Seattle Department of Transportation

University of Washington Subarea Multimodal Integrated Corridor Mobility for All (MICMA)

ADVANCED TRANSPORTATION AND CONGESTION MANAGEMENT TECHNOLOGIES DEPLOYMENT (ATCMTD) INITIATIVE

Cooperative Agreement Number 693JJ31950002

Program Final Report

October 2025

1 Executive Summary

Advancing Multimodal Innovation – Lessons from the UW MICMA Project

The University of Washington (UW) Multimodal Integrated Corridor Mobility for All (MICMA) project set out to pilot a multimodal, responsive traffic management system in the University of Washington subarea. While the project adapted from its original scope, it did so to take advantage of new technology opportunities and ultimately delivered breakthroughs that will help guide SDOT's technology strategy for years to come. The initiative positions Seattle as a leader in deploying real-world, data-driven solutions that make travel safer, more efficient, and more reliable.

1.1 Key Accomplishments and Innovations

Adaptive Signal Control. A peer-to-peer adaptive pilot was deployed at six signals along 15th Ave NE. This approach improved travel times and reliability while achieving a benefit-cost ratio exceeding 30 to 1 when using the FHWA Tool for Operations Benefit Cost Analysis, demonstrating that adaptive operations can deliver rapid return on investment and significant benefits to people traveling. Implementation of the adaptive signal controllers on the corridor resulted in approximately 15-20% improved reliability overall. Overall southbound travel times decreased by 19.8 seconds, on average, an 11% drop. Overall northbound travel times decreased by 9.2 seconds, on average, a 6% drop. All time periods reviewed had lower travel times.

GreenWave Emergency Vehicle Preemption. A cloud-based, center-to-center solution integrating emergency dispatch data expedited responder times by more than 40 percent and improved arrivals on green from 59 percent to 76 percent. These results highlight the strong potential for citywide expansion in the future.

Figure 1: Seattle Fire Department vehicle receiving real-time cloud-based signal priority along a MICMA corridor

Video Analytics for Multimodal Detection and Safety Insights. AI-based video successfully validated passive detection of pedestrians and bicyclists, ensuring they are reliably served by traffic signals. Beyond detection, the system generated near-miss analyses, conflict heat maps, and other safety metrics. This provides SDOT with new tools to proactively identify existing high-risk conditions, prioritize safety investments, and design corridors that better serve vulnerable travelers.

Figure 2: Near miss detections between vehicles and vulnerable road users at a MICMA intersection

Automated Traffic Signal Performance Measures (ATSPM). A cloud-based ATSPM system was implemented and is now used by SDOT staff to monitor operations, conduct before-and-after studies, and reduce the need for field visits, creating new efficiencies in signal management.

Integrated Corridor Management. Incident management software and Application Programming Interfaces (APIs) were deployed to enable data sharing with WSDOT's Virtual Coordination Center (VCC) and third-party navigation providers, strengthening regional coordination and public access to verified traffic impacts.

Mobility-as-a-Service and Data Portal. SDOT launched internal and public-facing data portals consolidating multimodal volumes, crash data, and street closures. This system reduces staff time spent responding to data requests while improving transparency and enabling self-service access for researchers, consultants, and the public.

Alignment with ATCMTD Expected Benefits

- **Safety.** GreenWave improved emergency response times and arrivals on green, while video analytics introduced new capabilities such as near-miss detection, heat maps, and rich safety datasets that can inform proactive safety strategies.
- **Congestion and Reliability.** Adaptive signal control reduced delays and improved travel reliability with a high benefit-cost return.
- **Emissions.** Decreased idling from adaptive operations contributes to lower fuel use and reduced carbon emissions.
- **Multimodal Performance.** Passive detection of bicycles and pedestrians enables traffic signals to serve all travelers more effectively.
- **Information Access.** The public-facing data portal and real-time APIs enhance access to integrated traffic and multimodal data.
- **Cost Savings.** Adaptive control produced a rapid return on investment (ROI), while the data portal reduces staff workload and costs.

1.2 Looking Ahead

The MICMA project demonstrated multiple pilots that delivered measurable value and established a foundation for Seattle's next generation of smart mobility initiatives. These pilots provided relevant lessons for peers throughout the country and created proven solutions that SDOT is now expanding citywide:

- **Emergency and Transit Signal Priority:** The GreenWave pilot proved effective at reducing response times for emergency vehicles. The same cloud-based technology is now being deployed to provide Transit Signal Priority, helping Seattle's buses stay on schedule and improving travel reliability for riders.
- **Network Reliability:** Peer-to-peer fiber-optic communications demonstrated unmatched reliability and low latency, confirming that fiber is the preferred medium for high-availability, high-bandwidth transportation systems that underpin the city's traffic management network.
- **Pedestrian Safety and Accessibility:** Continuous pedestrian-recall signal operations were shown to deliver more consistent crossings and fewer public-safety conflicts than dynamic detection, advancing the city's Vision Zero goal of eliminating serious and fatal crashes.
- **Performance Management:** Building on the success of Automated Traffic Signal Performance Measures (ATSPMs), SDOT will expand continuous performance management capabilities to support data-driven maintenance and optimization.

Together these initiatives establish a clear pathway toward a smarter, more resilient, and more reliable transportation system that advances the Seattle Transportation Plan's goals of safety, sustainability, and modernization.

2 Project Summary

The University of Washington (UW) Multimodal Integrated Mobility for All (MICMA) project intent is to test an urban arterial operations environment that is responsive to all modes, and all travelers, at all times. Core to the intent, the project supports passive detection and traffic signal response for cyclists and pedestrians on par with how vehicles are traditionally detected and managed. The project is located in the University of Washington subarea, with the project boundaries and intersections that demonstrated improvements shown in Figure 3.

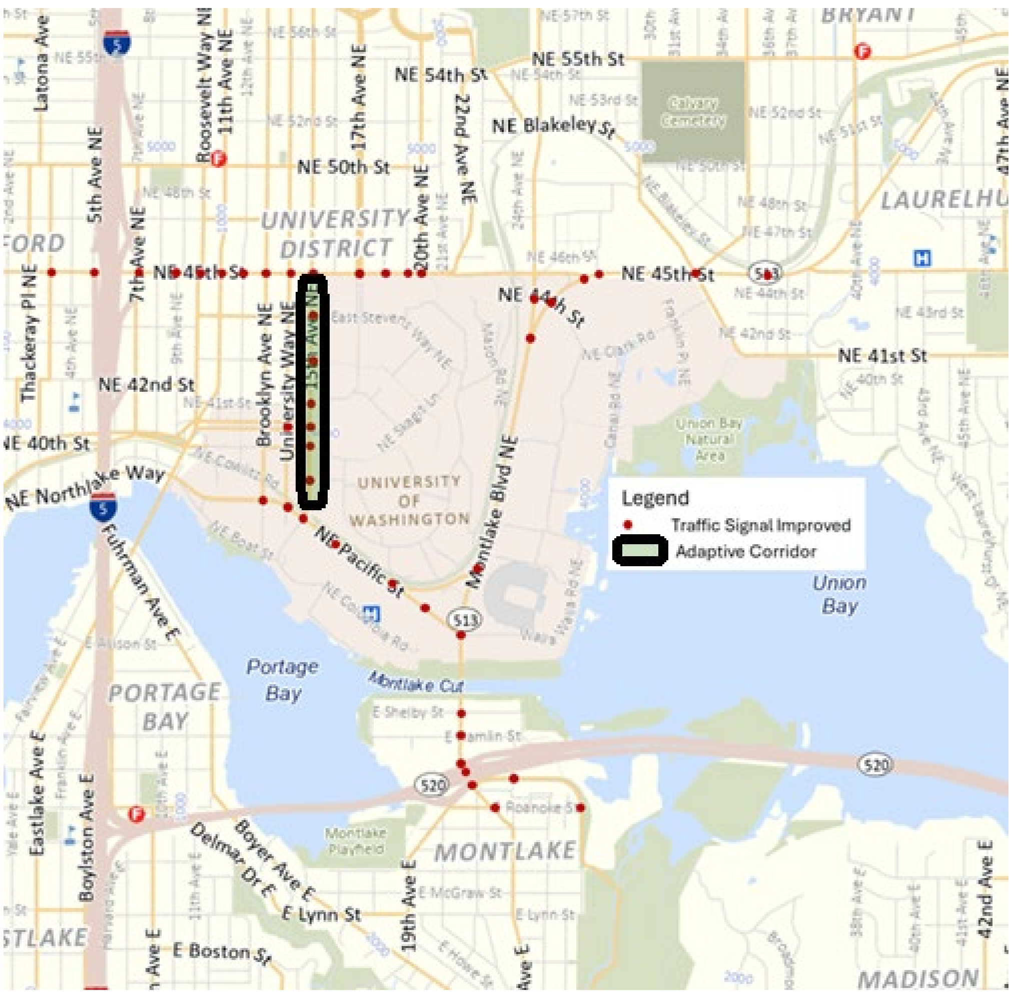

Figure 3: Project Vicinity Map and Intersections Improved

2.1 Conditions the Project Addresses

The UW subarea is characterized by high pedestrian and cyclist volumes and higher than Seattle -average crash occurrence. Traffic and pedestrian surges occur frequently due to UW operations and events at its many venues – including the 72,500-person capacity Husky Stadium – along with pedestrian surges from two light rail stations located in the subarea. The subarea also experiences traffic disruptions due to two moveable bridge operations, and incidents on two highways that bound the west and south of the subarea. Emergency vehicle response, including two emergency rooms (ERs) in the subarea, have historically been increasing.

2.2 Project Use Cases

The MIMCA project replaced obsolete traffic signal control infrastructure and installed fiber optic communications in the subarea. These improvements served as a base to enable the implementation of dynamic technologies and systems that support the following use cases:

Use Case 1: All traffic signals to respond, in real-time, to pedestrian volume demand.

Layered onto the adaptive signal control use case, pedestrian surge management provides traffic signal timing changes to respond to increases in pedestrian volumes at an intersection based on passive detection of pedestrians. Passive pedestrian detection places the detection of pedestrians on par with vehicle detection, meaning pedestrians do not need to do anything, like pushing a button, to be detected.

Use Case 2: Allow traffic signals to respond, in real time, to bicycle travelers.

Passive cyclist detection detects cyclists in the street, treating them on par with motor vehicles in terms of traffic signal detection (as motor vehicles are passively detected).

Use Case 3: Adaptive Traffic Signal Control - Allow traffic signals to respond, in real time, to traffic volumes.

Allows traffic signals to respond in real-time to vehicle volume demands. Automated Traffic Signal Performance Measures (ATSPMs) gather high resolution data from traffic signals for use in planning, evaluation, and operations.

Use Case 4: Green Wave Emergency Vehicle Pre-Emption (EVPE) - Improve emergency vehicle travel time to the two ERs in the subarea using Green Wave.
Green Wave enables traffic signals to adjust and provides a green signal indication to clear traffic in advance of approaching emergency vehicles.

Use Case 5: Integrated Corridor Management (ICM) - Integrate freeway data with arterial data to respond to incidents and provide alternate routes.
ICM enables data sharing with the Washington State Department of Transportation (WSDOT) to improve joint response to incidents on all roadways.

Use Case 6: Mobility-as-a-Service (MaaS) - Enhance MaaS platform to include ADA barriers, wheelchair-accessible taxi service, single point of payment, and trip planning.
The MaaS Use Case provides the following services:

- **Accessible walking path data.** This service enhances mobility for people with disabilities by distributing data on barriers that exist in the public right-of-way (stairs, steep grades, etc.) to people either directly or via third-party applications (apps). It is noted here that this use case could not be fully implemented.
- **Data Portal.** The Data Portal provides historical traffic volume, speed, crash and other traffic data via an online portal for SDOT internal and public access.
- **Real-time incident data feed.** Create a real-time data feed containing incident data for use by WSDOT to support ICM, as well as any private sector (third party) traffic data services that wish to use the data.

Each use case, including the technologies implemented to support the use case, is further described and evaluated in Chapter 3 of this report.

2.3 Project Timeline

The project was submitted in June 2017 for consideration in response to the FY 2017 ATCMTD Grant Notice of Funding Opportunity. The Cooperative Agreement was signed January 16, 2019, amended July 17, 2020, amended May 30, 2023, amended February 11, 2025, and ended on July 16, 2025.

2.4 Project Technology Evolution

During the course of the project, there were changes to the project partners and to the technologies applied. There were two systems already in place at the start of the project that were intended to support and be enhanced by the project innovations: Trusted Data Collaborative and Base ITS Adaptive Control. These systems and the project changes are described below.

Trusted Data Collaborative

The Trusted Data Collaborative was in place at the project outset and was hosted by the University of Washington. It was to be a secure data repository for SDOT and other agency data and be the source for distribution of the data to public and private partners. Unfortunately, this service was eliminated by the University of Washington in early 2020. SDOT has since enhanced its own capacity to manage its own data, and the project further funded a Data Portal for enhanced access to data that is frequently used by SDOT staff and the general public. This project element was consolidated with the Data Portal portion of the MaaS Use Case, with data storage and access/distribution as a single service.

Base ITS Adaptive Control

SDOT had invested in a central adaptive traffic signal control software platform that was to be leveraged for this project. However, after it was deployed in the UW MICMA subarea, this existing software was found to operate unreliably when intermittent minor communications failures occurred. Rather than abandoning adaptive signal control completely, SDOT chose to pilot a local, peer-to-peer based adaptive software solution on a single corridor (MAXTIME adaptive from the firm Q Free). While this allowed us to still test out adaptive signal control, the number of applicable signals went from 31 to 6.

