APPENDIX A

Needs Evaluation Memorandum

MEMORANDUM

123 Ohme Garden Road, Suite 8, Wenatchee, WA 98801 | P 425.252.7700

To: Riley Shewak

From: Jennifer Saugen, PE
Brent Powell, PE

Date: August 20, 2021

Re: SR 28 Corridor Study – Needs Evaluation

INTRODUCTION

Chelan Douglas Transportation Council (CDTC) hired Perteet Inc. to complete a corridor evaluation focused on SR 28 between East Wenatchee and Rock Island. This memorandum documents Perteet's needs evaluation for the different users of the study area. The needs evaluation spans the full extent of the study area in Figure 1 and focuses on safety for all users, multi-modal connectivity and comfort, mobility, and community needs.

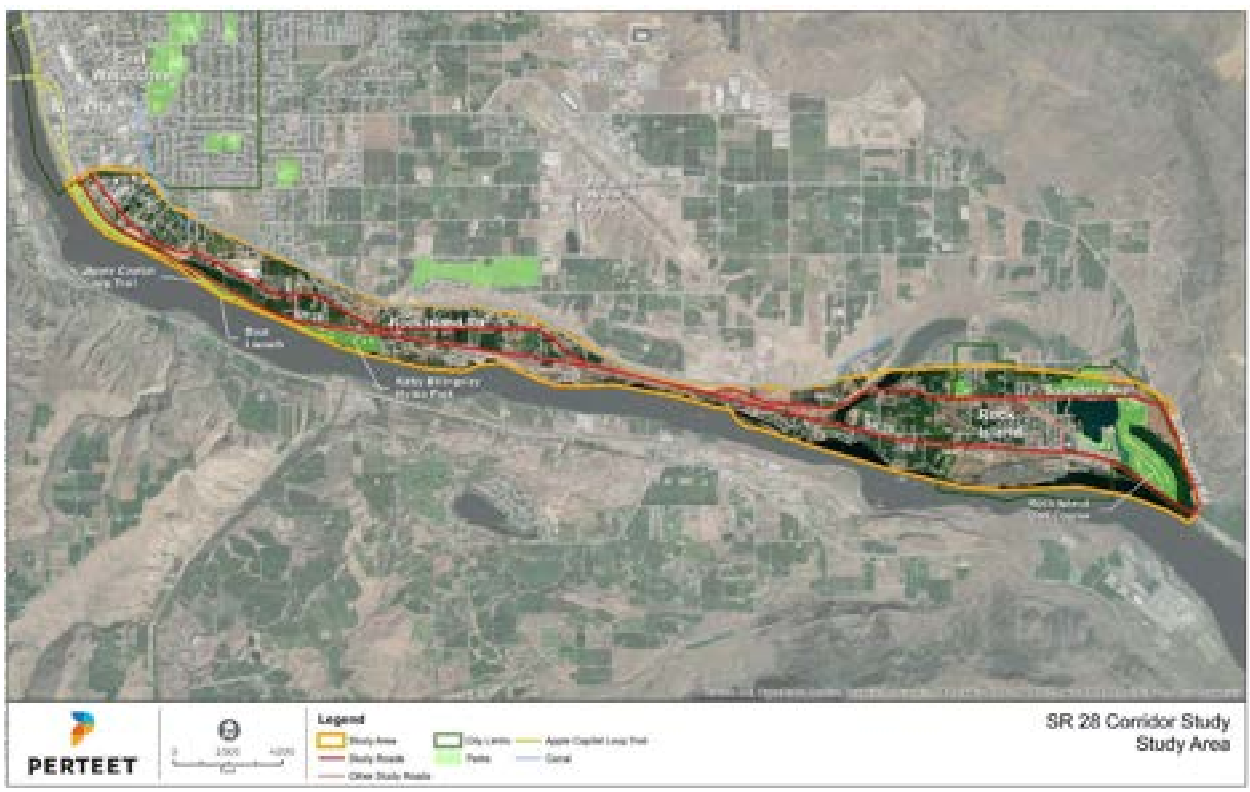

Figure 1. Study Area Map.

This needs evaluation serves as the basis for future coordination between the project team and stakeholders to assess potential treatments for the SR 28 corridor and surrounding transportation network. The evaluation covers three primary areas:

1. Safety needs,
2. Active transportation needs (i.e. pedestrians and bicyclists), and
3. Vehicle mobility needs, including transit and freight.

SAFETY NEEDS

Perteet used a combination of quantitative and qualitative evaluations to assess areas of recommended improvements to address safety needs for the study area. This evaluation included looking at all modes and focusing on locations with high existing crash rates, elements of the current transportation network that could be modified for a general safety improvement, and contributing factors that led to fatal or serious-injury crashes in the past five years.

Data Sources

The WSDOT crash history provided to Perteet spanned January 1, 2016 through December 31, 2020. Perteet used this full five-year history for analysis. Perteet reduced this dataset to evaluate only the crashes that occurred within the study area limits, which include the SR 28 corridor as well as the study roadways shown in Figure 1. This reduced dataset included 230 total crash records.

For crash modification factor (CMF) data, Perteet relied on the information included in the *Highway Safety Manual* (*HSM*) and the online database http://www.cmfclearinghouse.org/.

As the *HSM* evaluation requires information on configuration elements and traffic demand data, Perteet collected that information using available online resources such as aerial imagery (for lane configurations, intersection control, etc.), GIS map information, and existing and future traffic model data from CDTC.

Highway Safety Manual Evaluation

The *HSM* uses crash rates, presented in crashes per year, to evaluate corridors. Perteet sorted the 230 study crash records by segment/intersection, number of vehicles, and severity to match the *HSM*'s required inputs.

The *HSM* uses the Federal Highway Administration (FHWA) "KABCO" classification scale to denote the most severe injury experienced by a driver, passenger, pedestrian, or bicyclist in a crash. Each state provides definitions for each letter grade. The Washington classification, from WSDOT's *Safety Analysis Manual*, is provided in Table 1.

Table 1. Washington KABCO Classification.

KABCO	WSDOT	Crash Record Coding
K	Fatality	Fatal injury
A	Suspected serious injury	Suspected serious Injury
B	Evident injury	Suspected minor injury
C	Possible injury	Possible injury
O	Property damage only	No apparent injury

For urban arterial analysis in the *HSM*, crashes are aggregated into two groups: KABC (any fatality, injury, or possible injury) and O (property damage only). For segments, crashes are broken out into multiple-vehicle driveway crashes, multiple-vehicle non-driveway crashes, and single-vehicle crashes. At intersections, crashes are broken out only by number of vehicles involved (multiple-vehicle or single-vehicle). Tables 2 and 3 present the number of crashes in the five-year record for each HSM classification. The annual rates are in crashes per year and are the average amount of crashes per year over the five-year period.

Table 2. Segment *HSM* Crash Inputs.

Segment	KABCO	Multiple Vehicles at Driveways		Multiple Vehicles not at Driveways		Single Vehicle	
		5-Year Crashes	Annual Rate	5-Year Crashes	Annual Rate	5-Year Crashes	Annual Rate
SR 28, 3rd St SE to Battermann Rd	KABC	1	0.2	16	3.2	10	2.0
	O	1	0.2	23	4.6	26	5.2
Rock Island Rd (west)	KABC	0	0.0	0	0.0	0	0.0
	O	0	0.0	0	0.0	0	0.0
Rock Island Rd/Ave/Drive (east)	KABC	0	0.0	0	0.0	3	0.6
	O	0	0.0	1	0.2	5	1.0
Batterman Rd, SR 28 to Saunders Ave	KABC	0	0.0	0	0.0	0	0.0
	O	0	0.0	0	0.0	0	0.0

Table 3. Intersection *HSM* Crash Inputs.

Intersection	KABCO	Multiple Vehicles		Single Vehicle	
		5-Year Crashes	Annual Rate	5-Year Crashes	Annual Rate
SR 28 (Spur) & 3rd St SE	KABC	9	1.8	0	0.0
	O	11	2.2	0	0.0
SR 28 & Lyle Ave	KABC	1	0.2	1	0.2
	O	0	0.0	0	0.0
SR 28 & S Mary Ave	KABC	2	0.4	0	0.0
	O	2	0.4	0	0.0
SR 28 & S Nile Ave	KABC	3	0.6	0	0.0
	O	2	0.4	5	1.0
SR 28 & Perry Ave S	KABC	0	0.0	2	0.4
	O	0	0.0	0	0.0
SR 28 & Quincy Ave S/Akamai Way	KABC	0	0.0	0	0.0
	O	1	0.2	0	0.0
SR 28 & S Union Ave	KABC	0	0.0	0	0.0
	O	1	0.2	0	0.0
SR 28 & S Tyee Ave	KABC	2	0.4	0	0.0
	O	1	0.2	1	0.2
SR 28 & Rock Island Rd (West)	KABC	1	0.2	0	0.0
	O	1	0.2	0	0.0
SR 28 & Rock Island Rd (East)	KABC	1	0.2	0	0.0
	O	1	0.2	0	0.0
SR 28 & Columbia Cove Ln	KABC	0	0.0	0	0.0
	O	0	0.0	1	0.2

Intersection	KABCO	Multiple Vehicles		Single Vehicle	
		5-Year Crashes	Annual Rate	5-Year Crashes	Annual Rate
SR 28 & Riverside Place	KABC	0	0.0	0	0.0
	O	0	0.0	1	0.2
SR 28 & Nature Shore Dr	KABC	1	0.2	0	0.0
	O	2	0.4	0	0.0
SR 28 & Rock Island Dr	KABC	3	0.6	0	0.0
	O	1	0.2	0	0.0
SR 28 & Battermann Rd	KABC	1	0.2	0	0.0
	O	2	0.4	0	0.0
Rock Island Rd (West) & 3rd St SE	KABC	0	0.0	0	0.0
	O	0	0.0	0	0.0
Rock Island Rd (West) & 8th St SE	KABC	0	0.0	0	0.0
	O	0	0.0	0	0.0
Rock Island Rd (West) & S Nile Ave	KABC	0	0.0	0	0.0
	O	0	0.0	0	0.0
Saunders Ave & N Garden Ave	KABC	1	0.2	0	0.0
	O	0	0.0	0	0.0
Batterman Rd & Saunders Ave	KABC	1	0.2	0	0.0
	O	1	0.2	1	0.2

The *Highway Safety Manual* builds off national safety and crash data research to create an analytical way to predict the annual crash rate for segments and intersections using a variety of geometric and traffic parameters. The “predictive method” of analysis for urban arterials (Chapter 12 of the *HSM*) provides an anticipated annual crash rate for segments and intersections based on their characteristics.

The *HSM* predicted annual crash rate can be compared to the safety performance of the project study area that is presented in the five-year crash history. The *HSM* uses an “expected average crash frequency” statistic to quantify the anticipated crash rates for the study segments and intersections based on the inputted past crash data shown in Tables 2 and 3. The inputted crash rates are broken down into different classifications on the KABCO scale based on assumed crash type percentages for a segment/intersection type. So, while the overall expected average crash frequency (in crashes per year) for all KABCO crashes is roughly equal to the observed crash rate over the five-year dataset, the KACB and O groups may have different crash rates than what has been observed because these proportions of the total are based on national averages for a site type as opposed to the inputted data. The expected average crash frequency can be viewed as the anticipated safety performance for each site assuming no improvements are made to the corridor.

If the expected average crash frequency is lower than the predicted average crash frequency, the site is projected to operate with fewer crashes per year than a comparable site with similar characteristics would. If the no-build expected average crash frequency is higher than the predicted average crash frequency, the site will likely operate with more crashes per year than a comparable site with similar characteristics would, and the difference between the expected and predicted average crash frequencies is classified as the “potential for improvement.” Table 4 presents those three crash metrics for locations with a potential for improvement greater than 0, which for this project are only intersections; all segments have fewer expected crashes than predicted.

Table 4. Predicted Crash Rates and Expected Crash Rates (Crashes per Year).

Intersection	KABCO	Predicted Average Crash Frequency	Expected Average Crash Frequency	Potential for Improvement
SR 28 (Spur) & 3rd St SE	**KABCO**	**1.3**	**3.2**	**2.0**
	KABC	0.4	1.0	0.6
	O	0.9	2.2	1.3
SR 28 & S Mary Ave	**KABCO**	**1.0**	**1.1**	**0.1**
	KABC	0.4	0.4	-
	O	0.6	0.7	0.1
SR 28 & S Nile Ave	**KABCO**	**1.0**	**1.3**	**0.4**
	KABC	0.4	0.5	0.1
	O	0.6	0.8	0.2
SR 28 & Rock Island Rd (West)	**KABCO**	**0.1**	**0.2**	**0.1**
	KABC	0.1	0.1	0.1
	O	0.1	0.1	-
SR 28 & Nature Shore Dr	**KABCO**	**0.4**	**0.6**	**0.1**
	KABC	0.2	0.3	0.1
	O	0.2	0.3	0.1
SR 28 & Rock Island Dr	**KABCO**	**0.7**	**0.8**	**0.1**
	KABC	0.3	0.3	-
	O	0.4	0.5	0.1
SR 28 & Battermann Rd	**KABCO**	**0.4**	**0.6**	**0.1**
	KABC	0.2	0.3	0.1
	O	0.2	0.3	0.1

See Appendix B for the *HSM* calculations, which present results to three decimal places for full accuracy. Results in this memorandum are rounded to one decimal place in summary tables to conform with WSDOT safety analysis guidance. Figure 2 illustrates the “potential for improvement” metric from Table 4 in a map format. Two locations in Figure 2—SR 28 (Spur) at 3rd Street SE and SR 28 at S Nile Avenue—are color-coded red and orange to indicate they have the highest potential improvement.

