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The Green Line

Promoting Safety and Connections Through a Year Round Bicycle Network for Fargo, North Dakota.

A DESIGN THESIS SUBMITTED TO THE
DEPARTMENT OF ARCHITECTURE AND LANDSCAPE ARCHITECTURE
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By

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TABLE OF CONTENTS

INTRODUCTION

1

This paper will define what qualities make bicycle paths and lanes safe and easy to see. Winter maintenance strategies that are successful in ensuring year round use will be defined as well. First, data from various sources is gathered to determine factors that can allow a bike path or lane to be safe and enjoyable to ride on for all seasons. Data that will be researched will consist of:

1. Comparing different types of bike paths and their specific qualities such as width and paint coloring.
2. Road speeds and widths.
3. Winter maintenance plans used in other cities and determining what they did and how they maintained their bike pathways

Secondly, Existing community data consisting of surveys and city plans will be collected to determine what the community of Fargo would like to see in the city of Fargo's bike network, this will be done by:

1. Contacting organizations focused on bicycles and transportation to see what they would like to see.
2. Study case studies to see how different types of interventions were viewed by the community.
3. Collect existing survey relating to bicycle infrastructure and past project to determine overall public approval of increasing the existing bicycle network.

Third, Data provided from the City of Fargo will be collected. Data will consist of past projects relating to transportation specifically codes and regulations focusing on cyclists, City GIS data and city plans. Using this data will help determine:

1. What factors make a path a bicycle path.
2. What are the limitations found here in Fargo
3. What has been done thus far.

Lastly, the research gathered is used to create a bike path that is approved by the city and its people and is both safe and enjoyable to be on.

ABSTRACT

STATEMENT OF INTENT

During 2015 a local nonprofit group called Great Rides Fargo with the help of B-Cycle introduced a bike share system aimed for North Dakota State University students and downtown visitors. Together they installed 11 docking stations and 101 bicycles throughout NDSU and Downtown Fargo that can be rented out to the public. With this change in focus from the automobile to the pedestrian the next step would be a strong well connected bicycle network for these new cyclists. Currently, there are many existing bicycle paths found throughout Fargo, however, many of these bike lanes are disconnected from one another, Existing Bike Lanes are worn and hard to distinguish due to lack of maintenance. Lastly, during the winter these paths become unusable due to markings being covered by snow and street runoff. When the streets are maintained and plowed during the winter the removed snow is pushed off the road and onto the bicycle paths leaving them unusable to cyclists. Since Fargo has very long winters it is important to provide bicycle paths that are both safe and seasonal. Doing so will increase transportation options throughout the year and provide additional routes that can not only be used in the winter but all year.

PROJECT TYPOLOGY

Typology | Year-round accessibility planning, Bicycle transportation planning

Claim | Providing a bicycle paths with characteristics found through research that make the path both safe and accessible all year. This will provide the city of Fargo with an additional transportation option year round.

Theoretical Premise | Current bike paths in the Fargo are lacking in year round use causing bike paths to be unaccessible, hazardous. Currently bike paths are ignored during the winter and the bike share system is stored for the winter leaving Fargo's winter cyclists with little options for half of the year. Improving Fargo's bike paths to allow for extended use will provide the people of Fargo with additional transportation options.

Project Justification | The popularity of cycling has grown throughout the years. Back in spring of 2008 there were roughly 47.16 million cyclists in the United States, that statistic has risen up to 67.33 million in spring of 2014 a 70% increase. Increasing and improving the existing bicycle infrastructure can benefit the city's economic growth though increased revenue and the creation of new jobs. Implementing additional bicycle infrastructure will encourage more residents to pick up this mode of transportation increasing the popularity of this form of transportation.

LITERARY REVIEW

Many studies have focused heavily on safety and how different factors like lane type and with can influence the safety of the bicycle lane. The width of both the bicycle lane and the road can determine how safe a street is. Cyclists and non-cycle users strongly prefer to cycle within bicycle lanes and that the implementation of cycle lanes positively correlates with cycle use. A narrow bicycle lane for example can create tension and an unsafe experience for both parties involved. Vehicles are more likely to encroach into other lanes that can result in vehicular crashes, cars are also more likely to hit a cyclists due to lake of space for the cyclist (Pulugurtha, 2014). Wider car lanes had the opposite effect on safety, a study titled *Influence of road markings, lane widths and driver behavior on proximity and speed of vehicles over taking cyclists* found that wider car lanes encouraged cars to increase their speed to pass the cyclists. Factors that deterred this were slower narrower car lanes, and the absence of center lane markings (Shackel, 2014). Shackels' study focused heavily on how speed limits effect overall safety. The study was conducted on a variety of road types during different times of the day and focused on speeds between 20 and 30 mph. When roads were 20 mph lane width, markings did not make a difference in driver behavior; however as speed increased to 30 mph cars increased overtake speeds as well as streets with duel lane markings. Significantly greater passing speeds were recorded on roads with a 30 mph speed limit when compared to 20 mph roads. Overtaken speeds were even greater when vehicles exceeded the speed limit which has led to many reduced traffic speed interventions. When passing cyclists at higher speeds the vehicle can apply lateral force to the cyclists. This study found that on faster roads that exceeded 40 miles per hour (mph) passing vehicles generated a side force of 3.75 lbs on the cyclists (Shackel, 2014). The study found effective ways to reduce speed of vehicles was to lower road speed limits and to remove center lane marking on the streets. This was thought to be because the lack of a center line created the effect of an absence of a line provided to 'drive-to', causing drivers to consider their road position and speed more carefully (Shackel, 2014).

Another study titled *Effect of Wide Curb Lane Conversion on Bicycle and Motor Vehicle Interactions* looked into what the impact was of changing a 14 foot wide curb lane into an 11 foot travel lane with an additional 3 foot undesignated lane. The study was conducted by the Florida Department of Transportation by Willaim W. Hunter and John R. Feaganes. The study sites were a mix of various lane configurations with varying speed limits. All together there were 4 sites in total, M-6, M-7, I-4 and I-5. The results were found by observing actions of both cyclists and motorists on the four individual sites and comparing findings. They found that cyclists rode 7 to 9 inches further away from the gutter seam. Motorist's actions also were effected, when the 3 foot undesignated lane was added motorists drove 6 to 12 inches further away from the gutter on average. With these changes more space is created for the bicyclist to travel reducing risk of injury. On average, encroachment rates were reduced by 15 to 40 percent once the 3 foot undesignated lane was added. The study concluded that this type of roadway stripping has the potential to improve both bicycle and motor vehicle safety (Hunter, 2004).

In 2014 a study titled *Evaluating the effectiveness of on-street bicycle lane and assessing risk to bicyclists in Charlotte, North Carolina* was conducted to determine the overall safety of marked on street bicycle pathways. Written by Srinivas S. Pulugurtha and Vidya Thakur they studied an area in Charotte, North Carolina, they compared streets that had on street bicycle lanes to streets without to compare measures involving the amount of bicycle crashes that occurred there. What they found was that bicyclist were four times at a higher risk when on a street without bicycle lanes. The width of the bicycle lane also increased safety with the wider the bicycle path the safer it was for both the car and the cyclists. The ideal bike lane for most cyclists; however, is a lane separated from the street. If a separate path cannot be done a solid lateral line that clearly indicates a separation can also be effective. This study also found that in some areas overall bicycle crashes were not significantly higher when comparing both streets with and without bicycle lanes meaning that in some areas the effectiveness of street bicycle lanes depends heavily its visibility to traffic flow (Pulugurtha, 2014). Roadways with a high speed/ high traffic volume showed that on-street bicycle lanes are not suitable nor safe for cyclists. The increase in both the bicycle lane and right-most travel lane both correlated with a decrease in bicycle crashes; however the introduction of a right-most travel lane on a street with no existing bicycle lane is more effective while one with a bicycle lane yields no benefits. The amount of driveways on a given street also can determine whether or not a cyclists is more likely to experience a crash, if the number of driveways exceeds 50 per mile. If there are over 10 unsignalized approaches per mile or greater than 2 signalized intersections per mile the likelihood of crashes increase as well.

Studies focusing on bike lanes used during the winter were also looked into, in a study titled *Cycling characteristics in cities with cold weather* written by M. Amiri and F. Sadeghpour, a survey was conducted asking bicyclists questions on safety concerns, temperature comfort, trip purpose, trip distance, trip duration, and concerns with regards to infrastructure deficiencies. In total 105 cyclists participated in this survey. Results from this survey showed that a large majority of the cyclist, (96%) used cycling for commuting to work. Most of the participants (71%) indicated that they did not mind cycling in temperatures up to −4 ◦F or colder. In this survey cyclists found icy roads to be the greatest safety concern in winter cycling. When participants were asked for ways to improve the bike lanes their first choice was better snow and gravel removal. Surprisingly, one third of the cyclists in this study were in the oldest age category which was over the age of 44 years old. The study concludes with a prediction that states, "As cycling is emerging as a sustainable mode of transportation to reduce GHG emissions in transportation, it is expected that cities will become more involved in planning for their cycling facilities. The results of this survey can help in planning for future cycling facilities, as well as the improvement of the existing ones in cities which experience cold weather conditions"(Amiri, Sadeghpour, 2013).

Guidelines for bike lanes have been created and a bike path can differ given the different context. In *NACTO Urban Bikeway Design Guide* different factors such as the width, location, and length are discussed in detail. The guidelines show that the required length of a bike lane adjacent to the curb face is 6 feet with a minimum of 3 feet, the guidebook also suggests that a 5 foot lane is suggested in urban environments where illegal parking in bike lanes may occur. When placed adjacent to a parking lane the combined length of the two must be a minimum of 12 feet with a suggested 14.5 feet. Symbols and words to identify a bicycle lane must be used and placed outside of the motor vehicle tread path to minimize wear. The bike path must also be marked with a solid white line to separate the lane from the vehicular lanes. Bike lanes also must not be positioned to the right of a right turn lane; however, if split phased signal timing is used than it is allowed. NACTO recommends that bike lanes be as wide as possible to increase both comfort and safety for both the motorists and the cyclists. Drains and gutter seams should also be flush with the surface to prevent accidents. The use of signage and color can also be used to enhance visibility.

To help users of bike paths navigate the area the use of wayfinding on bike paths can greatly help cyclists navigate the area and better show key locations. When creating a wayfinding sign it should include destinations and distance/ time, the use of arrows should never be used. The placement of each sign should be every ¼ to ½ on off street facilities and every 2 to 3 blocks along bicycle facilities, unless another type sign is used. For example, a wayfinding sign should be placed 150 feet away from a turn or decision sign. Bike lane signs should also be placed after turns so the cyclist can confirm they are going in the correct direction. Different types of signs used in bike lanes include:

1. Turn Signs which indicate where a bike way turns onto another street.
2. Confirmation Signs are used to show both motorist and cyclists that this lane is a designated bikeway.
3. Decision Signs mark the junction of two or more bikeways and show bicyclists the correct bike route to reach their destination.

Bike lanes in downtown Fargo are heavily shared lanes meaning that the lane is to be used by both cyclists and motorists, NACTO has a series of guidelines of how these lanes should be marked. By marking the street is enforces the cyclists right to use that street as well, the markings can also increase the safety of the cyclists by providing the bicyclist with proper positioning. The markings also alert motorists that there could potentially be bicyclists on the street and keeps bicyclist out of the "door zone" which is the area near parked cars were cyclists have a chance of hitting opened car doors as people are exiting a car.

Turn Sign

Confirmation Sign

Decision Sign

Different types of bike lanes are also mentioned in this guide book starting with:

1. Conventional bike lane that is typically 6 feet with a 3 foot minimum, these are used on roads with lower speed limits. Speed limits that exceed 35 miles per hour (mph) should implement lanes that provide additional space between the motorists and the bicyclists, these lane types are mentioned below.

2. Buffered bike lanes are conventional bike lanes paired with a buffer space to allow more separation of motorists and cyclists. The extra room allows cyclists to easily pass other cyclists, gives additional space without making wide enough to be confused for a travel or parking lane. These types of lanes are suggested on streets that experience high amounts of traffic and higher speed limits. Required characteristics include the use of markings to show it is a bike lane and that the buffer zone be marked with 2 solid white lines with white hatches in-between. Some recommended elements include that the buffer should be at least 2 feet wide, on intersection approaches with no dedicated right turn the buffer should transition to a dashed line. Color can also be used to keep motorists off the bicycle lane. More maintenance is needed due to the addition of the buffer.

3. Contra-Flow Bike Lanes are bike lanes designed for bicyclists to ride in the opposite direction of motorists. Essentially this converts a one-way traffic street into a two-way street; one direction for both motorists and bicyclists and the other direction strictly for cyclists. Contra-Flow Bike lanes are separated with a yellow center lane striping. These lanes allow more connectivity for cyclists, reduces wrong-way riding and reduces sidewalk riding. This type of bike path is suited for streets where a large number of bicyclists are riding the wrong way and where alternate routes require excessive out-of-direction travel. The ideal streets are low speed, low volume streets. Required characteristics for this type of lane include the use of symbols to show it is a bike lane, signage indicating that the street is a one way with "except bikes" sign located underneath. Intersection traffic controls must be installed and oriented towards bicyclists. Maintenance is similar to other bike path types.

4. Left-Side Bike Lanes are conventional bike lanes placed on the left side of one-way streets. These lanes avoid right side traffic conflicts, improve visibility, and lowers bus and truck conflicts. These lanes are used on one-way streets with frequent bus and truck stops, streets with high parking turnover and on streets with rush hour parking restrictions. These lanes must include markings to show it is a bike lane and this guide book recommends the use of signage and in high demand areas a buffer can be added if space allows. Maintenance is similar to other bike path types.

CRITICAL EVALUATION

The studies all focused heavily on overall safety and how some simple additions can really improve a cyclists overall safety. Data from these studies involving ideal road speeds, lane widths and markings can be used to generate new ideas and strategies. Looking into past studies like the ones listed above I can figure out what works and then compare the solutions to find what would work best in the city of Fargo. The most important takeaway from the research on overall safety was that when separating a driving lane from a bike line through markings and white lines can improve cyclist's safety; however, as speeds increase the effectiveness of bike lanes decrease. A wider bike lane is always suggested and if space allows a designer should use that space to increase the width of the lane. Articles and research papers involving winter cycling were very valuable. The detailed maintenance plans that were provided for different towns in Europe were very helpful since two of these areas; Umea, Sweden and Oulu, Finland will be used as case studies. Survey data from these studies revealed that many winter bicyclists were male and that many riders did so to get to work or school. Currently Fargo has received a bronze status on bike friendliness. Bike friendliness at the state level is less promising, overall North Dakota ranks in the 40 to 50 range while North Dakota's neighbor ranks in the top 10. Why is that? What systems has Minnesota implemented? Given that both share a similar climate the city of Minneapolis is a perfect case study. Recently Minneapolis has made a large push to incorporate protected bikeways into Minneapolis's street infrastructure. The proposal would add 30.7 miles of protected bike lanes to city streets by 2020, once other types of recommended off-road bikeways are added. Another 12 miles are proposed for construction after 2020. A protected bikeway is a bike lane that is completely separated from both the pedestrian sidewalk and the street by plastic poles, curbs, plantings and even using parked cars to create a buffer. The cities aim is to encourage timid cyclists to start cycling by providing routes that are more enjoyable and safe to be on. With the information given my hypothesis is if safer and more enjoyable bike paths are incorporated into Fargo, North Dakota's streets then Fargo, ND will become more bike friendly.

RESEARCH HYPOTHESIS

I expect to find research that supports the idea of using a bicycle as a mode of transportation in a subarctic climate similar to Fargo, ND. Many countries in Europe have very cold climates but still have a strong bicycle ridership overall. I expect to find statistics and studies that support the implementation of bicycle infrastructure, specifically protected bicycle infrastructure. I expect that the overall bicycle path width and type of bicycle path will play an important role in creating a successful bicycle network. Finally, I predict that improving a portion of Fargo, NDs bicycle network will increase overall ridership.

RESEARCH QUESTIONS

-What is the current bicycle ridership percent for Fargo, ND?

-How many people use the current bike share program?

-What is the overall size of the current bicycle network?

-Where are there gaps in the current bicycle network?

-What types of bike lanes comprise Fargo's bike network?

-What role can a strong bicycle network play in a cities overall growth and popularity?

CASE STUDIES: EUROPE

In Europe traveling by bicycle is much more common due to a different culture and overall view on cycling. Traveling by bike is growing in popularity in the United States, however traveling by bike has been a staple mode of transportation in Europe for decades. Due to European cities having more experience with bicycle infrastructure two areas within Europe were examined. These two areas, Umea, Sweden and Oulu, Finland were chosen because they share a similar climate to Fargo, ND and these two areas show high bicycle ridership during the winter.

01

UMEA, SWEDEN

OULU, FINLAND

02

Oulu, Finland

Bicycle Network Type: A separate and straightforward cycle path network
Population: 196,828

Size: 142.6 mi^2

Amount of Bicycle Paths: Approximately 373 miles.

Planning Process: Oulu's bicycle planning started in the 1970s. Their bicycle network has been being constructed along with the city making the network very strong and easy to navigate.

Winter Maintenance: In general, the anti-skid treatment used on the cycle paths is plowing and sanding. At certain locations, separate permission can be granted for the use of salt in spring and autumn. The plows use perforated blades so as not to create a slippery surface. Oulu's winter maintenance is also broken up into two quality classes.

Class 1: Snow limit 2 cm, 3 cm during snowfall, The aim is to keep the routes clear of ice at all times. Plowing and anti-skid treatment is carried out before 7 am and 4 pm. After 6 pm, the snow does not need to be plowed unless the accumulated snow coverage thickness is over 8 cm. Methods used are plowing and sanding

Class 2: Snow limit 3 cm, 5 cm during snowfall The aim is to clear any ice from the routes by applying anti-skid treatment with a few hours delay Plowing and anti-skid treatment is carried out after the maintenance of the class I routes. Methods used are plowing and sanding.

Cities Bicycle Network Successes: The key to Oulu's success was the early implementation of bicycle friendly design. The first bicycle plan was made in the early 1970's and was implemented by 1982. Ever since the city of Oulu has constructed an average of 17 km bicycle paths/ year. Thanks to this long term dedicated work, cycling has become an essential element in land use and traffic planning procedures. Due to the history the residents of Oulu find cycling a normal mode of transportation, even in harsh winter conditions which is made apparent since Oulu, Finland was named winter cycling capitol of the world.