Other changes to the project scope are summarized in Table 1. Despite these changes, the project intent and objectives remained unchanged.

Table 1: Summary of Other Changes to the Project Scope

Project Technology Element	Original Proposed Technology Approach	Deployed Technology Approach
Communications for Adaptive Control and other Field ITS – Impacting Use Cases 2 and 3	Communications were to be supplied via a private sector partner by deploying cellular small cell communications and providing cellular communications.	Fiberoptic communication was deployed.
Use Case 2: Passive Cyclist Detection	A mobile phone application (app) was to be supplied, along with field equipment for cyclists to be detected at traffic signals.	AI-processed video detection was deployed to passively detect cyclists for traffic signal detection.
Use Case 3: Adaptive Control - Detection	Vehicle detection was to be supplied via the private sector partner using a Data-as-a-Service (DaaS) model.	Traditional vehicle detection via loops and video was deployed.
Use Case 3: ATSPMs	A new ATSPM tool was to be developed by one of the private sector partners.	A cloud-based ATSPM that integrates local traffic signal detailed data with probe-based data was procured
Use Case 5: ICM	DMS were going to be deployed.	No dynamic message signs (DMS) were deployed. Rather, investments in an Application Programming Interface (API) were implemented to feed SDOT data to WSDOT and private sector transportation partners to improve joint incident response.
Use Case 6: Information delivery for Mobility-as-a-Service (MaaS)	Information kiosks were to be deployed.	Kiosks were not deployed. Rather, available MaaS data were incorporated into SDOT's publicly available data sets.

3 Project Goals, Hypotheses, and Performance measures

This section addresses the UW MICMA project use cases alignment with the expected benefits outlined in the Cooperative Agreement Statement of Purpose Section A.1.

3.1 Reduced Traffic-Related Fatalities and Injuries

The following use cases are intended to provide benefits in the area of improving safety:

Use Case 1: Pedestrian Surge Management
By adjusting traffic signal timing to better serve surges in pedestrian demand, vehicle-pedestrian conflicts and near misses should be reduced.

Use Case 2: Passive Cyclist Detection

Passively detecting cyclists reliably at traffic signals ensures they will be provided with a green phase, minimizing the times when cyclists might choose to proceed with a red phase.

Use Case 4: Green Wave
The Green Wave system will increase arrivals on green, improving response times for emergency responders. Increased arrivals on green also reduces risks of collisions between emergency vehicles and pedestrians, cyclists, and other vehicles.

3.2 Reduced Traffic Congestion and Improved Travel Time Reliability

The following use cases are intended to provide benefits in reducing congestion:

Use Case 1: Pedestrian Surge Management
By responding to surges in pedestrian demand, pedestrian wait times are reduced and thus mobility is improved.

Use Case 2: Passive Cyclist Detection.
Detecting cyclists passively and reliably at traffic signals is intended to improve cyclist mobility and safety.

Use Case 3: Adaptive Signal Control
Adaptive signal control is intended to directly reduce congestion by reducing signal control delays for transit and other vehicles.

Use Case 4: ATSPMs
ATSPMs will indirectly support reduced congestion by providing indicators of signal control delay and other actionable data to signal operations staff, allowing staff to adjust signal timing/phasing if needed.

Use Case 5: Integrated Corridor Management
Coordination between WSDOT and SDOT regarding incidents in the area that may affect each agency's facilities is intended to support reduction in travel delays as each agency can disseminate information to the public if alternative routes are available that may help to reduce trip delays.

Use Case 6: Mobility-as-a-Service
Enhancing access to data for all modes is intended to improve mobility for all users, including disabled persons.

3.3 Reduced Transportation-Related Emissions

The following use cases are intended to provide benefits in the area of reducing emissions:

Use Case 3: Adaptive Signal Control
By reducing idling due to control delay, adaptive signal control is intended to reduce environmental impacts.

3.4 Optimized Multimodal System Performance

The following use cases are intended to provide benefits in the area of optimizing multimodal system performance:

Use Case 1: Pedestrian Surge Management
By responding to surges in pedestrian demand, pedestrian wait time is reduced, and thus mobility is improved.

Use Case 2: Passive Cyclist Detection
Detecting cyclists reliably at traffic signals is intended to optimize the system performance specifically for cyclists.

Use Case 3: Adaptive Signal Control
Adaptive signal control is intended to maximize the use of the available space by adjusting traffic signal phase timing in real-time to respond to demand.

ATSPMs will indirectly support performance improvements by providing data that can be used to optimize signal timing.

3.5 Public Access to Real-Time Transportation Integrated Traffic, Transit, and Multimodal Transportation Information to Make Informed Travel Decisions

The following use case is intended to provide benefits in the area of real-time information dissemination:

Use Case 6: Mobility-as-a-Service
Enhancing access to data for all modes is intended to improve mobility for all travelers, including people with disabilities.

3.6 Cost Savings to Transportation Agencies, Businesses , and the Traveling Public

The following use cases are intended to provide benefits in the area of cost savings:

Use Case 3: Adaptive Signal Control
Adaptive Signal Control is intended to reduce costs to the traveling public through fuel cost savings and time savings.

Use Case 6: Mobility-as-a-Service
The Data Portal element of the MaaS Use Case is intended to reduce staff costs due to manually retrieving and disseminating data internally and to the public.

3.7 Project Hypotheses and Performance Measures

As the project evolved over the course of the grant, some measures of effectiveness were changed or not able to be measured. Table 2 summarizes these changes for each use case and hypothesis.

Table 2: Summary Table by Use Case and Hypothesis

Use Case	Hypothesis	Original MOE	Revised MOE
Use Case 1: Pedestrian Surge Management	Pedestrian / vehicle conflicts will decrease during times of peak pedestrian demand.	Percent reduction in pedestrian / vehicle conflicts and near misses.	Not able to measure
Use Case 1: Pedestrian Surge Management	Pedestrian delay will decrease during periods of peak pedestrian demand.	Green time allocated to pedestrian phase per cycle and/or per 5-minute bin.	Not able to measure
Use Case 1: Pedestrian Surge Management	Vehicle travel times along the affected corridor will remain the same during periods of peak pedestrian demand.	Percent change in vehicle time during periods when pedestrian surge is activated.	Not able to measure
Use Case 2: Passive Cyclist Detection	When a detection occurs, an input will be sent to the controller 100% of the time	Traffic signal receipt of detection input	No change
Use Case 2: Passive Cyclist Detection	Cyclists will be detected 90% of the time at all times of day in all environmental conditions	Number of cyclists detected	No change
Use Case 3: Adaptive Signal Control	Travel times will decrease during non-peak periods	Percent change in travel times by hour	No change
Use Case 3: Adaptive Signal Control	Travel time reliability will increase (excluding during major events or incidents on adjacent freeways)	Percent Change in Planning Time Index	No change
Use Case 3: Adaptive Signal Control	Overall vehicle delay will decrease (excluding during major events or incidents on adjacent freeways)	Percent change in overall vehicle delays at different time periods	No change

Use Case	Hypothesis	Original MOE	Revised MOE
Use Case 3: Adaptive Signal Control	Pedestrian delay will remain the same	Percent change in pedestrian phase timing	Not able to measure
Use Case 3: Adaptive Signal Control	Transit travel times will remain the same	Percent change in transit travel time	No change
Use Case 3: Adaptive Signal Control	The benefit cost of implementing adaptive signal control will be positive	Benefit cost (calculated using FHWA TOPS-BC model)	No change
Use Case 4: Green Wave Emergency Vehicle Pre-Emption (EVPE) and ATSPMs	Emergency responder travel time will decrease	Percent reduction in travel time before and after Green Wave implementation.	Percent reduction in responder vehicle average speed before and after Green Wave implementation.
Use Case 4: Green Wave Emergency Vehicle Pre-Emption (EVPE) and ATSPMs	Emergency responder arrivals on green will increase	Percent increase in arrivals on green before and after Green Wave implementation	No change
Use Case 4: Green Wave Emergency Vehicle Pre-Emption (EVPE) and ATSPMs	Vehicle delay will increase (on side streets)	Not able to measure	Not able to measure
Use Case 4: Green Wave Emergency Vehicle Pre-Emption (EVPE) and ATSPMs	Impact to vehicle delay will not spread beyond a 15-minute recovery period	Not able to measure	Not able to measure

Use Case	Hypothesis	Original MOE	Revised MOE
Use Case 4: Green Wave Emergency Vehicle Pre-Emption (EVPE) and ATSPMs	ATSPMs support effective assessment of signal operations	Staff interviews of use of ATSPM data to assess traffic signal operations	No change
Use Case 4: Green Wave Emergency Vehicle Pre-Emption (EVPE) and ATSPMs	ATSPMs will speed response to malfunctions	Staff use of alarms, reports, etc. to respond to malfunctions	No change
Use Case 4: Green Wave Emergency Vehicle Pre-Emption (EVPE) and ATSPMs	ATSPMs based on probe data alone can provide actionable information to SDOT	Staff assessment of intersection data reports with and without enumerations	No change
Use Case 5: Integrated Corridor Management	WSDOT operators find shared data useful in managing incidents	WSDOT Traffic Management Center (TMC) operators and/or supervisors perceive value in the shared data and can cite planned or actual uses of the data	No change
Use Case 5: Integrated Corridor Management	Incident response time will decrease when managing joint incidents.	Incident response time for joint incidents.	Not able to measure
Use Case 6: Mobility-as-a-Service	The IMS will improve and streamline data entry and reporting	Staff qualitative reports	No change

Use Case	Hypothesis	Original MOE	Revised MOE
Use Case 6: Mobility-as-a-Service	The Data Portal will reduce time/cost to access data internally and externally	Reduce associated cost and time to perform public disclosure requests, internal requests, and the Annual Traffic Report	No change
Use Case 6: Mobility-as-a-Service	The Data Portal will enable staff to gain insights in an efficient manner	Improved efficiencies in accessing the data and improved data analytic capabilities (based on qualitative staff assessment)	No change
Use Case 6: Mobility-as-a-Service	The Data Portal will increase public usage of the hosted data	Increase public access requests/attempts to the hosted data	No change

4 Evaluation Results

The following results are organized by the use cases and include the hypotheses and measures of effectiveness evaluated. Each use case includes a description of the technologies applied. If there were any limitations that may have affected the project's intended outcomes, these are also described.

4.1 Pedestrian Surge Management (Use Case 1)

The system incorporates the following:

- AI-processed video (processing locally at the cabinet) which detects and counts pedestrians.
- Integration of the pedestrian detections with the traffic signal controller.
- Configuring the local adaptive control system to respond to the pedestrian detections in a dynamic manner.

The location selected to pilot pedestrian surge technologies/operations is 15th Ave NE at NE 43rd St. This location is adjacent to a Sound Transit light rail station, and it provides access to an important pedestrian corridor on the UW campus, as shown in Figure 4.

Figure 4: Map of Pedestrian Surge Intersection Vicinity

The signal is configured to recall pedestrian phases with the associated vehicle phase, and also includes a pedestrian phase, with phases 4 and 8 operating simultaneously, as shown in the phasing diagram in Figure 5.

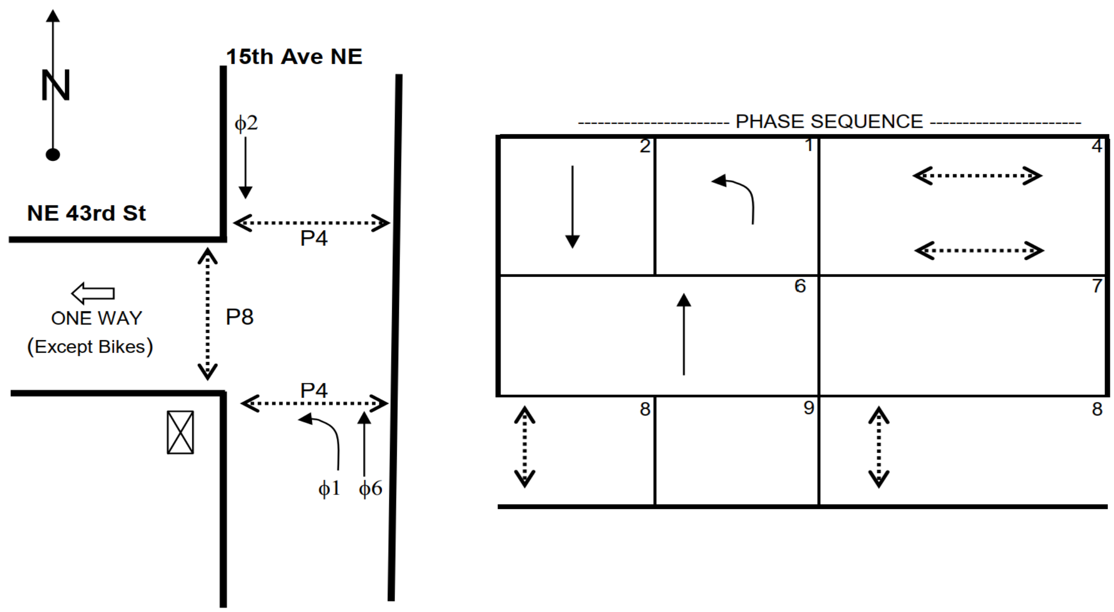

Figure 5: 15th Ave NE at NE 43rd Signal Phasing Diagram

4.1.1 Concept of Operations

Pedestrian surge operations were tested as part of the corridors adaptive signal control system. The system uses the pedestrian inputs to bring up the all-walk phase more often when more pedestrians are present. This is the same logic the adaptive system uses to serve vehicles more often when there are more vehicles. Over a 5-minute period, pedestrians are counted, then over the next 5-minute period a new timing plan is in place to serve pedestrians more often, and the process is repeated.

