DEPARTMENT OF TRANSPORTATION

Using Apps to Notify the Public of Local Road and Bridge Closures

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Athey Creek Consultants

March 2024

Research Project
Final Report 2024RIC02

LRRB
LOCAL ROAD RESEARCH BOARD

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The traveling public increasingly relies on navigation systems, either as part of their vehicles or through their handheld phones or mobile devices. Currently there is not a consistent system, tool, or process being used by cities and counties in Minnesota to report road or bridge closures that local transportation agencies can use to display to the traveling public or provide to third-party mapping/navigation companies (e.g., Waze, TomTom, HERE Technologies, Google, Apple) so that these companies can display the information to the public. To move toward an approach for reporting road and bridge closures by local counties and cities, the Minnesota Local Road Research Board (LRRB) initiated this project, *Using Apps to Notify the Public of Local Road and Bridge Closures*. The objectives of this project were to identify and describe an approach the Minnesota LRRB could use to implement a user-friendly road closure reporting system and develop a guide on how local agencies could currently report closures to third-party mapping and navigation companies.

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Table of Contents

List of Figures

List of Tables

List of Abbreviations

API	Application Programming Interface
CARS	Condition Acquisition Reporting System
CEAM	City Engineers Association of Minnesota
COTS	Commercial off-the-shelf
DOT	Department of Transportation
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
GRIT	Geographic Roadway Inventory Tool
ICEA	Iowa County Engineers Association
IT	Information Technology
JSON	JavaScript Object Notation
KML	Keyhole Markup Language
LRRB	Local Road Research Board
LRS	Linear Referencing System
MCEA	Minnesota County Engineers Association
MDOT	Maryland Department of Transportation
MDSS	Maintenance Decision Support System
MnDOT	Minnesota Department of Transportation
MPO	Metropolitan Planning Organization
MRCR	Maryland Road Closure Reporter
NDSU	North Dakota State University
OAuth	Open Authentication
ODOT	Oregon Department of Transportation
OEM	Original Equipment Manufacturer

RFP	Request for Proposals
RTMC	Regional Transportation Management Center
SaaS	Software as a Service
SHA	State Highway Administration
SPR	State Planning and Research
TAP	Technical Advisory Panel
TLE	TripCheck Local Entry
TMS	Traffic Management System
TSMO	Transportation Systems Management and Operations
UGPTI	Upper Great Plains Transportation Institute
URL	Uniform Resource Locator
WZDx	Work Zone Data Exchange
XML	Extensible Markup Language

Executive Summary

The traveling public increasingly relies on navigation systems, either as part of their vehicles or through their handheld phones or mobile devices, as part of their regular driving experience. Currently there is not a consistent system, tool, or process being used by cities and counties in Minnesota to report road or bridge closures (referred to throughout this document as road closures) that local transportation agencies can use to display to the traveling public or provide to third-party mapping/navigation companies (e.g., Waze, TomTom, HERE Technologies, Google, Apple) so that these companies can display the information to the public.

Travelers on Minnesota's state highways and interstates benefit from road closures and other driving condition information entered by the Minnesota Department of Transportation (MnDOT) staff into MnDOT's traveler information system. Once closures are reported to the system, they are shared with travelers through MnDOT's traveler information dissemination mechanisms (e.g., website, mobile application) and are available to third-party mapping/navigation companies though an internet data feed.

In addition, any Minnesota transportation agency (i.e., state or local) may notify third-party mapping/navigation companies of closures manually (e.g., submitting closure details via an email address or webpage). However, reporting of closures manually or automated on local Minnesota roads by cities and counties is inconsistent at best, if it even occurs.

To move toward an approach for consistent reporting of road closures by local counties and cities, the Minnesota Local Road Research Board (LRRB) initiated this project, *Using Apps to Notify the Public of Local Road and Bridge Closures*.

The objectives of this project were to identify and describe an approach the Minnesota LRRB could use to implement a user-friendly road closure reporting system and develop a guide on how local agencies could currently report closures to third-party mapping/navigation companies.

Project Objectives

- Identify and describe an approach the Minnesota LRRB could use to implement a user-friendly road closure reporting system for local agencies.
- Develop a guide on how local agencies could currently report closures to third-party mapping/navigation companies.

To accomplish the project objectives, best practices were documented by reviewing and interviewing transportation agencies operating the following different types of reporting systems. See Table E.1.

- Oregon DOT (ODOT) TripCheck Local Entry (TLE)
- Iowa County 511 Map
- North Dakota State University (NDSU) Upper Great Plains Transportation Institute (UGPTI): Geographic Roadway Inventory Tool (GRIT)
- Maryland Road Closure Reporter (MRCR)
- MnDOT Statewide Condition Reporting System

For example, local counties collaborated in Iowa through the Iowa County Engineers Association (ICEA) to create a standalone road and bridge closure system known as the Iowa County 511 Map. Individuals from the ICEA were interviewed to document and understand mapping and road nomenclature, tool administration, quality control, allowed content, funding, local participation, additional uses of the events entered, and training. These same details were gathered for the other systems reviewed to summarize overall best practices.

Table ES.1 Interview Description by System Type

System	System Type	Interview Description
ODOT TLE	State owned and maintained standalone system that interfaces with the statewide reporting system	ODOT maintains and operates a statewide traveler information system called TripCheck. Local agencies can request access to enter construction, road conditions, and weather hazards into TLE. Events entered into TLE appear on the statewide TripCheck traveler information website and are published by the TripCheck data portal. An interview was held with ODOT staff as well as a representative from Klamath County to document experiences from the perspective of the DOT and the perspective of a county on local entry.
Iowa County 511 Map	Standalone system	Local counties collaborated in Iowa to create a standalone road and bridge closure system. The interview included representatives from the ICEA Service Bureau that developed and continue to operate and maintain the system.
NDSU UGPTI: GRIT	Standalone system	NDSU UGPTI developed a standalone asset management system used by counties in North Dakota and Minnesota. Closures are entered into GRIT under a construction layer in the tool. NDSU GRIT was interviewed to document the development and use of the tool.
MRCR	State owned and maintained standalone system that does not interface with the statewide reporting system	The MRCR is a standalone system for local jurisdictions to enter road closures in Maryland. The interview included discussions with staff from the Maryland DOT (MDOT) State Highway Administration (SHA) that owns and operates that system, Harford County that uses the system, and consultant staff that developed the system.
MnDOT Statewide Condition Reporting System	State owned and maintained system without local entry	MnDOT's statewide condition reporting system provides real-time information for MnDOT owned and operated roads. The interview with MnDOT also included consultant staff that support the system and understand the capabilities and options for a local road reporting system.

Based on the documentation and review of these five systems, three options were identified for the LRRB Technical Advisory Panel (TAP) to consider implementing a road closure entry system. The TAP included representatives from MnDOT, Carver County, the city of Plymouth, and the city of Crystal.

- Option #1: Partner with MnDOT to adapt and use the statewide condition reporting system.
- Option #2: Develop a standalone statewide local road entry closure tool.
- Option #3: Create individual county/city road closure internet data feeds.

Selected Local Road Closure System Approach

Partner with MnDOT to adapt and use the statewide condition reporting system for local closure reporting.

Considerable detail was developed to describe each option and was based on input from the TAP. For a number of reasons, **Option #1: Partner with MnDOT to Adapt and Use the Statewide Condition Reporting System** ultimately was determined to be the preferred approach for a local road closure entry system in Minnesota. Additional details were then developed to support this option including contracting, funding, estimated costs, benefits, drawbacks, and timeline for development.

In addition, to support local agencies with the ability to immediately report closures to third-party mapping/navigation providers, a user guide was developed and incorporated into this document. The guide provides information for reporting closures to the following mapping/navigation providers: TomTom, Waze, HERE Technologies, Google, and Apple.

Three different methods were identified for submitting road closures to these private company providers.

- Method #1: Email request to each mapping company
- Method #2: Use mapping companies' online tools
- Method #3: Automated entry using an application programming interface (API) or extensible markup language (XML) feed.

Details for submitting requests for each method include email addresses, links to online tools, and links to instructions for data feed content.

Ultimately, the *Using Apps to Notify the Public of Local Road and Bridge Closures* project provided LRRB with two outcomes. The first was a preferred option and supporting documentation for moving forward with implementing a road closure reporting system. The second was a guide for local agencies to immediately provide road closures to selected third-party mapping/navigation providers. These outcomes were consistent with the mission of LRRB to help improve the quality of Minnesota's transportation systems.

Chapter 1: Introduction

The traveling public increasingly relies on navigation systems, either as part of their vehicles or through their handheld phones or mobile devices, as part of their regular driving experience. Currently there is not a consistent system, tool, or process being used by cities or counties in Minnesota to report road or bridge closures (referred to throughout this document as road closures) that local transportation agencies can use to display to the traveling public or provide to third-party mapping/navigation companies (e.g., Waze, TomTom, HERE Technologies, Google Maps) so that these companies can display the information to the public.

Travelers on Minnesota's state highways and interstates benefit from road closures and other driving condition information entered by Minnesota Department of Transportation (MnDOT) staff into MnDOT's traveler information system. Once closures are reported in the system, they are shared with travelers through MnDOT's traveler information dissemination mechanisms (e.g., website, mobile application) and are available to third-party mapping/navigation companies though an internet data feed.

In addition, any Minnesota transportation agency (i.e., state or local) may notify third-party mapping/navigation companies of closures manually (e.g., submitting closure details via an email address or webpage). However, reporting of closures manually or automated on local Minnesota roads by cities and counties is inconsistent at best, if it even occurs.

Project Objectives

- Identify and describe an approach the Minnesota LRRB could use to implement a user-friendly road closure reporting system for local agencies.
- Develop a guide on how local agencies could currently report closures to third-party companies.

Previously the Minnesota LRRB completed a related project: *Transportation Research Synthesis: Systems for Notifying the Public of Local Road Closures Using Smartphone Map Applications* (Linsenmayer, 2020). The document presents the findings of a survey of state and local agencies and the support programs for gathering and distributing road closure data at the local and state levels. A literature search was also conducted to provide relevant national and state practices and guidance. The information gathered from this effort was reviewed for this project.

To move toward an approach for consistent reporting of road closures by local counties and cities, the Minnesota Local Road Research Board (LRRB) initiated this project, *Using Apps to Notify the Public of Local Road and Bridge Closures*.

The objectives of this project were to: 1) identify and describe an approach the Minnesota LRRB could use to implement a user-friendly road closure reporting system and 2) develop a guide on how local agencies could currently report closures to third-party mapping/navigation companies.

To accomplish the project objectives, best practices were documented by reviewing and interviewing transportation agencies operating different types of reporting systems. Based on the documentation and review of these systems, options for implementing a road closure entry system were identified for the LRRB Technical Advisory Panel (TAP) to consider. Considerable detail was developed to describe each option to assist in determining a preferred approach for a local road closure entry system in Minnesota.

In addition, to support local agencies with the ability to immediately report closures to third-party mapping/navigation providers a guide was developed. The guide provides information for reporting closures to selected established mapping/navigation providers.

This report includes the following sections:

- Chapter 2: Local Road Closure Reporting Systems Best Practices
- Chapter 3: Options and Selected Approach for a Local Road Closure Reporting System in Minnesota
- Chapter 4: User Guide to Report Local Road Closures to Third-Party Companies
- Chapter 5: Next Steps

Chapter 2: Local Road Closure Reporting Systems Best Practices

The following steps were utilized to research and document best practices in local road and bridge closure reporting. See Figure 2.1.

- **Step 1: Summary of User Needs** – The first step in documenting best practices was to work with the LRRB TAP members during an interactive webinar in February 2023 to understand the needs that would be addressed by a local road and bridge closure system. These needs were the foundation for defining use cases in Step 2, developing interview questions for Step 3, and eventually researching best practices to address the needs. The documentation also provided a framework for user needs from the perspective of local Minnesota agencies that could translate to requirements if a solicitation is eventually used to procure a local road reporting system. See Appendix A for a listing of the user needs.
- **Step 2: Documentation of Use Cases** – Once the needs were understood, a series of potential use cases were documented to describe possible scenarios for how a local road and bridge closure system could be used. See Appendix B for the use cases defined.
- **Step 3: Best Practices Research** – During Step 3, research involved webinar interviews with five entities that operate closure reporting systems (four states outside Minnesota as well as the Minnesota Department of Transportation (MnDOT) and the contractor supporting the MnDOT reporting system currently used for closures and other condition reporting on state highways and Interstates). The underlying questions used in the webinar interviews were derived from the user needs and use cases developed in Steps 1-2 as well as from the key considerations identified in the project scope of work (mapping and road nomenclature, tool administration, quality control, and allowed content). See Appendix C for a list of interview questions and interview summaries.
- **Step 4: Summary of Best Practices Findings** – Finally, a concise set of findings presented in Section 2.1 were derived from the best practices research and was the basis for the creation of options for the LRRB to consider for a road and bridge closure system as describe in Section 3.

