mean Travel Time**	**Standard Deviation**	**Mean Speed**	**85th PCT Speed**	**Median**	**Min**	**Max**	**25th PCT**	**75th PCT**	**95th PCT**
1	4:30 PM	4:45 PM	11	3.83	0.68	30.91	38.55	3.53	2.88	4.73	3.34	4.47	4.72
	4:45 PM	5:00 PM	10	4.59	0.52	25.81	27.75	4.57	3.68	5.73	4.32	4.80	5.73
	5:00 PM	5:15 PM	6	3.47	0.75	34.08	40.38	3.04	2.87	4.51	3.02	4.37	4.51
	5:15 PM	5:30 PM	13	3.96	1.34	29.87	41.08	3.20	2.77	7.40	3.00	4.53	7.07
2	4:30 PM	4:45 PM	12	3.99	0.73	29.65	38.66	4.18	2.97	4.92	3.11	4.56	4.91
	4:45 PM	5:00 PM	12	3.86	0.63	30.68	39.86	4.15	2.80	4.69	3.39	4.30	4.66
	5:00 PM	5:15 PM	8	4.00	0.57	29.57	37.48	4.19	3.04	4.53	3.65	4.38	4.53
	5:15 PM	5:30 PM	7	4.21	0.72	28.15	37.13	4.51	3.04	4.84	3.60	4.64	4.84
3	4:30 PM	4:45 PM	11	3.85	0.67	30.74	38.95	3.93	2.99	4.83	3.11	4.36	4.82
	4:45 PM	5:00 PM	8	3.84	0.71	30.83	39.32	4.05	2.78	4.64	3.17	4.42	4.64
	5:00 PM	5:15 PM	6	3.51	0.74	33.71	41.66	3.25	2.81	4.52	2.89	4.35	4.52
	5:15 PM	5:30 PM	14	3.90	0.60	30.32	37.35	4.18	3.02	4.63	3.23	4.41	4.61
Average	**4:30 PM**	**5:30 PM**	**118**	**3.94**	**0.73**	**30.17**	**38.10**	**3.92**	**2.97**	**5.09**	**3.32**	**4.47**	**5.04**

US97 NB Bluetooth
Length 1.97 miles

			Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
Day	Start	End	**Sample Size**	**Mean Travel Time**	**Standard Deviation**	**Mean Speed**	**85th PCT Speed**	**Median**	**Min**	**Max**	**25th PCT**	**75th PCT**	**95th PCT**
1	4:30 PM	4:45 PM	9	4.17	0.40	28.39	31.58	4.17	3.60	4.77	3.91	4.39	4.77
	4:45 PM	5:00 PM	14	4.17	0.58	28.39	33.47	4.20	3.00	5.05	4.07	4.62	4.99
	5:00 PM	5:15 PM	19	4.48	0.92	26.45	33.24	4.31	3.19	7.17	3.99	4.75	6.44
	5:15 PM	5:30 PM	9	3.73	0.49	31.77	36.36	3.61	2.87	4.42	3.44	4.09	4.42
2	4:30 PM	4:45 PM	7	3.84	0.65	30.84	37.12	3.64	3.17	4.62	3.24	4.51	4.62
	4:45 PM	5:00 PM	14	4.45	0.83	26.59	34.57	4.36	2.97	5.67	4.05	5.15	5.65
	5:00 PM	5:15 PM	6	3.93	0.47	30.15	35.39	4.05	3.09	4.37	3.73	4.28	4.37
	5:15 PM	5:30 PM	11	4.44	0.48	26.67	30.84	4.47	3.62	5.03	4.11	4.86	5.03
3	4:30 PM	4:45 PM	11	4.13	0.76	28.70	37.65	4.04	3.01	5.43	3.77	4.53	5.42
	4:45 PM	5:00 PM	16	4.55	1.09	26.03	33.79	4.24	3.41	7.32	3.81	4.82	6.96
	5:00 PM	5:15 PM	8	4.35	0.58	27.20	32.15	4.40	3.41	5.11	3.95	4.81	5.11
	5:15 PM	5:30 PM	14	4.34	0.45	27.25	30.94	4.32	3.73	5.13	3.99	4.75	5.10
Average	**4:30 PM**	**5:30 PM**	**138**	**4.27**	**0.68**	**27.79**	**33.71**	**4.19**	**3.26**	**5.60**	**3.88**	**4.68**	**5.44**

TRAVEL TIME DATA

15 MINUTE STATISTICAL SUMMARY

ROUTE INFORMATION
Name / Number:
Label: North of Yew to South of Evergreen
Length of Segment: 1.973156732 miles
Direction:

Beginning Station: BA7 North of Yew
Latitude: 44.24565667
Longitude: -121.1901833
Ending Station: A0C South of Evergreen
Latitude: 44.27072833
Longitude: -121.171095

Date: 6-Jun-17
Day of Week: Tuesday

Project Name: Redmond Bluetooth

			Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
Time	Begin Time	End Time	Sample Size	Mean Travel Time	Standard Deviation	Mean Speed	85th PCT Speed	Median	Min	Max	25th PCT	75th PCT	95th PCT
Midnight	12:00 AM	12:15 AM	5	3.07	0.20	38.52	41.12	3.04	2.87	3.38	2.90	3.22	3.38
	12:15 AM	12:30 AM	2	3.03	0.06	39.08	39.68	3.03	2.98	3.07	2.98	3.07	3.07
	12:30 AM	12:45 AM	2	2.96	0.04	40.02	40.36	2.96	2.93	2.98	2.93	2.98	2.98
	12:45 AM	1:00 AM	0										
	1:00 AM	1:15 AM	1	2.87	0.00	41.30	41.30	2.87	2.87	2.87	2.87	2.87	2.87
	1:15 AM	1:30 AM	1	3.01	0.00	39.35	39.35	3.01	3.01	3.01	3.01	3.01	3.01
	1:30 AM	1:45 AM	0										
	1:45 AM	2:00 AM	0										
	2:00 AM	2:15 AM	0										
	2:15 AM	2:30 AM	1	3.18	0.00	37.19	37.19	3.18	3.18	3.18	3.18	3.18	3.18
	2:30 AM	2:45 AM	2	3.08	0.05	38.45	38.92	3.08	3.04	3.12	3.04	3.12	3.12
	2:45 AM	3:00 AM	1	2.90	0.00	40.82	40.82	2.90	2.90	2.90	2.90	2.90	2.90
	3:00 AM	3:15 AM	1	2.98	0.00	39.68	39.68	2.98	2.98	2.98	2.98	2.98	2.98
	3:15 AM	3:30 AM	0										
	3:30 AM	3:45 AM	1	2.87	0.00	41.30	41.30	2.87	2.87	2.87	2.87	2.87	2.87
	3:45 AM	4:00 AM	0										
	4:00 AM	4:15 AM	2	3.01	0.15	39.30	40.71	3.01	2.91	3.12	2.91	3.12	3.12
	4:15 AM	4:30 AM	3	3.13	0.28	37.78	40.36	3.02	2.93	3.45	2.95	3.34	3.45
	4:30 AM	4:45 AM	4	2.98	0.22	39.68	42.34	2.94	2.79	3.27	2.81	3.15	3.27
	4:45 AM	5:00 AM	1	3.11	0.00	38.09	38.09	3.11	3.11	3.11	3.11	3.11	3.11
	5:00 AM	5:15 AM	4	2.62	0.14	45.24	47.12	2.57	2.51	2.82	2.53	2.70	2.82
	5:15 AM	5:30 AM	0										
	5:30 AM	5:45 AM	0										
	5:45 AM	6:00 AM	2	4.26	2.23	27.77	44.12	4.26	2.68	5.84	2.68	5.84	5.84
	6:00 AM	6:15 AM	3	3.26	0.70	36.30	48.16	3.64	2.46	3.68	2.75	3.67	3.68
	6:15 AM	6:30 AM	0										
	6:30 AM	6:45 AM	4	2.49	0.48	47.51	55.06	2.32	2.13	3.19	2.22	2.77	3.19
	6:45 AM	7:00 AM	5	3.39	0.39	34.89	40.33	3.40	2.84	3.86	3.12	3.70	3.86
	7:00 AM	7:15 AM	1	3.86	0.00	30.68	30.68	3.86	3.86	3.86	3.86	3.86	3.86
	7:15 AM	7:30 AM	5	2.79	0.29	42.43	45.68	2.68	2.58	3.28	2.61	2.91	3.28
	7:30 AM	7:45 AM	10	3.04	0.42	38.97	45.10	3.03	2.54	4.05	2.75	3.17	4.05
	7:45 AM	8:00 AM	8	3.61	0.51	32.79	40.73	3.70	2.88	4.28	3.15	4.00	4.28
	8:00 AM	8:15 AM	8	3.05	0.53	38.76	46.58	3.03	2.48	3.83	2.59	3.44	3.83
	8:15 AM	8:30 AM	9	3.48	0.59	33.98	40.59	3.50	2.63	4.64	3.04	3.75	4.64
	8:30 AM	8:45 AM	9	3.19	0.33	37.11	41.96	3.28	2.80	3.61	2.84	3.47	3.61
	8:45 AM	9:00 AM	8	3.84	0.51	30.81	35.75	3.97	2.95	4.41	3.47	4.25	4.41
	9:00 AM	9:15 AM	9	3.54	0.53	33.43	40.05	3.31	2.85	4.27	3.13	4.03	4.27
	9:15 AM	9:30 AM	6	3.04	0.34	38.89	43.47	3.01	2.65	3.60	2.83	3.17	3.60
	9:30 AM	9:45 AM	12	3.45	0.62	34.32	41.78	3.28	2.65	4.66	3.14	3.63	4.65
	9:45 AM	10:00 AM	6	3.18	0.29	37.19	40.94	3.14	2.77	3.62	3.07	3.36	3.62
	10:00 AM	10:15 AM	4	3.74	0.44	31.68	36.64	3.76	3.18	4.25	3.45	4.02	4.25
	10:15 AM	10:30 AM	8	4.64	1.25	25.54	33.71	4.42	3.03	6.32	3.74	5.71	6.32
	10:30 AM	10:45 AM	6	3.84	0.54	30.83	34.48	3.60	3.37	4.82	3.53	4.13	4.82
	10:45 AM	11:00 AM	8	4.01	0.40	29.50	32.71	3.95	3.57	4.63	3.67	4.33	4.63
	11:00 AM	11:15 AM	16	4.31	0.69	27.44	33.27	4.23	3.17	5.61	3.74	4.79	5.52
	11:15 AM	11:30 AM	9	3.84	0.42	30.80	33.07	3.84	2.85	4.27	3.74	4.15	4.27
	11:30 AM	11:45 AM	8	3.83	0.54	30.88	36.66	3.83	3.02	4.68	3.44	4.20	4.68
	11:45 AM	12:00 PM	7	4.16	0.72	28.49	34.90	4.45	3.25	5.17	3.52	4.62	5.17
Noon	12:00 PM	12:15 PM	7	3.77	0.50	31.37	35.63	3.73	2.93	4.59	3.65	3.98	4.59
	12:15 PM	12:30 PM	15	4.71	1.00	25.13	33.65	4.82	2.82	6.75	4.39	5.30	6.50
	12:30 PM	12:45 PM	10	4.23	0.39	27.99	31.22	4.15	3.73	4.93	3.92	4.50	4.93
	12:45 PM	1:00 PM	8	3.95	0.64	30.00	35.70	3.86	2.97	4.98	3.55	4.40	4.98
	1:00 PM	1:15 PM	9	4.35	1.05	27.23	35.22	4.26	2.86	5.93	3.52	4.93	5.93
	1:15 PM	1:30 PM	5	4.79	0.61	24.73	28.09	4.55	4.18	5.52	4.29	5.40	5.52
	1:30 PM	1:45 PM	10	4.95	1.10	23.90	32.89	4.72	3.43	6.60	4.28	5.96	6.60
	1:45 PM	2:00 PM	14	4.21	0.52	28.10	31.21	4.23	3.23	5.63	3.98	4.37	5.40
	2:00 PM	2:15 PM	9	4.31	1.39	27.49	37.31	3.92	3.07	7.68	3.61	4.52	7.68
	2:15 PM	2:30 PM	12	3.85	0.37	30.79	34.42	3.80	3.42	4.50	3.47	4.12	4.48
	2:30 PM	2:45 PM	8	3.79	0.85	31.22	40.08	3.67	2.87	4.89	3.03	4.58	4.89
	2:45 PM	3:00 PM	6	4.02	0.54	29.48	34.99	4.09	3.20	4.77	3.66	4.27	4.77
	3:00 PM	3:15 PM	5	6.17	5.04	19.19	33.77	4.07	3.39	15.17	3.74	7.07	15.17
	3:15 PM	3:30 PM	6	6.11	4.00	19.36	27.07	4.53	4.27	14.28	4.53	4.53	14.28
	3:30 PM	3:45 PM	9	8.72	8.12	13.58	27.04	4.82	3.50	23.27	4.69	9.59	23.27
	3:45 PM	4:00 PM	13	7.38	6.28	16.04	30.87	5.06	3.58	21.47	4.39	5.76	21.46
	4:00 PM	4:15 PM	10	3.70	0.71	31.97	39.03	3.86	2.43	4.58	3.13	4.25	4.58
	4:15 PM	4:30 PM	11	5.07	0.85	23.33	28.02	5.07	3.28	6.18	4.75	5.70	6.18
	4:30 PM	4:45 PM	9	4.17	0.40	28.39	31.58	4.17	3.60	4.77	3.91	4.39	4.77
	4:45 PM	5:00 PM	14	4.17	0.58	28.39	33.47	4.20	3.00	5.05	4.07	4.62	4.99
	5:00 PM	5:15 PM	19	4.48	0.92	26.45	33.24	4.31	3.19	7.17	3.99	4.75	6.44
	5:15 PM	5:30 PM	9	3.73	0.49	31.77	36.36	3.61	2.87	4.42	3.44	4.09	4.42
	5:30 PM	5:45 PM	12	4.43	0.48	26.70	30.32	4.61	3.37	4.88	4.09	4.79	4.88
	5:45 PM	6:00 PM	11	4.06	0.32	29.16	31.19	4.03	3.62	4.73	3.88	4.13	4.71
	6:00 PM	6:15 PM	8	4.19	0.58	28.23	33.47	4.26	3.39	5.09	3.67	4.60	5.09
	6:15 PM	6:30 PM	14	5.09	1.44	23.25	33.41	5.39	2.90	8.03	3.93	5.98	7.72
	6:30 PM	6:45 PM	7	4.10	0.92	28.85	36.62	3.83	3.23	5.84	3.36	4.53	5.84
	6:45 PM	7:00 PM	17	3.72	0.53	31.79	40.79	3.90	2.70	4.50	3.43	4.09	4.44
	7:00 PM	7:15 PM	3	3.35	0.50	35.34	42.54	3.55	2.78	3.72	2.97	3.67	3.72
	7:15 PM	7:30 PM	9	3.64	0.48	32.56	38.16	3.62	2.78	4.22	3.44	4.13	4.22
	7:30 PM	7:45 PM	7	3.19	0.45	37.11	43.05	3.14	2.75	3.91	2.77	3.54	3.91
	7:45 PM	8:00 PM	8	3.73	0.52	31.75	37.60	3.68	3.13	4.43	3.25	4.21	4.43
	8:00 PM	8:15 PM	4	3.59	0.41	33.00	37.33	3.56	3.15	4.08	3.26	3.92	4.08
	8:15 PM	8:30 PM	7	3.37	0.37	35.17	41.17	3.39	2.87	3.86	3.01	3.60	3.86
	8:30 PM	8:45 PM	10	3.41	0.40	34.72	39.79	3.28	2.95	4.07	3.12	3.80	4.07
	8:45 PM	9:00 PM	6	3.34	0.63	35.47	42.28	3.20	2.77	4.38	2.85	3.62	4.38
	9:00 PM	9:15 PM	5	2.92	0.31	40.57	45.98	3.11	2.57	3.17	2.59	3.15	3.17
	9:15 PM	9:30 PM	5	3.26	0.21	36.37	39.44	3.32	2.97	3.48	3.07	3.42	3.48
	9:30 PM	9:45 PM	3	2.75	0.03	43.05	43.31	2.73	2.73	2.78	2.73	2.77	2.78
	9:45 PM	10:00 PM	5	2.95	0.26	40.11	43.28	2.81	2.73	3.28	2.76	3.20	3.28
	10:00 PM	10:15 PM	7	2.81	0.21	42.17	45.87	2.75	2.56	3.11	2.62	3.00	3.11
	10:15 PM	10:30 PM	7	3.26	0.26	36.33	39.91	3.25	2.87	3.67	3.07	3.41	3.67
	10:30 PM	10:45 PM	6	2.95	0.18	40.19	43.74	3.02	2.63	3.13	2.82	3.07	3.13
	10:45 PM	11:00 PM	2	3.10	0.54	38.19	43.58	3.10	2.72	3.48	2.72	3.48	3.48
	11:00 PM	11:15 PM	4	3.02	0.24	39.25	42.41	2.99	2.78	3.30	2.82	3.21	3.30
	11:15 PM	11:30 PM	4	2.83	0.30	41.78	48.00	2.90	2.43	3.10	2.60	3.07	3.10
	11:30 PM	11:45 PM	4	2.70	0.04	43.85	44.40	2.70	2.67	2.73	2.67	2.73	2.73
Midnight	11:45 PM	12:00 AM	2	3.25	0.61	36.43	42.03	3.25	2.82	3.68	2.82	3.68	3.68

SUMMARY

			Total Number of Samples	Averages of the 15 Minutes periods		
				Mean Travel Time	Standard Deviation	Mean Speed
AM Peak Period	**7:00 AM**	**9:00 AM**	58	3.36	0.40	35.69
Midday Period	**12:00 PM**	**2:00 PM**	78	4.37	0.73	27.31
PM Peak Period	**4:00 PM**	**6:00 PM**	95	4.23	0.59	28.27
Daily	**12:00 AM**	**12:00 AM**	597	3.73	0.72	33.38

TRAVEL TIME DATA

15 MINUTE STATISTICAL SUMMARY

ROUTE INFORMATION
Name / Number:
Label: North of Yew to South of Evergreen
Length of Segment: 1.973156732 miles
Direction:

Beginning Station: BA7 North of Yew
Latitude: 44.24565667
Longitude: -121.1901833
Ending Station: A0C South of Evergreen
Latitude: 44.27072833
Longitude: -121.171095

Date: 7-Jun-17
Day of Week: Wednesday

Project Name: Redmond Bluetooth

	Begin Time	End Time	Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
Time			**Sample Size**	**Mean Travel Time**	**Standard Deviation**	**Mean Speed**	**85th PCT Speed**	**Median**	**Min**	**Max**	**25th PCT**	**75th PCT**	**95th PCT**
Midnight	12:00 AM	12:15 AM	1	2.92	0.00	40.48	40.48	2.92	2.92	2.92	2.92	2.92	2.92
	12:15 AM	12:30 AM	2	3.05	0.24	38.82	41.06	3.05	2.88	3.22	2.88	3.22	3.22
	12:30 AM	12:45 AM	2	2.43	0.38	48.65	54.64	2.43	2.17	2.70	2.17	2.70	2.70
	12:45 AM	1:00 AM	4	3.04	0.09	38.90	40.25	3.06	2.93	3.12	2.97	3.11	3.12
	1:00 AM	1:15 AM	1	3.44	0.00	34.40	34.40	3.44	3.44	3.44	3.44	3.44	3.44
	1:15 AM	1:30 AM	1	2.63	0.00	44.96	44.96	2.63	2.63	2.63	2.63	2.63	2.63
	1:30 AM	1:45 AM	0										
	1:45 AM	2:00 AM	2	2.83	0.13	41.78	43.18	2.83	2.74	2.93	2.74	2.93	2.93
	2:00 AM	2:15 AM	0										
	2:15 AM	2:30 AM	0										
	2:30 AM	2:45 AM	0										
	2:45 AM	3:00 AM	0										
	3:00 AM	3:15 AM	1	3.18	0.00	37.19	37.19	3.18	3.18	3.18	3.18	3.18	3.18
	3:15 AM	3:30 AM	1	2.72	0.00	43.58	43.58	2.72	2.72	2.72	2.72	2.72	2.72
	3:30 AM	3:45 AM	1	2.56	0.00	46.28	46.28	2.56	2.56	2.56	2.56	2.56	2.56
	3:45 AM	4:00 AM	1	2.97	0.00	39.79	39.79	2.97	2.97	2.97	2.97	2.97	2.97
	4:00 AM	4:15 AM	2	2.75	0.23	42.99	45.68	2.75	2.59	2.92	2.59	2.92	2.92
	4:15 AM	4:30 AM	0										
	4:30 AM	4:45 AM	2	3.01	0.14	39.30	40.59	3.01	2.92	3.11	2.92	3.11	3.11
	4:45 AM	5:00 AM	1	2.92	0.00	40.48	40.48	2.92	2.92	2.92	2.92	2.92	2.92
	5:00 AM	5:15 AM	1	3.55	0.00	33.35	33.35	3.55	3.55	3.55	3.55	3.55	3.55
	5:15 AM	5:30 AM	2	3.33	0.03	35.56	35.79	3.33	3.31	3.35	3.31	3.35	3.35
	5:30 AM	5:45 AM	5	3.25	0.46	36.41	41.78	3.02	2.78	3.86	2.93	3.67	3.86
	5:45 AM	6:00 AM	2	2.70	0.34	43.78	48.00	2.70	2.47	2.94	2.47	2.94	2.94
	6:00 AM	6:15 AM	1	2.63	0.00	44.96	44.96	2.63	2.63	2.63	2.63	2.63	2.63
	6:15 AM	6:30 AM	5	2.87	0.34	41.20	48.57	3.03	2.35	3.17	2.61	3.13	3.17
	6:30 AM	6:45 AM	2	2.76	0.39	42.92	47.67	2.76	2.48	3.03	2.48	3.03	3.03
	6:45 AM	7:00 AM	7	3.26	0.32	36.35	40.11	3.18	2.93	3.78	3.00	3.51	3.78
	7:00 AM	7:15 AM	1	3.27	0.00	36.24	36.24	3.27	3.27	3.27	3.27	3.27	3.27
	7:15 AM	7:30 AM	5	2.74	0.25	43.16	48.08	2.75	2.40	3.08	2.59	2.90	3.08
	7:30 AM	7:45 AM	5	3.17	0.40	37.31	43.65	3.23	2.65	3.62	2.84	3.50	3.62
	7:45 AM	8:00 AM	8	3.29	0.44	35.93	42.01	3.31	2.55	3.92	3.04	3.59	3.92
	8:00 AM	8:15 AM	5	3.26	0.43	36.35	39.63	3.11	2.97	4.02	3.03	3.36	4.02
	8:15 AM	8:30 AM	7	3.27	0.31	36.16	41.57	3.38	2.82	3.58	2.97	3.52	3.58
	8:30 AM	8:45 AM	9	3.88	0.83	30.52	38.87	3.97	2.64	5.56	3.35	4.18	5.56
	8:45 AM	9:00 AM	7	3.80	0.47	31.12	36.37	4.09	3.02	4.22	3.47	4.19	4.22
	9:00 AM	9:15 AM	11	3.34	0.51	35.42	42.53	3.50	2.32	4.03	2.95	3.62	4.02
	9:15 AM	9:30 AM	6	3.69	0.45	32.05	36.82	3.63	3.03	4.27	3.50	4.10	4.27
	9:30 AM	9:45 AM	7	3.67	0.38	32.25	36.27	3.54	3.11	4.08	3.43	4.03	4.08
	9:45 AM	10:00 AM	7	3.61	0.30	32.79	36.22	3.63	3.20	4.11	3.39	3.72	4.11
	10:00 AM	10:15 AM	11	3.55	0.36	33.38	35.23	3.49	3.02	4.52	3.43	3.57	4.48
	10:15 AM	10:30 AM	9	3.64	0.48	32.48	37.51	3.52	3.00	4.24	3.25	4.13	4.24
	10:30 AM	10:45 AM	9	3.65	0.34	32.47	37.56	3.73	3.07	4.02	3.40	3.91	4.02
	10:45 AM	11:00 AM	12	3.54	0.51	33.44	39.52	3.63	2.52	4.23	3.17	3.87	4.22
	11:00 AM	11:15 AM	6	3.96	0.50	29.93	34.25	3.89	3.30	4.72	3.69	4.25	4.72
	11:15 AM	11:30 AM	6	3.46	0.26	34.25	37.19	3.40	3.05	3.77	3.38	3.73	3.77
	11:30 AM	11:45 AM	9	3.70	0.47	32.04	37.03	3.72	3.18	4.48	3.20	3.92	4.48
	11:45 AM	12:00 PM	11	4.08	0.77	29.02	33.52	3.93	3.00	5.91	3.66	4.16	5.86
Noon	12:00 PM	12:15 PM	7	3.87	0.44	30.56	35.34	4.06	3.17	4.45	3.55	4.16	4.45
	12:15 PM	12:30 PM	9	3.57	0.45	33.17	39.53	3.69	2.92	4.06	3.07	3.95	4.06
	12:30 PM	12:45 PM	6	4.48	0.55	26.46	30.36	4.48	3.90	5.25	3.90	4.83	5.25
	12:45 PM	1:00 PM	10	3.86	0.69	30.69	38.61	3.74	2.83	5.07	3.53	4.40	5.07
	1:00 PM	1:15 PM	11	4.46	0.72	26.55	34.63	4.42	3.23	5.40	4.29	4.99	5.40
	1:15 PM	1:30 PM	8	4.30	0.64	27.55	31.26	4.27	3.25	5.57	4.09	4.43	5.57
	1:30 PM	1:45 PM	8	3.97	0.42	29.80	31.99	3.85	3.62	4.95	3.73	4.02	4.95
	1:45 PM	2:00 PM	16	4.12	0.35	28.72	31.26	4.15	3.26	4.57	3.93	4.41	4.54
	2:00 PM	2:15 PM	11	3.84	0.44	30.82	35.12	3.85	3.14	4.57	3.55	3.99	4.56
	2:15 PM	2:30 PM	5	3.75	0.46	31.57	35.52	3.67	3.25	4.49	3.50	3.94	4.49
	2:30 PM	2:45 PM	6	3.61	0.78	32.81	42.66	3.53	2.76	4.56	2.80	4.47	4.56
	2:45 PM	3:00 PM	12	4.98	0.86	23.79	29.50	5.02	3.65	6.65	4.30	5.63	6.55
	3:00 PM	3:15 PM	12	4.45	1.64	26.60	34.79	3.92	2.95	8.95	3.46	4.79	8.64
	3:15 PM	3:30 PM	7	4.52	0.58	26.22	30.02	4.30	3.83	5.29	4.06	5.07	5.29
	3:30 PM	3:45 PM	11	4.41	0.98	26.87	32.96	4.16	3.26	6.77	3.67	4.91	6.69
	3:45 PM	4:00 PM	11	4.12	0.39	28.75	31.99	4.10	3.46	4.57	3.80	4.51	4.57
	4:00 PM	4:15 PM	10	3.64	1.08	32.48	39.25	3.11	2.80	5.63	3.02	3.87	5.63
	4:15 PM	4:30 PM	18	4.14	0.85	28.58	37.58	3.93	3.01	5.70	3.42	4.93	5.56
	4:30 PM	4:45 PM	7	3.84	0.65	30.84	37.12	3.64	3.17	4.62	3.24	4.51	4.62
	4:45 PM	5:00 PM	14	4.45	0.83	26.59	34.57	4.36	2.97	5.67	4.05	5.15	5.65
	5:00 PM	5:15 PM	6	3.93	0.47	30.15	35.39	4.05	3.09	4.37	3.73	4.28	4.37
	5:15 PM	5:30 PM	11	4.44	0.48	26.67	30.84	4.47	3.62	5.03	4.11	4.86	5.03
	5:30 PM	5:45 PM	9	4.50	0.74	26.29	31.09	4.77	2.72	5.10	4.45	4.87	5.10
	5:45 PM	6:00 PM	8	4.24	0.49	27.90	31.09	4.13	3.63	5.18	3.93	4.50	5.18
	6:00 PM	6:15 PM	6	3.67	0.47	32.25	37.00	3.56	3.10	4.30	3.35	4.15	4.30
	6:15 PM	6:30 PM	12	4.08	0.50	29.01	33.55	4.08	3.43	4.97	3.64	4.32	4.96
	6:30 PM	6:45 PM	7	4.37	0.27	27.08	28.93	4.45	3.81	4.59	4.32	4.56	4.59
	6:45 PM	7:00 PM	7	4.27	0.34	27.76	30.75	4.35	3.85	4.62	3.91	4.57	4.62
	7:00 PM	7:15 PM	11	4.48	2.21	26.44	34.86	3.78	3.23	11.02	3.52	4.35	10.69
	7:15 PM	7:30 PM	13	3.89	0.59	30.41	36.06	3.84	3.25	5.43	3.42	4.19	5.25
	7:30 PM	7:45 PM	5	3.59	0.21	32.98	35.65	3.70	3.27	3.80	3.43	3.73	3.80
	7:45 PM	8:00 PM	8	3.52	0.64	33.68	40.66	3.41	2.90	4.72	2.96	3.88	4.72
	8:00 PM	8:15 PM	6	3.92	0.57	30.19	37.21	4.22	3.11	4.41	3.29	4.27	4.41
	8:15 PM	8:30 PM	6	3.24	0.51	36.52	42.28	3.12	2.80	4.04	2.80	3.57	4.04
	8:30 PM	8:45 PM	5	3.62	0.43	32.67	37.12	3.57	3.09	4.29	3.39	3.84	4.29
	8:45 PM	9:00 PM	7	3.47	0.67	34.16	42.88	3.33	2.68	4.52	2.92	3.99	4.52
	9:00 PM	9:15 PM	8	3.24	0.44	36.50	40.95	3.25	2.50	4.09	3.10	3.33	4.09
	9:15 PM	9:30 PM	3	2.97	0.26	39.87	42.54	2.86	2.78	3.27	2.80	3.16	3.27
	9:30 PM	9:45 PM	0										
	9:45 PM	10:00 PM	4	2.77	0.30	42.76	48.44	2.79	2.42	3.07	2.52	3.02	3.07
	10:00 PM	10:15 PM	2	3.52	0.07	33.67	34.15	3.52	3.47	3.57	3.47	3.57	3.57
	10:15 PM	10:30 PM	4	3.23	0.16	36.66	39.17	3.30	2.99	3.33	3.15	3.31	3.33
	10:30 PM	10:45 PM	4	2.86	0.37	41.36	46.20	2.76	2.54	3.39	2.65	3.08	3.39
	10:45 PM	11:00 PM	4	3.49	0.22	33.89	36.84	3.58	3.17	3.64	3.37	3.62	3.64
	11:00 PM	11:15 PM	1	3.42	0.00	34.65	34.65	3.42	3.42	3.42	3.42	3.42	3.42
	11:15 PM	11:30 PM	3	2.81	0.28	42.07	44.96	2.68	2.63	3.13	2.64	3.02	3.13
	11:30 PM	11:45 PM	2	2.72	0.16	43.58	45.53	2.72	2.60	2.83	2.60	2.83	2.83
Midnight	11:45 PM	12:00 AM	1	3.24	0.00	36.52	36.52	3.24	3.24	3.24	3.24	3.24	3.24

SUMMARY

			Total Number of Samples	Averages of the 15 Minutes periods		
				Mean Travel Time	**Standard Deviation**	**Mean Speed**
AM Peak Period	**7:00 AM**	**9:00 AM**	47	3.34	0.39	35.85
Midday Period	**12:00 PM**	**2:00 PM**	75	4.08	0.53	29.19
PM Peak Period	**4:00 PM**	**6:00 PM**	83	4.15	0.70	28.69
Daily	**12:00 AM**	**12:00 AM**	560	3.54	0.42	34.31

TRAVEL TIME DATA

15 MINUTE STATISTICAL SUMMARY

ROUTE INFORMATION
Name / Number:
Label: North of Yew to South of Evergreen
Length of Segment: 1.973156732 miles
Direction:

Beginning Station: BA7 North of Yew
Latitude: 44.24565667
Longitude: -121.1901833
Ending Station: A0C South of Evergreen
Latitude: 44.27072833
Longitude: -121.171095

Date: 8-Jun-17
Day of Week: Thursday

Project Name: Redmond Bluetooth

	Begin Time	End Time	Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
Time			**Sample Size**	**Mean Travel Time**	**Standard Deviation**	**Mean Speed**	**85th PCT Speed**	**Median**	**Min**	**Max**	**25th PCT**	**75th PCT**	**95th PCT**
Midnight	12:00 AM	12:15 AM	1	2.89	0.00	40.94	40.94	2.89	2.89	2.89	2.89	2.89	2.89
	12:15 AM	12:30 AM	2	3.77	0.00	31.43	31.43	3.77	3.77	3.77	3.77	3.77	3.77
	12:30 AM	12:45 AM	2	3.07	0.85	38.61	48.00	3.07	2.47	3.67	2.47	3.67	3.67
	12:45 AM	1:00 AM	2	2.84	0.31	41.72	45.24	2.84	2.62	3.06	2.62	3.06	3.06
	1:00 AM	1:15 AM	3	3.30	0.22	35.88	38.82	3.38	3.05	3.47	3.13	3.45	3.47
	1:15 AM	1:30 AM	0										
	1:30 AM	1:45 AM	0										
	1:45 AM	2:00 AM	0										
	2:00 AM	2:15 AM	2	3.73	0.04	31.78	32.00	3.73	3.70	3.75	3.70	3.75	3.75
	2:15 AM	2:30 AM	0										
	2:30 AM	2:45 AM	3	2.99	0.07	39.57	40.13	2.95	2.95	3.07	2.95	3.04	3.07
	2:45 AM	3:00 AM	0										
	3:00 AM	3:15 AM	0										
	3:15 AM	3:30 AM	1	2.57	0.00	46.13	46.13	2.57	2.57	2.57	2.57	2.57	2.57
	3:30 AM	3:45 AM	0										
	3:45 AM	4:00 AM	0										
	4:00 AM	4:15 AM	0										
	4:15 AM	4:30 AM	3	2.84	0.08	41.62	42.41	2.81	2.79	2.93	2.80	2.90	2.93
	4:30 AM	4:45 AM	1	2.71	0.00	43.71	43.71	2.71	2.71	2.71	2.71	2.71	2.71
	4:45 AM	5:00 AM	2	2.75	0.38	42.99	47.67	2.75	2.48	3.03	2.48	3.03	3.03
	5:00 AM	5:15 AM	2	3.05	0.12	38.82	39.91	3.05	2.97	3.13	2.97	3.13	3.13
	5:15 AM	5:30 AM	0										
	5:30 AM	5:45 AM	1	3.10	0.00	38.19	38.19	3.10	3.10	3.10	3.10	3.10	3.10
	5:45 AM	6:00 AM	5	3.26	0.49	36.28	42.89	3.27	2.75	3.77	2.78	3.75	3.77
	6:00 AM	6:15 AM	4	2.92	0.14	40.56	42.82	2.92	2.75	3.08	2.82	3.01	3.08
	6:15 AM	6:30 AM	2	3.23	0.19	36.71	38.29	3.23	3.09	3.36	3.09	3.36	3.36
	6:30 AM	6:45 AM	4	3.40	0.25	34.80	36.71	3.31	3.22	3.77	3.26	3.55	3.77
	6:45 AM	7:00 AM	10	3.13	0.33	37.80	41.30	2.97	2.87	3.82	2.90	3.37	3.82
	7:00 AM	7:15 AM	6	3.01	0.57	39.35	47.23	2.92	2.50	3.83	2.52	3.37	3.83
	7:15 AM	7:30 AM	6	3.45	0.32	34.30	37.74	3.40	3.05	3.95	3.27	3.64	3.95
	7:30 AM	7:45 AM	7	2.87	0.21	41.21	43.61	2.82	2.69	3.32	2.74	2.89	3.32
	7:45 AM	8:00 AM	8	3.40	0.48	34.83	40.78	3.44	2.72	4.00	2.98	3.81	4.00
	8:00 AM	8:15 AM	7	3.75	0.75	31.58	42.54	4.00	2.78	4.63	2.97	4.38	4.63
	8:15 AM	8:30 AM	8	3.33	0.36	35.58	39.97	3.31	2.66	3.78	3.15	3.63	3.78
	8:30 AM	8:45 AM	9	3.70	1.07	31.96	44.33	3.38	2.60	6.18	3.06	4.09	6.18
	8:45 AM	9:00 AM	7	4.35	0.60	27.19	32.25	4.45	3.35	4.98	3.97	4.91	4.98
	9:00 AM	9:15 AM	9	3.55	0.63	33.31	41.18	3.36	2.73	4.40	3.04	4.16	4.40
	9:15 AM	9:30 AM	4	3.83	1.05	30.92	40.31	3.55	2.88	5.33	3.15	4.51	5.33
	9:30 AM	9:45 AM	6	3.28	0.24	36.07	39.55	3.33	2.97	3.55	3.03	3.48	3.55
	9:45 AM	10:00 AM	10	4.68	1.74	25.31	35.17	3.85	2.93	8.15	3.47	5.60	8.15
	10:00 AM	10:15 AM	10	3.74	0.51	31.63	35.34	3.78	2.68	4.39	3.49	4.09	4.39
	10:15 AM	10:30 AM	11	3.73	1.01	31.70	39.46	3.43	2.91	6.12	3.02	4.35	6.06
	10:30 AM	10:45 AM	10	4.07	0.82	29.05	37.09	3.94	3.12	5.38	3.40	4.87	5.38
	10:45 AM	11:00 AM	7	3.74	0.25	31.62	34.43	3.82	3.38	4.12	3.55	3.83	4.12
	11:00 AM	11:15 AM	8	4.05	0.54	29.25	33.66	3.98	3.21	4.88	3.69	4.47	4.88
	11:15 AM	11:30 AM	12	3.57	0.44	33.17	39.14	3.60	2.89	4.32	3.25	3.79	4.31
	11:30 AM	11:45 AM	7	4.58	1.33	25.82	34.00	4.47	3.27	7.38	3.78	4.61	7.38
	11:45 AM	12:00 PM	9	4.47	0.87	26.48	34.93	5.01	3.23	5.57	3.51	5.05	5.57
Noon	12:00 PM	12:15 PM	8	3.81	0.61	31.05	38.45	3.87	2.82	4.68	3.38	4.25	4.68
	12:15 PM	12:30 PM	7	3.93	0.45	30.12	33.72	3.86	3.34	4.81	3.70	4.04	4.81
	12:30 PM	12:45 PM	8	4.04	0.69	29.33	36.45	4.00	2.93	5.04	3.64	4.51	5.04
	12:45 PM	1:00 PM	7	4.01	0.48	29.54	34.69	4.05	3.37	4.69	3.56	4.31	4.69
	1:00 PM	1:15 PM	12	4.90	0.67	24.17	27.16	4.90	3.43	5.96	4.62	5.21	5.94
	1:15 PM	1:30 PM	9	4.71	0.62	25.12	30.28	4.78	3.77	5.94	4.48	4.88	5.94
	1:30 PM	1:45 PM	9	4.56	1.56	25.96	31.73	4.08	3.63	8.67	3.98	4.29	8.67
	1:45 PM	2:00 PM	8	4.60	0.68	25.71	29.57	4.42	3.82	5.93	4.16	4.97	5.93
	2:00 PM	2:15 PM	4	4.73	0.14	25.02	25.87	4.75	4.57	4.85	4.62	4.85	4.85
	2:15 PM	2:30 PM	9	3.98	0.35	29.75	32.27	3.88	3.49	4.63	3.76	4.18	4.63
	2:30 PM	2:45 PM	9	4.36	0.60	27.15	32.31	4.49	3.46	5.52	3.94	4.62	5.52
	2:45 PM	3:00 PM	8	4.10	0.71	28.85	36.86	4.17	2.97	5.02	3.62	4.64	5.02
	3:00 PM	3:15 PM	8	4.38	0.21	27.06	28.45	4.41	3.99	4.71	4.28	4.46	4.71
	3:15 PM	3:30 PM	12	4.42	0.32	26.79	27.92	4.32	4.01	5.18	4.29	4.40	5.16
	3:30 PM	3:45 PM	12	4.19	0.62	28.25	32.77	4.23	3.01	5.42	3.79	4.57	5.34
	3:45 PM	4:00 PM	10	4.41	0.37	26.87	30.10	4.45	3.85	4.84	4.07	4.76	4.84
	4:00 PM	4:15 PM	9	4.63	0.45	25.59	28.06	4.62	4.18	5.68	4.30	4.76	5.68
	4:15 PM	4:30 PM	5	3.67	0.42	32.27	36.15	3.48	3.23	4.22	3.36	4.06	4.22
	4:30 PM	4:45 PM	11	4.13	0.76	28.70	37.65	4.04	3.01	5.43	3.77	4.53	5.42
	4:45 PM	5:00 PM	16	4.55	1.09	26.03	33.79	4.24	3.41	7.32	3.81	4.82	6.96
	5:00 PM	5:15 PM	8	4.35	0.58	27.20	32.15	4.40	3.41	5.11	3.95	4.81	5.11
	5:15 PM	5:30 PM	14	4.34	0.45	27.25	30.94	4.32	3.73	5.13	3.99	4.75	5.10
	5:30 PM	5:45 PM	7	4.09	0.47	28.98	32.75	3.98	3.40	4.70	3.80	4.53	4.70
	5:45 PM	6:00 PM	17	4.35	0.66	27.20	31.33	4.17	3.44	5.63	3.92	4.74	5.62
	6:00 PM	6:15 PM	9	3.96	0.74	29.88	41.50	4.21	2.78	4.84	3.44	4.54	4.84
	6:15 PM	6:30 PM	9	4.15	1.07	28.54	34.06	3.75	3.06	6.76	3.58	4.35	6.76
	6:30 PM	6:45 PM	12	4.67	0.40	25.36	28.19	4.66	4.07	5.37	4.41	4.87	5.35
	6:45 PM	7:00 PM	11	4.65	0.75	25.45	29.27	4.63	3.08	5.78	4.26	5.22	5.76
	7:00 PM	7:15 PM	10	3.56	0.38	33.29	36.90	3.40	3.19	4.25	3.23	3.88	4.25
	7:15 PM	7:30 PM	12	4.15	0.50	28.52	33.55	4.32	3.22	4.83	3.75	4.51	4.81
	7:30 PM	7:45 PM	10	3.90	0.43	30.38	32.58	3.95	2.93	4.48	3.68	4.22	4.48
	7:45 PM	8:00 PM											
	8:00 PM	8:15 PM											
	8:15 PM	8:30 PM											
	8:30 PM	8:45 PM											
	8:45 PM	9:00 PM											
	9:00 PM	9:15 PM											
	9:15 PM	9:30 PM											
	9:30 PM	9:45 PM											
	9:45 PM	10:00 PM											
	10:00 PM	10:15 PM											
	10:15 PM	10:30 PM											
	10:30 PM	10:45 PM											
	10:45 PM	11:00 PM											
	11:00 PM	11:15 PM											
	11:15 PM	11:30 PM											
	11:30 PM	11:45 PM											
Midnight	11:45 PM	12:00 AM											

SUMMARY

			Total Number of Samples	Averages of the 15 Minutes periods		
				Mean Travel Time	Standard Deviation	Mean Speed
AM Peak Period	**7:00 AM**	**9:00 AM**	58	3.48	0.55	34.50
Midday Period	**12:00 PM**	**2:00 PM**	68	4.32	0.72	27.62
PM Peak Period	**4:00 PM**	**6:00 PM**	87	4.26	0.61	27.90
Daily	**12:00 AM**	**12:00 AM**	511	3.81	0.51	31.93

TRAVEL TIME DATA

15 MINUTE STATISTICAL SUMMARY

ROUTE INFORMATION
Name / Number:
Label: South of Evergreen to North of Yew
Length of Segment: 1.973156732 miles
Direction:

Beginning Station: A0C South of Evergreen
Latitude: 44.27072833
Longitude: -121.171095
Ending Station: BA7 North of Yew
Latitude: 44.24565667
Longitude: -121.1901833

