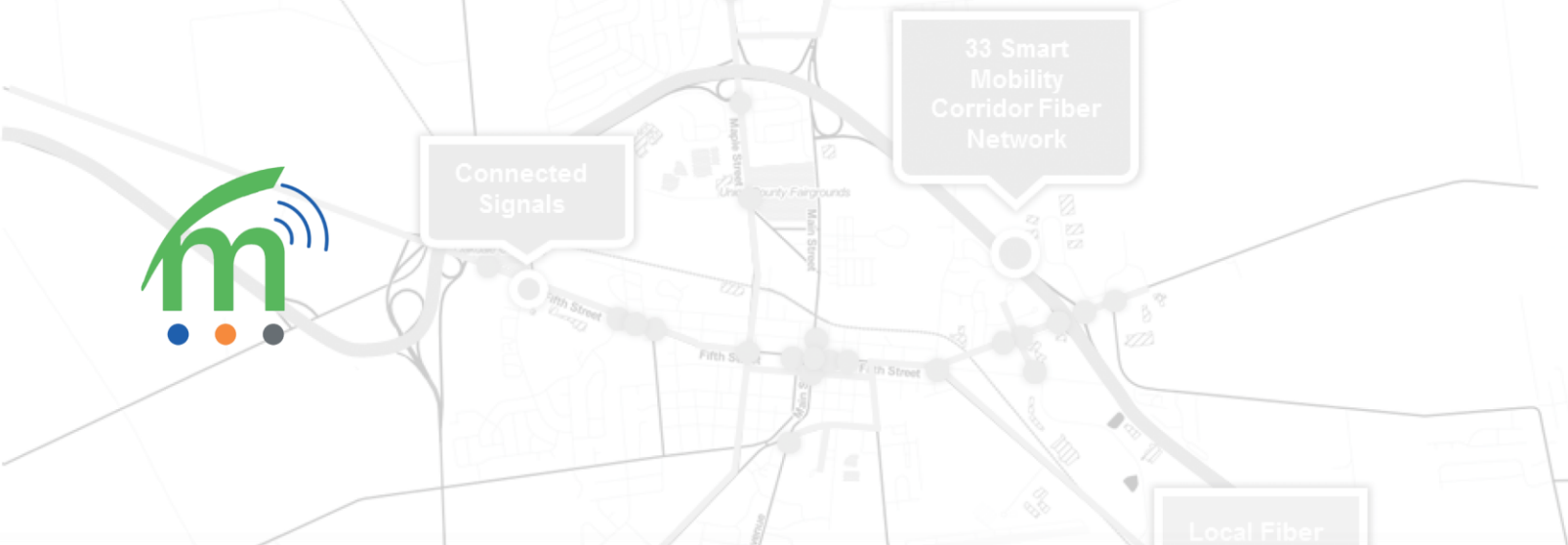

PHASE 1

Connected Marysville Pilot Analysis

U.S. Department of Transportation
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Ohio Department of Transportation

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16. Abstract
This report summarizes the outcomes of phase 1 of the Connected Marysville Pilot Analysis project and includes a deployment plan, technology summary, design of experiment and recruitment plan. It is expected to serve as the foundation for the next phase of the project, the recruitment and deployment of connected vehicle technology in 400 private citizen vehicles in the City of Marysville, OH.

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FINAL REPORT

Connected Marysville Pilot Analysis — Phase 1

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SECTION 1

Introduction

The purpose of this report is to document the activities and outcomes of Phase 1 of the Connected Vehicle Analysis in Connected Marysville Pilot project, and to offer recommendations and planning options to the Ohio Department of Transportation (ODOT) for their consideration and subsequent implementation of Phases 2-4 of this research project.

1.1 Background

In 2016, the City of Dublin, the City of Marysville, Union County and the Marysville-Union County Port Authority created the NW 33 Council of Governments (COG) to oversee and manage development along the US 33 corridor. This Smart Mobility Corridor has $217 million of investment along the 35-mile corridor, supported by a fiber optic network. A component of that investment is a USDOT grant for an Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) project; that $6 million will deploy and test Dedicated Short Range Communications (DSRC) roadside units (RSU) along the Smart Mobility Corridor, including 27 signalized intersection in the City of Marysville. ODOT is a partner in the US 33 Smart Mobility Corridor, having funded the fiber optic network along US 33 and continuing to support the COG and their deployment team.

