Utah DOT Snow Removal Performance Metrics.....2.0

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PNS CONFERENCE 2018

Spokane, WA

First…..A Little About ME

- Grew up in Salt Lake City (Midvale) Utah
- Joined the **US NAVY** and went to boot camp **26** days after high school graduation to get **$$$** for college
- **Sonar Technician 2nd class (E-5)** on naval destroyer **USS Kinkaid (DD-965)**
- Decomissioned ship in January 2003
- USS Kinkaid was sunk during a SINKEX in July 2004
- Now an artificial reef off the coast of Hawaii

First…..A Little About ME

- Sonar Technician 2nd Class on naval destroyer **USS Fletcher (DD-992)** after participating in the **Sea Swap Program**
- Goal of **Sea Swap Program** was to extend time "in theater"
- USS Fletcher was sunk during a SINKEX in July 2008
- Now an artificial reef off coast of Hawaii

****

- Spent **6 years** in the **US NAVY** – Received **Honorable Discharge**

First.....A Little About ME

- Attended **Arizona State University (ASU)** using the **GI Bill** after my 6-year enlistment in the **US Navy**

- Graduated in spring of 2009 with a **Bachelor of Science (BSE)** in Civil Engineering

ASU
ARIZONA STATE UNIVERSITY

First…..A Little About ME

- Started working for **UDOT** in fall of **2009** as an **Unbenefited Intern** in the **Asphalt Mix Laboratory** at UDOT Central where we did Material testing (asphalt, binder, aggregate, concrete)
- Got accepted into **UDOT's** Rotational Engineering Program in spring of **2011** – spent 3 years as a **Rotational Engineer**
- Earned my **Professional Engineering (P.E.) License** spring of **2014**

First.....A Little About ME

- During time in **Rotational Engineering Program** at **UDOT** I got the opportunity to work in these 4 Departments:
  - Construction (6 mos)
  - Maintenance (6 mos)
  - Construction again (6 mos)
  - Design (12 mos)
  - Traffic & Safety (6 mos)

- After getting a full time job at **UDOT** in spring 2014 I have worked:
  - Design (3 yrs)
  - Traffic and Safety (1 yr)
  - Currently in MAINTENANCE PLANNING (8 mos)

Now, Down To Business.....

Winter Road Weather Index

- UDOT rolled out what was called the **Winter Road Weather Index (WRWI)** in October of 2013 – 1st iteration of what would eventually become.....

- The **Snow & Ice Performance Measure** followed in October of 2015 – system has now been online for **just under 3 years** and for **3 winters**:
- 2015/2016
- 2016/2017
- 2017/2018

Now, Down To Business.....

Winter Road Weather Index

- The **WRWI** and **Snow & Ice Performance Measure** were created in conjunction with UDOT Traffic Operation Center (TOC) Weather Group's

- **Jeff Williams (Weather Program Manager)**

and.....

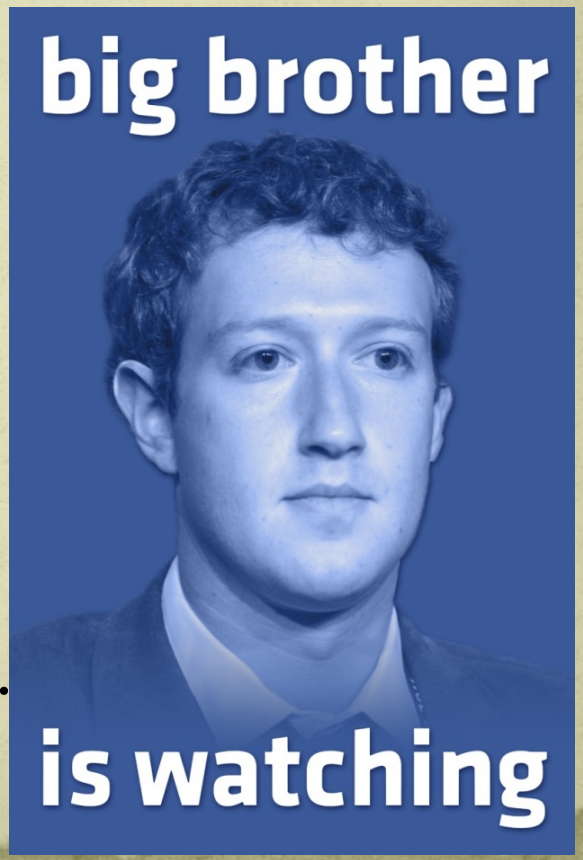
- **Cody Opperman (Weather Program Specialist)**

- UDOT's Weather Website:

http://www.udottraffic.utah.gov/ForecastView/Default.aspx

Initial Hesitation With GPS Units

- Transportation Technicians were at first very hesitant to have “tracking devices” installed in their plows
- Snow & Ice Performance Measure is supplemented by a GPS system installed in the plow trucks
- GPS units allow for Automatic Vehicle Location (AVL)
- **BIG BROTHER** is watching us….



Initial Hesitation With GPS Units

- GPS units work with **Force America controllers** inside of snow plows to document the locations of such parameters as:

  - Types of material dispensed (salt, brine, sand, etc.)
  - Rate of materials dispensed
  - Blade time up/down
  - Lane miles plowed
  - Vehicle min/max speed
  - Salt "blast" duration for emergencies and accidents
  - Pre-wetting time for anti-icing operations

Initial Hesitation With GPS Units

- Decision came down Maintenance Planning and upper management's desire to better optimize snow plow operations → **be good stewards of TAXPAYER $$$**