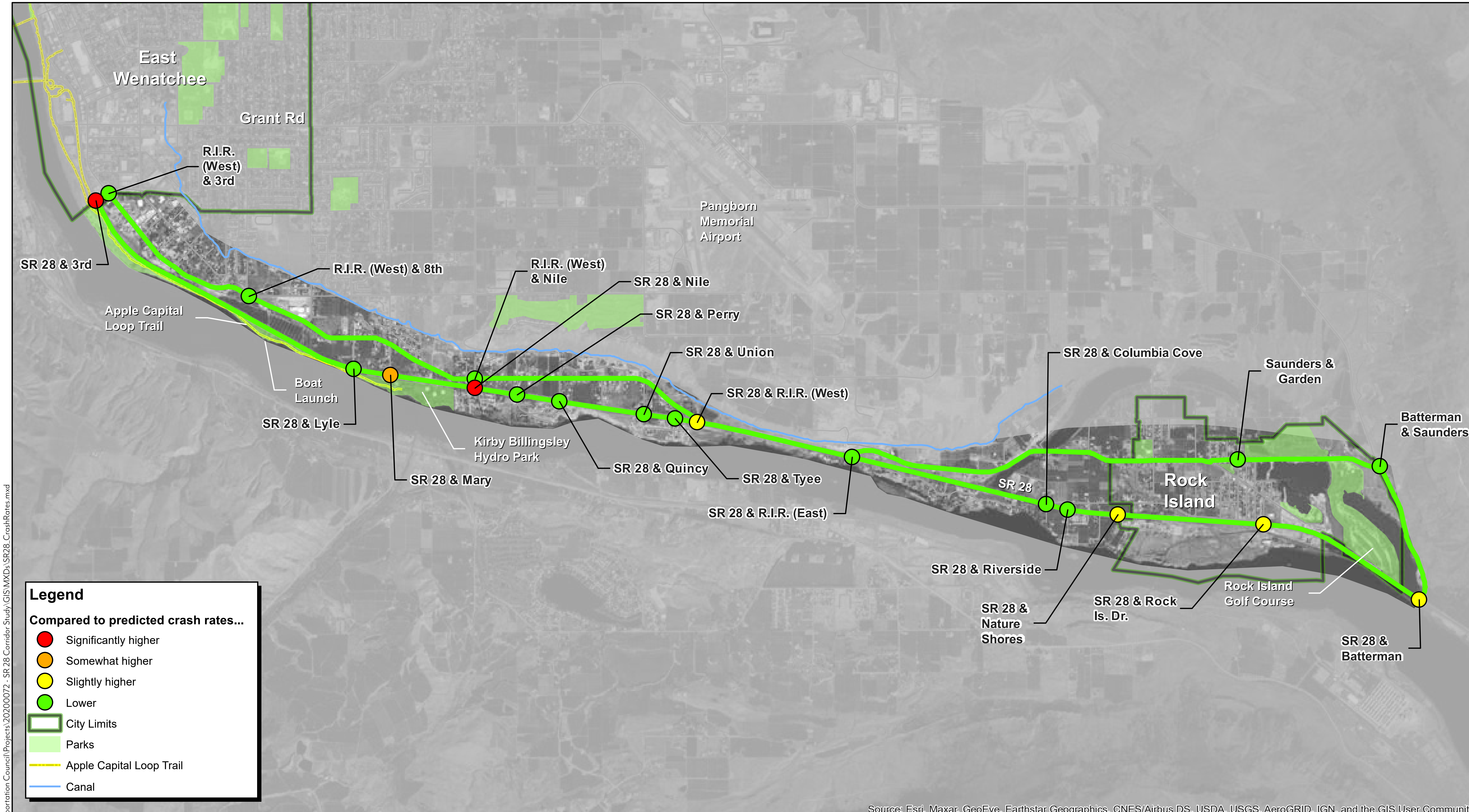

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Figure 2

SR 28 Corridor Study
Crash Rates

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Source: Douglas County GIS; ESRI

Fatal and Serious-Injury Crash Review

There were six crash events in the five-year dataset that included a report of at least one fatality or serious injury. These crashes are summarized in Table 5.

Table 5. Fatal and Serious-Injury Crash Summary.

Crash Location	MP	No. of Fatalities	No. of Serious Injuries	Description
SR 28, west of Hydro Park	1.75	0	1	Opposite directions; one vehicle was defective and crossed the centerline; dawn
SR 28 at S Mary Ave	2.85	0	2	Entering at angle; northbound vehicle from S Mary Ave did not grant right-of-way to eastbound SR 28 vehicle; daylight
SR 28, west of S Perry Ave	3.50	1	1	Same-direction sideswipe; one driver, under the influence of alcohol, attempted to improperly pass the second driver; dark, with no street lights
SR 28 at S Tyee Ave	4.53	1	1	Eastbound SR 28 driver stuck and killed a crossing pedestrian, who was reported as not granting right-of-way to the vehicle; dark, with no street lights
SR 28, west of Rock Is. Rd (east)	5.45	2	3	Opposite directions; eastbound SR 28 vehicle listed as exceeding reasonable safe speed, no other information provided; daylight with snow/slush surface conditions
SR 28, east of Rock Is. Dr	8.42	0	2	Opposite-direction sideswipe; eastbound SR 28 driver listed as exceeding reasonable safe speeds; dark, with no street lights, with snow/slush surface conditions

The crash record at milepost 5.45 listed in Table 5 contained minimal details, but Perteet found extra information on this event from local news reporting from December 2016. A Wenatchee World article on the crash reported that the fatalities were passengers in a minivan moving westbound on SR 28, which crossed over the centerline and was struck by an eastbound semi-truck and was then deflected back into the westbound lane and struck by a westbound sedan. The WSDOT crash record listed five involved vehicles; the remaining two vehicles were traveling eastbound and swerved into the SR 28 roadside ditch and did crash into any vehicles.

All four crashes in Table 5 that occurred beyond intersections involved vehicles crossing the centerline.

Improvement Measures

Perteet evaluated different tactics to improve safety performance for the study area. The first set of tactics is countermeasures to reduce crash rates for known areas of needed improvement, which are those listed in Table 4. The improvements targeted by these tactics include intersection reconfigurations (e.g. adding a turn lane) or changes in control type (e.g. converting a side-street stop-controlled intersection to a roundabout). The benefits of these tactics are quantified using CMFs.

The second set of tactics are corridor-wide strategies to modify the general configuration of SR 28. Instead of relying on only CMFs for this evaluation, Perteet looked at baseline crash rate values for different global attributes of a corridor with all other variables being equal. Some strategies include adding one lane per direction or installing a continuous median along the segments. This evaluation is still relevant even though the segment of SR 28 between 3rd Street SE and Batterman Road is not listed in Table 4, as that segment includes locations with reported near-miss crashes and crash performance can always be improved to approach zero.

Countermeasures to Address Specific Locations

Table 5 provides a collection of available intersection countermeasures that could be applied to the locations on SR 28 (and SR 28 Spur) listed in Table 4. Applicable candidate intersections are noted below.

Table 6. Candidate Countermeasures and Locations.

Treatment	CMF	Candidate Locations
Convert intersection to roundabout	0.52	SR 28 Spur & 3rd St SE
	0.56	All stop-controlled intersections
Install left-turn lanes on major road approaches	0.67	SR 28 & Rock Island Rd (West) SR 28 & Nature Shores Dr SR 28 & Battermann Rd
Install intersection conflict warning system[1]	0.73 – 0.74	All stop-controlled intersections
Provide right-turn lanes on major road approaches[2]	0.74	SR 28 & S Nile Ave
	0.86	SR 28 & S Mary Ave (one approach) SR 28 & Rock Island Rd (West) SR 28 & Nature Shores Dr
	0.96	SR 28 Spur & 3rd St SE (one approach)
Provide intersection illumination[3]	0.91	SR 28 & Rock Island Rd (West) SR 28 & Nature Shores Dr
Provide flashing beacons at stop-controlled intersections	0.95	All stop-controlled intersections
Restrict right turn on red (CMF is per approach)	0.98	SR 28 Spur & 3rd St SE

[1] CMF of 0.73 for two-lane at two-lane intersections in a rural context. Four-lane at two-lane intersections in a rural context have a CMF of 0.74. **Study citation:** Himes, S., F. Gross, K. Eccles, and B. Persaud. "Multi-State Safety Evaluation of Intersection Conflict Warning Systems (ICWS)". Presented at the 95th Annual Meeting of the Transportation Research Board, Paper No. 16-4225, Washington, D.C., (2016).

[2] Qualifying right-turn additions per the *HSM* must be dedicated right-turn lanes; short pockets or tapers do not qualify for this CMF. WSDOT North Central Region generally requires dedicated right-turn lanes on similar state routes include a 12-foot-wide offset from adjacent through travel lanes.

[3] Adding illumination on state routes is subject to requirements of WSDOT *Design Manual* Chapter 1040.

The CMF values listed in Table 6 are all less than 1, meaning that they all suggest a reduction in crashes per year if implemented. Mathematically, the anticipated impact can be achieved by multiplying a crash rate by a CMF to produce a "build crash rate." Multiple CMFs can be multiplied together.

Realistically, treatments may not be practical for all locations, even if they are listed as a candidate location. For example, restricting left-turn access from SR 28 to Rock Island Drive would be a significant change for Rock Island residents and could lead to safety concerns at other access points in the network.

Based on the existing crash records and patterns Perteet has identified, Perteet recommends considering the following treatments to reduce crash rates at these intersections:

- **SR 28 Spur at 3rd Street SE.** Supplemental signal heads and signal-ahead warning signing for eastbound approach, due to the sharp horizontal curvature. Signal-ahead warning signing for westbound and southbound movements to improve driver attention. Consider extending the duration of all-red timing following the southbound phase to decrease angle crash likelihood. As an alternative, consider converting traffic signal to a roundabout.
- **SR 28 at S Mary Avenue.** Convert intersection to a roundabout to address entering-at-angle crashes.
- **SR 28 at S Nile Avenue.** Convert intersection to a roundabout to address entering-at-angle and object crashes.
- **SR 28 at Rock Island Road (West).** Install center turn lane on SR 28 at intersection.
- **SR 28 at Nature Shores Drive.** Install center turn lane on SR 28 at intersection.
- **SR 28 at Rock Island Drive.** No clear pattern among the crash records, consider a roundabout treatment to generally reduce crashes.
- **SR 28 at Battermann Road.** Install center turn lane on SR 28 at intersection.

Corridor-Wide Strategies

Table 7 summarizes the predicted crash performance for a roadway with SR 28's characteristics with three different alternative lane configurations. Compared to the existing condition, which is a two-lane undivided highway, adding additional lanes generally increases crash rates, both injury and property-damage-only. However, installing a median or physical barrier between directions reduces crash rates, to an even larger degree. Widening to four lanes *and* installing a dividing median would reduce anticipated crash rates to be less than the existing condition, by around 25%.

Table 7. Corridor-Wide Predicted Crash Rates (crashes per year).

Segment Strategy	KABCO	KABC	O
Two lanes, undivided (typical existing condition)	**24.4**	6.7	17.7
Three lanes, center turn lane	**26.9**	7.3	19.6
Four lanes, undivided	**28.8**	9.0	19.9
Four lanes, divided (physical divider)	**19.6**	5.4	14.2

The data in Table 7 comes from an analysis of the SR 28 corridor using the *Highway Safety Manual* with all variables being equal, other than number of lanes and median length. The *HSM* does not provide a quantifiable benefit for a divided two-lane roadway or for a two-lane roadway with passing lanes.

For that data, Perteet used information from the online CMF Clearinghouse. One study found a CMF of 0.29 associated with installing a raised median[4]. For passing lanes, data is available for rural roads (note that WSDOT classifies all of the study area as urban). A study on periodic passing lanes showed a CMF of 0.65 for injury/fatal crashes[5], while a separate study on "short 2+1 road sections" (i.e. a three-lane roadway with alternating directional passing opportunities) found a CMF of 0.53 for that treatment[6]. Both treatments are used on WSDOT state routes.

ACTIVE TRANSPORTATION NEEDS

Active transportation users are pedestrians, which include people walking and people using mobility devices such as scooters, and bicyclists. The study area includes multiple pedestrian and bicycle facilities, including the Apple Capitol Loop Trail and the local street networks surrounding SR 28 and within Rock Island. The CDTC *2020 Regional Transportation Plan Update*, CDTC *Regional Bicycle Plan*, and WSDOT *Active Transportation Plan 2020 and Beyond – Part 1* are relevant planning documents for the active transportation modes.

Existing Network

The existing active transportation network is limited in most of the study area. The Loop Trail is a regional facility that connects East Wenatchee to Hydro Park and is used by pedestrians and bicyclists for recreational travel. South of 3rd Street SE, there are no marked crossings available for people in the study area to access the Loop Trail, which limits its utility as a route for local trip making. Local walking or biking trips typically occur on the edge of the roadway, in a shoulder if available, throughout the study area. There are a few locations in the East Wenatchee and in Rock Island portions of the study area (not on SR 28) that have sidewalks available as well as some crosswalks. There is one segment of existing bicycle lanes on 3rd Street SE.

Planned Projects and Future Network

The *2020 Regional Transportation Plan Update* and *Regional Bicycle Plan* include one relevant project to improve active transportation facilities in the study area. The former document includes an unprioritized expansion project listing for "Access and circulation projects consistent with Rock Island Waterfront Plan." The full transportation project list from the *Rock Island Waterfront Subarea Plan* is included as Figure 11 in a later section of this memorandum. The relevant pedestrian and bicycle projects listed are a 1.5-mile-long waterfront trail and potential grade-separated crossings (likely undercrossings) of SR 28 and railroad tracks in the waterfront area. Intersection improvements are also listed as SR 28 with Rock

[4] **Study Citation:** Schultz, G.G., K.T. Braley, and T. Boschert, "Correlating Access Management to Crash Rate, Severity, and Collision Type." TRB 87th Annual Meeting Compendium of Papers CD-ROM. Washington, D.C., (2008).
[5] **Study Citation:** Park, B., Fitzpatrick, K., and Brewer, M., "Safety Effectiveness of Super 2 Highways in Texas." Transportation Research Record: Journal of the Transportation Research Board, No. 2280, Transportation Research Board of the National Academies, Washington, D.C., 2012, pp. 38-50. DOI: 10.3141/2280-05
[6] **Study Citation:** D'Agostino, C., S. Cafiso, and M. Kiec. "Comparison of Bayesian techniques for the before–after evaluation of the safety effectiveness of short 2+1 road sections". Accident Analysis and Prevention, Vol. 127, (2019) pp. 163-171.

Island Drive and SR 28 with Nature Shores Drive, which could include crossing enhancements for active transportation users.

The existing and future pedestrian facility network from existing plans are shown in Figure 3. The existing and future bicycle facility network from existing plans are shown in Figure 4. Perteet did not modify these facility elements; this linework comes from the CDTC.

