



Technology Implementations for Rural Road Safety Data Collection, Analysis & Visualization

Portia Shields, Assistant Manager, Yakama Nation

Kameron Greene, MBA, Channel Marketing Manager, AIWaysion

December 2023



AIWAYSION



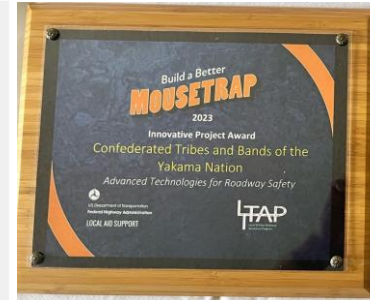
FHWA Build a Better Mousetrap Awards

- 2023 Innovative Project Award
- 2023 Best All Around Award



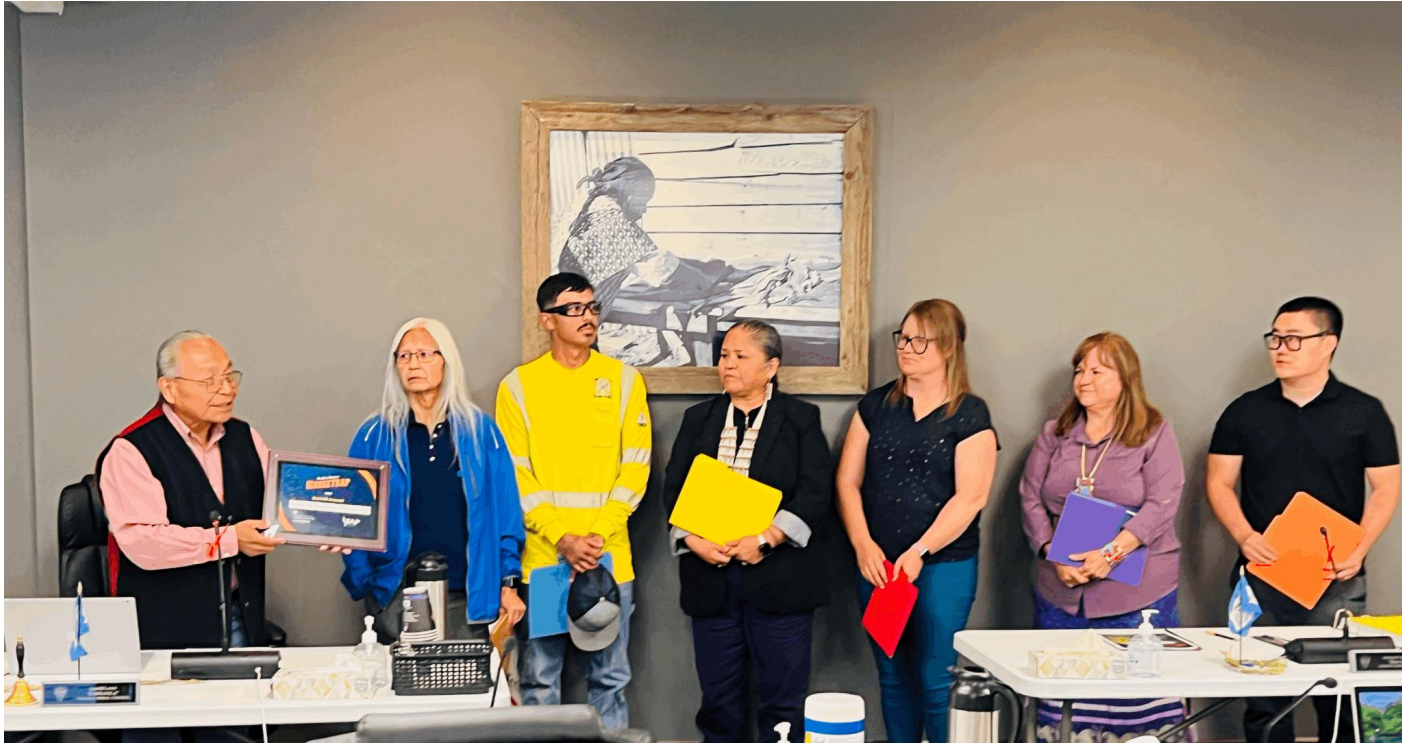
Innovative Project Award:

Confederated Tribes and Bands of the Yakama Nation for the Mobile Unit Sensing Traffic (MUST) Devices to improve rural road safety. For more information



https://www.fhwa.dot.gov/clas/babm/babm_winners.aspx#innovative

FHWA Build a Better Mousetrap Awards



AIWAYSION



WSDOT

2023

Build a Better
MOUSETRAP

WINNERS

Without further ado,

Build a Better
MOUSETRAP

Innovative Project Award

**Confederated Tribes and
Bands of the Yakama Nation**

*Innovation Solution:
Mobile Unit Sensing Traffic
(MUST) Devices.*



mobile unit sensing
traffic (MUST) devices.



Innovative Project Award

- Monitors traffic and detects dangerous events
- Provides real-time warning messages
- Specifically designed for rural roads
- Supports traffic planning
- Offers a comprehensive approach to enhancing transportation and infrastructure within Tribal and rural communities.



specifically designed for rural roads.



