Improving the Resilience of Transit Systems Threatened by Natural Disasters

Monday, March 12, 2018
1:00-3:00 PM ET
Purpose


Learning Objectives

At the end of this webinar, you will be able to:

• Discuss the benefits of resilience practices and describe the process steps to improve transit resilience at their agency
• Identify at least two tools and/or resources to advance resilience planning and implementation at their agency
• Compare the experiences of other agencies with their own agency’s experiences and identify different pathways to resilience that might be right for their agency
Transit Cooperative Research Program
Web-Only Document 70:

Improving the Resilience of Transit Systems Threatened by Natural Disasters
What We Will Cover Today

• Transit Resilience- Guidebook 60 minutes
  o Consider definitions & domains of resilience adoption
  o Explore path(s) to resilience that might be right for you
  o Learn basic steps to chart a course to resilience
  o Engage regional/ multi-sector interdependencies
  o Discover our database of tools and resources

• LA Metro experiences, Cris Liban 30 minutes
  o Resilience Indicator Framework +

• Q&A 30 minutes
OBJECTIVE: Develop a guidebook and support materials to help public transit systems become more resilient to natural disasters and climate events.

**PHASE I TASKS**

1. State of the Practice Literature Review
2. Transit Agency Case Studies (17)
4. Interim Report and Draft Outline of Guide

**PHASE 2 TASKS**

5. Draft Guide
6. Pilot Guide
### Project Team and Oversight

#### PROJECT LEADS
- Deborah Matherly (PI)
- Jon Carnegie (Co-PI)

**Key Support:** Guidebook Development: Jane Mobley (LB)

#### OVERSIGHT

**Panel Chair**
- Dr. Cris Liban (LACMTA)

**TRB Panel**
- Stephan Parker

**TCRP Senior Program Officer**
- Stephan Parker

#### Support

**Support - Literature Review, Case Studies, APTA standard**
- Brian Wolshon (LSU)
- John Renne (FAU)
- Jim Amdal (UNO)
- Tom Callahan (UII)
- Jim Shaw (APA)
- Bill Ankner (TS)
- Eric Peterson
- Marie Venner

**Support - Case Studies, Guidebook and Tool Development**

**Rutgers**
- Ryan Whytlaw

**Louis Berger**
- Julie MacLachlan
- Niek Veraart
Primary Work Products

• Guide for Improving Resilience in Transit Agencies

• Final Research Report on Improving the Resilience of Transit Systems Threatened by Natural Disasters
  - Includes project approach, literature synthesis, case study summaries, report on mid-project workshop, review of APTA interaction

• 17 Transit Resilience Case Studies
  - 15 large, mid-size and small U.S. agencies
  - 2 international examples

• Transit Resilience Website with a Database of Downloadable Information at resilienttransit.org
  - Full case study write-ups, profiles of the tools described in the Guide, literature summaries, and a range of other useful resources
Case Studies

- Hillsborough Area Regional Transit Authority (HART), FL
- Honolulu Department of Transportation Services (DTS), HI
- Valley Regional Transit (VRT), ID
- Kansas City Area Transit Authority (KCATA)- KS & MO
- Los Angeles County Metropolitan Transportation Authority (LA Metro), CA
- Maryland Transit Administration (MTA), MD
- Massachusetts Bay Transportation Agency (MBTA), MA
- Metropolitan Atlanta Rapid Transit Authority (MARTA), GA
- Nashville Metropolitan Transit Authority (MTA), TN
- New Jersey Transit Corporation (NJ TRANSIT), NJ
- New Orleans Regional Transit Authority (NORTA/ RTA), LA
- San Francisco Bay Area Rapid Transit (BART), CA
- San Francisco Municipal Transportation Agency (MUNI), CA
- Southeastern Pennsylvania Transportation Authority (SEPTA), PA
- Utah Transit Agency (UTA), UT
- Swedish Transportation Agency (STA), Sweden
- Transport for London (TfL), England
Guidebook

• Aimed at any agency personnel, but especially middle managers who often lead resilience planning efforts
• Presents an actionable, step-wise approach to help transit agencies meet the challenges created by climate change and the impacts of extreme weather
• Designed for easy printing and binding as agency workbook
• Includes case study examples, tools, and tips to try
01 Defining Resilience
“...the ability to prepare and plan for, absorb, respond, recover from, and more successfully adapt to adverse events.”

