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THESIS

A NATIONAL STRATEGY IS NEEDED TO PREVENT THE COMING WATER WAR: THE MISSISSIPPI RIVER WATERSHED SHOWS US WHY

by

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March 2014

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13. ABSTRACT (maximum 200 words)

The Mississippi River watershed is currently managed as six separate basins including the Missouri, Illinois, Ohio, Arkansas, and Upper and Lower Mississippi Rivers. This research pulls together several system components—navigation, flood control, environmental, municipal and industrial uses, and geopolitical concerns—and proposes treating the entire watershed as a system. The current problem is that actions taken in one basin often have consequences in another. This results in inefficient oversight, environmental harm, and adds to the cost of watershed management. These problems stem from the lack of a national water strategy. This thesis proposes a national water strategy and the formation of a regional planning body (RPB), with the National Ocean Policy Implementation Plan as a guide, to coordinate watershed planning. The watershed RPB would also coordinate inter-basin activities with the Great Lakes and Gulf of Mexico RPB's. Implementing the recommendations presented in this thesis is made difficult by the complexity of the watershed's ecosystem, the interconnectedness of the system components, the current legal framework for water rights, the myriad congressional oversight committees, numerous non-government organizations, and the many state, tribal, and local jurisdictions with a stake in the outcome.

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A NATIONAL STRATEGY IS NEEDED TO PREVENT THE COMING WATER WAR: THE MISSISSIPPI RIVER WATERSHED SHOWS US WHY

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ABSTRACT

The Mississippi River watershed is currently managed as six separate basins including the Missouri, Illinois, Ohio, Arkansas, and Upper and Lower Mississippi Rivers. This research pulls together several system components—navigation, flood control, environmental, municipal and industrial uses, and geopolitical concerns—and proposes treating the entire watershed as a system. The current problem is that actions taken in one basin often have consequences in another. This results in inefficient oversight, environmental harm, and adds to the cost of watershed management. These problems stem from the lack of a national water strategy. This thesis proposes a national water strategy and the formation of a regional planning body (RPB), with the National Ocean Policy Implementation Plan as a guide, to coordinate watershed planning. The watershed RPB would also coordinate inter-basin activities with the Great Lakes and Gulf of Mexico RPB's. Implementing the recommendations presented in this thesis is made difficult by the complexity of the watershed's ecosystem, the interconnectedness of the system components, the current legal framework for water rights, the myriad congressional oversight committees, numerous non-government organizations, and the many state, tribal, and local jurisdictions with a stake in the outcome.

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TABLE OF CONTENTS

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LIST OF FIGURES

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LIST OF TABLES

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LIST OF ACRONYMS AND ABBREVIATIONS

AWO	American Waterways Operators
AWRA	American Water Resources Association
BOR	Bureau of Reclamation
CAG	Collision, Allision, and Grounding
CCAWG	Climate Change and Water Working Group
CFS	Cubic Feet per Second
CMO	Congressional Member Organization
CMTS	Committee on Marine Transportation System
CRS	Congressional Research Service
CSIS	Center for Strategic and International Studies
CWA	Clean Water Act
CWNS	Clean Watershed Needs Survey
DOI	Department of Interior
DOT	Department of Transportation
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FOSC	Federal On Scene Coordinator
GAO	Government Accountability Office
GIS	Geographic Information System
GLMRIS	Great Lakes Mississippi River Interbasin Study
HMTF	Harbor Maintenance Trust Fund
IHS	Indian Health Service
IWTF	Inland Waterways Trust Fund
LRD	Great Lakes and Ohio River Division
MKARNS	McClellan-Kerr Arkansas River Navigation System
MRC	Mississippi River Commission
MRCTI	Mississippi River Cities and Towns Initiative
MRGO	Mississippi River Gulf Outlet
MRMCM	Missouri River Master Control Manual
MSC	Major Subordinate Command

MTS	Marine Transportation System
MVD	Mississippi Valley Division
NEMWI	Northeast Midwest Institute
NEMW	Northeast Midwest
NEPA	National Environmental Policy Act
NGO	Non-Government Organizations
NIPP	National Infrastructure Protection Plan
NLE	National Level Exercise
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NRF	National Response Framework
NPS	Non Point Source
NWD	Northwest Division
NWS	National Weather Service
OMB	Office of Management and Budget
OSRO	Oil Spill Response Organization
PS	Point Source
QPF	Quantitative Precipitation Forecast
RIETF	River Industry Executive Task Force
SSA	Sector-Specific Agency
SWAQ	Subcommittee on Water Availability and Quality
UMRBA	Upper Mississippi River Basin Association
UMR-IWW	Upper Mississippi River-Illinois Waterway
USACE	United States Army Corps of Engineers
USBOR	United States Bureau of Reclamation
USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WRC	Water Resources Council
WRDA	Water Resources Development Act
WSA	Water Supply Act

EXECUTIVE SUMMARY

The Mississippi River watershed is a complex system that drains six river basins—Illinois, Missouri, Ohio, Arkansas, Upper Mississippi and Lower Mississippi River basins—from all or parts of 31 states. Each of these basins is currently managed as an individual part of the third largest watershed in the world. As such, each has its own intricacies that must be explored in the context of the larger watershed. The entire system has many components. This thesis explores the navigation, flood control, environmental, municipal and industrial uses, and geopolitical components of the system, and proposes a framework for pulling them all together into one system.

The history of the watershed for navigation and flood control spans over 200 years. In the early 1800s, the Army Corps of Engineers began efforts to control the river for flood control and navigation purposes. The ensuing debate over how to do this—levees-only or by increasing outlets to the sea—played out during the mid-1800s, and was eventually decided in favor of a levees-only approach.[1] This set the nation on a course of building higher levees and having more catastrophic floods, culminating in the spring flood of 1927. The 1927 flood was a turning point in the nation's history. The flood resulted in 246 deaths and over $400 million in damage, and was too costly for relief agencies like the American Red Cross, leading the federal government to come to the aid of individual citizens.[2]

Over the years, the complexity of issues with the watershed increased as a result of additional laws. The early period of the watershed was one of building and controlling the river. As the population of the U.S. grew and expanded west during the middle of the 1900s, the dialogue on water began to change. In the 1960s and 1970s, environmental laws and water quality entered the water resources debate. The late 1990s and early 2000's began a focus on water habitat restoration. This discourse evolved over time and led us to a point of today's integrated water resources management (IWRM) practices.

[1] John M. Barry, *Rising Tide: The Great Mississippi Flood of 1927 and How It Changed America*, 1st Touchstone Ed (Simon & Schuster, 1998), 40–54.

[2] Ibid., 286.

Managing water resources is no longer just about flooding and navigation, or solely about environmental considerations. IWRM is about putting all of these components together with the myriad uses and users, including municipal and industrial users, to determine the project priorities and benefits for a river basin. This thesis builds on IWRM concepts employed at the basin level, and propose the expansion of the concept to manage the entire Mississippi River watershed as one large system.

Adaptation to climate change is a current focus of IWRM concepts. Understanding the effects of change, and what to do about it, are particularly challenging for government agencies, academia, and watershed stakeholders. One important driver in these discussions is the dearth of water sources data. The current process by the USGS includes quantifying national water uses every five years. This is not frequent enough to change potentially damaging processes. For example, the water levels in several aquifers are declining for unknown reasons. Some authoritative sources point to the process of hydraulic fracturing as the cause of this drop. Others point to droughts and an increased use of groundwater for irrigation as a cause. It is likely a result of a combination of these increased uses. Regardless of the outcome of this debate, it is clear that the data does not currently exist to make a science-based determination on the causes and possible solutions.

The Mississippi River watershed is also connected to the Gulf of Mexico and the Great Lakes. The watershed drains into the Gulf of Mexico and carries pollutants from many sources including municipal and industrial discharges, farm and land runoff, and products spilled as a result of marine accidents. This has the net effect of creating a "dead zone" in the Gulf of Mexico that prevents the sustainment of fish stocks near the Mississippi River outlet.[3]

Invasive species is an environmental issue plaguing the watershed, and its connection to the Great Lakes and other inland lakes. The man-made connection between the watershed and the Great Lakes is a source of cross-contamination of non-native

[3] Committee on the Mississippi River and the Clean Water Act, National Research Council, *Mississippi River Water Quality and the Clean Water Act: Progress, Challenges, and Opportunities* (Washington, D.C.: National Academies Press, 2008), 4, http://proxy2.hec.ca/login?url=http://site.ebrary.com/lib/hecm/Doc?id=10495438.

species such as zebra mussels, which came from the Great Lakes down the Illinois River, and the potential for Asian Carp to migrate into the Great Lakes. The latter is the subject of a task force that is evaluating several options for how to stop Asian Carp from entering the Great Lakes. This is a controversial issue given the stakes of the Great Lakes fisheries weighed against the economic value provided by the Chicago Area Waterway System (CAWS) that connects the Great Lakes to the inland marine transportation system (MTS). Given the interconnectedness of these bodies of water, it is not as simple as physically isolating them as some are advocating.

Addressing how to address complex issues such as invasive species is one of several aspects to this thesis. Executive Order 13547, *Stewardship of the Ocean, Our Coasts, and the Great Lakes*, directed federal actions, including the formation of regional planning bodies to coordinate efforts in nine regions along the U.S. coast and Great Lakes. The National Ocean Council released the *National Ocean Policy Implementation Plan* in 2013 that further delineates how executive agencies of the government will coordinate efforts. Building upon this framework, this thesis proposes the creation of a regional planning body (RPB) for the watershed. Through this RPB, the complex challenges presented in this thesis can begin to be addressed as a system-wide issue, vice local or regional issues.

Understanding the relationship of water to our national security is also explored. The nexus between water and energy is examined through the lens of hydraulic fracturing, or fracking, a controversial process to extract shale gas from below the surface. Fracking is the subject of many current studies to determine its impacts on the environment, specifically water. The consumption of water for the fracking process, the resulting waste product, and the impacts on ground water quality are all considerations explored in this thesis. Incorporating these into a management framework is important for watershed sustainability.

Research into why the U.S. does not have a national water strategy revealed several previous attempts to establish one. National water commissions were formed in 1950 and 1968. The recommendations of each of these two commissions were not formally adopted, although some were incorporated into federal agency actions in the

ensuing years.[4] One of the recommendations that came out of a series of four National Water Policy Dialogues, held between 2002 and 2008, was a call for a National Water Vision. This recommendation was not implemented; however, the federal government continues to modify how it is managing water resources projects.

As a result of the Water Resources Development Act of 2007 (WRDA), the Council on Environmental Quality (CEQ) published updated Principles and Requirements (P&R) for water resources projects in 2013.[5] This process was usually performed by the U.S. Army Corps of Engineers (USACE). The change to the CEQ releasing the P&R appears to be an attempt to coordinate federal investments in water resources projects across the government. The issue with this approach is that it is not tied to a national water strategy. This thesis explores the need for a national water strategy, and uses a Government Accountability Office (GAO) framework to propose one.

[4] Betsy Cody and Nicole T. Carter, *35 Years of Water Policy: The 1973 National Water Commission and Present Challenges* (Washington, D.C.: Congressional Research Service, May 11, 2009), 65.

[5] Council on Environmental Quality, "Principles and Requirements for Federal Investments in Water Resources" (The Office of the White House, March 2013).

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I. INTRODUCTION

> The Mississippi is well worth reading about. It is not a commonplace river, but on the contrary is in all ways remarkable.
>
> Mark Twain, *Life on the Mississippi*, 1863

A. PROBLEM STATEMENT

The United States is a maritime nation that relies on the oceans, coastal seaports, interstate highways and railways, intermodal transportation centers, and the inland river system to connect our nation's agricultural and industrial products to the world market. The U.S. maritime domain includes 3.4 million square nautical miles of exclusive economic zone and contains 95,000 miles of coastline, 12,000 miles of navigable rivers, and 361 ports.[1] The inland navigable waters of the Mississippi River watershed makes up 10,300 miles of those inland navigable waters and is a critical component of the inland marine transportation system (MTS), linking the farm fields of the Midwest and Great Plains states to the global economy.[2] The inland MTS facilitates the movement of approximately 761 million short tons of cargo annually, including nearly 118 million short tons of hazardous cargo.[3]

The Mississippi River watershed (watershed) is the largest watershed in North America and the third largest in the world behind only the Amazon and the Congo.[4] The watershed moves excess rain, storm water, and snow melt out of the interior of the country to the Gulf of Mexico. Environmentally, the watershed is a system—an

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[1] U.S. Coast Guard, "Coast Guard Publication 3.0 Operations" (U.S. Coast Guard, February 2012), 9, http://www.uscg.mil/doctrine/CGPub/CG_Pub_3_0.pdf.

[2] Committee on the Marine Transportation System, "National Strategy for the Marine Transportation System: A Framework for Action" (Department of Transportation, July 10, 2008), www.cmts.gov/downloads/National_Strategy_MTS_2008.pdf.

[3] Department of the Army Corps of Engineers Institute for Water Resources, *Waterborne Commerce of the United States: Calendar Year 2011: Part 2 - Waterways and Harbors Gulf Coast, Mississippi River System and Antilles*, March 12, 2013, http://www.navigationdatacenter.us/wcsc/pdf/wcusmvgc11.pdf. Data is from pages 22, 26, 34, 55, and 185. Hazardous cargo includes petroleum and chemical-based cargo.

[4] Natural Resources Conservation Service, "Mississippi River Basin Healthy Watersheds Initiative" (U.S. Department of Agriculture, n.d.), 1, http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcsdev11_023950.pdf.

ecosystem—that relies on compliance with environmental laws and regulations. These laws protect the wildlife, plants, and freshwater supply. The watershed has many other uses including flood control, providing potable water for municipalities along the river, irrigation for farmers, and cooling water for power plants.

Various federal, tribal, state and local agencies oversee watershed uses. The U.S. Army Corps of Engineers (USACE) provides engineering expertise to manage a series of levees, dams, dykes, reservoirs and other flood and navigation control structures throughout the watershed. Additionally, the Bureau of Reclamation manages water reservoirs in the western states and is responsible for overseeing the storage and release of rainwater and snow melt. The states that border the rivers making up the watershed, along with individual property owners share various land and water rights, making watershed management complex.

For the purposes of this thesis, complexity is defined by two or more components interacting with each other in ways that are not predictable or repeatable. There are varying degrees of water resources complexity that will be explored within this thesis. Synonyms for complexity will be used and they include complex, complicated, intricate, and difficult.

Currently, the Water Resources Development Act (WRDA) authorizes the USACE and affords congressional approval of new construction and civil works projects that provide flood protection and navigation improvements. This is usually a biennial process, but has often been delayed in the past decade due to the growing complexity of issues surrounding new USACE projects.[5] WRDA authorizes funding for projects done at the sub-basin or basin level, but there does not appear to be a mechanism for planning of projects with adjacent basins.[6] .

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[5] N. T. Carter, *Water Resources Development Act (WRDA)- Army Corps of Engineers Authorization Issues in the 109th Congress* (Washington, DC: Congressional Research Service, April 24, 2006), CRS–3, Water Resources Development Act (WRDA)- Army Corps of Engineers Authorization Issues in the 109th Congress.

[6] Leonard Shabman and Paul Scodari, *Towards Integrated Water Resources Management: A Conceptual Framework for U.S. Army Corps of Engineers Water and Related Land Resources Implementation Studies*, Working Paper (Institute for Water Resources: U.S. Army Corps of Engineers, February 2012), 4.

It is becoming increasingly difficult to manage the watershed as a system primarily used for navigation and flood control. The water management paradigm shifted in the 1970s "from a traditional supply-oriented, infrastructure-based water management framework to one that places a growing emphasis on meeting both basic human and environmental needs for water in an equitable and sustainable manner."[7] The emergence of environmental issues, namely the Federal Water Pollution Control Act (Clean Water Act), Endangered Species Act (ESA) and the National Environmental Policy Act (NEPA), has created additional challenges to managing the watershed system. These environmental laws must be taken into account, with potential impacts mitigated, before projects are constructed. The intersection of construction authorization, environmental compliance and restoration, and an increasing dialogue on climate change is further exacerbating the complexity of the system. While the watershed is essential for navigation and flood control, managing the watershed as a system is important to the long-term sustainability of fresh water and also the health of connecting basins of water such as the Gulf of Mexico and the Great Lakes. Due to the interwoven federal and state water rights laws, an integrated solution is needed to address the competing demands of water nationally. Implementing a regional approach to water management could be applied to the watershed.

During the 2000's, four national water policy dialogues were held that brought together stakeholders from all levels: government, academia, non-governmental organizations, and consultants. As a result of the nearly seven years of dialogue, the U.S. Army Corps of Engineers released their revised Civil Works Strategic Plan, 2011–2015 that calls for movement towards a vision of integrated water resources management. Despite this recently updated strategic plan, watershed activities continue to be managed in much the same way with federal, state, and local agencies retaining their jurisdiction and authority, and the appropriations process following agency-specific processes.

[7] J. C. Padowski and J. W. Jawitz, "The Future of Global Water Scarcity: Policy and Management Challenges and Opportunities," *Whitehead Journal of Diplomacy & International Relations* 10, no. Summer/Fall (2009): 105.

Given the intricacy of the water issues facing our country, an effective management framework is needed to ensure the right policy and funding priorities are in place to protect the watershed, a natural resource of national significance. This research proposes a national water strategy to guide federal agency actions, in addition to a framework to guide oversight of the watershed as a single system. This research builds on the existing literature and can be used by federal, tribal, and state agencies to achieve an integrated water resources management process for the watershed. This thesis will also identify the critical elements of a successful model and evaluate and compare these elements against the current process.

The primary audience for this research will be the Office of Management and Budget (OMB) and federal interagency stakeholders who would be responsible for developing national strategies and implementation plans for watershed management. Non-governmental organizations (NGO) may also find use with this work including the American Water Resources Association (AWRA). Other consumers might include environmental groups, academic institutions, and international organizations such as the World Water Council and the International Water Resources Association.

B. RESEARCH QUESTIONS.

In order to develop an effective watershed management strategy, or planning framework, this thesis will address the following research questions:

1. What are the components that make up the Mississippi River watershed system?
2. How can these components be used as a model for a national water strategy ?
3. What criteria should be used to evaluate an effective water management framework?
4. How could a regional planning effort be implemented for the Mississippi River Watershed?

C. LITERATURE REVIEW

Based on the literature, it is clear that the Mississippi River watershed is taken as important to the economic security of our nation. No authoritative source outlines the cost-benefit ratio of the Mississippi River watershed system, although a January 2011 report by the Center for Transportation Research at the University of Tennessee provides a good start towards accounting for river economics.[8] Many documents, including Congressional Research Service (CRS) and U.S. Army Corps of Engineers (USACE) reports mention the importance of the river system to the economy but do not provide specific cost-benefit comparisons. These reports and other documents also discuss the importance of the river system to the federal, state and local economy and how it provides the marine transportation corridor that is a critical component of the nation's marine transportation system (MTS); linking the farm fields of the Midwest and Great Plains states to the global economy.[9] A significant amount of literature discusses the various uses of the individual components of the Mississippi River system, but there is very little research done on the relationships between the components, uses, or an attempt to prioritize them. Instead, the USACE relies on their water control plans and policies to manage the watershed as effectively as possible. The book *Rising Tide* by John Barry provides a well-sourced early history of controlling this watershed and outlining how the USACE leadership started tackling this complex system in the 1800s.

1. Watershed Oversight

The literature on the management of the watershed is predominantly written by government agencies and consists mostly of agency policy, laws, congressional hearings, and Congressional Research Service (CRS) reports. The watershed was established and shaped through a series of laws passed by Congress that gave the USACE their authorization to build the individual system components. The literature is in agreement

[8] Dr. Larry G. Bray, C. Michael Murphree, and Chrisman A. Dager, *Toward A Full Accounting of the Beneficiaries of Navigable Waterways*, Advisory (Center for Transportation Research: University of Tennessee, 2011), http://www.nationalwaterwaysfoundation.org/study/BeneficiariesofNavigableWaterways14Jan11Ver.pdf.

[9] Committee on the Marine Transportation System, "National Strategy for the Marine Transportation System: A Framework for Action."

that the primary purpose of government's role in the watershed is navigation, flood control and ecosystem restoration.[10] Flood control became a concern in the mid-1800s with the U.S. Army Corps of Engineers (USACE) being the federal agency responsible for managing the river depths and navigation. The authoritative source on this historical account is Rising Tide with current USACE leadership requiring it to be read by engineers managing the watershed. The literature on managing navigation focuses largely on the precedent that Congress set in 1896 when they gave the USACE authorization to maintain a 9 foot deep by 250 foot wide channel from Cairo to the mouth of the Mississippi River, then increased to a 300 foot wide channel in 1928.[11] The channel dimension concept has gone unchallenged in literature until the last decade when multiple uses entered the discussion. More recent literature has begun debating how the channel authorization should be viewed against other uses and whether some users should be given priority over others. A 2005 CRS report advised Congress on the developing discussion about priority amongst users, but there is no documentation of work being done to resolve this debate. This issue likely stems from federalism and the federal government not wanting to pre-empt states rights.

