Google Glass In-Service Road Safety Review Pilot Project

Craig Milligan, P.Eng.,
Transport Infrastructure Specialist, Fireseeds North Infrastructure
craig.milligan@fireseedsnorth.ca

Rebecca Peterniak, M.Sc., EIT,
Transport Infrastructure Specialist, Fireseeds North Infrastructure
rebecca.peterniak@fireseedsnorth.ca

Amanda Price
Transportation Program Development Coordinator, Yukon Government Highways and Public Works
amanda.price@gov.yk.ca

Paper prepared for presentation at the
Advances in Collision Data Collection, Analysis, and Interpretation Session

of the 2015 Conference of the
Transportation Association of Canada
Charlottetown, PEI

ABSTRACT

This paper outlines the results of a pilot program for using Google Glass technology to support efficiency and effectiveness in road safety audits, or in-service road safety reviews. Phase 1 of the pilot program involves safety reviews at over 30 sites in 6 jurisdictions and runs from February to June 2015.

Google Glass is a wearable computing technology that offers geo-referenced video, photo, and voice recording, contextual information, interactive workflows, and live uploads to collaborators off-site. Using Google Glass during preparation, site visit, and post-visit analysis/reporting offers the potential to streamline the process (greater efficiency) and to offer new insights by connecting data from different sources in the field (greater effectiveness).

Alternatives to Google Glass include conventional pen-and-paper field visits, using GPS enabled tablets or cameras, using GPS enabled dash cameras with voice recording, and using GoPro or similar wearable cameras. Many of these alternatives are commonly used and have been used by the authors. This pilot marks the first application in the world of Google Glass to in-service road safety reviews or audits.

The paper will describe the pilot parameters, the reviews conducted, the evaluation criteria and results (quantitative evaluation of time saved and qualitative evaluation of other benefits). The paper will also give the reader an understanding of how the technology works using screen-shots from the Google Glass and from the interactive mapping program that is used for post-processing. The main lessons learned will be summarized, and plans for technology modification and a Phase 2 pilot will be discussed.

1. Introduction

This paper provides an overview of a pilot project to use Google Glass to support in-service road safety reviews. In-service road safety reviews (ISRSRs) are part of a quantitative road safety management program. Google Glass is a hands-free inspection technology that can facilitate site visits, increase collaboration, and provide an inspector with location-specific contextual information in the field. Jurisdictions from across Canada have participated in this pilot program and the initial results indicate that the practice can result in time savings of over 30%. Section 2 of this paper discusses the role of ISRSRs in road safety management; Section 3 outlines the Google Glass ISRSR concept; Section 4 describes the pilot participants and evaluation parameters; and Section 5 provides the evaluation results. Section 6 provides the conclusion, followed by a series of screenshots and images from the pilot in Section 7.

2. ISRSRs and Quantitative Road Safety Management

Quantitative Road Safety Management (QRSM) is the practice of continuously improving road safety by applying rigorous, evidence-based scientific and engineering knowledge in planning, design, treatment and policy selection, operations and regulation, and road safety budget allocations.

An *In-Service Road Safety Review* (ISRSR) is "an in-depth engineering study of an existing road using road safety principles with the purpose of identifying cost-effective countermeasures that would improve road safety and operations of all road users" (TAC, 2005). These differ slightly from road safety audits in that they usually focus on operational roads where network screening has identified a high potential for improvement while audits often focus on the various stages of the design, construction, and opening of a new facility.

ISRSRs are a key step in the QRSM process, in that network screening focuses ISRSR resources on sites with the most potential for improvement and the ISRSR uses collision and other quantitative engineering data to identify effective countermeasures, the effect of which can often be estimated with empirical collision modification factors (CMF). Figure 1 shows key elements of an ISRSR, and Figure 2 shows what we consider to be the most relevant TAC guidelines on linking QRSM and ISRSRs.