In January of 2018, ODOT's Office of Statewide Planning and Research advertised Solicitation 2018-27 entitled Connected Vehicle Analysis in Smart Marysville Pilot, with the goal of deploying Connected Vehicles (CV) technology in 400 private vehicles that operate on the streets of Marysville, OH. The concept was to leverage the region's deployment of the connected vehicle (CV) infrastructure, and collect critical information from these vehicles to inform planners, policymakers, engineers, and operations and maintenance staff about the safety, mobility and environmental impact of travel on state and local roads. The RFP called for a four-phase approach to conduct this pilot, with this phase, Design, comprising the work associated with this solicitation.

In April of 2018, ODOT selected a team led by WSP, and which included the University of Cincinnati's Department of Civil and Architectural Engineering and Construction Management, MurphyEpson/Engage and Battelle Memorial Institute. In line with ODOT's desired outcomes, the team has specific experience in developing and deploying connected vehicle (CV) technology, extensive background in CV research — including the benefits of the data, and a strong track record working with ODOT for outreach and

communications activities; all critical components to the pilot planning and execution process.

Beginning with the May 2018 kickoff meeting, the team has been performing the work outlined in the approved work plan. We have met with ODOT, local stakeholders, and partners on a regular basis, and coordinated with other activities in the region (specifically the US 33 Smart Mobility Corridor work). We have also submitted various work products that collectively serve as the basis for the budget, schedule, and scope for executing a full-scale pilot.

1.2 Organization

This final report is organized in the same order that the work plan was executed during this project. Each deliverable item is summarized with its key purpose, takeaways, and how it contributes to the overall project. New insights gathered during the execution of the project are also be documented, as are their effects on the previous assumptions or understanding. Interactions with various parties that occurred during the project are also documented, and recommendations for next steps are included. Specifically, the document is organized as follows:

- **Section 2:** Work Plan Review
- **Section 3:** Results of Task 2: Literature Review
- **Section 4:** Results of Task 3: Technology Assessment
- **Section 5:** Highlights of Task 4: Design of Experiment
- **Section 6:** Task 5 IRB Status
- **Section 7:** Task 6 Pilot Deployment Plan
- **Section 8:** Task 7 Recruitment Plan
- **Section 9:** Task 8 Partner / Agency Engagement
- **Section 10:** Lessons Learned / Assumptions
- **Section 11:** Summary and Recommendations

SECTION 2

Work Plan Review

The work plan was developed to identify the activities and schedule necessary to achieve the goals of Phase 1 of this research project as delineated in ODOT's RFP and as originally articulated in WSP's response to the RFP.

2.1 Description of activity

Based on the scope of work defined by the RFP the research team identified 12 high-level tasks necessary to achieve the scope of the work in meeting the goals of this phase. Most of these tasks resulted in a work product, which served to contribute to the broader understanding of the pilot tasks.

The specific tasks include:

- **Task 1:** Project Startup Meeting
- **Task 2:** Literature Review
- **Task 3:** Technology Assessment
- **Task 4:** Design of Experiment
- **Task 5:** Institutional Review Board (IRB)
- **Task 6:** Pilot Deployment Plan
- **Task 7:** Recruitment Plan
- **Task 8:** Partner Agency Engagement
- **Task 9:** Phase 1 Report
- **Task 10:** Research Results Presentation
- **Task 11:** Final Phase 1 Report
- **Task 12:** Monthly Reporting

This document, the Final Report—Phase 1, comprises three of the tasks, including a draft and final version of this report, as well as a presentation on the findings and next steps associated with the project. This document is written assuming that all three tasks have been completed and any comments received through the review and presentation of the project have been incorporated.

2.2 Outcomes / status

All planned tasks were performed by various team members and submitted to ODOT for review. In turn, ODOT distributed these deliverables to various technical panel members for their input. A series of review meetings were convened to walk through each of the documents. The following table lists each deliverable item, the dates when the draft and final were submitted and other important details. A summary discussion and final versions of each of the deliverable items are included as attachments to this report.

