RWIS Automated Advisory System

Centralized advisory system for the control of Dynamic Message Signs

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Schneider Electric

Alberta Transportation

Presentation Learning Outcomes

- Weather can have large impacts on small sections of roadway
- Local knowledge, experience and field support is very valuable
- Getting system design and requirements finalized takes work, but can pay future benefits


Great Slave Lake
Hudson Bay
Caribou Mountains
Lake Athabasca
Birch Mountains
Quebe
Canada
James Bay
Dixon Entrance
Hecate Strait
British Columbia
Alberta
Manitoba
Canadian Shield
Ontario
Lake Winnipeg
Queen Charlotte Sound
Saskatchewan
Lake Nipigon
Columbia Mountains
Lake Manitoba
Vancouver Island
Strait of Georgia
Lake Superior
Georgian Ba
Strait of Juan de Fuca
Lake Huron
Washington
Green Bay
North Dakota
Minnesota
Michigan
Cascade Range
Montana
Wisconsin
Lake Michigan
Bitter Rocky Mountains
Ohio
Salmon River Mountains
Oregon
Idaho
South Dakota
Iowa
Illinois
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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Image IBCAO
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Introduction

- Alberta Highway #22 experiences dangerous wind gusts
  - Mostly occurring between kilometers 7 and 27
  - Dubbed by locals as the “Wind Tunnel”
  - Local geography and Chinook winds are the cause
- Between November and April, motorists are at highest risk
  - Strong wind gusts blow vehicles over, even if they are parked
  - Vehicles are blown into on-coming traffic in the other lane
- Alberta Transportation wanted to take a **pro-active approach**
  - Try to reduce the number of wind related accidents and improve safety for the motoring public.

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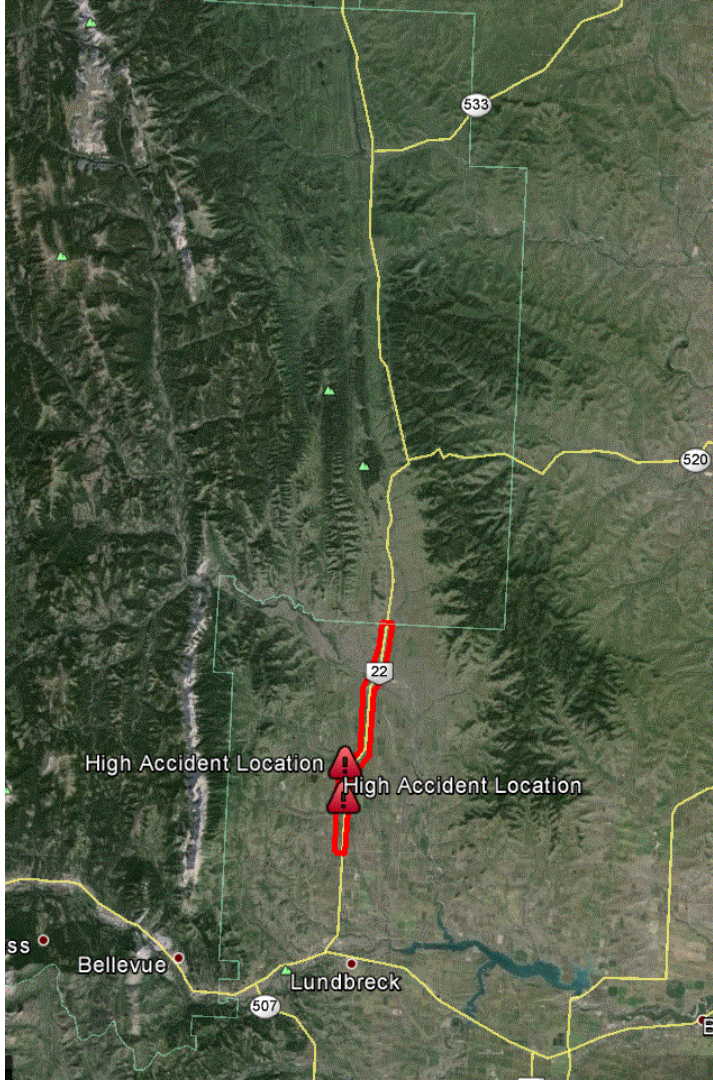


