Analytical Tools for Identifying Bicycle Route Suitability, Coverage, and Continuity

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Prepared for

Idaho Transportation Department

Research Program

Division of Highways, Resource Center

http://itd.idaho.gov/highways/research/

May 2012

Standard Disclaimer

1. Report No. FHWA-ID-12-204	2. Government Accession No.	3. Recipient's Catalog No.		
4. Title and Subtitle Analytical Tools for Identifying Bicycle Route Suitability, Coverage, and Continuity		5. Report Date May 2012		
		6. Performing Organization Code		
7. Author(s) Michael B. Lowry, PhD; Daniel Callister		8. Performing Organization Report No.		
9. Performing Organization Name and Address National Institute for Advanced Transportation Technology University of Idaho PO Box 440901; 115 Engineering Physics Building Moscow, ID 83844-0901		10. Work Unit No. (TRAIS)		
		11. Contract or Grant No. RP204		
12. Sponsoring Agency Name and Address Idaho Transportation Department Division of Highways: Resource Center, Research Program PO Box 7129 Boise, ID 83707-7129		13. Type of Report and Period Covered Final Report 01/03/11 – 05/31/12		
		14. Sponsoring Agency Code		
15. Supplementary Notes				
16. Abstract This report presents new tools created to assess "bicycle suitability" using geographic information systems (GIS). Bicycle suitability is a rating of how appropriate a roadway is for bicycle travel based on attributes of the roadway, such as vehicle volumes, shoulder width, and bike lane width. The new GIS tools are based on the Bicycle Level-of-Service method in the 2010 Highway Capacity Manual (HCM). The Idaho Transportation Department (ITD) can use the new tools to assess state highways when conducting corridor planning. The tools can be used to prioritize improvement strategies, such as wider bike lanes or new shared-use paths. Local planners, perhaps working with ITD, can use the tools to evaluate the "bikeability" of their community, i.e. the ability to access important destinations by bicycle. Example output is provided for three case study communities. This report also summarizes a literature review on bicycle suitability and presents the results from a survey that was conducted to determine data availability and GIS skills throughout Idaho. Over 100 responses were received from engineers and planners across the state. The results suggest many Idaho communities already have key data to calculate bicycle suitability and most communities have access to GIS software and personnel with GIS skills.				
17. Key Words bicycle suitability, bikeability, bicycle level-of- service, corridor planning, scenario analysis, geographic information systems		18. Distribution Statement Copies available online at http://itd.idaho.gov/highways/research/		
19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified		21. No. of Pages 119	22. Price None

FHWA Form F 1700.7

METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4		mm
ft	feet	0.3048		m
yd	yards	0.914		m
mi	Miles (statute)	1.61		km
		AREA		
in^2	square inches	645.2	millimeters squared	cm^2
ft^2	square feet	0.0929	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
mi^2	square miles	2.59	kilometers squared	km^2
ac	acres	0.4046	hectares	ha
		MASS (weight)		
oz	Ounces (avdp)	28.35	grams	g
lb	Pounds (avdp)	0.454	kilograms	kg
T	Short tons (2000 lb)	0.907	megagrams	mg
		VOLUME		
fl oz	fluid ounces (US)	29.57	milliliters	mL
gal	Gallons (liq)	3.785	liters	liters
ft^3	cubic feet	0.0283	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3

Note: Volumes greater than 1000 L shall be shown in m^3

Symbol	When You Know	Multiply By	To Find	Symbol
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (°F-32)	Celsius temperature	°C
		ILLUMINATION		
fc	Foot-candles	10.76	lux	lx
fl	foot-lamberts	3.426	candela/m^2	cd/cm^2
		FORCE and PRESSURE or STRESS		
lbf	pound-force	4.45	newtons	N
psi	pound-force per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	Miles (statute)	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
km^2	kilometers squared	0.39	square miles	mi^2
ha	hectares (10,000 m^2)	2.471	acres	ac
		MASS (weight)		
g	grams	0.0353	Ounces (avdp)	oz
kg	kilograms	2.205	Pounds (avdp)	lb
mg	megagrams (1000 kg)	1.103	short tons	T
		VOLUME		
mL	milliliters	0.034	fluid ounces (US)	fl oz
liters	liters	0.264	Gallons (liq)	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3

Symbol	When You Know	Multiply By	To Find	Symbol
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 °C+32	Fahrenheit temperature	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/cm^2	candela/m^2	0.2919	foot-lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	pound-force	lbf
kPa	kilopascals	0.145	pound-force per square inch	psi

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List of Acronyms

BCI	Bicycle Compatibility Index
BLOS	Bicycle Level-of-Service
BYPAD	Bicycle Policy Audit
BSIR	Bicycle Safety Index Rating
BSL	Bicycle Stress Level
BSA	Bicycle Suitability Assessment
BSR	Bicycle Suitability Rating
BSS	Bicycle Suitability Score
BTPO	Bannock Transportation Planning Organization
DOTs	Departments of Transportation
GIS	Geographic Information Systems
HCM	Highway Capacity Manual
ITD	Idaho Transportation Department
LAB	League of American Bicyclists
LOS	Level-of-Service
MPO	Metropolitan Planning Organization
PBIC	Pedestrian and Bicycle Information Center
RCI	Road Condition Index
RBCI	Rural Bicycle Compatibility Index
TAC	Technical Advisory Committee

Executive Summary

This report introduces new tools that were created to assess "bicycle suitability." Bicycle suitability is a rating of how appropriate a roadway is for bicycle travel based on attributes of the roadway, such as vehicle volumes, shoulder width, bike lane width, and vehicle speeds. The new tools can be used by the Idaho Transportation Department (ITD) to assess state highways when conducting corridor planning or during other planning activities. The tools can be used to compare the benefits from different improvement strategies, such as wider bike lanes or new shared-use paths. Local planners can use the tools to evaluate their community's bikeway network. The project scope did not include creating tools for general public use, such as tools for helping bicyclists find better bike routes (although future research could extend the new tools in that direction).

Why Are New Tools Needed?

In 2009, prior to this project, ITD conducted a customer satisfaction survey in which 55 percent of the respondents said providing safe facilities for bicycling is "very important" and an additional 20 percent said it is "important." These results suggest ITD can improve customer satisfaction by improving bicycle suitability on roadways throughout Idaho.

A literature review conducted for this project revealed numerous methods exist for calculating bicycle suitability. The most recent method that has been developed is called Bicycle Level-of-Service (BLOS) and is part of the 2010 Highway Capacity Manual (HCM).[1] The BLOS method is considered state-of-the-art. It builds on dozens of earlier studies and, presumably, engineers and planners across the country will become increasingly familiar with the BLOS method as they utilize the 2010 HCM. Consequently, this report and the new tools focus on the BLOS method.

The literature review also revealed that none of the methods for calculating bicycle suitability, including the BLOS method, are readily available as tools for geographic information systems (GIS). A survey conducted for this project showed there is great potential for using GIS to assess bicycle suitability because many Idaho communities already have much of the GIS data needed to calculate BLOS.

What Are The New Tools And How Are They Used?

This research developed 14 new GIS tools and 6 spreadsheet tools to help assess bicycle suitability. The GIS tools are written in open-source python code for ArcGIS® 10 and the spreadsheet tools are written for Microsoft Excel. The tools are organized in an electronic folder for easy sharing and distribution.[1] The electronic folder includes example data for each tool.

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[1] The files are about 215 MB. However, 160 MB are from a shapefile used by the "Create Streets" tool. This shapefile contains every street in Idaho. If the user does not need to create a streets file, this shapefile could be deleted for a drastic reduction in overall file size.

The GIS tools are organized into 2 "toolsets" as shown in Figure 1. The first toolset has five "Data Preparation Tools" that help a user prepare for analysis and were developed based on findings from case studies conducted for this project. The remaining nine tools were developed for conducting analysis and are located in the toolset called "Bicycle Analysis Tools."
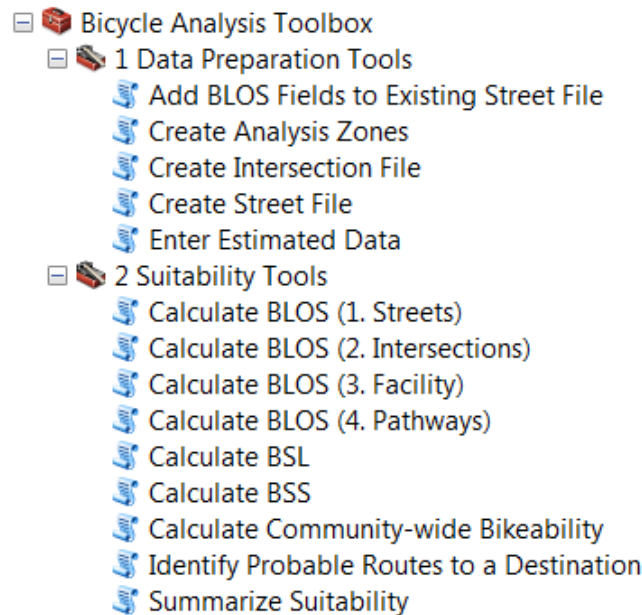
Figure 1. New GIS Bicycle Analysis Tools

Figure 2 shows the user-interface for the tool called "Calculate BLOS (1. Streets)." Other tools have a similar user-interface with input and output parameters. The tools are run by hitting "OK" and help documentation is accessed by hitting "Show Help." The run time for the tools is typically less than one minute. The exceptions are the tools called "Calculate Community-wide Bikeability" and "Identify Probable Routes to a Destination" which can take up to 10 minutes to run.

Calculate BLOS (1. Streets)" is a key tool. It was very useful during the case studies and will be very useful for many communities and ITD. It is 1 of 4 new tools based on the 2010 HCM.[1] The HCM based tools calculate BLOS for streets, intersections, facility, and pathways, respectively. The HCM defines a street as the section of a street between two intersections and a facility as a series of contiguous links and intersections.[1] The calculations for the BLOS tools are sophisticated non-linear equations that require various look-up tables. It is beyond the scope of this report to reproduce the equations here; the interested reader is advised to consult the 2010 HCM.[1]

The new tools "Calculate Community-Wide Bikeability" and "Identify Probable Routes to a Destination" are based on novel equations that were developed by the research team for this project.
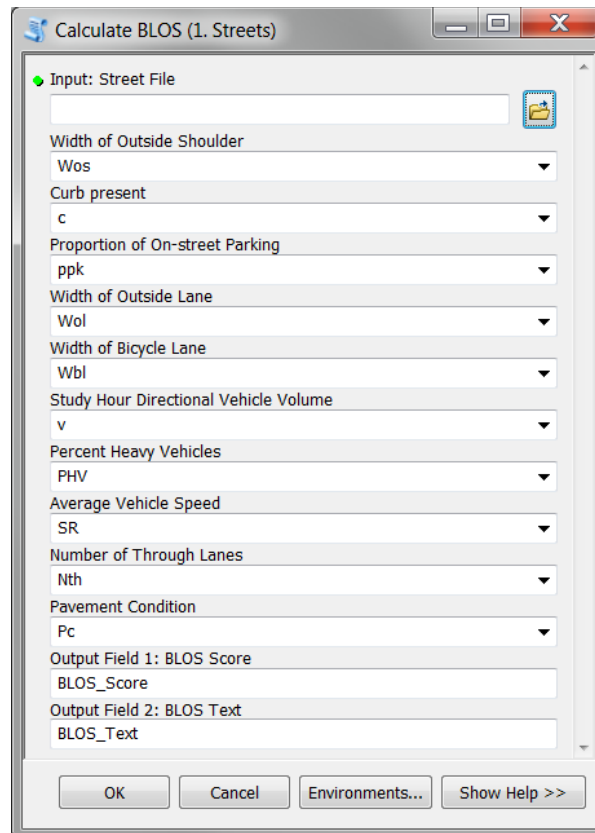
Figure 2. Example User-Interface for One of the New Tools

Using the Tools

The tools produce results that can be displayed graphically as maps. Figure 3 shows examples of maps that can be generated with the tools. Maps such as these can help engineers and planners identify problems and develop improvement strategies. Furthermore, the maps can help explain needs and benefits to the public and elected decision-makers. The usefulness of the example maps shown in Figure 3 and others are explained in this report.

The tools can be used for comparing different improvement scenarios, such as new bike lanes or re-striping narrower lanes and wider shoulders. For example, a district planner for ITD might use the tool called "Calculate BLOS (3. Facility)" for comparing a few different improvement scenarios when conducting corridor planning. The results would help determine the tradeoffs and expected benefits for different facility improvements. Likewise, local planners might use the tool called "Calculate Community-Wide Bikeability" to see how land use changes would improve bikeability for certain populations of their community.

a. Example Results from "Calculate BLOS."
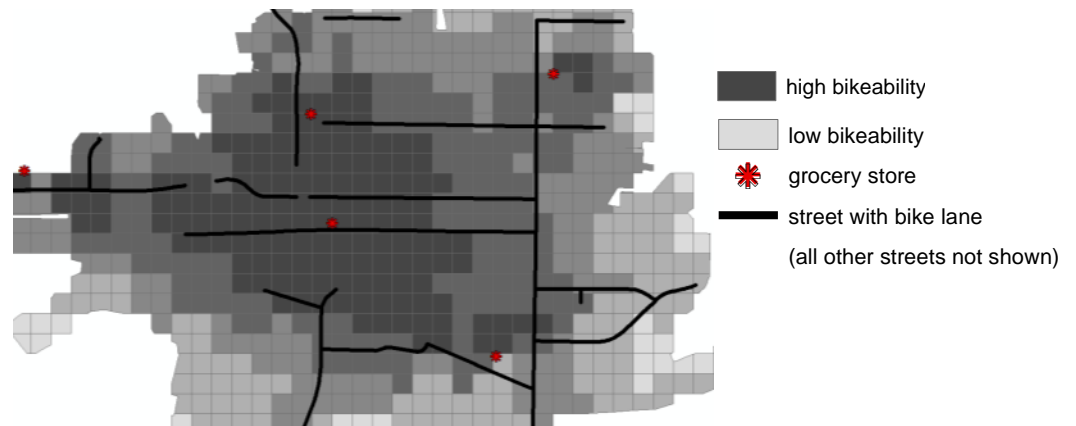
b. Example Results from "Community-Wide Bikeability"
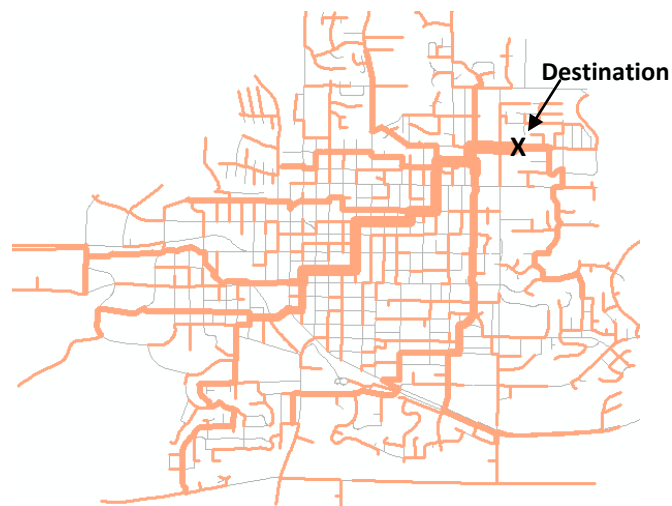
c. Example Results from "Identify Probable Routes to a Destination"

Figure 3. Examples of the Visual Results from Some of the New Tools

The tools were tested and refined through three case studies. The intent was to improve tool performance and make the tools more user-friendly. Every tool was improved in some way through the case study experience, and a few tools were conceived and developed specifically to address concerns that arose during the case study experience.

Selected results from the case study are included in this report to help demonstrate the usefulness of the tools. Certain tools may prove more useful than others for some users. For example, the data preparation tools might be the most useful for small-sized communities, who may lack sufficient GIS data. On the other hand, the tools concerning community wide analysis might be more useful for local engineers and planners who are often concerned with area-wide coverage. Likewise, the tools for facility analysis might be the most useful for ITD engineers who are often tasked with assessing facility performance of corridors.

What Are the Next Steps?

There are a number of immediate steps ITD can take to move forward with the products and findings of this research project. The following are few possible immediate next steps:

- Incorporate "Calculate BLOS (1. Streets)" into standard level-of-service analyses for roadways in urban settings. The tool will make the analysis much easier and allow quick comparisons of different improvement scenarios.

- Use the "Calculate BLOS (3. Facility)" tool during corridor planning in urban settings. This tool will make the otherwise tedious calculations much easier and allow quick comparisons of different improvement scenarios.

- Provide a download link for the tools on ITD's Bicycle and Pedestrian webpage called "Publications and Tools."

- Provide training on the tools to all ITD district planners and other ITD employees involved with bicycle planning and/or corridor planning. Furthermore, make the training available for local-level community planners and engineers. The training could be conducted by the ITD Bicycle and Pedestrian Coordinator.

- Assess the usability of the tools and identify potential improvements.

Chapter 1
Introduction

Bicycle ridership has increased throughout Idaho. The growth mirrors the national trend and is expected to continue for various reasons, including rising gas prices, increased traffic congestion, concerns for the environment, and a widespread desire for healthy, active travel. In fact, many believe the trend will become more dramatic if the federal government, states, and local communities direct more money toward infrastructure for bicycles, pedestrians, and transit and enact growth policies that encourage mixed land use and compact development.

Prior to this project in 2009, the Idaho Transportation Department (ITD) conducted a customer satisfaction survey. Of the respondents, 55 percent said providing safe walking/biking routes is "very important" and an additional 20 percent said it is "important.

Bicycle suitability is a rating of how appropriate a roadway is for bicycle travel based on attributes of the roadway, such as vehicle volumes, shoulder width, bike lane width, and vehicle speeds. ITD can use bicycle suitability to identify where improvements are needed, such as wider bike lanes or new shared use paths. Communities can examine their entire bikeway network to determine if important destinations can be accessed conveniently by bicycle and explore different scenarios in which the bikeway network could be improved.

This report presents new tools that were created to assess bicycle suitability using GIS. ITD can use the tools to assess state highways when conducting corridor planning. Local planners, perhaps working with ITD, can use the tools to evaluate the entire bikeway network for their community.

The following section lists the project objectives that guided the development of the new tools. This is followed by a section that provides an overview of the tasks and scope of the project. The last section in this chapter outlines the report organization.

Project Objectives

The project objectives were to:

- Determine an Idaho-specific methodology for ITD and local decision makers to assess bike route "suitability" for on-street and off-street bike routes
- Create analytical GIS tools to analyze network-wide bike route suitability in order to identify gaps and missing connections
- Develop a process for using the new tools to help decision makers prioritize projects that will improve network-wide bike route suitability

Tasks and Scope

The project tasks were divided into four phases. In the first phase, the project team conducted a literature review concerning bicycle suitability methods. Also, during the first phase, the project team

sent an online survey to communities across Idaho to determine data availability and GIS skill levels. In phase two, the project team created new GIS tools. In phase three the project team tested the new tools with data from three case study communities in order to improve and refine the tools. In the fourth phase, the project team developed and finalized this report and other supporting material.

The project tasks focused on creating analytical tools that could be used by ITD and local engineers and planners. The tools analyze the suitability of existing bikeways and impact of proposed changes. The project scope did not include creating tools for general public use, such as tools for helping bicyclists find better bike routes (although future research could extend the new tools in that direction). The new tools require basic GIS skill. The output is analytical and intended to be part of a larger process that might, for example, include public meetings and focus groups.

Report Organization

This report is organized into six chapters. Following the introduction, Chapter 2 summarizes the findings from the literature review and Chapter 3 summarizes the results from the survey that was sent to communities across Idaho. An overview of the new tools is presented in Chapter 4 and further explanation of a few tools is provided in Chapter 5 through case study examples. Chapter 6 offers conclusions about the research project and recommendations to ITD for implementing the new tools.

Chapter 2
Literature Review

The research team conducted a literature review of existing methods that are used to assess the comfort and convenience of bicycle travel in a community. Library databases, such as the Transportation Research Information Services, and the World Wide Web, via Google Scholar, were searched for major reports and key journal articles. Various keywords were used in the search and cross-references were checked to establish a broad understanding of the state-of-the-practice.

One finding from the literature review is an inconstancy of terminology. The forthcoming *AASHTO Guide for the Planning, Design, and Operation of Bicycle Facilities* does provide definitions for some terms; for example, "bikeway" is defined as any road, street, path or way designated for bicycle travel.[1] However, terms related to the assessment of bicycle travel, such as "suitability" and "bikeability" are used differently by some authors and interchangeably by others. We propose the following definitions:

> **bicycle suitability** – an assessment of the perceived comfort and safety of a linear section of bikeway.

> **bikeability** – an assessment of an entire bikeway-network in terms of the ability and perceived comfort and convenience to access important destinations.

> **bicycle friendliness** – an assessment of a community for various aspects of bicycle travel, including bikeability, laws and policies to promote safety, education efforts to encourage bicycling, and the general acceptance of bicycling throughout the community.

The following sections provide a summary of the literature reviewed for each assessment type.

Bicycle Suitability

Numerous methods exist for assessing bicycle suitability. Table 1 lists several methods frequently cited in the literature. Each method attempts to provide a score (i.e. rating) of the comfort and convenience of a linear section of bikeway. Essentially, all bicycle suitability methods do the same thing: they calculate a score by summing various points associated with certain attributes of the bikeway. The choice of attributes to include and the points associated with each attribute are what distinguish the different methods. The authors of each method usually provide empirical findings and rationale to support the inclusion or exclusion of certain attributes and the associated point system.

Table 1. Common Bicycle Suitability Methods

Name of Method	Acronym	Reference	Reference Date
Bicycle Safety Index Rating	BSIR	Davis[3]	1987
Bicycle Stress Level[a]	BSL	Sorton and Walsh[4]	1994
Road Condition Index	RCI	Epperson[5]	1994
Interaction Hazard Score	HIS	Landis[6]	1994
Bicycle Suitability Rating	BSR	Davis[7]	1995
Bicycle Level-of-Service	BLOS	Botma[8]	1995
Bicycle Level-of-Service	BLOS	Dixon[9]	1996
Bicycle Suitability Score[a]	BSS	Turner et al[10]	1997
Bicycle Compatibility Index [a]	BCI	Harkey et al[11]	1998
Bicycle Suitability Assessment [a]	BSA	Emery and Crump[12]	2003
Rural Bicycle Compatibility Index	RBCI	Jones and Carlson[13]	2003
Compatibility of Roads for Cyclists	CRC	Noel et al[14]	2003
Bicycle Level-of-Service	BLOS	Zolnik and Cromley[15]	2007
Bicycle Level-of-Service	BLOS	Jensen[16]	2007
Bicycle Level-of-Service	BLOS	Petritsch et al[17]	2007
Bicycle Environmental Quality Index	BEQI	SFDPH[18]	2009
Bicycle Quality Index	BQI	Birk et al[19]	2010
Bicycle Level-of-Service[a]	BLOS	HCM[1]	2011

[a] Selected methods are presented as examples in Appendix A.

