SR 503/SR 502 Intersection Design, Phase 1

SR 503/SR 502
Battle Ground, Washington

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1 INTRODUCTION

The SR 503/SR 502 project is located in the City of Battle Ground, Washington (Figure 1). The intersection of SR 503 and SR 502, two key regional highways, is an important focal point for the community, with shops and businesses located in the vicinity of the intersection (Figure 2).

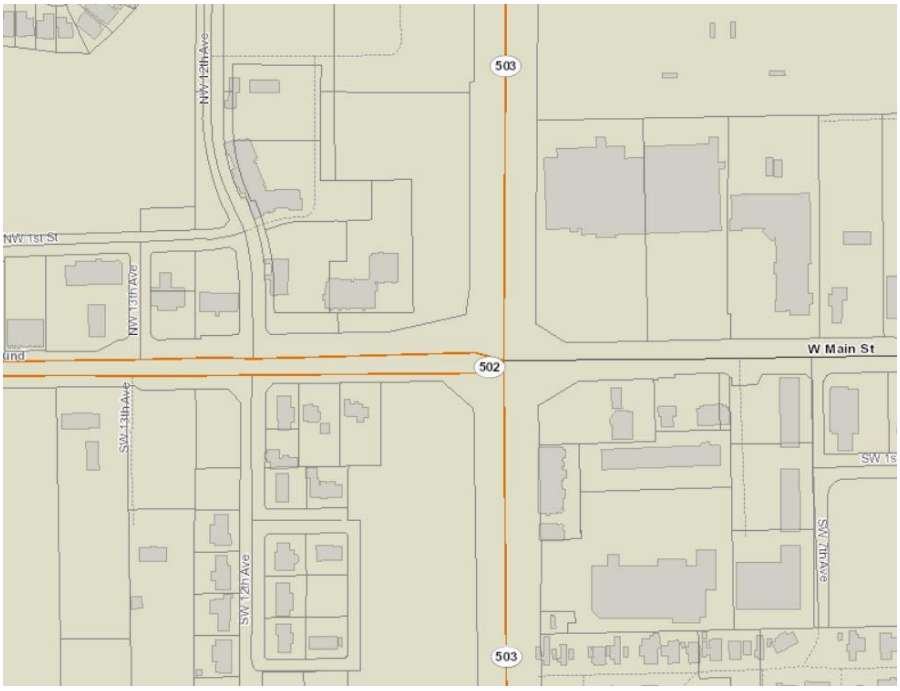


Figure 1. Vicinity map of project area.

The City of Battle Ground (City) has experienced significant population growth in recent years, which has increased vehicle traffic and created challenges for motorists. Intersection improvements are essential to keep up with the community growth and changes in context of the surrounding area. The City is working collaboratively with Washington State Department of Transportation (WSDOT), key stakeholders, and the community to improve this intersection in the most practical and cost-efficient manner.

This report explains the procedures and processes that PBS Engineering and Environmental Inc. (PBS) and the City of Battle Ground performed as part of the practical solutions and design process, as outlined in WSDOT Design Manual Chapter 1100. The basis of these procedures is to maximize use of project funds and includes a bottom-up design process. This report provides draft design concepts brought to a planning-level design for evaluation purposes, with final design still to be completed. Therefore, these draft design concepts shall not be construed as construction documents. Cost opinions of the alternative solutions are also included and are based on WSDOT Planning Level Cost Estimation (PLCE) procedures, using best information known at the time.

Through the practical solutions and design process, a recommended preferred alternative is discussed, along with rationale, including recommendations moving forward for final design.



Figure 2. SR 503/SR 502 intersection is an important focal point for the Battle Ground community.

2 PROJECT DESCRIPTION AND BACKGROUND

SR 503 serves as a regional north–south highway and is designated an Urban Freeway/Expressway and a partially controlled limited access highway. SR 502 runs east–west, providing access between SR 503 and Interstate 5 (I-5), which serves as a key interstate for the City of Battle Ground for regional and interregional travel. SR 502 is labeled as Managed Access Class 4.

Significant businesses for the City are found near or within the project site and are important community focal points. Schools and communities near the SR 503/SR 502 intersection also are found with further facilities that support the City. Also, SR 502 leads into W Main Street, which is part of the older city downtown setting from which is developed just east of the larger commercial business district.

The core of the project includes assessment of congestion relief at the busy intersection, which is functioning below community user standards in its current state, with trends indicating that it will perform much lower in the future. The intersection improvements to relieve congestion will help the vitality of growth and commerce to the City, while also maintaining the integrity of the limited access SR 503 freeway function. Other needs are also identified, which this document will explain further and are either WSDOT policy or deemed essential to the community.

Various studies have been performed recently on this project. There are several projects that are interrelated to this project which were recently constructed or are planned for future construction in the near term. These projects include the following:

- SR 503 Shared Use Path Project from SR 502 to Onsdorff Boulevard
- W 8th Avenue Project (on W Main Street)
- W 12th Avenue Intersection Signal Removal Project (just completed)
- NW 5th Way (Right-In/Right-Out Access to Fred Meyer) (just completed)
- NW 5th Street (Future Right-In/Right-Out High School Intersection on SR 503)
- Acceleration Lane for 5th Way Right-In/Right-Out Project onto SR 503
- W 15th Avenue/SR 502 Intersection Project

See Appendix A for further information on these projects.

It is noted that WSDOT has plans to expand SR 503 to two lanes in each direction north of the intersection. This plan, however, is not within the near future, and analysis or assessment of options is limited in nature to this expansion.

The public has recently expressed the desire to evaluate other improvements for right-turn movements. Existing average peak-hour delays can be seen at 45 seconds with D level of service (LOS), with anticipation that the delays and LOS continue to drop. Due to the project's vicinity to substantial commercial businesses, impacts to the adjacent properties and access to the businesses are also deemed a key aspect of the project.

3 PRACTICAL DESIGN AND SOLUTIONS PROCESS

Overview of Practical Design Process

The practical design process per WSDOT Design Manual Chapter 1100 includes practical solutions planning and practical design. The practical solutions process involves evaluating the core goals or needs of the project and keeps the project focused on accomplishing these goals and meeting these needs. The practical solutions process includes the following steps:

- **Define project needs and baseline metrics.** Determine context and baseline needs of the project. Assign baseline needs metrics that the design alternatives are to be evaluated against.
- **Analyze contributing factors.** Evaluate all contributing factors affecting the performance of the baseline needs on the project.
- **Define project context and design controls.** Determine context of the project and define basic design controls to be used on the practical solutions alternatives.
- **Develop alternatives for practical solutions.** Develop alternatives for practical solutions that meet the metrics assigned to the project and attempt to meet contextual needs of the project.
- **Involve the public and stakeholders.** Reach out to key stakeholders and the general public to get feedback on the practical solutions alternatives in a collaborative manner.
- **Compare the practical solutions alternatives.** Compare the practical solutions alternatives to an agreed design comparison grading scheme based on baseline needs, contextual needs, and project cost.
- **Select the preferred alternative.** Select the design alternative with the best value and confirm the feasibility of constructing the alternative within available project funds.
- **Select practical design elements.** Select general elements that are to be included on the recommended preferred alternative.
- **Perform practical design element dimensioning.** Perform bottom-up design dimensioning of the elements incorporated on the preferred alternative with justification for dimensions if required.

This process was done for the SR 503/SR 502 intersection project in concert with planning-level public outreach efforts and traffic analysis performed by GT Engineering. See GT Engineering's Traffic Analysis Report for traffic engineering analysis used to develop this report.

4 PROJECT BASELINE NEEDS

Overview of Baseline Needs

Baseline needs are assessed so that the focus can be on meeting specific project needs and limiting project spending to addressing those needs. Doing this helps prevent unnecessary improvements or modifications to existing infrastructure and minimize project impacts to the public. This section outlines the basic needs collaboratively identified by the design team, key stakeholders, and general public.

4.1 Reduce Delays to Users

The users are identified as the individuals who travel through the SR 503/SR 502 intersection. The users of the community are experiencing delays beyond the acceptable limit in current conditions, with PM peak-hour conditions causing the most delays to users. The delay and level of service (LOS) identified to users in a horizon design year of 2035 has the delays vastly compounded, with expected continued growth of the City, and the emerging regional importance of SR 503 as a north–south freeway. The significant traffic movements with the current year's peak-hour volumes for the intersection are summarized below, based on traffic analysis performed by GT Engineering:

Traffic Movement	Peak-Hour Volume (number of vehicles)
AM Peak-Hour	
SB SR 503 Through	650
EB SR 502 Through	354
WB W Main Street Through	383
WB W Main Street Left	200
NB SR 503 Left	194
SB SR 503 Left	190
PM Peak-Hour	
EB SR 502 Through	567
WB W Main St Through	557
NB SR 503 Through	500
NB SR 503 Right	381
NB SR 503 Left	324
WB W Main St Left	265

These movements are observed for both local trips and interregional trips for different vehicle types of users. The intersection also serves as a key east–west access for pedestrians and bicyclists to cross the high-speed, limited-access facility of SR 503.

Average peak-hour delays during both AM and PM peak hours are typically described in seconds. This is often corresponded to an LOS, which is also used to described traffic conditions. However, this metric can be subjective and will only be used as a reference for determining traffic delay. The SR 503/SR 502 intersection is currently performing at an LOS of D. The AM and PM peak-hour average delays are as follows:

- AM peak-hour delay = 36 seconds
- PM peak-hour delay = 45 seconds

A horizon year of 2035 is selected as the design year, which is described further in detail. Many factors are considered when forecasting design volumes, which is described in greater detail in the Traffic Analysis Report, with average forecasted traffic delays in horizon year 2035 summarized as follows:

Highway Capacity Manual (HCM) 2000 for SR 503/SR 502, 2035 (no-build condition)

- AM peak-hour control delay = 82.5 seconds, volume to capacity (V/C) = 1.06, LOS = F
- PM peak-hour control delay = 164.8 seconds, V/C = 1.29, LOS = F

Based on the City's current traffic standards, the perceived delays for the SR 503/SR 502 intersection under current conditions are seen as unfavorable. Conditions will be significantly beyond that threshold in future conditions, with PM peak-hour delays of 164 seconds. The estimated LOS in the future for this intersection is projected at level F, with maximum delays much beyond normal thresholds of tolerance. The existing LOS of D is also seen as a poor performing intersection for some movements and is an indicator of poor performance for users. Based on this information, it is apparent that intersection improvements that will reduce traffic delays for motorists is at the top of the project's priorities.

4.2 Baseline Needs Summary

Other needs were assessed for the project; however, these were not deemed crucial, as the primary need is reducing delays to users and improving overall mobility through the intersection. Safety statistics were reviewed for the last five years of collision data. No severe or fatal accidents were found at or near the intersection, removing safety improvements as a targeted baseline need. However, safety will always be incorporated into the designs using current design standards, with engineering judgement. Additional needs are discussed further in the Contextual Needs section.

Some additional needs include pedestrian and freight mobility, which were assessed as baseline needs but were considered incidental to the purpose of the project. The baseline need serves as the core issue to be addressed in all of the practical solutions alternatives.

4.3 Project Need Statement

The Project Need Statement used for the project and presented to the public outreach events is as follows:

> *The intersection of SR 502 and SR 503 has average delays for the AM and PM peak hours up to 45 seconds with delays up to 164 seconds in the future horizon year of 2035. The community has expressed frustration with the excessive delays which are expected to be compounded with further City of Battle Ground growth and have determined that improvement to congestion at this intersection is needed to reduce peak hour delays. The project will decrease maximum delays for the PM and AM peak hours for all movements to 50 Seconds in the AM Peak Hour and 70 Seconds for PM Peak Hour for the horizon year of 2035.*

The metrics behind a Project Need Statement are discussed further in the next section. This information is also coordinated with the contributing factors analysis performed. This Project Need Statement is recommended for use from here on to serve the project.

5 BASELINE PERFORMANCE TARGETS AND METRICS

5.1 Delay to Users

In conjunction with traffic analysis performed by GT Engineering, the recommended delay to users performance metric shall apply to both existing conditions and forecasted horizon year 2035 traffic conditions as follows, per the Project Need Statement provided in Section 4.3:

- AM and PM peak-hour average delay = 50 seconds

This delay is consistent with all WSDOT Design Manual, AASHTO/FHWA, and City of Battle Ground delay standards, with slight modifications specific to the project due to the following reasons:

- Project funding
- Impacts to the public
- Impacts to adjacent properties
- Environmental impacts

As discussed previously, other metrics can be used to determine traffic capacity and performance.

The design team found the peak-hour delay as the true parameter to compare traffic capacity, which also tends to be what is perceived by the driver. LOS, which is commonly used as a metric, may be discussed but will not serve as the metric that the project is to achieve and is only used for discussion purposes. It should be noted that the delay is directly related to the signal phasing performance and may also include the ability of a pedestrian to cross the intersection in all directions. The performance metric of peak-hour delay will be used to assess if practical solutions meet the intended goals of the project. This will be evaluated as part of the traffic operations improvement comparison, including assessment of contextual needs.

The performance metrics will be used to assess if practical solutions meet the intended goals of the project. This will be evaluated as part of the traffic operations improvement comparison, including assessment of contextual needs.

6 PROJECT CONTEXTUAL NEEDS

The project contextual needs are as follows:

- Intersection safety
- Multimodal needs
- Limited impacts to businesses
- Limited impacts to the public
- Environmental compliance
- Freight mobility
- Benefits to other City of Battle Ground planned projects

6.1 Intersection Safety

WSDOT's Target Zero policy remains focused on intersections. Intersections are some of the most dangerous aspects of a roadway, with conflict points created from a signalized intersection between cars and other modes of transportation. Though severe or fatal accidents have not occurred at this intersection in the last five years, the most important contextual need is maintaining safety as part of the alternatives analysis. Designs will consider safety aspects, and each alternative will be selectively compared from a safety standpoint. A reduction in safety from current conditions will not be permitted as part of the design alternatives process.

6.2 Multimodal Needs

WSDOT's policy is to promote multimodal travel. This project is no exception because it is a key convergence point for community transportation modes. The existing project conditions include sidewalks along SR 502 and sidewalks south of SR 502 on both sides of SR 503. Bicycle lanes exist on SR 502 west of SR 503 but terminate at the intersection. A future shared use path is to be constructed east of SR 503 and north of SR 502/W Main Street within the WSDOT right-of-way (ROW).

All of these facilities serve to accommodate the pedestrian needs for community shopping, schools, and community centers in the core area of the City. Enhancing the pedestrian and bicycle facilities within the project area will be an important aspect of the preferred alternative. Pedestrian and bicycle modal demands are expected to increase as the area continues to grow and become more urban.

6.3 Limited Impacts to Businesses

Privately owned parcels exist on all corners of the intersection, and rights-of-way are owned by businesses on three of the four corners. The improvements resulting from the project alternatives can have positive or negative impacts to business access along SR 502/W Main Street.

Mitigating impacts to businesses should be considered a contextual need. This contextual need can be compared among the alternatives in regard to ROW acquisition for the purpose of accessing businesses or to reduce traffic near businesses to help overall access. The project ideally will not negatively impact businesses; however, mitigating impacts to businesses may directly conflict with other contextual needs and the traffic delay reduction baseline need.



Figure 3. Businesses in the Project Vicinity.

6.4 Limited Impacts to the Public

Roadway construction projects can have significant temporary and permanent, positive or negative impacts to the public. Minimizing negative impacts is considered a contextual need of the project.

Some permanent negative impacts include the following:

- Additional visual obstructions
- Increased noise
- Visibility of roadway and business signage
- Inconveniences such aggressive driving behaviors, illegal pedestrian crossing, or traffic confusion

Some temporary negative impacts to the public include the following:

- Maintenance of traffic during construction
- Utility disruptions
- Construction noise
- Temporary access closure or construction easements on properties

6.5 Environmental Compliance

Meeting state and federal environmental regulations is required for the project. Wetlands may be present on the northwest and southwest corners behind the adjacent shopping complex. Wetlands have generally been identified both east and west of SR 503 within the WSDOT ROW. Mitigating impacts to these adjacent wetlands is a general need on the project that should be evaluated for all practical solutions alternatives.

A biological assessment will be conducted to explore whether some wetlands are critically sensitive. Impacts to the environment not only include permanent land disturbances but also stormwater quality. Practical solutions alternatives should be compared against each other to determine whether they can accommodate green storm treatment designs or to evaluate additional impervious surfaces for stormwater runoff. Environmental wetland mitigation costs are included in cost estimates for each alternative to remediate any impacts to wetlands.



Figure 4. Wetland in the surrounding project area.

6.6 Freight Mobility

Freight mobility is typically a contextual need included on most intersection designs. SR 503 is labeled a freight corridor for interregional freight, and the SR 503/SR 502 intersection is currently a key point of access to Interstate 5 for the region. This will be discussed in more detail later in this report.

Careful intersection design balances all needs of intersection. A dilemma often encountered on intersections is the competing factors of freight mobility against pedestrian and signal timing needs. A typical intersection without an island has a larger curb radius for truck mobility (and overall width of crosswalk), but it is in conflict with pedestrian exposure to traffic and basic signal time for pedestrian crossing. Islands are sometimes used to help improve this scenario. However, an island may complicate the safety of pedestrians and may hinder large freight truck mobility.

Freight mobility is needed for economic growth and vitality of businesses, the City of Battle Ground, and the overall region. However, freight mobility can also be a detriment to the operations of an adjacent business. Though the project is not developed specifically for freight mobility, any enhancements for freight mobility should be weighed against other needs, including the baseline need of reducing motorist delay.

6.7 Benefits to Other City of Battle Ground Planned Projects

Some project alternatives may have direct positive or negative impacts on other City projects. These projects are listed in Section 2 of this report. It is desirable that this project be fully compatible with other designed projects; otherwise, this project's scope or needs may need to be reduced. The alternatives will be compared against each other for impacts to other City projects. The project alternatives will also be compared for being forward compatible with SR 503 expanding in the future to two lanes in each direction.

