# Improving Safety in Canada's Oil Sands with Temporary Signal Lights

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# Abstract

Supporting transportation infrastructure for Canada's oil sands operations is a challenging task at the best of times, where items such as extraordinarily large equipment, atypical modal splits and non-standard peak period travel patterns ensures that any transportation design requires special consideration. Continued growth and production at a major oil sands site in northern Alberta has resulted in a substantial amount of vehicular traffic travelling on site 24 hours a day, 7 days a week. This growth has resulted in inefficient operations at one of the major intersections on site.

Currently this intersection is stop-controlled during non-peak periods. During peak periods, manual control in the form of flaggers is brought in to direct traffic in order to improve efficiency. Although the flaggers facilitate and improve movements through this intersection, there are evident safety concerns noted having laborers working in such close proximity to the roadway as well as subjecting them to the harsh northern elements. Due to these safety concerns and on-going operational costs, Stantec was acquired to conduct a scoping study of the area of concern.

Results of the scoping study recommend traffic signals for this intersection. Since this would mark the first signalized intersection on site, our client sought further assurance that a signalized intersection would – at a minimum – maintain current levels of service through the intersection before making the long-term investment in a permanent system. In order to test the effectiveness of signals on the intersection, an 8-week trial was conducted with portable traffic lights.

This paper will review and summarize the portable traffic lights trial, how it performed and its effect on safety at the intersection. The usefulness of portable traffic lights as an interim solution prior to the implementation of permanent installations will also be reviewed.

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# 1. Introduction

In an industry constantly under watch and often scrutinized for its effects on the environment, safety standards have taken a front row seat, usually going above and beyond helping to ensure that workers in the oil sands industry return home safely after each shift.

In the spring of 2013, Stantec was asked to review operations at a major three-leg intersection on a prominent industrial site near Fort McMurray, Alberta. During non-peak hour periods, this intersection is stop-controlled while during peak hour periods, manual control in the form of flaggers is brought in to direct traffic and improve efficiency. Although the flaggers facilitate and improve movements through this intersection, there are evident safety concerns noted having laborers working in such close proximity to the roadway on a bi-daily basis as well as subjecting them to the harsh northern elements.

Due to these safety concerns and on-going operational costs, Stantec was acquired to conduct a scoping study of the area of concern. Results of the scoping study concluded the installation of traffic signals as the preferred solution at this location.

It is important to note that the analysis of the intersection completed for the scoping study did not show significant improvement with the addition of signals. With regards to performance, the goal of the trial and subsequent installation of permanent signals was to – at a minimum – maintain current traffic conditions on site. The overall goal of the project was to improve safety by removing flaggers working in close proximity to the roadway, maintain current traffic conditions, and improve operating costs.

Further to being a critical intersection on site, critical utilities located above and below ground in close proximity to the roadway would translate into a costly permanent signals installation. Because of this, and due to the enormous size of equipment moving on site as well as atypical traffic patterns, our client sought further assurance that traffic signals were indeed the correct solution for this site. An 8-week trial with temporary traffic signals was suggested to assist in determining the effectiveness of signals before committing to the cost of a permanent system. Temporary signals would also provide further insight into the future development of a permanent system that would function in harmony with queues generated by specific operations on our client's site.

## 2. Site Characteristics

As previously mentioned, this project is a three-leg intersection located on an industrial site near Fort McMurray, Alberta. For the purposes of this report, the connecting roads of this intersection shall be identified as Leg #1, Leg #2, and Leg #3. Figure I displays an aerial photograph of the project site.


Photo Credit: https://www.google.ca/maps

Figure I: Aerial view of the project site

Leg #1 – This leg connects on the northwest side of the intersection and approaches the intersection at a slight uphill incline. Leg #1 operates as a through-road to Leg #3 during non-peak hours. This leg also has several access points to facilities near the intersection, as well as another stop controlled intersection approximate 350m north.

Leg #2 – This leg approaches from the northeast side of the intersection and is stop-controlled during non-peak periods. It approaches our site at a slight downhill incline

Leg #3 – The final leg of this intersection approaches from the southwest at a slight downhill incline. As noted, this leg works as a through road to Leg #1 during non-peak hours.

