ADVANCED TRANSPORTATION AND CONGESTION MANAGEMENT TECHNOLOGIES DEPLOYMENT (ATCMTD) PROGRAM

GREAT PLAINS RURAL FREIGHT TECHNOLOGY CORRIDOR PROJECT

(U.S. 83 Advanced Technology)

Concept of Operations (ConOps)

FHWA Funding Opportunity Number: 693JJ321NF00005
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List of Acronyms and Abbreviations

AASHTO .....American Association of State Highway and Transportation Officials
API ..... Application Programming Interface
ARC-IT ..... Architecture Reference for Cooperative and Intelligent Transportation
ATCMTD.....Advanced Transportation and Congestion Management Technologies Deployment
ATMS ..... Advanced Transportation Management System
BSM ..... Basic Safety Message
C-V2X..... Cellular-Vehicle to Everything
CCTV..... Closed-Circuit Television
ConOps ..... Concept of Operations
CV ..... Connected Vehicle
DBB ..... Design-Bid-Build
DMS ..... Dynamic Message Sign
DTPS..... Dynamic Truck Parking Sign
FOC..... Fiber Optic Cable
FCC..... Federal Communications Commission
FSP..... Freight Signal Priority
FHWA..... Federal Highway Administration
GNSS ..... Global Navigational Satellite System
IEEE..... Institute of Electrical and Electronics Engineers
ICS ..... Interface Control Specification
ISP..... Information Service Provider
ITS..... Intelligent Transportation Systems
K-TRIPS ..... Kansas Truck Routing Intelligent Permitting System
KDOT ..... Kansas Department of Transportation
MAASTO..... Mid-America Association of State Transportation Officials
MOT..... Maintenance of Traffic
NTCIP ..... National Transportation Communications for ITS Protocol
O&M ..... Operations and Maintenance
OBU ..... Onboard Unit
OEM..... Original Equipment Manufacturer
ORR ..... Operational Readiness Review
PEP..... Project Evaluation Plan
PER ..... Project Evaluation Report
PID ..... Personal Information Device
PII..... Personally Identifiable Information

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PMP ..... Project Management Plan
PSEMP ..... Project Systems Engineering Management Plan
PSID ..... Provider Service Identifier
RITSA ..... Regional ITS Architecture
RSU ..... Roadside Unit
RTCM ..... Radio Technical Commission for Maritime
RTVM ..... Requirements Traceability Verification Matrix
RWIS ..... Roadway Weather Information System
SAE ..... Society of Automotive Engineers
SEA ..... Systems Engineering Analysis
SERF ..... Systems Engineering Review Form
SITSA ..... Statewide ITS Architecture
SCMS ..... Security Credential Management System
SOP ..... Standard Operating Procedure
SPaT ..... Signal, Phase and Timing
SRM ..... Signal Request Message
SSM ..... Signal Status Message
SSP ..... Service Specific Permissions
SwRI ..... Southwest Research Institute
TIM ..... Traveler Information Message
TPIMS ..... Truck Parking Information Management System
TRR ..... Test Readiness Review
UAV ..... Uncrewed Aerial Vehicle
V2I ..... Vehicle to Infrastructure
V2V ..... Vehicle to Vehicle
V2X ..... Vehicle to Everything
VDS ..... Vehicle Detection System
WTMC ..... Wichita Transportation Management Center (called WICHway)
WZDx ..... Work Zone Data Exchange

Executive Summary

This U.S. 83 Advanced Technology project Concept of Operations (ConOps) is a systems engineering document that informs project stakeholders in layman's language, as much as possible, of project goals, needs, and functionalities, and of the operational scenarios that will be encountered. It is intended to be a high-level view of the system that each stakeholder can use to understand how the system will be operated and maintained. This ConOps is being prepared in the early stages of the project lifecycle and, as a living document, is expected to evolve and be revised as the project proceeds.

This document details the project elements and location, existing and future stakeholders, current corridor conditions, and why the technology deployments and project are needed. Further, the document presents the user needs which is one of the first steps in the system engineering process. The document then describes how the project and applications will operate based on the deployed system and provides operational scenarios to step through various facets of the project technology and processes.

The project includes the installation of new fiber optic cable (FOC) on U.S. 83 and deployment of Advanced Technology improvements to the existing Intelligent Transportation System (ITS). The Wichita Transportation Management Center (WTMC), called WICHway, will be used to operate the new systems on U.S. 83. These improvements are categorized into four distinct groups of enhancements. The four groups are KaITS ATMS improvements, KanDrive improvements, roadside technology improvements, and CV technology. Among other functions, the project will introduce new roadside, third-party and crowdsourced data (e.g., INRIX, HERE or REKOR), and CV technologies. The new technologies will send weather and traffic travel advisories directly to the drivers and assist those who are freight drivers with improved traffic signal priority. Collectively, the project will result in the deployment of a unified operational system with the overall goals to enhance regional mobility and safety on the U.S. 83 corridor for both commercial and personal traffic.

This project Concept of Operations document is one of several systems engineering documents and complements the Data Management Plan (DMP), Project Evaluation Plan (PEP), Project Management Plan (PMP) and Project Systems Engineering Management Plan (PSEMP).

1. Overview

In September 2022, the Federal Highway Administration (FHWA) awarded the Kansas Department of Transportation (KDOT) an Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Grant (Funding Opportunity Number 693JJ321NF00005) for the KDOT Great Plains Rural Freight Technology Corridor Project (U.S. 83 Advanced Technology project).

The project includes installation of new FOC on U.S. 83 and the implementation of advanced ITS hardware infrastructure and supporting software for a fully integrated system. Collectively, the

project will result in the deployment of a unified operational system that users and operators experience as a single system with the overall goals to enhance regional mobility and safety on this rural freight corridor.

The FHWA requires Systems Engineering Analysis (SEA) for all ITS projects using federal funds, by FHWA Rule 940. The ITS SEA should be on a scale commensurate with the project scope. Since the project is, in part, federally funded and regarded as high risk because of new software, technology, systems and interfaces, the project must undergo high-risk systems engineering development and testing, scaled accordingly.

The material in this ConOps is based upon work supported by the FHWA under the ATCMTD Cooperative Agreement awarded to KDOT for the Project titled Great Plains Rural Freight Technology Corridor Project (U.S. 83 Advanced Technology).

1.1 Identification

Project Name: Great Plains Rural Freight Technology Corridor Project (U.S. 83 Advanced Technology)

Internal KDOT Project Identification:

- Kansas Project Number KA-6234-01
- Kansas Project Number KA-6234-02

This ATCMTD Grant project includes the installation of new fiber optic cable (FOC) on U.S. 83 (KA-6234-01) and improvements to the hardware infrastructure, as well as the development of KaITS, KanDrive and supporting software (to integrate the infrastructure components into a usable and effective system (KA-6234-02). Collectively, this will result in the deployment of a well-integrated and unified U.S. 83 Advanced Technology project. Systems engineering is needed for the advanced ITS portion of the project.

1.2 Purpose and Intended Audience

The purpose of this ConOps document is to:

- Communicate user needs and the proposed system expectations.
- Communicate the system developer's understanding of the user needs and how the system will meet those needs.
- Build consensus among user groups or developers.
- Create the basis for requirements development and verification.
- Create the framework for system validation.
- Provide an overview for, or to be part of, a press release or informational brochure.

The intended audience for this ConOps document includes the following groups of stakeholders:

- KDOT staff.
- Non-technical program management and sponsors.
- Technical management of participating agencies.
- System developers.
- Traffic and freight operations managers and operators.
- Others who fulfill special roles or oversight of the project.

The audience will consist of stakeholders from multiple parties with varying levels of technical knowledge. Therefore, the document is written to communicate the technical material in a way that the reader can understand the first time they encounter the material.

1.3 Document Overview

This ConOps document describes the existing system and operations, the need for the project, changes that address the needs, and the final proposed system after project implementation.

The system incorporates new technologies related to CV systems to enhance the U.S. 83 Advanced Technology corridor and facilitates safer travel and provides a better user experience by providing additional traveler information and allowing for an improved situational awareness for the traveler.

1.4 High-Level System Overview

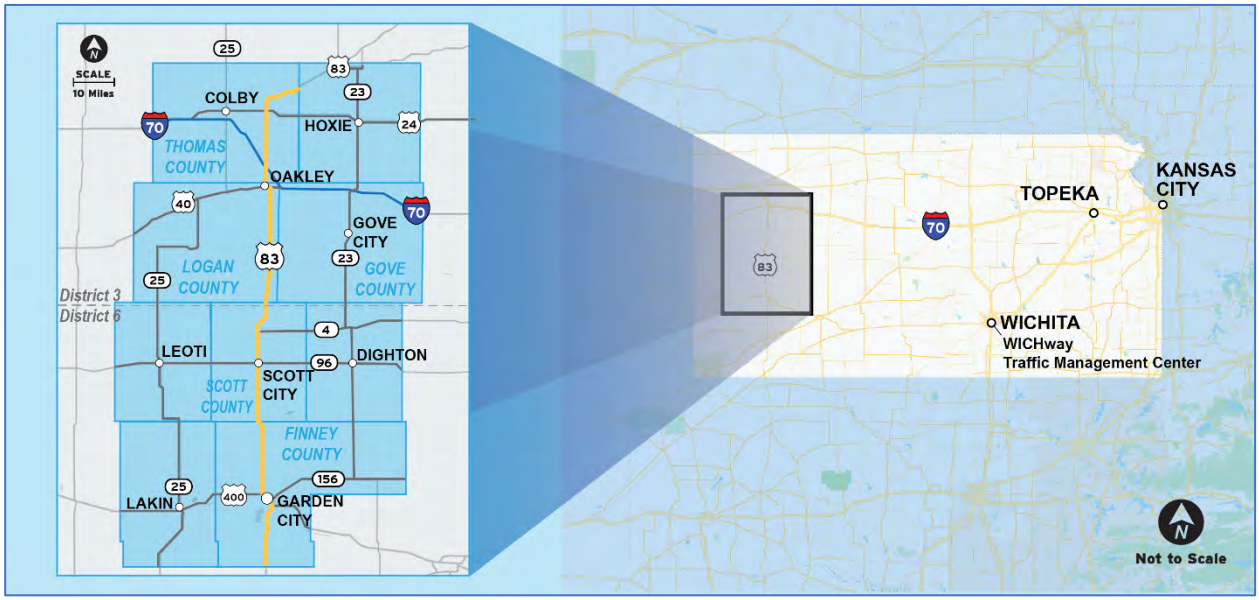
This section provides a high-level overview of the U.S. 83 Advanced Technology project, which is situated on a two-lane rural corridor in western Kansas. U.S. 83 is a Kansas Critical Freight Corridor with multiple uses for the agricultural and freight industries. The overall U.S. 83 project will be implemented with the execution of two subprojects. The FOC deployment will install approximately 90 miles of FOC in advance of the technology deployment. The technology deployment will use the FOC and install advanced ITS hardware on U.S. 83 and new software technologies.

The advanced ITS will deliver traffic, weather and other operational information to commercial trucking to improve mobility. Benefits include safety for highway users and improved economic opportunities for the state. For example, new safety features include Freight Signal Priority (FSP) with fewer trucks stopping at intersections and the hands-free aspect of communicating with the KanDrive system.

Existing software operated by the WTMC will control new roadside devices on U.S. 83. The Road Weather Information Systems (RWIS) sensors will communicate weather data and CV Roadside Units (RSUs), truck detectors, and other traffic sensors will communicate traffic data. The existing Kansas Active ITS (KaITS) will process and provide new information to the KanDrive public website and to third-party data providers. KanDrive provides up-to-date traffic information for interstates, U.S. routes and state highways across Kansas. KanDrive has a webpage format and supports a mobile app available on iOS and Android platforms for hands-free, eyes-free audio notifications of traffic and traveler information. KanDrive also supports the 511 call-in system for traveler information.

The existing ATMS (KaITS) is housed at the WTMC in the City of Wichita in KDOT District 5. The project area of the U.S. 83 corridor is in western Kansas in KDOT Districts 3 and 6 as shown in Figure 1.

Figure 1: Project Location



1.5 Stakeholders

The KDOT is the designated lead agency, as the recipient of an ATCMTD Grant, that has provided the funding match for the U.S. 83 Advanced Technology project. The FHWA will provide technical guidance and oversight of the system as it is developed. Headquartered in Topeka, Kansas, KDOT maintains six districts and fourteen divisions and bureaus employing 2,351 employees. The project corridor covers KDOT District 3 (Thomas, Gove, and Logan Counties) and District 6 (Scott and Finney County). Project stakeholders and anticipated roles are discussed further in Section 2.4.

2. Current System and Situation

This section of the ConOps provides an overview of the current system and situation, including the current situation background, corridor traffic and safety, existing ITS elements, stakeholder profiles, and the support environment.

2.1 Current Situation Background

Kansas has the seventh-largest state agricultural economy in the U.S. with much of the state's nearly $20 billion in direct agricultural products annually coming from the five county-region anchored by U.S. 83. The corridor has a global export market, currently valued at more than $4 billion annually. The production of more than 40 percent of the state's international agricultural exports occurs in the region served by the U.S. 83 corridor. These five counties (Thomas, Logan, Gove, Scott, and Finney) are key to the state's livestock, grain, gas and biofuel industries. This corridor was designated as a Critical Rural Freight Corridor in the 2017 Kansas Statewide Freight Plan.

U.S. 83 is an important, landlocked, anchor point for an international supply chain sending products to 89 different countries, including its top-five markets: Mexico, Japan, South Korea, China and Canada. It is imperative that locally produced agricultural products move safely and efficiently to help Kansas remain a competitive player in the global agriculture marketplace. It is also important to expand good-paying jobs and strengthen the economic vitality in this rural area where personal incomes are below-average compared to the rest of the state.

The corridor is an important supply line for oil and gas production totaling millions of cubic feet (Mcf) annually. It serves the Kansas portion of the Hugoton Oil and Natural Gas Area, the largest gas field in North America.

There is a need to enhance freight mobility and safety in the corridor which the project aims to accomplish through new technologies.

2.2 Corridor Traffic and Safety

2.2.1 Corridor Characteristics

This project corridor is a 131-mile section of U.S. 83 traversing north-south from the Finney/Haskell County line in the south to the Thomas/Sheridan County line in the north. Garden City is north of the southern border of the project. U.S. 83 proceeds north through Scott City and intersects I-70, a cross-state and cross-country Interstate highway. The roadway proceeds north from Oakley at I-70 to the northeast then the project terminates in the north at the border between Thomas and Sheridan Counties. From Garden City, U.S. 400/U.S. 50 proceeds east to Wichita, the location of the WTMC.

The U.S. 83 corridor supports an abundance of commercial truck and farm equipment traffic which can account for up to one-third to one-half of total traffic. The commercial truck traffic consists of every size vehicle including many oversize/overweight and "*super-load*" vehicles, which require permitting and monitoring, on nearly a daily basis, often three or more per day. Super-loads include very long and wide flatbed trucks carrying 300-foot wind turbine blades. In this document, both oversize, overweight and super-load vehicles are termed oversized. Oversized vehicles can disrupt both directions of traffic flow in the corridor. From a driver point of view, on any day there can be a significant number of oversized vehicles traveling the U.S. 83 corridor.

Livestock and produce deliveries are extremely time sensitive in terms of animal safety, product freshness, and production efficiency. In an area with sparse state highway connections that can provide alternative routes, traffic and weather incidents can delay traffic longer since alternate routing can require significant advance notice.

2.2.2 Traffic Conditions

The corridor has delays due to crashes, weather conditions and work zones in progress. Extreme weather conditions can impact the flow of goods. KDOT recognizes the need for better coordination and management of the regional transportation network to optimize travel in the corridor.

2.2.2.1 Traffic Composition and Volume

Corridor traffic averages 2,500 to 5,000 vehicles per day in the middle of the corridor to more than 10,000 vehicles per day where agricultural product manufacturers and distributors are concentrated. This concentration of employers is around I-70 and U.S. 50/U.S. 400, with greater access to labor markets. Commercial trucks and farm equipment traffic account for as much as one-third to one-half of total traffic. For the section of U.S. 83 between Garden City and Scott City, in 2022, there were approximately 1,000 permitted oversize vehicles, on average, almost three per day.

2.2.2.2 Crashes

Incidents on rural two-lane highways can block traffic for hours. Emergency response times in rural areas can be twice, or longer, than that of urban areas. Speed of access to crash victims by emergency responders is a key factor in survival rates, according to the National Highway Traffic Safety Administration. The deployment of advanced ITS is designed to improve incident detection and response.

Based on historical statewide data, about 20 percent of crashes occur in inclement weather. Advance warning puts drivers on notice of deteriorating weather conditions along their routes in time for them to make alternate travel plans or reschedule departures if strategically advantageous.

KDOT crash data from 2021 reveal hot spot crash locations at or near the intersection of U.S. 83 with:

- K-156 east, East Kansas Avenue in Garden City
- K-96, West 5th Street in Scott City
- I-70 in Oakley.

These are also the busiest intersections in the U.S. 83 corridor.

Driver actions contributing to these crashes could be impacted by ATIS. Greater situational awareness of roadway conditions could help mitigate drivers' actions, such as following too closely, hitting a stopped or slower vehicle, running off the road, or exceeding safe speeds during poor weather. Technologies can minimize the severity and frequency of incidents with advanced rapid detection, responses and better real-time traveler information.

2.2.2.3 Travel Time Reliability

Users of the corridor have a need for improved travel time reliability that enables drivers to choose from among rerouting options or to reschedule discretionary travel in response to weather or traffic conditions. These include improvements in the corridor's buffer and planning times, so shippers and freight carriers improve their competitiveness.

2.3 Description of the Current ITS

This section provides a description of the existing traffic management system in the project region and defines existing local and regional ITS projects that may interface with the U.S. 83 Advanced Technology project.

2.3.1 Existing ITS Overview

KDOT operates several ITS devices along U.S. 83 through the WTMC. KDOT does not operate or maintain traffic signals along the corridor. Typically, statewide, local transportation agencies operate and maintain the signals.

ITS equipment on the U.S.83 corridor consists of the following elements:

- Five isolated traffic signals (city owned, four roadway traffic signals and one pedestrian signal), some of which are 30 years old and do not support CV RSUs.
- Three CCTV cameras located along the Garden City bypass that are owned and operated by KDOT. The cameras are presently connected to WTMC by cellular modems which provide streaming video and periodic still image drops that are shared on KanDrive.
- Three RWIS stations owned and operated by KDOT.

The existing traffic signals are located in Scott City and Garden City. The cameras are located in the Garden City area. The RWIS are located on or near the corridor in Oakley, Scott City and Garden City.

Oversized vehicles get permits through the KDOT K-TRIPS permitting system. Work zones are managed through the Castle Rock's KCARS system. Presently, U.S. 83 has cellular connections to the WTMC, and KanDrive broadcasts its coverage with its mobile application. Weather, work zone and incident information are available to freight dispatchers and mobile users through the KanDrive application statewide. TPIMS offers truck parking information for truck parking lots on I-70. The nearest lots to U.S. 83 are about 20 miles away in each direction, east and west on I-70.

Currently, U.S. 83 roadway management is limited to accumulating data from several sources. These include the KCARS work zone management and three RWIS stations. Along the section of U.S. 83 that runs concurrently with U.S. 400 there are two Dynamic Message Signs (DMSs), two Closed-Circuit Television (CCTV) cameras and one still image camera located at an RWIS station. These devices operate over cellular connections. Based on this information, KanDrive disseminates travel advisories via a KanDrive website and a smartphone app available for download on iOS and Android smartphones.

KanDrive.gov is KDOT's official traffic and traveler information web presence. KanDrive provides up-to-date traffic information for interstates, U.S. routes and state highways across Kansas. The KanDrive platform provides pre-trip and enroute automated and continuous information to dispatchers, drivers, and others on travel conditions, weather conditions, construction detours and closures, and traffic-impacting incidents on the corridor. The website displays an interactive map of Kansas roads that provides graphical and visual depictions of road conditions in real time on the computer and mobile devices (through the KanDrive app). The platform is fed by several electronic sources from across the state and by an administrative website called KCARS that WTMC operators and KDOT District staff use to manually input information. KanDrive is updated in real time. Information is provided in formats tailored to desktop computers, personal devices and smartphone applications.

Work zone information currently provided by the KanDrive API is not presently compliant with the federal Work Zone Data Exchange (WZDx) Specification, which makes it more difficult and costly for original equipment manufacturers (OEMs) and navigation applications to access and use these data across various jurisdictions. The WZDx specification enables infrastructure owners and operators (IOOs) to make harmonized work zone data available for third party use.