7 DRAFT CONTRIBUTING FACTORS ANALYSIS

7.1 Traffic Congestion – Civil/Site Condition Contributing Factors

Proximity of Adjacent Intersection on W Main Street at W 8th Avenue. The intersection of W 8th Avenue is approximately 500 feet from the intersection of SR 503/SR 502. Signalized intersection spacing that is too close can often hinder the capabilities of one intersection's operations. While W Main Street at W 8th Avenue is not a state highway, intersection spacing should generally strive to be under ¼ mile per WSDOT standards on Managed Access Class 5. Close proximity of intersections can lead to these common issues:

- Lack of signal timing, which hinders proper movement from one intersection to the intersection downstream of traffic.
- Lack of storage space for turning movements on the upstream intersection, influencing operations of free-flowing traffic through the downstream intersection.
- Queues from the upstream intersection affecting the downstream intersection in all directions.



Figure 5. Near W Main Street and W 8th Avenue.

Size of Intersection. The size of an intersection may create operational issues and cause excessive delays. The SR 503/SR 502 intersection is six to seven lanes across in addition to shoulders. Width of intersections can have negative effects on intersections by increasing signal phasing for pedestrian movement crossings and increasing time for vehicles to travel through the intersection. Growing pedestrian volumes at the intersection will lead to crossing time phases over 20 seconds to allow crossing per ADA guidelines. This equates to over 80 seconds on four phases of the signal cycle, not including left-turn movement phasing, which is required.

Pedestrian Conflicts. With the increasing pedestrian activity and urbanizing of the City, a direct conflict between right-turning vehicles and pedestrian through crossing movements occurs at signalized intersections. This conflict requires a turning vehicle to stop other vehicles in the lane to yield to the pedestrian movements. Increase in pedestrian use compounded with right-turning movements may cause operational delay to both through and right-turn movements.

Limited Local Roadway Grid System for City of Battle Ground. The limited east–west and north–south local roadways across SR 503 and SR 502 pose a dilemma for many of the fast-growing communities around Battle Ground. This issue is partially a result of trying to balance the interregional travel goals of maintaining a partial limited access highway of SR 503. In the current state, SR 503 acts as a barrier splitting down the middle of region constraining east/west traffic to certain focused intersections. SR 502 also serves as direct access to Interstate 5, which places a high demand on the intersection of SR 502/SR 503 for interregional travel.

Traffic congestion is not only in the east–west direction. Because of limited principal arterials running north–south within the City of Battle Ground, drivers tend to use SR 503. Additional north–south routes would give drivers options to access SR 502 and W Main Street at different intersections, reducing the overall traffic at the project intersection. Planning-level discussions for more principal arterial construction within the City of Battle Ground have taken place. However, no confirmed plans for improvements are within the 2035 horizon year of this project's improvements.

Lack of Right-Turn Storage Auxiliary Lanes. At some busy intersections, adding storage at the signal may increase the signal operations. Additional storage can allow an increase of cars queued closer to the intersection with more opportunity for vehicles to travel through the intersection in a given cycle. Currently, the intersection of SR 503/SR 502 has left-turn lanes (dual for eastbound [EB] and westbound [WB]) and a right-turn lane for northbound [NB] SR 503. However, no right turn lanes currently exist for the EB, WB, and southbound [SB] movements of the intersection. Use of right-turn lanes may help performance operations of the intersection in some cases.

Lack of Left-Turn Storage Auxiliary Lanes. A high volume is seen specifically at the NB SR 503 to WB SR 502 left turn movement. Currently, the existing roadway only provides one left turn. Both existing and future traffic demands a high amount of PM and AM volumes for this movement connecting these two regional highways. This movement is a direct connection that is anticipated to increase significantly with regional area growth.

Lack of Deceleration Lanes for SR 503. SR 503 is a high-speed facility with a speed limit 55 miles per hour (mph). Deceleration for cars turning right on a high-speed facility can limit the ability of the through movements and cause slowdown. Allowing vehicles to get outside of the through lane of travel before decelerating can mitigate slowdown to through lanes and allow more vehicles to move through a green signal phase for the through movements. This has shown to marginally improve traffic conditions for higher speed facilities and increase the number of vehicles that travel through a given cycle time. Deceleration lanes may also reduce rear-end collisions, which may reduce congestion as result of accidents.

Lack of Acceleration Lanes on SR 503. Acceleration lanes can benefit traffic operations when coupled with higher speed facilities. By creating an acceleration lane, right-turn movements at a controlled stop can turn onto the higher speed facility with more ease, allowing more turn movements onto facilities rather than waiting for green lights to complete the turn. More cars navigating the intersection outside of the green phase may allow other movements to get queued closer to the intersection, allowing vehicles to enter through the intersection in an improved manner. SR 503 currently does not have right-turn acceleration lanes. Adding acceleration lanes can also increase safety by reducing rear-end collisions, thereby reducing delays to traffic caused by accidents.

Access Within Functional Intersection Zone. Right-in/right-out accesses for Safeway and Shell are seen within the functional intersection zone of W Main Street connecting to SR 503. The functional area consists of the immediate area on the far end of the intersection of travel and within any zone that a turn lane develops

or a driver requires perception, decision, reaction, and maneuvering. The access appears to meet the partial limited access control requirements of Chapter 530. However, AASHTO guidelines do not recommend placing driveway access within the functional zone. The Safeway driveway is seen directly within this zone and the Shell driveway is close to this area. Creating access (exit or entrance) within the functional zone causes disturbance and increases risk of accidents. This can hinder the operation of an intersection, especially at the peak hours.



Figure 6. Safeway driveway access.

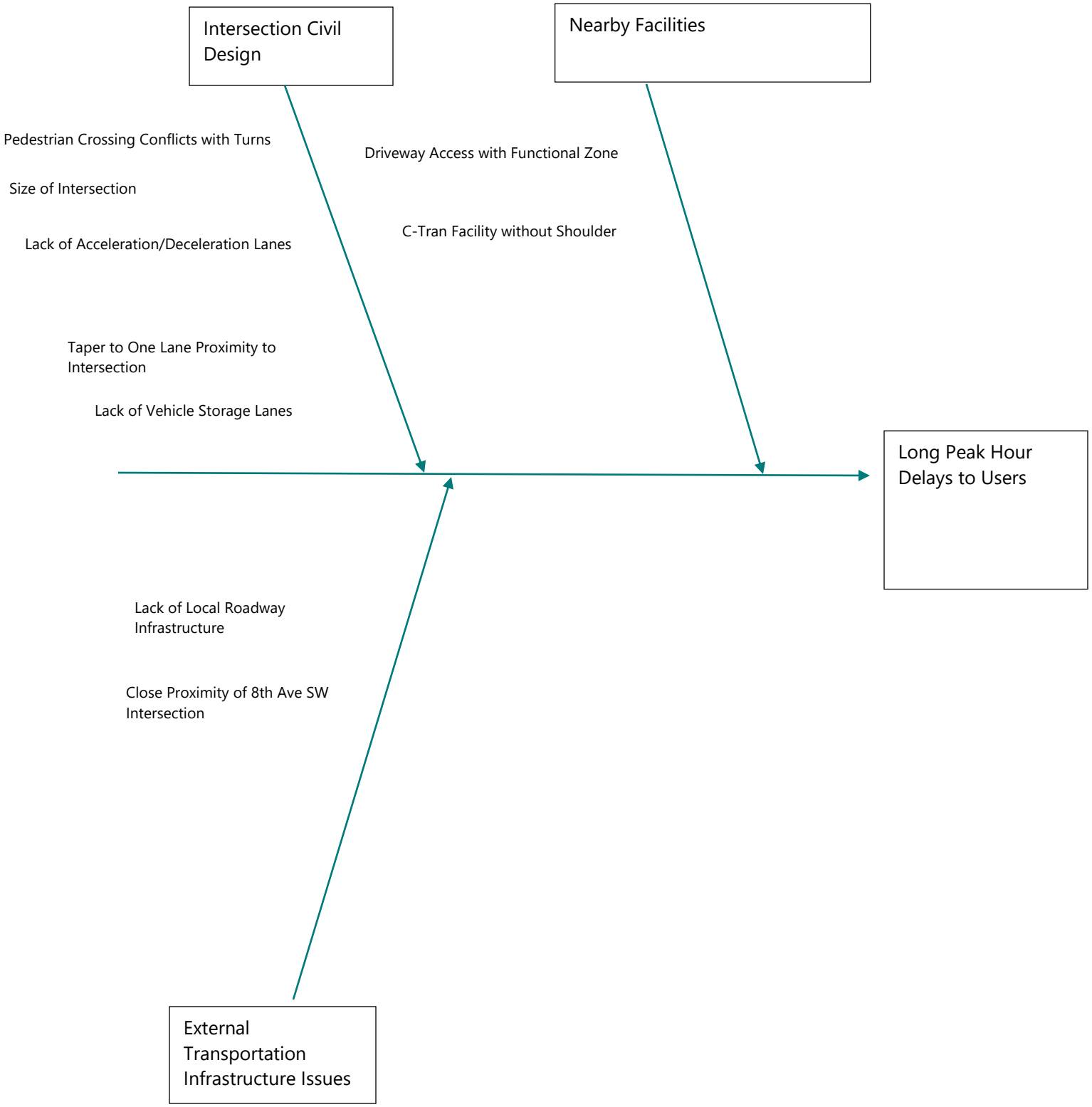
Effects of 2-Lane Reduction to 1-Lane Roadway Just North of Intersection. In some situations, the reduction of lane location with regard to the intersection can have negative effects. The acceleration length to 55 mph does not appear to be accommodated for NB SR 503 before the merge, which has a taper just north of the roadway around 500 feet away from the stop bar. WSDOT design guidelines (and AASHTO) recommend 960 feet of acceleration length to travel from a stopped condition to 55 mph. Regional truck usage on this route can compound this dilemma. This limits the ability of vehicles to accelerate to 55 mph with ease before merging into one lane, which can affect the capacity of an intersection's performance. Truck traffic often compounds this issue. Close transitions to the intersection may also cause cautious drivers to favor the left lane in advance of the intersection, which may skew more traffic to one through lane instead of the other. Uneven lane balance ultimately can have negative impacts on a signalized intersection performance.



Figure 7. SR 503 current condition.

Effects of Bus Stop Within Traveled Lane for EB SR 502. The current C-TRAN bus stop utilizes the existing lane with little to no shoulder just west of the intersection because no conventional bus pullout currently exists. Peak-hour traffic tends to also lend more bus frequency to meet the demand of users and hence more bus activity. Because the current condition requires buses to stop inside the traveled through lane (and lane for right-turn movements), it can adversely impact traffic during the peak hours and cause intermittent reductions to one lane. This, coupled with already congested conditions, can cause a reasonable amount of disturbance to traffic flow.

Cause and Effect Diagram



8 PROJECT LAND USE CONTEXTS

Project land use context is important to understanding the most practical design and keeping the end result within the community character. Language per WSDOT Design Manual Chapter 1102 focuses on three distinct factors to determine land use context:

- Land Uses
- Density
- Setbacks

These factors are broken down further:

Factor	Criteria
Land Use	Land uses within ½ mi of roadway
Density	Housing units/acre
Density	Jobs/acre
Density	Jobs/acre
Density	Typical building height
Setback	Typical building setback
Setback	Parking (on street or off street)

Land use context can be further broken down into existing and future land use contexts. Current land use contexts are often easier to define because there is sufficient information to assess the context. Future land use contexts are often more challenging to define and require speculation on community growth, emerging industries, and economic changes. Both are discussed further in detail for the SR 503/SR 502 Intersection Improvements Project. See Appendix B for Land Use Context information documents.

8.1 Current Land Use Context

The land use defined within ½ mile consists of mainly commercial businesses, with residential neighborhoods in close proximity. The commercial businesses bordering the intersection and along SR 502 provide key shopping to the residents of the City and outlying areas, and produce significant traffic volumes. Significant stores such as Safeway, Fred Meyer, Ace Hardware, Wilco Farm Store along with many smaller businesses and restaurants are in close proximity to the intersection and depend on the intersection operations for economic vitality. Low- to medium-level pedestrian usage is seen at the intersection based on observation. Increased pedestrian usage is expected shortly after the SR 503 trail north of the intersection is constructed.

Significant community entities such as City Hall, police and fire departments, hospitals, churches, and schools are in close proximity to the SR 503/SR 502 intersection. This intersection provides a true intersection through all the major businesses and community growth, which leads to the assumption that development is highly related to the intersection of these two regional highways. Public transit runs on SR 502 through the intersection to W Main Street, with transit stops within a block of the intersection. Generally, most transportation seems dependent on vehicles within the City with limited transit stops for intercity or regional travel. Small sidewalk facilities are present near the project (except for SR 503 north), and SR 502 also includes capacity for bicycle lanes.

Density can be explored using WSDOT guidelines by the following:

Housing units/acre = 2.0 units per acre estimated (EPA estimated 1.0 in 2010)
Jobs/acre = Estimated at approximately 2.0 jobs per acre (EPA estimated around 1.5 in 2010)
Intersections per square mile = Approximately 100 based on research from EPA website
Typical building height = Typical building heights vary from one to three stories within the immediate project limits, with most being single-story structures

Setback distances are typically more than 100 feet within the immediate project limits. However, parking lots encroach the roadway limits with little to no buffer largely because large-scale commercial development and retail stores typically have significant parking facilities. The setback distance farther away from the intersection shows building closer to the highway both east and west of the intersection on SR 502. The setback distances do not apply to SR 503, which has limited access and sufficient ROW buffer to lower density properties north and south of the intersection. On-street parking is not allowed near the vicinity of the intersection and along all of SR 502 and SR 503. This is due to the freeway or principal arterial function of the highways where parking is not a priority function. East of the intersection, W Main Street serves as a lower speed roadway and is an older local roadway with a business context. However, it still does not provide on-street parking.



Figure 8. Land use context of general area in the vicinity of SR 503.

Based on the analysis of these categories, the number of commercial businesses, and current uses on the project, the project land use context is defined as *suburban land use context* based on guidance given under WSDOT Design Manual Chapter 1102. SR 502 and SR 503 are also identified as "main streets" per WSDOT designation.

8.2 Future Land Use Context

The City has experienced significant growth over the last 20 years, with over 100 percent growth in population since the year 2000. Although growth has slowed over the past few years, the Traffic Analysis Report completed by GT Engineering indicates an anticipated growth rate of 1.6 percent per year.

Growth is always challenging to accurately predict. However, the following are a few clear indicators of future growth:

- Construction and manufacturing is the leading industry in the City.
- The average age of residents of the City of Battle Ground is younger than the average age of residents in other cities in Washington State, indicating new or younger families and potential increase in population.
- The number of new house construction permits per 10,000 residents was three times the Washington State average.
- Growth and business in the Vancouver and Portland metropolitan areas are thriving, which will continue to have a ripple effect in surrounding communities such as Battle Ground.

The project intersection has regional importance with possible growth indicators that point to the City of Battle Ground as a center node for the region.

Based on the indicators listed above, the expected future land use context is estimated as follows:

- Increase in commercial development and more multifamily dwelling units near the immediate intersection limits.
- Increase in pedestrian and bicycle usage as a result of additional multifamily dwelling units, increase in commercial businesses, and general increase in industries and school sizes for the City of Battle Ground.
- The City of Battle Ground area has more affordable housing, which attracts more residents. This will cause an increase in the number of commuters to the Vancouver and Portland areas who will use the intersection to get to freeways. Increased number of commuters using the intersection to get to freeways, with overall residential growth in the Battle Ground area because of more affordable housing with daily commutes for work in the Vancouver and Portland areas.
- Outlying areas to the current City of Battle Ground thrive off of the city center area for shopping and industry.
- Increase in public transit to accommodate commuters to more metropolitan areas as well as serve the local needs for the City of Battle Ground.

Based on the estimated growth in the City of Battle Ground, growth to the overall regional area, more multimodal travel, and continued importance of SR 502 and SR 503 as regional highways, the project land use context is defined as *urban land use context with some suburban characteristics* based on guidance given under WSDOT Design Manual Chapter 1102.

9 PROJECT TRANSPORTATION USE CONTEXTS

Another context consideration that is a key component to comprehensive designs is understanding the current and future transportation contexts. This includes the roadway infrastructure, modal types, transportation needs, and possibly sub-mode categories. This is explained below for both the current and existing conditions.