-The National Academies of Sciences, Engineering and Medicine
What Definition is Right for You?

“The ability to provide core functions in the face of threats, and recover quickly from major shocks or changing conditions.” — LA Metro

Being able to “…bounce back from shocks during natural disasters or weather-related events.” — KCATA

“Being better prepared to withstand and recover from an extreme weather event or threat.” — NJ TRANSIT

“How fast can a service be safely restored? …Resilience is the new reality.” (Engineering motto) — SEPTA

One definition need not fit all. It is up to you to figure out what resilience means for your agency.
Why Resilience Matters

U.S. 2017 Billion-Dollar Weather and Climate Disasters

- North Dakota, South Dakota, and Montana Drought: Spring–Fall 2017
- Western Wildfires, California Firestorm: Summer–Fall 2017
- California Flooding: February 8–22
- Colorado Hail Storm and Central Severe Weather: May 8–11
- Midwest Severe Weather: June 27–29
- Midwest Severe Weather: June 12–16
- South/Southeast Severe Weather: March 26–28
- Minnesota Hail Storm and Upper Midwest Severe Weather: June 9–11
- Midwest Tornado Outbreak: March 6–8
- Central/Southeast Tornado Outbreak: February 28–March 1
- Missouri and Arkansas Flooding and Central Severe Weather: April 25–May 7
- Southeast Freeze: March 14–16
- Southern Tornado Outbreak and Western Storms: January 20–22
- Hurricane Harvey: August 25–31
- Hurricane Irma: September 6–12
- Hurricane Maria: September 19–21

Source: NOAA website – Billion dollar disasters
Why Resilience Matters - continued

Source: NOAA website – Billion dollar disasters
The Business Case for Resilience

Enhanced resilience allows better anticipation of disasters and better planning to reduce disaster losses, rather than waiting for an event to occur and paying for it afterward.

— National Academies of Sciences, Engineering and Medicine

2017 NIBS report documents 6::1 payoff for past mitigation investments
Many Paths to Resilience

- Past Disaster Experience
- Asset Management and State of Good Repair
- Sustainability and Environmental Programs
- Leadership and Organizational Culture
Past Disaster Experience

• **MBTA**: Boston MA 2015 winter snow storms—changes in operations protocols, equipment upgrades

• **Nashville MTA**: 2010 flooding and partial fleet destruction—operations changes and MOUs

• **New Orleans NORTA**: 2005 Hurricane Katrina and fleet destruction—operational changes and MOUs

• **San Francisco Muni and BART**: Loma Prieta Earthquake (1989), Northridge Earthquake (1994)—changes in structural design standards, infrastructure, equipment retrofits, warning systems

• **SEPTA**: Repeated flooding, high heat, winter storms in Philadelphia area—multifaceted cost-effective responses

• **London TfL**: Bombings, flooding, high heat and 2012 Olympics—improved preparedness
NJ Transit, Newark, NJ

- **Agency Size:** Large
- **5,000+ vehicles**
- **271 m unlinked trips**
- **Location:** East Coast
- **Modes:** Commuter rail, light rail, bus, demand response
- **Hazards:** Flooding, high winds, coastal storm surge, sea-level rise, high heat, extreme cold, winter storms
- **Resilience strategies:** Capital investments + operations improvements- COOP, SOPs, training, communications, more
Leadership & Organization Culture

• **Nashville MTA**: Mayor, CEO and COO committed to expand transit service and preparedness

• **MARTA and Muni** leadership cultivate “cultures of collaboration and forward thinking,” as well as asset management systems that provide a foundation for resilience

• **LA Metro**: Mid-level management leadership and successes have cultivated senior management and board-level buy-in

• **Swedish Transportation Authority**: Maintenance crews alerted the authority to larger, more frequent restoration, repair and reconstruction projects, due to weather and climate effects
HART, Tampa, FL

- **Agency Size**: Medium
- **Location**: Gulf Coast
- **Modes**: Light rail, bus, demand response
- **Hazards**: Heavy precipitation and flooding, high winds, coastal storm surge, wave action, sea-level rise, high heat
- **CFO interested and empowered**
- **Resilience strategies**: O&M-fleet monitoring; systems planning-nimble rerouting, relocate planned BRT route → flooding
Sustainability & Environmental Programs

• Federal Transit Administration (FTA): Promotes sustainability through Environmental Management Systems (EMS)