Figure 2.1 Best Practices Steps

2.1 Summary of Best Practice Findings

Best practices for a local road closure system were identified by reviewing and interviewing transportation agencies operating the following different types of reporting systems. See Table 2.1.

- Oregon DOT (ODOT) TripCheck Local Entry (TLE)
- Iowa County 511 Map
- North Dakota State University (NDSU) Upper Great Plains Transportation Institute (UGPTI): Geographic Roadway Inventory Tool (GRIT)
- Maryland Road Closure Reporter (MRCR)
- MnDOT Statewide Condition Reporting System

For example, local counties collaborated in Iowa through the Iowa County Engineers Association (ICEA) to create a standalone road and bridge closure system known as the Iowa County 511 Map. Individuals from the ICEA were interviewed to document and understand mapping and road nomenclature, tool administration, quality control, allowed content, funding, local participation, additional uses of the events entered, and training. These same details were gathered for the other systems reviewed to summarize overall best practices.

Table 2.1 Interview Description by System and Type

System	System Type	Interview Description
ODOT TLE	State owned and maintained standalone system that interfaces with the statewide reporting system	ODOT maintains and operates a statewide traveler information system called TripCheck. Local agencies can request access to enter construction, road conditions, and weather hazards into TLE. Events entered into TLE appear on the statewide TripCheck traveler information website and are published by the TripCheck data portal. An interview was held with ODOT staff as well as a representative from Klamath County to document experiences from the perspective of the DOT and the perspective of a county on local entry.
Iowa County 511 Map	Standalone system	Local counties collaborated in Iowa to create a standalone road and bridge closure system. The interview included representatives from the ICEA Service Bureau that developed and continue to operate and maintain the system.

System	System Type	Interview Description
NDSU UGPTI: GRIT	Standalone system	NDSU UGPTI developed a standalone asset management system used by counties in North Dakota and Minnesota. Closures are entered into GRIT under a construction layer in the tool. NDSU GRIT was interviewed to document the development and use of the tool.
MRCR	State owned and maintained standalone system that does not interface with the statewide reporting system	The MRCR is a standalone system for local jurisdictions to enter road closures in Maryland. The interview included discussions with staff from the Maryland DOT (MDOT) State Highway Administration (SHA) that owns and operates that system, Harford County that uses the system, and consultant staff that developed the system.
MnDOT Statewide Condition Reporting System	State owned and maintained system without local entry	MnDOT's statewide condition reporting system provides real-time information for MnDOT owned and operated roads. The interview with MnDOT also included consultant staff that support the system and understand the capabilities and options for a local road reporting system.

The fact that each of these systems has been operating for multiple years and has a sustained set of users identifies these as best practice examples. This section summarizes information that was gathered from the five agencies interviewed for this project. The information is presented in the following categories:

- Addressing the Primary LRRB Closure Reporting Goals
- Mapping and Road Nomenclature
- Tool Administration
- Quality Control
- Allowed Content
- Funding
- Local Participation and Active Entry of Road and Bridge Closures
- Additional Uses of the Events Entered
- Training

The interviews and demonstrations of local entry systems affirmed that local road entry systems are achievable and that gaining user participation from many of the counties and cities in a state is feasible, although it will take time and should be assumed that other issues will come up that will need to be addressed. Each agency interviewed is proud of their respective system, but each expressed some changes they would make or challenges they encountered (described below). The challenges and insights from the

interviews with the participating entities were considered and included in the recommended approach for a road closure system developed for LRRB consideration described in Section 3.

2.1.1 Addressing the Primary and Secondary LRRB Closure Reporting Goals

During the process of identifying needs, members of the LRRB TAP indicated that the primary goal of a local closure reporting system was for road and bridge closures to be shared with mapping and navigation providers. A secondary goal was for closures on local roads to be shared with travelers within the state.

Primary Goal

To communicate road and bridge closures to mapping and navigation providers.

Secondary Goal

To communicate road and bridge closures to Minnesota travelers.

Those agencies interviewed with an active real-time dissemination of closure events through a public facing application programming interface (API) or automated email have been successful in communicating closures to external entities, summarized as follows:

- In Maryland, entries of local closures into the MRCR system automatically generate emails to the Waze community and Waze editors typically enter these into the Waze system.
- In Iowa, there is a web interface for each county that includes their current reported closures. During the interview, it was noted that TomTom has reached out to the ICEA asking for information on how to access the data, but it is unknown if they are pulling the data.
- In Oregon, the TLE has a dedicated API that is included in the suite of APIs that ODOT operates. They noted that Waze/Google are subscribers to the local reporting API.
- The NDSU GRIT reporting tool does not have an Extensible Markup Language (XML) output or API therefore there is no real-time exchange of closure reports with any outside entities. However, they have indicated there have been expressions of interest in developing a sharing mechanism for the closure reports.
- The interview with MnDOT identified that the current condition reporting system is outputting all active events through an XML/JavaScript Object Notation (JSON) interface and that Waze/Google are subscribing to their events.
- During the April 2023 LRRB TAP webinar, panel members demonstrated the use of the Waze map editor to enter closures into Waze and discussed the role of authorized Waze editors. This added context to the processes documented regarding how closures not included in a formal Internet feed that Waze is subscribed to can be shared with Waze.

2.1.2 Mapping and Road Nomenclature

Not only do the local agencies need a user-friendly mechanism for identifying the road and describing the location on the road for the closure, but the entries must also be understandable by travelers and recognized and consumable by third-party mapping/navigation companies.

- Each of the local road entry agencies interviewed utilized Google Maps as the foundation (or in a supporting role) to their mapping of closures and/or events. Google Maps includes local roads and provides the level of detail that each site found supports their mapping needs.
- The sites explained typical entry procedures that generally included starting/ending locations at crossroads that were also identified from Google Maps.
- Google Maps also enables the software systems to extract the latitude/longitude of locations selected, and these values can be included in the data feed shared to describe the event. The road closure information entered by local agencies can be displayed in various ways.
    - ODOT displays information entered by local agencies as a layer that can be toggled on or off on their state DOT's traveler information website.
    - The Iowa DOT provides a web link from their state DOT website to the Iowa County 511 Map.
    - A county could display the information on their own website. For example, the Iowa County 511 Map is available on its own webpage.
    - The information could also be displayed on a third-party mapping or navigation provider's application by ingesting an API provided by a local agency even if the local agencies don't display the information. The ODOT TLE has a separate API for information entered by locals. This API is available for ingest by third-party providers such as Waze, Google, etc. If a standalone system is built, ensure it produces a Geographic Information System (GIS) service for ease of ingesting data between agencies or third-parties.

2.1.3 Tool Administration

The web-based model affords the option for individuals from many agencies entering road closures through one common reporting tool. However, there is an underlying degree of administration that is required to address such things as: creating new accounts, resetting passwords, managing software upgrades, troubleshooting, and user training. While not unsurmountable, these administrative actions cannot be underestimated or minimized.

- A recurring expression in the best practice research was the need for local reporting systems to be easy to use and to require minimal administration. This is primarily because the tool is typically not used frequently, unlike other software where users are active in the system daily.
- The local road reporting systems reviewed expressed the challenges of managing users from multiple counties/cities, but several best practices were identified:
    - "Nameless" accounts were used in one state, effectively it does not require individuals to have their own account, but rather one account per county that multiple users could use. This minimized the role of managing multiple accounts and eliminated concerns with individuals forgetting passwords. This also minimizes risks of only one individual receiving an alert to remember to update an event. Instead, multiple people with access to the account would receive the alert.

- Another state utilizes open authorization (OAuth) authentication (i.e., similar to logging in to Microsoft or Google) where users (once approved for an account) select their own password and can reset the password through online authentication (eliminating the need for an administrator to create accounts and assign passwords).
- Finally, in situations where an administrator performs the role of creating/resetting accounts, these were delegated to each agency. The local administrator is then the key contact if there are issues, to remove or grant access, or when a password is forgotten, reducing the role of a statewide administrator. This alleviates concerns over the time and staff needed from state DOTs providing administrative tasks even if they fund and maintain the system.

2.1.4 Quality Control

The entry of temporary closures introduces the need to remove the entry when the stretch of road is no longer closed. This can be done when entering the closure by indicating the "expiration" of the closure or manually when the cause of the closure is removed. Accidentally leaving a reported closure for an additional day or weekend can jeopardize the traveling public's perception of the system. This is one example of the need for the cities and counties that eventually use the system to agree to an approach for quality control.

- From those interviewed for this project, each noted that it is the responsibility of each agency that creates and updates the closure reports to ensure the information is correct. Although to enhance consistency among agencies entering, it may be desired to develop a quality control plan.
- To help reduce the number of events that remain in the system after the closure has ended or that are no longer current, the local systems reviewed included an alert function where alerts are sent when an event is going to expire as a reminder to extend the closure expiration date or to let it time out. It is important that the alert is sent to multiple individuals or a group in case the individual that entered the event is out of the office.

2.1.5 Allowed Content

Once a reporting system is operational to allow entry of road closures, the same tool could use a drop-down list to allow entry of additional events such as winter driving conditions, delays due to roadwork, and height and weight limits. This could provide additional information to travelers but also complicates the boundaries of reporting.

- Two systems reviewed (ODOT TLE and NDSU's GRIT) allow entry of multiple conditions (e.g., closures, restrictions, driving conditions, delays, work zones).
- One system (MRCR) limits the reports to closures. The Iowa system identifies closures and vehicle restrictions, but there are examples of roadwork entries that are not road or lane closures.
- A key takeaway is that identifying a system as only including road and bridge closures narrows the expectations of consumers of the data (e.g., they are not expecting other types of reports).

Those systems that advertise that they include other content (e.g., driving conditions, delays, work zones not impacting lanes of travel) introduce more uncertainty into what should be entered, and would increase the amount of effort to report, as well as additional quality control.

2.1.6 Funding

Funding is critical to the success of a local road and bridge closure reporting system, including initial development costs as well as continued operations and maintenance. Almost every state has some form of a statewide reporting system for Interstates and state highways, typically funded by the state DOT. Reporting systems for local roads are less common, and the funding challenges are more complex. Part of the review of the best practices sites was to understand how the funding works (e.g., state funds or local funds) for the deployment and operations of the reporting systems.

- Two of the systems reviewed for this project (MRCR and ODOT TLE) were funded and continue to be operated and maintained by their state DOT.
- One system receives funding through a multi-state pooled transportation research initiative (GRIT).
- One system (Iowa County 511) was funded and continues to be operated and maintained by their county engineer's association.
- The Iowa system was built by ICEA staff. They noted that they believe this led to lower deployment costs and now all modifications can be made by internal staff. They reported that this was possible because of local staff capabilities and experience developing other Internet based systems for other county engineer functions.

2.1.7 Local Participation and Active Entry of Road and Bridge Closures

If closures reported on local roads are disseminated to travelers, the lack of consistent closure reports statewide (e.g., if closures are only entered for a portion of the state) can be misleading to travelers. For example, when seeing no road closures reported for the county they are traveling in, they might interpret this as "there are no closures" when in fact there are closures, but they are not reported.

- From those interviewed in this project, it is understood that even though local agencies may have access to an entry system it may not be used. None of the sites shared that all counties in the state equally enter conditions.
- Each site interviewed expressed that they had local discussions about the need for / benefits of an automated ingest from GIS to prevent those counties that already enter closures into their GIS from having to perform dual entry. While none of the systems operate a GIS interface, input included:
    - Oregon noted that the most populated county in the state (Multnomah) does not enter events into the local entry system because they use GIS for closures and restrictions and do not want to perform dual entry.
    - Iowa noted a similar situation with participation from Polk County, Iowa (where Des Moines is located).

    - Both the NDSU and Maryland interviewees indicated that the topic of a GIS interface has been discussed.
- Nonetheless, an interface to ingest closures in GIS systems is not a universal fix to accomplish participation from all counties, as feedback from the interviewees indicated that many counties do not use GIS to enter closures and restrictions and therefore, they would rely on the manual entry options of a reporting system.

2.1.8 Additional Uses of the Events Entered

One of the best motivators for individuals to actively update event entry systems is when they can see the benefits of their entries reaching the traveling public or reducing their workload for related reporting. Some additional uses of the reporting tool and events entered were captured.

