



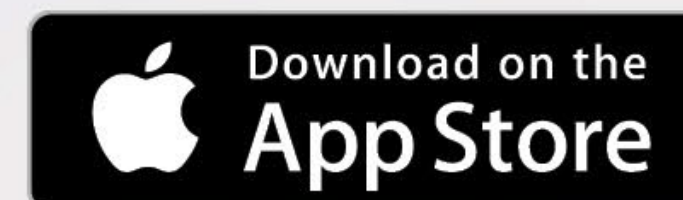
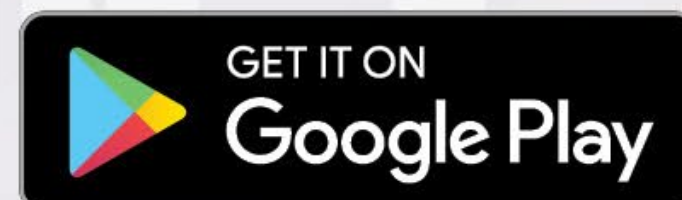
Advancing Pavement Asset Management in Public Works with AI





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Advancing pavement Asset Management in Public Works with AI - Agency Case Study

Insights from Harris & Associates' Pilot Studies

09/11/2024



Harris & Associates



Watsonville
CALIFORNIA



#PWX2024

Presentation Roadmap

Panel Introduction & Learning Objectives

The City of Watsonville

AI in Pavement Management: The Promise and Journey

Overview of Pilot Studies (Watsonville Case Study)

Key Technologies Driving AI-Powered Inspections

Critical Field Observations

Results and Findings from AI Pilot Study

CYVL AI

Conclusion and Recommendations

10%



The Panel

PUBLIC AGENCY



ENGINEERING FIRM



TECHNOLOGY



City of Watsonville,
California

Courtney Lindberg
(Director of Public
Works and Utilities)

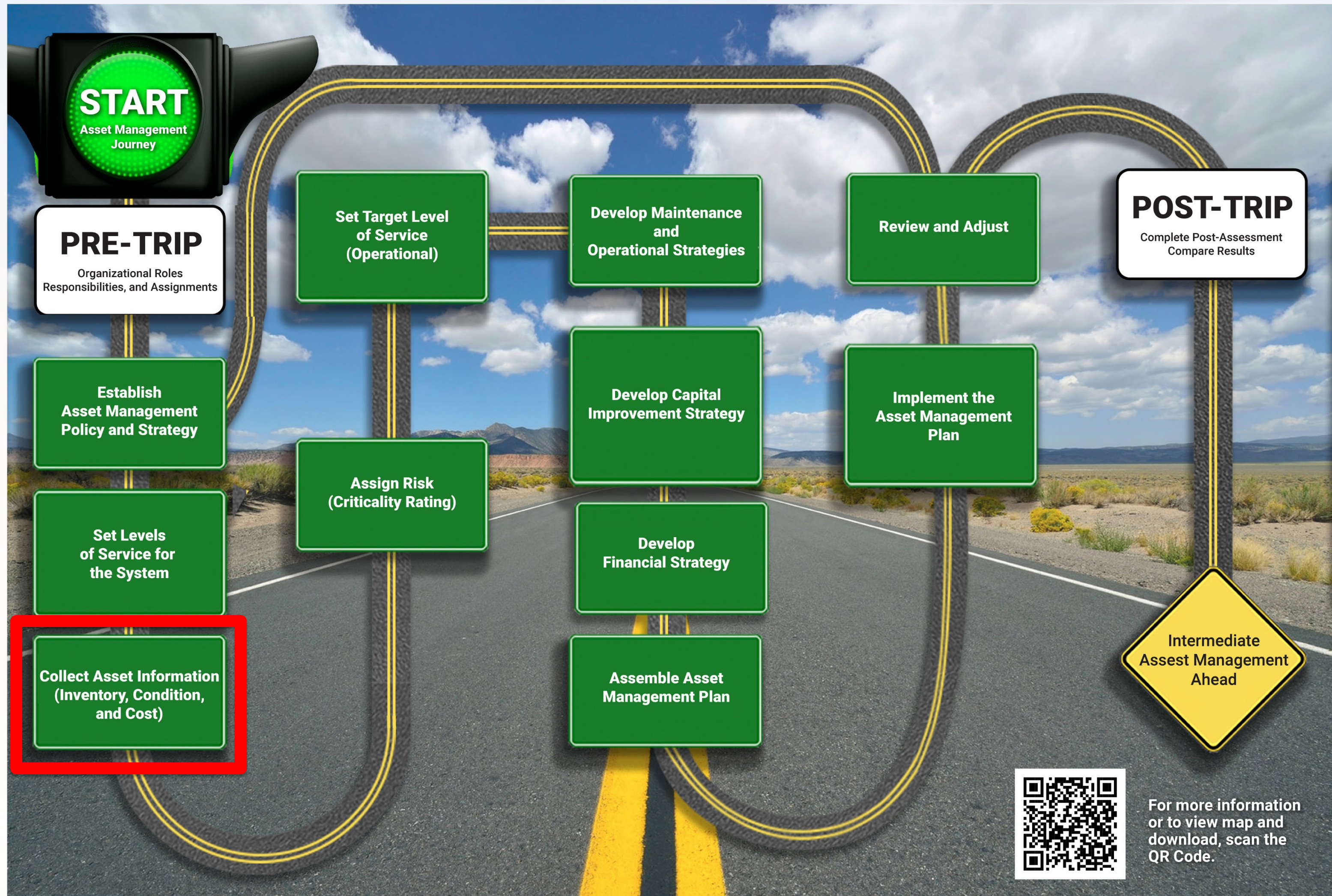
Harris & Associates

Mark Nassar, PE, MBA
(Vice President, Program
Management)

Vijay Pulijal, PE, PMP
(Asset Management Lead)

Cyvl.ai

Daniel Palaez
(Co-Founder, CEO)



ASSET MANAGEMENT

This presentation has a core focus of asset management. Relatable steps from the Roadmap are:

- **Collect Asset Information (Inventory, Condition, and Cost):** This step is directly aligned with our focus on leveraging AI to enhance the collection of accurate data on pavement and non-pavement assets.

LEARNING OBJECTIVES

At the end of this learning experience, I will be better able to...

- 1 Insights into AI's Potential and Practical Limitations
- 2 The AI Implementation Journey
- 3 Setting Realistic Expectations for AI Integration

AI – The Newest Tool in the Toolbox

AI Definition: *Simulation of human intelligence in machines programmed to think, learn, and make decisions in ways that mimic human cognitive processes. AI systems can process vast amounts of data, recognize patterns, make predictions, and solve complex problems. These systems are capable of tasks such as reasoning, learning from experience, understanding natural language, and even perceiving their environment through visual, auditory, or other sensory inputs.*

One successful example of its application is in:
In the Asset Management of Public Roads Pavement



Presentation Roadmap

- ✓ Panel Introduction & Learning Objectives

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CYVL AI

Conclusion and Recommendations

20%



The City of Watsonville



About:

- Watsonville Demographics
 - Size: 6.8 Square Miles
 - Population: 52,457
- Public Works
 - Public Works Budget: \$55,538,225
 - CIP Budget: \$79,291,154
- Public Works Services
 - Solid Waste Division
 - Water Division
 - Sewer and Waste Water Treatment Division
 - Engineering, Road Infrastructure and Maintenance Division



The City of Watsonville



- **The Importance of Pavement**

- Impact on Public Service
- Capital and Maintenance Costs
- Budget Impacts

- **Why Advance AI?**

- **Importance of Communication**



The City of Watsonville



Watsonville's Pavement Management Plan (PMP)

- Pavement Condition Index (PCI)
- Optimized Funding
- ADA Compliance
- Data optimization (ramps, safe routes to school, ATP, etc.)



