# Chicago Transit Authority (CTA) Climate Adaptation Pilot

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2012 SUSTAINABILITY AND PUBLIC TRANSPORTATION WORKSHOP

# Climate Adaptation Pilot Overview
# Project Workplan

- Task I: Survey of System Vulnerabilities (35% of total effort)
  - Deliverable: Overview of key vulnerabilities (with level of risk) through survey of general asset classes (e.g. substations, ROW, viaducts)
- Task II: Adaptation Implementation Plans (45% of total effort)
  - Deliverable: In-depth analyses of three specific project areas for applying adaptation principles (e.g. traction power, right-of-way flooding)
- Task III: Integration into Standard Practices (20% of total effort)
  - Deliverable: Long-term strategies to integrate adaptation into standard CTA business practices (e.g. asset management; safety and operations planning)


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# Climate Adaptation Pilot Overview
# Progress to Date

- Expert Interviews: Held interviews with 30 subject matter experts
  - CTA Infrastructure, Operations, Safety & Security, Planning, plus City of Chicago Sustainability, Transportation, and Emergency Management/Communications
- Data Collection: Compiled data from internal/external sources in these general categories:
  - Service Disruptions (e.g. flooding incidents, signal failures, MMIS)
  - Financial Costs (e.g. FEMA claims, traction power)
  - System Vulnerabilities (e.g. urban heat islands, viaduct flooding)
- Data Synthesis (ongoing)
  - Conducting initial analysis to correlate meteorological data with disruption, cost, and vulnerability data
  - Prioritize Task II/III study areas based on data synthesis and CTA stakeholder workshop

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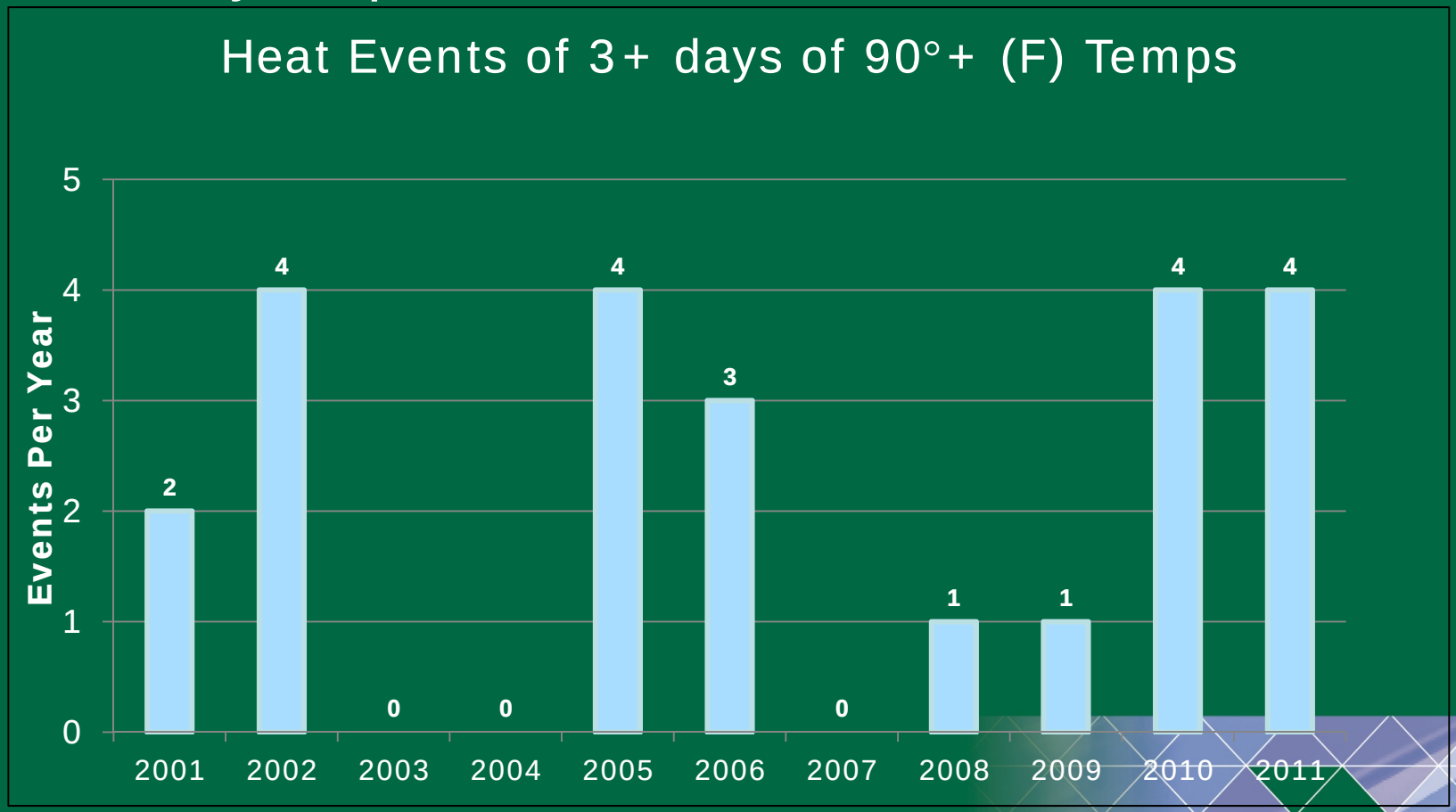
# Chicago Climate Change Projections
## Periods of Extreme Heat / Precipitation