- The Maryland entry tool is used by local agencies to assemble information for their own website dissemination. For example, local cities and counties use the statewide system to enter closures and they receive data output from the system (i.e., through a data feed operated by the statewide system) and integrate this data into their internal data processing and reporting systems. This eliminates them from needing their own reporting tool.
- The entry of future road or lane closing events into a system can assist travelers with knowledge of upcoming events. These future events are also useful for adjacent counties to understand plans for simultaneous roadwork and closures in upcoming months. This can allow the entry tool to become a planning tool, helping to avoid multiple closures in adjacent counties.

2.1.9 Training

Finally, user training is always a topic requiring management, and was discussed with each site.

- All sites noted that the on-line use of the entry tool and the use of Google Maps makes training very easy.
- There was recognition that staff turnover will occur, and it is likely there will be multiple individuals in each agency that require training. Therefore, when creating a new system, the system should be intuitive, easy to use, and require minimal training.
- Online videos on entry will help with consistent training as new staff take on the task of entering, updating, and deleting events.

Chapter 3: Options and Selected Approach for a Local Road Closure Reporting System in Minnesota

From the summary of best practices documented in Chapter 2, options for how Minnesota LRRB could accomplish a user-friendly system for local road closure entry were identified. The options took into consideration the following three primary constraints that were identified when documenting best practices.

- **GIS Entry.** Some Minnesota counties currently enter road closures into their GIS. The approach for local closure reporting system should allow an automated ingest of these GIS entries to avoid duplicate entry.
- **Manual Entry.** Some Minnesota counties do not enter road closures into any systems. The approach for a local closure reporting system should allow for manual entry.
- **API Ingest.** Currently Minnesota counties have not established an API for mapping and navigation providers to ingest closure events. The approach for a local closure reporting system should allow for individual county API feeds or one overall API feed delivering all Minnesota local closures.

Based on these constraints and the best practices documented in Chapter 2, three options were identified to determine one preferred approach for implementing a local road closure system. See Figure 3.1.

- **Option #1:** Partner with the MnDOT Regional Transportation Management Center (RTMC) to adapt and use the statewide condition reporting system.
- **Option #2:** Develop a standalone statewide local road entry closure tool.
- **Option #3:** Create individual county/city road closure internet data feeds.

Details were gathered on all three options that included an overall summary of the option, contracting, funding and estimated cost of the option, estimated benefits and drawbacks, timeline for development, and a conceptual architecture for each option.

Option 1: Partner with MnDOT	LRRB to partner with MnDOT to deploy a local agency layer or version of the statewide condition reporting system that would include an automated ingest from local agencies GIS, manual entry tool for local agencies, and publication of closures on MnDOT's existing internet data feed.
Option 2: Standalone Statewide Local Entry Tool	LRRB to procure or develop a standalone closure reporting system to be used by local agencies in Minnesota that would include an automated ingest from local agencies GIS, manual entry tool for local agencies, and development of a new internet data feed to publish closures.
Option 3: Individual County/City Data Feeds	LRRB to define a model internet data feed and encourage Minnesota counties and cities with GIS (or other tools) to publish similar feeds for ingest by mapping/navigation providers or request MnDOT to ingest and publish with existing internet data feed.

Figure 3.1 Options for a Local Road Entry System in Minnesota

The information for all three options was then reviewed by the members of the project's TAP, and Option #1 was selected as the preferred approach for implementation of a road closure reporting system for local agencies throughout Minnesota.

Selected Approach

Partner with MnDOT to adapt and use the statewide condition reporting system.

Option #1 is only possible if MnDOT agrees to the collaboration with LRRB to implement this option. This section provides details on Option #1, summarizing the approach, a risk assessment and mitigation approach, as well as guidelines and expectations to assist in the collaboration between MnDOT and LRRB. Appendix D includes details on Option #2 and Option #3.

- **A summary of the selected approach**. Describing key aspects of the overall selected approach.
- **A risk assessment and mitigation table.** This implementation approach is only possible with agreement from MnDOT's RTMC that operates the existing reporting system. This table summarizes risks associated with this approach and mitigation strategies for each risk.
- **A summary of guidelines and expectations**. As part of the strategies to mitigate risks, a number of guidelines and expectations were prepared for discussion and agreement between LRRB members and MnDOT RTMC staff.

3.1 Summary of Selected Approach

MnDOT operates and maintains a statewide traveler information system that disseminates information through a public facing website, a mobile application, a 511-phone system, and an internet data feed. The source of the data disseminated is a statewide entry tool and overall aggregator of event and closure reports. The events in the statewide entry tool include road conditions, traffic incidents, closures,

commercial vehicle restrictions, and other reports of events or conditions that impact travel. Some additional information about the current MnDOT condition reporting system is presented as follows:

- **Detours.** The MnDOT condition reporting system allows users to enter detours around road closures. These detours are posted to the external API as part of the standardized message. However, it is unknown if mapping/navigation companies ingest and/or use the detour information.

- **Maintenance and construction work zone entry on existing roads.** The MnDOT condition reporting system allows users to create full descriptions and indicate locations of work zones for construction and maintenance. Work zone entry introduces additional risks of incomplete, inaccurate, or not precise event reports, and therefore requires additional quality control. For example, some states include generic work zone descriptions (e.g., "On Hwy ##, from Exit ## to Exit ##, there is road construction from May 1st through August 1st, expect intermittent lane closures." While reports like this may be accurate, they lack the precision that is needed to add value to drivers (or eventually to connected or automated vehicles). The value comes in when the actual start and end times of lane closures or work zone activities that restrict speed or access to the road are included. Capturing these additional details from the work zone crews is challenging. Therefore, the MnDOT condition reporting system has the capability to support very accurate and precise roadwork reports, if the information is available. A recent industry trend has been the transition to the Work Zone Data Exchange (WZDx), which is a nationally recognized specification for sharing and ingesting work zone event information. There is increasing industry recognition and use of the WZDx, with mapping/navigation providers and automobile original equipment manufacturers (OEMs) developing the capability to receive work zone reports compliant with the WZDx specification. The MnDOT condition reporting system has implemented a WZDx data feed to publish work zone reports that are compliant with the WZDx. However, assembling the data into the WZDx may not make a fully compliant WZDx report. The WZDx specification allows flexibility to include more or less information, however more data will generally make a feed more useful, and verifying the data will make it higher quality and trusted more. One example of an optional but valuable WZDx data element is a report of whether or not workers are present at the worksite. This element should be updated in real-time when workers are present and again changed when workers are no longer at the site. In summary, entry of work zones, especially if compliance with the WZDx is desired, may require a more active reporting, updating, and quality control process.

- **Road Construction for New Roads.** A demonstration of the MnDOT condition reporting system illustrated entry of the construction of new roads or segments of roads (e.g., those not in Google Maps or in the MnDOT linear referencing system). This is possible, and the geographic location can be entered and appear on the MN511 website. However, it is not understood if/how mapping/navigation companies would display this information to travelers.

- **Local Road Conditions on the Current System.** The current MnDOT condition reporting system includes a mechanism for users to select "other road" and manually enter an event to describe conditions on local (non-MnDOT roads). This process is not straightforward or easy, but there are examples of it that have occurred, and the reports appear on the MN511 website. It is also unknown if mapping/navigation companies are able to process this information.

The existing (or upgraded) condition reporting system would be used by local agencies for local road and bridge closure reporting. There would not be entry of driving conditions or other events that do not close roads or bridges. The functions of MnDOT's condition reporting system specific to Option #1 include:

- Allow manual entry of road/bridge closures on local roads (as demonstrated by the MnDOT condition reporting system vendor during a project webinar on March 30, 2023) through the current interface or through a separate local entry interface.
- Operate a module of the condition reporting system that functions as an ingest to pull in closure reports exported by local agency GIS. A collaborative model for the data exchange could be built or modeled after existing outputs.
- Dissemination of local road/bridge closures using the existing MnDOT internet data feed.

The current funding identified for this option does not include modifications to the MnDOT traveler information website to display local road closures. This is a possible addition in the future. Considerations for this would be whether a separate tab/page on 511mn.org should be created to display the local road events and to clarify to website visitors that not all closures on cities and county roads are included.

The current budget identified also does not include dissemination of the local road closures on the 511 phone system or mobile application, but are possible options for future consideration.

Contracting, Funding, and Estimated Costs

The following describes an approach for proposed contracting, proposed funding, and estimated costs for this approach.

- **Proposed contracting approach.** The proposed concept is that the existing MnDOT contract for the condition reporting system operations and additions be utilized for any efforts to perform system changes to accommodate local agency participation and for any additional operations/hosting costs.
- **Proposed funding approach.** The LRRB project would recommend consideration of LRRB or State Aid funding and support to initiate the project and fund additional expenses incurred by the MnDOT Transportation Systems Management and Operations (TSMO) Office.
- **Estimated costs.** While MnDOT would need to receive a cost estimate and negotiate with the current or future vendor(s), preliminary cost estimates are summarized in Table 3.1.

Table 3.1 Estimated Costs of Implementation

Cost Item	Estimated Cost
Deployment of existing reporting system to support local entry	$50,000-100,000
Development and deployment of ingest of local road GIS reports	$25,000-$50,000
Ongoing Operations	$50,000-$75,000/year

Estimated Benefits of this Approach

The following are the estimated benefits of this proposed approach:

- **Minimize deployment costs.** By adapting and using the existing system there are expected cost savings when compared to procuring or developing a new standalone system.
- **Minimize deployment time.** Using the existing MnDOT contract (and any future MnDOT contracts for the statewide reporting system) would eliminate the need for the procurement process, and instead only require negotiations with the current vendor for adaptations to the current system and completion of any required additions.
- **One common system.** In the event that MnDOT eventually decides to include closures or other events on local roads in the information disseminated to Minnesota travelers, avoiding a standalone system will streamline these eventual changes.

Potential Drawbacks to this Approach

Potential drawbacks to this proposed approach:

- Using the existing MnDOT contract, there would only be one request for a cost proposal and no option for cost comparisons from other vendors. This drawback would be minimized in future years when MnDOT conducts a procurement process to recompete their system.
- Option #1 is only possible with MnDOT agreement.

Timeline for Development

It is estimated that deployment could occur within 6-12 months.

Conceptual Architectures for Implementation:

The following three options were discussed for integrating local closures into the existing MnDOT reporting system to minimize impacts on existing MnDOT users:

- *Conceptual Option 1a: Local Entry into Existing System and GIS Ingest.* The existing system would be used by local agencies and modified to ingest reports from local agency GIS. See Figure 3.2.

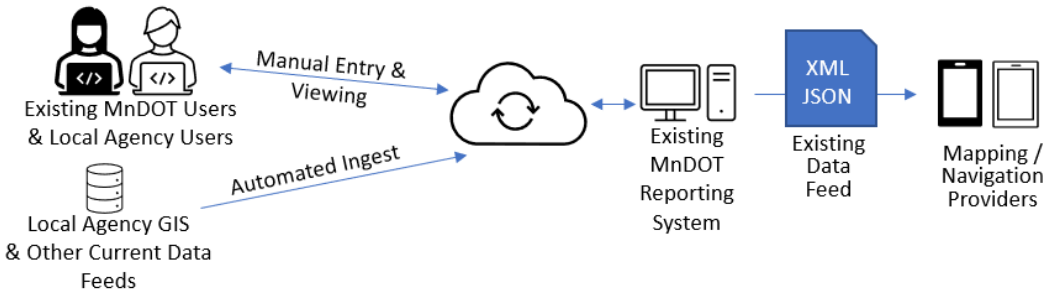

Figure 3.2 Option #1a: Local Entry into Existing Reporting System and GIS Ingest

- *Conceptual Option #1b: Separation of MnDOT and Local Closures Using a Local Module.* In Option #1b, a "Local Road" module of the MnDOT reporting system would be deployed and used by local agencies. This local module could operate a data feed with only local road closures reported. See Figure 3.3.