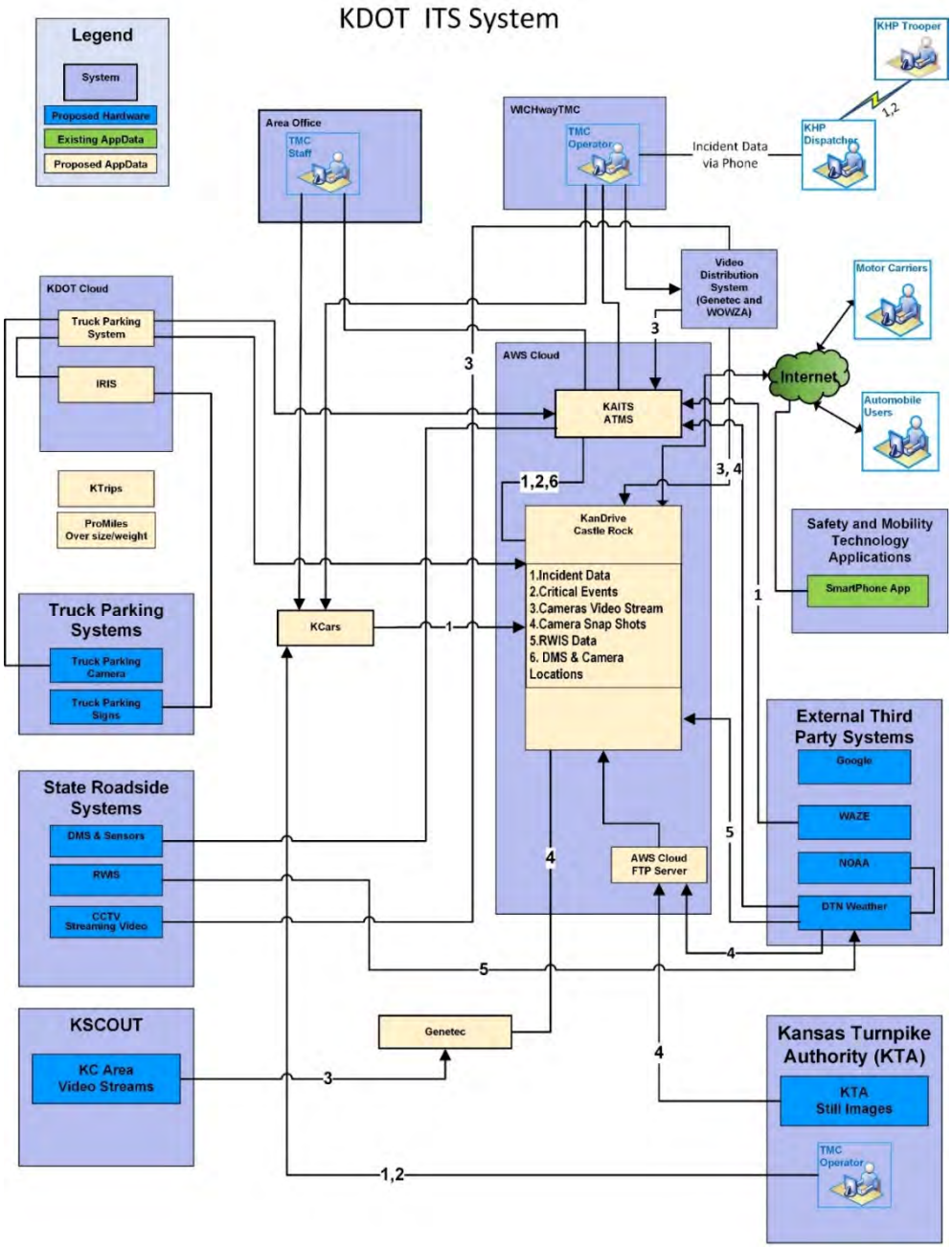
KDOT also provides traveler information through a 511 call line. By calling 511, travelers are provided automated, near real-time, route-specific road conditions, construction detours and weather (both current and forecasted) for Interstate, US, or state highways in Kansas and for the Kansas Turnpike.

KDOT's Kansas Truck Routing Intelligent Permitting System (K-TRIPS) service (see https://k-trips.ksdot.gov/) provides truck routing and permitting for identifying safe, legal routes for oversized vehicles to travel and secure related permits.

The Truck Parking Information Management System (TPIMS) monitors truck parking availability at 18 public rest areas along I-70 and provides truck parking availability information through roadside signs, KanDrive and an Application Programming Interface (API). The TPIMS project was developed by eight member states from the Mid America Association of State Transportation Officials (MAASTO). Each state in the TPIMS Partnership developed a consistent API for sharing data with other states and private third-party application developers. The Kansas TPIMS "Computer Vision" system was developed by the University of Minnesota. KanDrive, other websites, mobile applications and Dynamic Truck Parking Signs (DTPS) provide truck parking availability data to truck drivers. Parking information for up to three of the nearest parking facilities is displayed on each DTPS.

Figure 2 depicts the current KDOT ITS operations as it is now, prior to the addition of new elements that will come from the U.S. 83 Advanced Technology project's proposed additional features. The new features are discussed in Section 4, Concepts for the Proposed System. In Figure 2, the numerals inserted in the data flows refer to the items listed in the AWS Cloud box in the center of the diagram. Figure 3 provides similar information as Figure 2 but provides it in an ARC-IT ITS/CV point of view.

Figure 2: Existing Data Management System Operations

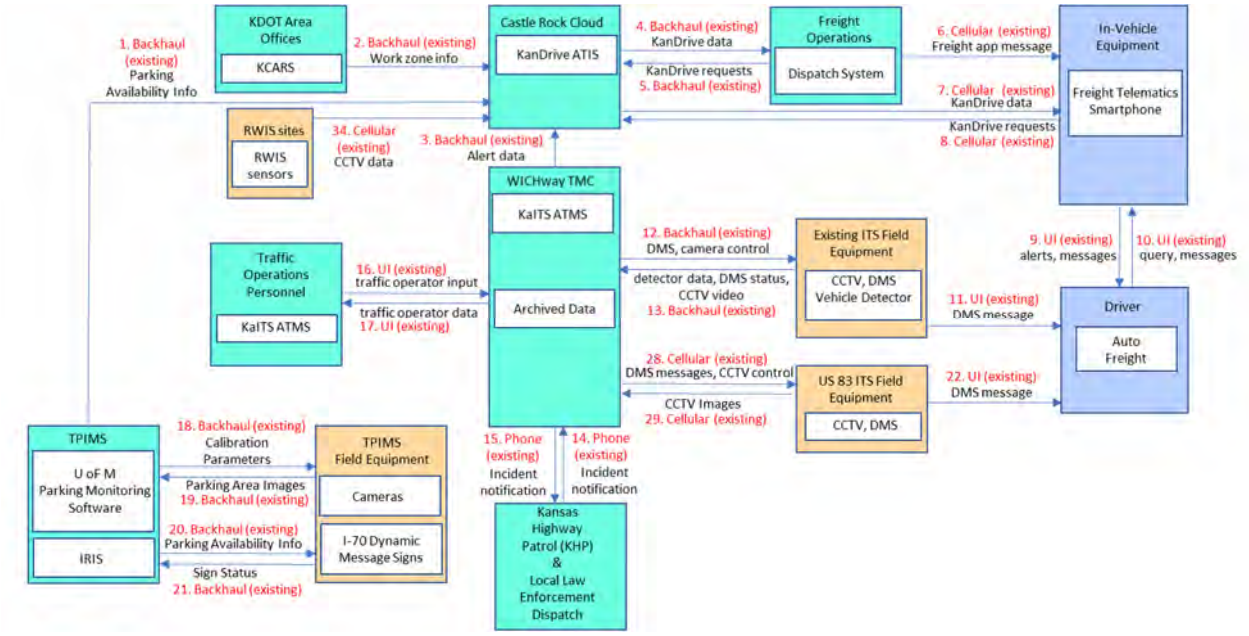


2.3.2 Existing ITS Data Flows

Figure 3 shows the current U.S. 83 physical systems and their data flows from the point of view of the WTMC, apart from internal operations shown in Figure 2. The diagram is meant to show how all the various systems send data at a high level. The diagram only lists the critical systems without going into software interrelationships or data flows within the WTMC and externally to various stakeholders. The diagram is an architecture view of the entire system and is used to illustrate the before conditions (Figure 3); a similar figure is used to depict the proposed system diagram (Figure 7 in Section 4.3.11).

The figure follows the color code as described here: green is for TMC-based functions; beige is for field equipment; and blue is for vehicle/driver equipment. Functions relative to the user service are shown in the white interior boxes. The figures show data flows with blue arrows. Data flows are numbered approximately clockwise with media type in red, either existing or project based, and data sent in black (all data flows in this diagram are existing).

Figure 3: Current System Diagram with Data Flows and Communications Media



The diagram represents data flows and communications media. KanDrive is shown as existing in the cloud. KaITS is shown as part of the WTMC and could be separated to the cloud as well, but this representation reduces complexity of the figure.

Key information flows of note in Figure 3 show KaITS in the WTMC receiving traffic data from its ITS field equipment per data flows 12 and 13 and forwarding synthesized data to KanDrive. Truck parking data goes into KanDrive from TPIMS and work zone information from KCARS. Some freight operations process and deploy the KanDrive data via their 3rd party smartphone and

telematics communications systems per data flows 4 – 8. Two of the existing three CCTV cameras along U.S. 83 are currently connected to the WTMC. The other camera, located at an RWIS site, transmits still images to the DTN weather system, a third-party company (not shown in Figure 3), which then goes on to KanDrive.

The Truck Parking Information Management System (TPIMS) software and equipment are indicated, as well. The TPIMS are self-operating, giving drivers parking occupancy messages over local Dynamic Truck Parking Signs (DTPS), freight telematics and smartphones. Operational oversight is done by a contractor who routinely (e.g., weekly) checks the number of spaces available versus the number reported electronically and makes adjustment to the count as needed.

2.4 Stakeholders

The existing stakeholder groups are composed of the agencies and organizations that are involved with, impacted by, or interested in the existing and the new U.S. 83 Advanced Technology project. Their roles, responsibilities, and contractual relationships are discussed along with their relevance to the system.

The KDOT ITS Bureau has undertaken coordination with FHWA, the KDOT District Offices, the WTMC staff and contractors, and local transportation agencies and has established a Project Advisory Group with industry, agriculture and the public in the counties most affected.

2.4.1 KDOT

KDOT is the ATCMTD grant recipient and is responsible for the U.S. 83 Advanced Technology project. KDOT is the state government organization in charge of maintaining public roadways in Kansas. Headquartered in Topeka, Kansas, KDOT maintains six districts and fourteen divisions and bureaus employing 2,515 employees.

KDOT has coordinated across multiple bureaus for development of the project. KDOT Districts 3 and 6 are responsible for the operations and maintenance of U.S. 83 in the project area. For maintenance of ITS field devices statewide, KDOT contracts with private contractors. The RWIS sites are maintained by KDOT staff from headquarters Maintenance section.

The KDOT IT Services will share oversight of the Security Credential Management System (SCMS) purchase and system cybersecurity in coordination with the KDOT ITS Bureau.

2.4.2 Wichita Traffic Management Center (WTMC)

WICHway is the name of the traffic operations center for the highway network in Wichita, Kansas and statewide, referred to in this document as the WTMC. It is owned and operated by the KDOT in cooperation with many regional partners. Over time, the services of the WTMC have expanded to the rural areas of the state. Incidents are detected and verified, and incident information is provided via KanDrive to the appropriate emergency management agencies (e.g., Fire/Rescue

Dispatch, Police Dispatch, KHP Dispatch, etc.), travelers and to 3rd party data providers. The WTMC and KDOT Districts input maintenance work schedules and road closure information into KCARS which is then displayed on KanDrive.

2.4.3 Scott City and Garden City

Scott City and Garden City own and operate the traffic signals along the project corridor . There is a need for KDOT to create agreements with Scott City and Garden City that cover installation of new equipment and ongoing maintenance at the traffic signals. There will be a short-term need for RSU, traffic signal controller and Onboard Unit (OBU) equipment operations and maintenance training.

2.4.4 Kansas Highway Patrol

The Kansas Highway Patrol (KHP) is the highway patrol agency for Kansas and has statewide jurisdiction. While the patrol's primary focus is maintaining the safety of the highways, it is also responsible for providing support to rural and small sheriff's offices and municipal police departments when specialized services are needed. Within the project corridor KHP Troop E is responsible for Finney and Scott counties and Troop D has coverage for Thomas, Logan and Gove counties. KHP Troop I is responsible for the weigh stations in Kansas and there are no fixed weigh stations existing within the corridor's limits allowing for mobile units for this function.

2.4.5 Local Law Enforcement and Fire Rescue

Local police and sheriffs' departments provide their services on local and county roadways and provide support to KHP for incidents and enforcement. Within the corridor there are three local police departments. They are the Oakley, Scott City and Garden City police departments. Each of the project corridor counties also has a sheriff's department.

The fire rescue agencies provide emergency services for incidents within the project limits. Within the project limits, all fire departments are volunteer, with the exception of the Garden City Fire Department.

2.4.6 Agriculture Shippers, Manufacturers, and Distributors

Agriculture shippers, manufacturers, and distributors use this corridor for high value, time sensitive local, regional, national, and global shipments. The disproportionately large truck contingent, one-third to one-half of total traffic, encounters traffic signal delays in Scott City and Garden City. The oversized vehicles cause significant delays for vehicles, due to deliveries in the burgeoning wind farm industry in the region and other industries.

Enabling these users with traffic signal priority and information to optimize time-critical routing and arrival and departure times will improve safety and productivity while also reducing shipping

costs and delays. This stakeholder group will benefit from signal priority and additional traveler information on the corridor.

2.4.7 Auto Highway Users

Auto highway users utilize the corridor during their daily activities, such as for work, school or shopping trips. They comprise about 60 percent of traffic. Auto drivers have a need for incident notification, rerouting options to avoid crashes and delays, or to choose to reschedule discretionary travel in response to weather or traffic conditions. Traffic flows are impacted by school buses that stop on the highway and by oversized vehicles.

2.5 Support Environment

KDOT is responsible for delivering the project and has systems in place for working with project stakeholders and contracting for necessary services.

The KaITS ATMS, also known as ActiveITS, is supported, maintained, and enhanced under contract with Southwest Research Institute (SwRI). ActiveITS advanced traffic management system (ATMS) supports state transportation departments and local agencies involved in management of vehicular traffic and emergency response. The SwRI ActiveITS is a standards-based platform that provides truck parking, CV integration, decision support system (DSS), support of partners and third-parties, traffic signal systems and a wide range of device protocols. The CV module of ActiveITS is not yet used in KaITS.

The KanDrive website is supported, maintained, and enhanced under contract with Castle Rock, a software company specializing in Advanced Transportation Information System (ATIS). Castle Rock's software platform empowers the public to get travel knowledge through interactive websites, 511 phone systems, iOS and Android mobile apps, social media, and more.

3. Change Justification

3.1 Justification for Changes

In 2017 KDOT issued a Statewide Freight Plan that identified four important goals KDOT would focus on for freight movements in the state:

- Improve the mobility of the freight system
- Improve the safety of the freight system
- Support economic development, trade, and commerce in Kansas
- Minimize the environmental impacts of the freight system

KDOT further explored the applications of technologies in advancing the safety and mobility of freight movements in the state with the 2021 report, *Kansas Connected and Automated Vehicle Implementation*. This plan defined a pilot program to explore rural technologies focused on

priority freight corridors in the state to improve safety, operations, and mobility that would also have economic benefits for the state. With these two important planning efforts in place, the concept of the Great Plains Rural Freight Technology Corridor was conceived.

The objective of this U.S. 83 Advanced Technology project is to provide enhanced safety and mobility for the freight and agricultural community and the residents and travelers in the corridor. Better management of the corridor truck movements will improve routing choices forced by corridor traffic incidents or weather conditions and minimize impacts on commercial drivers trying to balance traffic conditions with the demands of just-in-time manufacturing and pick-up/drop-off scheduling.

KDOT's assessment of the corridor has identified the following characteristics and constrains:

- Long length of the roadway
- Large amount of truck traffic
- Rural nature of the corridor/region
- Limited alternate routes (often gravel)
- High wind and severe weather potential
- Economic importance of the corridor
- Opportunity to improve infrastructure and operations of the corridor
- Opportunity to expand existing technology applications

The project Grant application listed goals of the U.S. 83 Advanced Technology system as shown in Table 1 and how each goal is supported with project elements.

Table 1: Goals, Solutions and Proposed Technologies

Key Project System Element	Improve Safety	Improve Efficiency	Improve System Performance	Improve Infrastructure ROI	Improve Environmental Impacts	Ensure a State of Good Repair	Accelerate Deployment of V2V and V2I
Expanded Fiber-Optic Network	✓	✓	✓	✓		✓	✓
Road Traffic Weather and Traffic Conditions Information Systems	✓	✓	✓	✓	✓		✓
KanDrive, Electronic Applications Expansion	✓	✓	✓	✓	✓	✓	✓
Advanced Signal Phase, Timing and Priority	✓	✓	✓	✓	✓		✓
DMS and Advanced Traffic Signal Controllers Expansion	✓	✓	✓	✓	✓		✓
User-Defined System Expansions	✓	✓	✓	✓	✓	✓	✓

3.2 User Needs

Defining user needs is an essential first step in determining what the users aim to accomplish with the system. Toward this end, a stakeholder survey was distributed to 120 potential stakeholders for response over the period March 9 to April 7, 2023. There were 31 responses to the survey (U.S. 83 Advanced Technology Project Stakeholder Survey). The responses were analyzed, and an Advisory Group Meeting was held May 24, 2023, with select survey respondents.

In the survey, stakeholders showed interest in information from KanDrive having to do with messages about work zones, weather, truck parking, and incidents (Question 10 in the survey). They wished to receive information via smartphone apps, map services, the internet and 511 traffic information services primarily (Question 11 in the survey).

Stakeholder Needs, derived from the Stakeholder Survey, Advisory Group Meeting and advanced ITS project needs, are summarized in Table 2. Through the process of identifying stakeholder needs, the team has identified what the project stakeholders want from the intended system. The 18 stakeholder needs listed in Table 2 overlap with each other. They were combined and analyzed to develop the nine System User Needs listed in Table 3. The rightmost column in Table 3 references the Stakeholder Needs from Table 2 that are combined in the User Needs. The System User Needs in Table 3 are applied in the Project Systems Engineering Management Plan (PSEMP) and Requirements Traceability Verification Matrix (RTVM) as sources for the detailed requirements and in the PEP for evaluation of how well the User Needs were met.

Table 2: Stakeholder Needs

No.	Stakeholder Need Summary	Stakeholder Need Description
1	Improve transportation safety	KDOT needs to provide emerging technological and operational strategies to reduce the number and severity of incidents within the state.
2	Improve management of traffic incidents	KDOT needs to coordinate with law enforcement and emergency responders to identify rural incidents and improve the collective response time.
3	Improve corridor performance	KDOT needs to improve travel time consistency and improve mobility messaging to drivers.
4	Better inform travelers of route options	KDOT needs to provide more accurate messages to drivers for rescheduling trips or generating alternate route options based on the current and evolving conditions on the transportation network.
5	Provide for system security	KDOT needs to provide CV data integrity and keep the system itself secure from intrusion and data theft.
6	Provide for system reliability and maintenance	KDOT needs to ensure the ITS system and its components operate properly within all applicable specifications and standards for accuracy and functionality.

No.	Stakeholder Need Summary	Stakeholder Need Description
7	Evaluate system effectiveness	KDOT needs the system to collect and archive system performance during normal and adverse weather conditions and the system's impacts on traffic and safety.
8	System expansion	KDOT needs to extend information sharing to existing in-cab telematics, such as smartphones or other portable electronic device applications.
9	Maintain system effectiveness	KDOT needs to operate, maintain, and extend the ITS system over its lifecycle.
10	Improve sustain-ability and livability in rural Kansas	KDOT needs to improve transportation services that support safe, corridor-wide travel supporting local economic development and environmental quality.
11	Improve freight efficiency and safety	Freight vehicles need the capability to proceed through traffic signals safely with fewer stops.
12	Improve freight scheduling	Freight dispatch and hauling need real-time traffic and weather data to improve scheduling and routing.
13	Improve driver safety	Freight dispatch and hauling, and all other vehicles, need real-time traffic data to improve response to downstream traffic delays from crashes and work zones.
14	Improve freight weather safety	Freight dispatch and hauling need real-time weather data to reduce weather-related incidents, crashes, secondary crashes and blow overs of high-profile vehicles.
15	Improve freight tiredness safety	Freight dispatch and hauling need truck parking occupancy data to reduce driver tiredness and improve utility of downstream truck parking lots.
16	Emergency response	KHP, local police and emergency vehicles need to receive improved data on real-time traffic and travel conditions, crash locations and incident management.
17	Third-party data	Third-party providers need improved capability to receive real-time traffic and travel conditions.
18	Weather data	KDOT District Offices need a corridor real-time weather reporting system to use and provide accurate and timely data and information (e.g., air temperature, wind speed, precipitation, visibility) about fast-changing conditions such as fog, whiteouts, and high winds.

