



# AGING AND FAILING INFRASTRUCTURE SYSTEMS: NAVIGATION LOCKS

December 8, 2015; 1300 EST

PREPARED BY: OPERATIONAL ANALYSIS DIVISION

## SCOPE

The U.S. Department of Homeland Security/Office of Cyber and Infrastructure Analysis (DHS/OCIA) produces Critical Infrastructure Security and Resilience Notes in response to changes in the infrastructure community's risk environment from terrorist activities, natural hazards, and other events. This note summarizes the findings related to navigation locks identified in the National Risk Estimate on Aging and Failing Critical Infrastructure Systems, released by DHS/OCIA in December 2014.<sup>1</sup> This Critical Infrastructure Security and Resilience Note supports DHS leadership; other Federal, State, and local agencies; and private sector decision makers.

## KEY FINDINGS

- **Fifty-four percent of Inland Marine Transportation System (IMTS) structures are more than 50 years old; 36 percent are more than 70 years old.**
- **Mechanical breakdowns resulting in lock closures steadily increased from 2000 to 2010.**
- **The Inland Waterways Trust Fund (IWTF) is an important funding source for lock construction and rehabilitation, but the barge fuel tax that funds the IWTF has not increased since 1995. This tax would need to increase by more than 50 percent to have the same purchasing power today.**
- **Dam projects are expensive, and funds are limited. As a result, priority projects are often delayed, which leads to more unscheduled lock closures.**

## OVERVIEW

For this National Risk Estimate, DHS/OCIA subject matter experts highlighted the current state of critical infrastructure and identified the trends and physical characteristics that increased infrastructure risk of failure. The study also identified market, regulatory, and policy factors that affect infrastructure risk.

Forty-one States, including all States east of the Mississippi River, are served by commercially navigable waterways. The U.S. inland waterway system consists of 12,000 miles of navigable waterways in five systems: the Mississippi River, the Ohio River Basin, Great Lakes-St. Lawrence Seaway, the Gulf Intracoastal Waterway, and the Pacific Coast system. The inland waterway system includes more than 200 locks, which raise and lower river traffic between stretches of water of different levels.<sup>2,3</sup> Navigation locks are generally associated with dams, which provide the majority of the impoundment of water within the upstream pool, and are considered a Subsector under the Dams Sector.

<sup>1</sup> Office of Cyber and Infrastructure Analysis, National Risk Estimate on Aging and Failing Critical Infrastructure Systems, Washington, D.C.: Department of Homeland Security, December 2014.

<sup>2</sup> American Society of Civil Engineers, "2009 Report Card for America's Infrastructures: Inland Waterways," <http://www.infrastructurereportcard.org/a/#p/inland-waterways/overview>, accessed April 24, 2014.

<sup>3</sup> The Intracoastal Waterway is an inland waterway consisting of inlets, saltwater rivers, and bays that form a navigable route on the Atlantic and Gulf coasts.

The Nation's inland waterways facilitate the movement of 15 percent of all coal, 56 percent of all petroleum products, 22 percent of all basic chemicals, and 18 percent of all agricultural products transported in the United States. The inland waterway system moves more than 550 million tons of freight each year, valued at more than \$152 billion.<sup>4</sup>

The U.S. Army Corps of Engineers (USACE) is responsible for managing and maintaining most of the IMTS, including most of the navigation locks and dams. The U.S. Department of Transportation Saint Lawrence Seaway Development Corporation in cooperation with the Canadian Government maintains some locks.

## RISK OF FAILURE

Most locks are designed to last for 50 years, but 54 percent of IMTS locks are more than 50 years old, and 36 percent are more than 70 years old.<sup>5</sup> Many of these locks are in need of repair and replacement, and some lack basic maintenance. Concrete is crumbling at some locks, and some have not been painted in 25–30 years, increasing the risk of corrosion.<sup>6</sup>

