Development, Construction and Operations of a new Traffic Calming Tool

A.E. (Tony) Churchill, M.Sc, P.Eng, Sr. Traffic Engineer, The City of Calgary
Joanna Domarad, P.Eng, Traffic Safety Engineer, The City of Calgary
Surendra Mishra, M.Sc, P.Eng, Traffic Safety Engineer, The City of Calgary

Paper prepared for presentation
at the Improving Road Safety in Urban Areas Session

of the 2017 Conference of the
Transportation Association of Canada
St. John's, NL

ABSTRACT

Traffic calming measures continue to be effective ways of re-designing our roads to reduce speeds, increase yielding, and improve safety in our urban areas. The processes to implement traffic calming, however, can be long and arduous due to the many obstacles to permanent construction. In many cases the obstacles to implementation of traffic calming result in large delays during which time there are on-going safety concerns or collisions in many cases. These obstacles include funding, utilities, drainage and public support, to name a few. To overcome some of these obstacles the City of Calgary developed a pre-cast concrete shape, called Traffic Calming Curbs (TC Curbs) that allow modular creation of common traffic calming features that can be deployed quickly, at a low cost, and with a high degree of flexibility. The innovative process to design and construct the TC Curbs is described as well as process considerations for implementing their placement and lessons learned so far regarding their use. Case studies of TC Curb placement are examined including geometric design, placement, winter operations, and supporting traffic control. More importantly, evaluations of changes in motorist behaviours such as speed and yielding behaviour, and perceptions of various stakeholders are presented. Initial indications are that TC Curbs are a useful and effective tool to implement traffic calming as either an interim or potentially long term solution.

BACKGROUND

The City of Calgary (The City) has a vision of 'Safe Mobility for all Users' as identified in the Calgary Safer Mobility Plan (SMP) 2013-2017 (1). The SMP sets out targets in five areas and specific strategies that The City has been taking, or plans to undertake, which include actions such as increasing innovation and continuing traffic calming.

High vehicle speeds, long pedestrian crossing distances and large complex intersections can create an auto-centric community that feels dangerous for residents (by various modes of transportation) and detracts from community wellbeing and sense of place. Traditional traffic calming offers various tools to alleviate these issues, such as those identified in the Calgary Traffic Calming Policy (2). However, the implementation of traffic calming measures is often limited by substantial construction cost; issues with constructability of retrofits (i.e. utilities, drainage, etc.); and community consensus – all of these considerations increase the duration of these projects and frustrations to communities.

In the past, temporary concrete barrier sections and low profile barrier sections have been used to narrow down roadways and calm traffic; however, these large objects pose a hazard to errant vehicles, increasing struck object collision frequency and collision severity. The full size concrete barriers can be expensive and aesthetically unpleasing

To provide a better alternative than the current standard of concrete barriers, a small team of City employees designed, constructed and implemented a new traffic calming product called 'Traffic Calming Curbs' (TC Curbs). TC Curbs are 150 mm high pre-cast concrete blocks, 1 m by 2.75 m in size, which can

be arranged to simulate various traffic calming measures such as curb and median extensions, mini roundabouts, or chicanes. Preliminary results have shown that TC Curbs can reduce crossing distance and speeds and improve yielding to pedestrians and stop compliance. The cost to produce a TC Curb is approximately $750 per unit, with the total cost of implementation being approximately one tenth to one fifth of traditional permanent construction.

Other benefits of TC Curbs include:

- Allowing for quick implementation and improved response to public concerns
- Lower cost and can be moved to other sites
- Ability to maintain existing drainage patterns – relocation of catch basins not required which can be $10-15K each
- Potential to be permanent or temporary
- May be used as proof of concept or to gain community buy-in before a permanent solution is implemented
- Enables planners and engineers to adjust the design and to work out any potential issues before the permanent solution is implemented

The site selection process involved consultations with the community and community associations where qualitative data was gathered on community perceptions of safety and the experience of the built environment, along with quantitative metrics on collision data and traffic volume.

The TC Curbs also serve a catalyst to make communities more pedestrian focused by: improving the scale of intersections and spaces used by people walking; improving safety for vulnerable road users; serve as proof of concept tool to gain community support for smaller intersections making it possible to implement permanent traffic calming projects and to influence the design of new intersections.