Five of the methods shown in Table 1 are described in more detail in Appendix A. These methods include:

- **Bicycle Stress Level (BSL)** This method, which was developed by Sorton and Walsh, provides a simple and easily understandable calculation requiring relatively little data.[3]

- **Bicycle Suitability Score (BSS)** developed by Turner et al for TxDOT is also simple and easily understandable; plus, it is a good example for ITD and other state Departments of Transportation (DOTs) because it was developed specifically for state roadways where data is often limited.[10]

- **Bicycle Compatibility Index (BCI)** was developed by Harkey et al as part of an extensive project sponsored by the Federal Highway Administration.[11]

- **Bicycle Suitability Assessment (BSA)** is the most recent version of the pioneering work done in the late 1980's by Davis (Various methods, including RCI, BSR, and BSA are all variants of Davis' pioneering BSIR).[12] Furthermore, the BSA method provides a good example of a user-friendly form that could be filled out by engineers or the general public to conduct an assessment. The form is shown in Appendix A.

- **Bicycle Level-of-Service (BLOS)** method was developed for the most recent edition of the HCM.[1] Presumably, engineers and planners across the country will become increasingly familiar with the BLOS method as they utilize the ubiquitous HCM.

Table 2 shows the attributes that are used to assess bicycle suitability in the 5 example methods presented in Appendix A. The BSA method requires more data than others, while the BSL method requires the least. Lane width, vehicle traffic volumes, and vehicle speeds are used in all five methods.

In addition to the formal methods found in the literature, there are hundreds of *ad hoc* methods devised by local communities often for the purpose of creating bicycle suitability maps for residents and tourists. Two bicycle suitability maps are shown in Appendix A. The first example shows excerpts from a large folding map-brochure for Syracuse, New York.[20] The second example shows screen shots from an online bicycle suitability map for Tampa, Florida.[21] Both examples provide to the user a general description of the bicycle suitability ratings, but without much detail of the methods used to determine bicycle suitability. Often it is not clear if the bicycle suitability ratings on such maps are derived from a formal calculation or simply demarcated by planners based on local knowledge.

Table 2. Attributes for Selected Example Bicycle Suitability Methods

Attribute	Method [a]				
	BSL	BSS	BCI	BSA	BLOS
Width of Outside Lane	x	x	x	x	x
Width of Bike Lane			x	x	x
Width of Shoulder		x	x	x	x
On-Street Parking			x	x	x
Presence of Curb				x	x
Vehicle Traffic Volume	x	x	x	x	x
Number of Lanes				x	x
Speed Limit	x	x	x	x	x
Percent Heavy Vehicles			x		x
Pavement Condition		x		x	x
Elevation Grades				x	
Adjacent Land Use			x	x	
Storm Drain Grate				x	
Physical Median				x	
Turn Lanes			x	x	
Frequent Curves				x	
Restricted Sight Distance				x	
Numerous Driveways				x	
Presence of Sidewalks				x	

[a] See Table 1 for full names and reference citation numbers for each method.

Another common practice is to provide bicyclists information about certain attributes of the roadway without calculating a bicycle suitability score. For example, ITD currently maintains an online "Idaho Bike Map" that displays layers that can be turned on or off.[22] Appendix A provides a screenshot. Some of the layers depict attributes of the state roadways, such as shoulder width. Bicyclists who use the Idaho Bike Map must determine for themselves which bikeways they deem suitable. Some bicyclists actually prefer this approach. For example in the study by Turner et al. for TxDOT, a few experienced bicyclists said they would prefer knowing the attributes of a roadway instead of an unfamiliar and somewhat mysterious bicycle suitability score.[10] In a similar way, the print version of ITD's map has three different colors corresponding to three categories of shoulder width (essentially a single attribute bicycle suitability rating).[23] A number of other state DOTs have similar print maps; some provide additional color-coding to indicate vehicle traffic volumes.[10]

Which method is best? The answer depends on various factors. One important factor is data availability. As was shown in Table 2, some methods require more data than others. Another important consideration is the intended audience and purpose. For example, the BLOS method in the 2010 HCM is primarily intended for engineers and planners seeking to identify locations where improvements are needed. [1] Some practitioners and members of the public might regard the BLOS method as overly confusing and unnecessarily abstruse if the intent is, for example, to help make route decisions. Furthermore, some methods were developed for specific types of bikeways, such as urban streets (e.g. BLOS), rural highways (e.g. RBCI), or state roadways (e.g. BSS). Finally, it is important to recognize that bicycle suitability is subjective and may vary greatly for different people depending on many things, such as gender, age, and experience. The formal bicycle suitability methods were developed in an attempt to distinguish bikeways for a particular type of bicyclist. Most of the formal bicycle suitability methods specifically target intermediate or experienced adult bicyclists.

None of the existing methods are readily available as GIS tools.

Bikeability

In this report, bikeability is defined as an assessment of an entire network of bikeways in terms of access to important destinations. Unlike bicycle suitability methods, there are very few examples of bikeability methods in the literature. Three examples were found during the literature review.

The first is the Bikeability Checklist that was developed by the Pedestrian and Bicycle Information Center (PBIC) at the University of North Carolina through funding from the US Department of Transportation and National Highway Traffic Safety Administration.[24] The Bikeability Checklist is a simple two page form to be filled out by any member of the general public to assess their community. The user is asked to take a bike trip to one of their regular destinations and answer a series of questions about the comfort and convenience of their experience. Figure 4 shows the first page of the Bikeability Checklist.

Figure 4. PBIC Bikeability Checklist[24]

The second example of bikeability assessment is called Cycle Zone Analysis developed by Alta Planning + Design for the 2009 update of Portland, Oregon's Bicycle Master Plan.[19] For a particular "cycle zone" (i.e. subsection of a community), bicycle suitability scores and other measures of bicycle comfort and convenience are used to calculate overall cycle zone ratings (i.e. bikeability ratings). Planners can use cycle zone ratings to prioritize large areas for improvement and benchmark progress as improvements are made. Figure 5 shows 36 cycle zone ratings for Portland, Oregon.
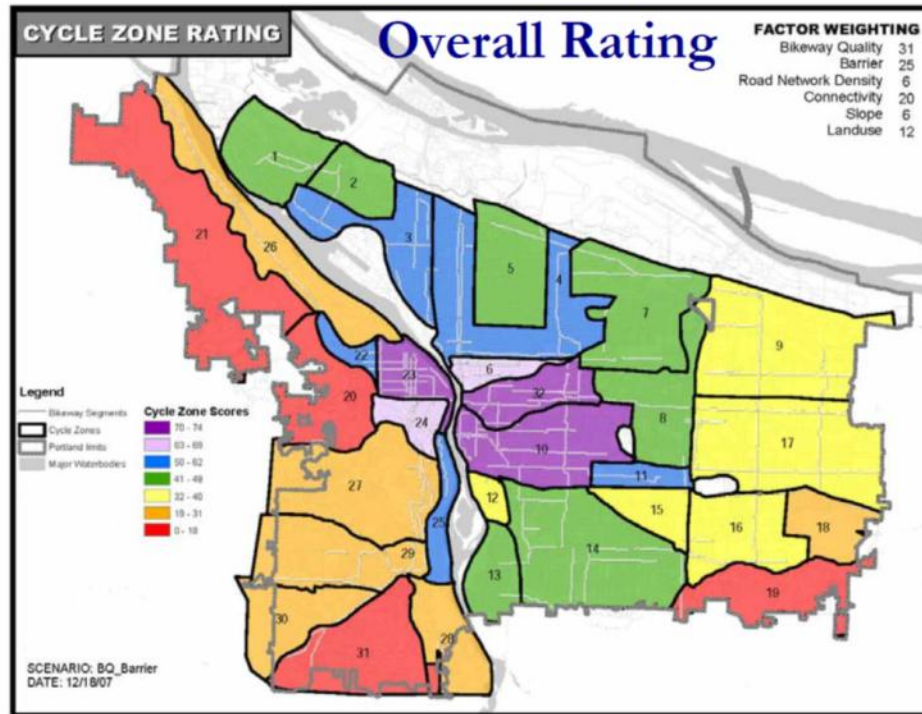
Figure 5. Cycle Zone Rating[19]

The third example of bikeability assessment was developed by McNeil.[25] The method assigns points to various destination types (e.g. grocery store, movie theater) and calculates a score out of 100 for a given location by summing any points for destinations within a 20 minute bike ride from the given location. Table 3 shows the point system for different destination types. The method is similar to the popular Walk Score®, which calculates a score out of 100 for a given address based on the number of amenities within walking distance.[26]

None of the existing bikeability methods are readily available as GIS tools.

Table 3. Point System for the 20-Minute Bikeability Method[25]

Destination Type	Max Points	Scoring Criteria
Light Rail Stops	5.0	Full points for 1 occurrence
Bus Lines	5.0	1.25 for each occurrence up to full points (4 occurrences)
Parks and Open Spaces	10.0	Full points for 1 occurrence
Libraries	2.5	Full points for 1 occurrence
Child Care	2.5	Full points for 1 occurrence
Preschools	2.5	Full points for 1 occurrence
Elementary Schools	2.5	Full points for 1 occurrence (public only)
Middle Schools	2.5	Full points for 1 occurrence (public only)
High Schools	2.5	Full points for 1 occurrence (public only)
Full Grocery Stores	7.5	3.75 for each occurrence up to full points (2 occurrences).
Specialty Grocery Stores	2.5	0.625 for each occurrence up to full points (4 occurrences).
Clothing Stores	5.0	1.25 for each occurrence up to full points (4 occurrences).
General Goods Stores	5.0	1.25 for each occurrence up to full points (4 occurrences).
Beauty Salons, Barbers,	2.5	0.625 for each occurrence up to full points (4 occurrences).
Banks	2.5	1.25 for each occurrence up to full points (2 occurrences).
Mail Services	2.5	Full points for 1 occurrence
Laundry and Cleaners	2.5	1.25 for each occurrence up to full points (2 occurrences).
Fitness Locations	5.0	2.5 for each occurrence up to full points (2 occurrences).
General Entertainment	2.5	1.25 for each occurrence up to full points (2 occurrences).
Drinking Establishments	5.0	1.25 for each occurrence up to full points (4 occurrences).
Movie Theaters	2.5	1.25 for each occurrence up to full points (2 occurrences).
Restaurants	7.5	0.625 for each occurrence up to full points (12 occurrences).
Cafés and Snacks	5.0	1.25 for each occurrence up to full points (4 occurrences).
Religious Organizations	7.5	1.5 for each occurrence up to full points (5 occurrences).
Maximum Total	100.0	

Bicycle Friendliness

In this report, bicycle friendliness is defined as an assessment of a community for various aspects of bicycle travel, including bikeability, laws and policies to promote safety, education efforts to encourage bicycling, and the general acceptance of bicycling throughout the community. Often the assessment of bicycle friendliness is combined with efforts to assess the level of bicycling in the community.

One well-known bicycle friendliness assessment method was developed by the League of American Bicyclists (LAB).[27] Since 2003, LAB has assessed 158 communities across the country for bicycle friendliness. The LAB assessment is based on achievement in five categories: engineering, education, encouragement, enforcement, and evaluation. Communities must apply and pay a fee to be assessed. Participant communities are awarded a designation of platinum, gold, silver, or bronze which indicate the level of bicycle friendliness (platinum is the best). As of 2010, 3 Idaho communities have been assessed: Wood River Valley (silver), Ada County (bronze), and Coeur d'Alene (bronze).

LAB also has a state level assessment based on five categories: legislation, policies and programs, infrastructure, education, enforcement, and evaluation. Each year LAB assesses every state and announces rankings for the whole country. Idaho's ranking has improved over the last 3 years: 37th in 2008, 34th in 2009, 26th in 2010. Recently, LAB introduced two new bicycle friendliness assessments, one for universities and another for businesses. Three businesses in Idaho and Boise State University have been assessed.[27]

The Alliance for Biking and Walking assesses bicycle friendliness every 2 years for all 50 states and select communities.[28] The results are published in a biennial benchmarking report. The recent *Bicycling and Walking in the U.S.: 2010 Benchmarking Report* ranks Idaho 5th in the nation for commuters biking to work, 4th for bicycle safety, and 17th for per capita funding to bike and pedestrian facilities.[29]

A number of state and city organizations have devised bicycle friendliness assessment methods (often called "report cards").[29] For example, Oregon's Bicycle Transportation Alliance developed the *Bike Friendly Report Card* to compare cities throughout Oregon and "grade" them on their bicycle-friendliness.[30]

There are a number of international examples for assessing bicycle friendliness.[29] One example is the Bicycle Policy Audit (BYPAD) funded by the European Union. BYPAD has been used to assess more than 100 European cities in 21 countries.[31]

None of the existing bicycle friendliness methods are readily available as GIS tools. The new tools presented in Chapter 4 could be integrated into existing bicycle friendliness methods.

Chapter 3
State-of-the-Practice Survey

The research team sent an online survey via email to communities across Idaho to better understand the state-of-the-practice concerning planning for bicycles. The survey was sent to nearly 300 people on the Association of Idaho Cities contact database. The survey was open for 2 weeks and 115 responses were received (approximately 30 percent response rate). The survey asked questions related to four topics:

- Information about the respondent and their community.
- Information about planning for bicycles.
- Data availability.
- GIS capabilities.

The following sections discuss the response for key questions from each topic. The complete survey and a summary of responses is presented in Appendix B.

Respondent and Community Information

Respondents were asked to identify their role in the community. For the purposes of the survey, "communities" included a variety of jurisdictional units, such are neighborhoods, cities, counties and tribal reservations.

A diverse group of people completed the survey as shown in Figure 6. A high percentage of respondents were planners or elected officials.
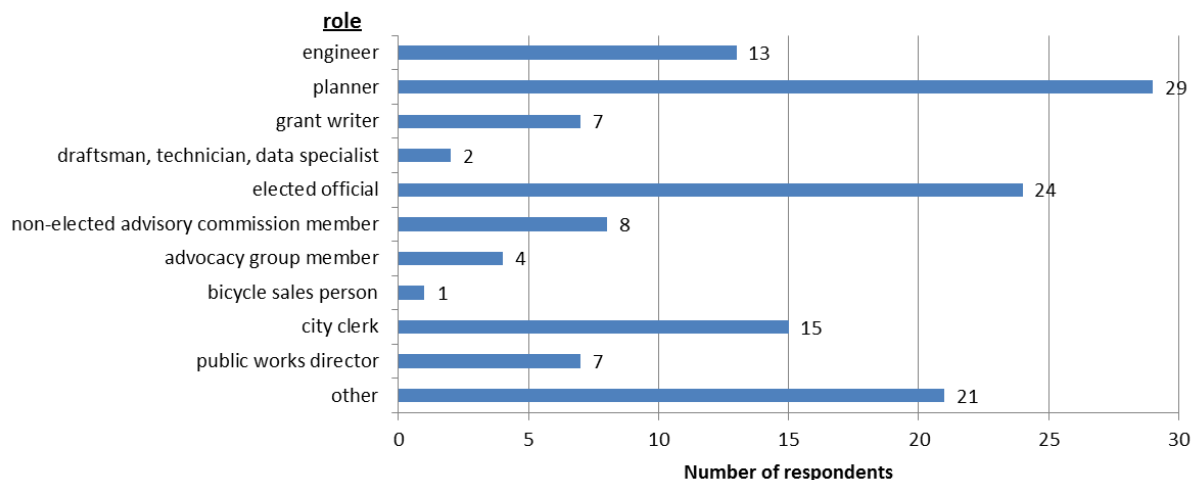

Figure 6. What Is Your Role in the Community?

Respondents were asked to provide the name of their community and approximate population. Answers to these questions were not required (none of the questions in the survey were required). Consequently, it is difficult to precisely determine how many unique communities were represented by those respond to the survey because some individuals did not provide the name of their community and multiple responses may have come from the same community from different people.[2] Nevertheless, it is estimated that at least 60 unique communities were surveyed. The complete list of communities is found in Appendix B. Figure 7 shows the distribution of approximate population size as indicated by the respondents. It appears that a diverse set of communities were surveyed, and not surprisingly, a high percentage of small communities were surveyed.
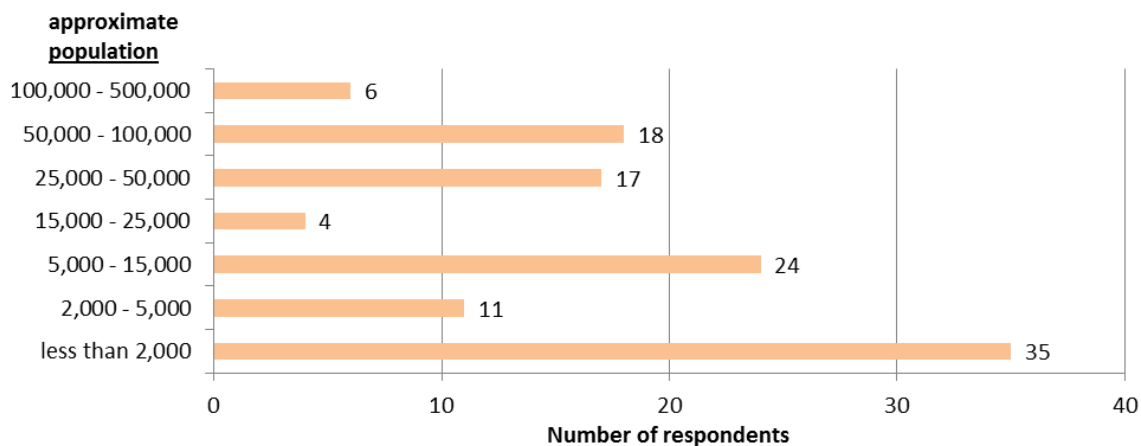
Figure 7. What Is the Approximate Population of Your Community?

Planning for Bicycles

Respondents were asked to identify the various reasons and methods used to decide where and when bicycle facilities will be provided in their community. (Figure 8) The results suggest legal requirements and public input are the most common reasons for providing bicycle facilities. Most respondents (80 percent) said formal studies of bicycle crashes or bicycle traffic volumes are "very rarely" or "never" used to decide where new bicycle facilities should be located. Many respondents (70 percent) said the decision is "very rarely" or "never" based on vehicle traffic volumes. Likewise, many respondents (60 percent) said GIS analysis is rarely or never used to help make the decision.

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[2] The ITD project manager and research team decided that making all questions optional and allowing multiple responses from the same community would produce better results.
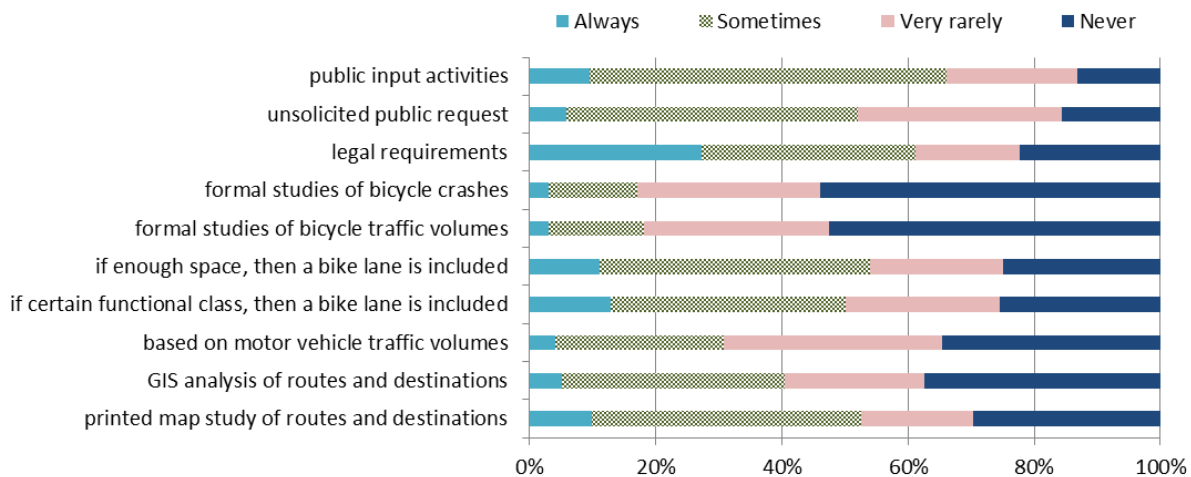
Figure 8. Reasons and Methods Used to Decide Where and When Bicycle Facilities Should Be Provided

Respondents were given the opportunity to provide "any additional information about how planning for bicycling occurs in [their] community." Of the respondents, 65 wrote something in the text box. Typically responses were only a few sentences long. The project team identified two major themes from the comments received. Nearly every response was either a comment about how the respondent's community is very small, so planning for bicycles is currently not and probably never will be a priority; or a comment about the insufficiency of current bicycle planning and the need for improvement. Examples of the comments received are provided below:

> *Our streets are still unpaved and will most likely remain so for quite a while. Besides our city streets, our main thoroughfares are state highways. At this point in time, there is not much if any emphasis on planning for bicycle lanes within the 4 blocks of city limits.*

> *[Planning for bicycles] is done poorly because we rely heavily on other transportation agencies to do this and it is not done well by them. Coordination is also very lacking.*

The second comment illustrates another common theme: lack of authority, or lack of clarity concerning authority, with regards to bicycle planning. When asked how well planning for bicycles is addressed in their community's comprehensive plan (or similar plan), a high percentage (56 percent) of respondents said "not very well."

Only 3 of the 115 respondents said a bicycle suitability method is used in their community. One respondent said Kootenai County determines bicycle suitability based on traffic volumes. Another respondent said local volunteers have rated certain routes throughout the City of Idaho Falls (although it was not specified how this was done). Another respondent said Coeur d'Alene rates bike routes based on bikeway dimensions.

Data Availability

Survey respondents were asked to identify the types of information which are typically collected or available for the streets of their community. Most respondents (76 percent) indicated that at least some information is collected (12 percent said data is not collected and another 12 percent said they did not know). Table 4 shows the percentage of respondents who indicated key data elements used to calculate bicycle suitability. A comparison of Table 4 and Table 5 indicates that most communities already collect some of the data needed for calculating bicycle suitability. However, quite a few communities (probably 60 percent or more) would need to start collecting (or estimating) a few key items, such as vehicle traffic volumes, shoulder width, and the percentage of heavy vehicles.