123"

YEARLY SNOW FALL

BICYCLE RIDERSHIP: 22%

BIKE SHARE SYSTEM: YES

BIKELANE WIDTH: 5'-10'

Umea, Sweden

Bicycle Network Type: Prioritized cycle path and footway network

Population: 120,777

Size: 13.19 mi^2

Amount of Bicycle Paths: Approximately 150 miles, 41 miles belong to the prioritized cycle path and footway network, which has stronger winter maintenance quality requirements

Planning Process: The town of Umea looked over all of their bicycle network and determined areas that saw high traffic. These areas were then prioritized into the cycle path and footway network mentioned above. This network grants access to all residential areas to the university, hospital and the city center

Winter Maintenance: Winter maintenance varies between the prioritized cycle path and footway network and other pathways and networks throughout the city.

Prioritized cycle path and footway network: Snow limit of 4 cm, any higher and the area will be plowed. Anti-skid treatment is carried out frequently. Methods used to remove snowfall are plowing and warmwetted sanding

Other cycle path and footway network: Snow limit of 6–8 cm, any higher and the area will be plowed. Anti-skid treatment is applied only when ice is detected. Methods used to remove snowfall are plowing and sanding

Cities Bicycle Network Successes: Umea succeeds in cost effectiveness, by separating heavily used pathways from pathways that are not used very often Umea saves money on winter maintenance costs. By separating paths and networks into two categories Umea saves money by not heavily maintaining pathways that will not be heavily utilized in the winter.

BICYCLE RIDERSHIP: 19%

BIKE SHARE SYSTEM: YES

BIKELANE WIDTH: 5'-10'

CASE STUDIES: UNITED STATES

03

SEATTLE, WA

Bicycle Ridership has seen a steady increase throughout the years with overall ridership growing over 60% between the years 2000 and 2009. It is safe to say that overall ridership will continue to increase and eventually achieve ridership percentages similar to what is seen in European countries.

MINNEAPOLIS, MN

04

Like in Europe two cities in the United States were selected to examine. Seattle, WA was chosen due to Seattle being one of the most bicycle friendly cities in the United States. Minneapolis was chosen because of the similar climate and the fact that it ranks number 2 in most bicycle friendly cities.

THE LEAGUE OF AMERICAN BICYCLISTS since 1880

All rankings where provided by the League of American Bicyclists, an organization promoting bicycle friendliness.

Seattle, WA

Bicycle Network Type: Multiple on street and off street bike network

Population: 626,600

Size: 142.5 mi^2

Amount of Bicycle Paths: Seattle has 88 miles of on street bikeways and 47 miles of off street bikeways. Seattle is planning however to increase their total to 608 miles of both on-street and off-street bicycle infrastructure.

Planning Process: Seattle's bike plan is supported by five goals: safety, connectivity, ridership, equity and livability. The projects and programs implemented in 2015 support those goals in many ways, including building protected bicycle lanes and neighborhood greenways that expand the "all ages and abilities" network, installing wayfinding and bicycle parking to make trips by bike easier and more convenient, maintaining and improving our existing facilities, and providing educational materials and programs that encourage more people to ride, and to ride safely.

Winter Maintenance: Seattle's winter maintenance includes power sweeping, trash and debris pick-up. In the Winter bike paths are plowed, sanded, and salted. Also on protective bikeways buffers that could be damaged due to plowing are also removed. When a pathway is damaged paved surface repairs are done which include asphalt patching and crack sealing.

Cities Bicycle Network Successes: Seattle focuses heavily on safety which has helped create a network that encourages ridership due to the safety that the network provides. Seattle promotes safety by providing well maintained and design infrastructure and by keeping residents well informed with safety procedures leaving little to no gray areas between the motorists and the cyclist.

BICYCLE RIDERSHIP: 4.10%

BIKE SHARE SYSTEM: YES

BIKELANE WIDTH: 5'-6'

Minneapolis, Minnesota

Bicycle Network Type: Multiple on street and off street bike network

Population: 400,070

Size: 58.4 mi²

Amount of Bicycle Paths: Minneapolis has 128 miles of on street bikeways and 97 miles of off street bikeways.

Planning Process: The current Minneapolis Bicycle Master Plan was adopted by City Council in 2011. This plan is used to improve safety and mobility for bicyclists and increase the number of trips taken by bicycle. The master plan is broken up into different categories including bicycle policy, existing conditions, a needs analysis, a list of projects and initiatives, and funding strategies to be implemented to complete the plan.

Winter Maintenance: In the master plan are maintenance procedures that the city of Minneapolis uses. These include power sweeping, trash and debris pick-up. In the Winter bike paths maintenance includes plowing, sanding, and salting. Also on protective bikeways buffers that could be damaged due to plowing are also removed. When a pathway is damaged paved surface repairs are done which include asphalt patching and crack sealing.

Cities Bicycle Network Successes: Minneapolis, Minnesota was currently placed 18 in the world's best bike cities. Minneapolis soared into the top rankings because of its network of on-street bikeways and bike paths and a great bike share program. This along with a well thought out and executed master plan has helped Minneapolis become a very bike friendly city.

BICYCLE RIDERSHIP: 3.80%

BIKE SHARE SYSTEM: YES

BIKELANE WIDTH: 5'-6'

METHODOLOGY

RESEARCH APPROACH

Creating new bicycle paths in the City of Fargo that are a safe and pleasant experience for the cyclists of Fargo and are accessible year round needed a plan backed with appropriate research to determine what can and cannot work in the City of Fargo. This study employed mixed methodology to collect qualitative and quantitative information.

First, the research needed to qualitatively understand what characteristics makes bike paths safe and seasonal. Various surveys were collected that were taken throughout the country by many people to see what people want in regards to bicycle infrastructure.

Second, quantifying information through Geographic Information System (GIS) software that identified locations of existing bike paths and bike share systems in Fargo. Locations with successful seasonal bike paths and data locating areas where protected bike lanes have been established will also be compared with other areas including the city of Fargo to determine if strategies used could also be used in Fargo.

RESEARCH MEASURES

Climate: To gather data on climate reputable weather websites will be researched to find the average high and average low temperatures for that area. Snowfall data will be collected by using the same strategy to find the temperatures. This data is important since different strategies that worked well in one area may not work the same in another area due to different variable like climate. For example in Oulu, Finland winter bikeways are maintained by compacting snow to provide a surface for bikers. This strategy would not work in warmer climates due to snow melting and in areas with little snowfall.

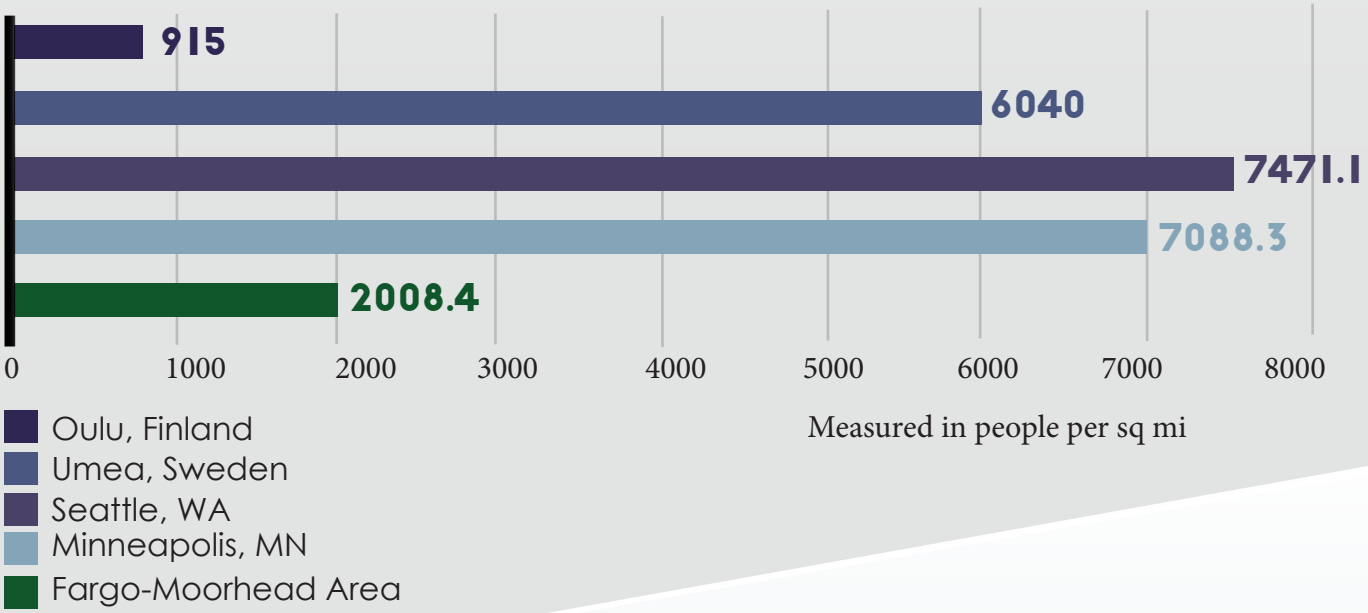
Bikeways: Focusing on both safety and visibility, this portion of the research will look at what design solutions have been used to make bicycle paths both safe and visible for both the motorists and the cyclists. Data will be collected through surveys and studies.

Maintenance: Data detailing each areas maintenance plan was collected and compared to find similarities and differences. Data was found through research papers involving the towns maintenance plan and through the cities own data provided from their online database.

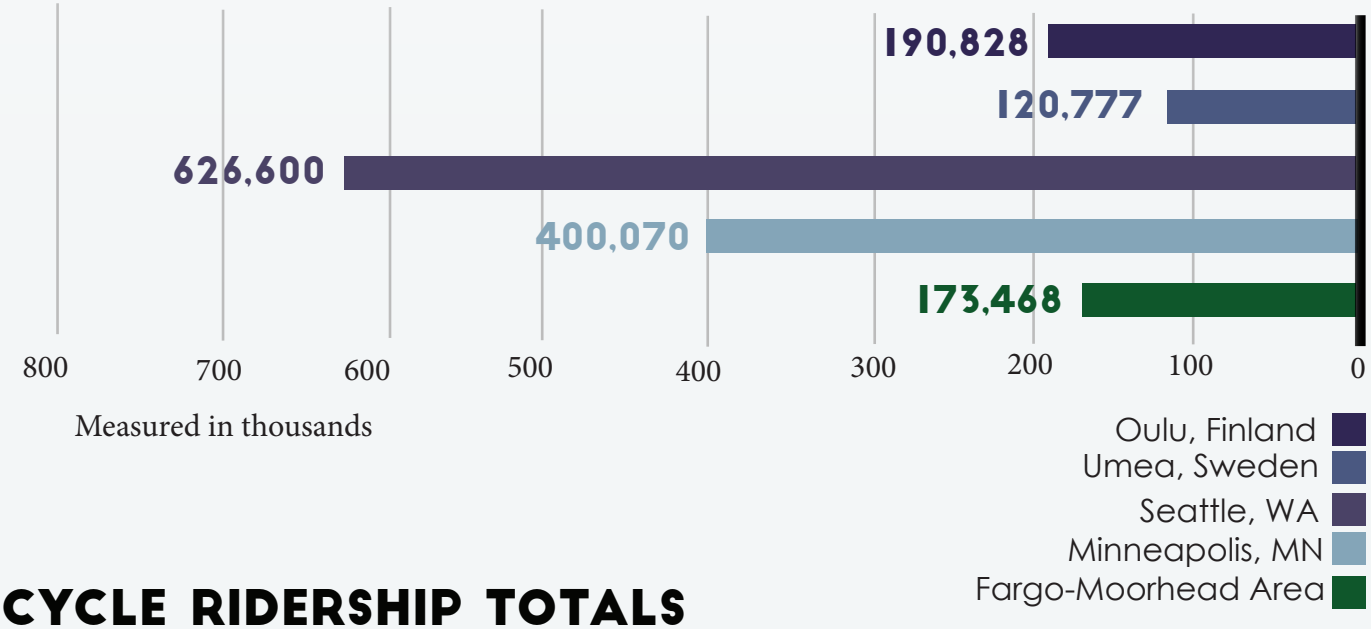
Bike Friendliness: The League of American Bicyclists data base and report cards will be used to located the cities with the highest scores for bike friendliness. These cities will then be researched to see what they are implementing into their bicycle network.

CASE STUDY COMPARISON

POPULATION DENSITY



POPULATION TOTAL



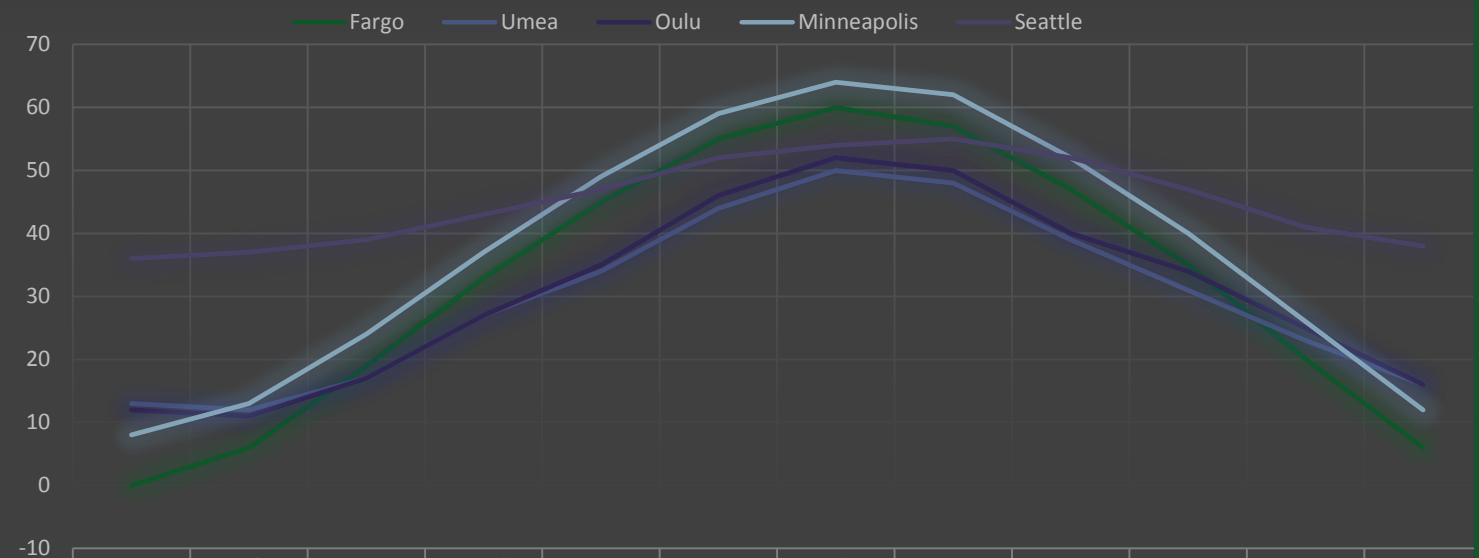
BICYCLE RIDERSHIP TOTALS

BIKE SHARE STATIONS AVAILABLE

Oulu, Finland	Umea, Sweden	Seattle, WA	Minneapolis, MN	Fargo-Moorhead Area
YES	YES	YES	YES	YES

CLIMATE

Measured in degrees Fahrenheit



	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Fargo	0	6	19	33	45	55	60	57	47	35	20	6
Umea	13	12	17	27	34	44	50	48	39	31	23	16
Oulu	12	11	17	27	35	46	52	50	40	34	25	16
Minneapolis	8	13	24	37	49	59	64	62	52	40	26	12
Seattle	36	37	39	43	47	52	54	55	52	47	41	38

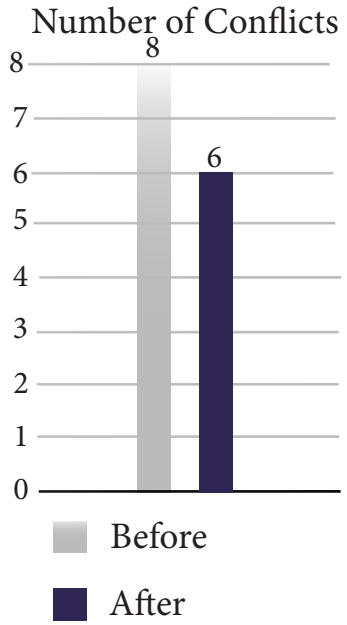
YEARLY SNOWFALL

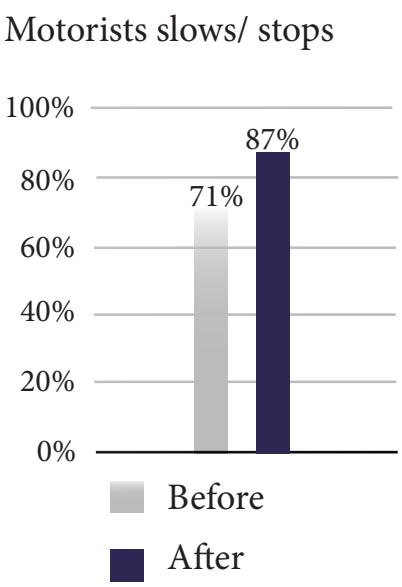
Oulu, Finland	Umea, Sweden	Seattle, WA	Minneapolis, MN	Fargo-Moorhead Area
123"	118"	11"	45"	38"

BIKE LANE RESEARCH

VISIBILITY

Study done in Portland, recorded data through video of the street without a painted lane and with a painted lane.





FINDINGS FROM EUROPE

-A Swedish study found the use of colored markings increased safety per bicyclist by 20 percent.

-Denmark found the use of blue markings reduced bike motorvehicle collisions by 38 percent and fatalities and serious injuries by 71 percent.

-Studies in England showed colored markings to be effective at reducing conflicts.

