



CITY OF RAPID CITY

RAPID CITY, SOUTH DAKOTA 57701

Public Works Department Engineering Services Division

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MEMORANDUM

TO: Mayor Alan Hanks

FROM: John Less
Traffic Engineer

THROUGH: Robert Ellis
Public Works Director

Dale Tech
City Engineer

SUBJECT: W. Main Street, Cross St. To West St.
Median Evaluation Study

DATE: August 11, 2009

INTRODUCTION

Every intersection and driveway approach to a roadway creates conflict points at which vehicles have to share right-of-way. In an urban environment, the aggregate of these conflict points has a direct effect on roadway operations. To address these effects, transportation planners and engineers employ a variety of strategies that fall under the general description of access management. The goal of access management is to balance the need for property access with the goal of preserving to the largest extent possible the safety and efficiency of the roadway system. The purpose of this study is to examine in detail traffic operations along W. Main Street between Cross Street and West Street and to evaluate the particular access management strategy of a median to determine if it is appropriate for present conditions and for anticipated future conditions.



EQUAL HOUSING
OPPORTUNITY

EQUAL OPPORTUNITY EMPLOYER

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TRAFFIC OPERATIONS

Crash History

Motor vehicle crashes are relatively rare and unpredictable events that impose significant societal costs in the form of lost financial resources, injuries and fatalities. All of the factors resulting from a crash are the result of the interaction of many contributing elements arising from the human operator, the vehicle, the physical roadway environment and the prevailing social/economic environment. It is important to note that the inherent variability in the various elements make it inevitable that crashes will occur, despite whatever engineering strategies are applied to a roadway or intersection. The crash rate for a roadway segment, expressed in the number of annual crashes per 100-million vehicle miles traveled, provides a quantitative tool to help identify locations that have an abnormal concentration of crashes.

The following table presents the 2000 – 2008 State reported crash history of the subject segment of W. Main Street:

Table 1 – Crash History 2000 – 2008

DATE	TIME	LOCATION	CRASH TYPE	INJURY*	COMMENTS
6/29/2000	11:50 AM	1600 BLOCK	EB-EB SIDESWIPE	5	
7/12/2000	5:30 PM	1300 BLOCK	WB-WB REAR END	5	
12/15/2000	2:55 PM	1400 BLOCK	EB-EB SIDESWIPE	5	
12/26/2000	3:53 PM	1300 BLOCK	WB-WB REAR END	5	ICY ROAD
5/24/2001	12:05 PM	1300 BLOCK	WB-WB REAR END	4	
9/6/2001	7:12 AM	1300 BLOCK	WB-WB REAR END	5	
6/25/2002	11:45 AM	1300 BLOCK	WB-WB REAR END	5	
7/23/2002	5:33 PM	1300 BLOCK	WB-WB REAR END	5	
8/6/2002	5:28 PM	1300 BLOCK	WB-WB REAR END	5	
6/17/2003	3:41 PM	1300 BLOCK	EB FIXED OBJECT	5	LOOSE TIRE HIT CAR
7/24/2003	12:39 PM	1400 BLOCK	EB-EB REAR END	4	
10/30/2003	6:05 PM	1300 BLOCK	WB-WB REAR END	5	
3/15/2004	2:06 PM	1600 BLOCK	EB-EB REAR END	4	
5/7/2004	3:41 PM	1300 BLOCK	WB-WB REAR END	3	
1/5/2005	2:12 PM	1300 BLOCK	WB-EB ANGLE	5	ICY ROAD
3/3/2005	7:58 AM	1400 BLOCK	EB-EB REAR END	4	
3/15/2005	4:32 PM	1400 BLOCK	SB LT FAILED TO YIELD TO EB	5	ROOSTER DRIVEWAY
4/15/2005	5:05 PM	1300 BLOCK	EB-EB REAR END	5	
5/25/2005	8:41 AM	1300 BLOCK	WB-WB REAR END	5	
6/27/2005	8:13 PM	1600 BLOCK	DEER HIT	5	

