APPENDIX A

TRAFFIC ANALYSIS

1) 9/15/06 Traffic Analysis Memo; revised 9/29/06, 11/1/06, and 1/02/07
2) 7/6/09 SDDOT Traffic Analysis Recommendations for SD20/US81 Intersection

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Memo

To:	Watertown South Connector Process Team Members: SDDOT - Terry Keller (Office of Project Development) - Jeff Senst (Aberdeen Region Engineer) - Ron Sherman (Watertown Area Engineer) - Rich Laughlin (Corridor Preservation Specialist – Sioux Falls) Watertown - Herb Blomquist, Director of Public Works
From: HDR	Project: Watertown South Connector
Date: September 15, 2006; revised 9/29/06, 11/1/06, 1/02/07	Job No: 39319

RE: Traffic Analysis and Roadway Lane Recommendations

Purpose

The purpose of this memorandum is to

1. Present the traffic analysis for the proposed south connector
2. Recommend the travel lane layout for the proposed south connector

Background

The proposed South Connector roadway project is considered a vital part of the City of Watertown's long range transportation system. According to the Watertown Area Transportation Plan (updated in 2005), the south connector is needed to relieve congestion and reduce accidents on Highway 212 and to provide good access, especially for trucks, to the rapidly developing industrial area on the City's south side.

The Watertown Comprehensive Land Use Plan contains the following statements:

> *"Highway 212 is the most traveled thoroughfare within the community. The traffic volumes combined with the incidence of accidents and the future planned development of the Endres Industrial Park, Mallard Point Business Park and the Terry Redlin Art Museum will continue to make this thoroughfare a corridor of concern. The following three recommendations may alleviate problems and facilitate traffic flow along Highway 212."* The third of the recommendations is:
>
> > *"There are three (3) major traffic linkages shown on the Major Street Plan Map which are intended to improve the arterial grid and provide alternative routes for cross-town and through traffic."* The third of the linkages is:
> >
> > > *"The third linkage is a possible southern business route which would connect Interstate 29 to either U.S. Highway 81 or South Dakota 20. Until an additional off-ramp can be constructed south of U.S. Highway 212 which would link U.S. Highway 81 to Interstate 29, an intermediate solution may be to utilize 29th Street East and 20th Avenue South as a means to reduce truck traffic on U.S. Highway 212 between U.S. Highway 81 and Interstate 29. An additional scenario may be to extend a road from South Dakota Highway 20 east to a point along Broadway Street somewhere north of 20th Avenue South."*

Traffic Volumes Analysis

The attached graphic "Traffic Volumes and Lane Configurations" (Figure 1) shows:

- Current Daily Traffic Volumes (based on data compiled from years 2000 to 2004)
- Future (year 2030) Daily Traffic Volumes **without** South Connector
- Future (year 2030) Daily Traffic Volumes **with** South Connector

The first 2 sets of traffic volumes were included in the Watertown Area Transportation Plan – 2005 Update prepared by URS Corporation.

The third set of traffic volumes was provided to HDR by URS in May 2006. These volumes are based on the Watertown area regional travel demand model established as part of the transportation plan update.

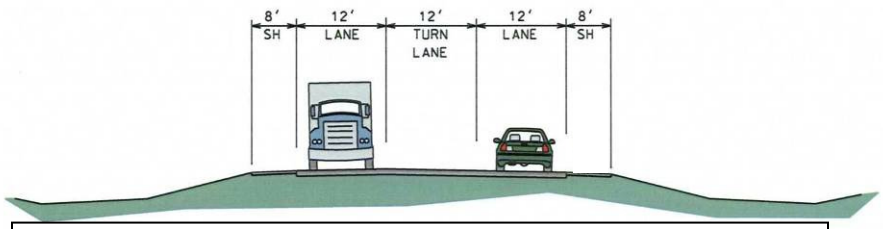
Level of Service Considerations

Segments 1 and 2A

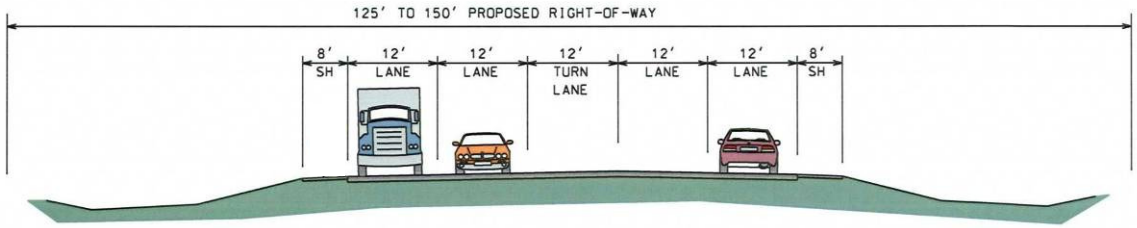
HDR has determined that South Connector segments 1 and 2A would operate at a planning[1] level of service "C" or better throughout the design period (to year 2030) with a 3 lane undivided roadway section. With this section, the center lane would be a continuous two way left turn lane. (The section of 20th Avenue between the Big Sioux River and Willow Creek will likely not need a center two-way left turn lane. There would not be enough turning traffic or access points to warrant a center turn lane except at 17th Street.) Traffic flow would benefit from right turn lanes at high volume trip generator sites such as Great Plains Ethanol Plant and at major intersections.

