

TRANSPORTATION RESEARCH BOARD

The Mighty River — Inland Waterway Resilience Analysis

December 15, 2021

@NASEMTRB
#TRBwebinar

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- 1.5 Professional Development Hour (PDH) – see follow-up email for instructions
- You must attend the entire webinar to be eligible to receive PDH credits
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#TRBwebinar

AICP Credits

- Eligible for 1.5 AICP CM credits
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Learning Objectives

1. Analyze resiliency and economic equity in a complex marine network
2. Determine how to improve resilience, economic equity, and freight vulnerabilities



THE MIGHTY RIVER – INLAND WATERWAY RESILIENCE ANALYSIS



Sara Walfoort
Southwestern PA Commission

The River System that Built America

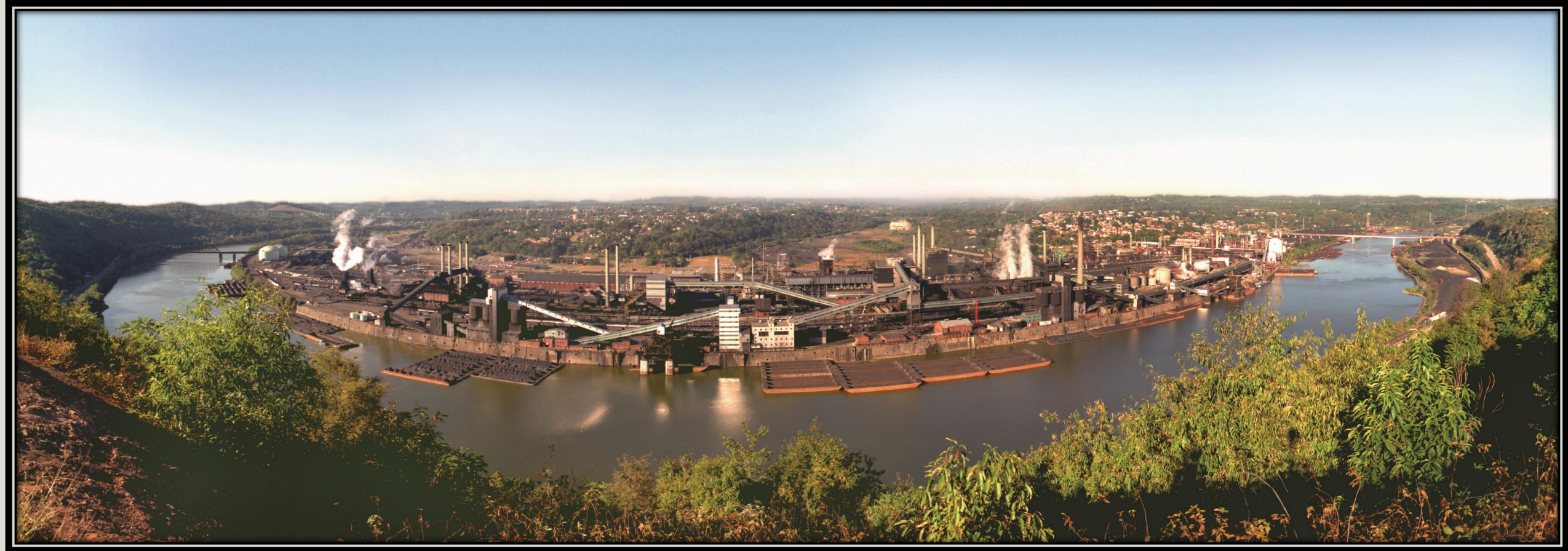
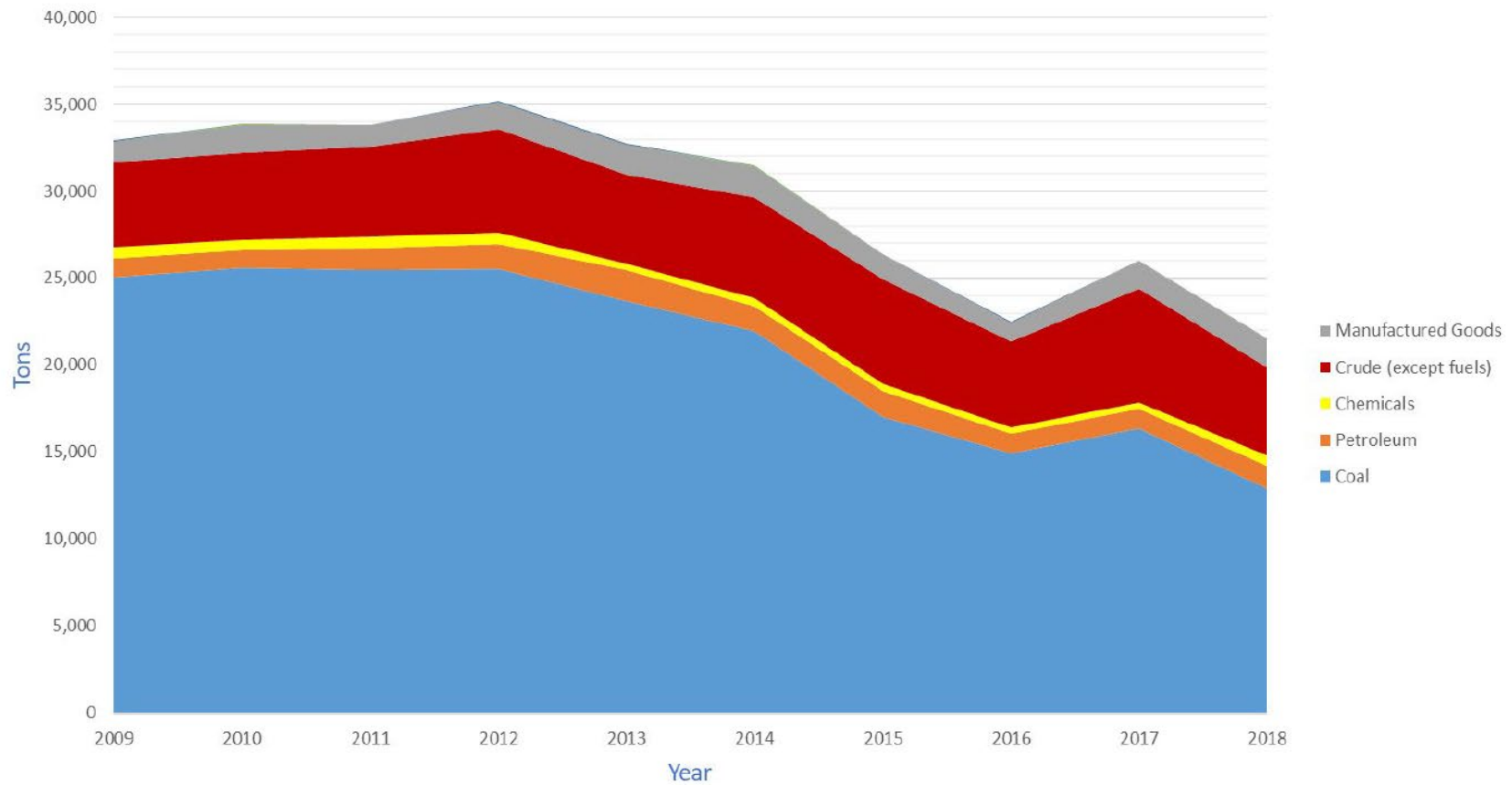
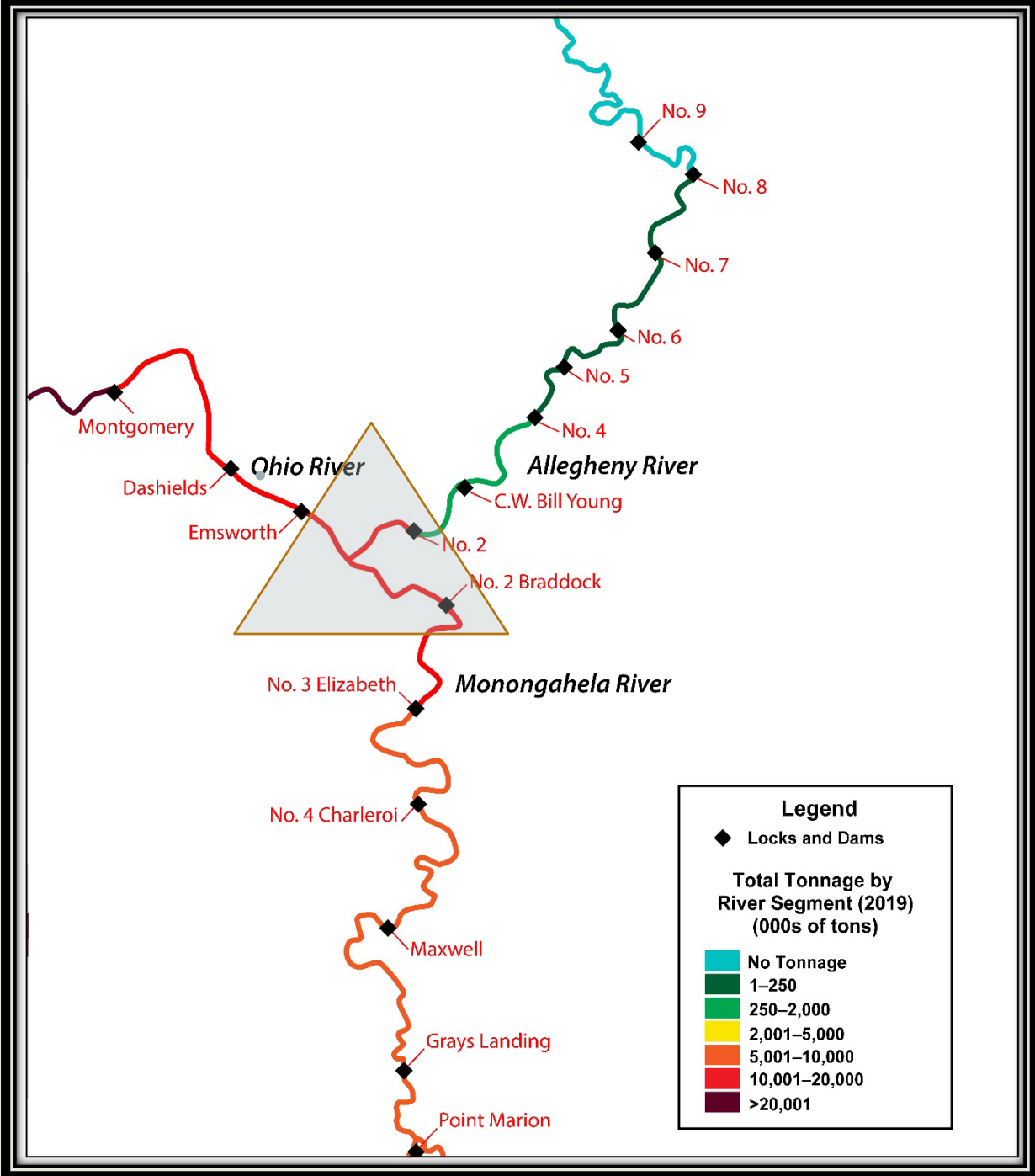


