

Technical Memorandum

To: **Brandon Green**, Project Manager, City of North Vancouver (CNV)
From: Andres Baez, Senior Transportation Planning Engineer, Morrison Hershfield
Copy: **Jennifer Draper**, Deputy Director Planning & Development CNV
Date: October 22, 2019
Subject: Technical Peer Review for Coverley Community Traffic Calming Plan

Per your request, Morrison Hershfield (MH) has analyzed the implemented Cloverley Traffic Calming Plan (CTCP) and all available technical and procedural documentation, including available background data and information, monitoring data, community feedback, applicable policies, council reports, relevant technical projects in the area, media reports and overall contextual information. This memorandum documents our analyses and findings. The goal of this review is to identify opportunities for improvements, and to evaluate and recommend options moving forward.

Based on our review, it is MH's opinion that the process followed was generally in line with common practices and in accordance with applicable City's Traffic Calming Policies. That said, opportunities for improvement were found regarding the rationale behind some of the decisions taken, as well as some of the technical aspects of the project.

BACKGROUND/CONTEXT

Since 2016, the City has been consulting with residents in the Cloverley neighborhood to develop traffic management/calming plans in hopes to deter commuter traffic from using residential streets to shortcut congestion on Keith Road and 3rd Street.

From public records, it is understood, the process followed applicable municipal Traffic Calming Policy. The process and methodology delivered generally resembles acceptable practices, taking steps aimed at identifying issues, assessing risks and impacts, implementing actions and monitoring results.

Despite the above, and after multiple rounds of data collection, community feedback, technical analysis, and implementation phases, the effectiveness of the measures implemented remain questionable and residents support is fragmented. Some residents support more restrictive self-enforcing measures (i.e. diverters, medians, lane closures, etc.); others more passive controls (i.e. warning/advisory signs, reduced posted speed, traffic calming signs, etc.).

After post-implementation monitoring, the City has reported modest volume reductions while shortcutting seem to have shifted to nearby streets and back lanes through even more circuitous routes than before. Speeding has apparently receded likely after the widespread installation of speed humps in the neighborhood.

THE PROCESS

While is our opinion that the process followed was generally adequate and well intentioned, we believe there were aspects that could have been done better:

- Assessment of traffic impacts during construction of Lower Lynn Improvements upon neighboring communities along the corridor,
- Additional coordination and shared evaluation of outcomes by all jurisdictions involved City, District and Ministry of Transportation.
- Hierarchy of treatments to first target arterial road networks (i.e. access management and signal timing optimization)
- Considerations as to whether an area-wide plan versus street specific treatments were more suitable
- Objective evaluation of risks against pre-established criteria

DIAGNOSTIC

At its core, we believe that the shortcutting issue is largely attributed to the extraordinary level of congestion on Keith Rd and 3rd Street which was not anticipated to the fullest. Basically a supply and demand issues, the throughput capacity on Keith and 3rd Street has been severely reduced during construction of the Lower Lynn project and is insufficient to handle local and commuter traffic bound for the Ironworker Bridge and across Hwy 1. The demand and supply imbalances are so severe that short-cutters do not seem at all discouraged by the customary traffic calming measures implemented even though these have proven effective in comparable conditions in other areas across Metro Vancouver.

There are additional factors that contribute to the exacerbation of congestion along adjacent arterial roads that are discussed at length in **Appendix A**. These include:

- Minimal access management along arterial Keith St. and 3rd St E.
- Severe capacity restrictions due to traffic management plans for construction of Lower Lynn Improvements
- Severe traffic disturbance due to accidents on the bridge
- Limited redundancy on transportation networks across the North Shore

From the above, we believe that a more holistic and multi-jurisdictional evaluation of area-wide traffic impacts brought by the Lower Lynn project upon nearby communities would have led to the realization that a corridor-oriented **access management approach along Keith Rd and 3rd Street** was a key component among the possible array of solutions.

Appendix A discusses in greater detail the importance of access management along urban corridors and how critical it is to safeguard the intended functionality and operation of key intersections along such corridors. In particular, we strongly advocate for the preservation of the intended operation of the intersection of Keith Rd/Brooksbank Ave/Mountain Hwy., by restricting access within its functional area in order to prioritize throughput traffic on the major roads. Further, we believe that by virtue of higher-order access management on arterial roads, more effective traffic calming plans for neighboring communities can be achieved.

RECOMMENDATIONS

Two plans are recommended, an **Interim Plan (Exhibit A)** and **Ultimate Plan (Exhibit B)**. The former encompasses improvements to the existing CTCP plan implemented, and the latter is envisioned for longer-term implementation once the Lower Lynn project is completed. Key principles in the formulation of these plans include:

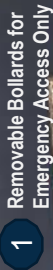
- A. To eliminate the main incentive for shortcutting/queue jumping using neighborhood roads
- B. To maximize the efficiency/operation of adjacent arterial and collector road by all means necessary (i.e. access management, ITS, signal optimization, capacity improvements, demand management, etc.)
- C. To prioritize self-enforcing measures over passive regulatory signage

Interim and Ultimate plans are designed, first and foremost, to eliminate the possibility of vehicles from Heywood St. (and its back lane to the west) joining eastbound traffic on Keith Rd bound for the bridge, which is believed to be the prime incentive for shortcutting and a major disruptor of traffic and safety in the vicinity of the intersection of Keith Rd and Brooksbank Ave.

Also, arterial and collector roads are viewed as the first 'line of defense' against potential shortcutting traffic on neighborhood roads. Thus, access management controls are recommended along Keith Rd, 3rd Street and Queensbury Avenue. These are aimed to prioritizing thru traffic on main roads, minimizing crossing traffic from side streets, and maintaining reasonable resident's access to City roads. Additional details on recommended access management is provided in **Appendix A**.

Lastly, for neighborhood roads in the interface with the collector and arterial roads, the emphasis is for self-enforcing physical measures (i.e. diverters, bollards, closures, curb extensions, delineators etc.) to effectively redirect short-cutters back to nearby arterial and collector roads.

Interim











SCENARIO EVALUATION

Table 1 below compares some of the key aspects and highlights of each plan. **Table 2** summarizes the evaluation of each plan according to its potential to meet recommended criteria (i.e. speed reduction, volume reduction, impact to resident accessibility, ease of enforcement, impact to emergency/garbage collection, and implementation cost). **Appendix A** includes details of the key measures recommended including description of their primary purpose, relative effectiveness, advantages, disadvantages and high level order-of-magnitude cost. Detailed evaluation of resident's accessibility metrics is included in **Appendix B**.

