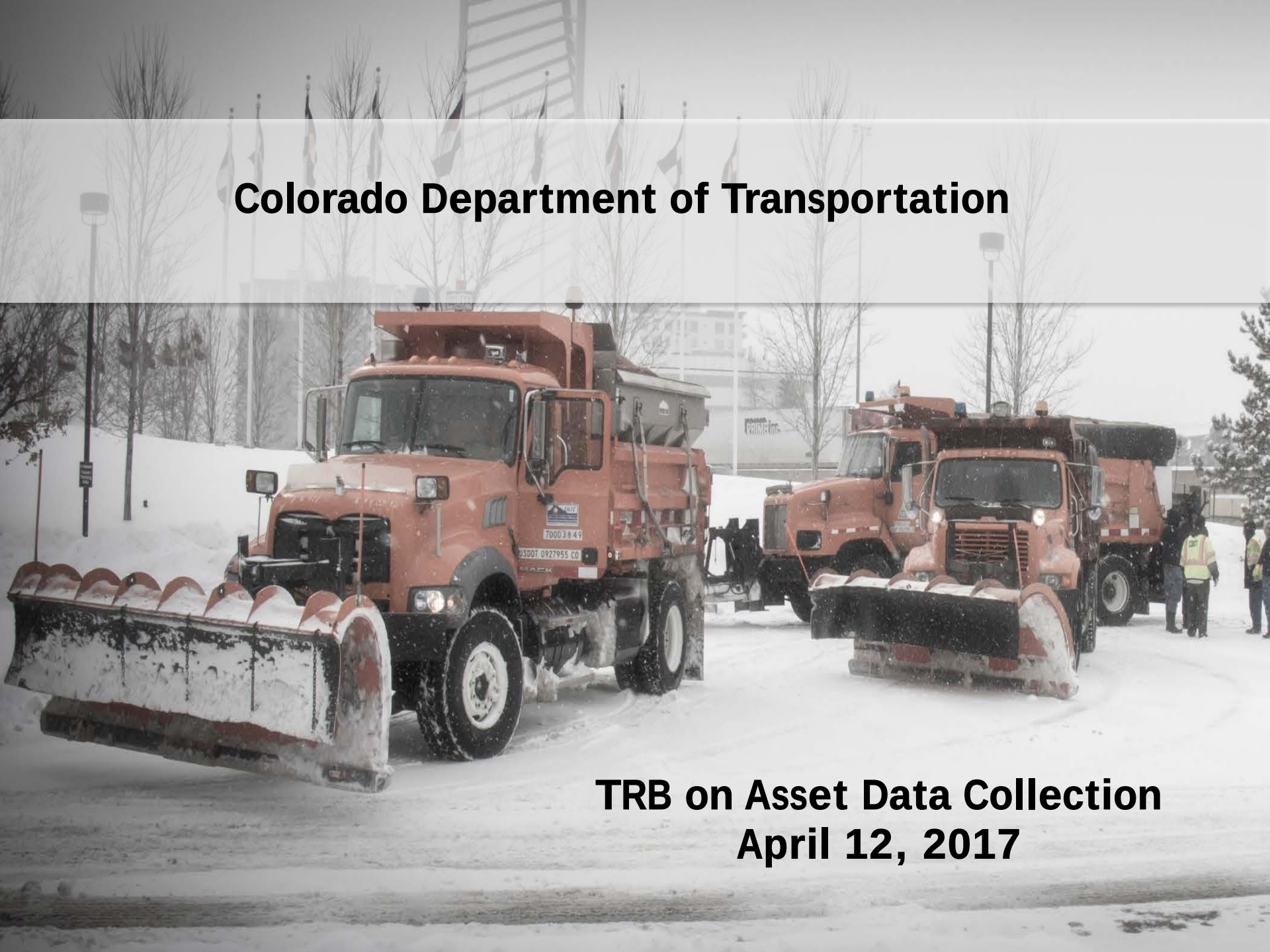
Colorado Department of Transportation



TRB on Asset Data Collection
April 12, 2017

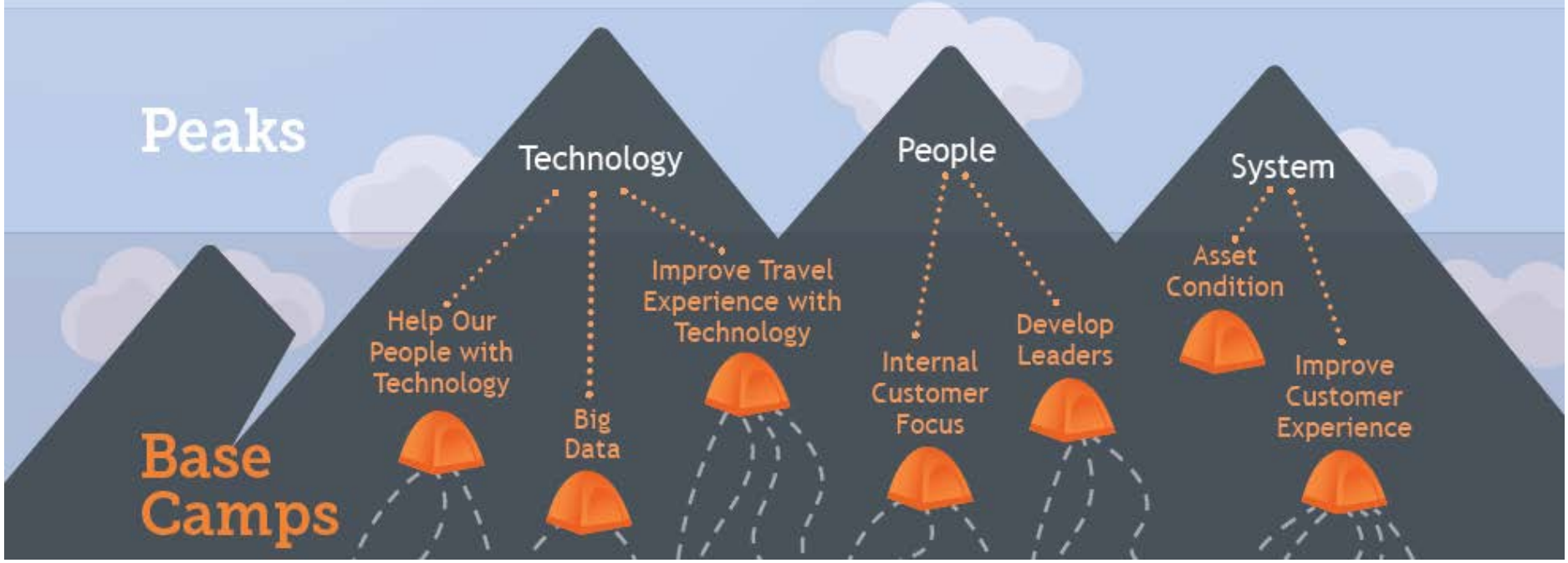
Introduction & Agenda

- CDOT Stats
- Colorado Risk Based Asset Management Plan and Trade-Off Analysis
- Maintenance Asset Management and Maintenance Levels of Service Program
- How CDOT-DHM is Collecting Data
- What Data is Being Collected
- Expanding Data Beyond Inventory and the future of Data Collection
- Further Discussion & Questions

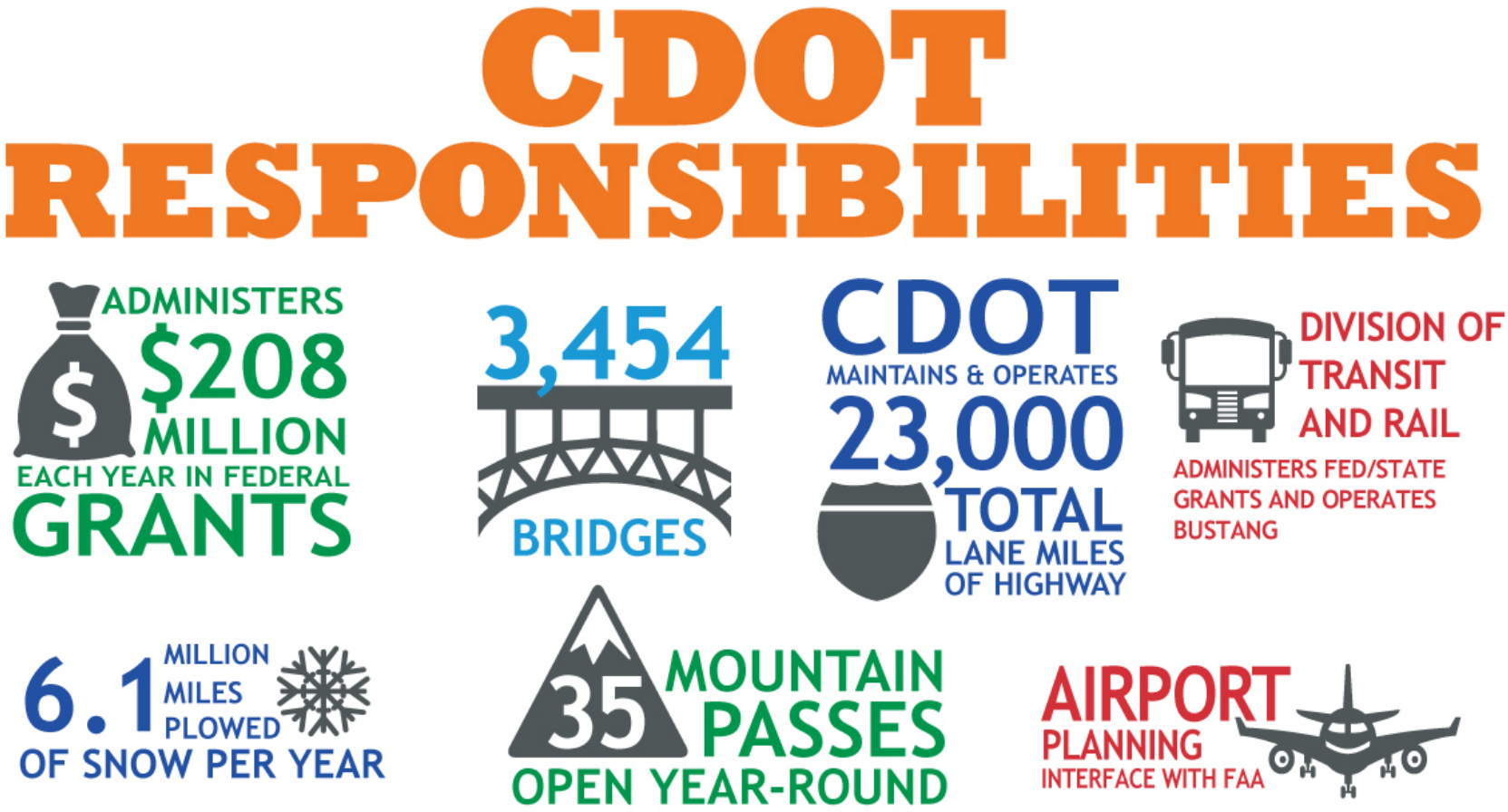
Purpose To save lives and make lives better by providing freedom, connection and experience through travel.

Values Safety, people, integrity, customer service, excellence and respect are at the heart of all that we do.

Summit The best DOT in the country for all customers by focusing on our people, leading-edge technology and a healthy multi-modal system.

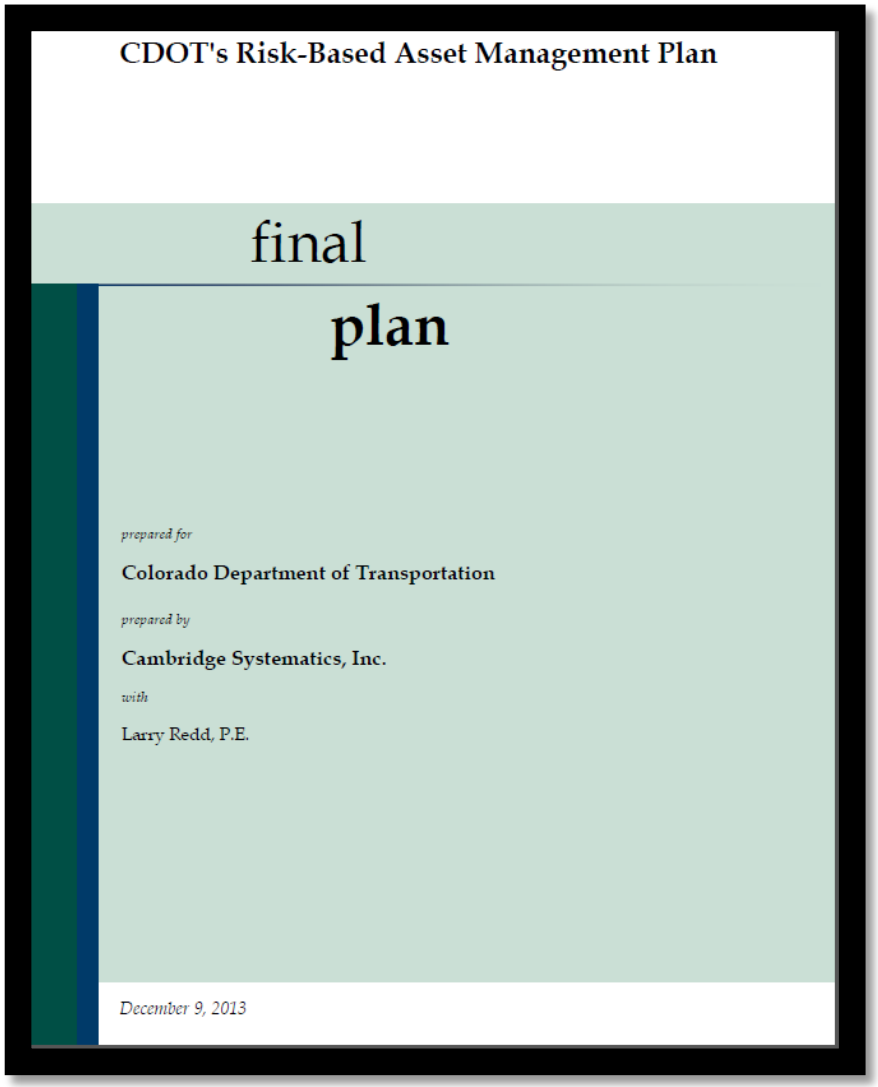


What Does CDOT Do?



Source: Colorado Department of Transportation, 2014

CDOT Asset Management
Risk Based Asset Management Plan



CDOT's Risk-Based Asset Management Plan

final

plan

prepared for

Colorado Department of Transportation

prepared by

Cambridge Systematics, Inc.

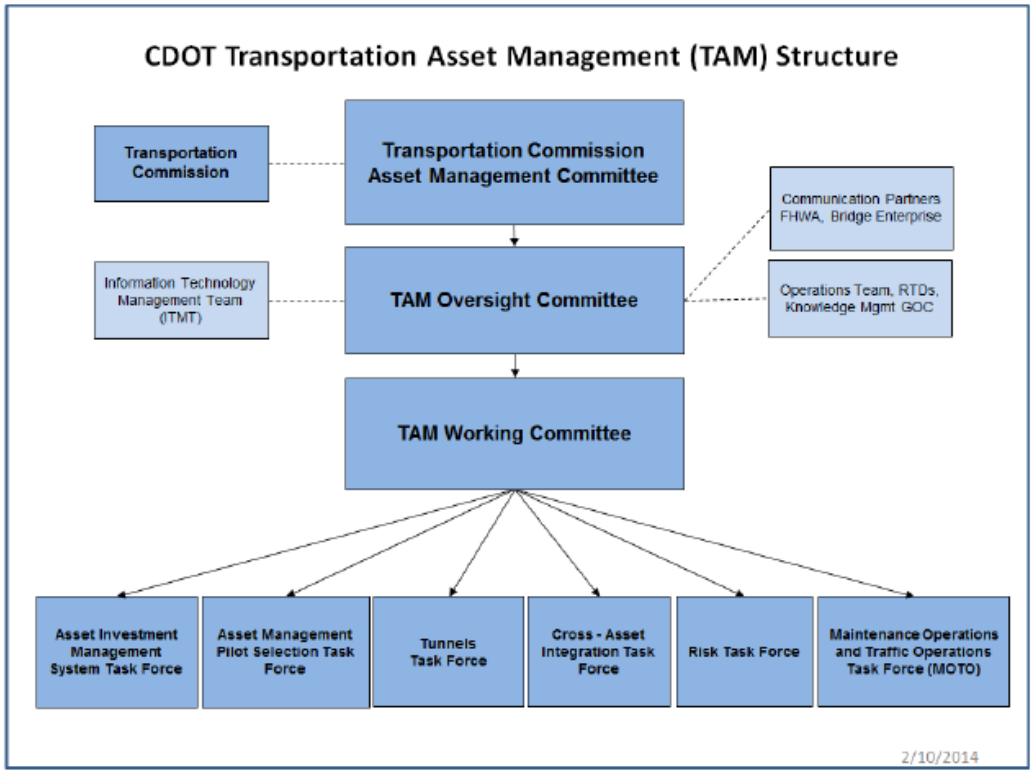
with

Larry Redd, P.E.

December 9, 2013

CDOT Asset Management
Asset Management Oversight Structure

Figure 5.1 CDOT Transportation Asset Management Organizational Structure



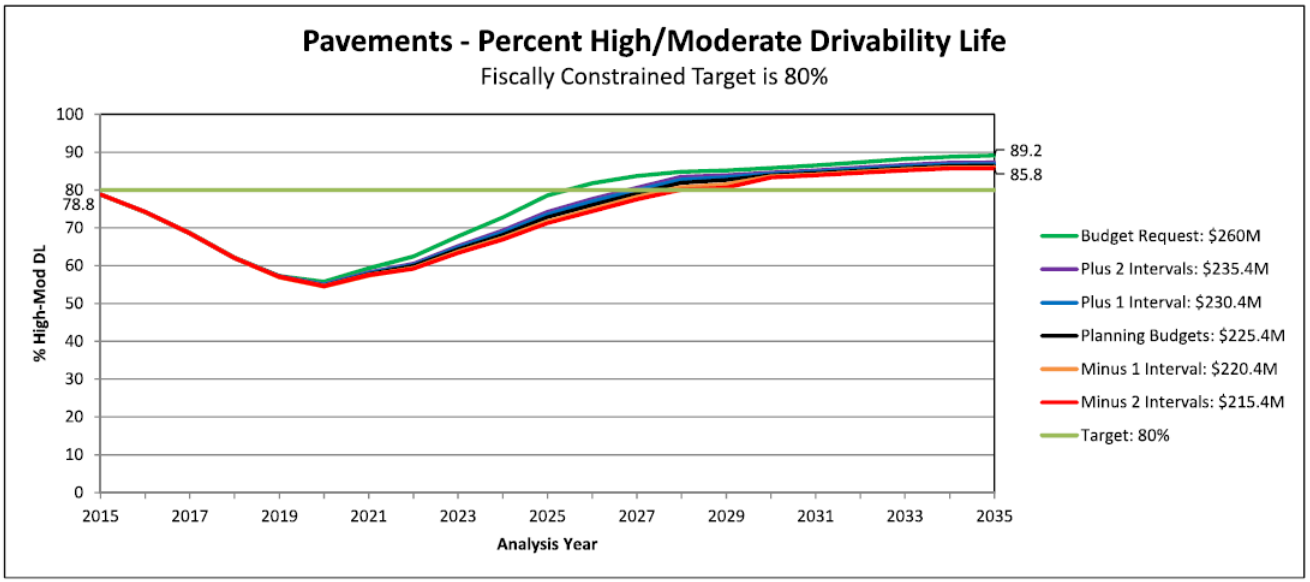
Source: CDOT

CDOT Risk Based Asset Management Plan

11 Asset Programs in CDOT's Risk Based Asset Management Plan

- MLOS
- Surface Treatment
- Bridge
- Signals
- ITS
- Rock Fall
- Equipment
- Property Management
- Culverts
- Tunnels
- Walls

