Introduction

• **Purpose**
  – Investigate work zone safety from a traffic crash perspective
  – Analyze crash reports, construction records
  – Find trends and data to support the goal of work zone improvement

• **Safety and Mobility Policy**
  – Requires analysis of crash data for continual improvement of work zone safety and mobility
  – Annual reporting

• **Toward Zero Deaths**
  – Supports the goal of Minnesota’s TZD Program by understanding how and where severe crashes are happening in work zones

• **Data Sources**
  – Transportation Information System database
  – Crash Application / DPS Crash Reports
  – Georilla
  – Variety of MnDOT Records
  – MnCMAT Issues
BACKGROUND

Introduction of Basic Work Zone Crash Information
Parameters

• Three years: 2012-2014
• Work zone crashes include any crash coded with a valid work zone type.
• Severe crashes are defined as fatal (K) or incapacitating injury (A) crashes.
• Percentages were calculated as the value of interest per total number of crashes.
By the Numbers
Work Zones

5,569 Crashes
58 Severe Crashes
24 Fatalities
40 Incapacitating Injuries
2,270 Total Injuries
119 Vehicles (Severe)
11,489 Vehicles (All)
By the Numbers
All Crashes

226,405 Crashes
3,963 Severe Crashes
1,179 Fatalities
5,753 Injuries
(due to severe crashes)
89,721 Total Injuries
6,212 Vehicles (Severe)
410,216 Vehicles (All)
Legend

- Crashes

5,659 work zone crashes have taken place in Minnesota over the years 2012-2014.

Minnesota Work Zone Crashes 2012-2014

Crash Map
All Work Zone Crashes
Crash Map
Severe Work Zone Crashes

Legend
58 severe work zone crashes have taken place in Minnesota over the years 2012-2014, leading to 24 fatalities and 40 incapacitating injuries.

Caitlin Johnson
July 8, 2015
Exposure

• The map to the right displays 2012-2014 data collected by 511 regarding work zone locations.
• The dataset for 2012 is incomplete, but all records are included for 2013 and 2014.
• 511 does not include any mobile work zones. The data shown here may be any stationary work zone from a one-day project to a long term work zone.
WORK ZONE STATISTICS
Comparing Work Zone Crashes with Other Crash Datasets
Work Zone Type

Severe Work Zone Crashes

- Lane Closure: 33%
- Shoulder/Median: 14%
- Lane Shift/Crossover: 10%
- Moving: 10%
- Intermittent: 9%
- Other: 24%

Total Crashes: 58

All Work Zone Crashes

- Lane Closure: 44%
- Shoulder/Median: 17%
- Lane Shift/Crossover: 16%
- Moving: 5%
- Intermittent: 4%
- Other: 14%

Total Crashes: 5,659
Location in Work Zone

Severe Work Zone Crashes

- Before First Sign: 3%
- Advance Warning: 12%
- Transition: 9%
- Activity: 48%
- Termination: 3%
- Other: 12%

All Work Zone Crashes

- Before First Sign: 3%
- Advance Warning: 10%
- Transition: 18%
- Activity: 48%
- Termination: 2%
- Other: 9%

Workers were present for 6 (10.3%) crashes.

Total Crashes: 58

Workers were present for 1,703 (30.1%) crashes.

Total Crashes: 5,659
September 26, 2013
11:33 PM

Dark, street lights on
Clear weather, dry road

Motorcycle, travelling eastbound on County Road 153 in Saint Anthony.

Eastbound traffic was crossed over onto the westbound lanes for construction.

In the termination area, the driver was confused, and drove between barrels, continuing into the westbound lanes.

