

# Findings and Methodology for Assessment of a Hudson River Tunnel Shutdown

Documentation for *A Preventable Crisis: The Economic and Human  
Costs of a Hudson River Rail Tunnel Shutdown*

February 2019

***A Preventable Crisis: The Economic and Human Costs of a Hudson River Rail Tunnel Shutdown***, released by Regional Plan Association and Arup in February 2019, describes the results of an effort to rigorously quantify the impacts of a partial shutdown of the only Hudson River passenger rail tunnel connecting New York and New England to the rest of the United States. This companion document provides more detail on the findings, assumptions and methodology for the study.

# Baseline Assumptions

- The project assessed the likely impacts if a planned shutdown of the Hudson River passenger rail tunnel is required for repairs prior to the completion of a new tunnel. An emergency shutdown resulting from a storm or other event would likely have worse consequences.
- The assessment does not project when a shutdown would occur. For analytic purposes, it models what the impacts would be if the shutdown occurred in 2019.
- It assumes that there would be four years in which only one track would be in service, with each tube closed for two years each based on available information. Actual time could be more or less.
- Capacity is projected to be reduced from 24 to 6 trains per hour, based on public projections from Amtrak. There is no service plan or agreement for how trains would be allocated between services. The scenario assessed in this analysis assumes five New Jersey Transit and one Amtrak train per hour.
- The results reflect estimated impacts without additional services or demand management policies by the transportation providers. While it is likely that some mitigation measures would be provided, these would be limited by physical and labor capacity constraints and would have their own set of impacts and costs.

# High-level methodology

## Amtrak – Tunnel closure assumptions

- Used public assumptions on capacity and duration of tunnel shutdown

## Air travel impacts and implications

- Estimated impact of displaced Amtrak passengers on air network using publicly available Amtrak information, and academic research (e.g., demand elasticities)

## Total and auto diversions

- Estimated total amount of diversions based on existing ridership versus capacity of five New Jersey Transit and one Amtrak train per hour
- Estimated diversions to both transit and auto based on facility capacity and other factors

## Non-auto diversions

- Estimated diversion to transit based NJ Transit, PA, Amtrak capacity estimates, other factors
- Estimated impact of 'lost trips' based on applied academic research

## Surface travel time impacts

- Leveraged NJTPA Sensitivity Test of NJRTME model to develop surface transportation travel time impacts from diversions to auto

## Surface travel time implications

- Leveraged auto diversion and travel time impacts to calculate:
  - Cost of additional passenger travel time (wage impacts) and related impacts (e.g., additional car O&M, parking costs)
  - Cost of freight congestion in general, and in area sea/airports
  - Safety and health impacts
  - Home price impacts
  - Customer experience impacts

# The assessment excludes many indirect impacts that are difficult to quantify but would substantially increase costs

FOR DISCUSSION

The current analysis represents a conservative estimate of the impacts of the HRT shutdown...

## Analysis included:

- ✓ Cost of **additional passenger travel time** (wage impacts) and related impacts (e.g., additional car O&M, parking costs)
- ✓ Cost of **freight congestion** in general, and in area sea/airports
- ✓ **Safety and health** impacts
- ✓ **Home price** impacts
- ✓ **Customer experience** impacts
- ✓ Estimated impact of displaced Amtrak passengers on **air network**
- ✓ Estimated the impact of **'lost trips'** based on the number of people who could no longer commute to NYC in peak times

... because it excludes several areas that could have additional impact on the region

## Analysis not included:

- ✗ **Assumed a planned, and not an emergency shutdown**
  - **Emergency shutdown** would likely **compound effects** (e.g., take both tubes out of service, not given people time to adjust to new service)
- ✗ **Buffer times** people will incorporate to account for increased variability in their commute time
  - E.g., a commuter diverted to bus and travelling from Oradell, NJ to Manhattan may add 30 minutes of buffer time to commute to ensure on-time arrival
- ✗ Impact on **Manhattan commercial real estate** values
  - Market value of Manhattan commercial real estate is **~\$215B**
- ✗ Impact of **additional stress on already overused infrastructure** in the New York metro area (e.g., additional wear and tear on roads)
- ✗ Effect on **regional competitiveness**
- ✗ Additional impact on region if other **transit links experience a shutdown** (e.g. MTA, PATH, PABT)

# Contents

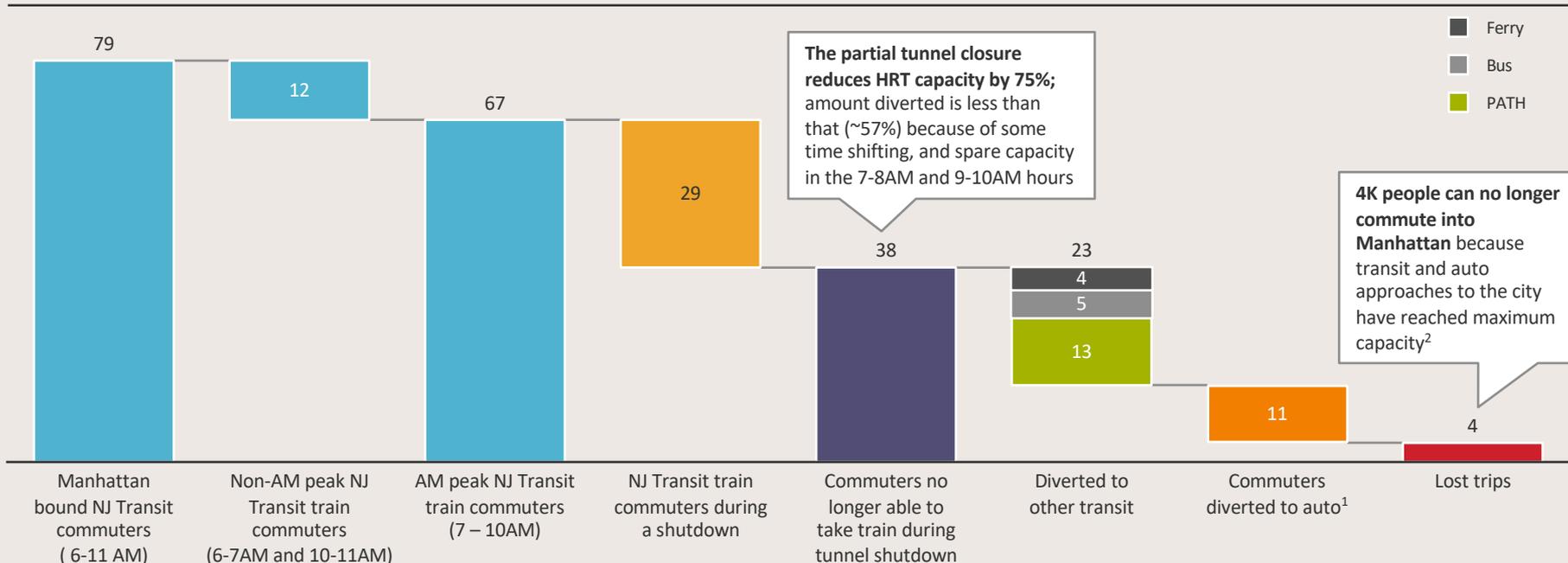
- A** Surface transportation (passenger)
- B** Surface transportation (freight)
- C** Air impact
- D** Safety impact
- E** Health impact
- F** Housing price impact
- G** Cumulative impact
  - Customer experience
  - Methodology and appendix

A

# Of the 67K peak NJT trans-Hudson train commuters, 38K will be diverted: 23K to other transit, 11K to auto, and 4K unable to make the trip

NJ Transit train commuters diverted to different modes of transportation due to the Hudson River Tunnel (HRT) shutdown,

Thousands of commuters



<sup>1</sup> Because of limited carpooling, this represents 10.1K additional Manhattan bound car trips; this equals the remaining peak capacity in the Lincoln and Holland tunnels, and 75% of the remaining George Washington Bridge capacity (remaining 25% of GWB capacity not handled because of inadequate access routes capacity)

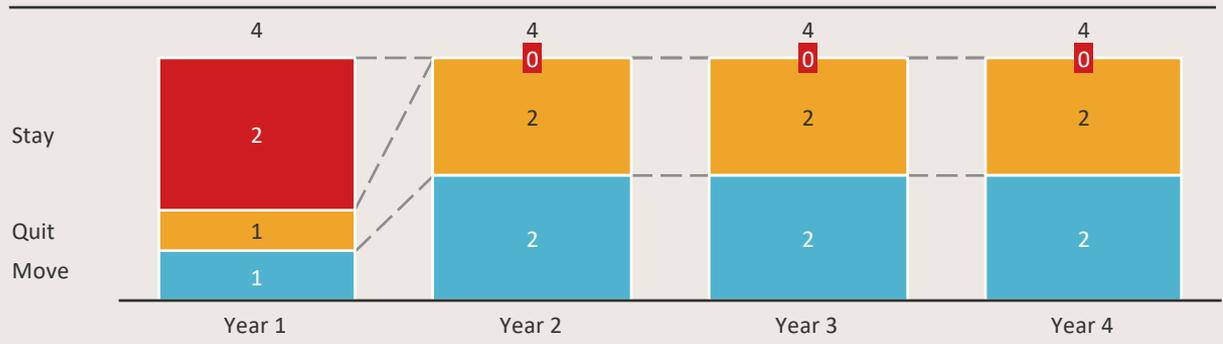
<sup>2</sup> Given assumptions about the propensity to time shift, and travel mode preferences; see appendix for details

A

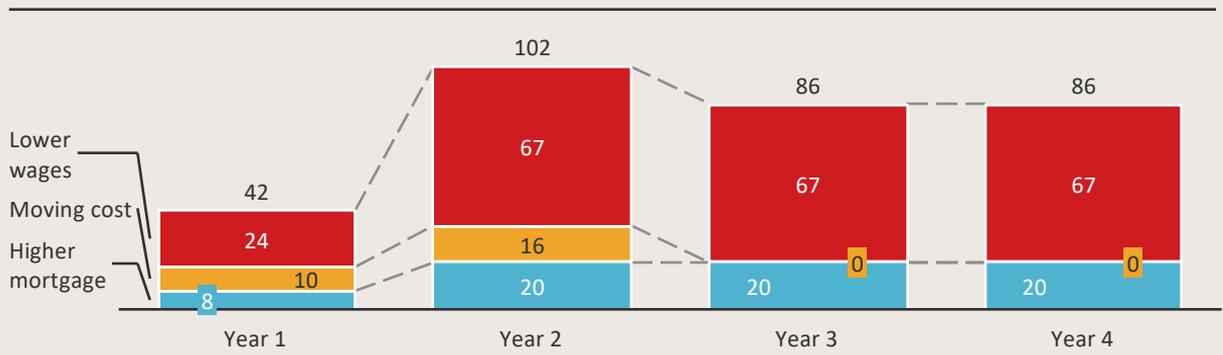
# 3.7K may eventually be forced to quit their jobs or move, since they are unable to get to Manhattan in the peak hour, costing ~\$316M over 4 yrs

Outcome of individuals who may no longer travel to NYC from NJ in each year

Thousands of commuters



Cost of those decisions, \$, Millions



- ~3.7K Manhattan bound commuters **unable to drive or take alternative transit** due to capacity constraints
- In first year of shutdown, estimate that:
  - ~60% would be able to make temporary arrangements to stay at current job (e.g., work from home, off-peak commute)
  - ~20% of commuters are likely to move to LI or Westchester
  - ~20% of commuters would quit current job and seek local work
- After year 1, likely infeasible for people to continue temporary arrangements, so **during year two, those who stayed in their jobs either have to quit or move**
- Quitters likely to see their wage rate drop** from Manhattan wage to New Jersey wage
- Movers may incur **one-time moving cost** of ~\$13K, and may also see an **additional annual increase in mortgage costs** given higher home values in LI and Westchester vs. NJ

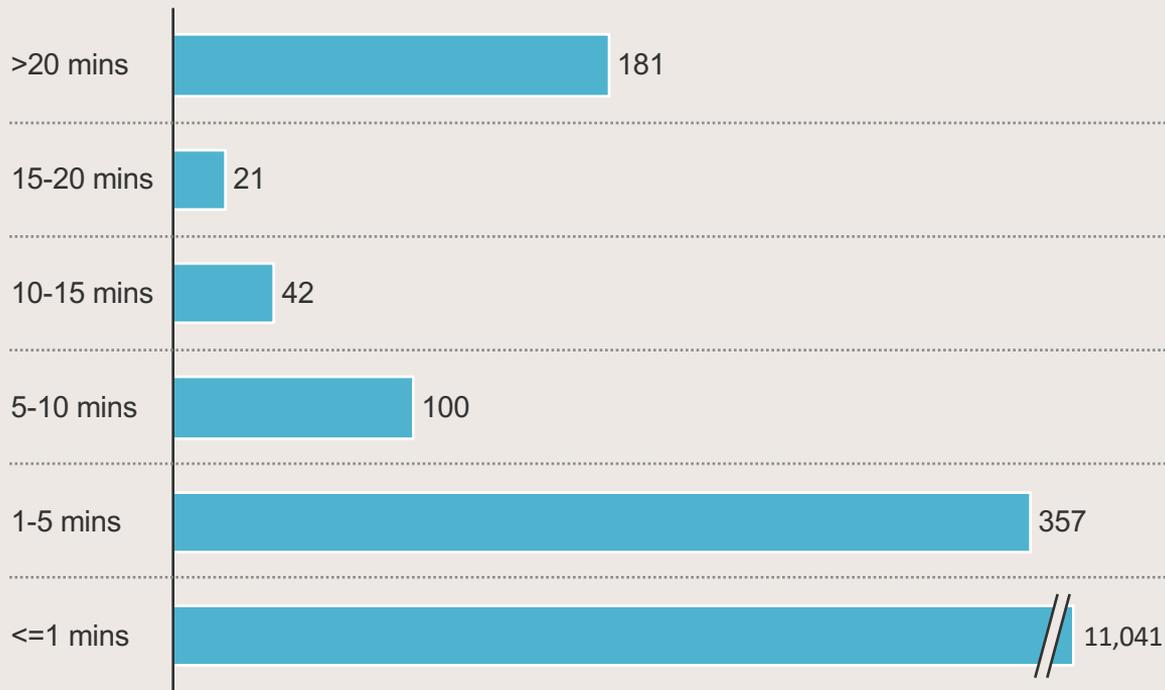
SOURCE: BLS, Worldwide ERC "The Substitution between Movers and Quitters" (Zax 1991), US Census

A

# Shifting just 11K commuters onto the roads is likely to increase the daily commutes of ~245K people by over 10 minutes

- The partial shutdown will likely force ~11K people to shift from rail to auto, in ~10K trips
- Travel times will increase for hundreds of thousands of commuters
  - ~181K increase by >20+ min
  - ~137K increase by >30+ min
  - ~112K increase by >45+ min
  - ~101K increase by over an hour
- These estimates do not include additional buffer time that people will need to incorporate into their trips to account for more variability in trip time
- Model also excludes impact on bus commuters

Number of commuters by minute increase in two-way commutes before and after a partial shutdown of the Hudson River Tunnel, Thousands of commuters



# Nearly half of the ~245K commuters whose trip times have increased by 10+ minutes, are headed to locations outside Manhattan

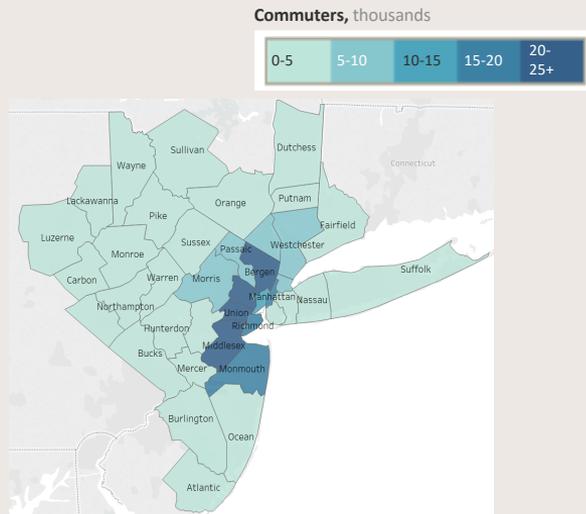
A

## Assumptions

- The shutdown does not just affect Manhattan-bound traffic – **only 52% of people** whose commute has increased by 10+ minutes are **traveling to Manhattan**
- **~35% of commuters** have **New Jersey** as their destination
- **~85% of commuters** traveling 10+ minutes are auto commuters, while **~15% are rail**

## Number of commuters with 10+ min increase in commutes after HRT shutdown, by origin

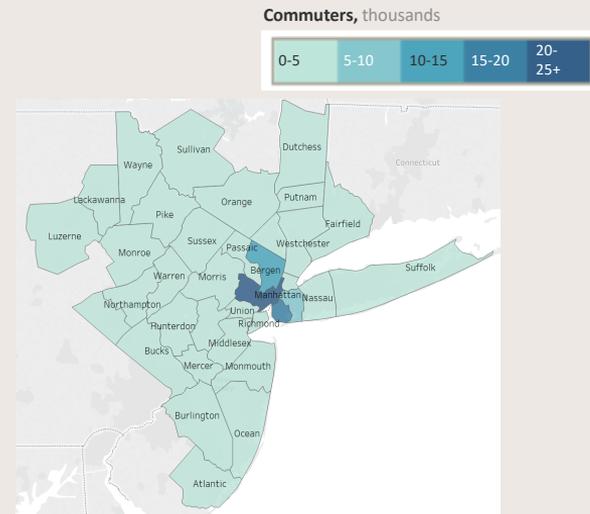
Thousands of commuters



## Percent of commuters from origin, by state



## Number of commuters with 10+ min increase in commutes after HRT shutdown, by destination, Thousands of commuters



## Percent of commuters by destination, by state



# Of the ~180K commuters whose trip times have increased by 20+ minutes, ~24% are traveling to New Jersey destinations

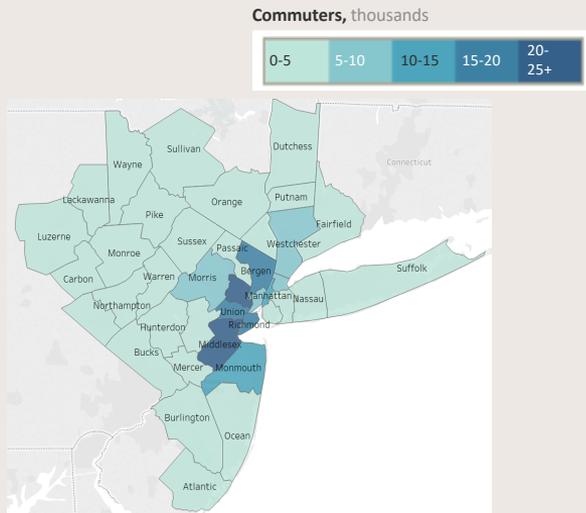
A

## Assumptions

- 76% of people with 20+ minute-added commutes are traveling to NYC
- Over 75% of people with 20+ minute-added commute originate in a ring of New Jersey counties around Manhattan
- ~89% of commuters now traveling an additional 20+ minutes are auto commuters, while ~11% are rail

## Number of commuters with 20+ min increase in commutes after HRT shutdown, by origin

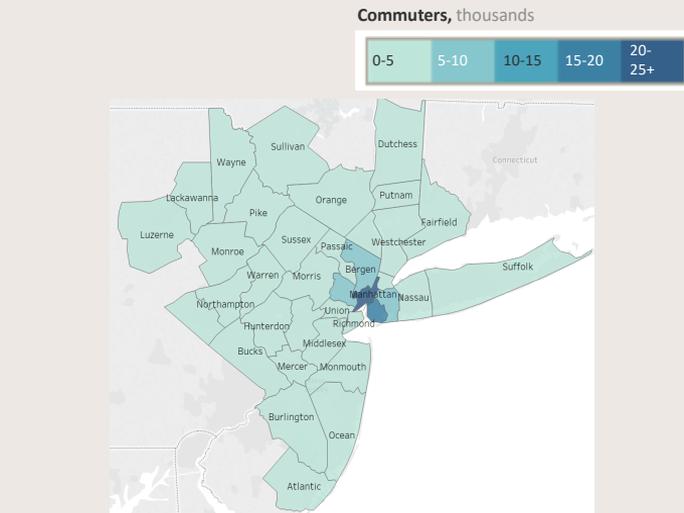
Thousands of commuters



## Percent of commuters from origin, by state



## Number of commuters with 20+ min increase in commutes after HRT shutdown, by destination, Thousands of commuters



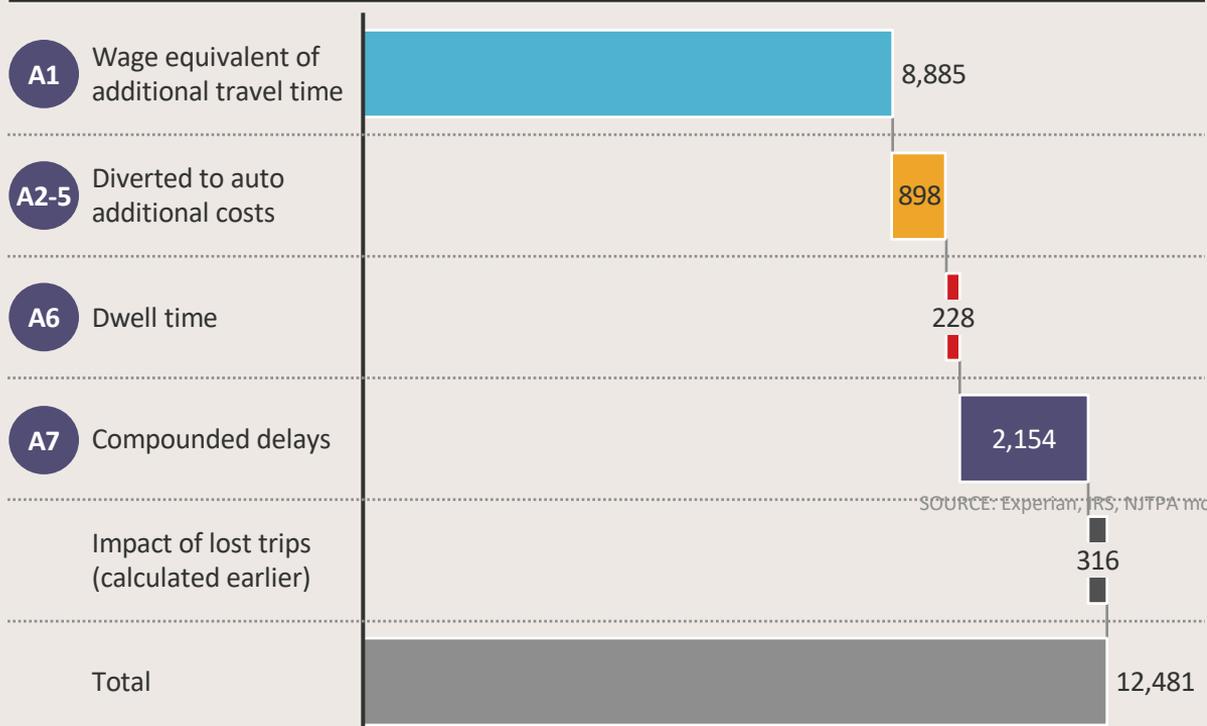
## Percent of commuters by destination, by state



