

# **Cascade Lakes Highway Corridor and Bicycle Facilities Study**



*November 2019*

Prepared By Western Federal Lands Highway Division  
for Deschutes County and Deschutes National Forest

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## A. Introduction

### 1. Background

The Cascade Lakes Highway is located in Central Oregon, southwest of Bend (Figure 1: Map of Study Area). The highway is within the Deschutes National Forest and provides access to many recreation sites in the Forest. The highway's underlying ownership is USFS, but is maintained by Deschutes County.

Deschutes County has become a major tourist and recreation destination. Cyclotourism has become popular and there is also a significant and robust local cycling community. An analysis of the facility relating to safety and bicycle use has never been performed.

Deschutes County and the Forest Service applied for Federal Lands Access Program (FLAP) funding in 2016 for a planning study. The scope of the planning project is to study the corridor and identify opportunities for safety improvements. The project was selected for FLAP funding and started in 2018.

### 2. Study Area

The study area consists of the Cascade Lakes Highway (CLH) from where the County takes over maintenance (MP 21.90) to the Klamath County line (MP 60.87). The entirety of the study area is on public land. CLH (also known as Highway 372 and as a portion of Century Drive) accesses over 440,000 acres of federal land, including the Three Sisters Wilderness area. In the project area, CLH provides access to:

- Rustic resorts - Elk Lake Resort, Cultus Lake Resort, Lava Lake Resort, South Twin Resort and Crane Prairie Resort;
- Campgrounds – established campgrounds, both traditional and horse camps, and dispersed campsites;
- Trailheads – many popular hikes are in the area, including the South Sister climb, Green Lakes basin, Todd Lake area, Broken Top, and access to the Pacific Crest Trail;
- Day use sites used for boating, fishing, and horseback riding;
- Forest Cabins – at Elk Lake there are 31 cabins that are privately owned and are on leased FS land.

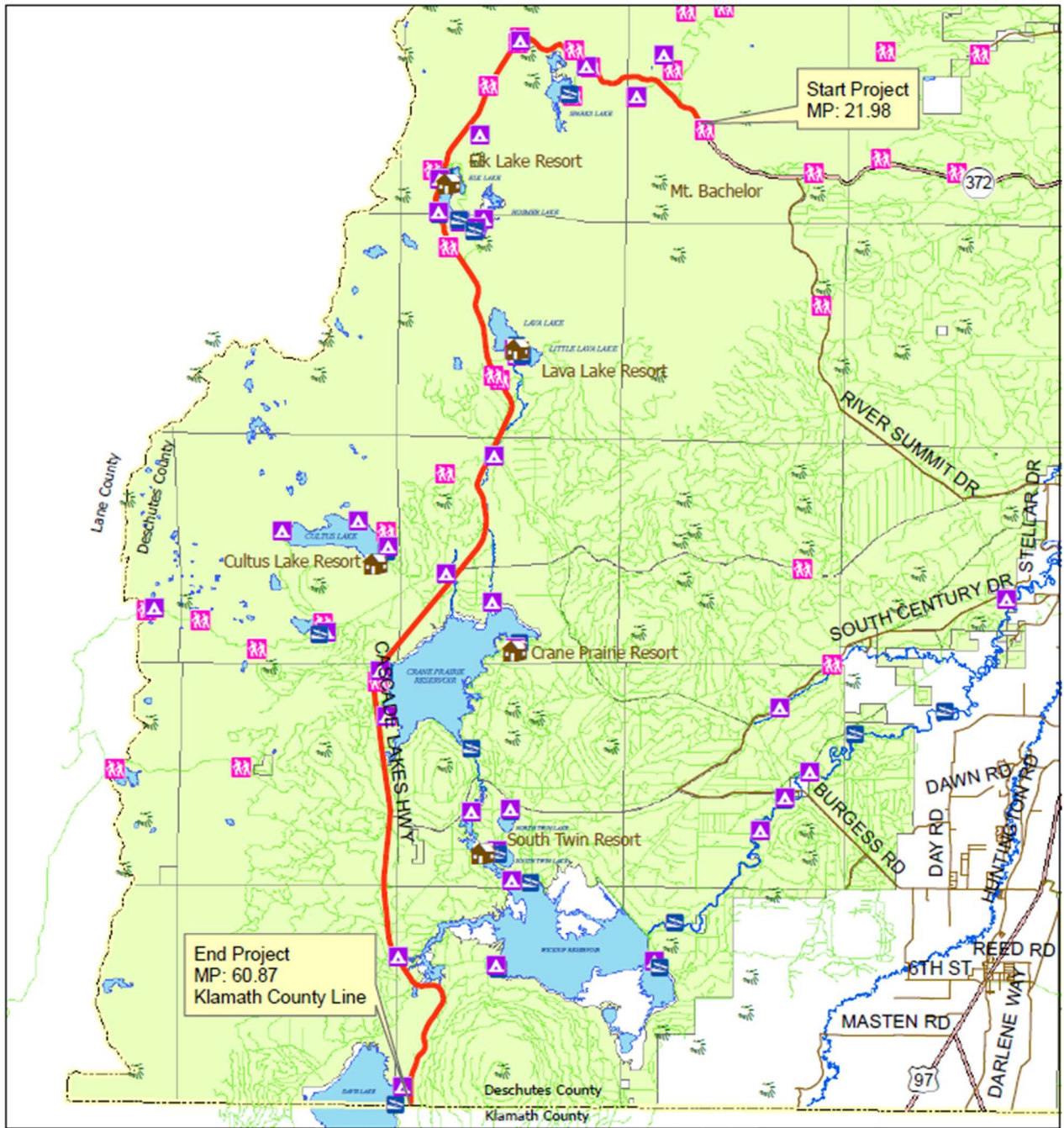
### 3. Format

The planning study consists of a planning document and a Road Safety Audit (RSA - attached as Appendix A). The RSA is an in-depth examination of the corridor and contains:

- Description of existing conditions
- A suite of possible corridor improvements
- FHWA's recommendations

This planning document summarizes the RSA and describes information not found in the RSA, such as:

- Project problem statement, goals, strategies, and actions
- Past, current and planned projects
- Existing planning documents relevant to the corridor
- Public involvement




**Legend**

- |                             |                                  |
|-----------------------------|----------------------------------|
| Bicycle Facilities          | County Routes                    |
| <b>Features of Interest</b> | USFS Roads                       |
| BOAT LAUNCH                 | County Line                      |
| CAMPGROUND                  | River                            |
| RESORT                      | Lake                             |
| TRAILHEAD                   | USFS - Deschutes National Forest |
| MOUNTAIN PEAK               |                                  |

0 3 6 9 12 Miles



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The information on this map was derived from digital databases on Deschutes County's GIS. Care was taken in the creation of this map. Deschutes County cannot accept any responsibility for errors, omissions, or positional accuracy and, therefore, there are no warranties which accompany this product. However, notification of any errors will be appreciated.

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Figure 1: Map of Study Area

## B. Problem statement, Goals and Strategies

### 1. Problem Statement

Through discussion with project partners, research on existing conditions, conversations with corridor users, and information from the FLAP application, the following problems were identified:

- Congestion, especially in the northern section of the corridor
- Parking on side of roadway which can cause safety issues
- Sight distance is compromised in some locations, due to grades, curves, and vegetation
- Speeding, especially in straightaways
- Unclear signage or lack of advanced signage
- Enforcement of speeding and parking violations is limited
- For some users, low awareness of cyclists and pedestrians

### 2. Goals and Strategies

This planning project has two main goals and provides strategies to meet these goals:

Goal 1: Improve safety for all users of the corridor

#### *Strategies*

- a. Alleviate congestion in northern part of corridor
- b. Remove or limit parking from side of road
- c. Improve sight distance
- d. Improve signage
- e. Provide geometrical or cross-sectional improvements
- f. Provide education to promote understanding of “rules of the road”
- g. Increase enforcement of existing or proposed laws

Goal 2: Provide a positive visitor experience

#### *Strategies*

- a. Provide safer and more convenient access to public lands by improving parking efficiency and providing alternate transportation options.
- b. Document how changes to the transportation network may affect public lands and consider when making funding decisions.

## C. Relevant Projects, Plans, and Design Manuals

### 1. Past, Current and Future Projects

When studying a corridor, it is important to know past, current or planned projects that impact or could impact the existing conditions. The Central Cascades Wilderness Strategies Project (CCWSP) currently in process by USFS has the potential for substantial changes to existing uses on the CLH. The CCWSP, as currently proposed, would put quotas on wilderness permits within the corridor, potentially addressing some of the most crowded parking areas. The CCWSP is described in more detail in this section.