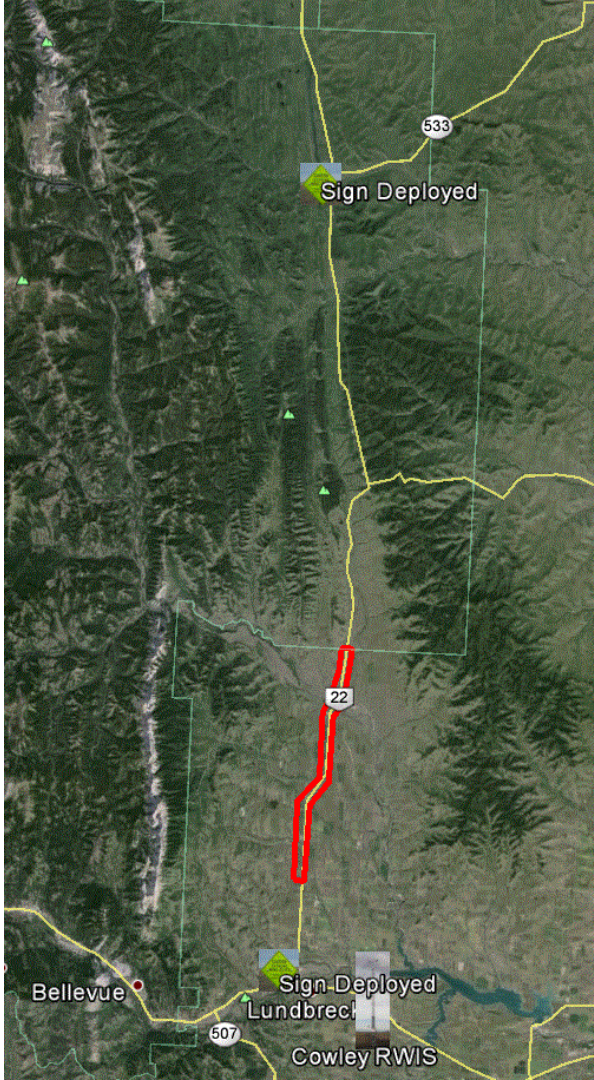
Alberta Transportation

Serious Accidents

- On February 11, 2011 approximately eight vehicles were blown over
  - 6 semi trailer units
  - 3 from BC, 2 from Ontario and 1 from Nevada
  - 1 pick-up with a utility trailer
  - 1 R.V. unit.
- Between September 2010 to April 2011 there were 16 similar accidents, and previous years had 4-6 accidents each
- Large cost per accident
  - Estimates range from $25k to $40k
  - Other DOTs estimate upwards of $80k

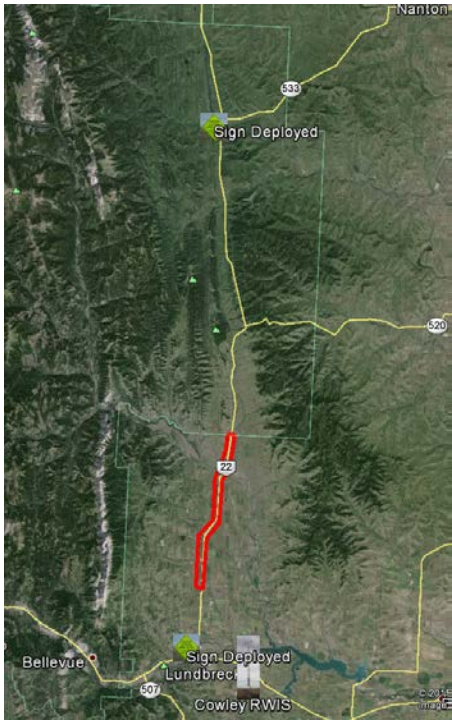
The Existing Advisory System

- Wind speed measured at the Cowley RWIS
  - Located approximately 8 kilometres east of the #22/#3 junction.
- When the wind gusts exceed 80 km/h at Cowley RWIS, the HMC Volker Stevin would deploy portable signs:
  - 150 meters north on #22.
  - Junction #533 and #22 near Chain Lakes to warn the south bound traffic
  - Calls would be placed to
    - Burmis VIS, if opened, who warns all other VIS sites in southern Alberta
    - Alberta Transportation & B.C. Ministry of Transportation.



Limitations of the Existing System

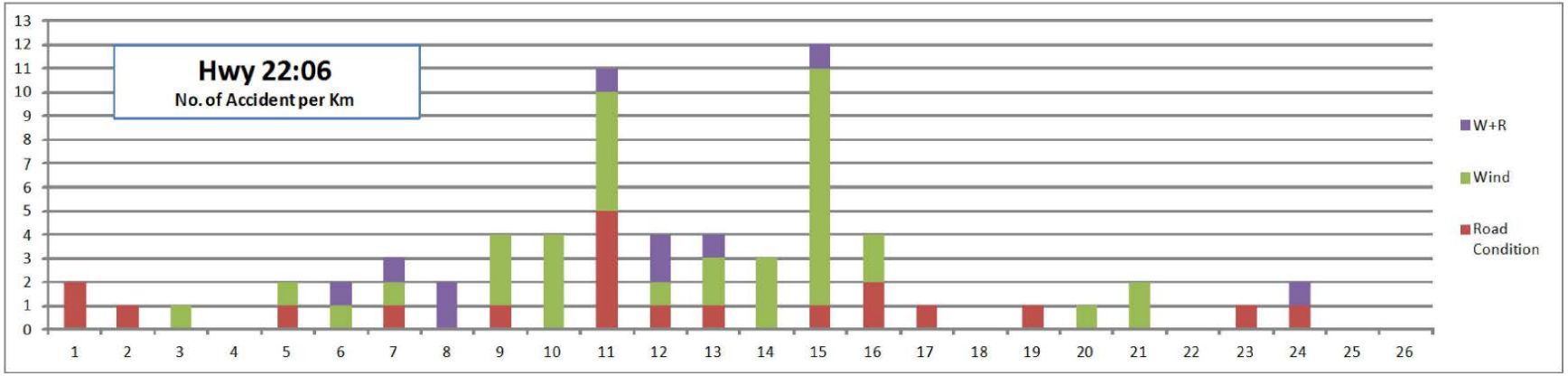
- The RWIS site at Cowley doesn't accurately reflect the wind speed on highway #22.
  - Experience has shown that only moderate winds are experienced at Cowley while extreme winds are occurring in the danger zone.
  - The other RWIS north on #22 is also not representative of the danger zone.
- This procedure is completely manual, and not fast enough
  - Monitoring the wind speed
    - Someone had to monitor the wind speed continuously, or by instinct.
    - New alerting capabilities from RWIS data management system helped
  - Deploying the signs
    - By the time personnel arrive the wind event is subsided or has already claimed a couple of vehicles.
  - Poor Sign Placement
    - Only HWY #22 is signed, and nothing on Highway #3.



