AVL and Salt Management

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Iowa Department of Transportation

Pacific Northwest Snowfighters
June 2023

About This Presentation

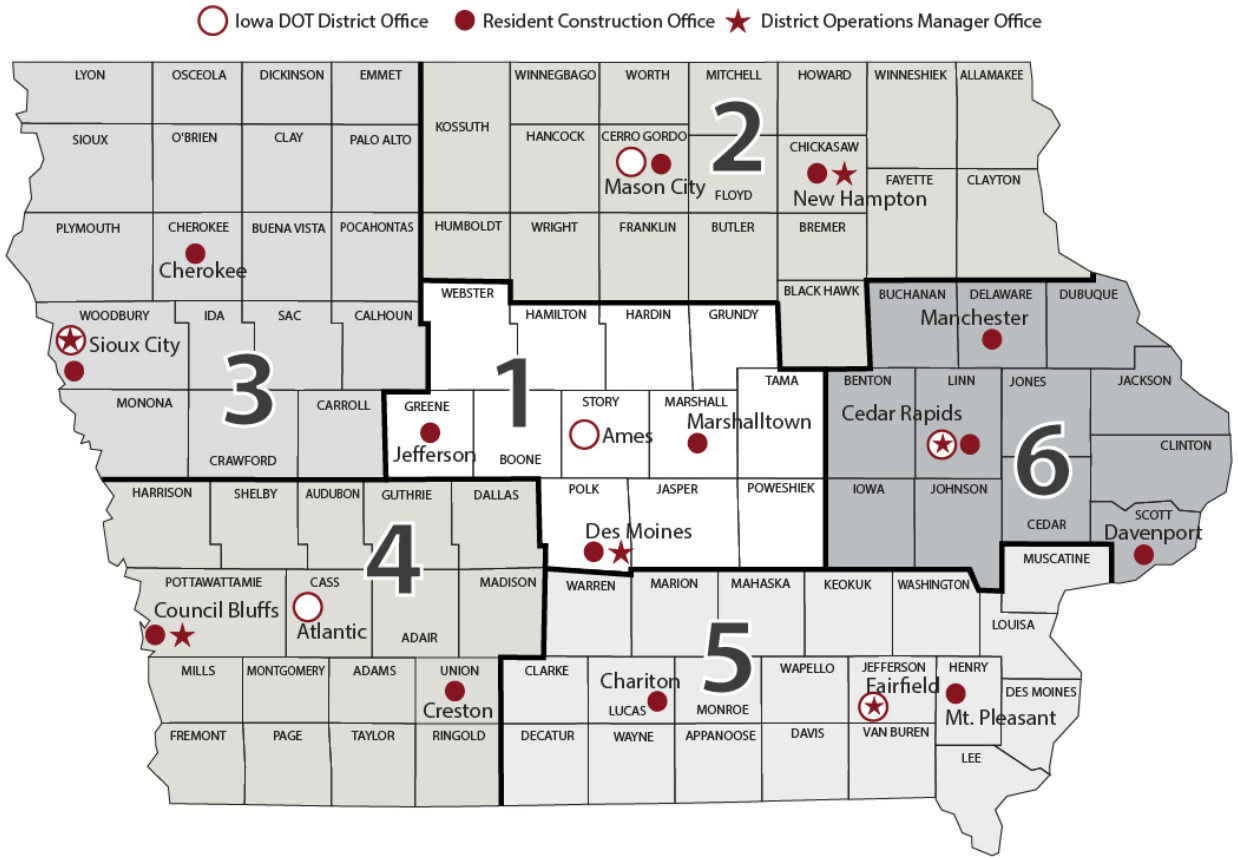
A review of spreader systems and methods we use for controlling salt placement and reducing waste. Also, see how we use AVL for in-storm operations, and how we use it with other winter data to improve our operations.

Topics

- About Iowa DOT
- Spreader systems
- Wheel-track placement technique
- Bounce and scatter testing
- AVL overview
- Info for process improvement

About Iowa DOT

- 6 Districts
- 100 maintenance garages
- 24,500 lane-miles of roadway, 24-hour operation
- Approx. 840 full-time operators
- Approx. 500 seasonal operators
- 5-year average material:
  - 156,600 tons salt
  - 31.5 Million gallons brine
  - 21,600 tons sand



Winter Materials

- Salt is our primary anti-icer, pre-wet, and deicer
- We use lots of brine. About 20M-30M gallons annually
- ~42,000 gallons Calcium Chloride as brine mix-in when needed
- ~20,000 tons sand

2500 Gal. Trailers

900 Gal Wedge Tanks

5000 Gal. Tankers

WARNING
DANGER
912
08/06/2013 11:32

MONROE SPREADER
WARNING
DANGER
08/06/2013 11:14

The Iowa DOT Wheel-path Technique

- What:
  - Purposely focusing all material to the wheel track
    - Can be right, left, or both
    - Both for anti-icing and deicing

- Why?
  - Very high concentration in a wheel path creates a very ‘quick burn’ down to the pavement
  - Drivers have good grip on at least 2 wheels
  - Mobility restored quickly and with little salt
  - Any bounce and scatter is far from the edge. Will land on the pavement where it can be useful

What About the Rest of the Road?

- Traffic and road crown quickly spread salt to other areas
- Enough to help, but the majority stays in the tracks – where it's most needed

Notice how little melting there is just past the paint lines.
Yet the mainline is bare.
The salt stayed in place.

For a road like this, it is ok for us to have snow on the paint during a storm. There is often enough salt, migrated by traffic and flowing down the crown, that the snow is unbonded beneath and will clean up easy. For now drivers have good mobility and can easily see their way.

Works well for interstates too, just rates may be a little higher to meet the required Service Level. But not much. Salt rates rarely exceed 250 lbs/lm even on our biggest roads

Equipment

This Technique Can be Started Simply…

- First units were cut PVC pipes and reused signs
- Anything that would focus the material and minimize bounce and scatter

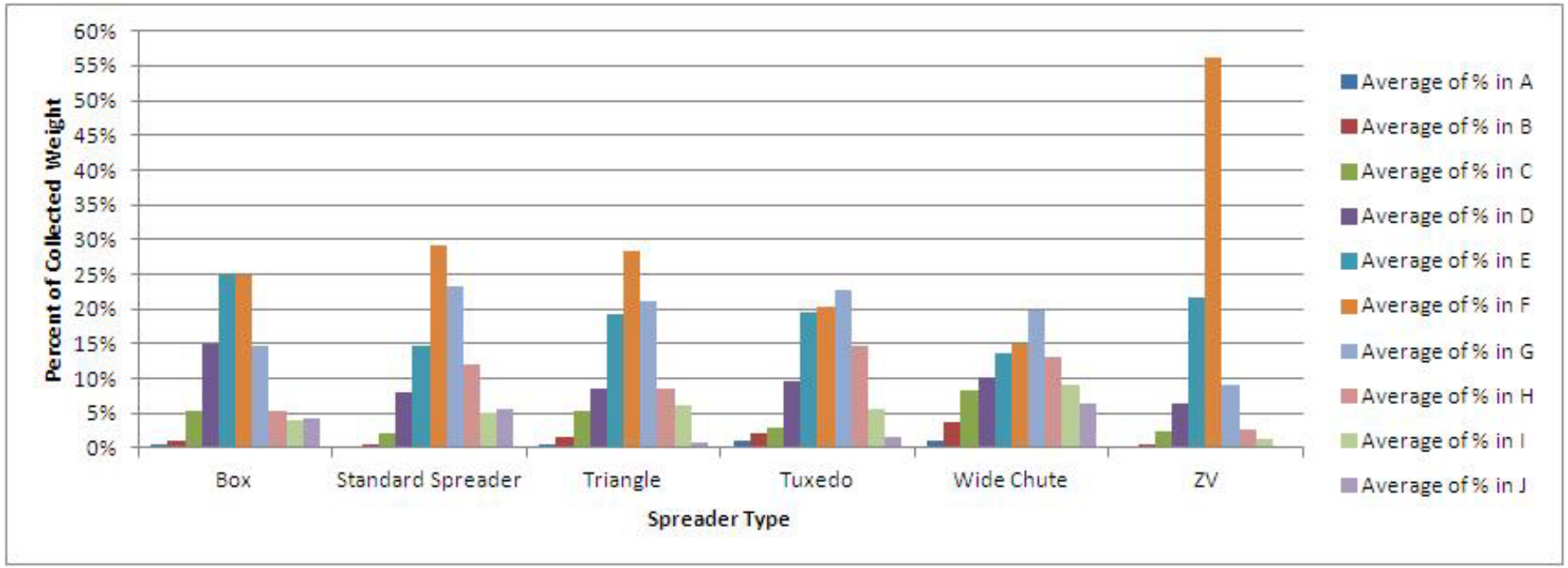
Spreader designs have been tested in 2013 and 2023 for bounce and scatter reduction