It is proposed that the Environmental Assessment (EA) and right-of-way acquisition be based on the potential future expansion of segments 1 and 2A to a 5 lane roadway. The timeframe of this expansion is unknown at this time. At the August 8, 2006 public meeting, it was noted that Segment 2A would likely remain a 3 lane section. However, after further analysis, it seems reasonable to allow for a future expansion to 5 lanes for Segment 2A.

The proposed typical sections for Segment 1 (along 20th Avenue) and Segment 2A are shown below.



Interim Typical Section – *Segment 1* from US 81 to 29th Street SE and *Segment 2A*

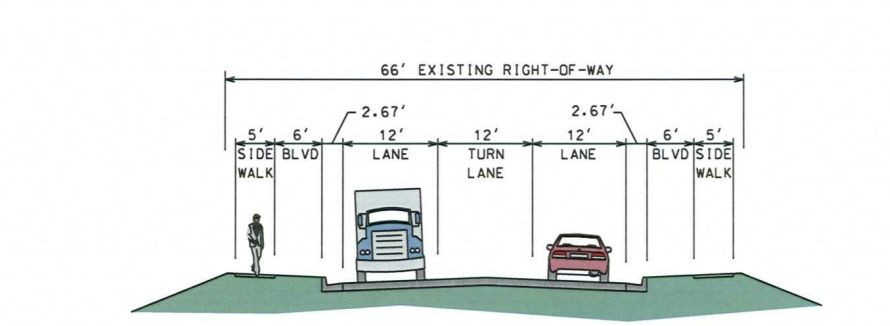


Ultimate Typical Section – *Segment 1* from US 81 to 29th Street SE and *Segment 2A*

HDR recommends that a 3 lane roadway section, interim and ultimate, is adequate for the portion of Segment 1 along 29th Street SE from 20th Avenue to just south of Highway 212. At this location, a 3-lane section already exists. This recommendation is based on these considerations:

- Once the proposed future interchange at I-29 (Segment 2B) is constructed, most of the traffic that utilized 29th Street SE will re-route to I-29. The travel demand model assumed option 3 for Segment 2B in its traffic forecasts. It seems reasonable that if Options 1 or 2 would be constructed for Segment 2B, a larger volume of vehicles would re-route to I-29 than the 3500 vehicles per day predicted by the model. During the preparation of the Interchange Justification Report (IJR) for Segment 2B, the model will be updated for all options.
- If the proposed I-29/20th Avenue South interchange is not constructed, it is unlikely that traffic volumes on the South Connector would ever increase to the point of justifying a 5 lane roadway section. If future development pressures dictate expansion to a 5 lane roadway section, the added cost for construction and right-of-way could potentially be the responsibility of the developments.

The proposed typical section for Segment 1 along 29th Street is shown below.



Segment 1 Typical Section
Looking North
29th Street SE from 20th Avenue to Existing 3-Lane Section (Urban)

Segment 2B

For Segment 2B, lane configuration will depend on proximity to the new interchange. SDDOT access control standards will limit access points (and the accompanying need for a center turn lane) near the interchange. However, beyond the access control limits, there will be access driveways to the South Connector and therefore a center turn lane will be needed. The lane layout at the I-29 interchange would be as shown on Figure 1. The updated Watertown area travel demand model will be used to determine traffic volumes on Segment 2B for all 3 options. This will be done as part of the Interchange Justification Report. At this time, it seems reasonable to use the same typical section for Segment 2B as for Segments 1 and 2A.

Lane and shoulder widths

Standard 12 foot travel lane widths are proposed for the South Connector. Shoulder widths are recommended to be 8 foot; this is based on the SDDOT guidelines which take into account anticipated average daily traffic volumes. The expected high proportion of truck traffic on the South Connector also would justify 8 foot shoulder widths.

Construction sequencing

In all segments, the 3 lane roadway section will be built first as indicated on Figure 1. It is recommended that the future lanes be added on each side of the initial 3 lanes. The benefits of this sequence would be:

- Right turn lanes may be added on each side of the South Connector as needed during the next 20+ years. The right turn lanes could then simply be extended to create a 5-lane section without significantly modifying the initial 3 lanes.
- Most of the South Connector is being initially designed as a rural roadway section. Where appropriate, based on adjacent development, curb and gutter could be constructed with the added outside lanes to create an urban roadway section. Again, this could be done without significantly modifying the initial 3 lanes.

Conclusion

Proper lane configuration for the South Connector is a critical aspect of the project. The roadway must operate adequately for the design period (from construction completion to year 2030). Provisions must also be made to ensure that the roadway can be expanded in the future to accommodate long term demand. The lane configurations illustrated on Figure 1 are recommended to meet short and long term traffic conditions. The project design and Environmental Assessment will proceed based on the recommended lane configurations.