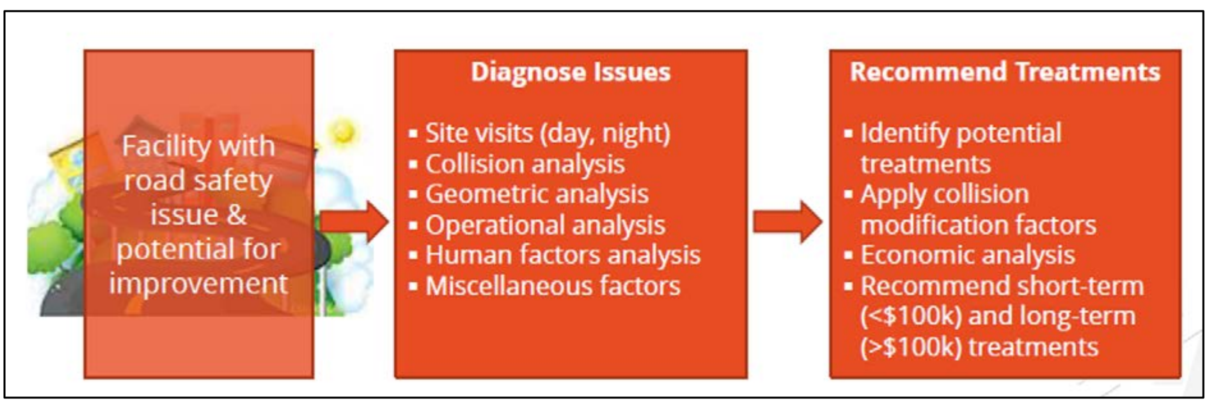

Figure 1: ISRSR components

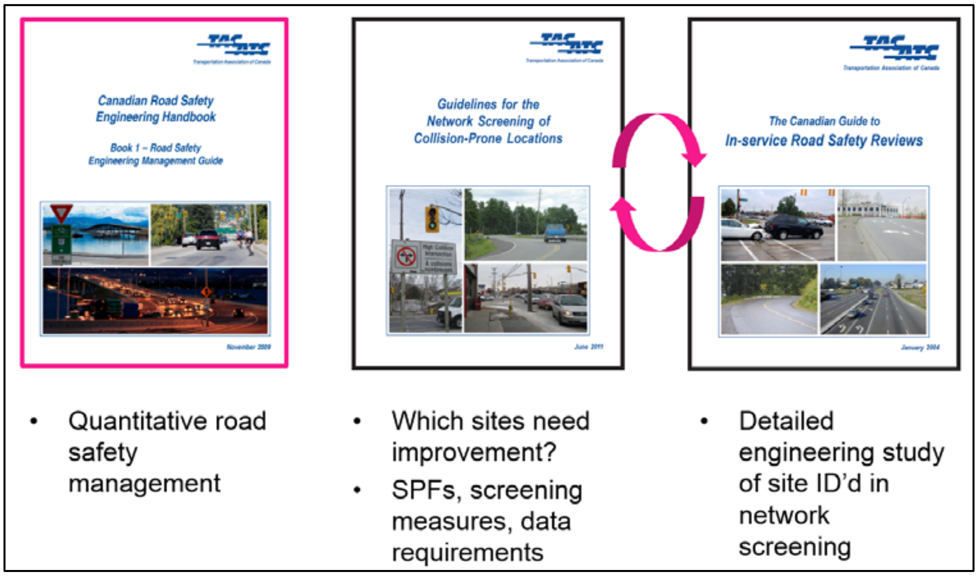

Figure 2: TAC Guides linking QRSM, Network Screening, and ISRSRs

3. Google Glass Technology applied to ISRSRs

Google Glass is a wearable computing technology that offers geo-referenced video, photo, and voice recording, contextual information, interactive workflows, and potentially uploads to collaborators off-site. VisualSpection is an ICT firm in Winnipeg that develops applications for wearable technology for all kinds of inspection work scenarios. VisualSpection developed an application for this pilot to facilitate In-Service Road Safety Reviews that are compliant with TAC guidelines. The application has an on-device component and a cloud-based online mapping portal to interact with the inspection results.