Table 1. Summary of Plan Scenarios, Highlights and Key Features

	EXISTING CTCP	PROPOSED INTERIM	PROPOSED ULTIMATE
Reliance on Self-Enforcing Physical Barriers			
	LOW	MODERATE-TO-HIGH	MODERATE-TO-HIGH
	Almost none except for:	Proposed temporary access management on Keith Rd. Right-In ONLY (with channelization) various locations (see map)	Proposed permanent access management on Keith Rd. Elimination of Right-In Only restriction on Heywood St. Permanent delinators for Dual Left Turn Lanes on Keith Rd. (Optional)
	Temporary curb extensions on 4t St. E and 6th Ste E.	Permanent curb extensions at various locations(see map) Lane closures with removable bollards at various locations (see map) Permanent and temporary road delinators (see map)	All other physical barriers as for the interim plan.
Reliance on Passive Advisory/Regulatory Signage			
	HIGH	MODERATE	LOW
	Almost fully dependable on: - Traffic Calming Area Advisory/Local Traffic Only Signs - Speed Bump Advisory Signs - No Right-Turn Signs - On Way / Do Not Enter Signs	Reinforce warning/advisory messages with: Curb extensions Removable bollards Traffic diverters channelization	Almost fully dependable on self-enforcing physical measures. Signage is there for information purposes only.
Access to Keith Road			
	GENERALLY UNRESTRICTED	HIGHLY RESTRICTED	ALMOST UNRESTRICTED
	- No Left-Out onto Heywood St. - No Right-Turn (3-6pm) on back alleys	Right-In Only Access at Heywood St. (and back lane), and Shavington St. (and back lane) Permanent No Right-Turns onto Keith from Heywood St. and Shavington St. All-turns access at Cloverley St. No-Left Turns from Keith onto Heywood St (and back lane), and Shavington St (and back lane) One way (south) conversion of Adderley St.	Right-In/Right-Out on Heywood St. No Right-Turns on Shavington No Right-Turns from Adderley St No Left-Turns from Adderley St
Access to/from Queensbury Ave.			
	MINORLY RESTRICTED	MODERATELY RESTRICTIVE	MID-HIGHLY RESTRICTED
	Directional Closures (curb extensions) AND One-Way Conversion on 4th Ave and 6th Ave No Right-Turn (3-6pm) onto 5th Ave from Queensbury Ave. Advisory Signs ("Traffic Calmed Area/Speed Bumps") on back lanes	Directional Closures (curb extensions) AND One-Way Conversion on 4th Ave and 6th Ave Close lane access to Queensbury Ave (removable bollards) except for lane between 6th and 7th Install median delinators on Queensbury Ave. by 5th St and by the Lane between 6th and 7th St Advisory Signs ("Traffic Calmed Area/Speed Bumps") on 5th St E.	Same features as Interim plus: - Raised median (with bicycle refuge area) on 4th St E and 7th St E.
Access to Hendry Ave.			
	UNRESTRICTED	MODERATELY RESTRICTIVE	MID-HIGHLY RESTRICTED
	Unrestricted	Directional Closures (curb extensions) AND One-Way Conversion of Adderley St. Close access to Hendry Ave (with removable bollards) from lane across 6th St. Install centre line delinators	Similar features as the Interim Plan
Access to 3rd Street			
	UNRESTRICTED	UNRESTRICTED	UNRESTRICTED

Table 2. Plans Scenario Evaluation

	EXISTING CTCP	PROPOSED INTERIM	PROPOSED ULTIMATE
Volume Reductions			
	LOW	MODERATE-HIGH	MODERATE-HIGH
	Limited to driver observance and compliance of advisory and regulatory signs	Self-enforcing measures have high potential for shortcutting volume reduction!:	Self-enforcing measures have high potential for shortcutting volume reduction!:
		- Channelized right-in only accesses to Keith Rd.	- Access controls onto Keith Rd.
		- Centre line delinators on Hendry Ave.	- Centre line delinators on Hendry Ave.
Speed Reduction			
	MODERATE	MODERATE-HIGH	MODERATE-HIGH
	Limited to the effects of speed bumps	Self-enforcing measures have high potential of speed reduction potential:	Self-enforcing measures have high potential of speed reduction potential:
		- Channelized right-in only accesses to Keith Rd.	- Access controls onto Keith Rd.
		- Centre line delinators on Hendry Ave.	- Centre line delinators on Hendry Ave.
Impact to Residents Accessibility			
	LOW - MODERATE	MODERATE-HIGH	MODERATE
	Avg. Distance per household (All Trips/All Routes): - 0.628 km/trip/house	Avg. Distance per household (All Trips/All Routes): - 0.745 km/trip/house	Avg. Distance per household (All Trips/All Routes): - 0.739 km/trip/house
	Refer to Appendix B for detailed calculations	Greater distances for residents on Heywood and Shavington St Refer to Appendix B for detailed calculations	Improved access to Keith Rd in the ultimate stage. Refer to Appendix B for detailed calculations
Ease of Enforcement/Compliance			
	LOW	MODERATE-HIGH	MODERATE-HIGH
	Frequent police presence for regulatory compliance	Self-enforcing measures require less / infrequent police presence	Self-enforcing measures require less / unffrequent police presence
Impact to Emergency Access/Garbage Collection			
	LOW	MODERATE-HIGH	MODERATE
	Longer routes for emergency and garbage collection vehicles due to current restrictions	Relative to existing: - More circuitious routes for garbage trucks overall - Most garbage pick up is done from lanes so closing lane on end end will be a challenge - Some streets such as Sutherland garbage is picked up from the street - Removable bollards are accessible to emergency and police vehicles - Access to Keith Rd is the most restricted of all scenarios	Relative to Interim: - Improved access to Keith Rd. - Garbage collection challenges as in the Interim still applies
Implementation Cost			
	LOW	MODERATE	MODERATE-HIGH
	Most measures are advisory and regulatory signs plus couple of temporary rubbered curb extensions	- Combination of advisory/regulatory signs plus temporary self-enforcing physical measures	- Mostly permanent self-regulatory physical measures
	\$100K-200K	\$300K-500K	\$500K-800K

OTHER CONSIDERATIONS

Connected Variable Message Boards: Research suggest that VMS effectiveness is highly dependent on context and site-specific conditions. In general, although the actual benefits in travel time savings and environmental impacts are relatively small, driver's perception of the benefits is much greater. Thus, VMS is generally well received by drivers and the public at large.

For continuous information (i.e. Estimated travel delays along Keith Rd and 3rd Street), research suggests that such information increases the use of the major route and reduces the use of alternative routes if there are no traffic problems reported on the major route. In this case, if delays reported seem acceptable to drivers – and no alternative routes are viable – then motorist might be more likely to stay on the major route as opposed to not having any information at all. With no information, drivers may decide to venture more quickly in the search for alternate routes.

For incident information (i.e. Accident on the bridge), it is not only the severity of the problem reported that influences the level of diversions, but other factors such as the availability of viable alternative routes to avoid the problem. In this case, impacts to diversion should be low as there are no viable alternative routes to the bridge.