Table 4. Is the Following Street Data Collected or Available?

Attribute	Yes, Collected or Available (%)
Width of Outside Lane	76
Number of Lanes	67
Speed Limit	66
Presence of Curb	58
Pavement Condition	48
Width of Shoulder	43
Vehicle Traffic Volume	42
On-Street Parking	41
Adjacent Land Use	40
Width of Bike Lane	31
Elevation Grades	26
Percent Heavy Vehicles	12

Information related more specifically to bicycle travel is rarely collected. For example, less than 3 percent of the respondents said information is collected concerning volumes of bicycle traffic or bicycle accident rates. Likewise, concerning bike racks and shelters, 83 percent of the respondents said no information is collected or that they don't know if it is collected.

The respondents were asked what data is available in GIS format. Table 5 shows the response for various data items. Most respondents (60 percent) said data concerning the street network and land use parcels is available in GIS format. However, it is unclear if this means the respondent's community has possession of GIS data because it is unclear how the respondents interpreted "available." Some respondents might have considered or assumed data is held by the state or other agencies and therefore "available."

The survey suggests data about bicycle facilities is infrequently available in GIS format. Approximately 35 percent of the respondents said GIS data is available concerning on-street bike lanes and off-street

bike paths; and only 1 percent of the respondents said GIS data is available for bike racks and shelters. However, it is possible that some of the communities simply do not have bicycle facilities.

Table 5. Percentage of Respondents Indicating that Key Data is Available in GIS Format

Data Item	Yes	No	Don't Know
Street Network	61	23	16
On-Street Bike Lanes	33	42	25
Off-Street Bike Paths	36	40	23
Bike Racks/Shelters, etc.	1	66	33
Land Use Parcels	59	22	19
Land Use Zoning	65	19	16

GIS Capabilities

Many respondents (66 percent) said that their community has access to GIS software. However, it is not known if the respondents interpreted "access" to mean their community has "possession" of GIS software or simply the ability to use the software that belongs to a different community or entity. Some respondents might consider the software owned by the state or other agencies as accessible. Table 6 shows the response when asked to indicate the GIS skill level for their community. Respondents from larger communities (population >25,000) often said the GIS skill level for their community is "above average." Respondents from smaller communities (population <15,000) often said their community did not have any GIS skill, they did not know the skill level, or they chose not to answer.

Table 6. GIS Skill Level for Each Community Population Size

Community Population	Above Average (%)	Average (%)	Below Average (%)	None (%)	I don't know/ no answer (%)
Less than 2,000	9	23	9	31	29
2,000 - 5,000	18	18	18	27	18
5,000 - 15,000	29	29	13	4	25
15,000 - 25,000	50	25	0	25	0
25,000 - 50,000	71	18	0	0	12
50,000 - 100,000	67	6	0	0	28
100,000 - 500,000	33	33	0	0	33

Rows total 100%

Chapter 4
New Bicycle Analysis Tools

This chapter provides an overview of the new bicycle analysis tools developed as part of this project. The tools can be used to help assess bicycle suitability for existing conditions and proposed improvements. There are 14 GIS tools and 6 spreadsheet tools. The GIS tools are written in open-source python scripting for ArcGIS® 10 and the spreadsheet tools use Microsoft Excel. Additional information about the GIS tools can be found in the help documentation provided in Appendix C and accessible through ArcGIS. Chapter 5 provides further explanation of the GIS tools using case study examples.

Tool Organization

The tools are organized in an electronic folder for easy sharing and distribution.[3] The tools can be run directly from a CD or USB flash drive, but it is preferable to copy the tools to the hard drive to achieve faster execution.

Figure 9 shows the folder structure for the new tools. The subfolder for the GIS tools called "ExampleData" contains example shapefiles (See Appendix D for a summary of the example data). The subfolder called "ToolData" is critical for operation and should not be modified. It contains subfolders for special python libraries, a scratch folder, the python scripts, supporting shapefiles, and output symbology. Advanced users wishing to modify the GIS tools can open the python scripts with text-editing software, such as notepad.
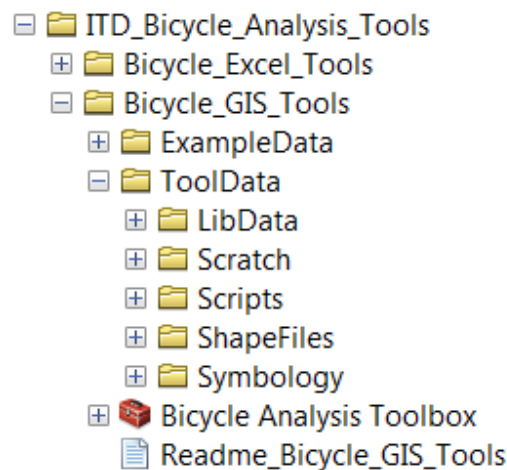
Figure 9. Folder Structure for GIS Tools

The 14 GIS tools are organized in 2 "toolsets" within the Bicycle Analysis Toolbox. Figure 10 shows the toolbox organization.

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[3] The files are about 215 MB. However, 160 MB are from a shapefile used by the "Create Streets" tool. The shapefile contains every street in Idaho. If the user does not need to create a streets file, the shapefile could be deleted for a drastic reduction in overall file size.
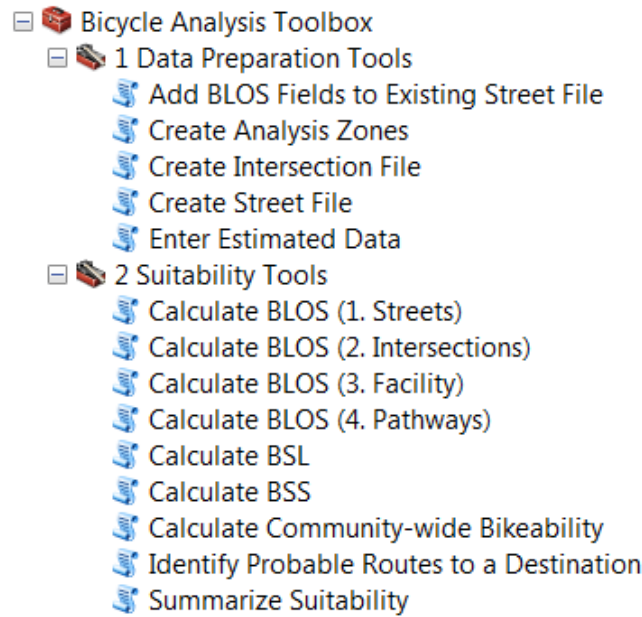
Figure 10. Bicycle Analysis Toolbox

Data Preparation Tools

The case study experience (see Chapter 5), prompted the development of 5 tools that can be used to prepare data for analysis. The first tool adds the necessary fields for BLOS analysis to a street file. The next three tools create shapefiles for zones, intersections, and streets, respectively. The fifth tool can be used to associate attribute data to a street file. The help documentation for each tool is provided in Appendix C.

Suitability Tools

Calculating BLOS

The first 4 tools in the suitability toolset calculate BLOS for streets, intersections, facilities, and pathways, respectively. The street calculation is for a "link" which is defined in the 2010 HCM as the section of a street between two intersections. Likewise, the 2010 HCM defines a facility as a series of contiguous links and intersections.[1] The calculations for the BLOS tools are sophisticated non-linear equations that require various look-up tables. It is beyond the scope of this report to reproduce the equations here; the interested reader is advised to consult the 2010 HCM.[1] For illustrative purposes, a simplified version of the street (link) equation is shown in Figure 28 in Appendix A of this report.

"Calculate BLOS (1.Streets)" is a key tool. It was the most useful tool during the case studies and will be very useful for many communities and ITD. Figure 11 shows the user interface for "Calculate BLOS (1. Streets)". Other tools have a similar user-interface with input and output parameters. The tools are run by hitting "OK" and the help documentation is accessed by hitting "Show Help." The run time for "Calculate BLOS (1. Streets)" and most of the other tools is less than 1 minute (The exceptions are the

tools called "Calculate Community-wide Bikeability" and "Identify Probable Routes to a Destination" which can take up to 10 minutes to run.).
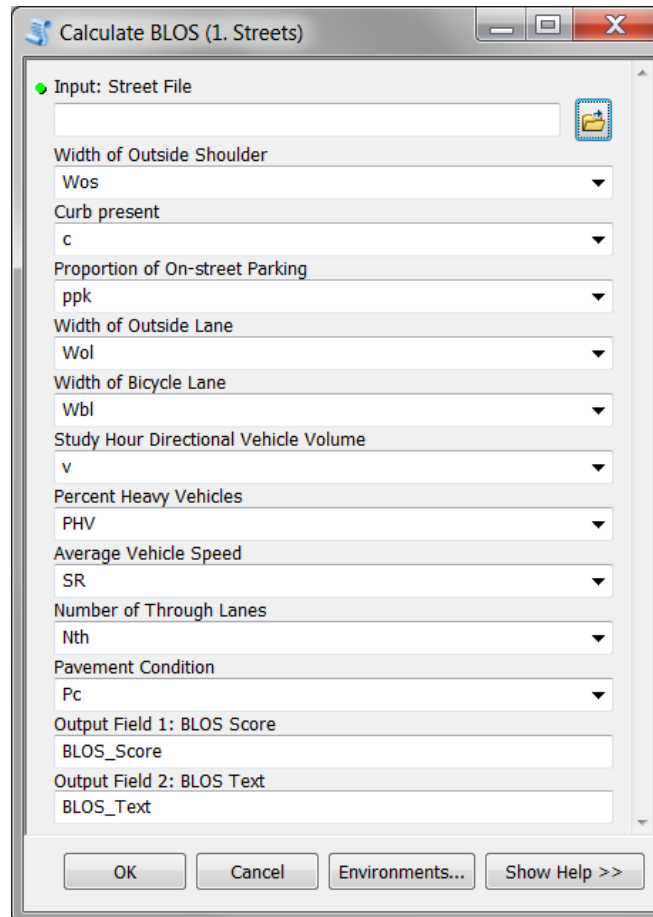

Figure 11. Tool-Interface for "Calculate BLOS (1. Streets)"

Calculating BSL and BSS

In addition to BLOS, the suitability toolset includes two other methods for calculating suitability: Bicycle Stress Level (BSL) and Bicycle Suitability Score (BSS). Table 7 shows that these methods require less data than the BLOS method. "Calculate BSL" and "Calculate BSS" are provided because it may be desirable for some communities to use suitability methods that require less data. Nevertheless, it is should be noted that the BLOS method is considered state-of-the-art and presumably, engineers and planners across the country will increasingly use the BLOS method since it is part of the ubiquitous HCM (see Chapter 2 for more information about bicycle suitability methods).[1]

Table 7. Required Data for Street Link Bicycle Suitability

Attribute	Method [a]		
	BLOS	BSL	BSS
Width of Outside Lane	x	x	x
Width of Bike Lane	x		
Width of Shoulder	x		x
On-Street Parking	x		
Presence of Curb	x		
Vehicle Traffic Volume	x	x	x
Number of Lanes	x		
Speed Limit	x	x	x
Heavy Vehicles	x		
Pavement Condition	x		x

[a] *BLOS = Bicycle Level-of-Service   BSL = Bicycle Stress Level,*
BSS = Bicycle Suitability Score

Calculating Community-Wide Metrics

The next 3 tools use street suitability, e.g. the results from "Calculate BLOS (1. Streets)," to make community-wide calculations. The tool called "Calculate Community-wide Bikeability" is an innovative calculation developed for this project by Lowry et al.[32] The calculation produces a bikeability score for analysis zones across a community. The bikeability score represents the ability and perceived comfort to travel by bicycle to important destinations throughout the community. The user chooses the destinations to include in the analysis, such as grocery stores, public parks, restaurants, and/or schools. The user also determines the importance for each destination, defined by "points." The points could be based on a characteristic of the destination, such as square floor footage or perhaps the points could be decided through a public town hall meeting or some other public involvement process. The points could be defined for every specific destination or defined generally for all destinations of a certain type, for example, 15 points could be associated with grocery stores, 10 points with restaurants; 5 points with banks, etc. (see Table 3 for an example point system). If the points are zero, then the destination does not contribute to the bikeability score. If the points are the same for a set of destinations, then those destinations are considered equally important. Example output for "Calculate Community-wide Bikeability" from a case study is shown in Chapter 5 and the help documentation is provided in Appendix C.

The second community-wide tool, "Identify Probable Routes to a Destination," identifies the streets that might be used if a bicyclist were to ride from every analysis zone to a particular destination. This tool is helpful, for example, if an analyst would like to know the most important routes to the city's junior high school or community center. This tool is also demonstrated through a case study in Chapter 5.

The last community wide tool is used to summarize the number of miles and percent of total miles for each level of suitability. The help documentation is provided in Appendix C.

Topology Requirements

Three of the new GIS tools have a critical prerequisite. "Calculate BLOS (4. Facility)", "Calculate Community-Wide Bikeability", and "Identify Probable Routes to a Destination" require correct topology for the bikeway network. This is not a trivial requirement and anyone familiar with GIS knows that obtaining correct topology can be very time intensive. Correct topology means that connections (i.e. shared endpoints) between links are correctly represented with the GIS shapefile. Figure 12 shows examples of correct and incorrect topology.
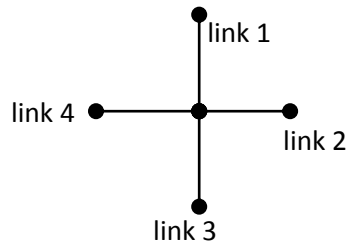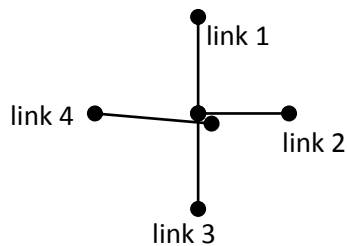

All 4 links share one end point.

a. Correct Topology
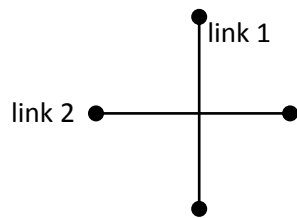
There is supposed to be four links, but instead there are two unconnected links. (This would be correct topology if link 1 is in fact an overpass across link 2 without any physical connection in the real world.)

b. Example of Incorrect Topology (Missing Connection)

Link 4 does not share an endpoint with the other links.

c. Example of Incorrect Topology (Misaligned Connection)

Figure 102. Examples of Incorrect and Correct Topology as Needed for Three of the New Tools

For the case studies, the Pocatello Metropolitan Area had a street file with correct topology, but Moscow and Driggs did not. The research team suspects that most small and medium sized communities do not have street files with correct topology, while on the other hand a Metropolitan Planning

Organization (MPO), like the MPO in Pocatello, usually have already refined their topology for use in travel demand forecasting. Luckily, since Driggs is so small, it did not take too long to correct the topology. Moscow however took a considerable amount of time to correct the topology.

There are existing tools in ArcGIS that can help correct topology.[33] Nevertheless our experience with Moscow prompted us to develop the new tool called "Create Streets File" in the Data Preparation toolset. The user provides contiguous zip codes. The output is a street network with "near" correct topology. The user finalizes the output, by deleting "isolated links" that are not connected to the main network (and perhaps other links that are not desired for the analysis area). Although it may be time consuming to delete links, in most cases this clean-up process will be much quicker than correcting the topology of an incorrect centerline file.

Figure 13 shows the output of a "Create Streets File." Note that a few streets need to be deleted because they are not connected to the main body of the network and others need to be deleted because they are outside of the desired study area.
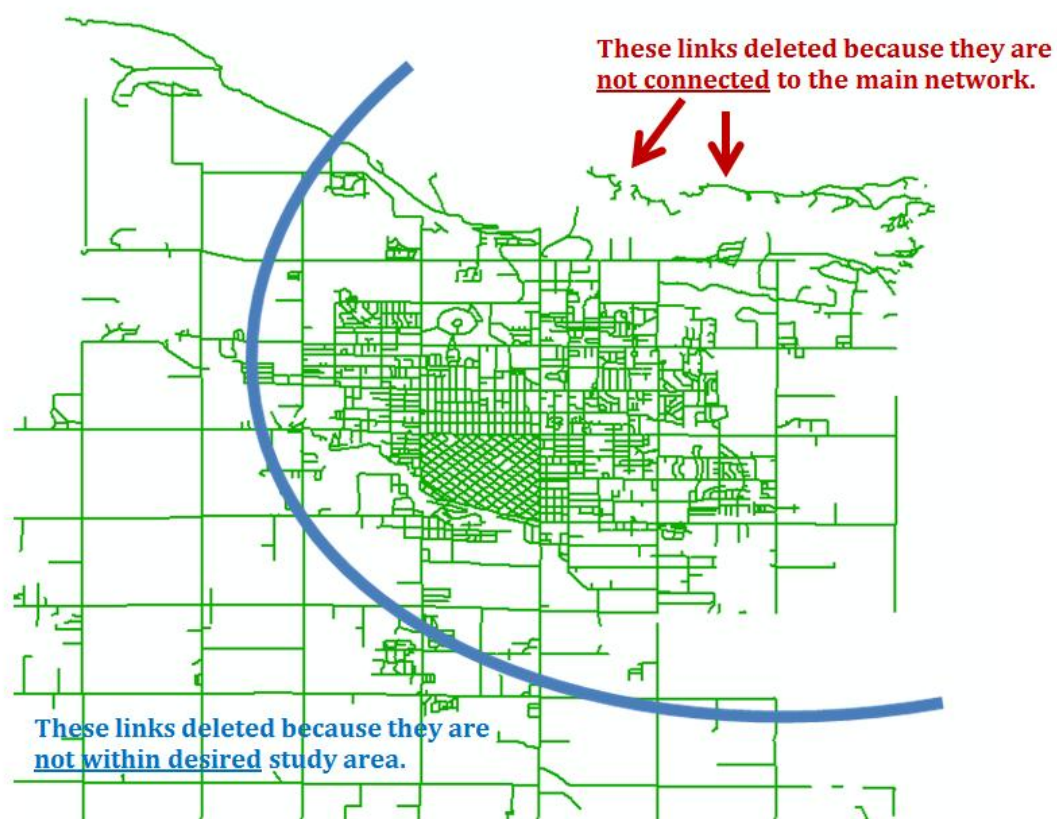

Figure 13. Deleting Links from "Create Streets File" Output to Assure Correct Topology

After deleting links in the output from "Create Streets File," the user can use "Add BLOS Fields to Street File" and then "Enter Estimated Data" to populate the attribute table (The user could also collect data for each link, or some combination of collecting data and estimating data). "Enter Estimated Data"

requires the user to first create a table for the estimated data like the one shown in Figure 14. Any type of classification and any number of classes can be used. The 10 attribute fields must be labeled just as in the illustration, though all 10 need not be included and the order of the fields can vary. The street type name must be text and match exactly (case sensitive) with a corresponding field in the street file. The analyst can create the table in a spreadsheet and then save it as a .csv file. Once the estimated data is entered, the analyst can make changes to specific links for which more accurate data is available.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Class	Wol	Wbl	Wos	ppk	v	SR	PHV	Pc	c	Nth	AccPts
2	Primary Highway	12	0	12	0.4	600	35	0.06	4.5	1	2	3
3	Secondary Highway	12	5	10.5	0.6	400	35	0.01	4.5	1	1	3
4	Local	12	0	8.5	0.4	50	25	0	4.8	1	1	4
5	Alley	10	0	0	0	10	15	0	3	0	1	4
6												

Figure 14. Example CSV File for "Enter Estimated Data"

Spreadsheet Tools

There are three spreadsheet files: BLOS_calcualtions.xlsx, BSL_calculations.xlsx, and BSS_calculations.xlsx. All three files have a similar look and use. Figure 15 shows a screenshot of the "Links" sheet in BLOS_calculations.xlsx. The user enters data in the orange cells and the suitability scores are output in the grey cells. The file for BLOS includes a sheet for Links, Intersections, Facilities, and Pathways. All sheets for all files are "protected," which means the user can only enter data into the orange input cells. The user can "unprotect" each sheet by going to Review/Unprotect Sheet. Furthermore, all sheets for all three files have intermediate calculations that are hidden. The user can "unhide" the rows by highlighting the rows above and below, right clicking, and selecting unhide.

Figure 15. Screenshot of Excel Tool for Calculating Link Bicycle Level-of-Service

The next chapter provides further explanation of the tools through three case study examples. Each case study presented unique challenges and opportunities to revise and improve the tools, and, in some instances, the case study experience motivated the creation of entirely new tools to address needs that were identified as potential barriers for other communities in Idaho.

Chapter 5
Case Study Examples

This chapter demonstrates the new bicycle analysis tools and provides further explanation of how they can be used through three case study examples. The example communities were selected with the help of the Technical Advisory Committee (TAC) appointed by ITD. The intent of the case studies was not to provide analysis for the communities, although the results may prove useful to them, but rather the intent was to help the research team test and refine the new bicycle analysis tools under different circumstances and conditions. For this reason, the communities selected were diverse in terms of population, bicycle infrastructure needs, and availability of GIS resources including software, data, and skill. The case study communities include the City of Driggs, the City of Moscow, and the Pocatello Metropolitan Area (see Figure 16).

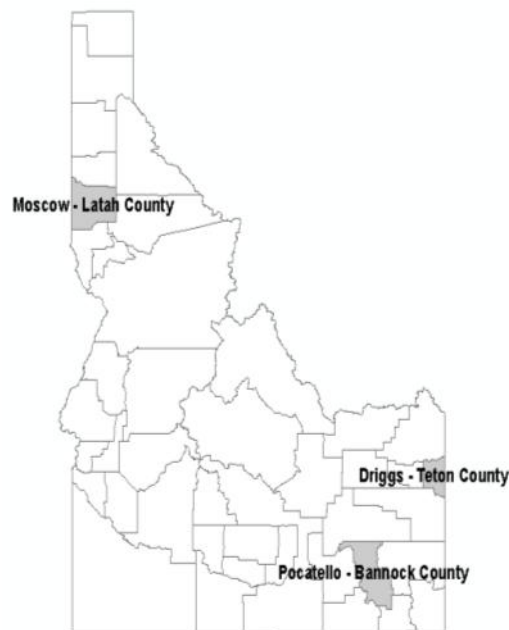
Figure 16. Three Case Study Communities

Specifically, the goal of the case studies was to help the research team:

1. Identify the problems faced by communities in collecting the necessary GIS data.

2. Gain a better understanding of what tools would be most useful for different types of communities.

3. Make the tools more user-friendly.

4. Improve and refine the tools for ITD purposes.

The case study experience resulted in improvements to every tool and led to development of a few additional tools specifically to address concerns that arose during the case study experience. Much of the tool improvement concerned the user-interface and "Help Documentation." The case study experience also prompted the research team to create a set of example data.