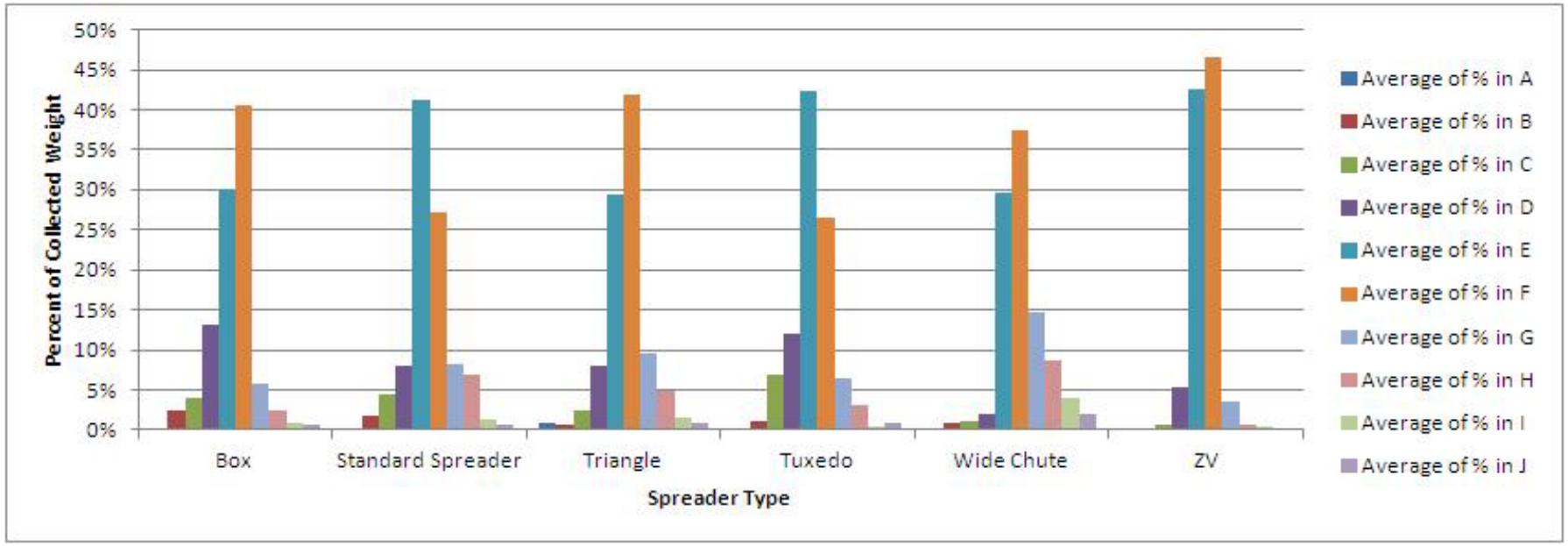
08/06/2013 11:28

08/05/2013 15:02

08/06/2013 11:51

- How you spread salt matters
  - Dry or prewetted?
  - Speed
  - What kind of spreader are you using?
  - What pattern are you aiming for?





Refinements

More Brine!

- Brine use is great for making salt stick regardless of technique
- Especially good for wheel-path since it enables the quick burn and the downhill flow of chemical

Oops…
If we do end up with bonding, a trickle of brine running down the slope can undercut the ice and perhaps allow us to scrape it off without having to melt it top-down

Notice the brine hoses to all of these spreaders

Drivers will have to consider slope. This driver is approaching a banked left curve and has switched granular drop to the right side to maximize chemical concentration on the uphill side.
Brine is still present at both sides – the left side is the ‘box sprinkler’ type and you can see the brine here.

Once back to straight, it’s back to left side granular (material focused at crown) and brine only right.

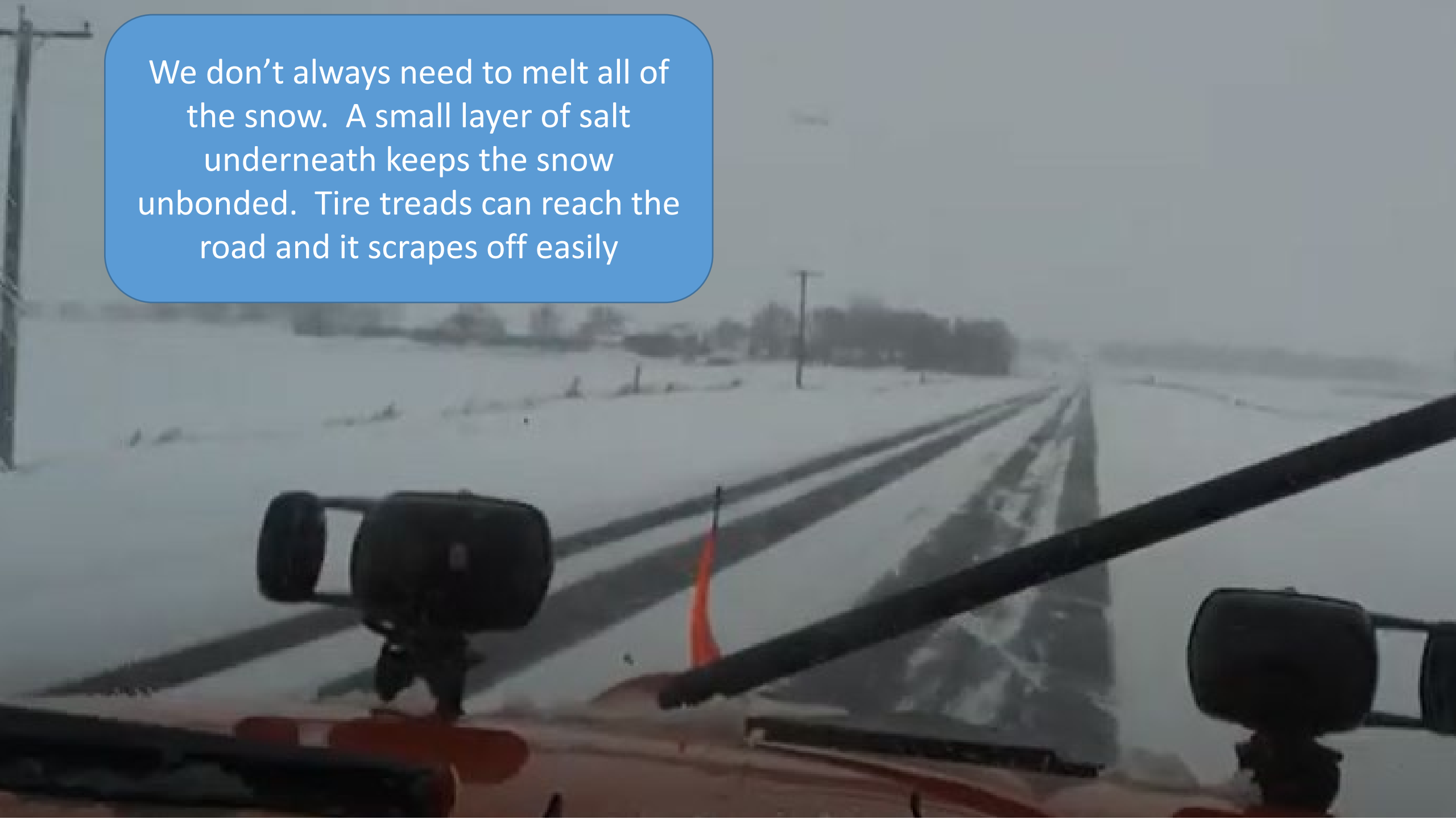
Even Anti-Ice Pattern is Modified

Nozzles like these are becoming less common

- Brine sticks great but nozzles still have some spray/drift
- We are often pumping 50+ gal/LM and it creates a lot of droplets that blow

MILE
111A
EXIT
LIQUID DEICER

- Open ended nozzles don’t create as much spray, even at faster speeds



We don’t always need to melt all of the snow. A small layer of salt underneath keeps the snow unbonded. Tire treads can reach the road and it scrapes off easily

Main Points: Wheel Track Pattern

- Purposely focusing all material to the wheel track(s)
- Very high concentration in a wheel path creates a very quick melt down to the pavement
- Drivers have good grip on at least 2 wheels
- Mobility restored quickly and with little salt
- Any bounce and scatter is far from the edge. Will land on the pavement where it can be useful
- Traffic and road crown quickly spread salt to other areas, enough to help, but the majority stays in the tracks – where it’s most needed

AVL and Salt Use Tracking

GPS/AVL & Plow Cam History

2010	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2017/2018
AVL program begins	**Trial AVL Deployment** **(LTI – Vendor)**	**Full AVL Deployment**	**Basic plow data for the public** **Introduced Plow Cam cameras -300 iPhones**	**Expanded Plow Cam cameras (iPhones) to the entire fleet**	**Transitioned to Skyhawk as AVL vendor** **Added Plow Cam camera images to 511**	**Transitioned from iPhones to Axis Cameras** **Added snowplow locations to 511**

GPS/AVL & Plow Cam History

2019/2020	2020/2021	2021/2022	2022/2023	2023….
Transitioned to Cypress as AVL vendor, utilizing same modems (CTM-200)	Developed Salt Ledger, Material Usage and Storm Reporting Dashboards Began reviewing Winter Season Material Usage data with Districts	Added Regional winter Road Conditions to 511	Cypress Replaced CTM-200 modems with the CTM One Modems	

cypress solutions

Username

craig.bargfrede@iowadot.us

Password Forgot?