Painted bikelane in New York

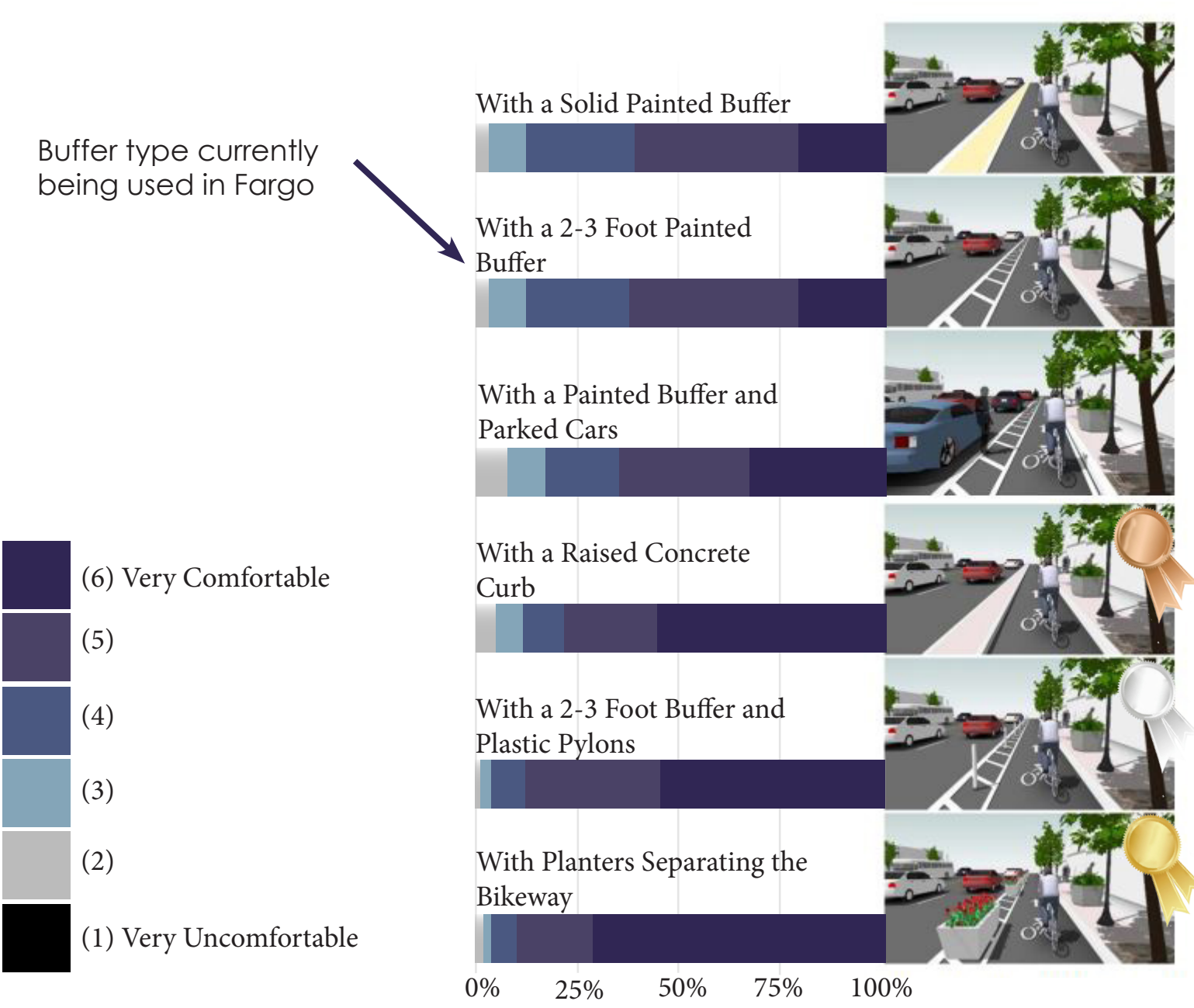
Painted bikelane in Oulu, Norway

BIKE LANE RESEARCH

SAFETY

This survey was given out to adults in the 50 largest U.S. metro areas by the National Association of Realtors, conducted by Portland State University

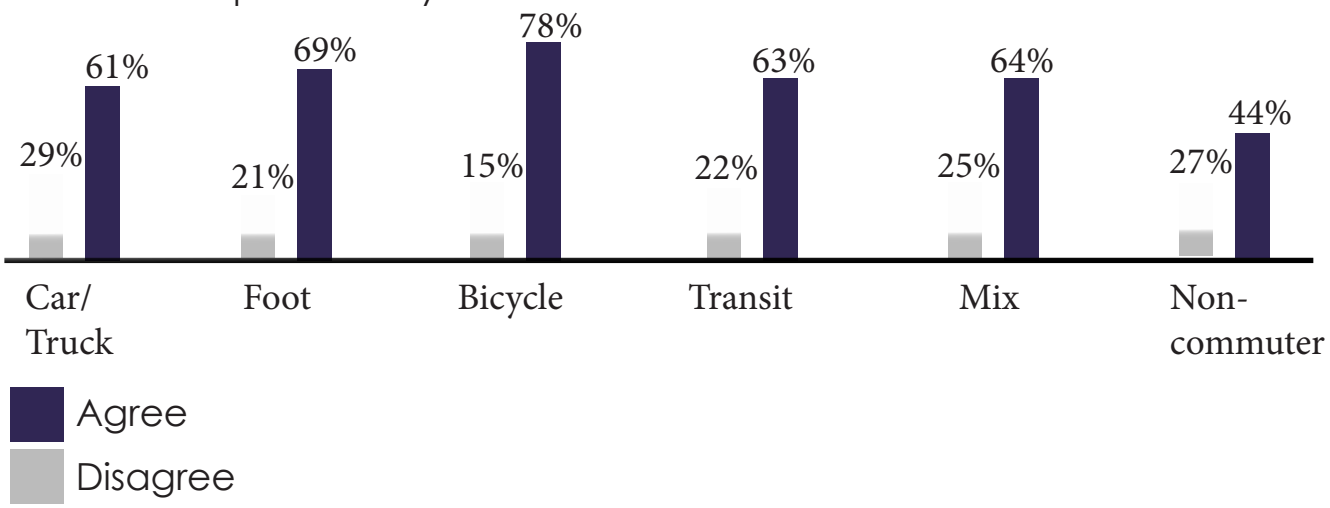
Buffer type currently being used in Fargo



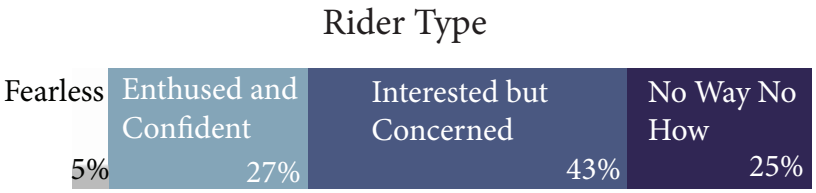
BIKE LANE RESEARCH

INTEREST IN CYCLING BY PRIMARY COMMUTE MODE

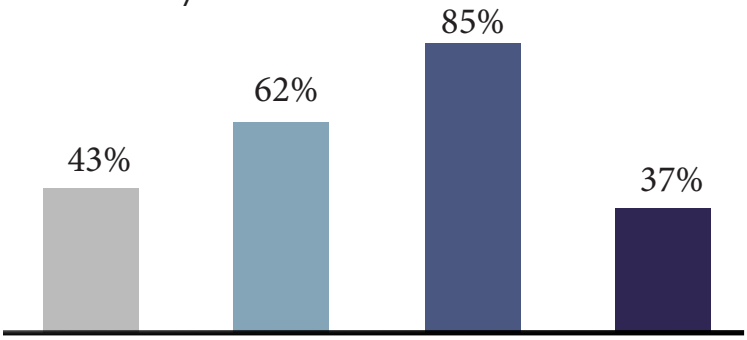
I would be more likely to ride a bicycle if motor vehicles and bicycles were separated by a barrier.



INTEREST IN CYCLING BY RIDER TYPE

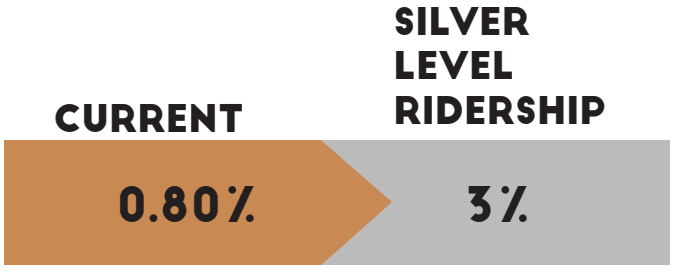


I would be more likely to ride a bicycle if motor vehicles and bicycles were separated by a barrier.



FARGO RIDERSHIP

Protected bike lanes have shown through surveys and research that they help increase ridership and encourage new cyclist growth.



PROJECT GOALS

01 **Build upon the existing bicycle network to make it available all year round.** This is done by implementing a maintenance plan that is similar what you would find in Europe. The Green Line would be designated a primary transportation route while the other bicycle lanes would be secondary. The plan for primary routes is that once the snow on the bike path reaches 4 cm the area will be plowed. Anti-skid treatment will be carried out frequently with methods used to remove snowfall being plowing and warmwetted sanding

02 **The bicycle network is easy to find and navigate**. To increase visibility the bicycle lanes will be painted green compared to the existing network paths that are not painted. Wayfinding will be used throughout the bicycle network to ensure that the rider is always confident in where they are going when traveling the Green Line.

03 **Create a bicycle network that will connect to the already existent transportation systems in the City of Fargo.** The Green Line will incorporate both the MATBUS transportation routes and the already existent bicycle network. This will enhance the already existing network by providing many transportation options for however uses the Green Line.

RESULTS

SAFETY

VISIBILITY

Various studies have shown that using painted bike lanes can help increase overall safety and visibility. Motorists have been shown to be more likely to look for and yield to cyclists at intersections where the bicycle lane was painted. Painted bike lanes have also been shown to increase visibility for cyclists since using the solid coloring better enforces that the lane is for designated for cyclists.

RIDERSHIP

The survey given out by he National Association of Realtors, conducted by Portland State University showed that most people approve of bicycle infrastructure and many believe that living in a neighborhood with strong bicycle infrastructure is desirable. Having a physical barrier was viewed as the safest and most comfortable with vertical elements like planters or pylons being the most preferred. Almost 3/4 of the survey responders stated that if the had access to a bike lane with a physical barrier they would be more likely to ride. Furthermore almost all of the respondents said that they prefer bicyclists and motorists to be separated.

CASE STUDIES

CLIMATE

Fargo shares similarities in climate with all of the case studies. Indicated by the temperature graph Fargo climate is most similar to Oulu, Finland, Umea, Sweden, and Minneapolis, MN. All of these areas are known for being bike friendly and Oulu, Finland is known to have the highest ridership during the winter. Average low temperatures for all of the areas never dip below -4 degrees Fahrenheit which was the cold cutoff temperature in a survey done by Icebike. Icebike asked what their cold cut-off temperature was and over 1/3 of the respondents said -4 degrees Fahrenheit. This leads to Fargo having the ability to have a successful winter bicycling network if only temperature was concerned.

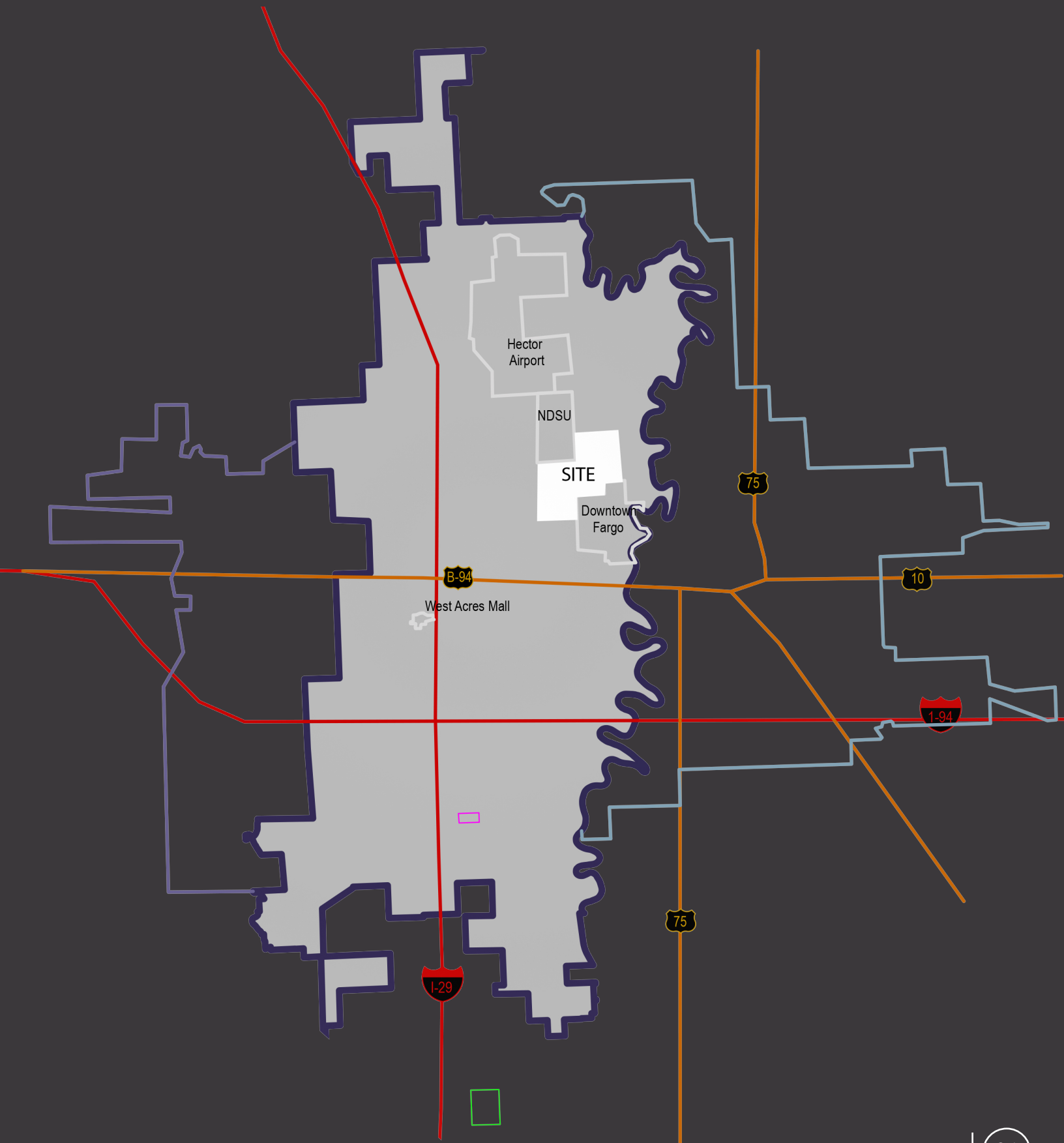
POPULATION

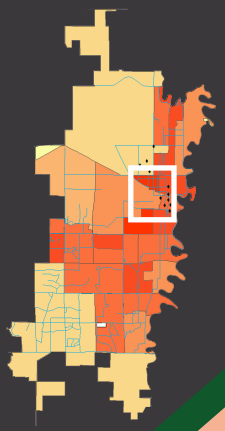
Population varied for the areas with Minneapolis, MN and Seattle, WA having the highest population. Population and population density was researched to determine if the lack of population could be a factor in low ridership. The research shows that Fargo, ND has the second lowest population with Oulu, Finland having the lowest.

