

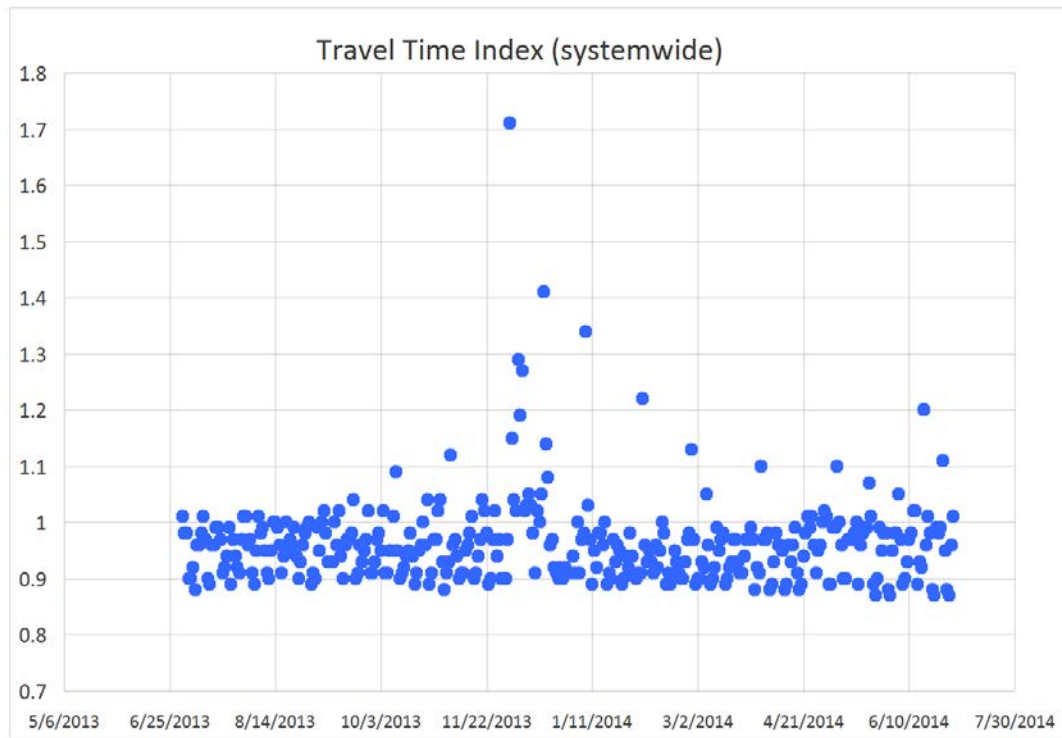
UDOT Snow and Ice Performance Measure

Jeff Williams, Cody Oppermann

Web Version



Weather and Travel Time Reliability

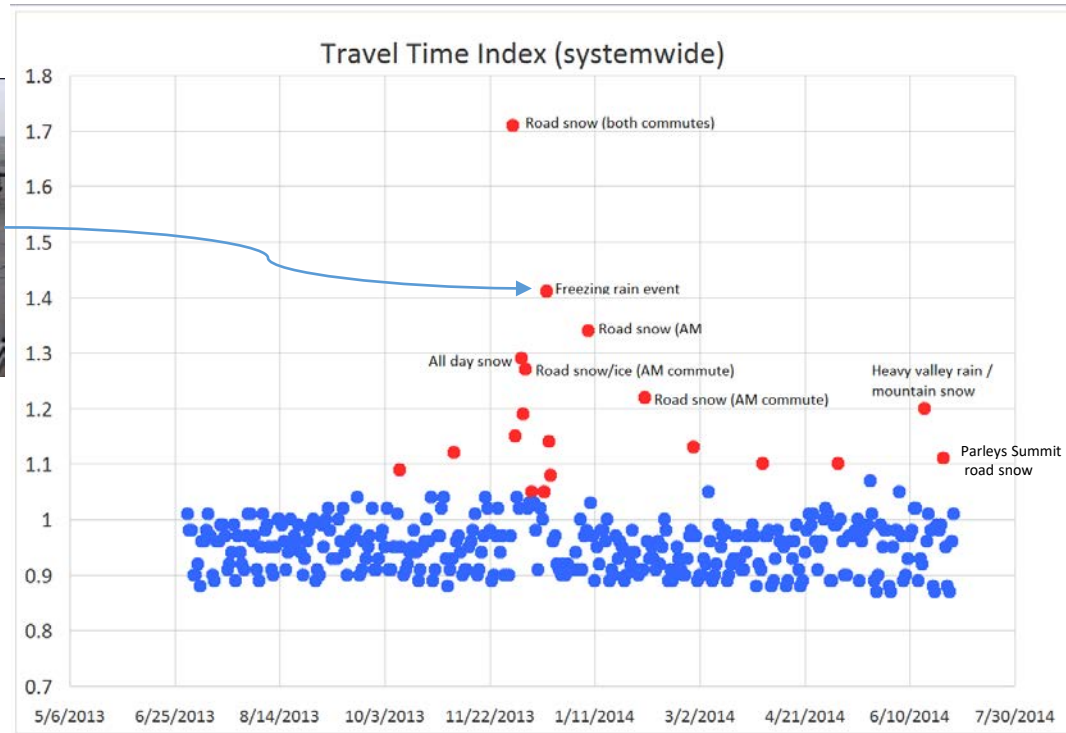


UDOT PeMS, 2014

Travel Time Index

The ratio of a measured *travel time* during congestion to the *time* required to make the same trip at free-flow speeds.

Weather and Travel Time Reliability



Travel Time Index

The ratio of a measured *travel time* during congestion to the *time* required to make the same trip at free-flow speeds.

Economic Impact of Road Weather Events

Economic impact in Utah for a 24 hour statewide winter storm

Total Economic Impact

•\$66.36 million

- **Wages & Salaries**
 - \$42.81 Million
- **Retail Sales**
 - \$18.26 million
- **Federal Taxes**
 - \$3.32 million
- **State and Local Taxes**
 - \$1.98 million



Source: American Highway Users Alliance performed by IHS Global Insight (2009)

The Problem Statement

- How can we measure our snow mitigation performance?
 - *What is measured can be managed -*
 - *and the converse is also true*

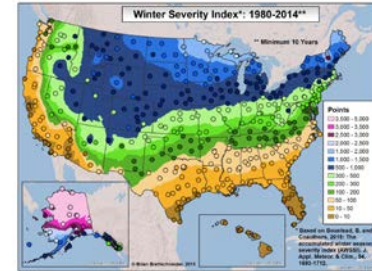


Acronyms

- **RWIS** – Road Weather Information System
- **SII** – Storm Intensity Index
- **S&I PM** – Snow and Ice Performance Measure
- **WRWI** – Winter Road Weather Index
- **Tr** – Road Temperature
- **Tw** – Wet-Bulb Temperature
- **SR** – Snowfall Rate
- **SRV** – Snowfall Rate Value
- **RTV** – Road Temperature Value
- **BSV** – Blowing Snow Value
- **FRV** – Freezing Rain Value

Indexes and Measures

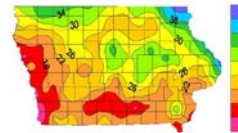
- Most winter severity indexes across the country
 - Utilizes Climate Network (National Weather Service)
 - No road weather data used
 - Snowfall measured on grass
 - Post analysis
- UDOT Snow and Ice Performance Measure (S&I PM)
 - Real-time index to evaluate weather and road conditions
 - Snowfall rates and road temperatures have the greatest impacts on roads
 - Wet-bulb temperature utilized for blowing snow, freezing rain and wet/dry snowfall
 - Developed in-house