Date: 6-Jun-17
Day of Week: Tuesday

Project Name: Redmond Bluetooth

Time	Begin Time	End Time	Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
			Sample Size	**Mean Travel Time**	**Standard Deviation**	**Mean Speed**	**85th PCT Speed**	**Median**	**Min**	**Max**	**25th PCT**	**75th PCT**	**95th PCT**
Midnight	12:00 AM	12:15 AM	5	2.83	0.41	41.81	51.52	3.08	2.18	3.13	2.54	3.11	3.13
	12:15 AM	12:30 AM	4	3.18	0.74	37.24	52.64	3.39	2.15	3.78	2.65	3.71	3.78
	12:30 AM	12:45 AM	5	3.02	0.33	39.16	43.35	2.85	2.71	3.45	2.78	3.34	3.45
	12:45 AM	1:00 AM	3	3.17	0.39	37.39	42.16	3.12	2.81	3.58	2.89	3.46	3.58
	1:00 AM	1:15 AM	2	2.71	0.15	43.71	45.53	2.71	2.60	2.82	2.60	2.82	2.82
	1:15 AM	1:30 AM	3	2.99	0.35	39.57	44.82	2.99	2.64	3.34	2.73	3.25	3.34
	1:30 AM	1:45 AM	2	3.27	0.54	36.24	41.06	3.27	2.88	3.65	2.88	3.65	3.65
	1:45 AM	2:00 AM	1	2.88	0.00	41.06	41.06	2.88	2.88	2.88	2.88	2.88	2.88
	2:00 AM	2:15 AM	1	3.42	0.00	34.65	34.65	3.42	3.42	3.42	3.42	3.42	3.42
	2:15 AM	2:30 AM	2	2.86	0.06	41.42	42.03	2.86	2.82	2.90	2.82	2.90	2.90
	2:30 AM	2:45 AM	3	2.82	0.26	41.99	45.39	2.73	2.61	3.12	2.64	3.02	3.12
	2:45 AM	3:00 AM	0										
	3:00 AM	3:15 AM	1	2.67	0.00	44.40	44.40	2.67	2.67	2.67	2.67	2.67	2.67
	3:15 AM	3:30 AM	1	3.18	0.00	37.19	37.19	3.18	3.18	3.18	3.18	3.18	3.18
	3:30 AM	3:45 AM	2	3.23	0.46	36.71	40.82	3.23	2.90	3.55	2.90	3.55	3.55
	3:45 AM	4:00 AM	0										
	4:00 AM	4:15 AM	0										
	4:15 AM	4:30 AM	2	2.51	0.09	47.12	48.32	2.51	2.45	2.57	2.45	2.57	2.57
	4:30 AM	4:45 AM	1	3.07	0.00	38.61	38.61	3.07	3.07	3.07	3.07	3.07	3.07
	4:45 AM	5:00 AM	2	2.96	0.30	39.96	43.05	2.96	2.75	3.18	2.75	3.18	3.18
	5:00 AM	5:15 AM	1	2.81	0.00	42.16	42.16	2.81	2.81	2.81	2.81	2.81	2.81
	5:15 AM	5:30 AM	3	2.65	0.23	44.68	48.65	2.63	2.43	2.89	2.48	2.83	2.89
	5:30 AM	5:45 AM	4	2.85	0.25	41.51	46.93	2.95	2.47	3.03	2.71	2.99	3.03
	5:45 AM	6:00 AM	3	3.50	0.60	33.85	41.06	3.53	2.88	4.08	3.04	3.94	4.08
	6:00 AM	6:15 AM	1	3.23	0.00	36.62	36.62	3.23	3.23	3.23	3.23	3.23	3.23
	6:15 AM	6:30 AM	6	2.96	0.40	40.04	44.68	2.80	2.57	3.68	2.77	3.12	3.68
	6:30 AM	6:45 AM	7	3.40	0.64	34.84	44.26	3.30	2.54	4.22	2.90	4.03	4.22
	6:45 AM	7:00 AM	7	3.02	0.34	39.23	44.99	3.12	2.52	3.37	2.74	3.33	3.37
	7:00 AM	7:15 AM	6	2.96	0.38	40.04	48.00	3.12	2.35	3.30	2.64	3.22	3.30
	7:15 AM	7:30 AM	13	2.99	0.33	39.64	45.19	3.05	2.43	3.56	2.71	3.21	3.53
	7:30 AM	7:45 AM	10	2.82	0.42	41.97	46.43	2.76	2.38	3.92	2.63	2.80	3.92
	7:45 AM	8:00 AM	11	3.11	0.46	38.01	45.90	3.29	2.48	3.77	2.68	3.48	3.76
	8:00 AM	8:15 AM	12	3.28	0.59	36.13	45.83	3.37	2.40	4.28	2.68	3.74	4.24
	8:15 AM	8:30 AM	14	5.27	3.17	22.45	38.82	4.19	2.64	12.81	3.11	4.38	12.26
	8:30 AM	8:45 AM	4	3.02	0.32	39.25	43.77	2.97	2.68	3.45	2.79	3.24	3.45
	8:45 AM	9:00 AM	15	3.62	0.52	32.69	39.16	3.55	2.74	4.42	3.24	4.12	4.37
	9:00 AM	9:15 AM	7	3.54	0.56	33.45	39.50	3.26	2.98	4.25	3.04	4.07	4.25
	9:15 AM	9:30 AM	9	3.22	0.59	36.73	43.31	2.88	2.73	4.23	2.76	3.86	4.23
	9:30 AM	9:45 AM	12	3.71	1.44	31.94	44.89	3.04	2.48	6.52	2.71	4.20	6.52
	9:45 AM	10:00 AM	9	3.57	0.88	33.18	43.22	3.27	2.58	4.86	2.89	4.41	4.86
	10:00 AM	10:15 AM	9	3.64	0.72	32.52	42.09	4.07	2.60	4.36	2.85	4.22	4.36
	10:15 AM	10:30 AM	7	4.37	1.46	27.10	39.44	4.57	2.84	7.13	3.21	4.79	7.13
	10:30 AM	10:45 AM	6	3.45	0.63	34.27	39.68	3.13	2.97	4.42	3.01	4.08	4.42
	10:45 AM	11:00 AM	12	3.61	0.48	32.76	38.54	3.52	3.00	4.31	3.16	4.10	4.30
	11:00 AM	11:15 AM	7	4.43	1.02	26.71	35.95	4.72	2.82	5.96	3.76	4.97	5.96
	11:15 AM	11:30 AM	10	3.81	0.77	31.08	40.36	3.78	2.79	5.07	3.02	4.47	5.07
	11:30 AM	11:45 AM	5	4.20	0.48	28.15	32.96	4.40	3.37	4.52	4.04	4.48	4.52
	11:45 AM	12:00 PM	9	3.56	0.65	33.28	42.00	3.82	2.78	4.29	2.92	4.14	4.29
Noon	12:00 PM	12:15 PM	5	3.43	0.95	34.52	43.98	2.88	2.68	4.77	2.71	4.27	4.77
	12:15 PM	12:30 PM	10	3.77	0.61	31.41	37.19	3.85	2.75	5.01	3.47	4.03	5.01
	12:30 PM	12:45 PM	4	3.52	0.57	33.65	41.16	3.62	2.83	4.01	3.05	3.99	4.01
	12:45 PM	1:00 PM	10	3.99	0.65	29.69	36.90	4.12	2.95	4.79	3.28	4.52	4.79
	1:00 PM	1:15 PM	9	3.56	0.83	33.23	40.02	3.09	2.91	5.31	3.03	4.10	5.31
	1:15 PM	1:30 PM	11	4.49	0.78	26.38	35.00	4.68	2.98	5.62	4.26	4.82	5.60
	1:30 PM	1:45 PM	9	3.66	0.60	32.35	37.37	3.25	3.03	4.78	3.24	4.05	4.78
	1:45 PM	2:00 PM	11	4.10	1.12	28.86	40.71	4.03	2.73	6.68	3.34	4.57	6.59
	2:00 PM	2:15 PM	6	3.34	0.60	35.41	41.54	3.05	2.75	4.22	3.00	3.99	4.22
	2:15 PM	2:30 PM	5	4.01	0.62	29.56	36.85	4.27	2.98	4.55	3.69	4.36	4.55
	2:30 PM	2:45 PM	7	3.68	1.06	32.14	41.18	2.97	2.78	5.57	2.95	4.34	5.57
	2:45 PM	3:00 PM	8	4.40	1.25	26.91	41.06	4.56	2.88	6.69	3.36	4.90	6.69
	3:00 PM	3:15 PM	14	4.25	0.57	27.83	34.50	4.45	3.12	4.83	4.02	4.77	4.82
	3:15 PM	3:30 PM	10	3.51	0.57	33.73	40.25	3.49	2.83	4.37	3.00	4.03	4.37
	3:30 PM	3:45 PM	8	4.36	0.94	27.14	31.70	4.18	3.02	6.34	4.09	4.50	6.34
	3:45 PM	4:00 PM	2	3.04	0.09	38.98	39.79	3.04	2.97	3.10	2.97	3.10	3.10
	4:00 PM	4:15 PM	14	3.72	0.55	31.79	37.00	3.45	3.07	4.50	3.28	4.28	4.50
	4:15 PM	4:30 PM	11	3.95	0.78	30.00	39.33	3.90	2.88	5.09	3.27	4.67	5.08
	4:30 PM	4:45 PM	11	3.83	0.68	30.91	38.55	3.53	2.88	4.73	3.34	4.47	4.72
	4:45 PM	5:00 PM	10	4.59	0.52	25.81	27.75	4.57	3.68	5.73	4.32	4.80	5.73
	5:00 PM	5:15 PM	6	3.47	0.75	34.08	40.38	3.04	2.87	4.51	3.02	4.37	4.51
	5:15 PM	5:30 PM	13	3.96	1.34	29.87	41.08	3.20	2.77	7.40	3.00	4.53	7.07
	5:30 PM	5:45 PM	17	4.15	0.58	28.55	36.51	4.33	2.97	4.81	3.80	4.51	4.76
	5:45 PM	6:00 PM	16	3.88	0.65	30.53	38.78	4.25	2.92	4.68	3.28	4.41	4.63
	6:00 PM	6:15 PM	20	3.87	0.77	30.61	37.99	3.68	3.04	5.60	3.13	4.49	5.28
	6:15 PM	6:30 PM	12	3.44	0.75	34.45	41.00	3.02	2.67	4.80	2.92	4.17	4.77
	6:30 PM	6:45 PM	7	3.52	0.71	33.64	40.56	3.18	2.80	4.72	3.05	4.08	4.72
	6:45 PM	7:00 PM	11	3.72	0.90	31.87	40.23	3.63	2.68	5.80	2.99	4.17	5.72
	7:00 PM	7:15 PM	11	3.06	0.57	38.69	45.07	2.72	2.62	4.23	2.69	3.29	4.22
	7:15 PM	7:30 PM	19	3.48	0.83	34.02	42.89	3.09	2.53	5.50	2.85	4.16	5.04
	7:30 PM	7:45 PM	14	3.09	0.84	38.28	45.80	2.82	2.38	5.70	2.72	3.19	5.33
	7:45 PM	8:00 PM	5	3.39	1.34	34.97	45.14	2.69	2.61	5.73	2.65	3.85	5.73
	8:00 PM	8:15 PM	4	3.65	0.65	32.47	41.52	3.77	2.75	4.29	3.26	4.03	4.29
	8:15 PM	8:30 PM	2	2.43	0.12	48.65	50.38	2.43	2.35	2.52	2.35	2.52	2.52
	8:30 PM	8:45 PM	6	3.56	1.56	33.25	45.68	2.81	2.57	6.55	2.62	4.00	6.55
	8:45 PM	9:00 PM	11	3.25	0.68	36.43	46.11	2.88	2.54	4.57	2.69	3.73	4.55
	9:00 PM	9:15 PM	8	3.11	0.32	38.04	42.34	3.10	2.65	3.72	2.93	3.23	3.72
	9:15 PM	9:30 PM	6	3.14	0.57	37.68	45.65	3.01	2.52	3.83	2.71	3.78	3.83
	9:30 PM	9:45 PM	4	3.08	0.48	38.45	41.91	2.85	2.83	3.80	2.83	3.33	3.80
	9:45 PM	10:00 PM	9	3.41	0.44	34.73	39.80	3.59	2.64	4.03	3.11	3.69	4.03
	10:00 PM	10:15 PM	4	3.15	0.35	37.58	42.79	3.14	2.73	3.58	2.90	3.40	3.58
	10:15 PM	10:30 PM	3	2.69	0.15	44.07	46.13	2.63	2.57	2.86	2.58	2.80	2.86
	10:30 PM	10:45 PM	2	3.12	0.94	37.99	48.32	3.12	2.45	3.78	2.45	3.78	3.78
	10:45 PM	11:00 PM	3	4.04	0.97	29.33	40.36	4.44	2.93	4.73	3.31	4.66	4.73
	11:00 PM	11:15 PM	2	2.85	0.32	41.60	45.24	2.85	2.62	3.07	2.62	3.07	3.07
	11:15 PM	11:30 PM	4	3.41	0.55	34.74	40.67	3.29	2.88	4.17	3.02	3.80	4.17
	11:30 PM	11:45 PM	3	3.82	0.69	31.02	38.82	4.00	3.05	4.40	3.29	4.30	4.40
Midnight	11:45 PM	12:00 AM	3	2.70	0.12	43.89	45.39	2.65	2.61	2.83	2.62	2.79	2.83

SUMMARY

			Total Number of Samples	Averages of the 15 Minutes periods		
				Mean Travel Time	**Standard Deviation**	**Mean Speed**
AM Peak Period	**7:00 AM**	**9:00 AM**	85	3.38	0.77	36.27
Midday Period	**12:00 PM**	**2:00 PM**	69	3.81	0.76	31.26
PM Peak Period	**4:00 PM**	**6:00 PM**	98	3.94	0.73	30.19
Daily	**12:00 AM**	**12:00 AM**	659	3.43	0.60	35.29

TRAVEL TIME DATA

15 MINUTE STATISTICAL SUMMARY

ROUTE INFORMATION
Name / Number:
Label: South of Evergreen to North of Yew
Length of Segment: 1.973156732 miles
Direction:

Beginning Station: A0C South of Evergreen
Latitude: 44.27072833
Longitude: -121.171095
Ending Station: BA7 North of Yew
Latitude: 44.24565667
Longitude: -121.1901833

Date: 7-Jun-17
Day of Week: Wednesday

Project Name: Redmond Bluetooth

Time	Begin Time	End Time	Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
			Sample Size	**Mean Travel Time**	**Standard Deviation**	**Mean Speed**	**85th PCT Speed**	**Median**	**Min**	**Max**	**25th PCT**	**75th PCT**	**95th PCT**
Midnight	12:00 AM	12:15 AM	0										
	12:15 AM	12:30 AM	1	3.16	0.00	37.48	37.48	3.16	3.16	3.16	3.16	3.16	3.16
	12:30 AM	12:45 AM	2	3.28	0.44	36.10	39.91	3.28	2.97	3.59	2.97	3.59	3.59
	12:45 AM	1:00 AM	3	2.83	0.25	41.83	46.43	2.92	2.55	3.02	2.64	2.99	3.02
	1:00 AM	1:15 AM	4	2.74	0.04	43.15	43.92	2.75	2.69	2.77	2.71	2.77	2.77
	1:15 AM	1:30 AM	2	2.75	0.12	43.05	44.40	2.75	2.67	2.83	2.67	2.83	2.83
	1:30 AM	1:45 AM	0										
	1:45 AM	2:00 AM	0										
	2:00 AM	2:15 AM	0										
	2:15 AM	2:30 AM	0										
	2:30 AM	2:45 AM	0										
	2:45 AM	3:00 AM	0										
	3:00 AM	3:15 AM	0										
	3:15 AM	3:30 AM	1	2.78	0.00	42.54	42.54	2.78	2.78	2.78	2.78	2.78	2.78
	3:30 AM	3:45 AM	2	2.66	0.06	44.54	45.24	2.66	2.62	2.70	2.62	2.70	2.70
	3:45 AM	4:00 AM	1	2.76	0.00	42.92	42.92	2.76	2.76	2.76	2.76	2.76	2.76
	4:00 AM	4:15 AM	4	2.68	0.52	44.19	53.81	2.68	2.19	3.17	2.23	3.13	3.17
	4:15 AM	4:30 AM	1	2.83	0.00	41.78	41.78	2.83	2.83	2.83	2.83	2.83	2.83
	4:30 AM	4:45 AM	0										
	4:45 AM	5:00 AM	0										
	5:00 AM	5:15 AM	2	2.78	0.58	42.66	50.02	2.78	2.37	3.18	2.37	3.18	3.18
	5:15 AM	5:30 AM	4	2.92	0.45	40.50	44.80	2.73	2.64	3.58	2.65	3.20	3.58
	5:30 AM	5:45 AM	5	2.66	0.17	44.54	46.89	2.65	2.53	2.94	2.53	2.72	2.94
	5:45 AM	6:00 AM	1	2.75	0.00	43.05	43.05	2.75	2.75	2.75	2.75	2.75	2.75
	6:00 AM	6:15 AM	2	2.88	0.45	41.18	46.28	2.88	2.56	3.19	2.56	3.19	3.19
	6:15 AM	6:30 AM	3	2.81	0.39	42.11	48.65	2.78	2.43	3.22	2.52	3.11	3.22
	6:30 AM	6:45 AM	2	3.04	0.25	38.92	41.30	3.04	2.87	3.22	2.87	3.22	3.22
	6:45 AM	7:00 AM	12	2.94	0.43	40.29	45.98	2.84	2.33	3.88	2.67	3.25	3.82
	7:00 AM	7:15 AM	9	2.81	0.16	42.06	44.42	2.82	2.52	3.07	2.72	2.90	3.07
	7:15 AM	7:30 AM	9	2.98	0.29	39.70	42.60	2.92	2.57	3.63	2.83	3.08	3.63
	7:30 AM	7:45 AM	13	2.89	0.47	41.01	47.36	2.75	2.40	3.95	2.56	3.03	3.90
	7:45 AM	8:00 AM	6	2.93	0.27	40.40	44.62	2.91	2.63	3.35	2.68	3.10	3.35
	8:00 AM	8:15 AM	8	3.12	0.56	37.94	48.99	3.16	2.42	4.22	2.77	3.24	4.22
	8:15 AM	8:30 AM	11	3.28	0.69	36.10	45.24	3.12	2.53	4.28	2.63	3.99	4.28
	8:30 AM	8:45 AM	12	3.77	0.54	31.43	38.75	3.92	2.88	4.33	3.19	4.23	4.33
	8:45 AM	9:00 AM	11	3.55	0.85	33.39	42.78	3.03	2.63	4.93	2.82	4.16	4.92
	9:00 AM	9:15 AM	13	3.69	1.02	32.09	43.01	3.25	2.57	5.98	2.85	4.45	5.77
	9:15 AM	9:30 AM	13	3.42	0.67	34.59	41.40	3.27	2.46	4.88	2.97	3.86	4.79
	9:30 AM	9:45 AM	8	3.31	0.71	35.81	46.28	3.06	2.50	4.38	2.76	3.97	4.38
	9:45 AM	10:00 AM	13	3.41	0.61	34.68	42.09	3.26	2.68	4.48	2.95	3.89	4.46
	10:00 AM	10:15 AM	3	2.73	0.10	43.31	44.96	2.74	2.63	2.82	2.66	2.80	2.82
	10:15 AM	10:30 AM	15	3.21	0.43	36.93	42.19	2.98	2.72	3.86	2.83	3.57	3.85
	10:30 AM	10:45 AM	9	3.49	0.42	33.96	38.90	3.43	2.82	4.10	3.21	3.81	4.10
	10:45 AM	11:00 AM	7	3.73	1.12	31.71	42.21	3.10	2.75	5.83	2.91	4.36	5.83
	11:00 AM	11:15 AM	11	2.95	0.56	40.15	47.91	2.78	2.30	4.30	2.68	3.22	4.26
	11:15 AM	11:30 AM	6	4.75	0.75	24.95	28.99	4.46	3.98	5.91	4.23	5.43	5.91
	11:30 AM	11:45 AM	5	2.97	0.19	39.93	43.02	2.98	2.72	3.22	2.82	3.09	3.22
	11:45 AM	12:00 PM	12	3.91	0.66	30.30	39.25	4.11	2.86	4.78	3.39	4.40	4.76
Noon	12:00 PM	12:15 PM	5	3.33	0.47	35.61	42.25	3.27	2.71	3.87	2.99	3.74	3.87
	12:15 PM	12:30 PM	11	3.47	0.72	34.14	40.94	3.06	2.85	4.86	2.90	4.16	4.83
	12:30 PM	12:45 PM	11	3.34	0.52	35.46	40.71	3.26	2.83	4.23	2.92	3.70	4.23
	12:45 PM	1:00 PM	11	3.47	0.54	34.17	39.74	3.23	2.72	4.29	3.07	3.93	4.29
	1:00 PM	1:15 PM	7	3.26	0.36	36.36	41.52	3.19	2.79	3.82	2.97	3.50	3.82
	1:15 PM	1:30 PM	4	4.03	0.70	29.38	37.30	4.16	3.08	4.72	3.54	4.52	4.72
	1:30 PM	1:45 PM	13	4.14	0.76	28.61	41.12	4.46	2.77	4.72	3.89	4.69	4.72
	1:45 PM	2:00 PM	11	4.00	0.58	29.62	37.62	4.07	2.78	4.66	4.03	4.36	4.65
	2:00 PM	2:15 PM	8	3.43	0.63	34.49	40.26	3.09	2.90	4.45	2.97	3.99	4.45
	2:15 PM	2:30 PM	6	3.95	0.83	30.00	38.31	3.89	3.00	4.88	3.22	4.79	4.88
	2:30 PM	2:45 PM	11	4.32	0.64	27.41	30.46	4.26	3.10	5.40	4.00	4.77	5.38
	2:45 PM	3:00 PM	11	4.70	0.95	25.16	33.16	4.98	2.85	6.12	4.10	5.30	6.08
	3:00 PM	3:15 PM	11	4.07	1.67	29.11	39.78	3.34	2.91	8.81	3.28	4.35	8.60
	3:15 PM	3:30 PM	8	3.94	0.93	30.06	40.28	3.95	2.93	5.47	3.02	4.57	5.47
	3:30 PM	3:45 PM	11	3.94	0.76	30.08	38.57	4.27	2.83	5.05	3.11	4.52	5.03
	3:45 PM	4:00 PM	10	4.06	1.23	29.14	36.43	3.56	3.06	7.24	3.33	4.37	7.24
	4:00 PM	4:15 PM	7	3.82	0.78	31.02	41.65	3.75	2.83	4.77	3.04	4.49	4.77
	4:15 PM	4:30 PM	11	3.92	0.70	30.20	39.49	4.01	2.83	4.96	3.22	4.42	4.93
	4:30 PM	4:45 PM	12	3.99	0.73	29.65	38.66	4.18	2.97	4.92	3.11	4.56	4.91
	4:45 PM	5:00 PM	12	3.86	0.63	30.68	39.86	4.15	2.80	4.69	3.39	4.30	4.66
	5:00 PM	5:15 PM	8	4.00	0.57	29.57	37.48	4.19	3.04	4.53	3.65	4.38	4.53
	5:15 PM	5:30 PM	7	4.21	0.72	28.15	37.13	4.51	3.04	4.84	3.60	4.64	4.84
	5:30 PM	5:45 PM	13	4.27	0.70	27.70	33.81	4.14	2.85	5.07	4.04	4.79	5.07
	5:45 PM	6:00 PM	13	4.10	0.89	28.88	39.75	4.28	2.70	5.23	3.34	4.82	5.22
	6:00 PM	6:15 PM	13	4.19	0.52	28.25	33.39	4.21	3.13	4.76	3.97	4.60	4.75
	6:15 PM	6:30 PM	14	4.20	0.68	28.16	38.56	4.54	2.98	4.82	4.00	4.70	4.82
	6:30 PM	6:45 PM	10	3.97	0.70	29.83	39.46	4.21	2.75	4.76	3.31	4.54	4.76
	6:45 PM	7:00 PM	12	3.36	0.71	35.24	41.18	3.05	2.75	5.13	2.97	3.62	5.03
	7:00 PM	7:15 PM	9	2.90	0.20	40.82	43.14	2.89	2.62	3.22	2.77	3.00	3.22
	7:15 PM	7:30 PM	8	3.62	0.66	32.72	38.77	3.32	2.87	4.50	3.13	4.34	4.50
	7:30 PM	7:45 PM	8	3.39	0.74	34.88	44.96	3.07	2.63	4.56	2.84	4.07	4.56
	7:45 PM	8:00 PM	6	2.85	0.18	41.56	45.16	2.93	2.61	3.00	2.64	2.98	3.00
	8:00 PM	8:15 PM	4	2.74	0.31	43.18	46.13	2.60	2.57	3.21	2.57	2.92	3.21
	8:15 PM	8:30 PM	5	3.08	0.33	38.38	43.98	3.10	2.60	3.49	2.88	3.32	3.49
	8:30 PM	8:45 PM	5	3.58	0.60	33.09	41.60	3.73	2.70	4.23	3.14	4.01	4.23
	8:45 PM	9:00 PM	7	3.40	0.78	34.81	41.11	3.18	2.82	5.07	2.93	3.48	5.07
	9:00 PM	9:15 PM	7	3.68	0.65	32.14	41.36	3.71	2.82	4.56	3.07	4.18	4.56
	9:15 PM	9:30 PM	3	3.17	0.30	37.35	40.82	3.11	2.90	3.50	2.95	3.40	3.50
	9:30 PM	9:45 PM	6	4.23	0.72	27.98	33.62	4.20	3.37	5.48	3.74	4.38	5.48
	9:45 PM	10:00 PM	6	3.64	0.49	32.52	37.48	3.63	3.14	4.48	3.18	3.78	4.48
	10:00 PM	10:15 PM	3	4.34	0.93	27.25	31.36	3.84	3.77	5.42	3.79	5.02	5.42
	10:15 PM	10:30 PM	9	3.98	0.43	29.71	33.63	3.90	3.35	4.54	3.61	4.42	4.54
	10:30 PM	10:45 PM	0										
	10:45 PM	11:00 PM	5	3.69	0.52	32.07	38.42	3.67	2.90	4.32	3.44	4.04	4.32
	11:00 PM	11:15 PM	2	4.64	0.11	25.51	25.92	4.64	4.57	4.72	4.57	4.72	4.72
	11:15 PM	11:30 PM	2	5.20	0.48	22.77	24.37	5.20	4.86	5.54	4.86	5.54	5.54
	11:30 PM	11:45 PM	6	4.02	0.41	29.46	32.78	3.93	3.43	4.65	3.89	4.28	4.65
Midnight	11:45 PM	12:00 AM	5	3.38	0.22	34.99	38.14	3.47	2.98	3.51	3.35	3.49	3.51

SUMMARY

			Total Number of Samples	Averages of the 15 Minutes periods		
				Mean Travel Time	**Standard Deviation**	**Mean Speed**
AM Peak Period	**7:00 AM**	**9:00 AM**	79	3.17	0.48	37.75
Midday Period	**12:00 PM**	**2:00 PM**	73	3.63	0.58	32.92
PM Peak Period	**4:00 PM**	**6:00 PM**	83	4.02	0.71	29.48
Daily	**12:00 AM**	**12:00 AM**	633	3.49	0.53	34.81

TRAVEL TIME DATA

15 MINUTE STATISTICAL SUMMARY

ROUTE INFORMATION
Name / Number:
Label: South of Evergreen to North of Yew
Length of Segment: 1.973156732 miles
Direction:

Beginning Station: A0C South of Evergreen
Latitude: 44.27072833
Longitude: -121.171095
Ending Station: BA7 North of Yew
Latitude: 44.24565667
Longitude: -121.1901833

Date: 8-Jun-17
Day of Week: Thursday

Project Name: Redmond Bluetooth

			Number of Good Data Points	Average of Travel Times for time Period, Minutes	Standard Deviation of the travel time data points	Average speed, MPH	85th percentile speed, MPH	Travel Time Statistics (minutes)					
Time	Begin Time	End Time	Sample Size	Mean Travel Time	Standard Deviation	Mean Speed	85th PCT Speed	Median	Min	Max	25th PCT	75th PCT	95th PCT
Midnight	12:00 AM	12:15 AM	3	4.00	0.02	29.60	29.78	4.01	3.98	4.02	3.98	4.01	4.02
	12:15 AM	12:30 AM	3	3.41	0.34	34.76	37.00	3.22	3.20	3.80	3.20	3.65	3.80
	12:30 AM	12:45 AM	0										
	12:45 AM	1:00 AM	4	3.64	0.50	32.53	36.54	3.49	3.22	4.36	3.33	3.95	4.36
	1:00 AM	1:15 AM	1	3.05	0.00	38.82	38.82	3.05	3.05	3.05	3.05	3.05	3.05
	1:15 AM	1:30 AM	2	3.18	0.42	37.19	41.06	3.18	2.88	3.48	2.88	3.48	3.48
	1:30 AM	1:45 AM	0										
	1:45 AM	2:00 AM	0										
	2:00 AM	2:15 AM	5	3.03	0.48	39.03	48.95	3.24	2.19	3.37	2.87	3.29	3.37
	2:15 AM	2:30 AM	1	3.16	0.00	37.48	37.48	3.16	3.16	3.16	3.16	3.16	3.16
	2:30 AM	2:45 AM	1	2.78	0.00	42.54	42.54	2.78	2.78	2.78	2.78	2.78	2.78
	2:45 AM	3:00 AM	3	3.15	0.26	37.55	40.48	3.09	2.93	3.44	2.97	3.35	3.44
	3:00 AM	3:15 AM	1	2.61	0.00	45.39	45.39	2.61	2.61	2.61	2.61	2.61	2.61
	3:15 AM	3:30 AM	2	3.50	0.04	33.79	34.07	3.50	3.47	3.53	3.47	3.53	3.53
	3:30 AM	3:45 AM	3	3.57	0.44	33.12	37.48	3.53	3.16	4.03	3.25	3.91	4.03
	3:45 AM	4:00 AM	0										
	4:00 AM	4:15 AM	1	2.72	0.00	43.58	43.58	2.72	2.72	2.72	2.72	2.72	2.72
	4:15 AM	4:30 AM	3	2.88	0.22	41.06	43.58	2.80	2.72	3.13	2.74	3.05	3.13
	4:30 AM	4:45 AM	0										
	4:45 AM	5:00 AM	0										
	5:00 AM	5:15 AM	2	3.39	0.76	34.95	41.54	3.39	2.85	3.92	2.85	3.92	3.92
	5:15 AM	5:30 AM	3	2.82	0.04	41.91	42.54	2.82	2.78	2.87	2.79	2.86	2.87
	5:30 AM	5:45 AM	0										
	5:45 AM	6:00 AM	1	2.65	0.00	44.68	44.68	2.65	2.65	2.65	2.65	2.65	2.65
	6:00 AM	6:15 AM	5	3.07	0.35	38.52	42.79	3.00	2.75	3.63	2.80	3.28	3.63
	6:15 AM	6:30 AM	3	2.79	0.45	42.41	51.10	2.85	2.32	3.21	2.45	3.12	3.21
	6:30 AM	6:45 AM	9	3.20	0.43	37.01	43.38	3.37	2.52	3.80	2.77	3.45	3.80
	6:45 AM	7:00 AM	6	3.12	0.49	37.94	44.96	3.08	2.53	3.77	2.78	3.47	3.77
	7:00 AM	7:15 AM	9	2.92	0.43	40.59	48.57	2.82	2.37	3.65	2.52	3.22	3.65
	7:15 AM	7:30 AM	7	2.95	0.49	40.13	46.62	2.98	2.43	3.93	2.64	3.03	3.93
	7:30 AM	7:45 AM	20	2.89	0.47	40.97	46.35	2.76	2.32	4.17	2.57	3.04	3.94
	7:45 AM	8:00 AM	10	3.16	0.58	37.49	43.05	2.85	2.51	4.38	2.80	3.62	4.38
	8:00 AM	8:15 AM	3	3.23	0.69	36.68	47.04	3.28	2.52	3.88	2.71	3.73	3.88
	8:15 AM	8:30 AM	17	3.58	0.58	33.11	41.00	3.63	2.78	4.33	3.03	4.07	4.33
	8:30 AM	8:45 AM	15	3.71	0.71	31.91	42.60	4.00	2.59	4.56	3.20	4.43	4.55
	8:45 AM	9:00 AM	17	4.38	1.35	27.01	38.22	4.02	2.72	7.27	3.69	4.55	7.27
	9:00 AM	9:15 AM	7	5.97	4.38	19.81	45.01	4.45	2.48	14.88	2.83	7.25	14.88
	9:15 AM	9:30 AM	17	4.69	3.67	25.23	44.10	2.93	2.33	14.09	2.75	4.20	13.35
	9:30 AM	9:45 AM	10	3.45	0.56	34.31	43.18	3.42	2.62	4.15	3.12	4.11	4.15
	9:45 AM	10:00 AM	14	3.34	0.44	35.50	41.27	3.27	2.76	4.07	2.97	3.63	4.04
	10:00 AM	10:15 AM	6	3.20	0.48	37.00	42.87	3.02	2.64	3.83	2.94	3.75	3.83
	10:15 AM	10:30 AM	11	3.20	0.56	37.04	42.92	2.99	2.54	4.62	2.90	3.45	4.56
	10:30 AM	10:45 AM	9	3.53	0.61	33.52	44.02	3.60	2.58	4.20	3.00	4.00	4.20
	10:45 AM	11:00 AM	9	4.16	2.68	28.48	42.25	3.18	2.77	11.15	2.81	4.12	11.15
	11:00 AM	11:15 AM	12	3.77	1.13	31.39	43.63	3.93	2.43	6.38	2.78	4.24	6.22
	11:15 AM	11:30 AM	6	3.37	0.54	35.18	41.78	3.34	2.80	4.17	2.88	3.66	4.17
	11:30 AM	11:45 AM	9	3.27	0.57	36.23	42.65	3.03	2.59	4.08	2.91	3.90	4.08
	11:45 AM	12:00 PM	10	3.94	0.97	30.07	41.78	4.03	2.75	6.04	3.17	4.18	6.04
Noon	12:00 PM	12:15 PM	17	3.89	1.17	30.43	40.53	3.78	2.79	7.98	3.11	4.09	6.71
	12:15 PM	12:30 PM	5	4.28	1.66	27.64	42.00	4.22	2.77	6.91	2.92	5.14	6.91
	12:30 PM	12:45 PM	12	4.32	1.63	27.39	39.41	4.28	2.78	8.68	3.04	5.00	8.32
	12:45 PM	1:00 PM	7	4.76	1.53	24.89	31.67	4.43	3.32	8.10	4.17	4.47	8.10
	1:00 PM	1:15 PM	11	3.55	0.63	33.36	39.62	3.33	2.90	4.57	3.03	4.24	4.56
	1:15 PM	1:30 PM	10	4.20	0.52	28.20	32.14	4.38	3.00	4.72	3.94	4.42	4.72
	1:30 PM	1:45 PM	5	4.87	0.35	24.29	26.13	4.81	4.49	5.40	4.61	5.11	5.40
	1:45 PM	2:00 PM	9	4.30	0.63	27.54	31.48	4.48	2.73	4.82	4.32	4.60	4.82
	2:00 PM	2:15 PM	9	5.84	5.76	20.27	38.04	4.38	2.99	21.10	3.34	4.68	21.10
	2:15 PM	2:30 PM	8	6.30	6.65	18.79	35.22	3.96	3.23	22.69	3.47	4.81	22.69
	2:30 PM	2:45 PM	11	3.91	0.66	30.25	35.52	3.82	3.08	5.26	3.34	4.33	5.23
	2:45 PM	3:00 PM	9	4.36	0.44	27.15	29.77	4.48	3.33	4.82	4.23	4.61	4.82
	3:00 PM	3:15 PM	8	4.95	0.38	23.92	26.21	4.92	4.40	5.47	4.66	5.28	5.47
	3:15 PM	3:30 PM	10	3.71	0.69	31.87	38.40	3.37	2.87	4.73	3.18	4.42	4.73
	3:30 PM	3:45 PM	17	4.23	0.70	27.96	37.00	4.52	3.11	5.03	3.52	4.79	5.02
	3:45 PM	4:00 PM	9	4.10	0.61	28.90	37.12	4.45	3.08	4.67	3.56	4.53	4.67
	4:00 PM	4:15 PM	12	5.09	0.89	23.27	25.19	4.84	3.47	6.73	4.78	5.28	6.72
	4:15 PM	4:30 PM	11	3.62	0.77	32.74	40.58	3.20	2.81	4.73	3.04	4.49	4.73
	4:30 PM	4:45 PM	11	3.85	0.67	30.74	38.95	3.93	2.99	4.83	3.11	4.36	4.82
	4:45 PM	5:00 PM	8	3.84	0.71	30.83	39.32	4.05	2.78	4.64	3.17	4.42	4.64
	5:00 PM	5:15 PM	6	3.51	0.74	33.71	41.66	3.25	2.81	4.52	2.89	4.35	4.52
	5:15 PM	5:30 PM	14	3.90	0.60	30.32	37.35	4.18	3.02	4.63	3.23	4.41	4.61
	5:30 PM	5:45 PM	16	3.78	0.68	31.33	38.29	3.54	2.92	4.67	3.15	4.51	4.67
	5:45 PM	6:00 PM	14	4.10	0.94	28.84	41.23	4.36	2.78	5.67	3.12	4.82	5.60
	6:00 PM	6:15 PM	13	3.78	0.54	31.35	37.34	3.84	2.91	4.54	3.30	4.34	4.54
	6:15 PM	6:30 PM	19	3.82	0.77	31.02	40.48	3.91	2.88	4.85	3.10	4.53	4.81
	6:30 PM	6:45 PM	9	3.73	0.86	31.76	43.58	4.04	2.72	4.72	2.73	4.44	4.72
	6:45 PM	7:00 PM	11	3.32	0.87	35.68	42.31	2.98	2.61	5.52	2.84	3.28	5.46
	7:00 PM	7:15 PM	8	3.14	0.50	37.71	43.26	2.98	2.67	4.24	2.82	3.31	4.24
	7:15 PM	7:30 PM	11	3.78	1.19	31.30	42.89	3.12	2.68	5.85	2.87	4.30	5.85
	7:30 PM	7:45 PM	3	2.98	0.26	39.68	44.12	3.13	2.68	3.13	2.80	3.13	3.13
	7:45 PM	8:00 PM											
	8:00 PM	8:15 PM											
	8:15 PM	8:30 PM											
	8:30 PM	8:45 PM											
	8:45 PM	9:00 PM											
	9:00 PM	9:15 PM											
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	10:15 PM	10:30 PM											
	10:30 PM	10:45 PM											
	10:45 PM	11:00 PM											
	11:00 PM	11:15 PM											
	11:15 PM	11:30 PM											
	11:30 PM	11:45 PM											
Midnight	11:45 PM	12:00 AM											

SUMMARY

			Total Number of Samples	Averages of the 15 Minutes periods		
				Mean Travel Time	Standard Deviation	Mean Speed
AM Peak Period	**7:00 AM**	**9:00 AM**	98	3.35	0.66	35.99
Midday Period	**12:00 PM**	**2:00 PM**	76	4.27	1.02	27.97
PM Peak Period	**4:00 PM**	**6:00 PM**	92	3.96	0.75	30.22
Daily	**12:00 AM**	**12:00 AM**	603	3.70	0.86	33.17

iPeMS - US 97 NB

Hour	Average Speed (n	Avg Travel Time (mins)
6/1/2017 16:00	26.89	4.47
6/1/2017 17:00	29.60	4.08
6/6/2017 16:00	29.60	4.08
6/6/2017 17:00	30.64	3.94
6/7/2017 16:00	29.17	4.16
6/7/2017 17:00	30.55	3.93
6/8/2017 16:00	30.65	3.92
6/8/2017 17:00	30.39	3.96
6/13/2017 16:00	30.59	3.94
6/13/2017 17:00	27.75	4.35
6/14/2017 16:00	32.24	3.72
6/14/2017 17:00	30.28	3.97
6/15/2017 16:00	26.96	4.49
6/15/2017 17:00	28.65	4.21
6/20/2017 16:00	29.97	4.01
6/20/2017 17:00	30.61	3.94
6/21/2017 16:00	29.89	4.08
6/21/2017 17:00	31.92	3.79
6/22/2017 16:00	26.11	4.72
6/22/2017 17:00	28.56	4.24
6/27/2017 16:00	32.38	3.71
6/27/2017 17:00	29.06	4.15
6/28/2017 16:00	32.39	3.76
6/28/2017 17:00	28.82	4.20
6/29/2017 16:00	30.50	3.96
6/29/2017 17:00	30.34	3.99
7/5/2017 16:00	26.82	4.49
7/5/2017 17:00	29.37	4.17
7/6/2017 16:00	28.98	4.18
7/6/2017 17:00	27.41	4.42
7/11/2017 16:00	29.02	4.15
7/11/2017 17:00	26.00	4.64
7/12/2017 16:00	32.35	3.73
7/12/2017 17:00	26.67	4.51
7/13/2017 16:00	28.40	4.24
7/13/2017 17:00	28.85	4.19
7/18/2017 16:00	27.07	4.46
7/18/2017 17:00	31.01	3.90
7/19/2017 16:00	30.16	4.04
7/19/2017 17:00	28.89	4.17
7/20/2017 16:00	28.17	4.30
7/20/2017 17:00	30.74	3.92
7/25/2017 16:00	30.56	3.93
7/25/2017 17:00	28.97	4.15
7/26/2017 16:00	26.56	4.55
7/26/2017 17:00	30.11	4.00
7/27/2017 16:00	29.75	4.05
7/27/2017 17:00	31.57	3.80
8/1/2017 16:00	27.21	4.42
8/1/2017 17:00	26.26	4.58
8/2/2017 16:00	31.46	3.83
8/2/2017 17:00	27.70	4.36
8/3/2017 16:00	25.39	4.74
8/3/2017 17:00	27.46	4.39
8/8/2017 16:00	28.66	4.21
8/8/2017 17:00	31.26	3.86
8/9/2017 16:00	26.92	4.47
8/9/2017 17:00	31.95	3.79
8/10/2017 16:00	27.80	4.36
8/10/2017 17:00	30.97	3.90
8/15/2017 16:00	28.73	4.21
8/15/2017 17:00	28.53	4.24
8/16/2017 16:00	26.20	4.61
8/16/2017 17:00	30.19	4.04
8/17/2017 16:00	28.91	4.17
8/17/2017 17:00	34.06	3.53
8/22/2017 16:00	28.08	4.34
8/22/2017 17:00	30.74	3.92
8/23/2017 16:00	29.80	4.03
8/23/2017 17:00	28.29	4.28
8/24/2017 16:00	29.16	4.15
8/24/2017 17:00	28.44	4.30
8/29/2017 16:00	27.68	4.36
8/29/2017 17:00	32.63	3.68
8/30/2017 16:00	29.62	4.06
8/30/2017 17:00	31.39	3.83
8/31/2017 16:00	30.69	3.93
8/31/2017 17:00	29.78	4.06

iPeMS - US 97 SB

Hour	Average Speed	Avg Travel Time (mins)
6/1/2017 16:00	30.40	4.39
6/1/2017 17:00	37.20	3.57
6/2/2017 16:00	27.74	4.79
6/2/2017 17:00	31.33	4.26
6/6/2017 16:00	35.50	3.77
6/6/2017 17:00	29.95	4.44
6/7/2017 16:00	31.24	4.32
6/7/2017 17:00	32.90	4.14
6/8/2017 16:00	32.69	4.06
6/8/2017 17:00	29.58	4.55
6/9/2017 16:00	25.04	5.33
6/9/2017 17:00	30.25	4.56
6/13/2017 16:00	27.99	4.76
6/13/2017 17:00	30.83	4.37
6/14/2017 16:00	28.78	4.63
6/14/2017 17:00	32.92	4.06
6/15/2017 16:00	26.35	5.04
6/15/2017 17:00	26.99	4.94
6/16/2017 16:00	29.19	4.56
6/16/2017 17:00	26.66	5.11
6/20/2017 16:00	33.23	4.02
6/20/2017 17:00	36.06	3.69
6/21/2017 16:00	30.69	4.35
6/21/2017 17:00	27.18	4.98
6/22/2017 16:00	30.56	4.36
6/22/2017 17:00	31.88	4.18
6/23/2017 16:00	27.65	4.81
6/23/2017 17:00	28.36	4.69
6/27/2017 16:00	33.56	3.99
6/27/2017 17:00	31.76	4.18
6/28/2017 16:00	30.69	4.34
6/28/2017 17:00	30.19	4.44
6/29/2017 16:00	32.82	4.05
6/29/2017 17:00	28.00	4.84
6/30/2017 16:00	28.21	4.72
6/30/2017 17:00	27.60	4.84
7/5/2017 16:00	30.36	4.38
7/5/2017 17:00	33.87	3.94
7/6/2017 16:00	29.90	4.45
7/6/2017 17:00	29.40	4.56
7/7/2017 16:00	30.06	4.44
7/7/2017 17:00	32.76	4.06
7/11/2017 16:00	31.48	4.23
7/11/2017 17:00	34.06	3.90
7/12/2017 16:00	35.69	3.75
7/12/2017 17:00	33.92	3.95
7/13/2017 16:00	27.70	4.83
7/13/2017 17:00	32.48	4.10
7/14/2017 16:00	29.88	4.44
7/14/2017 17:00	31.23	4.30
7/18/2017 16:00	33.64	3.96
7/18/2017 17:00	29.20	4.58
7/19/2017 16:00	35.27	3.77
7/19/2017 17:00	31.76	4.22
7/20/2017 16:00	28.83	4.68
7/20/2017 17:00	30.95	4.33
7/21/2017 16:00	22.66	5.87
7/21/2017 17:00	25.04	5.31
7/25/2017 16:00	32.96	4.04
7/25/2017 17:00	33.49	3.99
7/26/2017 16:00	33.14	4.01
7/26/2017 17:00	33.42	3.98
7/27/2017 16:00	28.48	4.68
7/27/2017 17:00	31.23	4.27
7/28/2017 16:00	32.56	4.15
7/28/2017 17:00	32.93	4.06
8/1/2017 16:00	29.85	4.47
8/1/2017 17:00	30.34	4.39
8/2/2017 16:00	28.53	4.73
8/2/2017 17:00	27.55	4.93
8/3/2017 16:00	25.87	5.30
8/3/2017 17:00	29.06	4.58
8/4/2017 16:00	30.30	4.45
8/4/2017 17:00	25.06	5.53
8/8/2017 16:00	33.13	4.02
8/8/2017 17:00	32.48	4.11
8/9/2017 16:00	27.33	4.87
8/9/2017 17:00	32.52	4.08
8/10/2017 16:00	28.06	4.84
8/10/2017 17:00	32.26	4.12
8/11/2017 16:00	25.38	5.31
8/11/2017 17:00	29.97	4.43
8/15/2017 16:00	31.03	4.29
8/15/2017 17:00	32.78	4.13
8/16/2017 16:00	31.41	4.23
8/16/2017 17:00	37.56	3.55
8/17/2017 16:00	31.02	4.29
8/17/2017 17:00	36.81	3.61
8/18/2017 16:00	38.96	3.41
8/18/2017 17:00	34.39	3.91
8/22/2017 16:00	33.94	3.94
8/22/2017 17:00	35.29	3.80
8/23/2017 16:00	34.70	3.86
8/23/2017 17:00	34.35	3.87
8/24/2017 16:00	33.29	3.99
8/24/2017 17:00	28.72	4.67
8/25/2017 16:00	31.99	4.15
8/25/2017 17:00	28.05	4.78
8/29/2017 16:00	34.33	3.88
8/29/2017 17:00	35.95	3.70
8/30/2017 16:00	34.60	3.84
8/30/2017 17:00	35.94	3.69
8/31/2017 16:00	30.75	4.33
8/31/2017 17:00	30.03	4.49

Attachment B. Existing Vissim Results Summary

2017 Existing - PM Peak

Node #	Primary Road	Secondary Road	Approach	Movement	Movement: Served Volume (vph)	Movement: Vehicle Delay (sec)	Movement: Max Queue (ft)	Movement: Standard Deviation (ft)	Movement: 95th Percentile Queue	Intersection: Vehicle Delay (sec)
1	SW Highland Avenue	SW 6th Street	EB	EBT	710	11.4	187	24	226	**9.1**
				EBR	61	5.1	93	29	141	
			SB	SBL	159	4.1	113	17	141	
				SBT	474	7.1	93	17	121	
2	SW Highland Avenue	SW 5th Street	EB	EBL	316	4.6	114	16	141	**7.2**
				EBT	553	4.4	115	16	142	
			NB	NBT	304	13.2	117	12	136	
				NBR	31	10.2	136	12	155	
10	SW Glacier Avenue	SW 6th Street	SB	SBT	576	14.9	224	27	268	**13.9**
				SBR	274	13.6	242	27	286	
			WB	WBL	56	9.3	226	53	313	
				WBT	368	13.2	221	53	308	
9	SW Glacier Avenue	SW 5th Street	WB	WBT	371	6.8	158	28	204	**14.7**
				WBR	229	8.4	198	33	252	
			NB	NBL	50	21.4	223	12	243	
				NBT	568	21.7	223	12	243	
8	US 97	SW Highland Ave/SW Glacier Ave	EB	EBL	372	49.0	262	24	302	**17.2**
				EBR	212	12.8	180	45	254	
			NB	NBL	318	62.5	235	26	277	
				NBT	1154	2.8	98	11	115	
			SB	SBT	936	11.8	293	35	351	
				SBR	283	3.9	155	43	226	
7	US 97	SW Veterans Way	EB	EBL	90	38.9	145	25	185	**22.6**
				EBT	136	48.4	216	44	288	
				EBR	216	10.7	246	44	318	
			NB	NBL	239	20.8	222	124	426	
				NBT	1200	11.6	464	85	604	
				NBR	111	13.7	468	85	607	
			WB	WBL	186	46.4	432	155	688	
				WBT	258	51.2	449	207	791	
				WBR	151	32.9	478	207	820	
			SB	SBL	56	20.5	79	15	105	
				SBT	958	21.5	484	50	566	
				SBR	54	19.2	511	50	592	
14	US 97	SE Pumice Avenue	EB	EBL	25	22.5	75	23	113	**22.5**
				EBT	0	0.0	98	23	137	
				EBR	68	10.7	97	23	135	
			NB	NBL	122	11.2	119	41	187	
				NBT	1533	1.5	0	0	0	
				NBR	0	16.1	0	0	0	
			WB	WBL	0	0.0	38	2	42	
				WBT	0	0.0	41	2	45	
				WBR	10	9.4	47	2	51	
			SB	SBL	9	16.9	72	24	112	
				SBT	1333	1.4	6	19	36	
				SBR	14	2.8	16	11	35	
6	US 97	SW Odem Medo Way	EB	EBL	264	36.6	175	14	198	**19.0**
				EBT	12	38.9	175	14	198	
				EBR	157	8.7	118	24	158	
			NB	NBL	211	62.2	511	198	838	
				NBT	1330	10.0	394	59	492	
				NBR	4	8.2	427	59	525	
			WB	WBL	12	53.1	45	14	68	
				WBT	28	58.3	93	18	123	
				WBR	9	26.1	109	18	139	
			SB	SBL	2	62.3	23	11	41	
				SBT	1085	16.3	339	77	465	
				SBR	278	10.0	170	24	210	
13	US 97	SW Wickiup Avenue	EB	EBL	0	0.0	0	0	0	**18.1**
				EBT	0	0.0	0	0	0	
				EBR	95	12.2	80	11	99	
			NB	NBL	61	10.0	113	40	179	
				NBT	1545	1.1	0	0	0	
				NBR	14	1.8	4	9	19	
			WB	WBL	4	18.1	69	15	93	
				WBT	1	10.7	22	21	57	
				WBR	16	8.9	68	15	93	
			SB	SBL	10	8.4	30	9	45	
				SBT	1208	1.6	8	24	48	
				SBR	49	3.2	31	39	95	

11	SW Canal Boulevard	SW Odem Medo Way	NB	NBT	302	21.6	239	46	315	**18.8**
				NBR	177	20.1	208	57	302	
			WB	WBL	179	12.1	134	26	178	
				WBR	341	8.5	178	69	291	
			SB	SBL	266	40.4	298	55	389	
				SBT	271	10.8	160	22	196	
15	SW Canal Boulevard	SE Pumice Avenue	NB	NBT	437	3.6	62	28	108	**28.2**
				NBR	67	5.1	104	26	147	
			WB	WBL	86	28.2	245	102	414	
				WBR	173	21.5	249	102	418	
			SB	SBL	74	3.6	96	45	170	
				SBT	507	2.0	61	47	138	
3	SW Canal Boulevard	SW Veterans Way	EB	EBL	8	15.4	31	10	48	**29.1**
				EBT	171	19.9	186	40	251	
				EBR	118	6.4	93	10	110	
			NB	NBL	129	58.6	211	28	256	
				NBT	309	41.1	451	128	662	
				NBR	100	6.7	84	4	90	
			WB	WBL	109	7.5	77	17	106	
				WBT	252	7.3	80	12	99	
				WBR	190	4.8	126	30	176	
			SB	SBL	173	56.5	167	21	202	
				SBT	344	43.0	494	90	643	
				SBR	14	34.2	520	90	669	
4	SW Yew Avenue	US 97 SB Ramps	EB	EBT	163	7.4	110	14	133	**7.9**
				EBR	198	7.3	112	10	129	
			WB	WBL	291	6.2	162	27	208	
				WBT	479	2.3	104	30	154	
			SB	SBL	98	36.1	141	25	183	
				SBR	103	8.1	95	11	114	
5	SW Yew Avenue	US 97 NB Ramps	EB	EBL	103	11.2	110	32	163	**16.2**
				EBT	158	3.4	70	23	108	
			NB	NBL	329	35.4	409	66	517	
				NBR	167	7.9	63	9	78	
			WB	WBR	106	3.6	101	12	120	
				WBT	441	11.7	313	72	432	
12	SW Yew Avenue	SW Canal Boulevard	EB	EBL	5	2.5	84	25	125	**11.5**
				EBT	193	2.5	84	25	125	
				EBR	51	2.7	85	25	126	
			NB	NBL	88	8.3	263	78	392	
				NBT	220	8.3	263	78	392	
				NBR	86	7.3	263	78	392	
			WB	WBL	71	11.3	385	128	596	
				WBT	347	11.2	385	128	596	
				WBR	162	10.7	385	128	596	
			SB	SBL	82	11.5	179	35	237	
				SBT	140	11.4	179	35	237	
				SBR	11	11.3	179	35	237	

Attachment C. Existing Synchro HCM Reports

hdrinc.com 1050 SW 6th Avenue, Suite 1800, Portland, OR 97204-1151
(503) 423-3700

Movement	EBL	EBR	NBL	NBT	SBT	SBR	SBR2	SEL	SER
Lane Configurations									
Traffic Volume (vph)	378	216	339	1191	965	0	257	0	0
Future Volume (vph)	378	216	339	1191	965	0	257	0	0
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	4.0	3.5	4.0	5.5	5.5		4.0		
Lane Util. Factor	0.97	1.00	0.97	0.95	0.95		1.00		
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		0.46		
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00		
Frt	1.00	0.85	1.00	1.00	1.00		0.85		
Flt Protected	0.95	1.00	0.95	1.00	1.00		1.00		
Satd. Flow (prot)	3221	1485	3159	3257	3167		650		
Flt Permitted	0.95	1.00	0.95	1.00	1.00		1.00		
Satd. Flow (perm)	3221	1485	3159	3257	3167		650		
Peak-hour factor, PHF	0.93	0.93	0.99	0.99	0.97	0.97	0.97	0.97	0.95
Adj. Flow (vph)	406	232	342	1203	995	0	265	0	0
RTOR Reduction (vph)	0	45	0	0	0	0	106	0	0
Lane Group Flow (vph)	406	187	342	1203	995	0	159	0	0
Confl. Peds. (#/hr)							919		
Heavy Vehicles (%)	3%	3%	5%	5%	8%	8%	8%	2%	0%
Turn Type	Prot	custom	Prot	NA	NA		Perm		
Protected Phases	8	8	1	6	2				
Permitted Phases		1					2		
Actuated Green, G (s)	20.3	35.8	15.5	90.2	70.7		70.7		
Effective Green, g (s)	20.3	36.8	15.5	90.2	70.7		72.2		
Actuated g/C Ratio	0.17	0.31	0.13	0.75	0.59		0.60		
Clearance Time (s)	4.0	4.0	4.0	5.5	5.5		5.5		
Vehicle Extension (s)	3.0	3.0	0.2	1.0	1.0		1.0		
Lane Grp Cap (vph)	544	498	408	2448	1865		391		
v/s Ratio Prot	c0.13	0.06	c0.11	0.37	c0.31				
v/s Ratio Perm		0.06					0.25		
v/c Ratio	0.75	0.38	0.84	0.49	0.53		0.41		
Uniform Delay, d1	47.4	32.6	51.0	5.9	14.8		12.6		
Progression Factor	1.29	0.69	1.09	0.45	1.00		1.00		
Incremental Delay, d2	5.2	0.4	9.5	0.5	1.1		3.1		
Delay (s)	66.5	22.9	65.2	3.1	15.9		15.7		
Level of Service	E	C	E	A	B		B		
Approach Delay (s)	50.6			16.9	15.8			0.0	
Approach LOS	D			B	B			A	