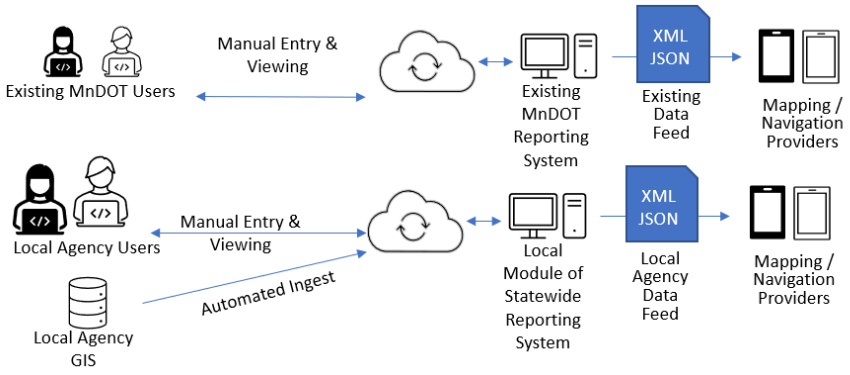

Figure 3.3 Option #1b: Separation of MnDOT and Local Closures Using a Local Module

- *Conceptual Option #1c: Local Module Relying on Existing Data Feed.* Option #1c is the same as Option 1b except that events in the local module would be ingested into the statewide system and the existing data feed. See Figure 3.4**.**

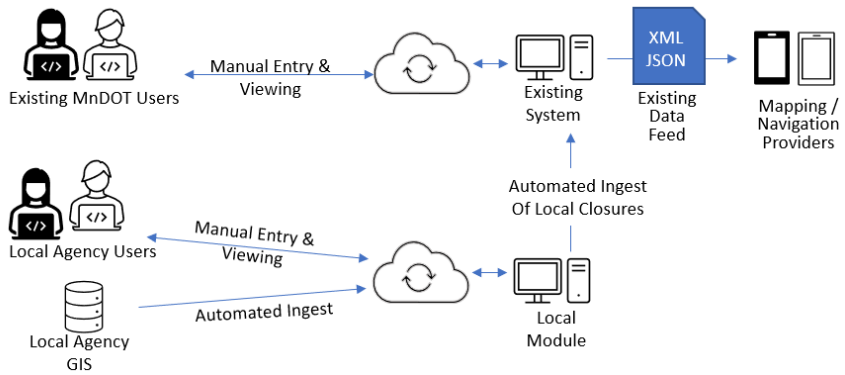

Figure 3.4 Option #1c: Local Module Relying on Existing System's Data Feed

3.2 Risk Assessment and Mitigation

The LRRB TAP reached out to the MnDOT RTMC staff to discuss the option of partnering with MnDOT for local road use of the existing statewide reporting system. During initial discussions with MnDOT staff, several risks were identified. The risk assessment table below summarizes these risks, rates them (i.e., high, medium, low), and describes a response and/or mitigation approach that was discussed with MnDOT on the June 9, 2023, webinar. After discussion, all risks and concerns were rated as low.

Table 3.2 Risk Assessment and Mitigation

Context: An LRRB partnership with MnDOT to enable local road closures in MnDOT's statewide reporting system would be a streamlined and efficient option for accomplishing the goals of this project. However, MnDOT expressed concerns and potential risks of this solution, addressed below.			
Risk/Concern Description	**Risk Rating**	**Risk Response and/or Mitigation**	**Post Response Risk Rating**
1. Increased MnDOT duties of administering additional user accounts, training, responding to 'help' requests, etc.	Medium	Local agencies would not ask MnDOT to perform any account administration, or user support. If a central role is required for local agency account administration, LRRB would seek support from State Aid to fund this position.	Low
2. MnDOT-entered closures, events, and condition reports are displayed on 511mn.org, the 511mn mobile application, and 511 phone system. Since not all counties and cities would be reporting, displays to the public could be confusing (i.e., travelers may perceive no entries as all roads open when the county is not participating).	High	**Mitigation 2A: Solely Third-Party Providers.** Local road closures would solely be disseminated on the internet data feed, not displayed on MnDOT's website, phone system, or mobile application. **Mitigation 2B: Public Dissemination.** The MN511 website could be modified to remove any misunderstandings related to local closures. For example, a separate page for local reports could be used. The counties not reporting closures could be grayed out. Final details to be defined later.	Low

Context: An LRRB partnership with MnDOT to enable local road closures in MnDOT's statewide reporting system would be a streamlined and efficient option for accomplishing the goals of this project. However, MnDOT expressed concerns and potential risks of this solution, addressed below.			
Risk/Concern Description	**Risk Rating**	**Risk Response and/or Mitigation**	**Post Response Risk Rating**
3. The MnDOT Traveler Information Coordinator performs quality control of MnDOT staff entries and does not have resources to perform quality control for entries made by counties or cities.	Medium	Local agencies would not ask MnDOT to perform any quality control. A series of "Guidelines and Expectations" were prepared and agreed between MnDOT and LRRB to include that quality control will be the responsibility of individual local agencies. See Section 3.3. Additionally, the intended use by local agencies is solely for road closures. By not including reports of driving conditions, delays, special events, etc. there is less quality control needed over local agency entries. Also, assigning local closure reports to a separate layer or graying out local events could reduce confusion by MnDOT staff.	Low
4. The entry of local closures may impact current MnDOT users, causing confusion as they perform entry.	Medium	A potential approach was discussed where a mirror application of the statewide entry tool could be operated for local road entry. Similarly, layering could be used as a way to ensure that MnDOT staff who enter into the statewide entry tool are not distracted or confused by local events.	Low
5. There will be increased costs with new functionality to support local entry. Current funding for the statewide reporting system would not be sufficient to cover this and the funding source may not be applicable to use for local roads.	High	The description of this option is recommending that the MnDOT LRRB and/or State Aid consider funding any costs incurred for modifications, additions, and increased operations costs based on the changes needed to the MnDOT system.	Low

3.3 Guidelines and Expectations for Local Road Closure Reporting in the MnDOT Road Condition Reporting System

The following table includes a series of guidelines and expectations for local agencies participating in reporting road closures through the MnDOT statewide reporting system. These guidelines and expectations were developed between MnDOT and the LRRB TAP to document clear expectations for local road closure reporting in the MnDOT road condition reporting system.

Table 3.3 Local Agencies Expectations and Guidelines

#	Title	Guideline / Expectation
1	Participation	The use of MnDOT's statewide reporting system would be available to any county or city wishing to report road closures. The expectations are that not every county and city in Minnesota will report closures into the system but that participation will increase gradually. No agencies will be forced to participate. If the number of counties and cities reporting reaches a level where the MnDOT reporting system operations are negatively impacted, MnDOT and LRRB may re-evaluate this overall approach.
2	Comprehensive Reporting	It is expected that those cities and counties that do report closures in the system will report all road closures in their jurisdiction that are expected to last longer than 4 hours.
3	Timeliness of Reporting	It is expected that all local road closure reports will either be manually entered into the MnDOT reporting system or published by the local agency GIS output within 1 hour of when the closure occurs. Closures may be entered prior to the closure by indicating the expected start date/time.
4	Timeliness of manual report updates	Local agency events entered into the reporting system or published by local agency GIS must accurately match the closure status of the road. It is expected that: • Closures that end earlier than the time/date entered in the event report will be removed from the reporting system within 1 hour of the closure ending and the road reopening; • Closures that extend longer than the expiration date/time entered into the reporting system will be updated prior to the system event expiring or if the event does expire a new closure report will be created.

#	Title	Guideline / Expectation
5	Minimum data content – local agency feeds	It is expected that all road closures published for ingest by the MnDOT condition reporting system will include minimum data required for the MnDOT reporting system to generate standards-based event reports including: key phrase describing the closure (e.g., “Closed”, “Bridge closed”), name of road that is closed, name of intersecting road where closure begins, name of intersecting road where closure ends, latitude/longitude of start and end of closure, date/time when closure begins, date/time closure is expected to end, direction of travel (if only one direction is closed), and contact name and email address for the closure.
6	Local agency data feed format	It is expected that local agencies publishing closure reports from their GIS (or other) system will follow a format defined by the MnDOT vendor operating the reporting system.
7	Quality Control	It is expected that local agencies take responsibility for checking road closures that are either entered manually or ingested from local agency GIS systems to ensure the reports for their jurisdiction are accurate.
8	Training	It is expected that local agencies using the manual entry portion of the MnDOT reporting system maintain at least one staff member who is familiar with the system and can train others on how to enter, update, and remove closure reports.

Chapter 4: User Guide to Report Local Road Closures to Third-Party Companies

This chapter includes immediate guidance for local agencies to submit local closures to the following established mapping and navigation providers:

- TomTom
- Waze
- HERE
- Google
- Apple

Three different methods were identified for submitting road and bridge closures. The details for submitting each method of request are included in Appendix E.

- **Method #1: Email Request to Each Mapping Company** (See Table E-1)
  - All 5 companies include an option to email details of a closure request.
  - The content request is the same for each mapping company, therefore, one email can be created and sent to email addresses of all mapping providers.
- **Method #2: Use Mapping Companies' Online Tools** (See Table E-2)
  - Waze, HERE, and TomTom provide an online tool for agencies to manually update details of a closure request.
  - A signed partnership is needed for the Waze entry tool, and an account is needed for the HERE and TomTom entry tools.
- **Method #3: Automated Entry Using an API or XML Feed** (See Table E-3)
  - Waze, HERE, and TomTom provide an option for agencies to notify them of an automated feed that includes closures.

The information gathered for this project came from an online review of each of the five mapping/navigation providers websites, input from the LRRB TAP assigned to this project and from the following related resource: ENTERPRISE Pooled Fund Study: Establishing a Framework for Communicating Map Updates to Mapping Companies (Roelofs & Preisen, 2022). This resource details a framework for DOTs to use as they provide map updates to select mapping/navigation companies. The steps DOTs follow are similar, but because details vary bey each mapping/navigation company, a separate framework was developed for each company.

Regardless of the method used to submit closures to mapping companies, the following information will be needed:

- The street name(s) of the road closure;
- Intersecting street where each closure begins and ends;
- Start date/time for each road closure;
- End date/time for each road closure;

- Identify if the entire road is closed or just one direction of travel; and
- Contact information (name, email address, phone of the person in your agency the mapping company should contact if additional clarification is needed).

The only mapping company with a stated requirement for the format of data received is Waze. Waze requires the information to be submitted in a spreadsheet.

The duration of the closure is indicated by the end date/time. If the closure period extends beyond the original date/time, a follow-up email to reset the closure end date/time is required, or if using the on-line tool, the original event must be removed and a new event created. Similarly, if the closure ends earlier than reported, a follow-up email to remove the closure is required, or if using the on-line tool, the event must be manually removed when the closure ends.

Chapter 5: Conclusions and Next Steps

This project provided the Minnesota LRRB with a preferred option (partner with MnDOT to adapt and use the statewide condition reporting system) and supporting documentation for moving forward with implementing a road closure reporting system as well as a guide for local agencies to immediately provide road closures to selected third-party mapping/navigation providers. Potential next steps include:

- **Step 1: Report distribution.**
  In Step 1, the Minnesota LRRB will post this report to the LRRB website and notify LRRB members of the report content and suggest distribution of the report to those in their agencies who may be interested in either (or both) of the following:
    - The selected approach to implement a user-friendly road closure reporting system for local agencies.
    - The user guide that describes how local agencies can immediately inform mapping and navigation companies of road closures.

  LRRB may also request that the report be distributed to the Minnesota County Engineers Association (MCEA) and the City Engineers Association of Minnesota (CEAM). This will provide local agencies with an interim method for alerting mapping/navigation companies of road closures while the process for implementing a road closure reporting system is considered and potentially planned, funded, and deployed. This will also inform cities and counties of the process conducted to identify and select an approach to implement a local road closure system in Minnesota.

- **Step 2: Outreach to MnDOT, local Cities and local counties**
  In Step 2, it is suggested that LRRB present the results of this project to MnDOT including RTMC and State Aid staff to alleviate any additional concerns regarding partnering with LRRB on this effort. LRRB may also request to present at an upcoming MCEA and CEAM event to share the project results and receive input on collaborating on a local closure reporting system. Local cities and counties would then communicate to MnDOT State Aid on their interest and priority in pursuing the selected option for implementing a local road closure reporting system.

- **Step 3: Consider Follow-On Activities**
  LRRB may also consider follow-on activities that may assist in decisions about funding and pursuing implementation of the recommended approach. The following options may be considered:

    - *Survey to understand local agency interest.* LRRB may consider a follow-on research project to survey Minnesota local governments regarding their interest in (and possible commitment to) using a local road closure reporting system, if implemented.

    - *Pilot Deployment of Manual Entry into MNDOT Condition Reporting System.* LRRB and MnDOT may consider identifying a limited pilot deployment where counties in the Twin

Cities metro area enter events using MnDOT's condition reporting system to demonstrate the process and benefits before exploring statewide deployment.

- *Pilot Deployment of Automated Ingest of Closures.* LRRB and MnDOT may consider a pilot deployment where the MnDOT condition reporting system is modified to ingest road closure reports exported by GIS systems in one or more metro area counties. Once ingested, these closure reports could be shared through the MnDOT internet data feed.

- **Step 4: Confirm MnDOT agreement on partnering with LRRB for a local road reporting system.** In Step 3, the LRRB TAP for this project may continue to meet with MnDOT RTMC staff and State Aid to continue the discussions initiated in this project for partnering on a local road closure entry through MnDOT's condition reporting system. This would also include sharing input gathered through outreach with the local cities and counties conducted in Step 2. At the conclusion of this step, the goal will be to reach a "go/no go" decision on proceeding with the recommended approach and, if appropriate, the formation of a formal agreement on partnering.

