

Draft Report



INTERSTATE 94 AND SUNSET DRIVE INTERCHANGE
PRELIMINARY ENGINEERING AND FEASIBILITY
STUDY

PROJECT NUMBER 1-094(231)152, PCN 23594

June 1, 2023

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1. Introduction

This report documents and evaluates the suggested alternatives for the Interstate 94 and Sunset Drive Interchange Preliminary Engineering and Feasibility Study. The purpose of this study is to provide an evaluation and understanding of the proposed improvements to the interchange. Improvements will be necessary to accommodate the anticipated increased travel demands resulting from continued growth of Mandan, north and west of the study area, and from a future extension of the Sunset Drive. This document discusses the potential improvements to the interchange while explaining current and projected roadway conditions.

2. Project Background and Justification

The City of Mandan, across the Missouri River from Bismarck, ND, continues to grow. Current plans for expansion include construction of a new high school facility, an increase of over 300 single family residential units, 6 commercial lots, and urban street reconstruction, all within 5 miles of the I-94 at Sunset Drive interchange. Additionally, the approved Master Plan calls for the future extension of Sunset Drive between 31st and 38th Street and additional growth, primarily on the easterly side on Sunset Drive. The goal of this study is to determine the feasibility of various reconstruction alternatives to the Sunset Drive interchange along Interstate 94, which will be carried forward into the Preliminary Engineering and Environmental review phases of the project.

The interchange of Interstate 94 and Sunset Drive currently functions as a conventional diamond rural interchange consisting of two signal-controlled intersections at the ramp termini. Sunset Drive is a 2-lane undivided principal arterial roadway that carries less than 15,000 vehicles per day beneath Interstate 94. The I-94 bridges over Sunset Dr are functionally obsolete and have aging components, such as low overhead clearance, which may necessitate rehabilitation or replacement in the upcoming years. With the projected growth and aging bridge infrastructure, improvements will be needed to the Sunset Drive corridor and in particular the Sunset Drive at I-94 interchange.

The performance goals of this project are to mitigate future expected congestion due to additional traffic from Sunset Drive and growth of north Mandan, as well as improve safety at the interchange. This study will recommend improvements and give guidance on timing to assist the sNorth Dakota Department of Transportation staff with planning and budgeting for any recommended improvements at the interchange.

It should be noted the Sunset Drive corridor has two ongoing independent studies. North Dakota Department of Transportation (NDDOT) is leading the Interstate 94 (I-94) and Sunset Drive Interchange Preliminary Engineering & Feasibility Study (this study), which focuses on interchange improvements / reconfigurations. The Bismarck-Mandan Metropolitan Planning Organization along with the City of Mandan are studying Sunset Drive in Mandan for potential traffic and safety improvements as part of the Sunset Drive Corridor Study.

3. Study Area

This study concentrates on the interchange of I-94 and Sunset Drive in the city of Mandan, ND. The logical termini of the study extends north along Sunset Drive, beginning at 18th Street, to Overlook Lane. Along I-94 the study area begins on the west at adjacent interchange at ND 25 continues easterly to the adjacent interchange at Mandan Avenue. A segment of Old Red Trail at the intersection of Sunset Drive, north of the study interchange and Boundary Street NW at the intersection of Sunset Drive will also be included in the analysis. The full extents of the study area are shown in Figure 1 and the primary study interchange is shown in Figure 2.

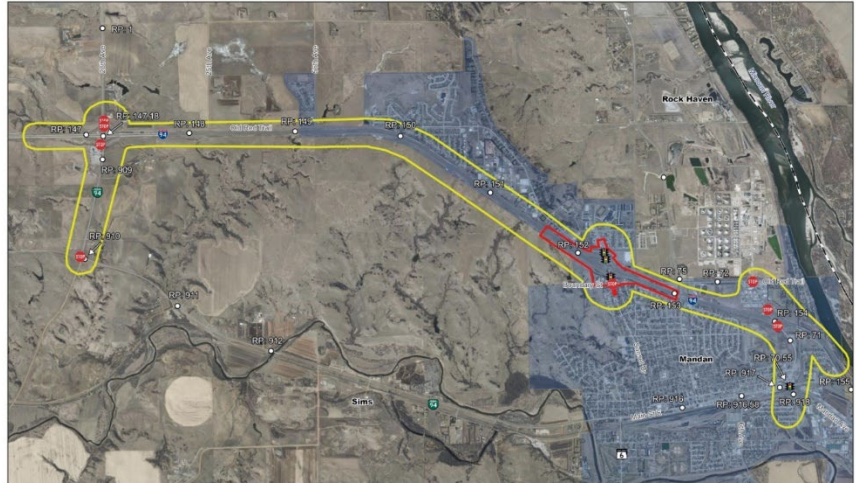


FIGURE 1: STUDY AREA

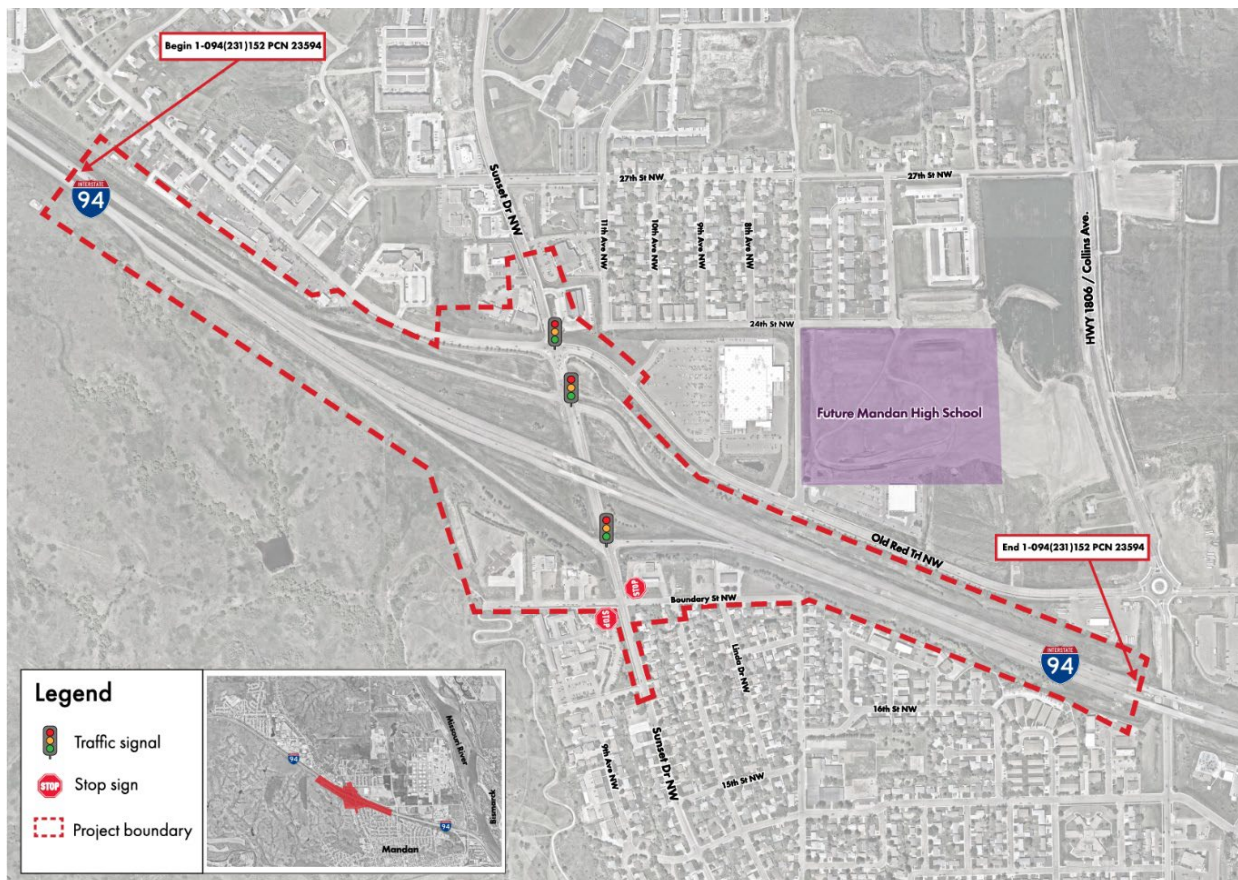


FIGURE 2: STUDY INTERCHANGE – INTERSTATE 94 AND SUNSET DRIVE

4. Existing Conditions

A. Project Area

INTERSTATE 94

Interstate 94 is an urban interstate highway running due east-west from approximately R.P. 147 through R.P. 150, then turns to a west-northwest-east-southeast orientation from R.P. 150 to R.P. 154.5. The posted speed limit is 75 mph west of R.P. 151, and 60 mph east of that point. The cross-section is 4-lane interstate highway section with dual 12-foot travel lanes, a 4-foot left shoulder, and 10-foot right shoulder in each direction. The travel lanes are separated by a 60' grassy median as measured between inside edges of the travel lanes. Construction for the original roadway started in 1963, with completion in 1965. Major rehabilitation projects occurred in 1999 and in 2019. The typical section of I-94 through the study area is shown in Figure 3.



FIGURE 3: INTERSTATE 94 TYPICAL SECTION

SUNSET DRIVE

Sunset Drive is a principal arterial south of the I-94 interchange, and a collector roadway north of the interchange. From Boundary Street, proceeding north, the pavement widens from 34-foot to 56-foot wide by the time it reaches Old Red Trail. The posted speed limit along Sunset Drive is 25 mph. The cross-section changes from two-lane, two-way at Boundary Street, to a 3-lane section at the I-94 EB ramps, to a 4-lane section at the I-94 WB ramps and at the Old Red Trail intersections. The typical section of Sunset Dr under the I-94 bridge is shown below in Figure 4, and the section between the I-94 WB ramp terminal and Old Red Trail is shown in Figure 5.



FIGURE 4: SUNSET DRIVE TYPICAL SECTION UNDER INTERSTATE 94

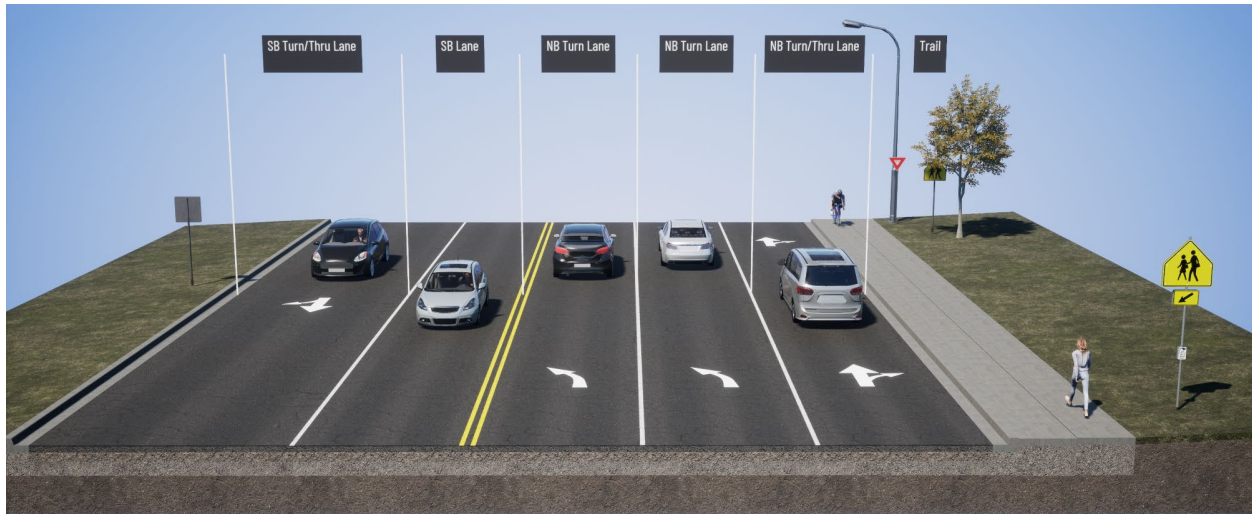


FIGURE 5: SUNSET DRIVE TYPICAL SECTION NORTH OF INTERSTATE 94

OLD RED TRAIL

Old Red Trail is a minor arterial north of the I-94 interchange. The posted speed limits are 35 mph east of Sunset Drive, and 25 mph west of Sunset Drive. The pavement has a 44-foot width east of Sunset Drive and is striped as a 3-lane cross-section. The pavement has a 48-foot width west of Sunset Drive and is striped for a 4-lane cross-section with no median. Old Red Trail runs concurrently with State Highway 1806 to the east and is a principal arterial for the length of the route concurrence.

BOUNDARY STREET NW

Boundary Street is a local roadway with a 32-foot-wide cross-section. It operates as a two-lane, two-way street, with parking on the EB approach to Sunset Drive. The posted speed limit is 25 mph, and the street intersects Sunset Drive south of the I-94 interchange as the minor street of a two-way-stop-controlled (TWSC) intersection.

B. Multi-model options

"Improve the continuity of the multimodal systems for pedestrians, cyclists, or transit riders; through improved network connections and reduction of system gaps."

Bis-Man MPO

Arrive 2045

Objective 3c

Multimodal Options

- Bis-Man Transit
- City of Mandan Parks and Recreation (Trails)
- City of Mandan (Sidewalk)

Key Components

- The Bis-Man Transit purple route currently utilizes Old Red Trail and Sunset Drive within the project area (shown below). The route provides stops at Mandan Walmart and the current Mandan High School, south of interstate 94.. City of Mandan Parks and Recreation Mandan has 25 to 30 miles of paved recreation trails including trails on Sunset Drive, Old Red Trail and Boundary Street.

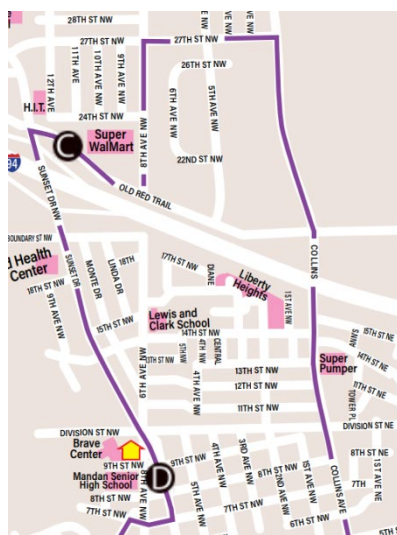


FIGURE 6: BIS-MAN TRANSIT PURPLE ROUTE

Through the Sunset Drive corridor, there is a 10-foot-wide combined use bike path and sidewalk running along the east side of Sunset Drive, separated by a 5-foot-wide grass terrace. The path crosses to the west side at Boundary Street, and ties into the path along the south side of Old Red Trail. Pedestrian and trail users cross the I-94 ramps and the Sunset Drive at Old Red Trail intersection using pedestrian signals, pushbuttons and at-grade marked crosswalks. Figure 7 shows the multi-use trail through the corridor. The Bis-Man Transit – Purple Route also travels through the corridor in Figure 6 and Figure 7.

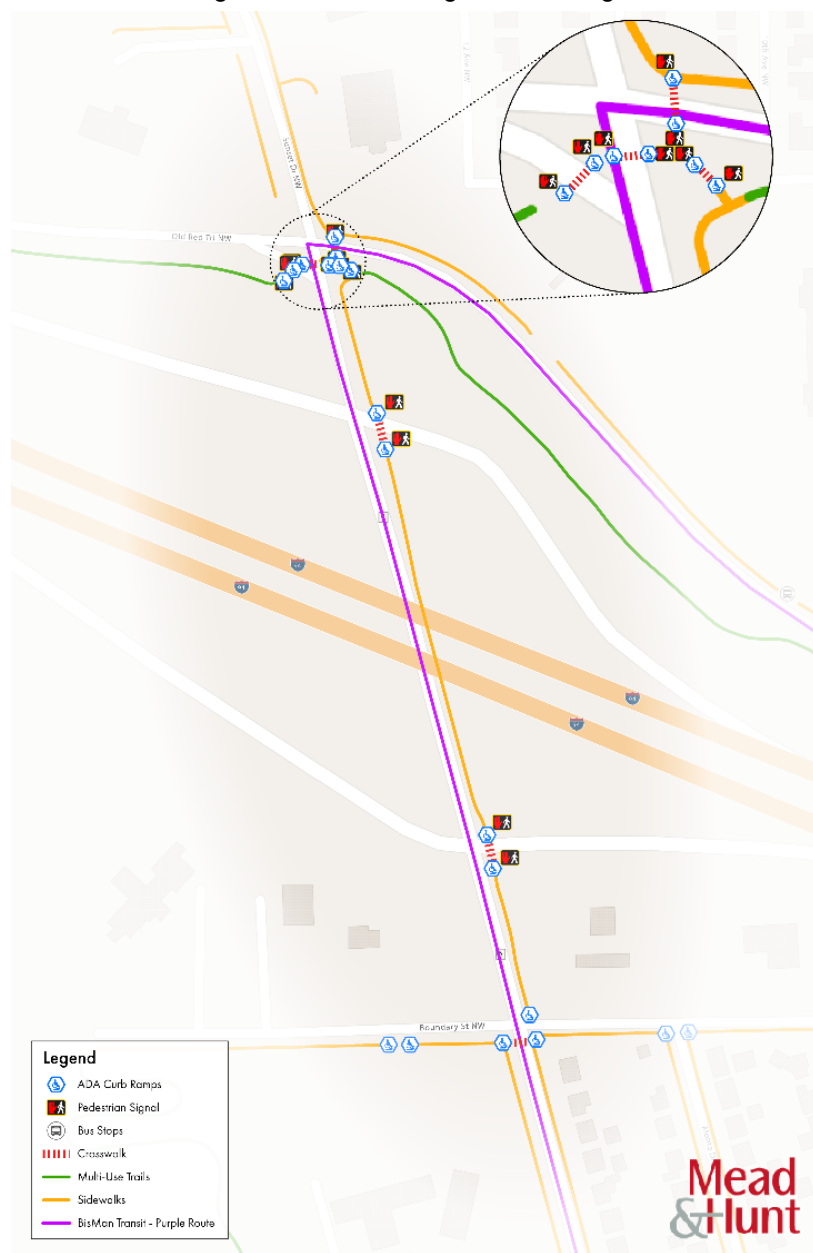


FIGURE 7: MULTI-MODEL OPTIONS ALONG SUNSET DRIVE

C. Land Use

The City of Mandan adopted the Land Use Plan in 2015, which defined future land uses within the study area, shown in Figure 9. Along with the existing commercial, residential, and industrial land uses, future industrial, commercial, and commercial/industrial uses were defined. The Future Land Use Plan also defined potential growth phasing scenarios adjacent to the study area, see Figure 8.

Growth of industrial land uses was identified in the northwest quadrant of the study area interchange within the next 30 years. Additionally, commercial/residential growth was identified to the north and west of Sunset Drive within the next 10, 20, and 30 years.