Team Members



Yakama Nation DNR Engineering

- Portia Shields, Assistant Manager
- Dwayne Valentine, Tribal Transportation Program Engineering Lead

University of Washington (UW) STAR Lab

- Dr. Yinhai Wang, Professor
 - Director, Northwestern Tribal Technical Assistance Program (NWTAP)
 - Director, Pacific Northwest Transportation Consortium (PacTrans)
- HollyAnna Littlebull, Assistant Director of NWTAP
- Ollie Wiesner, Research Assistant



AIwaysion (UW Spin-Off)

- Dr. Wei Sun, Chief Executive Officer
- Kameron Greene, Channel Marketing Manager
- Dr. Hung-Min Hsu, Senior Research Scientist
- George Ma, Software Development Engineer



AIWAYSION





Results Sharing & Peer Exchange

- ❑ 2023 NTICC
- ❑ 2023 ITE Annual Meeting
- ❑ 2023 BIA NWR Tribal Transportation Symposium
- ❑ 2023 ITS America Conference & Expo
- ❑ Yakama Nation Traffic Safety Committee Meetings
- ❑ 2021 Highway Safety Information System (HSIS) Annual Liaison Meeting
- ❑ 2022 TRB Annual Meeting
- ❑ 2022 ITA Annual Meeting



2023 NTICC





Yakama Nation

Confederated Tribes and Bands of the Yakama Nation

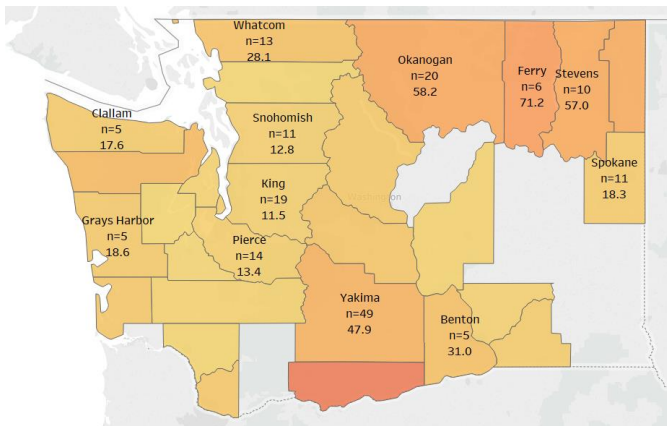
- Federally recognized tribe in Washington state
- Over one million acres, 1,200 miles of public roads, most are in rural areas



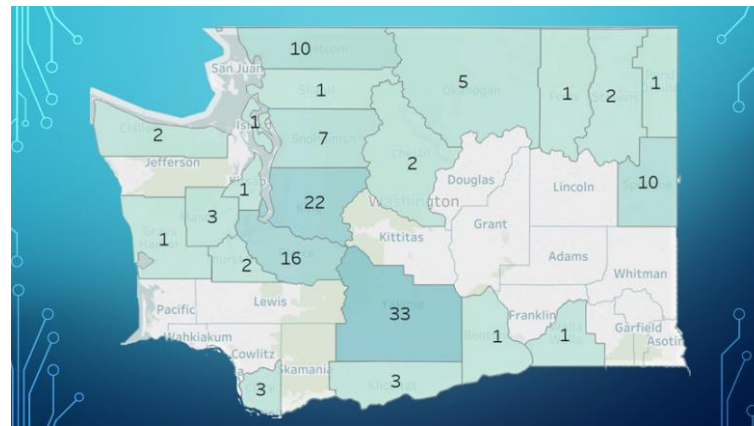


Prevailing Safety Issues

Yakima County has the **highest rates of motor vehicle and pedestrian fatalities** for Native American and Alaskan Native (NA/AN) Populations in Washington



AI/AN Motor Vehicle Fatality Counts and Rates per 100,000 Population by County of Residence, 2011-2016. (Source: Washington State death certificates linked to the Northwest Tribal Registry to identify AI/AN race)

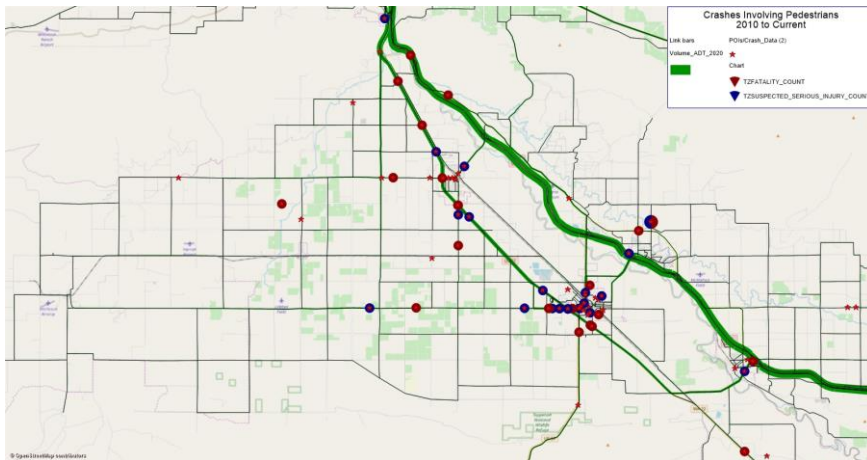


Count of AI/AN pedestrians killed by motor vehicles by residential county of descent. Yakima County: 33 in Yakima County as opposed to 91 total in Washington State. (Data source: Washington State death certificates linked to the NW Tribal Registry, 1999-2016.)



Prevailing Safety Issues

A large portion of these collisions occur on the **Yakama Nation reservation and ceded territory**



Prevailing Safety Issues

❖ Roadway geometry

- Rural roads with sharp corners, steep grades, and often inadequate shoulders and lack of ped/bike facilities, lack of signs, pavement markings, and traffic control devices.



❖ Adverse weather conditions

- Heavy fog/low visibility, snow and ice-covered roads, wildfires, etc.