All 14 tools were tested on each case study community; however, this chapter highlights only a few selected tools for each community to illustrate how communities of differing sizes can benefit from certain tools. Table 8 shows the tools highlighted in this chapter.

Table 8. Tools Highlighted in the Report from the Case Study Examples

Tool[1]	Driggs	Moscow	Pocatello Area
Add BLOS Fields to Street File			
Create Analysis Zones		x	
Create Intersection File			x
Create Streets File			
Enter Estimated Data	x		
Calculate BLOS (1. Streets)	x	x	x
Calculate BLOS (2. Intersections)			x
Calculate BLOS (3. Facility)			x
Calculate BLOS (4. Pathways)		x	
Calculate BSL			
Calculate BSS			
Summarize Suitability		x	
Calculate Community-Wide Bikeability		x	
Identify Probable Routes to a Destination		x	

1 Every tool was tested during the case studies; those indicated with an X are discussed in this report and blank cells means the tool is not highlighted in this report.

The two most important tools for the Driggs case study are "Enter Estimated Data" and "Calculate BLOS (Streets)". These tools can be very useful for small communities like Driggs because many small communities do not have GIS data and only need to perform basic analysis. "Enter Estimated Data" helps populate GIS data in a very easy manner. In fact, the research team was motivated to create the "Enter Estimated Data" tool because Driggs did not have the needed GIS data. "Calculate BLOS (Streets)" is the most basic analysis tool and most likely the only tool that small communities would need for basic HCM level-of-service analysis.

For Moscow, the tools that are highlighted in this chapter focus on community-wide analysis. These tools might be very useful for medium-sized communities or subsections of a larger metropolitan region where it is common to plan for an entire area.

A large MPO or an ITD District Planner would probably be most interested in analyzing a specific corridor. Consequently, for the Pocatello Metropolitan Area, the tools highlighted concern "facility analysis". Facility analysis is a common research task for engineers and planners conducting corridor planning. One tool involved with facility analysis is "Create Intersection File." The HCM method requires BLOS of intersections in order to calculate BLOS of a facility. As part of the Pocatello case study, the project team realized that most communities probably do not have an intersection shapefile (the Pocatello MPO did not, nor did the other two communities). Consequently, the Pocatello case study motivated the project team to develop the tool "Create Intersection File."

This chapter does not describe tool details, such as requirements for input data or calculation methodologies. The interested reader is advised to consult the Help Documentation in Appendix C for more detailed information about each tool and the overview of the tools provided in Chapter 4.

Driggs, Idaho

Driggs is the county seat of Teton County in Eastern Idaho and has an estimated population of 1,100.[34] It is a small community that benefits economically from recreation and tourism due to its proximity to Grand Teton and Yellowstone National Parks. The community is experiencing a great deal of growth in residential developments both within and outside the city limits. The community recognizes the benefits of improving its bicycle infrastructure, but is limited financially. Many of the roads in Driggs, and Teton County in general, are unpaved, which presents a potential obstacle to community bikeability. Teton County has adopted a long-term plan to build multi-use trails throughout the region including several trails in Driggs.[35]

Significant data collection was required to perform BLOS analysis for Driggs. Table 9 shows the initial data availability for all 3 communities. By far, the Pocatello Metropolitan Area had the most data. Consequently, although Pocatello was geographically the largest case study community, the analysis for Pocatello did not take as long because the data was already available.

Table 10 shows that Driggs has the essential shapefiles for parcels, off-street paths, and street centerlines (none of the communities had an intersection shapefile); however, these essential shapefiles did not include any attribute data, such as width of shoulder. The results from the survey presented in Chapter 3 suggest that this is common for small- and medium-sized communities. For this reason, the research team created the tool called "Enter Estimated Data," which allows a community to easily create the necessary attributes for the shapefile and enter estimated data based on street type. For example, Table 9 shows data for 5 street types in Driggs. The "Enter Estimated Data" tool takes a table like this and associates the data with the streets of a shapefile. The user can then modify specific streets if more precise information is available. In the Driggs case study, the attributes for a few key streets downtown were modified based on more specific information that was gathered through conversations with the local planner and also through Google Earth®.

**Table 9. Initial Data Availability for the Three Case Study Communities**

Shapefile	Attribute	Driggs	Moscow	Pocatello
Parcels	Land Use Type	x	x	
Off-Street Paths	Location	x	x	x
	Topology			x
	Width			
	Painted Line Information			
Streets	Location	x	x	x
	Topology			x
	Width of Outside Shoulder		x	x
	Curb Present		x	x
	Proportion of On-Street Parking			x
	Width of Outside Lane		x	x
	Width of Bicycle Lane		x	x
	Study Hour Directional Vehicle Volume			x
	Percent Heavy Vehicles			x
	Average Vehicle Speed			x
	Number of Through Lanes			x
	Pavement Condition			x
Intersections	Location			
	Vehicle Volumes			
	Width of Cross Street			

Blank cell indicates data was not available.

The project team used the "Calculate BLOS" tool to assess bicycle suitability. Figure 17 is a map showing the resulting BLOS score for each street (link) in the network. In general, the network exhibits acceptable BLOS. The only noticeably poor BLOS score is Highway 33 running north-south as Main Street. The map and results from the new tool provide a clear visual that planners could use in public meetings.

Table 10. Estimated Data for Driggs

Attribute	Gravel	Rural Paved	Urban Paved	Urban with Bike Lane	State Highway
Width of Outside Lane (ft)	9	12	12	12	18
Width of Bike Lane (ft)	0	0	0	5	0
Width of Shoulder (ft)	0	0	2	3	12
On-Street Parking (%)	0.0	0.0	0.1	0.0	0.3
Presence of Curb (yes/no)	0	0	1	1	1
Vehicle Traffic Volume (vph)	7	20	80	80	300
Number of Lanes (#)	1	1	1	1	1
Speed Limit (mph)	25	25	25	35	35
Heavy Vehicles (%)	0.01	0.01	0.05	0.10	0.20
Pavement Condition (rating)	1.5	3.5	4.0	4.0	4.0
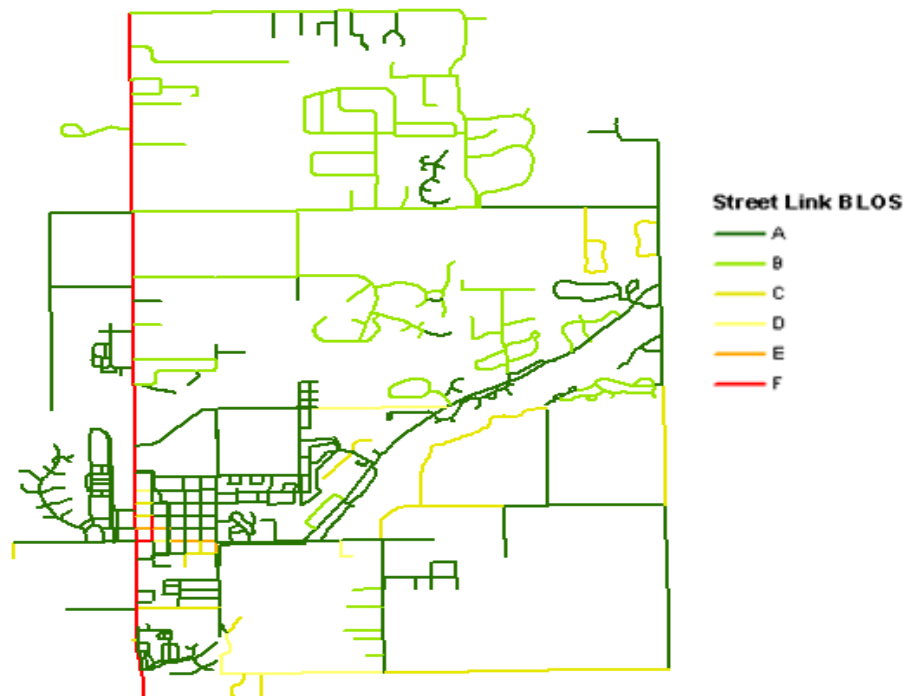
Figure 17. Results from "Calculate BLOS" for Driggs

Moscow, Idaho

Moscow is the county seat of Latah County in Northern Idaho and has an estimated population of 24,329 (2000 census). The city is home to the University of Idaho, and 11,180 students were enrolled at the Moscow campus.[36] The City of Moscow and the University of Idaho have made bicycle transportation a priority in their plans for future development and capital improvements.[37]

In this case study, we focused on the tools for community-wide analysis and demonstrate how the tools can be used for comparing different scenarios. Although various scenarios were analyzed, two scenarios are presented here: the current condition (status quo) and an improvement scenario with proposed new bike lanes and shared-use paths.

The first step was to use the tools called "Calculate BLOS (Streets)" and "Calculate BLOS (Pathways)" for the current conditions and the improvement scenario with proposed new bike lanes and shared-use paths. Next, the tool called "Suitability Summary Statistics" was run. The tool creates a text file with statistical information regarding the suitability scores as shown in Table 11. The results suggest that the improvement scenario would significantly increase the number of bikeway miles with BLOS "A."

Table 11. Results from "Suitability Summary Statistics" for Moscow

BLOS Score	Percent of Total Miles	
	Current	With Improvements
A	70	84
B	7	5
C	10	5
D	7	3
E	3	1
F	3	2

The tool called "Create Analysis Zones" was run in preparation for further community-wide analysis. Figure 18 shows the analysis zones that were created. The zones are 500 feet by 500 feet and buffer the street network by 500 feet. The tool allows the user to specify the zone dimensions.
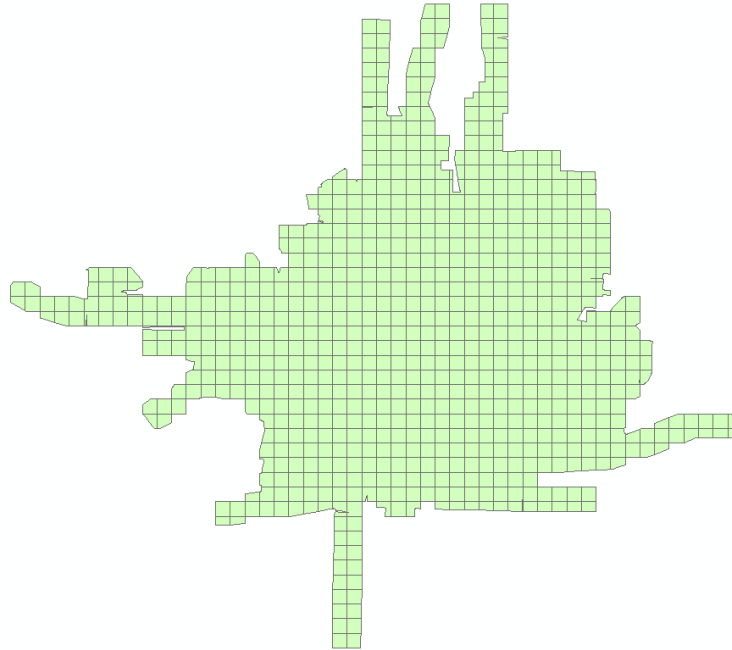
Figure 18. Results from "Create Analysis Zones" for Moscow

This innovative tool produces a bikeability score for every analysis zone. The score represents the ability to access "important destinations" by bicycle via a suitable corridor. For example, Figure 19 shows the results of the tool using Moscow's grocery stores as the "important destinations." Figure 19a shows the bikeability for each zone under the current conditions and Figure 19b shows the bikeability scores if the bikeway network were improved with additional bike lanes and an additional grocery store were to be zoned and developed in the north-east corner. The figure also shows bike lane locations.

In this example, Figure 19a shows that in the bikeability under the current conditions (status quo) is highest in the zones downtown where a bicyclist would have the best access to all 4 grocery stores. Figure 19b shows the improvement scenario exhibits better overall bikeability throughout the community due to the additional new bike lanes, and especially in the north-east corner, with the addition of a new grocery store. The results demonstrate how the "Community-Wide Bikeability" tool reveals the benefits from new bicycle infrastructure and land use modifications.

Other destinations could be used with the "Community-wide Bikeability" tool, such as public parks, restaurants, or schools. In fact, various destination types (restaurants, theaters, etc) could be analyzed at the same time by giving different points for different destination types and/or characteristics. For example, public parks could be given varying points based on size or amenities and grocery stores could be given different points based on floor-area square footage. See the Help Documentation in Appendix C and Lowry et al. for further discussion about giving points to destinations (Table 3 in Chapter 2 shows an example of giving points to destinations).[32]

Likewise, the analysis zones could be artificially created like those used in this example or they could be parcels or traffic analysis zones (TAZs).

a. Current Conditions
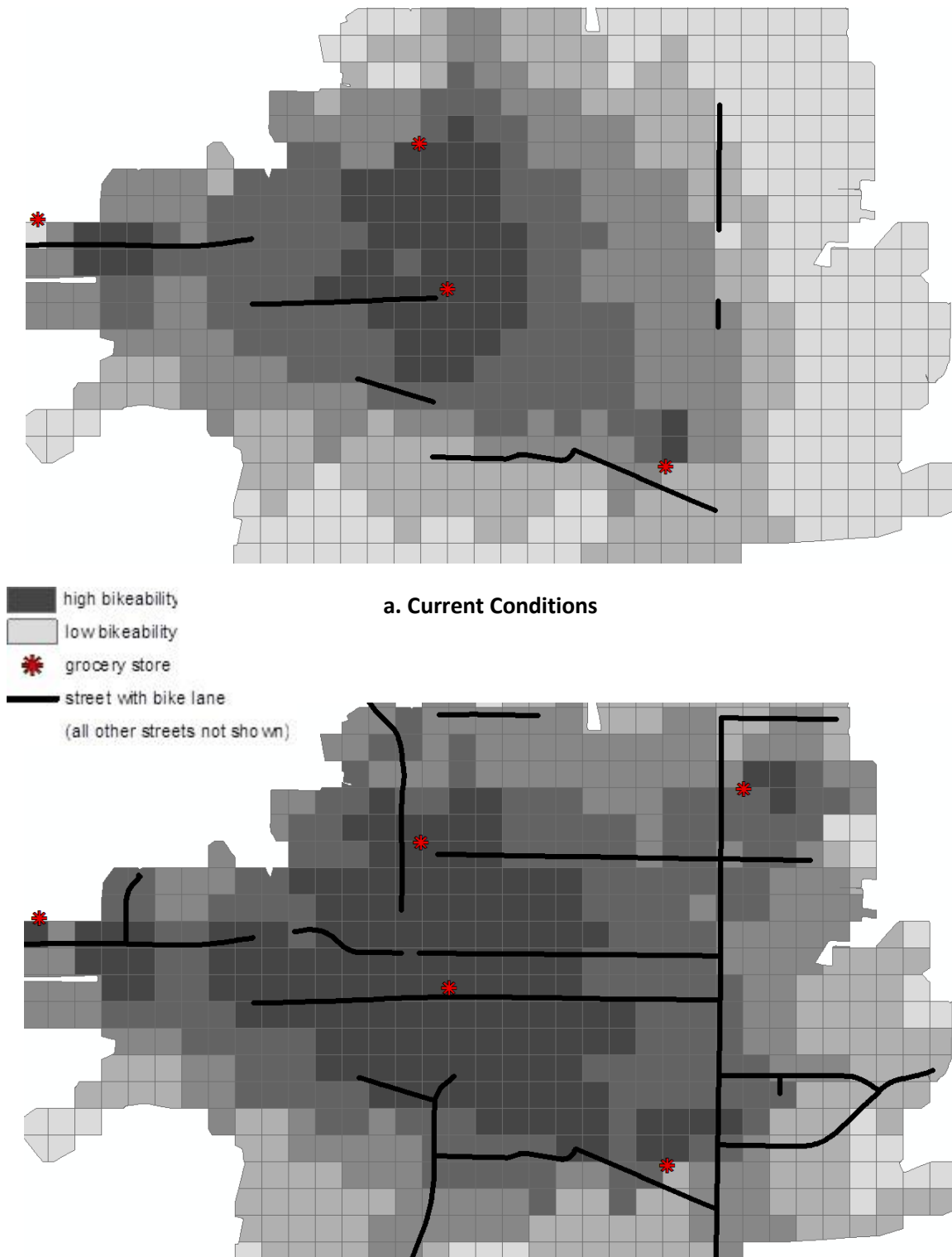
b. With Proposed Bikeway Improvements and New Grocery Store in the North-East Corner

Figure 19. Results from "Community-Wide Bikeability" for Moscow's Grocery Stores

The "Community-Wide Bikeability" tool has the longest processing time of any of the new bicycle analysis tools. During the Moscow case study, the research team identified ways to streamline the tool and significantly reduce the processing time. Figure 20 shows the linear relationship between processing time and number of analysis zones. There is a base processing time of about 8 minutes with an additional minute for every 500 zones. These results may vary from computer to computer.
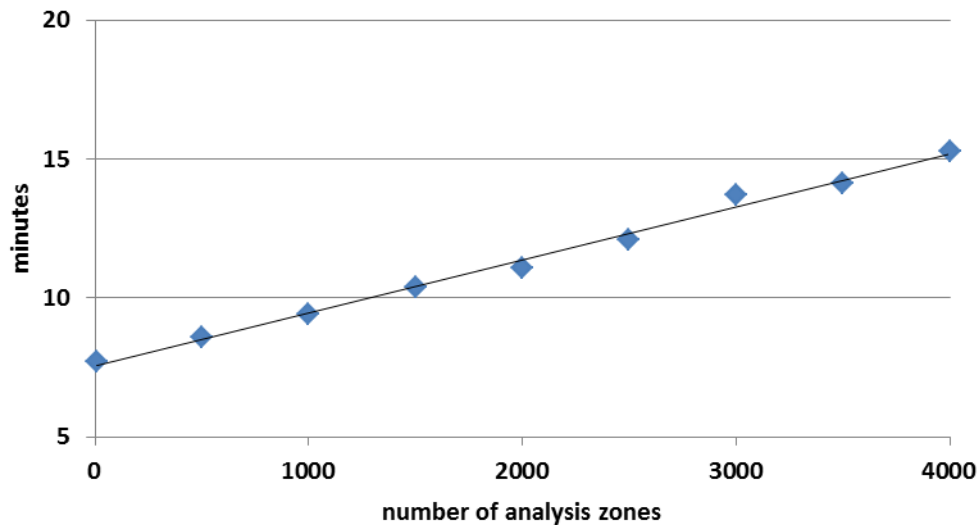
Figure 20. Processing Time for "Community-Wide Bikeability"

The project team developed the "Identify Probable Routes to a Destination" tool to help identify which street links might be the most important to cyclists travelling to a destination. The simplicity of the tool makes it more intuitive than the "Community-Wide Bikeability" tool. The analyst selects a destination by clicking on its location in the display window. The tool routes each zone to the destination based on link suitability and distance. Each link is then given a score indicating how often it is routed.

For example, Figure 21 shows the results when the destination is the Moscow Community Center. The results highlight potentially high-use routes. Research has suggested that in some situations bicycle suitability can be assumed to be a good predictor of route choice, but in some situations other factors such as hills and aesthetic features have a greater role in route choice. Interestingly, bicycle improvements are already proposed for a few locations identified by the tool as potentially high-use routes. Moscow is considering a bicycle boulevard on Cleveland Street and new bike lanes on Third Street. The results of the tool reinforce the benefits of these ideas by suggesting that they improve the suitability of direct routes to this important destination.
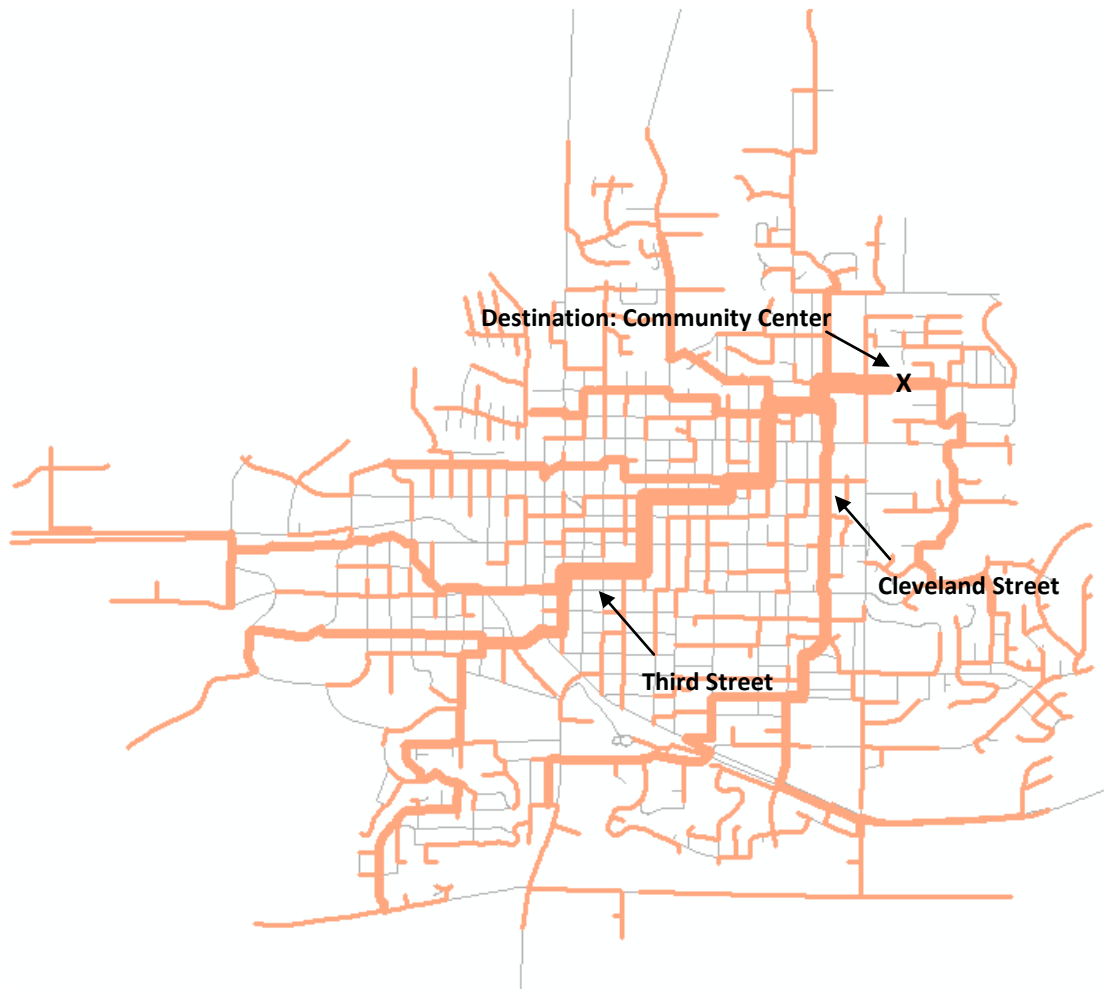
Figure 21. Results from "Identify Probable Routes to the Moscow Community Center"

Through the Moscow case study, the research team made improvements to a few tools to better suit the needs of medium-sized communities, including the "Community-Wide Bikeability" and "Identify Probable Routes to a Destination" tools. Furthermore, the Moscow case study motivated the development of the tools called "Create Analysis Zones" and "Create Streets File."