Currently, the Water Resources Development Act (WRDA) is the authorization bill for the USACE and affords congressional approval of new construction and civil works projects. This is usually a biennial process, but has often been delayed in the past decade due to the complexity of issues surrounding new USACE projects.[12] The USACE manages each river basin as its own system as evidenced by the Master Manual for the Missouri River.[13] The location and geographic responsibility of each USACE Division is the likely reason for this current structure.

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[10] N. T. Carter and Charles V. Stern, *Army Corps of Engineers Water Resource Projects: Authorization and Appropriations* (Washington, D.C.: Congressional Research Service, August 19, 2011), 8, http://www.fas.org/sgp/crs/misc/R41243.pdf.

[11] U.S. Army Corps of Engineers, "Mississippi River Navigation" (U.S. Army Corps of Engineers, Approximately 1985), http://www.mvn.usace.army.mil/PAO/history/MISSRNAV/federal.asp.

[12] Carter, *Water Resources Development Act (WRDA)- Army Corps of Engineers Authorization Issues in the 109th Congress*, CRS–3.

[13] U.S. Army Corps of Engineers, "Missouri River Mainstem Reservoir System Master Water Control Manual Missouri River Basin" (U.S. Army Corps of Engineers Northwest Division, March 2006).

Oversight of the watershed and its many complex systems has led to inclusion of the role of Congress in some documents. Congressional oversight for the watershed is spread over many committees and subcommittees, many that have competing interests.[14] "At the executive branch level, this interest and congressional direction have resulted in many agencies and organizations being involved in different but related and sometimes overlapping aspects of federal water policy."[15] Managing the watershed for navigation and flood control is now more complex as the USACE and U.S. Bureau of Reclamation (USBOR) need to take into account, among other things, endangered species, ecosystem restoration, climate change, recreation, power generation and water sharing principles.

Starting in the 1970s, environmental laws began to enter the picture and influence river management. The intersection of construction authorization and environmental compliance led to a growing body of literature in the 1990s that continues today. CRS reports provide good background information and highlight the challenges and issues facing Congress. However, they do not recommend a policy framework for Congress to enact. CRS reports are informative and provide context to the work that Congress has done in the past. For example, in a 2005 report, the CRS notes that "during the last decade, Congress has expanded Corps involvement in environmental and ecosystem restoration, but concerns persist about its role."[16] In literature from the CRS, the same authors or lead authors have been writing the reports for the past 10–15 years. They have been primarily authored or influenced by Betsy Cody and Charles Stern, specialists in natural resources policy, Nicole T. Carter, the Coordinator of the Resources, Science and Industry Division, and Cynthia Brougher, a Legislative Attorney in the American Law Division of the CRS.

In the 1990s and into the early 2000's, a growing body of literature began calling for the use of integrated water resources management (IWRM) principles for managing

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[14] Betsy A. Cody et al., *Selected Federal Water Activities: Agencies, Authorities, and Congressional Committees* (Washington, DC: Congressional Research Service, August 7, 2012), 5–40.

[15] Ibid., 1.

[16] N. T. Carter, H. S. Hughes, and P. A. Sheikh, *Army Corps of Engineers Civil Works Program: Issues for the 109th Congress* (Washington, DC: Congressional Research Service, June 9, 2005), Summary, http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA458264.

water resources in the United States. A body of literature exists on the need for IWRM but what is missing is the mechanics of what this framework would look like or how it will be implemented. Dr. Peter Gleick is one author who has been found in many documents calling for an integrated framework. While most of his work appears to be on ground water, he was co-author of a 2002 document that discusses the inclusion of surface water in the discussion of a water management framework.

There are also some comparative government papers that explore the approaches other countries have taken with water management issues. These documents do not get into the mechanics of how an integrated framework is organized or implemented.

2. Water Policy

Starting in the early 2000s, there have been a growing number of journal articles and think tank documents on the U.S. water policy and the growing global water supply shortage. In addition, there is mounting written material on climate change and its impact on the global water supply. This material has now entered the discussion and literature on managing the water resources in the United States. The USACE, USBOR, National Oceanic and Atmospheric Administration (NOAA), and the U.S. Geological Survey (USGS) formed "the Climate Change and Water Working Group (CCAWWG) in 2007 to provide scientific collaborations in support of water management as climate changes."[17] Together, they have produced a series of documents that look at climate change and the impacts on the U.S. water supply.[18] This literature is important to the topic of watershed system management because the concept of climate change and its impact on water supply is an important variable in future planning scenarios.

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[17] L. D. Brekke et al., *Addressing Climate Change in Long-Term Water Resources Planning and Management: User Needs for Improving Tools and Information*, Technical, U.S. Army Corps of Engineers Civil Works Technical Series (Washington, DC: U.S. Army Corps of Engineers and U.S. Department of the Interior Bureau of Reclamation, January 2011), 1, http://books.google.com/books?hl=en&lr=&id=GZbplKz5dvQC&oi=fnd&pg=PP1&dq=%22Hennig+and+Curt+Brown,+Research+and+Development%22+%22Raff,+Policy+and%22+%22Wittler,+Mid-Pacific%22+&ots=4vAmae_Dm1&sig=pdlxjoDMcZJRRKZuAsTIY3dQIGM.

[18] Brekke et al., *Addressing Climate Change in Long-Term Water Resources Planning and Management*; Levi D. Brekke et al., *Climate Change and Water Resources Management: A Federal Perspective* (Reston, VA: U.S. Department of the Interior U.S. Geological Survey, 2008).

Rising Tide by John Barry is required reading for all USACE employees with watershed responsibilities and includes an early history of the Mississippi River, the work of the USACE to build flood control and navigation structures, discussion on the geopolitical issues surrounding the work of the USACE beginning in the early-mid 1800s, and the impacts of the flood of 1927. It is widely viewed by USACE leadership as a good history of early involvement in the Mississippi River and the challenges that led to the design of the system that is in place today.

The lack of academic research on treating the Mississippi River watershed as a system is somewhat surprising. Little has been written about how to implement a management system for the entire watershed that takes into account the various uses and determines priorities within the sometimes competing demands on the inland river system. When coupled with the mounting environmental challenges associated with USACE and USBOR construction projects, this topic appears ripe for further research. The need for more research in water usage and water policy was a recurring theme in the report on the 2010 Center for Strategic and International Studies (CSIS) and the federal Subcommittee on Water Availability and Quality (SWAQ) co-hosted workshop on global water issues.[19]

From 1999–2011, the National Academy of Sciences produced several reports for the USACE that explored changes that may be needed by the USACE to better manage water resources projects. Additionally, the Congressional Research Service produced several reports since 2001 that focus on water resources issues dealing with the Army Corps of Engineers and other water-related issues including climate change, hydraulic fracturing, and the energy-water nexus.

The concept of a National Water Vision or Strategy was a recommendation that came out of the National Water Dialogues from 2002–2008. The earliest attempt at a National Water Commission was in 1950 with a subsequent commission in effect from 1968–1973. Despite the call for a National Water vision, Congress has not passed a law

[19] Katherine E. Bliss and Katryn F. Bowe, *Bridging Knowledge Gaps in Water Management: Integrating Approaches to Food, Water, Energy, and the Environment* (Washington, DC: Center for Strategic & International Studies, May 2011).

to create a commission or require a strategy. The White House Council on Environmental Quality has taken on an integration role within the executive branch on water resources projects under the purview of the USACE. The USACE was required by WRDA 2007 to update the 1983 Principles and Guidelines (P&G) for water resources projects. The CEQ released final Principles and Requirements (P&R) in 2013 that will go into effect 180 days after the release of final agency implementation plans.

The U.S. has a much more defined policy on the oceans, coastal waters and Great Lakes. Recommendations from the Interagency U.S. Ocean Policy Task Force were implemented by Executive Order 13547 in 2010, requiring federal agency participation in developing regional management plans for the coastal environment and Great Lakes. A National Ocean Policy Implementation Plan was released by the Council on Environmental Quality (CEQ) in 2013. Internal waters of the U.S. are missing from both the EO and the implementation plan, despite the natural and man-made connections between the Mississippi River watershed and the Gulf of Mexico and Great Lakes. It is not known why the watershed was left out of these documents.

3. Other Issues

Emergency response operations are also a component to effective management of the watershed. Disruptions to the marine transportation system (MTS) have come by way of bridge collapses as occurred with the I-35W bridge in Minneapolis on August 1, 2007 and the I-40 bridge near Weber Falls, Oklahoma on May 26, 2002.[20] There are hundreds of highway and railroad bridges that cross parts of the rivers making up the watershed and they are vulnerable to terrorism, lack of maintenance and impact from a towing vessel. Many bridges are considered critical infrastructure and need to be protected.

The navigation system is also vulnerable to the threat of earthquakes. "One of the most prominent features on the national seismic hazard maps is a zone of high hazard

[20] National Transportation Safety Board, *Collapse of I-35W Highway Bridge Minneapolis, Minnesota August 1, 2007*, Highway Accident Report (Washington, DC: National Transportation Safety Board, November 14, 2008), http://www.dot.state.mn.us/i35wbridge/ntsb/finalreport.pdf; National Transportation Safety Board, *U.S. Towboat Robert Y. Love Allision With Interstate 40 Highway Bridge Near Webbers Falls, Oklahoma May 26, 2002*, Highway/Marine Accident Report (Washington, DC: National Transportation Safety Board, August 31, 2004).

surrounding the New Madrid region in the Central United States. By some measures, the hazard in this region is as high as for places in California."[21] The New Madrid zone encompasses the confluence of the Ohio and Mississippi Rivers and poses additional challenges to managing river navigation and maintaining flood control structures. The impacts of an earthquake in the New Madrid seismic zone could be catastrophic to the hydrology of the river system, causing significant damage to the levees and even causing it to flow in reverse as it did for a period of time following the 1811–1812 earthquakes.[22]

D. METHODOLOGY

1. Sample

The nation currently lacks an effective strategy for managing the Mississippi River watershed to accommodate competing uses by multiple users. My sample for this project is the water management policy of the Mississippi River watershed and includes oversight entities and the myriad uses and users of the system. Oversight is currently provided by federal, tribal and state governments. Current uses of the watershed include navigation, flood control, critical habitat for wildlife, irrigation water, energy, and recreation. Users of the watershed include commercial and recreational mariners, private citizens, municipalities, corporations, and utility companies.

2. Sample Selection

The sample selection for this thesis was based largely on the author's personal experience and by conducting a literature review. The author has witnessed many challenges of managing the Mississippi River watershed system for multiple uses and users. Record high water and the resulting wide-spread flooding of the Mississippi and Missouri Rivers in the spring of 2011 required the activation of the Bird Point-New Madrid floodway for the first time since 1927, and the activation of the Morganza spillway for the first time since 1993. It was the first time that both of these systems had

[21] Joan Gomberg and Eugene Schweig, "Earthquake Hazard in the Heart of the Homeland" (U.S. Department of the Interior, U.S. Geological Survey, January 2007), http://pubs.usgs.gov/fs/2006/3125.

[22] S. E. Hough, "Cataloging the 1811–1812 New Madrid, Central U.S., Earthquake Sequence," *Seismological Research Letters* 80, no. 6 (November 11, 2009): 1045–1053, doi:10.1785/gssrl.80.6.1045.

been operated in the same year, and both had significant adverse economic and emotional effects on private residents in the impacted areas. As a result of 2011 high water and flood events, the USACE led the development of an Interagency Recovery Task Force with other federal agencies, and state government representatives.

While flooding was occurring in the inland rivers in the spring of 2011, federal and state agencies were planning to conduct National Level Exercise (NLE) 2011 that involved a simulated earthquake along the New Madrid fault. The New Madrid fault encompasses the confluence of the Ohio and Mississippi River and poses additional challenges to managing river navigation, maintaining flood control structures and training the river through a system of dykes, locks and dams. The impacts of an earthquake along the New Madrid fault could be catastrophic to the hydrology of the river system.

Nearly a year after the record high water, floods and NLE-11, the nation started to weather a persistent Midwest drought that resulted in water levels approaching the 1988 record low levels in the Upper Mississippi River near St. Louis in December 2012. These wide swings in river levels forced the U.S. Coast Guard (USCG), USACE, and the navigation industry to work collaboratively to facilitate the safest and most economic flow of commerce possible.

The challenges of keeping the MTS working during periods of high and low water drew the author to this topic. Coupled with the complex navigation challenges being faced in the watershed, the USACE budget is under intense scrutiny, and the critical infrastructure within the watershed is deteriorating quickly and taking far too long to rebuild. Mounting environmental issues including climate change, invasive species, and hydraulic fracturing are putting increasing pressure on water resources. Geopolitical considerations have lead to a lack of consensus on how to address the myriad intricacies of the watershed.

E. DATA SOURCES

The data for this thesis was derived from a combination of sources including academic and historic literature, government-contracted studies, and websites of government, and non-government organizations.

F. TYPE AND MODE OF ANALYSIS

This thesis calls for the development of a national water strategy that is based on a 2004 Government Accountability Office report that identifies qualities of an effective strategy.[23] In addition, this thesis proposes managing the Mississippi River watershed as a system through an integrated planning framework adapted from the National Ocean Council Implementation Plan and based on the eight-step process from *A Practical Guide for Policy Analysis; the Eightfold Path to More Effective Problem Solving.*[24] These steps include:

- Define the problem: This step involved fully developing the problem statement including the current state of water policy, watershed management, the effectiveness of the current process and the consequences if change isn't made.
- Compile evidence: This step included conducting a comprehensive literature review of the current process and research on proposed solutions and consequences.
- Outline the integrated framework components: This step involved outlining the current users, uses, and oversight roles for the watershed. This was accomplished by using a combination of literature and personal knowledge.
- Discuss and project the relationships between the components: This step begins the analysis phase of the thesis and involves using a soft systems methodology. The term soft system means that scientific evidence does not exist to support hard conclusions. Analyzing a soft system relies on articulated logic and reasoning for reaching conclusions. A well-reasoned discussion of trade-offs in this step is the key to its success.[25]
- Project outcomes of the integrated framework: This step expands on the analysis and projects how each use/user will perceive their relative importance within the framework. The key to a soft system is the need for equilibrium in the system, which often comes with compromise. Given the

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[23] R. A. Yim, *Combating Terrorism Evaluation of Selected Characteristics in National Strategies Related to Terrorism: Subcommittee on National Security, Emerging Threats, and International Relations, Committee on Government Reform, House of Representatives* (Washington, D.C.: Government Accountability Office (GAO), February 3, 2004).

[24] Eugene Bardach, *A Practical Guide for Policy Analysis: The Eightfold Path to More Effective Problem Solving, 4th Edition*, 4th ed. (CQ Press College, 2011).

[25] Donella H. Meadows, *Thinking in Systems: A Primer* (Chelsea Green Publishing, 2008); Peter Checkland and Jim Scholes, *Soft Systems Methodology in Action* (Wiley, 1999).

complexity of the watershed, compromise and the need for collaboration will be addressed throughout this thesis.

- Analyze trade-offs between competing uses/users: This step concludes the analysis phase with a qualitative summary.
- Propose the integrated management framework: This step will lay out the proposed framework for how the watershed regional planning body will be implemented.
- Explain recommendation: This is the conclusion of the thesis and explains why I came to my final recommendations.

G. OUTPUT

Given the multi-faceted water issues facing our country, a national water strategy is needed to guide the whole-of-government approach to water resources. A strategy that is built on the GAO-established criteria will ensure the right policy and funding priorities are in place to protect this natural resource. Building on the national water strategy, this thesis also proposes the creation of a regional planning body (RPB) that treats the Mississippi River watershed as a system. The final output will be a better definition of the problem, and a framework to coordinate planning of competing watershed uses and users.

The primary audience for this research will be the Office of Management and Budget (OMB), Congress, scholars and academic institutions, and federal interagency stakeholders responsible for developing action plans and budgets to implement this integrated, multi-use watershed management framework. The significance of this research is that it will propose a strategic framework that can be used by federal, tribal, and state agencies to more effectively coordinate watershed oversight activities. Other consumers might include non-government organizations (NGO) such as environmental groups, academic institutions and international organizations such as the World Water Council and the International Water Resources Association.

H. LIMITS OF THE STUDY

There are several assumptions that I will make for this thesis. The first is that federal laws and regulation can be changed to implement various elements of the framework. Congressional action will be needed to implement a whole-of-government approach to water resources management. Congress was unable to complete bills to

implement a National Water Commission in 2007 and 2008, but this is a necessary step to fully develop a national water strategy .

Another assumption is that all agencies will remain intact and retain their general structure. One idea that may be grounds for further research is to consolidate certain activities into one federal department such as the U.S. Department of Interior (USDOI) or U.S. Department of Transportation (USDOT). Currently, federal oversight is shared by agencies within the U.S. Department's of Defense (USACE), Agriculture (NRCS), Interior (USBOR and USGS), Transportation (Maritime Administration), and Homeland Security (Federal Emergency Management Agency (FEMA) and USCG). The USACE is the primary federal agency due to its responsibility for the system of levees, dikes, and dams critical for controlling the river during floods and for navigation purposes. However, given the growing complexity of the watershed, an argument could be made for making this a non-Defense Department responsibility under a domestic agency. For example, the environmental laws and regulations might lend itself to the USDOI leading watershed management. From a transportation viewpoint, the USDOT might be a good fit to lead both the engineering design and marine transportation system components of the entire watershed system.

This thesis will not examine the process used by federal agencies to quantify the stock—storage of water in reservoirs or behind dams—and flow—the quantity of water that moves through the watershed. The stock-and-flow system for managing water runoff will be discussed in general terms, including how it is needed to maintain navigation and minimize flooding impacts. With mounting literature and debate on climate change and population rise, fresh water resources are likely to become more critical. Future research could explore the concept of using the watershed as a potential source for fresh water for other portions of the country.

This thesis will not provide an in-depth overview of critical infrastructure protection; however, material condition of watershed infrastructure components is part of system-wide problems that will be presented. Additional research could be done to identify how to better protect the locks, dams, bridges, and levees from natural or man-

made threats. Lastly, there is a finite amount of resiliency built into the navigation and flood control system, making it a possible topic for future research.

II. NAVIGATION AND FLOOD CONTROL

The previous chapter laid out the problem space that this thesis will explore. This chapter begins to look at the system components of the watershed and focuses on those activities impacted by and impacting the watershed related to navigation and flood control. Based on the historical development of the watershed, navigation and flood control are inextricably linked. Throughout the 1800s and 1900s, the development of flood control structures has been based on the need to continue navigation to further the trade and economic development of the region. This chapter will provide a broad overview of the watershed from navigation and flood control perspectives. Due to space and the intricacies of the issues involved, this chapter will only supply a cursory look at the role of the Army Corps of Engineers, an agency that faces an enormous challenge in carrying out their responsibilities throughout the watershed.

The role of river flooding began to take on a significant national focus beginning with the Mississippi River flood of 1927. Mississippi River flooding had been a recurring issue dating back to the early 1800s, but it wasn't until the 1927 flood that federal efforts came under intense scrutiny when "the immensity of this disaster and the government's lack of response marked a dividing line, a watershed."[31] The 1927 flood was the result of immense spring time rains that repeatedly plagued the upper Midwest, and Ohio River, and Lower Mississippi River basins. The flood waters overtopped levees, and flooded cities and farmland throughout the watershed, despite an enormous government and public effort to keep the water back.

The Mounds Landing levee in Mississippi failed on April 21, 1927. This is the single largest levee failure ever experienced in the watershed and it flooded an area 50 miles wide by 100 miles long with up to 20 feet of water—displacing nearly all of the

[31] Barry, *Rising Tide*, 371.

185,749 people that lived in the region.[32] Despite the best efforts to fight the flood, 246 people died and over $400 million in damage was done, which overwhelmed the resources of the American Red Cross.[33] This resulted in a call to have the federal government step in and augment the disaster relief funds that were usually left to relief organizations.

President Calvin Coolidge tapped then Commerce Secretary, Herbert Hoover, to oversee all rescue and relief efforts for the flood.[34] When it became clear that the Red Cross could not handle all of the requests for assistance, the issue of the federal government providing assistance was raised and discussed in the media. Nearly 80% of newspaper editorials advocated for the President to call Congress back into session to vote on authorizing federal funding to assist with flood relief efforts.[35] This call was not made.

It wasn't until after the flood, that the relief sought by the states and media came to fruition. Up to that point, the states and local governments matched the federal government funding to maintain the levees that protected the citizens and municipalities along the river.[36] This changed with the Flood Control Act of 1928, when a bill known as the Jadwin Plan was passed, making the Lower Mississippi River basin a federal responsibility.[37] Through this and a series of subsequent flood control acts, Congress authorized the Army Corps of Engineers (USACE) to design and construct a flood control system to account for the design flood with the project being known as the Mississippi River and Tributaries (MR&T) project.[38] The discussions following the 1927 flood largely concentrated on the federal and state funding responsibilities; the

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[32] Ibid., 202–205.

[33] Ibid., 286.

[34] Ibid., 240.

[35] Ibid., 373.

[36] Ibid., 401.

[37] Ibid., 406–407.

[38] Mississippi River Commission, "The Mississippi River & Tributaries Project: Designing the Project Flood," 2008, http://www.mvd.usace.army.mil/Portals/52/docs/Designing%20the%20Project%20Flood%20info%20paper.pdf.

resulting compromise solution limited federal responsibility to just the Lower Mississippi River basin.[39] This discussion on the role of federal and state governments is important to the background of this thesis and will set the stage for the remainder of this chapter. Even to this day, the USACE conducts their water resources role "with full recognition of the primacy of state water rights and responsibilities."[40] Flooding issues dealing with the watershed will be discussed in more detail in a later section of this Chapter.