TASK AREA	DRAFT DATE	FINAL DATE	NOTES
Work Plan	N/A	5/18/18	
Task 1 — Startup Meeting	N/A	4/27/2018	
Task 2 — Literature Review	5/30/2018	10/1/2018	
Task 3- Technology Assessment	8/31/2018	10/1/2018	
Task 4 — Design of Experiment	8/31/2018	10/1/2018	Draft was submitted as part of Task 6 Draft submittal
Task 5 — IRB	8/31/2018	10/1/2018	Sample Protocol and Informed Consent submitted.
Task 6 — Deployment Plan	8/31/2018	10/1/2018	
Task 7 — Recruitment Plan	8/31/2018	10/1/2018	Draft was submitted as part of Task 6 Draft submittal
Task 8 — Partner Agency Engagement	Ongoing		
Task 9/11 — Phase 1 Report	10/1/2018	10/27/2018	
Task 10 — Results Presentation		10/12/2018	
Task 12 — Monthly Reporting	Ongoing		

SECTION 3

Results of Task 2: Literature Review

The purpose of this task was to provide comprehensive and detailed insight on previous research and pilot testing as it relates to CV technology and the impacts to state planning activities.

3.1 Description of activity

The literature reviewed was assembled by performing keyword searches of several industry-related resources. The search databases included the National Academy of Science's hosted TRID (which is an integrated database that combines the records from the Transportation Research Board's Transportation Research Information Services (TRIS) Database and the OECD's Joint Transport Research Centre's International Transport Research Documentation (ITRD) Database), the National Transportation Library (NTL), and the USDOT Joint Program Office CV Pilot website. The research team also conducted an extensive literature search for state-sponsored research and plans using Google. This extensive list was then shortened based on relevance and stakeholder feedback. Resources on this shortened list were then more thoroughly reviewed to create this report.

3.2 Outcomes / status

The results of the literature were organized into the following categories of information:

- CV Technology
- CV Applications
- Testbeds and Deployments
- Policy Issues

The report documents the findings for each of these areas. Based on an analysis of existing research, the following recommendations have been developed as potential solutions for how ODOT can continue to prepare for connected and automated vehicle (CAV) technology.

ODOT and Marysville representatives performed a cursory review of the draft report and recommendations were incorporated by the WSP team. The table below reflects the updated recommendations that were an outcome of this literature review:

SOLUTION	BENEFITS	DOWNSIDES
Enact legislation at the local and state level that enables on-street automated vehicle (AV) and CV testing	Demonstrate innovation, attract economic activity, improve technology readiness by providing real-world experience	Higher risk of incidents if technology is deployed before it has been fully proven elsewhere as well as push back from public
Apply dynamic road use pricing and space allocation that favors CAVs	Increased revenue, enhanced transportation management, promotion of new technology adoption	High cost to travelers, could receive blowback if "dynamic" pricing has unintended consequences
Equip infrastructure (signals, at intersections, along roadways, on railroad tracks, etc.) with CV technology to enable V2I communications	The government generally owns this infrastructure and has the jurisdiction to deploy, will ensure infrastructure is up-to-date	Expensive equipment may become obsolete if a newer model is released
Deploy road-ready CV applications	Improve safety for equipped (and non-equipped) vehicles	Not all vehicles will be CVs, so the solution may not work as designed
Develop open-source, open data tools	Transparency, solution crowdsourcing	Security

SECTION 4

Results of Task 3: Technology Assessment

The purpose of the Task 3 Technology Assessment was to identify and document the current state of the practices of technology and equipment that supports the connected vehicle environment, and how to best support a Connected Marysville CV pilot. Considerations included the technology that will be installed as part of the US 33 Smart Mobility Corridor grant, and any other local installations specific to this project.

4.1 Description of activity

Considerations included the technology that will be installed roadside and in-vehicle as part of the US 33 Smart Mobility Corridor project. Items assessed include roadside units, on-board units, network equipment, antennas, human-machine interface, and more. Further, the assessment identified which standards and applications these items support (as applicable), and specifics about the message data they exchange, performance requirements of that data, and interoperability among those devices.