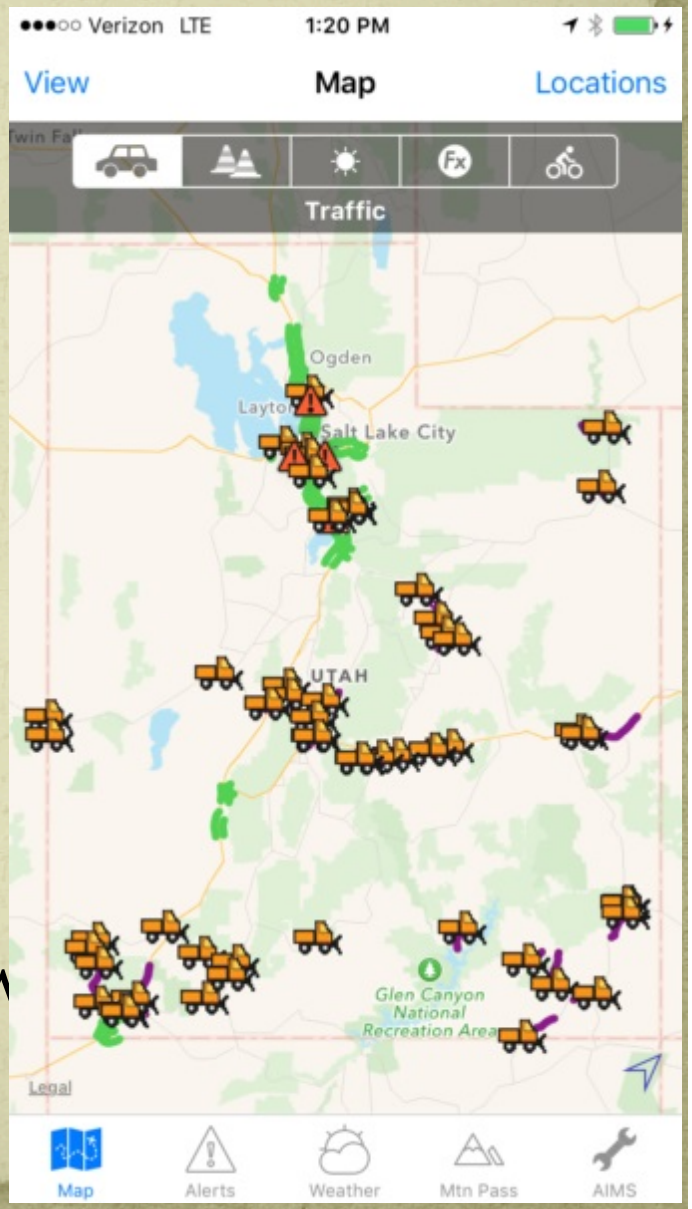
- Case was made to the Transportation Techs by upper management that MILLION+ DOLLAR MACHINES, aka **Snow Plows**, are worth tracking despite the perceived **BIG BROTHER EFFECT** they were feeling

- Distrust with the new tracking system faded over time because……

Time Heals All Wounds

Automatic Vehicle Location (AVL) System

- One thing that GPS units in snow plows allowed for is development of the Automatic Vehicle Location (AVL) system
- Using UDOT's Traffic app citizens can see the approximate locations of snow plows
- We set a <u>10 minute lag</u> to keep plow drivers safe from The Unruly



Automatic Vehicle Location (AVL) System

- **Beneficial for The Public:**
  - Can avoid where the snowplows are currently working
  - Can see what areas have already been plowed and are clear of snow and ice
  - Can see their tax **$$$'s** hard at work

- **Beneficial for UDOT:**
  - Better track plow movements to see what areas have already been plowed → **Reallocate Resources**
  - Respond to **Citizen Inquiries** to verify if plow has already been through and when they came through
  - **Plow Route Optimization** through trial and error

Some FACTS About Utah's ROADWAYS

- 5,865 Centerline Miles
- 24,300 Lane Miles
- 1,867 Bridges
- 25-35 Average Storm Events per year statewide
- Remove 65 million tons of snow & ice per year
- 500 Snow Plows
  - $5.6 million in Labor $$$ per year
  - $4.6 million in Equipment $$$ per year
  - $5.0 million in Material $$$ per year

Some FACTS About Utah's ROADWAYS

Interstate
Centerline Miles ~ 935, 16%
Lane Miles ~ 30%
VMT ~ 53%
Combo VMT ~ 62%

Level 1
>1,000 vehicles or 200 trucks per day
Centerline Miles ~ 2,980, 51%
Lane Miles ~ 51%
VMT ~ 45%
Combo VMT ~ 36%

Level 2
<1,000 vehicles or 200 trucks per day
Centerline Miles ~ 1,960, 33%
Lane Miles ~ 19%
VMT ~ 2%
Combo VMT, 2%

Total
Centerline Miles ~ 5,865
Lane Miles ~ 24,300
VMT ~ 47,712,150
Combo VMT ~ 5,726,3500

Some FACTS About Utah's SNOWFALL

- 80% of Utah's population is living along the Wasatch Front (Ogden, Salt Lake City, Provo)
- Terrain varies from **2000 ft - 13,500 ft** above sea level
- **Lake Effect Snowfall** – Great Salt Lake never freezes (salinity 5-27%) and causes its own weather formations
- Varied snowfall throughout Utah
  - Alta Ski Resort – 508 inches (42.3 ft) per year, record is 910 inches (75.8 ft) back in 1983
  - Wasatch Front – 40-120 inches per year (3.3 ft - 10 ft)
  - St. George – 3 inches per year
  - Wendover – 5 inches per year