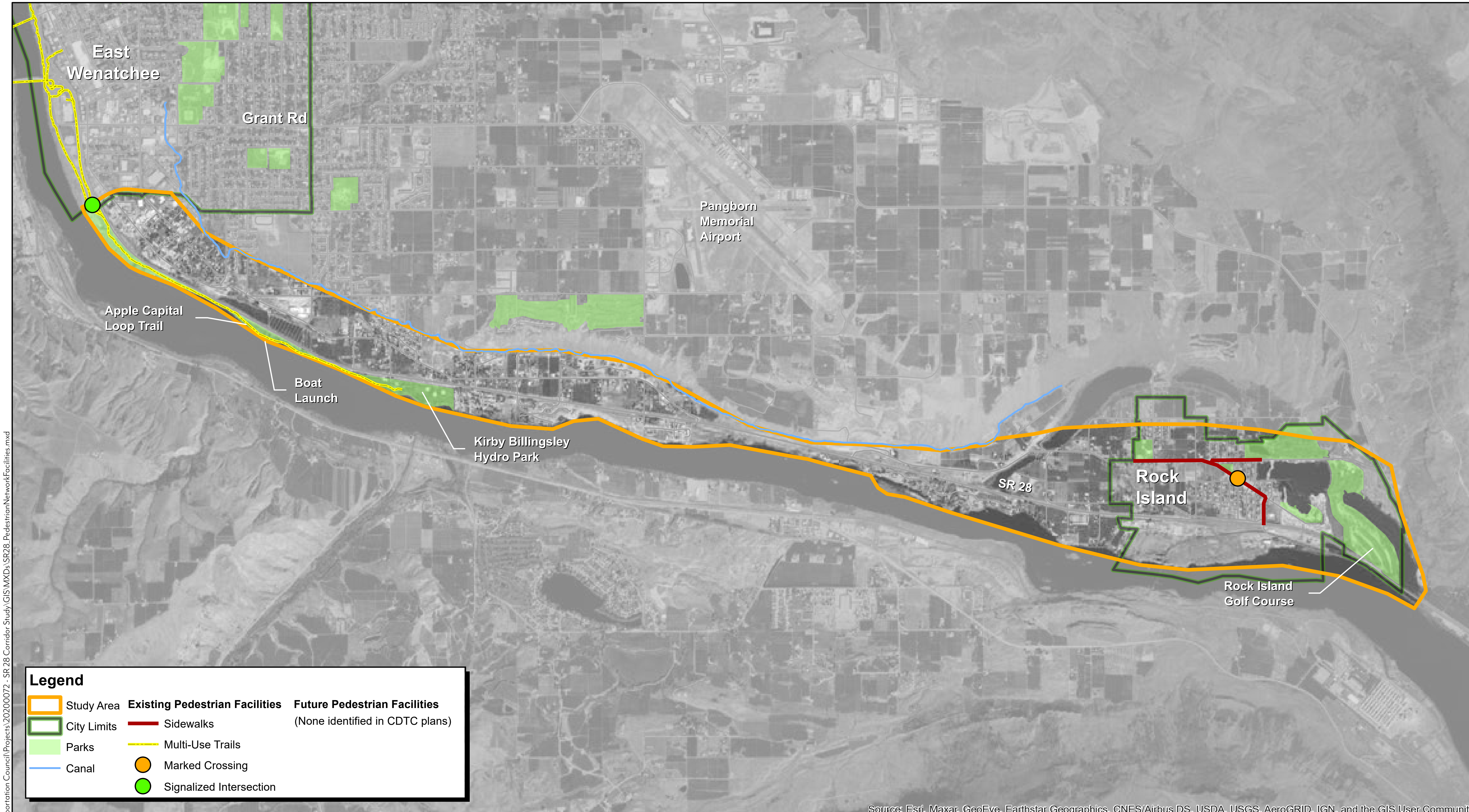

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Figure 3

SR 28 Corridor Study
Pedestrian Network Facilities

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Source: Chelan-Douglas Transportation Council; Douglas County GIS; ESRI

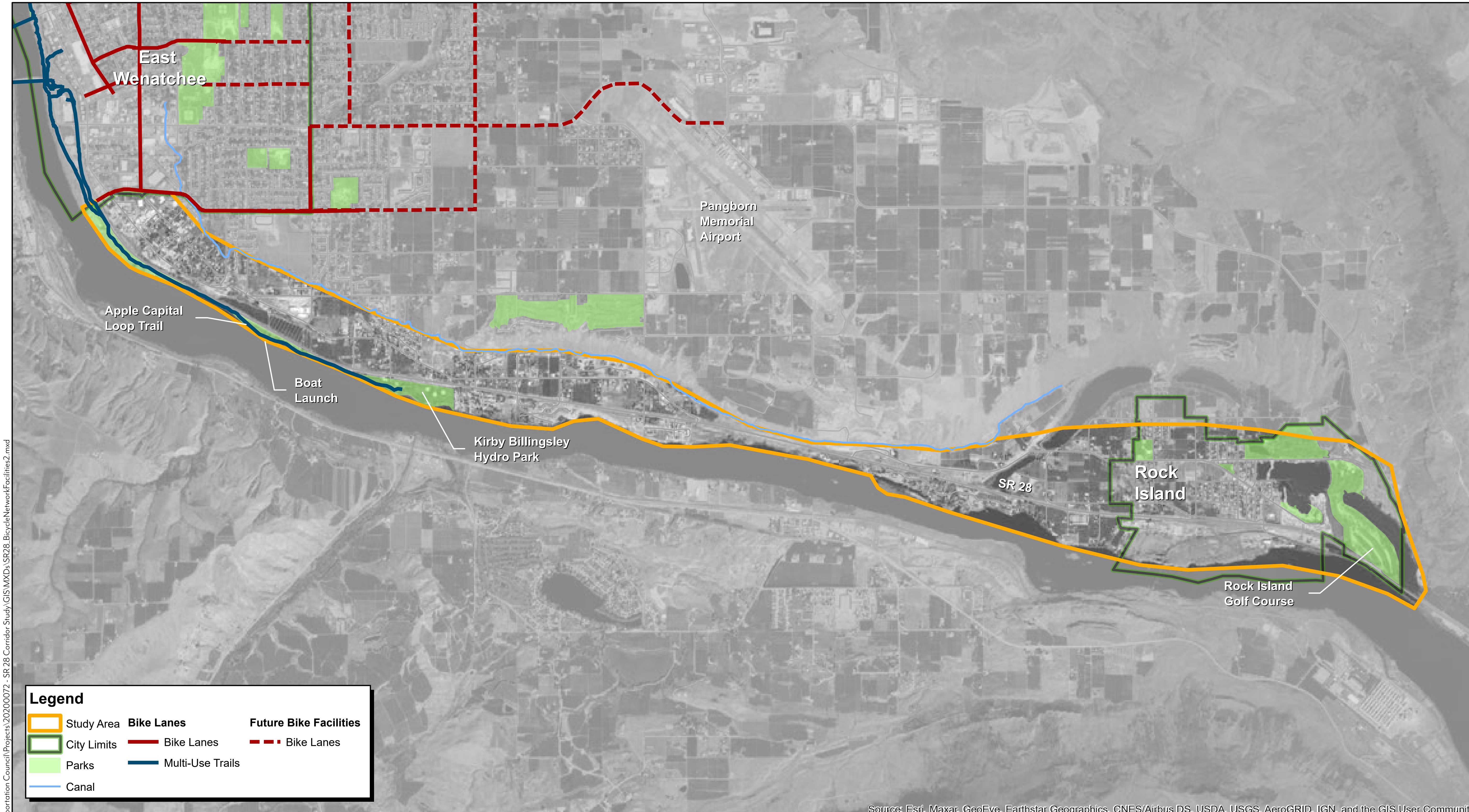

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Figure 4

SR 28 Corridor Study
Bicycle Network Facilities

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Source: Chelan-Douglas Transportation Council; Douglas County GIS; ESRI

Gap Analysis

Gaps in the active transportation network exist in two primary forms. First, a "missing link" gap is any location where there is a discontinuity in a facility that physically leaves a missing segment for users. An example would be a series of three blocks with sidewalk on the outer blocks only, leaving a missing sidewalk link in the middle block, creating a gap. Second, gaps can be created by areas of decreased user comfort along a facility. An example of this type of gap is a bicycle network that provides bicycle lanes until transitioning into a shared condition where bicycle and drivers both use the same lane width of pavement. The latter segment may be uncomfortable for some desired users. The two types of gaps often overlap—users feel less comfortable if a facility is not present for a segment of their travel path.

To quantify the concept of user comfort for pedestrian and bicycle facilities, WSDOT's *Active Transportation Plan 2020 and Beyond – Part 1* uses a metric called "level of traffic stress" (LTS). LTS is a numeric score for a facility—or a combination of facilities along a route—ranging from 1 to 4. LTS 1 facilities have the lowest stress on active transportation modes from adjacent vehicle traffic, whereas LTS 4 facilities represent the highest stress. WSDOT defines "low stress" facilities as those scoring as LTS 1 or 2 and "high stress" as LTS 3 or 4. The high-stress facilities typically constitute gaps for most users, as the degree of stress impacts many users to the point where the trip is undesirable along that route.

Level of traffic stress is measured separately for pedestrians (i.e. PLTS) and for bicyclists (i.e. BLTS). Figures 5 and 6 are taken from the *Active Transportation Plan 2020 and Beyond – Part 1*.

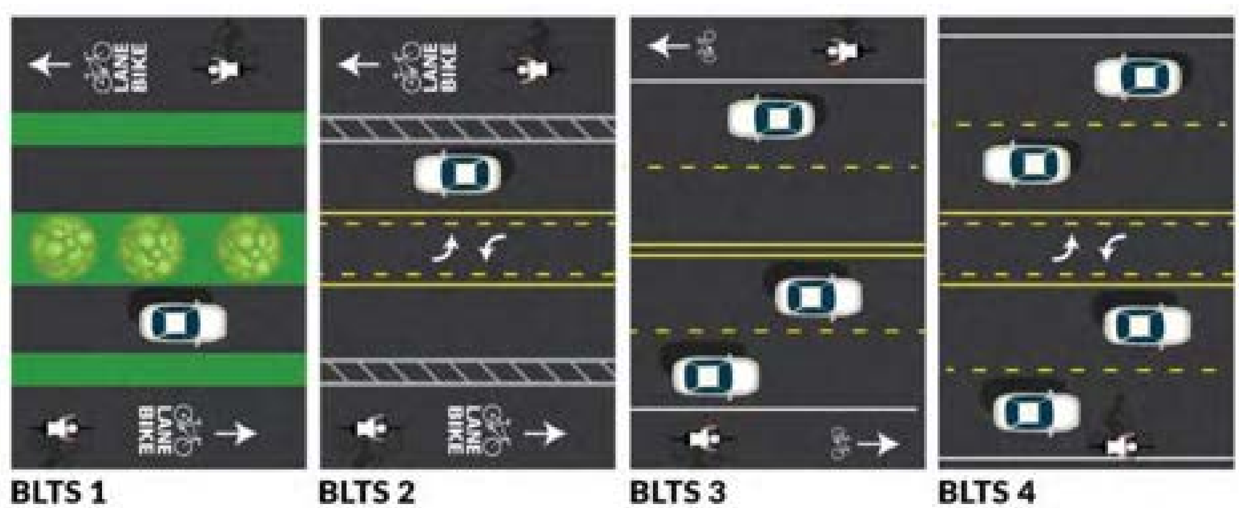

Figure 3-7: Bicycle level of traffic stress (BLTS) is illustrated by associating user types with examples of types of facilities that they feel comfortable using. The BLTS 1 scenario shows facilities that are likely to appeal to 100 percent of people who want to ride a bicycle. For BLTS 2 the facilities include buffered bike lanes which offer more separation than standard bike lines, but no physical barrier. 81% of bicycle riders would use this facility. For BLTS 3 standard bike lanes are provided and about 12 percent of riders would use this facility. Only about 1 percent of riders would use BLTS 4 facilities where no separated space is offered.

Figure 5. WSDOT Visualization of Bicycle Level of Traffic Stress.

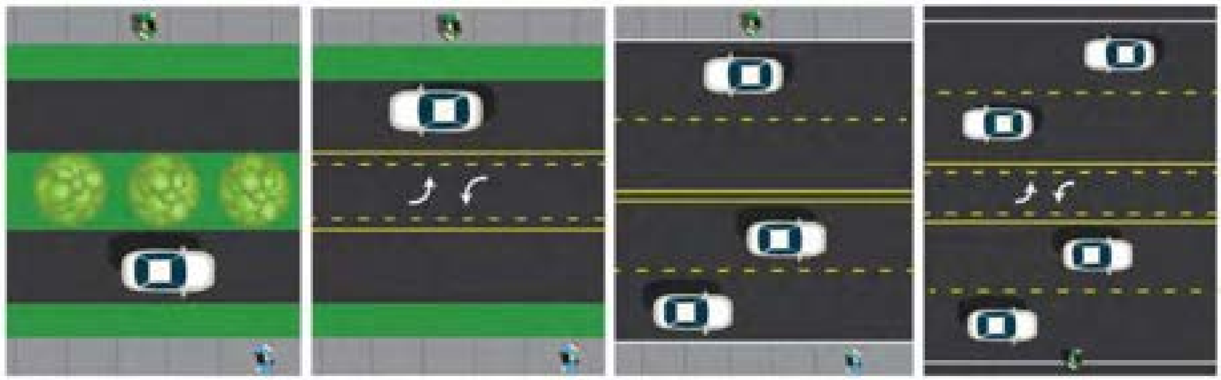

Figure 3-9: Pedestrian level of traffic stress (PLTS) is illustrated by associating user types with examples of types of facilities that they feel comfortable using. In the PLTS 1 scenario the facilities are presumed to appeal to anyone wants to walk. For PLTS 2 the facilities are presumed to appeal to a high percentage of people who want to walk. For PLTS 3 the facilities are likely to appeal to many people who want to walk, but separation from traffic is lower and there are more potential challenges, especially when it comes to crossing considerations (although these are not illustrated). For PLTS 4 the facilities are unlikely to appeal to very many people who want to walk. There is minimal separation from traffic and there are more potential challenges associated with a complex and wide roadway, especially when it comes to crossing considerations.