Following is the general approach used to complete this task:

- Brainstorm a list of vendors based on team experience and results of Task 2 Literature Review
- Perform a web search to identify other candidates
- Develop a matrix of features or capabilities that each class of equipment possesses
- Populate the matrix based on publicly available information
- Solicit detailed responses directly from vendors as warranted
- Evaluate the results of this assessment to inform the pilot planning

4.2 Outcomes / status

As documented in the Technology Assessment report, identifying several qualified vendors for each major technology component and competitively sourcing them, with a best-value condition, is an option. Considerations for selection must consider the ability to support the identified CV applications with minimal cost, adherence to stated standards, and if possible, OmniAir certification. If an On-Board Unit (OBU) does not support a stated application, availability of a software development kit (SDK) then becomes a priority.

The choice of OBUs is open. Those units that are packaged with electrical connections and mounting options designed for a vehicular environment are better choices for this project. Accompanying the OBU, the system should consider a purpose-specific display—either in the form of a rearview mirror solution or for ease of installation, or a standalone display—preferably in the form of a heads-up unit. An accompanying audio capability should be considered. Initial observations indicate that the thru-the-glass antenna solution is the most appealing for mounting, cabling, and likely performance. Most OBUs also appear to meet the minimum data needs required for event logging. This same data capability should be included in the US 33 OBUs as well. Finally, a hard wire to the OBD-II port, while complicating the installation, is preferred over a Bluetooth connection to an OBD-II dongle.

RSU choices by the US 33 team should support the advanced data collection needs of this project, including the ability to support over-the-air updates of OBU firmware and to collect event logs captured on OBUs. Otherwise, it will be necessary to include an additional roadside computing platform to handle message routing.

Detection equipment at intersections, if installed, needs to be thoroughly evaluated. The proposed applications related to detection at intersections are, in the author's opinion, very valuable, but have yet to be demonstrated. Of the technologies available for detection (outside of actual automated vehicle location (AVL) data), LIDAR seems to be the most promising—but it has limited use. In consideration of that, video (specifically infrared imaging) may be the best solution.

The decision for a security credential management system (SCMS) does not need to be made immediately but will be necessary before both RSUs and OBUs are deployed. A commercial SCMS, such as Green Hill, would likely cost under $50k for a year, and considering the effort to integrate and test the CAMP SCMS, it will likely be the best value.

Deployment of any permanent or semi-permanent wireless radios also requires a Federal Communications Commission (FCC) license. At one time, each RSU location had to be separately licensed, but recent FCC responses have allowed for a broader region, spanning multiple locations, to be considered in a single license application, specifically FCC 601 – Application for Radio Service Authorization.

The Task 3 report was reviewed by ODOT and Marysville staff and the version accompanying this final report reflects changes and additions requested by the review.

SECTION 5

Highlights of Task 4: Design of Experiment

The Phase 3 goal of this project, as noted in the RFP, is to perform data and system analysis from the data collected during the Phase 2 Pilot. However, to inform the pilot, and possibly other aspects of the research, it is necessary to develop a framework for the research in the form of a design of experiment. Description of activity

University of Cincinnati staff performed this task by first analyzing the eight proposed CV applications targeted for deployment in the region and then documenting the data types and collection methodology for these applications. Finally, seven unique applications/evaluations of this data were identified, along with the corresponding discussions to describe the data analysis methodology, often using surrogate means.

5.1 Outcomes / status

As noted above, beyond the proposed CV applications, the collected data has significant research value because it provides connected vehicle information that is hyper-frequent and hyper-local. It contains contextual mobility and environmental data to describe further the conditions under which these data were collected, including traffic flow information, traffic signal operation, and weather. This data will support continued advancements in the connected vehicle domain, as well as the development of applications to improve transportation operation and maintenance. Some of the potential uses are:

- Evaluation of Application Effectiveness
- Evaluation of Traffic System Performance
- Infrastructure Safety Assessment
- Infrastructure Pavement Assessment
- Connectivity / Communications Performance (Both V2I & V2V)
- Willingness-to-Pay for CV Technologies
- Driver Behavior / Highway Capacity Manual Additions / Larger System Benefits Estimation

Comments received by the WSP team and questions posed by the ODOT/Marysville review team were reflected in this updated version of the Design of Experiment.