Although the benefits in terms of travel times may not be substantial, the implementation of VMS could be considered, subject to public support and availability of funding, as part of package solution aimed to raise public perception of issues and to show the City's commitment to a more holistic strategy. The market price for the required hardware for a solar-powered VMS board ranges from fifteen to forty thousand dollars. In addition to the equipment cost, bringing software and network data including travel time data collection and display in real time will be require, as well as operational costs (staff, maintenance, etc.). The City's engineering department has indicated that a Recent Pilot DMS Project led by Ministry with similar scope was recently ended due to challenges measuring success and lack of support from residents and municipalities.

No-Right Turn Restriction from 3:00 pm to 6:00 pm. **We do not recommend** time-based right-turn restrictions onto Keith from Heywood St, Shavington St. Cloverley St. and Adderley St. We are of the opinion that the severity of the issues **warrants permanent implementation of such restrictions** at all times. Furthermore, we recommend self-enforcing measures such as Right-In Only directional accesses to eliminate the need of external enforcement.

Enforcement: In general, we are of the opinion that in this case traffic calming measures should be self-enforcing if at all possible. The use of passive advisory/regulatory signs requires frequent police enforcement, even under 'normal' circumstances, let alone in areas where congestion issues seem out of line. Compliance of passive advisory/regulatory signs is a challenge and can only be consistently achieved with visible police enforcement, a resource which is not always available. Resident's feedback during the CTCP process attested to this fact, reporting that many of the signs installed are frequently ignored and violated. While speeding issues have been effectively resolved by the abundance of speed bumps on almost every street and lane, violation of turning restrictions is still unresolved.

Garbage/Recycling Collection. It is understood that some of the controls recommended will also impact accessibility of recycling and garbage collection vehicles. It is also understood that currently garbage collection is done, for some street, by the curbside (curbside collection) along residential frontages. For other streets, it is done from the back lane. Lane garbage collection will be a challenged with the recommended removable bollards on the lanes. For such streets where garbage collection is currently done from the lane, curbside pick-up collection is recommended.

Appendix A- Supplementary Technical Discussion

THE SHORTCUTTING: ROOT CAUSES, ANALYSIS AND OPPORTUNITIES

Growing commuter congestion from traffic bottlenecks is common throughout the North Shore largely related to the limited redundancy in regional network connections for all modes. East-west connectivity across Highway 1 in particular is limited to a couple of road connections that are also part of the regional Lower Lynn system of interchanges which connects the north shore to the rest of the region.

Keith Road and the 3rd Street/Main Street corridor are especially overburdened with regional commuter flows and local east-west traffic along with sporadic construction activities and incident events (e.g. vehicle collisions). The root causes, scale, multiple jurisdictions, and temporality of some of the conditions are clearly beyond the purpose or scope of a neighborhood traffic calming plan. It is our opinion, therefore, that the traffic calming solutions for Cloverley should:

- a) Recognize the regional nature of the problem and the effects of the solutions thereof
- b) Be conceived and staged in the context of the Lower Lynn system upgrades and timelines
- c) Understand the importance of access management along Keith Rd. for regional and local traffic flows
- d) Recognize the temporary nature of construction disruptions and unpredictability of incident events

The Lower Lynn Improvements & Mountain Highway Interchange

The effects of the Lower Lynn system of interchanges is unquestionably a major contributor to the shortcutting traffic on nearby neighborhood roads. Current traffic issues on Keith Rd. and 3rd Street are expected to improve after long-term construction plans are complete and other ancillary measures are in place.

Central in the vision for the Lower Lynn improvements is to provide new east-west connections for local drivers without forcing them into highway traffic bound for the Ironworkers Memorial Second Narrows Crossing. Also key, is the provision of better on- and off-ramps expected to cut down on the number of collisions, which often bring nearby arterials to a standstill.

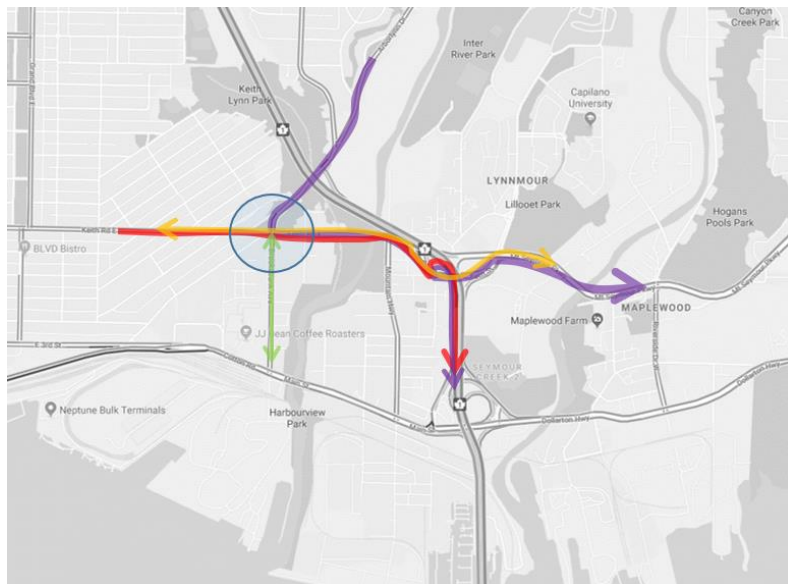


FIGURE 1. TRAFFIC FLOWS AT KEITH RD AND BROOKSBANK AVE INTERSECTION

still cut across thru traffic and join the eastbound dual left-turns lanes on Keith Rd, from either Heywood St or the adjacent back lane to the east.

In response to public discontent, adjustments have been made including changes to lane markings and recalibration of signal timing plans, mostly, to allocate more green time to eastbound and southbound movements. Such improvements are at the expense of other approaches. As congestion on Keith Rd and 3rd Street increases, potential travel time savings become even more attractive despite the measures implemented. **So long as the physical ability to shortcut exists and the gain in travel time savings remains so high, commuters will act to achieve their objective.**

In particular, the ongoing construction of the Mountain Highway Interchange has been particularly critical to the growing queueing on east Keith Road. Eastbound traffic on Keith Rd. routinely backs up to Grand Blvd. and then clears after the light at the Brooksbank Avenue intersection. Long queues over a kilometer long have been also reported¹ for southbound traffic after the opening of the New Mountain Highway Overpass. These traffic levels are understood to be significantly higher of what the intersection will be handling in its ultimate configuration. However, it is unknown if such large temporary impacts and externalities were ever thoroughly studied. As illustrated in **Figure 1**, this already busy intersection has been single-handedly accommodating a staggering amount of traffic from all directions, way over its intended design capacity.

Until the Mountain Hwy overpass eastbound on-ramp to the highway is complete, shortcutters can jump the queue by turning right from Heywood Street. In the future, when the on-ramp is open, shortcutters could

¹ <https://www.nsnews.com/news/new-mountain-highway-overpass-gets-congested-debut-1.23787930>

The City acknowledge that despite the interim adjustments done at the intersection, demand will continue upwards for the next couple of years until later phases of the ministry's project are completed. Until then, the intersection will continue to function under pressure for both north-south and east-west drivers. Once the twinning of the Lynn Creek Bridge is complete, traffic patterns are expected to shift and volumes through the intersection to decrease.

