Kendrick Street Bicycle Boulevard Project

Final Design Report

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Designed for:

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Submitted by:

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This report was prepared in cooperation with the City of Flagstaff Traffic Engineer Jeffery Bauman and the City of Flagstaff Multimodal Planner Martin Ince. Jeff and Martin have played a key role in the development of the Kendrick Street Bicycle Boulevard Project. They helped the designers with guidance and ideas regarding this project.

In addition, Logan Couch, City of Flagstaff Intern, provided the designers with pertinent information including City of Flagstaff .tiff images, crash data, and other various data elements.

The Arizona Department of Transportation provided instrumental specifications for design standards and related work that are used throughout this report.

John Koch from Ennis Flint provided unique and progressive specifications and recommendations for the bulb out traffic patterns used in the final design.

Finally, this concept and design would not have been possible without the National Association of City Transportation Officials (NACTO) Urban Bikeway Design Guide. This guide was the driving force behind the design of the Kendrick Street Bicycle Boulevard Project and would not have been possible without their leadership.

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Project Description

The purpose of this design is to convert Kendrick Street into a bicycle boulevard, providing a bicycle friendly alternative to Humphreys Street. Bicycle boulevards improve bicycle safety and circulation by having or creating low traffic volumes, discouraging non-local motor vehicle traffic, and providing free-flow travel for bikes by assigning the right-of-way to the bicycles at intersections. In addition, bicycle boulevards have "a distinctive look or ambiance such that cyclists become aware of the existence of the bicycle boulevard and motorists are alerted that the roadway is a priority route for bicyclists" [1]. This is accomplished by giving cyclists equal priority, providing pavement markings, eliminating stops along the bicycle boulevard, and designing the road so it is clear to all users that bicycles are welcome and encouraged. The extent of the work will be from US 180/ North Fort Valley Road to Birch Avenue along Kendrick Street. Currently, Kendrick Street does not have any of the above listed treatments intended for bicyclists. The City of Flagstaff is constantly seeking ways to improve its bikeways systems and this project will provide a crucial connection to the system. Completing this project will also connect the foot and bike trails of Northern Flagstaff to the campus of Northern Arizona University (NAU). Current conditions make it technically possible for bikers to get from Northern Flagstaff to NAU, but it is not as safe, simple, or easy as a bicycle boulevard will provide.

Kendrick Street offers the basic components of a safe bicycling environment. Bicycle boulevards can be tailored to existing conditions and desired outcomes. According to the National Association of City Transportation Officials (NACTO), design treatments are grouped into measures which provide the following benefits [2]:

- Route Planning
- Signs and Pavement Markings
- Speed Management
- Volume Management
- Minor Street Crossings
- Major Street Crossings
- Offset Crossings
- Green Infrastructure

This design takes into consideration and is aimed toward addressing each of these components. Route planning, or direct access to destinations, is addressed as the project is directly along the Flagstaff Urban Trail System route. Signs and pavements markings allow the bicycle boulevard to be easily recognized, easy to find, and easy to follow. Speed management ensures that motor vehicle speeds are lowered which allows a greater comfort among all riders. Volume management aim to lower or reduce motor vehicle volumes. Minor street crossings ensure that bicyclists delay is minimized and any major street crossings will be offered as safe and convenient crossings. Offset crossings, when present, require clear and safe navigation. Finally, green infrastructure mean enhancing environments and creating a healthier community. The treatments applied to the Kendrick Street Bicycle Boulevard project not only benefit citizens on bicycles, but will also help to create and maintain quiet residential streets and improve safety for all users.

Project Background

Kendrick Street is a local road that runs north-south in downtown Flagstaff, Arizona (Figure 1). The portion of Kendrick Street located in the project limits (N Kendrick Street) is approximately 0.5 miles long. It extends from US 180 to Birch Avenue parallel to Humphreys Street (one block west) (Figure 2). The north end of Kendrick Street is a one-way driveway allowing northbound Kendrick Street traffic access to US 180 / Fort Valley Road and not permitting US 180 / Fort Valley Road traffic access to

Figure 1: Project Location [3]

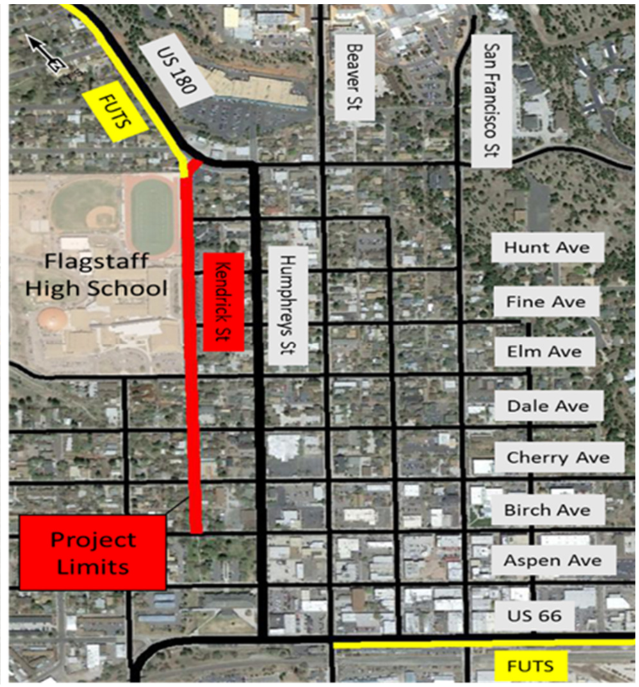

Figure 2: Project Limits [3]

Kendrick Street. Flagstaff High School is located along the northern portion of Kendrick Street between US 180 and Elm Avenue (Figure 2). The school building is on the west side of the street and student parking is on both sides of the street. The remainder of the project area, from Elm Ave to Birch Ave, consists of residential housing. The southernmost block from Cherry Avenue to Birch Avenue is a one-way street (north) with a separated pedestrian/ bicycle path. In addition to providing a mode of transportation to local and high school traffic, Kendrick St serves as a connection to the Flagstaff Urban Trails System (FUTS). FUTS "is a city-wide network of non-motorized shared-use pathways that are used by bicyclists, walkers, hikers, runners, and other users for both recreation and transportation." [4] FUTS serves north Flagstaff beginning at Schutlz Pass Road and runs parallel to US 180. Currently the trail terminates at Kendrick Street and resumes south at the intersection of Beaver Street and Route 66. Due to the large volume and lack of bicycle treatment on Humphreys Street, Kendrick Street is the ideal pathway for bicyclists traveling to and from north Flagstaff. The City of Flagstaff has begun to accommodate this preference by installing a paved pathway connecting the FUTS trail to Kendrick Street, however no bicycle treatments have been applied along Kendrick Street. Proposed changes along this route include delineated parking lanes, intersection control, vehicle choke points, and a unique branding for the bicycle boulevard. Therefore, this report addresses the missing link in the FUTS system by transforming Kendrick Street into a bicycle boulevard from the US 180 to Cherry Avenue.

Existing Conditions

Currently there are no bicycle facilities on Kendrick Street. The FUTS trail parallels US 180 and terminates at Kendrick Street. However, the City of Flagstaff has installed a FUTS connection at the north end of Kendrick Street. The connection has a wide pathway, ADA approved ramps, and is aesthetically appealing (Figure 3). The north end of Kendrick Street is a one-way driveway for northbound traffic. Once on Kendrick Street, bicyclists are forced to ride on an unstriped road or on the west side sidewalk given no pedestrian traffic (Figure 4). Near Flagstaff High School, street parking is permitted and there are parking lots and bus-traffic-only driveways on both sides of the. Elm Avenue (south side of high school) serves as a main bus route for Flagstaff High School and has priority over Kendrick Street traffic (Figure 5). Beginning at this street there are 2-way stop signs on Kendrick Street at the next four intersections. Between Cherry Avenue and Birch Avenue there is a one block segment of the FUTS which has a barrier from one-way northbound traffic (Figure 6). The south end of the project and Kendrick Street terminate at Wheeler Park. South of Flagstaff High School Kendrick Street serves as a local road for residential housing. Figure 7 is a summary of the existing traffic control along the entire segment in the project area. The sidewalk on the west side of Kendrick Street is continuous, 5 feet wide, and well maintained. In addition, the pavement conditions are average to poor. Many age and weather induced cracks are evident throughout the length of the street.

Figure 3: FUTS Connection [4]

Figure 4: West Side Sidewalk [4]

Figure 5: Parking Lot and Bus Access [4]

Figure 6: South End FUTS Connection [4]

Figure 7: Existing Traffic Control and Overview Map [3]

Constraints and Exclusions

The Kendrick Street Bicycle Boulevard project was constrained by several factors including working within existing right-of-way, keeping project costs and implementation costs as low as possible, and minimizing impact to local residents. The design specifications and geometric design changes were constrained to the existing right-of-way as there is no additional right-of-way available and any acquisition of such land would prove far too expensive for the aim of this project. Additionally, converting Kendrick Street from its existing conditions to a bicycle boulevard needs to be accomplished in the most economically efficient manner possible. Beyond the requirements set forth by the client, community feedback indicated that any increase in tax dollars to Flagstaff residents will not be acceptable and therefore is not desired. The design team accounted for this in many ways including reusing signs, leaving all existing utilities as is, not changing any curb and gutter locations, and not recommending any pavement design including. By excluding pavement and curb and gutter design, the design team recognized that all drainage and water issues were provided for as is. Lastly, minimizing impacts to local residents required the design did not affect any driveways, property, or access along the street. Therefore, all improvements made in the project work within the existing conditions and do not have any immediate effects to resident's property or access.

Northern Arizona Transportation Services (NATS) outlined project exclusions in the initial project proposal document. The exclusions of the design state that NATS is only responsible for the design report and design package. Therefore, they will only provide assistance with design clarification and not participate in the actual implementation of the design. In addition, NATS is not responsible for providing any materials or labor for the implementation of the project. As agreed upon with the client, NATS will not be involved in post implementation data collection or analysis. While the project does include components to mitigate cut through traffic, any actual traffic changes post design implementation of the bicycle boulevard is the sole responsibility of the City of Flagstaff. Lastly, NATS is not responsible for any work on side streets or property outside the right-of-way of Kendrick Street.

Background Research and Project Methods

The NATS team researched and utilized several resources to evaluate and design the Kendrick Street Bicycle Boulevard. The literature review included, but was not be limited to: study of previous bicycle boulevard projects, bicycle infrastructure guidelines at the state and national level, and existing conditions. The review was crucial in the project development phase as the findings provided the framework for the final design. All relevant research is explained and discussed in the Background Research Memo in Appendix A.

Figure 8 shows a basic flowchart of the method used. First, the designers were familiarized and inspired by the guidance provided within the NACTO Urban Bikeway Design Guide. In particular, this guide discusses the specific design elements associated with designing a bicycle boulevard (mentioned above). However, this guide is aimed to inform designers across state and national boundaries and therefore does not provide specific national and state specifications such as particular signage, appropriate markings, etc. To address these issues the guidance provided by the NACTO Urban Bikeway Design Guide was channeled through the Manual on Uniform and Traffic Control Devices (MUTCD) and the American Association of State Highway and Transportation Officials (AASHTO) Geometric Design Manual.

The MUTCD sets the minimum standards and guidance for uniformity of traffic control devices across the nation. The AASHTO Geometric Design Manual provides design control and constraints that guide design formulation. Therefore, the design components from the NACTO guide were evaluated and design to meet all specifications set forth by the MUTCD and AASHTO Geometric Design Manual.

Since bicycle boulevards are currently relatively new in the United States and are a continuously evolving design there are some components of this present design which are innovative and new. These elements mostly are included in the branding and marking specifications. They parallel work done in other bicycle boulevards and all non MUTCD approved elements have already been applied for Interim MUTCD approval. Finally, the design specifications were subjected to Arizona Department of Transportation (ADOT) design specifications. Most of the ADOT specifications match specifications in the MUTCD, but the team ensured the design met all state and local standards.

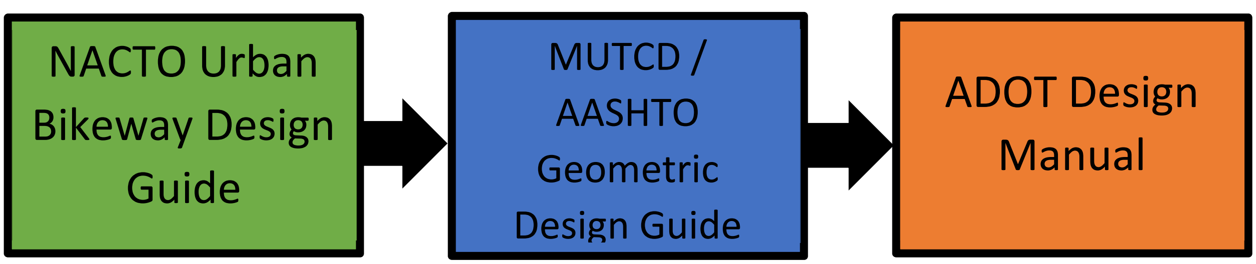

Figure 8: Flowchart of Methods used for Project Design

Data Collection and Results

Pneumatic Traffic Tube Volume Data

JAMAR technology TRAX pneumatic counters were used to collect vehicle volumes, speeds, and classifications. TRAX counters require two rubber tubes be laid across the full length of the street with a known distance between them. This allowed NATS to collect all the specified data and gain to the existing conditions. Tubes were placed at nine locations on side streets to account for all traffic entering into the project area. Additionally, tubes were placed at seven locations along Kendrick Street to account for corridor traffic. Although the data was collected in winter months, NATS chose days where the temperature was warmer in attempt to capture ideal bicycle traffic conditions. However, the cold temperatures periodically shut down the counters late at night and early in the morning. Although the vast majority of the collected data is valid, some discrepancies do exist. It should be noted that it is desirable for a bicycle boulevard to have less than 3000 ADT and an 85th percentile speed below 25 mph and the existing conditions meet these specifications [3].

Figure 9 shows the average daily traffic (ADT) along Kendrick Street and on the cross streets. The data shows that vehicular volumes are primarily greater on Kendrick Street compared to the cross streets. However, there are some places where the volumes are relatively the same. There is also significant traffic on Cherry Avenue and Elm Avenue. This is due mostly to the bus traffic and other vehicles travelling to and from Flagstaff High School. Although the data demonstrates that the existing stop sign configuration is appropriate for existing traffic conditions, changing the stop signs will result in new traffic patterns and is justified by engineering judgment. The data also supports that changing the orientation of stop signs on Elm Ave and Dale Ave is warranted, but Cherry is not. The orientation of stop signs also requires consideration for elevation changes as bicycles do not want to stop on hills. Therefore, the inclined nature of Elm Ave and Dale Ave justify changing the stop signs for free flow north-south while the flat grade at Cherry Ave allows for the stop signs to be left as is. The full data report can be found on the USB flash drive accompanying this report.

Figure 9: Average Daily Traffic for Vehicles in Project Area [3]

Pneumatic Traffic Tube Speed Data

Figure 10 shows the 85th percentile speed (mph) along Kendrick Street and on the cross streets. The data shows that vehicular speeds are greater on Kendrick Street in sections of free-flow in the north end of the project. There are also some places where the speeds are relatively the same such as Dale Avenue and Kendrick Street, and one place where the cross street, Cherry Avenue, has a higher 85th percentile speed. This is due mostly to the location of existing stop signs throughout the project limits. Although the data demonstrates that some vehicular volumes exceed the desired 25 mph threshold, traffic calming applications will bring the speeds down. The orientation of stop signs also requires consideration for elevation changes as bicycles do not want to stop on hills. The inclined nature of Elm Avenue and Dale Avenue justify changing the stop signs for free flow north-south while the flat grade at Cherry Avenue allows for the stop signs to be left as is. The full data report can be found on the USB flash drive accompanying this report.

Figure 10: 85th Percentile Speeds for Vehicles in Project Area [3]

Turning Movement Counts

Turning Movement Count (TMC) data was collected using JAMAR boards. Counts were taken at the morning, midday, and evening peak hours. The goal of collecting this data was to accurately gauge how many bicyclists used Kendrick Street and to see how the vehicles moved about the project area.

The data collected shows a smaller number of bicyclists using Kendrick Street then what was expected. One factor that significantly contributed to this was the cold temperatures. Unfortunately, an ideal bicycle setting could not be observed due to the time constrains of all team members. Nevertheless, there is still a strong presence of bicycles on Kendrick Street. Complete turning movement count reports can be found on the USB flash drive accompanying this report.

Community Involvement

The community plays an essential role in the development of the Kendrick Street Bicycle Boulevard. Therefore their involvement in the evolution of this design was key. The NATS team conducted an online survey through surveymonkey.com. This survey was aimed at an audience of all community members including, but not limited to, cyclists, motorists, pedestrians, residential community, and Flagstaff High School. The NATS team contacted known cyclists users of all levels, placed fliers on vehicles parked along Kendrick Street, handed out fliers to local Kendrick Street residents, and spread the interest by word of mouth. The nine question survey generated 66 responses of varying age, residential location, and riding ability. Further community input was gathered from Kendrick Street Bicycle Boulevard presentations at the Flagstaff Bicycle Advisory Committee and Flagstaff Transportation Committee meetings.

Figure 11 shows four selected questions from the online survey. As seen in the figure, the current usage of cyclists riding north-south through, or near, downtown Flagstaff was primarily often. In addition to the current usage, respondents commented that if a bicycle boulevard were implemented the majority of riders would bike more. This is desirable as the target users of a bicycle boulevard are riders of all confidence and ability levels. Currently, cyclists comfort level is in the range of 'somewhat safe'. However, a bicycle boulevard would increase this response to the desirable 'very safe' level. Finally, motorist's comfort in relation to driving when cyclists are in close proximity is an important component

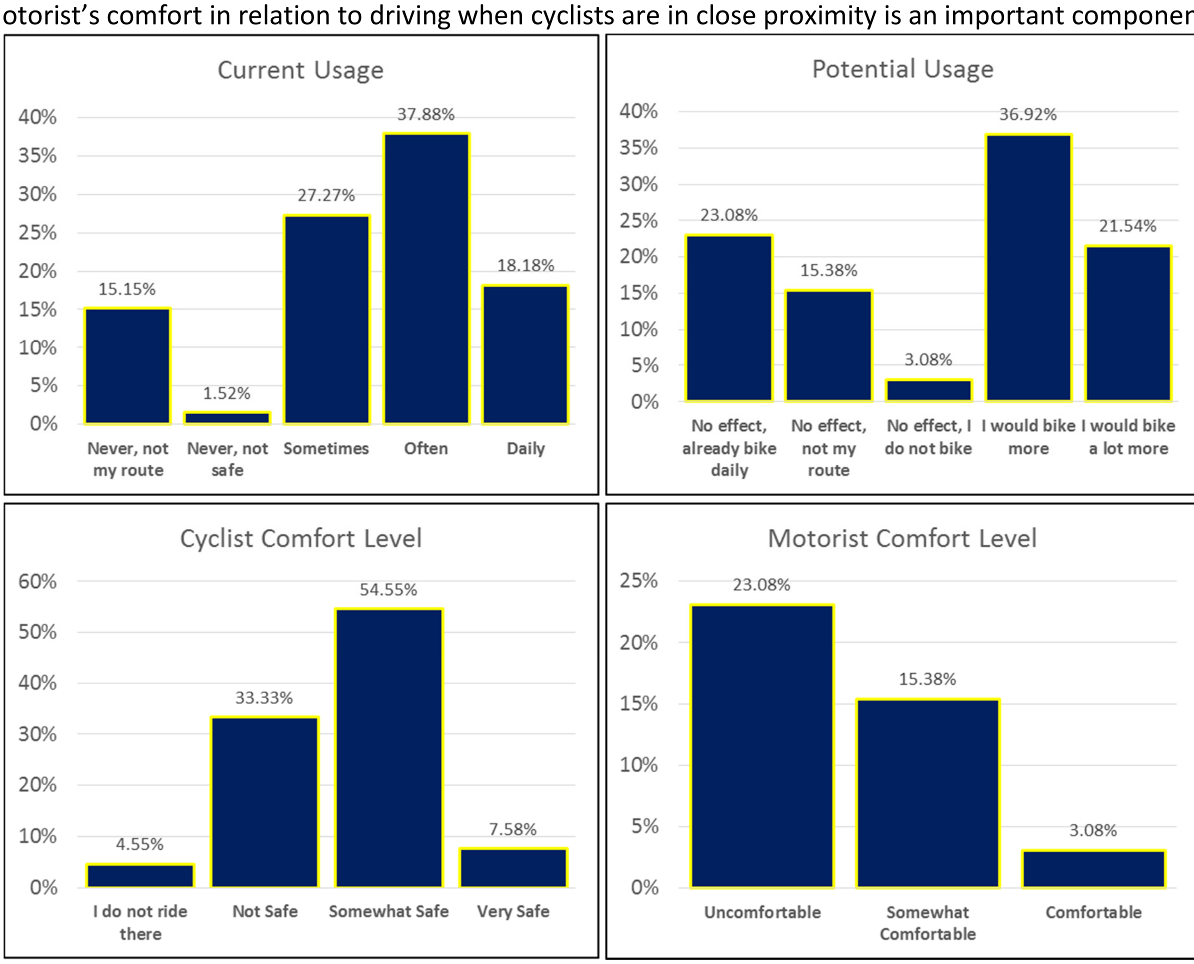

Figure 11: Selected Survey Responses from Kendrick Street Bicycle Boulevard Survey

of a bicycle boulevard. As seen in the figure, currently the majority of motorists are uncomfortable driving alongside cyclists. This is an important result because components of the design were chosen to not only benefit cyclists, but provide more comfortable driving conditions.

The survey also allowed respondents to provide any comments they chose regarding the project. Most of the comments were in support of the project, but some were opposed primarily for economic reasons. Some positive and negative responses included:

Example positive comments

- "As a resident of N Kendrick St. I would like to see a bike boulevard, not only for the safety of bikes but to preserve the street as a non-major alternative thoroughfare to Humphreys. There is a LOT of foot and bike traffic on Kendrick."
- "I encourage any forward progress in improving and promoting bike transportation in flagstaff, regardless if it benefits my route."
- "I am very much in favor of a bicycle boulevard on Kendrick St. as I use it often to travel to and from the grocery store and as an access point to the Flagstaff Trail System. Educating both cyclists and motorists to the rights and traffic procedures (proper traffic signaling by cyclists and motorists understanding that cyclists have a right to be on the road) is essential to ensuring safe and accessible travel."

Example negative comments

- "Motorist support for increased/improved bicycle facilities will not increase until bicyclist are taxed to pay for those facilities."
- "Of all the things to spend tax dollars on, are you serious? Help me understand how unequal tax dollar input from cyclists warrants the massive tax dollar output from people driving cars."

These responses reiterate the interest in the Kendrick Street Bicycle Boulevard Project, but also presented further evidence for the need to design the project with as little economic impact as possible.

Other Considerations

Other considerations for this project included emergency vehicle routes, fire hydrant access, and snow removal considerations. NATS contacted the City of Flagstaff Fire Department to gain an understanding of existing emergency vehicle routes. This allowed for the design to be carried forward in a manner that would not interrupt emergency responders by limited access due to geometric design alterations. Also, to maintain existing fire hydrant access, the design was required not to impose on existing access points by introducing new curb and gutter or new parking stalls. Finally, snow removal is a common practice in the winter months in Flagstaff which lead to the designers to eliminate design components that would interrupt or be destroyed by snow removal services. As seen in the final design, these considerations were all accounted for and will not be altered or interfered with the implementation of a bicycle boulevard along Kendrick Street.

Overview of Alternative Designs

The designers of Northern Arizona Transportation Services formulated and evaluated three design alternatives. The alternatives were constructed based on guidance provided by the NACTO design guide and MUTCD. The design alternatives are all aimed at minimizing implementation costs while transforming Kendrick Street into a bicycle boulevard. Additionally, NACTO identifies an ideal street for bicycle boulevard implementation as having less than 3000 average daily traffic (ADT) and an 85th percentile speed under 25 mph [3]. As shown in the data collection, existing conditions on Kendrick Street meet these criteria, but the designs need to ensure the conditions do not change. The design alternatives are also aimed to minimize current residential impact including eliminating all on street parking. Regardless of the alternative selected it is common practice for a city to rank bike boulevards higher among priority to receive scheduled maintenance. This ensures the bicycle boulevard is free of cracks and a smooth surface for riders.

Alternative 1

Shown in Figure 12, Alternative 1 consists of two 7 foot parking lanes, two 10 foot travel lanes, and 1.5 foot buffer lanes between the parking land and travel lane. Buffered lane are allowed under MUTCD guidelines for buffered preferential lanes.

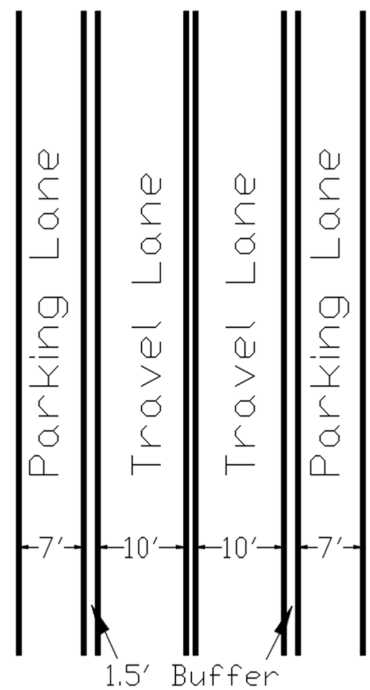

Figure 12: Alternative 1 [5]

Positive aspects for this alternative include the buffer zones acting as a safety precaution for bicyclists to open car doors. This alternative requires that the bicyclist take the travel lane and that motorists respect cyclists as having equal preference. Alternative 1 maximizes street parking, includes a buffer lane, but discourages respect among users.

Negative aspects of this alternative are, according to the NACTO guide, the center stripe discourages drivers from passing bicyclists on the roads. If a vehicle cannot easily pass other users using the full width of the street, it is likely there will be driver frustration and lack of respect [3]. Also, this alternative would require centerline striping throughout the length of the project along with pavement markings for the parking and buffer zone. The amount of striping necessary to implement Alternative 1 along the entire length of Kendrick Street increases the implementation cost of this design.