Some FACTS About Utah's ECONOMY

- **Economic Impact of a Single 24-Hour Storm Event:**

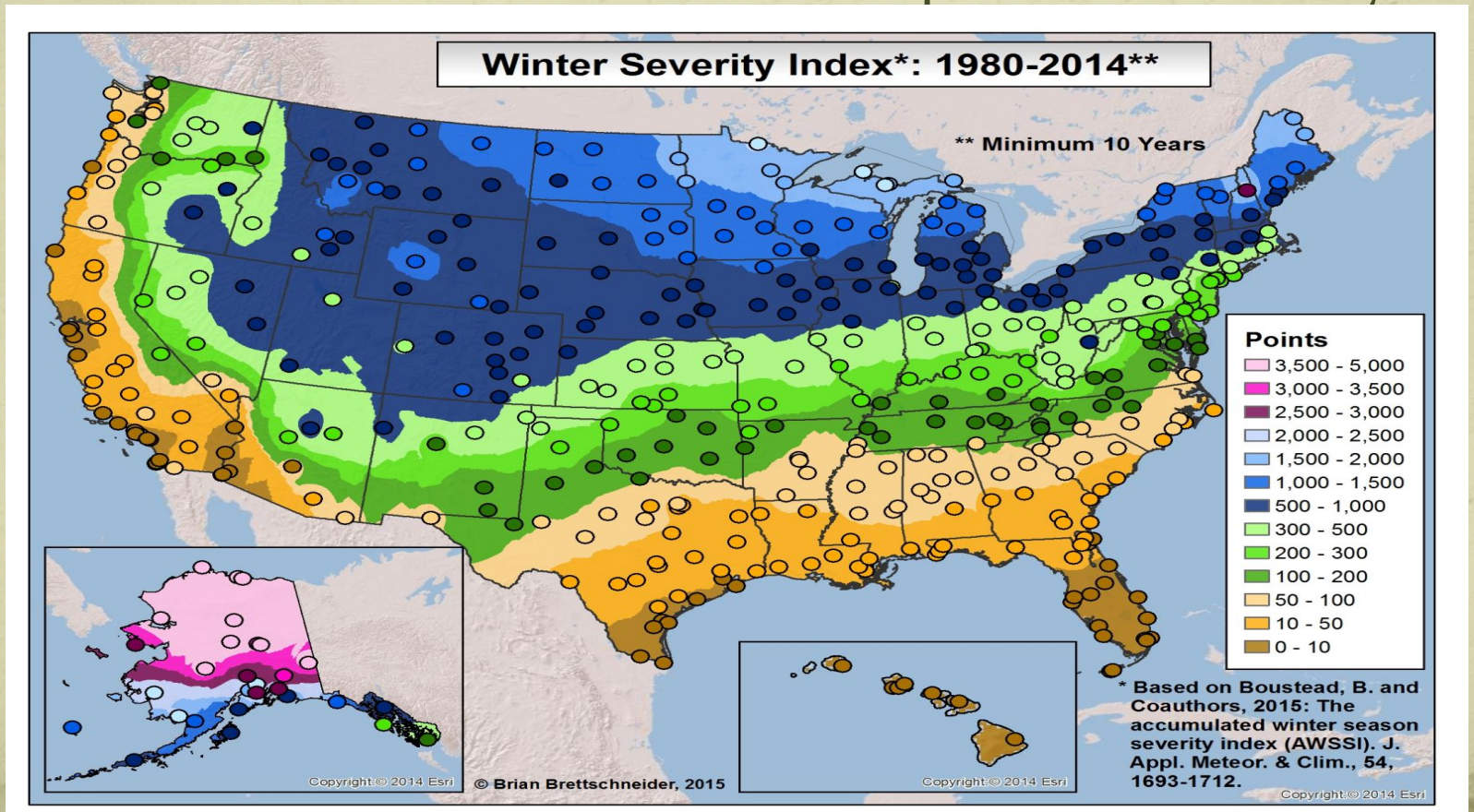
  - Wages & Salaries……..$42.81 M
  - Retail Sales……..$18.26 M
  - Federal Taxes……..$3.32 M
  - State & Local Taxes……$1.98 M

- Total Economic Impact **$66.37 million LOST**

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

Nationwide Index or Measures?

- **The Climate Network** (National Weather Service)
  - No **road weather data** is used
  - Snowfall is measured on **grass** – this methodology doesn't fit our needs in the transportation industry



Utah's Needs In A Measure/Index

- At UDOT we found that we needed a ***Real-Time Index*** to evaluate weather, road conditions, and the snow removal efforts performance by Maintenance Crews

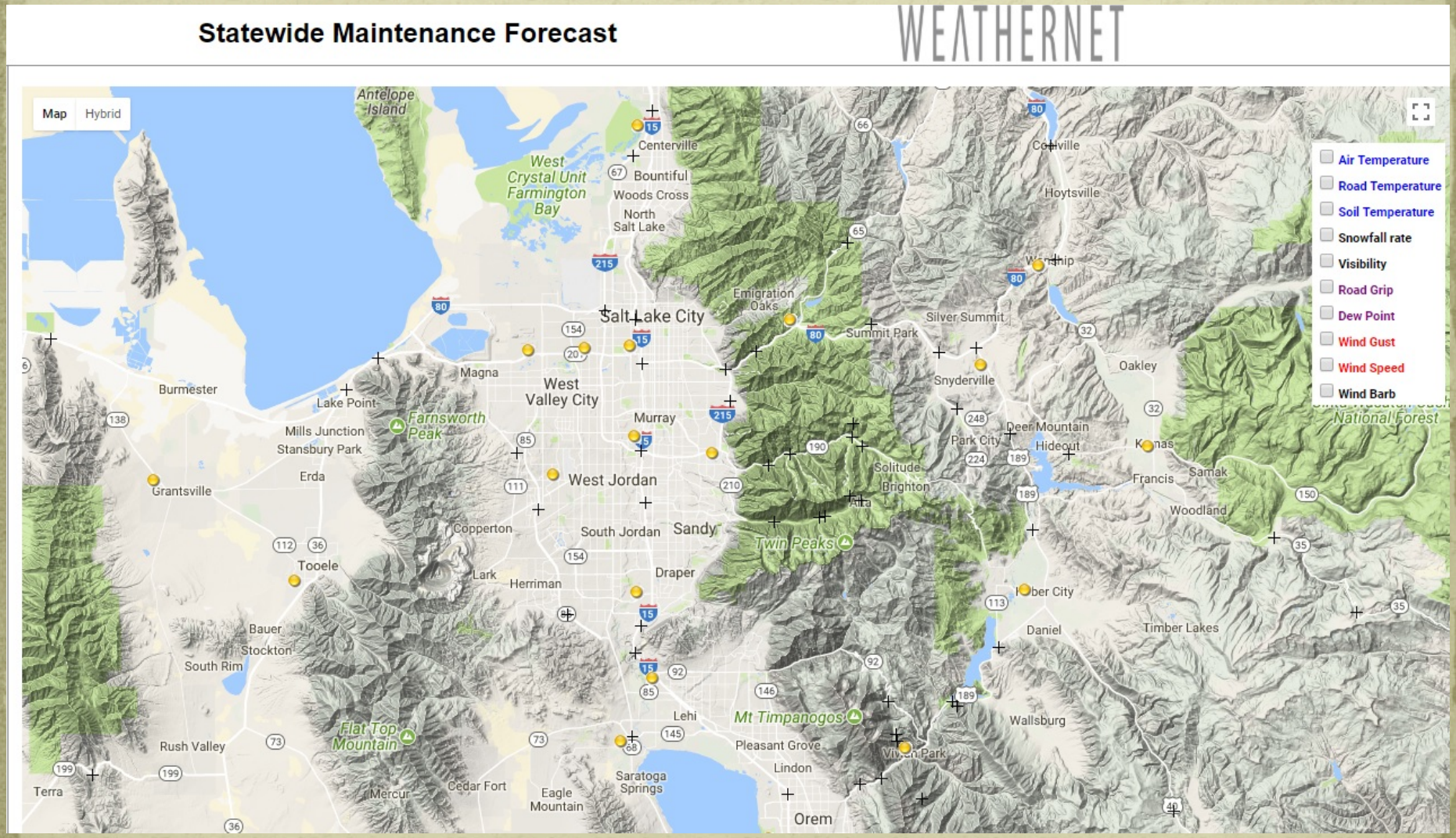
- We have found that **snowfall rates & road temps** have the highest impacts on "roadway health"

