AECOM

Flooding Resilience Plan for Bus Operations

Project Executive Summary for Pace Suburban Bus

Prepared for the Regional Transportation Authority of Northeast Illinois

May 18, 2018

Project Background and Summary

In Fall 2015, as a continuation of its Green Transit program, the Regional Transportation Authority (RTA) initiated a project to prepare a bus route flooding resilience plan for the RTA service area composed of its six-county jurisdiction in northeastern Illinois, including Cook, DuPage, Kane, Lake, McHenry, and Will Counties. The objective of this project was to identify CTA and Pace bus routes that are prone to flooding during both average rain events and extreme weather events and to develop recommendations to address flooding issues and reroute service during flooding. Aside from hampering citizens' mobility, such flooding events can have negative impacts on operating costs and ridership revenues.

Summary of Tasks and Themes

Based on observations of significant flood events during the last five to 10 years, flood events in the RTA service area are a combination of water body overflows, as well as stormwater runoff and localized drainage issues. Bus transit is most obviously impacted when roads are wholly flooded and impassible, and viaducts and underpasses around the region's railroad and highway network are particularly vulnerable. After a kickoff meeting in **Task 1**, the project team identified and reviewed datasets during **Task 2** describing the natural systems across the region—primarily the floodplains and floodways—as the starting point for identifying areas that present risk based on riverine and overbank flooding.

In addition to conclusions that can be inferred from an overlay of viaduct locations, conditions and bus routes, the project team supplemented its understanding of risk with anecdotal reports of flooding from the front lines—the Pace and CTA bus drivers who call in flooded roads and detours. Areas with recurring problems for boarding and alighting were provided by the drivers and operations management, as well as from passengers who make reports of access difficulties. Additionally, insight from emergency management stakeholders and local departments of stormwater management and transportation provided further insight into troubled areas, impact, and the status of mitigation work.

In **Task 3**, the project team examined the effects of changing climate patterns on the flood risk landscape in the region. Research conducted in 2008 for the Chicago Climate Action Plan indicated that increases in winter and spring precipitation are likely, with projected increases of about 10 percent by the year 2050, and of about 20 to 30 percent by 2099. At present, even minor storms are enough to overwhelm the stormwater system of some parts of the region, and these are expected to occur even more often. Additionally, the intensity of heavy precipitation events (storms with 5-, 10-, and 25-year recurrence intervals) is likely to continue to increase. Effects of these trends will vary across the region according to watershed and sub-watershed hydrological patterns. With input from county and local stormwater management departments, the project team assessed whether these forecasted increases are likely to worsen risk conditions for the bus routes selected by the agencies.

In **Task 4**, the project team prepared responses to the identified risks in three major categories:

- Reroute plans for impacted bus routes,
- Communications strategies for updating impacted stakeholders of service interruptions, and
- Inventories of potential mitigation projects and recommendations, with suggested next steps for items outside agencies' control

The resiliency strategies are composed of some projects that fall under the jurisdiction of CTA and Pace, but the majority are located in the public right-of-way or on private property. For these projects, the RTA, CTA, and Pace can influence other entities' actions but cannot control the outcome of these plans and may be able to participate from a funding or advocacy perspective.

The project completed work in 2017 and documentation in early 2018. This document represents an executive summary of the full project report and its accompanying technical appendices, available from the RTA. This document is tailored to Pace Suburban Bus, with a similar executive summary document for the CTA also available.

Flood Risk Areas and Hotspots

Current Flooding Concerns

This plan's analysis of current and future flood risk areas categorized two types of flooding: **urban**, with origins in the built environment and ability of infrastructure to manage large amounts of stormwater; and **riverine**, resulting from overbanking of water bodies (rivers, streams, reservoirs, etc.) from large amounts of stormwater. To identify flood risk areas and hotspots across the RTA service area, the project team collected a variety of data:

Problems Experienced by the Transit Agencies

- Locations of bus service interruption and route-level comments on typical flood problems reported by CTA staff
- Locations of bus service interruption and route-level comments on typical flood problems reported by Pace staff