SECTION 6

Task 5 Institutional Review Board (IRB) Status

This task comprises the initial steps necessary to implement a rigorous Human Use Approval process in support of the research that is intended to be conducted under the later phases of this project. By initiating IRB at this early stage, any extraordinary findings that may be identified can hopefully be addressed before commencing the actual pilot phase.

6.1 Description of activity

As part of Phase 1, Dr. Ma and University of Cincinnati staff completed a perfunctory review of both the Protocol and the Informed Consent forms that will be submitted to the University's Institutional Review Board for consideration before commencing recruitment activities or data collection. Both documents were provided to ODOT for review.

6.2 Outcomes / status

Comments were provided by ODOT, and further refinement of participant engagement activities was included in the documentation. A major item of discussion was the engagement of participants under the age of 18. Current practice requires those under 18 to receive parental approval for participating in research. Because a primary target of the recruitment activities are parents of students in Marysville Schools, and because training and using students to perform installations is possible, including this group of study participants is critical. The team agreed to focus on this from a common vehicle perspective: recruiting parents for vehicles driven primarily by the parents, but understanding that both adults and drivers under 18 may be operating the vehicle.

SECTION 7

Task 6 Pilot Deployment Plan

The purpose of this task is to develop the plan, budget and schedule for Phases 2 through 4 of a CV Pilot in coordination with ODOT, the City of Marysville, and the US33 Smart Mobility Corridor team. The pilot will support the collection of data that has been identified in the design of experiment (Task 4), and that will be useful for ODOT planners, engineers, operations, and maintenance.

7.1 Description of activity

Building off the high-level work breakdown structure (WBS) included in WSP's proposal to ODOT, the WBS was refined and expanded to include our updated understanding of the goals of the project as articulated by ODOT and Marysville stakeholders. A WBS dictionary was then developed, further describing the intent of each WBS element. The elements were then organized into logical groups, linked to form dependencies, and then their durations were estimated to develop a preliminary project schedule. Finally, based on this schedule and the expanded WBS dictionary, a rough-order of magnitude budget was prepared. The budget includes estimates for worst, best, and likely cases.

7.2 Outcomes / status

An initial draft of the Deployment Plan was submitted to ODOT and was reviewed in a walkthrough format throughout two different sessions with the ODOT technical panel. Changes captured during these meetings and subsequent reviews by ODOT staff were incorporated into this final version.

At a high level, the plan spans approximately 24 months, including approximately six months of upfront procurement, system development, and recruitment. As this project focuses on OBU installation, it depends on infrastructure to be installed by the US 33 Smart Mobility Corridor team, which could have an impact on this schedule.

SECTION 8

Task 7 Recruitment Plan

The purpose of this task is to develop a strategy that includes multiple tactics and multiple targets to allow for successful recruitment, participation, and retention of no less than 400 private vehicles in this pilot activity. To accomplish this goal, we have developed these measurable objectives:

- Recruit up to 1,600 individuals living, or working and driving, in the uptown Marysville area to participate in the connected vehicle pilot.
- Incentivize participation to ensure at least 400 Marysville-based private drivers take part for the duration of the pilot project.
- Recruit drivers per pre-determined age groups specified by ODOT.

8.1 Description of activity

To develop this recruitment plan, the Outreach and Communications team engaged with ODOT, Marysville, Union County Chamber of Commerce, Marysville Public Schools, Honda and the US 33 Smart Mobility project team to better understand the potential participant pool and ways to cross-market and recruit. The team also interviewed representatives of both the Tampa Hillsborough Expressway Authority (THEA) CV Pilot communications team, and the project manager for the Ann Arbor Connected Vehicle Test Environment (the continuation of the USDOT Safety Pilot Model Deployment). We also reviewed the demographics and psychographics of Marysville residents.