9.1 Current Roadway Type

The SR 503/SR 502 intersection involves the convergence of two important regional highways in the City of Battle Ground. The north and south legs are SR 503, the west leg is SR 502, and the east leg is W Main Street. These roadways are currently classified as follows:

- SR 503: Other Freeway/Expressway – Part of the National State Highway Log
- SR 502: Other Principal Arterial Highway – Part of the National State Highway Log
- W Main Street – Local Roadway Minor Arterial

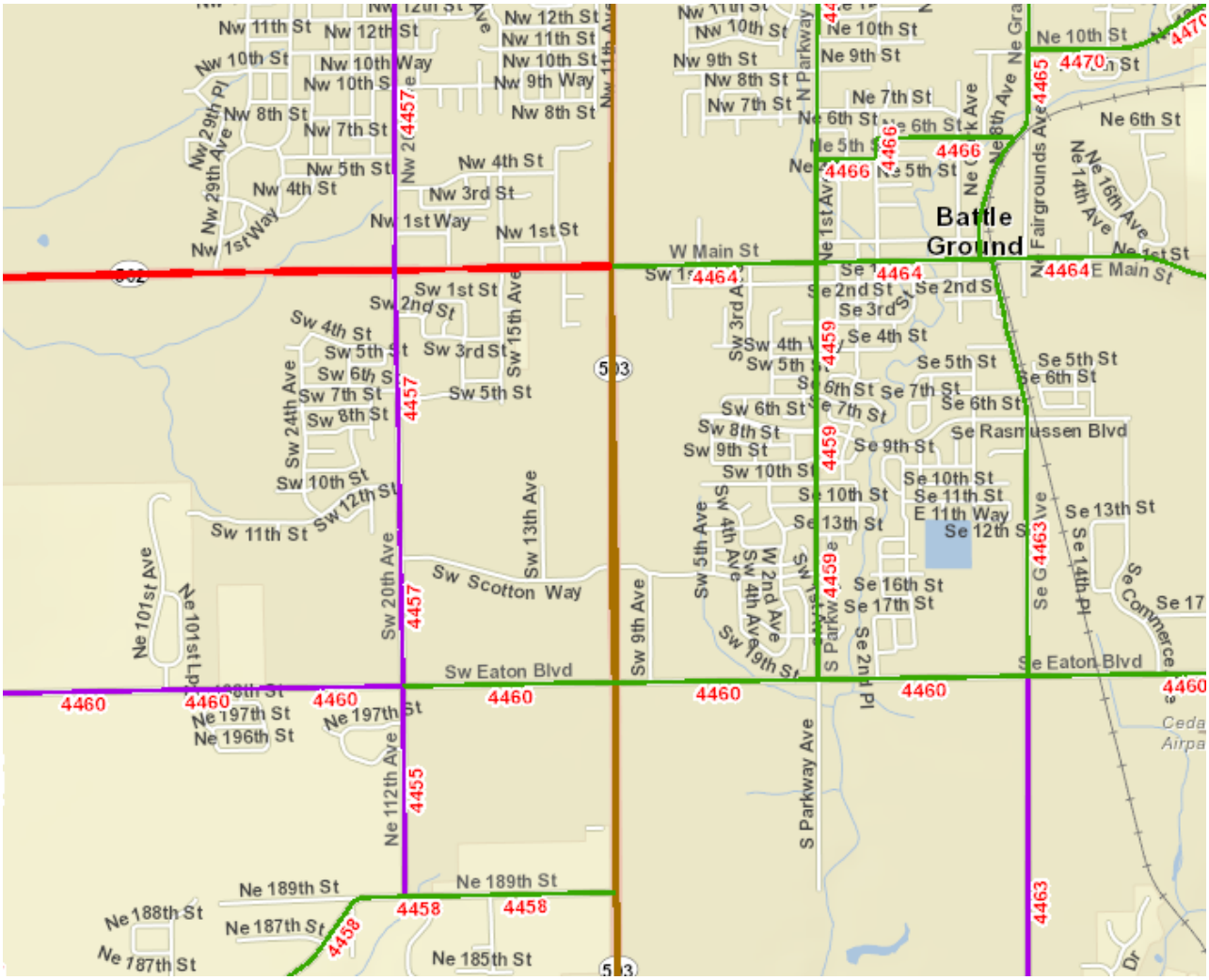


Figure 9. WSDOT roadway designation of SR 502 and SR 503. Red, for SR 502, indicates "other principal arterial" while brown, for SR 503, indicates "other freeway."

SR 502 and SR 503 are highways of regional importance, as discussed previously, and are part of the state national state highway log. A significant number of residents commute to and from work using SR 502 and SR 503 as part of their route as well as for local trips.

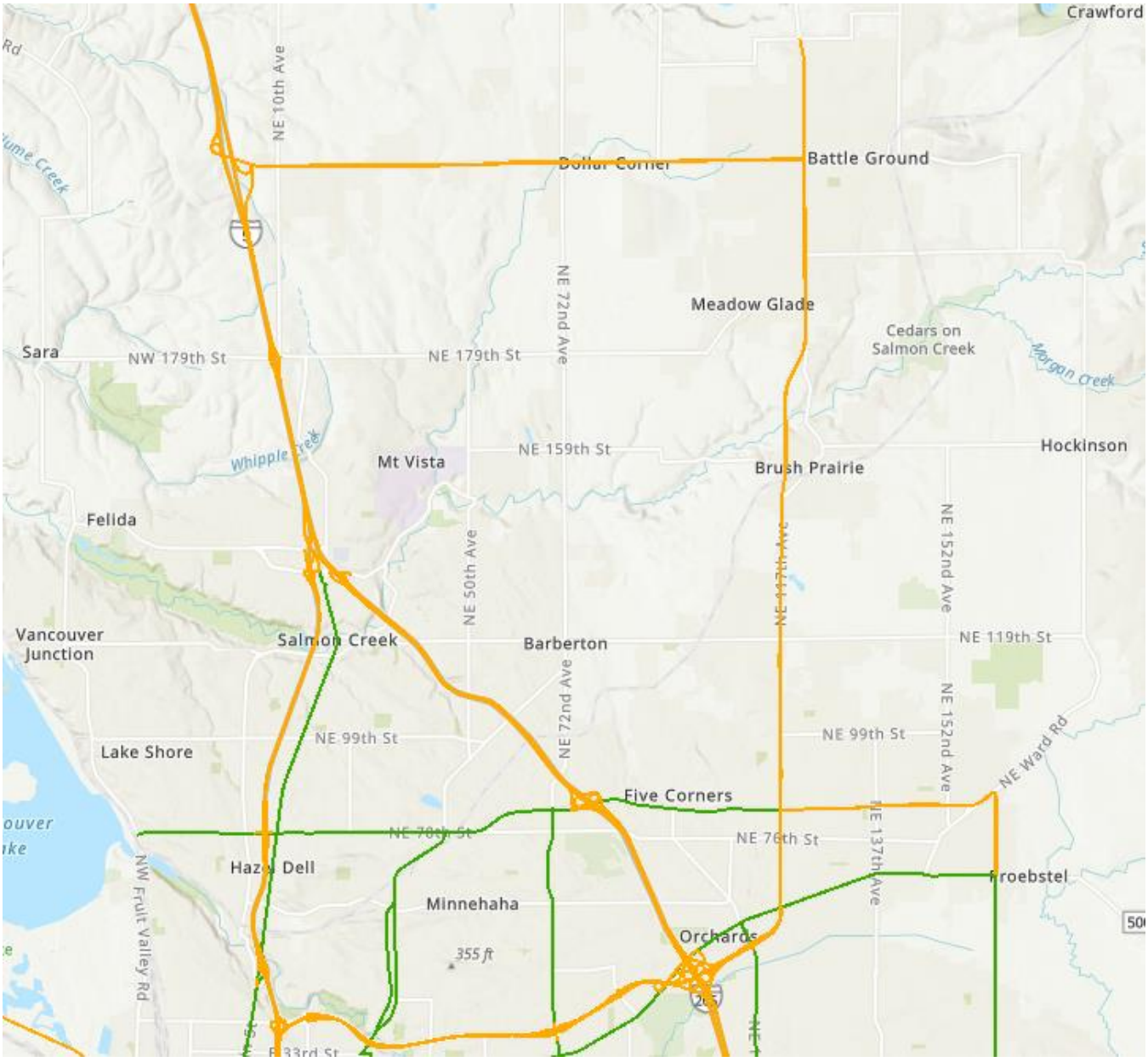


Figure 10. Regional highway map – National Highway Log

WSDOT continues to preserve access onto highways to maintain functionality, operations, and safety of the highway. In the immediate vicinity of the intersection, the following access is defined for the three roadways:

- SR 503: Partial Limited Access
- SR 502: Managed Access Class 4 (changes to Limited Access west of City limits)
- W Main Street: Access Management per City of Battle Ground guidelines

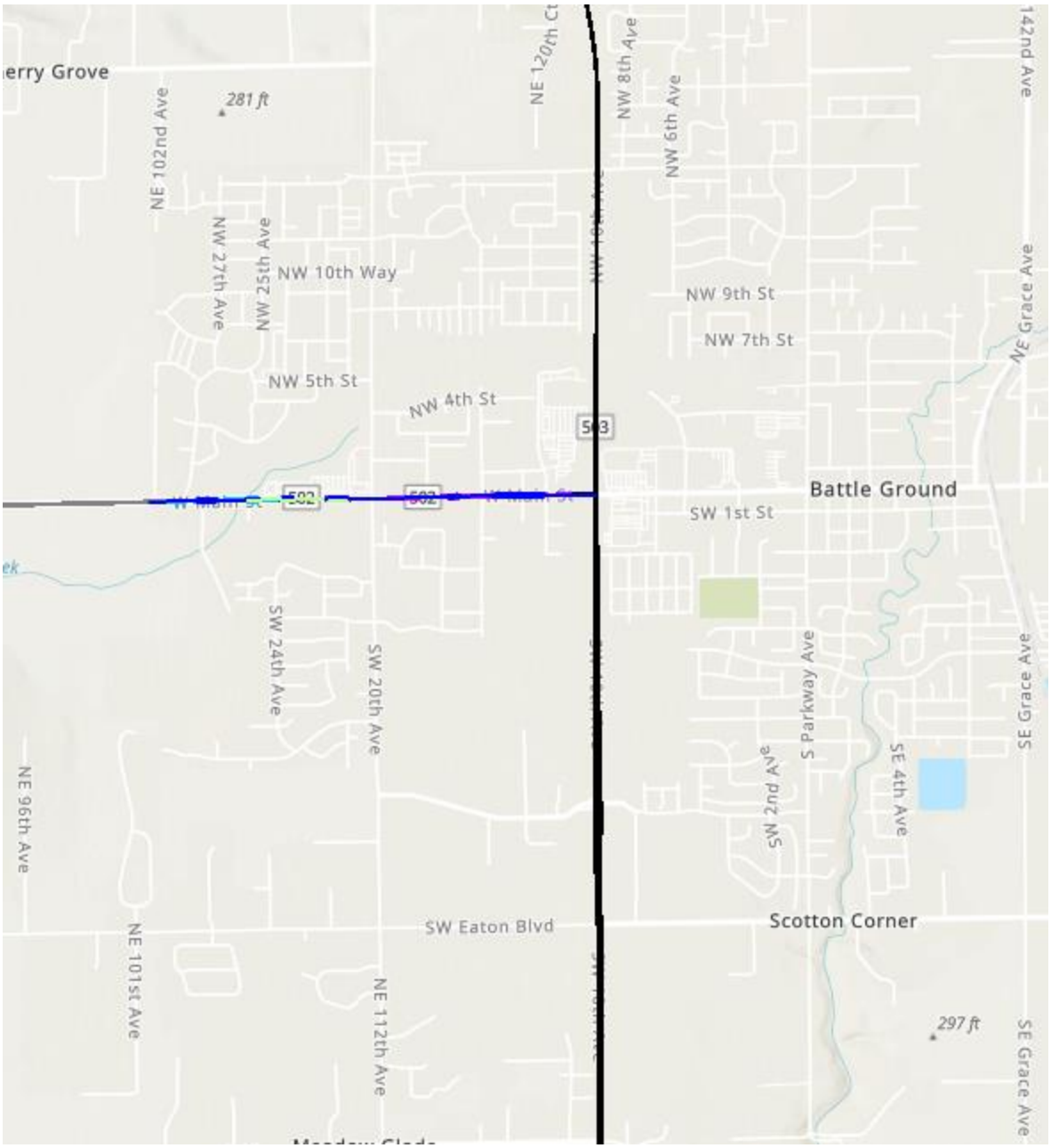


Figure 11. Access Log for State Highways (Black = Limited Access, Blue = Managed Access)

It is important to note that just west of the intersection, SR 502 turns into a Modified Limited Access facility, with the managed access near the City of Battle Ground development to commercial business centers.

Posted speed limits for the roadways is as follows:

- SR 503: 55 MPH
- SR 502: 40 MPH
- W Main Street: 25 MPH

The following are the types of trips that are typical for users of this intersection:

- Residential Trips
- Commuter Trips
- Trips to industries in the area

9.2 Future Roadway Type

Future master plans of the roadways include expanding SR 503 to a four-lane highway just north of the project, improving the freeway functionality of a highway. A future intersection north of this intersection is planned, as well a decrease in the overall limited access feel to SR 503. However, there are no plans in the foreseeable future to change the access designation of SR 503. It is anticipated that the through route of SR 503 is maintained without significant amounts of intersections added to this route within the City of Battle Ground over the next 20 years. Improving access within this corridor to a full limited access does not appear likely based on current master plans. It is assumed that this freeway corridor will maintain a high posted speed to facilitate transportation movement as a key north–south highway route for the region. It is also assumed that SR 503 will maintain its designation as a freeway/expressway on the national State Highway Log.

SR 502 has already taken on a form as a lower speed highway with managed access near the intersection. The growth of the City of Battle Ground and continued commercial business development will likely extend the managed access limits farther west. SR 502 will likely develop more to a multimodal urban street where aesthetic features may play a bigger role in the roadway. This may include lowering the design speed slightly to accommodate safety for bicycle and pedestrian users with improved access to business.

W Main Street will also follow suit with the City of Battle Ground and is expected to maintain a function of lower speed minor arterial where multimodal travel and aesthetic features could possibly be added to the roadway.

City Main Street Classification

SR 502 and SR 503 are designated "Main Streets" that are classified as routes with special importance to the City of Battle Ground. Main Street designations place special importance on these facilities for the city to which they travel through. As discussed earlier, significant commercial business growth along with access to regional highway or interstate facilities are key reasons for SR 502 and SR 503 to be labeled "Main Streets."

Existing Bicycle Route Type

SR 502 and SR 503 offer bicycle facility options in different manners. The routes provide key bicycle access from a regional and city perspective. Current bicycle use contexts are as follows:

- SR 503 – No identified designated bicycle route. However, sidewalks and shoulder are provided for possible bicycle use.
- SR 502 – Bicycle lanes classified as Citywide Connector Status.
- W Main Street – None.



Figure 12. Designated bicycle route is ahead on SR 503, as indicated by the road sign.

Future Bicycle Route Type

SR 503 has a separated shared use path project under design that will effectively allow safe travel from SR 502 to N Onsdorff Boulevard along the east side of SR 503. This will increase the effectiveness of bicycle travel in the area and help youth get to school in a safe manner. A shared use path condition exists further south of the intersection with sidewalks near roadway with curb and gutter near proximity of the intersection. It is anticipated that the City will undertake some improvements for multimodal travel on W Main Street to accommodate bicycle activity so bicycle travel along SR 502 and SR 503 can safely be continued into the downtown area. The future bicycle contexts are as follows:

- SR 503 – Shared use path north of the intersection to be classified as Citywide Connector Status.
- SR 502 – Bicycle lanes, to be classified as Citywide Connector Status.
- W Main Street – Anticipated bicycle lanes added to roadway as part of multimodal improvements, classified as Citywide Connector Status in connection to SR 502.

With the SR 503 shared use path project being constructed in the near future and safety needs to accommodate bicyclists on W Main Street, bicycle modes should be considered in the intersection design as part of WSDOT's policy for adopting multimodal designs into projects.

Existing Pedestrian Route Type

The project area is classified as suburban and, as described previously, pedestrian activity is limited. Most individuals rely on cars for transportation mode. However, pedestrian activity is expected due to the commercial businesses in the area and the intersection being in the city center. Significant pedestrian activity is also related to the schools located just north of the intersection.

The existing pedestrian routes are classified as follows:

- SR 503 Crossing – P-2 Low Volume: Estimated 11 pedestrians per hour (peak hour)
- SR 502 Crossing – P-2 Low Volume: Estimated 1 pedestrian per hour (peak hour)
- W Main Street Crossing – P-2 Low Volume: Estimated 1 pedestrian per hour (peak hour)

The volumes were observed in February and are the recorded volumes per the Traffic Analysis report. The volumes are expected to be higher outside of the winter months.



Figure 13. Pedestrian using the crosswalk at the SR 503/SR 502 intersection.

Future Pedestrian Route Type

The overall area will transform into more of an urban context with changes such as increased multifamily dwellings, multimodal and aesthetic features to SR 502 and W Main Street, possible transit service additions, and increases in commercial businesses and industries in the area. With those changes, it is anticipated that pedestrian travel along SR 502 and W Main Street will increase. The SR 503 Shared Use Path project will see higher pedestrian travel; however, it anticipated this corridor will be more heavily used by bicyclists rather than pedestrians because it is assumed that intersection spacing will still be large.

Construction of the shared use path north of the intersection is expected to give students a safe and quick route to the schools just north of the intersection in the City's future 5th Street Right-In, Right-Out Access project on SR 503. The future pedestrian existing routes are classified as follows:

- SR 503 Crossing – P-2 Low Volume – Estimated 15 pedestrians per hour (peak hour)
- SR 502 Crossing – P-2 Low Volume – Estimated 2 pedestrians per hour (peak hour)
- W Main Street Crossing – P-2 Low Volume – Estimated 2 pedestrians per hour (peak hour)

These volumes were calculated using a 2 percent growth factor from the volumes provided by the Traffic Analysis Report which was taken in the winter months. It is anticipated that the volumes listed above will be higher in months outside of the winter months. Overall, pedestrian facilities should be updated to meet ADA standards with facilities possibly increased on size to account for estimated increase pedestrian use in the future.

Existing Freight Route Type

The project area has some regional freight significance. Besides I-5 and I-205, SR 503 serves as a key north–south freight corridor for the regional area. SR 502 also has significant freight usage, which seems to derive from the City of Battle Ground by feeding into SR 503 and I-5. See Appendix B for a freight map.