Photo used with permission of USS



Year
Source: (1)

Figure 5. Port of Pittsburgh Commodity Tonnages, 2009–2018 (000s).

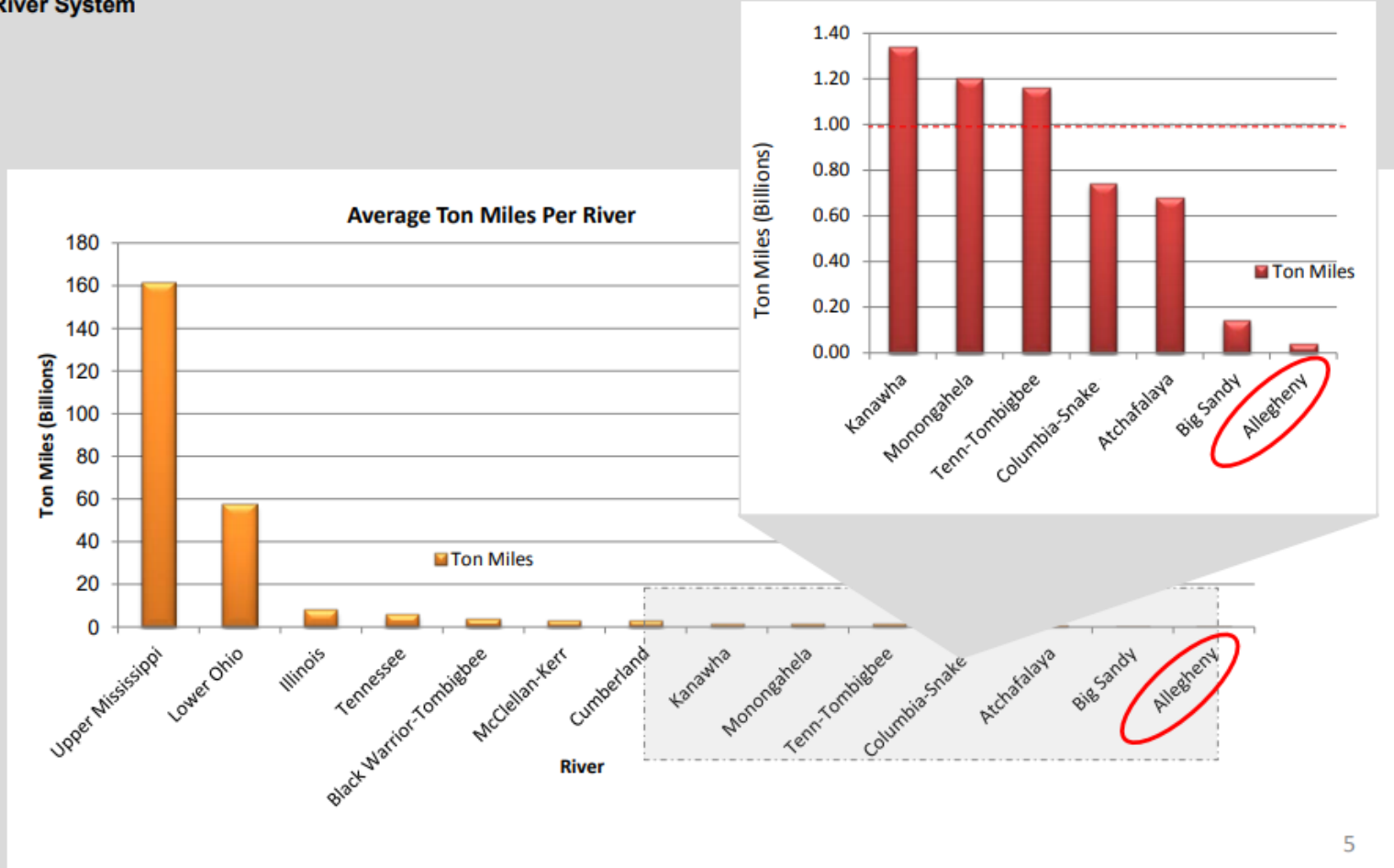


- Immediately east of these waterways rise the Allegheny Mountains, part of the Appalachian system.
- Water flowing downhill from the higher elevations to the east must be “pooled” by dams to permit depths sufficient to accommodate year round commercial navigation.
- Locks represent the “elevators” between the stepwise progression of pools, and permit the passage of commercial and recreational vessels.
- Locks and dams represent vital transportation, environmental and economic assets in our region.
- Commercial use of the locks tends to increase as the river progresses westward, as commodities diversify and overall river uses, barges and freight volumes expand.
- But existing metrics of lock utilization and value jeopardize the potential for continued investment in the outermost reaches of the river system.

The Allegheny River (Compared Nationally)

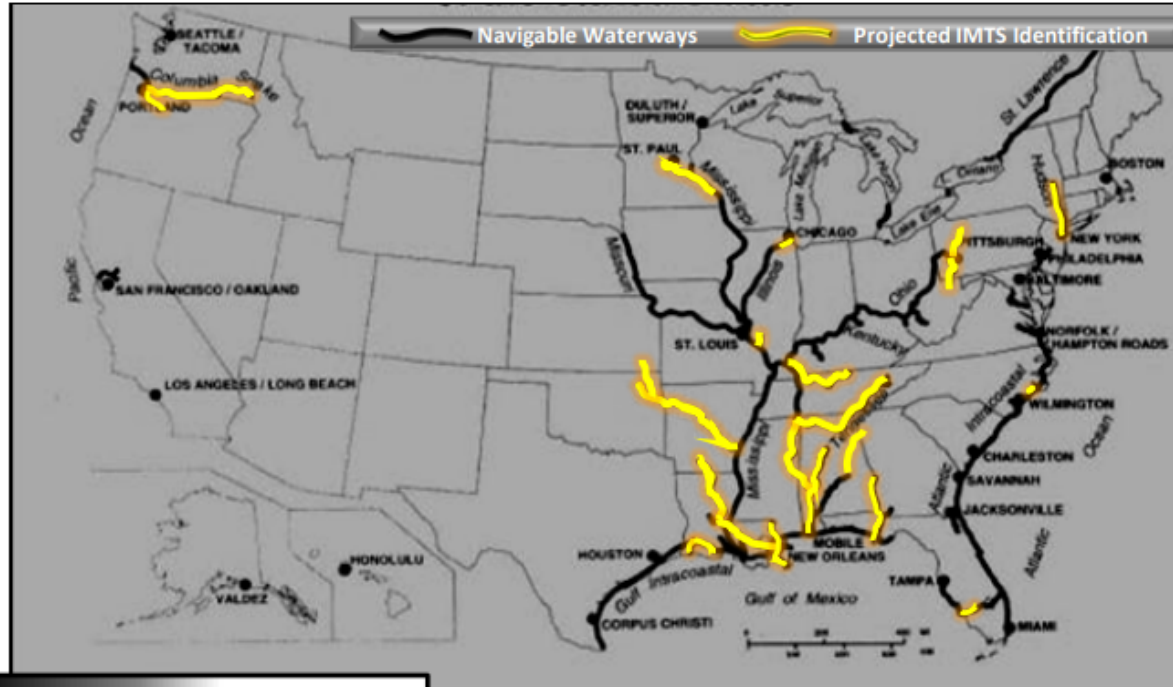
Low Use Navigation Systems: Less than 1 Billion River Ton Miles*

