



APPENDIX
Intersection Option Memo

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To: **Strathcona County**Date: **December 3, 2018**Attention: **Tony Maghee**Project No.: **14985**

Cc:

Reference: **Intersection Improvements**From: **Shelly Moulds**

Range Road 231 and 232 provide vital north-south access to the country residential and rural areas in between Highway 628 and Wye Road (Highway 630). Based on the initial RFP and feedback from stakeholder engagement, the primary concerns on these roadways are speed, safety, minor roadway access/egress, and active mode accommodation.

The intersections along the corridor are currently stop controlled on the minor leg. Both roadways currently have a posted speed of 80 km/h that reduces to 60 at Thomson Road and Salisbury Greenhouse on Range Road 231 and Range Road 232 respectively. The three most common collisions are read ends, struck an object, and run off road.

Traffic analysis for the future horizons has determined that several of the intersections will operate at a poor level-of-service (particularly on the side roads) based on existing conditions. The following intersections will need to be modified to achieve acceptable operations:

Range Road 231

- Elk Island Schools
- Strathcona County Christian Academy
- Future Hillshire/ Executive Estates North
- Meadowhawk/ Executive Estates South
- Windsor Estates South/ Sconadale North
- Deer Mountain Trail/ Sconadale South

Range Road 232

- Salisbury East Parkway
- Salisbury Greenhouse North

ISL has identified five intersection improvement options for Range Road 231 and 232 that have been evaluated based on its traffic impact, safety, active mode accommodation, and costs:

- Roundabouts
- Widening to 4 lanes
- Adding left and right turn bays on the main line
- All-way Stop Control
- Signalization

Traffic analysis was conducted on each option using the 2048 traffic volumes, as that is the worst scenario.



Roundabouts

This option involves installing roundabouts at all intersections requiring improvements.

Traffic Impact

The roundabout options were modeled using Sidra. All intersections operate at an overall LOS of A with no individual movements receiving an LOS of D or worse.

Safety

Traditional stop controlled on the minor leg intersections have a total of 32 vehicle-to-vehicle conflict points and 24 vehicle-to-pedestrian conflict points. Roundabouts reduce the conflict points to eight for both vehicle-to-vehicle and vehicle-to-pedestrian. A 18 % to 72 % reduction of all collisions with a 57.6% to 69.6% reduction of all fatal and injury collisions has been documented.¹ The most severe collisions, head-on and right-angle, are vastly reduced. Vehicle speeds are generally lower on roundabouts reducing the severity of injury in the event of a collision.

While roundabouts have been proven to reduce collisions, many drivers are unfamiliar with the proper roundabout procedures. This can lead to unsafe situations such as failing to yield to circulating traffic or driving in the wrong direction. Education campaigns or signage may be required to ensure proper usage of the new roundabouts.

Active Mode Accommodation

Pedestrian crossings are typically included in the design of roundabouts near residences. While pedestrians will not have a dedicated time to cross as with traffic signals, they may experience less delays at roundabouts since they don't not have to wait for the correct phase. Typical roundabout designs include splitter islands that reduce the crossing distance and provide refuge for crossers. Cyclists can use a roundabout the same way a vehicle does, however less confident cyclists may feel more comfortable using a sidewalk or trail system.

Land Impacts

Roundabouts may require additional right-of-way depending on the design.

Costs

Roundabouts typically have a higher installation cost than signal lights in a retrofit situation, although the cost over time is often less than signalization due to the lower operation and maintenance cost. The cost of a retrofit roundabout between \$250,000 and \$275,000 in 2012², which is approximately \$275,000 to \$300,000 in 2018 accounting for inflation. It is proven that roundabouts represent an environmental cost savings when designed properly by reducing collisions. Additionally, roundabouts may save fuel and reduce emissions due to reduced idling time.

Advantages and Disadvantages

A summary of the advantages and disadvantages of implementing roundabouts on the study roadways is provided below.

Table 1.1: Roundabout Advantages and Disadvantages

Advantages	Disadvantages
Forces drivers to slow down (safety perspective)	Forces drivers to slow down (driver perspective)
Easier for minor roads to enter and exit	Can be difficult for cyclists to navigate.

¹ Albert Transportation, *Methods of Reducing Collisions on Alberta Roads* (2003)

² Albert Transportation, *Methods of Reducing Collisions on Alberta Roads* (2003)



Significant collision reduction	Land acquisition required.
Significant collision severity reduction	Expensive installation
Pedestrians only crossing one lane of traffic	May require public education
Reduces time idling	
Low maintenance costs	
Meets all LOS requirements	
Long lifespan	

Widening to 4 Lanes

This option explores widening Range Road 231 and 232 from 2-lanes to 4-lanes. For this option analysis, the lane configuration is assumed a combination of through-left and through-right. A more detailed analysis is required to determine the optimal lane configuration.