Figure 6. WSDOT Visualization of Pedestrian Level of Traffic Stress.

The following sections document Perteet's evaluation of the two primary types of active transportation network gaps.

Missing Links Evaluation

Shared-Use Facilities

These facilities include multi-use paths, either alongside a roadway or in separate right of way, and roadway crossings to be used by pedestrians or cyclists. The primary shared-use facility in the study area is the Apple Capital Recreation Loop Trail that extends from East Wenatchee to Hydro Park. While the Loop Trail does not include any missing segments, its endpoint at Hydro Park means that it does not service the City of Rock Island and represents a missing link for potential Rock Island users.

While the Wenatchee Reclamation Ditch east of SR 28 connects East Wenatchee and Rock Island and includes an adjacent gravel road/pathway, this road/path is signed as "No Trespassing on Canal Right of Way" so it is not a current legal facility for either pedestrians or bicyclists to use as a connection.

Pedestrian Facilities

The CDTC *2020 Regional Transportation Plan Update* Figure 3-6, shown here as Figure 7, illustrates a pedestrian demand index evaluation for the Wenatchee, East Wenatchee, and Rock Island Urban Growth Areas (UGAs). The evaluation is limited to highways and primary roadways. CDTC has a policy target of 100% of the federal-aid road network having sidewalks on both sides[7].

The highest index—meaning the highest demand—value in Figure 7 is on Rock Island Avenue adjacent to Rock Island Elementary School. Other locations in this map with an index of at least 4 include:

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[7] CDTC exemptions to this policy from Page 2-5 of the *Regional Transportation Plan*: managed-access class 1, 2, or 3 roads or limited access roads; where a sufficient alternative is approved via the Complete Streets ordinance.

- SR 28 from 3rd Street SE to East Wenatchee UGA limits
- 3rd Street SE from Rock Island Road to Highline Drive
- Rock Island Road between S Iowa Avenue and 8th Street SE
- S Kentucky Avenue between 8th Street SE and Rock Island Road
- Rock Island Road at S Mary Avenue
- Rock Island Road at S Nile Avenue
- Rock Island Road/Avenue/Drive between Rock Island UGA and SR 28

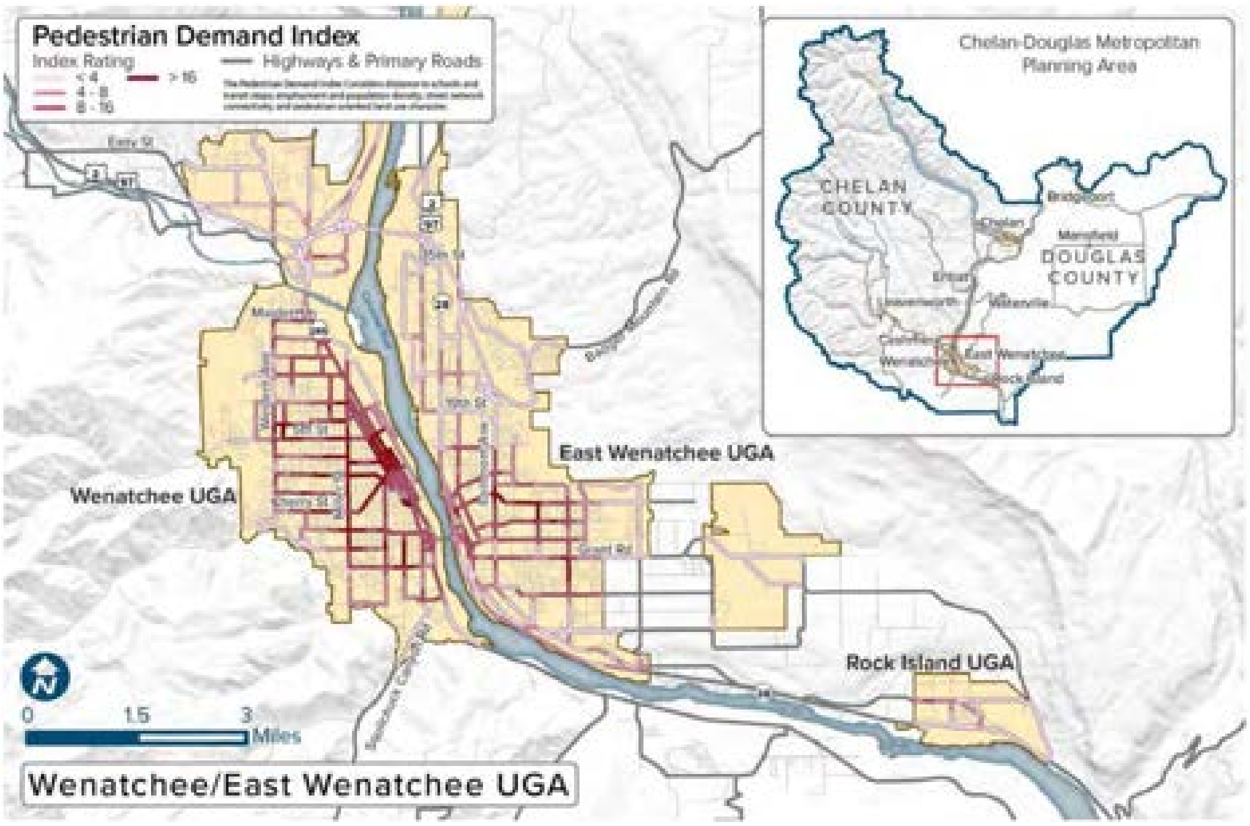


Figure 7. CDTC Pedestrian Demand Index Map.

Sidewalks currently exist in some portions of East Wenatchee and Rock Island within the study limits. In East Wenatchee, sidewalks are provided on 3rd Street SE and for a short distance on Highline Drive. In Rock Island, the sidewalk network includes Rock Island Avenue/Drive west of Center Street, Saunders Avenue, N Garden Avenue, and Delaware Avenue. Elsewhere, sidewalks are not provided, including where most of the higher demand index locations are as described above. Specifically, the higher-index locations listed above and illustrated in Figure 7 where sidewalks are not present are:

- SR 28 from 3rd Street SE to East Wenatchee UGA limits
- Rock Island Road between S Iowa Avenue and 8th Street SE
- S Kentucky Avenue between 8th Street SE and Rock Island Road
- Rock Island Road at S Mary Avenue
- Rock Island Road at S Nile Avenue
- Rock Island Road/Avenue between Rock Island UGA and Center Street

These six locations are considered missing links in the network because they do not provide a pedestrian facility for safe and comfortable travel. Note that the Loop Trail does service some of the demand for pedestrian travel on SR 28, but barriers to meet demand still exist because SR 28 does not have any marked or enhanced crossing locations to connect users to the Loop Trail south of 3rd Street SE. Figure 2-2 from the *Regional Transportation Plan*, included here as Figure 8, shows the existing sidewalk gaps identified by CDTC. However, this figure shows gaps on portions of Rock Island Drive and Saunders Avenue in Rock Island that have sidewalks on both sides today.

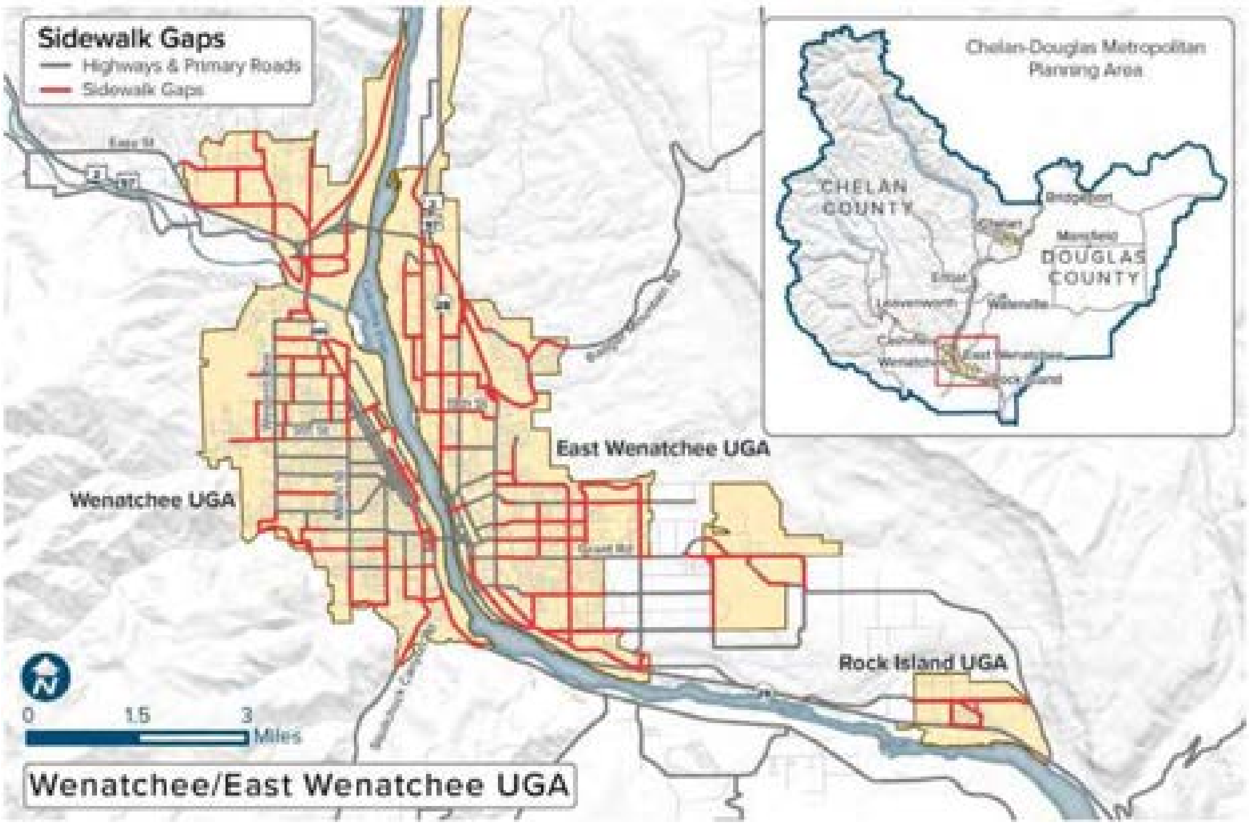


Figure 8. CDTC Sidewalk Gaps Map.

On the minor roadway network—the streets not shown in Figures 7 or 8—where sidewalks and crossings are provided, they are typically connected to other facilities. The segment of Fremont Avenue between Saunders Avenue and Rock Island Drive is the only portion of missing sidewalk between two adjacent segments on these types of streets.

Bicycle Facilities

The Loop Trail is the primary bicycle network element in this study area. However, there are existing bike lanes on 3rd Street SE in East Wenatchee. There are no bicycle facilities in or around Rock Island. The 3rd Street SE bicycle lanes connect to the Loop Trail and have a recommended expansion east to S Nile Avenue in the *Regional Bicycle Plan*.

The lack of a bicycle facility connecting Rock Island and the Loop Trail is considered a missing link. An extension of the Loop Trail across Hydro Park should evaluate potential Park and Trail user conflicts.

Level of Traffic Stress Evaluation

Perteet applied the WSDOT LTS methodology to generate the pedestrian and bicycle scores shown in Figures 9 and 10. Consistent with the relatively low number of sidewalks and bicycle lanes that exist in the network today, many facilities register as high-stress, with the majority at LTS 4.

Table 8 summarizes the type of facility and the corresponding LTS score for facilities ranking better than LTS 3. This threshold is the standard dividing line between "high-stress" and "low-stress" network elements. Note that some segments in Table 8 do not include sidewalks or bike lanes but score better than LTS 3 because of lower travel speeds and/or fewer adjacent travel lanes. All LTS calculations are provided in Appendix C.

All facilities not listed in Table 8 score at an LTS 3 or LTS 4. Note that this evaluation is only for facilities that run along or across roadways, so the Loop Trail is not included. For this reason, a low LTS score does not always mean that there is a gap in the network because users can take parallel routes, so long as they are connected. The Loop Trail may be able to service the needs of active transportation users, provided it has connectivity to other facilities via crossings that provide LTS 1 or LTS 2 scores. Figures 9 and 10 illustrate quarter-mile service areas around LTS 1 and 2 facilities to illustrate where active transportation needs are currently being met through parallel route options.