4.1.2 Pedestrian Surge Management Hypotheses and MOEs

The MOEs for this use case could not be measured during the grant timeline. As described below, SDOT did validate the system and collect some evaluation data.

4.1.3 Pedestrian Surge Management Data Collection

Data was collected first to evaluate the accuracy of the pedestrian detection for three hours (448 pedestrians crossing) on July 11, 2023, and then to perform the evaluation for six hours (1,582 pedestrians crossing) on July 21, 2025. Two technologies, one from Gridsmart, and one from Derq, were evaluated, both based on video processed via machine learning (AI). Detection accuracy was validated by staff reviewing video collected at the intersection where the pedestrian AI-processed video detection system was deployed.

4.1.4 Video Validation of Pedestrian Data

Log data, which includes the entering timestamp delineated by zone per each individual object detected, was requested from the vendor, Derq, for both cameras on the same date. Log data includes the classification, the speed, and the dwell time in the zone of the object.

Comparing the 'ground truth' video data with the output from the vendor's log allowed SDOT to validate the system. A short script was written in AutoHotKey to quickly label video data using specific keystrokes to pull the timestamp in VideoLAN VLC, a video player, as well as the direction and number of pedestrians directly into Excel. This allowed data to be reviewed four times faster than previously and was done once per zone grouping (West, East, South, and North).

Since the timestamp of the labelled data was not perfectly aligned with the log data, each object in the log was assigned an updated timestamp. Both validation videos started with a known action at a known time (such as waving a paper) to calibrate the log and video file timestamps, ensuring an accurate comparison.

4.1.5 Pedestrian Surge Management Evaluation Results

The operational evaluation of traffic signal response to pedestrian surges was not completed during the grant timeline. This work remains ongoing. One barrier to completion is that the traffic signal controller seems unable to manage the multiple systems used at this location, which include the passive pedestrian detection system, ATSPMs, Green Wave, and the adaptive signal control. The signal is frequently going into flash when the pedestrian surge system inputs are added. The controller issue was not diagnosed in time to complete the implementation.

4.2 Passive Cyclist Detection (Use Case 2)

SDOT tested a cyclist presence detection system at the signalized intersection of 15th Ave NE at NE 43rd St. Detecting cyclists in the roadway at signalized intersections could provide safety and efficiency benefits. Passive traffic signal actuation would improve the flow of cyclists while decreasing conflict points, especially in left-turn pockets.

To ensure accurate and effective implementation, configurations were tested across different environmental conditions to ensure their performance would not be compromised during adverse conditions, such as rainy and nighttime conditions.

4.2.1 Passive Cyclist Detection Hypotheses and MOEs

Table 3 outlines the hypotheses and associated MOEs used in the evaluation.

Table 3: Passive Cyclist Detection Hypotheses and MOEs

Hypothesis	MOE
When a detection occurs, an input will be sent to the controller 100% of the time	Traffic signal receipt of detection input
Cyclists will be detected 90% of the time at all times of day in all environmental conditions	Number of cyclists detected

4.2.2 Passive Cyclist Detection Data Collection

SDOT tested a cyclist presence detection system at the signalized intersection of 15th Ave NE at NE 43rd St. Four configurations were tested, each one providing better detection accuracy. The last configuration, with the best detection accuracy, was the use of two high-definition 360-degree cameras and the Derq Orion edge unit. The cameras were positioned with one at the northeast corner of the intersection and one at the southwest corner. Both cameras were used to monitor the detection zones in the roadway. The dual views allowed for redundant detection zones. Incorporating redundant detection zones provides the detection algorithm with an alternative viewpoint, which enables better detection results.

Data was collected and validated through recordings made at different times of day (to capture different light levels) and during rainy and dry conditions. The first recordings were completed in December 2022 and the last in May 2025 as different equipment configurations were reviewed. As key lighting and weather conditions, such as when it was dark and rainy, had few cyclists, a SDOT staff member would ride their bike through the intersection during the evaluation periods to provide more detection opportunities.

4.2.3 Passive Cyclist Detection Evaluation Results

The following summarizes the evaluation results for each hypothesis.

4.2.3.1 *Hypothesis: When a detection occurs, an input will be sent to the controller 100% of the time.*

The vendor's system provided data per second delineated per approach and classified the object in the detection zone. The final configuration included connecting the traffic signal controller to the cyclist detection edge unit. SDOT confirmed that every detection event registered in the cyclist detection edge unit was also registered in the traffic signal controller log. This configuration was confirmed on May 17, 2025 from 4 AM to 6 AM, during the final round of testing, as SDOT was also confirming detection accuracy in various lighting conditions.

4.2.3.2 *Hypothesis: Cyclists will be detected 90% of the time at all times of day in all environmental conditions.*

The second to last evaluation was run on April 18, 2024 from 11:45 AM to 12:50 PM for the condition of daytime with no rain, and May 4, 2024. from 3:05 PM to 4:45 PM for the condition of daytime with rain. This test period confirmed that during daytime with no rain, 98.2% of cyclists were detected (of 165 total cyclists). During daytime with rain, 100% of cyclists were detected (of 63 total cyclists). Other evaluation periods were run in the night with rain and without rain, but the results did not meet the 90% detection threshold. This was especially true at night with rain, where we suspect that the glare from headlights across standing water on the roadway made it especially hard for the system to detect cyclists.

The final evaluation replaced the cyclist detection edge unit with a newer model, the Derq Orion unit. This unit had additional processing capacity, allowing us to have both cameras detect cyclists in the same detection zone. The final evaluation was run on May 17, 2025 from about 4 AM to 6 AM. This test period was selected as it was continuously raining and the rising sun provided varying lighting conditions from the earliest stage of dawn, astronomical twilight, to full daylight.

Table 4: Bike detection final evaluation

Category	Lighting Conditions	Direction	Percent Detected	Total Actual Cyclists
Astronomical Twilight	3:55 AM to 4:03 AM	Overall	100.0%	4
Astronomical Twilight	3:55 AM to 4:03 AM	Eastbound	100.0%	2
Astronomical Twilight	3:55 AM to 4:03 AM	Northbound	100.0%	1
Astronomical Twilight	3:55 AM to 4:03 AM	Southbound	100.0%	1
Nautical Twilight	4:03 AM to 4:51 AM	Overall	98.4%	63
Nautical Twilight	4:03 AM to 4:51 AM	Eastbound	100.0%	27
Nautical Twilight	4:03 AM to 4:51 AM	Northbound	95.7%	23
Nautical Twilight	4:03 AM to 4:51 AM	Southbound	100.0%	13
Civil Twilight	4:51 AM to 5:29 AM	Overall	97.1%	70
Civil Twilight	4:51 AM to 5:29 AM	Eastbound	100.0%	33
Civil Twilight	4:51 AM to 5:29 AM	Northbound	100.0%	17
Civil Twilight	4:51 AM to 5:29 AM	Southbound	90.0%	20
Daylight	5:29 AM to 5:55 AM	Overall	97.4%	38
Daylight	5:29 AM to 5:55 AM	Eastbound	94.4%	18
Daylight	5:29 AM to 5:55 AM	Northbound	100.0%	10
Daylight	5:29 AM to 5:55 AM	Southbound	100.0%	10

Overall, during the final test period, 97% of the 175 possible cyclist detections were properly detected. No time-period or detection zone dropped below 90% detection accuracy. These were the best results yet and met the hypothesis.

4.3 Adaptive Signal Control (Use Case 3)

SDOT implemented an adaptive control system that functions locally via peer-to-peer communications on our fiber network. The adaptive software resides on the controllers as part of the controller firmware. This system was deployed along 15th Ave NE, from north of the NE Pacific St intersection to south of the NE 45th St intersection. Figure 6 depicts the extent of the deployment which includes the following six (6) signalized intersections:

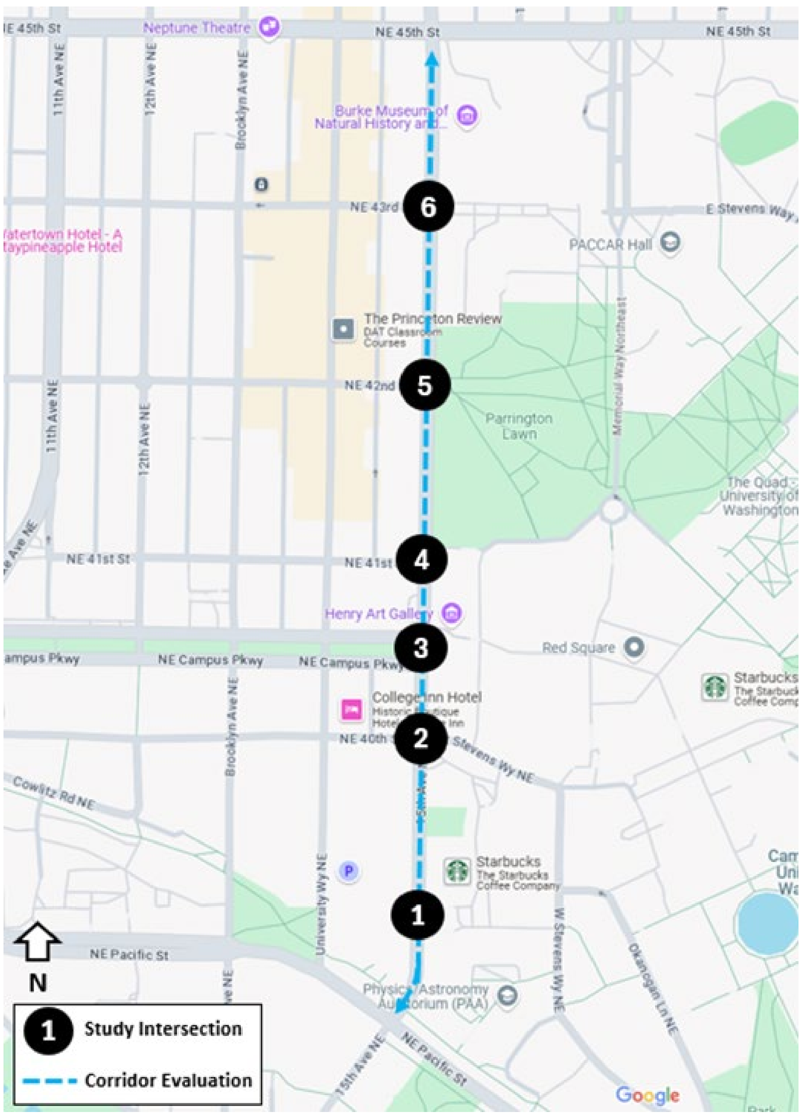

Figure 6: 15th Avenue NE Adaptive Corridor

1. 15th Ave NE, north of NE Pacific St (Pedestrian Crossing signal)
2. 15th Ave NE at NE 40th St/W Stevens Way NE
3. 15th Ave NE at NE Campus Parkway
4. 15th Ave NE at NE 41st St
5. 15th Ave NE at NE 42nd St
6. 15th Ave NE at NE 43rd St

4.3.1 Use Case 3: Adaptive Signal Control Hypotheses and MOEs

Table 5 outlines the hypotheses and associated MOEs used in the evaluation.

Table 5: Adaptive Signal Control Hypotheses and MOEs

Hypothesis	**MOE**
Travel times will decrease during non-peak periods	Percent change in travel times by hour
Travel time reliability will increase (excluding during major events or incidents on adjacent freeways)	Percent Change in Planning Time Index
Overall vehicle delay will decrease (excluding during major events or incidents on adjacent freeways)	Percent change in overall vehicle delays at different time periods
Pedestrian delay will remain the same	Percent change in pedestrian phase timing. Note that this MOE could not be measured
Transit travel times will remain the same	Percent change in transit travel time
The Cost-Benefit of implementing adaptive control will be positive	Cost benefit (calculated using FHWA TOPS-BC model)

4.3.2 Adaptive Signal Control Data Collection (Performance)

This section addresses the data collection specifically related to performance, with the cost-benefit data collection addressed separately. Note that count and corridor travel time data collected for performance was also used to assess cost-benefit. This system was deployed along 15th Ave NE, from north of the NE Pacific St intersection to south of the NE 45th St intersection.

Before and after intersection traffic counts and corridor travel times were extracted from the ATSPM platform. The ATSPM platform additionally provided probe-based travel times. For transit travel time, Automatic Vehicle Location (AVL) data was provided by King County Metro, the local transit provider.

The adaptive control system was initially implemented in February 2025. During the first few weeks of the operation, SDOT adjusted timing parameters based on field observations. Once the adaptive system was deemed to operate as needed, it was turned off at 12:00 PM (noon) on Monday, March 31, 2025, to establish a one-week 'before' period for data collection. Afterwards, the adaptive control system was turned on at 12:00 PM (noon) on Monday, April 7, 2025, until Monday, April 14, 2025, to establish a one -week 'after' period for data collection.