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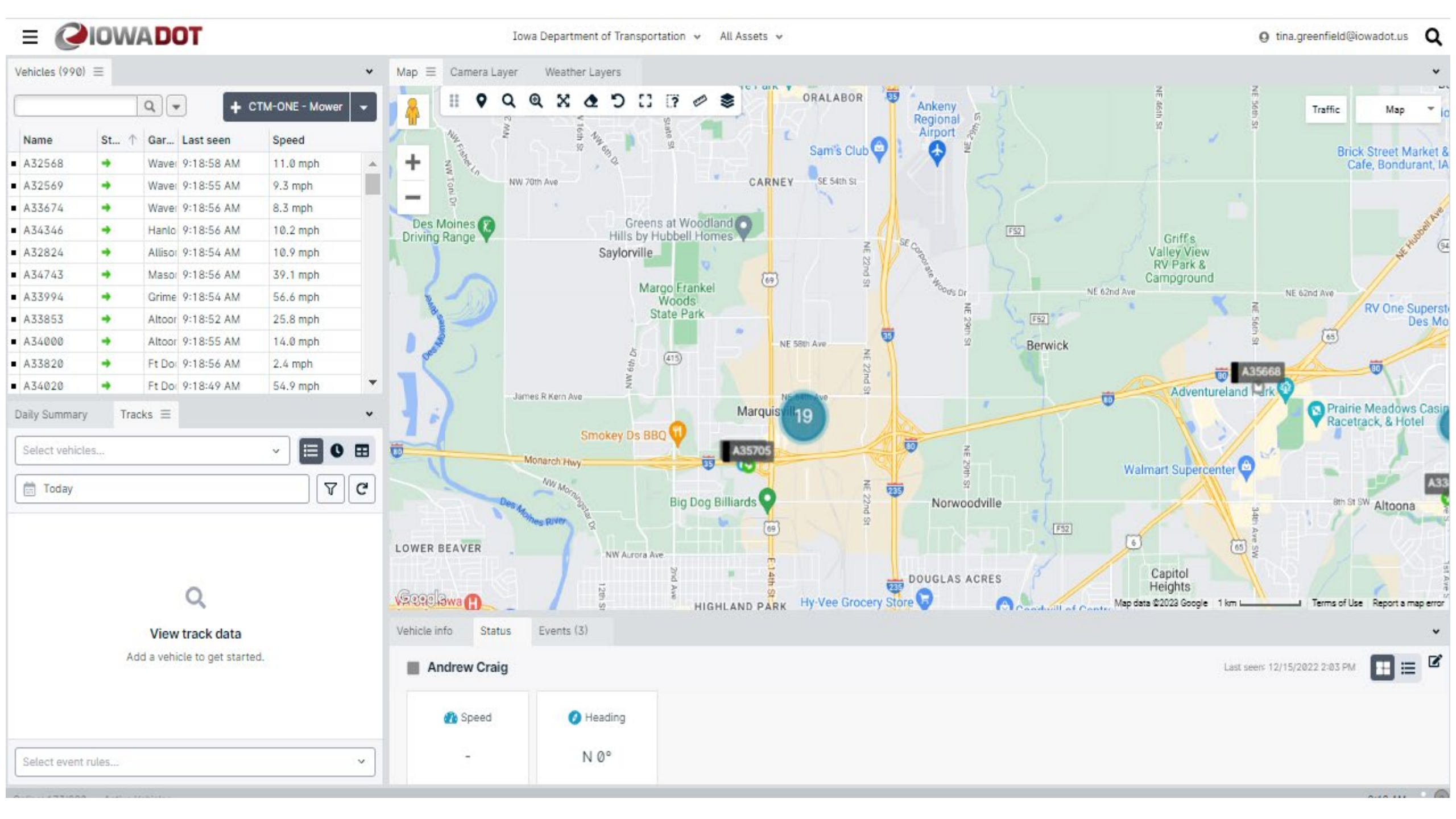
Log In


IOWADOT
Iowa Department of Transportation
All Assets
tina.greenfield@iowadot.us
Vehicles (990)
CTM-ONE - Mower
Name
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Gar...
Last seen
Speed
A32568 Wave 9:18:58 AM 11.0 mph
A32569 Wave 9:18:55 AM 9.3 mph
A33674 Wave 9:18:56 AM 8.3 mph
A34346 Hanlo 9:18:56 AM 10.2 mph
A32824 Allisor 9:18:54 AM 10.9 mph
A34743 Masor 9:18:56 AM 39.1 mph
A33994 Grime 9:18:54 AM 56.6 mph
A33853 Altoor 9:18:52 AM 25.8 mph
A34000 Altoor 9:18:55 AM 14.0 mph
A33820 Ft Dor 9:18:56 AM 2.4 mph
A34020 Ft Dor 9:18:49 AM 54.9 mph
Daily Summary
Tracks
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Select event rules...
Map
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Sam's Club
CARNEY
Des Moines Driving Range
Greens at Woodland Hills by Hubbell Homes
Saylorville
Margo Frankel Woods State Park
Griff's Valley View RV Park & Campground
Berwick
Adventureland Park
A35668
Marquisville
19
Smokey Ds BBQ
A35705
Monarch Hwy
Big Dog Billiards
Walmart Supercenter
Prairie Meadows Casino Racetrack, & Hotel
Norwoodville
Altoona
LOWER BEAVER
DOUGLAS ACRES
Capitol Heights
HIGHLAND PARK
Hy-Vee Grocery Store
Map data ©2023 Google
1 km
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Report a map error
Vehicle info
Status
Events (3)
Andrew Craig
Last seen: 12/15/2022 2:03 PM
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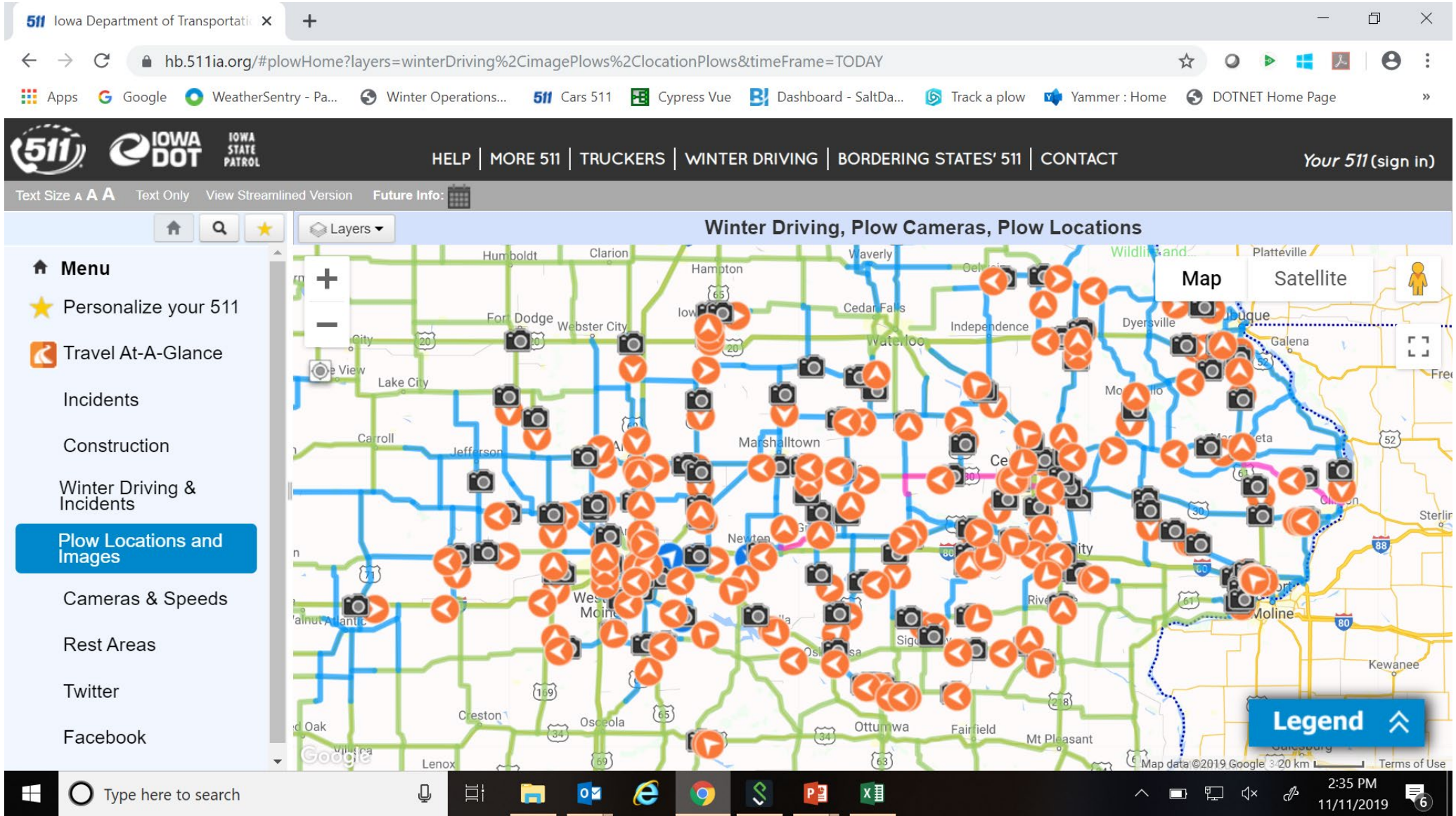
AVL Info