Attempted to return to the eastbound lanes, but hit the median. Driver was dead on arrival.
CRASH STATISTICS

Comparing Work Zone Crashes with Other Crash Datasets
Severity

All Work Zone Crashes

- Property Damage Only: 72%
- Non-incapacitating Injury: 8%
- Severe Crashes: 19%

Severe Work Zone Crashes

- Incapacitating Injury: 41%
- Fatality: 59%

Total Crashes: 5,659
Total Crashes: 58
Crash Diagram

Severe Work Zone Crashes

- Rear End: 29%
- Right Angle: 21%
- Other*: 17%
- Ran Off Road- Right: 9%
- Ran Off Road- Left: 7%
- Head On: 7%
- Left Turn: 3%
- Sideswipe- Same: 3%

Total Crashes: 58

All Work Zone Crashes

- Rear End: 51%
- Right Angle: 10%
- Other: 7%
- Ran Off Road- Right: 4%
- Ran Off Road- Left: 4%
- Head On: 3%
- Left Turn: 3%
- Sideswipe- Same: 16%

Total Crashes: 5,659

* “Other” collisions included: 1 pile-up, 2 pedestrian, 1 construction equipment, 4 motorcycle (hit drums, median, milled pavement), 1 non-collision

Note: Sideswipe- Opposing and Right Turn crashes were omitted from the “All Work Zone Crashes” graph, for purposes of comparison, because no fatal or serious crashes were of these types of collisions.
Crash Diagram

All Severe Crashes

- Rear End: 10%
- Right Angle: 21%
- Other: 13%
- Ran Off Road - Right: 16%
- Ran Off Road - Left: 12%
- Head On: 15%
- Left Turn: 4%
- Sideswipe - Same: 2%

Total Crashes: 3,963

All Crashes

- Rear End: 30%
- Sideswipe - Same: 11%
- Right Angle: 17%
- Other: 9%
- Ran Off Road - Right: 9%
- Ran Off Road - Left: 8%
- Left Turn: 5%
- Head On: 5%
- Sideswipe - Opposign: 2%
- Right Turn: 1%

Total Crashes: 226,405

Note: Sideswipe - Opposing and Right Turn crashes were omitted from the “All Severe Crashes” graph, for purposes of comparison, because none of the severe work zone crashes were of these types of collisions.
Contributing Factors

Severe Work Zone Crashes

- Inattention/Distraction: 13%
- Failure to Yield: 13%
- Illegal/Unsafe Speed: 9%
- Improper Lane Use: 6%
- Chemical Impairment: 4%
- Overcorrecting: 3%
- Disregarded Traffic Control: 3%
- Following Too Closely: 3%
- Non-Motorist Error: 3%
- Weather: 3%
- Driver Inexperience: 2%
- Impeding Traffic: 2%

Total Vehicles: 119

All Work Zone Crashes

- Inattention/Distraction: 18%
- Failure to Yield: 7%
- Illegal/Unsafe Speed: 5%
- Improper Lane Use: 5%
- Chemical Impairment: 2%
- Overcorrecting: 1%
- Disregarded Traffic Control: 2%
- Following Too Closely: 13%
- Non-Motorist Error: 0%
- Weather: 1%
- Driver Inexperience: 1%
- Impeding Traffic: 0%

Total Vehicles: 11,489

Notes: 1) Percentages were determined as the number of crashes due to each factor per total number of vehicles involved in crashes. 2) For purposes of comparison, contributing factors that didn’t lead to serious crashes were omitted from the “All Work Zone Crashes” graph. Omitted from both graphs were skidding, improper passing, and driving left of center, which each contributed to one serious crash but had negligible (<1%) percentages. “Other” contributing factors were also omitted.
Contributing Factors

**All Severe Crashes**

- Inattention/Distraction: 12%
- Failure to Yield: 14%
- Illegal/Unsafe Speed: 12%
- Improper Lane Use: 3%
- Chemical Impairment: 9%
- Overcorrecting: 3%
- Disregarded Traffic...: 5%
- Following Too Closely: 2%
- Non-Motorist Error: 2%
- Weather: 4%
- Driver Inexperience: 2%
- Impeding Traffic: 0%
- Skidding: 3%
- Driving Left of Center: 3%