Boustead et al., 2015

State	City	Station	Year	Winter Severity Index	Winter Severity Index	Winter Severity Index	Winter Severity Index	Winter Severity Index	Winter Severity Index
Alaska	Barrow	100000	2014	100	100	100	100	100	100
Alaska	Barrow	100000	2013	100	100	100	100	100	100
Alaska	Barrow	100000	2012	100	100	100	100	100	100
Alaska	Barrow	100000	2011	100	100	100	100	100	100
Alaska	Barrow	100000	2010	100	100	100	100	100	100
Alaska	Barrow	100000	2009	100	100	100	100	100	100
Alaska	Barrow	100000	2008	100	100	100	100	100	100
Alaska	Barrow	100000	2007	100	100	100	100	100	100
Alaska	Barrow	100000	2006	100	100	100	100	100	100
Alaska	Barrow	100000	2005	100	100	100	100	100	100
Alaska	Barrow	100000	2004	100	100	100	100	100	100
Alaska	Barrow	100000	2003	100	100	100	100	100	100
Alaska	Barrow	100000	2002	100	100	100	100	100	100
Alaska	Barrow	100000	2001	100	100	100	100	100	100
Alaska	Barrow	100000	2000	100	100	100	100	100	100
Alaska	Barrow	100000	1999	100	100	100	100	100	100
Alaska	Barrow	100000	1998	100	100	100	100	100	100
Alaska	Barrow	100000	1997	100	100	100	100	100	100
Alaska	Barrow	100000	1996	100	100	100	100	100	100
Alaska	Barrow	100000	1995	100	100	100	100	100	100
Alaska	Barrow	100000	1994	100	100	100	100	100	100
Alaska	Barrow	100000	1993	100	100	100	100	100	100
Alaska	Barrow	100000	1992	100	100	100	100	100	100
Alaska	Barrow	100000	1991	100	100	100	100	100	100
Alaska	Barrow	100000	1990	100	100	100	100	100	100
Alaska	Barrow	100000	1989	100	100	100	100	100	100
Alaska	Barrow	100000	1988	100	100	100	100	100	100
Alaska	Barrow	100000	1987	100	100	100	100	100	100
Alaska	Barrow	100000	1986	100	100	100	100	100	100
Alaska	Barrow	100000	1985	100	100	100	100	100	100
Alaska	Barrow	100000	1984	100	100	100	100	100	100
Alaska	Barrow	100000	1983	100	100	100	100	100	100
Alaska	Barrow	100000	1982	100	100	100	100	100	100
Alaska	Barrow	100000	1981	100	100	100	100	100	100
Alaska	Barrow	100000	1980	100	100	100	100	100	100

Bob Koeberlein, ITD, 2015



Iowa DOT, 2009

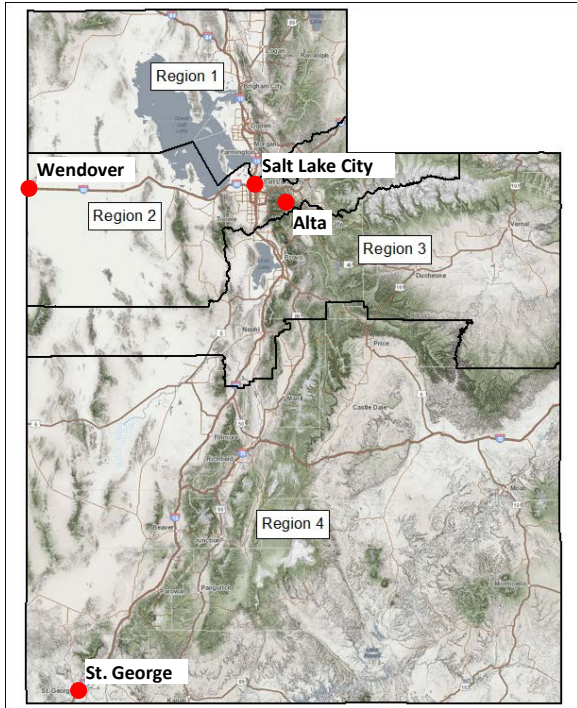


UDOT Snow Removal Policy

- UDOT Policy Number 06A-42, “Snow Removal”; updated January 15, 2008:

*“Each maintenance station operates under a Snow Plan... that is designed to keep at least one travel lane in each direction open [on all routes] during a storm where snow accumulates on the road at the rate of **one inch per hour** or less. When the rate of precipitation exceeds that design rate, snowfighting resources will be moved from lower priority routes to higher priority routes.”*

Utah's Climate



- Utah weather components evaluated:

Snowfall rate:

Lake effect snow and orographic effects can lead to snowfall rates that can exceed 5" per hour.

Road temperature:

Large elevation differences. Topography usually blocks Arctic air masses. Shaded canyons are cold.

Blowing snow, dryness of snow:

Winds usually are not strong due to topography, but light dry snow can easily blow and cover a road, particularly in the mountains.

Freezing rain:

Very rare in Utah as inversions usually mix out prior to precipitation, but can have an extreme impact.

	Wendover			Salt Lake City			Alta			St. George		
1981-2010	Dec.	Jan.	Feb.	Dec.	Jan.	Feb.	Dec.	Jan.	Feb.	Dec.	Jan.	Feb.
Avg. Mean Temp.	26.8 °F	26.4 °F	32.4 °F	30.3 °F	29.5 °F	34.2 °F	22.1 °F	22.5 °F	22.8 °F	41.3 °F	42.4 °F	47.0 °F
Average Snowfall	1.3"	1.6"	1.4"	13.2"	12.5"	10.7"	103.5"	71.4"	78.0"	0.1"	0.7"	0.3"

First Step: Winter Road Weather Index (WRWI)

- -Decided to use available RWIS data to take a first step at winter road weather severity

-Approach:

WRWI = 1 when:

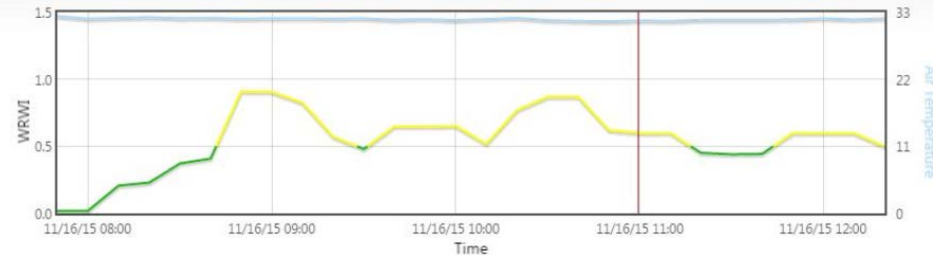
Snow-covered road

Snowfall rate = 1"/hr

Road temp. = Wet-bulb temp. = 32 °F

Wind gust < 20 mph

Value modified with worsening and improving road and weather conditions (more details below...)



Benefits:

Good identifier of traveling conditions and perhaps predicting short-term road conditions

Next step:

Need to evaluate performance - WRWI also equals 1 when road is wet and snowfall rate = 2"/hr...

Subtract the road conditions from the WRWI and compare to other atmospheric conditions.

Next Step: UDOT Snow and Ice Performance Measure (S&I PM)

Cause vs. Effect

Cause: *Storm Intensity Index* - atmospheric conditions and road temperature

Effect: Resulting road grip or road condition (non-invasive road sensors)

UDOT Maintenance Benchmarks

1" per hour for 32°F road temperature

3/4" per hour for 22°F road temperature

1/2" per hour for 17°F road temperature

Blowing snow and freezing rain also considered utilizing wet-bulb temperature



@jaegersloan, GIPHY, 2015

Performance is assessed every 10 minutes

Storm Intensity Index (SII)

If road is not dry...

$$\begin{aligned}
 \text{SII} &= \\
 &+ \text{(Snowfall Rate Value)} \\
 &+ \text{Road Temperature Value} \\
 &+ \text{Blowing Snow Value} \\
 &+ \text{Freezing Rain Value) } \times 2 + 1
 \end{aligned}$$

Visibility + Precipitation + Tw < 35
 SR = 0.5 / visibility
 SRV = (SR - 1) / 2

RTV increases linearly with colder Tr, more so below 22 degrees
 (=0.125 at 22 degrees)

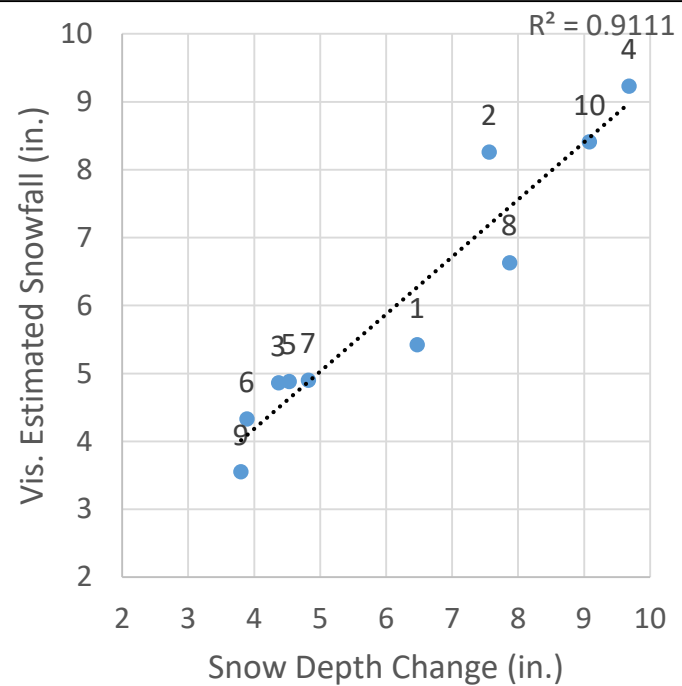
BSV increases linearly with colder Tw, more so below 20 degrees, AND more so as wind gust increases above 20 mph

FRV = 0.5 when Tr <= 32 and Tw >= 34 and road is not wet

Snowfall Rate Evaluation

After adjusting the visibility...