- Our ***Real-Time Index*** accounts for blowing snow (snow drifts), freezing rain, & wet/dry snowfall

Using RWIS Sites To Gather Data

- With no nationwide method we began to look at our RWIS stations for data to parse
- **RWIS:** **R**oadway **W**eather **I**nformation **S**ystem
- We use RWIS data along with a sophisticated algorithm to "**GRADE**" snow removal efforts
- Algorithm was developed by the UDOT Weather Group (namely **Jeff Williams** & **Cody Oppermann**)
- RWIS stations are spread out far apart throughout the state = Not a complete picture of ROADWAY HEALTH

RWIS Stations Along Wasatch Front



Data That RWIS Provides UDOT

- RWIS stations provide us with the following data:
  - Air Temp
  - **Road Temp**
  - Soil Temp
  - Soil Moisture
  - **Wet-Bulb Temp**
  - **Snowfall Rate (found through Visibility sensor)**
  - **Road Grip/Condition**
  - (see the "**Decision Matrix**" aka.....
  - .....the **Griffin Grip Cube**) →
  - Dew Point
  - **Wind Gust**
  - Wind Speed
  - Wind Direction
  - Solar Radiance

Mr. Kevin Griffin

Using RWIS Sites To Gather Data

- UDOT owns **109+** RWIS stations total
- **69** of these RWIS stations are compatible with Snow & Ice Performance Measure
- The other **40** stations are mobile trailers or are older stations not compatible
- **Goal:** minimum of **1** RWIS site per Maintenance Station
- Expand by **1** RWIS station per month on average

RWIS Road Condition Sensors

- Road Condition Sensor is pointed at a 45° angle to maximize data accuracy (***usually*** the far right lane)

- Analyzes approximately **5 ft²** of pavement

- Full RWIS station with Contractor install and instrumentation:

≈ $45,000 - $50,000

Looking Toward the Future With……

Connected/Autonomous Vehicles

- It is fiscally impractical to put RWIS stations along every section of corridor
- RWIS stations do not overlap; i.e. there are "gaps" that are not covered and thus → **do not** provide a clear picture of roadway weather or health
- Our goal is to have a statewide network for **Snow & Ice Performance Measure**
- UDOT has put forth a research proposal at **UTRAC (Utah Research Advisory Council)** to see if using Connected/Autonomous Vehicles help fill in "gaps"

Looking Toward the Future With.....

Connected/Autonomous Vehicles

Storm Intensity Index - SII

- Quantifies ***atmospheric conditions*** & ***road temperature*** into a single value = **Storm Intensity Index (SII)**

- **Storm Intensity Index (SII):** "The severity of the weather impacting the road. A value of **SII = 1** corresponds to **1"** of snowfall per hour with a road temp & wet bulb temp of **32° F** with light winds."

- **Storm Intensity Index (SII)** accounts for:
  1 - **Snowfall Rate** (found through Visibility sensor)
  2 - **Wind Gust** (≥ 20mph)
  3 - **Wet-Bulb Temperature** (used for determination of the ***Precipitation Type*** and ***Dry/Wet Snow***)
  4 – **Road Temperature**

Storm Intensity Index - SII

At temps > 35° F and dry road the SII will always equal 0

- **When road temperature < 35° F and road is <u>not</u> dry….**

1 - *<u>Snowfall Rate</u>*

- Visibility is used to estimate Snowfall Rate
- Precipitation occurrence is used to differentiate **Fog** from **Snow**

2 - *<u>Wind Gust (≥ 20mph)</u>*

- More impact with lower wet bulb temps (drier snow blows across road)
- Tends to cause snow drifting across roadways

Storm Intensity Index - SII

- **When road temperature < 35° F and road is <u>not</u> dry….**

3 - ***<u>Wet Bulb Temperature</u>***

- Used instead of Air Temperature because it tells us more
- Major factor in if it **Rains** or **Snows**
- Used to distinguish **Rain** from **Snow** in the algorithm
- Low wet bulb temp equates to drier snow = easier to haul off
- Major factor in if precipitation evaporates or ices over

4 - ***<u>Road Temperature</u>***

- The colder the road, the more difficult to mitigate
- Major factor in if precipitation evaporates or ices over

Snow & Ice Performance Measure

- The Snow and Ice Performance Measure then compares the 4 variables of the **Storm Intensity Index (SII)** to either the:

  - **Road Condition** (Dry, wet, slushy, snow, ice)
    - Different sensor than Road Grip

OR……

  - **Road Grip** (A value between 0 and 0.82)
    - Different sensor than Road Condition