**All Crashes**

- Inattention/Distraction: 13%
- Following Too Closely: 6%
- Failure to Yield: 10%
- Illegal/Unsafe Speed: 7%
- Improper Lane Use: 3%
- Disregarded Traffic...: 3%
- Chemical Impairment: 2%
- Improper Turn: 1%
- Improper Passing: 1%
- Overcorrecting: 1%
- Weather: 5%
- Inexperience: 1%
- Unsafe Backing: 1%
- Skidding: 3%

**Total Vehicles:**

- **6,212**
- **410,216**

**Notes:**
1) Percentages were determined as the number of crashes due to each factor per total number of vehicles involved in crashes.
2) Some factors were omitted from the “All Severe Crashes” graph, for purposes of comparison, because none of the severe work zone crashes were of these types of collisions. Improper passing was also omitted, which contributed to one severe work zone crash but had a negligible (<1%) percentage. “Other” contributing factors were also omitted from both graphs.
Crash Example
Distracted Driving

September 15, 2014
2:00 PM

Daylight
Clear weather, dry road

Passenger car travelling northbound on 5th Avenue South in Minneapolis.

A pavement marking operation was going on in the intersection of 5th Ave and 19th Street. Traffic control unknown.

The driver was looking down, texting, and struck the worker in the intersection, throwing him 37 feet. The worker suffered an incapacitating injury.

Google Maps Street View
Single or Multiple Vehicle

Severe Work Zone Crashes
- Single: 10%
- Multiple: 90%

All Work Zone Crashes
- Single: 15%
- Multiple: 85%

Total Crashes: 58
Total Crashes: 5,659
## Work Zone Crash Costs

<table>
<thead>
<tr>
<th>Crash Severity</th>
<th>Number of Crashes</th>
<th>Crash Value</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>24</td>
<td>$1,100,000</td>
<td>$26,400,000</td>
</tr>
<tr>
<td>Incapacitating</td>
<td>34</td>
<td>$570,000</td>
<td>$19,380,000</td>
</tr>
<tr>
<td>Non-Incapacitating</td>
<td>433</td>
<td>$170,000</td>
<td>$73,610,000</td>
</tr>
<tr>
<td>Possible Injury</td>
<td>1093</td>
<td>$83,000</td>
<td>$90,719,000</td>
</tr>
<tr>
<td>Property Damage</td>
<td>4070</td>
<td>$3,300</td>
<td>$13,431,000</td>
</tr>
</tbody>
</table>

The overall cost to Minnesotans due to work zone crashes from 2012 to 2014, is valued at **$223,540,000**.

Note: Crash values are taken from the Traffic Safety Fundamentals Handbook, developed by MnDOT OTST, revised June 2015.
DRIVER & VEHICLE STATISTICS

Comparing Work Zone Crashes with Other Crash Datasets
Drivers Involved

Severe Work Zone Crashes

All Work Zone Crashes

Note: Many of the driver ages in the database were found to be off by one year, due to a coding issue which caused rounding. This is a source of error in the “All Work Zone Crashes” graph.
Vehicle Type

Severe Work Zone Crashes

- Passenger: 67%
- Commercial: 20%
- Other: 13%

“Other” Includes:
- 7 Pedestrians
- 2 Bicycles
- 12 Motorcycles

All Work Zone Crashes

- Passenger: 88%
- Commercial: 4%
- Other: 8%

“Other” Includes:
- 51 Pedestrians
- 33 Bicycles
- 125 Motorcycles
- 1 Motorhome/RV
- 1 ATV
- 1 Construction
- 10 Mopeds/Scooters
- 11 Farm
- 13 Motorhome/RVs
- 2 ATVs

Total Vehicles: 119

Total Vehicles: 11,489
Typical Commercial Vehicle Data

All Crashes

Percentage of Traffic

• Only have trunk highway data for 2013.

• Typical volumes – may be different when work zones are present.