Alternative 2

Figure 13 shows Alternative 2. This alternatives has designated 5 foot bicycle lanes, two 10 foot travel lanes, and a 7 foot parking lane on one side of the street. In addition, the NACTO guide specifies that the buffer lane can take up part of the bike lane. Typically, 6 foot bicycle lanes are preferred, but the smallest cross sectional width of Kendrick Street (37 feet) does not allow for this.

Positive aspects for this alternative includes giving cyclists a designated lane in each direction. Designated lanes may ease motorist's comfortability driving alongside cyclists. Also, the travel lane is reduced to 10 feet which acts as a traffic calming measure. Other positives include providing a 1.5 foot buffer lane which acts as a safety precaution for bicyclists to open car doors.

Negative aspects of this alternative are it reduces street parking in most portions of Kendrick Street. During field visits the designers noticed that the parking spaces were typically filled and this design would interfere with local resident's acceptance of the bicycle boulevard. Also, this alternative again has a center lane striping which is not necessary on a local urban road with under 3000 ADT and a low 85th percentile speed. Centerline striping should only be within a short distance of any stop bars along bicycle boulevards. Otherwise, they can create increased driver frustration as they believe it is challenging to pass cyclists within a 10 foot lane. The amount of striping necessary to implement alternative 2 along the entire length of Kendrick Street makes increases the implementation cost of this design.

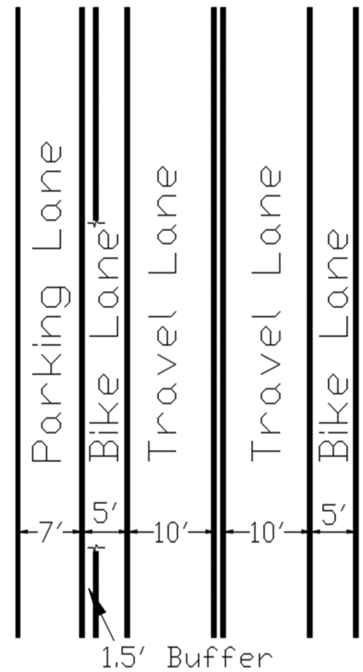

Figure 13: Alternative 2 [5]

Alternative 3

Shown in Figure 14, Alternative 3 is the simplest of all alternatives. It consists of two 7 foot parking lanes and two travel lanes without a centerline stripe and a total 23 foot cross section. According to NATCO policy:

> "Center line stripes shall be removed or not repainted, except for short sections on intersection approaches that have a stop line or traffic circle. Drivers have an easier time passing bicyclists on roads that do not have centerline stripes. If vehicles cannot easily pass each other using the full width of the street, it is likely that there is too much traffic for the street to be successful bicycle boulevard" [2].

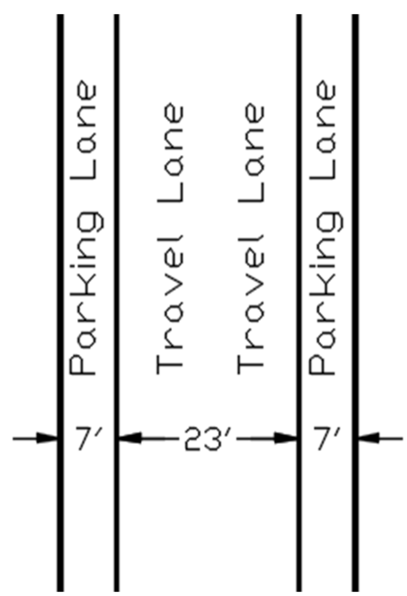

Figure 14: Alternative 3 [5]

This alternative allows for vehicles to confidently and safely pass bicycles while driving along the route. In addition, Alternative 3 creates an atmosphere of equal priority among all users as it allows cyclists to take the entire travel lane. This is key in the development and creation of a bicycle boulevard. This alternative also has the least impact on existing conditions including parking opportunities. Another primary component of this alternative is the minimal cost required to implement the design due to lack of striping.

There are little to no negative aspects of this alternative. Any drawbacks associated with lack of striping, and therefore regulation, are not evident as the existing conditions have no striping of any kind.

Selection of Chosen Alternative

Table 1 shows the decision matrix used for the selection of the chosen alternative. Residential impact and comfort level are represented by ranking scales from 0 to 5. For residential impact, 0 represents no residential impact and 5 represents extreme residential impact. A major goal of this project was to minimize residential impact and therefore all three alternatives scored very well. However, Alternative 2 eliminates parking spaces and therefore impacts local residents. Alternatives 1 and 3 scored the same with the only impact coming in the form of possible increased cyclist traffic.

Parking spaces were also considered when selecting the preferred alternative. Parking is common and essential to not only residential neighborhoods but near schools. Therefore, parking spaces were maintained at the highest rate possible for alternatives 1 and 3. Alternative 2 eliminated half of the parking spaces and therefore ranked lower.

Comfort level was a pertinent aspect to the choice of alternative as an objective of the bicycle boulevard design is high comfort levels among all users. Alternative 1 received a score of 0 as it restricted vehicles to a narrow travel way and does not provide the opportunity for comfortable passing. Alternative 2 scored slightly higher than alternative 1 as it provided striped bike lanes which can increase the comfort level for cyclists. However, Alternative 2 has centerline striping which is detrimental to the comfort level of motorists. Alternative 3 gives equal preference among all users, allows cyclists the entire lane, and does not restrict passing by motorists. Therefore, it received a perfect 5.

Striping lines required are included in the decision matrix because they directly impact comfort level and cost. The number in this column is a literal representation of the number of striping lines along Kendrick Street. As seen above, alternatives 1 and 2 require the installation of 6 striping lines, and Alternative 3 requires only 2. It should be noted that the two striping lines delineating parking spaces are no literal lines, but crosses (as seen in the final design).

Finally, the cost of implementation is a crucial component of the selection of the preferred alternative. As noted previously, the economic cost of implementing a bicycle boulevard on Kendrick Street needs to be as minimal as possible. Alternative 1 and 2 cost more to implement primarily to striping.

Therefore, the preferred alternative, Alternative 3, was chosen because it not only scored the highest among NACTO recommended characteristics, but it is also the most cost effective design. Alternative 3 does not include bike lanes, has an unmarked 23 feet travel way, and delineates parking spaces. NATS chose to omit bike lanes because they indicate that cyclists should only use the designated space. Bicycle boulevards should be inviting for all users and allow them to take the whole lane. Unique lane markings will provide guidance to motorists and cyclists at to equal preference.

Table 1: Preferred Alternative Decision Matrix

Alternative	Residential Impact	Parking Spaces	Comfort Level	Striping Lines Required	Cost of Implementation
1	1	98	0	6	$49,000
2	2	49	2	6	$47,000
3	**1**	**98**	**5**	**2**	**$42,000**

Final Design

The full design drawing package can be found in Appendix B. The design includes the striping plan, signage and wayfinding plan, traffic calming design, and complete project costs.

Right of Way Control

Along the route of the bicycle boulevard there are three existing stop signs. These stop signs do not allow for bicycle free-flow and increase delay. By changing the stop signs to allow for right-of-way priority to Kendrick Street, bicycles will be encouraged to use Kendrick Street as an alternative to other routes. Also, stop signs along the route will increase travel time and as a consequence there will be low compliance and predictability. The following warrants for the placement of stop signs are found in the MUTCD:

1. the intersection of a less important road with a main road where application of the normal right-of-way rule is unduly hazardous;
2. a street entering a through highway or street;
3. an unsignalized intersection in a signalized area;
4. other intersections where a combination of high speed, restricted view, and serious accident record indicates a need for control by the stop sign.

MUTCD Section 2B.04 Right-of-Way Intersections
Guidance:

02 Engineering judgment should be used to establish intersection control. The following factors should be considered:

A. Vehicular, bicycle, and pedestrian traffic volumes on all approaches
B. Number and angle of approaches
C. Approach Speeds
D. Sigh distance available on each approaches; and
E. Reported crash experience

07 Once the decision has been made to control an intersection, the decision regarding the appropriate roadway to control should be based on engineering judgment. In most cases, the roadway carrying the lowest volume of traffic should be controlled.

09 The following are considerations that might influence the decision regarding the appropriate roadway upon which to install a YIELD or STOP sign where two roadways with relatively equal volumes and/or characteristics intersect:

A. Controlling the direction that conflicts the most with established pedestrian crossing activity

Table 2: Stop Sign Warrant Data

Cross Street	Posted Speed	85th Percentile Speed	Cross Street ADT	Kendrick Street ADT	Crashes in the past 5 years	Sight Distance Restrictions
Elm Ave	25 mph	20 mph	1515 v/day	818 veh/day	5 Non Injury	None
Dale Ave	25 mph	23 mph	729 v/day	258 veh/day	1 Non Injury	None
Cherry Ave	25 mph	28 mph	1065 v/day	729 veh/day	1 Non Injury	None

Although Table 2 indicates that these streets have a higher ADT then Kendrick Street, the guidance set forth by the MUTCD indicates that the decision regarding the appropriate roadway to control should be based on engineering judgment. Therefore, to create free flow for bikes the stop control has been switched at Dale Avenue and Elm Avenue. These streets are at a location where there is a steep grade on Kendrick Street and cyclists would have a difficult time accelerating when at a complete stop. There is no evidence of crashes as a result of the stop signs and therefore nothing indicates an increase in crashes would occur.

Striping Plan

The final design for implementing a bicycle boulevard on Kendrick Street calls for two 7 foot parking lanes delineated by 'parking Ts'. Designed in accordance with the MUTCD and ADOT design manuals, the 'parking Ts' are 6 inch thick retroreflective paint extending 3 feet total (Figure 15). These parking delineators extend 1 foot into the road way which act as a buffer object marker. The final design calls for 98 parking stalls to be delineated. The parking stalls located at the end of a series is 20 feet in length, and the remainder stalls are 22 feet in length. This is in accordance with the City of Flagstaff standard of practice. Where perfect spacing was not possible, parking stalls were placed so as to allow for the best ease of access when entering a facility off of Kendrick Street.

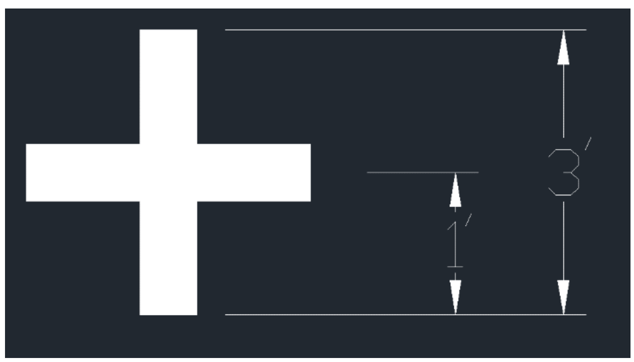

Figure 15: Parking T Dimensions

Other components of the striping plan include the addition of crosswalks and stop bar placements. Crosswalks were added at Cherry Avenue, Sullivan Avenue, and Dale Avenue. In accordance with MUTCD and Flagstaff standards, the crosswalks are 10 feet wide and are spaced in a manner that allow the vehicle path to be in-between the lines [6]. This allows for an increase in safety and visibility for pedestrians while increasing the longevity of the striping. Each line is one foot wide, with 6 inches between bar pairs, and two feet between pairs. Standard 18 inch stop bars are placed at locations with new stop signs.

Signage and Wayfinding Plan

Unique signage and pavement markings provide wayfinding for the new bicycle boulevard. These signs and markings provide a photographic uniqueness for the street and label the corridor as a bicycle route. They indicate that the roadway is intended as a shared, slow street, and reinforce the intention of priority for bicyclists along the given route [3]. They alone do not create a safe and effective bicycle boulevard, but they act as reinforcements to the traffic calming and operation changes made to the roadway. The signage and wayfinding plan is located in the final drawing package in Appendix B.

Figure 16: Modified Kendrick Street Sign

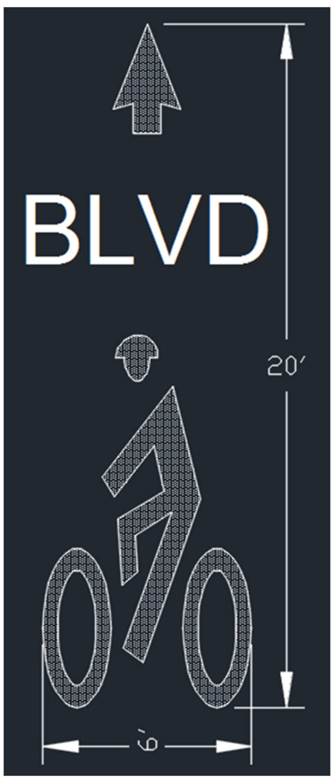

Figure 17: Pavement Marking

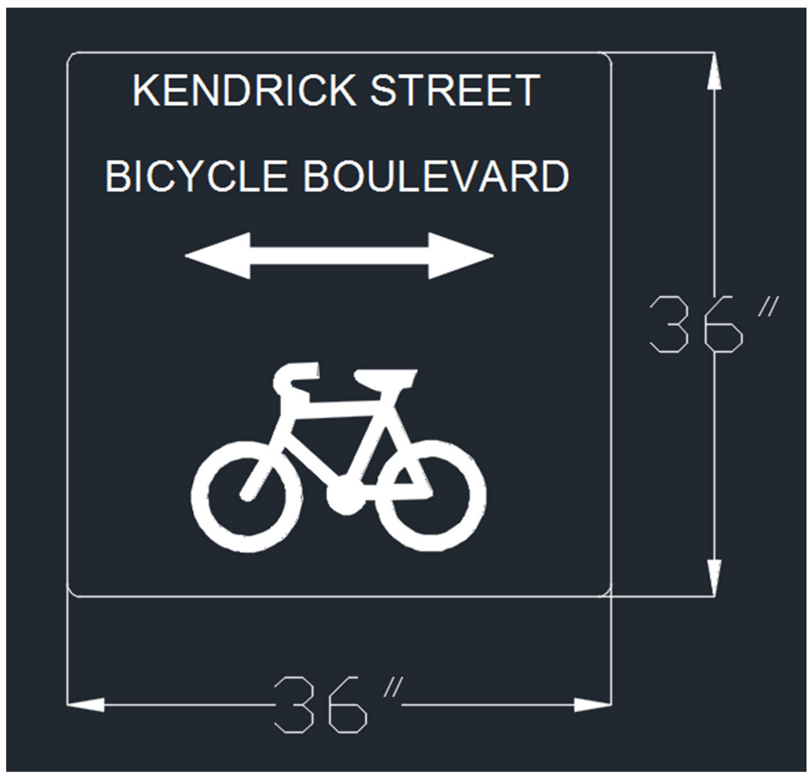

Figure 18: Advanced Boulevard Wayfinding Sign

Figure 16 shows a modified street sign which will be used to identify and brand the route on each street corner. These are one way in which drivers are alerted of the bicycle boulevard. Another way is the pavement marking shown in Figure 17. This 20 foot by 6 foot pavement marking will be located 150 feet or 200 feet apart (specified in drawing package) twice per block for a total of 23 times in the project limits. These markings identify the route as a bicycle boulevard and also alert cyclists that they may take the full lane. Figure 18 shows an advanced boulevard wayfinding signs. Each approach to Kendrick Street will have an advanced boulevard wayfinding sign. These signs help brand the bicycle boulevard and inform motorists of the equal priority. Placement of these signs is 50 feet from the intersection unless otherwise noted. This can be found in the construction notes. Future bicycle boulevards in the Flagstaff network can use the same templates as Kendrick Street and a network can be developed. The benefits associated with unique street signs and pavement markings differentiate the bicycle boulevard from other local streets. They designate this as a favorable route while prompting drivers to look for bicyclists. In addition, these signs and pavement markings brand the bicycle boulevard while raising awareness of the designated routes and will encourage the Flagstaff community to use it.

Traffic Calming

Eliminating the stop signs along the route may make Kendrick Street into an attractive shortcut to motorists. Therefore, to manage any increased speeds or traffic volumes along the corridor the application of bulb out treatments and speed tables will be utilized. The intersection of Kendrick Street and Dale Street will receive a bulb-out treatment (Figure 19). This treatment narrows the travel way which creates traffic calming that lowers speeds and discourages high traffic volumes. As seen in the figure, the bulb outs are proposed to consist of thermoplastic material. This material is provided by Ennis-Flint. The thermoplastic traffic patterns provide a cost-effective, traditional look and alternative to the use of brick and stone pavers. The material is surface applied and virtually maintenance free. The interconnect sheets will are heavy-duty intersection grade pavement marking material with enhanced durability. The 125 millimeter interconnect sheets of material are high skid and slip resistant. Instead of installing new curb and gutter around the intersection, this option is an economically efficient alternative that will allow for easy snow removal and not limit any turning radii for emergency vehicles.

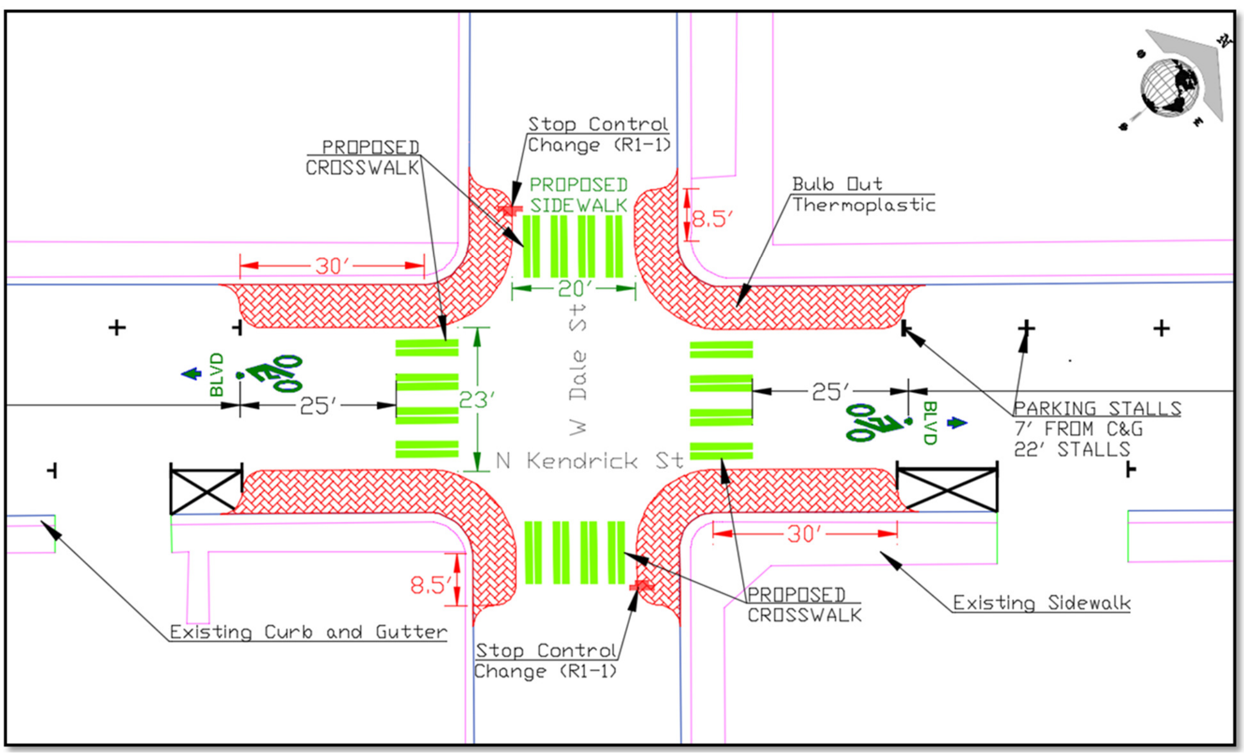

Figure 19: Bulb-Out Traffic Calming Treatment at Kendrick Street and Dale Avenue

The other traffic calming measure that will be installed along Kendrick Street are speed tables. Speed tables are areas of pavement raised a minimum of 3 inches in height over a length of 22 feet. They have 6-foot ramps on either-end and work by forcing motorists to slow down comfortably to pass over them. The advantages to using speed tables to calm traffic include they are self-enforcing, require minimum maintenance, and have minimal impact on snow removal. As seen in Figure 20, the speed tables on Kendrick Street are 22 feet in length and 3 inches high. Three speed tables will be placed on Kendrick Street between the intersections of Cherry Avenue and Dale Avenue, Dale Avenue and Elm Avenues, and Elm Avenue and Fine Avenue. These will produce a reduction in average speed of 2-8 mph and discourage high speeds and cut through traffic. They are only 20 feet wide in a 23 foot wide travel lane, so if bicycles desire not to ride over them they will be able to ride along side. However, the design of only 3 inch heights does not have a negative impact on cyclists [7].

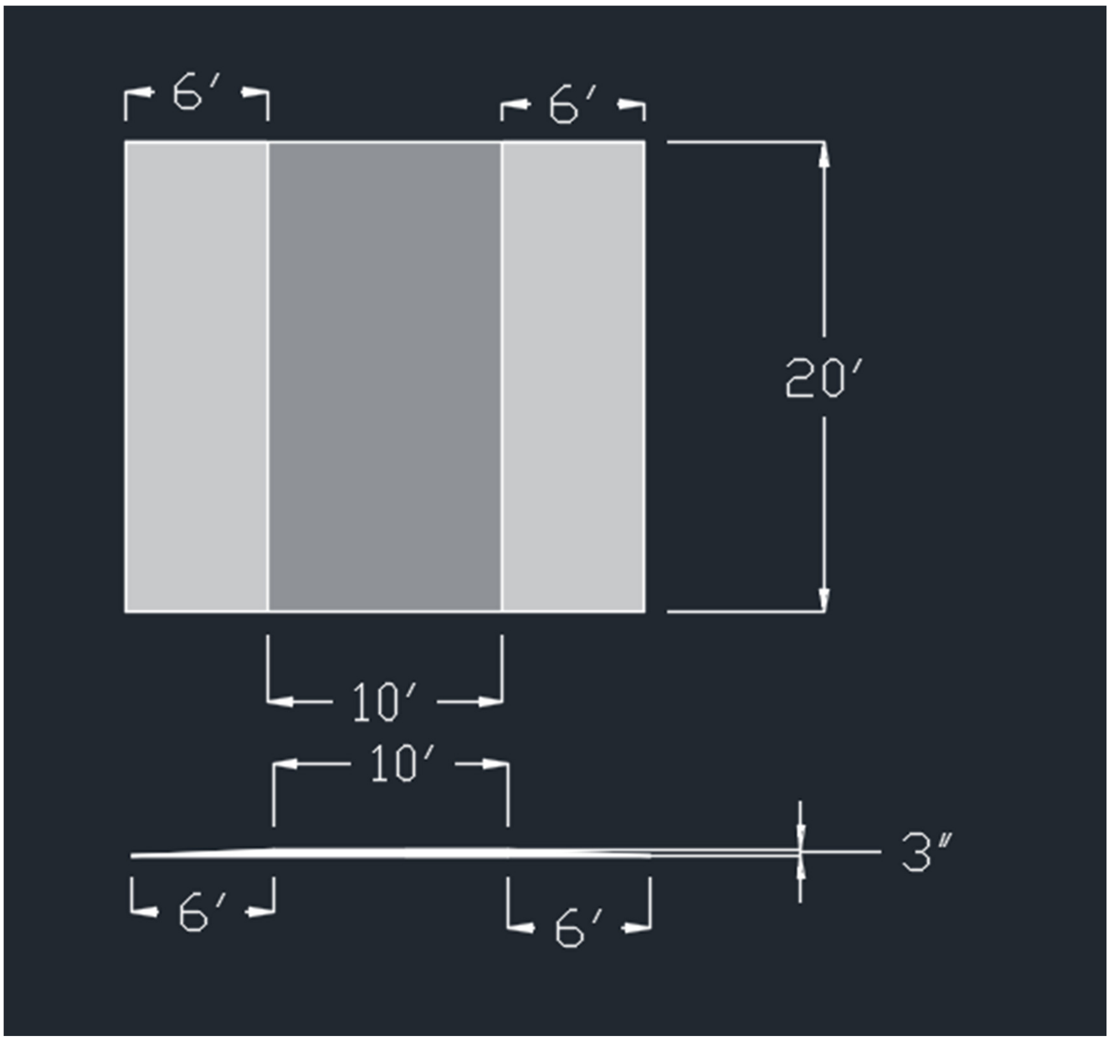

Figure 20: Speed Table Detail

External Impacts of Design

The external impacts of the design include economic impacts, societal and cultural impacts, environmental impacts, health impacts, and global impacts. The economic impacts include less pavement rehabilitation as a result of less motor vehicle traffic and a decreased amount of money spent on gasoline for citizens choosing to bike instead of drive. The societal and cultural impacts include an increase in interest in local cycling and an increase in the aesthetics and sense of community on Kendrick Street. Previous bicycle boulevard projects indicate that communities with bicycle boulevards have a happier community and in some instances see an increase in property value. The environmental impacts of the design include fewer greenhouse gas emissions due to less vehicles on the road. This also relates to the impacts to citizens health. Biking is good exercise and a bicycle boulevard will increase the number of people who chose to bike rather than drive. Overall, a bicycle boulevard promotes a healthier community. The global impacts of design are a result of the limited application of bicycle boulevards worldwide. Therefore, the Kendrick Street Bicycle Boulevard project paves the way for future bike boulevards nationally and internationally. Other communities can use Kendrick Street as an example and learn from the success and downfalls of the implementation.

Also, this project ties into future plans for the Flagstaff Urban Trail System. As seen in Figure 21, the FUTS trail will continue from the end of the Kendrick Street Bicycle Boulevard. This project plays a vital component in the completeness of the FUTS system.