Past projects in the corridor include:

- Replacement of the Fall Creek, Goose Creek (MP 26.3) and Soda Creek (MP 25.1) crossings with bridges. Federal Highway (FLAP) aquatic organism passage projects.
- Overlay and chip seal projects for portions of the corridor. Some of these projects were partially funded by FLAP.

Current and Future projects:

- FLAP is providing 75% funding for a chip seal project from Elk Lake to the Klamath County line to be completed in 2019.
- The County has applied for 50% FLAP funding for a chip seal from Mt. Bachelor to Elk Lake to be completed in 2020 or 2021.
- Bend to Mt. Bachelor (and Devil's Lake) summer transit
  - A pilot program for 2022 and 2023 has been proposed for summer transit between Bend and Devils Lake. The proposal is for a route that runs from Bend to Mt. Bachelor and a connecting route between Mt. Bachelor and Devils Lake with stops in the corridor at Todd Creek, Sparks Lake, Green Lakes and Devils Lake trailheads.
- FS Devil's Lake/South Sister Trail Reroute
  - Would reroute the beginning of the South Sister Climber's Route (#36) to utilize the existing underpass under Cascade Lakes Highway (see Figure 2). The project would provide an option to hike the trail without crossing the Cascade Lakes Highway at grade and would improve hiker safety.



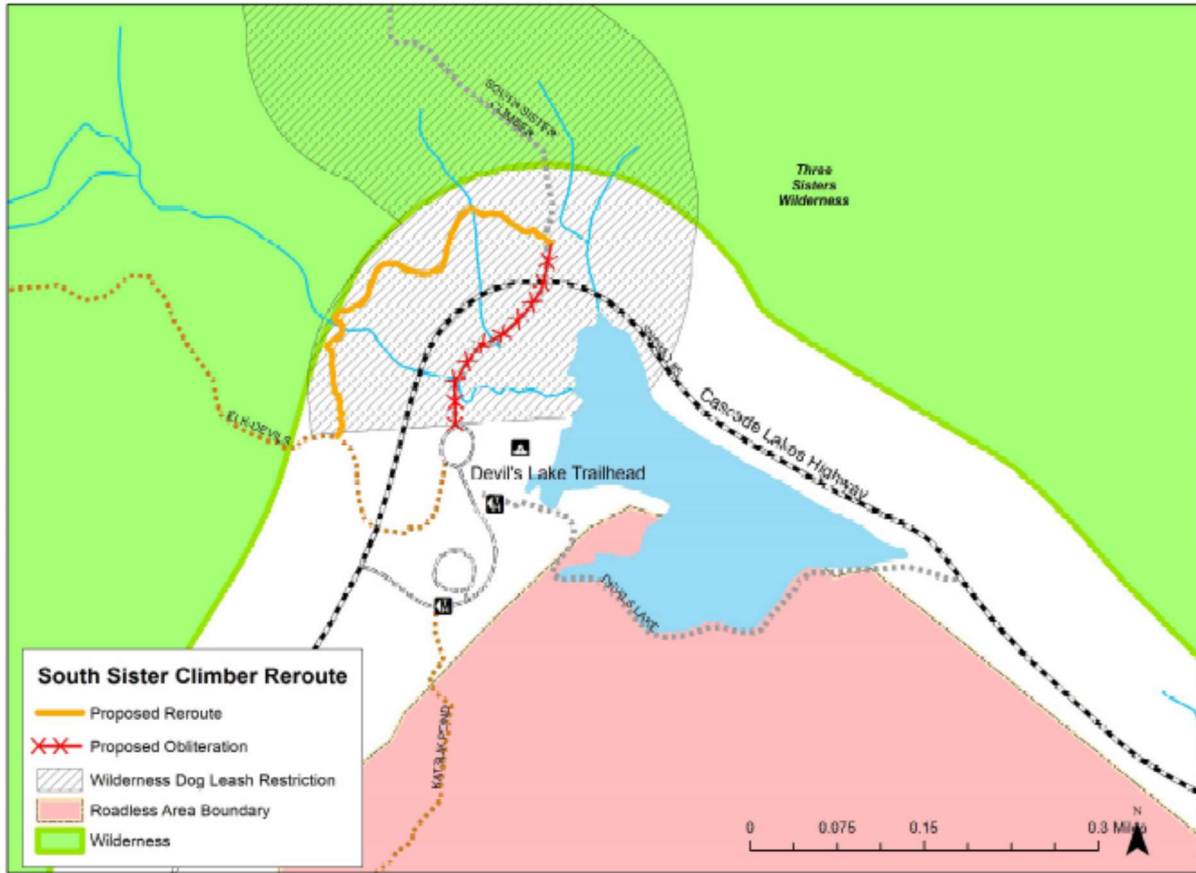


Figure 2: Devil's Lake/South Sister Trail Re-route Map

- FS Central Cascades Wilderness Strategies Project
  - In May 2019, FS issued a Final Decision Notice selecting a Wilderness Strategy that limits use of wilderness areas, starting in 2020, that are accessed by trailheads in the CLH corridor.
  - The limited entry to wilderness areas would likely change usage of the corridor, especially of high-use trailhead parking lots on the north end of the project area.
  - Quotas would be implemented for high-use trailheads, which would limit the number of overnight and day users at the following trailheads within the corridor:

	<b>Wilderness Area Trailhead</b>	<b>Overnight Group Quota</b>	<b>Day Use Individual Quota</b>
North ----- South	Todd Lake	3	12
	Broken Top	4	40
	Crater Ditch		16
	Tam McArthur Rim	5	80
	Green Lakes/Soda Creek	14	80
	Devils Lake (South Sister/Wickiup)	16	100
	Sisters Mirror	4	16
	Quinn Meadow	3	None
	Elk Lake	4	None
	Six Lakes	8	None
	Lucky Lake	5	None
	Corral Swamp	3	None
	Winopee/Corral Lake		None
	Deer Lake	3	None
Many Lakes	None		

- If the Wilderness Strategy moves forward as planned, it could reduce parking demand to below parking supply at the currently most crowded parking lots that overflow onto CLH (Green Lakes/Soda Creek and Devils Lake). While it is likely that parking along the road on CLH will be greatly reduced after the Wilderness Strategy takes effect, it may continue to a lesser degree (primarily at Devils Lake) due to user’s previous experience, or desire to park close to the start of the trail.
- The FS Environmental Assessment (EA) addressed the likelihood of displacement (people going to other trailheads if they cannot get a permit for a specific trail) due to the quota system. The selected strategy (Modified Alternative 4) would place overnight and day use quotas on most trailheads within the CLH corridor, so would only have minimal potential for displacement on the CLH within the study area of this planning document. The eight trailheads in the table above which do not have day use quotas have a “low” or “moderate” likelihood of receiving displacement, according to the EA. Even if the eight trailheads receive considerable increase in parking, they are not likely to cause overflow parking onto CLH (because of how far off the roadway they are located). However, decrease in usage of popular trailheads in the northern section of the corridor and increased usage of other trailheads may cause a shift in traffic within the corridor.

- For more information on the Central Cascades Wilderness Strategies Project, see the FS website: <http://www.fs.usda.gov/project/?project=50578>.
- The FS Final EA is located here: [https://www.fs.usda.gov/nfs/11558/www/nepa/105465\\_FSPLT3\\_4483294.pdf](https://www.fs.usda.gov/nfs/11558/www/nepa/105465_FSPLT3_4483294.pdf)
- The FS Final Decision Notice is located here: [https://www.fs.usda.gov/nfs/11558/www/nepa/105465\\_FSPLT3\\_4647968.pdf](https://www.fs.usda.gov/nfs/11558/www/nepa/105465_FSPLT3_4647968.pdf)

## 2. Existing Plans and Regulations

There are plans and regulations in and around the project area that are relevant to this study. A summary of the plans and regulations are below:

- Deschutes County Transportation System Plan (2010-2030)

According to the Deschutes County website (<https://www.deschutes.org/cd/page/transportation-planning>):

*The State of Oregon requires cities and counties to have 20-year plans for their major roads as well as other ways to travel such as air, bike, bus, and railroad. The County’s Transportation System Plan identifies roadway segments and intersections that will need to be improved by 2030 based on future traffic volumes and current land use zoning. The project list of the TSP prioritizes projects as high (needed within 0-5 years,) medium (6-10 years), or low (11-20 years). Deschutes County Road Department uses the TSP to determine its capital improvement program (CIP), and system development charges (SDC)...Input from the public, population forecast, other local governments, and the Oregon Department of Transportation (ODOT) guided the development of the TSP’s goals and policies as well as its project list.*

The TSP describes the goals and policies to coordinate and implement the WSP. Goal 15 is the County’s Bikeway and Pedestrian Plan, including the following relevant policies:

15.3 Deschutes County shall:

*f. Upgrade rural road shoulder widths to County standards during road modernization or maintenance projects involving overlays as funding allows, provided no additional purchase of right-of-way is required or substantial cut and fill or grading is needed*

...

