

Traffic Analysis

Introduction

The following traffic analysis will document the safety, operational and functional system issues for five access alternatives for the new Jordan Aggregates operations along TH 169. The site is located on a parcel between TH 169 and Valley View Drive near Jordan, MN shown in Figure 1. Truck operations are anticipated to begin in fall of 2013. According to the developer, the tractor trailer truck traffic generated by the proposed mining operation will result in a maximum daily volume of 110 round trips per day during periods of peak production. The anticipated truck volumes are expected to average of 5 round trips per hour with a maximum of 11 round trips per hour during peak production.

The Developer has estimated that 80% of the traffic based on anticipated markets will be to the north and 20% will be to the east or south of the mine site. The primary regional highway route proposed to be used for distributing the product to the intended market is TH 169. TH 169 is a principal arterial on the Metro Highway System plan and a High Priority Interregional Corridor on the state highway system. County Highway 9/282 is the primary east-west regional corridor in the vicinity of the proposed mine. It is designated as an A Minor roadway on the Metropolitan transportation system. CH 9 to the west provides access across the Minnesota River into Carver County on Carver County Road 45. The road directly serving this site is Valley View Drive. It is a township road under the jurisdiction of Sand Creek Township where it abuts the proposed project site. Valley View Drive to the south of the project site continues into the City of Jordan 1.5 miles where it intersects with County Highway 9. To the north, the site has access to TH 169 via 173rd Street.

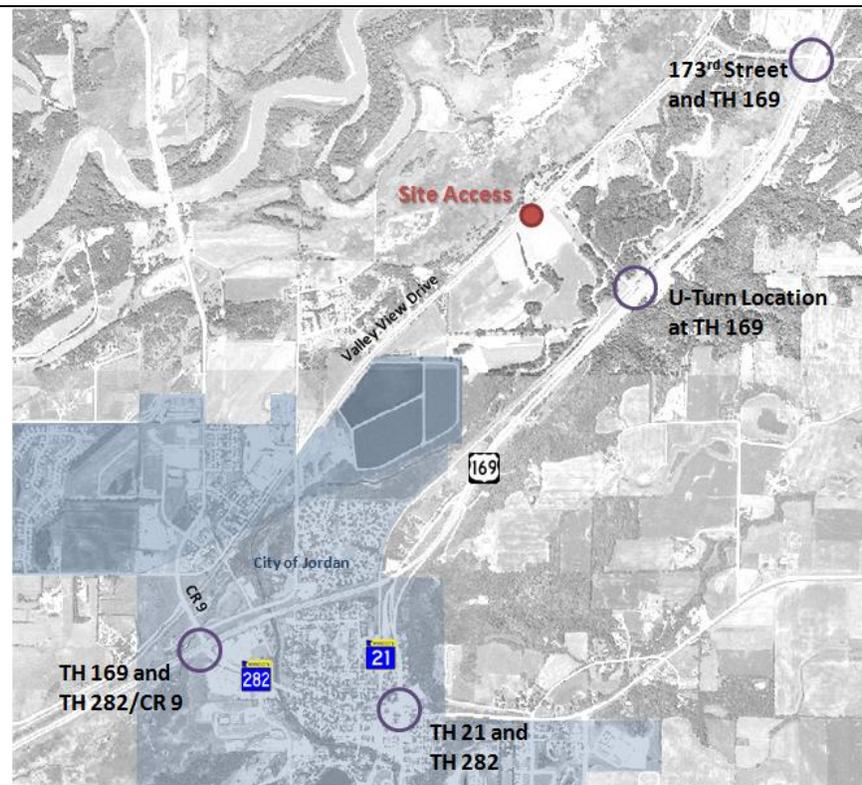


Figure 1
Study Area

As provided by the developer, the majority of the hauling trucks will want to access either northbound or southbound TH 169. The nearest access location is north of the site at 173rd Street which is a ¾ access intersection. Hauling trucks headed southbound on TH 169 will be able to use this access point to access TH 169. However, because of the ¾ access configuration, left turns from 173rd Street to northbound TH 169 are not allowed. The following alternatives were considered to accommodate northbound hauling trucks and are shown in Figure 2:

- a) Option 1 - Access to Valley View Road with an indirect connection to TH 169 via County Road 9 intersection
- b) Option 2 - Access to TH 169 southbound via 173rd Street with a U-Turn further south from the site for the northbound TH 169 direction
- c) Option 3 - Access to TH 169 southbound via 173rd Street with connection to TH 169 northbound via TH 21 and TH 282
- d) Option 4 - Access to TH 169 southbound via 173rd Street with connection to TH 169 northbound via TH 282 and TH 21
- e) Option 5 – Access to TH 169 southbound via 173rd Street with U-Turn at TH 282/CR 9 intersection

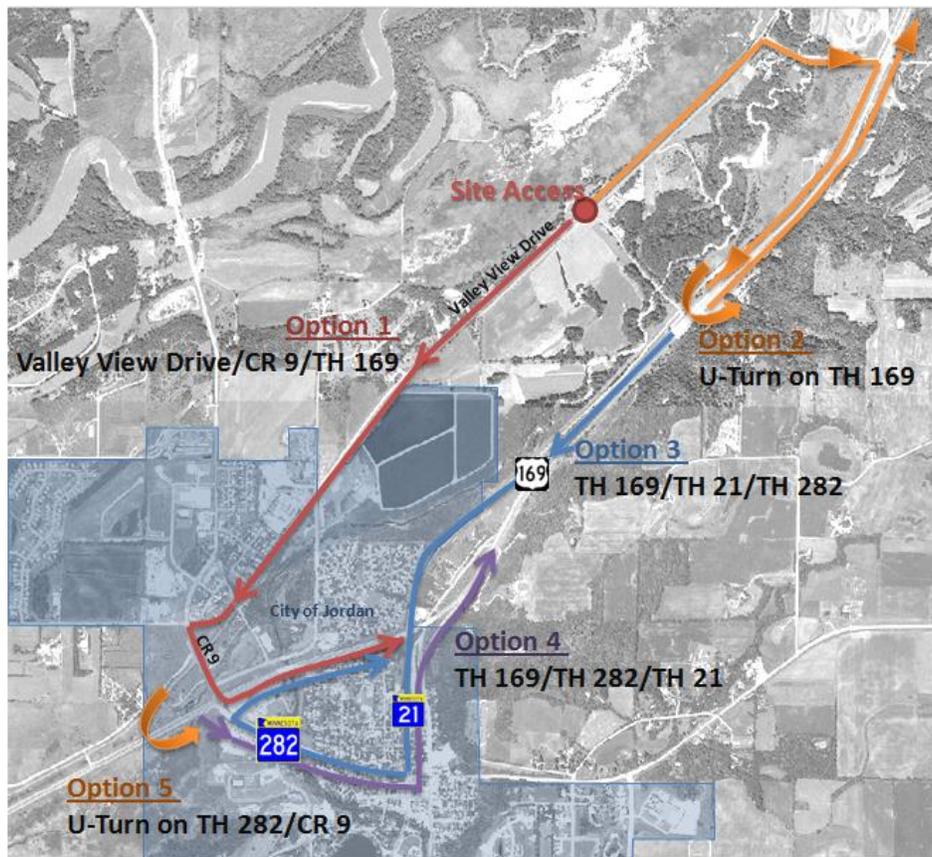


Figure 2
Alternative Routes for Northbound Site Traffic

Review of Alternatives – Key Intersections and Geometry

The following overview of the key intersections and geometry of the five truck haul route options includes, existing turn lane configurations, turn lane lengths and potential improvement constraints.