• Heavy vehicles made up 8.25% of the total vehicle miles traveled.

“Other” Includes:

- 2,582 Pedestrians
- 2,612 Bicycles
- 3,936 Motorcycles
- 197 Motorhome/RV
- 223 Snowmobile/ATV
- 371 Scooters/Mopeds
- 426 Farm
- 37 Skaters

Total Vehicles: 410,216
Crash Example
Commercial Vehicle

August 12, 2014
12:01 PM

Daylight
Clear weather
Dry road

Semi travelling southbound on County Road 20, pickup truck travelling westbound on MN 22, in Traverse Township (near St. Peter).

County Road 20 was a detour from construction on Hwy 169. No stop sign on 20. Signage on 22 leading to intersection: “Traffic Control Change Ahead”, “Detour North 169”, “Stop Sign Arrow”, “Cross Traffic Does Not Stop” with flashing lights. Also had rumble strips.

Driver of pickup truck failed to stop at intersection, crashed into semi at right angle. Driver was dead on arrival.

Following this crash, traffic control at this intersection was changed to a 4-way stop.
ROADWAY STATISTICS

Comparing Work Zone Crashes with Other Crash Datasets
Note: All timeframes are based on MnDOT volume by hour data. For weekdays: Morning Peak (6a – 10a), Day (10a – 3p), Evening Peak (3p – 7p), and Night (7p – 6a). For weekends: Day (7a – 12p and 4p – 7p), Peak (12p – 4p), and Night (7p – 7a).
Note: All timeframes are based on MnDOT volume by hour data. For weekdays: Morning Peak (6a – 10a), Day (10a – 3p), Evening Peak (3p – 7p), and Night (7p – 6a). For weekends: Day (7a – 12p and 4p – 7p), Peak (12p – 4p), and Night (7p – 7a).
Note: Many of the “All Work Zone Crashes” reports coded “other” for road type were found to be 4-6 lane divided roads not commonly considered highways (sections of University Ave, for example).
Road Type

All Severe Crashes

- Two Lane, Two Way: 2311
- Freeway: 287
- Other Divided Highway: 489
- 4 - 6 Lane Undivided: 476
- One Way Street: 49
- Freeway - Ramp: 57
- 3 Lane Undivided: 51

Total Crashes: 3,963

All Crashes

- Freeway: 36070
- Other Divided Highway: 28740
- Two Lane, Two Way: 81004
- 4-6 Lane Undivided: 40230
- Freeway Ramp: 7272
- One Way Street: 5499
- Other: 7048
- 3 Lane Undivided: 2324
- 5 Lane Undivided: 742

Total Crashes: 226,405

Note: For purposes of comparison, Alley/Driveways, Privately Owned Roads, 5 Lane Divided, and Other were excluded, because no work zone accidents occurred on this type of road.
### Speed Limit

#### Severe Work Zone Crashes

- **30-35 mph**: 45%
- **40-45 mph**: 19%
- **50-55 mph**: 7%
- **60-65 mph**: 7%
- **70+ mph**: 22%

#### All Work Zone Crashes

- **30-35 mph**: 28%
- **40-45 mph**: 13%
- **50-55 mph**: 36%
- **60-65 mph**: 18%
- **70+ mph**: 4%

**Total Crashes:** 58

**Total Crashes:** 5,659

Note: Speed limits of less than 30 mph were omitted from both graphs because there was an insignificant (≤1% of total) number or no crashes under these conditions.
Note: Speed limits of less than 30 mph were omitted from both graphs because there was an insignificant (≤1% of total) percentage of crashes under these conditions.
January 25, 2014
5:05 AM

Dark, street lights on
Overcast weather, wet road

SUV travelling northbound on US-52 Lafayette Bridge in St. Paul

Traffic was separated by concrete barriers. On the north end of the bridge traffic control curved to the right, then back left, due to construction.