Ultimate Mountain Hwy and Brooksbank Ave. Intersection Configuration

Once the Mountain Highway and Brooksbank Avenue intersection modifications are completed, traffic patterns are likely to shift and local-road volumes to decrease: southbound left-turn commuter traffic bound for the highway will be accommodated upstream, eastbound commuter traffic on Keith Road (west leg) bound for the highway will no longer be sharing lanes with straight-through traffic, and eastbound straight-thru traffic will gain additional capacity. The ultimate configuration of the intersection is shown in **Figure 2**.

These new higher-capacity left turn lanes and exclusive thru lanes, in conjunction with signal timing adjustments (i.e. optimal cycle length, protected left-turn phasing and optimized splits) should allow for better Level of Service (LOS) and more manageable queues. If queue lengths on Keith Rd. become manageable for the left storage capacity and green time allocation, progression of EB traffic on Keith will improve and the main incentive for shortcutting significantly reduced.

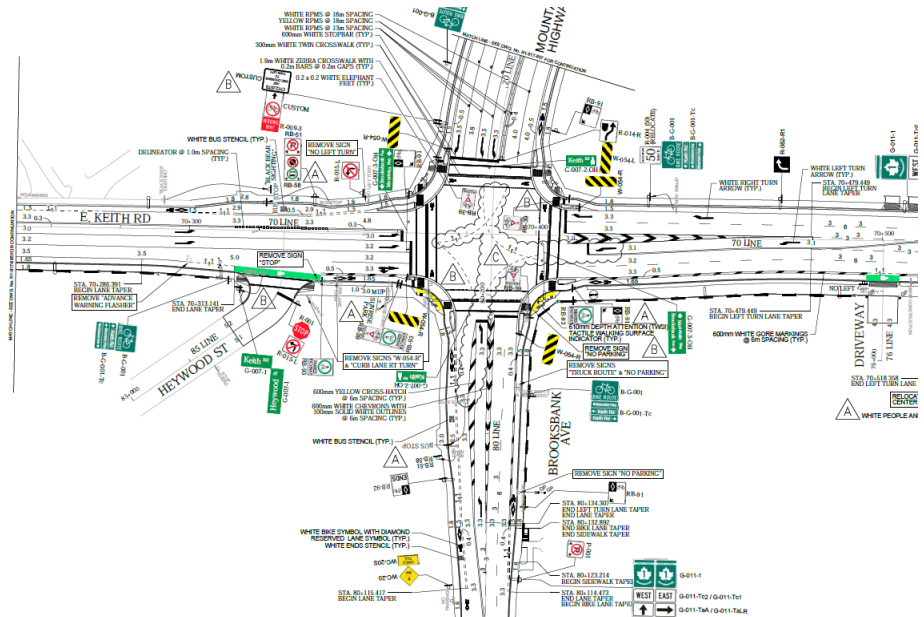


FIGURE 2. KEITH RD AND BROOKSBANK AVE ULTIMATE INTERSECTION CONFIGURATION

ACCESS MANAGEMENT IN THE VICINITY OF INTERSECTIONS.

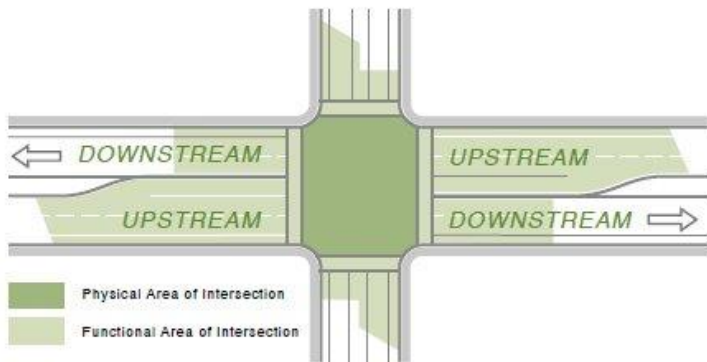


FIGURE 3. TYPICAL INTERSECTION FUNCTIONAL AREA

The negative effects on safety and operation of signalized intersection by locating accesses and driveways within the intersection functional area are well understood and documented. Reducing or eliminating the number of accesses and driveways on arterial roads is particularly beneficial as these streets are intended to prioritize mobility over property access.

It is therefore important to shield the intended operation of the intersection (physical and functional areas) from unintended disruptions. Based on the anticipated queueing, it is assumed that the functional area should extend possibly as far back as the intersection with Shavington Road. The ultimate intersection plans do not seem to strictly preserve the intersection functional

Efficient motor vehicle movements through Keith Road / Mountain Highway / Brooksbank Avenue is critical to mitigate traffic infiltration. One of the fundamental principles of access management in the vicinity of intersections is to preserve the functional area of the intersection in order to prioritize mobility on the major street and to respect the hierarchy of intersection movements. **Figure 3** provides a schematic representation of the typical functional and physical areas of an intersection. The functional areas of the intersection include the areas upstream and downstream in all directions.

area, by not eliminating the possibility of northbound traffic from Heywood Street (and the back lane to the east) to merge onto the proposed dual-left turn lanes near the head of the queue as shown in **Figure 4** below.