Wind Task Group

- The **Wind Warning Task Group was formed** in June 2011
  - With representatives from local RCMP, Landowners, Emergency Services, local MLA, District AT MCI, local gas plant owner and HMC Volker Stevin
- Concluded with two options proposed:
  - Plan A
    - A simplified RWIS station near Compton
      - Site chosen to reduce cost by partnering with private business for power and communications
      - Measures only wind
    - Wind data fed into AMA (now 511 Alberta) road reports
  - Plan B
    - Additional static signage on Hwy 22 and 3
    - Signs would include a wind-sock as seen in other jurisdictions
  - In the end, elements of these were combined into the final requirements

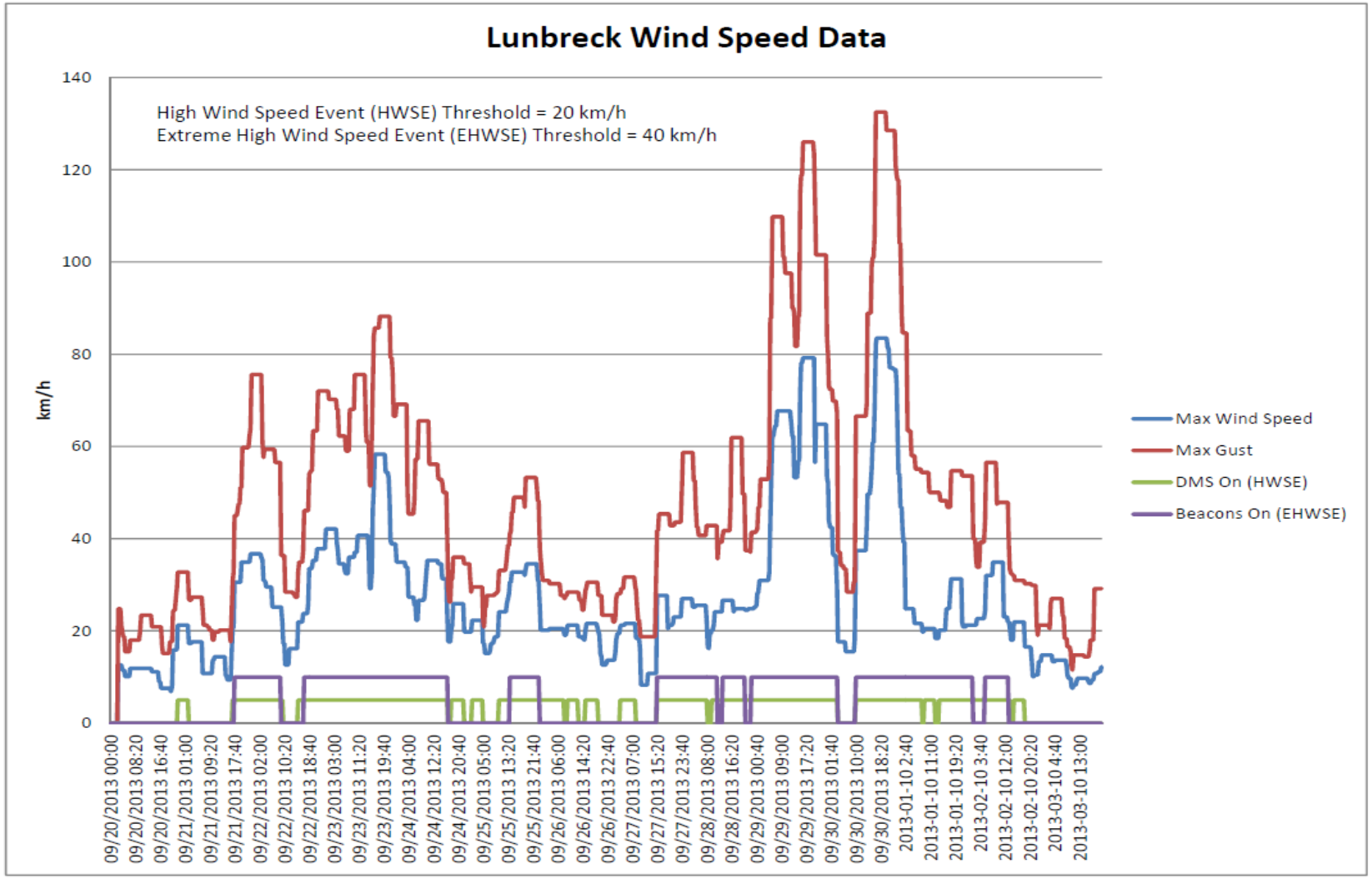
Accident Study



- A study was done to analyse MVA data
  - A clear picture started to form of where the wind and road condition accidents were occurring
  - The RWIS station was proposed near kilometre 15, also the location of the highest number of collisions
- Research from other DOTs was reviewed
  - Clear indications that an automated system can bring immediate benefits

Requirements Gathering

- Requirements were gathered from the key stakeholders
  - AT District MCI, Alberta Transportation
- A collaborative environment helped to define meaningful requirements
  - Having the system designer in the sessions helped
  - “Unwieldy” requirements were refined into those which could be delivered on
  - Potential issues arising from inexperience were avoided
  - Potential designs were discussed, which led to better understanding of the consequences of certain requirements.
- Simulators
  - Helped to explain complex concepts
    - Data smoothing
    - Asynchronicity
    - Activation hold timers


Lunbreck Wind Speed Data
High Wind Speed Event (HWSE) Threshold = 20 km/h
Extreme High Wind Speed Event (EHWSE) Threshold = 40 km/h
km/h
140
120
100
80
60
40
20
0
09/20/2013 00:00
09/20/2013 08:20
09/20/2013 16:40
09/21/2013 01:00
09/21/2013 09:20
09/21/2013 17:40
09/22/2013 02:00
09/22/2013 10:20
09/22/2013 18:40
09/23/2013 03:00
09/23/2013 11:20
09/23/2013 19:40
09/24/2013 04:00
09/24/2013 12:20
09/24/2013 20:40
09/25/2013 05:00
09/25/2013 13:20
09/25/2013 21:40
09/26/2013 06:00
09/26/2013 14:20
09/26/2013 22:40
09/27/2013 07:00
09/27/2013 15:20
09/27/2013 23:40
09/28/2013 08:00
09/28/2013 16:20
09/29/2013 00:40
09/29/2013 09:00
09/29/2013 17:20
09/30/2013 01:40
09/30/2013 10:00
09/30/2013 18:20
2013-01-10 2:40
2013-01-10 11:00
2013-01-10 19:20
2013-02-10 3:40
2013-02-10 12:00
2013-02-10 20:20
2013-03-10 4:40
2013-03-10 13:00
Max Wind Speed
Max Gust
DMS On (HWSE)
Beacons On (EHWSE)