❖ Human behavior

- Speeding, not wearing a seat belt, driving under the influence, distracted driving, failed to stop at stop signs, etc.
- Illegal crossing, walking on highway, etc.



US 97 Corridor

US 97 – Toppenish to Union Gap – Corridor

- A history of severe and fatal collisions
- Over the last 10 years: 350 serious injury crashes and 22 fatal crashes

US 97 CRASH HISTORY 2001 - 2021

	Lateral A	2 nd Avenue	Jones Road	W. Wapato Road	S. Wapato Road	McDonald Becker	Buster	Fort Road	SR 22	Larue Road	SR 22 SR 223
Fatalities	1	1	3	3	2	2	1	2	2	7	0
Injuries	55	20	35	78	22	56	21	73	38	26	11
Collisions	89	36	52	163	58	59	29	113	101	33	24





US 97 Corridor

US 97 – Toppenish to Union Gap – Corridor

- In the last 3 years, with approximately \$10 million federal and state funding, WSDOT has constructed one roundabout on US 97 at McDonald Road & Becker Road and planning on another roundabout on US 97 at Jones Road.

Highway 97 Corridor Safety Improvements





Rural road safety projects

Safety Data Tool

- Comprehensive Roadway Safety Data Visualization and Evaluation Platform for Yakama Nation
 - USDOT Safety Data Initiative
 - Development of a web-based comprehensive roadway safety tool
 - Establish access and better management of multi-source traffic safety related data

Edge AI Sensing Technology

- Edge Computing and Sensor Fusion System for Comprehensive Monitoring of Traffic and Road Conditions
 - FY23 USDOT Small Business Innovation Research (SBIR) Phase I Project
 - Monitor traffic and road conditions
 - Real-time detection of hazardous events and warning



SBIR
America's Seed Fund
POWERED BY DOT



Comprehensive Roadway Safety Data Visualization Evaluation Platform - USDOT Safety Data Initiative

Objectives

- Address the traffic safety issues through the development of a web-based comprehensive roadway safety tool
- Establish access and better management of multi-source traffic safety related data, both the public available state and county data and local datasets
- Target users: traffic planners and engineers of Yakama Nation DNR Engineering

United State Department of Transportation

- Paul Teicher, Senior Policy Analyst
- Tom Bragan, Traffic Records Division, NHTSA



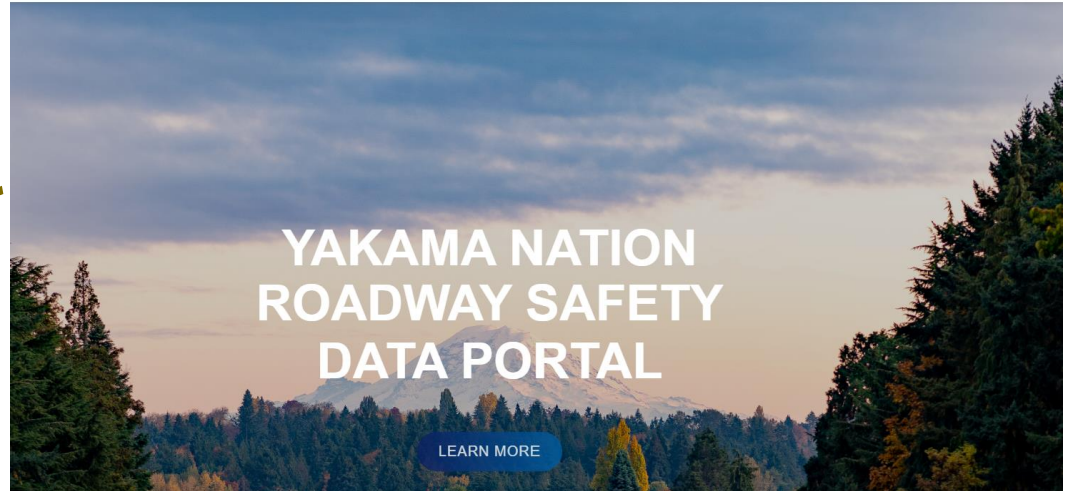
Yakama Nation Safety Data Portal









❑ GitHub repository:

(<https://github.com/AI-Group-STAR-Lab-UW/yakama-nation-roadway-safety-data-portal>)

❑ Training to Yakama Nation Employees on “Safety Data Collection, Management, and Analytics Technologies”