Option 1 – Valley View Road to County Road 9 to TH 169

The hauling route for Option 1 would follow Valley View Road from the site access to the intersection of County Road 9. This portion of Valley View Road includes an at-grade crossing of the Union Pacific railroad, as shown in Figure 3. The County Road 9 intersection, shown in Figure 4, currently does not have separate turn lanes on any of the approaches. To continue to northbound TH 169, hauling trucks would make a left turn onto CR 9 followed by another left turn onto TH 169 at the signalized intersection. The CR 9 approach for the intersection with TH 169 currently has a 350 foot left turn lane (see Figure 5).

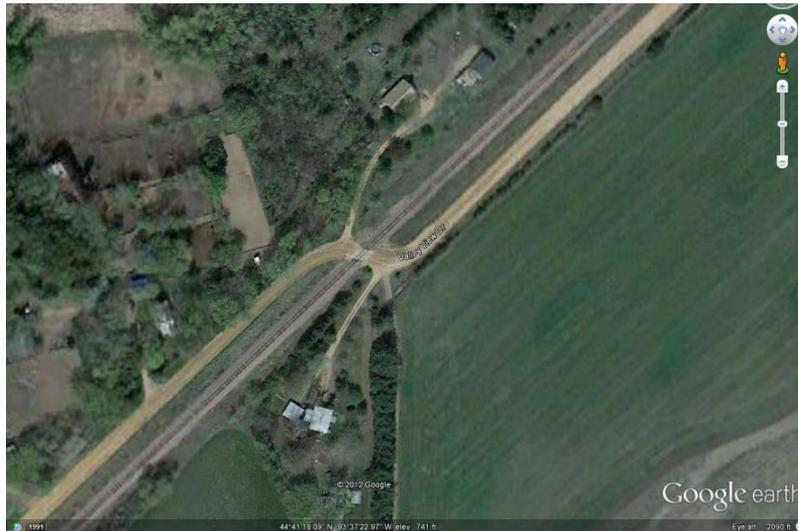


Figure 3
Option 1 - Valley View Road Railroad Crossing

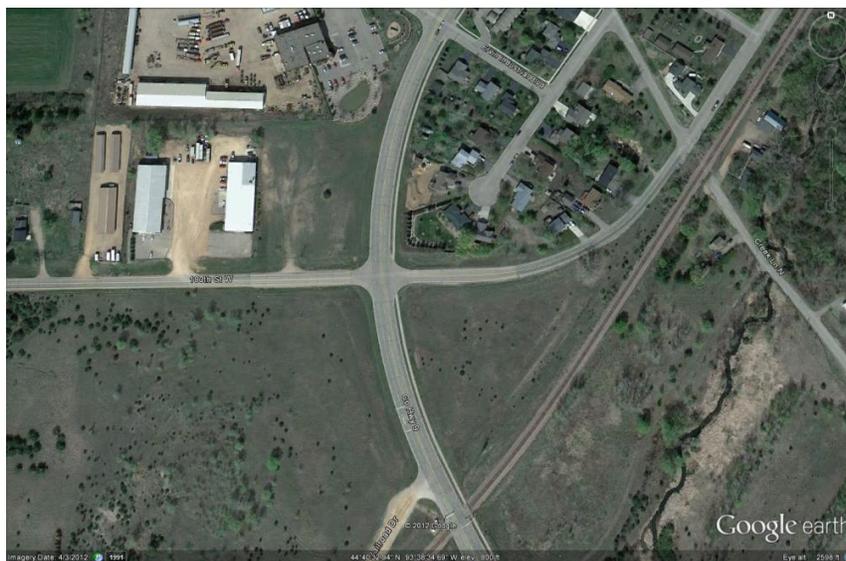


Figure 4

Option 1 -CR 9 and Valley View Road Intersection**Figure 5****Option 1- TH 169 and CR 9/TH 282 Intersection*****Option 2 – Access at 173rd and TH 169 with U-Turn at Median Opening***

The Option 2 hauling route uses 173rd Street to access onto southbound TH 169 (see Figure 6). Access for hauling trucks is limited to the southbound lanes because of the channelized median opening. The intersection currently has a 450 foot left turn lane for northbound TH 169 and a 410 foot right turn lane for southbound TH 169. There is a railroad crossing located 80 feet from the TH 169 travel lane on 173rd Street west of TH 169. The northbound hauling trucks would proceed southbound on TH 169 to a median opening located 4,720 feet south of the 173rd Street access (see Figure 7) to complete a U-turn maneuver to continue northbound on TH 169. The median opening access has a 315 foot left turn lane. The median opening provides access to commercial property on the east side of TH 169 and a residential property on the west side of TH 169.