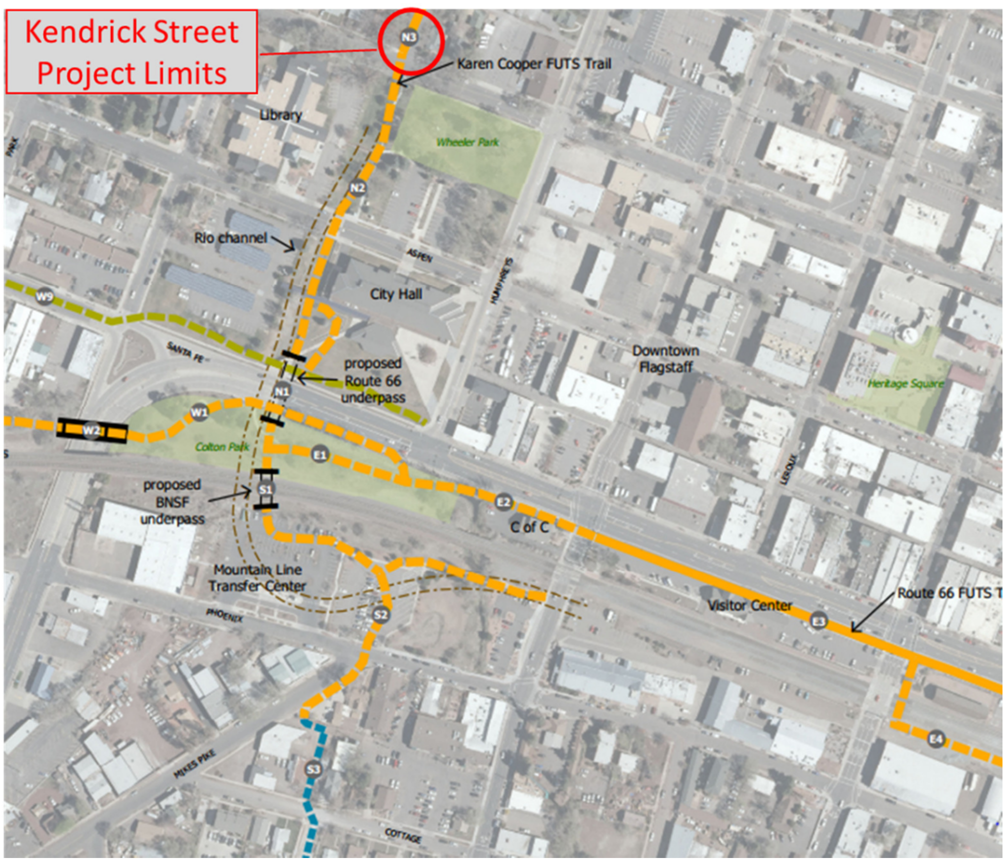

Figure 21: Downtown FUTS Concept Plan

Cost of Implementing the Design

The cost of implementing the design is based off a bid sheet provided by the City of Flagstaff. Table 3 shows the total cost for implementation of the design. Each line item cost incorporates material cost, man-hours, and installation.

Table 3: Cost of Implementing the Design and Total Project Cost

Total Project Cost				
Items	**Units**	**Unit Cost**	**Amount**	**Cost**
Parking Striping	LF	$0.70	600	$420
Speed Table	EA	$2,500	3	$7,500
Boulevard Striping	EA	$350	23	$8,050
Thermoplastic	SF	$13	1540	$20,020
Boulevard Signage	EA	$200	12	$2,400
Advance Signage	EA	$200	12	$2,400
Speed Table Signage	EA	$200	6	$1,200
R1-1 Signage Reuse	EA	$100	4	$400
			Implementation Cost	**$42,000**
			Administrative Cost	$43,000
			Grand Total	**$85,000**

- A conservative estimation of 600 linear feet of stripping for parking stalls and crosswalk additions is used. The material cost of the paint is $0.20/foot, with an additional $0.50/foot added in for labor cost. Time to measure was added into labor costs per foot.
- Three 25 mph-designed speed tables will be implemented as shown in Appendix B for approximately $2,500 per table for installation.
- Twenty three unique bicycle boulevard striping markers will cost $350 each including installation. They will be placed as shown in Appendix C.
- Hatched thermoplastic will be placed as a defining marker for the bulb out treatment on Dale Ave. and Kendrick St. The price was quoted to be $13 per square foot by the company that made the material.
- Close boulevard signage, placed by entrances to Kendrick St. on adjacent streets, costs $200 each including installation. Custom production cost of the sign was not considered as it was difficult to find a quote for it.
- Advance boulevard signage, placed by entrances to adjacent streets going towards Kendrick St., costs about $200 each including installation. Custom production cost was also not considered for the same reason as close signage.
- Speed table signage, placed X feet from each speed table for each direction, cost $200 each including installation.
- R1-1 signage, uprooted and moved at Elm & Kendrick and Dale & Kendrick, cost $100 each to move and reinstall a sign.
- Administrative cost includes all personnel hours spent on the design and predesign stages.

Summary of Project Costs

Project Completion Summary

Once the team was formed and attend an initial client meeting, overall major tasks (Software analysis, site lead, etc.) were decided on for each team member, with general tasks being distributed as needed within the group. Background research was conducted for the project, including a site visit and review of relevant codes for a bicycle boulevard. Once background research was done, data collection began with the laying of pneumatic traffic tubes to get traffic information for all intersections on Kendrick Street. Halfway through tube counts, JAMAR board turning movement counts began. Counts for every intersection along Kendrick Street for the morning, midday, and evening times were performed over the course of several weeks, not including winter hours. Once both the tube counts and hand counts were completed, information was compiled and allowed to be interpreted for the initiation of design work of the bicycle boulevard. Initial designs were proposed and evaluated. A community-wide survey was then created to gauge the community's thoughts on a potential bicycle boulevard. The team attended and presented to the Flagstaff Traffic Committee and the Flagstaff Bicycle Advisory Committee for feedback on the designs and presentation of work up to that point. A final design was decided upon based on further design ideas from the group, committee presentation suggestions, and technical advisor suggestions.

Project Schedule Changes

The original and final Gantt charts can be found in Appendix C. The primary construction time for the website was designated to be from August 2014 to December 2014. However, consistent changes to the website (namely updates) in the remaining months, January 2015 to April 2015, have pushed the website task to cover effectively the overall length of the project. Additionally, staffing and fees subtasks were removed from the final Gantt chart as they were accomplished on time according to the original Gantt chart. 3. Background Research, culminating in the completion of the "Background Research Memo", was extended from 35 days to 44 days and ended on November 11, 2014. 4. The literature review of Flagstaff, ADOT, AASHTO, and MUTCD codes, and previous bicycle boulevard implementations took less time than anticipated. Therefore, the remaining available time was spent using and interpreting NACTO guidelines for bicycle boulevards ("Relevant Literature"). Also, data collection took longer than initially proposed for all tasks. The time allotted for data collection expanded from 28 to 49 days for tube counts ("Volume Counts & Speed Analysis") and from 16 to 67 days (with winter break included) days for "Turning Movement Counts". Data analysis was originally not part of the critical path, but was changed to be included as part of the critical path.

Further, data analysis took less time to complete then initially proposed. Originally proposed to take 26 days, data analysis only required 10 days of work. This time was split evenly at 5 days for "Software Analysis" and "Warrant Analysis", whereas from proposed is was 21 and 5 days, respectively. "Pedestrian Accessibility" and "Traffic and Bike ROW" were removed in the final Gantt chart as no changes to pedestrian accessibility were needed and right-of-way was completed in less than 1 day. "Community Input" took much longer than proposed and encompassed both a community survey and multiple presentations to bicycle-oriented committees in Flagstaff. This took 35 days rather than the proposed 20 days. "Broader Impacts of Design" also took longer than proposed requiring 7 days rather then the proposed 5 days. The overall length of the project took longer than proposed and ended on May 5, 2015 rather then April 23, 2015.

Project Cost Changes

The project cost changes are associated with the man hours required to finish the Kendrick Street Bicycle Boulevard Design. There are no changes in implementation costs as this cost was not formulated until the final components and design were completed. However, there were project cost changes as a result in changes to man hours spent on the design. Tables 4 and 5 on the next page show the proposed verse actual personnel hours required to finish the design. The total project was proposed to take 804 hours. The actual hours required to complete the project was 500 hours. All proposal overestimations are the result of misunderstanding the amount of work required post-data collection for the project, and initially overestimating to account for any unforeseen complications.

Originally estimated to cost $128,000, the project is $85,000 under budget costing $43,000 for personnel hours. There was no proposed implementation costs, as these costs were not evaluated until after the preferred alternative was chosen. However, the man-hours associated with all aspects of the design including project management, background research, data collection, data analysis, design, meetings and deliverables took 300 hours less than anticipated.

Table 4: Proposed Project Hours

PRIME CONSULTANT	HOURS BY PERSONNEL AND TASK DESCRIPTION							
	Task 1 Project Management	Task 2 Background Research	Task 3 Data Collection	Task 4 Data Analysis	Task 5 Design	Task 6 Meetings	Task 7 Deliverables	Total Hours / Employee
Pierce-Jon McKelvey, Software Lead	0.00	10.00	20.00	40.00	70.00	36.00	30.00	206.00
Yousef Alkandari, Site Lead	30.00	10.00	40.00	6.00	50.00	36.00	30.00	202.00
Chris Sobie, Project Manager	60.00	10.00	10.00	8.00	60.00	36.00	30.00	214.00
Stephen Hirte, Research Lead	0.00	50.00	20.00	4.00	42.00	36.00	30.00	182.00
Total Hours per Task	90.00	80.00	90.00	58.00	222.00	144.00	120.00	804.00

Table 5: Actual Project Hours

PRIME CONSULTANT	HOURS BY PERSONNEL AND TASK DESCRIPTION							
	Task 1 Project Management	Task 2 Background Research	Task 3 Data Collection	Task 4 Data Analysis	Task 5 Design	Task 6 Meetings	Task 7 Deliverables	Total Hours / Employee
Pierce-Jon McKelvey, Software Lead	3.00	12.00	15.00	15.00	20.00	36.00	15.00	116.00
Yousef Alkandari, Site Lead	15.00	5.00	33.00	0.00	5.00	36.00	10.00	104.00
Chris Sobie, Project Manager	40.00	16.00	10.00	8.00	10.00	36.00	20.00	140.00
Stephen Hirte, Research Lead	5.00	40.00	20.00	4.00	15.00	36.00	20.00	140.00
Total Hours per Task	63.00	73.00	78.00	27.00	50.00	144.00	65.00	500.00

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[2] Urban Bikeway Design Guide. New York: National Association of City Transportation Officials, 2012. Print.

[3] Google Earth Pro (2011), Version 6.1 (Software), Available from http://www.google.com/enterprise/earthmaps/earthpro.html

[4] Pictures taken by Christopher Sobie

[5] *AutoCAD Civil 3D*. Vers. J.104.0.0. USA: Autodesk, 2014.

[6] Federal Highway Association. "MUTCD 2009 Edition, Dated December 2009 (PDF) - FHWA MUTCD." Manual on Uniform Traffic Control Devices (MUTCD) - FHWA. N.p., n.d. Web. 4 May 2015.

[7] Flagstaff Metropolitan Planning Organization & COF Staff. Guidebook for Residential Traffic Management. Guidebook. Flagstaff: City of Flagstaff, 2012. Print.

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APPENDIX A

BACKGROUND RESEARCH MEMO

APPENDIX B

COMMUNITY SUVEY RESULTS

APPENDIX C

FINAL DRAWING PACKAGE

APPENDIX D

PROPOSED AND ACTUAL GANTT CHART

APPENDIX A

BACKGROUND RESEARCH MEMO

#

Background Research Memo

TO: Jeff Bauman, PE, City of Flagstaff Traffic Engineer
Martin Ince, PE, City of Flagstaff Multi-Modal Planner

FROM: Northern Arizona Transportation Services
Christopher Sobie, Yousef Alkandri, Pierce-Jon McKelvey, Stephen Hirte

DUE DATE: November 7, 2014

SUBJECT: Kendrick St. Bicycle Boulevard Literature Review

Contents:

1. Literature Review

   This literature review expands on the basic principles of bicycle boulevards, design guidelines set forth by various agencies, and reviews existing bicycle boulevard treatments.

Introduction

Bicycle boulevards improve bicycle safety and circulation by hosting low traffic volumes, discouraging non-local motor vehicle traffic, and providing free-flow travel for bikes by assigning the right-of-way to the bicycles at intersections. [1] Additionally, bicycle boulevards have a distinctive look or ambiance such that cyclists become aware of the existence of the bicycle boulevard and motorists are alerted that the roadway is a priority route for cyclists. This is accomplished through several methods including increasing bike lane width, striping a continuous bike lane, eliminating stops along the bicycle boulevard, and designing the road so it is clear to all users that bicycles are welcome and encouraged. This literature review expands on the basic principles of bicycle boulevards, design guidelines set forth by various agencies, and reviews existing bicycle boulevard treatments.

Background

Designating a road as a bicycle boulevard originated in Europe. Termed 'neighborhood greenways' in the Netherlands, the primary objective of a bicycle boulevard was originally to serve the needs of cyclists in addition to improving neighborhood streets. [2] Further, a neighborhood greenway was originally designed to be a designated route on a street with aspects that transform cycling to be more pleasant and direct. Adopted in the 1990s, bicycle boulevards have been adopted and applied around the United States and are commonly used to provide a direct path between arterial streets or established bicycle routes. Using the latter description, Kendrick Street is an ideal location for a bicycle boulevard as it provides a direct path between two components of the Flagstaff Urban Trail System.

Purpose

Bicycle boulevards have many positive impacts and little to no negative drawbacks. According to the Berkeley Bicycle Plan, bicycle boulevards increase safety and flow (compared to other streets) by having or creating one or more of the following conditions:

- Low traffic volumes (or bike lanes where traffic volumes are intermediate);
- Discouragement of non-local motor vehicle traffic;
- Free-flow travel for bikes by assigning the right-of-way to the bicycle boulevard at intersections wherever possible;
- Traffic control to help bicycles cross major streets (arterials);
- A distinctive look and/or ambiance such that cyclists become aware of the existence of the bike boulevard and motorists are alerted that the roadway is a priority route for bicyclists. [1]

In addition, transportation organizations have set forth goals and objectives that guide the bicycle boulevard design process. The majority of goals identified applied to city wide bicycle boulevard networks. The primary goal that applied to this project is to create a safe environment for people of all bicycling abilities. They should be ideally placed where anyone would feel safe riding. [1] Additionally, users should be alerted, and feel comfortable, with the fact they are on a bicycle prioritized route. Meeting these goals can result in a future expansion, and replication, of bicycle boulevard implementations in the City of Flagstaff.

The objectives set forth by transportation organizations include designing the boulevard to be visually unique, minimizing alterations to existing traffic patterns and adjacent residential streets, utilizing traffic-calming devices that do not considerably constrain access of emergency vehicles and conforming to ADA standards, and incorporating pedestrian safety elements near schools. [1][2] Further objectives identified in European bicycle boulevard projects include encouraging more bike use, using existing streets to keep costs low, and functioning as traffic calming measures in residential streets. [2] These objectives can be used as the foundation of the objectives of the Kendrick Street bicycle boulevard project.

Street Characteristics

Proper selection of roadway to get the bicycle boulevard transformation depends on the existing street characteristics. In part this is due to minimizing economic costs by minimizing required reconstruction work done. The Berkeley Bicycle Plan outlines several criterion used for the selection of bicycle boulevards. These criteria include local street, not a truck route, little commercial frontage, within one quarter mile of a major street, continuous access to destinations, and connections to routes in cities. [1] While the street for this project has already been selected, identifying criteria, and demonstrating Kendrick Street meets the criteria, will assist when the project is presented to public and local agencies.

Benefits

There are numerous benefits to bicycle boulevards. Some bicyclists may be uncomfortable riding in bike lanes on major streets. Lower speeds and traffic volumes create an attractive pathway while connecting major destinations. [3] Also, bicycle boulevards are economical as they, "take advantage of existing facilities (local roads) and provide a low cost alternative to other types of bicycle accommodations." [3] Other benefits include safety and efficiency. The low volumes reduce potential conflicts between motorists and bicycles. In addition, traffic controls give right-of-way to the bicycle boulevard reduce the potential for conflicts. [1] Efficiency is increased by providing a continuous, direct, route with little to no stops. No stops translates to lowering delay. "A typical bicycle trip of 30 minutes is increased by 33% to 40 minutes if there is a STOP sign at every block." [1] This extra time can also be translated into increased energy on the part of the cyclist. Other benefits include less stressful cycling environment, greater alertness to bicyclists, and better visibility. In addition to these benefits listed, according to peopleforbikes.org and increase in the cyclists population results in an overall increase in the happiness of a community. [4]

Manual on Uniform Traffic Control Devices

Relevant codes taken from the Manual on Uniform Traffic Control Devices (MUTCD) regarding bicycles, in particular bicycle boulevards, are referenced and discussed here.

Table 2A-5 defines common color schemes for bicycle warning signage. This may be useful for any resultant relevant signage that may come from the design [5].

Part 9 defines traffic control for bicycle facilities. The part is too long to detail in this document adequately, but includes important specifications that must be followed by any bicycle facility design such as the application and placement of signs, the types of signage allowed for a bicycle facility, and marking for bicycle facilities [5].

Some specific codes that will be used from MUTCD:

1. Table 9b-1: Bicycle Facility Sign and Plaque Minimum Sizes
2. Figure 9B-2: Regulatory Signs and Plaques for Bicycle Facilities
3. Figure 9B-3: Warning Signs and Plaques and Object Markers for Bicycle Facilities
4. Figure 9B-4: Guide Signs and Plaques for Bicycle Facilities
5. Figure 9C-3: Word, Symbol, and Arrow Pavement Markings for Bicycle Lanes
6. Figure 9C-8: Examples of Obstruction Pavement Markings
7. Section 9B.19: Other Bicycle Warning Signs
8. Section 9B.21: Bicycle Route Signs
9. Section 9B.22: Bicycle Route Sign Auxiliary Plaques
10. Section 9B.25: Mode-Specific Guide Signs for Shared-Use Paths

Figure 9B-2 [5]

All marking and signage used or the design will be referenced appropriately from the MUTCD.

Coconino County

Coconino County classifies a bike lane is a portion of the roadway which has been designated by striping, signing, and pavement markings for the preferential or exclusive use of bicyclists. This includes a minimum width for a one way facility that carries traffic in the same direction as the adjacent motor vehicle lane. Two-way bicycle lanes on one side of the road is forbidden. If needed, the vehicle lane widths may be reduced to eleven feet for multiple lane roads to provide more space for the bike lane. This reduction in lane width must be approved by the County Engineer. The minimum bike lane width on an urban curbed street is four feet where parking is prohibited and five feet in areas where parking is allowed. Parking areas shall be eight feet wide. These distances are measured from the edge of the gutter. A minimum four inch wide stripe must be placed between the bike lane and the through traffic lanes, except at intersections and areas marked for merging. All sign along a bike route must conform to the MUTCD. Diamond and bike lane symbols along with bike lane signs will be placed at major and minor intersections along designated bike lanes in urban areas. These signs are to be placed every 1,400 feet in urban areas. Engineering judgment should be used when spacing signs in rural areas. Roads that are expected to have bicycle traffic shall not have rumble strips for the safety of the bicyclist. If the road includes drainage grates and utilities covers in the bike lane, these must be bicycle friendly All cattle guards, gutters, manholes, and all cut and patch sites on the roadways must have smooth transitions. [6]

AASTHO

Arizona Department of Transportation

The Arizona Department of Transportation Roadway Design Guidelines 2012 (revised last in April of 2014) requires that the bicycle designs on Arizona state lands conform to the 2007 ADOT Bike Policy, which incorporates the AASHTO Guide for the Development of Bicycle Facilities, 1999. [7] According to the Arizona Revised Statues, Title 28-101, a bicycle is any “device, including a racing wheelchair, that is propelled by human power and on which a person may ride and that has either: two tandem wheel, either of which is sixteen inches in diameter or three wheels in contact with the ground, any of which is more than sixteen inches in diameter.” [8]

According to the ADOT 2007 Bicycle Policy, all new major construction and reconstruction projects on the state highway system must accommodate for bicycle travel. Bridges and road widening are included in these categories. The AASHTO Guide for the Development of Bicycle Facilities must be used as the design guide for roadway features to accommodate bicycles. The Manual on Uniform Traffic Control Devices Part 9 as adopted in accordance with ARS 28-641 will be used for design of traffic controls for bicycle facilities. Bicycle lanes must be considered with major new construction or major reconstruction when incremental costs for construction and maintenance are funded by a local agency and the bicycle lane is included as a part of a bicycle facilities plan adopted by a local agency. The pavement surfacing materials used must provide reasonably smooth surfaces on travel lanes and shoulders in conjunction with paving projects. The impacts of bicyclists must be evaluated and considered when restriping roadways in conjunction with new construction, reconstruction, pavement preservation, and minor spot improvement projects. [8]

The ADOT Bicycle Policy has also listed items it excludes from design. It is ADOT’s Policy not to reduce existing travel lane widths to accommodate bicycle traffic unless supported by a traffic study. Concurrence by the State Traffic Engineer, the Assistant Engineer, and the Roadway Engineering Group are required. Sidewalks will not be signed or designated as bicycle routes or bikeways. Transportation enhancement funds will not be used for maintenance of bicycle facilities. Sidewalks or shared-use paths on State right of way parallel and adjacent to roadways will not be marked or signed for the preferential or exclusive use of bicyclists per ADOT Traffic Engineering PGP #1031. [9]

In order to construct a roadway with a variation or an exception to MGT 02-1, written approval must be obtained from the State Traffic Engineer and the Assistant State Engineer and Roadway Engineering Group in consultation with the State Bicycle Coordinator. [9]

Existing Bicycle Boulevard Case Study

A study conducted by Eric Minikel of the Urban Studies and Planning Department of the Massachusetts Institute of Technology compared the safety of bicyclists riding on bicycle boulevards to ones riding on arterial routes in Berkeley, California. Crash data was taken from the Statewide Integrated Traffic Records System from 2003 (when the bicycle boulevards were implemented) to 2008 (when the last data set was available). Important findings from this research are that bicycle boulevards are safer for cyclists than arterials, that collision rates are two to eight times lower on bicycle boulevards than arterials, and the previous results cannot be explained by a safety in numbers argument. [10]

This article provides compelling evidence that a bicycle boulevard, if warranted, will be an improvement in terms of safety for bicyclists looking to travel North and South through the Flagstaff downtown area.

Conclusion

A Bicycle Boulevard is a shared-use roadway optimized for bicycle traffic in many ways. A bicycle boulevard gives priority to cyclists by allowing them to take the lane instead of riding along the curb, it increases safety features for bicyclists and pedestrians, it discourages cut-through motor vehicle traffic, and it slows vehicular traffic. Bicycle boulevards provide way-finding signs and pavement markings, amenities such as rest nodes, drinking fountains and bike parking along the route, and access to major destinations, transit system connections, and the network of other safe bicycle routes. A secondary goal of bicycle boulevards is aesthetically pleasing medians and shoulders. Not just any road should be considered as a potential bicycle boulevard. A road might be chosen as a bicycle boulevard if it is a local street/low volume collector, is not a transit/truck route, is near major collectors and connects to other bike routes, and it provides access to major destinations. [11]

In conclusion, the findings reported in this background research report provide pertinent information and guidelines for designing and implementing a bicycle boulevard. These findings will be used towards the framework and foundation of the proposal and design of the Kendrick Street bicycle boulevard.

References

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[3] M. Tressider and L. Zefting, "Bicycle boulevard best practices memo," Alta Planning and Design, City of Rochester, Tech. Rep. 2A, 2014.

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[9] Arizona Department of Transportation. (2007, February 27). MGT 02-1 Bicycle Policy [Online] Available: http://www.azbikeped.org/images/MGT01-2%20Bike%20Policy.pdf

[10] E. Minikel, "Cyclist safety on bicycle boulevards and parallel arterial routes in Berkeley, California" *Accident Analysis & Prevention*, vol. 45, pp. 241-247, Mar 2012.

[11] J. Leijonhufvud, K. Gannon, C. Poster and M. Robinson, "Fourth Avenue/Fontana bike boulevard design concept," The Drachman Institute, University of Arizona, Tech. Rep. 1, 2009.

APPENDIX B

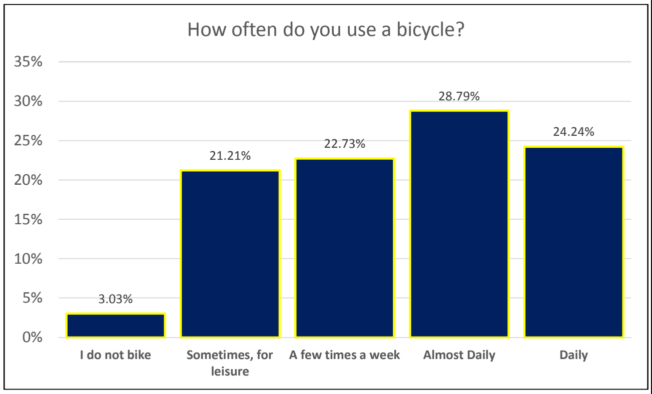
COMMUNITY SUVEY RESULTS

NATS Survey Results **Total Number of Responses = 66**

Question 1

How often do you use a bicycle?

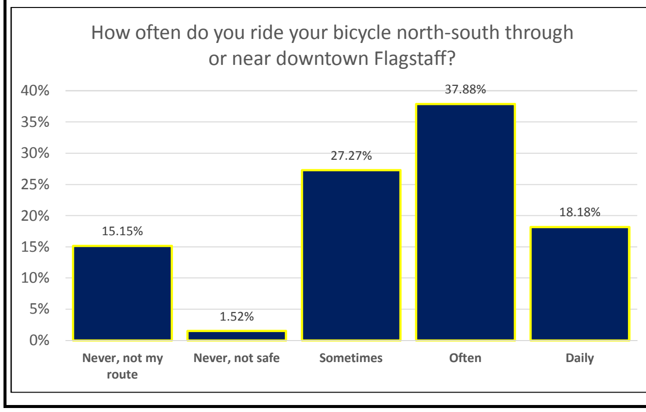
I do not bike	Sometimes, for leisure	A few times a week	Almost Daily	Daily
3.03%	21.21%	22.73%	28.79%	24.24%
2	14	15	19	16



Question 2

How often do you ride your bicycle north-south through or near downtown Flagstaff?

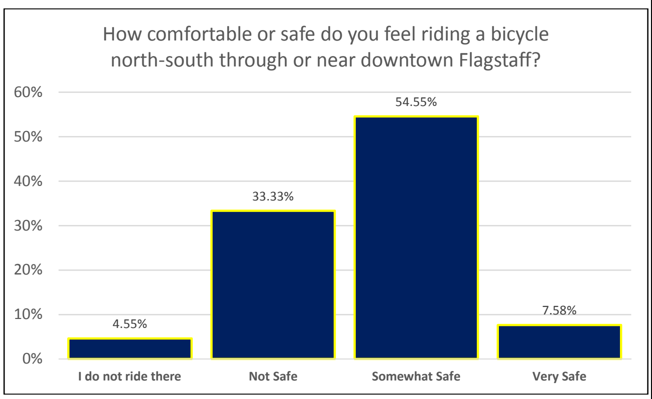
Never, not my route	Never, not safe	Sometimes	Often	Daily
15.15%	1.52%	27.27%	37.88%	18.18%
10	1	18	25	12



Question 3

How comfortable or safe do you feel riding a bicycle north-south through or near downtown Flagstaff?