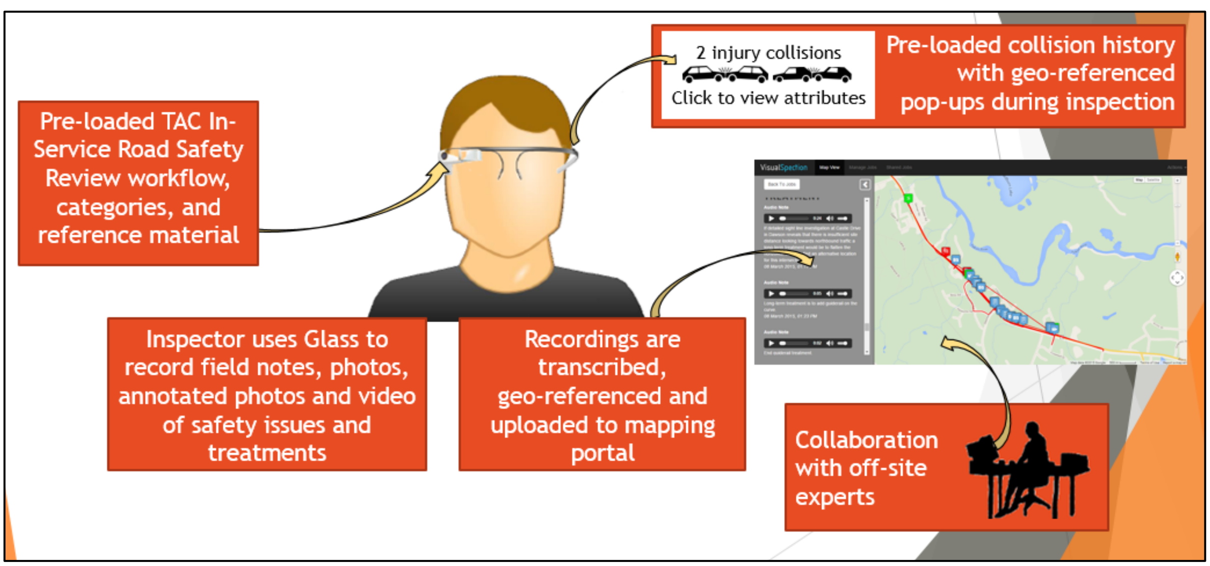

Figure 3: Google Glass ISRSR Concept

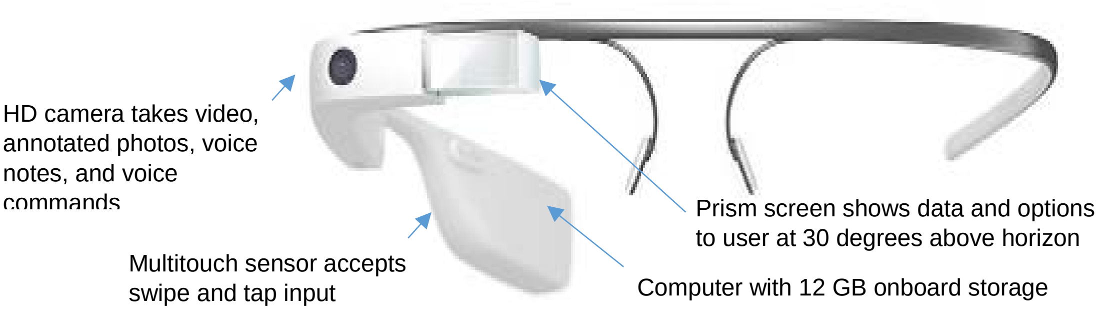

Figure 4: Google Glass - can be fitted with numerous interchangeable lenses including safety lenses. Arrow denotes prism where all of the application screens are shown to the user in the field.

IMAGES FROM THE PRISM SCREEN VIEWED WHILE WEARING THE GLASS

Figure 5: Home Screen for The VisualSpection TAC-Based ISRSR Application (viewed on prism screen on glass)