Presentation Roadmap

- ✓ Panel & Learning Objectives
- ✓ The City of Watsonville

AI in Pavement Management: The Promise and Journey

Overview of Pilot Studies

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CYVL AI

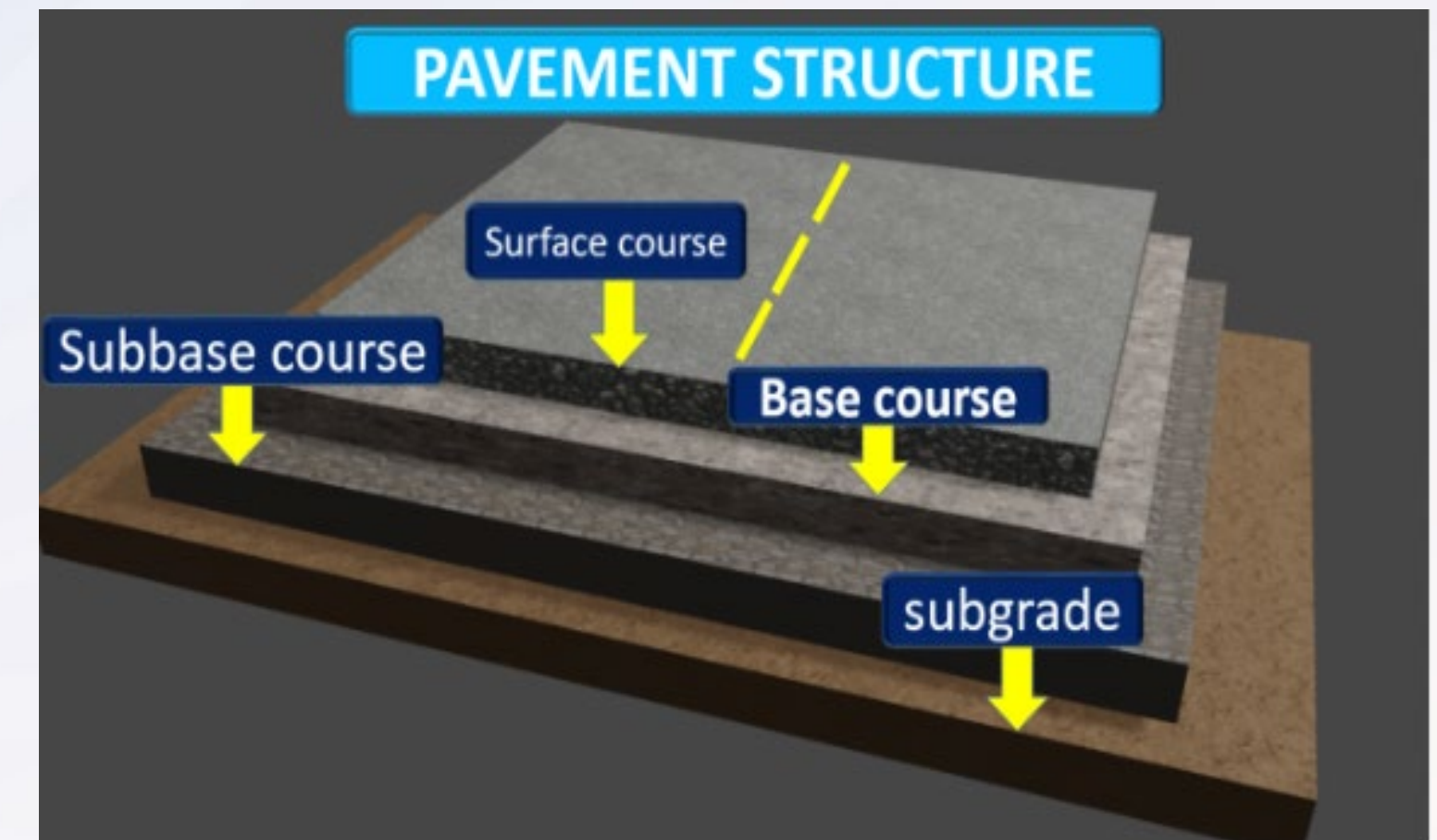
Conclusion and Recommendations

30%



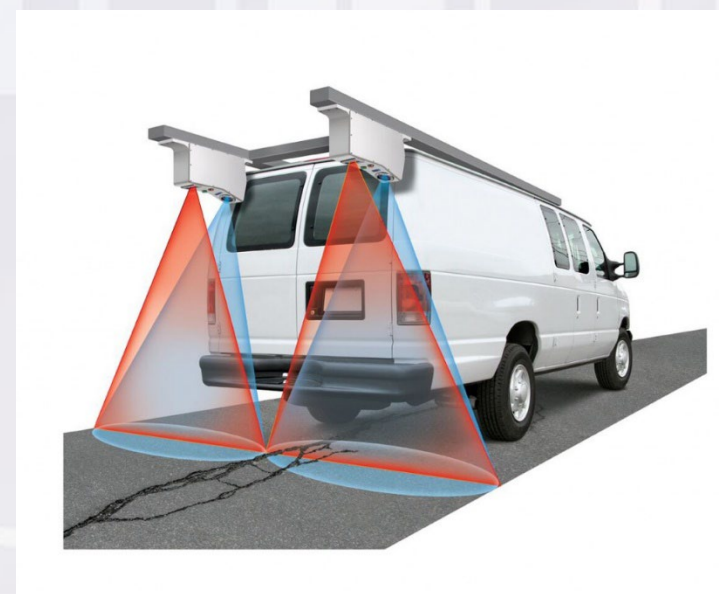
Traditional Pavement Asset Management

- **About Pavement:**
 - Structure & Management
 - Pavement Management Workflow



Traditional Pavement Asset Management

- **Condition Assessment (Standard & Tools):**
 - Inspection Standards (ASTM D6433/MTC Modified Standards)
 - Rater Certification Program
 - Available Tools (Manual/Automated)

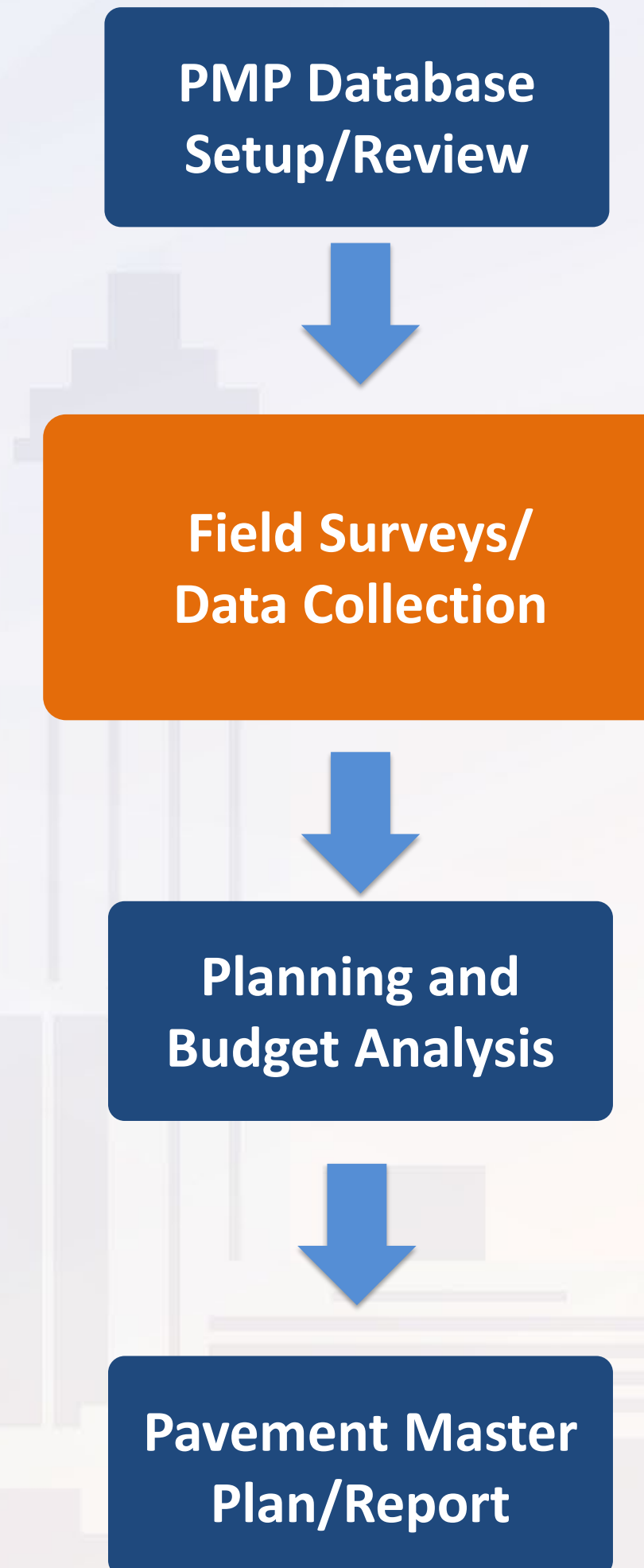


Advancing Pavement Management with AI

- **The Promise of AI:**
 - Enhancing data collection efficiency
 - Reducing manual efforts.
- **Strategic Integration:**
 - Compatibility (*Aligning AI with existing PMP standards*)
 - Non-disruptive (*Enhancements that do not require major changes to current systems.*)
- **Advancing the Tool:**
 - Targeted Pilot Studies
 - Continuous Research

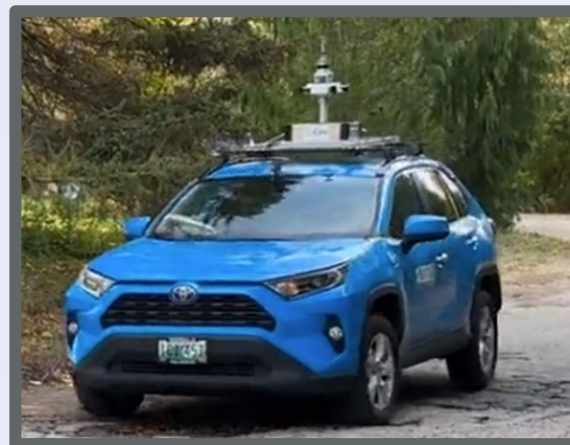
Unlocking the AI Potential in Data Collection

- **Pilot Study Focus:** Testing AI in field data collection (Pavement and ROW assets)
- **Key-Focus Areas:**
 - Enhance Efficiency & Speed
 - Elevate Safety
 - Consistent and Reliable Results
 - Accurate Pattern Detection
 - Adherence to ASTM D6433 Standards
- **Objective :**
 - Collect Pavement Distress Data only