*Ton Mile = Tons of cargo X number of miles moved on a specific River System



Paying for Maintaining our Nation's Aging Infrastructure

Budget reductions require tough decisions on how to invest our Nation's resources to maintain and operate the system



Service
Levels

Exceptions

Other
Considerations

Allegheny River Navigation
Projects are authorized for
Commercial Navigation

--Tonnage for Funding--

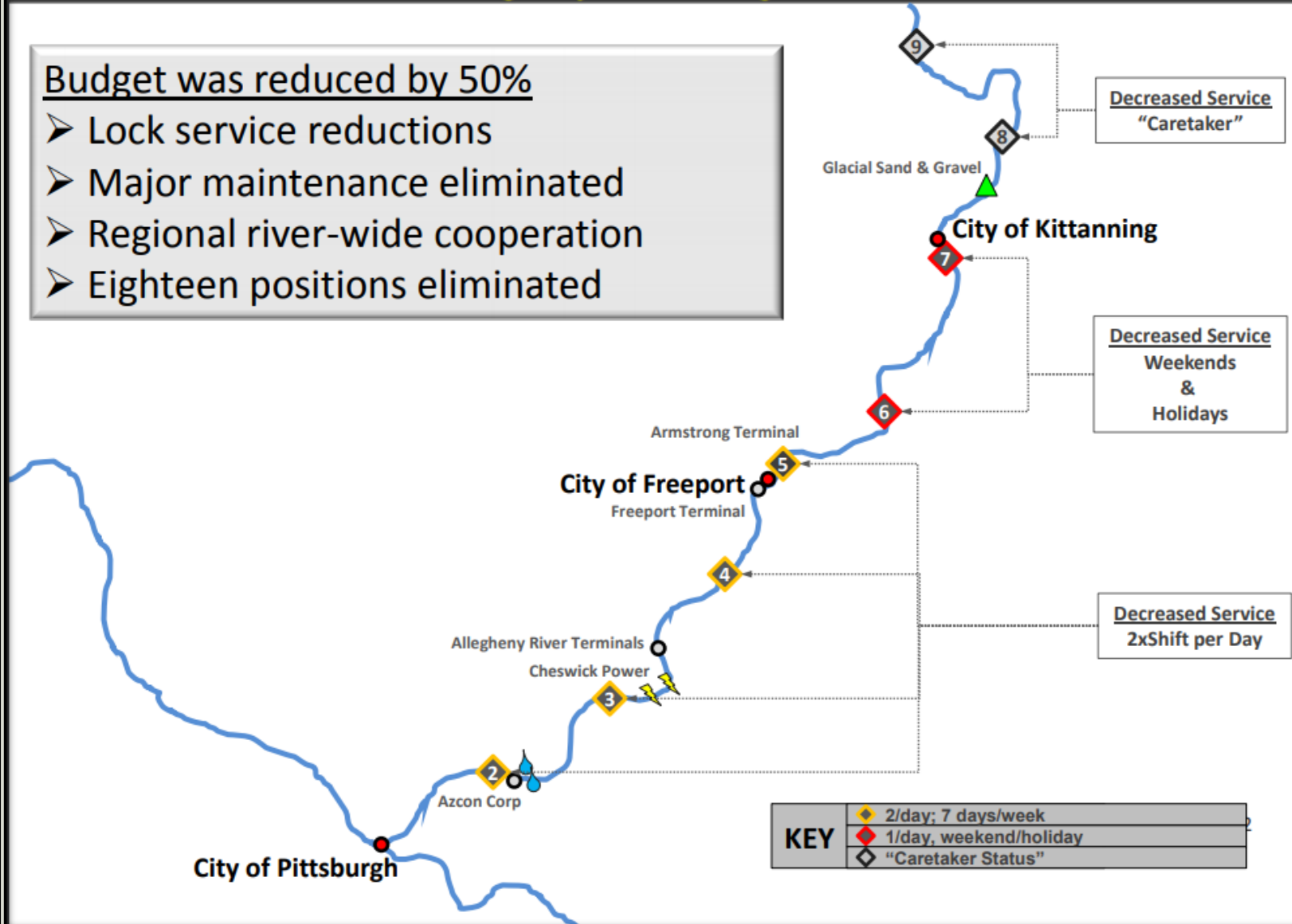
--Lockages for Service Levels--

THE IMPACTS OF IMTS IN SOUTHWESTERN PA

FY12 Allegheny River Budget Situation

Budget was reduced by 50%

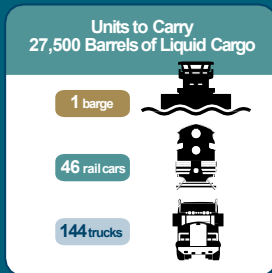
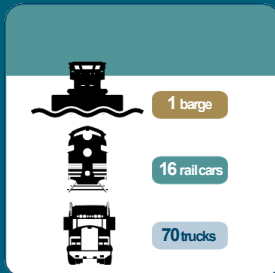
- Lock service reductions
- Major maintenance eliminated
- Regional river-wide cooperation
- Eighteen positions eliminated





BARgEs PuLL THEIRWEIGHt

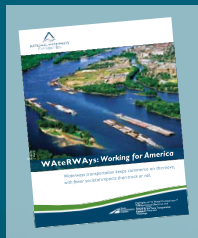
One common barge tow carries the load of hundreds of rail cars or trucks. As a mode of transportation, inland waterways have the capacity to transport today's bulk commodities and intermodal cargo, and are prepared to accommodate cargo diverted from overcrowded highways and railways in the future.




One loaded covered hopper barge carries 58,333 bushels of wheat, enough to make almost 2.5 million loaves of bread.



A loaded tank barge carries 27,500 barrels of gasoline, enough to keep about 2,500 automobiles running for an entire year.

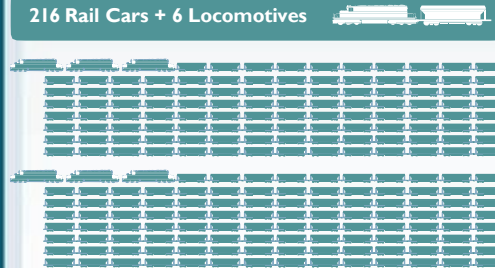


Statistics provided by the National Waterways Foundation from a study conducted by the Texas Transportation Institute. A copy of this report, titled *Waterways: Working for America* can be found on the Foundation's website: www.nationalwaterwaysfoundation.org