- Midway Airport Data 2001-2011



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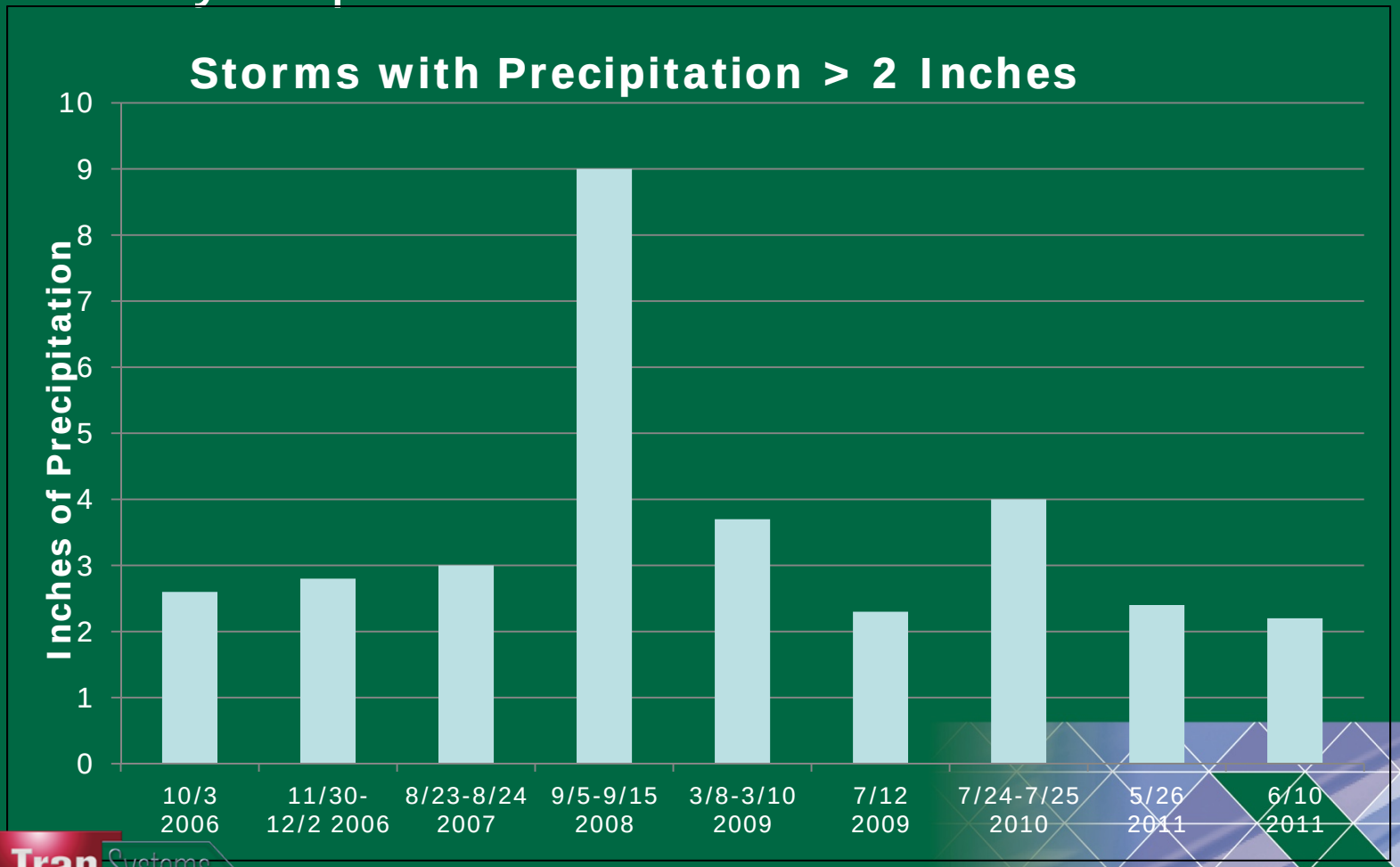
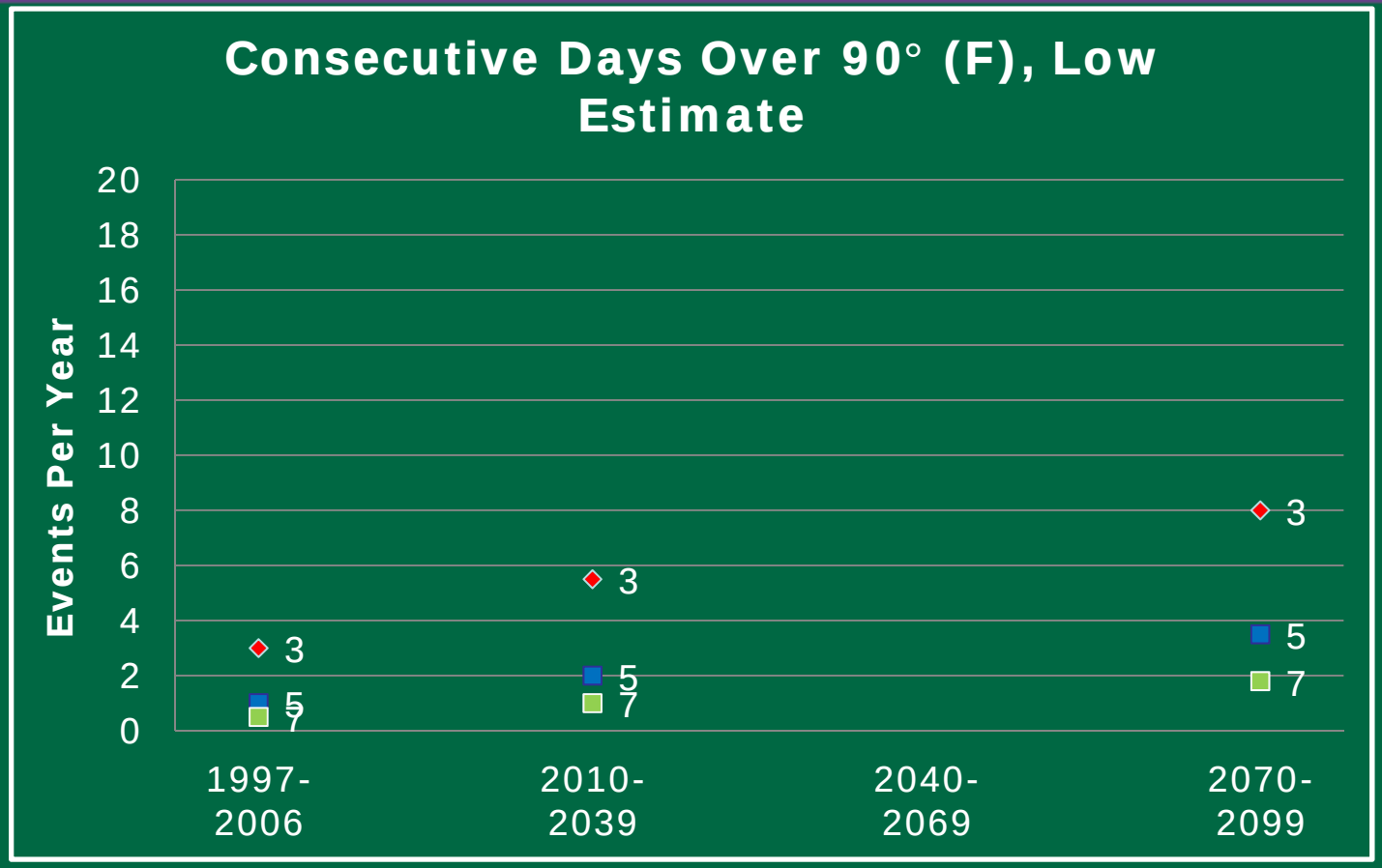
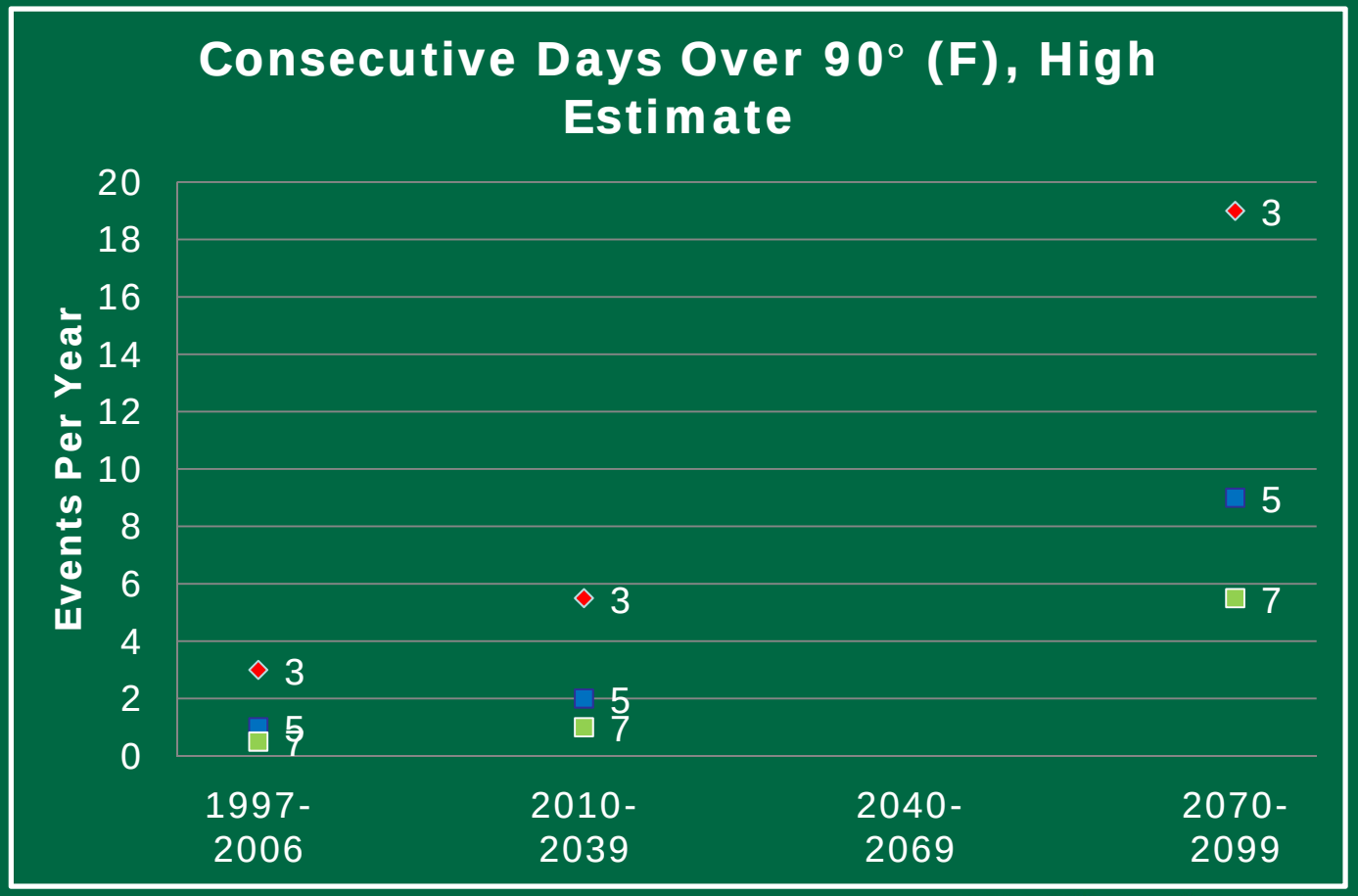