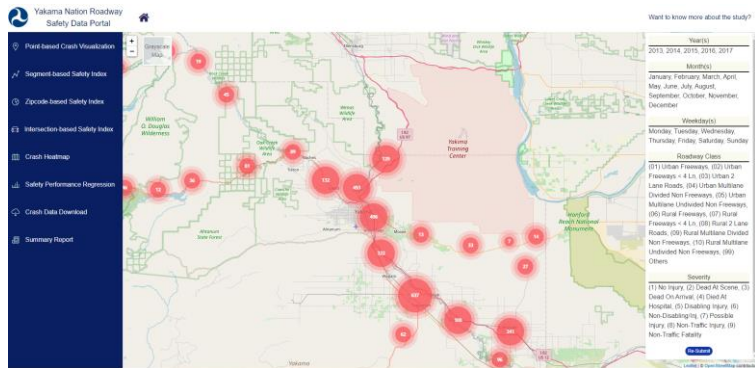
➤ May 19th, 2022 at the UW STAR Lab



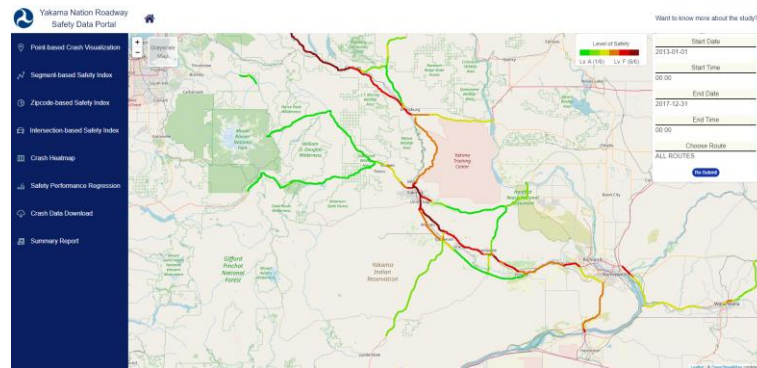
 Point-based Crash Visualization Visualize crash data on the map by the crashes locations	 Segment-based Safety Index Visualize crash data on the map by roadway segments	 Zipcode-based Safety Index Visualize crash data on the map by different zipcode	 Intersection-based Safety Index Visualize crash data on the map by different intersections
 Crash Heatmap Visualize crash frequencies and severities with heatmap	 Safety Performance Estimate traffic network safety and visualize the position of history incident events	 Crash Data Download Customized crash data download with user-specific settings	 Summary Report Reporting functions with customized tables and figures



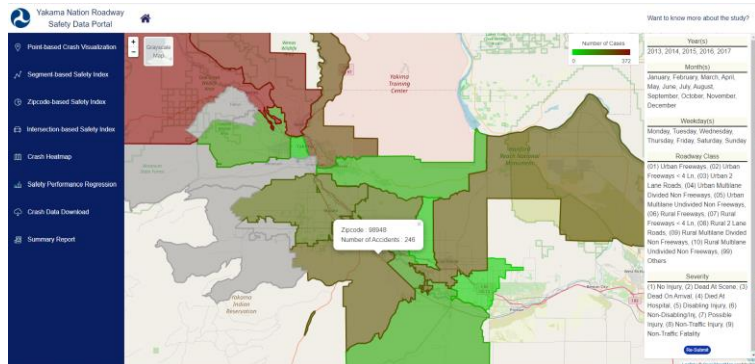
Yakama Nation Safety Data Portal



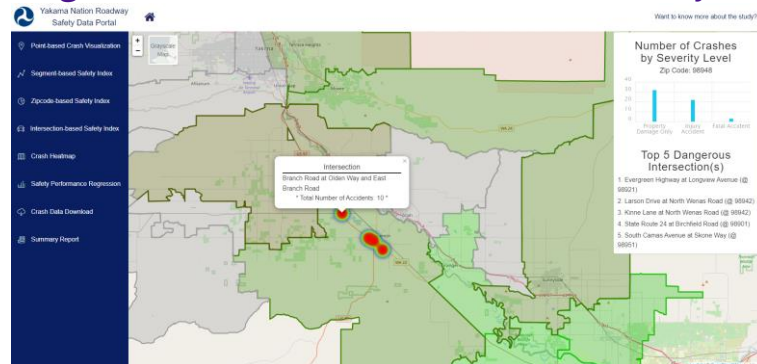
Point-Based Crash Visualization



Segment-Based Crash Visualization & Safety Performance



Area-Based Crash Visualization



Intersection-Based Crash Visualization



Lack of Data in Rural Roads

- ❖ Lack of funding and infrastructure support for deploying conventional data collection equipment
 - Limited internet connection
 - Low-volume rural roads
- ❖ Lack the technical personnel and technologies
 - To manage, visualize, and analyze the data collected
- ❖ Specific data collection needs
 - For example, agricultural vehicles, heavy fog/low visibility, animals, wildfires, etc.
- ❖ Tribal sovereignty and privacy over the data collected
 - Data processing within the device, protecting the privacy of communities
 - Data owned by tribe, and tribe should have control over how the data is used, shared, and stored.

AIWaysion

- ❖ University of Washington Spin-Off
- ❖ USDOT Small Business Innovation Research (SBIR) Awards
 - FY 2023 Phase 1 Funded on “Edge Computing and Sensor Fusion System for Comprehensive Monitoring of Traffic and Road Conditions”
 - FY 2022 Phase 1 & 2 Funded on “Edge Server-Based AI Application for Dilemma Zone and Traffic Conflict Events Detection”



SBIR
America's Seed Fund
POWERED BY DOT





Mobile Unit for Sensing Traffic (MUST)



Computer Vision



Artificial Intelligence



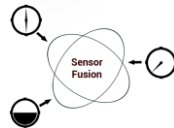
MAC Address Detection



Edge Computing



Environmental Sensing



Sensor Fusion



Communication
& Control



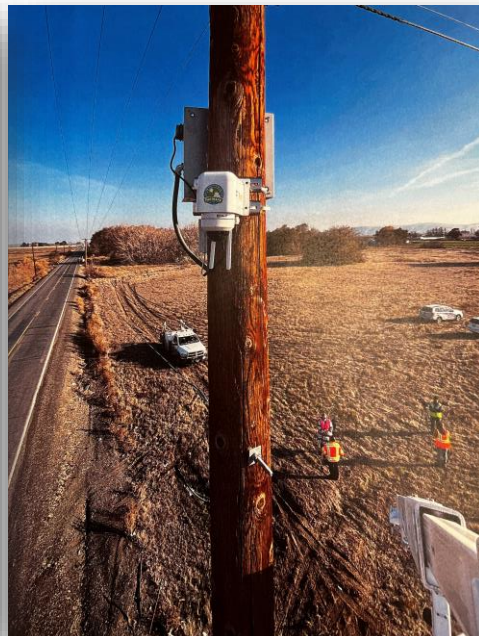
Perception & Computing & Communication All-In-One Unit