• Hillsborough Area Regional Transit (HART): Uses sustainability and EMS as organizing framework for resilience

• SEPTA: Has an active EMS program

• Kansas City Area Transit Authority (KCATA): Is advancing green infrastructure and other sustainability projects as part of city-wide initiatives

• MARTA: Has significant solar panel installations on bus facilities; the Atlanta region pursues system resilience in the context of the term “sustainability”
LA Metro, Los Angeles, CA

- **Agency Size:** Large
- **3,300 + vehicles**
- **476 m unlinked trips**
- **Location:** West Coast
- **Modes:** Heavy rail, light rail, bus, demand response
- **Hazards:** Earthquakes, flooding, mudslides, wildfires, high wind, sea-level rise, dust storms, high heat
- **Industry leader in Environmental Management System (EMS);** adds resilience data & metrics into EMS
Asset Management & State of Good Repair

- Maryland MTA: Incorporating climate/weather risk data and assessment as part of their AMS to monitor SGR

- Valley Regional Transit (Idaho): Focuses on event readiness and grounds resilience efforts in concepts of sustainability, asset management and emergency preparedness
MARTA – Atlanta, GA

- **Agency Size**: Large
- **130 m unlinked trips**
- **Location**: Southeast, not coastal
- **Modes**: Heavy rail, bus, demand response
- **Hazards**: Heavy precipitation and flooding, high heat, drought
- **Asset management** “baked in,” resilience folds in via risk management
Charting Your Agency’s Path to Resilience
Four Basic Steps

Getting Started
Taking Stock
Moving Forward
Monitoring Progress

Adjust course as needed
Step 1: Getting Started

• **Understanding** agency context

• **Engaging** to plan and implement
  o Who should be involved?

• **Identifying** opportunities and barriers to greater resilience
Understanding Agency Context

- Administrative Structure
- External Influences
- Agency Context
- Modes & Services
- Financial Resources
Engaging to Plan and Implement

- Board of Trustees
- General Manager
- Chief Financial Officer
- Directors & Middle-level Managers
- Front Line Workers
- Outside Stakeholders
- Vendors & Contractors

[Diagram showing the different groups involved in planning and implementing]
Identifying Opportunities & Barriers

- Where are there opportunities to support change?
- What do barriers to resilience look like?
- What can an agency do to get past them?
SWOT Analysis

- **Helpful to achieving the objective**
- **Harmful to achieving the objective**

**Internal Origin (attributes of the organization)**
- **STRENGTHS**
- **WEAKNESSES**

**External Origin (attributes of the environment)**
- **OPPORTUNITIES**
- **THREATS**
Step 2: Taking Stock

- **Assessing** Vulnerabilities and Risk
- **Domains** of Resilience Adoption
- **Processes** That Support Adoption
- **Assessing** the Current Status of Resilience Activity
  - What else can/should you be doing?
Assets Critical to an Agency’s Safe and Effective Operation

- Vehicles
- Facilities and Stations
- Fixed Guideways and Systems
- Personnel
Assessing Vulnerability & Risk

HAZARDS
• High heat days
• Very cold days
• High wind/lighting
• Heavy rain and flooding
• Coastal storm surge and wave action
• Sea-level rise
• Winter storms
• Earthquakes and Tsunami
• Wildfires
• Drought & Dust Storms

POTENTIAL IMPACTS
• Buckled rails, overheated equipment
• Frozen switches
• Power failures
• Washouts, scouring
• Salt water intrusion
• Guideway and equipment flooding
• Track & tunnel misalignment
• Vegetation loss impacting erosion control
Sample Risk Matrix

Likelihood

Low  Medium  High

Impact

High  MEDIUM  HIGH  CRITICAL

Medium  LOW  MEDIUM  HIGH

Low  LOW  LOW  MEDIUM
“Domains” of Adoption

The concept of improving transit systems resilience is framed around the idea of building resilience across all “domains” of transit agency business.
Processes to Support Resilience Adoption

**Risk Management**
- Risk Assessment
- Asset Assessment
- Resilience Investment Alternatives
- Insurance/Financial Implications