A

# Increases in travel time likely to have surface transportation impact of up to ~\$13B: ~\$9B in lost wages, and nearly \$4B in other impacts

Total surface transportation economic costs, \$, Millions



SOURCE: Experian, IRS, NJTPA model

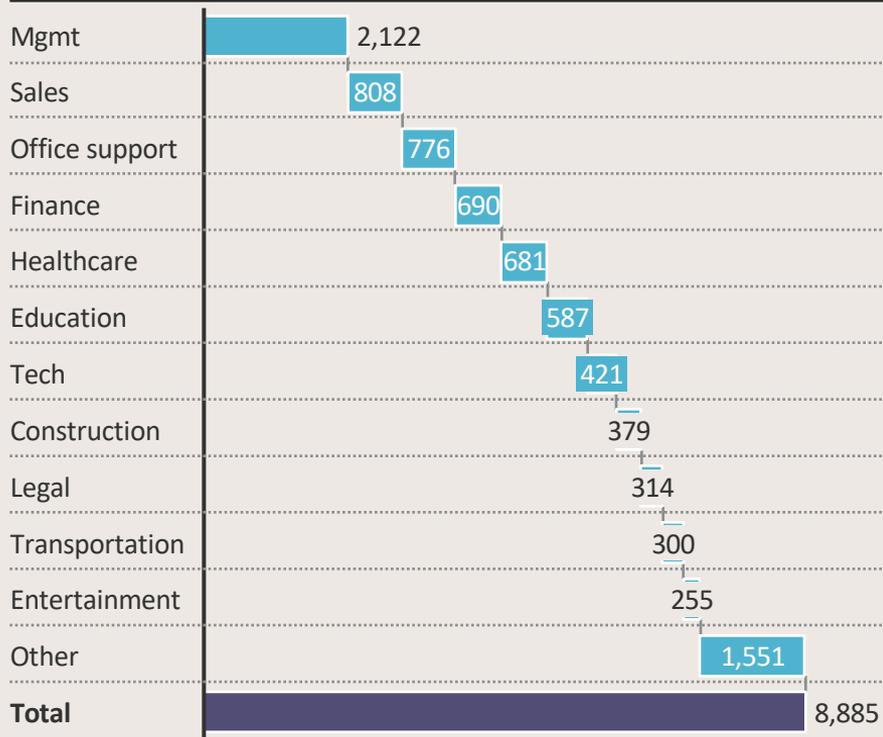
- The HRT shutdown may create **~272M additional hours of travel time over 4 years**
- This travel time is the equivalent of **~\$9B in lost wages** over 4 years <sup>1</sup>
- **~\$900M** is associated with the **commuters who are diverted from transit to auto**, (e.g. new parking and O&M costs)
- **Additional dwell time at PATH train stations** accounts for **~\$230M** of the cost
- **An increase in the impact of delays** due to weather or other service disruptions on roads and transit systems **cost ~\$2.2B over 4 years**

<sup>1</sup> The wage equivalent of commuting time is often assumed to be half the median wage. However, there is evidence that this substantially undervalues how commuters value time lost from delays (K.Chatterjee, et al, *The Commuting and Well-Being Study*, UWE Bristol, 2017). In this scenario in which the quality of the commute is substantially reduced, using the full wage as the equivalent is a conservative assumption.

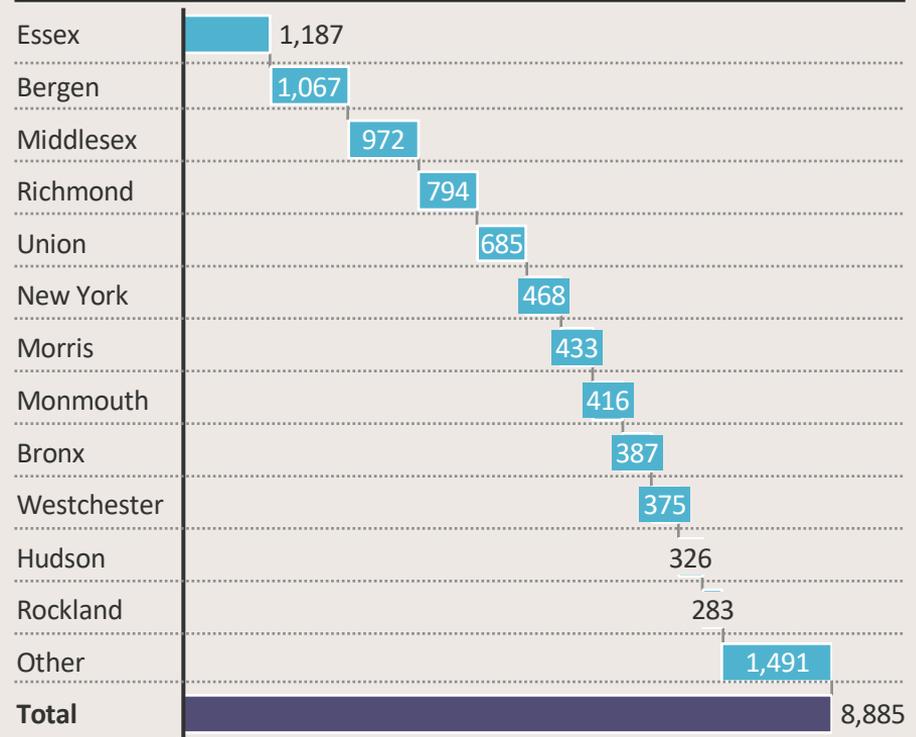
A1

# Increases in travel time equivalent to nearly \$8.9B in lost wages, spread out across service industries, but focused in NE NJ

Economic cost of additional commuting time by industry, \$, Millions



Economic cost of additional commuting time by geography (by origin), \$, Millions



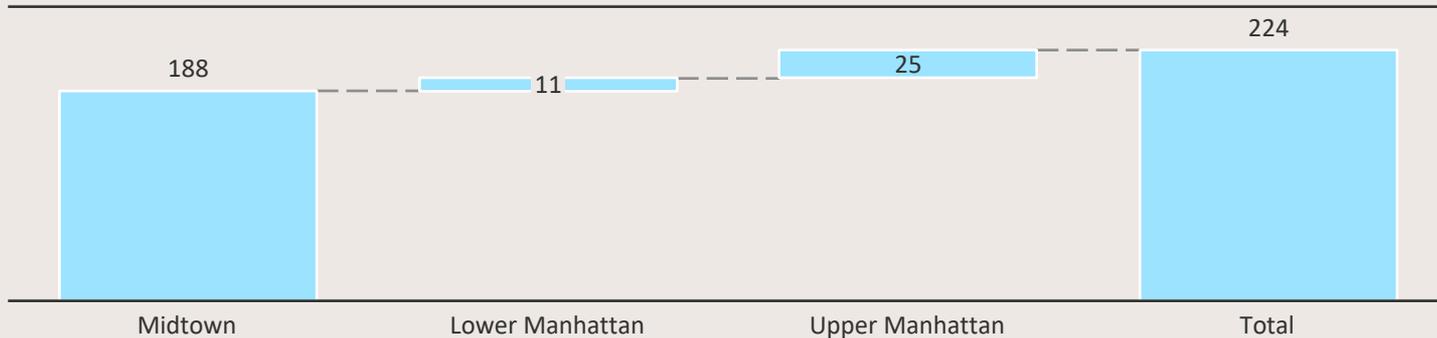
# In addition to wage impacts, the shutdown of the HRT may produce additional negative impacts on both transit and auto users

A

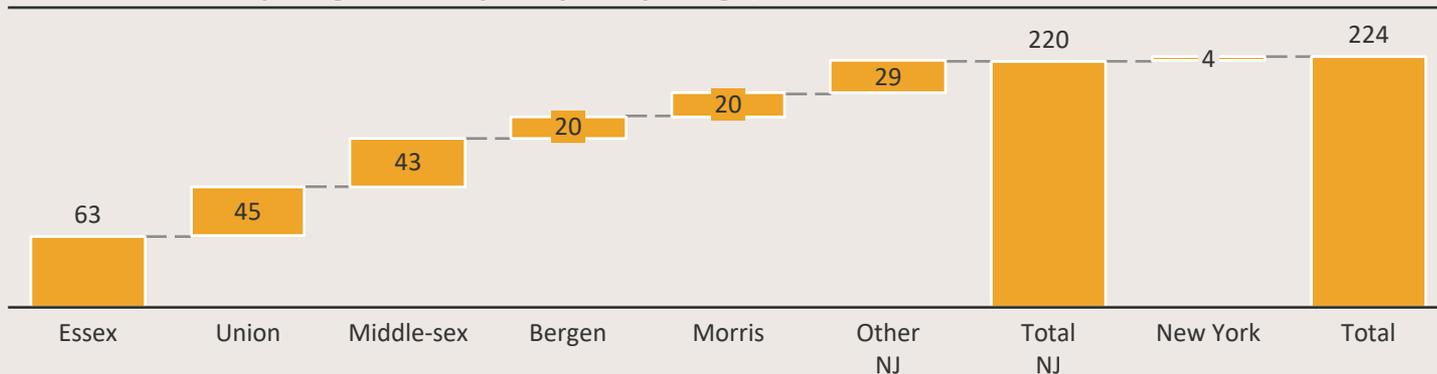
Impacts to explore		Description	4-year cost, \$, Millions
A2-5 Diverted to auto	A2 Parking	▪ Parking costs for transit riders diverted to automobiles	224
	A3 Driver time	▪ In-automobile time for transit riders diverted to automobile	325
	A4 Car O&M	▪ Fuel, depreciation cost for transit riders diverted to automobile	160
	A5 Car Ownership	▪ Cost to acquire car for 0-1 car households that formerly took transit and now diverted to automobile	189
A6 Transit users	Dwell time	▪ Additional time PATH trains held in station due to crowded conditions	228
A7 System-wide costs	Compounded delays		2,154
<b>Total additional impact</b>		▪ Additional delays that occur because of weather or other service disruptions	3,280

# Most commuters diverted to auto are travelling to Manhattan, and may incur a cumulative parking cost of nearly \$225M over 4 years

Additional parking cost over 4 years by destination, \$, Millions



Additional Manhattan parking cost over 4 years by county of origin, \$, Millions



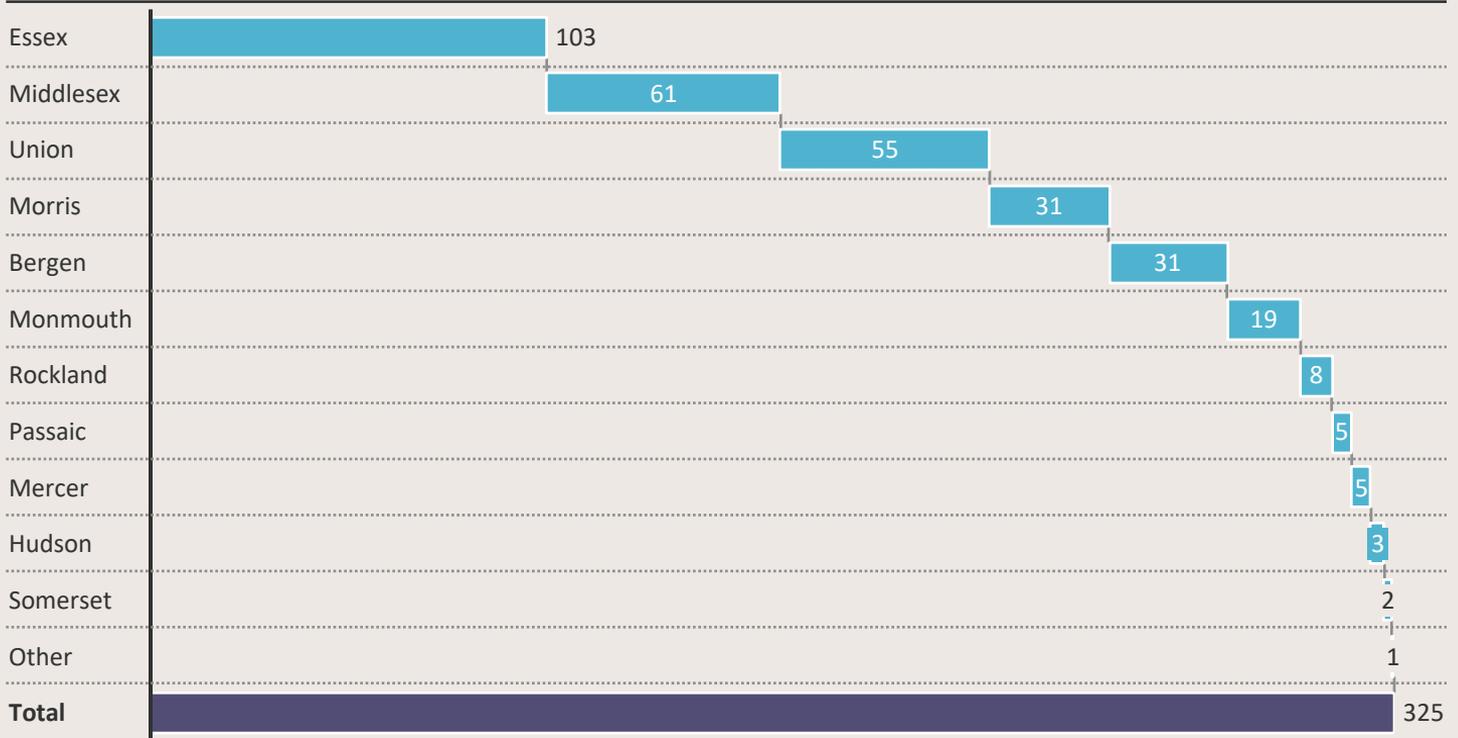
- **Estimate 11.3K** additional auto trips, **9.5K** of which are going to Manhattan
- **Average parking costs in NYC**
  - \$23/day in Midtown
  - \$34/day in lower Manhattan
  - \$24/day in upper Manhattan
- **Total of up to ~\$224M** in additional costs over 4 years, borne primarily by NJ commuters in Essex, Union and Middlesex counties

A3

# Former transit riders that will be diverted to auto may be penalized the equivalent of \$325M over 4 years

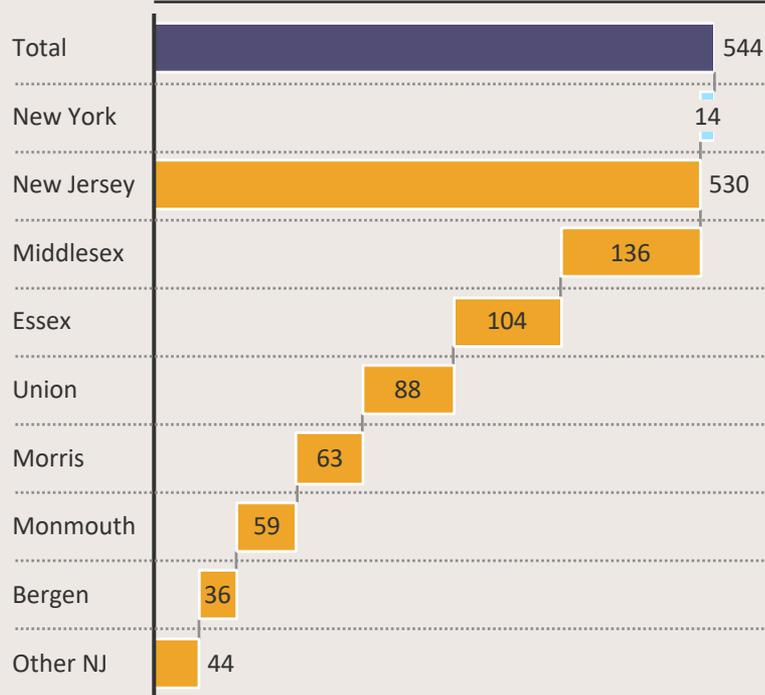
- Some drivers diverted from train to auto saw their trip time decrease, which registers as a benefit
- However, this is not a true benefit –these diverted drivers prefer to take these longer transit trips (e.g., to gain work, sleep time), through their behavior, they have demonstrated that they consider drive time to be a dis-benefit
- The cost of the drive for diverted trips is assumed to be the full annual wage rate by occupation for their new shorter commute

Economic annual cost of additional commuting time by county, \$, Millions

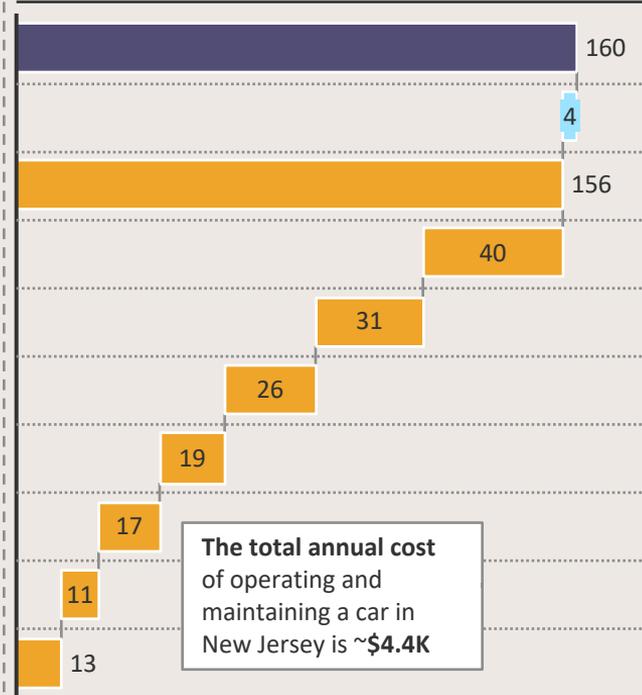


# 11.3K commuters diverted to 10.1K auto trips may collectively drive ~544K new miles daily, costing ~\$160M over 4 years

Number of daily driving miles traveled by diverted commuters, thousands of miles



Four year incremental cost of operating and maintaining car by county and state, \$, Millions



The total annual cost of operating and maintaining a car in New Jersey is ~\$4.4K

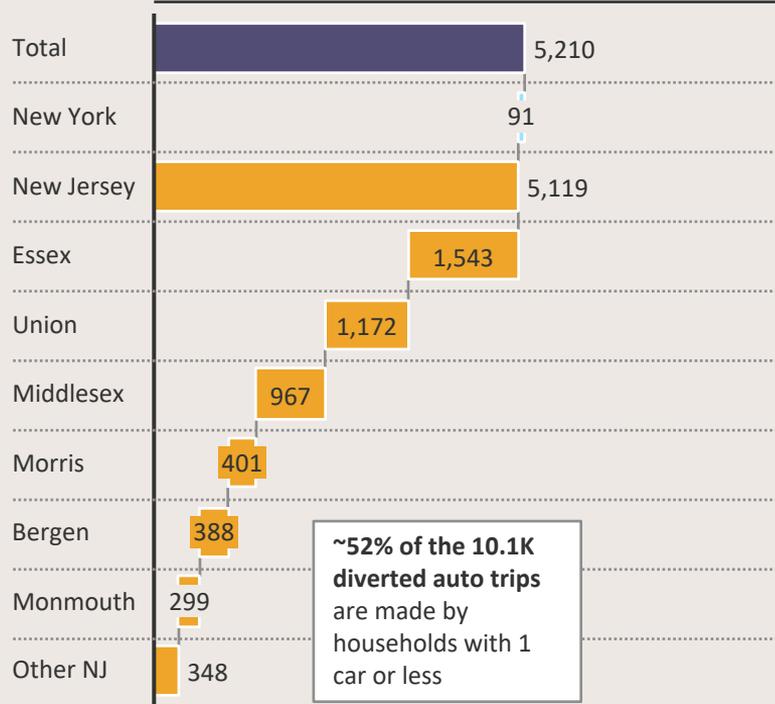
- Estimate 10.1K additional auto trips, collectively travel ~544K miles each day
- 29¢ average cost per mile<sup>1</sup> of operating and maintaining a car in New Jersey
- Over 4 years, 544K daily additional miles leads to nearly \$160M in extra car O&M costs, primarily borne by NJ commuters in Middlesex, Essex and Union counties

<sup>1</sup> Includes 17¢ gas cost per mile and 13¢ maintenance cost per mile

# Because over 50% of diverted commuters have 0-1 cars, ~5.2K commuters may have to purchase a car, costing ~\$190M over 4 years

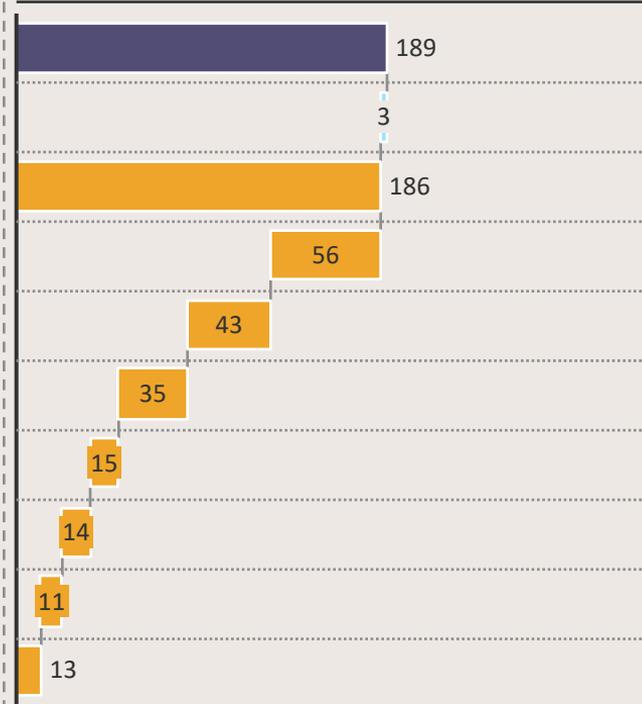
A5

Number of commuters with 0-1 cars who may have to purchase a car, people



~52% of the 10.1K diverted auto trips are made by households with 1 car or less

Cost of additional car ownership for up to 5.2K drivers who may have to purchase a car, \$, Millions



- 14% of 10.1K total diverted auto trips are made by people who do not have a car in their household, and 38% only have one car
- 1 car households now lack a car for daily errands, so 0-1 car households may have to purchase a car to allow for daily commuting
- ~\$9K annual fixed cost<sup>1</sup> of owning a car in New Jersey
- ~5.2K commuters may have to purchase a car, which could lead to ~\$190M in additional expenses over 4 years

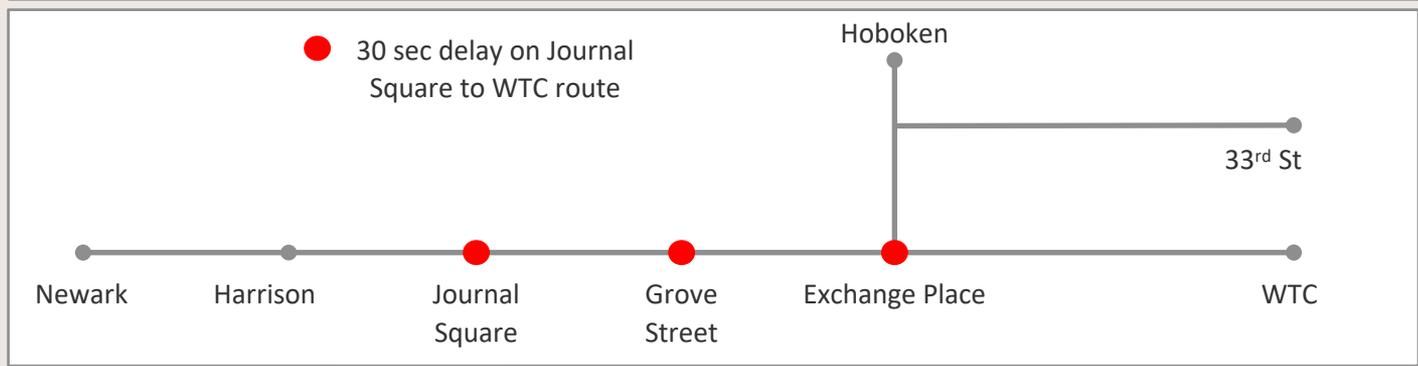
<sup>1</sup> Fixed costs (ownership costs) include insurance, license, registration, taxes, depreciation, and finance charges

A6

# For PATH riders, additional passengers may create congestion and increased dwell times, costing \$228M over 4 years

- 23K people diverted to transit and ~13K of them likely to take PATH
- These commuters are added to ~80K current weekday peak passengers on PATH
- Crowding on platforms leads to additional delay to board and de-board trains
- Given average PATH journey of ~4 stops, travel time increases estimated at \$228M in lost time over 4 years

## Example 90 second increase in dwell time from Journal Square to WTC



Estimate that dwell time in the peak period will **increase by ~30 seconds per stop** because of additional crowding, totaling **~6.7K additional daily hours** of commute times for a total of **~103K PATH commuters**. Dwell time is difficult to estimate, and a shorter dwell time would result in a smaller impact.