Logging and aggregate trucking of raw materials are seen heavily using SR 503, turning to and from SR 502 from north of the intersection to other regional areas. Some industry areas southeast of Battle Ground may use the intersection as access to I-5 heading northbound, including OldCastle Manufacturing. The freight routes are classified as:

- SR 503: T2 Freight Corridor South of Intersection / Connector to T2 Freight Route North of Intersection
- SR 502: Connector to T1 (I-5) and T2 (SR 503) Freight Route

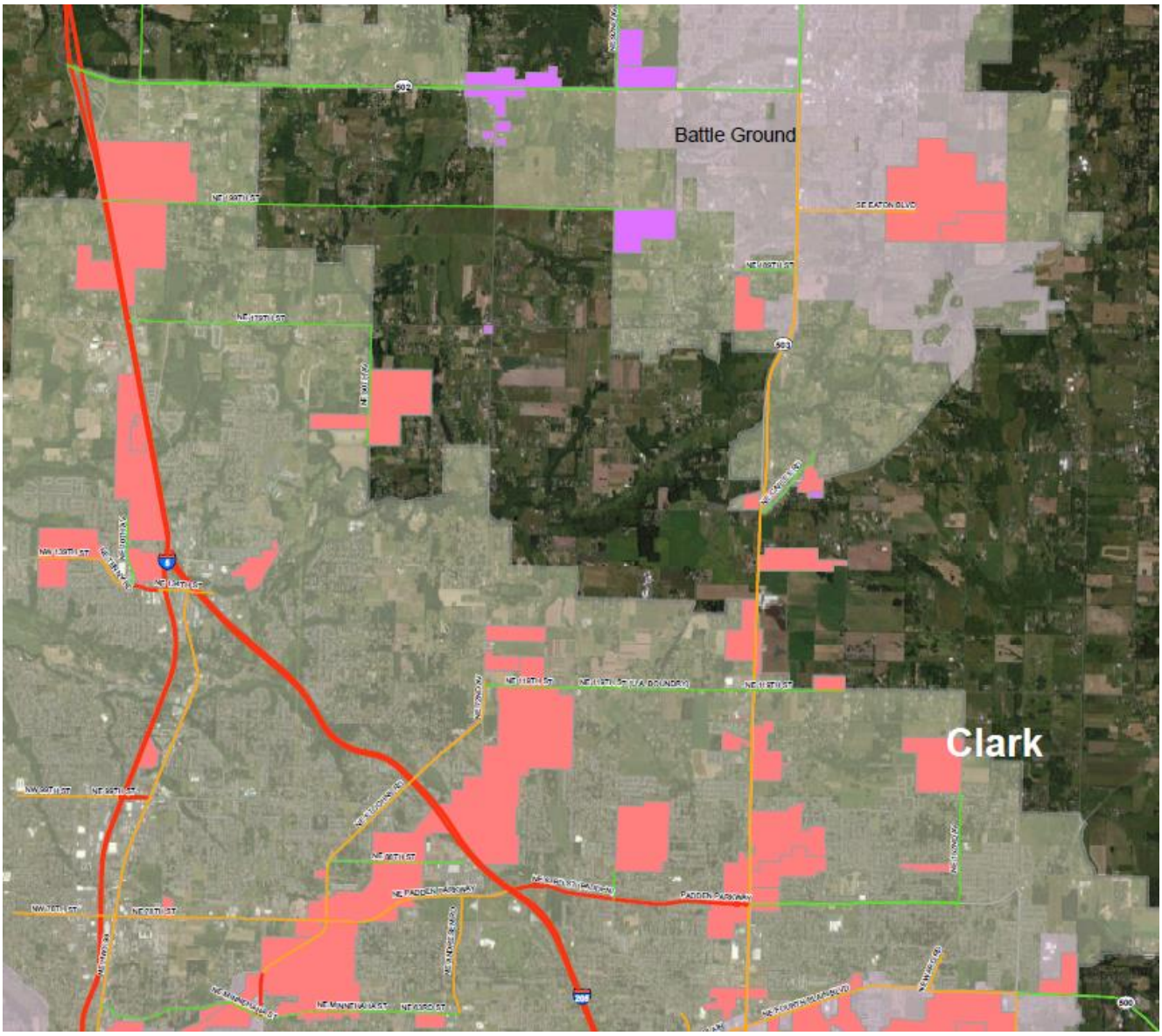


Figure 14. Current WSDOT-identified freight routes in the southwest region of Washington.

Future Freight Route Type

With continued growth, the City will increase in the commercial freight and raw materials industries. This will increase the freight demands in the area, which should be accounted for in the SR 503/SR 502 intersection design. Freight demands in the future will be in an increased capacity. Freight mobility will be assessed in terms of lane widths and turning movements at the intersections in both a design vehicle and accommodation fashion for the rare large vehicles.

Current Transit Use

Public transit stops are currently available around one block west of SR 503 on EB SR 502 and around two blocks east on Main Street. The current transit agency, C-TRAN, offers public transportation from Battle Ground to Vancouver with Routes 47 and 7, which travel through the intersection on SR 502 and Main Street.

These routes are already part of the regional transportation plan to accommodate interregional travel. Public school buses also use the intersection due to the large number of schools nearby.

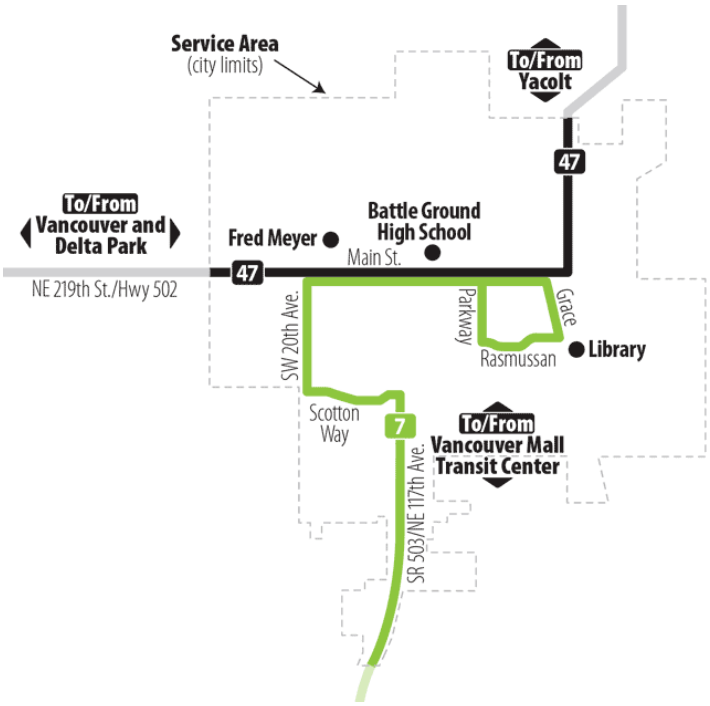


Figure 15. Current transit in the City of Battle Ground.

Future Transit Use

In coordinating with public transportation agencies such C-TRAN, continued interest to provide both local public transportation and regional transportation are seen within the design year of the project. Transit service is expected to increase with continued stops near the intersection. Design for transit service by maintaining stops will be assessed during the design to continue service along with possible upgrades to the stops integrated in the design alternatives.

10 PROJECT DESIGN CONTROLS

10.1 Design Year

Because the SR 503/SR 502 intersection design is a reconstruction project and has significant local importance to the City of Battle Ground and regional importance to WSDOT, we recommend a horizon year of 15 years from construction, or 2035, with the horizon year the same as the design year. This will require traffic forecasting, projecting growth, and accounting for possible future conditions. Typically, a horizon year is assessed at 20 years from construction. However, a conventional intersection indicates failure beyond the year 2035. WSDOT is still assessing overall plans for SR 503 beyond the year 2035, which is why the design team proposes a horizon year of 2035.

Terrain Classification

The terrain classification has little to no grade change within the project limits. There does not appear to be any operational or safety constraints related to grade change that are to be included on the project. A recommended terrain classification of "Level" is to be used for design on this project. Significant grade changes are anticipated for any of the project alternatives.

10.2 Modal Accommodation and Priority

Based on language used in WSDOT Design Manual Chapter 11.03, a suburban principal arterial should accommodate vehicles with a high level, bicyclists to a medium level, and pedestrians to a low level. However, the context of W Main Street just east of the intersection tends to promote a minor arterial for a local roadway, which leads to pedestrians being more of a priority.

Key facilities such as schools, businesses, and a new shared use path facility lend to increased pedestrian use. Also, the horizon year area context will likely have more urban elements associated, also increasing pedestrian modal priority. Transit currently uses SR 502 and W Main Street, with stops within a block of the intersection giving Transit Modes consideration in the practical solutions and design.

From the analysis above, the following recommended modal accommodation inputs are based on guidance from WSDOT Exhibit 1103-2 and 1103-3:

Motor Vehicles: High, with freight consideration (T-2 designation for SR 503)

Bicycles: Medium

Pedestrians: Medium

Transit: Medium

The intersection of SR 503/SR 502 is considered a well-established grid network for north Clark County, which leads to the basis that all modes have at least a medium modal priority and accommodation. Motor vehicles are designated as the modal priority with freight consideration. Transit is given a medium priority and ranks lowest compared to the other three contexts. However, careful consideration must not preclude future transit expansion. This modal priority is typical of suburban area context growing into more of urban context over the next 15 years.

The baseline needs for improving traffic conditions will focus on motor vehicles, with contextual needs focused on accommodating bicycles and pedestrians. Transit accommodation will be designed to only maintain the existing stop, with no further improvements.

Therefore, project design elements will focus on the motorist mode type, with the following sub-modes:

- Regional commuter
- Local user
- Industry and commerce use

Important safety considerations from a practical design standpoint need to be taken into account for pedestrian and bicycle users, as significant or severe crashes tend to be more common with these modes. The sub-modes of bicyclists and pedestrians are broken out as follows:

- Youth (children/students)
- Commuters
- Leisure users

10.3 Intersection Design Vehicle

The intersection design vehicle is often designated for the entire project or an entire intersection. However, this may often lead to overdesign for some intersections. Based on truck route designations, the T-2 truck route designation is defined as starting on SR 503 at the intersection and heading south. Based on this designation and the apparent commercial growth or needs, the existing freight traffic appears to be stemming from SR 502 and Main Street as the core of the City. However, the City has designated SR 503 as a recommended truck route north of the intersection, and significant truck turn movements are seen from SR 502 EB to NB SR 503. Smaller truck turning movements are seen from Main Street to NB SR 503, which will be evaluated for possible smaller design vehicle compared to the other movements, which may induce other benefits to pedestrian and bicycle movements.

The design vehicles are typically defined by the largest vehicle. However, this category is broken down into two further categories as *design* and *accommodated*. The design vehicle is defined as the largest vehicle commonly using the intersection. An accommodated vehicle is a vehicle that can still make the general route intended but will need to encroach onto other lanes (not oncoming) to perform the turn, which can be accompanied by a pilot car and may be done in non-peak hour times. This aspect of design versus accommodation will allow effective freight mobility while not overstepping other design aspects such as daily traffic, pedestrians, and bicyclists.

The design vehicle recommended for this project is currently defined as WB 62 (or WB 50 for some movements). This is due to the current and anticipated future commercial growth on SR 502, Main Street, and SR 503. This vehicle is expected to serve as the typical freight truck for increased commercial activity in the core City of Battle Ground area. This vehicle requires more turning requirements compared to the foreseeable transit design vehicle turns in the future. Existing industries in the area that would add to the freight demand are similar in size. No heavy industrial freight traffic nodes are or appear to be apparent except for southwest of the City core, which are not likely to use the intersection. However, some legs of the intersection can be designed for this. The design vehicle for the turning movements to NB SR 503 at the intersection may be evaluated for a smaller selection in final design to mitigate effects to other modes.

The accommodated design vehicle for this intersection is WB 67 due to the regional importance of SR 502 and SR 503. This will allow for the accommodation of large-scale truck traffic to support heavy industries and infrastructure improvements by use of pilot cars, trucking at off-peak hours, and other means to safely allow certain deliveries through the intersection. Preliminary Intersection Design Vehicles for specific turning movements are as follows:

NB (SR 503) to EB (W Main Street) – Design Vehicle WB 62 and Accommodated Vehicle WB 67

NB (SR 503) to WB (SR 502) – Design Vehicle WB 62 and Accommodated Vehicle WB 67

SB (SR 503) to WB (SR 502) – Design Vehicle WB 62 and Accommodated Vehicle WB 67

SB (SR 503) to EB (W Main St) – Design Vehicle WB 50 and Accommodated Vehicle WB 62

EB (SR 502) to NB (SR 503) – Design Vehicle WB 50 and Accommodated Vehicle WB 67

EB (SR 502) to SB (SR 503) – Design Vehicle WB 62 and Accommodated Vehicle WB 67

WB (W Main St) to SB (SR 503) – Design Vehicle WB 62 and Accommodated Vehicle WB 67

WB (W Main St) to NB (SR 503) – Design Vehicle WB 50 and Accommodated Vehicle WB 62

10.4 Access Control

SR 503 is designated as a partial limited access facility per the WSDOT access management log. No plans currently exist to reduce or increase the access designation of this facility. It is recommended that the SR 503 integrity be maintained, as this freeway will serve as a vital NB and SB route in future years when Interstate 5 and SR 502 trip times become longer. No foreseeable full limited access facility is expected for this route and should not be increased for this project.

SR 502 is currently designated as a Managed Access Class 4 facility, and there are no plans to increase or decrease the facility's access. It is not recommended that the facility maintain its current designation to help prolong business and commerce that is prevalent in the area. SR 502 terminates east of the intersection and is defined per the local agency access guidelines.

Selection of access for the facilities does not change from existing designation and is as follows:

SR 503: Partial Limited Access

SR 502: Managed Access Class 4

W Main St: Access Management per City of Battle Ground guidelines.

10.5 Design Speed

The speed selection of SR 503, SR 502, and Main Street will play an important role on both the traffic delay and safety needs of the project. These needs can often play against each other. The posted speed limits for SR 502 and SR 503 are high or intermediate speeds.

SR 503 serves as a freeway where long distances and vehicles are a modal priority and is identified as a high-speed facility. This need would be diminished with a reduction of speed. A shared use path separated facility will still accommodate other modes, and the separation will allow safety for bicyclists and pedestrians. Additional safety measures could be taken south of the intersection if deemed necessary by WSDOT, by creating separated pedestrian and bicycle facilities or using safety features such as a concrete barrier. For this reason, it is recommended that a design speed matches the current posted speed limit of 55 mph to maintain the core function of this limited access facility highway.

SR 502 currently is an intermediate speed highway that serves commercial and industry business access need, along with providing access to SR 503 (and the City of Battle Ground) from Interstate 5. The importance of economic vitality and business access to the City with a probable increase in pedestrian and bicyclist modes

leads to no increase in speed from a safety standpoint. Within the next 20 years, it is possible that the posted speed limit on SR 502 decreases to cater to more multimodal use for the City. However, the context of this project will not recommend a lower speed along this facility. A recommended design speed to match the current posted speed limit of 40 mph should be compatible with all future conditions, including dropping the speed limit for increased pedestrian and bicycle safety purposes. Traffic calming may be placed on SR 502 entering the intersection to match posted speed limits of 25 mph east of the intersection.

A design speed of 25 mph is recommended for Main Street to match current conditions. No increase to the speed is recommended to help accommodate multimodal travel and commercial business.

Design speeds are recommended to match existing posted speed limits as follows:

- SR 503: 55 mph
- SR 502: 40 mph (with possible traffic calming)
- W Main Street: 25 mph

Posted speeds are selected to match the design speeds, as no significant safety advantages are seen by going with a slightly higher design speed.

11 PRACTICAL SOLUTION ALTERNATIVES FORMULATION

Development of practical solutions can commence after defining the baseline needs, contributing factors, contextual needs, project context, and project design controls. Many practical solutions elements were developed but only five options will be discussed in this report. Refer to Appendix C for all the draft practical solution designs that were developed for the project but that are not discussed in detail in this report. The five options discussed are as follows:

- Do Nothing (no change)
- Alternative 1 - Signal Modifications and Refinements within the Existing Roadways
- Alternative 2 - Addition of Right-Turn Lanes
- Alternative 4 - Addition of Free Right-Turn Lanes (with Traffic Islands)
- Alternative 5 – Double-Lane Roundabout

It is conceivable that a full limited-access, grade-separated interchange could be constructed. However, this option was quickly disregarded by the design team for the following reasons:

- Not in character with the current SR 503 transportation and City of Battle Ground context
- Significantly outside of the project budget
- Significant impacts to the public
- Significant impacts to adjacent properties and wetlands

Basic practical solutions are designed to a planning level (or approximately 5% design stage). All information presented is preliminary for practical solutions/design purposes and shall not be construed as the final design. It is anticipated that these may be modified or altered for the final design based on additional research and evaluation.

Planning-level cost estimates and pros and cons tables are developed for each alternative to help compare the alternatives. Planning-level cost estimate (PLCE) backup information is provided in Appendix D for four of the practical solution alternatives. The basis for these estimates is also included in Appendix C for reference. All design was performed to WSDOT standards during the practical solutions development. All options are forward-compatible with a future SR 503 shared use path north of the intersection.

11.1 Do-Nothing Alternative

This option does nothing to improve current traffic delays. The option has no cost and no impacts to the public as advantages. No exhibit or cost estimate has been created for this option.

Do-Nothing Alternative Pros and Cons

Pros	Cons
No project cost	No reduction in AM/PM delays
No impacts to public	No multimodal improvements
No impacts to adjacent properties and wetlands	No increase to freight mobility
	No increase to safety

11.2 Alternative 1: Signal Modifications and Refinements within the Existing Roadways

This option has three improvement aspects. The first aspect retrofits the existing signal systems and adds Intelligent Transportation Systems (ITS) elements to help manage the intersection as efficiently as possible. This includes adding video detection cameras, VMS signs to alert motorists of delay along the corridors for

possible use of alternate routes and use of possible adaptive traffic signals to handle irregularity of intersection performance. Second, this includes re-phasing and possibly coordinating the signal systems better with adjacent intersections. This would involve coordinating all intersections on the corridor to see if additional benefits can be gained at the project intersection. Lastly, this option is to repurpose the existing north leg of this intersection to achieve a right-turn lane for SB SR 503 to WB SR 502. This includes reducing shoulders for SR 503 to allow a right-turn lane and removing left-turn access to the Shell gas station on W Main Street to add storage capacity for the left-turn lane to 8th Avenue SW.

This option has very minimal gains in traffic delay improvements and only minor reductions in the AM and PM peak-hour average delays. The average peak-hour delay would be 69 and 135 seconds for the horizon design year 2035 for AM and PM peak hours, respectively.

The minimal improvement to the baseline need is the major issue with this option. Benefits of this option include minimal impacts to the public, adjacent properties, and wetlands. This option also is the lowest cost compared to the other intersection improvement alternatives, with a PLCE at around $200,000 total project cost. This alternative has no negative or positive impacts to other City of Battle Ground or WSDOT future planned projects.