Traffic Impact

All intersections operate at an LOS of A with no individual movements with an LOS of D or worse on Range Road 232. Below is a table summarizing the 2048 4-lane traffic analysis results on Range Road 231.

Table 1.2: 4-Lane Analysis Results – Range Road 231

2048 Traffic Analysis Results				
Range Road 231				
Minor Road	Intersection LOS		Movements with LOS D or Worse	
	AM	PM	AM	PM
Elk Island Schools	A	A	-	EBL (D), EBR (D)
Strathcona Christian Academy	A	A	EBL (E), EBR (E)	EBL (E), EBR (E)
Hillshire/ Executive Estates North	A	A	-	EBL (D), EBR (D)
Meadow Hawk/ Executive Estates South	A	A	-	-
Windsor Estates North	A	A	-	-
Windsor Estates South/ Sconadale North	A	A	-	-
Deer Mountain Trail/ Sconadale South	A	A	-	-

Based on the above results, while several intersections' LOS improved, twinning Range Road 231 did not resolve all traffic issues.

Safety

Widening to 4-lanes has the following safety implications:

- Drivers could change lanes when a driver ahead of them is turning left or right, helping with traffic flow on the Range Roads and potentially reducing rear-end collisions;
- Weaving may lead to more sideswipes;
- More gaps for vehicles traveling from the minor roadways to turn right onto the Range Road;
- Left turning vehicles must now cross two lanes of traffic, requiring larger gaps;
- Increased the time required for pedestrians to cross the Range Roads and could potentially reduce pedestrian visibility. The same is true for cyclists.



Active Mode Accommodation

Widening the roadway affords the opportunity to install active mode infrastructure simultaneously. Crossing the Range Roads will become more difficult for active modes as the crossing distance will double.

Land Impacts

Widening to a 4-lane roadway will require significant land acquisition.

Costs

Widening to a 4-lane roadway will require significant land acquisition. Construction in wet or bogy areas will be unavoidable if the whole section is twinned. The construction will likely be costly as additional geotextile reinforcements will be required and drainage would need to be reconfigured.

Advantages and Disadvantages

A summary of the advantages and disadvantages of widening the Range Roads to 4-lanes is provided below.

Table 1.3: Widening Advantages and Disadvantages

Advantages	Disadvantages
Increased capacity (driver perspective).	Increased capacity, more noise (resident perspective).
Drivers can switch lanes when someone is trying to turn, potentially reducing rear end collisions.	The option to change lanes could lead to an increase in side swiping and aggressive driving behaviors.
Easier right turn onto the Range Roads.	Left turning vehicles must cross two lanes of traffic.
Potential to build active mode infrastructure and widening simultaneously.	Potential for reduced pedestrian visibility.
	Land acquisition required.
	Several intersections did not meet the LOS criteria on Range Road 231.
	Higher construction costs due to the nature of the soils in the area.
	Prolonged construction period with disturbances to traffic flow.

Left and Right Turn Bays

This option explores installing right and left turn bays at all intersections requiring improvements.

Traffic Impact

Initial modeling indicated that while traffic moved more smoothly on the Range Roads, the addition of turning lanes did not solve the access delay issues on the minor roadways. Given this is one of the primary issues on the Range Roads, no further modeling was done.

Safety

The addition of left and right turn bays may reduce the amount of rear end collisions along the roadway as turning vehicles would have a separate lane for deceleration. Providing additional space for vehicles to turn may have unintended safety consequences. Open house attendees noted that drivers will sometimes use the right turn lanes on Range Road 233 to maneuver around a vehicle attempting to turn left in the left-through lane.



Active Mode Accommodation

The addition of turn bays increases the roadway length pedestrians must cross. Pedestrian sightlines may be affected by turning traffic. Additional land would need to be acquired if the County wanted to install a multi-use path.

Land Impacts

Additional land acquisition may be required to accommodate the addition of left and right turn bays.

Costs

There will be construction and maintenance costs, as well as potential land acquisition costs.

Advantages and Disadvantages

A summary of the advantages and disadvantages of adding left and right turn bays to Range Road 231 and 232 is provided below.