AI-Enhanced Pavement Distress Data Integration for PMP Systems

AI Data Collection
(Approx. 40 mi/Day)



Manual Data Collection
(Approx. 8 mi/Day)

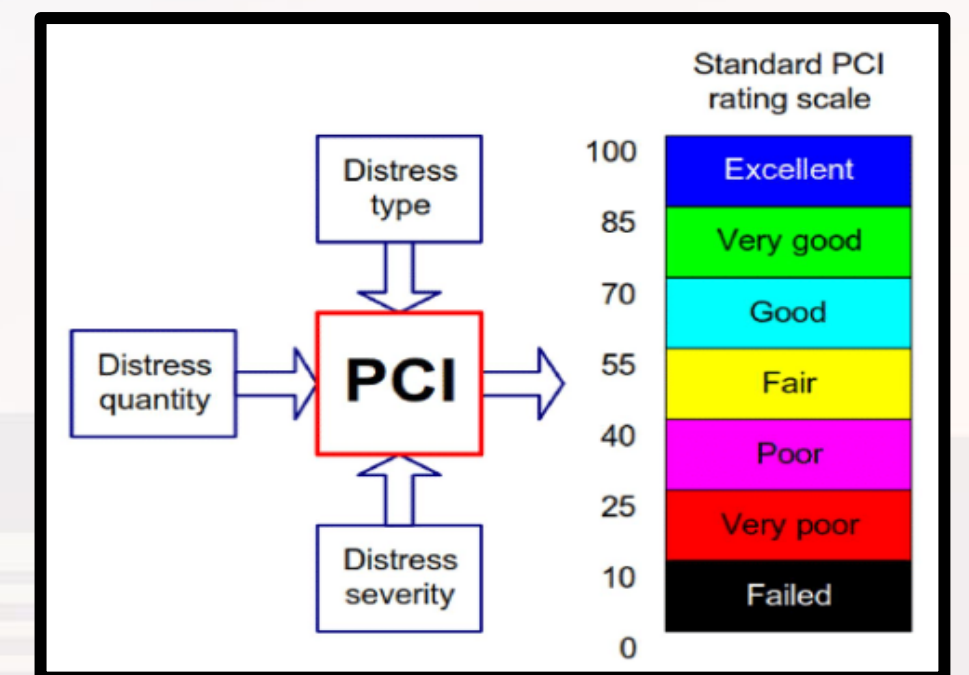


StreetID	SectionID	Inspector	Inspector	Inspector	Inspector	Inspector	DistressType	Severity	DistressSi	NoDistress	Special
11R007	'001	1	12/01/23	1600	100	100	Long. & Trans. Cracking	L	5	No	No
11R007	'001	3	12/01/23	1600	100	100	Long. & Trans. Cracking	L	75	No	No
11R007	'001	4	12/01/23	1600	100	100	Long. & Trans. Cracking	L	5	No	No
11R007	'001	5	12/01/23	1600	100	100	Alligator Cracking	M	96	No	No
11R007	'001	5	12/01/23	1600	100	100	Long. & Trans. Cracking	L	6	No	No
11R007	'001	8	12/01/23	1600	100	100	Block Cracking	L	45	No	No
11R007	'001	8	12/01/23	1600	100	100	Long. & Trans. Cracking	L	6	No	No
11R007	'001	1	12/01/23	1600	100	100	Weathering	L	1136	No	No
11R007	'001	2	12/01/23	1600	100	100	Weathering	L	1168	No	No
11R007	'001	3	12/01/23	1600	100	100	Weathering	L	1152	No	No
11R007	'001	4	12/01/23	1600	100	100	Weathering	L	1216	No	No
11R007	'001	5	12/01/23	1600	100	100	Weathering	L	1168	No	No
11R007	'001	6	12/01/23	1600	100	100	Weathering	L	1248	No	No
11R007	'001	7	12/01/23	1600	100	100	Weathering	L	1136	No	No
11R007	'001	8	12/01/23	1600	100	100	Weathering	L	1184	No	No
11R007	'001	9	12/01/23	640	40	40	Weathering	L	544	No	No
11R008	'001	1	12/01/23	1500	100	100	Weathering	L	1050	No	No
11R008	'001	2	12/01/23	1500	100	100	Weathering	L	1080	No	No

Processed Data for
PMP Integration
(ASTM D 6433 Std.)



Pavement
Management
Programs (PMPs)
Various Platforms

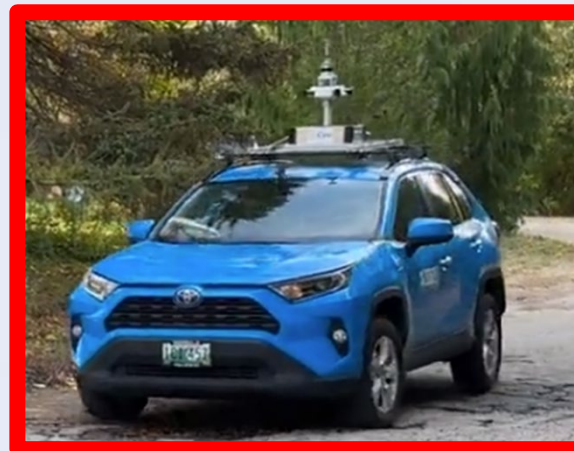


Pavement Condition
Index (PCI)



AI-Enhanced Pavement Distress Data Integration for PMP Systems

AI Data Collection
(Approx. 40 mi/Day)



Manual Data Collection
(Approx. 8 mi/Day)

AI Pavement Distress Data Processing

AI Platform

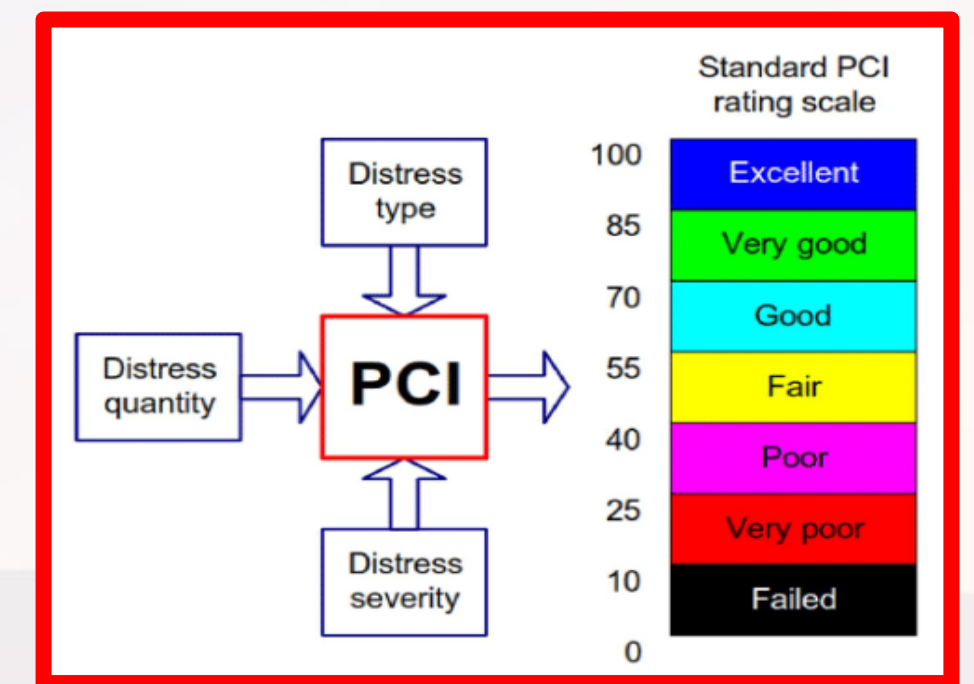
AI-generated PCI

StreetID	SectionID	Inspector	Inspector	Inspector	Inspector	DistressType	Severity	DistressSi	NoDistress	Special
11R007	001	1	12/01/23	1600	100	Long. & Trans. Cracking	L	5	No	No
11R007	001	3	12/01/23	1600	100	Long. & Trans. Cracking	L	75	No	No
11R007	001	4	12/01/23	1600	100	Long. & Trans. Cracking	L	5	No	No
11R007	001	5	12/01/23	1600	100	Alligator Cracking	M	96	No	No
11R007	001	5	12/01/23	1600	100	Long. & Trans. Cracking	L	6	No	No
11R007	001	8	12/01/23	1600	100	Block Cracking	L	45	No	No
11R007	001	8	12/01/23	1600	100	Long. & Trans. Cracking	L	6	No	No
11R007	001	1	12/01/23	1600	100	Weathering	L	1136	No	No
11R007	001	2	12/01/23	1600	100	Weathering	L	1168	No	No
11R007	001	3	12/01/23	1600	100	Weathering	L	1152	No	No
11R007	001	4	12/01/23	1600	100	Weathering	L	1216	No	No
11R007	001	5	12/01/23	1600	100	Weathering	L	1168	No	No
11R007	001	6	12/01/23	1600	100	Weathering	L	1248	No	No
11R007	001	7	12/01/23	1600	100	Weathering	L	1136	No	No
11R007	001	8	12/01/23	1600	100	Weathering	L	1184	No	No
11R007	001	9	12/01/23	640	40	Weathering	L	544	No	No
11R008	001	1	12/01/23	1500	100	Weathering	L	1050	No	No
11R008	001	2	12/01/23	1500	100	Weathering	L	1080	No	No

Processed Data for PMP Integration
(ASTM D 6433 Std.)