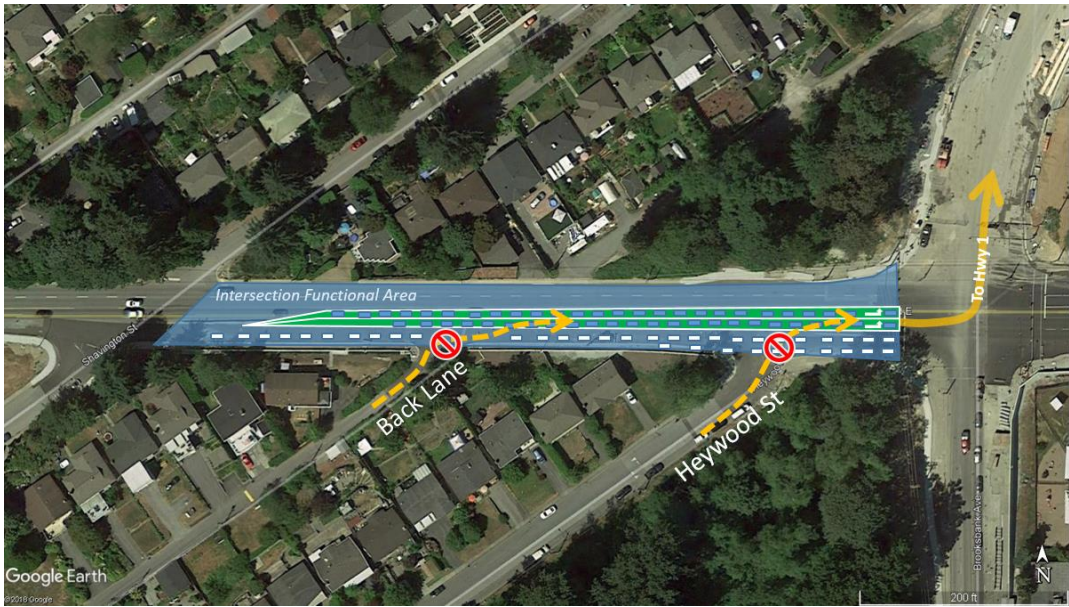


FIGURE 4. INTERSECTION FUNCTIONAL AREA MAIN DISRUPTIONS

From **Figure 4**, potential short-cutters could attempt to cut across eastbound through lanes and abruptly try to merge onto the left-turn lanes which at that point should have very few gaps, if any. In addition, sightlines are very restricted due to driveway and main road grade differentials and the presence of a screening wall flanking houses on the south side. Safety and operations will be notably compromised during commuter peak hours and on incident days at the bridge. The result will be undue traffic conflicts with both through and left turn traffic and unnecessary impact to overall eastbound traffic progression. It should be emphasize though that this applies only to peak-hour conditions as off-peak traffic infiltration is minimal.





Therefore, if appropriate access management along the entire length of Keith Road is carefully planned, it will go a long way in the mitigation of future shortcutting issues not only on Cloverley but also west of Queensbury Avenue. Overall mobility, transit operation efficiency, and road safety in the area would also benefit from access restrictions.


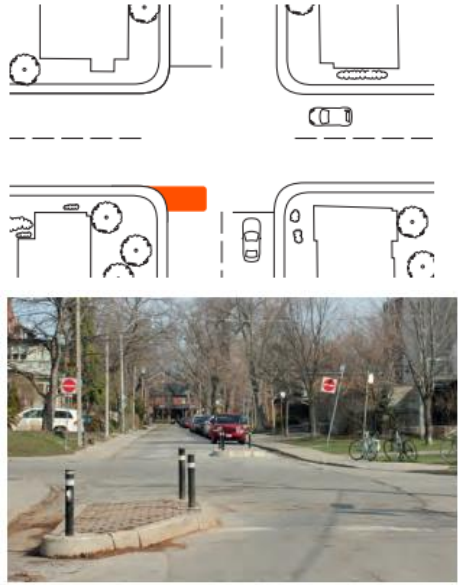
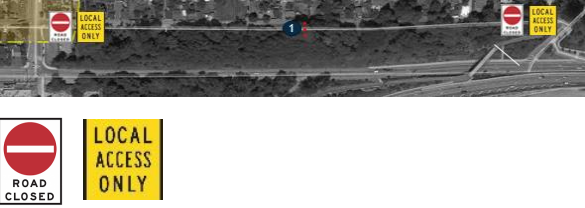
By emphasizing appropriate access management of surrounding arterial and collector roads, local roads can be relieved of the burden of having to deter shortcutting traffic which is not their intended function. Arterial and collector roads should be the first ‘line of defense’ against potential shortcutting traffic and should be able to efficiently manage and distribute traffic such that infiltration is negligible. In this scenario, occasional infiltration onto neighborhood roads can be handled with less restrictive countermeasures that are likely to be more acceptable to local residents. If more restrictive measures are eventually required, there would still be numerous traffic calming measures that could be evaluated at that time. In this sense, intervention on local neighborhood roads becomes more of a last recourse after all other appropriate access management considerations have been implemented.

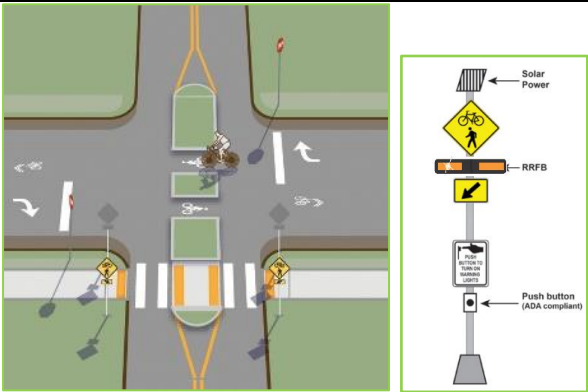
Treatments/Countermeasures Highlights

The following table summarizes possible modifications including its primary purpose, relative effectiveness, advantages, disadvantages and high level order-of-magnitude cost. For specific application please refer to recommended interim (Exhibit A) and ultimate (Exhibit B) in the main report.

Proposed Countermeasure	Highlights
Channelized Right-IN Only along eastbound approach of Keith Rd/Mountain Hwy/Brooksbank Ave.	<ul style="list-style-type: none">- <u>Primary Purpose</u>: Eliminate main incentive for shortcutting- <u>Effectiveness</u><ul style="list-style-type: none">▪ Volume reduction: High▪ Safety: High▪ Intersection operation High/Moderate- <u>Advantages</u><ul style="list-style-type: none">▪ Preserve intersection functional area▪ Eliminate unsafe maneuvers due to limited visibility reduced sightlines

	<ul style="list-style-type: none"> - <u>Disadvantage</u> <ul style="list-style-type: none"> ▪ Increase exiting trip length for resident on Heywood St. and (to lesser extent) on Shavington St. - <u>Cost per Measure</u> (\$10K-50K) <ul style="list-style-type: none"> ▪ Installation of temporary delineators (flexible pylons) ▪ Pavement line markings and signage
<p>Centerline Delineators on Hendry Ave</p>  <p>Install temporary centerline delineators</p> 	<ul style="list-style-type: none"> - <u>Primary Purpose</u>: Deter potential cut thru traffic from west of Hendry Ave towards Cloverley St and Shavington St. - <u>Effectiveness</u> <ul style="list-style-type: none"> ▪ Volume reduction: High/Moderate ▪ Safety: High ▪ Speed reduction: Moderate/High - <u>Advantages</u> <ul style="list-style-type: none"> ▪ Ensure alternate route to Keith St for Heywood St residents while still deterring cut thru traffic from west of Hendry Ave. ▪ Better distribution of neighborhood traffic at major decision points ▪ Eliminate unsafe maneuvers at skewed intersections with restricted sightlines ▪ Reduce conflict points at intersections near school site and still allow pedestrian crossings ▪ Improve overall safety along a key walk-to-school route - <u>Disadvantage</u> <ul style="list-style-type: none"> ▪ Reduce route options between residents east and west of Hendry Ave - <u>Cost per Measure</u> (\$10K-20K) <ul style="list-style-type: none"> ▪ Installation of temporary delineators (flexible pylons) ▪ Pavement line markings and signage
<p>Lane Closure with Removable Bollard for Emergency Access Only (various locations)</p> 	<ul style="list-style-type: none"> - <u>Primary Purpose</u>: Eliminate lane access from Queensbury Ave at key locations. - <u>Effectiveness</u> <ul style="list-style-type: none"> ▪ Volume reduction: High ▪ Speed reduction: Moderate ▪ Safety: Moderate - <u>Advantages</u> <ul style="list-style-type: none"> ▪ Full elimination of opportunities for shortcutters to avoid restriction on main roads while still allowing residents back alley access from one end of the lane. ▪ Accessible by fire and emergency services. ▪ Delineate space with clear visual deterrent, allowing pedestrians and cyclist to easily pass through while preventing vehicles from doing so. - <u>Disadvantage</u> <ul style="list-style-type: none"> ▪ Eliminate one-end lane access to/from adjacent collector roads for block residents - <u>Cost per Measure</u> (\$10K-20K) <ul style="list-style-type: none"> ▪ Installation of removable bollards (fold-down hinge and integrated lock) ▪ Pavement line markings and signage
<p>Diagonal Diverter (Sutherland Ave and 5th St E and Sutherland Ave and 7th St E)</p>	<ul style="list-style-type: none"> - <u>Primary Purpose</u>: Forced potential short cutters on 7th and 5th Streets to turn instead of straight through. - <u>Effectiveness</u> <ul style="list-style-type: none"> ▪ Volume reduction: High ▪ Speed reduction: Moderate