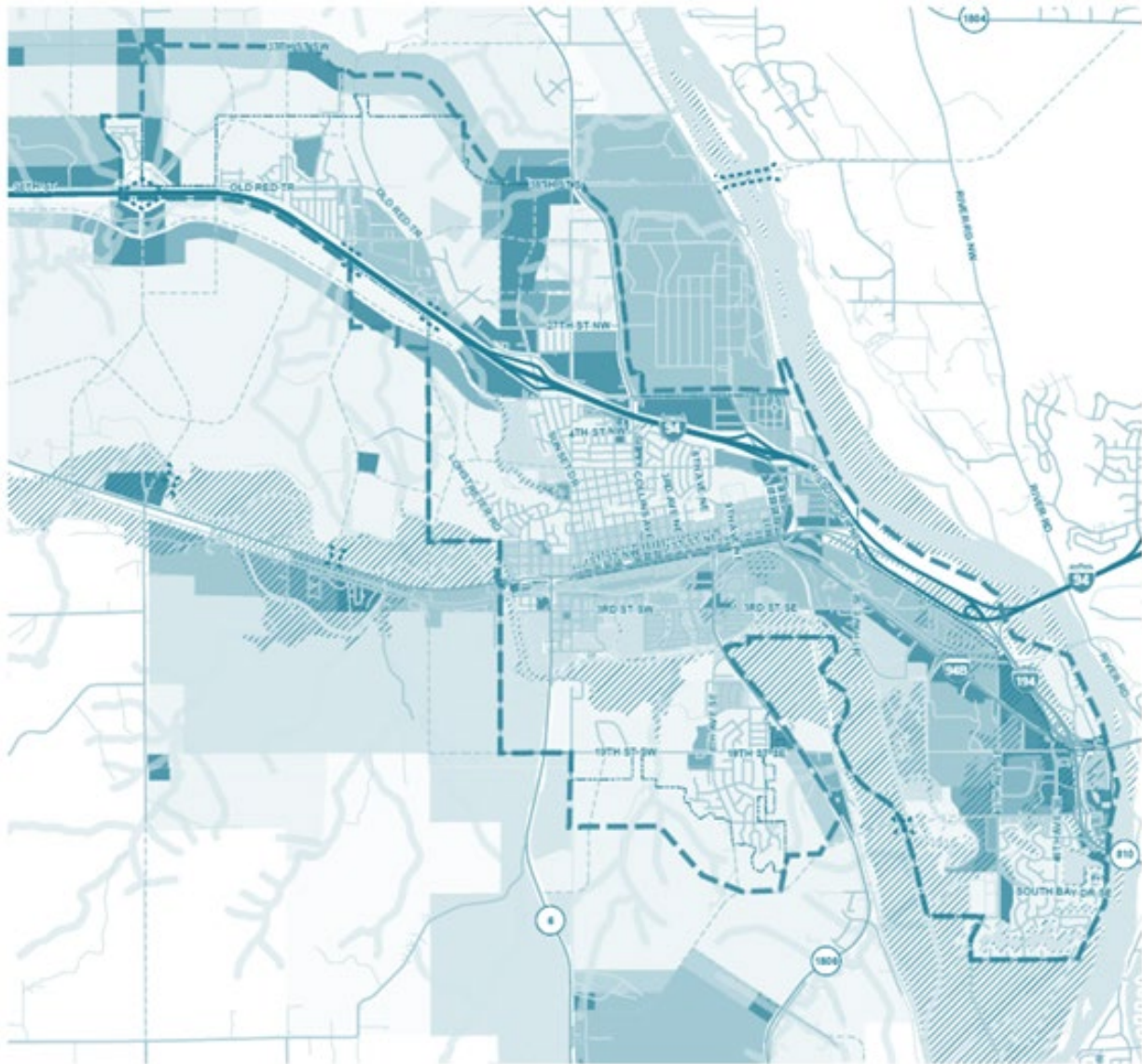
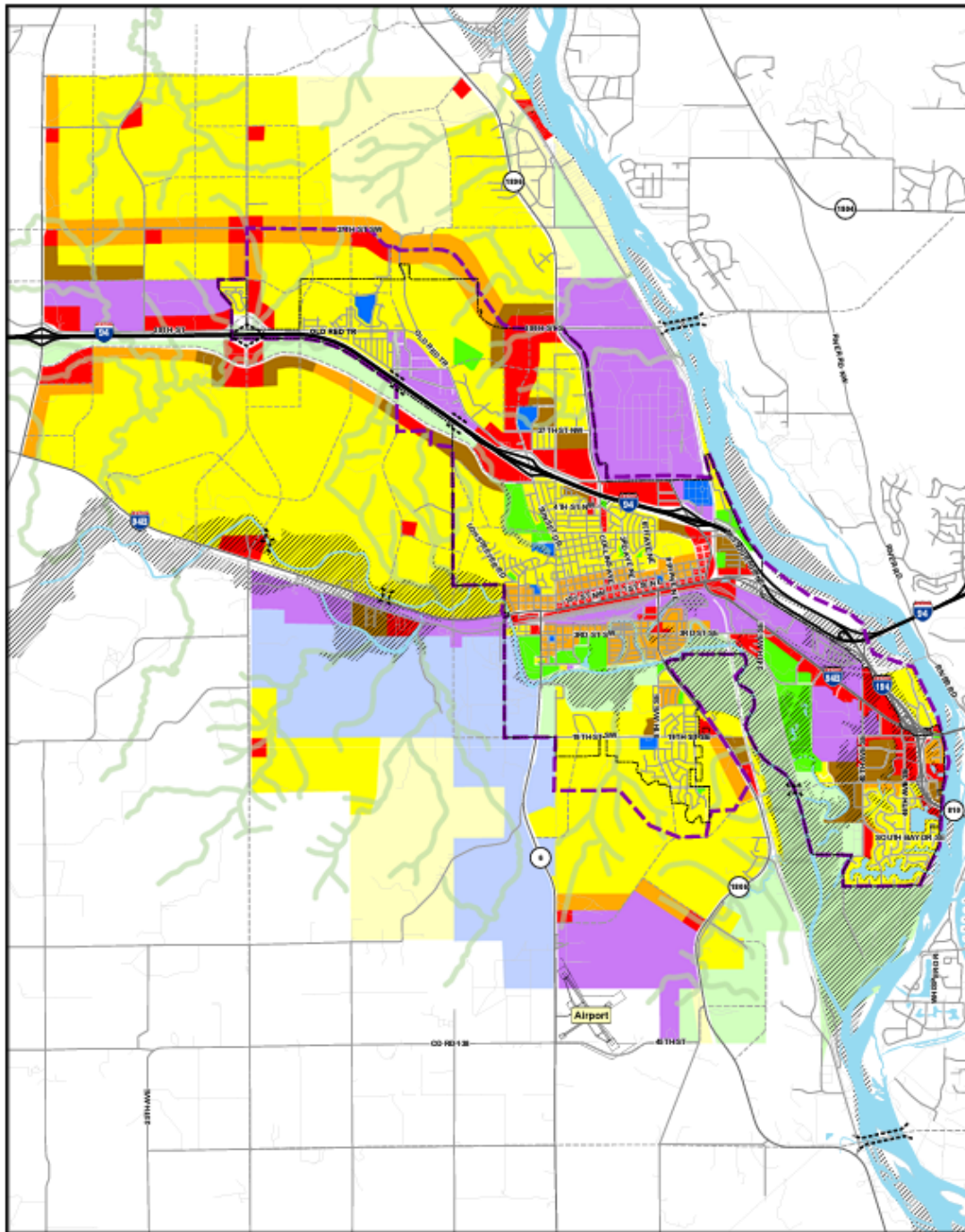


FIGURE 8: GROWTH PHASING ADJACENT TO STUDY INTERCHANGE



Planned Future Land Use

City of Mandan, North Dakota

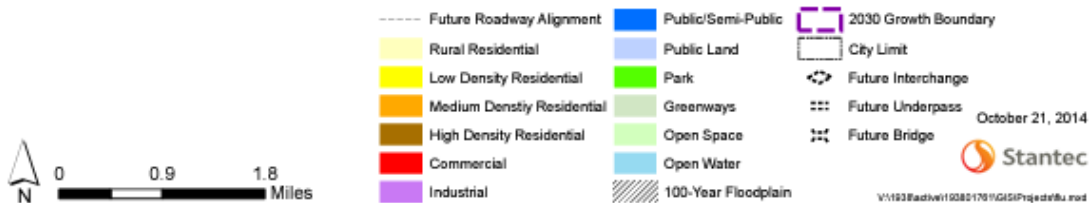


FIGURE 9: CITY OF MANDAN PLANNED FUTURE LAND USE

D. Traffic Data

Intersection Turning Movement Counts (TMCs) were collected on site at 12 different intersections within the study area in the Fall of 2022. Each turning movement count was conducted over a 24-hour period, and the data was analyzed to determine the peak hour volumes for both the AM and the PM peak periods.

Average daily traffic counts along freeway and arterial segments were also conducted during the same period. The counts collected vehicle classification data, volume data, and speed data for the 7-day period above for 15 different locations, including each of the interchange ramps. The data was used in conjunction with the TMCs to verify the peak periods.

Additionally, crash data from the years 2017 through 2022 was requested and provided from NDDOT for the study area intersections and segments.

E. Safety

A detailed breakdown of the crash locations, types, and adverse conditions that may have contributed and crash diagrams for study area, along with each intersection, can be found in the traffic operations report. Below is a summary of the findings related to study interchange.

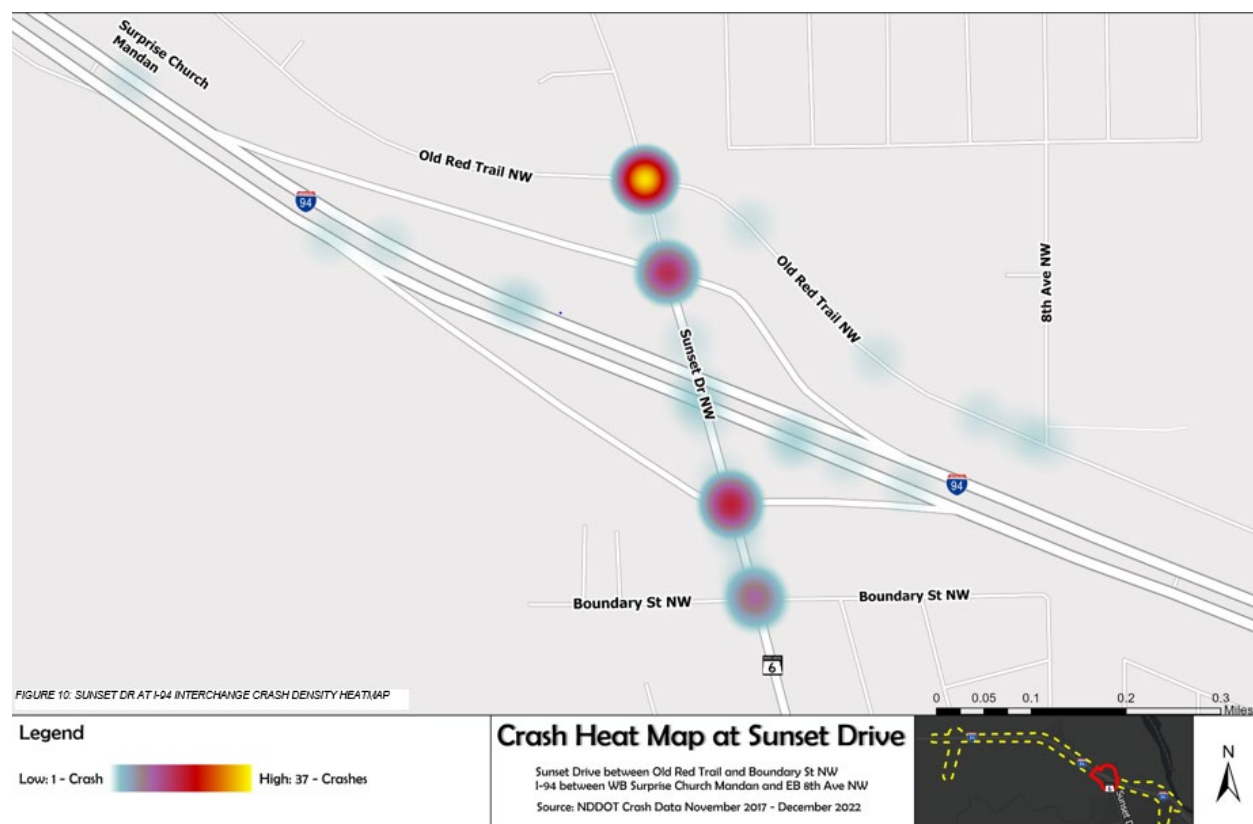


FIGURE 10: CRASH HEAT MAP OF SUNSET DRIVE

(1) Sunset Drive Corridor

Over the period from 2017 to 2022, there were 95 reported crashes along Sunset Drive between Boundary Street and Old Red Trail. Of those crashes, 84 were reported at the intersections within the corridor. Additionally, a crash heat map of Sunset Drive is shown in Figure 10 and a summary of crashes appear in Table 1 below.

Most crashes were property damage only, rear-end type collisions. Detailed review of the crashes gives a better indication where weather conditions, time of day, and roadway surface conditions contributed, in addition to roadway geometry and traffic control. It was noted that the number of crashes decreased in 2020 and 2021, which is likely attributable to the COVID-19 pandemic related shutdowns, and the resultant lower overall traffic volumes caused by persons working remotely and/or being unemployed. The number of crashes in 2017 and 2022 should not be considered for any type of regression analysis as neither year is indicative of the entire calendar year. The crash volumes and patterns do not indicate that there is any specific geometry or traffic control issue at this intersection.

Table 1: Summary of Sunset Drive Corridor Crashes

Year		# Crashes
2017		4
2018		29
2019		25
2020		11
2021		17
2022		9
Crash Type		# Crashes
Left Turn		7
Sideswipe		5
Rear End		57
Angle		15
Single Vehicle		8
Other		3
Injury/Fatality/Damage		# Crashes
Injury		24
Property Damage Only (PDO)		71
Roadway Surface		# Crashes
Dry		61
Wet		7
Snow/Ice		27
Weather		# Crashes
Sunny / Clear		77
Cloudy / Overcast		9
Precipitation		9
Time of Day		# Crashes
Day		77
Night / Dawn / Dusk		18

(2) I-94 Corridor

Over the period from 2017 to 2022, there were 72 reported crashes along I-94 between R.P. 147.2 and 154.5. These are mainline crashes only, and do not include crashes along the ramps. The I-94 crashes are summarized in Table 2.

TABLE 2: SUMMARY OF I-94 CORRIDOR CRASHES

Year	# Crashes
2017	7
2018	7
2019	27
2020	10
2021	15
2022	6
Roadway Surface	# Crashes
Dry	38
Wet	4
Snow/Ice	30

There was a greater prevalence of single-vehicle crashes along I-94. There is a correlation between the increase in 2019 crashes and the number of crashes involving slick pavement; both were higher, particularly west of Sunset Drive. As Sunset Drive is where the land uses generally change from urban to rural, it is possible that this contributed to the extra 2019 crashes during inclement weather. As noted with the Sunset Drive crash rate, the pandemic had an impact in 2020 and 2021 crash volumes. Also, 2017 and 2022 do not represent full calendar year data.

F. Freight Mobility

North Dakota has developed the “North Dakota Strategic Freight System Index”, shown below, that classifies “freight transportation infrastructure necessary to sustaining the state’s economic growth and competitiveness relative to International/Interstate, Regional/Intrastate, and Local movements of freight”

North Dakota Strategic Freight System Index

Freight Mode	<u>Level One</u> Critical Rural Freight Corridors International/Interstate	<u>Level Two</u> Regional/Intrastate	<u>Level Three</u> Local
Roads	Interstate & Interregional Highways Congressional Designated High Priority Corridors STRAHNET National Truck Network Energy/Agricultural Access Corridors High Truck Volume Segments Principal Arterials	State Corridors District Corridors Limited County Major Collectors City Principal Arterials	District Collectors Some County, City, Township and Tribal Roads

The Freight Mode of the roadways within the study area are identified as follows:

Interstate 94:	Strategic Highway Freight Level 1
HWY 1806 (Collins Ave):	Strategic Highway Freight Level 3 (Restricted Route Old Red Trail to north)
Sunset Drive:	Adopted Urban Strategic Freight Level 3
Old Red Trail:	Adopted Urban Strategic Freight Level 2 (Restricted Route Sunset Drive to Mandan Ave)

Many of the industrial land uses within the City of Mandan are located to the northwest of the Sunset Drive corridor and due to the reduced clearance beneath Interstate 94 at Sunset Drive, utilize the Mandan Avenue Interchange and TH25 Interchange to gain access to Interstate 94. These uses depend on passenger vehicles to enter their sites, but also depend on heavy commercial vehicles for delivery and shipment of various products. Cloverdale Foods, Pepsi-Cola, Mor-Gran-Sou Electric Co-op and Walmart are a few of the businesses adjacent to the study area that depend on heavy commercial traffic movement.

The study also reviewed past “oversized/overweight” (OSOW) permits for the study area. In general, it was found that most permitted loads utilized the TH 25 or Mandan Avenue Interchanges to access or depart from Interstate 94. It is anticipated a reconstruction scenario that increases the vertical clearance over Sunset Drive would increase the potential for these trips to occur in the future and should be considered in the future phases of the project.

G. Structures

The existing Sunset Drive Interchange consists of two 3-span continuous steel girder bridges (Bridge Numbers 0094-152.329 L/R) that carry I-94 over Sunset Drive. Each bridge has an overall length of approximately 165 feet and clear roadway width of 37 feet for two 12-foot lanes, a three foot inside shoulder, and a ten foot outside shoulder. The bridge is skewed approximately 37 degrees to the roadway such that the substructures are parallel to Sunset Drive. The bridges are not load posted and are reported to have an Operating Rating of 64.2 and Inventory Rating of 38.4 using Load Factor methodology.



FIGURE 11: PROFILE VIEW OF THE SUNSET DRIVE INTERCHANGE BRIDGES FROM THE SOUTH (11/9/2022)

The steel girders are supported by two parapet abutments and two multi-column piers. The concrete piers are located immediately behind the Sunset Drive curb-and-gutter and provide a clear roadway width of approximately 40-feet. The roadway below the bridge is currently striped for two thru lanes and one left turn lane. The vertical clearance is posted at 14'-2" which has contributed to multiple bridge hits over the bridge's life. The appraisal rating for NBI item 69, vertical and horizontal under clearances, is 3 indicating the condition is "basically intolerable requiring high priority of corrective action." Considering just the vertical clearance, the structure would receive an appraisal rating of 4 (meets minimum tolerable limits to be left in place as is) based on its posting of 14'-2" or 5 (somewhat better than minimum adequacy to tolerate being left in place as is) based on the 14.3 value of NBI Item 54, minimum vertical clearance, for the eastbound bridge. The minimum vertical clearance requirement for a new bridge in North Dakota is 16'-6".

The approach panels are tied to the bridge decks which rest on expansion joint filler separating the decks from the parapet abutment backwalls. The concrete approach roadways are also doweled into the approach panels. No expansion joints are located on the existing Sunset Drive bridges.

Sunset Drive was originally constructed with two 12-lanes centered below Span 2 of the bridges. This provided about 11.9-feet of lateral clearance to the piers. The roadway was constructed with an open ditch section and pier footings were placed at an elevation to accommodate this condition. At an unknown date, Sunset Drive was widened, and the ditch sections were filled.

Concrete slope paving protects the embankments at each abutment. The slope paving ties down immediately behind the western piers. On the east side, a trail exists between the slope paving and concrete piers. A masonry block retaining wall leads up to the bridge in the southeast quadrant, supporting the embankment and allowing for the trail to pass under the bridge. A 12-inch PVC sanitary sewer line runs parallel to Sunset Drive under the trail. Additional parallel utilities exist under both the east and west embankments.

These bridges were originally constructed in 1964 and have been rehabilitated three times. Known rehabilitations include the following:

- 1985 – Structural steel painting, construction of a concrete deck overlay, and installation of a braced double box beam rail retrofit
- 2006 – Installation of a free-standing double box beam rail retrofit, construction of a second concrete deck overlay, construction of new approach slabs, repair of concrete pedestals, and repair of concrete slope protection
- 2019 – Repair of spalls in the concrete deck, approach slab, and abutment; and resealing the joint between the approach slab and deck

According to the latest inspection report dated April 2021, the bridges are in good condition overall as defined in the National Bridge Inspection Standards. The reinforced concrete decks and concrete wearing surfaces are rated in very good condition; however some signs of deterioration are displayed. Transverse cracks with efflorescence are present on the underside of the decks as well as sealed cracks on the deck surface. Water was observed that appeared to be seeping through the joints between the abutment backwalls and the end beam.



FIGURE 12: TRANVERSE CRACKS WITH EFFLORESCENCE ON THE UNDERSIDE OF THE DECK (11/9/2022)

The superstructures are rated in good condition. The protective coating has chalked and isolated areas of paint failure or visible. Active corrosion is evident where the protective coating has failed.

Heavy corrosion is present at the bearings and protective coating effectiveness is very limited. The anchor bolts are bent towards the abutments and the beams are in contact with the backwall at each abutment. It is believed this is due to a combination of superstructure movement as well as the abutments deflecting towards Sunset Drive. Uplift is noticeable at the front of the bearings.

The substructures are rated in good condition. Isolated cracks, delamination, and spalls were observed on pedestals, backwalls and wing corners. Some settlement of the slope protection has occurred, resulting in cracked and buckled concrete.



FIGURE 13: PAINT CONDITION OF THE SOUTH FASCIA BEAM OF THE WESTBOUND BRIDGE (11/9/2022)

H. Right-of-Way

The North Dakota Department of Transportation maintains 200-feet to 980-feet of right-of-way along Interstate 94 through the study area. Additionally, NDDOT maintains approximately 80-feet to 200-feet of right-of-way along Sunset Drive North between Old Red Trail and Boundary Street NW. The established right-of-way accommodates the current roadway geometrics and conforms to current standards. Additional improvements to interchange may require the acquisition of additional right-of-way as identified on the alternative exhibits in Appendix #3.