# Chicago Climate Change Projections
# Extreme Heat (1)




Source: K. Hayhoe et al. Journal of Great Lakes Research, 2010

# Chicago Climate Change Projections
# Extreme Heat (2)

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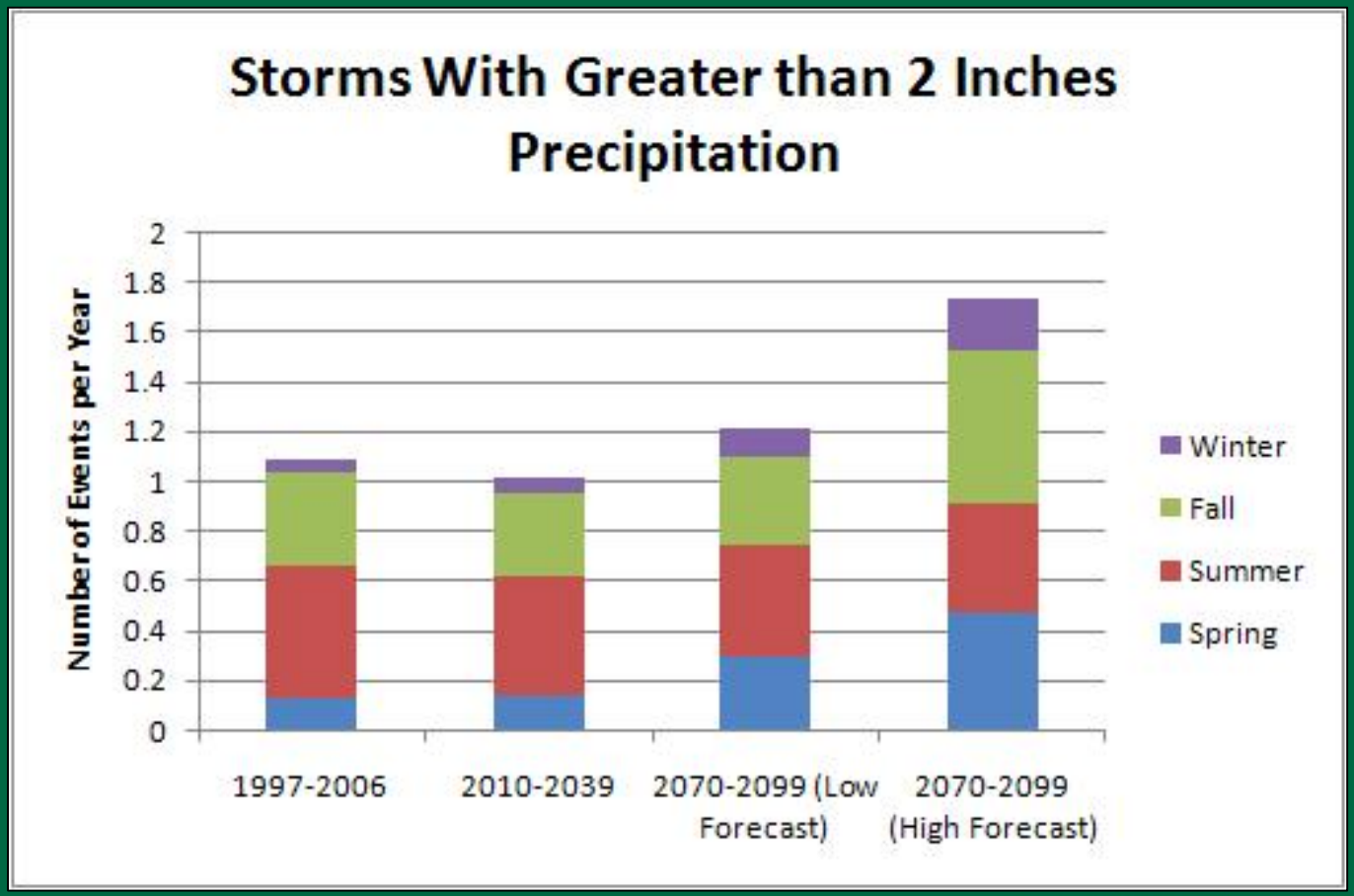
# Chicago Climate Change Projections Extreme Precipitation (1)