Specific to Urban Flooding

- Locations of road closures due to flooding reported by departments of transportation (municipal, county, state)
- Locations of viaducts (and annotation of "problematic" or "flood-prone" viaducts) by CDOT, CTA and Pace
- City of Chicago 311 reported flood calls, including water on pavement and flooded viaducts

Specific to Riverine Flooding

- FEMA 100-year and 500-year floodplain boundaries
- Local updates on floodplain boundaries / inundation areas from counties (Cook/MWRD, DuPage, Will)

Future Flooding Concerns

Stormwater and water resource engineers on the project team evaluated the potential increases in rainfall using the climate change scenarios from the Chicago Area Climate Action Plan and applying the increases for future climate change scenarios to the Illinois State Water Survey's Bulletin 70 24-hr rainfall amounts. The project team interpolated existing and future rainfall frequency curves to identify the equivalent storm frequency for future rainfall events at mid-century 2017 and late-century 2017. This generalized modeling of anticipated rainfall suggests storms of greater severity may occur more frequently in the future. That is….

The term "Storm Recurrence Interval" refers to the chance or probability that a storm of a certain magnitude may occur or be exceeded in a given year. For example, a "100-year storm" has a 1 in 100 chance of occurring in any given year, or 1% chance (called the "Annual Exceedance Probability"). It does not mean that such a storm only occurs once every 100 years, and once happened, won't happen again in the same 100-year period.

For severe storms:

A 100-year storm mid-century could be like today's 150-year storm
A 100-year storm late-century could be like today's 240-year storm

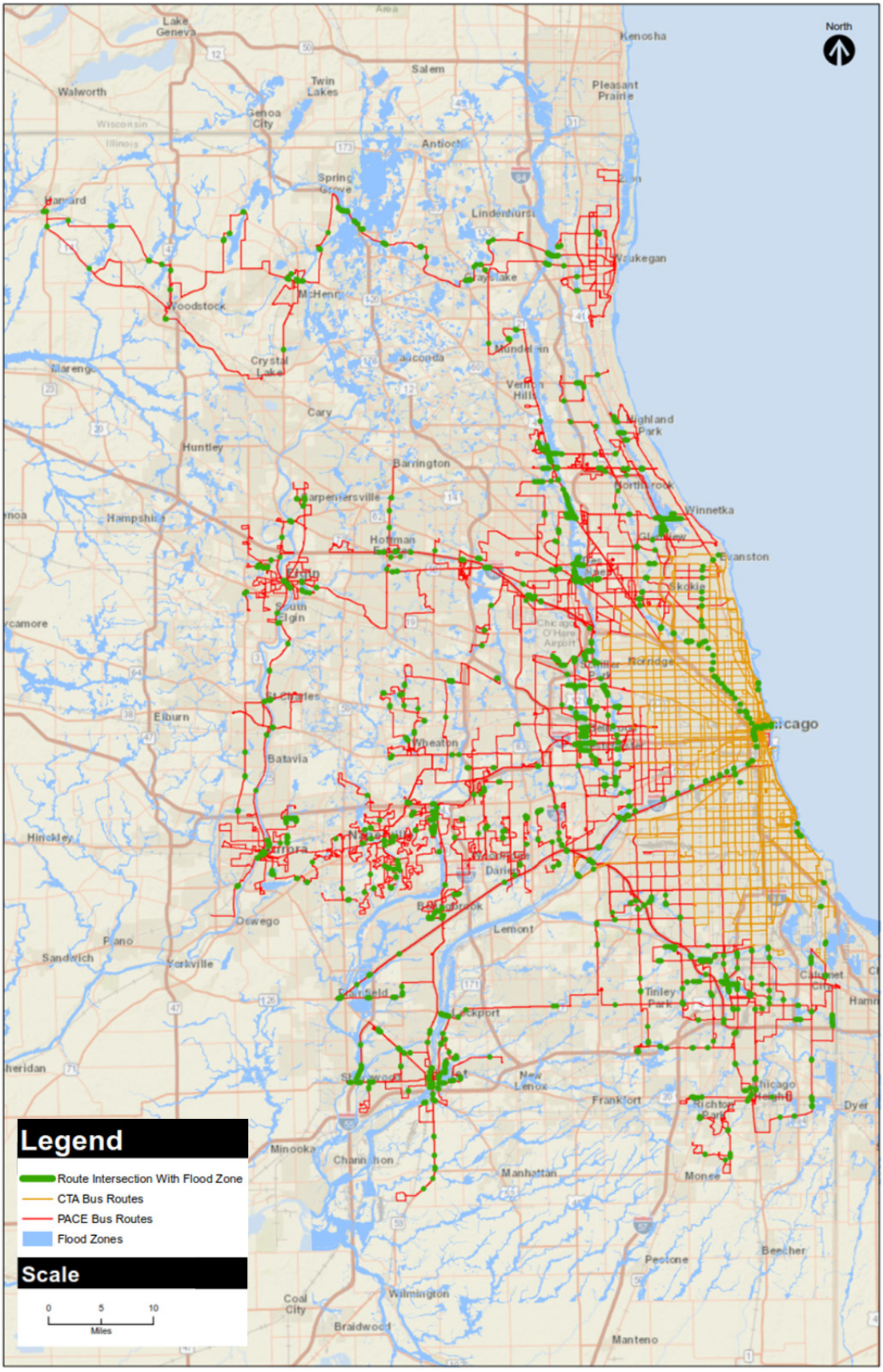
For moderate storms:

A 5-year storm mid-century could be like today's 11-year storm
A 5-year storm late-century could be like today's 14-year storm

A 1-year storm mid-century could be like today's 2-year storm
A 1-year storm late-century could be like today's 2.5-year storm

The potential impact of future climate change on riverine and suburban/exurban flooding patterns and levels are available from a 2010 report by the US Army Corps of Engineers for several water bodies in the RTA service area, include the Des Plaines River, Addison Creek, and Silver Creek. Storm profiles were reviewed to identify incremental surface elevation differences, which range from 0.8 to 2.4 feet, and were used to project potential future 100-year floodplain limits as located approximately halfway between the existing FEMA 100- and 500-year flood plain limits. In the absence of complex hydraulic and hydrologic modeling, this broad-brush approach is appropriate for identifying locations impacted by future conditions. This exercise concludes that there was very limited spatial expansion of floodplain areas impacting bus routes. This project's initial screening of Pace bus routes for risk of flood interruption was based on defining risk areas including both the 100- and 500-year floodplain limits, so adjustments for future conditions were already within the zones noted as potentially risk-prone. Across the RTA service area, there are few areas with 500-year floodplain concerns that intersect with bus routes. The conclusion from this exercise is similar to the project team's conclusion for urban flooding: locations that are currently prone to flooding may have more frequent or severe flooding in the future.