Alternative 1 Pros and Cons

Pros	Cons
Very small project cost	Minimal reduction in AM/PM delays
Very minor impacts to public	No multimodal improvements
No impacts to adjacent properties and wetlands	No increase to freight mobility (possible decrease)
	No increase to safety (possible safety concerns with reduced shoulders and offset north to south intersection legs)

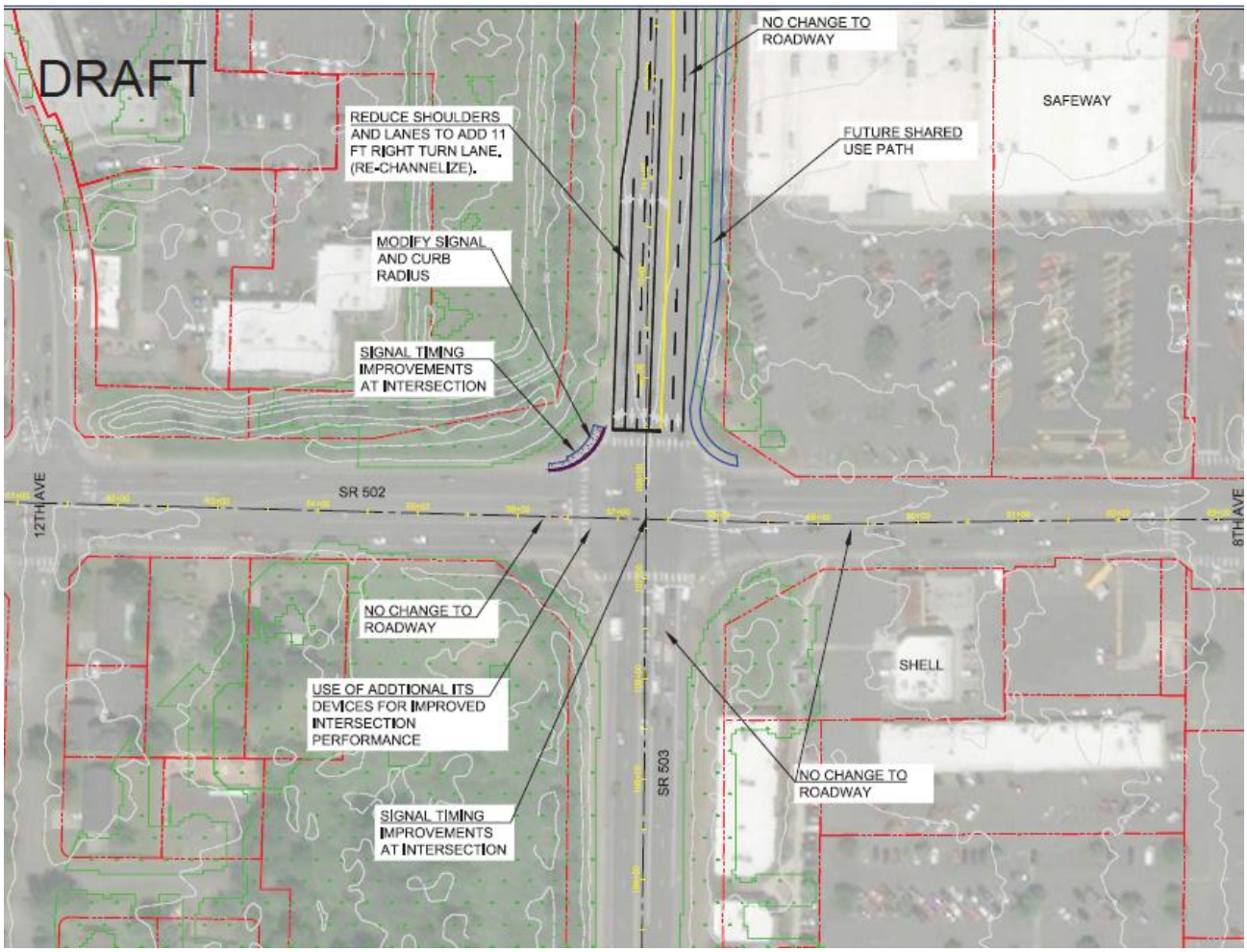


Figure 16. Alternative 1.

11.3 Alternative 2: Addition of Right-Turn Lanes

This option adds right-turn lanes on the northern, eastern, and western legs of the intersection. The option also includes adding another left-turn lane for the NB SR 503 to WB SR 502 movement. With the improvement, storage is added to the double left-turn lanes for EB SR 502 to NB SR 503. Storage is added for the left to W 8th Avenue by removing left-turn access to the Shell gas station on W Main Street, similar to Alternative 1.

Multimodal improvements are implemented for this option by extending the bicycle lanes on SR 502 to the intersection of W 8th Avenue. Other improvements include analyzing truck turn movements with reconstruction for freight mobility within the intersection.

This option improves traffic delay in the 2035 AM and PM peak hours, with an average delay of 42 and 65 seconds, respectively. Negative aspects include increased pedestrian crossing times and exposure on this intersection with the high-speed SR 503 facility, and encroachment into the Safeway and southwest corner property with reduction to parking stalls. This option has a PLCE estimated at around $2.7 M total project cost.

Alternative 2 Pros and Cons

Pros	Cons
Decrease to AM and PM peak-hour delays	No reuse of existing signal poles
Simple widening to outside of roadways	Impacts to Safeway property
Bicycle facilities improved	No increase to freight mobility (possible decrease)
Most freight mobility	Increased exposure to pedestrians at crossings, with longer signal phase times

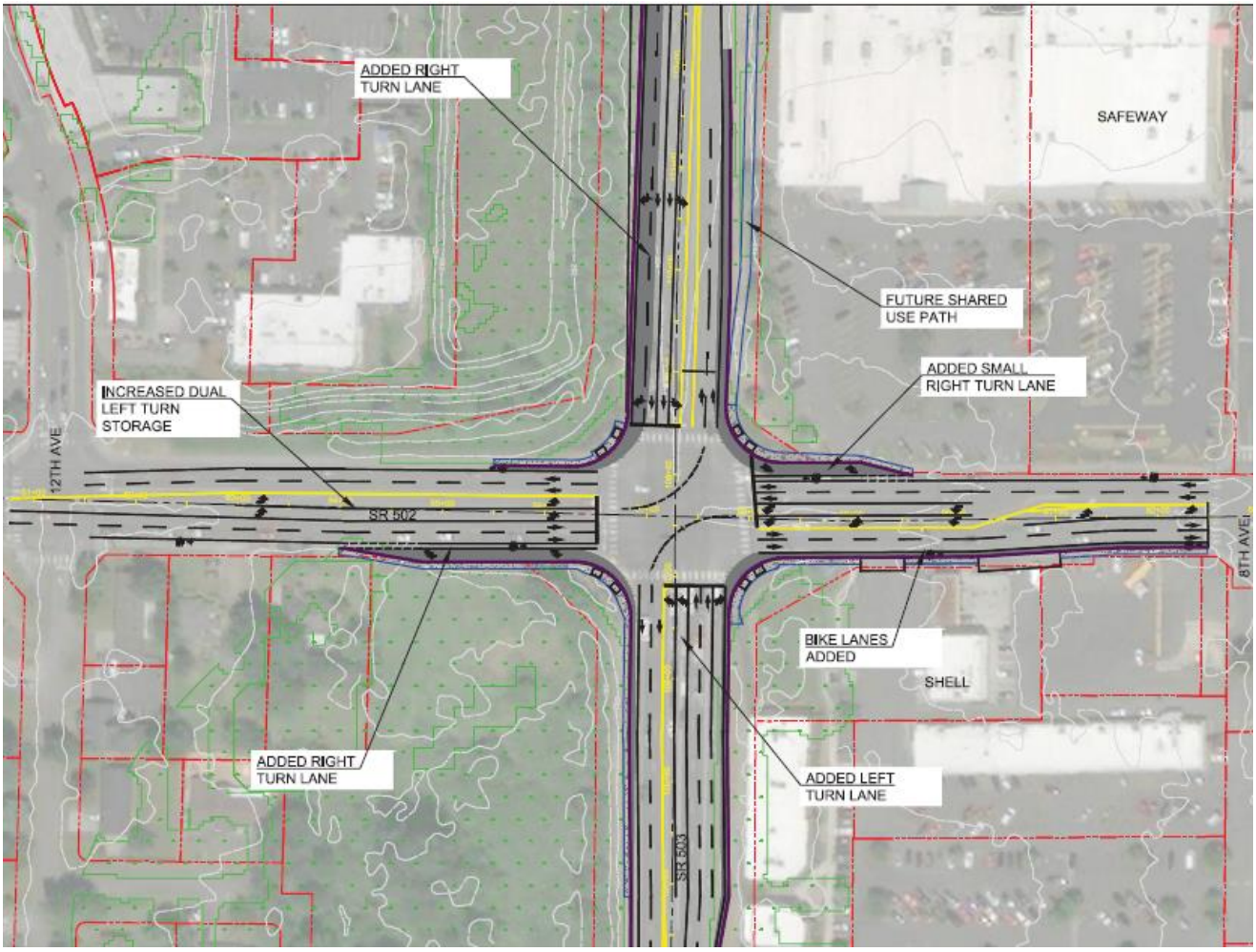


Figure 17. Alternative 2.

11.4 Alternative 4: Addition of Free Right-Turn Lanes (with Traffic Islands)

This option adds free right-turn lanes to the northern, eastern, and western legs of the intersection with use of traffic islands and yield control to pedestrians and merging. An additional left-turn lane is added to the NB SR 503 to EB SR 502 movement with storage added to the double left-turn lanes for EB SR 502 to NB SR 503, similar to Alternative 2. Storage is added for the left to W 8th Avenue by removing left-turn access to the Shell

gas station on W Main Street, similar to Alternatives 1 and 2. The design has 55 mph merge tapers onto SR 503; however, no acceleration lanes are provided. Alternative 4 has similar results in peak-hour delays but is a small gain over Alternative 2, with the ability to have smaller phasing on the signal times if permitted due to smaller pedestrian crossing times.

Multimodal improvements are implemented under this option by extending the bicycle lanes on SR 502 to the intersection of W 8th Avenue. Traffic islands are created, which reduce the crossing exposure and signal time. However, the free right-turn movements require another crossing that is only yield control and requires merging through bicycle lanes. Other improvements include analyzing truck turn movements with reconstruction for freight mobility within the intersection. Though the current location of the signal pole is likely to be in conflict, it is possible that the existing signal poles and equipment can be reused for this option.

This option improves traffic delay, with an average delay of 42 and 65 seconds for the year 2035 AM and PM peak hours, respectively. Negative aspects include increased pedestrian exposure at free right turns and encroachment into the Safeway and southwest corner property, with reduction to parking stalls. This option also shows more encroachment to the adjacent wetlands than the other options. Construction of the traffic islands would have more impacts to traffic during construction than other options with the exception of Alternative 5. This option's PLCE is estimated around $3.3 M total project cost, which is one of the higher costs of the alternatives.

Alternative 4 Pros and Cons

Pros	Cons
Seen as best overall traffic delay solution	Most impacts to adjacent properties and wetlands
Smaller pedestrian crossing widths and quicker signal phases	Impacts to traffic during construction
Bicycle facilities improved	Exposure to pedestrians on free right turns. Drivers merge through bike lanes for free right turn.
Improvement to freight mobility	Most pavement area added to project
Possible reuse of existing signal poles	Highest construction cost

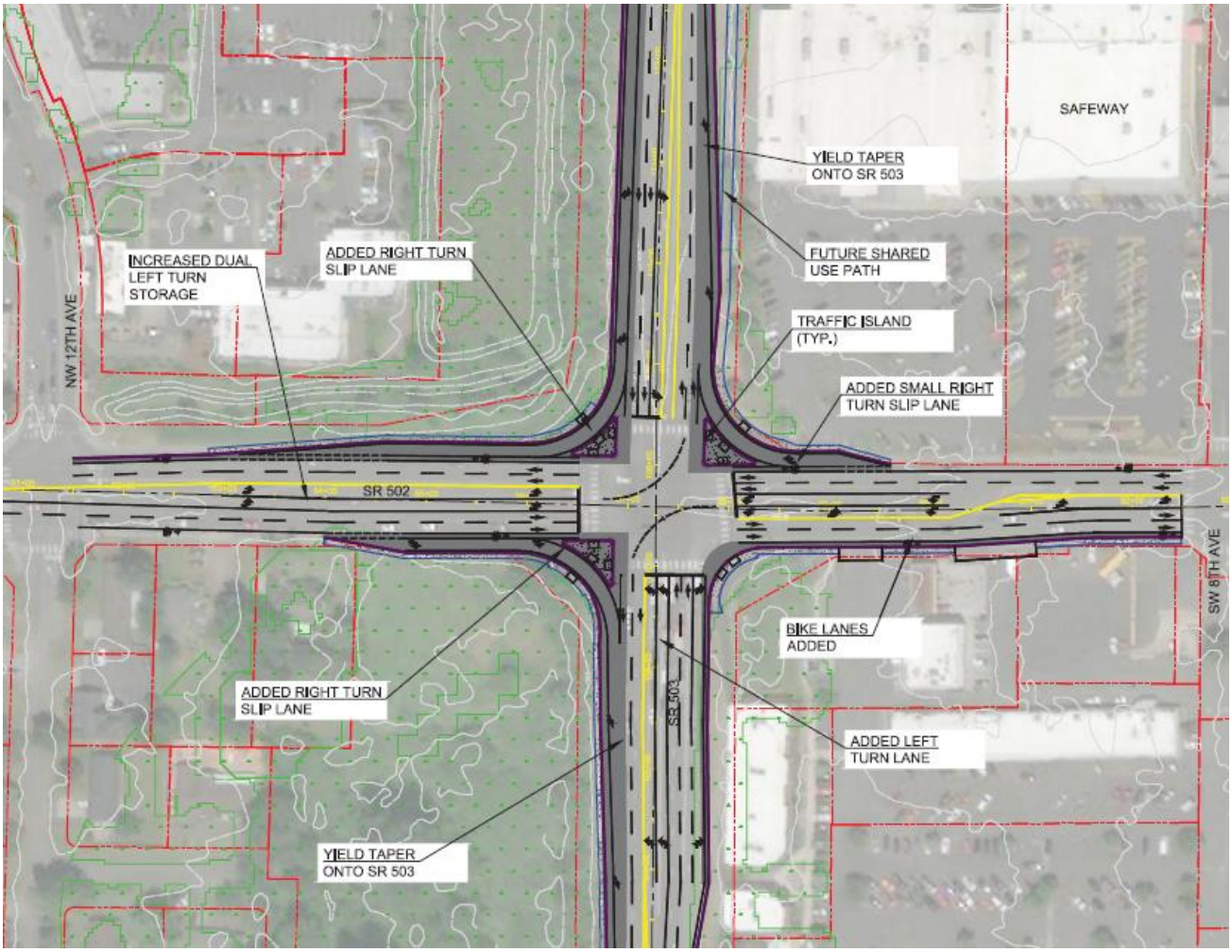


Figure 18. Alternative 4.

11.5 Alternative 5: Double-Lane Roundabout

This option reconstructs the signalized intersection with a double-lane roundabout. The design is laid out to WSDOT design guidelines, which includes a center island, truck apron, splitter islands with chicanes used for SR 503 for speed control, and use of 10-foot-wide crosswalks on all legs. Roundabouts can provide traffic congestion improvements in some cases and are seen superior to signalized intersections from a safety standpoint. Additional storage capacity is added for the left to W 8th Avenue by removing left-turn access to the Shell gas station on W Main Street, similar to Alternatives 1, 2, and 4. Alternative 5 is seen as the safest intersection; however, the traffic delay improvements are not significant enough compared to Alternatives 2 and 4 in the year 2035. The impacts of the signalized intersection 500 feet west on W 8th Avenue and significant amount of left turns through the intersection hinder the ability of a roundabout to perform in a free-flowing manner in the design year 2035.

Multimodal improvements are implemented for this option by extending the bicycle lanes on SR 502 to the intersection of W 8th Avenue. Other improvements include analyzing truck turn movements with reconstruction for freight mobility within the intersection. Freight traffic often requires larger trucks to use two lanes for the turn, which may be problematic during peak hours. Once constructed, the roundabout would

require the least amount of maintenance compared to the other alternatives. This option currently shows no impacts to adjacent properties and limited encroachment to the adjacent wetlands.

Safety advantages along with no maintenance are seen as the major benefits with this alternative. The roundabout center islands can also be used for City landmarks. Lastly, the double-lane roundabout option can be constructed within the existing ROW and without impacting adjacent wetlands.

Negative aspects include significant impacts during construction, with limited use for the future traffic demands compared to the other alternatives. Roundabouts can also cause unsafe exposure to pedestrians on high-speed facilities if they are not properly designed. Public acceptance of roundabouts is growing, but there can still be significant resistance. Lastly, the roundabout option is anticipated to have the highest impacts during construction and high costs for traffic control, as a result of the center island being built in the middle of the most used intersection in the region. This option has a PLCE of around $3.3 M, which is currently estimated as one of the highest alternatives.