Wind Advisory System Sin
www.
/WASsim/
2013/09/22 01:20:
Average Wind Speed: 20.88
Gust Wind Speed: 38.88
70
60
50
40
30
20
10
0
10:00
12:00
14:00
16:00
18:00
20:00
22:00
22Sep
02:00
04:00
06:00
08:00
10:00
12:00
14:00
Beacon Hold Timer Simulation
20
10
0
10:00
12:00
14:00
16:00
18:00
20:00
22:00
22Sep
02:00
04:00
06:00
08:00
10:00
12:00
14:00
HWY 22 TRAFFIC
HIGH WIND
ADVISORY
WHEN FLASHING
WIND SPEED: 21 km/h
Higher Wind-Threshold
0 km/h
150 km/h
Current Value: 50 km/h
Beacon Activation Hold Timer
0 mins
120 mins
Current Value: 41 mins (0.68hrs)
Select Data Set:
Lundbreck Small
Previous 24 hours
Previous 48 hours
Previous 72 hours
Show All data
Wind Advisory System Simulator - Pre-Alpha Version
© 2014 Schneider Electric [JH, JL]
DMS driven by average speed (if enabled)
Beacons driven by gust speed only

Final Requirements

Initial Requirements

- Wind-only RWIS, located at km 15
  - Save cost with less sensors
- Four advisory signs with dynamic elements
  - Installed at key turn-off points
  - Power and communications TBD
- Automatic updates of signs from RWIS
  - Parameters TBD
  - Data smoothing
  - Signs controlled by simple close-contact relays
  - SMS alerting on activity

Final Requirements

- A full RWIS site at this site
  - Upgrade to most rugged wind sensor available
  - Include full set of measurements
- Six advisory signs with dynamic elements
  - Installed at key turn-off points
  - 3 signs have power, 3 don’t. All have cell coverage
- Automatic control from the central server
  - Wind speed display constantly updating
  - Data smoothing by way of activity hold timers
  - Some signs have full NTCIP interface, some are simple close-contact relays
  - SMS & email alerting on activity, with rate limiting

Major Design Points

- Different Sign Types
  - Suitable for the location
- A Central System
  - Extreme distances involved
  - Future use of the system at 2 other locations in Alberta
  - Different sign communications
  - Logging and reporting requirements
  - Adjustability
  - Opens the possibility to use other data sets as input (forecasts, other observations, national meteorological service alerts)
- Notifications
  - Quiet periods & Rate Limiting

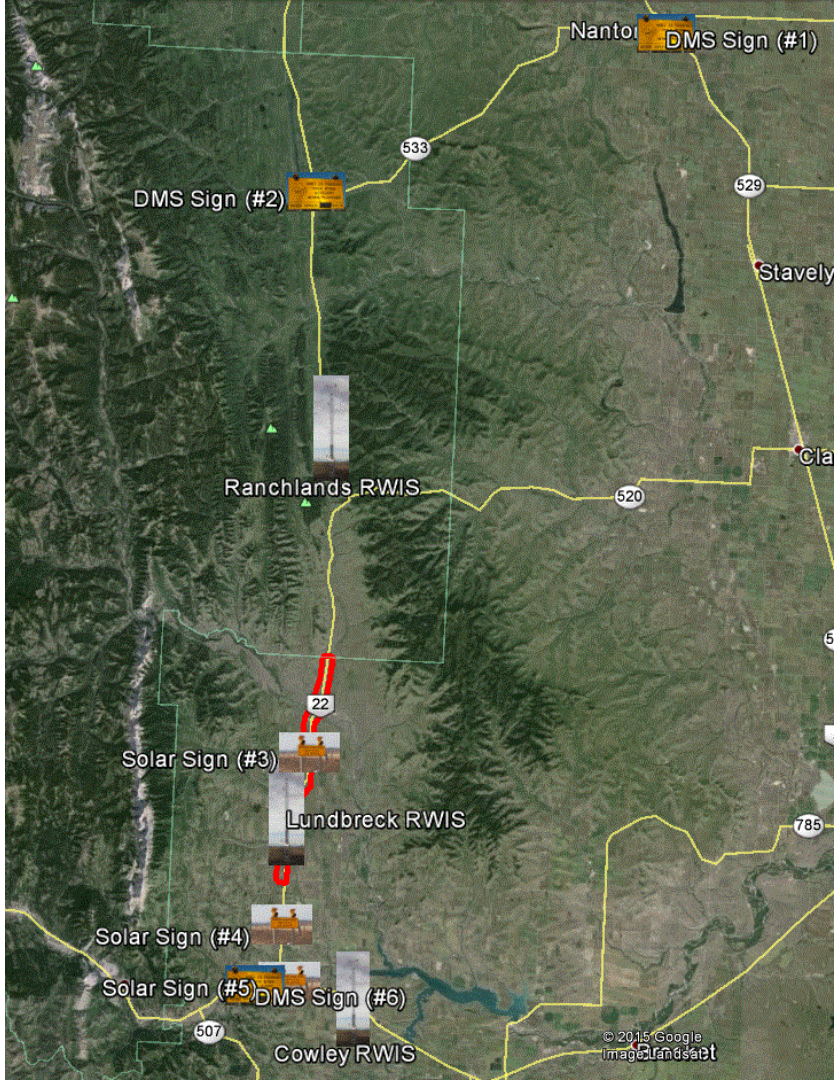
Sign Design

- Solar Sites
  - Flashing Beacons
  - Modbus controlled
  - Solar Powered
  - Local Override switch