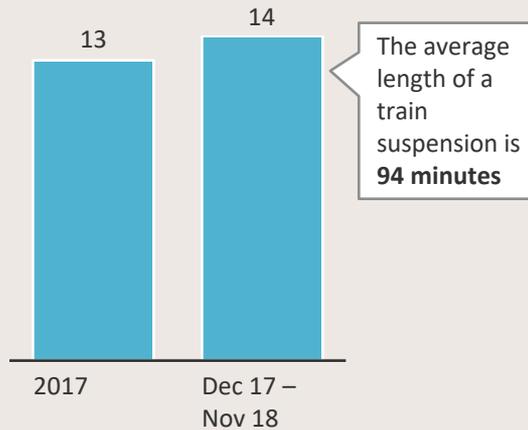
## Cost of PATH train dwell time over 4 years by state of origin, \$M



# Current service and weather disruptions increase congestion in the NYC metro area

## Public transit disruptions

Number of annual weekday peak PATH train suspensions



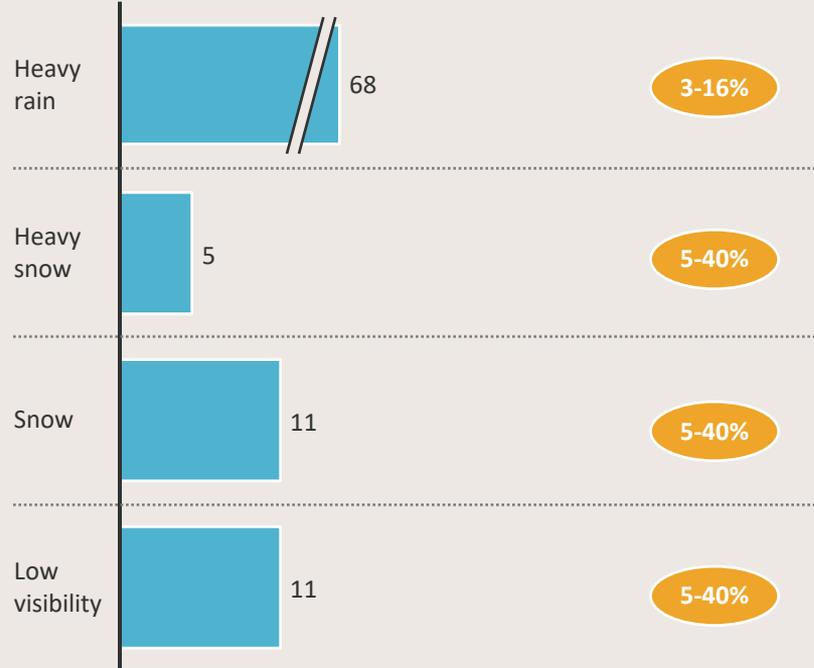
On-time performance of NJT buses, % of buses departing terminal within 6 minutes of schedule



## Total weather-related traffic disruptions

Number of weather incidents, Dec 17 - Nov 18

% reduction in road speed due to weather



- Because the roads more congested after the tunnel shutdown, assumed that the reduction in speed would be greater in the shutdown scenario compared to current state scenario
- Assumed average of 9% longer trips for each inclement weather day in the current state
- Assumed average of 14% longer trips for each inclement weather day in the tunnel shutdown scenario
- % reduction in speed translates directly to % increase in travel time

A7

# Service and weather disruptions could compound the impact of the shutdown, contributing up to ~\$2.2B worth of additional delays

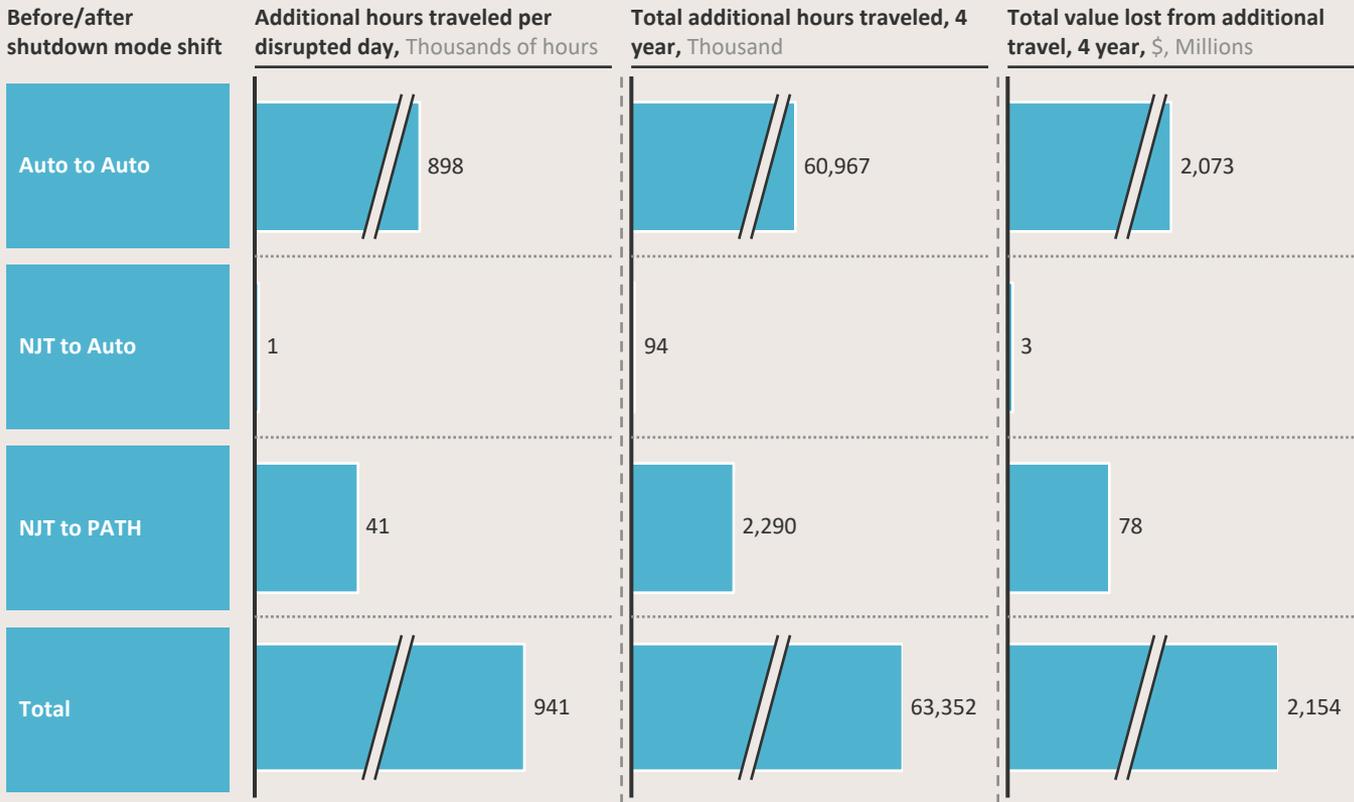
## Assumptions

### Auto trips

- The range of speed reductions for different weather instances ranges from ~5-40%, based on the type and frequency of weather in New York (e.g. delays for rain are less severe and more frequent)
- Assumed the lower third of the weighted average, 9% longer trips, for the status quo
- Assumed higher third of the weighted average, 14% longer trips, in the HRT shutdown scenario

### PATH

- 14 weekday peak shutdowns per year, lasting an average of 96 minutes, impacts riders diverted to PATH in a shutdown



SOURCE: PATH Twitter alerts, NJ Transit, National Weather Service, USDOT

# Contents

- Ⓐ Surface transportation (passenger)
- Ⓑ Surface transportation (freight)**
- Ⓒ Air impact
- Ⓓ Safety impact
- Ⓔ Health impact
- Ⓕ Housing price impact
- Ⓖ Cumulative impact
  - Customer experience
  - Methodology and appendix

# Trucks carrying \$450B worth of goods into the region

PRELIMINARY

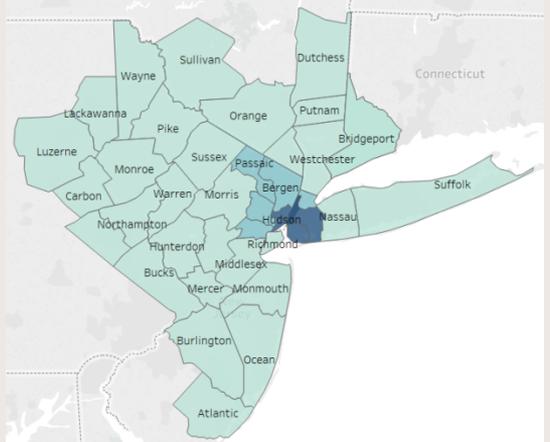
B

## may be delayed by 1.5%, suppressing regional demand and GDP by up to \$630M

**Regional trucks** make **147K trips** in the greater NY metro area; extra traffic may **delay them** by an aggregate 183K minutes, or **1.5%**<sup>1</sup>

### Truck traffic by destination county

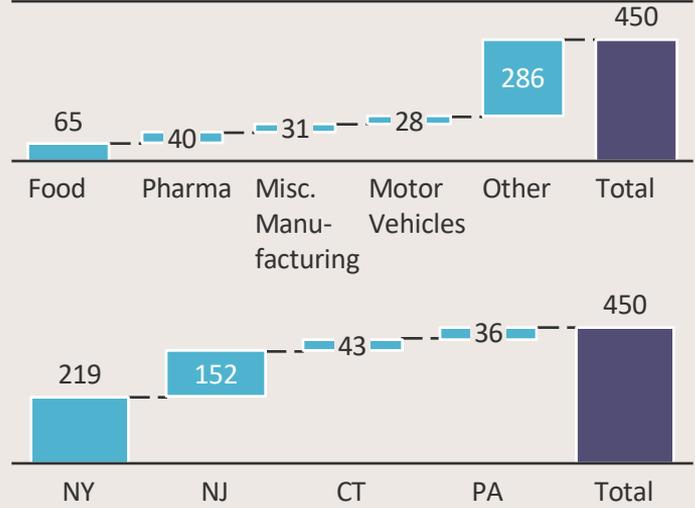
% increase in travel time



These trucks are **essential to the NYC economy** carrying **\$450B in goods**; this comprises nearly **90% of all freight traffic in the region**

### Value of inbound truck freight by commodity and destination

\$, Billions



- Increased delays raise the price of truck transportation
- This increase is fully passed on to other sectors, which lowers the demand and output of those sectors
- Estimate that net effect of lower output across sectors reduces total GDP by up to \$630M over 4 years, not including induced impacts<sup>2</sup>

<sup>1</sup> 1.5% is the regional aggregate increase in travel time based on the following increases for each sub-region (NY-1.8%, NJ-1.4%, CT-0.0%, PA-0.0%)

<sup>2</sup> The key element quantified is the extent to which industries buy fewer goods as a result of higher trucking prices

B

# Cost of supply chain disruption at NY/NJ port and airport facilities due to trucking congestion could add to costs of freight delays

		Daily economic cost of trucking delay at each facility due to shutdown, \$, Thousands	Travel Time Increase, %
Ports	Elizabeth	259	6.0%
	Port Jersey	92	7.4%
	Port Newark	96	6.9%
	Howland Hook	23	7.4%
	Red Hook	4	2.6%
	<b>Total Ports</b>	<b>474</b>	<b>4.6%</b>
Airports	Newark	60	2.8%
	JFK	8	0.6%
	La Guardia	0	0.7%
	<b>Total Airports</b>	<b>68</b>	<b>1.3%</b>
	<b>Total</b>	<b>542</b>	<b>3.0%</b>

## Key points:

- Delays driven by the fact that **truck congestion near ports/airports likely significantly 3X greater than the regional average**. Costs could be as high as \$542K per day, or \$540M over four years. This is an upper bound estimate due to limited data and number of assumptions required.

## Methodology:

- Port Authority estimates the costs of **closing ports** to be \$22M/day and cargo impacts from **closing airports** to be \$10M/day<sup>1</sup>
- Shutdown delays for truck traffic** were calculated in/out of port/airport TAZs, equivalent to 3.0% additional travel time
- Assuming 18 hr day at ports/airports, 6 hours at peak, 3.0% additional travel time across facilities is **equivalent to 23 min of shutdown a day at the ports and 7 min of shutdown a day at the airports**

<sup>1</sup> Key elements quantified are the costs of slowed ocean vessels, delayed containers, missed deadlines, and additional port staff time—costs are assumed to manifest as lost revenues for ports and airports

SOURCE: Based on PANYNJ data

# Contents

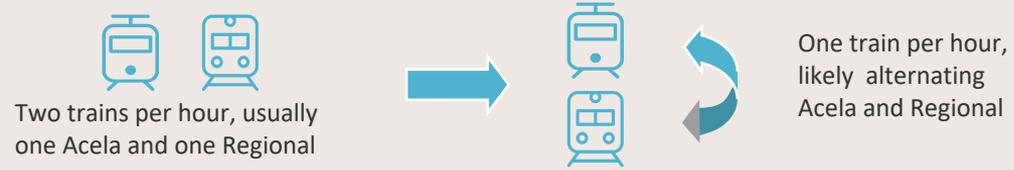
- Ⓐ Surface transportation (passenger)
- Ⓑ Surface transportation (freight)
- Ⓒ Air impact**
- Ⓓ Safety impact
- Ⓔ Health impact
- Ⓕ Housing price impact
- Ⓖ Cumulative impact
  - Customer experience
  - Methodology and appendix



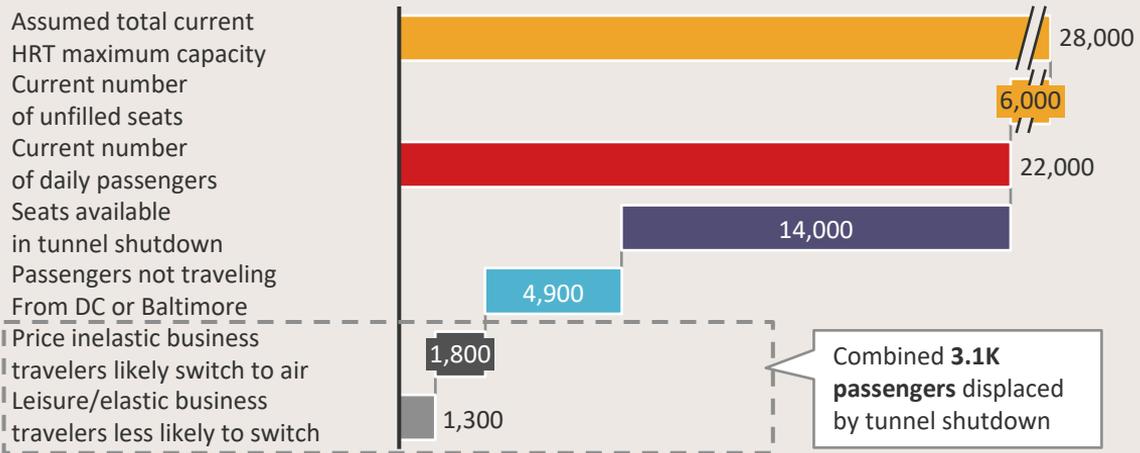
# With slot constraints, the amount of air travel supplied within the Northeast Corridor will not be able to meet rising demand...

Hudson River Tunnel shutdown may lead to ~3K daily passengers without DC/Baltimore to NYC train service...

Although NYP to BOS service unaffected, WAS to NYP is reduced



## Distribution of Amtrak passengers after tunnel shutdown



... but new travel options for them will likely be unavailable

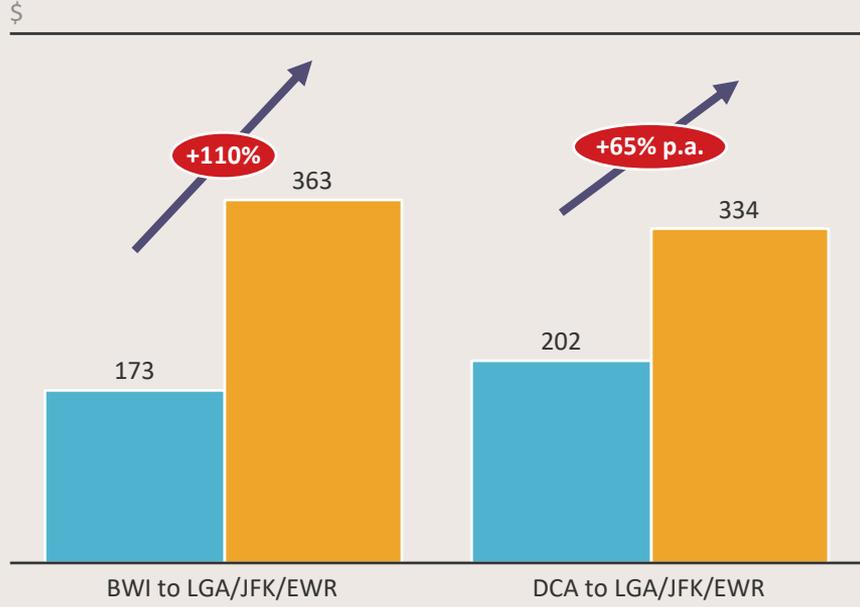
- Slot constraints at LGA, JFK, DCA mean those airports are not able to accommodate new flights
- This assumes airlines will not upgauge to larger planes. While this is possible, it could be costly and potentially disrupt airport operations elsewhere if number of planes is limited.
- Other options (e.g., bus, BWI→EWR flights) are undesirable due to high cost or significant increase in travel time to Manhattan
- Assumes that 90-95% of passengers in the peak are likely to switch to air due to the lack of viability of other options (e.g., bus, driving), while only 30-50% of passengers in the off-peak are likely to switch to air, when driving becomes more palatable

SOURCE: RPA, "Crossing the Hudson" (2017), Amtrak

# ...potentially increasing air fares for consumers by as much as 65% between DC and NYC and pricing out leisure and cost-conscious travelers

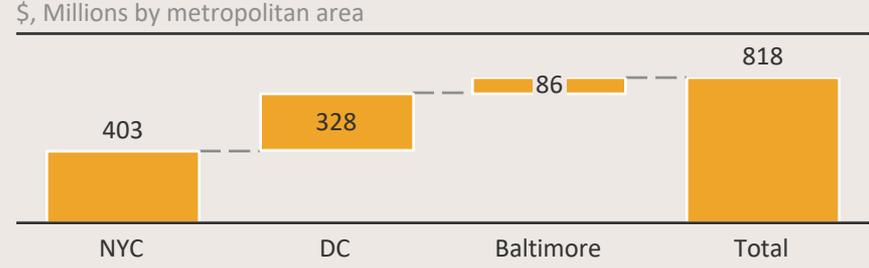
Increasing demand in the face of stagnant supply may raise prices, imposing costs to consumers...