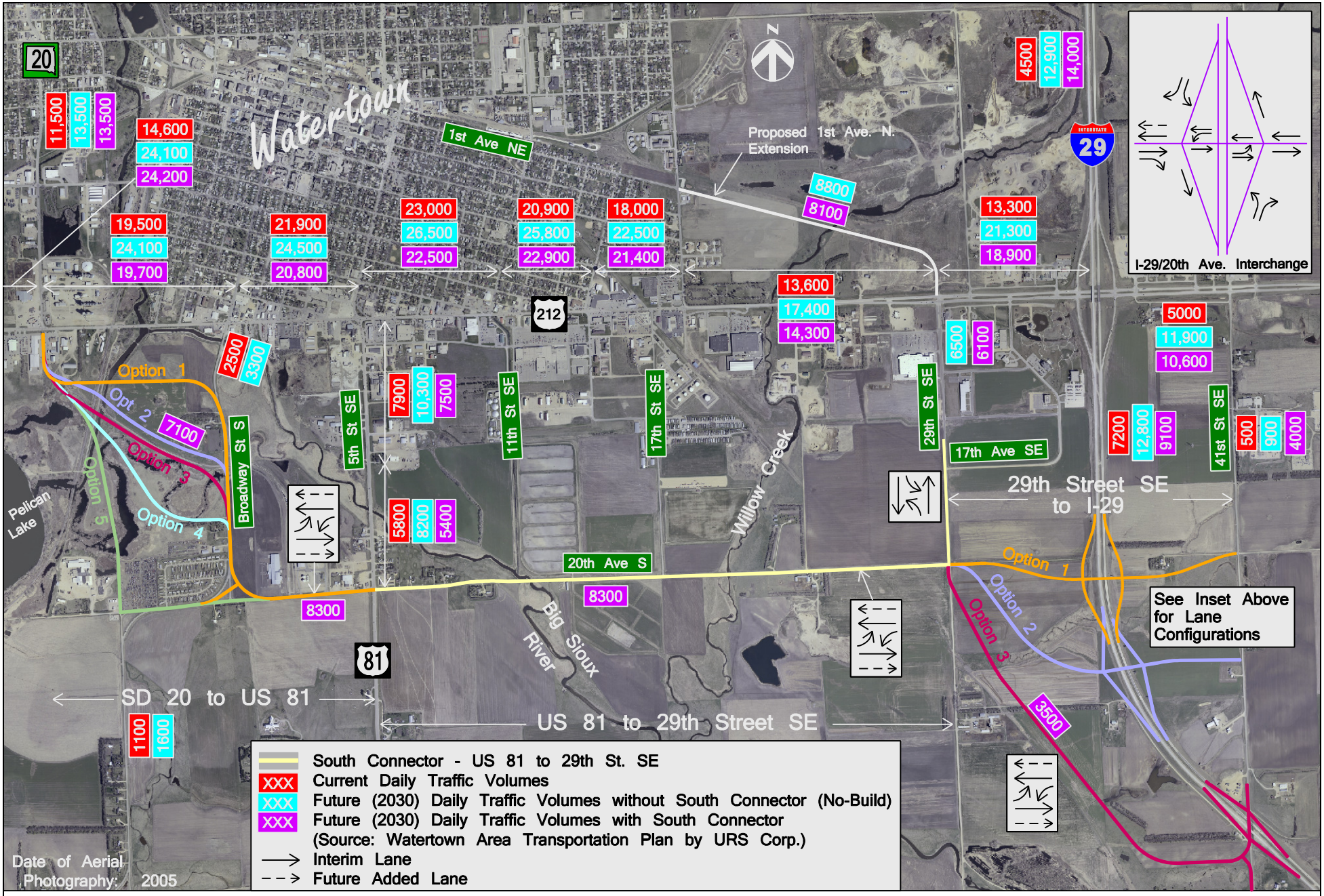
[1] The planning level of service was determined using the 2002 Florida DOT Quality/Level of Service Handbook, a tool used for planning or preliminary engineering level of analysis. The Florida DOT Handbook is based on nationally established procedures, with definitions and methodology based on the Highway Capacity Manual (HCM) 2000, as well as collected field data. The generalized tables in this handbook are recommended for future year analysis where roadway, traffic, and signalization characteristics are uncertain. The annual average daily traffic (AADT) tables in the handbook show maximum service volumes, which is the highest number of vehicles on a specific type of roadway segment, for a given level of service (LOS). Table 4-2 of the handbook was used for this analysis, as it is for a "fringe" area anticipated to become part of an urbanized area in the future. Inputs to the LOS tables include roadway classification and number of lanes. The classification Arterial Class II fits the South Connector.