This paper discusses the development of the TC Curbs, their construction and placement, observations of operations and motorist behaviours, and discusses how The City plans to use TC Curbs in the future.

DEVELOPMENT

The concept of modular traffic calming is not a new one. There are examples in Calgary of road narrowing using low profile barriers, triangular in section with a height of 450 mm, but many of these installations have resulted in ongoing negative feedback from the public and injury collisions in some cases (see Figure 1). These barriers can indeed be considered a roadside hazard themselves.

Figure 1: Low Profile Concrete barriers used for traffic calming

The City's Roads department initiated the 'Roads Innovation, Service, & Efficiency (RISE)' Program in the spring of 2015 with the goal of fostering continuous improvement. The concept to have an improved modular pre-cast concrete section to address some of the shortcomings of the low profile barriers was initiated and discussed extensively with City staff. Benefits and drawbacks of TC Curbs were discussed with a large variety of staff considering issues such as traffic engineering, geometric design, operations, and current practice in traffic calming. These conversations resulted in a continuous evolution of the shape and materials (noted in brackets below) to address the concerns and capitalize on opportunities and influenced the product specifications that were ultimately brought forward to the RISE evaluation committee, as shown in Figure 2. Some of the issued identified were that the TC Curbs would be driven over (structurally designed reinforcing and dowel holes for pinning if needed), exposed to chlorides (sulphate resistant type 50 cement), require curvature compatible with conventional geometry (5 m radii found to be most versatile), aesthetic appeal and issues with painting (yellow pigmented cement). The proposal to initiate a pilot of TC Curbs was approved by the rise committee and the preparation work allowed for the TC Curbs to be the first implemented measure out of the RISE program.

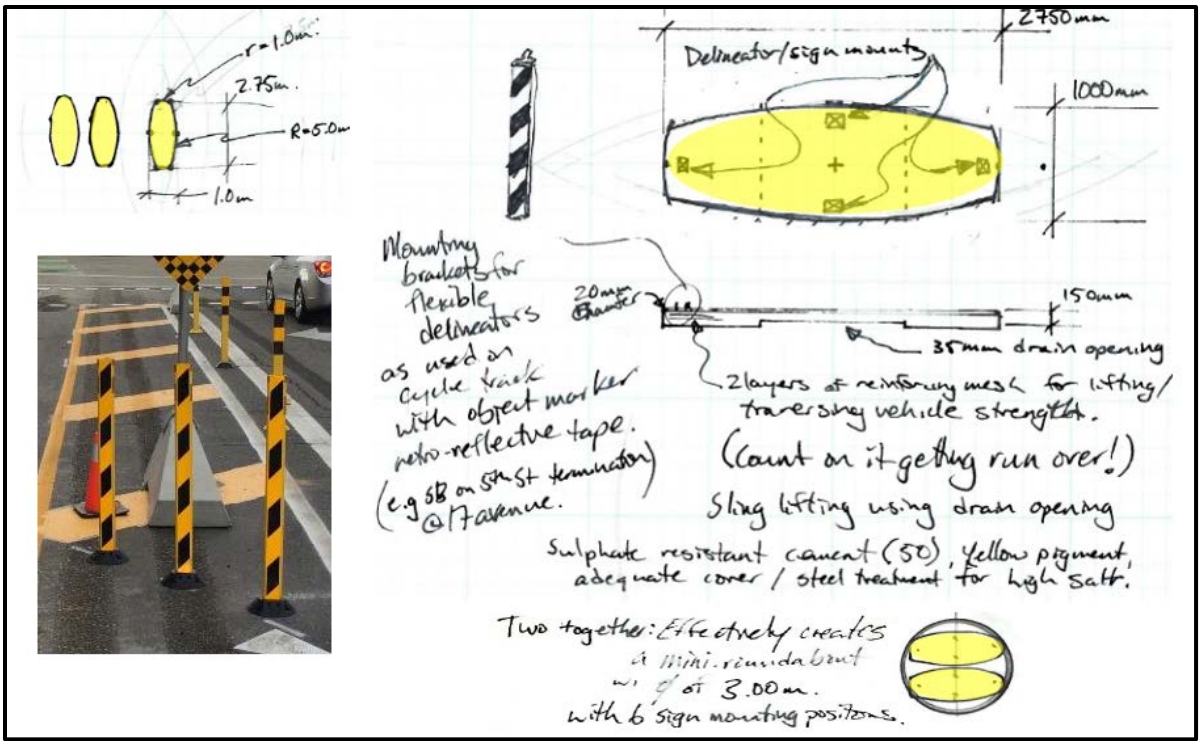


Figure 2: Initial concept for TC Curbs presented to the RISE evaluation Committee