**Environmental Management**
- Sustainability
- Operations
- Monitoring

**Communication**
- Internal to Agency
- With Regional Partners / Decisionmakers
- With Public

**Standard Operating Procedures**
- Maintenance & Operations
- Emergency Operations
- Coop

**Procurement Processes**
- Specifications
- Bids/Solicitations
- Verify Delivery, Quality
- Manage Warranties

**Personnel Development**
- Training
- Retention
- Succession Planning
Agency Self Assessment

• The Guide provides tools and examples to help agencies ask the probing questions that can lead to effective resilience planning and action. For example:

• *Where does your asset management system intersect with resilience? And what additional questions may need to be asked?*

LA Metro Resilience Indicator Framework worksheets in the Database, courtesy of LA Metro, can be extremely useful for an in-depth internal agency and external stakeholder review.
Step 3: Moving Forward

- Creating a shared sense of need
- Articulating a resilience vision, goals and desired outcomes
- Selecting and prioritizing implementation strategies
- Developing detailed action plans
- Mobilizing commitment
- Making change last
Create a Shared Sense of need

People are slow to embrace change unless they believe the need is real and they know:

• Why it’s important
• What difference it makes
• Their contributions count

A shared sense of need is critical to supporting change.
Articulating a Resilience Vision

Goals

Where do we want to go?

Desired Outcomes

How do we get there?

Results

How can we improve?

Measures, Metrics & Targets

How did we do?

Strategies

How do we get there?
Selecting and Prioritizing Strategies

Adaptation

Resilient Design

Mitigation
Developing Detailed Action Plans

- Action Steps
- Responsibilities
- Timeline
- Resources
Mobilizing Commitment

Commitment comes when people believe not only that they **CAN** do it, but also that they **MUST** do it.
To Create Lasting Change, Transit Agencies Can:

• **Invite transparency and innovation** to tackle organizational capacity constraints and competing demands for limited resources

• **Break open siloed business units** that too often focus on one mode, one function, or one program

• **Provide “how-to” guidance** on leading resilience practices

• Explore and **correct misperceptions about the costs** of resilience projects and practices

• **Accommodate differences** in planning horizons and implementation timeframes

• **Educate about the potential long-term benefits of resilience**
Step 4: Monitoring Progress

- **Choosing** performance measures and metrics
  - What makes a good metric?
- **Collecting** and tracking data
- **Evaluating** success and adjusting course as needed
Reinforce Regional Interdependencies
Thinking Beyond Your Agency…

...No agency is an island

- Who do you depend on?
- Who depends on you?
Identify Existing Regional Resilience Efforts

- Look to Mayors, MPO, County Executives, Non-profit Organizations, State Efforts, Others (may be more than one initiative)
  - Definitions of extreme weather risks, climate change scenarios
  - Vision and mission for resilience—time frames, action orientation—Capital? Operating? Addressing interdependencies?
- No Existing Organization?
  - Consider forming your own (see NCHRP Report 777, “Regional Transportation Planning for Disasters, Emergencies and Significant Events”).
Get Involved

• Make the Case for Transit as an Essential Partner for Resilience
• Contribute Time, Ideas, Questions, Answers, and Collaborative, Co-benefit Projects
• Participate in Planning and Carrying Out Regional Exercises
• Participate in Seeking Grants, Prioritizing Projects
• Develop Memoranda of Understanding (MOUs) With Diverse Partners
Transit Resilience Database

- Browse the Library
- Search by:
  - Resource type
  - Hazard type
  - Adoption domain
  - Transit mode
  - Keyword
  - Tags
- Print summary of selected resources
- Follow links to full documents or web references
Types of Resources in the Database

- Articles
- Case Studies
- Checklists
- Data Repositories
- Guidance Documents
- Mapping Tools
- Methodologies
- Plans
- Plan Templates

- Policies
- Process Aids/Worksheets
- Software Models
- Spreadsheet Tools
- Reports
  - Agency-specific
  - General
- Standard Operating Procedures (SOPs)
- Websites
Improving Transit Resilience Database

The Improving Transit Resilience Guide references and describes a variety of useful case studies, process aids, guidance documents, analysis frameworks, and other resources available to practitioners as they take steps to improve transit resilience at their agencies. Each resource profiled in the Guide and many more, are included in the online Improving Transit Resilience Database.

Use the following search tool to explore the resources included in the database.