As discussed in Chapter 1, the USACE is the federal agency charged with maintaining the navigation channel and managing flood control processes on the navigable rivers that make up the watershed. The watershed system consists of a series of levees, dams, dykes, reservoirs, and other flood and navigation control structures, managed and maintained by the U.S. Army Corps of Engineers (USACE) and the U.S. Bureau of Reclamation (USBOR), to prevent flooding and to aid in marine navigation.

> The Bureau currently manages hundreds of storage reservoirs and diversion dams in 17 western states, providing water to approximately nine million acres of farmland and 31 million people. The Corps's operations are much more widespread and diverse, and include several thousand flood control and navigation projects throughout the country, including 25,000 miles of waterways (with 238 navigation locks), nearly 1,000 harbors, and 400 dam and reservoir projects (with 75 hydroelectric plants).[41]

Due to the evolution of environmental laws and regulations, water resource projects have grown in complexity since the 1970s. The USACE primarily manages these projects through three Division Offices as shown in Appendix C, including the Northwest (Portland, OR), Mississippi Valley (Vicksburg, MS), and Great Lakes and Ohio River Divisions (Cincinnati, OH). Within each USACE Division are several District Offices

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[39] Barry, *Rising Tide*, 402–406.

[40] U.S. Army Corps of Engineers Civil Works Directorate, *Building Strong Collaborative Relationships for a Sustainable Water Resources Future: National Report: Responding to National Water Resources Challenges* (Washington, D.C., August 2010), vi, http://www.building-collaboration-for-water.org/Documents/nationalreport_final.pdf.

[41] Betsy A. Cody and H. S. Hughes, *Water Resource Issues in the 110th Congress* (Washington, DC: Congressional Research Service, June 1, 2007), CRS–4, www.doi.gov/library/Internet/subject/upload/RS20569.pdf.

that are responsible for management of their segments of the river. Each Division is tasked with the responsibility of managing their river basin in accordance with applicable water control manuals or operating guides, and with little consideration of each rivers impact on the entire watershed system. For example, the Missouri River has many authorized purposes, one of which is not to aid navigation on the main stem of the Mississippi River.[42] When water levels drop to extremely low levels on the upper portion of the Mississippi River, the USACE Northwest Division is not authorized to release more water from the reservoirs that feed the Missouri River, in order to aid navigation on the Mississippi River.[43]

Like most other watershed management processes, the USACE does this in collaboration with other federal, state, tribal, and local governments, and communicates with stakeholder groups through many forums. As a government agency, the USACE must be open and transparent while working with stakeholders. The USACE does this by working collaboratively with other government agencies and stakeholders, following federal laws and regulations, and advertising their projects in the Federal Register.

The Mississippi River Commission (MRC) also assists the USACE in carrying out its responsibilities. The MRC is comprised of seven people appointed by the President, including the USACE Mississippi Valley Division (MVD) Commanding General, who serves as the MRC Chairman. Since 1879, the MRC has been providing "water resources engineering direction and policy advice to the Administration, Congress and the Army."[44] Despite this effort to be transparent, there are some who disagree with the extent of USACE compliance with law. One article, written by Daren Bakst, called

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[42] U.S. Army Corps of Engineers, "Missouri River Master Control Manual," IV–1.

[43] Rachel Martin, "Army Corps' Options Dwindle Along With Mississippi River," *Weekend Edition* (National Public Radio, January 13, 2013), http://www.npr.org/2013/01/13/169243113/army-corps-options-dwindle-along-with-mississippi-river.

[44] "Mississippi River Commission (MRC)," *U.S. Army Corps of Engineers Mississippi Valley Division*, accessed February 16, 2014, http://www.mvd.usace.army.mil/About/MississippiRiverCommission(MRC).aspx.

into question the lack of clarity with how "waters of the U.S." are treated by the USACE and the EPA.[45]

There are many competing interests with regards to navigation and flood control that warrant further explanation. The navigation community is comprised of commercial and recreational mariners that share the rivers of the watershed for many purposes. A significant use of the waterway is to transport products from one location to another. This is done through towing vessels that push barges that are configured in many different arrangements depending on the type of cargo. These will be explored in more detail in the navigation section of this chapter.

A. DEFINITIONS

This thesis is about the Mississippi River watershed and national water policies that serve the purpose of commercial and recreational navigation and municipal and industrial uses while also looking at the way environmental and flood control issues are managed. The literature review revealed many instances in which it was unclear whether the policy on water applied to surface or ground water, or how watershed, river basin, and catchment areas were defined and used. These terms were often used interchangeably, and with different meanings depending on the author. Therefore, a look at terminology is important. The following terms will be used in this thesis:

Basin (also known as "drainage basin" or "river basin"): includes the area of land drained by a river and its tributaries that flow into one central river that goes out to the sea.[46] With this definition in mind, the Mississippi River is the central river that goes out to sea; however, the author is choosing to split the Mississippi River into two basins—upper and lower—as they are traditionally referred to in literature and practice. This distinction does not change the definition of the Missouri and Illinois River basins. The

[45] Daren Bakst, "Issue Brief No. 4122: EPA and the Corps Ignoring Sound Science on Critical Clean Water Act Regulations" (Heritage Foundation, January 8, 2014), http://thf_media.s3.amazonaws.com/2014/pdf/IB4122.pdf.

[46] Brahma Chellaney, *Water, Peace, and War Confronting the Global Water Crisis* (Lanham: Rowman & Littlefield Publishers, Inc., 2013), 357.

resulting six basins that comprise the Mississippi River Watershed, as defined in this thesis, include the following:

- The Missouri River Basin
- The Illinois River Basin
- The Upper Mississippi River Basin
- The Ohio River Basin
- The Arkansas River Basin
- The Lower Mississippi River

Catchment area (also known as "drainage basin" or "watershed"): "The area of land surface producing runoff. It collects the water originating as precipitation and drains it into a stream, river, lake, reservoir, or other body of water."[47]

Ecosystem: "A community of interdependent organisms together with the environment they inhabit and with which they connect."[48]

Ground water: "water beneath the land surface that fills the spaces between rock and sediment. Essentially it is rainfall and snowmelt lying in underground aquifers."[49]

Surface water: "water that flows in streams, rivers, ponds, lakes, wetlands and reservoirs."[50]

Watershed: watershed traditionally meant the dividing line between drainage basins but is more recently synonymous with river basin.[51] For the purposes of this thesis, the term watershed will mean the drainage of the five basins that enter into the lower Mississippi River, in addition to the drainage from the Lower Mississippi River basin to the point in which the combined flow enters into the Gulf of Mexico.

The meaning of the term watershed in the literature was often difficult to discern. This was particularly challenging when looking at some of the USACE documents. The

[47] Ibid., 358.

[48] Ibid.

[49] Ibid., 359.

[50] Ibid., 363.

[51] Ibid., 364.

author was able to discern that watershed within the USACE documents tends to follow the definition of basin as used in this thesis. This was evident from the USACE Civil Works Strategic Plan which states that "most of the MSC (major subordinate command) and District geographic boundaries are aligned with watershed boundaries."[52]

B. RIVER HYDROLOGY

River hydrology is an important concept to understand as it pertains to navigation and flood control. The tracking and reporting of current and forecast river stages is the primary responsibility of the National Oceanic and Atmospheric Administration's National Weather Service (NWS). Like many of the functions carried out on the watershed, there is shared responsibility with regards to forecast river stages. The USGS also tracks and reports stream gauge conditions under the National Streamflow Information Program. The NWS uses stream gauge readings and predicted precipitation, or quantitative precipitation forecast (QPF), in order to accurately predict future river stages.

There is another component to river forecasting that is often not understood. The controlling of releases from reservoirs is the responsibility of either the U.S. Bureau of Reclamation, or the USACE, depending on who owns the reservoirs. These releases are controlled using Water Control Manuals or operating guides developed for each of the river basins. The controlled releases need to be incorporated into the river forecasts. The coordination mechanism for this is in place through a memorandum of agreement between the USACE, NOAA, and the USGS.[53] The USACE uses the data to time reservoir releases in order to "lessen the amount of potential damage from overflowing streams and to prevent water from backing up into smaller tributaries when the main stem

[52] U.S. Army Corps of Engineers, "Sustainable Solutions To America's Water Resources Needs: Department of the Army Corps of Engineers Civil Works Strategic Plan 2011–2015" (U.S. Army Corps of Engineers, September 2011), 10.

[53] Chris Vaccaro, "NOAA, USACE, and USGS Partner to Support Water Resources Management," *USGS Newsroom*, May 11, 2011, http://www.usgs.gov/newsroom/article.asp?ID=2797.

already is bankfull."[54] According to the NWS, the river forecasts are also closely coordinated with tribal, other federal, and state agencies.[55] The current gauge readings and forecast river levels are published by the river forecast centers located throughout the watershed, making them publicly available.[56]

One area where his is especially important is with the commercial navigation industry and the loading of cargo barges. River forecasts from throughout the watershed drive decisions on how much product to load into barges. These decisions often need to be made weeks ahead of time due to the time and distance involved in the marine transportation system. There are several river forecast products that are produced, including a 5-day and 28-day forecast—both based only on the 24-hour QPF. The shorter forecast period is the most accurate and reliable. Operations managers for towing companies monitor the river gauges and forecast in order to determine the depths with which they can load their barges. The USACE is only authorized a 9 foot deep by 300 foot wide navigation channel, but the river often affords much more width and depth to the maritime industry. A delicate balance must be struck between loading too much or too little. The next section will explore the navigation aspect of the watershed in more detail.

C. NAVIGATION

Navigation is the process of moving vessels, people, and cargo from one point to another along the river. The oversight of marine transportation system (MTS) issues is a layered system of federal agencies and key stakeholders in the maritime environment. Laws and regulations are shared by 18 federal agencies and involve the states and tribal

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[54] G. P. Johnson, R. R. Holmes Jr., and L. A. Waite, "The Great Flood of 1993 on the Upper Mississippi River: 10 Years Later" (U.S. Department of the Interior, U.S. Geological Survey, May 2004), 5, http://il.water.usgs.gov/pubs/fs2004-3024.pdf.

[55] "River Forecast Centers," *National Weather Service Advanced Hydrologic Prediction Service*, December 8, 2011, http://water.weather.gov/ahps/rfc/rfc.php.

[56] National Weather Service National Oceanic and Atmospheric Administration, "Lower Mississippi River Forecast Center," *Lower Mississippi River Forecast Center*, n.d., http://www.srh.noaa.gov/lmrfc/?n=lmrfctributaryforecastsandhydrographs Note: This is the website for the Lower Mississippi River Forecast Center in Slidell, LA and is indicative of the other forecast center products.

governments.[57] The Committee on Marine Transportation Systems (CMTS) is the key federal component for dealing with navigation issues, and published a national strategy in 2008 to lay out goals and objectives in managing the MTS. The CMTS recognizes the importance and understands that "the economic health of the MTS and the natural health of the Nation's ocean, coastal, and freshwater ecosystems must co-exist in a way that supports transportation while protecting and sustaining human health and the environment."[58] Safe and secure navigation is vital to our nation's economy, and incorporating these principles into a national water strategy and management framework is needed.

In order to accomplish the goals and objectives of the CMTS, federal agencies work together to provide a navigation system on the inland rivers that meets the authorized depth of water, and a waterway marked with buoys and lights for vessels to safely navigate. The Army Corps is tasked with providing and maintaining a 9 foot deep by 300 foot wide navigation channel, and the Coast Guard is responsible for installing and maintaining the aids to navigation. The location, depth, and width of the channel in the river basins is largely dependent on river stages and the type of river that exists.

Rivers in the watershed are categorized as pooled or free-flowing rivers. A pooled river has a series of dams and/or locks that prevent the free flow of the river. These structures require a vessel to lock through from one level of the river to another. Upbound vessels enter the chamber lower than the upstream level, and water is pumped into the chamber to raise the vessel to match the elevation of the upper pool. The process works in reverse for downbound vessels. These structures aid the safety of navigation by reducing the current that is pushing on vessels navigating downstream, and controlling the speed of the towing vessel.

Free flowing rivers often need the USACE to survey after drops in river stages, since sediment may have built up in areas of reduced river current. The drop in speed results in suspended sediment dropping to the river bottom. USACE hydrographic

[57] Committee on the Marine Transportation System, "National Strategy for the Marine Transportation System: A Framework for Action," 10.

[58] Ibid., 9.

surveys allow the agency to better understand the condition of the navigation channel, whether the channel has moved, and if additional dredging is necessary.

The Ohio, Illinois, Missouri, Arkansas, and Upper Mississippi Rivers have some portions that are pooled, and some that are free flowing. Structures are located along the river to aid both flood control and navigation purposes. The Missouri River also has a series of dams, well upstream of the navigation channel, that are used for recreation, industrial, and municipal purposes. The lower Mississippi River is a free-flowing river and does not contain locks or dams that restrict navigation.

The USACE and USCG work closely to coordinate actions to account for channels shifting, river bends shoaling, and extreme low water conditions that often casue vessels to go aground. This requires all stakeholders to strike a delicate balance between safety and economics. A narrower and shallower river means industry is loading a lesser amount of cargo in each barge, and moving fewer barges with each towing vessel. This reduces their efficiency and profits. During normal and high water stages, there is more water available for navigation than the 9 foot by 300 foot channel. This is especially true at high water conditions. In these cases, the commercial industry will load barges to greater than 9 feet and will tow additional barges in a wider and longer configuration. A higher river stage leads to a broader and deeper river, and allows for more barges with deeper drafts.

As a result of previous navigation challenges dealing with high and low water, the USACE, USCG, and the navigation industry formed a River Industry Executive Task Force (RIETF). The RIETF is co-chaired by the Coast Guard's Eighth District Commander, the Army Corps' Mississippi Valley Division Commander, and an industry representative. Local committees were also formed in each Captain of the Port (COTP) zone, and are led by an industry chairperson that coordinates efforts with the USACE District Commander and USCG COTP to address localized waterway issues. The local committees are loosely affiliated with the RIETF, which addresses the larger, system-wide issues.

Building on the work of the RIETF and the local committees, the USACE, USCG, and industry have developed a Waterways Action Plan (WAP) for outlining how navigation will be managed during extreme river levels. The WAP consists of a base plan for the entire river system, annexes for each COTP zone, and is used to collaboratively manage navigation at the margins of the water cycle, including both high and low water periods.[59] Each Annex of the plan includes action points that trigger pre-planned actions or communications between the navigation industry, the USACE, and the USCG.

The discussion below comes from a 2005 hearing transcript on agricultural and energy transportation issues, and is focused on the Mississippi River between St. Louis, MO and Cairo, IL. This lies in the lower section, or open river portion, of the Upper Mississippi River basin. Gerald Barnes, Chief of the USACE Operations Division, explains the challenges with managing navigation on the river, and covers the issues of river stages, vessel drafts, industry practices, weather considerations, and collaboration between the stakeholders.

> On the middle Mississippi River, "drafts are historically unrestricted, as long as the Saint Louis gage is above 0 feet. Once stages reach, or are forecast to reach, the–2 to–3 feet stage, drafts have usually been reduced to less than 10 feet. Provided the stages fall at a reasonable rate, and there is not a catastrophic grounding which disturbs the bottom of the river, drafts of 9 feet or better can usually be accommodated with dredging.
>
> In addition to draft restrictions, tow sizes are also reduced as stages fall. Unrestricted tows on the Middle Mississippi are usually in the 36– to 40–barge range. With stages approaching 0, this would possibly be reduced to 30 barges or less. In the minus–2 to minus–3–foot range, tows would likely be reduced to barge configurations of 24 or less. With extreme low stages, two sizes might actually be reduced to 12 to 15 barges. This is very much dependent on the actual channel dimensions, however.
>
> Decisions regarding restrictions in tow sizes and drafts are made through a collaborative effort of the Corps, the Coast Guard, the National Weather Service, and the towing industry.[60]

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59 "Waterways Action Plan - Navigation Workgroups," *U.S. Coast Guard Eighth District Western Rivers*, September 9, 2013, http://www.uscg.mil/d8/westernrivers/.

60 *Discussion on Agricultural Transportation and Energy Issues* (Washington, DC: Government Printing Office, 2005), 13.

There are many commodities that move up and down the river, including coal, grain, fertilizer, petroleum, and other products vital to the local and national economy.[61] The river basins serve as a conduit from the heartland to the world, through the deep draft sea ports along the Gulf Coast. With over 760 million tons of cargo shipped annually through the river system, the watershed is a valuable resource to our nation's economy.[62] Balancing this aspect of the watershed with the ecological and flood control issues is one of many challenges.

Intermodal transportation systems, including rail and truck terminals in U.S. ports, are critical to the success of our nation's economy, and this is particularly true for the agricultural industry of the Midwest. When the river system was interrupted by flood waters in 2005, it was noted in a congressional hearing that "rail and truck transport have been critical for agriculture in this time of interrupted river traffic; but clearly, agriculture is heavily dependent on our rivers."[63] Aging infrastructure, some over 70 years old, will not allow us to keep pace with the rest of the world. This aging infrastructure affects both navigation and flood control. Locks age and break, and this results in loss of the navigation corridor: the longer the delay, the greater the impact.

The USACE is challenged by the cost of their construction projects, and the process by which their projects get authorized and funded. "Current financing mechanisms are not providing sufficient revenue to keep pace with construction, replacement, expansion, and rehabilitation projects, as the majority of the commercially active inland waterway locks and dams have been in place more than 50 years."[64] Figure 1 shows the few selected projects on the watershed that are being currently being

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[61] Ibid., 41.

[62] Department of the Army Corps of Engineers Institute for Water Resources, *Waterborne Commerce of the United States: Calendar Year 2011: Part 2 - Waterways and Harbors Gulf Coast, Mississippi River System and Antilles.*

[63] *Discussion on Agricultural Transportation and Energy Issues*, 2.

[64] Committee on the Marine Transportation System, "National Strategy for the Marine Transportation System: A Framework for Action," 5.

constructed.[65] These projects are multiple year projects, with the Olmstead project scheduled to take up to 20 years to complete. Given the austere budget climate of the early 2010's, creative financing may be needed to resolve this infrastructure challenge. There have been many financing proposals to solve the navigation challenges.[66]

A look at intermodal transportation methods and capacity is also needed as the nation explores growth industries. For example, extraction of natural gas and other natural resources in North Dakota and West Virginia is leading to an increase in commodity movements. As rail and highway capacity is reached, the Missouri, Ohio and Mississippi Rivers may need to be evaluated for additional marine traffic. Since the Missouri River currently facilitates the movement of a relatively small percentage of overall watershed commerce, additional marine traffic may lead to investing additional resources in channel and levee maintenance, and possibly looking at a longer navigation season.[67]

Figure 1. Selected Major Waterway Projects (from Stratfor Global Intelligence, 2013)

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65 Stratfor Global Intelligence, "United States: The Problem of Aging Infrastructure on Inland Waterways," November 5, 2013, http://www.stratfor.com/analysis/united-states-problem-aging-infrastructure-inland-waterways.

66 N. T. Carter and Charles V. Stern, *Army Corps of Engineers Water Resource Projects: Authorization and Appropriations* (Washington, DC: Congressional Research Service, October 18, 2013); John Frittelli, *Harbor Maintenance Finance and Funding* (Washington, D.C.: Congressional Research Service, September 12, 2013).

67 Department of the Army Corps of Engineers Institute for Water Resources, *Waterborne Commerce of the United States: Calendar Year 2011: Part 2 - Waterways and Harbors Gulf Coast, Mississippi River System and Antilles,* 34 Less than 1% of total river commerce is attributed to the Missouri River.

1. Bridges

Bridges serve a unique navigation function that will be discussed further in this section. For the purposes of this thesis, bridges include only those under the permit oversight of the U.S. Coast Guard. The General Bridge Act of 1946 (33 USC 525–533) provides the Coast Guard with the authority to oversee bridges that impact navigation. From a navigation standpoint, bridges are treated as obstructions to navigation and require close coordination with the bridge owner, such as the national highway administration for interstate highways, state department of transportation for state roads, and railroad companies for railroad bridges.

If a bridge is the subject of repeated allisions, an accident involving a moving waterborne vessel and an immovable object such as a bridge, piling, or dyke, it may be a candidate for a federal process known as Truman-Hobbs.[68] Bridges that are routinely allided with by boats and other vessels may be investigated by the Coast Guard for a possible issuance of an order to alter. Orders to alter unreasonably obstructive bridges allow for a federal cost share with the bridge owner; however, this appropriation is tied to the federal budget process and the appropriation counts against the Coast Guard's budget allocation. As such, the Coast Guard has not requested alteration of bridges budget authority in recent years. The most recent appropriation of federal funding for bridge alterations was in the American Recovery and Reinvestment Act of 2009 (P.L. 111–5), which funded four bridge projects.[69] As a result of this, there are still between 10 and 15 bridges that remain on the list of bridges with orders to alter, while waiting for federal funding.

Recent congressional action to restrict earmarks further complicates funding for navigation and bridge related projects.[70] Congress has taken a more conservative

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[68] Committee on the Marine Transportation System, "National Strategy for the Marine Transportation System: A Framework for Action," 8.