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7/18/2005	11:59 AM	1400 BLOCK	WB-WB REAR END	5	
1/11/2006	4:31 PM	1300 BLOCK	SB LT FAILED TO YIELD TO EB	2	DRIVEWAY
6/7/2007	9:55 AM	1500 BLOCK	EB-EB REAR END	5	ICY ROAD
8/24/2007	2:36 PM	UNKNOWN	EB-EB SIDE SWIPE	5	

* INJURY: 5 = PROPERTY DAMAGE ONLY, 4 = POSSIBLE INJURY, 3 = NON-INCAPACITATING INJURY, 2 = INCAPACITATING INJURY, 1 = FATALITY

The following table presents the calculated segment crash rate together with the State-wide reported crash rate:

Table 2 – State-wide Crash Rate Comparison

YEAR	CRASHES	ADT	CRASH RATE*	STATE-WIDE CRASH RATE**
2000	4	41,900	93.4	234.16
2001	2	40,200	48.7	211.43
2002	3	41,200	71.2	204.47
2003	3	44,500	66.0	215.99
2004	2	43,200	45.3	207.33
2005	7	46,000	148.9	200.07
2006	1	40,000	24.5	185.04
2007	2	39,000	50.2	191.25
2008	0	37,300	0	187.8
AVERAGE			60.9	204.2

* ANNUAL CRASHES PER 100-MILLION VEHICLE MILES TRAVELED

** SOURCE: SOUTH DAKOTA DEPT. OF PUBLIC SAFETY

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The following table presents a comparison of the calculated segment crash rate with those of other City roadways:

Table 3 – Crash Rate Comparison

YEAR	CRASH RATE*					
	W. MAIN ST. (CROSS ST. TO WEST ST.)	OMAHA ST. (LACROSSE ST. TO CAMBELL ST.)	JACKSON BLVD. (32ND ST. TO PARK DR.)	MAIN ST. (STURGIS RD. TO SHERIDAN LAKE RD.)	MAIN ST. (SHERIDAN LAKE RD. TO MOUNTAINVIEW RD.)	SHERIDAN LAKE RD. (CORRAL DR. TO JACKSON BLVD.)
2004	45.3	115.8	40.0	212.7	338.5	65.8
2005	148.9	54.9	19.7	193.2	518.4	100.2
2006	24.5	200.8	0.0	175.3	446.4	142.3
2007	50.2	27.7	88.5	341.6	388.6	81.0
AVERAGE	67.2	99.8	37.1	230.7	423.0	97.3

* RATES EXCLUDE SIGNALIZED INTERSECTIONS AND ARE EXPRESSED IN ANNUAL CRASHES PER 100-MILLION VEHICLE MILES TRAVELED

Please note that data availability limited the comparison to the years presented.

A review was made of available South Dakota Department of Transportation Hazard Elimination & Safety (1988 – 1998) reports, Roadway Safety Inspection (2000 – 2005) reports and 5-Percent (2006 – 2008) reports. Each of these programs reviewed crash data to identify and study locations that appeared to have abnormal crash patterns, with the 5-Percent report focusing on those locations that had crashes resulting in incapacitating injuries or fatalities. The subject section of W. Main St. did not appear in any of the reports. The Cross St. intersection was reviewed in 1992 with a recommendation to provide an eastbound center left turn lane (project implemented by City). The Jackson Blvd. intersection was reviewed in 1998, 2005 and 2006; no action was recommended. The West St. intersection was reviewed in 2005 due to left turn related crashes; no action was recommended.

Sight Distance from Driveways

Intersection sight distance, looking to the west from the driveways in the 1400 block, is less than that suggested in the American Association of State Highway Transportation Officials' A Policy on Geometric Design of Highways and Streets, 5th edition, (2004). The sight distance is limited due to vegetation on the slope, just west of the west most driveway. Available sight distance is approximately equal to the recommended stopping sight distance for 35 MPH.

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Speed Study

The posted speed limit for W. Main St. in the study area is 35 MPH. The design speed shown on the circa 1974 construction plans is 40 MPH. Vehicle speed data was collected over three days the week of July 27th from 0800 to 1000, 1200 to 1400 and 1600 to 1800. The total sample size was 7,675 vehicles; the results of the study follow:

The 50th percentile speed was 35.0 MPH. The 50th percentile speed is the speed at which 50% of drivers are moving at or below.