Resilient Transit Tools and Resources Details

Resilient Transit Tools and Resources Details

- Resource/Tool Name: Articulating a Resilience Vision Worksheet
- Type of Resource/Tool: Process Aid/Worksheet
- Description: A clearly articulated, future-oriented statement of what transit resilience means for your agency can be used as a guide for all of your agency’s resilience planning and adoption activities. This worksheet includes instructions for conducting a visioning session with key personnel at your agency, including a series of “prompt” questions designed to elicit themes and key words that can be used to craft a resilience vision tailored to the particular circumstances of your agency.
- Original Source: Transportation Research Board
- Date of Publish: 2017
- Link to Document: http://example.com/articulatingresiliencevision.pdf
Articulating Resilience Vision

**What** A resilience vision statement defines what your agency operations and services will look like in a future where weather-related disruptions are more common.

**Why** A vision reminds the agency that it is working to be more resilient, paints a picture of the benefits to be gained, and clarifies the goals and action plans that require focused attention to enhance agency resilience.

**How**

1. If you have a working group in place, convene this group for a 2 to 4 hour meeting to develop a customized agency resilience vision.
2. Assemble important background documents, including your agency’s customized definition of resilience and any other assessments about organizational context (see Chapter 3 and Organizational Context Worksheet), the current state of perceived resilience (or lack thereof), expected hazards and vulnerabilities, risk, stakeholder needs or expectations, and other information that will inform what your agency wants to achieve.
3. Convene the group and describe the goal for the meeting. “How do we describe what resilience looks like for our agency, our customers, and our community?” “How will it improve our ability to withstand weather events and bounce back more quickly in even better condition?”
4. Post a copy of the current agency-specific resilience definition where all can see. NOTE: as a result of the vision discussion, the definition may undergo additional refinements. Make notes about possible revisions directly on the posted version but keep the overall discussion focused on the vision exercise.
5. Designate a recorder to write important ideas where participants can see them. Keep an extra sheet available for recording topics that require discussion in other settings.
6. Work with the group to identify the strongest themes or keywords that come from discussion of each question as a way of summarizing each section before moving to the next section.
7. Before pulling the themes into a draft resilience vision, check the energy of the group and decide whether the drafting should be done by this group and in this meeting. You can either make the decision on your own or ask the group for their input. Depending on that decision, proceed with Step 9 below or set another meeting.
8. However, the first draft is completed, circulate it to the work group and any other key individuals. Provide a specific deadline for supplying feedback.
9. Incorporate the feedback and then reconvene the working group for additional comment and finalization. Don’t let the perfect be the enemy of the good.

**Sample visions**
- LACTMA: “To provide core functions in the face of threats, and recover quickly from major shocks or changing conditions”
- SEPTA: The critical measure for system performance is: how fast can a service be safely restored?

<table>
<thead>
<tr>
<th>Prompt</th>
<th>Questions</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>What does improved resilience mean to our customers, agency, and community?</td>
<td>Themes or Keywords:</td>
<td>Other Notes:</td>
</tr>
<tr>
<td>How can resilience measures help us withstand weather events?</td>
<td>Themes or Keywords:</td>
<td>Other Notes:</td>
</tr>
<tr>
<td>How can resilience measures help us restore service more quickly?</td>
<td>Themes or Keywords:</td>
<td>Other Notes:</td>
</tr>
<tr>
<td>How can resilience measures help us bounce back more quickly and in better condition?</td>
<td>Themes or Keywords:</td>
<td>Other Notes:</td>
</tr>
<tr>
<td>What themes are emerging in our answers?</td>
<td>Themes or Keywords:</td>
<td>Other Notes:</td>
</tr>
</tbody>
</table>

**DRAFT VISION**
Resilience Lenses

What... Why... How...

What: Looking at routine operations and on-going initiatives (from asset management through long-range planning) through the “lens” of resilience can change your point of view and stimulate new thinking.

Why: By looking at everyday activities while asking the question “Can we do this in a way that enhances resilience,” will likely yield ideas about how to leverage existing efforts to meet resilience goals.

How:
1. Ask the questions below when planning and executing any of the operations and initiatives already underway in your agency. Review Attachment 1 for examples from other agencies.
2. Consider including one or more of the questions at the bottom of every agenda.
3. Appoint a staff member (or one in each department) as the “resilience champion” responsible for consistently asking the questions below or questions that are tailored to your agency circumstances. This individual is not charged with answering the questions, only to consistently ask colleagues whether there are simple ways to adjust activities so they contribute to improved agency resilience.
4. Periodically ask the “resilience champion” what he or she observes about the impact of the question(s) on how groups plan and implement routine tasks. If there are multiple champions, bring them together quarterly to debrief what they are hearing and to provide input to you or others charged with enhancing resilience.
5. The collected feedback is important to refreshing your agency’s definition of resilience, updating goals, and developing new strategies and plans.