Pocatello Metropolitan Area

The Pocatello Metropolitan Area is located in Bannock County in Southeast Idaho and has an estimated population of 70,100. The City of Pocatello is home to Idaho State University.[38] Bannock Transportation Planning Organization (BTPO) maintains a great deal of data on their transportation network.

Although BTPO provided the most data of the 3 communities, 12 percent of the 4,320 links in the bikeway network lacked some piece of data for at least 1 attribute. Missing data is easily dealt with for the suitability tools, but for "Community-Wide Bikeability" and "Identify Probable Routes to a Destination" missing data is unacceptable and typically needs to be collected in the field or estimated as was done for Driggs and Moscow. However, the missing data is not a problem as the BTPO is most interested in assessing facility BLOS for corridor planning. The BTPO provided the necessary data for all

major streets, including US-91, US-30, and other major corridors in Pocatello to assess facility BLOS. In general, it is probable that medium sized communities like Moscow will focus on the bikeability tools, while large entities, like an MPO or ITD will focus on the facility BLOS tool.

The Pocatello case study prompted the research team to develop a tool for creating intersection shapefiles. None of the case study communities initially had intersection shapefiles (see Table 9). The tool called "Calculate BLOS (Intersections)" was used for the current conditions (status quo) and for an improvement scenario that would include new bike lanes. The 2010 HCM only provides a calculation for signalized intersections and gives all other intersections a BLOS "A."[1] Figure 22 shows the BLOS results of the 65 signalized intersections in the Pocatello Metropolitan Area. The improvement scenario of proposed new bike lanes would change the intersections such that there would be a 15 percent increase in signalized intersections with BLOS "A."

Using the link and intersection suitability results, the research team ran the tool called "Calculate BLOS (Facility)" for 7 facilities in downtown Pocatello. Figure 23a shows the results from the facility analysis for the current conditions (status quo). These key facilities are part of the north-south corridor through downtown. Main Street, Fourth Avenue and Fifth Avenue are comprised of two facilities each (i.e. they are split in two at a half-way point). The results for the improvement scenario of proposed new bike lanes are shown in Figure 23b. The BLOS results can help BTPO visualize the effects of making bikeway improvements on state highways and other major corridors. For this improvement scenario, every facility receives a better BLOS score.

The BTPO case study provided the research team an opportunity to refine the new bicycle analysis tools for a large community with ample data. The suitability analysis tools received a great deal of attention and scrutiny throughout this case study, resulting in more efficient and user-friendly suitability analysis tools.
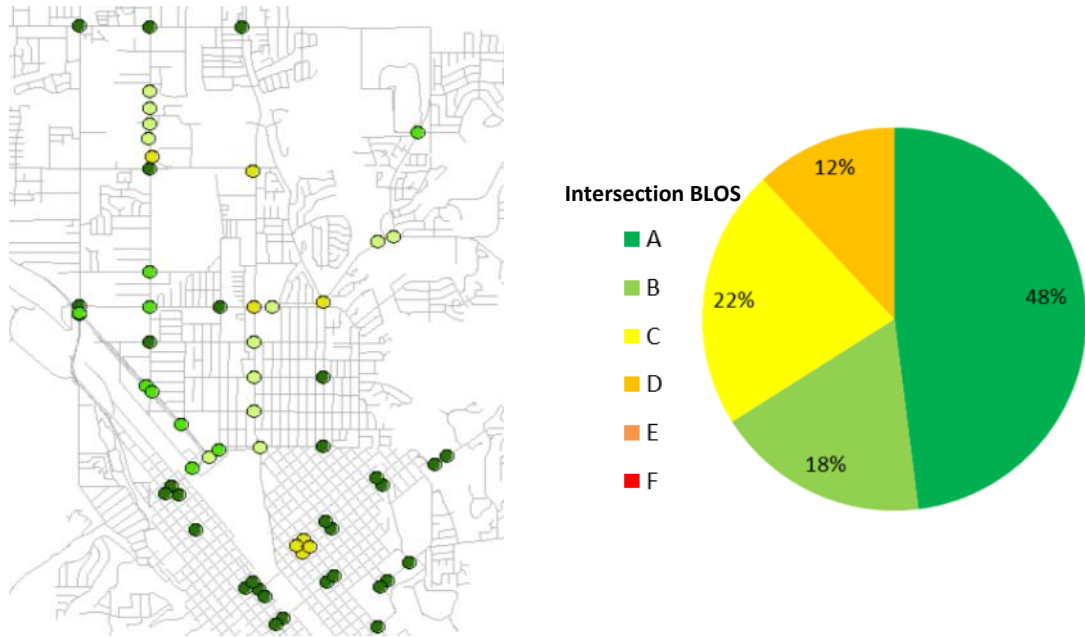
a. Current Conditions
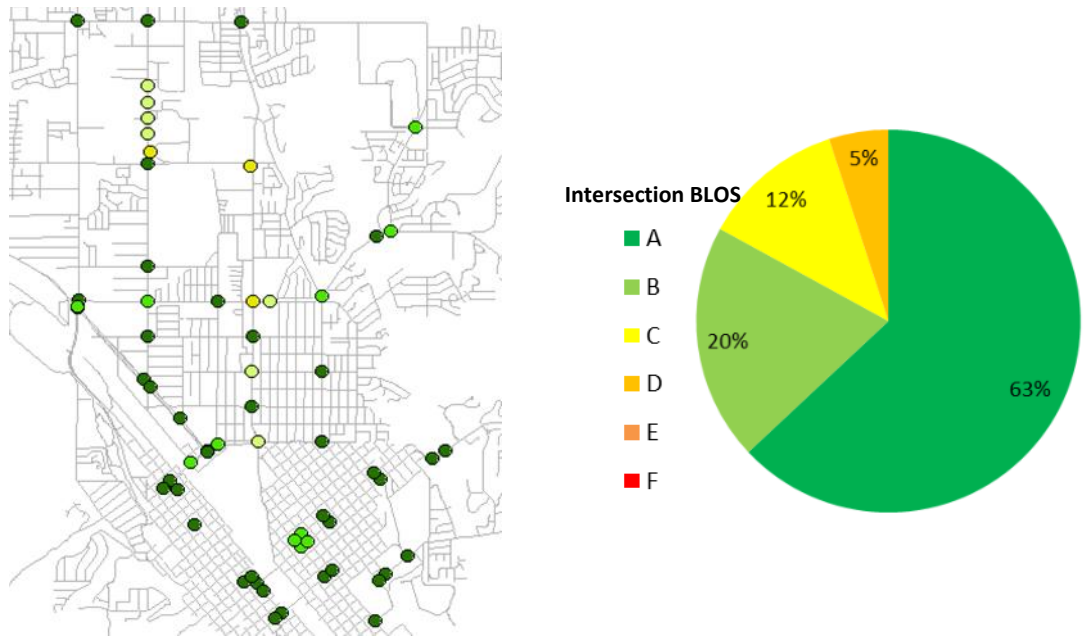
b. With Proposed Bikeway Improvements

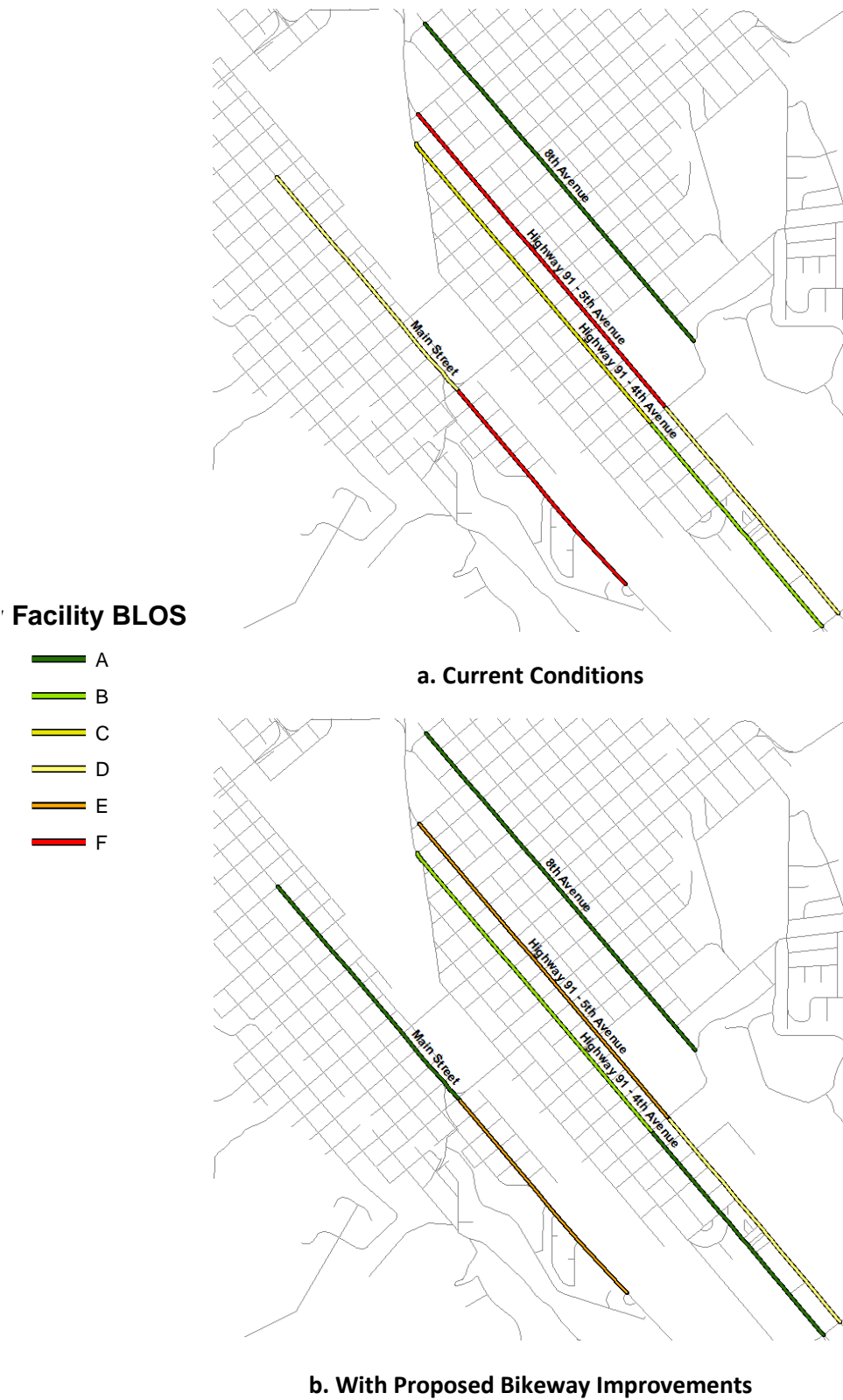**Figure 22. Results from "Calculate BLOS (2. Intersections)" for Pocatello**

Facility BLOS

▬▬▬	A
▬▬▬	B
▬▬▬	C
▬▬▬	D
▬▬▬	E
▬▬▬	F

a. Current Conditions

b. With Proposed Bikeway Improvements

Figure 23. Results from "Calculate BLOS (3. Facility)" for Pocatello Including State Highways

Chapter 6
Conclusions and Implementation Recommendations

This chapter provides conclusions about the research project and offers recommendations to ITD for implementing the new bicycle analysis tools.

The literature review revealed there has been a substantial amount of research done concerning bicycle suitability (the perceived comfort and safety of a linear section of bikeway). Numerous methods have been devised to calculate bicycle suitability. The BLOS method described in the 2010 Highway Capacity Manual is considered state-of-the-art.[1] It builds on dozens of earlier studies and, presumably, engineers and planners across the country will become increasingly familiar with the BLOS method as they utilize the ubiquitous Highway Capacity Manual.

Prior to this project, none of the methods for calculating bicycle suitability, including the BLOS method, were readily available as GIS tools. This project created several new GIS tools for assessing bicycle suitability using existing methods from the literature.

The literature review revealed that unlike bicycle suitability, very little research exists concerning "bikeability", i.e. the ability to access important destinations by bicycle. Only a few examples of assessing bikeability are documented in the literature and none of them are available as operational GIS tools.

This project created GIS tools for assessing bikeability. The suitability and bikeability tools are designed for engineers and planners to use when planning and prioritizing new bicycle facilities. The tools can be used for comparing the benefits of different improvement scenarios.

A survey conducted for this project suggests that throughout Idaho many local engineers, planners, and other community stakeholders would find the new tools useful. The survey suggested that many Idaho communities already have access to GIS software and at least minimal skill for conducting GIS analysis.

Next Steps

There are a number of immediate steps ITD can take to move forward with the products and findings of this research project.

- Incorporate "Calculate BLOS (1. Streets)" into standard level-of-service analyses for roadways in urban settings. The tool will make the analysis much easier and allow quick comparisons of different improvement scenarios.

- Use "Calculate BLOS (3. Facility)" tool during corridor planning in urban settings. The tool will make the otherwise tedious calculation much easier and allow quick comparisons of different improvement scenarios.

- Provide a download link for the tools on ITD's Bicycle and Pedestrian webpage called "Publications and Tools."[39]

- Provide training on the tools to all ITD district planners and other ITD employees involved with bicycle planning and/or corridor planning. Furthermore, make the training available for local-level community planners and engineers. The training could be conducted by the ITD Bicycle and Pedestrian Coordinator.

- Assess the usability of the tools and identify potential improvements.

Future Research and Development

The new bicycle analysis tools can be improved and expanded through future research and development. The following are a few possibilities.

1. The tools can be integrated with IPlan, an ITD project currently under development to create a one-stop online location for data and tools from many different sources. IPlan will allow ITD employees and partners to share data and will help streamline many planning activities.

2. The tools can be integrated with INSIDE Idaho, the official GIS data clearinghouse for the State of Idaho.[39] INSIDE Idaho has a "publishers" program that allows data to be automatically "harvested" from an agency's database. Various cities and counties already have data harvested periodically to make the data easily accessible to the public, ITD, or any other agency. The attribute schema for calculating BLOS could be included in the publishers program for harvesting. Furthermore, the tools could be made available at the INSIDE Idaho website.

3. The tools can be combined with benefit cost analysis to provide streamlined project prioritization. For example, NCHRP Report 552 presents a method for estimating costs and benefits of new bicycle facilities.[39] The method is available online, but does not use GIS. Future research could seek to combine the new bicycle analysis tools with the cost-benefit method on a GIS platform. Users would be able to use GIS data to analyze level-of-service and estimate costs on the same platform.

4. The tools can be extended and developed for use over the internet without requiring users to access ArcGIS® software. A webpage could be created for uploading data and running the analysis.

5. The concepts behind the tools can be modified and expanded for a broader audience. Currently the tools are intended for engineers and planners, but the concepts of bicycle suitability and bikeability could be useful for bicyclists. For example, a web interface could be created for bicyclists to help them identify routes that exhibit the best bicycle suitability or a webpage could be created for calculating bikeability for a given address, much like Walk Score®.

6. The method of calculating bikeability that was developed for this project can be improved. For example, the calculation can consider more route choice variables such as elevation and turning movements. Elevation data is readily available and turning movement data could be estimated. More research is required to better understand the effect of these variables on route choice.

7. The user-interface and help files can be improved based on feedback from ITD employees and other users. Like with most software, such improvement should be ongoing.

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Appendix A
Example Bicycle Suitability Methods

This appendix presents examples of various bicycle suitability methods. The first five examples are formal methods frequently cited in the literature. The next four methods are informal methods used by localities to provide helpful maps to residents and cyclists.

Equation

$$\text{Bicycle Stress Level} = \left[\text{Traffic Volume Component} + \text{Lane Width Component} + \text{Vehicle Speed Component} \right] * \frac{1}{3}$$

Input

Traffic Volume (vehicles per hour)	Lane Width (meters)	Vehicle Speed (km/h)	Stress Level Component
≤ 50	≥ 4.6	≤ 40	1
150	4.3	50	2
250	4	60	3
350	3.7	65	4
≥ 450	≤ 3.3	≥ 75	5

Output

Stress Level	Interpretation
1 (Very Low)	Street is reasonably safe for all types of bicyclists (except for children under 10).
2 (Low)	Street can accommodate experienced and casual bicyclists, and/or may need altering or have compensating conditions to fit youth bicyclists.
3 (Moderate)	Street can accommodate experienced bicyclists, and/or contains compensating conditions to accommodate casual bicyclists. Not recommended for youth bicyclist.
4 (High)	Street may need altering and/or have compensating conditions to accommodate experienced bicyclists. Not recommended for casual or youth bicyclists.
5 (Very High)	Street may not be suitable for bicycle use.

Intended for urban and suburban streets.

Figure 24. Bicycle Stress Level Method[4]

Equation

$$\text{Bicycle Suitability Score} = \text{Traffic Volume Factor Score} + \text{Shoulder Width Factor Score} + \text{Speed Limit Factor Score} + \text{Pavement Factor Score}$$

Input

Traffic Volume (ADT per lane)	Shoulder Width [If no shoulder, Curb Lane Width] (ft)	Speed Limit (mph)	Pavement Condition (HPMS rating)	Factor Score
≤ 1,000	≥ 6 [≥ 15]	≤ 40	4-5	2
1,000-1,999	4-6 [14-15]	49-50	3-4	1
2,000-4,999	2-4 [12-14]	50-59	3	0
5,000-9,999	0-2 [12]	60-69	2-3	-1
≥ 10,000	0 [≤ 12]	≥ 70	1-2	-2

Output

Score Range	Interpretation
6 to 8	All four suitability factors have greater than minimum desirable values. The physical characteristics of the roadway are most likely desirable by intermediate to experienced bicyclists.
-1 to 5	At least three of the four suitability factors have minimum desirable or greater than minimum desirable values. One suitability factor may have less than desirable values. The physical characteristics of the roadway could be desirable by intermediate to experienced bicyclists.
-2 to -5	At least two of the four suitability factors have less than minimum desirable values. One or two of the suitability factors may have minium desirable values. The physical characteristics of the roadway may not be desirable by intermediate to experienced bicyclists.
-6 to -8	All four of the suitability factors have less than the minimum desirable values. The physical characteristics of the roadway are most likely undesirable by intermediate to experienced bicyclists.

Intended for state highways and intermediate or experienced bicyclists.

Figure 25. Bicycle Suitability Score Method[10]

Equation

$$\begin{aligned}
\text{Bicycle Compatibility Index} = {} & 3.67 - 0.966 * BL - 0.410 * BLW - 0.498 * CLW + 0.002 * CLV \\
& + 0.0004 * OLV + 0.022 * SPD + 0.506 * PKG \\
& - 0.264 * AREA + FT + FP + FR
\end{aligned}$$

Input

Attribute	Description
BL	presence of bike lane or paved shoulder (yes= 1, no =0)
BLW	bicycle lane width (meters)
CLW	curb lane width (meters)
CLV	curb lane volume (vph)
OLV	other lane volume (vph)
SPD	85th percentile speed (km/h)
PKG	presence of parking lane (yes=1, no=0)
AREA	type (residential=1, otherwise=0)
FT	truck volume factor (see look up table)
FP	parking turnover factor (see look up table)
FR	right turn volume factor (see look up table)

Output

BCI range	Compatibility Level
≤ 1.5	Extremely High
1.51-2.30	Very High
2.31-3.40	Moderately High
3.41-4.40	Moderately Low
4.41-5.30	Very Low
>5.30	Extremely Low

Intended for average adult bicyclists. See source for look up tables.

Figure 26. Bicycle Compatibility Index Method[11]

Date:	April 4, 2002	Comments/Suggested Improvements:
Data Collector Name:	Jim	
Segment ID Number/Name:	101 – Sangole	
Boundary streets:	Walnut / Tulip	

A) General Road Factors	Measures
1) Annual Avg. Daily Traffic (AADT)	16,500
2) Total number of through lanes	2
3) Speed (mph)	35
4) Outside lane width (e.g., 11.5')	12.5
5) Bike lane or paved shoulder width (e.g., 4.5') (Note - a **marked** bike lane.)	Ø
Record these measures in the formula below	

C) Location Factors	Yes/No (circle)	Score for "Yes"
1) Angle Parking	Y (N)	0.75
2) Parallel Parking	(Y) N	(0.50)
3) Right-Only Turn Lanes	(Y) N	(0.25)
4) Center (Both)Turn Lane	Y (N)	-0.25
5) Physical Median	Y (N)	-0.50
6) Paved Shoulder	Y (N)	-0.75
7) Marked Bike Lane	Y (N)	-1.00
8) Severe Grades	Y (N)	0.50
9) Moderate Grades	(Y) N	(0.25)
10) Frequent Curves	(Y) N	(0.25)
11) Restricted Sight Distance	(Y) N	(0.50)
12) Numerous Driveways	(Y) N	(0.50)
13) Numerous Intersections	Y (N)	0.75
14) Difficult Intersections	Y (N)	1.00
15) Industrial Land Use	Y (N)	0.50
16) Commercial Land Use	(Y) N	(0.25)
17) Sidewalk Only One Side	(Y) N	(0.25)
18) Sidewalks do not exist	Y (N)	0.50
TOTAL all "YES" points *Record score in formula below*		2.75

B) Pavement Factors		Score
1) (circle one pavement description)		(record score)
Very Good	= 0.25	
Good	(= 0.75)	0.75
Fair	= 1.50	
Poor	= 2.25	
Very Poor	= 3.75	
2) Presence of a Curb	(Y) N	Yes = (0.25)
3) Rough RR Crossing	Y (N)	Yes = 0.50
4) Storm Drain Grate	(Y) N	Yes = (0.75)
TOTAL Scores *Record score in formula below*		1.75

$$\frac{AADT}{\#\ of\ thru\ Lanes\ 2 \times 2500} + \frac{Speed\ (mph)}{35} + \frac{14 - Outside\ Lane\ Width\ 12.5 - Bike\ Lane\ or\ Paved\ Shoulder\ Width\ Ø}{2} + Pavement\ Factors\ 1.75 + Location\ Factors\ 2.75 = Bicycle\ Suitability\ Score\ 9.6$$

Filled values: AADT = 16,500; # of thru Lanes = 2; Speed = 35; Outside Lane Width = 12.5; Bike Lane or Paved Shoulder Width = Ø; Pavement Factors = 1.75; Location Factors = 2.75; Bicycle Suitability Score = 9.6

Figure 27. Bicycle Suitability Assessment Method (Example of a Completed Form)[12]

Equation

$$\text{Bicycle Level of Service} = 0.76 + [-0.005((w_{ol} + w_{bl} + w_{os})(2 - 0.005v) + (w_{bl} + w_{os} - 20p_{pk}) - 1.5c)^2]$$
$$+ 0.507 \ln\left(\frac{v}{4N_{th}}\right)$$
$$+ 0.199[1.119\ln(S - 20) + 0.8103](1 + 0.1038P_{HV})^2 + 7.066(\frac{1}{P_c^2})$$

Input

Attribute	Description
wol	width of outside lane (ft)
wbl	width of bike lane (ft)
wos	width of outside shoulder including parking and gutter (ft)
ppk	estimated proportion of on-street parking that would be occupied during analysis period (decimal)
c	curb present (yes = 1, no = 0)
v	directional analysis period vehicle volume (vph)
Nth	number of through lanes (#)
S	average vehicle speed (mph)
PHV	percent heavy vehicles (decimal)
Pc	pavement condition (poor-excellent) (0-5)

Output

BLOS	Letter Grade
≤ 2.00	A
2.00-2.75	B
2.75-3.50	C
3.50-4.25	D
4.25-5.00	E
>5.00	F

Intended for urban streets. See source for additional information concerning conditions for attributes.