Snow & Ice Performance Measure

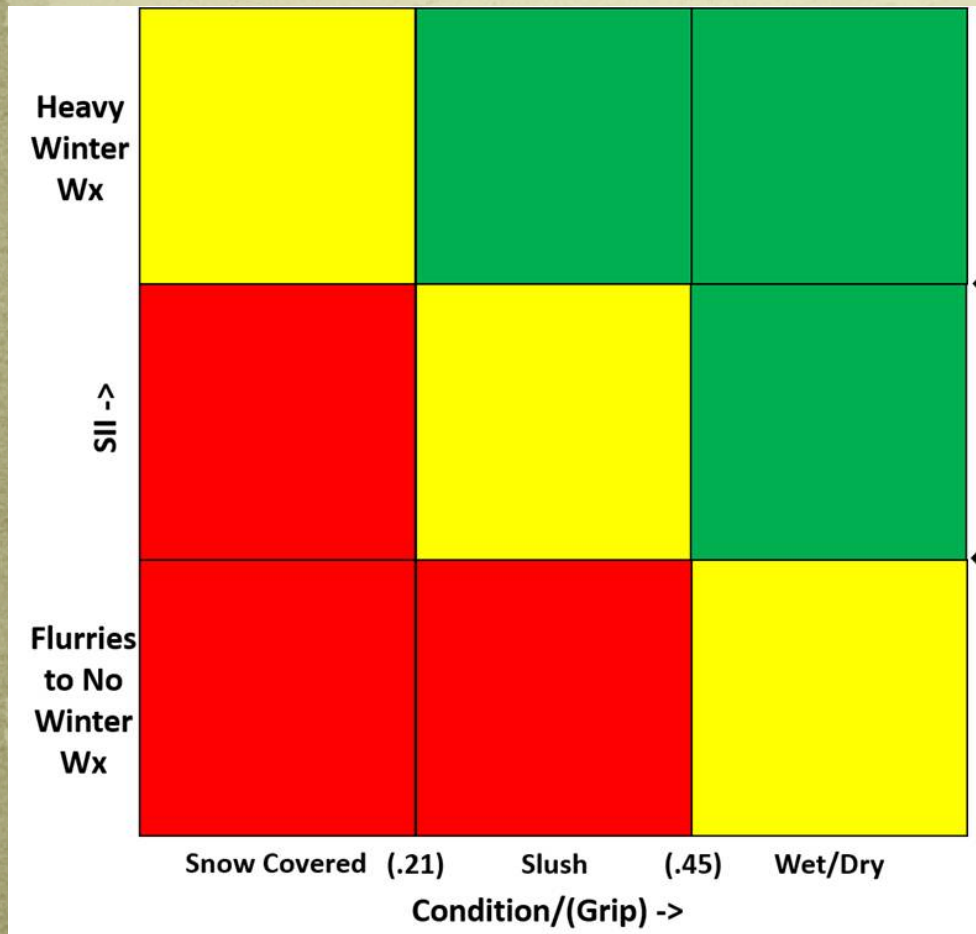
- UDOT uses the **CAUSE** **vs.** **EFFECT** approach
  - Atmospheric Conditions & Road Temperature **(CAUSE)**

VS……..

  - The resulting Road Grip or Road Conditions **(EFFECT)**
- **Road Grip/Conditions** categorized into:
  - Snow covered
  - Partially snow covered/slushy
  - Wet/dry

Decision Matrix

- Let us take a gander at the **Decision Matrix.....** aka **Griffin Grip Cube**



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

Decision Matrix Explained

Status of Snowfall	Snowfall Rate	Expected Mitigated Road Condition
Heavy	> 1" per hour	Snow Covered
Light to Moderate	0.25 to 1" per hour	Slushy/Partially Snow Covered
Flurries or No Snow	< 0.25" per hour	Wet or Dry

UDOT's Benchmark For Snow Removal

- UDOT's benchmark target for snow removal is to handle:

1" of snow / hour at 32° F

- The breakdown based on temperature:
  - **1"** per hour for **32° F** road temp & wet bulb temp
  - **3/4"** per hour for **22° F** road temp & wet bulb temp
  - **1/2"** per hour for **17° F** road temp & wet bulb temp

Storm Severity Index - SSI

- **Storm Severity Index (SSI):** The **Average SII** multiplied by the **Storm Duration** in HOURS.

Storm Severity Index =

(Storm Intensity Index) x (Duration of Storm)