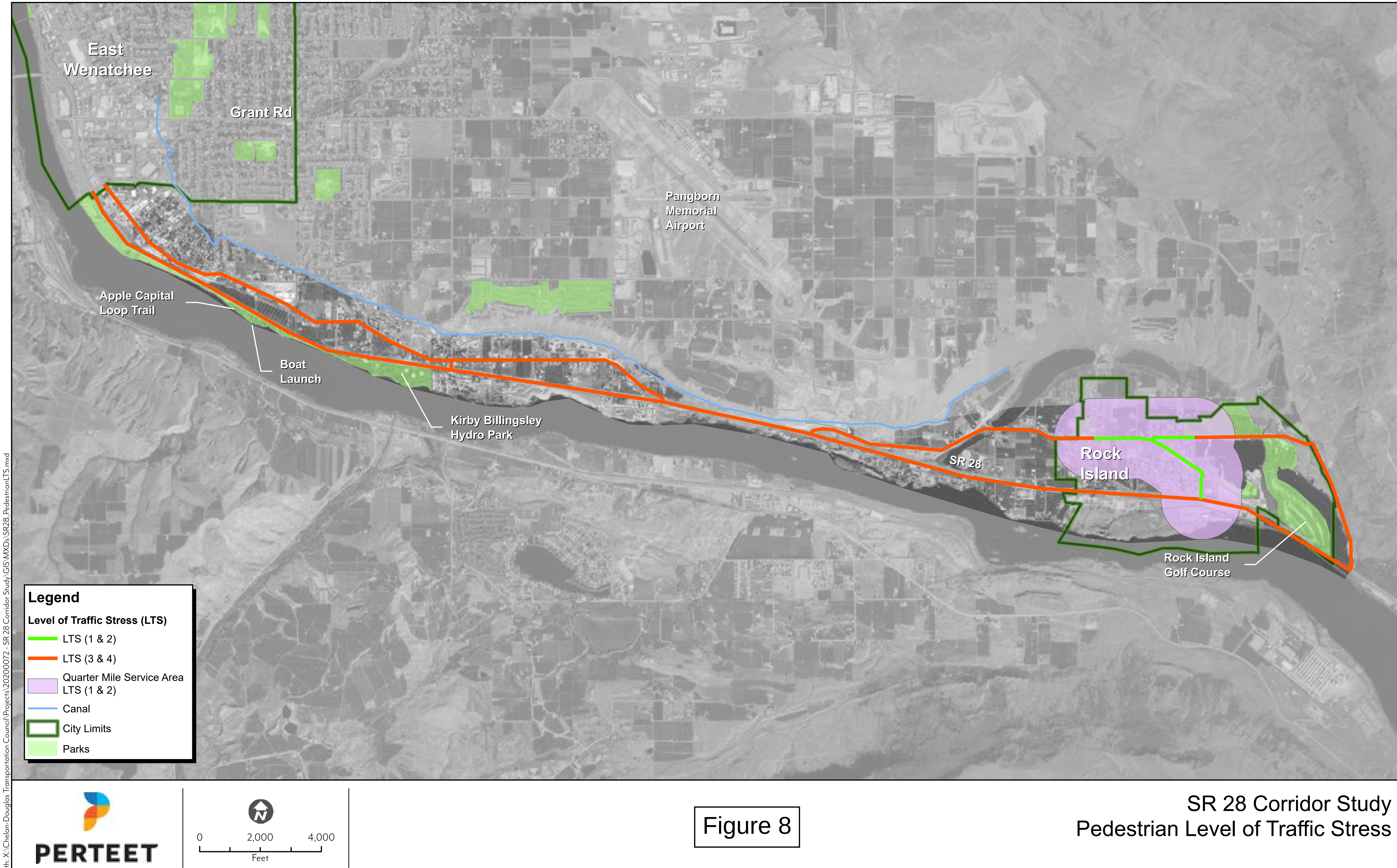
The current WSDOT LTS methodology for intersection scoring is based on the assumption of an unsignalized crossing without a median refuge. This assumption holds for this existing condition analysis, but proposed treatments may enhance crossings or modify intersection configurations such that this assumption would no longer apply to this study. In this case, Perteet plans to use the LTS evaluation framework used by Oregon Department of Transportation[8] to quantify the benefits of those candidate treatments for active transportation users.

Table 8. LTS 1 and LTS 2 Facilities.

Segment/Intersection	Facility Type	LTS
Pedestrian Facilities		PLTS
Saunders Ave from Delaware Ave to Rock Island Drive (E) Rock Island Dr from Saunders Ave to SR 28	Sidewalks, both sides	2
Rock Island Rd (E) from Saunders Ave to Center St	Sidewalks, one side	2
Saunders Ave and N Garden Ave Rock Island Dr and Saunders Ave Rock Island Dr (E) and Douglas St Rock Island Dr (E) and Center St Rock Island Dr and S Garden Ave Rock Island Rd (W) and S Mary Ave Rock Island Rd (W) and S Kentucky Ave Rock Island Rd (W) and 8th St SE Rock Island Rd (W) and S Iowa Ave	n/a (Intersection)	2

[8] Oregon Department of Transportation (ODOT) LTS evaluation procedures are documented in ODOT's *Analysis Procedures Manual Version 2*, Chapter 14.4 (bicycle LTS) and Chapter 14.5 (pedestrian LTS). ODOT pedestrian LTS calculations incorporate posted/prevailing speed; number of lanes crossed; daily traffic volume; and presence of medians, crosswalk markings, signage, illumination, beacons, in-street signs, curb extensions, or raised crossings.

Segment/Intersection	Facility Type	LTS
Bicycle Facilities		BLTS
Saunders Ave from Delaware Ave to Rock Island Drive (E) Rock Island Rd (E) from Saunders Ave to Center St Rock Island Dr from Saunders Ave to SR 28	No bicycle lanes	2
Saunders Ave and N Garden Ave Rock Island Dr and Saunders Ave Rock Island Dr (E) and Douglas St Rock Island Dr (E) and Center St Rock Island Dr and S Garden Ave Rock Island Rd (W) and S Mary Ave Rock Island Rd (W) and S Kentucky Ave Rock Island Rd (W) and 8th St SE Rock Island Rd (W) and S Iowa Ave	n/a (Intersection)	2



PERTEET

Figure 8

SR 28 Corridor Study
Pedestrian Level of Traffic Stress

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Source: Chelan-Douglas Transportation Council; Douglas County GIS; ESRI

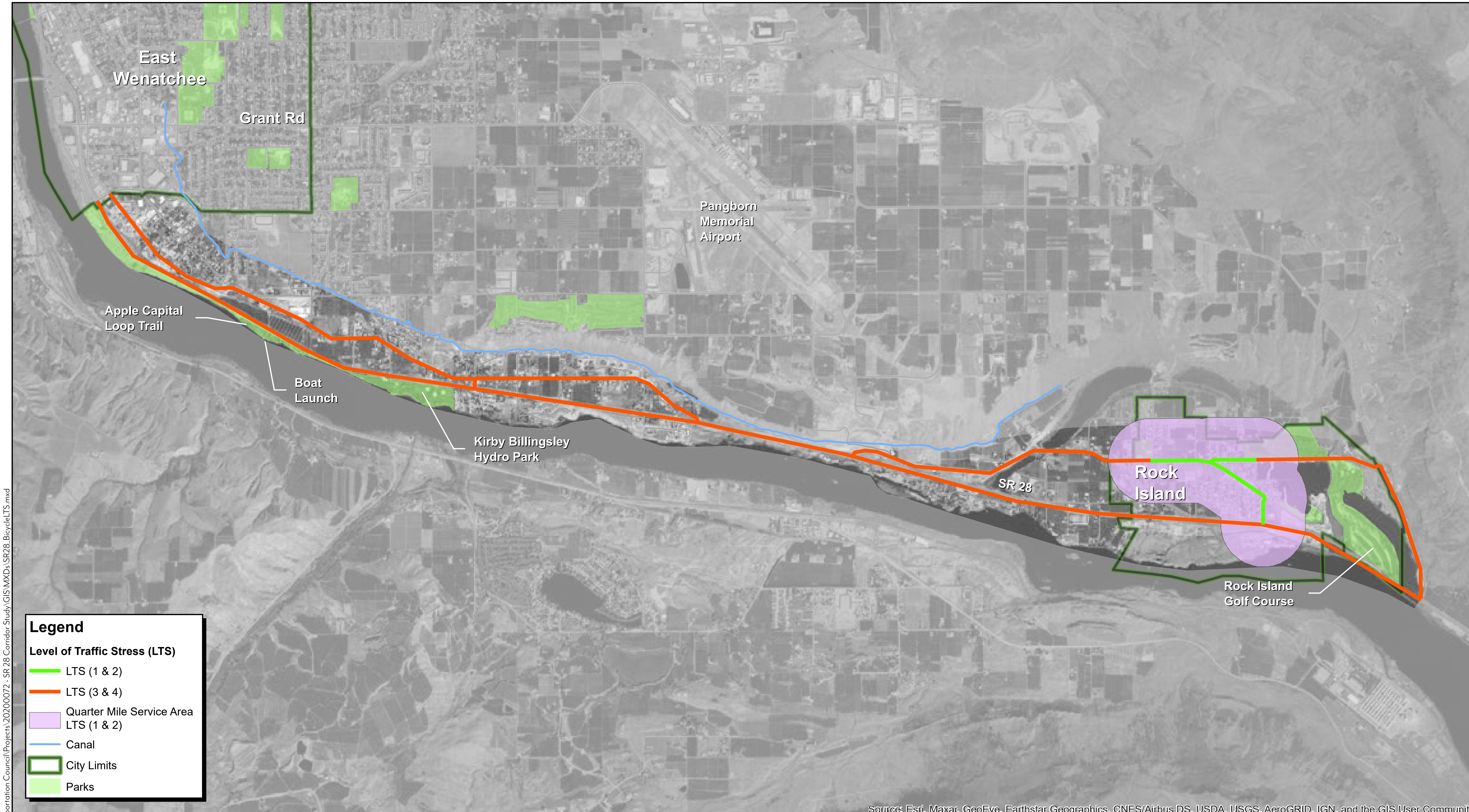

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Figure 9

SR 28 Corridor Study
Bicycle Level of Traffic Stress

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Source: Chelan-Douglas Transportation Council; Douglas County GIS; ESRI

VEHICLE MOBILITY NEEDS

Transit, freight, and general-purpose traffic all have varying priorities and typical routes through the study area. Perteet's evaluation of the needs for each mode is summarized below.

Transit

The study area is serviced by LINK Transit's Route 23, which connects Wenatchee to Rock Island via East Wenatchee. The route map is shown in Figure 12. This route primarily uses roads other than SR 28, however, it does use SR 28 for the segment between Rock Island Road to the east and west, since there is no other parallel route to use.

Per the LINK Transit route timetable, the eastbound trip lasts 27 minutes end-to-end and the westbound trip lasts 23 minutes. The route runs nine times per weekday.

Transit Needs

Transit is optimized when the service has adequate speed and reliability and when ridership is maximized for the context of an area.

Both speed and reliability can suffer in areas with high traffic volumes and congestion patterns. However, Route 23 uses Rock Island Road, which tends to feature low traffic volumes and consistent travel speeds. The components of the route map that stand out as potential reliability issue areas are the turns to and from SR 28, particularly the left turns required from Rock Island Road onto SR 28. As traffic volumes increase in the study area over time, delays to make these turning movements will likely increase for buses absent any intersection re-configurations or route adjustments.

Ridership for a bus route is generally described in terms of a walkshed, which is the standard area within a certain distance of bus stops that riders will walk to reach the transit service. Typical transit planning walksheds are one-quarter-mile radii from each stop. The current routing along Rock Island Road appears to maximize the walkshed for users north of SR 28, as it cuts through the middle of Rock Island on the east end and approximately halfway between SR 28 and 8th Street SE on the west end of the study area. However, the walkshed is limited for potential transit riders south of SR 28. In some locations, properties south of SR 28 are located more than one-quarter mile away from the nearest transit stop. And for the parcels that are within the walkshed, potential riders face a barrier in having to cross SR 28, which does not currently have any marked crossings south of East Wenatchee.

Figure 11 presents ridership data in terms of average boardings plus alightings at the stops along Route 23. The data in the chart is aggregated by pair of stops, so both directions are captured in a column. The left side of the chart reflects ridership at the north end of the study area near 3rd Street SE and the right side of the chart is ridership in Rock Island. Data was available for weekday averages and Saturdays.

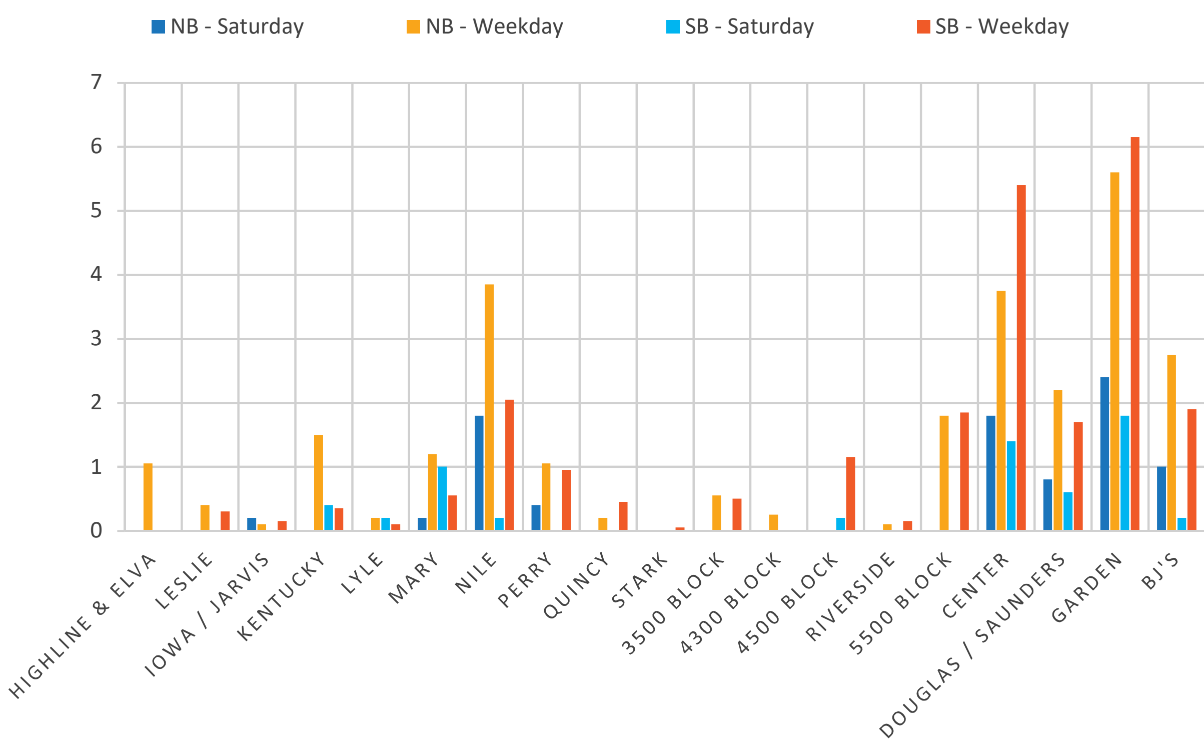


Figure 11. LINK Transit Route 23 Average Ridership.

Figure 11 illustrates that the highest-rider stops are in Rock Island, which today are generally surrounded by sidewalk. Outside of Rock Island, the stops at S Nile Avenue have the highest activity.

Note there is a Rock Island Park and Ride facility located west of Battermann Road, but it does not currently have any transit service.