Table 3: System User Needs

User Need ID	System User Need Summary	System User Need Description	Stakeholder Needs No.
UN001	Basic CV services	Need to provide CV services between WTMC, RSUs and CV equipped vehicles.	1, 10, 11
UN002	Road conditions	Need to obtain road conditions along the corridor (e.g., third-party and crowdsourced traffic, RWIS data) for use in KaITS and KanDrive.	3, 12, 14, 16, 17, 18
UN003	Driver Information Messages	Need to provide KanDrive smartphone messages, traveler information messages and DMS messages for work zones, weather, truck parking, incidents.	1, 2, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18
UN004	Communications to WTMC Expansion	Need to enhance KanDrive to receive messages from drivers from smartphone, voice controlled, or in-vehicle freight telematics	3, 4, 13, 14
UN005	System Reliability	Need to provide measures of system reliability – monitor and update all field devices' system health (up-time, communication strength, device status) remotely.	6
UN006	Evaluate System Effectiveness	Need capability to provide measures to evaluate system effectiveness.	7
UN007	Maintain System Effectiveness	Need capability to provide measures to maintain system effectiveness.	9
UN008	Provide for System Security	Need to ensure that software systems and data transfer to/from WTMC, vehicles and devices are secure.	5
UN009	Interface with other systems	Need to interface with any other ITS systems operated by KaITS and KanDrive.	1, 2, 5, 6, 8, 10, 13, 15, 16, 17

4. Concepts for the Proposed System

This section defines the background and scope of the proposed system, describes the operational policies and constraints imposed on the proposed system, describes the proposed system, and outlines its modes of operations and the users and interactions involved in the system. This section also discusses the risks associated with this deployment and support environment in which the proposed system will operate. The details presented in this section explain how the proposed system is envisioned to meet the user needs and requirements outlined in Section 3 without specifying design details.

The following sections include information on the:

- Proposed system's objectives, and scope
- Operational policies or constraints imposed on the proposed system
- Description of the proposed system
- Modes of operation

- User involvement and interaction
- Support environment.

In this Advanced Technology project, KDOT is the system owner and has two contractors who supply software and support services for the ITS. SwRI and Castle Rock, Associates, Inc. are the developers of KaITS and KanDrive and will supply software integration and enhancements with their respective systems. TranSystems is under contract to KDOT for operational support for the WTMC.

As part of its Design-Bid-Build (DBB) contracting, KDOT will hire two contractors to be responsible for (1) the design phase and (2) the implementation phase. In the implementation phase, the responsible contractor or their subcontractor shall be the systems integrator and shall do installations and system integration of the system components. Various vendors will supply the implementation contractor with equipment.

4.1 Background, Objectives, and Scope

The current U.S. 83 roadway and ITS and the System User Needs have been discussed in Sections 2 and 3. Although concentrated in the urban areas, KDOT has a robust statewide transportation technology network with ATMS and ATIS supporting the safety and mobility of travelers. KDOT is responsible for the operations and maintenance of the U.S. 83 corridor and partners as needed with the local and regional agencies.

The proposed system changes apply only to U.S. 83 corridor. Software for KaITS will be expanded to ingest and use the CV data from the RSUs, provide high wind and visibility warnings based on RWIS data and identify traffic flow disruptions using third-party and crowdsourced data. KanDrive will be expanded to provide enhanced audio messaging and share all data through an API. Additionally, several OBUs will be installed on private commercial vehicles or KDOT vehicles from Districts 3 and 6.

4.2 Operational Policies and Constraints

The proposed U.S. 83 Advanced Technology project shall be built upon the existing data management system as described in this ConOps. ITS follows operational policies and constraints that are well defined by the National Transportation Communications for ITS Protocol, or NTCIP, which works with a number of standards agencies to promote systems interoperability.

Because CVs are the newest feature of ITS equipment to come to standardizations development, a discussion of CV operational policies follows.

4.2.1 Connected Vehicle

The system designer and integrator shall assure interoperability between all existing systems in the WTMC, KaITS, KanDrive and the new U.S. 83 Advanced Technology system. As part of this project, the system integrator will develop sufficiently accurate MAP intersection data (MAP data

is a descriptive name, not an acronym), perform equipment development and installation, configure and test RSU and OBU operability and other system components in the field, and perform project management. The system integrator shall also deliver all MAP and Signal, Phase and Timing (SPaT) configuration files to the entity that owns the traffic controller operations at the end of the project. KDOT will serve as the licensee for RSUs and will manage the transportation-related communications licensing and frequency coordination with public agencies.

A Test Readiness Review (TRR) and Operational Readiness Review (ORR) will be performed by the vendor(s), system integrator, and KDOT in the field on all RSU locations. The field equipment will be fully operational at the stage at which it is developed in this deployment. The project will only involve procuring a limited number of OBUs, so the systems integrator will need to test the RSUs and project OBUs for J2735 message operability. The project will install, field test, and operationally utilize the RSUs for communication with OBUs and the WTMC. Additional field tests with OBUs will extend to sending and receiving messages from among the SAE J2735 message set list which includes:

1. MAP*
2. SPaT*
3. Basic Safety Message (BSM)*
4. Common Safety Request
5. Emergency Vehicle Alert
6. Intersection Collision Announcement
7. NMEA corrections
8. Probe Data Management
9. Probe Vehicle Data
10. Road-Side Alert
11. Radio Technical Commission for Maritime (RTCM) Services Corrections
12. Signal Request Message (SRM)*
13. Signal Status Message (SSM)*
14. Traveler Information Message (TIM)*
15. Personal Safety Message (PSM)
16. Test Messages

* The asterisked items (BSM, SPaT, MAP, TIM, SRM, and SSM data) and, in addition, SCMS messages are necessary for the CV system to work at a basic level. OBUs use the Global Navigational Satellite System (GNSS), which is a generic term for satellite navigation systems that provide autonomous geospatial positioning with global coverage. PSMs, the pedestrian equivalent of vehicular BSMs, are required for pedestrian applications, but don't apply to this project.

Definitions from SAE are offered for seven key J2735 message sets which will be used with the FSP application:

- The MAP message is used to provide intersection and roadway lane geometry data for one or more locations (e.g., intersections and fragments of maps). Almost all roadway geometry information, as well as roadway attributes (such as where a do-not-block region exists, or what maneuvers are legally allowed at a given point), is contained in the "generic lane" details of this message. MAP messages are used in intersections to number and

describe lane level details of each lane, while the SPaT message provides the current state of each signal head controlling the ability to stop or pass in a given lane.

- The SPaT message is used to provide the current signal phase timing data (times at which signals will change) for one or more signalized intersections, as well as other time of day status details. All SPaT messages link to MAP messages to convey the roadway details and to link the signal controller phases to the correct set of lanes.
- The all-purpose BSM is used by both light-duty vehicles and other types with various Part II content present, depending on the applications being supported. See the different J2945/x documents for further details. In simple terms, all equipped vehicles broadcast a stream of BSM messages at a 10Hz rate. Nearly all application exchanges (Vehicle to Vehicle (V2V), Vehicle to Infrastructure (V2I), Vehicle to Everything (V2X)) make use of the presence of BSMs as a prerequisite for operation.
- The TIM is designed to send text messages of traffic condition. TIMs will not be used in this project, except possibly as part of the RSU vendor's CV FSP application. TIMs will be tested for driver messaging as part of RSU functionality, but, other than possibly for FSP, driver messaging will be done exclusively, for now, with KanDrive.
- The SRM is a message sent by a Cellular Vehicle to Everything (C-V2X) equipped entity (such as a vehicle) to the RSU in a signalized intersection. Vehicles approaching an intersection use this message to affect the signal operation. This is how traditional preemption and priority requests are handled for intersection safety in 5.9 GHz C-V2X systems.
- The SSM is a message sent by an RSU in a signalized intersection. It is used to relate the current status of the signal and the collection of pending or active preemption or priority requests acknowledged by the controller. Any prior request services (SRM messages) and their outcomes are reflected here as well. This message, therefore, serves as a means to acknowledge signal requests.

Provider Service Identifiers (PSIDs) are message/application classifiers and Service Specific Permissions (SSPs) are the specific bits required for OBUs and RSUs to verify whether a given message sender was authorized to indicate certain message content for a given PSID. The PSID and SSP are indicated in the message sender's Institute of Electrical and Electronics Engineers (IEEE) 1609.2 signing certificate. For security, each piece of CV equipment – RSU, OBU and the WTMC service must be enrolled in SCMS by the manufacturer and have an enrollment certificate in order to obtain operational certificates. This allows the association of application messages to trusted users in the CV ecosystem.

Certificate types include the following:

Enrollment Certificates – Used by each device for requesting operational certificates from the Certificate Management System (CMS). Operational certificates may be of type Pseudonym, Application or Identity

Pseudonym Certificates – used by OBUs when privacy protections are needed

Application Certificates – used by RSUs and the TMC Authority to perform V2I/I2V application messaging to surrounding devices

Identity Certificates – used by OBUs to identify/authenticate themselves when identity is specifically required for enabled applications like FSP

KDOT will use Pseudonym Certificates. Pseudonym Certificates for OBU equipped vehicles will include the PSID/SSPs from both "OBU Message PSIDs for Pseudonym Certificates" and "OBU Message PSIDs for Identity Certificates for Fleet Vehicles." It is important for OBU Suppliers and KDOT Districts to ensure that only OBUs for Fleet Vehicles are provisioned with this combined set of PSID/SSPs.

The primary CV functionality will be Freight Signal Priority (FSP). FSP will use SPaT, MAP, SRM, SSM and TIM data in the FSP app running in the RSU.

4.3 Description of the Proposed System

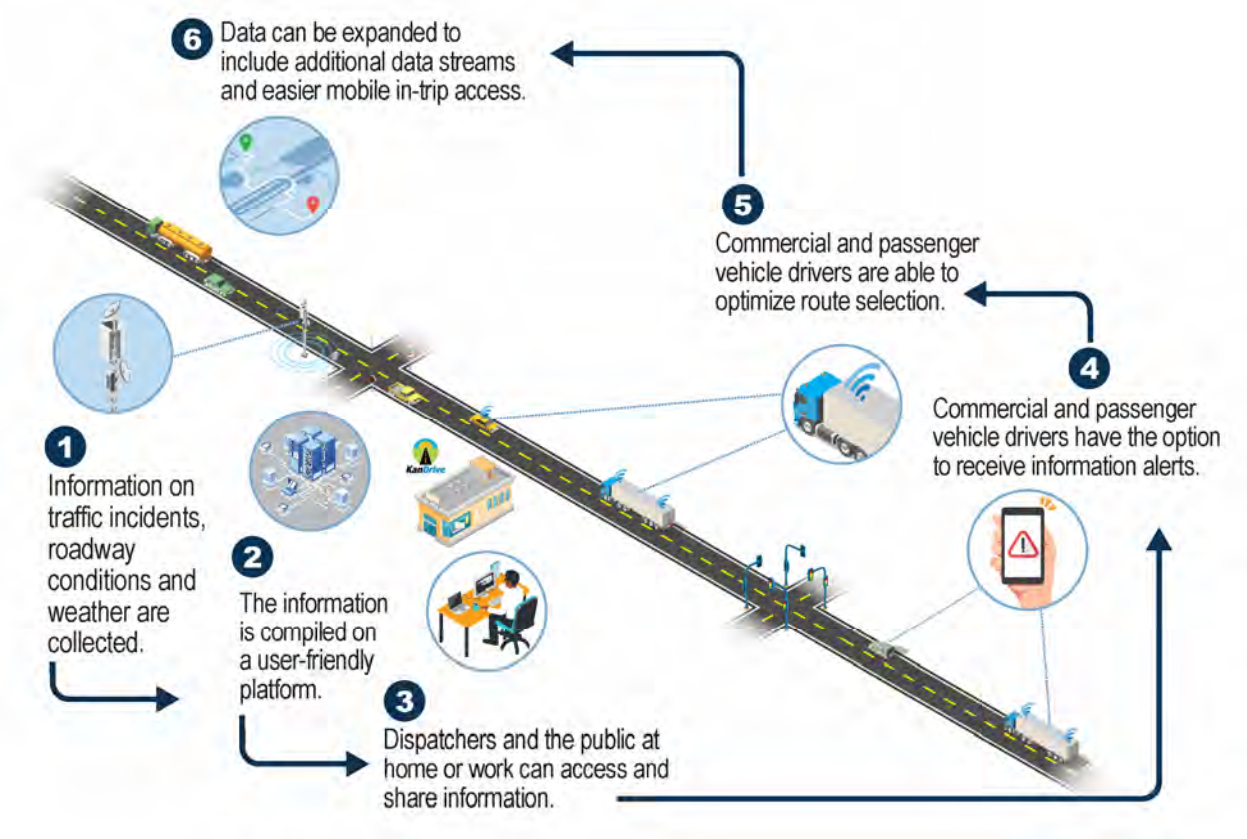
KDOT plans to expand the ITS including CV capabilities and technology on the U.S. 83 Advanced Technology corridor. This will be accomplished with four distinct groups of enhancements. The four groups are KaITS improvements, KanDrive improvements, Roadside Technology improvements, and CV Technology. Table 4 summarizes the system enhancements envisioned with a brief statement of purpose. The four subsections following (Sections 4.3.1 – 4.3.4) further explain the functionality of the four groups.

Table 4: Summary of System Enhancements

System Enhancements	Enhancement Purpose
KaITS	To provide: • Integration of third-party and crowdsourced data (e.g., INRIX, HERE, REKOR) • Interface and processing improvements with KanDrive in support of new information sources in the project
KanDrive	To provide enhancements to: • Communications with KanDrive users o Integration into CarPlay, Android Auto and Alexa o Detour routes reported with audio messages o High wind and visibility warnings o Oversize truck warnings • KanDrive API for data collection and sharing o Public reporting o Work zone data o Recommended detours o Oversize vehicle locations
Roadside Technology Improvements	
Fiber Optic Cable	To provide 90 miles of seven-way duct and fiber backbone from I-70 to Garden City enabling the project deployments (under separate contract)
RWIS	To provide new sensors and some relocation to provide enhanced weather data for the U.S. 83 corridor, including wind and visibility warnings
CCTV Cameras	To implement four categories of cameras: 1. PTZ cameras at the existing and relocated RWIS sites 2. Additional cameras at high incident areas along the U.S. 83 corridor 3. PTZ cameras for spot congestion monitoring 4. PTZ cameras at signalized intersections where FSP is implemented
Vehicle Detection System (VDS)	To provide detection of trucks approaching a traffic signal to complement CV-based FSP and to provide a count of all vehicle types, including oversized vehicles
Dynamic Message Signs (DMS)	To provide incident warnings, travel advisories, TPIMS truck parking availability and other informational messages
Spot Congestion Monitoring	To warn drivers of congestion at sites that have repeated traffic congestion
CV Technology	
RSUs	To provide bi-directional communication of CV data to OBUs and to the WTMC
RSU-compatible signal controllers (or adaptive hardware and software)	To provide traffic signal-RSU, bi-directional communications for use by CV applications
OBUs	To provide J2735 message set data for CV app testing and use in FSP
CV applications and support	To provide for: • FSP • Intersection Speed Warnings (SPaT and MAP) • CV Data Warehousing • CV system support from SCMS

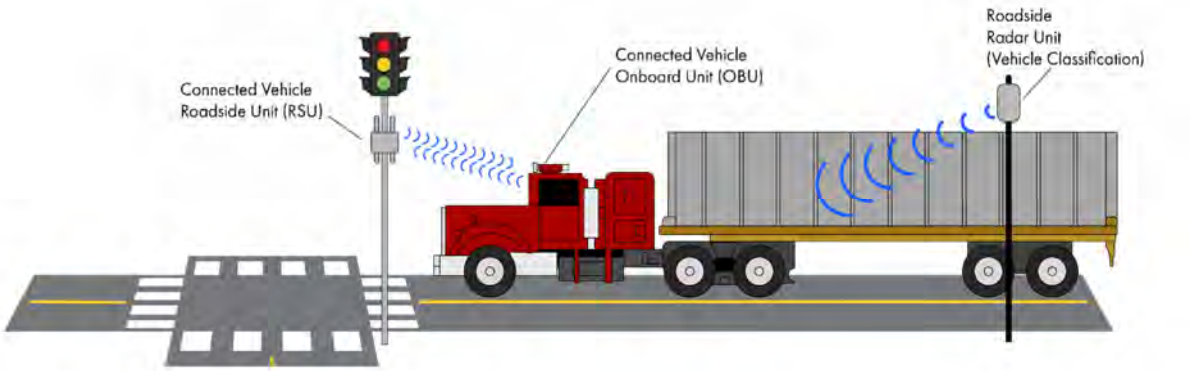
Figure 4 illustrates the overall system concept linking components listed in Table 4. The figure is a high-level schematic of the corridor operations and technologies. This figure shows how information collected from ITS technologies mounted on the roadside are collected by the WTMC resulting in a message being disseminated by KanDrive so that drivers and dispatchers have the situational awareness of corridor conditions.

Figure 4: Proposed New and Enhanced Functionalities



Also, not shown in Figure 4 are the CV operations. The CV RSU will be pole or signal mast mounted. The RSU communicates with the OBU in the vehicle, as illustrated in Figure 5. Additionally, a radar unit (e.g., VDS) can assist with identifying and counting all vehicles and vehicle types, unlike OBUs which will only identify BSMs from OBU-equipped vehicles. The radar unit will also be used to request signal priority for trucks.

Figure 5: FSP Intersection Configuration



The KaITS and KanDrive system software and interfaces are shown in Figure 6. The software changes and new components are discussed in the following sections.