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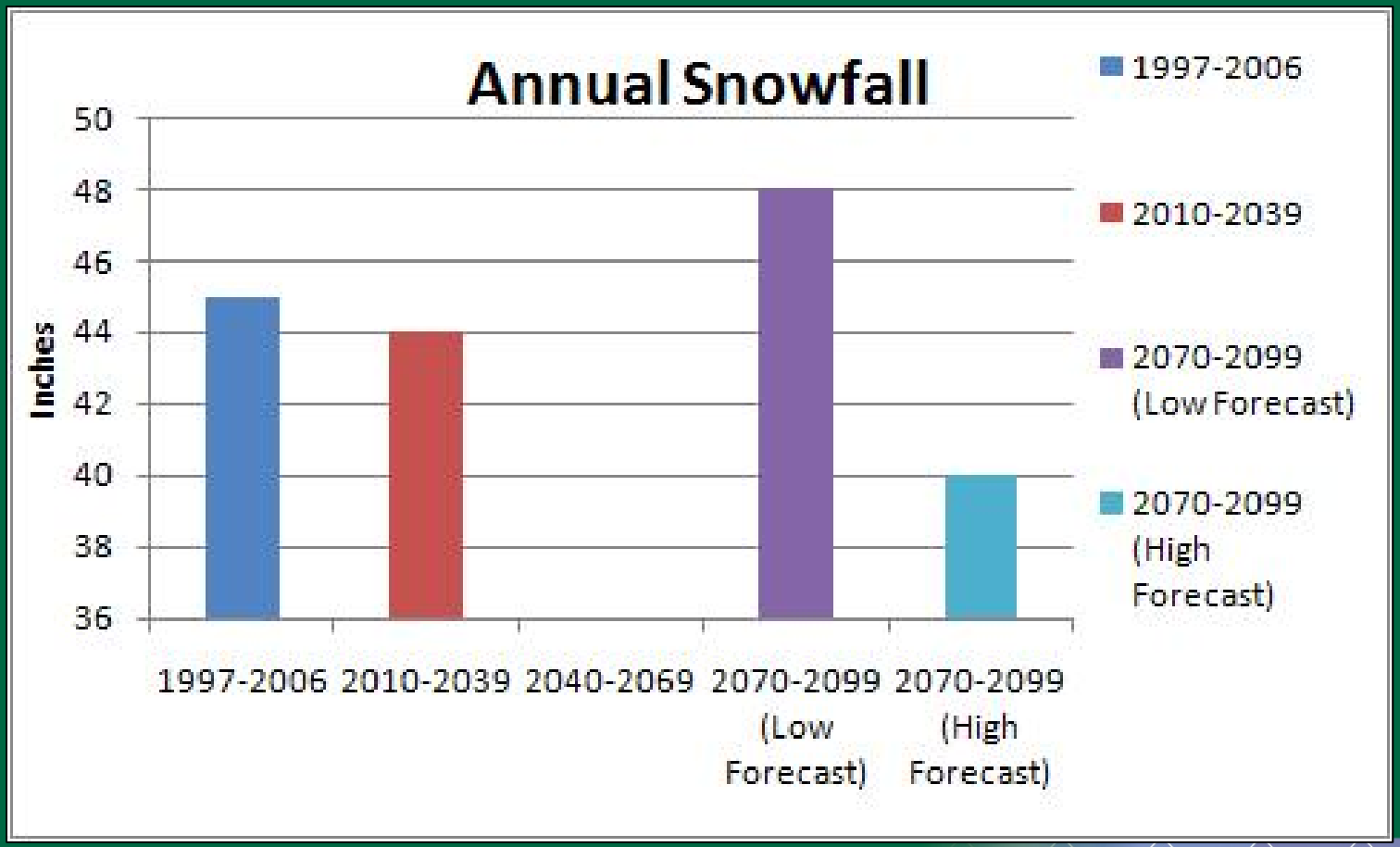
# Chicago Climate Change Projections
# Extreme Precipitation (2)