Using the ATSPM dashboard tool supporting the UW MICMA project, traffic volumes and corridor travel times for both weeks of analysis were extracted, including for individual time periods, to evaluate differences in performance based on time of day and/or day of week. In order to include the largest data set possible and eliminate any weekend effects on the data, the 72-hour period from 12:00 AM Tuesday to 11:59 PM Thursday was used for both 'before' and 'after' weeks.

4.3.3 Adaptive Signal Control Evaluation Results (Performance)

The following summarizes the evaluation results related to system performance. The cost-benefit results are in a subsequent section of this report.

4.3.3.1 *Hypothesis: Travel time reliability will increase (excluding during major events or incidents on adjacent freeways)*

The before and after travel time data was extracted by time-of-day to determine if any time-of-day changes occurred with the implementation of adaptive control. No incidents or major events occurred during the analysis periods. No major differences were observed in weather conditions during the analysis periods. Southbound traffic is the primary direction of travel with roughly 40% more traffic than northbound during the AM peak and roughly 10% more than northbound traffic during the PM peak.

Table 6 and *Table 7* summarize the before and after analysis of corridor travel times, with northbound travel times shown in Table 6 and southbound travel times shown in Table 7.

Table 6: Northbound Changes in Average Travel Time Due to Adaptive Control

Time Period	Before	After	Change	% Change
AM (12 to 6)	130.5 sec	117.4 sec	-13.1 sec	-10.0%
AM Peak (6 to 11)	140.4 sec	139.4 sec	-1.0 sec	-0.7%
Midday (11 to 2)	151.5 sec	141.2 sec	-10.3 sec	-6.8%
PM Peak (2 to 8)	164.5 sec	150.5 sec	-14.0 sec	-8.5%
PM (8 to 12)	143.5 sec	133.0 sec	-20.5 sec	-7.3%
24-Hour Average	149.4 sec	140.2 sec	-9.2 sec	-6.2%

Table 7: Southbound Changes in Average Travel Time Due to Adaptive Control

Time Period	Before	After	Change	% Change
AM (12 to 6)	161.8 sec	123.8 sec	-38.0 sec	-23.5%
AM Peak (6 to 11)	174.8 sec	159.4 sec	-15.4 sec	-8.8%
Midday (11 to 2)	168.4 sec	162.8 sec	-5.6 sec	-3.3%
PM Peak (2 to 8)	190.1 sec	157.6 sec	-32.5 sec	-17.1%
PM (8 to 12)	175.2 sec	142.5 sec	-32.7 sec	-18.7%
24-Hour Average	175.4 sec	155.6 sec	-19.8 sec	-11.3%

An average of 9.2 seconds of travel time savings in the northbound direction and 19.8 seconds in the southbound direction were realized due to the implementation of adaptive control. These average per vehicle travel time savings result in a total of 251.41 hours of total person-hours savings for travelers in cars and trucks (not including persons in transit) per day.

4.3.3.2 *Hypothesis: Travel time reliability will increase (excluding during major events or incidents on adjacent freeways)*

Table 8 and *Table 9* provide summaries of the impacts of adaptive control on the Planning Time Index during different periods over the day on weekdays, with Table 8 showing northbound and Table 9 showing southbound impacts. The index is a ratio of the 95th-percentile travel time and free flow travel time.

Table 8: Changes in Northbound Planning Time Index Due to Adaptive Control

Time Period	Before	After	Change	Percent Change
AM (12 to 6)	1.71	1.49	-0.22	-12.9%
AM Peak (6 to 11)	1.82	1.97	+0.15	+8.2%
Midday (11 to 2)	2.81	1.92	-0.89	-31.7%
PM Peak (2 to 8)	2.77	2.26	-0.51	-18.4%
PM (8 to 12)	2.09	1.82	-0.27	-12.9%
24-Hour Average	2.35	1.98	-0.37	-15.7%

Table 9: Changes in Southbound Planning Time Index Due to Adaptive Control

Time Period	Before	After	Change	Percent Change
AM (12 to 6)	2.56	2.08	-0.48	-18.8%
AM Peak (6 to 11)	2.27	2.14	-0.13	-5.7%
Midday (11 to 2)	2.25	2.45	+0.20	+8.9%
PM Peak (2 to 8)	4.91	4.16	-0.75	-15.3%
PM (8 to 12)	2.42	2.15	-0.27	-11.2%
24-Hour Average	3.05	2.47	-0.58	-19.0%

A Planning Time Index value closer to 1.00 indicates less congestion on the corridor and greater reliability. Implementation of the adaptive signal controllers on the corridor resulted in approximately 15-20% improved reliability overall. Over the 24-hour period, the reliability of travel time improved with the implementation of adaptive control. While some degradation in the planning time index occurred for Northbound AM Peak period travel (between 6 AM and 11 AM) and Southbound Midday (11 AM to 2 PM) travel, these reductions were less than 9% for both periods. As the planning time index encompasses 95% of all traffic, it's easy for outliers to impact the result. All other time periods experienced improvements in the planning time index.

4.3.3.3 *Hypothesis: Overall vehicle delay will decrease (excluding during major events or incidents on adjacent freeways)*

Table 10 provides a summary of the impacts of adaptive control on the overall control delay per vehicle along the 15th Ave NE corridor during different periods over the day on weekday. The results summarized represent the overall control delay per vehicle considering each approach and phase. During each period and overall, the control delay per vehicle improved after implementation of adaptive control, with an overall reduction in control delay per vehicle of 1.8 seconds.

Table 10: Changes in Per Vehicle Control Delay Due to Adaptive Control

Time Period	Before	After	Change	% Change
AM (12 to 6)	11.9 sec	10.9 sec	-1 sec	-8.4%
AM Peak (6 to 11)	14 sec	12.1 sec	-1.9 sec	-13.6%
Midday (11 to 2)	17.8 sec	15.7 sec	-2.1 sec	-11.8%
PM Peak (2 to 8)	20.4 sec	18.5 sec	-1.9 sec	-9.3%
PM (8 to 12)	13.7 sec	11.3 sec	-2.3 sec	-16.8%
24-Hour Average	15.5 sec	13.7 sec	-1.8 sec	-11.6%

4.3.3.4 *Hypothesis: Pedestrian Delay will remain the same.*

During the course of the UW MICMA project, SDOT modified its policies regarding pedestrian signal timing to support the City of Seattle's Vision Zero efforts. All traffic signals in the UW subarea are configured in pedestrian recall. In other words, the pedestrian phase will always appear with the associated non-conflicting vehicle phase, whether or not a pedestrian push button is depressed. Therefore, this hypothesis could not be measured in any meaningful way.

4.3.3.5 *Hypothesis: Transit travel times will remain the same*

Table 11 and Table 12 summarize the adaptive control impact on transit travel times using King County Metro AVL data for an approximately 0.3-mile portion of the corridor. It is noted the time periods King County Metro uses to summarize travel time do not correspond directly to the same hours of the day as the ATSPM travel time bins used for general vehicle traffic but are related to transit scheduled frequency. The same time period used for vehicle travel times was also used for transit travel tines. Table 11 shows northbound, and Table 12 shows southbound transit travel time impacts.

Table 11: Changes in Northbound Average Transit Travel Time Due to Adaptive

Time Period	Before	After	Change	Percent Change
Overnight (10 PM to 5 AM)	122.1 sec	107.7 sec	-14.4	-11.8%
AM (5 AM to 9 AM)	112.4 sec	124.4 sec	+12.0	+10.7%
Midday (9 AM to 3 PM)	136.2 sec	113.8 sec	-22.4	-16.4%
PM (3 PM to 7 PM)	166.5 sec	132.0 sec	-34.5	-20.7%
Evening (7 PM to 10 PM)	121.0 sec	133.1 sec	+12.1	+10.0%

Table 12: Changes in Southbound Average Transit Travel Time Due to Adaptive

Time Period	Before	After	Change	Percent Change
Overnight (10 PM to 5 AM)	114.6 sec	105.8 sec	-8.8	-7.7%
AM (5 AM to 9 AM)	84.2 sec	124.4 sec	+40.2	+47.8%
Midday (9 AM to 3PM)	97.4 sec	112.1 sec	+14.7	+15.0%
PM (3 PM to 7 PM)	124.1 sec	106.0 sec	-18.1	-14.6%
Evening (7 PM to 10 PM)	118.8 sec	103.9 sec	-14.9	-12.5%

The average transit travel time did not show the same benefit as passenger car and truck travel times. This is likely because of other factors that impact transit travel times such as variations in dwell times at bus stops due to changes in boarding and deboarding. Travel times for transit in the northbound and southbound directions ranged from 35 seconds faster to 40 seconds slower compared to baseline conditions, with the PM Peak period performing better in both the northbound and southbound directions.

4.3.3.6 *Hypothesis: The Cost-Benefit of implementing adaptive control will be positive*

For the Cost Benefit Analysis, the FHWA Tool for Operations Benefit Cost Analysis (TOPS-BC Version 4.0) tool was used, with base unit pricing updated to reflect local values wherever possible. The cost analysis for a 5-year and 10-year period was derived using this tool, and the tool was also used to determine which benefit parameters should be analyzed for this BCA task.

Cost data was provided by SDOT, and it included basic infrastructure equipment costs for the deployment of the adaptive system (Linked Signal System LAN, annual signal timing/monitoring costs), as well as incremental costs per intersection for deployment of the system (signal controllers, switches, installation crew costs) for the corridor.

Table 13 provides an excerpt from the annualized cost worksheets from the TOPS-BC to itemize the results over 5 years. The purpose is to estimate lifecycle costs for adaptive signal control.

Table 13: 5-year infrastructure equipment costs

Equipment	Useful Life (Years)	Capital / Replacement Costs (Total) ($)	O&M Costs (Annual) ($)	Annualized Costs ($)
Linked Signal System LAN	10	166,898	34,000	50,690
TOTAL Infrastructure Cost	10	**166,898**	**34,000**	**50,690**
Signal Controller	10	2,500	-	250
Switch	5	5,500	-	1,100
Installation Crew Costs	10	2,500	-	250
TOTAL Incremental Cost	-	**10,500**	**-**	**1,600**

This project was one deployment over six intersections in 2025. The 5-year annualized cost for the infrastructure equipment is $60,290. The 5-year levelized costs (used for a benefit cost ratio calculation) is $86,402.

This process was repeated to also derive a 10-year annualized cost. The purpose is to estimate lifecycle costs for adaptive signal control. The 10-year annualized cost for the infrastructure equipment is $60,290, same as for the 5-year annualized cost. The 10-year levelized costs (used for a benefit cost ratio calculation) is $67,722.

For both the 5-year and 10-year time horizon, an annualized cost was calculated and used as the basis for comparison to the corresponding benefits. The resulting annualized costs for the six intersections where adaptive was deployed are:

- 5-year annualized cost: $86,402
- 10-year annualized cost: $67,722

In the TOPS-BC tool, there are several general parameters used in calculating the benefits of a given improvement project. Selected key values were updated to reflect the latest available (2024/2025) local area values as shown in Table 14. Otherwise, the TOPS-BC base values were used. Table 14 shows the updated general parameters and sources used for updates.

Table 14: TOPS-BC General Parameter Updates

Parameter	**Default Value**	**Updated Value**	**Source**	**Methodology**
Inflation Rate	2.5%	4.2%	Seattle-Tacoma-Bellevue WA CPI for all Urban Consumers[1]	Average from years 2017-2024 used
Default Time Horizon	20	10	Tiger Grant Application Guidance (2010)	Based on speed of change of ITS technology
Percentage Trucks	10%	1%	SDOT	January 2025 corridor count data
Fuel Use – Per Gallon	$2.82	$3.80	U.S. Energy Information Administration[2]	2024 Seattle Rate used minus state gas tax amount

The TOPS-BC tool quantifies benefits across a vast array of parameters. For this analysis, before and after data were used to assess costs (positive or negative) due to:

[1] https://data.bls.gov/pdq/SurveyOutputServlet
[2] https://www.eia.gov/petroleum/gasdiesel/

1. Travel Time – Dollar value of person hour for various usages, calculated as net savings per day along the corridor
2. Reliability/predictability of travel – change in travel time index and planning time index in each mainline direction of the corridor
3. Energy – Dollar value of fuel savings

The travel time, reliability/predictability, and energy savings were calculated with values provided by the ATSPM system, Flowlabs. The system uses vehicle probe data to estimate values throughout the day. The corridor, with 6 signalized intersections was reviewed to collect the above metrics. Transit travel times are evaluated and summarized separately with data provided by King County Metro, our local transit agency. Due to the short 'before' and 'after' study periods, no safety/collision data was collected or used in the BCA.

Travel time and reliability benefits are reported as the Total Buffer Travel Time Benefit per Period from the Tops BC tool. The Buffer Travel Time Savings uses the travel time index (average travel time / free-flow travel time) as an input to derive the person-hours saved from travelers no longer having to account for potentially longer travel times to arrive on-time (i.e. "buffer" time). The same dollar value per hour used in the travel time monetary savings were applied to the buffer time monetary savings.

The travel time and reliability improvements translated to a total of 251.41 hours of weekday person-hours savings. After incorporating car and truck operating costs, fuel consumption and work vs. leisure traveler cost assumptions, this translated to an average weekday savings of $10,079 for all users. As a percentage of the total savings, average travel time benefits accounted for 64% of the total benefit, travel time reliability accounted for 33%, and fuel savings accounted for 3%. Table 15 summarizes the breakdown of benefits by category for travelers in cars and trucks.