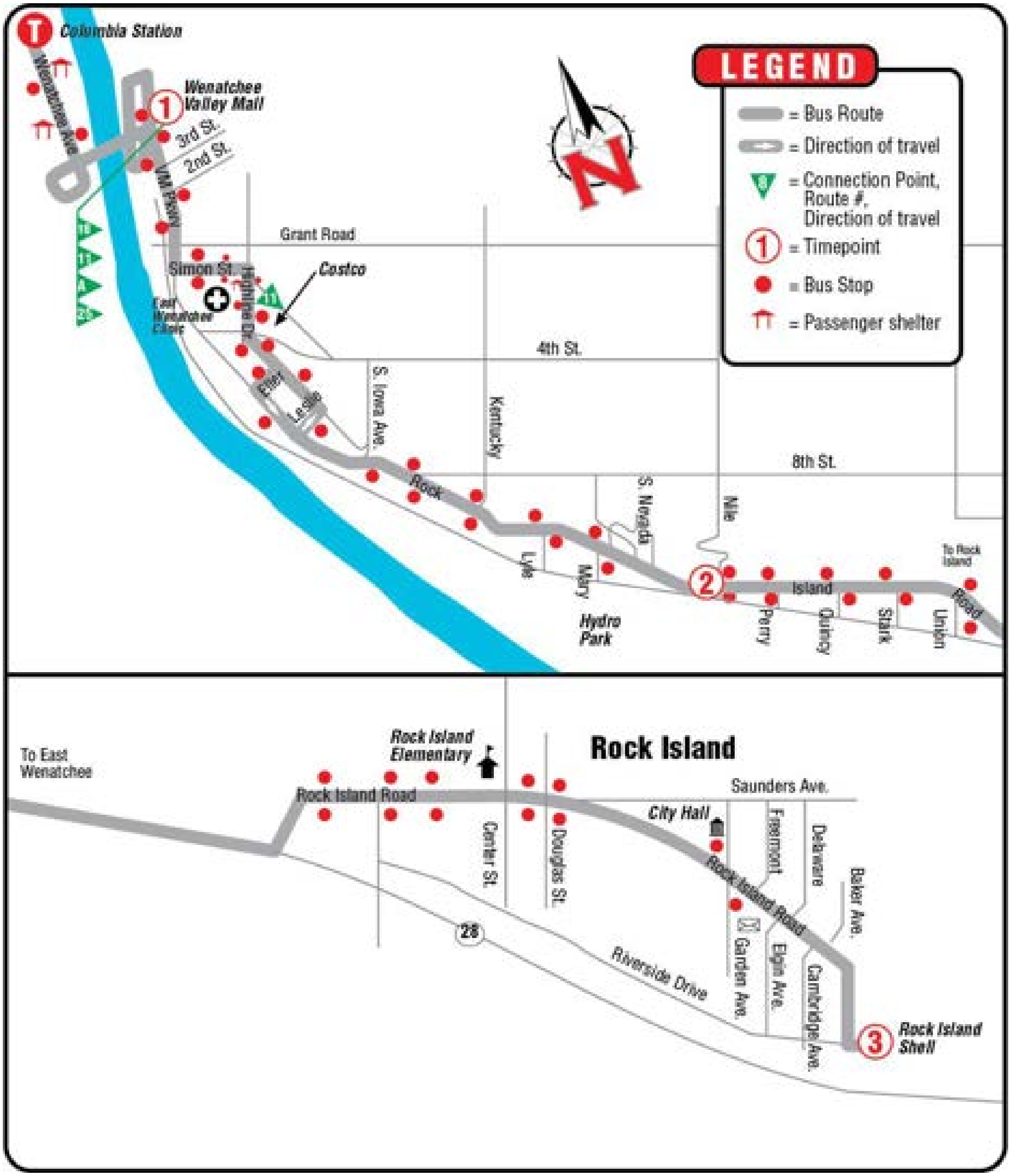


Figure 12. LINK Transit Route 23 Map.

Freight

SR 28 is the primary freight route through the study area. Approximately 10% of all trips on SR 28 are by commercial trucks. This route is a key connection between the Wenatchee Valley and I-90.

A key need for efficient freight movement is reliable travel times. Travel time can increase due to vehicle congestion, required stoppages at intersections or crosswalks, or increased side-street activity that either slows traffic turning off of SR 28 onto local streets or adds traffic that must accelerate after turning on SR 28. The CDTC *2020 Regional Transportation Plan Update* Table 2-1 outlines that a performance target for the full CDTC jurisdiction is that a metric called "Level of Travel Time Reliability Ratio" is at least 70%, with current performance (as of 2020) at 92%. This high percentage indicates that current roadways in the CDTC study are operating with more consistent travel times during peak periods as compared to the agency target. The companion CDTC *2020 System Performance Report* shows that SR 28 is classified as a "reliable" facility.

General-Purpose Traffic

All roadways in the study area service general-purpose trip demands. Local roadways in Rock Island and East Wenatchee are primarily used by local residents or employees of businesses, whereas SR 28 is also used for recreational and inter-county trips.

Like all other modes, safety is a top priority need for general-purpose traffic. Mobility and access are also key needs. These are discussed in the following sections.

Planned Improvements

Figure 13 shows the transportation entries in Table 3 from the *Rock Island Waterfront Subarea Plan*, which envisions a revised transportation network between SR 28 and the Columbia River.

Project	Description	Cost Forecast
TRANSPORTATION		
SR 28/Rock Island Drive Intersection	Construct a one-lane roundabout in the existing right-of-way when development reaches approx. 154,000 square feet or 185 total weekday PM peak hour trips	$1,600,000 to $2,500,000
SR 28/Nature Shores Drive Intersection	Modify intersection to be right-in/right-out when development reaches approx. 154,000 square feet or 185 total weekday PM peak hour trips	$20,000 to $30,000
At-Grade Railroad Crossing Improvement	Install signal and crossbars at existing rail crossing	$1,000,000 to $1,500,000
Railroad Grade-Separated Crossing	Grade-separated crossing of rail line to provide second point of access	$8,000,000 to $10,000,000
SR 28 Undercrossing	Type, size, and location study for vehicle and pedestrian undercrossing	$150,000 to $250,000
Interior Streets	SR 28 frontage street and interior loop. Full width with sidewalk and lighting (approx. 8,000 linear feet)	$3,000,000 to $4,500,000
OPEN SPACE AND TRAILS		
Waterfront Trail	Approximately 1.5 mile, paved trail	$250,000 to $350,000

Figure 13. Relevant *Rock Island Waterfront Subarea Plan* Project Listing.

The subarea plan calls for some internal improvements, but also modifications that would affect travel on SR 28 with improvements at the intersections of SR 28 and Rock Island Drive (proposed roundabout) and SR 28 and Nature Shores Drive (proposed right-in/right-out configuration).

A proposed but unprioritized expansion project in the *2020 Regional Transportation Plan Update* is to add passing lanes on SR 28 from Wenatchee to Crescent Bar. This expansion project would primarily benefit general purpose traffic by providing recurring locations to pass slower-moving heavy vehicles ahead of them.

Origin and Destination Patterns

As with freight, SR 28 is the primary route for general-purpose trips through the study, even for trips with an origin or destination point elsewhere in the study area. Perteet coordinated with CDTC to evaluate origin-destination data for trips on SR 28, which revealed the breakdown of local versus regional uses for the facility.

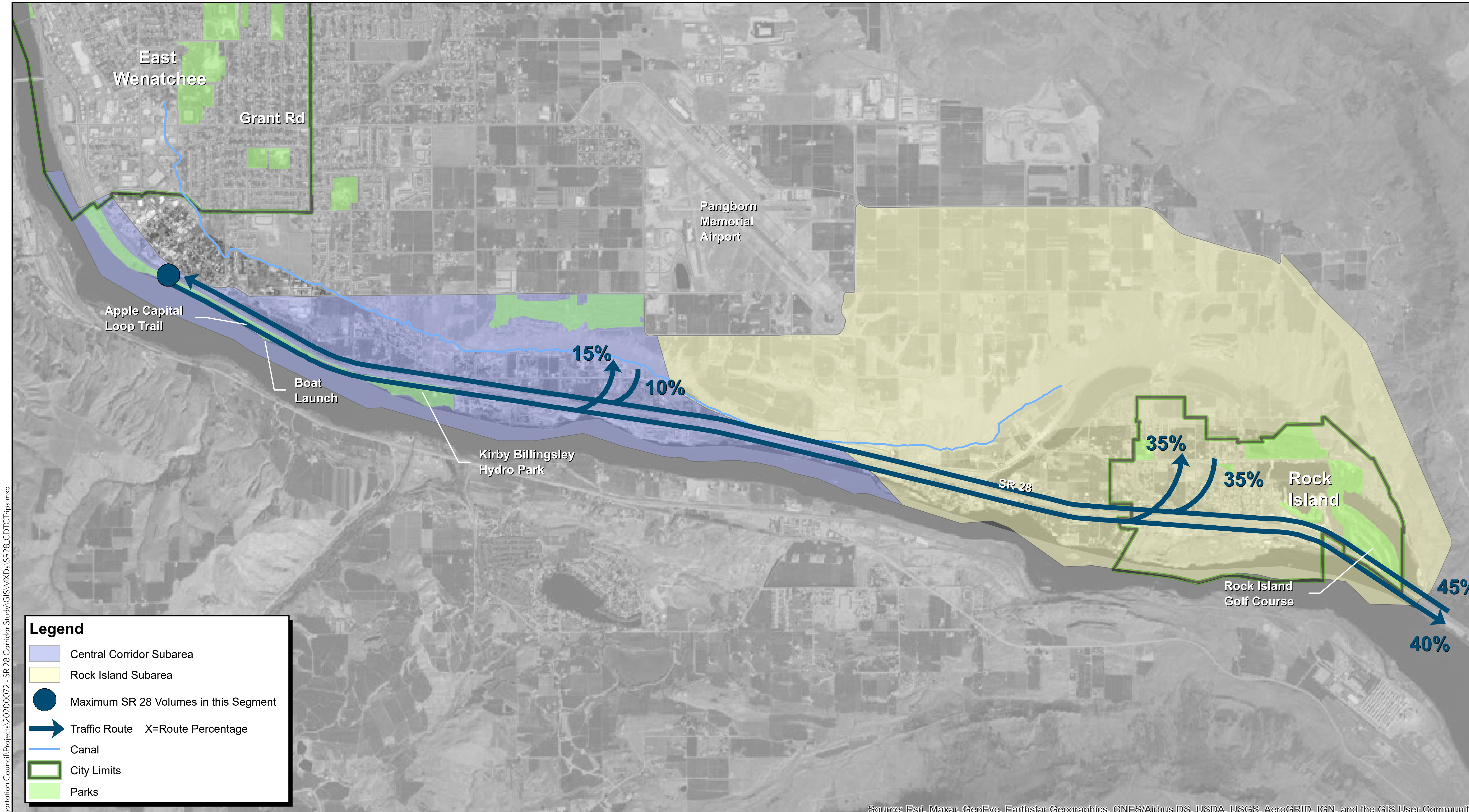
Figure 14 illustrates this breakdown at one point along SR with the highest daily use: between 3rd Street SE and the boat launch along the Columbia River. This data is also summarized in Table 9. All of this analysis is based on P.M. Peak Hour data from CDTC's 2045 travel demand model.

Table 9. SR 28 Origin-Destination Data for Trips South of 3rd Street SE.

To/From Zone	Southbound	Northbound
"Central Corridor Subarea"	15%	10%
"Rock Island Subarea"	35%	35%
South/east of Rock Island	40%	45%
Other	10%	10%
Total	**100%**	**100%**

As Table 9 and Figure 14 show, SR 28 supports roughly equal local versus regional demand in the P.M. Peak Hour.

Perteet also evaluated trip patterns to/from each subarea and found that 90% of trips from both subareas come from or head to either East Wenatchee or the airport vicinity. Around two-thirds of these movements happen via SR 28, with the remaining third using alternate routes.



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SR 28 Corridor Study
Trip Origin-Destination
2045 P.M. Peak Hour

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Source: Chelan-Douglas Transportation Council; Douglas County GIS; ESRI

Access

This segment of SR 28 is classified by WSDOT as partially controlled limited access. The WSDOT *Design Manual* Section 530.04(3)(b)(1) standard for intersection spacing on a partially controlled limited access principal arterial is 1 mile, minimum, for crossroads with average daily travel volumes of less than 2,000. Intersection with crossroad volumes above 2,000 vehicles per day in a 20-year horizon should "plan for grade separation."

Between and including the intersections of SR 28 at S Lyle Avenue and SR 28 at Battermann Road, there are 14 intersections along the state highway in a 6.5-mile stretch. The smallest distance between two intersections is 0.13 miles between S Tyee Avenue and Rock Island Road (west). There are opportunities throughout the corridor to either consolidate access points on one side of SR 28 or to remove the offset in existing access points on either side of SR 28.

Intersection locations may be dictated by the location of developments on the waterfront side of SR 28, as they have a more constrained existing and potential street network than the north side of SR 28. These existing developments on the south side are spaced less than one mile apart, which may present a barrier to achieving the WSDOT standard for intersection spacing. Still, there are potential access changes for these locations that can be explored to bring intersection spacing closer to the standard minimum.

Based on Perteet's evaluation of anticipated 2045 peak hour traffic demands, three intersections are projected to exceed the 2,000 vehicle per day threshold listed in Section 530.04(3)(b)(1): SR 28 at 3rd Street SE, SR 28 at Rock Island Road (east), and SR 28 at Rock Island Drive.

Capacity

Perteet evaluated traffic SR 28 segment volume projections for 2045. For this phase of the study, these volumes reveal anticipated planning-level levels of service for different SR 28 configurations. Future phases of SR 28 analysis will dive deeper into traffic data and establish intersection turning movement volumes. The traffic volumes analysis is detailed in Appendix A.

Table 10 shows the peak hour traffic volumes Perteet established for the SR 28 corridor for 2045. See Appendix A for additional details on how these numbers were developed.

Table 10. 2045 Peak Season P.M. Peak Hour SR 28 Traffic Volumes.

SR 28 Segment	Southbound	Northbound	Total
3rd Street SE to S Nile Avenue	1440–1530	1360–1430	2800–2960
S Nile Avenue to Rock Island Road (East)	1390–1460	1350–1410	2740–2870
Rock Island Road (East) to Rock Island Drive	980–1040	1040–1090	2020–2130
Rock Island Drive to Battermann Road	670–710	740–780	1410–1490

Perteet compared these anticipated volumes to planning-level level of service tables found in HCHRP Report 825, *Planning and Preliminary Engineering Applications Guide to the Highway Capacity Manual (2016)*. These planning-level tables provide maximum volumes per hour per lane for different level of service (LOS) classifications (A-C, D, and E). Exhibit 30 in NCHRP 825 covers multi-lane highways, Exhibit

36 has data for two-lane highways, and Exhibit 45 addresses urban streets (see note below). These three exhibits span the current SR 28 corridor strategy alternatives in review with this study.