Vehicle was moving at a high rate of speed, didn’t curve, and struck the concrete barrier head on. Driver was ejected and killed.
Road Ownership

Severe Work Zone Crashes

- MnDOT: 29%
- County: 62%
- City: 9%

Total Crashes: 58

All Work Zone Crashes

- MnDOT: 14%
- County: 19%
- City: 67%

Total Crashes: 5,659
Road Ownership

All Severe Crashes
- MnDOT: 39%
- County: 17%
- City: 39%

All Crashes
- MnDOT: 42%
- County: 27%
- City: 29%

Total Crashes:
- All Severe Crashes: 3,963
- All Crashes: 226,405
TRENDS

Work Zone Crash Data By the Year
Note: The values shown in the graphs above exclude crashes coded as “moving” work zones. However, moving work zones are one of the less common types, so while the values shown may be skewed, the general trends should still be true.
By the Year
Work Zone Type

2012
- Lane Closure: 875
- Shoulder/Median: 306
- Lane Shift/Crossover: 282
- Intermittent: 105
- Other: 119

2013
- Lane Closure: 849
- Shoulder/Median: 284
- Lane Shift/Crossover: 71
- Intermittent: 81
- Other: 233

2014
- Lane Closure: 742
- Shoulder/Median: 310
- Lane Shift/Crossover: 86
- Intermittent: 72
- Other: 304

Legend:
- Green: Lane Closure
- Orange: Shoulder/Median
- Red: Lane Shift/Crossover
- Blue: Intermittent
- Teal: Other
SIDE NOTES

Other Important Work Zone Safety Topics
Approximately 335 MnDOT-owned vehicles have been hit in work zones by the public over the past three years.

180 of these were part of a plowing or sanding operation.

The most common types of crashes were hitting a plow (138), rear-ends (113) and sideswipes (51).

Note: The data is based on in-house motor vehicle accident reports, sorted by date, type of operation (to pinpoint work zones) and if caused by the public.
MnDOT Vehicles

- 838 total crashes; 118 resulted in injury.
- The number of MnDOT vehicles hit in work zones has been increasing over the past ten years.
- A 295% increase is seen between 2004 and 2014.

Note: The data is based on in-house motor vehicle accident reports, sorted by date, type of operation (to pinpoint work zones) and if caused by the public.
Crash Example
MnDOT Vehicle

October 16, 2014  Daylight
1:54 PM   Clear weather, dry road

RV travelling westbound on US-169 in Ramsey.

Work was being done on shoulder. Traffic control as described by officer matches Layout 45 from the Field Manual. (shadow with message board, second shadow, work vehicle)

RV was travelling in right lane, attempted to pass the three trucks, but veered in and hit the work vehicle. Driver ejected and dead on arrival.
Worker Injuries

- Information regarding worker injuries was found to be conflicting between various sources. Complete, accurate, statewide data is unavailable at this time.

- Worker’s Memorial
  - No fatalities in this time frame
  - MnDOT projects only

- MnDOT Motor Vehicle Accident Reports
  - 31 MnDOT employees were injured in work zone crashes.
  - Exclusively MnDOT employees

- National Statistics
  - 23% of worker fatalities nationwide are due to pedestrian workers being struck by traffic.
CASE STUDIES

A Closer Look at Three Work Zone Crash Clusters
Crash Clusters
All Work Zone Crashes
Crash Clusters
All Work Zone Crashes
Crash Cluster
I-494 between MN-100 and MN-77

• 140 Crashes
  – 1 fatality, 59 injuries
  – July 2012 to October 2013
  – 94 rear end, 34 sideswipe, 6 ran off road

• SP 2785-367
  – Xerxes Ave bridge, pavement rehabilitation, grade and surface
  – Shoulder closed
  – (3) 11’ lanes
  – Concrete barrier on shoulder in first stage and along median in later stages
  – Ramp closures