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Easy Installation Plug-and-Play



Bellevue, WA



Toppenish, Yakama Nation



Lynnwood, WA

Data Collection: FHWA 13-Class

Class 1 Motorcycles		Class 7 Four or more axle, single unit	
Class 2 Passenger cars		Class 8 Four or less axle, single trailer	
Class 3 Four tire, single unit		Class 9 5-Axle tractor semitrailer	
Class 4 Buses		Class 10 Six or more axle, single trailer	
Class 5 Two axle, six tire, single unit		Class 11 Five or less axle, multi trailer	
Class 6 Three axle, single unit		Class 12 Six axle, multi-trailer	
		Class 13 Seven or more axle, multi-trailer	





Software: Dashboard

Device Management

A sign-in form with a blue background and a network diagram. It includes fields for "Email" (admin@alwayision.com) and "Password" (masked with dots), a "Forgot Password?" link, and a "Continue" button.

Sign In

Email

admin@alwayision.com

Password

Forgot Password ?

Continue

Login

A screenshot of the dashboard showing a "Devices" table and a map of the Seattle area. The table lists 8 devices, all with "Online" status. The map shows several blue location pins in the Seattle area.

Dashboard

Home - Dashboard

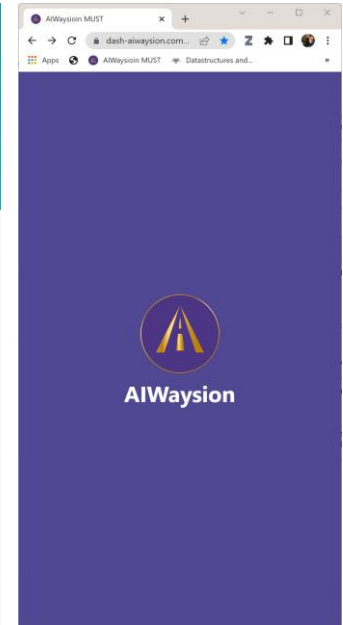
Devices

You have 25 devices

N.O	NAME	STATUS
0	Bellevue Intersection1	Online
1	Bellevue Intersection1 E	Online
2	Bellevue Intersection1 N	Online
3	Bellevue Intersection1 S	Online
4	Bellevue Intersection2	Online
5	Bellevue Intersection2 E	Online
6	Bellevue Intersection2 N	Online
7	Bellevue Intersection2 S	Online

Any question? [Contact Us](#)


Device list & map



Mobile APP

Software: Dashboard

Data Management, Visualization & Insights




Bellevue3 Online

Location: Lakemont Blvd SE, Bellevue, WA 98006

Installed at: 2022-11-23 16:18:30

Last updated at: 2023-03-23 09:34:36

Overview
History
Analytics
Map
Event



44.6 °F | 7.0 °C
Temperature

77.0 %
Humidity


Wet
Road Condition

180 veh/h
Upstream Traffic Count

32 veh/h
Downstream Traffic Count

36.6 mph
Traffic Speed

Road




Bellevue Intersection 1 Online

Location: 156th Ave NE & NE 8th St, Bellevue, WA 98006

Installed at: 2022-11-23 16:18:30

Overview
Events
Map



2023-03-28 14:56:34.99

Show Video Overlay:

Intersection

25

Software: Dashboard

Hazardous Events Detection with Snapshots/Video Clips

Bellevue2 Online
 Location: Lakemont Blvd SE, Bellevue, WA 98006
 Installed at: 2022-11-23 16:18:30
 Last updated at: 2023-04-05 11:49:43

Overview History Analytics Map **Event**

Warning Notification
Monitor Activity

Message	Warning Type	Last Updated Time	Snapshot
Change from dry to wet	Road Condition Event	2023-03-29 02:39:00	
Change from dry to wet	Road Condition Event	2023-03-27 03:55:00	
Change from dry to wet	Road Condition Event	2023-03-25 06:45:00	
Change from dry to wet	Road Condition Event	2023-03-25 02:21:41	
Change from dry to wet	Road Condition Event	2023-03-24 19:22:52	

Snapshots

Overview **Events** Map

Show By Event Type:
All

Pedestrian Crossing Violation
Occurred at 2023-03-26 20:44:30

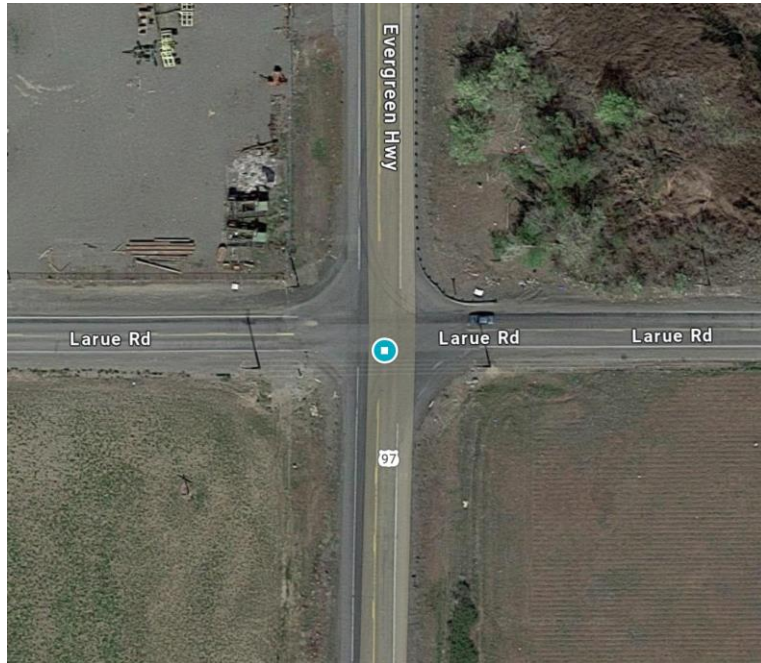
Near Miss Event
Occurred at 2023-03-26 16:58:57