Figure 28. Bicycle Level-of-Service Method[1]
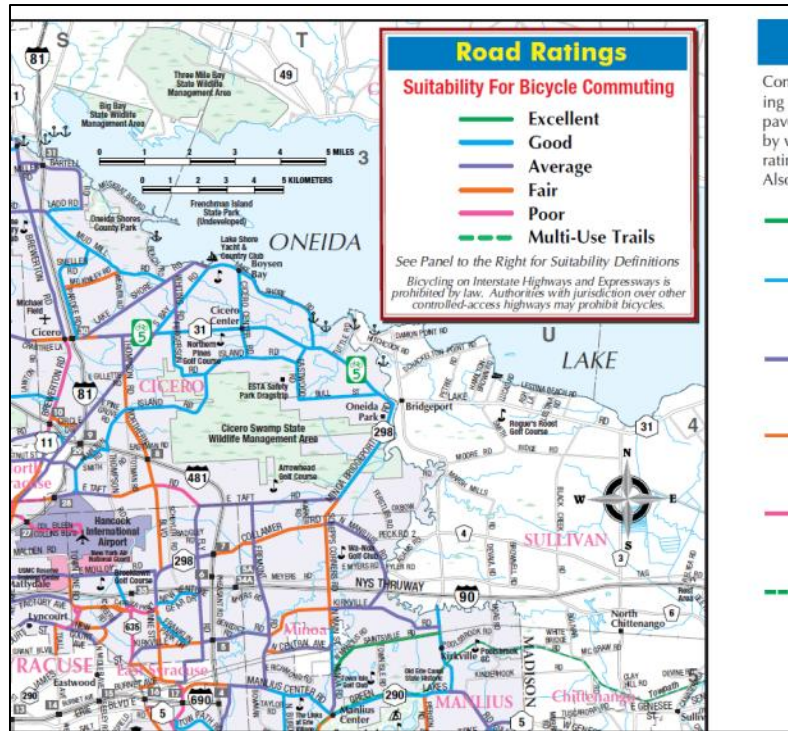
a. Map Excerpt
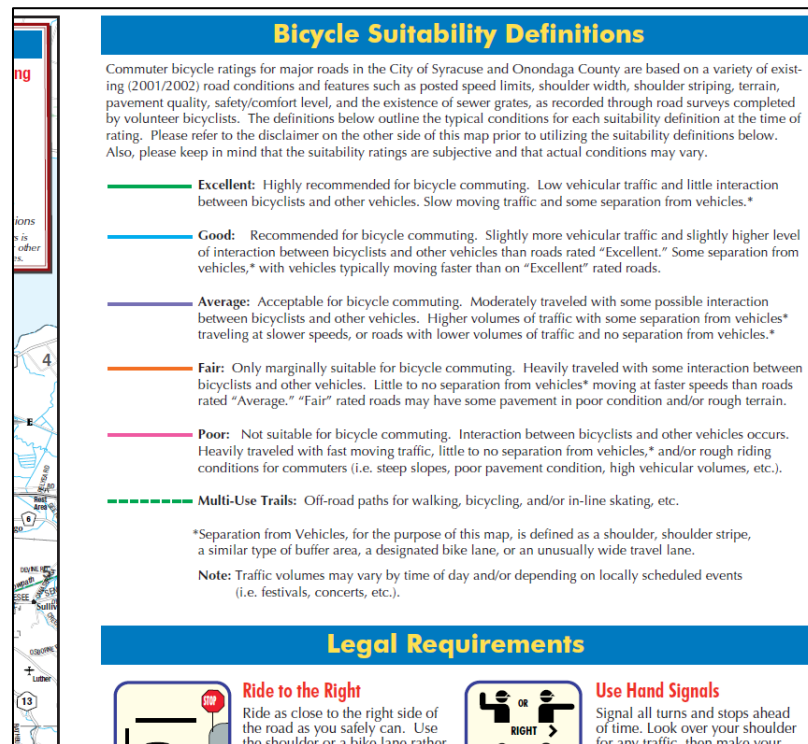
b. Bicycle Suitability Definitions Excerpt

Figure 29. Excerpts from Syracuse, New York's Bicycle Suitability Map[20]
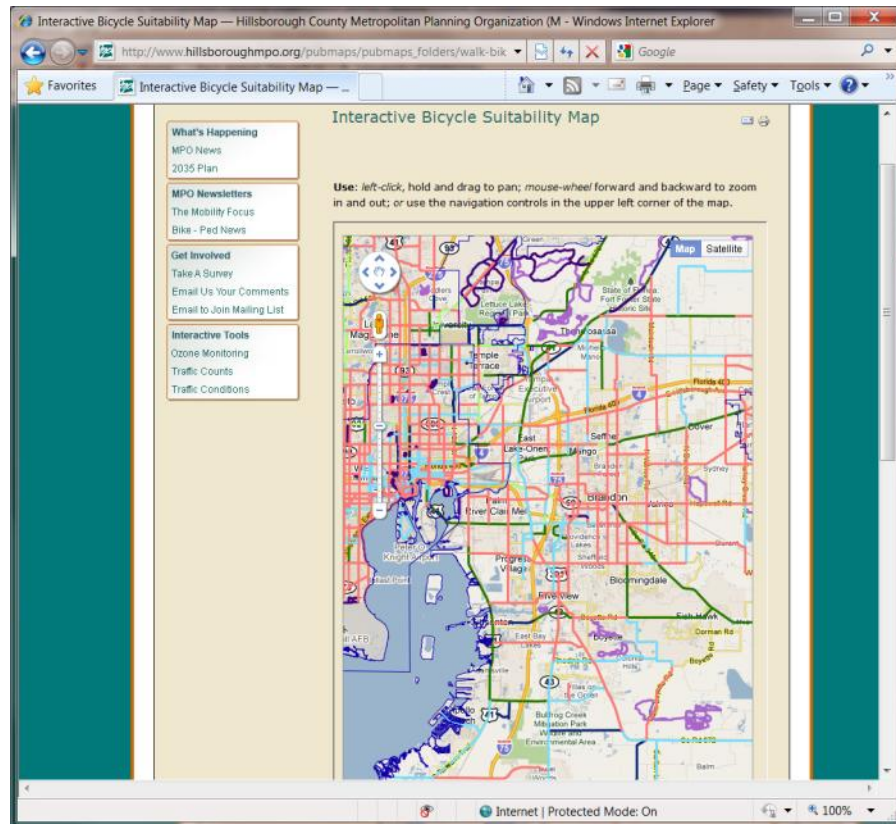
a. Map Screenshot
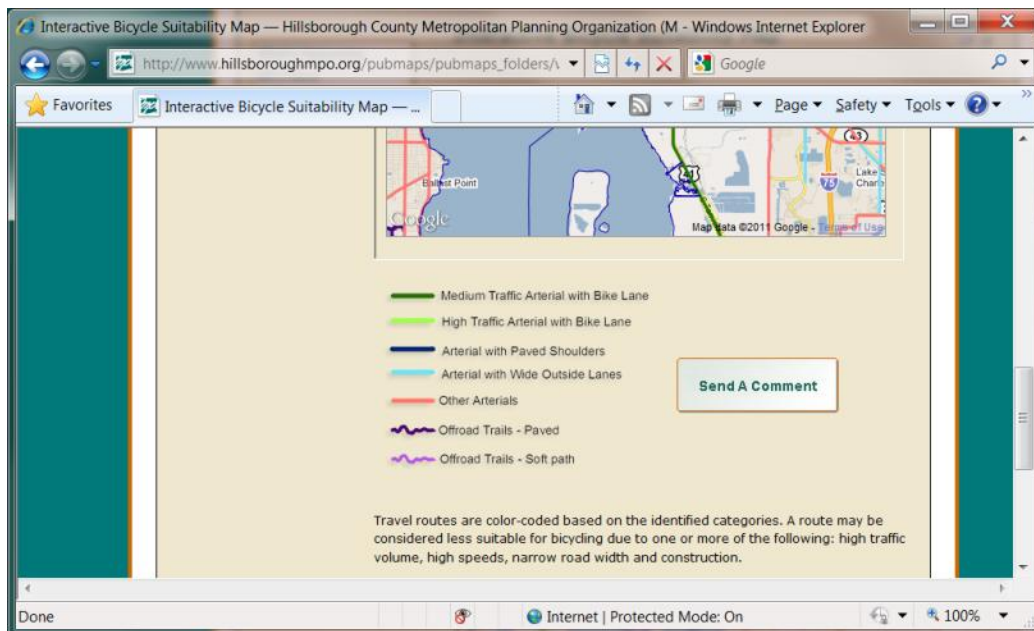
b. Bicycle Suitability Definitions

Figure 30. Screen Shots from Tampa, Florida's Online Bicycle Suitability Map[21]
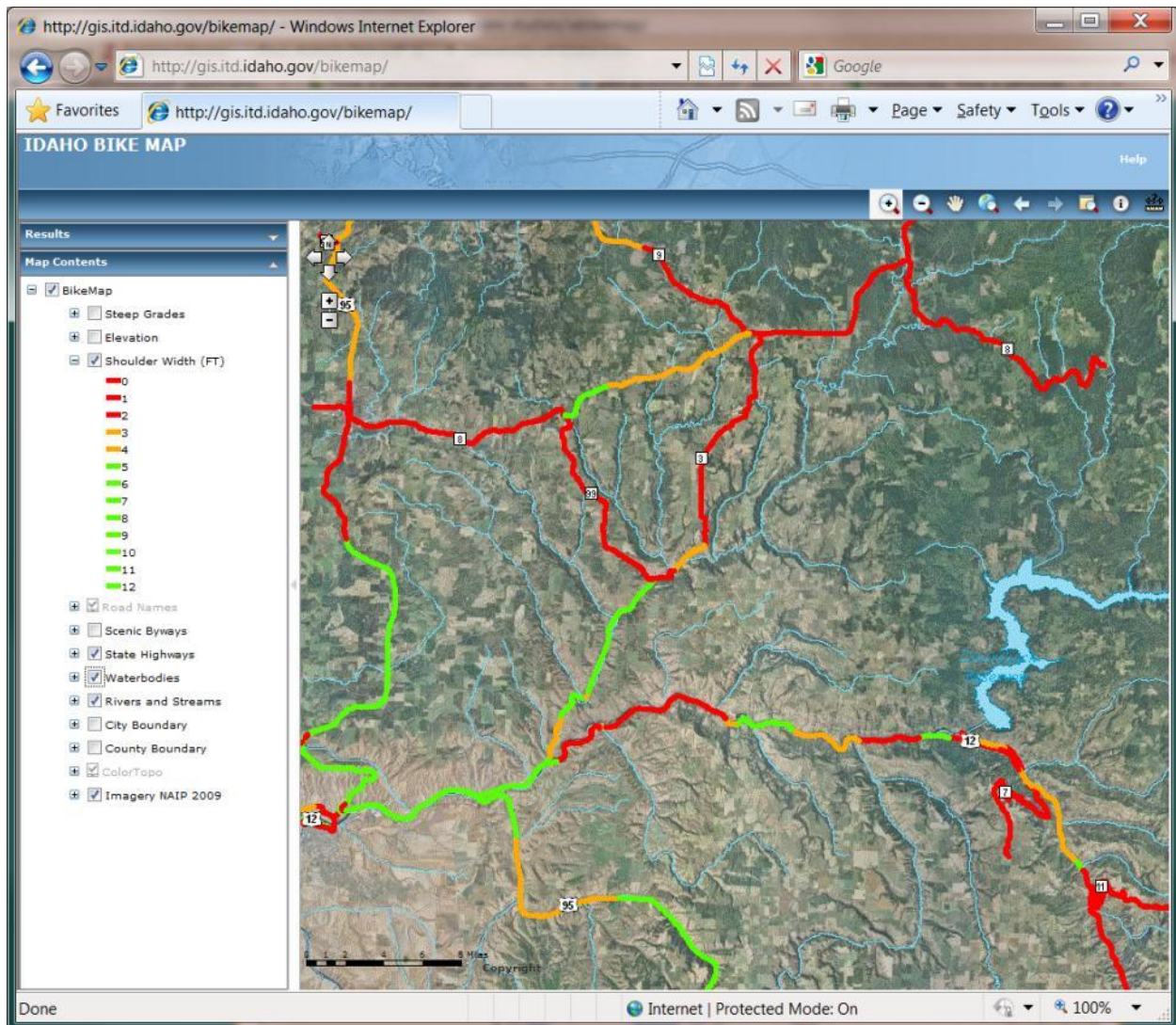
Figure 31. Screen Shot of the Online Idaho Bike Map[(22)]
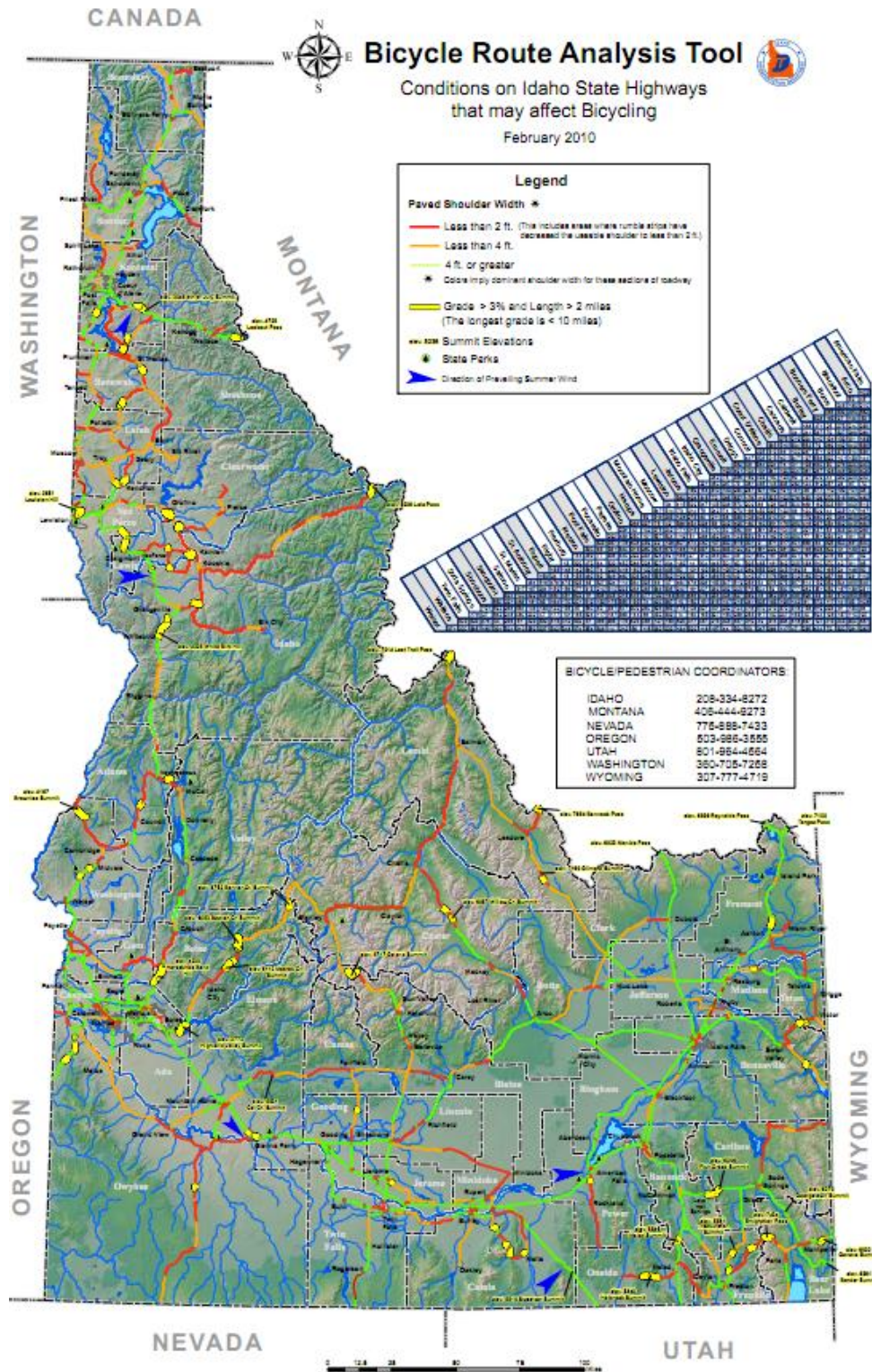
Figure 32. Bicycle Route Analysis Tool for Idaho[23]

Appendix B
Survey Questions and Summary of Responses

This appendix provides all the questions from the survey and a summary of the responses.

1. What is your role in the community? (Please select all that apply)		Response Percent	Response Count
engineer		11.3%	13
planner		25.2%	29
grant writer		6.1%	7
draftsman, technician, data specialist		1.7%	2
elected official		20.9%	24
non-elected advisory commission member		7.0%	8
advocacy group member		3.5%	4
bicycle sales person		0.9%	1
Other (please specify)		37.4%	43
	answered question		115
	skipped question		0

2. What is the name of your community? (i.e. city, county, reservation, etc.)	Response Count
	110
answered question	110
skipped question	5

57

Question 2. What is the name of your community?

ACHD	City of Meridian (8 responses)
Aberdeen, City	City of Nampa (4 responses)
American falls	City of Payette
Boise City	City of Post Falls (3 responses)
Bonneville Metropolitan Planning Area	City of Priest River
Canyon	City of Rathdrum (2 responses)
Cascade	City of Ririe
Chubbuck (2 responses)	City of Shelley
City (9 responses)	City of Spencer
City of Ammon	City of St. Anthony (2 responses)
City of Bonners Ferry	City of Stanley
City of Burley	City of Teton (3 responses)
City of Challis	City of Tetonia
City of Coeur d'Alene (5 responses)	City of Twin Falls (3 responses)
City of Council (2 responses)	City of Weiser (2 responses)
City of Crouch	Dayton City (2 responses)
City of Dayton	Donnelly
City of Emmett (2 responses)	Eagle
City of Fairfield	Fruitland City
City of Franklin	Grand View
City of Garden City (2 responses)	Jerome
City of Georgetown	Kootenai County (2 responses)
City of Grace	Mackay City
City of Hailey	New Meadows
City of Hansen	No answer (5 respondents)
City of Homedale	Orofino
City of Idaho Falls	Pocatello
City of Island Park (2 responses)	Sandpoint (4 responses)
City of Kamiah (2 responses)	Sugar City
City of Kuna	Swan Valley
City of Lewiston (3 responses)	Victor
City of McCall (3 responses)	

After accounting for repeats and no answer, an estimated 60 unique communities were surveyed.

3. What is the approximate population?

		Response Percent	Response Count
less than 2,000		30.4%	35
2,000 - 5,000		9.6%	11
5,000 - 15,000		20.9%	24
15,000 - 25,000		3.5%	4
25,000 - 50,000		14.8%	17
50,000 - 100,000		15.7%	18
100,000 - 500,000		5.2%	6
greater than 500,000		0.0%	0
	answered question		115
	skipped question		0

4. How well does your community's comprehensive plan (or similar plan) address the following issues?

	Not very well	Well	Very well	I don't know	Rating Average	Response Count
bicycle planning for existing development	56.3% (63)	31.3% (35)	9.8% (11)	2.7% (3)	1.52	112
bicycle planning for future development	40.0% (44)	34.5% (38)	21.8% (24)	3.6% (4)	1.81	110
				answered question		113
				skipped question		2

59

5. Which methods does your community use to decide where and when to provide on-street bike lanes, off-street bike paths, and bike racks? (Think of your existing and proposed bicycle facilities).

	Never	Very rarely	Sometimes	Always	Rating Average	Response Count
public input activities such as town hall meetings	13.2% (14)	20.8% (22)	**56.6% (60)**	9.4% (10)	1.62	106
unsolicited public request	15.7% (16)	32.4% (33)	**46.1% (47)**	5.9% (6)	1.42	102
legal requirements for new subdivisions or other city ordinances	22.3% (23)	16.5% (17)	**34.0% (35)**	27.2% (28)	1.66	103
formal studies of bicycle crashes	**54.0% (54)**	29.0% (29)	14.0% (14)	3.0% (3)	0.66	100
formal studies of bicycle traffic volumes	**52.5% (52)**	29.3% (29)	15.2% (15)	3.0% (3)	0.69	99
if there is enough space, then a bike lane is included	25.0% (25)	21.0% (21)	**43.0% (43)**	11.0% (11)	1.40	100
if the street is a certain functional classification, then a bike lane is included	25.5% (26)	24.5% (25)	**37.3% (38)**	12.7% (13)	1.37	102
based on motor vehicle traffic volumes	**34.7% (35)**	**34.7% (35)**	26.7% (27)	4.0% (4)	1.00	101
community-wide study of routes and destinations using GIS analysis	**37.4% (37)**	22.2% (22)	35.4% (35)	5.1% (5)	1.08	99
community-wide study of routes and destinations using printed maps	29.7% (30)	17.8% (18)	**42.6% (43)**	9.9% (10)	1.33	101
				Other (please specify)		10
				answered question		107
				skipped question		8

6. In the text box below, please provide any additional information about how planning for bicycling occurs in your community.