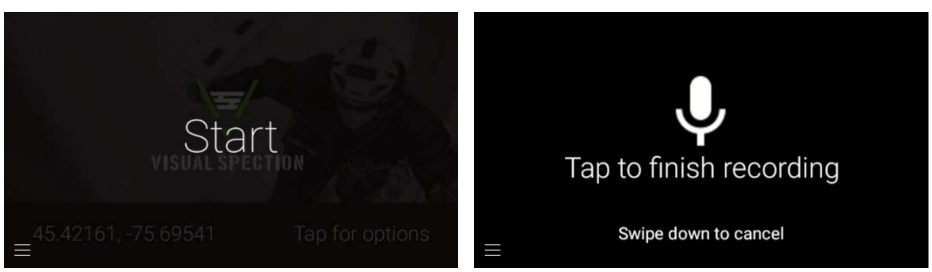

Figure 6: Start a job and record the job name (viewed on prism screen on glass)

Figure 7: Application records issues and treatments in five categories based on the TAC Guide (viewed on prism screen on glass, activated by touch or voice input)

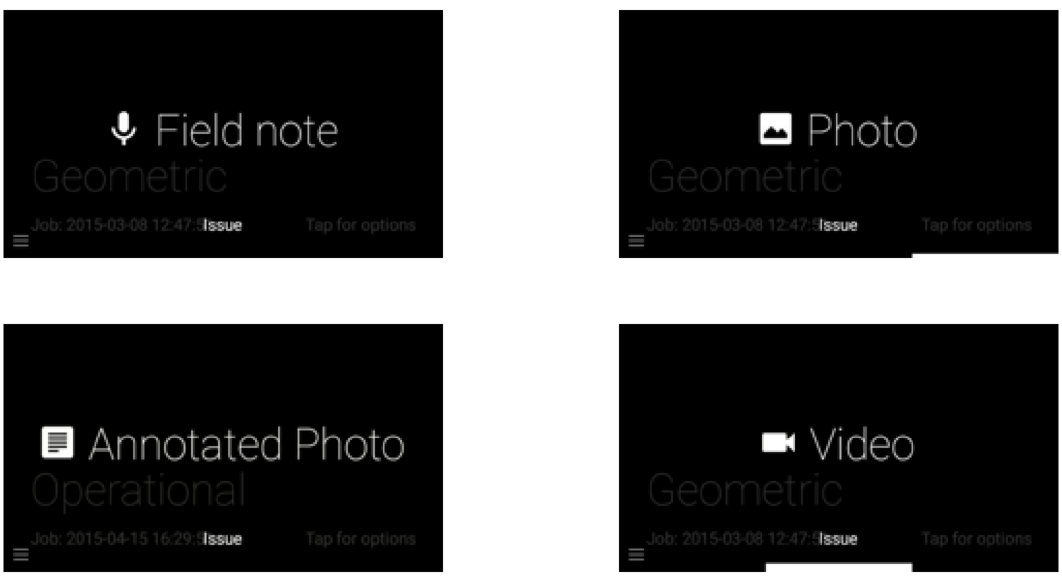

Figure 8: Application can record 4 types of field observations in any of the categories. (e.g. Treatment → Geometric → Annotated Photo) (viewed on prism screen on glass, activated by touch or voice input)