- Vehicle speed and location
- Engine fault codes
- Spreader:
  - Material types
  - Set rates
  - Actual rates
  - Pavement/air temperature
- Plow Cams
  - Axis M1065-L

AVL on 511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Winter Operations...
Cars 511
Cypress Vue
Dashboard - SaltDa...
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IOWA DOT
IOWA STATE PATROL
HELP | MORE 511 | TRUCKERS | WINTER DRIVING | BORDERING STATES' 511 | CONTACT
Your 511 (sign in)
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Incidents
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Plow Locations and Images
Cameras & Speeds
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hb.511ia.org/#plows/A33506-i?timeFrame=TODAY&layers=winterDriving%2CimagePlows%2ClocationPlows

Apps | Google | WeatherSentry - Pa... | Winter Operations... | Cars 511 | Cypress Vue | Dashboard - SaltDa... | Track a plow | Yammer : Home | DOTNET Home Page | Iowa DOT Performa... | WOPR Jr | KCCI Weather | Weatherview | Iowa DOT LMS Login

HELP | MORE 511 | TRUCKERS | WINTER DRIVING | BORDERING STATES' 511 | CONTACT

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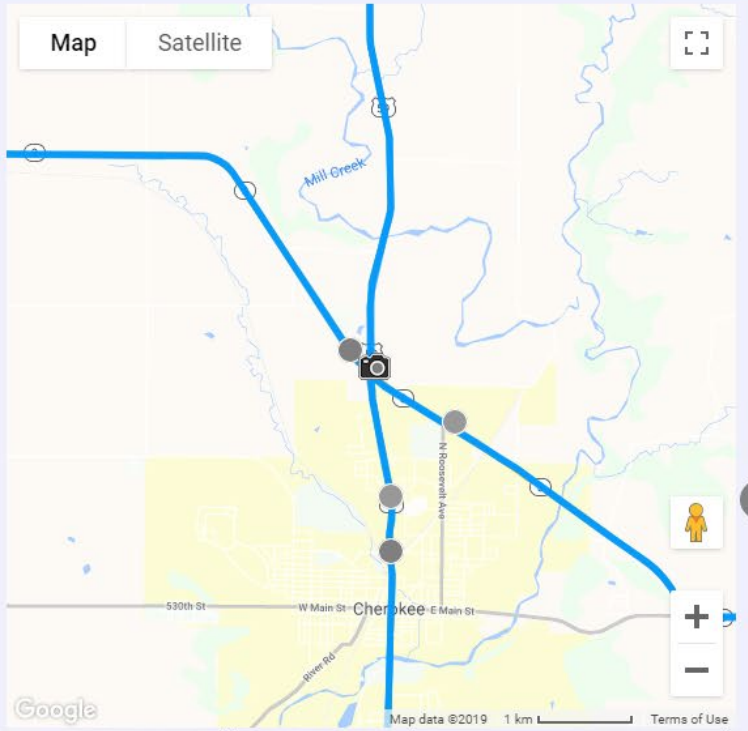

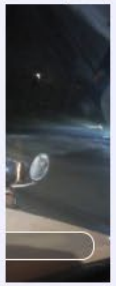

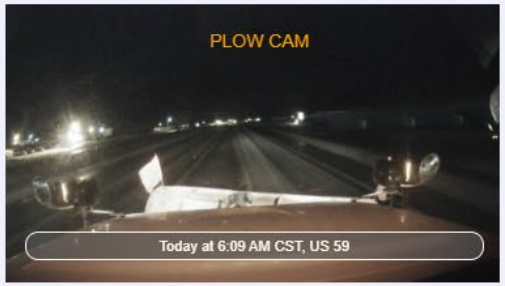

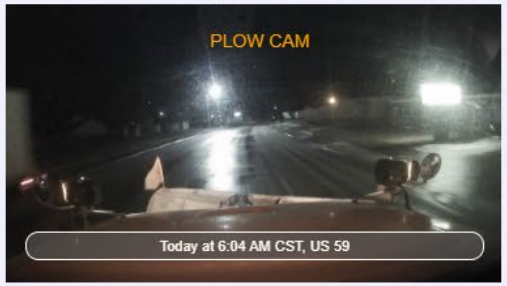

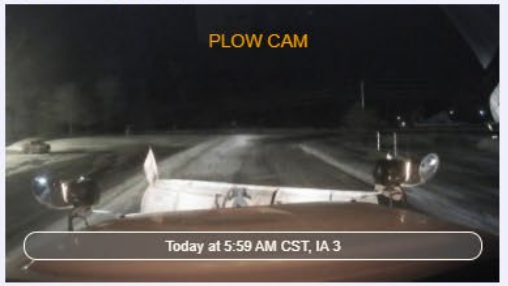

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11/13/2019

Winter Operations Data

District	Total Rock Salt Tons	Total Salt Brine	Total 50/50 Salt/Sand	Total CaCl Brine	Total Sand Tons	Average Winter Index	Average Snow Inches	Average Precipitation Events	Total Blowing Snow Hours	Total Bridge Frost Hours	Total Freezing Rain Hours	Total Mixed Precip Hours	Total Refreeze Hours	Total Road Frost Hours	Total Sleet Hours	Total Snow Hours	Total Miles	Miles >8K Veh/lane	5K-8K veh/lane	.25K-5K veh/lane	1.5K-2.5K veh/lane	800-1,500 veh/lane	<800 veh/lane	Material Cost	Material Cost per Lane Mile	Average FY21 Salt Price /Ton	Average Sand Price
1	14,248	4,294,896	1,005	9,643	-	18.7	30.5	38	817	193	382	197	186	119	22	1,877	4,558.9	244.8	257.3	650.2	703.3	915.0	1,788.3	$ 1,974,384.63	$ 433.09	$ 75.50	$ 15.32
2	13,412	3,064,215	1,121	-	3,384	20.9	33.6	67	3,030	482	561	435	948	236	72	2,485	3,949.5	5.1	81.7	416.9	705.5	1,471.9	1,268.4	$ 1,833,416.88	$ 464.21	$ 83.62	$ 13.32
3	8,526	2,075,478	1,078	-	438	17.4	19.5	37	837	254	420	284	250	101	82	2,023	4,090.9	4.4	37.4	337.5	897.0	1,348.2	1,466.5	$ 1,088,743.74	$ 266.14	$ 73.28	$ 13.28
4	11,562	3,359,490	0	-	25	14.8	24.9	31	620	226	305	317	147	232	13	1,913	3,721.6	47.1	264.9	258.3	478.2	870.0	1,803.1	$ 1,436,136.56	$ 385.89	$ 65.33	$ 16.35
5	11,950	3,840,076	1,444	2,450	771	18.2	35.0	43	1,444	132	524	200	152	100	18	2,181	4,029.1	0.0	42.5	477.6	1,002.1	974.3	1,532.6	$ 1,742,945.02	$ 432.59	$ 74.41	$ 16.40
6	20,773	4,081,668	724	-	457	24.5	34.4	70	1,874	916	544	153	645	288	74	2,339	4,272.3	256.4	216.0	699.8	741.1	624.6	1,734.5	$ 2,415,041.72	$ 565.27	$ 76.80	$ 14.60
Statewide	**80,470**	**20,715,823**	**5,372**	**12,093**	**5,076**	**18.9**	**29.2**	**47**	**8,621**	**2,203**	**2,737**	**1,586**	**2,328**	**1,076**	**281**	**12,818**	**24,622.3**	**557.8**	**899.7**	**2,840.3**	**4,527.1**	**6,204.0**	**9,593.4**	**$ 10,490,668.54**	**$ 426.06**	**$ 74.73**	**$ 14.82**