Table 1.4: Turn Bays Advantages and Disadvantages

Advantages	Disadvantages
Drivers are no longer required to slow down for turning vehicles, potentially reducing rear end collisions.	More lanes for pedestrians to cross.
Less delay on Range Roads.	Potential for reduced pedestrian visibility.
	Land acquisition required.
	Construction period with disturbances to traffic flow.
	No improvement to minor road delays
	Potential for illegal weaving.

Four Way Stops

This option involves installing 4-way stops at all intersections requiring improvements.

Traffic Impact

The following table summarizes the 2048 Traffic Analysis Results with the 4-way stop option.

Table 1.5: 4-Way Stop 2048 Traffic Analysis

2048 Traffic Analysis Results				
Range Road 231				
Minor Road	Intersection LOS		Movements with LOS D or Worse	
	AM	PM	AM	PM
Elk Island Schools	E	F	NBL (D), NBT (D), SBT (E)	NBL (F), NBT (F), SBT (E)
Strathcona Christian Academy	D	F	NBT (D), SBT (D)	NBT (F), SBT (F)
Hillshire/ Executive Estates North	C	F	-	NBT (F), NBR (F)
Meadow Hawk/ Executive Estates South	C	F	SBT (D)	NBT (F), NBR (F)
Windsor Estates North	A	A	-	-
Windsor Estates South/ Sconadale North	D	F	SBL (D), SBT (D)	NBL (F), NBT (F), NBR (F)
Deer Mountain Trail/ Sconadale South	D	F	SBL (D), SBT (D)	NBL (F), NBT (F), NBR (F)



Range Road 232				
Minor Road	Intersection LOS		Movements with LOS D or Worse	
	AM	PM	AM	PM
Estates Court	A	A	-	-
Salisbury East Parkway	C	D	-	NBR (E), NBT (E), NBL (E)
Estates Drive	A	A	-	-
Salisbury Greenhouse North	B	C	-	NBT (D), NBR (D)
Salisbury Greenhouse South	A	A	-	-
East Whitecroft North	A	A	-	-
West Whitecroft North	A	A	-	-
East Whitecroft South	A	A	-	-
West Whitecroft South	A	A	-	-
Scot Haven/ Graham Heights North	A	A	-	-
Scot Haven/ Graham Heights South	A	A	-	-
Winfield Heights North/Carriage Lane North	A	A	-	-
Carriage Lane South	A	A	-	-
Winfield Heights South/Carriage Lane New	A	A	-	-

Based on the Synchro results, implementing 4-way stops at trouble intersections drastically worsens the LOS on the Range Roads. This is to be expected, as 4-way stops operate best when there is an even volume split between the roadways.³

Safety

Converting two-way stop controlled intersections to all-way stop controlled may reduce the total collisions by 47 percent with right-angle and collisions with injuries reduced by 72 and 71 percent respectively.⁴ An increase in rear end collisions may occur, particularly in icy conditions.

Active Mode Accommodation

A 4-way stop controlled intersection would generally make it easier for active modes to cross as drivers in all directions would be required to stop at the intersection. It must be noted, however, that too many stop signs may lead to complacency and carelessness. This can be dangerous for pedestrians and cyclists as the stop sign may give them a false sense of safety.

Land Impacts

Converting 2-way stop controlled intersections to 4-way would have no impact on the lands.

Costs

Costs associated with a 4-way stop conversion are minimal. Potential costs include signage, lane painting, and occasional sign replacement.

³ Tian, Z. et al., “Simulation-based study of traffic operational characteristic at allway-stop-controlled intersections”, Transportation Research Record, (2001), p. 81.

⁴ Lovell, J., and Hauer, E., “The safety effect of conversion to all-way stop control”, Transportation Research Record 1068, (1986), p. 107.



Advantages and Disadvantages

A summary of the advantages and disadvantages of implementing 4-way stops on the study roadways is provided below.

Table 1.6: 4-Way Stop Advantages and Disadvantages

Advantages	Disadvantages
Easier for pedestrians to cross	Could lead to increased rear-end collisions
Easier for minor roads to enter and exit	Increased idling time
No land acquisition required	Significant delays on the Range Roads
Short “construction” phase	Does not meet the LOS requirements
Inexpensive	Too many stop signs may lead to carelessness or non-compliance.
Low maintenance costs	Unbalanced traffic volumes on intersecting roadways lead to high delays on the Range Roads.

Traffic Signals

Traffic signals were considered at all intersections requiring improvements.

