Chapter 4
Needs Analysis
4 Needs Analysis

This section discusses the steps that were taken during the planning process to identify the greatest need for bicycling facilities, as well as the types of facilities that bicyclists need to feel comfortable depending on their level of confidence.

4.1 LATENT DEMAND MODEL

The development and output of a bicycle latent demand model for the City of Winston-Salem was a critical step in conducting the needs analysis. The purpose of this model is to identify areas of the city with the most potential for bicycle infrastructure needs. In other words, the output of this model will answer the question: where should on-street bicycle facilities be installed to maximize use by bicyclists? This model, built in ArcGIS, takes into account a variety of factors (listed below) that influence bicycle use at any given location.

- Distance to schools
- Distance to colleges and universities
- Distance to parks
- Distance to greenway entrances
- Distance to bus stops
- Population density
- Short distance (less than 15 minutes) commuter density
- Zero-car household density
- Single-car household with multiple commuter density
- Job density
- Retail/accommodation/food service density

To create this model, scores were spatially assigned to the City of Winston-Salem based on their favorability to bicycle usage. This was performed through raster transformations in GIS where areas of the city were scored based on their proximity to the variables. The variables were then given weights based on which was most likely to influence bicycle demand. The assigned weights were 5, 10, 15 and 20 where 20 represents highest latent demand. Table 4-1 summarizes that assigned variable weights and Figure 4-1 shows these final values, with red displaying the highest predicted demand and blue displaying the lowest predicted demand. Areas of highest predicted demand (red) were prioritized for bicycle facilities infrastructure.
Figure 4-1: Latent Demand Model
the body of knowledge informing the projects outlined in this Bicycle Master Plan for the City of Winston-Salem. The information is used in the development of projects in Section 5 and provides the basis for achieving the city’s goal of becoming a safer community for bicyclists.

The data used in this Bicycle Crash Analysis was sourced from NCDOT and the Winston-Salem Police Department. Crash information in this dataset comes from police-reported bicycle-vehicle accidents on public roads, public areas, and private property (when reported) between January 2007 and December 2015. It is important to acknowledge that the nature of the available dataset means that unreported bicycle collisions are not included in this analysis (Figure 4-2).

Between 2007 and 2015 there were a total of 132 reported bicycle crashes in the City of Winston-Salem. Crash counts peaked in 2011, with 23 recorded collisions. These crashes range in severity for driver and bicyclist alike. Since 2011, there has been downward trend in bicycle crash counts, with 12 crashes reported in both 2014 and 2015.

Key crash characteristics are included in the graphs below (Figure 4-3, Figure 4-4, and Figure 4-5). In terms of age distribution, the majority of crashes - 32.8 percent - involved bicyclists between 30 and 49 years old, with 16.0 percent of all bicyclists in crashes between 30 and 39 years old.
years old, and 16.8 percent between 40 and 49 years old. Crashes were distributed throughout all days of the week, with slightly more on Monday, Thursday, Wednesday, and Friday. In terms of hours of the day, 28.8 percent of all crashes occurred between 5:00pm to 7:59pm, likely correlated with peak rush hour. This time also coincides with early sunsets during the winter. Early sunset may have an impact due to darkness during the evening commuting time.

Figure 4-3: Percent Bike Crashes by Age Group

Figure 4-4: Percent Bike Crashes by Day of the Week
Over half of all reported bike crashes (55.3 percent) occurred in intersections or intersection-related areas. The remaining 44.7 percent of incidents are coded as non-intersection or non-roadway collisions. Figure 4-6 provides a spatial glance of where bicycle crashes have occurred 2002-2018. Although bike crashes occur throughout the city, there are concentrations of crashes along main thoroughfares and in the denser parts of the city.

The NCDOT Bicycle Crash dataset also provides crash type assignment for each conflict. From 2002 to 2018, the most frequently recorded bicycle crash types and their counts include the following:

- Motorist Left Turn – Opposite direction (17 counts)
- Motorist Drive Out – Sign-controlled intersection (13 counts)
- Bicyclist Ride Through – Sign-controlled intersection (8 counts)
- Motorist Drive Out – Commercial driveway / alley (6 counts)
- Motorist Right Turn – Same direction (6 counts)

An analysis of crash data using the most up-to-date data should be included in any feasibility or engineering study that is conducted on projects that are recommended in this Plan.
Figure 4-6: Crash Data Map