[69] Anne L. Richards, *Use of American Recovery and Reinvestment Act Funds by the U.S. Coast Guard for the Alteration of Bridges Program* (Washington, D.C.: Department of Homeland Security Office of Inspector General, November 2011), 2.

[70] Carter and Stern, *Army Corps of Engineers Water Resource Projects: Authorization and Appropriations*, October 18, 2013, 8.

funding posture and is not currently allowing earmarks in spending bills which has curtailed spending on navigation and bridge projects. These projects were routinely funded only after a congressional member inserted a rider to a spending bill. The USACE is increasingly relying on supplemental funding to complete their work with a 56% increase in total funding for the period 2003–2013 through supplemental appropriations.[71] The next section will explore the flood control processes and challenges.

D. FLOOD CONTROL

The modern era of federal flood control emerged with the Flood Control Act of 1936 (49 Stat. 1570), which declared flood control a "proper" federal activity in the national interest. This followed on the heels of the 1928 Act, passed in the aftermath of the 1927 flood. As a result of these Acts, the USACE began to manage floods more authoritatively.

The authors' hypothesis is that the watershed needs to be managed as a system and that a framework is needed to integrate the systems into one oversight process to ensure long-term sustainability and resiliency in the face of a rapidly changing environment. This section shows how such a framework might work, since the watershed is designed for a project flood. This looks at the flow of water as a system. This thesis does not evaluate the stock and flow calculations that go into the design flood, but it would not be possible to discuss navigation and flood control in general terms without at least discussing the basics of how water is stored and released to manage navigation and prevent flooding.

The watershed stock and flow process is designed to control river flow in order to keep each river segment below the maximum flow. Figure 2 shows how the system is designed to work within a maximum water flow, measured in cubic feet per second (cfs),

[71] Ibid.

to account for the design flood.[72] This is the design flood that our nation is currently preparing for, and is greater than the 1936 and the 2011 actual river flows.

Timing of water releases from the Ohio River basin, by the USACE Lakes and Rivers Division (LRD), must be well coordinated with water releases by other USACE Divisions (NWD and MVD) in order to prevent inadvertent flooding. Water control processes involve multiple coordination points and potential areas for conflict, especially if multiple basins need to release water to avoid flooding. Releasing of water in accordance with a basin control manual may greatly increase the risk of flooding in a downstream basin. This played out in the spring of 2011 due to extremely high rainfall in the Midwest and Ohio Valley. As a result, the design flood flow of nearly 2 ½ million cubic feet per second (cfs) was reached, requiring the need for activating the Birds Point-New Madrid Floodway and the diversion of over 500 cfs from the rivers.[73]

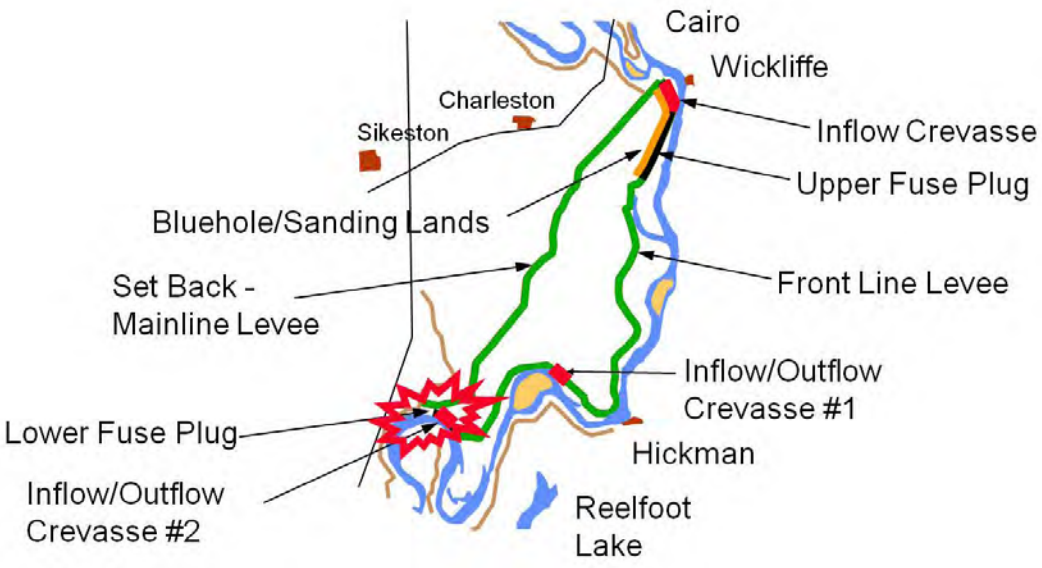

Figure 2. Birds Point-New Madrid Floodway (from Mississippi River Commission, n.d.)

[72] Mississippi River Commission, "The Mississippi River & Tributaries Project: Designing the Project Flood," 5.

[73] Mississippi River Commission, "The Mississippi River & Tributaries Project: Birds Point-New Madrid Floodway" (Mississippi River Commission, N.D.), 3, http://www.mvm.usace.army.mil/publicaffairs/News/press_releases/bpnm/BPNM_paper.pdf.

The Birds Point-New Madrid Floodway is a controversial flood control topic, because a federal right of way was created after the 1927 flood in order to save downstream property owners. The result was sacrificing parts of Missouri farmland in order to protect a greater number of property owners. This local issue has national impacts. The Flood Control Act of 1928, codified at 33 U.S.C. § 702c, specifically limits federal liability for flooding along the Mississippi River including the Birds Point-New Madrid floodway.[74]

In a 2007 hearing that explored dam and levee safety nationwide, it was revealed that an "initial review of over 2,000 levees found 56 percent to be acceptable, 38 percent minimally acceptable, and 6 percent or 122 levee segments at risk due to unacceptable maintenance."[75] A complete inventory of the nation's levees has not been completed, nor has there been a comprehensive review of levee adequacy.[76] As pointed out by Congresswoman Schmidt (R-OH) in the 2007 hearing on the levee and dam safety programs, "thanks to the Dam Safety Program Act, we know a great deal more about our Nation's dams. When it comes to our Nation's levees, however, we know very little."[77]

The comments in the hearing represented some frustration with how the levees are maintained. This is because our levees are a patchwork of federal, state, local, and private levees constructed over many decades to prevent the next flood. These levees are built to different standards and offer varying degrees of protection. There is not one agency responsible for the entire system of levees and a central repository of levee data does not exist. This is largely because of how the flood control process was designed in the 1800s with local levee boards raising funds and owning the maintenance of levees. The USACE has developed additional responsibility over the years with regards to levees, but the process is still very much in the hands of the local levee districts and boards. The

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74 *Expenditures for Construction Work; Conditions Precedent; Liability for Damage from Flood Waters; Condemnation Proceedings; Floodage Rights, 33 U.S.C. § 702c*, accessed January 28, 2014, http://www.gpo.gov/fdsys/pkg/USCODE-2010-title33/html/USCODE-2010-title33-chap15-sec702c.htm.

75 *National Levee Safety and Dam Safety Programs* (Washington, DC: Government Printing Office, 2007), 1.

76 Ibid.

77 Ibid., 4.

condition of the levees in our country rated a grade of D- in the 2013 infrastructure report produced by the American Society of Civil Engineers.[78]

The concept of dam safety that was raised in the hearing was also an interesting side note. Dams in the United States, while clearly a federal responsibility, are not faring too well for federal funding. The 2013 ASCE infrastructure report graded the condition of dams in the U.S. as poor with a grade of D, due in large part to their age and the high number of high-hazard dams.[79]

The next section will begin to explore the unique characteristics of the six river basins defined in this thesis.

E. UPPER MISSISSIPPI RIVER BASIN

Geographically, the three northernmost basins are the Missouri, Illinois and Upper Mississippi River basins. Figure 3 shows the area of the U.S. that these basins cover, and the interconnectedness between them.[80] This section will highlight some of the more significant flood control issues experienced within these river basins, starting with the upper Mississippi River.

78 American Society of Civil Engineers, *2013 Report Card for America's Infrastructure*, March 2013, 23, www.infrastructurereportcard.org.

79 Ibid., 14–16.

80 James P. Kahan et al., *From Flood Control to Integrated Water Resource Management; Lessons Learned for the Gulf Coast from Flooding in Other Places in the Last Sixty Years* (Rand Corporation Gulf States Policy Institute, 2006), 17.

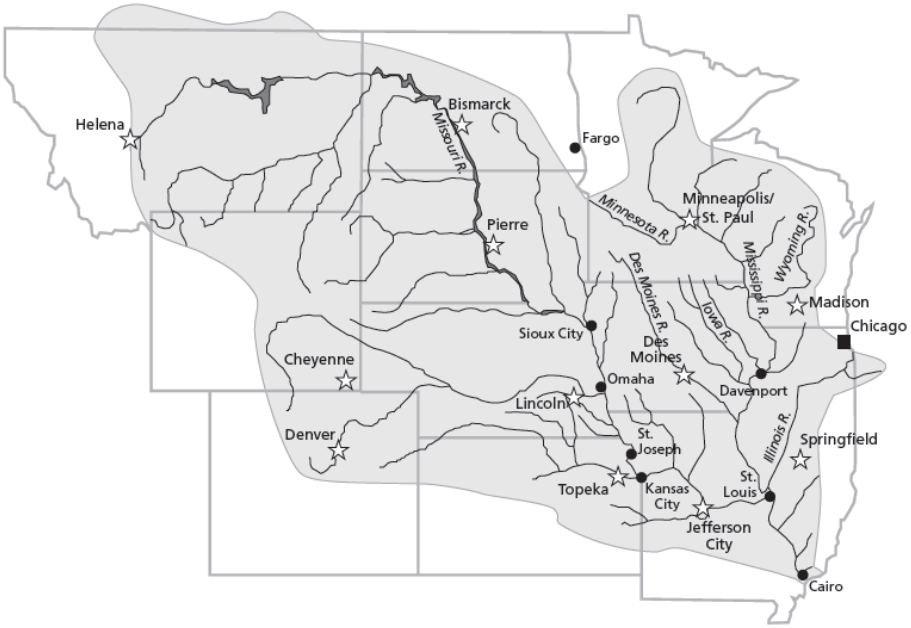

Figure 3. The Upper Mississippi, Illinois and Missouri River Basins (from Kahan et al., 2006)

This basin starts at the headwaters of the Mississippi River in Minnesota and generally runs from north to south through Minnesota, then along the Wisconsin-Minnesota border to the confluence of the Ohio and Mississippi Rivers. The Upper Mississippi River is a pooled river north of St. Louis and free flowing south of St. Louis. The flow south of St. Louis includes the Missouri and Illinois basin outflows. The USACE has the authority to control the amount of water released from the reservoirs at the headwaters as stipulated by "Section 7 of the Rivers and Harbors Act of 1917 (40 Stat. 266; 33 U.S.C. 1) and Section 216 of the Flood Control Act of 1970 (84 Stat. 1830; 33 U.S.C. 549a)."[81]

F. MISSOURI RIVER BASIN

This section will look at the Missouri River and its unique characteristics that impact navigation and how it is being managed for flood control. The Missouri River is overseen by the USACE Northwest Division (NWD) headquartered in Portland, OR.

[81] U.S. Army Corps of Engineers, "Reservoirs at Headwaters of the Mississippi River; Use and Administration," *Federal Register* 78, no. 249 (December 27, 2013): 78717.

NWD manages the river through District Offices in Omaha, NE and Kansas City, KS. As shown in Figure 4, the Missouri River is considered a low-use waterway, since the volume of cargo moved on the river is less than 1 billion ton-miles.[82] As a result, it does not get first priority among federal investment in dredging projects. This complicates matters when the Coast Guard has to maintain aids to navigation on the river, in order to facilitate commerce. Since the river is not managed as part of a system, the USCG may invest money into maintaining aids to navigation when the USACE is not maintaining the navigation channel.

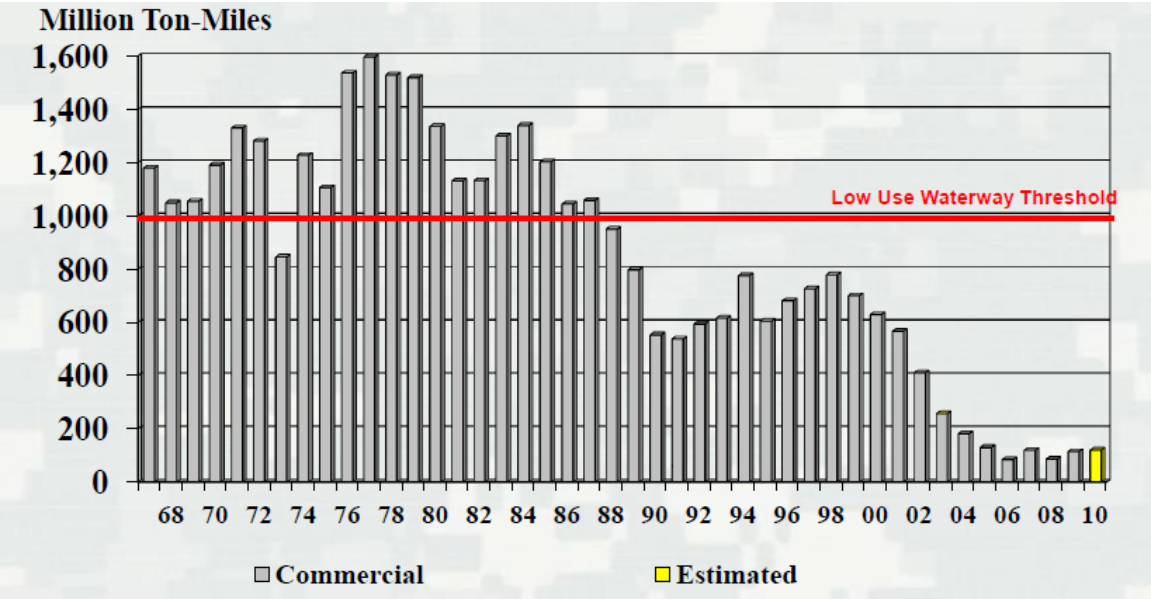

Figure 4. Missouri River Total Navigation Ton-Miles 1967–2010 (from LaRandeau, 2011)

Reclamation of water is a key concept as it pertains to the western part of the Missouri River basin and its ties to water runoff from the Rocky Mountains east of the continental divide. To address the use of all water sources, the NWD uses the Missouri River Master Control Manual (MRMCM) as its playbook.[83] The MRMCM is produced

[82] John LaRandeau, "Corps Navigation Mission Civil Works Challenges – Shrinking National and Missouri River Budgets" (presented at the 2011 Missouri River/TEXOMA Regional Conference, Kansas City, MO, 2011), 22–23, http://samekc.org/useruploads/files/northwestern_division_-_larandeau.pdf.

[83] U.S. Army Corps of Engineers, "Missouri River Master Control Manual."

by the USACE, in coordination with the USBOR, to manage the storage and release of water for navigation and flood control on the Missouri River. This is critical during the Missouri River navigation season, which runs from 1 April to 1 December each year. Within the last few decades, it has been modified to allow timed releases to support the U.S. Fish and Wildlife Service in its efforts to protect threatened and endangered fish species.

Water scarcity in the west is a growing concern and the Mississippi River watershed, primarily the Missouri River, has been looked at as a water source. "The Flood Control Act of 1944 in which Congress provided that the use for navigation of "waters arising in States lying wholly or partly west of the ninety-eighth meridian shall be only such use as does not conflict with beneficial consumptive use" for other specific purposes, including irrigation."[84] As shown in Figure 5, the ninety-eighth meridian lies to the west of the Mississippi River; however, it dissects the Missouri River basin and informs why certain decisions are made with respect to the Missouri River.[85] The Missouri River Water Control Manual documents the authorized uses and operating conditions that the USACE follows to manage this river.

[84] J. P. Deason, T. M. Schad, and G. W. Sherk, "Water Policy in the United States: A Perspective," *Water Policy* 3, no. 3 (2001): 180.

[85] Graphic Maps, "U.S. States Latitude and Longitude Map," *World Atlas*, accessed February 16, 2014, http://www.worldatlas.com/webimage/countrys/usalats.htm.

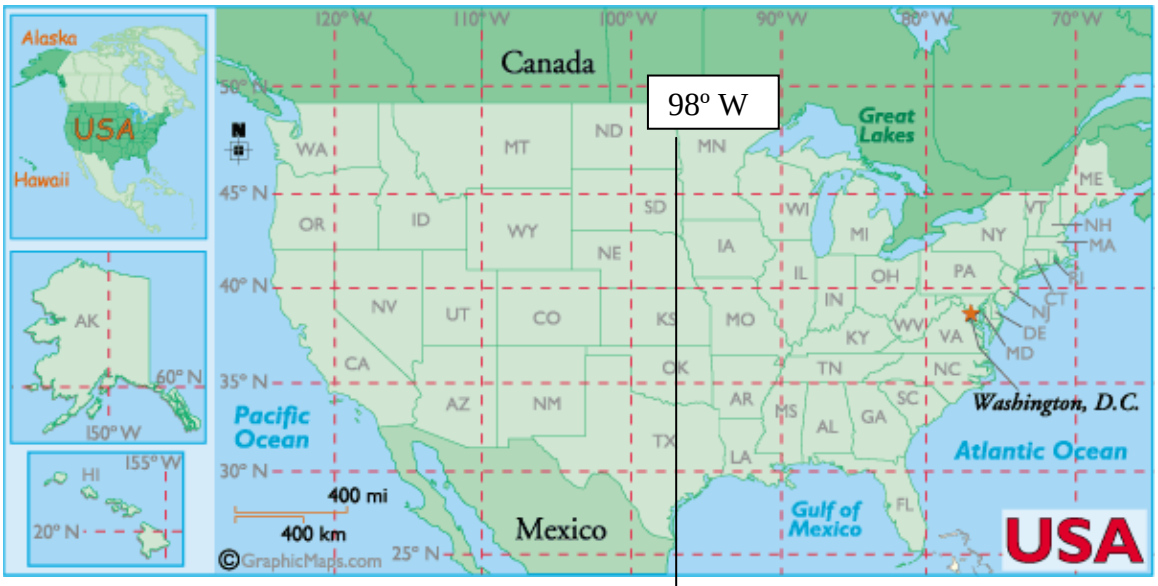

Figure 5. U.S. States Latitude and Longitude Map (after Graphic Maps, n.d.)

The current Missouri River watershed is largely the product of the Flood Control Act of 1944, and a rivalry that existed between the Assistant Regional Director of the USBR's Upper Missouri Region, William G. Sloan, and then USACE Missouri River Division Engineer Colonel Lewis A. Pick.[86] The compromise plan developed by the USBOR and the USACE was known as the Pick-Sloan Plan and was codified in the Flood Control Act of 1944. This plan allowed for the development of storage reservoirs, the construction of levees along the Missouri River, the construction of hydroelectric power plants, and the use of the river for irrigation. Combined, these initiatives were designed to provide economic stability and economic growth while providing a navigation channel and flood protection.

The Missouri River floods of 2011 were also matched by flooding on the Mississippi River, and the activation of the entire flood control system to handle the design flood. However, the flooding highlighted the need for better coordination between federal, tribal, state, and local stakeholders. One area identified for improvement was the collection and dissemination of data used to make decisions. This was cited in a congressional hearing on the Missouri River, and also in public comments received on

86 *The Missouri River Flood: An Assessment of the River Management in 2011 and Operational Plans for the Future* (Washington, DC: Government Printing Office, 2011), 4.

the draft National Ocean Policy Implementation Plan.[87] The use of geographic information system (GIS) products is becoming commonplace in today's society; however, the author did not find a central repository for mapping all of the watershed projects.

The flood of 2011 highlighted challenges faced by the USACE in managing the entire system for flood control. The first was in regards to how the Corps managed the system of reservoirs throughout the system.[88] Decision-making for water releases was based on the Missouri River master control manual that did not take into account water releases from the Ohio River system and the state of the Mississippi River water levels. Significant rainfall in the spring of 2011 may have led to higher than normal flooding on the Missouri River. This led several witnesses to use the statement that "that this flood was part natural disaster and part manmade disaster."[89]

The need for water coordination was apparent during the flood of 2011, and needs to be codified in the water control manuals, and daily practice. Transparency of data is needed so that all stakeholders—utility owners, municipalities, shipping agents, and homeowners—can make informed decisions about actions they should take to protect themselves and their property. The timing of actions taken by the USACE in the 2011 floods was called into question during the congressional hearing, since their "decisions led to tremendous devastation."[90]

The concept of flexible management of the river was noted in the 2011 hearing on the Missouri River flooding. Flexibility is needed to a point, but only seven of the eight governors agreed on flood control being the highest priority. While the hearing doesn't say which governor didn't feel that way, it was most likely Montana's governor since Montana is upstream of the free-flowing section of the Missouri River where flooding

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87 Council on Environmental Quality, *Final Recommendations of the Interagency Ocean Policy Task Force* (Washington, D.C.: The Executive Office of the White House, July 19, 2010).

88 *The Missouri River Flood: An Assessment of the River Management in 2011 and Operational Plans for the Future*, 39.

89 Ibid., 54.

90 Ibid., 40.

usually does not occur. How the decision to flood areas downstream of the Gavins Point dam was made should be explored.