Intersection Summary			
HCM 2000 Control Delay	22.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	13.5
Intersection Capacity Utilization	61.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	91	140	209	182	256	157	245	1248	111	58	1039	46
Future Volume (vph)	91	140	209	182	256	157	245	1248	111	58	1039	46
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.94		1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1676	1765	1500	1676	3161		1629	3217		1598	3176	
Flt Permitted	0.24	1.00	1.00	0.41	1.00		0.12	1.00		0.12	1.00	
Satd. Flow (perm)	418	1765	1500	716	3161		208	3217		207	3176	
Peak-hour factor, PHF	0.96	0.96	0.96	0.85	0.85	0.85	0.94	0.94	0.94	0.93	0.93	0.93
Adj. Flow (vph)	95	146	218	214	301	185	261	1328	118	62	1117	49
RTOR Reduction (vph)	0	0	187	0	83	0	0	4	0	0	2	0
Lane Group Flow (vph)	95	146	31	214	403	0	261	1442	0	62	1164	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	5%	5%	5%	7%	7%	7%
Turn Type	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	3	8		7	4		1	6		5	2	
Permitted Phases	8		8	4			6			2		
Actuated Green, G (s)	23.5	16.4	16.4	28.3	18.8		80.6	70.8		63.9	58.6	
Effective Green, g (s)	24.5	16.9	16.9	29.3	19.3		81.1	71.3		64.9	59.1	
Actuated g/C Ratio	0.20	0.14	0.14	0.24	0.16		0.68	0.59		0.54	0.49	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5		4.5	4.5		4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	165	248	211	254	508		353	1911		179	1564	
v/s Ratio Prot	0.04	0.08		c0.07	0.13		c0.11	c0.45		0.02	0.37	
v/s Ratio Perm	0.08		0.02	c0.13			0.39			0.17		
v/c Ratio	0.58	0.59	0.15	0.84	0.79		0.74	0.75		0.35	0.74	
Uniform Delay, d1	40.8	48.3	45.2	41.5	48.4		22.5	17.9		15.1	24.4	
Progression Factor	1.34	1.27	3.90	1.00	1.00		1.76	0.56		0.97	0.66	
Incremental Delay, d2	4.6	3.4	0.3	21.6	8.3		5.5	1.9		1.0	2.8	
Delay (s)	59.4	64.6	176.6	63.1	56.7		45.1	12.1		15.6	18.8	
Level of Service	E	E	F	E	E		D	B		B	B	
Approach Delay (s)		116.7			58.7			17.1			18.7	
Approach LOS		F			E			B			B	

Intersection Summary			
HCM 2000 Control Delay	35.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	77.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	261	12	164	11	29	10	222	1386	5	4	1162	277
Future Volume (vph)	261	12	164	11	29	10	222	1386	5	4	1162	277
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.96		1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1593	1676	1500	1710	1731		1644	3287		1613	3226	1443
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.07	1.00		0.10	1.00	1.00
Satd. Flow (perm)	1593	1676	1500	1710	1731		126	3287		171	3226	1443
Peak-hour factor, PHF	0.80	0.80	0.80	0.82	0.82	0.82	0.97	0.97	0.97	0.93	0.93	0.93
Adj. Flow (vph)	326	15	205	13	35	12	229	1429	5	4	1249	298
RTOR Reduction (vph)	0	0	152	0	11	0	0	0	0	0	0	166
Lane Group Flow (vph)	326	15	53	13	36	0	229	1434	0	4	1249	132
Heavy Vehicles (%)	2%	2%	2%	0%	0%	0%	4%	4%	4%	6%	6%	6%
Turn Type	Split	NA	Perm	Split	NA		pm+pt	NA		pm+pt	NA	Perm
Protected Phases	8	8		4	4		1	6		5	2	
Permitted Phases			8				6			2		2
Actuated Green, G (s)	30.7	30.7	30.7	6.2	6.2		69.6	64.2		53.5	52.6	52.6
Effective Green, g (s)	31.2	31.2	31.2	6.7	6.7		70.1	64.7		54.5	53.1	53.1
Actuated g/C Ratio	0.26	0.26	0.26	0.06	0.06		0.58	0.54		0.45	0.44	0.44
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5		4.5	4.5		4.5	4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	414	435	390	95	96		238	1772		94	1427	638
v/s Ratio Prot	c0.20	0.01		0.01	c0.02		c0.10	0.44		0.00	0.39	
v/s Ratio Perm			0.04				c0.46			0.02		0.09
v/c Ratio	0.79	0.03	0.14	0.14	0.37		0.96	0.81		0.04	0.88	0.21
Uniform Delay, d1	41.3	33.2	34.1	53.9	54.6		36.0	22.6		20.4	30.4	20.5
Progression Factor	1.29	1.33	2.98	1.00	1.00		1.00	1.00		1.37	0.87	2.42
Incremental Delay, d2	6.8	0.0	0.1	0.7	2.4		47.5	4.1		0.1	5.8	0.5
Delay (s)	60.2	44.0	101.8	54.6	57.0		83.6	26.7		28.0	32.4	50.3
Level of Service	E	D	F	D	E		F	C		C	C	D
Approach Delay (s)		75.4			56.5			34.5			35.8	
Approach LOS		E			E			C			D	

Intersection Summary			
HCM 2000 Control Delay	41.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	71.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	114	168	0	0	454	93	313	0	178	0	0	0
Future Volume (vph)	114	168	0	0	454	93	313	0	178	0	0	0
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	4.0	4.0			4.0	4.0	4.0	4.0				
Lane Util. Factor	1.00	1.00			1.00	1.00	1.00	1.00				
Frt	1.00	1.00			1.00	0.85	1.00	0.85				
Flt Protected	0.95	1.00			1.00	1.00	0.95	1.00				
Satd. Flow (prot)	1676	1765			1748	1485	1676	1500				
Flt Permitted	0.24	1.00			1.00	1.00	0.95	1.00				
Satd. Flow (perm)	418	1765			1748	1485	1676	1500				
Peak-hour factor, PHF	0.89	0.89	0.89	0.75	0.75	0.75	0.89	0.89	0.89	0.90	0.90	0.90
Adj. Flow (vph)	128	189	0	0	605	124	352	0	200	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	58	0	149	0	0	0	0
Lane Group Flow (vph)	128	189	0	0	605	66	352	51	0	0	0	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA			NA	Perm	Perm	NA				
Protected Phases	5	2			6			8				
Permitted Phases	2					6	8					
Actuated Green, G (s)	51.0	51.0			39.7	39.7	20.0	20.0				
Effective Green, g (s)	51.5	51.5			40.2	40.2	20.5	20.5				
Actuated g/C Ratio	0.64	0.64			0.50	0.50	0.26	0.26				
Clearance Time (s)	4.5	4.5			4.5	4.5	4.5	4.5				
Vehicle Extension (s)	3.0	3.0			3.0	3.0	3.0	3.0				
Lane Grp Cap (vph)	383	1136			878	746	429	384				
v/s Ratio Prot	c0.03	0.11			c0.35			0.03				
v/s Ratio Perm	0.18					0.04	c0.21					
v/c Ratio	0.33	0.17			0.69	0.09	0.82	0.13				
Uniform Delay, d1	8.5	5.7			15.1	10.4	28.0	22.9				
Progression Factor	1.51	1.29			1.00	1.00	1.00	1.00				
Incremental Delay, d2	0.5	0.3			4.4	0.2	11.9	0.2				
Delay (s)	13.4	7.7			19.5	10.6	39.9	23.1				
Level of Service	B	A			B	B	D	C				
Approach Delay (s)		10.0			18.0			33.8			0.0	
Approach LOS		A			B			C			A	

Intersection Summary			
HCM 2000 Control Delay	21.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	60.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	179	193	261	506	0	0	0	0	103	0	119
Future Volume (vph)	0	179	193	261	506	0	0	0	0	103	0	119
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)		4.0	4.0	4.0	4.0						4.0	4.0
Lane Util. Factor		1.00	1.00	1.00	1.00						1.00	1.00
Frt		1.00	0.85	1.00	1.00						1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00						0.95	1.00
Satd. Flow (prot)		1731	1471	1676	1765						1693	1515
Flt Permitted		1.00	1.00	0.59	1.00						0.95	1.00
Satd. Flow (perm)		1731	1471	1041	1765						1693	1515
Peak-hour factor, PHF	0.98	0.98	0.98	0.85	0.85	0.85	0.92	0.92	0.92	0.82	0.82	0.82
Adj. Flow (vph)	0	183	197	307	595	0	0	0	0	126	0	145
RTOR Reduction (vph)	0	0	85	0	0	0	0	0	0	0	0	124
Lane Group Flow (vph)	0	183	112	307	595	0	0	0	0	0	126	21
Heavy Vehicles (%)	4%	4%	4%	2%	2%	2%	2%	2%	2%	1%	1%	1%
Turn Type		NA	Perm	pm+pt	NA					Perm	NA	Perm
Protected Phases		2		1	6						8	
Permitted Phases			2	6						8		8
Actuated Green, G (s)		44.9	44.9	59.7	59.7						11.3	11.3
Effective Green, g (s)		45.4	45.4	60.2	60.2						11.8	11.8
Actuated g/C Ratio		0.57	0.57	0.75	0.75						0.15	0.15
Clearance Time (s)		4.5	4.5	4.5	4.5						4.5	4.5
Vehicle Extension (s)		3.0	3.0	3.0	3.0						3.0	3.0
Lane Grp Cap (vph)		982	834	869	1328						249	223
v/s Ratio Prot		0.11		0.05	c0.34							
v/s Ratio Perm			0.08	0.22							0.07	0.01
v/c Ratio		0.19	0.13	0.35	0.45						0.51	0.10
Uniform Delay, d1		8.4	8.1	3.1	3.7						31.4	29.5
Progression Factor		1.00	1.00	0.46	0.40						1.00	1.00
Incremental Delay, d2		0.4	0.3	0.2	0.8						1.6	0.2
Delay (s)		8.8	8.4	1.6	2.2						33.0	29.7
Level of Service		A	A	A	A						C	C
Approach Delay (s)		8.6			2.0			0.0			31.2	
Approach LOS		A			A			A			C	

Intersection Summary			
HCM 2000 Control Delay	8.7	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	60.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	30	0	73	0	0	10	125	1588	0	2	1412	16
Future Volume (Veh/h)	30	0	73	0	0	10	125	1588	0	2	1412	16
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.80	0.80	0.80	0.42	0.42	0.42	0.95	0.95	0.95	0.93	0.93	0.93
Hourly flow rate (vph)	38	0	91	0	0	24	132	1672	0	2	1518	17
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								TWLTL			TWLTL	
Median storage veh)								2			2	
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2654	3466	768	2790	3475	836	1535			1672		
vC1, stage 1 conf vol	1530	1530		1936	1936							
vC2, stage 2 conf vol	1124	1936		854	1539							
vCu, unblocked vol	2654	3466	768	2790	3475	836	1535			1672		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.2			4.2		
tC, 2 stage (s)	6.5	5.5		6.5	5.5							
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.3		
p0 queue free %	56	100	74	100	100	92	69			99		
cM capacity (veh/h)	86	65	345	42	38	315	420			362		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	129	24	132	1115	557	761	776
Volume Left	38	0	132	0	0	2	0
Volume Right	91	24	0	0	0	0	17
cSH	183	315	420	1700	1700	362	1700
Volume to Capacity	0.71	0.08	0.31	0.66	0.33	0.01	0.46
Queue Length 95th (ft)	109	6	33	0	0	0	0
Control Delay (s)	61.6	17.4	17.5	0.0	0.0	0.2	0.0
Lane LOS	F	C	C			A	
Approach Delay (s)	61.6	17.4	1.3			0.1	
Approach LOS	F	C					

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	111.3%	ICU Level of Service	H
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	98	4	0	20	28	1614	15	12	1294	48
Future Volume (Veh/h)	0	0	98	4	0	20	28	1614	15	12	1294	48
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.73	0.73	0.73	0.58	0.58	0.58	0.99	0.99	0.99	0.93	0.93	0.93
Hourly flow rate (vph)	0	0	134	7	0	34	28	1630	15	13	1391	52
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2348	3144	722	2549	3162	822	1443			1645		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2348	3144	722	2549	3162	822	1443			1645		
tC, single (s)	7.5	6.5	6.9	7.6	6.6	7.0	4.2			4.2		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.3		
p0 queue free %	100	100	64	8	100	89	94			96		
cM capacity (veh/h)	16	10	374	8	9	311	456			371		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	134	41	28	1087	558	13	927	516
Volume Left	0	7	28	0	0	13	0	0
Volume Right	134	34	0	0	15	0	0	52
cSH	374	40	456	1700	1700	371	1700	1700
Volume to Capacity	0.36	1.03	0.06	0.64	0.33	0.04	0.55	0.30
Queue Length 95th (ft)	40	100	5	0	0	3	0	0
Control Delay (s)	19.9	307.2	13.4	0.0	0.0	15.0	0.0	0.0
Lane LOS	C	F	B			C		
Approach Delay (s)	19.9	307.2	0.2			0.1		
Approach LOS	C	F						

Intersection Summary			
Average Delay	4.8		
Intersection Capacity Utilization	60.7%	ICU Level of Service	B
Analysis Period (min)	15		

Attachment D. Existing HCS Reports

HCS7 Freeway Diverge Report

Project Information

Analyst	Joe Kirkland	Date	4/19/2019
Agency	HDR	Analysis Year	2019
Jurisdiction		Time Period Analyzed	PM
Project Description	US 97 NB Diverge at Yew Avenue		

Geometric Data

	Freeway	Ramp
Number of Lanes (N)	2	1
Free-Flow Speed (FFS), mi/h	55.0	30.0
Segment Length (L) / Deceleration Length (L_D), ft	1500	235
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

Adjustment Factors

Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Volume (V_i), veh/h	1447	491
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	3.00	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.971	0.980
Flow Rate (v_i), pc/h	1585	533
Capacity (c), pc/h	3872	1839
Volume-to-Capacity Ratio (v/c)	0.41	0.29

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	15.8
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (D_S)	0.551
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/h/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	Off-Ramp Influence Area Speed (S_R), mi/h	47.2
Prop. Freeway Vehicles in Lane 1 and 2 (P_{FD})	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	1585	Ramp Junction Speed (S), mi/h	47.2
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	-	Average Density (D), pc/mi/ln	16.8
Level of Service (LOS)	B		

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HCS7 Freeway Merge Report

Project Information

Analyst	Joe Kirkland	Date	4/19/2019
Agency	HDR	Analysis Year	2019
Jurisdiction		Time Period Analyzed	PM
Project Description	US 97 NB Merge at Yew Avenue		

Geometric Data

	Freeway	Ramp
Number of Lanes (N)	2	1
Free-Flow Speed (FFS), mi/h	50.0	35.0
Segment Length (L) / Acceleration Length (L_A), ft	1500	250
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

Adjustment Factors

Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Volume (V_i), veh/h	1447	207
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.00	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.980	0.980
Flow Rate (v_i), pc/h	1571	225
Capacity (c), pc/h	3678	1936
Volume-to-Capacity Ratio (v/c)	0.49	0.12

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	17.9
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (M_S)	0.327
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/h/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	On-Ramp Influence Area Speed (S_R), mi/h	46.6
Prop. Freeway Vehicles in Lane 1 and 2 (P_{FM})	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	1571	Ramp Junction Speed (S), mi/h	46.6
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	1796	Average Density (D), pc/mi/ln	19.3
Level of Service (LOS)	B		

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HCS7 Freeway Diverge Report

Project Information

Analyst	Joe Kirkland	Date	4/19/2019
Agency	HDR	Analysis Year	2019
Jurisdiction		Time Period Analyzed	PM
Project Description	US 97 SB Diverge at Yew		

Geometric Data

	Freeway	Ramp
Number of Lanes (N)	2	1
Free-Flow Speed (FFS), mi/h	50.0	30.0
Segment Length (L) / Deceleration Length (L_D), ft	1500	210
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

Adjustment Factors

Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Volume (V_i), veh/h	1174	222
Peak Hour Factor (PHF)	0.94	0.97
Total Trucks, %	2.00	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.980	0.980
Flow Rate (v_i), pc/h	1274	234
Capacity (c), pc/h	3678	1839
Volume-to-Capacity Ratio (v/c)	0.35	0.13

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	13.3
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (D_S)	0.524
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/h/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	Off-Ramp Influence Area Speed (S_R), mi/h	45.2
Prop. Freeway Vehicles in Lane 1 and 2 (P_{FD})	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	1274	Ramp Junction Speed (S), mi/h	45.2
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	-	Average Density (D), pc/mi/ln	14.1
Level of Service (LOS)	B		

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HCS7 Freeway Merge Report

Project Information

Analyst	Joe Kirkland	Date	4/19/2019
Agency	HDR	Analysis Year	2019
Jurisdiction		Time Period Analyzed	PM
Project Description	US 97 SB Merge at Yew Avenue		

Geometric Data

	Freeway	Ramp
Number of Lanes (N)	2	1
Free-Flow Speed (FFS), mi/h	55.0	35.0
Segment Length (L) / Acceleration Length (L_A), ft	1500	325
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

Adjustment Factors

Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Volume (V_i), veh/h	1174	454
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	3.00	6.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.971	0.943
Flow Rate (v_i), pc/h	1286	512
Capacity (c), pc/h	3872	1936
Volume-to-Capacity Ratio (v/c)	0.46	0.26

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	17.3
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (M_S)	0.322
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/h/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	On-Ramp Influence Area Speed (S_R), mi/h	49.9
Prop. Freeway Vehicles in Lane 1 and 2 (P_{FM})	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	1286	Ramp Junction Speed (S), mi/h	49.9
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	1798	Average Density (D), pc/mi/ln	18.0
Level of Service (LOS)	B		

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Attachment E. Traffic Volume Forecasts Memorandum

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Portland, OR 97205
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TECHNICAL MEMORANDUM

DATE: March 18, 2019

TO: Project Team and Stakeholders

FROM: John Bosket, PE; Aaron Berger, PE; Dock Rosenthal, EIT

SUBJECT: US 97 Redmond South Corridor Area Facility Plan
Traffic Volume Forecasts

This memorandum describes the process followed for forecasting future traffic volumes in the US 97 Redmond study corridor for the year 2040 and the traffic volumes resulting from that process. The Origin-Destination matrix developed in this process was used to forecast future traffic volumes in the No-Build and Build condition road networks. This memorandum provides more detail into the windowed subarea travel demand modeling process outlined in the "Traffic Volume Modeling Methodology Memo" for this project.

EXECUTIVE SUMMARY

Future traffic volumes for the year 2040 were forecast for the No-Build and Build conditions based on a windowed subarea model of the regional Bend-Redmond Model (BRM). The windowed subarea modeling approach provides more sensitivity to local traffic control and circulation changes and allowed for the ability to better estimate changes in travel patterns associated with new traffic signals, roundabouts, street connections, and local access changes. The same demand matrix was used for analysis of the No-Build and Build models.

Most of the land use growth in the study area forecast by the year 2040 is related to employment (i.e., commercial and industrial businesses), with a net increase of about 700 workers in the areas immediately adjacent to US 97 (a 97% increase over 2010). The distribution of this employment growth varies along the corridor, ranging from slight decreases in some mostly built out areas to substantial increases at the southern end of the corridor where new development is expected on vacant parcels. The employment growth coupled with housing growth elsewhere in the City of Redmond and regional travel growth on US 97 will increase traffic activity, with average daily traffic volumes increasing from approximately 28,000 vehicles in 2017 to approximately 36,000 vehicles in 2040. This corresponds to an average annual growth rate of 1.24%

The 2040 No-Build network included one new street connection: the Quartz Avenue extension between Canal Boulevard and US 97. This new facility provided a more direct connection for some trips within the study area. The diversion created by the Quartz Avenue extension resulted in future traffic volume forecasts that were lower than the existing traffic counts at intersections as listed below:

- US 97 & Odem Medo Way westbound left movement
- Canal Boulevard & Quartz Avenue northbound through, eastbound left, and eastbound right movements
- Canal Boulevard & Pumice Avenue northbound through, northbound right, and westbound left movements
- US 97 & Pumice Avenue eastbound left and eastbound right movements
- Canal Boulevard & Veterans Way northbound left, northbound through, northbound right, and southbound left movements
- US 97 & Veterans Way eastbound left and eastbound right movements

The 2040 Build network included new traffic signals on US 97, new roundabouts on Canal Boulevard, and three additional connections between Canal Boulevard and US 97 at Wickiup Avenue, Umatilla Avenue, and a connection between Reindeer Avenue and Salmon Avenue. These new connections and intersection traffic controls cause changes in trip routing that moves trips move off US 97. In addition, travel demand on existing connections between Canal Boulevard and US 97 is redistributed across the new street extensions, decreasing trips on existing east-west connections compared to the No-Build scenario. The most significant traffic volume changes on the study area street network caused by the Build scenario are described below.

Volume Increases:

- <u>Eastbound and westbound Quartz Avenue</u> – Southbound to westbound demand from US 97 shifts to westbound Quartz Avenue instead of using Veterans Way. This shift is likely due to reduced intersection delay caused by the construction of a roundabout at the intersection of Quartz Avenue and Canal Boulevard (in contrast with No-Build). This reduced delay coupled with additional signals along US 97 results in a faster travel time for these vehicles. Eastbound Quartz Avenue also attracts additional trips headed to northbound US 97.
- <u>Eastbound and Westbound connection between Reindeer Avenue and Salmon Avenue</u> – The westbound connection primarily attracts northbound US 97 trips headed west to Salmon Avenue. The eastbound connection primarily attracts northbound trips from Canal Boulevard headed to northbound US 97. This connection in the central area of the US 97 corridor provides a more direct route for vehicles from Salmon Avenue that

previously accessed US 97 via Odem Medo Way or Quartz Avenue in the No-Build network.

- Eastbound and westbound Umatilla Avenue – Westbound Umatilla Avenue serves as a cut-through route from US 97 via Odem Medo Way to Canal Boulevard. The reduction of eastbound volume along Odem Medo Way makes the unsignalized left turn accessing this cut-through route a faster option compared with the signal at Odem Medo Way and Canal Boulevard. Eastbound Umatilla Avenue also serves as access to the adjacent commercial properties. With no left northbound left turn allowed the intersection with US 97 vehicles headed to those properties either turn left at Wickiup Avenue to access via Quartz Boulevard or make a U-turn at Odem Medo Way.
- Westbound Wickiup Avenue – Serves northbound US 97 traffic headed to local destinations along Canal Boulevard. This new connection serves volume that formerly traveled further north on US 97 and turned at Odem Medo Way.

Volume Decreases:

- Eastbound and westbound Odem Medo Way – Volume on this link decreases significantly because of the new east-west connections. In the No-Build network, Odem Medo Way provides the main east-west connection in the southern portion of the US 97 corridor. With additional connections at Wickiup Avenue and Umatilla Avenue, the volume is more evenly distributed on these other routes.
- US 97/ Yew Avenue southbound off-ramp – With connections available at Wickiup Avenue and Umatilla Avenue to the north, volume on the US 97/ Yew Avenue southbound off-ramp headed to northbound Canal Boulevard decreases in the Build scenario. This volume is headed west and the new connections provide a more direct route for these vehicles' ultimate destinations.
- US 97 southbound volume accessing via OR 126 – Additional delay from signals along US 97 makes the southbound travel time along Airport Way a faster path for regional trips headed south from OR 126.

In general, the new traffic signals on US 97 increase delay, while the new street connections reduce trip lengths for drivers coming from and going to Canal Boulevard. This results in a reduction of volume along US 97 as trips shift to the new connections that provide faster and more direct access to drivers' ultimate destinations.

The types of trips using the US 97 corridor were sampled between Glacier Avenue/Highland Avenue and Yew Avenue in the No-Build and Build networks. Trips beginning (entering the subarea network) or ending (leaving the subarea network) at driveways along US 97 were classified as "access" trips. Those beginning and/or ending at other external roads, such as Canal Boulevard or Veterans Way, using US 97 for a portion of the trip, but not accessing any business along US 97, are classified as “local”. Those trips driving through the study area on US 97, without stopping, are classified as “regional”.

A comparison between No-Build and Build showed that all traffic volumes along US 97 reduce by approximately 6% in the Build network. Looking at specific trip types, regional trip volumes remain identical in the two networks. Intuitively, these long-distance, through trips will continue to use US 97 as it provides the most direct route. The volume reduction along US 97 in the Build network results from lower relative volumes of local and access trips. The same trips are still being made in the Build network, however, they are leaving US 97 earlier and using new connections to avoid congestion and reach their destination faster. More information about the impact to access trips from the Build network changes can be found in the Existing Access Conditions Technical Memorandum.

INTRODUCTION

The overall model process is shown below. Further detail into each step of the process is provided in the subsequent sections.

MODELING APPROACH

This section provides an overview of the modeling approach used for this analysis. More detailed information can be found in the Traffic Volume Modeling Methodology Memorandum.

The 2010 Bend-Redmond (BRM) regional travel demand model was used as a basis for this analysis. A windowed subarea was created from this regional model for the corridor of US 97 contained within OR 126, Veterans Way, and Airport Way to the east, Evergreen Avenue to the north, 11th Street, Veterans Way, and Canal Boulevard to the west and Yew Avenue and Airport Way to the south.

The windowed approach typically holds volumes constant at the boundaries for consistency with the larger regional model while adding street network density to achieve a more detailed model of local circulation. In this case, the street network density was increased by adding all the driveway access points that are located within the US 97 corridor.

Extract 2010 Subarea Demand

The year 2010 demand was extracted from the 2010 BRM Emme model for the windowed subarea containing the study area. This demand was then imported as a matrix into the detailed Visum network for the windowed subarea. This step resulted in an uncalibrated 2010 average weekday subarea model.

Land Use and Demand Refinements

The next step in the modeling process focused on filling in the gaps in the model data between the BRM base year (2010) and the windowed subarea base year (2017). As expected, some Traffic Analysis Zone's (TAZ's) from the 2010 base year model did not reflect existing development in 2017. Therefore, prior to any interpolation to reach a year 2017 estimate, the following adjustments were added or subtracted from the 2010 demand to help develop a reasonable Origin-Destination (O-D) distribution for 2017.

A BRM TAZ between Veterans Way and Canal Boulevard now includes a home improvement store that was not constructed in 2010 and therefore is not included in the base year demand matrix, which models the TAZ as nearly vacant. For this TAZ, the 2017 (existing) land use was calculated based on a similar TAZ in the Bend area of the regional model, using a linear regression of regional model data to estimate the 2017 demand. This demand adjustment was added to the 2010 demand as part of the 2010 to 2017 demand adjustment process. This change was only made to develop the 2017 calibrated windowed subarea model, as the BRM 2040 land use data contained reasonable land use for this specific TAZ.

Another BRM TAZ contained an overestimate of existing employment for 2010 (but not 2040) due to the presence of the school district administration office. All school district employment was associated with the district office address in the 2010 land use dataset, leading to the TAZ employment overestimate. This overestimate was corrected using a linear regression equation developed from existing BRM model land use and re-calculating the base year demand for this TAZ based on school district office employment information from the 2040 land use.

External TAZ's are zones that access roads outside of the study area boundary and are included in a model to provide a link to the larger region outside of the model boundary. Demand accessing the external zone at SW Juniper Avenue and SW 11th Street was adjusted to correct the vehicles that were routing through the model. SW 11th Street is a one-way southbound link but is coded as a two-way connection in the regional model. The regional impact of this error is insignificant but in the more refined subarea model (with 11th Street coded as a one-way road) the discrepancy was resulting in significant volume looping through 9th Street to Glacier Avenue to access 11th Street southbound. To correct this issue the demand accessing SW Juniper and SW 11th Street was shifted south, shifting demand to the left at SW Kalama Avenue and bypassing the loop from 9th Street to 11th Street.

Estimate 2017 Demand and Seasonal Adjustment

Significant growth has occurred in the model area since the 2010 base year and therefore the initial model assignments were well below actual 2017 traffic counts. To develop a more reasonable 2017 demand, a demand matrix was extracted from the 2040 BRM model. The 2040 and 2010 matrices were linearly interpolated to generate an estimated 2017 demand.

As the BRM is an average weekday model, the 2017 counts were also seasonally factored to an average weekday. As the counts were collected in June, the seasonal adjustment factor (based off Automatic Traffic Recorders (ATR) located along US 97 in the Redmond area) was 0.91, or 91% of the 2017 counts. The average weekday on the corridor represents typically April/October conditions.

Origin-Destination Matrix Estimation Adjustments

Following the 2017 demand estimation, the assigned windowed subarea model volumes were closer to the seasonally adjusted average weekday count totals, but significant discrepancies remained, with differences ranging between 300 and 500 vehicles for through movements on US 97 and up to 150 vehicles for turning movements. To correct for these discrepancies a demand matrix correction procedure was run using the TFlowFuzzy Origin-Destination Matrix Estimation (ODME) tool in Visum. The ODME adjustments were saved in a trip adjustment matrix, representing the inherent O-D distributive differences between the BRM demand, which is calibrated to link volumes on higher classification streets, and the windowed subarea demand, which is calibrated to turns volumes in a much smaller area with more network detail. Therefore, this demand correction trip matrix was also applied to the 2040 data extracted from the BRM model.

US 97 Driveway TAZ and Pass-By Trip Adjustments

Travel demand in the BRM entering and exiting US 97 was low compared to the driveway counts, as the BRM models pass-by trips as through trips. Count volumes into and out of all zones along US 97 were approximately 150 higher than the assigned volume from the calibrated 2017 demand matrix. Therefore, these additional trips entering and exiting US 97 TAZs were assumed to be pass-by trips, allowing a demand pairs to be split into two demand pairs (the original origin zone to a US 97 driveway and the US 97 driveway to the original destination zone) without influencing the trip generation basis for the model. Movement volumes from major origins and destinations to the north and south corridor were calculated using screenlines. The pass-by trip volume was calculated from the difference between the counted and assigned volume into or out of the zones along US 97. This fixed pass-by adjustment was also applied to the future year demand matrix.

2017 Subarea Model Calibration and Validation

Demand matrix circulation within the subarea was calibrated to match counted traffic volumes. Modeled traffic volumes were compared to counted and seasonally factored volumes obtained for the major intersections in the model area. One tool used in the calibration process was adjusting the delay incurred by traffic control devices, specifically traffic signals. Signals in the study area use SCATS, an adaptive timing system. The subarea modeling tool can use green time data from the signal timing to generate a more intelligent traffic assignment but cannot replicate the flexibility of an adaptive system. Therefore, the initial model runs used fixed cycles from the base SCATS timing provided by ODOT. Some of the modeled routes deviated from the actual routes used (e.g., traffic using local streets rather than arterials). The green time allocated to problematic movements was adjusted to create more or alleviate delay and therefore adjust the route selection within the model.

Model circulation is also influenced by segment speed. Model speeds were inventoried from speed limits identified through field work and modeled appropriately. When certain routes attracted a disproportionate share of the volume and intersection signal delay was reasonable, particularly in the downtown grid network, link speeds were adjusted based on roadway characteristic (neighborhood streets, downtown streets with lots for parking activity, higher than posted prevailing speeds on mainline links, etc.) to shift that volume back to the preferred path based on count information. Table 1 identifies the locations where link speed in the windowed subarea model deviates from that in the regional model.

Table 1: Link Speed Deviations between US 97 Subarea Model and Bend-Redmond Model

Road	From	To	Subarea Model Speed (MPH)	Bend-Redmond Model Speed (MPH)
SW Highland Ave	SW 11th St	SW 6th St	30	25
SW Veterans Wy	US 97	SW Highland	35	30
SW Kalama Ave	SW Veterans Wy	SW Canal Blvd	35	20-25
SW Canal Blvd	SW Pumice Dr	SW 6th St Fork	35	30
SW 6th St	SW Highland Ave	SW Evergreen Ave	20	25-35
SW 5th St	SW Highland Ave	SW Evergreen Ave	20	25-35
SW Evergreen Ave	SW 11th St	SW 6th St	25	20
US 97	SW Glacier/ SW Highland	SW Evergreen Ave	50	45
US 97	SW Wickiup	SW Veterans	40	45
US 97	Yew Ave North Ramps	SW Wickiup	50	55
Pumice Ave	SW Canal Blvd	US 97	20	30
SW Odem Medo Way	SW Canal Blvd	US 97	35	25

2040 Horizon Year

The 2040 horizon year subarea demand matrix was calculated from the extracted Bend-Redmond model 2040 demand matrix, the ODME demand correction adjustments, and the pass-by adjustment matrix. The two adjustment matrices were identical to those used to calibrate the 2017 subarea model demand matrix. Future 2040 Average Weekday turn volumes at the study intersections were post-processed from the windowed subarea model link volumes and the seasonally adjusted average weekday counts using NCHRP 765 methodology. The forecasted 2040 turn volumes were then seasonally adjusted to the 30th highest hour (30HV), using a seasonal adjustment factor of 1.13 (derived from ATR data on US 97 in Redmond). This seasonal factoring method ensured that the seasonal portion of the traffic growth also increased between 2017 and 2040, along with the more typical weekday traffic. The post-processed 30HV volumes were balanced where appropriate, such as between intersections where there are no other routes available (e.g., US 97/ Yew Avenue interchange).

To ensure consistency with the BRM regional model, the post-processed volumes from the subarea assignment were compared with post-processed volumes derived from the BRM using the same counts. The BRM post-processed total intersection volumes were within 2% for the southern subarea boundary and 3% for the northern subarea boundary. The discrepancy between the volumes from the BRM and windowed subarea models was due entirely to the NCHRP methodology. Post-processing BRM volumes involves a model base year of 2010 and a count year of 2017, while the subarea model base year (2017) and count year (also 2017) are identical. The most prevalent NCHRP method using either model is the Average method which uses an average of the Modified Ratio and Difference methods. However, due to the greater difference in count volume and base model assignment the Difference method is far more prevalent when using the BRM (this is net model growth plus counts), while the subarea model post-processing is more likely to trigger the Ratio or Modified Ratio, which incorporate a growth rate component, opposed to a net growth.

2040 No-Build

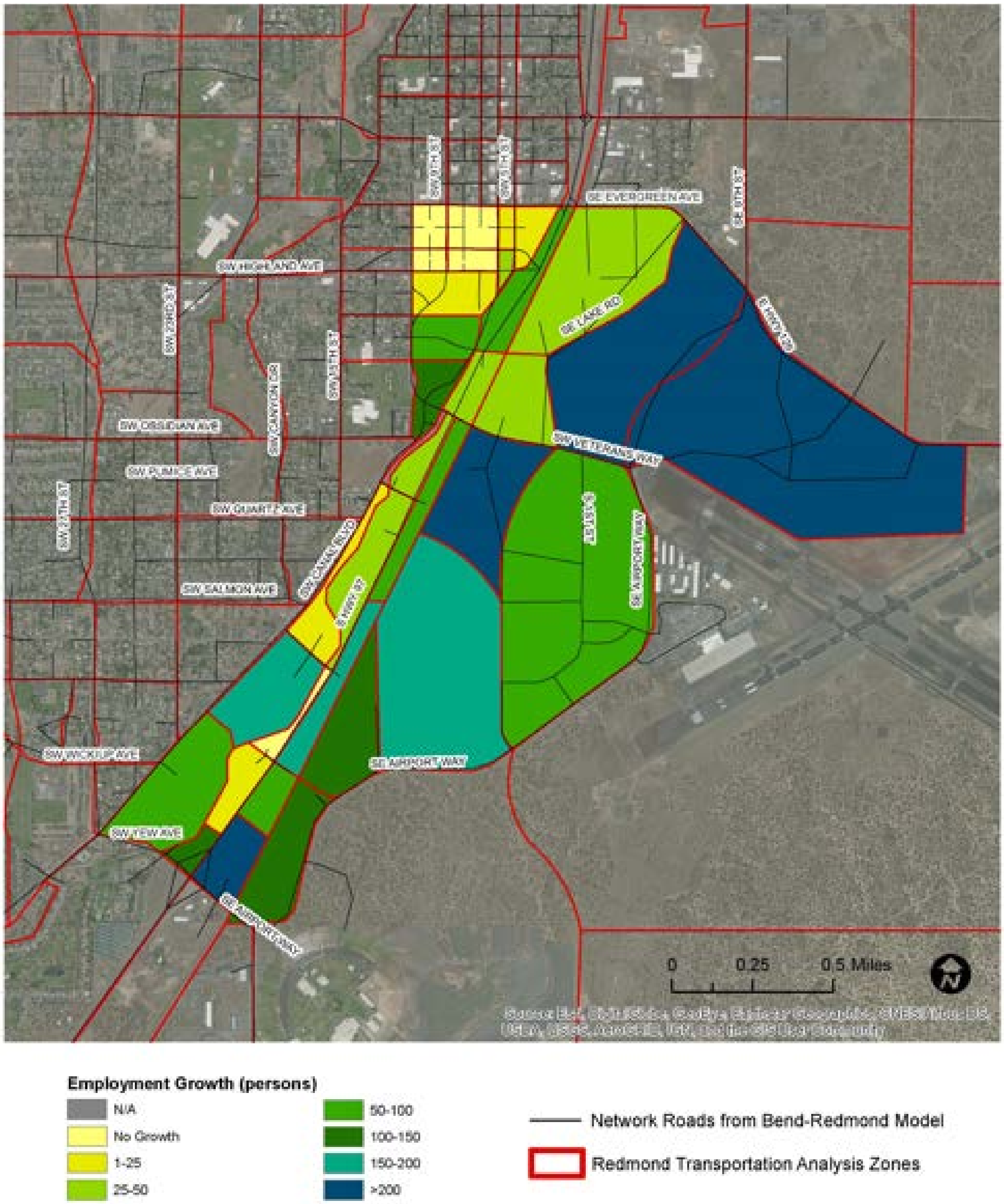
The BRM Financially Constrained model was used as the basis for the 2040 No-Build forecasts. This model included the following projects, which are assumed to be reasonably likely to be constructed by the year 2040:

- Quartz Avenue Extension between Canal Boulevard and Airport Way

The BRM 2040 land use was used to estimate TAZ level trip growth. The BRM 2040 land use matches the growth projections developed for Redmond by Portland State University. As shown in Figure 1 below, most TAZs in the US 97 subarea model are expected to experience employment growth from 2010 to 2040, with a net increase of about 700 workers in the TAZs immediately adjacent to US 97 (a 97% increase over 2010). The distribution of this employment growth varies along the corridor, ranging from slight decreases in some mostly built out areas to substantial increases at the southern end of the corridor where new development is expected on vacant parcels. The employment growth coupled with housing growth elsewhere in the City of

Redmond and regional growth on US 97 at the study area gateways is likely to increase traffic activity in 2040.

Figure 1: Employment Growth in the US 97 Subarea Model (2010 to 2040)



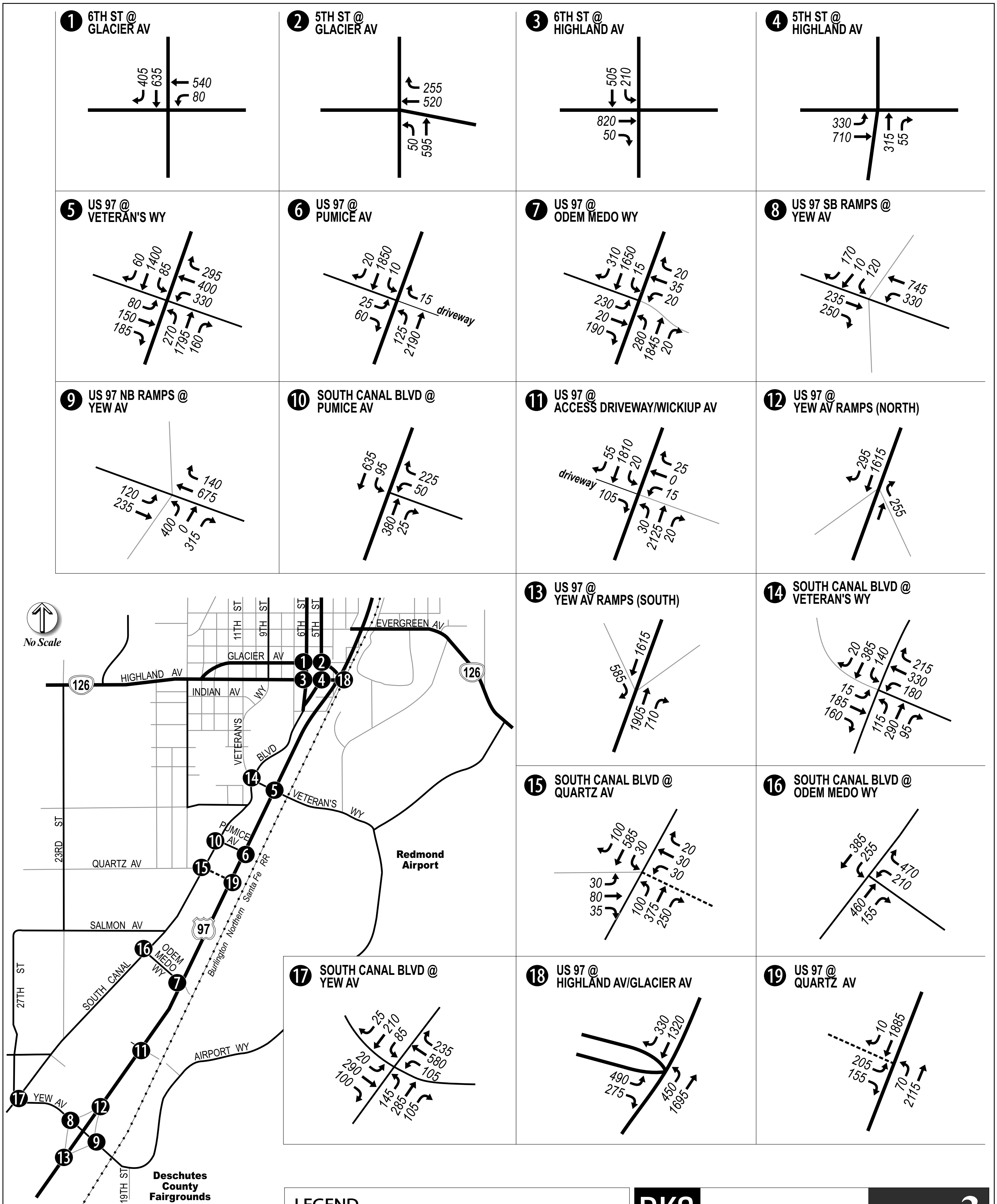
No-Build Traffic Volumes

Figure 2 below shows the study intersections within the boundary of the subarea model and the 2040 No-Build 30HV traffic volumes at each intersection. These traffic volumes will be used to establish baseline future traffic conditions without proposed improvements in place.

Negative growth occurs at the following locations in the subarea network due to the additional east-west connection provided at Quartz Avenue:

- US 97 & Odem Medo Way westbound left movement
- Canal Boulevard & Quartz Avenue northbound through, eastbound left, and eastbound right movements
- Canal Boulevard & Pumice Avenue northbound through, northbound right, and westbound left movements
- US 97 & Pumice Avenue eastbound left and eastbound right movements
- Canal Boulevard & Veterans Way northbound left, northbound through, northbound right, and southbound left movements
- US 97 & Veterans Way eastbound left and eastbound right movements

The decrease of these movements generally follows a volume shift off of northbound Canal Boulevard between Quartz Avenue and Veterans Way. This shift was made possible by the additional connection at Quartz Avenue.



LEGEND

- # Study Intersection
- ← 00 Traffic Volume with Turn Movement Indication
- ----- Future Roadway

Note: Intersection diagrams are schematic and not to scale.

DKS

Figure 2

2040 No-Build Design Hour Traffic Volumes

2040 BUILD

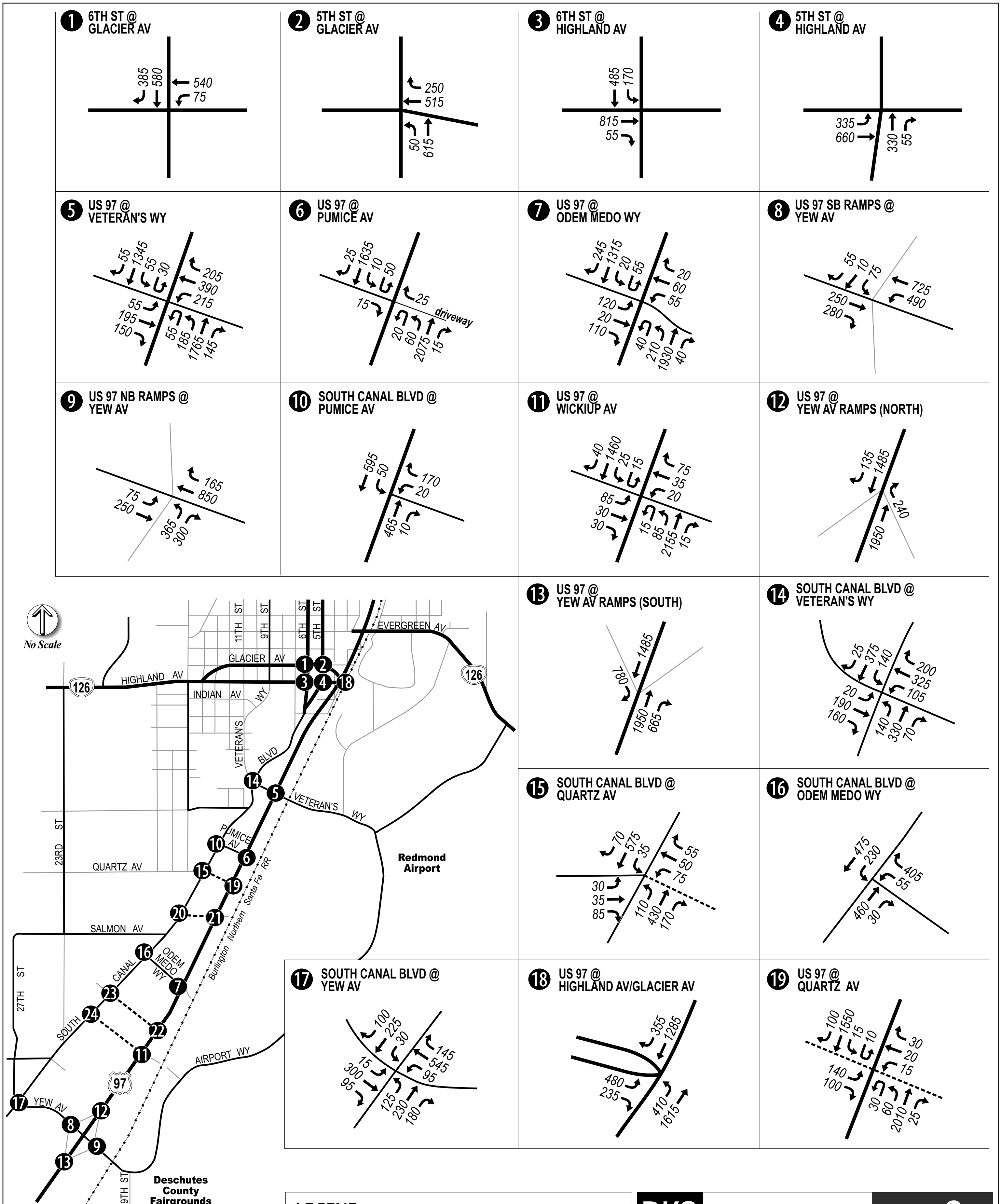
For the evaluation of the Build network the assumptions in the BRM model remained the same as the No-Build analysis. Sensitivity testing of the projects included in the Build network indicated negligible regional impact from the additional east-west connections. Future turn forecasts were then based on the same demand matrix as the No-Build turn forecasts with the additional road network including three new east-west connections between US 97 and Canal Boulevard as described below and shown in Figure 3.

- The extension of SW Wickiup Avenue
- The extension of SW Umatilla Avenue
- A new roadway connection between SW Salmon Avenue and SW Reindeer Avenue

US 97 Corridor Volumes in Build and No-Build

The types of trips using the US 97 corridor were sampled between Glacier Avenue/Highland Avenue and Yew Avenue in the No-Build and Build networks. Trips beginning (entering the subarea network) or ending (leaving the subarea network) at driveways along US 97 were classified as "access" trips. Those beginning and/or ending at other external roads, such as Canal Boulevard or Veterans Way, using US 97 for a portion of the trip, but not accessing any business along US 97, are classified as "local". Those trips driving through the study area on US 97, without stopping, are classified as "regional".

A comparison between No-Build and Build showed that all traffic volumes along US 97 reduce by approximately 6% in the Build network. Looking at specific trip types, regional trip volumes remain identical in the two networks. Intuitively, these long-distance, through trips will continue to use US 97 as it provides the most direct route. The volume reduction along US 97 in the Build network results from lower relative volumes of local and access trips. The same trips are still being made in the Build network, however, they are leaving US 97 earlier and using new connections to avoid congestion and reach their destination faster. More information about the impact to access trips from the Build network changes can be found in the Existing Access Conditions Technical Memorandum.