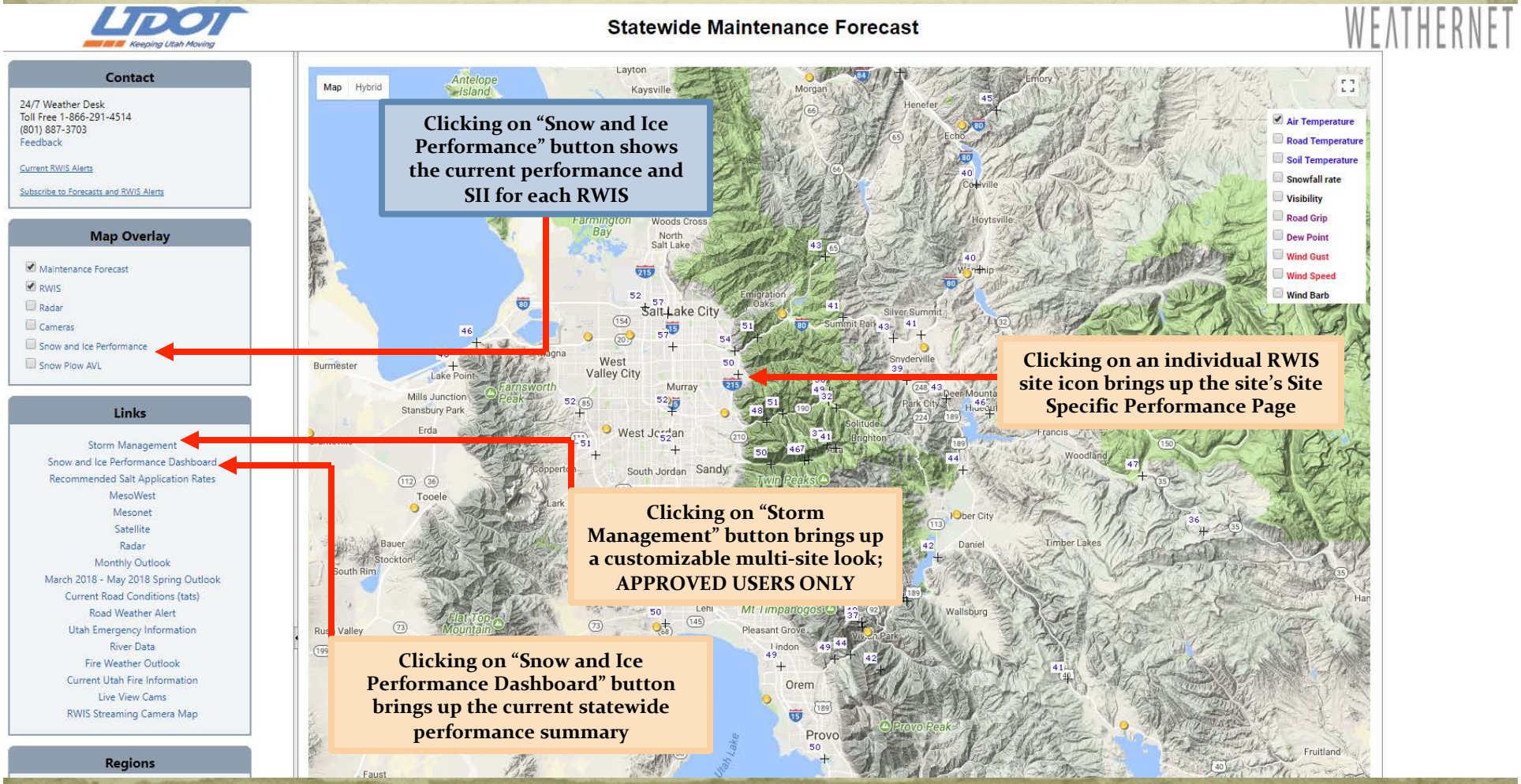
→

SSI = (SII) x (Duration of Storm)

Let's See This Thing Already.....

RWIS/Forecast Page – Your Portal

- URL: **http://www.udottraffic.utah.gov/ForecastView/Default.aspx**



Site Specific Performance Page

(By clicking on **individual RWIS site** icon)

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

11/17/2017 10:00 am

11/17/2017 10:00 am

11/17/2017 10:00 am

Conditions at: 11/17/2017 10:00 am

Tmp/RH: 31.0 °F/ 94.7%| **Wnd:** 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

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

Selected Storm Event Summary - Storm 4

Weather Statistics	Minumum	Average	Maximum
Air Temp	23.7° F	28.9° F	36.0° F
Road Temp	29.8° F	31.9° F	40.1° 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

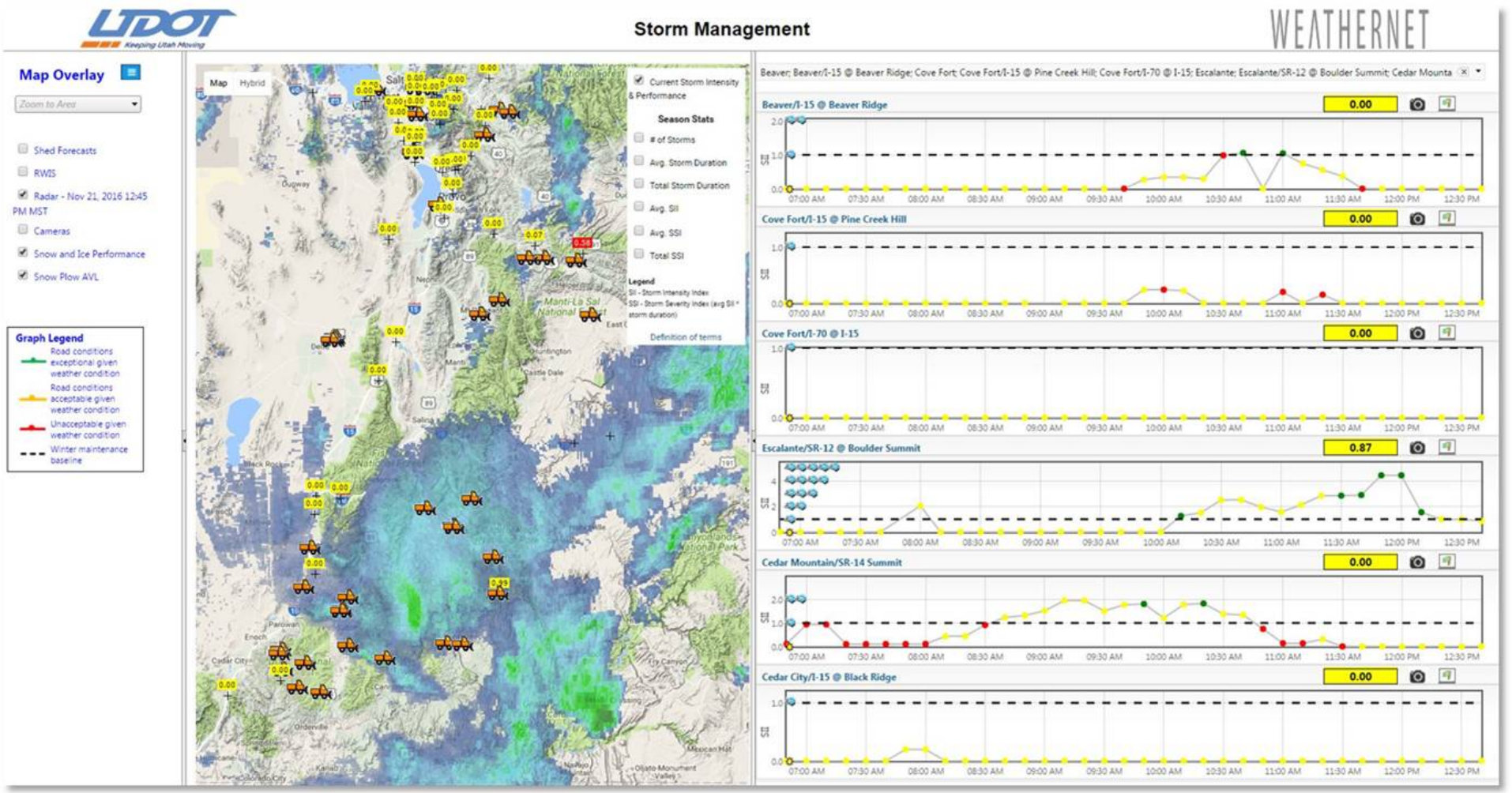
More information on the Storm Intensity Index and Snow and Ice Performance Measure