	Response Count
	65
answered question	65
skipped question	50

7. Does your community use a rating system to assess the quality of bike routes? For example, some communities determine a rating (or score) for every street based on traffic volumes and lane width.

		Response Percent	Response Count
Yes		6.7%	7
No		72.4%	76
I don't know		21.0%	22
	If Yes, please explain		11
	answered question		105
	skipped question		10

8. What information is typically collected/available for the STREETS of your community? (Check all that apply.)			
		Response Percent	Response Count
I don't know		12.3%	13
no information is collected/available		5.7%	6
functional classification		58.5%	62
street width		**75.5%**	**80**
number of lanes		67.0%	71
lane widths		60.4%	64
shoulder width		42.5%	45
right-of-way width		68.9%	73
presence of curb		57.5%	61
presence of on-street parking		40.6%	43
on-street parking occupancy rate		11.3%	12
presence of bike lane		41.5%	44
presence of bike route (designated by signs or public maps)		34.9%	37
adjacent land use		39.6%	42
speed limit		66.0%	70
percentile speeds		12.3%	13
vehicle traffic volumes (such as AADT or hourly volumes)		41.5%	44
percentage of heavy vehicle traffic		12.3%	13
pavement condition		48.1%	51
elevation grades		26.4%	28
Other (please specify)		4.7%	5

9. What information is typically collected/available for ON-STREET BIKE LANES and ON-STREET BIKE ROUTES of your community? (Check all that apply)

	Response Percent	Response Count
I don't know	20.0%	21
no information is typically collected/available	37.1%	39
location	35.2%	37
lane width	31.4%	33
volume of bicycle traffic	1.9%	2
accident rates	5.7%	6
paint marking information	17.1%	18
pavement condition	20.0%	21
elevation grades	12.4%	13
Other (please specify)	8.6%	9
answered question		105
skipped question		10

10. What information is typically collected/available for OFF-STREET BIKE PATHS of your community? (Check all that apply)

	Response Percent	Response Count
I don't know	21.9%	23
no information is typically collected/available	36.2%	38
location	41.0%	43
path width	35.2%	37
volume of bicycle traffic	2.9%	3
accident rates	1.9%	2
paint marking information	4.8%	5
pavement condition	15.2%	16
elevation grades	9.5%	10
Other (please specify)	7.6%	8
answered question		105
skipped question		10

11. What information is typically collected/available for BIKE RACKS/SHELTERS etc in your community? (Check all that apply)

		Response Percent	Response Count
I don't know		27.6%	29
no information is typically collected/available		**55.2%**	**58**
location		15.2%	16
rack or shelter type		7.6%	8
capacity or number of racks/shelters		8.6%	9
usage rates		1.0%	1
infrastructure condition		1.0%	1
Other (please specify)		5.7%	6
		answered question	105
		skipped question	10

12. Does your community have access to Geographic Information System (GIS) software?

		Response Percent	Response Count
Yes		**66.3%**	**69**
No		24.0%	25
I don't know		9.6%	10
If Yes, please specify (e.g. ESRI ArcGIS 10, ESRI ArcView 3, Autodesk Map 3D)			34
		answered question	104
		skipped question	11

65

13. Does your community have access to Computer Aided Design (CAD) software?

		Response Percent	Response Count
Yes		49.0%	51
No		32.7%	34
I don't know		18.3%	19
	If Yes, please specify (e.g. AutoCAD, MicroStation)		19
		answered question	104
		skipped question	11

14. What is the level of skills/capability currently available from the personnel of your community? (yourself and/or the other engineers, planners, staff, etc.)

	None	Below Average	Average	Above Average	I don't know	Rating Average	Response Count
GIS skills/capability	16.0% (16)	8.0% (8)	24.0% (24)	40.0% (40)	12.0% (12)	2.00	100
CAD skills/capability	18.8% (19)	5.0% (5)	20.8% (21)	38.6% (39)	16.8% (17)	1.95	101
					answered question		101
					skipped question		14

15. Does your community keep GIS or CAD information for the following?

	Yes	No	I don't know	Response Count
the street network	61.4% (62)	22.8% (23)	15.8% (16)	101
on-street bike lanes/routes	33.3% (32)	41.7% (40)	25.0% (24)	96
off-street bike paths	36.2% (34)	40.4% (38)	23.4% (22)	94
bike racks/shelters etc.	1.1% (1)	65.9% (60)	33.0% (30)	91
land use parcels	58.6% (58)	22.2% (22)	19.2% (19)	99
land use zoning	65.0% (65)	19.0% (19)	16.0% (16)	100
			answered question	102
			skipped question	13

Appendix C
Help Documentation for Tools

Help documentation for each tool can be accessed by clicking "Tool Help" on the interface as shown in Figure 33 or by right clicking the tool and choosing "Item Description" shown in Figure 34. The difference is that "Item Description" includes images. This appendix reproduces the item description in this order:

- Add BLOS Fields to Street File
- Create Analysis Zones
- Create Intersection File
- Create Streets File
- Enter Estimate Data
- Calculate BLOS (1. Streets)
- Calculate BLOS (2. Intersections)
- Calculate BLOS (3. Facility)
- Calculate BLOS (4. Pathways)
- Calculate BSL
- Calculate BSS
- Community-Wide Bikeability
- Identify Probable Routes to a Destinations
- Suitability Summary Statistics
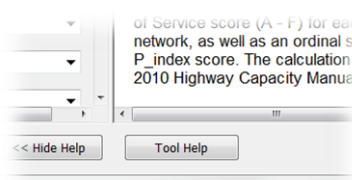
Figure 33. Tool Help Button
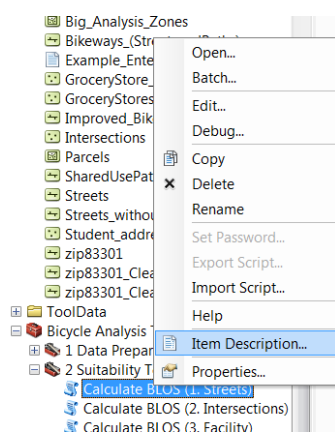
Figure 34. Item Description Button

Title   Add BLOS Fields to Street File

Summary

Adds fields to a street file for BLOS calculations. The first 10 fields are the default names for the fields needed for the tool called "Calculate BLOS (1. Streets)." The 11th field is the default name for the field needed for "Calculate BLOS (4. Facility)." The new fields include:

Wol   - width of outside through lane
Wos   - width of paved outside shoulder
Wbl   - width of bicycle lane
Ppk   - proportion of on-street parking occupied
v   - midsegment vehicle demand flow rate
PHV   - percent heavy vehicles in the midsegment demand flow rate
SR   - motorized vehicle running speed
Nth   - number of through lanes on the segment in the subject direction of travel
Pc   - pavement condition rating
AccPts – number of access points

Illustration

c	v	Nth	Wol	Wbl	ppk	Wos	PHV	Pc	SR	AccPts
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0

Usage

The tool is useful for planners and engineers that wish to use the tools "Calculate BLOS (1 . Streets)" and "Calculate BLOS (4. Facility)."

Syntax

CreateAnalysisZones (Input_Bikeway_Network, Zone_Width, Zone_Length, Ouput_Analysis_Zones)

Parameter	Explanation	Data Type
Input_Bikeway_Network	**Dialog Reference** Input street feature that needs new fields. Existing fields will not be created.	Feature Layer

Credits

Copyright © 2011 Michael Lowry. Created for the Idaho Transportation Department by Michael Lowry. *2010 Highway Capacity Manual*. Transportation Research Board, 2011.

Title   Create Analysis Zones

Summary

Creates a polygon, fishnet-grid of analysis zones. The analysis zones are intended to cover a community by buffering the street network. The user provides a street network file and specifies the desired zone dimensions.

Illustration
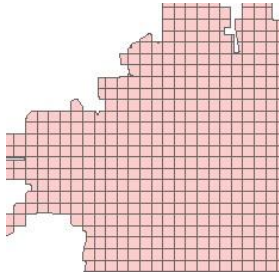
Usage

The tool is useful for planners and engineers that wish to use a uniform set of analysis zones for community-wide bikeability analysis, perhaps because a parcel file or traffic analysis zones are not available.

Syntax

CreateAnalysisZones (Input_Bikeway_Network, Zone_Width, Zone_Length, Ouput_Analysis_Zones)

Parameter	Explanation	Data Type
Input_Bikeway_Network	**Dialog Reference** Input feature that contains the links of the bikeway network. Zones will be created at an extent equal to the extent of the input bikeway network.	Feature Layer
Zone_Width	**Dialog Reference** Desired width (in feet) of the custom analysis zones being created. Default is 500 feet.	Double
Zone_Length	**Dialog Reference** Desired length (in feet) of the custom analysis zones being created. Default is 500 feet.	Double
Ouput_Analysis_Zones	**Dialog Reference** Name and folder directory for the new analysis zones feature.	Feature Class

Credits

Copyright © 2011 Michael Lowry. Created for the Idaho Transportation Department by Michael Lowry.

Title   Create Intersection File

Summary

Creates nodes for each intersection in a street network. It also creates fields necessary for calculating intersection Bicycle Level-of-Service (BLOS).

Illustration
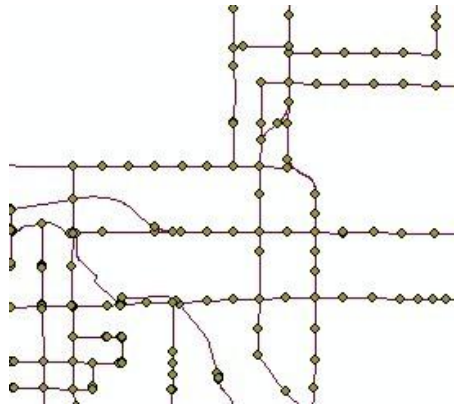
Usage

This tool creates nodes that can be used in an accompanying tool that calculates intersection BLOS. The tool is meant to help city planners and engineers to prioritize bikeway improvements.

Syntax

CreateNodes (Input_Network, Output_Nodes)

Parameter	Explanation	Data Type
Input_Network	**Dialog Reference** The street network from which to creation the intersection feature.	Feature Layer
Output_Nodes	**Dialog Reference** Name and folder directory for the output feature containing the newly created nodes.	Feature Class

Credits

Copyright © 2011 Michael Lowry. Created for the Idaho Transportation Department by Michael Lowry, Daniel Callister and Brandon Moore.

Title   Create Streets File

Summary

Creates a feature class containing street links for specified zip codes. The new file includes fields necessary for calculating Bicycle Level-of-Service.

⚠ **Caution:** The output is a street network with correct topology, but requires deleting "isolated links" that are not connected to the main network and links that are not part of the analysis area. Although it may be time consuming to delete links, in most cases this clean-up process will still be much quicker than fixing the topology of a poorly designed street centerline file. The ExampleData shows a streetfile before and after links are deleted.

📒 **Note**: This tool works only for zip codes in the state of Idaho. The zipcodes need to be contiguous.

Illustration
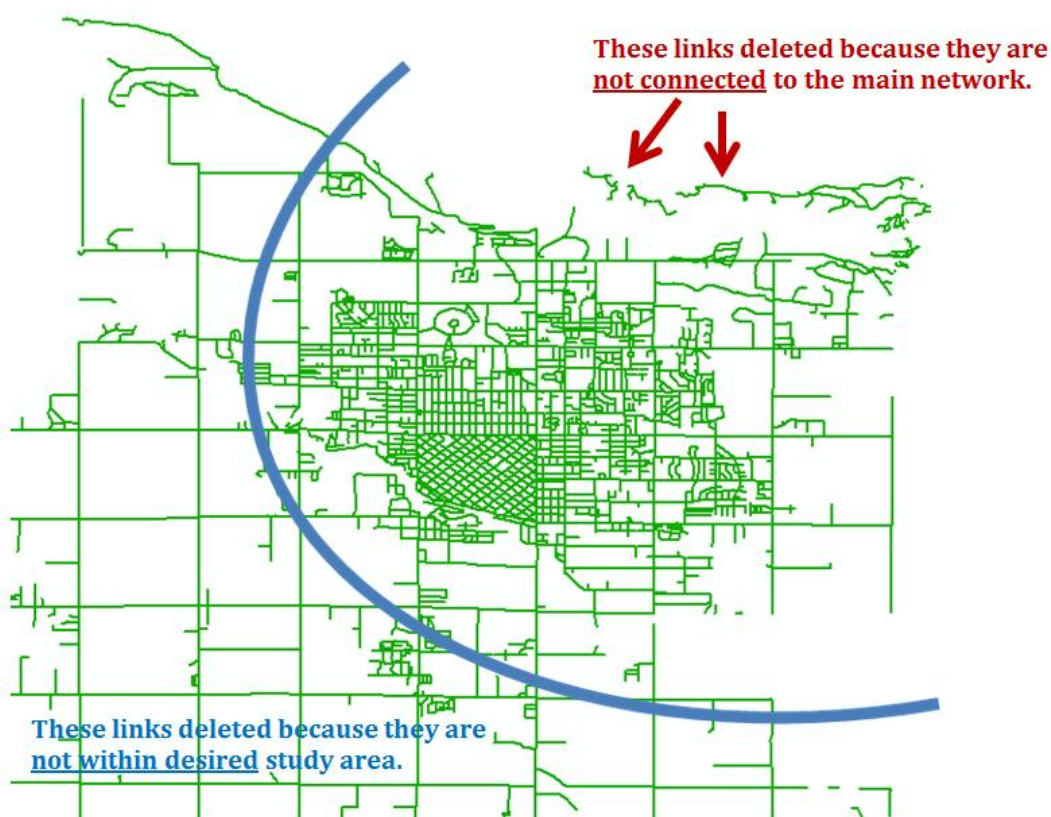
Usage

This tool creates street links that can be used with the other bicycle analysis tools. The tool is meant to help city planners and engineers to prioritize bikeway improvements.

Syntax

CreateStreets (Zipcodes, Output__Clipped_Steets)

Parameter	Explanation	Data Type
Zipcodes	**Dialog Reference** Provide zip code(s) from which to create a streets file.	Multiple Value
Output__Clipped_Steets	**Dialog Reference** Name and folder directory for the output feature containing the newly created street links. The output is a street network with correct topology, but requires deleting "isolated links" that are not connected to the main network and links that are not part of the analysis area. Although it may be time consuming to delete links, in most cases this clean-up process will still be much quicker than fixing the topology of a poorly designed street centerline file. The ExampleData shows a streetfile before and after links are deleted.	Feature Class

Credits

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Title   Enter Estimated Data

Summary

Populates link attributes based on street type/classification. Any type of classification and any number of classes can be used. The attribute fields must be labeled exactly (case sensitive) the same in the csv file and shapefile attribute table. Any number of attributes can be included the order doesn't matter. The street type name must be text and match exactly (case sensitive) with a corresponding field in the street file.

Illustration

StreetType	Wos	c	ppk	Wol	v	PHV	SR	Nth	Pc	Wbl
Gravel	0	0	0	9	7	0.01	25	1	1.5	0
Paved with Bike Lane	3	0	0	12	80	0.1	35	1	4	5
Rural Paved	0	0	0	12	20	0.01	25	1	3.5	0
Urban Paved	2	1	0.1	12	80	0.05	25	1	4	0
State Highway	15	1	0.3	18	300	0.2	35	1	4	0

Usage

Tool is helpful for quickly populating street link attributes when other options for data collection are not feasible. The tool is meant to help city planners and engineers to prioritize bikeway improvements.

Syntax

EnterEstimatedData (Input_Street_File, Category_Field_Text, Input_Data_File)

Parameter	Explanation	Data Type
Input_Street_File	**Dialog Reference** Select the feature containing the street links. Links must contain an attribute that distinguishes type or classification of some sort. This file will be updated by the tool to include data estimates.	Feature Layer
Category_Field_Text	**Dialog Reference** Text field that will be matched for entering data.	Text field
Input_Data_File	**Dialog Reference** .csv file with estimated data. Any type of classification and any number of classes can be used. The attribute fields must be labeled exactly (case sensitive) the same in the csv file and shapefile attribute table. Any number of attributes can be included the order doesn't matter. The street type name must be text and match exactly (case sensitive) with a corresponding field in the street file.	csv file

Credits

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Title   Calculate BLOS (1. Streets)

Summary

Calculates Bicycle Level-of-Service (BLOS) for each link in a network. The calculation is based on the 2010 Highway Capacity Manual. The tool creates two new fields: one for a numeric score and one for the associated letter grade.

⚠ **Caution:** If the output fields already exist, the existing data is overwritten.

⚠ **Caution:** This tool cannot have any blank fields for any links. Please provide data (perhaps estimates) or delete links that do not have data.

Illustration

BLOS_Score	BLOS_Text
4.79	E
3.77	D
3.73	D
1.25	A
1.25	A
2.94	C
2.96	C
2.31	B

Usage

The tool is useful for city planners and engineers to quickly calculate BLOS scores for links in their street network. The tool is meant to identify BLOS deficiencies and help prioritize bikeway improvements.

Symbology is provided in a layer file in the ToolData folder.

Street Link BLOS
— A
— B
— C
— D
— E
— F

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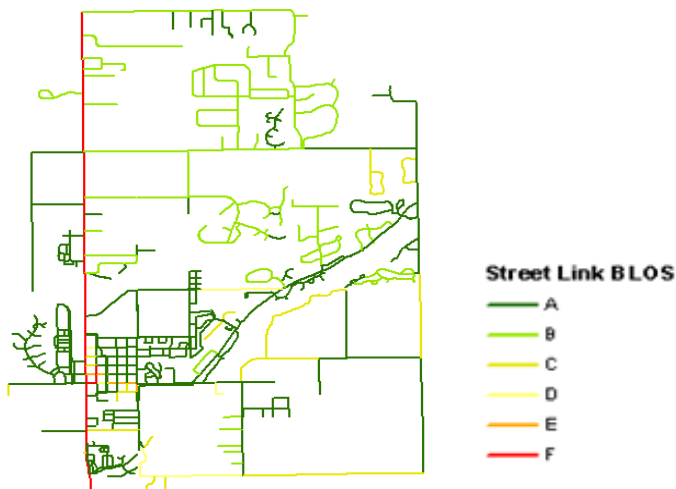
Syntax

CalculateBLOS (Input__Street_File, Width_of_Outside_Shoulder, Curb_present, Proportion_of_On-street_Parking, Width_of_Outside_Lane, Width_of_Bicycle_Lane, Study_Hour_Directional_Vehicle_Volume, Percent_Heavy_Vehicles, Average_Vehicle_Speed, Number_of_Through_Lanes, Pavement_Condition, Output_Field_1__BLOS_Score, Output_Field_2__BLOS_Text)

Parameter	Explanation	Data Type
Input__Street_File	**Dialog Reference** A line feature representing the street network in your community. This file should include values for the ten attributes listed below the input dialogue.	Feature Layer
Width_of_Outside_Shoulder	**Dialog Reference** Select the field that contains measurements for the width of paved outside shoulder for each of the links in the network. This measurement must be in feet and should include parking and gutters if applicable.	Field
Curb_present	**Dialog Reference** Select the field that contains a value for the presence of a curb for each of the links in the network. A valid entry will be either "0" or "1" representing the absence or presence of a curb, respectively.	Field
Proportion_of_On-street_Parking	**Dialog Reference** Select the field that contains the proportion of on-street parking occupied for each of the links in the network. This is the estimated proportion of on-street parking that would be occupied during the analysis period and is given as a decimal. For example: "0.20"	Field
Width_of_Outside_Lane	**Dialog Reference** Select the field that contains measurements (in feet) for the width of outside through lane for each of the links in the network.	Field
Width_of_Bicycle_Lane	**Dialog Reference** Select the field that contains measurements (in feet) for the width of bicycle lane for each of the links in the network. If no bicycle lane is present, the field should read "0".	Field
Study_Hour_Directional_Vehicle_Volume	**Dialog Reference** Select the field that contains measurements of the midsegment vehicle demand flow rate for each of the links in the network. (ex. "235" or "13567")	Field
Percent_Heavy_Vehicles	**Dialog Reference** Select the field that contains measurements (in decimal	Field

75

	form) for percent heavy vehicles in the midsegment demand flow rate for each of the links in the network.	
Average_Vehicle_Speed	**Dialog Reference** Select the field that contains measurements (in miles per hour) for motorized vehicle running speed for each of the links in the network.	Field
Number_of_Through_Lanes	**Dialog Reference** Select the field that represents number of through lanes on the segment in the subject direction of travel for each of the links in the network.	Field
Pavement_Condition	**Dialog Reference** Select the field that represents the pavement condition rating for each of the links in the network. This is a score ranging from 1 - 5 meaning poor to excellent pavement condition respectively. (see HPMS rating)	Field
Output_Field_1__BLOS_Score	**Dialog Reference** Name of the new field that displays the numerical result of the BLOS calculation. The Default name of "BLOS_Score" is recommended for ease in using additional tools within the New Bicycle Analysis Tools.	String
Output_Field_2__BLOS_Text	**Dialog Reference** Name of the new field that displays the textual result of the BLOS calculation (A - F, or "Missing Data"). The Default name of "BLOS_Text" is recommended for ease in using additional tools within the New Bicycle Analysis Tools.	String

Credits

Created for the Idaho Transportation Department by Michael Lowry, Daniel Callister and Brandon Moore. *2010 Highway Capacity Manual*. Transportation Research Board, 2011.

Title Calculate BLOS (2. Intersections)

Summary

Calculates Bicycle Level of Service (BLOS) for each intersection in a network. The calculation is based on the 2010 Highway Capacity Manual. The tool creates two new fields: one for a numeric score and one for the associated letter grade.

⚠ **Caution:** If the output fields already exist, the existing data is overwritten.

📋 **Note:** Non-signalized intersections receive BLOS "A." Consequently, attribute data is only needed for signalized intersections.

Illustration

BLOS_Score	BLOS_Text
1.68	A
2.31	B
2.91	C
1.29	A
2.88	C
2.31	B
1.25	A
3.52	D
1.25	A

Usage

The tool is useful for city planners and engineers to quickly calculate BLOS scores for intersections in their street network. The tool is meant to identify BLOS deficiencies and help prioritize bikeway improvements.

Symbology is provided in a layer file in the ToolData folder.