AIMS Performance Curve



- AIMS Cross Asset FY20 Recommendation: $x Million
- FY20 Request: $260 Million

CDOT Asset Management
Asset Prioritization

Priority 1 – Treatments Plants, Route Segments, Maintenance Yards

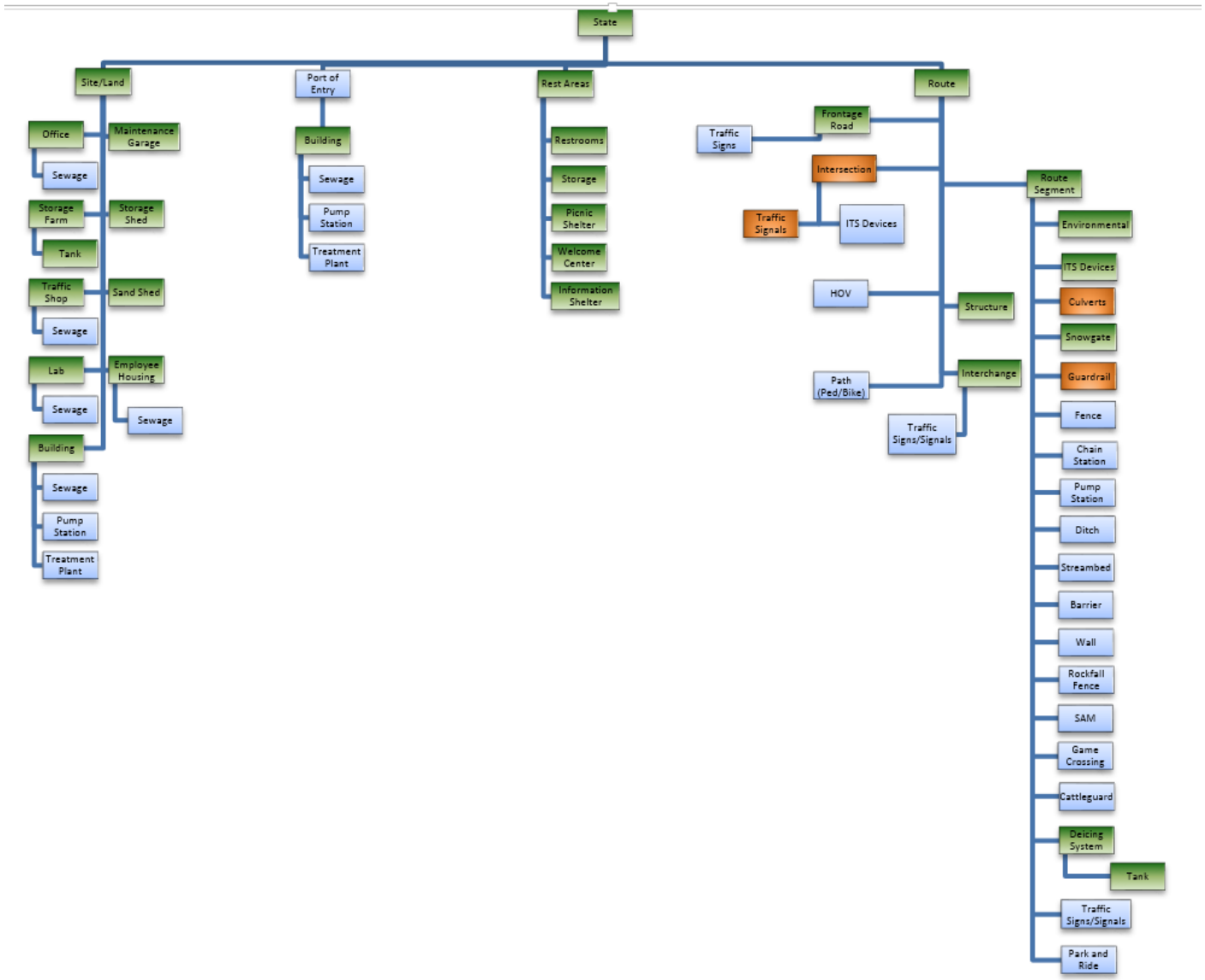
Priority 2 – Guardrails and End Treatments, Traffic Signals, Rock Fall Protection Devices, Traffic Controllers, Runaway Ramps, Fences, Drainage Structures, Walls, Culverts, Road Closure Gates

Priority 3 – Traffic Conflict Monitors, De-icing Systems, Traffic Signal Poles, Cabinets, Ports of Entry, Luminaires, Barriers, Drains, Rest Areas, Beacons, Weigh Stations

Priority 4 – Roadway Light Poles, Sewage, Sign Panels, Signs, Sign Posts, Noise Walls, Pavement Stencils, High Mast Lights, Slope Paving, Park-n-Rides, Ditches, Pump Stations, Bike Paths, Delineators

Priority 5 – Divided Highway Crossovers, Power Supply Connection Points, Curb Ramps, Sidewalks, Game Crossings, Streambeds in ROW, Blank Out Signs, Cattle Guards, In-ground Pull Boxes, Landscaping Acreage

Plant Maintenance Master Data Hierarchy

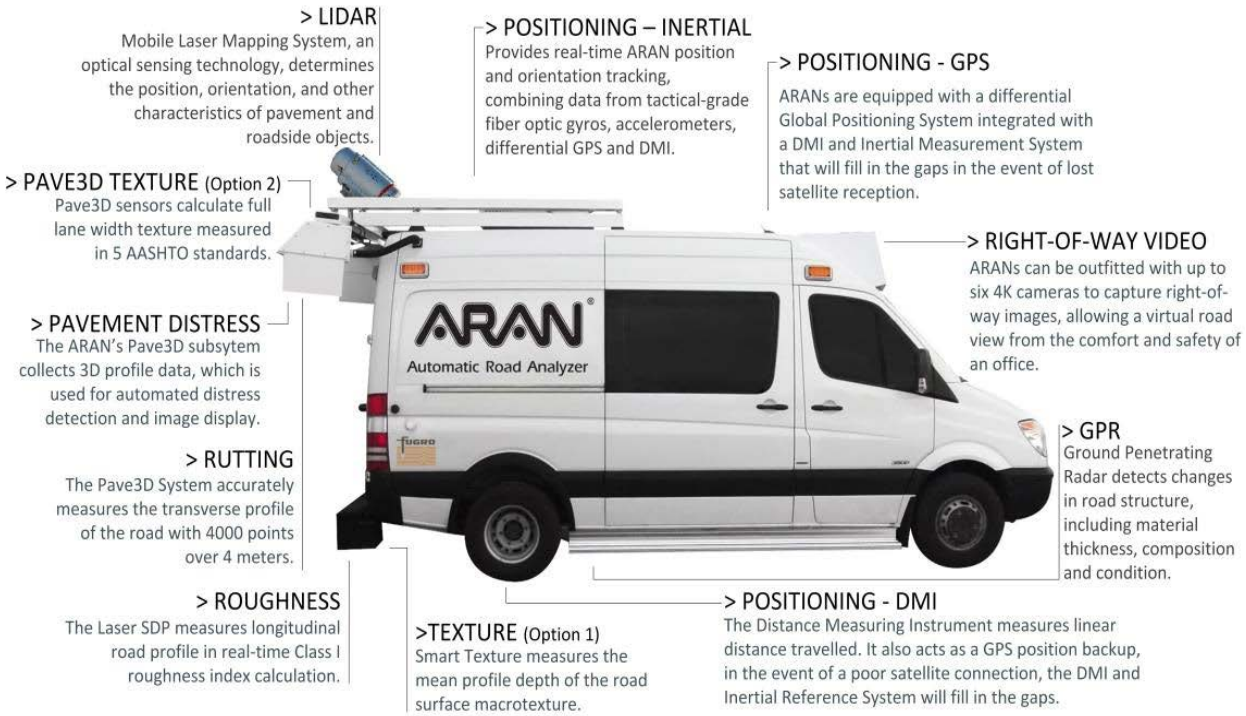


How are you collecting data?

- Collection Methods
  - Field – visit and collect using GPS, tools, and mobile devices
  - Remote – visual identification, measure, location

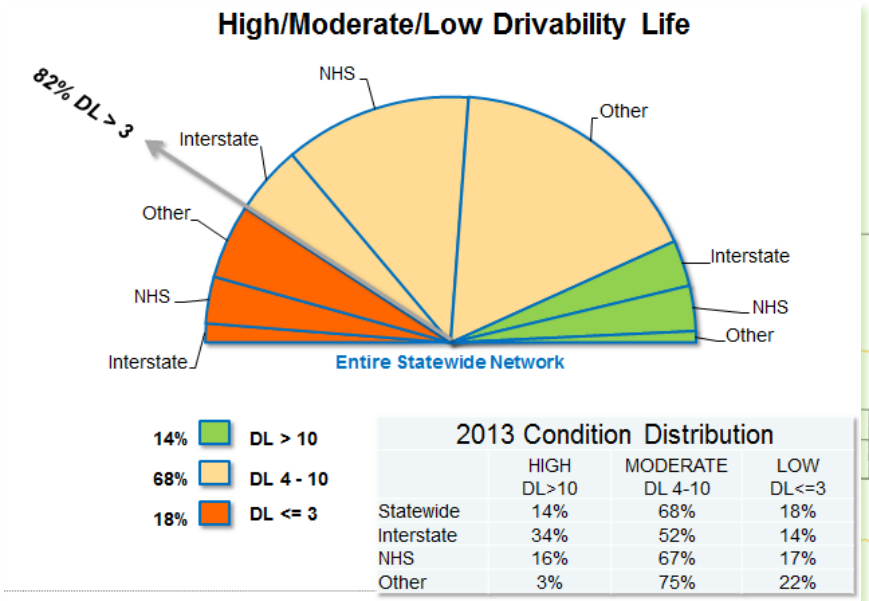
- Data Update
  - Maintenance employees
  - Regular inspections
  - Revisit every few years – build new inventory
  - Surveys and As-Built data

How is Data Collected?



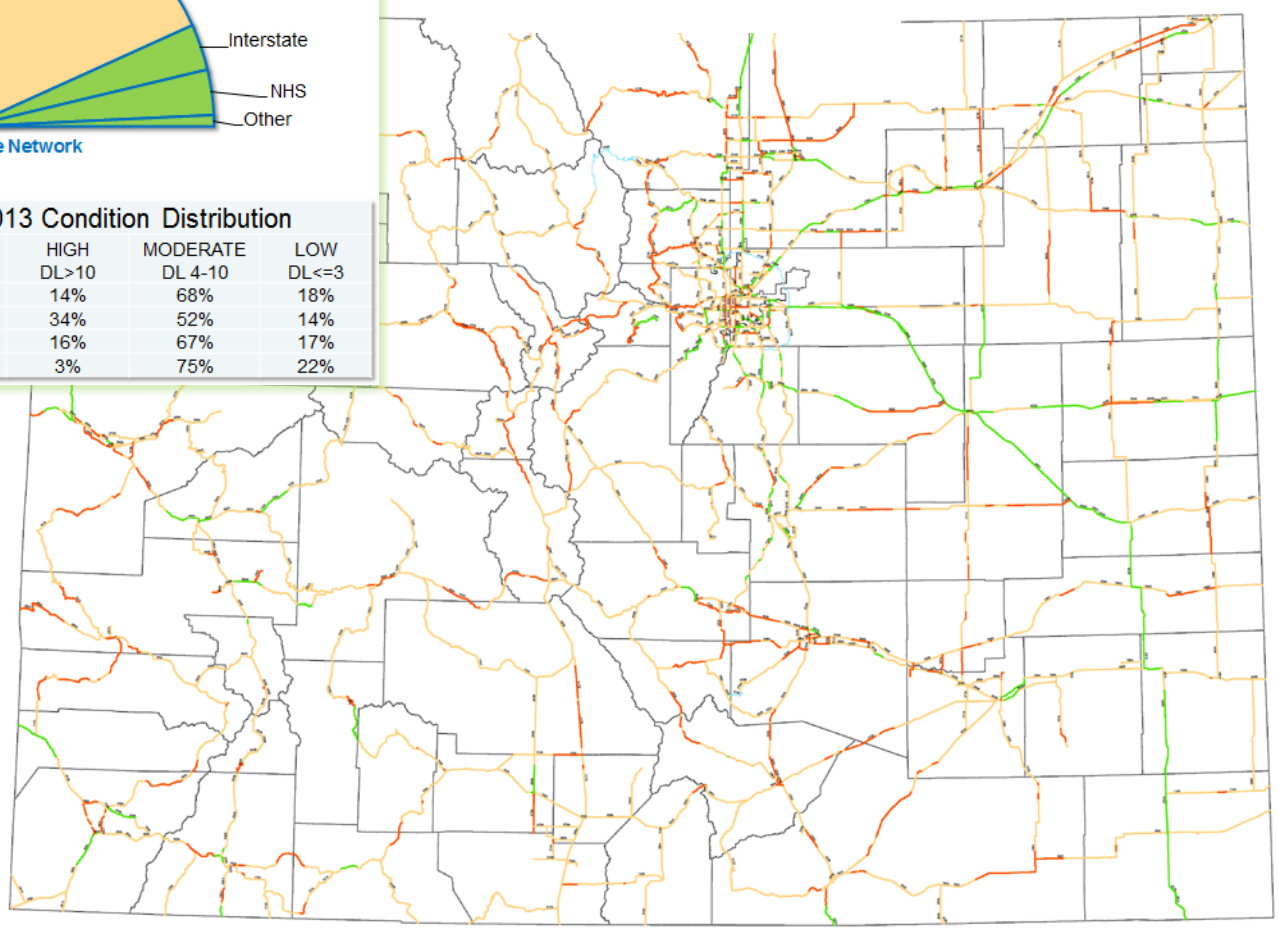
- **Two vans started collection in January and should complete collection by May**

Current Condition of Pavements



2013 Condition Distribution

	HIGH DL>10	MODERATE DL 4-10	LOW DL<=3
Statewide	14%	68%	18%
Interstate	34%	52%	14%
NHS	16%	67%	17%
Other	3%	75%	22%



Project Predictive Capabilities

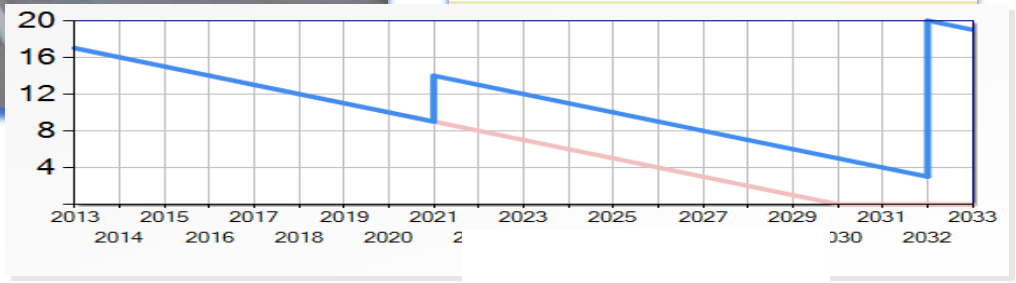
Example: Highway 076A, Milepost 35.9–40.5

- **2000 Concrete construction**
- **AADT = 11,000 AADT Combination Trucks = 1,634**
- **DL = 17 Years**

Recommendation:

2021 Preventive Maintenance $218,000 per mile

2032 Minor Rehab $870,000 per mile



Asset Condition Surveys
Maintenance and Staff Bridge

Bridge Condition Assessments

- Bridge inspections completed by Staff Bridge inspectors
- Inspection results entered into BrM
- All bridges inspected every 2 years
- Inspection results shared with Maintenance for performance-based budgeting
- Bridge rating scales defined by Staff Bridge
- Critical bridge repair list provided to Maintenance
- Manual data entry into SAP

Future Plans

- Create interface between SAP and BrM to:
  - Auto-populate inspection data
  - Automatically create notifications in SAP for critical bridge repairs
  - Eliminate manual data entry

CDOT Collaboration

Purpose of Project

- Annually collect roadway condition data and images for all state maintained highways and off-system NHS routes (roughly 12,000 miles a year)
- The condition data is used for federal reporting by Pavement Management and HPMS reporting
- Pavement Management uses data to calculate Drivability Life metric, maintenance calculations, and project selection
- Make pavement condition data and images available for all of CDOT and the public to use

Stakeholders

- Pavement Management
- Division of Transportation Development
  - Data Management Unit (HPMS)
  - GIS Support Unit (Imagery)
- Division of Highway Maintenance

Where Can You Find This Data?

CDOT Online Transportation Information System

This is the access point to information frequently used for transportation planning and project development. Information is provided on current and projected traffic volumes, state highway attributes, summary roadway statistics, demographics and geographic data.

What's new?

2016 roadway imagery and condition data now available in Windshield/Videolog

---

DRAPP 2016 aerial imagery now available in MapView (Internal Only)

MAP VIEW

View and query Colorado transportation data and related images and documents. Create customized maps.

HIGHWAY DATA

View highway features, traffic data, photos and documents. Export reports and data.

TRAFFIC DATA

Traffic Data Explorer displays traffic counts and statistics including AADT, Truck AADT and VMT.

DATA CATALOG

Search for spatial and tabular data, documents, metadata and glossary terms.

MAPS

View and download statewide and regional maps. View, download and order the Official Colorado Travel Map.

SL DIAGRAM

SLD (Straight Line Diagram) application displays selected highway features along the road displayed as a straight line and map.

WINDSHIELD

Videolog application that plays highway images as if viewed from the windshield of a vehicle.

REPORTS

View and download annual highway, county and city mileage, Truck statistics, Volume/Capacity and Demographic data.

YOUR CDOT $

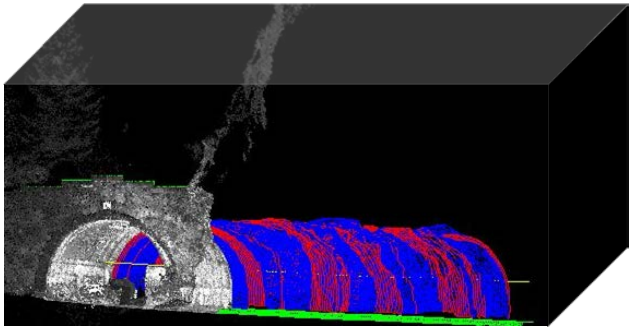
Your CDOT Dollar tracks CDOT performance and transportation expenditures.

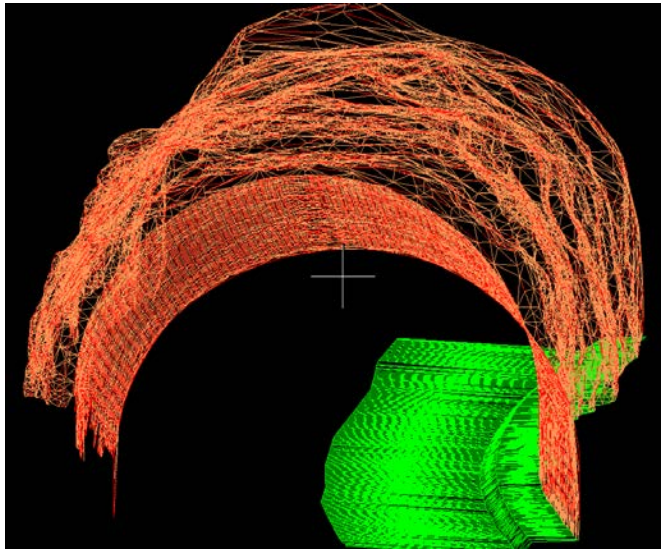
CDOT Tunnel Overview

- # of Vehicular Tunnels: 39 total
  - On-System 20 vehicular, 2 closed
  - Off- System 11 with 6 closed
- Types of Tunnels:
  - Rock Lined
  - Cast in Place Lined
  - Shotcrete Lined
- Max Elevation: 11,158 ft with avg snowfall of 380 inches
- Asset Valuation Efforts $1.8B

Plan of Action

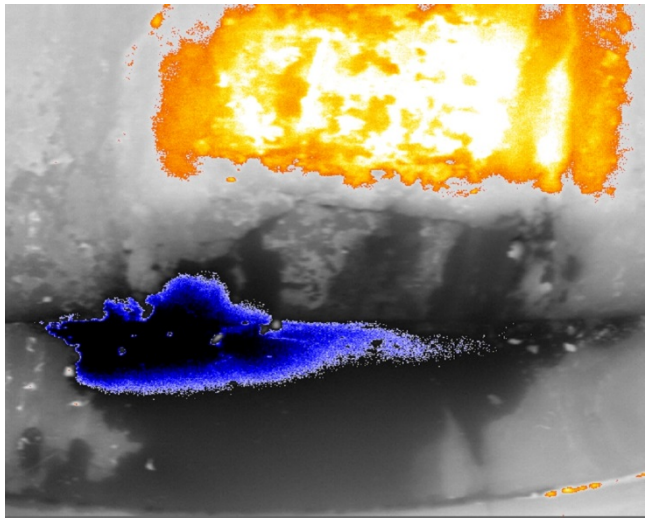
- Year 1
  - Figure out program
  - Implementation support meeting
  - Analyze different options
- Year 2
  - Implementation of NDT technique





Finding areas of interest and comparing to confirm effectiveness.