PowerPoint

UDOT Weather Desk : 801-887-3703

Storm Management Dashboard

(By clicking on "**Storm Management**" button, Authorized Users only)



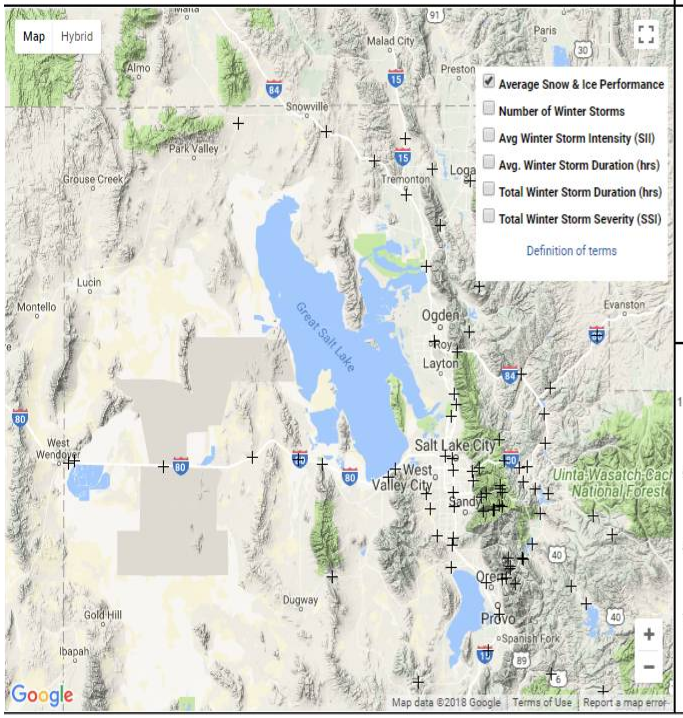
Statewide Snow & Ice Performance Dashboard (By clicking on "Snow & Ice Performance Dashboard" button)

Clicking on "Storm Performance Reports" brings up a customizable summary by Date Range, Region, and/or Route

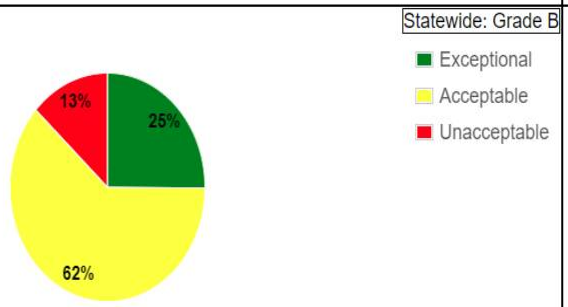
Statewide Snow and Ice Performance Dashboard

Storm Performance Reports

2017-2018 Statewide Winter Storm Statistics



2017-2018 Average Statewide Snow and Ice Performance



Data for winter storm events:

11/1/2017 12:00:00 AM - 3/25/2018 6:50:00 AM

Statewide Maintenance Forecast page

Average Statewide Snow and Ice Performance

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

Storm Performance Reports

(By clicking on "**Storm Performance Reports**" button)

Filter box to find any storm by Date Range, Region, and/or Route and also the related snow removal performance letter grade (A-F)

UDOT Keeping Utah Moving

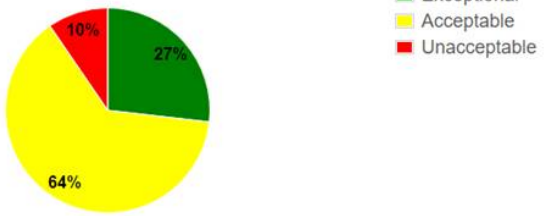
Storm Performance Reports

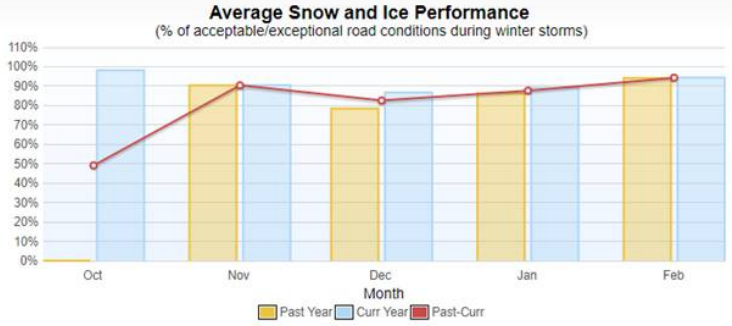
Start Date 10/1/2017 12:00 AM End Date 2/28/2018 10:06 AM