	<ul style="list-style-type: none"> ▪ Safety: Moderate - <u>Advantages</u> <ul style="list-style-type: none"> ▪ Obstruct short-cutting or through traffic ▪ May reduce traffic speeds. ▪ Reduces accident potential by eliminating conflicting traffic movements. ▪ Can be attractively landscaped ▪ Still allows pedestrian, wheelchairs, and cycling crossings. ▪ Can be mounted by emergency vehicles - <u>Disadvantage</u> <ul style="list-style-type: none"> ▪ May increase traffic on adjacent streets ▪ May increase trip length for some residents - <u>Cost per Measure</u> <ul style="list-style-type: none"> ▪ Temporary: (\$10K-20K) for flexible delineators, signs and pavement markings ▪ Permanent: \$50K-\$100K (reconstruction of curb and sidewalk, landscaping, installation of relocation of catch basins, installation of bollards)
<p>Directional Closures (Curb Extension)</p> 	<ul style="list-style-type: none"> - <u>Primary Purpose</u>: Shortcutting volume reduction upstream on Queensbury Ave. These are already in place at 4th and 6th Street. - <u>Effectiveness</u> <ul style="list-style-type: none"> ▪ Volume reduction: High/Moderate ▪ Speed reduction: Low ▪ Safety: Moderate - <u>Advantages</u> <ul style="list-style-type: none"> ▪ Obstruct short-cutting or through traffic ▪ May reduce traffic speeds. ▪ Allow to maintain two-way traffic for residents ▪ Its effectiveness is increased with one-way directional restrictions (optional). - <u>Disadvantage</u> <ul style="list-style-type: none"> ▪ May increase traffic on adjacent streets ▪ May increase trip length for some residents ▪ Could be violated, especially in the late evening. - <u>Cost per Measure</u> <ul style="list-style-type: none"> ▪ Temporary (\$10K-20K) for flexible delineators, signs and pavement markings ▪ Permanent: \$15K-\$50K (reconstruction of curb and sidewalk, installation of tactile strips, relocation of catch basins, installation of bollards)
<p>Midblock Lane Closure with Removable Bollards</p> 	<ul style="list-style-type: none"> - <u>Primary Purpose</u>: Eliminate shortcutting along the lane on the back of 4th Street. The closure must be located between driveways serving adjacent residences - <u>Effectiveness</u> <ul style="list-style-type: none"> ▪ Volume reduction: High ▪ Speed reduction: Moderate ▪ Safety: Low - <u>Advantages</u> <ul style="list-style-type: none"> ▪ Obstruct short-cutting or through traffic ▪ Allow full access to residents back alley entrances. ▪ Pedestrian and cyclist access provided across the bollards ▪ Accessible by fire and emergency services. - <u>Disadvantage</u> <ul style="list-style-type: none"> ▪ Traffic may be diverted onto adjacent parallel streets. ▪ May increase trip length for some residents - <u>Cost per Measure</u> (\$10K-20K) <ul style="list-style-type: none"> ▪ Installation of removable bollards (fold-down hinge and integrated lock) ▪ Pavement line markings and signage
<p>Bicycle-Friendly Raised Median with Cyclist/Pedestrian Activated RRFB flashings on 4th Street E</p>	<ul style="list-style-type: none"> - <u>Primary Purpose</u>: Eliminate east-west cut thru traffic across Queensbury Ave. - <u>Effectiveness</u> <ul style="list-style-type: none"> ▪ Volume reduction: High

	<ul style="list-style-type: none"> ▪ Safety: High ▪ Speed reduction: High - <u>Advantages</u> <ul style="list-style-type: none"> ▪ Eliminate east-west cut thru traffic on 4th St. E while still allowing cyclist and pedestrian crossing. ▪ Enhanced Pedestrian and Cyclist crossing by activated Rapid Flashing Beacons, median refuge areas and marked zebra crossing ▪ Encourage lower speeds by narrower travel lanes ▪ Improve and prioritize cycling mobility on designated Bikeway - <u>Disadvantage</u> <ul style="list-style-type: none"> ▪ Reduce east-west connectivity for local residents across Queensbury Ave. - <u>Cost per Measure</u> (\$100K-\$200K) <ul style="list-style-type: none"> ▪ (Length and width of median, material, removal and repair of pavement) ▪ Pavement line markings and signage ▪ Furnish and install RRFB (from \$4,500 to \$52,000) each. ▪ Energy supply and conduits.
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ULTIMATE ACCESS MANAGEMENT ON KEITH RD.

The recommended ultimate traffic calming plan was developed under the assumption that Phases 1 and 4 of the Lower Lynn Improvements project are complete, including the Keith Rd and Brooksbank Ave intersection, and the Mountain Highway Interchange with its eastbound on-ramp towards the expanded Lynn Creek Bridge. From the Ministry website it is understood that these projects are anticipated to be completed by 2021.

The plan also **recommended access management improvements** along Keith Rd beyond the intersection functional area (west of Shavington St.) as far west as Hendry Ave. Careful consideration was given to circulation patterns on both sides of Keith Rd, with a view for optimizing turning capabilities to/from crossing streets, consolidating all-turns accesses at key locations, improving transit operation, and improving safety of pedestrian crossings, while maintaining appropriate accesses and connectivity for area residents. Figure XX below illustrates the recommended access management modifications along Keith Road that are fully integrated with the recommended traffic calming plan and overall circulation on the Cloverley neighborhood for the ultimate scenario.



FIGURE 5. ULTIMATE RECOMMENDED ACCESS MANAGEMENT ON KEITH RD.