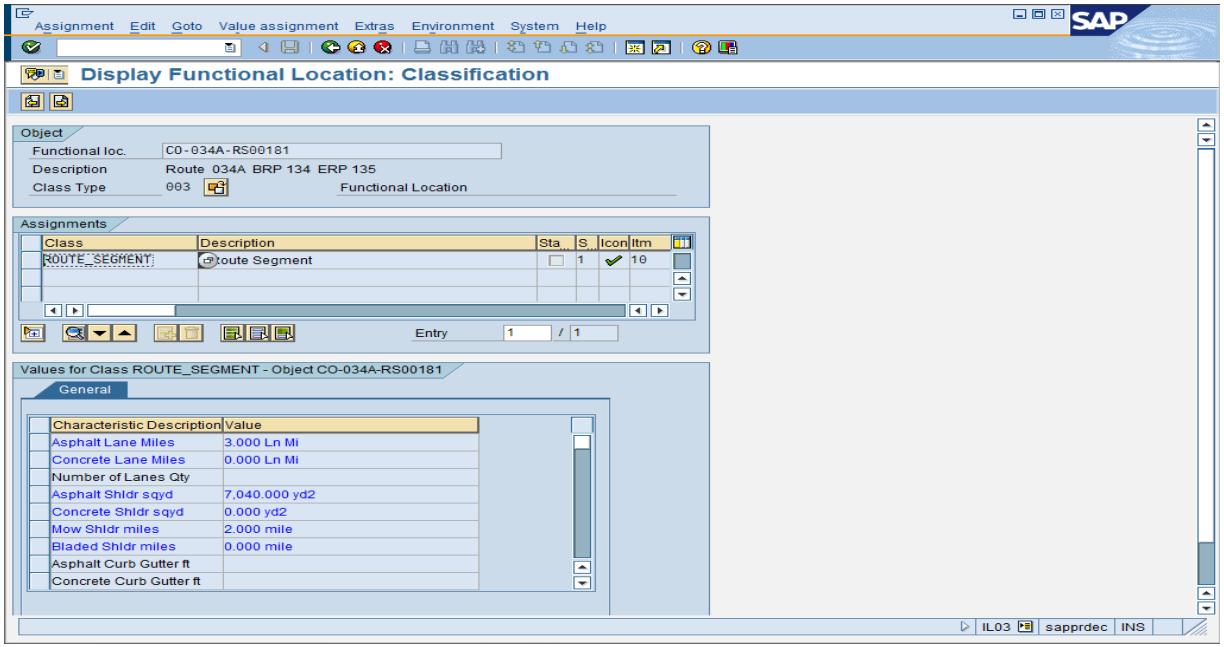
Thermal Image



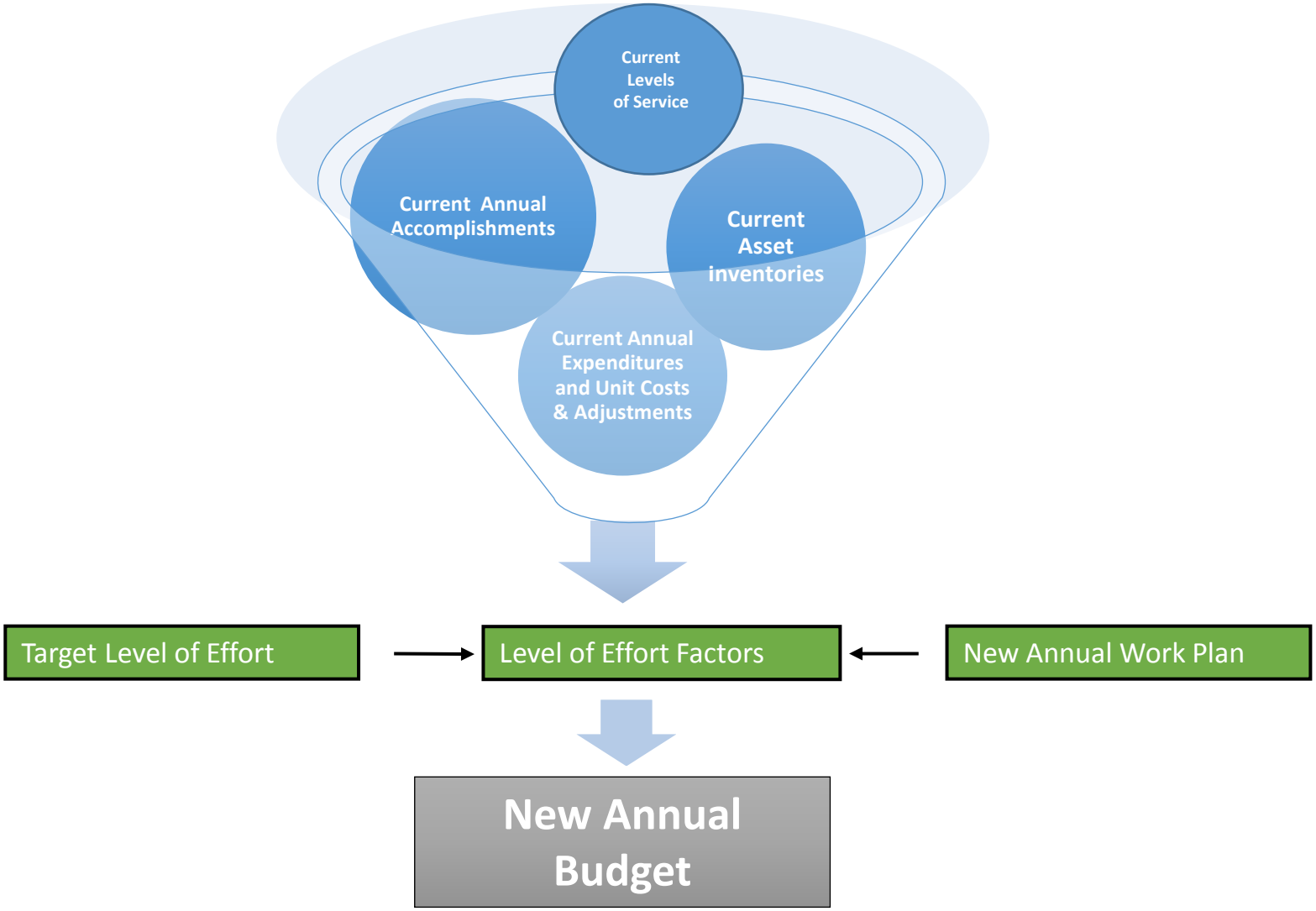
Actual Photo

SAP Plant Maintenance

- Maintenance section staff are also responsible for conducting periodic field inventories to ensure that a complete data inventory of maintainable roadway and roadside features (such as box culverts, curb and gutter, and lighting) is available.



Funding Maintenance: Elements of LOS-Based Funding



LOS-Based Budgeting, Percent of Total

- 6 of 9 MPA's included in the Budget Model that are performance-based and have sound performance data.
  - 150-Roadway Surface – 14%
  - 200-Roadside Facilities – 9%
  - 250-Roadside Appearance – 4%
  - 300-Traffic Services – 24%
  - 350-Structure Maintenance – 2%
  - 450-Buildings and Equipment – 7%
- 3 of the 9 MPA's do not have sound performance-based targets for this model
  - 100-Planning and Training – 6%
  - 400-Snow and Ice Removal – 30%
  - 500-Tunnels – 2%
- Managed Corridors – 1%

MLOS Performance Goals and Results

Maintenance Levels of Service by Program Area

Maintenance Program Area Description	Funding Needed for 'A' Rating	Budget FY2016-17 Funding	FY 2013-14 Budget	FY 2014-15 Actual	FY 2016-17 Projected
Planning, Training and Scheduling	$25.4M	15.9 M	C-	C	C-
Roadway Surfacing	$177.2M	$40.0 M	B+	B+	C+
Roadside Facilities	$41.7M	$22.3M	A-	B+	C
Roadside Appearance	$12.7M	$8.6M	B	B-	C
Traffic Services	$109.5M	$67.7M	C+	C+	C-
Bridges & Structures	$122.0M	$12.2M	B-	C+	C
Snow & Ice	$88.5M	$73.5M	B	B	B
Service Equipment, Buildings & Grounds	$25.1M	$15.7M	C+	B-	C-
Tunnels	$9.8M	$6.2M	C+	B-	C+
US 36 (mtc. contract)		$1.2 M			
OVERALL MLOS	$611.9M	$262.6M	B-	B-	C+

MLOS Actual Performance Trends

Overview-Condition Assessments

- There are 6 MLOS condition assessments conducted each year.
  - Roadway Surface Remote Data Collection
  - Bridge Inspections
  - Winter (October through March) – snow and ice control
  - Night Inspections
  - Summer (Last week of June) – all infrastructure
  - Buildings, Grounds and Rest Areas
- Winter surveys are conducted by all employees during storms.
- Night inspections are conducted quarterly starting in July. All assets that reflect or give off light are assessed.
- Summer surveys are conducted by 8 survey teams outside their own maintenance section.
- Buildings, grounds and rest areas assessments conducted by Property Management.

Condition Assessments

- Creating a more objective condition data model
  - Using quarterly night-inspection for specific assets
  - Leveraging Pavement Management condition data and allowing Pavement Management to define levels of service rating scales
  - Measuring sample length/quantity vs. deficiency in sample

Asset Condition Surveys
Maintenance and Surface Treatment

Condition Assessments by CDOT Staff

- Annual pavement condition data collection by Maintenance employees
- Random survey locations, assessing 3/10th of a mile for pavement defects
- Subjective ratings
- Manual data entry into the SAP system
- Safety concerns having employees in right-of-way

Remote Condition Data Collection

- Annual pavement condition data collection as part of the Long-Term Pavement Performance (LTPP) program
- 100% pavement condition collected
- Leveraging IRI, rutting and photo images for
    - Longitudinal cracking
    - Transverse cracking
    - Fatigue cracking
    - Rut depth
    - Faulting
    - Potholes

Winter Condition Surveys

Winter Condition Assessments

- Time to bare pavement after snow fall ends
- Grading scales differ based on highway category
- All maintenance employees plowing provide time to bare pavement data
- Data used to populate Snow LOS Map

Time to 95% Bare Pavement for your category of road, from the end of the storm: (if your road never became covered or snow packed during the storm, check the first box for your category road)

Category 1	Category 2	Category 3	Category 4	Category 5
☐ Bare Pvmt Maint	☐ Bare Pvmt Maint	☐ < 2 Hours	☐ Bare Pvmt Maint	☐ < 2 Hours
☐ < 1 Hour	☐ < 2 Hours	☐ < 4 Hours	☐ < 2 Hours	☐ < 4 Hours
☐ < 2 Hours	☐ < 4 Hours	☐ < 6 Hours	☐ < 4 Hours	☐ < 6 Hours
☐ < 3 Hours	☐ < 6 Hours	☐ < 8 Hours	☐ < 6 Hours	☐ < 8 Hours
☐ > 3 Hours	☐ > 6 Hours	☐ > 8 Hours	☐ > 6 Hours	☐ > 8 Hours

Category 6	Category 7	Category 8	Category 9	Category 10
☐ < 4 Hours	☐ < 2 Hours	☐ < 4 Hours	☐ < 6 Hours	☐ < 8 Hours
☐ < 6 Hours	☐ < 4 Hours	☐ < 6 Hours	☐ < 8 Hours	☐ < 24 Hours
☐ < 12 Hours	☐ < 6 Hours	☐ < 12 Hours	☐ <16 Hours	☐ < 48 Hours
☐ < 16 Hours	☐ < 8 Hours	☐ < 16 Hours	☐ < 24 Hours	☐ < 72 Hours
☐ > 16 Hours	☐ > 8 Hours	☐ > 16 Hours	☐ > 24 Hours	☐ > 72 Hours

HIGHWAY CATEGORY DESIGNATIONS

Category 1	Interstate, > 75,000 ADT
Category 2	Interstate, 15,000 – 75,000 ADT
Category 3	Interstate, < 15,000 ADT
Category 4	NHS, > 75,000 ADT
Category 5	NHS, 15,000 – 75,000 ADT
Category 6	NHS, < 15,000 ADT
Category 7	Other, > 50,000 ADT
Category 8	Other, 5,000 – 50,000 ADT
Category 9	Other < 5,000 ADT
Category 10	Mountain Passes (Non-Interstate)
Category 11	Seasonal Highways (Mt. Evans and Independence Pass) (No survey on Cat 11 highways for winter maintenance)

Expanding Data Beyond Inventory
Winter Condition Surveys

MPA: Snow and Ice Control

Illustrations	LOS	Description
LOS A 	A	Plowing and chemicals or abrasives applications proactively maintain very high levels of mobility throughout storms (refer to accompanying tables). Snow drifts and localized ice patches are treated quickly to avoid closures and hazards. Proactive avalanche control minimizes traffic interruptions and avoids unanticipated road closures.
LOS B 	B	Plowing and abrasives or chemicals applications maintain high levels of mobility as much as possible (refer to accompanying tables). Snow drifts and localized ice patches may be treated during storm with abrasives or chemicals. Proactive avalanche control minimizes traffic interruptions and avoids unanticipated road closures.
LOS C 	C	Plowing and abrasives or chemicals applications maintain good levels of mobility on high-standard roads (refer to accompanying tables). Snow drifts and localized ice patches are treated as soon as possible at end of storm. Avalanche control focuses on high-priority locations and situations.
LOS D 	D	Plowing and abrasives or chemicals applications are performed on limited basis, and some traffic delays are anticipated on all roads (refer to accompanying tables). Snow drifts and localized ice patches are treated after mainline roads are cleared. Limited avalanche control is performed. Chain station operation may be scaled back.
Living Snow Fence 	F	Plowing and abrasives or chemicals applications are performed on very limited basis, impairing mobility on all roads (refer to accompanying tables). Snow drifts and localized ice patches may not be treated for some time. No preventive avalanche control is performed. Chain station operations are scaled back or suspended.

Expanding Data Beyond Inventory
Winter Snow Map

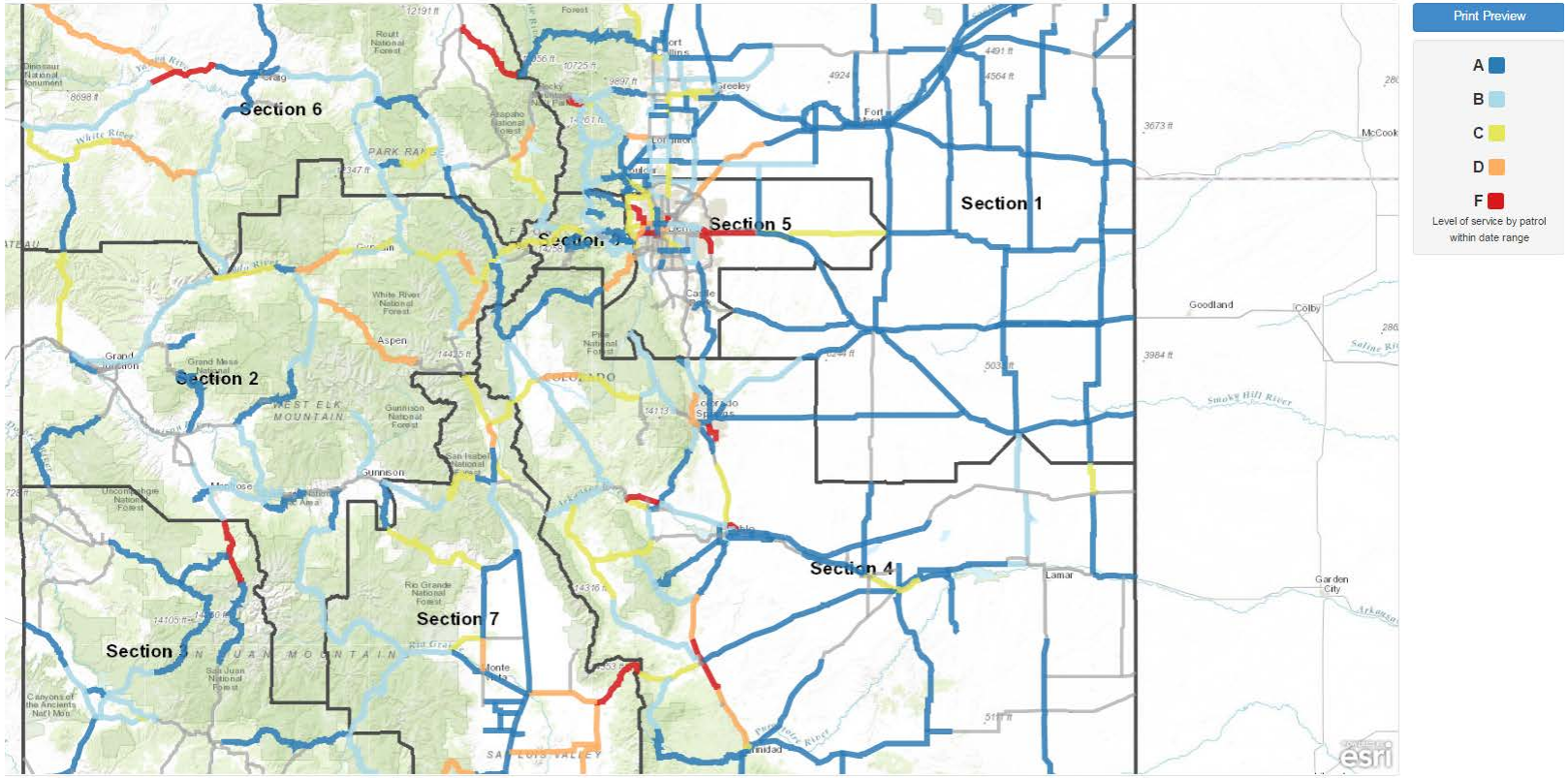
Section 1 Section 2 Section 3 Section 4 Section 5 Section 6 Section 7 Section 9 Disclaimer

12/16/2016

Statewide LOS

B

		LOS		LOS		LOS		LOS		LOS
Region	1	B-	2	B	3	B-	4	A-	5	B
Sections	5	C	4	B	2	B-	1	A-	3	B+
	9	B			6	B-			7	B



Expanding Data Beyond Inventory Maintenance Night Inspections

Current Process

Night Inspection Form

Patrol No.	Route:	Begin MP:	End MP:	Date	Survey Team:
68	25A	94.769	102.161	9/26/2016	TM II Tom Coffield TM I Kenny Vialpando