In addition to the MRMCM, the USACE produces an Annual Operating Plan for the Missouri River that takes into account public comment and stakeholder inputs. This annual operating plan does not appear to take into account operations downstream of the Missouri River basin, nor does it look at the impacts the Missouri River has on the downstream portion of the watershed. One of the outcomes of the 2011 flooding was the call for greater data transparency and improved USACE decision-making.[91] Despite this call for transparency, the USACE is still required to operate within the parameters of the MRMCM and its purposes. Balancing these competing interests can be a contentious issue, and highlights the political sensitivities that exist. In a written statement to the hearing on Missouri River flooding, the Mayor of Pierre, SD stated that "as time has passed, however, the importance of flood control has become increasingly diluted."[92] This helps to show the intricacy of managing the system independently of the much larger system of watersheds that feed the lower Mississippi.

There are eight authorized purposes for the USACE reservoirs including navigation, fish/wildlife, recreation, flood control, low flow augmentation, water quality, water supply, and water conservation.[93] In response to a question on having flood control be the number one priority while the watershed is in a drought, USACE General McMahon outlined the intricacies of managing the tension between flood control which requires open space, and the other seven authorized purposes which require "water stored in the system to be flowed on a metered pace to serve those purposes."[94] It was noted that we have seen droughts and that they are not as devastating as floods.[95] The balance between the need for flood control and other authorized purposes was also tempered by

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91 Ibid., 47.

92 Ibid., 59.

93 Congressional Budget Office, "How Federal Policies Affect Water Allocation" (Congressional Budget Office, August 7, 2006), 13, http://www.cbo.gov/publication/18035.

94 *The Missouri River Flood: An Assessment of the River Management in 2011 and Operational Plans for the Future*, 108.

95 Ibid., 109.

Brad Lawrence, the Director of Public Works for the city of Fort Pierre, SD, who indicated that droughts adversely impact power generation.[96] By focusing too much on flood control, we will not have a measured approach advocated by General McMahon

G. ILLINOIS RIVER BASIN

The Illinois River Basin is unique in that it serves as the transition between the Great Lakes and Mississippi River Watershed. This is done through a manmade canal known as the Chicago Area Waterway System. This system allows navigation stakeholders to transit vessels between the Great Lakes and the Illinois River and therefore bypassing thousands of miles of waters including the St. Lawrence Seaway, Atlantic Ocean and the Gulf of Mexico. It is the quickest and cheapest way to navigate between the two basins.

This interconnectedness between the Great Lakes and the Mississippi River via the Illinois River is an important component of the navigation system, but it is not without its controversy. As will be discussed in the next chapter, invasive species are threatening to harm the Great Lakes ecosystem, if steps are not taken to prevent non-native species such as Asian Carp from crossing between the two basins by way of the Chicago Area Waterway System.

H. OHIO RIVER BASIN

The Ohio River basin extends from West Virginia in the east to the confluence with the Mississippi River. It is overseen by the USACE Great Lakes and Ohio Rivers Division (LRD) in Cincinnati, Ohio. The Ohio River basin is mostly an open river system, although at certain river stages, wickets in the river are lowered and the river becomes free flowing. This is a unique characteristic of this basin. The new construction projects being built by the USACE are located on the Ohio River, and when completed, will greatly aid commercial navigation through improved capacity and reliability.

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[96] Ibid.

I. ARKANSAS RIVER BASIN

The Arkansas River basin extends from the Colorado Rockies to the confluence of the Arkansas River with the lower Mississippi River. The primary navigation channel is the McClellan-Kerr Arkansas River Navigation System (MKARNS). Like the other river basins, the USACE manages the flood control and channel depth of this river basin and the USCG. It is important to note that this basin is overseen by the Southwest Division of the USACE under the guidance of the Little Rock District. This means that there are four USACE Divisions that oversee the six river basins.

The basin consists of some pooled sections and some free flowing sections and resembles the Ohio River basin in that respect. The Arkansas River basin does not see as much commercial navigation as the Ohio River does. For the purposes of this thesis, no additional attributes from the Arkansas River basin will be covered.

J. LOWER MISSISSIPPI RIVER BASIN

The lower Mississippi River basin drains the upper Mississippi River, Missouri River, Illinois River and Ohio River basins, in addition to the Arkansas River basin. The lower Mississippi River has some unique flood control characteristics including the Morganza Floodway and the Bonnet-Carre Spillway.[97] Both were utilized in the 2011 flooding event and performed as designed, with the Morganza Floodway carrying 600,000 cfs and the Bonnet-Carre Spillway handling 250,000 cfs.[98]

In addition, the Old River Control Structure diverts 620,000 cfs from the lower Mississippi River to the Atchafalaya River basin.[99] This is part of the design flood, and also diverts needed sediment to the basin which helps slow the erosion of coastal Louisiana.[100] Coastal erosion has become a significant, and highly contentious, local

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97 Mississippi River Commission, "The Mississippi River & Tributaries Project: Designing the Project Flood," 5.

98 Ibid.

99 Ibid.

100 Katherine Kemp, "The Mississippi Levee System and the Old River Control Structure," *The Louisiana Environment*, January 6, 2000, http://www.tulane.edu/~bfleury/envirobio/enviroweb/FloodControl.htm.

issue. Given the coastal land loss, and the threat of sea-level rise due to climate change impacts, sediment diversion projects are being studied as a possible solution. Regardless of the outcome of these studies, coastal erosion provides additional reason for managing the entire watershed as a system that takes into account the geopolitical, navigation, flood control, and environmental factors.

1. New Madrid Seismic Zone

A 2007 hearing on the new Madrid Seismic Zone revealed vulnerabilities to flood control structures, such as levees. With three large earthquakes, 7.0 or greater on the Richter scale, from 1811–1812, the New Madrid Seismic Zone became a point of study and concern in the center of the United States. "The earthquakes were so powerful that they changed the course of the Mississippi River and the Mississippi River actually flowed backwards for some time."[101] The National Earthquake Hazards Reduction Program coordinated by the USGS is one way that the federal government collaborates with the states to ensure communities are able to reduce impacts from future earthquakes and to respond and rebuild when they do. This region and scenario was the basis for a National Level Exercise (NLE) in 2011 that coincidentally did not include many key federal, state and local agencies due to the ongoing flood fight that spring. The Central U.S. Earthquake Consortium (CUSEC) evaluates the impacts of Earthquakes within the New Madrid Seismic Zone, and serves the "critical role of coordinating multi-State efforts of the Central Region."[102]

2. Sea Level Rise

One of the problems with the way the system was developed and is currently managed is that it has gotten too complex and that it does not fully account for climate change and sea-level rise. Sea-level rise will impact the watershed. As the sea-level rises over time, it puts pressure on the outflow of the watershed at the mouth of the Mississippi River in the Louisiana delta. By way of example, during Hurricane ISAAC in 2012, the

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101 *The New Madrid Seismic Zone: Whose Fault Is It Anyway?* (Washington, DC: Government Printing Office, 2007), 1–2, http://www.gpoaccess.gov/congress/index.html.

102 Ibid., 16.

short-term rise in sea level at the mouth of the Mississippi River caused a 9 foot rise in water elevation as far north as Baton Rouge, LA; nearly 220 miles upriver.[103]

A worst-case scenario for flood planners, is a hurricane paired with a high water event. An early season tropical storm off the coast of Louisiana could cause a prolonged on-shore flow of waves and storm surge. Even a 6–8 foot surge would cause the river to rise to the same level. If the storm coincided with a 12–17 foot river level on the Carrollton gauge in New Orleans, the result could be levee overtopping, and significant urban flooding. Fortunately, the high water season typically runs from the spring into early summer due to the spring thaw and snow melt runoff and the peak of hurricane season is late August to mid October. However, as will be discussed in the environmental chapter of this thesis, climate change and sea-level rise are two inter-connected topics that also have implications for navigation and flood control management. Future improvements to the system will need to take into account each of these component pieces of a larger puzzle. Deciding how, and who is responsible for these decisions, will be keys to ensuring success.

K. CONCLUSION

This chapter painted a broad picture of the complexities of the watershed as it relates to navigation and flooding issues. The navigation system is part of the larger marine transportation system (MTS) that connects the Midwest farms and industries to the global market. It also connects the watershed to the Great Lakes. The Army Corps of Engineers and other federal, tribal, state, and local agencies face a monumental task of planning, budgeting, and carrying out their work to manage navigation channels and flood control infrastructure. This has become more complex with the mounting environmental considerations and impacts with every project.

The Army Corps is often criticized for how it prioritizes its appropriated funds; however, the Corps and the nation face a growing need for investment to replace aging infrastructure and a budget that is not keeping up with the need. This is coming at a time

[103] Alex Demas, "USGS Release: Mississippi River Flows Backwards Due to Isaac" (U.S. Geological Survey, August 29, 2012), http://www.usgs.gov/newsroom/article.asp?ID=3387&from=rss#.UwAz0M7-VnQ.

when the USACE is trying to reinvent their water resources program to one based on the principle of integrated water resources management and focused at the basin level. In one hearing, the Corps was questioned on why there were spending $6 million on flood control on the Missouri River and $73 million on habitat restoration.[104] This highlights the complexity of the issue and how views and opinions can influence decisions. The point that Congressman Graves (R-MO) was making was that our funding priorities are mis-aligned; we should be spending money on protecting life and property of humans and not fish.

The complexity of this problem is how to balance all of these competing funding needs and how to establish priorities. For this reason, this thesis will explore the need for a system-wide approach for the watershed that includes the flood control structures and the marine transportation system. As will be pointed out in future chapters, these are just two components of a more complex system. The next chapter will focus on environmental issues impacting the system at the basin level which also has consequences for the watershed.

104 *The Missouri River Flood: An Assessment of the River Management in 2011 and Operational Plans for the Future*, 28.

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III. ENVIRONMENTAL MANAGEMENT OF THE WATERSHED

This thesis is about the macro watershed system comprised of the Mississippi, Missouri, Ohio, and Illinois River systems including their tributaries. All of these rivers are made up of many smaller watersheds. The definition of watershed, as used in this context, is "a geographic area in which water, sediments, and dissolved materials drain to a common outlet such as a point on a larger stream, a lake, an underlying aquifer, an estuary, or an ocean."[105] The use of the term "watershed" does not have a consistent application in the literature. In this chapter, many of the quotes from other documents that use the term "watershed" are speaking of micro portions of the larger watershed or river basins. These differences will be pointed out.

This chapter outlines environmental management of the entire Mississippi River watershed, and the current and future environmental considerations that must be taken into account to effectively integrate oversight of the watershed. There are several government agencies with regulatory oversight of environmental laws that directly impact the watershed. These agencies and their roles will be discussed.

Federal regulatory oversight of the watershed is undertaken by a tapestry of agencies with various authorities. The primary agency with environmental responsibilities over the watershed is the U.S. Environmental Protection Agency (USEPA). Gaining its regulatory authority primarily from the Clean Water Act, the USEPA is responsible for the quality of water in the watershed. In order to carry out its responsibilities, the USEPA works closely with state and other federal agencies through various agreements that allocate responsibility for environmental concerns related to the watershed. For example, due to its expertise in maritime pollution, the U.S. Coast Guard

105 U.S. Environmental Protection Agency Office of Wastewater Management, *Clean Watershed Needs Survey 2000 Report to Congress* (Washington, D.C.: U.S. Environmental Protection Agency), 5–1, accessed November 3, 2013, http://water.epa.gov/scitech/datait/databases/cwns/2000rtc_toc.cfm.

(USCG) provides Federal On-Scene Coordinator (FOSC) support in the inland zone as defined by, and in accordance with, a Memorandum of Agreement.[106]

In addition to the USEPA, other federal and state agencies control or permit activities that have environmental impacts on the watershed. These agencies and activities include the USCG which administers the federal bridge program over navigable waters, the USACE which oversees all marine construction and dredging activities, and the U.S. Department of Agriculture (USDA) which overseas farming and potential runoff implications to water quality. Additionally, the Department of Interior (DOI), through the USBOR oversees some of the water storage reservoirs in the western states that feed the watershed.

This Chapter will provide a broad overview of the environmental challenges in each of the various federal, state, tribal and local jurisdictions that make up the watershed but will not provide an in-depth environmental review. The author will give an overview of environmental law impacting the watershed to show the complexity of the issues and how environmental law needs to be incorporated into an integrated watershed management framework.

The main environmental laws impacting the watershed are the Clean Water Act (CWA), 33 USC §1251, and the National Environmental Policy Act of 1969 (NEPA), 42 USC § 4321. There are other environmental laws, such as the Clean Air Act, 42 USC § 7401, that have an impact on users of the watershed; however, the CWA and NEPA are the two main environmental laws that govern watershed activities. A discussion of these two laws will be used in this chapter to support the idea that the watershed is worth protecting as a domestic water source.

Federal law does not pre-empt States from prescribing more stringent laws and regulations, and some states do that to better protect the environment. One commonly referenced example is the more stringent air quality emission laws for new cars sold in

106 U.S. Coast Guard Seventh District et al., "Memorandum of Agreement Between U.S. Coast Guard Fifth, Seventh, and Eighth Districts and U.S. Environmental Protection Agency, Region 4 Regarding Response Boundaries for Oil and Hazardous Substances Pollution Incidents and Federal On Scene Coordination Responsibilities," October 29, 2013, http://www.uscg.mil/npfc/docs/PDFs/urg/App/CNCS_EPA_USCG_MOU_AppA.pdf.

the State of California. Although not directly related to the watershed, this is one example of how interpretation of laws may shape future views of the watershed and ways in which the States could decide to impose stronger controls on discharge and stormwater runoff.

When talking about pollution-related environmental issues, it is important to have a definition of the various sources. For this thesis, the author will use Point Source (PS) and Non Point Source (NPS) pollution to identify where pollution sources originate. NPS pollutants originate away from a river and find their way into the watershed through another means, such as storm water drainage or agricultural runoff. Although NPS pollution includes both air and water pollution from a myriad of sources, only water pollution will be discussed in the remainder of the chapter. In contrast, PS pollution also comes from many sources but discharges pollutants directly into the water. Some of these sources include chemicals and petroleum products that are intentionally or accidentally discharged directly into the water, such as from tug and barge traffic operating on the river, or direct release from an industrial facility adjacent to the water.

The remaining portions of this chapter will highlight several current and emerging environmental concerns dealing with watershed management. This chapter will lay out the issues, with the intent of identifying the breadth and complexity of the major environmental challenges that will need to be included in an integrated management framework that will be discussed in Chapter 6.

A. CLIMATE CHANGE

Climate change is an emerging environmental challenge that is impacting the watershed. This section will explore the inclusion of climate change in current and future management and oversight of the watershed. There is a significant body of literature that exists on climate change research and federal agencies have been directed to study, understand and address climate change in their activities.[107] As a result, future design and modeling efforts of the watershed need to include climate change impacts.

[107] *Global Change Research Act of 1990, 15 USC,* 1990.

Figure 6 shows the temperature rise in the Contiguous 48 States from 1901 through 2012.[108] By looking at a little over a century worth of data, it is easy to see why climatologists are concerned. Continued temperature growth could have significant adverse environmental impacts, not just on the watershed.

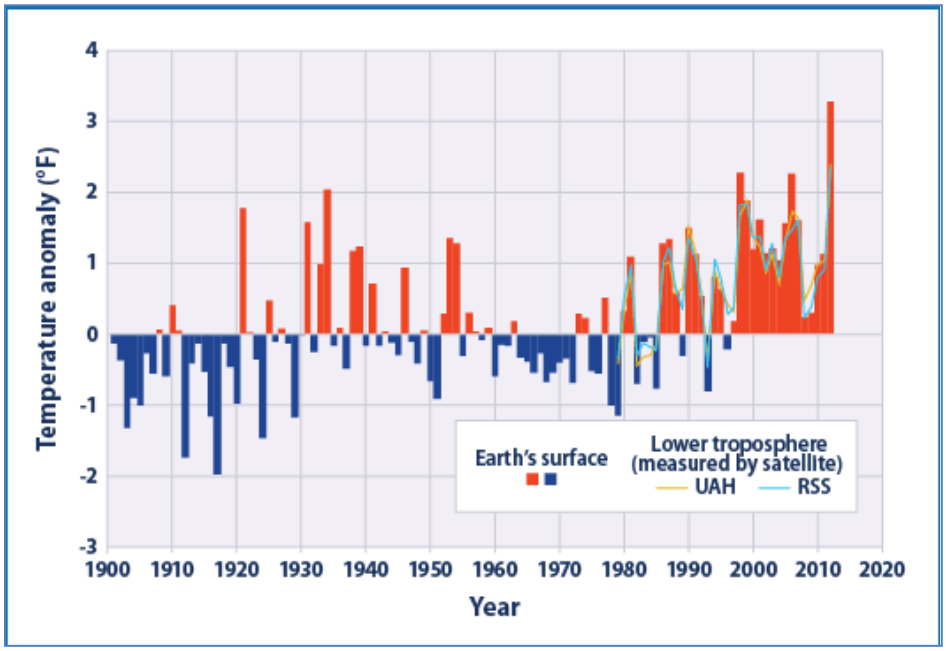

Figure 6. Surface Temperatures in the Contiguous 48 States since 1900 (from U.S. EPA 2013)

The questions moving forward are what implications does this have for the watershed and how do we adapt to the impacts of climate change. The Government Accountability Office (GAO) recently studied the impacts of climate change on federal infrastructure investments and identified a few adaptation lessons we have learned from recent projects. "When the climate changes, infrastructure—typically designed to operate within past climate conditions—may not operate as well or for as long as planned, leading to economic, environmental, and social impacts."[109] Adaptation requires

[108] Climate Change Division U.S. EPA, "Climate Change Indicators in the United States," Reports & Assessments, *Society and Ecosystems*, accessed October 20, 2013, http://www.epa.gov/climatechange/science/indicators/society-eco/index.html.

[109] David C. Trimble et al., *Climate Change: Future Federal Adaptation Efforts Could Better Support Local Infrastructure Decision Makers* (Washington, D.C.: GAO, April 2013).

modifying your assumptions and design parameters and taking into account the unknown future climate and its impacts on your decision making. This adds to the complexity. However, by realizing that the problem is here and needs to be accounted for now, it can be addressed within the proposed watershed management framework. Climate change and its impacts will most certainly impact the functions or operations of each agency covered by this thesis. It will impact navigation, flood control, the environment and political decision-making. This thesis will not prescribe the manner in which to adapt to climate change, but will offer a proposal on how to incorporate it into the decision-making process.

The GAO report calls for the Executive branch to better define climate change impacts on infrastructure planning, and for the Council on Environmental Quality (CEQ) to implement guidelines on how climate change should be included in NEPA review.[110] This is especially critical for design and replacement of river structures such as dams, levees, and bridges. These projects are very costly, and the wrong decisions in the design stage can significantly alter the total cost of the project over its lifespan.

An increasing body of literature on climate change also explores the concept of adaptive management, and looks at including climate variability in current management frameworks. The following definition of adaptive management is used in this thesis and comes from the National Global Change Research Plan, 2012–2021.[111]

> **Adaptive management:** Process that focuses on learning and adapting through partnerships of managers, scientists, and stakeholders who learn together how to improve outcomes. Operational decisions, principally for managing entities that are influenced by climate variability and change. These decisions can apply to the management of infrastructure (e.g., a wastewater treatment plant), the integrated management of a natural resource (e.g., a watershed), or the operation of societal response mechanisms (e.g., health alerts, water restrictions). Adaptive management operates within existing policy frameworks or uses existing infrastructure, and the decisions usually occur on timescales of a year or less.

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110 Government Accountability Office, *Climate Change: Federal Efforts Under Way to Assess Water Infrastructure Vulnerabilities and Address Adaptation Challenges* (Washington, D.C., November 2013), 87.

111 John P. Holdren, "The National Global Change Research Plan 2012–2021: A Strategic Plan for the U.S. Global Change Research Program" (National Science and Technology Council, April 2, 2012), 119.

The National Global Change Research Plan is a result of the Global Change Research Act of 1990, 15 USC §2921. This strategic plan "has broadened its range of emphasis over time, from a primary focus on climate science toward a deeper integration of other Earth system science disciplines."[112] The plan attempts to lay out how it will ensure sustainability, another key concept in the future of the watershed. The complexity of the climate change issue includes other science disciplines including social, behavioral, and economical.[113] This thesis will not explore each of those other disciplines; however, it is important to recognize that the complexity of climate change is not just about the physical environment—humans interact with the watershed and can alter their behavior, in a positive or negative way, to change the physical environment.

One example of how adaptive measures could be included in design parameters for structures in the watershed is with bridges. Existing bridges are modified by owners, or through appropriations managed by the USCG, pursuant to the Bridge Act of June 21, 1940, also known as the Truman-Hobbs Act, 33 USC §518.[114] In order to determine whether the Coast Guard issues an order to alter a private bridge under the Truman-Hobbs program, an investigation must first reveal that it is unreasonably obstructive to waterborne navigation, and worth federal investment. Alterations of bridges under the Truman-Hobbs Act, involve a cost share between the federal government and the bridge owner. Because of the complex cost-benefit calculations, very few bridges fall under this program. Climate change predictions are not currently considered as part of the investigation process.