I. Access

NDDOT manages the access control along both the Interstate 94 and Sunset Drive corridors throughout the study area. Currently all access points meet NDDOT access management requirements, other than one commercial driveway located in the northeast quadrant of the Sunset Drive and Boundary Street NW intersection. The western driveway of the Mobil Gas Station is located less than 50-feet from the Northbound Sunset Drive travel lanes and falls within NDDOT right-of-way. Currently, the Mobil station uses the western entrance for inbound truck delivery into the property. The eastern entrance is utilized for the outbound movement. This driveway falls within the functional area of the Boundary Street intersection with Sunset Drive. It is recommended by NDDOT that unsignalized accesses on the same side of the road should not lie within 325 feet of each on a roadway with a 25 MPH posted speed limit. The two driveways for the gas station are 160 feet apart. Therefore, it is recommended that consideration should be given to closing the western access consolidating all access to and from the Mobil station to the eastern driveway.

No other driveways or access points were found to conflict with any of the roadways or intersections in the study area.

J. Lighting

Existing continuous lighting along Sunset Drive is limited to north of Old Red Trail and south of Boundary Street NW. Within the interchange functional area, high mast lighting units are installed adjacent to Interstate 94 and ramps. No other lighting is provided along Sunset Drive between Old Red Trail and Boundary Street.

Complete interchange lighting provides relatively uniform lighting within the limits of an interchange, including main lanes, direct connections, ramp terminals, frontage road or crossroad intersections. NDDOT policy notes that when lighting warrants are satisfied, then complete interchange lighting may be installed at the option of NDDOT. The interchange meets Warrant 2C under Existing Conditions (with AADTs on Sunset Drive > 10,000), so complete interchange lighting would be satisfied under all alternatives.

K. Geotechnical

A geotechnical screening was completed to provide a summary of expected geotechnical conditions and risks at the site for the planned construction. The evaluation was based on the following information:

- Soil borings completed for the original construction of the bridge and interchange structures, as presented on the as-built plan sheets, Project I-94-4(10).
- North Dakota Department of Transportation (NDDOT) Design Manual.
- Historical geotechnical explorations completed near the site by Terracon.
- Available public aerial imagery, geologic, soil, and hazard maps for the site vicinity.

A summary of existing geotechnical conditions was developed and expected geotechnical risks for this site that may impact the proposed design and construction of the four interchange options that will be described in the following sections. The risk matrix, included in Appendix #1, is based on a review of sources cited above, information provided by the client, and Terracon's experience in the project vicinity. Due to limited design information for each of the alternatives, risks are not assigned to individual design options.

Additionally, the following preliminary geotechnical design considerations are summarized below for assistance in conceptual planning purposes. These considerations should be verified and revised as necessary through a geotechnical site exploration program, and engineering analysis.

- The North Dakota Department of Transportation's Bridge Design Manual was referenced to anticipate foundation types. Based on Section IV of the Design Manual, we anticipate deep foundations will likely consist of driven steel H-pile.
- Corrosive soils are anticipated at the site.
- Expansive soils are anticipated at the project site. These soil conditions may be difficult to work, and near-surface subgrade soils are expansive when subjected to an increase in water content.
- Slopes graded at 2H:1V or steeper should be assumed to require slope paving. Due to observed slope distress and anticipated soil conditions, unreinforced or protect slopes will likely need to be constructed at 3H:1V or flatter.
- Retaining walls consisting of soil nail, ground anchor and Mechanically Stabilized Earth (MSE) walls are likely appropriate for the site if designed correctly, accounting for site soils. Soil nails or ground anchor lengths may be longer than typical, or spacing may be tighter than typical, due potential creep issues from clay soils. If Cast-In-Place cantilever or gravity retaining walls are desired, consideration needs to be given to drainage aggregate and a drain tile system, otherwise these wall types may not be suitable for the site due to potential for subgrade movement (settlement or expansion).

L. Environmental Screening

Preliminary environmental screening reviewed potential resources within and adjacent to the project area. These included soils, land use, environmental justice, cultural resources, wetlands and aquatic resources,

threatened and endangered species, water quality, and floodplains. The screening process indicated the existing conditions within which project alternatives were evaluated, and potential project impacts were identified. Each of the resources evaluated were summarized and reviewed for the potential level of impact specific to the project.

SOILS AND PRIME FARMLAND

The Farmland Protection Policy Act (FPPA) is intended to minimize the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. A query of the Natural Resources Conservation Service (NRCS) Web Soil Survey (WSS) indicates the presence of prime farmland and farmland of statewide importance within the Study Area. Projects completed by a federal agency or with federal assistance are subject to the FPPA; however, FPPA does not apply for projects entirely within land already in urban development. The project site is located entirely within an already urbanized area in the City of Mandan, and therefore, FPPA does not apply.

LAND USE/SECTION 4F

The project area mostly consists of developed land. The Study Area is predominately zoned as right-of-way (ROW) with adjacent land use zoned as commercial, agricultural, and residential. Old Red Trail is a designated City bike trail within the Study Area. The Mandan Park District has a trailhead at the intersection of Sunset Drive and Old Red Trail, which was funded with federal grants. The trail and associated parcels appear to meet Section 4(f) criteria and would need to be further evaluated for potential project impacts.

VISUAL

Existing and proposed visual aesthetics would be similar. The project will not change the land use of the Study Area from existing conditions.

ENVIRONMENTAL JUSTICE/SOCIOECONOMIC

The Federal Highway Administration (FHWA) HEP-GIS and U.S. Environmental Protection Agency (EPA) EJScreen Mapping Tool indicate that the percent minority population, percent of people in poverty, number of people with disabilities, and percent of households without a car are fairly homogeneous throughout the Study Area and immediate vicinity. The residential area north of I-94 business loop and south of I-94 corridor has an increased percentage of people in poverty. Environmental justice will be considered during further evaluation of the project.

CULTURAL RESOURCES AND HISTORIC PROPERTIES

A Class I Literature review has been completed for the Study Area. There are 96 cultural resources recorded within the one-mile radius study area of the project. In addition, 80 cultural resource investigations have been conducted within the Study Area. As currently proposed, the project is not anticipated to impact any previously recorded cultural resources, because of the disturbed nature of the area-of-potential effect (APE). Additionally, the project area has been previously inventoried and additional inventories are unlikely to record resources that would meet the 50-year guidelines to be assessed for inclusion on the National Register Historic Places (NRHP) that have not been previously recorded. No NRHP properties are identified within the Study Area. The Study Area is part of the NPS Lewis and Clark National Historic Trail auto tour route. Consultation with the North Dakota State Historic Preservation Office (SHPO) will occur as part of

evaluation of the project.

AIR QUALITY

Review of the EPA Air Quality Index and FHWA HEP-GIS indicate that the current air quality in the area is considered good. There are no notable air quality concerns from the FHWA HEP-GIS tool. The Study Area is not located in a Class I area or a transportation conformity area.

NOISE

The City of Mandan municipal code and city ordinances were reviewed. The Study Area is an existing highway corridor, and project noise levels are expected to be consistent with the current use. Areas zoned as ROW do not have noise limits or time restrictions in Mandan; noise limits are set for motor vehicles.

WATER QUALITY

The North Dakota Department of Environmental Quality (DEQ) Surface Water Quality Data indicate no areas of water quality concern located in the Study Area. Construction stormwater management will be required through state permitting mechanisms.

WETLANDS AND AQUATIC RESOURCES

A query of the U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) and U.S. Geological Survey (USGS) National Hydrography Dataset (NHD) indicated no wetlands, streams, or other aquatic resources identified within the Study Area. However, desktop analysis of aerial imagery indicates the presence of five potential road ditch wetlands within the Study Area. Field aquatic resource delineations will be performed once a project alternative is selected.

THREATENED OR ENDANGERED SPECIES

The USFWS Information for Planning and Consultation (IPaC) indicated the northern long-eared bat, piping plover, red knot, whooping crane, Dakota skipper, and monarch butterfly may be present within the Study Area. The Study Area is not anticipated to provide significant habitat for rare species. The project will comply with Section 7 of the Endangered Species Act as required.

MIGRATORY BIRDS, BALD AND GOLDEN EAGLES

The Study Area is located within the range of the golden eagle. No bald or golden eagle habitat is identified in the Study Area.

WILDLIFE

According to the USFWS IPaC, no critical habitat is located within the Study Area. The closest identified critical habitat is located approximately 1.7 miles east of the Study Area.

FLOODPLAINS

The FEMA Flood Map Service Center/National Flood Hazard Data Layer show that the Study Area is not within the floodplain, but it is located near a Zone A and Zone AE floodplain (approximately 1,400 feet northeast and 800 feet southwest of the Study Area).

WILD AND SCENIC RIVERS

There are no wild and scenic rivers in North Dakota according to the National Wild and Scenic Rivers System database.

COASTAL BARRIERS/COASTAL ZONE

There are no coastal resources in the Study Area.

HAZARDOUS WASTE

According to the EPA Cleanups in My Community dataset, there are no areas of concern in the Study Area.

5. Purpose and Need

PROJECT PURPOSE

The purpose of this project is to evaluate existing conditions and develop plausible alternatives to address and improve the traffic movement efficiencies of the functional area of Exit 152 by: increasing capacity; motorized and non-motorized user mobility; safety; improving freight mobility; and reducing intersection queues and vehicle backups onto Interstate 94.

PROJECT NEED

Existing Conditions:

The need of this project is driven by increases in traffic due to growth in Mandan, north of Interstate 94. During AM and PM peak hours, the interchange experiences significant delays and long queues in traffic causing congestion that backs onto Interstate 94. There is a need to improve traffic flow through the intersections with the proximity of close traffic signals.

Deficiencies:

- Traffic operational issues at the interchange causing delays from queuing of vehicles. Primarily Westbound I-94 off-ramp to Northbound Sunset Drive traffic movements and Southbound Sunset Drive to Eastbound I-94 traffic movements.
- Traffic growth at this interchange is degrading operations with long queues during peak hours that extend onto the interstate. Most notably at the westbound off-ramp to Sunset Drive.
- The I-94 westbound ramps and Old Red Trail are separated by 325 feet. These short distances create operational challenges as queues developed during peak hours exceed the existing storage capacity at the intersections.
- By the year 2045, many traffic movements through the study area are expected to operate an unacceptable level of service E or F.
- The existing vertical clearance beneath the structure carrying Interstate 94 over Sunset Drive is substandard by more than 2 feet, limiting freight movement crossing beneath the interstate.
- The skew of Sunset Drive to Interstate 94 creates sight distance constraints at the ramp intersections to Sunset Drive.
- Drainage Issues are present in the northwest quadrant of the intersection of Boundary Street and Sunset Drive which cause water to sit on the roadway during heavy rains and snowmelt conditions.

6. Public Involvement

Public engagement is an important element of all planning processes. These efforts can help to identify and confirm existing conditions and characteristics of an area, define problems, provide potential solutions, and test recommendations. To provide input for the Sunset Drive Interchange Study at all four of these levels, a technical advisory committee was developed, and a stakeholder and public input meeting were held during project development.

TECHNICAL ADVISORY COMMITTEE

The technical advisory committee was comprised of staff from the Bis-Man MPO, NDDOT, City of Mandan, Morton County, and Federal Highway Administration (FHWA). The group was engaged throughout all stages of the project, from data collection to the final report. Steering committee members were tasked with serving as advocates for the planning process by participating in discussion and sharing project milestones within their networks. A total of three meetings were held throughout the study development to review and discuss findings:

- Meeting 1 – Field Review Meeting
- Meeting 2 – Existing conditions review
- Meeting 3 – Draft alternative review

STAKEHOLDER MEETING

A stakeholder meeting was held in April of 2023. The meeting was conducted as an in-person open house meeting format with a presentation and was intended for attendees to review alternatives and ask questions of staff. The open house was held at the Mandan Middle School to present findings and alternatives to the city officials, business owners, landowners adjacent to the interchange, and emergency services and ask for opinions of the alternatives for the study interchange.

PUBLIC INPUT MEETING

A public meeting was held in April of 2023. The meeting was conducted as an in-person open house meeting format with a presentation and available online for a fifteen-day period was intended for attendees to review alternatives and ask questions of staff. The open house was held at the Mandan Middle School to present findings and alternatives to the public and ask for opinions of the study interchange.

Table 3 below summarizes the responses received in support of the alternatives from public comment period via email, online, and in-person comments. In general, alternative #1 received the most support with a split on the option for signals or roundabouts at Old Red Trail and at Boundary Street NW. The public information summary report can be found in Appendix #2.

Table 3: Summary of Public Responses.

Alternative	Comment supporting as "PRIMARY Choice"	Comments supporting as "Secondary Choice"	Intersection Control Options	
			Signals	Roundabouts
No Build	---	---	---	---
Alternative #1 SPUI	9	3	3	3
Alternative #2 PARCLO	4	2	---	2
Alternative #3 DDI	---	---	---	---
Alternative #4 Diamond w/Roundabouts	4	3	1	1

7. Description of Alternatives

The following sections describe the interchange alternatives evaluated based on the finding from the future traffic conditions evaluations.

A. No Build

A No Build Scenario would maintain the Unmodified Existing Diamond Interchange and condition at the intersections of Old Red Trail and Boundary Street NW. The pavement would continue to deteriorate at an accelerated rate as traffic volumes continue to increase and structure over Sunset Drive would remain functionally obsolete and over time would require repair to address deteriorating condition. The existing (No Build) interchange will result in failing levels of service in not only the build year of 2030 but also the design year of 2045 as described in Section 8 of this report.

Advantages:

- Lower initial costs

Disadvantages:

- This alternative does not meet the purpose and need of the project.
- Future maintenance costs to keep this interchange operating at an acceptable level of service.
- By 2045 many intersections degrade to deficient operations.
- Continual queuing impacts to Interstate 94 operations.

B. Interchange Alternatives

This interchange will condense the diamond so that all ramps intersect with Sunset Drive at a single point under the I-94 centerline. This configuration will increase the distance between ramp intersections from Old Red Trail and from Boundary Street, allowing for greater design flexibility for the approaches to those intersections, but will require a four-span structure over Sunset Drive to accommodate the wider interchange cross-section, which is shown in Figure 15. The lane configuration of the interchange below Interstate 94 is shown below in Figure 14 and a larger version of the conceptual layout in Figure can be found in Appendix #3.

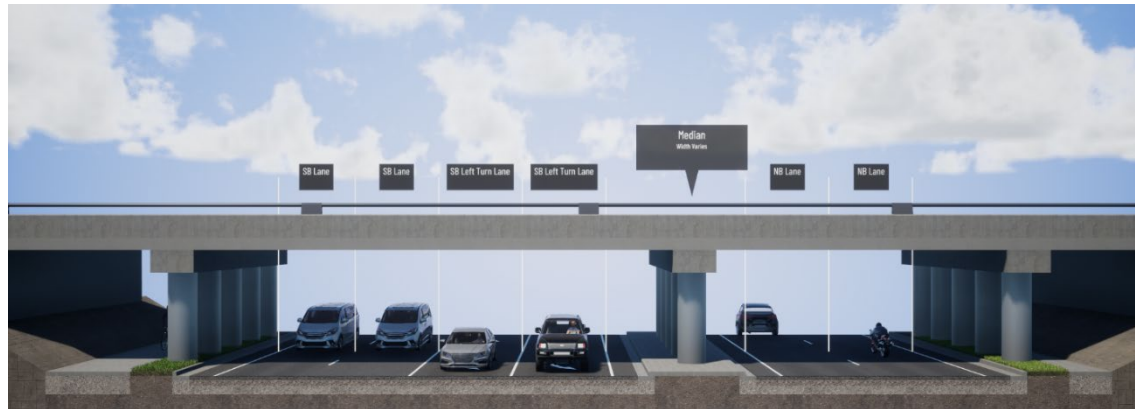


FIGURE 14: SUNSET DRIVE SPUI TYPICAL SECTION UNDER INTERSTATE 94

Advantages:

- This configuration increases the spacing between ramp intersections from Old Red Trail and from Boundary Street.
- Provides Acceptable LOS in 2045
- Improved safety with only one signalized intersection rather than two at a conventional diamond interchange, vehicles only cross paths at one location.
- Main intersection operates with three traffic signal phases rather than four phases in a conventional diamond interchange, which reduces overall interchange delay and improves efficiency.
- A single signalized intersection, rather than two intersections at a conventional diamond interchange, improves travel times along Sunset Drive.

Disadvantages:

- Requires four-span structures to carry Interstate 94 to accommodate the wider cross-section of Sunset Drive.
- Less pedestrian and bicycle friendly than other alternatives
- There would be property impacts at the Old Red Trail and Boundary Street intersections. The estimated property impacts would be up to 0.07 acres.
- Highest Cost Alternative



This interchange would construct a loop ramp in the southwest quadrant to serve the Sunset Drive southbound to eastbound Interstate 94 movement. The interchange configuration would maintain the existing on-ramp in the southeast quadrant to serve the Sunset Drive northbound to Interstate 94 eastbound movement, allowing for free-flow movements for traffic accessing I-94. The tight geometry of such a loop ramp would require an acceleration lane along I-94, whose terminus would nearly coincide with the entrance gore for the northbound-to-eastbound ramp to remain. The configuration would remove the southbound left turn to the I-94 EB on-ramp, thus simplifying the operation of the signal and removing the volume of vehicles bound for I-94 EB from the intersection. The lane configuration of the interchange is shown below in Figure 17, and the typical section under the I-94 bridge is shown in Figure 16.



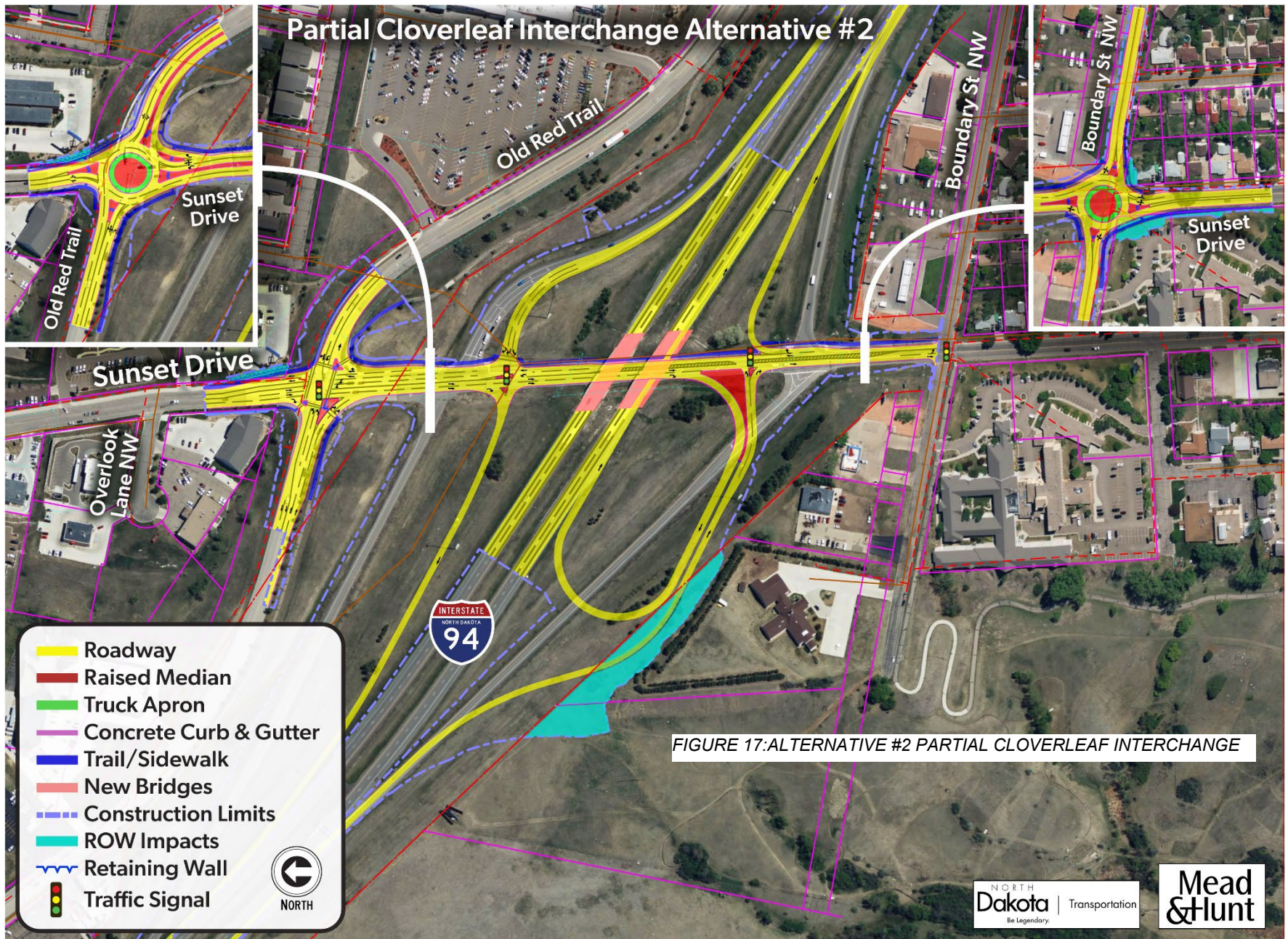
FIGURE 16: SUNSET DRIVE PARCLO TYPICAL SECTION UNDER INTERSTATE 94

Advantages:

- This alternative has the most familiar driver understanding with numerous partial cloverleaf interchange configurations located throughout North Dakota.
- Provides Acceptable LOS in 2045.
- Provides for improved operations on the crossroad by eliminating the left turn onto the eastbound Interstate 94 entrance ramp for eastbound movement.
- Easier access to freeway and improved safety by allowing southbound traffic on Sunset Drive to enter the freeway without crossing opposing northbound lanes of traffic, reducing the number of conflict points.
- A Parclo can have a narrower cross section and relatively low cost.