District	FY18 Rock Salt Tons	FY18 Salt Brine	FY18 Winter Index	FY18 Material Cost per Lane Mile	FY19 Rock Salt Tons	FY19 Salt Brine	FY19 Winter Index	FY19 Material Cost per Lane Mile	FY20 Rock Salt Tons	FY20 Salt Brine	FY20 Winter Index	FY20 Material Cost per Lane Mile	FY21 Rock Salt Tons	FY21 Salt Brine	FY21 Winter Index	FY21 Material Cost per Lane Mile	FY22 Rock Salt Tons	FY212 Salt Brine	FY22 Winter Index	FY22 Material Cost per Lane Mile
1	31,925	6,468,378	25.5	$ 805.84	29,317.0	7,004,067	36.6	$ 773.71	25,467	6,670,632	24.6	$ 694.35	20,769	5,615,789	24.0	$ 606.72	14,248	4,294,896	18.7	$ 421.96
2	24,196	3,932,272	29.2	$ 859.52	24,541.5	4,598,015	36.8	$ 830.73	22,710	4,405,389	27.8	$ 735.65	17,290	3,766,418	23.2	$ 565.56	13,412	3,064,215	20.9	$ 444.42
3	20,983	3,545,397	29.0	$ 547.43	18,848.8	3,858,529	33.4	$ 529.76	21,887	4,155,416	26.5	$ 575.87	17,094	3,571,350	21.4	$ 483.39	8,526	2,075,478	17.4	$ 278.04
4	30,617	5,416,587	24.1	$ 816.21	30,997.5	6,317,275	36.6	$ 872.76	21,744	5,145,564	21.0	$ 643.38	23,904	5,708,051	23.0	$ 718.06	11,562	3,359,490	14.8	$ 369.83
5	22,752	5,220,052	23.2	$ 693.62	31,547.5	8,754,803	38.0	$ 1,050.69	22,536	6,900,174	25.3	$ 738.40	20,731	5,958,677	24.0	$ 687.15	11,950	3,840,076	18.2	$ 422.59
6	41,181	7,755,082	30.8	$ 1,137.21	43,544.1	8,747,537	46.1	$ 1,271.84	36,058	7,631,760	35.2	$ 997.56	41,176	8,408,461	29.9	$ 1,076.24	20,773	4,081,668	24.5	$ 541.03
Statewide	171,654	32,337,768	27.0	$ 812.36	178,796.4	39,280,226	37.6	$ 889.67	150,403	34,908,935	26.6	$ 733.30	140,964	33,028,745	24.1	$ 690.91	80,470	20,715,823	18.9	$ 406.25

Winter Operations Data

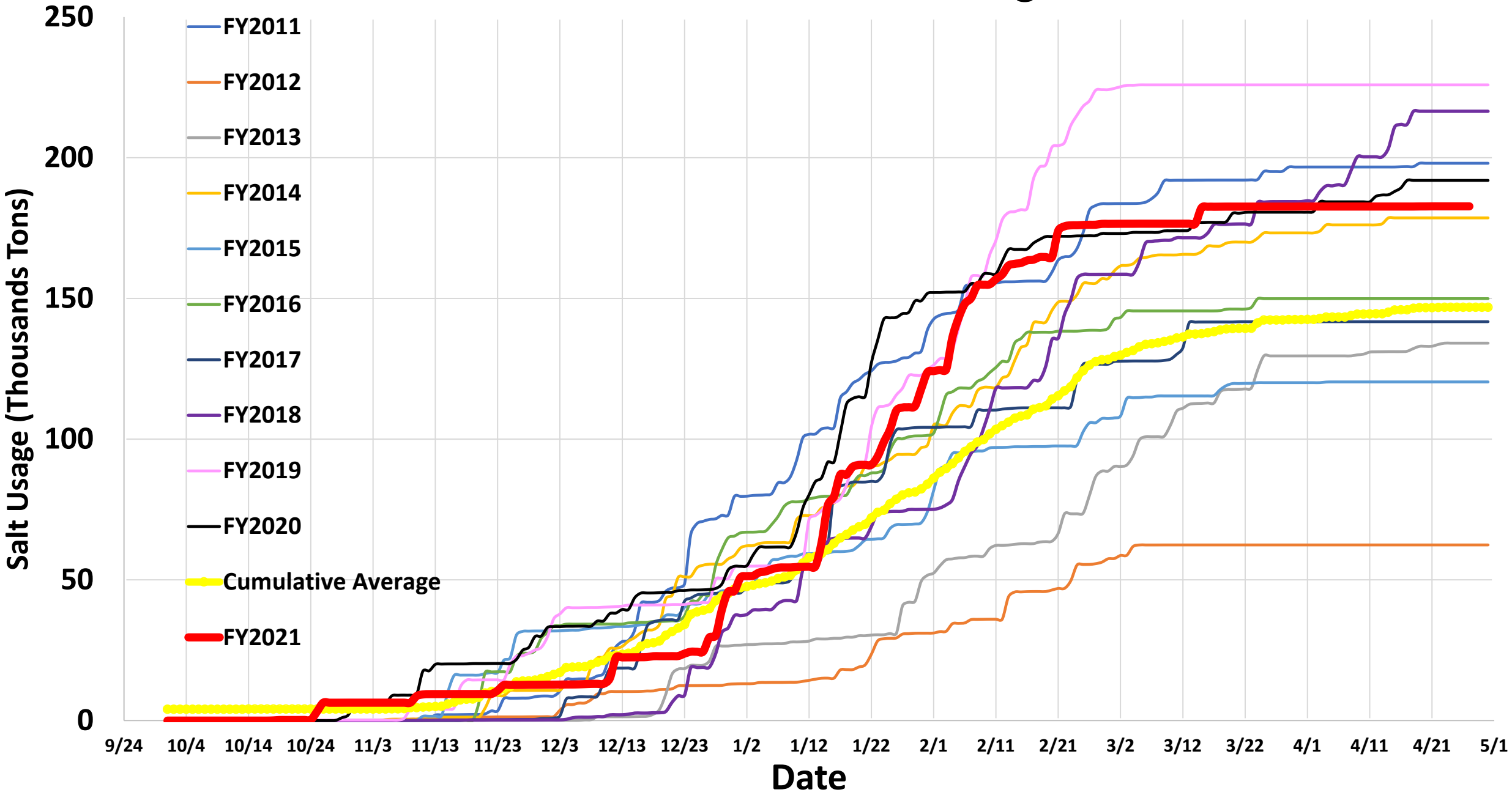
- Conduct a Post Winter Review with each District
- Discuss ideas and questions
- Meet in small groups, but everybody gets all info from all regions

The Problems With Basic Data

- Weather varies a lot!
  - Storm to storm
  - Same storm, different areas
  - Winter to Winter
- Miles and service expectations change
  - Each garage has a different mix of miles
  - Types of roads that make up each garage
    - rural low-volume vs. urban interstate?
  - We've gained about 1,000 miles in the last decade

How do you know what's good or bad, if you're improving or declining, when there are so many variables??

Current and Historical Salt Usage



Salt/labor management dashboard

What

- Produces ‘expected’ salt/labor use for each area for each day
- Compares ‘expected’ vs. ‘use’

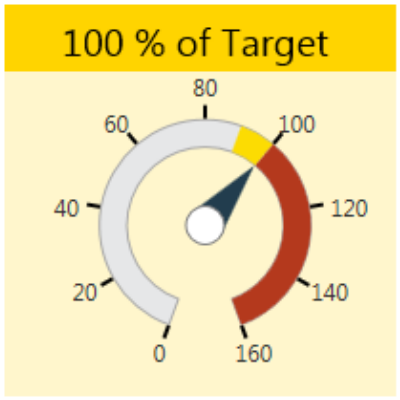
Why

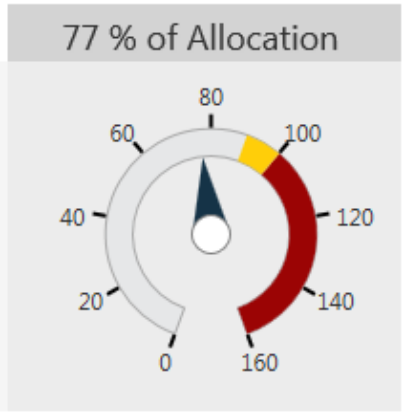
- Shows how well we adhere to our use guidelines for each unique storm and location