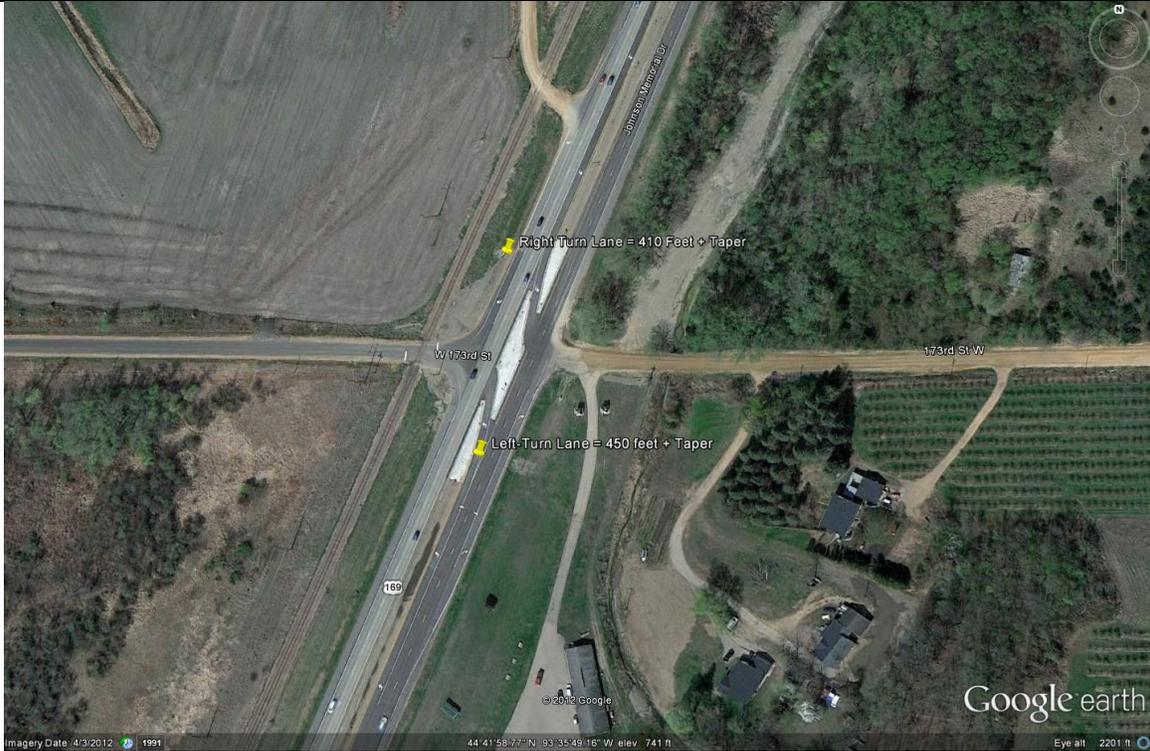


Figure 6
Options 2, 3 and 4 - 173rd Street (CR 73) and TH 169



Figure 7
Option 2 - U-Turn Location, 4,720 feet south of 173rd Street Access

Option 3 - Connection to TH 169 northbound via TH 21 and TH 282

Hauling trucks using the Option 3 route would use 173rd Street, head southbound on TH 169 and use the TH 21 access into Jordan, as shown in Figure 6. The access has a 400 foot right turn lane with an exit ramp design. The trucks would follow TH 21 for 4,400 feet to the signalized intersection of TH 21 and TH 282 (see Figure 9). The trucks would turn right onto westbound TH 282. The TH 21 and TH 282 intersection currently has a 50 foot right turn lane with development constraints including the St. John the Baptist Church and School on both sides of TH 21. The hauling trucks would continue westbound on TH 282 for 3,800 feet to the TH 282/CR 9 and TH 169 signalized intersection. Trucks would then be able to make a right turn and proceed northbound on TH 169. The TH 282 approach currently has a left turn lane and two through lanes with no separate right turn lane.

Option 4 - Connection to TH 169 northbound via TH 282 and TH 21

Option 4 uses 173rd Street to southbound TH 169 to the TH 282/CR 9 and TH 169 intersection, turning left onto eastbound TH 282 (see Figure 10). Hauling trucks would then continue on TH 282 to the TH 21 intersection (see Figure 9) and take another left to go northbound on TH 21 to the TH 169 entrance ramp. The TH 169 and TH 282/CR 9 intersection has a 370 foot left turn lane for southbound TH 169. This turn lane is constrained in length by a structure just north on TH 169.

Option 5 - Connection to TH 169 northbound via U-Turn at TH 169 and TH 282/CR 9 Intersection

Option 5 uses 173rd Street to southbound TH 169 to the TH 282/CR 9 and TH 169 intersection and then using the protected left turn phase to U-turn at the signal and continue north on TH 169.



Figure 8

Option 3 - TH 21 Access from Southbound TH 169



Figure 9
Options 3 and 4 - TH 282 and TH 21 Intersection



Figure 10
Option 4 - TH 169 and TH 282/CR 9 Intersection
(SB TH 169 Left Turn to EB TH 282)

Traffic Operations

The current and forecasted traffic volumes from the Scott County Comprehensive Plan are shown in Table 1 for TH 169, TH 282, TH 21 and County Road 9. All of the major roadways are expected to have significant increases in traffic volumes by the year 2030. The small increase in truck traffic (11 trucks in the peak hour) is far exceeded by general growth in the background traffic by 2030. Any future operational issues will be likely caused by this increase in regional traffic and not caused by trips generated from the Jordan Aggregates site and therefore only existing conditions were analyzed for this memorandum.

Table 1
Existing (2007) and Forecast (2030) Daily Traffic Volumes

	Existing Daily Traffic	2030 Forecast Daily Traffic
TH 169 (TH 21 to CH 9)	22,500	48,000
TH 169 (173 rd Street to TH 21)	28,000	48,000
TH 282 (TH 169 to TH 21)	4,700	15,500
TH 21 (TH 169 to CR 66)	6,600	10,000
CR 9 (TH 169 to River Crossing)	2,650	20,000

Each of the hauling route options has unique traffic operations characteristics and issues. Three of the four options will utilize the TH 169 and TH 282/CR 9 signalized intersection. The operation of signalized intersections is a function of three items – 1) peak hour traffic volumes, 2) roadway approach geometry, and 3) signal operations (cycle lengths and phasing). Roadway operations were estimated using a Level of Service (LOS) measure that is based on the amount of delay experienced by motorists.

Congestion is rated from A to F, with LOS A representing little to no delay at the intersection and LOS F representing high levels of congestion with very long delays and slow speeds. The LOS D/E boundary was used as the performance measure for Level of Service (see Figure 11).

Existing peak hour turning counts were collected at the intersection of TH 169 and TH 282/CR 9 in August 2012 and are shown in Table 2 and the existing intersection geometry is shown in Figure 12. Signal timing and phasing were provided by MnDOT with eight phases and an actuated cycle lengths averaging between 90 and 120 seconds.

A capacity analysis of the existing intersection operations during the peak hours was completed using Synchro software. The intersection operates at LOC C during the AM peak hour and LOS D during the PM peak hour with all approaches having similar level of service varying between LOS C and LOS D as show in Table 3.

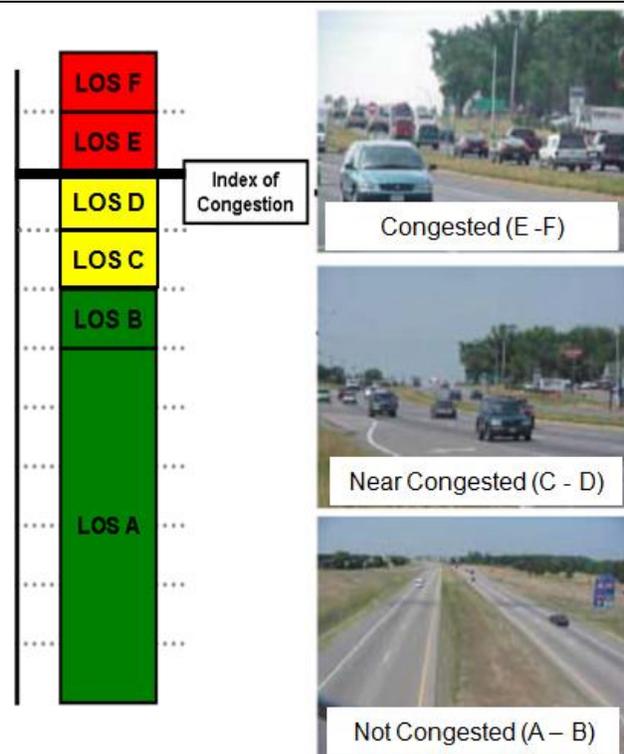


Figure 11
Level of Service

Table 2
Peak Hour Turning Volumes – TH 169 and TH 282/CR 9 Intersection – Year 2012