LEGEND

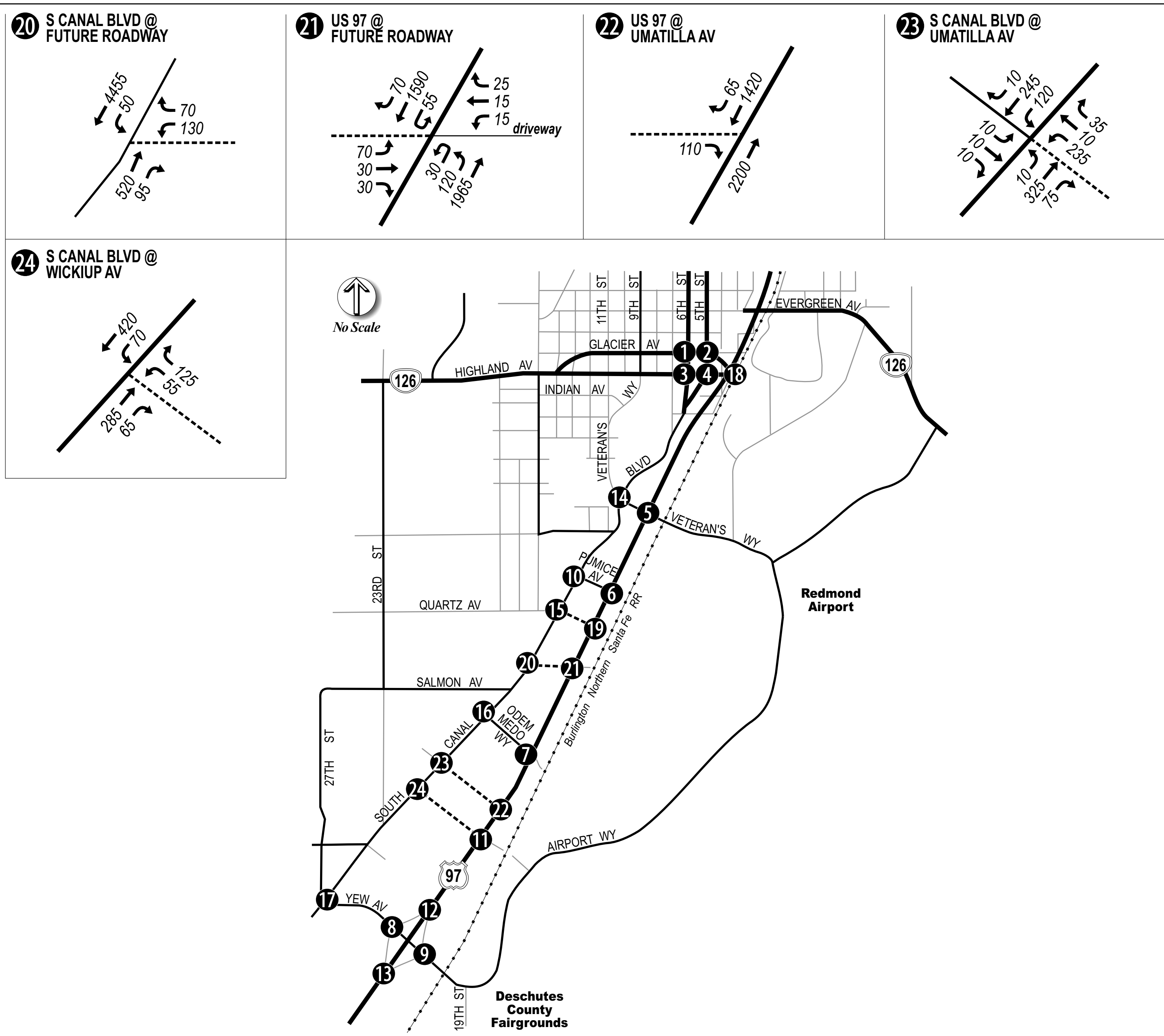
- Study Intersection
- Traffic Volume with Turn Movement Indication
- Future Roadway

Note: Intersection diagrams are schematic and not to scale.

DKS

Figure **3a**

2040 Build Design Hour Traffic Volumes



LEGEND

- Study Intersection
- 00 Traffic Volume with Turn Movement Indication
- Future Roadway

Note: Intersection diagrams are schematic and not to scale.

DKS

Figure **3b**

2040 Build Design Hour Traffic Volumes

Build Traffic Volumes

In general, trips move off US 97 in the Build scenario. This shift is related to the three additional signals along the US 97 corridor (resulting in delay and travel time increases) and new roundabouts along Canal Boulevard that reduce the delay for left turns onto and off this facility. Demand on connections west of US 97 is distributed across the new roadway extensions, decreasing demand on existing east-west connections compared to the No-Build scenario. Figure 4 illustrates how traffic volumes change on the street network during the weekday p.m. peak hour if the Build scenario is implemented. The most significant traffic volume changes on the study area street network caused by the Build scenario are described below.

Volume Increases:

- Eastbound and westbound Quartz Avenue – Southbound to westbound demand from US 97 shifts to westbound Quartz Avenue instead of using Veterans Way. This shift is likely due to reduced intersection delay caused by the construction of a roundabout at the intersection of Quartz Avenue and Canal Boulevard (in contrast with No-Build). This reduced delay coupled with additional signals along US 97 results in a faster travel time for these vehicles. Eastbound Quartz Avenue also attracts additional trips headed to northbound US 97.
- Eastbound and Westbound connection between Reindeer Avenue and Salmon Avenue – The westbound connection primarily attracts northbound US 97 trips headed west to Salmon Avenue. The eastbound connection primarily attracts northbound trips from Canal Boulevard headed to northbound US 97. This connection in the central area of the US 97 corridor provides a more direct route for vehicles from Salmon Avenue that previously accessed US 97 via Odem Medo Way or Quartz Avenue in the No-Build network.
- Eastbound and westbound Umatilla Avenue – Westbound Umatilla Avenue serves as a cut-through route from US 97 via Odem Medo Way to Canal Boulevard. The reduction of eastbound volume along Odem Medo Way makes the unsignalized left turn accessing this cut-through route a faster option compared with the signal at Odem Medo Way and Canal Boulevard. Eastbound Umatilla Avenue also serves as access to the adjacent commercial properties. With no left northbound left turn allowed the intersection with US 97 vehicles headed to those properties either turn left at Wickiup Avenue to access via Quartz Boulevard or make a U-turn at Odem Medo Way.
- Westbound Wickiup Avenue – Serves northbound US 97 traffic headed to local destinations along Canal Boulevard. This new connection serves volume that formerly traveled further north on US 97 and turned at Odem Medo Way.

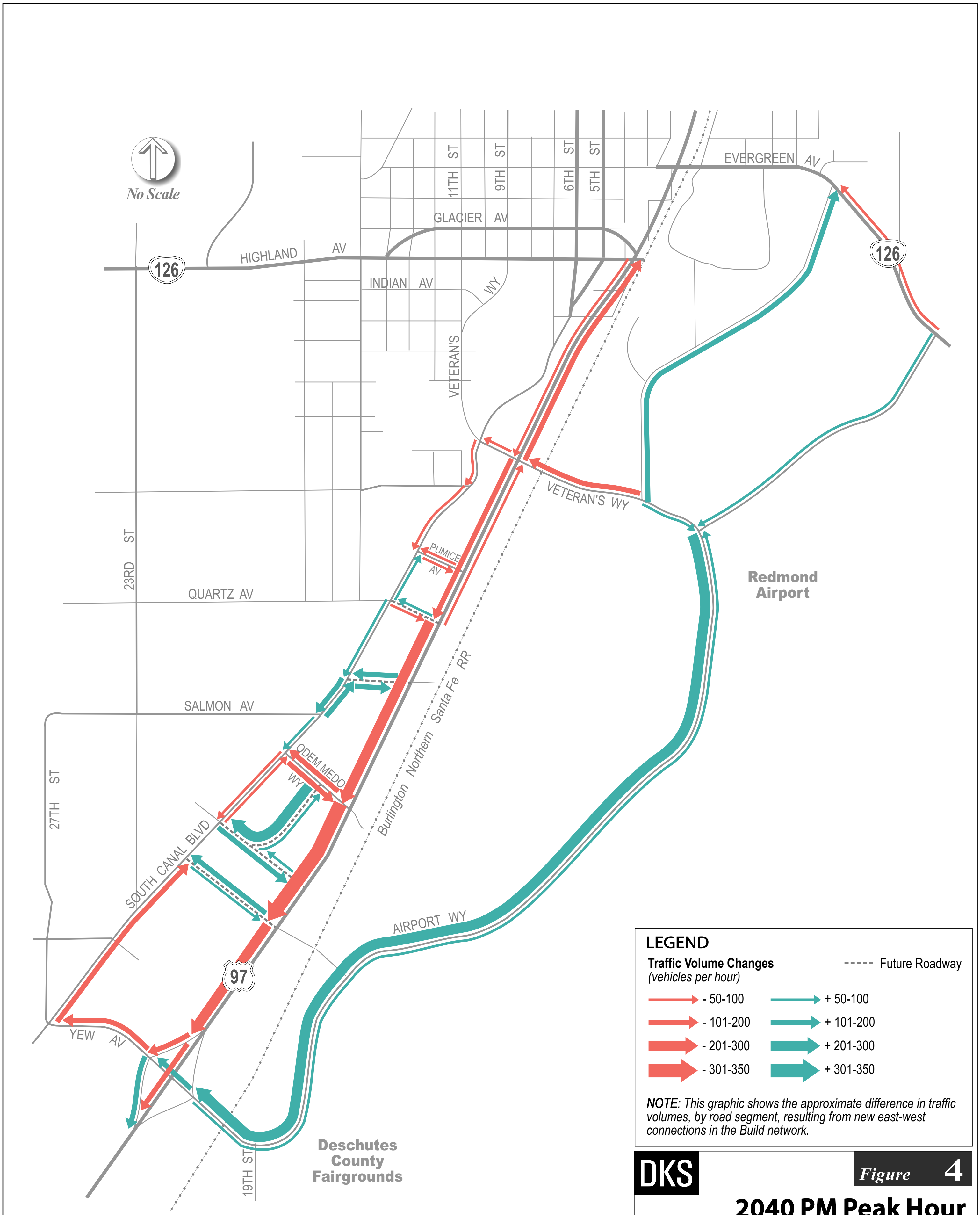


Figure **4**

2040 PM Peak Hour Build vs. No-Build Traffic Volume Shifts

Volume Decreases:

- Eastbound and westbound Odem Medo Way – Volume on this link decreases significantly because of the new east-west connections. In the No-Build network, Odem Medo Way provides the main east-west connection in the southern portion of the US 97 corridor. With additional connections at Wickiup Avenue and Umatilla Avenue, the volume is more evenly distributed on these other routes.
- US 97/ Yew Avenue southbound off-ramp – With connections available at Wickiup Avenue and Umatilla Avenue to the north, volume on the US 97/ Yew Avenue southbound off-ramp headed to northbound Canal Boulevard decreases in the Build scenario. This volume is headed west and the new connections provide a more direct route for these vehicles' ultimate destinations.
- US 97 southbound volume accessing via OR 126 – Additional delay from signals along US 97 makes the southbound travel time along Airport Way a faster path for regional trips headed south from OR 126.

Attachment F. Future Vissim Results Summary

2040 No-Build - PM Peak

Node #	Primary Road	Secondary Road	Approach	Movement	Movement					Intersection
					Served Volume (vph)	Vehicle Delay (sec)	Max Queue (ft)	Standard Deviation (ft)	95th Percentile Queue	Vehicle Delay (sec)
1	SW Highland Avenue	SW 6th Street	EB	EBT	929	11.8	270	28	316	**11.1**
				EBR	59	5.9	87	28	133	
			SB	SBL	223	6.2	138	23	175	
				SBT	499	12.5	140	35	197	
2	SW Highland Avenue	SW 5th Street	EB	EBL	433	4.3	190	63	293	**7.8**
				EBT	720	4.6	190	63	294	
			NB	NBT	310	18.8	151	12	172	
				NBR	45	15.8	170	12	191	
10	SW Glacier Avenue	SW 6th Street	SB	SBT	643	15.5	435	60	534	**17.0**
				SBR	509	17.6	453	60	552	
			WB	WBL	80	15.2	302	16	329	
				WBT	427	18.9	297	16	324	
9	SW Glacier Avenue	SW 5th Street	WB	WBT	440	16.0	255	31	307	**20.6**
				WBR	328	11.5	372	45	446	
			NB	NBL	65	26.2	330	47	407	
				NBT	677	27.4	330	47	407	
8	US 97	SW Highland Ave/SW Glacier Ave	EB	EBL	436	77.4	309	20	342	**24.1**
				EBR	326	23.6	330	50	412	
			NB	NBL	442	71.6	377	73	497	
				NBT	1601	3.0	105	12	124	
			SB	SBT	1470	20.3	924	134	1145	
				SBR	330	9.5	237	80	370	
7	US 97	SW Veterans Way	EB	EBL	124	31.0	172	30	221	**79.0**
				EBT	184	38.4	324	75	448	
				EBR	253	12.3	355	75	478	
			NB	NBL	222	137.9	1546	1	1548	
				NBT	1656	68.9	1542	1	1544	
				NBR	115	66.2	1545	1	1547	
			WB	WBL	264	130.6	1136	12	1156	
				WBT	330	135.4	1133	7	1145	
				WBR	278	121.4	1162	7	1174	
			SB	SBL	88	92.4	142	34	198	
				SBT	1499	72.6	1685	566	2618	
				SBR	90	73.2	1711	566	2645	
14	US 97	SE Pumice Avenue	EB	EBL	31	77.4	93	39	158	**86.5**
				EBT	5	86.5	108	39	173	
				EBR	0	0.0	107	39	171	
			NB	NBL	0	0.0	0	0	0	
				NBT	1981	18.0	643	47	719	
				NBR	6	1.4	643	47	719	
			WB	WBL	4	36.5	34	9	49	
				WBT	0	0.0	34	9	49	
				WBR	11	41.9	54	9	69	
			SB	SBL	9	21.8	73	19	104	
				SBT	1953	1.5	98	142	333	
				SBR	11	2.3	98	142	333	
16	US 97	SW Quartz Avenue	EB	EBL	45	74.6	156	16	182	**26.7**
				EBR	23	51.6	193	16	219	
			NB	NBL	273	79.0	2207	408	2879	
				NBT	1983	40.8	2210	370	2821	
			SB	SBT	1900	3.6	360	231	742	
				SBR	51	5.2	360	231	742	
6	US 97	SW Odem Medo Way	EB	EBL	337	53.3	380	71	496	**74.2**
				EBT	17	50.8	380	71	496	
				EBR	222	25.1	287	78	416	
			NB	NBL	244	148.9	1855	0	1855	
				NBT	1887	71.6	1851	0	1851	
				NBR	15	69.9	1851	0	1851	
			WB	WBL	23	66.5	76	19	107	
				WBT	42	71.7	145	27	190	
				WBR	19	42.2	160	27	205	
			SB	SBL	15	149.3	82	20	115	
				SBT	1607	79.7	2174	290	2653	
				SBR	301	60.9	208	43	279	
13	US 97	SW Wickiup Avenue	EB	EBR	103	18.7	119	36	179	**55.9**
			NB	NBL	74	74.0	306	212	656	
				NBT	2229	67.3	5353	1572	7947	
				NBR	29	61.8	5401	1572	7996	
			WB	WBL	8	54.8	113	20	146	
				WBT	2	15.6	56	30	106	
				WBR	33	55.9	112	20	145	
			SB	SBL	25	39.5	105	31	156	
				SBT	1792	2.1	35	75	158	
				SBR	45	2.8	59	86	200	

11	SW Canal Boulevard	SW Odem Medo Way	NB	NBT	347	27.6	423	90	570	23.6
				NBR	242	29.5	386	98	548	
			WB	WBL	242	13.1	227	58	322	
				WBR	343	6.7	180	53	268	
			SB	SBL	336	50.1	669	266	1107	
				SBT	396	15.1	323	138	550	
17	SW Canal Boulevard	SW Quartz Avenue	EB	EBL	64	13.2	79	18	110	37.6
				EBT	3	15.9	81	18	111	
				EBR	104	8.2	93	17	121	
			WB	WBL	93	33.8	386	73	507	
				WBT	13	37.6	388	73	509	
				WBR	149	28.5	395	73	516	
			NB	NBL	31	4.0	84	32	137	
				NBT	419	1.5	42	35	100	
				NBR	34	1.3	42	35	100	
			SB	SBL	8	4.0	155	84	294	
				SBT	579	2.0	110	74	232	
				SBR	103	2.3	120	70	236	
15	SW Canal Boulevard	SE Pumice Avenue	NB	NBT	603	1.0	96	53	184	26.8
				NBR	28	3.5	142	54	230	
			WB	WBL	65	26.8	152	37	213	
				WBR	93	18.7	155	37	217	
			SB	SBL	69	5.2	268	70	384	
				SBT	627	2.3	241	70	357	
3	SW Canal Boulevard	SW Veterans Way	EB	EBL	10	15.9	36	12	56	39.6
				EBT	217	28.5	257	48	335	
				EBR	138	8.8	129	39	193	
			NB	NBL	155	76.7	601	253	1019	
				NBT	323	50.6	779	180	1076	
				NBR	173	10.3	115	17	144	
			WB	WBL	157	28.8	250	35	307	
				WBT	328	30.9	229	31	280	
				WBR	159	11.0	151	26	194	
			SB	SBL	172	73.7	189	22	226	
				SBT	352	55.9	665	97	826	
				SBR	18	50.1	691	97	852	
4	SW Yew Avenue	US 97 SB Ramps	EB	EBT	258	11.7	231	85	371	12.3
				EBR	293	11.4	175	26	218	
			WB	WBL	422	10.3	421	110	602	
				WBT	634	8.4	348	237	739	
			SB	SBL	129	33.6	185	27	230	
				SBR	148	18.4	160	49	240	
5	SW Yew Avenue	US 97 NB Ramps	EB	EBL	150	14.8	135	22	171	27.2
				EBT	237	3.8	118	24	157	
			NB	NBL	392	61.1	1307	1099	3121	
				NBR	284	32.1	203	71	320	
			WB	WBR	189	6.6	132	14	155	
				WBT	661	22.3	659	181	959	
12	SW Yew Avenue	SW Canal Boulevard	EB	EBL	11	3.5	145	23	182	180.1
				EBT	292	3.8	145	23	182	
				EBR	82	4.0	145	23	182	
			NB	NBL	173	58.3	868	97	1027	
				NBT	284	58.0	868	97	1027	
				NBR	148	56.4	868	97	1027	
			WB	WBL	82	65.4	1287	203	1622	
				WBT	527	65.9	1287	203	1622	
				WBR	165	65.7	1287	203	1622	
			SB	SBL	110	178.1	898	14	921	
				SBT	203	180.1	898	14	921	
				SBR	25	179.9	898	14	921	

2040 Build - PM Peak

Node #	Primary Road	Secondary Road	Approach	Movement	Movement					Intersection
					Served Volume (vph)	Vehicle Delay (sec)	Max Queue (ft)	Standard Deviation (ft)	95th Percentile Queue	Vehicle Delay (sec)
1	SW Highland Avenue	SW 6th Street	EB	EBT	849	11.2	262	35	319	**10.8**
				EBR	49	5.3	54	23	92	
			SB	SBL	159	5.8	93	21	128	
				SBT	485	12.1	131	33	185	
2	SW Highland Avenue	SW 5th Street	EB	EBL	355	3.6	175	42	245	**8.7**
				EBT	654	5.1	175	42	245	
			NB	NBT	352	19.1	167	16	193	
				NBR	56	17.3	186	16	213	
10	SW Glacier Avenue	SW 6th Street	SB	SBT	607	14.4	357	58	453	**15.1**
				SBR	422	15.0	375	58	471	
			WB	WBL	38	12.4	211	38	274	
				WBT	402	16.4	206	38	269	
9	SW Glacier Avenue	SW 5th Street	WB	WBT	383	5.8	130	23	168	**21.6**
				WBR	257	21.4	427	63	532	
			NB	NBL	58	30.5	347	35	405	
				NBT	649	30.2	347	35	405	
8	US 97	SW Highland Ave/SW Glacier Ave	EB	EBL	492	72.0	401	36	460	**23.4**
				EBR	215	12.2	191	30	241	
			NB	NBU	11	63.8	442	62	544	
				NBL	315	69.0	442	62	544	
				NBT	1506	3.9	151	84	289	
			SB	SBT	1268	20.4	789	153	1041	
				SBR	327	13.2	244	42	313	
7	US 97	SW Veterans Way	EB	EBL	71	33.6	114	28	161	**55.1**
				EBT	143	59.3	306	79	435	
				EBR	159	11.0	327	79	457	
			NB	NBU	57	75.0	314	49	395	
				NBL	114	69.5	314	49	395	
				NBT	1554	49.8	1487	53	1574	
				NBR	162	50.9	1516	53	1603	
			WB	WBL	291	71.4	1191	323	1723	
				WBT	300	67.4	905	277	1362	
				WBR	211	53.5	931	277	1388	
			SB	SBU	30	76.0	234	37	295	
				SBL	79	71.7	234	37	295	
				SBT	1237	57.7	974	75	1098	
				SBR	89	59.7	1001	75	1125	
14	US 97	SE Pumice Avenue	EB	EBL	0	0.0	0	0	0	**13.1**
				EBT	5	39.6	55	17	83	
				EBR	30	10.4	77	14	100	
			WB	WBL	9	37.9	33	11	51	
				WBT	4	42.5	87	34	143	
				WBR	78	17.0	113	34	169	
			NB	NBU	0	0.0	97	21	131	
				NBL	46	28.3	97	21	131	
				NBT	1805	8.0	599	117	791	
				NBR	32	6.7	609	117	802	
			SB	SBU	11	36.9	93	13	114	
				SBL		35.7	93	13	114	
				SBT	1481	15.8	939	63	1044	
				SBR	245	25.1	979	63	1083	
16	US 97	SW Quartz Avenue	EB	EBL	20	61.8	68	16	94	**16.7**
				EBT	4	0.8	74	16	100	
				EBR	150	9.4	109	16	135	
			WB	WBL	28	68.4	81	19	112	
				WBT	2	85.2	129	32	181	
				WBR	106	17.7	147	32	199	
			NB	NBU	26	69.4	503	147	745	
				NBL	234	70.3	503	147	745	
				NBT	1757	8.9	903	262	1335	
				NBR	64	9.3	903	262	1335	
			SB	SBU	3	82.6	109	26	151	
				SBL	33	67.1	109	26	151	
				SBT	1358	13.9	622	66	730	
				SBR	138	20.3	646	66	754	
100	US 97	SW Reinmon Avenue	EB	EBL	12	35.0	46	9	61	**17.8**
				EBT	2	37.9	81	27	126	
				EBR	98	9.7	98	27	142	
			WB	WBL	7	38.0	34	13	56	
				WBT	6	41.5	44	13	66	
				WBR	14	16.6	77	16	103	
			NB	NBU	0	0.0	121	32	174	
				NBL	63	46.6	121	32	174	
				NBT	1992	18.4	1162	129	1376	
				NBR	0	0.0	1162	129	1376	
			SB	SBU	65	42.8	121	24	160	
				SBL	7	35.0	121	24	160	
				SBT	1405	14.1	839	237	1230	
				SBR	113	23.2	880	237	1271	
6	US 97	SW Odem Medo Way	EB	EBL	291	71.9	493	115	682	**30.4**
				EBT	15	67.8	493	115	682	
				EBR	111	23.0	115	33	170	
			NB	NBL	323	41.1	534	334	1086	
				NBT	1782	21.7	1322	249	1733	
				NBR	54	26.0	1322	249	1733	
			WB	WBL	54	74.8	137	25	177	
				WBT	26	68.3	115	14	139	
				WBR	32	30.3	122	14	146	
			SB	SBU	41	75.9	157	39	221	
				SBL	13	72.2	157	39	221	
				SBT	1347	27.6	1064	108	1242	
				SBR	73	10.9	65	30	114	

13	US 97	SW Wickiup Avenue	EB	EBL	108	71.0	243	56	335	12.0
				EBT	6	52.5	77	26	119	
				EBR	43	14.0	98	26	140	
			NB	NBL	23	13.8	40	16	65	
				NBT	1986	10.7	884	164	1154	
				NBR	18	10.7	892	164	1162	
			WB	WBL	37	64.7	109	32	163	
				WBT	11	62.4	110	32	164	
				WBR	44	21.8	134	37	195	
			SB	SBL	32	64.0	109	28	155	
				SBT	1349	5.7	317	31	369	
				SBR	69	6.1	330	35	388	
101	SW Canal Boulevard	SW Wickiup Avenue	WB	WBL	57	12.8	70	22	107	15.6
				WBR	50	7.5	64	27	108	
			NB	NBL	344	11.9	170	42	239	
				NBT	100	15.6	170	42	239	
			SB	SBL	58	8.4	167	201	498	
				SBT	386	7.2	167	201	498	
11	SW Canal Boulevard	SW Odem Medo Way	NB	NBT	255	31.6	264	37	325	22.1
				NBR	87	8.8	81	24	121	
			WB	WBL	43	18.9	71	14	94	
				WBR	422	16.6	316	87	460	
			SB	SBL	212	31.3	163	10	180	
				SBT	413	20.3	362	110	544	
103	SW Canal Boulevard	SW Reinmon Avenue	WB	WBL	91	8.9	117	27	161	19.9
				WBR	90	3.8	117	27	161	
			NB	NBT	407	14.8	290	67	401	
				NBR	12	19.9	290	67	401	
			SB	SBL	100	9.1	178	32	230	
				SBT	442	7.4	178	32	230	
17	SW Canal Boulevard	SW Quartz Avenue	EB	EBL	35	19.2	158	40	224	32.2
				EBT	73	17.6	158	40	224	
				EBR	39	15.4	158	40	225	
			WB	WBL	72	28.5	484	79	615	
				WBT	80	32.2	484	79	615	
				WBR	219	27.9	484	79	615	
			NB	NBL	108	17.7	384	113	570	
				NBT	413	18.8	384	113	570	
				NBR	67	26.7	384	113	570	
			SB	SBL	34	34.3	760	43	831	
				SBT	608	27.4	760	43	831	
				SBR	39	28.3	760	43	831	
15	SW Canal Boulevard	SE Pumice Avenue	NB	NBT	608	4.1	208	185	514	14.0
				NBR	14	2.4	208	185	514	
			WB	WBL	83	14.0	243	63	347	
				WBR	213	12.1	243	63	347	
			SB	SBL	22	14.3	453	122	654	
				SBT	570	12.4	453	122	654	
3	SW Canal Boulevard	SW Veterans Way	EB	EBL	20	18.4	42	16	69	46.7
				EBT	180	24.5	213	47	291	
				EBR	156	8.0	125	23	164	
			NB	NBL	212	86.9	971	324	1506	
				NBT	403	51.7	870	152	1121	
				NBR	82	32.4	74	19	106	
			WB	WBL	29	13.8	41	13	63	
				WBT	328	49.6	283	34	339	
				WBR	147	12.5	153	31	205	
			SB	SBL	111	72.3	151	11	169	
				SBT	404	54.8	731	88	876	
				SBR	30	48.4	757	88	902	
5	SW Yew Avenue	US 97 SB Ramps	EB	EBT	262	15.3	361	121	561	17.2
				EBR	253	22.7	325	112	511	
			WB	WBL	563	15.9	614	11	631	
				WBT	724	11.7	566	113	753	
			SB	SBL	68	57.0	160	44	233	
				SBR	67	33.8	105	27	149	
4	SW Yew Avenue	US 97 NB Ramps	EB	EBL	53	35.6	89	29	137	62.9
				EBT	275	16.6	375	127	585	
			NB	NBL	383	62.2	1198	263	1633	
				NBR	322	26.8	274	184	577	
			WB	WBR	89	64.3	97	15	121	
				WBT	904	92.2	1861	95	2019	
12	SW Yew Avenue	SW Canal Boulevard	EB	EBL	32	8.8	276	76	402	248.8
				EBT	278	9.0	276	76	402	
				EBR	99	9.0	276	76	402	
			NB	NBL	171	20.3	604	129	816	
				NBT	244	20.9	604	129	816	
				NBR	167	19.7	604	129	816	
			WB	WBL	117	79.9	1445	63	1549	
				WBT	494	83.9	1445	63	1549	
				WBR	162	83.8	1445	63	1549	
			SB	SBL	71	248.8	1771	538	2660	
				SBT	212	242.4	1771	538	2660	
				SBR	54	245.7	1771	538	2660	

Attachment G. Future Synchro HCM Reports

Movement	EBL	EBR	NBL	NBT	SBT	SBR	SBR2	SEL	SER
Lane Configurations									
Traffic Volume (vph)	490	275	450	1695	1320	0	330	0	0
Future Volume (vph)	490	275	450	1695	1320	0	330	0	0
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	4.0	3.5	4.5	5.5	5.5		4.0		
Lane Util. Factor	0.97	1.00	0.97	0.95	0.95		1.00		
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		0.46		
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00		
Frt	1.00	0.85	1.00	1.00	1.00		0.85		
Flt Protected	0.95	1.00	0.95	1.00	1.00		1.00		
Satd. Flow (prot)	3221	1485	3159	3257	3167		650		
Flt Permitted	0.95	1.00	0.95	1.00	1.00		1.00		
Satd. Flow (perm)	3221	1485	3159	3257	3167		650		
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	516	289	474	1784	1389	0	347	0	0
RTOR Reduction (vph)	0	22	0	0	0	0	154	0	0
Lane Group Flow (vph)	516	267	474	1784	1389	0	193	0	0
Confl. Peds. (#/hr)							919		
Heavy Vehicles (%)	3%	3%	5%	5%	8%	8%	8%	2%	0%
Turn Type	Prot	custom	Prot	NA	NA		Perm		
Protected Phases	8	8	1	6	2				
Permitted Phases		1					2		
Actuated Green, G (s)	25.5	54.0	28.5	115.0	82.0		82.0		
Effective Green, g (s)	25.5	55.0	28.5	115.0	82.0		83.5		
Actuated g/C Ratio	0.17	0.37	0.19	0.77	0.55		0.56		
Clearance Time (s)	4.0	4.0	4.5	5.5	5.5		5.5		
Vehicle Extension (s)	3.0	3.0	0.2	1.0	1.0		1.0		
Lane Grp Cap (vph)	547	544	600	2497	1731		361		
v/s Ratio Prot	c0.16	0.08	c0.15	0.55	c0.44				
v/s Ratio Perm		0.09					0.30		
v/c Ratio	0.94	0.49	0.79	0.71	0.80		0.54		
Uniform Delay, d1	61.5	36.7	57.9	9.0	27.5		21.0		
Progression Factor	0.68	0.61	0.68	0.34	1.00		1.00		
Incremental Delay, d2	23.5	0.6	0.6	0.2	4.0		5.6		
Delay (s)	65.6	23.1	40.1	3.3	31.5		26.6		
Level of Service	E	C	D	A	C		C		
Approach Delay (s)	50.3			11.0	30.5			0.0	
Approach LOS	D			B	C			A	

Intersection Summary			
HCM 2000 Control Delay	24.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	78.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	80	150	185	330	400	295	270	1795	160	85	1400	60
Future Volume (vph)	80	150	185	330	400	295	270	1795	160	85	1400	60
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.94		1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1676	1765	1500	1676	3139		1629	3217		1598	3177	
Flt Permitted	0.22	1.00	1.00	0.28	1.00		0.07	1.00		0.07	1.00	
Satd. Flow (perm)	394	1765	1500	486	3139		114	3217		112	3177	
Peak-hour factor, PHF	0.95	0.95	0.95	0.92	0.92	0.92	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	84	158	195	359	435	321	284	1889	168	89	1474	63
RTOR Reduction (vph)	0	0	172	0	83	0	0	4	0	0	2	0
Lane Group Flow (vph)	84	158	23	359	673	0	284	2053	0	89	1535	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	5%	5%	5%	7%	7%	7%
Turn Type	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	3	8		7	4		1	6		5	2	
Permitted Phases	8		8	4			6			2		
Actuated Green, G (s)	26.0	17.4	17.4	48.0	34.9		84.0	84.0		64.5	64.5	
Effective Green, g (s)	27.0	17.9	17.9	48.5	35.4		84.5	84.5		65.0	65.0	
Actuated g/C Ratio	0.18	0.12	0.12	0.32	0.24		0.56	0.56		0.43	0.43	
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5		4.5	4.5		4.5	4.5	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	148	210	179	368	740		311	1812		98	1376	
v/s Ratio Prot	0.03	0.09		c0.17	0.21		0.15	c0.64		0.03	c0.48	
v/s Ratio Perm	0.07		0.02	c0.14			0.36			0.36		
v/c Ratio	0.57	0.75	0.13	0.98	0.91		0.91	1.13		0.91	1.12	
Uniform Delay, d1	53.5	63.9	59.1	45.0	55.7		48.9	32.8		69.1	42.5	
Progression Factor	0.58	0.67	1.40	1.00	1.00		1.05	0.72		1.00	0.94	
Incremental Delay, d2	4.8	13.9	0.3	40.0	15.0		15.9	63.3		46.4	59.1	
Delay (s)	35.8	56.6	82.8	85.0	70.7		67.1	87.0		115.6	99.0	
Level of Service	D	E	F	F	E		E	F		F	F	
Approach Delay (s)		64.3			75.3			84.6			99.9	
Approach LOS		E			E			F			F	

Intersection Summary			
HCM 2000 Control Delay	85.6	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.12		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	103.7%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	205	155	70	2115	1885	10
Future Volume (vph)	205	155	70	2115	1885	10
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800
Total Lost time (s)	4.0		4.0	4.0	4.0	
Lane Util. Factor	1.00		1.00	0.95	0.95	
Frt	0.94		1.00	1.00	1.00	
Flt Protected	0.97		0.95	1.00	1.00	
Satd. Flow (prot)	1649		1710	3420	3417	
Flt Permitted	0.97		0.04	1.00	1.00	
Satd. Flow (perm)	1649		72	3420	3417	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	216	163	74	2226	1984	11
RTOR Reduction (vph)	18	0	0	0	0	0
Lane Group Flow (vph)	361	0	74	2226	1995	0
Turn Type	Prot		pm+pt	NA	NA	
Protected Phases	8		1	6	2	
Permitted Phases			6			
Actuated Green, G (s)	34.0		107.0	107.0	95.0	
Effective Green, g (s)	34.5		107.5	107.5	95.5	
Actuated g/C Ratio	0.23		0.72	0.72	0.64	
Clearance Time (s)	4.5		4.5	4.5	4.5	
Vehicle Extension (s)	2.5		2.5	2.5	2.5	
Lane Grp Cap (vph)	379		138	2451	2175	
v/s Ratio Prot	c0.22		0.03	c0.65	0.58	
v/s Ratio Perm			0.35			
v/c Ratio	0.95		0.54	0.91	0.92	
Uniform Delay, d1	56.9		54.7	17.2	23.8	
Progression Factor	0.90		0.59	0.55	0.75	
Incremental Delay, d2	30.0		1.4	3.1	2.0	
Delay (s)	81.4		33.6	12.6	19.8	
Level of Service	F		C	B	B	
Approach Delay (s)	81.4			13.3	19.8	
Approach LOS	F			B	B	

Intersection Summary			
HCM 2000 Control Delay	21.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	90.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	230	20	190	20	35	20	280	1845	20	15	1650	310
Future Volume (vph)	230	20	190	20	35	20	280	1845	20	15	1650	310
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.94		1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1593	1676	1500	1710	1701		1644	3283		1613	3226	1443
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.06	1.00		0.06	1.00	1.00
Satd. Flow (perm)	1593	1676	1500	1710	1701		106	3283		104	3226	1443
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	250	22	207	22	38	22	295	1942	21	16	1737	326
RTOR Reduction (vph)	0	0	162	0	16	0	0	0	0	0	0	131
Lane Group Flow (vph)	250	22	45	22	44	0	295	1963	0	16	1737	195
Heavy Vehicles (%)	2%	2%	2%	0%	0%	0%	4%	4%	4%	6%	6%	6%
Turn Type	Split	NA	Perm	Split	NA		pm+pt	NA		pm+pt	NA	Perm
Protected Phases	8	8		4	4		1	6		5	2	
Permitted Phases			8				6			2		2
Actuated Green, G (s)	31.8	31.8	31.8	7.5	7.5		90.9	90.9		67.1	67.1	67.1
Effective Green, g (s)	32.3	32.3	32.3	8.0	8.0		91.4	91.4		67.6	67.6	67.6
Actuated g/C Ratio	0.22	0.22	0.22	0.05	0.05		0.61	0.61		0.45	0.45	0.45
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5		4.5	4.5		4.5	4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	343	360	323	91	90		332	2000		70	1453	650
v/s Ratio Prot	c0.16	0.01		0.01	c0.03		0.15	c0.60		0.00	c0.54	
v/s Ratio Perm			0.03				0.39			0.10		0.13
v/c Ratio	0.73	0.06	0.14	0.24	0.49		0.89	0.98		0.23	1.20	0.30
Uniform Delay, d1	54.8	46.8	47.6	68.1	69.0		49.0	28.5		56.7	41.2	26.2
Progression Factor	0.77	0.76	1.15	1.00	1.00		1.00	1.00		1.16	0.89	1.63
Incremental Delay, d2	4.9	0.0	0.1	1.4	4.1		23.7	16.2		0.6	90.8	0.5
Delay (s)	47.0	35.6	55.0	69.5	73.1		72.8	44.6		66.2	127.5	43.2
Level of Service	D	D	E	E	E		E	D		E	F	D
Approach Delay (s)		49.9			72.1			48.3			113.8	
Approach LOS		D			E			D			F	

Intersection Summary			
HCM 2000 Control Delay	76.7	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	88.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	120	235	0	0	675	140	400	0	310	0	0	0
Future Volume (vph)	120	235	0	0	675	140	400	0	310	0	0	0
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	4.0	4.0			4.0	4.0	4.0	4.0				
Lane Util. Factor	1.00	1.00			1.00	1.00	1.00	1.00				
Frt	1.00	1.00			1.00	0.85	1.00	0.85				
Flt Protected	0.95	1.00			1.00	1.00	0.95	1.00				
Satd. Flow (prot)	1676	1765			1748	1485	1676	1500				
Flt Permitted	0.13	1.00			1.00	1.00	0.95	1.00				
Satd. Flow (perm)	230	1765			1748	1485	1676	1500				
Peak-hour factor, PHF	0.95	0.95	0.95	0.92	0.92	0.92	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	247	0	0	734	152	421	0	326	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	61	0	237	0	0	0	0
Lane Group Flow (vph)	126	247	0	0	734	91	421	89	0	0	0	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA			NA	Perm	Perm	NA				
Protected Phases	5	2			6			8				
Permitted Phases	2					6	8					
Actuated Green, G (s)	49.6	49.6			38.3	38.3	21.4	21.4				
Effective Green, g (s)	50.1	50.1			38.8	38.8	21.9	21.9				
Actuated g/C Ratio	0.63	0.63			0.48	0.48	0.27	0.27				
Clearance Time (s)	4.5	4.5			4.5	4.5	4.5	4.5				
Vehicle Extension (s)	3.0	3.0			3.0	3.0	3.0	3.0				
Lane Grp Cap (vph)	275	1105			847	720	458	410				
v/s Ratio Prot	c0.04	0.14			c0.42			0.06				
v/s Ratio Perm	0.24					0.06	c0.25					
v/c Ratio	0.46	0.22			0.87	0.13	0.92	0.22				
Uniform Delay, d1	12.2	6.5			18.3	11.3	28.2	22.4				
Progression Factor	1.35	1.04			1.00	1.00	1.00	1.00				
Incremental Delay, d2	1.2	0.5			11.6	0.4	23.3	0.3				
Delay (s)	17.7	7.2			29.9	11.7	51.5	22.7				
Level of Service	B	A			C	B	D	C				
Approach Delay (s)		10.8			26.8			38.9			0.0	
Approach LOS		B			C			D			A	

Intersection Summary			
HCM 2000 Control Delay	28.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	77.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	235	250	330	745	0	0	0	0	120	5	170
Future Volume (vph)	0	235	250	330	745	0	0	0	0	120	5	170
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)		4.0	4.0	4.0	4.0						4.0	4.0
Lane Util. Factor		1.00	1.00	1.00	1.00						1.00	1.00
Frt		1.00	0.85	1.00	1.00						1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00						0.95	1.00
Satd. Flow (prot)		1731	1471	1676	1765						1700	1515
Flt Permitted		1.00	1.00	0.53	1.00						0.95	1.00
Satd. Flow (perm)		1731	1471	942	1765						1700	1515
Peak-hour factor, PHF	0.95	0.95	0.95	0.92	0.92	0.92	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	247	263	359	810	0	0	0	0	126	5	179
RTOR Reduction (vph)	0	0	94	0	0	0	0	0	0	0	0	152
Lane Group Flow (vph)	0	247	169	359	810	0	0	0	0	0	131	27
Heavy Vehicles (%)	4%	4%	4%	2%	2%	2%	2%	2%	2%	1%	1%	1%
Turn Type		NA	Perm	pm+pt	NA					Perm	NA	Perm
Protected Phases		2		1	6						8	
Permitted Phases			2	6						8		8
Actuated Green, G (s)		43.6	43.6	59.5	59.5						11.5	11.5
Effective Green, g (s)		44.1	44.1	60.0	60.0						12.0	12.0
Actuated g/C Ratio		0.55	0.55	0.75	0.75						0.15	0.15
Clearance Time (s)		4.5	4.5	4.5	4.5						4.5	4.5
Vehicle Extension (s)		3.0	3.0	3.0	3.0						3.0	3.0
Lane Grp Cap (vph)		954	810	815	1323						255	227
v/s Ratio Prot		0.14		0.07	c0.46							
v/s Ratio Perm			0.12	0.26							0.08	0.02
v/c Ratio		0.26	0.21	0.44	0.61						0.51	0.12
Uniform Delay, d1		9.4	9.1	3.5	4.6						31.3	29.4
Progression Factor		1.00	1.00	0.19	0.27						1.00	1.00
Incremental Delay, d2		0.7	0.6	0.2	1.1						1.7	0.2
Delay (s)		10.1	9.7	0.9	2.3						33.1	29.7
Level of Service		B	A	A	A						C	C
Approach Delay (s)		9.9			1.9			0.0			31.1	
Approach LOS		A			A			A			C	

Intersection Summary			
HCM 2000 Control Delay	8.5	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	77.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	25	0	60	0	0	15	125	2190	5	10	1850	20
Future Volume (Veh/h)	25	0	60	0	0	15	125	2190	5	10	1850	20
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	27	0	65	0	0	16	132	2305	5	11	1947	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			TWLTL	
Median storage veh)											2	
Upstream signal (ft)								727				
pX, platoon unblocked	0.31	0.31		0.31	0.31	0.31				0.31		
vC, conflicting volume	3412	4554	984	3632	4562	1155	1968			2310		
vC1, stage 1 conf vol	1980	1980		2572	2572							
vC2, stage 2 conf vol	1432	2574		1060	1990							
vCu, unblocked vol	4347	8081	984	5067	8107	0	1968			743		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.2			4.2		
tC, 2 stage (s)	6.5	5.5		6.5	5.5							
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.3		
p0 queue free %	49	100	74	100	100	95	53			96		
cM capacity (veh/h)	53	15	248	16	0	334	284			255		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	92	16	132	1537	773	984	994
Volume Left	27	0	132	0	0	11	0
Volume Right	65	16	0	0	5	0	21
cSH	119	334	284	1700	1700	255	1700
Volume to Capacity	0.77	0.05	0.47	0.90	0.45	0.04	0.58
Queue Length 95th (ft)	110	4	58	0	0	3	0
Control Delay (s)	98.5	16.3	28.3	0.0	0.0	2.2	0.0
Lane LOS	F	C	D			A	
Approach Delay (s)	98.5	16.3	1.5			1.1	
Approach LOS	F	C					

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	128.3%	ICU Level of Service	H
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	105	15	0	25	30	2120	20	20	1805	50
Future Volume (Veh/h)	0	0	105	15	0	25	30	2120	20	20	1805	50
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	0	114	16	0	27	32	2232	21	21	1900	53
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	3176	4286	976	3412	4302	1126	1953			2253		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	3176	4286	976	3412	4302	1126	1953			2253		
tC, single (s)	7.5	6.5	6.9	7.6	6.6	7.0	4.2			4.2		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.3		
p0 queue free %	100	100	55	0	100	86	89			90		
cM capacity (veh/h)	3	2	254	1	1	194	288			212		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	114	43	32	1488	765	21	1267	686
Volume Left	0	16	32	0	0	21	0	0
Volume Right	114	27	0	0	21	0	0	53
cSH	254	3	288	1700	1700	212	1700	1700
Volume to Capacity	0.45	13.18	0.11	0.88	0.45	0.10	0.75	0.40
Queue Length 95th (ft)	54	Err	9	0	0	8	0	0
Control Delay (s)	30.2	Err	19.1	0.0	0.0	23.8	0.0	0.0
Lane LOS	D	F	C			C		
Approach Delay (s)	30.2	Err	0.3			0.3		
Approach LOS	D	F						

Intersection Summary			
Average Delay	98.4		
Intersection Capacity Utilization	78.4%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBR	NBU	NBL	NBT	SBT	SBR	SBR2	SEL	SER
Lane Configurations										
Traffic Volume (vph)	495	225	11	330	1510	1275	0	325	0	0
Future Volume (vph)	495	225	11	330	1510	1275	0	325	0	0
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	4.0	3.5		4.5	5.5	5.5		4.0		
Lane Util. Factor	0.97	1.00		0.97	0.95	0.95		1.00		
Frpb, ped/bikes	1.00	1.00		1.00	1.00	1.00		0.46		
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00		1.00		
Frt	1.00	0.85		1.00	1.00	1.00		0.85		
Flt Protected	0.95	1.00		0.95	1.00	1.00		1.00		
Satd. Flow (prot)	3221	1485		3159	3257	3167		650		
Flt Permitted	0.95	1.00		0.95	1.00	1.00		1.00		
Satd. Flow (perm)	3221	1485		3159	3257	3167		650		
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	521	237	12	347	1589	1342	0	342	0	0
RTOR Reduction (vph)	0	14	0	0	0	0	0	158	0	0
Lane Group Flow (vph)	521	223	0	359	1589	1342	0	184	0	0
Confl. Peds. (#/hr)								919		
Heavy Vehicles (%)	3%	3%	5%	5%	5%	8%	8%	8%	2%	0%
Turn Type	Prot	custom	Prot	Prot	NA	NA		Perm		
Protected Phases	8	8	1	1	6	2				
Permitted Phases		1						2		
Actuated Green, G (s)	28.4	56.9		28.5	112.1	79.1		79.1		
Effective Green, g (s)	28.4	57.9		28.5	112.1	79.1		80.6		
Actuated g/C Ratio	0.19	0.39		0.19	0.75	0.53		0.54		
Clearance Time (s)	4.0	4.0		4.5	5.5	5.5		5.5		
Vehicle Extension (s)	3.0	3.0		0.2	1.0	1.0		1.0		
Lane Grp Cap (vph)	609	573		600	2434	1670		349		
v/s Ratio Prot	c0.16	0.07		0.11	c0.49	c0.42				
v/s Ratio Perm		0.08						0.28		
v/c Ratio	0.86	0.39		0.60	0.65	0.80		0.53		
Uniform Delay, d1	58.8	33.3		55.5	9.3	29.1		22.4		
Progression Factor	0.68	0.60		1.02	0.65	1.00		1.00		
Incremental Delay, d2	10.6	0.4		0.3	0.4	4.2		5.6		
Delay (s)	50.6	20.4		56.9	6.5	33.3		28.0		
Level of Service	D	C		E	A	C		C		
Approach Delay (s)	41.1				15.8	32.2			0.0	
Approach LOS	D				B	C			A	

Intersection Summary			
HCM 2000 Control Delay	26.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	74.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL
Lane Configurations												
Traffic Volume (vph)	75	140	165	330	385	210	50	105	1550	165	30	80
Future Volume (vph)	75	140	165	330	385	210	50	105	1550	165	30	80
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0			4.0	4.0			4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95			1.00	0.95			1.00
Frt	1.00	1.00	0.85	1.00	0.95			1.00	0.99			1.00
Flt Protected	0.95	1.00	1.00	0.95	1.00			0.95	1.00			0.95
Satd. Flow (prot)	1676	1765	1500	1676	3175			1644	3210			1619
Flt Permitted	0.23	1.00	1.00	0.29	1.00			0.95	1.00			0.95
Satd. Flow (perm)	410	1765	1500	519	3175			1644	3210			1619
Peak-hour factor, PHF	0.95	0.95	0.95	0.92	0.92	0.92	0.94	0.95	0.95	0.95	0.94	0.95
Adj. Flow (vph)	79	147	174	359	418	228	53	111	1632	174	32	84
RTOR Reduction (vph)	0	0	126	0	51	0	0	0	5	0	0	0
Lane Group Flow (vph)	79	147	48	359	595	0	0	164	1801	0	0	116
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	5%	5%	5%	2%	7%
Turn Type	pm+pt	NA	Perm	pm+pt	NA		Prot	Prot	NA		Prot	Prot
Protected Phases	3	8		7	4		1	1	6		5	5
Permitted Phases	8		8	4								
Actuated Green, G (s)	22.7	16.7	16.7	41.9	31.4			16.2	81.1			13.5
Effective Green, g (s)	23.7	17.2	17.2	42.4	31.9			16.7	81.6			14.0
Actuated g/C Ratio	0.16	0.11	0.11	0.28	0.21			0.11	0.54			0.09
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5			4.5	4.5			4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0			3.0	3.0			3.0
Lane Grp Cap (vph)	119	202	172	310	675			183	1746			151
v/s Ratio Prot	0.03	0.08		c0.16	0.19			0.10	c0.56			0.07
v/s Ratio Perm	0.08		0.03	c0.16								
v/c Ratio	0.66	0.73	0.28	1.16	0.88			0.90	1.03			0.77
Uniform Delay, d1	56.1	64.1	60.7	49.6	57.2			65.8	34.2			66.4
Progression Factor	0.61	0.70	0.83	1.00	1.00			0.84	0.69			0.94
Incremental Delay, d2	12.9	12.1	0.9	101.1	12.9			30.8	27.1			14.5
Delay (s)	47.3	57.1	51.6	150.7	70.1			86.4	50.8			76.8
Level of Service	D	E	D	F	E			F	D			E
Approach Delay (s)		52.8			98.9				53.8			
Approach LOS		D			F				D			