Video clips

Hazardous events
 (collision/near-miss, speeding, adverse weather and road surface conditions, dilemma zone, wrong way, lane compliance, illegal crossing, pothole, debris, crack, etc.)



Larue Rd & Hwy 97 Intersection



US 97 CRASH HISTORY 2001 - 2021

	Lateral A	2 nd Avenue	Jones Road	W. Wapato Road	S. Wapato Road	McDonald Becker	Buster	Fort Road	SR 22	Larue Road	SR 22 SR 223
Fatalities	1	1	3	3	2	2	1	2	2	7	0
Injuries	55	20	35	78	22	56	21	73	38	26	11
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Larue Rd and Highway 97, Toppenish, Yakama Nation

Smart Roadside Device Installation

Mobile Unit for Sensing Traffic (MUST)

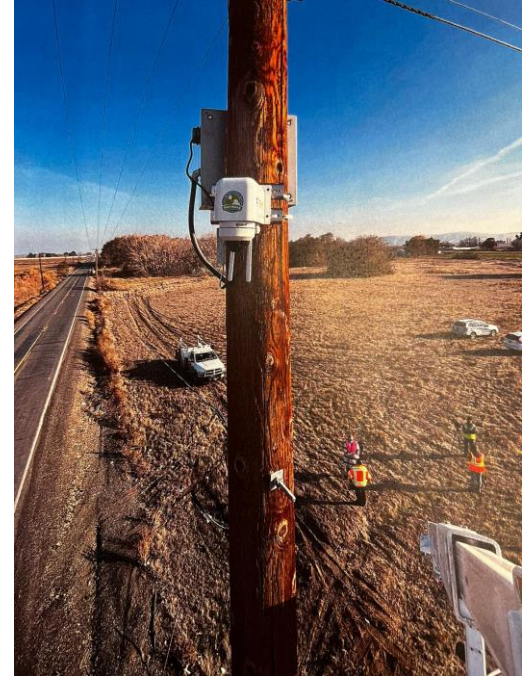


Larue Rd and Highway 97, Toppenish, Yakama Nation



Highway 97 Corridor Safety Improvement

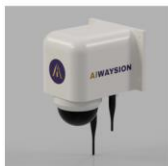
- ❖ **Monitor** traffic, vulnerable road users (pedestrian, cyclists), roadway surface conditions (e.g., snow, ice, wet, and dry), environmental conditions (temperature and humidity), visibility conditions, etc.
- ❖ **Detect hazardous events** such as stopped vehicles, speeding, heavy fog/low visibility, adverse roadway surface conditions, collision, etc.
- ❖ **Communicate** with TMC or traffic control devices (e.g., variable message signs) for real-time countermeasures.





Traffic and Road Conditions Monitoring

Web dashboard



Toppenish1 Online
Location: US-97 & Larue Rd, Toppenish, WA 98948
Installed at: 2022-11-15 15:26:30
Last updated at: 2022-12-04 20:30:00

Overview

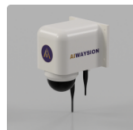


-3 °C
Temperature

66.4 %
Humidity

Snow
Road Condition

35.0 mph
Traffic Speed



yakama01 Online
Location: US-97 & Larue Rd, Toppenish, WA
Installed at: 2023-01-05 03:46:04
Last updated at: 2023-03-13 13:04:36

Overview History Analytics Map Event

03/13/2023

DATE	HUMIDITY	TEMPERATURE	ROAD CONDITION	TRAFFIC COUNT	TRAFFIC SPEED	IMAGE
2023-03-13 12:58:00	58	12	Wet	12	0	
2023-03-13 12:57:00	58	12	Wet	12	0	
2023-03-13 12:56:00	58	12	Wet	36	0	
2023-03-13 12:55:00	58	12	Wet	36	0	
2023-03-13 12:54:00	58	12	Wet	36	0	
2023-03-13 12:53:00	58	12	Wet	3	0	
2023-03-13 12:52:00	58	12	Wet	3	0	