Figure 6: WTMC Software and Interfaces to Hardware

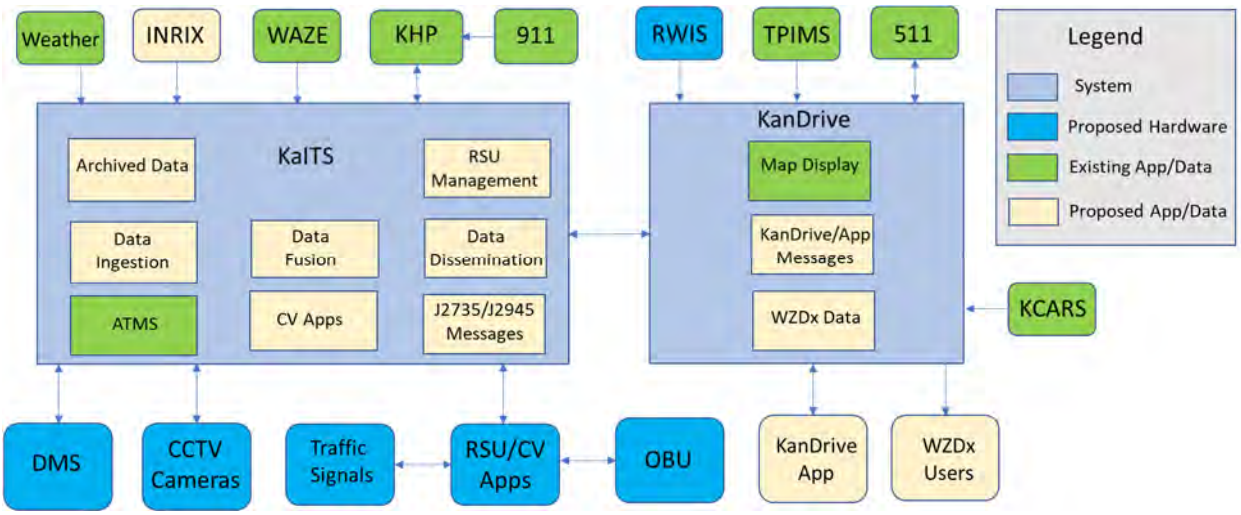
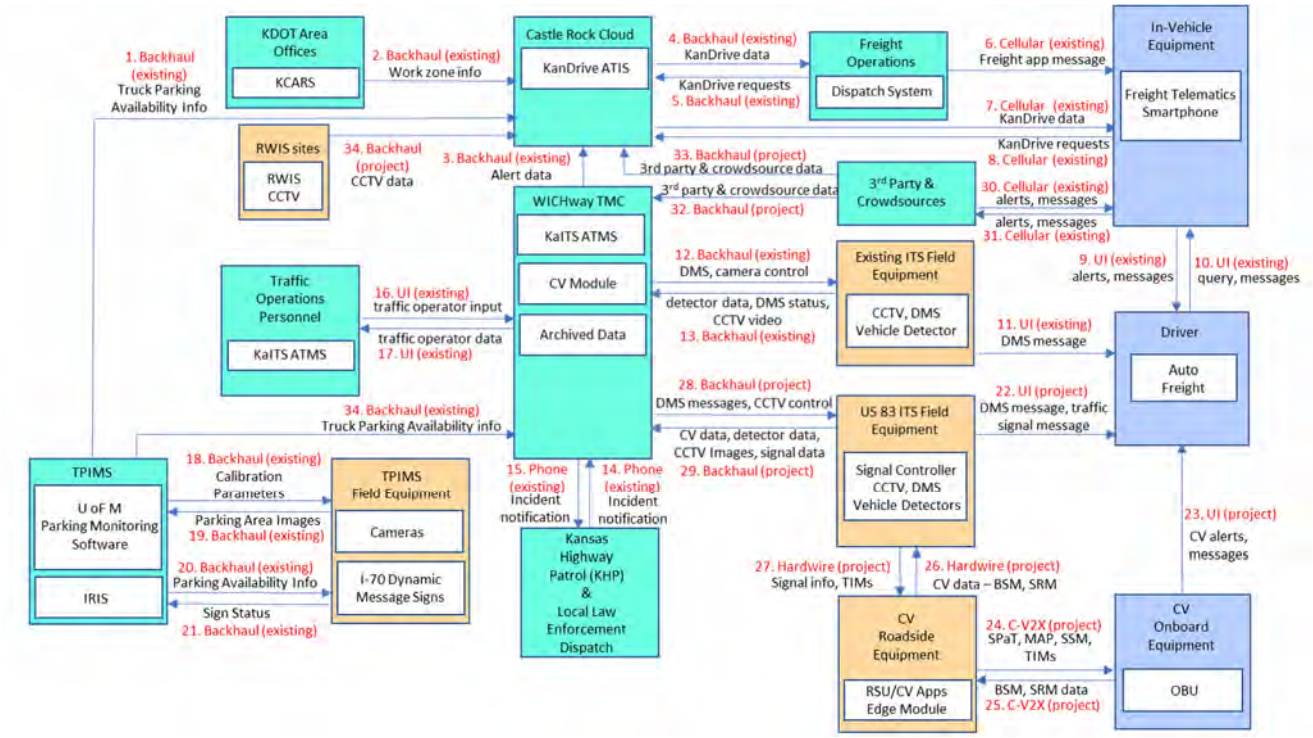


Figure 7 extends the illustration of the current system that was shown in Figure 3 to include the proposed system with new ITS elements added. It similarly uses the WTMC as the central point of view for discussion.

Figure 7: Proposed System Diagram with Data Flows and Communications Media



As in Figure 3, this diagram represents data flows and communications media. KanDrive exists in the cloud. KaITS is shown as part of the WTMC and could be separated to the cloud as well, but this representation reduces complexity of the figure.

New data flows are shown in data flows 22 – 34. Data flows 28 and 29 connect the new U.S. 83 field equipment to the KaITS and are shown as on project because the FOC is being added to U.S. 83. The figure adds third-party and crowdsourced data to the system, which can feed to KaITS and KanDrive. Data flow 34 provides parking availability data to KaITS for display on new DMSs along U.S. 83 approaching I-70.

Connected Vehicles

On the bottom right are boxes for the new CV Roadside Equipment and CV Onboard Equipment. The CV BSMs and FSP requests and permissions will be counted and archived at the WTMC with other traffic data for performance evaluation.

As discussed in Section 4.2.1, CV equipment will communicate Society of Automotive Engineers (SAE) J2735 message sets to RSUs that will forward to the WTMC for processing in use for local intersection applications. Message types include most prominently:

- Basic Safety Messages (BSMs)
- Signal Phase and Timing (SPaT)

- Map geolocation (MAP)
- Traveler Information Message (TIM)
- Signal Status Message (SSM)
- Signal Request Message (SRM)

These message types are shown in Figure 7. Message data for local intersection applications, such as FSP, will be processed at the RSU and the data will also be sent to the WTMC for collection, storage and system evaluation along with BSMs.

The SCMS, which is essential to the CV system, is not shown here since it will exist as a separately run system. Project architecture changes are recommended to the SITSA and are discussed in the PSEMP, Section 3.2 and in the SERF.

The following subsections discuss essential background knowledge and functionality of the enhancements in the order shown in Table 4.

4.3.1 KaITS

KaITS is an ATMS package supported by SwRI, also known as ActiveITS, that was developed by Florida DOT and the Texas DOT and licensed to KDOT, among other states. The system is a standards-based platform that supports the WTMC's daily needs for incident management and ITS integration. ITS systems include the following devices and applications: CCTV, DMS, vehicle detection, CV and RWIS support. KaITS does not directly manage traffic signals but could be configured to download information from signal controllers.

Currently, KDOT has one deployment of KaITS and it supports close to 300 CCTV and DMS devices in Kansas. KaITS has proven to be a stable platform and can grow with the addition of new devices as allowed by the new FOC being added to U.S. 83 (project KA-6234-01). Roadside devices will communicate the information to the WTMC where the KaITS will process and provide information to KanDrive. KaITS also provides real-time traffic, safety, and weather information to motorists through DMSs and enables collaboration between KDOT traffic managers.

4.3.1.1 Incident Detection and Communication

Incident detection and communication will be integrated into the corridor in two ways. The project will make use of third-party and crowdsourced data yielding low-cost incident detection over the corridor. The project will improve the availability of real-time travel data that will enable KDOT to take a more proactive and effective response to disruptions in corridor operations. Through the project's data collection, analysis, and distribution, KDOT will improve incident management, response to weather hazards, and work zone management as its real-time situational awareness is increased. This also will enable KDOT to more effectively:

- Address congestion and staging of commercial vehicles during peak agricultural season by providing data to freight dispatchers for improved decision support.

- Present roadway conditions, work zone information, incident information, and more to commercial and non-commercial travelers before they reach a congested segment of the system.
- Detect incidents and more quickly respond to these incidents thereby reducing traffic congestion as well as the risk for secondary crashes in the resulting backup of traffic.
- Fill rural and statewide data gaps for Kansas with greater travel data in this rural area.

The second method of enhanced incident detection will occur through automated incident detection implemented through roadside detection devices which will monitor traffic conditions and alert to changes in conditions. This detection will be implemented at strategic locations prone to traffic incidents and congestion. These detection devices may include a mixture of VDS and video analytics, depending on the location within the corridor. Roadside devices will communicate the information to the WTMC where the KaITS will process and provide information to KanDrive.

KaITS will need to interface with and process improvements made to KanDrive in support of new information sources in the project. KaITS will need to receive data and notify operators about driver incident reports provided through the KanDrive app. These KanDrive improvements are discussed next.

4.3.2 KanDrive

KanDrive is an ATIS package supported by a vendor, Castle Rock Associates, Inc. KanDrive is KDOT's web platform for automatically and continuously updating the traveling public, freight dispatchers, and freight drivers with timely weather conditions, construction detours and closures, and traffic-impacting incidents on interstates, U.S. highways, and Kansas routes. KanDrive uses an interactive map of Kansas roads that provides graphical and visual depictions of road conditions in real-time on computer and mobile devices. The platform is fed by KaITS and several other electronic sources (see Figure 2) from across the state and KCARS for operators to manually enter information directly. Information is provided in formats tailored to desktop computers and personal information devices (PID) using the KanDrive smartphone application. The smartphone application has a "TellMe" feature that provides audio alerts to drivers running the app.

The U.S. 83 corridor project will expand KanDrive's ability to leverage its commercial vehicle mode to better serve logistics-driven industries with richer information on current conditions. Currently, companies can create text and email alerts pertaining to specific or heavily traveled routes, weigh stations, and rest areas. Alerts can be served auditorily to minimize driver distractions.

The following new features will be added to KanDrive as part of this project, as shown in Table 5.

Table 5: KanDrive Enhancements

KanDrive Enhancement	Enhancement Detail
Public reporting to KanDrive web and mobile app	Provides app users the ability to submit reports about issues encountered
KanDrive for CarPlay	Provides in-vehicle, hands-free control of the KanDrive app via vehicle's CarPlay interface
KanDrive for Android Auto	Provides in-vehicle, hands-free control of the KanDrive app via vehicle's Android Auto interface
KanDrive for Alexa in-vehicle and home speakers	Provides control of the KanDrive app via Alexa Home devices and vehicle's Alexa Auto interface
Work Zone Data Exchange (WZDx)/Smart Work Zones	Provide WZDx formatted data to make harmonized work zone data available for third party use
Detours for the public and 3rd party navigation apps	Provide data on recommended detours where it is important to emphasize public rerouting
RWIS integration	Integrate data from RWIS sensors to provide high wind and visibility warnings
Oversized vehicle warnings	Monitors oversized vehicle movements and anonymously displays oversized vehicle locations on KanDrive

4.3.3 Roadside Technology Improvements

Several subsections follow covering the additions and enhancements of FOC, RWIS, CCTV cameras, VDS, DMS and spot congestion monitoring on this project.

4.3.3.1 Fiber Optic Cable (FOC)

The new FOC with over 90 miles of seven-way duct and fiber backbone from I-70 to Garden City will enable the project deployments. The FOC is being deployed under a separate contract (KA-6234-01). The project design and implementation contractor will provide for interfacing of the project equipment with the FOC.

4.3.3.2 Roadway Weather Information System (RWIS)

The addition of new RWIS data collection sensors connected to the WTMC via the FOC will improve the situational awareness of WTMC operators to inclement weather conditions including fog, dust storms, and high winds. The WTMC can use real-time data to distribute corridor conditions to the users and responders allowing them to make better travel decisions and incident response.

The RWIS data will be enhanced and phased from cellular connections which will be replaced by FOC deployed in the project. This will allow critical weather information to be obtained more

quickly and reliably by KanDrive to facilitate visibility and wind warnings. The weather data will be made available to the DTN RWIS Data Management System by FOC replacing the existing cellular connections used today. KanDrive will get the RWIS data from DTN for display and use in generating alerts for high winds and visibility problems. The alerts will go from KanDrive to the WTMC.

One RWIS site, located north of Scott City near U.S. 83 and K95, will be relocated to a location along the corridor. Visibility sensors will be added to the three RWIS sites along the corridor. Additional wind speed and visibility sensors will also be deployed along the corridor at critical locations. These sensors will be connected back to one of the existing RWIS sites. These remote sensors will likely be deployed in conjunction with cameras to use the camera pole for mounting.

4.3.3.3 CCTV Cameras

Additional traffic cameras will be added to facilitate travel information collection and distribution. To provide the needed video several camera types will be included in the design. These include:

1. PTZ cameras at the existing and relocated RWIS sites
2. Additional PTZ cameras at high incident areas along the U.S. 83 corridor
3. PTZ cameras for spot congestion monitoring
4. PTZ cameras at signalized intersections where FSP is implemented

Cameras may also be used to classify vehicles where they are warranted and are not redundant with respect to VDS classifications. The real-time video from stationary cameras will be used by WTMC operators to provide accurate information to motorists allowing them to make informed decisions regarding weather, traffic, and work-zone conditions.

Selected sites where routine spot freight congestion occurs, such as near heavily used road cuts for agribusiness deliveries and departures, will be monitored. Spot congestion sites will include CCTV monitoring and video analytics alerts to WTMC operators so that messages to warn drivers upstream and downstream of the congestion can be posted.

4.3.3.4 Vehicle Detection System (VDS)

VDS, such as microwave or video analytics, will be added to facilitate traveler information data collection and distribution at critical spot locations. Automated monitoring of traffic by VDS allows real-time detection of congestion and incidents, providing for faster situational awareness for U.S. 83 corridor traffic operations.

VDS will not be deployed along the entire corridor. The VDS units will be deployed to classify vehicles approaching traffic signals to allow requests for FSP. VDS may be used for data collection at traffic signals. The FSP will use both VDS and CV as triggers.

4.3.3.5 Dynamic Message Signs (DMS)

DMSs are a popular information source for commercial drivers and the general traveling public. They provide drivers, who are not using CV applications, an alternate information source on travel conditions ahead. The project will deploy additional DMS in the corridor serving traffic in both the northbound and southbound directions. Used with new RWIS data collection sensors, DMS may be used to support drivers at any location near high profile truck blow-over sites. The U.S. 83 interchange at I-70 may provide a useful location as a major decision point in the road network and other locations are under consideration. On DMSs approaching I-70, truck parking availability from the TPIMS lots along I-70 can also be displayed on the signs.

The signs will be located at key decision points to provide users with timely travel information. The DMSs will allow users to make informed decisions regarding whether to divert around incidents, change their travel plans, or proceed with caution.

4.3.3.6 Spot Congestion Monitoring

To warn drivers of congestion at hot-spot sites that have occasional but repeated traffic congestion, a package of technologies may be applied. One option is spot detection where VDS (microwave or video analytics) would be deployed to detect the presence of congestion on the roadway. They would be positioned at tactically useful locations such as at the high truck volume roadway entry/exit points.

4.3.4 CV Technology

The new CV technology will include the use of RSUs and OBUs. The project does not involve vehicle-to-vehicle (V2V) communications, but only vehicle-to-infrastructure (V2I) communications.

4.3.4.1 RSUs

RSUs are industry standardized[1]. RSUs are mounted on a standalone pole or traffic signal mast pole. RSUs send Society of Automotive Engineers (SAE) J2735 message sets over the CV-dedicated Cellular Vehicle to Everything (C-V2X) 5.9 GHz frequency band, which is the officially designated ITS frequency. C-V2X uses the 3rd Generation Partnership Project (3GPP) standardized 4G LTE or 5G mobile cellular connectivity to exchange messages between vehicles, pedestrians, and wayside traffic control devices such as traffic signals. C-V2X use has a limited range in the order of 600 - 1350 meters based on industry testing [2].

[1] RSU Standard Connected Transportation Interoperability (CTI) 4001 v01.00, a connected intersection-ready Standard of AASHTO, ITE, NEMA and SAE International, September 2021.
[2] Qualcomm Technologies, Inc. *C-V2X Technical Performance: FAQs*, October 11, 2019 (80-PE732-67 Rev. A).

RSUs will be located at the four signal controllers for CV-based FSP. In addition, RSUs may be deployed at DMSs along the corridor to demonstrate functionality in typical rural highway conditions.

4.3.4.2 RSU-Compatible Signal Controllers

Implementation of FSP will require upgrading the traffic signal controllers at the intersections along with firmware that enables priority requests. The signals are owned and operated by the cities of Scott City and Garden City, so the KDOT will need to get an interagency agreement with the city to make the needed upgrades and implement FSP. In Scott City the FSP will not be implemented at the pedestrian signal.

The FSP application will be implemented at the two traffic signals in Scott City and the two traffic signals in Garden City using two different technologies to request priority, CV technology and VDS. They will be used in a complementary manner to determine that trucks are approaching an intersection. FSP will either extend the green phase for U.S. 83 through movement or request an earlier return to the green phase for the U.S. 83 through movement. The priority request will not preempt cross-street or pedestrian phases.

4.3.4.3 Onboard Units (OBUs)

In this project OBUs can be of two types that perform the same functions. A standard J2735 OBU that connects over the air to an RSU via C-V2X by means of:

- A unit built into the vehicle by the OEM
- An aftermarket unit, added to the vehicle after manufacture.

The market penetration of trucks with OBUs using the corridor will be low for the foreseeable future. The system integration contractor will use their own OBUs to test the RSUs, but that effort will only last until system acceptance. Once system acceptance is complete, the data will show the use of OBUs on the roadway. It is anticipated that that number will be very low. As a contingency, aftermarket OBUs will be implemented on private commercial trucks or KDOT District vehicles that regularly use the corridor. This may require FHWA guidance on fair distribution of OBUs to private entities.

One advantage of using KDOT vehicles is that it avoids issues that arise in equipping privately owned trucks. Giving volunteer local companies OBUs might be possible if FHWA allows it. However, issues of fairness may arise in distributing the OBUs. With a sparse data set of users, it could be obvious that the vehicles were from volunteer sources, making privacy a potential issue. The trucks would also need to be vehicles that regularly use the corridor or are assigned to the corridor. Supplying private companies with OBUs is preferred, but these considerations may make deployment in KDOT District vehicles more advantageous.

4.3.4.4 Proposed CV Applications

KDOT will be installing RSUs at the four intersections along the corridor which are in Garden City and Scott City. The Scott City signal controllers and cabinets will need replacing to work with RSUs and to implement their proposed functionality, as the controllers are 30 years old.

Based on projected changes to the Statewide ITS Architecture (SITSA), discussed further in the PSEMP and in the Systems Engineering Review Form (SERF), new functionalities will be added to the existing SITSA that use several CV elements from the Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT):

- CVO06 – FSP
- DM01 – ITS Data Warehouse
- DM02 – Performance Monitoring
- TM04 – CV Traffic Signal System
- SU01 – CV System Monitoring and Management
- SU08 – Security and Credentials Management

ARC-IT service packages have overlapping functionalities and can be combined and reduced to several of primary importance to the project. The primary applications initiated with this project include:

1. FSP at intersections (CVO06, TM04)
2. Performance Monitoring – using BSMs, etc. in data collection, storage, processing and system monitoring and management (SU01, DM01, DM02)
3. System support from SCMS (SU08)

The ARC-IT service packages are used here to help identify only the CV functionalities being introduced. Other ARC-IT service packages are introduced in the project and are discussed in the PSEMP and SERF.

Freight Signal Priority (FSP)

The FSP application requests priority as an OBU-equipped truck approaches an intersection. The application uses SAE J2735 MAP messages, which define a MAP message for intersection geometric data in CV use. The FSP app uses the intersection MAP to determine the vehicle's vicinity to the intersection and to determine when to make the priority request. Figure 5, presented earlier, illustrated the communication of the OBU with the RSU.
The FSP will use both VDS and CV as triggers. CV FSP will be assisted by a VDS for FSP at the same signals, as shown in Figure 5.

CV Performance Monitoring

Whether it is more cost effective to use KaITS speed data or purchase third-party archived data from a crowdsourcing vendor will be determined in the design phase.

CV Performance Monitoring includes CV System Monitoring and Management (SU01), ITS Data Warehousing (DM01) and Performance Monitoring (DM02) in ARC-IT and aims to provide access to transportation data to support transportation planning, condition and performance monitoring, safety analysis, and research. It is particularly important to the project's performance evaluation. Data Warehousing of CV data includes BSMs, SRMs, and SSMs received, TIMs sent and other ITS traffic data from VDS, RWIS and so forth. Details of the data warehousing, its memory needs, etc., will be sorted out in the design phase.

Of special note with respect to CV data are BSMs, which are essential for CV operations. BSMs are generated by the vehicle's OBU 10 times per second (10 Hertz (Hz)). The BSM data set includes:

- Timestamp
- Latitude
- Longitude
- Elevation
- Position Accuracy (estimate)
- Speed
- Heading
- Acceleration
- Yaw Rate
- Steering Wheel Angle
- Transmission State
- Brake System Status
- Vehicle Size (Length and Width)
- Path History and Path Prediction
- Event Flags (e.g., hard braking, traction control, etc.)
- Exterior Lights

The most relevant BSM data to project monitoring and evaluation will be used in the CV apps and will be collected, stored and processed, as discussed in the PEP.

CV System Support from SCMS

SCMS is shown in the ARC-IT as SU08, Security and Credentials Management, as a service package. ARC-IT changes are treated further in the PSEMP, Section 3.2.

SCMS has yet to be implemented in Kansas but is envisioned in the future, it may be initiated for the CV-based FSP at the four signals in this U.S. 83 project. KDOT will examine the needs and economics of its desired SCMS coverage and determine its SCMS policy as to the sharing of

SCMS regionally. Procurement of SCMS could be left to the systems designer or systems integrator to do as part of the project but might be undertaken by KDOT separately.

4.4 User Involvement and Interaction

The systems engineering procedures for user involvement are tailored according to the scope, complexity, and risk of the project. At this early stage of development, details of the U.S. 83 Advanced Technology system user involvement are unclear but not daunting. The U.S. 83 Advanced Technology system will be built to pair with and complement the operational functions of current systems. WTMC and KanDrive user interactions and resources may change due to the introduction of new device types.