Intersection Summary			
HCM 2000 Control Delay	54.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.5
Intersection Capacity Utilization	97.6%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	1275	75
Future Volume (vph)	1275	75
Ideal Flow (vphpl)	1800	1800
Total Lost time (s)	4.0	
Lane Util. Factor	0.95	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3170	
Flt Permitted	1.00	
Satd. Flow (perm)	3170	
Peak-hour factor, PHF	0.95	0.95
Adj. Flow (vph)	1342	79
RTOR Reduction (vph)	3	0
Lane Group Flow (vph)	1418	0
Heavy Vehicles (%)	7%	7%
Turn Type	NA	
Protected Phases	2	
Permitted Phases		
Actuated Green, G (s)	78.4	
Effective Green, g (s)	78.9	
Actuated g/C Ratio	0.53	
Clearance Time (s)	4.5	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	1667	
v/s Ratio Prot	c0.45	
v/s Ratio Perm		
v/c Ratio	0.85	
Uniform Delay, d1	30.5	
Progression Factor	0.66	
Incremental Delay, d2	3.9	
Delay (s)	23.9	
Level of Service	C	
Approach Delay (s)	27.9	
Approach LOS	C	

Intersection Summary

Movement	EBL	EBR	NBU	NBL	NBT	SBU	SBT	SBR
Lane Configurations								
Traffic Volume (vph)	0	15	25	10	1855	46	1405	235
Future Volume (vph)	0	15	25	10	1855	46	1405	235
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)		4.0		4.0	4.0	4.0	4.0	
Lane Util. Factor		1.00		1.00	0.95	1.00	0.95	
Frt		0.86		1.00	1.00	1.00	0.98	
Flt Protected		1.00		0.95	1.00	0.95	1.00	
Satd. Flow (prot)		1526		1667	3288	1676	3157	
Flt Permitted		1.00		0.95	1.00	0.95	1.00	
Satd. Flow (perm)		1526		1667	3288	1676	3157	
Peak-hour factor, PHF	0.92	0.92	0.94	0.95	0.95	0.94	0.95	0.95
Adj. Flow (vph)	0	16	27	11	1953	49	1479	247
RTOR Reduction (vph)	0	16	0	0	0	0	5	0
Lane Group Flow (vph)	0	0	0	38	1953	49	1721	0
Heavy Vehicles (%)	2%	2%	2%	4%	4%	2%	6%	6%
Turn Type		Perm	Prot	Prot	NA	Prot	NA	
Protected Phases			1	1	6	5	2	
Permitted Phases		8						
Actuated Green, G (s)		2.4		6.5	126.5	7.6	127.6	
Effective Green, g (s)		2.9		7.0	127.0	8.1	128.1	
Actuated g/C Ratio		0.02		0.05	0.85	0.05	0.85	
Clearance Time (s)		4.5		4.5	4.5	4.5	4.5	
Vehicle Extension (s)		2.5		2.5	2.5	2.5	2.5	
Lane Grp Cap (vph)		29		77	2783	90	2696	
v/s Ratio Prot				0.02	c0.59	0.03	c0.55	
v/s Ratio Perm		c0.00						
v/c Ratio		0.01		0.49	0.70	0.54	0.64	
Uniform Delay, d1		72.1		69.8	4.3	69.2	3.5	
Progression Factor		1.00		1.17	0.25	1.07	0.74	
Incremental Delay, d2		0.1		2.1	0.9	2.4	0.5	
Delay (s)		72.2		83.5	2.0	76.5	3.1	
Level of Service		E		F	A	E	A	
Approach Delay (s)	72.2				3.5		5.2	
Approach LOS	E				A		A	

Intersection Summary			
HCM 2000 Control Delay	4.6	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	65.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBR	NBU	NBL	NBT	SBU	SBT	SBR
Lane Configurations								
Traffic Volume (vph)	275	85	60	360	1535	80	1340	20
Future Volume (vph)	275	85	60	360	1535	80	1340	20
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	4.0			4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00			1.00	0.95	1.00	0.95	
Frt	0.97			1.00	1.00	1.00	1.00	
Flt Protected	0.96			0.95	1.00	0.95	1.00	
Satd. Flow (prot)	1679			1710	3420	1710	3412	
Flt Permitted	0.96			0.95	1.00	0.95	1.00	
Satd. Flow (perm)	1679			1710	3420	1710	3412	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	289	89	63	379	1616	84	1411	21
RTOR Reduction (vph)	7	0	0	0	0	0	1	0
Lane Group Flow (vph)	371	0	0	442	1616	84	1431	0
Turn Type	Prot		Prot	Prot	NA	Prot	NA	
Protected Phases	8		1	1	6	5	2	
Permitted Phases								
Actuated Green, G (s)	33.5			39.1	85.2	17.8	63.9	
Effective Green, g (s)	34.0			39.6	85.7	18.3	64.4	
Actuated g/C Ratio	0.23			0.26	0.57	0.12	0.43	
Clearance Time (s)	4.5			4.5	4.5	4.5	4.5	
Vehicle Extension (s)	2.5			2.5	2.5	2.5	2.5	
Lane Grp Cap (vph)	380			451	1953	208	1464	
v/s Ratio Prot	c0.22			c0.26	0.47	0.05	c0.42	
v/s Ratio Perm								
v/c Ratio	0.98			0.98	0.83	0.40	0.98	
Uniform Delay, d1	57.6			54.8	26.1	60.8	42.1	
Progression Factor	1.00			0.92	0.87	0.72	0.91	
Incremental Delay, d2	39.5			30.5	3.0	0.7	16.3	
Delay (s)	97.1			81.1	25.8	44.6	54.6	
Level of Service	F			F	C	D	D	
Approach Delay (s)	97.1				37.6		54.1	
Approach LOS	F				D		D	

Intersection Summary			
HCM 2000 Control Delay	49.6	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.5
Intersection Capacity Utilization	95.9%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBU	NBL	NBT	SBU	SBT	SBR
Lane Configurations								
Traffic Volume (vph)	40	105	55	130	1855	35	1380	95
Future Volume (vph)	40	105	55	130	1855	35	1380	95
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	4.0			4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00			1.00	0.95	1.00	0.95	
Frt	0.90			1.00	1.00	1.00	0.99	
Flt Protected	0.99			0.95	1.00	0.95	1.00	
Satd. Flow (prot)	1602			1710	3420	1710	3387	
Flt Permitted	0.99			0.95	1.00	0.95	1.00	
Satd. Flow (perm)	1602			1710	3420	1710	3387	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	42	111	58	137	1953	37	1453	100
RTOR Reduction (vph)	68	0	0	0	0	0	2	0
Lane Group Flow (vph)	85	0	0	195	1953	37	1551	0
Turn Type	Perm		Prot	Prot	NA	Prot	NA	
Protected Phases			1	1	6	5	2	
Permitted Phases	8							
Actuated Green, G (s)	12.0			21.3	118.2	6.3	103.2	
Effective Green, g (s)	12.5			21.8	118.7	6.8	103.7	
Actuated g/C Ratio	0.08			0.15	0.79	0.05	0.69	
Clearance Time (s)	4.5			4.5	4.5	4.5	4.5	
Vehicle Extension (s)	2.5			2.5	2.5	2.5	2.5	
Lane Grp Cap (vph)	133			248	2706	77	2341	
v/s Ratio Prot				0.11	c0.57	0.02	c0.46	
v/s Ratio Perm	c0.05							
v/c Ratio	0.64			0.79	0.72	0.48	0.66	
Uniform Delay, d1	66.6			61.9	7.6	69.9	13.2	
Progression Factor	1.00			0.85	0.73	1.15	0.86	
Incremental Delay, d2	9.0			7.2	0.8	1.1	0.5	
Delay (s)	75.5			59.8	6.4	81.4	11.8	
Level of Service	E			E	A	F	B	
Approach Delay (s)	75.5				11.2		13.4	
Approach LOS	E				B		B	

Intersection Summary			
HCM 2000 Control Delay	14.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	78.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	140	15	95	20	35	15	260	1845	50	55	15	1360
Future Volume (vph)	140	15	95	20	35	15	260	1845	50	55	15	1360
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0			4.0	4.0
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00		1.00	0.95			1.00	0.95
Frt	1.00	1.00	0.85	1.00	0.96		1.00	1.00			1.00	1.00
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00			0.95	1.00
Satd. Flow (prot)	1593	1676	1500	1710	1720		1644	3275			1663	3226
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.11	1.00			0.95	1.00
Satd. Flow (perm)	1593	1676	1500	1710	1720		191	3275			1663	3226
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.95	0.95	0.95	0.94	0.95	0.95
Adj. Flow (vph)	152	16	103	22	38	16	274	1942	53	59	16	1432
RTOR Reduction (vph)	0	0	90	0	11	0	0	1	0	0	0	0
Lane Group Flow (vph)	152	16	13	22	43	0	274	1994	0	0	75	1432
Heavy Vehicles (%)	2%	2%	2%	0%	0%	0%	4%	4%	4%	2%	6%	6%
Turn Type	Split	NA	Perm	Split	NA		pm+pt	NA		Prot	Prot	NA
Protected Phases	8	8		4	4		1	6		5	5	2
Permitted Phases			8				6					
Actuated Green, G (s)	17.9	17.9	17.9	6.1	6.1		112.5	100.0			8.0	90.5
Effective Green, g (s)	18.4	18.4	18.4	6.6	6.6		113.0	100.5			8.5	91.0
Actuated g/C Ratio	0.12	0.12	0.12	0.04	0.04		0.75	0.67			0.06	0.61
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5		4.5	4.5			4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)	195	205	184	75	75		318	2194			94	1957
v/s Ratio Prot	c0.10	0.01		0.01	c0.02		c0.10	c0.61			0.05	0.44
v/s Ratio Perm			0.01				0.54					
v/c Ratio	0.78	0.08	0.07	0.29	0.57		0.86	0.91			0.80	0.73
Uniform Delay, d1	63.8	58.3	58.2	69.4	70.3		36.3	20.9			69.9	20.9
Progression Factor	0.74	0.68	1.82	1.00	1.00		0.72	0.65			0.89	0.71
Incremental Delay, d2	13.8	0.1	0.1	2.2	9.5		10.1	3.3			29.2	1.9
Delay (s)	61.1	40.0	105.8	71.6	79.8		36.2	16.9			91.6	16.7
Level of Service	E	D	F	E	E		D	B			F	B
Approach Delay (s)		76.8			77.4			19.2				19.7
Approach LOS		E			E			B				B

Intersection Summary			
HCM 2000 Control Delay	24.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.5
Intersection Capacity Utilization	80.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	125
Future Volume (vph)	125
Ideal Flow (vphpl)	1800
Total Lost time (s)	4.0
Lane Util. Factor	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1443
Flt Permitted	1.00
Satd. Flow (perm)	1443
Peak-hour factor, PHF	0.95
Adj. Flow (vph)	132
RTOR Reduction (vph)	45
Lane Group Flow (vph)	87
Heavy Vehicles (%)	6%
Turn Type	Perm
Protected Phases	
Permitted Phases	2
Actuated Green, G (s)	90.5
Effective Green, g (s)	91.0
Actuated g/C Ratio	0.61
Clearance Time (s)	4.5
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	875
v/s Ratio Prot	
v/s Ratio Perm	0.06
v/c Ratio	0.10
Uniform Delay, d1	12.3
Progression Factor	0.93
Incremental Delay, d2	0.2
Delay (s)	11.7
Level of Service	B
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	85	15	35	30	20	25	90	2150	10	30	1455	65
Future Volume (vph)	85	15	35	30	20	25	90	2150	10	30	1455	65
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00		1.00	0.95		1.00	0.95	
Frt		0.96			0.96		1.00	1.00		1.00	0.99	
Flt Protected		0.97			0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1684			1606		1644	3286		1613	3206	
Flt Permitted		0.70			0.83		0.11	1.00		0.04	1.00	
Satd. Flow (perm)		1218			1365		185	3286		64	3206	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	92	16	38	33	22	27	95	2263	11	32	1532	68
RTOR Reduction (vph)	0	9	0	0	12	0	0	0	0	0	2	0
Lane Group Flow (vph)	0	137	0	0	70	0	95	2274	0	32	1598	0
Heavy Vehicles (%)	0%	0%	0%	5%	5%	5%	4%	4%	4%	6%	6%	6%
Turn Type	Perm	NA		Perm	NA		pm+pt	NA		pm+pt	NA	
Protected Phases		8			4		1	6		5	2	
Permitted Phases	8			4			6			2		
Actuated Green, G (s)		18.5			18.5		112.9	112.9		111.3	111.3	
Effective Green, g (s)		19.0			19.0		113.4	113.4		111.8	111.8	
Actuated g/C Ratio		0.13			0.13		0.76	0.76		0.75	0.75	
Clearance Time (s)		4.5			4.5		4.5	4.5		4.5	4.5	
Vehicle Extension (s)		2.5			2.5		2.5	2.5		2.5	2.5	
Lane Grp Cap (vph)		154			172		209	2484		105	2389	
v/s Ratio Prot							0.02	c0.69		0.01	c0.50	
v/s Ratio Perm		c0.11			0.05		0.32			0.21		
v/c Ratio		0.89			0.41		0.45	0.92		0.30	0.67	
Uniform Delay, d1		64.5			60.3		10.5	14.5		39.6	9.7	
Progression Factor		1.00			1.00		1.00	1.00		0.46	0.38	
Incremental Delay, d2		42.3			1.1		1.1	6.7		0.9	1.2	
Delay (s)		106.8			61.4		11.7	21.2		19.3	4.8	
Level of Service		F			E		B	C		B	A	
Approach Delay (s)		106.8			61.4			20.8			5.1	
Approach LOS		F			E			C			A	

Intersection Summary			
HCM 2000 Control Delay	18.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	90.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	60	275	0	0	855	220	370	0	330	0	0	0
Future Volume (vph)	60	275	0	0	855	220	370	0	330	0	0	0
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	4.0	4.0			4.0	4.0	4.0	4.0				
Lane Util. Factor	1.00	1.00			1.00	1.00	1.00	1.00				
Frt	1.00	1.00			1.00	0.85	1.00	0.85				
Flt Protected	0.95	1.00			1.00	1.00	0.95	1.00				
Satd. Flow (prot)	1676	1765			1748	1485	1676	1500				
Flt Permitted	0.09	1.00			1.00	1.00	0.95	1.00				
Satd. Flow (perm)	152	1765			1748	1485	1676	1500				
Peak-hour factor, PHF	0.95	0.95	0.95	0.92	0.92	0.92	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	63	289	0	0	929	239	389	0	347	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	68	0	257	0	0	0	0
Lane Group Flow (vph)	63	289	0	0	929	171	389	90	0	0	0	0
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA			NA	Perm	Perm	NA				
Protected Phases	5	2			6			8				
Permitted Phases	2					6	8					
Actuated Green, G (s)	50.7	50.7			42.0	42.0	20.3	20.3				
Effective Green, g (s)	51.2	51.2			42.5	42.5	20.8	20.8				
Actuated g/C Ratio	0.64	0.64			0.53	0.53	0.26	0.26				
Clearance Time (s)	4.5	4.5			4.5	4.5	4.5	4.5				
Vehicle Extension (s)	3.0	3.0			3.0	3.0	3.0	3.0				
Lane Grp Cap (vph)	186	1129			928	788	435	390				
v/s Ratio Prot	c0.02	0.16			c0.53			0.06				
v/s Ratio Perm	0.20					0.11	c0.23					
v/c Ratio	0.34	0.26			1.00	0.22	0.89	0.23				
Uniform Delay, d1	16.0	6.2			18.8	9.9	28.5	23.3				
Progression Factor	1.00	1.10			1.00	1.00	1.00	1.00				
Incremental Delay, d2	1.1	0.5			29.8	0.6	20.2	0.3				
Delay (s)	17.0	7.4			48.6	10.6	48.8	23.6				
Level of Service	B	A			D	B	D	C				
Approach Delay (s)		9.1			40.8			36.9			0.0	
Approach LOS		A			D			D			A	

Intersection Summary			
HCM 2000 Control Delay	34.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	82.6%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	250	250	535	690	0	0	0	0	85	0	80
Future Volume (vph)	0	250	250	535	690	0	0	0	0	85	0	80
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)		4.0	4.0	4.0	4.0						4.0	4.0
Lane Util. Factor		1.00	1.00	1.00	1.00						1.00	1.00
Frt		1.00	0.85	1.00	1.00						1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00						0.95	1.00
Satd. Flow (prot)		1731	1471	1676	1765						1693	1515
Flt Permitted		1.00	1.00	0.52	1.00						0.95	1.00
Satd. Flow (perm)		1731	1471	924	1765						1693	1515
Peak-hour factor, PHF	0.95	0.95	0.95	0.92	0.92	0.92	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	263	263	582	750	0	0	0	0	89	0	84
RTOR Reduction (vph)	0	0	82	0	0	0	0	0	0	0	0	76
Lane Group Flow (vph)	0	263	181	582	750	0	0	0	0	0	89	8
Heavy Vehicles (%)	4%	4%	4%	2%	2%	2%	2%	2%	2%	1%	1%	1%
Turn Type		NA	Perm	pm+pt	NA					Perm	NA	Perm
Protected Phases		2		1	6						8	
Permitted Phases			2	6						8		8
Actuated Green, G (s)		44.4	44.4	64.1	64.1						6.9	6.9
Effective Green, g (s)		44.9	44.9	64.6	64.6						7.4	7.4
Actuated g/C Ratio		0.56	0.56	0.81	0.81						0.09	0.09
Clearance Time (s)		4.5	4.5	4.5	4.5						4.5	4.5
Vehicle Extension (s)		3.0	3.0	3.0	3.0						3.0	3.0
Lane Grp Cap (vph)		971	825	893	1425						156	140
v/s Ratio Prot		0.15		c0.13	0.43							
v/s Ratio Perm			0.12	c0.40							0.05	0.01
v/c Ratio		0.27	0.22	0.65	0.53						0.57	0.06
Uniform Delay, d1		9.1	8.8	2.8	2.6						34.8	33.1
Progression Factor		1.00	1.00	0.24	0.26						1.00	1.00
Incremental Delay, d2		0.7	0.6	0.6	0.5						5.0	0.2
Delay (s)		9.8	9.4	1.3	1.2						39.7	33.3
Level of Service		A	A	A	A						D	C
Approach Delay (s)		9.6			1.2			0.0			36.6	
Approach LOS		A			A			A			D	

Intersection Summary			
HCM 2000 Control Delay	6.4	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	82.6%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Attachment H. Future HCS Reports

HCS7 Freeway Diverge Report

Project Information

Analyst	Joe Kirkland	Date	4/19/2019
Agency	HDR	Analysis Year	2040
Jurisdiction		Time Period Analyzed	PM
Project Description	US 97 NB Diverge at Yew Avenue		

Geometric Data

	Freeway	Ramp
Number of Lanes (N)	2	1
Free-Flow Speed (FFS), mi/h	55.0	30.0
Segment Length (L) / Deceleration Length (L_D), ft	1500	235
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

Adjustment Factors

Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Volume (V_i), veh/h	1905	710
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	3.00	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.971	0.980
Flow Rate (v_i), pc/h	2087	771
Capacity (c), pc/h	3872	1839
Volume-to-Capacity Ratio (v/c)	0.54	0.42

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	20.1
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (D_S)	0.573
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/h/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	Off-Ramp Influence Area Speed (S_R), mi/h	47.0
Prop. Freeway Vehicles in Lane 1 and 2 (P_{FD})	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	2087	Ramp Junction Speed (S), mi/h	47.0
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	-	Average Density (D), pc/mi/ln	22.2
Level of Service (LOS)	C		

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HCS7 Freeway Merge Report

Project Information

Analyst	Joe Kirkland	Date	4/19/2019
Agency	HDR	Analysis Year	2040
Jurisdiction		Time Period Analyzed	PM
Project Description	US 97 NB Merge at Yew Avenue		

Geometric Data

	Freeway	Ramp
Number of Lanes (N)	2	1
Free-Flow Speed (FFS), mi/h	50.0	35.0
Segment Length (L) / Acceleration Length (L_A), ft	1500	250
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

Adjustment Factors

Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Volume (V_i), veh/h	1905	255
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.00	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.980	0.980
Flow Rate (v_i), pc/h	2068	277
Capacity (c), pc/h	3678	1936
Volume-to-Capacity Ratio (v/c)	0.64	0.14

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	22.1
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (M_S)	0.345
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/h/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	On-Ramp Influence Area Speed (S_R), mi/h	46.5
Prop. Freeway Vehicles in Lane 1 and 2 (P_{FM})	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	2068	Ramp Junction Speed (S), mi/h	46.5
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	2345	Average Density (D), pc/mi/ln	25.2
Level of Service (LOS)	C		

HCS7 Freeway Diverge Report

Project Information

Analyst	Joe Kirkland	Date	4/19/2019
Agency	HDR	Analysis Year	2040
Jurisdiction		Time Period Analyzed	PM
Project Description	US 97 SB Diverge at Yew		

Geometric Data

	Freeway	Ramp
Number of Lanes (N)	2	1
Free-Flow Speed (FFS), mi/h	50.0	30.0
Segment Length (L) / Deceleration Length (L_D), ft	1500	210
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

Adjustment Factors

Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Volume (V_i), veh/h	1615	295
Peak Hour Factor (PHF)	0.94	0.97
Total Trucks, %	2.00	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.980	0.980
Flow Rate (v_i), pc/h	1753	310
Capacity (c), pc/h	3678	1839
Volume-to-Capacity Ratio (v/c)	0.48	0.17

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	17.4
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (D_S)	0.531
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/h/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	Off-Ramp Influence Area Speed (S_R), mi/h	45.2
Prop. Freeway Vehicles in Lane 1 and 2 (P_{FD})	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	1753	Ramp Junction Speed (S), mi/h	45.2
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	-	Average Density (D), pc/mi/ln	19.4
Level of Service (LOS)	B		

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HCS7 Freeway Merge Report

Project Information

Analyst	Joe Kirkland	Date	4/19/2019
Agency	HDR	Analysis Year	2040
Jurisdiction		Time Period Analyzed	PM
Project Description	US 97 SB Merge at Yew Avenue		

Geometric Data

	Freeway	Ramp
Number of Lanes (N)	2	1
Free-Flow Speed (FFS), mi/h	55.0	35.0
Segment Length (L) / Acceleration Length (L_A), ft	1500	325
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

Adjustment Factors

Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Volume (V_i), veh/h	1615	585
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	3.00	6.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.971	0.943
Flow Rate (v_i), pc/h	1769	660
Capacity (c), pc/h	3872	1936
Volume-to-Capacity Ratio (v/c)	0.63	0.34

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	22.2
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (M_S)	0.343
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/h/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	On-Ramp Influence Area Speed (S_R), mi/h	49.6
Prop. Freeway Vehicles in Lane 1 and 2 (P_{FM})	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	1769	Ramp Junction Speed (S), mi/h	49.6
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	2429	Average Density (D), pc/mi/ln	24.5
Level of Service (LOS)	C		

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HCS7 Freeway Diverge Report

Project Information

Analyst	Joe Kirkland	Date	4/19/2019
Agency	HDR	Analysis Year	2040
Jurisdiction		Time Period Analyzed	PM
Project Description	US 97 NB Diverge at Yew Avenue		

Geometric Data

	Freeway	Ramp
Number of Lanes (N)	2	1
Free-Flow Speed (FFS), mi/h	55.0	30.0
Segment Length (L) / Deceleration Length (L_D), ft	1500	235
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

Adjustment Factors

Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Volume (V_i), veh/h	1920	700
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	3.00	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.971	0.980
Flow Rate (v_i), pc/h	2104	760
Capacity (c), pc/h	3872	1839
Volume-to-Capacity Ratio (v/c)	0.54	0.41

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	20.2
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (D_S)	0.572
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/h/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	Off-Ramp Influence Area Speed (S_R), mi/h	47.0
Prop. Freeway Vehicles in Lane 1 and 2 (P_{FD})	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	2104	Ramp Junction Speed (S), mi/h	47.0
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	-	Average Density (D), pc/mi/ln	22.4
Level of Service (LOS)	C		

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HCS7 Freeway Merge Report

Project Information

Analyst	Joe Kirkland	Date	4/19/2019
Agency	HDR	Analysis Year	2040
Jurisdiction		Time Period Analyzed	PM
Project Description	US 97 NB Merge at Yew Avenue		

Geometric Data

	Freeway	Ramp
Number of Lanes (N)	2	1
Free-Flow Speed (FFS), mi/h	50.0	35.0
Segment Length (L) / Acceleration Length (L_A), ft	1500	250
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

Adjustment Factors

Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Volume (V_i), veh/h	1920	280
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.00	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.980	0.980
Flow Rate (v_i), pc/h	2084	304
Capacity (c), pc/h	3678	1936
Volume-to-Capacity Ratio (v/c)	0.65	0.16

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	22.5
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (M_S)	0.346
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/h/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	On-Ramp Influence Area Speed (S_R), mi/h	46.4
Prop. Freeway Vehicles in Lane 1 and 2 (P_{FM})	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	2084	Ramp Junction Speed (S), mi/h	46.4
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	2388	Average Density (D), pc/mi/ln	25.7
Level of Service (LOS)	C		

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HCS7 Freeway Diverge Report

Project Information

Analyst	Joe Kirkland	Date	4/19/2019
Agency	HDR	Analysis Year	2040
Jurisdiction		Time Period Analyzed	PM
Project Description	US 97 SB Diverge at Yew		

Geometric Data

	Freeway	Ramp
Number of Lanes (N)	2	1
Free-Flow Speed (FFS), mi/h	50.0	30.0
Segment Length (L) / Deceleration Length (L_D), ft	1500	210
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

Adjustment Factors

Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Volume (V_i), veh/h	1460	165
Peak Hour Factor (PHF)	0.94	0.97
Total Trucks, %	2.00	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.980	0.980
Flow Rate (v_i), pc/h	1585	174
Capacity (c), pc/h	3678	1839
Volume-to-Capacity Ratio (v/c)	0.43	0.09

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	16.0
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (D_S)	0.519
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/h/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	Off-Ramp Influence Area Speed (S_R), mi/h	45.3
Prop. Freeway Vehicles in Lane 1 and 2 (P_{FD})	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	1585	Ramp Junction Speed (S), mi/h	45.3
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	-	Average Density (D), pc/mi/ln	17.5
Level of Service (LOS)	B		

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HCS7 Freeway Merge Report

Project Information

Analyst	Joe Kirkland	Date	4/19/2019
Agency	HDR	Analysis Year	2040
Jurisdiction		Time Period Analyzed	PM
Project Description	US 97 SB Merge at Yew Avenue		

Geometric Data

	Freeway	Ramp
Number of Lanes (N)	2	1
Free-Flow Speed (FFS), mi/h	55.0	35.0
Segment Length (L) / Acceleration Length (L_A), ft	1500	325
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

Adjustment Factors

Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Volume (V_i), veh/h	1460	785
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	3.00	6.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f_{HV})	0.971	0.943
Flow Rate (v_i), pc/h	1600	886
Capacity (c), pc/h	3872	1936
Volume-to-Capacity Ratio (v/c)	0.64	0.46

Speed and Density

Upstream Equilibrium Distance (L_{EQ}), ft	-	Density in Ramp Influence Area (D_R), pc/mi/ln	22.5
Distance to Upstream Ramp (L_{UP}), ft	-	Speed Index (M_S)	0.346
Downstream Equilibrium Distance (L_{EQ}), ft	-	Flow Outer Lanes (v_{OA}), pc/h/ln	-
Distance to Downstream Ramp (L_{DOWN}), ft	-	On-Ramp Influence Area Speed (S_R), mi/h	49.6
Prop. Freeway Vehicles in Lane 1 and 2 (P_{FM})	1.000	Outer Lanes Freeway Speed (S_O), mi/h	-
Flow in Lanes 1 and 2 (v_{12}), pc/h	1600	Ramp Junction Speed (S), mi/h	49.6
Flow Entering Ramp-Infl. Area (v_{R12}), pc/h	2486	Average Density (D), pc/mi/ln	25.1
Level of Service (LOS)	C		

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Appendix D US97 SRC Transportation Safety Evaluation Memorandum

720 SW Washington St., Suite 500
Portland, OR 97205
503.243.3500
www.dksassociates.com

TECHNICAL MEMORANDUM

DATE:	August 27, 2019
TO:	Project Team and Stakeholders
FROM:	Kamilah Buker, EIT; John Bosket, PE
SUBJECT:	US 97 Redmond South Corridor Area Facility Plan Transportation Safety Evaluation

This memorandum provides the findings of the transportation safety evaluation conducted within the study area for existing conditions and future (year 2040) conditions with and without the proposed improvements to the US 97 corridor.

EXECUTIVE SUMMARY

Key findings from the safety analysis of the study area include:

- Along the US 97 corridor, there were 214 crashes between the years 2011 and 2015.
- Crash types vary, but the majority involved rear-end, turning movements, and sideswipe crashes.
- There were three crashes resulting in fatalities, two of which were located along the segment portions of US 97 near the Yew Avenue interchange. Two of the fatalities involved pedestrians.
- There were four pedestrian and four bicycle crashes within the study area.
- Approximately 48% of crashes resulted in only property damage.
- The segments of US 97 between Evergreen Avenue and Veterans Way and between Veterans Way/Wickiup Avenue have recently experienced crash rates higher than the statewide average.
- Four of the 16 study intersections were flagged as safety focus locations, including the one top 10% SPIS site at Veterans Way. Table 1 shows which study intersections were flagged as safety focus areas and why.
- If no improvements are made within the US 97 corridor, crashes are predicted to increase from approximately 43 per year today to 76 per year by 2040.

- The proposed improvements will improve safety in the US 97 corridor. In 2040, the Build scenario is predicted to reduce crashes by 12 per year and would lessen the severity of many of the crashes that do occur.
- Key contributing factors to the predicted crash reduction and overall improvement in safety resulting from the Build scenario include:
  - the addition of a raised median island (reduces the frequency and severity of crashes and provides a pedestrian crossing refuge);
  - new signalized intersections (lessens the severity of crashes and provides for controlled pedestrian crossings); and
  - improved east-west connectivity (reduces traffic volumes on US 97).

Table 1: Intersections Flagged as Safety Focus Areas

Int. No.	Intersection Name	Reason Intersection was Flagged as Safety Focus Area			
		High Intersection Crash Rate	Overrepresentation of a Crash Type	Top 10% SPIS Site	High Segment Crash Rate
1	US 97 @ Glacier/Highland	Yes			Yes
2	US 97 @ Veterans Wy.			Yes	Yes
3	US 97 @ Pumice Ave.				Yes
4	US 97 @ Odem Medo Wy.		SS-O		Yes
5	US 97 @ Wickiup Ave.				Yes
6	US 97 SB @ Yew Ave.		Turn		
7	US 97 NB @ Yew Ave.		Angle		
8	Canal Blvd. @ Veterans Wy.		Turn		
9	Canal Blvd. @ Pumice Ave.	Yes			
10	Canal Blvd. @ Quartz Ave.				
11	Canal Blvd. @ Odem Medo Wy.				
12	Canal Blvd. @ Yew Ave.				
13	5th St. @ Highland Ave.		Angle		
14	5th St. @ Glacier Ave.		Angle		
15	6th St. @ Highland Ave.	Yes	Angle		
16	6th St. @ Glacier Ave.	Yes	Angle		

EXISTING AND FUTURE NO-BUILD ANALYSIS

The project team conducted a comprehensive safety analysis of the US 97 and adjacent Canal Boulevard corridors using crash data from 2011 to 2015 obtained from ODOT's Crash Analysis and Reporting Unit for select study segments and intersections. The following sections summarize the key findings related to crash trends and identification of high-crash locations (referenced below as safety focus areas). The crash trends will be discussed in terms of crash frequency, crash type, crash location, and crash severity.

Table 2 provides a summary of performance measures that were used for the safety analysis of existing and future No-Build conditions and those that will be used later to evaluate future conditions with proposed improvements.

Table 2: Safety Analysis Performance Measures

Performance Measures	Existing Conditions	Future (2040) No-Build	Future (2040) Build Alternative
Intersection Crash Rate Analysis			
observed crash rate (MEV)	x		
critical crash rate (MEV)	x		
statewide mean crash rate (MEV)	x		
90th percentile crash rate (MEV)	x		
excess proportion of specific crash types	x		
Highway Segment Crash Rate Analysis			
observed crash rate (MVM)	x		
statewide average crash rate (MVM)	x		
Safety Priority Index System			
ratings among top 10%	x		
Predictive Crash Analysis			
expected crash frequency (intersections)	x	x	
expected crash frequency (segments)	x	x	
net change in expected crash frequency (intersections)			x
net change in expected crash frequency (segments)			x
potential crash reduction			x

MEV = crashes per million entering vehicles
MVM = crashes per million vehicle-miles traveled

Crash Trends

Over the five-year period analyzed (2011-2015), there were 391 crashes within the study area on US 97 and Canal Boulevard. Of these, 260 occurred at intersections while the remaining 131 crashes occurred along the segment portions of US 97 and Canal Boulevard. Crashes in the study corridor are mapped in Figures 1, 2, and 3. Breakdowns of crash types and severities on US 97 are provided in Figures 4 and 5.

Figure 1: Study Corridor Crashes (2011-2015): North Area

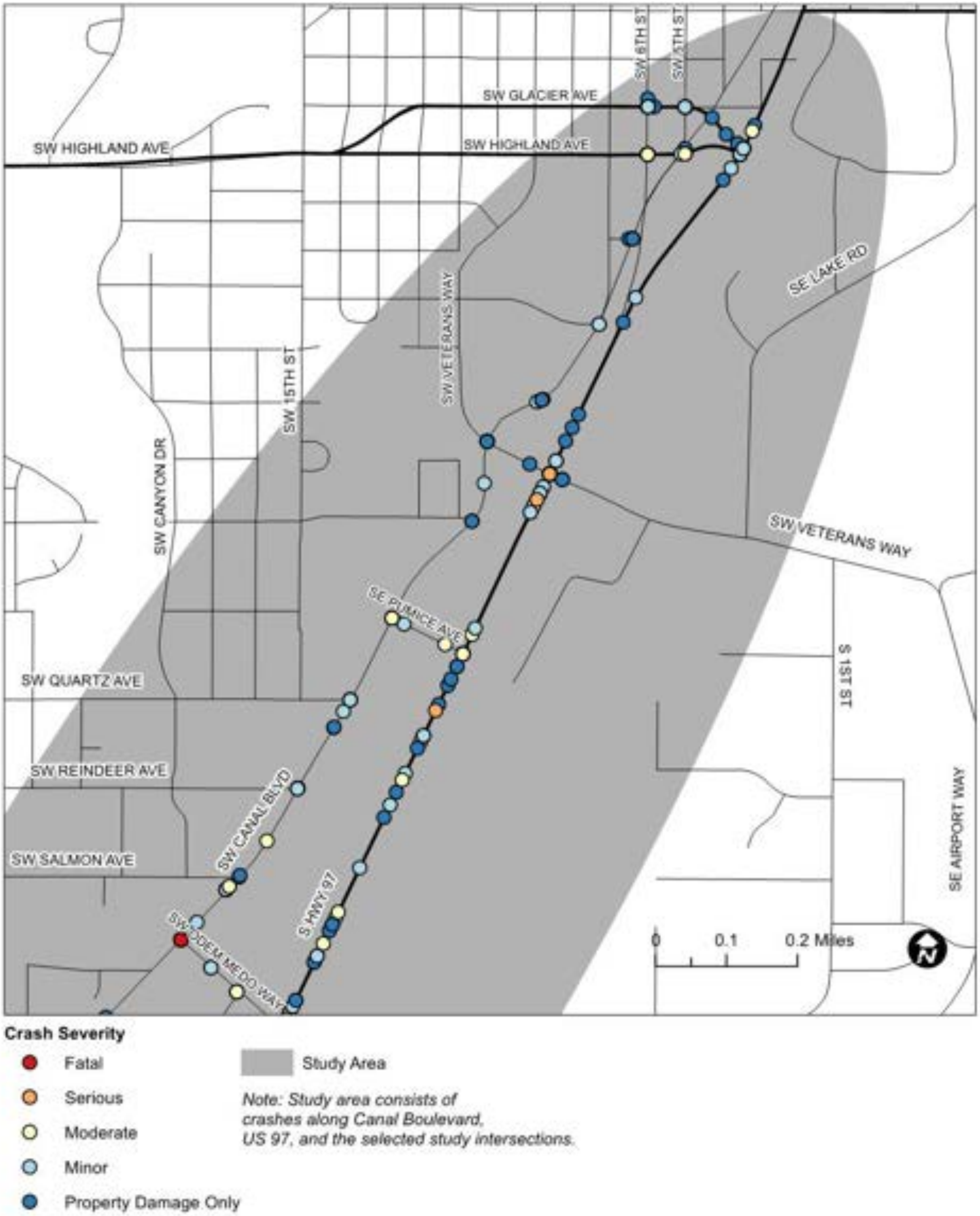


Figure 2: Study Corridor Crashes (2011-2015): South Area

Figure 3: Study Corridor Crashes Involving People Walking and Biking (2011-2015)

Along the US 97 corridor, there were 214 crashes. Crash types vary, but the majority involved rear-end, turning movements, and sideswipe crashes. More than half of the rear-end collisions were caused by the driver following too closely, while approximately a third were due to careless driving and the driver failing to avoid the vehicle ahead. Just over half of the turning movement collisions were caused by the driver failing to yield the right-of-way. The remaining turning movement collisions were due to the driver disregarding the traffic signal and performing improper-turns. Most of the sideswipe collisions (64%) were caused by the driver performing improper lane changes. Of the 214 collisions, 12 were classified as driveway-related and 22 were classified as intersection-related.

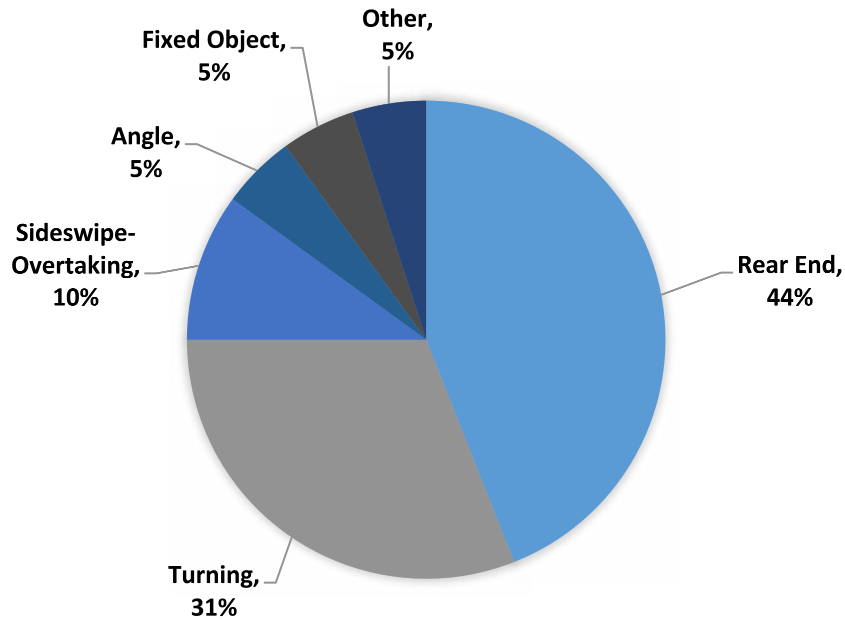


Figure 4: Crash Types along US 97 (2011-2015)

There were three crashes resulting in fatalities reported from 2011 to 2015, two of which were located along the segment portions of US 97 near the Yew Avenue interchange. Locations of the fatalities can be seen in Figures 1, 2, and 3. Two of the fatalities involved pedestrians, one of which occurred at the intersection of Canal Boulevard and Odem Medo Way. The fatal collisions resulted from improper lane changes, a non-motorist illegally in the roadway, and the driver disregarding the signal.

As shown in Figure 5, most crashes resulted in only property damage or minor injuries. However, eight crashes resulted in serious injury (i.e., incapacitating injury).

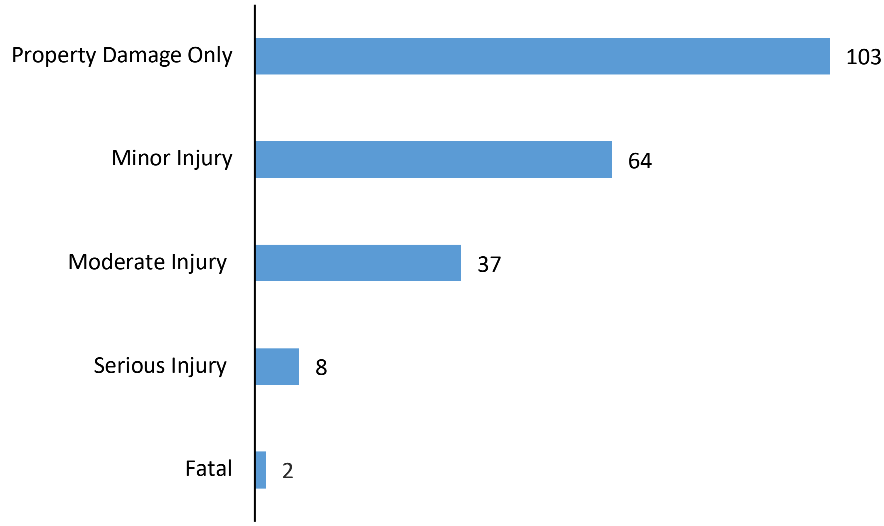


Figure 5: Crash Severities along US 97

Crash Rate Analysis

Crash rate analysis was completed for each study intersection and segments along US 97, with the results compared to rates observed for similar facilities to identify where the frequency of crashes occurring may be higher than should be expected. Intersections and segments were flagged as safety focus locations if observed crash rates surpassed the accepted rates described below.

Intersection Crash Rate Analysis

The observed crash rate for intersections is a function of the number of crashes and the annual average daily traffic (AADT). Each intersection is grouped into a reference population based on intersection control. The crash rates (crashes per million entering vehicles) for each intersection were compared to two different standards:

1. A critical crash rate, which compares performance to other similar intersections being studied in the project area, and
2. A 90^{th} percentile crash rate, which is based on similar intersections throughout the state (obtained from ODOT's Analysis Procedures Manual Exhibit 4-1).

Table 3 shows the crash rates for each study intersection where crashes were recorded. Intersections that have observed crash rates greater than either the critical or 90^{th} percentile crash rate were flagged as safety focus areas for further consideration. Full calculations are provided in the appendix.

Table 3: Intersection Crash Rates* (2011-2015)

Int. No.	Intersection Name	Safety Focus Area	Observed Crash Rate	Critical Crash Rate	90th Percentile Crash Rate
1	US 97 @ Glacier/Highland	Yes	0.533	0.386	0.509
2	US 97 @ Veterans Wy.		0.451	0.624	0.860
3	US 97 @ Pumice Ave.		0.176	0.210	0.292
4	US 97 @ Odem Medo Wy.		0.552	0.633	0.860
5	US 97 @ Wickiup Ave.		0.031	0.297	0.408
6	US 97 SB @ Yew Ave.		0.155	0.737	0.860
7	US 97 NB @ Yew Ave.		0.119	0.740	0.860
8	Canal Blvd. @ Veterans Wy.		0.238	0.680	0.860
9	Canal Blvd. @ Pumice Ave.	Yes	0.287	0.262	0.293
10	Canal Blvd. @ Quartz Ave.		0.261	0.265	0.293
11	Canal Blvd. @ Odem Medo Wy.		0.254	0.440	0.509
12	Canal Blvd. @ Yew Ave.		0.396**	NA	NA
13	5th St. @ Highland Ave.		0.535	0.735	0.860
14	5th St. @ Glacier Ave.		0.450	0.744	0.860
15	6th St. @ Highland Ave.	Yes	0.892	0.712	0.860
16	6th St. @ Glacier Ave.	Yes	1.041	0.731	0.860

*Crash rates are crashes per million vehicles entering the intersection.
**There is no comparable critical crash rate for roundabout-controlled intersections.

Four intersections were flagged as safety focus areas: The intersection of Glacier Avenue/Highland Avenue at US 97, the intersection of Canal Boulevard and Pumice Avenue, the intersection of 6th Street at Highland Avenue, and the intersection of 6th Street at Glacier Avenue. It should be noted that the observed crash rate for the roundabout-controlled intersection of Canal Boulevard and Yew Avenue was higher than the critical crash rate for a four-legged stop-controlled intersection. Therefore, this intersection is concerning and warrants further discussion.

Excess Proportion of Specific Crash Types Analysis

The excess proportion of specific crash types analysis looks at the proportion of crash types (i.e., rear-end, backing, angle, etc.) for each intersection and compares it with the average for the reference population to determine if certain types of crashes are more prevalent than should be expected. A reference population must contain at least five intersections to be valid. Furthermore, at least two crashes of the same type are necessary to calculate the excess proportion for that intersection.[1] Crash types with an excess proportion greater than 0.1 were flagged as safety focus areas. Table 4 presents only the flagged intersections and show that

[1] Analysis Procedures Manual Version 2

angle, rear-end, and turning crashes are the most commonly overrepresented crash type at study intersections. It should be noted that the intersections of 6th Street at Highland Avenue and 6th Street and Glacier Avenue were flagged in Table 3 and are also flagged in Table 4 suggesting an emphasis for further consideration.

Table 4: Excess Proportion of Crashes (2011-2015)

Int. No.	Intersection Name	Crash Type	Excess Proportion	Crash Type	Excess Proportion	Crash Type	Excess Proportion
4	US 97 @ Odem Medo Wy.	SS-O*	0.10	Turn	0.23	Rear-end	0.59
6	US 97 SB @ Yew Ave.	Turn	0.36				
7	US 97 NB @ Yew Ave.	Angle	0.29				
8	Canal Blvd. @ Veterans Wy.	Turn	0.36				
13	5th St. @ Highland Ave.	Angle	0.13	Turn	0.15		
14	5th St. @ Glacier Ave.	Angle	0.73	Rear-end	0.18		
15	6th St. @ Highland Ave.	Angle	0.79	Rear-end	0.14		
16	6th St. @ Glacier Ave.	Angle	0.45				

*SS-O = Sideswipe crash that occurred while overtaking another vehicle

Segment Crash Rate Analysis

In addition to individual intersections, crash rates for segments of US 97 were analyzed to identify potential problem areas of the corridor. Pre-defined highway segments along US 97 and their crash rates were obtained from the 2015 ODOT State Highway Crash Book. Crash rates experienced for each of the last reported five years (between 2011-2015) were compared against the statewide average crash rate for similar facilities using Crash Rate Table II in the Crash Book.

This analysis led to the flagging of two segments as safety focus areas for further investigation and potential mitigation through alternatives considered (see Table 5). These included the segments of US 97 from Evergreen Avenue to Veterans Way and from Veterans Way to Wickiup Avenue. The segments south of Wickiup Avenue experienced considerably lower crash rates, which could be due to the limited number of intersections and driveways accessing the highway.

Table 5: US 97 Segment Crash Rates*

Start Milepoint	End Milepoint	Segment Name	Safety Focus Area	Area Type	Observed Crash Rate	Statewide Average Crash Rate
121.21	121.98	Evergreen Ave. to Veterans Wy.	Yes	Urban City	2.15	0.93
121.98	123.17	Veterans Wy. to Wickiup Ave.	Yes	Urban City	2.23	0.93
123.17	124.4	Wickiup Ave. to Redmond South City Limits		Urban City	0.52	0.93
124.4	124.72	Redmond South City Limits to Urban Growth Boundary		Suburban Area	0.36	0.90

*Crash rates are crashes per million vehicle-miles traveled.

A region-wide safety assessment was recently completed for the ODOT All Roads Transportation Safety (ARTS) Program[2], which identified regional hot spots for further safety focus. This assessment did show two locations as being among the top safety concerns in Region 4. The two locations noted were US 97 at Veteran's Way and US 97 at Odem Medo Way, both of which fall within the safety focus areas identified.

Safety Priority Index System

The Safety Priority Index System (SPIS) provides another method for identifying potential safety problems and crash patterns on state highways. The SPIS is a method developed by ODOT and is a scoring system based on three years of crash data and considers crash rates, severities, and frequencies. The highest rated sites are considered for potential safety improvements.

The 2015 SPIS ratings for US 97 were obtained from ODOT to screen for locations with SPIS ratings among the state's top 10%. One location in the study area, the intersection on US 97 at Veterans Way, was found to be rated among the state's top 10% SPIS sites, and has been flagged as a safety focus area.

Predictive Method

The Highway Safety Manual (HSM), published in 2010, is the first national resource that provides quantitative information and methods to evaluate the safety performance of roadways. The predictive method, Part C within the HSM, estimates the expected crash frequency (for existing conditions) and the net change in expected crash frequency (for alternatives evaluation) on a facility, segment, or at an intersection using a combination of site characteristics and historical crash data. The expected crash frequency is calculated using a Safety Performance Function (SPF), which is a regression equation developed for a specific type of facility using a

[2] *ODOT All Roads Transportation Safety (ARTS) Program – Hot Spot Report,* Prepared by DKS Associates, May 2015.

national database of information. Each SPF was then adjusted to account for specific site characteristics using Crash Modification Factors (CMFs). CMFs can also be applied to estimate the effectiveness of various countermeasures. Countermeasures were sourced from the ODOT-approved set of countermeasures and were associated with Crash Reduction Factors (CRFs) that were used for the All Roads Transportation Safety (ARTS) Program. For alternatives where ODOT-approved countermeasures were not available, a CMF from the HSM Part D or from the CMF Clearinghouse was used.[3][4]

The Oregon HSM Spreadsheet for Urban and Suburban arterials, provided by ODOT, was used to conduct all of the HSM analyses and countermeasure investigations. The ISATe Spreadsheet for Freeways and Interchanges was used to analyze interchanges. According to ODOT's Analysis Procedures Manual (APM), freeways and interchanges must be analyzed as separate segments. The output of the Oregon HSM Spreadsheets and the ISATe spreadsheet was the expected number of crashes per year for the entire study site, including sub-segments and intersections. The expected number of crashes for each study site was used to evaluate the relative safety performance of the site. This analysis was conducted on the immediate US 97 corridor for existing conditions and the future 2040 No-Build alternative.

Local Calibration Factors

The SPFs and CMFs used in the HSM were derived from a national database of roadways and intersections. As such, the equations need to be calibrated to local conditions to account for differences in driver behavior, weather, and crash reporting thresholds, among other factors. Previous research efforts have developed a set of recommended calibration factors for the State of Oregon, which are outlined the APM. For Urban and Suburban Arterials intersections, the calibration factors are 0.35, 0.45, 0.73, and 1.05, for 3-leg minor stop, 4-leg minor stop, 3-leg signalized, and 4-leg signalized intersections, respectively. For Urban and Suburban Arterial segments, the calibration factors are 0.64, 0.63, and 0.64, for 4-lane divided, 4-lane undivided, and 5-lane with two-way-left-turn-lane (TWLTL).