Lanes	Median	Planning Level of Service				
		A	B	C	D	E
2	undivided	n/a	n/a	10,500	14,500	15,300
4	divided*	n/a	3,700	24,400	30,600	32,200

n/a: not available

* "Divided" does not necessarily indicate raised median. In this case, a 4 lane roadway with a center two way left turn lane would be considered a divided roadway.

HDR has conducted further research based on the same established procedures and assumptions as the Florida DOT Handbook and the Highway Capacity Manual. That research has resulted in a planning level of service "C" threshold of 11,400 AADT with a 3 lane roadway section, the middle lane functioning as a two way left turn lane. Right turn lanes at intersections and/or high volume traffic generators will further increase capacity to a level of service "C" threshold of 16,000 AADT.



Drawn by: B. Miller
Date: 9-29-06

Checked by: J. Unruh
Date: 9-29-06

Revision Date: May 2007

WATERTOWN South Dakota's Rising Star

South Dakota DOT Department of Transportation

HDR

Traffic Volumes and Lane Configurations

Watertown South Connector, Codington County, SD
Project EM 4411(01) PCN 00RV

Figure A-1

M E M O R A N D U M

TO: Jeff Senst, Aberdeen
Region Engineer
Mark Leiferman, Chief Road Design
Engineer

FROM: Dan Martell, Traffic Design
Engineer Specialist

DATE: July 6, 2009

SUBJECT: Traffic Analysis Recommendations

RE: P 4020(01), Codington County, PCN 00RW
New Street fm SD20 to US81 Segment 2 of the South Connector at Watertown
Structure #'s 15-179-183 (Diversion Channel) & 15-184-186 (Cutoff Channel)
Grading, Structures, Surfacing & Signals

The South Dakota Department of Transportation is currently developing plans to construct the Watertown South Connector between SD20 and US81. The purpose of this report is to make recommendations for geometric or operational considerations of the intersection of US212 & SD20 with the addition of the South Connector.

The study analyzes the existing conditions and projected conditions in terms of level of service (LOS).

Existing Conditions

US212 and SD20 is the junction of two principal arterials on the west side of Watertown. The intersection is currently a T intersection with US212 being an east west route and SD20 is a T on the north side of US212. The traffic signal at this intersection is currently operating fully actuated with an eastbound left turn phase. The number of existing lanes is as follows for each approach.

North Approach:	Two left turn lanes with the outside left turn lane having a right turn slip lane.
East Approach:	Two through lanes with the outside through lane having a right turn slip lane.
West Approach:	One left turn lane with 100' of storage. Two through lanes.

Existing peak hour turning movement traffic volumes are shown on Figure 1.

Traffic Volume Projections

The 2030 projected daily traffic volumes come from the 2006 Watertown South Connector study done by HDR. Projected hourly turning movement volumes were then calculated using methods from NCHRP 255.

Traffic Analysis

A level of Service (LOS) was done for the intersection of US212 & SD20 for the following options:

- Existing conditions (Figure 2).
- Projected traffic volumes with pavement marking striping of existing roadway (Figure 4)
- Projected traffic volumes with proposed lanes (Figure 5).

The intersection capacity analyses were completed using software based on the Highway Capacity manual.

The concept of LOS has been developed to correlate numerical traffic data to subjectively describe traffic performance at an intersection.

The description for level of service (LOS) of a signalized intersection is as follows:

LOS A	$\leq$ 10.0 sec/veh of control delay. Low control delay. Many vehicles do not stop.
LOS B	10.1 – 20.0 sec/veh of control delay. A few more vehicles stop than LOS A.
LOS C	20.1 – 35.0 sec/veh of control delay. Individual cycle failures may begin to appear. The number of vehicles stopping increases significantly, though many vehicles pass through the intersection without stopping.
LOS D	35.1 – 55.0 sec/veh of control delay. Many vehicles stop, and the portion of vehicles not stopping declines. Individual cycle failures are noticeable.
LOS E	55.1 – 80.0 sec/veh average delay. Individual cycles failures frequent.
LOS F	>80.0 sec/veh of control delay. Capacity of the intersection is exceeded.