Alternative 5 Pros and Cons

Pros	Cons
Safest intersection control	May require corridor improvements to be effective
No impacts to adjacent properties	Most impacts to traffic during construction
Minimal impacts to adjacent wetlands and less pavement required	Possible public resistance to change
Low long-term maintenance	Highest estimated construction costs
	May hinder truck movement at peak hours

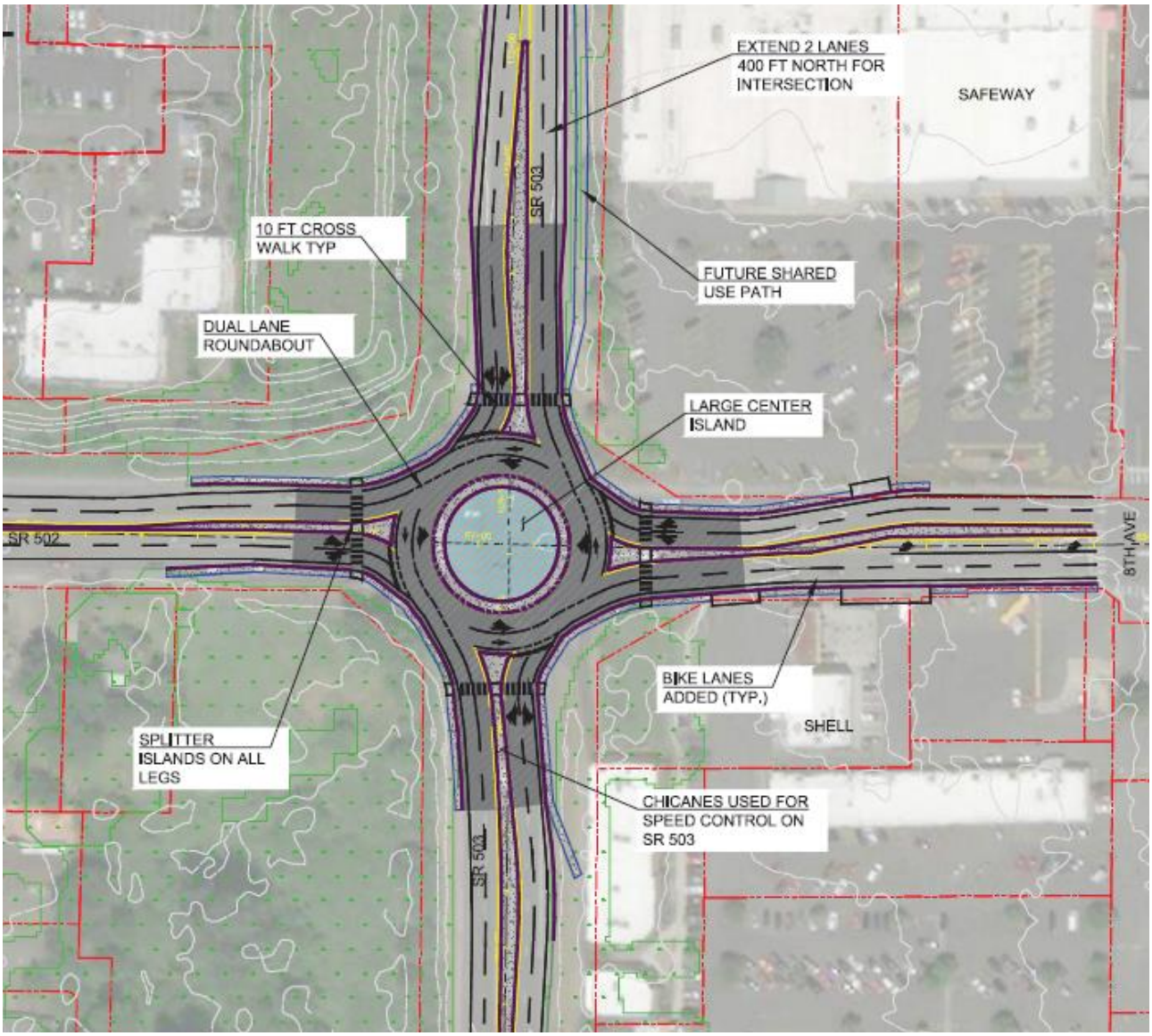


Figure 19. Alternative 5.

12 PUBLIC INVOLVEMENT PROCESS

As part of the practical solutions process, the design team made efforts early on to reach out to the public and key stakeholders to explain the practical solutions process and alternatives being evaluated for input and comment. Gaining acceptance, or "buy in," of transportation infrastructure improvement projects is key to project success because it ultimately affects the community and users both in the present and future years to come. The two categories of public involvement efforts include (1) general public outreach and (2) key stakeholder coordination. The two public involvement categories are explained in further detail.

12.1 General Public Outreach

The public involvement process was kept simple by means of posting the practical solutions options on the City of Battle Ground website, stating what the project goals were and providing four practical solutions options at the intersection. Comments were made by the public online and were received directly by the City for evaluation. The general comments from the online information showed a concern about the roundabout option and interest in the ability to accommodate pedestrians for child safety.

A public outreach open house for the practical solutions process that discussed the alternatives was held on March 26, 2018 in the City of Battle Ground. Representatives from the City, WSDOT, and the design team attended the public open house to answer questions and discuss the alternatives being assessed for the intersection improvements to reduce peak-hour delays. An open house comment form was given to attendees to provide formal comments. The general comments from the public open house are summarized as follows:

- Was a continuous flow intersection considered?
- Was an all pedestrian phase considered?
- Roundabout option is the best long-range plan.
- Alternative 4 provides best traffic and pedestrian movements.
- Alternative 1 does not provide enough improvement.

See Appendix E for public open house comments.

These comments and consensus of the public outreach efforts indicate a general public opinion that Alternative 4 is the best solution, while there were complaints about Alternative 5. Other results indicate that multimodal improvements are, in fact, a key aspect of the project.

12.2 Key Stakeholder Coordination

The design team identified key stakeholders for the project outside of the public outreach efforts that would require extra coordination and briefing efforts. Key stakeholders are identified as agencies, companies, organizations, or individuals that the project has a greater effect on compared to the general public. With the City of Battle Ground and WSDOT as the primary agencies performing the project, the following key stakeholders were identified:

- C-TRAN
- Clark County
- City of Battle Ground Public School District
- Power and Gas Company
- Safeway
- Shell Gas Station
- SW Property Owner
- NW Property Owner
- Department of Ecology

Coordination efforts were presented, and discussions were held with these stakeholders to inform and obtain comments during the practical solutions alternative development and assessment.

12.3 Public Involvement Summary

Overall, the public perception is that Alternative 4 provides the best solution from the public standpoint. General concerns were expressed about the double-lane roundabout option; however, some individuals thought it was the best long-term solution. Key stakeholder buy-in was only initiated during the development and selection of the practical solutions preferred alternative, and key stakeholder coordination will be continued further in the design process.

13 ALTERNATIVES ANALYSIS AND PERFORMANCE TRADEOFFS

After developing the practical solutions and performing planning-level public outreach, the design team could perform the alternatives analysis process per WSDOT Design Manual 1104. The alternatives analysis process is used to objectively evaluate the alternatives based on baseline and contextual needs. Public comment also is considered in the assessment of the alternatives.

The process of adequately choosing the preferred alternative is done in the following manner in conjunction with guidance from WSDOT Design Manual Chapter 1104:

- Analysis of the practical solution's ability to meet the baseline needs (project priority)
- Analysis of performance tradeoffs associated with contextual needs
- Assessment of public outreach
- Assessment of PLCE through cost-benefit analysis

Through assessment of these four project aspects, the design team can objectively compare the practical solutions that have been formulated. Ultimately, the double-lane roundabout alternative was not evaluated further from a traffic analysis and an alternatives analysis standpoint because of the lack of public acceptance and political reasons. The alternatives analysis scoring system is evaluated using a customized table that makes use of the first three aspects listed above, with a weighted average as shown in Appendix E. The weighted average values are as follows:

- Meets baseline need: 50%
- Meets contextual needs of the project (performance tradeoffs): 5 to 8%
- Public acceptance: 10%

The reasoning behind the scoring system is that the baseline need of the project should be given the most weight, as the practical solutions process should be geared toward finding a solution that meets the project needs the best. Any solutions that do not address the need will likely be graded out through the scoring.

Contextual needs play a secondary role. However, these performance tradeoffs are important for the evaluation process for performance tradeoff comparison. The contextual needs have not been weighted equally, as some are considered more important to the project than others. They are weighted as follows:

  - Safety – 8%
  - Multimodal needs – 7%
  - Limited impacts to businesses – 5%
  - Limited impacts to the public – 5%
  - Environmental compliance – 5%
  - Freight mobility – 5%
  - Benefits to other City roadway projects – 5%

The public acceptance aspect holds the least amount of weight toward the project, at 10%, compared to the baseline need and total of performance tradeoffs. However, the design team included the scoring directly into the evaluation to get public input included in the evaluation process.

Once the evaluation was graded, the design team compared the results to the planning-level cost estimates per WSDOT guidelines to the alternatives that scored highest in the practical solutions grading. This serves the purpose of analyzing the benefit-cost ratio of the project alternatives. For instance, if one alternative is showing slightly better grading criteria compared to another option but the cost is double, then the benefit-

cost ratio would show that the lower cost option may be the better option, provided it meets the baseline need performance metric of reducing peak AM and PM hour average delays to 50 seconds.

The scoring category results for evaluation comparison are summarized below.

13.1 Baseline Need: Reducing Peak-Hour Delays (50 pts)

After performing preliminary traffic analysis for forecasted volumes in the year 2035, the "do nothing" and Alternative 1 fall far below the baseline needs. The baseline need made the project consisted of a maximum average peak-hour delays of 50 seconds for AM and 70 seconds for PM in the horizon year of 2035. The "do-nothing" alternative and Alternative 1 had PM peak hour delays far above the baseline need with 165 and 135 seconds, respectively. To keep this report and analysis concise, the report does not discuss other performance tradeoffs for these two options as the baseline need is not close to being met, and grading will be significantly below the other aspects.

Alternatives 2 and 4 show comparable traffic improvements, with maximum average peak-hour delays of around 43 seconds in the PM 2035 peak hour. This exceeds the baseline need metric of 50 seconds, which leads to these two alternatives rather than the other assessed alternatives.

Though Alternatives 2 and 4 show comparable results, if pedestrian volumes increase, the longer crossing times required for Alternative 2 would give Alternative 4 an edge in this category. Alternative 4 would have more phasing options due to less crossing length of pedestrians and vehicles. Alternative 4 could also achieve more free-flowing conditions for right-turn movements onto SR 503, with future acceleration lane widening to help improve capacity performance.

Alternative	Horizon AM Peak Hour Intersection Delay (Seconds)	Horizon PM Peak Hour Intersection Delay (Seconds)
Do Nothing	83	165
1- ITS and Misc Road Improvements	69	135
2 - Added Right Turn Lanes and left turn lane	42	60
4 - Added full free right turn lanes and left turn lane (with traffic islands)	42	60
Baseline Need Statement	50	70

See the Traffic Analysis Report by GT Engineering for further analysis information related to forecasted volumes and performance.

13.2 Safety

Alternatives 2 and 4 include bicycle lanes through the intersection to improve bicycle safety. However, both alternatives have negatives from a safety standpoint. Alternative 2 increases overall crossing lengths for the roadways, which increases exposure to pedestrians. Alternative 4 exposes pedestrians on the free right turns,

which relies on drivers properly yielding to pedestrians. Because of these factors, they both score closely on this performance tradeoff.

Alternative 1 may actually decrease some safety aspects of the project to create more roadway lanes with reduction of shoulders and slightly offset the north and south legs of the intersection.

13.3 Multimodal Improvements

Alternatives 2 and 4 provide the pedestrian/bicycle lanes through the intersection, promoting use of bicycles in a safer manner, which may help encourage this mode of transportation. Traffic islands are also seen as an improvement to pedestrian movement in some cases, as it can promote quicker signal phasing. On the other hand, traffic islands assume that the driver will yield to both bicyclists and pedestrians and may cause some points of conflict, but that are mitigated with red lights and signals for Alternative 2. For this reason, Alternatives 2 and 4 are scored comparably for multimodal improvements. Alternative 1 and the Do Nothing alternative are scored low on this aspect, as no improvements are made.

13.4 Impacts to Adjacent Businesses

There is encroachment onto the southwest corner and northeast corner (Safeway) properties for Alternatives 2 and 4. The encroachment to these properties for both alternatives is comparable, with only slightly less encroachment on the southwest corner for Alternative 2. The impact to the Safeway property is essentially the same for both alternatives. For comparisons purposes, Alternative 1 and the Do Nothing alternative option score higher.

13.5 Impacts to the Public

As discussed previously, public impacts include both temporary and permanent impacts. See the contextual needs section for reference on identified public impacts. After assessing the identified possible permanent impacts, the design team concluded that all the permanent impacts are essentially the same and were scored as such. The temporary public impacts, in order of importance, are as follows:

- Impacts to traffic during construction
- Utility disruptions
- Noise impacts

Alternatives 1 and the Do Nothing alternative score higher on this category, with minimal impacts to the public. With the order of importance listed above, Alternative 2 scores higher as it is the easiest alternative to construct with the least amount of disturbance to traffic compared to Alternative 4. Alternative 4 has more disruption to traffic during construction and has utility disruptions.

13.6 Environmental Compliance

Environmental compliance generally has two aspects: environmental wetland impacts and impervious pavement. Alternatives 2 and 4 both show comparable impacts to wetlands. Alternatives 1 and the Do-Nothing alternative score higher, as they do not have any impacts. Alternative 4 scores lower than Alternative 2 because it encroaches more into wetlands.

Regarding impervious pavement, Alternative 4 shows higher pavement increase than Alternative 2, giving Alternative 2 a higher score. Alternatives 1 and the “Do-Nothing” alternative score higher as they do not have any increase.

Freight Mobility

Alternative 2 has a slight edge on freight mobility over Alternative 4, as a larger vehicle is likely to turn through an intersection without traffic volumes. The traffic islands may be designed bigger to account for trucks in the future, but the roadway width restriction is still seen on Alternative 4. Freight mobility may be lower for Alternative 1 due to reducing shoulders for SR 503 on the north leg. Because no improvements are being made in Alternative 1 and the Do Nothing alternative, they are scored low on this category.

13.7 Compatibility with Other Projects

Alternatives 2 and 4 are fully compatible with all other planned projects near the area listed in Appendix A for the City's transportation improvements. In particular, the improvements of the intersection of 8th Street project would be fully coordinated with the intersection designs. Alternative 1 and the Do Nothing Alternative do not improve performance of any other projects and are scored lower.

13.8 Public Involvement Input

The public expressed more interest in Alternative 4 than all other options. Overall, the public gave more positive feedback to Alternative 4 than Alternative 2. For this reason, Alternative 4 is scored higher than Alternative 2. Alternative 1 was deemed insufficient for improvement by the public and is scored the lowest.

13.9 Alternatives Comparison

As discussed previously, the scoring was systematically done for the alternatives. A benefit-cost ratio was performed for Alternatives 2 and 4, which scored the highest among all alternatives. A total of 100 points is a perfect score. The benefit-cost ratio was disregarded for Alternative 1 and the Do Nothing alternative because the scores were so low, and the low cost would manipulate the weight in the benefit-cost ratio analysis. The scores from two independent design teams were averaged, and the results are shown in the following table.

Alternatives Comparison Table - SR 502 and SR 503 Intersection Improvements (Average Scores)

Date: 6-8-18

ALTERNATIVE	Baseline Performance Metrics	Contextual Performance Metrics / Performance Trade Offs										Total Scoring	Cost (Million)	Benefit to Cost Ratio (Score/Cost (Million))
Mode	Auto													
Performance METRIC	Mobility - Decrease Peak AM and PM Hour Delays - 50 PTS MAX	Safety - 8 PTS MAX	Multi-Modal Accomodation - 7 PTS MAX	Limited Impacts to Businesses - 5 PTS MAX	Limited Impacts to the public - 5 PTS MAX	Environmental Compliance - 5 PTS MAX	Freight Mobility - 5 PTS MAX	Benefits to other City Projects - 5 PTS MAX	Public Involvment Input - 10 PTS MAX					
Have you considered these fundamental Performance categories? o Safety o Mobility o Environmental o Economic Vitality o Other project specific														
No Build	0	0.0	0.0	5.0	5.0	5.0	1.0	0.0	0.0			16	N/A	
OPTION 1 - SIGNAL IMPROVEMENTS/ USE OF EXISTING CIVIL FEATURES	10	1.5	1.0	5.0	5.0	5.0	0.5	1.0	1.5			30.5	0.7	29.44444444
OPTION 2 - ADDED RIGHT TURN LANES	44	6.5	6.0	3.0	3.0	3.0	4.0	5.0	5.0			79.5	2.7	24.41176471
OPTION 4 - ADDED RIGHT TURN SLIP LANES	46	7.0	5.5	2.5	2.0	1.5	4.5	5.0	9.0			83	3.4	

14 RECOMMENDED PREFERRED ALTERNATIVE

The scoring system for the practical solutions was performed by the design team's project manager and lead designer. The results showed the overall highest score was Alternative 4, with a total average of 83 points. Alternative 2 scored slightly lower, with an average score of 79.5 points. Alternative 1 and the Do Nothing alternative scored low at 30.5 and 16 points, respectively.

The benefit-cost ratios were selectively done for only Alternatives 2 and 4 because the other alternatives did not meet the baseline needs for acceptable improvement. The benefit-cost ratio is the average score divided by the cost (per million) to take into account project fund spending. The design team felt the benefit-cost ratio would show an unbiased assessment of the best overall practical solution by accounting for project cost. Based on benefit-cost ratios, Alternative 2 scored the highest, with a benefit-cost ratio of 29.4, and Alternative 4 scored at 24.4.

To meet the baseline need, Alternatives 2 and 4 had the peak-hour delays at approximately the same traffic capacity based on the Traffic Analysis Report by GT Engineering. A small advantage is given to Alternative 4 due to possibility of quicker phasing; however, these options show similar performance. Performance tradeoffs based on assessing the contextual needs are summarized below:

	Alternative 2	**Alternative 4**
Safety	Equal	Equal
Pedestrian/Bicycle Mobility	Equal	Equal
Impacts to Public	Advantage	Disadvantage
Impacts to Businesses	Advantage	Disadvantage
Environmental Impacts	Advantage	Disadvantage
Freight Mobility	Equal	Equal
Compatibility with Future Projects	Equal	Equal
Public Input	Disadvantage	Advantage

From a performance tradeoff perspective, Alternative 2 has fewer impacts to the public and fewer environmental impacts while Alternative 4 has more public acceptance. The other contextual needs were more or less evaluated equally.