Locks lacking maintenance or in need of repair and replacement are more likely to have unscheduled closures. Unscheduled closures are more costly than scheduled closures, because vessel operators and companies are unable to plan to offset the delays from these incidents.<sup>7</sup> The annual number of unscheduled lock closures has steadily increased since 1992. Fewer than 7,000 unscheduled closures occurred every year before 2000, and more than 7,000 occurred every year after 2000, peaking in 2008 with 13,250.<sup>8</sup> Unscheduled closures can result from weather, water surface conditions, tow conditions, lock conditions, or other events; Figure 1 shows that the total length of unscheduled delays specifically from mechanical breakdowns steadily increased from 2000 to 2010.<sup>9</sup>

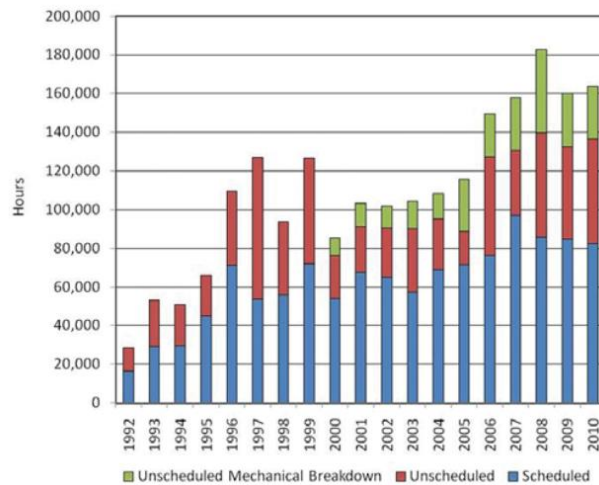


FIGURE 1—UNSCHEDULED OUTAGES DUE TO MECHANICAL BREAKDOWNS<sup>10</sup>

In 2013, unscheduled lock closures were often short, usually lasting fewer than 6 hours. In general, impacts resulting from these short-term closures are economic, but are not as significant as long-term, more catastrophic,

<sup>4</sup> American Society of Civil Engineers, "2013 Report Card for America's Infrastructure," <http://www.infrastructurereportcard.org/>, accessed April 25, 2013.

<sup>5</sup> U.S. Army Corps of Engineers, Navigation Data Center, "Lock Characteristics," <http://www.navigationdatacenter.us/db/lockchar/xls/>, accessed April 22, 2013.

<sup>6</sup> Glass, Pamela, "Head Lock: Neglect of locks and dams could result in a failure of the waterway system," <https://www.workboat.com/newsdetail.aspx?id=16860>, accessed April 29, 2013.

<sup>7</sup> Economic Development Research Group, Inc., Failure to Act: The Economic Impact of Current Investment Trends in Airports, Inland Waterways, and Marine Ports Infrastructure, Reston, VA: American Society of Civil Engineers, 2012.

<sup>8</sup> U.S. Army Corps of Engineers, Navigation Data Center, "Locks by Waterway: Lock Unavailability," <http://www.navigationdatacenter.us/lpms/lock2012webunavail.htm>, accessed June 13, 2013.

<sup>9</sup> U.S. Army Corps of Engineers, "Sustainable Solutions to America's Water Resources Needs,"

[http://planning.usace.army.mil/toolbox/library/Misc/Sustainable\\_Solutions-2011-15.pdf](http://planning.usace.army.mil/toolbox/library/Misc/Sustainable_Solutions-2011-15.pdf), accessed May 13, 2014.

<sup>10</sup> Ibid.

closures that require goods to be transported via other, more expensive, methods, including alternative maritime routes, trains, and commercial vehicles. For some goods, no readily available transportation alternatives exist.

The Economic Development Research Group, Inc., estimated that if current investment trends continue, deterioration of the inland waterways and ports will result in \$1.3 trillion in lost business sales by 2020, \$270 billion in lost exports by 2020, and almost \$2 trillion in lost exports by 2040. In addition, DHS/OCIA assessed that 738,000 fewer jobs will exist by 2020, and 1.4 million fewer jobs will exist by 2040.<sup>11</sup>

Weather can also have negative consequences for the IMTS. Severe droughts can lower the water level of major rivers resulting in barges' inability to safely navigate the waterways. Droughts can last for long periods and have severe economic consequences. High water levels and floods can also prevent barges from safely traveling on portions of rivers.