2012 Traffic Volumes (Counts collected August 28, 2012)												
	CR 9 EB			TH 282 WB			TH 169 NB			TH 169 SB		
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Number of Lanes	1	2	Shared	1	2	Shared	1	2	1	1	2	1
AM Peak Hour (6:30 – 7:30 AM)	130	183	42	128	243	34	91	762	128	90	502	14
PM Peak Hour (4:30 to 5:30 PM)	73	433	76	235	240	45	44	656	162	122	941	43

Table 3
LOS and Delay for the TH 169 and TH 282/CR 9 Intersection

	Overall	Approach LOS / Delay			
	Intersection LOS/Delay	South (TH 169 NB)	North (TH 169 SB)	East (TH 282 WB)	West (CR 9 EB)
2012 AM Peak Hour	LOS C (30 sec)	LOS C (28 sec)	LOS C (27 sec)	LOS D (37 sec)	LOS D (35 sec)
2012 PM Peak Hour	LOS D (38 sec)	LOS D (37 sec)	LOS D (39 sec)	LOS C (33 sec)	LOS D (44 sec)



Figure 12
TH 169 and TH 282/CR 9 Intersection Geometry

The developer provided a maximum number of 11 hauling trucks during the peak hours of the mining operations on the site. The worst case scenario in terms of the site generated hauling trucks impacting operations at the TH 169 and TH 282/CR 9 intersections would be if they were using the intersection during the AM and PM peak hours. A quick review of adding 11 trucks in the corresponding turn lanes

(for example, Option 1 would add the 11 hauling trucks to the eastbound CR 9 left turn lane whereas Option 3 adds the trucks to the westbound TH 282 right turn volume), shows that the trucks have little to no impact on the traffic operations of the intersection creating, at most, an additional second of overall delay for the intersection. Traffic volumes with site generated traffic are shown in Table 4 and results of the intersection operation review are shown in Table 5 and Figure 13.

Table 4
Traffic Volumes with Site Generated Traffic Volumes at TH 169 and TH 282/CR 9 Intersection

Option 1	CR 9 EB			TH 282 WB			TH 169 NB			TH 169 SB		
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
<i>Number of Lanes</i>	1	2	Shared	1	2	Shared	1	2	1	1	2	1
AM Peak Hour (6:30 – 7:30 AM)	141	183	42	128	243	34	91	762	128	90	502	14
PM Peak Hour (4:30 to 5:30 PM)	84	433	76	235	240	45	44	656	162	122	941	43
Option 3	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
AM Peak Hour (6:30 – 7:30 AM)	130	183	42	128	243	45	91	762	128	90	502	14
PM Peak Hour (4:30 to 5:30 PM)	73	433	76	235	240	56	44	656	162	122	941	43
Option 4 & 5	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
AM Peak Hour (6:30 – 7:30 AM)	130	183	42	128	243	34	91	762	128	101	502	14
PM Peak Hour (4:30 to 5:30 PM)	73	433	76	235	240	45	44	656	162	133	941	43

Table 5
LOS and Delay for the TH 169 and TH 282/CR 9 Intersection – Peak Hour Intersection Operations with Hauling Route Options

	Overall	Approach LOS / Delay			
	Intersection	South	North	East	West
2012 AM Peak Hour	LOS/Delay	(TH 169 NB)	(TH 169 SB)	(TH 282 WB)	(CR 9 EB)
No Build	LOS C (30 sec)	LOS C (28 sec)	LOS C (27 sec)	LOS D (37 sec)	LOS D (35 sec)
Option 1	LOS C (31 sec)	LOS C (28 sec)	LOS C (27 sec)	LOS D (38 sec)	LOS D (35 sec)
Option 3	LOS C (31 sec)	LOS C (28 sec)	LOS C (27 sec)	LOS D (37 sec)	LOS D (35 sec)
Options 4&5	LOS C (31 sec)	LOS C (28 sec)	LOS C (27 sec)	LOS D (38 sec)	LOS D (35 sec)
2012 PM Peak Hour	LOS/Delay	South	North	East	West
No Build	LOS D (38 sec)	LOS D (37 sec)	LOS D (39 sec)	LOS C (33 sec)	LOS D (44 sec)
Option 1	LOS D (38 sec)	LOS D (36 sec)	LOS D (38 sec)	LOS C (34 sec)	LOS D (45 sec)
Option 3	LOS D (38 sec)	LOS D (37 sec)	LOS D (39 sec)	LOS C (33 sec)	LOS D (44 sec)
Options 4 & 5	LOS D (39 sec)	LOS D (37 sec)	LOS D (39 sec)	LOS C (33 sec)	LOS D (44 sec)

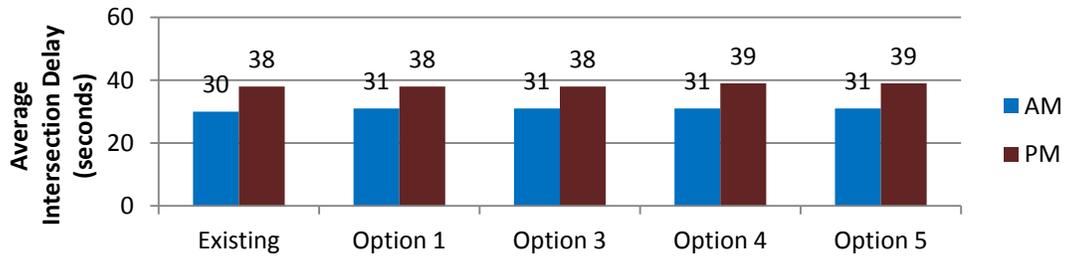


Figure 13

Average Delay at TH 169 and TH 282/CR 9 Intersection

Peak hour turning counts were not available for the intersection of TH 21 and TH 282 within the downtown of Jordan. Numbers were estimated based on existing daily traffic and using the same percent of the average daily traffic volumes experienced on TH 169 at the TH 282/CR 9 intersection, a 50 percent directional split and distribution based on daily traffic along each intersection approach. The traffic turning volumes estimated based on using these planning level assumptions are shown in Table 6. With these volumes a Synchro analysis was completed and provided LOS A results for both the AM and PM peak hour, confirming that there is adequate capacity at this intersection and that the addition of the hauling trucks can be accommodated without decrease to operations of the intersection.

Table 6

Peak Hour Turning Volumes – TH 21 and TH 282– Year 2012

2012 Traffic Volumes*												
	TH 21 Southbound			TH 21 Northbound			TH 282 Eastbound			TH 282 Westbound		
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
<i>Number of Lanes</i>	1	1	1	1	1	1	1	1	Shared	1	1	1
AM Peak Hour	56	82	78	109	90	81	84	73	107	68	66	55
PM Peak Hour	70	102	96	135	111	101	104	91	133	84	82	68

*Traffic volumes estimated based on percent of daily traffic volume in the peak hour from TH 282/CR 9 intersection, 50% directional split, and distribution based on ADT on each approach

In addition to the TH 169 and TH 282/CR 9 intersection, the ¾ access at 173rd Street and TH 169 would also be used for the hauling route options. No traffic volumes are available for this intersection, but based on a field review of the site, the roadway experienced less than 100 vehicles during the peak hour providing access to a Public Safety Training Facility and a retirement community. Based on the Synchro analysis, including adjusting to have the correct mix of passenger and truck traffic (20%), the eastbound right turning vehicles experience a delay of between 12 seconds in the AM (LOS C) and 19 seconds (LOS C) in the PM waiting for a gap in traffic in order to turn onto TH 169.