8.2 Outcomes / status

Based on our research and stakeholder interviews we identified strengths, weaknesses, opportunities, and threats to this effort, including:

STRENGTHS

- Improving safety is an issue everyone cares about
- Marysville has a lot of civic pride and will be making history with this pilot
- The ability to offer incentives will help motivate people to participate throughout the pilot

WEAKNESSES

- Concerns about data privacy
- Participating for two years is a big commitment
- Concerns about what will physically happen to their vehicles
- Piloting can be perceived as “testing” which can sound unappealing
- Time needed to install the equipment

OPPORTUNITIES

- Participants will be contributing to improving safety not just in their town, but across the nation
- Showcasing the benefits CV technology can offer
- Prior experience shows that parents, grandparents, and students are often motivated to participate in supporting school fundraising efforts
- Prior experience shows that study participants may be motivated by personal incentives such as gift cards or donations to a favorite cause or charity
- The City of Marysville, the Union County Chamber of Commerce, and Marysville Public Schools have all agreed to assist with communicating and recruiting via their communication channels. Honda has agreed to continue discussions to identify ways to collaborate in marketing efforts.

CHALLENGES

- People are very busy, so time-consuming activities can be unappealing. The Tampa CV pilot experienced a significant drop-off in participation when people realized the time commitment, their obligations, and the need for ongoing check-ins. In that study, the recruitment goal had to be increased by 400 percent to get to desired participation number.
- There have been deaths associated with AV technology—often, the public confuses AV and CV technologies.

TARGET AUDIENCES

- Drivers 16+ who travel Marysville streets primarily. Target age groups: 16-25, 26-35, 36-45, 46-60
- Parents via Marysville Public Schools
- Union County Chamber business members with Marysville-focused drivers and employees (e.g., pizza delivery, tow truck companies, sales forces)
- Other major Marysville-area employers/Marysville-based employees
- Major hospitals/healthcare facilities

- City of Marysville and Union County employees

Further, preliminary messaging, branding, graphic design and continued discussion on incentives continues.

Strategies include:

- Create a 360˚ marketing outreach strategy so drivers, whether parents or not, married or single, male or female, of all ages are aware of the opportunity to participate in the pilot within the prescribed recruiting timeframe.
- Establish a name, mark, logo, possible tagline and well-defined message strategy that will foster awareness and engage target audiences with the pilot.
- Engage local companies, organizations, and schools as partners to help communicate. Those that can deliver large pools of potential candidates should be approached first to save money and time on recruiting. For example, the school system has approximately 8,000 parents, which makes it an ideal partner to help disseminate information and connect to active, prominent groups such as the Monarch Athletic Association, the Quarterback Club, marching band and the PTO (which is very strong in Marysville).
- Create a website with key messages, downloadable recruitment materials, screening information and questionnaires, driver information, and consent forms.
- Develop metrics for analyzing results that address the critical success factors of this effort.
- Create a final report for ODOT at the completion of the recruitment effort to summarize activities and outcomes to aid in the development of similar, future projects.
- Keep communications clear, simple, and brief.

SECTION 9

Task 8 Partner / Agency Engagement

The purpose of this activity is founded in the need to engage a broad group of stakeholders and to coordinate activities among multiple partners associated with both this project and other ongoing projects in the region.

9.1 Description of activity

Engagement activities associated with this project include:

MEETING TYPE	DATE(S)	OUTCOMES
Project Kick Off	4/27/2018	Introduce team member to technical panel, refine project scope and schedule and commence work.
Project Technical Panel Meetings	Recurring ~ Monthly/As-Needed	Review project status, deliverables, scope and plan next steps.
Project Presentation	10/12/18	Present summary of Phase 1 research and answer any questions on deliverable items.
US 33 Smart Mobility Corridor — Vehicle Working Group	Recurring ~ monthly	Serves to understand hardware and applications to be deployed and to convey needs of this project for broader consideration in the US 33 SMC design.
US 33 Smart Mobility Corridor — Outreach and Communications Working Group	Recurring ~monthly	Serves to coordinate messaging activities between the multiple projects in the region. Different targets, but one brand.
Drive Ohio Alliance	Quarterly	Remain aware of broader ODOT and DriveOhio activities and goals.
Meeting with City of Marysville / Union Co.	7/5/2018	Brainstormed list of local businesses and organizations that would be potential targets for participant recruitment.
Meeting with Marysville City Schools	9/14/2018	Discussed opportunity for engaging parents and even students as participants in this project by incentivizing with contributions to extra-curricular activities.
Meeting with Honda North America	9/24/2018	Discussed opportunity for engaging Honda associates that are not part of the company car program. Further discussion will be necessary, but opportunity exists.
Conversation with THEA CV Pilot Communications Team	Ongoing	Communications team engaged in multiple exchanges to better understand the success