- DMS Sites
  - Flashing Beacons
  - Wind Speed display in the DMS
  - NTCIP controlled
  - Utility power
  - Local Override Switch

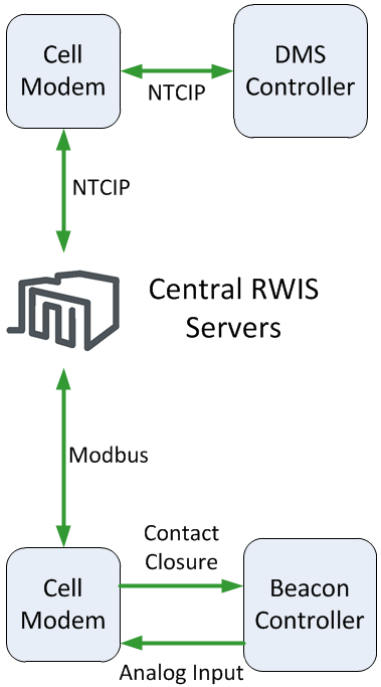
Sign Placement

- 6 Advisory signs were installed
  - Locations prior to turn off points were chosen, to give drivers the chance to choice alternate routes.
    - 4 of the 6 semis in the February 2011 accident were not local drivers
    - Local drivers rely on tricks of the trade to know if Hwy 22 is dangerous
      - E.g A flag flying 4 miles east of the #22/#3 turn-off
- Signs were located over a 100 km stretch of roadways
  - Traditional radio communication designs would not be appropriate



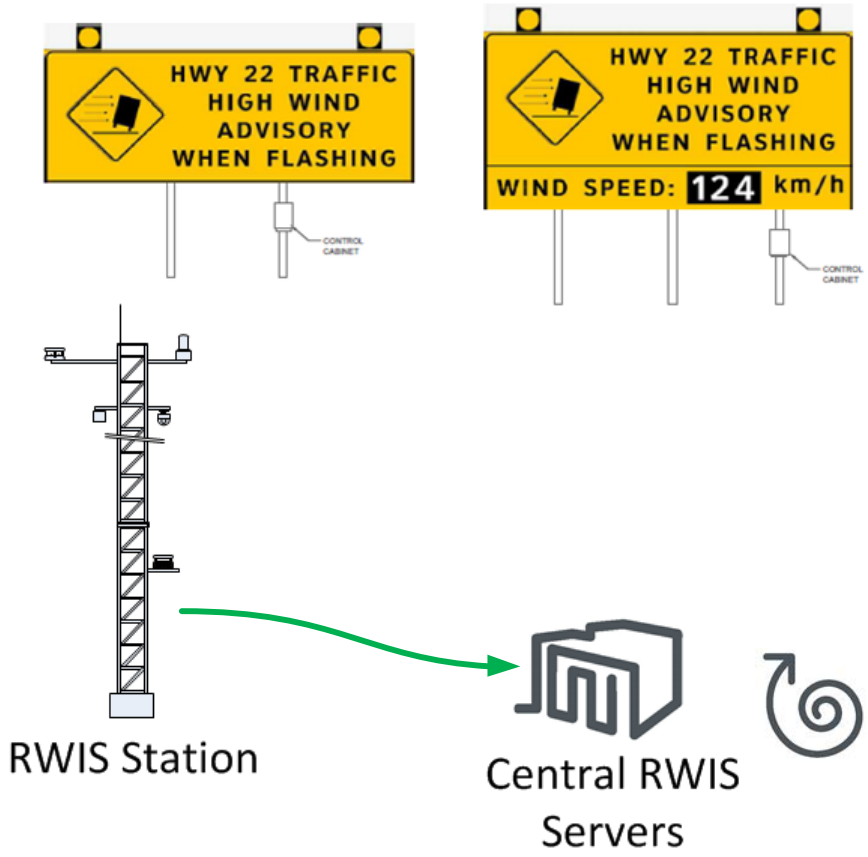
Flexible Sign Control Strategies

- The solar power sites were not NTCIP
  - These meant that the control system had to be able to control signs with different protocols
- Significant cost savings
  - Being able to use solar power reduced the cost of the solar sites.
- Being hardware and protocol agnostic helped
  - The rule engine is abstracted from the sign control protocols, allowing future hardware types to be support easily

