

## Lessons Learned From Extreme Weather Events

Pat Kennedy, PE Denver Public Works

2011 APWA North American Snow & Pacific Northwest Snowfighters Conference

April 12, 2011, Spokane WA




- Denver- 2006/2007 Blizzardpalooza



- Washington D.C.- 2010 Snowmageddon



April 12, 2011



## Commonalities

- Extraordinary circumstances
- Exceeded contingency plans
- Resources stretched
- Planning on the fly
- Changed business practices




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## Agenda

- Overview of Denver Snow Operations
- Storms of 2006/2007 (Blizzardpalooza)
- Lessons learned
- Changes Made
  - Weather Planning
  - Response Planning



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**Denver Streets**

- ARTERIAL
- COLLECTOR
- LOCAL



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## Denver Winter

- Snowiest of 50 largest Cities  
(Apologies to Syracuse)
- Average 60" snow
 

– 2003-2004	38"
– 2004-2005	39"
– 2005-2006	30"
– <b>2006-2007</b>	<b>72"</b>
– 2007-2008	46"
– 2008-2009	38"
– 2009-2010	59"
– 2010-2011	20"

**311** • 30 Events, 15-20 deployments



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## Snow Operations

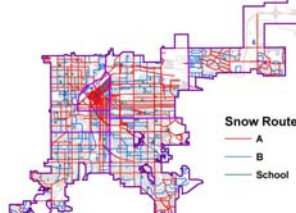
- 68 Tandem Plows
  - Mix of liquid and dry deicers
- 11 Heavy equipment



## Snow Operations

**2006 Policy**

- 6 Districts
- Snow routes
  - A Routes
  - B routes
  - School routes
- Local streets only after dedicated routes addressed in major events (>12" storms)

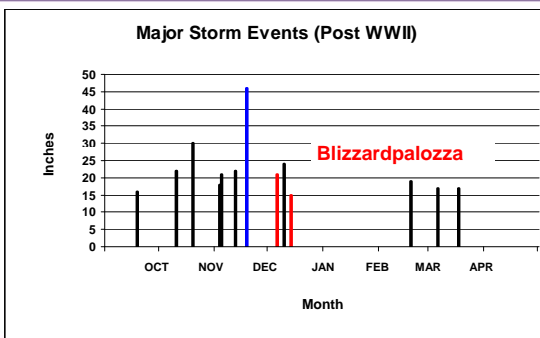


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## Largest Storms

**Major Storm Events (Post WWII)**



Month	Inches
OCT	15
NOV	20
NOV	30
NOV	20
DEC	45
DEC	25
DEC	15
JAN	15
FEB	15
MAR	15
APR	15

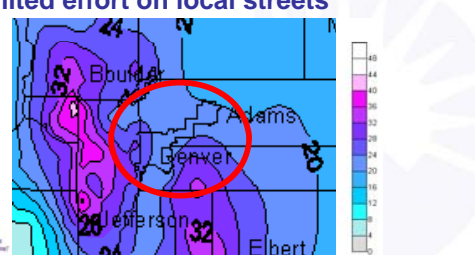
**Blizzardpalozza**

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## Round 1, 12-21-06

- 20"-24"
- Primary snow routes kept clear
- Limited effort on local streets

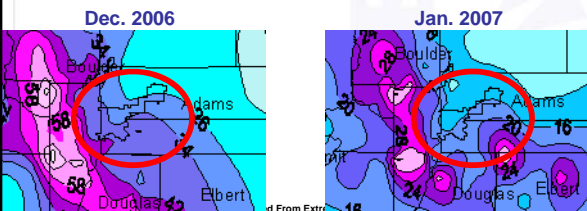


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## Round 2, 12-28-06

- Another 15"-24"; two storm total >40"
- Large plows concentrated on routes
- Light plow fleet created/mobilized

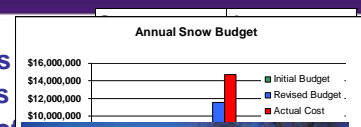



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## Effects

- Major streets
- Local streets
- All plowing of
- Contractor su
- Continued mi
- efforts
- Costs vastly e
  - Annual budget,
  - Actual costs, \$1

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**Media**

- Some mixed messages
- News reports focused on problems
- Commentary laid blame

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**Lessons**

- Expect the unexpected
- Policy was deficient for mid-winter storms of this magnitude
- Need for separate residential plowing program
- Media important part of snow fighting

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**Changes Made**

- Weather Planning
  - Go beyond historic norms
  - Multiple storm scenario
  - Weather Forecasting (MDSS)

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**Maintenance Decision Support System (MDSS)**