Roadway Elements

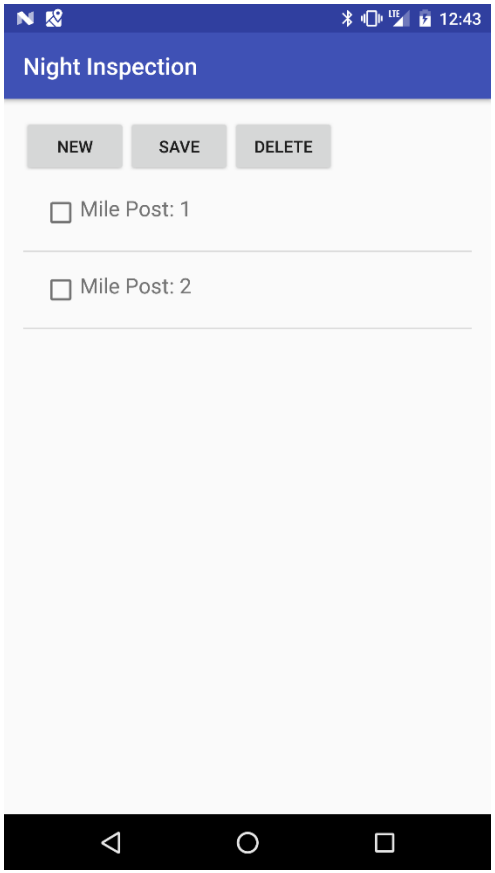
Mile Post	Delineators	Guardrail Delineators	Signs	Roadway Lighting	Tunnel Lights	Flashing Beacons	Shoulder Line Visibility	Center Line Visibility	Stencil Visibility	Road Closure Gates
96.3 n/b 100.1 n/b 101.5 s/b	☐ post ☐ button ☐ reflectivity	☐ damaged ☐ reflectivity ☒ end treatment	☐ missing ☐ reflectivity ☐ damaged ☐ multi post	☐ missing ☐ out ☐ damaged quantity:	☐ missing ☐ out ☐ damaged quantity:	☐ missing ☐ out ☐ damaged	☐ good ☐ fair ☐ poor	☐ good ☐ fair ☐ poor	☐ good ☐ fair ☐ poor	☐ luminaire function ☐ reflectivity
95.7 n/b 99.8 n/b 100 n/b fr	☐ post ☐ button ☐ reflectivity	☐ damaged ☐ reflectivity ☐ end treatment	☐ missing ☒ reflectivity ☐ damaged ☐ multi post	☐ missing ☐ out ☐ damaged quantity:	☐ missing ☐ out ☐ damaged quantity:	☐ missing ☐ out ☐ damaged	☐ good ☐ fair ☐ poor	☐ good ☐ fair ☐ poor	☐ good ☐ fair ☐ poor	☐ luminaire function ☐ reflectivity
94.769 102.161	☐ post ☐ button ☐ reflectivity	☐ damaged ☐ reflectivity ☐ end treatment	☐ missing ☐ reflectivity ☐ damaged ☐ multi post	☐ missing ☒ out ☐ damaged quantity:	☐ missing ☐ out ☐ damaged quantity:	☐ missing ☐ out ☐ damaged	☐ good ☐ fair ☐ poor	☐ good ☐ fair ☐ poor	☐ good ☐ fair ☐ poor	☐ luminaire function ☐ reflectivity
	☐ post ☐ button ☐ reflectivity	☐ damaged ☐ reflectivity ☐ end treatment	☐ missing ☐ reflectivity ☐ damaged ☐ multi post	☐ missing ☐ out ☐ damaged quantity:	☐ missing ☐ out ☐ damaged quantity:	☐ missing ☐ out ☐ damaged	☐ good ☐ fair ☐ poor	☐ good ☐ fair ☐ poor	☐ good ☐ fair ☐ poor	☐ luminaire function ☐ reflectivity
	☐ post ☐ button ☐ reflectivity	☐ damaged ☐ reflectivity ☐ end treatment	☐ missing ☐ reflectivity ☐ damaged ☐ multi post	☐ missing ☐ out ☐ damaged quantity:	☐ missing ☐ out ☐ damaged quantity:	☐ missing ☐ out ☐ damaged	☐ good ☐ fair ☐ poor	☐ good ☐ fair ☐ poor	☐ good ☐ fair ☐ poor	☐ luminaire function ☐ reflectivity

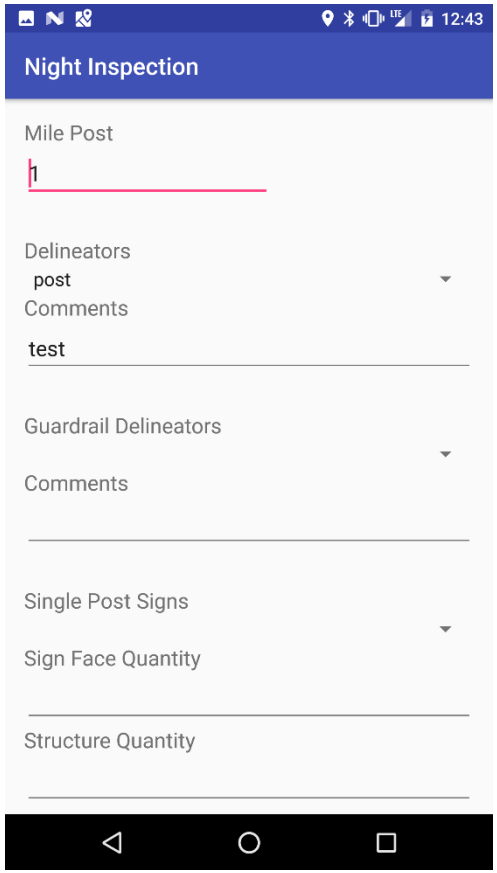
Comments

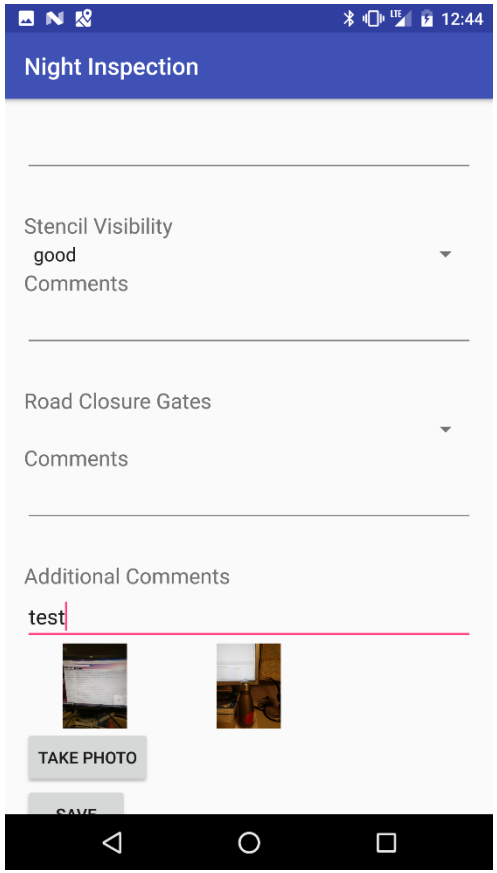
Please include the mile post(s) and asset you are referring to in your comments.	Guardrail end treatments stickers need replaced	Hospital sign needs replaced exit adv speed 30 chevron 26 lights out along interstate					

Expanding Data Beyond Inventory Maintenance Night Inspections

Future Process







Expanding Data Beyond Inventory Maintenance Summer Surveys

Over 800 1/10th mile random survey locations

- Boots on the ground assessments of:
  - Shoulder drop-offs
  - Drop inlets and catch basins
  - Pipes and culverts
  - Ditches and streambeds
  - Slopes
  - Fence, gates and cattle guards
  - Snow fence
  - Retaining walls
  - Litter and debris
  - Roadway sweeping
  - Mowing and vegetation
  - Brush and trees
  - Signs
  - Delineators
  - Metal guardrail
  - Concrete guardrail
  - Cable guardrail
  - End Treatments
  - Impact attenuators
  - Roadway lighting

How Ratings are Set: Condition Assessment Surveys

DROP INLETS/CATCH BASINS – STRUCTURE

BUDGETED ACTIVITY DESCRIPTION: 202 – DROP INLETS/CATCH BASINS REPAIR OR REPLACE

Installing, replacing, or repairing, of drop inlets, manholes, underground structures and gabion catch basins.

Rating Indicator:	Drop inlets or catch basins are deteriorated, chipped, or damaged, or there is an abrupt change in surface elevation adjacent to the structure that is beyond designed use and creates a hazard for the traveling public.
Outcome Measure:	Number of damaged or deficient drop inlets/catch basins (DICB).
Outcome Unit:	% Deficient: (100 * No. of Deficient DICB/ Total No. of DICB)

NOTES

Functional

Deficient

Grade	Percent Deficient
A+	.167
A	.5
A-	.833
B+	1.333
B	2
B-	2.667
C+	3.333
C	4
C-	4.667
D+	5.833
D	7.5
D-	9.167
F	10

- Specific questions and measurements are made for each asset
- Survey over 800 randomly selected 1/10th mile road segments every year

2016 Summer Survey for 070A 158.000
2016 Summer Survey for 070B 10.820
2016 Summer Survey for 009D 109.000
2016 Summer Survey for 071C 51.000
2016 Summer Survey for 141A 5.000
2016 Summer Survey for 025A 39.010
2016 Summer Survey for 040B 270.000
2016 Summer Survey for 002A 3.420
2016 Summer Survey for 002A 9.830
2016 Summer Survey for 002B 11.490
2016 Summer Survey for 002C 15.430
2016 Summer Survey for 006G 279.210
2016 Summer Survey for 006G 281.260
2016 Summer Survey for 006G 274.770
2016 Summer Survey for 006G 276.180
2016 Summer Survey for 006G 282.490
2016 Summer Survey for 006H 295.120
2016 Summer Survey for 006H 295.870
2016 Summer Survey for 007D 64.920
2016 Summer Survey for 007D 75.960
2016 Summer Survey for 008A 3.380
2016 Summer Survey for 022A 1.970
2016 Summer Survey for 025A 203.190
2016 Summer Survey for 025A 167.590
2016 Summer Survey for 025A 174.940
2016 Summer Survey for 025A 187.640

LOS Target Setting Results – Traffic Services Example

2017	Statewide	MAINTENANCE WORK PROGRAM AND BUDGET						Annual Budget (For LOS-Rated Assets Only)				
Asset Group	Asset Feature	Current LOS	Target LOS	Target FY	Yrs to Target	Activity	Description	Labor	Equipment	Materials	Other	Total
300 - Traffic Services	Traffic Signs	B+	B+	2018	1	302	Single Post Signs - Install Mtce Replace	2,473,308	853,564	1,300,914	5,965	$ 4,633,751
						303	Multi Post Signs - Install Mtce Replace	526,925	232,434	389,083	1,284,050	$ 2,432,493
								$ 3,000,233	**$ 1,085,998**	**$ 1,689,997**	**$ 1,290,015**	$ 7,066,244
	Delineators, Mile Markers	A	B+	2018	1	304	Delineator Post Install Mtce & Replace	2,330,534	747,779	710,425	836	$ 3,789,574
								$ 2,330,534	**$ 747,779**	**$ 710,425**	**$ 836**	$ 3,789,574
	Metal Guardrail	A-	B+	2018	1	306	Metal Guard Rail Mtce Install Straighten	1,421,167	469,439	951,999	96,658	$ 2,939,263
								$ 1,421,167	**$ 469,439**	**$ 951,999**	**$ 96,658**	$ 2,939,263
	Concrete Guardrail	A-	B+	2018	1	307	Concrete Rail Mtce & Installation	56,109	32,317	40,883	65	$ 129,374
								$ 56,109	**$ 32,317**	**$ 40,883**	**$ 65**	$ 129,374
	Cable Guardrail	A-	B+	2018	1	305	Cable Rail Mtce Install & Repair	424,824	110,808	678,899	-	$ 1,214,531
								$ 424,824	**$ 110,808**	**$ 678,899**	**$ -**	$ 1,214,531
	Striping	D	C	2020	3	308	Pavement Striping - Machine	2,226,023	1,714,503	14,304,588	9,375,425	$ 27,620,540
								$ 2,226,023	**$ 1,714,503**	**$ 14,304,588**	**$ 9,375,425**	$ 27,620,540
	Markings	D-	C	2018	1	310	Pavement Marking/Removal - Hand Machine	598,120	309,815	1,402,237	4,975,982	$ 7,286,153
								$ 598,120	**$ 309,815**	**$ 1,402,237**	**$ 4,975,982**	$ 7,286,153
	Lighting	A+	C	2018	1	312	Roadway & Sign Lighting	636,581	359,569	1,360,141	10,035	$ 2,366,326
								$ 636,581	**$ 359,569**	**$ 1,360,141**	**$ 10,035**	$ 2,366,326
	Traffic Signals	A-	C+	2018	1	314	Traffic Signal Mtce & Repair	881,836	626,974	2,659,984	918,773	$ 5,087,567
						326	Traffic Signal Interconnect Systems	167,708	73,568	1,451,364	-	$ 1,692,640
								$ 1,049,544	**$ 700,542**	**$ 4,111,348**	**$ 918,773**	$ 6,780,207
	Energy Attenuators	A	A	2018	1	316	Energy Attenuator Mtce	198,384	66,360	906,946	-	$ 1,171,690
								$ 198,384	**$ 66,360**	**$ 906,946**	**$ -**	$ 1,171,690
	Electrical Systems, Wires	A	B	2018	1	320	Electrical Wiring - Refurb & Mtce	600,165	153,424	143,037	-	$ 896,625
								$ 600,165	**$ 153,424**	**$ 143,037**	**$ -**	$ 896,625
	ITS Equipment	A	B	2018	1	321	Intelligent Transport Systems	75,823	8,765	22,652	-	$ 107,239
								$ 75,823	**$ 8,765**	**$ 22,652**	**$ -**	$ 107,239
	MPA 300 Summary	C+	C+					**$ 12,617,508**	**$ 5,759,320**	**$ 26,323,152**	**$ 16,667,787**	**$ 61,367,766**

Striping Example

2017	Statewide	MAINTENANCE WORK PROGRAM AND BUDGET						Annual Budget (For LOS-Rated Assets Only)				
Asset Group	Asset Feature	Current LOS	Target LOS	Target FY	Yrs to Target	Activity	Description	Labor	Equipment	Materials	Other	Total
	Striping	D	C	2020	3	308	Pavement Striping - Machine	2,226,023	1,714,503	14,304,588	9,375,425	$ 27,620,540
								$ 2,226,023	$ 1,714,503	$ 14,304,588	$ 9,375,425	$ 27,620,540

3 Year Target

LOS Target	Labor	Equipment	Materials	Other	Total
C-	$2,017,634	$1,586,704	$13,397,427	$8,794,257	**$25,796,022**
C	$2,226,023	$1,714,503	$14,304,588	$9,375,425	**$27,620,540**
C+	$2,434,413	$1,842,302	$15,211,750	$9,956,593	**$29,445,058**
B-	$2,642,802	$1,970,101	$16,118,912	$10,537,761	**$31,269,576**

1 Year Target

LOS Target	Labor	Equipment	Materials	Other	Total
C-	$2,968,172	$2,141,155	$17,725,403	$12,131,536	**$34,966,266**
C	$3,593,340	$2,524,551	$20,446,888	$13,875,041	**$40,439,820**
C+	$4,218,509	$2,907,948	$23,168,373	$15,618,545	**$45,913,375**
B-	$4,843,677	$3,291,345	$25,889,858	$17,362,050	**$51,386,930**

Current Data Collection Efforts – Culverts and Walls

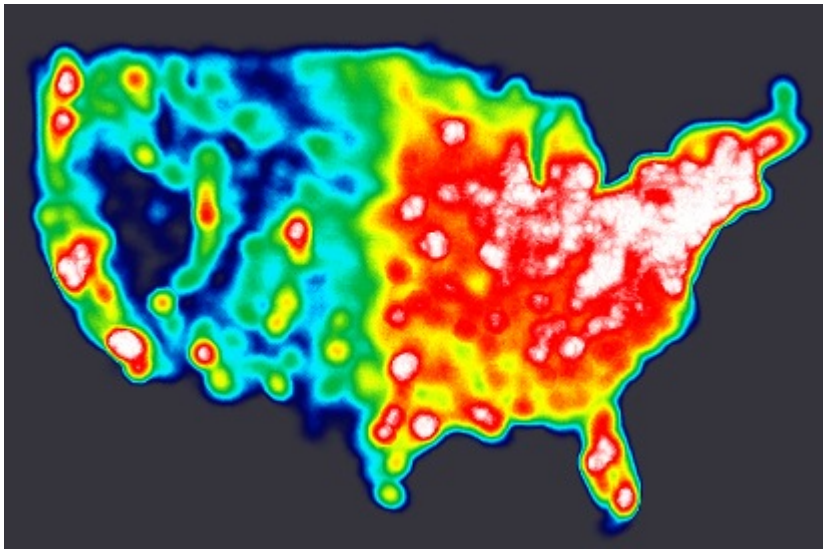
- Boots on the ground
  - Maintenance Crews
  - Trimble Juno Handheld units
  - Collected data on culverts:
    Type, orientation, inlet/outlet type, culvert material, length, height, width, diameter, latitude/longitude coordinates, location
  - Collected data on walls:
    Type, location, latitude/longitude, use, material, orientation, height, length, condition

Future of Data Collection

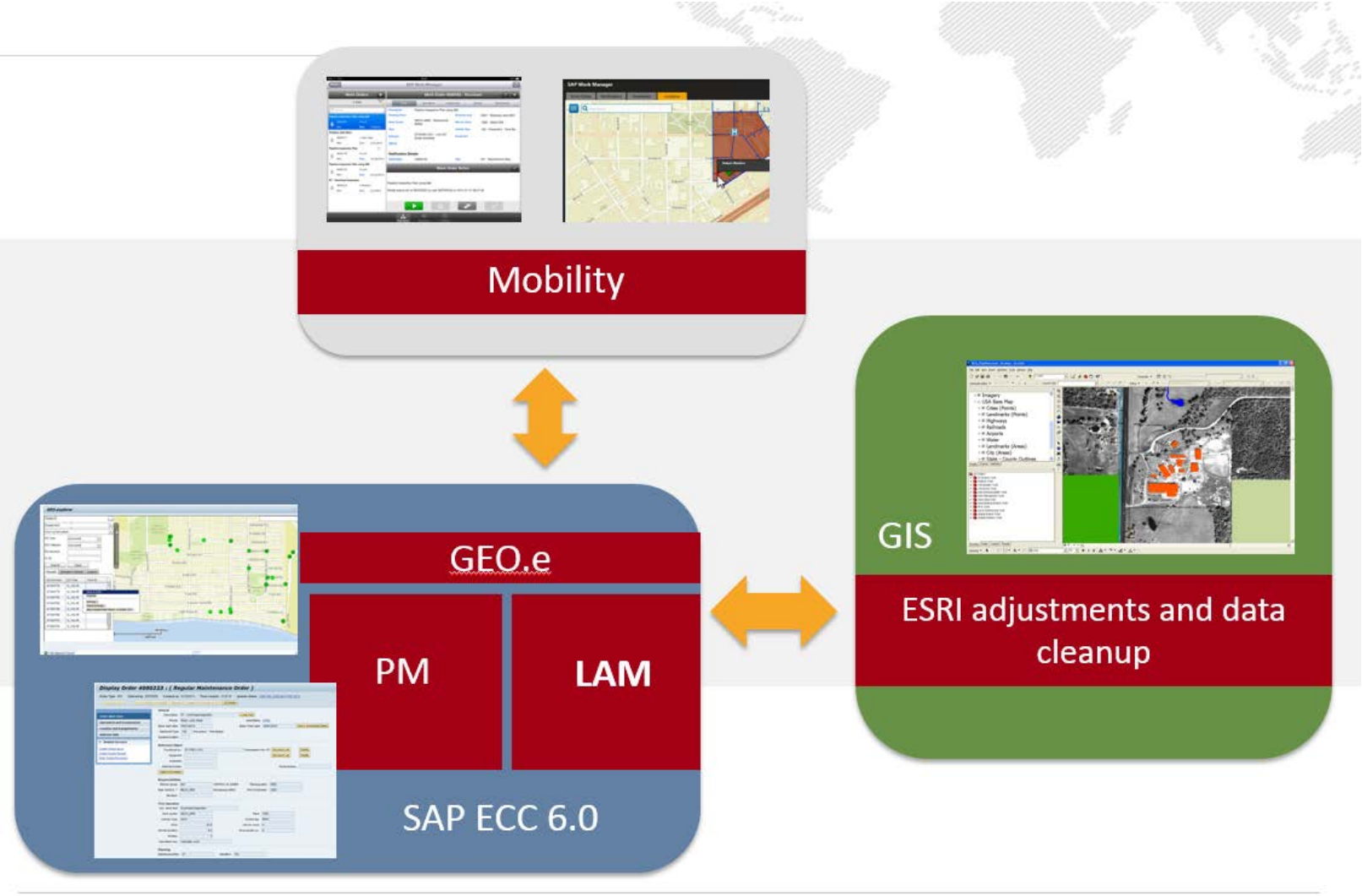
- What was the catalyst that allowed your effort to get off the ground (I.e., how did you convince management)?
  - Change in how budget is allocated, asset management
  - Competing with other assets for funding
    - Voting process
- Setting budgets four years in advanceWhat types of analysis are you planning (or have you performed) with the data?
  - Maintenance Optimization Project
    - Lane Mile per FTE
    - Facilities
    - Performance-based budgeting
- What is your longer-term maintenance plan to keep the data current?
  - Using mobile applications for boots-on-the-ground updates
  - LIDAR – using contractors to collect specific assets