Disadvantages:

- This alternative has the highest right-of-way impact. There would be property impacts at the Old Red Trail and Boundary Street intersections and the southwest quadrant to accommodate the loop ramp. The estimated property impacts would be up to 1.47 acres.
- Interstate 94 eastbound off-ramp may not meet signal warrants in the build year and may operate as a stop-controlled intersection.



This interchange will replace the existing ramp intersections with new ones that allow the mainline Sunset Drive to cross over to the left side of the road, allowing for free flow left turn movements without oncoming traffic conflicts. The bridge decks would need to be lengthened to accommodate the wider interchange cross-section. Figure 19 shows the lane configuration of the interchange, and Figure 18 shows the typical section of Sunset Dr. The conceptual layout can be found in Appendix #3. The initial design and preliminary analysis results showed that the interchange would operate acceptably with the outer southbound lane dropping as an exclusive left toward I-94 EB, with one lane at the signal at the southern half of the interchange. However, further analysis showed that the queue at southbound through movement would spill back through the northern half of the interchange and affect the Old Red Trail intersection. A sensitivity analysis was performed and indicated the single through lane at the southern intersection (Sunset Dr and I-94 EB ramps) would begin to break down sometime between 2040 and 2045. It may be possible to design the DDI interchange in such a way that the interchange can initially be striped with a SB lane drop at the I-94 EB on-ramp and sometime closer to the design year be modified to include the second SB through lane at the southern crossover.

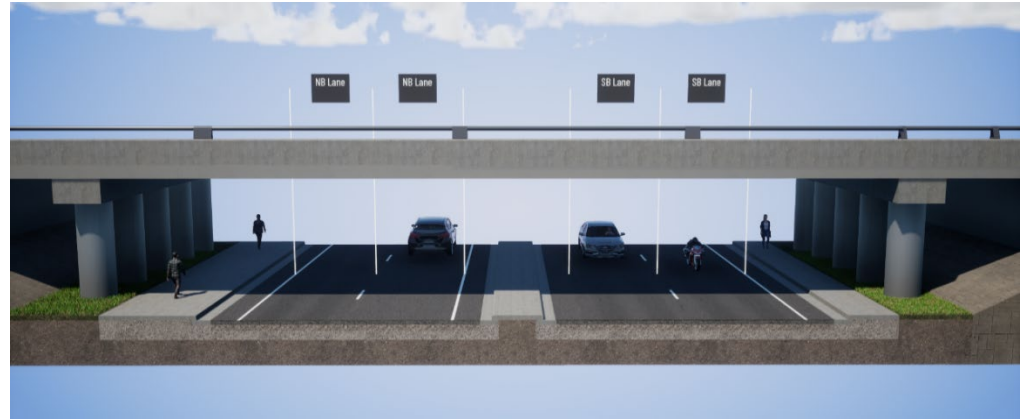


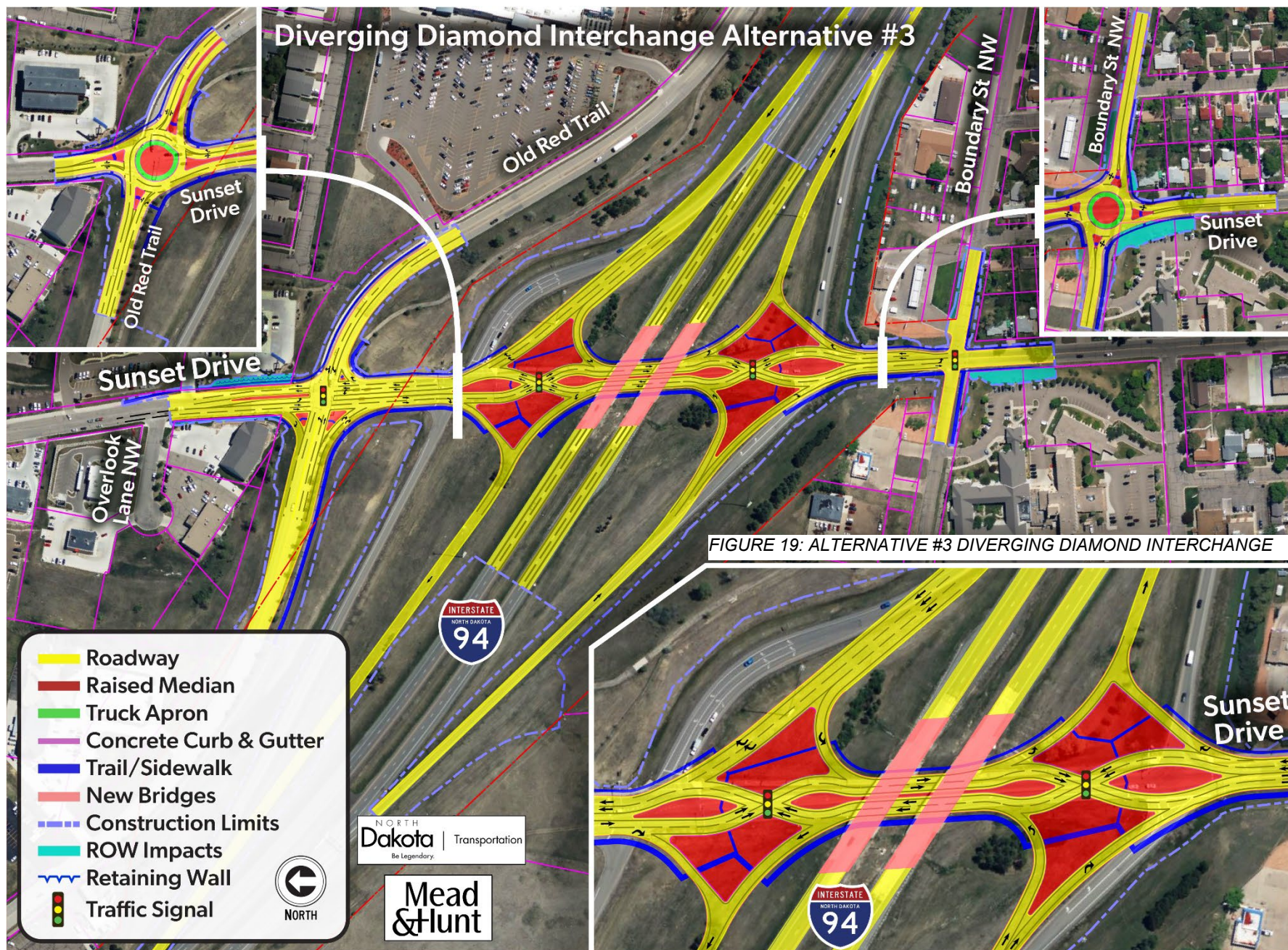
FIGURE 18: SUNSET DRIVE DDI TYPICAL SECTION UNDER INTERSTATE 94

Advantages:

- This configuration moderately increases the distance between ramp intersections from Old Red Trail and from Boundary Street.
- The alternative reduces conflicts by removing left turning movements through the signalized intersections.
- It improves operations at the interchange by no longer needing left turn phases at the traffic signals.
- Provides Acceptable LOS in 2045

Disadvantages:

- Requires additional driver education due to crossovers and complexity of the movements.
- There would be property impacts at the Old Red Trail and Boundary Street intersections. The estimated property impacts would be up to 0.40 acres.
- Second highest cost alternative
- While increasing efficiency for the ramp movement to and from Sunset Drive, the alternative increases the delay for the through movement traveling north-south along Sunset Drive.



This configuration would replace the signalized intersections of the interchange with roundabouts. This allows all traffic to operate generally with continuous flow and removes signal infrastructure, although it requires a larger footprint at the ramp terminals. The lane configurations of both roundabouts are shown in Figure 21, and the typical section of Sunset Dr is shown in Figure 20. A conceptual layout of a series of roundabouts is shown in Appendix #3 A bridge retention alternative with one northbound lane under the bridge and through the I-94 westbound ramp terminal intersection was initially evaluated. However, two northbound lanes were determined necessary between the I-94 EB ramp terminal intersection and Old Red Trail for continuity of the section with the upstream and downstream roundabouts (i.e., avoiding lane drops), simplifying northbound operation and reducing the weaving between northbound vehicles and vehicles exiting I-94 WB. It was also determined that a second northbound lane opening south of Boundary St would become necessary to mitigate queueing which would cause inadequate operation of the intersection between 2030 and 2035. With queueing issues arising and a single lane not reaching a 10+ year life, a single NB lane is not recommended as an interim design option.

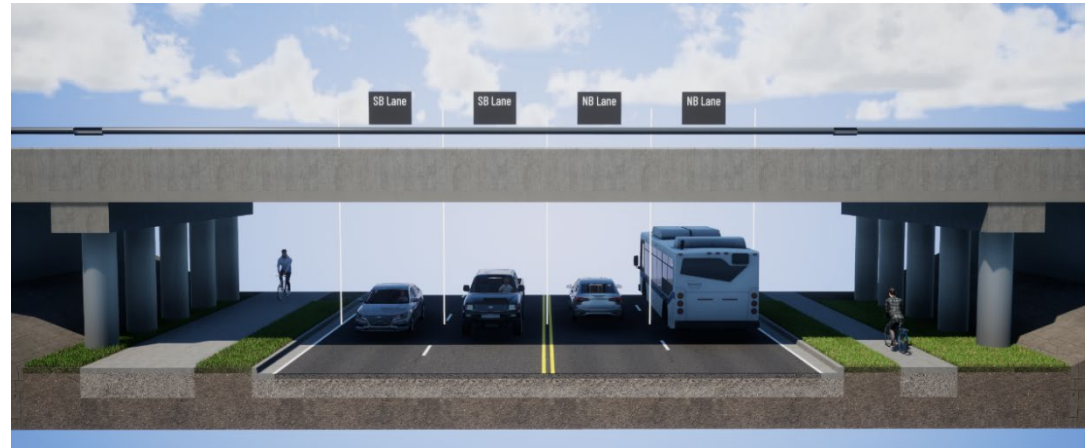


FIGURE 20: SUNSET DRIVE DIAMOND INTERCHANGE W/ROUNDABOUTS TYPICAL SECTION

Advantages:

- Potential reduction in queue lengths along Sunset Drive
- Reduces the number of points where vehicles can cross paths and eliminates the potential for right-angle and head-on crashes.
- Eliminates signal coordination between the two ramp terminals.
- Allows for a narrower bridge as it eliminates at least two turning lanes.
- No raise to the mainline profile required as the structure depths of the bridges are relatively similar.
- Lowest cost alternative

Disadvantages:

- Little to no increase in spacing between adjacent intersections.
- Queues along the WB Off-ramp may impact I-94 WB mainline operations.

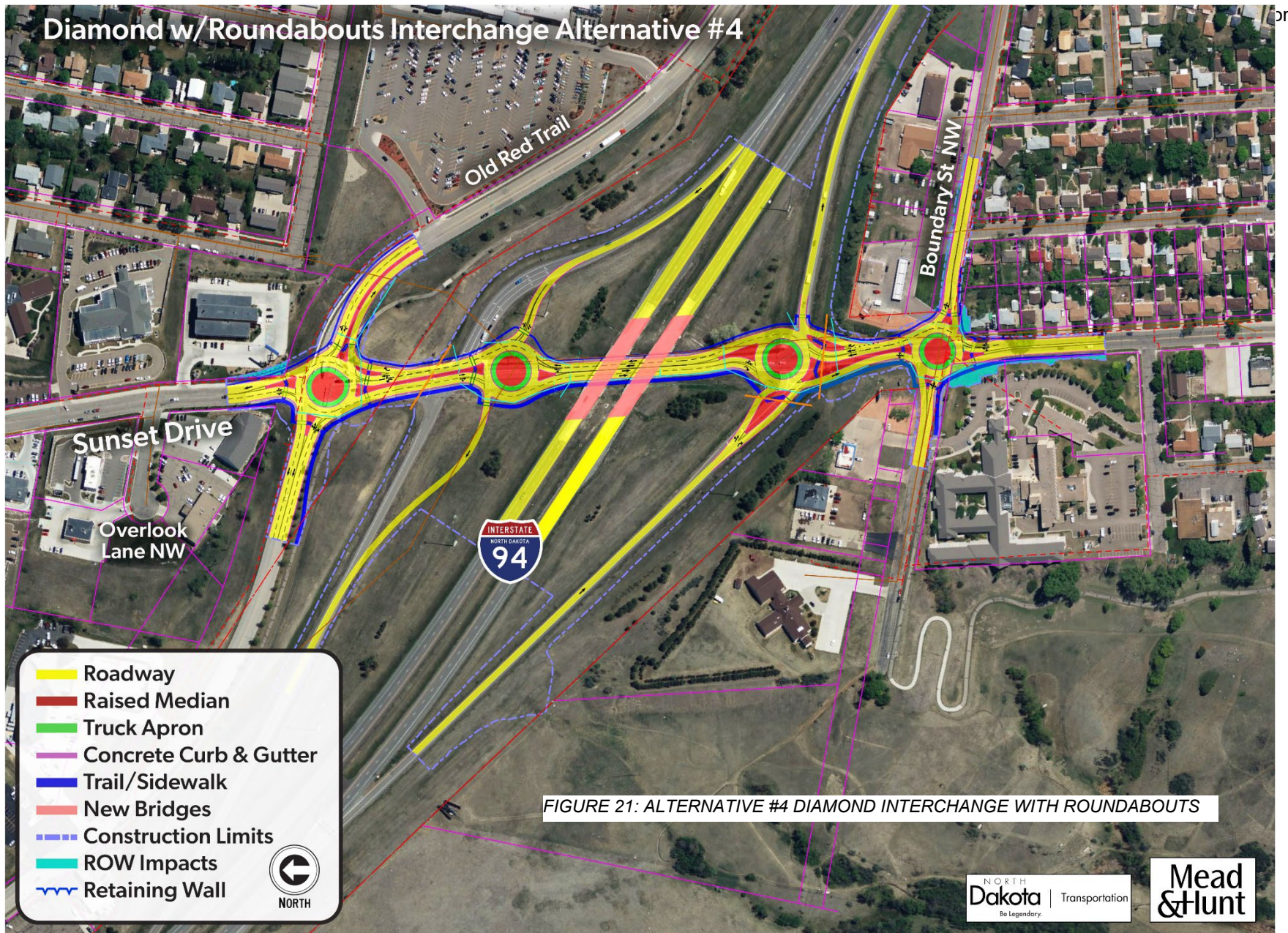


Table 4: Interchange Alternative Advantages and Disadvantages

Alternative	Advantages	Disadvantages
Alternative #1 Single-Point Interchange	<ul style="list-style-type: none"> • Increased the spacing between intersections. • Provides Acceptable LOS in 2045 • Replaces traffic signals at the ramp terminals with a single traffic signal under the I-94 bridges. • Reduced overall interchange delay and improved efficiency. • Improves travel times along Sunset Drive. 	<ul style="list-style-type: none"> • Requires four-span structures to carry Interstate 94. • Less pedestrian and bicycle friendly than other alternatives • Property impacts at the Old Red Trail and Boundary Street intersections. • Highest Cost Alternative
Alternative #2 Partial Cloverleaf Interchange	<ul style="list-style-type: none"> • Familiar driver understanding • Provides Acceptable LOS in 2045. • Eliminates the left turn onto the eastbound Interstate 94 • Easier access to freeway and improved safety. • Narrower cross section and relatively low cost. 	<ul style="list-style-type: none"> • Highest right-of-way impact. • Interstate 94 eastbound off-ramp may not meet signal warrants in the build year and may operate as a stop-controlled intersection.
Alternative #3 Diverging Diamond Interchange	<ul style="list-style-type: none"> • This configuration moderately increases the distance between ramp intersections. • Reduces conflicts by removing left turning movements through the signalized intersections. • Eliminates left turn phases at the traffic signals. • Provides Acceptable LOS in 2045 	<ul style="list-style-type: none"> • Requires additional driver education due to complexity. • Property impacts at the Old Red Trail and Boundary Street intersections. • Second highest cost alternative • Increased delay for the through movement traveling north-south along Sunset Drive.
Alternative #4 Diamond Interchange with Roundabouts	<ul style="list-style-type: none"> • Potential reduction in queue lengths along Sunset Drive • Reduces the total number of conflict points • Eliminates signal coordination between the two ramp terminals. • Allows for a narrower bridge as it eliminates left turn lanes. • No raise to the mainline profile required as the structure depths of the bridges are relatively similar. • Lowest cost alternative 	<ul style="list-style-type: none"> • Little to no increase in spacing between adjacent intersections. • Queues along the WB Off-ramp may impact I-94 WB mainline operations. • Due to potential ramp backup on WB off-ramp, this alternative does not meet purpose and need to improve operations along the corridor.

C. Sunset Drive at Old Red Trail Intersection Alternatives

At the intersection of Sunset Drive and Old Red Trail, two alternatives were analyzed to improve traffic operations in the future year. The intersection would tie-in with one of the interchange configurations described above to the south and is assumed to narrow down to a three-lane cross-section north of the intersection. The intersection capacity analysis summary table for all alternatives is shown in Table 11 of the Traffic Operations Report. Table 1 highlights the advantages and disadvantages of the intersection alternatives.

ADDITIONAL TURN LANES

This alternative would mitigate the failing operations of the intersection by providing eastbound and westbound left turn lanes with protected phasing, an additional southbound and northbound through lane, and an additional eastbound right turn lane. The additional lanes will reduce the average intersection delay and reduce 95th percentile queue lengths below the length at which they would exceed the available queuing distance, specifically at the northbound approach. The intersection operates at LOS C during both the AM and PM peaks in the 2045 analysis year.

The second northbound through lane on Sunset Dr is necessary to provide adequate capacity through the intersection in the 2045 scenario and manage queue lengths. Initial analysis of the intersection had the second lane dropping as a merge approximately 400 ft beyond the signal, however, NDDOT prefers to avoid midblock lane drops as they may cause uneven lane utilization (i.e., the outer through lane may be underutilized as motorists would prefer the inner lane to avoid merging). Therefore, it is assumed that the lane drop would occur further downstream at an intersection as an exclusive turn lane. Initial discussion suggested dropping the outer lane as a right-turn only lane at 27th Street N, however, this is beyond the limits of the study area. Further coordination with the Bismarck-Mandan Metropolitan Planning Organization and City of Mandan may be necessary to determine how to accommodate an additional northbound lane on Sunset Dr north of Old Red Trail and tie-in with the proposed three-lane cross-section of the Sunset Drive Corridor Study.

ROUNDBOUT

This alternative would be a two-lane roundabout, which would remove the existing signal control and allow for near constant vehicular flow. The proposed lane configuration would improve the operation of the northbound approach, reducing the 95th percentile queue length to below the distance between the approach and the upstream intersection with I-94 WB ramps. The second eastbound right turn lane would allow vehicles from Old Red Trail bound for I-94 EB to make the movement into the inner southbound lane of Sunset Dr, eliminating the need for a lane change.

D. Sunset Drive at Boundary Street NW Alternatives

Two alternatives were analyzed at the intersection of Sunset Dr and Boundary St NW to improve operations of the side streets. The intersection would tie-in with one of the interchange configurations described above to the north and is assumed to narrow down to a three-lane cross-section south of the intersection. The intersection capacity analysis summary table is shown in Table 12 of the traffic

operations report in Appendix #4.