Intersection of Bus Routes with Current 100-Year and 500-Year Flood Zones



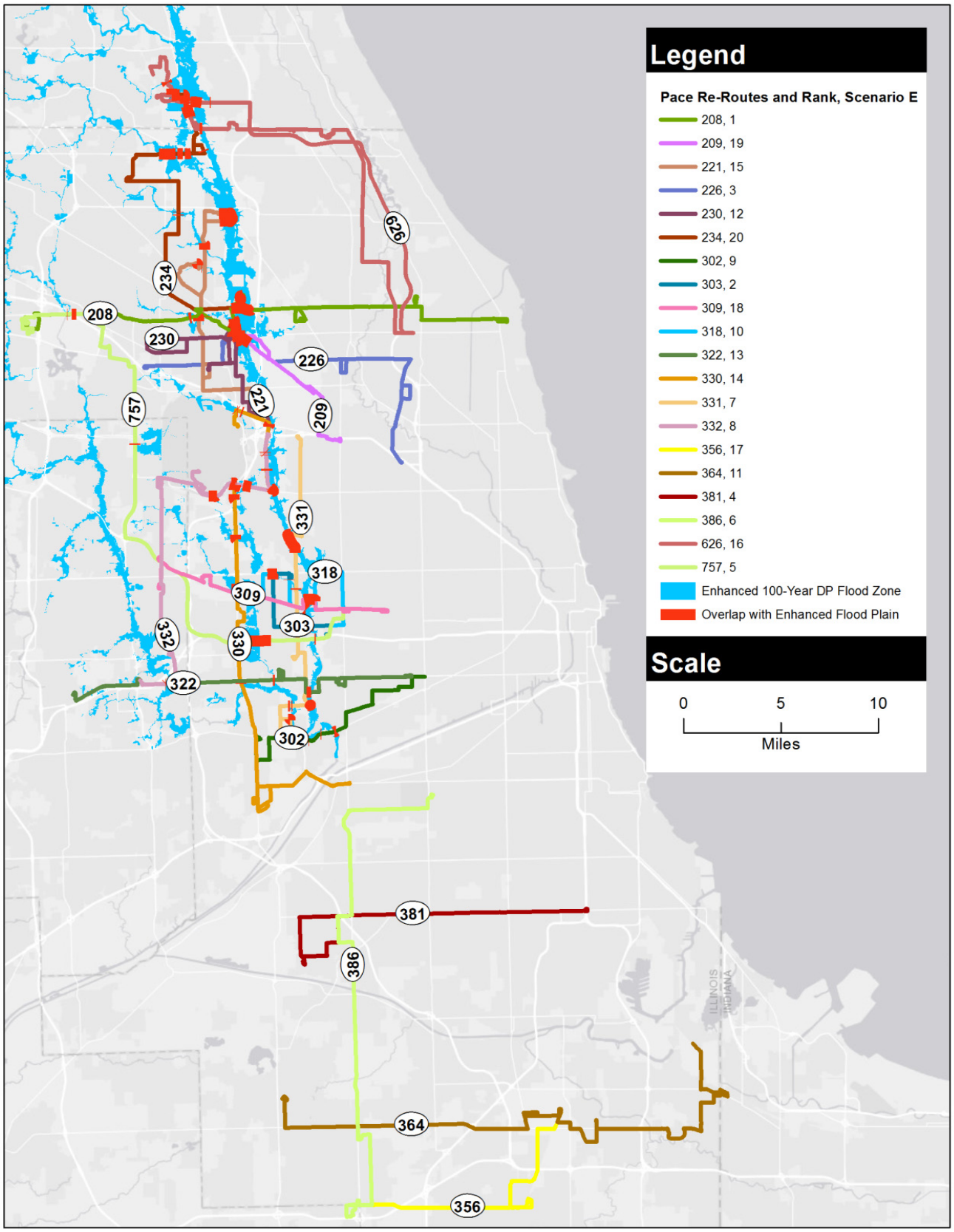
Reroutes and Impact Analysis

Due to the size of the RTA service region and breadth of Pace's service area, this project was unable to analyze each and every bus route for flood impacts and plan for reroutes. The project team provided a variety of prioritization criteria to CTA and Pace to select a subset of routes for further analysis. Routes were filtered and sorted based on criteria such as: actual reports of flooding by drivers, number of intersections with flood zones (based on the 100- and 500-year flood plains), ridership, and number of connections with the regional transit network. Pace representatives decided that they would most benefit from analysis of the routes in Scenario E, which filtered routes by actual flood reports, and sorted by transit network connectivity and ridership.

Pace Scenario E Routes	
208	Golf Road
209	Busse Highway
210	Lincoln Avenue
221	Wolf Road
226	Oakton Street
230	South Des Plaines
234	Wheeling - Des Plaines
272	Milwaukee Avenue North
302	Ogden - Stanley
303	Forest Park - Rosemont
309	Lake Street
318	West North Avenue
319	Grand Avenue
322	Cermak Road - 22nd Street
326	W Irving Park Road / Rosemont CTA to Norridge
330	Mannheim - LaGrange Roads
331	Cumberland - 5th Avenue
332	RT 83 / River Road - York Road
356	Harvey - Homewood - Tinley Park
364	159th Street
381	95th Street
386	South Harlem
565	Grand Avenue
572	Washington
619	Des Plaines Station - Willow Road Corridor
620	Yellow Line Dempster - Allstate
626	Skokie Valley Limited
757	Oak Park - Schaumburg Limited