As shown in figure XX above, the recommended access management plan includes complete elimination of potential vehicles merging in with left turn traffic bound for Hwy 1, from either Heywood St or the lane west of it. A proposed Channelized Right-In/Right-Out Only access is proposed on Heywood St. which will allow traffic from Heywood St. to turn right on Keith to either continue eastbound straight thru or to turn right onto Brooksbank Ave. Heywood Street residents bound for Hwy 1 will either travel south on Heywood and eastbound on 3rd Street towards the Main St. on-ramp to the bridge, or travel internally on neighborhood roads towards the all-turns intersection at Cloverley St and Keith Rd (discussed below).

In addition, flexible delineators are recommended on the outside of the dual left-turns (in-between the outer left lane and thru lane) so to prevent any illegal maneuvers. Flexible delineators (pylons) have recently gained popularity as lane separation devices and in many access management applications. They provide functionality between the totally physically restrictive nature of concrete barriers and the physically unrestrictive nature of pavement markings.

A channelized Right-In Only configuration is proposed at the lane immediately west so to eliminate right-out movements. Significant safety improvements are expected by these restriction not only for the reduction of conflict points near the intersection but also because existing and future sightlines are very restricted due to the grade differences and the skewed angle of these approaches. Figure XX also shows median treatments in the functional area of the intersection (between Brooksbank Ave. and Shavington St) and beyond at other intersection approaches so to limit turning capabilities to right-in right-out maneuvers along Keith Rd for better traffic progression.

An all-turns intersection is recommended at the junction of Keith Rd and Cloverley St. Being a mid-way point between Hendry Ave and Brooksbank Ave. The ultimate configuration of Shavington Street at Keith Road intersection is understood to be agreed upon as part of the Ministry engagement process for the Lower Lynn improvements. One minor modification is recommended so to eliminate right-out movement from Shavington St. This restriction will also deter potential shortcutting. Such modification is not expected to inflict too much of an inconvenience for Shavington's residents as the next street west (Cloverley St) will feature all-turning movement capabilities.

Modifications and access restrictions are also suggested at Adderley St. intersection with Keith Rd. as all most turns can be consolidated at the nearby intersection of Keith Rd. and Hendry Ave.