The system designers and integrators will extend existing KaITS and KanDrive operations and document Standard Operating Procedures (SOPs) (see *Kansas Department of Transportation: Final System Design Document for KAITS and KDOT Sign and Camera SOP*) for the use of the U.S. 83 Advanced Technology system. The SOPs will include operational interfaces and maintenance requirements of field equipment (e.g., RSUs and OBUs). The system integrator will train, as needed, the WTMC administrators and operators and any other system users or operators in the use of the U.S. 83 Advanced Technology system, who will use the SOPs accordingly.

4.4.1 System Maintainers

KDOT's maintenance contractor personnel shall be trained to test and maintain new equipment. Maintainers will attend the vendor training and employ the training to test the:

- RWIS sensors
- CCTV cameras
- Vehicle detectors
- New traffic signal controllers
- RSUs and OBUs to ensure that the RSU equipment works correctly with OEM and/or aftermarket OBUs to include:
  - BSM, SPaT, MAP, SRM, SSM and TIM data comply with SAE Vehicle to Everything (V2X) J2735SET_202007 or latest version
  - SPaT message status matches the signal head status
  - BSMs comply with SAE J2735, per the pending or published status.

Vendor installers will be responsible to install and test the vehicle OBUs according to TRR and ORR plans. TRR and ORR plans are further explained in the U.S. 83 Advanced Technology PSEMP.

4.4.2 WTMC Operators

WTMC operators will monitor their workstations for system responses, including the user interface of the KaITS and KanDrive systems for alerts that are generated from data received by the new advanced ITS and associated applications. The operator's general workflow will not change, but

additional information and volume of information will be available to them for situational awareness and alerts that are occurring. Additionally, as they normally produce messages for DMSs, they will also produce messages to be broadcasted to vehicles for in-vehicle message display.

4.4.3 KDOT and Commercial Fleet Drivers

OBUs will be installed on private commercial trucks or KDOT vehicles to ensure use of the RSUs and ongoing verification of TIMs. Drivers will be trained in the use of the OBUs and to expect TIMs and FSP at the Scott City and Garden City intersections. One of their duties will be to report any systems failures that may appear.

4.5 Assumptions and Constraints

Assumptions and constraints include:

- KDOT obtaining timely FCC licensing for project related RSUs
  - Waiver for use of C-V2X
- KDOT obtaining an SCMS platform
- Stakeholder coordination, cooperation and approval of plans
- Agreement with Scott City and Garden City public works departments for integration of their signals with RSUs and FSP app
- Coordination with private commercial truck operators or KDOT District fleet user for CV FSP use
- Coordination with KDOT District RWIS use and verification
- Development and implementation of an explicit Operations and Maintenance (O&M) Plan acceptable to all partners (e.g., Scott City and Garden City)
- Technology changes and advancement during the life of the project are manageable
- Reduction of risks that could lead to schedule slippage
- Maintaining contractor oversight
- Operations training
- Maintenance training
- Sufficient Operations and Maintenance funding
- Proprietary equipment agreements
- Equipment warranties transferable to KDOT

Software will adhere to functional requirements set in the RTVM to be completed by the system designer. A first draft of the RTVM will be completed by the systems engineering firm for use in creating the Request for Proposal (RFP), as delineated in the PSEMP.

All deployed CV devices are expected to be OmniAir Certified[3], per its nationally applicable standards for CV, at the time of deployment. Pre-deployment testing will be performed to ensure that functional and performance requirements are met – this testing will be especially important when multiple vendors are involved so that progress (operability and adherence to requirements and design) can be assessed and verified throughout the pre-deployment collaboration process. Vendor proposals and past performance will be scrutinized to ensure the applications provided by a vendor is (or will be) capable of meeting performance requirements.

The WTMC will receive messages that are captured by roadside equipment and allow WTMC operators to monitor activity on the network as well as the status of equipment deployed for the CV environment. Captured messages (e.g., BSMs, SSM, SRMs) are to be filtered to remove any Personally Identifiable Information (PII) and only then archived by the operating system. This feature is part of the CV environment within KaITS. Its interfaces with other elements in the CV environment will be the responsibility of the RSU vendor to develop as specified in the system requirements documentation.

4.6 Identifying, Assessing and Mitigating Project Risks

As mentioned in Section 1, the project itself is termed "high risk", because of new software, technology, systems and interfaces, and must, therefore, undergo high-risk systems engineering development and testing, scaled accordingly. ATCMTD projects use advanced and new technologies, so they are considered high risk from a systems engineering viewpoint. However, there are no significant obstacles to deployment and certainly no insurmountable ones among the activities to be accomplished. Since the project risks primarily impact the project schedule, identifying, assessing, and mitigating risks are presented in the PSEMP (see PSEMP, Section 7).

4.7 Support Environment

This section describes the support environment that applies to the proposed system. It describes CV device standards, FCC licensing of RSUs, and the training, operations, and maintenance services necessary to keep the system active.

Tailoring the support environment according to the scope, complexity, and risk of the project, given the system's integration with existing software deployments, and at this early stage of the project development, means that project details will need to be refined throughout the timeline of the project.

The existing WTMC environment will not change substantially, and field deployment will follow a standard KDOT and ITS systems engineering approach.

[3] A consortium of members – industry leaders and transportation professionals – working to accelerate interoperability. Omni Air provides the opportunity for members to work collaboratively to develop and vote on requirements for national certification programs. Members have the opportunity to shape the future of tolling, connected vehicles and ITS technologies. See https://omniair.org/

4.7.1 CV Device Standards

The support environment in this project is provided by KDOT devices and communications infrastructure. KDOT supports CV project development through standards set by all applicable Manuals and Guidelines including those of the KDOT, FHWA, SAE, IEEE, American Association of State Highway and Transportation Officials (AASHTO) and all others as appropriate. CV equipment will be OmniAir Certified.

KDOT has typical detail drawings and specifications that are used for ITS projects. These drawings and specifications are refined annually to account for technology changes and enhance based on ITS designers and contractors.

4.7.2 Federal Communications Commission (FCC) Licensing

The Federal Communications Commission (FCC) has mandated changes to RSU communications that KDOT, agencies, and vendors nationally are working to adopt. The project will require FCC licensing of RSUs.

4.7.3 SCMS

The project will provide SCMS for data security. SCMS is discussed in several sections of this report. See especially Section 4.3.5.4.

4.7.4 CV Training

The RSU and any OBU provider(s) will supply classroom training(s) of equipment installation, configuration, integration, and commissioning of its RSU, OBU, equipment, assemblies, and all related components and capabilities. This training should also include a field trial of the equipment, as in Section 4.7.5 immediately below, since one classroom training does not equate to the real-world implementation.

4.7.5 CV Installation, Integration, Configuration, Monitoring

The vendor(s) will install the RSUs, OBUs and any additional equipment (e.g., antennas) with oversight by and training of KDOT staff or representatives. The vendor will supply the RSUs, and related equipment and undertake or oversee installation by owner-agencies. The vendor will supply OBU(s) for testing of RSU functionality and use on private commercial vehicles or KDOT vehicles. The vendor will supply field installation oversight and integration support (by phone and on-site, as needed).

The vendor will test and ensure proper operations and C-V2X message sending between the RSUs and the WTMC, and OBUs. As part of this testing and approval effort, KDOT and the WTMC will support the SCMS vendor with testing the SCMS.

4.7.6 U.S. 83 Advanced Technology Project Software Training

The vendor(s) will arrange for the training of WTMC operators in the use of the U.S. 83 Advanced Technology project software. The WTMC or an appropriate contractor entity will perform the installation and test with WTMC oversight.

4.7.7 U.S. 83 Advanced Technology Project Software Installation, Integration, Configuration, and Monitoring

The vendor(s) shall install, integrate, configure, and monitor the U.S. 83 Advanced Technology project software. The PSEMP discusses these responsibilities in greater detail.

4.7.8 Standard Operating Procedures

The vendor(s) shall work with KDOT and the WTMC to extend the existing SOPs and develop new ones for the U.S. 83 Advanced Technology project software for normal and maintenance modes of operations (see Section 5, Operational Scenarios).

5. Operational Scenarios

The following user scenarios provide different views of stakeholders using the U.S. 83 system. In system development and product management, a user scenario is an informal, natural language description of one or more features of a system in operation. User stories are usually written from the perspective of a user of a system.

User scenarios provide operational details, ideally, with enough information so that the system developers and system integrators can develop the system to suit user needs. Writing scenarios from different points of view are also meant to expose system features that are incomplete and need more work, revisions, or redesign.

The U.S. 83 system adds new third-party and crowdsourced traffic data and weather data and CV services to allow for greater situational awareness of traffic and road conditions on the corridor. User scenarios will be examined for the following scenarios:

1. Normal Operations
    a. Work Zone Traffic Operations and Information Dissemination
    b. Severe Weather Condition and Traffic Operations Response
    c. FSP – CV and non-CV
2. Maintenance Operations
    a. CV and/or Signal Maintenance

System failures are under the domain of KaITS and KanDrive SOPs. Failures of services or equipment of the Advanced Technology project are treated as maintenance issues.

The U.S. 83 improvements will expand on the existing by:

- Expanding KaITS and KanDrive to integrate data from an enhanced third-party and crowdsourced and RWIS environment
- Providing data interfaces to disseminate third-party and crowdsourced data fused with other road data for app users
- Deploying CV RSUs at four intersections to improve the operation of the signalized intersections through use of SPaT messaging and FSP

Thus, the U.S. 83 system affects users by increasing and improving the data collected and data uses available, so the functionality of the entire system improves. That is, data for predictive crash and congestion analytics improve demand management and rescheduling options with resulting rerouting over the larger network.

It is not generally possible to separate these functionalities in terms of what users perceive. User perception will largely be affected by their use or nonuse of the KanDrive system.

5.1 Normal Operations Scenarios

5.1.1 Work Zone Traffic Operations and Information Dissemination

Overview: A driver travels on U.S. 83 from north to south and will encounter a work zone in 25 miles.

Concepts and Services Included: KDOT area personnel reporting to KCARS and KanDrive data processing, WTMC KanDrive app messaging.

Story: Chris is a truck driver with the enhanced KanDrive app and gets alerts of work zones well before arrival.

System and User Behavior: The KDOT area personnel input the work zone information into KCARS. KCARS sends KanDrive a list of work zones and geographic limits as they are input. Third-party info on average speeds informs KaITS operators of the queue northbound and southbound. KaITS operator generates an event alert. KanDrive shows where the work zone is and the delay and queue. The KanDrive app audio message reports that projected congestion will be occurring several miles ahead. The driver safely slows down prior to encountering the work zone queue with hands-free reception of the message.

Actions:

1. Chris asks the KanDrive app to determine the conditions of the road network ahead. Chris follows the auditory instructions which give U.S. 83 conditions ahead.
2. KCARS receives the KDOT Area personnel input on the work zones and geographic limits.
3. KCARS transmits the work zone information to KanDrive
4. KaITS receives third-party speed data in the work zone vicinity.
5. The KaITS operator generates an event alert for congestion ahead.

6. The KanDrive platform broadcasts the information including the work zone data in the WZDx standard format and information on the congestion.
7. KanDrive sends a message to Chris' smartphone which he receives by the KanDrive audio feature as he approaches the work zone.
8. Chris prepares to slow down safely prior to the queue.
9. KanDrive collects and saves a record of the message sent for later project evaluation.

5.1.2 Severe Weather Condition and Traffic Operations Response

Overview: A driver travels on U.S. 83 from north to south and will encounter high winds in 5 miles.

Concepts and Services Included: RWIS sensors reporting to KanDrive, KaITS and KanDrive data processing, WTMC KaITS to KanDrive messaging, KanDrive alerts to the public.

Story: Alex is a truck driver with smartphone using the KanDrive app and gets alerts of high-wind warnings well before arrival to the high-wind area.

System and User Behavior: An RWIS wind sensor sends KanDrive wind speed data. KanDrive generates a warning of high winds. Using third party and crowdsourced data KaITS informs WTMC operators of slow speeds near the site. KaITS sends data to KanDrive on the slow-moving traffic. KanDrive provides an alert about the slow-moving traffic. The driver receives the KanDrive messages and safely slows down prior to encountering the high-wind area.

Actions:
1. Alex is driving on U.S. 83.
2. The RWIS sends wind speed data to KanDrive over FOC.
3. KanDrive ingests the RWIS-generated winds speed data and generates a high wind warning and geographic location.
4. KaITS ingests third-party and crowdsourced info.
5. The WTMC operator assesses the slow traffic warning information and decides to enter an event.
6. KanDrive broadcasts a high wind alert for the area and an alert on the slow-moving traffic.
7. Alex gets KanDrive messages on his smartphone.
8. Alex prepares to slow down safely prior to the high-wind area.
9. KanDrive collects and saves a record of the message sent for later project evaluation.

5.1.3 FSP

5.1.3.1 CV FSP Scenario

Overview: A truck driver with an OBU travels on U.S. 83 from north to south and approaches an intersection in Garden City.

Concepts and Services Included: RSU interface with signal controller, FSP SPaT, SRM, SSM messaging, OBU messaging to/from RSU and KaITS data processing.

Story: Mickey is a truck driver with an OBU and wishes to get FSP at the upcoming intersection.

System and User Behavior: Mickey's OBU messages the RSU that the freight vehicle is approaching the signal ahead. The RSU checks the BSM against SPaT and MAP per the signal controller, processes the SRM, sends an SSM and TIM to Mickey's OBU that signifies the time remaining for freight vehicle to proceed and continues to stop side street traffic. Mickey drives through the intersection without stopping.

The RSU also sends the BSM, SPaT, SRM, and SSM messages to the WTMC where KaITS collects and saves the data and processes it, as needed, for operator review on the user interface and for the system evaluation totals of FSP messages received.

Actions:

1. Mickey has set up the OBU to request FSP as he approaches intersections.
2. The OBU sends an SRM.
3. The RSU receives his SRM.
4. The RSU processes the SRM in the FSP app.
5. The FSP app calculates that extending the green for the north-south movement is allowable.
6. The FSP app sends the green extension to the traffic controller.
7. The signal controller extends the signal head green for his vehicle and keeps it red for side street vehicles.
8. The RSU sends the SSM and a TIM to Mickey's OBU signifying that the signal will give his vehicle signal priority with a countdown TIM Message.
9. Mickey safely proceeds through the intersection without stopping.
10. The RSU and signal controller coordinate the new signal timings after the FSP extension times out.
11. Over FOC the RSU sends the J2735 messages – BSM, SPaT, SRM, SSM, TIM – to the KaITS interface.
12. KaITS ingests the data and processes the FSP status for operator viewing and for system evaluation.

5.1.3.2 Freight Vehicle Detector FSP Scenario

Overview: A corporate truck driver, without an OBU, travels on U.S. 83 from north to south and approaches an intersection in Garden City.

Concepts and Services Included: Freight vehicle detector interface with signal controller, FSP built into the signal controller, and KaITS data processing.

Story: Parker is a truck driver, without an OBU, and will get FSP at the upcoming intersection.

System and User Behavior: Parker's freight vehicle is approaching the signal ahead and is detected to be a commercial truck. The detector prompts the signal controller, the signal control determines the through green interval can be extended, the green signal display for U.S. 83 through traffic is extended and side street traffic continues to see red signals. Parker drives through the intersection without stopping.

The controller also sends the successful detector-based FSP to the WTMC where KaITS collects and saves the data and processes it, as needed, for operator review on the user interface and for the system evaluation totals of non-CV FSP messages received.

Actions:

1. Parker approaches intersection.
2. The vehicle detector sends a freight vehicle prompt to the signal controller.
3. The signal controller receives the detector prompt.
4. The controller processes the prompt in its software.
5. The controller software calculates that extending the green for the north-south movement is allowable.
6. The signal controller extends the signal head green for Parker's vehicle and keeps it red for any side street vehicles.
7. Parker safely proceeds through the intersection without stopping.
8. The signal controller coordinates the new signal timings after the FSP extension times out.
9. Over FOC the signal controller sends a message to the KaITS interface.
10. KaITS ingests the data and processes the non-CV FSP status for operator viewing and for system evaluation.

5.2 RSU and/or Signal Maintenance Scenario

Overview: A WTMC operator identifies a CV and/or signal maintenance issue and sends a maintenance message to the local area maintenance engineer who contacts the maintenance contractor.

Concepts and Services Included: Identification of a signal maintenance issue, WTMC operator CCTV verification, FSP and SPaT processing, freight vehicle detector processing, driver notification.

Story: Lou is the WTMC operator on duty when the system gives a notice that there is a signal maintenance issue on U.S. 83 in Garden City.

System and User Behavior: A traffic signal sends a notice to KaITS of an interruption in CV or signal service. A WTMC operator notices a signal maintenance issue on the KaITS user interface. The operators follow SOPs, to be developed with the design and/or systems integration firm, to identify the maintenance engineer to perform needed repairs and replacements with Maintenance of Traffic (MOT) oversight by the appropriate agency, as needed. WTMC operators, as needed, will create an incident event that will be sent out on KanDrive of where and when signal maintenance is being done to:

- KanDrive users
- 511
- Freight dispatch
- Information Service Providers (ISPs)
- Others to be determined

Actions:

1. The RSU or signal controller sends a service interruption message to KaITS.
2. Lou, the WTMC operator, sees a maintenance message on the KaITS screen and checks the nearest CCTV camera and RSU and signal data to verify a possible malfunction.
3. Lou follows the established SOPs for a signal or RSU maintenance problem.
4. Lou determines it is a signal issue.
5. Lou contacts the local area engineer responsible for maintenance of Garden City signals.
6. The area engineer notifies the maintenance contractor.
7. Per the SOP, Lou creates an event and composes a message via KaITS to send to KanDrive users.
8. KanDrive transmits driver notifications of the delay ahead caused by signal maintenance.
9. Drivers in the area proceed with caution.
10. Lou monitors traffic in the area via third-party and crowdsourced and CCTV data.
11. Lou composes messages to update travelers approaching the maintenance vehicle and crew of a capacity restraint.
12. Lou gets a return message from the area engineer or maintenance contractor when the repair is completed.
13. Lou ends the messaging to drivers once the repair is complete.

6. Summary of Impacts

The U.S. 83 Advanced Technology project will introduce technological advances to Kansas travel. The implementation of advanced ITS technology aims to improve vehicular safety and mobility and provide useful information to the system owners, operators and users. Drivers will see benefits from the new technologies (see Section 4.3, Description of Proposed System), such as weather warnings, work zone warnings incident warnings oversized vehicle warnings and FSP. KDOT, as the system owner, can expect to see gains in safety, mobility, and network operations.

The KaITS and KanDrive operations shall be minimally affected as most of the new technology will operate automatically with little, new operator oversight. Drivers using the KanDrive app will be empowered by hands-free operations with reduced distraction from handling of smartphones.

Several issues, addressed in the PSEMP, Section 7, may impact the project schedule. There is a need for CV testing to ensure SAE J2735 SSM messages over C-V2X work properly, as well as SCMS and WTMC CV functions. TRR and ORR plans drawn up by the systems integration contractor will need to address these tests. KDOT review, testing and approval may be needed. FCC licensing is necessary. SCMS will be supplied through a private KDOT vendor. A procedure for identifying an SCMS vendor will be arranged through KDOT's contracting process. It is

expected that CV OBU market penetration will increase as OEMs and aftermarket OBU suppliers include more CV features in the coming years. More drivers will get V2V capability and V2V safety alerts will enhance driver abilities to sense queuing in the traffic ahead, avoid intersection crashes, and negotiate other challenging situations. The WTMC will operate CV only in the V2I environment. The project will leverage available BSM and other vehicle messages for the U.S. 83 Advanced Technology implementation. It will be necessary to address reports of CV operational and security failures. The CV deployment puts in place the elements necessary for CV V2I intersection operations and safety alerts. Because CV data production, data use and messaging to vehicles is automated, most impacts to WTMC operations at this time will be limited to analysis of traffic signal efficiency and FSP utility.

There is a need to create an agreement with the local signal owners in Garden City and Scott City that covers initial installation of new equipment and ongoing maintenance. There will be a short-term need for RSU, traffic signal and OBU equipment, operations and maintenance training. For RSUs and agency fleet OBUs, maintenance will be ongoing, as with all signal equipment. Once installed and tested, the equipment problems are expected to be minor. CV and traffic signal testing will be ongoing to ensure the system continues to work as designed.

No significant environmental impacts are anticipated from the ITS elements of the project.

7. Analysis of the Proposed System

7.1 Alternatives under Consideration

Alternative systems are under analysis for inclusion in the project:

- Deploying OBUs in some local freight company and agricultural trucks is being attempted. This option has benefits but may introduce problems of selection fairness, dedication of trucks to U.S. 83 travel, and maintenance responsibility and liability, which would require agreements. It would also require FHWA approval.
- Consideration is being given to raising the public awareness of KanDrive and its new features, and especially hands-free use of the app and reporting of incidents.