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# CTA Severe Weather Impacts
## Extreme Heat: Daily Rail Traction Power Consumption (kWh)

| Year | 3+ days 90+ degrees | Baseline days ~65 degrees | % Difference |
|---|---|---|---|
| 2001 | 537,864 | 470,643 | 14.3% |
| 2002 | 547,465 | 462,326 | 18.4% |
| 2003 | -- | 466,655 | -- |
| 2004 | -- | 531,413 | -- |
| 2005 | 595,921 | 558,343 | 6.7% |
| 2006 | 570,945 | 580,481 | -1.6% |
| 2007 | -- | 573,249 | -- |
| 2008 | -- | 582,826 | -- |
| 2009 | 1,216,889 | 1,011,761 | 20.3% |
| 2010 | 1,060,557 | 912,387 | 16.2% |
| 2011 | 1,083,957 | 1,018,733 | 6.4% |
| **Average** | **801,942** | **716,382** | **11.9%** |

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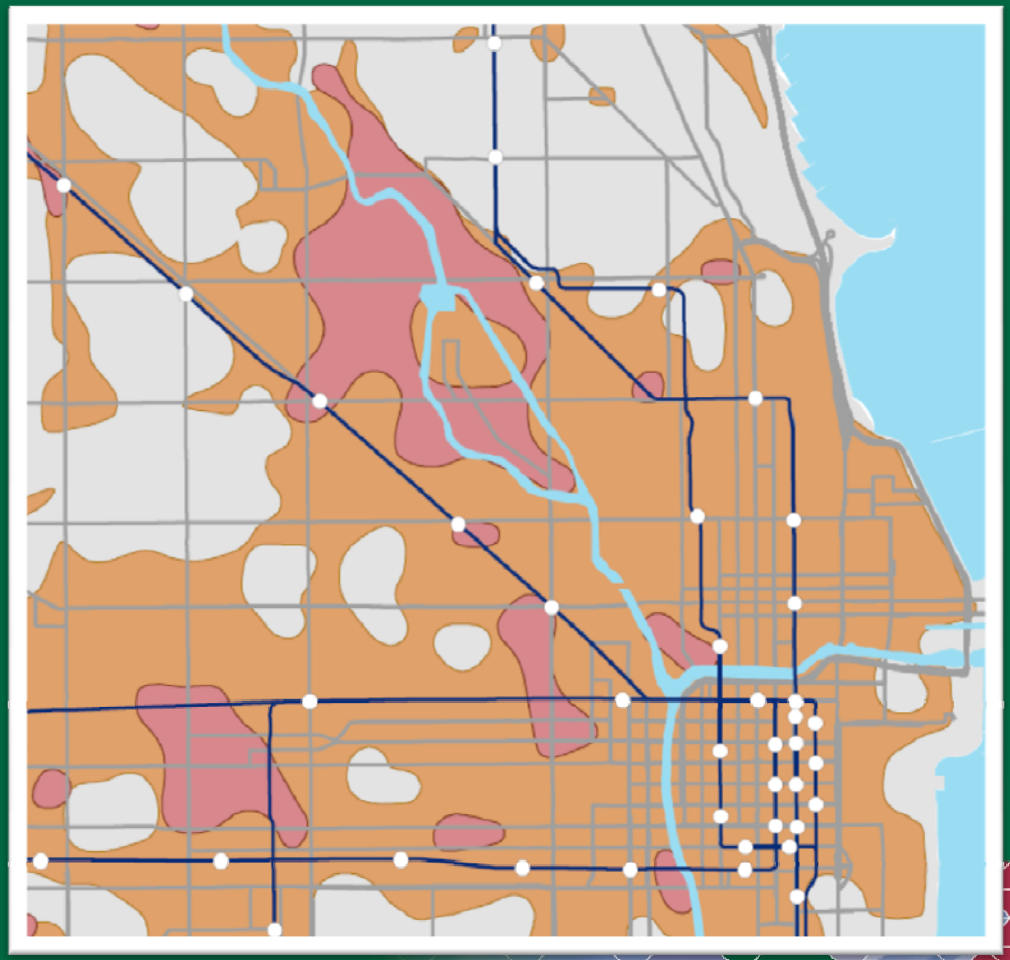
# CTA Severe Weather Impacts

## Extreme Heat: Urban Heat Islands (1)

- Urban Heat Islands (UHIs) refer to elevated temperatures due to intense urban development.
- Ambient air temperature can be elevated 2-8˚ F in UHI areas
- Two Landsat 7 satellite images were used to capture both day and night images in Chicago
  - Tier 1 areas are in the warmest 10% in both the day and night images
  - Tier 2 areas are in the top 10% of either of the day or night images



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# CTA Severe Weather Impacts