The 85th percentile speed was 37.7 MPH. The 85th percentile speed is the speed at which 85% of drivers are moving at or below and is generally accepted as the speed that a prudent and reasonable driver will operate their vehicle at when taking into consideration such factors as road and weather conditions, traffic volumes, adjacent obstructions and distractions. The Manual on Uniform Traffic Control Devices (2003) suggests that, "When a speed limit is to be posted, it should be within 5 mph of the 85th-percentile speed of free-flowing traffic."

The 10 MPH pace group was 31 – 41 MPH, comprising 95.4% of the total sample. The 10 MPH pace group is the speed range in which the most vehicles travel.

The maximum observed speed was 58 MPH and occurred between 1600 and 1700.

Available Opportunities to Turn Left at Driveways

According to A Policy on Geometric Design of Highways and Streets, 5th edition, a driver turning left from a driveway on to a six-lane roadway needs an 8.5-second opening in the opposing traffic flow. A survey of available openings for a location midway in the study section was made for six representative hours, with the results summarized in the following table.

Table 4 – Available Openings in EB/WB Traffic Stream

HOUR BEGINNING	OPENINGS IN TRAFFIC FLOW > 8.5 SECONDS (RECOMMENDED)
0800	24
0900	12
1200	5
1300	8
1600	9
1700	2
TOTAL	60

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Similarly, a driver turning left into a driveway from a six-lane roadway needs a 6.5-second opening in the opposing traffic flow. The available openings are summarized in the following table.

Table 5 – Available Openings in EB Traffic Stream

HOUR BEGINNING	OPENINGS IN OPPOSING TRAFFIC FLOW > 6.5 SECONDS (RECOMMENDED)
0800	115
0900	138
1200	93
1300	95
1600	106
1700	112
TOTAL	659

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Driveway Volumes

A survey of driveway volumes in the study section was made for six representative hours, with the results summarized in the following table.

Table 6 – Driveway Volumes

HOUR BEGINNING:		0800	0900	1200	1300	1600	1700
The Rooster / B & H Asphalt east drive (#1441)	RIGHT IN	0	0	0	1	0	0
	LEFT IN	0	0	0	0	0	0
	RIGHT OUT	0	0	0	1	0	0
	LEFT OUT	0	0	0	1	0	0
The Rooster / B & H Asphalt west drive (#1441)	RIGHT IN	2	7	9	9	3	4
	LEFT IN*	0	1	1	4	4	3
	RIGHT OUT	3	6	9	15	10	7
	LEFT OUT	1	4	0	4	3	2
*MAXIMUM OBSERVED QUEUE WAS 5 VEHICLES (1300 - 1400)							
Harry's Upholstery (#1441)	RIGHT IN	3	2	2	2	3	0
	LEFT IN**	0	4	1	1	2	0
	RIGHT OUT	0	5	2	0	0	0
	LEFT OUT	0	1	0	0	0	0
**MAXIMUM OBSERVED QUEUE WAS 5 VEHICLES (0900 - 1000)							
Tile & Stone Imports (#1607)	RIGHT IN	1	1	1	3	0	0
	LEFT IN***	0	0	1	0	0	0
	RIGHT OUT	1	0	2	2	0	0
	LEFT OUT	1	0	0	0	0	0
***NO QUEUE							

NB Right Turns on Red at Jackson Boulevard

The effects of northbound Jackson Blvd. vehicles turning on red at W. Main St. can be gauged from general site and traffic observations and an assessment of the change in intersection level of service (LOS) if turns on red were prohibited:

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- Obviously right turns on red can only be made when there is a sufficient opening in eastbound Main St. traffic. Northbound vehicles that “take” this opening eliminate the use of the opening by any turning vehicles further downstream.
- The Main St. driveways immediately east of Jackson Blvd. fall within the functional area of the intersection, causing the potential for conflicts between vehicles completing their turn on red and vehicles slowing to turn right into the driveways.
- Sight distance to the west for northbound right turning vehicles is frequently restricted by vehicles queued in the adjacent lanes and by vehicles parked in the lot on the southwest corner.
- Although delay for northbound right turning vehicles increases slightly (2.2 seconds in the morning peak), the overall intersection level of service calculated for the morning and afternoon peak hours does not change if right turns on red were prohibited.