Average plane ticket price before and after shutdown

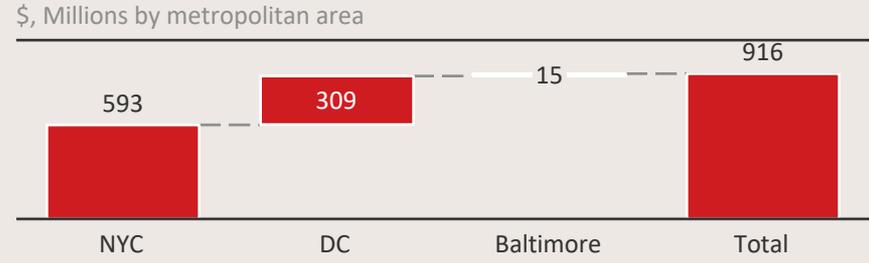


...and the nation likely to incur economic costs from avoided travel as well

Total additional 4 year plane ticket cost for all passengers



Total 4 year lost revenue from tourism from avoided leisure travel<sup>1</sup>



<sup>1</sup> Assumes all displaced leisure passengers choose not to take the trip (i.e. they do not take a bus or use another mode of transportation to take the trip), it does not take business travelers any longer to get to their destination if they choose to fly (no productivity time impact)

SOURCE: RPA "Upgrading to World Class" (2018), BTS T100, Diio Performance Tool, FAA OTP, OAG, "Air travel demand elasticities – Concepts, issues and measurement," Gillen, Morrison & Rietveld (2003), PANYNJ, MWCOG, VisitBaltimore, NYCGo, DestinationDC



# The negative impacts associated with air travel likely to be felt throughout the Northeast Corridor

## Total 4 year impact of HRT shutdown on air travel by state, \$, Millions



<sup>1</sup> Assumes all displaced leisure passengers choose not to take the trip (i.e. they do not take a bus or use another mode of transportation to take the trip), it does not take business travelers any longer to get to their destination if they choose to fly (no productivity time impact)

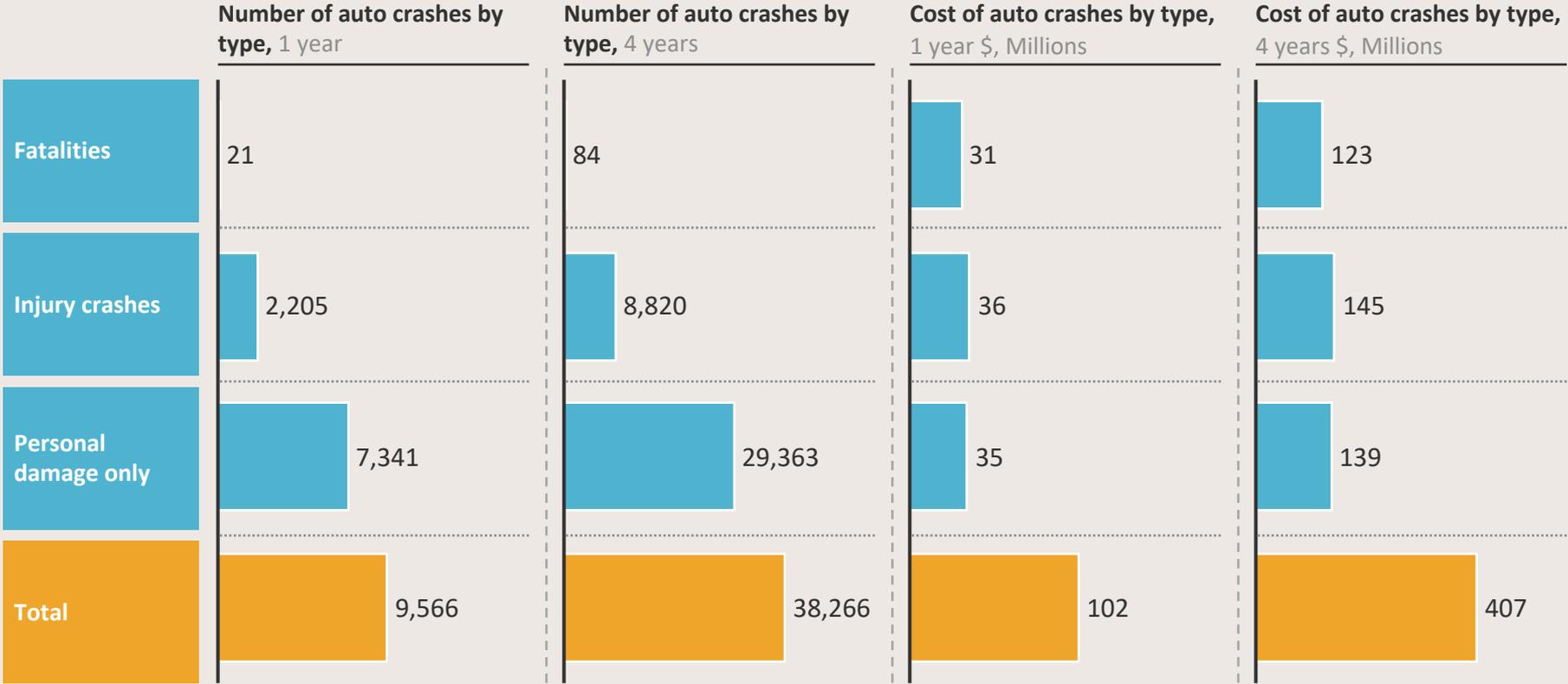
SOURCE: RPA "Upgrading to World Class" (2018), BTS T100, Diio Performance Tool, FAA OTP, OAG, "Air travel demand elasticities – Concepts, issues and measurement," Gillen, Morrison & Rietveld (2003), PANYNJ, MWCOG, VisitBaltimore, NYCGo, DestinationDC

# Contents

- Ⓐ Surface transportation (passenger)
- Ⓑ Surface transportation (freight)
- Ⓒ Air impact
- Ⓓ Safety impact**
- Ⓔ Health impact
- Ⓕ Housing price impact
- Ⓖ Cumulative impact
  - Customer experience
  - Methodology and appendix

D

# During the 4-year shutdown, ~9K additional crashes could occur, including 84 fatalities, costing ~\$400M, as a result of additional driving



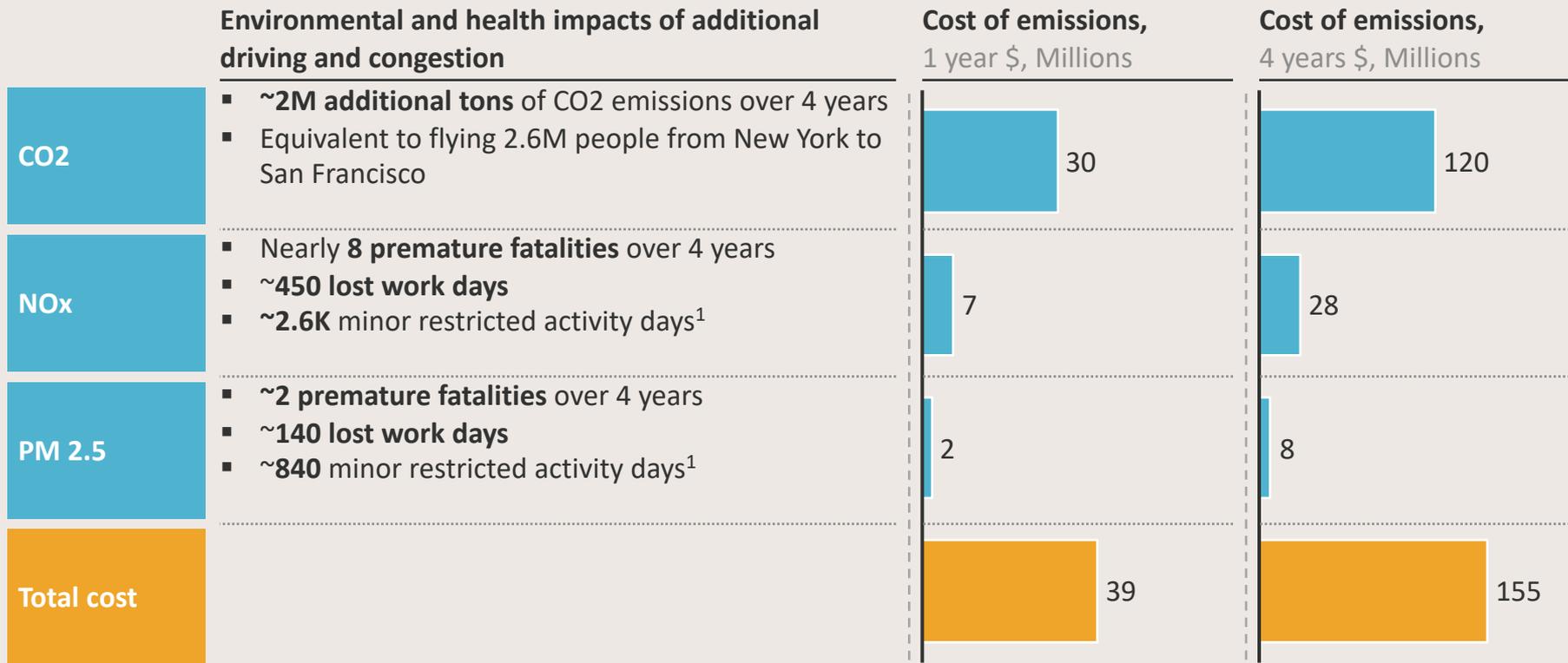
SOURCE: US DOT Fatality Analysis Reporting System, New Jersey DOT, National Safety Council, CDC

# Contents

- Ⓐ Surface transportation (passenger)
- Ⓑ Surface transportation (freight)
- Ⓒ Air impact
- Ⓓ Safety impact
- Ⓔ Health impact**
- Ⓕ Housing price impact
- Ⓖ Cumulative impact
  - Customer experience
  - Methodology and appendix

E

# Additional pollutant emissions due to additional driving and congestion may cost \$155M and cause ~10 premature fatalities over 4 years



<sup>1</sup> Minor restricted activity days (MRADs) occur when individuals reduce most usual daily activities and replace them with less strenuous activities or rest but do not miss work or school

SOURCE: EPA, Environmental Defense Fund, US DOT, NHTSA

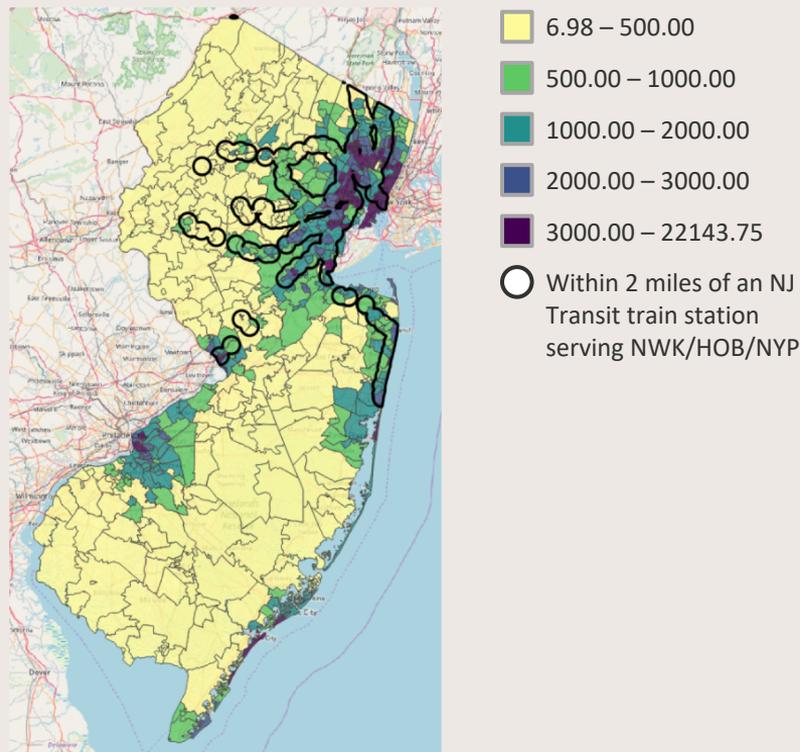
# Contents

- Ⓐ Surface transportation (passenger)
- Ⓑ Surface transportation (freight)
- Ⓒ Air impact
- Ⓓ Safety impact
- Ⓔ Health impact
- Ⓕ Housing price impact**
- Ⓖ Induced impact
  - Customer experience
  - Methodology and appendix

F

# Despite serving a small share of NJ's area, NJ Transit stations affected by the shut down are within 2 miles of over 40% of NJ's home value

Housing unit density by zip code in NJ, Housing units per square mile

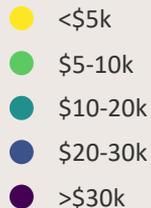
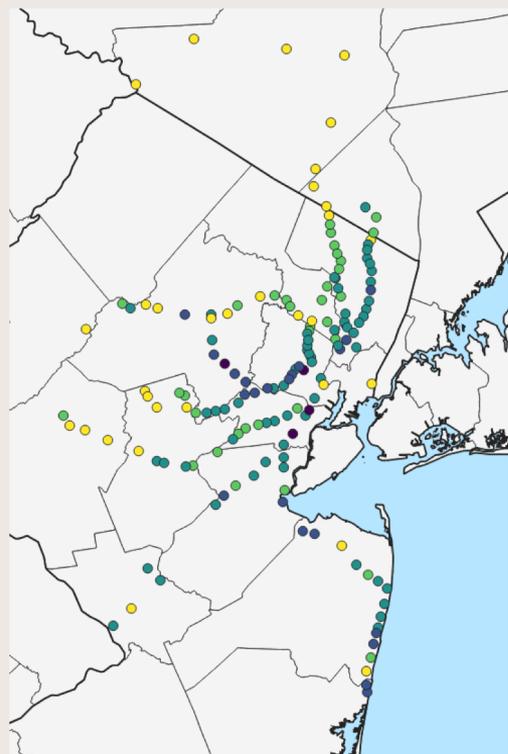


- NJ Transit stations serving New York Penn, Newark Penn and Hoboken, are **clustered in the densest, and wealthiest parts of the state**
- So **despite covering a relatively small area of the state**, of the \$846B in home value in NJ, **~40%, or \$346B, are in areas that are within two miles of an impacted NJ Transit train station**
- These stations currently serve as an amenity, **bolstering property values** in the areas close to the stations
- A partial shut down would degrade the quality of service, **negatively impacting property values around those stations**

F

# These home values could be reduced by up to \$22B in areas close to train stations, due to the increase in travel times from those stations

Average home value reduction by station, \$



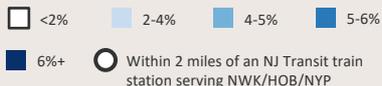
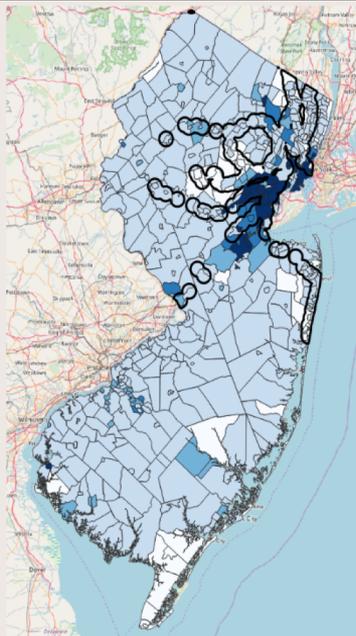
- Combined, cumulative loss in home value could be up to **\$22B**, for homes within 2 miles of NJ Transit train stations
- The average home could lose **\$13,600** in value, due to a reduction of about **\$800 - \$2,600** per additional minute of commuting time, with homes closer to the station more impacted by increases in commuting time
- This loss equals ~6% of home value in affected station areas, and 2.5% of all home value in NJ

# Dip in home values could lead to \$4.6B loss in property tax revenue over 4 years, or 1.2% of state and local tax revenue

F

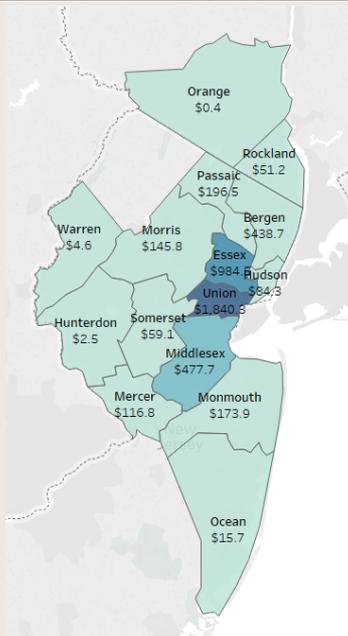
## NJ municipalities by property tax rate

Tax rate percentage



## 4-yr lost property tax revenues

\$, Millions



- \$22B dip in home values is expected to generate **\$4.6B loss in tax revenue** over 4 years, 99% of which is in NJ
- Impact amplified by the fact that **affected areas** have some of **highest property tax rates in the state**
- NJ revenue loss is **1.2% of 4-year total state and local taxes** and **4.1% of 4-year property taxes**, using 2015 revenues
- Pain will be acute in New Jersey as it is the **#2 state most reliant on property taxes** (29% of state and local tax revenue)
- Losses are expected to have the **greatest impact on local services** (e.g., public schools, fire departments) as property taxes account for a significant portion of budgets for school districts, counties, municipalities, and townships

# Contents

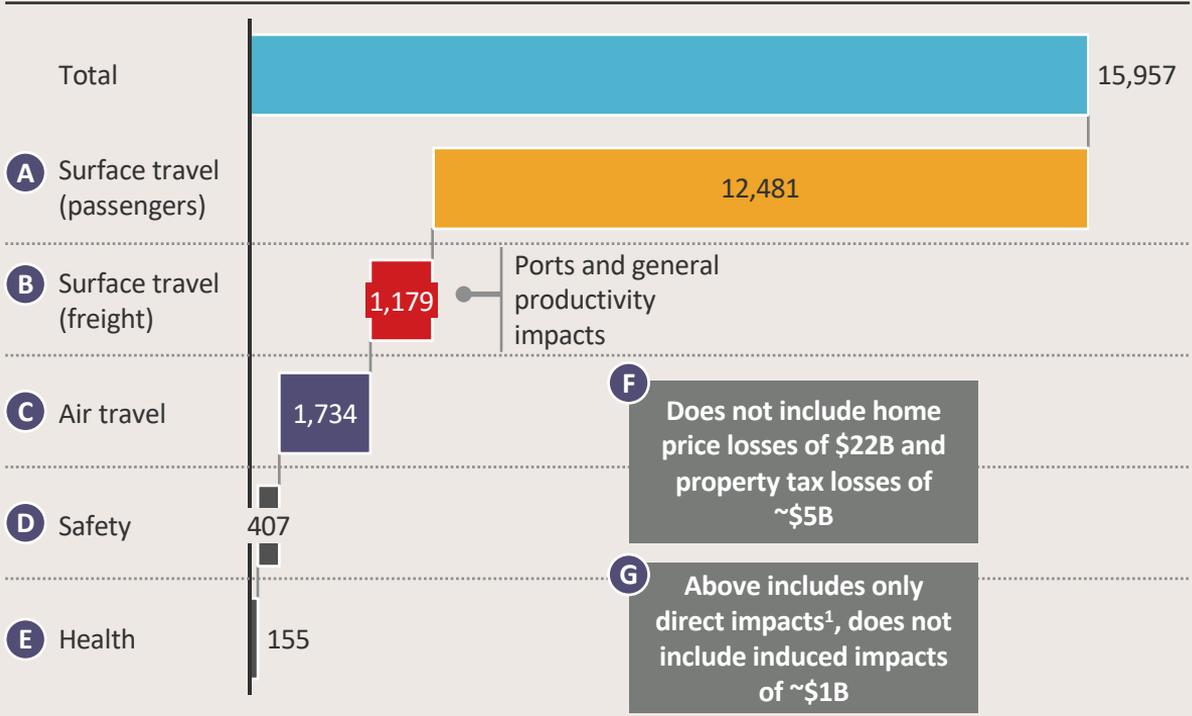
- Ⓐ Surface transportation (passenger)
- Ⓑ Surface transportation (freight)
- Ⓒ Air impact
- Ⓓ Safety impact
- Ⓔ Health impact
- Ⓕ Housing price impact
- Ⓖ Cumulative impact**
  - Customer experience
  - Methodology and appendix



# Cumulative impacts would cost the US ~\$16B over four years, not including induced impacts, reduced real estate values, and several difficult to quantify costs

## Four year costs of partial tunnel shutdown

\$, Millions

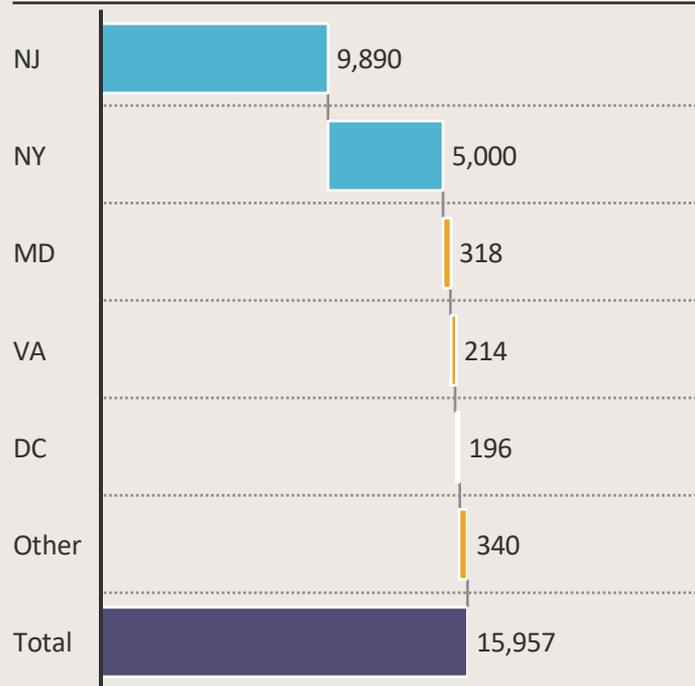


- Four year impacts of nearly \$16B, not including \$22B in lost housing value
  - Includes \$8.9B in lost wages over 4 years, equivalent to a loss of 33K jobs per year
- Equals a lost state, local and federal tax impact of ~\$2B, or ~\$7B including property tax losses
- 245K commuters will see their commutes increase over 10 minutes, primarily drivers headed to NYC or NE NJ destinations
- Extra travel time causes 9K additional accidents, resulting in 80-90 additional deaths
- Additional driving leads to an increase in pollution resulting in 450 lost work days and 5-10 additional deaths

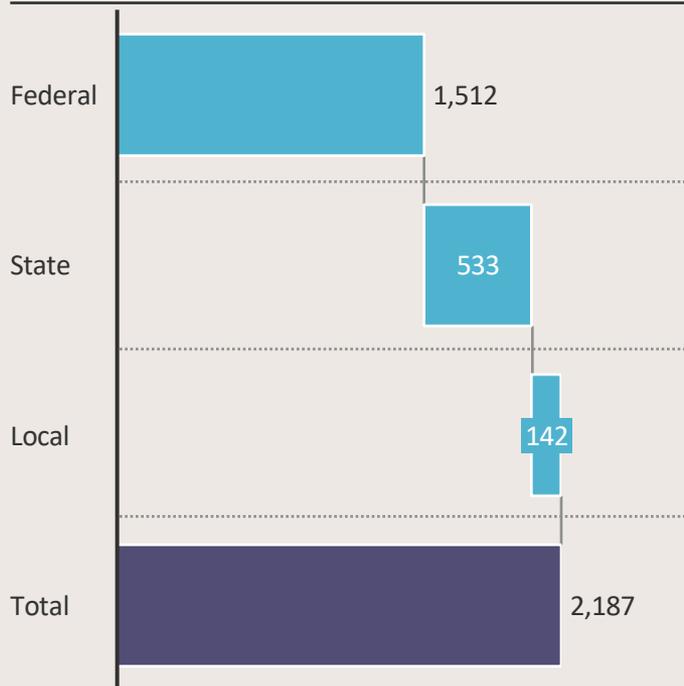
<sup>1</sup> With the exception of non-port freight impacts where indirect impacts are also considered

# Direct impacts would be greatest in New Jersey & New York, but would reverberate throughout the Northeast; Largest tax loss would be Federal revenue

Four year costs of partial tunnel shutdown by state, \$, Millions



Four year, non-property tax, revenue losses<sup>1</sup>, \$, Millions



- Most direct impacts likely focused in NJ or NY
- \$1.1B likely spread throughout the Northeast Corridor
- Potential of impacts to reverberate nationally: \$1.5B in lost federal tax revenue even when solely looking at impact of lost travel time