INVENTORY ANALYSIS

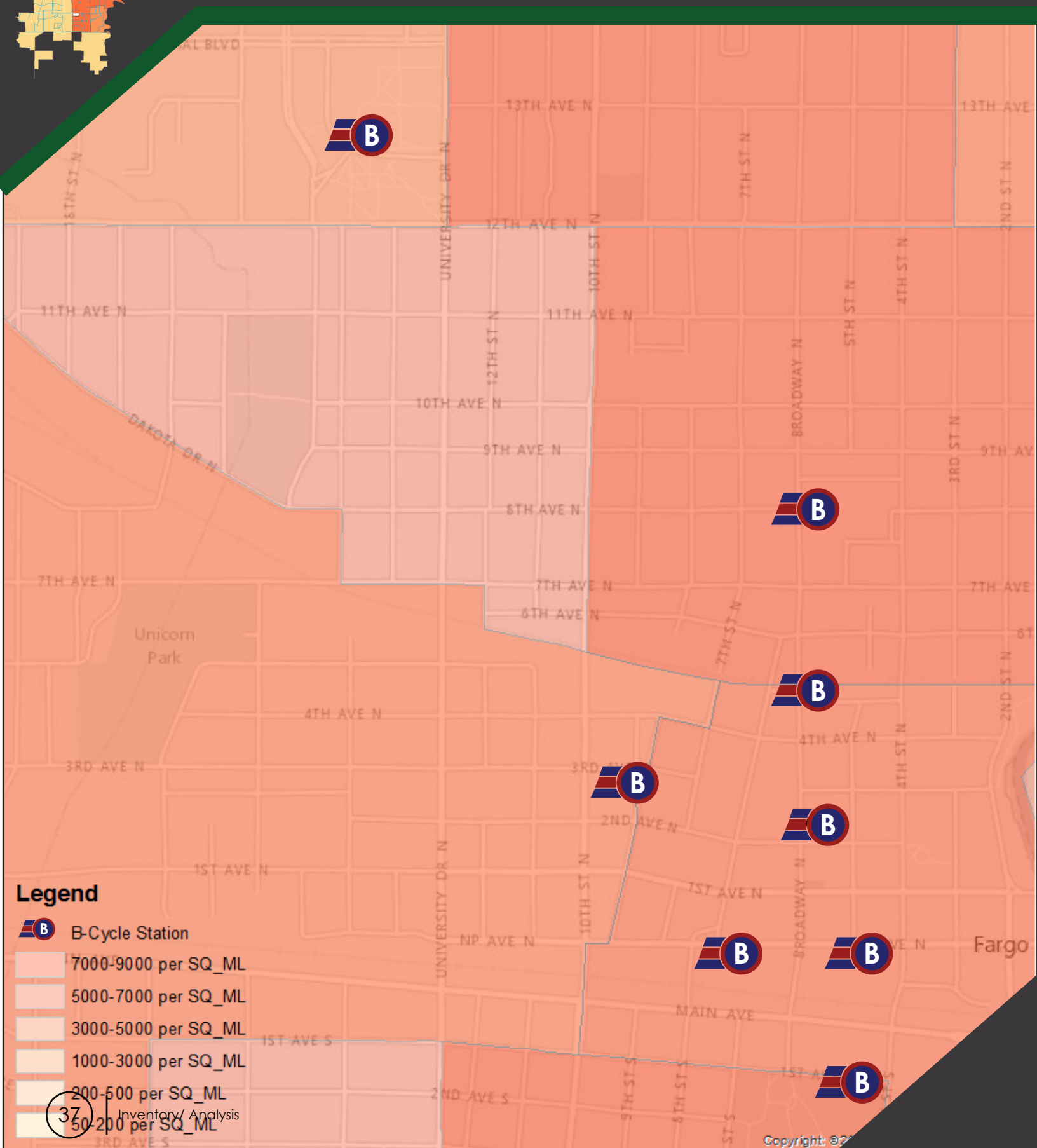
TRI-STATE AREA

FARGO-MOORHEAD BOUNDARY

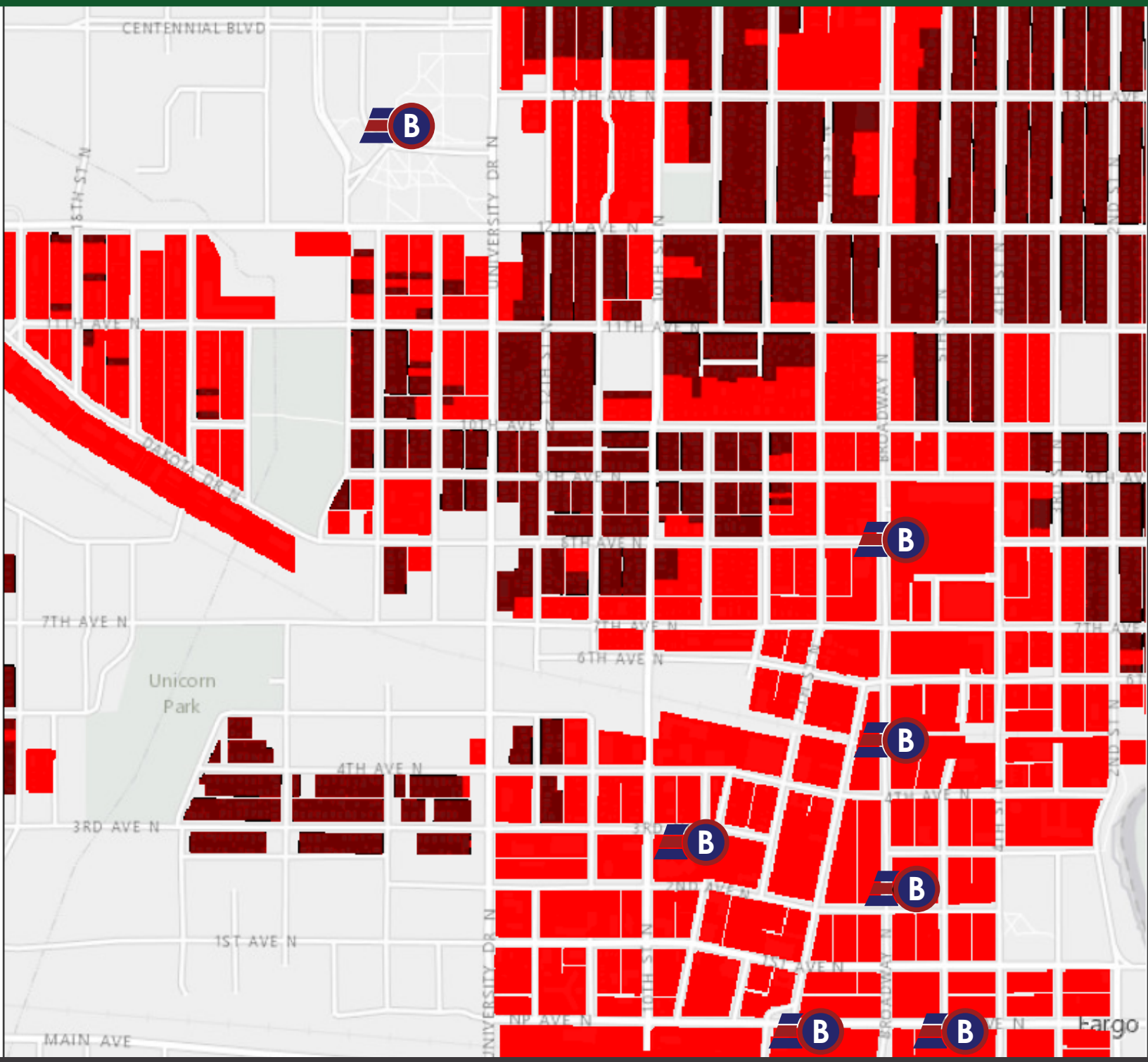




POPULATION DENSITY MAP



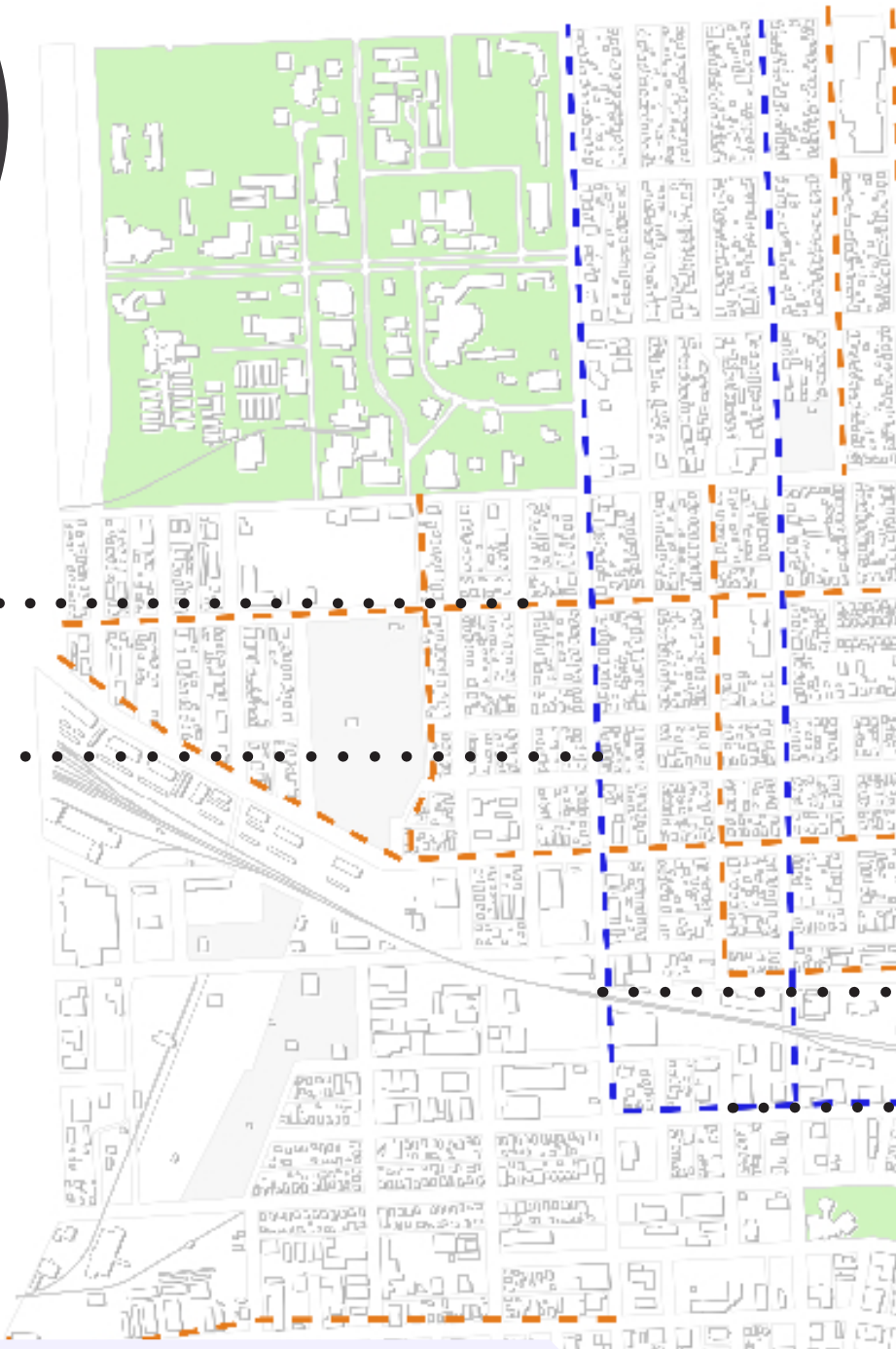
HOUSING DENSITY MAP



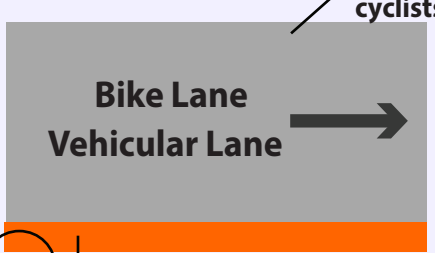
High Housing Density

Low Housing Density

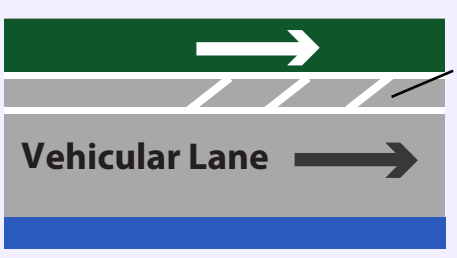
EXISTING BIKE NETWORK



SHARROW

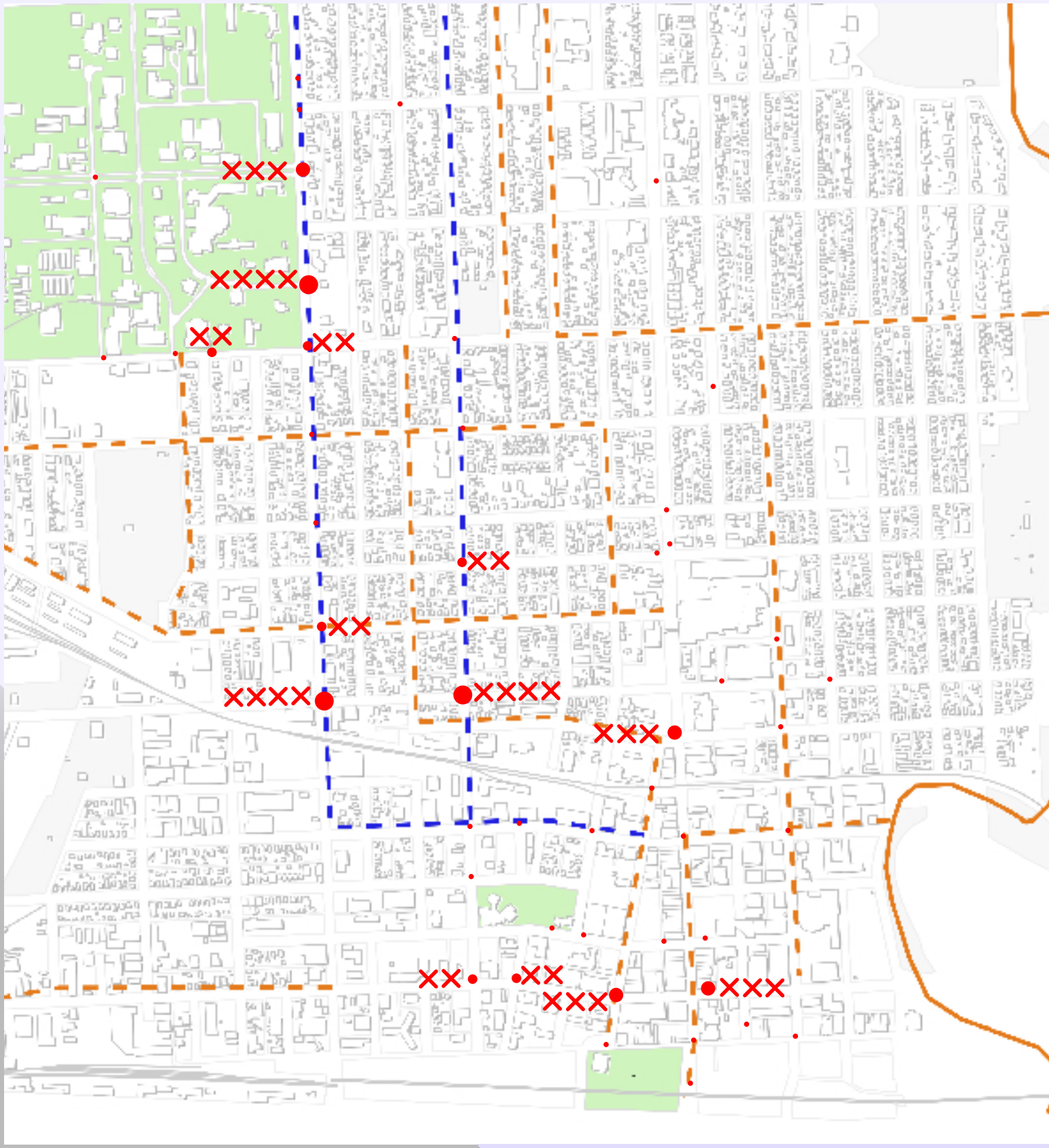


BUFFERED BIKELANE



BICYCLE CRASHES

1 Bike Crash



-Most of the collisions occurred at intersections

-Visibility of the bicycle lanes need to be increased. Especially at intersections

BIKE SHARE

The results of the GIS data showed areas that would benefit the most and where it would be most suitable to add or improve bicycle paths. Shown in *Figure 1* is all of the current bicycle routes and B-Cycle bike share stations in Fargo, ND. Using data provided from B-Cycle showed which stations were the most popular, from this data popular routes can be assumed by connecting the popular stations together. Finding heavily traveled routes and making them accessible year-round is important since it will provide people who bicycle for transportation routes that are accessible all year allowing them to travel throughout the City of Fargo without issues.

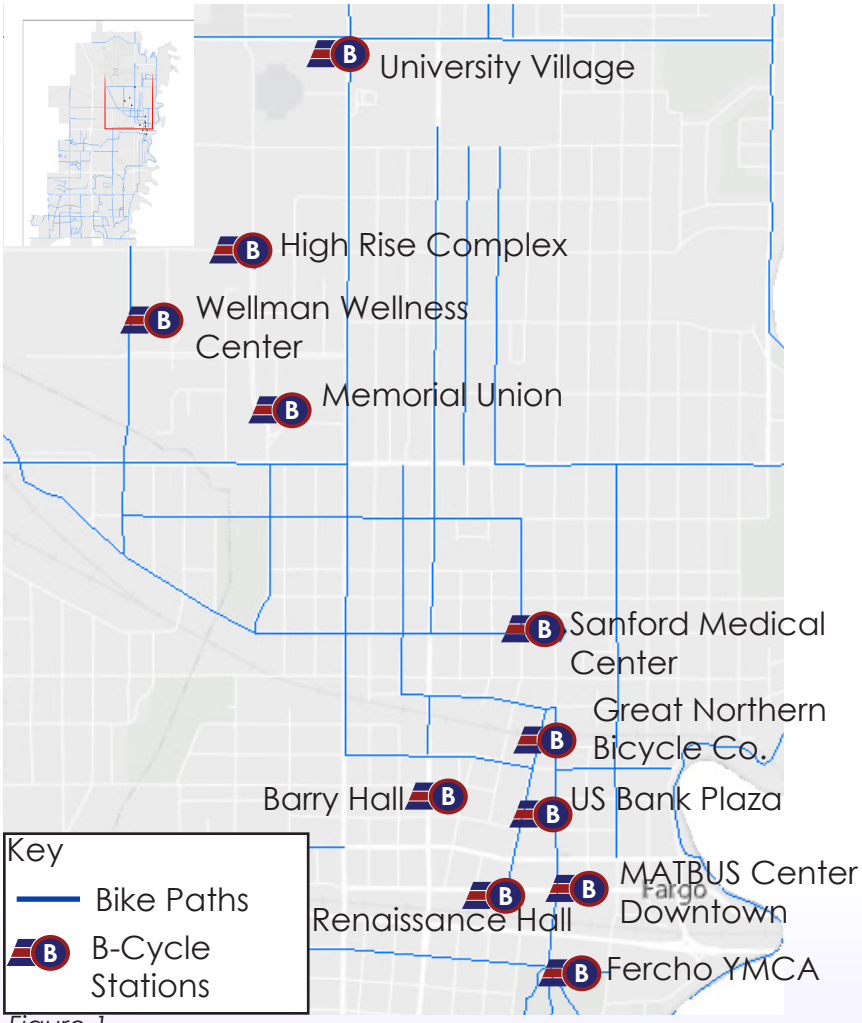
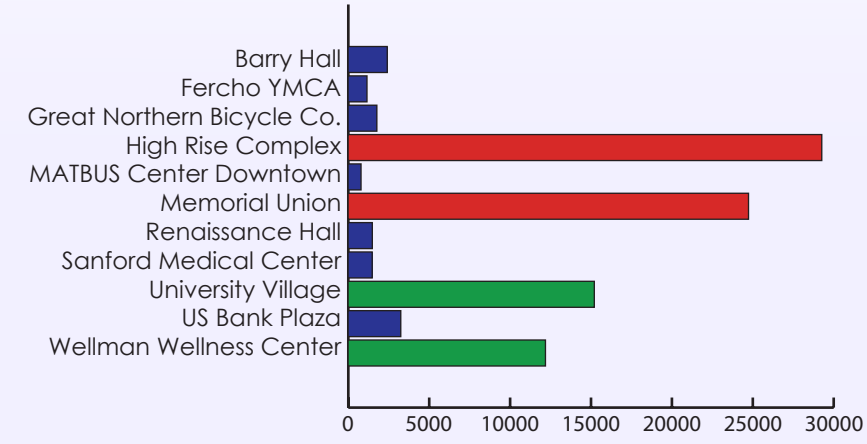