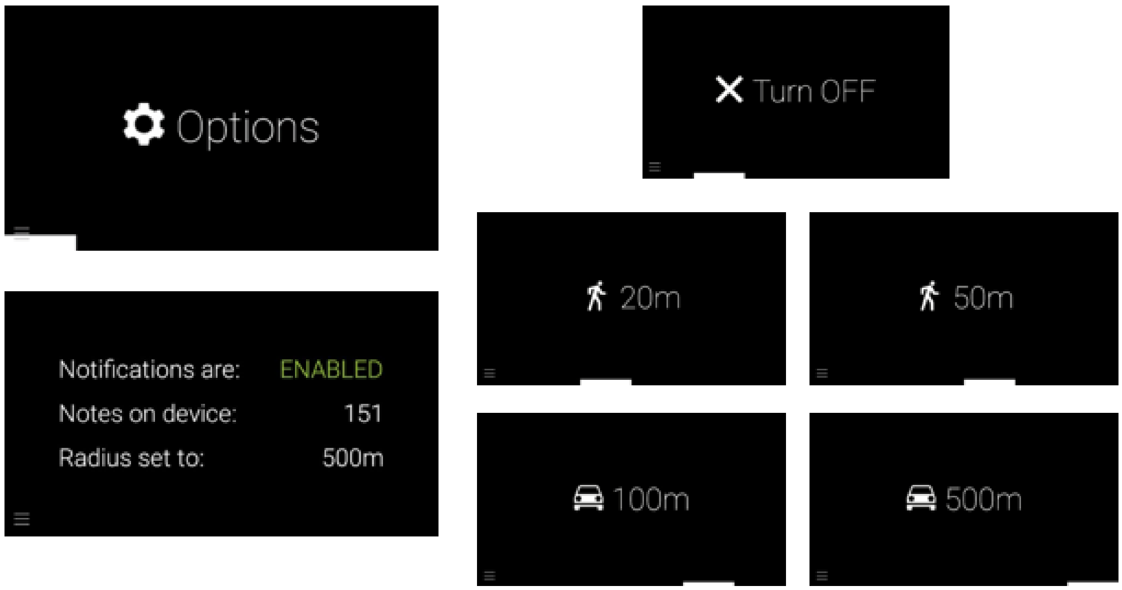

Figure 9: Application provides various settings for the 'pop-up' geo-referenced contextual notifications (Viewed on prism screen on glass)

Figure 10: Applications provides user with 'pop-up' geo-referenced contextual notifications of collision information. It can also provide any other location based information such as site details or citizen concerns linked to the site. (viewed on prism screen on glass)

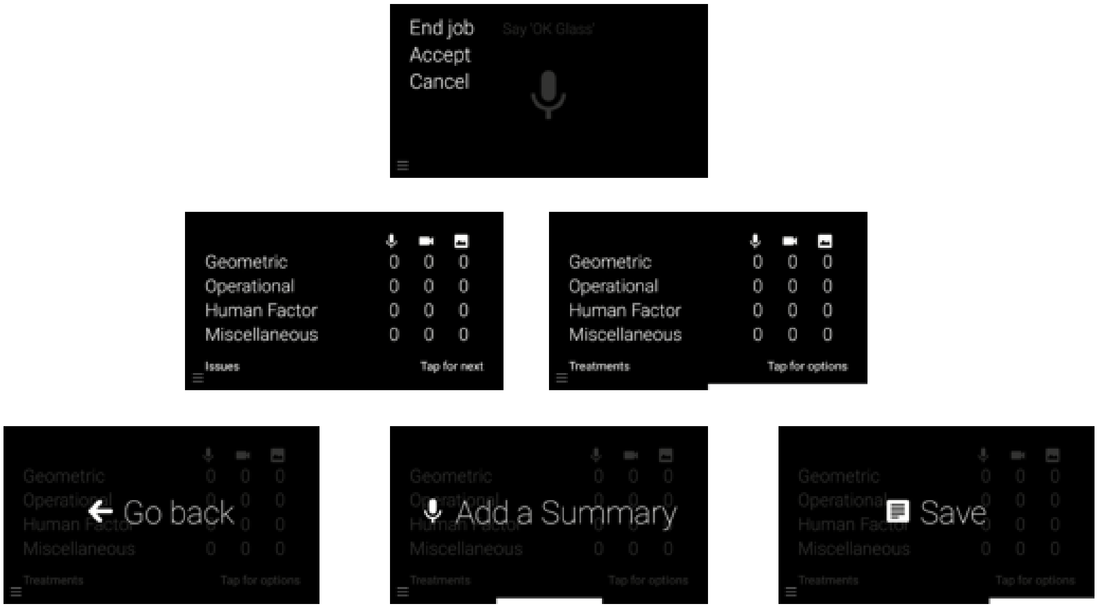

Figure 11: Application provides a job end workflow to review the number of issues and treatments by category and to add a summary dictation (viewed on prism screen on glass)