WINSTON-SALEM BICYCLE MASTER PLAN

Legend
- Bicycle-Involved Crash Accidents per Square Mile
  - High
  - Low
- Business 40 Multi-Use Path
- Existing Bicycle Facilities
- Signed Bike Route
- Interstate
- US Route
- NC Route
- Streets
- Water Bodies
- Park Property
- City of Winston-Salem
- Other Municipalities

This map is for reference only. Source: NCDOT NMD, NCDOT Map, ITWI, and AECOM.
4.3 PUBLIC INPUT

During the planning process, tools were developed to connect with the public, stakeholders and agencies to gather input that would help shape the recommendations of the Master Plan. The planning team provided ample opportunities for input, ideas and concerns, which were carefully reviewed by the city and, to the extent feasible, incorporated into the recommendations. The list below identifies the activities conducted, followed by a description of each. The detailed summaries, comment sheets and sign-in sheets of each meeting can be found in the appendix.

- Steering Committee Coordination
- Public Meetings
- Small Group Meetings
- Outreach at Community Events
- Community Surveys

4.3.1 Steering Committee Coordination

A committee was established at the beginning of the project to provide advice and help guide the project. Members included representatives from the city, National Cycling Center, NCDOT and Forsyth and Davie counties, as shown on Table 4-2.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Cycling Center</td>
<td>Michael Hosey</td>
</tr>
<tr>
<td>Winston-Salem/Forsyth County Department of Planning and Development Services</td>
<td>Amy Crum</td>
</tr>
<tr>
<td>Winston-Salem Recreation and Parks Department</td>
<td>William Royston</td>
</tr>
<tr>
<td>Davie County Development and Facilities Services</td>
<td>Amy Litz</td>
</tr>
<tr>
<td>Winston-Salem Engineering Department</td>
<td>Andrea Keyser</td>
</tr>
<tr>
<td>Winston-Salem Police Department (WSPD)</td>
<td>Sergeant Kevin Bowers</td>
</tr>
<tr>
<td>Forsyth County Health Department</td>
<td>Sharon Roberts</td>
</tr>
<tr>
<td>NCDOT Division 9</td>
<td>JP Couch, Fredrick Haith</td>
</tr>
<tr>
<td>WSDOT</td>
<td>Matthew Burczyk, Jeffrey Fansler, Hank Graham, Toneq’ McCullough</td>
</tr>
</tbody>
</table>

Three steering committee meetings were held to discuss various project elements, as described below:

- December 13, 2017 – introduced the project and provided an overview of the tasks and milestones, as well as expectations of the committee.
- July 17, 2018 – reviewed draft bicycle facility recommendations that included proposed facility types, as well as existing facilities and currently planned facilities.
- April 1, 2019 – reviewed the draft plan and provided input on proposed projects and other recommendations made in the plan.

The input and suggestions from committee members were incorporated into the planning process and draft recommendations, as feasible.

4.3.2 Public Meetings

Three public meetings were held to gather input and ideas from the public, as shown below.

**Public Meeting #1 - February 21, 2018**

Central Library Auditorium
660 W. Fifth Street
5:30-7:30 p.m.

The purpose of the meeting was to introduce the project, discuss various bike facilities that are being considered and have participants complete a survey. Approximately 75 people attended the meeting, which included a
presentation by the city, followed by opportunities for participants to view exhibit boards, write comments, complete the survey, and talk with staff and team members.

**Public Meeting #2 - August 16, 2018**

Enterprise Center, 1922 S. MLK, Jr. Drive  
5:30-7:30 p.m.

The purpose of the second public meeting was to review the draft bicycle infrastructure recommendations and obtain feedback from participants. Approximately 52 people attended, which began with a presentation by the city at 5:45 p.m. where the proposed bicycle facilities and recommendations were discussed. After the presentation, participants had an opportunity to view exhibits and graphics, mark up maps and talk to staff at four interactive stations.

Four interactive stations were provided to engage participants, and included the following:

**Station 1- Facility Visual and Description**

This station showed pictures of various types of bike facilities, written descriptions and a list of where the facility would be most effective (e.g., low traffic areas, urban setting).

**Station 2- Facility Preference and Priority**

Participants were given the opportunity to identify bike facilities they would like to see implemented. For example, participants could select their top three to four facilities and then “rank” them in order of preference.
4.3.3 Small Group Meetings

Small group meetings and personal interviews were also held to extend outreach efforts to parts of the city that had not participated at high levels based on geographic information provided through surveys, on the website, and at public input meetings. This section summarizes the meetings and input received.