<sup>1</sup> Calculates lost taxes on travel time wage impact (and diversion penalty travel time impact) only

<sup>2</sup> With the exception of non-port freight impacts where indirect impacts are also considered



# Induced impacts can only be calculated for freight and lost tourism revenue, because other impacts do not lend themselves to calculation

	Impacts	Reason for calculating induced impacts or not
Surface transportation - passenger	▪ Wage equivalent of additional travel time	✗ Wage equivalent of time, is a valuation of time, not a real loss of cash flows because no real wages are lost
	▪ Diverted to auto additional costs	✗ Auto costs (e.g. car O&M) transfer spend in-region, with no significant expected net effect
	▪ Dwell time	✗ Calculated based on wage equivalent of time
	▪ Compounded delays	✗ Calculated based on wage equivalent of time
Freight	▪ Impact of lost trips	✗ Lost trip costs transfer spend in-region, with no significant net effect
	▪ Freight GDP impact	✓ Creates real economic losses for businesses
	▪ Freight port impact	✓ Creates real economic losses for businesses
Health and safety	▪ Health impact	✗ Health impact equivalent does not affect cash flows
	▪ Safety impact	✗ Safety impact equivalent does not affect cash flows
Air	▪ Lost tourism impact	✓ Creates real economic losses for affected geographies
	▪ Increased ticket cost impact	✗ Increased ticket costs transfer spend in-region, with no significant net effect



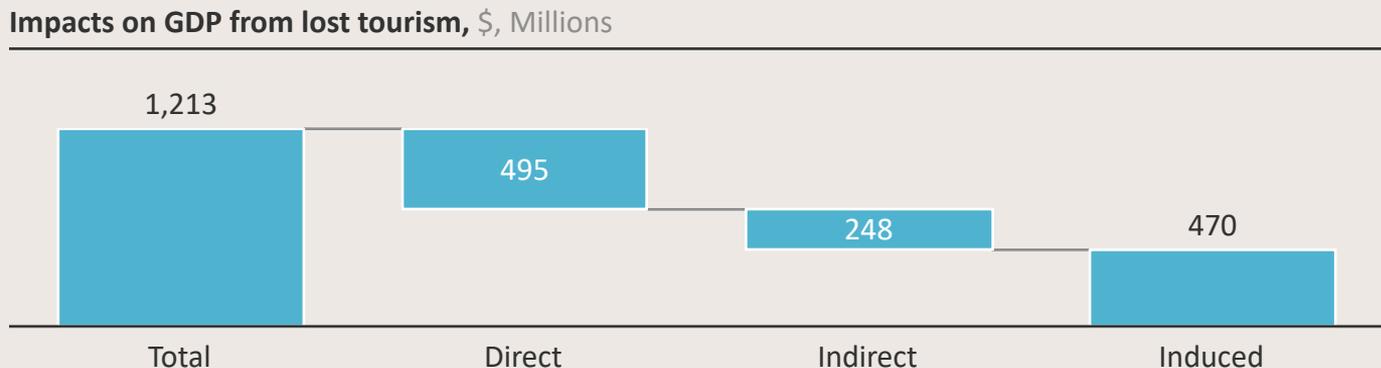
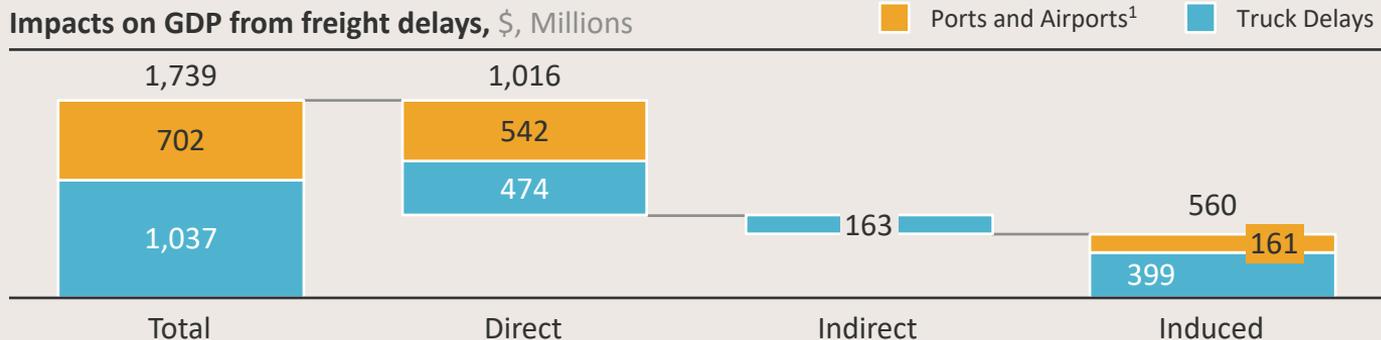
# Induced economic impacts from freight delays and lost tourism may dampen GDP by \$560M and \$470M, respectively for a total of ~\$1B

## Freight delays

- Over 4 years, freight delays directly translate to ~\$1B drop in GDP<sup>2</sup>; impacts on the supply chain and induced impacts increase the GDP loss to ~\$1.7B

## Lost tourism

- Because tourism generates economic activity, the \$916M revenue loss in leisure air travel due to the shutdown is estimated to yield a drop in GDP of \$1.2B from all effects on tourism spend



<sup>1</sup> Induced impacts are based on the assumption that economic costs manifest as lost shipping revenues to ports and airports because of delayed operations

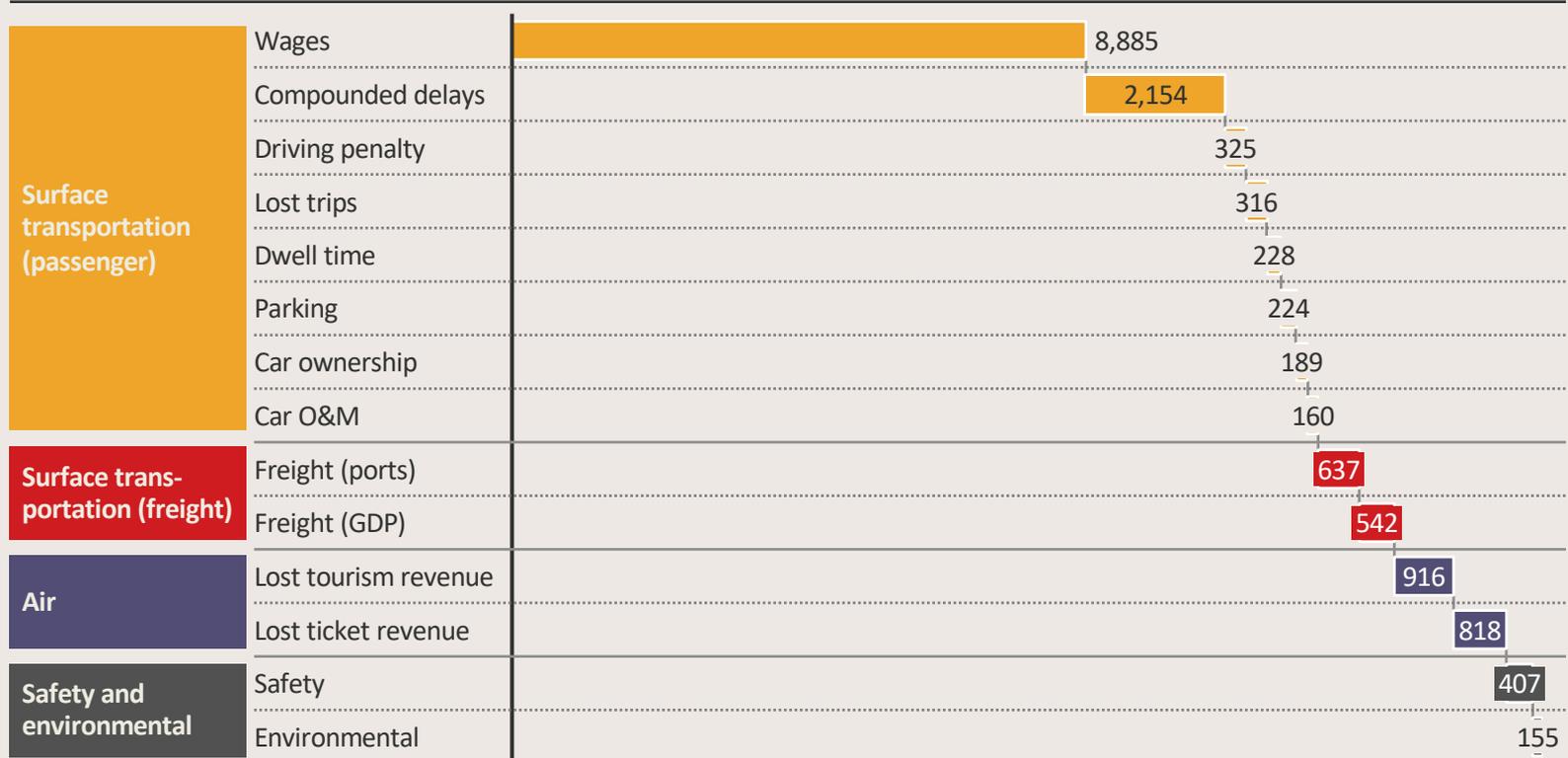
<sup>2</sup> Note that we calculate impacts on GDP from lost revenue which is higher than GDP since revenues = GDP + purchased inputs

SOURCE: EMSI multipliers applied to team estimates for lost output



# Nearly two-thirds of the impact likely on wages and compounded delays, with all other sub-components representing 6% or less of the total

Four year impact of economic shutdown, \$, Millions



# Contents

- Ⓐ Surface transportation (passenger)
- Ⓑ Surface transportation (freight)
- Ⓒ Air impact
- Ⓓ Safety impact
- Ⓔ Health impact
- Ⓕ Housing price impact
- Ⓖ Cumulative impact
- **Customer experience**
- Methodology and appendix

# A partial tunnel shutdown may cripple the region, but ~140K people are impacted the most harshly; these are representative examples

Name <sup>1</sup>	About them	Major impacts of the shutdown
	<p><b>“Diana”</b></p> <ul style="list-style-type: none"> <li>Executive Assistant who commutes daily from Oradell, NJ to Manhattan</li> <li>~11K people like Clara diverted from train to car</li> </ul>	<ul style="list-style-type: none"> <li>Forced to switch from train to car, increasing commute time by up to 100 mins per day</li> <li>Spends \$73 more per day on driving than train</li> <li>Family forced to get a second car</li> </ul>
	<p><b>“David”</b></p> <ul style="list-style-type: none"> <li>Owner of a trucking company near Allentown, PA that serves customers in NY/NJ</li> <li>4,500 truck trips delayed by 30+ mins</li> </ul>	<ul style="list-style-type: none"> <li>Has difficulty planning and delivering on-time</li> <li>Extra fuel and labor costs force price increases, loses customers and business</li> </ul>
	<p><b>“Lailah”</b></p> <ul style="list-style-type: none"> <li>Teacher from Hazlet, NJ who drives to school in Englewood, NJ</li> <li>~100K have 60+ minutes added to their commute</li> </ul>	<ul style="list-style-type: none"> <li>Commute time increases by up to 90 mins/day</li> <li>Returns late to home responsibilities, incurs additional child/elder care expenses</li> <li>Late for school, puts job at risk</li> </ul>
	<p><b>“Jerome”</b></p> <ul style="list-style-type: none"> <li>Non-profit Director who regularly travels from DC to NY on Amtrak</li> <li>1,300 people like Jerome may be priced out of train/air options and forced to take the bus</li> </ul>	<ul style="list-style-type: none"> <li>4+ additional hours roundtrip between NY/DC</li> <li>Can no longer work effectively during journey</li> <li>Departure and return times are outside son’s daycare drop-off and bedtime hours</li> </ul>
	<p><b>“Shayna”</b></p> <ul style="list-style-type: none"> <li>HR Manager who oversees 400+ shift workers who take transit to job sites</li> <li>3,200 companies like Shayna’s impacted</li> </ul>	<ul style="list-style-type: none"> <li>Spends an extra 17+ hours per week on additional administrative work</li> <li>Disappoints customers when workers are late or absent, loses key clients</li> </ul>

<sup>1</sup> Not real people, but narrative examples of the impacts of the shut down



# Meet Diana

**Location** Oradell, NJ

**Occupation** Executive Assistant

**Income** \$68K/yr

**Transit** To work via train

**Age** 51 years old

**Transportation mode: NJ Transit**



## Current journey

Diana is a working mother who travels to New York City every day to work as an Executive Assistant at an insurance company. She's extremely detail oriented and committed to being on-time both to work and getting back home to her family. Currently, from her home in Oradell she takes a quick walk to the train station and then departs at New York Penn Station which is walking distance from her office.

## Who Diana Represents

- **90 people** who take transit during peak hours from Oradell, NJ to the Herald Square area
- **15 people** who would be diverted to cars on this particular route, part of the **11,000** who would be diverted to cars in total by the shutdown
- Each diverted person on this route could be delayed up to **100 minutes** roundtrip each day, totaling **95 hours** for all diverted commuters

## What Might Happen

- Diana needs to show up before her boss arrives, and as a result **has to travel during the peak**, or wake up unreasonably early and waste morning hours in the office
- Shutdown service reductions on NJ Transit force Diana to **shift to car**. The family is forced to **buy a new car, a \$13.5K/yr expense**. Diana's total daily commuting **expenses increase by \$73 per day** including vehicle cost, tolls, and parking
- Delays getting home in the evening preclude Diana from picking up her children from sports practice; she incurs **additional childcare costs**
- **Shutdown decreases home value by \$25K**, frustrating family's interest in selling home. Simultaneously, local schools limit services (e.g. AP classes) as municipal budgets are **reduced by up to 15%** due to depressed property tax revenue

# Getting to know Diana and her current journey to work

## Overview information

Age: 51 years old

Location: Oradell, NJ

Relationship status: Married with two children

## Work information

Occupation: Executive Assistant at an insurance company

Income: \$68k/year

Location: New York, NY

## Transit information

### Takes the train everyday

Duration: 1 hour 20 min each way

Cost: \$12 roundtrip with monthly pass

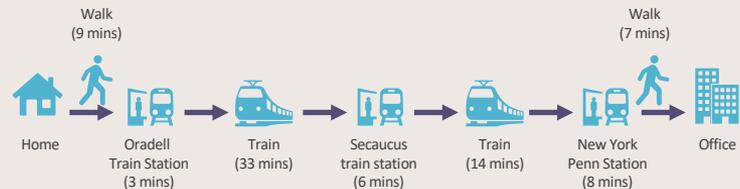
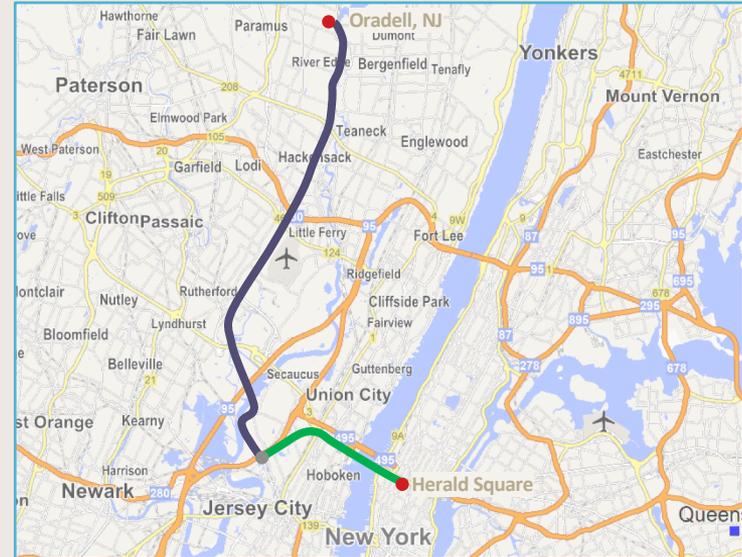
Diana buys a monthly transit pass at the station. Each trip ends up being about \$6 since she takes approximately 40 trips per month. Diana finds her commute to be relatively easy, and sometimes uses it to catch up on work or read.

### Other considerations:

- Very important for her to get to the office on time before her boss gets in
- Prefers not to take the bus due to less comfort and reliability
- Needs to be home in the evening to pick her children up from high school sports practice



“I need a reliable commute so I can make it to work on time. I’m now forced to drive even though it’s a big cost to my family and me.”

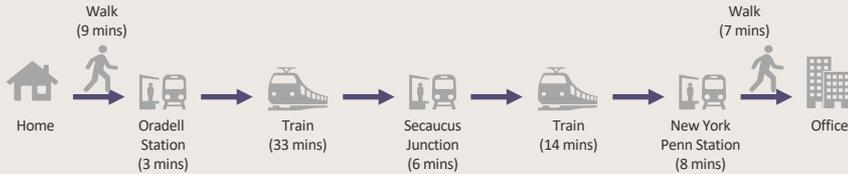


# Impact of a shutdown on Diana

The alternative modes in a shutdown require Diana to **leave at least 50 minutes earlier in the AM commute** to ensure that she gets to work on time

## Current mode: NJ Transit

1 hr 20 min



## Alternative mode in shutdown: Car

Up to 2 hr 10 min



## Alternative mode in shutdown: Bus to subway

Up to 2 hr 50 min



## Estimated impacts for Diana

### Time

- Journey can take **100 minutes longer roundtrip**. In addition to travel delays, variable traffic times require Diana to build in **buffer time and re-routing time**
- The variability makes her occasionally **late to work**, disappointing her boss

### Cost

- Total **additional weekly costs of \$525**:
  - **\$365 additional per week** in commuting costs (vehicle, parking, and tolls), 6x previous cost on NJ Transit
  - **\$160 in additional weekly child care expenses** due to delays on evening commute

### Other

- Additional stress on commute; **unable to work**
- Returns too late on certain days to **pick up kids** from sports practice
- Driving **less safe** than train
- Shutdown **depresses home values by 3%**. Family less likely to move/sell home. Simultaneously, local property tax revenue declines, putting **pressure on school budgets**

# Shutdown transforms Diana's journey from easy and predictable to difficult and variable – with impacts on her personal and professional life

## Diana: Current commute

-  **7 hours** of sleep; wake up at 6AM
-  **\$12** per day in NJ Transit commuting cost
-  **0 days** per week late for work
-  **0 days** per week unable to pick up kids from sports practice
-  **\$0** in additional weekly child care
-  **\$0** to buy, own & maintain new car
-  **\$0** in decreased home value
-  **No physical risk** due to road safety
-  **High level of comfort / productivity** on commute; Can work
-  **Low level of stress** on commute



## Diana: Future commute

-  **6 hours** of sleep; wake up at 5:00AM
-  **\$85 per day** in vehicle, fuel, parking and toll costs
-  **0-1 day** per week late for work
-  **0-1 day** per week unable to pick up kids from sports practice
-  **\$160** in additional weekly child care
-  **\$13.5K / yr** to buy, own, & maintain new car
-  **\$15K** in decreased home value
-  **Increased physical risk** due to road safety
-  **Low level comfort / productivity** on commute; Cannot work
-  **High level of stress** on commute



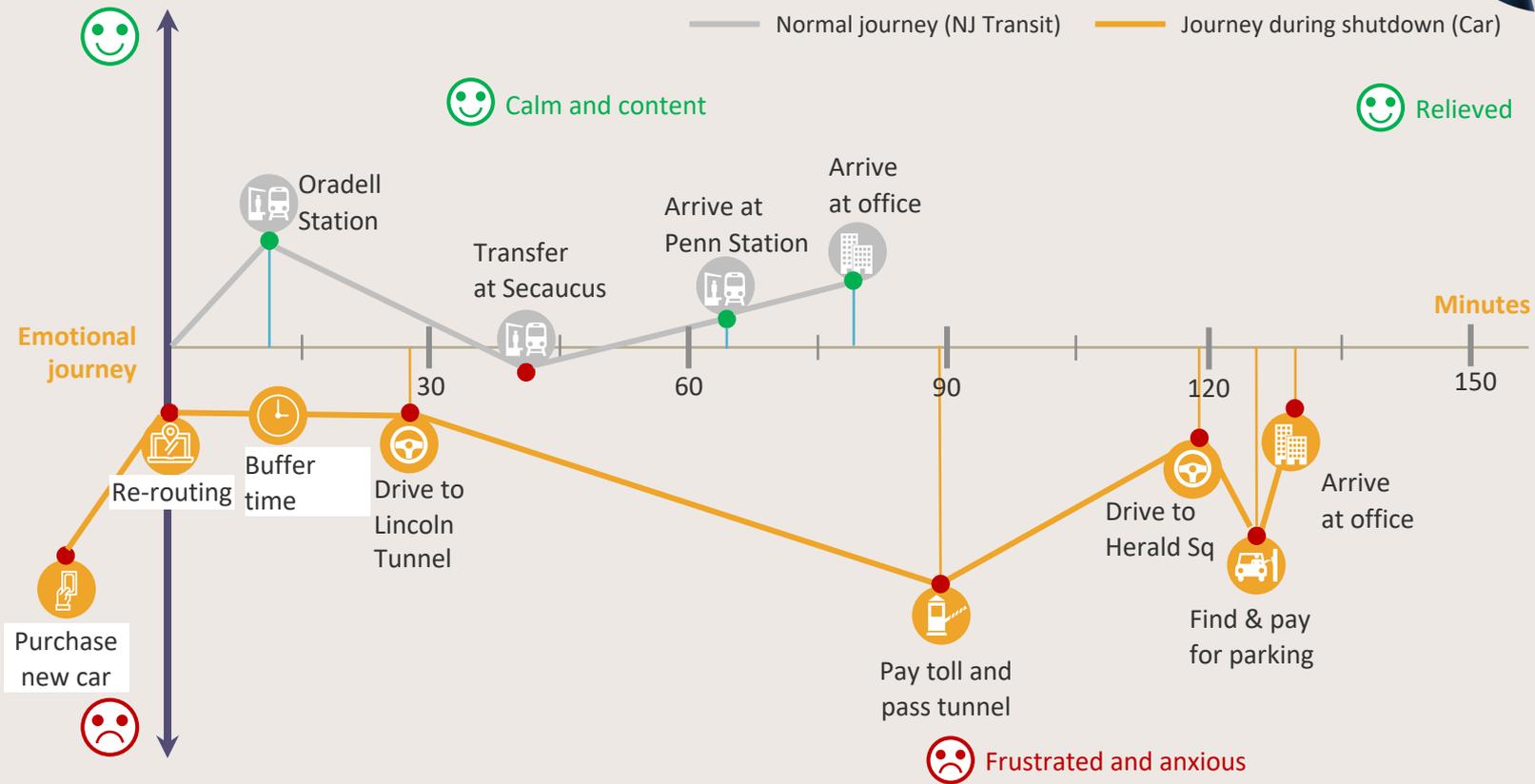
## Aggregate impacts

**15 people like Diana are affected**

-  **15 hours** of lost sleep
-  **\$1.1K** in additional commuting cost
-  **0-15 late work days** per week
-  **0-15 missed** evening commitments per week
-  **\$2.4K** in additional weekly child care
-  **\$200K / yr** to buy, own & maintain new cars
-  **\$230K** in decreased home values
-  **Increased physical risk** due to road safety
-  **Low levels of comfort / productivity** on commute
-  **High level of stress** on commute



# Switching transit mode to car creates a prolonged, negative emotional impact on Diana



# Meet David



**Location** Allentown, PA area

**Occupation** Freight Operator

**Income** \$140K/yr

**Transit** Regional highway network

**Age** 42 years old

**Transportation mode: Truck**



## Current journey

David runs a family-owned, mid-size trucking company based outside Allentown, Pennsylvania that is known for reliability and customer service. A significant portion of David's customers depend on him to deliver freight to the New York area. Most of these routes run over the George Washington Bridge and Verrazano-Narrows Bridge. The company uses several types of trucks and trailers, depending on the type of cargo being transported.