Image capture at: 2023-03-13 12:15:00

2023-03-13 12:14:00 60 11 Wet 51 0

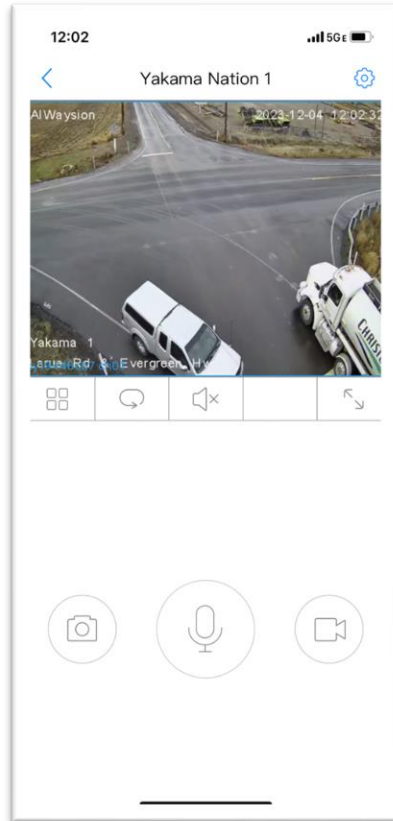
25



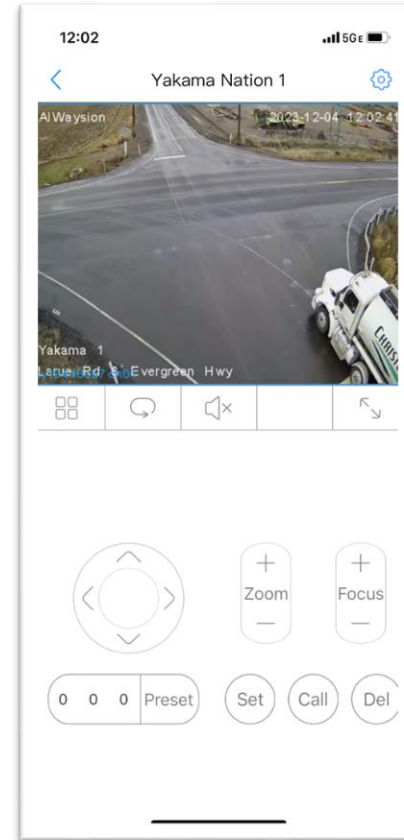
Traffic and Road Conditions Monitoring

Mobile App

- Real-Time Monitoring
- Screenshot
- Video recording



- Pan
- Tilt
- Zoom



Safety Data Collection & Analysis

- ❖ Movements of semi-trucks, agricultural vehicles





Safety Data Collection & Analysis

- ❖ Movements of semi-trucks, agricultural vehicles



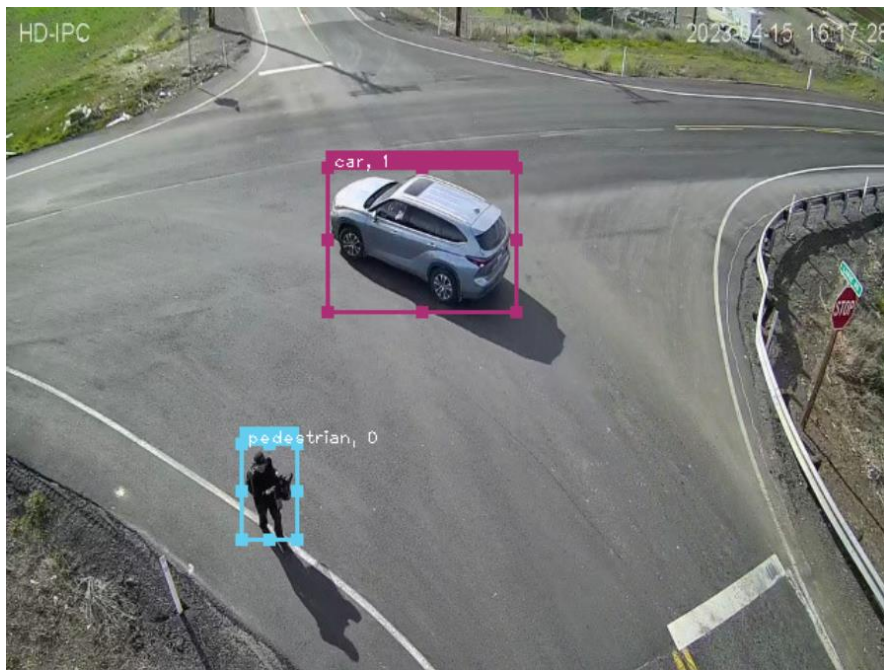
Safety Data Collection & Analysis

❖ Interactions (collision/near-miss events)



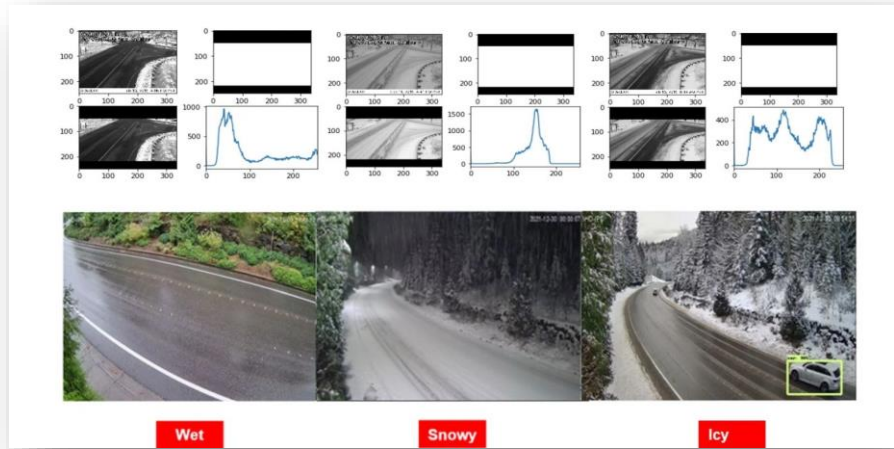
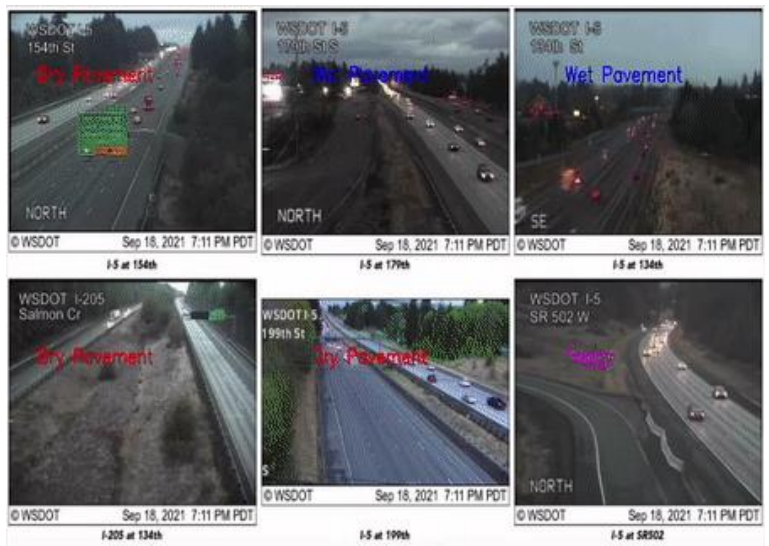
Safety Data Collection & Analysis