MEETING TYPE	DATE(S)	OUTCOMES
		and lessons learned from the THEA efforts. These helped shape the strategy and budget for the recruitment component of Phase 2-4.
Email exchange with Ann Arbor Connected Vehicle Test Bed PM	Ongoing	Communications team engaged in multiple exchanges to better understand the success and lessons learned from the Ann Arbor efforts. As this model is more representative of the Connected Marysville project, additional dialog is likely.
Emails / Conversations with OBU Vendors	Ongoing	The team is engaging OBU vendors to validate and further detail the OBU information captured in the technical assessment task.

As indicated in the outcomes, in general, engagement activities have been favorable and have helped to better scope and budget the future elements of this research. Local stakeholders are enthused and committed to the success of the project, and their continued support will be necessary and contribute to the success of the project.

SECTION 10

Lessons Learned / Assumptions

This section captures additions and identifies differences and changes between what was originally assumed in the WSP proposal, and what will be considered moving forward. These are identified for future benefit, not listed in order of priority or occurrence.

10.1 Assumptions

- This pilot will focus on private vehicles that regularly travel the streets of the City of Marysville.
- This pilot will leverage the infrastructure deployed by the US 33 Smart Mobility Corridor team, or others, but will not be responsible for deploying any infrastructure components—except software components necessary to capture and transmit collected data.
- This pilot does not intend to develop any new CV applications for deployment on vehicle OBUs. The pilot will leverage the CV applications that the US 33 Smart Mobility Corridor team has identified.
- The pilot will require a human-machine interface (HMI) to convey alerts and warnings to participants. Local leadership prefers head-up displays.
- This pilot will collect data from all vehicles that interact with the infrastructure deployed along and near US 33, including the cities of Marysville and Dublin.
- Only participants recruited specifically to this project will be subject to the rules of IRB.
- This pilot will implement a Security Credential Management System (SCMS) prescribed by the US 33 Smart Mobility Corridor team and ODOT.
- This pilot intends to leverage the Smart Columbus Operating System as the means to capture and store research data collected as part of this project. Review of PII/Privacy and Data Retention Policy must occur as part of the Phase 2 Design Activity.
- The recruitment will focus on drivers 18-years or older but will not intentionally preclude drivers under 18.
- Only a portion of the 400 equipped vehicles will implement an interface to the CAN bus (likely via the OBD-II port).

- The success of recruitment activities is likely to be highly dependent on the incentive offered. Presently, a$200donation to a 501c3 or other non-profit organization is proposed for participants who complete the study. Drivers opting not to donate to the non-profit may choose to select a gift card to a local establishment.

10.2 Lessons learned

- Participant recruitment and retention is likely the biggest challenge for this project. Metrics from THEA indicate that only roughly a quarter of registered participants follow through on the participation activities.
- This project will likely only see minimal benefits from mass-media outreach, but instead will likely require a grass-roots effort involving a significant amount of personal interaction and engagement activity.
- Participants will expect minimal impact to their daily routine from the CV technology.
- Installation activities such as extended hours (i.e., evenings and weekends) and local shuttle service to transport participants waiting for their installations will need to be designed to best support participant needs.

SECTION 11

Summary and Recommendations

As articulated in the original ODOT request for proposal (RFP) and reinforced in the subsequent project plan and project execution, the WSP team has completed the objectives of this phase and documented the outcomes of this work in a series of progressively more detailed deliverables.