A typical workday at this intersection requires two shifts of 7-8 flaggers (a total of 14 – 16 flaggers per day) to cover daily morning and evening peak-hour periods from 6:00 – 9:00 AM and 4:00 – 9:00 PM, respectively. At any given time during the peak periods, three flaggers are actively directing traffic, one situated at each intersection leg. Another three flaggers are required to rotate into the flagging positions, giving the active three flaggers the opportunity for a break. This becomes especially important during the harsh winter months, where temperatures regularly fall below -20°C, limiting the time a person can safely work outdoors. The remaining 1-2 laborers are required as drivers to rotate active flaggers as well as to monitor the busing activity, which will be further discussed later in this report.

Traffic counts taken by Stantec indicate maximum peak hour volumes averaging approximately 750 vehicles during the morning peak from 7:15 – 8:15 AM and approximately 600 vehicles during the evening peak from 3:45 – 4:45 PM. Total vehicular volumes during the AM and PM peak periods were recorded at approximately 1,750 and 2,100, respectively.

During peak periods, our client provides coach buses to aid in the transport of employees to and from work sites. During these busing events, a total of 40+ coach buses would move through the intersection in a matter of minutes, transporting employees to and from different areas of the industrial site. These busing events occur four times during the AM peak period and six times during the evening peak period.

Prior to the start of the trial, Stantec observed standard operations with the flaggers during an AM and PM peak period. Several observations were noted including the following:

- To help ensure their safety, flaggers had to be positioned with an escape route where they could move away from the roadway quickly and easily if required. Due to the amount of utilities located at ground level, flaggers on Legs #2 and #3 had to be positioned approximately 150m and 100m, respectively, away from the intersection. Figure II shows the approximate location of flaggers when directing traffic during peak periods.
- The flaggers directed traffic similarly to a three-phase signal, where only one leg was given right-of-way at a time. When it was safe to do so, flaggers would frequently direct vehicles that were not located in the right-of-way through the intersection, similar to a right-on-red movement. This was mainly apparent for movements coming from Leg #1, due to their relative close proximity to the intersection.

- Each leg was generally cleared of all queues during any given cycle.
- No set cycle sequence was in place. Specific legs were given priority based on observed queues noted by flaggers specific to that time and communicated through radio amongst the flaggers. General observations noted that Leg #1 was given right-of-way more frequently than the other two legs. This was done to maintain minimal queuing on this leg to ensure access to work sites along this road as well as to guarantee this site would not impede the four-way intersection located in the vicinity.
- Significant importance was placed on ensuring that busing operations were given priority during peak periods. Other vehicles travelling through site could be held up for upwards of four (4) minutes by flaggers waiting for their turn.


Photo Credit: https://www.google.ca/maps

Figure II: Flagging locations during peak hours

# 3. Trial Equipment

Ver-Mac temporary traffic lights were obtained for the pilot study for the site. The trial used TDL-3612 units for Legs #1 and #3 and a TDL-2312 unit on Leg #2. TDL-3612 and TDL-2312 units are shown in Figures III and IV, respectively.

Photo Credit: http://www.ver-mac.com/

Figure III: TDL-3612 units used on Legs #1 and #3

Photo Credit: http://www.ver-mac.com/

Figure IV: TDL-2312 units as used on Leg #2

# 4. Project Constraints

Several constraints were identified prior to and during the trial. The most notable constraints are identified below.

Due to the nature of the industrial facility, a significant amount of infrastructure was located aboveground adjacent to the roadway, thus limiting where the temporary units could be safely positioned. These space limitations resulted in the equipment being positioned in the same locations that the flaggers stood while directing traffic, as shown in Figure II. Although not ideal, permanent signals would have the opportunity to further improve efficiency being placed closer to the intersection.

Busing operations were required to maintain priority during the trial period. These busing events resulted in short but significant changes in pattern and volume and had to be carefully considered for the trial.

Height constraints were quickly identified once the trial commenced. The TDL-3612 units, located on Legs #1 and #3, operate with two signal heads. One signal head is located on the mast to the right of the driving lane, while another is located above the driving lane on the trailer boom. Immediately after the trial commenced, it was apparent that mobile cranes were unable to fit underneath the 6.5m tall trailer boom. The booms on both units were quickly lowered. The remainder of the trial utilized only the signal heads on the mast of these two trailers.