It should be noted that northbound right turns on red had been prohibited when Jackson Blvd. and W. Main St. were State highways. In May 1992, the prohibition was rescinded at the request of an alderman. In February 1995, the City Council rejected a recommendation to re-implement the restriction. A June 1999 letter on file indicates that the issue was to be re-examined following the opening of the “Southwest Connector”, however, no records could be located relative to this study.

ROADWAY NETWORK CONSIDERATIONS

The topography of Rapid City largely restricts east/west traffic to three corridors: Omaha St., W. Main St. and Catron Blvd. The 2008 daily traffic on these corridors was approximately 20,000, 35,700 and 9,050 respectively. The current Major Street Plan does not include any new east/west routes that would significantly reduce the volumes on either Omaha St. or W. Main St. Furthermore, past planning studies of extending Jackson Blvd. or Sheridan Lake Road to the north did not show a significant reduction in the volumes on either Omaha St. or W. Main St.

The 2025 forecast daily traffic volume for W. Main St. is approximately 50,700. Past experience with emergency closures of W. Main St. and the subsequent effects on the roadway network, underscores the road’s importance within the network.

GUIDELINES FOR MEDIAN INSTALLATION

Unlike STOP signs or traffic signals, there is not a nationally accepted set of warrants for when to install a flush (e.g. center left turn lane) or raised median. A Policy on Geometric Design of Highways and Streets, 5th edition, simply states that,

“Medians are a desirable feature of arterial streets and should be provided where space permits.”

The Transportation Research Board's Access Management Manual (2003) suggests that a non-traversable median is desirable for the following conditions,

- All new multilane urban arterial roadways.
- Existing multilane urban arterial roadways with ADT in excess of 24,000 to 28,000 vehicles per day.
- Multilane roadways with a high level of pedestrian activity.
- High crash locations or areas where it is desirable to limit left turns to improve safety.

The Federal Highway Administration's Access Management for Streets and Highways (1982) offers similar guidance, suggesting that a non-traversable median be considered on multilane roadways for the following conditions,

- Speed limits greater than 30 MPH.
- ADT in excess of 10,000 vehicles per day.
- Driveway density greater than 30 driveways per mile.
- Left turn volumes at driveways greater than 150 vehicles per hour per mile of roadway.
- High crash experience resulting from left turning vehicles.

The South Dakota Department of Transportation's Road Design Manual states that,

“Medians should be used as part of reconstruction in areas with high traffic volumes and high driveway densities. Reconstruction should also include driveway consolidation and the use of other means to allow turning traffic to reach the median openings.”

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All of the literature agrees on two points:

- 1) Installing a raised median barrier can be expected to reduce crashes up to 80%.
- 2) The need for alternative access to affected properties must be carefully considered as part of the design process.

SUMMARY

- 1) The segment crash history for 2000 – 2008 does not suggest any particular crash patterns or trends.
- 2) The segment crash rate for 2000 – 2008 is less than the overall state crash rate. The average rate is also less than the overall average state crash rate.
- 3) The segment crash rate for 2004 – 2007 is not unusually high when compared to other roads in the City. The average rate is also not unusually high when compared to the average of other roads.
- 4) The property owner should be contacted and the existing vegetation that limits sight distance from the driveways in the 1400 block should be cut down.
- 5) The observed speed data correlates well with the posted speed limit and the roadway design speed. Lowering the speed limit is not recommended as compliance would be problematic.
- 6) Existing conditions suggest a benefit to implementing NO TURN ON RED at the Jackson Blvd. intersection. Although delay to northbound right turning traffic would increase slightly, the overall intersection level of service would not change as a result of this restriction.
- 7) Opportunities to turn left out of driveways are severely limited. Although alternatives to this maneuver exist via a right turn to either West St. or West Blvd. (and then making a u-turn), certain drivers may choose to accept a smaller window of opportunity thus increasing the risk of a crash.
- 8) There are frequent opportunities to turn left into driveways and the existing driveways are very low volume. Even so, given the volume of traffic carried on W. Main St., traffic turning left into the driveways can create multi-car queues.
- 9) According to guidelines, the driveway density, turning volumes and crash history for the subject section of W. Main St. do not suggest an immediate

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need for a median. The need for a median is suggested however when considering the traffic volume and speed guidelines specified in most references. Additional weight should also be given to the importance of W. Main St. from a network perspective, that is, the lack of other east/west corridors supports placing greater weight on mobility versus property access.