- ❖ Pedestrian safety (near-miss events)



Roadway Conditions Monitoring

Road Surface Conditions (Snow, Ice, Wet, Dry)



Sensor-fusion ML algorithm with 95% accuracy in detecting road surface conditions

Visibility Conditions Monitoring

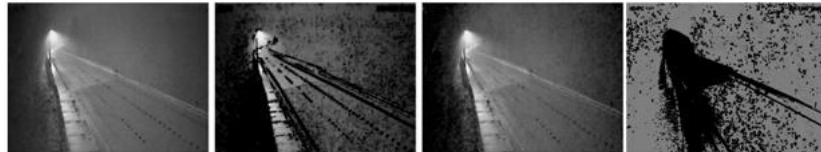
Heavy Fog/Visibility Conditions



(a) Original Image

(b) Dehazed Image

(c) Scattering Map



(d) Dark Channel

(e) Maximum Contrast

(f) Color Attenuation

(g) Hue Disparity

Threshold \ Visibility	$\pm 5\%$	$\pm 10\%$	$\pm 20\%$
$V_s < 500 \text{ m}$	85.29%	89.14%	93.18%
$500\text{m} \leq V_s < 1000 \text{ m}$	88.17%	90.25%	95.42%
$1000\text{m} \leq V_s < 2000 \text{ m}$	90.36%	93.22%	97.03%
$V_s \geq 2000 \text{ m}$	91.23%	95.78%	98.75%
Overall	89.27%	92.15%	96.61%

Real-time visibility estimation based on computer vision (i.e., dark channel prior)

Safety Data Collection & Analysis

- ❖ Heavy fog/low visibility, road surface conditions, visibility/fog, wildfire
- ❖ Human behaviors: speeding, illegal crossing, fail to stop at stop sign



Snow and ice-covered road surface conditions

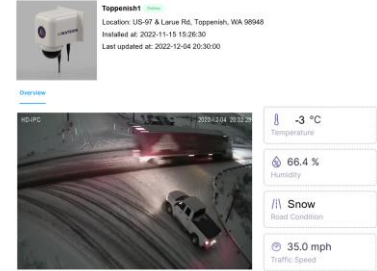
Information Dissemination

❖ Cellular communication

- Road users: mobile APP/text messages via Mobile App
- Traffic management center (TMC): web dashboard

❖ Connected traffic control system

- Variable message signs
- Variable speed limits
- Adaptive traffic-responsive streetlights
- Smart work zone
- Adaptive signal control





Next Step: Corridor Safety Enhancements

US 97 – Toppenish to Union Gap – Corridor

- A history of severe and fatal collisions
- Over the last 10 years: 350 serious injury crashes and 22 fatal crashes

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US 97 Corridor Safety Enhancement

Strengthening Mobility and Revolutionizing Transportation (SMART) Grant

- Deployment of the Cost-Effective Sensing and Alerting System for roadway and intersection safety improvement;
- Conduct safety data analysis to identify high-risk locations and contributing factors; and
- Update Yakama Nation's existing Safety Management Plan.



US 97 – Toppenish to Union Gap - Corridor





US 97 Corridor Safety Enhancement



Toppenish1 Online
Location: US-97 & Larue Rd, Toppenish, WA 98948
Installed at: 2022-11-15 15:26:30
Last updated at: 2022-12-04 20:30:00

[Overview](#)

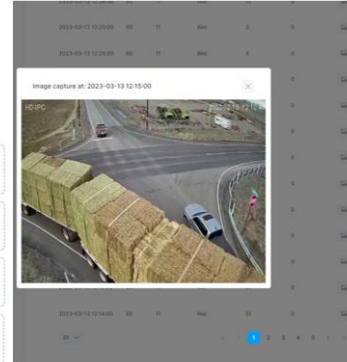


-3 °C
Temperature

66.4 %
Humidity

Snow
Road Condition

35.0 mph
Traffic Speed



Road Safety Information System



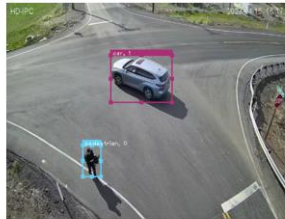
Edge AI Device for Traffic & Road Conditions Monitoring and Hazardous Events Detection



Trucks & Tractors



Road Conditions



Pedestrian Safety



Private 5G Communication



VMS Sign



Thanks! Questions?



Feel free to reach out with any other questions you may have!

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Ollie Wiesner – olw8@uw.edu