- **Step 5: Collaborate with MnDOT to determine LRRB and/or MnDOT State Aid funding requirements and opportunities.**
  The LRRB TAP and MnDOT will continue to meet to identify the funding options, process, and requirements to move forward with funding to partner on a local road closure entry through MnDOT's condition reporting system. This will include finalizing costs for the following:
  - Deployment of MnDOT's existing reporting system to support local entry
  - Development and deployment of ingest of local road GIS reports
  - Ongoing operations

- **Step 6: Participate with MnDOT to launch and begin using tools.**
  Once an agreement is established and a funding plan determined, the LRRB TAP will coordinate with MnDOT to provide input to development and implementation and then begin using the system to enter local road closures. This could be an iterative process to ensure that the final reporting system meets expectations of both the LRRB TAP and MnDOT.

- **Step 7: Evaluate local road closure reporting.**
  The final step would be to evaluate (as funding is available) the local road closure system. This would include documenting the implementation and funding process. Other items documented could include number of entries, quality control, local agency use, benefits, drawbacks, and any overall lessons learned.

References

Linsenmayer, M. (2020). *TRS Notifying the Public of Local Road Closures Using Smartphone Map Applications*. St. Paul, MN: MnDOT Local Road Research Board. https://mdl.mndot.gov/items/TRS2001

Roelofs, T., & Preisen. L. (2022). *Establishing a Framework for Communicating Map Updates to Mapping Companies* (ENTERPRISE pooled fund study). Lansing, MI: Michigan Department of Transportation. https://enterprise.prog.org/wp-content/uploads/ENT-DOT-Map-Updates-to-Map-Companies-FR-Jan-2022.pdf

Appendix A
Summary of User Needs

Summary of User Needs

The local agency user needs for road closures are presented in the following categories from the perspective of local Minnesota agencies.

- Communicating Closures (Needs 1-3) – See Table A.1
- Entry of Closures (Needs 4-16) – See Table A.2
- Updating and Expiring Closures (Needs 17-18) – See Table A.3
- Coverage, Accuracy and Quality of Reports (Needs 19-21) – See Table A.4
- Training and User Support (Needs 22-23) – See Table A.5

Table A.1 Communicating Closures: Challenges and Corresponding Local Agency User Needs

Coverage, Accuracy and Quality of Repo	Local Agency User Need
As local agencies plan for and close bridges and roads, this information may be communicated internally or to a project website. In some situations, a city or county may contact a navigation company to alert them of a closure. However, this is not currently performed city- or county-wide and typically closure information is not communicated to mapping and navigation companies by local agencies.	***Need #1***: A primary need is for local agencies to have a mechanism or system to support the communication of local road and bridge closures to mapping companies and navigation providers.
The Minnesota Department of Transportation (MnDOT) maintains and operates a statewide traveler information website for state maintained and operated roads. Local traveler information is not provided. Local agencies may have a public facing app or website for their county or city to provide road closure information. However, usage is low because this information is county or city specific and not statewide.	***Need #2:*** Local agencies have a secondary need to Need #1 to have the ability to communicate local road and bridge closures directly to the public (e.g., local website).

Cities and counties close roads and bridges throughout the year, however it is unknown in certain situations if a closure may impact a bordering city or county.	***Need #3***: Local agencies have a secondary need to Need #1 to have the ability to view current and planned closures in neighboring counties and cities in order to coordinate projects including detours.

Table A.2 Entry of Closures: Challenges and Corresponding Local Agency User Needs

Challenges	Local Agency User Need
The technology available and utilized by city and county staff varies among Minnesota local agencies. Not all local agencies have geographic information system (GIS) capable of supporting direct GIS exports of road and bridge closures.	***Need #4***: Local agencies need the option to enter road and bridge closures manually from an internet accessible tool.
City and county staff may enter information from the office or in the field.	***Need #5:*** Local agencies need a mechanism to provide local and bridge closure details through a mobile application.
Many local agencies in Minnesota operate a GIS and enter local road and bridge closures into the system. If another system is used where staff are asked to duplicate entry of closures, the second system may receive lower priority and closures may not be entered in the secondary system.	***Need #6:*** Local agencies need a mechanism for road and bridge closures entered into their GIS to reach the public and mapping/navigation companies without requiring dual entry.
Some project work is completed across local agencies' boundaries which involves coordination among bordering agencies.	***Need #8:*** Local agencies need the ability to enter closure details for work that is being completed across local boundaries.
City and county agencies gather details on closure information, however consistent content for entering the	***Need #9:*** Local agencies need a mechanism to identify the street name of all road or bridge closures.

information is critical to providing mapping and navigation companies with the needed information.	***Need #10:*** Local agencies need a mechanism to identify the intersecting street where each closure begins. ***Need #11:*** Local agencies need a mechanism to identify the intersecting street where each closure ends. ***Need #12:*** Local agencies need a mechanism to provide the start and end date/time for each road closure. ***Need #13:*** Local agencies need a mechanism to indicate if the whole road is closed or just one direction for each road closure. ***Need #14:*** Local agencies need a mechanism to provide an email or phone number of a local contact for each road closure. ***Need #15:*** Local agencies need a mechanism to describe detour routes when needed.
There is additional information that local agencies may want to share during a closure, however this detail is not intended for public viewing, but for other local staff to access.	***Need #16:*** Local agencies need the ability to share non-public additional closure details among local agencies.

Table A.3 Updating and Expiring Closures: Challenges and Corresponding Local Agency User Needs

Challenges	Local Agency User Need
Closure information that is inaccurate may lead to mistrust with the public.	***Need #17:*** Local agencies need to create closures with a planned expiration date. ***Need #18:*** Local agencies need the ability to update current events, including: - Expiring closures early (if roads reopen early); - Extending the expiry time (if closures extend longer than planned).

Table A.4 Coverage, Accuracy, and Quality of Reports: Challenges and Corresponding Local Agency User Needs

Challenges	Local Agency User Need
Initial participation from all local agencies is challenging.	***Need #19:*** The display of local road closures in Minnesota needs a mechanism to inform viewers that not all counties and cities are reporting local roads, allowing the system to operate with one or more county or city entering conditions. ***Need #20:*** Local agencies need a road and bridge closure system that is expandable to additional Minnesota cities and counties.
Accurate closure information is key for the public to deem it reliable.	***Need #21:*** Local agencies need a role in quality control to ensure closure reports are as accurate as possible.

Table A.5 Training and User Support: Challenges and Corresponding Local Agency User Needs

Challenges	Local Agency User Need
Training is critical for staff to consistently use a road and bridge closure system. Support is also critical as users may go months without entering a closure and forget their password.	***Need #22:*** Local agencies need a sustainable approach to perform training on a road and bridge closure system that is created. ***Need #23:*** Local agencies need a centralized system for user support on a road and bridge closure system.

Appendix B
Use Cases

Use Cases

Three use cases for how a local road closure system could be used for the following are summarized and described in Table B.1.

- Use Case #1: Geographic Information System (GIS) Exchange of a Planned County Road Closure to Waze (and potentially other mapping companies)
- Use Case #2: GIS Exchange of a Planned County Road Closure to a Minnesota Statewide System.
- Use Case #3: Manual Entry of a Planned County Road Closure into a Local Road Entry System

Table B.1 Road and Bridge Closure System Potential Use Cases

Use Case	How could a local road and bridge closure system be used?
Use Case #1 GIS Exchange of a Planned County Road Closure to Waze (and potentially other mapping companies)	A Minnesota county that regularly enters planned closures into their GIS is planning a bridge or road closure. • Staff enter the description of the closure into their local GIS system (including minimum data requirements). • A geodatabase model is used by the county that is recognized by Waze and the county (or a statewide GIS aggregator) has a database sharing relationship with Waze through a signed partnership with Waze for Cities. • Closure updates are entered within a few minutes to Waze. • As the planned closure concludes, the county updates their GIS entry and removes the closure. The database sharing with Waze ensures that the closure is removed from the Waze system within a few minutes after removal from the local system.
Use Case #2 GIS Exchange of a Planned County Road Closure to a Minnesota Statewide System	A Minnesota county that regularly enters planned closures into their GIS is planning a bridge or road closure. • Staff enter the description of the closure into their local GIS system (including minimum data requirements). • A common geodatabase model is used by all participating counties in Minnesota. This enables sharing of the closure report without further actions to the Minnesota Statewide System. A synchronization process is implemented where the closure reaches the Minnesota Statewide System in a reasonable timeframe. • The Minnesota Statewide System includes this closure report in the Extensible Markup Language (XML) feed accessed by mapping and navigation companies.

Use Case	How could a local road and bridge closure system be used?
	• The Minnesota Statewide System may or may not include the display of the closures to other users of the Minnesota Department of Transportation (MnDOT) statewide system or to visitors to the 511mn.org system (based on the number of counties participating). • As the planned closure concludes, the county updates their GIS entry to remove the closure. This synchronizes the systems and the closure is removed from the Minnesota Statewide System.
Use Case #3 Manual Entry of a Planned County Road Closure into a local road entry system	In Use Case #3, either the county does not have a GIS system compatible to interface to Waze directly or to a Minnesota Statewide GIS System. In this use case, local counties have collaborated to create a new system or procure the services of an existing product or service that serves as a statewide entry system for county and city road closures. • Staff at the county login to the system to enter the closure information, setting a planned expiration time of the closure. • If the closure extends beyond the planned expiration date/time, the staff will need to update the event. • As the closure is removed, staff log in to remove the closure (or to ensure that it automatically was removed as planned). • In this use case example, the closure exists in the system, with an XML interface for mapping companies to access. • There may or may not be an exchange with the Minnesota Statewide System to share the closures to the system. • Support for the local county staff (e.g., forgotten passwords, new users, training, etc.) would need to be the responsibility of a collaboration of counties and cities.

Appendix C
Interview Questions and Summaries

Interview Questions

Table C.1 Interview Questions

BACKGROUND
1. What was the reason(s) for local agencies having a mechanism to provide local road reports?
2. What type of system was developed (e.g., standalone system)?
3. Were any other options considered (e.g., ingesting event directly from local agency geographic information system (GIS))?
4. Who developed the system?
5. What on-line mapping source is used?
6. Who initially funded the system?
7. Which agency continues to fund and manage the system?
8. How long did it take to deploy the system?
9. How long has the system been operational?
10. Will the system continue?
11. Are there any agreements in place?
LOCAL PARTICIPATION
12. How many local agencies participate?
13. Was participation in stages (e.g., county by county) or all agencies at once?
14. Were local agencies interested in participating?
15. How were local agencies engaged?
16. Are there any issues if one county participates and one county doesn't? Please describe.
EVENT ENTRY, UPDATES, AND REMOVAL
17. What events are entered by local agencies (e.g., closures, road conditions)?
18. Is detour information provided? If so, is the detour entered in free text or is a detour drawn?
19. Are there any local routes that information is not provided on?
20. Are future planned events entered?
21. Describe how events are entered (e.g., field staff through a mobile app)?
22. What content is included in the entries?
23. If applicable, how are events manually entered (e.g., free text, menu, linear referencing system)?
24. If applicable, what content is included in GIS entries?
25. How are events updated?
26. How are events removed (e.g., timeout)?
27. How often are entries added (e.g., real time, once a week, as needed)? Are there any parameters with entry (e.g., duration)?
28. Describe the users' experience (good and bad) with maps, selection of a location, and the drawing geometry.
QUALITY CONTROL
29. Do local events go through a quality control process? Please describe.
30. How are agencies encouraged to enter and update in a timely manner?

31. If an agency isn't participating, is it noted anywhere (e.g., county closures not entered)?
USE
32. How is the information provided by local agencies used (e.g., State DOT uses to plan maintenance, planning detours for construction projects, coordinating with neighboring counties)?
33. If applicable, is GIS information shared into a statewide system or other GIS system?
DISPLAY
34. Where is the local information displayed?
35. Are there any mechanisms to receive alerts (e.g., email notification) for a selected area?
FORMAT
36. What data format or standard is used?
37. Is information entered by locals only entered into one system?
38. How is the information entered by locals available (e.g., separate application programming interface (API))?
39. Do you have information about who uses the data (e.g., Waze) and what data is used (e.g., local data, just interstates)?
40. If your entry and sharing is through your GIS, can we get a copy of your Geodatabase model (or information about it)?
TOOL ADMINISTRATION
41. Is there one statewide administrator? Or do each county/city administer?
42. Who is contacted if a password is forgotten?
TRAINING
43. Who is responsible for training staff?
44. What are some training challenges and approaches?
OTHER
45. If applicable, has your State Department of Transportation (DOT) considered integrating the data into their traveler information system?
46. Please describe any overall lessons learned.
47. Is there anything additional you would like to note as Minnesota local agencies consider an application for reporting bridge and road closures?