Limitations and Assumptions

The research used to develop CMFs/CRFs varies greatly in terms of data quality and analytical procedures. Countermeasures will refer to the CRF's in the All Roads Transportation Study (ARTS) CRF list and appendix as a first source.[5] If a desired countermeasure is not found, then a CMF may be selected if it has a rating of at least three stars and is based on assumptions that are consistent with the project area. A star-rating is applied to each CMF that indicates the quality of the study that produced the CMF, where five stars indicates the highest or most reliable rating. The CMFs that are integrated into the HSM Smart Spreadsheets all have star ratings of three or higher. To maintain consistency, only CMFs with three or more stars will be selected for countermeasures investigated in this analysis that are not included in the Smart

[3] Analysis Procedures Manual Version 2
[4] http://www.cmfclearinghouse.org/
[5] http://www.oregon.gov/ODOT/Engineering/Pages/ARTS.aspx

Spreadsheets. All CMFs are limited to a certain range of values depending on the dataset that was used to develop them.

Analysis Results

The following sections summarize the HSM Predictive analysis results for existing conditions, the future 2040 No-Build scenario, and the future 2040 Build scenario.

Existing Conditions

A comparison of the historical average number of crashes per year (2011-2015) with the expected average number of crashes per year (using the HSM analysis methods under existing conditions) gives a good sense of relative safety performance of the study site. Another measure of safety performance is the Excess Expected Crash Frequency, which is the difference between the predicted crash frequency (derived from an SPF) and the expected crash frequency (weighted with observed crash history using the EB method)[6]. Table 7 summarizes the historical and expected crash frequency for each site by crash severity (fatal and injury, property damage only, and total crashes). The summary of historical and expected crash frequency for the Yew Avenue interchange can be found in Table 8.

Table 7: Summary of Historical and Expected Crash Frequencies on US 97, Excluding the Yew Avenue Interchange

Study Site	Historical Crashes per Year (2011-2015)			Expected Crashes per Year			Excess Expected Crash Frequency (Total)
	Fatal and Injury	Property Damage Only	Total	Fatal and Injury	Property Damage Only	Total	
US 97 from SW Highland Ave. to South UGB (MP 121.46 to 123.43 & MP 123.89 to 124.40)	20.6	19.0	39.6	12.2	26.7	38.9	-5.5

Table 8: Summary of Historical and Expected Crash Frequencies for the US 97/Yew Avenue Interchange

Study Site	Historical Crashes per Year (2011-2015)			Expected Crashes per Year			Excess Expected Crash Frequency (Total)
	Fatal and Injury	Property Damage Only	Total	Fatal and Injury	Property Damage Only	Total	
US 97 at Yew Ave. (MP 123.43 to 123.89)	1.6	1.6	3.2	2.6	4.0	6.6	-2.6

As shown in Table 7, the study corridor experienced more crashes resulting in fatalities or injuries than would be expected, but fewer crashes that resulted in property damage only. Overall, the corridor experienced about one crash more per year than expected. The Yew

[6] More details can be found in the Appendix: Predictive Methodology Summary Tables

Avenue interchange experienced fewer crashes resulting in fatalities, injuries, or property damage, and fewer crashes overall than expected. As can be seen in Tables 7 and 8, there is a negative excess expected crash frequency for both the corridor and the Yew Avenue interchange, which means that the corridor experienced fewer crashes than was predicted for a facility with similar characteristics. More crashes were predicted than expected (excess expected crash frequency).

Future 2040 No-Build Conditions

In order to evaluate the safety performance of the study area and establish a baseline for the future 2040 No-Build scenario, the same HSM analysis summarized in the previous section was conducted using the future forecasted 2040 volumes and the same roadway characteristics as existing conditions. It should be noted, in the future 2040 No-Build scenario, the intersection of US 97 and Quartz Avenue is assumed to be signalized.

Table 9 summarizes the predicted crash frequency in the year 2040 excluding the Yew Avenue interchange. Table 10 summarizes the predicted crash frequency for the Yew Avenue interchange.

Table 9: Predicted Future 2040 No-Build Scenario Crash Frequencies on US 97, Excluding the Yew Avenue Interchange

Study Site	Predicted Crashes per Year		
	Fatal and Injury	Property Damage Only	Total
US 97 from SW Highland Ave. to South UGB (MP 121.46 to 123.43 & MP 123.89 to 124.40)	21.3	50.5	71.8

Table 10: Predicted Future 2040 No-Build Scenario Crash Frequencies for the US 97/Yew Avenue Interchange

Study Site	Predicted Crashes per Year		
	Fatal and Injury	Property Damage Only	Total
US 97 at Yew Ave. (MP 123.43 to 123.89)	3.8	7.3	11.1

Compared to the expected crashes under existing conditions, approximately 33 additional crashes per year are predicted to occur on the US 97 corridor by 2040. For the Yew Avenue interchange, the number of crashes is predicted to be higher by about five crashes per year.

FUTURE BUILD ANALYSIS

The following section describes the analysis conducted on the Future 2040 preferred alternative for the US 97 corridor.

Future 2040 Build Conditions

Proposed improvements for the future 2040 Build scenario for the US 97 corridor are as follows:

- A raised median (with openings for turns) along the whole corridor
- New signals at Pumice Avenue, and Wickiup Avenue
- A new signalized intersection connecting Canal Boulevard to US 97 between Reindeer Avenue and Salmon Avenue.

In order to evaluate the effectiveness of various countermeasures, the same HSM analysis summarized in the previous sections was conducted using the new roadway and roadside characteristics. For example, the HSM analysis was run assuming the presence of a raised median, and the resulting net change in the predicted average crash frequency (from future 2040 No-Build conditions) is a measure of the predicted benefit of installing a raised median. Table 10 summarizes the predicted crash frequency for the future 2040 Build scenario excluding the Yew Avenue interchange. Table 11 summarizes the predicted crash frequency for the future 2040 Build scenario for the Yew Avenue interchange.

Table 10: Predicted Future 2040 Build Scenario Crash Frequencies on US 97, Excluding the Yew Avenue Interchange

Study Site	Predicted Crashes per Year		
	Fatal and Injury	Property Damage Only	Total
US 97 from SW Highland Ave. to South UGB (MP 121.46 to 123.43 & MP 123.89 to 124.40)	18.6	41.4	60.1

Table 11: Predicted Future 2040 Build Scenario Crash Frequencies for the US 97/Yew Avenue Interchange

Study Site	Predicted Crashes per Year		
	Fatal and Injury	Property Damage Only	Total
US 97 at Yew Ave. (MP 123.43 to 123.89)	3.7	7.0	10.7

Tables 12 summarizes 13 summarizes the net change in the predicted average crash frequency between the future 2040 No-Build and future 2040 Build scenarios.

Table 12: Net Change in Predicted Average Crash Frequency between Future 2040 No-Build and Future 2040 Build Scenarios on US 97, Excluding the Yew Avenue Interchange

Study Scenario	Predicted Crashes per Year		
	Fatal and Injury	Property Damage Only	Total
Future 2040 No-Build Scenario	21.3	50.5	71.8
Future 2040 Build Scenario	18.6	41.4	60.1
Net Change between Scenarios	-2.7	-9.1	-11.7

Table 13: Net Change in Predicted Average Crash Frequency between Future 2040 No-Build and Future 2040 Build Scenarios for the Yew Avenue Interchange

Study Scenario	Predicted Crashes per Year		
	Fatal and Injury	Property Damage Only	Total
Future 2040 No-Build Scenario	3.8	7.3	11.1
Future 2040 Build Scenario	3.7	7.0	10.7
Net Change between Scenarios	-0.1	-0.3	-0.4

CONCLUSION

Overall, the Build scenario is predicted to improve safety in the US 97 corridor. In the year 2040, if no changes are made, crashes are predicted to increase by approximately 33 crashes per year (from 43 crashes per year currently) along the corridor and five crashes per year at the Yew Avenue Interchange. With the future 2040 Build scenario, compared to the future 2040 No-Build scenario, crashes along the corridor would decrease by 12 per year and crashes at the Yew Interchange would stay about the same (no geometric changes included in Build scenario). This reduction is primarily due to the added median and the added east-west connectivity diverting traffic off US 97 within the city. It should be noted that in addition to the crash reduction resulting from the Build scenario, the severity of many of the crashes that do occur is anticipated to be lower.

The addition of the median alone will reduce the crash frequency by about nine crashers per year. Raised medians have the potential to reduce all types of crashes by reducing turning conflicts and by providing a physical buffer between opposing traffic. By reducing turning conflicts, the frequency of severe crashes will decrease. This is because raised medians have the potential to reduce angle crashes (a high severity crash type) by approximately 55%.[7] Overall, when installing a raised median to replace a two-way left-turn lane, the average crash frequency for all severities is reduced by 23% per year.

In general, the installation of new traffic signals often prevents many high-severity turning and angle crashes, but introduces a number of new lower-severity rear-end crashes. On average, installing a traffic signal will reduce the frequency of angle crashes causing fatalities or injury by 67% per year,[8] but will also increase the average frequency for rear-end crashes of all severity types by approximately 59% per year.[8] Similarly, the proposed signalization of the intersections on US 97 at Pumice Avenue and Wickiup Avenue is anticipated to increase the overall number of crashes, but reduce the number of high-severity crashes.

While not directly accounted for in the calculation of predicted crashes, safety of highway crossings for people walking and biking are anticipated to improve significantly under the Build scenario. This is as a result of having more frequent signalized crossing opportunities and the raised median that can be used as a refuge for two-stage crossings.

Finally, the added east-west connectivity will reduce overall traffic volumes on the US 97 corridor, which also contributes to some of the predicted crash reduction.

As for the Yew Interchange, the average crash frequency is predicted to be very similar with a decrease of about 0.5 crashers per year. This was expected since there were no geometric changes between the future 2040 No-Build and Build scenarios for the interchange.

[7] http://www.cmfclearinghouse.org/
[8] http://www.cmfclearinghouse.org/

Appendix E US97 SRC Active Transportation Memorandum

Memo

Date:	Wednesday, April 25, 2018
Project:	U.S. 97: S Redmond Corridor
To:	Cari Charlton, ODOT
From:	Andy Johnson, HDR
Subject:	**Active Transportation Memo (Task 3.5)**

Introduction

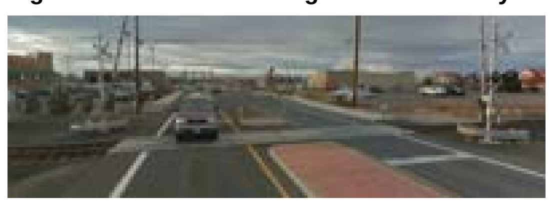
The purpose of this memorandum is to provide an overview of the existing conditions for people on foot or bicycle traveling along the US 97 corridor, the walking and biking access to and from the corridor from adjoining areas, and the connections of the project area to the larger pedestrian and bicycle networks. This memorandum identifies conditions that hinder or prevent walking or bicycling, or make these modes unattractive travel options. Furthermore, this memorandum introduces initial concepts and techniques that might be considered in improving the conditions for active transportation to and along the corridor.

Existing Conditions

Circulation for all modes of travel is constrained by physical barriers along both sides of US 97, resulting in limited east-west connectivity. Along the west side, the canal limits connections between the US 97 corridor and adjoining neighborhoods with only four existing canal crossings at Veterans Way, Pumice Avenue, Odem Medo Road, and Yew Avenue (Figure 1). Along the east side of US 97, the railroad tracks are a substantial barrier with only two at-grade crossings at Veterans and Airport Ways, effectively disconnecting the corridor from east side development (Figure 2).

Figure 1: Canal crossing at Pumice Ave

Figure 2: Railroad crossing at Veterans Way



Within the US 97 corridor, accommodations for people on foot or bicycle are substandard[1] with substantial gaps in the network, forcing people to walk or bike along the unprotected shoulder for significant distances. Crossing opportunities are limited to three existing signals at Highland Avenue, Veterans Way, and Odem Medo Road (Figure 3), which effectively prevents walking or biking access to destinations across the street

[1] The ODOT "Bicycle and Pedestrian Design Guide", 2011, recommends full separation of bike facilities from travel lanes for roadways with high traffic volumes and speeds, such as US 97. Similarly, it recommends a minimum five foot separation of sidewalks from traffic.

for much of the corridor. An underpass at Airport Way provides a grade separated crossing of US 97; however, the ramps to and from the corridor do not provide facilities for people on foot or bike (Figure 4).

Figure 3: Signal at Odem Medo Rd

Figure 4: Underpass at Yew Ave/Airport Way

The Dry Canyon Trail's southern end at Reindeer Avenue and 19th Street is less than a half mile west of the corridor. The trail provides a largely uninterrupted, paved path of about 3.7 miles for pedestrians and cyclists that extends north beyond downtown Redmond. An unpaved trail along the canal of about three quarters of a mile extends south from Yew Avenue.

Mode specific existing conditions are described below.

Pedestrian network

Substantially complete sidewalk networks exist in the neighborhoods west of 27th Street and in downtown north of Highland Avenue. Between 27th Street and US 97 is a fairly fragmented network of sidewalks with significant gaps. Sidewalks are present along most major east-west streets providing pedestrian connections to US 97 at signalized intersections.

Figure 5: Frequent sidewalk gaps along US 97

While sidewalks exist along US 97, frequent interruptions and sizable gaps prevent a safe and comfortable walking environment and do little to encourage walking along the corridor (Figure 5). In addition, the current intersection spacing creates long distances between pedestrian crossings and is suitable only for automobiles. Figure 6 shows existing sidewalks in the street network and trails, identifies existing signals and key destinations, and illustrates five-minute *walksheds* centered on each of the signalized intersections. The walksheds show how far the average person can walk in five minutes (a time most people are willing to walk)[2]. Most of the key destinations are currently beyond a five-minute walk from the corridor. Distances between existing signals far exceed acceptable walk times, particularly south of Veterans Way. Specifically, the walk time between Highland Avenue and Veterans Way is almost 12 minutes, between Veterans Way and Odem Medo Road about 19 minutes, and between Odem Medo Road and Yew Avenue/Airport Way about 17 minutes. In comparison, the walk time between Highland Avenue and Evergreen Avenue to the north is a much shorter five minute walk, as shown in Figure 6.

[2] A quarter-mile pedestrian shed was the basis of Clarence Perry's neighborhood unit in the 1920s. The five-minute walk concept was reintroduced more recently by Andres Duany, Elizabeth Plater-Zyberk and Jeff Speck in their book "Suburban Nation: The Rise of Sprawl and the Decline of the American Dream", 2001.

FIGURE 6: EXISTING PEDESTRIAN NETWORK

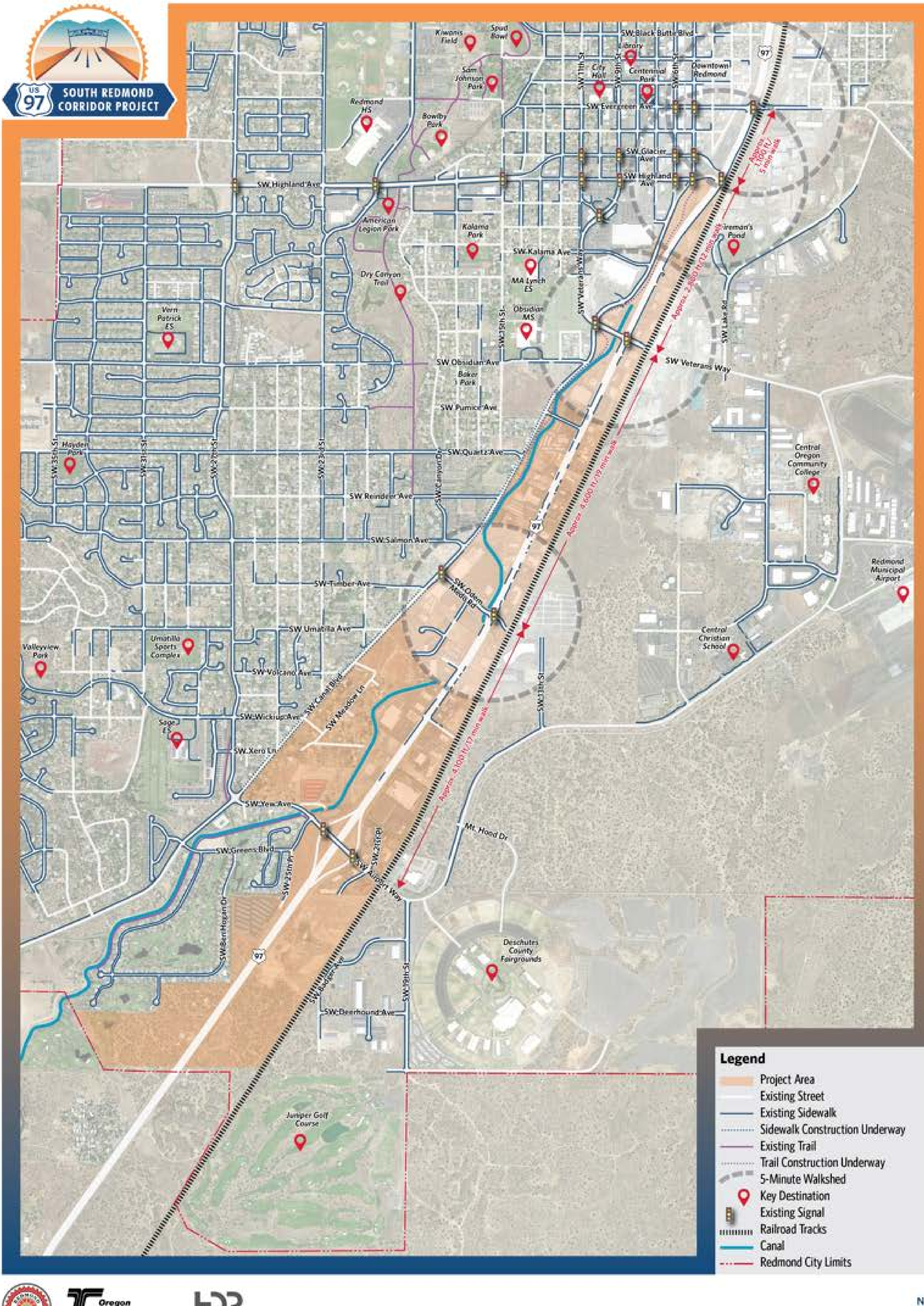


FIGURE 7: EXISTING BICYCLE NETWORK

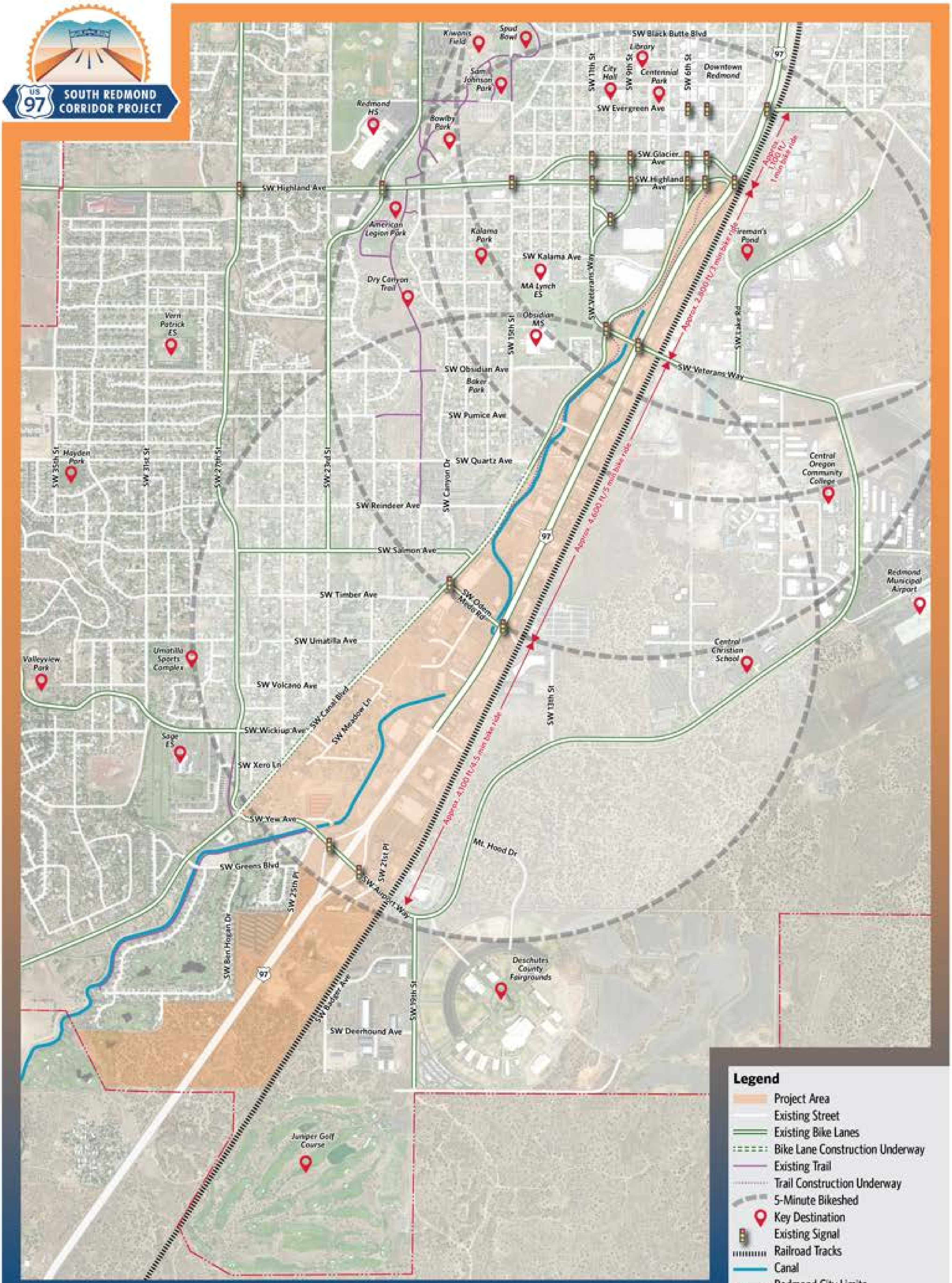


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Table 1 provides an overview of the walk times based on an average walking speed of four feet per second, a widely used standard[3], although the actual walking speed of individuals may vary. The average walk time between existing signals in the project area (including the Yew Ave/Airport Way underpass) is almost 16 minutes, rendering the corridor not walkable. In addition, these walk times are theoretical as walking is impractical due to significant stretches without sidewalks and the lack of pedestrian facilities connecting US 97 with Yew Ave or Airport Way.

Only a few sidewalks exist east of the railroad tracks, and they are isolated without connections to the US 97 corridor or the west side.

Where present, sidewalks are typically curb-tight without a landscape buffer between pedestrians and moving traffic. The lack of a landscape buffer contributes to a high stress environment, especially on higher speed and/or volume streets, such as US 97 (Figure 8).

Figure 8: Typical curb-tight sidewalk condition

Table 1: Existing walk times

Roadway segment	Approx. distance *feet*	Approx. walk time (4 ft/sec) *minutes*
*Evergreen Ave to Highland Ave**	*1,100*	*4.58*
Highland Ave to Veterans Way	*2,800*	*11.67*
Veterans Way to Odem Medo Rd	*4,600*	*19.17*
Odem Medo Rd to Yew Ave/Airport Way	*4,100*	*17.08*
Average	***3,833***	***15.97***

Note: * Listed for comparison – not included in average

Bicycle network

The bicycle network largely consists of in-street striped bike lanes along major north-south and east-west thoroughfares, which connect downtown and the west side neighborhoods (and to a lesser degree the east side industrial area) with the US 97 corridor at the existing signalized intersections at Highland Avenue, Veterans Way, and Odem Medo Road. Yew Avenue/Airport Way allow cyclists to cross the corridor in dedicated bike lanes within an underpass but do not provide access to US 97 itself. The west side neighborhoods consist of a fairly well connected network of neighborhood streets, which accommodate shared bike and automobile traffic away from major roadways.

[3] The "Manual on Uniform Traffic Control Devices", 2003 edition, cites a normal walking speed of 4 feet per second. While the 2009 edition reduced the speed to 3.5 feet per second, this memo uses the slightly faster speed for planning purposes.

Figure 9: Typical bike lane on US 97

Striped bike lanes also exist on US 97, however, frequent driveway interruptions and a lack of separation from fast moving vehicles contribute to a high stress bike environment (Figure 9). Furthermore, east-west connections are spaced far apart. Figure 7 shows existing bike lanes and trails, along with existing signals and key destinations. Figure 7 also illustrates five-minute *bikesheds* centered on each of the signalized intersection. The bikesheds show how far the average person can bike in five minutes at an average speed of ten miles per hour, a speed most casual riders can comfortably achieve[4]. Distances between existing signals generally are within a five-minute bike ride. The bike time between Highland Avenue and Veterans Way is about three minutes, between Veterans Way and Odem Medo Road a little over five minutes, and between Odem Medo Road and Yew Avenue/Airport Way almost five minutes. By comparison, the bike time between Highland Avenue and Evergreen Avenue to the north is just over a minute. South of Wickiup Avenue the bike lanes morph into shoulders with no designated bike accommodation on the ramps to and from Yew Avenue and Airport Way. Table 2 provides an overview of the bike times and indicates an average between existing signals in the project area (including the Yew Ave/Airport Way underpass) of almost five minutes.

Table 2: Existing bike times

Roadway segment	Approx. distance *feet*	Approx. bike time (10 mph) *minutes*
*Evergreen Ave to Highland Ave**	*1,100*	*1.25*
Highland Ave to Veterans Way	*2,800*	*3.18*
Veterans Way to Odem Medo Rd	*4,600*	*5.23*
Odem Medo Rd to Yew Ave/Airport Way	*4,100*	*4.66*
Average	***3,833***	***4.36***

Note: * Listed for comparison – not included in average

Identified gaps

Significant gaps in both the sidewalk and bikeway networks present a deterrent to walking and cycling to and along the US 97 corridor. The following is a summary of the gaps in either network. Figure 6 identifies where sidewalks are present; streets shown without sidewalks represent sidewalk gaps. Similarly, Figure 7 identifies streets with existing bike lanes and clearly shows missing links along the US 97 corridor and on major streets in its vicinity.

[4] Bicycling speeds vary significantly based on age and fitness of a rider, topography, and the type of bike. The chosen average speed for planning purposes is on the lower end of the range.

SIDEWALK GAPS

Sporadic sidewalks along the corridor make travel on foot impractical, with many gaps throughout and no sidewalks south of Wickiup Avenue. Canal Boulevard just west of the corridor almost entirely lacks sidewalks between Obsidian Avenue and Yew Avenue (Figure 10). Construction of improvements along Canal Boulevard began in March 2018. Slated to be completed by April 2019, the improvements include sidewalks along the full length of Canal Boulevard and a multi-use path on the east side from Salmon Avenue to Highland Avenue. The improvements underway will allow Canal Boulevard to function as alternative parallel route and greatly enhance the pedestrian network in the immediate vicinity of the US 97 corridor.

Sidewalks on Veterans Way provide pedestrian access to and across US 97; however, the sidewalks do not extend east beyond the railroad tracks and leave people in the east side industrial areas without feasible walking access. Both Veterans Way and Pumice Avenue provide sidewalk connections from US 97 to Canal Boulevard with tenuous connectivity to the neighborhoods to the west or downtown to the north, which will be remedied when the improvements described above are completed.

Figure 10: Canal Blvd lacks continuous sidewalks

Sidewalks along Quartz Avenue allow for uninterrupted pedestrian travel between Canal Boulevard and 35th Street to the west and provide access to the Dry Canyon Trail. However, Quartz Avenue does not currently connect to US 97. Similar to Veterans Way, sidewalks along Odem Medo Road provide pedestrian access to and across US 97, but the connection dead-ends at the railroad tracks east of the corridor. Sidewalks along Yew Avenue tie into 27th Street and provide good linkages on the west side. The sidewalks on Yew Avenue also allow people to walk along the underpass under US 97 to connect to Airport Way on the east side. However, the sidewalks end at the railroad tracks and fail to provide walking access to and from the Deschutes County Fairgrounds and adjacent areas. Furthermore, pedestrian connections between Yew Avenue/Airport Way and US 97 are absent.

BIKE LANE GAPS

US 97 has striped bike lanes north of Wickiup Avenue, although their utility in the existing state is questionable. The bike lanes transition to shoulders south of Wickiup Avenue, leaving about 40 percent of the corridor without dedicated bike facilities. In addition, there is no bike connection between US 97 and Yew Avenue/Airport Way. Canal Boulevard provides an alternate parallel route to US 97. While there are currently significant gaps between Quartz and Salmon Avenues and between Timber and Yew Avenues, the improvement project on Canal Boulevard will provide continuous bike lanes on both sides, in addition to the new off-street shared-use path that will connect the existing Homestead Canal trail with downtown and eventually extend north to Quince Avenue. Both Obsidian and Quartz Avenues extend from Canal Boulevard west to the city limits and connect to the Dry Canyon Trail, but neither currently have dedicated bike facilities.

Opportunities for Improvements

While the existing railroad tracks along US 97 severely restrict additional connections to the airport and surrounding industrial area, improving connectivity between the US 97 corridor and the neighborhoods to the west would benefit all modes of travel. Opportunities for improvements include enhancements of existing roadway crossings, provision of additional roadway crossings, provision of additional canal crossings, closure of gaps in the pedestrian and bike networks within and around the project area, and enhancements of pedestrian and bike facilities along the corridor.

Figure 11 and Figure 12 illustrate potential network improvements that would contribute to a better integration of the US 97 corridor into the urban fabric. Additional canal and roadway crossings would provide significantly improved east-west connectivity and would locate many destinations along US 97 within reasonable walking and biking distances from near west side neighborhoods. The improvements build upon the existing sidewalk and bikeway networks and begin to close gaps and introduce new connections.

Table 3 provides an overview of the effect the potential improvements would have on walk and bike times along the corridor. The improved conditions would provide an intersection density significantly more conducive to walking and biking, while maintaining the operational function of a major thoroughfare for automobiles[5].

Table 3: Improvement opportunities for walk and bike times

Roadway segment	Approx. distance *feet*	Approx. walk time (4 ft/sec) *minutes*	Approx. bike time (10 mph) *minutes*
*Evergreen Ave to Highland Ave**	*1,100*	*4.58*	*1.25*
Highland Ave to Kalama Ave	*1,600*	*6.67*	*1.82*
Kalama Ave to Veterans Way	*1,200*	*5.00*	*1.36*
Veterans Way to Pumice Ave	*1,500*	*6.25*	*1.70*
Pumice Ave to Quartz Ave	*700*	*2.92*	*0.80*
Quartz Ave to 17th Pl	*1,400*	*5.83*	*1.59*
17th Pl to Odem Medo Rd	*1,000*	*4.17*	*1.14*
Odem Medo Rd to Wickiup Ave	*1,800*	*7.50*	*2.05*
Wickiup Ave to Yew Ave/Airport Way	*2,300*	*9.58*	*2.61*
Average	***1,438***	***5.83***	***1.59***

Note: * Listed for comparison – not included in average

[5] The Institute of Transportation Engineers' "Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities", 2006, recommends intersection spacing of 660 to 1,320 feet for multiway boulevards, with 400 to 600 feet spacing for access lanes.

FIGURE 11: POTENTIAL PEDESTRIAN NETWORK

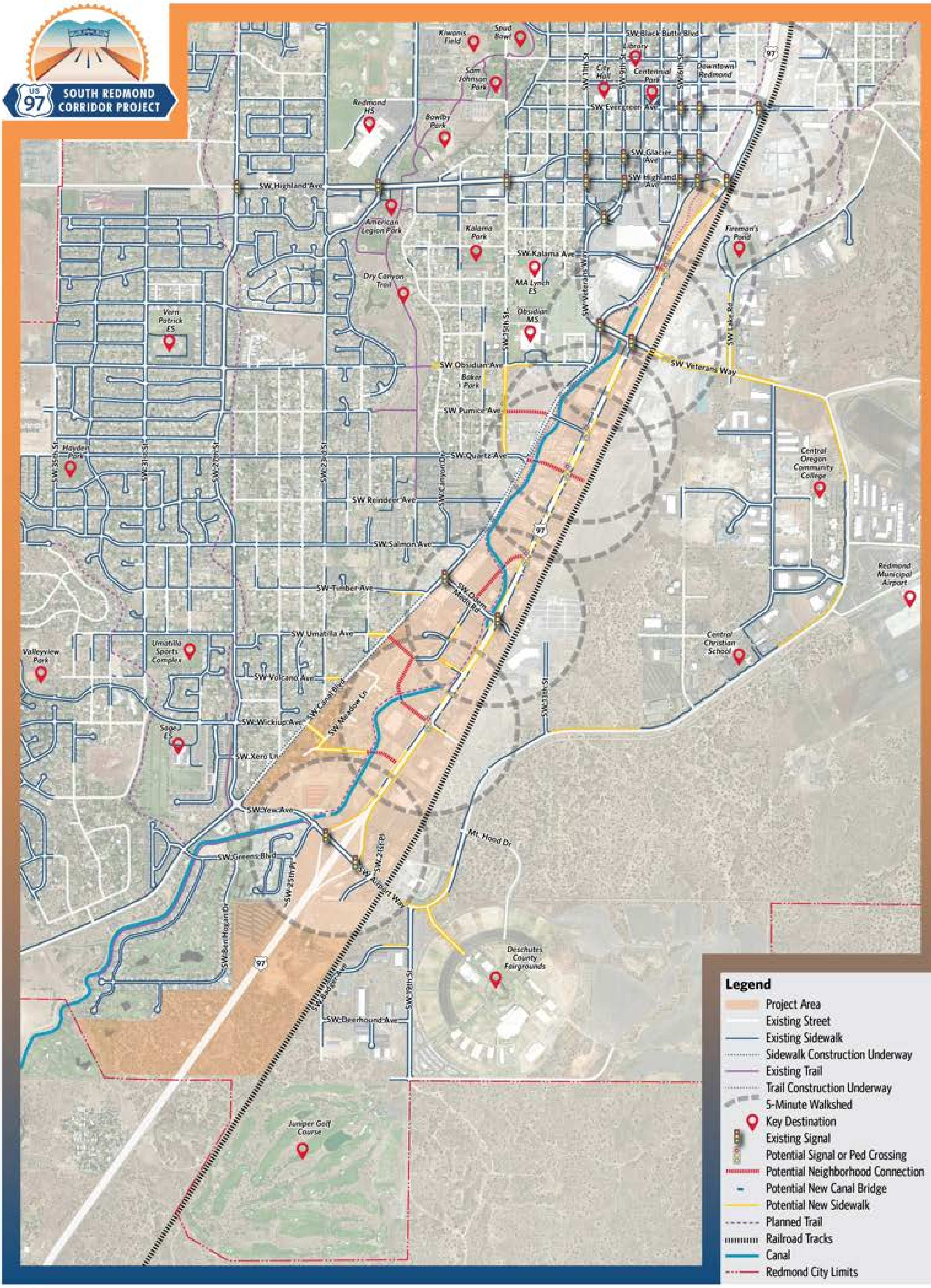

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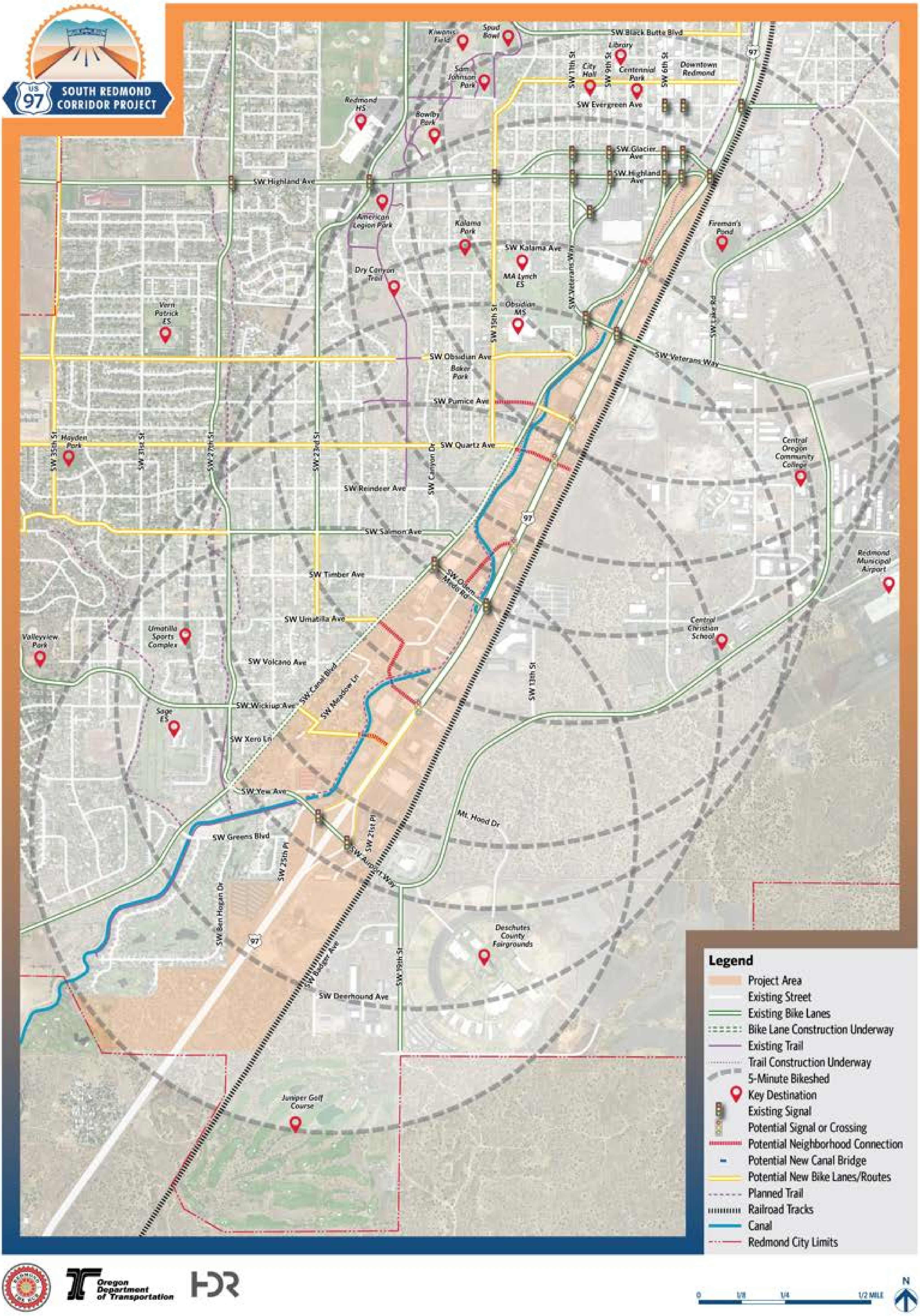
FIGURE 12: POTENTIAL BICYCLE NETWORK



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Crossings and Signals

The following is an overview of potential interventions that would contribute to improved networks for people on foot or bike. This is intended as a menu of options, each with varying benefits and considerations. Not every option is equally suited for a particular location, and context should be carefully considered in the development and evaluation of design alternatives. New signals would require evaluation to ensure the overall intersection safety and operations will be improved.

- New bridge connections across the canal
  - Contribute to a more tightly knit street network with more frequent and direct routes, which benefits all modes but particularly people on foot and bike.
  - Allow for more direct routes to east-west thoroughfares and make walking and cycling to and from west side neighborhoods more feasible.
- Additional signals along US 97
  - Provide access to additional east-west routes (in combination with additional canal crossings).
  - Reduce the distance between street crossings for people on foot or bike, which would improve the feasibility of walking and biking along the corridor and make destinations along the corridor's east side reasonably accessible (see Figure 11, Figure 12, and Table 3)
  - Allow for vehicle speed management through appropriate signal timing, which can help improve the safety and comfort of people on foot or bike.
- Pedestrian/cyclist activated signals
  - Provide signalized crossings where fully signalized intersections are not necessary or desirable.
  - Allow for midblock crossings where major destinations are far from intersections or in addition to signalized intersections where intersection spacing is too great.
- Unsignalized crossings
  - Allow for opportunistic crossing of US 97.
  - Should only be considered in conjunction with a median refuge and speed management.
  - Require careful design aimed at increasing pedestrian visibility that may include advance stop bars, signage, illumination, and staggered continental crosswalk striping.

Improved Pedestrian Facilities

US 97 is a challenging place to walk due to frequent sidewalk gaps and a predominance of curb-tight sidewalks that place pedestrians immediately adjacent to fast-moving automobiles. Existing sidewalks lack landscape buffers and often have minimal landscaping on the private property side, if any. This section provides an overview of potential improvements to the conditions for people walking in the US 97 corridor, illustrated in Figures 13 through 16 and summarized in Table 4.

CURB-TIGHT SIDEWALKS ALONG US 97 MAINLINE

Curb-tight sidewalks along US 97 mainline represent the status quo where sidewalks are present. Through pedestrian travel occurs along the mainline directly adjacent to travel lanes with access to businesses across the frontage road and/or parking areas as needed (Figure 13).

Figure 13: Curb-tight sidewalk on US 97 mainline

SEPARATED SIDEWALKS ALONG US 97 MAINLINE

Through pedestrian travel occurs along the mainline with a landscape buffer between sidewalk and travel lanes with access to businesses across the frontage road and/or parking areas as needed (Figure 14).

Figure 14: Separated sidewalk on US 97 mainline

SIDEWALKS ALONG FRONTAGE ROAD NEAR BUILDING FACADES

Pedestrian travel occurs along the building facades behind the frontage road. Through pedestrian travel requires crossing of the frontage road near intersections (Figure 15).

Figure 15: Sidewalk along frontage road

Table 4: Pedestrian facilities – key benefits and considerations

Facility type	Key benefits	Key considerations
Curb-tight sidewalk along US 97 mainline	• Easy gap closure of current conditions • Allows for walking along the corridor in a direct alignment without out-of-direction travel • Limited improvement but may be useful as secondary route if parallel walkways along building frontages are provided	• No buffer between fast automobile traffic and people walking with high level of stress • Requires crossing of frontage road and/or parking area to access businesses
Separated sidewalk along US 97 mainline	• Provides landscape buffers • Reduces level of stress for people walking along the corridor in a direct alignment without out-of-direction travel	• Requires crossing of frontage road and/or parking area to access businesses • Places people away from destinations
Sidewalk along frontage road near building facades	• Walking route along lower speed roadway, potentially buffered by on-street parking, with a lower level of stress • Places people near destinations with the potential for a more interesting pedestrian experience that may include storefront windows and outdoor seating areas	• May require out of direction travel where building frontages are set back • Requires crossing of frontage road and/or parking area to access intersections • Works best where adjacent building frontages are aligned and spaced closely together

Improved Bike Facilities

US 97 is a challenging place to ride a bike when considering automobile traffic volume and speed, frequent driveway conflicts, and bike lanes without any visual distinction or physical protection. This section provides an overview of potential bike facilities ranging from a low to a high degree of separation, illustrated in Figure 16 through Figure 25. Table 5 summarizes key benefits and considerations of each configuration.

BUFFERED BIKE LANES

Buffered bike lanes are street-grade facilities that provide additional space for bicyclists and visual separation from travel lanes through a striped buffer (Figure 16). Vertical delineators may be placed in the buffer to increase the visual separation (Figure 17).

Figure 16: Buffered bike lane

Figure 17: Buffered bike lane with vertical delineators

PROTECTED BIKE LANES

Protected bike lanes provide some degree of physical separation between bike and travel lanes to prevent automobiles from encroaching into the bike lane: The separation may consist of tuff curbs (Figure 18), modular plastic elements installed on top of the roadway surface, conventional concrete curbs (Figure 19), or raised medians, which may be hardscaped or landscaped (Figure 20). Due to the physical separation, bicyclists intending to make a left turn require a gap in the barrier to exit the bike lane and merge into the travel lanes approaching an intersection. Alternatively, a two-stage turn movement might be considered where bicyclist continue straight through the intersection and wait for the green signal at the cross street.

Figure 18: Protected bike lane with tuff curb

Figure 19: Protected bike lane with concrete curb

Figure 20: Protected bike lane with median

RAISED BIKE LANES

Raised bike lanes include a three-inch vertical separation between bike lane and travel lane by placing a gently sloped concrete curb between the lanes. The raised bike lane can further be visually separated by using concrete or pigmented concrete (Figure 21).

Figure 21: Raised bike lane

CYCLE TRACKS

Sidewalk level cycle tracks are separated from automobile traffic and located behind a landscape buffer at the grade of the sidewalk (Figure 22). An optional visual or physical separation between the walkway and bikeway may be provided.

Figure 22: Sidewalk level cycle track

TWO-WAY BIKE PATH

Two-way bike paths consolidate bike travel in one facility on one side of the road, which may be advantageous where most destinations and connections are located on one side (Figure 23).

Figure 23: Two-way bike path

SHARED-USE PATH

Shared-use paths provide a shared facility for two-way bike and pedestrian travel separated from automobile traffic on both sides of US 97 (Figure 24).

Figure 24: Shared-use path

SHARED LANES ON FRONTAGE ROAD:

Shared lanes allow bicycles to ride in the travel lanes along with slower moving automobile traffic on the frontage roads in lieu of a dedicated bike facility (Figure 25).

Figure 25: Shared lanes on frontage road

Table 5: Bike facilities – key benefits and considerations

Facility type	Key benefits	Key considerations
Buffered bike lane	• Spatial separation and better delineation and visibility than standard bike lane • Easy to maintain/sweep	• No physical separation between bikes and cars • Painted buffer degrades over time, reducing its effectiveness
Buffered bike lane with vertical delineators	• Vertical delineation provides added visual separation and comfort • Driveway cuts can easily be accommodated	• Delineators may have to be replaced often • Sweeping/snow removal may require special equipment
Protected bike lane with tuff curb **Protected bike lane with concrete curb** **Protected bike lane with raised median**	• Physical barrier between bikes and automobiles provides added comfort • Visually reduces roadway width • Collects less debris and requires less frequent sweeping due to separation	• Limits bicyclists' ability to exit bike lane • Curbs are susceptible to vehicle strikes and may have to be replaced frequently • Sweeping/snow removal may require special equipment • Stormwater management may be more challenging
Raised bike lane	• Vertical separation provides added comfort • Collects less debris and requires less frequent sweeping • Visually reduces roadway width	• Stormwater management may be more challenging • Tends to collect cinders during winter • Sweeping/snow removal may require special equipment
Sidewalk level cycle track	• Physical barrier between bikes and automobiles • Minimal debris collection at sidewalk level	• Places bicyclists farther from drivers' field of visions, requiring careful intersection and driveway cut design • Limits bicyclists' ability to exit bike lane
Two-way bike path	• Could allow cyclists to connect to the bike lane network of downtown and west side neighborhoods without crossing US 97	• Access to destinations on the other side of US 97 may be limited or require additional accommodation • Drivers at intersections and driveways may not expect bikes from opposite direction
Shared-use path	• Physical barrier between bikes and automobiles • Allows two-way bike travel on both sides of US 97	• Potential for conflict between slower pedestrians and faster cyclists • Drivers at intersections and driveways may not expect bikes from opposite direction
Shared lanes on frontage road	• Places bikes closer to potential destinations • Separates bike traffic from fast moving traffic on US 97	• No separation from automobile traffic; potential conflicts with parking • Potential for out-of-direction travel • May be difficult at intersections

Maintenance and Cost Considerations

The potential facilities for people on foot or bike described above differ in the level and difficulty of maintenance and the cost associated with maintaining them. Table 6 and Table 7 provide summaries of key maintenance considerations and high-level maintenance cost comparisons.

Table 6: Pedestrian facility maintenance and cost considerations

Facility type	Maintenance considerations	Cost of maintenance
Curb-tight sidewalk along US 97 mainline	• Minimal maintenance	low
Sidewalk along frontage road near building facades	• Maintenance is property owners' responsibility	
Separated sidewalk along US 97 mainline	• Landscape maintenance, including irrigation, weeding and periodic plant replacement • May allow sweeping/snow removal of bike and pedestrian facilities at once	medium

Table 7: Bike facility maintenance and cost considerations

Facility type	Maintenance considerations	Cost of maintenance
Buffered bike lane	• Easy to maintain/sweep with general roadway sweeping • Requires periodic restriping	low
Shared lanes on frontage road	• Easy to maintain/sweep with general roadway sweeping	
Sidewalk level cycle track	• Minimal debris collection at sidewalk level • Sweeping/snow removal may be possible with existing equipment if constructed to withstand weight • May allow sweeping/snow removal of bike and pedestrian facilities at once	medium
Two-way bike path		
Shared-use path		
Raised bike lane	• Collects less debris and requires less frequent sweeping • Stormwater management may be more challenging • Tends to collect cinders during winter • Sweeping/snow removal may require special equipment and additional labor	medium high
Buffered bike lane with vertical delineators	• Delineators may have to be replaced often • Sweeping/snow removal may require special equipment and additional labor	high
Protected bike lane with tuff curb	• Collects less debris and requires less frequent sweeping due to separation • Curbs are susceptible to vehicle strikes and may have to be replaced frequently • Sweeping/snow removal may require special equipment and additional labor • Stormwater management may be more challenging	
Protected bike lane with concrete curb		
Protected bike lane with raised median		

Draft Recommendations

The following summarizes initial key recommendations for active transportation improvements along and around the US 97 corridor, with intentions to foster an environment more conducive to walking and bicycling between destinations within the corridor and between the corridor and adjacent neighborhoods.

Eliminate gaps in the walking and bicycling networks

- Complete sidewalks where none are present along US 97 to allow people to safely walk between nearby destinations within the corridor.
- Complete sidewalks where none are present in the areas near the corridor to allow people to safely walk to and from the corridor.
- Add bike lanes along key routes and connect existing bike lanes to provide a seamless network of designated bikeways.

Increase network connectivity

- Reduce intersection spacing along US 97 significantly, in order to:
  - Provide more frequent crossing opportunities that enable walking and biking as feasible options.
  - Provide safe connections between nearby destinations on both sides of US 97.
- Provide additional bridge crossings and local street connections across the canal, in order to:
  - Improve permeability between west side neighborhoods and the US 97 corridor
  - Reduce reliance on US 97 for local trips.
  - Take pressure off of the few existing connections.
  - Provide additional routes that enable people to walk and bike from close-in neighborhoods to destinations along the corridor.