Overall, it is well documented that medians make any road safer and that similar benefit would be realized if a median project were implemented on the subject segment of W. Main St. It is also well documented that median installation has to consider the effect on access to abutting properties. Due to the limited left turns into the existing land uses, the installation of a median would not have a significant negative effect. Similarly, a reasonably convenient alternative exists for left turns out of the land uses (i.e. West St. and West Blvd.) One possible effect of eliminating left turns into the driveways is that vehicles that had been turning left may choose to use W. Omaha St. to Cross St., where they would then have to make a left turn across all lanes of traffic. If the decision is made to proceed with an immediate project, the recommended alternative of those considered is to reduce (from 12-feet) the traffic lanes to 11-feet wide and install an approximately 6-foot wide curbed island.

ESTIMATE OF COSTS - WEST MAIN STREET MEDIAN

<u>ITEM</u>	<u>UNIT</u>	<u>QUANTITY</u>	<u>UNIT COST</u>	<u>TOTAL COST</u>
MOB	LS	1	\$5,000.00	\$5,000.00
PCC REMOVAL	SYD	1080	\$15.00	\$16,200.00
STRIPING REMOVAL	LF	1700	\$1.00	\$1,700.00
24" CURB/GUTTER	LF	2500	\$20.00	\$50,000.00
GRAVEL CUSHION	TON	500	\$18.00	\$9,000.00
9" PCC PAVEMENT	SYD	260	\$125.00	\$32,500.00
4" PCC MEDIAN	SYD	290	\$50.00	\$14,500.00
SAWCUT	LF	2700	\$3.00	\$8,100.00
SIGNS	EA	10	\$200.00	\$2,000.00
TYPE 'B' INLET	EA	4	\$2,500.00	\$10,000.00
18" RCP	LF	114	\$55.00	\$6,270.00
CONNECT TO EXISTING STORM SEWER	EA	4	\$500.00	\$2,000.00
STRIPING	LF	1700	\$1.75	\$2,975.00
TRAFFIC CONTROL	LS	1	\$7,500.00	\$7,500.00
INCIDENTAL	LS	1	\$5,000.00	\$5,000.00
			Subtotal =	\$172,745.00
		CONTINGENCY =	15.0%	\$25,911.75
			TOTAL =	\$198,656.75