## REGIONS OF INCREASED RISK

Some locks are more economically critical than others based on the amount and type of goods that pass through them and the alternative transport methods used during lock closures. The most economically critical locks and the locks with the most closures are not located in any one region.

## DEPENDENCIES AND INTERDEPENDENCIES

Many sectors are critically dependent on navigation locks for transportation, including the Energy (15 percent of coal and 56 percent of petroleum products), Chemical (22 percent of basic chemicals), Food and Agriculture (18 percent of agricultural products), and Transportation Systems Sectors.<sup>12</sup>

Critical manufacturing facilities and coal powerplants may be designed to receive materials via barge, and alternative transportation modes may be insufficient or too costly. These facilities generally have a large enough supply onhand to operate temporarily without receiving new shipments (coal powerplants generally have a month's supply of coal), but a catastrophic lock failure could result in a lock closure lasting longer than the backup supply. For example, Michigan and Minnesota produce 99 percent of usable iron ore in the United States, and 79 percent of it is transported through the Soo Locks, located in the Great Lakes-Saint Lawrence Seaway. About \$5.4 billion dollars of iron was transported through the Soo Locks in 2012.

## MARKET, REGULATORY, AND POLICY FACTORS

The Inland Waterways Users Board (IWUB) is a federal advisory group responsible for monitoring the IWTF and makes recommendations to USACE and Congress on capital investment priorities. The IWTF, authorized in 1978 to help pay for construction and rehabilitation on U.S. inland and intracoastal waterways, is funded by a fuel tax that commercial towing companies pay when using the inland and intracoastal waterways. The 20 cents-per-gallon tax rate has not changed since 1995 and would need to increase by more than 50 percent to have the same purchasing power today.<sup>13</sup> Figure 2 illustrates the purchasing power of the IWTF from 1987 to 2013.

---

<sup>11</sup> U.S. Army Corps of Engineers, "Inland Waterways Trust Fund,"

<http://www.lrl.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10589/Article/9213/inland-waterways-trust-fund.aspx>, accessed January 3, 2014.

<sup>12</sup> Economic Development Research Group, Inc., Failure to Act: The Economic Impact of Current Investment Trends in Airports, Inland Waterways, and Marine Ports Infrastructure, Reston, VA: American Society of Civil Engineers, 2012, [http://www.asce.org/airports\\_inland\\_waterways\\_and\\_marine\\_ports\\_report/](http://www.asce.org/airports_inland_waterways_and_marine_ports_report/), accessed November 18, 2014.

<sup>13</sup> U.S. Army Corps of Engineers, "Inland Waterways Trust Fund,"

<http://www.lrl.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10589/Article/9213/inland-waterways-trust-fund.aspx>, accessed January 3, 2014.