*i. Emphasize the designation of on-road bikeways, where conditions warrant due to safety reasons and the cost of construction and maintenance of separate bike paths;*

The TSP outlines minimum bikeway design standards from the Deschutes County Code and states that a shoulder bikeway standard is 4 feet:

**Table 2.2.T15  
Selected Minimum Bikeway Design Standards**

Type	Stripe	On/ Off Road	Width			Vertical Clearance	Horizontal Clearance (ea. side)	Grade		ROW
			Min	Std	High Use			Min	Std	
Multiuse Path		Off	8'	10'	12'	8'	2'	5%	>5% up to 500'	15'
Mtn. Bike Trail		Off	n/a	2'	n/a	7'	n/a	n/a	n/a	n/a
Bike Lane	8" with painted stencil	On	4' w/open shoulder	6'					Use on URBAN arterial or major collector, or RURAL roads near urban areas with high anticipated bike use	
		5' w/curb or parking								
Shoulder Bikeway	4"	On	4'	4' w/ open shoulder	6'				Recommended on higher speed and traffic volume rural roads	
			5' w/ curb or other barrier							
Shared Road- way		On							Recommended only on local roads with speeds of 25 mph or less and <3,000 ADT	

Source: DCC 17.48.050, Table B

Cascade Lakes Highway is not listed in the “Future State Highway Projects and Policies” section, nor is it listed in Table 5.3.T1 under current “County Road and Highway Projects.”

The full Transportation System Plan can be found here:

<https://weblink.deschutes.org/public/Browse.aspx?dbid=0&startid=6052&row=1&cr=1>

- National Scenic Byway, National Forest Scenic Byway, Oregon State Scenic Byway

The *Cascade Lakes National Scenic Byway Corridor Management and Interpretive Plan* (2011) sets goals, objectives, strategies and actions that give overall direction for managing the byway. The plan also outlines design guidelines for the current and future interpretive sites. Improvements to the corridor will need to comply with the Scenic Byway Plan.

The full Plan can be found here:

[https://www.fs.usda.gov/Internet/FSE\\_DOCUMENTS/stelprdb5347314.pdf](https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5347314.pdf)

The National Forest Scenic Byways program is similar to National Scenic Byways program. The goals for the National Forest Scenic Byways program are:

- Showcase outstanding National Forest and Grassland scenery
- Increase public understanding of National Forests as a major provider of outdoor recreation
- Increase public awareness and understanding of all National Forest System activities
- Meet the growing demand of driving for pleasure as a significant recreation use
- Increase use of National Forests by nontraditional users, including minorities and the elderly
- Contribute to the nation's overall scenic byways effort
- Support and enhance rural community tourism economic development

More information can be found here:

<https://www.fs.fed.us/recreation/programs/tourism/TourUS.pdf>

### 3. Design criteria

FHWA used the following design guidance documents when developing this plan. Key pieces of information are summarized below (design criteria are described in more detail in the RSA - attachment A).

1. AASHTO. *A Policy on Geometric Design of Highways and Streets* (Green Book)

WFLHD is using a design speed of 60 mph for the CLH. Based on a 60 mph design speed, the Green Book recommends a minimum traveled way width of 24-ft plus 4- to 8-ft shoulders.

2. ODOT *Design Manuals and Bicycle and Pedestrian Plan*

The Plan outlines a framework for funding priorities in Oregon (1<sup>st</sup>: protect the existing system and address significant safety issues; 2<sup>nd</sup>: add critical connections and address other safety issues; 3<sup>rd</sup>: complete the system; 4<sup>th</sup>: elaborate the system). The Plan presents a methodology for measuring Bicycle and Pedestrian Level of Traffic Stress (LTS) based on traffic volume, speed, and paved shoulder width. LTS 1 is low stress, LTS 4 is highest stress.

Segment	Current LTS*	LTS with 4-6 foot shoulders*
Project start to Elk Lake	4	2
Elk Lake to S. Century Dr.	2-3	2
S. Century Dr. to Project end	2	2

\*Estimates based on known project information

ODOT Bicycle and Pedestrian Design Guide gives design standards for Oregon highways. Based on the traffic volume and physical conditions of the site, shoulder widths from 5 to 8 feet are recommended. According to the Guide, if there are physical width limitations a 4-foot should may be used. The ODOT Highway Design Manual gives the same design standard width for shoulders, though stating a minimum of 5-foot shoulders.

3. AASHTO *Roadside Design Guide* (RDG)

The RDG gives guidelines for clear zones, described as “unobstructed, traversable area provided beyond the edge of the through traveled way for the recovery of errant vehicles. The clear zone includes shoulders, bike lanes, and auxiliary lanes...” The RDG recommendation is 24 to 40-feet of clear zone,

varying depending on average daily traffic (ADT) volumes, foreslopes (the slope from edge of shoulder to bottom of ditch or bottom of roadway fill), and design speed.

The existing clear zone on CLH varies, including some areas where it is effectively zero feet due to cars parking along the roadway for long stretches.

#### 4. *AASHTO Guide to Bicycle Facilities, 4<sup>th</sup> Edition*

The Guide outlines the reasons for producing bicycle plans and suggests that communities may consider phasing bicycle improvements. Deschutes County may consider phasing improvements on the CLH, and this planning project outlines a phasing plan in Section G.

The Guide calls for a minimum shoulder bikeway width of 4' with a 4' standard for an open shoulder, 5' with curb or other barrier present and 6' wide for "high use" locations. Under current usage, CLH is not likely a "high use" location.

The RSA also describes other considerations when proposing bicycle improvements, such as:

- Facility types – examples are shared lanes (where bicyclists and autos use the same lanes), paved shoulders, shared use paths (paths separated from the roadway used by bicyclists and pedestrians)
- Wayfinding – specific wayfinding for cyclists is likely not necessary on the CLH
- Data – data can be used to guide improvement decisions, but no bicycle data on CLH is available and vehicle traffic data is outdated
- Bicycle operation and safety – it is believed that the typical bike used for designing improvements on the CLH is a road bike, with some mountain bikes. Also, the types of bicycle crashes and the causes can help with design. No bicycle crashes have been reported in the corridor, but conditions exist that could lead to bicycle crashes.

Based on usage, existing geometric and traffic conditions, and environmental considerations, paved shoulders and shared lanes are possible improvements options. Shared use paths have are likely excluded from further consideration for the following reasons:

- Environmental impacts of building a path next to the roadway are substantial
- Many areas within the corridor have limited clearance on either side of the road, so adding a separated path would have engineering challenges and would likely be costly
- Maintenance of the path would be more difficult, since it is separated from the roadway
- Grades would be challenging if the path were to meet ADA requirements
- Constructing a path on one side of the road could lead to increases in crossings of CLH

#### 5. FHWA. *Manual on Uniform Traffic Control Devices (MUTCD)*. Federal Highway Administration.

The MUTCD defines standards for traffic control devices on roadways. It is referenced in the RSA when making recommendations for signage and striping.

## D. Public Involvement

FHWA developed a Public Involvement Plan (PIP) in October 2018. The PIP identifies key stakeholders, outlines stakeholder involvement activities, methods to gather and address stakeholder input, lists effectiveness metrics, and documents the implementation of the plan.

FHWA representatives visited the site in September 2018. They met with FS and County partners in office meetings and on the corridor and obtained information about the background of the project, current and future issues, and goals of the FS and County.

FHWA also met with representatives of the Deschutes County Bicycle and Pedestrian Advisory Committee (BPAC) and the Elk Lake Forest Homeowners Association. Most of the concerns focused on at the north end of the corridor, generally between Elk Lake Resort and the Mt. Bachelor, with the concentration on roadway congestion areas between Devils Lake trailhead and Todd Lake trailhead.