Sample	Snow Depth Change	Vis.-Estimated Snowfall	Percent Change
1	6.47"	5.42"	16.1%
2	7.56"	8.26"	-9.3%
3	4.37"	4.86"	-11.1%
4	9.68"	9.23"	4.6%
5	4.53"	4.88"	-7.6%
6	3.89"	4.33"	-11.3%
7	4.82"	4.90"	-1.54%
8	7.87"	6.63"	15.7%
9	3.80"	3.55"	6.5%
10	9.08"	8.41"	7.4%



Snow and Ice Performance Measure “Rubik’s Cube”

Heavy Winter Wx	yellow	green	green
Mod. Winter Wx	red	yellow	green
Flurries to No Winter Wx	red	red	yellow
	Snow Covered (.21)	Slush (.45)	Wet/Dry
	Condition/(Grip) ->		

← Snowfall Rate = 1”/hr
Road Temp = 32°
Wet-Bulb Temp = 32°
Light winds

← Snowfall Rate = 1/4”/hr
Road Temp = 32°
Wet-Bulb Temp = 32°
Light winds

Definitions:

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

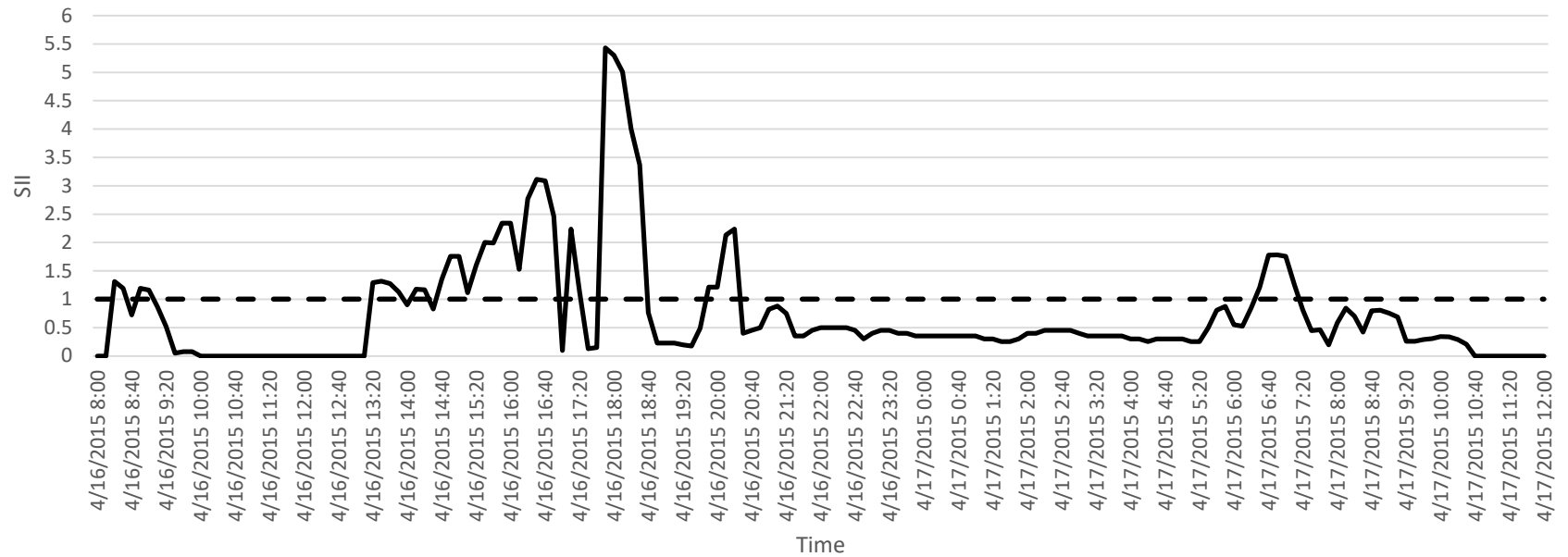
Yellow – Acceptable road conditions per given weather conditions

Red – Unacceptable; potential for improved road conditions per given weather conditions

*Exception: No overnight plowing

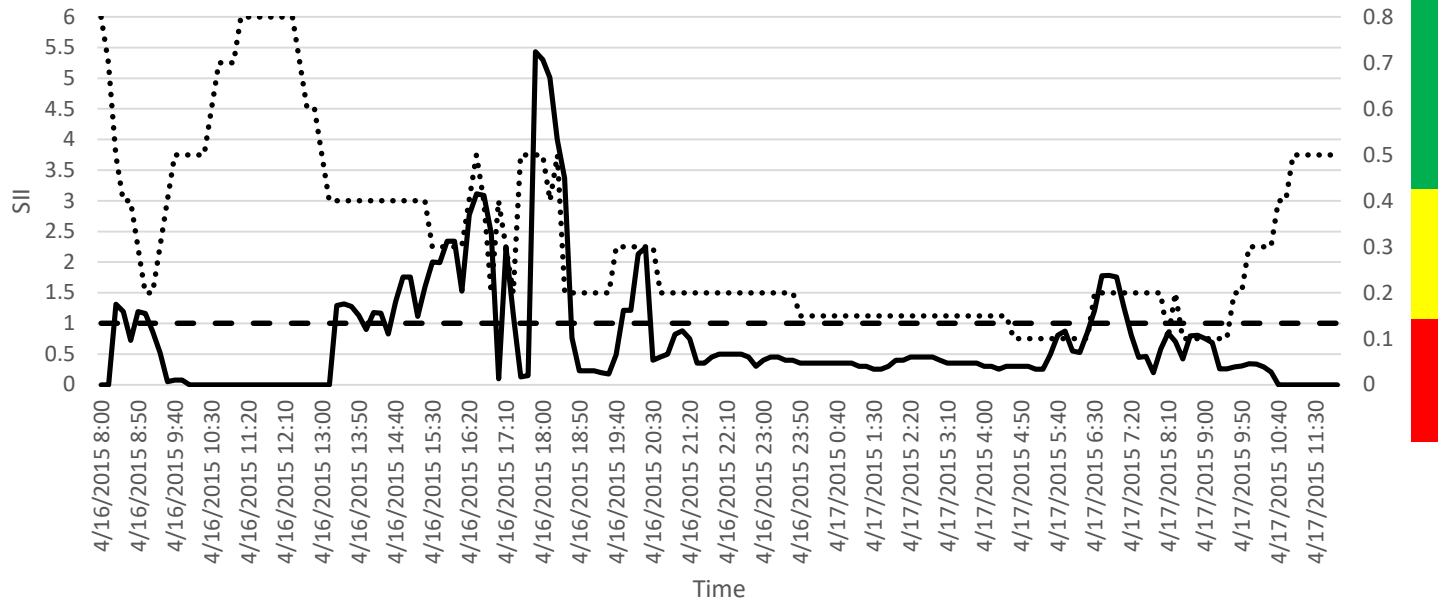
Storm Intensity Index (cause)...