Expanding Data Beyond Inventory

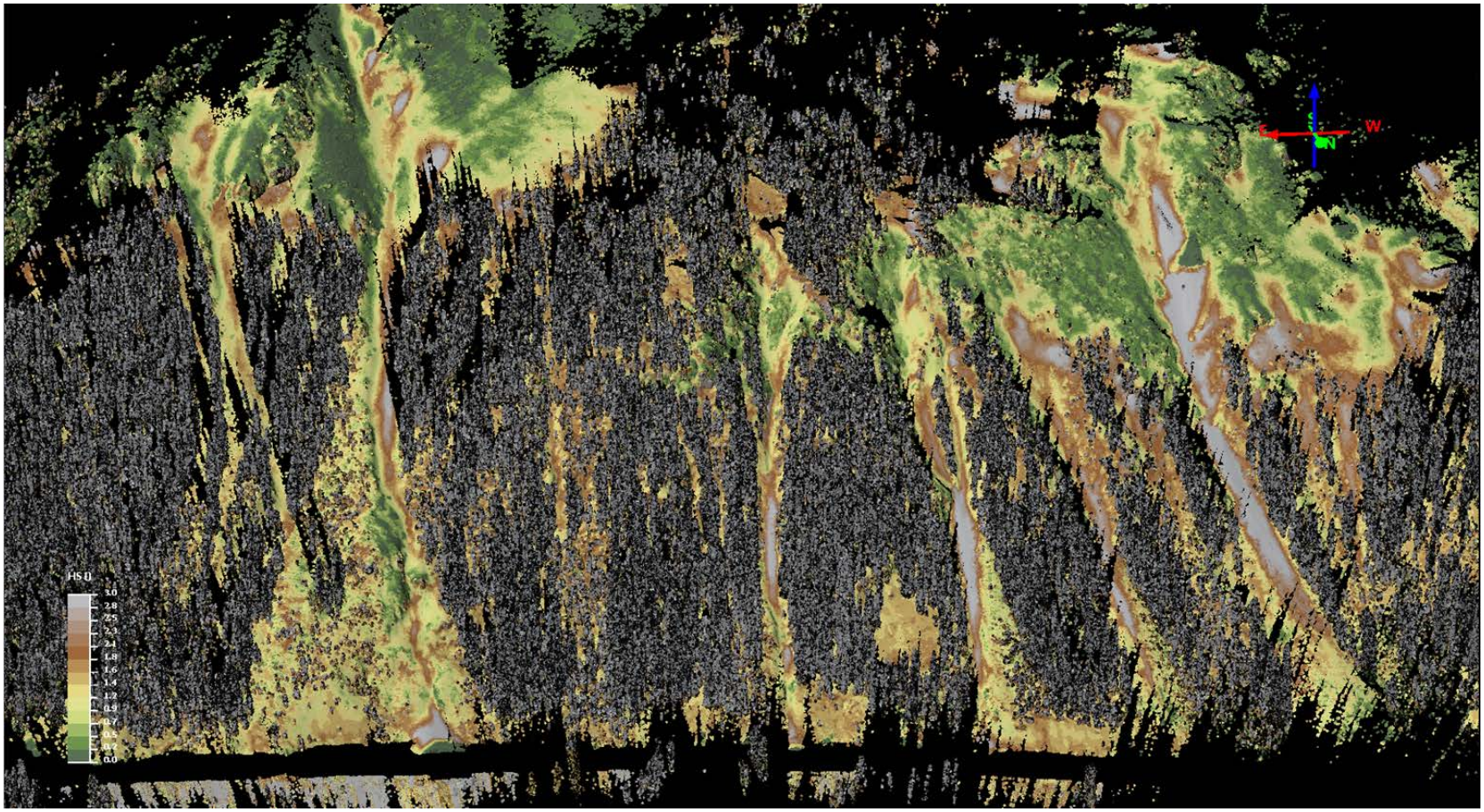
- GIS Integration - visualizing Data with charts, tables, and maps.
- Creating “Heat Maps” for deficient assets based on field condition assessments.
- Complete asset inventories and statistically-significant condition data at the Maintenance Area level provide the framework for bottom-up, performance-based budgeting.
- Enterprise asset inventory database that integrates with standalone asset inventory databases, i.e., Pavement Management, Bridge (BrM), Division of Transportation Development (DTD) (Online Transportation Information (OTIS))



SAP Linear Asset Manager, GEOe, and Mobile Work Manager



LIDAR-Based Asset Inventory



TRB - Practical Technology-Based Approaches to Highway Infrastructure Maintenance

UDOT Snow and Ice Performance Measure

Presented By:

Kevin E. Griffin P.E.

Director of Maintenance

Utah Department of Transportation

Outline

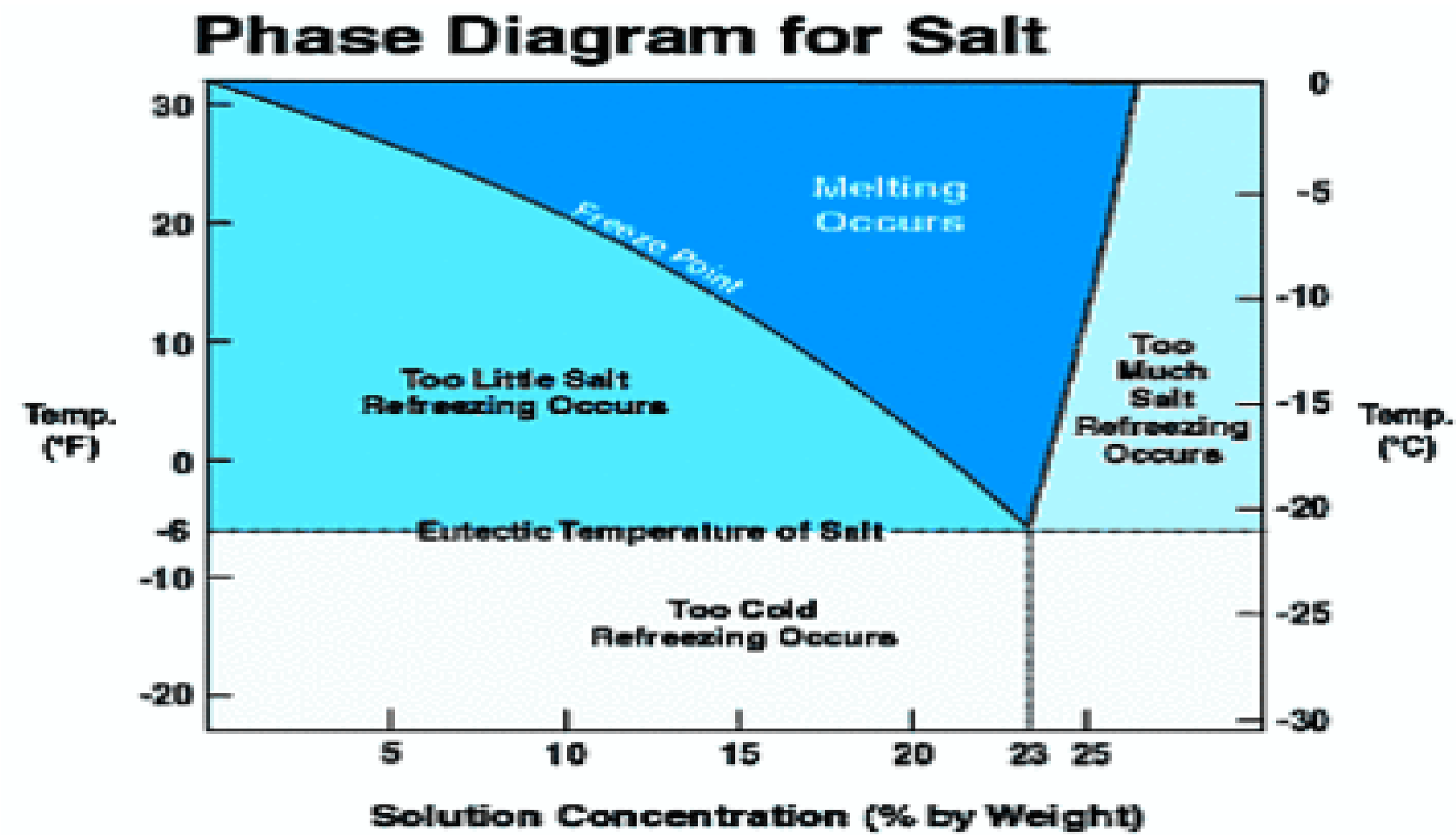
- How Salt Works
- UDOT Snow and Ice Performance Measure
- Safety Around Snow Plows

How Salt Works

How Salt Works

- Is more salt always better?
- There is a fine line between not enough and too much.
- 23% brine solution is the maximum.
- What happens when you exceed that amount?

How Salt Works



New UDOT Snow and Ice Performance Measure Using RWIS

Winter Road Weather Index

- Why is this important?
  - Real time road condition
  - Resource deployment benefits
  - Can set performance targets
  - Budget to meet identified performance level
  - Full build out 150 RWIS stations in 3 years

UDOT Snow and Ice Performance Measure

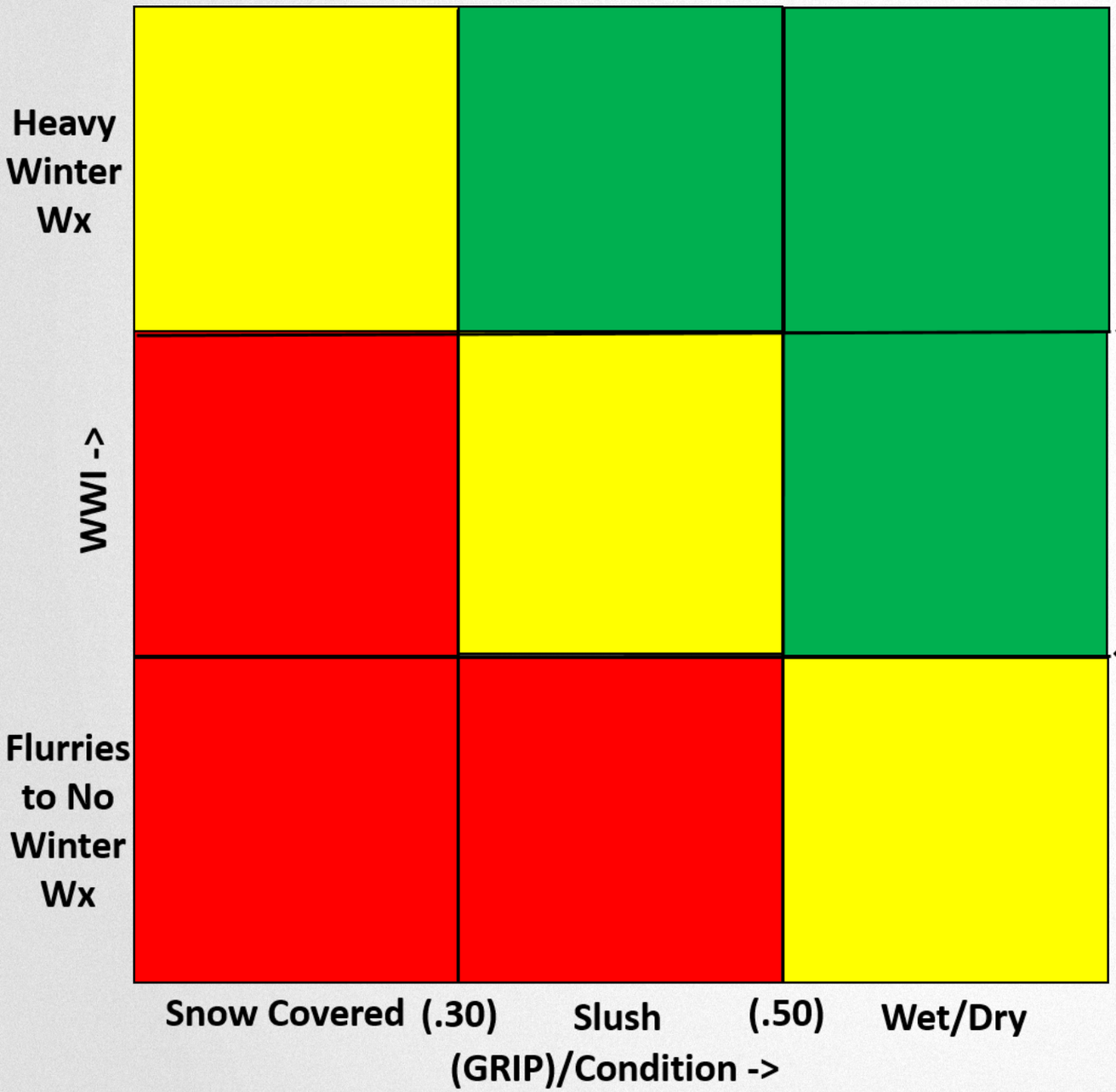
- Road Condition
  - Snow, ice and road grip (coefficient of friction)
- Road Temperature
  - The colder the road, the more difficult to mitigate
- Visibility
  - Used to estimate snowfall rate
  - Precipitation occurrence (yes or no)
    - Define start and end time of storm event
    - Precipitation occurrence used to differentiate fog from snow
- Wet-bulb Temperature
  - Lower the wet-bulb temperature equates to drier snow thus more transportable
  - Used to distinguish rain from snow
- Wind Gust (>= 20 mph)
  - More impact with lowering wet-bulb temperatures

Winter Road Weather Index

- **Winter Maintenance Performance Metric Basis**

Winter Weather Index	Snowfall Rate	Expected Mitigated Road Condition	Expected Grip
❄❄❄ Heavy	> 1" per hour	Snow Covered	< .30
❄❄ Light to Moderate	.25 to 1" per hour	Slushy/ Partially Snow Covered	.30 to .50
❄ Flurries or no snow	< .25" per hour	Wet or dry	.50 to .82
Contributing factors also considered with Winter Weather Index			
Road Temperature	Blowing snow	Wet or dry snow	

Performance Metric “Rubik’s Cube”



Definitions:

Green – Road condition exceeds acceptable road conditions per given weather conditions

Yellow – Acceptable road conditions per given weather conditions

Red – Recovery time. Potential for improved road conditions per given weather conditions

SR-12 @ Boulder Summit

Link to Mesowest

! Data during the selected time period has been manually flagged for !
! potential quality errors. Please contact 801-887-37 with any questions. !

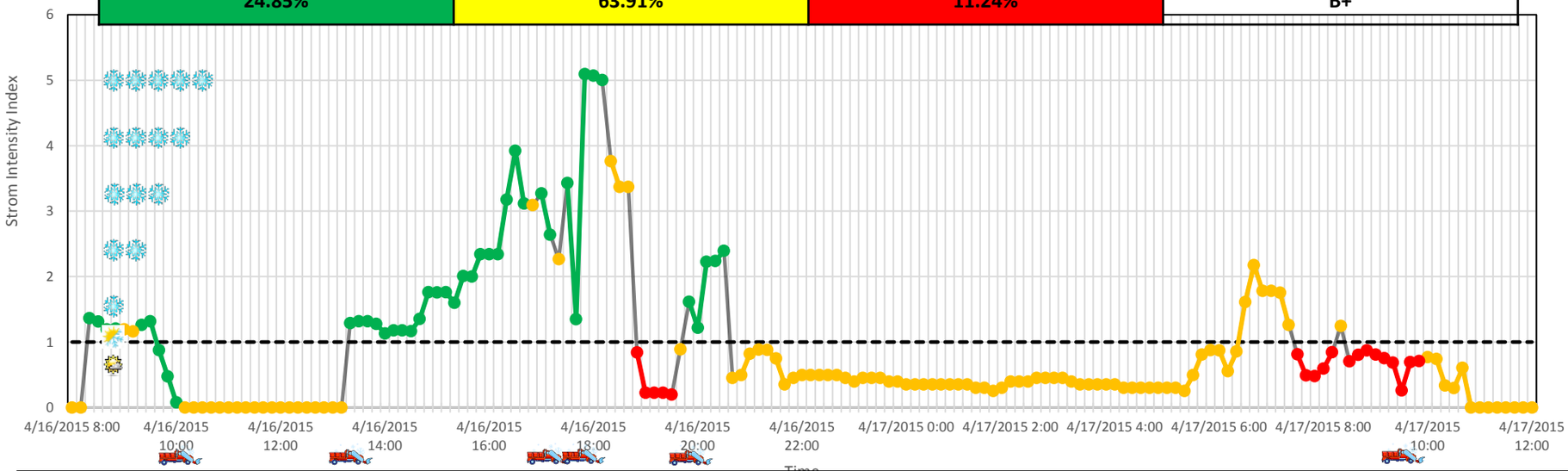
Select time frame by number of hours ago **OR** Select time frame by start and end date

Past 12 hrs | Past 24 hrs | Past 36 hrs | Past 48 hrs

Start Date 4/16/2015 7:50 AM End Date 4/17/2015 12:00 PM Go

Resource Performance Statistics – Storm 16

EXCEPTIONAL	ACCEPTABLE	UNACCEPTABLE	MAINTENANCE RESOURCE GRADE
24.85%	63.91%	11.24%	B+



Variable Graph Options Left Axis: Storm Intensity Index ▼ Right Axis: Storm Intensity Index ▼

4/17/2015 10:44 am

Conditions at 4/17/2015 10:30 AM
Temp/RH: 28.4 °F | **Wind:** N 17 mph, Gust 25 mph | **Road:** 35.1 °F, Ice | **Visibility:** 10.00 mi | **Snowfall rate:** n/a | **Snow Depth:** n/a | **Precip. Intensity:** Light | **Road Grip:** 0.3 | **SII:** 0.30

Current Season | 2014-2015 | 2013-2014

	Storm Event	Avg. Storm Intensity	Storm Duration (hrs)	Storm Severity Index	Performance
17	4/24/2015 11:10:00 PM - 4/26/2015 8:30:00 AM	0.81 *****	33.3	26.9	91.5% (A-)
16	4/16/2015 7:50:00 AM - 4/18/2015 8:50:00 AM	0.54	50	27.0	88.8% (B+)
15	4/15/2015 1:50:00 AM - 4/15/2015 9:10:00 AM	0.88	7.3	6.4	98.1% (A+)

Current Conditions

Sample Time:	8/26/15 10:00 AM
Temp/RH:	49 °F / 99%
Wind:	S 15 MPH, Gust 24 MPH
Visibility:	0.14 mi
Snowfall Rate:	n/a
Precipitation Intensity:	Heavy
Snow Depth:	n/a
Road:	50 °F, Wet
Road Grip:	0.50
Storm Intensity Index:	0.00 *(Sun/snowflake symbol)*

Legend

- Road conditions exceptional given weather conditions
- Road conditions acceptable given weather conditions
- Unacceptable given weather conditions
- Winter maintenance baseline

Selected Storm Event Summary – Storm 16

WEATHER STATISTICS	MINIMUM	AVERAGE	MAXIMUM
Air Temp.	14.5 °F	23 °F	30.0 °
Road Temp.	18.0 °F	32 °F	63.0 °
Wind Gust	10.5 mph	20 mph	33.5 mph
Est. Snowfall Rate	0”/hr	0.3”/hr	4.8”/hr
IceSight Grip	0.10	0.50	0.82

Current Winter Summary (through 4/26/2015 8:30 AM)

Average Resource Performance:	92.8% (A-)	(high)
Number of Storms:	17	(moderate)
Average Storm Duration (hrs):	30.2	(moderate)
Total Storm Duration: (hrs)	513.4	(high)
Average Storm Intensity Index:	0.74	(low)
Storm Intensity Index Sum:	12.6	(moderate)
Average Storm Severity Index:	20.1	(moderate)
Storm Severity Index Sum:	341.7	(moderate)

More information on the Storm Intensity Index and snow and ice performance:

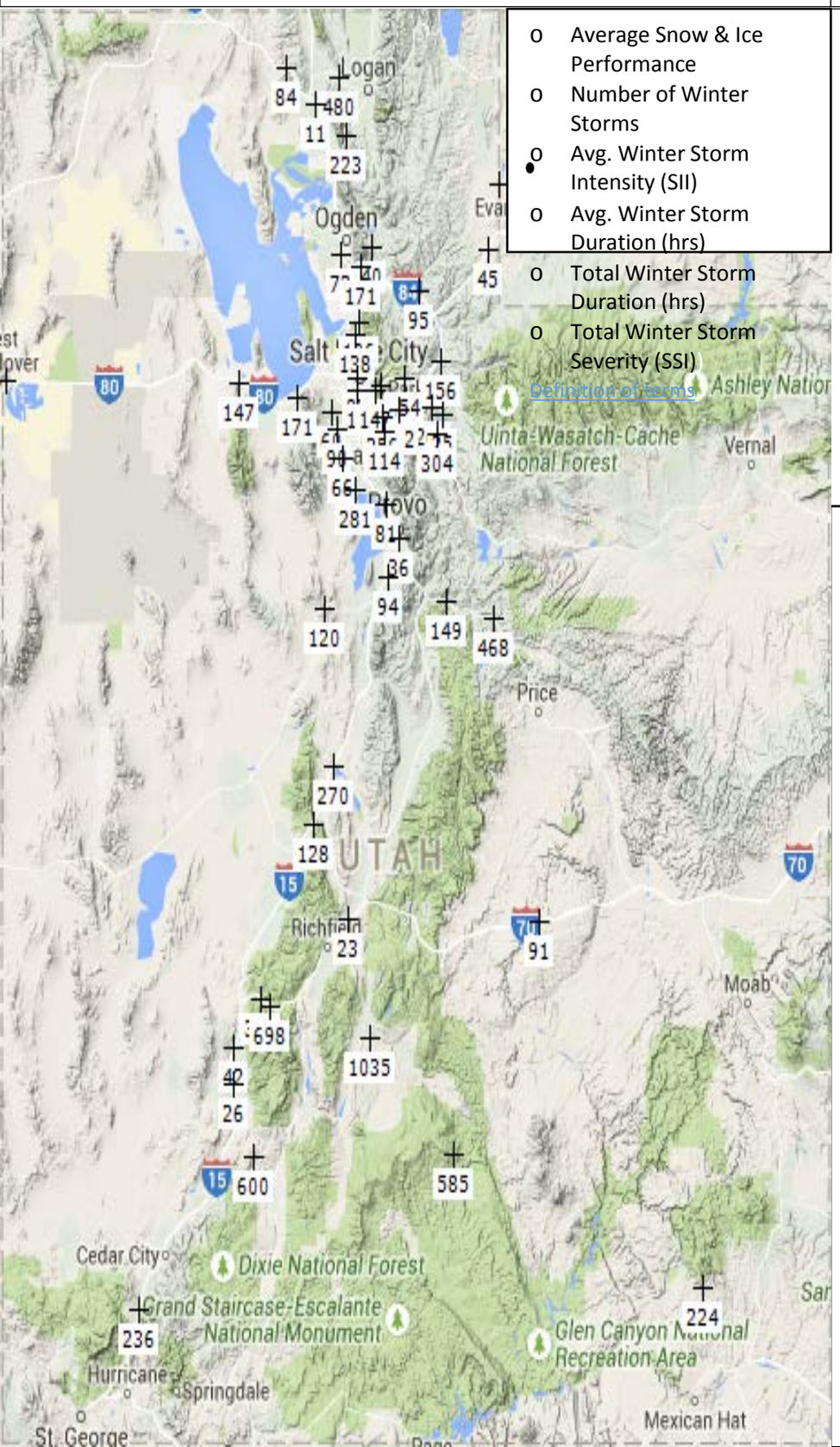
Video

Powerpoint

UDOT Weather Desk: 801-887-3703

Statewide Snow and Ice Performance Dashboard

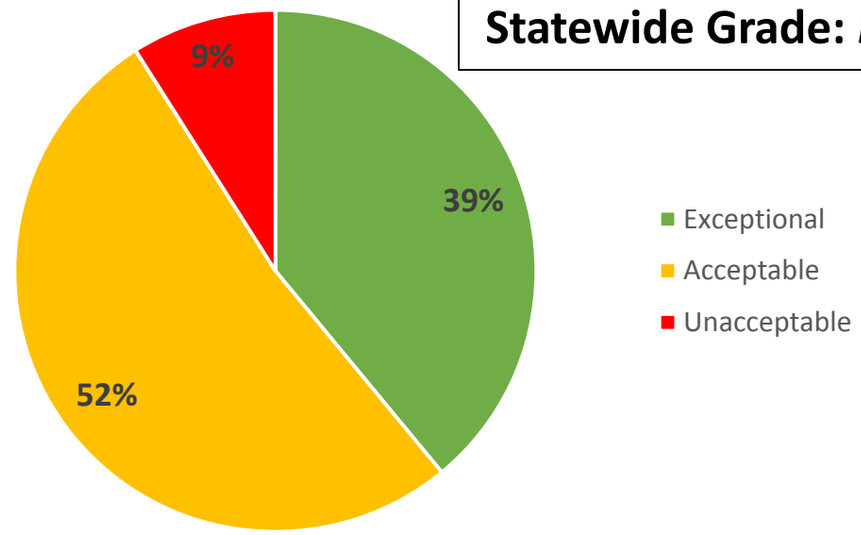
2015-2016 Statewide Winter Storm Statistics



- Average Snow & Ice Performance
- Number of Winter Storms
- Avg. Winter Storm Intensity (SII)
- Avg. Winter Storm Duration (hrs)
- Total Winter Storm Duration (hrs)
- Total Winter Storm Severity (SSI)

Definition of terms

2015-2016 Average Statewide Snow and Ice Performance

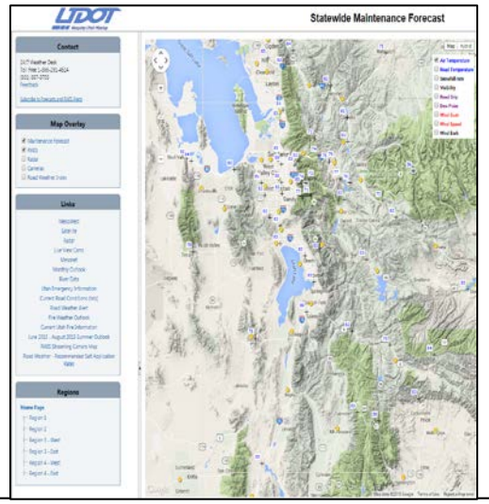


Statewide Grade: *B+*

Data for winter storm events:
10/01/15 12:00 A.M. – 04/30/16 12:10 P.M.

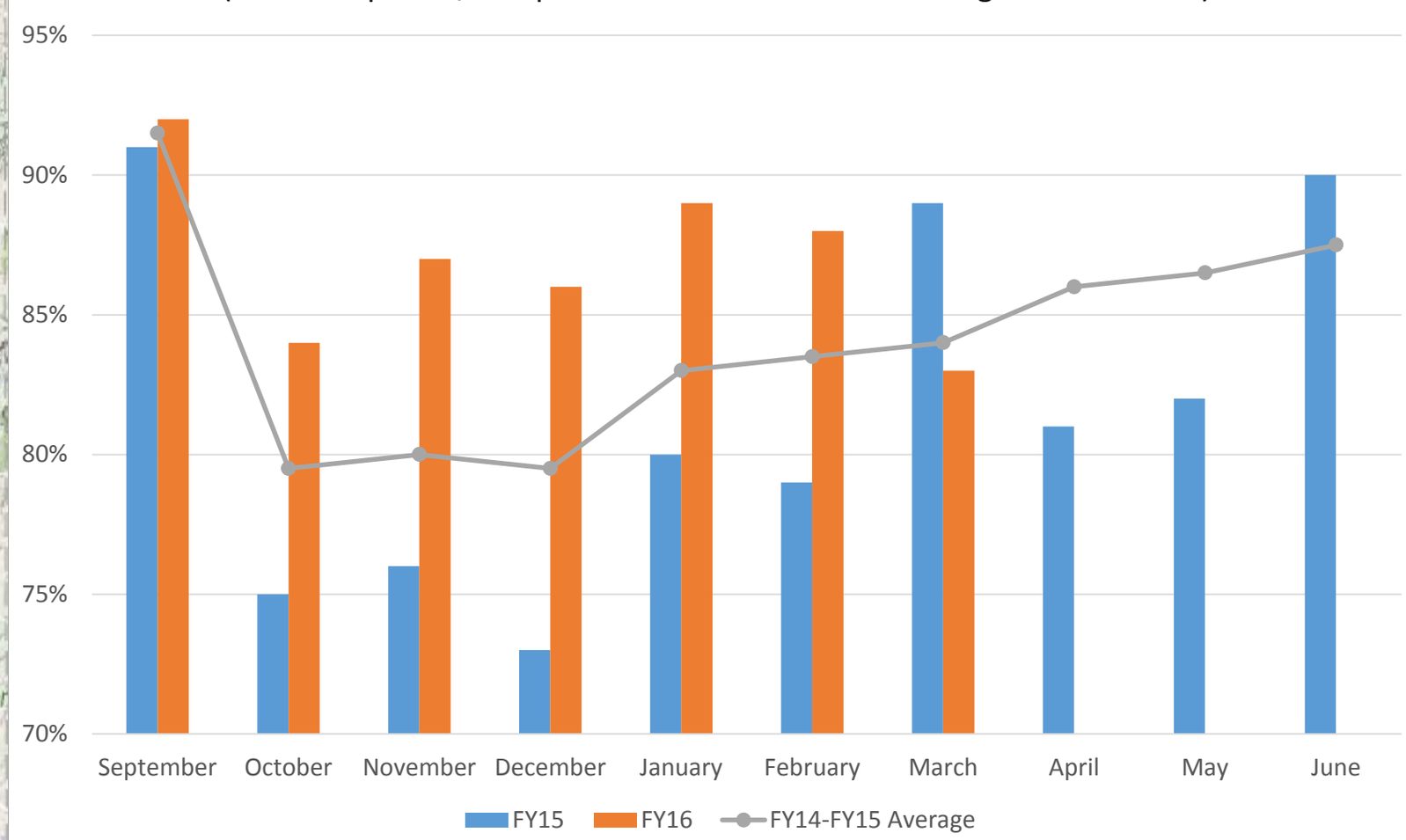
XX compatible RWIS sites

Statewide Maintenance



Average Statewide Snow and Ice Performance

(% of acceptable/exceptional ? road conditions during winter storms)



AVL/GPS

Why would we want this?

AVL/GPS

- Know where your fleet is
- Know where your fleet has been
- Know what your truck is doing
  - Plow up/down
  - Application of salt or brine
  - Truck speed
- Show the public the real picture
- Feed road condition data to the TOC

AVL/GPS

- 500+ Snow Plow equipped with GPS/AVL
- Real Time Engine Diagnostics
- Incident Management Trucks also Equipped
- Potentially other equipment

Microsoft Word - Edited f... | UDOT Weather forecast 1/... | http://www.udo.../Default.aspx | Storm Management

udottraffic.utah.gov/forecastview/stormmanagement.aspx

safety around snow plows

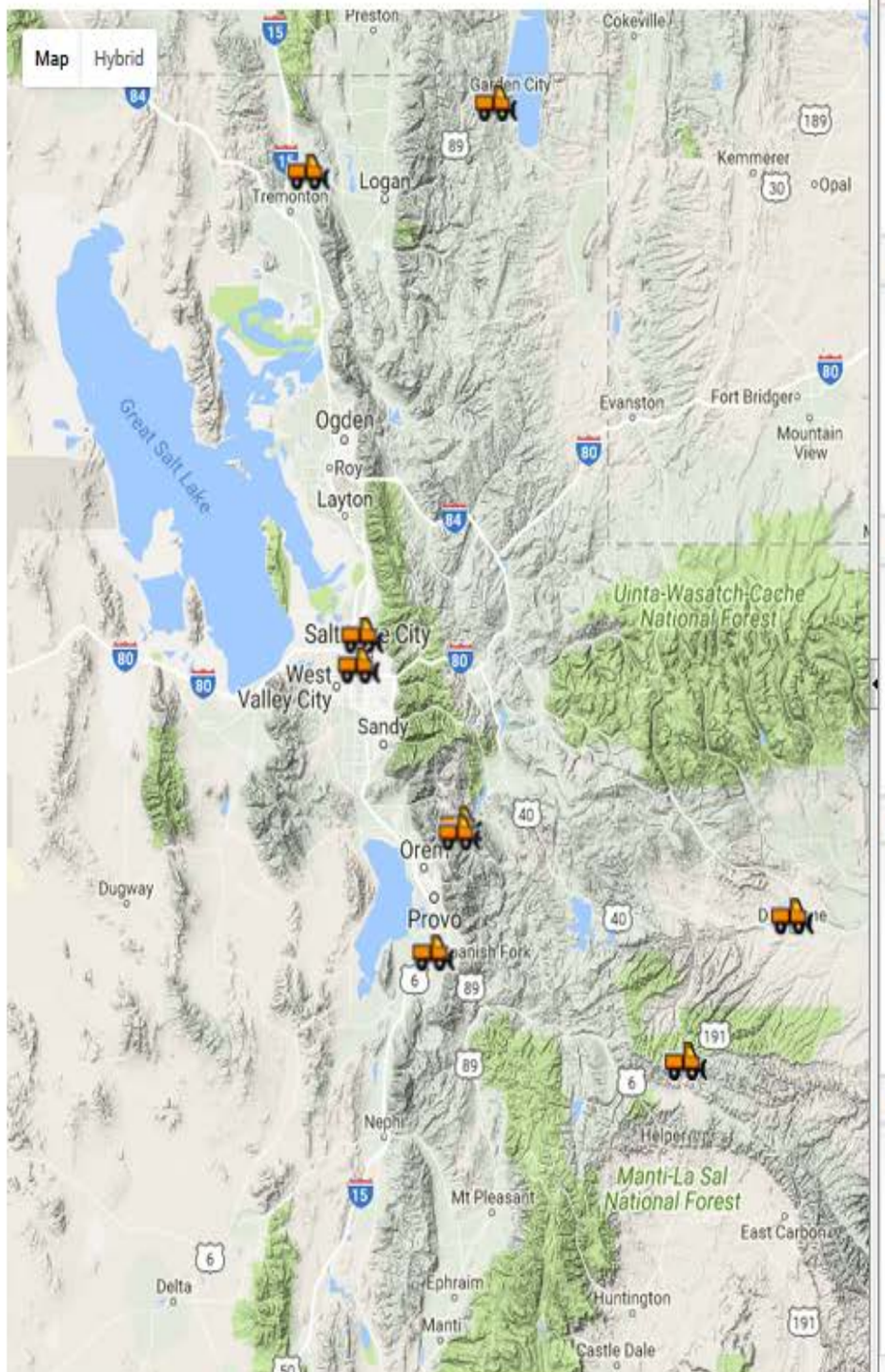
Map Overlay

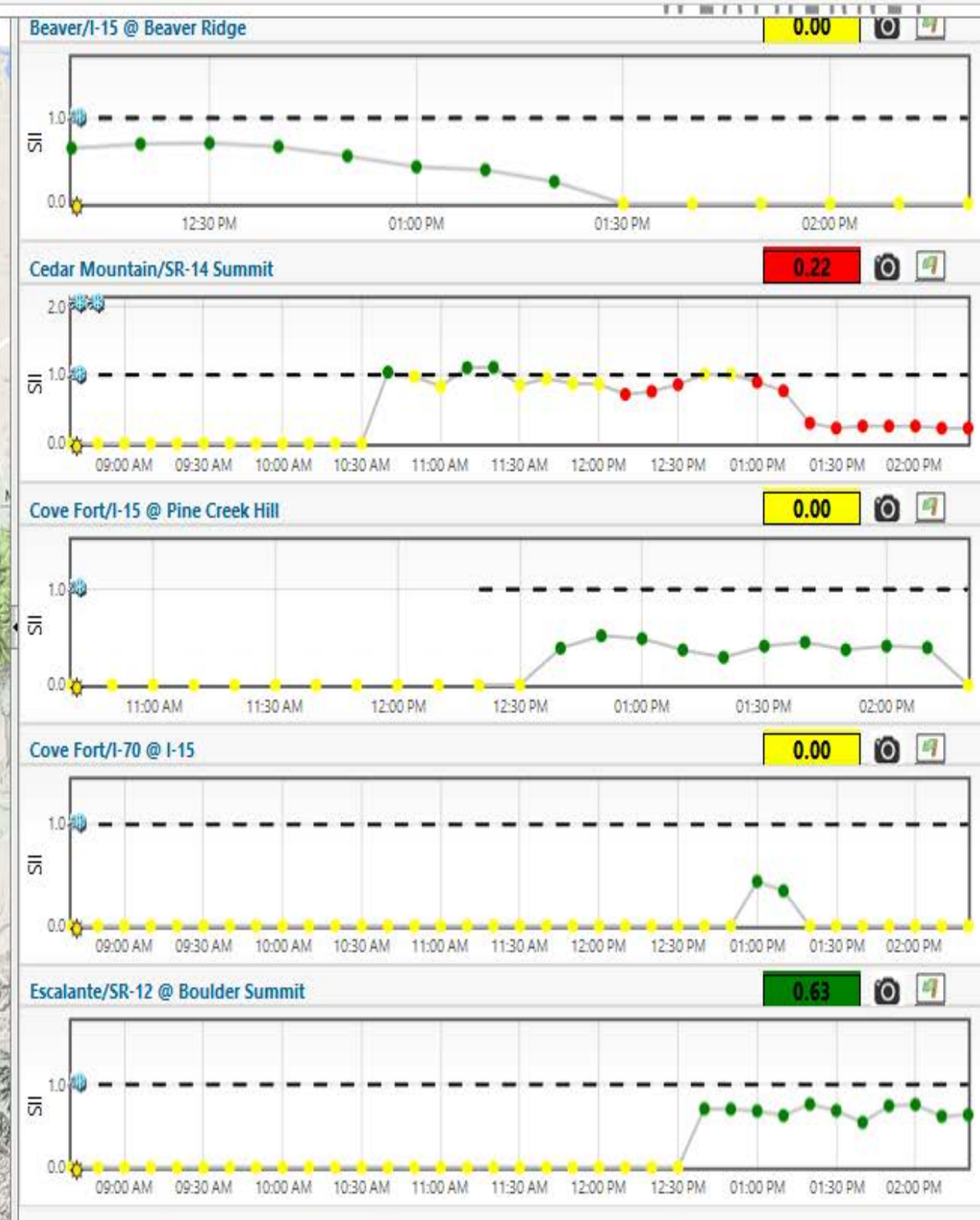
Zoom to Area

- [ ] Shed Forecasts
- [ ] RWIS
- [ ] Radar
- [ ] Cameras
- [ ] Snow and Ice Performar
- [x] Snow Plow AVL

Graph Legend

- Road conditions exceptional given weath condition
- Road conditions acceptable given weath condition
- Unacceptable given weather condition
- Winter maintenance baseline





2:33 PM
1/7/2017

Snow Plow Route Optimization

Snow Plow Route Optimization

- Using same defined routes for many years
- Based on Station and Region boundaries
- Some routes still incorporate “Deadhead”
- Did the best with the tools we had

Snow Plow Route Optimization

- Navteq data software driven solution
- Look at doing things differently
- Possible outcomes:
  - Interstate plow groups
  - Combining stations
  - Some areas are at optimal

Snow Plow Route Optimization

- Currently Analyzing the Wasatch Front From Provo to Box Elder County Line
- Evaluate the entire state
- Results Implemented Next Winter Plow Season

Safety Around Snow Plows

UDOT Plow Accident

https://youtu.be/S9jrCEVOvrY

Wing Plow Lights

Safety Around Snow Plows

- What is the safe Traveling Distance Behind a Plow?
- Don’t Crowd the Snow Plow
- Echelon Plowing

Safety Around Snow Plows

- Watch for Plows Operating in Your Lane
- Don’t Travel Beside the Plows
- Snow Plows Operate at Slower Speeds
- Slow Down During Adverse Weather Conditions

Safety Around Snow Plows

- Wings and Tow Plows
- Plows Create Their Own Weather Environment
- Snow Plow Operators Field of Vision is Limited
- Snow Plows Turn and Exit the Road Frequently

THANK YOU

Evaluation of Emerging Technologies for Safety & Operations Infrastructure Inventory and Condition Assessment

Paul Carlson, PhD, PE

Texas A&M Transportation Institute

TxDOT Call for Innovations (fall 2014)

- **Technical Area 2: Zero-intrusive maintenance**
  - TxDOT seeks innovative proposals under this area to identify, develop, and prove infrastructure maintenance technologies and methods that produce *no disruption to facility use* during maintenance activities.

Motivation

- *TxDOT's maintenance budget is $1 billion short and growing (circa 2014)*
- *Need to make more cost-effective decisions with limited resources*
- *Need the right data to make more cost-effective decisions*
- *Need to keep traffic flowing and TxDOT personnel safe*
- *Need to be able to respond to vendors' request to collect highway infrastructure data*

Traditional Forms of Data Collection

- Subjective Accuracy
- Low frequency
- Low dollar

- Objective Accuracy
- Low frequency
- High dollar

Why mobile high speed?

- Manual Data Collection
  - Can be time-consuming
  - Exposes DOT staff to traffic
  - Is often asset specific
  - Subjective

Can mobile high speed…

- Reduce costs?
- Increase safety?
- Obtain accurate data?
- Provide robust data for predictive modeling?
- Collect multiple asset data simultaneously?

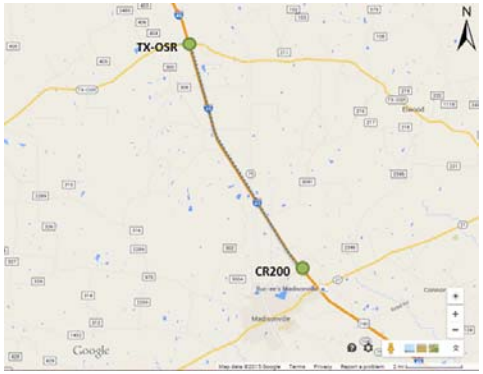
What is Mobile High Speed?