Table 15: Adaptive Control Benefit by Category for Travelers in Cars and Trucks

Benefit Category	$/Day	% of Total Savings
Travel Time	$6,460.31	64%
Reliability	$3,339.32	33%
Energy (Fuel)	$279.72	3%
Total	**$10,079.36**	**100%**

The results for the 5-year and 10-year horizons yield benefits-to-cost ratios of 29.16 and 37.21, respectively. With daily cost savings of $10,079 in present dollars, the savings surpass the cost of implementation in approximately 1-2 months. Total net savings in present dollars are approximately $12.2 million when evaluating a 5-year horizon, and nearly $24.7 million when evaluating a 10-year horizon. Table 16 summarizes the cost-benefit calculations of the analysis.

Table 16: BCA and Total Benefits for Five- and Ten-Year Periods

Item	5-Year Period	10-Year Period
Daily Benefit (TOPS BC)	$10,079	$10,079
Annual Benefit (250 days)	$2,519,838	$2,519,838
Cumulative Cost Over Period (TOPS BC)	$399,898	$602,898
Net Present Value of Costs (TOPS BC)	$354,265	$475,649
Levelized Annual Cost (TOPS BC)	$86,402	$67,722
Benefit to Cost Ratio	29.16	37.21
Net Savings Over Period	$12,244,923	$24,722,726

4.4 Green Wave (Use Case 4)

Prior to the Grant, SDOT had very limited implementations of a local, line-of-sight EVPE system across the city, with two locations within the UW MICMA subarea. The MICMA grant supported SDOT's deployment of a cloud-based center-to-center Emergency Vehicle Preemption (EVPE) solution in the UW MICMA subarea for every major signalized intersection. The solution enables programming to achieve the Green Wave response proposed in the grant. The Green Wave response clears traffic in advance of approaching emergency response vehicles by preempting downstream signals and providing fire-lane green, based on parameters set and input to the software platform.

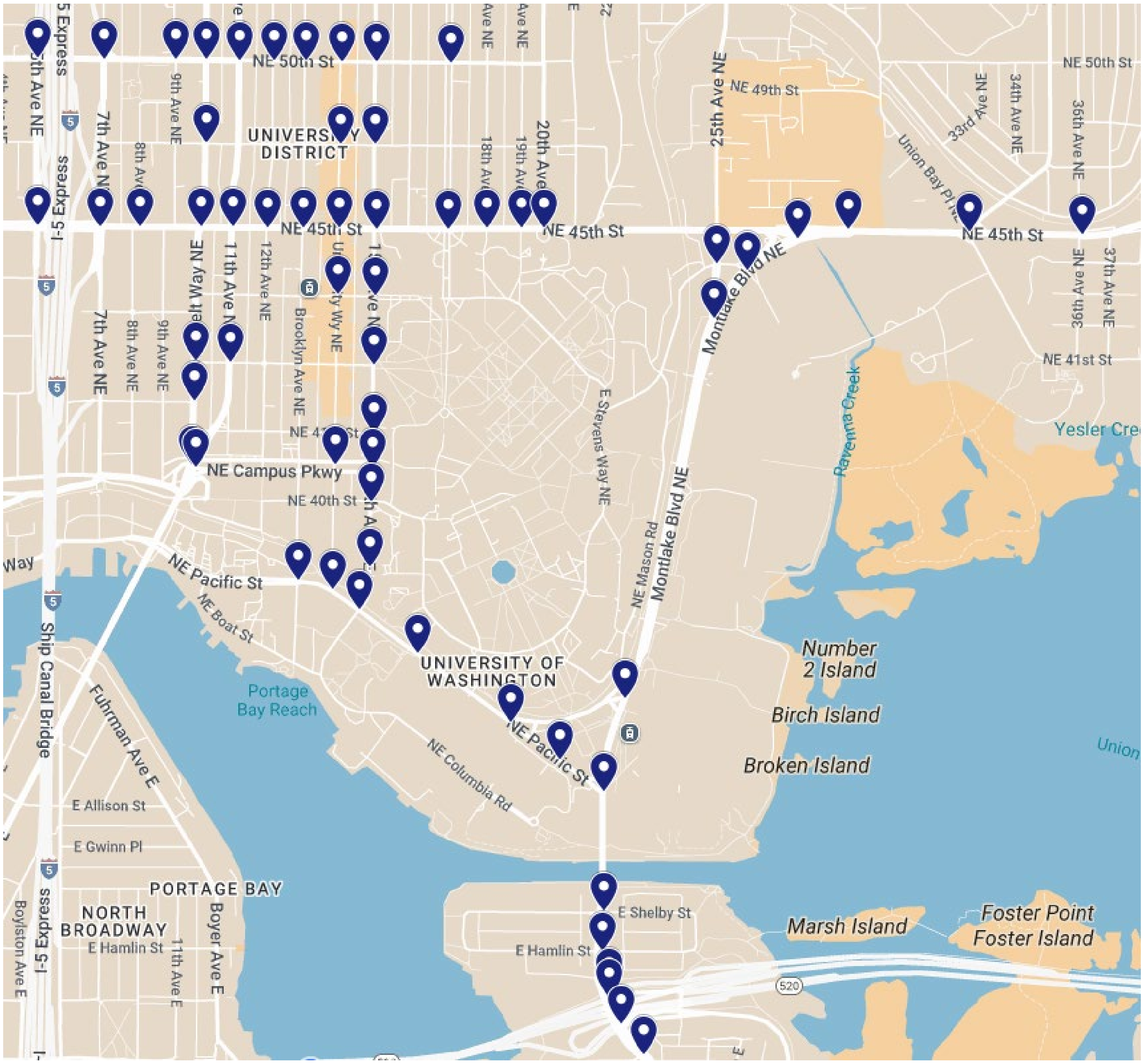

Figure 7 Map of Green Wave enabled signals

4.4.1 Green Wave Hypotheses and MOEs

Table 17 provides the hypotheses and associated MOEs used in the evaluation.

Table 17: Green Wave Hypotheses and MOEs

Hypothesis	MOE
Emergency responder travel time will decrease.	Percent reduction in responder vehicle average speed before and after Green Wave implementation.
Emergency responder arrivals on green will increase.	Percent increase in arrivals on green before and after Green Wave implementation.

4.4.2 Green Wave Data Collection

Before and after data for vehicle speed and arrivals on green was collected via the EVPE central system platform. The system was turned on August 29, 2023. The month of August 2023 is the before data. The after data is for the period May 15, 2024, through May 13, 2025. A secondary review of the data was done with an after period of August 2024, to better align the duration of the before and after periods. Due to issues in how the data were stored, only the responder vehicle arrival on green was available for the secondary review. Both time periods are outlined in *Table 18* below. Both evaluations were performed on the 15th Ave NE and NE 45th St corridors. This consisted of 23 signalized intersections across about 2.25 miles.

There were issues with the ATSPM system's ability to gather detailed traffic signal operations data (enumerations) during the data collection period, so it was not possible to reliably calculate vehicle delay due to Green Wave pre-emptions. The issues stemmed from faulty controller hardware, improper setup of some intersections in the ATSPM central platform, and intermittent communications outages.

4.4.3 Green Wave Evaluation Results

Table 18 shows the before and after evaluation results.

Table 18: Green Wave Evaluation Results

MOE	**Before: August 2023**	**After: May 15, 2024, through May 13, 2025**	**Percentage Change**
Average Responder Vehicle Speed	17.3 MPH	25 MPH	+45%
Percent Responder Vehicle Arrival on Green	58.6%	75.7%	+29%
MOE	**Before: August 2023**	**After: August 2024**	**Percentage Change**
Percent Responder Vehicle Arrival on Green	58.6%	67%	+14%

The Green Wave system improved responder speeds by 45% on average, and arrivals on Green by 14% to 29%, depending on the evaluation time periods. This data was collected using the Green Wave central monitoring platform.

4.5 ATSPMs (Use Case 4)

A cloud-based ATSPM software tool was implemented. This tool additionally incorporates vendor-specific probe data into the performance metrics, which also enables gathering of corridor travel times.

4.5.1 Additional Considerations for Implementing ATSPMs and Data Collection

Significant setup was necessary to implement ATSPMs. First, all signal phasing data needed to be provided to the ATSPM vendor for them to program their platform. This was not a "plug and play" solution. Second, the firmware for each intersection needed to be upgraded to be NTCIP compliant to support ATSPMs. Despite the firmware being confirmed by the firmware supplier to be NTCIP compliant, each vendor delivers the data in different ways, and the NTCIP standard allows for some vendor-specific elements, and the standard does not address the specifics of external access to the data. Two different vendors' firmware and controllers were deployed in the MICMA subarea. The ATSPM Vendor had issues depending on the controller and firmware type, which would result in data not being read properly, or not at all. The ATSPM vendor coordinated with the firmware and controller vendors to understand how the data was being provided and was able to reliably pull the data after this coordination was completed. Last, issues encountered related to implementing an All-Ped phase were difficult to resolve since the ATSPM platform did not include an All-Pedestrian phase. The ATSPM vendor updated their system to enable this configuration.

Also of note is how the hardware stores the enumerations that are pulled for ATSPM data. One of the controllers used an SD card for read/write functions for the data storage and retrieval. SD cards are not designed for continuous read/write, and several failed during the course of the project and had to be replaced.

Overall, the ATSPM vendor was responsive and capable of addressing any issues that arose in a timely manner, but the process was not as streamlined as expected. SDOT worked with the vendor to fix the issues that were encountered.

4.5.2 ATSPMs Hypotheses and MOEs

Table 19 outlines the hypotheses and associated MOEs used in the evaluation.

Table 19: ATSPM Hypotheses and MOEs

Hypothesis	MOE
ATSPMs support effective assessment of signal operations.	Staff interviews of use of ATSPM data to assess traffic signal operations.
ATSPMs will speed response to malfunctions.	Staff use of alarms, reports, etc. to respond to malfunctions.
ATSPMs based on probe data alone can provide actionable information to SDOT.	Staff assessment of intersection data reports with and without enumerations.

4.5.3 ATSPMs Data Collection

SDOT operations and planning staff were interviewed to determine how the ATSPM data sets would support their work. Data to support the effectiveness of probe data alone was gathered from the ATSPM central platform by turning detailed data collection from the controllers off for a one-week period.

4.5.4 ATSPMs Evaluation Results

The evaluation results for each of the three hypotheses for ATSPMs are provided below.

4.5.4.1 *Hypothesis: ATSPMs support effective assessment of signal operations*

With the ATSPM platform, traffic signal engineers were able to more easily assess the status of a traffic signal's performance. In real time, engineers were able to analyze and visualize historical traffic data. The traffic operations staff at SDOT believe that they may be able to replace some field visits by analyzing the ATSPM data and metrics. Indeed, the system was used to support implementation and tuning of the adaptive signal control system as part of this project, providing valuable insights into operations.

SDOT also used the ATSPM platform to assist with and expand on preexisting activities. In the report *Impact on Agency Activities in the Performance-Based Management of Traffic Signals* (NCHRP 954), several activities are outlined to benchmark the benefit extracted from ATSPMs. A summary of the activities outlined in that report that SDOT implemented is provided in Table 20. A few highlights of the benchmarks achieved include shareable reports, quantitative performance tracking, comparing equipment types, and evaluating cost-benefit for programs and grants. It's worth noting that this relatively small pilot (involving less than 5% of our signalized intersections) did not lead to a cultural or policy shift. It did provide useful exposure to modern signal analytics, as well as a successful pilot to make the case for further exploration.

Table 20: SDOT Attained ATSPM-Based Activities

Category	**Metric**	**Attained by SDOT?**
Organizational	Culture shift to performance-based prioritization	No
Organizational	Shareable reports	Yes
Organizational	Quantitative performance tracking	Yes
Organizational	Agency policies and standard practices	No
Organizational	Inter-agency collaboration	No
Organizational	IT staff integration	Yes
Planning	Model validation	No
Planning	Evaluate cost-benefit for programs and grants	Yes
Traffic Operations	Continuously available data for less modeling	No
Traffic Operations	Automated alerts for operational issues	Yes
Traffic Operations	Prioritize signal retiming	Yes
Traffic Operations	Confirm public service requests	Yes
Maintenance	Continuously available data to support preventative maintenance	No
Maintenance	Automated alerts for maintenance issues	No
Maintenance	Prioritize infrastructure improvements	Yes
Design and Construction	Compare equipment types	Yes
Design and Construction	Evaluate maintenance of traffic (MOT)	No

Using data and metrics available in the ATSPM platform to support evaluation and analysis for projects or grants, such as before and after evaluations, proved valuable and provided cost savings and deeper insights into existing traffic conditions over time as compared to performing these analyses using traditional data collection methods.

ATSPMs are well suited for before and after evaluations as they provide simple, yet effective data associated with changing conditions. An example of use of the ATSPM data as part of the MICMA project evaluation includes assessing the cost-benefit of implementing adaptive signal control along the 15th Ave NE corridor in the MICMA sub-area, extracting travel times and cycle times from the system.