FIGURE 1
US212 & SD20
EXISTING VOLUMES
APRIL 2009

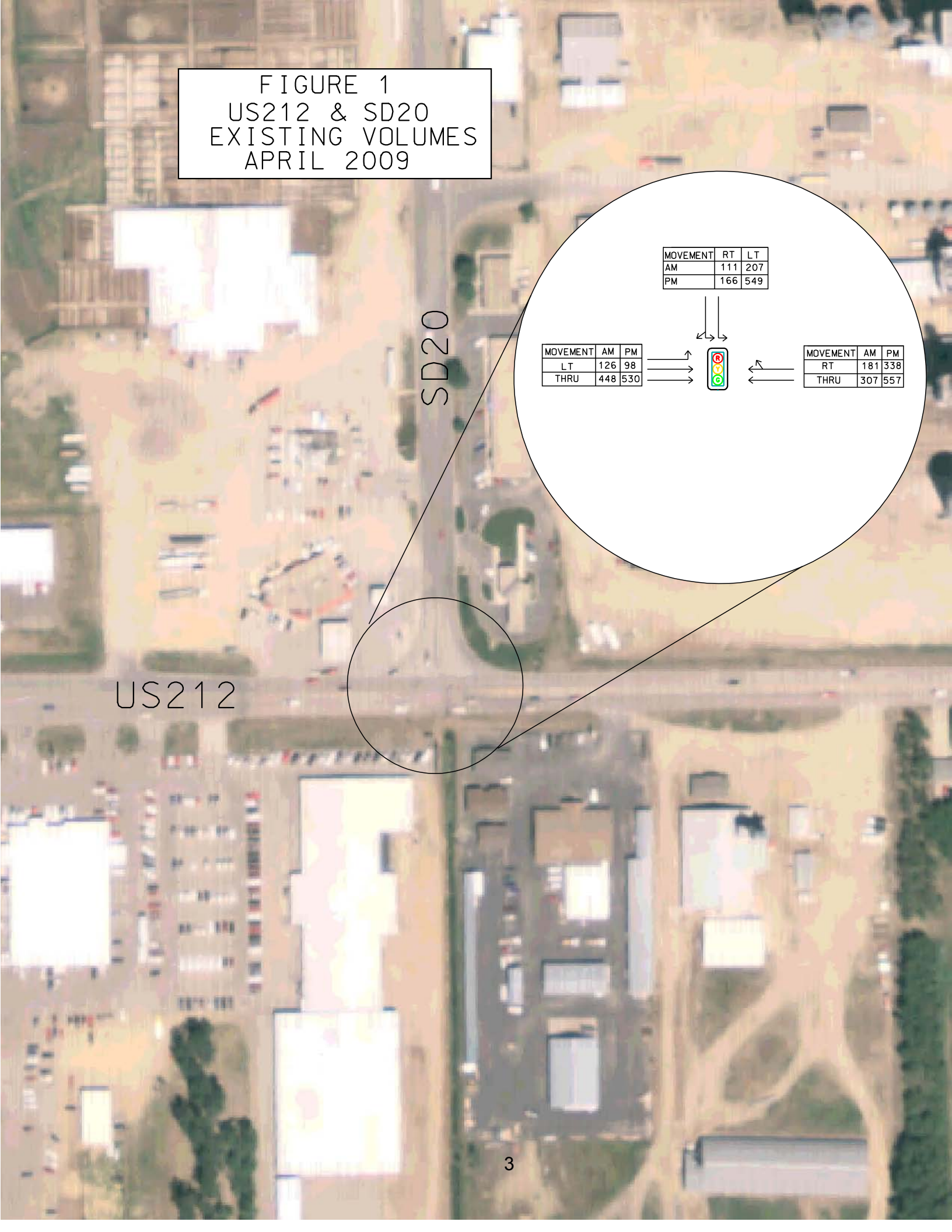


FIGURE 2
US212 & SD20
EXISTING LOS
& QUEUE LENGTHS