Appendix B - Accessibility Evaluation Metrics

Scenario	# of House, N	Distance Travelled, d (km)				Weighted Distance Travelled, N*d (km)				Additional Distance Travelled, Δd = d - d _{baseline} (km)		Weighted Additional Distance Travelled, N*Δd (km)		Scenario 1A				
		FROM	TO	Existing	Interim	Ultimate	Existing	Interim	Ultimate	Interim	Ultimate	Interim	Ultimate	SUM	MEAN	Interim	Ultimate	
1A	25	4th Street East (700 Block)	Keith Road East and Queensbury Ave	0.530	0.750	0.550	13.750	13.750	13.750	-	-	-	-	-	-	-	-	-
	22	4th Street East (800 Block)	Keith Road East and Queensbury Ave	0.750	0.750	0.750	15.000	15.000	15.000	-	-	-	-	-	-	-	-	
	22	5th Street East (700 Block)	Keith Road East and Queensbury Ave	0.450	0.450	0.450	9.000	9.000	9.000	-	-	-	-	-	-	-	-	
	22	5th Street East (800 Block)	Keith Road East and Queensbury Ave	0.600	0.600	0.600	12.000	12.000	12.000	-	-	-	-	-	-	-	-	
	20	7th Street East (700 Block)	Keith Road East and Queensbury Ave	0.200	0.200	0.200	4.000	4.000	4.000	-	-	-	-	-	-	-	-	
	20	7th Street East (800 Block)	Keith Road East and Queensbury Ave	0.400	0.400	0.400	8.000	8.000	8.000	-	-	-	-	-	-	-	-	
1B	12	Keith Road East (700 Block)	Keith Road East and Queensbury Ave	0.100	0.100	0.100	1.200	1.200	1.200	-	-	-	-	-	-	-	-	
	10	Keith Road East (800 Block)	Keith Road East and Queensbury Ave	0.300	0.300	0.300	3.000	3.000	3.000	-	-	-	-	-	-	-	-	
	25	Keith Road East and Queensbury Ave	4th Street East (700 Block)	0.750	0.900	0.900	18.750	22.500	22.500	-0.150	+0.150	-3.750	+3.750	-	-	-	-	
	20	Keith Road East and Queensbury Ave	4th Street East (800 Block)	0.900	0.900	0.900	18.000	18.000	18.000	-0.650	+0.650	+14.300	+14.300	-	-	-	-	
	22	Keith Road East and Queensbury Ave	5th Street East (700 Block)	0.450	1.100	1.100	9.900	24.200	24.200	-0.200	-0.200	-4.000	-4.000	-	-	-	-	
	20	Keith Road East and Queensbury Ave	5th Street East (800 Block)	0.800	0.600	0.600	16.000	12.000	12.000	-	-	-	-	-	-	-	-	
2A	22	Keith Road East and Queensbury Ave	6th Street East (700 Block)	0.550	0.550	0.550	12.100	12.100	12.100	-	-	-	-	-	-	-	-	
	20	Keith Road East and Queensbury Ave	6th Street East (800 Block)	0.300	0.300	0.300	6.000	6.000	6.000	-	-	-	-	-	-	-	-	
	20	7th Street East (700 Block)	Keith Road East and Queensbury Ave	0.200	0.200	0.200	4.000	4.000	4.000	-	-	-	-	-	-	-	-	
	20	7th Street East (800 Block)	Keith Road East and Queensbury Ave	0.400	0.400	0.400	8.000	8.000	8.000	-0.150	-0.150	-3.000	-3.000	-	-	-	-	
	12	Keith Road East (700 Block)	Keith Road East and Queensbury Ave	0.100	0.100	0.100	1.200	1.200	1.200	-	-	-	-	-	-	-	-	
	10	Keith Road East (800 Block)	Keith Road East and Queensbury Ave	0.300	0.300	0.300	3.000	3.000	3.000	-	-	-	-	-	-	-	-	
2B	25	Keith Road East and Hendry Avenue	4th Street East (700 Block)	0.900	0.900	0.900	22.500	22.500	22.500	-	-	-	-	-	-	-	-	
	22	Keith Road East and Hendry Avenue	4th Street East (800 Block)	0.700	1.100	1.100	14.000	22.000	22.000	-0.400	+0.400	+8.000	+8.000	-	-	-	-	
	22	Keith Road East and Hendry Avenue	5th Street East (700 Block)	0.600	0.800	0.800	12.000	17.600	17.600	-0.200	+0.200	+4.000	+4.000	-	-	-	-	
	22	Keith Road East and Hendry Avenue	5th Street East (800 Block)	0.600	0.400	0.400	12.000	8.000	8.000	-	-	-	-	-	-	-	-	
	20	Keith Road East and Hendry Avenue	6th Street East (700 Block)	0.700	0.700	0.700	15.400	15.400	15.400	-	-	-	-	-	-	-	-	
	20	Keith Road East and Hendry Avenue	6th Street East (800 Block)	0.300	0.300	0.300	6.000	6.000	6.000	-	-	-	-	-	-	-	-	
3A	20	Keith Road East and Hendry Avenue	7th Street East (700 Block)	0.350	0.300	0.300	7.000	10.000	10.000	-0.150	+0.150	+3.000	+3.000	-	-	-	-	
	20	Keith Road East and Hendry Avenue	7th Street East (800 Block)	0.200	0.200	0.200	4.000	4.000	4.000	-	-	-	-	-	-	-	-	
	12	Keith Road East and Hendry Avenue	Keith Road East (700 Block)	0.250	0.250	0.250	3.000	3.000	3.000	-	-	-	-	-	-	-	-	
	10	Keith Road East and Hendry Avenue	Keith Road East (800 Block)	0.050	0.050	0.050	0.500	0.500	0.500	-	-	-	-	-	-	-	-	
	25	4th Street East (700 Block)	3rd Street East and Queensbury Ave	0.200	0.200	0.750	5.000	5.000	18.750	-	+0.550	-	+11.750	-	-	-	-	
	20	4th Street East (800 Block)	3rd Street East and Queensbury Ave	0.400	0.400	0.950	8.000	8.000	19.000	-	+0.550	-	+11.000	-	-	-	-	
3B	22	5th Street East (700 Block)	3rd Street East and Queensbury Ave	0.350	0.500	0.850	7.700	11.000	18.700	-0.150	+0.150	+3.300	+3.300	-	-	-	-	
	22	5th Street East (800 Block)	3rd Street East and Queensbury Ave	0.500	0.750	0.750	10.000	15.000	15.000	-0.250	+0.250	+5.000	+5.000	-	-	-	-	
	22	6th Street East (700 Block)	3rd Street East and Queensbury Ave	0.450	0.450	0.600	9.900	9.900	9.900	-	-	-	-	-	-	-	-	
	20	6th Street East (800 Block)	3rd Street East and Queensbury Ave	0.600	0.600	0.600	12.000	12.000	12.000	-	-	-	-	-	-	-	-	
	20	7th Street East (700 Block)	3rd Street East and Queensbury Ave	0.550	0.550	0.550	11.000	11.000	11.000	-	-	-	-	-	-	-	-	
	20	7th Street East (800 Block)	3rd Street East and Queensbury Ave	0.750	0.900	0.900	15.000	18.000	18.000	-0.150	+0.150	+3.000	+3.000	-	-	-	-	
4A	12	Keith Road East (600 Block)	3rd Street East and Heywood Street	0.850	0.650	0.650	7.800	7.800	7.800	-	-	-	-	-	-	-	-	
	10	Keith Road East (700 Block)	3rd Street East and Heywood Street	0.950	0.850	0.850	8.500	8.500	8.500	-	-	-	-	-	-	-	-	
	25	4th Street East (700 Block)	3rd Street East and Heywood Street	0.750	0.750	1.100	18.750	17.500	27.500	-0.350	-0.350	-5.000	-5.000	-	-	-	-	
	22	4th Street East (800 Block)	3rd Street East and Heywood Street	0.750	0.500	0.500	15.000	10.000	10.000	-	-	-	-	-	-	-	-	
	22	5th Street East (700 Block)	3rd Street East and Heywood Street	0.750	0.750	0.750	15.000	15.000	15.000	-	-	-	-	-	-	-	-	
	20	6th Street East (700 Block)	3rd Street East and Heywood Street	0.950	0.950	0.950	20.900	21.000	21.000	-0.050	+0.050	+1.000	+1.000	-	-	-	-	
4B	20	6th Street East (800 Block)	3rd Street East and Heywood Street	0.750	1.050	1.050	15.000	21.000	21.000	-0.300	+0.300	+6.000	+6.000	-	-	-	-	
	20	7th Street East (700 Block)	3rd Street East and Heywood Street	1.000	1.050	1.050	20.000	21.000	21.000	-0.050	+0.050	+1.000	+1.000	-	-	-	-	
	12	Keith Road East (600 Block)	3rd Street East and Heywood Street	1.150	1.150	1.150	13.800	13.800	13.800	-	-	-	-	-	-	-	-	
	10	Keith Road East (700 Block)	3rd Street East and Heywood Street	1.300	1.300	1.300	13.000	13.000	13.000	-	-	-	-	-	-	-	-	
	25	3rd Street East and Heywood Street	4th Street East (700 Block)	0.700	0.700	0.700	17.500	17.500	17.500	-	-	-	-	-	-	-	-	
	20	3rd Street East and Heywood Street	4th Street East (800 Block)	0.500	0.500	0.500	10.000	10.000	10.000	-	-	-	-	-	-	-	-	
5A	22	3rd Street East and Heywood Street	5th Street East (700 Block)	0.800	0.800	0.800	17.600	17.600	17.600	-	-	-	-	-	-	-	-	
	22	3rd Street East and Heywood Street	5th Street East (800 Block)	0.600	0.600	0.600	12.000	12.000	12.000	-	-	-	-	-	-	-	-	
	20	3rd Street East and Heywood Street	6th Street East (700 Block)	0.900	0.900	0.900	18.000	18.000	18.000	-	-	-	-	-	-	-	-	
	20	3rd Street East and Heywood Street	6th Street East (800 Block)	0.700	0.700	0.700	14.000	14.000	14.000	-	-	-	-	-	-	-	-	
	20	3rd Street East and Heywood Street	7th Street East (700 Block)	1.000	1.000	1.000	20.000	20.000	20.000	-	-	-	-	-	-	-	-	
	12	3rd Street East and Heywood Street	7th Street East (800 Block)	0.800	0.800	0.800	16.000	16.000	16.000	-	-	-	-	-	-	-	-	
5B	10	Keith Road East (600 Block)	Keith Road East (700 Block)	1.000	1.000	1.000	12.000	12.000	12.000	-	-	-	-	-	-	-	-	
	23	4th Street East and Hendry Avenue	Keith Road East and Hendry Avenue	0.950	0.950	0.950	9.500	9.500	9.500	-	-	-	-	-	-	-	-	
	28	Heywood Street (1300 Block)	Keith Road East and Hendry Avenue	0.800	0.800	0.800	8.800	8.800	8.800	-	-	-	-	-	-	-	-	
	28	Heywood Street (1300 Block)	Keith Road East and Hendry Avenue	1.200	1.200	1.200	33.600	33.600	33.600	-	-	-	-	-	-	-	-	
	17	Heywood Street (1600 Block)	Keith Road East and Hendry Avenue	0.950	0.950	0.950	27.250	27.250	27.250	-	-	-	-	-	-	-	-	
	4	Chowbey Street (600 Block)	Keith Road East and Hendry Avenue	0.850	0.850	0.850	7.650	7.650	7.650	-0.100	+0.100	-4.000	-4.000	-	-	-	-	