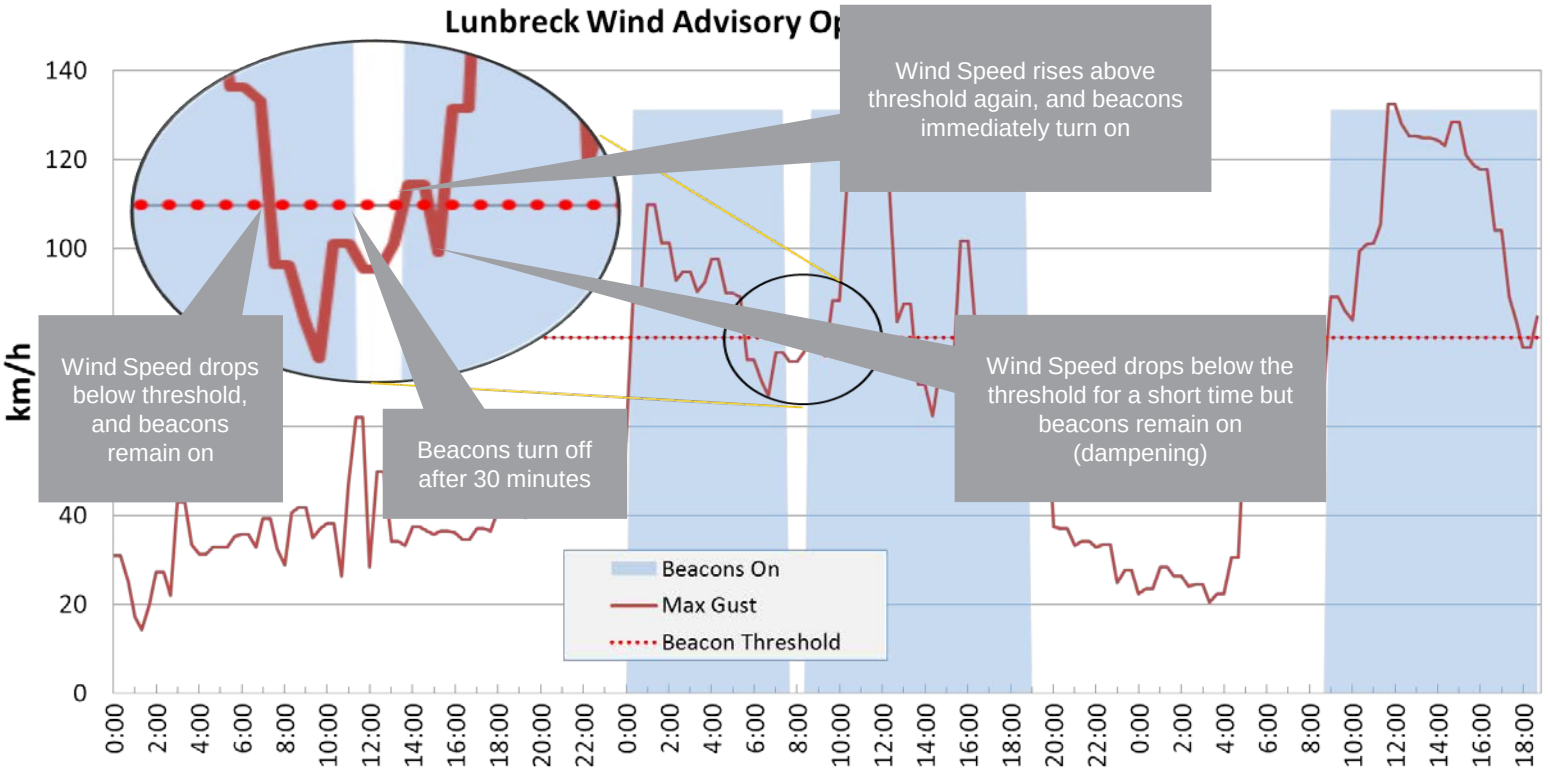


Overview of Operation

1. Wind Data from the Lundbreck RWIS retrieved by Central Server

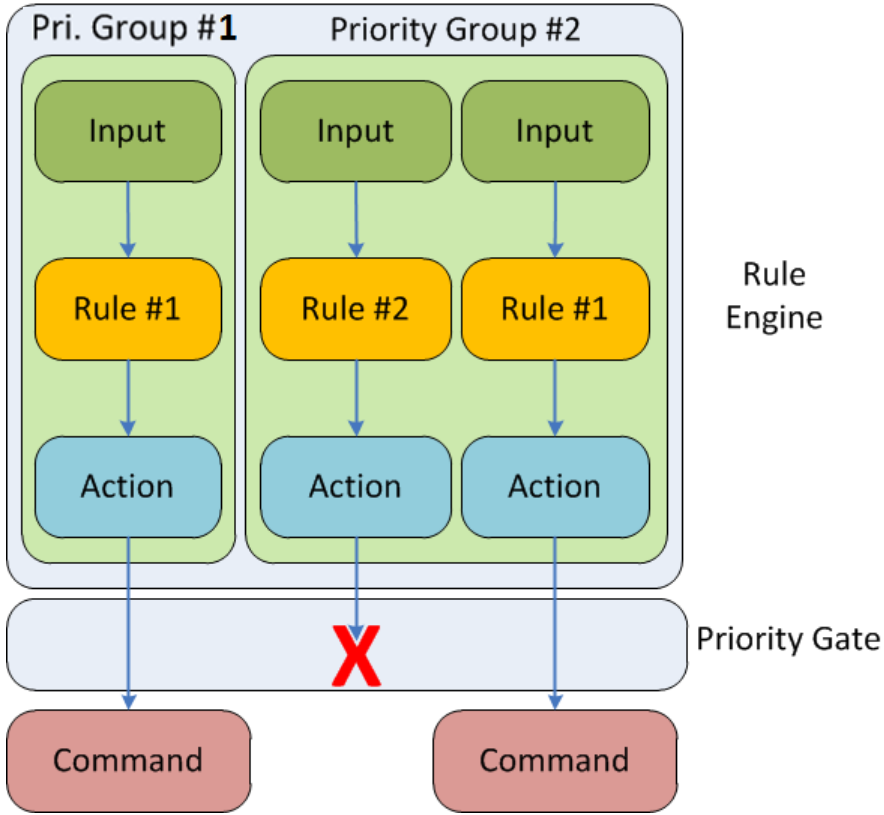


Example Operation



Central System Rule Engine

- Inputs
  - Real-time data from field devices
  - Configurable smoothing and hold-off periods
  - Manual triggers & periodic events
- Rules
  - Generic evaluators on inputs
- Actions
  - Commands to field devices
  - Triggers of other actions or sequences of actions
- Prioritization
  - Rules belong to a priority group, and have a unique priority within the group
  - The highest priority rule in a group wins, and only its action is executed



Rule Engine Benefits

- AT wanted to keep the door open to future research on advisory algorithms
  - Can easily implement new rules as research progresses
  - Can use inputs from others sources
    - Example: forecasted weather, other observation stations or groups of stations (static, mobile), national meteorological service alerts
  - Can control DMS assets anywhere.
    - Example: mobile DMS trailers during storms or certain seasons
- Re-useable
  - Spring 2016 implementation for bridge decks will use the same rule engine. No custom coding required.