Boulder Summit SII 4/16-17/2015



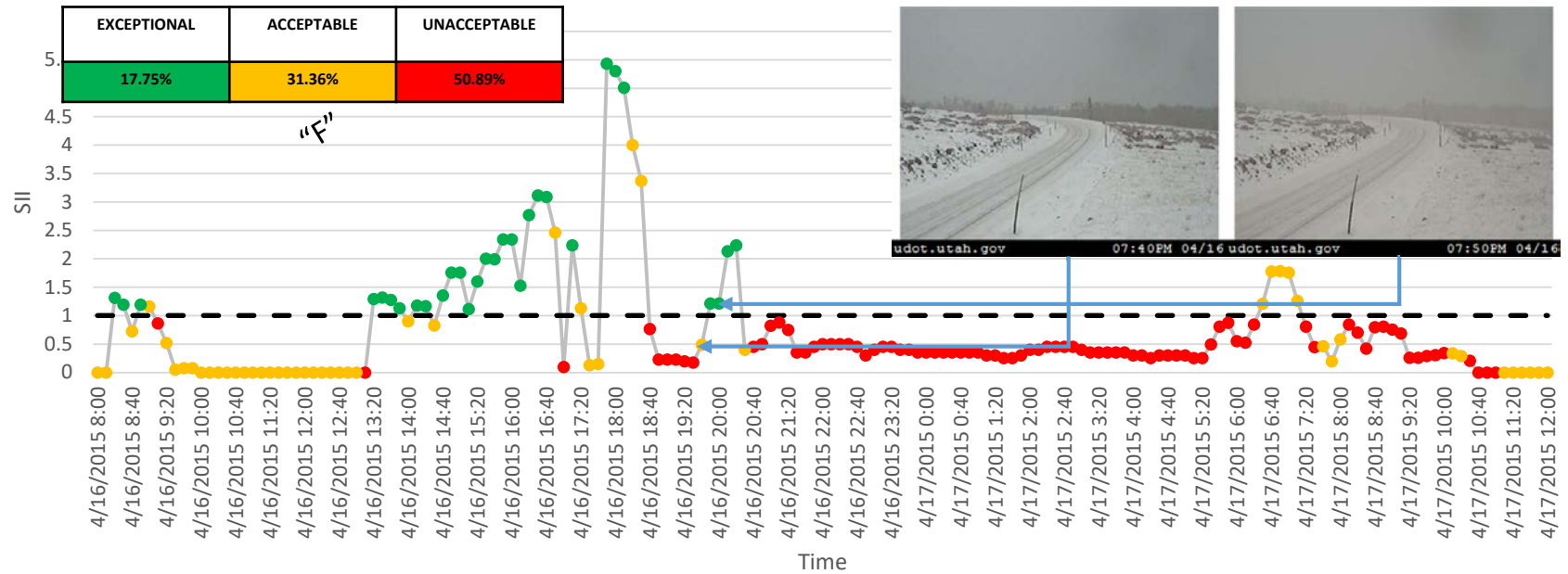
...with grip (effect)

Boulder Summit SII vs. Grip 4/16-17/2015



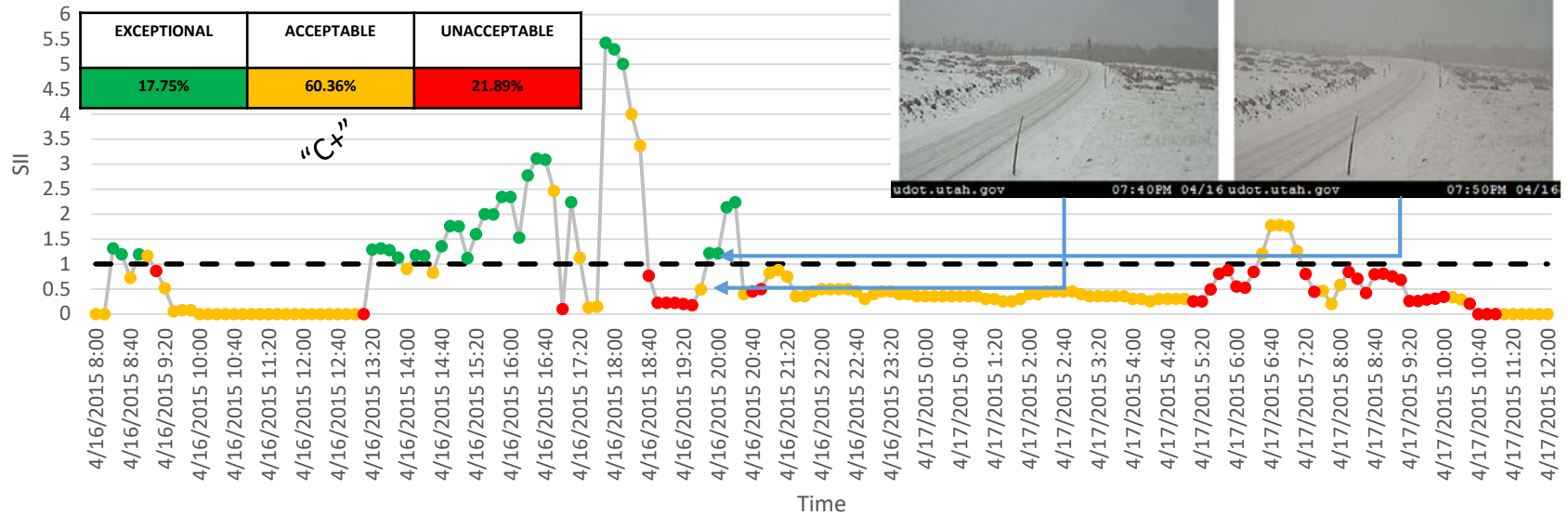
S&I PM

Snow and Ice Performance Measure - Boulder Summit 4/16-17/2015



S&I PM

Snow and Ice Performance Measure - Boulder Summit 4/16-17/2015 - No Overnight Plowing



Detailed Example 1 – Strong Event

Strong Event - 750 MST 14 December 2015

RWIS Site: I-80 @ Mouth of Parley's (MesoWest Site ID: UT5)

RWIS Variable	740 MST	750 MST	Worst Condition	WRWI Variable	
IceSight Grip	0.15	0.15	0.15	RCV	1.200
Precipitation Detected	Yes	Yes	Yes		
Visibility (mi)	0.23	0.35	0.23	SRV	0.585
Snowfall Rate (in/hr)	1.42	2.17	2.17	RTV	0.063
Road Temperature (°F)	26.96	26.96	26.96	BSV	0.061
Wet-bulb temperature (°F)	26.1	26.4	26.1	FRV	0.000
Wind gust (mph)	0*	0*	0*	WRWI	1.909
				SII	2.419
				S&I PM	Acceptable



udot.utah.gov

07:48AM 12/14

Detailed Example 2 – Weak Event

Weak Event - 1540 MST 30 January 2016

RWIS Site: US-6 @ Red Narrows (MesoWest Site ID: RDN)

RWIS Variable	1530 MST	1540 MST	Worst Condition	WRWI Variable	
Vaisala DSC Condition	Wet	Wet	Wet	RCV	0.500
Precipitation Detected	Yes	Yes	Yes		
Visibility (mi)	1.62	1.76	1.62	SRV	-0.345
Snowfall Rate (in/hr)	0.31	0.28	0.31	RTV	0.011
Road Temperature (°F)	32	31.1	31.1	BSV	0.059
Wet-bulb temperature (°F)	26.34	26.3	26.3	FRV	0.000
Wind gust (mph)	14.69	15.34	15.34	WRWI	0.226
				SII	0.451
				S&I PM	Exceptional



udot.utah.gov

03:40PM 01/30

Detailed Example 3 – Heavy Snow, Wet Road

Heavy Snow, Wet Road - 330 MST 24 January 2016
RWIS Site: SR-85 @ Dannon Way (MesoWest Site ID: UTDWY)

RWIS Variable	320 MST	330 MST	Worst Condition	WRWI Variable	
Vaisala DSC Condition	Wet	Wet	Wet	RCV	0.500
Precipitation Detected	No	Yes	Yes		
Visibility (mi)	0.4	0.39	0.39	SRV	0.140
Snowfall Rate (in/hr)	1.25	1.28	1.28	RTV	0.025
Road Temperature (°F)	30.2	30.02	30.02	BSV	0.005
Wet-bulb temperature (°F)	31.5	31.6	31.5	FRV	0.000
Wind gust (mph)	11	8.8	11	WRWI	0.670
				SII	1.340
				S&I PM	Exceptional