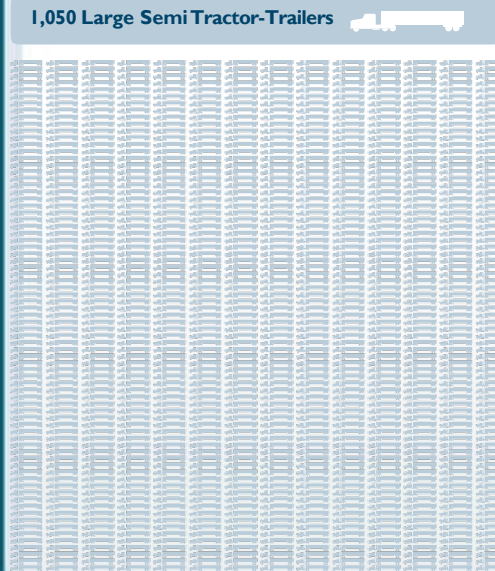
One 15-Barge Tow



216 Rail Cars + 6 Locomotives



1,050 Large Semi Tractor-Trailers

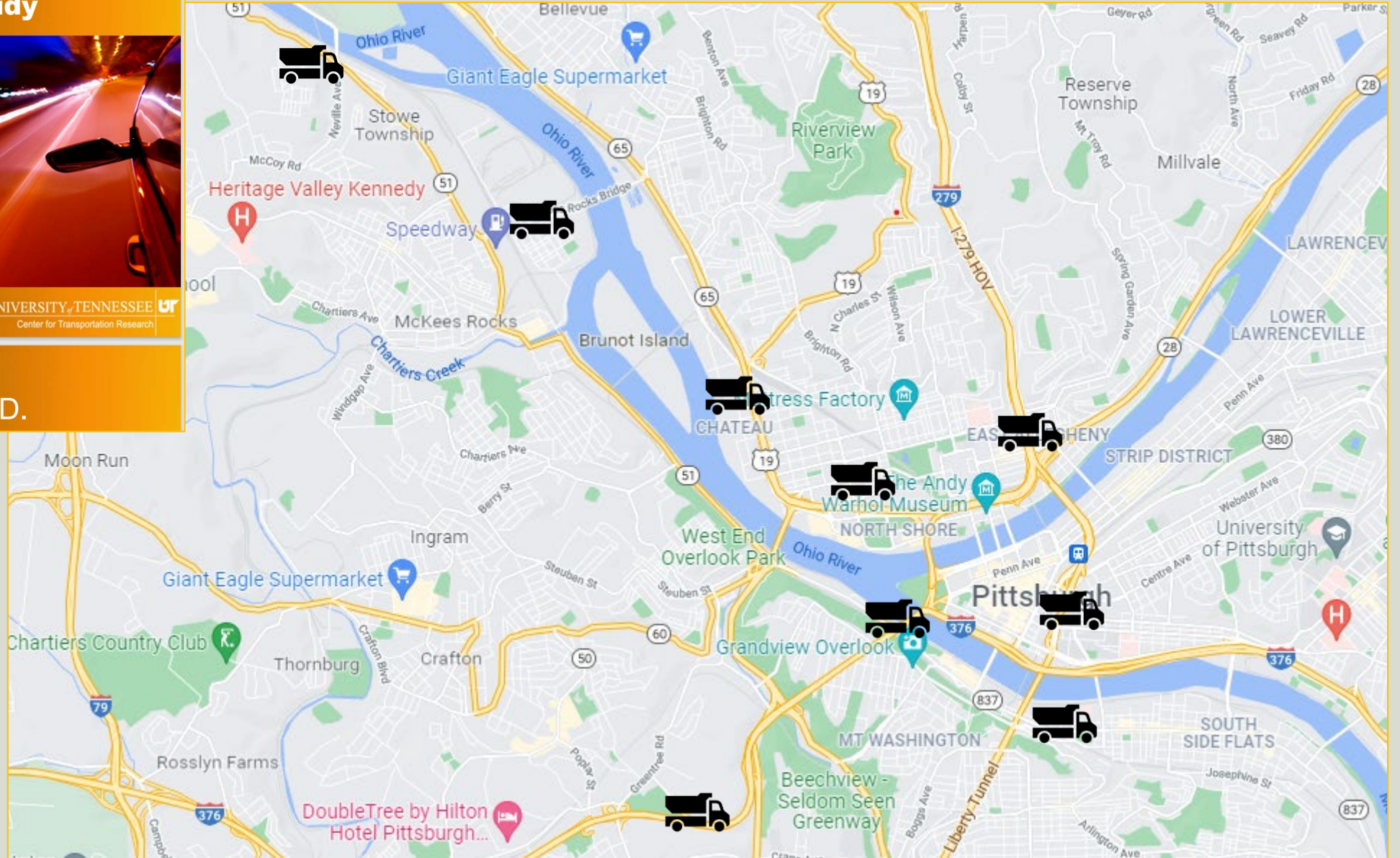


Pittsburgh Area Lock Closure Externality Study

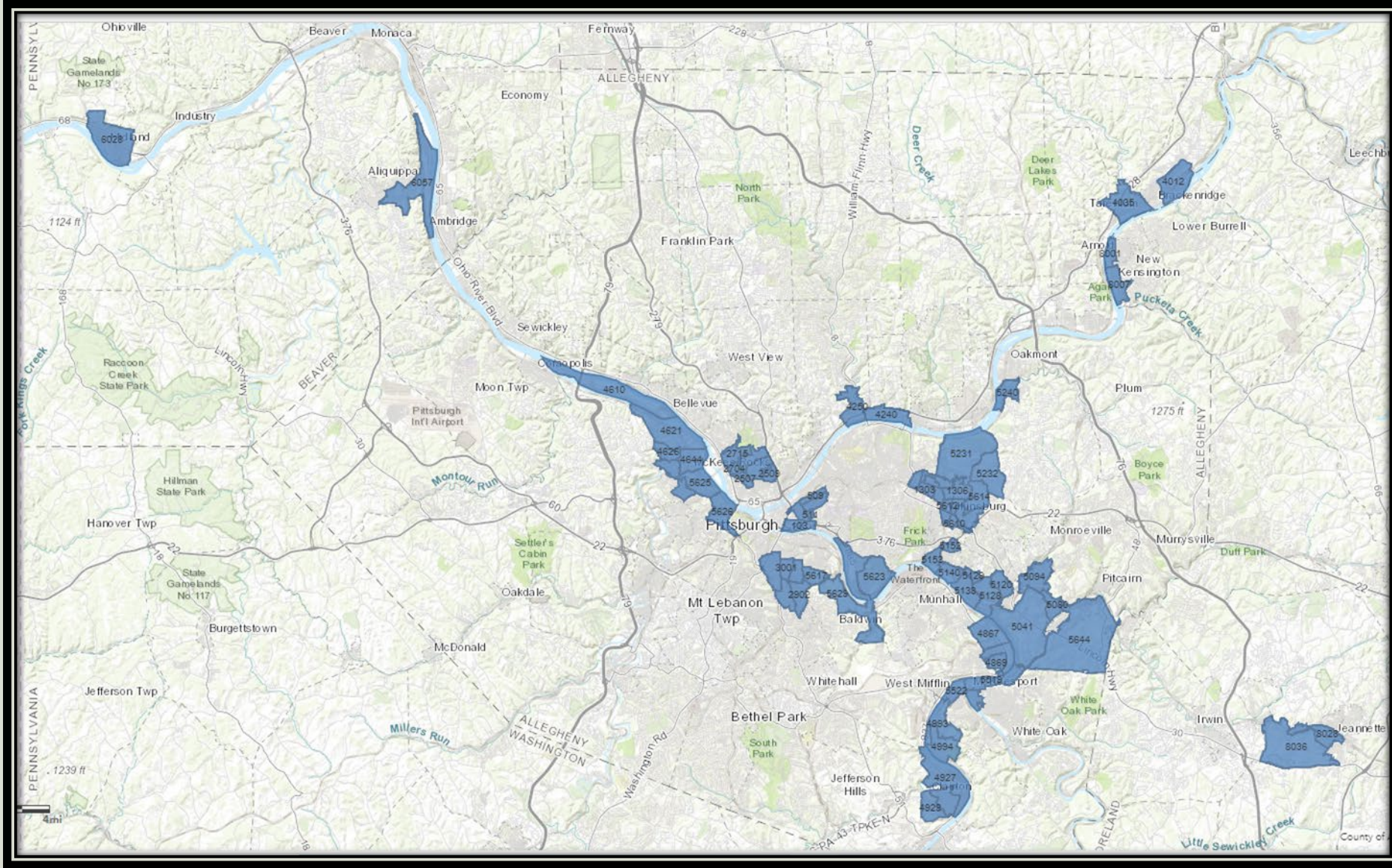


THE UNIVERSITY OF TENNESSEE
Center for Transportation Research

Larry Bray, Ph.D.



FEDERAL OPPORTUNITY ZONES IN SW PA



THIS PRESENTATION INCORPORATES PORTIONS OF THE FOLLOWING WORKS.

The Port of Pittsburgh: Impact, Opportunities and Challenges, Port of Pittsburgh Commission, 2021

Choke Point of a Nation: The High Cost of an Aging River Lock, New York Times, Nov 23, 2016

Allegheny River Service Changes Stakeholders Meeting, COL William Graham, District Engineer, USACE, Oct 24, 2012

Modal Diversion Impacts on Resident Traffic, Larry G. Bray, University of Tennessee, Knoxville, Presentation to TRB Joint Summer Meeting Multimodal Freight/Waterways Track July 12, 2010 Minneapolis, MN

For More Information: Sara Walfoort, Freight Planning Mgr, Southwestern PA Commission, Swalfoort@spcregion.org

CASE STUDY:

CUMBERLAND/TENNESSEE RIVER INLAND WATERWAY RESILIENCE ANALYSIS

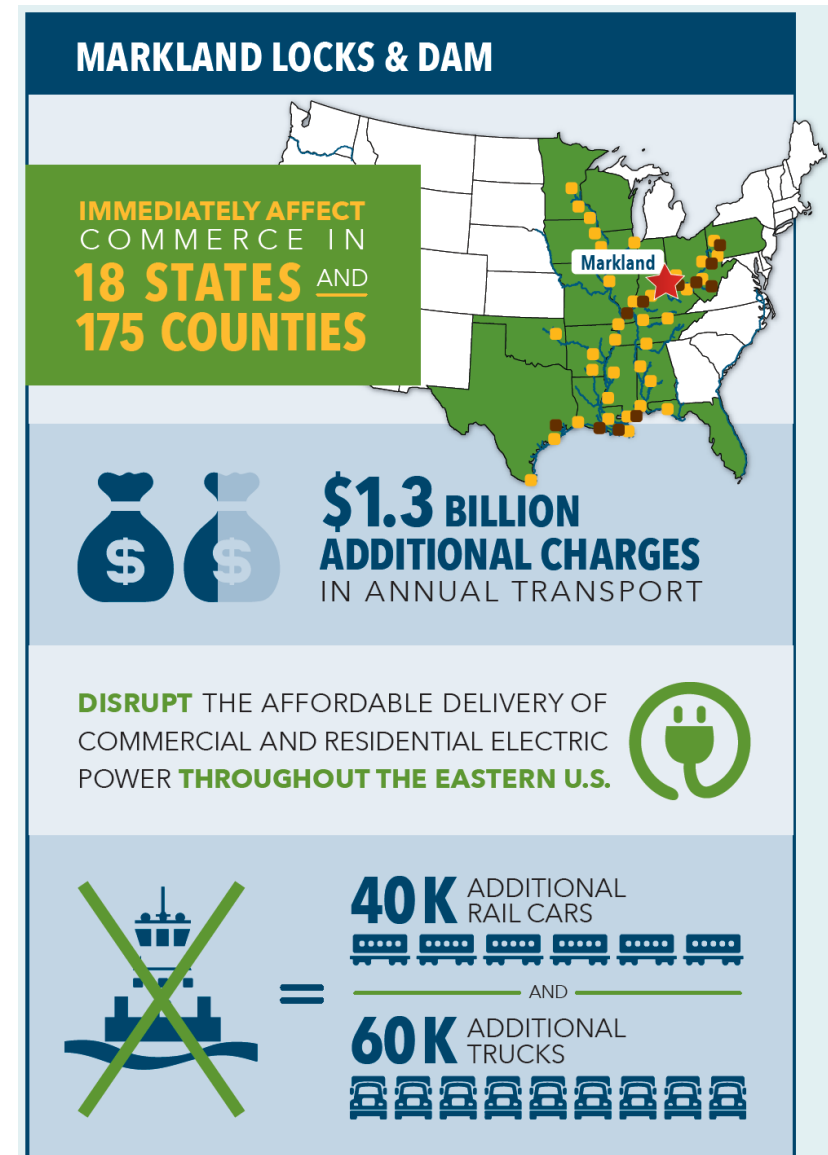
IN SUPPORT OF THE DHS/USACE PORT RESILIENCE GUIDE



Janey Camp, PI
Craig Philip, Co-PI
Miguel M. Moravec

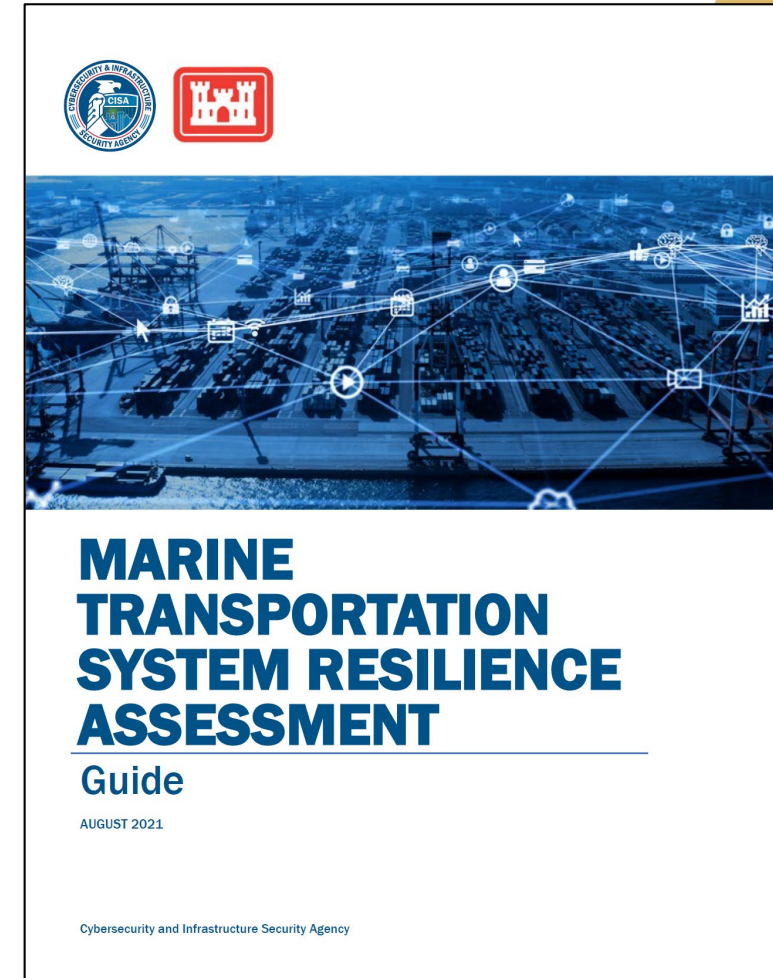
RESILIENCE FOR THE INLAND SYSTEM

- Outages on the inland system have significant impacts
- Ports/terminals provide critical connections between modes for supply chains



PORT RESILIENCE GUIDE

- The MTS resilience guide advocates for a functional approach to characterization
- The MTS provides two major functions--the transport of people and cargo—and relies upon several sub-functions to enable them:
 - Navigation, cargo transfer, storage, cargo tracking/monitoring, ship services, etc.
- Systems can be characterized by understanding which infrastructure supports which functions throughout the MTS being assessed



CASE STUDIES TO VALIDATE GUIDE PROCESS

1. Bayesian Network Analysis of Earthquake Resilience at the Port of Portland

Lead: Dr. Martin Schultz, EL

2. Inland Waterway Petroleum Supply Chain

Leads: Drs. Janey Camp and Craig Phillip, Vanderbilt

3. National MTS Network Analysis

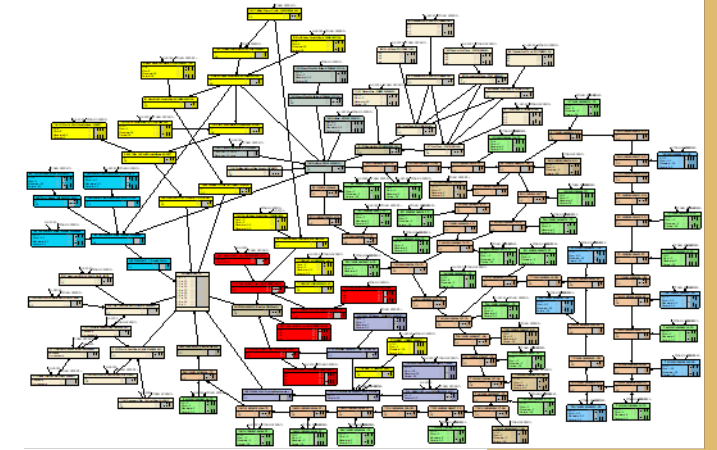
Lead: Dr. Brandan Scully, CHL

4. Caribbean Critical Supply Chains RRAP Project

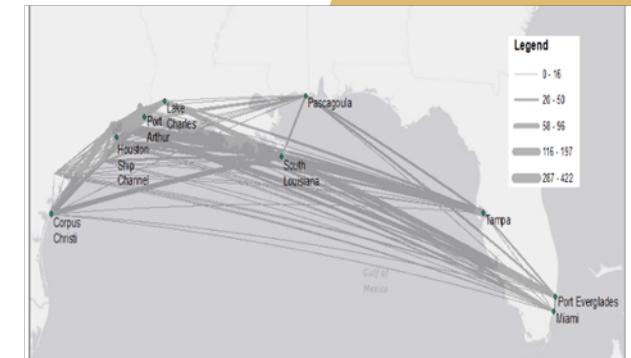
Leads: CISA HQ, Dr. Paul Lewis and James Butler, Argonne National Lab

5. Institutionalizing Resilience: Insights From Resilience Assessment Initiatives at Sea Ports

Leads: Austin Becker and Ellis Kalaidjian



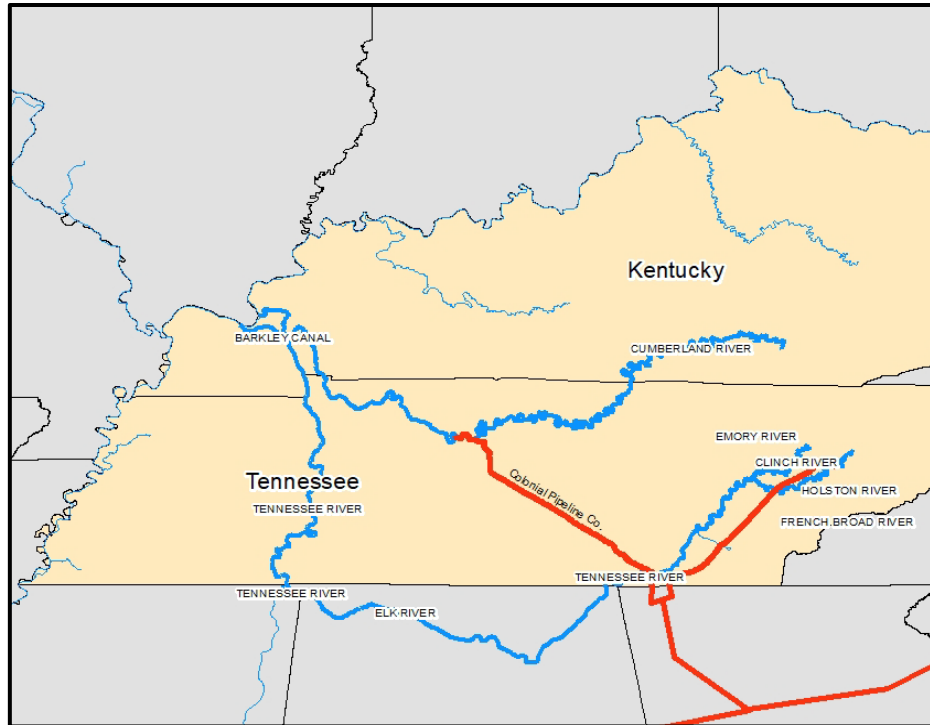
Bayesian Network of Critical Infrastructure Systems
Source: Schultz et al 2016



Network of Gulf Port Connectivity. Source: Scully and Chambers 2019.