The Synchro analysis assumes a critical gap of 7.1 seconds, meaning a vehicle does not enter TH 169 unless there is at least a 7 second gap in traffic. While the 7 seconds of gap may be appropriate for a passenger vehicle to make the right turn and accelerate with minimal interruption to TH 169 traffic, the acceleration and maneuverability of a hauling vehicle requires some special consideration. Table 7 provides assumptions used to determine the amount of time and distance required for a hauling truck turning right onto TH 169 to reach 39 mph (60% of the speed limit as prescribed in the Minnesota Road Design Manual, Table 5-4.01A). From this analysis, the hauling truck would need to pick a gap of close to 70 seconds (approximately 7,000 feet) in order to not require a vehicle headed southbound on TH 169 to either slow down behind the hauling truck or switch lanes to pass. Based on field visit

observations, there are few, if any, 70 second gaps in traffic, meaning the amount of delay experienced by hauling trucks would likely be higher than what is being reported in the macro simulation software.

Table 7
Time and Distance Requirements for Hauling Truck Maneuvers onto TH 169

	Time	Distance
Maneuver #1: Turning onto TH 169 and Reaching 60% of Posted Speed (Options 2, 3 and 4)		
Gap Recognition and Begin of Right Turn Maneuver <i>Source: ITE Traffic Engineering Manual, Perception-Reaction Time</i>	2.5 seconds	0 feet
Acceleration from 0 mph to 39 mph (60% of posted speed limit) <i>Source: Time: ITE Traffic Engineering Manual, (182 kg/kW), Distance: MnDOT Road Design, Table 5-4.01A, Desirable Length of Full Width Median Acceleration Lane</i>	65 seconds	1,670
Gap Needed for Hauling Truck to Maneuver onto TH 169 and reach 60% of Posted Speed (Without Acceleration Lane)	67.5 seconds	
Maneuver #2: Merging to Left Turn Lane at Median Opening (Option 2 only)		
Gap Recognition for Merge Maneuver <i>Assumed 39 mph</i>	2.5 seconds	150 feet
Merge Maneuver <i>Note: To estimate merging maneuver, assumed length of a shifting taper in temporary traffic control distance charts, MnDOT Field Manual (18-foot shift without acceleration lane (inside travel lane and into turn lane), 30-foot shift with acceleration lane (two TH 169 through lanes and into left-turn lane))</i>	15 seconds (w/out accel lane)	600 feet (w/out accel lane)
	22.5 seconds (with accel lane)	1,000 feet (with accel lane)
Deceleration (39 mph to 0 mph) <i>Source: ITE Traffic Engineering Manual, Table 10-2, Page 172</i>	11 seconds	710 feet
Distance Required between Access Locations to Complete Maneuvers #1 and #2	3,130 feet (without acceleration lane)	
	3,530 feet (with acceleration lane)	
Maneuver #3: Making U-Turn at Median Opening (Option 2 only)		
Gap Recognition and Begin of U-Turn Maneuver <i>Source: ITE Traffic Engineering Manual, Perception-Reaction Time</i>	2.5 seconds	0 feet
Complete U-Turn Maneuver <i>Assumed 0.98 ft/sec² acceleration and 24 feet of distance</i>	7 seconds	24 feet
Acceleration from 0 mph to 39 mph (60% of posted speed limit) <i>Source: Time: ITE Traffic Engineering Manual (182 kg/kW), Distance: MnDOT Road Design, Table 5-4.01A, Desirable Length of Full Width Median Acceleration Lane</i>	65 seconds	1,670 feet
Gap Needed for Hauling Truck to U-Turn onto TH 169 and reach 60% of Posted Speed (Without Acceleration Lane)	74.5 seconds	

Geometric Considerations

A review of geometric considerations at the key intersections was completed including the following issues:

- Option 1 – Railroad crossing on Valley View Road
- Option 1 – The intersection sight distance at CSAH 9 and Valley View Road
- Option 2 - Hauling trucks ability to make U-Turn maneuver at median opening within existing TH 169 lanes and need for acceleration lane
- Option 5 - Hauling trucks ability to make U-Turn maneuver at TH 169 and TH 282/CR 9 intersection
- Option 3 - Ability of trucks to complete right turn at TH 21 and TH 282 without encroaching on opposing through lane
- All Options – review of the lengths of turn lanes for all affected movements at the TH 169 and TH 282/CR 9 intersection, TH 21 and TH 282 intersection and at the median opening

Option 1 – Railroad Crossing on Valley View Road

The alignment of Valley View Road includes a series of short radius curves on the approaches to the railroad crossing. Sand Creek Township recently worked with the railroad to add gate arms and lights to the crossing. The township has indicated that they would like geometric improvements at the crossing that would lengthen the curves and provide a 90-degree approach to the tracks. This type of geometric improvement would require additional right-of-way from adjacent parcels. While geometric improvements would provide better sight lines for trucks approaching the railroad crossing, there is no technical analysis that would suggest that the additional investment (beyond the gate arm and lights) would result in any measurable improvement in safety at the grade crossing.

Option 1 – Sight Distance at CSAH 9 and Valley View Road

There are sight distance issues at the intersection of CSAH 9 and Valley View Road. The current distance of around 480 feet is less than the desirable distance of 800 feet. The options for mitigating the sight distance issue include:

1. Improve sight distance with an easement and removal of obstructions in the north east quadrant of the intersection (see Figure 14).
2. Change access control to provide the necessary gaps in traffic with either an All-



Figure 14
Sight Distance at Valley View Drive and CSAH 9

Way Stop control or signal. An All-Way Stop is usually used at intersections that have almost equal traffic volumes, but CSAH 9 has a significantly larger volume than Valley View and may not

be the correct traffic control option. Also, signal warrants are unlikely to be met due to the low daily volumes on Valley View. This option may not be feasible.

3. Hauling route could divert to the frontage road and access CSAH 9 just west of the TH 169 and TH 282/CSAH 9 intersection. This access is located 200 feet west of the intersection, and may have queuing that extends beyond this access during peak hours.