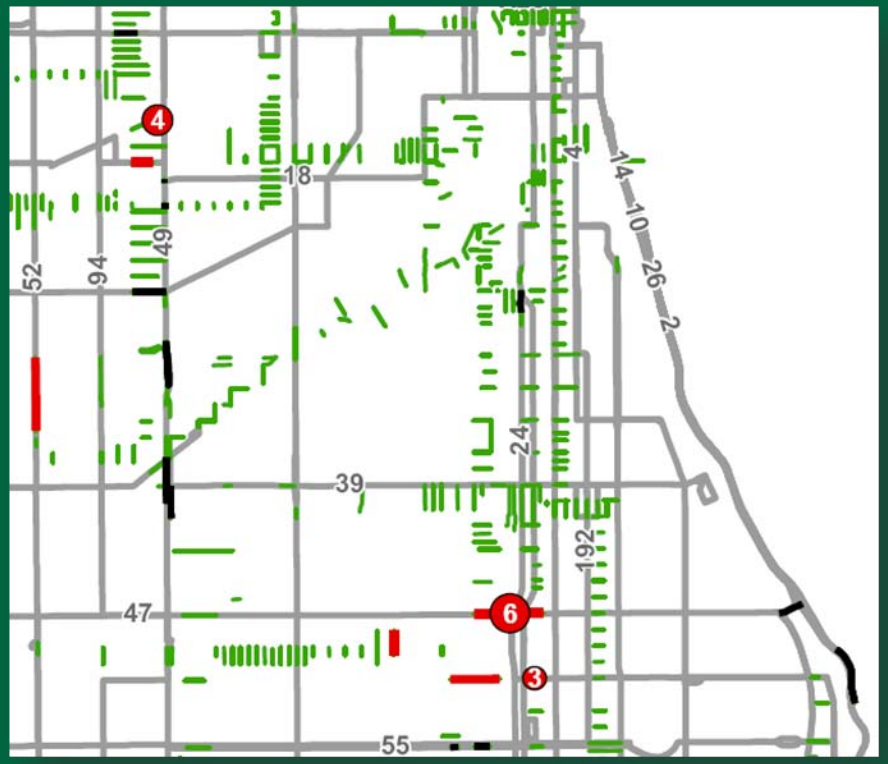
## Extreme Heat: Urban Heat Islands (2)

| Rail Branch Name | UHI Tier 1 | UHI Tier 2 | Total | 2012 Heat-Related Signal Disruptions |
|---|---|---|---|---|
| Loop Elevated | 0% | 100% | 100% | 0 |
| Red Line Dan Ryan | 0% | 87% | 87% | 7 |
| Blue Line O'Hare | 12% | 72% | 83% | 1 |
| Blue Line Forest Park | 5% | 71% | 75% | 5 |
| Pink Line | 5% | 59% | 64% | 11 |
| Orange Line | 10% | 48% | 58% | 0 |
| Green Line Lake Street | 8% | 50% | 58% | 1 |
| Green Line South | 0% | 36% | 36% | 1 |
| Red Line North Side | 1% | 30% | 32% | 5 |
| Brown Line | 0% | 27% | 27% | 0 |
| Purple Line | 0% | 0% | 0% | 2 |

# CTA Severe Weather Impacts
## Extreme Heat: Heat Kinks

| Date | Daily High Temp(F) | Branch | Location |
|---|---|---|---|
| 4/26/10 | 61 | Blue (FP) | Lathrop |
| 7/6/10 | 91 | Yellow | Skokie |
| 7/12/10 | 84 | Red (DR) | 76th |
| 8/18/10 | 83 | Red (DR) | 69th |
| 8/18/10 | 83 | Red (DR) | 71st |
| 10/10/10 | 84 | Yellow | Hamlin |
| 5/12/11 | 87 | Orange | 35th/Archer |
| 6/7/11 | 96 | Blue(FP) | Racine |
| 7/21/11 | 101 | Red (DR) | Cermak to 35th |
| 7/21/11 | 101 | Red (DR) | Cermak |

# CTA Severe Weather Impacts
# Extreme Precipitation: ROW Flooding (1)




| Viaduct Location | Frequency | Bus Routes Affected |
|---|---|---|
| W. 47th / Shields | 6 | 47,24 |
| W. Ogden / Claremont | 4 | 18,49 |
| N. Sacramento / Carroll | 4 | 65 |
| W. 51st / Dan Ryan | 3 | 192, 24 |
| S. State / 63rd | 3 | 29, 63 |
| E. 79th / Avalon | 3 | 79, 28 |
| E. 95th / Cottage Grove | 3 | 100, 111, 4 |

## Viaduct Flooding, 2010-2012

normal viaduct

troubled (CDOT)

troubled (CTA)

4 frequency of CTA reroutes

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# CTA Severe Weather Impacts
# Extreme Precipitation: ROW Flooding (2)

| Rail Station Standing Water Events, 2010-2012 | |
|---|---|
| Line | Number of Events |
| Red | 66* |
| Blue | 45 |
| Green | 17 |
| Brown | 10 |
| Loop | 10 |
| Pink | 5 |
| Orange | 4 |
| Purple | 1 |

| Rail Station Standing Water Events, 2010-2012 | | |
|---|---|---|
| Line | Station | Frequency |
| Red | Harrison | 9 |
| Red | Grand | 8 |
| Red | Jackson | 6 |
| Loop | Lasalle | 5 |
| Red | Howard | 4 |
| Brown | Irving Park | 4 |
| Blue | Irving Park | 4 |