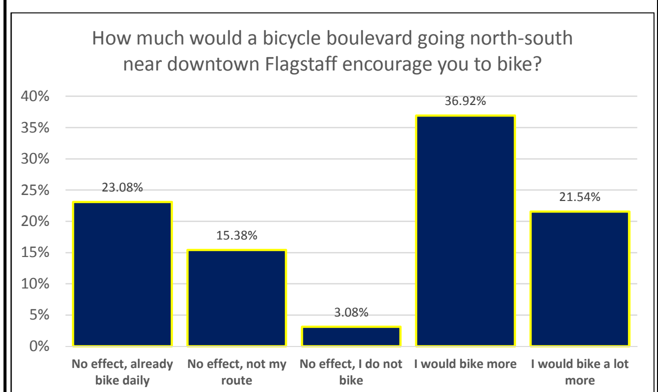
I do not ride there	Not Safe	Somewhat Safe	Very Safe	
4.55%	33.33%	54.55%	7.58%	
2	14	15	19	



Question 4

How much would a bicycle boulevard going north-south near downtown Flagstaff encourage you to bike?

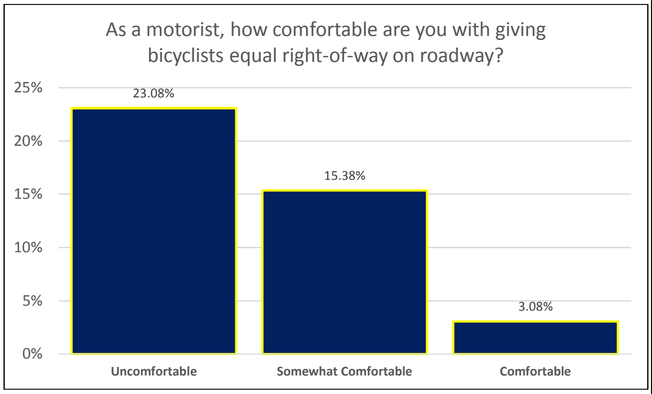
No effect, already bike daily	No effect, not my route	No effect, I do not bike	I would bike more	I would bike a lot more
23.08%	15.38%	3.08%	36.92%	21.54%
15	10	2	24	14



Question 5

As a motorist, how comfortable are you with giving bicyclists equal right-of-way on roadway?

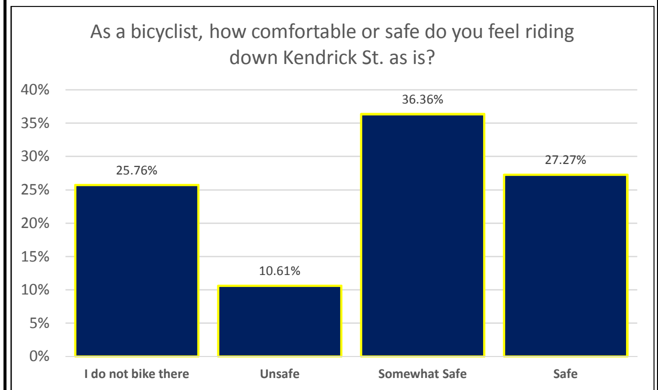
Uncomfortable	Somewhat Comfortable	Comfortable		
23.08%	15.38%	3.08%		
15	10	2		



Question 6

As a bicyclist, how comfortable or safe do you feel riding down Kendrick St. as is?

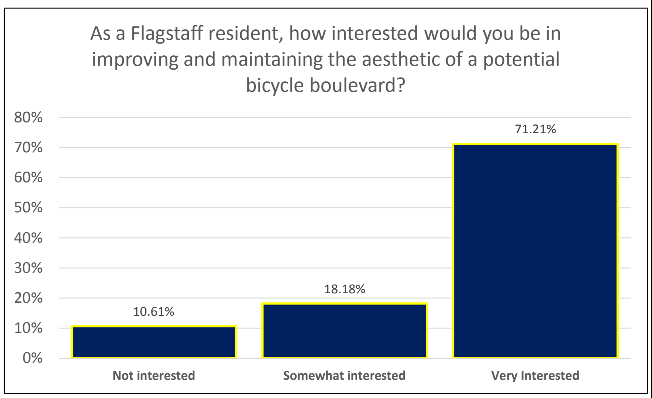
I do not bike there	Unsafe	Somewhat Safe	Safe	
25.76%	10.61%	36.36%	27.27%	
17	7	24	18	



Question 7

As a Flagstaff resident, how interested would you be in improving and maintaining the aesthetic of a potential bicycle boulevard?

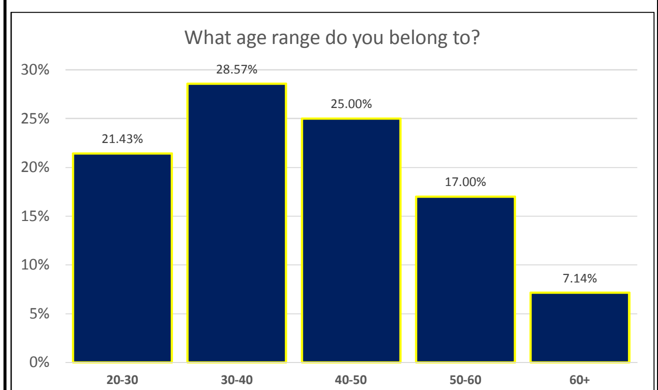
Not interested	Somewhat interested	Very Interested		
10.61%	18.18%	71.21%		
7	12	47		



Question 8

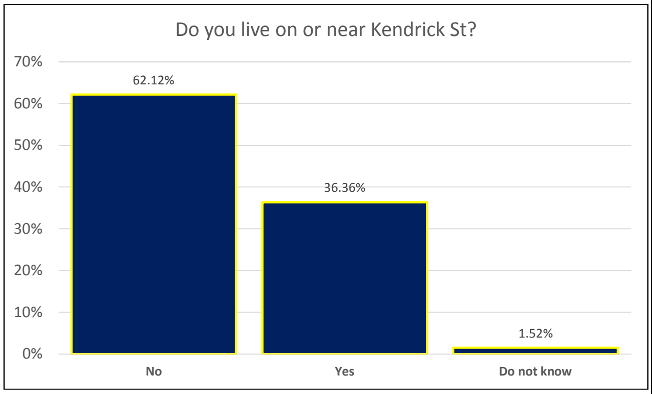
What age range do you belong to?

20-30	30-40	40-50	50-60	60+
21.43%	28.57%	25.00%	17.00%	7.14%
12	16	14	10	4



Question 9

Do you live on or near Kendrick St?				
No	Yes	Do not know		
62.12%	36.36%	1.52%		
41	24	1		



Comments:
Even though I don't really ride that side of town, I'm all for it. If it gets implemented and goes well, there are a lot of other places that might benefit from a bike boulevard.
As a resident of N Kendrick St. I would like to see a bike boulevard, not only for the safety of bikes but to preserve the street as a non-major alternative thoroughfare to Humphreys. There is a LOT of foot and bike traffic on Kendrick.
I am very much in favor of a bicycle boulevard on Kendrick St. as I use it often to travel to and from the grocery store and as an access point to the Flagstaff Trail System. Educating both cyclists and motorists to the rights and traffic procedures (proper traffic signaling by cyclists and motorists understanding that cyclists have a right to be on the road) is essential to ensuring safe and accessible travel.
Believe this project lends itself well to encouraging more ridership in downtown area, plus compliments other bike facility improvements, e.g., US Bike Routes and Mayors Challenge for safe cycling.
An interesting idea, think Kendrick would be a good candidate, just wonder how it would interact with out letting into downtown.
I live on the corner of Kendrick and dale and I love bicycles. Any projects giving more access to bikes/encouraging bicycle riding I will stand behind 100%!
You have my full support.
great initiative that actually earns Flagstaff the "bicycle friendly" designation! keep up the effort
I would support the development of bicycle boulevards all over town. Starting downtown is important given the amount of bicycle and motor vehicle traffic. An east-west axis going towards the mall and beyond would be great, as well as an option going south that connects with campus and the Harkins/Woodlands area.
Awesome idea! For all the bike commuters in Coconino Estates, Cheshire, and North of the Hospital this would be awesome!
Would love to see these all around town!
My main concern regarding this route is when you reach Cherry and then try to cross Humphrey's, its nearly impossible due to the lack of a signal and the fact that cars do not stop for people at the crosswalk. I do not use this "futs bicycle route" due to this issue and instead use Birch or Aspen.
If a designated bike boulevard is going to be developed and maintained, a special tax should be applied for bicyclists for O&M. Register bikes or tax applied at bicycle stores when buying a bicycle.
I think this is a great project. One comment -- think about how someone traveling on the Rt66 bike path would connect to this segment.
Just want to give a shout of encouragement for your project. I can't make it to the meeting, but hope that by doing the survey I can send my support :)
I live on Kendrick Street in the area you are talking about and would be very enthusiastic to see it converted into a bicycle boulevard. I have kids and its hard to feel comfortable with them riding around downtown Flagstaff with cars as is. I think it would also bring a greater sense of community to our neighborhood. My one concern would be how local car traffic for residents is handled. My driveway is on Kendrick and there is no other outlet for me to back out onto another street. I would want to make sure that I could safely backout and drive to the nearest intersection without interfering with the bicycle path too much. Thanks for the opportunity to comment!
Fantastic idea. Th3re should be more safe routes around town. This amy help cyclists new to riding feel better about commuting more often.
I encourage any forward progress in improving and promoting bike transportation in flagstaff, regardless if it benefits my route.
Would like to see one tested and this seems like a good place.
I do use the street to get to Thorpe park
I currently use Leroux to bike north from downtown to Forest Ave- that works pretty well. Isn't Beaver already a bike blvd
Of all the things to spend tax dollars on, are you serious? Help me understand how unequal tax dollar input from cyclists warrants the massive tax dollar output from people driving cars.
Motorist support for increased/improved bicycle facilities will not increase until bicyclist are taxed to pay for those facilities.
I would be able to comfortably commute to and from work if Kendrick bike boulevard were built.
Commuting to and from NAU from the Lake Mary neighborhood is by far my most common route of travel on my bike.
Sounds like a great idea. Make it happen!

APPENDIX C

FINAL DRAWING PACKAGE

Northern Arizona Transportation Services

CENE 486C

Final Report AutoCAD Drawing Package

NOTES:

DESIGNED	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE	05/05/15
		SCALE BAR	N/A
APPROVED	Kendrick St Bicycle Boulevard Cover Page	SHEET	1 OF 31

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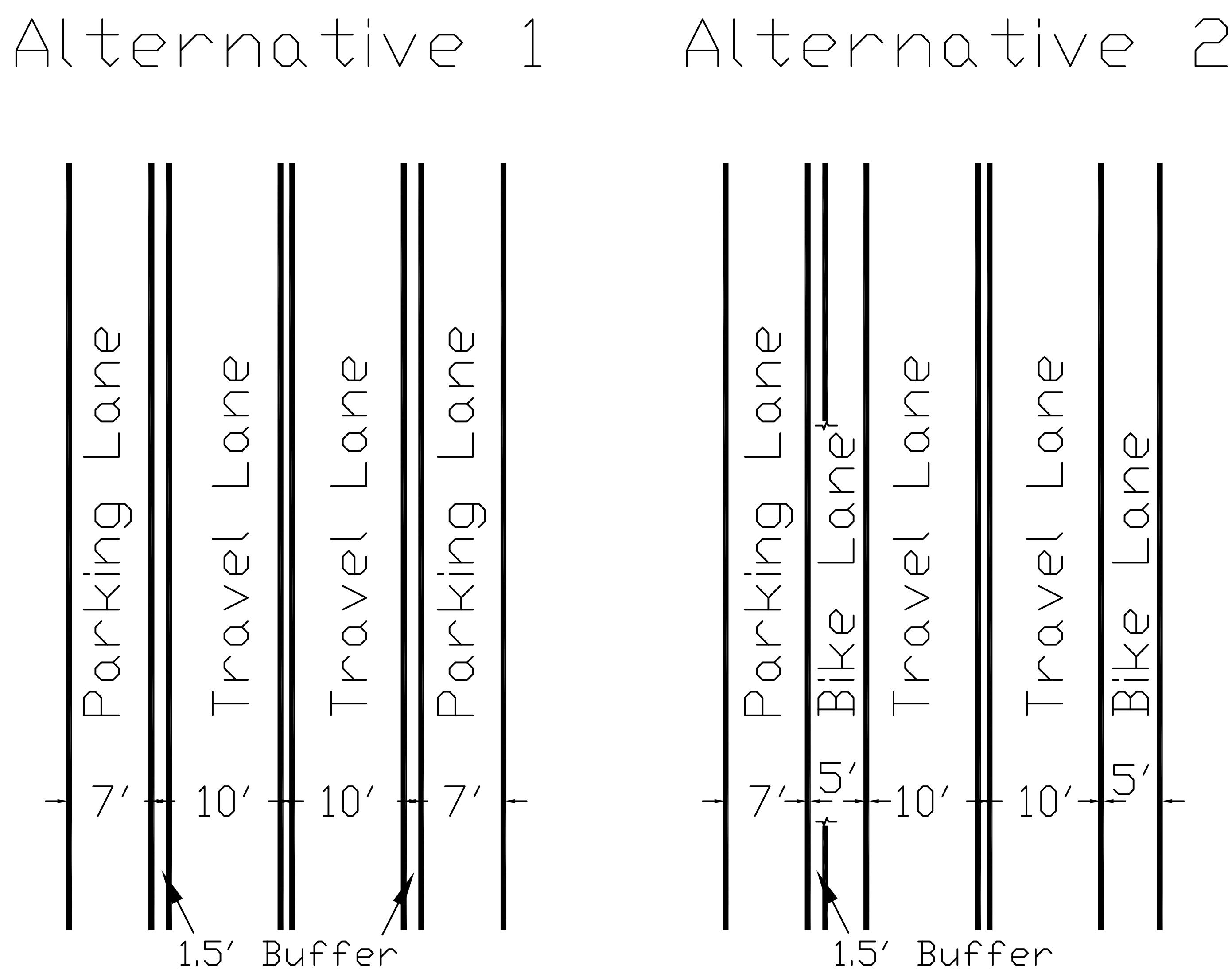
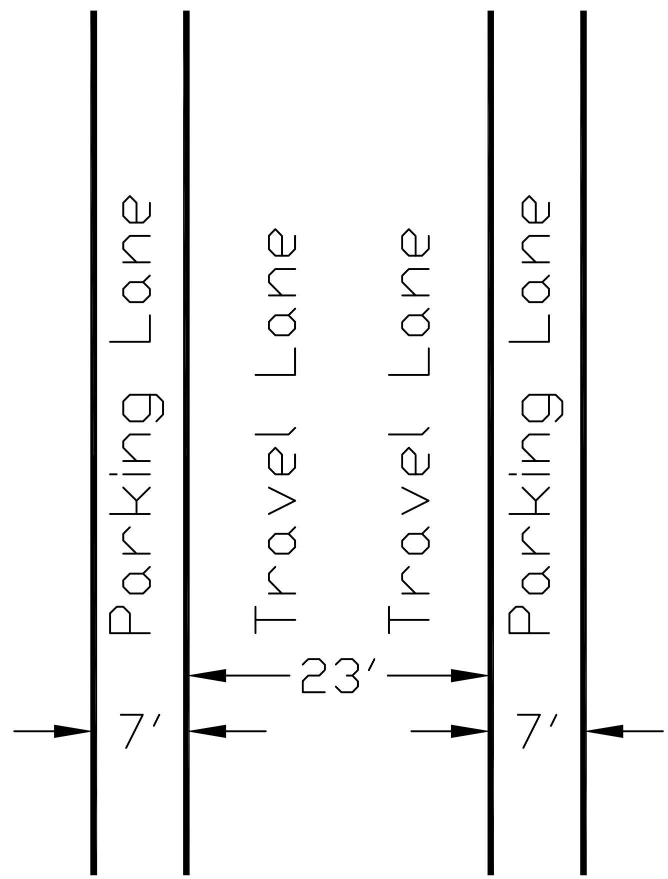
APPROVED	Kendrick St Bicycle Boulevard Table of Contents	SHEET 2 OF 31



NOTES:
Alternatives Considered

DESIGNED CES	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15
		SCALE BAR N/A
APPROVED SMH	Kendrick St Bicycle Boulevard Alternative Designs	SHEET 3 OF 31

Alternative 3



NOTES: **Preferred Alternative**	DESIGNED CES	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15
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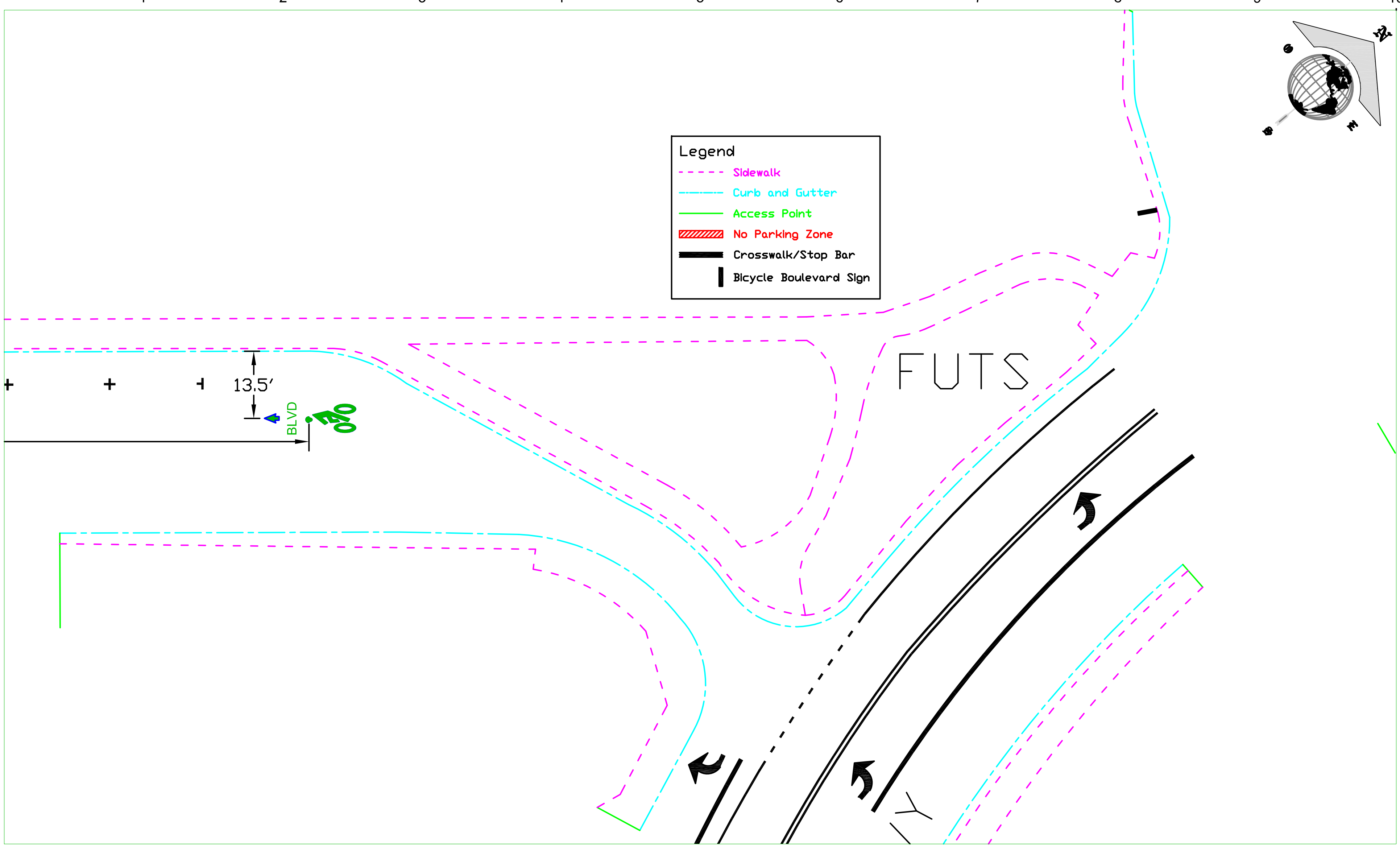


NOTES:

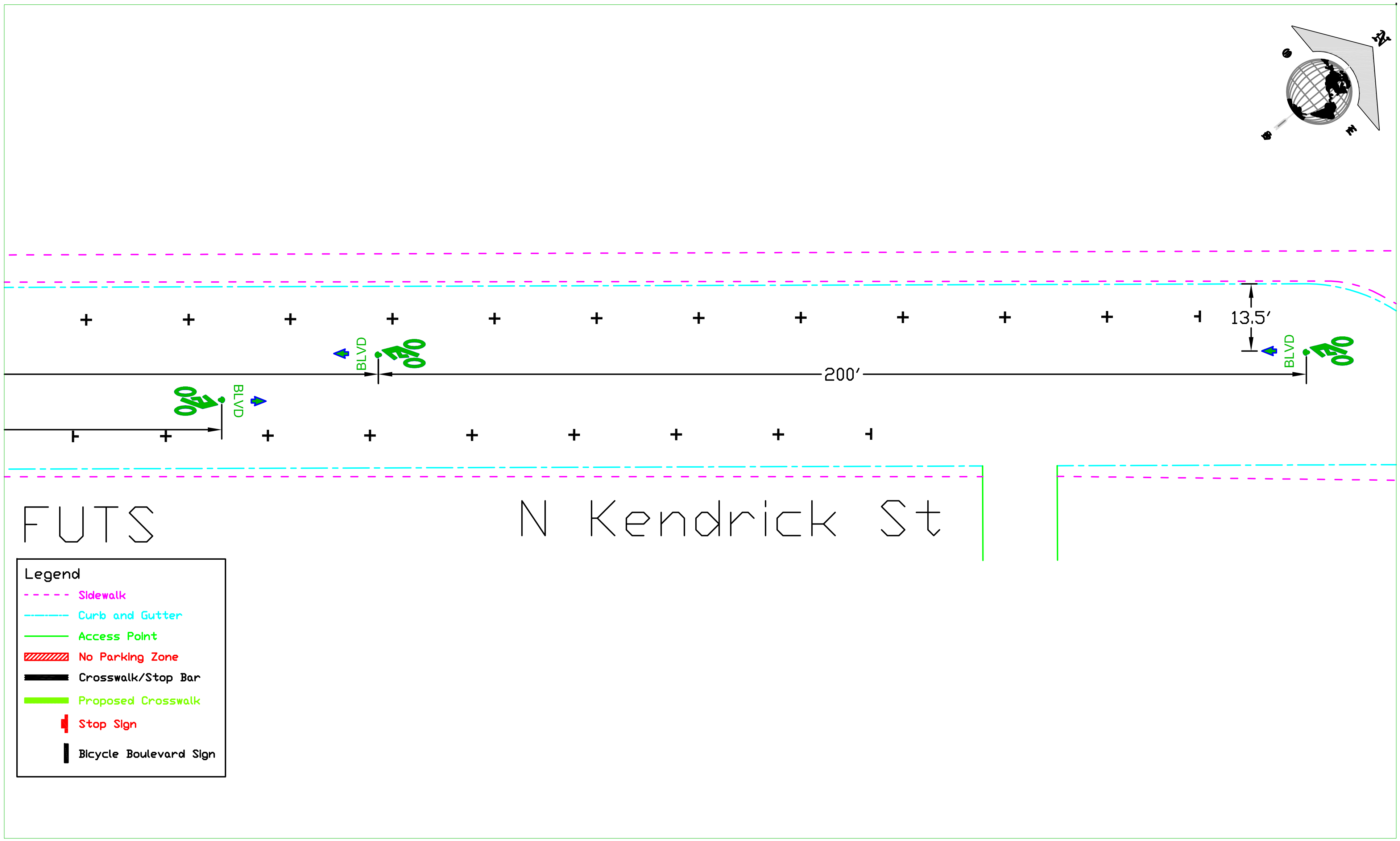
DESIGNED CES	Northern Arizona Trans Services CENE 486C Final Report
APPROVED SMH	Kendrick St Bicycle Boulevard North Kendrick St Striping

REVISION DATE 05/05/15

SCALE BAR 1" = 30'