TN/CUMBERLAND RIVER SYSTEM REGION OVERVIEW



INLAND WATERWAYS SUPPORT TENNESSEE'S KEY INDUSTRIES

Industry Sub-Category	Percent of Goods Shipped by Water (Tons)	Direct Tennessee Jobs
Crop production	↻ 34.2% of inbound ↻ 15.0% of outbound	1,860*
Utilities	↻ 12.0% of inbound	3,560
Transportation** & Warehousing	↻ 8.3% of inbound	38,560

*Total for Agriculture, Forestry, Fishing, and Hunting sector (NAICS 11)

**Related to water transportation

TOP INLAND WATERWAYS COMMODITIES BY WEIGHT (comprising 62% of total tonnage)

Sand, gravel, shells, clay, salt, and slag **9.4 million tons**

Coal, lignite, and coal coke **6.2 million tons**

Petroleum products **3.4 million tons**

TOP INLAND WATERWAYS COMMODITIES BY VALUE (comprising 65% of total value)

Gasoline **\$1.3 billion**

Fuel Oils **\$1.2 billion**

Transportation equipment, including railcars, aircraft, and commercial ships **\$857.7 million**

TENNESSEE'S INLAND WATERWAY ASSETS AT A GLANCE

Tennessee, Mississippi, and Cumberland Rivers

5 public ports

In 2018, **30.8M** tons of freight valued at

\$5.2 BILLION

moved on Tennessee's inland waterways, which is equivalent to **770,000 TRUCKS**

Avoided trucks translates into **reduced congestion, emissions, and crashes**, lessening impacts on highway infrastructure

PROJECT ACTIVITIES/TASKS

1. Plan and Convene **2 Stakeholder Roundtable Sessions**
2. Prepare summary of **Priorities and Takeaways** from the Stakeholder roundtables
3. Identify and secure necessary data to **Characterize the System**
4. **Apply *Guide* methodology**/approach and/or RRAP approaches to characterize/evaluate region
5. **Identify and evaluate 3 disruption scenarios**
6. **Estimate impacts for each scenario** on the case study area & the petroleum supply chain
7. **Identify potential operational resilience strategies** including operational variability and recovery time, etc.

Assessment Objectives

Define functions & characterize the system in steady state

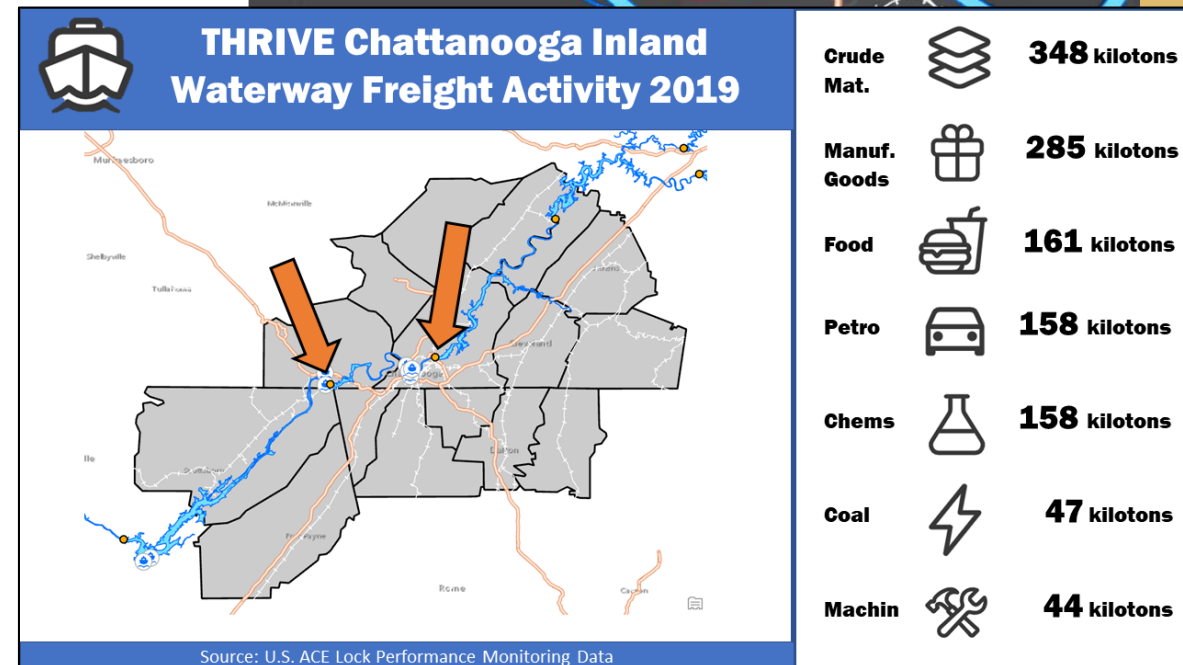
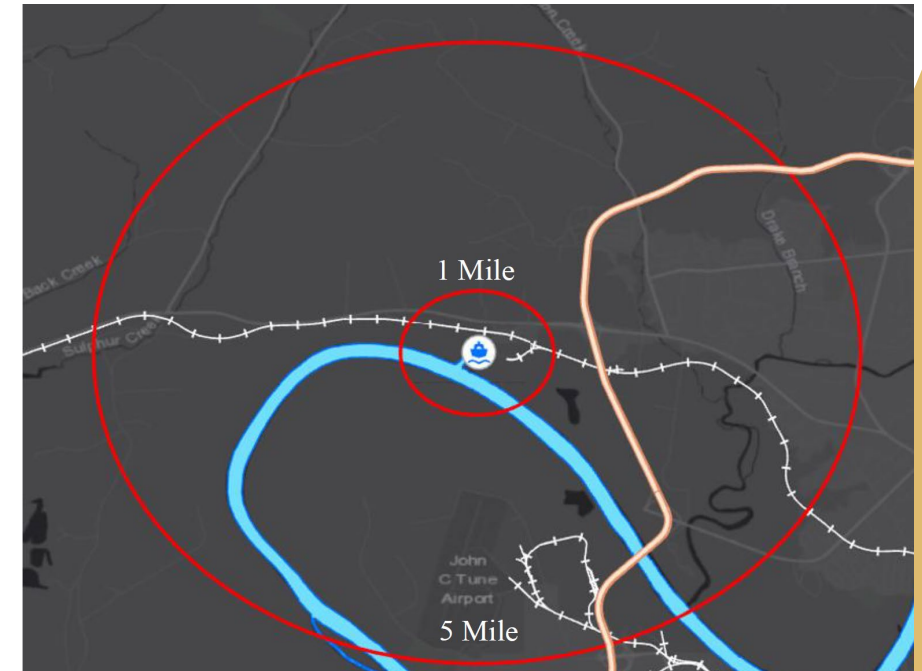
Analyze critical infrastructure & dependencies

Understand the impacts of disruptive events

ID & evaluate resilience enhancement alternatives

CHARACTERIZING THE REGION

- Considering key assets and infrastructure
- Evaluating connectivity and opportunities for multi-modal transfers
- Reviewing historical commodity flows (including during times of disruption)
- Identifying disruptions and potential impacts



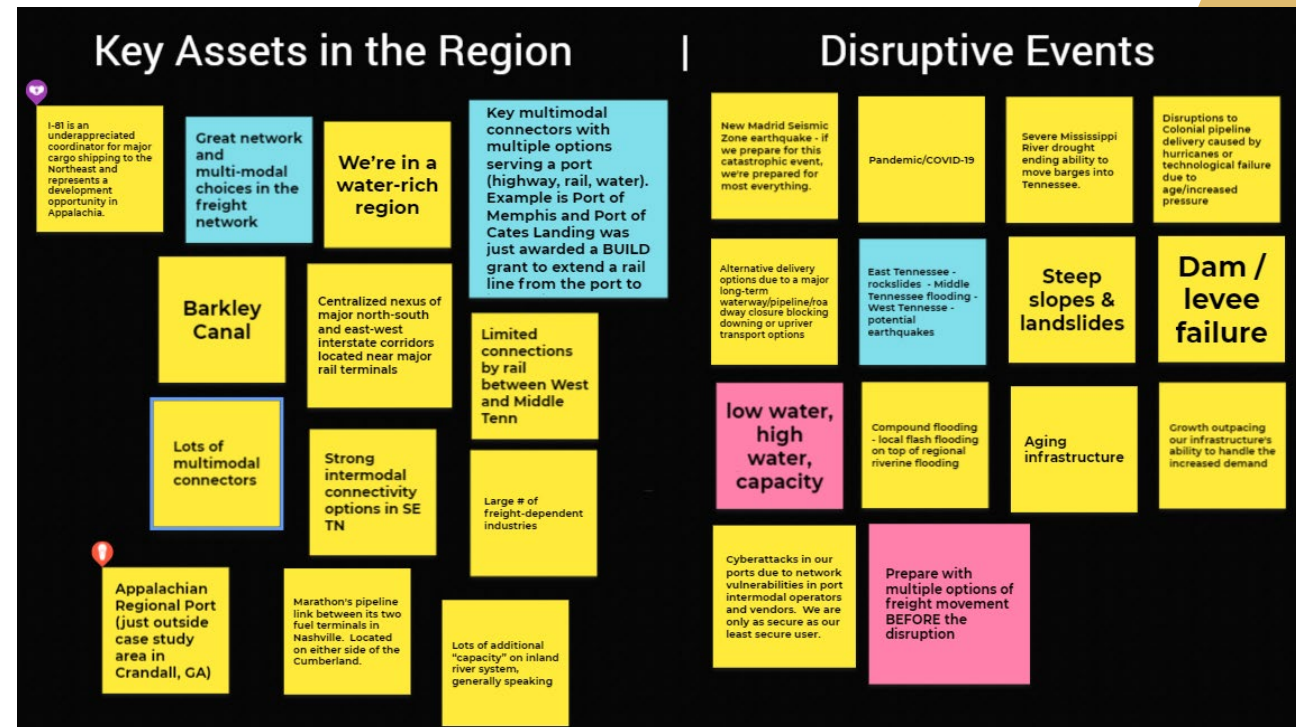
STAKEHOLDER INVOLVEMENT – MTG 1

- Key Assets Identified

- Port of Memphis Intermodal Hub
- Barkley Canal
- Tennessee–Tombigbee Waterway

- Disruptions Outlined

- Seismic, Waterway Outage, and Pipeline Disruption
- Lack of Redundancy in Petro and other supply chains
- Resilience Actions