Oregon Department of Transportation (ODOT) TripCheck

Table C.2 ODOT TripCheck Interview Summary

Interview Date	• March 22, 2023
Interview Participants	• Brent Atkinson, ODOT • Abby Smith, ODOT • Jeremy Morris, Klamath County
Description	• ODOT's statewide traveler information system is called TripCheck that allows web visitors and 511 phone callers to access information about closures, delays, restrictions, and driving conditions. The primary sources of road condition reports on TripCheck is the TripCheck entry system owned and operated by ODOT, where state DOT staff enter reports that include: driving conditions, commercial vehicle restrictions, delays, closures. • In order to add local content to the TripCheck website, ODOT created a system called TripCheck Local Entry (TLE), that launched in 2019. • Trip Check Website: https://tripcheck.com/
Background	• ODOT first started researching the need for and intended uses of a local entry system in 2006. An initial system was created but was not fully embraced by users. ODOT decided to rebuild the system using current tools (e.g., Google Maps) and a new system was developed by Oregon State University.
Mapping and Road Nomenclature	• Google Maps is the online mapping source used. Users can enter text descriptions of the locations along roads and also rely on Google Maps addressing and road identifiers. • TLE entered events are published on an ODOT operated application programming interface (API). ODOT is aware that third-parties are pulling the API feed, however it is unknown which companies are utilizing the local Trip Check entry API. The feed is standard JavaScript Object Notation (JSON) or Extensible Markup Language (XML). However, Waze ingests events from the API for both the TripCheck events on state operated highways and the TLE entered events on local roads. • ODOT also has a partnership and program in place where ODOT ingests events entered into Waze for display on state and local roads. • The local agencies that use the TLE entry tool are able to use it on mobile devices. There are no plans to develop an application for TLE. • Information entered by local agencies is displayed on the ODOT Trip Check statewide map. • ODOT also has a dedicated Waze feed. However, going forward it is important there is not a separate feed for each partner due to maintenance challenges.
Tool Administration	• There is one administrator assigned within each agency that approves users and accounts. ODOT uses open authorization (OAuth) to approve members and allow members to self-establish login credentials and passwords. OAuth allows users to recreate passwords if forgotten and therefore no

	administration of passwords is required (beyond approving users). ODOT does not have to manage local agency accounts.
Quality Control	• ODOT has staff assigned to monitor events in TripCheck. As TLE entered events reach TripCheck, these staff can also review the local events and could remove or edit events using TLE. ODOT noted that this would not be as easy if the system were ingesting a GIS feed. • ODOT did not cite any major issues with TLE. The most significant is that some events may remain active in the system beyond the period that the event or closure is occurring.
Allowed Content	• Local municipalities can use TLE to enter construction, road conditions, closures, weather hazards, and other events in TripCheck.
Funding	• Originally TLE was funded in part by the Metropolitan Planning Organization (MPO), however ongoing maintenance and support is from ODOT, not the local agencies.
Local Participation	• Initially there were 29 users and now there are 53 organizations with access to enter information into TLE. This includes cities, counties, forest service, and in one instance a private sector company that performs contracted work on local sewers and has the need and authority to close roads. • There are currently 175 users from local organizations. • Local sheriffs also have access to assist in identifying roads that are inaccessible in the winter where they can't rescue stranded motorists. • Using the system is not forced on local agencies, however those that use it continue to advocate for it.
Entry	• The TLE system was designed for easy entry of events, recognizing that users may only enter events periodically (i.e., not every day) and therefore the system was designed for ease of use. A user can login in, drag an icon to the location of the event, then specify the exact details of the location. • TLE allows entry of multiple types of events and is not limited to just closures. Entry involves selection from pre-defined phrases describing the event (e.g., closure, crash, hazard, construction, weather) and there is an option to write in additional details (e.g., both lanes impacted). Feedback from users is that it takes less time to enter an event than to develop a press release. • Local agencies often still issue press releases for major events or closures; however, mapping and navigation companies are more likely to pull events from TLE through ODOT API's (that includes a dedicated API for TLE entered events). A future feature would be including a link to the press release from the event entered in TLE and displayed on TripCheck. • There has been discussion to integrate an automated ingest of events from local agency GIS into TLE, but this is complex and expensive. ODOT noted that counties that enter their events into GIS are less likely to use TLE for event entry. For example, Multnomah County (where Portland, Oregon is located) does not enter into TLE because they enter events into their local GIS and TLE entry would be duplicate entry.

	• ODOT noted that TLE was designed with the intent that public information officers and/or public affairs staff would perform entry. As it turns out, it is common for engineers to do the entry into TLE, and a system that includes GIS ingest would have allowed more events to be included.

Use	• There have been 3,000 events entered since the local agency rollout of TripCheck in 2019. There is continued active use.
	• Klamath County participated in the best practices interview and shared the following specifics about their use of TLE:
	  ○ Klamath County noted the TripCheck tool is great for traffic control, but also for projects such as when a fiber optic line is being installed. The event can be entered with a start and end date. A reminder is then sent in advance of the expiration date as a reminder to extend or let it run out. However, one challenge is the reminder is only set to the individual that created the event. If they are out of the office, it can be an issue. A future enhancement would be to allow others to receive the alert.
	  ○ Klamath County has entered information on mountain pass roads when weather hazards are impacting travel. The additional information has helped inform truck drivers to avoid these routes.
	  ○ Klamath County does use GIS for asset management that includes 1,000 centerline miles and 200 bridges. It is not used to publish information about closures. They use TLE for sharing information about temporary events and closures.
	  ○ TLE can be used to see existing and future events. However, a user in one county is not able to see future events entered in neighboring counties. A future enhancement could include the ability to see a neighboring counties events but not be able to edit.

Iowa County 511

Table C.3 Iowa County 511 Interview Summary

Interview Date	• March 27, 2023
Interview Participants	• Danny Waid, Iowa County Engineers Association (ICEA) Service Bureau • Brian Moore, ICEA Service Bureau • Bob Gray, ICEA Service Bureau
Description	• The ICEA developed a standalone system (Iowa County 511) for local agencies to enter information and provide details on road closures. ICEA was established in 1988 as a service bureau to serve all 99 county engineers and counties in the state of Iowa. ICEA support includes assisting counties with technology and creating web-based applications as needs arise. • County 511 Map Website: https://www.iowacountyroads.org/connections#county-511-map • Public Road Notifications Map: https://www.iceasb.org/roads/ • The URL pattern is /county/<name>/FeatureServer where <name> is “all” for all counties or the name of the county lower case such as “buchanan” or “black-hawk”.
Background	• In 2006, Iowa county engineers were interested in tracking road closures, notifications, and if a detour was associated with the closure. An initial system was developed by ICEA to support this request. The application was then redone in 2017. • As technology requests have increased over the years, ICEA builds and supports applications in-house. Previously contracts were established to complete projects, however there were challenges with end products not completely meeting the needs of the counties.
Mapping and Road Nomenclature	• The information entered by Iowa counties is displayed on the County 511 map. • Iowa DOT’s 511 website provides a link to the County 511 map. There have been discussions with Iowa DOT to ingest the county data for display on the statewide traveler information map, however there are concerns with the holes in the dataset provided by the counties since not all counties enter information. • Google Maps was used for developing interactive maps. ICEA also has a GIS server for generating map tiles that are pulled from the Iowa DOT. • ICEA published the Information in an ArcGIS format. Some Iowa counties pull that information and maybe some cities. Typically, a county reaches out and ICEA provides the Uniform Resource Locator (URL).
Tool Administration	• ICEA supports all apps they build; this includes administering the County 511 website.

	• Each Iowa DOT county can identify their own administrator for the Iowa County 511 system. The administrator can add, manage users, and reset passwords.
Quality Control	• A disclaimer is noted on the Iowa County 511 website: *Information available here may not include all issues affecting travel on Iowa's county roads. Each county chooses what information to make available. All information is subject to change without notice.* The disclaimer helps users understand that not all local information is entered. • ICEA provides support or trains staff if needed. However, ICEA leaves it up to each county to ensure the information displays correctly.
Allowed Content	• The Iowa County 511 Map provides active county road restrictions due to projects, maintenance work, embargos, and emergencies, along with detour routes.
Funding	• It took approximately 700 hours to complete the County 511 Map by ICEA with a $50,000 development cost. ICEA continues to maintain and operate the County 511 Map for the counties.
Local Participation	• Each county in Iowa has access to the County 511 Map, however not all counties enter information. Polk County for example is less likely to enter closures or restrictions because the majority of their county is the city.
Entry	• ICEA provides standard categories of information of what the counties can select for display on the map. • Counties have started to enter restriction information in the last year and half. • Counties can click and draw a detour on the map. • ICEA does not pull from GIS systems. • Planned events are not usually entered into the County 511 Map. If they are entered, the county users can see, but it hard for the public to see. However, this could be a future feature enhancement. • Iowa DOT counties typically communicate with their neighbors outside of using the County 511 Map. However, a county can subscribe to receive alerts for an adjacent county as they come in.
Use	• All counties in Iowa have access to the Iowa County 511 system, however, is up to each county if it is used. • Counties can set up contacts (e.g., sheriff's office, school, emergency personnel) to alert of a closure. The alerts can also be shared via social media mechanisms (e.g., Facebook, Twitter).
Other	• A user can subscribe to receive an email alert when a selected county has entered an event. • TomTom has reached out for information provided by the counties.

North Dakota University (NDSU) Upper Great Plains Transportation Institute (UGPTI): Geographic Roadway Inventory Tool (GRIT)

Table C.4 NDSU GRIT Interview Summary

Interview Date	• March 21, 2023
Interview Participants	• Brad Wentz, NDSU –UGPTI
Description	• The Geographic Roadway Inventory Tool (GRIT) is a standalone asset management program developed initially for county road managers in North Dakota and has since expanded to Minnesota. • GRIT Website: https://www.ugpti.org/resources/grit/
Background	• GRIT was developed to support a 20-year forecasting needs study for the state of North Dakota. • North Dakota counties do not use GIS, therefore the GRIT system needed to be a web-based application that was easy for staff to enter information. • NDSU – UGPTI developed the system and hosts the GRIT system on its own servers.
Mapping and Road Nomenclature	• Google Maps is used as the base map for GRIT. • All data that has been entered into GRIT is located on a server. GIS services created and built web maps and dashboards to show different graphs and provide a real time representation of what is out there. • North Dakota's 511 system does not display the information from GRIT, however in the future it could be added as another layer. However, the DOT does provide a link to road restriction information from GRIT. • JavaScript was the programming language used to develop GRIT. • Currently there is not an XML feed provided of the information in GRIT. Increased participation is needed by the counties before this is considered. • Cass County has their own ArcGIS online. Information is displayed online by adding the service. An XML feed could be created for Cass County. • It is best to create a service so that data is always up-to-date. If data has to be exported, it is only current at that time.
Tool Administration	• UGPTI manages passwords for users. • With staff turnover, videos are provided on how to enter and edit information. Typically, it takes about 20 minutes to figure it out. It is pretty intuitive to use.
Quality Control	• If a user does not update their status, a reminder email is sent. • There is no manual quality control. • County staff that enter information have to select from a list of options.

Allowed Content	• Layers in the tool include an inventory history about the roadway (e.g., when it was built, thickness of pavement, construction planning). Closures are part of the construction planning layer.
Funding	• Funding for building the GRIT application came through the North Dakota legislature through a 20-year forecasting needs study. North Dakota DOT funding supports the continued operations and maintenance of GRIT.
Local Participation	• All counties in North Dakota have data for the 20-year forecasting needs study. However, there are challenges with entering emergency projects (real-time) due to staff personnel. There are two user groups, one for North Dakota and one for Minnesota, that those that enter information into GRIT are invited to meetings to discuss GRIT and suggest new features.
Entry	• Users can enter a 5-year plan or enter emergency projects (e.g., flooded road) for real time use. There is also the ability to draw a detour. • There are challenges if an event goes for a long duration in the summer if it is not updated regularly when the status has changed. • County staff drop a pin on a map where the event starts and stops. Way points can also be added.
Use	• Some counties in North Dakota have staff enter data for the 20-year forecasting study; other counties utilize consultants to enter the data. • Minnesota counties are entering information into GRIT as the number of counties participating increases research and deterioration rates will be identified to determine how long pavements are lasting. These datasets can be beneficial for neighboring counties.