APRIL 2009

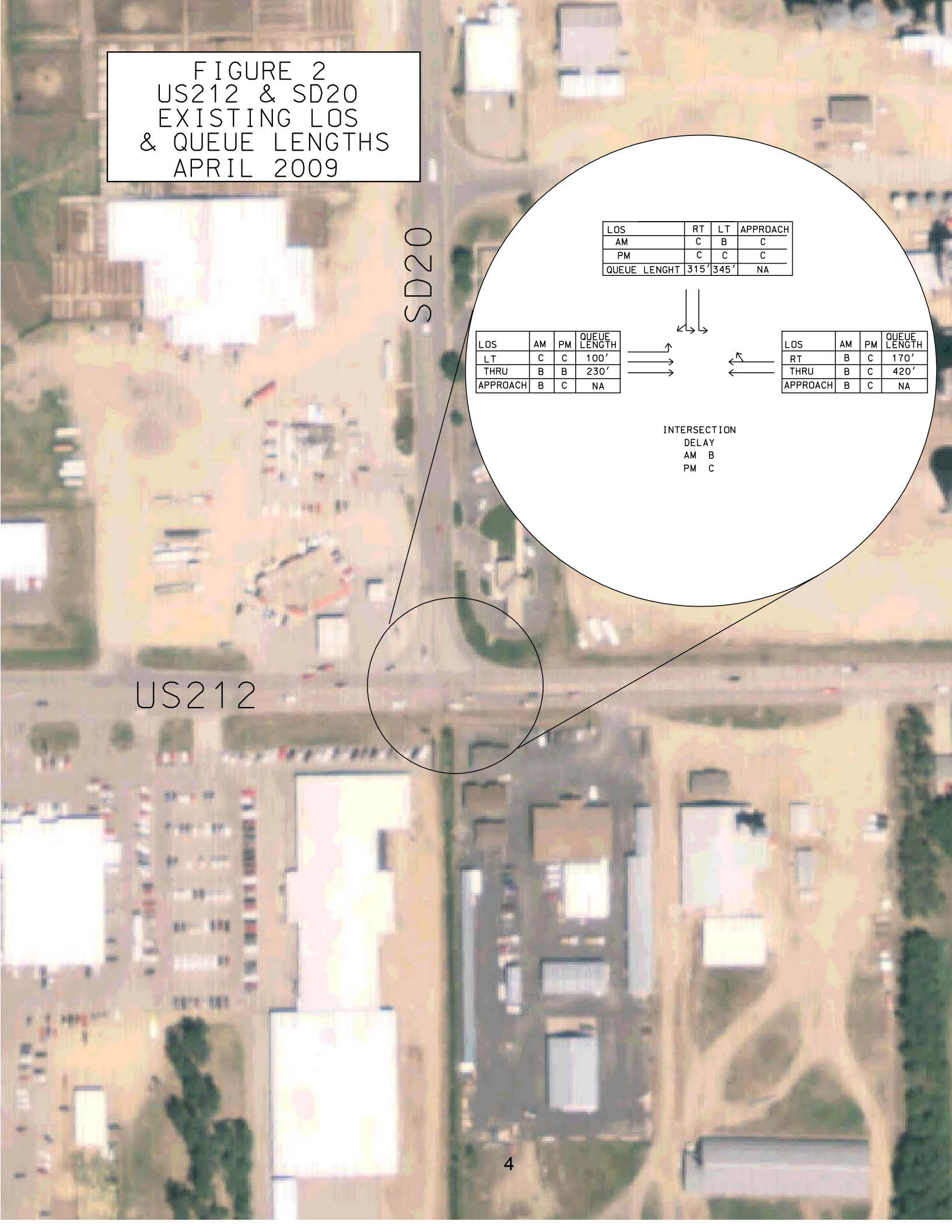


FIGURE 3
US212 & SD20
PROJECTED VOLUMES
2030

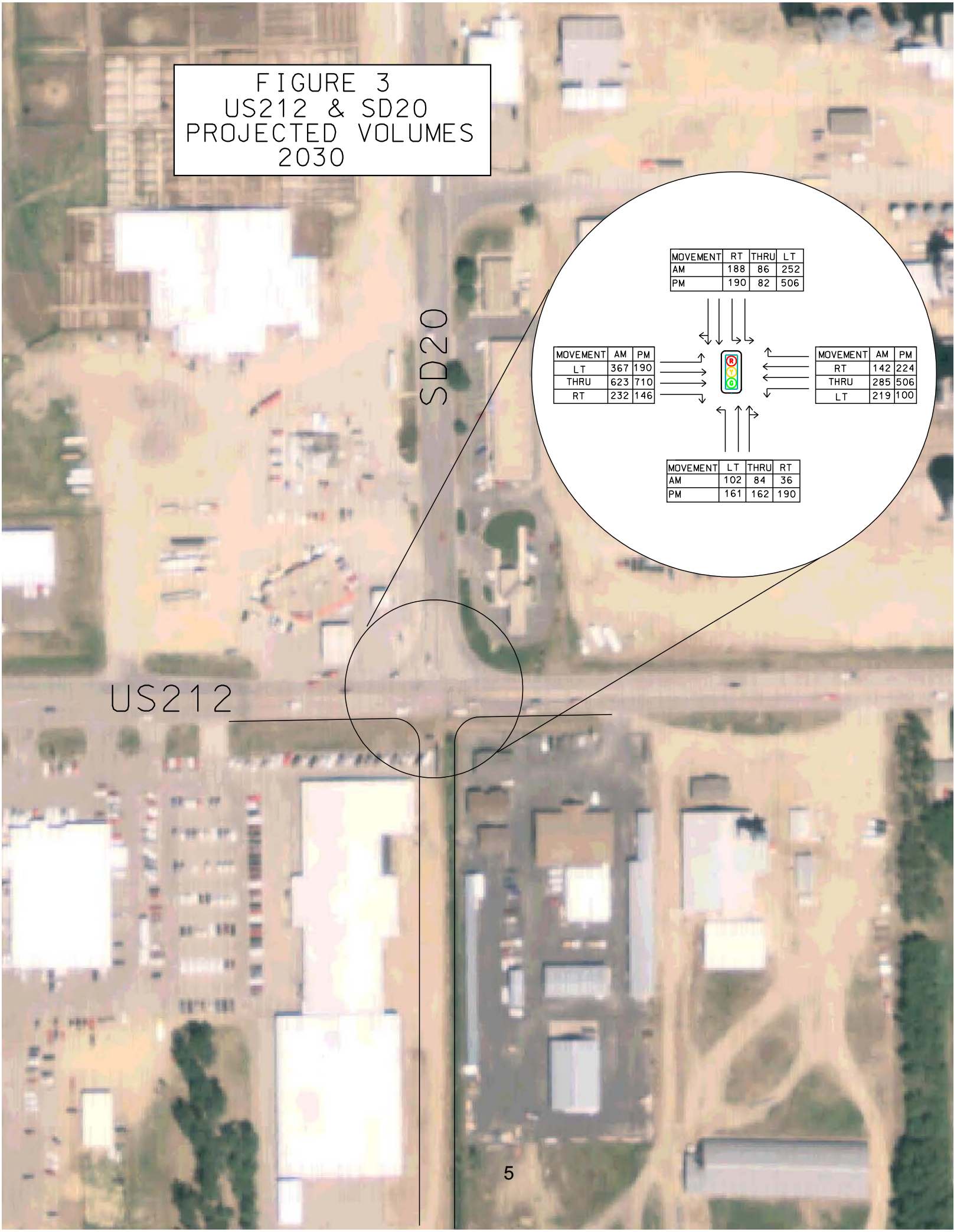