## Who David Represents

- **105 companies truck freight** from Fogelsville, PA to Queens during peak hours may be impacted by the shutdown.<sup>1</sup> The shutdown will impact a total of **147K trucks** per day
- The full journey (requiring re-routing and refueling) can be **nearly 3 hours** longer roundtrip, **totaling 290 hours** for all trucks
- Driving time can be extended by 100 minutes roundtrip, totaling **175 hours** for all trucks

## What Might Happen

- Increased traffic creates **higher fuel and labor costs**, causing David to raise prices
- This causes David to **lose some customers**
- Other customers **pass on price increases to their buyers**, lowering the total amount bought and sold
- Simultaneously, it becomes **harder for David to plan and execute timely deliveries**, frustrating customers who need their goods on-time

# Getting to know David's company and current freight journey

## Overview information

Age:	42 years old
Location	Allentown, PA area
Relationship status	Married with four children

## Work information

Occupation	Owner/operator of freight trucking service
Income	\$140k/year
Location:	Northeast Corridor

## Journey information

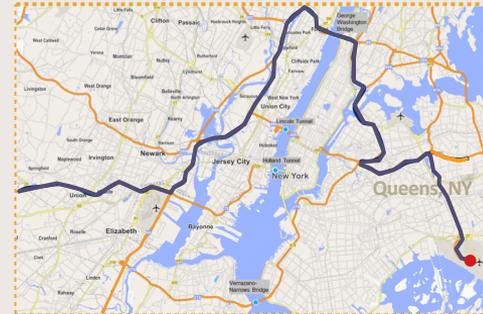
David sends a dry van (53-foot trailer) with a full truckload of metal goods to a manufacturer in Queens

Duration	4 hrs each way
Cost	\$400 roundtrip, including all fuel, vehicle, and driver costs <sup>1</sup>

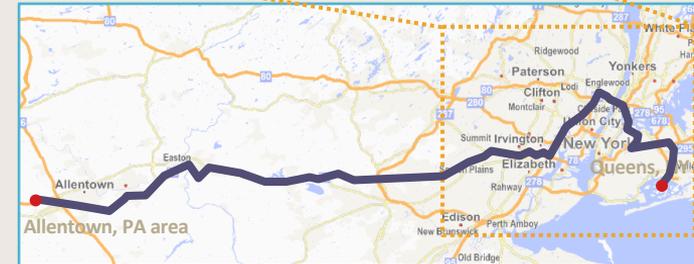
David serves customers across a variety of industries. Customers pay 30 days credit on negotiated rates based on mileage, weight, and additional factors.

### Other considerations:

- Can only take truck routes, restricting route-planning
- David needs precise route-planning in order to craft efficient schedules and forecast costs
- Some of David's customers do just-in-time manufacturing or have similar needs which make delays particularly costly
- As a family-owned business, family members like David's son sometimes step in when there are needs



"The George Washington and Verrazano-Narrows Bridges are on some of my most important routes. The entire East Coast depends on them. Additional traffic in these choke-points is a huge blow to our business and customers."



Dispatch from  
Fogelsville, PA  
(15 mins)



Travel to  
NYC  
(136 mins)



Cross GWB  
(18 mins)



Travel to  
delivery point  
(55 mins)



Delivery at JFK  
(18 mins)

# Impact of a shutdown on David's business

The alternative routes in a shutdown require the driver to leave over **an hour earlier** and build in additional time for refueling and driver needs

## Current route: George Washington Bridge

4 hr 2 min



## Shutdown alternative: Maintain route and wait out traffic

5 hr 25 min



## Shutdown alternative: Re-route to Verrazano-Narrows

5 hr 43 min



## Estimated impacts for David's business

### Time

- Roundtrip journey takes **almost 3 hrs longer** in shutdown
- Longer drive times** and additional time needed for **re-routing and refueling**
- Lack of reliability for on-time deliveries creates **decreased customer and employee satisfaction**, eventually leading to lost business

### Cost

- Delays cost \$180 per trip** (~\$1 per minute of delay for fuel, vehicle, and driver costs)<sup>1</sup>
- Delay causes fleet to run under optimal capacity, causing David to find **more trucks and drivers**

### Other

- Increased admin/operational burden**; time that could be spent on higher priority business issues
- Drivers require **more bathroom stops, meals**, etc. for more hours on the road
- Health and safety impacts** of driving more congested roads

# Shutdown transforms freight journey from a standard route to a difficult and expensive one – creating real impacts on the business and family

ILLUSTRATIVE

## David: Current route

 **8 hours** of sleep; wake up at 6AM

 **0 late deliveries** per week

 **0 dissatisfied customers**

 **3 hours** of family time in evening

 **0 family events** missed

 **\$0** in delay cost

 **Normal** physical risk due to road safety

 **0 minutes** of additional route planning and administrative burden

 **Low level** of stress

## David: Future route

 **6.5 hours** of sleep; wake up at 4:30AM

 **0-3 late deliveries** per week

 **0-3 dissatisfied customers**

 **2 hours** of family time in evening

 **0-1 family event** missed

 **\$180** in delay cost

 **Increased** physical risk due to road safety

 **40 minutes** of additional route planning and administrative burden

 **High level** of stress

## Aggregate impacts

**105 trucking journeys** like this one are affected

 **160 hours** of lost sleep

 **0-315 late deliveries** per week

 **0-315 dissatisfied customers**

 **105 hours** of lost family time

 **0-105 family events** missed per week

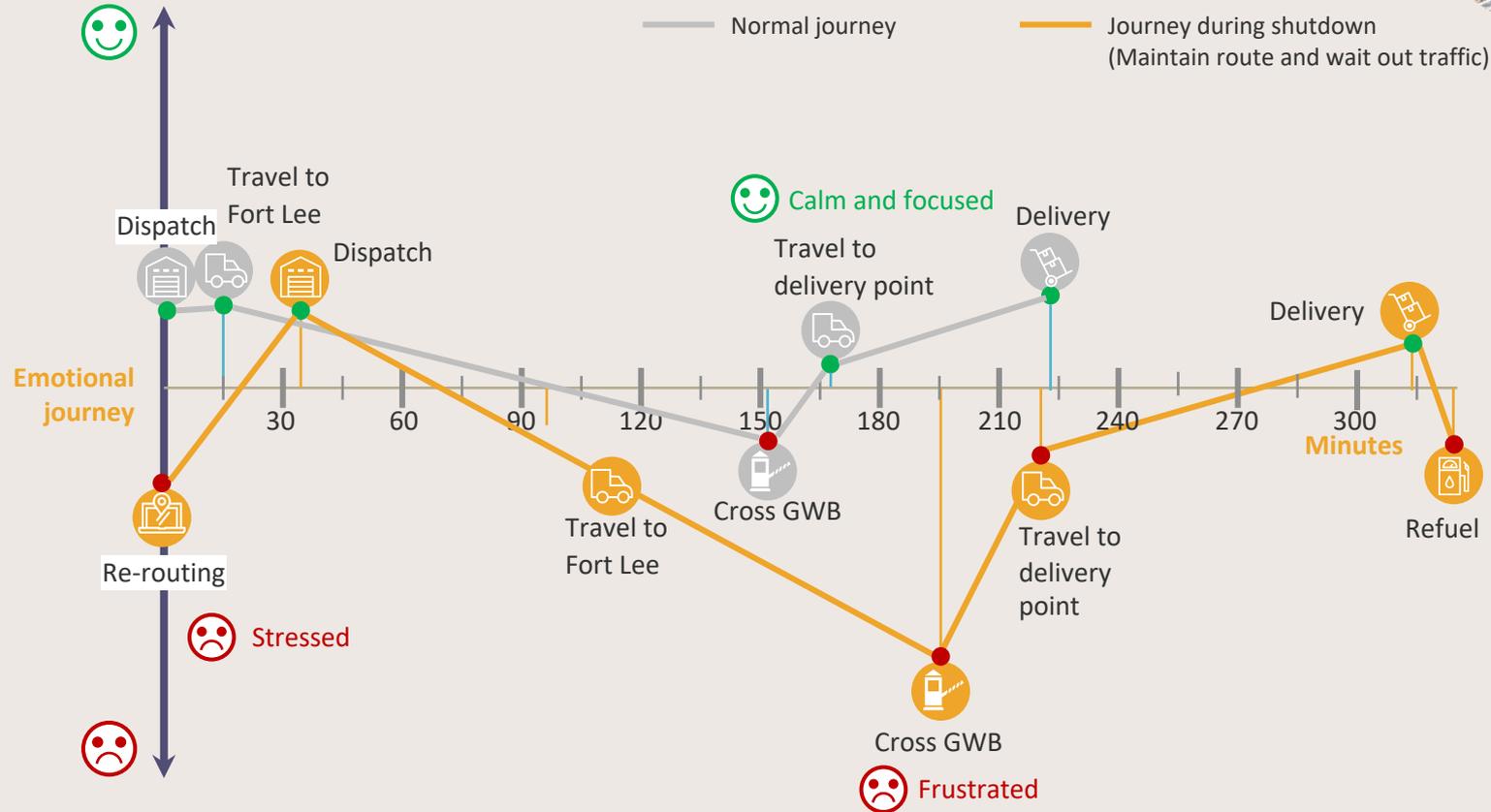
 **\$18.5K** in delay cost

 **Increased** physical risk due to road safety

 **70 hours** of additional route planning and administrative burden

 **High level** of stress

# Shutdown turns a routine freight delivery into an extended, stressful ordeal





# Meet Lailah

**Location** Hazlet, NJ

**Occupation** Teacher

**Income** \$55k/yr

**Transit** To work via car

**Age** 37 years old

**Transportation mode:** car



## Current journey

Lailah is a language teacher at a private school in East Rutherford, NJ. She has taught there for 10 years, and loves her job, making the 1 hour commute worthwhile from her home in Hazlet, NJ. Lailah leaves early and drives her family's Toyota Corolla. She heads home in the evening to care for her elderly mother and spend time with her young children.

## Who Laila Represents

- **80 people** drive to East Rutherford from eastern Monmouth County during peak hours
- Part of the **100,000 people** whose round trip commutes increase by over **60 minutes**
- The full journey (requiring route-finding and adding buffer time for variable delays) can be 90 minutes longer, **totaling 120 hours** for all drivers
- Driving time may be extended by 30 minutes round trip, **totaling 45 hours** for all drivers

## What Might Happen

- Lailah has to shift her wake-up time **from 6AM to 5AM** to take care of morning responsibilities at home and make it to work on time
- Traffic variability requires Lailah to **plan for the worst possible delays**; otherwise, she risks disappointing her students and school administrators
- Lailah incurs **\$200 in additional weekly child and elder care expenses**, as she cannot be as prompt in picking up her kids and relieving her elderly mother's caretaker
- The disruption to her personal life forces her to **consider changing jobs or where she lives**
- **Home value decreases by 6%, or \$23,000**, as a result of the shutdown. Family decides not to put home on the market. Simultaneously, local school and fire department under pressure to reduce services as decreases in property tax revenue reduces municipal budget by up to 25%

# Getting to know Lailah and her current journey to work

## Overview information

Age: 37 years old

Location: Hazlet, NJ

Relationship status: Married with three children

## Work information

Occupation: Language teacher

Income: \$55k/year

Location: East Rutherford, NJ

## Transit information

### Drives to work every morning

Duration: 1 hour 8 min each way

Cost: \$40 roundtrip<sup>1</sup>

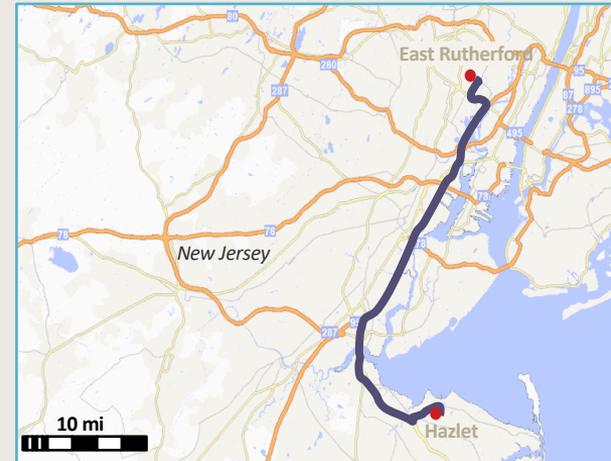
Lailah and her husband have a house in Hazlet, NJ large enough for them, their three children, and Lailah's mother. Lailah commutes to a private school in a high-income neighborhood to teach, where it is less affordable for them to live.

Other considerations:

- Lailah needs to be on time for classes, as students depend on her
- She leaves in the late afternoon to pick up her children from daycare and her elderly mother, who requires a caretaker during the day
- There are transit alternatives to East Rutherford from Lailah's home more than double the travel time of driving



“Some of us who are hit hardest by the shutdown are regional car commuters – we don't use the tunnel or even cross the Hudson River on our daily commute.”



<sup>1</sup> Includes full vehicle O&M cost

# Impact of a shutdown on Lailah

Additional traffic in a shutdown requires Lailah to shift her wake-up time from 6AM to 5AM to ensure that she gets to work on time and avoids worst-case traffic. She is also under stress during her return journey, as she needs to be prompt in taking care of her kids and mother.

## Current commute

1 hr 8 min



## Commute in a shutdown

Up to 1 hr 52 min



## Estimated impacts for David's business

### Time

- 6AM wakeup time shifts to 5AM
- Traffic variability requires her to plan for the worst possible delays, causing her to build in 25 minutes of buffer time
- Arrives late for school ~1 day per week, disappointing students and school leaders
- She risks losing her job if lateness continues
- Also late in picking up kids / relieving mother's caretaker in evening

### Cost

- \$200 in additional weekly child/elder care costs due to later evening return times
- \$12 in daily additional vehicle O&M costs due to delay (\$0.40 per minute of vehicle traffic/idle time)

### Other

- Disruption to personal and professional life causes her to consider moving or seeking a new job
- Additional stress from attempting to avoid traffic and seek alternative routes each morning

# Shutdown weighs heavily on Lailah's personal and professional life

## Lailah: Current commute

 **7 hours** of sleep; wake up at 6AM

 **4 hours of family time** in evening, caring for children and elderly mother

 **0 days** per week late for school

 **0 days** per week unable to prepare meals for family

 **\$0** in additional weekly child and elder care

 **\$0** per day in vehicle traffic/idle time cost

 **\$0** in decreased home value

 **Normal** physical risk due to road safety

 **Low level of stress** on commute

## Lailah: Future commute

 **6 hours** of sleep; wake up at 5AM

 **3 hours of family time** in evening, caring for children and elderly mother

 **0-1 day** per week late for school

 **0-1 day** per week unable to prepare meals for family

 **\$200** in additional weekly child and elder care

 **\$12** per day in vehicle traffic/idle time cost, \$3K per year

 **\$23K** in decreased home value

 **Increased** physical risk due to road safety

 **High level of stress** on commute

## Aggregate impacts

**80 people like Lailah are affected**

 **80 hours** of lost sleep

 **80 hours** of lost family time

 **0-80** late work arrivals per week

 **0-80** missed meal preparations per week

 **\$16K** in additional child and elder care

 **\$900** per day in vehicle traffic/idle time cost, \$240K per year

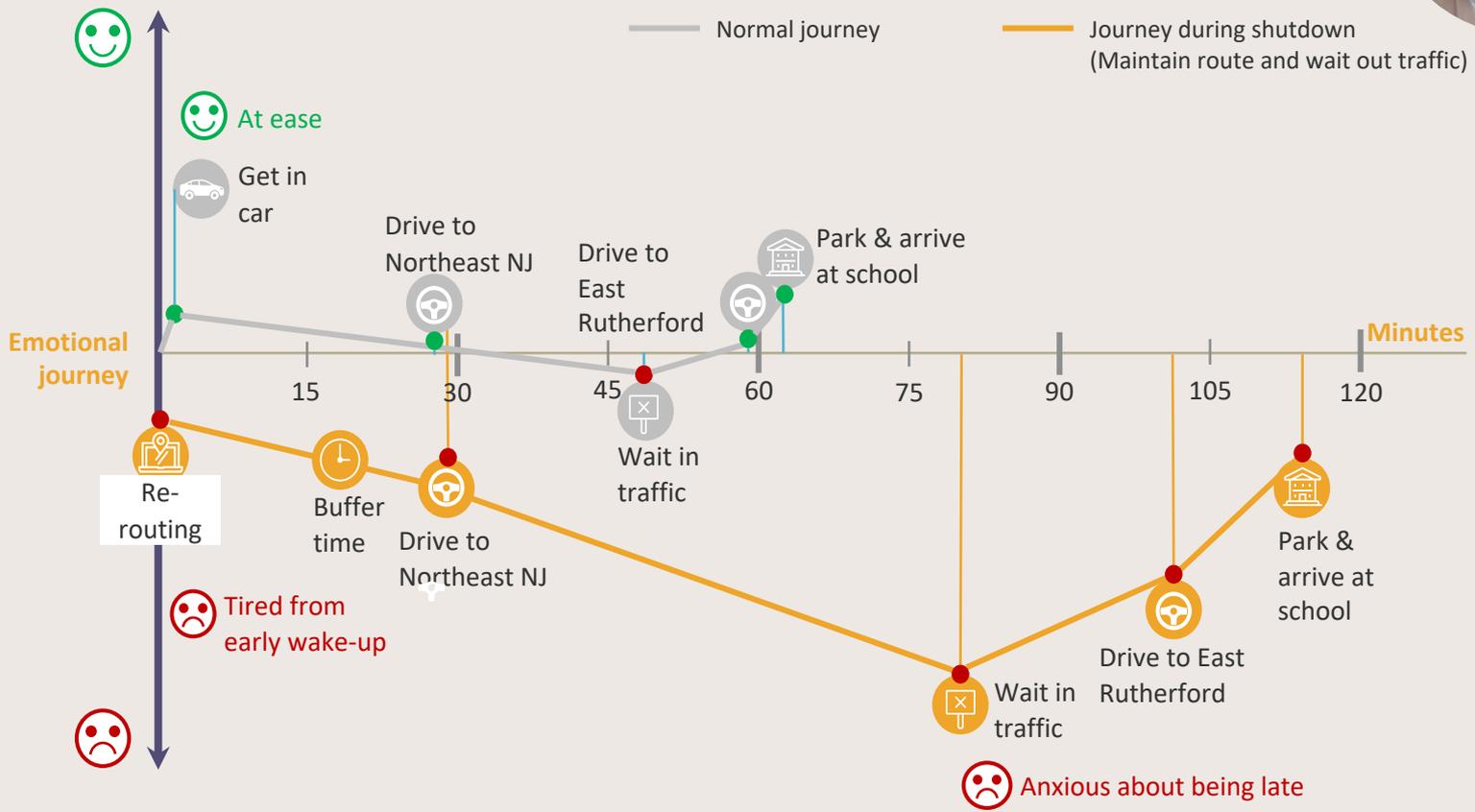
 **\$1.8M** in decreased home values

 **Increased** physical risk due to road safety

 **High level of stress** on commute



# Shutdown prolongs Lailah's journey and adds considerable stress



# Meet Jerome



**Location** Washington, DC

**Occupation** Program Director

**Income** \$68k/yr

**Transit** Amtrak

**Age** 46 years old

## Current journey

Jerome is the Northeast Program Director at a non-profit organization focused on U.S. healthcare. The organization is based in Washington and he travels to New York and other cities several times per month to coordinate with funders and partners. Jerome is responsible for advocacy and fundraising, requiring significant face time. He typically drops his son off at daycare early in the morning before catching a train. He works on the Amtrak and enjoys the calm and comfortable journey.

**Transportation mode: Amtrak**



## Who Jerome Represents

- **3,000 passengers** who travel between DC/Baltimore and NYC
- Of these, **1,300 are price elastic business or leisure travelers** who may be priced out of train and air options and forced to take the bus
- These travelers will incur increased travel time of 2 hours each way, totaling **4K roundtrip hours**

## What Might Happen

- The bus is a less **productive work environment**, reducing the amount of work that Jerome can do while travelling.
- The bus is **less reliable** than the train, forcing travelers to budget 30 minutes of buffer time into journeys in which they are already leaving earlier and/or arriving later.
- Jerome's new travel schedule is outside the hours that he can **drop his son off at daycare** in the morning and return in time for bedtime.

# Getting to know Jerome and his current journey

## Overview information

Age:	46 years old
Location	Washington, DC
Relationship status	Married with one child
Work information	
Occupation	Program Director
Income	\$68k/year
Location:	Meetings in New York, NY

## Transit information

Travels to Washington DC several times per month for meetings

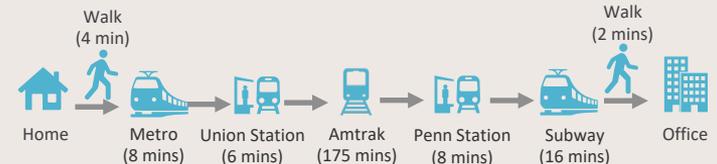
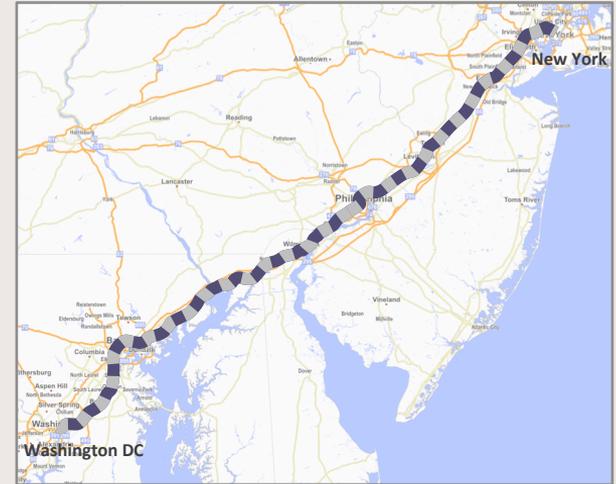
Duration	3 hrs 40 mins each way way
Cost	\$200-550 roundtrip

Jerome's organization works closely with government partners and funders. He travels several times per month to meet with stakeholders and attend conferences, and the in-person face time is quite valuable. As often as possible, Jerome tries to make his NYC travels a day trip, avoiding the need to stay overnight.