Table 5: Alternative Advantages and Disadvantages at Old Red Trail and Boundary Street

Alternative	Advantages	Disadvantages
Sunset Dr at Old Red Trail Intersection Alternatives		
Additional Turn Lanes	<ul style="list-style-type: none"> • Acceptable 2045 LOS • Driver understanding 	<ul style="list-style-type: none"> • No increase in spacing between adjacent intersections. • Increases intersection footprint and may require retaining walls and additional right-of-way
Roundabout	<ul style="list-style-type: none"> • Fewer conflict points • Potential reduction in queue lengths • Acceptable 2045 LOS • Provides U-turn capability for emergency services and maintenance vehicles 	<ul style="list-style-type: none"> • Increases intersection footprint and may require retaining walls and additional right-of-way. • No increase in spacing between adjacent intersections
Sunset Dr at Boundary St NW		
Signalization	<ul style="list-style-type: none"> • Acceptable 2045 LOS • Operational improvement of Boundary St NW 	<ul style="list-style-type: none"> • Disruption of Sunset Dr traffic • Potential for queueing issues between intersection and I-94 EB Ramps
Roundabout	<ul style="list-style-type: none"> • Minimal disruption of Sunset Dr traffic • Operational improvement of Boundary St NW • Provides U-turn capability for emergency services and maintenance vehicles 	<ul style="list-style-type: none"> • Unacceptable degree of saturation in 2045 with single lane configuration • Increases intersection footprint and may require retaining walls and additional right-of-way

E. Other Design Considerations

During the alternative development process, the following items were also evaluated as part of the study:

MAINLINE PROFILE

The alternatives were evaluated for options to eliminate or minimize the need to modify the Interstate 94 profile through the project. In general, the design team found lowering Sunset Drive to provide the standard clearance (16'-6") and meet roadway standards and provide drainage through the interchange was feasible. However, this configuration would not be constructable without a full closure of Sunset Drive and could have impacts on the city of Mandan Sanitary Sewer system. This is due to the vertical clearance reduction due to the proposed structure depth over the existing Sunset Drive roadway during construction (< 12 feet) and the inability to maintain traffic lanes adjacent to the deep cuts upwards to 5 feet.

For these reasons, the alternatives show raising Interstate 94 by a distance equal to the difference between the existing and the proposed structure depth for each alternative. This allows the existing 14-foot clearance to be maintained throughout construction stages and reduces the lowering of Sunset Drive to approximately 2.5 feet to achieve a 16'-6" vertical clearance.

BRIDGE RETENTION

As a goal of the study, NDDOT asked that options to retain the existing bridges be evaluated to determine if the structures could be retained for the full design life of the interchange or at a minimum, the project be staged if the interchange could operate in an interim condition to preserve the structures for at least another 10 years from the initial construction year.

Of the four new interchange alternatives being considered, only two had a potential to retain the existing bridges with some geometric modifications, the partial cloverleaf interchange (Alternative #2), and the diamond interchange with roundabout ramp intersections (Alternative #4). The diverging diamond interchange and single point urban interchange cannot operate within the limitations of the existing bridges.

The partial cloverleaf interchange alternative could be constructed under Span 2 of the existing bridges without modification. However, the eastbound bridge would need to be widened to accept the new auxiliary lane in addition to the minimum required rehabilitation described under the No Build alternative. For this reason, this alternative was eliminated as a retention alternative.

The diamond interchange with roundabout ramp intersections alternative would need to retain a two- or three-lane roadway section below the bridge. A three-lane roadway was considered with a single lane in the northbound direction. It was determined that the bridge could not remain in service in this condition for a minimum of 20 years before Sunset Drive would require an additional second northbound lane. For this reason, this alternative was eliminated as a retention alternative.

Considering the information noted above, our conclusion is that a retention alternative that meets traffic needs and keeps the existing Sunset Drive bridges in service for a minimum of 20 years does not exist.

8. Future Conditions and Traffic Forecast

A. Traffic Forecasts

A detailed discussion of the traffic forecast development can be found in the Traffic Operation Report. The following summarizes the key points of the volume development process for the study:

1. Annual traffic volume growth rates were developed from the Bismarck Mandan Metropolitan Organization Travel Demand Model (TDM) using base year (2015) and future year (2030) ADT outputs. The Sunset Drive extension to 38th Street was included in the 2030 model.
2. Forecasted 2022 ADTs were developed using the 2015 ADTs from the TDM and the annual growth rates. These forecasted ADTs were compared to 2022 historical ADT counts and found to be

approximately 20% too low.

3. To compensate, the 2030 ADTs from the TDM were increased/adjusted by 20%. The 2015 to 2030 growth rates were recalculated and used to develop 2030 peak hour turning movement volumes from the baseline turning movement counts.
4. 2045 peak hour turning movement volumes were then developed from the 2030 peak hour turning movement volumes using the growth trend of the TDM.

It should also be noted that forecasts consider the following:

- Change in travel patterns due to the vacation of the current Mandan High school, and recent construction of the new Mandan High school. Motorists who previously wanted to access the high school in its previous location south of the proposed interchange, will instead travel to its new location northeast of the interchange. These updated travel patterns of local motorists have been incorporated in all future volume scenarios.
- The approved Master Plan for Mandan details development and growth along Sunset Drive as Sunset Drive will be extended past its current terminus of 31st Street to 38th Street. This development has been accounted for in all future volume scenarios.

The adjusted average daily trips (ADT) for the current, build, future years can be found in Figure 22 and Table 6 below:

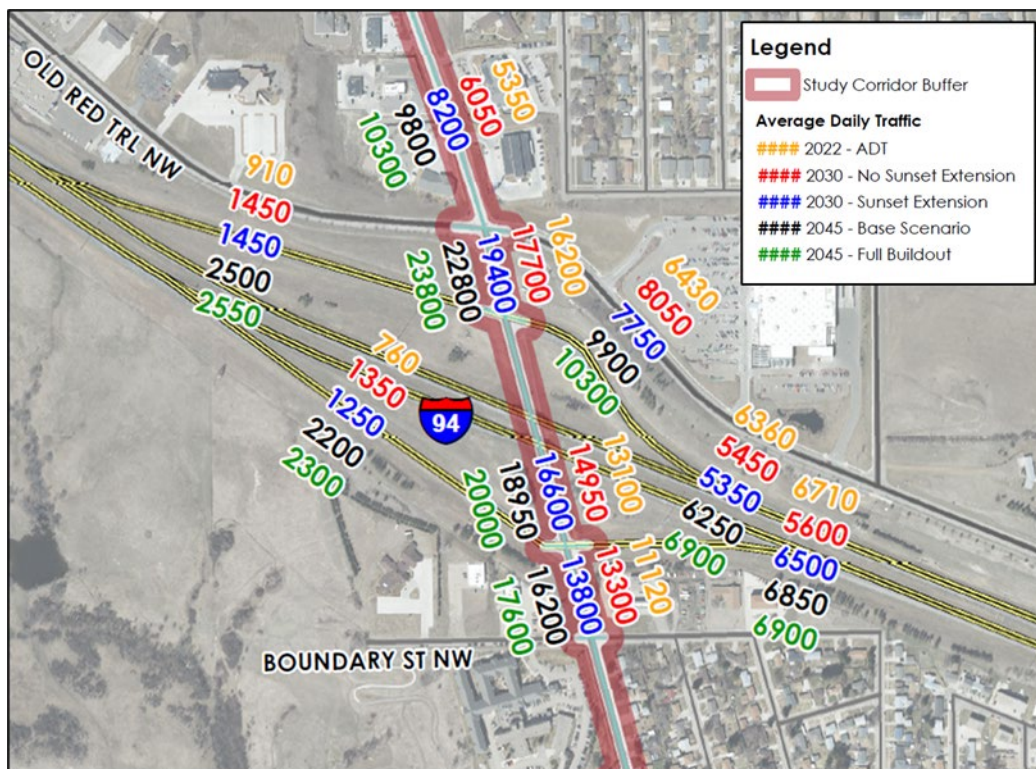


FIGURE 22: SUNSET DRIVE CORRIDOR STUDY – ADJUSTED ADTS

Table 6: Sunset Drive Corridor Study - Adjusted ADTs

	2022	2030 - No Sunset Extension	2030 - Sunset Extension	2045 - Base Scenario	2045 - Full Build Out
I-94 WB Exit Ramp	6,430	8,050	7,750	9,900	10,300
I-94 WB Entrance Ramp	910	1,450	1,450	2,500	2,550
I-94 EB Exit Ramp	760	1,350	1,250	2,200	2,300
I-94 EB Entrance Ramp	6,535	5,525	5,925	6,550	6,900
Sunset Dr S of I-94 EB Ramps	11,120	13,300	13,800	16,200	17,600
Sunset Dr between I-94 Ramp Terminals	13,100	14,950	16,600	18,950	20,000
Sunset Dr between I-94 WB Ramps and Old Red Trail	16,200	17,700	19,400	22,800	23,800
Sunset Dr north of Old Red Trail	5,350	6,050	8,200	9,800	10,300

B. Traffic Operations Analysis

(1) Interchange Alternatives

At the interchange of I-94 at Sunset Dr, the four alternatives were analyzed. The intersection capacity analysis summary table for all interchange alternatives is shown in Table 10 of the Traffic Operations Report in Appendix #4. The intersection LOS for alternative can be seen on the maps in Figure 23 and Figure 24 for 2030 and 2045, respectively.

(a). Single Point Urban Interchange (SPUI)

The interchange operates at an acceptable LOS C in both the AM and PM peak hours in 2045. Due to the merge on the I-94 EB on-ramp downstream of the southbound left turn, an uneven lane utilization was considered for the movement. It was assumed in the analysis that approximately two thirds of the movement volume would use the inner turn lane, adjacent to the through lane.

All movements operate at LOS D or better in the 2045 analysis year except for the following:

- Westbound Left, LOS E, AM Peak

(b). *Alternative 2: Partial Cloverleaf A (Parclo A)*

The ramp termini intersections operate at acceptable levels of service in 2045. The intersection with the WB ramp operates at LOS C in both peaks, and the intersection with the EB ramps operates at LOS A in both peaks.

All movements operate at LOS D or better in the 2045 analysis year except for the following:

- Sunset Dr at I-94 WB Ramps:
 - o Northbound Left, LOS F, PM Peak
- Sunset Dr at I-94 EB Ramps:
 - o Eastbound Left, LOS E, AM Peak

(c). Alternative 3: Diverging Diamond Interchange (DDI)

The initial design and preliminary analysis results showed that the interchange would operate acceptably with the outer southbound lane dropping as an exclusive left toward I-94 EB, with one lane at the signal at the southern half of the interchange. However, further analysis showed that the queue at southbound through movement would spill back through the northern half of the interchange and affect the Old Red Trail intersection. A sensitivity analysis was performed and indicated the single through lane at the southern intersection (Sunset Dr and I-94 EB ramps) would begin to break down sometime between 2040 and 2045. It may be possible to design the DDI interchange in such a way that the interchange can initially be striped with a SB lane drop at the I-94 EB on-ramp and sometime closer to the design year be modified to include the second SB through lane at the southern crossover. However, for the purposes of this analysis, the configuration shown in Figure 19 was analyzed for all future scenarios. In 2045, both the northern and southern halves of the interchange operate at acceptable levels of service. The northern signal operates at LOS C in both peaks, and the southern signal operates at LOS B in both peaks.

All movements operate at LOS D or better in the 2045 analysis year except for the following:

- Sunset Dr at I-94 WB Ramps:
 - o Westbound Left, LOS F, AM Peak
 - o Northbound Through, LOS E, AM and PM Peaks

(d). Alternative 4: Diamond with Roundabouts (RAB)

As mentioned before, two northbound lanes were determined necessary between the I-94 EB ramp terminal intersection and Old Red Trail for continuity of the section with the upstream and downstream roundabouts (i.e. avoiding lane drops), simplifying northbound operation and reducing the weaving between northbound vehicles and vehicles exiting I-94 WB and it was also determined that a second northbound lane opening south of Boundary St would become necessary to mitigate queueing which would cause inadequate operation of the intersection between 2030 and 2035. With queuing issues arising and a single lane not reaching a 10+ year life, a single NB lane is not recommended as an interim design option and the analysis was performed under all alternatives with two NB lanes as shown in Figure 21. The northern roundabout operates at LOS C and D in the AM and PM peaks, respectively. The southern roundabout operates at LOS B during both the AM and PM peaks.

All movements operate at LOS D or better in the 2045 analysis year except for the following:

- Sunset Dr at I-94 WB Ramps:
 - o Westbound Left, LOS F, PM Peak
 - o Westbound Right, LOS F, PM Peak

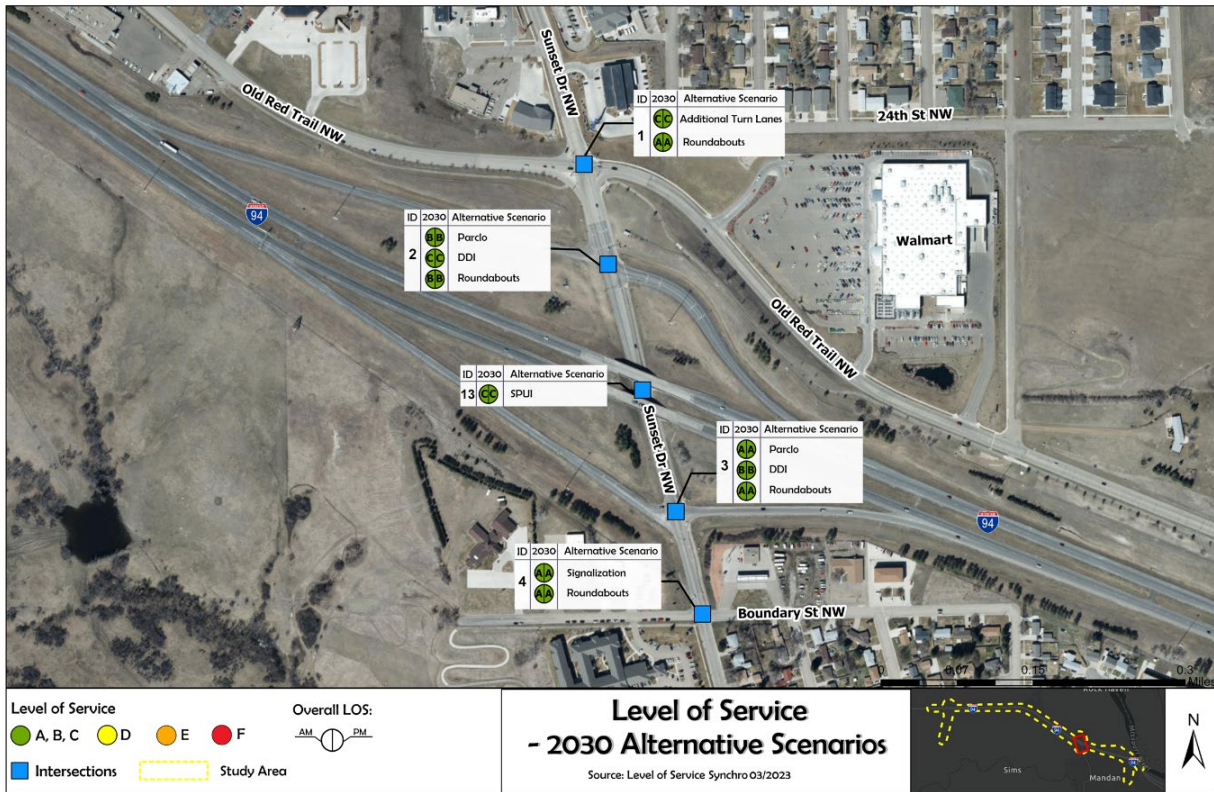


FIGURE 23: 2030 ALTERNATES LEVEL OF SERVICE MAP

(2) Sunset Drive at Old Red Trail Alternatives

At the intersection of Sunset Drive and Old Red Trail, three alternatives were analyzed to improve traffic operations in the future year. The intersection would tie-in with one of the interchange configurations described above to the south and is assumed to narrow down to a three-lane cross-section north of the intersection. The intersection capacity analysis summary table for all alternatives is shown in Table 10 of the Traffic Operations Report. The intersection LOS for the Old Red Trail alternatives can be seen on the maps in Figure 23 and Figure 24 for 2030 and 2045, respectively.

(a). Additional Turn Lanes

The additional lanes will reduce the average intersection delay and reduce 95th percentile queue lengths below the length at which they would exceed the available queuing distance, specifically at the northbound approach. The intersection operates at LOS C during both the AM and PM peaks in the 2045 analysis year.

All movements operate at LOS D or better in the 2045 analysis year except for the following:

- Southbound Through-Right, LOS E, AM Peak

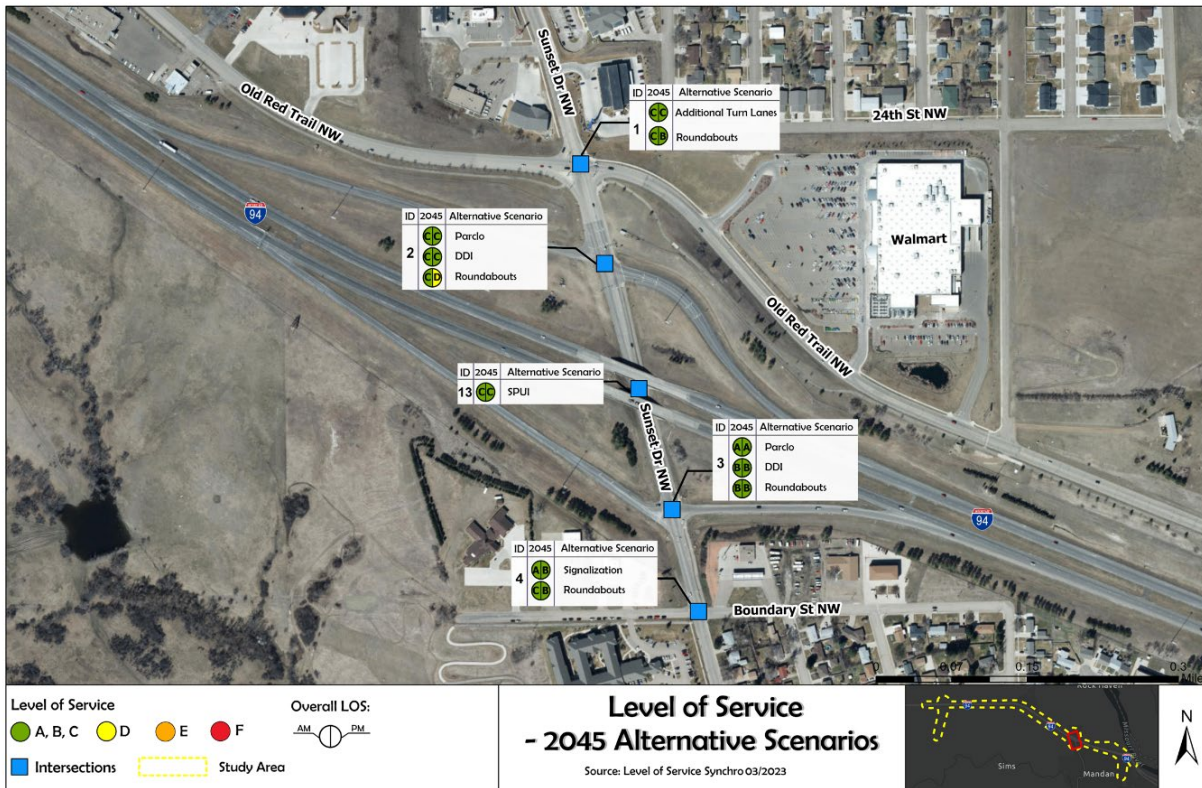


FIGURE 24: 2045 ALTERNATIVES LEVEL OF SERVICE MAP

(a). Roundabout

The lane configuration would improve the operation of the northbound approach, reducing the 95th percentile queue length to below the distance between the approach and the upstream intersection with I-94 WB ramps. The second eastbound right turn lane would allow vehicles from Old Red Trail bound for I-94 EB to make the movement into the inner southbound lane of Sunset Dr, eliminating the need for a lane change. The intersection operates at LOS C and B in the AM and PM peak hours, respectively, in 2045. All movements would operate at LOS D or better.

(3) Sunset Drive at Boundary Street NW Alternatives

Two alternatives were analyzed at the intersection of Sunset Dr and Boundary St NW to improve operations of the side streets. The intersection would tie-in with one of the interchange configurations described above to the north and is assumed to narrow down to a three-lane cross-section south of the intersection. The intersection capacity analysis summary table is shown in Table 10 of the Traffic Operations Report found in Appendix #4. The intersection LOS for the Boundary Street NW alternatives can also be seen on the maps in Figure 23 and Figure 24 for 2030 and 2045, respectively.

(a). Signalization

A signal warrant analysis was performed for the intersection, using a 2030 opening year forecasted turning movement count volume. The analysis found that a full color traffic signal is warranted at the intersection by 2030, with volumes meeting the minimum requirements for Warrant 2 (Four Hour Volume). The signalization of the intersection will mitigate the excessive delays of the side street approaches, while not

significantly impacting the mainline approaches of Sunset Dr. The southbound approach will have left turn pocket, all other approaches will be one lane, shown in **Figure 37** below. The intersection will operate at LOS A and B in the AM and PM peaks, respectively, during 2045.