A meeting was held with residents of Bon Air, Gilmer, and 28th Avenue on October 15, 2018. The purpose was to engage residents in a discussion of bike and pedestrian safety, whether residents biked for commuting or recreational purposes, and what type of bike facilities would be helpful in their neighborhoods. The following questions were asked to initiate a discussion:

- Do you own a bike?
- Why do you ride a bike?
- Where do you ride?
- Do you ride on the sidewalk or street?
- Do you feel safe riding on the street?
- What would make your bike commute better?
- Are there specific streets or intersections that you feel are unsafe for cyclists?
- Do you ride public transportation? if so, do you take your bike on the bus?
- Are there areas where you would like to see better bike facilities or connections?

However, because most of the residents who attended the meeting did not ride a bike, the conversation was adjusted to focus on their concerns about walking and biking within their neighborhoods. Residents indicated that they would like better sidewalks and perhaps a bike lane along 28th Avenue (note: on-street parking within neighborhoods could make it difficult to add bike lanes) where most people ride.

In addition, three bicycle commuters from underrepresented areas were interviewed to gain specific information and comments on respective routes, areas, and facilities. Comments ranged from providing bike lanes (or other infrastructure) on narrow streets, where currently there is not sufficient space to share a lane with motor vehicles, to being generally happy with current conditions. One suggested that the city evaluate roads to determine which can be reconfigured to eliminate motor vehicle lanes in favor of bike infrastructure, especially on...
The second survey was a follow up to the proposed draft recommendations that were shown at the public meeting in August 2018. Summary results from the surveys are discussed in Section 3.3. Both survey instruments and responses are in Appendix E.

### 4.4 DESIGN NEEDS OF BICYCLISTS

Bicyclists’ skills, confidence, and preferences vary significantly, and designing for their needs and in ways that will encourage bicycling can be challenging. Some bicyclists are comfortable riding anywhere they are legally allowed to operate, including space shared with motorized vehicles. Some bicyclists prefer to use roadways that provide space separated from motorists. Bicyclists can be classified as falling into one of four categories based on confidence and skill levels, including “Strong and the Fearless,” “Enthused and the Confident,” “Interested but Concerned.” The fourth group consists of non-riders, called the “No Way No How” group.

### 4.3.4 Pop-Up Events

City staff attended several “pop-up” events, as listed on Table 4-3. At most of the events, tables were set up with maps, surveys and other cycling information. As participants stopped by, staff shared project website information and discussed the challenges cyclists/pedestrians face and reasons why they do or do not choose to ride a bike. This input was included in the development of the Plan, where applicable.

### 4.3.5 Community Surveys

Two surveys were developed during the course of the project and were distributed via the project website. The first survey gathered information and input about current biking conditions, routes and amenities, as well as safety concerns and future improvements that would provide more convenient and safe bicycle transportation.

<table>
<thead>
<tr>
<th>Pop-Up Event</th>
<th>Date</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Winston-Salem Creek Week Keynote</td>
<td>March 20, 2018</td>
<td>22</td>
</tr>
<tr>
<td>Piedmont Environmental Alliance Earth Day Fair</td>
<td>April 21, 2018</td>
<td>94</td>
</tr>
<tr>
<td>Safe Kids Coalition of Northwest Piedmont Bike Safety Day</td>
<td>April 28, 2018</td>
<td>41</td>
</tr>
<tr>
<td>Inmar Bike Month Ride</td>
<td>May 2, 2018</td>
<td>25</td>
</tr>
<tr>
<td>Temple Emanuel Environmental Movie Event</td>
<td>May 3, 2018</td>
<td>15</td>
</tr>
<tr>
<td>Sierra Club Event</td>
<td>May 10, 2018</td>
<td>10</td>
</tr>
<tr>
<td>Wake Forest University Baptist Medical Center Employee Wellness Day</td>
<td>May 16, 2018</td>
<td>37</td>
</tr>
<tr>
<td>Fairgrounds Farm Market</td>
<td>May 26, 2018</td>
<td>15</td>
</tr>
<tr>
<td>Walk &amp; Roll Winston-Salem</td>
<td>May 28, 2018</td>
<td>51</td>
</tr>
<tr>
<td>Neighbors for Better Neighborhoods Grand Opening</td>
<td>June 4, 2018</td>
<td>33</td>
</tr>
<tr>
<td>East Ward Town Hall Meeting</td>
<td>June 7, 2018</td>
<td>10</td>
</tr>
<tr>
<td>Tour To Tanglewood</td>
<td>September 22, 2018</td>
<td>12</td>
</tr>
<tr>
<td>Transit Center</td>
<td>November 8, 2018</td>
<td>16</td>
</tr>
<tr>
<td>Happy Hill Neighborhood Association Meeting*</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Note: *Although this group did not want a presentation, city staff provided materials and website details.

narrow roads or roads with narrow lanes.
Cyclists who are not confident riders are generally not afraid of other cyclists, or pedestrians, or of injuring themselves in a bicycle-only crash. When they say they are “afraid” it is a fear of people driving automobiles.