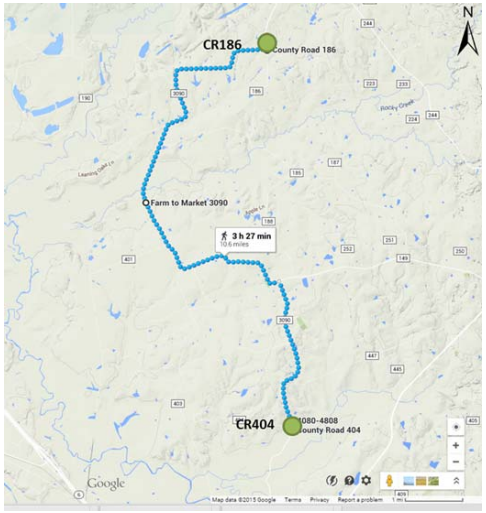
- No limits on technology
- Had to be a mobile platform
- High speed preferably >35 mph

	Avg. Speed (mph)	
	IH 45	FM 3090
A	54.01	43.10
B	60.00	38.75
C	NA	15.65
D	62.23	46.06
E	Posted	Posted
F	45.30	42.50

Routes and Testing Conditions

- *TxDOT Highways:*
  - *IH-45 (north of Houston)*
    - *~10 miles*
    - *Rural environment*
    - *Two-way frontage roads*
  - *FM 3090 (near Navasota)*
    - *~10 miles*
    - *Low ADT*
    - *Horizontal and vertical curvature*





Selection of Contractors

- Contractor selection criteria:
  - Past Experience
  - Technology – Lidar, 3D Photogrammetry…
  - Unique Capabilities – Retroreflectivity
  - Unique Mobile Platform – Unmanned Aerial Vehicle
- Contractors:
  - Data Transfer Solutions (DTS)
  - DBi Services, (AMAC)
  - Arch Aerial (AALLC)
  - Mandli Comm.
  - Pathway Services
  - Fugro Roadware

Performance Metrics

- ***Service Metrics***
  - *mobilization time,*
  - *data collection time,*
  - *processing time,*
  - *approximate cost*
- ***Identification Metrics***
  - *asset identification (e.g., MUTCD sign designations),*
  - *asset material (e.g., sign sheeting, pavement markings),*
  - *general sizes.*
- ***Quantification Metrics***
  - *asset quantities*
    - *both point and linear totals.*
- ***Accuracy Metrics***
  - *horizontal,*
  - *linear, and*
  - *elevation measurements (GPS accuracy)*
  - *sign text*
  - *retroreflectivity*
  - *mowable acres*

What did we learn?

- Data Dictionary is key to success
  - Contractors/TxDOT not given enough time for comment
  - Examples
    - Rumble Strips without Left/Right positioning
  - Specific guidance on measurements
    - Lane measurements – from inside stripe or centerline?
  - Mailboxes – The assembly not the number of boxes.
  - Count of pavement markers: single v double yellow

What did we find?

- *Cost comparison per miles delivered*

Delivered Miles	Collection	Processing/Reporting	Total
20	$ 751.01	$ 498.99	$ 1,250.00
42	$ 391.35	$ 271.34	$ 662.69
10	$ 1,387.40	$ 883.37	$ 2,270.77
20	$ 338.51	$ 86.49	$ 425.00
40	$ 333.00	$ 207.00	$ 540.00
20	$ 988.01	$ 735.99	$ 1,724.00
Per Mile Average	$ 698.21	$ 447.20	$ 1,145.41

- *Includes processing and reporting*
- *Estimated manual costs*
  - *740 man-hours @ $100 (40) = $1,850 per lane mile*

Unique Aspects

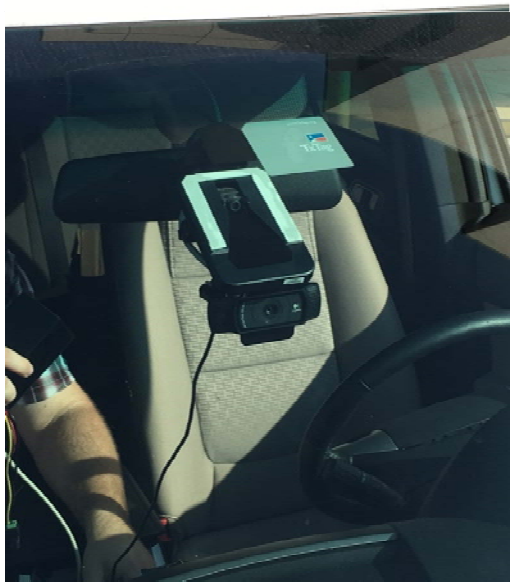
- Measured retroreflectivity of signs and markings allows predictive modeling (i.e., cost savings)
- GPS accuracies have considerable variability
- Easy to use results?
- All technologies provide a snapshot in time

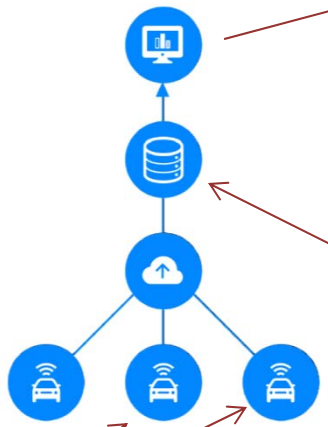
For more info

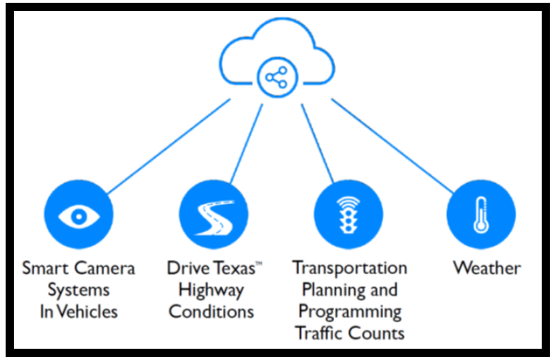
- Full Report
  - http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/0-6869-1.pdf
- Condensed Version
  - TRB Annual Meeting, Paper 17-05078

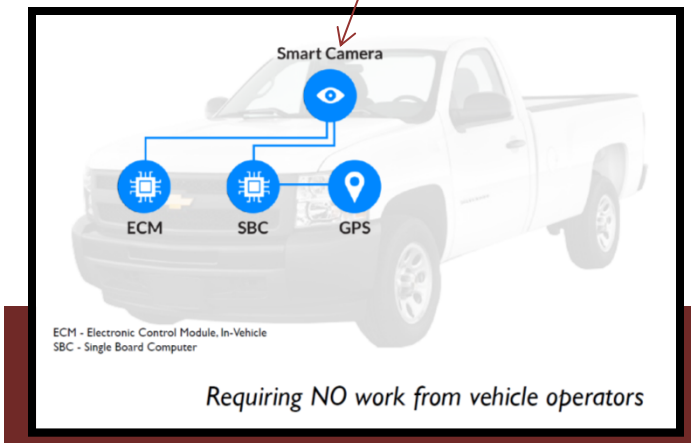
Vehicle Sensors and Crowd Sourcing Strategies to Provide Safety & Operations Infrastructure Inventory and Condition Assessment