- Road weather forecasting
  - Tactical forecasts, 48-72 hr windows
    - frequent updates
    - multiple weather attributes
    - point and area observations
  - Pavement predictions
    - surface temperatures
    - moisture phase
    - snow accumulation and icing potential
  - Treatment recommendations
    - anti-ice
    - application time
    - application rate

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**MDSS**

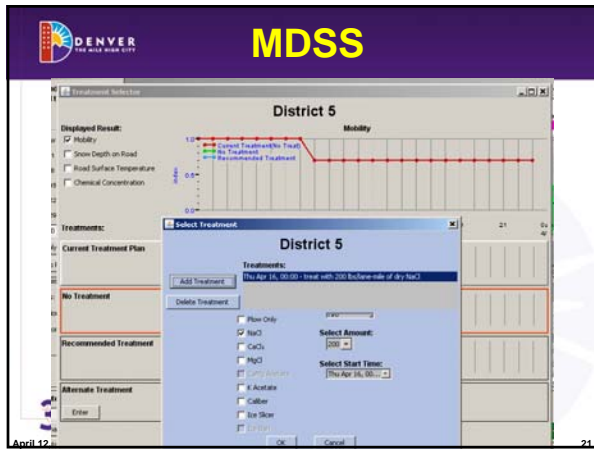
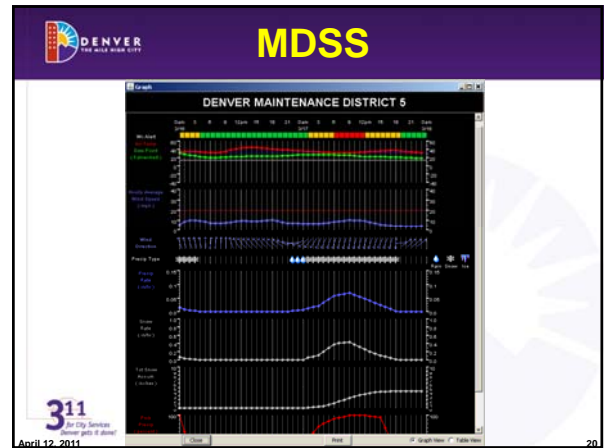
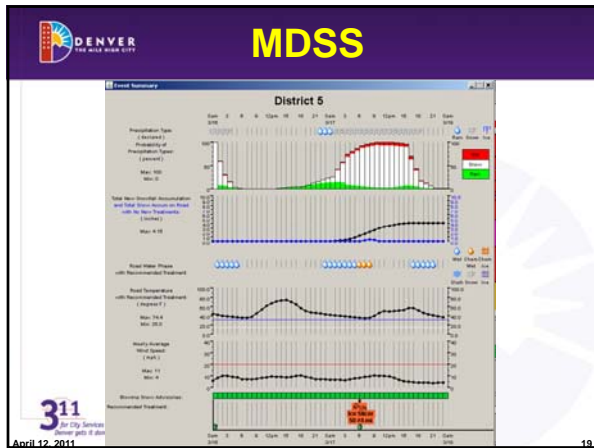
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**MDSS**

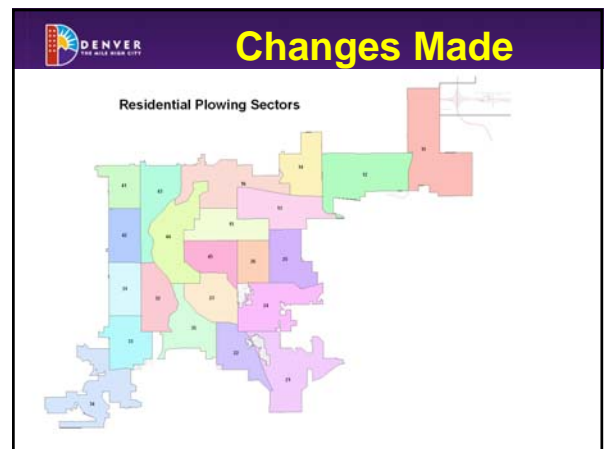
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- Changes Made**
- Response Planning
    - Route planning
    - Residential program
    - Media
    - Training
    - Operations
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- Changes Made**
- Route Planning**
- Annual review of all routes and truck assignments
  - Agency input
    - City Managers/Supervisors
    - Denver Public Schools
    - EMS
  - Snow Emergency parking restrictions
  - Updated Snow Book
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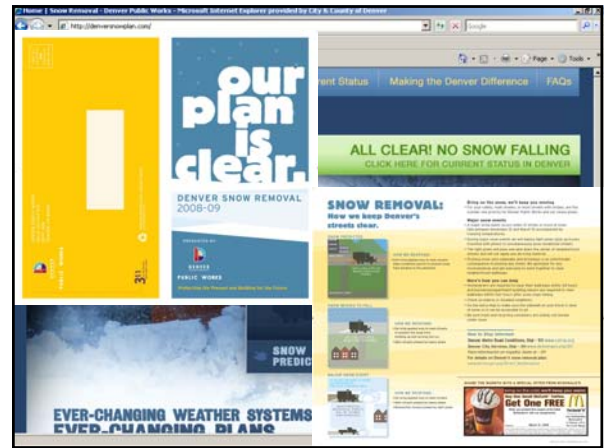
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## Residential Callout