Pavement Management Programs (PMPs)
Various Platforms



Pavement Condition Index (PCI)

Presentation Roadmap

- ✓ Panel & Learning Objectives
- ✓ The City of Watsonville
- ✓ AI in Pavement Management: The Promise and Journey

Overview of Pilot Studies

Key Technologies Driving AI-Powered Inspections

Critical Field Observations

Results and Findings from AI Pilot Study

CYVL AI

Conclusion and Recommendations

40%



AI Pilot Program: Framework and Execution



Initial Research & Outreach

(Webinars, Emails, Research)



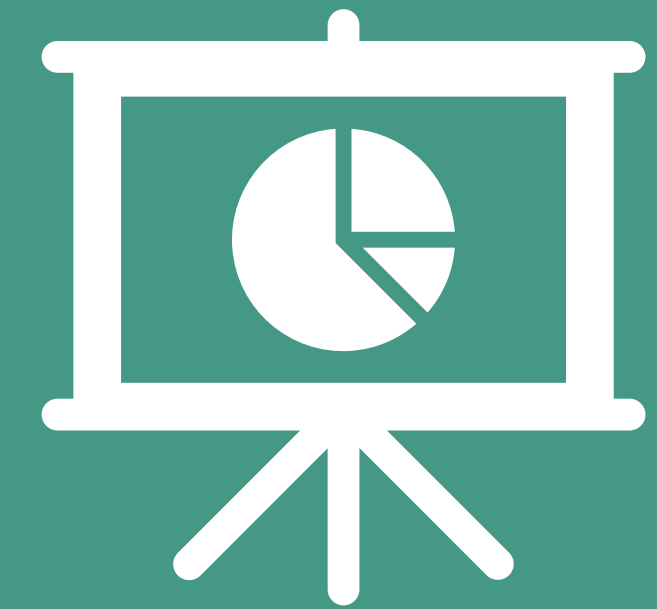
Engagement & Collaboration

(Set up Strategic Meetings)



Deployment

(Equipment Deployed for field Use)

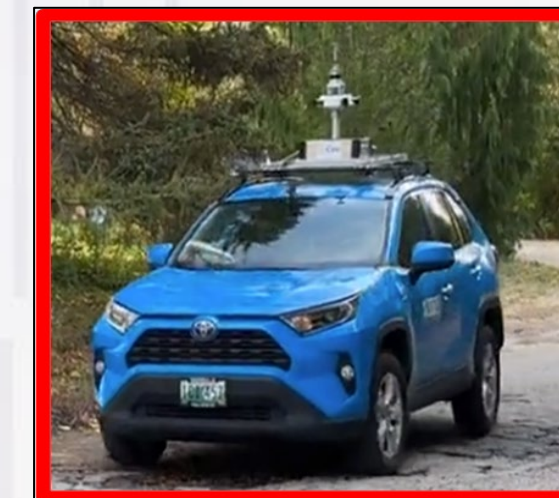
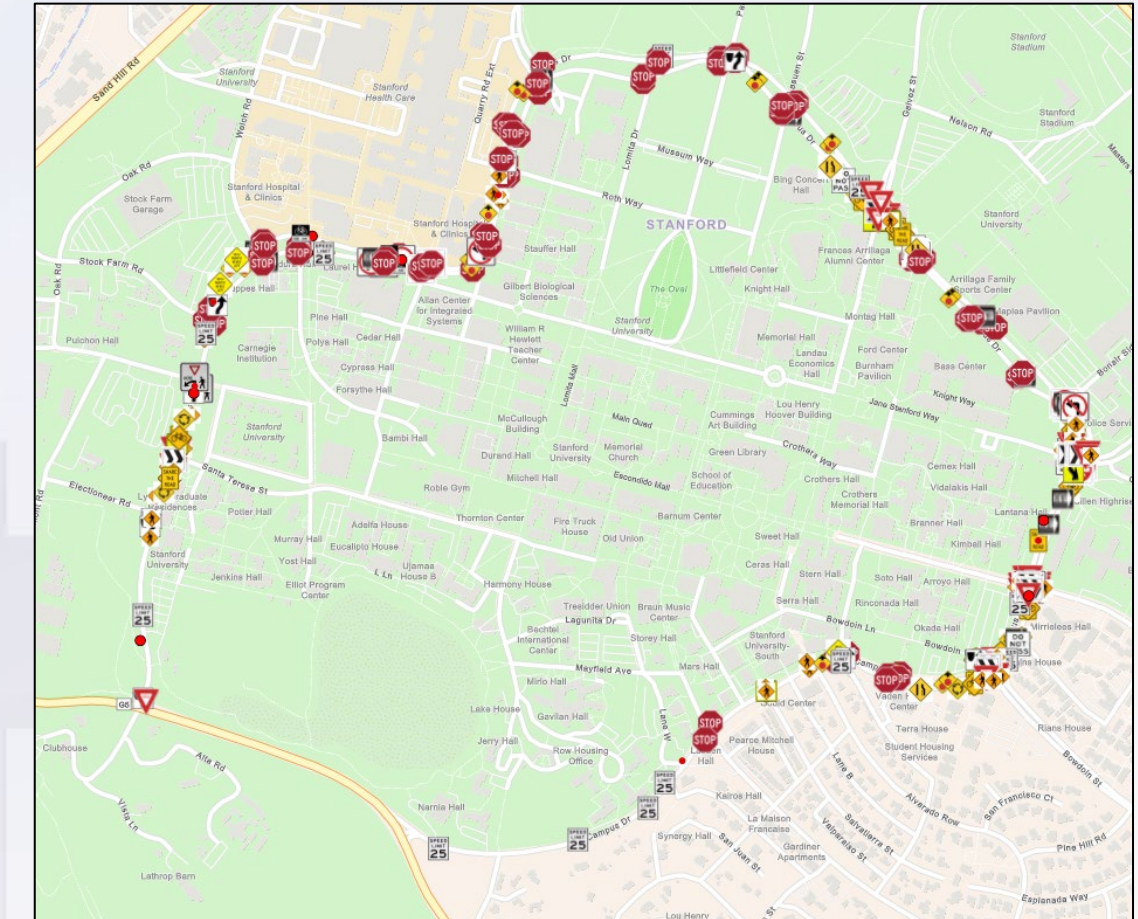


Pilot Testing

(Demos and Pilot Studies conducted)

Pilot Study Requirements and Framework

- **Project Scope:**
 - Focus on Urban, Suburban, and Rural Terrains
 - Pavement Distress and Traffic Sign Evaluation
- **Evaluation Criteria:**
 - Align with Manual Inspection Standards
 - Maintain Data Integrity through QA-QC



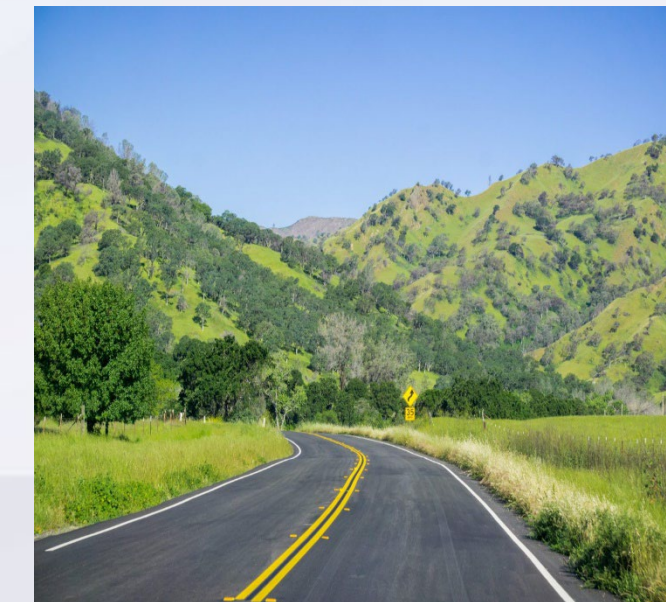
Pavement Distress Identification: QA-QC Protocols (MTC Guidelines)

To confirm consistency among distress surveys and compliance with the distress survey protocol, all re-surveys will meet the following two criteria:

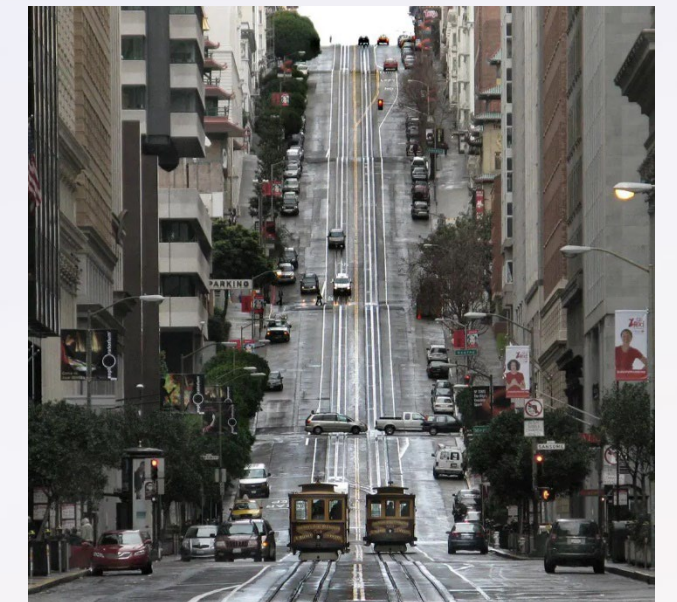
- **At least 50%** of the streets re-surveyed as part of the QA/QC must be **within** plus or minus **eight PCI points** of the initial PCIs calculated, and
- **No more than 12%** of the re-surveyed units can have a difference greater than plus or minus **18 PCI points** from the initial PCI value calculated based on the initial data collected.