Improve quality of pedestrian and bicycle facilities

- Improve sidewalks and walkways along US 97:
  - Include landscape buffers between pedestrians and fast moving automobiles to increase pedestrian comfort and reduce the level of stress.
  - Reduce the frequency and lengths of sidewalk interruptions due to driveway cuts to improve pedestrian safety.
  - Provide direct walkway connections between adjacent businesses at or near the building facades to encourage walking between nearby destinations.
  - Provide sidewalks with appropriate widths and features that reflect their context, which may include the need for street furnishings, outdoor merchandise display, or café seating.
  - Provide safe and convenient sidewalk and walkway connections to street crossings.

- Improve bicycle facilities along US 97
    - Enhance bike lanes to include visual and/or physical separation from automobile traffic to increase bicyclist visibility, provide additional comfort for people on bikes, and reduce their level of stress.
    - Design bike facilities that accommodate both experienced cyclists riding the length of the corridor and less experienced cyclists riding between nearby destinations.
    - Provide safe and convenient crossing opportunities of US 97 and cross streets.
- Improve safety and comfort of crossings
    - Minimize crossing distances by keeping travel lane widths and curb radii at a minimum.
    - Provide pedestrian refuge islands, particularly at unsignalized crossings.
    - Provide advance stop bars to increase visibility and reduce the risk of multiple-threat crashes.
    - Include appropriate street lighting to increase visibility of people on foot or bike.

Appendix F US97 SRC Public Involvement Memo

Oregon Department of Transportation

Public Involvement Memo

Date:	Friday, October 06, 2017
Project:	**US 97 South Redmond Corridor Project**
To:	ODOT
From:	HDR
Subject:	**Public Involvement Memo**

Project Overview

The Oregon Department of Transportation (ODOT), in collaboration with the City of Redmond, is studying potential improvements to the US 97 South Redmond Corridor. With businesses directly lining this portion of the highway, safety is a concern as cars pull on and off of the highway abruptly, creating potential for collisions and disruptions in traffic. The US 97 South Redmond Corridor Project will work closely with local property owners, corridor users and the City of Redmond to devise roadway solutions that provide safety and economic viability to the community as a whole.

The purpose of public involvement in this project is to fully understand stakeholder issues in regards to the US 97 Corridor. It also seeks to engage stakeholders in alternatives, development and selection of the project design.

Objectives

Key project objectives that should be communicated throughout the public involvement process include:

- Improve access to local businesses and promote economic vitality
- Increase safety along the corridor
- Create a more welcoming and pedestrian-friendly environment
- Establish connectivity to downtown Redmond, and between the highway and surrounding neighborhoods

Key Messages

Key messages that should be communicated throughout the project include:

- We're not starting from scratch. Discussions about the US 97 South Redmond Corridor have been underway for several years as traffic on the highway and tourism in Redmond have been steadily increasing, posing the need for improvements.

- With businesses directly lining this section of US 97, safety is a concern as cars pull on and off of the highway abruptly, creating potential for collisions and disruptions in traffic. Because of this, changes in access to businesses along the highway are needed to improve safety.
- Updates to this area of Highway 97 are necessary to improve access to local businesses, increase safety, create a welcoming environment, and establish connectivity to downtown Redmond and surrounding neighborhoods.
- Collaborating closely with businesses along the corridor, ODOT will create solutions that benefit the community while improving highway safety and operations.

Key Stakeholders & Issues

Key stakeholders for this project include agencies, property and business owners, residents and stakeholders of other interests. Below is a list of key stakeholder groups and the issues they are likely to be interested in. By identifying stakeholders and their areas of concern, the team can engage in targeted outreach around specific concerns.

Stakeholder Group	Key Issues	Description
Business Owners	• Business Access	Business owners may be concerned with retaining easy access to their businesses for maximum economic opportunity.
Property Owners	• Business Access • Changes to properties and structures	While also concerned with business access, property owners may be interested in whether changes to the size or look of their properties will be required with construction of a new design. They'll also be interested in who is required to pay for those changes.
Residents	• Connectivity • Bicycle/Pedestrian Facilities • Traffic	Residents may be interested in creating improved connectivity between their homes, the highway and businesses. They may also be concerned about potential changes in traffic patterns, as well as opportunities for bicycle and pedestrian facilities.
The City of Redmond	• Coordination with Local Plans • Tourism • Business Access • Transportation Network • Safety	The City may be concerned with how this project fits into the local Transportation System Plan and the overall transportation network. Additionally, it may take interest in the opportunity to increase tourism and create better business access while maintaining safety.
Deschutes County	• Coordination with Regional Plans • Transportation Network • Safety	The County may be interested in coordinating with regional roadway plans and how this project will affect the overall transportation network. Safety in the region may also be of concern.
Freight Interests	• Transportation Network • Traffic	Truck drivers and companies who use this route for deliveries may be interested in how the project will affect their route and traffic patterns along it.
Frequent Highway Users	• Traffic • Transportation Network • Business Access	General highway users, such as those who commute between Redmond and Bend for work, may be interested traffic changes along the highway. They may

		also be interested in gaining safer, easier access to businesses along the corridor.
Multimodal Interests	• Bicycle/Pedestrian Facilities • Business Access	Bicyclists, pedestrians and related advocacy groups may be interested in the opportunity to create a safer, more accessible environment for multimodal use. They may also be interested in future multimodal access to businesses in the area.
Elected Officials	• Coordination with Local Plans • Business Access • Transportation Network	Elected officials in the city of Redmond will be interested in coordinating with other local plans and initiatives for the area, as well as increasing business opportunity.

See **Appendix A** for an ongoing Stakeholder Database with contact information for specific stakeholders. The team will continue to add to this list as new stakeholders present themselves.

Committees

The following selected committees are an important aspect of the planning process for this project. They represent a wide variety of interests and initiatives throughout the local, regional and state community. Lists of committee members and their contacts will be attached to this document in Appendix B as they become available.

Stakeholder Advisory Committee (SAC)

The Stakeholder Advisory Committee highlights the importance of local community members in the planning process. The selected SAC consists of the following members:

Gill Platt	Business Owner	Mindstate Power Sports
Charley Miller	Business Owner	Miller Lumber
Lindsey Greco	Business Manager	Wilson's Furniture
Paul Rodby	Business Owner	McDonald's
Frank Bowen	Business Owner	Napa Auto Parts
Jeff Nordstrom	Manager	Safeway
Mark Malott	Business Owner	Central Oregon Ranch Supply
Laura Garcia	Business Owner	Mazatlan
Scott Carlson	Community Member	Hooker Creek Construction Materials
Jon Stark	Community Member	Economic Development for Central Oregon
Ed Fitch	Community Member	Fitch Law Group
Bill Hilton	Community Member	Redmond Urban Area Planning Commission
Joseph Zika	Planning	Redmond Urban Area Planning Commission
Angela Boothroyd	Business	Redmond Executive Association
Roger Lee	Business	Economic Development for Central Oregon
Bill Braly	Bike/Ped	Redmond Bicycle & Pedestrian Advisory Committee
Michael Duncan	Project Manager	ODOT

Technical Agency Group (TAC)

The Technical Agency Group consists of staff members from the Oregon Department of Transportation, the City of Redmond and the Oregon Department of Land Conservation and Development. Members include:

Michael Duncan	Project Manager	ODOT
Scott Woodford	Planning Lead	City of Redmond
David Knitowski	Region Access Management Engineer	ODOT
Joel McCarroll	Traffic/Safety	ODOT
Matin Matejsek	Roadway	ODOT
Amy Pfeiffer	Environmental	ODOT
Jenny Kneece	Right of Way	ODOT
Abbey Driscoll	Community Liaison	ODOT
Mike Caccavano	City Engineer	City of Redmond
Bill Duerden	Public Works Director	City of Redmond
David Pilling	Public Works Development Manager	City of Redmond
Scott Edelman	Central Oregon Regional Representative	Oregon DLCD

Steering Committee (SC)

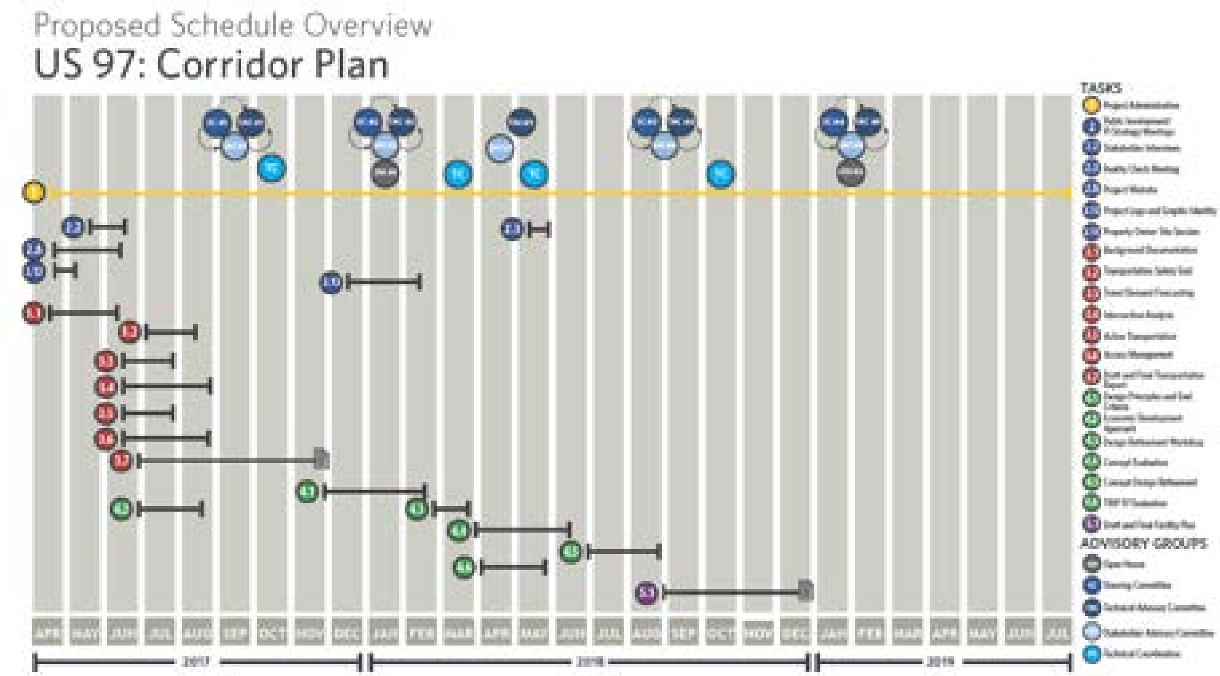
The Steering Committee consists of the following members:

Gary Farnsworth	ODOT
Bob Bryant	ODOT
Keith Witcosky	City of Redmond
Kate Porsche	City of Redmond

Schedule

The Public Involvement Schedule lays out dates and descriptions for each outreach activity. Specific dates and other important information will be added to the schedule as it becomes available. The PI Schedule is followed by a graphic representation of the overall Project Schedule, which includes events relating to research, planning and design in addition to PI activities.

Public Involvement Schedule		
What	**When**	**Notes**
Stakeholder Interviews	May – July 2017	Several interviews conducted with individual stakeholders and small groups to receive feedback used in planning
PI Plan and Stakeholder List	Draft September 2017 Final October 2017	Creation of a plan that outlines project objectives, key messages, stakeholders and the schedule for implementation
Project Logo/Graphic Identity	June 2017	Coordination with designer to create a succinct project logo that will represent the project and appear on all project-related materials
Project Website	Website Launch – August 2017	Creation of an informative project website that presents opportunities for public feedback and updates on project events
Factsheet Newsletter /Mailer (Optional)	TBD	A fact sheet or newsletter announcement mailed to stakeholders, if deemed necessary
Property Owner Site Sessions	November 2017 – February 2018	Visits to property owners and owner groups, as identified and needed
Open House Events (2)	January 2018 (Date TBD) January/February 2019 (Date TBD)	Two open houses held in Redmond that are open to the general public to inform interested parties about the project and offer opportunities for feedback and involvement
Stakeholder Advisory Committee Meetings (4-5)	September – October 2017 January – February 2018 April – May 2018 August – September 2018 January – February 2019 (Optional)	Meetings with the selected Stakeholder Advisory Committee at key points in the project. These will coincide with the timing of other committee meetings.



Outreach Activities

A list of public involvement techniques and activities that will be used throughout the project are provided below. Refer to the Public Involvement Schedule above for dates and descriptions of each of the activities.

- Open Houses (2)
- Stakeholder Advisory Committee meetings (4-5)
- Face-to-face stakeholder interviews
- Project website
- Newsletter/mailer (optional)

Attachment A. [Stakeholder Database]

US 97 South Redmond Corridor Stakeholder List

Category	Name	Organization	Title	Email	Phone	Address	City	Zip	Source
Project Team	Abbey Driscoll	ODOT	Community Liaison	Abbey.DRISCOLL@odot.st	541-388-6064				
Stakeholder	Adriana Leon					1604 S Hwy 97			97 Traffic Petition
Stakeholder	Alex Hendrickson					250 SW Indian Ave			97 Traffic Petition
Stakeholder	Allie Colosky			acolosky@bendbulliten.com					Open House 1
Stakeholder	Amy Peebles			amycp7@yahoo.com	541-280-3341				Open House 1
Project Team	Andy Johnson	HDR	Project Manager	andrew.johnson@hdrinc.	(503) 423-3749	1001 SW 5th Avenue, Suite	Portland	97204-1134	
Agency	Annie McVay	City of Redmond		annie.mcvay@ci.redmond.or.us					Open House 1
Elected	Anthony DeBone	Deschutes County	Commissioner	Tony.DeBone@deschutes	(541) 388-6568	1300 NW Wall St	Bend		
Stakeholder	Antoine Santos								97 Traffic Petition
Stakeholder	Ashish Pato					15445 Hwy 97			97 Traffic Petition
Stakeholder	Aurora Bartolonekuiz					1604 S Hwy 97			97 Traffic Petition
Agency	Bill Duerden	City of Redmond		bill.duerden@ci.redmond.or.us					Open House 1
Stakeholder	BJ Higgins					23335 S Hwy 97			97 Traffic Petition
Stakeholder	Brad Evest			aspendev@bendcable.co	541-408-7978	61165 River Bluff	Bend	97702	Open House 1
Stakeholder	Brenda Grow					1910 S Hwy 97			97 Traffic Petition
Stakeholder	Brian Hefter			bhefter12@gmail.com					Open House 1
Business	Calvin Olheiser	Abby's Legendary Pizza	General Manager	Gm54@abbyspizza.com	(541) 548-5266	1938 S Hwy 97	Redmond	97756	
Elected	Camden King	Redmond City Council	Councilor	Camden.King@ci.redmon	541-280-2258	411 SW 9th St.	Redmond	97756	
Stakeholder	Cameron Joyce					5063 S Hwy 97			97 Traffic Petition
Stakeholder	Candice Harvey					1548 S Hwy 97			97 Traffic Petition
Project Team	Cari Charlton	ODOT	Project Manager	Cari.Charlton@ODOT.state.or.us					
Stakeholder	Catherine McFarland					1421 S Hwy 97	Redmond	97756	97 Traffic Petition
Stakeholder	Chance Koch					2130 S Hwy 97			97 Traffic Petition
Stakeholder	Char Berry					2421 S Hwy 97			97 Traffic Petition
Stakeholder	Chase Gillespie					2750 SW Indian Ave			97 Traffic Petition
Stakeholder	Colleen Leary	The Greens Homeowne	President		(503) 887-3321				Open House 1
Stakeholder	Craig Tgh					2130 S Hwy 97			97 Traffic Petition
Stakeholder	Crystal Richmond					2600 SW Canal			97 Traffic Petition
Stakeholder	Daniel Jones					2184 S Hwy 97			97 Traffic Petition
Stakeholder	Darren Graciano					1532 S Hwy 97			97 Traffic Petition
Agency	Deborah McMahon	City of Redmond	Planning Manager	Deborah.McMahon@ci.re	541-923-7724	411 SW 9th St.	Redmond	97756	
Stakeholder	Derek Baker			Dande4x4@hotmail.com					Via website contact form
Project Team	Doug Zenn	HDR	Public Involvement Proje	doug.zenn@hdrinc.com	503.423.3889	1001 SW 5th Avenue, Suite	Portland	97204-1134	
Stakeholder	Eduardo Villiana					2330 S Hwy 97			97 Traffic Petition
Business Organiz	Eric	Redmond Chamber of C	Executive Director	info@visitredmondoregon	541-923-5191	446 SW 7th Street	Redmond	97756	
Stakeholder	Eric Sande	Redmond Chamber of Commerce		eric@visitredmondoregon.com		446 SW 7th St	Redmond		Open House 1
Stakeholder	Eric Wilson					2127 Hwy 97			97 Traffic Petition
Stakeholder	Frank Platt					32905 Hwy 97			97 Traffic Petition
Stakeholder	Fred Baldwin					284 NW Lynch Lane			97 Traffic Petition
Stakeholder	Fred Lelacheur	Fly Redmond		fred.lelacheur@flyrdm.com					Open House 1
Stakeholder	Gary Snair					22905 S Hwy 97			97 Traffic Petition
Elected	George Endicott	Redmond City Council	Mayor	George.Endicott@ci.redm	541-948-3219	411 SW 9th St.	Redmond	97756	
Stakeholder	Georgia Nonemaker					3000 S Hwy 97			97 Traffic Petition
Elected	Ginny McPherson	Redmond City Council	Councilor	Ginny.McPherson@ci.red	541.923.7710	411 SW 9th St.	Redmond	97756	
Project Team	Heather Cassaro	City of Redmond	Communications Manage	Heather.Cassaro@ci.redm	(541) 504-3031	411 SW 9th St.	Redmond	97756	
Stakeholder	Heidi Mauch					15985 Hwy 97			97 Traffic Petition
Stakeholder	Henry Keesling			halkeesling@yahoo.com					Via website contact form
Stakeholder	Irene Francis			jhipf7@yahoo.com					
Stakeholder	Jack White					15725 Hwy 97			97 Traffic Petition

Stakeholder	Jamie Lakanen	Abby's Legendary Pizza							97 Traffic Petition
Business Organiz	Jana Jarvis	Oregon Trucking Associa	President	jana@ortrucking.org	503.513.0005	4005 SE Naef Road	Portland	97267	
Elected	Jay Patrick	Redmond City Council	Councilor	Jay.Patrick@ci.redmond.o	541-508-8408	411 SW 9th St.	Redmond	97756	
Stakeholder	Jeff England			jeff@cipconsult.com					Via website contact form
Stakeholder	Jenny Oroch					2570 S Hwy 97			97 Traffic Petition
Business	Jerry Jones	Norco		jerryj@norco-inc.com	(541) 548-1044	3039 S Hwy 97	Redmond	97756	
Stakeholder	Jesse White					1604 S Hwy 97			97 Traffic Petition
Stakeholder	Jim Cook	Studio JMC		jim@studiojmc.com					Open House 1
Stakeholder	Jim Jacobs					2145 S Hwy 97	Redmond	97756	97 Traffic Petition
Stakeholder	Joe Bessman	Transight Consulting		joe@transightconsulting.com					Via website contact form
Rail	Johan Hellman	BNSF Railway Co	Regional AVP for OR,WA and BC		206-625-6135	2454 Occidental Ave. So., B	Seattle	98134	
Stakeholder	John & Linda Callahan			John_N_Linda@yahoo.co	503-805-5372	979 SW 26th	Redmond		Open House 1
Business Organiz	Jon Stark	Economic Development for Central Oregon		jon@edcoinfo.com	541-923-5223	411 SW 9th St., Suite 203	Redmond	97756	
Stakeholder	Jonathon Murders	Dextra Construction		jonathon@dextraconstruction.com		PO Box 1824	Redmond	97756	Open House 1
Elected	Joseph Centanni	Redmond City Council	Councilor	Joe.Centanni@ci.redmond	541-350-1013	411 SW 9th St.	Redmond	97756	
Stakeholder	Justin Peterson			justinwpeterson@gmail.c	541-510-1253	1542 NW 22nd St.	Redmond		Open House 1
Stakeholder	Karin D Powers					24215 S Hwy 97			97 Traffic Petition
Stakeholder	Katerina Lesoparsky								97 Traffic Petition
Agency	Katie Hammer	Redmond Parks & Recre	Executive Director	raprd@raprd.org	541-548-7275	465 SW Rimrock Dr	Redmond	97756	
Stakeholder	Keith Sides			sideskeith@gmail.com					Via website contact form
Stakeholder	Kelly Carter					2209 SW 97	Redmond	97756	97 Traffic Petition
Stakeholder	Kim Eorto					2005 SW Hwy 97			97 Traffic Petition
Stakeholder	Lana Haas					821 NW Kingwood Ave			97 Traffic Petition
Stakeholder	Larry & Kathy Morris			lkmorris@msn.com		1535 NW Kingwood Ave.	Redmond		Open House 1
Property Owner	Lawnae Hunter	Hunter Properties	Owner	lhunter@plusmanagemen	541-923-6768	695 SW Mill View Way	Bend	97702	
Stakeholder	Lee Barker				541-923-2571	1312 SW Evergreen	Redmond		Open House 1
Project Team	Lindsay McWilliams	HDR	Public Involvement Coord	lindsay.mcwilliams@hdrin	503-423-3842	1001 SW 5th Avenue, Suite	Portland	97204-1134	
Stakeholder	Lisa Goad					2127 S Hwy 97			97 Traffic Petition
Stakeholder	Lonnie Cotter					843 SW 24th Ct			97 Traffic Petition
Stakeholder	Lorraine K Laknes					3601 Valley View Court			97 Traffic Petition
Stakeholder	Manuel Meda					750 NE Quince Avnue			97 Traffic Petition
Stakeholder	Marjorie Lickley			marjiedell@hotmail.com					Open House 1
Stakeholder	Marti Hicks			donandmarti@yahoo.com	541-516-1120	3849 SW Tommy Armour La	Redmond		Open House 1
Stakeholder	Megan Curtis					2421 S Hwy 97			97 Traffic Petition
Stakeholder	Mike Reinemer			mikereinemer@gmail.com		PO Box 1447	Redmond	97756	Open House 1
Stakeholder	Nancy Shaver			shavers2@yahoo.com	541-788-5458	2646 SW Juniper Lane	Redmond		Open House 1
Business	Pablo Pena	Madealine's Grill & Stea	Owner	pablopena15@gmail.com	(541) 548-9964	2414 S Hwy 97	Redmond	97756	
Stakeholder	Pamela Lester					2421 S Hwy 97			97 Traffic Petition
Stakeholder	Paul Snobech					1604 S Hwy #12			97 Traffic Petition
Elected	Phil Henderson	Deschutes County	Commissioner	Phil.Henderson@deschut	(541) 388-6569	1300 NW Wall St	Bend		
Stakeholder	Ray Lengele					2523 NW 35th			97 Traffic Petition
Stakeholder	Richard Tomera			oregon.truck@rocketmail	541-699-8982	808 NW 13th St	Redmond	97756	Open House 1
Agency	Rob Peters	City of Redmond	Transportation Division M	Rob.peters@ci.redmond.o	(541) 504-2018	411 SW 9th St.	Redmond	97756	
Agency	Robert Bryant	ODOT	Region 4 Manager	Robert.W.BRYANT@odot.	541-388-6184	63055 North Highway 97	Bend	97703	
Stakeholder	Sean W Anthony					2014 S Hwy 97			97 Traffic Petition
Elected	Tammy Baney	Deschutes County	Commissioner	Tammy.Baney@deschute	(541) 388-6567	1300 NW Wall St	Bend		
Stakeholder	Thomas Kuhn					2392 S Hwy 97			97 Traffic Petition
Stakeholder	Tia Hines					1935 S Hwy 97			97 Traffic Petition
Business	Todd Layport	Layport, Inc.	Owner		541-604-4843 541-548-2722	1705 SW Odem Medo Rd	Redmond	97756	
Stakeholder	Tom Katzke		Resident	tkatzke@yahoo.com					Via website contact form

Stakeholder	Tom Michael					2190 S Hwy 97			97 Traffic Petition
Project Team	Tom Shook	HDR	Deputy Project Manager	thomas.shook@hdrinc.co	503-423-3777	1001 SW 5th Avenue, Suite	Portland	97204-1134	
School	Tony Pup	Redmond School Distric	Director of Operations	anthony.pupo@redmond	541.923.5437 ext 11	145 SE Salmon Ave	Redmond	97756	
Elected	Tory Allman	Redmond City Council	Councilor	Tory.Allman@ci.redmond	541-923-7710	411 SW 9th St.	Redmond	97756	
Stakeholder	Tracy Resnick					2058 S Hwy 97			97 Traffic Petition
Stakeholder	Travis Kloo					532 SW Rimrock			97 Traffic Petition
Stakeholder	Tuan Nguyen					1440 Majestic Rock Drive			97 Traffic Petition
Stakeholder	Vicky & Charlie Mauck			2charlievicky@gmail.com	530-925-2164 530-859-2995	3533 SW47th St	Redmond	97756	Open House 1
Stakeholder	Vicky Spalinger					2130 S Hwy 97			97 Traffic Petition
Stakeholder	Victoria Stephens					1833 SW Canal			97 Traffic Petition
Stakeholder	Yadika Medina					2403 NW Glen Oak			97 Traffic Petition
Business	Zachary Bass	Redmond Airport	Airport Director	RDM@flyrdm.com	541-504-3499	2522 SE Jesse Butler Circle,	Redmond	97756-8642	
Business		O'Reilly Auto Parts			(541) 504-8114	1154 US-97	Redmond	97756	
Business		Taco Bell			(541) 548-5580	1214 S Highway 97	Redmond	97756	
Business		Cindy's Chinese Garden			(541) 923-9928	1362 S Hwy 97	Redmond	97756	
Business		Verizon			(541) 923-9970	1438 S Hwy 97	Redmond	97756	
Business		Walgreens			(541) 548-1731	1450 S Hwy 97	Redmond	97756	
Business		Columbia Bank		jcreamer@columbiabank.	(541) 923-4400	1502 SW Odem Medo Way	Redmond	97756	
Business		Redmond Cinema			(541) 548-8777	1535 SW Odem Medo W	Redmond	97756	
Business		Redmond Inn			(541) 548-1091	1545 S Hwy 97	Redmond	97756	
Business		Domino's Pizza			(541) 504-5577	1604 S Hwy 97	Redmond	97756	
Business		Express Eco Laundromat			(541) 728-3715	1604 S Hwy 97 #1	Redmond	97756	
Freight		YRC Freight			(541) 548-2537	1701 SW 1st St	Redmond	97756	
Business		CoEnergy Propane		info@CoEnergy.net	(541) 504-9444	1818 S Hwy 97	Redmond	97756	
Freight		Saia Motor freight Line			(541) 548-1379	2051 SW 1st St	Redmond	97756	
Business		Silver Moon Brewing (Production Facilitiy)			(541) 388-8331	2095 SW Badger Ave	Redmond	97756	
Business		Redmond Antique Mall		redmondantiquemall@gn	541) 548-6208	2127 S Hwy 97	Redmond	97756	
Business		ACE Cash Express			(541) 923-3386	2130 S Hwy 97 Ste	Redmond	97756	
Freight		Roadrunner Express		cs@roadrunner-express.c	(541) 923-6224	2138 SW 2nd Ct	Redmond	97756	
Business		Wet Willy's			(541) 923-2300	2180 S Hwy 97	Redmond	97756	
Business		Comfort Suites Redmond Airport			(541) 504-8900	2243 SW Yew Ave	Redmond	97756	
Business		La Frontera			(541) 504-0708	2330 US-97	Redmond	97756	
Business		Gills Point S Tire		bjhiggins@pointstire.com	(541) 548-6171	2333 S Hwy 97	Redmond	97756	
Business		Hub City Bar & Grill		greg97756@q.com	(541) 923-7101	2498 US-97	Redmond	97756	
Business		Best Western Plus Rama Inn			(541) 548-8080	2630 SW 17th Pl, Redmond	Redmond	97756	
Business		LKQ Brad's Auto and Truck Parts		awkanski@lkqcorp.com	(800) 232-2723	2727 SW 13th St	Redmond	97756	
Business		Big Country RV				2795 S Hwy 97	Redmond	97756	
Business		Blue Dog RV			541-526-7799	2910 S HWY 97	Redmond	97756	
Business		Jim Smolich Motors			(541) 548-1448	2987 S Hwy 97	Redmond	97756	
Business		Northwest Farm Credit Services			(541) 504-3500	3113 S Highway 97 # 100	Redmond	97756	
Business		Midstate Power Products			(541) 548-6744	3290 S Hwy 97	Redmond	97756	
Business		Resers Fine Foods			(541) 548-8666	3292 S Hwy 97	Redmond	97756	
Business		Ferguson Waterworks			(541) 548-2865	3292 S Hwy 97	Redmond	97756	
Business		Possibilities Thrift Store		info@opportunityfound. org	(541) 548-5288	3294 S Hwy 97	Redmond	97756	
Business		Timber's Bar & Grille			(541) 923-7604	3315 S Hwy 97	Redmond	97756	
Business		BasX Solutions		info@basxsolutions.com	(541) 647-6650	3500 SW 21st Pl	Redmond	97756	
Faith-based		Mission Church Redmond Campus			(541) 526-5505	3732 SW 21st Pl #104	Redmond	97756	
Business		Kim & Karla's			(541) 516-8556	3835 SW 21st St #5	Redmond	97756	

Business		Fitness 1440			(541) 504-6050	3853 SW 21st St #107	Redmond	97756	
Business		Hershey Cattle			(541) 548-3949	4098 S Hwy 97	Redmond	97756	
Business		Absolute Spas & Billiards		adgenie@gmail.com	(541) 504-2570	4500 S Hwy 97	Redmond	97756	
Business		Storage Central							

Attachment B. [Committees]

DRAFT Committee Roster

1. Stakeholder Advisory Committee (SAC)

Gill Platt	Business Owner	Mindstate Power Sports
Charley Miller	Business Owner	Miller Lumber
Lindsey Greco	Business Manager	Wilson's Furniture
Paul Rodby	Business Owner	McDonald's
Frank Bowen	Business Owner	Napa Auto Parts
Jeff Nordstrom	Manager	Safeway
Mark Malott	Business Owner	Central Oregon Ranch Supply
Laura Garcia	Business Owner	Mazatlan
Scott Carlson	Community Member	Hooker Creek Construction Materials
Jon Stark	Community Member	Economic Development for Central Oregon
Ed Fitch	Community Member	Fitch Law Group
Bill Hilton	Community Member	Redmond Urban Area Planning Commission
Joseph Zika	Planning	Redmond Urban Area Planning Commission
Angela Boothroyd	Business	Redmond Executive Association
Roger Lee	Business	Economic Development for Central Oregon
Bill Braly	Bike/Ped	Redmond Bicycle & Pedestrian Advisory Committee
Michael Duncan	Project Manager	ODOT

2. Technical Advisory Committee (TAC)

Michael Duncan	Project Manager	ODOT
Scott Woodford	Planning Lead	City of Redmond
David Knitowski	Region Access Management Engineer	ODOT
Joel McCarroll	Traffic/Safety	ODOT
Matin Matejsek	Roadway	ODOT
Amy Pfeiffer	Environmental	ODOT
Jenny Kneece	Right of Way	ODOT
Abbey Driscoll	Community Liaison	ODOT
Mike Caccavano	City Engineer	City of Redmond
Bill Duerden	Public Works Director	City of Redmond
David Pilling	Public Works Development Manager	City of Redmond
Scott Edelman	Central Oregon Regional Representative	Oregon DLCD

3. Steering Committee (SC)

Gary Farnsworth	ODOT
Bob Bryant	ODOT
Keith Witcosky	City of Redmond
Kate Porsche	City of Redmond

Appendix G US97 SRC Open House Mailer

FROM
City Hall

THE CITY NEEDS YOUR INPUT!

Joint Transportation System Plan Update and US97 South Redmond Corridor Project Open House 2018

The City of Redmond will host an Open House on Wednesday, February 7, 2018 from 4:00 - 6:00 p.m. at Redmond City Hall, 411 SW 9th Street. Residents and business owners are encouraged to attend, meet with Redmond's transportation project teams, review our current systems, and provide feedback on proposed future walking, biking, driving, public transit and freight improvements. Through this effort, and with your help, the City of Redmond will identify the best ways to build upon our existing system and make smart future investments to increase choices for getting around.

The Open House will also focus on proposed improvements to the South US97 corridor as they relate to access, medians, landscaping, and center lanes. As the City of Redmond continues to grow, updates to Highway 97 south of downtown are necessary to improve safety and mobility, spur economic development and promote corridor vitality while maintaining the community's unique character. The Oregon Department of Transportation and the City of Redmond are collaborating closely with businesses along the corridor to create solutions that benefit the entire community while improving highway safety and operations.

This is a great opportunity for attendees to review improvement concepts and give valuable input. For more information or if you can't make it in person, visit www.southredmond97.org and / or http://redmondtsp.com/ where you can review project materials and provide comments.

Appendix H US97 SRC Site Session Mailer

US 97 SOUTH REDMOND CORRIDOR PROJECT

Dear US 97 Businesses and Property Owners,

We need your input!

The Oregon Department of Transportation and the City of Redmond invite business and property owners along the US 97 corridor to come to an informational session to preview potential concepts for the US 97 South Redmond Corridor Project. At each session, project team members will be on hand to discuss two potential concepts and collect feedback about how changes might benefit or impact nearby businesses. Please join us at the session closest to you or at a time that is most convenient.

Project Area Business and Property Owner Meetings

Wednesday, June 13th, 2018

11:00 a.m. – 12:00 p.m. at Mazatlán Mexican Restaurant
1:00 p.m. – 2:00 p.m. at Abby's Legendary Pizza
3:00 p.m. – 4:00 p.m. at Madaline's Grill & Steakhouse

You're also welcome to join us for the **Stakeholder Advisory Committee meeting on June 13th from 5:30 p.m. – 7:30 p.m. at Redmond City Hall** (411 SW 9th Street, Redmond, OR).

If you cannot attend a session and would like to discuss the project, please contact us through the project website at **www. southredmond97.org/contact**.

Thank you. We appreciate your input.

Sincerely,

Cari Charlton, ODOT Project Manager
Email: Cari.Charlton@odot.state.or.us
Phone: (541) 388-6047

MAKING THE CORRIDOR SAFER & MORE VIBRANT

The Oregon Department of Transportation and the City of Redmond are collaborating to improve safety and operations on US 97 with solutions that benefit the entire community. With the community's input, the project team is studying concepts to make the US 97 South Redmond Corridor a safer, more vibrant business district. The project team would like to dicuss these concepts with you. **See inside for more details.**

LEARN MORE ONLINE
www.SouthRedmond97.org

Oregon Department of Transportation

ODOT Region 4
63055 North Highway 97
Bend, OR 97703

APPLY POSTAGE HERE

Name
Addresss
City, State, Zip Code

Appendix I US97 SRC Alternatives A and B Fact Sheet

Creating a Safer, More Vibrant Corridor

As the city of Redmond continues to grow, Highway 97 south of downtown requires updates to improve safety and mobility, spur economic development and promote corridor vitality while maintaining the community's unique character. The Oregon Department of Transportation and the City of Redmond are continuing to collaborate with businesses to create solutions that will keep the corridor vibrant in the future while improving highway safety and operations.

Working with a Stakeholder Advisory Committee, the project team has developed two potential design concepts that are consistent with previous visions. Public input and technical analysis will continue to shape these concepts to create a final plan that makes the US 97 South Redmond Corridor a safer, more vibrant business district for everyone. The project team is looking to hear from nearby residents, property owners and business owners about how changes might benefit or impact nearby businesses.

See back to learn about potential concepts!

SHARE YOUR THOUGHTS

Your feedback is important to this process. These concepts, along with feedback received from the community, will be discussed at the project's Stakeholder Advisory Group and Technical Advisory Group meetings in the coming months. In fall 2019, the team hopes to have consensus on a prefered option to move forward with.

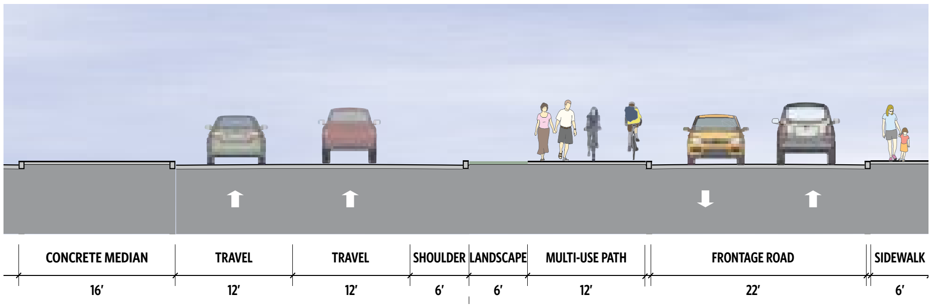
LEAVE A COMMENT

www.southredmond97.org

CONTACT US

Cari Charlton, ODOT Project Manager
Email: Cari.Charlton@odot.state.or.us
Phone: (541) 388-6047

Concept A: A Multi-Way Boulevard

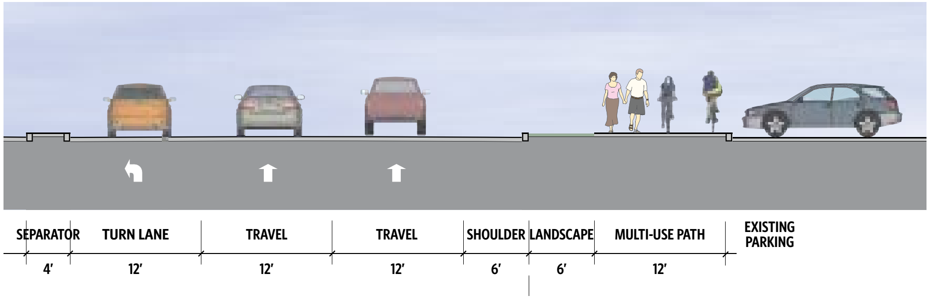


This concept introduces multi-way boulevards to the corridor as a way of managing access to businesses and creating safer access points. Multi-way boulvards run parallel to the highway and can be in front of businesses along the highway (called a frontage road) or behind businesses (called a back access road). In this concept, several frontage roads would be constructed on either side of the highway with designated points of access, along with three areas of back access road. Once on a frontage road, drivers are able to turn in and out of business parking lots at a slower speed, without having to pull directly onto the highway upon exiting.

Key features of this concept include:

- Frontage roads and some back access roads that allow safer access to businesses
- Three new roads that cross the canal and one other additional road that connect US 97 to neighborhoods on the west side
- Traffic separators that allow for additional pedestrian crossings
- New sidewalks and multi-use paths throughout the length of the corridor and along new connecting roads
- Additional landscaping along multi-use paths and new multi-way boulevards
- A new multi-use trail along Canal Boulevard and the canal

Concept B: Channelized Access and Crossings



Concept B proposes traffic separators between the northbound and southbound lanes on US 97, which allow protected left-hand turning movements, as well as U-turns at signalized intersections. It would also add some short segments of frontage road along the highway, primarily between Veterans Way and Odem Medo Way. These combined elements allow for safer turning movements into businesses along the corridor without adding a lot of new roadway, making it a lower-cost option than Concept A.

Key features of this concept include:

- Traffic separators between the northbound and southbound lanes on US 97 allowing protected left-hand turning movements and U-turns at signalized intersections
- Short segments of frontage road between Veterans Way and Odem Medo Way
- Three new roads that cross the canal and one other additional road that connect US 97 to neighborhoods on the west side
- New sidewalks and multi-use paths throughout the length of the corridor and along new connecting roads
- A new multi-use trail along Canal Boulevard and the canal

Appendix J US97 SRC Concepts

Scorecard

OVERVIEW

CRITERIA	CONCEPT A: Multi-Way Boulevard	CONCEPT B: Channelized Access and Circulation	CONCEPT C: Signalized Protected Access	CONCEPT D: Super Street Mobility	CONCEPT E: Recommended Concept
ROW Cost / Impact	Poor	Good	Average	Average	Good
Construction Cost	Poor	Good	Average	Average	Good
Access	Average	Poor	Average	Poor	Average
Safety	Average	Good	Good	Good	Good
Community Character*	Good	Average	Average	Poor	Average
Phaseability	Poor	Good	Good	Average	Good
Traffic Mobility	Poor	Average	Poor	Good	Average
Active Transportation	Good	Good	Good	Good	Good

Qualitative ranking: ● Poor ● Average ● Good

*Note: improvement in Community Character under all options requires the involvement of private property and/or business owners

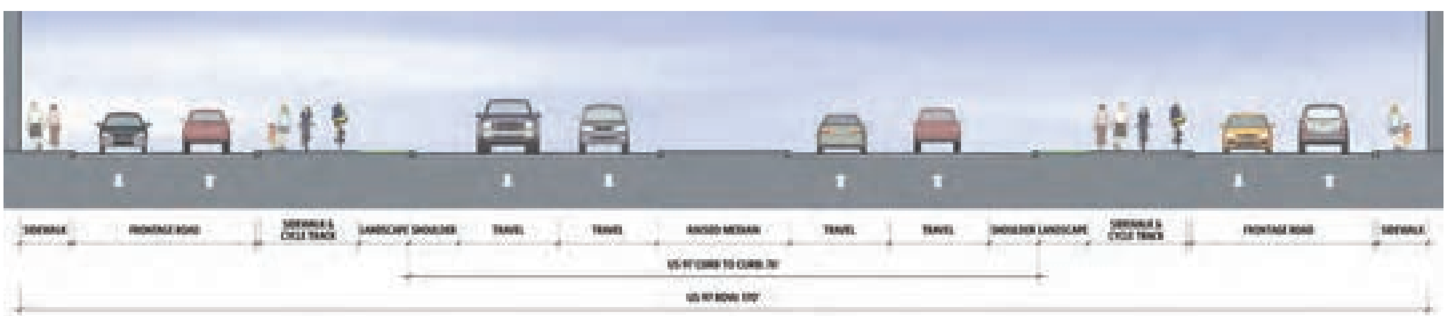
Scorecard

CONCEPT A: Multi-Way Boulevard

This concept introduces multi-way boulevards to the corridor as a way of managing access to businesses and creating safer access points. Multi-way boulevards run parallel to the highway and can be in front of businesses along the highway (called a frontage road) or behind businesses (called a back access road). In this concept, several frontage roads would be constructed on either side of the highway with designated points of access, along with three areas of back access road. Once on a frontage road, drivers are able to turn in and out of business parking lots at a slower speed, without having to pull directly onto the highway upon exiting.

Key features of this concept include:

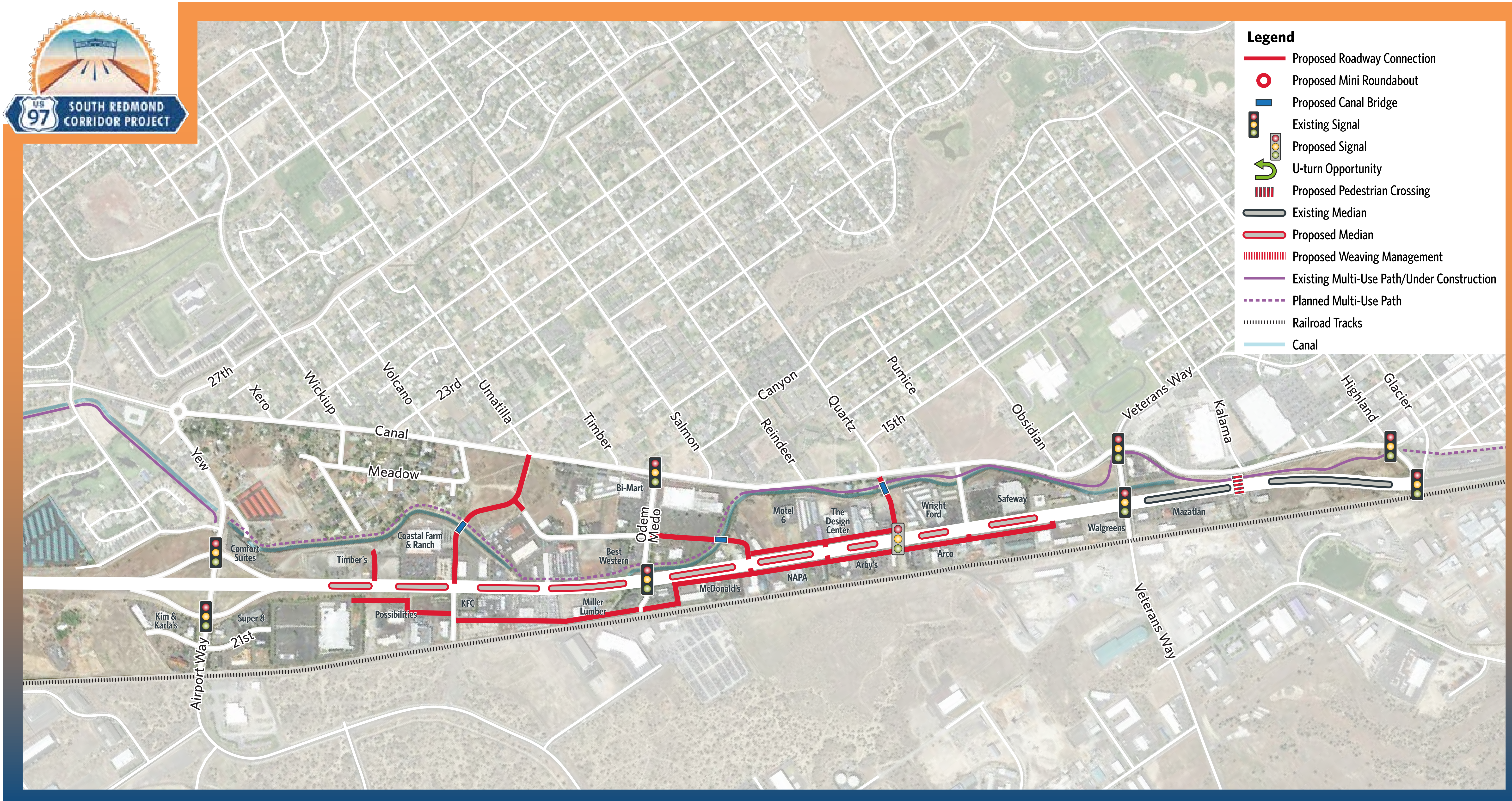
- Frontage roads and some back access roads that allow safer access to businesses
- Three new roads that cross the canal and one other additional road that connect US 97 to neighborhoods on the west side
- Traffic separators that allow for additional pedestrian crossings
- New sidewalks and multi-use paths throughout the length of the corridor and along new connecting roads
- Additional landscaping along multi-use paths and new multi-way boulevards
- A new multi-use trail along Canal Boulevard and the canal



ROW Cost / Impact	Construction Cost	Access	Safety	Community Character	Phaseability	Traffic Mobility	Active Transportation
Poor	Poor	Average	Average	Good	Poor	Poor	Good

Qualitative ranking: ● Poor ● Average ● Good

CONCEPT A - MULTIWAY BOULEVARD



Oregon Department of Transportation

HDR

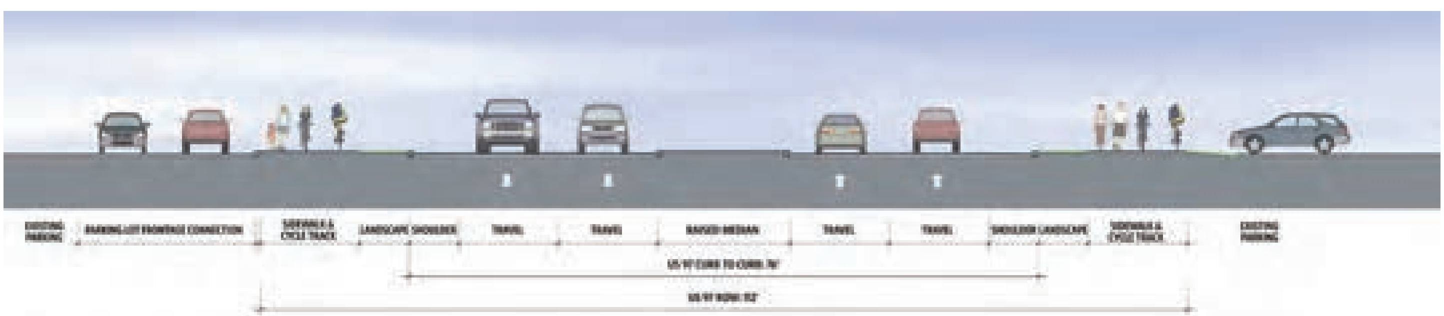
Scorecard

CONCEPT B: Channelized Access and Circulation

Concept B proposes traffic separators between the northbound and southbound lanes on US 97, which allow protected left-hand turning movements, as well as U-turns at signalized intersections. It would also add some short segments of frontage road along the highway, primarily between Veterans Way and Odem Medo Way. These combined elements allow for safer turning movements into businesses along the corridor without adding a lot of new roadway, making it a lower-cost option than Concept A.