All movements operate at LOS D or better in the 2045 analysis year except for the following:

- Eastbound Left-Through-Right, LOS F, PM Peak

The NDDOT Traffic Operations Manual states that exclusive left-turn lanes are recommended at all signalized intersections. The above analysis represents the minimum design that would operate at acceptable levels in each alternative. Inclusion of exclusive left-turn lanes would not have any substantive effect on the operation of the intersection or the Sunset Dr corridor but have been added to the layouts in Appendix #3 per the NDDOT Traffic Operations Manual recommendations.

(a). Roundabout

A roundabout at this intersection would improve the operation of the east and westbound approaches of Boundary St NW, without disrupting the flow of traffic on Sunset Dr like a signalized intersection would. The roundabout would have a one lane entrance from the north, east, and west legs, and two entrance and circulating lanes from the south leg, shown in the alternative layout in Appendix #3. The 2nd northbound lane becomes necessary to mitigate queueing concerns observed in the 2045 scenario. The one lane configuration would become inadequate between 2030 and 2035. The roundabout operates at LOS C and B in the AM and PM peaks, respectively, during 2045.

C. Network Delay, Queueing, and Arterial Travel Time

To evaluate the interchange alternatives in combination with the intersection improvements at Sunset Dr and Old Red Trail and Sunset Dr and Boundary St NW, four alternative packages were modelled in VISSIM. The series of four roundabouts, and the Parclo, SPUI, and DDI, all with additional lanes at Sunset Dr and Old Red Trail and a signal at Sunset Dr at Boundary St NW, were selected for VISSIM analysis based on the results in the Alternatives Assessment section of the Traffic Operations Report.

The measures of effectiveness recorded from the simulations include total network delay (including latent delay), average network delay, total network travel times, vehicle throughput, average arterial travel time and speed, and maximum queue lengths. Network delay and travel times are summarized in Figure 23, Figure 24, and Figure 25, respectively. The queueing summary is shown in Table 17 of the Traffic Operations Report in Appendix #4. Note the maximum queue length is reported and is greater than the average and 95th percentile queue length.

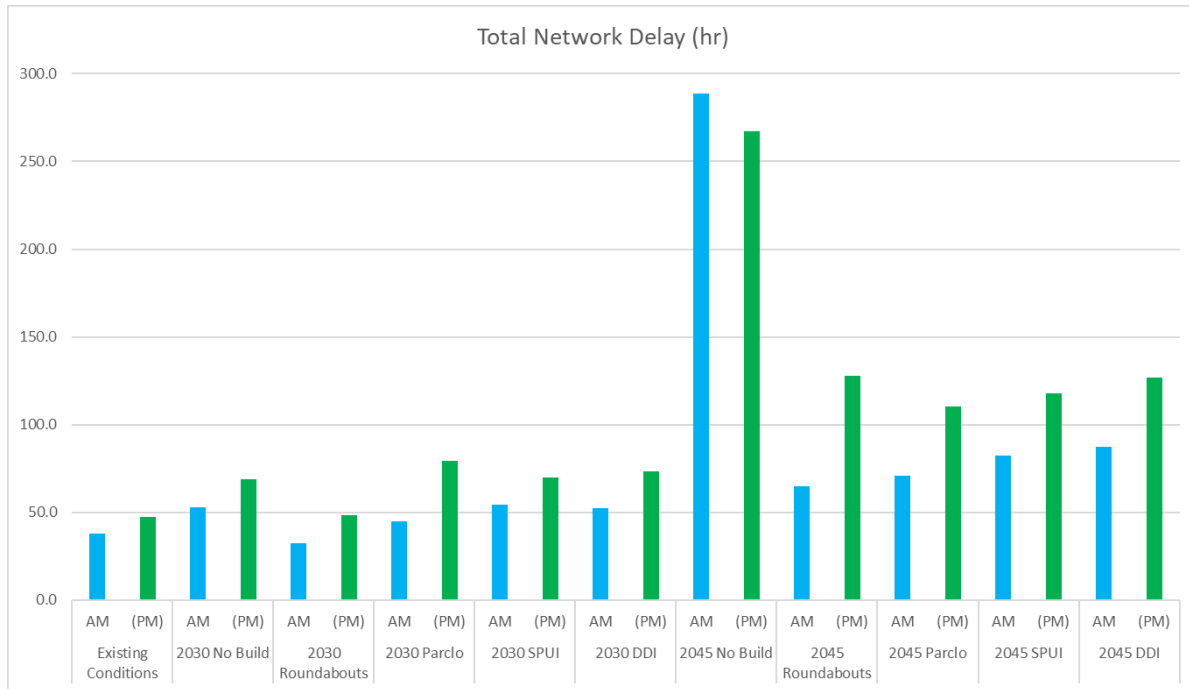


FIGURE 25: AVERAGE TRAVEL TIMES ON SUNSET DRIVE NORTHBOUND

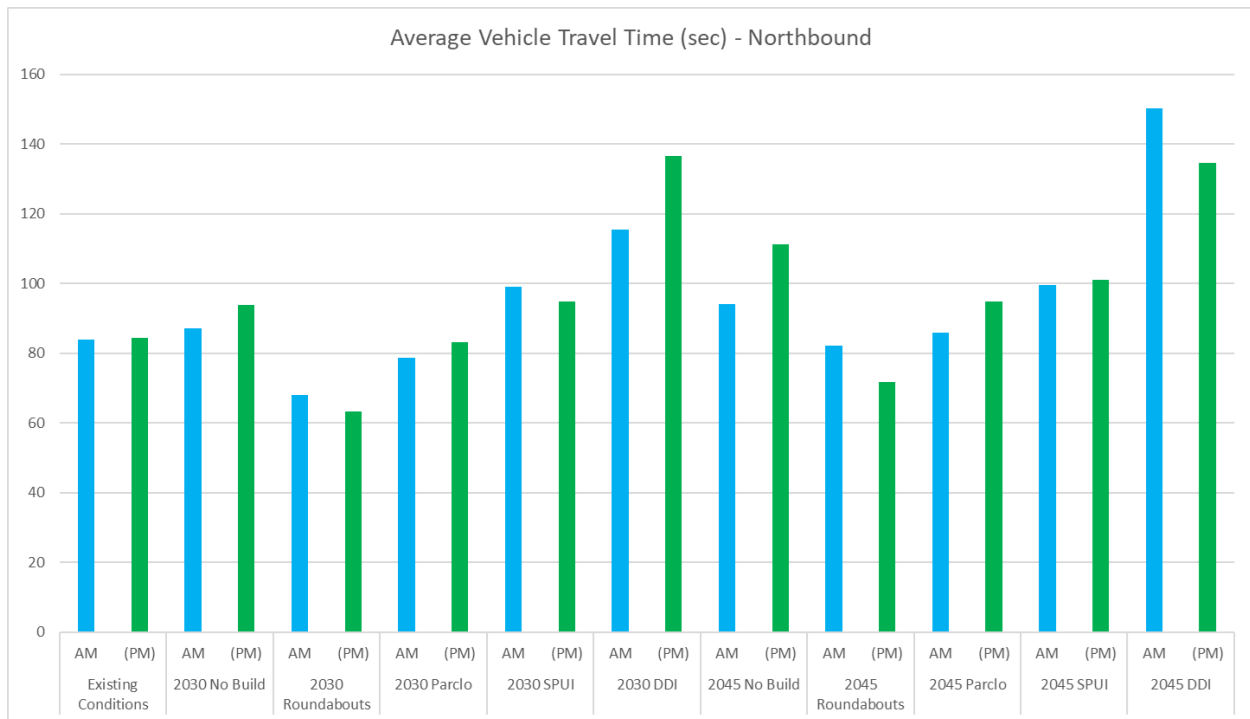


FIGURE 26: AVERAGE TRAVEL TIMES ON SUNSET DRIVE NORTHBOUND

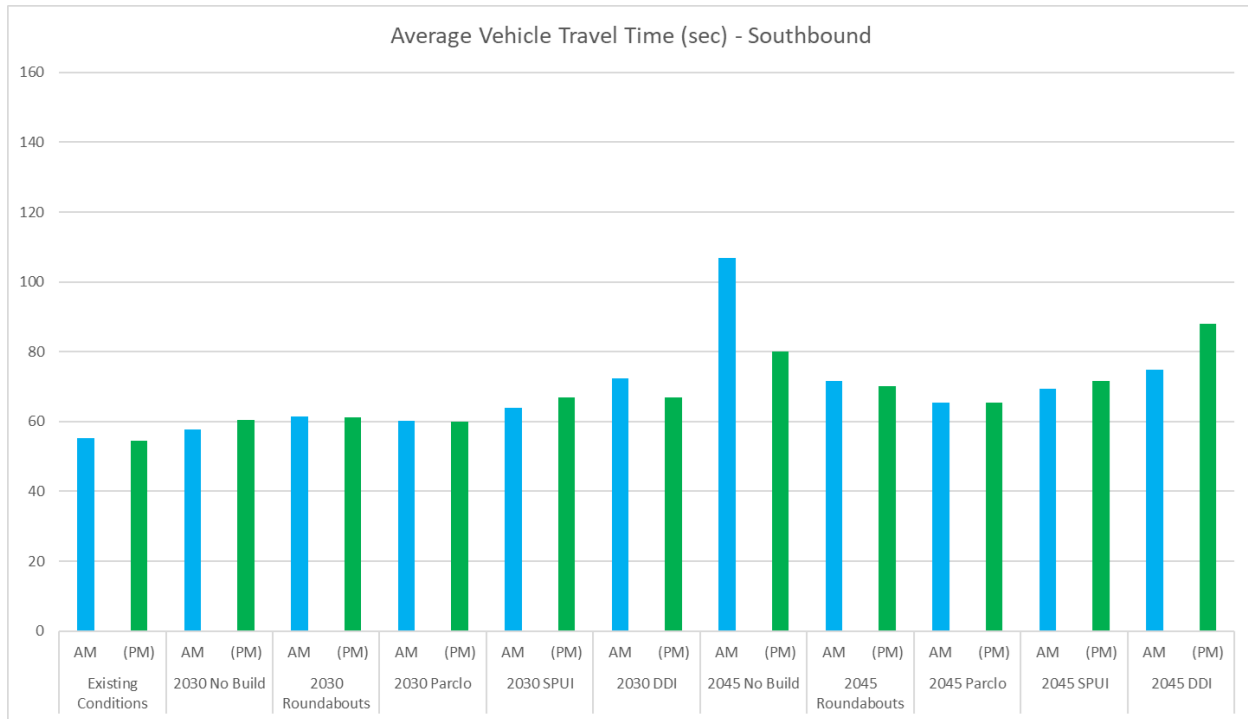


FIGURE 27: AVERAGE TRAVEL TIMES ON SUNSET DRIVE SOUTHBOUND

Based on the results Traffic Operations Report, the alternatives were compared and ranked. Table 5 below ranks the four alternatives in seven categories:

- Intersection operations,
- Queueing and intersection spacing,
- Sunset Dr travel times,
- Total network delay,
- Impact to I-94 mainline operations,
- Intersection safety,
- Multimodal/pedestrian accommodation.

The categories are color coded and scored, dark green showing significant improvement over No Build conditions, worth two (2) points, light green showing moderate over No Build, worth one (1) point, yellow showing no change, worth zero (0) points. The orange and red colors show slight and moderate deterioration compared to No Build, worth negative one (-1) and negative two (-2) points, respectively.

D. Predictive Safety

A full analysis of the predictive safety analysis can be found in the traffic operation report in Appendix #4. The results of the IHSDM analysis are summarized in Table 7 and Table 8, below. Each table has the predicted number of crashes under each alternative as well as the relative difference between the predicted number of crashes in the no-build alternative and the alternatives number of crashes for each severity type. The number of predicted crashes for each alternative is shown for an evaluation period of 5 years.

TABLE 7: INTERSECTION ALTERNATIVES - PREDICTIVE SAFETY ANALYSIS RESULTS

Intersection	Alternative	Predicted Crashes (FI)	Relative Difference, FI (%)	Predicted Crashes (PDO)	Relative Difference, PDO (%)
Sunset Dr & Old Red Trail	No Build	4	-	8	-
	Additional Turn Lanes	3	-25%	7	-13%
	Roundabout	2	-50%	4	-50%
Sunset Dr & Boundary St	No Build	3	-	6	-
	Signalization	2	-33%	4	-33%
	Roundabout	2	-33%	4	-33%

* Crash totals shown for an analysis period of five years

A direct comparison of the number of crashes for the intersection alternatives shows that the additional turn lanes and signalization both provide a reduction in crashes. The roundabout at Old Red Trail, where the CMF was applied, shows a reduction in crashes over the additional turn lanes alternative. The signalization and the roundabout at Sunset Dr & Boundary St provide the same reduction in crashes over the no build.

TABLE 8: INTERCHANGE ALTERNATIVES - PREDICTIVE SAFETY ANALYSIS RESULTS

Site Type	Description	No Build		SPUI		Parclo		DDI		Ramp Terminal Roundabouts	
		Predicted Crashes (FI)	Predicted Crashes (PDO)	Predicted Crashes (FI)	Predicted Crashes (PDO)	Predicted Crashes (FI)	Predicted Crashes (PDO)	Predicted Crashes (FI)	Predicted Crashes (PDO)	Predicted Crashes (FI)	Predicted Crashes (PDO)
Freeway Segments	All Segments	4	7	4	7	4	6	4	7	4	7
Ramps	Entrance Ramps	2	3	2	3	4	5	2	4	2	3
	Exit Ramps	2	3	2	3	2	3	3	6	2	3
Ramp Terminals	EB Ramp Terminal	4	7	5	16	4	5	3	5	2	4
	WB Ramp Terminal	4	6			4	6	2	4	2	3
SUM		15	25	13	28	18	25	15	25	11	19
Relative Difference				-13%	12%	21%	-2%	-1%	-1%	-23%	-26%

* Crash totals shown for an analysis period of five years

The Ramp Terminal Roundabouts alternative provided the highest percent reduction in the total number of crashes. This alternative removes conflict points at the ramp terminals, leading to a higher percent reduction over the predicted number of crashes. The DDI also provides a reduction in crashes at the ramp terminals for the same reason.

The Parclo alternative reduces the number of property damage only crashes but provides a similar number of fatal/ injury crashes. This is due to the addition of entrance ramps and the presence of more uncontrolled movements. The SPUI alternative reduces the number of fatal/ injury crashes but increases the number of PDO crashes.

E. Traffic Analysis Recommendations

Based on the results of the Alternatives Assessment and Network Analysis section, the alternatives were compared and ranked. Table 9 below ranks the four alternatives in seven categories: intersection operations, queueing and intersection spacing, Sunset Dr travel times, total network delay, impact to I-94

mainline operations, intersection safety, and multimodal/pedestrian accommodation. The categories are color coded and scored, dark green showing significant improvement over No Build conditions, worth two (2) points, light green showing moderate over No Build, worth one (1) point, yellow showing no change, worth zero (0) points. The orange and red colors show slight and moderate deterioration compared to No Build, worth negative one (-1) and negative two (-2) points, respectively.

TABLE 9: ALTERNATIVE RANKING SUMMARY

Alternative	Intersection Operations	Queueing/ Intersection Spacing	Travel Time	Network Delay	I-94 Operations	Safety	Multi-modal	Total Score	Overall Rank
#1 SPUI	2	2	1	2	1	0	-1	7	1
#2 Parclo	2	0	1	2	1	-1	0	5	2
#3 DDI	2	1	-1	2	1	0	-1	4	3
#4 Roundabout	-2	-1	2	2	-2	2	1	2	4

From a traffic operations perspective, the SPUI shows the greatest improvement of queue lengths over No Build conditions, and had the fewest spillbacks compared to the other alternatives. The travel times, though not the lowest of the alternatives, is comparable to the roundabout and parclo alternatives, and the difference can be attributed to the additional signal phases of the SPUI. The total network delay of the four alternatives is similar, and a significant improvement over No Build. The SPUI is preferential to the other alternatives, as it best addresses existing concerns of intersection spacing on Sunset Dr, and queueing concerns on Sunset Dr and on the I-94 WB off-ramp. A drawback of the SPUI is the complication of multimodal movement and operation, as it increases the number of crossings a pedestrian or cyclist must make to navigate the intersection. However, safe multimodal operations can still be provided with proper pedestrian signing, marking, and signalization.

Secondary to the SPUI, the Parclo operates adequately, showing significant operational improvement over the no build. The removal of southbound lefts bound for I-94 EB to the loop ramp reduces total delay and travel time, as a major movement in the corridor is provided free operation. However, the alternative does not address the intersection spacing concerns between the I-94 WB ramp terminal and Old Red Trail, as the configuration of the westbound ramps is to remain the same as No Build.

The DDI alternative improves general traffic operations along the corridor and provides a moderate increase in intersection spacing between the I-94 WB ramps and Old Red Trail. However, the configuration of the interchange disbenefits vehicles on Sunset Dr not bound to or from I-94 in a manner which the other alternatives do not. The signal operation of the DDI causes Sunset Dr to be split phased and introduces additional signal delay to through vehicles on Sunset Dr, increasing the travel time over the No Build condition.

The roundabout alternative operates best in terms of vehicle travel time and intersection safety but is not preferred due to the intersection operations and queueing. The roundabout at Sunset Dr and I-94 WB ramps operates with a degree of saturation of 0.99 in the PM peak of the 2045 analysis year and sees a maximum

queue length on the I-94 WB off-ramp that spills back to the mainline of I-94 WB, an operational failure that is unacceptable.

9. Structures

This section describes the recommended bridge alternatives for the four new interchange alternatives described in Section 8. The four alternatives were evaluated for options, including interim configurations, to retain the existing structures. However, the analysis found they do not offer an opportunity to retain the existing bridges without significant modifications to the existing structures. The design basis of these alternatives is included, as well as potential opportunities to refine these bridge options should they be selected as the preferred alternative.

A. Bridge Reconstruction Alternatives

The following four interchange alternatives are under consideration which would result in new bridges at the Sunset Drive Interchange.

SINGLE POINT URBAN INTERCHANGE

The single point urban interchange alternative results in the widest roadway section below the Sunset Drive bridges. In addition to two 12-foot lanes for through traffic in both directions on Sunset Drive, various turning movements need to be considered for ramp traffic. Median islands are introduced in this alternative both to channelize traffic and to offer a refuge where piers can be constructed. These geometric needs result in a four-span bridge alternative.

The Sunset Drive roadway width necessitates the need for substructures between traffic movements and outside the full roadway width. Piers parallel to Sunset Drive are proposed beyond the trail and walk to avoid tall abutments. These piers were set to provide a minimum lateral clearance of 16-feet to ramp movements and 18-feet to through movements. This provides the full roadway clear zone in accordance with Section IV-02.02.04 of the NDDOT Design Manual. This also offers available width for snow storage. These piers, as well as the abutments, are aligned with each other on both the eastbound and westbound bridges. The northwest and southeast piers controlled the substructure layout due to the roadway skew.

An additional pier is located on each bridge between through traffic on Sunset Drive and ramp traffic to avoid an excessively deep superstructure. These piers are entirely located within the interchange on a median island and parallel to Sunset Drive. A 4-foot minimum lateral clearance is proposed for this interchange configuration. The piers are staggered such that the layout of the eastbound and westbound bridges is similar. This results in a reversed span configuration between the two bridges and identical bridge designs.

The longest span for each bridge is approximately 172-feet between pier centerlines measured along the I-94 alignment. Continuous welded plate girders with a 60-inch web were selected to achieve this span. The adjacent span over Sunset Drive is approximately 114-feet in length. End spans were set at approximately 55-percent of the main span length. The overall length of each bridge is approximately 470-feet.

Due to the bridge length, skew, and superstructure type, parapet abutments are assumed. Embankments with slope protection and a 2.5:1 slope are also assumed. The stability of this slope will need to be confirmed in detailed design. A five-foot wide maintenance area at a 12:1 slope is located adjacent to the abutments face. This embankment design yields a large open area between the pier and embankment slope. This open area can be minimized by flattening the slope and/or decreasing the end span length. Uplift requirements will need to be verified in final design.

Like the other alternatives, single-lane traffic is assumed for I-94 allowing construction of one bridge followed by the other. Due to the new bridge length compared to the existing bridge, this alternative will result in the largest amount of temporary shoring to support the existing roadway embankment during construction. Lane closures are only expected for specific operations, such as the removal of the existing bridge and erection of new girders. The large span lengths may require shoring towers or multiple cranes to facilitate erection. Anticipated erection sequencing should be considered when identifying splice locations.