Pace had already defined turn-by-turn reroute directions for numerous routes throughout the region in response to historic flood incidents that have impeded regular operations. Most Scenario E routes have reroutes in place already, defined by Pace, and used routinely during storm events. Notably, these reroutes have not required further diversion, even during severe storms experienced in 2013, 2016 and 2017. These reroutes formed the basis of analysis during this project, although may need to be adjusted in the future by Pace as actual situations may warrant.

Pace Scenario E Reroutes



The project team estimated quantitative impacts of the Scenario E reroutes, including changes in stops serviced based on the reroute alignment, associated changes in ridership, travel time, and operating costs. The estimates presented assume full implementation of reroutes as documented, including situations where a route may have multiple diversions.

- In most cases, the reroute diversions reduce the number of locations where a route alignment encounters a flood risk areas; however, there are a pair of instances (330 and 332) where the reroute touches one or two additional areas; feedback from Pace staff on the reliability of their defined reroutes even through severe storm events suggests this is a point to monitor rather than a concern.
- The number of bus stops on the original routing skipped by the reroute ranges from nominal to many; while in some situations this metric may appear high, it reflects designating stops at every intersection while Pace transitions to fixed stops from flag stops.
- From the recalculation of bus stops serviced, the project team re-estimated potential ridership on the reroute. Changes in ridership for most routes is less than 10 percent, with only four routes experiencing substantial numbers of riders impacted (potentially lost or diverted) due to skipped stops. These estimates do not take into account counteracting communications mechanisms which would direct impacted riders to alternate stop locations on the reroute or alternate transit routes, thus reducing the potential lost system ridership.
- Operational impacts to reroutes are estimated based on travel times for the altered routes. Changes in travel times on a per-trip basis between the standard route and the reroute vary substantially. In some cases, a reroute is longer than the standard route, and incurs greater travel time; in other cases, a reroute runs shorter and faster. Base travel time estimates for the reroutes are presented. Estimates of impacts to operating costs are calculated using each route's cost per-hour metric. As with the changes in travel times, changes in trip cost likewise show as positive and negative, with increased costs projected to be incurred in some situations, and savings in other situations.

Estimated Key Performance Indicators for Selected Reroutes

Route	# of Flooding Incidents on Original Route	Change # of Flooding Incidents with Reroute	Missed Bus Stops with Reroute	Existing Average Daily Ridership (ADR)	Estimated ADR with Reroute	Net Riders Impacted by Reroute	Change in Travel Time in Minutes (Base Reroute)	Change in Cost per Trip (Base Reroute)
208	1	-1	34	1,847	1,687	160	-22	-$27.25
209	1	0	6	369	368	1	-2	-$2.54
221	0	0	34	726	683	43	-10	-$12.68
226	1	0	17	696	694	2	-12	-$15.21
230	1	0	7	370	365	5	-7	-$8.87
234	0	0	30	266	248	18	-13	-$15.84
302	2	0	2	551	546	5	3	$3.05
303	5	-5	138	1,130	515	615	-5	-$6.09
309	2	0	25	881	820	61	3	$3.66
318	3	-1	32	2,402	926	1476	9	$10.36
322	2	0	2	2,243	2,175	68	7	$7.92
330	6	+2	16	1,223	948	275	6	$7.31
331	4	-1	33	1,142	1,080	62	5	$6.09
332	4	+1	19	629	477	152	-6	-$7.31
356	2	0	7	581	567	14	3	$3.68
364	1	0	0	2,043	2,043	0	0	$0.00
381	1	-1	7	3,669	3,631	38	-2	-$1.67
386	1	-1	10	1,423	1,344	79	3	$3.33
626	0	0	0	346	346	0	5	$5.83
757	0	0	0	210	210	0	2	$1.83