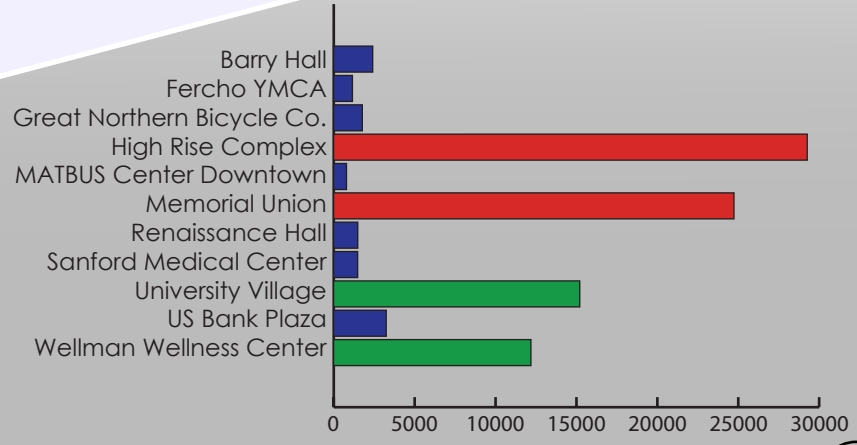
Figure 1

CHECKOUT



Barely Used
Moderately Used
Heavily Used

RETURN



MATBUS ROUTES

MATBUS ROUTE

POTENTIAL DESTINATION

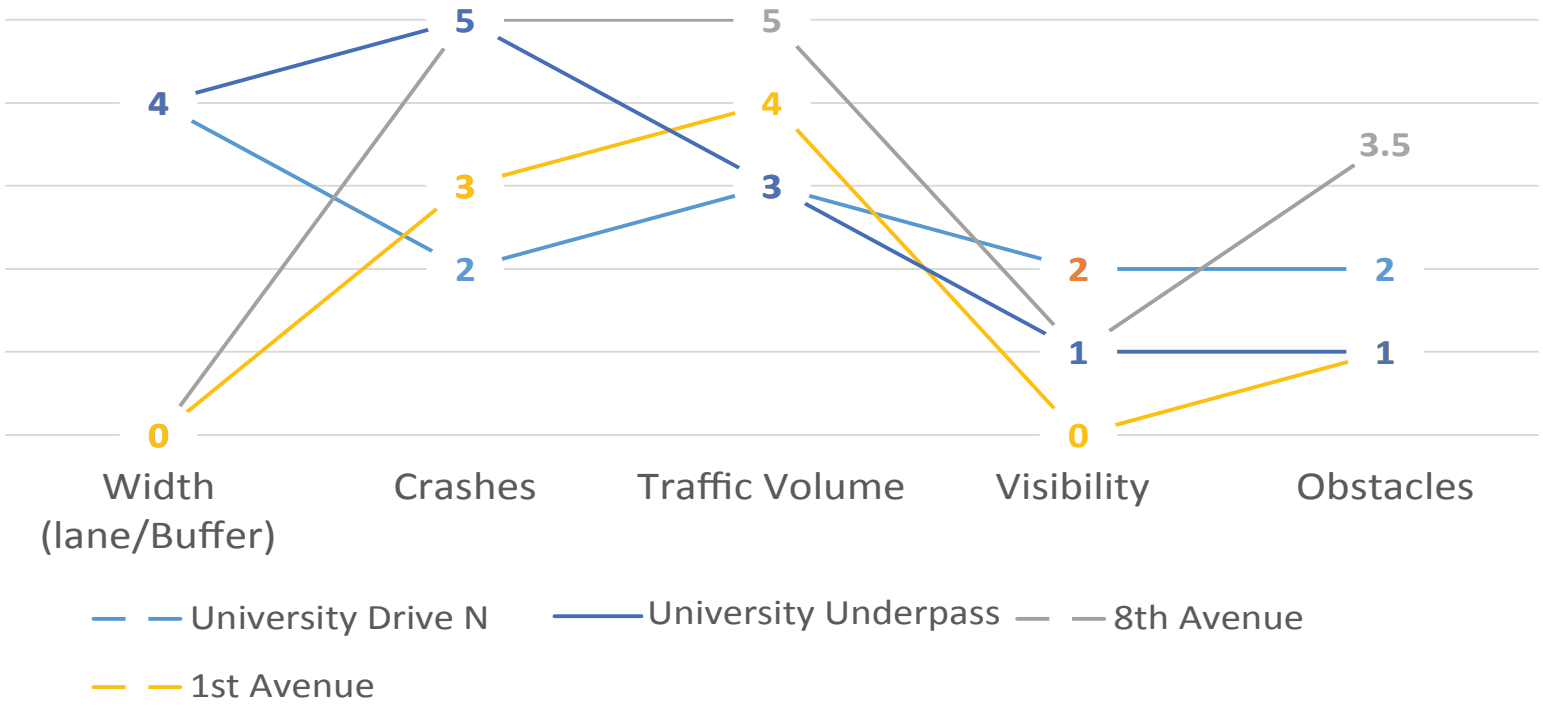
NDSU

200M

BUS SHELTER

DESIGN AMENITIES

STREET RANKING



AMENITIES

- Painted Bike Lane
- Wider Physical Bicycle Buffer
- Vertical seperation buffer
- Increased Lighting
- Brigher Materials

CURRENT CONDITIONS

UNI UNDERPASS

- **Width:** 5' Lane
- **Crashes:** 12
- **Traffic Volume:** High
- **Visability:** Not Painted/ Worn down
- **Obstacle:** Drainage Grates, Curb, Trash

AMENITIES

- Painted Bike Lane
- Designated Bike Lanes
- Bike Racks/ Storage
- Signals at intersections
- Increased wayfinding

CURRENT CONDITIONS

1AVE STREET N

- **Width:** No Lane or Sharrow
- **Crashes:** 10
- **Traffic Volume:** High
- **Visability:** No Lanes present
- **Obstacle:** Drainage Grates, Curb

CLIMATE/ ACCESSABILITY

ISSUES

During the winter months current bicycle paths get covered in runoff from prior snowfalls.

Heavy snowfall leads to bicycle paths becoming narrower and more hazardous as debris and slush cause slippery conditions.

Bike Share Stations are currently being implemented in both downtown Fargo and NDSU, however, neighborhood between the two areas are left without a bike share station.

Cold temperatures combined with high winds make winter month very uncomfortable for both the pedestrian and the cyclists.

AMENITIES

Buffer seperated allows for less runoff to accumulate on the bicycle paths, maintinence for these paths will be similar to how the walkways are treated currently.

Establishing two additional bike share stations between NDSU and Downtown Fargo. This will increase accessability by allow people who between to have nearby access.

Implimenting more bus shelters with heating options will provide areas of temporary relief for both pedestrian and cyclists.

UNIVERSITY DRIVE N

CURRENT CONDITIONS

Width: 5' Lane

Crashes: 20

Traffic Volume: High

Visability: Not Painted/ Worn down

Obstacle: Drainage Grates, Curb, Trash

AMENITIES

- Painted Bike Lane
- Wider Physical Bicycle Buffer
- Wider Pedesterian and Bicycle crossing at intersections
- Warning signs at intersections
- Increased wayfinding

8TH AVENUE

Width: No Lane, 24'Total, Sharrow is 14' from curb

Crashes: 3

Traffic Volume: Low

Visability: Not Painted/ Worn down/ Not spaced

Obstacle: Passing Vehicles and dooring

- Painted Bike Lane
- Designated Bike Lanes
- Bike Racks/ Storage
- Signals at intersections
- Increased wayfinding

DISCUSSION

Gaps in the current bicycle network were. This was done by creating a population map in ArcGIS to find areas that would most benefit from the bicycle network. Through analysis it was found that bicycle infrastructure was most abundant in both downtown Fargo and NDSU. However, the areas between these two had less bicycle infrastructure and no bike share stations. The Green Line serves as the bridge between NDSU and Downtown Fargo. This is done by increasing and improving the bicycle infrastructure and introducing additional bike share stations.

One area that was disconnected from the current network was Roosevelt neighborhood. The area has both a high housing and population density. However there is not a bike share station or any designated bike lanes. Increasing and improving the bicycle infrastructure will encourage more people to ride and provide connections to the people of the Roosevelt neighborhood who did not have them before.

Crash data was collected and analyzed to show streets and intersections that needed the most improvement as far as safety and visibility was concerned. Through this four areas were identified and given ranks in safety, visibly, and infrastructure. From here possible design solution were created to mediate the problems and improve the overall area.

Popular areas were looked at too see were people would most likely go and see if the area is well connected. With this the overall frame work for the Green Line was established.

Bicycle share date was collected and analyzed to show the dominant user and also to determine where the most popular bike share stations were located. From there I found that students were the primary user with the most popular station being on NDSU main campus.

D

DESIGN

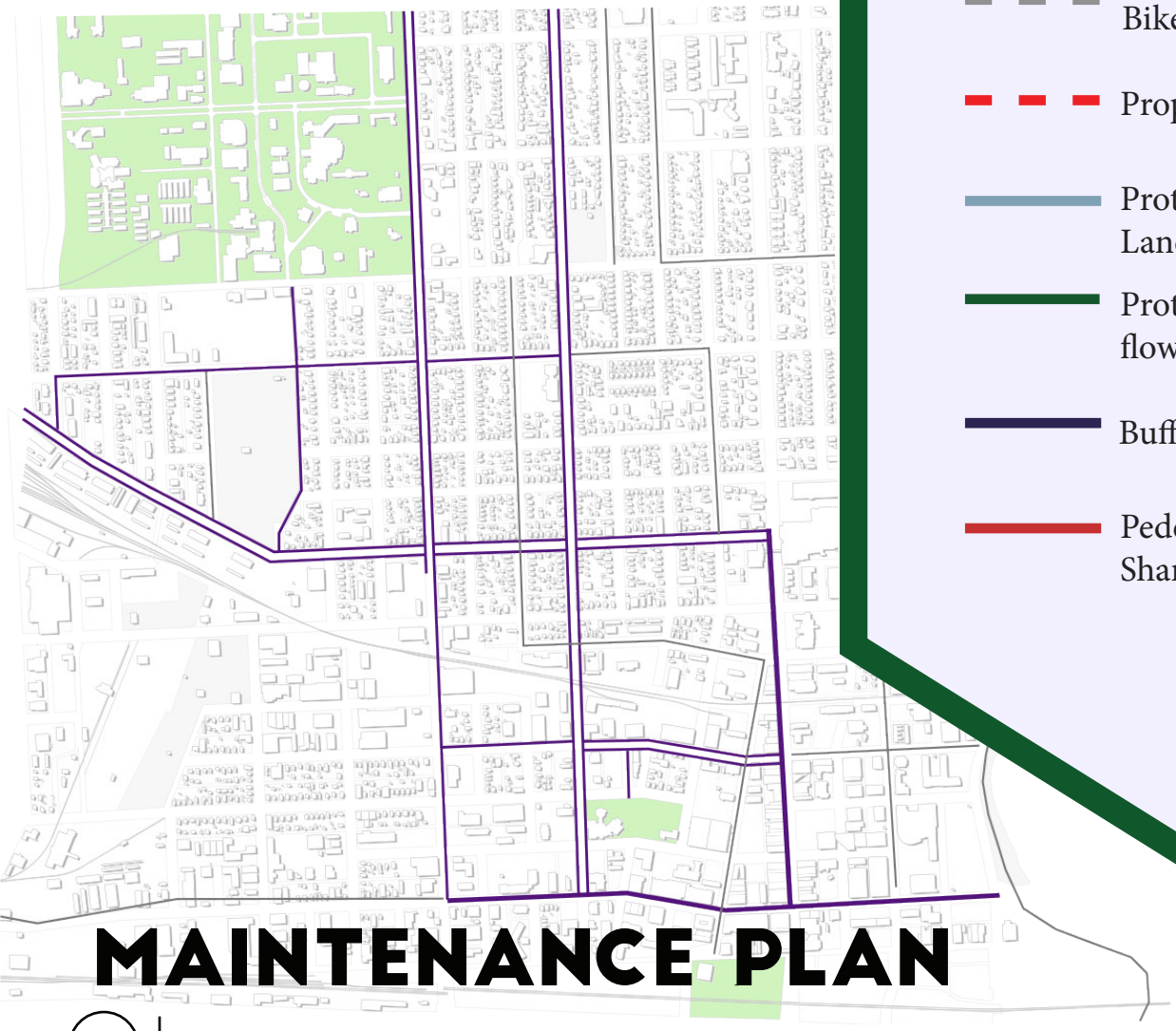
ROUTE TYPES

PRIMARY

Primary routes are plowed within four hours of 3 centimeters of snow accumulation and de-icing treatments are applied before 7 am. Plowing is done before 7 am when snowing at night.

SECONDARY

Secondary routes are plowed within four hours of 5 centimeters of snow accumulation and de-icing treatments are applied as needed. Plowing is done before 7 am when snowing at night



MAINTENANCE PLAN

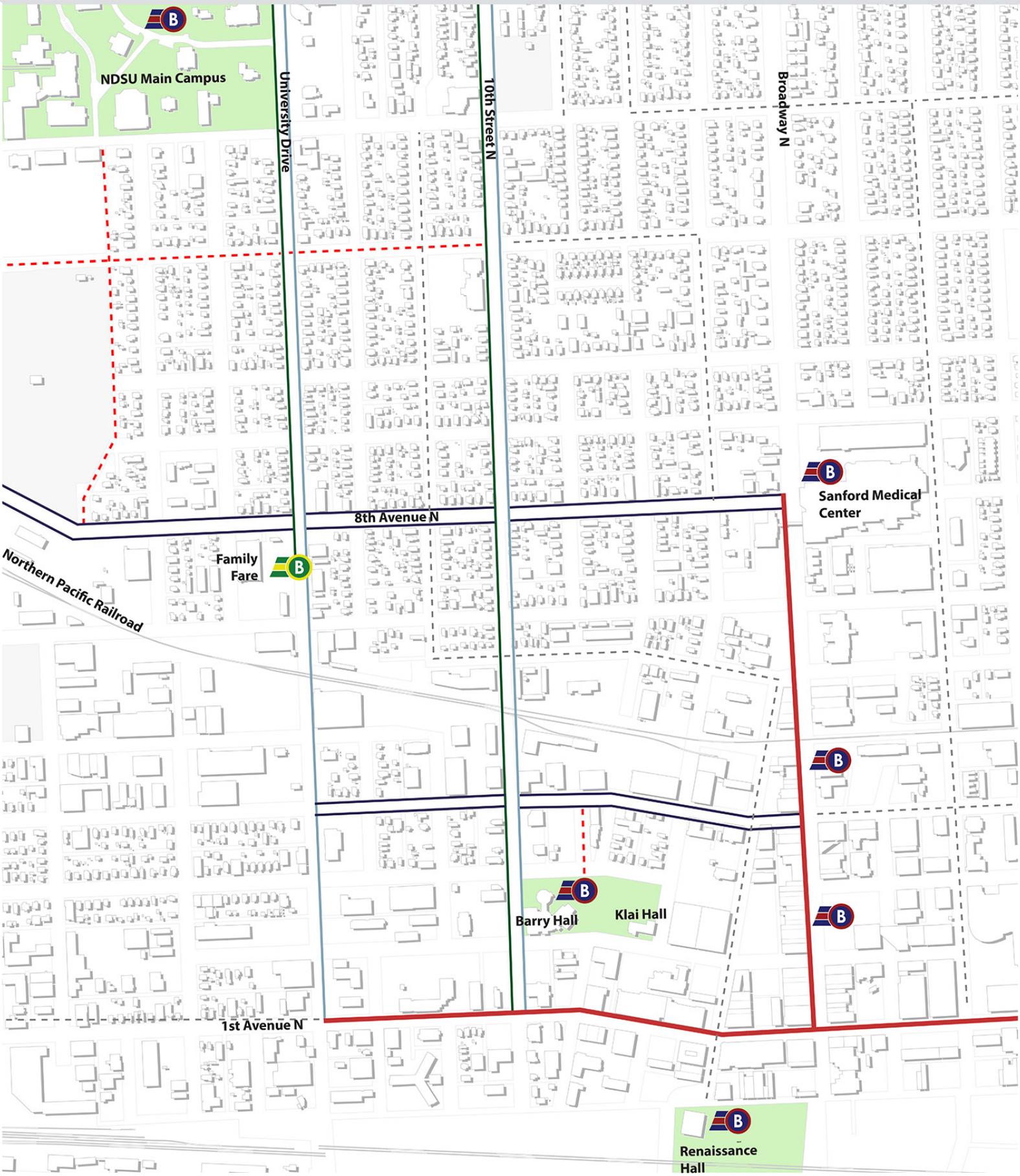
MASTER PLAN

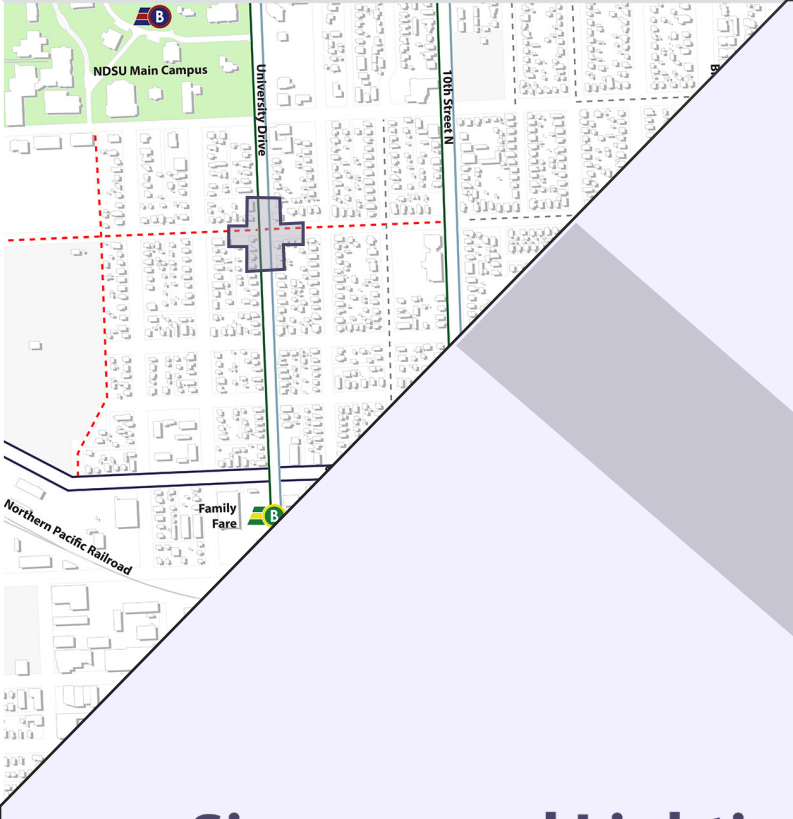
KEY

- Existing Bike Share Station
- Proposed Bike Share Station
- NDSU Buildings
- Existing Park

BIKE LANE TYPES

- Existing Bike Lane
- Proposed Sharrow
- Protected Bike Lane
- Protected contra flow Bike Lane
- Buffered Bike Lane
- Pedestrian and Cyclist Shared Lane


NDSU Main Campus
University Drive
10th Street N
Broadway N
8th Avenue N
Family Fare
Northern Pacific Railroad
Sanford Medical Center
Barry Hall
Klai Hall
1st Avenue N
Renaissance Hall
0'
100'
200'
400'
800'
N

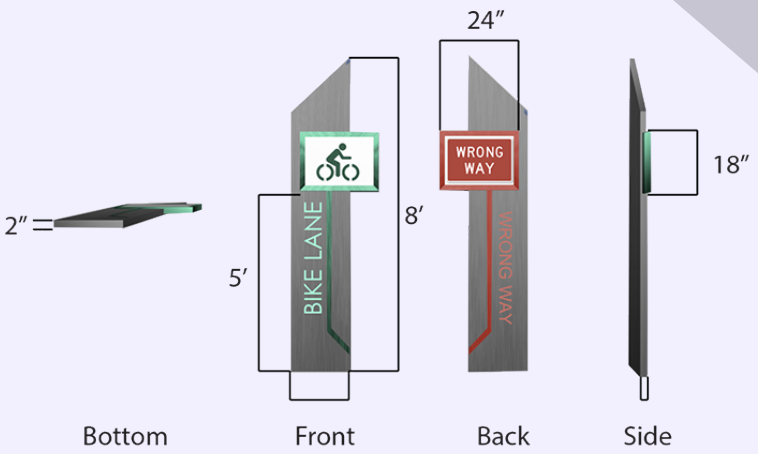


Signage and Lighting

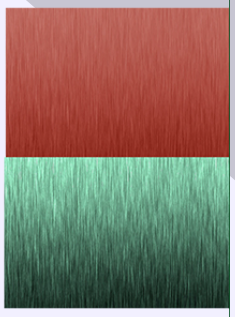
The Green Line features custom made bicycle wayfinding signs. The bicycle sign meets the size requirements and features two sides to tell the user if they are going the right direction of the wrong direction.