The main input into the process of determining whether a bridge meets the definition of unreasonably obstructive is the past record of bridge allisions. Allisions are common on the watershed as a result of varying circumstances and often occur between towing vessels pushing many barges, and bridges that are usually not wide enough between support piers to accommodate the vessel in the existing river environment. By

112 Ibid., 22.

113 Ibid., 24.

114 *Truman Hobbs Act*, *Electronic Code of Federal Regulations*, 1999, http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&sid=7499ad329c53c13c55bc96bf99f57020&rgn=div5&view=text&node=33:1.0.1.10.60&idno=33.

looking ahead at the potential impacts of climate change, the Coast Guard might come to a different conclusion as to whether to order a bridge alteration. For example, climate change impacts may include greater frequencies of extreme high water and larger flow volumes on the watershed. These high flow periods result in greater risk for towing vessels pushing barges downstream. As a result, a higher bridge allision rate is possible. By accounting for climate change impacts in the Truman Hobbs decision process, the Coast Guard may come to a different decision on ordering an alteration of a bridge. This would reduce the number of bridge allisions and thereby prevent the unintended release of cargo from barges damaged by the allision.

Quadrennial National Climate Assessments are required by the Global Change Research Act of 1990.[115] These assessments provide the science behind adaptation efforts of the federal government. These are necessary to ensure consistency in adaptation efforts across the government, which is crucial to the future success of climate change management. "In February 2013, federal agencies released their first-ever climate change adaptation plans, outlining strategies to reduce the vulnerability of Federal programs, assets, and investments to the impacts of climate change, such as sea level rise or more frequent or severe extreme weather."[116]

Another climate change result is sea-level rise. As polar ice caps melt, the sea itself is rising. This can have significant adverse effects on coastal lands such as the low-lying marshes of coastal Louisiana. The GAO highlighted sea level rise and the potential climate change impacts on future infrastructure projects. A good example of using climate change predictions in design projects, was Louisiana's effort to raise U.S. Highway 1, and the Interstate 10 twin spans between Slidell and New Orleans East, following destruction of the bridges in Hurricane KATRINA.

> CEQ's (Council on Environmental Quality) draft NEPA guidance states that climate change effects should be considered in the analysis of projects that are designed for long-term utility and located in areas that are

115 Trimble et al., *Climate Change: Future Federal Adaptation Efforts Could Better Support Local Infrastructure Decision Makers*, 68.

116 Council on Environmental Quality, "Climate Change Resilience," The White House, accessed October 20, 2013, http://www.whitehouse.gov/administration/eop/ceq/initiatives/resilience.

> considered vulnerable to specific effects of climate change (e.g., increasing sea level or ecological change) within the project's time frame.[117]

The watershed is impacted by sea level rise since the water depth at the mouth of the Mississippi River is controlled by a combination of sea level and river stage. River stages coincide with the current and forecast water levels at various locations along the waterway as measured by the National Weather Service and reported by the respective river forecast center.[118] As sea level rises, it will cause impacts farther up the river. Cumulative impacts from sea-level rise and climate change on watershed infrastructure needs to be accounted for in all future infrastructure investments.

What is missing from agency adaptation plans is a coordinated whole-of-government approach similar to that outlined in the 2010 *National Security Strategy*.[119] This is a systemic problem across government; as the size and complexity of government grows, so do the tentacles of each program and their impacts on other programs. This becomes a wicked problem, "a form of social or cultural problem that is difficult to solve because of incomplete, contradictory, and changing requirements."[120] This wicked problem is further complicated by adding additional intersecting wicked problems. To try and resolve these wicked problems, the government has created task forces and other cross-agency workgroups. Unfortunately, what sometimes occurs is what happened with the task force on climate change—the federal government ends up with a menu of

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117 Trimble et al., *Climate Change: Future Federal Adaptation Efforts Could Better Support Local Infrastructure Decision Makers*, 84.

118 National Oceanic and Atmospheric Administration, "Lower Mississippi River Forecast Center"; National Weather Service National Oceanic and Atmospheric Administration, "North Central River Forecast Center," *North Central River Forecast Center*, n.d., http://www.crh.noaa.gov/ncrfc/index.php?view=hydro_fcst; National Weather Service National Oceanic and Atmospheric Administration, "Arkansas-Red Basin," *Arkansas-Red Basin*, n.d., http://www.srh.noaa.gov/abrfc/; National Weather Service National Oceanic and Atmospheric Administration, "Missouri Basin, Pleasant Hill," *National Weather Service River Forecast Center*, n.d., http://www.crh.noaa.gov/mbrfc/; National Weather Service National Oceanic and Atmospheric Administration, "The Ohio River Forecast Center (OHRFC)," *The Ohio River Forecast Center (OHRFC)*, n.d., http://www.erh.noaa.gov/ohrfc/.

119 The Office of the President, "National Security Strategy" (The Office of the White House, May 2010), 14.

120 Austin Center for Design, "Understanding Wicked Problems," *ac4d*, accessed January 12, 2014, http://www.ac4d.com/home/philosophy/understanding-wicked-problems/.

individual agency plans on how they will adapt to climate change. These solutions are not implemented as a whole-of-government approach, and therefore result in planning and funding challenges later. Watershed management needs to account for climate change as a system and not through individual agency adaptation measures.

B. INVASIVE SPECIES

Another environmental challenge facing the watershed is the threat from invasive species. Also known as non-native or non-indigenous species, invasive species consist of plants, fish, or other marine life that change the ecosystem in ways that can be devastating. One example is the influx and rapid expansion of Asian Carp within the watershed. A 2012 Congressional Research Service (CRS) report on Asian Carp and the Great Lakes region, outlines the issues with Asian Carp. Figure 7 shows the spread of several species of Asian Carp throughout the eastern United States.[121] As the Asian Carp population grows, they are spreading out and threatening adjacent water bodies, such as the Great Lakes. This has the potential to devastate the Great Lakes ecosystem.

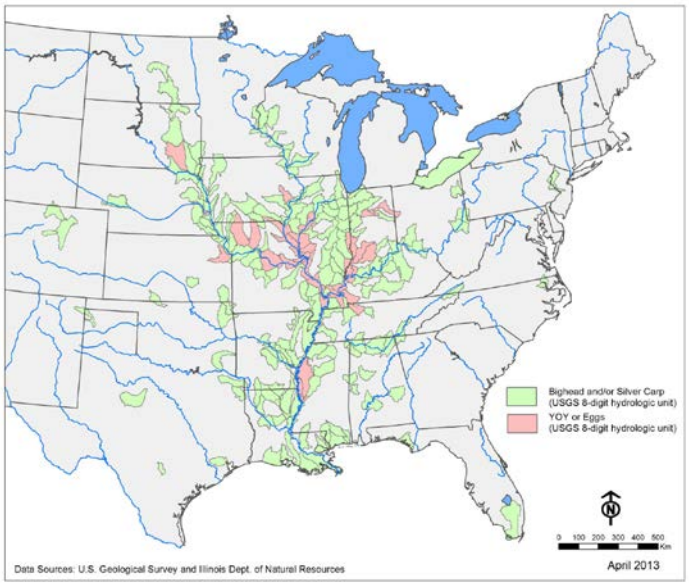

Figure 7. Asian Carp Distribution (from Baerwaldt, Benson and Irons, 2013)

[121] Kelly Baerwaldt, A. Benson, and Kevin Irons, *Asian Carp Distribution in North America*, Report to the Asian Carp Regional Coordinating Committee, April 2013, 2.

As a result, the Army Corps of Engineers was authorized by Congress and installed an electrified barrier under the Illinois River in order to stop the migration of Asian carp into Lake Michigan. While electrifying the waterway poses additional risks to the recreational public and the towing vessel industry, the threat to the Great Lakes ecosystem was seen as a greater threat. Figure 8 shows the Chicago Area Waterway System (CAWS), and the location of the electrified barrier on the Illinois River.[122]

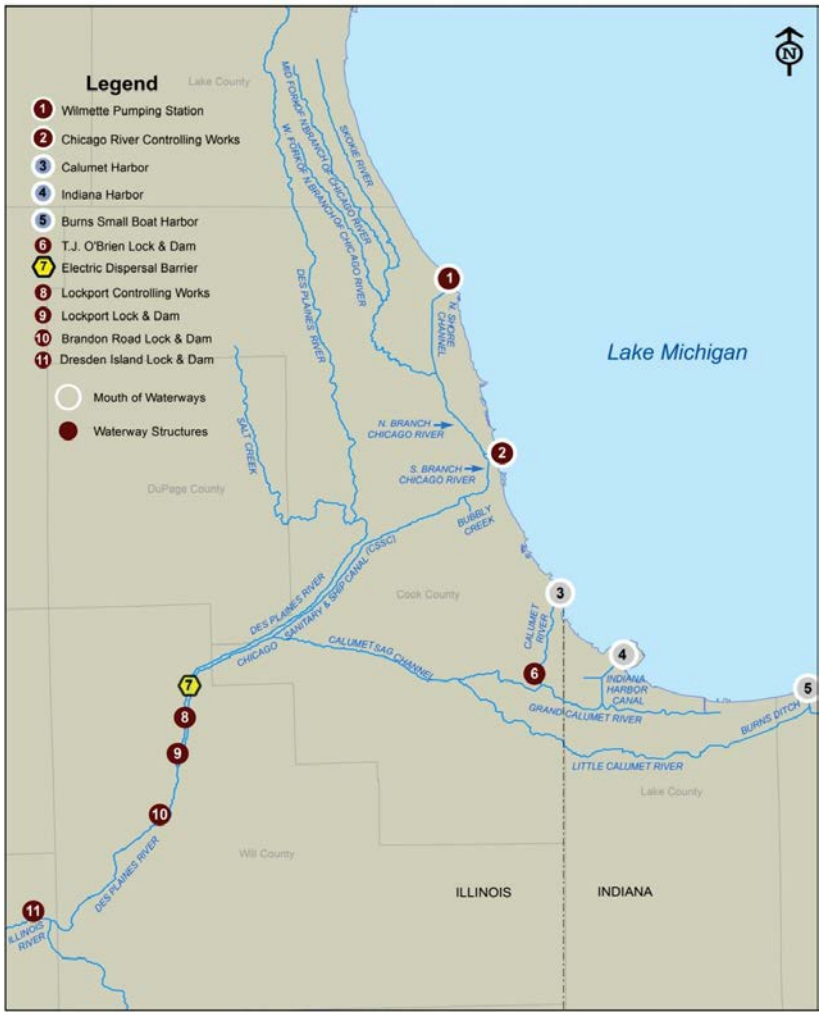

Figure 8. Chicago Area Waterway System (from U.S. Army Corps of Engineers, 2014)

122 U.S. Army Corps of Engineers, *The GLMRIS Report: Great Lakes and Mississippi River Interbasin Study* (U.S. Army Corps of Engineers, January 6, 2014), ES–2.

Environmental and sport fishing groups have called for the physical isolation of the Great Lakes from the Mississippi River watershed, by shutting down the shipping channel and isolating the Illinois River from Lake Michigan. Thus, far, the call to isolate the Great Lakes from the watershed has not been successful, although five Great Lakes States joined in a lawsuit to require the shutdown of the canal. The lawsuit has been dismissed by a federal district court judge.[123] In response to the outcry from the States, the federal government created a task force to work on this issue, and President Obama appointed an Asian Carp Director to coordinate the interagency effort.[124]

The focus on keeping Asian Carp out of the Great Lakes is highlighted here for a few reasons. The first is that the Great Lakes are not part of the Mississippi River watershed; however, by connecting the two through a canal, we may have inadvertently altered the ecosystem of one or both of them. This compounds the complexity of management and oversight. The second is that invasive species can cause significant damage, not just to the area where they are first introduced, but they can also migrate to other bodies of water, or have eggs transported by boats that have live wells—compartments on boats to keep bait or caught fish alive to preserve the freshness of fish.

State-owned inland lakes and streams are also vulnerable to these types of infestations. Many states now have laws and regulations prohibiting the movement of boats with water in the vessels' live wells. This is a preventive program designed to stop the spread of invasive species by recreational fisherman. Another example of a preventive program to stop the spread of invasive species is New York's prohibition against transporting firewood more than 50 miles from where it originated. This is designed to protect trees by stopping the spread of wood-boring insects. These are examples of mitigation techniques to limit the risk of spreading a dangerous problem. Unfortunately, these programs rely on individual compliance because there are not

123 Noah Hall, "Great Lakes Law: Asian Carp and Chicago Canal Litigation," *Great Lakes Law*, December 22, 2012, http://www.greatlakeslaw.org/blog/asian-carp/.

124 John Goss, "Protecting Our Great Lakes from Asian Carp | The White House," *The White House Council on Environmental Quality*, December 22, 2010, http://www.whitehouse.gov/blog/2010/12/22/protecting-our-great-lakes-asian-carp.

enough enforcement officers to prevent violations. An active and ongoing public message campaign is needed to ensure that these invasive species are not moved by humans.

The final decisions on Asian Carp issues are likely years away. In the meantime, there are likely to be other invasive species that impact the watershed and threaten to spread to other connected bodies of water. Moving forward, the work of the Asian Carp Task Force should be monitored by the stakeholders of the Mississippi River watershed. What might be good for the Great Lakes may not be good for watershed stakeholders, and vice-versa. As was pointed out in Chapter 2, this is especially true for the navigation users who rely on the interconnectedness of the Great Lakes and the Mississippi River via the Illinois River.

C. WATER QUALITY

Another key environmental concept of watershed management is water quality. "More than 50 cities and 18 million people rely on the Mississippi River for their daily water supply."[125] It is important to note that these numbers are just for the Mississippi River. The other rivers that make up the watershed also supply water to local communities for public uses, but a consolidated statistic could not be found. The concept of water quality is relatively new to the United States with the first federal mandate coming in 1972. "Prior to the enactment of the Federal Water Pollution Control Act Amendments of 1972 (1972 Amendments), no national policy existed in the United States calling for the protection of the quality of the nation's water resources."[126] The Federal Water Pollution Control Act became known as the Clean Water Act (CWA) in 1977.[127]

The CWA requires a report by the USEPA that outlines state and federal estimates for complying with the Act. To meet this mandate, the USEPA coordinates data

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[125] Natural Resources Conservation Service, "Mississippi River Basin Healthy Watersheds Initiative," *USDA NRCS - Natural Resources Conservation Service*, accessed October 20, 2013, http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/farmbill/initiatives/?cid=stelprdb1048200.

[126] Deason, Schad, and Sherk, "Water Policy in the United States," 185.

[127] Committee on the Mississippi River and the Clean Water Act, National Research Council, *Mississippi River Water Quality and the Clean Water Act: Progress, Challenges, and Opportunities*, 2.

collection and reporting by the states and develops the Clean Watershed Needs Survey (CWNS) every four years. The report is designed to identify the capital funding needs to improve wastewater and stormwater runoff projects, and to reduce non-point source (NPS) pollution.[128] In the 2000 CWNS report to Congress, the EPA recognized that "many States are now moving toward developing and enhancing their environmental protection programs with a different geographic focus—the watershed."[129] By taking a watershed view, as opposed to a state-wide view, the states are better positioned to identify problems, address them as they occur and prioritize the problem watersheds first, thereby "achieving real ecological results."[130] By assisting the states address these smaller watersheds through federal grant and subsidy programs, the federal government is also cleaning up the larger watershed. In other words, the larger watershed becomes healthier and cleaner as a direct result of the State watersheds getting cleaner—a win-win situation. If only it was that easy.

The USEPA and the USACE have been questioned on their application of the Clean Water Act with regards to NPS pollution.[131] By not recognizing some smaller rivers as "waters of the U.S.," the USEPA and USACE have not been enforcing the CWA.[132] The USEPA sent their draft rules to the Office of Management and Budget (OMB) in September 2013, in order to clarify the definition of waters subject to the Clean Water Act.[133] This was ahead of the scientific report that the rule should be based upon, calling into question whether the USEPA is being objective in their definition of "waters

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128 U.S. Environmental Protection Agency Office of Wastewater Management, "Clean Watersheds Needs Survey Overview," accessed November 9, 2013, http://water.epa.gov/scitech/datait/databases/cwns/.

129 U.S. Environmental Protection Agency Office of Wastewater Management, *Clean Watershed Needs Survey 2000 Report to Congress*, 5–1.

130 Ibid., 5–8.

131 Committee on the Mississippi River and the Clean Water Act, National Research Council, *Mississippi River Water Quality and the Clean Water Act: Progress, Challenges, and Opportunities*, 8–9.

132 Daren Bakst, "Issue Brief No. 4122: EPA and the Corps Ignoring Sound Science on Critical Clean Water Act Regulations," 1.

133 U.S. EPA, "Clean Water Act Definition of 'Waters of the United States,'" *United States Environmental Protection Agency*, November 25, 2013, http://water.epa.gov/lawsregs/guidance/wetlands/CWAwaters.cfm.

of the U.S." and application of the CWA.[134] The USEPA also has a number of existing regulatory-exempt activities, including the agricultural sector in order to "ensure the continuing production of food, fiber and fuel to the benefit of all Americans."[135]

There are some voluntary efforts being undertaken to improve water quality of the watershed. A cooperative partnership has developed between the Natural Resources Conservation Service (NRCS) and volunteers—including landowners and producers—to "implement voluntary conservation practices that improve water quality, restore wetlands, enhance wildlife habitat and sustain agricultural profitability in the Mississippi River Basin."[136] Through this project known as the Mississippi River Basin Healthy Watersheds Initiative (MRBI), the NRCS works with states, local communities, and individual landowners through grant programs to reduce pollution into the watersheds, and to protect and restore wetlands. Figure 9 shows the fiscal year 2012 focus areas for the MRBI, and Figure 10 shows the approved NRCS projects for fiscal years 2010–2012.[137] "Through MRBI, NRCS and its partners use a "conservation systems approach" to help producers avoid, control and trap nutrients and sediment to address water quality concerns."[138] This leads to a reduction in the level of Non-Point Source (NPS) pollution and therefore a healthier water quality.

134 Daren Bakst, "Issue Brief No. 4122: EPA and the Corps Ignoring Sound Science on Critical Clean Water Act Regulations."

135 U.S. EPA, "Clean Water Act Definition of 'Waters of the United States.'"

136 Natural Resources Conservation Service, "Mississippi River Basin Healthy Watersheds Initiative."

137 Ibid.

138 Ibid.

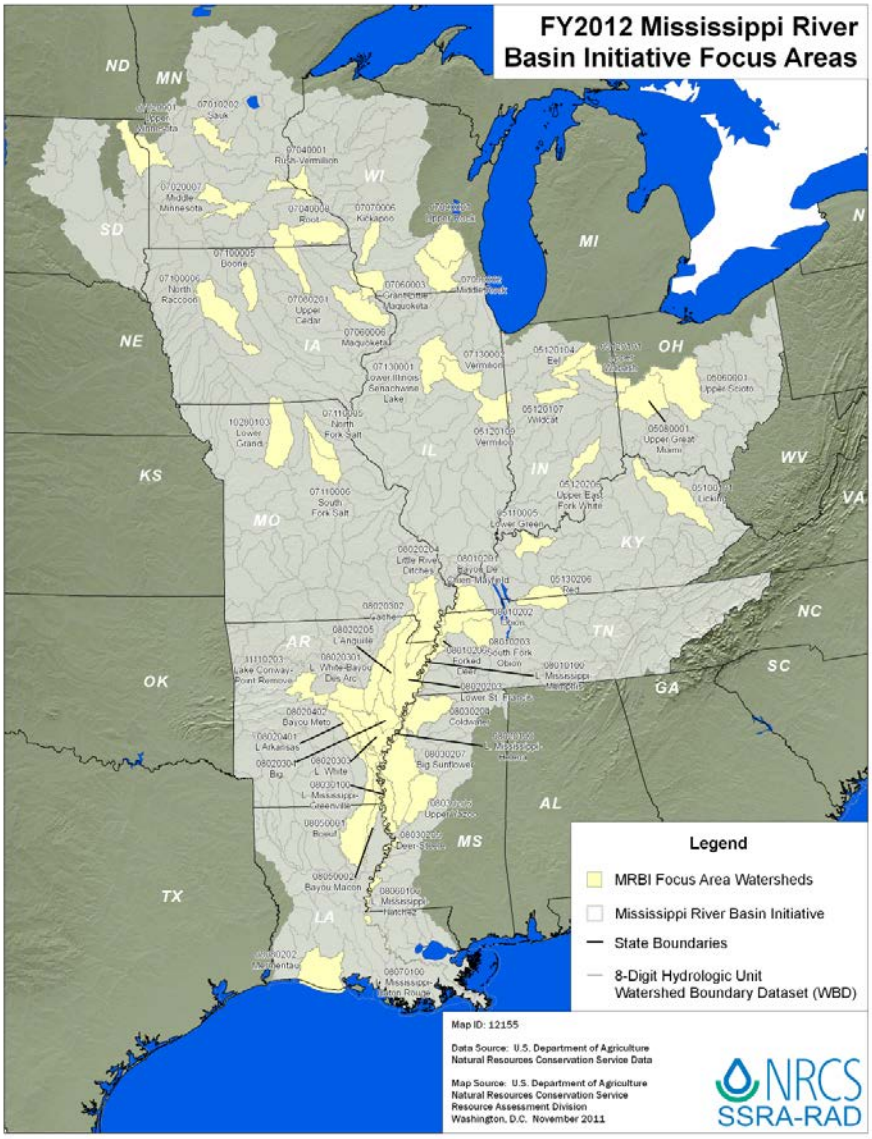

Figure 9. Focus Areas of the Mississippi River Basin Initiative (from NRCS, 2013)