A bridge layout sheet and a site plan depicting the roadway layout and locations of critical lateral clearance is in Appendix #5

PARTIAL CLOVERLEAF INTERCHANGE

The partial cloverleaf interchange alternative introduces a loop ramp in the southwest quadrant for southbound Sunset Drive traffic to access I-94 eastbound. This results in two 12-foot lanes on Sunset Drive in the southbound direction and a single 12-foot lane in the northbound direction separated by an 8-foot painted median. A 24-inch curb & gutter is also provided adjacent to each direction of traffic on Sunset Drive. A 10-foot-wide trail is located along the east side of the road separated from the adjacent curb & gutter by a 4-foot boulevard. From the outside of the trail to the outside of the southbound gutter line, this multi-modal roadway alternative is 62-feet wide perpendicular to Sunset Drive. A three-span alternative was selected to span this width.

In accordance with Section IV-02.02.04 of the NDDOT Design Manual, piers are located to provide the full roadway clear zone for Sunset Drive. Given the low-speed nature and high ADT of the road, Table 1 in NDDOT's Design Manual Appendix III-14 B specifies a clear zone distance of 16-feet to 18-feet. For this alternative, 18-feet was used as the clear zone for both directions of traffic on Sunset Drive. Although the outermost southbound lane is an auxiliary ramp movement, a lower value of 16-feet was not used as this lane carries through traffic north of the bridge. An exception was made at the southwest corner where slightly less than 18-feet is provided at the ramp entrance. The trail can be contained entirely within the specified clear zone.

The two piers on each of the I-94 bridges are aligned with each other and set parallel to Sunset Drive. This resulted in a span length of 104.5-feet between pier centerlines measured along the I-94 alignment. 45-inch prestressed concrete I-beams were selected to achieve this span. An identical typical section was assumed for the end spans to provide for a continuous composite design as specified in Section IV-02.06.01 of the NDDOT Design Manual. Approach span lengths were set at approximately 60-percent of the main span length to avoid uplift.

The westbound I-94 bridge has a clear roadway width of 40-feet which allows for two 12-foot lanes, a 6-foot inside shoulder, and a 10-foot outside shoulder. The eastbound I-94 bridge has a wider clear roadway width of approximately 50-feet. This is necessary to accommodate the onramp in the southwest quadrant. This roadway width allows for two 12-foot thru lanes, an additional 12-foot auxiliary lane, a 6-foot inside shoulder, and a 6-foot minimum outside shoulder adjacent to the auxiliary lane. The minimum shoulder width occurs at the back of Abutment 1 to accommodate ramp geometrics. The southern edge-of-deck is set parallel to the I-94 alignment, resulting in a constant bridge width. The wingwall is slightly kinked to maintain a minimum 6-foot shoulder adjacent to the ramp on the approach slab. Opportunities to refine ramp geometrics to eliminate the variable shoulder width across the bridge can be explored. Modified ramp geometrics may result in additional right-of-way impacts.

The overall length of each bridge as described above is approximately 237-feet. Since the bridge skew is over 30 degrees at approximately 37 degrees, parapet abutments are assumed. Substructures on the eastbound and westbound bridges are aligned with each other. Embankments with slope protection and a 2.5:1 slope are also assumed. The stability of this slope will need to be confirmed in detailed design. A 5-foot-wide maintenance area at a 12:1 slope is located adjacent to the abutments face. This embankment design yields an open area between the pier and embankment slope. This open area can be minimized by flattening the slope and/or decreasing the end span length. Uplift requirements will need to be verified in final design.

A bridge layout sheet and a site plan depicting the roadway layout and locations of critical lateral clearance is in Appendix #5

DIVERGING DIAMOND INTERCHANGE

The diverging diamond interchange alternative results in two 12-foot lanes and two 3-foot shoulders adjacent to 24-inch curb & gutters in both directions of Sunset Drive. A 4-foot median exists between the curb & gutters separating northbound and southbound Sunset Drive. A 10-foot-wide trail and 5-foot wide walk are located along the west and east sides of the road, respectively, both separated from their adjacent curb & gutter by a 5-foot boulevard. From the outside of the trail to the outside of the walk, this multi-modal roadway alternative is 97-feet wide perpendicular to Sunset Drive. A three-span alternative was selected to span this width.

In accordance with Section IV-02.02.04 of the NDDOT Design Manual, piers are located to provide the full roadway clear zone for Sunset Drive. Given the low-speed nature and high ADT of the road, Table 1 in NDDOT's Design Manual Appendix III-14 B specifies a clear zone distance of 16-feet to 18-feet. For this alternative, 18-feet was used as the clear zone for through traffic on Sunset Drive and 16-feet for ramps. The walk on the east side of the roadway can be contained entirely within the specified clear zone. An additional 3-feet of clearance is required on the west side of the roadway to contain the trail assuming a 1-foot buffer from the trail to the pier. Given this small increase, it was decided to locate the trail and walk within the main span of the bridge.

The location of Pier 2 is controlled by the northwest quadrant while the southeast quadrant controlled the location of Pier 3. This is based on the roadway skew and the proximity of these piers to the ramp intersections. Piers 2 and 3 are parallel with each other and Sunset Drive. This resulted in a span length of approximately 148-feet between pier centerlines measured along the I-94 alignment. 72-inch prestressed concrete I-beams were selected to achieve this span. An identical typical section was assumed for the end spans to provide for a continuous composite design as specified in Section IV-02.06.01 of the NDDOT Design Manual. Approach span lengths were set at approximately 60-percent of the main span length to avoid uplift.

The overall length of each bridge as described above is 326.3-feet. Since the bridge skew is over 30 degrees at approximately 37 degrees, parapet abutments are assumed. Substructures on the eastbound and westbound bridges are aligned with each other. Embankments with slope protection and a 2.5:1 slope are also assumed. The stability of this slope will need to be confirmed in detailed design. A 5-foot-wide maintenance area at a 12:1 slope is located adjacent to the abutments face. This embankment design yields a large open area between the pier and embankment slope. This open area can be minimized by flattening the slope and/or decreasing the end span length. Uplift requirements will need to be verified in final design.

To maintain I-94 traffic during construction, it is assumed that single-lane traffic will be diverted to one of the existing bridges while the other bridge is reconstructed. Upon completing construction of the first bridge, traffic can then be switched to the new bridge allowing for construction of the second bridge. Following this approach, bridge construction can occur under traffic with closures only necessary for specific operations, such as the removal of the existing bridges and erection of new girders.

A bridge layout sheet and a site plan depicting the roadway layout and locations of critical lateral clearance is in Appendix #5

DIAMOND INTERCHANGE WITH ROUNDABOUT RAMP INTERSECTIONS

The diamond interchange with roundabout ramp intersections alternative is very similar to the partial cloverleaf interchange alternative as discussed above in the near vicinity of the Sunset Drive bridges. Below the bridges, Sunset Drive consists of four 12-foot lanes and two 24-inch curb & gutters. A 10-foot-wide trail and 5-foot-wide walk are located along the west and east sides of the road, respectively, both separated from their adjacent curb & gutter by a 5-foot boulevard. From the outside of the trail to the outside of the walk, this multi-modal roadway alternative is 77-feet wide perpendicular to Sunset Drive. A three-span alternative was selected to span this width.

In accordance with Section IV-02.02.04 of the NDDOT Design Manual, piers are located to provide the full roadway clear zone for Sunset Drive. Given the low-speed nature and high ADT of the road, Table 1 in NDDOT's Design Manual Appendix III-14 B specifies a clear zone distance of 16-feet to 18-feet. For this alternative, 18-feet was used as the clear zone for both directions of traffic on Sunset Drive as each lane is used by through traffic. The trail can be contained entirely within the specified clear zone.

The two piers on each of the I-94 bridges are aligned with each other and set parallel to Sunset Drive. This

resulted in a span length of approximately 110-feet between pier centerlines measured along the I-94 alignment. 45-inch prestressed concrete I-beams were selected to achieve this span. An identical typical section was assumed for the end spans to provide for a continuous composite design as specified in Section IV-02.06.01 of the NDDOT Design Manual. Approach span lengths were set at approximately 60-percent of the main span length to avoid uplift.

The overall length of each bridge as described above is 241.5-feet. Since the bridge skew is over 30 degrees at approximately 37 degrees, parapet abutments are assumed. Substructures on the eastbound and westbound bridges are aligned with each other. Embankments with slope protection and a 2.5:1 slope are also assumed. The stability of this slope will need to be confirmed in detailed design. A five-foot wide maintenance area at a 12:1 slope is located adjacent to the abutments face. This embankment design yields an open area between the pier and embankment slope. This open area can be minimized by flattening the slope and/or decreasing the end span length. Uplift requirements will need to be verified in final design.

A bridge layout sheet and a site plan depicting the roadway layout and locations of critical lateral clearance is in Appendix #5

B. Potential Refinements

The alternatives presented above are based on NDDOT design standards using tools, ratios, and engineering judgment to identify viable structure alternatives; no detailed design analysis has been performed to date. Prestressed concrete I-beam superstructures were sized using a beam chart developed by the Minnesota Department of Transportation. This chart was last published in their February 2014 LRFD Design Manual as the beam shapes have since been archived in that state. This chart does not account for recent changes in design standards or continuity. Welded plate girders were sized assuming a web depth of 0.029 times the longest span length. It is our opinion that these approaches are accurate for alternative evaluation and possibly slightly conservative. Full detailed design will be performed on the preferred alternative. Additional potential refinements include the following:

- Skewing the substructures relative to Sunset Drive to allow for integral abutments – NDDOT's preferred abutment type is an integral abutment. The maximum length of an integral abutment bridge is 400-feet multiplied by the cosine of the skew angle. Integral abutments are not to be used on bridges skewed more than 30-degrees. With exception being the single point urban interchange alternative, each bridge alternative's overall length would allow for an integral abutment if the skew was reduced. Consideration of the increased span length and parallel bridge substructure alignments would be needed.
- Reducing required lateral clearance to decrease span length – The clear zone used for pier placement is based on a design speed up to 40 mph as refined clear zone distances do not exist for low-speed roadways. This is controlling the main span length and similarly the approach span length to prevent uplift. A performance-based practical design approach could be implemented to identify the lateral clearance need for items such as snow storage and maintenance. If reduced, options exist for a shorter and shallower bridge, including placement of the trail and walk behind the piers, further away from Sunset Drive.

- Increasing deck cantilever length to optimize prestressed concrete beam capacity – The maximum cantilever length is limited to 0.4 times the beam spacing per NDDOT Design Manual Section IV-02.06.07. In certain instances, with tight beam spacing, this requirement could prohibit the use of a shallower prestressed concrete beam. These instances also result in small cantilevers due to the beam spacing. Allowing a slightly larger cantilever length could result in a more optimal superstructure design without impacting the deck thickness or reinforcement design. The Extreme Event II load combination would need to be verified in deck overhang design.
- Increasing beam spacing to eliminate a beam line – The maximum girder spacing allowed per Section IV-02.06.08 of the NDDOT Design Manual is 10-feet. A larger girder spacing, even when coupled with a thicker deck, could result in an optimized structure design. Similarly, slightly increasing the beam spacing to reduce the deck cantilever length could be an optimal design that avoids the fascia beam controlling beam sizing.
- Specifying an alternative prestressed concrete beam shape – Alternative prestressed concrete beam shapes have been introduced across the country to optimize bridge design. One such example is the new Minnesota shape that is currently being used on the Fargo-Moorhead Area Diversion Project. Modifications would be necessary to meet NDDOT standards, such as adding end blocks and details for continuous design. Transportation costs would need to be considered as Rinker Material's Menoken plant cannot currently fabricate this shape.

These alternatives were developed based on horizontal geometry without consideration of profile. The bridge recommendations presented could be accomplished by lowering Sunset Drive and leaving I-94 at existing grade, raising I-94 and leaving Sunset Drive at existing grade, or a combination of lowering Sunset Drive and raising I-94. The exact bridge length for the preferred alternative will consider vertical geometry as the option is refined.

10. Utilities

A. Existing Conditions

Preliminary utility coordination was completed to determine where existing utilities are located with the project area. Based on the NDDOT RIMS Report showing utility locations and ownership, letters were sent to nine utility companies with infrastructure located within the project area. Six companies responded by providing maps and other information. These maps were compared to field collected survey data to ensure a complete picture of all utilities encountered on the project. Lines were added to the topographic drawing where necessary and marked with "Approx Location." GIS utility data from the City of Mandan was also combined with the utility company maps and survey data. All utilities in the project area are located underground. An overall utility location map of the project area was created using the gathered data and information and can be found in Appendix #6.

There are several fiber optic lines running parallel to Sunset Drive on the west side, crossing I-94. Montana Dakota Utilities (MDU) has a 6-inch gas line located along the east side of Sunset Drive, running parallel to the corridor. WBI Energy operates two 12-inch, high pressure gas lines located near the east end of I-94 eastbound on ramp. These lines run perpendicular to I-94 and cross under the roadway to the north connecting with a line running parallel to Old Red Trail, and south connecting with a line running parallel to Boundary Road within a dedicated right-of-way and easements.

There is a 12-inch sanitary sewer line owned by the City of Mandan running along the east side of Sunset Drive near the MDU gas line. This sanitary sewer line connects to a 6-inch PVC forcemain just south of the Sunset Drive intersection with the I-94 westbound off ramp, where the forcemain crosses under the off ramp and continues to the north.

There are several inlets and 30-inch concrete stormwater pipes in the project area. One crosses perpendicular to Sunset Drive just south of the intersection with Old Red Trail. The other stormwater pipe runs along the west side of Sunset Drive, crossing I-94 and outlet into a roadway ditch approximately 100 feet to the south. There are numerous culverts that also convey stormwater near the existing I-94 access ramps. Additionally, electric lines in the project area are used by NDDOT for their high mast lighting along I-94 and its access ramps.

Electric

MOR-GRAN-SOU ELEC. COOP.

Gas

MONTANA-DAKOTA UTILITIES CO.
WBI ENERGY TRANSMISSION

Water and Sanitary

CITY OF MANDAN

Communications

(Telephone, Fiber Optic, and
Television)

MID-CONTINENT
COMMUNICATIONS
DAKOTA CARRIER NETWORK
MONTANA-DAKOTA UTILITIES
CENTURYLINK
LUMEN

B. Anticipated Impacts

INTERCHANGE ALTERNATIVES

Within the interchange, there are three communication lines (MIDCO, Dakota Carrier network, and CenturyLink), a MDU gas line, and a 12-inch PVC Sanitary sewer. It is anticipated that the communication line and gas line will need to be relocated. The Sanitary sewer is approximately 11 feet deep in the current configuration. A lowering of Sunset Drive approximately 2.5 feet to achieve desirable vertical clearance will reduce the cover over the Sanitary main. This change in cover will need to be coordinated with the city of Mandan early in the project to confirm impacts would not require relocation of the sewer.

INTERSECTION ALTERNATIVES AT OLD RED TRAIL:

At Old Red Trail, there are three communication lines (MIDCO, Dakota Carrier network, and CenturyLink), a MDU gas line, and Mor-Gran-Sou three phase electric circuit. There are also NDDOT traffic signals and lighting circuits within the intersection. Adjustments and relocations to these facilities are anticipated. The incorporation of a roundabout will have a greater impact on these facilities to minimize having these facilities crossing beneath the circulatory roadway when possible.

INTERSECTION ALTERNATIVES AT BOUNDARY STREET NW:

At Boundary Street NW, there are three communication lines (MIDCO, Dakota Carrier network, and CenturyLink), a MDU gas line, and two 12-inch-high pressure gas mains operated by WBI. Adjustments and relocations to these facilities are anticipated. The incorporation of a roundabout will have a greater impact on these facilities to minimize having these facilities crossing beneath the circulatory roadway when possible. Additionally, the WBI facilities currently limit the ability to lower the ditch on the west side of Sunset Drive. The depth of these facilities will need to be determined early in the design process to determine limitations these facilities would have on lowering of the roadway and installation of drainage systems within the intersection.

11. Drainage

The existing drainage within the project area consists of open channel flow, culverts (sizes ranging from 18 inches to 36 inches), and small storm sewer networks. There are no known storm water quality facilities (i.e. ponds, infiltration basins) within the project area. A significant portion of the interchange drains towards the southeast quadrant of the intersection of the EB On-ramp with Sunset Drive requiring a concrete slab at the end wall for scour protection/energy dissipation (shown right).



In the northwest quadrant of the intersection of Boundary Street NW and Sunset Drive, standing water on Sunset Drive can be observed after heavy rainfalls and during periods of snowmelt. This is due to a lack of drainage ditch adjacent to the roadway due to the proximity to a WBI high pressure gas main facilities at this location. The area is currently drained by a long concrete flume with minimal slope and is ineffective at removing the stormwater away from the roadway quickly. The preliminary design will require additional investigation to develop alternatives to correct the concern while minimizing

impacts to this facility. This item applies to all alternatives.

ALTERNATIVE #1 - SPUI:

Alternative 1 (SPUI) consists of a main trunkline along the right side of the roadway that is approximately 1100' in length. Starting at the eastbound I-94 off-ramp, there will be a secondary trunkline along the left side of the roadway that will convey drainage down to crossline that is located approximately 175' from the Southern intersection. Substantial modifications will also be required to modify the existing drainage at the intersection of Old Red Trail and Sunset Drive in either the signalized or roundabout traffic control options. Due to the increased cross section of Sunset Drive, it is anticipated that the SPUI alternative will have greater increases in runoff than the PARCLO or Diamond w/Roundabout options. Additional erosion control measures may be necessary to mitigate the increased flow in the southeast quadrant of the EB ramp intersection. Another option would be to install stormwater retention/detention facilities to mitigate these increases due to the reconfiguration of the ramps.

ALTERNATIVE #2 – PARTIAL CLOVERLEAF:

This alternative will utilize a single trunkline along the right side of the project that is approximately 625' in length. This trunkline will intake water from the Northwest and Northeast ramp areas via inlets and route the runoff to the southeast quadrant, following the existing drainage pattern. Substantial modifications will also be required to modify the existing drainage at the intersection of Old Red Trail and Sunset Drive in either the signalized or roundabout traffic control options. Due to the footprint, it is anticipated that the PARCLO alternative has the smallest increase in runoff flows out of the four interchange alternatives.

ALTERNATIVE #3 - DDI:

The DDI alternative utilizes inlets in areas in and around the ramps and islands drain low points and provide spread reduction in these locations. These inlets in the northern portion of the study interchange will connect to a main trunkline that begins at the I-94 westbound bridge and continues south for approximately 325 feet. The system will continue to drain to the south where it will be conveyed to the outfall of the project using a cross culvert that is located approximately 175' north of Boundary Street NC. This alternative will also utilize a cross culvert located approximately 220' from the Old Red Trail that will convey runoff from the west side of the project site to the east. Like Alternative #1, this alternative will have substantial increase in runoff flow due to the increase pavement area. This may require additional erosion control measures or the use of stormwater detention/retention facilities to minimize flows exiting the study interchange area.

ALTERNATIVE #4 – DIAMOND INTERCHANGE WITH ROUNDABOUTS:

The drainage collected from the Interstate 94 westbound ramp roundabout will be conveyed via a trunkline that is approximately 2000' in length. Runoff from the I-94 eastbound ramp roundabout will be collected in the trunk line and will be discharged via a cross culvert that is located approximately 175' from the I-94 eastbound ramp intersection.

Existing crosslines will be utilized in the Northern and Southern portions of the project to maintain existing drainage patterns and reduce the amount of storm sewer necessary to convey runoff to the project outfall.

INTERSECTION ALTERNATIVES AT OLD RED TRAIL AND BOUNDARY STREET NW:

For the signalized options, adjustments will be required to maintain the existing drainage infrastructure when possible, to reduce the amount of new drainage devices required and to maintain existing drainage patterns. The intersection of Old Red Trail and Sunset Drive will continue to collect runoff via inlets where it will be conveyed East to the storm system located along Old Red Trail.

The signalized intersection at Boundary Street NW has minimum proposed storm sewer drainage and efforts will be made to rehabilitate the existing curb and gutter drainage to minimize potential impacts to the WBI high pressure gas main located north of the intersection.

The roundabout option for the Old Red Trail intersection will utilize drainage inlets to collect water at low points and to provide adequate spread conditions. This runoff will be conveyed eastward via new storm sewer that will tie into the existing system along Old Red Trail.

The Boundary Street roundabout will utilize storm sewer drainage in a similar manner to the Old Red Trail intersection, but adjustments to the intersection profile may be required to provide adequate depth for inlets and pipes and to ensure positive drainage. If adjustments to the intersection profile are not feasible or desired adjustments will be made to drain runoff away from the intersection in a similar manner current condition (improved curb and gutter/flume). The use of flumes would need to be thoroughly review to alleviate current drainage concerns as noted below.

In the northwest quadrant of the intersection of Boundary Street NW and Sunset Drive, standing water on Sunset Drive can be observed after heavy rainfalls and during periods of snowmelt. This is due to a lack of a drainage ditch adjacent to the roadway due to the proximity to WBI high pressure gas main facilities at this location. The area is currently drained by a long concrete flume with minimal slope and is ineffective at removing the stormwater away from the roadway quickly. The preliminary design will require additional investigation to develop alternatives to correct the concern while minimizing impacts to this facility. This item applies to all alternatives.