Table 11 summarizes the key pieces of the NCHRP 825 data relevant to this SR 28 study.

Table 11. NCHRP 825 Relevant Planning-Level Threshold Volumes.

Facility Type	Peak Hour Directional Volume (veh/hr)		
	LOS A-C	LOS D	LOS E
Multi-lane highway (urban, level terrain)	2720	3400	3880
Two-lane highway (Class 1[9], level terrain)	440	750	1490

Note that these planning-level thresholds incorporate a series of assumptions from the *Highway Capacity Manual* methodology. One assumption for the two-lane highway data in Table 11 is a configuration with 20% no-passing zones.

Table 11 does not include an analysis of an "urban street," even though that planning-level information is available in NCHRP 825. The reason is that the assumptions for the urban street analysis include signalized intersections at 1,500-foot spacing for a 45-mph facility. For this SR 28 study area, that frequency would translate to approximately 30 signals on the corridor, which is not consistent with existing conditions or any future configuration scenario. Therefore, the urban street values cannot be accurately used in this planning-level assessment.

Comparing Tables 10 and 11 shows that a multi-lane highway would have operations in the LOS A-C range because the Table 11 data is in vehicles per lane, so the directional capacity would be approximately double the anticipated demand. For a two-lane highway (Class 1), operations for most segments would be at LOS E. However, in the southbound direction the upper range of volumes for the 3rd Street SE to S Nile Avenue section would reach LOS F performance. And in both directions the segment between Rock Island Drive and Battermann Road would reach LOS D operations.

The capacity analysis is subject to further refinement in future phases of the study when highway modeling can address the assumptions included in this planning-level assessment.

ATTACHMENTS

Appendix A-1	Data and Traffic Volumes Forecast and Analysis Memorandum
Appendix A-2	*Highway Safety Manual* Evaluations
Appendix A-3	Level of Traffic Stress Evaluations

[9] From NCHRP 835: Class 1 highways are highways where motorists expect to travel at relatively high speeds.

APPENDIX A-1

Data and Traffic Volumes Forecast and Analysis Memorandum

MEMORANDUM

123 Ohme Garden Road, Suite 8, Wenatchee, WA 98801 | P 425.252.7700

To: Riley Shewak

From: Brent Powell, PE
Jennifer Saugen, PE
Cody Wuestney, EIT

Date: July 30, 2021

Re: SR 28 Corridor Study – Data and Traffic Volumes Forecast and Analysis Memorandum

INTRODUCTION

Chelan Douglas Transportation Council (CDTC) hired Perteet Inc. to complete a corridor evaluation focused on SR 28 between East Wenatchee and Rock Island. The intent of this phase of the study is to evaluate three high-level concepts for overall SR 28 planning: two-lane rural, four-lane rural, and two-lane urban. The study also includes evaluations of Rock Island Road and Battermann Road as parallel routes with potential for urban and/or multi-modal upgrades. Though this phase of the study will not include detailed traffic modeling, Perteet will compare the traffic volumes discussed in this against planning-level level-of-service thresholds to shape SR 28 concepts.

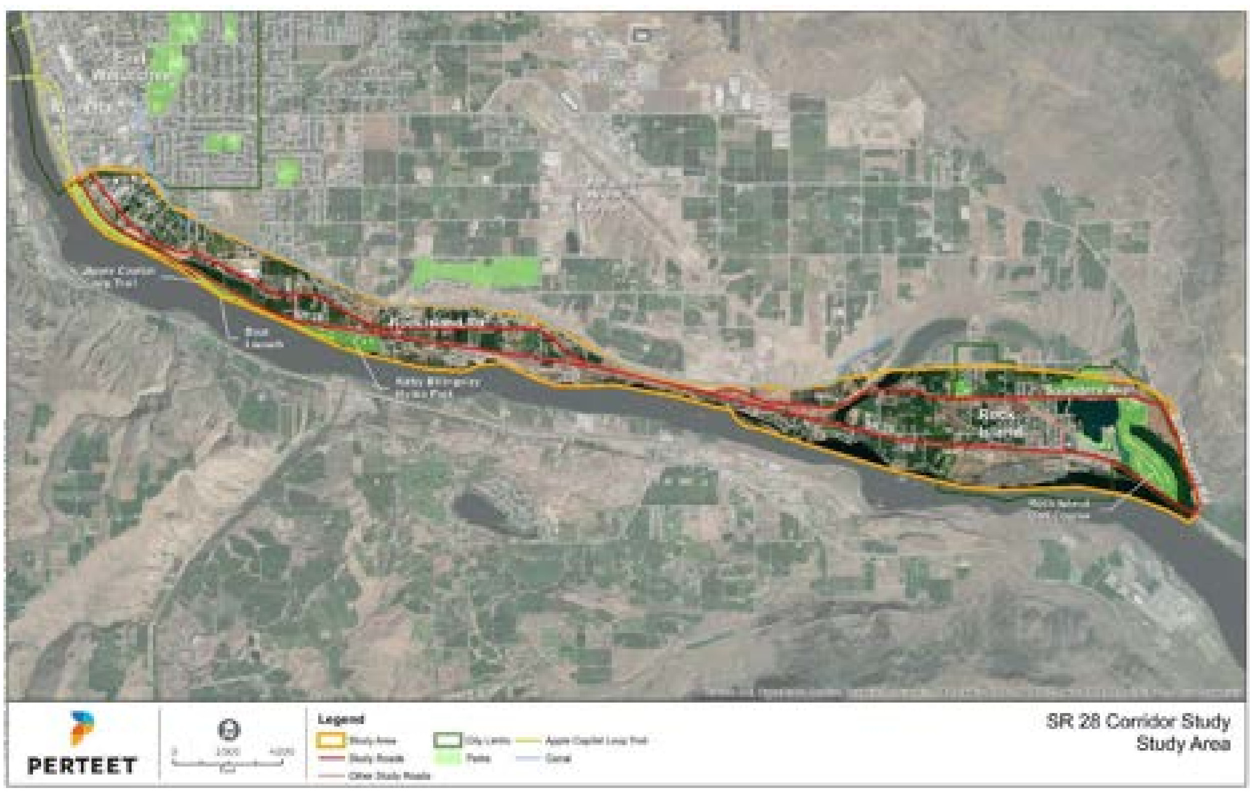


Figure 1. Study Area Map

File location: https://perteet.sharepoint.com/sites/ActiveProjects/20200072CDTCSR_28_Corridor_StudyInternal/Traffic/06-Documentation/03-Final-Memo/SR_28_Corridor-Study_Traffic_Volumes_Memorandum.docx

This memorandum documents Perteet's evaluation of traffic volumes throughout the study area and details expected ranges of traffic volumes on four SR 28 segments. The analysis provides volumes for peak season in the P.M. Peak Hour of the horizon year (2045).

The four SR 28 segments are:

1. 3rd Street SE to S Nile Avenue[1]
2. S Nile Avenue to Rock Island Road (East)
3. Rock Island Road (East) to Rock Island Drive
4. Rock Island Drive to Battermann Road

Project Direction Notation

Within the project limits, SR 28 is oriented both north-south and east-west. North and west of the Kirby Billingsly Hydro Park driveway (roughly at milepost 1.25), SR 28 will be referred to as a north-south roadway with the intersecting roadways oriented east-west. South, east, and at the Kirby Billingsly Hydro Park driveway, SR 28 will be referred to as an east-west roadway with the intersecting roadways oriented north-south.

EXISTING TRAFFIC VOLUMES AND DATA

Perteet obtained traffic, roadway, and development data from CDTC, Washington State Department of Transportation (WSDOT), Douglas County, City of East Wenatchee, and City of Quincy. (City of Rock Island did not provide any relevant traffic data upon request.) Traffic data consisted of: intersection turning movement counts, average annual daily traffic (AADT), travel demand model (TDM) outputs, past transportation studies in the vicinity, and crash records. Roadway data consisted of: intersection control, roadway and intersection configuration, and operational data. Development data consisted of: planned transportation projects in the area as well as reviewing nearby city comprehensive or transportation plans and reviewing WSDOT planning documents including WSDOT's *Active Transportation Plan Part 1, 2020 and Beyond*.

The available data provided sufficient information to calculate the high-level volumes necessary for the planning applications of this phase of the SR 28 study. However, new traffic volume data would be helpful to model intersection treatments and other traffic control elements—such as enhanced intersection crossings—in future phases of the study. Perteet recommends collecting new count data concurrently at all locations that may see intersection control modifications in future phases. The available turning movement count data provided by CDTC and WSDOT covers most of the major intersections along SR 28 within the study limits, but data was collected during different months and years. If older data is used in conjunction with new traffic counts, Perteet recommends applying annual growth and seasonal adjustment factors to the older data to provide a consistent analysis framework.

One data gap that Perteet found is that no current speed data was available for analysis. Perteet recommends collecting travel speed data for future phases of the study.

[1] The 3rd Street SE to S Nile Avenue segment includes the SR 28 Spur instead of SR 28 when the two highways run parallel. See Figure 1 for project study roads.

TRAFFIC VOLUMES ANALYSIS

Perteet determined with CDTC and WSDOT that using a range of traffic volumes per SR 28 segment would be appropriate for this planning study. The following sections detail the steps Perteet took to develop these volume ranges. All of the calculations are presented in tabular form in Appendix B.

Perteet found that the 2020 CDTC travel demand model (TDM) output for the SR 28 corridor and intersections included noticeably higher traffic volumes than the counts collected along the corridor in the 2010s showed. For this reason, Perteet, CDTC, and WSDOT agreed to set the low end of the volume range based on the traffic demand recorded in the turning movement counts with the high end of the volume range at the CDTC model projection.

Low-End Volume Range Calculations

One location in the corridor had multiple counts available to perform a regression analysis: SR 28 Spur at 3rd Street SE. Perteet compared volumes collected at this intersection in 2013, 2015, 2017, and 2018 to find a trendline to project volumes to 2020, the year of the CDTC TDM baseline. For this analysis, Perteet isolated the volumes on the south leg of the intersection, since those are within the boundaries of the study area and could be easily compared to CDTC's outputs. This analysis step showed that the CDTC model included 294 southbound departure vehicles from the 3rd Street SE intersection versus 221 estimated vehicles from the trendline estimate, a difference of 73 vehicles.

Perteet used origin-destination (O-D) data provided by the CDTC TDM (the 2045 model) to estimate how to distribute this 73-vehicle difference across the four study segments. The O-D data shows that the highest travel volumes on SR 28 (or SR 28 spur) are near the 3rd Street SE intersection, with volumes progressively lowering to the south along the corridor. To account for this, Perteet reduced the volume difference segment by segment. For example, at the final study segment of Rock Island Drive to Battermann Road, Perteet estimated that the volume difference would be only 40% of what it is at 3rd Street SE, since approximately 40% of the SR 28 traffic from the north continues on the corridor to reach Batterman Road.

Perteet performed the same analysis and adjustments for the northbound traffic. All calculations are summarized in Appendix B. Perteet adjusted the 2045 CDTC TDM outputs by the volume differences to produce the lower volume ranges for each study segment. The final adjustment required was applying a peak season adjustment factor to bring both the low end and high end of the volume range up to peak season demands.

Seasonal Adjustment – Peak Season

Traffic volumes vary throughout the year, with lower than average volumes in the winter and higher than average volumes in the summer. The magnitude of seasonal variation varies based on location, with urban areas staying closer to average and rural areas experiencing higher peaks in the summer from recreational and agricultural traffic. Accounting for seasonal adjustment is important in developing average annual traffic volumes, since individual counts taken on a given day, if extrapolated, may under- or overestimate the average annual traffic at that location. Seasonal adjustment factors can be used to adjust raw count data to average annual volumes as well adjusting average annual volumes to seasonal volumes.

Perteet used WSDOT’s permanent traffic recorder (PTR) data on the Sellar Bridge (WSDOT PTR site S103) to evaluate the seasonal variation on a month scale. We calculated the seasonal adjustment factors for each month between 2017 and 2019 and found the month with the peak volume is May. The seasonal adjustment factor to adjust average annual to the peak month (May) volumes is 1.058.

2045 Analysis Traffic Volumes

Table 1 shows the segment volume ranges throughout the SR 28 corridor that Perteet determined based on the above analysis steps.

Table 1. 2045 Peak Season P.M. Peak Hour SR 28 Traffic Volume Ranges.