0 15 30

SHEET 5 OF 31



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DESIGNED PJM	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15	SCALE BAR 1" = 30' 0 15 30
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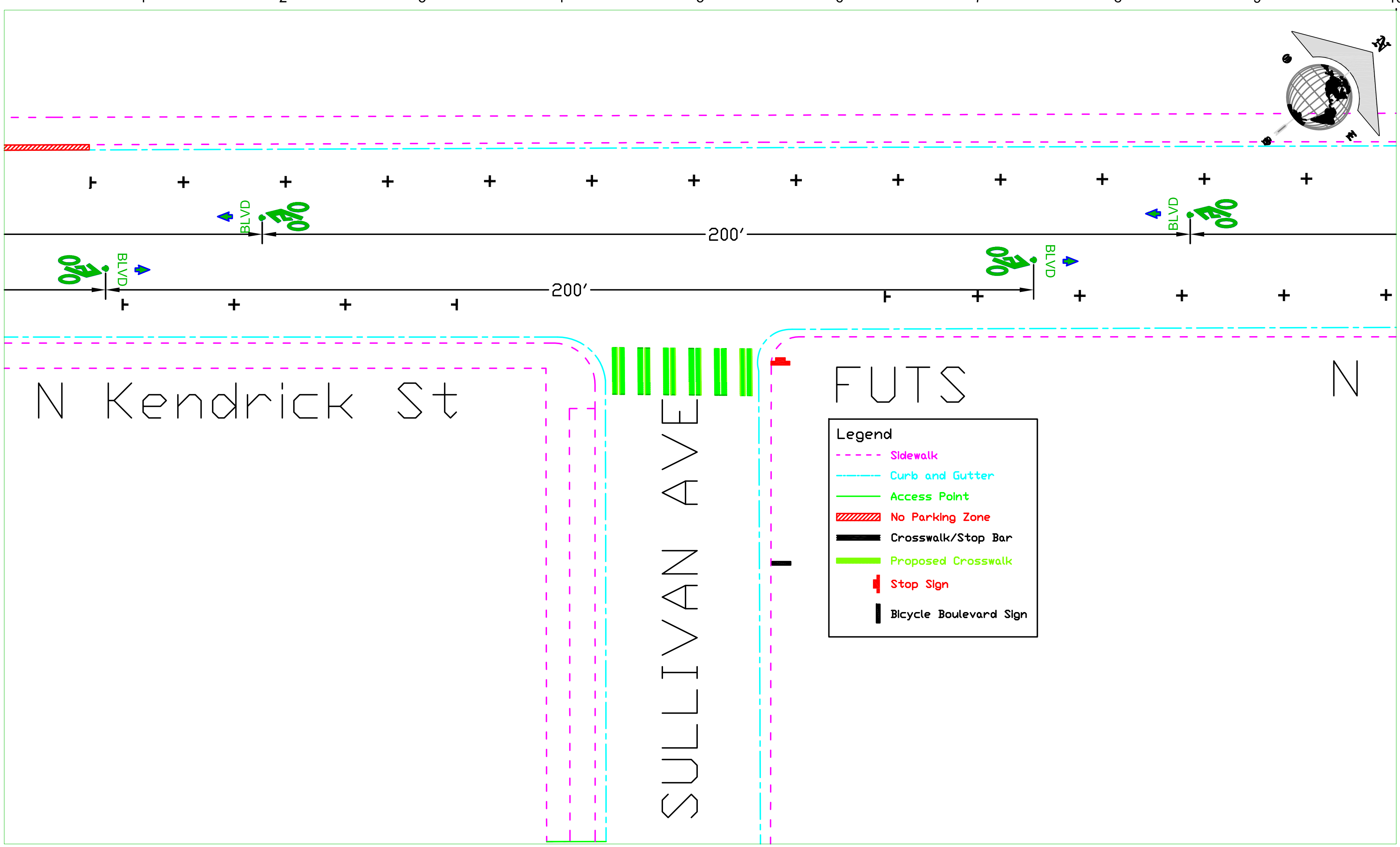

NOTES:

DESIGNED PJM	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15
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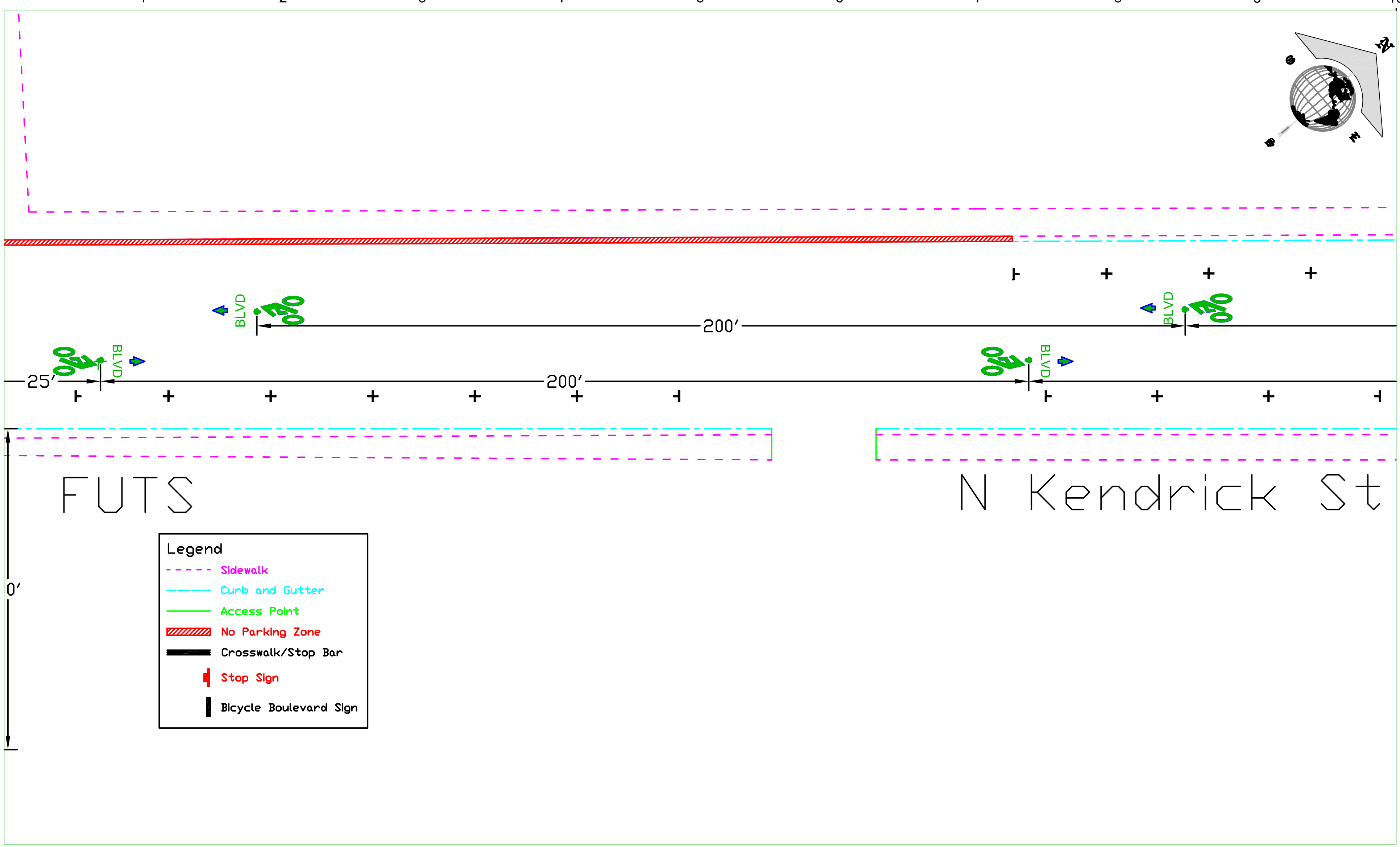

NOTES:

DESIGNED	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15
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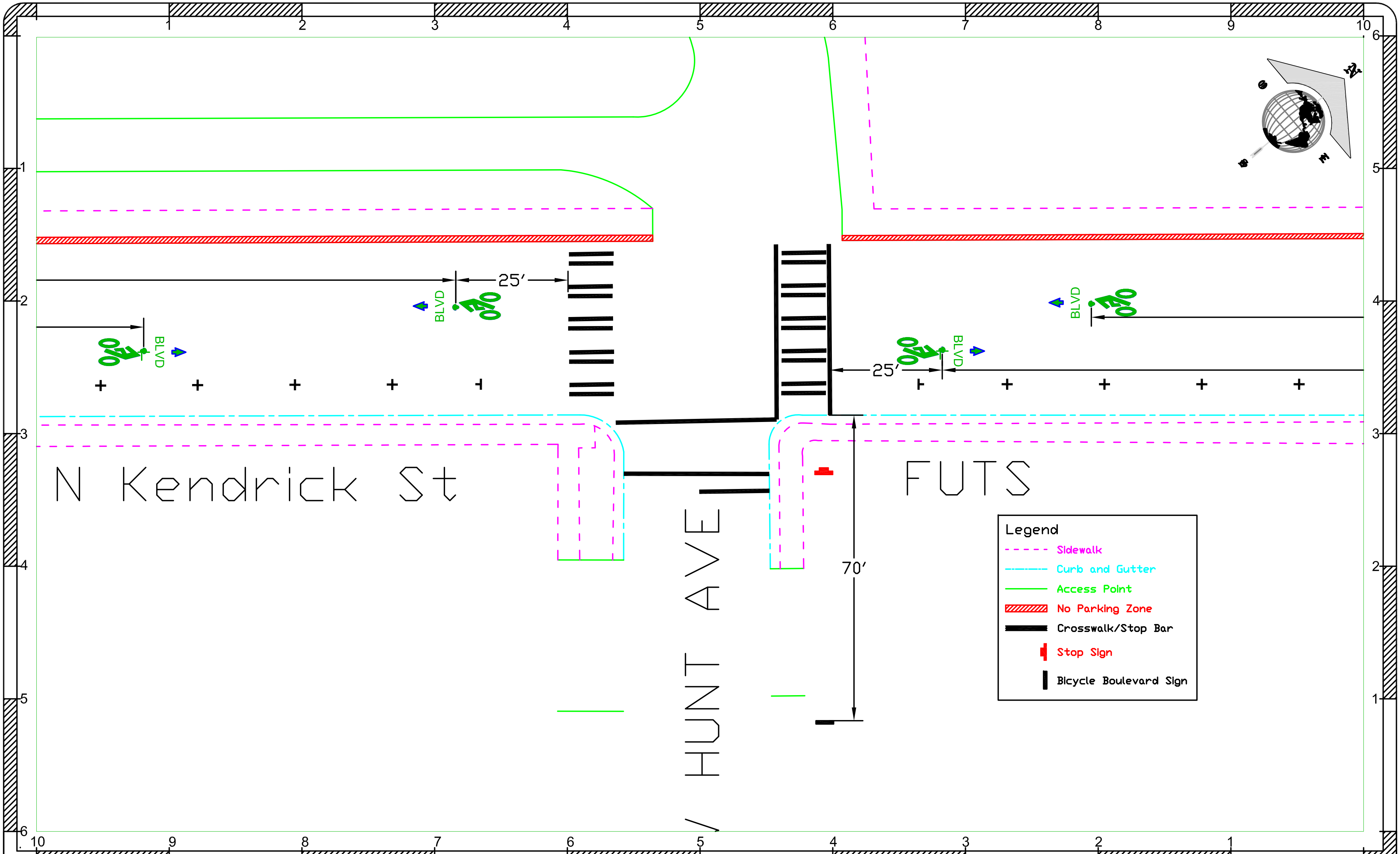

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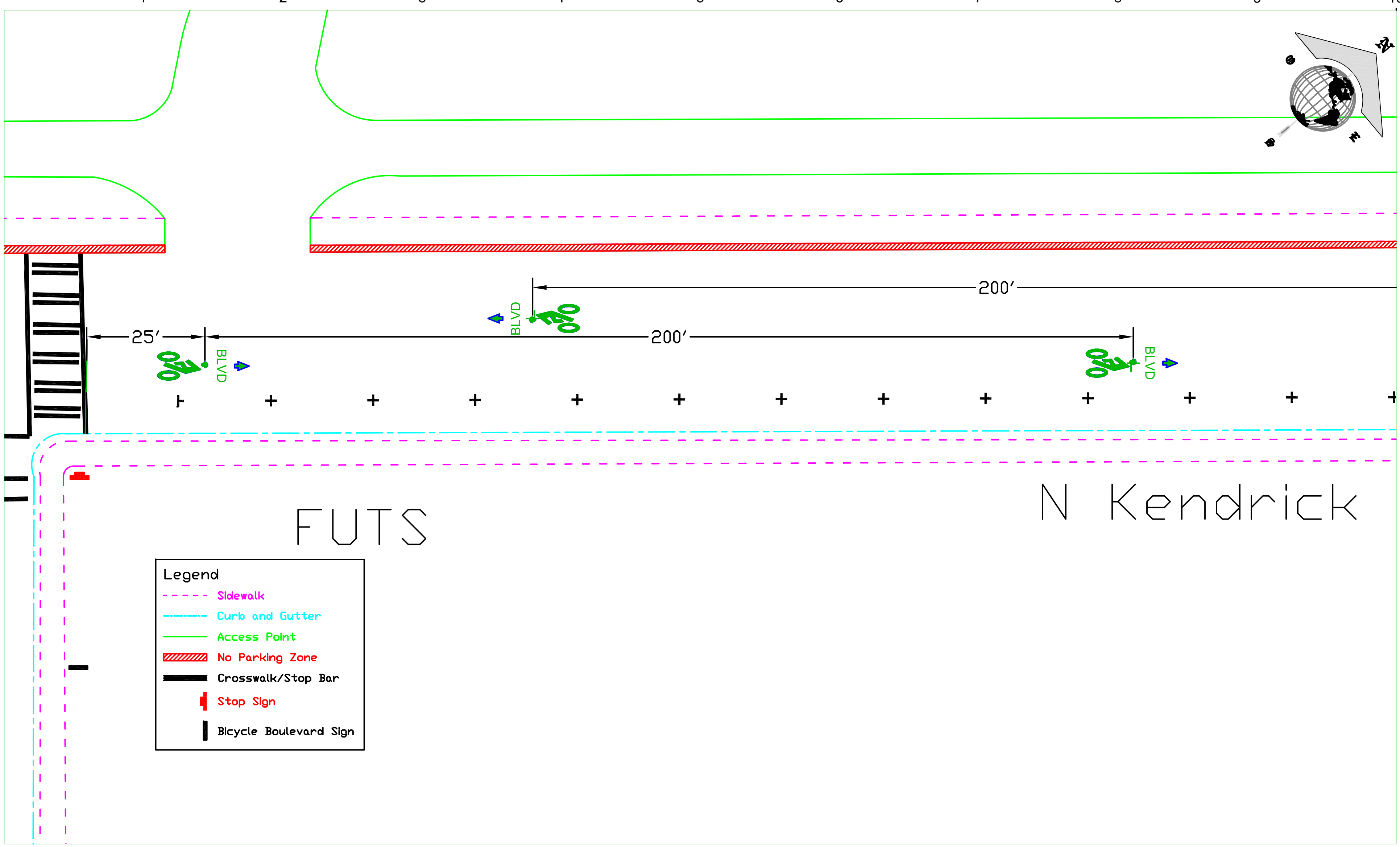

NOTES:

DESIGNED PJM	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15	SCALE BAR 1" = 30' 0 15 30
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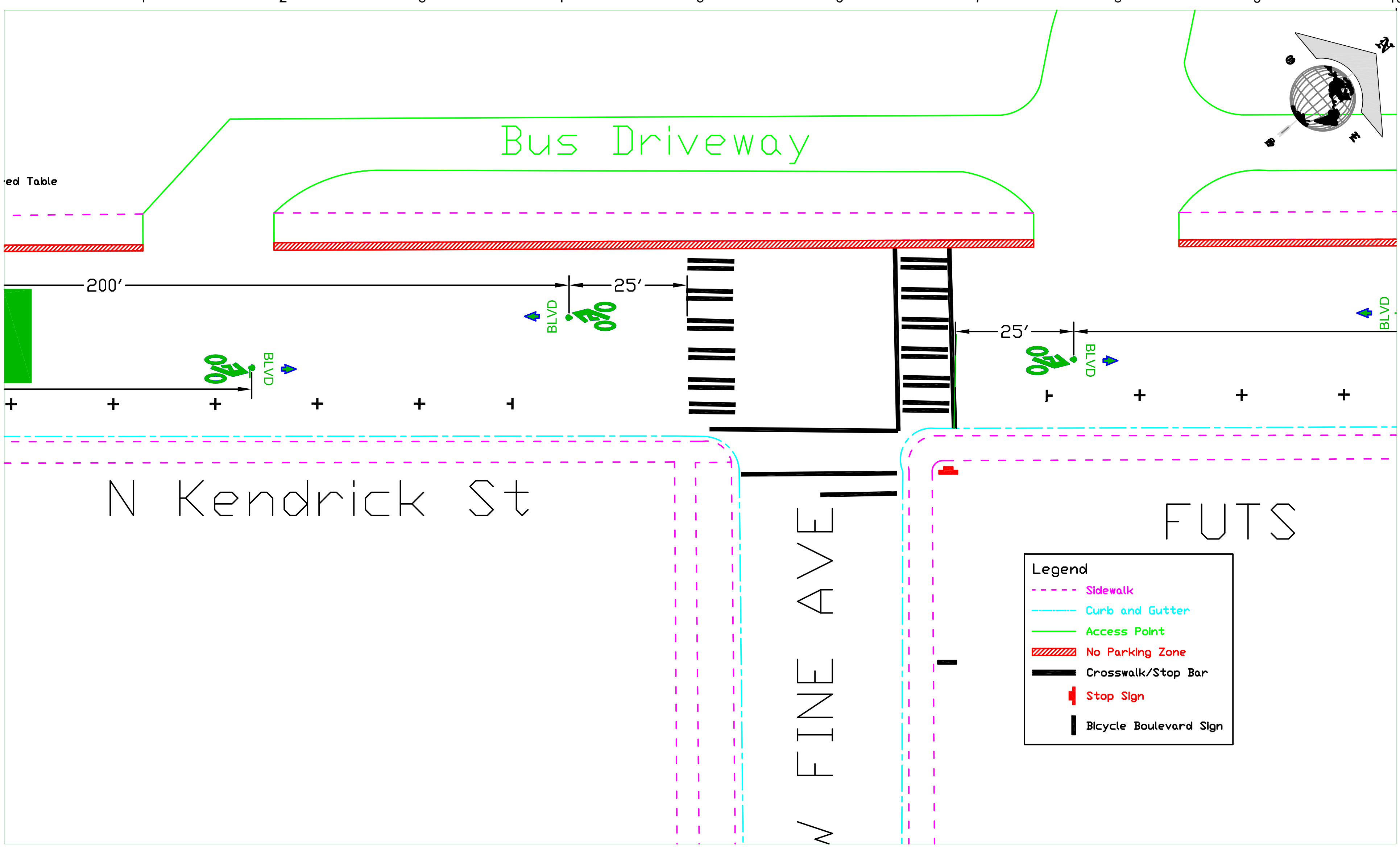

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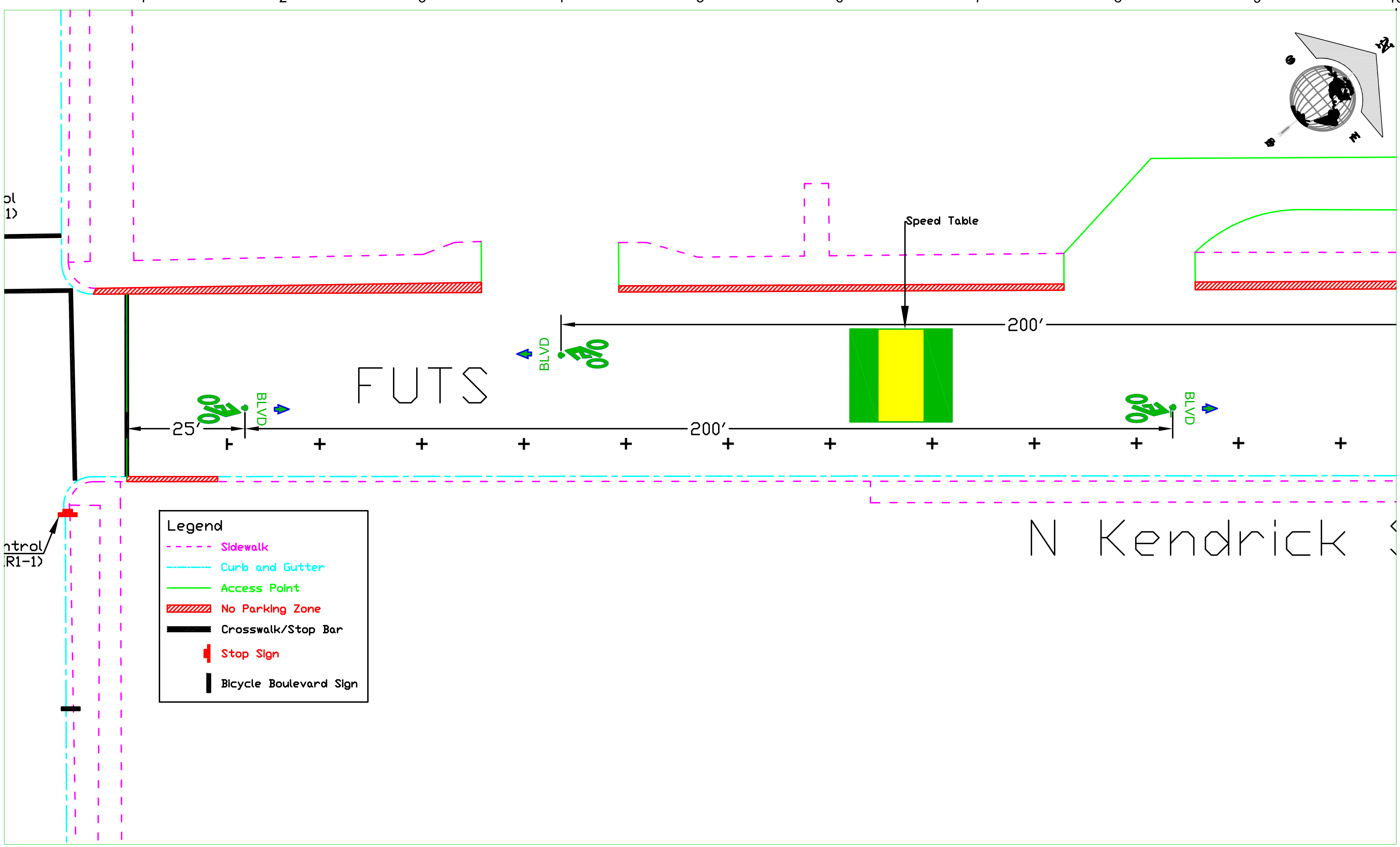

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DESIGNED PJM	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15
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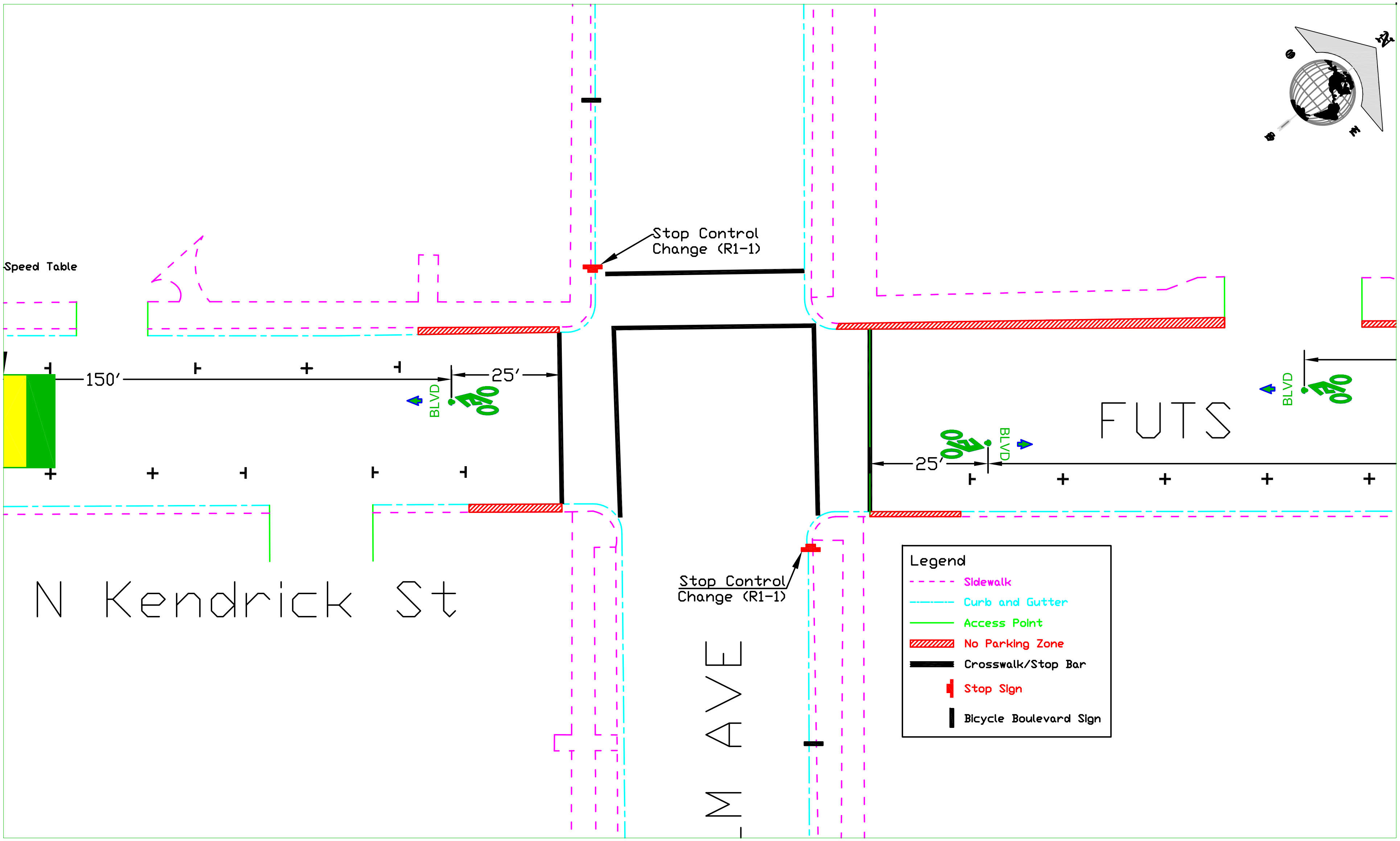
		SHEET 12 OF 31



NOTES:

1. STOP BARS SHALL BE ADDED AT NEW STOP SIGN LOCATIONS AT THE DISCRETION OF THE ENGINEER.

DESIGNED PJM	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15	SCALE BAR 1" = 30' 0 15 30
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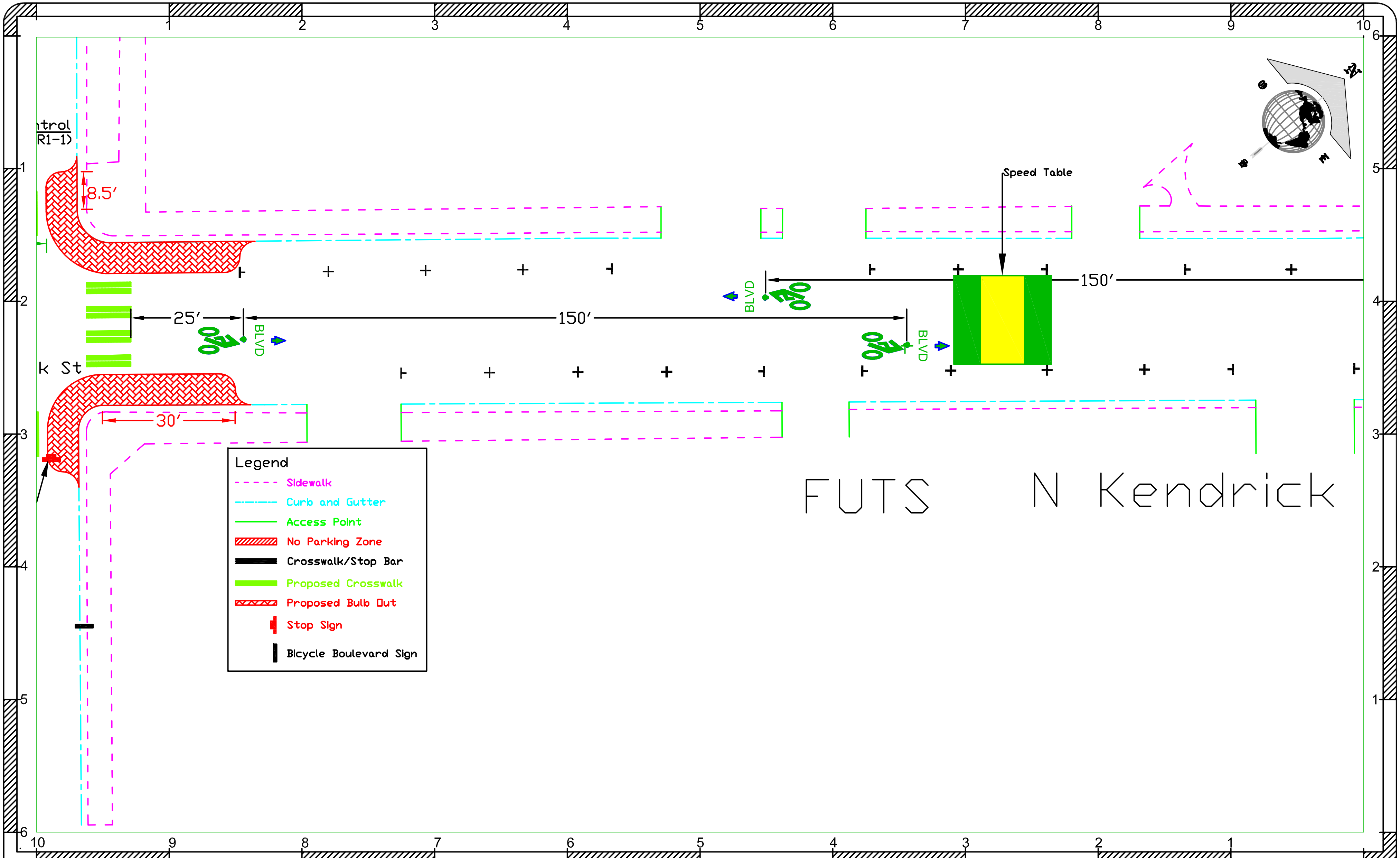

NOTES:	DESIGNED PJM	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15
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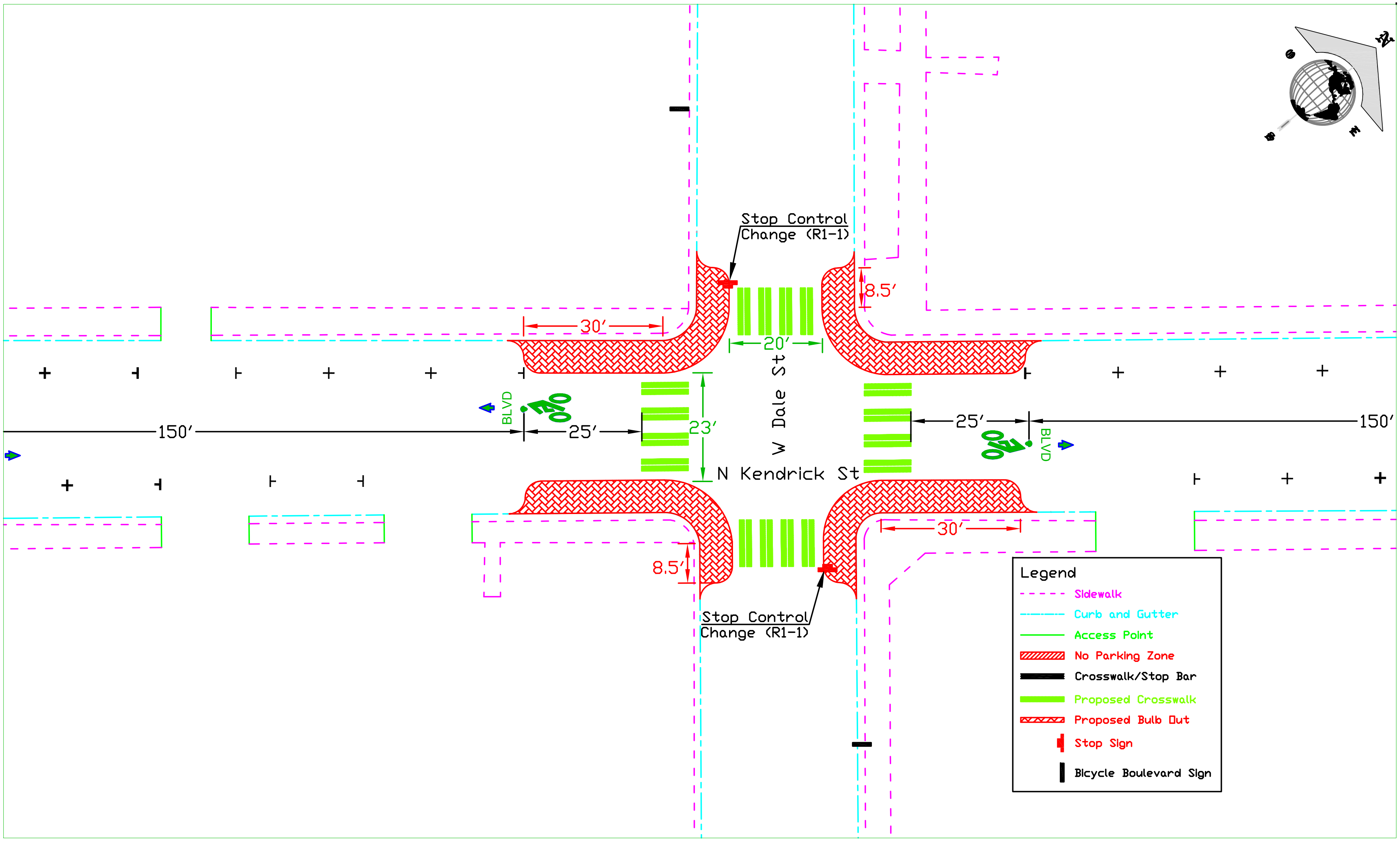
	APPROVED SMH	Kendrick St Bicycle Boulevard Dale/Elm Ave Striping Plan	SHEET 14 OF 31



NOTES:

1. STOP BARS SHALL BE ADDED AT NEW STOP SIGN LOCATIONS AT THE DISCRETION OF THE ENGINEER.

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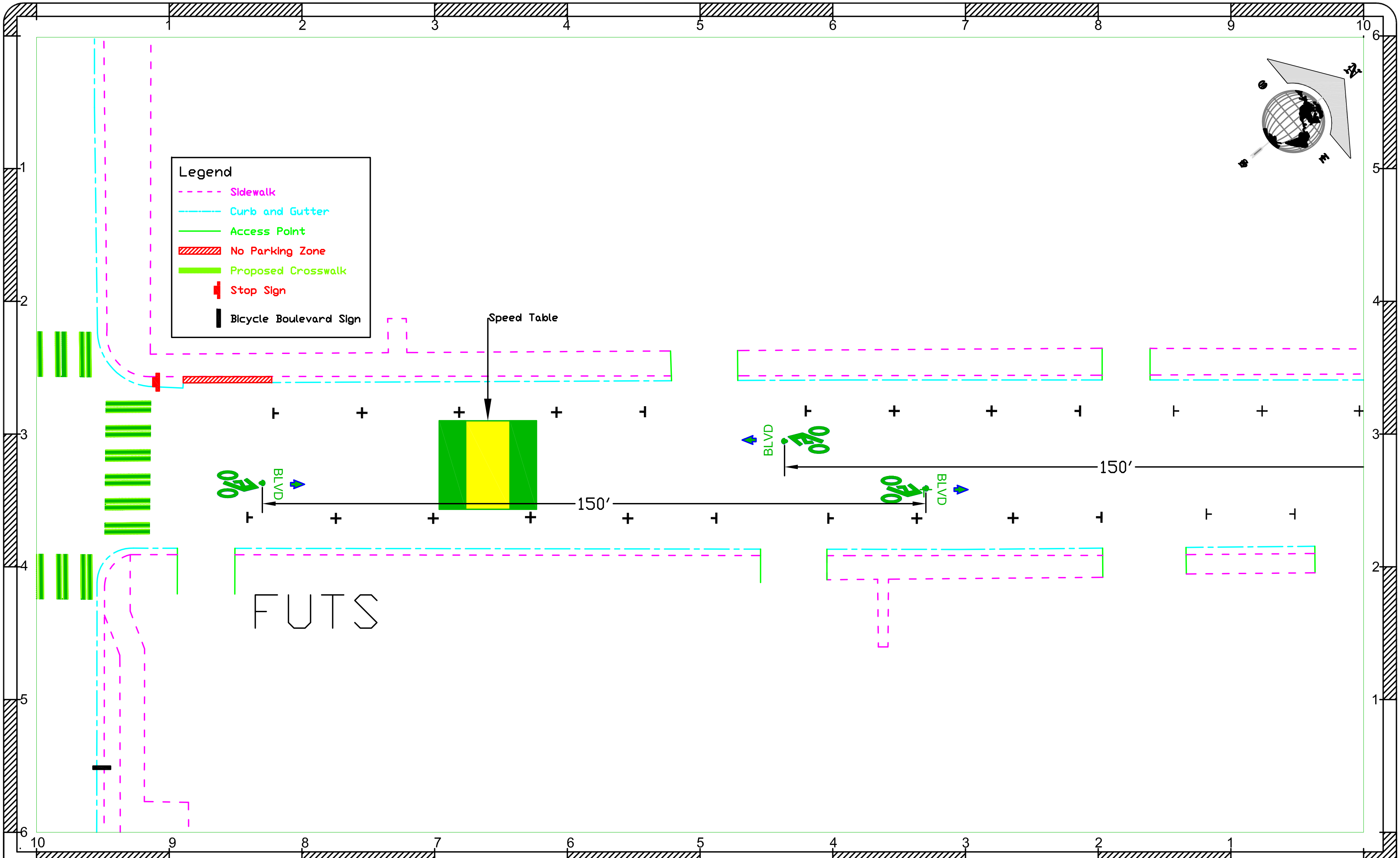
APPROVED: SMH	Kendrick St Bicycle Boulevard Dale Ave Striping Plan	SHEET: 15 OF 31



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DESIGNED PJM	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15	SCALE BAR 1" = 30'
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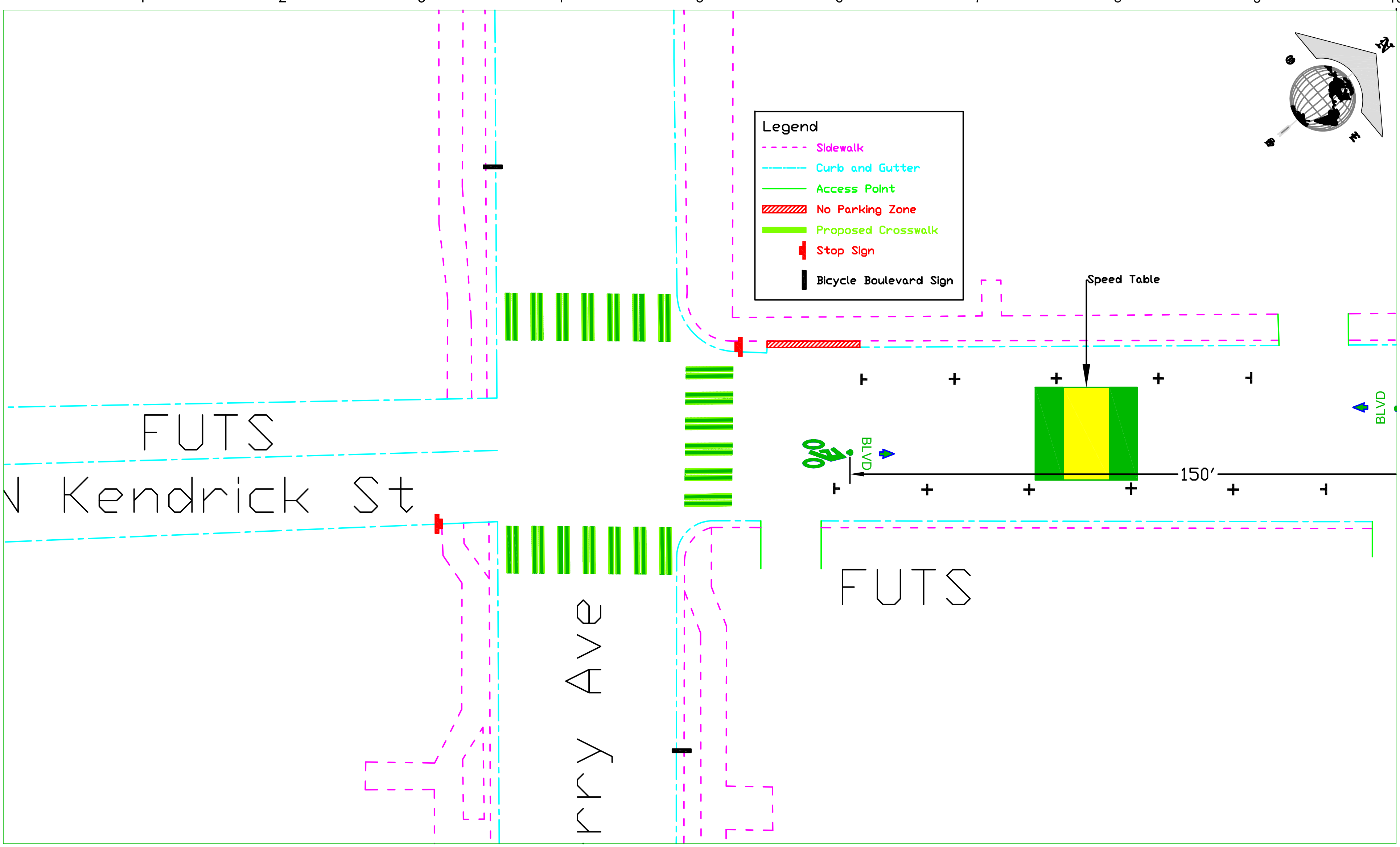

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DESIGNED PJM	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15 SCALE BAR 1" = 30' 0 15 30
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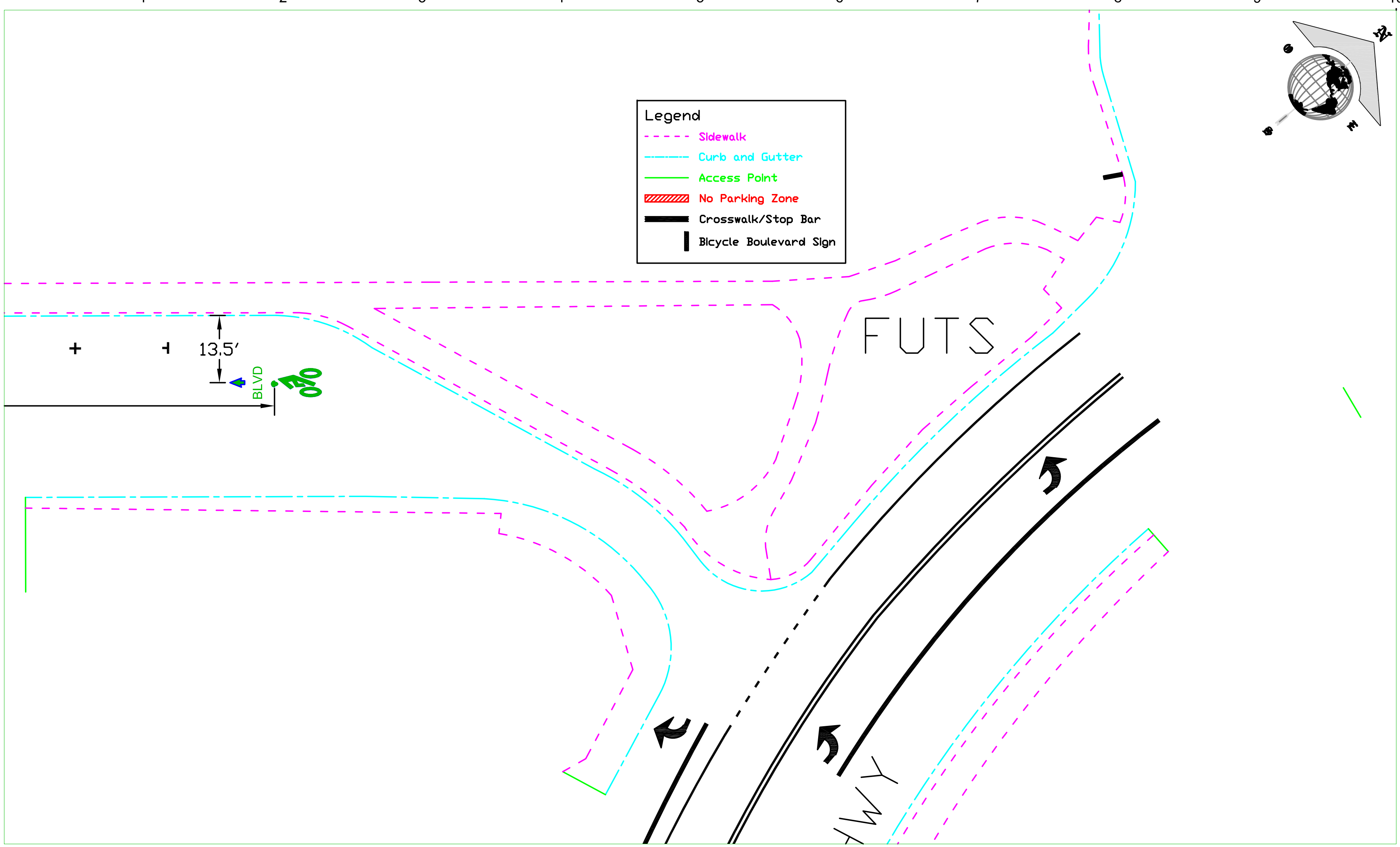

NOTES:

DESIGNED PJM	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15
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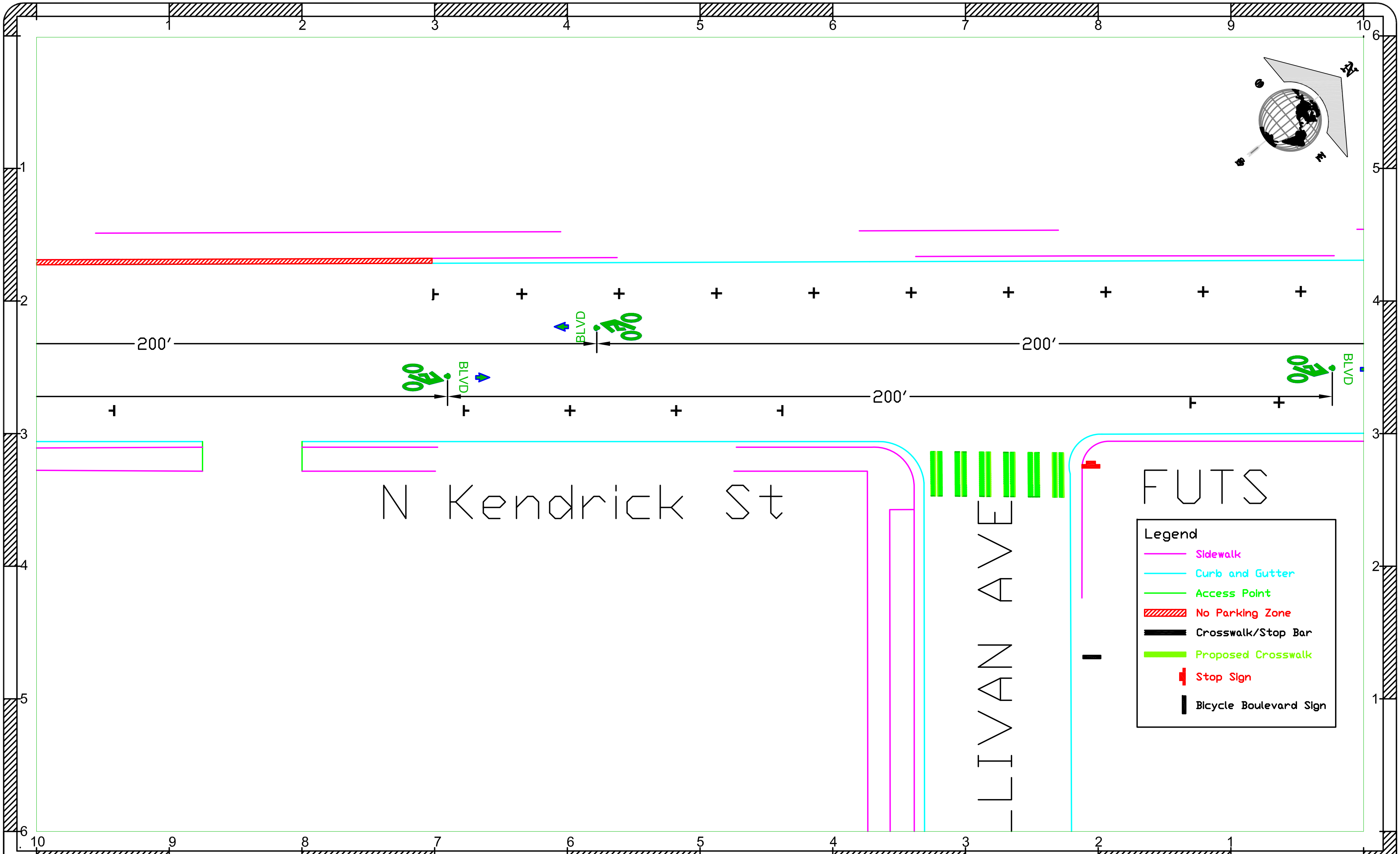

NOTES:

DESIGNED PJM	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15
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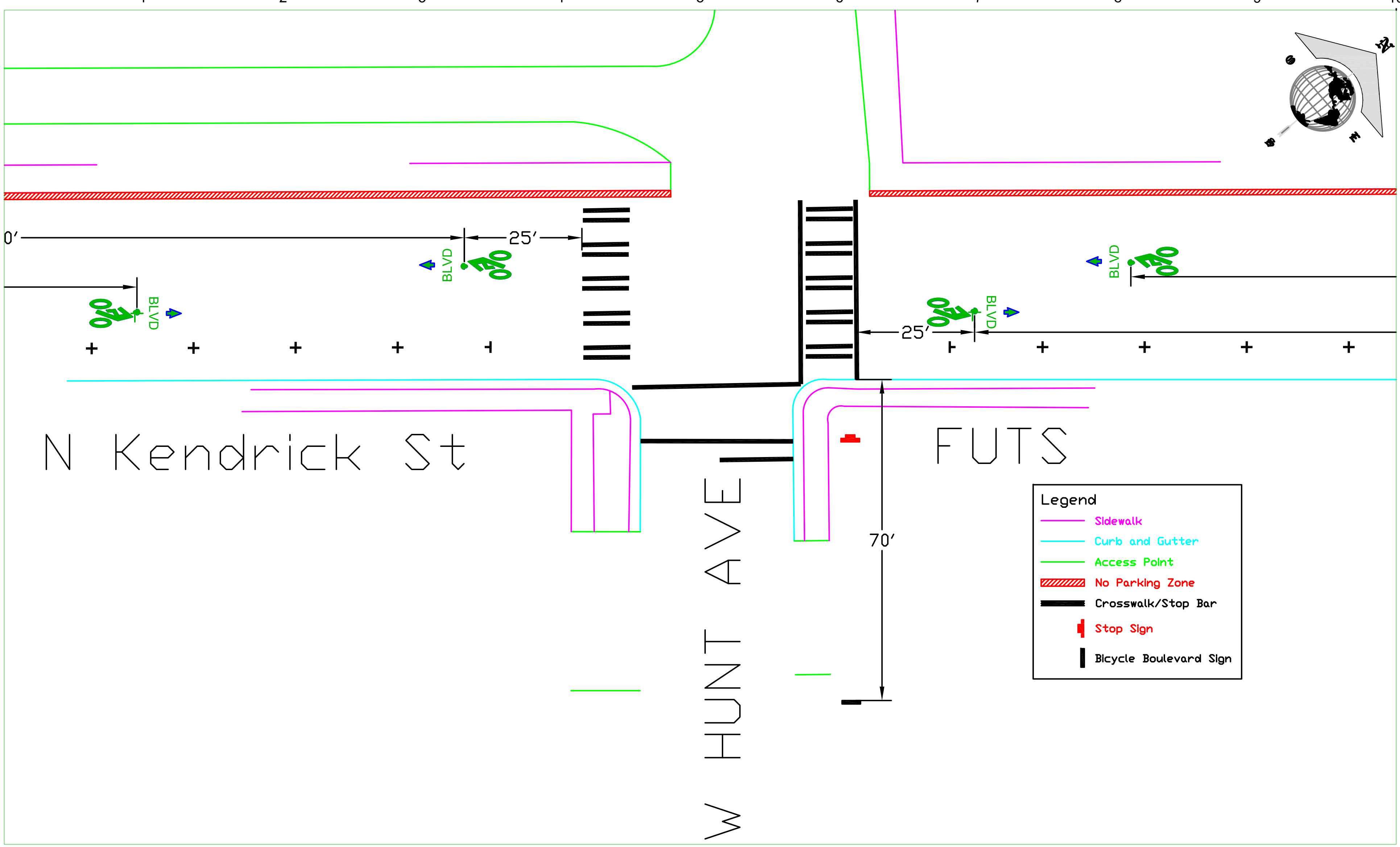
APPROVED SMH	Kendrick St Bicycle Boulevard Sullivan Ave Signage Plan	SHEET 19 OF 31