City of Rapid City
Pennington County

WEST MAIN STREET MEDIAN PROJECT
CROSS STREET TO WEST STREET

CITY OF RAPID CITY PROJECT NO. ST09-XXXX
CIP # 50XXX

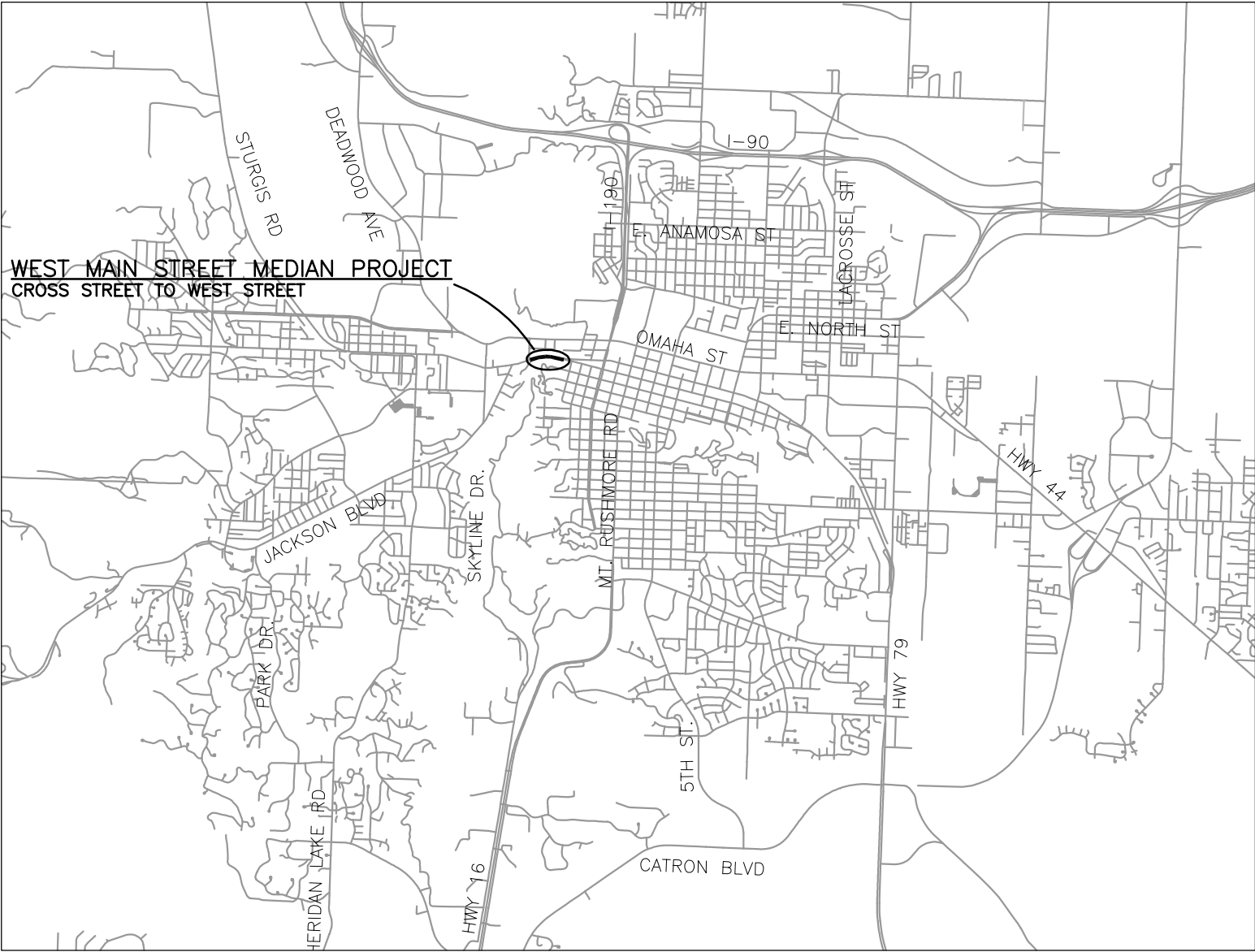
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Public Works Department
Engineering Division


CITY OF RAPID CITY
PUBLIC WORKS DEPARTMENT
ENGINEERING SERVICES

WEST MAIN STREET MEDIAN PROJECT
CROSS STREET TO WEST STREET
PROJECT NO. ST09-XXXX

Plan Set Number :