7.2 Cost, Schedule, and Procurement Options

The project is supported by total funding of $21,174,997 with funding of $14,495,925 from KDOT and a FHWA ATCMTD Grant of $6,679,072 (68 percent match).

A PSEMP and PMP accompany this ConOps with a cost, schedule, and additional procurement details, as well as details of the work of the contractors. Procurement will follow KDOT rules for DBB contracts. The entire ATCMTD Grant will be managed with two DBB projects:

- FOC Deployment (KA-6234-01)
- Advanced ITS Technology Deployment (KA-6234-02).

The beginning of advanced ITS installation will coincide with the completion of the FOC contract. The advanced ITS Technology Deployment (KA-6234-02) will be done with a design consultant and a systems integration contractor in separate contracts. The consultant procurement will be qualifications based and the integration contractor procurement will be DBB.

The project will need to include the purchase of SCMS from a vendor. The availability of vendors will be explored through the KDOT contracting process.

The project start date was October 1, 2022, and it will run through the end of 2028. System acceptance will not end the project as the PEP requires data collection and analysis well into the operational period and the writing of an evaluation report and Final Report for FHWA.

7.3 Systems Engineering Plan

The PSEMP treats systems engineering management and the PMP covers overall project management.

The following is a preliminary summary of systems engineering project activities:

- Planning Phase – PMP, PSEMP, ConOps, DMP, PEP and draft RTVM
- Preliminary Design – RTVM, Interface Control Specification (ICS), Verification Plan
- Design Phase – FOC, Field Devices along with WTMC and 3rd party software
- Deployment Phase
    - Install RSUs, signal controllers, RWIS, DMS, vehicle detectors, CCTV cameras
    - Development and Integration of data systems and applications
    - Tests and Systems Acceptance – TRR and ORR Plans
- Operations and Maintenance Phase, including data collection and analysis
- Project Evaluation Report (PER)

7.4 Project Evaluation Plan (PEP)

The project Cooperative Agreement identifies the need for a PEP. As stated in the Cooperative Agreement, KDOT shall submit to FHWA for approval an Evaluation Plan, which shall include, at a minimum:

a) Statement of **Project Objectives**
b) List of **Evaluation Criteria** (e.g., quantitative performance metrics and/or qualitative assessments) tailored to the Project Objectives
c) Description of **Data-Collection** procedures tailored to these criteria, which could include, for example, before/after data, surveys, interviews, system-monitoring data, or other data needed to report on achievement of project objectives
d) Outline of **Evaluation Report** (1-page, draft list of topics to be addressed)

This PEP document addresses the required criteria in the context of the FHWA publication: *Evaluation Methods and Techniques, ATCMTD Program* (FHWA-HOP-19-053, Dec 2019). The guidance intends to assist grantees in designing and executing robust evaluations that enable them

to fulfill the reporting requirements of the ATCMTD Grant. The *Evaluation Methods and Techniques, ATCMTD Program* report shall be closely followed in the production of a final PEP and a resulting Project Evaluation Report (PER).

This project PEP is in the early stages of the project lifecycle and, as a living document, is expected to evolve and be revised as the project proceeds. The KDOT Project Manager, as Project Sponsor for the ATCMTD Grant Cooperative Agreement, shall submit the PEP to the designated FHWA Federal Project Contact (Kansas Division) Project Manager for FHWA oversight and approval. The KDOT Project Manager will then coordinate the execution of the PEP and will evaluate and revise the plan annually to include ongoing progress.

8. References

Table 6: References in support of U.S. 83 Advanced Technology Project

Document Name	ID, Revision, Date, etc.	Link, or Contact Info to Obtain
23 Code of Federal Regulations (CFR) Part 940, Intelligent Transportation System Architecture and Standards – Final Rule (latest edition).	Federal Regulation	23 CFR 940 - INTELLIGENT TRANSPORTATION SYSTEM ARCHITECTURE AND STANDARDS - Content Details - CFR-2021-title23-vol1-part940 (govinfo.gov)
Systems Engineering for Intelligent Transportation Systems: A Guide for Transportation Professionals	January 2007	https://ops.fhwa.dot.gov/publications/seitsguide/seguide.pdf
Systems Engineering Guidebook for ITS	Version 3.0, August 2020	https://www.fhwa.dot.gov/cadiv/segb/
Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT)	Version 9.1, November 2022	Architecture Reference for Cooperative and Intelligent Transportation (arc-it.net)
Guide to the Systems Engineering Body of Knowledge (SEBOK)	Version 2.7, October 2022	https://sebokwiki.org/wiki/Guide_to_the_Systems_Engineering_Body_of_Knowledge_(SEBoK)
Kansas Statewide ITS Architecture Plan	January 2008	Microsoft Word - Vol.1 KS Statewide ITS Architecture Plan v.1.00.doc (ksdot.gov)
Wichita Regional ITS Architecture	Updated 11/27/2006	Home (iteris.com)
V2X Communications Message Set Dictionary J2735_202007	Revised 7/23/2020	J2735_202007: V2X Communications Message Set Dictionary - SAE International
Connected Vehicle Deployment Technical Assistance Onboard Unit (OBU) Lessons Learned and Best Practices, FHWA-JPO-20-786	March 2020	https://www.pcb.its.dot.gov/documents/OBU_LessonsLearned_Report.pdf

Document Name	ID, Revision, Date, etc.	Link, or Contact Info to Obtain
Evaluation Methods and Techniques, Advanced Transportation and Congestion Management Technologies Deployment Program, FHWA-HOP-19-053	December 2019	https://ops.fhwa.dot.gov/publications/fhwahop19053/fhwahop19053.pdf
Creating a roadmap for successfully planning, implementing, and administering complex multijurisdictional transportation technology projects.	Submitted to Transportation Research Board (TRB) July 31, 2018	https://trucksparkhere.com/wp-content/uploads/2019/01/White-Paper.pdf
Connected Vehicle Pilot Deployment Plan, Comprehensive Transition Plan – WYDOT, FHWA-JPO-18-724	July 29, 2022	USDOT ITS Research - Connected Vehicle Pilot Deployment Program
Connected Vehicle Pilot Deployment Plan, WYDOT CV Pilot Deployment Results and Transition Plan – WYDOT, FHWA-JPO-18-724	Accessed March 2023	https://www.its.dot.gov/pilots/pdf/CVP_Webinar_WYDOT_PerfMeasTransition.pdf
Connected Vehicle Pilot Deployment Program Phase 2, Final System Performance Report, Baseline Conditions – WYDOT, FHWA-JPO-17-474	April 10, 2017	USDOT ITS Research - Connected Vehicle Pilot Deployment Program
Initiating the Systems Engineering Process for Rural Connected Vehicle Corridors – NCHRP Research Report 978 Vol. 1: Research Overview Vol. 2: Model Concept of Operations Vol. 3: Model System Requirements Specification.	2021	http://nap.nationalacademies.org/26389 http://nap.nationalacademies.org/26388 http://nap.nationalacademies.org/26387
Kansas Department of Transportation: Final System Design Document for KaITS	January 4, 2021	Available through KDOT.
SunGuide Software User's Manual (SUM)	SunGuide version 8.2 December 12, 2022	http://sunguidesoftware.com/sunguidesoftware/documentlibrary/DragAndDropFTP/Development/SoftwareUsersManual/SunGuide-SUM-8.2.pdf
Release 8.2 SunGuide Operator Training	Release 8.2 2022	http://sunguidesoftware.com/sunguidesoftware/documentlibrary/DragAndDropFTP/Training/Operator/SunGuide_8.2_Operator_Training_Slides.pptx
Kansas Connected and Automated Vehicle Implementation	May 2021	https://www.ksdot.gov/Assets/wwwksdotorg/bureaus/divInnovTech/KS_CAV_IMP_FINAL.pdf
Security Credential Management System (SCMS) Technical Primer - FHWA-JPO-19-775	November 2019	https://rosap.ntl.bts.gov/view/dot/43635/dot_43635_DS1.pdf?

9. Notes

This section will be annotated, as needed, with changes to the approved ConOps document made over the course of the project. There are no notes at this time.

10. Appendices

Appendix A, U.S. 83 Advanced Technology Project Stakeholder Survey and Results is included in the end of this document.

11. Document Revision History

Changes to the ConOps following its initial approval shall be recorded in the Document Revision History below. Project contractors may suggest changes to meet new requirements, but only the listed project stakeholders may, upon consensus, approve changes to the ConOps.

Table 7: Document Revision History

DOCUMENT REVISION HISTORY			
Version Number	**Approved Date**	**Description of Change(s)**	**Created/ Modified By**
1.1		Incorporating comments received from FHWA	Chuck Miller, Victor Blue, Erin Flanigan
1.2		Removed instances of snowplow tracking and CCTV cameras in text and Figure 7	Chuck Miller, Victor Blue

Appendix A

U.S. 83 Advanced Technology Project

Stakeholder Survey and Results

U.S. 83 Connected Vehicle Project Survey Summary

Introduction

In September 2022, the Kansas Department of Transportation (KDOT) was awarded an Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Grant to design and build the Great Plains Rural Freight Technology Corridor Project also known as the U.S. 83 CV Project.

The U.S. 83 CV Project will improve safety, mobility, efficiency and economic productivity along U.S. 83, a two-lane Critical Rural Freight Corridor in western Kansas. It will install fiber-optic cable and advanced technologies along the 131 miles corridor to deliver, traffic, weather, construction, and other operational information to commercial trucking to optimize freight.

The U.S. 83 Connected Vehicle project team released a public survey to obtain feedback from key stakeholders to learn more about their concerns and issues along U.S. 83. The survey was available from March 9 to April 7, 2023. The survey was distributed to 120 identified stakeholders through email via the Public Involvement Management Application (PIMA). A follow-up email was sent on March 31 during the last week of eligibility.

The survey was designed to understand stakeholder concerns, needs, and desired outcomes regarding technology and travel on U.S. 83. The survey results will be used to inform the Concept of Operations document and preliminary design of the system.

Survey Results

A total of 31 responses were received. Several key conclusions were drawn from the results including:

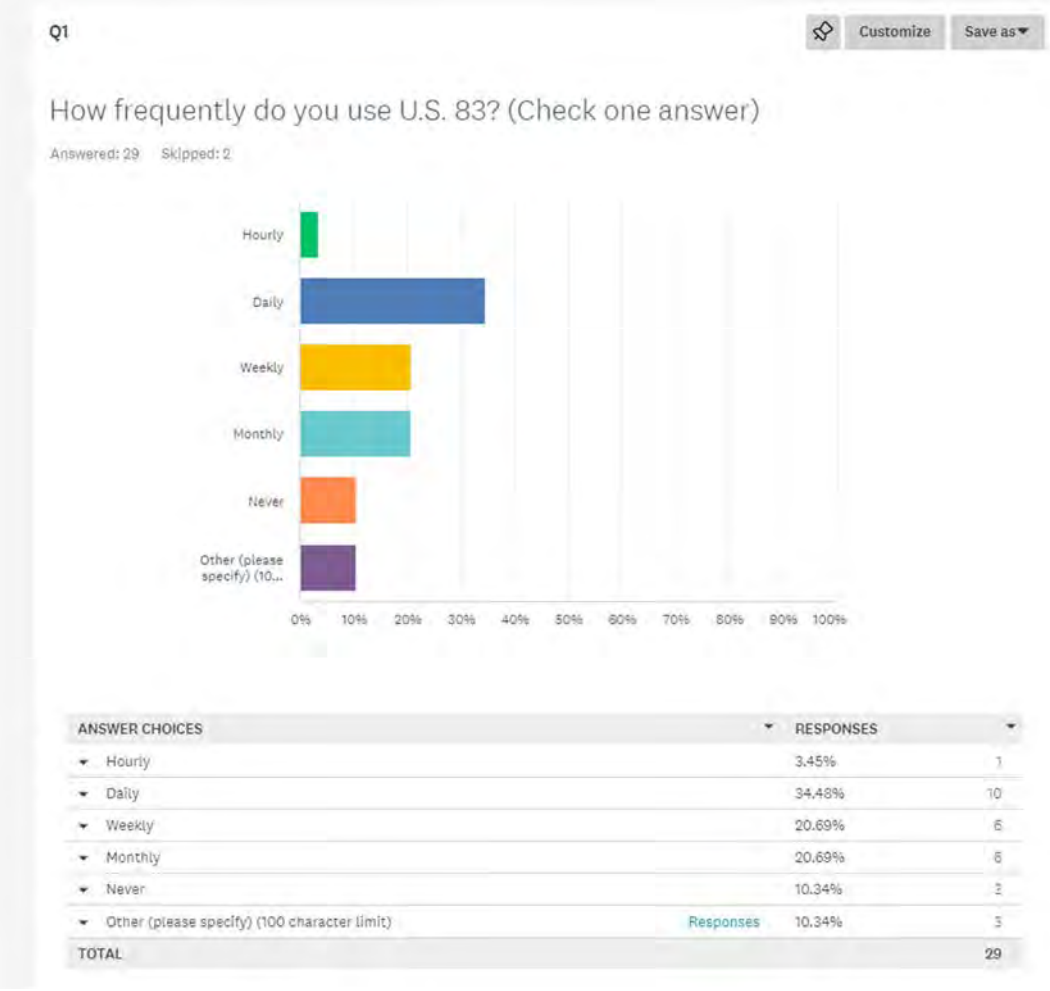
- **High Utilization Rate**
  - U.S. 83 has a high utilization rate most often used for personal travel or work
- **Drivers Plan Ahead**
  - The majority of U.S. 83 users plan their trips in advance and use a variety of applications to identify roadway conditions
- **Trip Reliability**
  - The most common barriers to efficient travel include bad weather, accidents, or congestion
- **Desire for Technology**
  - There is a strong desire for technology that provides real-time updates on roadway conditions
- **Access Issues**
  - Barriers to receiving real time updates include poor service issues along the corridor

Question Summary

The following summary provides a more detailed review of each question and highlights important themes and trends drawn from respondents' answers. **Appendix A** includes the raw results from takers of the survey.

Question 1

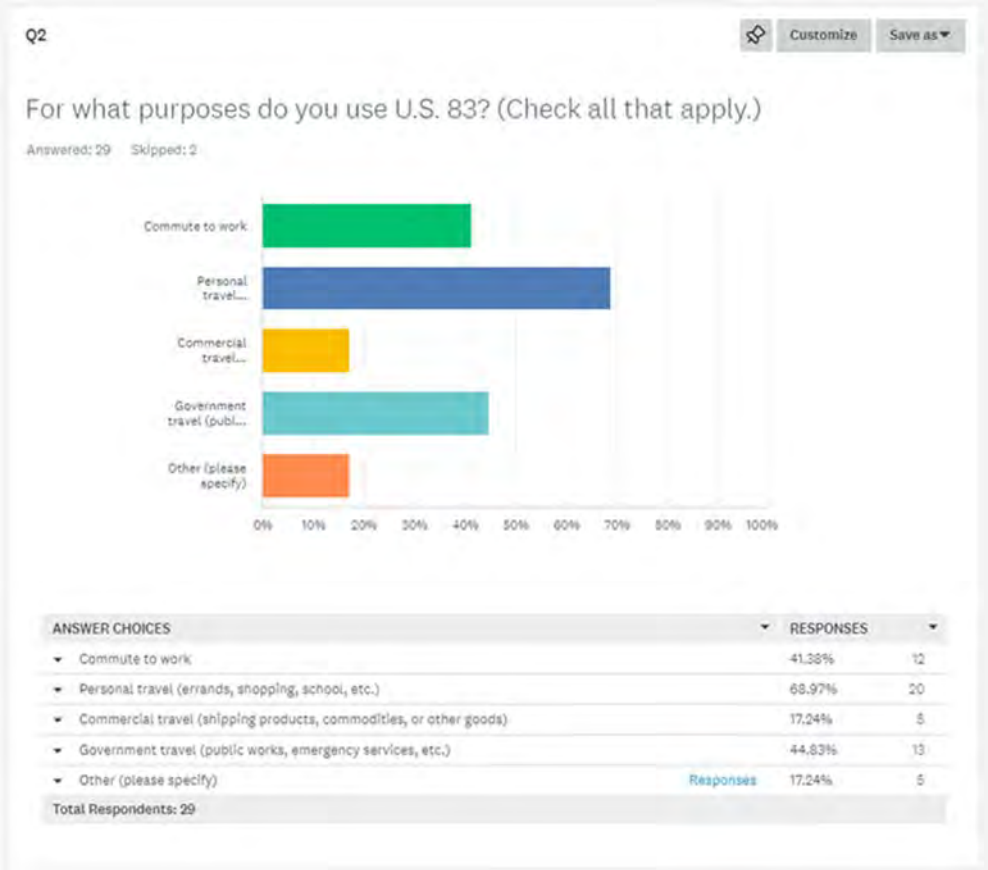
Nearly 58 percent of U.S. 83 users utilize the corridor on a weekly basis. The most common usage is daily at 34 percent, followed by weekly and monthly at 20 percent. Ten percent of respondents never use the corridor, and the remaining 3 percent use it on an hourly basis.



ANSWER CHOICES		RESPONSES	
Hourly		3.45%	1
Daily		34.48%	10
Weekly		20.69%	6
Monthly		20.69%	6
Never		10.34%	3
Other (please specify) (100 character limit)	Responses	10.34%	3
TOTAL			29

Question 2

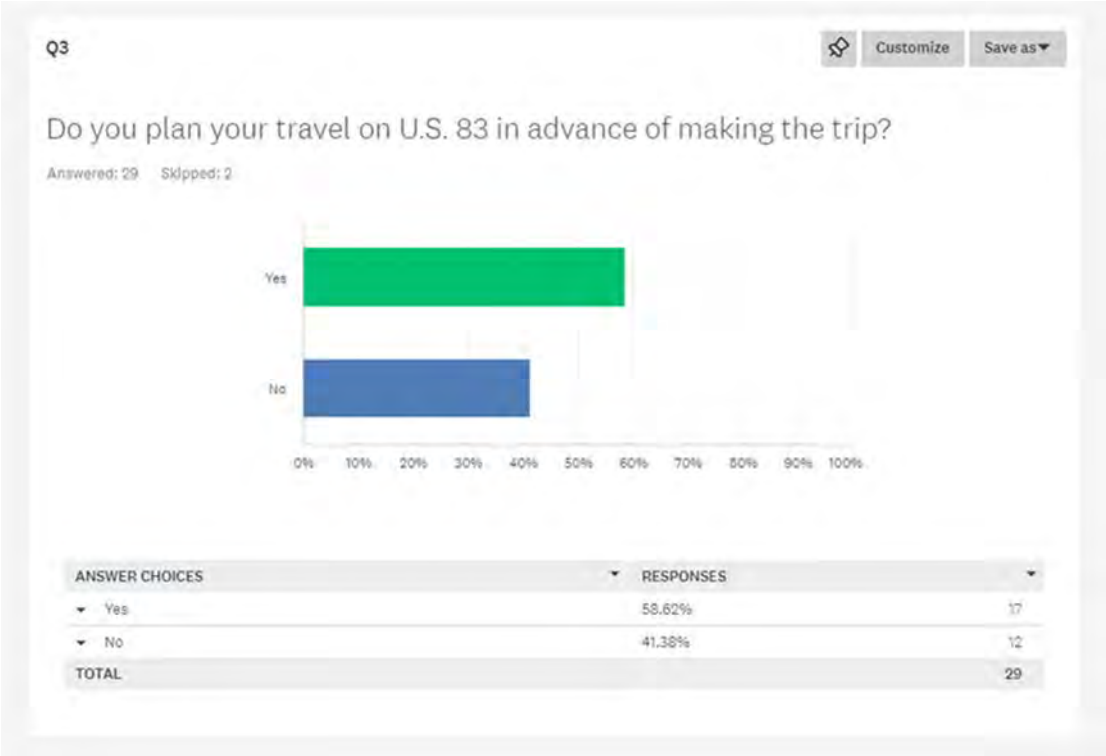
In Question 2, respondents were able to identify their primary purposes for using U.S. 83. The most common reason was for personal travel with 69 percent of respondents choosing this answer. The second and third most popular travel purposes included government travel and commuting to work at 44 percent and 41 percent, respectively. The remaining answers were split between commercial travel and other. Two respondents identified "other" as medical travel.