Other	• It was recommended that if Minnesota develops a standalone system, to ensure it produces a GIS service for ease of ingesting data between agencies or third-parties.
	• Minnesota counties can request a username and password to enter information into GRIT at no cost.
	• There is a $1,000 annual fee for Minnesota counties to participate and sign an agreement to receive the following:
	  ○ Participation in a Minnesota User Group to discuss feature enhancements.
	  ○ Unlimited county user accounts
	  ○ Access to a Pavement Performance 10-year Forecasting Dashboard. This information is forecasted based on what data is entered by the county.

Maryland Road Closure Reporter (MCRC)

Table C.5 MRCR Interview Summary

Interview Date	• March 24, 2023
Interview Participants	• Marshall Stevenson, Maryland Department Of Transportation (MDOT) - Consultant • Craig Mackowiak, MDOT State Highway Administration (SHA) • Renee Baumgardner, Harford County, Maryland • Steven Fabijanski, WBCM
Description	• Maryland DOT's active road closure system captures events by local jurisdictions. • MRCR website: https://maryland.maps.arcgis.com/apps/webappviewer/index.html?id=dd8df89e5d604ea4a8f36cf20cd394ec
Background	• A road closure system was developed in Maryland to understand the status in real time as well as to look back at data to understand what happened over time.
Mapping and Road Nomenclature	• When a closure is entered notifications can be sent to different users such as schools. • There is a 2-to-3-minute delay for an entry to show publicly. • Commercial off-the-shelf (COTS) configurable software is used. A customizable application was developed inside COTS for road closures. • There are two secure ArcGIS services for entry. • Maryland is documenting requirements and looking to migrate to a web app builder (Geocortex) to take the system to its next generation. • Maryland DOT is looking into consuming and pushing APIs. • MRCR works on Windows Workflow Foundation. • API is available. All that is needed is the services to pull it in. Local agencies can pull for their own displays.
Tool Administration	• Headless accounts are created for each jurisdiction.
Quality Control	• Local jurisdictions view what they enter to see if it is correctly entered. • There is not an alert provided when an event is coming due. Event expires. However, in Harford County they modified the system, so they are alerted when an event is ending.
Allowed Content	• Active and future road closures are entered into MRCR.

Funding	• MRCR as well as GIS development and planning is funded through State Planning and Research (SPR) funds. There is no cost sharing. • Maryland DOT owns and maintains the system.
Local Participation	• Local participation for entering events in MRCR has grown over time. One third of the state uses the system, few use it routinely. Some jurisdictions only use it if they have an emergency operations center activation.
Entry	• Once an agency is logged in, they are able to only access and enter information for their jurisdiction. • MRCR is a manual entry system and consumes what the locals provide. • Users can enter planned closures and specify the date and time. • There are options to select for the type of closure.
Use	• The system has evolved over time, for example the City of Frederick in Maryland was able to use the data entered in to MRCR for reimbursement from the Federal Emergency Management Agency (FEMA). The system was able to show historically all road closures. All data is archived. • Harford County uses information entered to help dispatch crews. • Counties can develop their own scripts using the map display. However smaller counties may only use the system.
Other	• All data has been stored since its inception. • Maryland DOT is looking at developing a feed for Waze. There have been challenges with information matching the requirements of Waze. • Email closures from MRCR go to the Waze community.

Minnesota Department of Transportation (MnDOT) Statewide Condition Reporting System

Table C.6 MnDOT Statewide Condition Reporting System Interview Summary

Interview Date	• March 22, 2023
Interview Participants	• Marcus Bekele, MnDOT • Garrett Schreiner, MnDOT • Tiffany Dagon, MnDOT • Brian Kary, MnDOT • Kelly Braunig, MnDOT • Todd Fairbanks, MnDOT • Mary Crowe, Castle Rock • Munir Henry, Castle Rock
Description	• Condition Acquisition Reporting System (CARS) is the system used by MnDOT for traveler information. Statewide closures, events, and road conditions are entered by MnDOT staff and through automated reporting (e.g., MnDOT's Maintenance Decision Support System (MDSS)). Castle Rock is the CARS vendor supporting MnDOT. Local information is not included on the map, except for traffic speeds
CARS	• Castle Rock will be updating MnDOT's system to CARS 5 which will make information easier to enter. • The information displayed to the public also goes via an XML feed that was built in conjunction with Waze. Waze is ingesting MnDOT's statewide data. • There is a linear referencing system (LRS) system interaction with MnDOT. LRS is used for state routes, highways, and interstates. • A demonstration of a local entry system that Castle Rock developed for Indiana was shown. The system was built to get roadway information to the public. The entry form includes road, mile marker, and selecting which lane is closed. The format is a Google specification (latitude, long). • If you enter an event in CARS a configurable alert can be sent to remind agencies to update their event if needed or let it time out.
Options for a Road Closure System in Minnesota	• MnDOT's current CARS system could be modified to allow agencies to enter information on local roads. However, there was concern by MnDOT with challenges with managing the system for locals. • A separate system could also be built for local agencies to enter information. MnDOT could have the option to ingest the local information as a layer on their map. The information could be a separate XML feed and a separate website. However, the primary goal is to get the information to mapping and navigation providers. • It is important to attribute who entered the event.

	• It is unclear if Waze would ingest data from a single county without a partnership agreement or if the feed would be accepted under MnDOT's Waze agreement. • MnDOT State Aid could also be a resource for the counties to work with to create a local feed. • The system could also be slowly built out. For example, an initial county could start with providing road closures through the information that is already entered into GIS and then other counties could be added at later dates. • The system would need to allow manual entry as well as GIS ingests to accommodate the counties.

Appendix D
Local Road Closure Entry System Options

Option #2: Develop a Stand-alone Statewide Local Entry Road/Bridge Closures Tool

In Option #2 the Local Road Research Board (LRRB) would take the lead to procure or develop a stand-alone closure reporting system to be used by local counties and cities in Minnesota.

Summary of Option #2

If Option #2 is pursued, LRRB (or a partner Minnesota Department of Transportation (MnDOT) group or local agency) would procure a stand-alone closure entry tool (either a system or software as a service (SaaS)). In this option, a scalable approach would most likely be implemented with one or more counties serving as pilot deployments before expanding to other counties and cities that are interested. The core functionality required of the system would include:

- Allow manual entry of road and bridge closures on local roads throughout Minnesota;
- Operate an automated ingest to pull in closure reports exported by local agency geographic information systems (GIS) (following the current Carver County ArcGIS REST or other standardized format);
- Publication of local road closures on a public Internet data feed (e.g., Extensible Markup Language (XML)/JavaScript Object Notation (JSON)) that adheres to the Waze standard (https://developers.google.com/waze/data-feed/cifs-specification) or the Work Zone Data Exchange (WZDx) specification (https://www.transportation.gov/av/data/wzdx).
- Develop and follow the process to introduce these data access points to mapping navigation providers (e.g., Waze, Google).

Contracting, Funding, and Estimated Cost of Option #2

The following describes an approach for proposed contracting, proposed funding, and estimated costs for Options #2.

- **Proposed contracting approach.** A state or local agency would need to agree to procure the system and administer the contract for operations of the system. Candidate options for contracting would include:
    - Public solicitation process to procure a system/service. The majority of existing products are operated through cloud servers, so the procurement might result in a "software as a service" contract, or a stand-alone software product owned by LRRB.
    - Contracting with a local university through established contracts (i.e., an approach similar to that used in Oregon where Oregon Department of Transportation (ODOT) hired Oregon State University to develop the local reporting system).
- **Proposed funding approach**. The LRRB project would recommend consideration of LRRB or State Aid funding and support to initiate the project and fund operations expenses.
- **Cost considerations.** The costs of implementing a Minnesota local road closure reporting system will vary based on multiple factors, including:

- *Vendor products.* There are a number of vendors with reporting systems that would enable manual entry of local road closures. Pricing is typically not based on effort to create a new software system, but rather, prices set by the vendor are based on their overall investment in their product. Therefore, actual quotes are difficult to predict prior to a procurement process.
- *Scaling product costs to this project.* Examples of sites that procure reporting systems also involved procurement of information dissemination (e.g., phone, web, applications) as well as integration with traffic management systems (TMS). Because Option #2: would solely be a reporting system, vendor pricing may not scale down as much as desired.
- *Varying costs.* Once a vendor product is selected, the costs will typically include deployment, training, operations, and maintenance/upgrades. Vendors approach these differently. There are industry examples of lower deployment cost but higher costs for operations and hosting.
- *New system development.* For Option #2, it is likely that a new system could be created by a university or consultant (as opposed to procuring an existing product). There are two examples of the costs of developing entry systems that were gathered during interviews conducted by this project. However, these costs are only estimates of what LRRB might encounter. Both examples had unique circumstances (i.e., Oregon hired a local university with experience creating software for the Department of Transportation (DOT), and the Iowa example was internal development by the Iowa County Engineers Association (ICEA) based on unique skills of an existing staff member).
- *Mobile application or mobile use of website.* If field entry is important, the options are either to develop a mobile application or have the web-based user interface responsive to phones or mobile devices. Costs would vary based on which approach is selected.
- *Local export of closure reports.* Local agencies wishing to have their locally entered closures ingested would need to implement an output from their GIS (or other system) to make the reports available through internet access and in the format agreed during development. Local costs for this are not estimated below.

- **Estimated costs of Option #2.**
  - Scoping and procurement of system: $50,000
  - System delivery, deployment, launch, testing, training: $200,000 - $300,000 (Based on ODOT experiences with Oregon State University developing software (estimated costs to be $235,000 but leveraged local university knowledge of state information technology (IT) systems). Also, based on ICEA (estimated 700 hours by internal staff, but leveraged existing code and experiences of internal staff). Also considered experiences of other states procuring reporting systems as part of overall traveler information system projects.)
  - Ongoing operations: $25,000 - $75,000/year

Estimated Benefits of Option #2

The following are benefits for developing a stand-alone local entry road/bridge closure tool.

- **Independent system.** An LRRB stand-alone system would enable participating counties and cities to select the vendor/developer they choose and make all decisions about the system.
- **Adaptable to LRRB member needs.** As increasing numbers of counties or cities begin using the system, if additional needs for event reporting are identified (e.g., reporting that does not match the interests of MnDOT), the participating agencies could collectively decide changes or additions to the systems.

Estimated Drawbacks of Option #2:

There are also drawbacks to developing a stand-alone local entry road/bridge closure tool.

- **Costs won't scale to use.** A web-based entry tool is typically capable of large numbers of users simultaneously entering events, as well as automated ingests of large amounts of data from external sources. If the LRRB project procures a system or service and only a few counties are initially participating (with limited closure events) the costs will likely not scale down to the usage. It is most likely that a vendor or developer will charge the same costs regardless of if there are 100 users or 3 users. Therefore, the return on investment would likely be low until multiple counties are participating regularly.
- **Procurement process.** There would most likely need to be the creation of a request for proposals (RFP). The outcomes of this project would likely serve as a baseline set of requirements for responders to propose. However, a process would still be required to solicit proposals, evaluate proposals, and select a vendor, adding time and costs to the deployment timeline.
- **Costs of upgrades or improvements.** The functions required by the LRRB closure reporting system are standard for reporting systems. Therefore, the products used by the industry would most likely meet all needs, with the exception of the integration from local GIS systems. Nonetheless, over time, software maintenance and upgrades (e.g., to maintain compatibility with Internet browsers and/or data exchange standards) are likely. With a stand-alone system, the LRRB members would need to support all the costs of upgrading and maintaining the system, whereas a partnership with MnDOT could allow for cost sharing on updates and maintenance.

Timeline for Development of Option #2

The timeline for deployment would depend on several factors, including:

- **Approach to procurement.** If an existing contract can be used for a local university or company to build the system, this can be minimized. If an RFP needs to be created, this could take 6-18 months depending upon the agency's approach to solicitations and whether a separate consultant is hired to develop procurement materials.

- **System development.** If a vendor with an existing project is selected, system development time would likely be minimal (i.e., 3-6 months). If the approach involves developing a new system, this could take 12-18 months.
- **System implementation, testing, training**. If the selected product is an established product, implementation will likely require minimum time (i.e., 6 months or less). If a new system is needed, implementation may be 6-12 months.
- **Total estimated deployment time range is estimated to be:** 12 months – 36 months.

Conceptual Architecture for Option #2

Figure D.1 illustrates the conceptual architecture for the option of developing a stand-alone statewide local entry road/bridge closures tool. A new LRRB procured system would ingest local agency GIS feeds of closures and manual entry by local agencies to create a feed for ingest by mapping and navigation providers.