# 5. Trial Methodology

The trial used the temporary traffic lights in lieu of flaggers during peak hours of operation while maintaining the current operations as a through road between Legs #1 and #3, and stop-controlled on Leg #2 during non-peak hours.

Schedule of the trial was proposed as follows:

Weeks 1-4: Temporary signals would be operated entirely by the judgment of the flaggers. Signal timings for each leg would be determined for each cycle at that specific time based on the flagger's observations and judgment.

Weeks 5-6: During this period the signals would be run on set cycle timings based on data obtained during the first four weeks of the trial and analysis completed based on traffic volumes of the site. The flaggers controlled the set timings manually. This was done in order to ensure bus operations maintained priority or adjustments could be made easily if necessary due to significant delays.

Week 7-8: Based on the previous phases of the trial, the option to run the system completed automated would be applied.

Throughout Weeks 1-6 of the trial, the traffic signals were to be operated manually by the flaggers from the unit located on Leg #1. A manual setting was applied from a controller box also located at the unit on Leg #1. Once the manual setting was applied, control of the light was achieved with the aid of a button attached with a 25ft cable to the unit. This allowed the flagger managing the system to stand away from the road or even sit in a site vehicle during inclement weather while still maintaining control of the signal lights. When set cycle timings were applied, digital timers were used in combination with the manual control to allow some flexibility if necessary. A photo of the controller box is shown in Figure V.


Figure V: Controller box located within the unit on Leg #1

## 6. Trial Summary

The temporary signals were delivered to site and set up on September 22 and 23, 2014. The traffic signals began directing traffic during the evening peak hours on September 23, 2014.

Weeks #1 and #2 (September 22 – October 5, 2014)

During Weeks #1 and #2, the signals were operated manually at the discretion of the flaggers. As mentioned previously, no set timings were applied during this time. This allowed vehicular traffic to ease into the new system, such that flaggers would continue to clear each leg of the intersection during a single cycle. Bus events maintained their priority during this time.

No significant delays beyond what would normally be experienced with the flaggers were recorded during this portion of the trial. Occasionally, due to the direction given to the flaggers to maintain bus priority, a specific intersection leg could be given the right of way for nearly four (4) minutes waiting for all the buses to clear the area. This would be no different than when the flaggers would flag the intersection, however due to some uncertainty from drivers, a right-on-red movement was less common with the signals in place.

There were several note-worthy differences with the commencement of the temporary signal lights pilot. One such difference between the temporary signals and the flagging operation was the signals now released traffic in set sequence from Leg #1, followed by Leg #2 and ending with Leg #3 before restarting the sequence. While each leg was still being cleared of all queues, this contributed some structure to the system, allowing drivers to better anticipate their upcoming right-of-way.

The number of flaggers required to direct traffic was another notable difference. When flagging, two shifts of 7-8 flaggers (a total of 14-16 flaggers per day) would be required. During the temporary signals trial only two shifts of 2-3 persons (a total of 4-6 flaggers per day) were required to operate the system. In actuality, only one laborer controlled the flow of traffic. A second person was required on Leg #2 to report queue lengths to the person controlling the lights. Due to the large distance between the units and incline on Leg #2, the queues on Leg #2 were not visible to the person on Leg #1.

Most importantly, the temporary signals allowed flaggers to position themselves further from the roadway. While flagging, the flaggers would need to stand on the edge of the roadway in order to be visible for directing vehicles. Although they wore the proper PPE and took all necessary precautions, their close proximity to the roadway was unavoidable. With the inclusion of the temporary signals, both the laborer operating the lights and the laborer located on Leg #2 could stand away from the roadway and complete their jobs within the safety of a site vehicle if desired.

Lastly, the addition of the temporary signals significantly reduced the possibility of human error associated with directing traffic. The signals are programmed with safety mechanisms to ensure that at absolutely no time will two green lights be shown on different legs at the same time, whereas a miscommunication between the flaggers while flagging, although unlikely, could cause this event to occur, compromising the safety of workers travelling through this intersection.