- Two deployments since inception
- Successful effort to proactively keep residential streets clear.

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## Changes Made

### Training

- Plow Drivers
  - How to deal with traffic
  - Problem areas, sidewalks, ADA access
- Light Plow drivers
  - Annual refresher
- Table Top
- Media

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## Changes Made

### Operations

- Even minor storms are emergency ops
- Weather Forecasting
  - MDSS
  - Multiple sources
- Media
  - Keep PIO informed
  - Keep the message positive and accurate
- Residential plowing decision making

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## Conclusions

- Plan
  - Weather
    - Limited weather history?
    - Realistic but extreme
    - Multiple storms
  - Operations
    - Multiple agency response
    - Many more demands for service

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## Conclusions

- Train
  - Table top
  - Primary staff
  - Secondary staff
  - Media

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**Conclusions**

- **Message**
  - Accurate/timely
  - Multiple outlets
  - Positive
  - Proactive

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**Closing**

- We have no control over weather
- We do have control over our response
- Stay on top
  - Forecasts
  - Operations
  - Message
- Flexible

**Be Smart!**

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**GARY'S WEATHER FORECASTING STONE**

CONDITION	FORECAST
Stone is Wet	Rain
Stone is Dry	Not Raining
Shadow on Ground	Sunny
White on Top	Snowing
Can't See Stone	Foggy
Swinging Stone	Windy
Stone Jumping Up & Down	Earthquake
Stone Gone	Tornado

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District of Columbia  
 Snow Season 2009-2010

**SNOWMAGEDDEN** d.

Robert L. Marsili, Jr.  
 Snow Coordinator  
 District Department of Transportation (DDOT)

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**Topics**

- Overview of Season
- Successes
- Feb Blizzard
- How we responded
- On-the-fly changes
- Media
- Lessons Learned/Improvements

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**Snow Plan Scope**

The District Department of Transportation (DDOT) and the Department of Public Works (DPW) jointly coordinate the snow and ice removal for the District of Columbia. For a full deployment major snow/ice event the scope of operations is significant.

- 1,100 miles of roadways and 241 bridges to be cleared excluding NHS
- Zones 1-14 = 69 primary and secondary routes, 82 residential routes, approximately 257 pieces of equipment.
  - DPW= 63 Heavy plows needed for 45 heavy routes (some requiring 2 trucks)
  - DPW= 53 Light Plow Trucks needed for 53 Light Plow Routes
  - DDOT= 31 Heavy Plows needed for 24 heavy routes (some requiring 2 trucks)
  - DDOT=29 Light Plow needed for 29 Light Plow Routes
- Contract Plow Program supplements our municipal trucks for snow events over 6 inches.
  - Not reliable
  - District owned plows

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## Deployment

Joint effort between DDOT & DPW

DPW responsible for zones 1-9 and 14 (primary & secondary)

DDOT responsible for 10-13 and 14 (residential light plow)

DDOT contractor responsible for NHS routes

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## NHS Contract

- Snow removal for the 75 miles of NHS routes
- 33 heavy 10 wheel dump truck
- 3 spray trucks
- 3 pick-up trucks for ramps
- Contract managed by DDOT

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## Residential Routes

- 82 new light plow routes – doubles the snow plows providing residential treatments

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## Record Annual Snowfall – 1960 - 2010

Year	Snowfall (inches)
1960-61	40.0
1961-62	20.0
1962-63	25.0
1963-64	30.0
1964-65	28.0
1965-66	32.1
1966-67	25.0
1967-68	20.0
1968-69	15.0
1969-70	18.0
1970-71	22.0
1971-72	15.0
1972-73	18.0
1973-74	20.0
1974-75	25.0
1975-76	32.7
1976-77	20.0
1977-78	25.0
1978-79	30.0
1979-80	25.0
1980-81	20.0
1981-82	15.0
1982-83	20.0
1983-84	25.0
1984-85	20.0
1985-86	15.0
1986-87	20.0
1987-88	15.0
1988-89	10.0
1989-90	15.0
1990-91	10.0
1991-92	15.0
1992-93	10.0
1993-94	15.0
1994-95	10.0
1995-96	46.0
1996-97	15.0
1997-98	10.0
1998-99	15.0
1999-00	10.0
2000-01	15.0
2001-02	10.0
2002-03	15.0
2003-04	10.0
2004-05	15.0
2005-06	10.0
2006-07	15.0
2007-08	10.0
2008-09	15.0
2009-10	56.4