The “Strong and the Fearless” generally represent the smallest population of bicycle riders. These are the people who will ride in Winston-Salem regardless of roadway conditions. They are ‘bicyclists’; riding is a strong part of their identity and they are generally undeterred by roadway conditions.

The “Interested but Concerned” bicyclists include those who are comfortable riding on most types of bicycle facilities and on roads without any bicycle facilities. The group includes bicyclists willing to ride on busy roads, navigating traffic, as well as bicyclist who prefer to ride on low-traffic streets and shared-use paths. Experienced bicyclists can include commuters, long distance road bicyclists, racers, and cyclists who regularly participate in organized rides.

The “Interested but Concerned” riders include the majority of the population. These bicyclists typically require a physical network of visible, convenient, and well-designed bicycle facilities. According to the 2012 American Association of State Highway and Transportation Officials (AASHTO) AASHTO Guide for the Development of Bicycle Facilities, there are four types of these riders: 1) those who ride frequently for multiple purposes; 2) those who enjoy bicycling occasionally but only ride on paths or low traffic and low speed streets and in favorable conditions; 3) those who ride for recreation; and 4) riders who use the bicycle as a necessary mode of transportation.

The final category, the “no way, no how”, group is not interested in bicycling at all, for reasons of topography, inability, or simply a complete lack of interest.

4.5 FACILITY TYPES

Incorporating the varying bicyclist’s needs into a bicycle network can be challenging because typically constructing on-road bicycle infrastructure requires an existing roadway network. Aside from greenways, which are typically off-road facilities that follow easements and stream corridors, most bicycle infrastructure will need to be constructed adjacent to, and within the limits of vehicular street right-of-way. AASHTO provides six design options for bicycle facilities.

- Bike lanes (striped and/or protected)
- Bicycle boulevards
- Shared use paths

Corridors can use multiple facility types depending on the appropriateness of the road. The best application of these facilities is dependent on data analysis, engineering judgement and budget constraints. And selection should be based on the following:

- Road function
- Traffic volume
- Speed
- Traffic mix (e.g., truck percentage)
- Expected users
- Road conditions
- Driveways/access points
- Topography
- Existing and proposed adjacent land uses
- Cost

AASHTO provides general considerations for when and where to use the different bikeway types, as shown on Table 4-4.
Table 4-4: General Considerations for Different Bikeway Types