Detailed Example 4 – No Snow, Snow-Covered Road

No Snow, Snow-Covered Road - 1020 MST 4 February 2016
 RWIS Site: SR-12 @ Boulder Summit (MesoWest Site ID: UTBLD)

RWIS Variable	1010 MST	1020 MST	Worst Condition	WRWI Variable	
IceSight Grip	0.2	0.2	0.2	RCV	1.100
Precipitation Detected	No	No	No		
Visibility (mi)	10	10	10	SRV	-0.500
Snowfall Rate (in/hr)	0	0	0	RTV	0.039
Road Temperature (°F)	30	28.9	28.9	BSV	0.000*
Wet-bulb temperature (°F)	18.7	19.7	18.7	FRV	0.000
Wind gust (mph)	7.45	9.21	9.21	WRWI	0.639
				SII	0.078
				S&I PM	Unacceptable



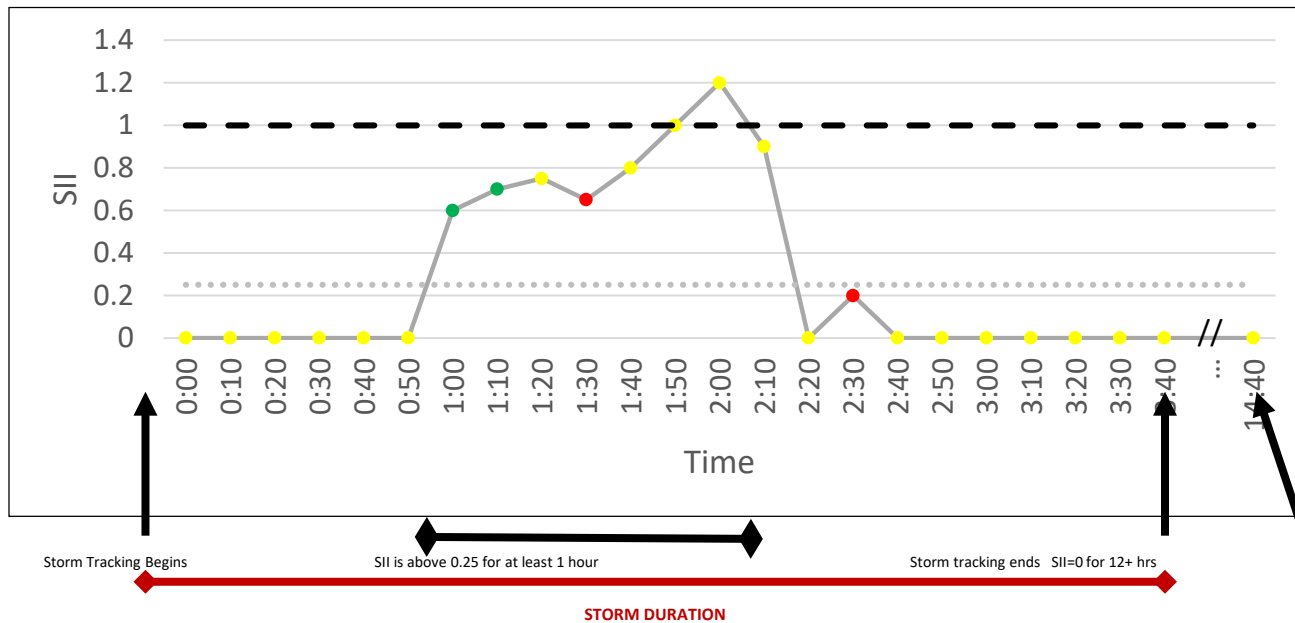
Detailed Example 5 – Freezing Rain

"Freezing Rain" Scenario - 820 MST 15 February 2016
RWIS Site: SR-190 @ Cardiff (MesoWest Site ID: UTCDF)

RWIS Variable	810 MST	820 MST	Worst Condition	WRWI Variable	
IceSight Grip	0.22	0.22	0.22	RCV	1.060
Precipitation Detected	Yes	Yes	Yes		
Visibility (mi)	9.63	9.62	9.62		
Snowfall Rate (in/hr)	0	0	0	SRV	-0.500
Road Temperature (°F)	30.92	30.92	30.92	RTV	0.014
Wet-bulb temperature (°F)	35.29	35	35	BSV	0.000
Wind gust (mph)	19.07	17.97	19.07	FRV	0.500
				WRWI	1.074
				SII	1.027
				S&I PM	Exceptional



Automated Storm Identification

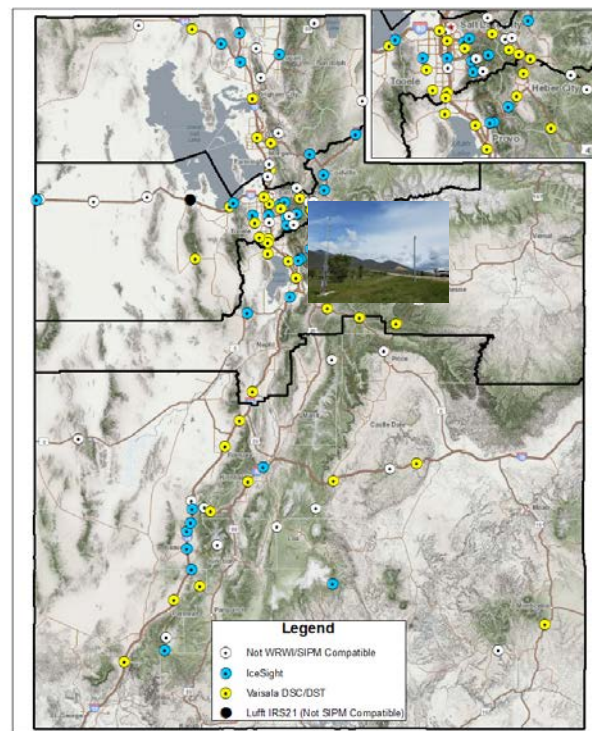


UDOT's RWIS Network

- 109+ RWIS stations
- 69 compatible stations
- Over 1200 devices
- Goal: Minimum one site per maintenance shed (53/78 sheds complete)
- Currently expanding on average about one RWIS per month



UDOT RWIS, 1/1/2018



Instruments Used/S&I PM Variables Needed

- For the S&I PM:

- -Air temperature/relative humidity:
(Vaisala HMP45C, HC2S3 Rotronic HygroClip2, or Elektronik EE181)

→Wet-bulb temperature

- -Visibility/precipitation occurrence
(Campbell Scientific CS125)

→Snowfall rate

- -Wind speed/**gust**/direction
(RM Young 05103/05108-45)

- -**Road condition/road grip/road temperature**
(High Sierra Electronics IceSight, Vaisala DSC/DST)

- Other sensors used for support:

- -18" soil temperature
(Campbell Scientific 107)

- -Soil moisture
(Campbell Scientific CS655)

- -Liquid accumulation
(Texas Instruments TE525)

- -Snow depth
(Campbell Scientific SR50A)

- -Solar radiation
(LI-COR LI200X)



Images courtesy of Campbell Scientific, Inc., Vaisala, and High Sierra Electronics, Inc., 2018



Campbell Scientific, Inc., 2018



Morningstar Corp., 2018



Red Lion Controls, Inc., 2018

Siemens, 2018

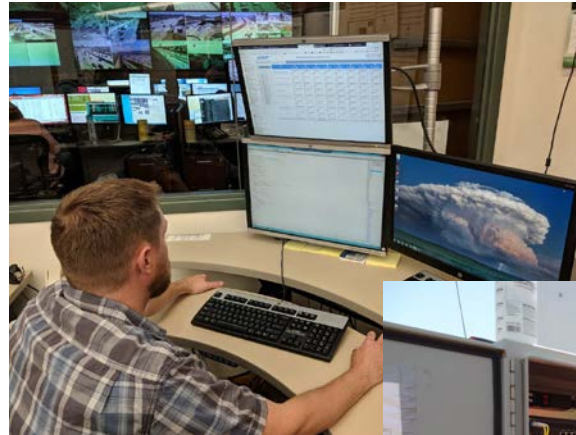


RELION Batteries, 2018

RWIS Maintenance Plan

- Contract Meteorologists provide:
 - Installation and integration**
 - Preventative maintenance** on every compatible site at least once per year
 - Quick response maintenance**
 - At least **90%** uptime of all RWIS sensors since November 2014
 - Budget for **end-of-life replacement** for all sensors and solar power equipment
 - Datalogger Programming**