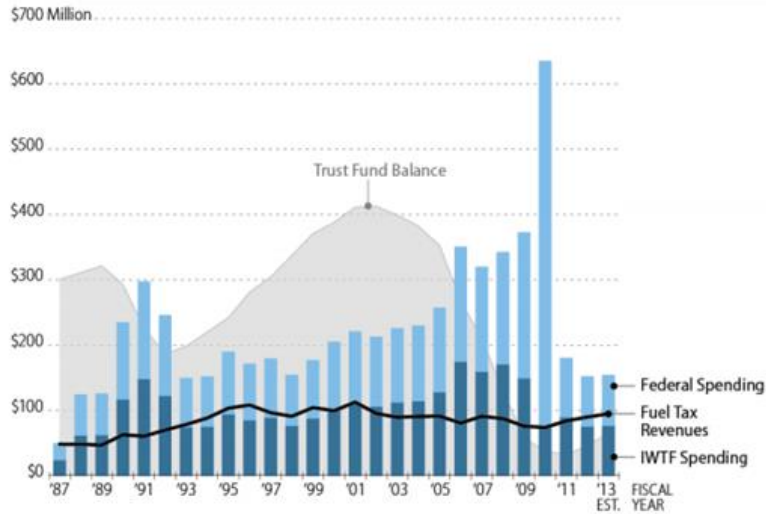


FIGURE 2—FEDERAL INLAND WATERWAY PROJECTS: FINANCING TRENDS, FY1987–FY2013<sup>14</sup>

The IWTF is used to fund construction and rehabilitation costs. These costs are shared with the Federal Government, which also covers operation and maintenance costs.<sup>15</sup> The IWTF has been declining since 2003. Increased amounts of the fund have been used to modernize the inland waterway system, and revenues have been flat or declining. As of 2009, the IWTF balance has decreased to the point that expenditures are limited to annual fuel tax revenues collected for that particular year. This has resulted in a backlog of authorized projects, further decreasing reliability and revenues. Maintenance funding gaps will reach \$17 billion by 2040, if funding levels continue at current rates. Planned construction and rehabilitation projects will not be completed until 2090.<sup>16</sup>

Dam and lock rehabilitation can cost millions of dollars, and new construction can cost billions. The project to replace the Olmsted Locks and Dam, located on the Ohio River between Kentucky and Illinois, was authorized in 1988 at a total cost of \$775 million. In April 2012, it was announced that the total cost would be more than \$2.9 billion and completion was not expected until 2024. To meet this completion date, annual expenditures going forward will need to be approximately \$150 million. Under the current rates, only \$170 million is expected to be annually available for all inland waterway projects. Therefore, little progress can occur on other priority inland waterway projects until the Olmsted Locks and Dam project is completed.<sup>17</sup>

## MITIGATION INITIATIVES

USACE is collaborating with the IWUB to help offset the substantial backlog of authorized projects and the declining reliability of the IMTS. The IWUB has made the following suggestions to mitigate risk to navigation locks and dams:<sup>18</sup>

- Increase the fuel tax by 30–45 percent to account for inflation. This will help develop a balanced IWTF and support repair, rehabilitation, and new construction projects.
- Change the funding structure for lock and dam construction and rehabilitation. The current structure supported by the fuel tax is insufficient to maintain the IMTS.
- Carry out process improvements for rehabilitation, repair, and maintenance projects, including certifying project management and developing risk-based cost estimates.

<sup>14</sup> Stern, Charles V., "Inland Waterways: Recent Proposals and Issues For Congress," <http://www.fas.org/sgp/crs/misc/R41430.pdf>, Congressional Research Service, July 14, 2011, accessed December 3, 2015.

<sup>15</sup> American Society of Civil Engineers, "2013 Report Card for America's Infrastructure," <http://www.infrastructurereportcard.org/>, accessed April 25, 2013.

<sup>16</sup> Ibid.

<sup>17</sup> Inland Waterways Users Board, Inland Waterways Users Board 25th Annual Report, 2012.

<sup>18</sup> Inland Waterways Users Board, "General Information," <http://www.waterwaysusers.us/>, accessed June 14, 2013.

In 2009, the Saint Lawrence Seaway Development Corporation initiated the U.S. Seaway Asset Renewal Program (ARP). The ARP Capital Investment Plan addresses many funding requirements for the U.S. Seaway locks and the Seaway International Bridge connecting Ontario, Canada, and New York State. The ARP is a coordinated effort to repair and modernize the U.S. Seaway infrastructure and includes maintenance, dredging, operational systems, and equipment purchase. The Harbor Maintenance Trust is a similar program to the IVTF used for dredging the Saint Lawrence Seaway.<sup>19</sup> The modernized infrastructure and new equipment made available because of the ARP plan will help to ensure the long-term reliability of the Saint Lawrence Seaway.

The Office of Cyber and Infrastructure Analysis (OCIA) provides innovative analysis to support public and private-sector stakeholders' operational activities and effectiveness and impact key decisions affecting the security and resilience of the Nation's critical infrastructure. All OCIA products are visible to authorized users at [HSIN-CI](#) and [Intelink](#). For more information, contact [OCIA@hq.dhs.gov](mailto:OCIA@hq.dhs.gov) or visit <http://www.dhs.gov/office-cyber-infrastructure-analysis>.

---

<sup>19</sup> Saint Lawrence Seaway Management Corporation, "Asset Renewal Program," <http://www.greatlakes-seaway.com/en/management/slsdc/asset>, accessed August 18, 2014.