*45 of these events occurred on Red Line subway

# CTA Severe Weather Impacts
# Extreme Precipitation: Financial Impacts

- Financial Impacts of Select Severe Weather Events

| Date | Weather Event | Weather Specifics | Cost |
|---|---|---|---|
| Sep-Nov 2008 | Flood | 9” of rain (9/5-9/15) | $3,058,145 |
| Jan-Feb 2011 | Blizzard | 20” of snow (1/31-2/1)) | $670,610 |
| Aug 2007 | Heavy Rainstorm | 3” of rain (8/23-8/24) | $50,207 |
| Aug-Sep 2005 | Hurricane Katrina | CTA Evacuee Assistance | $448,173 |

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# CTA Severe Weather Impacts
## Extreme Weather and Ridership (1)

- Methodology:
  - Build on 2007 study
    - Focus on extreme weather events
  - 2001-2011 NOAA data
    - Heat Index
    - Rainfall
    - Snowfall
  - 2001-2012 CTA ridership data

# CTA Severe Weather Impacts
## Extreme Weather and Ridership (2)

- Output:
  - Extreme Heat: Decline in ridership at high range
  - Extreme Cold: Decline in ridership for all periods
  - Heavy Rainfall: Decline in ridership on weekends
  - Heavy Snowfall: Insufficient observations

| | **Rail Ridership** | | | **Bus Ridership** | | |
|---|---|---|---|---|---|---|
| ***Day Type*** | *80+ Days* | *90+ Days* | *100+ Days* | *80+ Days* | *90+ Days* | *100+ Days* |
| Weekday | -5.50% | -7.70% | -12.70% | -3.80% | -4.10% | -4.90% |
| Saturday | 15.10% | 6.50% | -14.40% | -8.00% | -10.00% | -33.20% |
| Sunday | 1.70% | -2.70% | -8.90% | -19.40% | -19.10% | -37.30% |

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# CTA Stakeholder Workshop
# July 2012

- Rank Catalog of Impacts
- Create Risk Matrix
- Define Task II/III Selection Criteria

| TASK II (Implementation) |
| --- |
| Severity (over frequency) |
| Capital (over operating) |
| Safety (over comfort) |
| Pervasiveness (A to B to C) |
| Expected future frequency increase |
| Complement ongoing projects |
| Availability of supporting data |

| TASK III (Integration) |
| --- |
| Frequency (over severity) |
| Operating (over capital) |
| Coordination issues (cooling buses) |
| Process over infrastructure |
| Complement ongoing projects |
| Availability of supporting data |

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# Climate Adaptation Pilot Overview: Next Steps

- Complete Task I Data Synthesis
  - Correlate observed costs/impacts with CCAP climate data
  - Integrate additional CTA data sets
- Develop Task II/III Priorities
  - Identify areas of greatest risk to be explored further in Task II, prioritized based on quantitative/qualitative criteria
- Complete Task I (August 2012)
  - Complete final memorandum of prioritization strategies and prepare launch of Task II analysis.
- Complete Task II (late 2012/early 2013)
  - Complete benefit-cost analyses to prepare shovel-ready projects for future implementation funding

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# Transit Asset Management Initiative

- CTA received $5.4 million grant through the US Dept. of Transportation State of Good Repair Initiative (SGR) 2010
- Focus on Bus Maintenance Facility Assets:
  - Goal is to establish baseline structure for future expansion into other asset categories
  - Project Efficiencies lead to scope expansion to include some rail maintenance facilities
- Four phases of work:
  1. Phase A: Software Enhancement and Data Migration
  2. Phase B: Facility Asset Inventory and Assessment
  3. Phase C: Reporting and Prioritization
  4. Phase D: Process Evaluation and Training

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# Asset Attribute Inventory

Critical asset information collection including the following attributes:

- Type
- Size
- Replacement Value
- Condition
- Expected Life
- Vulnerability to climate
- Install Year
- Location
- Deficiency Type(s)
- Deficiency Quantity

# Data Collection Methodology

- Two multi-disciplinary teams of engineers perform the survey: 7 garages, 3 maintenance shops and 10 rail maintenance facilities
- Collect key inventory and perform condition assessments on over 3 million sf of facilities
- Develop cost estimates for identified deficiencies

- Involvement of organization personnel to observe contractor assessment to promote learning with the ultimate goal of self-performance

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# Long Term Inspection Approach

- Routine assessments completed by trained in-house staff
- Prioritized inspections based on asset criticality and condition
- Inspections treated as required work orders within EAM
- Utilize available technology to streamline deficiency tracking and reporting

- LTI approach allows for continued migration to proactive versus reactive maintenance utilizing updated inventory and assessment data

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