ANSWER CHOICES		RESPONSES	
Commute to work		41.38%	12
Personal travel (errands, shopping, school, etc.)		68.97%	20
Commercial travel (shipping products, commodities, or other goods)		17.24%	5
Government travel (public works, emergency services, etc.)		44.83%	13
Other (please specify)	Responses	17.24%	5
Total Respondents: 29			

Question 3

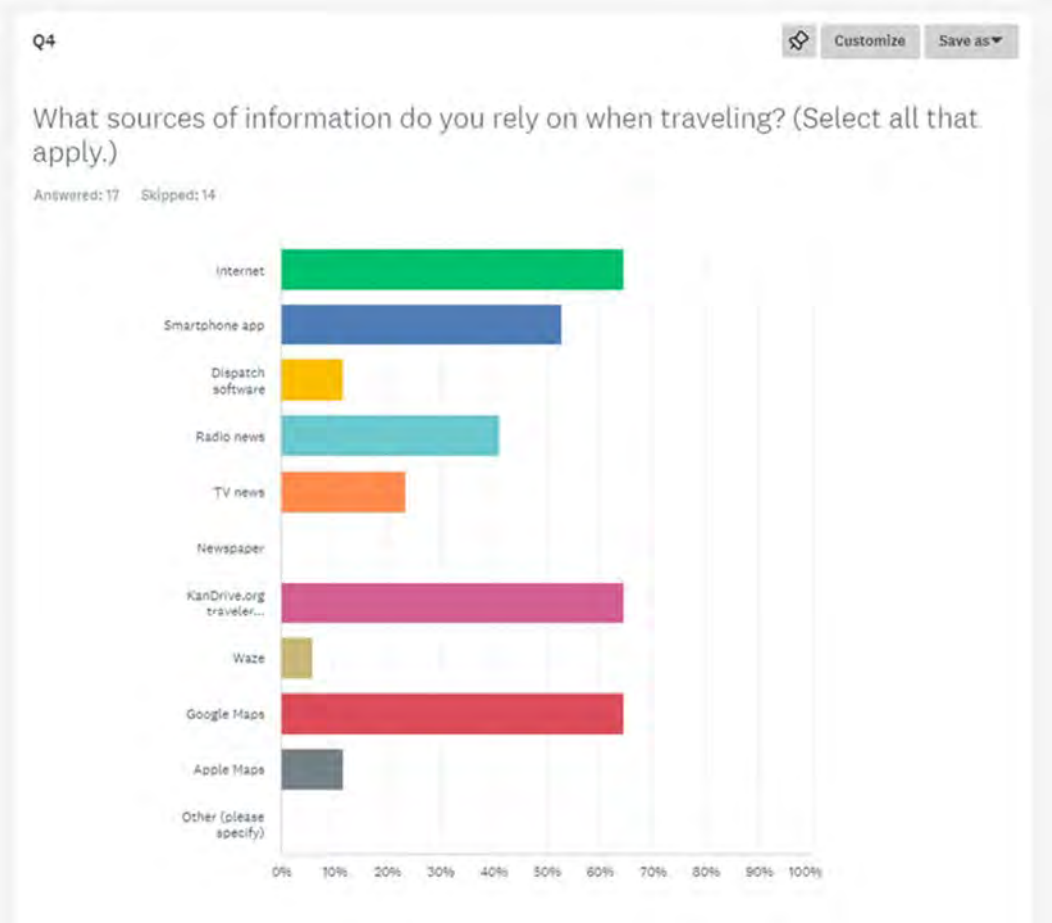
Question 3 asked respondents to identify whether they planned trips in advance. The majority of drivers (58 percent) admitted that they planned their trips ahead of schedule. The remaining did not plan travel in advance.



ANSWER CHOICES	RESPONSES	
Yes	58.62%	17
No	41.38%	12
TOTAL		29

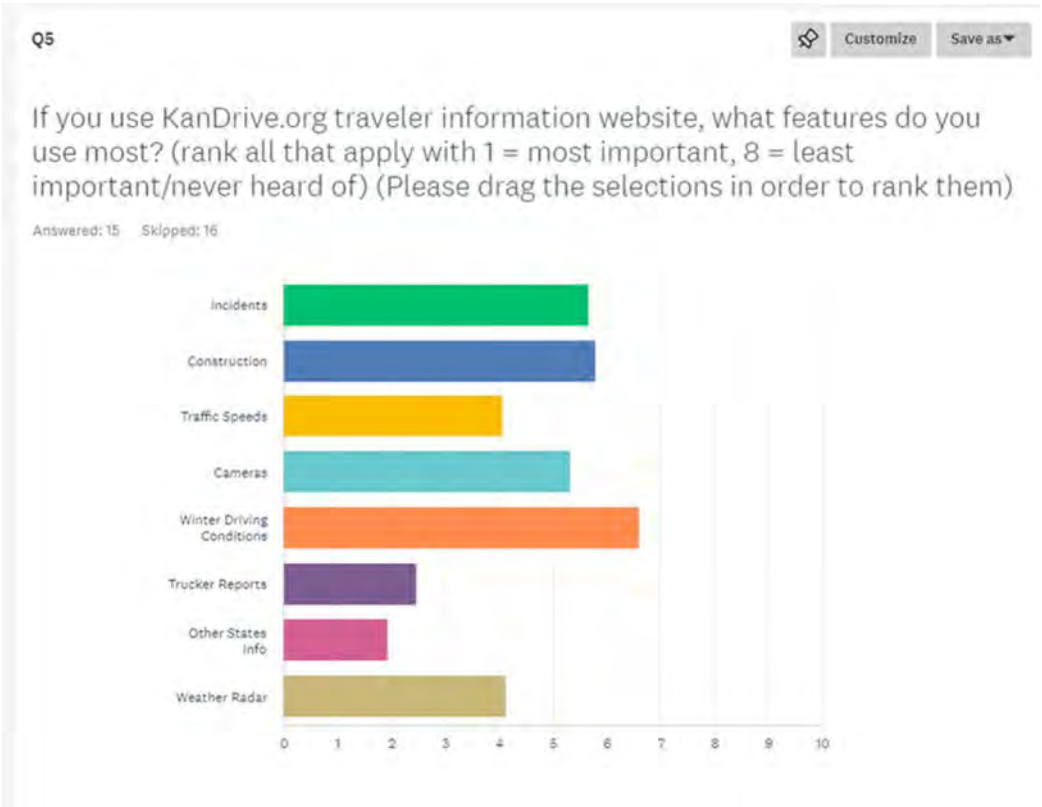
Question 4

Those that do plan ahead were asked to select all sources of information that they used to inform their travel. The top answers chosen included internet, KanDrive.org and Google Maps with 64 percent of respondents using those platforms. These were followed smartphone apps and radio news at 53 percent and 41 percent, respectively. A smaller portion of users utilized TV news, dispatch software, Apple Maps and Waze.



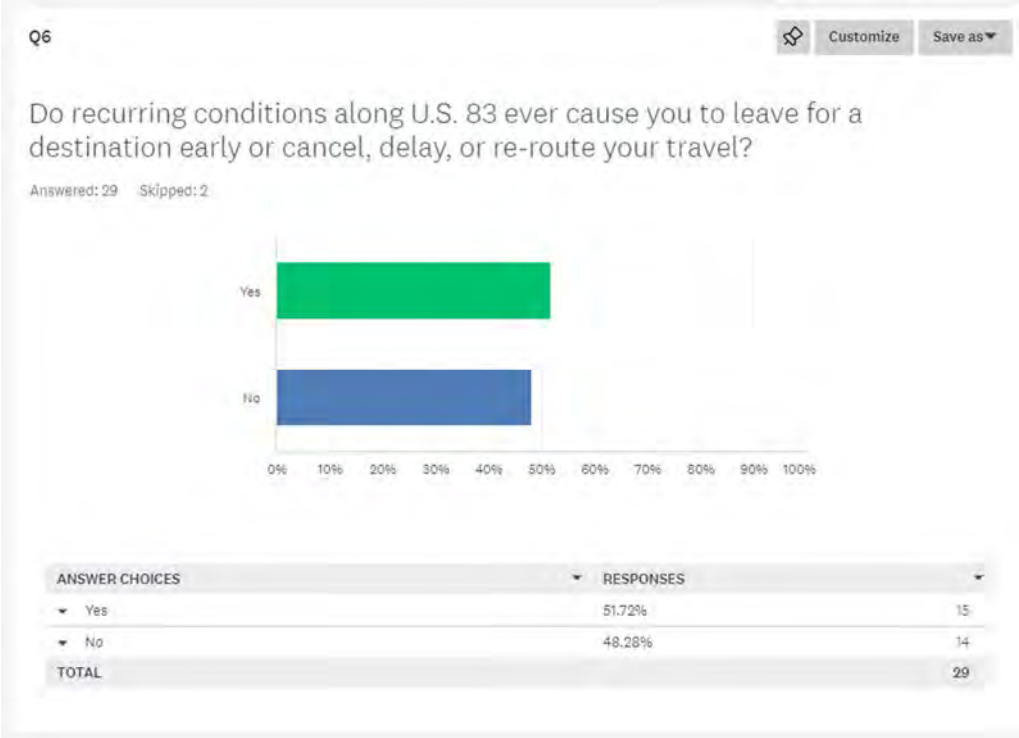
Question 5

This question was targeted towards those that selected KanDrive.org as their most predominant way to gather traveler information. Respondents were asked to identify the ways in which they utilized the platform the most. The most commonly sought-after information was winter driving conditions, construction, incidents, cameras, traffic speeds and weather radar information. As evidenced in the data below, KanDrive.org is a popular platform among U.S. 83 commuters and it is utilized for a variety of different purposes.



Question 6

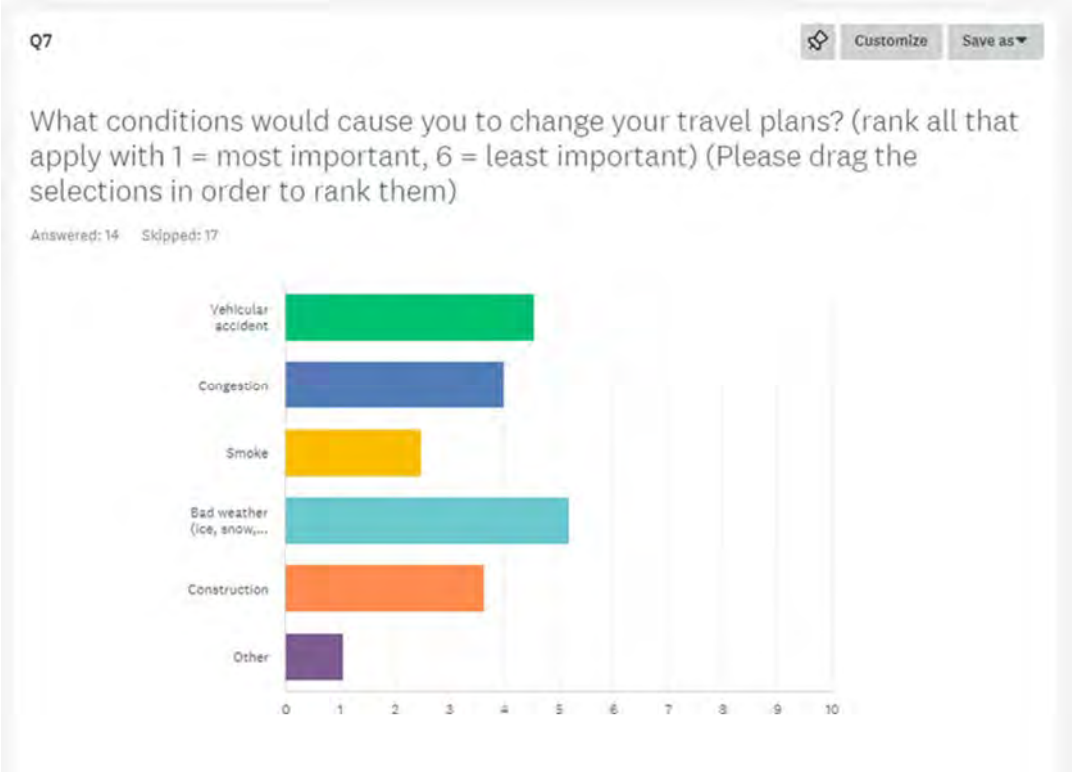
Question 6 was used to gauge if U.S. 83 users altered their travel plans due to recurring conditions along the corridor. A slight majority (52 percent) said that conditions along U.S. 83 caused them to reroute or alter their travel plans. The remaining (48 percent) respondents did not change their travel patterns due to recurring conditions along U.S. 83.



ANSWER CHOICES	RESPONSES	
Yes	51.72%	15
No	48.28%	14
TOTAL		29

Question 7

This question was a follow-up to question 6 and was used to identify which recurring conditions were responsible for altered or re-routed travel. The most common reason to alter travel was due to bad weather, with 50% or respondents ranking this as their most prevalent issue. Other common issues included vehicular accident, congestion and construction. A smaller portion of respondents ranked smoke as common issue along the corridor.



Question 8

Question 8 was a follow-up, clarifying question to question 7. For those who ranked “other” higher than 6, we wanted to understand what other conditions might impact travel plans and patterns. According to responses, there were no additional conditions that impacted travel. One respondent explained that smoke was rare and was usually only associated with wildfire.

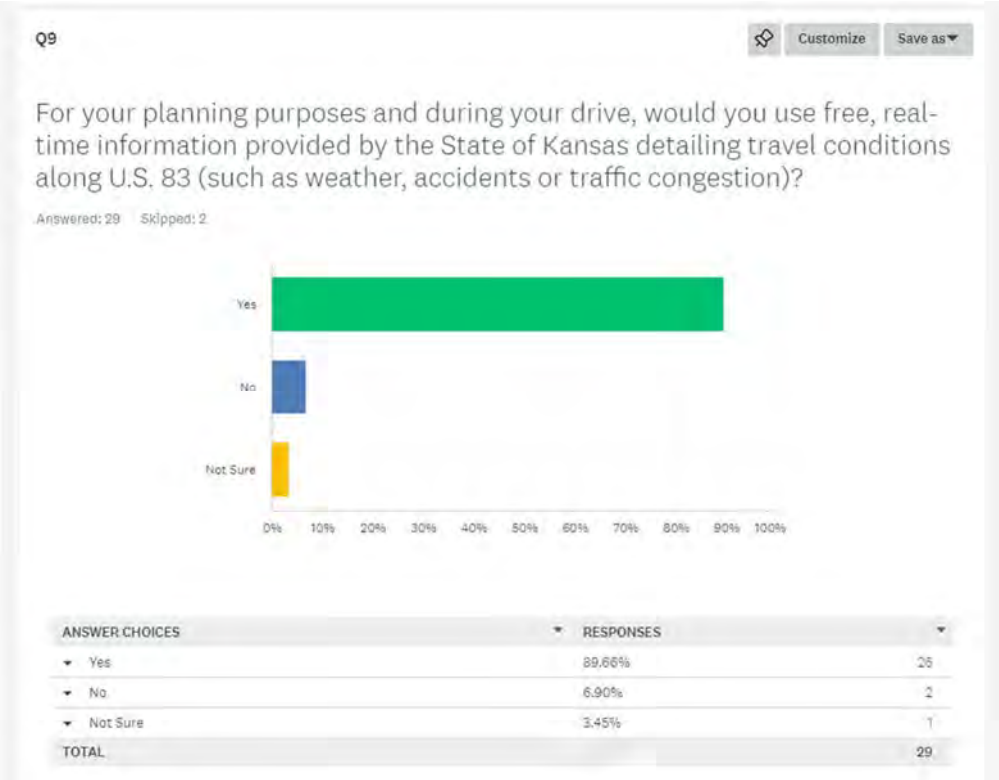
Q8 If you ranked Other higher than 6, please specify.

Answered: 6 Skipped: 25

#	RESPONSES	DATE
1	N/A	4/1/2023 6:53 AM
2	NA	3/31/2023 11:21 AM
3	Na	3/9/2023 12:37 PM
4	Smoke along this corridor is rare, and typically only associated with wildfire.	3/9/2023 11:26 AM
5	na	3/9/2023 10:39 AM
6	other	3/9/2023 9:58 AM

Question 9

An overwhelming majority of respondents (90 percent) expressed that they wanted free, real-time information provided by the State of Kansas including weather, accidents, and traffic congestion alerts. Only 10 percent of respondents declined or were unsure of using free, real time traffic information.



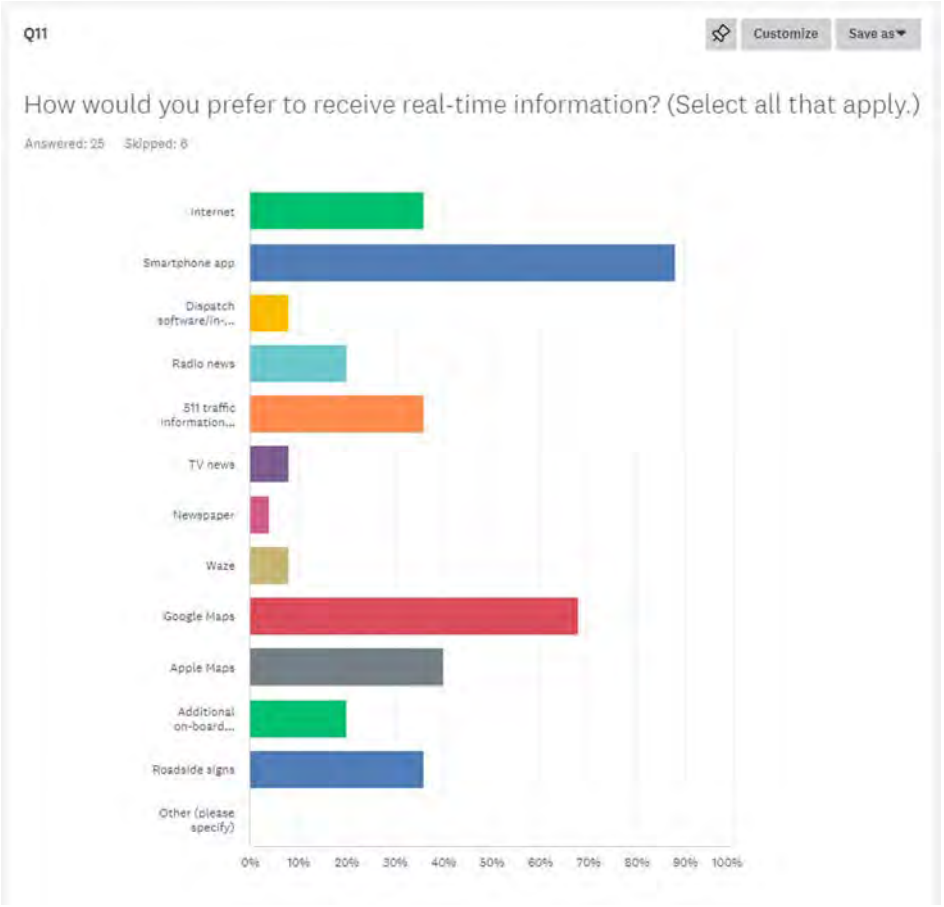
ANSWER CHOICES	RESPONSES	
Yes	89.66%	26
No	6.90%	2
Not Sure	3.45%	1
TOTAL		29

Question 10

This question was directed towards those, in question 9, who did desire free, real-time traffic alerts. Answers to this question were mixed. Over 70 percent of respondents selected accident location, weather conditions, construction locations, accident status, construction detours and hazards. A small majority (54 percent) also voted for average traffic speed and travel time difference information.

Question 11

This question was used to identify the most preferred methods to receive real-time information. An overwhelming majority, over 65 percent, preferred to access this type of information via smartphone app and Google Maps. All other options were selected by less than 40 percent of respondents.



Question 12

Question 12 was an open-ended response question and allowed respondents to describe any barriers that might prevent them from receiving real-time information. Five respondents expressed that connectivity issues in the corridor would be the most prevalent barrier preventing them from accessing information, with Wi-Fi access and fiber being two barriers specifically named. There was also a desire for information to be relayed through GPS-capable smartphone apps.

U.S. 83 Connected Vehicle Project Survey

Q12 What barriers would prevent you from accessing or using free, real-time information? (For example: no smartphone.)

Answered: 15 Skipped: 16

#	RESPONSES	DATE
1	None, if fiber was available!	4/3/2023 5:12 PM
2	None.	4/1/2023 6:54 AM
3	None	3/31/2023 11:24 AM
4	wifi access	3/31/2023 11:22 AM
5	accessibilty and Cost	3/31/2023 11:10 AM
6	NA	3/14/2023 1:11 PM
7	Assuming it is a smart phone app or GPS alert, I would not have any barriers.	3/13/2023 4:54 PM
8	I would rather enjoy the drive than pay attention to a device.	3/9/2023 6:39 PM
9	none	3/9/2023 4:20 PM
10	no phone	3/9/2023 11:51 AM
11	None	3/9/2023 11:27 AM
12	No service on my phone or service has been interrupted.	3/9/2023 11:17 AM
13	none	3/9/2023 10:40 AM
14	service issues	3/9/2023 10:08 AM
15	none	3/9/2023 10:05 AM

Questions 13-15

The survey concluded by gathering demographic information from respondents, asking them if they wanted to be contacted to further the study, and asking them to provide any additional contacts they believe should be involved in the study. Respondents that answered question 15 listed several important stakeholders to include in future outreach activities including the agricultural community, schools, Sheriff's Department, and other freight carriers.