How

- Uses detailed observed weather data
- Uses each garages’ responsibility info. – lane miles and service level
- Computes expected use according to guidelines

- Finished its 12th year of operation
- Web-based
- Updates daily





Freezing Rain Hours: 4,395

Heavy Snow Hours: 2,921

Medium Snow Hours: 8,378

Light Snow Hours: 4,218

Blowing Snow Hours: 6,864

Frost, Refreeze, Sleet Hours: 5,785

Show Data For Location: All

From: 2016/10/15

To: 2017/04/15

View 675 Hours Info

View All Hours Info

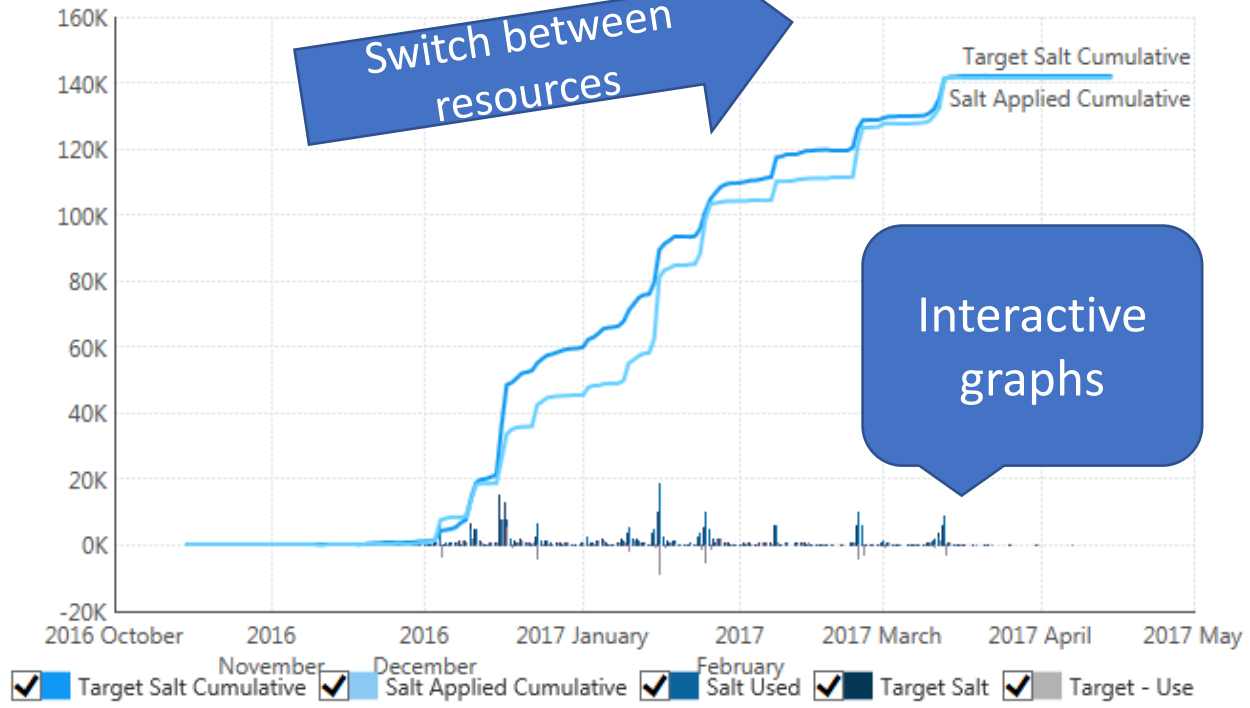
Salt Applied: 141,722

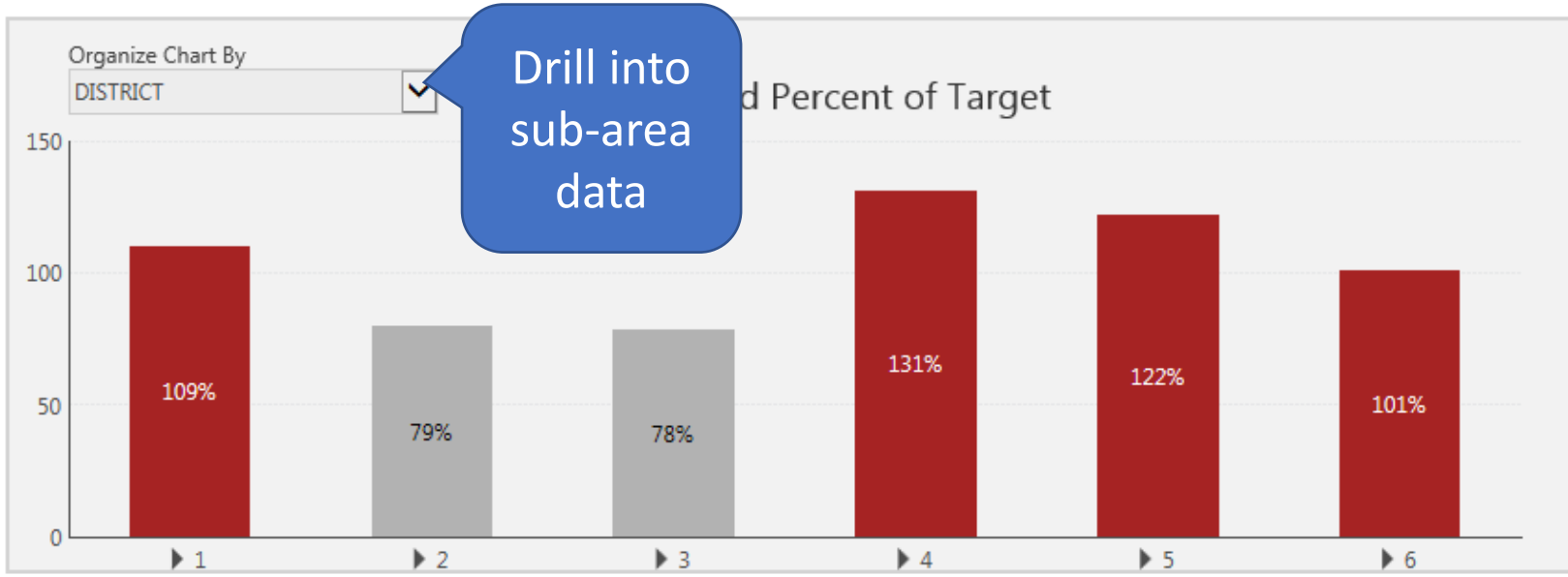
Target: 142,164

Target Minus Use: 442

Allocation: 184,274

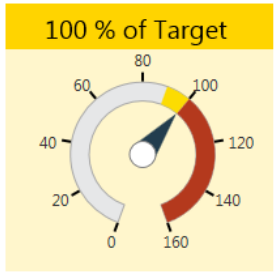
Allocation Remaining: 42,540

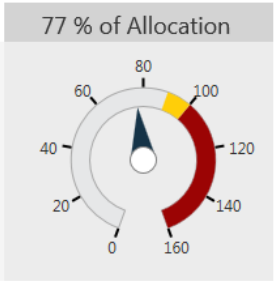




What Does This Mean For people?

- Targets provide a benchmark
- Visual way to compare
  - Across time or location
  - Outliers become obvious
    - Simple reporting errors
    - Unusual use
- New data daily
  - Catch potential problems early





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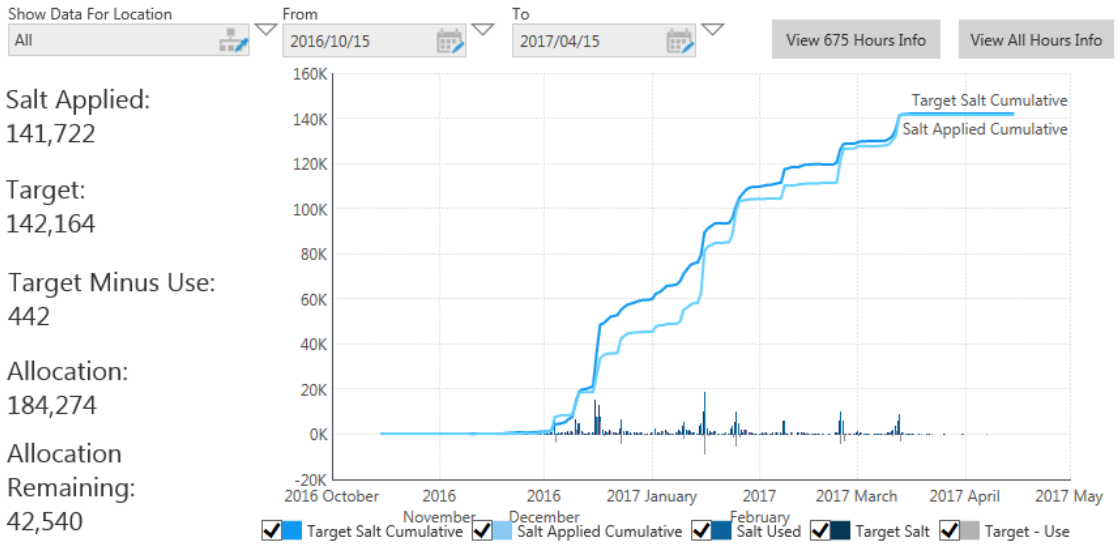