Option 2 – U-Turn Maneuver at Median Opening

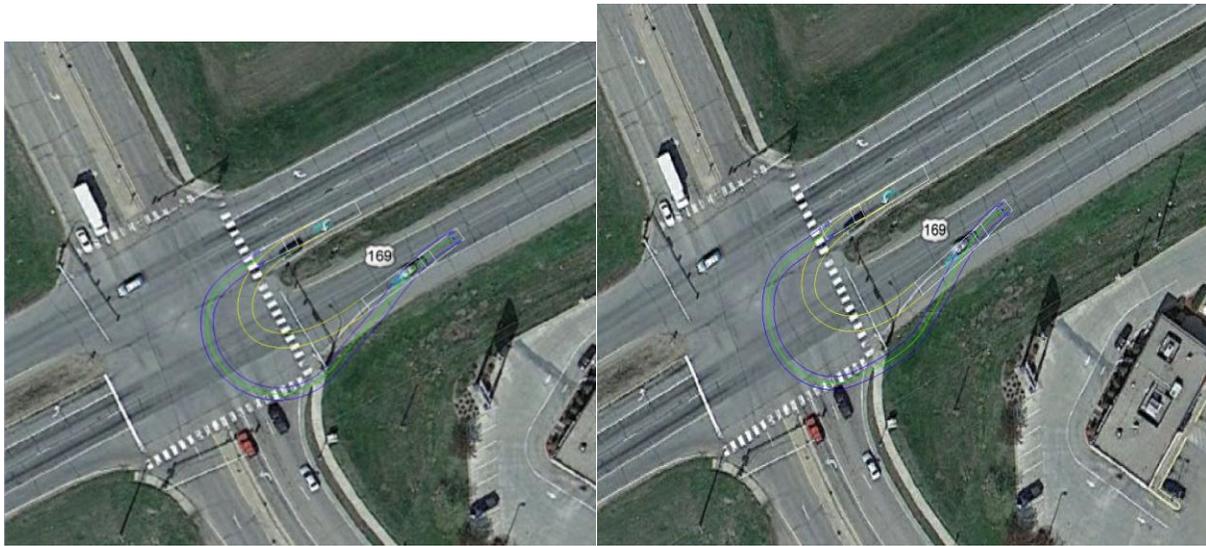
Review of the turning tracks for two sizes of tractor trailer show that haul trucks will be able to make the U-turn maneuver at the median opening with only minimal need to use the shoulder of TH 169 (see Figure 15).



Figure 15
Tractor Trailer Turning Track at U-Turn Median – WB-62 and WB-67

Option 5 – U-Turn Maneuver at TH 169 and TH 282/CR 9 Intersection

The U-turn at the existing TH 169 and TH 282/CR 9 signalized intersection would require moving the signal mast arm and curb line located in the southeast quadrant 15 feet to provide enough maneuvering space for both the W-62 and W-67 size tractor trailer to complete the U-turn as shown in Figure 16.

**Figure 16**

Tractor Trailer Turning Track at TH 169 and TH 282/CR 9 Intersections – WB-62 and WB-67

Option 3 – Right Turn at TH 21 and TH 282

As shown in Figure 8, hauling trucks will not be able to utilize the short 50 foot right turn lane, and will more than likely use the through lane when making the right turn. From the southbound through lane, there is adequate space for trucks to make the right turn without having to encroach onto the eastbound left turn lane.

All Options – Turn Lane Lengths

A review of the existing turn lanes that would be utilized by the hauling route options provides an analysis of the existing ability of the turn lanes to provide both the necessary storage and deceleration lengths to accommodate the speeds and level of traffic volumes at the intersections. The safety concern with shorter than desirable turn lanes lengths is the potential for the hauling trucks not being able to be completely within the turn lane and the trailer extending out into the mainline. Table 8 provides a comparison and summarizes the analysis. Out of the five turn lanes that will be utilized, only one currently provides adequate length (eastbound CR 9 left turn lane at TH 169 intersection). Three other locations, do not provide the desirable length, are constrained by adjacent land use, access locations and railroad tracks to make lengthening not feasible. The left turn lane at the median used for the U-turn in Option 2 should be lengthened to 690 feet to provide adequate deceleration and storage of one tractor trailer.

Table 8
Comparison of Existing vs. Desirable Turn Lane Lengths

	Existing Turn Lane Length	Desirable Turn Lane Length	Ability to Provide Desirable Turn Lane Length
Option 1 - CR 9 Eastbound Left Turn Lane (TH 282/CR 9)	350 + taper	Meets desirable length ¹	NA
Option 2 – TH 169 Southbound Left Turn Lane (Median Opening)	315 + taper	690 feet + taper ²	Yes
Options 4 & 5 -TH 169 Southbound Left Turn Lane (TH 282/CR 9)	370 + taper	830 feet + taper ³	No – constrained by structure located north of intersection – will not be able to lengthen turn lane
Option 3 - TH 21 Southbound Right Turn Lane (TH 21 & TH 282)	50 feet + taper	At least 245 feet ⁴	No – constrained by impacts to adjacent parcels (school and church)
Option 4 - TH 282 Eastbound Left Turn Lane (TH 21 & TH 282)	130 feet + taper	At least 245 feet ⁴	No – constrained by adjacent parcel and street access and railroad crossing

1. Assumed no deceleration in through lane, 50 mph design speed (425 feet for deceleration), assumed 90 feet of storage (Synchro 95th percentile in PM peak) = 515 feet – 180 taper = 335 feet
2. Assumed no deceleration in through lane, 70 mph design speed (820 feet for deceleration), assumed 50 feet of storage = 870 feet total – 180 taper = 690 feet
3. Assumed no deceleration in through lane, 70 mph design speed (820 feet for deceleration), assumed 190 feet of storage (Synchro 95th percentile in PM peak) = 1,010 feet total – 180 taper = 830 feet
4. Without more accurate traffic volume numbers, a storage length could not be assigned. To accommodate deceleration, the lanes would be at least 425 feet – 180 foot taper = 245 feet plus whatever storage is needed assuming a 50 mph design speed.

TH 169 Acceleration Lane – All Options

As shown in Table 7, the length of an acceleration lane that would provide enough length for a hauling truck to go from stop condition to 39 mph (60% of the speed limit as prescribed in the Minnesota Road Design Manual, Table 5-4.01A) is 1,670 feet. An acceleration lane would be suggested for southbound TH 169 at 173rd Street for Options 2, 3, 4 and 5. It would also be suggested at the median opening for the U-turn in Option 2 on northbound TH 169.

Safety Analysis

Five years of crash records (from 2007 to 2011) were used to complete the safety analysis, which included development of crash rates, severity rates, critical crash rates, distribution of crash type, road surface conditions, light conditions, day of week/time of day, and driver age for each intersection. Table 9 below provides a summary of the crash analysis findings by roadway segments, including the expected and actual crash rates and crash severity distribution; Table 10 provides this information for the key intersections.

Crash rates for roadway segments are measured as crashes per million vehicle miles, while intersection crash rates are measured as crashes per million vehicles entering an intersection. The critical crash rate is a statistical quality control technique that is used to identify those locations most at-risk, segments or

intersections, with crash rates statistically significantly higher than the statewide average for similar facilities. The expected crash rate, based on the state average, for a 4-lane divided rural roadway is 0.7 crashes per million vehicles miles and 2.7 crashes per million vehicles miles for urban sections.

The segments of TH 169 between 173rd Street and TH 282/CR 9 experienced higher than critical crash rate in the last five years and TH 282 between TH 169 and TH 21 in Jordan also experience higher than the critical crash rate suggesting safety concerns for these two segments.