CONSTRUCTION

The specifications, having been established through the development process, were sent to local pre-cast producers for bids and Key Concrete Products Ltd. (Key) in Calgary was selected as the successful producer of TC Curbs for the pilot program. The City worked collaboratively with Key to fine tune the design to improve production and handling characteristics of the finished product. The shop drawings for the design of the TC Curbs is shown in Figure 3.

In total, Key produced 296 TC Curbs for the pilot program with the first 75 being produced in wooden forms and the remainder in steel forms which Key commissioned from a local concrete form supplier. Photos of the wooden formwork and the reinforcing steel configuration are shown in Figure 4.

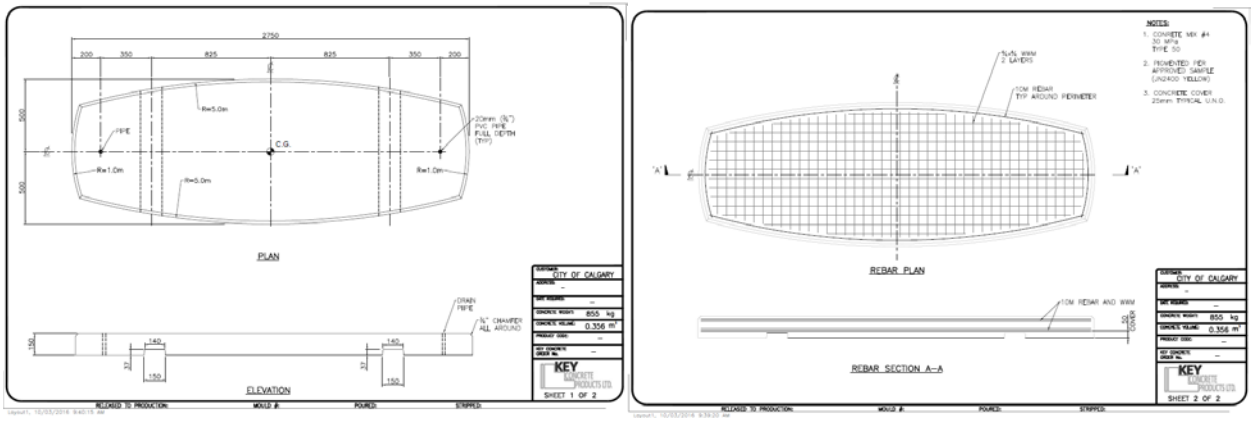


Figure 3: Shop drawings for TC Curb production, produced by Key Concrete Products Ltd.

Figure 4: Wooden formwork with reinforcing, and cast units with yellow pigmented type 50 cement