NOTES:

DESIGNED PJM	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15	SCALE BAR 1" = 30'
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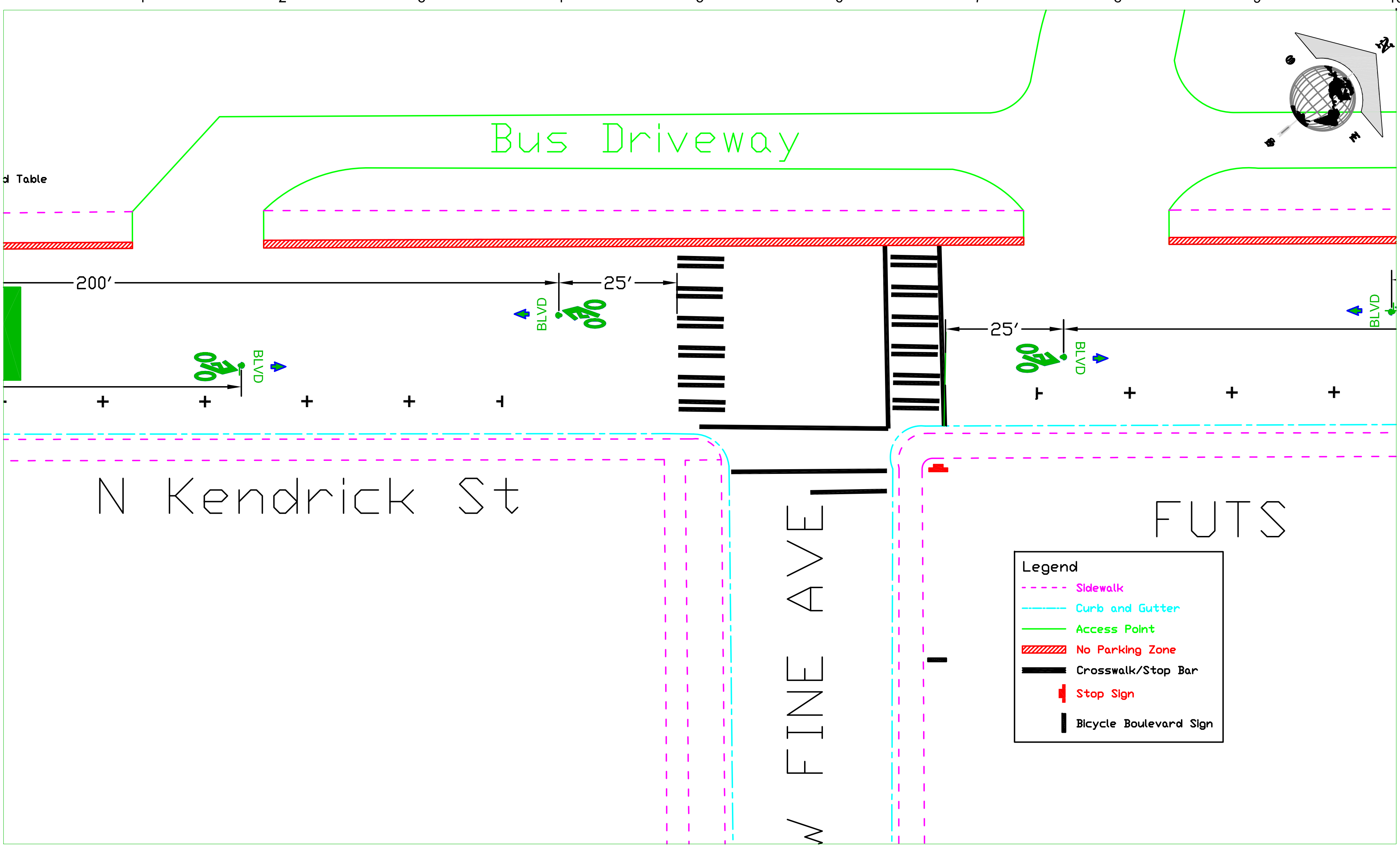
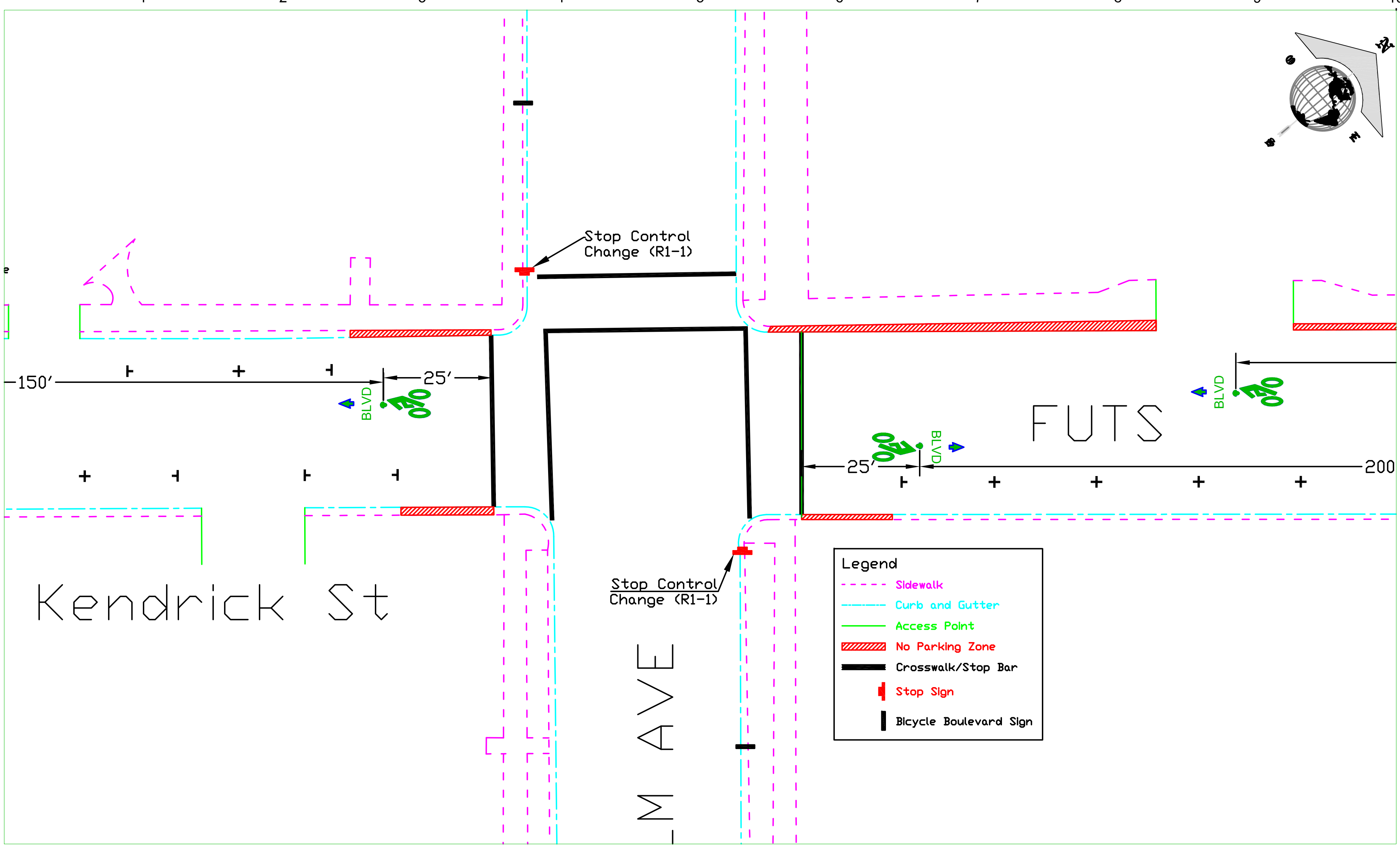


NOTES:

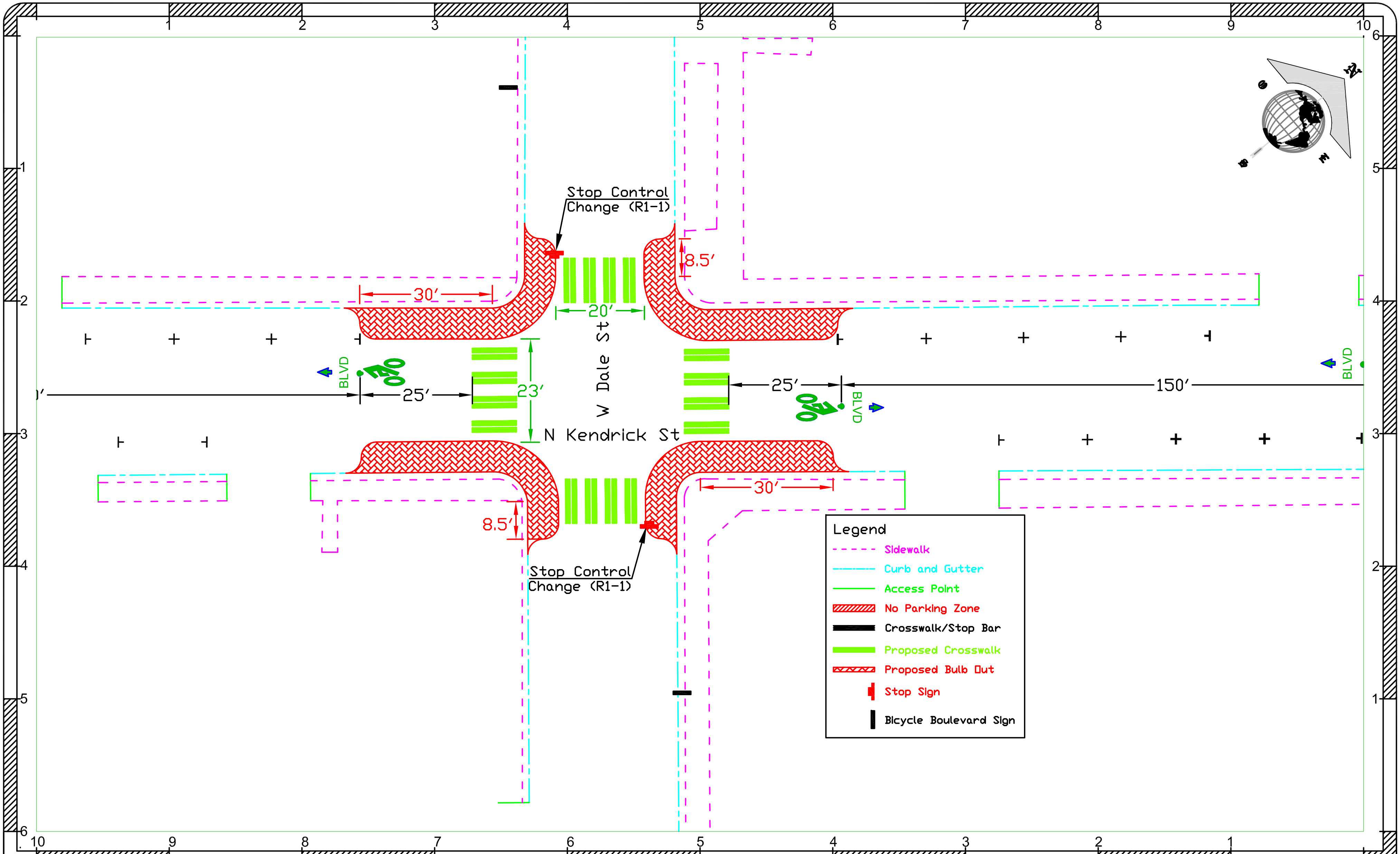
DESIGNED PJM	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15
		SCALE BAR 1" = 30' 0 15 30
APPROVED SMH	Kendrick St Bicycle Boulevard Fine/Elm Ave Signage Plan	SHEET 21 OF 31



NOTES:

1. STOP BARS SHALL BE ADDED AT NEW STOP SIGN LOCATIONS AT THE DISCRETION OF THE ENGINEER.

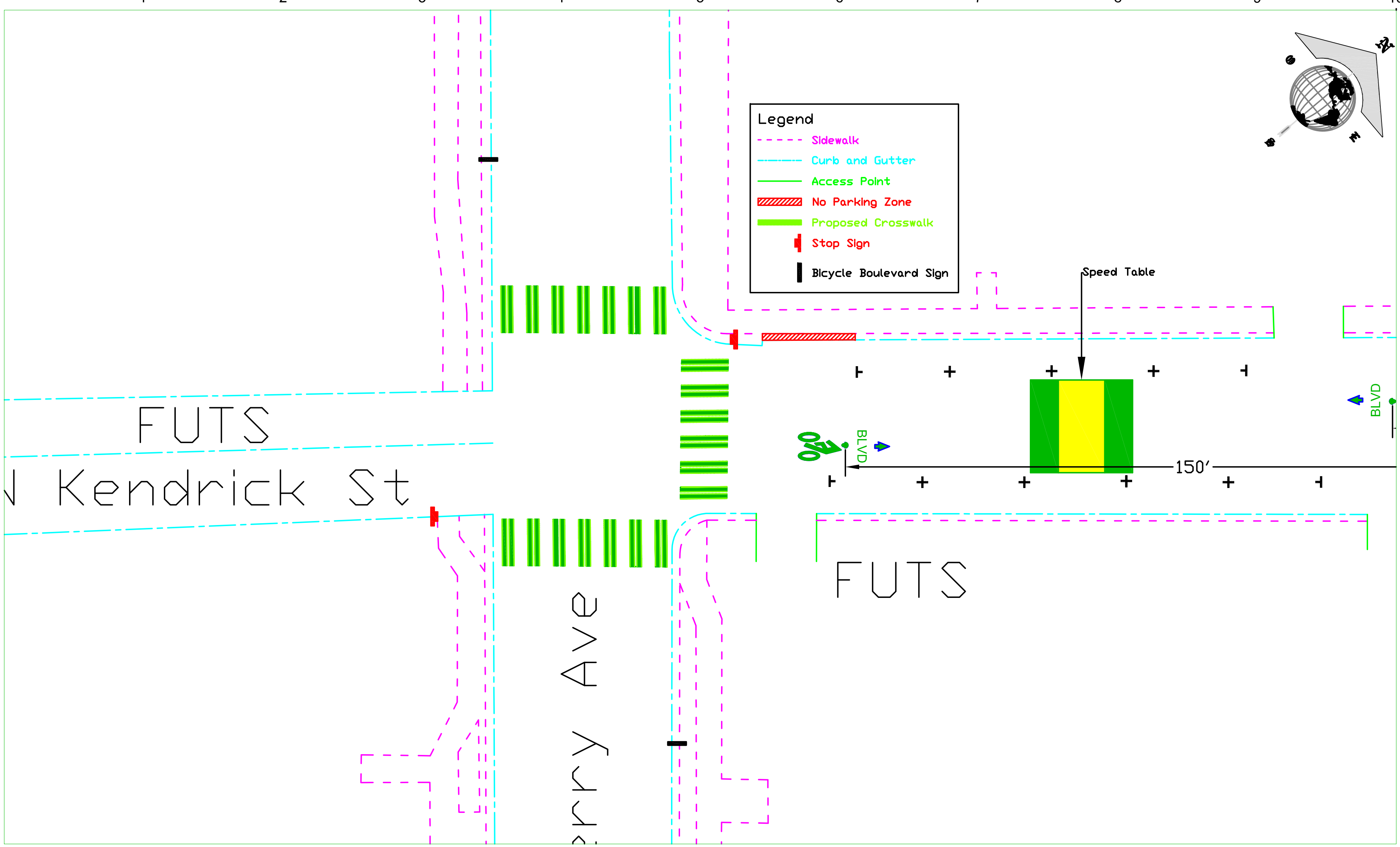
DESIGNED	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15
PJM		SCALE BAR 1" = 30' 0 15 30
APPROVED SMH	Kendrick St Bicycle Boulevard Elm Ave Signage Plan	SHEET 22 OF 31



NOTES:

1. STOP BARS SHALL BE ADDED AT NEW STOP SIGN LOCATIONS AT THE DISCRETION OF THE ENGINEER.

DESIGNED	PJM	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15
APPROVED	SMH	Kendrick St Bicycle Boulevard Dale Ave Signage Plan	SCALE BAR 1" = 30' (0, 15, 30)
			SHEET 23 OF 31



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DESIGNED PJM	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15	SCALE BAR 1" = 30' 0 15 30
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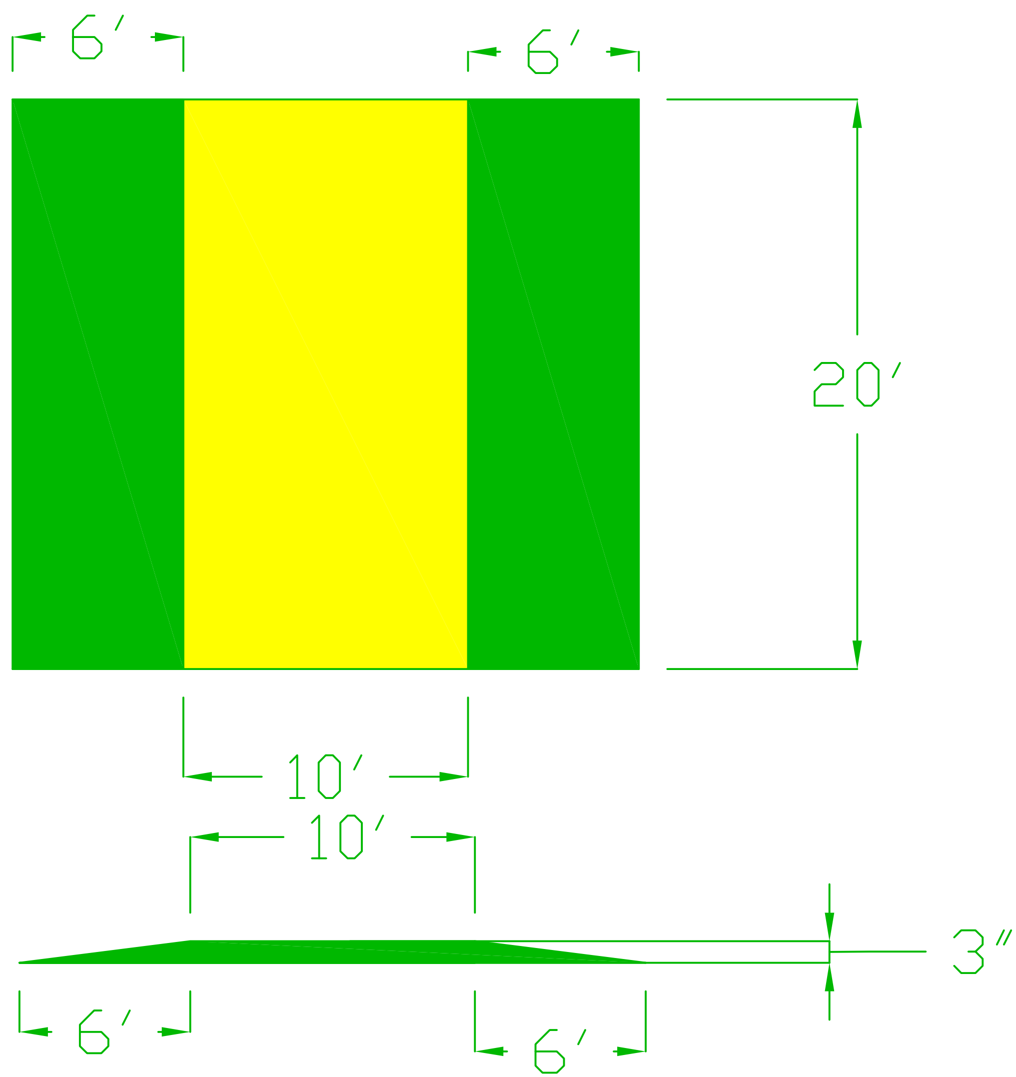
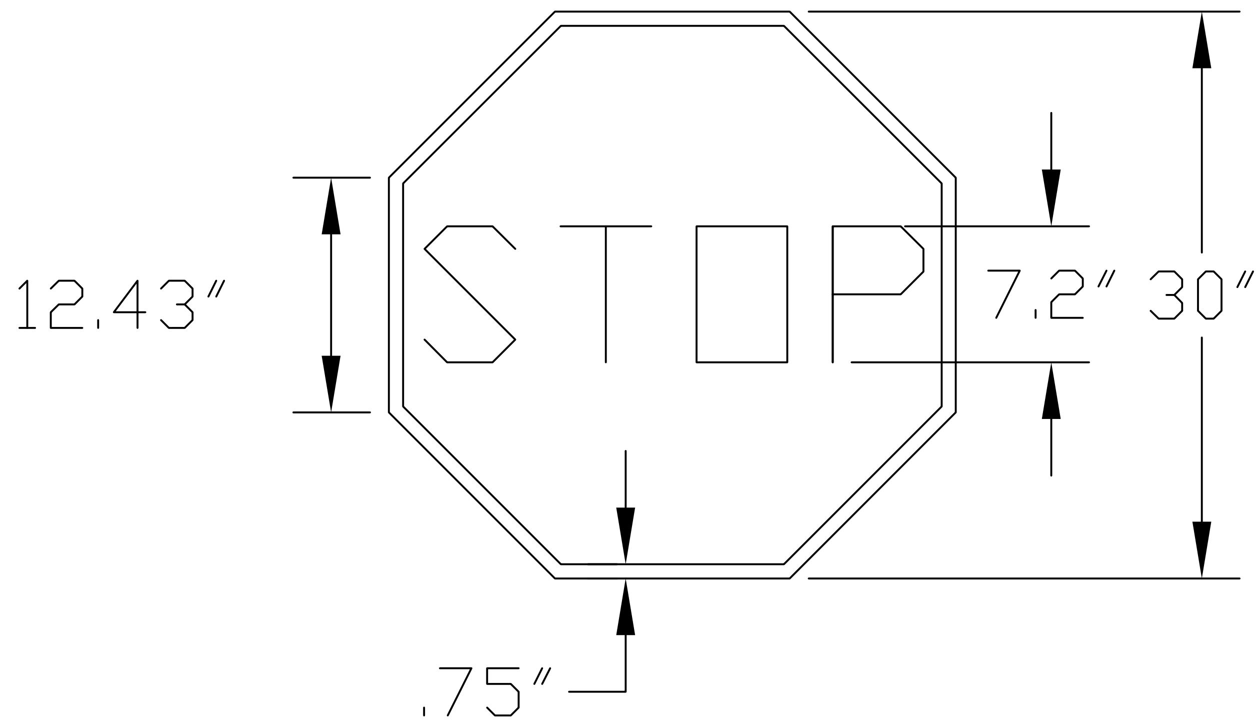


NOTES:

1. SPEED TABLES SHALL FOLLOW DESIGN PARAMETERS SET IN THE NACTO URBAN BIKEWAY DESIGN GUIDE, PAGE 214
2. ONE SPEED TABLE SHALL BE PLACED IN BETWEEN THE FOLLOWING STREETS: CHERRY AND DALE, DALE AND ELM, ELM AND FINE
3. SPEED TABLE SHALL HAVE A MAXIMUM HEIGHT OF 3 INCHES.
4. RAMPS ON EITHER SIDE OF THE PLATEAU OF THE SPEED SHALL BE 6 FEET LONG. THE PLATEAU SHALL BE 10 FEET LONG

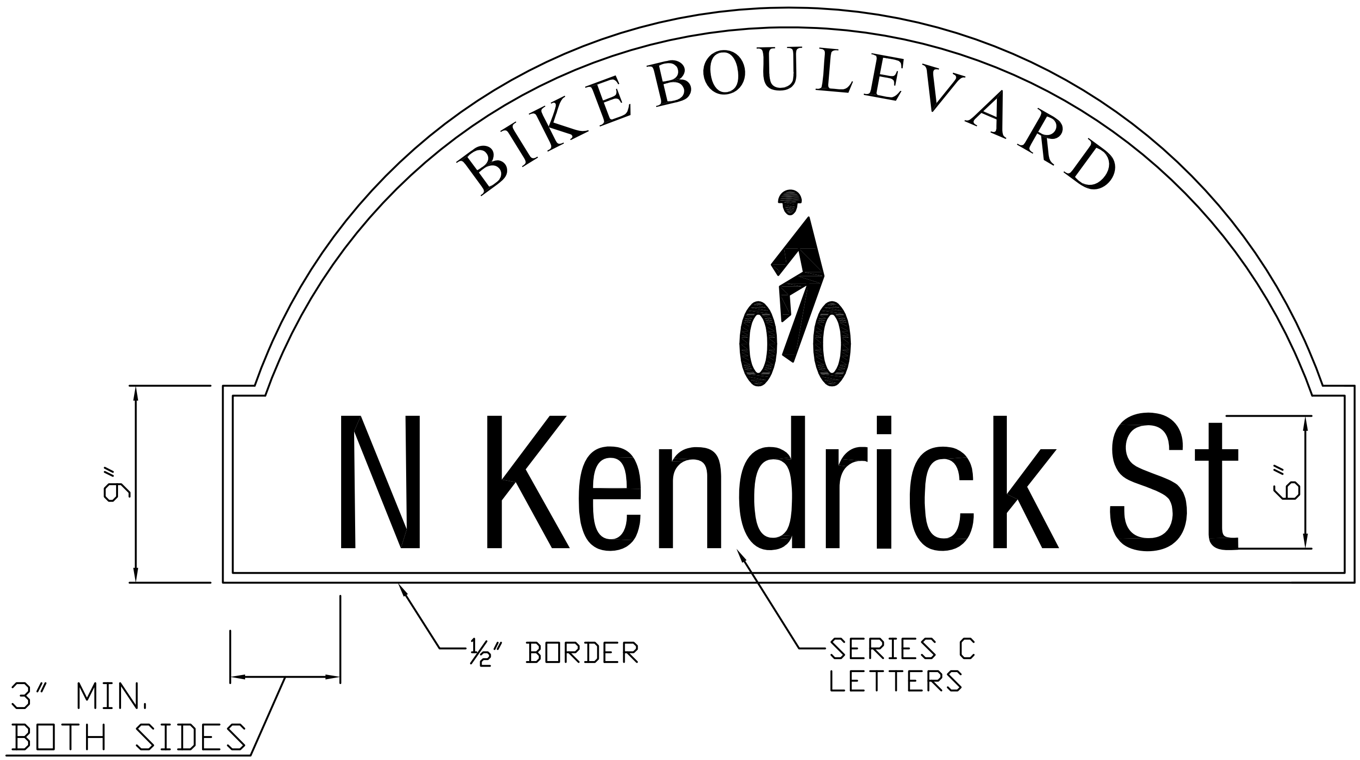
DESIGNED SMH	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15	SCALE BAR N/A
APPROVED PJM	Kendrick St Bicycle Boulevard Speed Table Detail	SHEET 25 OF 31	



NOTES:

1. SIGNING MATERIAL AND FABRICATION SHALL BE IN ACCORDANCE WITH THE MUTCD AND ADOT TRAFFIC ENGINEERING MANUAL OF APPROVED SIGNS.