Project partners held a public meeting on April 29, 2019 and public comment period in April-May 2019 after releasing the draft version of this plan document. The meeting was advertised in the *Bend Bulletin*, on the FHWA website, by Deschutes County and FS, and through an email blast to the contacts list. The meeting was held at the Deschutes County Road Department conference room. The meeting was held in open house style, and meeting materials were an information sheet, comment form, and display boards. Six people attended and two written comments were received. Meeting materials and comments are included in Appendix H.

## E. Existing Conditions

The RSA describes the existing conditions in the corridor, pulling information from the FLAP application, traffic and crash data, and September 2018 FHWA site visit.

### 1. Overall Corridor

#### *Overall Usage*

According to FS and Deschutes County information and backed up by traffic and wilderness usage data, there has been a substantial increase in usage in the corridor, especially in the last 5-10 years. For example, Forest Service data indicates that the total wilderness area visitors by year (permit data) at the Three Sisters Wilderness (near the north end of the study area) increased from 46,999 in 2011 to 132,118 in 2016.

Due to high usage, users often park vehicles on the edge of CLH in the northern part of the corridor near Green Lakes and Devils Lake parking lots. As noted above, the implementation of parking quotas by the Wilderness Strategy will likely decrease parking on the side of the road, but may not eliminate it.

#### *Bicycle Usage*

According to information from Deschutes County, FS, the Deschutes County Bicycle and Pedestrian Advisory Committee, and a representative from the Elk Lake Cabin Homeowners association, the greatest bike usage and potential for conflict is in the northern part of the corridor. Minimal shoulders for riding, shoulder parking on the CLH, pedestrians crossing the CLH, steep grades, and tight curves are all concerns for cyclists in the corridor.

Prior to this study, no count of bicycle usage had been completed in the corridor.

#### *Transit*

There is not currently any public transit in the corridor. A pilot program has been funded through the FLAP would run shuttle buses in the summers of 2022-2023 from Bend to Mt. Bachelor and to Devils Lake.

#### *Traffic Data*

Deschutes County, in partnership with the City of Bend obtained counts for several locations along CLH during the summer of 2019. The ADT for vehicles ranged from 775 ADT South of S. Century Drive to 2282 ADT East of the Green Lakes intersection. The ADT for bicycles ranged from 3 ADT at North of S. Century Drive to 9 ADT South of Elk Lake Resort intersection. *RSA Appendix G – 2019 Traffic Data* contains the complete dataset.

#### *Geometric Conditions*

The RSA describes the geometry of the corridor in eight sections, shown in Figure 3. Below is a brief summary of each section:

1. Section 1 (MP 21.98 to 23.68): Horizontal alignment is on tangent or mild to moderate curvature with level to rolling vertical terrain. Paved shoulder widths are approximately 1-2'.
2. Section 2 (MP 23.68 to 25.98): Horizontal alignment has several curves with moderate curvature and back to back reverse curves. Vertically, some of the grades are 7-9%, the steepest in the



study, likely in the mountainous terrain category. There are several areas of limited horizontal sight distance due to trees and/or cut slopes. Paved shoulder widths are approximately 1-2'.

3. Section 3 (MP 25.98 to MP 26.68): Horizontal alignment is nearly tangent and the vertical grade is nearly level. Paved shoulder widths are approximately 1-2', aside from the area near a recent bridge replacement. There is an area of substantial parking along the roadway when the Green Lakes Day Use Area parking lot fills up. The mild to flat gravel foreslope makes it easier for vehicles to park along the roadside.
4. Section 4 (MP 26.68 to 28.48): Nearly all the section is curvilinear and contains the sharpest horizontal curves in the study and has moderate to steep vertical grades. Some areas of limited sight distance. Paved shoulders are approximately 1-2' in most locations, though there is substantial parking near the trailhead access points.
5. Section 5 (MP 28.48 to 32.28): Mild horizontal curvature and mild vertical grades. Paved shoulders are approximately 1-2'.
6. Section 6 (MP 32.28 to 34.18): Mild to moderate curvilinear horizontal alignment with a generally rolling vertical terrain. Some areas of limited horizontal sight distance. Paved shoulders are approximately 1-2' width.
7. Section 7 (MP 34.18 to 51.98 - Intersection with S. Century Dr.): Some long tangent and nearly tangent sections (up to nearly 4.5 miles) with some areas of mild to moderate horizontal curvature. Some locations of limited horizontal sight distance. Vertical grades are level to rolling. Paved shoulders are 1-2'. Contains access to several lakes, including Lava Lake, Little Lava Lake, Cultus Lake and the Crane Prairie Reservoir.
8. Section 8 (MP 51.98 – S. Century Dr. to MP 60.87 – Klamath County Line): Mostly long tangents or gentle horizontal curves with a moderate curvilinear section near the south end as the alignment traverses around an old lava flow. Paved shoulders are approximately 4' in width for most of the section.

# 2016 Cascade Lakes Bicycle Facilities Study

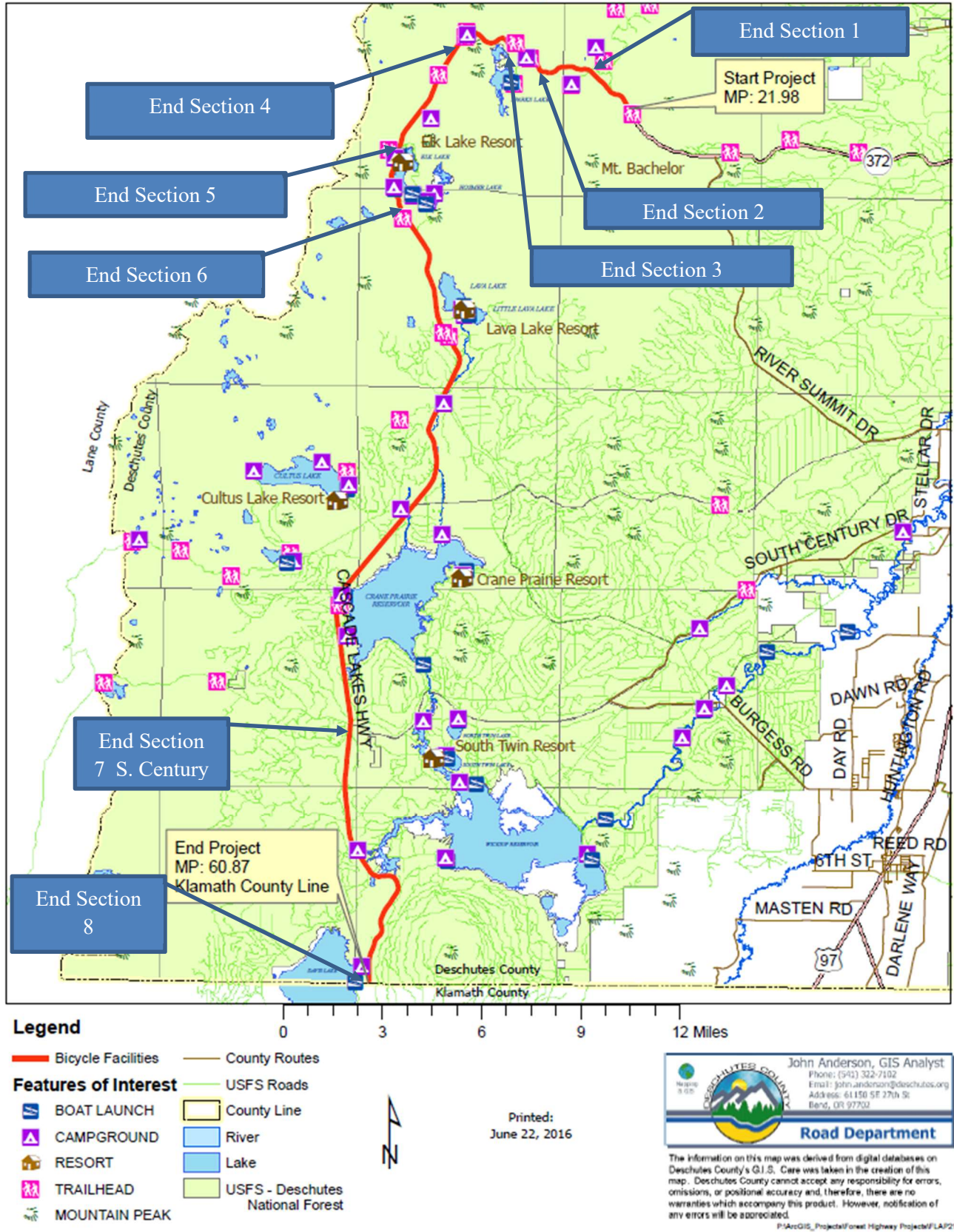


Figure 3: Sections in the Study Area

### *Route Continuity*

When studying a route, the concept of route continuity (consideration of geometric elements of adjacent routes) will help gauge the range of possible improvements to a given corridor. The three adjacent routes to this study area are:

- *To the northeast – Continuation of CLH toward Bend (ODOT Highway 372).* This portion has approximately 12' lanes with 6' shoulders. The posted speed limit is 55mph, there are locations of four-lane sections (for passing) and there are centerline rumble strips. According to ODOT, the AADT was 1,400 vpd as of 12/14/2017 (GIS processing date, ODOT TransGIS). To the west of the turnoff for the Mt Bachelor Resort, the ODOT data indicates the AADT is 1,000 vpd showing that the Resort is a significant traffic destination. The alignment is generally smooth with some sharper horizontal curves and moderate grades, though not as sharp as some of the horizontal curves in the CLH area of study. It appears that a moderate to substantial clear zone is provided. There are some locations of guardrail, presumably where clear zone slopes are not met.
- *To the south – Continuation of CLH in Klamath County (County Route 1352 and 1351).* This portion of CLH has approximately 11' lanes and 4' shoulders. Alignment is similar to Section 8 of the CLH.
- *Intersecting with CLH – South Century Drive.* For the portion under Forest Service maintenance, from CLH to approximately Burgess Rd., the traveled way width and paved shoulder width are similar to the CLH corridor north of S. Century Drive. There is vegetation encroachment leading to horizontal sight distance concerns. The centerline striping is very faint and there is virtually no edge line striping. For the portion under County maintenance the road has 4' paved shoulders, good striping conditions and better vegetation clearing, similar to Section 8 of the CLH.

### *Signing*

The corridor has advanced curve warning signs for substandard horizontal curves. Pedestrian warning signing and general congestion signing are present at the Devils Lake area. No intersection warning signs were observed during the field review at minor or major intersections throughout the corridor.

Numerous guide signs were found to be in poor condition, lacked visibility (sometimes due to vegetation or placement), appeared to be too small for visibility at high speeds and lacked advanced notice prior to the decision point. No regulatory speed or speed limit signs were observed in the corridor.

### *Striping*

Deschutes County stripes 11' lanes throughout CLH with a 4" width as their standard. The County has been especially cognizant of passing zones near locations of driveways and approach roads in general on county roads.

### *Speeds*

Oregon's basic rule law applies to CLH. A conversation with a Forest Service LEO indicates that speeds can often reach 70+mph on portions of CLH. The LEO has witnessed people driving over 100 mph on CLH near the road that leads to Cultus Lake. He believes the average speed for tangent segments is likely 65 mph or more.

### *Maintenance*

Deschutes County uses chip seals to help preserve the pavement throughout the CLH corridor. The County considers cyclist use on the shoulders and uses a smaller gradation of aggregate for chip seals on the shoulder portion.

Snow plow operations occasionally damage signs throughout the corridor. The County strives to get these repaired or replaced in the spring following any damage.

At the time of the field visit (September 2018), the County stated that a vegetation clearing operation was to occur that week within the corridor.

## 2. Site Specific Locations

### Todd Lake Day Use Area

The Todd Lake Day Use Area is a popular destination that has seen an increase in usage in recent times. The parking lot for accessing Todd Lake is small (18-25 spots on an unpaved surface) and gets filled up, leading to parking along the access road (NF-370) which has caused severe congestion on NF-370 at times. According to the FS, during the weekend of September 8-9, 2018, 123 vehicles attempting to access the Crater Ditch and Broken Top Trailhead (farther along on NF-370) were turned away at the Todd Lake Trailhead. Vehicles do not park along CLH to access the Todd Lake and Broken Top Trailheads but these popular sites add to the general congestion in the CLH corridor. According to the Forest Service, the resources along the trails cannot handle any increase in use.

At the intersection with the Todd Lake Day Use Area and the equestrian-use area on the opposite side of the highway, there is a sight-distance concern for vehicles making the turn out of the equestrian side (southwest quadrant). Vehicles pulling horse trailers have longer functional lengths and slower accelerations which can compound the intersection sight distance concern. The horizontal alignment curves away from the intersection and existing vegetation blocks sight distance (Figure 4).



*Figure 4 - Todd Lake Intersection, Southwest Quadrant, Looking Northwest*



*Figure 5 - Todd Lake Intersection, Southwest Quadrant, Looking Southeast*

Existing vegetation blocks sight distance looking southwest, too, as shown in Figure 5.

Warning signs for equestrian use are shown in Google Earth to the east and west of this intersection, indicating that a regular crossing may occur in between the two signs. There are no known issues with crossings in this area. CLH is on a tangent through here with apparent adequate stopping sight distance.

### **Green Lakes Trailhead**

As mentioned in Past, Current and Future Projects, the conditions described at, Green Lakes, Devils Lake and the rest of the CLH corridor are based on current usage. The proposed Wilderness Strategies may significantly affect the described issues throughout and are discussed in more detail in *Section C Relevant Projects, Plans, and Design Manuals*.

The parking lot for this trailhead fills up during peak and some non-peak times. When full, visitors park along CLH for up to a ½ mile each way, according to the Forest Service. The parking lot has 46 single parking spots and six RV/trailer spaces. During the team’s visit on Monday, September 17, 2018 the parking lot was nearing capacity at an off-peak period and the RV spaces were being used by regular vehicles (Figure 6). Forest Service may issue citations for this type of parking that is in violation of the posted signs.



*Figure 6 - Green Lakes Parking Lot - RV/Trailer Spaces Used by Non-RV/Trailer Vehicles*

According to the Forest Service, on Saturday, September 8, 2018 the parking lot was full by 8:00am. At 3:00pm that day, approximately 103 cars were parked in the parking lot and 167 were parked along CLH. On Sunday, September 9, 2018 the parking lot was full by 8:30am. In the afternoon, 110 cars were parked in the parking lot and 116 were along CLH (see example in Figure 7). It is believed that there is consistent high usage on the weekends during the summer (and even fall) months, but high weekday usage is becoming more common as well.



*Figure 7 – Cars parked on roadway near Green Lakes Trailhead*



## Devils Lake Trailhead

This parking lot and trailhead area is a launch point for the South Sister hike and other trails. Recreation also occurs in and near Devils Lake, with a unofficial boat launch point within the gravel turnout on the inside of the horizontal curve along CLH.