SELECT DISRUPTION SCENARIOS

1. Multimodal Impact Event

- Colonial Pipeline Spur to Tennessee

2. Lock Outage

- Cheatham Lock and Dam Maintenance

3. Waterway Navigability Impacted by Earthquake

- New Madrid Fault Event Impacting Tennessee/Cumberland/Ohio River Confluence and Bridge Crossings

DISRUPTION SCENARIO:

COLONIAL PIPELINE SPUR TO TENNESSEE, SERVICE INTERRUPTION

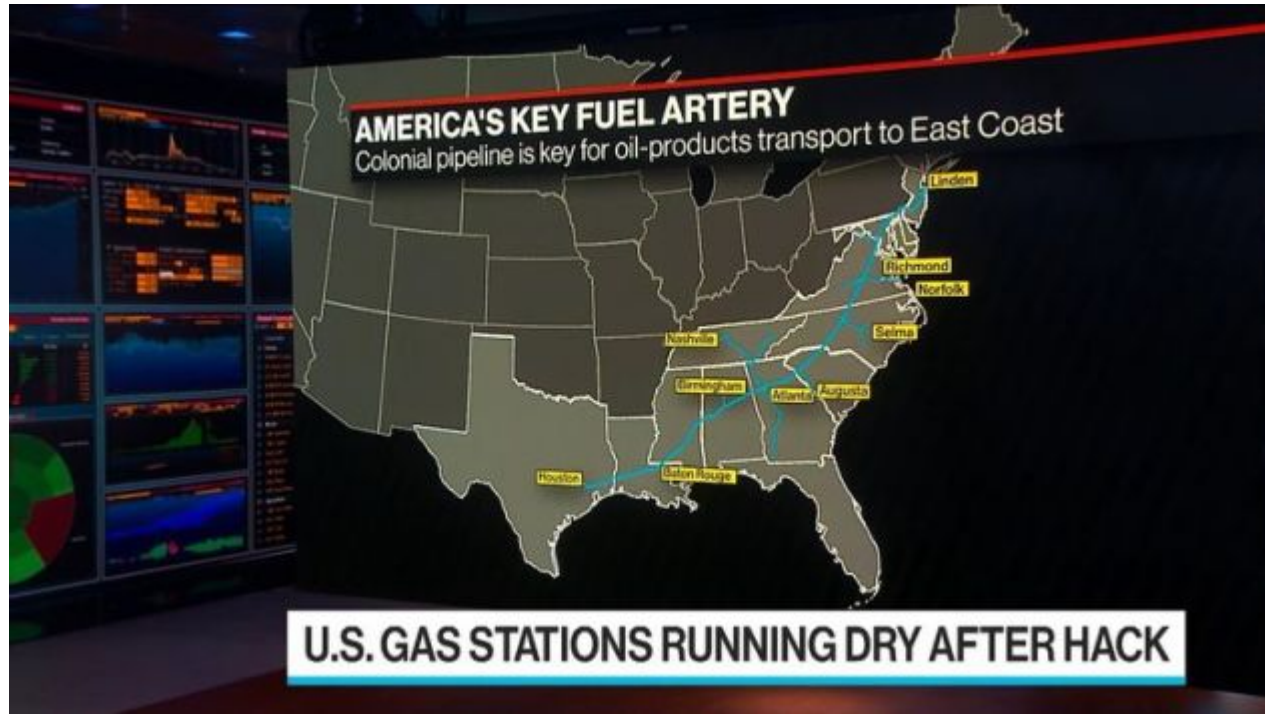
**CONTINGENCY PLANS, IMPACTS, LESSONS LEARNED,
RECOVERY AND RESILIENCE**



Miguel M. Moravec
PhD Student

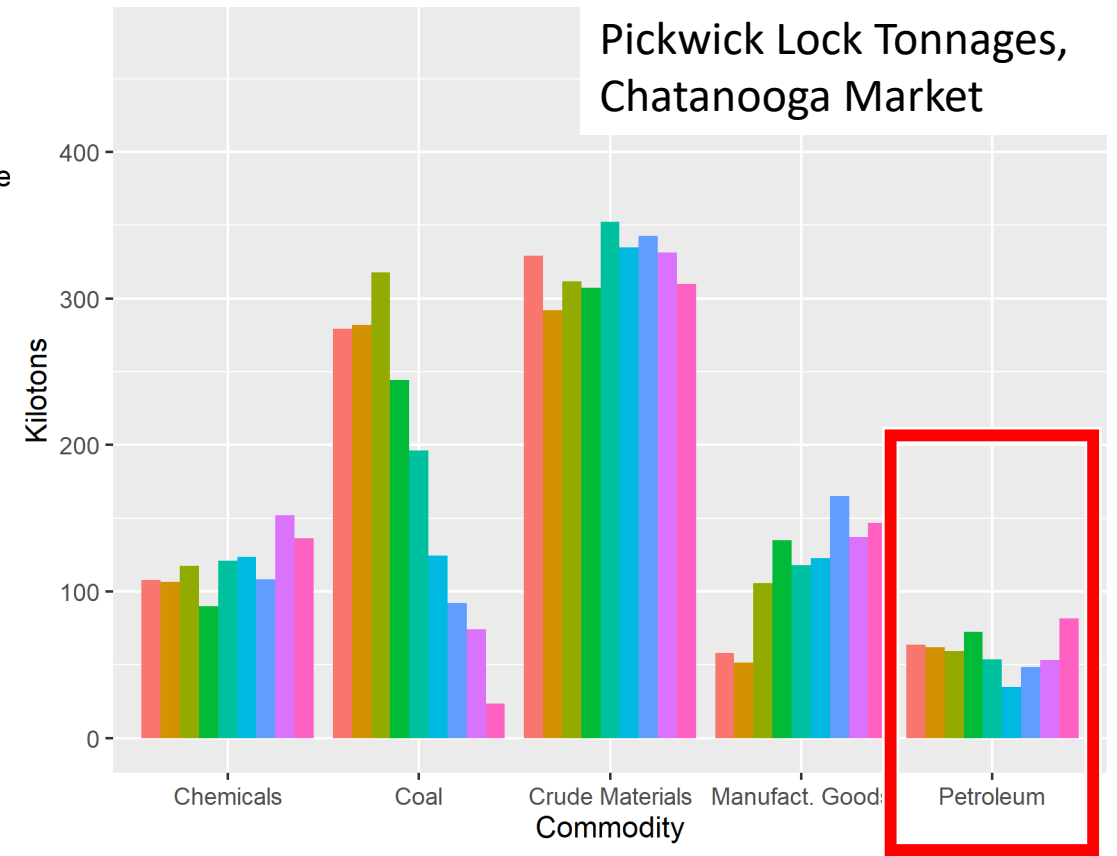
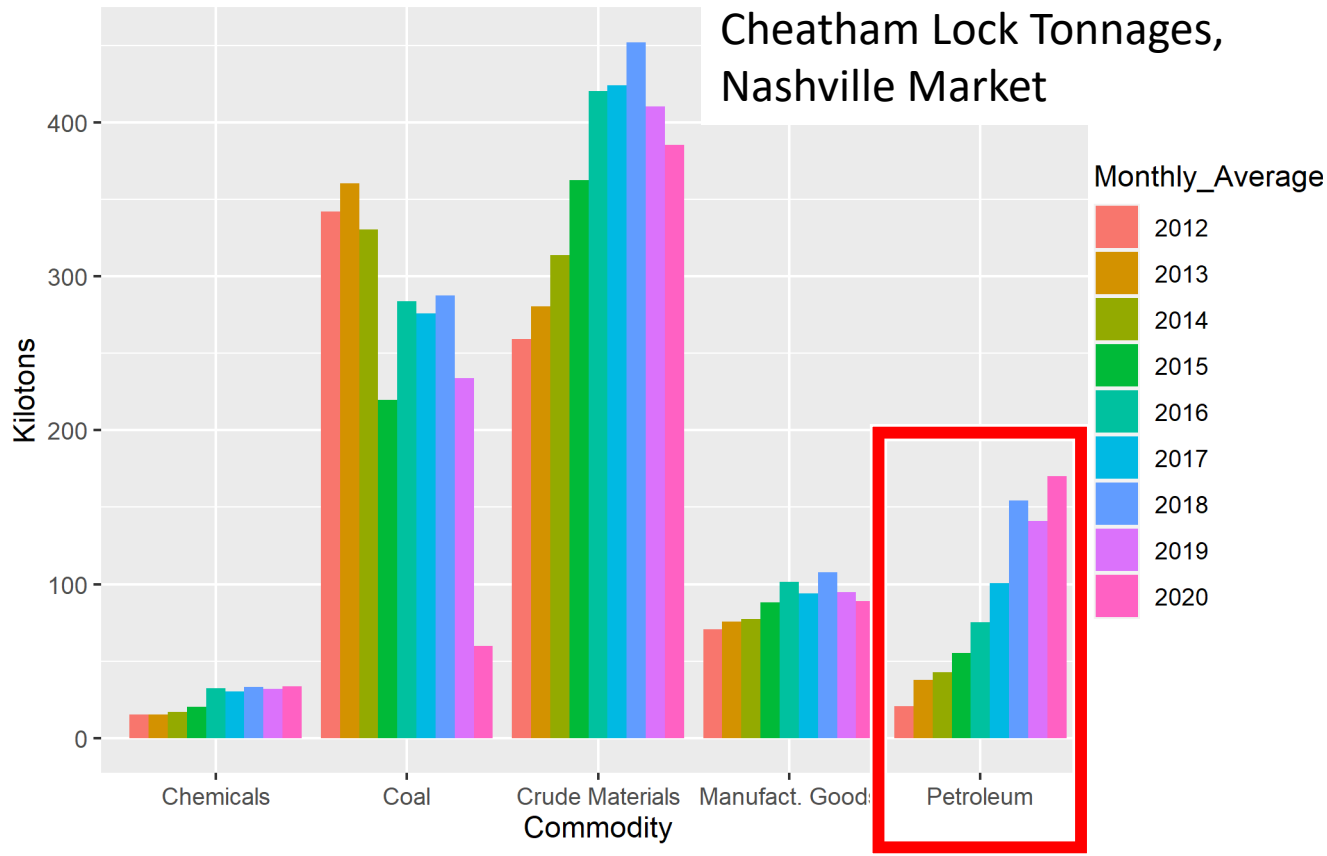
HISTORICAL DISRUPTIONS OF COLONIAL PIPELINE