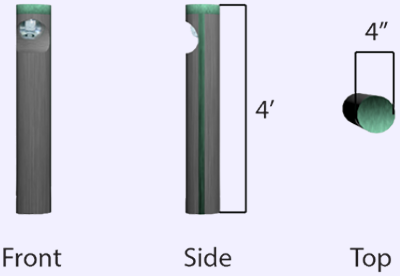
Key

- **A** Painted Bike Lane
- **B** Dashed Bike Lane indicating vehicles can cross
- **C** Lighting
- **D** Vegetative buffer made up of prairie grasses and wildflowers
- **E** Widened crosswalk to increase visibility
- **F** Wayfinding Signage
- **G** Existing Sharrow
- **H** Gap in buffer to allow water to drain



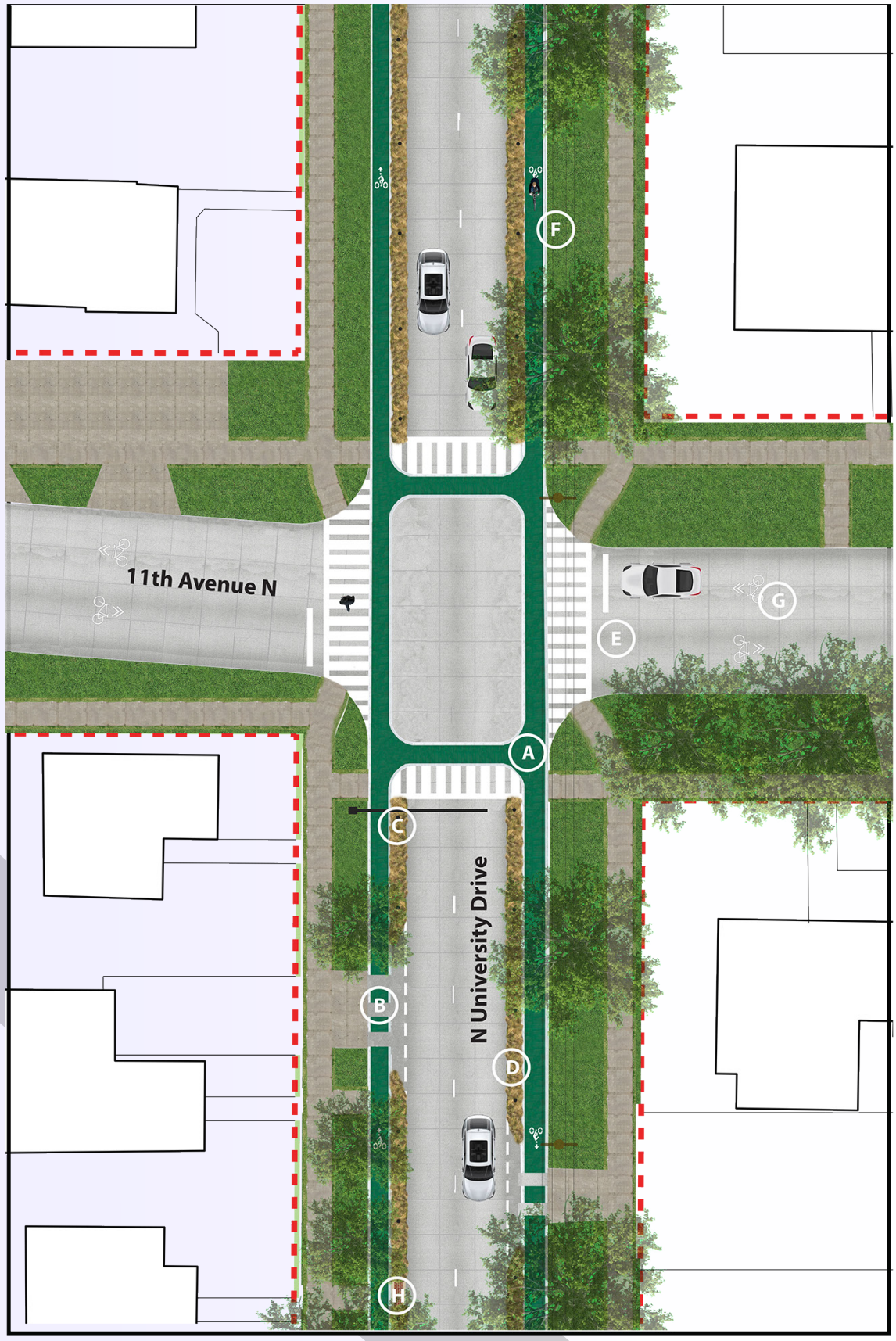
Powder Coated Steel





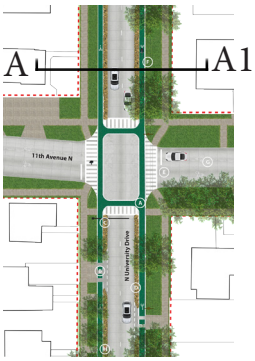
Stainless Steel

UNIVERSITY DRIVE N



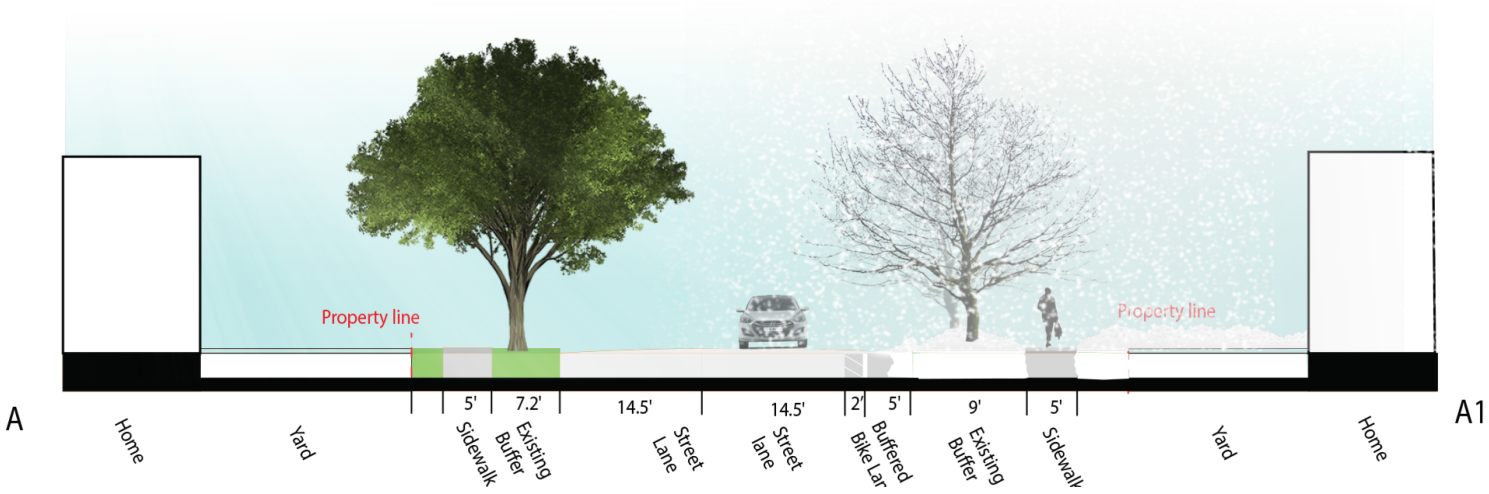
BIKE LANE PERSPECTIVE

SPRING

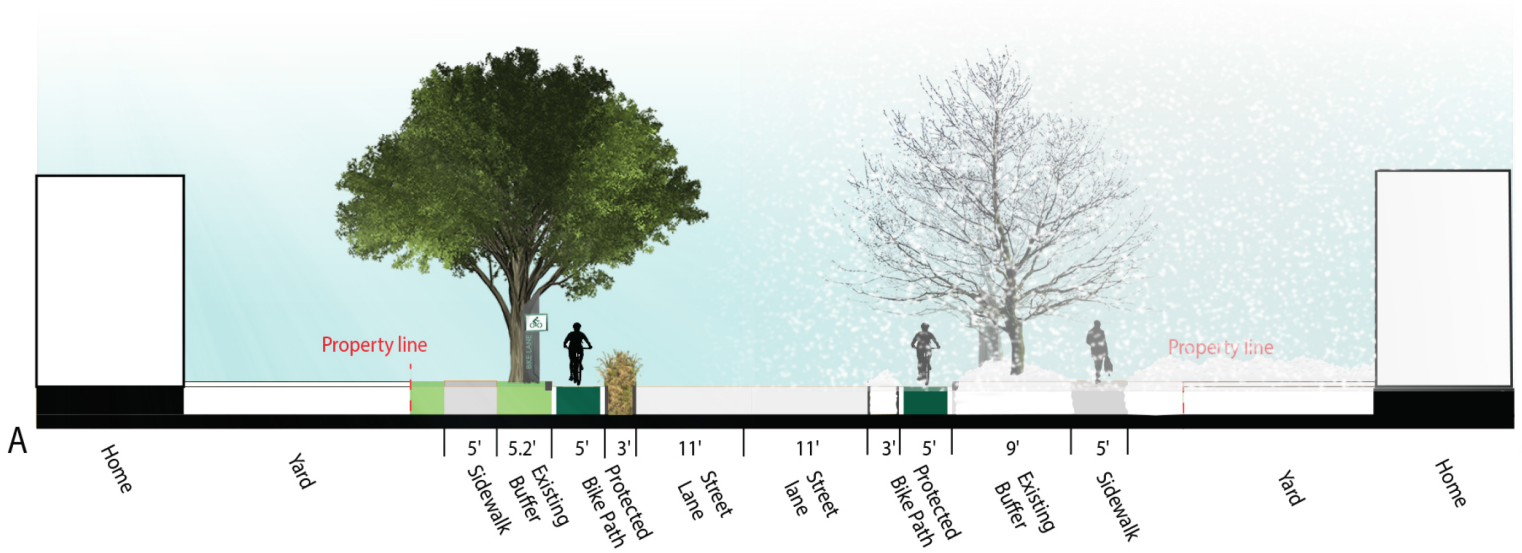


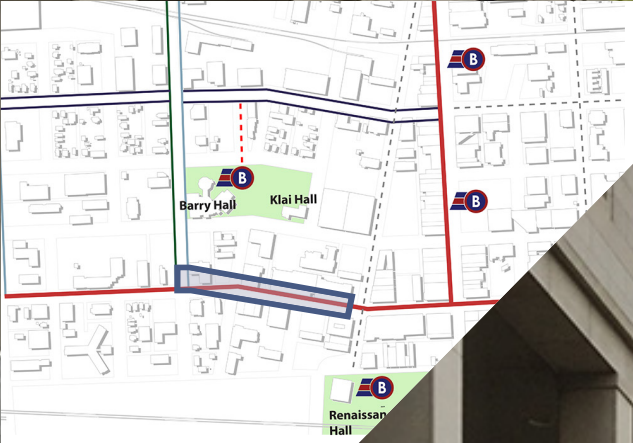
STREET SECTIONS

EXISTING SECTION



PROPOSED SECTION





Key

(A) Mixed use walkway for both pedestrians and cyclists

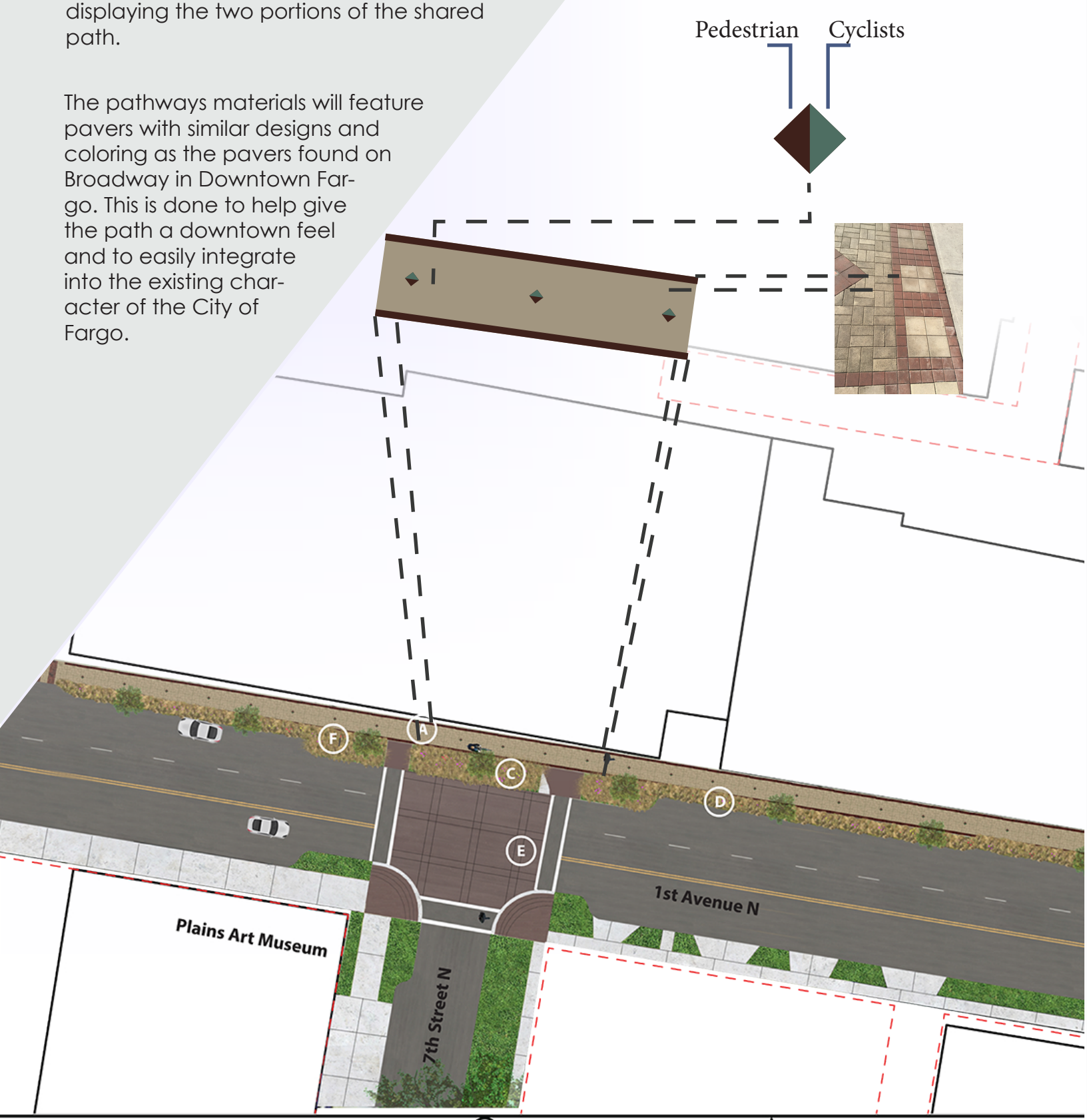
(B) D... in...

(F) Wayfinding Signage

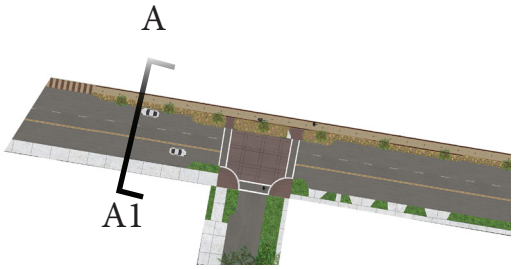
1ST AVENUE N

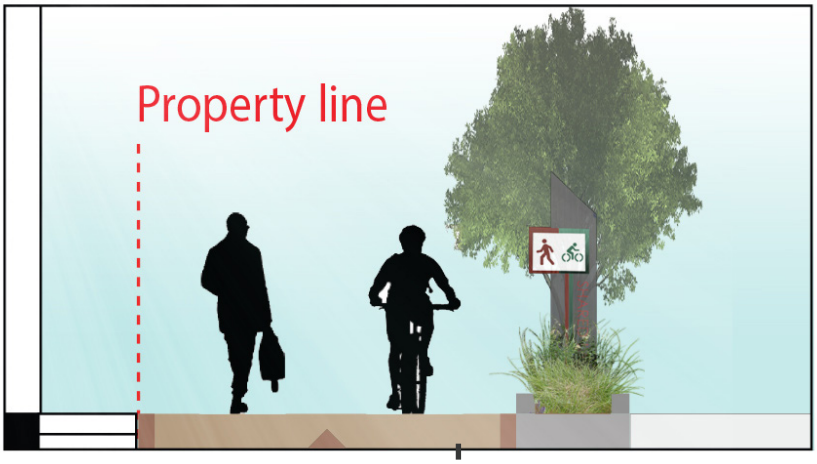
The symbol on the pathway helps separate between the pedestrian and the cyclist. The wayfinding signs on this path feature the same color scheme better displaying the two portions of the shared path.