Pilot Study Requirements and Framework

- **AI Tools Assessment:**
 - Assess Diverse AI technology (*Cell Phones/Go Pro Cameras/3D Lidar Scanner*)
 - Evaluate AI Performance Across Varied Terrains
- **Collaboration:**
 - Partner with Watsonville for Strategic Support
 - Continuous Stakeholder Feedback and Engagement



Sonoma County CA



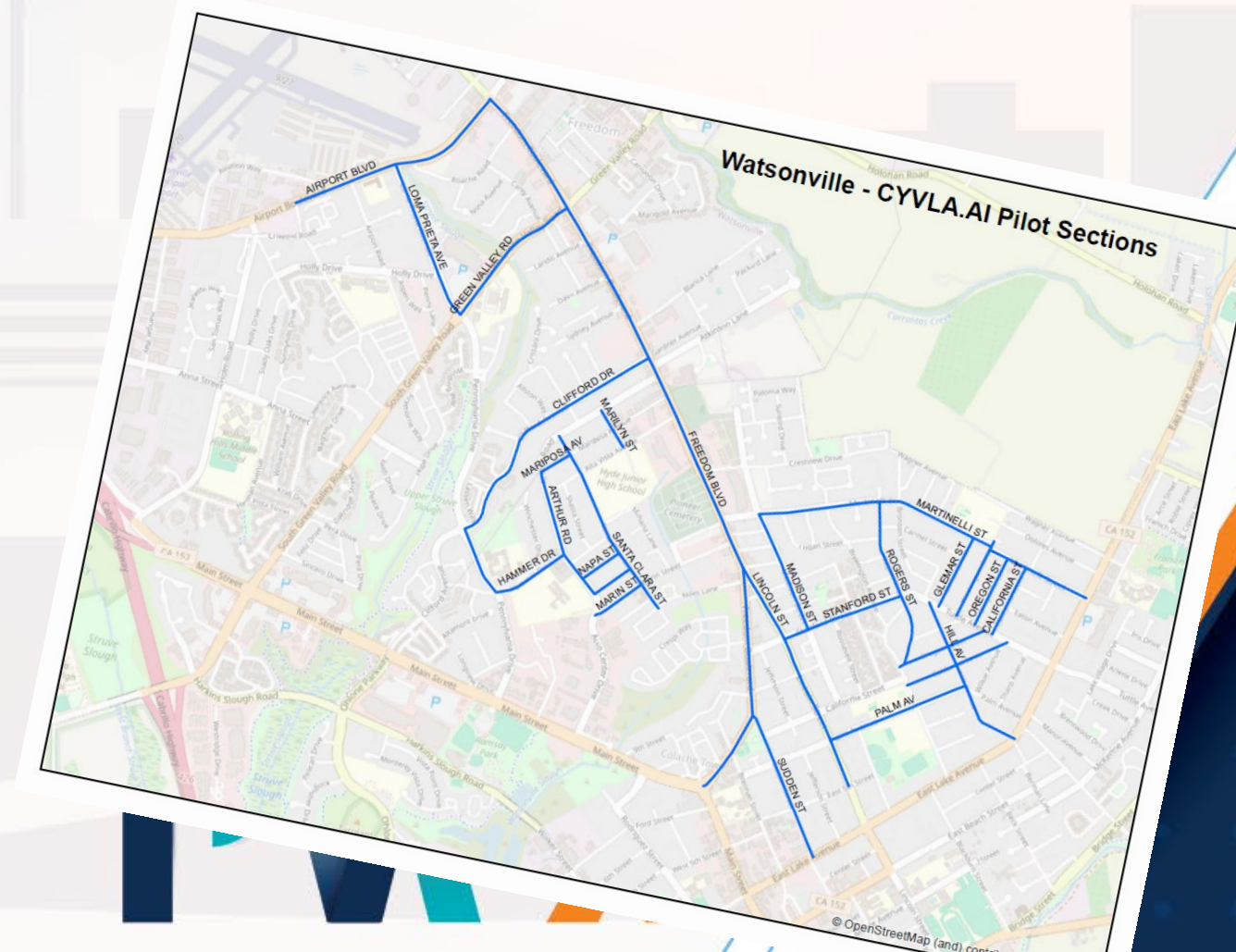
San Francisco CA



Watsonville CA



Stanford University



Presentation Roadmap

- ✓ Panel & Learning Objectives
- ✓ The City of Watsonville
- ✓ AI in Pavement Management: The Promise and Journey
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Key Technologies Driving AI-Powered Inspections

Critical Field Observations

Results and Findings from AI Pilot Study

CYVL. AI

Conclusion and Recommendations

50%



Key Technologies Driving AI-Powered Inspections



3D-LIDAR Scanner



Smart Phone



GoPro Cameras

Key Technology – 3D Lidar Scanner

Functionality

- Laser technology is used to create detailed 3D models of road surfaces.

Key Features

- Provides precise surface mapping
- Ideal for in-depth pavement condition assessments.
- Operates at high speeds, minimizing time on-site.



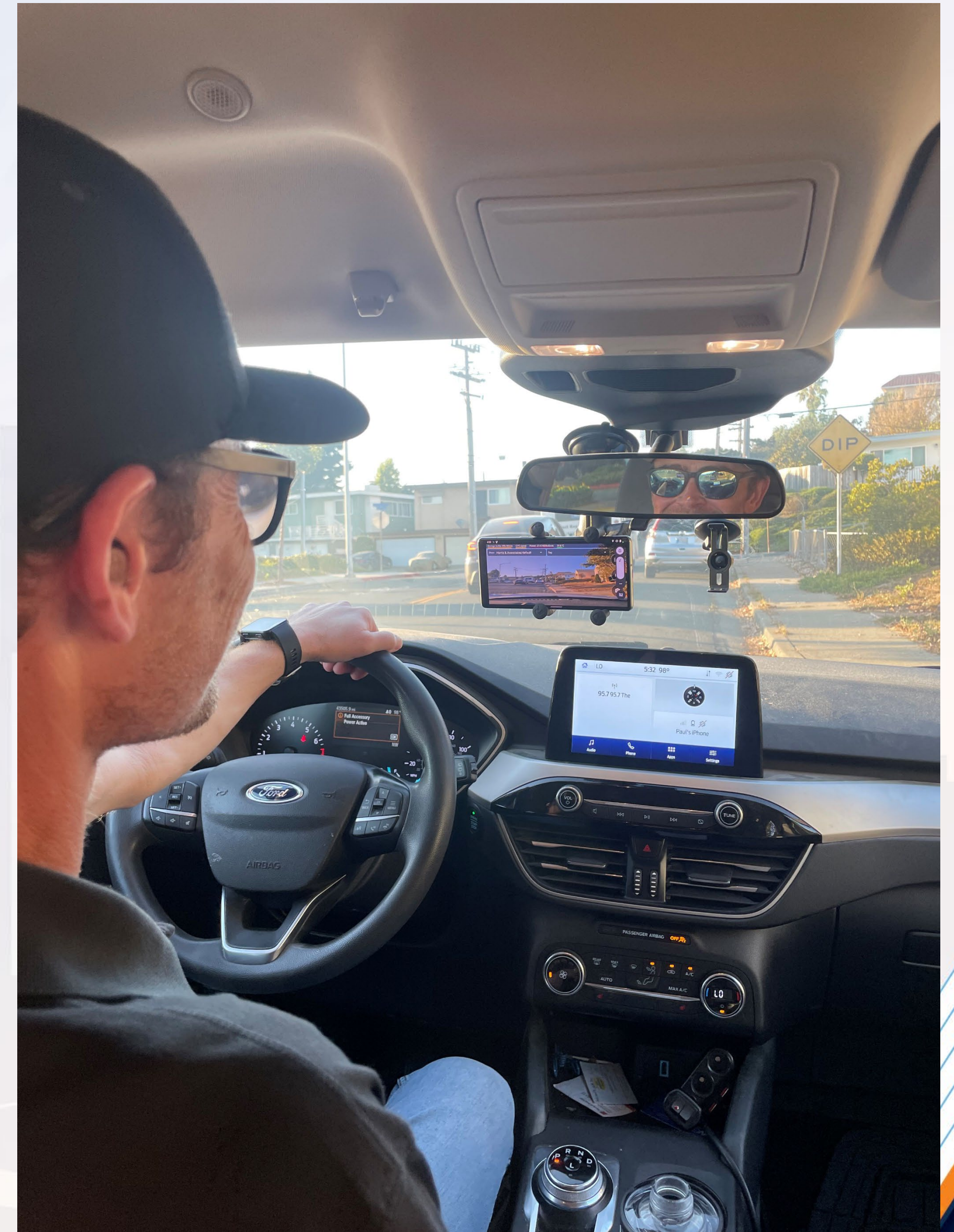
Key Technology – Smart Phone

Functionality

- Captures geospatial video
- Utilizes computer vision for real-time analysis
- Employs customized algorithms to interpret and analyze video/data