- Reagan National totals are usually lower
- Among top 5 snowfalls recorded in Washington DC
- Total of 56.4 inches for season is highest ever recorded in Washington DC

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## What happened?

- December 18-19 Storm
  - 18 inches of accumulation
    - Largest snow event since 2003
    - Average precipitation for the month of December: 3.1 inches\*
    - Winter average for the District 15.2 inches
  - DPW/DDOT resources adequately cleared roadways
  - District snow team effort was outstanding
  - No closures necessary for Monday, December 21st

\*www.dci.gov

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## Feedback from December Storm

**The Washington Post** "The District was leading in the street-clearing effort, reporting that most of the major work had been done and that crews would tackle missed streets and revisit some that had been plowed early in the storm. Montgomery County plows were tackling neighborhoods in the most densely populated areas. It might be Wednesday before the first path is opened into some Northern Virginia neighborhoods, and Prince George's County was bedeviled by ice." – *WashingtonPost.com, 12/22/2009*

**The Washington Post** "Arlington has the worst snow-removal plan I've seen," said Kendall Church, who lives near the Ballston Metro station. "I've yet to see any snowplows come through any of the streets in my neighborhood, but Arlington will not take removal requests like D.C. will, nor do they have a status map that shows what streets have been cleared already." – *WashingtonPost.com, 12/22/2009*

**NBC** "And the Fenty administration deserves kudos thus far for its communications efforts. Fenty has held a number of press conferences already on the storm, and has provided constant updates to the press ... The city even has a nifty map showing where its snow equipment is located..." – *NBCWashington.com*

**dcist** "I still want to give Mayor Adrian Fenty a high-five for handling snow removal – especially on major roadways – like a champ. Thinking back to the blizzard of '03, it took the better part of the week to even get out of the house safely." – *DCist.com*

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### Snow Performance Measure – Penguin Chart


Storm Type	Accumulation	Major Streets		Residential Streets	
		Time from storm end	Percent of streets passable	Time from storm end	Percent of streets passable
Freezing rain/ice	Coating	12 hours	85%	12 hours	85%
Snow	0 to 2 inches	4 hours	85%	8 hours	85%
	2 to 4 inches	6 hours	85%	8 hours	85%
	4 to 8 inches	12 hours	85%	24 hours	85%
	8 to 12 inches	18 hours	85%	36 hours	85%
	12 to 18 inches	36 hours	75%	48 hours	75%
	over 18 inches	36 hours	75%	60 hours	75%

↓ More aggressive timeline  
 ↓ Residential deployment starts at same time; bare pavement policy (vs. passable in previous standard)

DDOT/DPW met the performance measures last year for all the storms

### What happened?

- January 30<sup>th</sup> Storm
  - 6.4 inches of accumulation on the 30<sup>th</sup>
  - Temperatures remained below freezing
  - DDOT/DPW resources adequately cleared roadways
- Feb 2<sup>nd</sup> 3.5 inches fell
- Feb 5<sup>th</sup>-7<sup>th</sup> = 28inch forecast



### What Happened?

Forecasted Precipitation for First Storm Feb 5-7


Date of Forecast	Amt of Snow	Predicted Storm Duration
Feb 3 <sup>rd</sup> , 1pm	8-16 inches	18 hours beginning Fri
Feb 4 <sup>th</sup> , noon	10-16 inches	Fri Afternoon-Saturday eve
Feb 5 <sup>th</sup> , 6am*	16 inches	Fri afternoon- Saturday eve
Feb 5 <sup>th</sup> , 2pm	16-24 inches	Fri eve- Saturday eve
Feb 6 <sup>th</sup> , 5am	16-24 inches	Fri eve- Saturday eve

Actual Accumulation for first storm: 28 inches  
 Temps in the 20s-Winds up to 30MPH  
 Trees down-Power Outages  
 Salt Shortages

### What Happened?

More Snow February 9<sup>th</sup> and 10<sup>th</sup>

- Temperatures remained below freezing between storms
- 10-14 more inches of snow added to the first storm's accumulations-50MPH W
- Back to back storms left little time for crews and equipment to recover
- Trees down
- 4 snow events in 10 days