Using the ATSPM platform simplifies the process of collecting data for a before and after analysis, and the data was continuous. For project evaluations, without this platform, data collection would not be continuous and would require:

- Performing manual turning movement counts
- Placing tube counters on each approach at every intersection
- Performing “manual” travel time (also known as floating car) studies

For traffic signal operations and timing/tuning, the platform enabled near real-time assessment of timing changes, and allowed engineers to aggregate data over several days. These tools were used and well-liked by the signal timing engineers when implementing adaptive control. Without the ATSPM platform, daily hours-long field visits would be done to assess operations

From the interviews conducted, an individual attributed high costs for traditional, manual data collection methods as a reason why ATSPM platforms are better suited for before and after analysis for all types of studies and for signal timing changes. The continuous data stream was also noted as being of high value.

4.5.4.2 *Hypothesis: ATSPMs Will Improve Response Time to Signal Malfunctions*

During the interviews, both of the interviewed SDOT staff reported that the ATSPM platform allows engineers to more efficiently respond to disruptions in signal performance at individual locations. Using the embedded alert systems, traffic signal engineers could more closely monitor signal deficiencies that they would normally only attend to if a public complaint was received or if it appeared during the traffic signal retiming process. This gives a proactive approach, rather than a reactive approach to signal retiming. Through interviews with the traffic signal engineer, alerts have been established for specific corridors in the MICMA sub-area to provide notifications when deficiencies arise. Three separate alerts were configured including: health alerts, threshold alerts, and trend alerts.

Health alerts are specific to the platform procured for the project. They are based on a weighted index out of 100 called a 'Health Score', which is derived from several performance metrics available in the system. For networks, intersections, and phases, separate 'Health Scores' can be tailored to a user's specific needs by weighing each performance metric individually from 1 to 5. Health alerts can subsequently be configured to alert the user when the overall health score has deviated by a preset amount when compared to a rolling 28-day average. During the interviews, one SDOT staff reported that creating an index gives traffic signal engineers a unique quantitative value to gain insights into traffic performance in the ATSPM area that they would not typically have access to.

Threshold alerts similarly alert the user when a single performance metric falls above or below a predetermined value when compared to its 28-day average. During the interviews, one SDOT staff reported that this enables engineers to monitor traffic signals closely without needing to analyze the data in detail. For example, users may set thresholds when the arrivals on green drop below 50% or when the split failures as a percentage of cycles exceeds 15%. This drastically improves response time for engineers as they have a proactive approach to managing their traffic signals.

Finally, trend alerts can be configured to receive alerts if any set performance metric shows a significant negative change in performance over the selected period. Trend alerts monitor month-over-month change and alert the user when the values deviate by a set percentage.

For each alert, email and push notifications can be enabled to identify and respond to deficiencies in signal performance. As a best practice, the sensitivity of alerts should be balanced to not provide too many or too few alerts.

Both of the interviewed SDOT employees indicated that they currently use the alert system to swiftly respond to concerns that, in the past, they would not be aware of. Rather than waiting for a public complaint or for the traffic signal timing review process to trigger an investigation, engineers were able to respond quickly to malfunctions or sub-optimal timing issues.

4.5.4.3 *Hypothesis: ATSPMs Offer Insights with Only Probe Data*

The study investigated the feasibility of using probe-only data instead of probe data coupled with enumerations from the traffic signal controller . This was conducted to assess the benefits of a city-wide performance measure solution, which can be deployed more easily without needing to ensure the firmware and detectors in the cabinet are pathed properly to the ATSPM platform, and could be deployed at intersections that are not connected to a communications infrastructure. The "base case" for the UW MICMA project is for the ATSPM platform to ingest both the probe data and enumerations.

An analysis was conducted at seven (7) intersections along the 15th Ave NE corridor in the MICMA sub-area to assess the differences between the quality of metrics from probe-only data and probe and signal data. The intersections included in the evaluation are:

- 15th Ave NE, north of NE Pacific St
- 15th Ave NE/NE 40th St
- 15th Ave NE/NE 41st St
- 15th Ave NE/NE 42nd St
- 15th Ave NE/NE 43rd St
- 15th Ave NE/NE Campus Parkway
- University Way NE/NE Campus Parkway

Signal enumerations were removed from these intersections between April 28 and May 4, 2025 (the probe data only period). The period between April 21 and April 27, 2025 (the probe data + enumerations period) was used to compare the quality of the two data sets. Metrics were summarized Monday through Friday for each hour of the day, then aggregated to assess the overall correlation between the two configurations. A summary of findings based on this approach is outlined in Table 21.

Table 21: Correlation of Probe-Only versus Probe and Enumerations

Metric	Correlation	Interpretation
Arrivals on Green (AOG)	0.818	High positive correlation
Average Daily Traffic (ADT)	0.995	Very high positive correlation
Number of Stops	0.918	Very high positive correlation
Severe Speed Limit Violation Rate	0.513	Moderate positive correlation
Speed Limit Violation Rate	0.877	High positive correlation
Split Failures (% of vehicles)	0.796	High positive correlation

Average Daily Traffic (ADT) and Number of Stops show a high positive correlation between the two sources of data. Arrivals on Green, Speed Limit Violation Rate, and Split Failures (% of vehicles) have a high positive correlation. Therefore, these metrics appear to provide stable outputs for intersections where signal log data is not available. Conversely, Severe Speed Limit Violation Rate, which has a moderate correlation, would not provide satisfactory metrics in these areas.

In general, Probe-Based Signal Performance Measures (PBSPMs) provide a robust, infrastructure-independent alternative and complement to traditional ATSPMs. Using GPS trajectory data for probe data, PBSPMs deliver accurate insights, especially at locations without communications in place, or with poor detection reliability or placement.

4.6 Integrated Corridor Management (Use Case 5)

At the project outset, SDOT had proposed to exchange data with the Washington State Department of Transportation (WSDOT) to improve the joint management of their facilities during incidents and major events. The WSDOT facilities SR 520 and Interstate 5 (I-5) bound the south and west of the subarea. Potential improvements to incident response and public information were suggested to be incorporated into the ICM strategies. The work was also to include a Concept of Operations that would outline how the data was to be used to support improved joint incident management.

In July 2020, WSDOT was awarded a separate ATCMTD Grant titled The Virtual Coordination Center (VCC) for Multimodal Integrated Corridor Management Project. This grant created and deployed a cloud-based environment that enables regional stakeholders to share a common working environment in support of coordinated mobility management. Upon completion of this grant in September 2023, WSDOT continued funding the VCC to support ongoing operations and functionality improvements. Any data generated by SDOT, including new feeds supported by the UW MICMA Grant are to be entered into the VCC. The VCC also included a Concept of Operations, so a separate Concept of Operations was not developed for the UW MICMA project.

The UW MICMA Grant deployed software for SDOT to manage incidents and planned events. That software includes an API to feed the VCC. WSDOT declined to participate further in an assessment of the impacts of this data on their response to incidents in the UW MICMA subarea. In addition, no major events or incidents occurred during the term of the Grant. Therefore, the ability to provide any quantitative assessment was no longer available.

4.6.1 Hypotheses and MOEs

While it was not possible to collect quantitative evaluation data, qualitative interviews were conducted. Table 22 provides the hypothesis and associated MOE used in the evaluation.

Table 22: ICM Hypothesis and MOE

Hypothesis	MOE
WSDOT operators find shared data useful in managing incidents	WSDOT Traffic Management Center (TMC) operators and/or supervisors perceive value in the shared data and can cite planned or actual uses of the data.
The IMS will improve and streamline data entry and reporting.	Staff qualitative reports.

4.6.2 Data Collection

Data was collected via informal interviews of key WSDOT and SDOT operations staff.

4.6.3 Evaluation Results

Based on the interviews, the shared data was found to be useful for SDOT Transportation Operations Center (TOC) and WSDOT Traffic Management Center (TMC) joint incident management. The SDOT software to manage incidents and planned events uses an API to feed the large incidents into the VCC. This saves SDOT staff time in re-entering the incident information into the VCC. Before the use of the VCC every large incident that required coordination between SDOT and WSDOT required multiple phone calls between the operation centers. The use of the VCC reduces the need for such calls as standard information is proactively shared in a joint operations view. From the interviews with SDOT operators, it was noted that while no distinct count of coordination phone calls was compared, the operators appreciated the VCC system and felt it increased information sharing while reducing the phone calls necessary.

4.7 Mobility-as-a-Service (MaaS) (Use Case 6)

The MaaS portion of the MICMA project included three services:

- Accessible walking path data provision.
- Developing an arterial-focused Incident Management Software (IMS) to streamline workflows and to provide an API to support real-time incident data communications for the SDOT-WSDOT ICM and to provide SDOT with enriched historical incident data access.
- Implementation of a Data Portal for internal access to SDOT data sets.

Each service was intended to improve data availability and access.

4.7.1 Hypotheses and MOEs

Table 23, below, provides the hypothesis and associated MOE used in the evaluation for the MICMA project. Each service is discussed separately, below.

Table 23: MaaS Hypothesis and MOE

Hypothesis	MOE
For accessible walking path data provisioning, hypothesis were to be developed during implementation of the service. No hypotheses developed as the data available was not viable for the purpose.	N/A

4.7.2 Accessible Walking Path Data Provision

SDOT was able to publish the accessible walking path data they gather, including developing a machine-readable API containing this data, as well as a public-facing GIS-based data repository. This was a collaboration with the Traffic Data Equity Initiative, led by the University of Washington Taskar Center for Accessible Technology. They develop open-source tools to collect and standardize data on pedestrian infrastructure. However, creating a service for third-party app developers that contained accessible path data was not accomplished. The following outlines the challenges encountered.

4.7.2.1 *Data Standard/Specification*

SDOT reviewed a broad range of standards related to accessibility data. Globally, there are a myriad of companies, cities, research foundations, and other groups dedicated to providing accurate and open mobility information to citizens, especially those with physical accessibility constraints. They often have trouble integrating and distributing this information due to the absence of well-defined data standards.

The recent literature on urban accessibility and open data reflects a shared concern about the lack of open data standards nationally and globally. Presented below is a brief selection of articles that were included in the literature review.

- A 2019 paper[3] published by a global team of experts on accessible maps and infrastructure noted that "Unlike with road networks, there are no widely accepted open standards describing and governing data formats for the accessibility of streets, sidewalks, and indoor spaces."
- A group of researchers from a selection of academic institutions in Germany reviewed the existing landscape for accessible datasets and their limitations in another study[4], stating that "no current dataset adequately captures the complexity of real-world urban scenes."
- A poster paper[5] published by researchers at the Allen School of Computer Science and Engineering at the University of Washington introduced Sidewalk Gallery, the first and largest interactive gallery of categorized sidewalk accessibility problems in existence. They noted that "There is growing recognition of the importance in collecting and publishing open datasets in the accessibility community" and recognize the lack of these open datasets as a critical gap in the urban design space.

The literature review also revealed conflicts within the community supporting accessibility data, with requirements to meet the needs for the full range of

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[3] https://makeabilitylab.cs.washington.edu/media/publications/Froehlich_GrandChallengesInAccessibleMaps_2019.pdf

[4] https://arxiv.org/pdf/1604.01685

[5] https://makeabilitylab.cs.washington.edu/media/publications/Duan_SidewalkGalleryAnInteractiveFilterableImageGalleryOfOver500000SidewalkAccessibilityProblems_ASSETS2021.pdf

disabilities (vision, hearing, mobility, sensory) suggesting different data needs and standards. One notable example of a conflict is how each community views the manner in which data sets linking outdoor and indoor spaces should interact

4.7.2.2 *Transforming Accessibility Data Sets*

To make data more reliable and easier to access, SDOT has looked to Socrata, an open data platform used by thousands of municipalities, but that previously had limited support for geospatial data.

Through the efforts of SDOT's data science team, Socrata has expanded their feature set to better support GeoJSON in addition to its other flat file formats. This presents a timely opportunity to leverage the City's existing license to create a better flow of data from internal to external sources.

In collaboration with the Traffic Data Equity Initiative Project, four data feeds were selected for transformation utilizing Socrata to provide a straightforward means to access, export, and utilize data:

- Sidewalks
- Curb ramps
- Street signs
- Street signals

These feeds can now be accessed programmatically for both numeric *and* geospatial analysis and visualization. This is an important step in improving access for, and value to, users of Seattle's asset data.

4.7.2.3 *MICMA Basic API Update*

SDOT published new test open data sets for Sidewalks and Curb Ramps that are provisioned to support Socrata's API query functions. These datasets are refreshed weekly through an automated process that uploads from the existing open data versions of the same data that are linked to the City's Esri web services. The API documentation contains the information needed to access the data. Note that available response types also include GeoJSON, a spatial version of JSON, with the extension ".geojson" (e.g. submitting a pull request to include geojson as a response type in the documentation).

SDOT has also developed a machine-readable API for Street (Traffic) Signals and Street Signs, but these currently remain in "private", or internal only, mode. These feeds were not requested by the Traffic Data Equity Initiative Project upon completion of their initial work. SDOT can release these APIs upon request.

4.7.2.4 *Provisioned API Benefits*

We are referring to "provisioned" datasets as those that can be consumed, queried, and filtered using the Socrata API on the City's Open Data platform. The provision of the dataset as a Socrata API has advantages compared to publishing data within the ArcGIS repository:

- The provisioned APIs provide an additional, widely used way to access and consume the data.
- Because Socrata Open Data is the City of Seattle's designated open data platform, the new APIs for these datasets have the same format and documentation as hundreds of City published datasets. The City is also moving to further integration with the Socrata Connected Cloud, which allows internal collaboration in a hosted environment.
- The APIs will be found at data.seattle.gov will be fully provisioned and functional compared to the current versions that are limited and linked to ArcGIS instead of imbedded.
- Provisioned datasets automatically generate a site-specific developer portal with API documentation and examples in several programming languages.
- Consumers and app developers can use the Socrata API documentation maintained at https://dev.socrata.com. This API may be easier to use for developers that are not traditionally consuming ArcGIS products. The ArgGIS developer documentation is maintained at https://developers.arcgis.com/documentation/.
- Because consumption of these datasets occurs on Socrata servers, high impact use will not impact the City's provisioned GIS servers.
- The provisioned API will not be subject to internal server outages.