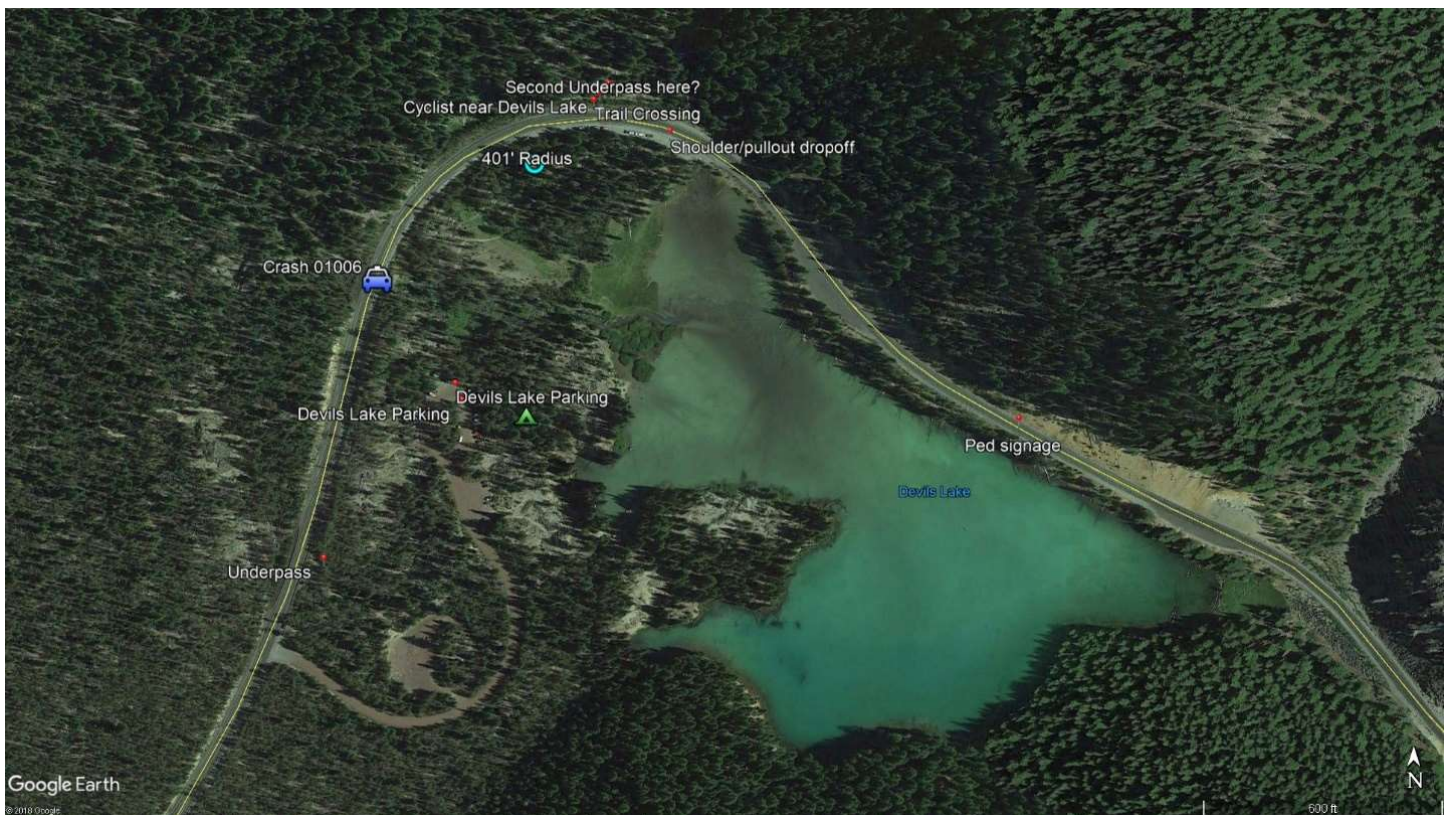


Figure 8 – Devils Lake Trailhead overview

Considerable parking demand occurs at this site, and during peak times parking along CLH can extend for up to a mile (Figure 9). According to the Forest Service, on Saturday, September 8, 2018, the parking lot was full by 8:00am. At 3:15pm, 96 vehicles were parked on the CLH and 199 in the parking lot. On Sunday, September 9, 2018, the parking lot was full by 8:30am. In the afternoon, 101 cars were parked along CLH, and 194 parked in the parking lot. The existing parking lot is unpaved and there are no stall lines.



*Figure 9 – Parking along CLH near Devils Lake trailhead, peak time, looking west*

The team observed a major pedestrian crossing near the apex of the horizontal curve (Figure 10). There is not a distinct pattern of pedestrian movement as parking occurs along the roadway here so crossings may happen anywhere along the horizontal curve. During their site visit in an off-peak time, the team observed approximately 10 pedestrians crossing CLH in this area over approximately an hour.



*Figure 10 – Pedestrian crossing near apex of curve, Devils Lake, non-peak period, looking east*

The sharp horizontal curve, relative to the rest of the CLH corridor, significantly limits sight distance through this area. This increases the safety hazard for the pullout on the inside of the curve. There is a large potential for conflict between pedestrians and motorists as well as bicyclists.

There is an existing underpass with some hiker, equestrian and snowmobile use to the southwest of the “main” crossing location on the apex of the horizontal curve. The Forest Service indicated that the beginning of the South Sister trail is in the process of being used so that it uses the existing underpass.

There are existing pedestrian warning signs, with supplemental 350’ plaques, as one approaches from either direction to this area as well as a congestion sign.

Of the available crash data, Crash 1006 occurred near the end of the 400’ radius curve on the south/west end. This was a single-vehicle, injury B crash with an animal, believed to be traveling from north to south. It is possible the horizontal curve contributed to a lack of visibility of the animal.

## Additional Site Specific Issues

The following is a list of additional site specific issues noted in the RSA. For more information, see the RSA.

1. Quinn Meadows equestrian camp (NF-450) intersection – approximately 750' of intersection sight distance to the south. 750' may be adequate for passenger cars, but may be insufficient for horse trailers.
2. Elk Lake Area intersection(NF-4600 - Forest Service road names: Elk Lake Lodge to the east of CLH and the Elk Lake Trailhead to the west).
  - a. Approximate location of three crashes. “Stop Ahead” sign on western approach from NF-4600 to CLH is damaged, not retroreflective, and farther from intersection that guidelines suggest.
  - b. The brown (recreational) guide signs on CLH are in poor condition or hidden from view. Some of the text is too small to be read at higher speeds.
  - c. 1/3 mile south of intersection, several areas of poor horizontal sight distance due to the horizontal alignment and vegetation.
3. Lava Lake Road intersection
  - a. Limited sight distance, especially to the south. Vegetation obstructing view.
  - b. A trailhead sign just south of the. intersection is obstructed by vegetation. A small “Trailhead Jct Ahead” sign is provided in advance of the intersection from both directions.
4. South Century Drive intersection
  - a. Approaching intersection from the north, the first guide sign is located right at the intersection so it is easy to miss or requires a motorist to slow down in order to read.
  - b. Approaching intersection from the south, the main sign assembly is cluttered and blocked by vegetation.

## F. Corridor Improvements

### 1. Improvement Options

This section summarizes the range of improvements from the RSA and recommendations from FHWA. For more information on the full range of potential improvements and the information that led to these recommendations, see the RSA.

It is important to recognize that the proposed FS Wilderness Strategy would limit parking at the most popular trailheads and likely change traffic and usage in the corridor. The probable changes have been taken into consideration when making the recommendations.

The matrix below in Figure 11 summarizes the recommendations to improve safety in the corridor. The improvements are described in more detail following the Figure.

The relative costs are subjective but for CLH are considered to be approximately \$0-50k for Very Low, \$50-100k for Low, \$100k-1M for Medium and \$1M+ for High.

The green, yellow and red colors indicate level of recommendation:

- Green = effective improvement and part of the sequence of improvements.
- Yellow = improvement is believed to be marginally effective, or more data is needed, or the effects of the Wilderness Strategies need to commence first.
- Red = not an effective improvement to support the overall goals for CLH.

		Timeline to Implement		
Relative Cost		Near-Term (0-5 years)	Mid-Term (5-10 years)	Long-Term (10+ years)
Very Low	NV1: Vegetation clearing (maintenance of original cleared areas); Improved/ additional guide, warning and regulatory signing; 6-inch edge line striping	MV1: Increased enforcement presence, especially during peak times	LV1: Increased enforcement presence, especially during peak times	
	NV2: Increased enforcement presence, especially during peak times; educational outreach strategies	MV2: Educational outreach strategies	LV2: Educational outreach strategies	
	NV3: Maintain good crash records; set simple performance goals	MV3: Maintain good crash records, monitor performance goals	LV3: Maintain good crash records, monitor performance goals	
	NV4: Minor improvements at Devils Lake along CLH to limit parking.			
	NV5: Moderate improvements at Devils Lake along CLH to limit parking.			
Low	NL1: Additional clearing along curves, intersections; traditional bicycle warning signing	ML1: Collect regular traffic data at key locations	LL1: Collect regular traffic data at key locations	
	NL2: Centerline rumble strips and delineators.			
	NL3: Collect regular traffic data at key locations			
	NL4: Dynamic warning signs for bicyclists.			
Medium	NM1: Transit Pilot Project	MM1: Parking lot expansion of Green Lakes and Devils Lake		
	NM2: Parking lot enhancements (revise existing layouts to be more efficient)	MM2: Additional congestion management/ITS solutions		
	NM3: Improvements at Devils Lake along CLH to limit parking, reduce speeds and improve crossing safety.			
High		MH1: Widen to 4' shoulders from begin through Elk Lake with minor areas of realignment	LH1: Widen to 4' shoulders from Elk Lake south to S. Century Dr.	
		MH2: Widen to 5' shoulders from begin through Elk Lake with minor areas of realignment	LH2: Widen to 5' shoulders from Elk Lake south to S. Century Dr.	
		MH3: Widen to 6' shoulders from begin through Elk Lake with minor areas of realignment	LH3: Widen to 6' shoulders from Elk Lake south to S. Century Dr.	
		MH4: Bypass of existing Devils Lake alignment.		