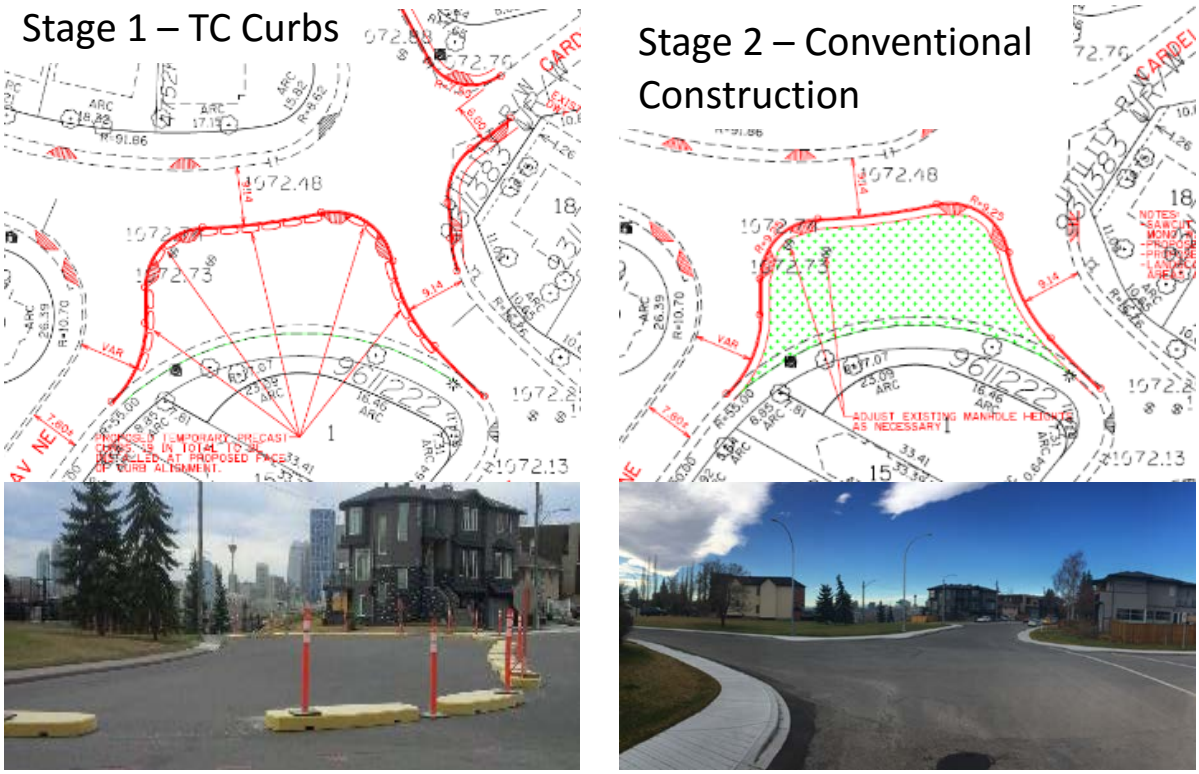
The City completed various projects in 2016 using TC Curbs for a variety of traffic calming projects throughout the city such as curb extensions, median refuge islands, right turn channelization, lane narrowing at mid-block crosswalks, etc. The TC Curbs were placed using 'picker trucks' as shown in Figure 5.

Figure 5: Placing TC Curbs with picker truck, 22 curbs placed in 6 hours including 4 trips to storage yard

TC Curbs have been used as a temporary measure for periods of months but also envisioned for applications of two years or more pending findings of pilot project evaluation. Twenty Two TC Curbs were placed at the intersection of Regal Crescent in 6 hours by two staff and were in place from April 12, 2016 until construction of permanent sidewalk work commenced on May 26, 2016 when they were rapidly relocated to other locations. The installation depicted in Figure 5 and described above was the first implementation of TC Curbs and received a great deal of media on the web, radio, and in print (3-5). The installation of TC Curbs as a temporary measure allowed for a good comparison of speed of implementation and overall costs; images of applications and summary measures are shown in Figure 6.

OPERATIONS

In Calgary, these devices have allowed The City and municipal politicians to respond rapidly and meaningfully to the concerns regarding traffic calming or traffic collisions. One of the early examples of this was at McKenzie Towne Link and McKenzie Towne Gate where there was a high profile collision involving a pickup truck that failed to stop at a STOP Sign and collided with a transit bus; the bus then went off the road and struck an apartment complex(6). Upon review it was found that this collision was not unique for this location and that stop control enhancements were warranted. Curb Extensions and Median Islands with supplementary STOP Signs were added as shown in Figure 7. Stop compliance was measured before and after enhancement with TC Curbs and the results are presented in Figure 8.