The pathways materials will feature pavers with similar designs and coloring as the pavers found on Broadway in Downtown Fargo. This is done to help give the path a downtown feel and to easily integrate into the existing character of the City of Fargo.



SECTIONS

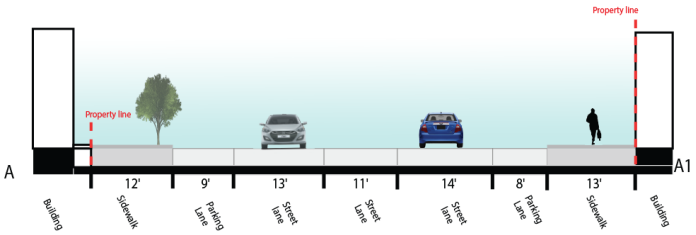


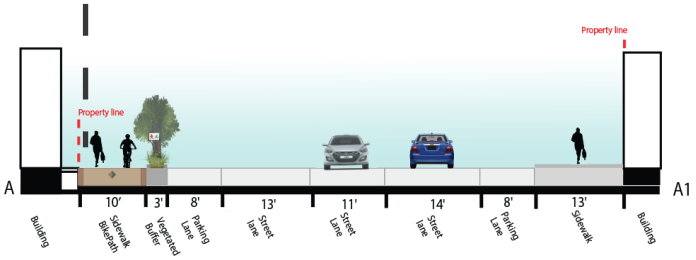


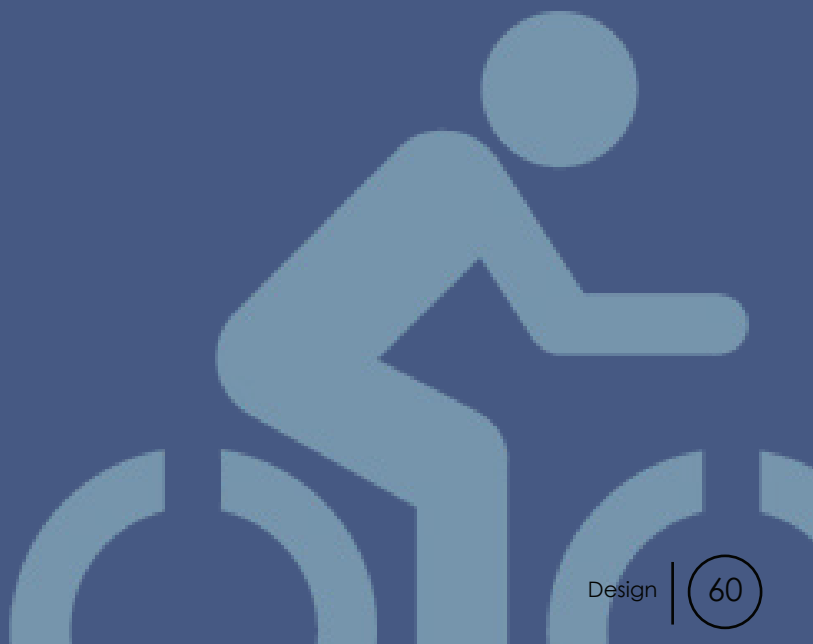
SPRING

Similar to the other sites maintenance plans the shared use path can store some of the snow in the 3 foot buffers to provide a barrier in the winter.

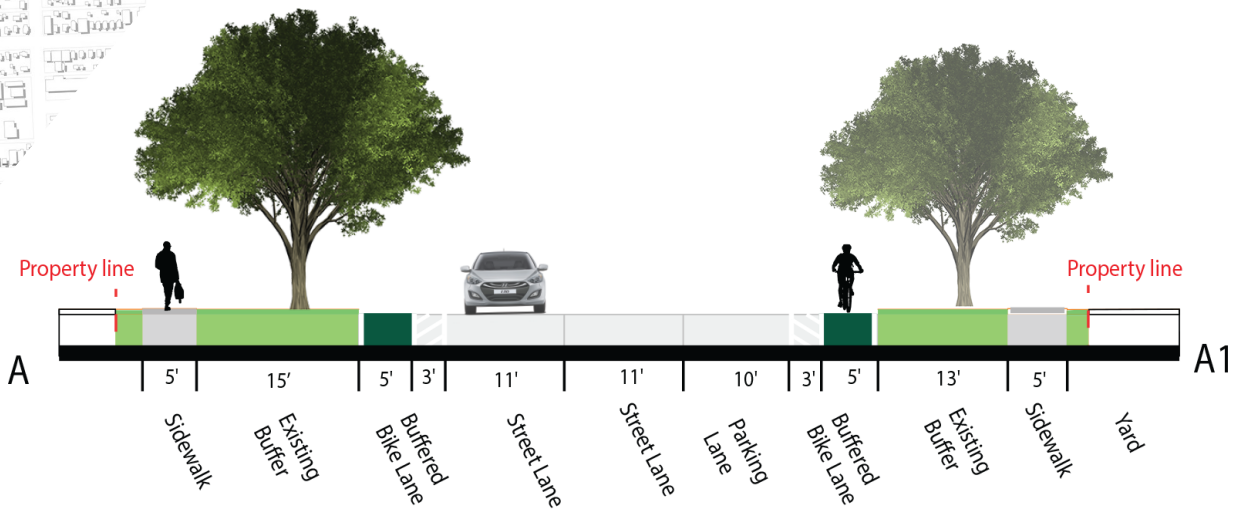
WINTER

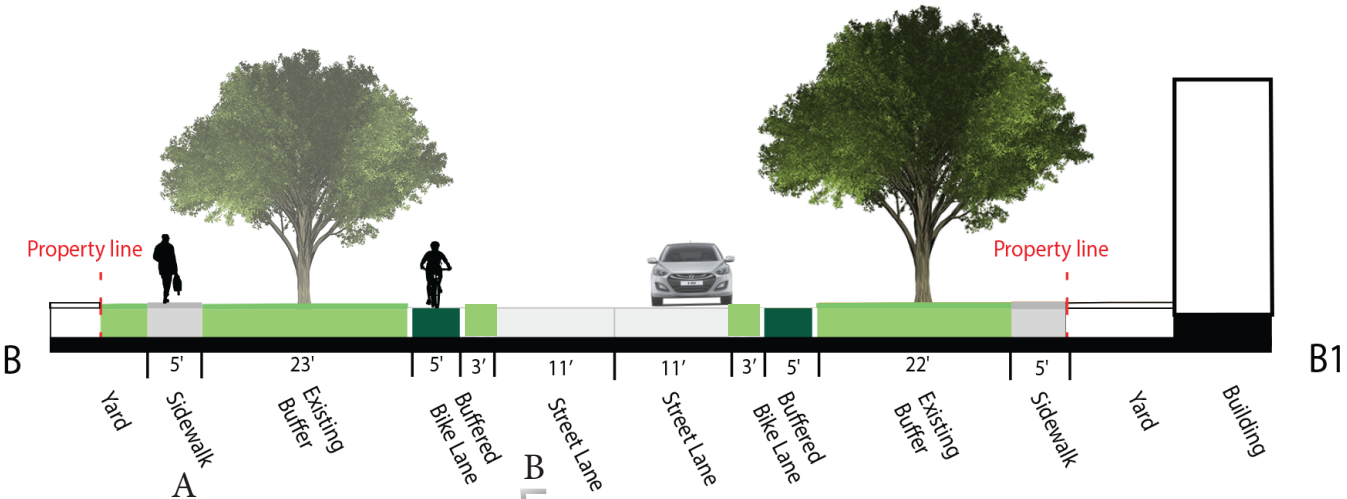


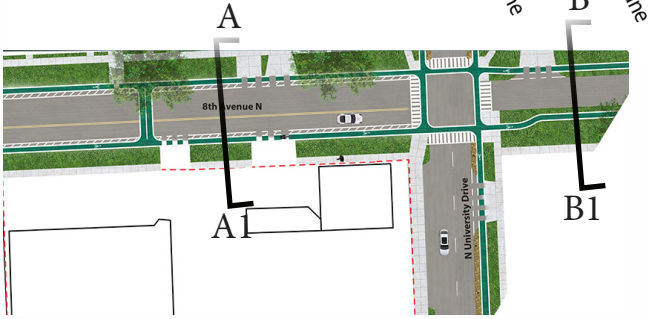




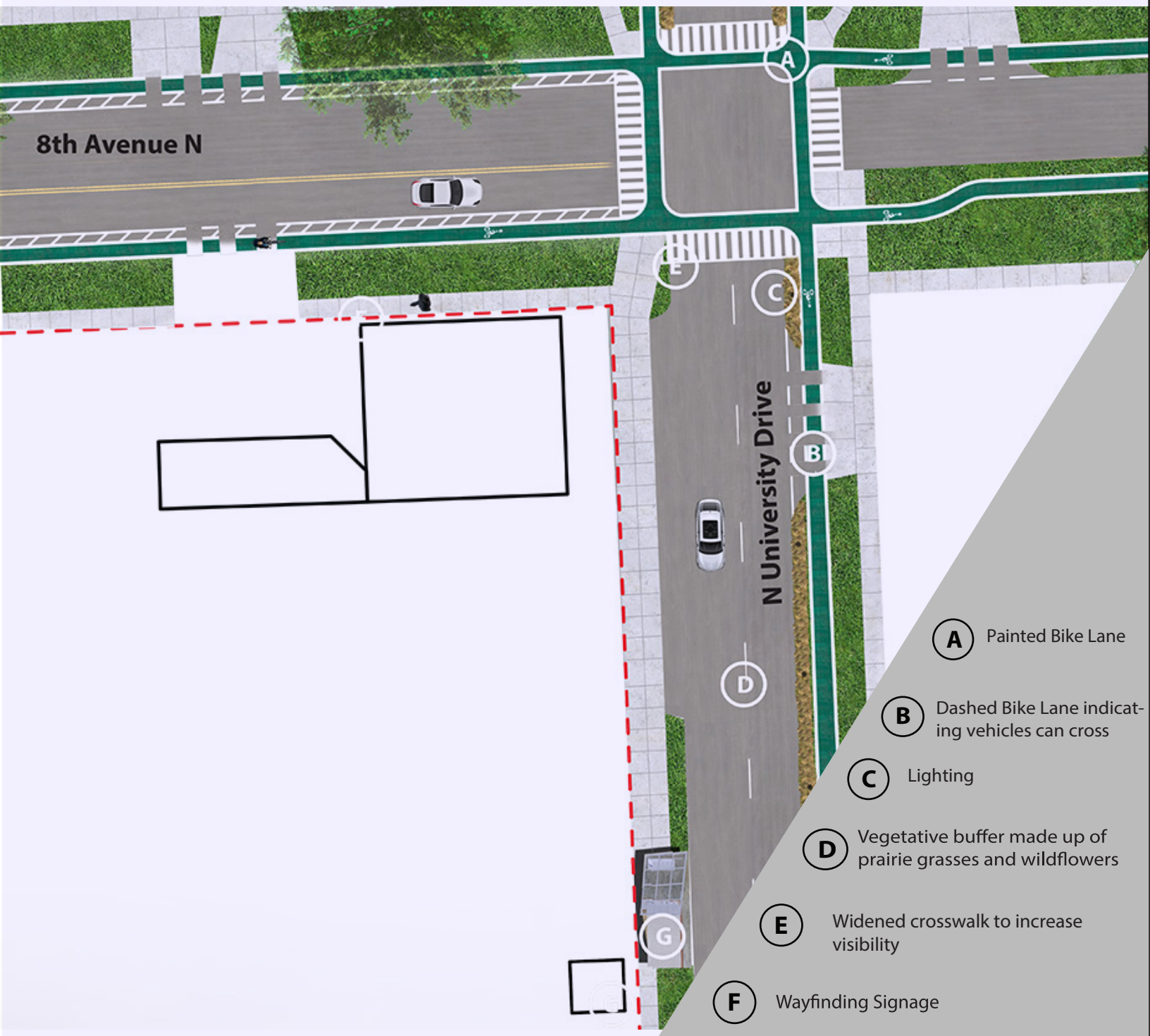
STREET SECTIONS

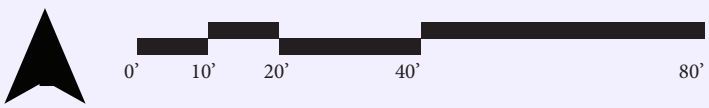






8TH AVENUE N





A Painted Bike Lane

B Dashed Bike Lane indicating vehicles can cross

C Lighting

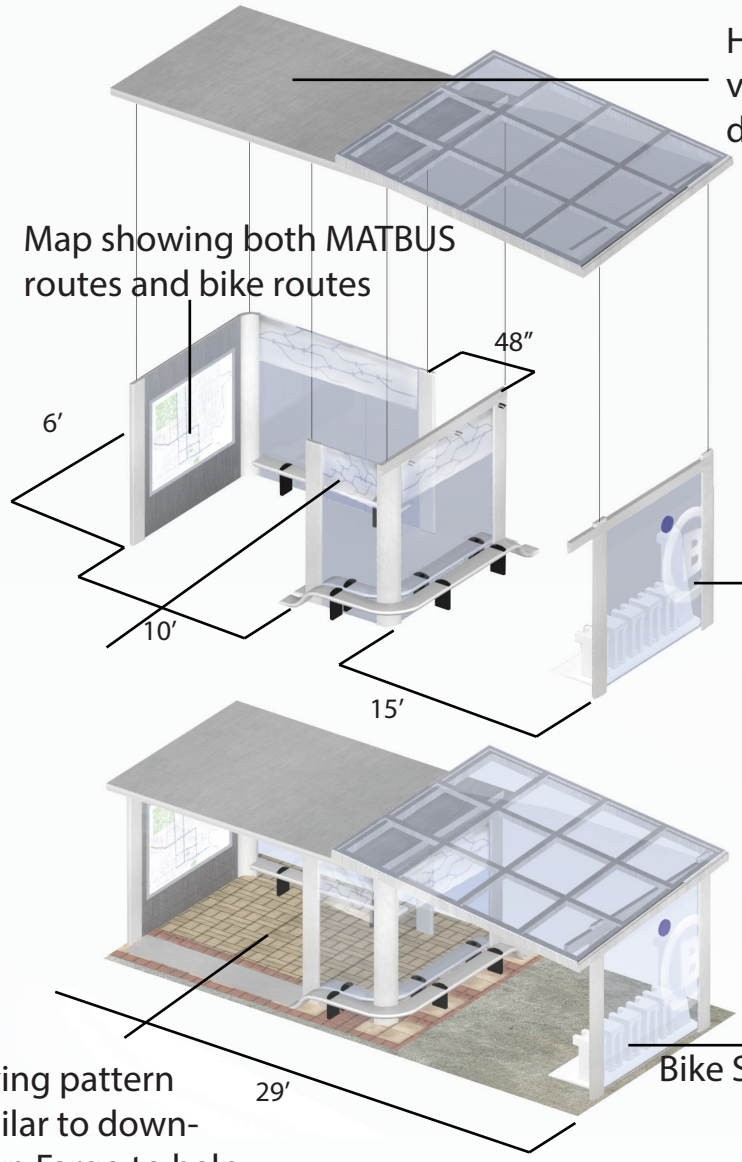
D Vegetative buffer made up of prairie grasses and wildflowers