Communications and Coordination Plans

In the event that severe rain events disrupt regular bus service, communications and coordination plans are critical for notifying the public about service changes, including reroutes. Pace has well-established procedures tested and refined over the course of numerous severe rain events as well as other types of service interruptions, weather-related and not. Recommendations from this project include identification for areas of new or deeper collaboration among interested agencies, as well as suggestions for consideration of additional technological resources; both of which are subject to available financial and human resources. Key activities and potential innovations include:

Pre-Flooding Preparedness Operations

Operations will:

- Monitor weather forecast for rainfall that may produce flood water impediments to bus operations.
- Coordinate with local partners in anticipation of potential reroutes to confirm the decision-making process.
- Communicate potential detour recommendations to Service Planning via detour@pace.com email to Garages.

Service Planning will:

- Obtain management approvals for service detours.
- Prepare passenger detour notifications.
- Inform Communications about impending service detours to provide patrons with detour notifications.

Communications will:

- Prepare to communicate potential service reroutes.

Flood Operations

Operations will:

- Garages will re-route bus operations based on information that route sections are impassible, from drivers, supervisors, or other external sources.
- Supervisors will coordinate with Dispatch to respond to route flood conditions that are not historically typical.
- Communicate re-route activations to Service Planning via detour@pace.com.
- Coordinate with Communications to publish and relay bus service updates to the public.

Service Planning will:

- Obtain management approvals for service detours.
- Prepare passenger detour notifications.
- Send Communications a reroute notice to approve.

Communications will:

- Approve Service Planning's reroute notification and relay bus service updates to various parties.
- Send out a GovDelivery blast to passengers who have signed up for updates on a specific route. This could be 400 to 2,000 people, via email and/or text message; this update happens after the online web page post goes live.
- In an extreme event, Communications can put an emergency bulletin on the front page of the Pace website and alert subscribers to "What's New" alerts via GovDelivery.

Pace Garages will:

- Post notices on the actual buses (printed at the garage or received from headquarters).
- Post each route's detour notice on every bus in that division garage, sometimes with multiple notices in each bus.
- If there is sufficient time and Pace believes the detour warrants it, laminated copies will be posted on location. The Garage may also put the notices up at terminals.

Potential Innovations

- Using real-time information signs at Transit Centers to display notice text.
- Using real-time web-connected onboard monitors as an alternative to paper notices.
- Submitting real-time detour information to Pace's own mapping engine, Google Maps, or other mapping or trip-planning applications.

Action Plan Matrix

Pace can coordinate with a broad range of partners to pursue general short and long term flood mitigation actions.

Project/Policy	Agency/ Organization	Cost	Notes
Viaduct improvement projects	CREATE public and private partners; Metra; railroads; local departments of transportation and water management	$$$	CREATE Viaduct Improvement Program completed in 2015. Negotiate additional funding for expansion of that program along with remaining CREATE projects.
Underground construction projects	Local and county departments of transportation and water management	$$$	Such projects may be initiated through municipal, sister-agency and/or public (311) requests.
Clearance of drains of debris prior/during storm	Local departments of transportation, streets & sanitation	$	Proactive pre-storm preparation
Coordination with other development/ utility/ roadwork projects	Local Councils of Governments	$	Participate in Transportation Improvement Program (TIP) planning process to reinforce priority hotlist
Watershed planning councils	MWRDGC, local departments of planning, transportation, and water management	$	Identify risk areas and problems, with corresponding mitigation projects and policies
		$$	Prepare stormwater master plans to address urban flooding; five pilot studies under way or complete; expand to other high-priority / high-flood risk areas
Green infrastructure	MWRDGC, local departments of planning, transportation, and water management	$$	Implement carefully curated palettes of green infrastructure for maximum benefit
Ongoing monitoring and data collection	Pace operating systems; local 311/911 services; smart cities service providers	$	Use of flood report data to identify and monitor problem areas can be used to generate hot list for participation in infrastructure planning meetings (above); provide to streets and sanitation departments for debris clearance (above)
	County and municipal water management departments; CMAP; IDNR; FEMA; CNT	$$	Develop and enhance/maintain county and/or regional database of flood incidents; rainfall, water level, and flood forecasts; risk factors; and mitigation measures
Cost-sharing for local capital improvement projects to alleviate flooding issues	County DOTs, County, municipality, stormwater agencies	$$	Coordinate problem diagnosis and solution planning among agencies
Cost-sharing on major capital improvement projects pertaining to riverine flooding	County and municipal stormwater departments; MWRDGC, IDOT, US Army Corps of Engineers	$$$	Projects include reconstruction of a segment of I-290 (IDOT), Des Plaines River Levee 9 (US ACE), Buffalo Creek reservoir expansion (MWRDGC), Addison Creek (in design phase, MWRDGC), Silver Creek (IDOT), among others