Figure 11 – CLH Improvement Matrix and Recommendations

**Near-Term, Very Low Cost (NV1) – Vegetation Clearing (Maintenance), Improved/Additional Signing, 6-inch Edge Line Striping:**

- Clear vegetation back to original cleared areas to improve sight distance throughout the corridor.
- Evaluate all guide signing in the corridor. Replace signs too small for 60mph operating speeds. Add advance guide signing for major destinations in a consistent manner.
- Add warning signage for remaining horizontal curves not meeting 55mph posted speeds per MUTCD. Add intersection warning signage for major intersections. In advance of any special innovative bicycle warning signage, install traditional standard MUTCD bicycle/Share the Road warning sign assemblies at key locations in the corridor.
- Add Speed or Speed Limit signs at key locations (near major destinations/approach roads, begin/end of jurisdictional limits). Consider temporary speed drops at Devils Lake and Green Lakes until Wilderness Strategies go into effect.
- Make 6-inch edge line striping the new standard for CLH.
- Consider removing sign panels for winter to avoid damage from plow operations in spring.

**Near-Term, Very Low Cost (NV2) – Increased Enforcement, Educational Strategies:**

- Utilize County and Forest Law Enforcement Officers especially during peak times. Increase presence when feasible. Increased enforcement is intended to help manage motorist speeds and manage compliance with various regulations (Wilderness Area enforcement, illegal parking, etc.).
- Review existing educational materials as related to highway safety from both the County and Forest resources. Team up together and with other advocacy groups (BPAC, bicycle groups, trail maintenance/hiking organizations, resort HOA, RV touring, fishing/hunting groups, etc.) to provide campaigns, materials and disseminate information to a variety of audiences. Use social media, websites and occasional changeable message signs in the corridor.

**Near-Term, Very Low Cost (NV3) – Crash Records, Performance Measure Goals:**

- Work with County and Forest LEOs to ensure a process is in place to collect adequate crash data and store records for easy access and retrieval. The format that ODOT uses for crash data collection is preferred for consistency with state records.
- Set simple performance measures with an end goal of zero fatal and serious injury crashes by a certain date in the future. Some examples are listed in the ODOT Design Manuals and Bicycle Pedestrian Plan. Monitor performance measures annually and communicate with elected officials on the status of measures and goals.

**Near-Term, Low Cost (NV4) – Minor Improvements to Limit Parking Near Devils Lake along CLH:**

As discussed in *Section E.2 Devils Lake Trailhead*, implement the desired minor modifications (signing) to limit parking along CLH as needed once Wilderness Area Strategies go into effect. This may require a county ordinance and county and/or Forest enforcement.

**Near-Term, Low Cost (NV5) – Moderate Improvements to Limit Parking Near Devils Lake along CLH:**

- [Dependent upon the final outcome and effects of Wilderness Strategies. Similar to NM3 but focused on short-term measures] Reduce parking limits with bollards, delineators or similar barriers placed at areas most undesirable for parking (e.g. along turnout on inside of horizontal curve). Guardrail may be used as well.

#### Near-Term, Low Cost (NL1) – Vegetation Clearing (Additional), Traditional Bicycle Signing:

- Determine areas where additional vegetation clearing, beyond the original cleared limits, will increase sight distance along horizontal curves and near intersections to meet AASHTO recommendations for a 60mph design speed, or as high as practical. Some areas of concern are noted throughout this study but an extensive evaluation should be performed. Additionally, identify where additional vegetation clearing can be accommodated to meet clear zone guidelines, especially in higher-risk areas such as the outside of horizontal curves. Clear and grub this vegetation.
- Install traditional (static, not flashing) bicycle warning signs at key locations throughout the corridor.

#### Near-Term, Low Cost (NL2) – Centerline Rumble Strips, Delineators:

- Install centerline rumble strips and post-mounted delineators throughout the entire CLH corridor. Use ODOT delineator standard drawings to keep consistent with other ODOT state highways. These typically decrease the spacing between delineators on sharper horizontal curves. If desired, utilize lower-noise, “mumble” strips as are being experimented with in California, Oregon and Washington state.

#### Near-Term, Low Cost (NL3) – Traffic Data:

- Using traditional traffic counting methods or innovative methods (intermittent or permanent stations), conduct traffic data collection on a regular basis. See the *RSA Section B.3 Traffic Data* for more information on the locations the team believes are most important at this time as well as the frequency of collection.

#### Near-Term, Low Cost (NL4) – Dynamic Warning Signs for Bicyclists:

- Install several dynamic warning signs at key locations throughout the corridor as described in the *RSA Section C.5.a.3 Bicyclist Signing*. These could be installed before or after the collection of vehicular and bicyclist traffic data throughout the corridor. If continuous counters such as the type used in the CTIP project are installed, these signs can be added on to the system at a later date. Preliminary cost estimates are provided in Appendix E. Near-Term, Low Cost (NL4) – Minor Improvements to Limit Parking Near Devils Lake along CLH:

#### Near-Term, Medium Cost (NM1) – Transit Pilot Project:

- Evaluate the effectiveness (ridership, reduction in congestion) of the proposed transit program in the corridor. Depending on the effectiveness, consider continuing the transit program into future years. (A FLAP application for a transit pilot project is currently under consideration for funding).

#### Near-Term, Low Cost (NM2) – Parking Lot Enhancements:

- [Dependent upon the final outcome and effects of Wilderness Strategies.] Revise the parking lots and access roads as desired at Todd Lake, Green Lakes and Devils Lake. This could include paving areas at Todd Lake and Devils Lake within the existing footprint and adding striping to maximize efficiency for all users (including equestrian use at Devils Lake). Signs may be needed



to direct users such as RVs and trailers to appropriate areas. The goal here would be to ensure as many vehicles can park within the parking lots as possible and off of CLH.

**Near-Term, Medium Cost (NM3) – Improvements at Devils Lake along CLH to Reduce Parking, Lower Speeds and Improve Crossing Safety:**

- [Dependent upon the final outcome and effects of Wilderness Strategies and other possible options that may have been tried, such as NV4 and NV5.] If the strategies do not proceed or do not have the intended effect on parking along CLH, implement a permanent speed reduction within the Devils Lake area, coupled with physical barriers such as guardrail to limit parking, channel pedestrians to one crossing location and install high visibility crossing signage, crosswalk markings and possibly a rectangular rapid flashing beacon (RRFB).
- Several of the options in this area, and referenced in the Appendix E – Cost Estimates, could be combined and tried, working from least costly and impactful to more costly.

**Mid-Term, Very-Low Cost (MV1) – Continue Increased Enforcement:**

- Continuation of NV2. Use traffic and crash data to best focus efforts and locations.

**Mid-Term, Very-Low Cost (MV2) – Continue Educational Outreach:**

- Continuation of educational outreach strategies from NV2. Use traffic and crash data to best focus efforts and locations.

**Mid-Term, Very-Low Cost (MV3) – Continue Crash Records, Performance Measure Goals:**

- Continuation of NV3. Evaluate performance goals and adjust based on safety performance and traffic data.

**Mid-Term, Low Cost (ML1) – Continue Traffic Data:**

- Continuation of NL3. Adjust frequency and locations as needed.

**Medium-Term, Medium Cost (MM1) – Parking Lot Expansion at Green Lakes and Devils Lake:**

- [Dependent upon the final outcome and effects of Wilderness Strategies.] Expand high-use parking lots in the corridor such as Green Lakes and Devils Lake to add capacity to parking areas and reduce parking on CLH.

**Medium-Term, Medium Cost (MM2) – Congestion Management, ITS Solutions:**

- [Dependent upon the final outcome and effects of Wilderness Strategies.] Utilize state-of-the-art technology to monitor use throughout the corridor in real time and provide information via media to help users make decisions about destinations.

**Medium-Term, High Cost (MH1) – Widen to 4' Shoulders from Begin to Elk Lake:**

- Construct 4' paved shoulders as an upgraded typical section from the begin of the study through Elk Lake with minor areas of realignment. Add a foot of shoulder width in front of guardrail and any other structures to meet AASHTO guidelines for shy distance. Improve side slopes where possible and increase horizontal sight distance as needed along the curves that do not meet AASHTO criteria. Install additional guardrail as needed where slopes cannot meet clear zone

guidelines. Install centerline rumble strips if not already installed, post-mounted delineators and high-type pavement markings. Adjust structures and extend or replace culvert as needed.