Instrumentation purchasing not limited to one vendor; customizable system



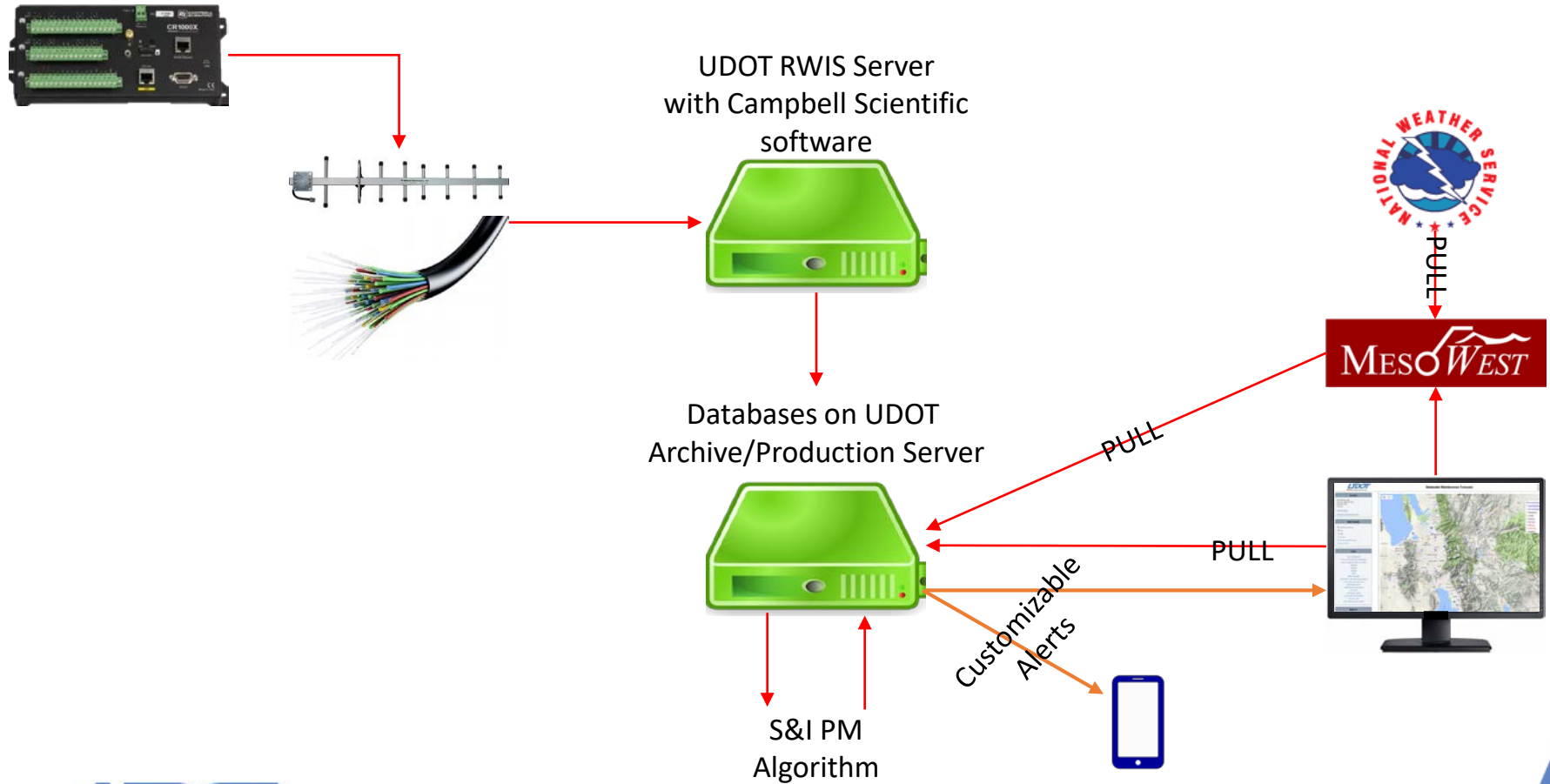
RWIS Costs and Challenges

- Full RWIS with contractor installation and instrumentation (including camera):
~\$45,000 - \$50,000



- -Find a representative area with interesting weather/crash hot spot.
- Find an adequate camera view, if applicable.
- Follow World Meteorological Organization/Federal Highway Administration recommendations.
- Get a pole within 20' of the fog line to achieve a 45° angle; data accuracy found to be maximized at this angle.
- Try to get road sensor to sample the right lane, the main lane plowed.

RWIS/S&I PM Dataflow



CR1000X Sample Code

```

1  'Master_Vaisala_1_5.CR1X
2  'CR1000X program to run with a Vaisala DSC/DST.
3
4  'Version: 1.5
5  'Date: 04/16/2018
6  'Program author: Cody Oppermann
7
8  '(Version 1 publish date: 11/29/2017)
9
10 'Other instruments: Rotronic, HMP45C, EE181, RMYoung 05103, 107, SR50A, LI200X,
11 '  CS125, TE525
12 'DOES NOT INCLUDE: IRS21, ARS31, 108, IceSight, Sentinel
13 'Data Tables: MesoAtmo, MesoRoad, PresentWx, Daily
14 'All data tables
15
16 'Edits:
17 '2 - 11/30/2017:
18 '
19 '
20 '3 - 12/12/2017:
21 '4 - 2/20/2018:
22 '
23 '5 - 4/10/2018: Added LI200X and CC640 to the program.
24 '6 - 4/16/2018: Fixed problem with Batt_volt being in Tw code rather
25 '               than RH_percent.
26
27 '-
28 'Run in SequentialMode? Used primarily for SnowDepth?
29 '-
30
31 'Declare Constants
32
33 'Declare Snow Depth Constant
34 Const SR50_initial_dist_in = 54.25055
35 'Does tipping bucket exist? No = 0, Yes = 1
36 Const rain_exist = 0
37

```

```

38 'Declare Public Variables
39 'Main variables
40 Public Batt_volt
41 Public Air_Temp_f
42 Public RH_percent
43 Public TdC
44 Public TdF
45 Public TwC
46 Public TwF
47 Public Wind_Dir_deg
48 Public Wind_Speed_mph
49 Public Two_Min_Wind_Dir_deg
50 Public Two_Min_Wind_Speed_mph
51 Public Precip As String *3
52 Public Precip_Intensity As String *8
53
54 Public Analog
55 Public Solar_v
56 Public Solar_mj
57 Public Ground_18in_Temp_f
58 Public SnowfallRate
59
60 'SR50A variables
61 Public Snow_Depth_in
62 Public TCdT
63 Public SR50(2)
64 Alias SR50(1) = dist_raw_in
65 Alias SR50(2) = SR50Quality
66
67 'DST/DST variables
68 Public dscraw As String * 400
69 Public dscpoll As String
70

```

UDOT's RWIS/Forecast Page

The screenshot displays the UDOT website's RWIS/Forecast page. On the left is a sidebar with sections: **Contact** (24/7 Weather Desk, Toll Free 1-866-291-4514, (801) 867-3703, Feedback, Current Road Alerts, Subscription to Forecasts and RWIS Alerts), **Map Overlay** (Maintenance Forecast, RWIS, Radar, Cameras, Snow and Ice Performance, Snow Plow AVL), and **Links** (Storm Management, Snow and Ice Performance Dashboard, Recommended Salt Application Rates, MesoWest, Masonet, SateSite, Radar, Monthly Outlook, March 2018 - May 2018 Spring Outlook, Current Road Conditions (bats), Road Weather Alert, Utah Emergency Information, River Data, Fire Weather Outlook, Current Utah Fire Information, Live View Cams, RWIS Streaming Camera Map). Below these is a **Regions** section. The main area is titled **Statewide Maintenance Forecast** and features a map of Utah with various weather data overlays. A legend on the right lists: Air Temperature, Road Temperature, Soil Temperature, Snowfall rate, Visibility, Road Grip, Dew Point, Wind Gust, Wind Speed, and Wind Barb. Annotations with red arrows point to specific features: one points to the 'Snow and Ice Performance' option in the Map Overlay section; another points to the 'Storm Management' link in the Links section; a third points to a specific RWIS site on the map; and a fourth points to the 'Snow and Ice Performance Dashboard' link in the Links section.