• Takeaways
  – Investigate closer coordination with incident management during peak hours
  – Detriment of having no escape area (shoulder)
  – Free flow speed is known to be affected by lane width and clearance
    • More back-ups = More rear ends
    • Narrower lanes and lane shifts = More sideswipes
Crash Cluster
I-694 between CR 152 and MN-65

• 110 Crashes
  – 1 fatality, 40 injuries
  – June 2013 to November 2013
  – 80 rear end, 21 sideswipe, 2 ran off road

• SP 0285-65
  – Bituminous overlay, concrete paving
  – (2) 11’ lanes, (1) lane closed
  – Concrete barrier used at bridges, mostly used drums and striping
  – Ramp closures
  – MN-100 on-ramp changed from add-lane to merge

• Takeaways
  – Consider shorter activity areas
    – No work occurring (concrete cure time, etc.)
    – Full lane width and no barriers
    – Drivers get comfortable, meaning less caution and higher speeds
  – Drivers are habitual, changes like the MN-100 on ramp may be missed
Crash Cluster
I-94 near Moorhead and Glyndon

- 15 Crashes
  - 11 injuries (3 were incapacitating)
  - June 2012 to August 2013
  - 10 rear end, 2 sideswipe, 1 ran off road, 1 head on

- SP 1480-162
  - Grade and surface
  - (2) 12’ lanes
  - Concrete barrier along work area
  - Not restrictive

- SP 1480-163
  - Median cable installation
  - Temporary lane closures
  - Not restrictive

- SP 1480-157
  - Bridge rehabilitation
  - Crossover; 1 lane each way, instead of 2
  - Caused large traffic backups extending beyond advance warning signs.

- Takeaways
  - In less restrictive work zones (flat, wide, good sight distance), drivers tend to speed and use less caution
  - Consider weekend traffic counts for heavily used recreational routes.
  - ITS may provide a higher level of advance notification.
Summary

• Work Zone Type: Lane Closure
• Location in Work Zone: Activity Area
  – Second most common: Transition
  – Second most commonly severe: Advance Warning
• Severity: Property Damage Only
  – 28% still resulted in injuries or deaths
• Crash type: Rear End
  – Second most common: Sideswipe
  – Second most commonly severe: Right Angle
• Contributing Factors:
  – Inattention/Distraction
  – Failure to Yield
  – Illegal/Unsafe Speed
  – Following Too Closely
• Total Cost: $223,540,000
• Drivers:
  – Most common: young males
  – Most commonly severe: middle-aged males
• Vehicles: Passenger Cars
  – Higher percentage of heavy vehicles
  – Mostly multiple-vehicle crashes
• Time: Evening Peak (rate)
• Road: Freeways
  – Most commonly severe: Two-lane, two-way
• Ownership: 67% MnDOT roads
• Speed Limits: 50-55 and 30-35 mph
  – Significantly fewer at 40-45 mph
• Trends: Steady/Decreasing
• MnDOT Vehicles: 6% of crashes (335)
  – Over half (180) involved a plow
  – Increasing 10-year trend
Conclusions

• Statistics are related – lane closures cause backups, which lead to rear ends, since drivers are distracted and following too closely, causing large numbers of property damage only crashes.
  – Zipper merge signing, Changeable message sign, “Stopped or slow traffic ahead” warning system, Advance warning signs

• Activity Area
  – Consider shorter activity areas when possible, to reduce distractions, keep drivers focused.

• Continue to:
  – Discourage distracted driving
  – Discourage speeding
  – Encourage cautious driving near plows

• Find ways to discourage:
  – Following too Closely
  – Failure to Yield

• Catch driver attention at merge points and intersections
  – Specifically where changed due to work zone
  – Avoids mistakes due to driver habit

• Try to provide emergency pull-off locations.

• Improve traffic control on two-lane, two-way roads to reduce severe crashes.
  – Consider truck detours, detours, and full closures.

• The majority of work zone crashes occur on MnDOT roads – our efforts make a difference!