Traffic Calming Curbs
Deployed in six hours by two staff
Cost as placed: $18,000

Traditional cub & gutter design
Construction period of 6 weeks
Cost: $115,000

Figure 6: Comparison of TC Curb use and conventional Construction

Figure 7: Before and after photos of stop control enhanced with TC Curbs

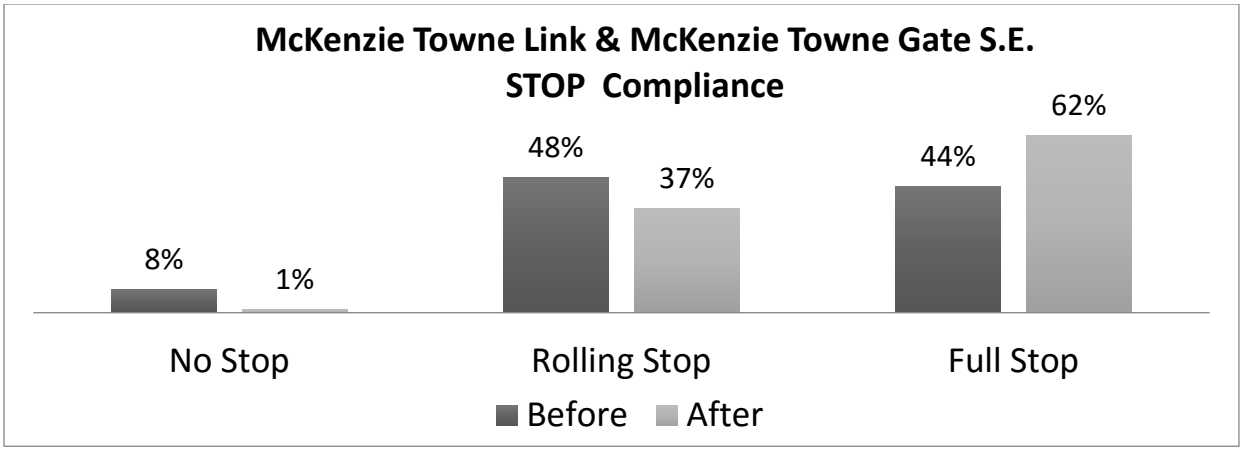


Figure 8: Before and after compliance with STOP control enhanced with TC Curbs

Once the evaluation and geometric checks were completed it was a matter of days for the TC Curbs to be placed and the improvements in stop compliance realized. Construction using conventional processes would have taken weeks or possibly not have been initiated until the following construction season based on utility and drainage impacts.

Maintenance and snow clearing activities were discussed with crews prior to placement of the TC Curbs and also reviewed prior to winter operations. Shortly after placement of TC Curbs in the community of Erin Woods, where neighbourhood traffic calming was completed at 13 intersections, two TC Curbs in different locations were run over and moved (see Figure 9) by larger vehicles, likely school busses. These curbs were pinned to the asphalt using the pre-cast dowel holes and have not moved since.

Figure 9: TC Curb moved and evidence curbs were driven over, note white placement marking

The purpose of TC Curb deployment in Erin Woods was primarily for traffic calming, and specifically to reduce speed and increase yielding compliance to pedestrians at crosswalks (7). The entire neighbourhood was evaluated since TC Curbs were a potential way to reduce the cost from $1.5M to $120K. One main intersection of concern was at the junction of Erin Woods Boulevard and Erin Dale Crescent, photos shown in Figure 10 and plan drawing in Figure 11.

Figure 10: Looking at Erin Woods Boulevard before and after installation of TC Curbs