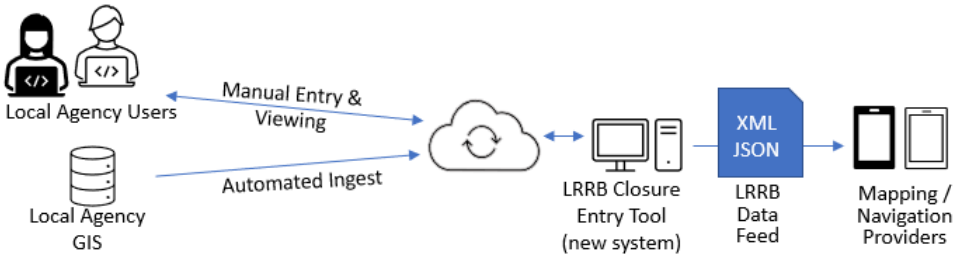

Figure D.1 Option #2: Develop a Stand-alone Statewide Local Entry Road Closure Tool

Option #3: Create Individual Local Agency Closure Data Feeds

Some Minnesota counties currently enter road closures into their GIS. However, there are no examples where these closures are published to websites or application programming interfaces (APIs) for mapping and navigation companies to ingest. In this option LRRB would define a model data feed specification and encourage any counties or cities with GIS (or other tools) capable of outputting closure reports to publish these to public facing Internet access points.

Summary of Option #3

Option #3 is primarily a coordination effort to encourage as many local agencies as possible to create public facing APIs to share their road and bridge closure information. Example data feeds, samples of GIS configurations, and step by step instructions could be created to guide local agencies to establish real-time feeds of their reported road and bridge closures.

In Option #3, once local agencies develop individual data feeds of closures, two approaches could be considered to reach mapping/navigation companies:

1. Develop and follow the process to introduce these data access points to mapping navigation providers (e.g., Waze, Google).
    - Once this is accomplished for one county, the process could be well documented and step by step instructions prepared for other counties to follow.

2. Request MnDOT to develop an automated ingest of individual county feeds for roadway closures into their CARS System.
    - Request that a process be established with MnDOT where an automated ingest is developed to ingest data from local county feeds. Each time a new county launches a feed, a process to test the ingest could be followed and ultimately lead to MnDOT ingesting the closures and converting the data into CARS events for publication on the XML/JSON API operated by MnDOT.

Contracting, Funding, and Estimated Cost of Option #3

The following describes an approach for proposed contracting, proposed funding, and estimated costs for Options #3.

- **Proposed contracting approach.** If the project team determines that a consultant support contract is needed to document the data feed approach and perform outreach and engagement to counties and cities, this would require a contract (i.e., most likely an LRRB contract process). If these efforts are performed by county staff, there would be no overall contracting needed.
- **Proposed funding approach.** The LRRB project could recommend consideration of LRRB or State Aid funding and support to document the process and perform outreach and engagement with counties and cities, explaining this approach. Each local agency would be responsible for developing their local data feed using either internal staff or contracting with a vendor to

develop a feed if necessary. If the option of MnDOT developing an automated ingest is selected, LRRB or State Aid funding would be suggested to fund these efforts.

- **Cost considerations.** The costs of implementing a Minnesota local road closure reporting system will vary based on multiple factors, including:
    - *Vendor products.* There are a number of vendors with reporting systems that would enable manual entry of local road closures. Pricing is typically not based on effort to create a new software system, but rather prices set by the vendor are based on their overall investment in their product. Therefore, actual quotes are difficult to predict prior to a procurement process.
    - *Varying costs.* Once a vendor product is selected, the costs will typically include deployment, training, operations, and maintenance/upgrades. Vendors approach these differently. There are industry examples of lower deployment cost but higher costs for operations and hosting.
    - *Mobile application or mobile use of website.* If field entry is important, the options are either to develop a mobile application or have the web-based user interface responsive to phones or mobile devices. Costs would vary based on which approach is selected.
    - *Local export of closure reports.* Local agencies wishing to have their locally entered closures ingested would need to implement an output from their GIS (or other system) to make the reports available through internet access and in the format agreed upon during development. Local costs for this are not estimated below.
- **Estimated costs of Option #3.** The costs of implementing the published feeds at each agency would be different for each agency.
    - *Documentation of selected data feed format:* $25,000 - $50,000 (Estimates based on consultant costs if activities are not performed by internal staff)
    - Outreach to counties/cities to encourage use: $25,000 - $50,000 (Estimates based on consultant costs if activities are not performed by internal staff)
    - Development of local feeds at each agency: Would vary by each county/city depending upon GIS application. Estimated to be minimal costs (e.g., less than $10,000) per agency.
    - Development of CARS ingest (optional): $25,000 - $50,000 (assumes modification of existing ingest)

Estimated Benefits of Option #3:

The following are benefits for creating individual local agency closure data feeds.

- **Minimal costs.** No new reporting system would be procured or developed. If MnDOT agreed to ingest events from the local agency feeds, this may involve a new data ingest feature in CARS or the counties could output a format currently supported by CARS.
- **Scalable solution.** In this approach, costs are only incurred for the counties that decide to output the data feed.

Estimated Drawbacks of Option #3:

There is also one drawback noted for Option #3 in that there would be no manual entry of closures. Only local agencies with closures entered in GIS or with a locally created mechanism for creating an XML feed with data describing closures would benefit from this option.

Timeline for Development of Option #3

The timeline would vary for each local agency preparing a data feed. Each local agency would need to ensure the information entered into their GIS meets the specifications desired by the mapping and navigation providers.

Conceptual Architectures for Option #3

The following two options were discussed during project webinars for integrating local closures into:

- **Conceptual Option #3a: Mapping/Navigation Providers Automated Ingest of Local Agency Data Feeds.** Local agencies would individually develop a data feed for ingest by mapping and navigation providers. See Figure D.2.

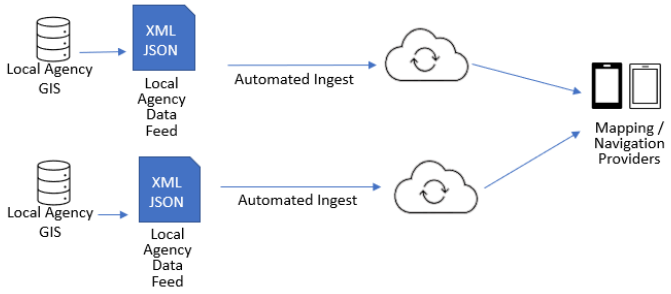

Figure D.2 Option #3a: Mapping/Navigation Providers Automated Ingest of Local Agency Data Feeds

- **Conceptual Option #3b: MnDOT CARS Automated Ingest of Local Agency Data Feeds.** Similar to Option #3a, local agencies would individually develop a data feed for ingest by MnDOT's existing CARS. The CARS feed would then be available for ingest by mapping and navigation providers. See Figure D.3.

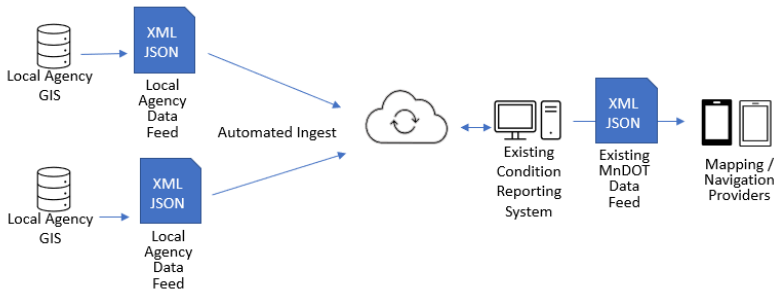

Figure D.3 Option #3b: MnDOT Condition Reporting System Automated Ingest of Local Agency Data Feeds

Appendix E
User Guide

Email Request

Table E.1 Email Request to Inform Mapping and Navigation Companies of a Closure

Company	TomTom	Waze	HERE	Google	Apple
Email Request	Brandy Boyle: brandon.boyle@tomtom.com	closures@waze.com *For emergency closures, include "URGENT" in the subject line.* *Waze requests information in a Spreadsheet format.* Requests can also be made to Waze Map Editors (volunteer community who help edit the Waze map). To connect with your local editor, fill out a connection request form[1].	Derek Barthel: derek.barthel@here.com Alonso Victal: Alonso.victal@here.com	closures@google.com	maps_support@apple.com
Confirm Request	View on TomTom MyDrive Route Planner[2]	View on Waze live map[3] *Allow up to two business days for the request to be processed.*	View on HERE live map[4]	View on Google Maps[5]	View on Apple Maps[6]
Other Information		To submit a screenshot or map image, include the following details: • **Screenshot**: Event area, closed roads marked and start and end date/time of each closure • **Map image**: Start and end date/time of each closure and all roads that will be affected For additional information go to: Sharing Road Closures to Help Reroute Waze Drivers[7]		Waze is owned by Google, and therefore events entered in Waze typically also show in Google. If a longer closure (e.g., over 30 minutes) is set in Waze, the closure report typically shows in Google.	

Online Tool Request

Table E.2 Online Tool Request to Inform Mapping and Navigation Companies of a Closure

Company	TomTom	Waze	HERE	Google	Apple
Tool	**Road Event Reporter Tool** Create an account with Road Event Reporter[8] Input planned temporary closures and unplanned emergency road closures.	*NOTE: A signed partnership with Waze for Cities[9] is required to make map updates using the Closures Tool.* **Closures Tool** Log in to your Waze for Cities account to search for the location of your closure and select streets to add the closure and details in the Waze Map Editor[10]	**Online Editing Tool** Create an account with HERE Map Creator[11] Provide a direct edit after logging into the HERE Map Creator Tool	Tool not found through an online search.	Tool not found through an online search.
Confirm Request	View on TomTom MyDrive Route Planner	• View on Waze live map • Login into the Waze Map Editor • Download the Waze Feed[12]	• View on HERE live map • View the "Your Stuff" section of HERE Map Creator		
Other Information		Once a start and end date of a closure are entered, you are unable to update the event. The current event will need to be removed and a new event entered. To learn how to use the Closures Tool, watch the video walkthrough For additional information go to: Sharing Road Closures to Help Reroute Waze Drivers	A closure period is requested when entering details into the HERE Map Creator Tool. For additional instructions go to: Video tutorials to get you started with HERE Map Creator[13]	Waze is owned by Google, and therefore events entered in Waze typically also show in Google. If a longer closure (e.g., over 30 minutes) is set in Waze, the closure report typically shows in Google.	

Automated Request

Table E.3 Automated Closure Requests to Mapping and Navigation Companies

Company	TomTom	Waze	HERE	Google	Apple
Automated Request	Create your application programming interface (API) or data feed (Extensible Markup Language (XML) or Keyhole Markup Language (KML)) and email TomTom to notify them of the feed: Brandy Boyle: brandon.boyle@tomtom.com *NOTE: Coordinate with TomTom on data feed content as it is developed.*	*NOTE: A signed partnership with Waze for Cities is required to share all closure automatically.* Create your basic feed (XML or JavaScript Object Notation (JSON)) by reviewing the guidelines included in the Sharing Road Closures to Help Reroute Waze Drivers. Set up feed in the Partner Portal after logging into your Waze for Cities account.	Create your API and email HERE to notify them of the feed: Derek Barthel: derek.barthel@here.com Alonso Victal: Alonso.victal@here.com *NOTE: Coordinate with HERE on data feed content as it is developed.*	Instructions not found through an online search.	Instructions not found through an online search.
Confirm Request	View on TomTom MyDrive Route Planner	View on Waze live map *Closures will appear within 1 to 4 minutes.*	View on HERE live map		
Other Information		For additional information go to: Sharing Road Closures to Help Reroute Waze Drivers		Waze is owned by Google, and therefore events entered in Waze typically also show in Google. If a longer closure (e.g., over 30 minutes) is set in Waze, the closure report typically shows in Google.	

[1] Waze Connection Request Form: https://www.waze.com/il-ContactForm/form-web/en/partners-ehc?ref_topic=6324424&visit_id=638121639211581704-1207537912&rd=1&locale=en
[2] TomTom My Drive Route Planner: https://mydrive.tomtom.com/
[3] Waze Live Map: https://www.waze.com/live-map
[4] HERE Live Map: https://wego.here.com
[5] Google Map: https://maps.google.com
[6] Apple Maps: https://www.apple.com/maps/
[7] Waze Sharing Road Closures to Help Reroute Waze Drivers: https://waze.medium.com/sharing-road-closures-to-help-reroute-waze-drivers-9ee2ac1c0459
[8] TomTom Road Event Reporter: https://www.tomtom.com/products/road-event-reporter/
[9] Waze for Cities: https://www.waze.com/wazeforcities/
[10] Waze Map Editor: https://www.waze.com/en-US/editor
[11] HERE Map Creator: https://mapcreator.here.com/
[12] Waze Data Feed: https://support.google.com/waze/partners/answer/10618035?hl=en
[13] HERE: Video tutorials to get you started with HERE Map Creator: https://www.here.com/learn/blog/video-tutorials-to-get-you-started-with-here-map-creator