After assessment of Alternatives 2 and 4, the design team recommends Alternative 2 as the preferred alternative, which includes the addition of right-turn lanes without traffic islands. The rationale for the selection is summarized as follows:

- 20% lower cost while still achieving the same general peak traffic delay improvements in the horizon year 2035.
- Performance tradeoffs for public and environmental impacts are less compared to Alternative 4.
- Public feedback that was superior for Alternative 4 can be discussed with the public again by going over the practical solutions process to show why Alternative 2 was selected as the preferred alternative.

15 DESIGN ELEMENTS SELECTION

After selecting the preferred alternative through the practical solutions process, the design team evaluated the design elements that were changed and required to be upgraded per the design guidelines listed under WSDOT Design Manual Chapter 1105. Exhibit 1105-1 and Section 1105.02(1) cover the required design elements. New elements changed or modified are discussed in Section 1105.02.

Design elements selection and other practical design documentation are summarized in the table from the WSDOT Basis of Design Document (Official Basis of Design Document forthcoming). A summary of design elements is shown below:

Section 5) Design Element Selection

For each design element below, identify the design elements that will have dimensions changed in the preferred alternative for each alignment or location. You can group alignments into a single location if desired. You may need to add or delete columns.

Design Element	Alignment #1 – SR 502	Alignment #2 – SR 503	Alignment #3	Alignment #4	Alignment #5	Alignment #6
1. Lane	X	X				
2. Median / Buffer		X				
3. Shoulder	X	X				
4. Streetside / Roadside Zone	N/A	N/A				
5. Pedestrian Facility	X	X				
6. Bicycle Facility	X					
7. Bridges	N/A	N/A				
8. Horizontal Alignment	X	X				
9. Vertical Alignment						
10. Cross Slope	X	X				
11. Side Slope	X	X				
12. Clear Zone	X	X				
13. Barrier, Guardrail & Rumble Strips	X	X				
14. Signals, Illumination, and ITS	X	X				

15. Signing and Delineation	X	X
16. On/Off Connections	N/A	N/A
17. Intersection / Ramp Terminal		
18. Road Approaches	X	
19. Roundabout	N/A	N/A
20. Access Control		

The forthcoming Basis of Design document will have the formal submittal take place with the design documentation package.

15.1 Required Design Elements

Based on the WSDOT Design Manual and Legal Policy for a Mobility Project, the following elements are required improvements on the project:

WSDOT Design Manual Exhibit 1105-1 Required Design Elements

	Design Elements						
	ADA	**Clear Zone [1]**	**Roadside Safety Hardware [3]**	**Signing & Delineation [4]**	**Illumination [7]**	**ITS [8]**	**Signal Hardware**
I-1 Mobility **I-3 Economic Initiative - Trunk System** **I-6 Sound Transit**	Apply the content in Chapter 1510 (1510.05)	Apply the content in Chapter 1600	Apply the content in Chapters 1600, 1610 and 1620	Apply the content in Chapter 1020 for signing and Chapter 1030 for delineation	Apply the content in Chapter 1040	Apply the content in Chapter 1050	[5] Contact Regional Traffic for Requirements

Based on WSDOT policy, full improvements per the individual WSDOT chapters are required to be improved as part of a I-1 mobility project. These improvements will be assessed and implemented through final design of the project.

15.2 Design Elements Being Added or Changed

In addition to the required elements listed above that are to be evaluated for the project, the following design elements will be either relocated, changed, or added as a result of the preferred alternative per WSDOT Design Manual Chapter 1105.02:

Lanes – Auxiliary lanes (turning lanes) are added to all legs of the intersection. As a result of alignment shifts and added lanes, the other lanes at the intersection will either shift their location and/or be assessed for width. All lanes at the intersection will be assessed for dimensioning.

Median/Buffer – A median is seen south of the intersection on SR 503 before addition of left-turn lanes for NB SR 503. The preferred design may affect this existing median and will be assessed. A median will be assessed north of the intersection of SR 503/SR 502 for SR 503, which is not currently present. No median will be assessed for SR 502.

Shoulders – Shoulders currently exist on both SR 502 and SR 503 near the intersection. The shoulders will be assessed for change in width and/or change in location due to roadway changes. All legs approaching the intersection will have shoulders assessed for dimensioning.

Pedestrian Facility – Pedestrian facilities currently exist on SR 502 and the south leg of SR 503. The preferred alternative proposes maintaining the same pedestrian facilities, along with adding a shared use path to the east side of SR 503 north of the intersection. These facilities, however, will change location due to alignment shifts and will be assessed for dimensioning.

Bicycle Facility – Bicycle facilities are currently provided on SR 502 west of the intersection, and the preferred alternative will add bicycle lanes just east of the intersection. No bicycle lanes will be added to SR 503. However, a shared use path will be added east of SR 503 north of the intersection. The facilities will be analyzed for dimensioning and design.

Horizontal Alignment – The horizontal alignments of SR 502 and SR 503 along with lane configurations will be slightly modified as a result of the preferred alternative. The horizontal alignment, including tapers and channelization geometry, will be evaluated in the design dimensioning section.

Cross Slope – The roadways will be either widened or the location changed as a result of the preferred alternative. This will likely require regrading and reconstruction of the pavement to achieve uniform crowned cross slopes. As a result, the cross slope will be evaluated as part of the design dimensioning for the preferred alternative.

Side Slope – The preferred alternative has adjustments to the roadway footprint, including areas where it is widened. This will require small fill slopes to be constructed on the project. No cut slopes are anticipated on the project. New fill slopes will be evaluated on the project as part of the design dimensioning process.

Road Approaches – Road approaches are found on the eastern leg of the intersection on W Main Street. With widening and as part of the preferred alternative, the driveways will be modified or assessed for relocation/removal due to traffic impacts.

Clear Zone and Roadside Safety – With the roadway modifications required for the preferred alternative, areas where roadside safety elements are required and the roadway clear zone will be assessed. This will be done per the WSDOT Design Manual Chapter 1600 as part of the required elements but will be discussed specifically for design modification in the design dimensioning (Section 16).

16 DESIGN ELEMENT DIMENSIONS

This section outlines the procedures in WSDOT Design Manual Chapter 1106 for design element dimensions of the elements discussed in Section 15 of this report, Design Element Selection. As part of the WSDOT Design Manual Chapter 1106.04, highways are to be designed using the "design up" process per Chapter 1231 and 1106. SR 502 is currently identified as a highway while SR 503 is currently identified as an "other" freeway facility. Though bottom up design method is not necessarily needed for freeways, SR 503 currently has pedestrian elements involved with the highway, including an intersection itself. For this reason, SR 503 has the complexities that account for other modes of travel similar to highways, and "design up" procedures will be imposed on SR 503 as well.

A mode/function/performance approach per WSDOT Design Manual Chapter 1106.03 will be used in conjunction with Chapters 1231, 1232, and other chapters to determine the most appropriate dimension or design for the SR 503/SR 502 intersection improvements project. Design parameters will be completed with the design documentation package for the project.

16.1 Lanes

WSDOT Design Manual Chapters 1231 and 1232 will apply to the design element dimension for SR 502 and SR 503, respectively, with specific requirements set forth in Chapter 1310. SR 503 will be a focused section based on motor vehicles and trucks. SR 502 will be a section that balances motor vehicles, trucks, and transit. Key aspects of the lane width selection are the class of roadway and speed.

SR 502 serves as a managed access facility with access to many businesses currently as well as after project completion. The roadway is anticipated to serve more as a multimodal corridor context as growth continues in the City. Since transit is currently using and will continue to use SR 502 in the foreseeable future, accommodations for buses should be made. A high use of trucks also drives a need for the SR 503 and Main Street intersection; however, the intersection does not have any significant curves other than turning radii on the right and left turns.

Lastly, SR 502 transitions from a 40 mph to a 25 mph facility at this intersection. Based on this information, to accommodate a sufficient width for trucks and transit while also calming traffic to a reduced speed, the design team recommends 11-foot-wide through lanes for SR 502/W Main Street. The 11-foot lanes will also have added buffer to the curb and gutter with use of bicycle lanes, which will not hinder performance to freight and transit. To accommodate transit and freight trucking on turns, the design team recommends 12-foot widths with possible 13-foot widths on double left-turn lanes to help accommodate truck turning movements. Performance tradeoffs associated with 11-foot lanes will serve essentially the same function within the constrained ROW and wetlands adjacent to the project. This also allows better accommodation of bicycle and pedestrian facilities for the multimodal corridor aspect of SR 502 and W Main Street.

SR 503's mode currently serves motorists and a significant amount of freight vehicles. Its context is still a freeway that has managed access with a higher speed of 55 mph. To help serve higher speeds and freight mobility, the design team recommends an 11-foot inside through lane and a 12-foot outside lane to accommodate freight. This would allow the freight mobility while using a minimal yet safe width for the other through lane anticipated to be used by motorists. To help achieve mobility of freight and maintain the highway's function as a freight corridor, 13-foot lanes will be used for turning movements off SR 503, unless an AutoTURN analysis concludes that 12-foot lanes are acceptable.

	SR 502/W Main Street	SR 503
Mode	Motorists, freight, transit	Motorists, freight
Function	Provide freight mobility to modes	Provide freight mobility to modes
Performance	Safety performance of traffic calming for through lanes through intersection to reduce speed from 40 mph to 25 mph. Mobility performance of freight and transit on turn lanes to reduce possible delays and improve economic vitality.	Safety performance associated with higher speed facilities and freight on corridor for through lanes. Mobility performance of freight on turn lanes to reduce possible delays and improve economic vitality.
WSDOT Design Manual Range	11 to 12 feet	11 to 12 feet
Recommended Selection	11-foot through lanes, 12- or 13-foot turn lanes based on AutoTURN analysis	11 ft inside through lane, 12 ft outside lane, 12-13 ft turn lane depending on AutoTURN analysis

16.2 Shoulders

WSDOT Design Manual Chapters 1231, 1232, and 1239 will apply to the design element dimension for SR 502 and SR 503. SR 503 will be a focused section based on motor vehicles and trucks. SR 502 will be a section that balances motor vehicles, trucks, and transit. Key aspects of the lane width selection are class of roadway and speed.

SR 502 serves as a managed access facility with access to many businesses currently as well as after project completion. Currently, it already serves as a designated bicycle route until it connects with SR 503 where the bike lanes abruptly end. It is anticipated that the roadway will have more of a multimodal corridor context as growth continues in the City. To accommodate bicycle mode safety and achieve modal improvements, it is recommended that the shoulders on SR 503 and W Main Street serve as marked bicycle lanes rather than shoulders. Selection of bicycle lane widths is described in Section 16.4, Bicycle Facility.

SR 503's mode currently serves motorists and a significant amount of freight vehicles. Its context is still a freeway that has managed access with a higher speed of 50 mph. To help serve higher speeds and freight mobility, a sufficient shoulder to pull over outside of the through lanes should be considered. The shoulders along SR 503 also serve as a buffer to sidewalk pedestrian facilities and the future shared use path along SR 503. A recommended 8-foot shoulder width should accommodate a pulled-over vehicle sufficiently. However, it is common for reduced outside shoulders to be used where turning lanes are introduced. This is especially the case for right-turn lanes, where stalled vehicles would only partially block the turn lane rather than blocking a through lane. Typically, normal vehicles can navigate the stalled vehicle at a lower speed without veering into the adjacent through lane.

The performance tradeoffs associated with using a smaller shoulder near right-turn lanes is that it will ultimately require less ROW and reduce impacts to the adjacent wetlands. The design team does not foresee this impacting the baseline need of reduced delay nor decreasing safety where added near a right-turn lane. A recommended 4-foot shoulder near right-turn lanes will be utilized along SR 503. If the roadway is curbed, a 4-foot width should still accommodate drainage adequately and the shoulder width increased as such as design progresses.

	SR 502/W Main Street	SR 503
Mode	Bicyclist, motorists, freight, transit	Motorists, freight
Function	Provide freight mobility to bicycle mode. Buffer to curbed pedestrian sidewalk.	Allow stalled vehicles to stop outside of traveled lane. Clear zone safety, buffer to sidewalk facilities. Drainage if curbed.
Performance	Modal accommodation of bicycle facilities meets current and future context of a multimodal corridor with lower speeds and access to businesses.	Allow adequate buffer to sidewalk/ pedestrian facilities. Allow stalled vehicles to pass without blocking through lanes. Added buffer to edge of roadway helps drivers feel more comfortable at higher speeds.
WSDOT Design Manual Range	N/A – See Section 16.4, Bicycle Facility	8- to 10-foot outside shoulders.
Recommended Selection	N/A	4-foot minimum, 8-foot typical. Design analysis required for use of 8-foot shoulders near right-turn lanes.

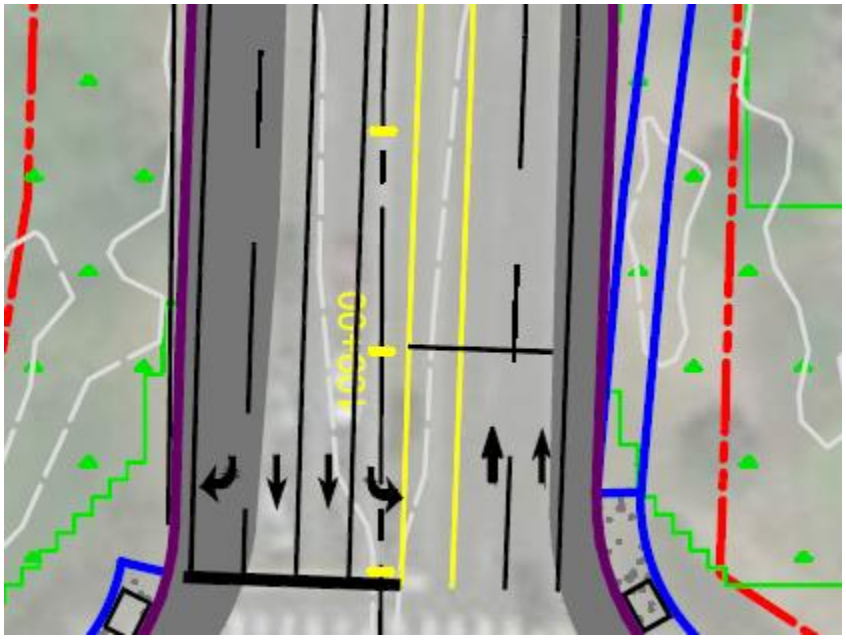


Figure 20. Typical setup of shoulders and functionality on SR 503.

16.3 Pedestrian Facilities

WSDOT Design Manual Chapters 1231 and 1232 apply to the design element dimensioning for SR 502 and SR 503. WSDOT Design Manual Chapters 1510 and 1520 specifically apply to pedestrian design. SR 503 currently has pedestrian sidewalk facilities south of the intersection with a planned shared use path north of the intersection. SR 502 and W Main Street currently have sidewalk facilities on both sides of the roadway.

Both SR 502 and SR 503 serve low volumes of pedestrians based on traffic data found in the Traffic Analysis Report. However, these facilities are anticipated to have a higher number of pedestrians with growth in the

City, with this intersection being a focal point near many pedestrian nodes. Pedestrian demand is anticipated to be at a medium level in the horizon year because it is anticipated that transit use for regional trips to the Vancouver area will increase as a result of overall congestion in the area.

Current sidewalk facilities are minimal along SR 502, and many of them are not ADA-compliant. A 5-foot minimum width is required. However, a minimum width section can cause conflict points and is not conducive to safety when paired next to bicycle facilities. Currently, 8- or 10-foot-wide sidewalks overserve the need, as well as in the future, and would excessively impact the adjacent businesses, ROW, and wetlands. A recommended 6-foot-wide sidewalk will accommodate the pedestrian needs within the horizon year. Sidewalk increases can easily be accommodated in the future if the need grows beyond anticipated volumes. Sidewalk buffers are not currently provided along SR 502 and W Main Street. Due to lack of ROW and the impacts to businesses, no buffer will be provided as no significant pedestrian-related injuries were seen in the last five years (except for crossing of SR 503).

SR 503 currently has 6-foot-wide sidewalks south of SR 502/W Main Street. This appears to serve the low (current conditions) to medium (horizon year) needs of the future. The demand for future sidewalk width is not anticipated along SR 503 compared to SR 502 and had less overall volumes. Buffer space will be provided to match existing conditions as no significant safety issues are seen for pedestrians along SR 503 related to pedestrians on sidewalks. Also, adequate shoulders will be provided to give extra space differential. By using a slightly increased sidewalk width from 5 feet to 6 feet, the project will improve upon pedestrian mobility, with the anticipation of higher pedestrian volumes by the year 2035.

The shared use path facility planned along SR 503 is expected to serve low to medium numbers of bicyclists and pedestrians. Ten- to 12-foot sections of shared use path are anticipated to provide sufficient mobility to both pedestrians and bicyclists. Ten- to 12-foot sections of path are consistent with other WSDOT shared use path facilities and should easily meet the needs of its purpose. This facility is also anticipated to have a buffer to SR 503, which will ensure adequate safety and comfort to users. A recommended buffer shall be that of the clear zone or 10 feet minimum to the edge of roadway, if roadway safety elements are provided with landscaping planting buffers. With a clear zone maintained or roadside safety elements added, the buffer will be a visual and sound barrier design rather than safety oriented.

	SR 502/ Main St	**SR 503**
Mode	Pedestrians	Pedestrians.
Function	Pedestrian access and mobility along both sides of corridor.	Pedestrian access and mobility.
Performance	Serve a low to medium number of pedestrians. Meet ADA requirements. Promote mobility on multimodal corridor.	Serve a low to medium number of pedestrians. Meet ADA requirements. Achieve adequate buffer for pedestrians and higher speed facilities for safety.
WSDOT Design Manual Range	5 to 10 feet	N/A – No typical pedestrian facilities on freeways.
Recommended Selection	6-foot-wide typical	6-foot-wide typical for sidewalk facilities. Ten- to 12-foot-wide shared use path facility east of SR 503.