Key features of this concept include:

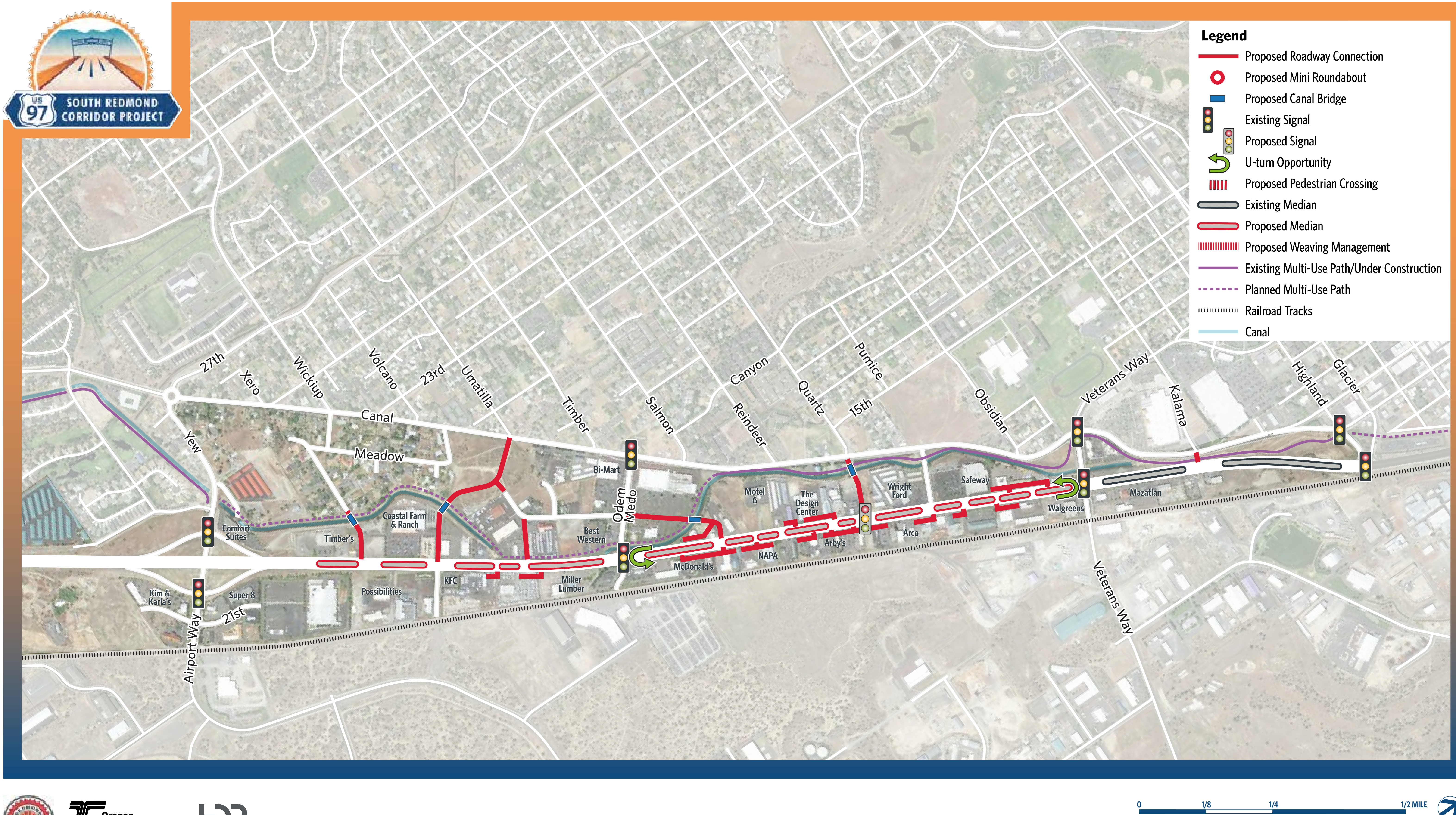
- Traffic separators between the northbound and southbound lanes on US 97 allowing protected left-hand turning movements and U-turns at signalized intersections
- Short segments of frontage road between Veterans Way and Odem Medo Way
- Three new roads that cross the canal and one other additional road that connect US 97 to neighborhoods on the west side
- New sidewalks and multi-use paths throughout the length of the corridor and along new connecting roads
- A new multi-use trail along Canal Boulevard and the canal



ROW Cost / Impact	Construction Cost	Access	Safety	Community Character	Phaseability	Traffic Mobility	Active Transportation
● Good	● Good	● Poor	● Good	● Average	● Good	● Average	● Good

Qualitative ranking: ● Poor ● Average ● Good

CONCEPT B - CHANNELIZED ACCESS & CIRCULATION



Oregon Department of Transportation

HDR

Scorecard

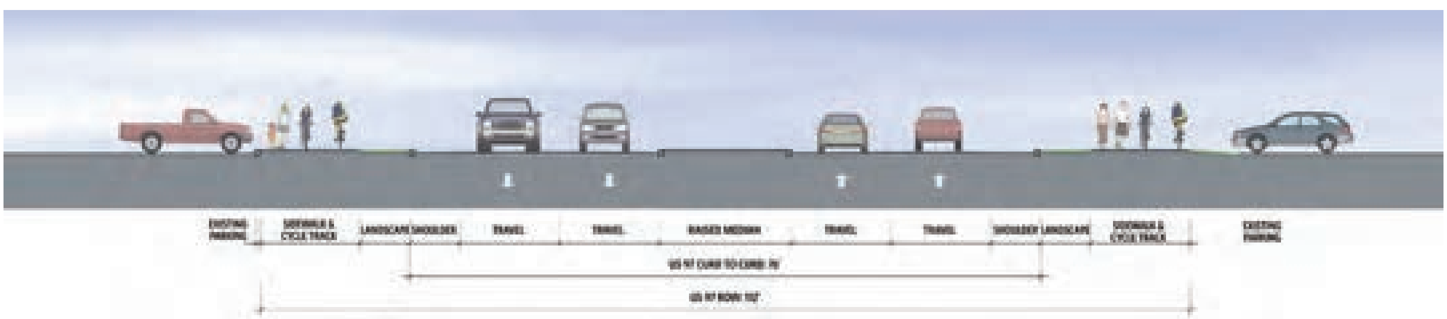
CONCEPT C: Signalized Protected Access

Concept C introduces five new signals as a way to provide safe turns at intersections. In this concept, additional signals slow traffic and offer additional safer crossing areas to connect sidewalks and multi-use paths.

Cost and impacts for this concept are estimated to be lower than concepts A and B.

Key features of this concept include:

- Three new partial signals (protected movement) and two new full signals along US 97
- Three new roads that cross the canal and one other additional road that connects US 97 to neighborhoods on the west side
- Areas for safe pedestrian refuge halfway across the street, where crossing the entire road without delay is difficult
- New sidewalks and multi-use path paths throughout the length of the corridor and along east/west connecting roads
- A new multi-use path trail along Canal Boulevard and the canal (already planned)



ROW Cost / Impact	Construction Cost	Access	Safety	Community Character	Phaseability	Traffic Mobility	Active Transportation
Average	Average	Average	Good	Average	Good	Poor	Good

Qualitative ranking: Poor Average Good

Oregon Department of Transportation

CONCEPT C - SIGNALIZED PROTECTED ACCESS

Oregon Department of Transportation

HDR

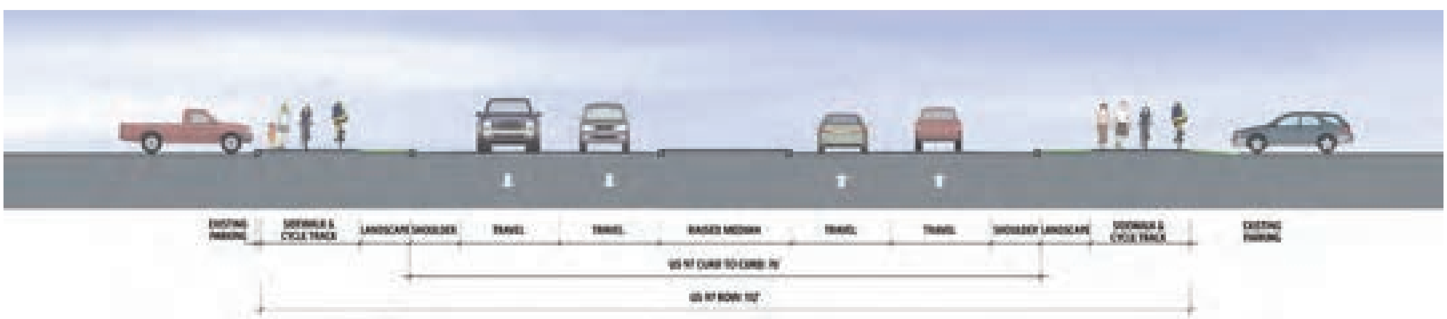
Scorecard

CONCEPT D: Super Street Mobility

This concept introduces U-turns that reduce conflict and movements at intersections. To make a left-turn, drivers must proceed to a designated U-turn area. This concept includes a two-phase signal versus the standard four-phase signal, increasing traffic flow and auto mobility along the corridor. These combined elements reduce congestion without adding new roadway. This concept would best provide mobility for US 97 and minimize delay at the intersections. The costs and new impacts for this concept is estimated to be lower than concepts A and B.

Key features of this concept include:

- Signalized U-turns to reduce conflicts at intersections and reduce delay while accessing businesses
- Three new roads that cross the canal and one additional road that connects US 97 to neighborhoods on the west side
- Additional pedestrian crosswalks
- New sidewalks throughout the length of the corridor and along new east/west connecting roads
- A new sidewalk and multi-use path along Canal Boulevard and the canal (already planned)
- Removal of left turn movements at Veterans



ROW Cost / Impact	Construction Cost	Access	Safety	Community Character	Phaseability	Traffic Mobility	Active Transportation
Average	Average	Poor	Good	Poor	Average	Good	Good

Qualitative ranking: Poor Average Good

CONCEPT D - SUPER STREET MOBILITY

0 1/8 1/4 1/2 MILE

N

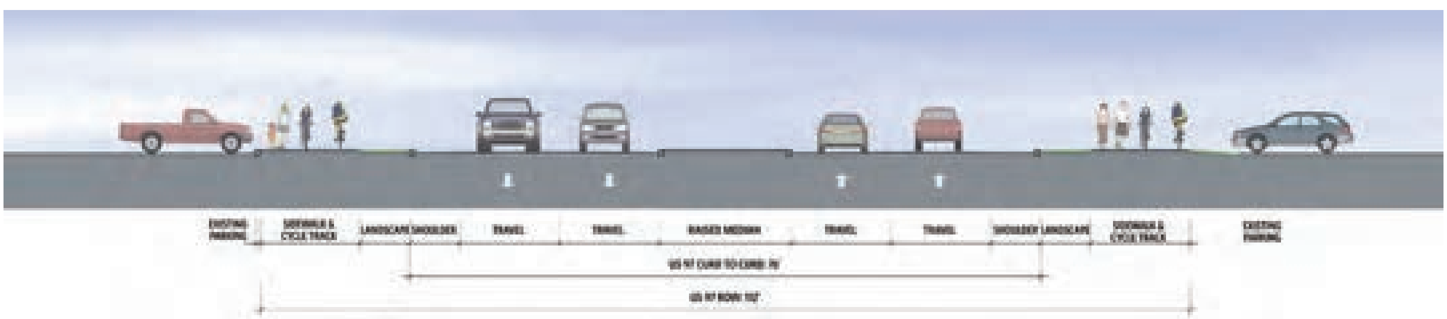
Scorecard

CONCEPT E: Recommended Concept

The recommended concept introduces three new signals and introduces U-turns that reduce conflict and movements at intersections. To make a left-turn, drivers must proceed to a designated U-turn area. In this concept, additional signals slow traffic and offer additional safer crossing areas to connect sidewalks and multi-use paths. Cost and impacts for this concept are estimated to be lower than concepts A and B.

Key features of this concept include:

- Three new signals along US 97
- Three new roads that cross the canal and one other additional road that connects US 97 to neighborhoods on the west side
- Traffic separators between the northbound and southbound lanes on US 97 allowing protected left-hand turning movements and U-turns at signalized intersections
- Areas for safe pedestrian refuge halfway across the street, where crossing the entire road without delay is difficult
- New sidewalks and multi-use path paths throughout the length of the corridor and along east/west connecting roads
- A new multi-use path trail along Canal Boulevard and the canal (already planned)



ROW Cost / Impact	Construction Cost	Access	Safety	Community Character	Phaseability	Traffic Mobility	Active Transportation
Good	Good	Average	Good	Average	Good	Average	Good

Qualitative ranking: ● Poor ● Average ● Good

RECOMMENDED CONCEPT

Oregon Department of Transportation

HDR

Appendix K US97 SRC Stakeholder Interview Summary

TECHNICAL MEMORANDUM

LELAND CONSULTING GROUP	Date	October 05, 2017 | Final
	To	Michael Duncan, ODOT
	From	Dave Siegel, Leland Consulting Group & Tom Shook, HDR

Redmond South US-97 Corridor Plan

Public Involvement: Stakeholder Interview Summary

Contents

Introduction and Background

This stakeholder interview summary is part of a broader planning effort to improve the overall functionality and community benefit of the US Highway 97 (US-97) corridor in South Redmond. A number of transportation and land-use issues currently facing the corridor are identified as having a negative impact on the community, including:

- Problems with safety;
- Poor access and circulation (both vehicular and pedestrian);
- Land underutilization;
- Lack of aesthetic appeal/continuity;
- Auto-dominance; poor walking and biking environment;
- Lack of gateway presence; and
- Confusing wayfinding/signage.

The planning team is considering a range of possible design and configuration solutions to address those problems, including:

- Streetscape improvements (including gateway monumentation);
- Clustered access;
- Traffic calming;
- Local side access roads (frontage);
- Backage roads;
- Enhanced circulation measures (potentially including additional traffic signals, additional bridges, etc.);
- Turn “pockets,” islands, or median treatments;
- Bike/ped improvements (potentially involving new paths and trails and improved or additional crossings); and
- Distinctive solution elements across multiple “character area” segments.

The above solutions are not necessarily mutually exclusive and may be used together in a variety of possible combinations. Each component carries with it the potential to impact the community and corridor stakeholders positively, but some may also include some risk of negative impacts at the individual property level.

Public Involvement

Public participation is an integral part of the planning process, helping ensure that decisions are made in consideration of and to benefit public needs and preferences. Ensuring that the public and other specific stakeholders are involved with the project at an early stage helps to bring diverse viewpoints and values into the decision-making process. This process enables agencies to make better informed decisions through collaborative efforts and builds mutual understanding and trust between the agencies and the public they serve. Successful public participation is a continuous process, consisting of a series of activities and actions to both inform the public and stakeholders, and to obtain input from them which influence decisions that affect their lives. Although information gathered from public involvement efforts such as stakeholder interviews is inherently qualitative in nature, its value is in helping determine the criteria against which project alternatives may be assessed.

Stakeholder Interviews

Leland Consulting Group conducted stakeholder interviews with a sampling of property owners, real estate professionals (brokers, developers), business owners, economic development officials, and adjacent neighborhood representatives. These stakeholder interviews were intended to better inform the team on:

1) How businesses currently operate along the corridor;
2) Short- and long-term plans for business growth and/or redevelopment;
3) Barriers to business vitality;
4) Customer behavior (mode, target markets, etc.); and
5) A vision for the corridor as a "business environment" from the perspective of corridor businesses.

Further, these interviews provided an opportunity to discuss previous concepts, performance measures achieved in case study cities, and potential performance measures to be applied to US-97. Interviews were conducted in person and via telephone. A list of preapproved prompting questions was used during the interviews to guide the discussions, and can be found in Appendix A.

The following is a summary memorandum of the stakeholder interviews conducted the week of July 17, 2017 in Redmond, Oregon and via phone. The memorandum summarizes the main challenges and concerns, opportunities, and general thoughts expressed within each stakeholder meeting.

Summary of Findings

Vision

In 2014, the City of Redmond (City) adopted a resolution (no. 2014-02) to partner with the Oregon Department of Transportation (ODOT) to refine, design, and implement a corridor improvement project for the US-97 South Corridor. As part of the adoption of the 2014 resolution, the group agreed upon the following vision for the corridor:

> *"The South US-97 Corridor is a vibrant business district that is safe and accessible to shoppers traveling by car, bus, bike or on foot. The corridor is aesthetically pleasing and provides opportunities for business and community interaction. Traffic moves efficiently and at a reasonable speed in both the north-south and east-west directions."*

The stakeholders interviewed in conjunction with the current project generally agreed with this vision, typically only disagreeing with the transportation modes, noting that it is improbable that shoppers will travel to or from the corridor by bike or on foot. With this said, most agreed that there is potential for increased pedestrian and bicycle activity in certain parts of the corridor, and that internal bike/ped circulation would be optimal.

Major Themes and Takeaways

Several clear themes emerged throughout the stakeholder interviews. For the most part, these themes were consistent across property owners, business owners, economic development officials, and real estate professionals.

Access is a Priority

Access to and from the corridor's properties is a top priority for business and property owners. Industrial and commercial businesses are frequent freight users and have trucks delivering and picking up goods to and from their properties. Ease, safety, and timeliness of deliveries are important considerations. As such, access from US-97 remains a major concern, and there is fear that delays will only get worse as traffic increases in the future.

Going forward, access for freight/delivery/pickup is critical to future efforts. Business owners have concerns that direct access to individual businesses may be compromised as the project progresses.

Is the Future of the Corridor a Local Street or a Highway?

Many stakeholders agreed that long-term decisions for the corridor will depend on whether this stretch of US-97 will functionally remain a highway, or whether it will transition to a local street. The latter option would likely only occur if the second phase of the bypass were to go ahead. These decisions should be made now before any major investments are made.

For context, most of the stakeholder's concerns, opportunities, visions, general thoughts and opinions presented in this report assume that the roadway will continue functioning as a highway indefinitely. As a highway, maintaining the efficiency and safety of both those driving the road and those walking or biking alongside it should be the priority. Those priorities change if the long-term goal is to transition the road to a local street. A local street would likely prioritize multimodal activity (including pedestrian, cycling, and transit activity); as such, it would promote slower speeds, more stops, and improved infrastructure, among other components. However, if this is the long-term vision for the corridor then plans should be put in place immediately so that resources are distributed in the most efficient way possible. Further, the City should designate the corridor a local street in the comprehensive plan so that the necessary protections can be put in place.

Medians vs. Access Roads

Previous concepts for the corridor were discussed during the interviews. Many of the stakeholders were aware of previous studies, which included consideration of medians and access roads. For the most part, business and property owners were more supportive of access roads over medians. However, many people voiced support for backage roads only and strongly opposed frontage roads unless the lack of land meant that a backage road was not possible (such as in the northernmost section of the corridor).

Access roads should also be low speed, shared use facilities, so that speeds can be maintained along US-97. With that said, designated turn lanes in both directions may be required to limit congestion or traffic backups from cars slowing to turn from 40 MPH. Backage roads should be prioritized where possible, which would enhance freight access, preserve speeds and through traffic on US-97, allow buildings to maintain visibility and locate closer to the property line, and maintain parking.

While backage roads seemed to be the top choice among stakeholders, medians were not completely disregarded by all. If medians were considered, businesses would want access prioritized – whether through U-turns or through designated left-turn lanes into their property (preferred). It was generally accepted that left-turn lanes may require some level of access consolidation in order to maintain efficient traffic flow, although it was noted that business owners rarely recognize the benefits of doing so for their own businesses. Further, the opposition to medians may stem from the misperceived idea that a median will run the entire length of the corridor with very few breaks for access. If medians are a recommended roadway improvement, they should be implemented in pieces, minimizing "out of direction" travel to get to a business, and perhaps implemented through as "test zones" to mitigate these fears.

Beautification an Important Early Step

Beautification efforts may address many different issues in the corridor. There was general consensus that cost-effective initial steps could be taken along the corridor to improve its identity and attractiveness to drivers traveling through Redmond, improve the attractiveness of the built environment to existing and potential customers, and also help to slow speeds. With that said, the visibility of properties to passing drivers is an important factor to businesses, so beautification efforts (such as trees) should try to limit blocking sightlines to signage.

Throughout the interviews were frequent references to the recent beautification effort in Madras (and one additional reference to Sisters). Stakeholders understood that the Madras improvements required using significant portions of the right-of-way, and that spatial limitations were not a factor, which contrasts greatly with the conditions and limitations of the South Redmond US-97 Corridor. Using Madras as an example going forward and using many of the same components would appear to have the support of stakeholders on the corridor. This may include consideration of some financial components, such as incentives and/or City matching funds. Many stakeholders noted that some businesses have already undertaken beautification efforts already, and most are receptive to improving the look and feel of the corridor.

Speed and Safety Needs Improvement

Safety and speed in the corridor were two reoccurring themes throughout the interviews. For the most part, any discussion of safety was in reference to speed. Stakeholders were split between whether the speed limit on US-97 was too high, or whether drivers simply drove too fast over the limit. However, stakeholders generally agreed that the speeding issue pertains mainly to drivers traveling north into Redmond from the south, and the corridor's businesses will benefit from ensuring people drive the speed limit. Streetscape improvements and signage could improve the speed issue.

Further safety discussions related to lighting and pedestrian accessibility. Lighting is important for visibility, particularly in a sparsely populated area such as the corridor, and proper crossings and sidewalks (and organized traffic flow) help to reduce potential accidents. The importance of lighting is highlighted by the fact that businesses on the corridor close relatively early so there is not much lighting after 8 p.m. during most times of the year. Stakeholders generally agreed that any previous efforts to improve lighting have typically been conducted by property owners and not coordinated through any cohesive or consistence process with a public partner.

Corridor Needs an Identity

Most stakeholders argued that US-97 needs an identity that can be either extended to the wider city or is reflective of the City's vision. The three previously identified "districts" in the corridor are a good starting point; identifying the prevailing characteristic of each can help build a sense of identity.

Establishing an identity is particularly important to capture potential customers, not just for businesses on the corridor but for the rest of the city. Many people driving on US-97 are simply passing through from one town to the next, and their only impressions of Redmond is what they see on the corridor. It is imperative that the corridor's aesthetic appearance is consistent and appealing. Establishing a shared vision for what the corridor's district(s) could or should be and working that into future planning efforts would be significant, especially from a visual standpoint.

The corridor's existing architecture and landscape character does not have a strong identity, and there is little historical context or consistent theme to build upon. However, the prevailing characteristic of the corridor is the surrounding mountain views and proximity to the canal. These are features that can be brought into the corridor by reflecting this character in both the architecture and landscape. Implementing this identity may be achieved through beautification efforts, which might include landscaping, walking/biking paths, and some marketing components like banners and consistent lighting.

Ultimately, however, an identity cannot be created overnight. The City and its planning department must work with businesses and property owners to cultivate a unique and lasting identity for the corridor. This will include promoting economic development through good and sustainable design, landscaping, and public and private investment. Any future residential development should be designed to establish a "sense of place" and provide pedestrian-friendly connections to local and regional sidewalks and trail systems. In the short-term, leveraging the gateway aspect of the South US-97 corridor can help create a stronger identity for the surrounding neighborhoods and increase the engagement of businesses along the corridor.

Auto-dominated Mode

The US-97 corridor is characterized by auto-dominated infrastructure and businesses. It will take significant investments and improvements to create a truly multimodal corridor. General consensus among stakeholders was that the most successful businesses are largely auto-oriented and/or benefit from the high exposure/visibility to through-traffic. Businesses like the lumber yard, typically described as "destination retail" establishments, are still auto-oriented because of freight delivery needs and because their customer base usually requires a car to transport goods.

At present, bicycle and pedestrian traffic is insignificant, and in the near future internal circulation between adjacent or nearby businesses is far more likely than attracting pedestrian traffic from residential areas to the west of the corridor. With that said, the areas closest to existing populations, such as the middle section of the corridor west of the canal have the highest potential to implement more walkable development types that may encourage more commute-type travel by foot and bike. This may be enhanced by creating more connections over the canal to the west.

Demonstration Project(s)

This section refers to two main items: (1) the application of property/business improvement loans or grants such as those deployed downtown, and (2) certain (non-specific) roadway-environment improvements. For example, if improvements are to be phased, a project demonstrating certain concepts or design alternatives may be useful, not only to help communicate how something could work and look, but also to see if it *would* work. This was a highly debated topic of conversation among stakeholders, with divided opinion on whether significant improvements should be made incrementally, area-by-area, or whether it would be best to focus on certain components throughout the entire corridor.

With regard to property/business improvement loans or grants, some stakeholders referenced certain funding programs such as the façade and infrastructure improvement funds provided by the City for downtown properties as replicable programs for the corridor. It is also worth noting that these programs are common practices across the county, and are often implemented through business improvement districts, urban renewal districts, or local improvement districts.

This topic included whether the City should pledge financial resources or other incentives to small-scale improvements throughout the entire corridor (such as beautification) or instead focus mainly on a highly visible "demonstration project" or even "demonstration area." It was argued that a well-designed demonstration project might generate more growth than small-scale efforts, although small-scale efforts may be considered more equitable for every business or property owners in the corridor, rather than demonstration projects that could be perceived as unfairly benefitting the adjacent businesses. As such, both types of actions may be appropriate.

Existing Challenges

Through the stakeholder interviews, a variety of challenges for the success of this current project were noted, ranging from business-level concerns, barriers to investment, and overarching corridor concerns. A summary listing these challenges is noted below.

Property/Business Owner Resistance

- Modifying access/signage is potentially problematic:
    - Businesses rarely recognize the benefits of combining access points; and
    - Perception that any change will harm access (ingress/egress to sites) for customers and freight/delivery, parking, signage, and visibility.
- There are many absentee property owners along the corridor (i.e. the owners of the property are not necessarily the business owners) and, as such, are not engaged in the local community or ongoing efforts to improve the corridor.

Uncertainty about the Future of the Corridor

- The uncertainty surrounding the future role of the corridor has warded off investment and/or other businesses.
- There is a perception that potential expansion of the right-of-way will restrict or eradicate development and business opportunities.
- ODOT is perceived by some as being hard to work with, so many stakeholders are reluctant to commit to the project.

- There is concern that if the corridor was envisioned as a local street, traffic would need to be slowed, which would be contrary to freight movement and access.

Vehicular Traffic/Congestion

- Turning vehicles currently cause lengthy backups as one of the two through-traffic lanes is effectively eradicated, with cars slowing from 40 miles per hour to almost a complete stop to turn.
- Congestion is a frequent occurrence and expected to get worse.
- Locals use Canal Street to avoid US-97.
- Sidewalk “humps” create congestion from business’ parking lots back onto the roadway.
- Vehicles generally speed above the limit, particularly from the south, which is a deterrent to pedestrians and cyclists.
- There is a perception that the corridor is unsafe to drive on. For example, Hooker Creek Construction tracks near misses on their fleet vehicles and views the corridor as a hot spot.

Utilities

- The City needs to improve and/or upgrade the capacity and quality of the corridor’s utilities – particularly stormwater infrastructure.
- Utilities and construction are exceptionally expensive because of the lack of top soil (meaning excavation of bedrock is required).

Perception

- Redmond is perceived by some as an “old country redneck town,” which is detrimental to attracting higher quality establishments and businesses.
    - Businesses with the means of locating in the region may look at Redmond and decide “it’s not Bend.”
    - It is imperative for Redmond to forge a unique identity and distinct character for the corridor to mitigate these perceptions.
- There is a distinct and noticeable lack of pedestrian activity, which adds to the perception of an empty and floundering district; one stakeholder indicated that when a person is seen walking the corridor you question if there’s something wrong.
- Redmond, upon first driving in (from the south), feels old. Much of this is due to the dated and inconsistent architecture, streetscape, and infrastructure.

Market Conditions

- While the market in the region is relatively strong and supportive of new business, the alternatives elsewhere in the city are more attractive. For example, pedestrian-oriented commercial development is best served downtown; industrial development is clustered around the airport; and residential development is typically clustered to the west (existing) and around schools (new).
- New development and redevelopment on the corridor has been slow, relative to the rest of the region. Newer properties—of which there are few—such as the Redmond Design Center (built in 2008), have struggled to find tenants.
- There is a strong need to establish the corridor’s competitive advantage. The market is currently driven by Bend, with businesses typically locating in Redmond after being priced out of Bend.

Streetscape

- The entire corridor experiences a lack of sidewalk consistency and quality.
- There are comprehensive ADA and mobility issues.
- There is a corridor-wide lack of adequate pedestrian and bike facilities.

- The corridor is not an "attractive address for businesses."

Opportunities

Discussion of the US-97 corridor's opportunities included reference to potential development types (existing and future), specific areas most appropriate and primed for development and/or investment, and potential target markets. Specific opportunities included:

Development-Friendly City

- Enterprise benefits in Redmond are a good draw for business and growth. The presence of tenant improvement (TIs) and tax abatement programs are effective economic development drivers.
- Redmond has some helpful mechanisms and programs in place for business development, so new incentives may be unnecessary. These mechanisms are currently deployed in the downtown area. It would be good to also extend them to support demonstration projects along the corridor to help generate more interest and growth.

Market Conditions

- The corridor's main regional competitive advantage over Bend is currently the access to the highway and low land cost.
    - Redmond benefits from being part of a strong regional market—driven mostly by Bend. Businesses that are priced out of Bend and wish to remain in the region are the most likely candidates for new businesses on the corridor.
    - The cost of land in Redmond is about three dollars per square foot – about one-quarter to one-third of the cost of land in Bend.
- Redmond's strongest sector is industrial, particularly seeing as Bend is undersupplied. Some industrial uses may be appropriate on the corridor, although most will still be directed to the land in the east by the airport.
- The local (Redmond) office and hotel market is weak and, nationally, brick-and-mortar retail is in decline due to the growth of ecommerce and omnichannel retail and a societal shift in consumer spending from materialism to "experiences." Despite this decline, retail remains the best development type for the corridor because of its auto-oriented nature and lack of feasible alternatives (industrial aside).

Potential for Development

- Development on the corridor is likely to remain focused on commercial, with some light industrial uses possible.
    - There are opportunities for additional restaurants and/or breweries, which were identified as underserved subsectors.
    - Light and heavy industrial uses have the biggest opportunities, but may not fit the desired character for the corridor.
- The regional commercial market is good, and large retail stores are interested in the region (such as Walmart, Fred Meyer, Cabela's, etc.). The corridor may be able to capture some of this interest under the right conditions.
- There are distinct differences between opportunities in the west versus east of the corridor. In the east, the land is far more constrained and therefore the opportunities are limited to rehabilitation or redevelopment, and existing properties are likely to remain as retail. The west is more flexible in terms of available land and potential development types.

- The westside (around Odem Medo Way and west of the canal) is the most likely area to see significant improvements in walkability and new larger, planned developments because of the area's proximity to existing residential populations, the large tracts of undeveloped land, and the existing grid and access to unique features such as the canal.
  - Infill may be feasible in this area (such as near Albertsons) to increase density.
  - There is potential to leverage the existing office space in the west to create a moderately-sized office cluster, particularly as office users typically do not require highway exposure.
  - The westside is likely to be the only place in the short- and medium-term that residential development is considered.
- New development may not "pencil" due to high construction costs, so rehabilitation and redevelopment of existing structures—particularly older and run-down properties—will likely be the best course of action. This will also increase the attractiveness of the corridor and allow phased development to occur on vacant land as rents increase.
- US-97 is a car-oriented corridor, with very little opportunity for walkability. However, the area along the canal and the larger tracts in the middle-western section (west of the canal) offers the best opportunities to become a much more walkable, neighborhood-type area.

Connections

- Multimodal connections are important for circulation, and east-west connections should be prioritized.
  - This may include adding connections to the west with new roads and bridges over the canal.
- Small area improvements in pedestrian infrastructure and/or internal circulation should be prioritized in the western section of the urban commercial zone.
- The canal is a unique asset, and could be the focus of new pedestrian and bike infrastructure.

Other Opportunities

- Redmond's low density has maintained views of the surrounding mountain ranges, and has excellent access to surrounding recreational opportunities.

Conclusion

The Redmond South US-97 Corridor Plan is more than simply a road improvement project. The City of Redmond and ODOT have been keen to stress that this project should be about business vitality, economic development and creating a quality place for all modes of transportation. The stakeholders that were interviewed for this project strongly support this notion, although there are differing opinions on how this might happen.

The top priority for stakeholders seems to be access for customers, deliveries, and employees. While many stakeholders are reluctant to accept medians or access roads (frontage/backage), most understand that access consolidation needs to happen and that backage roads would be the preferred option. Further, any decisions about corridor improvements need to be phased and considered within the context of the long-term future of the corridor (i.e. whether it remains the main highway or it is converted to a local street and a bypass is constructed). Increased east-west connections, improved circulation and multimodal access, and traffic calming should be priorities.

Additionally, in order to ensure the corridor prioritizes community character, placemaking, and economic development, it must have an identity. This identity should be unique to the corridor and reflective of existing and desired businesses within the corridor. A carefully cultivated identity may also greatly benefit from a demonstration project (or area) which directly reflects the desires of the City and the corridor's stakeholders. This project should reflect the needs of the most feasible development types given current market conditions, which currently consists of industrial and commercial development. Some residential development may be feasible at a later date, but likely only in certain pockets of the corridor.

The City should be prepared to upgrade utilities, implement beautification and/or placemaking components, and ultimately assist businesses with repositioning the corridor to mitigate misgivings, fears, or misperceptions about the corridor (e.g. in regard to safety, attractiveness, and business vitality).

Finally, it is clear that many of the stakeholders interviewed prefer visual depictions to enhance the understanding of options. Care needs to be taken to ensure that planning, development, and design concepts are communicated effectively with drawings, renderings, or photographs.

APPENDICES

Appendix A: Stakeholder Interview Questions

How businesses currently operate along the corridor

- What typically drives a tenant (residential (?), commercial, employment) to choose to locate here?
- How is the market performing for your type of development? How does the Corridor compare to other competitive areas? What areas do you consider to be the competition? What trends are you seeing?
- Is the Corridor a good place to do business? Easy to do development? What are some of the challenges?
- What factors do you think contribute to a business's success if it is located on the corridor? Think about things like the type of establishment, access, size, signage, façade, design, parking, and other factors
- In order to facilitate a comprehensive study, we would like to learn as much about your facility and your business as possible, and we want to give you the opportunity to share information about your company with us. Can you provide us with some general details about what your facility does each day? Do you service clients in the nearby area? What are your operating hours? How many people do you employ?
- Where is your property or business located?
- What type of business do you conduct?
- How long have you owned or been established at this location?
- How many employees do you have in your organization?
- Approximately how large is your establishment?
- How long does it take to get to work in the morning? Do you live nearby?
- Does your business use the hotels in the area?

Short- and long-term plans for business growth and/or redevelopment

- What is your vision for the corridor? What do you think should go there, or what changes should be made? Why? (alternatively: if you looked 20 years into the future, what would you like the Corridor area to be?)
- What are the opportunities for development/redevelopment in the corridor?
- What are the existing assets in or near the corridor that can be leveraged to promote business growth?
- What specific industries or types of businesses have growth potential in the Corridor and where are the most appropriate locations for these types of uses?
- Are there specific types of businesses or residences you would like to see?
- What other kind of retail is needed in the area? Name some stores
- What actions could the City take to support small businesses along the Corridor? How can the City use the Corridor Plan to facilitate investment?

Barriers to business vitality

- What are the greatest challenges facing the corridor today?
- What improvements does the area needs today?
- Are there needs that existing corridor businesses or new development can or should address?
- Are there additional services, amenities, or uses that would improve the corridor?
- What do you feel will be the key challenges the corridor will face in the next 10 to 20 years?

- Is the corridor a good place to do business/development? Why, yes or no?
- Are there barriers to investment on the corridor (e.g., physical, financial, market, regulatory, political)? If so, what can/should be done to address those barriers?

Customer behavior (mode, target markets)

- What markets should corridor businesses be targeting?
- What is the typical mode (i.e. car, bus, walk, bicycle) of customers? Would changes/improvements to the infrastructure change that, in your opinion?
- How do you get to and get around Redmond? What challenges do you or others have in accessing the corridor?
- What markets should the corridor target? Are these different in certain sections of the corridor?
- Where do Redmond residents typically shop? Downtown? The Corridor? Other?
- Are there transportation improvements that would make access to or around downtown better? (Such as; roadway improvements, transit, bicycle or pedestrian facilities)

Other/Closing

- In your opinion, what are the most important issues regarding transportation and transportation facilities, such as streets, sidewalks and bike routes, in the corridor?
- Are there other groups or individuals we should engage in this plan? What are the best ways to get their input?
- Is there anything else you think we should know in regard to the Corridor?
- Is there anyone else we should talk to?

Appendix B: Stakeholder Interview Responses

Economic Development Officials

Jon Stark, Redmond Manager, Redmond Economic Development Commission

- REDI: industrial oriented (traded sector)
- Vision:
  - Beautification
    - Great downtown example, improve lighting (businesses close after 8 pm so it's dark)
    - Landscaping – need to change/add code
  - Supportive of access roads
    - Need to ensure access is maintained for trucks to rear of properties
  - Speed should be no lower than 40 MPH
    - Maintain as highway
    - Known as a good alternative route to I-5 – need to maintain
  - Wayfinding/Signage
    - Adds to identity (e.g. advertising events with banners, etc.)
    - Capture thru-traffic
  - Identity:
    - Add wayfinding between Yew & Veterans
    - Prioritize areas from North to South

- Development
    - Little opportunity for industrial
        - No manufacturing
        - Land too expensive
        - Call center may work
    - Restaurants/breweries
    - Opportunities – underserved retail
- Challenges/barriers
    - Speed
        - Access roads need an easy way in so traffic not going from 40 to 0 MPH
    - Sidewalk "humps" created congestion
    - Need utility improvement – particularly stormwater infrastructure
    - Parking
    - Signage
- Business growth/development
    - Redmond already has URA downtown, so probably unlikely in corridor; however, best vehicle for change
    - Programs already in place (e.g. expedited permitting process, façade improvement program, etc.)

Eric Sande, Exec. Dir., Redmond Chamber of Commerce

- Community had initial fear of median down the middle of US-97, which has now dissipated (in part due to time)
    - Fear of change
    - Can mitigate with proper outreach
    - Community is *very* visual oriented – any outreach should include visual aids
- Charette had a positive outcome
- Streetscape/Aesthetics:
    - Downtown has been a good example of the benefits of improving the look of a place
    - Consensus that aesthetics is good for business
    - South US-97 is calling out for "inclusion"
        - Lampposts, banners, lighting, etc.
- People recognize the need for safety improvements due to accidents, etc.
- Identity:
    - "Districts" will help build a sense of identity on the corridor
- Alternatives help show what *could be* and show that the current situation is below-par
- Big 5 landscaping effort had a ripple effect throughout the community
- Commercial sector is lacking; not vibrant
    - Starting to see increased interest in Redmond downtown
    - Still recovering from the recession; the first phase of the bypass was completed at the beginning of the recession (bad timing)
- Strengths of corridor:
    - Great exposure and visibility from the road
    - City of Redmond is known as being flexible – they will help people get past a "no"
- Barriers to investment
    - ODOT has a reputation for being hard to work with

        - Modifying access/signage is potentially problematic
    - New utilities and construction very expensive because of the lack of top soil (meaning excavation of bedrock is required)
    - Lack of consistency (i.e. sidewalks)
- Start design standards NOW
- Types of development
    - Clothing
    - Better restaurants
    - Breweries/Distilleries
- Consumer behavior
    - Redmond residents do not shop local – potential leakage
    - Education of business owners required to address opening hours of current stores
    - Cycling is insignificant throughout the City, but need to accommodate
    - Trails along canals would be well received
- Madras great example of visual improvement
    - California too?
- Financial/Investment
    - If the City has money, it should use it now
- Takeaways:
    - Need consistency
        - Sidewalks, landscaping

Real Estate Professionals

Kirk Schueler, President/CEO, Brooks Resources Corporation

- Brooks Resources Corporation:
    - Real Estate Development Co.
    - Offers planning and development services, etc.
    - "Land developers" – mostly residential; new urbanist development to traditional subdivisions
    - Engaged in large-scale planning world
- Vision:
    - Auto dependent businesses or destinations
    - Streetscape is a "starting point"
        - Need designs that promote slower speeds
        - Buffer the high-speed road (main highway) from sidewalks with planted strips, lighting, trees, etc.
    - Transformation requires major changes to access
        - Supportive of access lanes (backage/frontage roads)
            - Need to have 20-25 MPH speed limits and encourage local foot/bike traffic
        - Control access with center medians,
            - Can be implemented in pieces to test out (like in North).
            - Breaks in the medians need to be well thought out – you don't want to encourage U-turns
- Development
    - Residential challenging:

            - Lack of streetscape
            - Similar to Bend corridor into downtown – need to improve pedestrian environment
            - Canal has potential for residential development
            - Limitation: wedged between commercial suburban development
            - If street is deemed a local street in future, then residential will be first development type to come
    - Development types:
        - Exposure/auto-oriented: gas stations, banks with drive-throughs, fast food, restaurants, etc.
        - Retail in decline, although still the best sector
        - "Trips by the door" doesn't matter to office users
        - Land price a major factor
            - Bend Parkway land prices potentially an interesting comparison
        - Redmond can capitalize on the major industrial shortage in Bend
    - Few new developments to look at
        - Design Center Building (/Central Oregon Premier Office Building) at 2127 S Highway 97 – built 2009, had struggled to get tenants but now tenanted? Weakness – set back from road?
- Challenges
    - Pedestrian activity: if you see a person walking you wonder what's wrong
    - Current speeds not a problem, but will need to break out slower traffic on side streets
    - Question of alternatives. i.e. downtown has pedestrian-oriented commercial, airport has industrial, residential clustered around schools
- Transformation:
    - Need to encourage pedestrians to cross
    - Circulation HUGE for adjacent land uses and businesses
    - <u>Investment</u> will make the difference, not incentives
    - A "friendly" environment will help businesses

Dan Kemp, Broker, Compass Commercial

- Vision
    - Look at Bend – they thought about the whole puzzle.
        - Redmond is more piecemeal
    - Supportive of access roads
        - Would allow the highway to be a highway
    - More planned developments
        - Should factor into the master plan
        - Have to start south of Odem Medo
        - Gentrification would then bleed out
        - Old Mill in Bend is a great example (& NW Crossing)
    - Identity:
        - Demonstration projects first, then look at the little stuff
            - Small beautification efforts will not generate growth
    - Streetscape improvements
        - All about access
        - Sisters great example of beautification

        - Easy to do first up
- Development
    - Office Weak
    - Retail decent but Brick & Mortar Retail on decline
        - Mixed Use communities more popular with supportive retail
        - Proximity to amenities is important
    - Industrial strong
        - Workforce can afford to live in Redmond
        - Industrial users priced out of Bend
            - Bend hugely undersupplied with industrial
        - Potential demand for industrial business park
            - Lots of industrial users need one-acre or less (1,000 to 3,500 SF spaces); mainly target contractor-based tenants like roofers, auto mechanics and welders
    - Warehouse/Recreational facilities
- Opportunities/Strengths of Redmond
    - Views!
    - Low land cost compared to Bend (about $3 PSF – 1/4 to 1/3 the cost of Bend)
    - Enterprise benefits in Redmond are good draw for business and growth
        - Plus help with TIs and tax abatements?
- Challenges/Barriers
    - Redmond known as "old country redneck town"
    - "It's not Bend"
    - Redmond, upon first driving in, feels old.

Business/Property Owners

Scott Carlson, Hooker Creek Construction & Formerly on the Economic Development Commission

- Vision
    - Phased approach
        - Highway for next 20 years
        - Long term goal: make local street
            - Should start planning for now; implement unified code for aesthetics
    - Beautification
        - Madras excellent example
        - Landscaping difficult until street is *localized*
- Bypass
    - Business owners are receptive
        - 1st phase (north) good example
- Hooker Creek Construction:
    - Owns 2 businesses just S of Veteran's Way and 1 in SE section of corridor
    - Material supply company – few customers come to them; mostly deliveries
- Corridor issues:
    - Safety: HCC tracks near misses on their fleet vehicles and the corridor is a hot spot

- Traffic
- Congestion through south section
- Slow redevelopment of corridor
  - Need to establish competitive advantage – currently driven by Bend, once businesses are priced out of area.
- Opportunities
  - Light and heavy industrial have biggest opportunities
  - Regional market is good – large retail stores are interested in the region (Walmart, Fred Meyer, Cabela's, etc.)
- Takeaways:
  - US-97 should be looked at like a local road and planned backwards

Frank Bowen, NAPA Auto Parts

- Constraints
  - East side (where NAPA located) constrained by the railway tracks
- Business needs
  - Access for tractor/trailer
  - Parking for customers
  - Would rather maintain parking than add turn lane
- Madras great example
  - *But* they moved highway over to make room for frontage road and US-97 doesn't have the space to do the same
- Customer behavior
  - Traffic-oriented businesses in north of corridor
  - Destination businesses – i.e. people go there for a particular reason
  - Redmond is an overflow City for Bend – both for businesses and residents
- Vision:
  - Supportive of median
    - Important for safety
  - Don't want bypass *but* will be very busy road without one
  - Beautification
    - City should provide incentives to improvement look of existing businesses
  - Sidewalks – improvements would immediately add curb appeal
  - Traffic lights – encourage/help pedestrian activity
- Development:
  - Land is experience so:
    - Commercial development only
    - No industrial
    - Potential hotel

Suzanne Michaels, Development Director, Opportunity Foundation

- Opportunity Foundation
  - Owns five acres on the corridor

        - Buildings include 12,000 SF thrift store next to BasX
    - Plans
        - 5-10 years: renovate rear building and small building (may lease out at some point)
        - Business priority is supportive employment – they may grow to a point that they need to move locations
- Corridor issues
    - Speed
        - Too fast: 65 MPH from south
    - Ingress/egress to sites
    - Lack of adequate ped/bike facilities
    - ADA/mobility issues
- Customers:
    - Most are from Redmond
    - All customers use car, but out of necessity
    - Many locals avoid US-97 altogether and use other routes
        - Canal to go downtown and western backroads to Bend
- Vision
    - Highly support access lanes
        - Frontage road and/or turn lanes would encourage redevelopment
    - More green space
    - ADA compliance
- Development
    - No residential – no one wants to live on a highway
    - Business/Commercial
    - Transportation hub with fixed bus route to downtown?
    - City should focus on improvements like lighting
        - Could wave SDCs?
- Barriers:
    - Perception that future expansion will restrict/eradicate development/business opportunities

Bob Eberhard, Eberhard's Dairy

- Vision
    - Phased development
    - Adjust to 35 MPH with signals and turn lanes
        - Would help attract shoppers and ped activity
    - Make Canal Blvd more significant part of corridor
        - Bike traffic on Canal
        - Add connections east/west
        - Bridges across Canal would increase access and biz vitality
    - Potentially have COI cover the canal and remove as a barrier
        - COI loses 40% of their water to evaporation
    - Ensure US-97 still okay for freight
- Development
    - No need for more hotels
        - 1 hotel around for 9 years – first year making a profit

- Issues
  - Speed
    - 40 MPH too fast
    - Adjust
  - Absentee owners

Paul Rodby, Owner, McDonald's

- Owns all MC's in Redmond and 1 in Madras
- Need to establish whether US-97 is to be a highway or a local street
- Issue
  - SPEED – people are not going the speed limit
    - Corridor will never be a successful business district until speed limit is reduced
  - Lack of turn lanes reduces the 4-lane road to 2 lanes as people turn – major congestion
  - Accidents/crashes
    - Hurt business
    - City utilities – Potentially at capacity
- Vision:
  - Beautification and improvement of existing businesses
    - Helpful for speed
    - Attract customers
    - Trees must not block signage
  - Supportive of backage road
  - Does not support frontage road or median
    - Would hurt business
  - Add signals, activated signals, etc. to reduce speed
- Customer behavior
  - Very little foot traffic; almost all by car
- Development
  - Albertson's area – prime for redevelopment
  - Business owners need to lead the charge
  - Enact similar incentives to the downtown revitalization process
- Takeaways
  - Economic development requires slowing down traffic
  - A light at Quartz would be preferable

Keith Sides, Cinder Rock Veterinary Clinic

- Vision
  - Hard to see US-97 as a pedestrian friendly road unless the 2nd phase of the bypass was built
    - Need to get heavy traffic off the road
  - Business owners are concerned about turn lanes and accessibility
  - Canal (+ Blvd) can be ped-friendly core
    - Add pedestrian bridges?
  - Business would benefit from slow traffic
    - Additional signals do not create a good atmosphere
    - Signals might work in the interim but Bend shows it may not be practical long-term

        - Round-a-bout?
    - Supportive of backage road
        - Gets local traffic off the highway
        - Parking would still be an issue for business
- Issues
    - Businesses rarely recognize the benefits of combining access points
    - Traffic
        - Locals use Canal to avoid US-97
    - Access
        - Particularly for delivery and freight trucks
        - Safeway did a good job with their access
- Business vitality
    - Beautification would be effective (but who pays?)
    - Financial incentives
        - Worked well in downtown Redmond
- Opportunities
    - Distinct differences between opportunities in the West vs East
        - Professional office cluster in west without need for highway exposure
    - Add east-west connections
- Takeaways:
    - Beautification most important component
    - If driving through corridor, outsider's only impression of Redmond is US-97; why would they want to explore more if it was ugly?

Charley Miller, Owner, Miller Lumber

- Charley Miller previously involved with various stages of project; served on previous committees
- Vision:
    - Desires a communally accepted community plan (no piecemeal)
    - Supportive of backage roads (potentially frontage in north section of corridor) due to the added attractiveness
    - Stoplight access at Odem Medo intersection
    - Buildings pushed closer to the front of property lines
    - Attractive streetscape (continuous sidewalks) and good business access
- Miller Lumber:
    - Focused on freight (movement, access) – heavy traffic on US-97
    - Safety: business taken upon themselves to improve safety
    - Future plans: may redevelop site to higher and better use that can utilize the higher exposure from the road and high traffic counts
- Business Development:
    - Corridor is "a good place to do business"
- Challenges:
    - Access (getting trucks in and out)
- Opportunities:
    - Infill
    - Rehab/Redevelopment
    - Especially if backage/frontage roads implemented and access is improved

- Target westside as more of a planned, walkable environment – potential for residential
- Barriers:
    - Uncertainty
    - If the corridor was envisioned as a local street traffic would need to be slowed, which would be contrary to freight movement and access

Ed Fitch, Fitch Law Group & Former Chair of Redmond Development Foundation

- Streetscape improvements
    - Traffic has got worst since 2013 when ODOT first looked at access roads
    - Need an interim solution before second phase of bypass occurs
        - Needs to be affordable
        - ODOT bad at corridor planning
        - Supportive of median with quarter-mile access points
        - Add signal/light at Obsidian with a ped crossing
            - All the ped activity is coming from the west
    - Implement phased landscaping by priority
    - Opportunity for internal circulation and improvements in western section of urban commercial zone
- City Action
    - City of Redmond can designate US-97 a corridor and protect it in the comprehensive plan
    - Create Local Improvement District (LID) through the City comp plan, esp. on the westside
- Businesses
    - High turnover of business in corridor
        - Difficult to establish leaders
- Development
    - Currently oversaturated commercially zoned land
        - Need low-traffic businesses on the east side
    - No opportunity for office until improvements are made
    - Should target restaurants, hotel, and office development
- Identity
    - Can carve out identity on the west side
    - Leverage the canal and build walking paths; follow a village concept