Tip: Project case study interviews revealed that many transit agencies have found that incremental or step-wise approaches to enhancing resilience have been more effective than the creation of new initiatives or departments. Looking at ongoing activities through a resilience lens is a simple method for building awareness that translates in actions that will cumulatively improve the ability of your agency to withstand a weather-related service disruption. Please refer to the LACMTA Resilience Indicator Framework as well as other tools and case studies as well.

Resilience Lenses Questions
Ask where all of the questions as needed:
1. Will this action improve agency ability to withstand and weather-related events?
2. Will this action improve agency ability to quickly return to service after a weather-related event?
3. Will this action help the agency adapt more quickly to weather-related hazards?

Attachment 1: Examples of Transit Agency Resilience Lenses

<table>
<thead>
<tr>
<th>Overarching Practices</th>
<th>Sample Resilience Lens</th>
<th>System Example(s)</th>
<th>Your Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>Safety inspectors &amp; O&amp;M personnel alert and report “anomalies” &amp; weather impacts</td>
<td>STA (Sweden), MRTA, SEPTA</td>
<td></td>
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<tr>
<td>Asset Management</td>
<td>Risk analysis explicitly includes changing climate impacts</td>
<td>LACMTA, SEPTA</td>
<td></td>
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<tr>
<td>Sustainability</td>
<td>Seek co-benefits, support self-sufficiency, redundancy for critical systems, e.g., alternate power</td>
<td>HART, KCATA, stormwater efforts</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Domain</td>
<td>Sample Resilience Lens</td>
<td>System Example(s)</td>
<td>Your Agency</td>
</tr>
<tr>
<td>Policy and Administration</td>
<td>Support enthusiasm for change, reward “innocent truths” about safety, resilience, operations</td>
<td>MARTA</td>
<td></td>
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<tr>
<td>System Planning</td>
<td>Plan re-routing for emergency conditions, look for patterns for needed long-term changes or interventions for resilience</td>
<td>BART, HART, NSTA, MTA, LACMTA</td>
<td></td>
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<tr>
<td>Project Development</td>
<td>Facilitate life-cycle &amp; risk-based planning through criteria, awards Avoid minimum standards/ value engineering that “design out” resilience</td>
<td>BART, LACMTA (working on it), MARTA, SEPTA, FTA</td>
<td></td>
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<tr>
<td>Capital Programming</td>
<td>“Extra credit” for resilience in prioritization rankings: Cost Benefit Analysis (CBA) factors in climate risk</td>
<td>SEPTA, NJ, TRANSIT, FTA-developed tools</td>
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<tr>
<td>Maintenance &amp; Operations</td>
<td>Value of front line “first alert” and “eyes and ears” awareness and reporting of anomalies, early signs of weather-related problems, and patterns</td>
<td>TRANSIT, NJ, MTA, NORTA, NFMA</td>
<td></td>
</tr>
<tr>
<td>Emergency Preparedness</td>
<td>For response and recovery and in After Action Reports (AARs), look for root causes of failures and seek long-term solutions to relocate a facility to reduce hazards Build redundant control centers Move vehicle fleet</td>
<td>NJ TRANSIT, SEPTA, NORTA, (DTS), NFMA</td>
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TCRP A-41
Improving the Resilience of Transit Systems Threatened by Natural Disasters

Extensive weather events and other natural disasters threaten the operations and the capital assets of transit systems across the United States. This website was created as part of TCRP (Transit Cooperative Research Program) A-41: Improving the Resilience of Transit Systems Threatened by Natural Disasters—a research project funded by the Transportation Research Board.

Click on the links below to find out more about the project’s three main work products:
- Improving Transit Resilience Guide
- Improving Transit Resilience Database
- TCRP A-41 Final Report

GUIDE

DATABASE

FINAL REPORT
For Further Information

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Jon Carnegie  |  848.932.2840  |  carnegie@ejb.rutgers.edu
Rethinking Adaptation and Resiliency
(In A Rapidly Expanding System)

Cris B. Liban, D.Env., P.E.
Los Angeles County Metropolitan Transportation Authority
March 12, 2018
LA Metro is Los Angeles County’s...