16.4 Bicycle Facility

WSDOT Design Manual Chapters 1231 and 1232 will apply to the design element dimension for SR 502 and SR 503, respectively along with Chapter 1530 specifically for bicycle facilities. SR 503 currently has no bicycle facilities while SR 502 has bicycle lanes adjacent to the curb west of the intersection, with facilities ending east of the intersection.

SR 502 currently has 5-foot-wide bicycle lanes adjacent to the curb and gutter west of the intersection. The abrupt end at the intersection is mitigated by extending the bicycle lane to 8th Avenue to help improve safety and operations at the intersection while helping promote bicycle use. Though accounting for bicycle access is a goal of the project, the volumes are indicative of substantial volumes and does not warrant a width wider than the 5 ft minimum standard. Buffer space also does not seem warranted due to low volumes. Use of buffer space would impact the adjacent ROW and wetlands further, only be implemented for a small stretch of the SR 502 corridor, and would require additional costs. For these reasons, the design team recommends using the minimum bicycle lane width for SR 502. Using a 2-foot buffer with a 3-foot bicycle lane would provide the same width. However, this channelization would not be practical with the addition of right-turn lanes.

SR 503 currently does not provide designated bicycle lanes. Based on observation, the mode is currently served by the sidewalk facilities or large shoulders. SR 503 is not a designated bicycle route. It serves more of a freeway function than multimodal corridor. The project does not have bicycle access and it is not identified as baseline need. Therefore, it is not practical to add a small stretch of bicycle facility along SR 503 south of the intersection. SR 503 currently has a shared use path planned for construction east of SR 503 and north of the intersection. Expansion of this shared use path facility to the south along SR 503 could be done in the future if the need progressed.

	SR 502/W Main Street	**SR 503**
Mode	Bicyclist (designated bicycle route).	Bicyclist.
Function	Serve bicycle access safely along designated bicycle route. Serve access from SR 502 to shared use path/bicycle facilities SR 503. Promote bicycle use.	Bicycle access provided on shared use path adjacent to SR 503 (north). Not a designated bicycle route.
Performance	Serve as designated bicycle route and provide to W Main Street and the SR 503 shared use path. Demand for route is not high but should be provided to allow movement.	Serve a low to medium number of pedestrians. Meet ADA requirements. Achieve adequate buffer for pedestrians and higher speed facilities for safety.
WSDOT Design Manual Range	3- to 8-foot-wide lane, 2- to 3-foot buffer typical.	N/A – No typical bicycle facilities on freeways.
Recommended Selection	5-foot-wide lane, no buffer provided.	No proposed change to roadway south of intersection. 10- to 12-foot-wide separated shared use path provided north of intersection.

16.5 Horizontal Alignment

The project includes an intersection improvement, which does not provide much discussion for horizontal geometrics with shallow curves involved in the design of the centerline roadways. Storage lengths for turning lanes will progress as design progresses to provide the minimum requirements or as required by traffic performance. Key aspects that pertain to the horizontal geometrics include the following:

- Taper rates
- Truck turns and curb radii (discussed previously in design controls)
- Horizontal intersection offset

Taper rate standards for intersections are defined under WSDOT Design Manual Chapter 1310, which include 4:1 minimum tapers for right-turn lanes. For left-turn lanes, 15:1 tapers are desirable; however, 4:1 can be used with justification. The design team recommends using a 4:1 minimum taper for all right-turn lanes to be added to the project to mitigate excessive ROW and wetland impacts, and keep costs minimal on the project.

Left turns to be implemented on the project should differ between SR 502 and SR 503. SR 503 is a higher speed facility in which taper rates may warrant a more gradual change to left turns. SR 503 also has a larger ROW width than SR 502. The 15:1 desirable taper rate will be implemented to help increase safety for vehicles maneuvering into the left lane. SR 502 has more urban restrictions, including adjacent intersections and constrained ROW with businesses. SR 502 and W Main Street also have lower speeds than SR 503. By using an aggressive 4:1 taper rate, more queue space can be provided without impacting the adjacent intersections and properties while still serving their functionality safely.

Offset intersections generally should be avoided on higher speed facilities, and adding this negative safety aspect to SR 503 appears to have minimal gains and is not recommended. Offset intersections, however, are used on lower speed facilities. SR 502 and W Main Street are lower speed facilities and the intersection is currently large enough to easily navigate slight offsets while still serving the same functionality. A maximum of 6 feet may be used for offset intersections per the WSDOT Design Manual, and the design team recommends using a maximum of 4 feet to help achieve geometrics within the constrained ROW east of SR 503 on W Main Street.

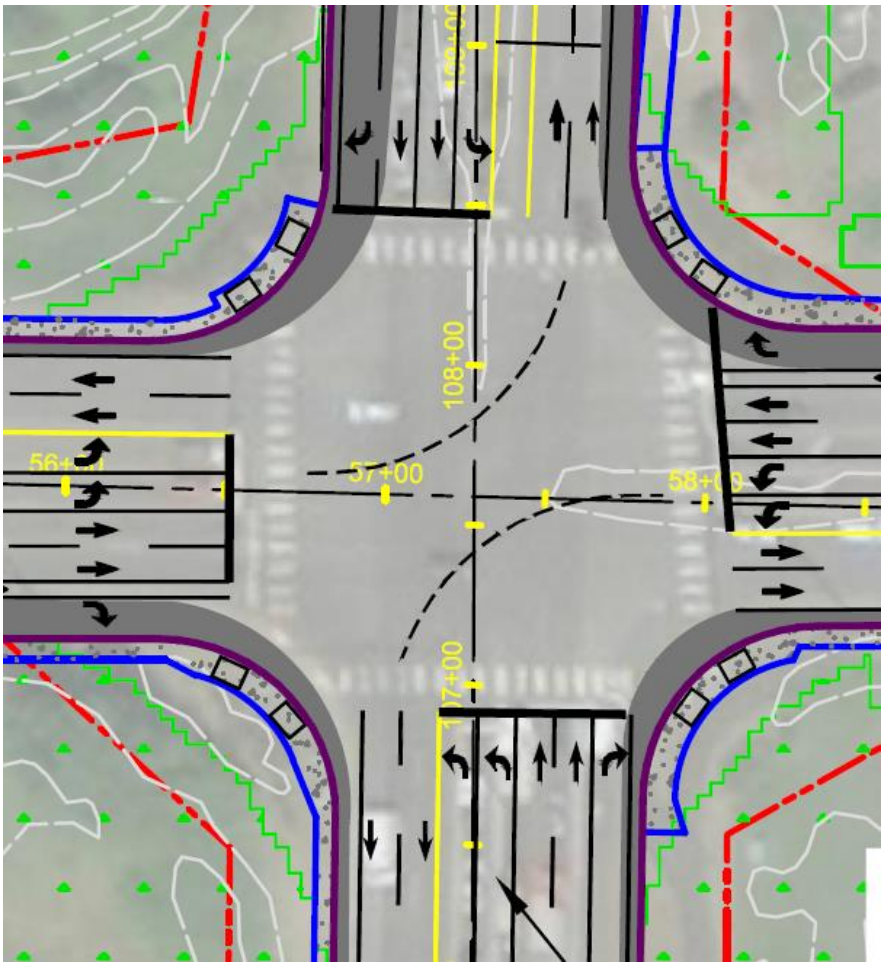


Figure 21. Depiction of alignments at SR 503/SR 502 intersection.

16.6 Cross Slope

Though the preferred alternative changes the cross slope with changes to the intersection configuration, the design would not change the cross slope of the existing roadways and would provide crowned roadways with 2% cross slopes to accommodate drainage. No superelevation is required on the project. The project design team recommends a standard 2% cross slope (per WSDOT Design Manual Chapter 1239) for drainage to match existing roadway configuration.

16.7 Side Slopes

WSDOT Design Manual Chapters 1231 and 1232 apply to the design element dimension for SR 502 and SR 503, respectively, along with Chapter 1239 specifically for side slopes to be used on the project. Side slopes are typically designed concurrently with roadside safety analysis. Typical design calls for 4:1 slopes, with 6:1 slopes desirable. A minimum of 2:1 slopes are typically used, provided safety measures are provided when required.

SR 502 and W Main Street are managed access facilities with slopes to the back of sidewalk outside of the defined clear zone. 2:1 side slopes do not present safety concerns for pedestrians, considering the grade differentials are not anticipated to be over 5 feet from the back of sidewalk to the adjacent grade. A

recommended 2:1 side slope is recommended to mitigate excessive impacts to the adjacent wetlands and ROW.

SR 503 has two distinct sections of roadway on the project: curbed sections south of the roadway and non-curbed sections north of the intersection. With widening required for the added turn lanes, impacts to the adjacent wetlands is already anticipated. Furthermore, the SR 503 shared use path will likely encroach within the roadway clear zone for the 55 mph facility. For these reasons, 2:1 side slopes with guardrail is recommended to mitigate impacts to the wetlands and provide safety buffer to the adjacent path north of the intersection. The curbed roadways provide a sidewalk buffer eliminates the need for a 4:1 slope from the back of the sidewalk. From a practicality standpoint and to eliminate excessive impacts to the wetlands, a 2:1 side slope is recommended on SR 503 improvements as well with appropriate roadside safety.

16.8 Road Approaches

WSDOT Design Manual Chapter 1340 applies to the driveways on SR 502. SR 503 is a limited-access facility with no approaches, and there is no intention of providing additional access on the project. SR 502 has two roadway approaches/driveways on the south side between W 12th Avenue and SR 503. These driveways do not appear to be causing safety or traffic issues, as the approaches are away from the intersection, toward the center of the block. Adjustments of the driveways may need to be coordinated on the project; however, the access is intended to remain the same for this Managed Access Class 4 facility. The width of the driveways will meet City of Battle Ground standards.

W Main Street has access points to the adjacent businesses between W 8th Avenue and SR 503. The existing Safeway driveway access is not encroaching limited access guidelines; however, it is within the functional intersection and does pose safety hazards and disruptions to traffic. Access to Safeway can still be made to the property via the adjacent driveway to the center of the parking lot. The design team proposes closing down this access. For traffic operation purposes and to obtain additional left-turn storage on Main Street to turn onto 8th Avenue and SR 503, the design team recommends closing the left access to the Shell gas station. Access can be achieved from the left turn at the signal from 8th Avenue to the properties.

	SR 502/W Main Street	**SR 503**
Design Element	Private property/business access	N/A
Function	Serve access to private properties along SR 502. Serve access to commercial businesses on W Main Street.	N/A
Performance	Provide effective access to commercial properties on W Main Street (other access points may be available). Maintain access to private properties on SR 502.	N/A
WSDOT Design Manual Range	Width defined by Design Vehicle and City of Battle Ground standard of 25 feet minimum (SR 502). City of Battle Ground standard for project-specific width (15 to 35 feet) for commercial driveways (W Main Street).	N/A - No new access points allowed per Limited Access requirements.
Recommended Selection	Width to match where driveway is.	N/A – No access points proposed.

	SR 502/W Main Street	SR 503
	Adjustments are made with 25 feet minimum on SR 502. Driveway access to remain on SR 502. Width to be project-specific designed for commercial properties when modified on W Main Street, or match existing conditions. Driveway closed for western Safeway access point.	

16.9 Clear Zone, Median, and Roadside Safety

WSDOT Design Manual Chapters 1600 and 1610 discuss guidance on roadside safety measures. By definition, these are mandatory standards for Mobility projects, as they are policy safety improvements. They are summarized briefly below.

Clear Zone

Clear zone is defined by the class of highway, speed, average daily traffic (ADT), and other measures. The design team will fully meet WSDOT Design Manual Chapter 1600 for clear zone requirements, which are summarized as follows:

	SR 502/W Main Street	SR 503
Design Element	Clear zone.	Clear zone.
Function	Roadside safety adjacent to curb. Collisions at lower speeds are less dangerous.	Provide safety for motorists leaving roadway for high speed roadway.
Performance	Roadside safety adjacent to curb. Collisions at lower speeds less dangerous.	Improved to fully meet current WSDOT and AASHTO guidelines.
WSDOT DM Range	Clear zone defined by City of Battle Ground per WSDOT Design Manual Chapter 1600.02(2).	55 mph with ADT over 6,000 – Use Exhibit 1600-2.
Recommended Selection	No specific requirements noted in City of Battle Ground Standards. Coordination with City of Battle Ground ongoing or 2 feet minimum beyond face of curb.	No 55 mph with ADT over 6,000 – Use Exhibit 1600-2. Curb not a barrier for errant vehicles.

Medians

A striped median with rumble strips currently exists on SR 503 south of the intersection where it terminates near the left-turn pocket channelization for NB SR 503 to WB SR 502. No median barrier is provided north of the intersection for SR 503. Based on review of accident crash data for severe or fatal accidents, no significant amount of head-on collisions has taken place in the last five years. As part of the practical design process, the design team recommends maintaining the same median functionality as the existing condition because introducing a median barrier is beyond the project's intent and will be deferred to a later date if safety problems develop.

SR 502 is currently defined as a Managed Access facility where medians typically are not provided.

Roadside Safety Elements
Roadside safety for clear zone is described in Chapters 1600 and 1610. Based on guidance given under Chapter 1600.01, priorities for correcting roadside safety hazards are as follows:

1. Remove hazard
2. Redesign fixed object
3. Relocate hazard
4. Reduce impact severity
5. Shield with traffic barrier
6. Delineation

No anticipated roadside safety measures are required on SR 502. Based on guidance for correctable slopes (4:1) under Exhibit 1600-2, a clear zone of 29 feet is required for fill slopes. No cut slopes are anticipated on the project. This clear zone distance is wide enough, paired with a 4:1 slope that would require extensive grading and tree removal within wetland areas southwest and northwest of the intersection. The preferred alternative would also include work outside of the WSDOT ROW. 2:1 slopes are proposed on the project to keep wetland impacts and work outside of the ROW to a minimum.

Though traffic curb does not provide a barrier per the WSDOT Design Manual, it still serves as a partial barrier, paired with an 8-foot-wide shoulder. Accident data review does not show any severe or fatal incidents within the last five years related to the existing conditions. Therefore, the design team does not recommend any change to the existing conditions.

Currently, SR 503 does not have curbed sections north of the intersection. With 2:1 slopes used to mitigate wetland impacts, a selection of guardrail is used to act as a traffic barrier. Guardrail will be designed per WSDOT Design Manual Chapter 1610. Guardrail is also selected on the north leg of the intersection to provide a barrier between the future shared use path and errant vehicles.

	SR 502/W Main Street	**SR 503**
Design Element	Roadside safety barrier.	Roadside safety barrier.
Function	No function or need on managed access and low-speed facilities.	Redirect errant vehicles on non-recoverable slopes. Act as barrier between shared use path and SR 503.
Performance	N/A	Existing conditions show no significant safety collisions related to clear zone and roadside hazards.
WSDOT Design Manual Range	N/A	1. Remove hazard 2. Redesign fixed object 3. Relocate hazard 4. Reduce impact severity 5. Shielding with traffic barrier 6. Delineation
Recommended Selection	N/A	Use of guardrail on north leg of intersection with 2:1 slopes to mitigate

	SR 502/W Main Street	SR 503
		wetland impacts and redirect errant vehicles away from the future shared use path. No proposed changes to south leg of the intersection based on lack of severe or fatal accidents in last five years. Curbed section to be rebuilt to maintain corridor consistency south of the intersection.

17 PRACTICAL SOLUTIONS AND DESIGN SUMMARY

This report discusses the analysis and processes the design team performed as part of the Practical Solutions and Design procedures outlined in WSDOT Design Manual Chapter 1100. This document serves as planning tool to define a preferred alternative solution by assessing baseline needs, contextual needs, project contexts, project modes, and design controls to be used. These were selected using the WSDOT procedures, project research, coordination with WSDOT and the City of Battle Ground, and using engineering judgement in accordance with WSDOT standards. Ultimately, this led to a baseline need that required reducing average peak hour delays of the intersection in the year 2035 to 50 seconds and 70 seconds in the AM and PM peak hours, respectively. No severe or fatal crashes were seen over the last five years at this intersection, which took safety improvements out of the primary baseline needs discussion. However, safety standards will be followed to meet WSDOT guidelines for newly constructed elements to maintain a safe facility in the future.

Project context considerations included assessing the growth of the area, functionality of the highways, modes of travel, and other goals of the project. Contextual needs were ultimately defined as follows: Safety, Pedestrian and Bicycle Mobility, Impacts to Public, Impacts to Adjacent Businesses, Environmental Impacts, and Freight Mobility. A public open house was performed to get public input on the project and directly weighed in on the project alternative solution scoring. The double-lane roundabout option was discussed and ultimately taken out of consideration due to public opinion and political factors.

After developing preferred alternatives with cost estimates using WSDOT planning-level cost estimate procedures, alternatives analysis concluded that Alternative 2 was the preferred alternative as it provides comparable performance of reducing AM and PM peak-hour average delays in the horizon year of 2035 compared to Alternative 4. Additionally, Alternative 2 had a better benefit-cost ratio, which warranted its selection. It scored well in some contextual needs compared to Alternative 4 but lower on other contextual needs, leading to performance tradeoffs that were equal for the two options.

After Alternative 2 was chosen as the preferred alternative, design element selection and dimensioning were performed in accordance with the WSDOT Design Manual Chapters 1105 and 1106. It was determined the bottom-up design dimensioning on elements would be applied on the project. This was done to balance project needs, safety, WSDOT design standards, negative impacts, and project cost. The basis of design documentation and design documentation package will be submitted formally at a later date.

APPENDIX A

Future Projects

APPENDIX B

Project Context Support Documents

APPENDIX C

Practical Solutions Alternatives

APPENDIX D

Planning-Level Cost Estimates

APPENDIX E

Alternatives Analysis

APPENDIX F

Traffic Documents

APPENDIX G

Practical Design Information (forthcoming)

APPENDIX H

Public Involvement Comments