These deliverables include this Final Report—Phase 1, as well as a detailed Technology Assessment, Design of Experiment, and Recruitment Plan. The provided Deployment Plan offers a detailed scope, schedule, and budget information related to the subsequent phases. The budget also provides the best- and worst-case numbers for planning purposes and options for varying levels of conducting the next phase. Table 2 summarizes these budget estimates, by phase, and include a breakout of materials and purchased services.

	WORST CASE	BEST CASE	LIKELY
Materials / Purchased Services	$ 1,472,146.62	$ 561,846.62	$ 891,846.62
Phase II - Pilot	$ 3,250,450.00	$ 1,005,450.00	$ 1,460,850.00
Phase III - Analysis	$ 137,500.00	$ 137,500.00	$ 137,500.00
Phase IV - Reporting	$ 95,000.00	$ 95,000.00	$ 95,000.00
Total (est.)	**$ 4,955,096.62**	**$ 1,799,796.62**	**$ 2,585,196.62**

Using the likely budget scenario number of about $2.5m, this translates to the equivalent of about $6400 per person to recruit, equip, monitor, and report on the CV environment. Comparing to the THEA number, which is estimated to be approximately $5800 per vehicle for the same efforts, but including, 1) quantities of scale, 2) $1600 for THEA vs. $400 for this project and, 3) the fact that THEA has a captive audience and it targeted only one major participant group, indicates that the budget estimates are comparable.

Regarding the schedule, the RFP-specified timeline is reasonable. However, our team feels that the Phase 2 portion will likely need to extend to six months, as opposed to four months originally planned, to recruit and equip the participants. Phase 3 and 4 would remain the same duration as proposed.

To meet the Phase 1 objectives outlined by ODOT, our team:

- Researched existing technologies and implementations around the country and globally and identified possible future trends relating to CV and potential solutions that will improve Ohio's transportation system. Recommendations were provided.
- Conducted a broad literature search to identify best practices nationally and locally.
- Worked with specific project partners to better understand the needs of the pilot. The team proposed additional items for consideration and assessment based on datasets and the value to ODOT.
- Reported on the work products that are part of this pilot to provide ODOT the best value
- Consulted with multiple existing and developing pilots to further define data available, develop a pilot working plan (including plans for volunteer driver recruitment and management), and develop the initial scope, budget, and schedule for the subsequent pilot phases.

Our team also addressed the additional broader research objectives from the RFP, and:

- Considered OBU providers by developing an expansive set of vendors and vital features
- Developed the strategy to increase vehicle penetration by recruiting about 400 volunteer drivers
- Provided examples of the visual dashboards to allow stakeholders to view and understand the data that will become available
- Confirmed with the US 33 Smart Mobility Corridor team the need for over-the-air updates
- Considered and documented vendor solutions presently used for over-the-air updates
- Documented the available data for analysis and the intended use of this data
- Aligned with the ODOT project team for all requested AV/CV elements
- Recommended uses for existing data (such as Highway Capacity Manual additions and signal timing), and suggested additional data that would be valuable

In addition to completing the prescribed tasks, our team is confident that the environment that is being built in the region, coupled with the support of state partners, local partners, stakeholders, and the participant base, offer an opportunity for a truly unique pilot.

Two important questions that this work raises are: how critical is the target number of vehicles, and to what extent does ODOT want to expend the budget and effort to reach this goal? Our team is optimistic about the opportunity with Marysville Schools and Honda, and it is quite possible that all 400 participants may come from that group. However, if we must reach out beyond these large opportunities to find smaller groups of potential participants, the budget could increase. The cost of OBUs, installation, and their management has the same per-unit cost whether there are 100 participants or 400 participants. And, the cost to report and analyze data for 100 vehicles or 400 vehicles is the same. However, each time a new group of potential participants is engaged, there is an incremental cost. As such, if the need arises, our team recommends pursuing one or two additional tactics beyond the direct Marysville Schools and Honda engagement and considering those efforts as sufficient for this pilot.

WSP recommends that ODOT proceed with Phases 2-4. This includes, 1) limiting the CV applications to the proposed applications from the US 33 Smart Mobility Corridor project, 2) procuring on-board equipment that will support the needs of the pilot, 3) potentially leveraging the Smart Columbus Operating System for data collection, and 4) leveraging the knowledgeable resources within the state to become a model for other cities.