None of the key intersections had higher than the critical crash rates; however, new analysis methods used in the Minnesota Department of Transportation County Road Safety Plans suggest that this does not mean there is no risk at these intersections. In addition to reviewing crash history at the 173rd Street intersection, a new systemic method to safety analysis was completed. This approach has been added to the safety planning process in Minnesota to better address the over representation of severe crashes in rural areas at expressway intersections, the very low density of these crashes in rural areas and to complement the black spot component of the safety program to address the challenge associated with identifying candidates for safety investment in rural areas with low densities of severe crashes applies to both the state and local highway systems where severe crashes are almost equally divided.

The objective of the systemic method is the same as for the black spots, to identify candidates for the deployment of safety improvement projects. However, this method makes one fundamental change in the approach. The black spot method assumed that the presence of (large numbers of) crashes equaled risk and that the absence of crashes indicated that there was no risk. The systemic method is based on the assumption that the absence of crashes does not equate to no risk.

The adoption of this premise about risk presented one very significant challenge – MnDOT previously had no method to assess risk using any measure other than crashes. In order to support the development of a new approach that defines risk based on crashes plus a variety of surrogate measures, research was conducted that identified rural segments and intersections with crashes and then documented the geometric and traffic features that were common among the various locations. This research identified a series of risk rating factors that could then be applied to the analysis of the key elements of rural systems in order to help distinguish those elements that are most at-risk.

The risk factors associated with rural intersections include:

- **Geometry of Intersection** - Previous research has shown that skewed intersections have a higher risk of crashes.
- **Geometry of Roadway** - Previous research has shown that intersections located on or near a horizontal curve are subject to a higher level of risk.
- **Commercial Development in Quadrants** - Previous research has shown that intersections with commercial development located in one or more of the intersection quadrants have a higher level of risk. Private residences or farms were not included in this category.
- **Distance to Previous STOP Sign** - Previous research has shown that drivers lose attention when traveling for longer distances without a STOP sign. Therefore, intersections with minor leg approaches without a STOP sign within 5 miles have a higher level of risk.
- **ADT Ratio** - There is a range of ADT ratio (minor/major) on the County system that is more susceptible to severe crashes than others. Intersections with an ADT ratio between 0.6 and 1 have a higher level of risk.

- **Railroad Crossing on Minor Approach** - Intersections on or near a railroad line are subject to an increased level of risk. Drivers must navigate the railroad tracks while approaching the intersection.
- **Crash History** – Intersection has experience crashes in the last five years.

Based on these risk factors, the intersection of 173rd Street and TH 169 has four of the seven risk factors as shown in Table 11, indicating the intersections to be a high risk location because it has the characteristic (roadway and traffic) of similar intersections with severe crashes.

Table 11
Presence of Risk Factors at 173rd Street Intersection

Risk Factor	Presence of Risk Factor
Geometry of Intersection	✓ - Skewed Intersection
Geometry of Roadway	NO Not located near horizontal curve
Commercial Development in Quadrants	✓ - Commercial Vehicles accessing the Jordan Aggregate site
Distance to Previous STOP sign	NO Next STOP located with 5 miles of this intersection
ADT Ratio	NO ADT ratio not within the range of 0.6 to 1
Railroad Crossing on Minor Approach	✓ - There is a railroad crossing located on the eastbound approach
Crash History	✓ - There were a total of 15 crashes in the last five year period

Table 9
Segment Crash Analysis Summary

	Start	End	Facility	Length	Rural/ Urban	AADT	Total Crashes	Crash Severity					Segment Crash Rate (All Crashes)		
								K	A	B	C	PDO	Actual	Expected*	Critical
CR 9	Frontage Road/CR 9	Syndicate/Valley View	2-lane	2.2	Rural	6,600	2	-	-	-	-	2	0.1	1.1	1.5
Valley View	Valley View/Syndicate	Valley View/CR 65	2-lane	0.8	Urban	800	1	-	-	-	1	-	0.8	1.1	3.1
TH 169	173 rd Street	TH 282	4-lane divided	0.4	Urban	31,000	131	2	-	11	31	87	6.4	0.8	1.2
TH 21	TH 169	TH 282	4-lane	1.1	Urban	7,100	11	-	-	-	-	11	0.8	0.8	1.2
TH 282	TH 169	TH 21	2-lane	1.2	Rural	8,600	40	-	-	3	10	27	2.1	0.8	1.2

Source: MNCMAT Data 2007-2011, US/TH Volumes 2010, CSAH/CR Volumes 2011

*Expected rates for US and TH from MnDOT Green Sheets 2009, http://www.dot.state.mn.us/stateaid/sa_traffic_safety.html.

 Crash Rate Higher than the Critical Crash Rate

Table 10
Intersection Crash Analysis Summary

Sys	Intersection Description	Entering ADT	Traffic Control	Location	Total Crashes	Severity					Crash Rate		
						K	A	B	C	PDO	Actual	Expected	Critical
CR 9	CR 9 and Valley View Dr.	7,150	Thru Stop	Urban	2			1		1	0.2	0.3	0.6
CR 9	CR 9 and Frontage Rd/Syndicate	6,778	Thru Stop	Urban	3					3	0.2	0.3	0.6
173 rd Street	173rd St. and TH 169	29,600	Thru Stop	Urban	15			1	5	9	0.3	0.3	0.4
TH 169	TH 282 and TH 169	30,300	Signal	Urban	47	1		5	4	37	0.8	0.6	0.8
TH 21	TH 282 and TH 21	14,350	Signal	Urban	9					9	0.3	0.6	0.9

Source: MNCMAT Data 2007-2011, US/TH Volumes 2010, CSAH/CR Volumes 2011

*Expected rates for US and TH from MnDOT Green Sheets 2009, http://www.dot.state.mn.us/stateaid/sa_traffic_safety.html.

 Crash Rate Higher than the Critical Crash Rate

Mitigation Strategies

The following provides a summary of the five hauling route options, including a summary of the operational impact of the alternative on the local roadway network and the ability of the existing geometry to accommodate the site generated traffic and potential mitigation strategies that can be applied to provide improvement to operations or safety. A summary of these factors is also shown in Table 12.

Option 1 - Access to Valley View Road with an indirect connection to TH 169 via County Road 9 intersection

- **Benefit:** This option has the least impact on TH 169 traffic operations with trucks accessing the expressway using local street connections and a signalized intersection.
- **Difficulties:** The adjacent land use of the local street connection along Valley View Road is residential. Railroad crossing on Valley View has difficult geometry with tight curves. Also there is limited intersection sight distance at CSAH 9 and Valley View Road.
- **Improvement Needed:** Paving of Valley View Drive from the Jordan Aggregate site, upgrade of Valley View to County State Aid Standards and geometric improvements to the railroad crossing.
- **Cost of Suggested Improvements:** Paving of 1.2 miles of Valley View = \$240,000 (\$200,000 per mile), enhance paved section of Valley View for 0.6 miles = \$120,000 (\$200,000 per mile).