Key Features

- Mounted on the windshield for a stable view
- Secured with a RAM Cradle for optimal stability
- Includes a polarization filter to reduce sun glare
- Regular driving speeds



Key Technology – GoPro Camera

Functionality

- High-Definition Video Capture
- Flexible, integrates with AI systems

Key Features

- Wide-angle lens for comprehensive coverage
- Rugged, waterproof design for diverse conditions
- Compact, portable, easy to reposition
- High frame rate for fast-moving object capture



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Critical Field & Post-Processing Observations

Results and Findings from AI Pilot Study

CYVL AI

Conclusion and Recommendations

60%



Field Observations

- **Set Up & Build**
 - **3D LIDAR**
 - Setup requires some effort but offers precision and robust results
 - **Smart Phone**
 - Quick installation
 - minor adjustments are needed for polarization filters.
 - **GoPro**
 - Fast and efficient setup
 - Needs Initial calibration



Field Observations

- **Operation**

- Time-of-day impacts visibility—optimal performance midday.
- Multiple passes needed for full coverage.
- Tracking and managing routes is challenging.

- **Data Collection Issues**

- Encountered operational Issues - equipment failures/Missed Data Capture.



Field Observations

- **Tech Support**

- Response Time: Quick and responsive support was essential.
- Expertise: Some support lacked technical knowledge.

- **Security/Liability**

- Equipment Risks: High-value equipment posed significant risks.
- Theft & Insurance: Concerns over equipment security and coverage.



Post-Processing Challenges & Observations

- **Data Processing**

- Extended Data Acquisition Timeframes
- Inconsistent Data Formats and Importation Issues

- **Severity Level Assessment**

- Severity Levels Often Grouped as One

StreetID	SectionID	Inspector	Inspector	Inspector	Inspector	DistressType	Severity	DistressSi	NoDistres	Special
11R007	001	1	12/01/23	1600	100	Long. & Trans. Cracking	L	5	No	No
11R007	001	3	12/01/23	1600	100	Long. & Trans. Cracking	L	75	No	No
11R007	001	4	12/01/23	1600	100	Long. & Trans. Cracking	L	5	No	No
11R007	001	5	12/01/23	1600	100	Alligator Cracking	M	96	No	No
11R007	001	5	12/01/23	1600	100	Long. & Trans. Cracking	L	6	No	No
11R007	001	8	12/01/23	1600	100	Block Cracking	L	45	No	No
11R007	001	8	12/01/23	1600	100	Long. & Trans. Cracking	L	6	No	No
11R007	001	1	12/01/23	1600	100	Weathering	L	1136	No	No
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11R007	001	5	12/01/23	1600	100	Weathering	L	1168	No	No
11R007	001	6	12/01/23	1600	100	Weathering	L	1248	No	No
11R007	001	7	12/01/23	1600	100	Weathering	L	1136	No	No
11R007	001	8	12/01/23	1600	100	Weathering	L	1184	No	No
11R007	001	9	12/01/23	640	40	Weathering	L	544	No	No
11R008	001	1	12/01/23	1500	100	Weathering	L	1050	No	No
11R008	001	2	12/01/23	1500	100	Weathering	L	1080	No	No
11R008	001	3	12/01/23	1500	100	Weathering	L	1140	No	No
11R008	001	4	12/01/23	1500	100	Weathering	L	1065	No	No
11R008	001	5	12/01/23	1500	100	Weathering	L	1140	No	No
11R008	001	6	12/01/23	1500	100	Weathering	L	1020	No	No
11R008	001	7	12/01/23	1500	100	Weathering	L	990	No	No
11R008	001	8	12/01/23	1500	100	Weathering	L	1106	No	No

Importation File

```

11R007 - 001</u></b> has Inspection Area (13440) greater than 105% of Section Area (10920.00) OR not between 1000 and 4000 sf
11R008 - 001</u></b> has Inspection Area (12000) greater than 105% of Section Area (9720.00) OR not between 1000 and 4000 sf
11R006 - 001</u></b>, Insp# 6 has Distress Type Weathering has Distress Area (1328) > 105% of Inspection Area (480)
11R104 - 001</u></b>, Insp# 4 has Distress Type Weathering has Distress Area (884) > 105% of Inspection Area (782)
11R105 - 001</u></b>, Insp# 2 has Distress Type Weathering has Distress Area (22500) > 105% of Inspection Area (3000)
11R051 - 002</u></b>, Inspection #5 has duplicate (L) Severity and (Long. & Trans. Cracking) Distress Type Combination.
11R105 - 001</u></b>, Inspection #1 has duplicate (M) Severity and (Alligator Cracking) Distress Type Combination.
11R105 - 001</u></b>, Inspection #2 has duplicate (M) Severity and (Alligator Cracking) Distress Type Combination.
11R105 - 001</u></b>, Inspection #2 has duplicate (L) Severity and (Long. & Trans. Cracking) Distress Type Combination.
11R105 - 001</u></b>, Inspection #2 has duplicate (L) Severity and (Patch & Util. Cut Patch) Distress Type Combination.
11R105 - 001</u></b> has Inspections with the combination of Patch, Raveling, and Weathering > 105% of the Inspection Area.
11R105 - 001</u></b> Insp # 2 Insp Date 12/01/2023 00:00:00 has sq feet of Patching + Weathering > 105% of Inspection Area
11R006 - 001</u></b> has the combination of Raveling and Weathering greater than 105% of Insp Area
11R104 - 001</u></b> has the combination of Raveling and Weathering greater than 105% of Insp Area
11R105 - 001</u></b> has the combination of Raveling and Weathering greater than 105% of Insp Area
    
```

Error File



Post-Processing Challenges & Observations

- **Data Accuracy Concerns**

- Misidentification of Distresses (e.g., Utilities marked as Distress)
- Missed identifying Inspections at times.

- **AI Limitations**

- Struggles in Detecting Certain Distresses

Special	Inspection #	Inspection Area	Inspection Date	Distress Type	Severity	Quantity
No	446	1,190 sq. ft.	05/24/2023	Alligator Cracking	High	84.00 sq. ft.
				Long. & Trans. Cracking	Low	76.00 ft.
				Patch & Util. Cut Patch	Low	87.00 sq. ft.
Comments:						
No	447	1,150 sq. ft.	05/24/2023	Long. & Trans. Cracking	Low	77.00 ft.
Comments: Cyl inspect_id: IA01348						
No	448	790 sq. ft.	05/24/2023	Alligator Cracking	High	6.00 sq. ft.
				Patch & Util. Cut Patch	Low	9.00 sq. ft.
Comments:						
No	449	1,190 sq. ft.	05/24/2023	Long. & Trans. Cracking	Low	5.00 ft.
				Weathering	High	984.00 sq. ft.
Comments:						
No	450	1,190 sq. ft.	05/24/2023	Long. & Trans. Cracking	Low	133.00 ft.
				Weathering	High	991.00 sq. ft.
Comments:						
No	451	1,190 sq. ft.	05/24/2023	Long. & Trans. Cracking	Low	119.00 ft.
				Rutting/Depression	Medium	398.00 sq. ft.
				Weathering	High	994.00 sq. ft.
Comments:						
No	452	1,180 sq. ft.	05/24/2023	Long. & Trans. Cracking	Low	1.00 ft.
				Patch & Util. Cut Patch	Low	92.00 sq. ft.
						77.00 sq. ft.
						532.00 sq. ft.
						804.00 sq. ft.

Special	Inspection #	Inspection Area	Inspection Date	Distress Type	Severity	Quantity
No	1	3,200 sq. ft.	03/09/2023	Block Cracking	Low	2400.00 sq. ft.
				Rutting/Depression	Low	25.00 sq. ft.
				Alligator Cracking	High	100.00 sq. ft.
				Alligator Cracking	Medium	400.00 sq. ft.
				Raveling	Medium	64.00 sq. ft.
				Weathering	High	1280.00 sq. ft.
				Weathering	Medium	1760.00 sq. ft.
				Patch & Util. Cut Patch	Low	100.00 sq. ft.