Contact
24/7 Weather Desk
Toll Free 1-866-291-4514
(801) 867-3703
Feedback
Current Road Alerts
Subscription to Forecasts and RWIS Alerts

Map Overlay
☒ Maintenance Forecast
☒ RWIS
☐ Radar
☐ Cameras
☐ Snow and Ice Performance
☐ Snow Plow AVL

Links
Storm Management
Snow and Ice Performance Dashboard
Recommended Salt Application Rates
MesoWest
Masonet
SateSite
Radar
Monthly Outlook
March 2018 - May 2018 Spring Outlook
Current Road Conditions (bats)
Road Weather Alert
Utah Emergency Information
River Data
Fire Weather Outlook
Current Utah Fire Information
Live View Cams
RWIS Streaming Camera Map

Regions

Statewide Maintenance Forecast

Clicking on "Snow and Ice Performance" shows the current performance and SII for each RWIS

Clicking on an individual RWIS site brings up the site's Performance Page

Clicking on "Storm Management" bring up a customizable multi-site look; approved users only

Clicking on "Snow and Ice Performance Dashboard" brings up the current statewide performance summary

udottraffic.utah.gov/forecastview

Site-Specific Performance Page

I-80 @ Parleys Summit

Link to Mesowest (tabular data)

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

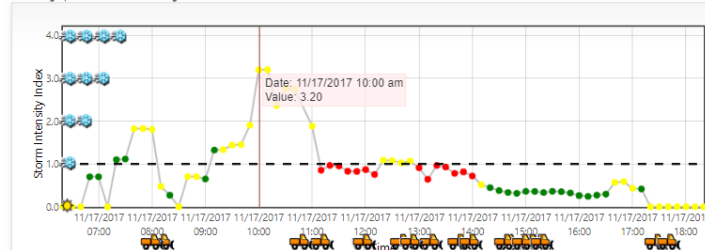
Past 12 hrs Past 24 hrs Past 36 hrs Past 48 hrs Start Date 11/17/2017 6:20 AM End Date 11/17/2017 6:20 PM Go

Download RWIS Data

Resource Performance Statistics - Storm 4

EXCEPTIONAL	ACCEPTABLE	UNACCEPTABLE	MAINTENANCE RESOURCE GRADE
30.56%	50.0%	19.44%	B-

Click on graph to view data and images...



Graph Variables Left Axis Storm Intensity Index Right Axis Select Right Axis



Conditions at 11/17/2017 10:00 am

Tmp/RH: 31.0 °F/ 94.7% Wind: W 7.2 mph, Gust: 9.2 mph | Rd: 30.9 °F, Snow | Vis: 0.16 mi | Snow: 3.14 in/hr | Depth: n/a | Precip: Heavy | Grip: 0.33 | SII: 3.20

Current Season		2016-2017	2015-2016	2014-2015		
No	Storm Event	Avg. Storm Intensity *	Storm Duration =	Storm Severity Index	Performance	
7	12/20/2017 2:40:00 PM - 12/21/2017 1:00:00 PM	.48 (***)	22.33	10.75	93.33% (A)	
6	12/16/2017 12:00:00 PM - 12/17/2017 6:20:00 AM	.13 (*)	18.33	2.32	100% (A+)	

Current Conditions	
Sample Time:	2/28/18 9:20 AM
Temp/RH:	19.5° F / 90.0%
Wind:	W 9.0 mph, Gust 14.7 mph
Visibility:	10.00 mi
Snowfall rate:	0.00 in/hr
Precipitation Intensity:	Light
Snow Depth:	n/a
Road:	28.9° F, Damp
Road Grip:	0.81
Storm Intensity Index	0.00

Legend	
Green line	Road conditions exceptional given weather condition
Yellow line	Road conditions acceptable given weather condition
Red line	Unacceptable given weather condition
Dashed line	Winter maintenance baseline

Selected Storm Event Summary - Storm 4			
Weather Statistics	Minimum	Average	Maximum
Air Temp	23.7° F	28.9° F	36.0° F
Road Temp	29.8° F	31.9° F	42.1° F
Wind Gust	7.7 mph	20.0 mph	31.1 mph
Est. Snowfall Rate	0.0°/hr	0.6°/hr	3.1°/hr
Road Grip	0.25	0.60	0.78

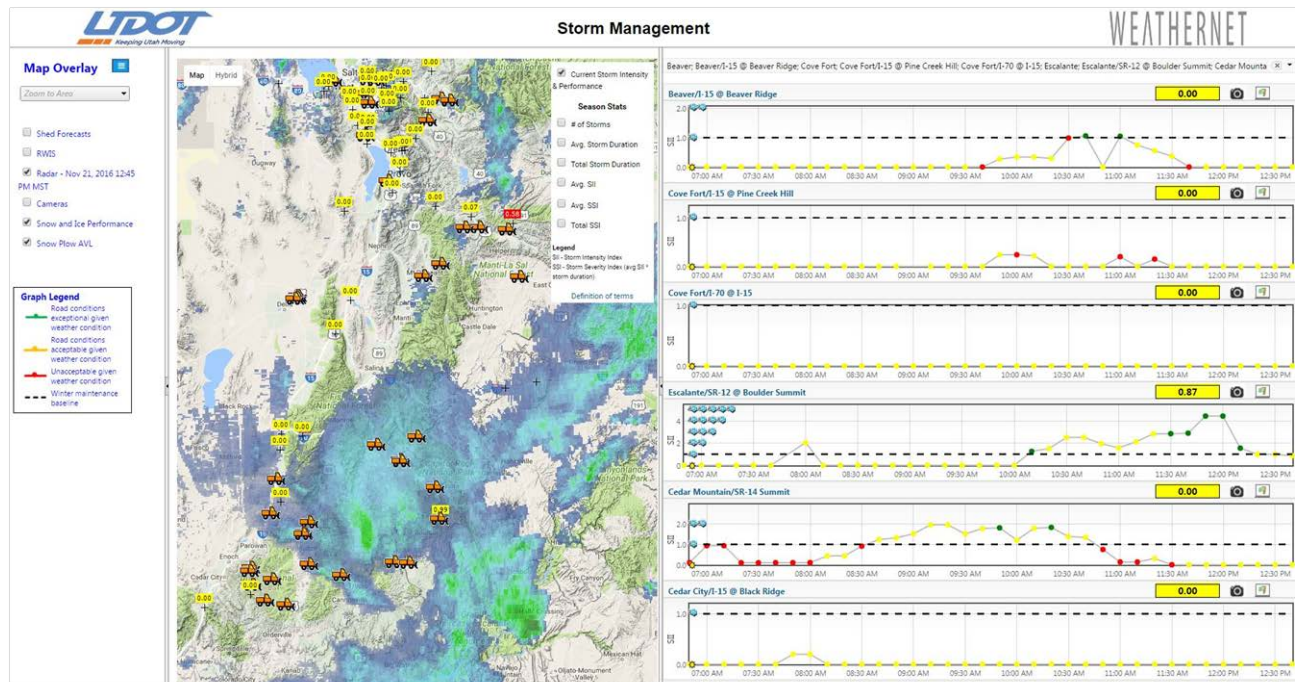
Current Winter Summary (through 2/25/2018 10:20:00 AM)	
Average Resource Performance: 90.55% (A-)	High
Number of Storms: 14	High
Average Storm Duration (hrs): 28.9	Moderate
Total Storm Duration (hrs): 404.7	High
Average Storm Intensity Index: 0.50	High
Storm Intensity Index Sum: 6.96	High
Average Storm Severity Index: 17.31	High
Storm Severity Index Sum: 242.39	High

More information on the Storm Intensity Index and Snow and Ice Performance Measure