Traffic Impact

Synchro analysis of the signal option resulted in the following observations:

- All study intersections met the LOS requirements in 2048 except the unsignalized intersection on Range Road 231.
- The unsignalized intersection of Windsor Estates North and Range Road 231 eastbound left-right has an LOS of D during the 2048 PM peak hour.
- The delay on the Windsor Estates North eastbound approach increased from 21.1 seconds in the 2048 PM peak model with original geometry to 25.4 seconds with signals.
- The change at Windsor Estates North is likely due to traffic flow changes from signalization.
- Windsor Estates North is likely not worth signalizing as the eastbound movement only fails by 0.4 seconds.

Signal coordination will be necessary along the corridor to prevent stop and go traffic flows during the peak hours.

Safety

Collisions have been found to decrease 10.9 percent after the installation of traffic signals with an injury or fatal reduction of 42 percent.⁵ Traffic signal warrant analysis is required to determine whether signalization is a merited. It was also found that installing signals at an intersection where signals are not warranted increased the overall collision frequency of 28.3 percent and the rate of rear end collisions by 222 percent.⁶

Traffic signals provide a protected phase for pedestrians to cross the roadway, however pedestrian safety lowers based on the number of right and permitted left turns. This should not be an issue for the study corridors as the traffic on the minor road is relatively low.

⁵ “Crash history after installation of traffic signals (warranted vs. unwarranted)”, Kentucky Transportation Centre, (2008).

⁶ “Crash history after installation of traffic signals (warranted vs. unwarranted)”, Kentucky Transportation Centre, (2008).



Active Mode Accommodation

Signalization would make it easier for active modes to cross as they would be given dedicated walk times. Traffic signals would also make it safer for cyclists to cross the intersection.

Land Impacts

Traffic signals typically do not require additional right of way.

Costs

Costs associated with signalization include signal lights, installation, operation, and maintenance costs. The approximate purchase and installation cost of signalization is \$240,000. Eight intersections have been identified for signalization, making the total cost of signalization approximately \$1,920,000. Operation and routine maintenance costs of a signalized intersection are typically higher than roundabouts at approximately \$2,000 and \$1,000 per year respectively.⁷

Advantages and Disadvantages

A summary of the advantages and disadvantages of signalizing the Range Roads to 4-lanes is provided below.

Table 1.7: Signalization Advantages and Disadvantages

Advantages	Disadvantages
Dedicated pedestrian crossing phase	32 vehicle-to-vehicle conflict points and 24 vehicle-to-pedestrian conflict points.
Easier for minor roads to enter and exit	Higher maintenance and operation costs
Reduction in T-bone collisions	Increase in rear-end collisions
Meets LOS requirements (within 0.4 seconds)	High purchase and installation cost
No land acquisition required	

Options Comparison

The following comparison table summarizes the effects each option has on the key consideration of this project.

Table 1.8: Options Comparison

	Capital Cost			User Impacts		Safety					Traffic Flow		
	Cost	Right-of-Way	Yearly Costs	Construction	Active Mode	Rear-End	T-Bone	Side Swipe	Pedestrian	Cyclist	Minor Leg	Range Roads	Speed
Widening	●	●	●	●	●	●	●	●	●	●	●	●	●
Turn Bays	●	●	●	●	●	●	●	●	●	●	●	●	●
4-Way Stops	●	●	●	●	●	●	●	●	●	●	●	●	●
Roundabouts	●	●	●	●	●	●	●	●	●	●	●	●	●
Traffic Signals	●	●	●	●	●	●	●	●	●	●	●	●	●

⁷ Based on internal estimations.



Based on this comparison, the roundabout and signal options address most of the issues on Range Road 231 and 232.

Sensitivity Analysis

The signal and roundabout options were analyzed to determine the lifespan of the improvement. The 2048 Synchro files for both options were taken and the Alberta Transportation background volumes were applied to through traffic until the intersection received a LOS of D. No growth factors were applied to the turning and side street volumes as it is assumed the residential areas will be fully built out and occupied by 2048.

Roundabout Sensitivity Analysis

Only intersections that are proposed to have a roundabout treatment were modeled. The results of the sensitivity analysis is provided below.

Table 1.9: Roundabout Sensitivity Analysis

Range Road 231		
Minor Road	Years to Trigger a Movement with LOS D	
	AM	PM
Elk Island Schools	35	35
Strathcona Christian Academy	48	13
Hillshire/ Executive Estates North	41	19
Meadow Hawk/ Executive Estates South	66	30
Windsor Estates North	63	31
Windsor Estates South/ Sconadale North	64	33
Deer Mountain Trail/ Sconadale South	100+	29
Range Road 232		
Minor Road	Years to Trigger a Movement with LOS D	
	AM	AM
Salisbury East Parkway	53	31
Estates Drive/ Glenwood	57	39

Based on the analysis, the majority of roundabouts will operate at an acceptable LOS for more than 30 years after 2048.