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- ✓ Critical Field & Post-Processing Observations

Results & Findings from AI Pilot Study

CYVL. AI

Conclusion and Recommendations

70%



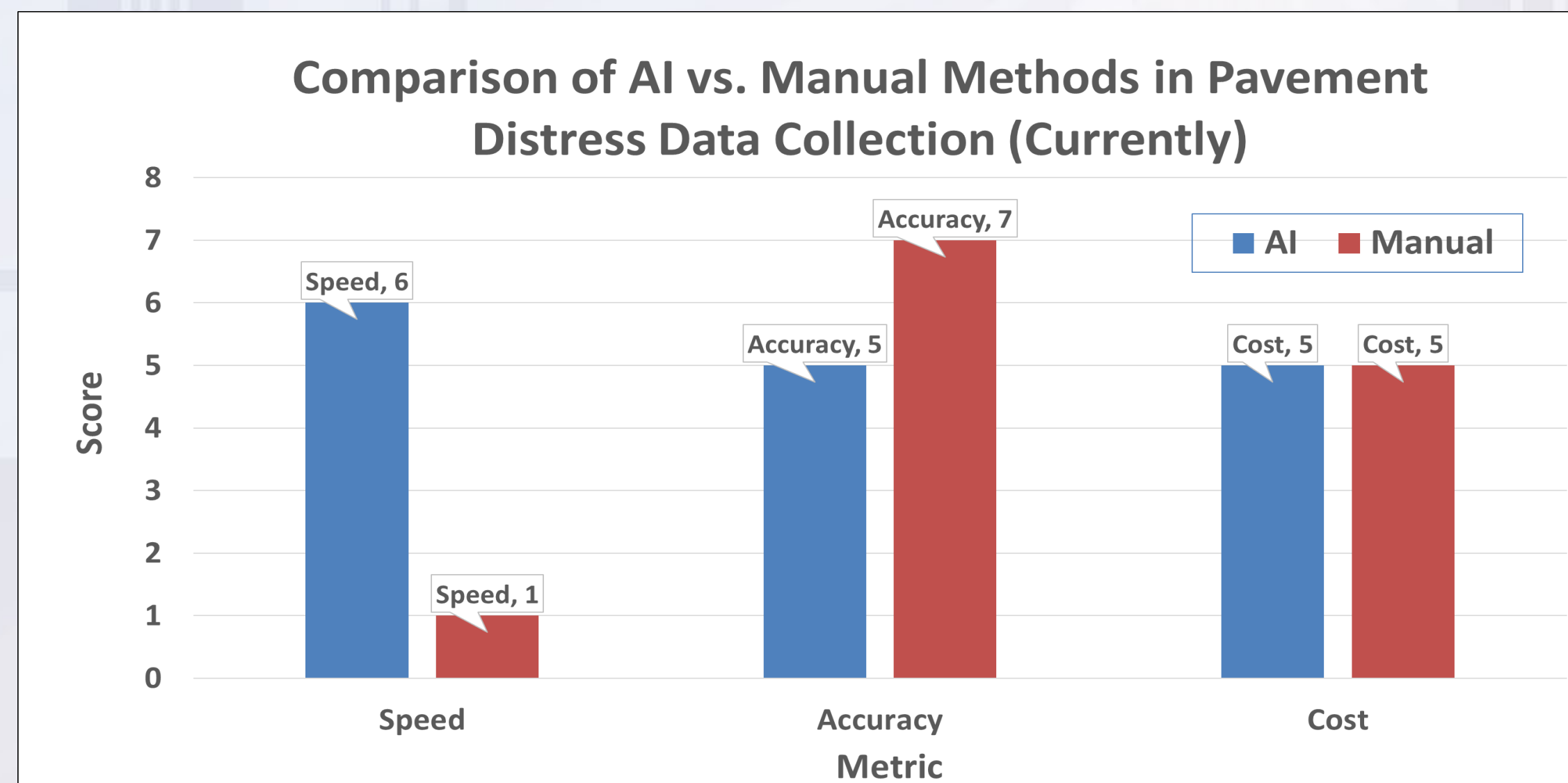
AI Pavement Distress Evaluation Results

- **Data Integration:** AI-generated distress data was imported into the Pavement Management Program (PMP).
- **Comparison:** PCI scores from AI were compared against PCI from manually collected data.
- **Key Results**
 - **Variations:** Significant differences between AI and manual PCI scores.
 - **Overestimation:** AI often overestimates medium and high distress levels.
 - **QA-QC Standard:** AI data did not meet the required QA-QC standards.

AI Pavement Distress Evaluation Results

➤ AI Performance Overview

- Results are harsh compared to manual evaluations
- Over-detection of certain distresses.
- Inconsistent distress identification in sections with no issues.



Next Steps

- **Development Status:** AI is still evolving and is expected to be fully reliable by mid-2025
- **AI Continuous Refinement**
 - **Iterative Data Importation** - Continuous comparison between AI and manual data
 - **Algorithm Refinement** - Enhancing distress identification and classification with each iteration.
 - **Adapting Across Terrains-** Testing algorithms for adaptability and reliability in diverse terrains.
 - **Maintaining Standards** - Ensuring AI aligns with engineering standards
- **Cost Implications:** Current costs are comparable with manual methods but offer long-term savings due to increased efficiency and reduced labor needs.

Presentation Roadmap

- ✓ Panel & Learning Objectives
- ✓ The City of Watsonville
- ✓ AI in Pavement Management: The Promise and Journey
- ✓ Overview of Pilot Studies (Watsonville Case Study)
- ✓ Key Technologies Driving AI-Powered Inspections
- ✓ Critical Field & Post-Processing Observations
- ✓ Results and Findings from AI Pilot Study

CYVL AI

Conclusion and Recommendations

80%



Introducing CYVL: AI for Pavements

- Our Mission
- How Our Tech Has Helped 200+ DPWs
- The Collaboration with Harris/Watsonville
- Path Forward for Replicating Success for California DPWs



CYVL' Mission

Accelerate the future of infrastructure.

Why This Mission Matters:

- \$2.6 trillion infrastructure gap
- Limited budgets to combat aging roads
- Lack of data + inefficient use of resources



CYVL' Mission

Accelerate the future of infrastructure.

Cyvl provides the critical data needed by DPWs to **accurately inform budgets, optimize resource allocation, secure funding, and effectively close the infrastructure gap.**



200+ DPW Success Stories

Cyvl is used by **leading governments** and engineering firms.