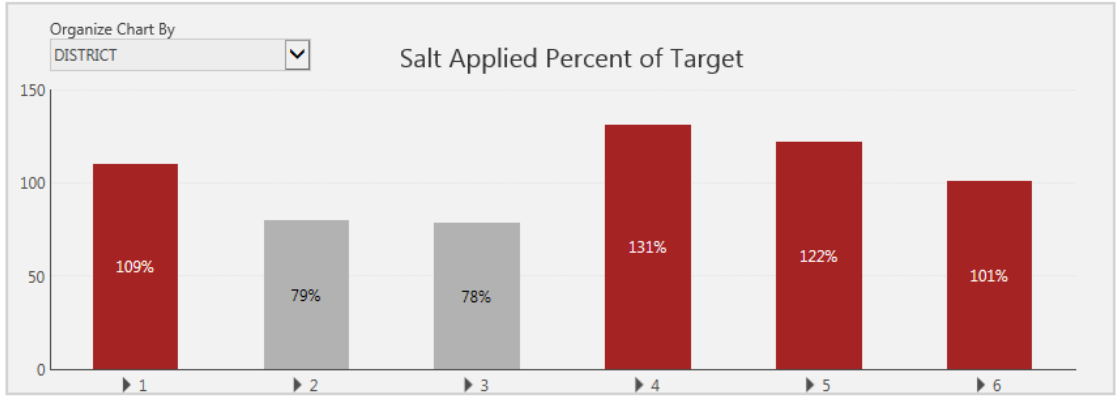

How It's Made: Automating Our Rate Guidelines

Salt Application Rate Guidelines							
Assuming:	Prewetted salt & 12-foot lane		Hours: 2		Level:	standard	100%
	Surface Temperature (F):	**33-30 F**	**29-27 F**	**26-24 F**	**23-21 F**	**20-18 F**	**17-15 F**
Pounds of Salt*	**Heavy Frost, Light Snow**	50	75	95	120	140	170
	Medium snow (1/2 inch per hour)	75	100	120	145	165	200
	Heavy Snow (one inch per hour)	100	140	185	250	300	350***
	Freezing rain, drizzle, sleet	140	185	250	300	350***	400***

Pavement temperature from RWIS stations

Our spreaders are capped at 300 lbs/LM

Precip type and duration from crew records

Salt Application Rate Guidelines							
Assuming:	Prewetted salt & 12-foot lane		Hours: 2		Level:	standard	100%
	Surface Temperature (F):	33-30 F	29-27 F	26-24 F	23-21 F	20-18 F	17-15 F
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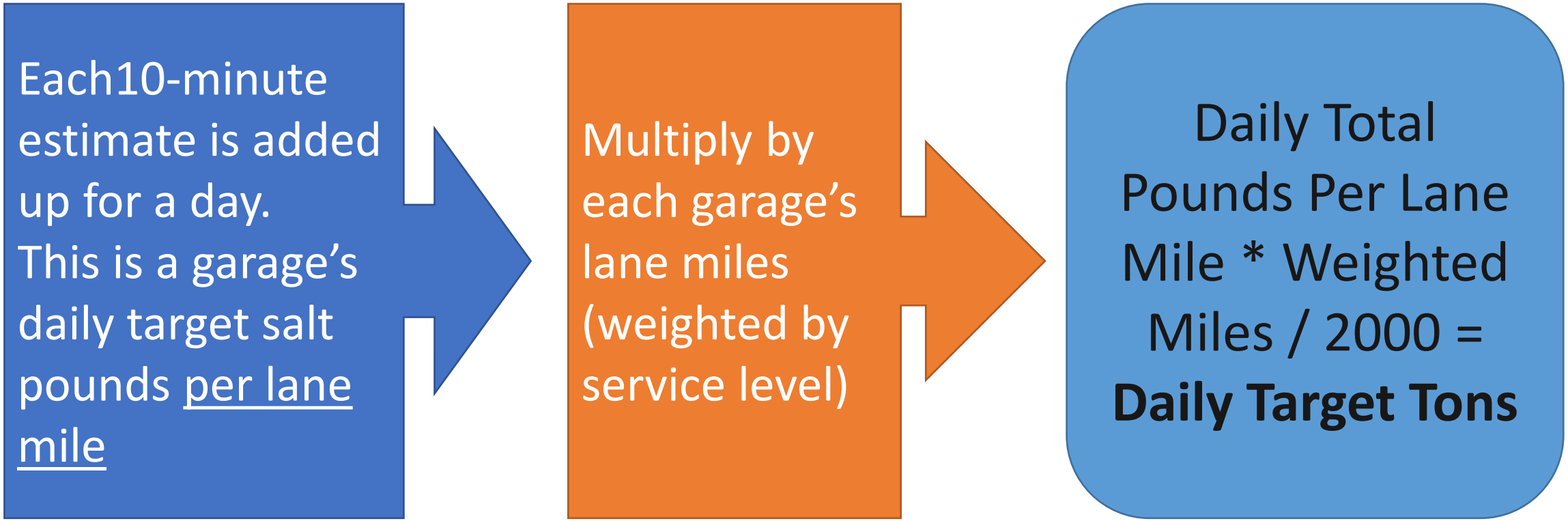
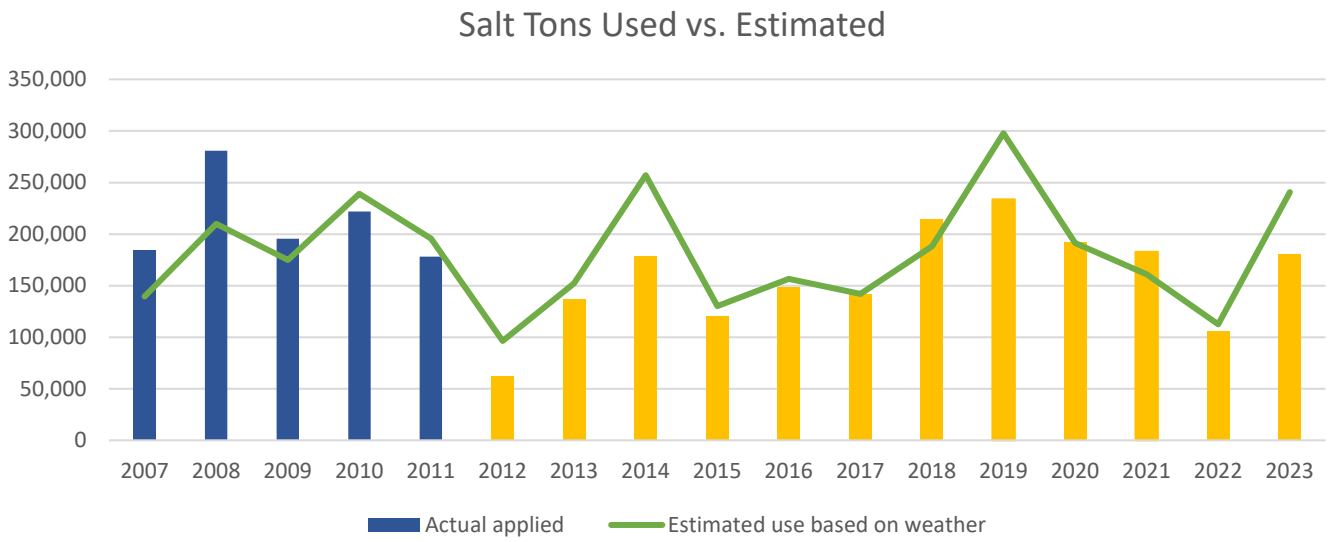
- Rates are assessed in 10 minute periods
- For example, 140 Pounds/LM in 2 hours = 11.67 Pounds/LM in 10 minutes
- 10-minute scale lets the salt rate adjust as temperatures or storm types change
- Adds up all of the 10-minute amounts to create daily rates