FIGURE 4
US212 & SD20
PROJECTED LOS
& QUEUE LENGTHS
2030

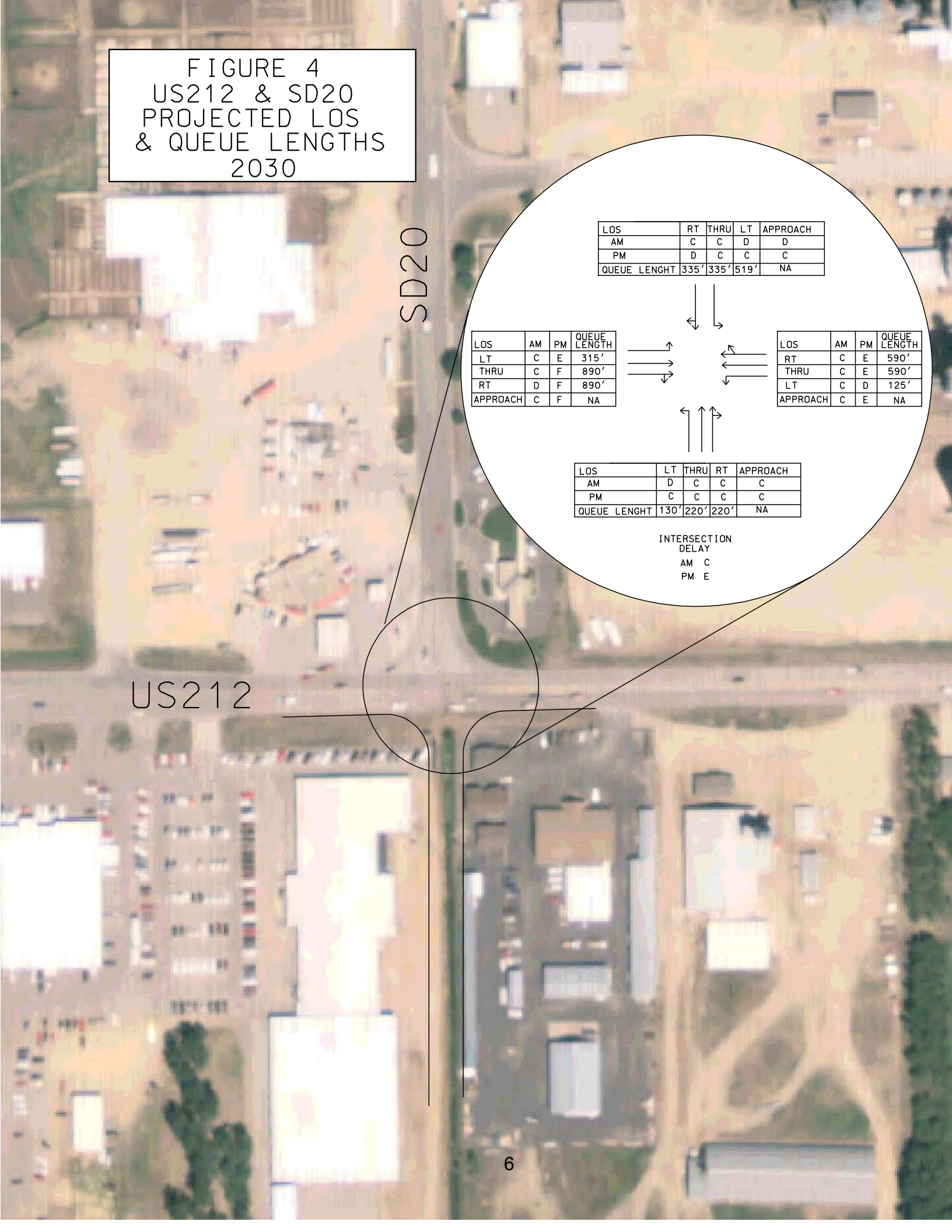
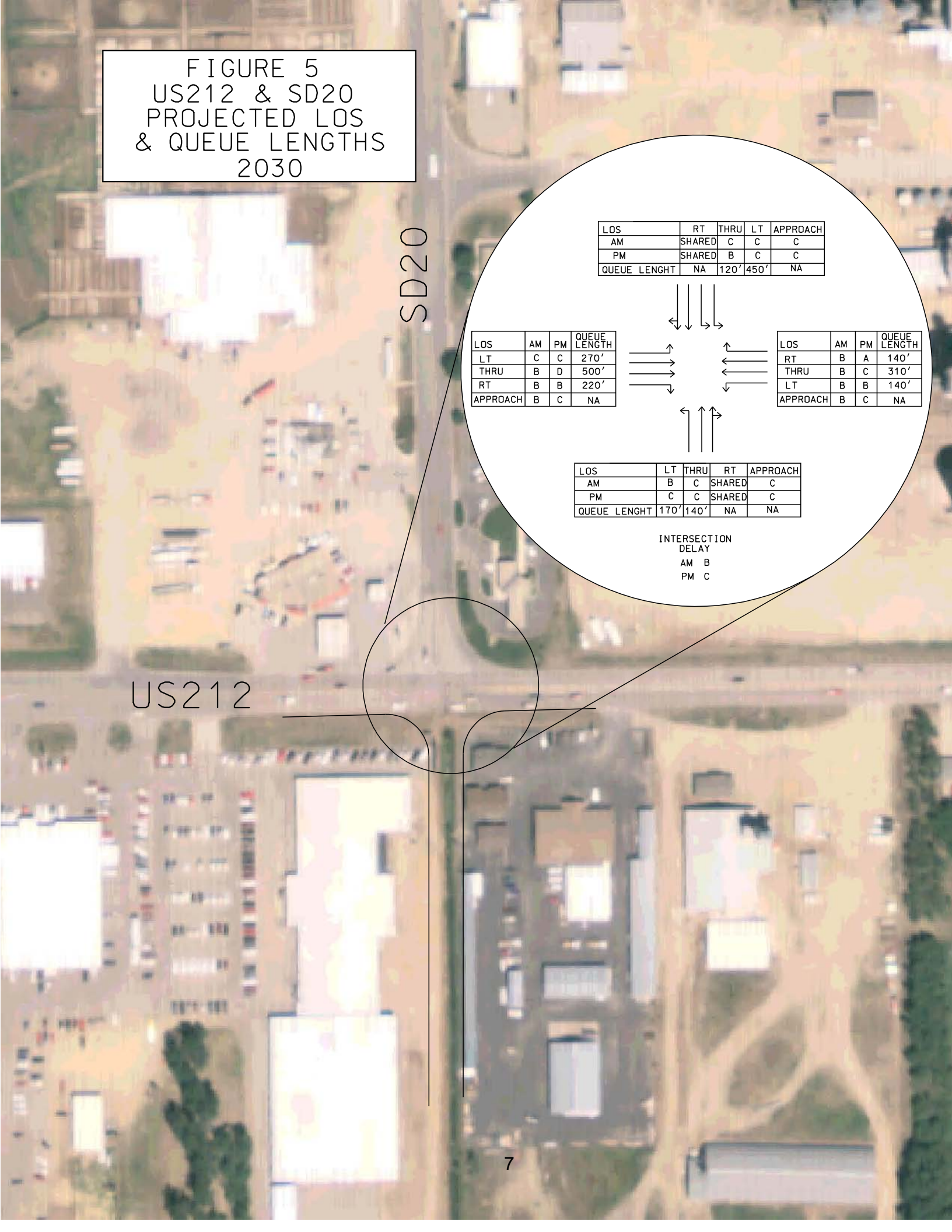