CITY OF RAPID CITY, SOUTH DAKOTA

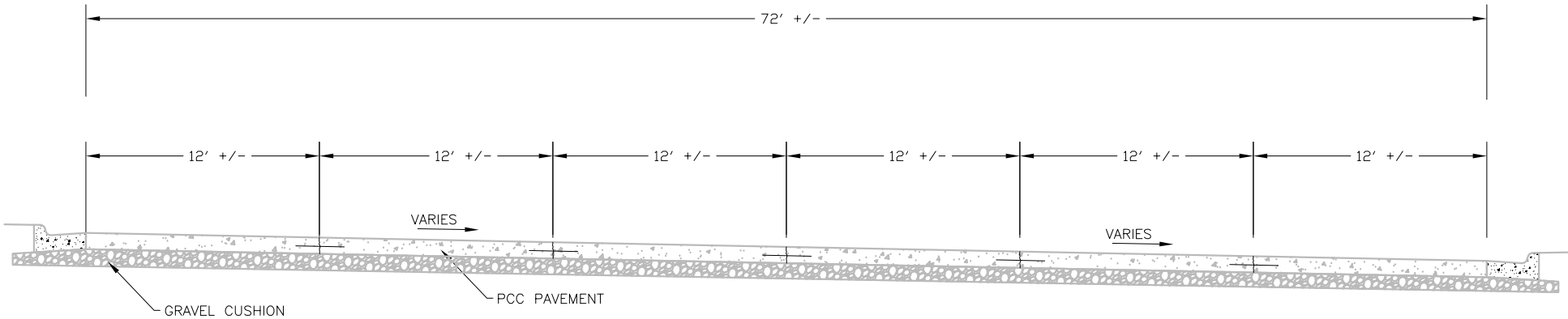


INDEX OF SHEETS

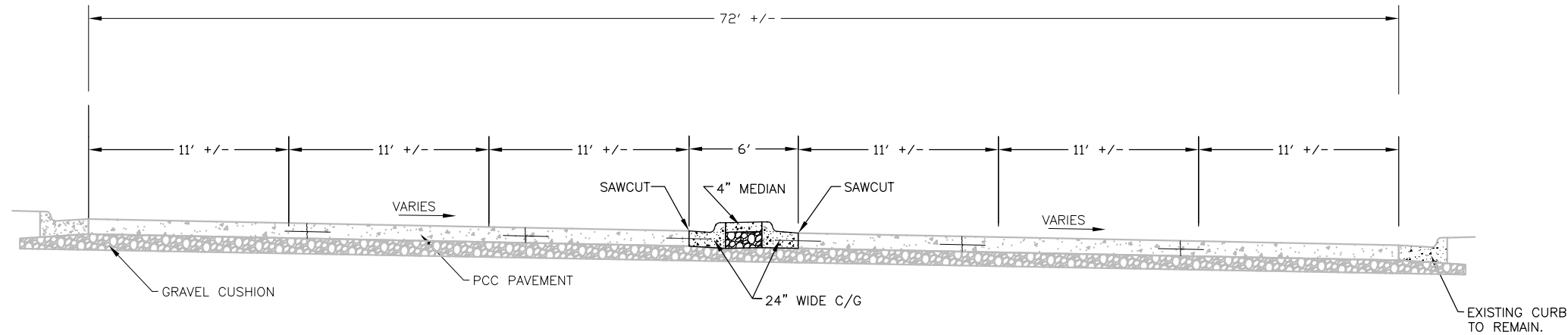
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| 1.1 | COVER SHEET |
| 1.2 | TYPICAL SECTIONS |
| 2.1-2.3 | PLAN SHEETS |



ONE CALL
BEFORE DIGGING
1-800-781-7474



① EXISTING TYPICAL SECTION



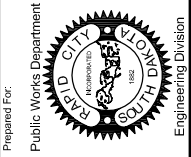
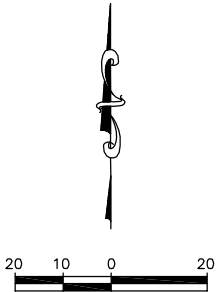
② PROPOSED TYPICAL SECTION

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WEST MAIN STREET MEDIAN PROJECT
CROSS STREET TO WEST STREET

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Sheet Title:	TYPICAL SECTIONS
Sheet:	1.2



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WEST MAIN STREET MEDIAN PROJECT
CROSS STREET TO WEST STREET

CITY PROJECT #	ST09-xxxx
Sheet Title:	W. MAIN STREET PLAN SHEET
Sheet:	2.1



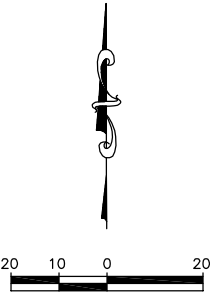
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**WEST MAIN STREET MEDIAN PROJECT
CROSS STREET TO WEST STREET**

CITY PROJECT #	ST09-xxxx
Sheet Title:	W. MAIN STREET PLAN SHEET
Sheet:	2.2



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Sheet Title:

W. MAIN STREET
PLAN SHEET

Sheet:

2.3