Regional Transit Planner/Funder

Regional Transit System Builder

Regional Transit Operator
Los Angeles County

- Includes Los Angeles City and 88 other cities
- Large area – 4,751 mi² (~12,308 mi²)
- Large Population
  - Over 10 million people in LA County; 17.6 million in surrounding counties
  - More than 42 states
- Diverse – More than 40% foreign-born, over 220 languages spoken
- County with largest economy in the U.S.; 19th largest economy in the world
- Projected to grow by 1.5 million by 2050
Measure R Transit Program (Existing and Future)

Existing + Measure R:
Total: 197-205 stations, 236+ miles
390,000+ New Boardings

Existing Lines:
96 stations
105 miles
370,000 Daily Boardings
Transit Program (Existing and Future)

Existing + Measure R:
- Total: 197-205 stations, 236+ miles
- 390,000+ New Boardings

Existing Lines:
- 96 stations
- 105 miles
- 370,000 Daily Boardings

2016, Measure M
- No sunset; $120B funding in 30 years
- Environmental and Sustainability Strategy Reframing

Existing + Measure R:
- Total: 197-205 stations, 236+ miles
- 390,000+ New Boardings
## Major Capital Projects

### IN THE WORKS

**Transit, Highway and Capital Acquisitions Costs**

**Total Cost**: $14B

<table>
<thead>
<tr>
<th>Metro Transit Projects</th>
<th><strong>= $8.5B</strong></th>
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<tbody>
<tr>
<td>Gold Line Foothill Extension</td>
<td>$851M</td>
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<tr>
<td>Exposition Line Phase 2</td>
<td>$1.5B</td>
</tr>
<tr>
<td>Regional Connector</td>
<td>$1.4B</td>
</tr>
<tr>
<td>Purple Line Extension Segment 1</td>
<td>$2.8B</td>
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<tr>
<td>Crenshaw/LAX Transit Project</td>
<td>$2B</td>
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<table>
<thead>
<tr>
<th>Metro in Cooperation with Caltrans</th>
<th><strong>= $4.3B</strong></th>
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</thead>
<tbody>
<tr>
<td>I-5 (all projects under construction)</td>
<td>$3.3B</td>
</tr>
<tr>
<td>I-10 (all projects under construction)</td>
<td>$430M</td>
</tr>
<tr>
<td>SR-138 (all projects under construction)</td>
<td>$460M</td>
</tr>
<tr>
<td>I-710 (all projects under construction)</td>
<td>$160M</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metro Major Initiatives Capital Acquisitions</th>
<th><strong>= $1.2B</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus Purchases</td>
<td>$308M</td>
</tr>
<tr>
<td>Rail Purchases</td>
<td>$739M</td>
</tr>
<tr>
<td>Blue Line Enhancements</td>
<td>$46M</td>
</tr>
<tr>
<td>Division 13</td>
<td>$120M</td>
</tr>
</tbody>
</table>

*Metro Share: $80 million, Metro Share: $468 million, Metro Share: $46 million, Metro Share: $14.3 million*
An Integrated Approach

Environment and Sustainability
- Environmental Planning
- Environmental Compliance
- Environmental Remediation
- Environmental Due Diligence and Liabilities

- Env/Sust. Policy Dev. and Implementation
- Energy Conservation/Renewable Energy Mgt
- Environmental Management System
- Climate Change and GHG Emissions Mgt.

- EV Charger Program
- Sustainability Capital
- Real Estate Ops
- Permit Management
- HazMat Site Management

Carbon Credits Administration
Adaptation Metrics

1. Has a vulnerability assessment been conducted?
2. Have adaptation actions been prioritized?
3. Have vulnerable assets been mapped with transit dependent and low-income populations?
4. Number of injuries/medical emergencies to workers and riders by temperature and rainfall.
5. Does the agency have overheating standards for public transport facilities and rolling stock?
6. Capacity to monitor weather and temperature conditions in real time at key locations in the service area.
7. Extreme weather impacts on service delays and cancellations.
Critical and At Risk Facilities

Stressors
- High heat days
- Precipitation
- Flooding
- Wind
- Wildfire
- Earthquake
- Sea Level Rise
vs. Vulnerable Populations
What Have We Done Since Then?