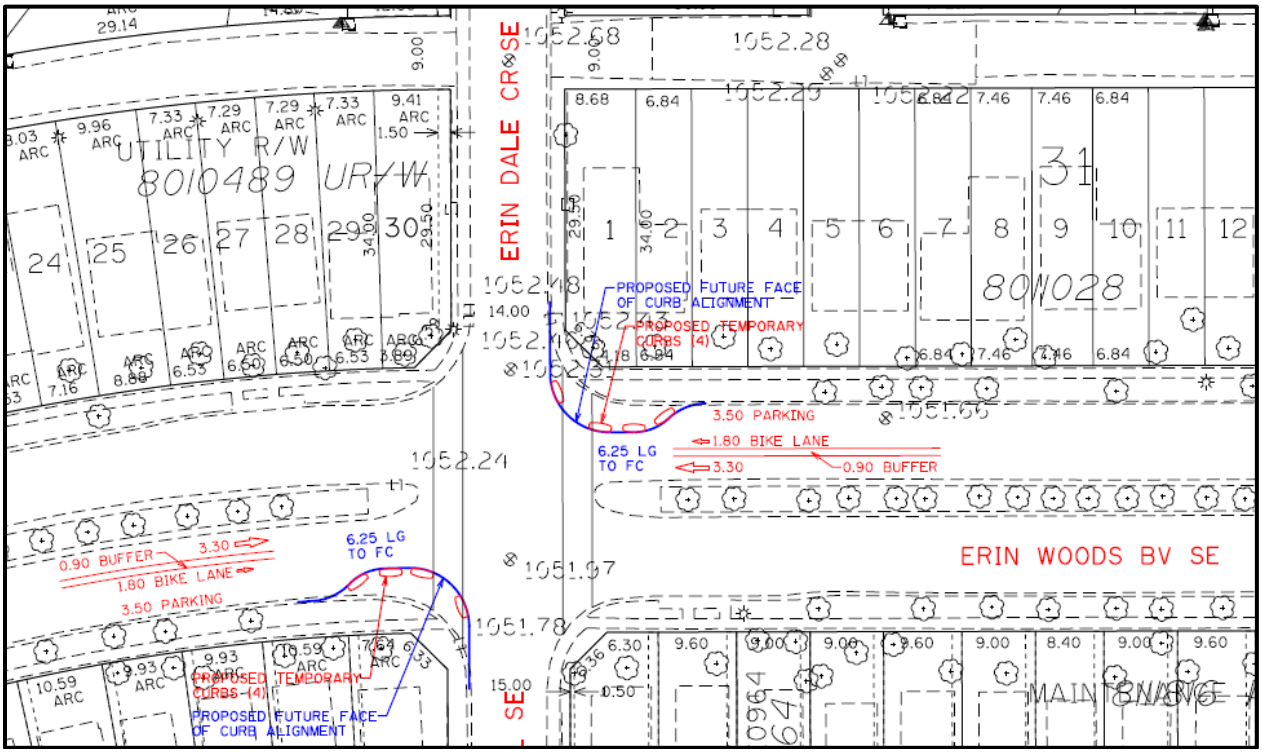


Figure 11: Plan View of TC Curb installation at Erin Woods Boulevard and Erin Dale Crescent

Key measurement metrics for the evaluation of this treatment for speed and yielding compliance were measured 1 week before installation of TC Curbs and 2 weeks after the installation. Yeilding compliance was measured using a standard procedure that The City adapted from a FHWA procedure (8) for the evaluation of Rectangular Rapid flashing Beacons.

Data were collected for each experimental crossing when vehicles were approaching along the free flow approach during good surface conditions. Two people were involved, one to carry out experimental crossings safely, and one to observe and record motorist behaviour. For each experimental crossing the observer noted the following:

a. Yielding compliance:
   - Noted as yielding if vehicle stopped or slowed to allow pedestrian to cross.
   - Noted as not yielding if vehicle did not stop, but would have been able to do so safely. The ability to stop safely was determined based on the threshold distance calculated using the Institute of Transportation Engineers (ITE) signal formula and the posted speed on the approach (60 m for 60 km/h, 45 m for 50 km/h).
   - For each crossing, all incompliant vehicles were noted as not yielding and the first yielding vehicle per lane was noted as yielding.

b. Unsafe behaviours:
   - Attempts to pass a stopped/yielding vehicle
   - Hard braking behind a stopped/yielding vehicle
   - Vehicle/pedestrian conflicts involving evasive action taken by a driver or pedestrian
   - Pedestrian trapped at centerline/median

At least 50 compliance samples were collected during the before period and 50 or more compliance samples were collected during the after period. The samples were collected during a peak period as the motorist behaviour tends to be most aggressive during this time.

The experimental crossings were conducted in a consistent manner, mimicking the natural behaviours and appearance of a typical pedestrian. Crossings were conducted in both directions. The 'crosser' approached the crosswalk and placed one foot in the crosswalk when the vehicle was beyond the threshold distance. If the driver(s) made no attempt to stop, the pedestrian did not proceed to cross. If the driver(s) stopped, pedestrian began crossing, but made sure vehicles in the opposing direction were stopped before proceeding. Other conventions were adopted as follows:

- If a pedestrian used the crossing, the data associated with the crossing was included in the study
- If a vehicle did not come to a complete stop, the location of the lowest velocity was used
- Pedestrian would wear similar clothing during the before and after study without bright colours or safety equipment.