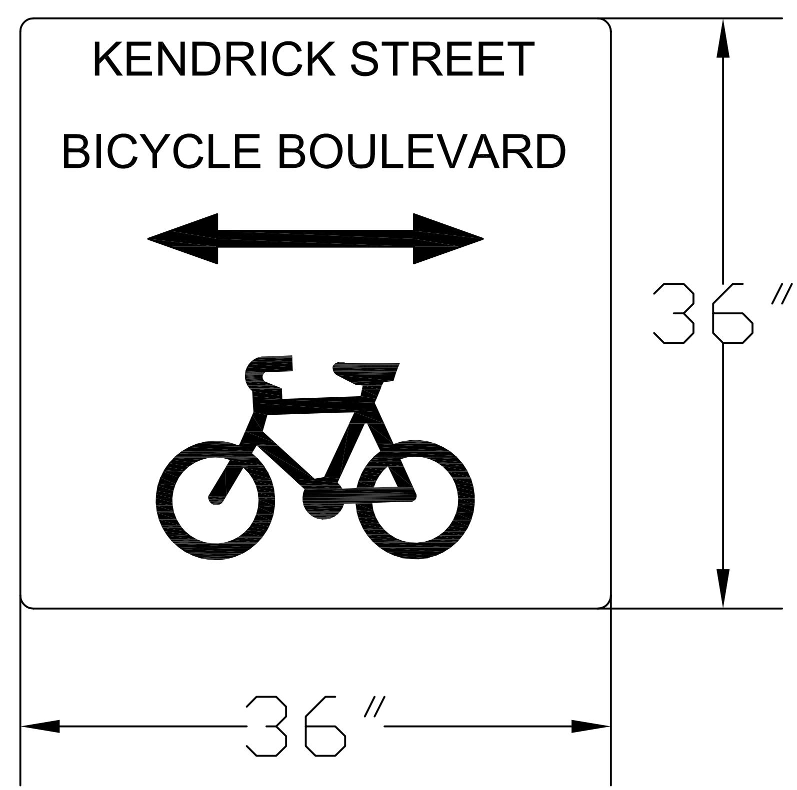
DESIGNED SMH	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15
		SCALE BAR N/A
APPROVED PJM	Kendrick St Bicycle Boulevard Stop Sign Detail (R1-1)	SHEET 26 OF 31



NOTES:

1. SIGNING MATERIAL AND FABRICATION SHALL BE IN ACCORDANCE WITH THE MUTCD AND ADOT TRAFFIC ENGINEERING MANUAL OF APPROVED SIGNS.
2. TYPE 2 SIGNS SHALL BE WHITE LETTERING ON GREEN BACKGROUND, ½" WHITE BORDER, NO MARGIN, DOUBLE-SIDED.
3. SIGN BLADE SHALL BE 9" EXTRUDED ALUMINUM, TREATED, 0.080 GAUGE, EXCEPT 12" BLADE SHALL BE USED FOR STREET NAMES CONTAINING LOWER CASE LETTERS WITH DESCENDING STEMS OR TAILS (E.G., "g", "p", "y").
4. SIGN SHEETING SHALL BE 3M DIAMOND GRADE DG3 REFLECTIVE SHEETING SERIES 4000.
5. LETTERING SHALL BE FORMED USING 3M ELECTROCUT (EC) FILM SERIES 1170.
6. FONT SHALL BE HIGHWAY GOTHIC SERIES C, 6" UPPER AND LOWER CASE.
7. POSTS SHALL BE 2"x2" SQUARE STEEL POSTS AS PER STD DWG D3-1.
8. MOUNTING HARDWARE SHALL BE ZUMAR Z12RDSQ200EX CAP AND ZUMAR 812EX90X CROSSPIECE, OR APPROVED EQUAL.
9. LAYOUT OF NON-NUMBERED STREET NAME LETTERING) WILL BE PROVIDED BY THE ENGINEER.
10. THIS MODIFIED SIGN SHALL BE SUBMITTED FOR APPROVAL TO THE MUTCD.

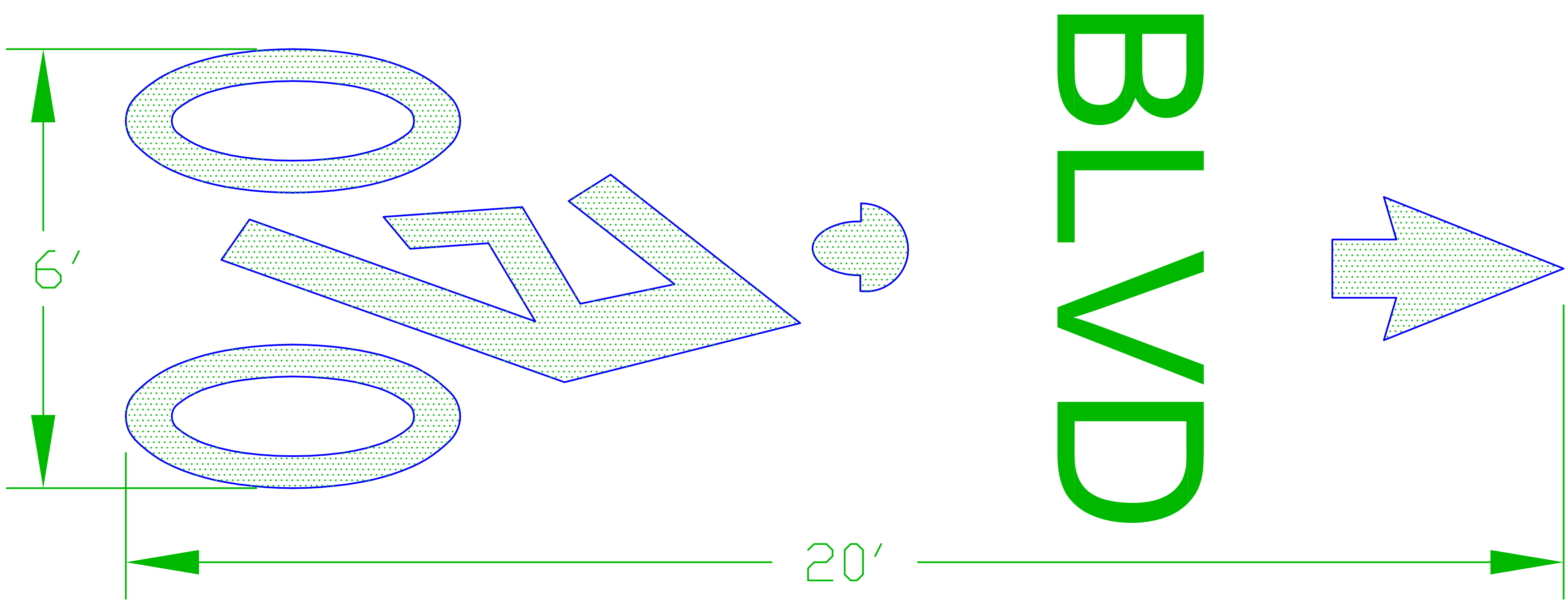
DESIGNED CES	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15	SCALE BAR N/A
APPROVED SMH	Kendrick St Bicycle Boulevard Bicycle Boulevard Sign	SHEET 27 OF 31	



NOTES:

1. THE "BICYCLE BOULEVARD AHEAD" SIGN DIMENSIONS SHALL BE 36 INCHES BY 36 INCHES
2. SIGNING MATERIAL AND FABRICATION SHALL BE IN ACCORDANCE WITH THE MUTCD AND ADOT TRAFFIC ENGINEERING MANUAL OF APPROVED SIGNS.
3. TYPE 2 SIGNS SHALL BE WHITE LETTERING ON GREEN BACKGROUND, ½" WHITE BORDER, NO MARGIN, DOUBLE-SIDED.

DESIGNED SMH	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15	SCALE BAR N/A
APPROVED PJM	Kendrick St Bicycle Boulevard Bicycle Boulevard Sign	SHEET 28 OF 31	



NOTES:
1. BICYCLE LANE MATERIAL SHALL BE LOW PROFILE PREFORMED THERMOPLASTIC (90 MIL.).
2. DIMENSIONS: ADJUSTMENTS TO DIMENSIONS SHALL BE APPROVED BY THE ENGINEER.

DESIGNED CES	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15	SCALE BAR None
APPROVED SMH	Kendrick St Bicycle Boulevard Bicycle Boulevard Decal	SHEET 29 OF 31	

Cost of Implementation

Items	Units	Unit Cost	Amount	Cost
Parking Striping	LF	$0.70	400	$280
Speed Table	EA	$2,500	3	$7,500
Boulevard Striping	EA	$350	23	$8,050
Thermoplastic	SF	$13	1540	$20,020
Boulevard Signage	EA	$200	12	$2,400
Advance Signage	EA	$200	12	$2,400
Speed Table Signage	EA	$200	6	$1,200
R1-1 Signage Reuse	EA	$100	4	$400
Subtotal				$42,250
Administrative Cost				$42,918
Grand Total				$85,168

NOTES:
1. Grand total includes all material costs and manhour costs.

DESIGNED	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15 SCALE BAR N/A
APPROVED	Kendrick St Bicycle Boulevard Cost and Line Items	SHEET 30 OF 31

Construction Notes

- All parking stalls begin 20 feet from the closest crosswalk unless otherwise noted, per Flagstaff City Code.
- The parking stall nearest an intersection shall be 22 feet long, all others shall be 20 feet long.
- All parking striping "white Ts" shall have 6 inch wide strips and each arm will be 2.5 feet long per MUTCD Figure 3B-21.
- All "bicycle boulevard decals" shall be 25 feet from a cross walk and spaced 150-200 feet apart after that, depending on the length of road between intersections.
- All advanced warning Bicycle Boulevard signs shall be 50 feet before an intersection unless otherwise noted.

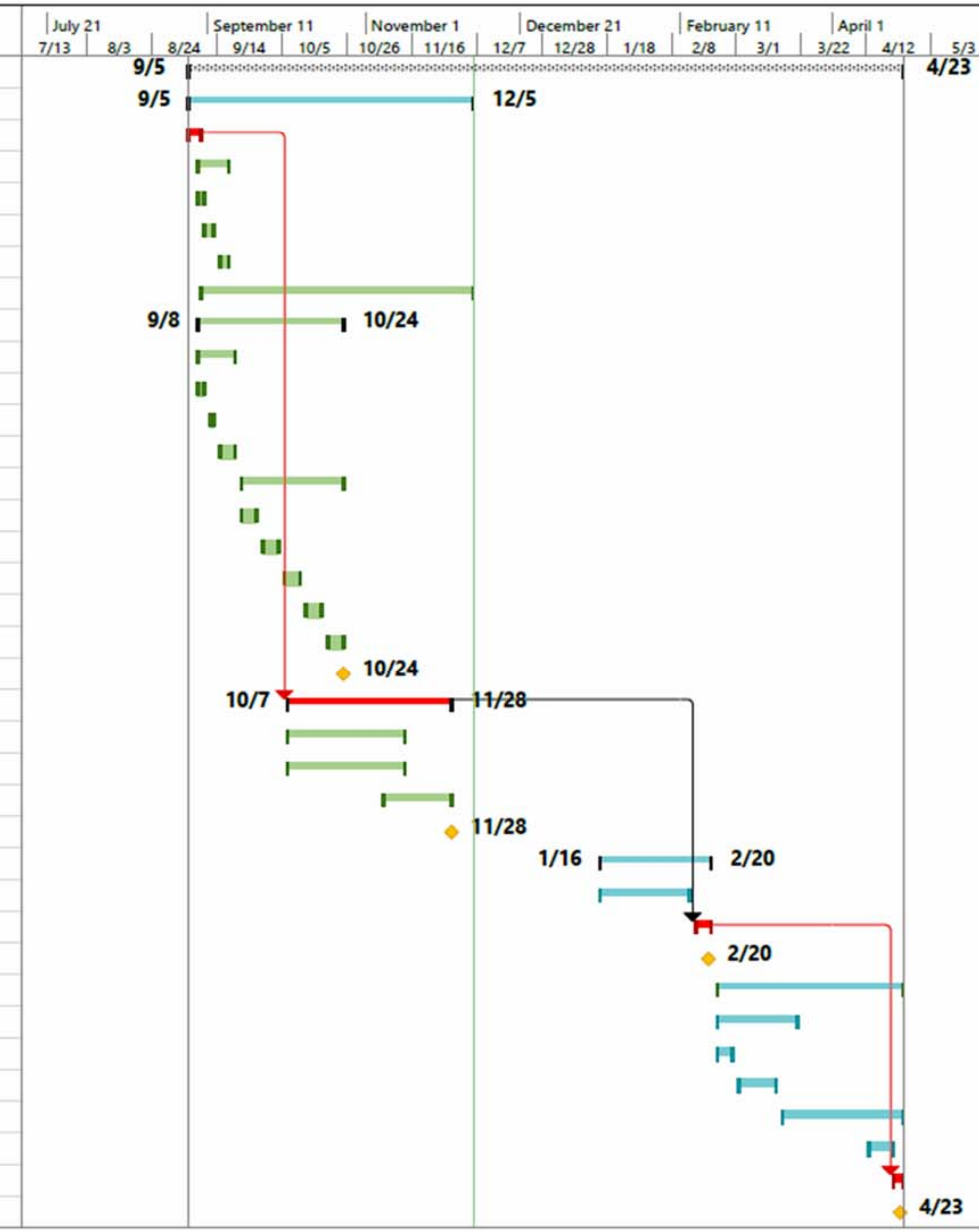
NOTES:	DESIGNED	Northern Arizona Trans Services CENE 486C Final Report	REVISION DATE 05/05/15
			SCALE BAR N/A
	APPROVED	Kendrick St Bicycle Boulevard Construction Notes	SHEET 31 OF 31

APPENDIX D

PROPOSED AND ACTUAL GANTT CHART

Proposed

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
0		**KendrickProjectSchedule**	**165 days**	**Fri 9/5/14**	**Thu 4/23/15**	
1		**1 Project Management**	**66 days**	**Fri 9/5/14**	**Fri 12/5/14**	
2		*1.1 Project Roles*	*2 days*	*Fri 9/5/14*	*Mon 9/8/14*	
3		*1.2 Staffing and Fees*	*8 days*	*Mon 9/8/14*	*Wed 9/17/14*	
4		1.2.1 Project Staff	2 days	Mon 9/8/14	Tue 9/9/14	
5		1.2.2 Hourly Breakdown	3 days	Wed 9/10/14	Fri 9/12/14	
6		1.2.3 Fees	3 days	Mon 9/15/14	Wed 9/17/14	
7		*1.3 Website*	*64 days*	*Tue 9/9/14*	*Fri 12/5/14*	
8		**2 Background Research**	**35 days**	**Mon 9/8/14**	**Fri 10/24/14**	
9		*2.1 Existing Conditions*	*10 days*	*Mon 9/8/14*	*Fri 9/19/14*	
10		2.1.1 Site Visit	2 days	Mon 9/8/14	Tue 9/9/14	
11		2.1.2 Client Meeting	1 day	Fri 9/12/14	Fri 9/12/14	
12		2.1.3 Crash History Data	5 days	Mon 9/15/14	Fri 9/19/14	
13		*2.2 Literature Review*	*25 days*	*Mon 9/22/14*	*Fri 10/24/14*	
14		2.2.1 Flagstaff Codes	5 days	Mon 9/22/14	Fri 9/26/14	
15		2.2.2 ADOT Codes	5 days	Mon 9/29/14	Fri 10/3/14	
16		2.2.3 AASHTO Codes	5 days	Mon 10/6/14	Fri 10/10/14	
17		2.2.4 MUTCD Codes	5 days	Mon 10/13/14	Fri 10/17/14	
18		2.2.5 Relevant Literature	5 days	Mon 10/20/14	Fri 10/24/14	
19		*2.3 Research Completed*	*0 days*	*Fri 10/24/14*	*Fri 10/24/14*	
20		**3 Data Collection**	**39 days**	**Tue 10/7/14**	**Fri 11/28/14**	2
21		*3.1 Volume Counts*	*28 days*	*Tue 10/7/14*	*Thu 11/13/14*	
22		*3.2 Speed Analysis*	*28 days*	*Tue 10/7/14*	*Thu 11/13/14*	
23		*3.3 Turning Movement Counts*	*16 days*	*Fri 11/7/14*	*Fri 11/28/14*	
24		*3.4 Data Collection Completed*	*0 days*	*Fri 11/28/14*	*Fri 11/28/14*	
25		**4 Data Analysis**	**26 days**	**Fri 1/16/15**	**Fri 2/20/15**	
26		*4.1 Software Analysis*	21 days	Fri 1/16/15	Fri 2/13/15	
27		*4.2 Warrant Analysis*	5 days	Mon 2/16/15	Fri 2/20/15	20
28		*4.3 Data Analysis Completed*	0 days	Fri 2/20/15	Fri 2/20/15	
29		**5 Design**	**44 days**	**Mon 2/23/15**	**Thu 4/23/15**	
30		*5.1 Community Input*	20 days	Mon 2/23/15	Fri 3/20/15	
31		*5.2 Pedestrian Accessibility*	5 days	Mon 2/23/15	Fri 2/27/15	
32		*5.3 Traffic and Bike Right of Way*	10 days	Mon 3/2/15	Fri 3/13/15	
33		*5.4 Roadway and Striping Design*	29 days	Mon 3/16/15	Thu 4/23/15	
34		*5.5 Other Recommendations*	6 days	Mon 4/13/15	Mon 4/20/15	
35		5.6 Broad Impacts of Design	3 days	Tue 4/21/15	Thu 4/23/15	27
36		*5.7 Design Complete*	0 days	Thu 4/23/15	Thu 4/23/15	

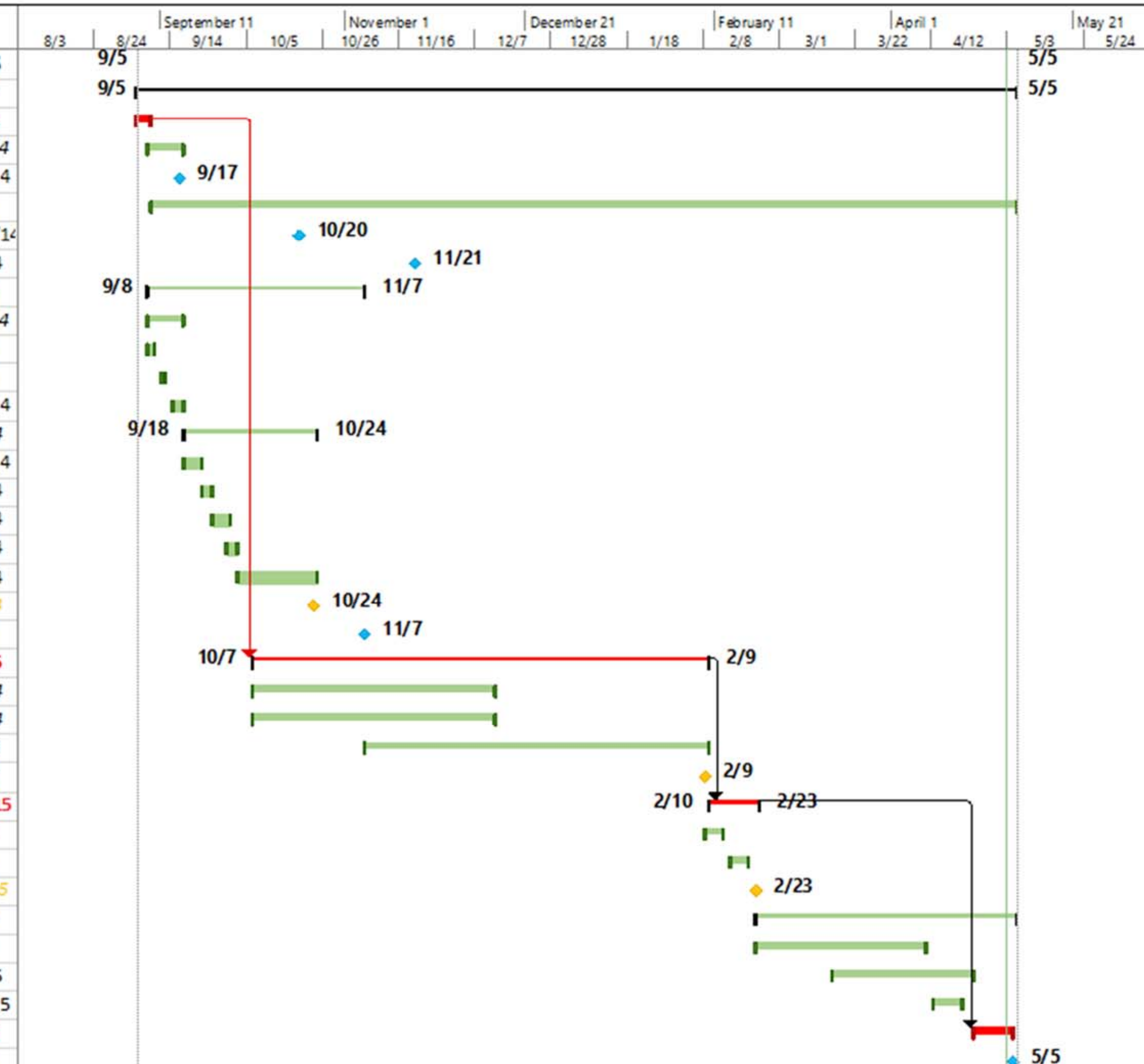


Project: KendrickProjectSchedu
Date: Sat 12/6/14

Completed Tasks to Date
Uncompleted Tasks to Date
Critical Tasks
Project Summary
Task Summary Format
Subtask Summary Format
Subsubtask Summary Format
Milestone

Actual

ID	Task Mode	Task Name	Duration	Start	Finish
0		**KendrickProjectScheduleFinal**	**173 days**	**Fri 9/5/14**	**Tue 5/5/15**
1		**1 Project Management**	**173 days**	**Fri 9/5/14**	**Tue 5/5/15**
2		*1.1 Project Roles*	*2 days*	*Fri 9/5/14*	*Mon 9/8/14*
3		*1.2 Staffing and Fees*	*8 days*	*Mon 9/8/14*	*Wed 9/17/14*
7		*1.3 Project Understanding Memo Complete*	0 days	Wed 9/17/14	Wed 9/17/14
8		*1.4 Website*	*171 days*	*Tue 9/9/14*	*Tue 5/5/15*
9		*1.5 Scope & Schedule Memo Complete*	0 days	Mon 10/20/14	Mon 10/20/14
10		*1.6 Staffing and Cost of Services Memo Complete*	0 days	Fri 11/21/14	Fri 11/21/14
11		**2 Background Research**	**44 days**	**Mon 9/8/14**	**Fri 11/7/14**
12		*2.1 Existing Conditions*	*8 days*	*Mon 9/8/14*	*Wed 9/17/14*
13		2.1.1 Site Visit	2 days	Mon 9/8/14	Tue 9/9/14
14		2.1.2 Client Meeting	1 day	Fri 9/12/14	Fri 9/12/14
15		2.1.3 Crash History Data	3 days	Mon 9/15/14	Wed 9/17/14
16		*2.2 Literature Review*	*27 days*	*Thu 9/18/14*	*Fri 10/24/14*
17		2.2.1 Flagstaff Codes	3 days	Thu 9/18/14	Mon 9/22/14
18		2.2.2 ADOT Codes	3 days	Tue 9/23/14	Thu 9/25/14
19		2.2.3 AASHTO Codes	3 days	Fri 9/26/14	Tue 9/30/14
20		2.2.4 MUTCD Codes	3 days	Tue 9/30/14	Thu 10/2/14
21		2.2.5 Relevant Literature	16 days	Fri 10/3/14	Fri 10/24/14
22		*2.3 Research Completed*	*0 days*	*Fri 10/24/14*	*Fri 10/24/14*
23		*2.4 Background Research Memo Complete*	0 days	Fri 11/7/14	Fri 11/7/14
24		**3 Data Collection**	**90 days**	**Tue 10/7/14**	**Mon 2/9/15**
25		*3.1 Volume Counts*	*49 days*	*Tue 10/7/14*	*Fri 12/12/14*
26		*3.2 Speed Analysis*	*49 days*	*Tue 10/7/14*	*Fri 12/12/14*
27		*3.3 Turning Movement Counts*	*67 days*	*Fri 11/7/14*	*Mon 2/9/15*
28		*3.4 Data Collection Completed*	*0 days*	*Mon 2/9/15*	*Mon 2/9/15*
29		**4 Data Analysis**	**10 days**	**Tue 2/10/15**	**Mon 2/23/15**
30		*4.1 Software Analysis*	5 days	Mon 2/9/15	Fri 2/13/15
31		*4.2 Warrant Analysis*	5 days	Mon 2/16/15	Fri 2/20/15
32		*4.3 Data Analysis Completed*	*0 days*	*Mon 2/23/15*	*Mon 2/23/15*
33		**5 Design**	**52 days**	**Mon 2/23/15**	**Tue 5/5/15**
34		*5.1 Community Input*	35 days	Mon 2/23/15	Fri 4/10/15
35		*5.2 Roadway and Striping Design*	29 days	Mon 3/16/15	Thu 4/23/15
36		*5.3 Other Recommendations*	6 days	Mon 4/13/15	Mon 4/20/15
37		5.4 Broader Impacts of Design	7 days	Fri 4/24/15	Mon 5/4/15
38		5.5 Final Design Report Complete	0 days	Tue 5/5/15	Tue 5/5/15



Project: KendrickProjectSchedu
Date: Sun 5/3/15

Completed Tasks to Date	Uncompleted Tasks to Date	Subtask Summary Format	Memo/Report Milestone
Project Summary	Critical Tasks	Subsubtask Summary Format	Design Milestone