Other considerations:

- Jerome's organization is budget-constrained and cannot consistently pay for flights if they are more expensive
- Jerome has a young son at home. He drops his son off at daycare and attempts to be home each night before he goes to bed

“Traveling to NYC is a must for our organization. The tunnel shutdown makes it hard to get on Amtrak, and the alternatives are a pain.”

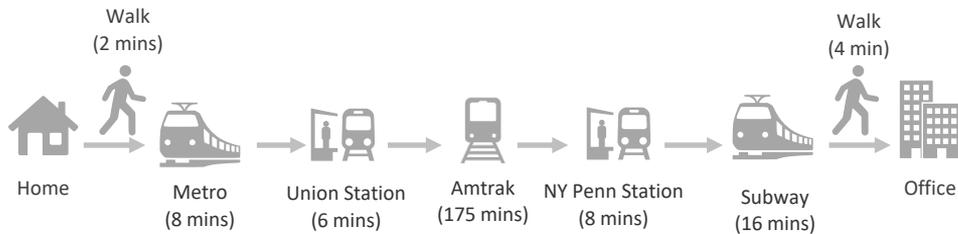


# Impact of a shutdown on Jerome

Shutdown can add **over 4 hours** to Jerome's roundtrip journey. He is significantly less productive on the bus than on the train and jeopardizes his evening family time.

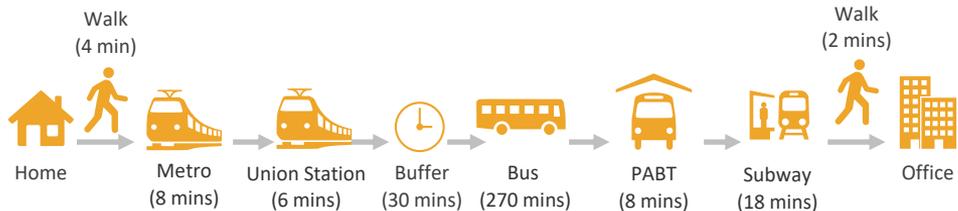
## Current mode: Amtrak

3 hr 39 min



## Alternative mode under shutdown: Bus

5 hr 46 min



## Estimated impacts for Jerome

### Time

- Journey can take **over 4 hours longer** roundtrip
- Additional **variability** introduced, due to traffic, requiring **buffer time**

### Cost

- Jerome can work for 2.5 hrs on the train and only 30 minutes on the bus. The value of the **lost productivity** is \$120.
- Bus is cheaper; but for less comfortable experience
- Airline prices will increase 65% between DC and NYC, making **flying infeasible**
  - Demand will rise from displaced Amtrak passengers, while supply will remain fixed due to airport slot constraints

### Other

- The departure and return times for this longer journey are **outside the hours for dropping off his son at daycare and seeing him at night before bed**
- Bus is **less safe, less comfortable, and adds more stress** than train

# Jerome is forced to take a longer journey, impacting his work and family life

ILLUSTRATIVE

## Jerome: Current commute

-  **7 hours** of sleep; goes to bed at 10PM
-  **1.5 hours of family time**, puts son to bed
-  **7 hours** of work time in NYC
-  **5 hours** of commute work time
-  **\$0** in lost productive commute work time
-  **4 partner meetings** per day
-  **No physical risk** due to road safety
-  **Low level of stress** on commute

## Jerome: Future commute

-  **5 hours** of sleep; goes to bed at 12AM
-  **0 hours of family time**, misses son's bedtime
-  **5 hours** of work time in NYC
-  **1 hour** of commute work time
-  **\$120** in lost productive commute work time
-  **2 partner meetings** per day
-  **Increased physical risk** due to road safety
-  **High level of stress** on commute

## Aggregate impacts

**1.3K people like Jerome are affected**

-  **2.6K hours** of lost sleep
-  **2K hours** of lost family time
-  **2.6K hours** of lost work
-  **5.2K hours** of lost commute work time
-  **\$160K** in lost productive commute work time
-  **2.6K fewer meetings**
-  **Increased physical risk** due to road safety
-  **High level of stress** on commute

# Meet Shayna



**Location** Midtown, NYC

**Occupation** HR Manager

**Income** \$48k/yr

**Transit** Bus & train

**Age** 36 years old

## Current journey

Shayna is a manager at ABC Industries, an employer of 7,000 maintenance and facility service workers in New York. She oversees 70+ office buildings in Manhattan and ensures that they receive daily janitorial, electrical, HVAC/mechanical, engineering, parking, and landscaping services. Many of the workers Shayna is responsible for do not have cars and take the bus or train into Manhattan from New Jersey and the outer boroughs

**Transportation mode: Train & bus**



## Who Shayna Represents

- Managers of the **28,000 facilities workers** in the New York region
- **3,200 companies** that employ those workers, disrupting services and creating **70,000 hours of additional work** for those who manage these workers

## What Might Happen

- A tunnel shutdown would impact hundreds of the facilities workers that Shayna manages, **causing lateness, absenteeism, and turnover**
- Gaps in service coverage have particularly costly consequences for certain functions (e.g. security, cleaning, electrical work, etc.) causing **customer complaints**
- Shayna spends **17+ hours per week** on additional administrative work (e.g. backfilling employees) that could have been spent on other business priorities

# Getting to know Shayna and her current workflow

ILLUSTRATIVE

## Overview information

Age:	36 years old
Location	Midtown, NYC
Relationship status	Partner, no children
Work information	
Occupation	Manager at ABC Industries
Income	\$48k/year
Location:	New York, NY

## Workflow information

### Ensures facility services at 70+ NYC office buildings

400+ employees perform facilities and maintenance work each week on the 70+ office buildings that Shayna manages. Key components of her workflow include scheduling, performance management, quality assurance, and invoicing/payments.

### Other considerations

- Shayna maintains a tight schedule of shifts. High levels of absenteeism or turnover cause major disruptions, particularly when it is difficult to find substitutes who can backfill promptly
- Workers perform critical functions where being short staffed bears significant consequences for customers (e.g. front desk security, plumbers/janitors, electrical maintenance, etc.)
- Workers mainly commute from New Jersey and the outer boroughs by train or bus. Few own cars, and driving/parking is unaffordable

“Facility services help keep New York City running. When my people can’t get to work, we all have a big problem.”



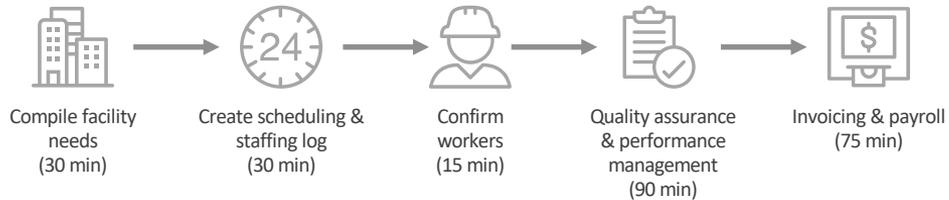
# Impact of a shutdown on Shayna and her company

ILLUSTRATIVE

Shutdown creates considerable **uncertainty for business operations**, **decreases service quality/reliability**, and places **strain on workers**. Shayna struggles to balance customers' needs, workers' satisfaction, and business obligations/KPIs.

## Current workflow

4 hrs



## New workflow in shutdown

5 hr 46 min



## Estimated impacts for Shayna

### Time

- Additional administrative complexity can increase **time spent on workflow by 40%**
- Workers' **timeliness/attendance is unreliable**

### Cost

- Increased **administrative costs** associated with scheduling, coordination, and complexity amounting to **\$370 per week**
- Company pays **overtime** to those extending their shifts to cover for late/no-show workers
- Workers may incur **additional commuting costs and personal expenses** (e.g., childcare)

### Other

- Lack of reliability leads to **decreased customer and employee satisfaction** – risking employee turnover and customer attrition
- Increased operational burden means less time spent on other priority business issues

# Shutdown places additional stress on Shayna as well as her relationships with customers and employees

ILLUSTRATIVE

### Shayna: Current workflow

- 0-4 facilities workers late for work per week
- 0-1 employees fail to show up per week
- 0-2 customer complaints per week
- 0 hours of additional administrative work per week
- 0-1 workers who have to work overtime/overnight per week
- High employee satisfaction; low disruption in personal/family time
- No need to engage temporary or under-trained workers
- Low physical risk for employees due to road safety
- Low level of stress



### Shayna: Future workflow

- 0-32 facilities workers late for work per week
- 0-6 facilities workers fail to show up per week
- 0-6 customer complaints per week
- 17.5 hours of additional administrative work per week
- 0-10 workers who have to work overtime/overnight per week
- Low employee satisfaction; disruption in personal/family time
- High need to engage temporary or under-trained workers
- Increased physical risk for employees due to road safety
- High level of stress



### Aggregate impacts

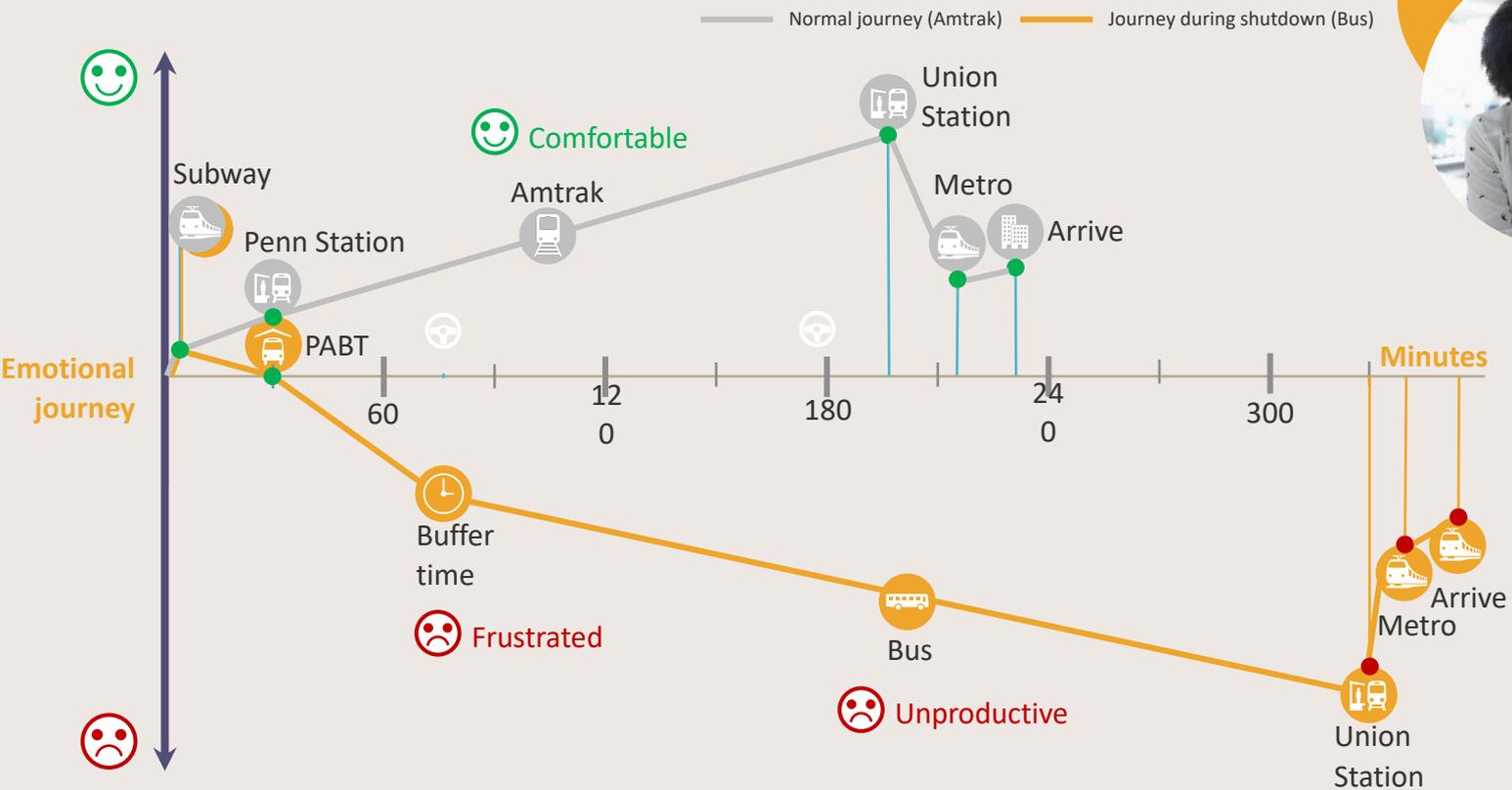
**3.2K companies that employ 28K facilities workers are affected<sup>1</sup>**

- 0-2.2K facilities workers late for work per week<sup>1</sup>
- 0-420 facilities workers fail to show up per week<sup>1</sup>
- 0-300 customer complaints per week<sup>2</sup>
- 70K hours of additional administrative work per week<sup>3</sup>
- 0-700 workers who have to work overtime/overnight per week<sup>1</sup>
- Low employee satisfaction; low disruption in personal/family time
- High need to engage temporary or under-trained workers
- Increased physical risk for employees due to road safety
- High level of stress

1 Assumed 70% of 40K total employees are facilities workers and consistent rates of absenteeism, tardiness, and overtime  
2 Assumed 8 facilities workers per customer (3.5K customers) and consistent complaint rate  
3 Assumed 10% of 40K total employees are HR Managers and consistent rate of added work

# Shutdown adds complexity, stress, and cost to an otherwise routine process

ILLUSTRATIVE



# Contents

- Ⓐ Surface transportation (passenger)
- Ⓑ Surface transportation (freight)
- Ⓒ Air impact
- Ⓓ Safety impact
- Ⓔ Health impact
- Ⓕ Housing price impact
- Ⓖ Cumulative impact
  - Customer experience
  - **Methodology and appendix**
    - **Diversions**
    - Surface transportation (freight)
    - Air impacts
    - Safety and health impacts
    - Housing price impacts
    - Customer experience

# Analysis of diversions in constrained scenario

## Description of analysis

### Key assumptions

- 38K morning commuters are diverted from NJ Transit trains due to tunnel shutdown;
- Of these people, all attempt to convert to another means of transit (before trying to drive if they have a car), but have different time and mode shift constraints and preferences
- It is assumed that 70% will attempt the PATH as an alternative; 10% will attempt the ferry; and 25% will attempt the bus—and will proceed through their non-NJT rail options in that order before considering driving
- Roughly ¼ are shift workers and likely cannot change times; the other ¾ can reasonably be expected to change one hour in either direction

## Source

- NYMTC Hub bound report
- NJ Transit
- Assumption on preferences
- ACS data analysis

### Max and excess capacity of current transit, and willingness to switch and time shift to these options

	Max capacity	% would use	% would time shift
Bus	Based on 2016 max average bus load rate (42 pax per bus during 7-8am) and existing service frequencies by hour	25%	18.75%
PATH	Based on 2017 max average car load (100 pax per car during 8-9am) and existing service frequencies by hour	70%	18.75%
Ferry	Based on 50% usage of 2016 available capacity and existing service frequencies by hour	10%	18.75%

- PANYNJ
- NYMTC
- NJ Transit

### Answer

- 5.7K workers would be able to maintain their peak of the peak 8-9AM commute using spare bus and ferry capacity, mostly those unable to time shift; 10.6K commuters would likely remain in their existing 7-8AM and 9-10AM slots, using spare PATH, bus, ferry options
- Of the 29K workers able to time shift, 3.8K could reasonably be expected to shift to 7-8AM slots or 9-10AM slots; and an additional ~1K could be expected to switch to shoulders (6-7AM and 10-11AM)
- **Thus, ~23K can be accommodated by transit, ~11K would likely have to drive, and the remaining ~4K would represent lost trips that could no longer commute to Manhattan during the peak hours**

- Assumption

# Estimated diversions by hour and mode

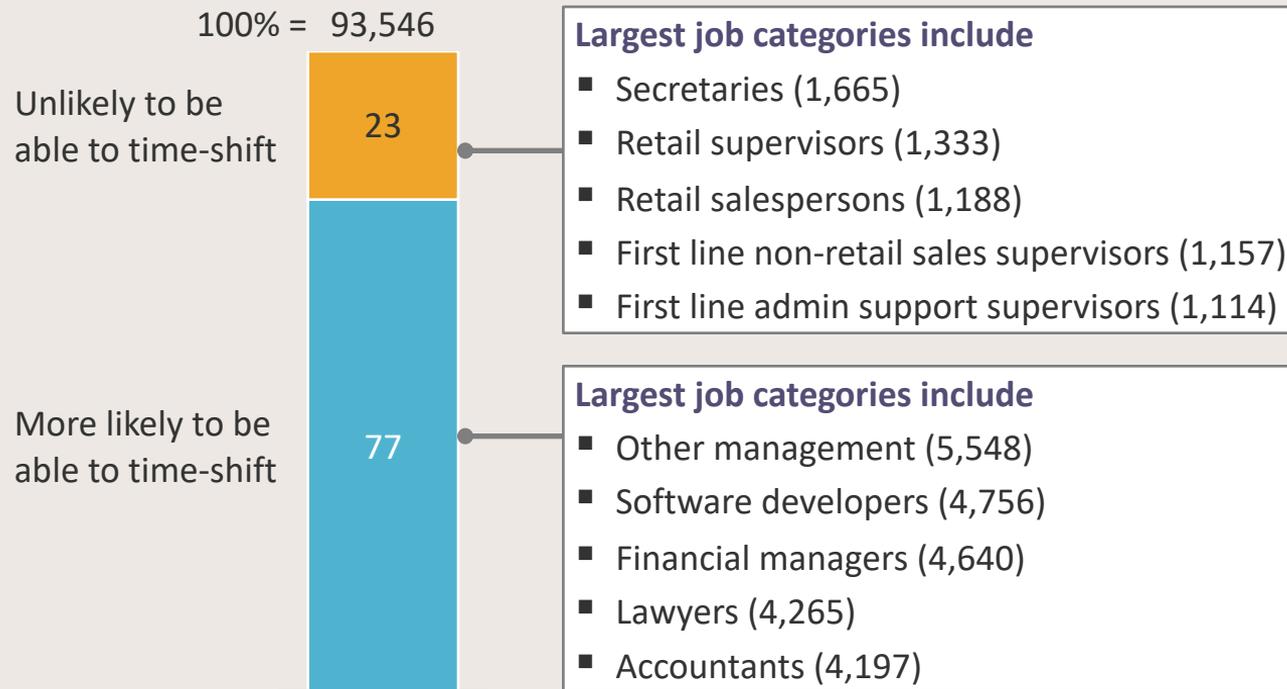
Time	2016 NJT Manhattan CBD AM Peak travelers	2019 NJT Manhattan CBD AM Peak travelers <sup>1</sup>	Capacity in a shutdown <sup>2</sup>	Total diversions within hour <sup>3</sup>	Diversions to PATH	Diversion to Bus	Diversion to Ferry	Diversion to Auto Person Trips	New auto trips (w/ HOV conversation factor)	Lost Trips	
6 - 7AM	5,481	5,988	8,110	0	522	994	75				
7 - 8AM	16,349	18,181	8,110	7,949	7,217	0	1,031	2,925	2,602		
8 - 9AM	28,675	33,285	8,110	25,175	0	3,230	2,518	4,441	3,950	3,745	
9 - 10AM	13,004	15,538	8,110	4,990	5,145	1,214	735	3,540	3,149		
10 – 11AM	4,934	5,607	8,110	0	327	0	47				
Diversions to Cuomo, Goethals and Outerbridge									410	364	
Total	68,443	78,599		38,114	13,211	5,437	4,405	11,316	10,064	3,745	

1. 3 year growth from 2016 based on historic relationship between NJT ridership and NYC employment
2. 5 NJT trains per hour
3. Some trips previously taken at 7am and 9am are accommodated during shoulder hours

# Estimate that about 25% of commuters unable to time shift

## Workers living in NJ commuting to NY via rail in 2017

100% = Number of commuters, percent



- Rail commuters from NJ into NY broken out into 181 occupation codes
- Each code considered for whether they may have the ability to time shift, i.e., are they a shift worker
- Of these commuters, about  $\frac{1}{4}$  of workers are either shift workers or directly supervise them, so unlikely that they are able to time shift