IMAGES FROM THE WEBMAP PORTAL THAT AUTOMATICALLY RECEIVES DATA FROM GOOGLE GLASS

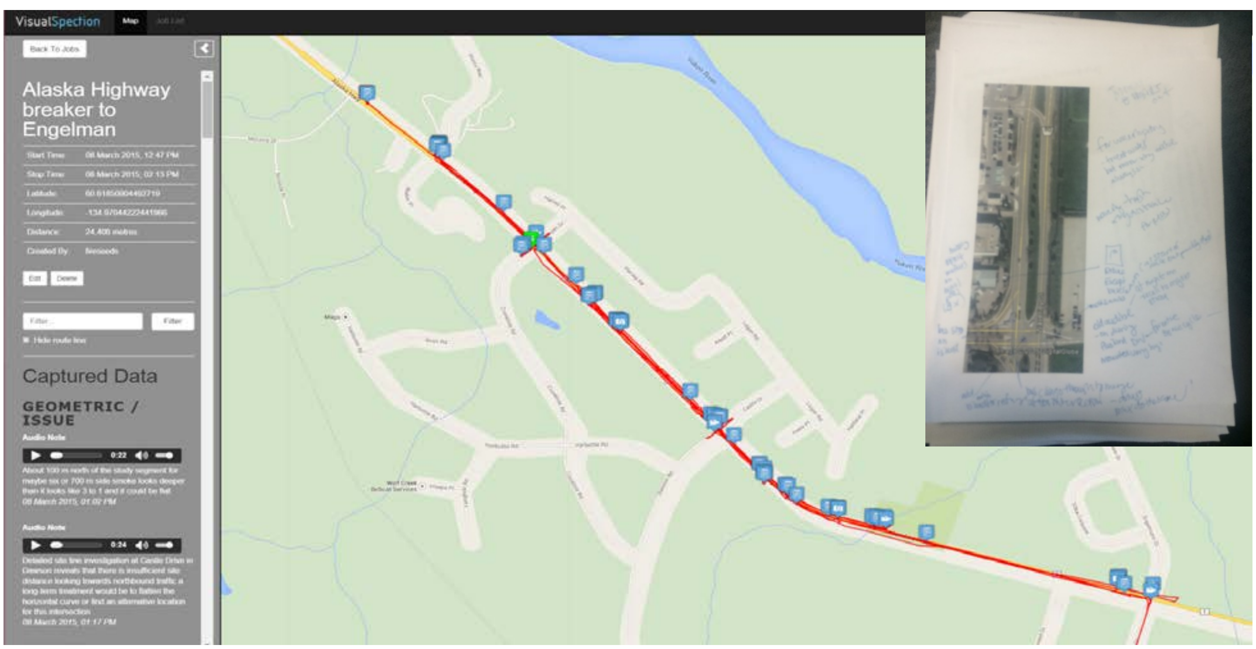

Figure 12: Web portal job-view shows all recorded issues and treatments. User can click to interact with a recording or filter for key words on the left. In-set image shows what our field reports used to look like.

Figure 13: Web portal allows user to interact with recordings inside StreetView. Clicking a blue icon will bring up a note, photo, or video about an issue or treatment.

4. Pilot Project Overview – Objectives, Evaluation Parameters, and Participants

The pilot objectives, besides the normal objectives of improving safety associated with doing ISRSRs, are to determine if: (A) meaningful time savings can be achieved by using the technology; (B) if contextual data provided to inspectors on the Glass screen during the inspection can leverage greater insight; and (C) if the Glass can be used to facilitate live-off-site collaboration can save time by reducing the number of experts that have to be deployed to each site. In Phase 1, the use of contextual data focuses on collision record details or summaries thereof that are provided to the inspector on the Glass screen in the vicinity of occurrence. Later in the pilot, we plan to explore opportunities to provide geo-referenced community member concerns as in-field contextual information.

Table 1: Evaluation Parameters for Each Pilot Objective

Objective	Evaluation Parameter
(A)Time Savings	Quantitative: Difference in time between FNI internal baseline and FNI experience using Google Glass across 16 sites
(B) Contextual Data Usefulness	Qualitative: Opinion of FNI engineers
(C) Offsite Collaboration	Quantitative: Binary – function works (Y/N) Qualitative: Opinion of FNI engineers as to the usefulness of this function in reasonably allowing one participating engineer to remain

off-site.