FIGURE 5
US212 & SD20
PROJECTED LOS
& QUEUE LENGTHS
2030



Summary and Recommendations

The existing traffic conditions were analyzed to establish a baseline condition for comparison. Then traffic volumes were projected for the year 2030 and LOS analyzed for the recommend lane configuration (figure 5).

If no changes were to be made to the existing intersection, with the exception of pavement marking changes to accommodate the addition of the South Connector (figure 4) the intersection would operate at a LOS of C with a delay of 30.9 seconds for the AM and LOS of E for the PM with a delay of 61.8 seconds for the 2030 projected traffic volumes. The through movements for the eastbound and westbound traffic would operate at a level service of F and E for the PM projected peak traffic volumes. With the addition of an eastbound and westbound right turn lane the LOS for the intersection would be B for the AM and C for the PM. The through traffic LOS would be D for the eastbound and C for the westbound for the PM peak traffic volumes with the additional right turn lanes.

The recommendations for the number of lanes are as follows:

North Approach:	One left turn lane with 450' of queue length plus deceleration. Two through lanes with the outside lane being a combination through and right turn lane.
South Approach:	One left turn lane with 170' of queue storage. Two through lanes with the outside lane being a combination through and right turn lane.
East Approach:	One left turn lane with 140'of queue length plus deceleration Two through lanes One right turn lane with 140' feet of queue length plus deceleration.
West Approach:	One left turn lane with 270'of queue length plus deceleration Two through lanes One right turn lane with 220' feet of queue length plus deceleration.

cc: Ron Sherman, Watertown Area Engineer
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