Region Region 2 Routes I-80

Filter Download

Performance: Grade A-





Location	Event Time		Duration	Avg. Index	Storm Index	Performance			
	Start	End				Exp. %	Acpt. %	Unacpt. %	Grade
Location:I-80 @ Coalville									
I-80 @ Coalville	2/18/2018 6:40:00 PM	2/19/2018 2:20:00 AM	7.67	0.67	5.10	0.0	0.0	0.0	*
I-80 @ Coalville	1/19/2018 8:30:00 PM	1/21/2018 3:00:00 AM	30.50	0.37	11.20	24.0	61.2	14.8	B
I-80 @ Coalville	12/24/2017 7:30:00 PM	12/25/2017 10:00:00 AM	14.50	0.57	8.25	9.1	44.3	46.6	F
I-80 @ Coalville	12/23/2017 6:50:00 AM	12/23/2017 3:50:00 PM	9.00	0.42	3.76	18.2	63.6	18.2	B-
I-80 @ Coalville	12/20/2017 5:40:00 PM	12/21/2017 9:50:00 AM	16.17	0.20	3.24	26.8	73.2	0.0	A+
I-80 @ Coalville	12/3/2017 5:20:00 PM	12/4/2017 6:00:00 AM	12.67	0.33	4.24	37.7	50.6	11.7	B+
Location:I-80 @ Lakepoint									
I-80 @ Lakepoint	2/23/2018 12:00:00 AM	2/23/2018 4:00:00 PM	16.00	0.53	8.50	28.9	50.5	20.6	C+
I-80 @ Lakepoint	2/18/2018 6:40:00 PM	2/19/2018 11:00:00 PM	28.33	0.29	8.25	22.4	73.9	3.7	A
I-80 @ Lakepoint	1/19/2018 3:50:00 PM	1/20/2018 6:50:00 PM	27.00	0.28	7.65	31.9	58.3	9.8	A-
I-80 @ Lakepoint	1/6/2018 12:30:00 PM	1/6/2018 4:40:00 PM	4.17	0.13	0.53	42.3	57.7	0.0	A+
I-80 @ Lakepoint	12/24/2017 5:40:00 PM	12/25/2017 9:00:00 AM	15.33	0.24	3.68	6.5	37.6	55.9	F
I-80 @ Lakepoint	12/20/2017 2:40:00 PM	12/20/2017 10:40:00 PM	8.00	0.29	2.30	28.6	61.2	10.2	B+
I-80 @ Lakepoint	12/16/2017 9:30:00 AM	12/17/2017 8:10:00 AM	22.67	0.15	3.32	24.1	72.3	3.6	A
I-80 @ Lakepoint	12/4/2017 7:30:00 AM	12/4/2017 12:30:00 PM	5.00	0.32	1.58	29.0	54.8	16.1	B
Location:I-80 @ mp 1									
I-80 @ mp 1	2/22/2018 4:40:00 PM	2/22/2018 9:10:00 PM	4.50	0.23	1.04	35.7	64.3	0.0	A+
I-80 @ mp 1	2/18/2018 8:00:00 PM	2/19/2018 12:40:00 AM	4.67	0.16	0.77	55.2	44.8	0.0	A+
I-80 @ mp 1	1/19/2018 10:40:00 PM	1/20/2018 2:40:00 AM	4.00	0.15	0.59	40.0	60.0	0.0	A+
Location:I-80 @ Parleys Canyon Quarry									
I-80 @ Parleys Canyon C	2/24/2018 7:20:00 PM	2/25/2018 9:00:00 AM	13.67	0.17	2.30	19.3	80.7	0.0	A+
I-80 @ Parleys Canyon C	2/22/2018 9:00:00 PM	2/23/2018 9:00:00 PM	24.00	0.38	9.17	32.4	67.6	0.0	A+
I-80 @ Parleys Canyon C	2/18/2018 6:00:00 PM	2/20/2018 1:50:00 PM	43.83	0.57	24.99	31.8	64.8	3.4	A
I-80 @ Parleys Canyon C	2/14/2018 10:40:00 PM	2/15/2018 6:00:00 PM	19.33	0.17	3.29	28.2	71.8	0.0	A+
I-80 @ Parleys Canyon C	1/25/2018 4:10:00 PM	1/26/2018 8:30:00 AM	16.33	0.07	1.15	12.1	87.9	0.0	A+
I-80 @ Parleys Canyon C	1/19/2018 5:10:00 PM	1/21/2018 12:20:00 AM	31.17	0.30	9.20	51.6	46.3	2.1	A+

1 2 3 Page size: 25 69 items in 3 pages

Grade of * means insufficient data for calculation

Challenges With This System

- **Data Quality and Verification**
  - RWIS Coordinator/Meteorologist manually checks data weekly with aid of saved camera images from RWIS stations
- **Common Issues**
  - Occasional road sensor inaccuracy
  - Sensor failure
  - Flurries in fog confuse sensors
  - High traffic prevents sensors from seeing roadway
  - Reasonable SII in extreme conditions
- **Physical Challenges**
  - Requires intensive RWIS Station maintenance (need them working!!)
  - Only samples a small area of roadway despite many lane-miles of responsibility

Future Improvements To Be Made

- The ever-expansion of our RWIS network
- Better storm identification
- Algorithm tweaks

- Instrumentation in market improves over time
- Set performance benchmarks for different priority routes
- Using Connected/Autonomous Vehicles to fill in “RWIS gaps”

Now…..Something Near and Dear To Me

- End of discussion about **Snow & Ice Performance Measure** and on to……

Light Sabers!!

Challenges UDOT Plow Drivers Face

- **Plow Driver Hours** are long and unforgiving
- **Older Fleet** is slow to be replaced by new equipment
- **Filling All Vacancies** can be a problem – high turnover rate due to the dangers of the job and pay **$$$**
- **Bad Winter Driving Habits** of citizens can cause accidents

Challenges UDOT Plow Drivers Face

- US-6 in Spanish Fork Canyon January 12th, 2017……

Challenges UDOT Plow Drivers Face

Spanish Fork Canyon --- January 12th, 2017

- **Terry Jacobson**, a 23 year veteran UDOT Transportation Technician in Region 3, was plowing WB lanes of SR-6 in Spanish Fork Canyon
- An impatient semi-truck driver pushed his UDOT plow off of the road while attempting to pass him on the right - clipped his Wing Plow
- Terry's snow plow gated through the W-beam guardrail and rolled down a 300 foot embankment

Challenges UDOT Plow Drivers Face

- Let us watch the **VIDEO** captured by the dash camera of a semi-truck driver heading in the opposite direction.....

https://youtu.be/HHXkafQ5pAU

Challenges UDOT Plow Drivers Face

- Terry survived the accident, but does not plow anymore
- Passenger side of cab was crushed. Would have killed a passenger had there been one
- Lends credence to why we constantly communicate to the public.....

STAY <u>BEHIND</u> THE PLOWS!

Challenges UDOT Plow Drivers Face

- UDOT Wing Plows used to have just an **orange flashing light** on the end of the wing
- In response to Terry's accident UDOT adopted what we call "**Light Sabers**" to go on the end of Wing Plows
- Let us watch a video of the **Light Saber** in action……

https://youtu.be/5AxWknqruYM

THE END!!!

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