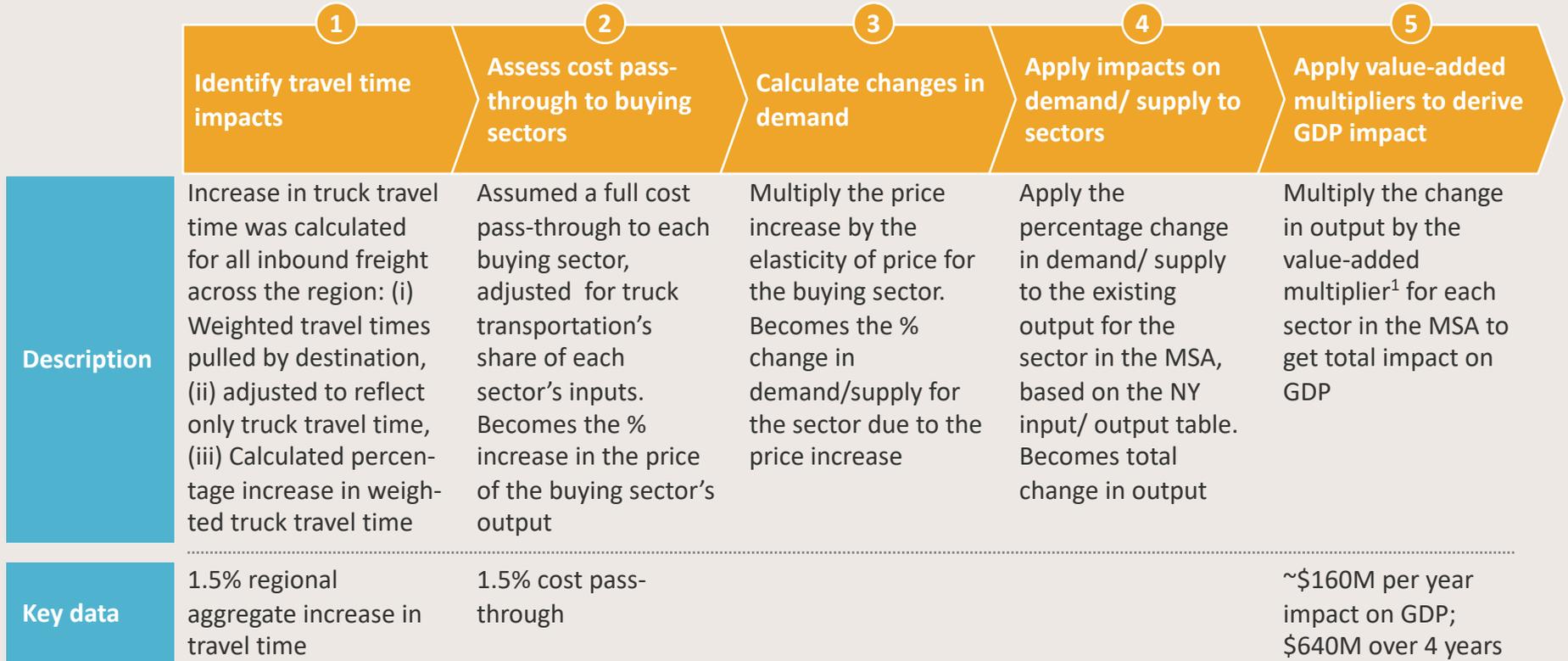
# Methodology for lost trips analysis

	Description of analysis	Coefficients	Source
New Jersey home prices	<ul style="list-style-type: none"> <li>Academic literature on the propensity of commuters to change their work situation based on an increase in commute time suggests that:               <ul style="list-style-type: none"> <li>~20% of commuters will move</li> <li>~20% of commuters will quit current job and seek local work</li> <li>~60% of commuters will stay at their current job (e.g. telecommute, non-peak commute)</li> </ul> </li> </ul>		<ul style="list-style-type: none"> <li>"The Substitution between Movers and Quitters" (Zax 1991)</li> </ul>
	<ul style="list-style-type: none"> <li>For the first year, assumed the above ratios of move to quit to stay</li> <li>However, likely infeasible for temporary arrangements to work from home for commute in off-hours would be long-term, so in 2<sup>nd</sup> year, works who stay quit or move at same ratio as those who did not stay in the first year</li> </ul>		
	<ul style="list-style-type: none"> <li>For quitters, assume wage rate dropped from median Manhattan wage to median New Jersey wage</li> </ul>	<ul style="list-style-type: none"> <li>\$95,350 annual median wage in Manhattan</li> <li>\$58,650 annual median wage for New Jersey</li> </ul>	<ul style="list-style-type: none"> <li>US Census</li> </ul>
	<ul style="list-style-type: none"> <li>For movers, assume a one-time moving cost</li> <li>Also for movers, assume an additional annual increase in mortgage cost based on the median value of a New Jersey home (~\$316K) vs. Nassau/Westchester home (~\$520K)</li> </ul>	<ul style="list-style-type: none"> <li>\$13K one-time moving cost</li> <li>\$316K median value of New Jersey home</li> <li>\$520K median value of Nassau/Westchester county home</li> </ul>	<ul style="list-style-type: none"> <li>ERC Worldwide</li> <li>BLS</li> </ul>

# Contents

- Ⓐ Surface transportation (passenger)
- Ⓑ Surface transportation (freight)
- Ⓒ Air impact
- Ⓓ Safety impact
- Ⓔ Health impact
- Ⓕ Housing price impact
- Ⓖ Cumulative impact
  - Customer experience
  - **Methodology and appendix**
    - Diversions
    - **Surface transportation (freight)**
    - Air impacts
    - Safety and health impacts
    - Housing price impacts
    - Customer experience

# Methodology for estimating freight impact on regional demand suppression and economic output



<sup>1</sup> Value-added multipliers are applied to an investment or input amount to calculate effect on GDP (which is a value-added concept)

# Methodology for freight impact of congestion at ports and airports

	Description of analysis	Source
Key assumptions	<ul style="list-style-type: none"> <li>▪ The economic cost of a one-day closing of NY/NJ port facilities is \$22.2M and airport facilities is \$10.1M</li> <li>▪ Costs are associated with a slowdown of the port and holding up cargo</li> </ul>	<ul style="list-style-type: none"> <li>▪ PANYNJ</li> </ul>
	<ul style="list-style-type: none"> <li>▪ Additional traffic in/out of port facilities will have an equivalent, proportional economic cost to this due to similar slowdown effects</li> <li>▪ The economic cost of additional travel time can therefore be derived by: (i) disaggregating the economic cost of port/airport closure by facility, (ii) weighting the disaggregated costs by throughput volume at each facility, (iii) adjusting the cost for the peak hours (6 hrs of 18 hr day, 33%), and (iv) multiplying this disaggregated, weighted, and peak-adjusted economic cost of closure by the percentage increase in travel delay in/out of port facilities</li> </ul>	<ul style="list-style-type: none"> <li>▪ Assumption</li> </ul>
Method	<ul style="list-style-type: none"> <li>▪ <b>Calculate weighted, peak-adjusted economic cost of closure per facility:</b> <ul style="list-style-type: none"> <li>— <b>Ports:</b> (i) Determine the terminal throughput of each port/airport facility and calculate each facility's percentage of the total, (ii) Multiply each facility's percentage by the \$22.2M economic cost, (iii) Multiply by each facility's weighted economic cost by 33% (adjustment for peak hours represented in work day, assumed to be 6 out of 18)</li> <li>— <b>Airports:</b> (i) Use already disaggregated figures for cargo delay provided by PANYNJ at EWR, JFK, and LGA, (ii) Multiply each facility's economic cost of cargo delay by 33% (adjustment for peak hours represented in work day, assumed to be 6 out of 18)</li> </ul> </li> <li>▪ <b>Calculate percentage increase in travel time in/out of facilities:</b> (i) Determine the TAZs of each facility, (ii) Pull Arup data for these TAZs both by origin (outbound) and by destination (inbound), ensuring that Weighted Auto+Truck Time Open/Closed is included (iii) Calculate the percentage contribution of trucks vs. automobiles, and adjust figures to reflect only truck travel time (iv) Calculate the weighted travel times for trucks in open/closed scenarios, (iv) Apply percentage change formula to derive percentage increase in travel time</li> <li>▪ <b>Calculate economic cost of travel delay:</b> Multiply the increase in travel time at facility TAZ by the weighted/peak-adjusted cost of closure for each facility. Multiply by 1,000 operating days to derive impact over 4 years.</li> </ul>	<ul style="list-style-type: none"> <li>▪ PANYNJ</li> <li>▪ NJTPA model</li> </ul>
Answer	<ul style="list-style-type: none"> <li>▪ <b>Current unconstrained scenario results:</b> <ul style="list-style-type: none"> <li>— \$540M in economic cost of travel delay in/out of all port/airport facilities, from 3.0% overall increase in travel time in/out of port/airport TAZs</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>▪ See above</li> </ul>

# Contents

- Ⓐ Surface transportation (passenger)
- Ⓑ Surface transportation (freight)
- Ⓒ Air impact
- Ⓓ Safety impact
- Ⓔ Health impact
- Ⓕ Housing price impact
- Ⓖ Cumulative impact
  - Customer experience
  - **Methodology and appendix**
    - Diversions
    - Surface transportation (freight)
    - **Air impacts**
    - Safety and health impacts
    - Housing price impacts
    - Customer experience

# We used NYMTC, Amtrak and NJ Transit data to estimate amount of passengers that would be willing to switch to air (1/2)

	Description of analysis	Coefficients	Source
Key assumptions	<ul style="list-style-type: none"> <li>21,882 Amtrak passengers travel through HRT daily</li> <li>Share of types of Amtrak trains passing through the HRT: 22% Acela, 56% regional, 22% other<sup>1</sup></li> <li>50% reduction in number of Amtrak trains (2 → 1 per hour)</li> <li>6 hours per day of peak travel (6-9am, 4-7pm)</li> <li>63% of Amtrak passengers are from DC/Baltimore, and 44% of regional passengers are from DC/Baltimore</li> </ul>		<ul style="list-style-type: none"> <li>NYMTC</li> <li>Amtrak</li> <li>Assumption</li> <li>Assumption</li> <li>NJ Transit</li> <li>Amtrak</li> </ul>
Passenger	<ul style="list-style-type: none"> <li>Total Amtrak train current demand, peak vs. non-peak               <ul style="list-style-type: none"> <li>8.3K non-peak current demand</li> <li>13.5K peak current demand</li> </ul> </li> <li>Calculate total Amtrak train capacity, peak vs. non-peak               <ul style="list-style-type: none"> <li>11.2K peak capacity</li> <li>22.2K non-peak capacity</li> </ul> </li> <li>Make assumptions on tunnel shutdown scenario load factors (i.e. assume non-peak will not reach 100% capacity even in tunnel shutdown scenario)               <ul style="list-style-type: none"> <li>Assume total capacity is halved due to tunnel shutdown</li> </ul> </li> <li>Calculate the number of displaced passengers by subtracting tunnel shutdown max capacity from current demand               <ul style="list-style-type: none"> <li>Assume share of passengers on Amtrak and Regional trains from DC or Baltimore who would have the option to fly</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Assume maximum capacity of 50 people per train</li> <li>100% for peak trains, or 11.2K capacity</li> <li>75% for non-peak trains, or 16.6K capacity</li> <li>Max capacity falls from 27.8K to 13.9K</li> <li>8K total passengers displaced due to shutdown</li> <li>3.1K displaced passengers are Amtrak or Regional passengers from DC or Baltimore</li> </ul>	<ul style="list-style-type: none"> <li>NYMTC</li> <li>Assumption</li> <li>Assumption</li> <li>Assumption</li> </ul>
Answer	<ul style="list-style-type: none"> <li>Calculate relative share of passengers by Acela vs. Regional and coach vs. business vs. first class type               <ul style="list-style-type: none"> <li>Assumed willingness to switch to air based on train type and peak vs. non-peak</li> </ul> </li> <li>Calculate average number of passengers willing to switch to air</li> </ul>	<ul style="list-style-type: none"> <li>Acela business – 89%</li> <li>Acela first class – 11%</li> <li>Regional coach – 92%</li> <li>Regional business – 8%</li> <li>Acela business – 95% switch in peak, 53% non-peak</li> <li>Acela first class – 95% switch in peak, 53% non-peak</li> <li>Regional coach – 95% switch in peak, 30% non-peak</li> <li>Regional business – 95% switch in peak, 30% non-peak</li> <li><b>Final value: ~1,800 passengers willing to switch to air</b></li> </ul>	<ul style="list-style-type: none"> <li>Amtrak</li> <li>Assumption</li> </ul>

<sup>1</sup> Includes Keystone, Pennsylvanian, Vermonter, Cardinal, Silver Service/Palmetto, Carolinian

# Based on the ~1,800 price insensitive passengers, we calculated the impact on ticket prices and tourism (2/2)

	Description of analysis	Coefficients	Source
Key assumptions	<ul style="list-style-type: none"> <li>~1,400 DC&lt;&gt;NYC passengers willing to switch to air</li> <li>~400 NYC&lt;&gt;Baltimore passengers willing to switch to air</li> <li>~100% of leisure passengers are displaced by price insensitive business travelers</li> <li>All displaced leisure passengers choose not to take the trip</li> <li>It does not take business travelers any longer to get to their destination</li> </ul>		<ul style="list-style-type: none"> <li>Survey data</li> <li>City Lab</li> </ul>
Ticket price impact	<ul style="list-style-type: none"> <li>Use current daily passenger demand to approximate the share of future passenger demand for each route</li> <li>Use share of passengers on each route to calculate additional air demand after tunnel shutdown:               <ul style="list-style-type: none"> <li>~1,400 DC&lt;&gt;NYC additional passenger demand</li> <li>~400 Baltimore&lt;&gt;NYC additional passenger demand</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>3,390 DC&lt;&gt;NYC daily passengers</li> <li>635 Baltimore&lt;&gt;NYC daily passengers</li> </ul>	<ul style="list-style-type: none"> <li>BTS T100; Diio Perform. Tool; FAA OTP; OAG</li> </ul>
	<ul style="list-style-type: none"> <li>Determine average price elasticity for short haul business travel</li> <li>Using data on price elasticity for short haul business air travel, current and future air travel demand, and current cost of a ticket, calculate the future cost of a ticket after the tunnel shutdown:               <ul style="list-style-type: none"> <li><b>\$334 ticket price DC&lt;&gt;NYC</b></li> <li><b>\$363 ticket price Baltimore&lt;&gt;NYC</b></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>-0.7 price elasticity</li> <li>Current cost of a ticket               <ul style="list-style-type: none"> <li>\$202 current ticket price DC&lt;&gt;NYC</li> <li>\$173 current ticket price Baltimore &lt;&gt;NYC</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Gillen, Morrison &amp; Rietveld (2003)</li> <li>BTS T100; Diio Perform. Tool; FAA OTP; OAG</li> </ul>
Tourism impact	<ul style="list-style-type: none"> <li>Use data on the % of passengers who are leisure travelers and % of passengers who are "local" (i.e. do not have connecting flights) to calculate the number of leisure passengers traveling to each destination:               <ul style="list-style-type: none"> <li>570 leisure passengers traveling to NYC</li> <li>640 leisure passengers traveling to DC</li> <li>50 leisure passengers traveling to Baltimore</li> </ul> </li> <li>Calculate the lost annual revenue for each destination city based on reduced number of leisure travelers               <ul style="list-style-type: none"> <li><b>\$148M lost tourism revenue for NYC</b></li> <li><b>\$77M lost tourism revenue for DC</b></li> <li><b>\$4M lost tourism revenue for Baltimore</b></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>56% departing DC are leisure</li> <li>75% departing NYC are leisure</li> <li>68% departing Baltimore are leisure</li> <li>50% departing DC are local</li> <li>37% departing NYC are local</li> <li>20% departing Baltimore are local</li> <li>\$711 lost revenue per NYC visitor</li> <li>\$330 lost revenue per DC visitor</li> <li>\$200 lost revenue per Baltimore visitor</li> </ul>	<ul style="list-style-type: none"> <li>PANYNJ</li> <li>MWCOG</li> <li>BTS T100; Diio Perform. Tool; FAA OTP; OAG</li> <li>NYCGO</li> <li>Destination DC</li> <li>Visit Baltimore</li> </ul>

# Contents

- Ⓐ Surface transportation (passenger)
- Ⓑ Surface transportation (freight)
- Ⓒ Air impact
- Ⓓ Safety impact
- Ⓔ Health impact
- Ⓕ Housing price impact
- Ⓖ Cumulative impact
  - Customer experience
  - **Methodology and appendix**
    - Diversions
    - Surface transportation (freight)
    - Air impacts
    - **Safety and health impacts**
    - Housing price impacts
    - Customer experience

# Environmental and safety impact methodology (1/2)

		Description of analysis	Coefficients	Source
Environmental	All impacts	<ul style="list-style-type: none"> <li>From NJTPA model results: additional minutes traveled by cars and trucks in each scenario</li> <li>Make assumptions about average auto speed and fuel efficiency                             <ul style="list-style-type: none"> <li>Average speed for all urban driver in New York city area of 20 mph</li> <li>Fuel rate for trucks at 20 mph is 7 mpg</li> <li>Fuel rate for cars at 20 mph is 25 mpg</li> </ul> </li> </ul>		<ul style="list-style-type: none"> <li>NJTPA model</li> <li>EPA</li> </ul>
	CO2	<ul style="list-style-type: none"> <li>Determine amount of CO2 emitted per gallon of gas</li> <li>Determine the grams of CO2 burned per hour (grams per gallon * miles per hour / miles per gallon = grams CO2/hour)</li> <li>Calculate cost associated with CO2 emissions</li> </ul>	<ul style="list-style-type: none"> <li>10,180 grams of CO2 emitted/gallon of diesel</li> <li>8,887 grams of CO2 emitted/gallon of gas</li> <li>7,110 g CO2 burned per hour driving car</li> <li>29,085 g CO2 burned per hour driving truck</li> <li>~\$60 cost/ton of CO2 emitted</li> </ul>	<ul style="list-style-type: none"> <li>EPA</li> <li>EPA, US DOT, NHTSA</li> </ul>
	NOx	<ul style="list-style-type: none"> <li>Use known values of grams of NOx emitted per mile and grams of CO2 emitted per mile</li> <li>Assume same ratio of grams emitted per hour of NOx and CO2 to determine amount of NOx emitted per hour</li> <li>Calculate cost associated with NOx emissions</li> <li>Calculate health impacts of additional NOx emitted into atmosphere</li> </ul>	<ul style="list-style-type: none"> <li>404 grams CO2 emitted per mile for car</li> <li>2,130 grams CO2 emitted per mile for truck</li> <li>0.69 grams of NOx emitted per mile</li> <li>12 grams NOx emitted per hour driving car</li> <li>50 grams NOx emitted per hour driving truck</li> <li>~\$7,350 cost/ton of NOx emitted</li> <li>0.002 deaths per ton of NOx emitted</li> <li>0.12 work loss days per ton NOx emitted</li> <li>0.69 incidents of minor Restricted Activity Days per ton of NOx emitted</li> </ul>	<ul style="list-style-type: none"> <li>EPA</li> <li>EPA, US DOT, NHTSA</li> <li>EPA</li> </ul>
	NOx	<ul style="list-style-type: none"> <li>Use known values of grams of PM 2.5 emitted per mile and grams of CO2 emitted per mile</li> <li>Assume same ratio of grams emitted per hour of PM 2.5 and CO2 to determine amount of PM 2.5 emitted per hour</li> <li>Calculate cost associated with PM 2.5 emissions</li> <li>Calculate health impacts of additional PM 2.5 emitted into atmosphere</li> </ul>	<ul style="list-style-type: none"> <li>404 grams CO2 emitted per mile for car</li> <li>2,130 grams CO2 emitted per mile for truck</li> <li>0.004 grams of PM 2.5 emitted per mile</li> <li>0.08 grams PM 2.5 emitted per hour driving car</li> <li>0.32 grams PM 2.5 emitted per hour driving truck</li> <li>~\$336K cost/ton of PM 2.5 emitted</li> <li>0.1 deaths per ton of PM 2.5 emitted</li> <li>5.9 work loss days per ton NOx emitted</li> <li>35 incidents of minor Restricted Activity Days per ton of NOx emitted</li> </ul>	<ul style="list-style-type: none"> <li>EPA</li> <li>EPA, US DOT, NHTSA</li> <li>EPA</li> </ul>

# Environmental and safety impact methodology (2/2)

	Description of analysis	Coefficients	Source
Safety	<ul style="list-style-type: none"> <li>Input from NJTPA model: additional minutes traveled by cars and trucks in each scenario</li> </ul>		
	<ul style="list-style-type: none"> <li>Split safety impacts into 5 categories and using data on crashes per 100 million minutes traveled, calculated the number of additional crashes</li> </ul>	<ul style="list-style-type: none"> <li>0.53 fatalities/100 mil minutes</li> <li>0.83 major crashes/100 mil minutes</li> <li>9.31 moderate crashes/100 mil minutes</li> <li>45.58 minor crashes/100 mil minutes</li> <li>185.5 PDO/100 mil minutes</li> </ul>	CDC, National Safety Council
	<ul style="list-style-type: none"> <li>Calculate cost associated with additional crashes in each category</li> </ul>	<ul style="list-style-type: none"> <li>\$1,470,656 cost/fatality</li> <li>\$101,238 cost/major crash</li> <li>\$26,659 cost/moderate crash</li> <li>\$12,823 cost/minor crash</li> <li>\$4,724 cost/PDO</li> </ul>	

# Contents

- Ⓐ Surface transportation (passenger)
- Ⓑ Surface transportation (freight)
- Ⓒ Air impact
- Ⓓ Safety impact
- Ⓔ Health impact
- Ⓕ Housing price impact
- Ⓖ Cumulative impact
  - Customer experience
  - **Methodology and appendix**
    - Diversions
    - Surface transportation (freight)
    - Air impacts
    - Safety and health impacts
    - **Housing price impacts**
    - Customer experience

# Methodology for home price analysis

	Description of analysis	Coefficients	Source
New Jersey home prices	<ul style="list-style-type: none"> <li>Using the “ARC Effect”, segment home prices by station and “distance bucket” — i.e., distance from the station</li> </ul>		
	<ul style="list-style-type: none"> <li>Calculate pre-tunnel shutdown home price for each station and “distance bucket” based on the four key buckets:               <ul style="list-style-type: none"> <li>&lt;0.5 miles</li> <li>0.5-1 mile</li> <li>1-1.5 miles</li> <li>1.5-2 miles</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Average increase in home values per minute reduction in trip times, \$2018               <ul style="list-style-type: none"> <li>\$3,409 for &lt;0.5 miles</li> <li>\$2,268 for 0.5-1 mile</li> <li>\$1,310 for 1-1.5 miles</li> <li>\$882 for 1.5-2 miles</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>RPA, “The ARC Effect” (2010)</li> </ul>
	<ul style="list-style-type: none"> <li>Adjust numbers specific to each county based on change in median home price from 2008-2017, using census data</li> </ul>		<ul style="list-style-type: none"> <li>US Census</li> </ul>
	<ul style="list-style-type: none"> <li>Input from NJTPA model: Average increase in commuter time from each New Jersey station</li> </ul>		<ul style="list-style-type: none"> <li>NJTPA model analysis</li> </ul>
	<ul style="list-style-type: none"> <li>Calculate cumulative losses in home values for each station               <ul style="list-style-type: none"> <li>[Station A trip-time improvement] * [Number of housing units within 0.5 miles of Station A] * [Average decrease per minute-equivalent for homes within 0.5 mile] ...</li> </ul> </li> </ul>		<ul style="list-style-type: none"> <li>RPA, “The ARC Effect” (2010)</li> </ul>
	<ul style="list-style-type: none"> <li>Calculate the percent decrease in home value due to tunnel shutdown for each station</li> </ul>		
	<ul style="list-style-type: none"> <li>Aggregate cumulative losses across stations to size full impact of tunnel shutdown</li> </ul>		

# Contents

- Ⓐ Surface transportation (passenger)
- Ⓑ Surface transportation (freight)
- Ⓒ Air impact
- Ⓓ Safety impact
- Ⓔ Health impact
- Ⓕ Housing price impact
- Ⓖ Cumulative impact
  - Customer experience
  - **Methodology and appendix**
    - Diversions
    - Surface transportation (freight)
    - Air impacts
    - Safety and health impacts
    - Housing price impacts
    - **Customer experience**

# Methodology for customer experience impacts

## Description of analysis

## Source

### Key assumptions

- Travel times
- Number of people/businesses in each user group

---

- Profile information (e.g. income, origin/destination, professional/family details)

- NJTPA model

---

- Assumption

### Method

- Segment users, prioritize profiles, and fill-in profile information (e.g. income, O/D, professional/family details)
- List journey steps and determine timings for current and alternative journeys
- For relevant profiles, determine travel times and aggregate number of users for using Arup model output. Use reference TAZs in analysis spreadsheet for each user
- Calculate relevant costs, delay hours, aggregation impacts, etc. using analysis spreadsheet for each user. Reference “route alternatives” tab to sum travel time of each journey step and “aggregations” to sum data points on user group aggregation impacts

- NJTPA model

---

- Research, interviews