The pilot participants for Phase 1 are:

- Yukon Government
- City of Ottawa
- Strathcona County, Alberta
- York Region, Ontario

The pilot participants for Phase 2 are:

- Ontario Ministry of Transportation
- City of Vancouver
- City of Calgary
- City of Surrey
- City of Vancouver
- City of Montreal
- Insurance Corporation of British Columbia (by way of cost-share with BC jurisdictions)
- Potentially others

For each Phase 1 participant, FNI is completing five ISRSRs, and the jurisdictions contribute a pilot fee that covers the site visits, preparation of ISRSR reports, and a portion of the technology evaluation.

The pilot is structured into three phases to reflect the fact that this is an early stage technology where feedback is being rapidly incorporated into further development of the application. Phases 2 and 3 have not started as of the writing of this article. Additional jurisdictions may participate in further phases, including potentially jurisdictions from Quebec and further East in Canada.

5. Evaluation Results

Phase 1 of the Pilot is still underway at the time of writing this paper, but at this time we can confirm some of the initial evaluation results, which consist of data on the evaluation parameters as well as general observations about the hardware and software.

(A) Time Savings

Our initial experience indicates time savings of approximately 13.5 hours per job, as indicated in the Table below. These time savings easily provide us an excellent return on investment for the hardware and application subscription costs we incur from VisualSpection.

Task	*Baseline*[1]	*With VisualSpection/ Google Glass*	*Savings*
Site Visit	12 hr	8 hr	4 hrs
Field Report	8 hr	4 hr	4 hrs
Analysis & Report	20 hr	14.5 hr	5.5 hrs
		TOTAL SAVINGS PER JOB	***13.5 hrs***

Note: [1]The baseline for time savings is based on Fireseeds North Infrastructure experience on previous in-service road safety reviews, which is about 40 hours for a moderately complex site.

The four hour saving on the site visit task reflects a savings of 1-hour during each visit, added across two engineers in the field and two visits per site (day and night). Previously, members of our firm would take several plan sheets of the site, a camera, a dash camera, and a notebook to in-service road safety review sites. With the Glass, we are saving the time to write down detailed observations including locational references and references to media files recorded at the site.

To produce the field observational report, we formerly spent a lot of time transcribing handwritten notes from our site plans into an equivalent digital file, positioning text, and including numerical references to photos and videos taken at the site. Theoretically, with the Glass application, this time should be reduced to zero because a Google Earth KML file can be exported from the online mapping portal containing all of the georeferenced photos, notes, and annotated videos in a map view with automatic voice-to-text transcription. However, we still require about 4 hours to produce this report. This is for two reasons: (1) we need to allocate some administrative staff time to listen to our recordings and correct the transcriptions; and (2) sometimes the files, especially larger ones, do not upload seamlessly from the Glass and time needs to be spent to administer and monitor the file uploads. These items can seem frustrating as we want it to work seamlessly, but we are still saving 50 percent of our field observational report preparation time.

The time to produce the in-service review report, including the geometric, operational, human factors and other analyses, selection of key issues, selection of countermeasures and estimates of effectiveness is largely reduced because of the ability to interact with the field report on the online mapping portal. The portal contains a filter query, so that a user can type in words like ‘pedestrian,’ ‘side slope’, or ‘positive guidance’ to see anytime these words were used in any of the transcribed notes.

(B) ***Contextual Data Usefulness***

We have found that contextual data provides good additional insight and convenience for the inspector. In the past, we have taken multiple pages of tables or maps with plotted collisions into the field. The convenience of having this information provided on screen when needed is helpful. We have experimented with different formats of contextual information to present. One option that was helpful for rural segments was to provide a separate record for each individual collision that contained the key collision attributes concatenated into one text box. An option that has been helpful for urban intersections are a set of records that defined the distribution of collisions by time of day, configuration, approach leg, severity, and other breakdowns.

(C) Off-site Collaboration

We have not thoroughly tested this capability yet but plan to do so in Phase 2 of the pilot. One issue we have worked through with the developers is that off-site collaboration will likely not be possible with videos over 10 seconds long with the current version of Google Glass. For geo-referenced field notes and photos, it likely will be possible. However, the VisualSpection staff still need to optimize the upload sequencing in order to launch this function in Phase 2 of the pilot.