12. Noise Evaluation

This interchange project is classified as a Type 1 project in NDDOT's Noise Policy since there is an addition or relocation of interchange lanes or ramps which requires a noise analysis to be completed. In predicting traffic noise, three parameters are used: Pavement Type, Traffic Characteristics, and Noise Contours (affected by geometric changes). The pavement type will not be changed for any alternative because all ramps are proposed to be constructed of similar concrete pavement. This shall help with noise mitigation since concrete surfaces are reported to have a lower noise level than the existing asphalt surface of the ramps today. The traffic characteristics are also similar for each proposed alternative. Alternatives 1,3, and 4 will have every ramp pulled in toward the interstate which will create more space from the ramp travel lane to any potential noise sensitive area, this shall decrease traffic noise to those areas. However, Alternative 2 will be adding an acceleration lane to the EB roadway and will be ramp lanes outside of its current footprint in the SW quadrant of the interchange, increasing traffic noise for businesses near this area.

When determining traffic noise impacts and considering noise abatement measures, consideration is given to exterior areas where frequent human use occurs. These are broken down into land use categories, these are weighted with a grade from A (most sensitive) to G (least sensitive). Figure 28 below shows land use categories for each parcel in the area.

Based on this evaluation, the Partial Clover Interchange (Alternative 2) is anticipated to have the largest noise impacts. A detailed noise analysis will be completed for each alternative in next phase of the project.



FIGURE 28: NOISE ANALYSIS LAND USE ADJACENT TO SUNSET DRIVE INTERCHANGE

13. Construction Considerations

The constructability of the interchange alternatives was evaluated to determine staging challenges associated with the alternatives, construction timelines, and initial costs associated with the construction (widening, crossovers, additional staging items). In general, construction is anticipated to take two or more years.

In general, the alternatives are anticipated to follow the timeline. Additional investigation and refinement will be necessary in the preliminary design phase as the design is in progressed to refine impact and to continue coordination with stake holders along the project.

Year 1: Utility Relocation and Pre-Staging Construction

This stage will focus on relocation of utilities by the utility providers prior to the main interchange reconstruction. Staging work will be completed to setup for an early lane shift in year 2 of the project.

This work will focus on construction of crossovers on Interstate 94 and minor widening if required. As an option this setup work can be released as a separate PS&E ahead of the primary interchange project.

Year 2: Replacement of the Eastbound Bridge and Off-alignment work

Early year 2 construction activities will focus on a traffic shift along Interstate 94 (I-94 head-to-head traffic on Westbound lanes (12' wide) to allow Eastbound bridge replacement). The shift will allow for the removal and replacement of the of the existing structure. Short-duration closures of Sunset Drive may be necessary during bridge removal and girder-placement operations. Off-alignment grading activities could begin along Sunset Drive, I-94 interchange ramps, and at the adjacent intersections during this construction season while maintaining head-to-head traffic beneath Interstate 94. The construction of southbound Sunset Drive will not be completed around Westbound I94 bridge until Year 3, when the existing substructure will be removed. Traffic on Interstate 94, Sunset Drive, and side roads will be placed back into the original configurations prior to the winter season.

Year 3: Replacement of the Westbound Bridge and Sunset Drive Construction

Year 3 construction activities will focus on a traffic shift along Interstate 94 (I-94 head-to-head traffic on Eastbound lanes (12' wide) to allow Westbound bridge replacement). The shift will allow for the removal and replacement of the of the existing structure. Short-duration closures of Sunset Drive may again be necessary during bridge removal and girder-placement operations. Upon removal of the Westbound bridge, the widen roadway will be completed and traffic shifted for the remainder of the season to remove the existing roadbed and reconstruct the remainder of the roadway.

Year 4: Remainder work and incidentals

Depending on the selected alternative, a fourth year may be necessary to complete any outstanding items, final lane markings, turf establishment, other miscellaneous items.

Items to be reviewed further in preliminary design phase:

- Coordination with the City of Mandan, the Mandan School District, emergency service providers, transit providers, and school bus routes on short duration closures for timeline and alternate routes/detours during these events)
- Evaluation of the construction staging traffic to determine impacts, mitigation routes/strategies, and need for additional temporary traffic control (i.e., Signals at the Mandan Avenue Ramp Terminals may be necessary).
- Continued outreach to business owners and residents on staging impacts is encouraged to communicate impacts and develop plans to maintain access.
- Widening and additional temporary easements may be necessary to facilitate intersection construction at Old Rad Trail and Boundary Street.

From a constructability standpoint, Alternative #1 provided advantages over the other alternative due to the wide cross-section beneath Interstate 94. It allows Sunset Drive traffic to be staged while reducing the need for additional widenings and can provide for more separation between work zone and the traveling public upon removal of the I-94 structures. Alternative #3 follows closely behind due to similar reason but does add more complexity associated with the crossover construction at the ramp terminals.

Alternative 2 and Alternative 4 pose more challenges to maintaining traffic due to the narrow cross section at I-94 and the lowering of Sunset Drive associated with Alternative #2.

14. Cost Estimates

As part of this study, planning level cost estimates have been developed and are shown in Appendix #7 for each of the proposed alternatives. The estimated costs for these alternatives are below:

Alternative/Option		Preliminary Cost in millions (2023 Dollars)
Alternative #1 – Single Point Urban Interchange		\$45.8
Alternative #2 – Partial Cloverleaf Interchange		\$34.8
Alternative #3 – Diverging Diamond Interchange		\$45.4
Alternative #4 – Diamond w/Roundabouts		\$34.5
Option #1 – Roundabout at Old Red Trail	Alternative #1	+\$0.3
	Alternative #2	+\$1.2
	Alternative #3	-\$1.2
Option #2 – Roundabout at Boundary Street NW	Alternative #1	+\$1.2
	Alternative #2	+\$3.6
	Alternative #3	+\$1.3

15. Alternative Evaluation

Each interchange alternative was developed as a plausible solution to meet the study's purpose and need. Evaluation criteria was created based upon the issues and concerns identified along the corridor. The criteria are intended to provide for a quantitative and/or qualitative evaluation of each of the alternatives, assisting in the refinement of interchange and intersection recommendations. Environmental considerations are included within the criteria to provide a planning-level estimate of potential impacts that may require avoidance, minimization or mitigation during project development and the development of the environmental document (DCE).

Categories were developed based on initial agency input and data collection and provided for the development of measurable criteria for the comparison of alternatives. The prioritized categories include:

- | | |
|-----------------------|--------------------------|
| 1. Purpose and Need | 5. Environmental Factors |
| 2. Traffic Operations | 6. Preliminary Cost |
| 3. Safety | 7. Right-of-way |
| 4. Freight Mobility | 8. Complexity |

Measurable criteria were developed within each of these categories, described below, and allowing for a comparison of alternatives. The Sunset Drive Interchange alternatives were measured against the criteria to identify the alternatives that best fit the criteria.

PURPOSE AND NEED

Alternatives were evaluated against the purpose and need statement developed for the project. Therefore, the Sunset Drive Interchange alternatives were evaluated for providing a positive benefit to:

- Capacity – Alternative solutions shall provide sufficient capacity to accommodate existing and future volumes and operate at an acceptable LOS D or higher in the design year of 2045. Alternatives should alleviate congestion and back-ups affecting Interstate 94, Sunset Drive, and the local roadways.
- Safety – Alternatives should provide an overall safety benefit to motorized and non-motorized users within the study corridor.
- Freight Mobility - Alternatives should provide a solution improves mobility of heavy commercial and passenger vehicles moving through the interchange.

TRAFFIC OPERATIONS

Traffic Operation is an important of maintaining flow and effectiveness of the transportation system. This category set out to assess the benefits and impacts to capacity and mobility for the study interchange as result of improvements.

1. Intersection Operations

A future year 2045 intersection level of service was developed for each of the alternatives. The 2045 analysis found that all intersections, under all alternatives continued to operate a LOS D or better under future year 2045 conditions. Alternatives that provided improved levels of service under the future year scored higher than those providing a lower level of service.

2. Queuing/Intersection Spacing

Modeled microsimulations of these alternatives in combination to evaluate the network as a whole and determine any queuing impacts/ interactions between the I-94 ramp terminals and adjacent intersections on Sunset Drive. The average queue length could reveal the operational efficiency and confirm the conclusions from the network delay. Alternatives that reduced or had shorter queue lengths scored higher.

3. Change in Travel Time

Modified turning movements, intersection controls, and spacing may results in improvements or impacts to travel time within the study interchange. This criterion evaluated changes in travel time within the Sunset Drive Interchange scoring alternatives that reduce travel time through the interchange higher than those with increased travel time.

4. Network Delay

The network delay is significant since it correlates with level of service and could reflect the operational efficiency of the proposed alternative. This criterion evaluated changes in total network delay of the proposed changes within the Sunset Drive Interchange.

5. Interstate 94 Operations

I-94 mainline was analyzed from the interchange at SR 25 to the interchange at Mandan Ave. This criterion evaluated the proposed alternatives effects on Interstate 94 and the adjacent interchanges.

6. Multimodal

Multimodal facilities were also considered in the design of the alternatives. Alternatives that impeded, increased complexity to travel through the interchange, or increase conflict points for bicyclist and pedestrians were evaluated lower than other alternatives in this category.

SAFETY

Safety analysis plays a key role in the assessment of alternatives. IHSDM models provide two different categories of safety results: predicted crashes and expected crashes. The difference between the expected and predicted crashes is the potential for safety improvements at the interchange. This criterion evaluates the alternative based on the relative difference between the predicted number of crashes in the no-build alternative and the alternatives number of crashes for each severity type noted below.

1. Reduction in Crashes (Fatal or Injury)
2. Reduction in Crashes (Property Damage Only)

FREIGHT MOBILITY

A transportation system that adequately accommodates heavy commercial traffic, in addition to passenger vehicles, to support existing and future economic growth within the city of Mandan. Alternatives were evaluated for the improvements' compatibility year-round truck volumes. Criteria in this category is qualitative and was evaluated by the ability of the alternative to accommodate of heavy trucks within proposed geometrics.

ENVIRONMENTAL FACTORS

A review of the potential impacts to environmental factors at the planning level provides an initial review of avoidance, minimization and mitigation considerations that may need to be managed during design and the development of environmental documentation (DCE). This category evaluated the quantifiable and qualitative impacts to various environmental resources within the study area.

The following factors were reviewed and found to have little or no impact to the study interchange alternatives. These

- Soils and Prime Farmland
- Visual

- Threatened or Endangered Species
- Air Quality
- Migratory Birds, Bald and Golden Eagles
- Wildlife
- Floodplains
- Wild and Scenic Rivers
- Coastal Barriers/Coastal Zone
- Hazardous Waste
- Cultural Resources and Historic Properties

The following factors were reviewed, and measurable impacts were scored for the alternatives.

1. Land Use/Section 4f

The project area mostly consists of developed land. Old Red Trail is a designated City bike trail within the Study Area. The Mandan Park District has a trailhead at the intersection of Sunset Ave and Old Red Trail. The trailhead was funded with federal grants. The trail and associated parcels appear to meet Section 4(f) criteria and would need to be further evaluated for potential project impacts.

2. Environmental Justice/Socioeconomic

Screening indicated that the percent minority population, percent of people in poverty, number of people with disabilities, and percent of households without a car are homogeneous throughout the Study Area and immediate vicinity. Environmental justice will be considered during further evaluation of the project.

3. Noise

The City of Mandan municipal code and city ordinances were reviewed. The Study Area is an existing highway corridor, and project noise levels are expected to be consistent with the current use. A quantitative analysis of I-94 and the changes to the ramps were analyzed for potential increases to noise levels to adjacent properties. Further analysis will occur as part of the evaluation of the project.

4. Wetlands and Aquatic Resources

U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) and U.S. Geological Survey (USGS) National Hydrography Dataset (NHD) indicated no wetlands, streams, or other aquatic resources identified within the Study Area. However, desktop analysis of aerial imagery indicates the presence of five potential road ditch wetlands within the Study Area. Initial impacts were measured based on these areas. For planning purposes minor impacts of these resources are anticipated to be less than 0.10 acres for each of the alternatives as shown in Table XX below. Field aquatic resource delineations will be performed once a project alternative is selected.

PRELIMINARY COST

Preliminary construction costs were developed for each alternative based on 2023 construction costs. These estimates are based on preliminary engineering, and will require modification during project development; however, they provide for an initial comparison of the proposed intersection improvements.

1. Estimated Construction Cost

Construction estimates were developed for each alternative based on the planning level design and 2023 dollars. Estimates include the overall cost of construction, engineering contingency and estimated right-of-way acquisition. The estimates for the alternatives ranged from \$28.3 million to \$47.3 million dollars.

RIGHT-OF-WAY

This category evaluates right-of-way acquisition required to complete each alternative.

1. Right-of-Way Impacts

This criterion evaluated the estimate acquisitions, in acres, needed to complete the proposed alternatives. Additional acquisition ranging from 0.1 acres to 1.5 or more acres would be required to construct some alternatives.

2. Impacted Parcels

The total number of impact parcels (parcels that right-of-way would be acquired from) were assessed in this criterion. Of the alternatives requiring acquisition, one to five parcels of land would be impacted.

3. Total and Partial Property Acquisitions

Depending on the total right-of-way needed, acquisition will result in total or partial takes. A total property acquisition includes the purchase of an entire parcel for highway right-of-way. In some cases, these total acquisitions can also result in relocations if a residence or business is located on the parcel. This criterion evaluated the number of total and partial property acquisitions required for each alternative.

COMPLEXITY

Proposed improvements can vary in complexity related to construction, construction timeline, and driver familiarity. This category was developed to evaluate the complexity of each alternative against these three criteria.

1. Construction Timeline

The estimated construction timeline needed to complete the proposed improvements was evaluated with this criterion. Proposed alternatives are anticipated for completion in two to three construction seasons, assuming typical conditions and an early phase to setup crossovers and widening in advance of major interchange staging. Alternatives that could be completed within two seasons were considered to meet the evaluation criteria.

2. Constructability

Constructability evaluates the alternatives complexity in staging and evaluates the following:

- Drivers' ability to clearly travel through the work zone.
- Safety from motorized and non-motorized users to travel through the worksite.
- Safety for crews working adjacent to traffic.
- Number of phases to construct the alternative and the necessity of temporary work not utilized as part of the permanent construction (i.e., temporary crossovers/widenings that are not utilized as part of the permanent embankment/grading).

3. Driver Familiarity

This criterion provided a qualitative evaluation of the driver familiarity with the proposed improvements. This analysis utilized the presence of similar transportation solutions within the region that drivers are more familiar with. For example, there are no Diverging Diamond Interchange constructed within NDDOT District 1 or within the State of North Dakota, resulting in a solution (Alternative 3) that will be unfamiliar to most drivers in the region.

EVALUATION MATRIX

An evaluation matrix was developed to compare the results of the alternative comparison between each of the defined criteria. This evaluation provided a format for scoring and ranking each of the alternatives based upon the priority's evaluation criteria. The scoring helped to separate the benefits and impacts between each alternative. Public and agency input received throughout the planning process helped to identify a score for qualitative evaluation criteria.

SCORING CRITERIA

Each alternative was assigned a score based on criterion identified in the project feasibility report. Scores were assigned based on the alternative's ability to meet each criterion.

- 5 Points – The alternative demonstrates the highest benefit and/or provides no impact to the screening criteria.
- 4 Points - The alternative is acceptable and provides benefit and/or no impact to the screening criteria but is less desirable than the alternatives receiving 5 points.
- 3 Points – The alternative moderately satisfies the criteria and provides no distinguishing characteristics.
- 2 Points – The alternative demonstrates potential impacts of concern and/or offers little to no benefit to the evaluation criteria when compared to other alternatives.
- 1 Point – The alternative fails to meet the evaluation criteria and demonstrates the highest impact and/or no benefit.

TABLE 10: INTERCHANGE ALTERNATIVE RANKING SUMMARY

Weight			No Build		Alternative 1		Alternative 2		Alternative 3		Alternative 4							
			Signalized		Roundabouts		Signalized		Roundabouts		Signalized		Roundabouts		Alternative 4			
			Data	Score	Data	Score	Data	Score	Data	Score	Data	Score	Data	Score	Data	Score		
	Purpose and Need																	
	1	Addresses Purpose and Need Statement	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No						
1.10	Traffic Operations (See Traffic Operations Report)																	
	1	Intersection Operations	1	5	5	5	5	5	5	1								
	2	Queuing/Intersection Spacing	1	5	5	3	3	4	4	2								
	3	Travel Time	1	4	4	4	4	2	2	5								
	4	Network Delay	1	5	5	5	5	5	5	5								
	5	I-94 Operations	1	4	4	4	4	4	4	1								
	6	Multimodal	1	2	2	3	3	2	2	4								
1.50	Safety																	
	1	Reduction in Crashes (Fatal/Injury)	0%	2	-18%	4	-23%	5	5%	1	0%	2	-9%	3	-14%	4	-32%	5
	2	Reduction in Crashes (Property Damage Only)	0%	2	0%	2	-8%	3	-8%	3	-15%	4	-8%	3	-15%	4	-31%	5
1.20	Heavy Commercial Compatability																	
	1	Ability to accommodate year round heavy commercial traffic	Poor	1	Good	5	Mod	4	Good	5	Mod	4	Good	5	Mod	4	Acc	3
1.10	Environmental Factors																	
	1	Soil and Farmlands	None	5	None	5	None	5	None	5	None	5	None	5	None	5	None	5
	2	Land Use/ Section 4F	None	5	None	4	None	3	None	4	None	3	None	4	None	3	None	3
	3	Visual	None	5	None	5	None	5	None	5	None	5	None	5	None	5	None	5
	4	Environmental Justice/Socioeconomic	None	5	None	5	None	5	None	4	None	4	None	4	None	4	None	4
	5	Cultural Resources and Historic Properties	None	5	None	5	None	5	None	5	None	5	None	5	None	5	None	5
	6	Air Quality	None	2	None	5	None	5	None	5	None	5	None	5	None	5	None	5
	7	Noise	None	5	None	5	None	5	None	3	None	3	None	5	None	5	None	5
	8	Water Quality	None	5	None	5	None	5	None	5	None	5	None	5	None	5	None	5
	9	Wetlands and Aquatic Resources	None	5	0.06	4	0.06	4	0.02	4	0.02	4	0.07	4	0.06	4	0.03	4
	10	Threatended and Endangered Species	None	5	None	5	None	5	None	5	None	5	None	5	None	5	None	5
	11	Wildlife	None	5	None	5	None	5	None	5	None	5	None	5	None	5	None	5
	12	Floodplains	None	5	None	5	None	5	None	5	None	2	None	5	None	5	None	5
	13	Wild and Scenic Rivers	None	5	None	5	None	5	None	5	None	5	None	5	None	5	None	5
	14	Coastal Barrier/Coastal Zone	None	5	None	5	None	5	None	5	None	5	None	5	None	5	None	5
	15	Hazardous Waste	None	5	None	5	None	5	None	5	None	5	None	5	None	5	None	5
1.10	Preliminary Costs																	
	1	Estimated Construction Costs (2023 Dollars)	0	5	45.8	2	47.3	2	34.8	4	39.7	3	45.4	2	45.5	2	34.5	4
1.05	Right-of-Way																	
	1	Right-of-Way Impact Area (acreage)	0	5	0.06	5	0.068	5	1.29	3	1.47	3	0.4	4	0.39	4	0.45	4
	2	Impacted Parcels (number)	0	5	4	3	4	3	5	2	5	2	4	3	4	3	4	3
	3	Total Property Acquisitions (number)	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5
	4	Partial Property Acquisitions (number)	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5
1.00	Complexity																	
	1	Construction Timeline	Good	5	Good	4		4		5		4		4		4		4
	2	Constructability	Good	5	Good	5		4		3		3		4		3		3
	3	Driver familiarity	Good	5	Mod	3	Low	2	Good	5	Good	4	Low	2	Low	2	Mod	3
Overall Weighted Score			135.5		156.1		155.0		148.8		143.3		148.7		148.6		149.4	
Ranking			**		1		2		3		6		4		5		**	

** Alternative does not meet purpose and need

16. Evaluation Results

The results of this alternatives evaluation indicate Alternative 1 (Single Point Urban Interchange) with traffic signals at Old Red Trail and Boundary Street is the best based upon the evaluation criteria and rankings in Table 10 followed closely by Alternative #1 with roundabout at Old Red Trail and Boundary Street NW. All four of the alternatives exhibit both positive and negative impacts, but Alternative 1 ranks the highest given the analysis described above and has public support based on the comments received as described in Section 6.