Signal Sensitivity Analysis

The results of the signal sensitivity analysis are provided in the table below.



Table 1.10: Signal Sensitivity Analysis

Range Road 231		
Minor Road	Years to Trigger a Movement with LOS D	
	AM	PM
Elk Island Schools*	30+	16
Strathcona Christian Academy*	30+	24
Hillshire/ Executive Estates North*	30+	30+
Meadow Hawk/ Executive Estates South*	30+	30+
Windsor Estates North	10	0
Windsor Estates South/ Sconadale North*	30+	30+
Deer Mountain Trail/ Sconadale South*	30+	30+
Range Road 232		
Minor Road	Years to Trigger a Movement with LOS D	
	AM	PM
Estates Court	30	30+
Salsbury East Parkway*	30+	30+
Estates Drive	20	30+
Salisbury Greenhouse North*	30+	30+
Salisbury Greenhouse South	30+	12
East Whitecroft North	20	10
West Whitecroft North	30+	12
East Whitecroft South	30+	20
West Whitecroft South	10	4
Scot Haven/ Graham Heights North	10	4
Scot Haven/ Graham Heights South	10	10
Winfield Heights North/Carriage Lane North	10	4
Carriage Lane South	30+	4
Winfield Heights South/Carriage Lane New	10	10

Based on the analysis, the majority of intersections will operate at an acceptable LOS for more than 30 years after 2048. The unsignalized intersections are more sensitive to volume increases, and the majority are expected to no longer have an acceptable LOS in 2058.

Signal vs Roundabout Comparison

The two options that best address the key issues on Range Road 231 and 232 are signalization and roundabouts. It was proven in the sensitivity analysis that both options would be viable for over 30 years. This section provided a more detailed comparison of the other key considerations for the Range Road upgrades.



Traffic Flow

Both options address the delay issues during the peak hours, however the off peak driver experience should also be considered. Roundabouts allow easy access onto the Range Roads with no stopping required if there is no traffic. Depending on the sensitivity and location of the signal's sensors, drivers on the minor roadways may be required to stop.

Safety

Roundabouts significantly reduce potential conflict points. Because the geometry necessitates reduced speeds, conflicts that do occur at a roundabout will be less severe than those at traditional signalized intersection. It is likely that not all of the proposed signalized intersections are warranted. Unwarranted intersections which may lead to an increase of rear end collisions. Give the ratio of drivers on the Range Roads versus the minor roads, this rear end collision increase will likely cause far more property damage and injury than what the signal prevents with T-bone collisions.

Signalized intersections are generally safer for pedestrians and cyclists as it provides these groups dedicated crossing times. However, once again, vehicle-pedestrian collisions that occurs at a signalized intersections are likely more severe than those at roundabouts.

Active Mode Accommodation

As previously mentioned, signalized intersections can easily accommodate pedestrians due to the dedicated crossing times. Roundabouts do not offer pedestrians protected crossing times, however they are often designed with splitter islands that reduce the crossing distance and provide refuge for crossers. Cyclists that choose to drive on the roadway like a vehicle are likely more comfortable with signalized intersection rather than roundabouts.

Land Impacts

Signalized intersections generally require less right-of-way at the intersection than roundabouts.

Costs

Roundabout and signal installation had been found to have similar costs, as such; the operation and maintenance costs are the deciding factor. Both options have relatively the same amount of roadway that would need maintaining. Roundabouts have few operation and maintenance costs save maintenance to the island assuming it is landscaped. Maintenance must be done on traffic signals at least twice a year for winterization and de-winterization, amounting to approximately \$2,000 a year. The majority of signals operate using LED lights that cost approximately \$1,000 based on the typical power usage and energy costs in Strathcona County.

Residential Considerations

ISL has held two public engagement events to determine the public's opinion on the Range Road upgrades. The topic was fairly polarizing; however overall there seemed to be more support for roundabouts rather than signals. This is especially the case when considering the options in the Glenwood Memorials area.

A common concern from stakeholder engagement was the effect construction of these improvements will have on the Range Road residents. From this perspective, signals are preferable as they can go up with relatively limited traffic disturbances. Conversely, roundabouts require reconfiguration of the entire intersection and may limit traffic flow in the area for several weeks.



Conclusion

The roundabout option provides the greatest safety improvements, and has lower operation and maintenance costs compared to traditional signals. While residents will be inconvenienced during construction and there is sure to be a transition period, overall traffic flow and safety along the corridor is expected to improve with the installation of roundabouts.