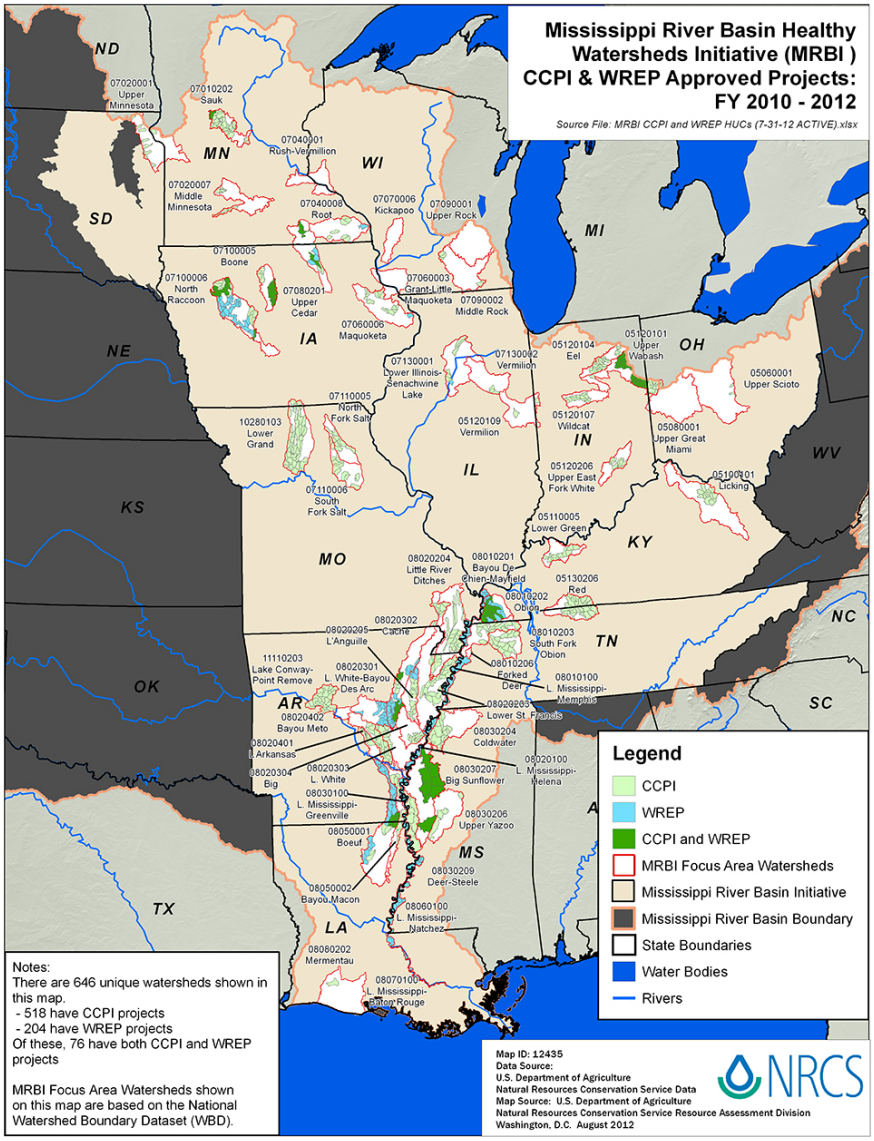

Figure 10. Mississippi River Basin Initiative Projects 2010–2012 (from NRCS, 2013)

As will be discussed in Chapter IV, water quality is very important to municipalities that rely on the watershed for drinking water. "Missouri's edge-of-field monitoring system, now utilized by several states participating in the MRBI, is in place and capturing data on about 200 acres of resource-rich land in Missouri."[139] This

139 Natural Resources Conservation Service, "Mississippi River Basin Healthy Watersheds Initiative 2010 Conservation Activities" (U.S. Department of Agriculture, 2010), 4, http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/farmbill/initiatives/?cid=stelprdb1048200.

program could be expanded, or implemented by law or regulation, to ensure a greater impact. Similar conservation measures in the Chesapeake Bay Watershed have been shown to positively impact water quality.[140]

"Producers upstream from the Gulf of Mexico in the Mississippi Delta have found ways to reduce the runoff of nutrients through MRBI assistance."[141] This reduction of runoff helps prevent field erosion and alters the amount of sediment in the river system. The cumulative effect of sedimentation in the river systems results in the need for dredging to accommodate navigation. This is a significant issue in the Upper Mississippi River basin and is caused by the higher concentration of locks and dams.[142] By reducing sediment, frequency of dredging may be reduced. In her thesis on implementing a sediment transfer strategy and network, Haley Heard advocates for turning the problem of sediment into an opportunity for states to reclaim their land by investing in recovery and reuse of the sediment.[143] This is an ingenious way of attempting to tackle the problem on a watershed scale.

Industries have a significant impact on the watershed. One of those, farming, has both a positive and negative impact on the watershed. Farming is positive in that it provides an economic boost to Great Plains states by getting their products to market. But farmers also pose risks to the watershed by way of storm water runoff, that erodes soil and deposits farm chemicals, pesticides, and sediment in the river. Many farmers are becoming environmentally conscious and taking steps to improve their environmental footprint on the watershed through work with the Natural Resource Conservation Service (NRCS). One example of how farmers are joining the environmental movement:

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140 Conservation Effects Assessment Project (CEAP) Cropland Modeling Team, *Impacts of Conservation Adoption on Cultivated Acres of Cropland in the Chesapeake Bay Region, 2003–06 to 2011*, Conservation Progress Report (U.S. Department of Agriculture, Natural Resources Conservation Service), accessed December 19, 2013, http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/?cid=stelprdb1240074.

141 Natural Resources Conservation Service, "Mississippi River Basin Healthy Watersheds Initiative," 4.

142 Committee on the Mississippi River and the Clean Water Act, National Research Council, *Mississippi River Water Quality and the Clean Water Act: Progress, Challenges, and Opportunities*, 4.

143 Haley R. (Haley Ruth) Heard, "Deconstructing the Mississippi River : Restoring a Continental System through the Integration of Flexible Infrastructure" (Thesis, Massachusetts Institute of Technology, 2010), http://dspace.mit.edu/handle/1721.1/59736.

> The Chris Krielow Farm and Bayouland Farms recognize the broader natural resource impacts of farming in the Mississippi River Basin, and recently enrolled over 990 acres in the MRBI. Both farms are applying precision agriculture technology to collect crop nutrient needs more precisely, evaluate production input factors, accurately predict crop yields and precisely apply variable rates of nutrients across their fields. This technology will focus application of nutrients, reducing nutrient runoff and improving water quality.[144]

Water quality is also important for adjacent geographic areas such as the Gulf of Mexico. As a result of nutrient runoff along the watershed, there is a large "dead zone" that forms in the Gulf of Mexico. By reducing this runoff, the ecosystem in the Gulf of Mexico might also be able to flourish.

D. TRANSPORTATION CONSIDERATIONS

This section explores the use of the watershed to transport hazardous substances and looks at the oversight of this process. One developing controversial topic is the shipment of wastewater from the hydraulic fracturing process, a potentially hazardous substance. The U.S. Coast Guard, by virtue of 46 USC §3703, is the federal agency responsible for regulating the bulk shipment of liquid dangerous cargoes on navigable waters of the United States. Navigable waters include the inland rivers that make up the Mississippi River Watershed. On October 2013, the U.S. Coast Guard published a notice of availability in the Federal Register of a draft policy letter on the shipment of wastewater from a process known as hydraulic fracturing, and requested public comments.[145]

Hydraulic fracturing, also known as fracking, is a controversial process of injecting a high pressure mixture of water, sand and/or chemicals into rock formations in

144 Natural Resources Conservation Service, "Mississippi River Basin Healthy Watersheds Initiative," 3.

145 U.S. Coast Guard, "Carriage of Conditionally Permitted Shale Gas Extraction Waste Water in Bulk," *Regulations.gov*, October 31, 2013, http://www.regulations.gov/#!docketDetail;D=USCG-2013-0915.

order to break them up and extract natural gas that is trapped.[146] The fracking process has been controversial in many states due to the unknown long-term health impacts to ground water and the environment.[147] The water that is used for fracking is being linked to many ground-water wells drying up and the depletion of aquifers, situations that have been exacerbated by a drought that has plagued much of the United States over the past three years.[148] The fracking process draws a lot of water from many different sources and results in a waste water product that needs to be captured and either recycled or disposed of so as not to cause environmental damage.

Due to a large amount of waste water that is generated, industry officials are exploring the idea of shipping the waste by barge through the Mississippi River watershed. For purposes of vessels carrying hazardous cargoes, the implementing regulations for the Coast Guard's oversight can be found in 46 Code of Federal Regulations (CFR), Subchapter O. The Coast Guard proposed a policy letter for public comment, that outlines how it will treat the shipments of shale gas extraction waste water as an unlisted cargo, regulated under Title 46, CFR, Part 153 (Ships Carrying Bulk Liquid, Liquefied Gas, or Compressed Gas Hazardous Materials).[149] The policy letter outlines the independent testing that would be needed in order to obtain USCG approval to ship shale gas extraction waste water by tank barge.[150]

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146 Ground Water Protection Council and ALL Consulting, *Modern Shale Gas Development in the United States: A Primer*, April 2009, 56, http://energy.gov/fe/downloads/modern-shale-gas-development-united-states-primer; Adam Vann, Brandon J. Murrill, and Mary Tiemann, *Hydraulic Fracturing: Selected Legal Issues* (Washington, D.C.: Congressional Research Service, November 15, 2013), 1, http://digital.library.unt.edu/ark:/67531/metadc267822/m1/1/high_res_d/R43152_2013Nov15.pdf.

147 Hilary Boudet et al., "'Fracking' Controversy and Communication: Using National Survey Data to Understand Public Perceptions of Hydraulic Fracturing," *Energy Policy* 65 (February 2014): 57–67, doi:10.1016/j.enpol.2013.10.017; Karen Charman, "Trashing the Planet for Natural Gas: Shale Gas Development Threatens Freshwater Sources, Likely Escalates Climate Destabilization," *Capitalism, Nature, Socialism* 21, no. 4 (2010): 72–82.

148 Karen Charman, "Trashing the Planet for Natural Gas: Shale Gas Development Threatens Freshwater Sources, Likely Escalates Climate Destabilization," 79.

149 U.S. Coast Guard, "Carriage of Conditionally Permitted Shale Gas Extraction Waste Water in Bulk."

150 J.W. Mauger, "Proposed Policy Letter: Carriage of Conditionally Permitted Shale Gas Extraction Waste Water in Bulk" (US Coast Guard, n.d.), http://www.regulations.gov/#!docketDetail;D=USCG-2013-0915.

E. CHAPTER CONCLUSION

The third largest watershed in the world is a national asset that must be protected. As outlined in Chapter II, the United States relies on the watershed to get farm goods and other products to market, and to relieve flooding pressures along the inland rivers. This chapter outlined the environmental complexities of the watershed including the impacts of pollution, climate change, invasive species, water quality, and transportation of hazardous cargoes.

These complex challenges are currently being managed as individual issues and not part of a larger interconnected system. As discussed in Chapter II, the marine transportation system relies on the Chicago Area Waterway System (CAWS) to connect the Great Lakes to the Mississippi River watershed. However, this man-made connection risks allowing the introduction of Asian Carp to the Great Lakes with potential devastating impacts to the Great Lakes ecosystem. Navigation and invasive species are related in this context. One possibility being studied is to physically isolate the watershed from the Great Lakes. However, the issue of Asian Carp plays out, it has highlighted the devastation that invasive species can cause and why it is important to look at issues holistically.

Similarly, climate change is already causing increased instances of floods, droughts, and watershed impacts.[151] Understanding what this means to the watershed as a system, and to the individual components, is an area for further study. Regardless of the outcome of future research and study, incorporating climate change in an integrated framework is needed. Additionally, construction of new infrastructure on the watershed needs to account for climate change. There is evidence of some success with that following Hurricane KATRINA; however, design standards need to be developed.[152]

Lastly, many of the municipalities along the watershed rely on the water for drinking, industrial processes, and for generating electricity. In order to protect the

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[151] The Office of the President, "The President's Climate Action Plan" (The Executive Office of the President, June 2013), 4.

[152] Trimble et al., *Climate Change: Future Federal Adaptation Efforts Could Better Support Local Infrastructure Decision Makers.*

watershed, we need to ensure that it is clean, healthy, and managed as one system. This chapter shows the complexity of keeping the watershed clean and healthy, now and into the future, and how the various federal and state agencies must work with all stakeholders to accomplish this task. This chapter built on the navigation and flood control chapter to show the interconnectedness of the issues. The next chapter will explore the municipal and industrial uses of the watershed, and how these uses related to navigation, flooding, and sustaining a clean and healthy watershed.

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IV. MUNICIPAL AND INDUSTRIAL USES

This chapter will focus on those activities impacted by, and impacting the watershed related to, municipal uses and industrial processes. For the purpose of this thesis, municipal uses will refer to potable water and wastewater treatment. Industrial processes will include irrigation, power generation and hydraulic fracturing.

In order to understand municipal and industrial water uses and their impacts on water, it is important to highlight how water consumption works. There are two types of water—surface and ground water. This thesis will not provide an in-depth overview of these water sources, but a cursory overview is needed to provide context for how municipalities and industries obtain and use water. Figure 11 includes a look at the water cycle.[153]

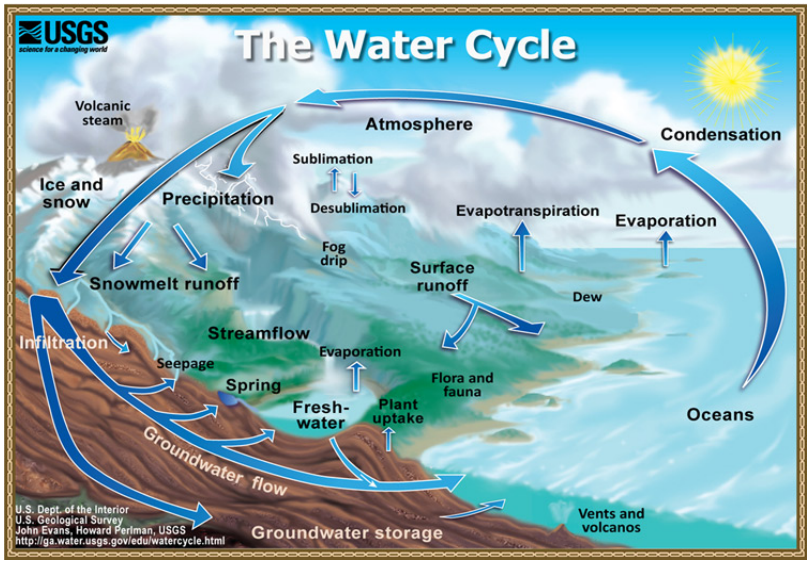

Figure 11. Water Cycle (from USGS, 2013)

Surface water consists of water from lakes, rivers, and streams and is the result of standing water that has not seeped into the ground or evaporated. It is replenished from a combination of sources including aquifers and precipitation sources. Ground water comes

[153] U.S. Geological Survey (USGS) Water Science School, "The Water Cycle," *The Water Cycle-Water Science for Schools*, November 5, 2013, http://ga.water.usgs.gov/edu/watercycle.html.

from water that is below the surface, and includes aquifers and water that has seeped into the ground.[154] Ground water is replenished by precipitation that seeps through the soil and into underground aquifers.

The main federal agency tasked with overseeing water usage in the United States is the U.S. Geological Survey (USGS). The USGS produces water reports for the nation based on many different data sources. The consumption of water specifically within the watershed is not known, but for the purposes of this thesis, the USGS calculations of freshwater withdrawals from 2005, the latest year available, will be used.[155]

Figures 12 and 13 depict the 2005 water consumption from surface and ground water by all users.[156] There are two notes worth highlighting with regard to these figures; the first is the consumption of surface water for thermoelectric power generation and the second is consumption of ground water for irrigation. These uses will be discussed in more detail later in this chapter.

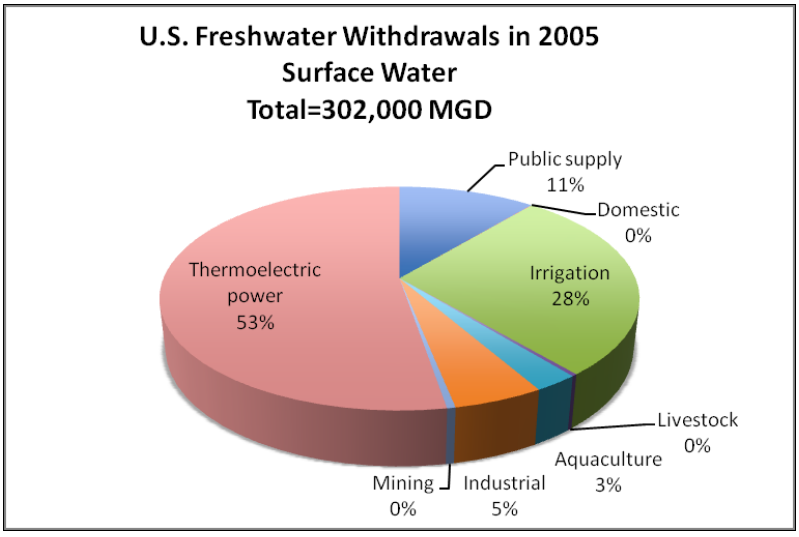

Figure 12. Surface Freshwater Usage Within the U.S., 2005 (from USGS, 2013)

154 U.S. Geological Survey, "Trends in Water Use in the U.S., 1950 to 2005, the USGS Water Science School," *The USGS Water Science School*, May 23, 2013, http://ga.water.usgs.gov/edu/wateruse-trends.html.

155 Ibid.

156 Ibid.

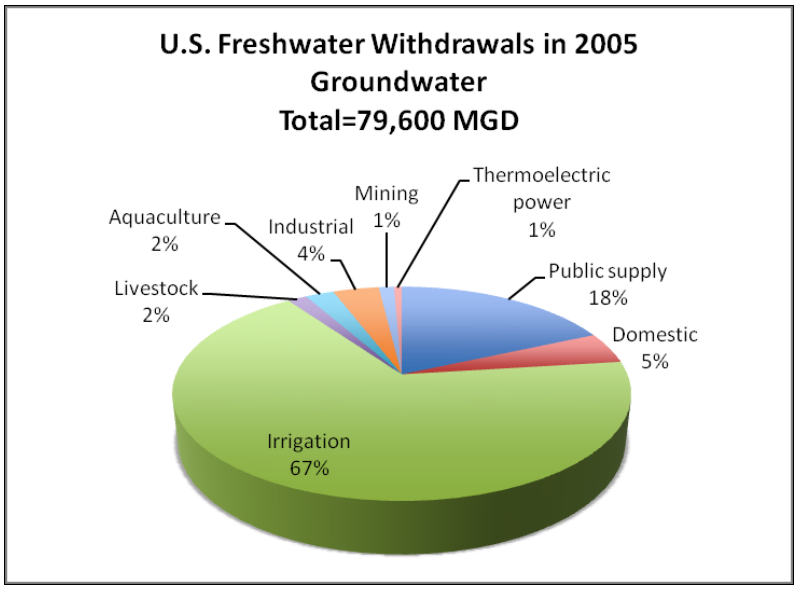

Figure 13. Ground Freshwater Usage Within the U.S., 2005 (from USGS, 2013)

The discussion of water usage is increasing due to the expansion of hydraulic fracturing, irrigation demands, and a persistent drought in the Great Plains. "Current water use on the Great Plains is unsustainable, as the High Plains aquifer continues to be tapped faster than the rate of recharge."[157] In 1986, Congress required the USGS to report on the changing water levels with the aquifer every two years. The 2011 report notes that since development began, the aquifer has lost 246 million-acre-feet compared to the 2.96 billion acre-feet of water that existed pre-development.[158] Figure 14 shows the locations of existing U.S. aquifers.[159] Of note is that the aquifers cross state boundaries and often encompass large areas of the country. For example, the High Plains,

[157] *Global Climate Change Impacts in the United States: A State of Knowledge Report from the U.S. Global Change Research Program* (Cambridge [u.a.: Cambridge Univ. Press, 2009), 124.

[158] "USGS Scientific Investigations Report 2012–5291: Water-Level and Storage Changes in the High Plains Aquifer, Predevelopment to 2011 and 2009–11," accessed January 14, 2014, http://pubs.usgs.gov/sir/2012/5291/.