HNTB



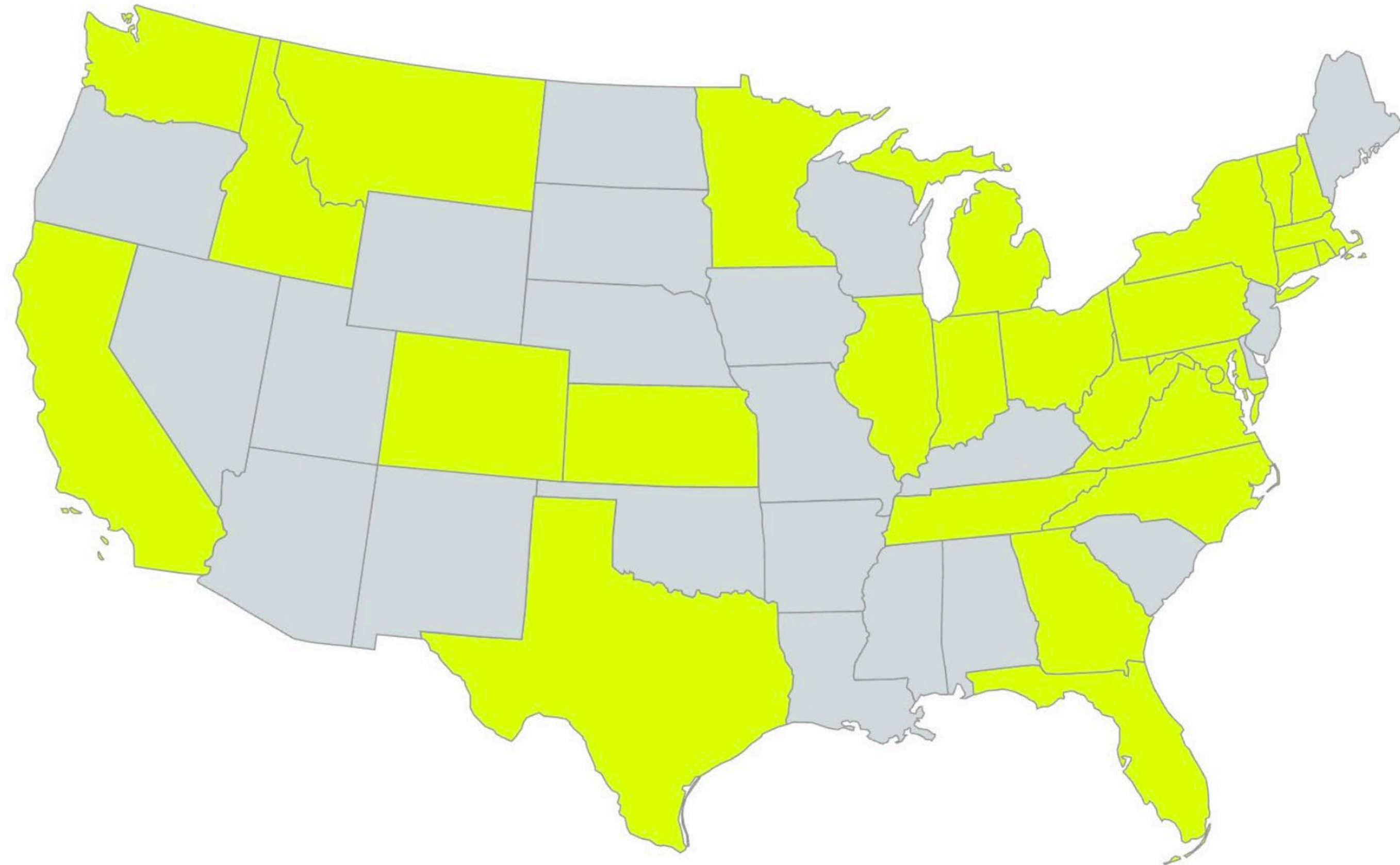
AECOM



Kimley»Horn



APEX



200+ DPW Success Stories

How It Works



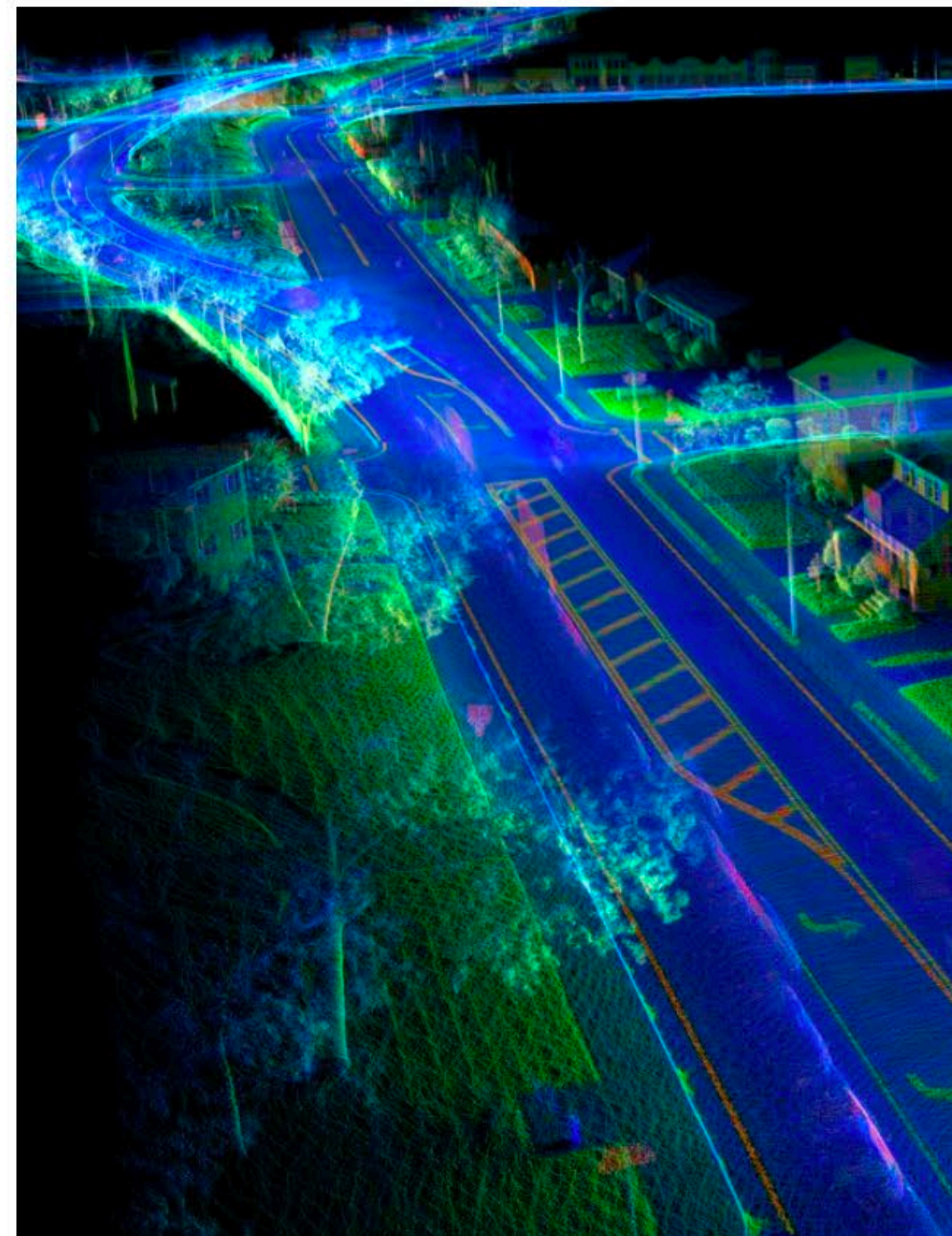
01

We map your roads with street view cameras and LiDAR.



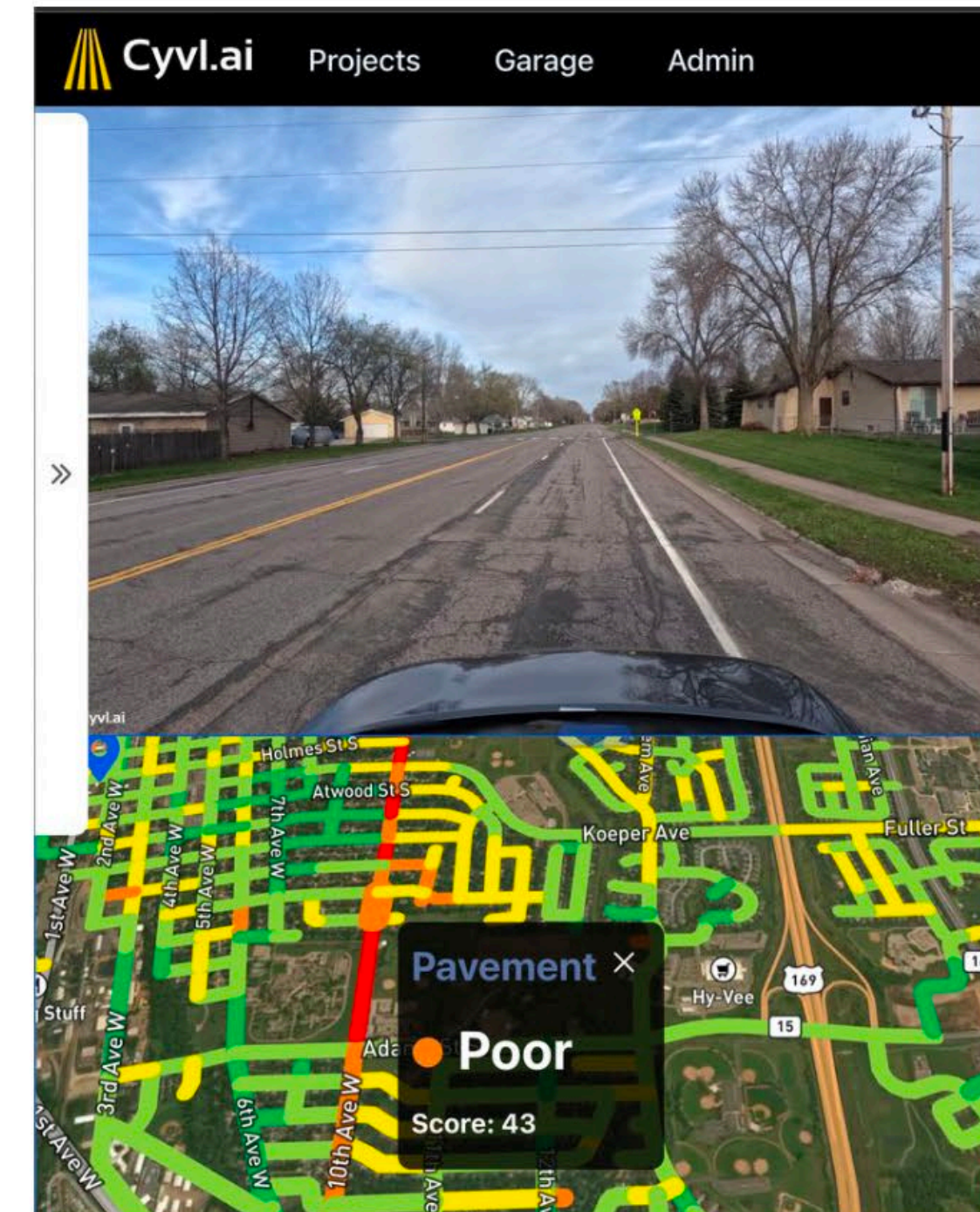
02

Our algorithms process the data and we perform QA/QC.



03

You receive high quality infrastructure reports quickly.



CYVL + Harris + Watsonville

- All stakeholders are innovative, forward thinking
- First CYVL projects mapping California roads
- First projects integrating CYVL data into StreetSaver as Pavement Management System
- **Key Takeaway:** different regions in US require different reporting techniques; what works in Tennessee might not work in California



Path Forward for Success in CA

- Continue to work with Harris to tune our AI models to ensure meeting distress identification requirements
- Collaborate with Harris + MTC to integrate CYVL data into StreetSaver seamlessly
- Scale up in CA to 1,000s of miles of pavements inspected by end of 2025



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- ✓ CYVL AI

Conclusion and Recommendations

90%



Advice to Engineering Service Providers

- Don't expect AI to print out a perfect answer
- Budget time for reviewing and calibrating the tool
- Monitor for the various challenges covered
- Be prepared to adjust your criteria
- Establish and routinely apply a QC plan
- Partner with the tech firm and involve the Public Agency/ Owner throughout the AI journey



Advice to Public Agencies



- Embrace emerging technologies.
- Choose consultants that support your vision.
- Provide feedback to consultants.
- Measure public benefits.

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