- Updated Design Criteria
- Enhanced Project Specifications
- Require Project Sustainability Plan
- Develop Agency-wide Environmental Management System
- Conduct National Engagement
  - Federal/State: FTA/FHWA and Caltrans
  - City and County of Los Angeles
  - USGBC/TRB/APTA
  - Mero Sustainability Council
Sustainability Plan Process Map
(Existing Framework for Design Build Project Delivery)
Siting Integration/Floodplain Analysis

Flood Zones:
- Floodway
- 100 Year Floodplain
- 500 Year Floodplain
Siting Integration/Floodplain Analysis

Flood Zones
- Floodway
- 100 Year Floodplain
- 500 Year Floodplain
Sustainability Plan Process Map
(Existing Framework for Design Build Project Delivery)
Sustainability Plan Process Map
(Existing Framework for Design Build Project Delivery)
Operational Strategies

- Pre-emptive maintenance or inspection
- Bus and Rail Assets and Facilities
- Weather/climate-related monitoring and alerts
- Operational design criteria, e.g., materials up to 120° F
- Energy efficiency and off-peak activities planning
- Upgrade and update of OCS
LA Metro Resiliency Indicator Framework Project

Scope

- Develop a framework to evaluate technical and organizational resilience to climate change
- Key climate stressors considered: extreme heat and precipitation

LACMTA definition of resiliency

- Ability to provide core functions in the face of threats and recover quickly from major shocks or changing conditions
Technical Basis

- Builds on existing Metro climate work
- Indicators help prioritize and evaluate adaptation implementation priorities
- Criteria for future funding streams
- Mapping of assets vs. vulnerable populations
- Incorporating resiliency into Metro processes (e.g., in State of Good Repair Asset Management Database)
- Familiarizing Metro team with concept of Resiliency and Team
  - Internal and External
Implementation

- Continuity of business assessments and coordination
- Design Criteria strategies
- Strengthen implementation strategies
  - Asset Management Integration
  - Connections with other Metro efforts
  - Evaluate Metro’s Technical resiliency
- Identify potential cost impacts
- Energy and Water Resiliency
- City-wide resiliency efforts to disasters and climate change
- Resiliency Policy
Adaptation Metrics

1. Has a vulnerability assessment been conducted? ★
2. Have adaptation actions been prioritized? ★
3. Have vulnerable assets been mapped with transit dependent and low-income populations? ★
4. Number of injuries/medical emergencies to workers and riders by temperature and rainfall. ★
5. Does the agency have overheating standards for public transport facilities and rolling stock? ★
6. Capacity to monitor weather and temperature conditions in real time at key locations in the service area. ★
7. Extreme weather impacts on service delays and cancellations. ★
• Unified Cost Management Process and Policy
  • Design Criteria
  • Specifications
  • Sustainability Plan
    • Metro Policies and Requirements
    • CA Green Building Code
    • Statutes and Regulations
    • Ordinances
    • Best Management Practices from Certification Systems (as applicable)

• Operations and Maintenance
  • Costs
  • Technology Advancement
  • Workforce Development
• Unified Cost Management Process and Policy
  (Additional Mandates [with Life Cycle])
  • Design Criteria
  • Specifications
  • Sustainability Plan
    • Metro Policies and Requirements
    • CA Green Building Code
    • Statutes and Regulations
    • Ordinances
    • Best Management Practices from Certification Systems
      (as applicable)

• Operations and Maintenance
  • Costs
  • Technology Advancement
  • Workforce Development

• Sustainability Implementation Plan
  • Internal facing
  • External Input
  • Sustainability Council

New Strategy
Other Factors to Consider
- Reconciliation of Underlying Science with Practice
- Sustainable Infrastructure Standards
- Resiliency Standards
- Funding Resiliency Projects
- Staff Training
- Contractor Training
- Other Factors Related to Project Acceleration
Incorporating Climate Change into Infrastructure

- California AB2800 (Quirk). Climate change: infrastructure planning
  - Take into account the current and future impacts of climate change when planning, designing, building, operating, maintaining, and investing in state infrastructure
  - Establish a Climate-Safe Infrastructure Working Group

- Develop an American Society of Civil Engineers Design Standard for Sustainable Infrastructure

- Understand and use alternative financing mechanisms to implement

- Other LA Metro efforts
Questions/Discussion

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- Emanuel (Cris) Liban, LA Metro, LibanE@metro.net
Panelists Presentations


After the webinar, you will receive a follow-up email containing a link to the recording
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