<u>Weeks #3 and #4 (October 6 – 19, 2014)</u>

Due to technical issues with the controller box and potential safety issue associated with this, the traffic signals were temporarily shut down for Weeks #3 and #4 until the supplier could return to site to replace the controller and re-program the system.

During this period, cycle timings were generated using Synchro 7.0. The resulting signal timings were based on traffic volumes obtained for the scoping study and verified with information obtained during the first two weeks of the trial. The generated cycle times applied for the next phase of this trial were rounded to the following:

AM Peak:

Leg #1 – 20 second green + nominal yellow and red
Leg #2 – 20 second green + nominal yellow and red
Leg #3 – 75 second green + nominal yellow and red

PM Peak:

Leg #1 – 30 second green + nominal yellow and red
Leg #2 – 30 second green + nominal yellow and red
Leg #3 – 30 second green + nominal yellow and red

<u>Week #5 (October 20 – 26, 2014)</u>

Following the replacement and reprogramming of the temporary signal lights on October 21, 2014, Week #5 returned to operating the signals manually with right-of-way times at the discretion of the flaggers. This allowed vehicular traffic to ease back into the system as well as ensure the flaggers had a thorough understanding of the system before any element was modified.

Weeks #6 and #7 (October 27 – November 9, 2014)

For the following two weeks of the study, the signal timings listed above were applied to the intersection in both the AM and PM peak periods. In order to maintain bus priority, a 2:00 minute green light would be permitted during each bus event coming from Leg #1 and Leg #2, where fleets of 17 buses (plus 1-2 spares) would arrive at each leg within minutes of each other. No special priority was given to buses entering site on Leg #3 as they arrived staggered over a longer time frame at this leg.

During the AM peak, the timings noted above worked generally well except on Leg #1 from approximately 7:45 - 8:00 AM. Due to the shift-change, traffic would queue beyond the neighboring four-way intersection. There were no bus events that occurred on Leg #1 during this time that would contribute to this queue. Queues were mainly composed of light vehicular traffic and due to the high volume of traffic additional time had to be given in order to clear the queues on this leg.

During the PM peak periods, the timings worked especially well. No significant delays or queues were noted during this time. It should be noted, however, that during the last hour of the operation of the signals (8:00 – 9:00 PM), traffic volumes were low and traffic control seemed unnecessary for the low volume of vehicles moving through this intersection.

As noted above, bus events from Legs #1 and #2 were each given a singular 2:00 minute green light in an attempt to move all 40+ coach buses through the intersection. The 2:00 minute green time was generally enough to move all coach buses from Leg #1 through the intersection. On Leg #2, if the buses arrived while the cycle was green on another leg, this would allow the buses to queue and regroup until the cycle returned to Leg #2, where a 2:00 minute green light would then be provided. In this instance described above, all the buses would be able to clear the intersection in 2:00 minute interval. However, if the light was green when the first bus arrived, a 2:00 minute green light was insufficient to clear all the buses from this leg. This was due to gaps that would manifest between buses during the drive from the busing facility accessed through Leg #2, located approximately 5.0 km from the intersection.

Week #8 (November 10 – 17, 2014)

Permission was received from our client to run the set timings without bus prioritization for peak periods from November 8-11, inclusive. These dates fell on a weekend and continued into the Remembrance Day holiday, when traffic was expected to be lighter than normal.

For this period, the green signal timings for Leg #1 and Leg #2 were increased from 20 to 30 seconds for the morning peak hours in order to better accommodate the bus events.

Significant delays were reported on Leg #3 from Saturday, November 8, to Wednesday, November 12, 2014. Traffic was reportedly queued to approximately 2.0 km from the intersection on Leg #3. Signal timings were increased from 75 seconds to 90 seconds for Leg #3 on November 12. Delays were still recorded following this change.

Upon investigation, we eliminated the following potential causes for these delays on Leg #3:

- There was no special maintenance work on site that would increase the number of workers and thus vehicles on site;
- No known shift schedules were revised due to the daylight savings time change on March 9;
- Signal timings were being applied as directed;
- No accidents were reported on Leg #3;
- No road maintenance work was scheduled for this time at this location; and
- Inclement weather was not a factor.