U.S. 83 Connected Vehicle Project Survey

Q15 Are there any other groups or organizations that you know of that rely heavily on U.S. 83 that you think we should talk to?

Answered: 11 Skipped: 20

#	RESPONSES	DATE
1	Any farmer, any livestock owner, shipper, any contractor, etc. The amount of commerce (revenue) from agriculture that Scott County produces on behalf of the State of Kansas (#2 in the State) affects every single citizen in western Kansas either indirectly or directly. Just keep moving this infrastructure discussion forward with real intent, please.	4/3/2023 5:17 PM
2	Citizens of Scott City.	4/1/2023 6:56 AM
3	Truckers/Harvesters/Commuters	3/31/2023 11:26 AM
4	NA	3/31/2023 11:23 AM
5	Not at this time.	3/13/2023 4:55 PM
6	Kansas Motor Carriers	3/9/2023 6:40 PM
7	Truck driver and semis as they are moving products for our businesses	3/9/2023 12:40 PM
8	Agriculture entities (i.e. - transport for cattle, feed, grains, fuel, etc., school districts	3/9/2023 11:29 AM
9	The Schools in Gove and Logan County, Sheriffs Departments	3/9/2023 11:19 AM
10	Sporer Land Development	3/9/2023 10:41 AM
11	RUAN	3/9/2023 9:59 AM

Conclusion

Survey respondents provided detailed and informative responses that identified several desired outcomes and technologies throughout the corridor and provided key details relating to access issues and technology barriers along U.S. 83. Several key conclusions and themes can be drawn from these survey results including:

1. U.S. 83 is a highly used and vital corridor
2. Many drivers plan their trips ahead of time
3. Trip reliability is a common issue for many commuters along U.S. 83
4. U.S. 83 users desire advanced technology so they can receive traffic updates
5. Service access is a prevalent issue along the corridor

The project team will now use the results of the survey to inform the Concept of Operations and preliminary design of the system.

Appendix A

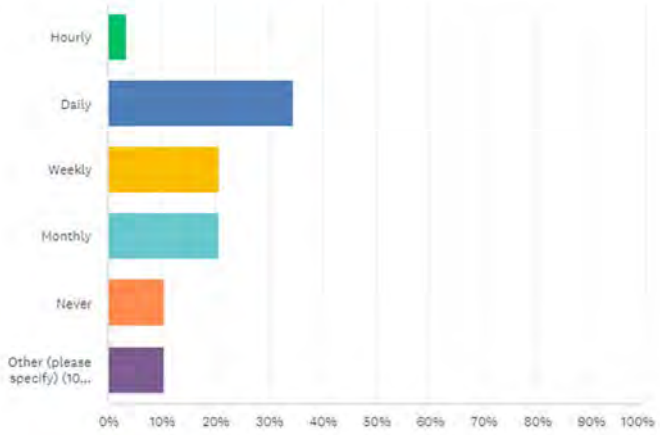
Question 1

Q1

Customize | Save as

How frequently do you use U.S. 83? (Check one answer)

Answered: 29 Skipped: 2



ANSWER CHOICES		RESPONSES	
Hourly		3.45%	1
Daily		34.48%	10
Weekly		20.69%	6
Monthly		20.69%	6
Never		10.34%	3
Other (please specify) (100 character limit)	Responses	10.34%	3
TOTAL			29

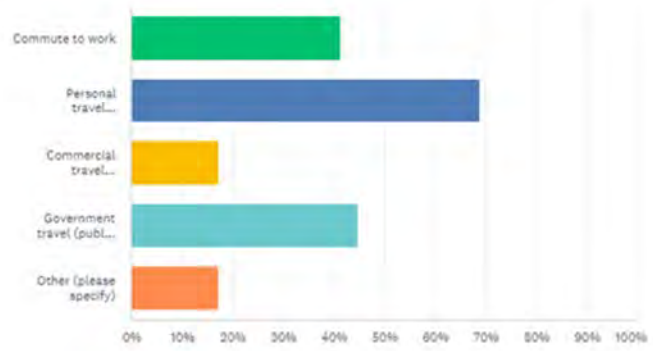
Question 2

Q2

Customize | Save as

For what purposes do you use U.S. 83? (Check all that apply.)

Answered: 29 Skipped: 2



ANSWER CHOICES		RESPONSES	
Commute to work		41.38%	12
Personal travel (errands, shopping, school, etc.)		68.97%	20
Commercial travel (shipping products, commodities, or other goods)		17.24%	5
Government travel (public works, emergency services, etc.)		44.83%	13
Other (please specify)	Responses	17.24%	5
Total Respondents: 29			

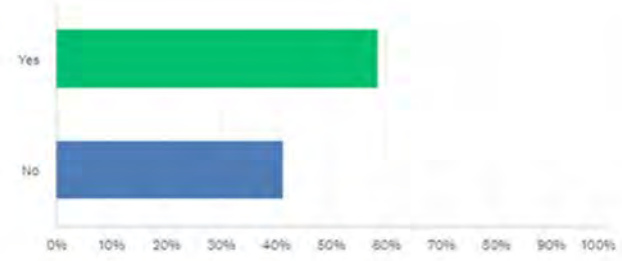
Question 3

Q3

Customize Save as

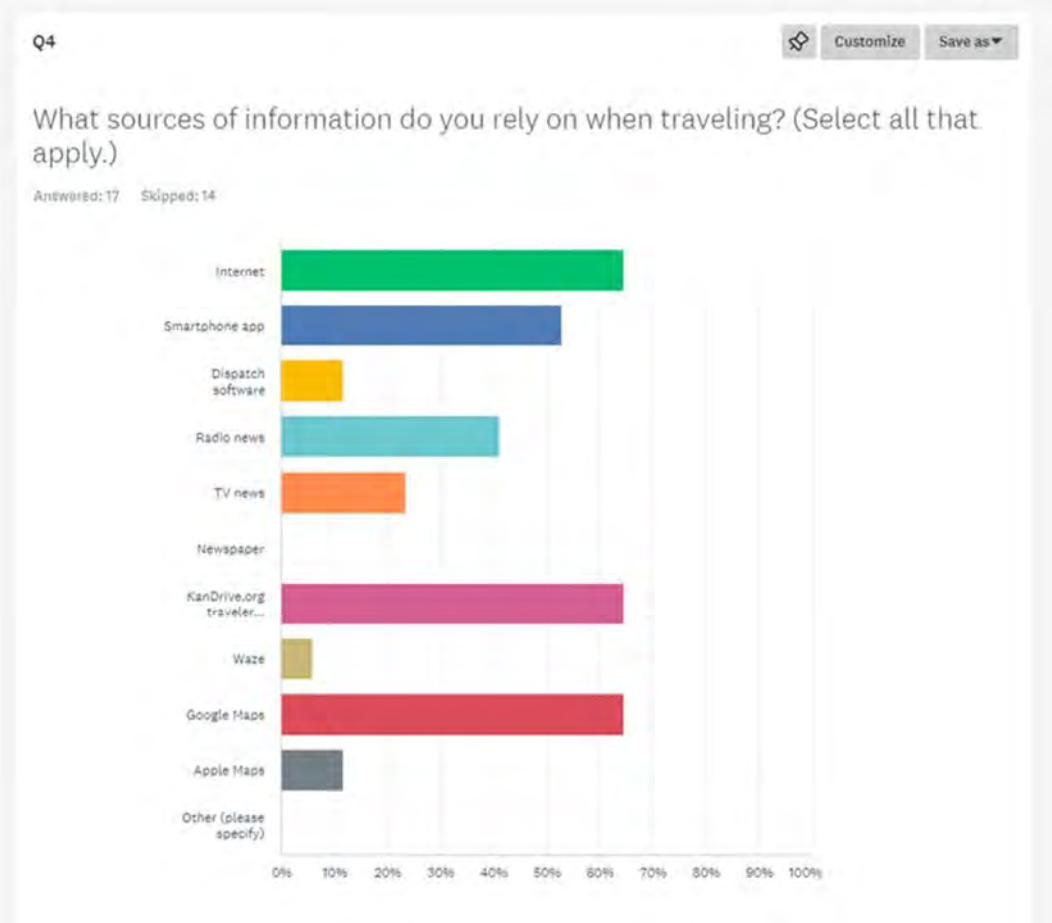
Do you plan your travel on U.S. 83 in advance of making the trip?

Answered: 29 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	58.62%	17
No	41.38%	12
TOTAL		29

Question 4


Q4
Customize
Save as
What sources of information do you rely on when traveling? (Select all that apply.)
Answered: 17 Skipped: 14
Internet
Smartphone app
Dispatch software
Radio news
TV news
Newspaper
KanDrive.org traveler...
Waze
Google Maps
Apple Maps
Other (please specify)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

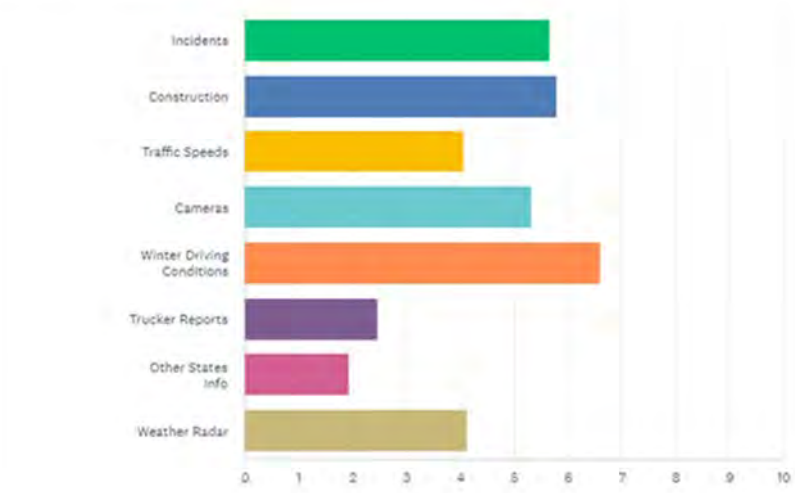
Question 5

Q5

Customize | Save as

If you use KanDrive.org traveler information website, what features do you use most? (rank all that apply with 1 = most important, 8 = least important/never heard of) (Please drag the selections in order to rank them)

Answered: 15 Skipped: 16



Question 6

Q6

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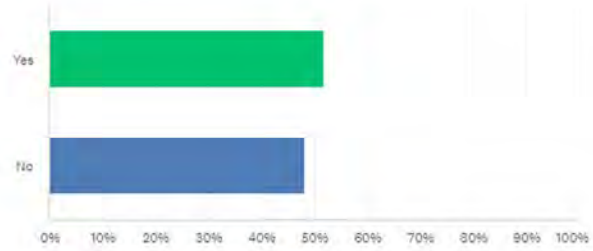
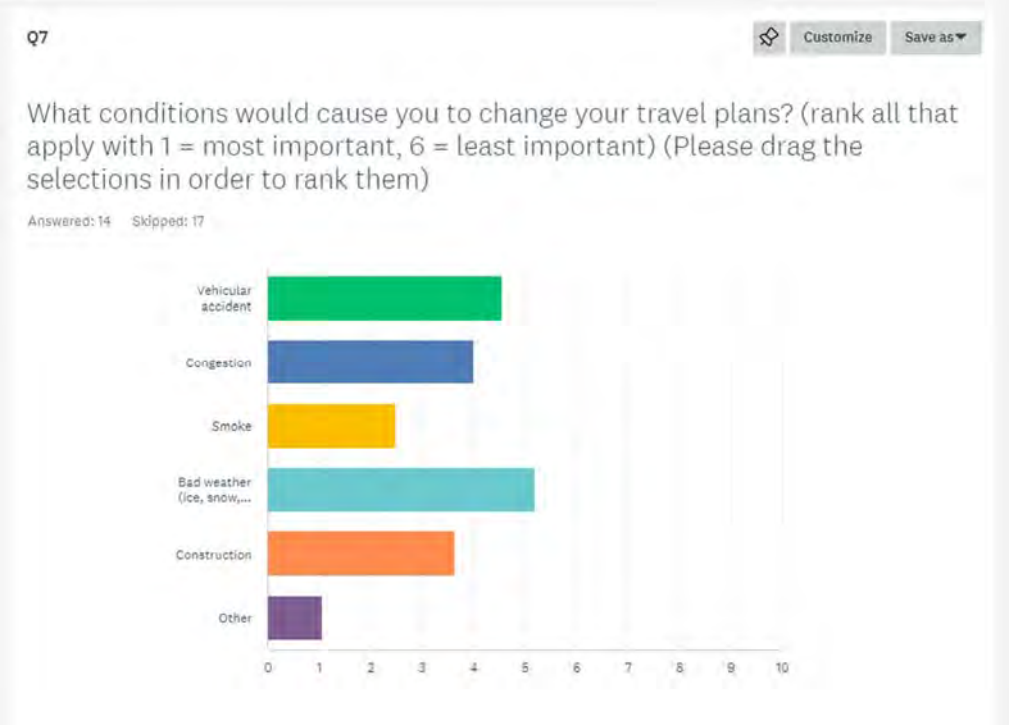
Do recurring conditions along U.S. 83 ever cause you to leave for a destination early or cancel, delay, or re-route your travel?

Answered: 29 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	51.72%	15
No	48.28%	14
TOTAL		29

Question 7



Question 8

Q8 If you ranked Other higher than 6, please specify.

Answered: 6 Skipped: 25

#	RESPONSES	DATE
1	N/A	4/1/2023 6:53 AM
2	NA	3/31/2023 11:21 AM
3	Na	3/9/2023 12:37 PM
4	Smoke along this corridor is rare, and typically only associated with wildfire.	3/9/2023 11:26 AM
5	na	3/9/2023 10:39 AM
6	other	3/9/2023 9:58 AM

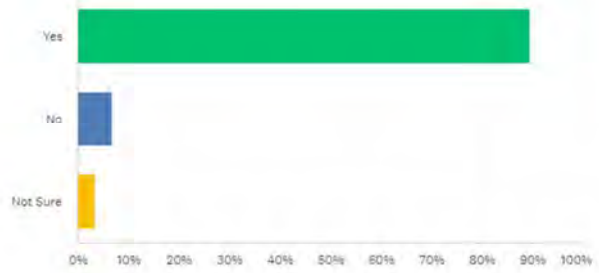
Question 9

Q9

Customize Save as

For your planning purposes and during your drive, would you use free, real-time information provided by the State of Kansas detailing travel conditions along U.S. 83 (such as weather, accidents or traffic congestion)?

Answered: 29 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	89.66%	26
No	6.90%	2
Not Sure	3.45%	1
TOTAL		29

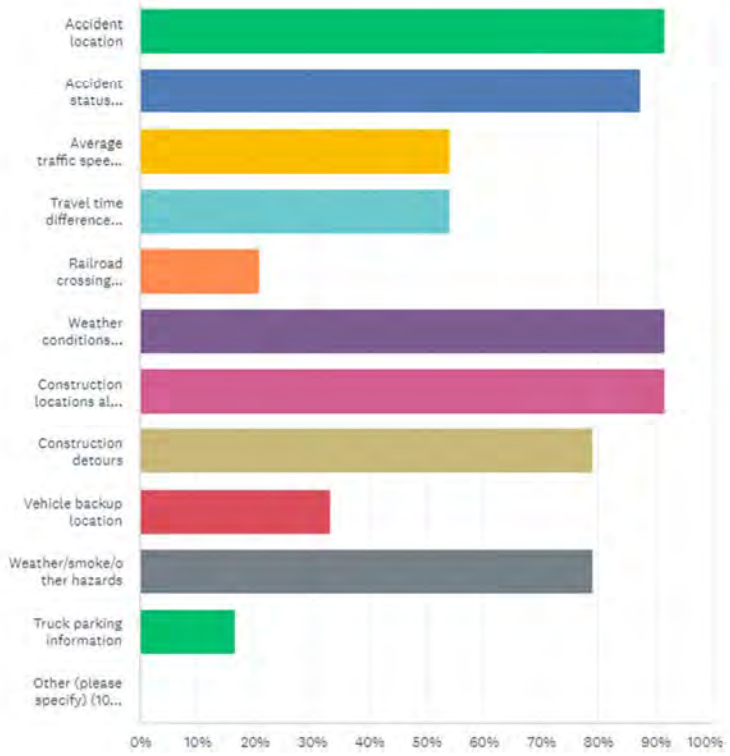
Question 10

Q10

Customize Save as

Regarding real-time information provided by the State of Kansas, what information would you like to see provided? (Check all that apply)

Answered: 24 Skipped: 7



Question 11


Q11
Customize
Save as
How would you prefer to receive real-time information? (Select all that apply.)
Answered: 25 Skipped: 6
Internet
Smartphone app
Dispatch software/in-...
Radio news
511 traffic information...
TV news
Newspaper
Waze
Google Maps
Apple Maps
Additional on-board...
Roadside signs
Other (please specify)
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Question 12

U.S. 83 Connected Vehicle Project Survey

Q12 What barriers would prevent you from accessing or using free, real-time information? (For example: no smartphone.)

Answered: 15 Skipped: 16

#	RESPONSES	DATE
1	None, if fiber was available!	4/3/2023 5:12 PM
2	None.	4/1/2023 6:54 AM
3	None	3/31/2023 11:24 AM
4	wifi access	3/31/2023 11:22 AM
5	accessibilty and Cost	3/31/2023 11:10 AM
6	NA	3/14/2023 1:11 PM
7	Assuming it is a smart phone app or GPS alert, I would not have any barriers.	3/13/2023 4:54 PM
8	I would rather enjoy the drive than pay attention to a device.	3/9/2023 6:39 PM
9	none	3/9/2023 4:20 PM
10	no phone	3/9/2023 11:51 AM
11	None	3/9/2023 11:27 AM
12	No service on my phone or service has been interrupted.	3/9/2023 11:17 AM
13	none	3/9/2023 10:40 AM
14	service issues	3/9/2023 10:08 AM
15	none	3/9/2023 10:05 AM

Question 13

The information gathered from this question included demographic information and contact information. This information can be reviewed in the complete data summary excel sheet and pdf.

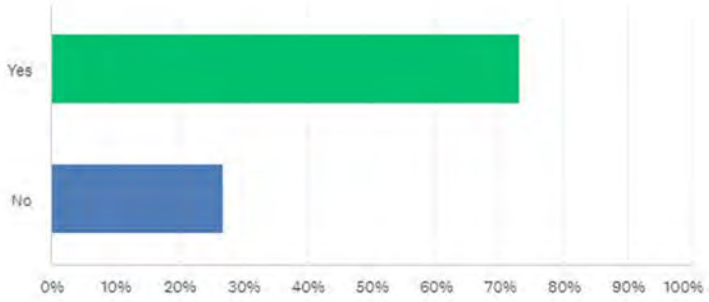
Question 14

Q14

Customize Save as

Would you like to be contacted to help further shape how the U.S. 83 Connected Vehicle Project is designed and developed?

Answered: 26 Skipped: 5



ANSWER CHOICES	RESPONSES	
Yes	73.08%	19
No	26.92%	7
TOTAL		26

Question 15

U.S. 83 Connected Vehicle Project Survey

Q15 Are there any other groups or organizations that you know of that rely heavily on U.S. 83 that you think we should talk to?

Answered: 11 Skipped: 20

#	RESPONSES	DATE
1	Any farmer, any livestock owner, shipper, any contractor, etc. The amount of commerce (revenue) from agriculture that Scott County produces on behalf of the State of Kansas (#2 in the State) affects every single citizen in western Kansas either indirectly or directly. Just keep moving this infrastructure discussion forward with real intent, please.	4/3/2023 5:17 PM
2	Citizens of Scott City.	4/1/2023 6:56 AM
3	Truckers/Harvesters/Commuters	3/31/2023 11:26 AM
4	NA	3/31/2023 11:23 AM
5	Not at this time.	3/13/2023 4:55 PM
6	Kansas Motor Carriers	3/9/2023 6:40 PM
7	Truck driver and semis as they are moving products for our businesses	3/9/2023 12:40 PM
8	Agriculture entities (i.e. - transport for cattle, feed, grains, fuel, etc., school districts	3/9/2023 11:29 AM
9	The Schools in Gove and Logan County, Sheriffs Departments	3/9/2023 11:19 AM
10	Sporer Land Development	3/9/2023 10:41 AM
11	RUAN	3/9/2023 9:59 AM