- Install left-turn and right-turn lanes as warranted by current traffic counts at major destinations (Green Lakes, etc.).
- 3R Analysis estimated cost: \$10.4 million

#### Medium-Term, High Cost (MH2) – Widen to 5' Shoulders from Begin to Elk Lake:

- Construct 5' paved shoulders as an upgraded typical section from the begin of the study through Elk Lake with minor areas of realignment. Improve side slopes where possible and increase horizontal sight distance as needed along the curves that do not meet AASHTO criteria. Install additional guardrail as needed where slopes cannot meet clear zone guidelines. Install centerline rumble strips if not already installed, post-mounted delineators and high-type pavement markings. Install shoulder rumble strips or edge line rumble strips. Possible structure adjustments and culvert extensions or replacements.
- Install left-turn and right-turn lanes as warranted by current traffic counts at major destinations (Green Lakes, etc.).
- 3R Analysis estimated cost: \$11.29 million

#### Medium-Term, High Cost (MH3) – Widen to 6' Shoulders from Begin to Elk Lake:

- Construct 6' paved shoulders as an upgraded typical section from the begin of the study through Elk Lake with minor areas of realignment. Improve side slopes where possible and increase horizontal sight distance as needed along the curves that do not meet AASHTO criteria. Install additional guardrail as needed where slopes cannot meet clear zone guidelines. Install centerline rumble strips if not already installed, post-mounted delineators and high-type pavement markings. Install shoulder rumble strips or edge line rumble strips. Possible structure adjustments and culvert extensions or replacements.
- Install left-turn and right-turn lanes as warranted by current traffic counts at major destinations (Green Lakes, etc.).
- 3R Analysis estimated cost: \$12.18 million

#### Medium-Term, High Cost (MH4) – Bypass of Devils Lake:

- [Dependent upon the final outcome and effects of Wilderness Strategies.] However, this could be an option in either situation. Construct a bypass of the Devils Lake area as described in Section 6c *Devils Lake Trailhead and Parking Lot Area* of the RSA. A high-level estimate of \$3M per mile (for construction costs) is assumed, with approximately 1 mile in length to complete this bypass. This could also be an option in the Long-Term.

#### Long-Term, Very Low Cost (LV1) – Continue Increased Enforcement:

- Continuation of MV1. Use traffic and crash data to best focus efforts and locations.

#### Long-Term, Very Low Cost (LV2) – Continue Educational Outreach:

- Continuation of educational outreach strategies from MV2. Use traffic and crash data to best focus efforts and locations.

#### Long-Term, Very Low Cost (LV3) – Continue Crash Records, Performance Measure Goals:

- Continuation of MV3. Evaluate performance goals and adjust based on safety performance and traffic data.

#### Long-Term, Low Cost (LL1) – Continue Traffic Data:

- Continuation of ML1. Adjust frequency and locations as needed.

#### Long-Term, High Cost (LH1) – Widen to 4' Shoulders from Elk Lake to S. Century Dr.:

- Construct 4' paved shoulders as an upgraded typical section from the Elk Lake through S. Century Dr. with minor areas of realignment. Add a foot of shoulder width in front of guardrail and any other structures to meet AASHTO guidelines for shy distance. Improve side slopes where possible and increase horizontal sight distance as needed along the curves that do not meet AASHTO criteria. Install additional guardrail as needed where slopes cannot meet clear zone guidelines. Install centerline rumble strips if not already installed, post-mounted delineators and high-type pavement markings. Possible structure adjustments and culvert extensions or replacements.
- Install left-turn and right-turn lanes as warranted by current traffic counts at major destinations (S. Century Dr., etc.).
- 3R Analysis estimated cost: \$6.92 million

#### Long-Term, High Cost (LH2) – Widen to 5' Shoulders from Elk Lake to S. Century Dr.:

- Construct 5' paved shoulders as an upgraded typical section from the Elk Lake through S. Century Dr. with minor areas of realignment. Improve side slopes where possible and increase horizontal sight distance as needed along the curves that do not meet AASHTO criteria. Install additional guardrail as needed where slopes cannot meet clear zone guidelines. Install centerline rumble strips if not already installed, post-mounted delineators and high-type pavement markings. Possible structure adjustments and culvert extensions or replacements.
- Install left-turn and right-turn lanes as warranted by current traffic counts at major destinations (S. Century Dr., etc.).
- 3R Analysis estimated cost (note that Section 8 will maintain the existing 4' shoulder width; costs are to install rumble strips and other countermeasures): \$8.01 million

#### Long-Term, High Cost (LH3) – Widen to 6' Shoulders from Elk Lake to S. Century Dr.:

- Construct 6' paved shoulders as an upgraded typical section from the Elk Lake through S. Century Dr. with minor areas of realignment. Improve side slopes where possible and increase horizontal sight distance as needed along the curves that do not meet AASHTO criteria. Install additional guardrail as needed where slopes cannot meet clear zone guidelines. Install centerline rumble strips if not already installed, post-mounted delineators and high-type pavement markings. Possible structure adjustments and culvert extensions or replacements.
- Install left-turn and right-turn lanes as warranted by current traffic counts at major destinations (S. Century Dr., etc.).
- 3R Analysis estimated cost: \$9.01 million

## 2. Potential Impacts of Proposed Improvements

Widening shoulders on the CLH could have substantial impacts to the environmental and vehicle and bicycle traffic in the project area, specifically:

- Increasing the roadway prism would disturb adjacent land, which could disturb sensitive areas (e.g. wetlands/creeks, habitat, steep slopes, cultural resources). A full NEPA analysis and all required permitting and consultation would need to be completed prior to any widening construction project.
- Adding wider shoulders could very likely induce bicycle demand on CLH. If bicyclists feel more comfortable riding in the corridor, more bicyclists might choose to ride on the CLH. It could also increase the usage of bicyclists with less familiarity riding on high-speed highways. Additionally, a wider traveled way could increase automobile vehicle speed.

## G. Conclusion

FHWA's recommended improvements are summarized below:

- Implement the “green”-coded Very Low and Low cost improvements.
- Collect vehicle and bicycle traffic data (counts, turning movements, and speed [if possible]) to help determine the impacts of the Wilderness Strategy and to provide more information on the viability of the “yellow”-coded improvements.
  - Key locations:
    - Study Begin (MP 21.98)
    - Todd Lake Intersection
    - Green Lakes Intersection
    - Devils Lake Intersection
    - Elk Lake Resort Intersection
    - S. Century Drive Intersection
  - Collect counts during peak season, in 2019 (prior to Wilderness Strategy going into effect), 2020 (after Wilderness Strategy), then every 2 years for short term, and every 5 years for long term.
- There are no preferred shoulder widths at this time because additional traffic data is needed to validate the use and need throughout the corridor. The following options are considered the reasonable menu of options based on the analysis performed throughout this document.

### Option 1:

1. MH3: construct 6' shoulders from the begin of study through Elk Lake. Estimated cost = \$12.2M
2. LH2: construct 5' shoulders from Elk Lake through S. Century Dr. Estimated cost = \$8.01M
3. S. Century Dr. to end of study – maintain 4' shoulders with minor improvements from other alternatives.

Option 1 Total Cost = \$20.2M (2018 dollars)

### Option 2:

1. MH2: construct 5' shoulders from the begin of study through Elk Lake. Estimated cost = \$11.29M
2. LH2: construct 5' shoulders from Elk Lake through S. Century Dr. Estimated cost = \$8.01M
3. S. Century Dr. to end of study – maintain 4' shoulders with minor improvements from other alternatives.

Option 2 Total Cost = \$19.3M (2018 dollars)

### Option 3:

1. MH2: construct 5' shoulders from the begin of study through Elk Lake. Estimated cost = \$11.29M
2. LH1: construct 4' shoulders from Elk Lake through S. Century Dr. Estimated cost = \$6.92M
3. S. Century Dr. to end of study – maintain 4' shoulders with minor improvements from other alternatives.

Option 3 Total Cost = \$18.21M (2018 dollars)

Option 4:

1. MH1: construct 4' shoulders from the begin of study through Elk Lake. Estimated cost = \$10.4M
2. LH1: construct 4' shoulders from Elk Lake through S. Century Dr. Estimated cost = \$6.92M
3. S. Century Dr. to end of study – maintain 4' shoulders with minor improvements from other alternatives.

Option 4 Total Cost = \$17.32M (2018 dollars)