2021 Ransomware Cyberattack



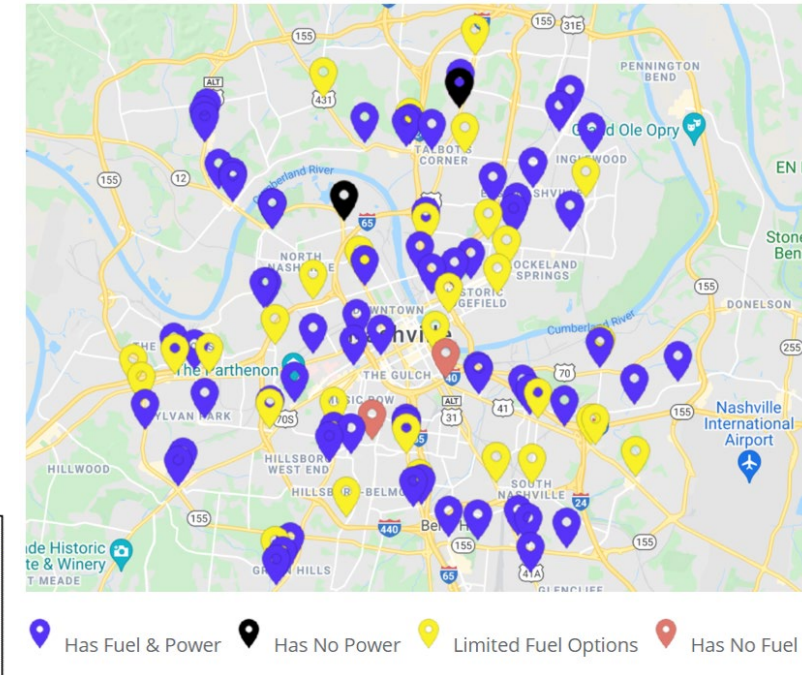
- 2017 Hurricane Harvey Closure
- 2016 Explosion Closure

SINCE 2012 RIVER DELIVERED REFINED PETROLEUM HAS SUPPLEMENTED THE COLONIAL PIPELINE INTO THE NASHVILLE MARKET



WHAT HAPPENED DURING THE 2021 PIPELINE DISRUPTION?

- Source: GasBuddy
 - Quoted by NPR, WSJ, the Tennessean
 - Daily Gas Station Outages by city, daily
 - Largest gas price discovery platform in North America
 - Caveat: crowdsourced



City	7 th Day Station Outages (%)	12 th Day Station Outages (%)	Annual Petro Vol (kt)	Population [43]	Per Capita Petro barge Volumes (kt/person)
Nashville, TN	34.4	18.9	1715	692,587	0.002476
Chattanooga, TN	44.6	34.1	158	179,690	0.000879
Knoxville, TN	41.4	31.6	85.83	186,173	0.000461
Raleigh, NC	75.7	44.1	0	464,485	0
Charlotte, NC	66.4	41.6	0	857,425	0
Asheville, NC	73	60.1	0	91,560	0

RESILIENCE ENHANCEMENT OPTIONS (REOs) IDENTIFIED IN PREVIOUS DHS MARINE RELATED PROJECTS

- **Compile and Document Information**

- Infrastructure vulnerabilities and priority list for repair
- Critical infrastructure lists
- Roles/responsibilities during disaster scenarios
- Standard and alternate operating procedures

- **Collaborate and Coordinate**

- Host a series of planning workshops to familiarize partners with risk
- Inform public and private entities of relevant vulnerabilities to systems and provide support for enhancing resiliency
- Work collaboratively with local, state, and federal emergency management organizations

- **Improve existing infrastructure**

- Address aging infrastructure (bridges, locks, dams)
- Undertake soil liquefaction mitigation efforts in earthquake prone areas
- Share results of natural hazard modeling on facility specific basis to encourage owner/operator hazard mitigation planning

- **Incorporate Additional Tools**

- Vessel Queue Prioritization and Sorting Tool (USCG)
- Cyber Security Evaluation Tool (CSET) and Cyber Resilience Review (CRR)

STAKEHOLDER MEETING 2

Disruption Scenario 1 – Multimodal Impacts

- Colonial Pipeline Spur to Tennessee, Service Interruption
 - Megan Simpson – USACE Nashville District
 - Ben Bolton – TDEC Office of Energy Program's (OEP)
 - Barry Gipson - James Companies, former Pipeline Company Executive
 - Moderator: Miguel Moravec – Vanderbilt University

Disruption Scenario 2 – Lock Outage

- Cheatham Lock and Dam Maintenance
 - Megan Simpson – USACE Nashville District
 - Gene Whelan - Pine Bluff Materials
 - Steve Southern - Ingram Barge Company
 - Moderator: Craig Philip – Vanderbilt University

Disruption Scenario 3 – Waterway Navigability Impacted by Earthquake

- New Madrid Fault Event
 - James M. Wilkinson, Jr. – Executive Director, CUSEC (Central US Earthquake Consortium)
 - Ben Bolton – TDEC Office of Energy Program's (OEP)
 - Moderator: Janey Camp - Vanderbilt University

RESILIENCY ENHANCEMENT OPTIONS FOR REGION

- **Expand Chattanooga and Knoxville terminals to accept fuel barges**
 - Theme: Improve existing infrastructure
 - Note: Colonial pipeline purchased one of the fuel terminals in Chattanooga, so when their services went offline it impacted that terminal as well
- **Increase Traffic on Tombigbee River**
 - Theme: Collaborate and Coordinate
 - Scenarios: Earthquake impacting Mississippi river, shutdown of colonial pipeline
 - Note: TennTom much more narrow than Cumberland, Tennessee
- **Update Building Codes**
 - Theme: Improve existing infrastructure
 - Scenarios: All
 - Proactive building codes are among best mitigation techniques

KEY TAKEAWAYS

- Evaluating resilience for an inland system (large or small) requires the following:
 - Stakeholder involvement
 - A well-defined process and good data to characterize the assets and opportunities
 - Consideration of scenarios (including or excluding multiple modes)
 - Wholistic approaches and partnerships

VANDERBILT CENTER FOR TRANSPORTATION AND OPERATIONAL RESILIENCY (VECTOR)



Craig Philip
Director of
VECTOR



Mark Abkowitz



Hiba Baroud



Janey Camp,
Associate Director
of VECTOR



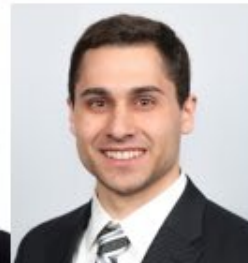
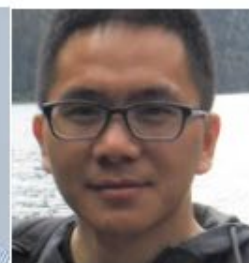
Bob Stammer



Dan Work



Abhishek Dubey



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Today's Panelists

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Vanderbilt University

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