4.7.2.5 *Challenges and Lessons Learned in Accessible Path Data Provisioning*

SDOT has published a set of available data to support third party development of accessible path applications. The data includes sidewalks and curb ramps. This data, however, has been found to be insufficient for most app developers, and will not likely be used in third-party applications. The following outlines the main factors behind this result.

- Universal data standards/specifications/schema are not yet available.

Although data standards are being developed, with the Traffic Data Equity Initiative Project leading the way through international researcher collaboration and the OpenSidewalk standard, there is no “adopted” standard in place. SDOT chose to comply with the data definitions in OpenSidewalk standard. This standard is documented and available, and other app developers can use the data provisioned by SDOT. However, it is possible that others may bring competing standards to this space. App developers need to be cognizant of each standard.

- Data must be collected in a way that supports the use case.

More important than the data specification (format, metadata, etc.), is ensuring that the data collected matches the use case. An example of conflicts in use cases is illustrated by SDOT curb ramp data. SDOT collects data on the location of curb ramps as a single point. Essentially, the data indicates that a curb ramp is present. Additional data sets connect to this single point such as condition, slope compliance with standards, or tactile warning plate in place. This data was collected to meet SDOT’s use cases which are related to asset maintenance and compliance with Americans with Disabilities Act (ADA) requirements.

The Traffic Data Equity Initiative Project use case differs from SDOT’s. Their use case focuses on supporting persons in their use of a wheelchair, motorized wheelchair or a cane. The Traffic Data Equity Initiative Project developed a use case that requires more than a single point be provided for a curb ramp so that grades, cross slopes and other key features can be developed from the data set. Their use case centers around the development of an app for these users. Figure 8 illustrates the multiple data points that must be collected to support their use cases.

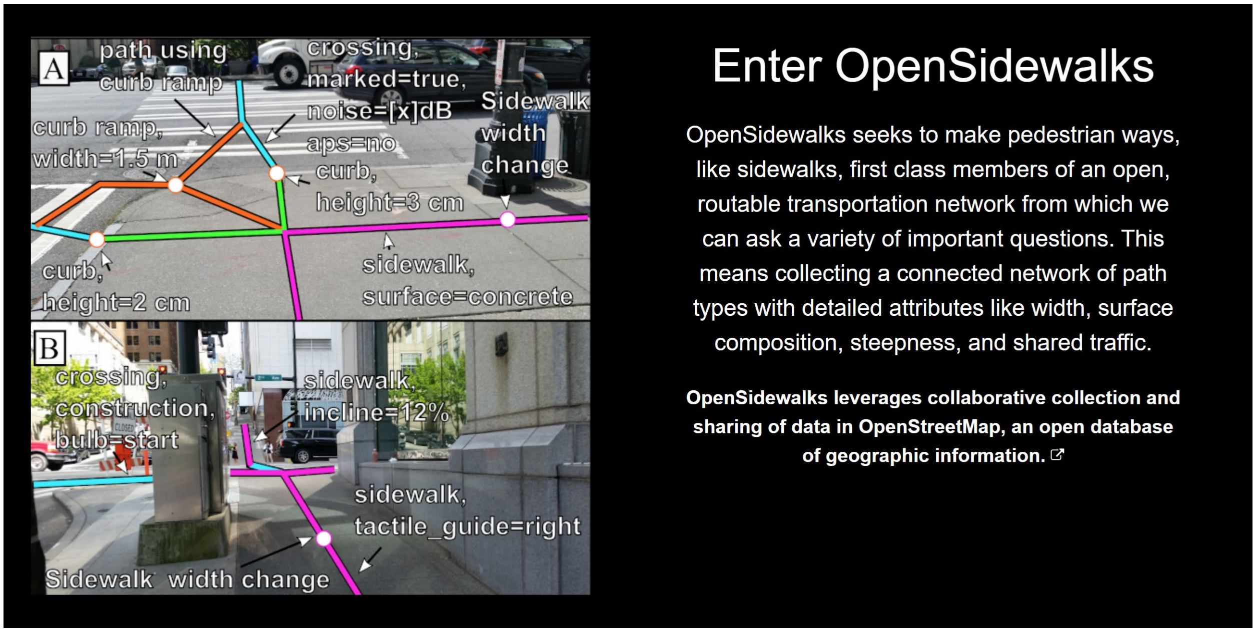

Figure 8: Illustration of Multiple Data Point Locations for Open Sidewalks Project

Other advocacy groups and researchers are advocating that a universal data set and associated standards be developed to address the full range of people's abilities. SDOT has begun addressing these other use case data needs, such as by adding Accessible Pedestrian Signal (APS) locations to their data sets.

Overall SDOT's current use case for data is focused on asset management. Through the upcoming work, SDOT will be evaluating if it would be feasible to modify its data collection approach to support additional use cases.

4.7.2.6 *Conclusion*

Through the UW MICMA project API/Data Strategy work, the need to improve data access was highlighted and resulted in upcoming future funded projects. SDOT was also able to provide a set of data via a machine-readable API. However, the data was not ingested into an app to support users in finding accessible path information due to the mismatch between SDOT's use case for data collection and the use cases for developers of accessible walking path apps.

4.8 Data Portal (Use Case 6)

A consolidated web-based data portal solution was purchased from Urban Logic, a third-party vendor, to eliminate data silos managed by different organizations within SDOT to create an integrated platform facilitating data access and retrieval. The Data Portal additionally enables data analysis. The data selected for integration into the Data Portal was the most commonly requested data. This includes historical crash data, multimodal traffic volumes and turning movement counts. Both an internal (City staff only) and external (public-facing) portal were implemented.

4.8.1 Previous (Before) System and Workflow

Data was stored in several different locations, with each having their own separate data exports and visualizations. Previously, data was stored and accessed via five different electronic locations managed by different employees, each with different access controls and data export processes, with some supporting data visualization. Having separate platforms made it difficult to access the data, and data visualizations (such as trends) were dependent on the capabilities of in-house “portals” built by internal staff, with each portal built to meet their organization’s specific needs/use cases. In addition, if the employee that coded the system left City employment, maintenance of the systems was difficult as there was little, if any, documentation.

Three staff at SDOT were responsible for responding to internal and external data retrieval requests (among other duties). External requests come in the form of public disclosure requests (PDRs) from individuals interested in obtaining data from the City of Seattle. These requests range from multi-year crash data requests to individual location traffic volumes and vary significantly in the time required to respond. PDRs require employees to respond within a set time. These staff are also responsible for compiling SDOT’s Annual Traffic Report that summarizes traffic data and trends within the city.

4.8.2 Data Portal: Updated Data Locations and Workflow

Data from the various existing systems have been consolidated in the Urban Logic data portal, consolidating the information in one location. The Vendor accesses the data through APIs from the previous data locations, or through an electronic shared drive where SDOT places PDFs (transformed by the Vendor to accessible data using optical character recognition) and Excel workbooks for the Vendor to store. Several different formats of PDFs were housed in the previous data locations and the Vendor imports each unique format and transforms them via Optical character recognition to individual data elements.

The Data Portal includes four distinct internal workspaces to organize and interpret data from SDOT: (1) Intersection Volume Data, (2) Road Segment Volume Data, (3) Crash Data, and (4) Active Transportation Volume Data. Each workspace below notes the method in which the Vendor accesses the data.

4.8.2.1 *Intersection Volume Counts*

This workspace allows the user to view all available intersection turning movement count data. The intersection count data can be found either by searching for an intersection by name in the search bar, filtering by COMPKEY (an SDOT-created unique identifier), or clicking directly on the intersection via the map. The Intersection Counts workspace summarizes turning movement counts in an easily digestible interface with the ability to visualize total volume delineated by mode, turning movement counts, as well as peak hour volume. Various visualizations are also enabled by the Data Portal with an example provided in Figure 9.

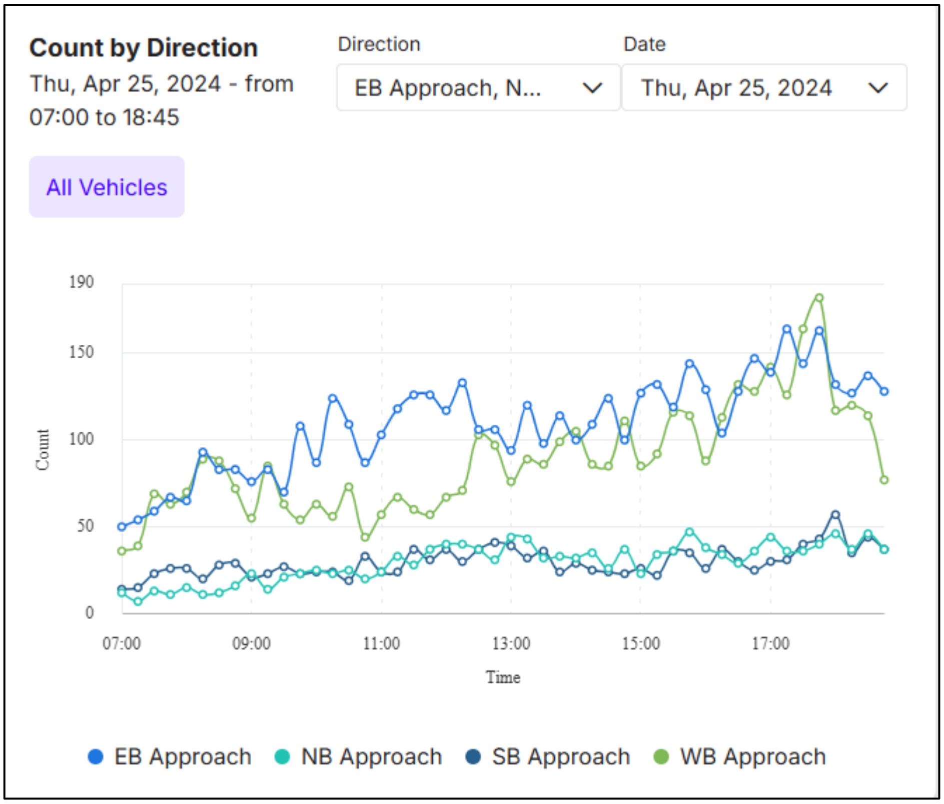

Figure 9: Intersection Count Visualization Sample

Data imported into this workspace is first uploaded to a shared drive by an SDOT staff person as PDFs and Excel workbooks to a shared drive with the Vendor. Then, a Vendor-developed script automatically reads and pulls data from each report. This process is subsequently verified by a Vendor employee to ensure data is read correctly on a weekly basis.

4.8.2.2 *Road Segment Volume Counts*

In a separate interface, road segment counts collected from tube counts and cameras can be investigated. The road segment counts are arranged spatially and can be found by searching for a road segment by name in the search bar, filtering by COMPKEY, or clicking directly on the road segment via the map. The data can be further filtered by studies collected as tube volume counts or by speed and classification reports. The tube volume counts give multi-day volumes, peak hour counts, and AADT whereas the speed report displays average speeds and counts delineated by measured speed.

Data imported into this workspace is accessed automatically via an API through the Seattle Open Data portal. The workflow to provide this data to the Seattle Open Data portal was built to support this project.

4.8.2.3 *Crash Data*

The Crash Analysis workspace visualizes and summarizes vehicular crash data labeled internally by SDOT. The workspace allows users to query reports based on specific factors (e.g. location, crash type, etc.) and to export the data in various formats including metric insights and raw data crash locations in table form. The associated visualizations allow users to quickly gain insights into the underlying data without the need to export or process the data. Additionally, the data can be exported, which could decrease the number of PDRs that SDOT staff would be required to fulfill. Among other visualizations, the tool offers a before and after tool to analyze two separate time periods and compare the crash trends between the two periods simultaneously. An example visualization is shown in Figure 10.

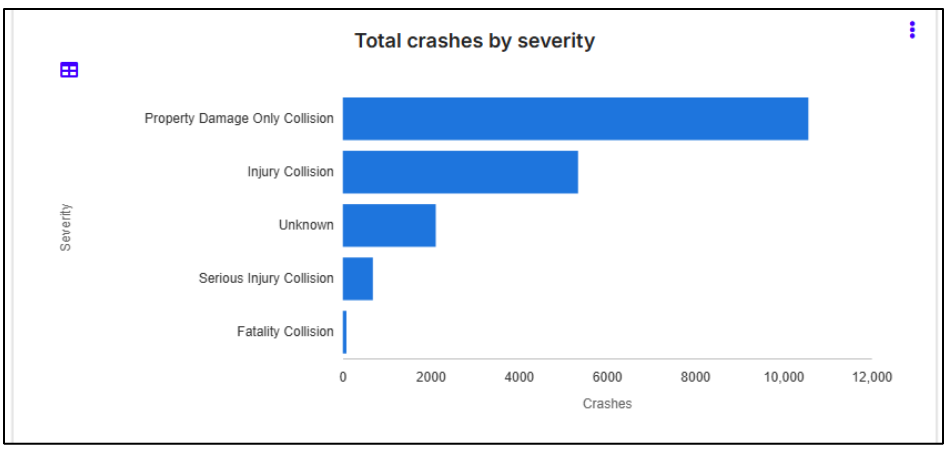

Figure 10: Example Crash Data Visualization

Data imported into this workspace is accessed automatically via an API through the Seattle Open Data portal.