Flood Mitigation Projects

As noted above, Pace needs to coordinate primarily with three agencies (MWRDGC, IDOT, and US Army Corps of Engineers) to deal with most of the flood problems identified for the Scenario E routes studied. In terms of prioritizing projects to mitigate flooding issues, the County DOTs, County or municipal stakeholders and stormwater agencies are good partners, as these agencies may be dealing with additional local impacts from the same problems or locations, and may offer cost- sharing arrangements for studying solutions. A number of mitigation strategies have already been brought forward and are described below:

Route	Mitigation Strategy
209, 226	IDNR-OWR has built two flood control projects in this area in the last decade that should solve most of the flooding problems shown. It is uncertain whether floodplain maps were ever updated with the results of these projects; it might be the method of handling the enhanced flood plain in this area that flags these areas as potential problems. These routes should experience infrequent flooding at the worst.
230	Pace needs to lobby Congress regarding funding for the Corps Des Plaines River Levee 9. The Des Plaines River project was authorized by Congress in the Water Resources Development Act of 2016. As of this report, Congress has to include funding for the project in budget.
234	MWRDGC is studying reservoir expansion on Buffalo Creek upstream of this flooding problem. Need to coordinate with MWRDGC to move this project forward.
303, 309, 330	MWRDGC's Addison Creek project that is moving into the design phase should reduce the flood frequency for these routes.
318	MWRDGC's Addison Creek project and a study by IDOT on North Avenue at Silver Creek should reduce the flooding frequency along this route.
331	The Corps Des Plaines River Levee 4 with two closure structures should reduce the flood frequency for this route. The Grand Avenue closure structure would close Grand Avenue but will allow Des Plaines River Road to remain open, and generally would be closed between the 10 and 50-yr flood event. The closure structure at Des Plaines River Road and 5th Avenue would close Des Plaines River Road here during the 100-yr events.
332	DuPage County Stormwater did not show the portion of this route on 22nd Street flooding. They will need to coordinate with Elmhurst regarding solutions for the York Road underpass flooding. The portion of the route along Irving Park Road and Bensenville Ditch may have been addressed when Irving Park and Bensenville Ditch were relocated for the O'Hare Airport Expansion.
626	The Aptakisic Creek flooding along a portion of this route should be coordinated with the Lake County Stormwater Management Commission. The roads are IDOT's jurisdiction at this location and talks about any flooding problems here should also be discussed with IDOT.
757	The flooding shown along I-290 portion of this route should be addressed when IDOT reconstructs I-290. Pace needs to work with IDOT on scheduling this reconstruction.

Decode of Agency / Organization Abbreviations

CMAP – Chicago Metropolitan Agency for Planning
CNT – Center for Neighborhood Technology
CREATE - Chicago Region Environmental and Transportation Efficiency Program
CTA – Chicago Transit Authority
DOT – Department of Transportation
FEMA – Federal Emergency Management Agency
IDNR – Illinois Department of Natural Resources
IDOT – Illinois Department of Transportation
MPC – Metropolitan Planning Council
MWRDGC – Metropolitan Water Reclamation District of Greater Chicago
RTA – Regional Transportation Authority
USACE – United States Army Corps of Engineers

Pace Scenario E Reroutes and Mitigation Projects