After narrowing down the potential reasons causing the significant delay on Leg #3, it is most likely the additional time provided to Leg #1 and Leg #2 caused the delays experienced on Leg #3 during the AM peak period. The timings were increased from 20 to 30 seconds on each of these two legs. This increase of 20 seconds in total cycle time was not matched on Leg #3, where the 75 seconds was maintained. Even the addition of 15 seconds on Leg #3 to increase the total green time to 90 seconds could not clear the extra vehicles being added to the queue on Leg #3.

# 7. Trial Aftermath

Confident with the results and nearing the completion of the temporary traffic signals trial, our client had begun to investigate and discuss permanent traffic signal options for the project site. This was briefly pursued however at the end of 2014, as oil prices dropped, subsequently leading to potential variances in traffic volumes on site, the design of a permanent traffic signal system at this location was put on hold until the economy stabilized.

# 8. Alternative Uses for Temporary Traffic Signals

To most people working in the transportation sector, temporary traffic signals are synonymous with construction zones. They are in place temporarily to aid with construction and/or until permanent signals are erected and functioning as desired.

This trial portrays the usefulness of using temporary traffic signals as a means of evaluating the effectiveness of signals beyond computer analysis but without the price tag and time associated with design and construction of a permanent system. This was especially useful for this site, where large vehicles and atypical traffic patterns governed.

Other potential uses for temporary traffic signals are for interim periods before permanent signals are in the process of design and construction. Once a site has determined signals are necessary, temporary signals could be positioned to direct traffic during the interim period prior to a permanent system design and installation. This temporary solution would allow drivers to immediately start adjusting to signals at the intersection and immediately experiencing the benefits of signals. This can be especially important where safety is a concern.

Lastly, temporary signals could be a cost effective solution for remote locations where the cost of shipping and installing permanent signals is over the budgeted allowance.

# 9. Conclusions

Overall temporary signals provided a successful indication of how permanent signals could work at this site. The trial was less expensive than the cost of design and subsequent construction of permanent signals and gave the client better assurance that permanent signals would indeed function at this location, without compromising the current traffic conditions.

From the standpoint of safety, there were several benefits of the temporary signals, including:

- Completely removing flaggers from the roadway allowing them to sit within the safety of a site vehicle or stand at a safe distance from the roadway. This becomes especially important during the winter months, where snow and ice on increase the risk of vehicles losing control.
- Eliminating the possibility of human error associated with directing traffic. The signals are programmed with safety mechanisms to ensure that at

absolutely no time will two green lights be shown on different legs at the same time, whereas a miscommunication between the flaggers while flagging, although unlikely, could cause this event to occur, compromising the safety of the flaggers as well as vehicles travelling through this intersection.

Several other conclusions can also be drawn from this trial. For the first time a structured cycle was applied successfully at this location. While the flaggers would release traffic based on the queues and follow no specific pattern, a cyclic pattern allows drivers to better anticipate how the intersection works, and tends to reduce the likelihood of drivers attempting risky maneuvers.

Another important conclusion of the trial was that the cost to rent and operate the temporary signal lights was significantly less than the cost to employ 14-16 flaggers (two shifts of 7-8 persons). Running the temporary signal lights required only 4-6 persons (two shifts of 2-3 persons) plus the cost to rent the signals. It is important to be aware that the site is remote and thus wages are higher at this location than at other similar sites across Canada.

Lastly, it should be noted that due to the general function of temporary signal lights as temporary units only, the complexity for our trial remained fairly basic. A permanent traffic lighting system would allow for varying cycle timings at different periods during the peak hours. Another major limitation of the temporary signals was placement of the units. Due to their size and limited space at our specific site, the units were placed considerably far apart (the units on Leg #2 and #3 were approximately 300 meters apart). During the timed sequences in Weeks #6 and #7, the time required for vehicles to clear the intersection added approximately 20 seconds for each leg. This resulted in a total of 60 seconds, a lot of which could be eliminated if the signals could be placed closer together. Permanent signals could also include technology such as detection loops, sensors, and advance signal priority for the coach buses, which could further optimize a permanent system at this location.

Overall, the temporary signal lights trial was a success. The trial further strengthened the recommendation for a permanent system at this location, proving that current traffic conditions could be maintained with permanent or temporary signals and subsequently improving safety by removing flaggers from the roadway at one of the most critical and busy intersections on site during the busiest times of the day.