### Snowmagedden Comes to DC

Note – Reagan National understated the total for most of the District

Totals in D C closer to 65-70 inches for year



#### Snowfall Totals - Washington DC February 2010

Location	Feb 6-7 (inches)	Feb 9-10 (inches)
Reagan National Airport	17.8	10.8
Dulles/Carle Reservoir DC	28	9.4
American University (nonofficial)	27.5	14

- Among top 5 snowfalls recorded in Washington DC
- Total of 56.4 inches for season is highest ever recorded in Washington DC
- Two storms back to back meant crews had no time to recharge
- Snow totals in northwest are much higher than Reagan National

### Recap

- 20 Snow Events for season
- 56.4 inches-70 inches NW
- 750 employees/nonstop for 10 days 12 hour shifts
- 78,000 tons of salt
- 200,000 gal. of brine
- Worked snow all February



### On The Fly Changes

- As storm worsened, mobilized specialized equipment and operator assistance from contractors throughout the mid-Atlantic and Northeast- Residential Plows could not push the snow-Bobcats, backhoes, loaders
- Inspection/Monitoring team for additional equipment was a challenge
- Whiteout situations-Never seen in DC
- Salt Shortages in region required us to haul from Depot in Baltimore
- Hauling Snow- Areas to dump snow

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### Progress (Shifts 1&3 of first storm)

Green color represents streets that have been treated

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### Media

- Mayor held 24 press conferences in 10 days to update public from various locations around the city
  - Press releases – writing, editing, posting, e-mail,
  - Twitter, Facebook
  - Location changes
  - Coordination with Mayor’s office

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### Lessons Learned

- Snow team will conduct facilitated de-brief with stakeholders
- Should the District benchmark its snow plan on a historic storm event?
  - Remember performance for December 18 inch snowfall was successful
- Solutions likely involve some local capital investment in combination with the creation of a solid contingency plan for major snow events

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### Developing the New Snow Plan/Lessons Learned

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### Post Event Critique Meeting

- Meeting held March 4
- Document major categories/lessons learned
- 12 Committees established to review major items and implement recommendations
  1. Development of contingency plans for 12” snow
  2. Equipment Improvement-Aging Fleet
  3. Improved Training Program-Plowing Skills
  4. Logistics Improvement-Hotels/Food/Transp.
  5. Manual snow Clearing/Sidewalks
  6. Parking- Pilot plans in neighborhoods

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### Post Event Critique Meeting

7. Logistics Improvements/Hotels/Food
8. IT Support-AVL /Mapping
9. Scrub Snow Plan-Update Plan 2010-2011
10. Safety Improvements
11. Administrative-Policies Reviewed
12. Coordination of Agency Resources-CDL

### Contingency Plans over 12 inches

- 50 Additional Snow Plows from Hertz
- Expanded NHS Contract (Capitol Paving) by 30% More Plows, Spray trucks and loaders
- COG Salt Contract as backup
- Expanded BPA for Contract Plow Equipment and Trucks- Bobcats, Loaders, Backhoes
- Specialized Equipment Contract- 50 Bobcat Plan

### Changes/Improvements from 2009-2010

- Improved Citywide Supervision and situational awareness---(DDOT Planners) (MSS Managers)
- Hertz Rental of 50 Plow Trucks – Contract for added equipment- All routes covered with equipment at all times
- COG Salt Contract as back up supply for DC
- Additional Equipment in NHS Contract
- Contingency Plans for Specialized Equipment

### Changes/Improvements from 2009-2010

- Increased Situation Awareness with AVL data to identify streets that were not serviced-Must utilize AVL data
- 1-Floating Plow Truck in every ward with captain as a backup to address quickly any concerns from Snow Command or Mayor
- Improved Training Program-Supervision/Drivers
- Simulator Training to enhance driver plowing skills
- Expanded anti-icing pre-treatment of residential streets using 4 small spray trucks procured last year
- Improved Cost Accounting with Storm Trak system

### Issues /Areas for Improvement

1. Snow Fall > 12 inches-Contracts in place for resources
2. Training Program-Re-evaluate training program- Snow Plow Simulator
3. Coverage of Residential Streets- Increase situational awareness and supervision
4. Pedestrian Challenges- Property owners clean their sidewalks, Plowing techniques, communicate to contractors
5. Transit Access-Bus Stops cleared
6. Chain of Accountability
7. Increased oversight of cost tracking
8. Manage Expectations



SnowPlow Training from the driver's perspective.

### Snow Plow Simulator-Enhanced Training Program



Simulator