PowerPoint

UDOT Weather Desk: 801-887-3703

Storm Management Dashboard



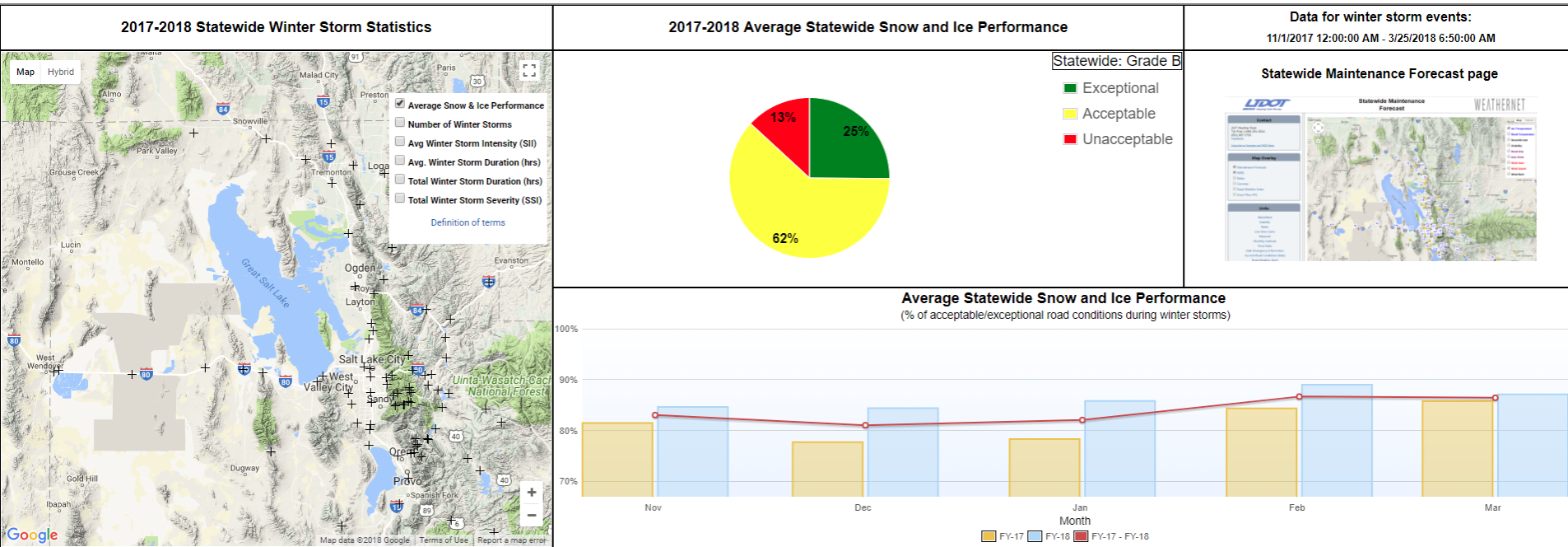
For approved users

Clicking on "Storm Performance Reports" brings up a customizable performance summary by route and/or UDOT region and date range

Performance Dashboard

Statewide Snow and Ice Performance Dashboard

[Storm Performance Reports](#)

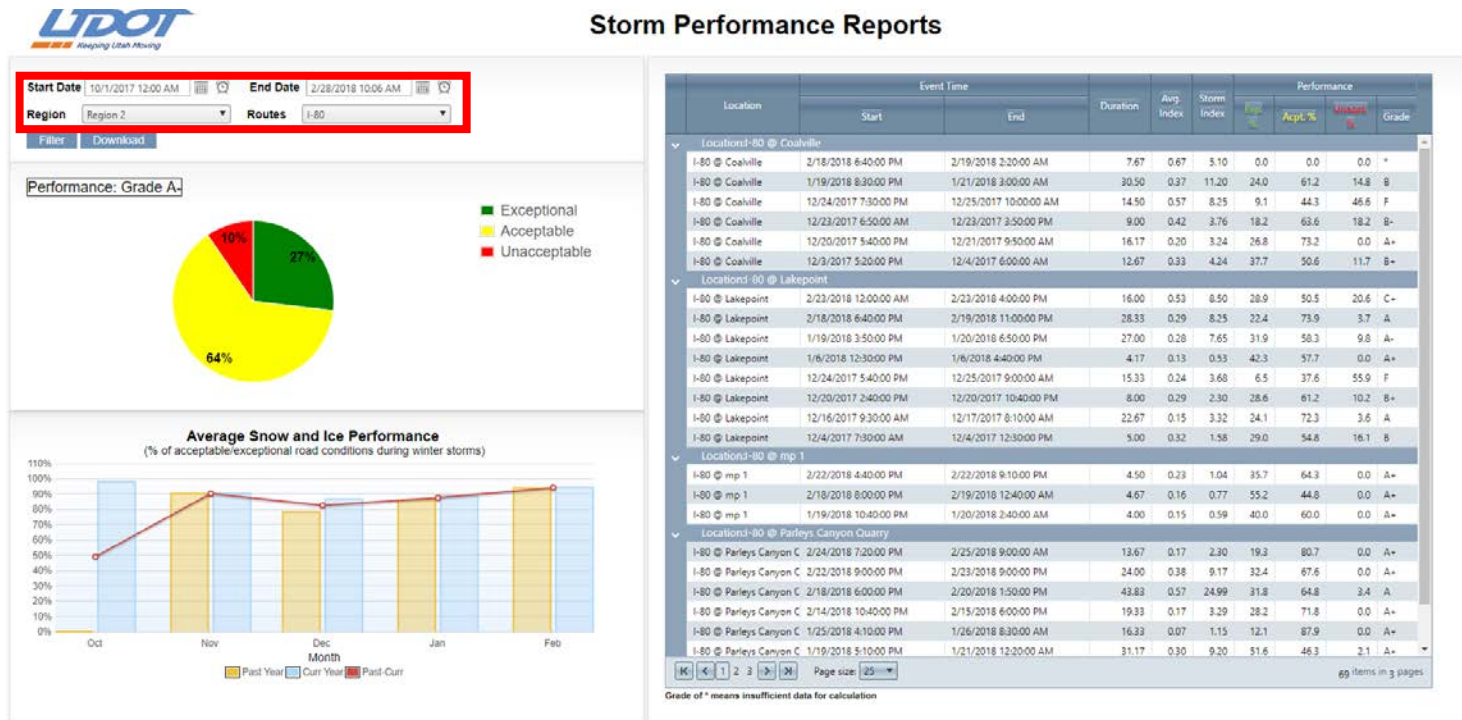


udottraffic.utah.gov/forecastview/ssipdashboard.aspx



Performance Reports

Storm Performance Reports



udottraffic.utah.gov/forecastview/PerformanceGrades.aspx

Challenges

- Data quality/verification
 - Need a reliable RWIS network
 - Check data weekly, with the aid of saving nearby camera images
 - Known issues:
 - Occasional road sensor inaccuracy
 - Sensor failure
 - Flurries in fog
 - High traffic
 - Reasonable SII in extreme conditions?



Future Improvements

- Expansion of RWIS network
- Better storm identification
- Instrumentation improvements
- Snowfall rate adjustments in troublesome conditions
- Algorithm tweaks?
- 35 mph traffic speeds
- Set performance benchmarks for different route priorities
- Better functionality, mobile support?
- Integrated Mobile Observations to fill in the gaps?
- Further develop UDOT Maintenance's knowledge and use

Summary

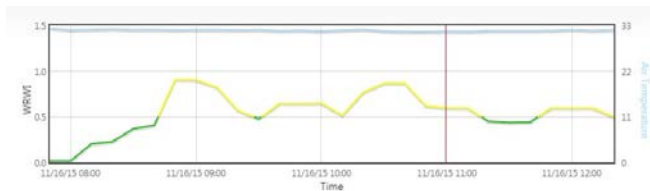
WRWI



S&I PM

SII + Road Condition

SII VS. Road Condition



Good at identifying (and potentially predicting) bad travel conditions...
But what kind of travel conditions?



Succinctly tells us how intense the storm was and how crews performed at specific times. Better decision making can then be made during and after the storm, and summarized at the end of winter for long-term resource decisions.

White Paper



Questions?



Jeff Williams
Weather Program Manager
jeffwilliams@utah.gov

Cody Oppermann
RWIS Coordinator/Research Meteorologist
coppermann@utah.gov