- All automation happens in the central system
  - Fully automated. No humans required. Works 24x7 un-aided
  - Easy access to all operational reports and logs.
  - Notifications via SMS and email are easy and reliable.
- Safe
  - Obeys the local override setting on each sign
  - Monitors itself and the signs for proper operation, and will blank all signs on major problems

Notifications

- Groups of interest
  - Users are placed in a group attached to a site
  - Only users interested in notifications for that site get the notifications
- Categories
  - Notifications fall into different categories, and users will only get the types of notifications they care about.
- Rate Limiting
  - Fully automated systems need to rate limit themselves so that they don’t spam the users
  - Rate-limiting is per-category.

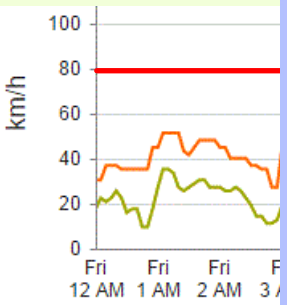
Current Performance

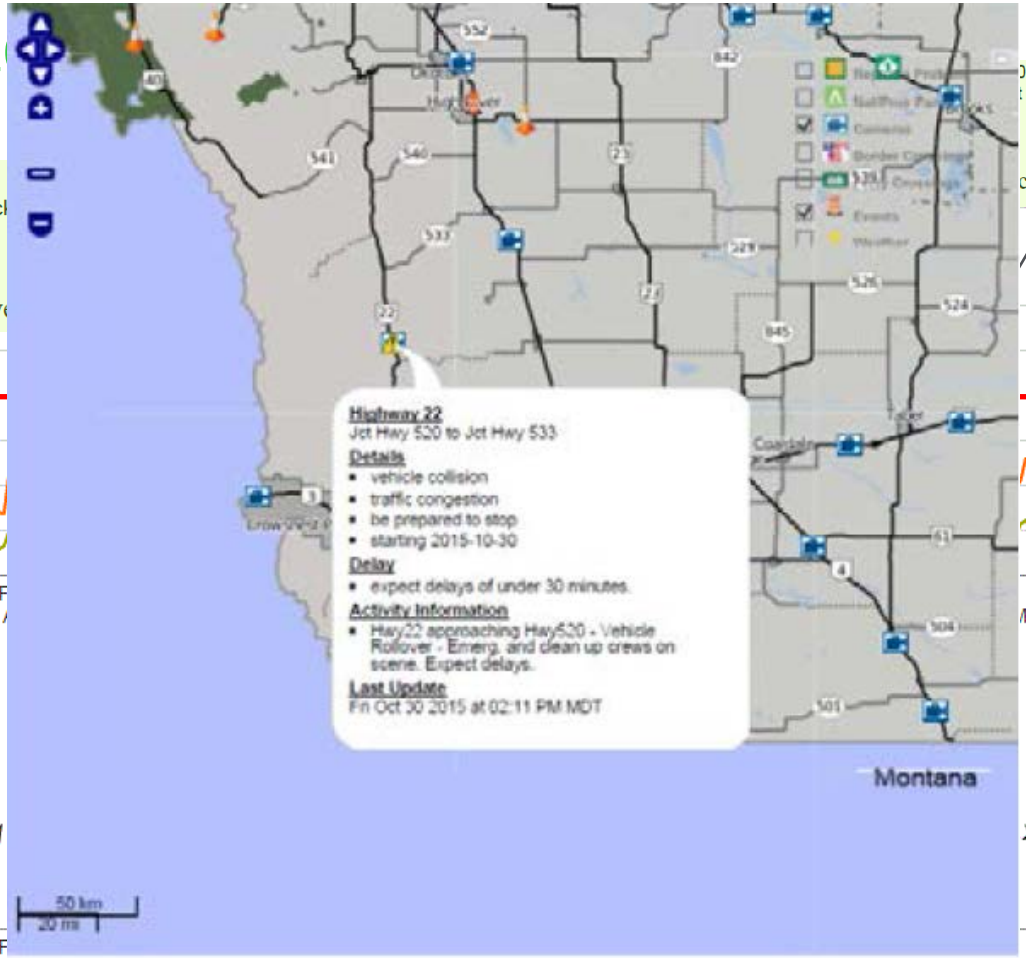
- The system (hardware + software) is currently in Operational Performance Testing
  - Troubles with the DMS sign hardware has delayed commissioning
- Accuracy thus far
  - Wind season came early (see following slides)
  - The system has correctly controlled all 6 signs through dozens of high wind events
  - The data smoothing employed has made the system responsive and without “chatter”
  - Having the RWIS at the exact trouble zone has made the system more representative of the area
    - Nothing can substitute for local measurements to rely on
  - Communications are not perfect, and the system is handling it ok
    - Improvements are scheduled to make the system more resilient
    - Remove false alarms from communication outages