General Evaluation Observations Related to Hardware and Application

- **Battery life**. Short battery life is a well-known problem with Google Glass. The device may function for 1 to 4 hours with no battery pack, depending on how much video is taken during that time. To overcome this challenge, we connect the Glass to a 16,000 mAh (about 10 cell phones) battery pack supplied by ViualSpection to extend the battery life. This is necessary for extended time in the field. We have operated the Glass at temperatures below -40 □C during pre-testing in Winnipeg with no problems when using the battery pack. The battery pack can power the Glass for several days without re-charging.
- **Overheating.** We found that in certain situations the Glass overheats. This usually happens when we are charging it and using the processor heavily (longer videos, using voice-driven mode). The Glass displays a message that it needs to cool down, and temporarily disconnecting the charging cord from the battery pack usually helps. This happened on two of our first 32 field visits and in each case delayed us by about 7-8 minutes. We are hoping that the next release of Google Glass will address this issue.
- **Voice-Driven Controls.** During the first eight site visits (in Yukon), the application could only be controlled by touch interactions. The side of the Glass can be controlled by swiping a finger in four directions or applying a single or double tap. Before the second set of site visits in Ottawa, VisualSpection had introduced voice control to the application. This is very helpful especially for cold weather use, and creates a more seamless inspection experience. The controls work well, but in very high wind conditions, we still use the touch mode to avoid unintended command selection from background noise. The Glass seems to have a good noise filters for removing background noise when recording audio notes so we want to explore if the same noise filters can be used to avoid triggering unintended commands from the wind.
- **Transcriptions.** The voice-to-text transcriptions of notes, videos, and annotated photos require correction, but this can be done by an administrative support person. VisualSpection has indicated that the transcriptions are provided by the same web-service used by Android and Apple phones for speech recognition.
- **Data Transfer.** VisualSpection is still in the process of optimizing data transfer algorithms and code for their application. This affects the application use in two ways. First, the data has to be sent from the device to the mapping portal. This works well wirelessly and automatically over the cell network for small jobs and small files, but the uploads slow down significantly and require moderate manual user interaction when the size of the job or files increases (e.g. videos over 10 seconds). Second, when viewing data on the web-map portal, voice notes, photos, and some small videos will display quickly. However, where there are larger videos or many videos in a job, the videos can take a long time to play or sometimes not play at all. This is connected to: (A) the browser running out of memory allocation when the application instructs it to pre-cache all the videos on the job portal webpage; and (B) possible limitations on the Amazon

cloud services used to store and serve the job files. There are concrete strategies in place to address these issues by modifying the application code, and VisualSpection is working on these. In the meantime, when some videos do not play on the portal, we can play a locally stored copy of the required videos by matching date stamps. We expect that the time to produce the field observational report will drop further when these issues are addressed.

6. Conclusion

The Google Glass In-Service Road Safety Review Pilot has created a good amount of interest among participating jurisdictions across the country. ISRSRs are an important component of a progressive quantitative road safety management program. The ability to complete such studies more efficiently has the potential to release more resources for additional studies or additional countermeasure implementations. Since the technology is in an early stage, the pilot has revealed a number of areas where it can improve. While some of these areas of improvement can be frustrating at times, we are still completing studies in substantially less time than our benchmarks from past studies.

Many of the areas for improvement are being addressed during Phase 2 of the pilot. Phase 2 of the pilot has three purposes: (1) to allow more jurisdictions to have road safety reviews completed at sites with safety concerns; (2) to allow more jurisdictions to try the technology, and (3) to test the improvements made during Phase 1. The jurisdictions confirmed for participation in Phase 2 are the cities of Montreal, Calgary, Surrey, and Vancouver, as well as the Ministry of Transportation of Ontario. Key features to be tested in Phase 2 of the pilot are: (1) improved upload strategy to allow for better real-time communication between office and field; (2) use of ESRI-based mapping portal instead of Google-based mapping portal; and (3) improved video playback through the use of compression and other techniques. The improved video playback has already been implemented and has solved all the challenges with video playback from Phase 1.

Overall, the technology is very promising. It offers time savings for conducting important road safety engineering work, allowing to accomplish more with less resources. These results are preliminary and we anticipate sharing more details in the national pilot report once all phases are completed.