E Widened crosswalk to increase visibility

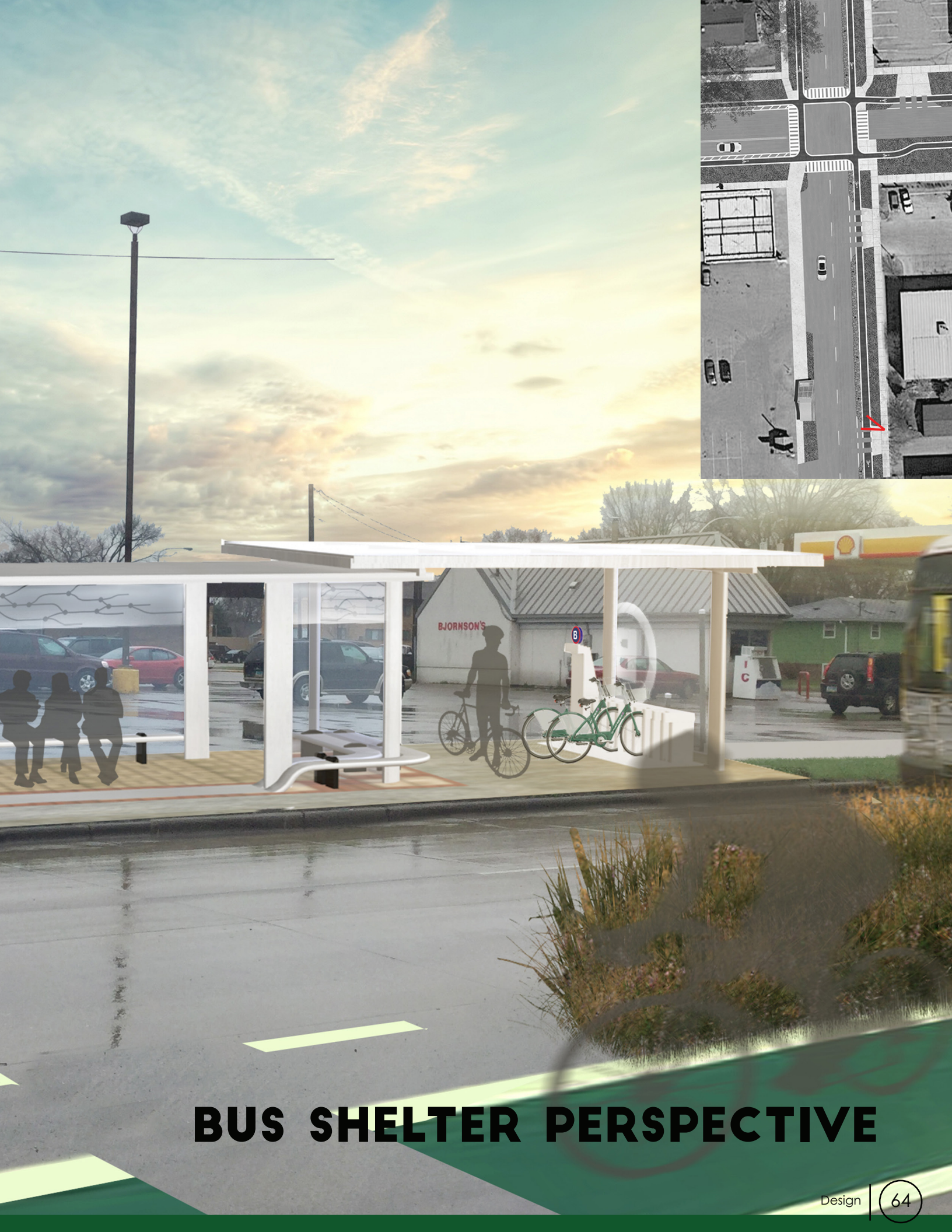
F Wayfinding Signage

G Bus Shelter and Bike share station

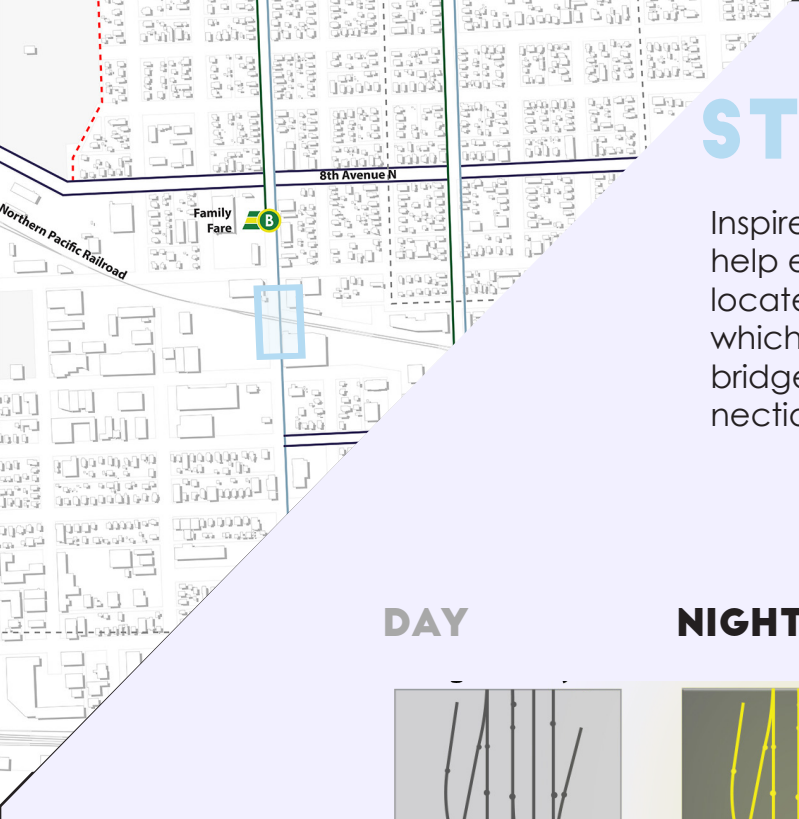
H Bike lane crossing to allow cyclists access to the Family Fare grocery store



BUS SHELTER DETAIL
BUS SHELTER DESIGNS



BUS SHELTER PERSPECTIVE

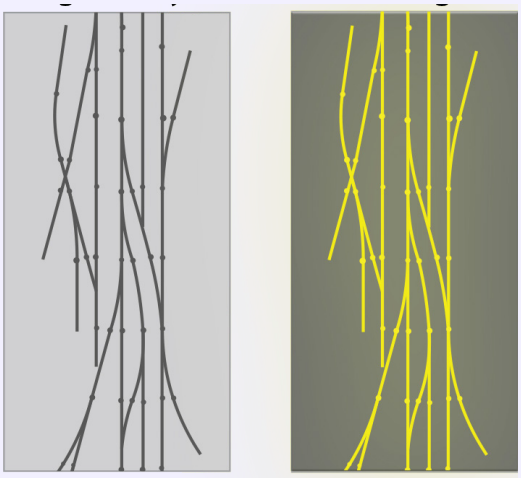


STEEL PANEL DETAIL

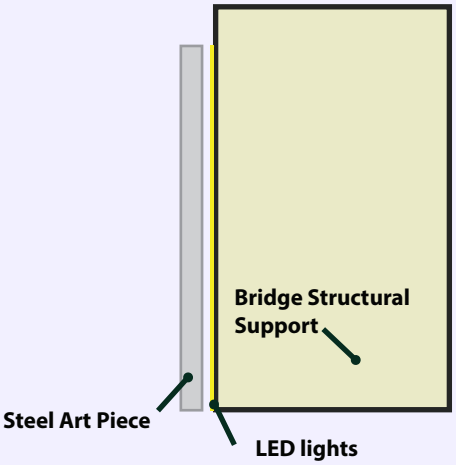
Inspired by railroad connection maps these cutout help enforce the bike path and the bridge that it is located on. This bicycle map provides connections which these art pieces display. The fact that this bridge is for railroad crossings is the reason train connection maps were used.

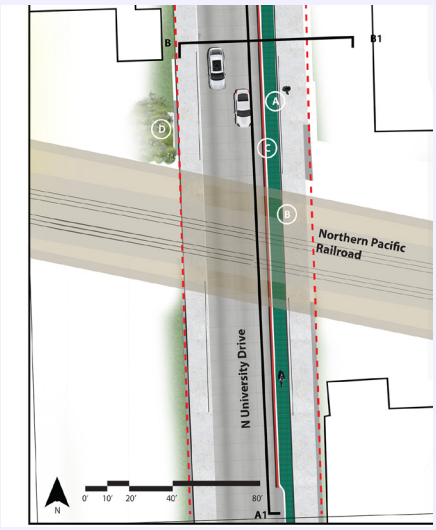
DAY

NIGHT

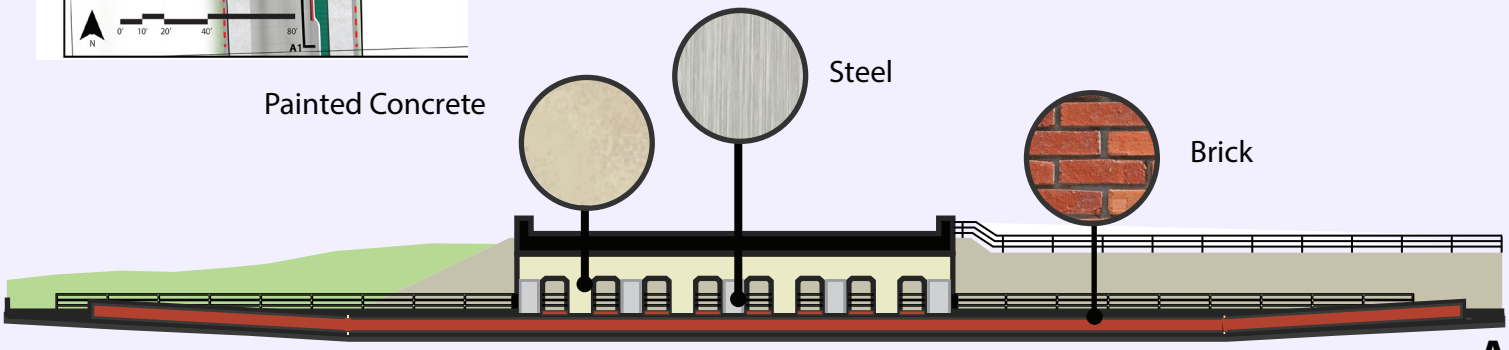


SIDE DETAIL





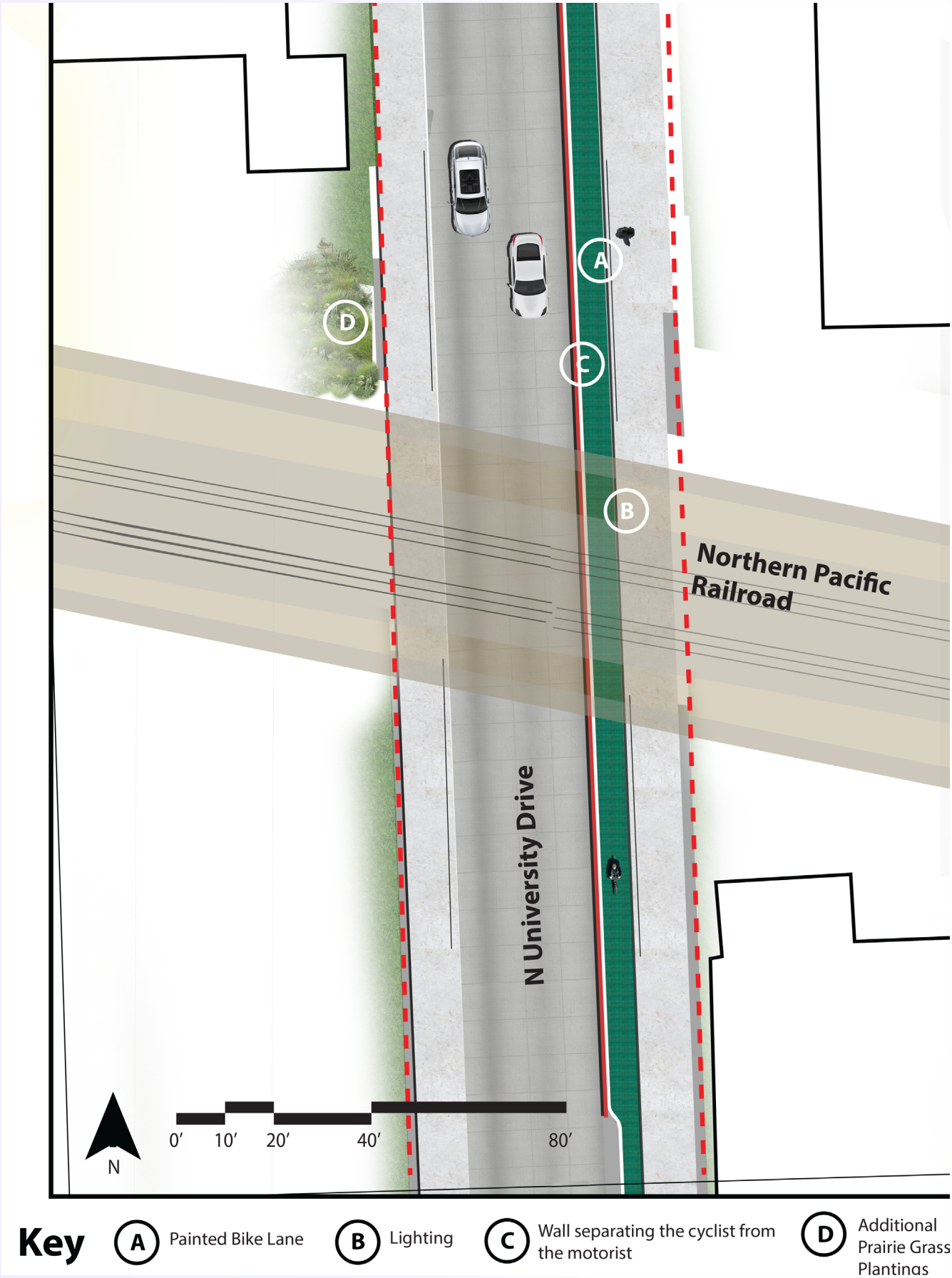
SECTION CUT



A

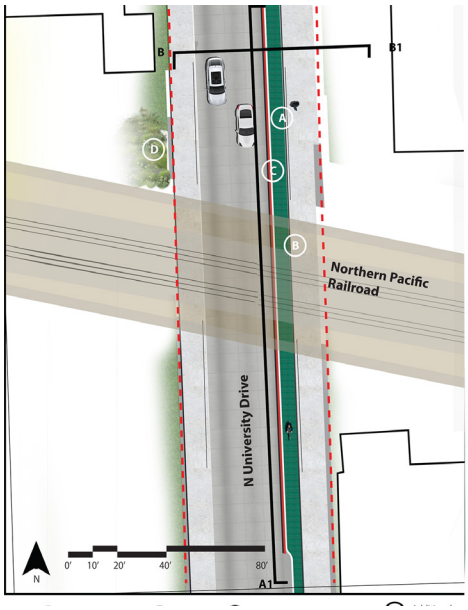
A1

UNIVERSITY UNDERPASS

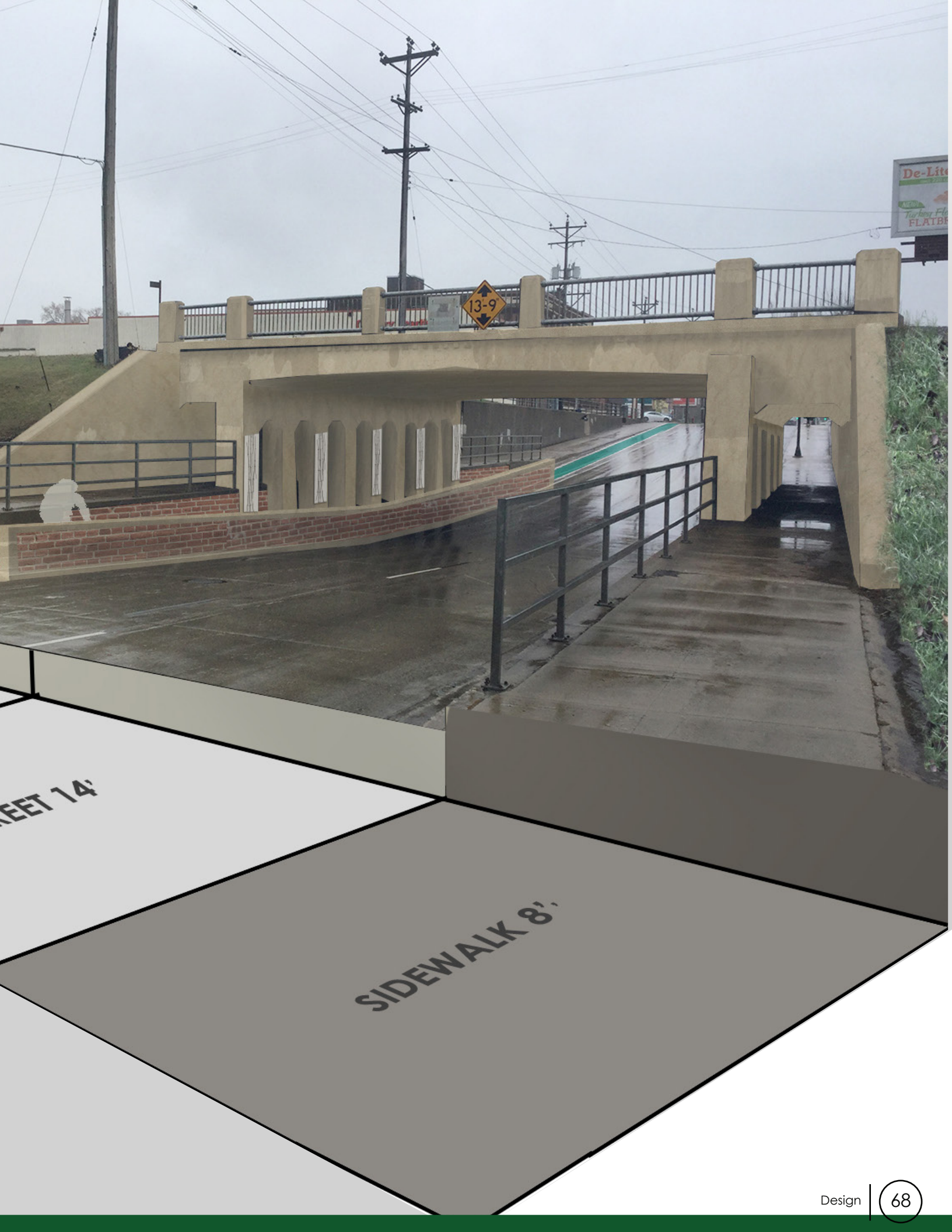


Key

- (A) Painted Bike Lane
- (B) Lighting
- (C) Wall separating the cyclist from the motorist
- (D) Additional Prairie Grass Plantings



SECTION PERSPECTIVE

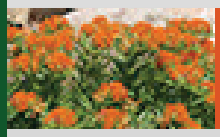

13'-9"
EET 14'
SIDEWALK 8'

PLANT LIST

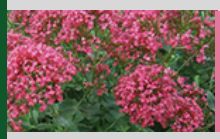
Wild Flowers

Threadleaf Coreopsis

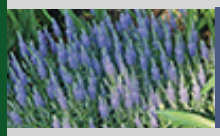
Happy Returns Daylily



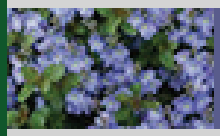
ButterFly Weed



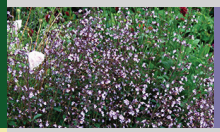
Red Valerian



Blue Carpet Speedwell



Waterperry Blue Speedwell



Calamint

Grasses

Dwarf Fountain Grass

Blonde Ambition

Karl Foerster

Indian Grass

CONCLUSION

Fargo is growing its bicycle infrastructure and overall bike friendliness. It is clear through their GO2030 report that improvements are and will be made. Past examples also show the desire for the City of Fargo to be a bike friendly community. These examples are the bike share implementation and events heavily involving both cyclists and pedestrians like Fargo's Streets Alive event. With this the next step should be to ensure that the current bicycle network is both well connected and safe year round. Doing so will encourage more people to bike and attract people from around the United States who favor strong bicycle infrastructure.

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