SR 28 Segment	Southbound	Northbound	Total
3rd Street SE to S Nile Avenue	1440–1530	1360–1430	2800–2960
S Nile Avenue to Rock Island Road (East)	1390–1460	1340–1410	2730–2870
Rock Island Road (East) to Rock Island Drive	970–1040	1020–1090	1990–2130
Rock Island Drive to Battermann Road	670–710	710–780	1380–1490

ATTACHMENTS

Appendix A-1-1 CDTC TDM Outputs
Appendix A-1-2 Volume Analysis

APPENDIX A-1-1

CDTC Model Outputs

CDTC Regional Model	2020 Baseline	PM Volumes

CDTC Regional Model | 2045 No Build Baseline | PM Volumes

APPENDIX A-1-2

Volumes Analysis

SR 28 at 3rd Street SE Historical Volumes				
Year	SB Depart.	NB Approach	Total	*Notes*
2013	239	414	653	*4-5pm 1/18-19/2013 WSDOT Miovision count*
2015	250	575	825	*5-6pm 6/10/2015 WSDOT Miovision count*
2017	231	667	898	*Avg of 4:15-5:15pm 4/25-26/2017 WSDOT Miovison count*
2018	234	592	826	*2/1/2018 CDTC Miovision count*

SR 28 at 3rd Street SE Historical and TDM Volumes					
Year	A.A. Factor	SB Depart.	NB Approach	Total	*Notes*
2013	1.118	267	463	730	*Converted to average annual for 2013*
2015	0.948	237	545	782	*Converted to average annual for 2015*
2017	0.976	225	651	876	*Converted to average annual for 2017*
2018	1.049	245	621	866	*Converted to average annual for 2018*
2020	-	294	778	1072	*TDM model output*
2045	-	549	1347	1896	*TDM model output*

SR 28 at 3rd Street SE Overall Volume Adjustments				
Year	SB Depart.	NB Approach	Total	*Notes*
2020 (Trendline Estimate)	221	721	942	*See chart below for trendline equations*
2020 (TDM)	294	778	1072	
Adjustment to TDM	-73	-57	-130	

SR 28 Segment Volume Adjustments (2020, 2045)					
Segment	Southbound		Northbound		
	Impact %	Adjustment	Impact %	Adjustment	Total
3rd Street SE to S Nile Avenue	100%	-73	100%	-57	-130
S Nile Avenue to Rock Island Road (East)	75%	-55	80%	-46	-101
Rock Island Road (East) to Rock Island Drive	60%	-44	65%	-37	-81
Rock Island Drive to Battermann Road	40%	-29	45%	-26	-55

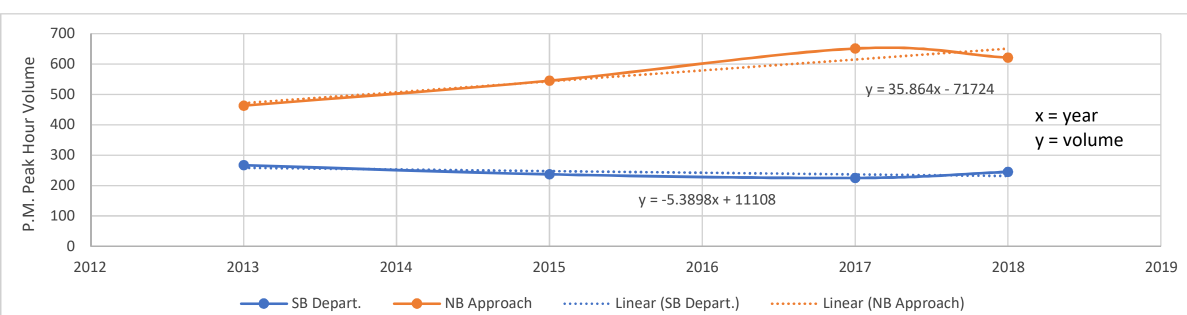
SR 28 P.M. Peak Hour CDTC 2045 TDM Outputs			
Segment	Southbound	Northbound	*Notes on Collection Point*
3rd Street SE to S Nile Avenue	1440	1347	*Maximum value, at midpoint*
S Nile Avenue to Rock Island Road (East)	1375	1324	*Maximum value, just east of Nile*
Rock Island Road (East) to Rock Island Drive	976	1021	*Maximum value, just east of R.I.R. (East)*
Rock Island Drive to Battermann Road	665	731	

SR 28 P.M. Peak Hour Segment Volumes (2045) (Average Annual)						
Segment	Southbound		Northbound		Total	
	Low End	High End	Low End	High End	Low End	High End
3rd Street SE to S Nile Avenue	1360	1440	1290	1350	2650	2790
S Nile Avenue to Rock Island Road (East)	1320	1380	1270	1330	2590	2710
Rock Island Road (East) to Rock Island Drive	930	980	980	1030	1910	2010
Rock Island Drive to Battermann Road	630	670	700	740	1330	1410

Peak Season Adjustment Factor **1.058** (coverts from average annual to peak season)

SR 28 P.M. Peak Hour Segment Volumes (2045) (Peak Season)						
Segment	Southbound		Northbound		Total	
	Low End	High End	Low End	High End	Low End	High End
3rd Street SE to S Nile Avenue	1440	1530	1360	1430	2800	2960
S Nile Avenue to Rock Island Road (East)	1390	1460	1350	1410	2740	2870
Rock Island Road (East) to Rock Island Drive	980	1040	1040	1090	2020	2130
Rock Island Drive to Battermann Road	670	710	740	780	1410	1490

Note: Results rounded to nearest 10 vehicles. Low-end volumes rounded down. High-end volumes rounded up.



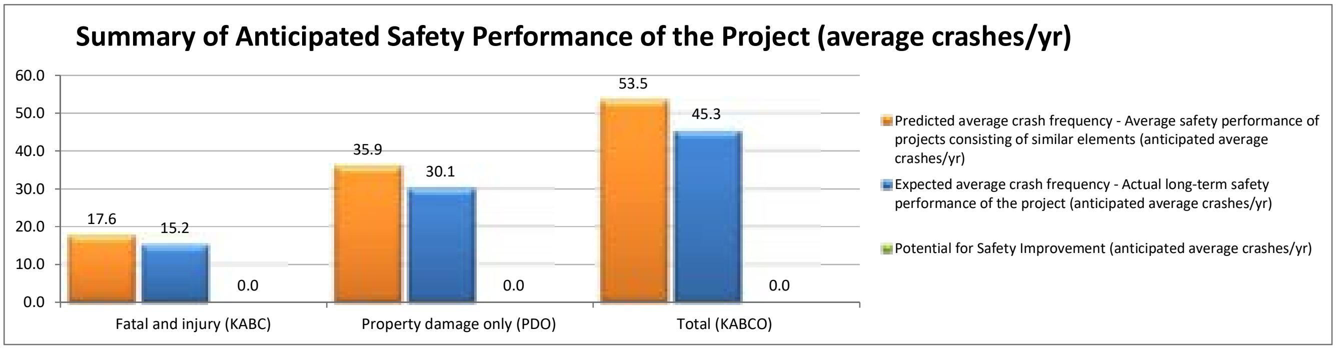
APPENDIX A-2

Highway Safety Manual Evaluations

PROJECT SAFETY PERFORMANCE SUMMARY REPORT

General Information	
Project Name	SR 28 Corridor Study
Project Description	Project Description
Reference Number	20200072
Analyst	Cody Wuestney
Agency/Company	Chelan Douglas Transportation Council (CDTC)
Contact Email	cody.wuestney@Perteet.com
Contact Phone	206.436.0515
Date Completed	05/12/11 — Years of crash data incorporated into the analysis: 5

PROJECT SUMMARY



Project Element	Total Crashes/yr (KABCO)			Fatal and Injury Crashes/yr (KABC)			Property Damage Only Crashes/yr (PDO)		
	Predicted average crash frequency $N_{predicted\ (KABCO)}$	Expected average crash frequency $N_{expected\ (KABCO)}$	Potential for Improvement	Predicted average crash frequency $N_{predicted\ (KABC)}$	Expected average crash frequency $N_{expected\ (KABC)}$	Potential for Improvement	Predicted average crash frequency $N_{predicted\ (O)}$	Expected average crash frequency $N_{expected\ (O)}$	Potential for Improvement
INDIVIDUAL SEGMENTS									
SR 28 Spur Segment 1 Grant - 3rd	1.5	2.3	0.8	0.5	0.7	0.2	1.1	1.6	0.5
SR 28 Segment 2 3rd - Battermann	24.4	15.8	0.0	6.7	4.3	0.0	17.7	11.4	0.0
Battermann Segment 3 SR 28 - Saunders	0.2	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
R.I.R. (East)/Saunders Segment 4 Batterman - SR 28	2.3	2.0	0.0	0.8	0.7	0.0	1.5	1.3	0.0
R.I.R (West) Segment 5 SR 28 - Grant	2.9	0.6	0.0	1.0	0.2	0.0	1.9	0.4	0.0
INDIVIDUAL INTERSECTIONS									
Intersection 1 28 Spur & Grant	2.3	10.1	7.8	0.8	3.7	2.8	1.5	6.5	5.0
Intersection 2 28 Spur & 3rd	1.3	3.2	2.0	0.4	1.0	0.6	0.9	2.2	1.3
Intersection 3 28 & Mary	1.0	1.1	0.1	0.4	0.4	0.0	0.6	0.7	0.1
Intersection 4 28 & Nile	1.0	1.3	0.4	0.4	0.5	0.1	0.6	0.8	0.2
Intersection 5 28 & Tyee	1.2	1.0	0.0	0.4	0.4	0.0	0.7	0.6	0.0
Intersection 6 28 & R.I.R. (West)	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Intersection 7 28 & R.I.R. (East)	0.6	0.5	0.0	0.2	0.2	0.0	0.4	0.3	0.0
Intersection 8 28 & Rock Is. Dr	0.7	0.8	0.1	0.3	0.3	0.0	0.4	0.5	0.1
Intersection 9 28 & Battermann	0.4	0.6	0.1	0.2	0.3	0.1	0.2	0.3	0.1
Intersection 10 Batterman & Saunders	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Intersection 11 Saunders & Garden	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Intersection 12 R.I.R. (West) & Nile	0.4	0.3	0.0	0.1	0.1	0.0	0.3	0.2	0.0
Intersection 13 R.I.R. (West) & 8th	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.1	0.0
Intersection 14 R.I.R. (West) & 3rd	0.8	0.4	0.0	0.3	0.2	0.0	0.5	0.2	0.0
Intersection 15 R.I.R. (West) & Grant	3.9	0.7	0.0	1.4	0.3	0.0	2.5	0.5	0.0
Intersection 16 28 & Lyle	0.8	0.5	0.0	0.4	0.2	0.0	0.5	0.3	0.0
Intersection 17 28 & Perry	1.8	0.7	0.0	0.7	0.3	0.0	1.1	0.4	0.0
Intersection 18 28 & Quincy/Akamai	2.1	0.8	0.0	0.8	0.3	0.0	1.3	0.5	0.0
Intersection 19 28 & Union	1.8	0.7	0.0	0.7	0.3	0.0	1.1	0.4	0.0
Intersection 20 28 & Nature Shore	0.4	0.6	0.1	0.2	0.3	0.1	0.2	0.3	0.1
Intersection 21 28 & Columbia Cove	0.4	0.3	0.0	0.2	0.1	0.0	0.2	0.1	0.0
Intersection 22 28 & Riverside	0.7	0.4	0.0	0.2	0.2	0.0	0.4	0.3	0.0
COMBINED (sum of column)	53.5	45.3	0.0	17.6	15.2	0.0	35.9	30.1	0.0

PROJECT SUMMARY -- Site-Specific EB Method Summary Results for Urban and Suburban Arterial Project

Crash severity level	$N_{predicted(PROJECT)}$ Predicted average crash frequency - Average safety performance of projects consisting of similar elements (anticipated average crashes/yr)	$N_{expected\ (PROJECT)}$ Expected average crash frequency - Actual long-term safety performance of the project (anticipated average crashes/yr)	$N_{potential\ for\ improvement\ (PROJECT)}$ Potential for Safety Improvement (anticipated average crashes/yr)
Fatal and injury (KABC)	17.6	15.2	N/A
Property damage only (PDO)	35.9	30.1	N/A
Total (KABCO)	53.5	45.3	N/A

HSM1 Extended Spreadsheet for Part C Chapter 12 v.9

Discussion of Results

Given the potential effects of project characteristics on safety performance, results indicate that:

1. It is anticipated that the project will, on average, experience 45.3 crashes per year (15.2 fatal and injury crashes per year; and 30.1 property damage only crashes per year).

2. A similar project is anticipated, on average, to experience 53.5 crashes per year (17.6 fatal and injury crashes per year; and 35.9 property damage only crashes per year).

#VALUE!

APPENDIX A-3

Level of Traffic Stress Evaluations

Road	From	To	Pedestrian Facility Type	Bike Lane Width	Veh. Lanes per Dir.	Speed Limit	BLTS	PLTS
SR 28	Battermann Rd	3rd Ave	No sidewalk	0	1	60	4	4
Battermann Rd	SR 28	Saunders Rd	No sidewalk	0	1	50	4	4
Saunders Rd	Battermann Rd	Delaware Ave	No sidewalk	0	1	35	4	4
Saunders Rd	Delaware Ave	Rock Island Drive (E)	Complete sidewalk on both sides	0	1	25	2	2
Rock Island Rd (E)	Saunders Rd	Center St	Complete sidewalk on one side	0	1	25	2	2
Rock Island Rd (E)	Center St	SR 28	No sidewalk	0	1	35	4	4
Rock Island Dr	Saunders Rd	SR 28	Complete sidewalk on both sides	0	1	25	2	2
Rock Island Rd (W)	SR 28	S Nile Ave	No sidewalk	0	1	35	4	4
Rock Island Rd (W)	S Nile Ave	3rd St SE	No sidewalk	0	1	30	3	3
S Nile Ave	SR 28	Rock Island Rd (W)	No sidewalk	0	1	30	3	3

Road	Cross Street	Speed Limit	Total Lanes Crossed	BLTS	PLTS
SR 28	3rd St SE	40	3	4	4
SR 28	Mary Ave	60	2	4	4
SR 28	S Nile Ave	60	2	4	4
SR 28	Perry Ave S	60	2	4	4
SR 28	Quincy Ave S	60	2	4	4
SR 28	S Union Ave	60	2	4	4
SR 28	Rock Island Rd (W	60	2	4	4
SR 28	Rock Island Rd (E)	60	2	4	4
SR 28	Riverside Pl	60	2	4	4
SR 28	Rock Island Dr	60	4	4	4
SR 28	Battermann Rd	60	2	4	4
Battermann Rd	Saunders Ave	50	3	4	4
Saunders Ave	N Garden Ave	25	2	2	2
Rock Island Dr	Saunders Ave	25	2	2	2
Rock Island Rd (E)	Douglas St	25	2	2	2
Rock Island Rd (E)	Center St	25	2	2	2
Rock Island Rd (E)	S Ohio St	35	2	3	3
Rock Island Rd (E)	Riverside Dr	35	2	3	3
Rock Island Dr	S Garden Ave	25	2	2	2
Rock Island Rd (W)	S Union Ave	35	2	3	3
Rock Island Rd (W)	Quincy Ave S	35	2	3	3
Rock Island Rd (W)	Perry Ave S	35	2	3	3
Rock Island Rd (W)	S Nile Ave	35	2	3	3
Rock Island Rd (W)	S Mary Ave	30	2	2	2
Rock Island Rd (W)	S Kentucky Ave	30	2	2	2
Rock Island Rd (W)	8th St SE	30	2	2	2
Rock Island Rd (W)	S Iowa Ave	30	2	2	2
Rock Island Rd (W)	3rd St SE	30	4	3	3