4.8.2.4 *Active Transportation Volume Data*

The Active Transportation workspace summarizes (1) permanent bicycle volumes provided from a proprietary platform purchased by the City of Seattle, (2) quarterly (6-hour) bicycle and pedestrian counts, and (3) temporary bicycle counts from week-long pneumatic tube studies. Consolidating these in one platform allows users to visualize the data comprehensively and to quickly see the availability of vulnerable road user volume data for planning purposes.

Data imported into this workspace is accessed automatically via the platform's API.

4.8.3 Data Portal: Public Facing Interface

After extensive internal testing, the Vendor team, Urban Logic, also implemented a public-facing data portal to remove barriers the public faces in accessing SDOT data related to multimodal transportation volumes and crash data. This process was conducted to expedite the time required for consultants, researchers, lawyers, and citizens to access SDOT's data by offering an option to download data without needing to submit a public disclosure request (PDR). The external data portal differs slightly from the internal dashboard to support users that are not as familiar with the data sources, and to add required disclaimers and limitations of the data. It enables users to query data based on location, datetime, and specific attributes, and provides a range of data analytics and graphic data representation options. The intent is to improve public access to SDOT data.

4.8.4 Data Portal Implementation Considerations

To implement the Data Platform, platform software updates and QA/QC checks conducted by SDOT and the Vendor were required to ensure the data was displayed accurately. Occasionally, misrepresented data – whether from internal data collected by SDOT or from the Vendor's algorithms used to read or process the data– would populate the reports. SDOT worked with the Vendor to fix the issues that were uncovered, and SDOT must continue to conduct QA/QC checks to ensure that data is not misrepresented depending on the query. To fix these concerns, the Vendor's team is available via live chat, email, and phone.

4.8.5 Data Portal Hypotheses and MOEs

For the Data Portal evaluation, the following hypotheses and MOEs outlined in Table 24 were assessed.

Table 24: Data Portal Hypothesis and MOEs

Hypothesis	MOE
The Data Portal will reduce time/cost to access data internally and externally.	Reduce associated cost and time to perform public disclosure requests, internal requests, and the Annual Traffic Report.
The Data Portal will increase public usage of the hosted data.	Increase public access requests/attempts to the hosted data.
The Data Portal will enable staff to gain insights in an efficient manner.	Improved efficiencies in accessing the data and improved data analytic capabilities (based on qualitative staff assessment).

4.8.6 Data Collection

The MOEs were assessed via staff interviews before and after the internal and external portal was implemented. Three interview periods were conducted: (1) before access was granted to the Vendor's internal platform, (2) during the initial launch of the internal Vendor platform, and (3) after staff had time to use the internal Vendor platform.

Staff with the primary responsibility of accessing and distributing data internally at SDOT and to the public based on PDRs were asked the following questions at three points in the evaluation: before implementation, just after initial implementation, and 6 months after implementation. The following questions were posed:

- For each type of data, what is the average length of time it takes to pull the data?
- How often do you pull each type of data and how much of your time is devoted to those tasks?
- How do you search for data?
- What types of data exports are available?

- What is the pipeline for updating the data platforms with new features or data?
- Who or how is data access managed?
- Do you think accessing, updating, adding, or deleting data is accurate and efficient?
- Do you encounter any delays from other people or systems in accessing data?
- Do you typically encounter any issues or errors?
- How long do you estimate a new employee would need to learn the data request workflow?
- Do you have anything else you'd like to share?

4.8.7 Data Portal Evaluation Results

The evaluation results from the interviews are outlined below.

4.8.7.1 *Hypothesis: Reduced Time/Cost to Access Data*

With the new data platform, there is potential to reduce the hours required to extract and analyze data from the interviewed staff by 6.25%, which would correspond to saving 2.5 hours/week for each staff member (7.5 hours/week in total). The value of these time savings is estimated at $24,200 per year (based on a fully loaded hourly labor rate of $64.55 per hour). Reduced time and associated value stems from more immediate access to data (e.g. no longer need to request data from multiple other SDOT employees), the consolidation of data silos, and improved geospatial extraction of data, which streamlines staff's ability to share data both internally and externally.

This estimate is very conservative as many other staff (planners, engineers) in addition to those assigned to traffic and crash data retrieval use the previous tools and will also find time savings using the new platform. It is anticipated that more SDOT staff will use the new Data Portal over time.

Table 25: Estimate of Annual Data Extraction Costs for Crash and Traffic Data Retrieval Staff

Activity Category	Before: Annual Staff %	Before: Annual Staff Hours	Before: Value of Rounded Wages	After: Annual Staff %	After: Annual Staff Hours	After: Value of Rounded Wages	Savings: Annual Staff %	Savings: Hours	Value of Savings: Wages
Public Disclosure Requests	2.5%	150	$9,700	1.25%	75	$4,800	1.25%	75	$4,900
Internal Requests	5%	300	$19,400	2.5%	150	$9,700	2.50%	150	$9,700
Annual Traffic Report	7.5%	450	$29,000	5%	300	$19,400	2.50%	150	$9,600
Total	15%	900	$58,100	9%	525	$33,900	6.25%	375	$24,200

4.8.7.2 *Hypothesis: Increased Public Usage of Hosted Data*

The public portion of the data dashboard was launched on July 1, 2025. After this date, usage statistics were generated to assess how frequently the portal was being used. Figure 11 shows early results on the public-facing portal usage. On average over the subsequent month of July, there were roughly 25 unique visitors per day who viewed the site an average of 3.6 times each per visit for an average of 90 page views a day. These values show public users are accessing the data, which may decrease the amount of time SDOT staff need to respond to PDRs.

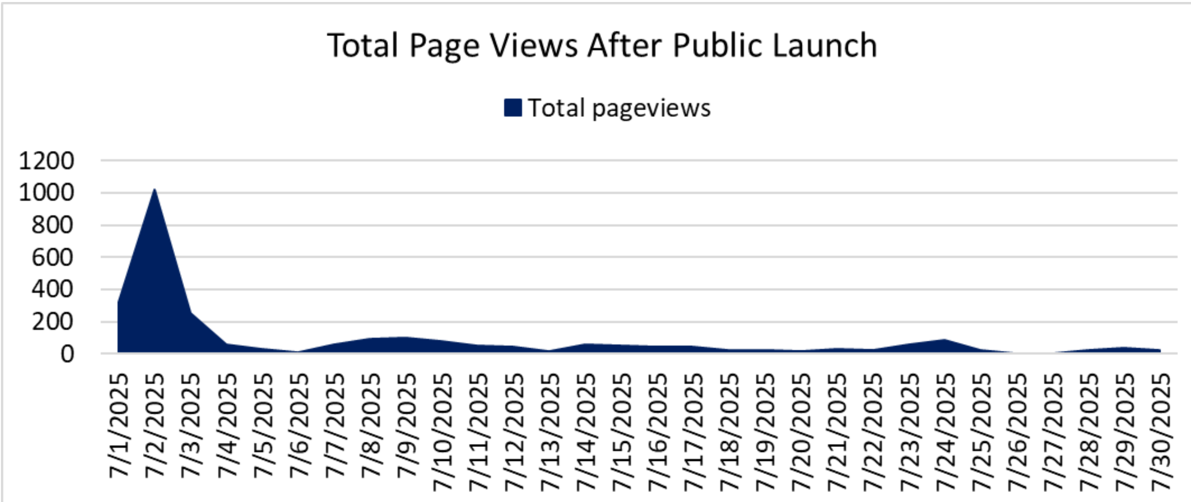

Figure 11: Usage Statistics After Public Portal Launch

As the public portal has only been launched for a brief period, it is expected these values will continue to grow over time, leading to further time savings at SDOT.

4.8.7.3 *Hypothesis: More Efficient Access and Insights into Data*

The Data Portal enable staff and the public to gain insights more efficiently as compared to the previous tools. The geospatial framework simplifies the process of obtaining the data. With visualizations embedded in the platform, individuals no longer need to generate their own visualizations, unless the specific purpose requires additional analytics outside of those available in the Data Portal.

Volumetric Road Segment and Intersection Data

For volumetric studies, employees would previously have to navigate to one of the data sources, search by COMPKEY (SDOT's unique naming convention for intersections and road segments), pull the static report, and then assess or further analyze the report. Now, users can navigate geospatially, select the desired locations, and quickly visualize the data as well as download the source report or underlying data. Since many of the original reports are stored as PDF files, the process to extract and analyze the data was time consuming, especially when considering multiple locations.

Crash Data

For crash data, the city hosts the data internally in a database and externally via the Open Data Portal. Querying for data is possible through the Open Data Portal, but the Vendor's platform offers more insights and summary statistics.

Active Transportation Data

The active transportation data includes bicycle and pedestrian data throughout the city and comes from several different sources. The data platform combines the multiple sources in one location, which makes it easier to identify where available records are while also providing easy access to the data. This improves accessibility and decreases the amount of time required to find requisite data.

5 Programmatic Observations

The following provides some lessons learned through implementation of the UW MICMA project and suggestions for other agencies implementing technology-centric grants. Some lessons learned are also interspersed throughout the report when they relate to a specific section.

New technology is often marketed with ambitious promises of efficiency and transformative results. The reality can fall short of these claims due to unforeseen limitations and integration challenges. An example of this discrepancy is seen in our experience with traffic signal controllers that were designed to use SD memory cards for data storage and logging. The SD cards frequently failed, leading to data loss, system interruptions, and increased maintenance. This example underscores the importance of critically evaluating technological solutions not just on their advertised capabilities, but on their proven performance in operational environments.

As technology systems grow increasingly complex, they often evolve into "black boxes"-opaque systems whose internal workings cannot be examined. This lack of transparency can significantly hinder problem-solving efforts, as it becomes challenging to pinpoint the origin of a malfunction or unexpected behavior. We had this issue when testing bicycle and pedestrian detection. We could observe reality and compare it with the detection system. Yet whether an issue stems from hardware, software, data inputs, or algorithmic logic, was hard to determine. We were reliant on the vendors to troubleshoot their systems, often able to identify when the systems had issues, but not the causes. This complexity underscores the need for better observability, documentation, and explainability in modern technological design. This example underscores the importance of critically evaluating technological solutions to ensure they provide detailed logs that allow for better understanding and troubleshooting of the systems.

5.1 Results of the Pilot Project

The UW MICMA project resulted in the advancement of several innovative technologies that will support improvements in multimodal operations and safety. SDOT was not able to fully complete all aspects of the project as originally envisioned, but it was able to achieve several accomplishments which can be applied by other agencies facing similar operations and/or technical challenges. These are:

Use Case 1: Pedestrian Surge Management

Although SDOT was unable to adopt traffic signal timing changes that respond to pedestrian surges due to failures with the traffic signal controller, the project was able to implement a system that passively detects and counts pedestrians both approaching and within an intersection, and SDOT was able to provide this data as a detection input to the traffic signal controller. These two functions are key innovations in the industry and can advance many urban pedestrian safety operations.

Use Case 2: Passive Cyclist Detection

Proving that SDOT can passively and reliably detect cyclists in the roadway will be valuable in improving cyclist mobility and safety. The challenges of video camera placement, including management of glare from standing water in wheel wells and determining the optimal camera view angle were overcome.

Use Case 3: Adaptive Signal Control

By implementing and local peer-to-peer adaptive signal control approach, SDOT was able to overcome a challenge with the existing communications system that prevented use of a centralized adaptive control platform.

The ATSPM platform was more challenging to implement than expected, and the Vendor had to work with SDOT to configure their system appropriately to provide reporting in alignment with SDOT's many “special” traffic signal phasing patterns and changes to traffic signal controller firmware. Despite that challenge, the usefulness of the system has proven to be significant in supporting improved traffic signal operations and before-and-after analyses. Adding additional intersections should be easier as the vendor has learned many of SDOT's unique phasing patterns.

Use Case 4: Green Wave Emergency Vehicle Pre-Emption (EVPE)

The adoption of Green Wave resulted in significant response time savings to the Seattle Fire Department (SFD). SFD staff were quick to realize the system benefits and have asked for further expansion of the system beyond the UW subarea. They were especially pleased with the ability to clear traffic ahead of approaching response vehicles.

Use Case 5: Integrated Corridor Management

SDOT had not anticipated that WSDOT would change their approach to ingesting, managing and using SDOT incident data over the course of the UW MICMA program. However, the two agencies remain committed to working together to improve joint response to incidents in the UW subarea and across the city. WSDOT is pleased to have automated incident data provided to them, replacing texts, emails and phone calls.

Use Case 6: Mobility as a Service

SDOT had not expected that the Data Portal would result in over 1,000 page views at launch, with the associated reduction in staff time focused on responding to data requests.

In terms of real-time data feeds, the ability to provide real-time incident data in an electronic format to WSDOT was a key accomplishment. The API includes both real-time and planned (e.g. major construction) incidents.

Last, SDOT learned of the many conflicting approaches to accessibility data for streets and sidewalks in the public right-of-way while conducting this project. Although the data SDOT collects may not be well suited to use for assessing accessible walking paths, SDOT provisioned the data via an API for use by any interested party.