<table>
<thead>
<tr>
<th>Type of Bikeway</th>
<th>Best Use</th>
<th>Motor Vehicle Design Speed</th>
<th>Traffic Volume</th>
<th>Classification or Intended Use</th>
<th>Other Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shared lanes (nospesial provisions)</td>
<td>Minor roads with low volumes, where bicyclists can share the road with no special provisions.</td>
<td>Speeds vary based on location (rural or urban).</td>
<td>Generally less than 1,000 vehicles per day.</td>
<td>Rural roads, or neighborhood or local streets.</td>
<td>Can provide an alternative to busier highways or streets. May be circuitous, inconvenient, or discontinuous.</td>
</tr>
<tr>
<td></td>
<td>Major roads where bike lanes are not selected due to space constraints or other limitations.</td>
<td>Variable. Use as the speed differential between bicyclist and motorists increases. Generally any road where the design speed is more than 25 miles per hour (mph).</td>
<td>Generally more than 3,000 vehicles per day.</td>
<td>Arterials and collectors intended for major motor vehicle traffic movements.</td>
<td>Explore opportunities to provide marked shared lanes, paved shoulder, or bike lanes for less confident bicyclists.</td>
</tr>
<tr>
<td>Marked shared lanes</td>
<td>Space constrained roads with narrow travel lanes, or road segments upon which bike lanes are not selected due to space constraints or other limitations.</td>
<td>Variable. Use where the speed limit is 35 mph or less.</td>
<td>Variable. Useful where there is high turnover in on-street parking to prevent crashes with open car doors.</td>
<td>Collectors or minor arterials.</td>
<td>May be used in conjunction with wide outside lanes. Explore opportunities to provide parallel facilities for less confident bicyclists. Where motor vehicles allowed to park along shared lanes, place markings to reduce potential conflicts with opening car doors.</td>
</tr>
<tr>
<td>Paved shoulders</td>
<td>Rural highways that connect town centers and other major attractors.</td>
<td>Variable. Typical posted rural highway speeds (generally 40-55 mph).</td>
<td>Variable.</td>
<td>Rural roadways; inter-city highways.</td>
<td>Provides more shoulder width for roadway stability. Shoulder width should be dependent on characteristics of the adjacent motor vehicle traffic, (i.e., wider shoulders on higher-speed and/or higher-volume roads).</td>
</tr>
<tr>
<td>Bike lanes</td>
<td>Major roads that provide direct convenient, quick access to major land uses. Also can be used on collector roads and busy urban streets with slower speeds.</td>
<td>Generally, any road where the design speed is more than 25 mph.</td>
<td>Variable. Speed differential is generally a more important factor in the decision to provide bike lanes than traffic volumes.</td>
<td>Arterials and collectors intended for major motor vehicle traffic movements.</td>
<td>Where motor vehicles are allowed to park adjacent to bike lane, provide a bike lane of sufficient width to reduce probability of conflicts due to opening vehicle doors and objects in the road. Analyze intersections to reduce bicyclist/motor vehicle conflicts.</td>
</tr>
<tr>
<td>Bicycle boulevards</td>
<td>Local roads with low volumes and speeds, offering an alternative to, but running parallel to, major roads. Still should offer convenient access to land use destinations.</td>
<td>Use where the speed differential between motorists and bicyclists is typically 15 mph or less. Generally, posted limits of 25 mph or less.</td>
<td>Generally less than 3,000 vehicles per day.</td>
<td>Residential roadways.</td>
<td>Typically only an option for gridded street networks. Avoid making bicyclists slope frequently. Use signs, diverters, and other treatments so that motor vehicle traffic is not attracted from arterials to bicycle boulevards.</td>
</tr>
<tr>
<td>Shared use path; linear corridors in greenways, or along waterways, freeways, active or abandoned rail lines, utility rights-of-way, unused rights-of-way. May be a short connection, such as a connector between two cul-de-sacs, or a longer connection between cities.</td>
<td>N/A</td>
<td>N/A</td>
<td>Provides a separated path for non-motorized users. Intended to supplement a network of on-road bike lanes, shared lanes, bicycle boulevards, and paved shoulders.</td>
<td>Analyze intersections to anticipate and mitigate conflicts between path and roadway users. Design path with all users in mind, wide enough to accommodate expected usage. On-road alternatives may be desired for advanced riders who desire a more direct facility that accommodates higher speeds and minimizes conflicts with intersection and driveway traffic, pedestrians, and young bicyclists.</td>
<td></td>
</tr>
<tr>
<td>Shared use path: adjacent to roadways (i.e., sidepath)</td>
<td>Adjacent to roadways with no or very few intersections or driveways. The path is used for a short distance to provide continuity between sections of path on independent rights-of-way.</td>
<td>The adjacent roadway has high-speed motor vehicle traffic such that bicyclists might be discouraged from riding on the roadway.</td>
<td>The adjacent roadway has very high motor vehicle traffic volumes such that bicyclists might be discouraged from riding on the roadway.</td>
<td>Provides a separated path for non-motorized users. Intended to supplement a network of on-road bike lanes, shared lanes, bicycle boulevards, and paved shoulders. Not intended to substitute or replace on-road accommodations for bicyclists, unless bicycle use is prohibited.</td>
<td>Several serious operational issues are associated with this facility type. These include dangerous intersection conditions where motorists don’t notice cyclists approaching from the right, or cyclists crossing the intersection at unexpected speeds (relative to pedestrians). Other issues include sidepath width constraints, and limited crossing points of roads.</td>
</tr>
</tbody>
</table>
Consideration and appropriateness of facility types was included as the project team developed the network and high priority projects for the Winston-Salem Bicycle Plan. Specific discussion of the location of facility types is included in the next Section, and typical cross sections for the various bikeway types are included in Appendix B.

4.6 SUMMARY OF NEEDS ANALYSIS

This section identified the location of potential bicyclists and their potential destinations in the city based on a variety of socio-economic and location factors and also provided an analysis of the bicycle crashes in the city. It also summarized the public outreach efforts that were conducted to reach the bicycle community so as to have maximum public input in the Plan. Finally, it identified the types of bicycle facilities that are available to the city to accommodate all levels of comfort and confidence in the bicycling community.