Option 2 - Access to TH 169 southbound via 173rd Street with a U-Turn further south from the site for the northbound TH 169 direction

- **Benefit:** This option keeps the hauling route all within the TH 169 corridor.
- **Difficulties:** The median location is access to an existing commercial site and the uncontrolled U-turn relies on gaps in the traffic to complete the maneuver. Also, the primary point of access (173 St.) to TH 169 is an intersection that is considered to be at risk for safety based on the presence of roadway characteristics. MnDOT also has the right to close the median if future safety problems occur due to truck traffic.
- **Improvement Needed:** The following are suggested for improvements to not only provide necessary complete the U-turn maneuver, but also to minimize impacts to TH 169 operations with the hauling trucks slow accelerations speeds.
 - Add acceleration lane for 1,670 feet south of 173rd Street and north of the median opening
 - Lengthen left-turn lane at U-turn location to 690 feet plus 180 foot taper to accommodate deceleration and storage
 - Add wider shoulder at U-turn location to accommodate u-turning trucks
- **Cost of Suggested Improvements:** \$201,500 (\$50/foot, 3,340 feet of acceleration lane and 690 feet of turn lane)

Option 3 - Access to TH 169 southbound via 173rd Street with connection to TH 169 northbound via TH 21 and TH 282

- **Benefit:** Utilized existing roadway system for hauling truck route.

- Difficulties: The route includes going through downtown Jordan. Also, the primary point of access (173 St.) to TH 169 is an intersection that is considered to be at risk for safety based on the presence of roadway characteristics.
- Improvement Needed: While longer turn lanes at the TH 21 and TH 282 intersection would be desirable, adjacent land use constraint limits the ability to lengthen.
- Cost of Suggested Improvements: \$83,500 for acceleration lane at 173rd Street (\$50/foot, 1,670 feet). Longer turn lanes at TH 21 and TH 282 intersection would be desirable, but due to the existing constraints the financial cost of acquiring the right of way and impacting downtown Jordan would be extensive and therefore not financially feasible.

Option 4 - Access to TH 169 southbound via 173rd Street with connection to TH 169 northbound via TH 282 and TH 21

- Benefit: Utilized existing roadway system for hauling truck route.
- Difficulties: The route includes going through downtown Jordan. Also, the primary point of access to TH 169 is an intersection that is considered to be at risk for safety based on the presence of roadway characteristics.
- Improvement Needed: While a longer southbound TH 169 left turn lane at TH 282 and eastbound TH 282 at the TH 21 intersection would be desirable, adjacent land use and a structure located just north of the left turn lane on TH 169 limits the ability to lengthen.
- Cost of Suggested Improvements: \$83,500 for acceleration lane at 173rd Street (\$50/foot, 1,670 feet) and \$1.5 million for reconstruction of ½ mile of TH 169 and widening of TH 169 structure for a longer left turn lane for a total of \$1.6 million. Longer turn lanes at TH 21 and TH 282 intersection would be desirable, but due to the existing constraints the financial cost of acquiring the right of way and impacting downtown Jordan would be extensive and therefore not financially feasible.

Option 5 - Access to TH 169 southbound via 173rd Street with U-Turn at the TH 282/CR 9 Intersection

- Benefit: This option keeps the hauling route all within the TH 169 corridor and provides a protected phase at the signal for the U-turn maneuver to be completed without the need for additional acceleration lanes.
- Difficulties: Current location of the signal mast arm makes does not provide enough room for the U-turn maneuver. Also, the primary point of access to TH 169 is an intersection that is considered to be at risk for safety based on the presence of roadway characteristics. MnDOT also has the right restrict U-turns at the signal if future safety problems occur due to truck traffic.
- Improvement Needed: The signal mast arm would need to be moved 15 feet along with the edge of roadway.
- Cost of Suggested Improvements: Estimate of \$100,000 to move mast arm signal plus and additional \$20,000 for roadway work at the intersection, \$83,500 for acceleration lane at 173rd Street (\$50/foot, 1,670 feet) and \$1.5 million for reconstruction of ½ mile of roadway and widening of structure for a total of \$1.7 million.

Summary of Analysis

Analysis of the hauling route options provided the following information:

1. Intersection Traffic Operations - The addition of the hauling trucks to the key signalized intersections of TH 169 and TH 282/CR 9 and the intersection of TH 21 and TH 282 has little impact on operations and does not require any mitigation.
2. Existing Safety Issues - None of the intersections have higher than expected crash rates or current safety concerns, however, the intersection of 173rd Street and TH 169 does have intersection characteristics that suggest a higher risk of potential crashes. In addition, the segment of TH 169 between 173rd and TH 282/CR 9 and the segment of TH 282 between TH 169 and TH 21 have higher than expected crash rates for similar roadway segments.
3. Hauling Truck Operations – the operations of the larger hauling trucks, particularly as it pertains to the speed differential between an accelerating or decelerating hauling truck and other roadway users, causes the need for mitigation including longer turn lanes and acceleration lanes on TH 169.

Table 12
Summary of Evaluation Factors

	Safety	Community Impacts	Cost
	+ = Few Safety Risks 0 = Some Safety Risks - = Multiple Safety Risks	+ = Few Impacts 0 = Some Impacts - = Multiple Impacts	+ = Low Cost 0 = Medium Costs - = High Costs
Option 1 - Valley View Road to TH 169 and TH 282/CR 9 intersection	+ Trucks access TH 169 at signal controlled TH 282/CR 9 intersection	0 possible/marginal impacts related to noise and dust on Valley View Road	+ \$360,000
Option 2 - TH 169 with U-Turn at Median Opening	- Trucks enter TH 169 at location with multiple safety risk factors and make U-turn at uncontrolled median opening	+ All operations are on TH 169	+ \$201,500
Option 3 - TH 169 with northbound via TH 21 then TH 282	0 Trucks enter TH 169 at location with multiple safety risk factors	- All hauling trucks routed through downtown Jordan with potential mitigation impacts to church/school	- Over \$2 million (with ROW costs) for TH 21/TH 282 mitigation
Option 4 - TH 169 with northbound via TH 282 then TH 21	0 Trucks enter TH 169 at location with multiple safety risk factors	- All hauling trucks routed through downtown Jordan with potential mitigation impacts to church/school	- \$1.7 million for TH 169 and 173 rd Street improvements. Potentially an additional \$2 million (with ROW costs) for TH 21/TH 282 mitigation
Option 5 – TH 169 southbound with U-Turn at the TH 282/CR 9 Intersection	0 Trucks enter TH 169 at location with multiple safety risk factors but also make U-turn at signal controlled intersection	+ All operations are on TH 169	0 \$1.7 million for TH 169 and 173 rd Street improvements.

Suggested Access Option and Mitigation Strategy

To be determined based on further discussion with Scott County, MnDOT, City of Jordan, etc.

Other Considerations

While this analysis attempts to determine the most feasible hauling route for vehicles using the Jordan Aggregate site, the use of the preferred route is voluntary for the drivers unless restricted by weight limits or U-turn restrictions. It is recommended that the site development agreement address driver training, including a practice of providing the preferred hauling route map to drivers when leaving the site. This map could provide additional information, such as the location of the railroad crossing if Option 1 is chosen, or the appropriate U-turn location if Options 2 or 5 is chosen.