October 30th, 2

Date: 15/10/30 11:45
Subject: Event at site Lundbreck

Event at site Lundbreck: Wind ev

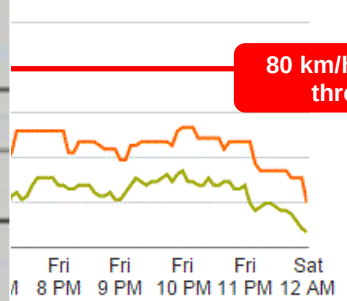


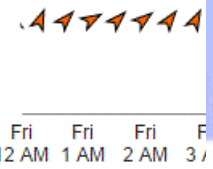


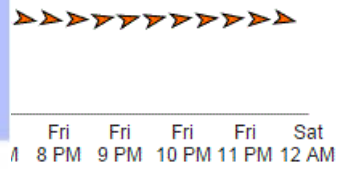
17:40
site Lundbreck: Wind event stopped with speed 59 km/hour

ck: Wind event stopped with speed 59 km/hour

80 km/hr (50mph) threshold







511 Alberta - Helping You Arrive Safely

Nov 5 Wind Event

Date:
Subject:

speed 85 km/hour

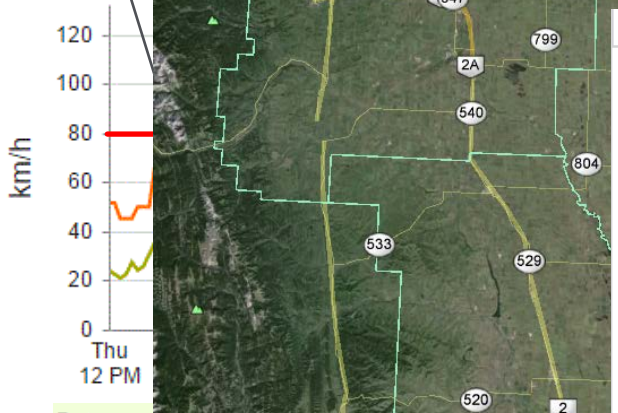
015

Preferences

nt started with speed 86 km/hour

15/11/12 17:51

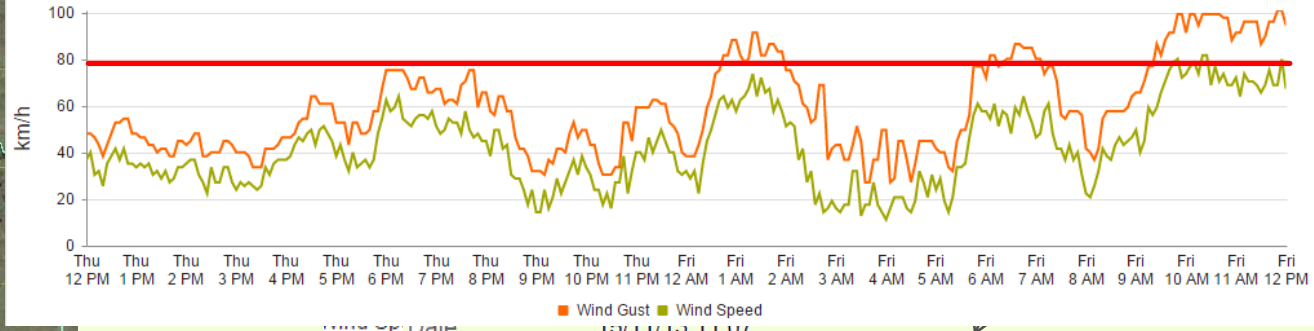
Event at site Lundbreck: Wind event started with speed 90 km/hour



AB 002-08 GRANUM for Nov 12, 2015 - Nov 13, 2015

Preferences

Wind Speed & Gust



Date:
Subject:

d with speed 73 km/hour

Date:

Subject: Event at site Lundbreck: Wind event stopped with speed 76 km/hour

Wind Direction

Presentation Learning Outcomes

- Weather can have large impacts on small sections of roadway
  - Accidents were statistically abnormal on a stretch of highway 22….and expensive; don't assume travellers are local
  - Despite best efforts, manual deployment of weather-driven countermeasures was not quick enough
- Local knowledge, experience and field support is very valuable
  - Years of maintenance experience is the foundation of this project and knowledge of local conditions was priceless
  - Excellent support from AT district staff and Volker Stevin
- Getting system design and requirements finalized takes work, but can pay future benefits
  - Get the control system people involved early in the requirements gathering
  - Be aware of who is giving initial requirements and who the end user is; be prepared for requirements to change/deepen
  - Simulators help people visualise difficult concepts; use it with a broad range of stakeholders and are invaluable for testing
  - A full FAT including all equipment for multiple days may be required
  - Never underestimate the availability of cellular communications; over-engineer the communications component
  - A hosted central system allows flexibility in inputs and field hardware for future projects

Next Steps

- Short-term
  - Improvements are scheduled to make the system more resilient
    - Installing cell-modem boosters and high gain antennas
  - Remove false alarms from communication outages
  - Monitor more power supply information
- Long-term
  - Spring 2016 expands into bridge decks with 3-line 20 character DMS sign
    - New notification types, new rule engine logic
- Future Direction(s)
  - Accident reduction and benefit analysis for 2015-2016 wind season (Nov – Feb)
  - Integration into 511 Alberta?
  - Utilize additional inputs
    - Visibility (fog), forecasts, National Meteorological Services alerts

Acronyms Used

511 Alberta	Alberta road information service	**Modbus**	Control Systems Protocol
AMA	Alberta Motoring Association	**MLA**	Member of the Legislative Assembly
AT	Alberta Transportation	**MVA**	Motor Vehicle Accident
BC	British Columbia	**NTCIP**	National Transportation Communications for ITS Protocol
DMS	Dynamic Message Sign	**RCMP**	Royal Canadian Mounted Police
DOT	Department of Transportation	**RWIS**	Road Weather Information System
EHWE/EHWSE	Extreme High Wind (Speed) Event	**SAT**	Site Acceptance Testing
FAT	Factory Acceptance Test	**SMS**	Short Message Service
HMC	Highway Maintenance Contractor	**TBD**	To Be Determined
HWE/HWSE	High Wind (Speed) Event	**VIS**	Vehicle Inspection Station
ITS	Intelligent Transportation Systems	**VS**	Volker Stevin
MCI	Maintenance Contract Inspector		

Thank you!

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