Syntax

IntersectionBLOS (Input_Feature, Signal_Field, Width_of_Cross_Street, Curb_Presence, Left-turn_Deman_Flow_Rate, Through_Demand_Flow_Rate, Right-turn_Deman_Flow_Rate, Number_of_Through_Lanes, Width_of_Outside_Lane, Width_of_Bike_Lane, Proportion_of_Occupied_On-Street_Parking, Width_of_Outside_Shoulder, Output_Field_1__BLOS_Score, Output_Field_2__BLOS_Text)

Parameter	Explanation	Data Type
Input_Feature	**Dialog Reference** Select the input feature containing nodes that represent the intersections in your bicycle network. If you have used the "Create Intersection File" tool included in the New Bicycle Analysis Tools, that output file may used here.	Feature Layer
Signal_Field	**Dialog Reference** Select the attribute field within the input feature that contains the data for whether the intersection is signalized or not. This must be shown using "0" to represent a non-signalized intersection and "1" to represent a signalized intersection.	Field
Width_of_Cross_Street	**Dialog Reference** Select the attribute field within the input feature that contains the data for width of the cross street. This measures the curb to curb width of the cross street (in feet).	Field
Curb_Presence	**Dialog Reference** Select the field that contains a value for the presence of a curb. A valid entry will be either "0" or "1" representing the absence or presence of a curb, respectively.	Field

Left-turn_Deman_Flow_Rate	**Dialog Reference** Select the attribute field within the input feature that contains the data for the left turn demand flow rate.	Field
Through_Demand_Flow_Rate	**Dialog Reference** Select the attribute field within the input feature that contains the data for the through demand flow rate.	Field
Right-turn_Deman_Flow_Rate	**Dialog Reference** Select the attribute field within the input feature that contains the data for the right turn demand flow rate.	Field
Number_of_Through_Lanes	**Dialog Reference** Select the field that represents the number of through lanes.	Field
Width_of_Outside_Lane	**Dialog Reference** Select the field that contains measurements (in feet) for the width of the outside lane.	Field
Width_of_Bike_Lane	**Dialog Reference** Select the field that contains measurements (in feet) for the width of the bicycle lane. If no bicycle lane is present, the field should read "0".	Field
Proportion_of_Occupied_On-Street_Parking	**Dialog Reference** Select the field that contains the proportion of on-street parking. This is the estimated proportion of on-street parking that would be occupied during the analysis period and is given as a decimal. For example: "0.20"	Field
Width_of_Outside_Shoulder	**Dialog Reference** Select the field that contains measurements for the width of the shoulder. This measurement must be in feet.	Field
Output_Field_1__BLOS_Score	**Dialog Reference** Name of the new field that displays the numerical result of the BLOS calculation. The Default name of "BLOS_Score" is recommended for ease in using additional tools within the New Bicycle Analysis Tools.	Field
Output_Field_2__BLOS_Text	**Dialog Reference** Name of the new field that displays the textual result of the BLOS calculation (A - F, or "Missing Data"). The Default name of "BLOS_Text" is recommended for ease in using additional tools within the New Bicycle Analysis Tools.	Field

Tags

BLOS, LOS, bicycle, level of service, intersection, HCM, highway capacity manual, suitability

Credits

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Created for the Idaho Transportation Department by Michael Lowry, Daniel Callister and Brandon Moore. *2010 Highway Capacity Manual*. Transportation Research Board, 2011.

Title   Calculate BLOS (3. Facility)

Summary

Calculates Bicycle Level of Service (BLOS) for a facility. A facility is defined as a series of contiguous links and intersections. The calculation is based on the 2010 Highway Capacity Manual. The tool creates a new feature with a numeric score and an associated letter grade.

Note: Before opening the tool, the user must select (i.e. highlight) on the map the start and end intersections for the facility. The tool will fail if exactly two intersections are not selected.

Note: This tool requires that the street network to have correct and complete topology. For more information about topology, search "topology" in ArcGIS Desktop Help. The tool "Create Streets File" can be used to help create a network with correct topology.

Illustration

BLOS_Score	BLOS_Text
1.68	A
2.31	B
2.91	C
1.29	A
2.88	C
2.31	B
1.25	A
3.52	D
1.25	A

Usage

The tool is useful for city planners and engineers to calculate BLOS scores for facilities in their street network, especially during corridor planning. The tool is meant to identify BLOS deficiencies and help prioritize bikeway improvements.

Symbology is provided in a layer file in the ToolData folder.

Syntax

CalculateFacilityBLOS (Calculation_Method, Link_BLOS_Relative_Weight, Intersection_BLOS_Relative_Weight, Street_Links, Link_BLOS_Field, Number_of_Access_Points, Intersections, Signal_Field, Intersection_BLOS_Field, Output_File, Output_Field__Facilty_Name)

Parameter	Explanation	Data Type
Calculation_Method	**Dialog Reference** Select a calculation method among the three models to calculate facility BLOS. Model 1: Method prescribed by HCM 2010 that does not allow for a BLOS score of "A". Model 2: Modification of model 1 that allows for a BLOS score "A". Model 3: Calculate facility BLOS based on user-defined relative weights of link BLOS and intersection BLOS.	String
Link_BLOS_Relative_Weight	**Dialog Reference** The relative weight given to intersection BLOS in the calculation of facility BLOS ("0" = no weight, "100" = total weight). Sum of link and intersection weights may not exceed "100".	Double
Intersection_BLOS_Relative_Weight	**Dialog Reference** The relative weight given to intersection BLOS in the calculation of facility BLOS ("0" = no weight, "100" = total weight). Sum of link and intersection weights may not exceed "100".	Double
Street_Links	**Dialog Reference** The street network that contains a suitability field. If you have used the "Calculate BLOS (1. Streets)" tool to calculate link suitability, that output feature may be used here.	Feature Layer
Link_BLOS_Field	**Dialog Reference** Select the field from "Street_Links" that contains a numerical BLOS score for links in the network.	Field
Number_of_Access_Points	**Dialog Reference** Select the field from "Street_Links" that contains the number of access points for links in the network.	Field

Intersections	**Dialog Reference** Select the feature that contains a populated suitability field for intersections in your street network. If you have used the "Calculate BLOS (2. Intersections)" tool to calculate intersection suitability, that output feature may be used here. Before opening the tool, the user must select (i.e. highlight) on the map the start and end intersections for the facility.	Feature Layer
Signal_Field	**Dialog Reference** Select the field from "Intersections" that indicates whether an intersection is signalized or non-signalized.	Field
Intersection_BLOS_Field	**Dialog Reference** Select the field from "Intersections" that contains a numerical BLOS score for intersections in the network.	Field
Output_File	**Dialog Reference** Name and folder directory for the output facility feature.	Feature Class
Output_Field__Facilty_Name	**Dialog Reference** Name of the facility. This will be shown in the attribute table under the heading "Facility Name" to identify this facility.	String

Tags

Facility, BLOS, LOS, bicycle, level of service, HCM, highway capacity manual, suitability

Credits

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Created for the Idaho Transportation Department by Michael Lowry, Daniel Callister and Brandon Moore. *2010 Highway Capacity Manual*. Transportation Research Board, 2011.

Title   Calculate BLOS (4. Pathways)

Summary

Calculates Bicycle Level of Service (BLOS) for pathways. The calculation is based on the 2010 Highway Capacity Manual. The tool creates two new fields: one for a numeric score and one for the associated letter grade.

⚠ **Caution:** If the output fields already exist, the existing data is overwritten.

Illustration

BLOS_Score	BLOS_Text
1.68	A
2.31	B
2.91	C
1.29	A
2.88	C
2.31	B
1.25	A
3.52	D
1.25	A

Usage

The tool is useful for city planners and engineers to quickly calculate BLOS scores for pathways in their street network. The tool is meant to identify BLOS deficiencies and help prioritize bikeway improvements.

Syntax

PathBLOS (Input_Pathways, Width, Centerline, BLOS_Score_Field, BLOS_Text_Field)

Parameter	Explanation	Data Type
Input_Pathways	**Dialog Reference** The input feature class or feature layer that contains the pathway data.	Feature Layer
Width	**Dialog Reference** Select the field from the Input Pathways that contains the values for width (in feet).	Field

Centerline	**Dialog Reference** Select the field from the Input Pathways that contains the values for the presence of a centerline ("1" = present, "0" = not present).	Field
BLOS_Score_Field	**Dialog Reference** The name of the numerical BLOS score field to be created. Defaul name is "BLOS_Score".	String
BLOS_Text_Field	**Dialog Reference** The name of the textual BLOS score field to be created. Defaul name is "BLOS_Text".	String

Credits

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Created for the Idaho Transportation Department by Michael Lowry and Daniel Callister. *2010 Highway Capacity Manual*. Transportation Research Board, 2011.

Title   Calculate BSL

Summary

This tool calculates Bicycle Stress Level for each link in a street network (Very Low, Low, Moderate, High, and Very High), as well as a numerical score. The calculation is based on the Bicycle Stress Level Method of Sorton and Walsh (1994).

⚠ **Caution:** If the output fields already exist, the existing data is overwritten.

Illustration

BSL	BSL_Score
High	4
Moderate	3.67
High	4
Low	2.33
Moderate	3
Moderate	3
Low	2.67
Low	2.33

Usage

Intended for urban and suburban streets. The tool is useful for city planners and engineers to quickly calculate bicycle suitability for links in their street network. The tool is meant to assist in prioritizing improvement projects.

Symbology is provided in a layer file in the ToolData folder.
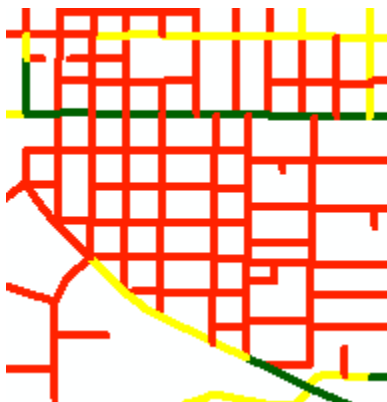
Syntax

CalculateBSL (Input_Feature_Class, Traffic_Volume_of_Outside_Lane, Width_of_Outside_Traffic_Lane, Vehicle_Speed, Output_Field_1__BSL_Score, Output_Field_2__BSL_Text)

Parameter	Explanation	Data Type
Input_Feature_Class	**Dialog Reference** Input shapefile that includes the necessary attribute fields for the BSL calculation. This will typically be a street network.	Feature Layer
Traffic_Volume	**Dialog Reference** Select the field that represents the traffic volume (in number of vehicles per hour) of the outside lane for each link in the network.	Field
Lane_Width	**Dialog Reference** Select the field that represents width (in feet) of the outside traffic lane for each link in the network.	Field
Vehicle_Speed	**Dialog Reference** Select the field that represents the vehicle speed (in miles per hour) for each link in the network.	Field
Output_Field_1__BSL_Score	**Dialog Reference** A name for the new BSL score field.	String
Output_Field_2__BSL_Text	**Dialog Reference** A name for the new BSL textual score field.	String

Credits

Copyright © 2011 Michael Lowry.

Created for the Idaho Transportation Department by Michael Lowry and Daniel Callister. Sorton, A., and T. Walsh. "Bicycle Stress Level as a Tool to Evaluate Urban and Suburban Bicycle Compatibility." *Transportation Research Record: Journal of the Transportation Research Board,* No. 1438 (1994): 17-24.

Title   Calculate BSS

Summary

This tool calculates a Bicycle Suitability Score for each link in a street network (shown as "Most Likely Desirable", "Could Be Desirable", "May Not Be Desirable", or "Undesirable"), as well as a numerical score. The calculation is based on the Bicycle Suitability Score Method developed by Turner et al. (1997).

⚠ **Caution:** If the output fields already exist, the existing data is overwritten.

Illustration

Usage

Intended for state highways.

Symbology is provided in a layer file in the ToolData folder.
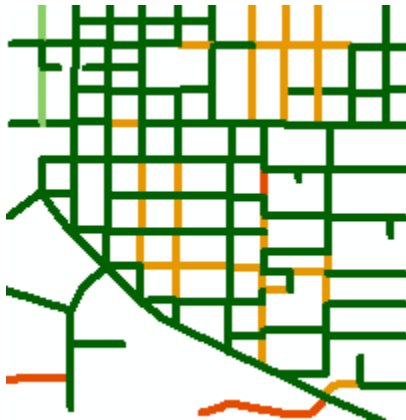
Syntax

CalculateBSS (Input_Feature_Class, Traffic_Volume, Shoulder_Width, Width_of_Outside_Lane, Speed_Limit, Pavement_Condition, Output_Field_1__BSS_Score, Output_Field_2__BSS_Text)

Parameter	Explanation	Data Type
Input_Feature_Class	**Dialog Reference** Input shapefile that includes the necessary attribute fields for the BSS calculation. This will typically be a street network.	Feature Layer
Traffic_Volume	**Dialog Reference** Select the field that represents the traffic volume (average daily traffic per lane) for each of the links in the network.	Field
Shoulder_Width	**Dialog Reference** Select the field that represents the shoulder width (in feet) for each of the links in the network.	Field
Curb_Lane_Width	**Dialog Reference** Select the field that represents the width of the curb lane (in feet) for each of the links in the network. If you have already selected a field to use as the shoulder width data, the width of the outside lane is not necessary for the BSS calculation.	Field
Speed_Limit	**Dialog Reference** Select the field that represents the speed limit (in miles per hour) for each of the links in the network.	Field
Pavement_Condition	**Dialog Reference** Select the field that represents the pavement condition for each of the links in the network. This is a score ranging from 0 - 5 meaning poor to excellent pavement condition respectively. (see HPMS rating)	Field
Output_Field_1__BSS_Score	**Dialog Reference** A name for the new BSS score field.	String
Output_Field_2__BSS_Text	**Dialog Reference** A name for the new BSS textual score field.	String

Credits

Copyright © 2011 Michael Lowry.

Created for the Idaho Transportation Department by Michael Lowry and Daniel Callister. Turner, S., S Shafer, and W Stewart. *Bicycle Suitability Criteria for State Roadways in Texas*. College Station, TX: Texas Transportation Institute, 1997.

Title   Community-Wide Bikeability

Summary

Calculates a bikeability score for input analysis zones. The score represents the ability and perceived comfort to travel by bicycle to important destinations throughout the community. The calculation is based on Lowry et al (2012). The analysis zones can be any polygon such as parcels or TAZs. The destinations can be points or polygons. The analysis zones and the destinations can be the same file.

The user chooses the destinations to include in the analysis, such as grocery stores, public parks, restaurants, and/or schools. The user also determines the importance for each destination, defined by "points." The points could be based on a characteristic of the destination, such as square floor footage or perhaps the points could be decided through a public town hall meeting or some other public involvement process. The points could be defined for every specific destination or defined generally for all destinations of a certain type, for example, 15 points could be associated with grocery stores, 10 points with restaurants, 5 points with banks, etc. If the points are zero, than the destination does not contribute to the bikeability score. If the points are the same for a set of destinations, then those destinations are considered equally important.

The output file is a copy of the input analysis zones with three new fields:

B = bikeability = [points for each destination * exp^(-BLOS * distance from the zone to the destination)] summed for all destinations

B_norm = bikeability normalized = B/(total points for all destinations)

B_scaled = bikeability scaled = [(B_norm – minimum B_norm)/(maximum B_norm – minimum B_norm)]

See Lowry et al (2012) for calculation details.

📄**Note:** This tool requires the street network to have correct and complete topology. For more information about topology, search "topology" in ArcGIS Desktop Help. The tool "Create Streets File" can be used to help create a network with correct topology

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Illustration
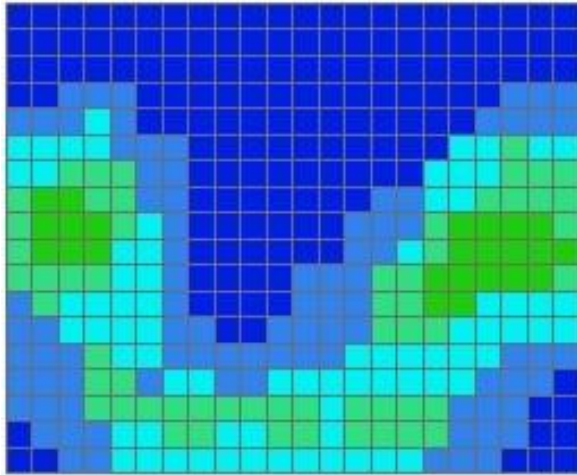
Usage

Tool is used to help planners and engineers visualize bikeability of a street network for specific destinations. The tool is meant to assist in prioritizing improvement projects.

Syntax

MultipleDestinations (Bikeway_Network, Suitablilty_Field, Analysis_Zones, Destinations, Activity-Level_Field, Output_Zones)

Parameter	Explanation	Data Type
Bikeway_Network	**Dialog Reference** The bikeway network. Feature must contain a suitability attribute, such as BLOS.	Feature Layer
Suitablilty_Field	**Dialog Reference** The field in "Bikeway_Network" that represents the numerical suitability score to be used in the calculation. It should be such that a higher number is worse suitability, like the BLOS score from the 2010 HCM. The default is "BLOS_Score."	Field

Analysis_Zones	**Dialog Reference** The analysis zones for which the bikeability scores will be calculated. The analysis zones can be any polygon such as parcels or TAZs.	Feature Layer
Destinations	**Dialog Reference** Select the feature to be used as destinations. Feature must include an attribute field representing destination points. The destinations can be points or polygons. The analysis zones and the destinations can be the same file.	Feature Layer
Destination_Points_Field	**Dialog Reference** From "Destinations" the field representing the importance for each destination. The points could be based on a characteristic of the destination, such as square floor footage or perhaps the points could be decided through a public town hall meeting or some other public involvement process. The points could be defined for every specific destination or more generally for all destinations of a certain type, for example, 15 points could be associated with grocery stores, 10 points with restaurants, 5 points with banks, etc. If the points are zero, than the destination does not contribute to the bikeability score. If the points are the same for a set of destinations, then those destinations are considered equally important.	Field
Output_Zones	**Dialog Reference** Name and folder directory for the output analysis zones feature. This feature will contain the bikeability score for each analysis zone.	Feature Class

Credits

Title   Identify Probable Routes to a Destination

Summary

Creates a new feature with values for link usage and relative usage for each link in the network. Usage represents how often a link was used in connecting all analysis zones to a user-defined destination via shortest route weighted by BLOS.

📒 **Note:** This tool requires that the street network to have correct and complete topology. For more information about topology, search "topology" in ArcGIS Desktop Help. The tool "Create Streets File" can be used to help create a network with correct topology

---

Illustration

Usage

The tool is useful for city planners and engineers to visualize the links in their street network that would be expected to be used by cyclists. The tool is meant to help prioritize bikeway improvements.

Syntax

SingleDestination (Streets, Suitability, Analysis_Zones, Destination, Output_Network)

Parameter	Explanation	Data Type
Streets	**Dialog Reference** Input feature that contains the links of the bikeway network. Feature must contain a suitability attribute (such as BLOS).	Feature Layer

Suitability	**Dialog Reference** The field in "Bikeway_Network" that represents the numerical suitability score to be used in the calculation. It should be such that a higher number is worse suitability, like the BLOS score from the 2010 HCM. The default is "BLOS_Score."	Field
Analysis_Zones	**Dialog Reference** Select a feature that contains analysis zones to be used as trip origins. Zone features must be polygons.	Feature Layer
Destination	**Dialog Reference** Add feature to be used as destination. This can be done interactively by clicking on a location in the ArcMap window, or by selecting a file that contains the destination feature.	Feature Set
Output_Network	**Dialog Reference** Name and folder directory for the output network. This feature will include the measurements for link usage and relative usage.	Feature Class

Tags

bicycle, level of service, suitability, destination, accessibility, connectivity, bikeability, usage, link, relative usage

Credits

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Created for the Idaho Transportation Department by Michael Lowry, Daniel Callister and Brandon Moore.

Title   Suitability Summary Statistics

Summary

This tool creates a table summarizing bicycle suitability for a street network, the number of miles in each level and the percent of total miles in each suitability level (BLOS, BSS, or BSL).

Illustration

```
Bicycle Level of Service      Miles     Percent of Total Miles
            A                 406.1            68.5
            B                  15.3             2.6
            C                  14.3             2.4
            D                  13.1             2.2
            E                   7.5             1.3
            F                   1.9             0.3
```

Usage

The output table provides a general description of the bicycle suitability characteristics of the input network. The tool is meant to assist in prioritizing improvement projects.

Syntax

SummaryStatistics (Input_Network, Suitability_Text_Field, Suitability_Method, Output_Table)

Parameter	Explanation	Data Type
Input_Network	**Dialog Reference** This is the street network (Feature Class) containing the bicycle suitability field(s).	Feature Layer
Suitability_Text_Field	**Dialog Reference** Select the field from Input Network that represents the bicycle suitability values you want the tool to summarize.	Field
Suitability_Method	**Dialog Reference** Select the suitability method used by the Text Field selected above. **BLOS**= Bicycle Level of Service **BSL**= Bicycle Stress Level **BSS**= Bicycle Suitability Score (Select only one)	String
Output_Table	**Dialog Reference** Name and folder directory for the output table containing summary statistics.	Folder

Credits

Appendix D
Example GIS Data

Example GIS data is available with the tools in the folder "ExampleData." Table 12 lists the files and provides a comment on possible use.

Table 12. Example GIS Data

File Name	Comment
Big_Analysis_Zones.shp	500ft x 500ft analysis zones for "Calculate Community-wide Bikeability" and "Identify Probable Routes to Destination"
Bikeways_(StreetsandPaths).shp	Streets and Shared-use Paths appended together for "Calculate Community-wide Bikeability" and "Identify Probable Routes to Destination"
Bikeways_Improved.shp	Improvement scenario to compare with the other bikeways shapefile.
Example_Enter_Data.csv	4 street classes to be used for illustration with zip883301_Cleaned.shp
GroceryStore_Destinations.shp	3 existing grocery stores and 1 proposed grocery store for use with "Calculate Community-wide Bikeability"
Intesections.shp	16 signalized intersections for "Calculate BLOS (2. Intersections)"
Parcels.shp	Parcels for analysis zones or for destinations for "Calculate Community-wide Bikeability"
SharedUsePathways.shp	Needs to be appended with Streets.shp to make a bikeways file.
Streets.shp	Can be used with BLOS, BSS, and BSL.
Student_addresses.shp	Origin locations for "Identify Probable Routes to Destination" The destination would be the Jr. High School in the center of the cluster.
zip83301.shp	Output from "Create Streets File" that needs to be cleaned up by deleting isolated links or links not within the study area.
zip83301_Cleaned.shp	After deleting isolated links or links not within the study area.
zip83301_Cleaned_withData.shp	Output after using "Enter Estimated Data".