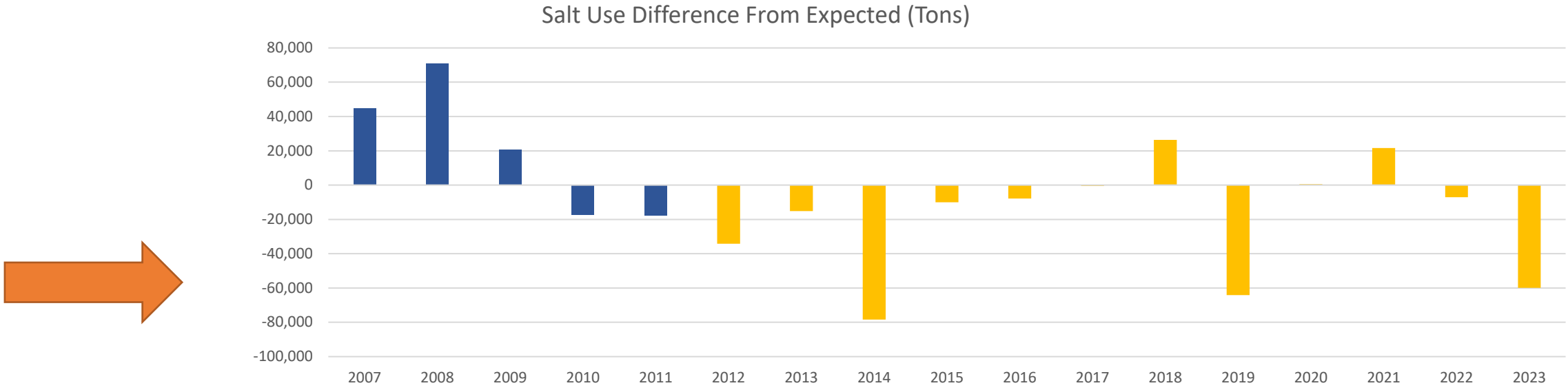
How It's Made


Each10-minute estimate is added up for a day. This is a garage's daily target salt pounds per lane mile
Multiply by each garage's lane miles (weighted by service level)
Daily Total Pounds Per Lane Mile * Weighted Miles / 2000 = **Daily Target Tons**

How Has Salt Use Changed?

- Overages tend to be less over
- More years under, and further under.

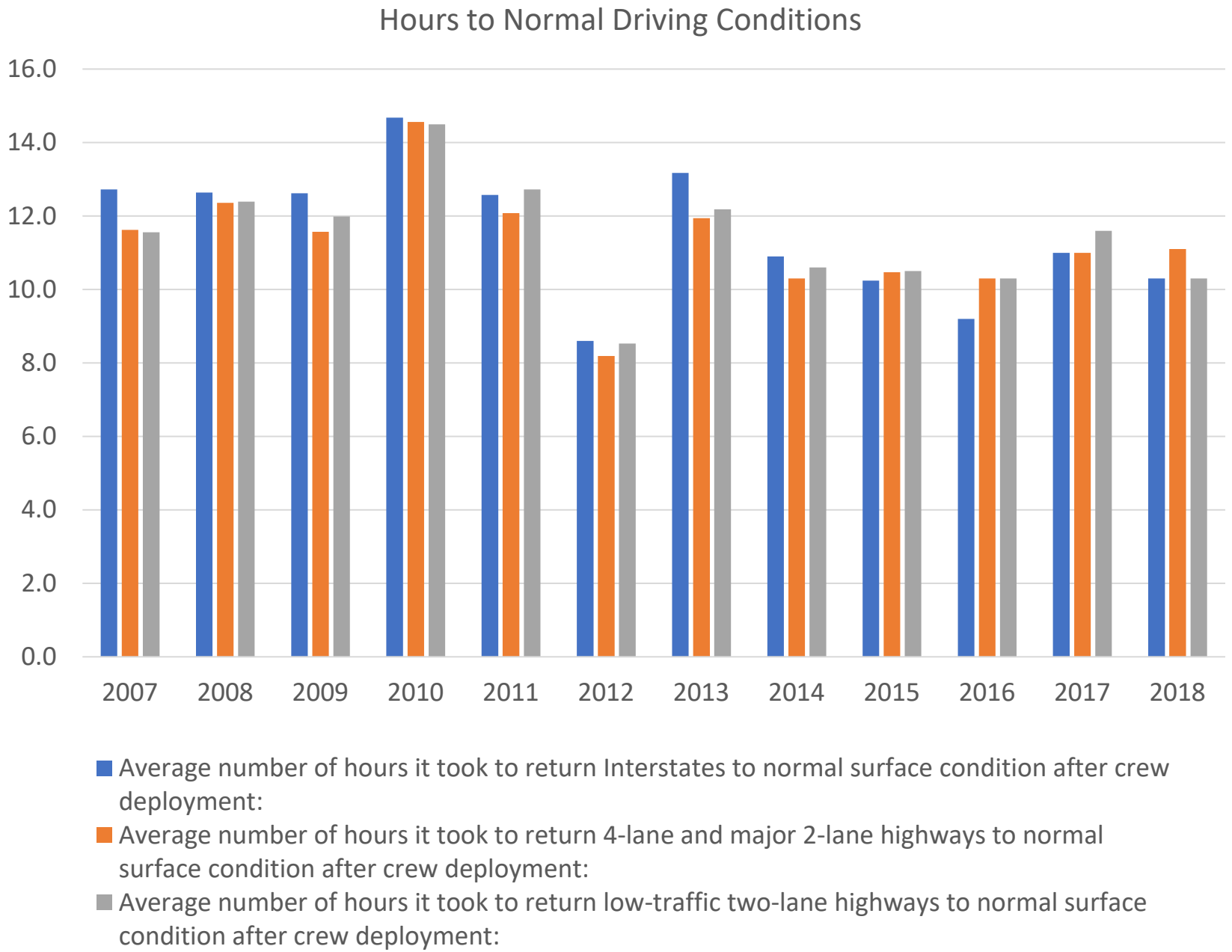




Performance Changes

FY 2007-2011 Average Hours to Normal:
A – 13.0
B – 12.4
C – 12.6

FY 2012-2018 Average Hours to Normal:
A – 10.5
B – 10.5
C – 10.6



Material Use and Storm Info Dashboard

- Shows statewide storm hour and snow amount comparisons
- Material usage detail for user-selectable years or time frames
- Link on DOTnet

Material Use Totals (Functions 675, 682)

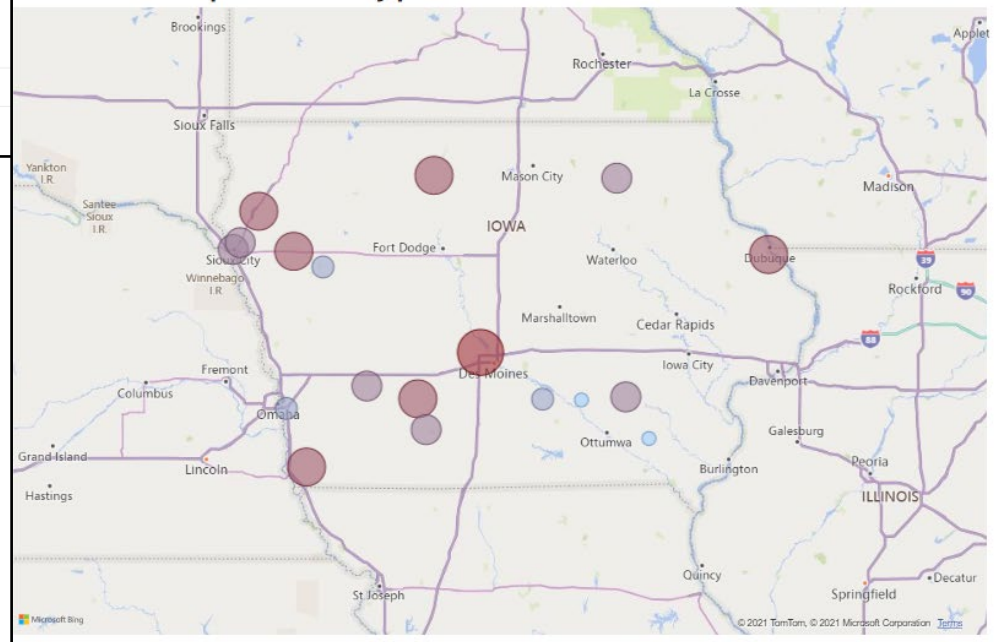
DistrictID	LIQUID CALCIUM CHLORIDE	SALT BRINE	SALT COMPOSITE 50/50 SALT/ SAND	SALT ROCK	SAND
1	11,389	5,615,789	2,207	20,769	270
2		3,766,418	2,150	17,290	4,099
3		3,571,350	974	17,094	2,044
4	2,192	5,708,051	333	23,904	227
5	6,172	5,958,677	2,254	20,731	1,837
6	2,452	8,408,461	2,969	41,176	938
Total	**22,205**	**33,028,745**	**10,887**	**140,964**	**9,414**

Chart defaults to FY21, all garages, year to date. You can edit these variables using the controls below.

Garage Name

All

FY22 Precipitation Type Hours



Thanks!

- Tina Greenfield
- Iowa DOT
- Tina.greenfield@iowadot.us