Vehicle Sensor Crowd Sourcing

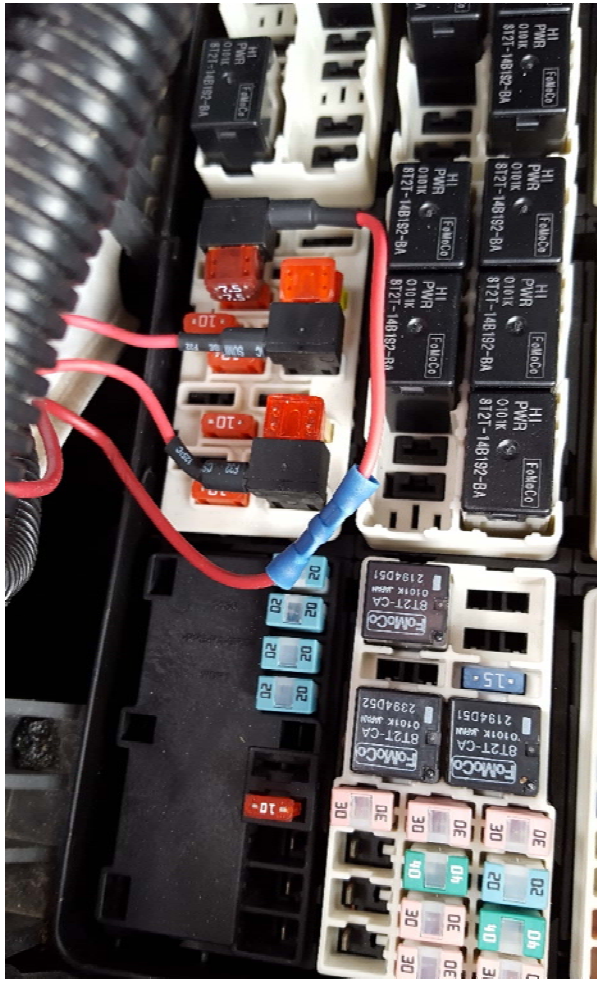




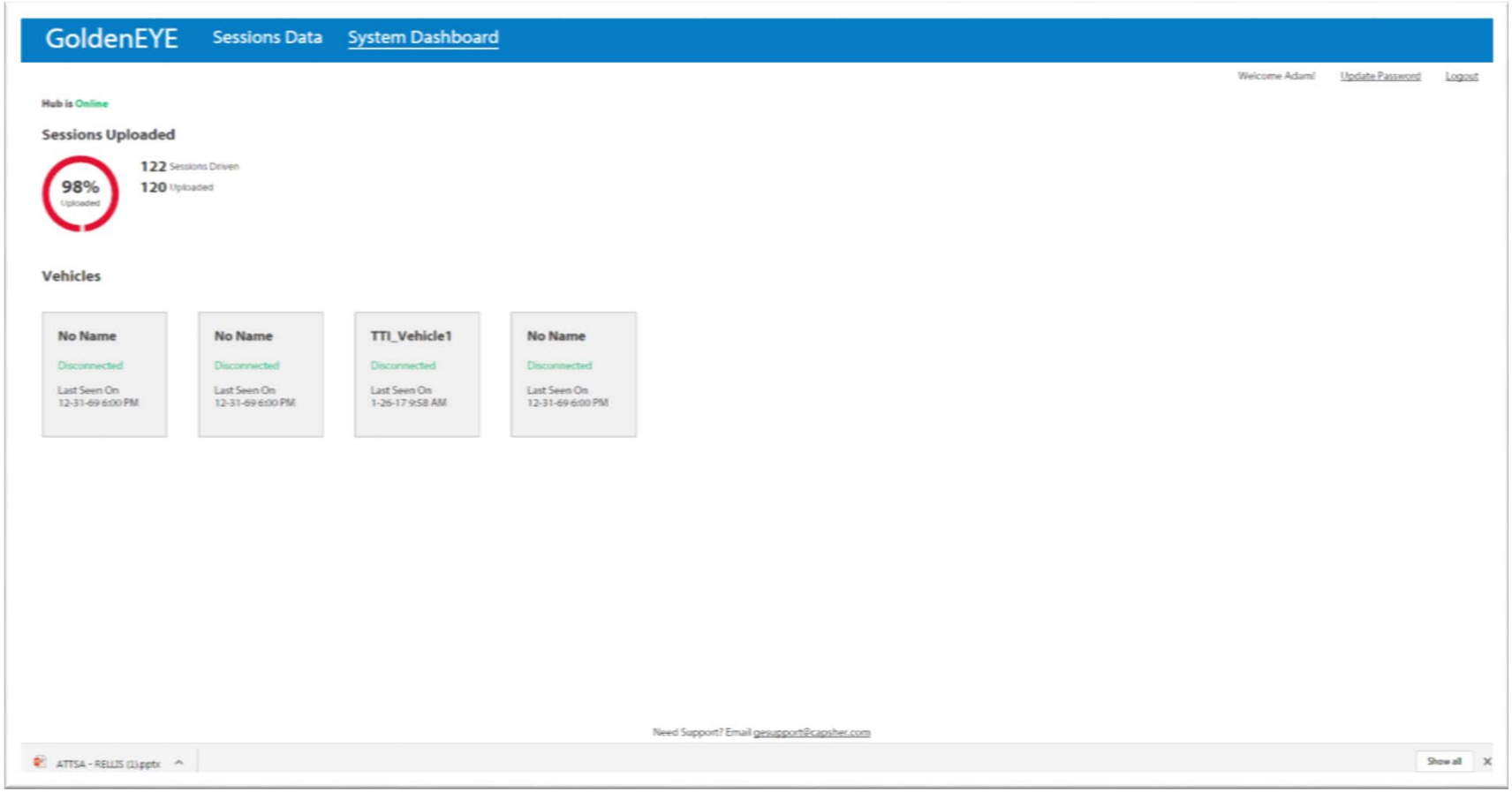




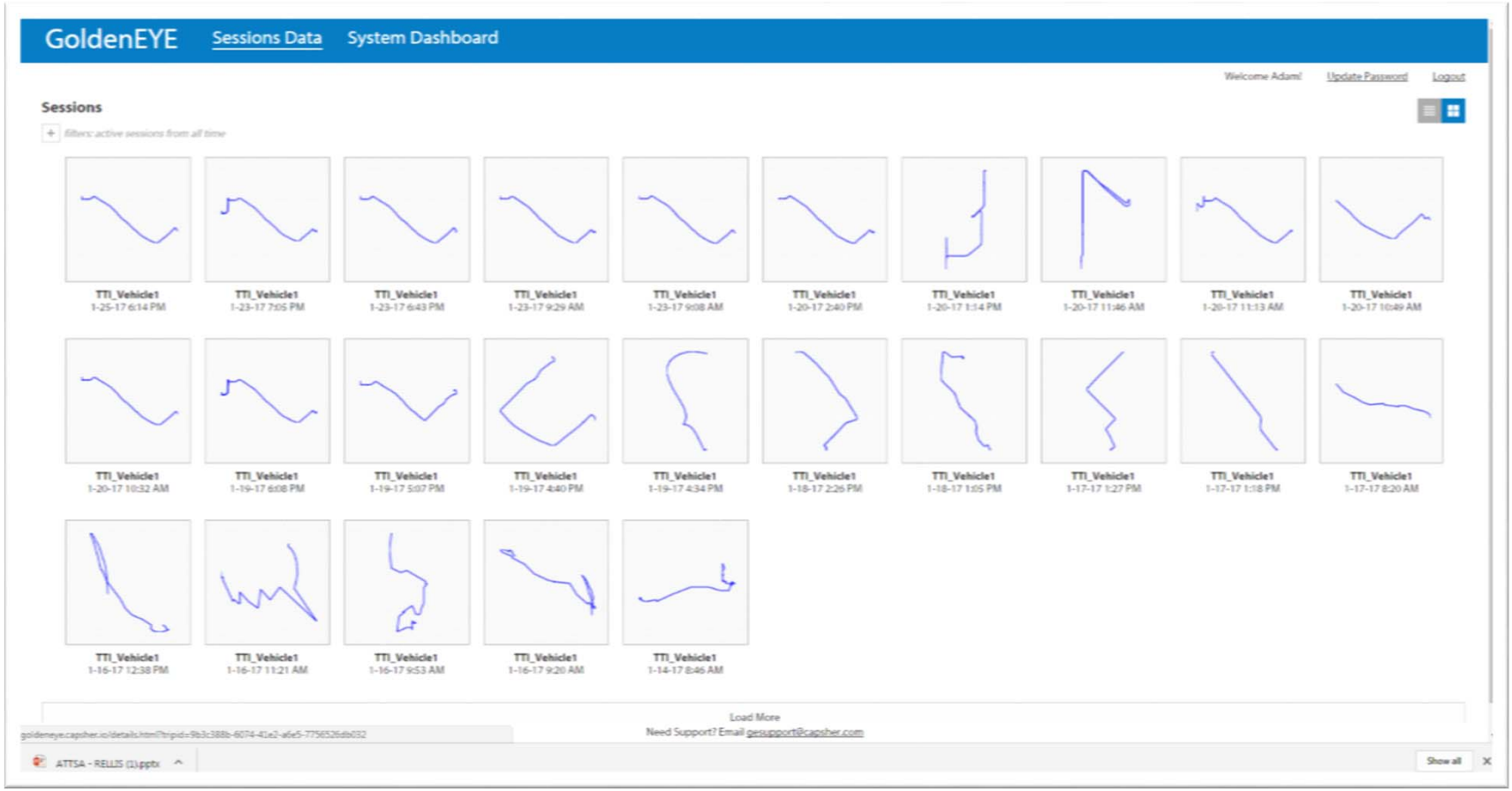
In-Vehicle Connections



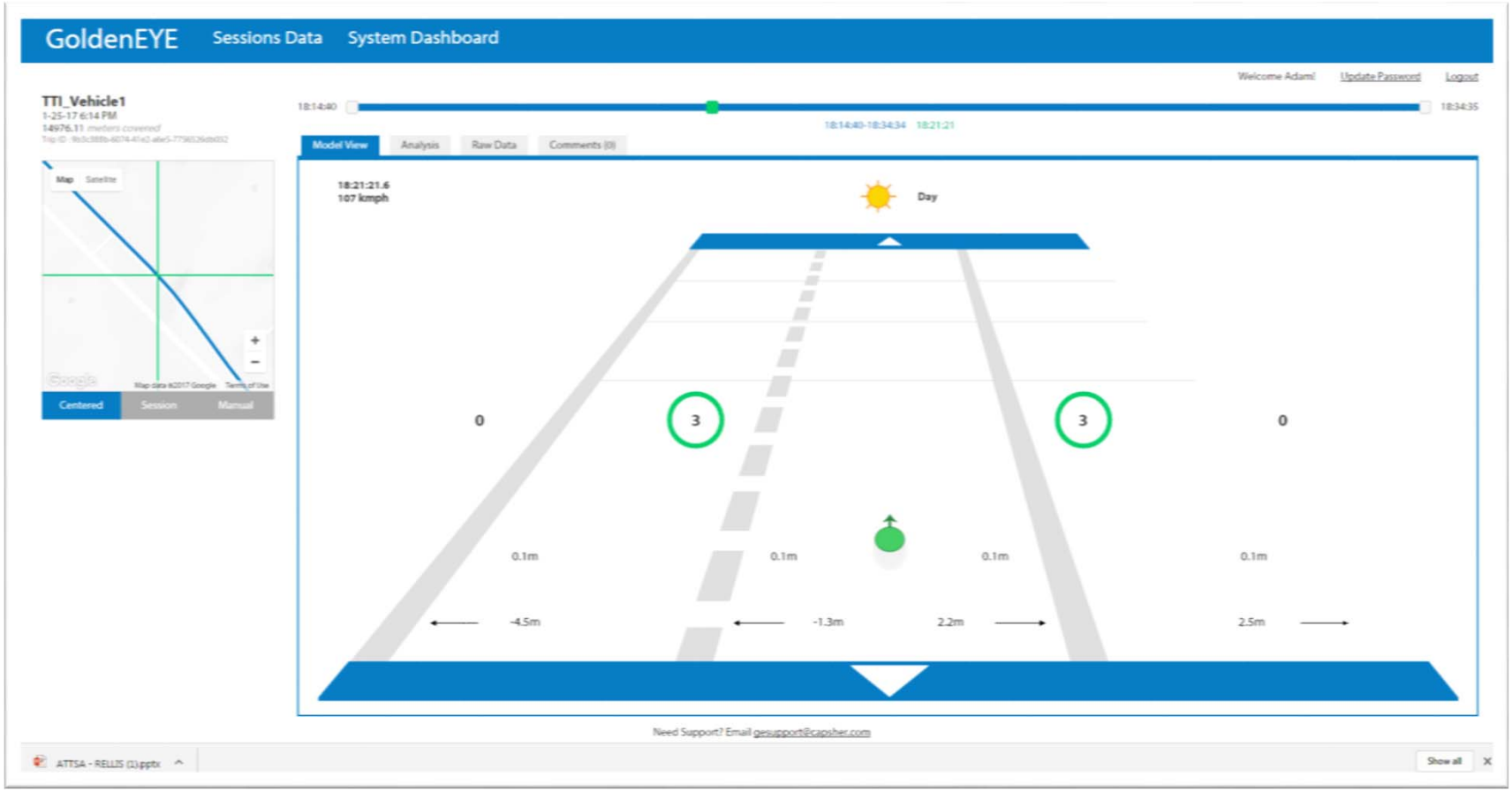
Web-Based Interface



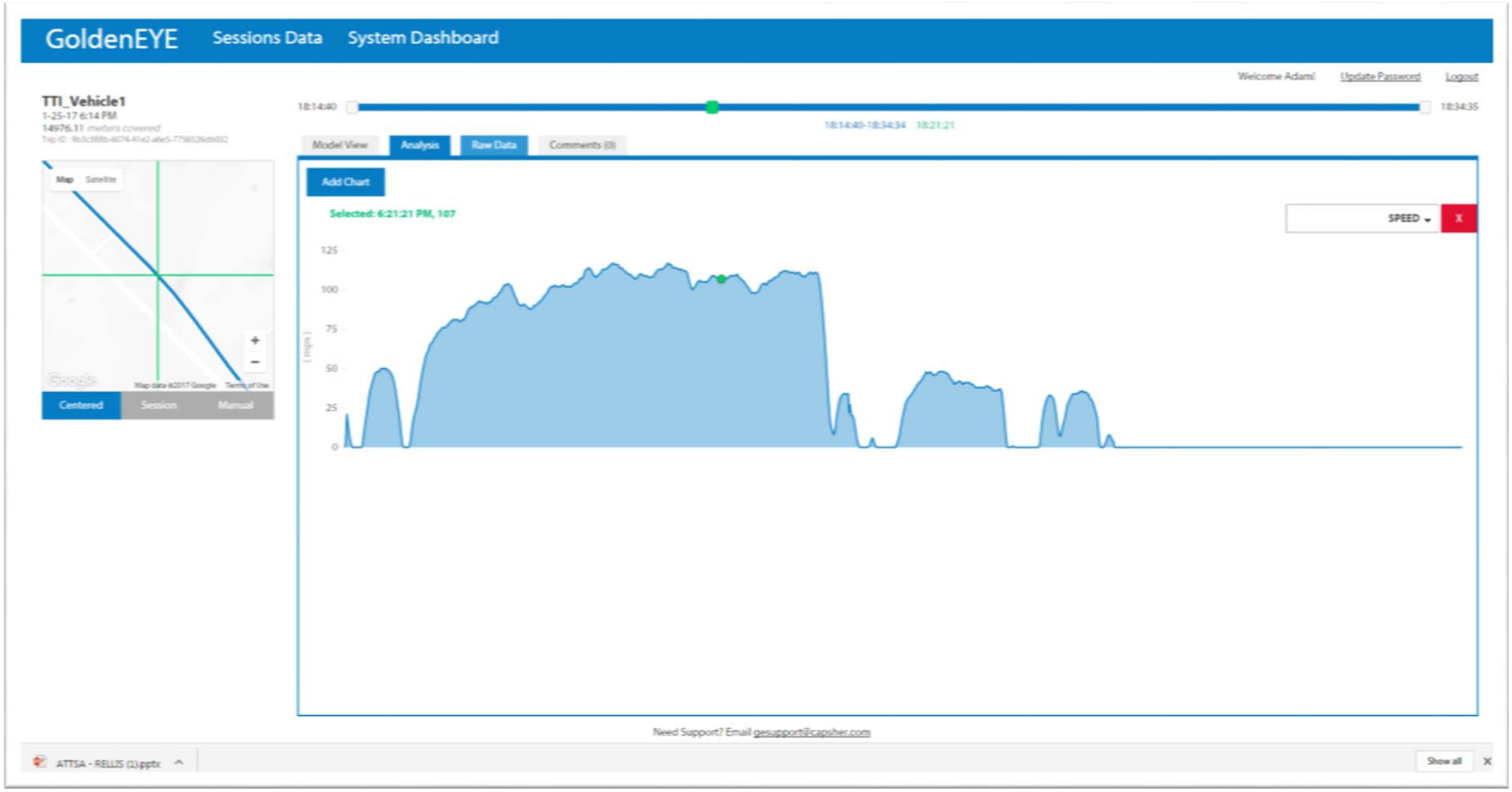
Sessions


GoldenEYE
Sessions Data
System Dashboard
Welcome Adam!
Update Password
Logout
Sessions
TTI_Vehicle1
1-25-17 6:14 PM
TTI_Vehicle1
1-23-17 7:05 PM
TTI_Vehicle1
1-23-17 6:43 PM
TTI_Vehicle1
1-23-17 9:29 AM
TTI_Vehicle1
1-23-17 9:08 AM
TTI_Vehicle1
1-20-17 2:40 PM
TTI_Vehicle1
1-20-17 1:14 PM
TTI_Vehicle1
1-20-17 11:46 AM
TTI_Vehicle1
1-20-17 11:13 AM
TTI_Vehicle1
1-20-17 10:49 AM
TTI_Vehicle1
1-20-17 10:32 AM
TTI_Vehicle1
1-19-17 6:08 PM
TTI_Vehicle1
1-19-17 5:07 PM
TTI_Vehicle1
1-19-17 4:40 PM
TTI_Vehicle1
1-19-17 4:34 PM
TTI_Vehicle1
1-18-17 2:26 PM
TTI_Vehicle1
1-18-17 1:05 PM
TTI_Vehicle1
1-17-17 1:27 PM
TTI_Vehicle1
1-17-17 1:18 PM
TTI_Vehicle1
1-17-17 8:20 AM
TTI_Vehicle1
1-16-17 12:38 PM
TTI_Vehicle1
1-16-17 11:21 AM
TTI_Vehicle1
1-16-17 9:53 AM
TTI_Vehicle1
1-16-17 9:20 AM
TTI_Vehicle1
1-14-17 8:46 AM
Load More
Need Support? Email gesupport@capsher.com
ATTSA - RELL25 (1).pptx
Show all

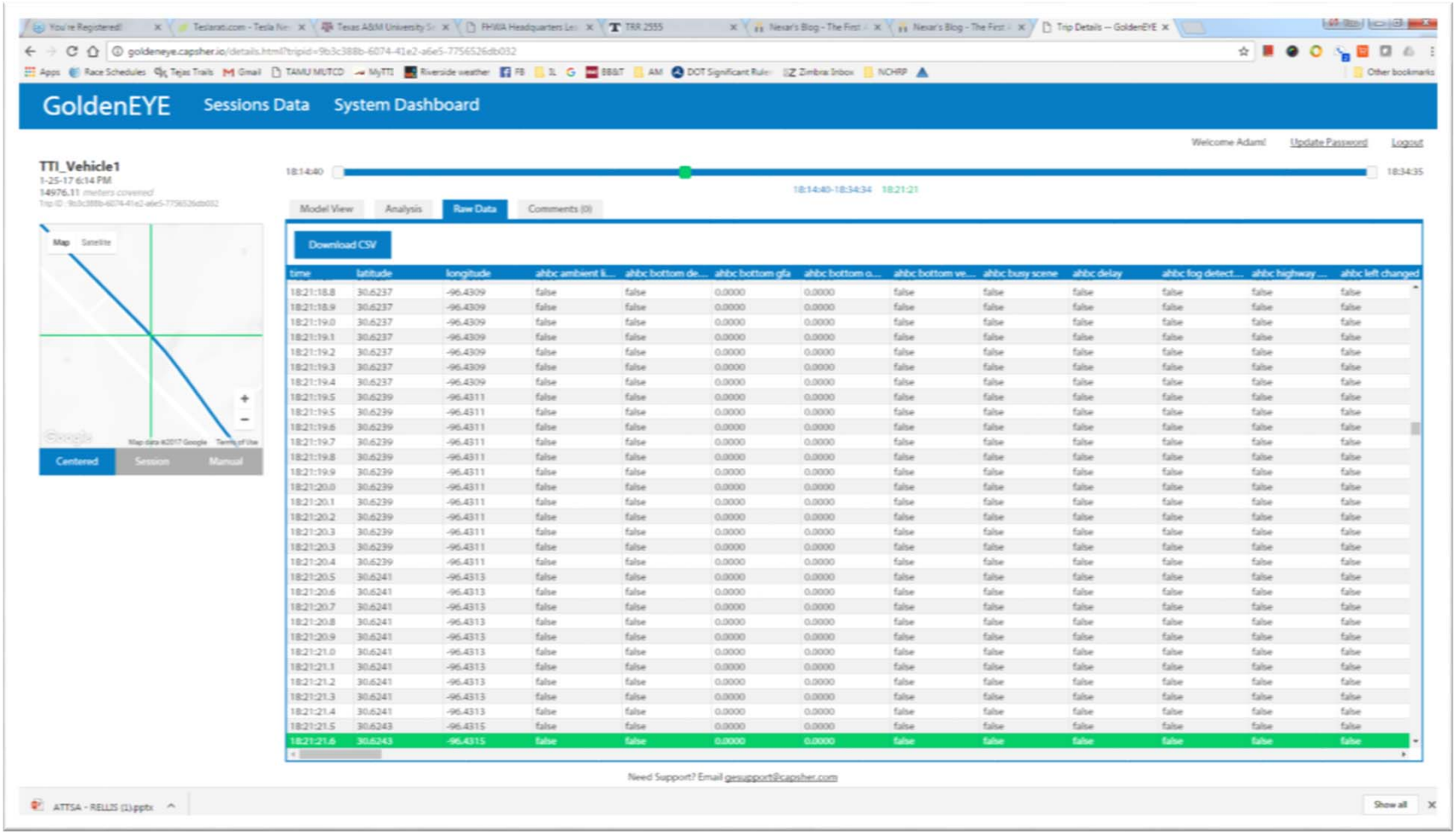
Visualizations



Meta Data – Speed Profile

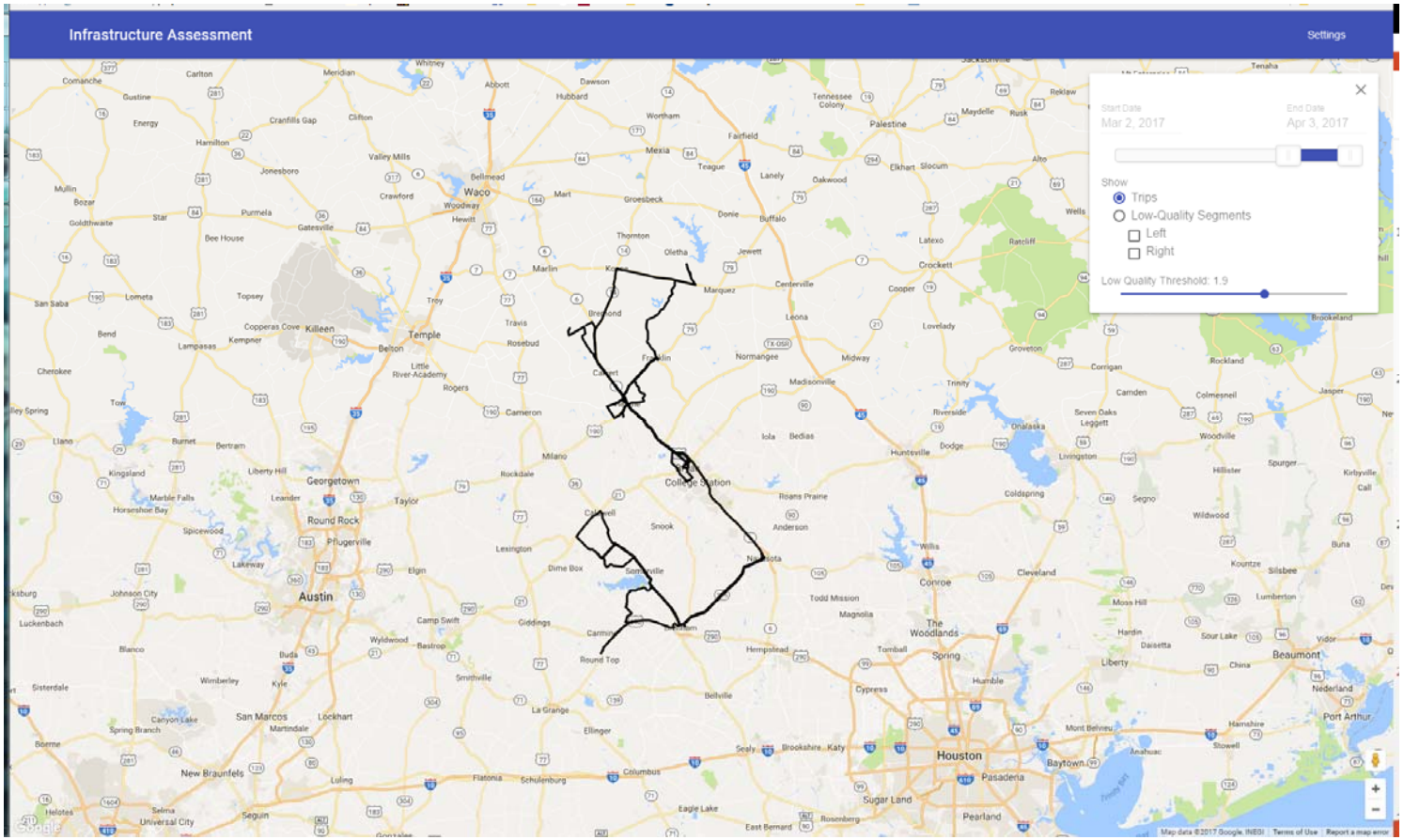


Raw Data



time	latitude	longitude	ahbc ambient li...	ahbc bottom de...	ahbc bottom gfa	ahbc bottom o...	ahbc bottom ve...	ahbc busy scene	ahbc delay	ahbc fog detect...	ahbc highway ...	ahbc left changed
18:21:18.8	30.6237	-96.4309	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:18.9	30.6237	-96.4309	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:19.0	30.6237	-96.4309	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:19.1	30.6237	-96.4309	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:19.2	30.6237	-96.4309	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:19.3	30.6237	-96.4309	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:19.4	30.6237	-96.4309	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:19.5	30.6239	-96.4311	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:19.5	30.6239	-96.4311	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:19.6	30.6239	-96.4311	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:19.7	30.6239	-96.4311	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:19.8	30.6239	-96.4311	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:19.9	30.6239	-96.4311	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:20.0	30.6239	-96.4311	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:20.1	30.6239	-96.4311	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:20.2	30.6239	-96.4311	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:20.3	30.6239	-96.4311	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:20.3	30.6239	-96.4311	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:20.4	30.6239	-96.4311	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:20.5	30.6241	-96.4313	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:20.6	30.6241	-96.4313	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:20.7	30.6241	-96.4313	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:20.8	30.6241	-96.4313	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:20.9	30.6241	-96.4313	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:21.0	30.6241	-96.4313	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:21.1	30.6241	-96.4313	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:21.2	30.6241	-96.4313	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:21.3	30.6241	-96.4313	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:21.4	30.6241	-96.4313	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:21.5	30.6243	-96.4315	false	false	0.0000	0.0000	false	false	false	false	false	false
18:21:21.6	30.6243	-96.4315	false	false	0.0000	0.0000	false	false	false	false	false	false

Trips in last 30 days



Infrastructure Assessment

Settings

Start Date: Mar 2, 2017

End Date: Apr 3, 2017

Show

● Trips

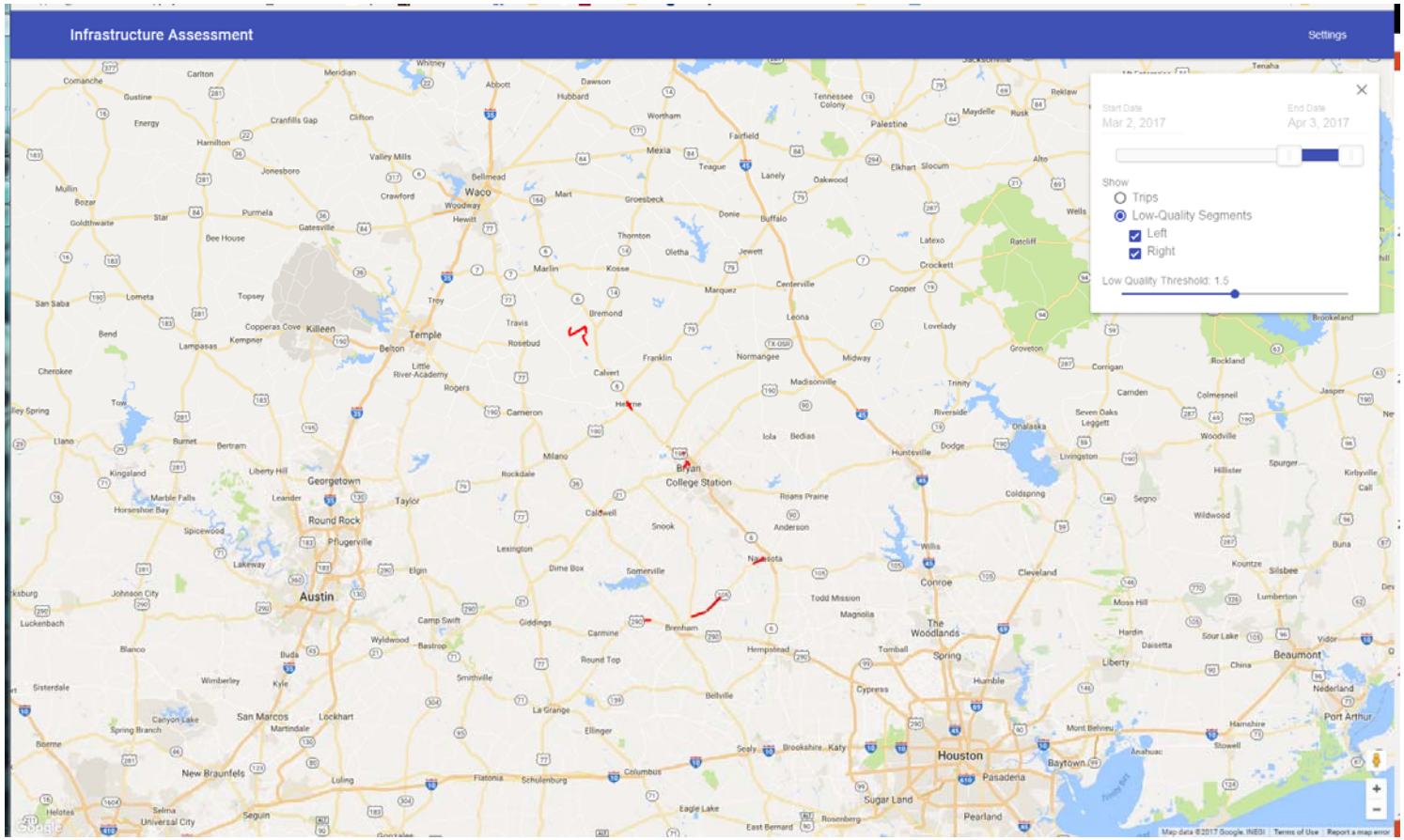
○ Low-Quality Segments

☐ Left

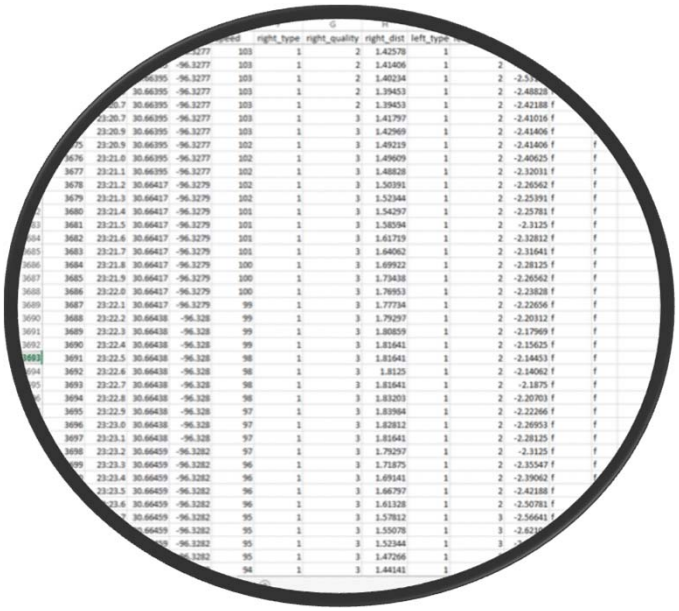
☐ Right

Low Quality Threshold: 1.9

Poor Markings



More Assets and Analytics Coming



Location Specific Details

High Level Dashboard