Speed data was collected using conventional pneumatic tube systems by City Transporation Data Staff.

The results of the before and after metrics are presented in Table 1. A follow up yielding study was completed 6 months after installation and compliance was found to be 83%. This indicates that there was some novelty effect but still a considerable improvement over the yielding behaviour before the TC Curbs were placed.

	Before	After	Change
Erin Woods BV & Erin Dale CR SE (EB)			
Average Speed (km/h)	47	44	-3
85th Percentile Speed (km/h)	55	52	-3
Speed Compliance (%)	71.9	83.2	11.3
Yielding Compliance (%)	42.9	90.0	47.1

Table1: Before and after TC Curb placement - speed and yielding metrics

Snow clearing activities went well but one area for improvement was hand clearing behind the curbs. Snow was strategically carried around the corners to avoid depositing windrows on the road surface in front of openings in the TC Curbs. A photo of typical winter conditions with TC Curbs in place is shown in Figure 12.

Figure 12: Winter conditions at Old Banff Coach Road and 89 Street N.W. - Narrowing of Old Banff Coach Road by one lane to address speeding and pedestrian crossing concerns.

Overall, citizen feedback has mostly been focused on reduced (illegal) parking near crosswalks, lanes feeling too narrow, and concern about hitting the TC Curbs. To balance these concerns, we have received thanks from communities that we were able to respond quickly, that they feel safer and have noticed changes in motorist behaviors. Most importantly, the changes in speeding behavior and yielding to pedestrians have been measured and have improved notably

since installation – these findings are very useful when speaking to citizens who are not in favor of their use.

NEXT STEPS

The City is in the design process to continue placing and evaluating TC Curbs in a variety of configurations to address diverse concerns. Evaluation of the efficacy of these treatments will continue and will likely include use of video based conflict analysis (computerized near miss analysis) as a better proxy for risk/collision reduction as a more proactive approach than waiting for collisions to occur. Purchase of additional curbs has been initiated and placement of 300-400 additional TC Curbs this year is planned to address traffic calming and operational safety issues across Calgary. By working with key stakeholders, the identified issues were addressed through process or design, but there are still some areas for improvement regarding snow clearing and spring cleanup. Based on initial evaluations presented above the TC Curbs appear to be performing as intended and the City will continue to monitor the TC Curbs installed in 2017 and re-assess how we will use TC Curbs in the future.

REFERENCES

1. The City of Calgary. "Calgary Safer Mobility Plan 2013-2017" http://www.calgary.ca/Transportation/Roads/Documents/Traffic/Traffic-safety-programs/Calgary-safer-mobility-plan.pdf Updated July 2015
2. The City of Calgary. "Traffic Calming Policy" http://www.calgary.ca/Transportation/Roads/Pages/Development-and-projects/Traffic-calming-measures.aspx Effective January 21, 2013
3. CBC. "Temporary concrete curbs for roads to slow speeders in select Calgary neighbourhoods." http://www.cbc.ca/news/canada/calgary/traffic-calming-curbs-calgary-pilot-1.3565312 Posted: May 03, 2016
4. Metro News. "New traffic calming device a made-in-Calgary solution." http://www.metronews.ca/news/calgary/2016/05/03/new-traffic-calming-device-a-made-in-calgary-solution.html Posted: May 03, 2016
5. Calgary City News Blog. "New traffic calming device invented right here at The City of Calgary." http://www.calgarycitynews.com/2016/04/new-traffic-calming-device-invented.html Posted: April 29, 2016
6. CTV News. "Bus crashes into condo complex in McKenzie Towne." http://calgary.ctvnews.ca/bus-crashes-into-condo-complex-in-mckenzie-towne-1.2784532 Published: February 19, 2016
7. Metro News. "Erin Woods to get traffic calming devices." http://www.metronews.ca/news/calgary/2016/06/29/erin-woods-to-get-traffic-calming-devices.html Posted: June29, 2016

8. Federal Highway Administration (FHWA) '*Effects of Yellow Rectangular Rapid-Flashing Beacons on Yielding at Multilane Uncontrolled Crosswalks'.* Shurbutt & Van Houten, 2010.