[159] U.S. Geological Survey (USGS), "USGS National Water Quality Assessments of Principal Aquifers (NAWQA): Regional Assessments of Principal Aquifers," *USGS National Water-Quality Assessment (NAWQA) Program*, January 11, 2013, http://water.usgs.gov/nawqa/studies/praq/.

or Ogallala, aquifer encompasses 175,000 square miles across eight states and parts of at least two river basins, including the Missouri and Arkansas.[160]

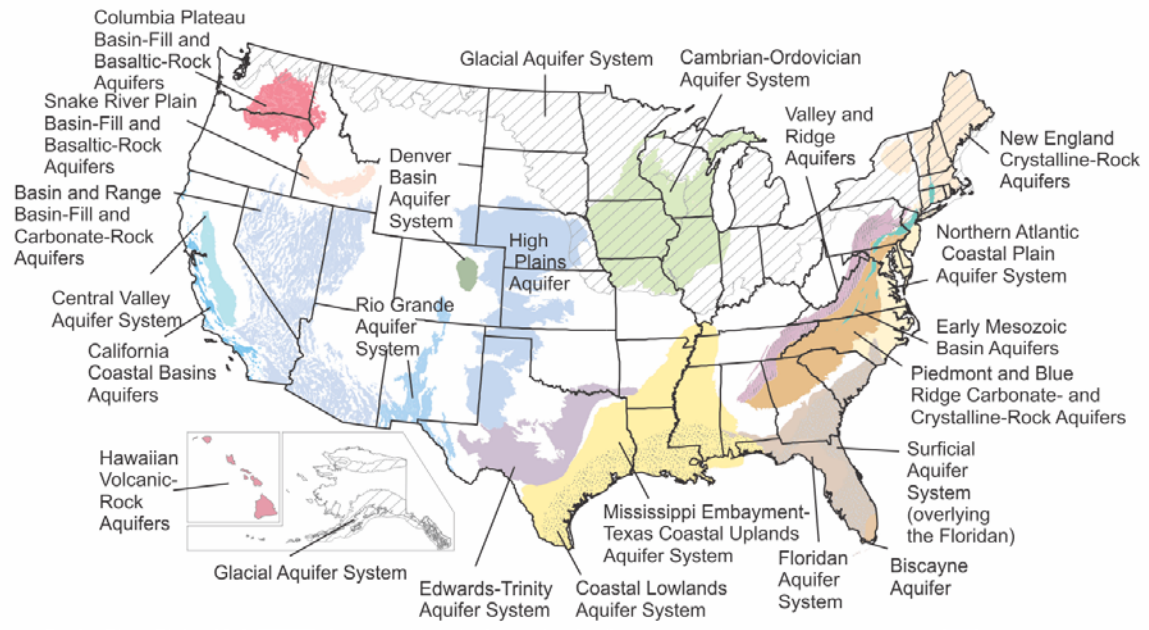

Figure 14. U.S. Principal Water Aquifers (from USGS, 2013)

One of the recurring themes from the literature was the need for better water data. This was not specifically noted in regards to water consumption, but data is used to drive science-based decisions, and the more data collected, the better the decisions that can be made. This was evident when trying to find data on water consumption from ground and surface sources. The most recent data was from 2005 and was published in 2009. Using this pattern of results, it is expected that the next water consumption report will be released in 2014.

Figures 15 and 16 show the trend in total water withdrawals by use and type, along with the population trends, from 1950 to 2005.[161] One thing to note from the graph is the leveling off of water consumption beginning in about 1980, despite the rise in

[160] U.S. Geological Survey (USGS), "High Plains Aquifer System," *National Water-Quality Assessment (NAWQA) Program - High Plains Regional Groundwater (HPGW) Study*, April 29, 2013, http://co.water.usgs.gov/nawqa/hpgw/HPGW_home.html.

[161] Joan F. Kenny et al., *Estimated Use of Water in the United States in 2005* (Reston, Va: U.S. Geological Survey Circular 1344, 2009), 44.

population. The current population in the U.S. is over 330 million, nearly 30 million more than in 2005. Given the nearly 9 year lag in data reporting, it will be interesting to see if the water consumption rate remains steady despite the growth in population. Another point to make with this data, is that it does not specifically account for the usage of water for hydraulic fracturing, although it is presumed that this is covered in the "other"category. Thermoelectric power generation, as mentioned earlier, does not result in removal of the water from the system, since it is generally considered to be a "flow-through process."[162]

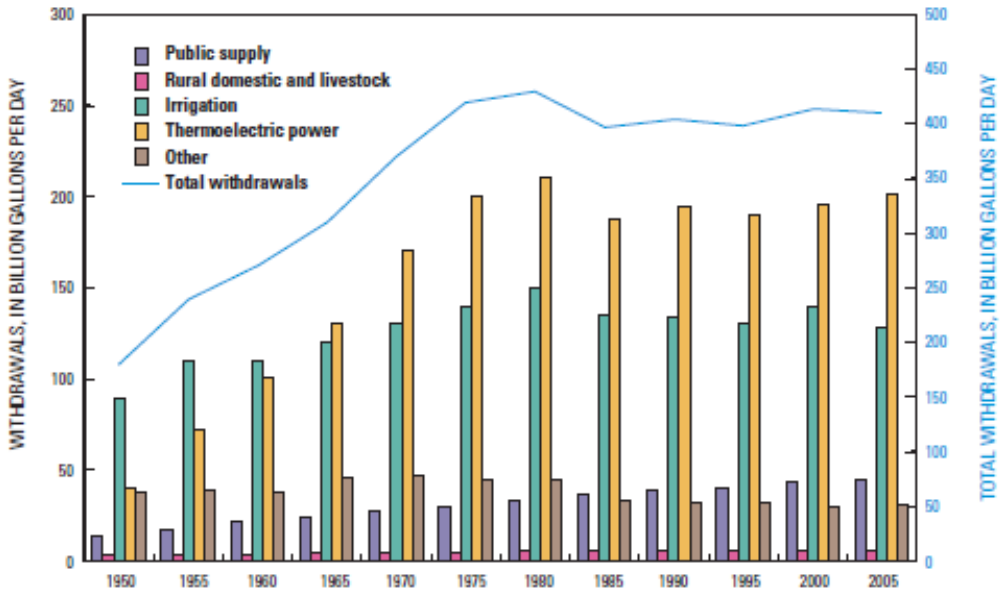

Figure 15. Trends in Total Water Withdrawals by Use, 1950–2005 (from USGS 2009)

162 "Total Water Use in the United States, 2005, the USGS Water Science School," accessed January 14, 2014, http://ga.water.usgs.gov/edu/wateruse-total.html.

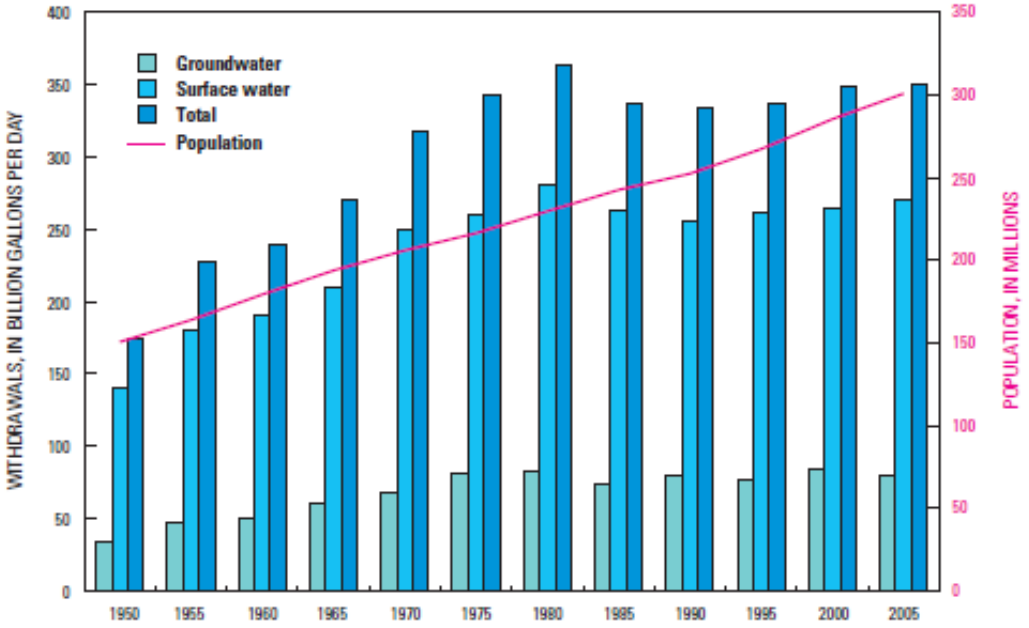

Figure 16. Trends in Population and Freshwater Withdrawals by source, 1950–2005 (from USGS 2009)

A. MUNICIPAL USES OF WATER

Municipalities use the watershed for many purposes including public consumption, firefighting, and wastewater treatment. The use of river water for these purposes is governed by state and local laws; however, federal agencies exercise environmental regulatory authority. The legal aspects governing ownership of water and water rights will be covered in detail in the following chapter.

1. Potable Water

Having clean and good tasting water is something that every American expects of the municipal water system. The ability of municipal water suppliers to accomplish this in communities in the Mississippi River watershed is often tied to the quality and quantity available in the river. As discussed in Chapter II, stock and flow is the process by which the USACE and USBOR manage their responsibilities under the Water Supply Act of 1958. In the traditional sense, stock and flow is the management of water to facilitate navigation interests and prevent flooding; however, there is often excess water in the system that can be sold for other purposes. In addition to pulling water directly from the

rivers of the watershed, municipalities may also buy water from the USACE and USBOR, if there is water in excess of authorized purposes.[163]

River levels can also impact the use of the river by municipalities. During periods of extremely low water in the lower Mississippi River, Plaquemines Parish in southeast Louisiana relies on the USACE to install a berm on the river bottom, in order to protect the municipal water supply that comes from the river. The berm acts as a plug, to prevent heavier salt water, from coming back up the river from the Gulf of Mexico and contaminating their fresh water supplies. Additionally, the USACE installs this berm upstream from some of the Parish fresh water intakes. In these locations, the Parish must shut down their intakes and rely on barges to bring in fresh water from outside sources.

Discharges from industrial facilities also pose risks to fresh water supplies available to municipalities. One example occurred on the Elk River of West Virginia which is part of the Ohio River basin. A tank containing the chemical 4-methylcyclohexanemethanol leaked up to 7500 gallons and contaminated the municipal water system for five days.[164] This spill was about one mile upstream of the water intake system for up to 300,000 residents of Charleston, West Virginia and nine nearby counties, who were told not to drink, cook, wash, or bathe using tap water immediately after the spill. Figure 17 shows the top 10 states for toxic releases, with 5 of the 10 impacting at least part of the Mississippi River watershed.[165]

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163 Cynthia Brougher and Nicole T. Carter, *Reallocation of Water Storage at Federal Water Projects for Municipal and Industrial Water Supply* (Washington, D.C.: Congressional Research Service, October 31, 2012), 2–5.

164 "Chemical Spill Shuts off Water to 300K in West Virginia," *CBS This Morning* (CBS, January 10, 2014), http://www.cbsnews.com/news/some-people-treated-for-water-related-issues-in-w-va/; "New Chemical Identified In West Virginia's Elk River Spill," *The Diane Rehm Show* (WAMU 88.5/National Public Radio, January 23, 2014), http://thedianerehmshow.org/shows/2014-01-23/new-chemical-identified-west-virginias-elk-river-spill/transcript.

165 Rob Kerth and Shelley Vinyard, *Wasting Our Waterways Report 2012: Toxic Industrial Pollution and the Unfulfilled Promise of the Clean Water Act* (Boston, MA: Environment America Research & Policy Center, May 2012), 15, http://www.environmentamericacenter.org/reports/ame/wasting-our-waterways-2012.

State	Toxic Releases (lbs.)	Rank
Indiana	27,384,933	1
Virginia	18,078,000	2
Nebraska	14,727,942	3
Texas	14,325,126	4
Georgia	12,620,709	5
Louisiana	10,903,183	6
Pennsylvania	10,121,165	7
Alabama	9,857,668	8
Ohio	9,192,337	9
North Carolina	9,168,645	10

Figure 17. Top 10 States by Toxic Releases, 2010 (from Kerth and Vinyard, 2012)

Although the Coast Guard has implemented double-hulled barge regulations on the commercial navigation industry, marine casualties such as collisions, allisions, and groundings (CAG) still occur on the rivers of the watershed, with some resulting in discharges of harmful chemicals or petroleum products. One example of a marine casualty impacting water supply intakes occurred on the Mississippi River near New Orleans, LA in 2008, when a towing vessel collided with the tank vessel TINTOMARA resulting in a spill of up to 419,000 gallons or nearly 10,000 barrels of fuel oil from the barge that was being pushed by the tug.[166]

The response to spills like this involve many federal, tribal, state, and local governments, in addition to oil spill response organizations (OSRO), who are contracted by the vessel owner(s) or the Federal On Scene Coordinator (FOSC) to clean up the spill. The FOSC will usually only open a funds accounting line to the Oil Spill Liability Trust Fund—established after the Motor Vessel EXXON VALDEZ grounded in Prince

[166] Cain Burdeau, "Ship-Barge Crash Closes Mississippi at New Orleans," *USATODAY.com*, July 23, 2008, online edition, sec. Money-Economy Jobs, http://usatoday30.usatoday.com/money/economy/2008-07-23-3769494252_x.htm; Dwayne Fatherree, "Tugboat Operators Involved in Collision Not Properly Licensed," *The Times-Picayune - NOLA.com*, accessed January 11, 2014, http://www.nola.com/news/index.ssf/2008/07/ap_collision_closes_mississipp.html.

William Sound Alaska in 1989—if the OSRO is not adequately containing and cleaning up the spill. This is a usual occurrence for larger spills.

For the first time ever, the USEPA began codifying toxic release data by Hydrological Unit Code in 2010, so that the river segment and basin where the pollution originated can be tracked.[167] This is an important point for being able to identify trends throughout the watershed, and for managing the watershed as a single system. Figure 18 shows the toxic discharges by basins for 2010, to show the significance of pollution within the Mississippi River watershed.[168] By tracking toxic releases to individual river segments and basins, the government will be better able to track long term effects and exposures. This will have implications to fish and wildlife studies, as well as water quality studies.

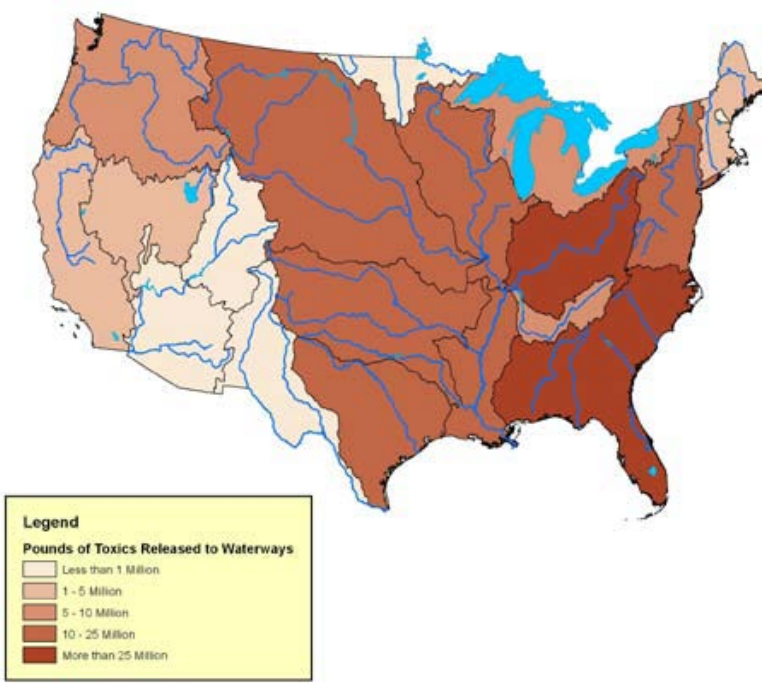

Figure 18. Toxic Discharges by Basins, 2010 (from Kerth and Vinyard, 2010)

[167] Kerth and Vinyard, *Wasting Our Waterways Report 2012: Toxic Industrial Pollution and the Unfulfilled Promise of the Clean Water Act*, 9.

[168] Ibid., 15.

2. Federal Role in Municipal Water Supply

Local municipalities also obtain water from federal water resources projects. The 1944 Flood Control Act (33 U.S.C. §708) significantly augmented the USACE involvement in large multipurpose projects, and authorized agreements for the temporary use of surplus water. Additionally, the Water Supply Act (WSA) of 1958 (43 U.S.C. §390b) authorizes the USACE to provide storage for municipal and industrial users in new and existing reservoir projects, with the local users paying 100% of the cost.[169] The local costs are for the water only as the cost to construct the reservoir was borne by the federal government.

Future environmental changes may change this relationship with local municipalities and industrial users. As discussed in Chapter III, climate change impacts are not fully understood, and future water needs and uses have not been calculated. In a 2012 Congressional Research Service report on the use of water from federal water storage projects, Cynthia Brougher and Nicole Carter posed several unanswered questions regarding the future federal role in municipal and industrial water. These questions involve the appropriate federal role in municipal water supply issues, how that role should evolve with climate change impacts, and whether the current laws and policies reflect the national interest.[170]

Water rights laws will be explored further in Chapter V; however, legal challenges to the WSA complicate the issue. This is especially true in the eastern states where droughts influence all riparian law users.[171] Riparian law affords individuals the right to water that touches their property, provided they do not abuse that right. Conversely, most of the western states use the prior-appropriation water laws which mean that there is seniority amongst water users based on whose property the water

169 N. T. Carter and Charles V. Stern, *Army Corps of Engineers Water Resource Projects: Authorization and Appropriations* (Washington, DC: Congressional Research Service, September 11, 2013), 19.

170 Brougher and Carter, *Reallocation of Water Storage at Federal Water Projects for Municipal and Industrial Water Supply*, 21.

171 Ibid., 1.

touches first. In the prior appropriation states, droughts do not affect users in the same way, due to the hierarchy of access to water. "Addressing these questions is complicated by the wide range of opinions on the proper response and the difficulty of enacting any change to how federal facilities are operated, other than incremental change or project-specific measures, because of the many affected constituencies."[172]

B. INDUSTRIAL USES

The USEPA oversees the National Pollution Discharge Elimination System (NPDES), which was established by the Clean Water Act of 1972, to restore the quality of water in the U.S. NPDES is managed by the states, with regulations provided by the USEPA. Despite the program improving water quality over the past 40 years, more work is needed. Figure 18 shows the amount of toxic substances that were released into the watershed in 2010. These chemicals pose risks to the downstream water supplies of many municipalities; however, the benefit of dilution of these chemicals in the river is also apparent, with many spills not triggering widespread downstream problems. Oftentimes, the spills only cause local water supply problems until the spill can be cleaned up.

Industrial users of the watershed also need to be responsible for preparedness and resiliency efforts. "Determining the most effective spending of money relative to size and mitigation is a question not many utilities have the personnel and the expertise to handle."[173] Preparedness and resiliency will be explored briefly in Chapter V; however, future research in this area could include a closer look at the role of the Federal Emergency Management Agency (FEMA) and the National Response Framework (NRF) to handle large-scale disasters affecting the watershed including a major earthquake, severe flood or prolonged drought.

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[172] Ibid., 21.

[173] *The New Madrid Seismic Zone: Whose Fault Is It Anyway?*, 17.

1. Thermoelectric Power

Water is used in the process of making thermoelectric power for distribution to the power grid; however the use of water for power generation does not result in the total loss of the water. Water for power generation is used to cool the power generating equipment, but is not able to be discharged directly back into the river due to the warmer temperatures. This heated water is put through a cooling tower where it is evaporated. This results in water taken out of the river, but released back into the water cycle through evaporation.

One of the recurring themes of this thesis is the aging infrastructure and the long-term health and viability of the infrastructure employed on the watershed. "Although hydropower is an extremely reliable and long-term resource, analysis shows that more than half of all hydropower turbines in the United States are more than 50 years old—35% are more than 75 years old."[174] It is the age of our nation's infrastructure that resulted in the American Society of Civil Engineers giving critical infrastructure a grade of D+ in 2012.[175]

Federal rights to water are also a part of the discussion for power generation. There are some who believe that the federal government, through the Federal Energy Regulatory Commission (FERC), may have "statutory authority under the Federal Power Act to allocate the waters of those rivers on which federally-licensed hydroelectric projects are located."[176] This argument is based on interpretations of past Supreme Court decisions; however, the specific argument of the FERC allocating water resources has not been addressed.[177]

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[174] U.S. Army Corps of Engineers, U.S. Department of Energy, and U.S. Department of the Interior, *Memorandum of Understanding For Hydropower; Two-Year Progress Report,* April 2012, 38.

[175] American Society of Civil Engineers, *2013 Report Card for America's Infrastructure*, 4.

[176] Deason, Schad, and Sherk, "Water Policy in the United States," 190.

[177] Ibid.

One thing to consider is that, as water levels drop, the ability to produce the same amount of power also drops. As a result, "the consequences of inadequate water for hydropower are already being felt in the United States."[178] While there are no examples currently in the watershed, one example from outside the watershed is the area behind Hoover Dam, where the decline of Lake Mead resulted in the reduction of peak capacity for its turbines from 130 megawatts to 100 megawatts.[179] This is a problem that will only be exacerbated if recent demographic shifts continue, and population growth in the southwestern part of the country adds additional stress to the water system. This is another reason a national water strategy is necessary.

2. Hydraulic Fracturing (Fracking)

As discussed in Chapter III, the fracking process has been controversial in many states, and also other countries, due to the unknown long-term health impacts to ground water and the environment.[180] The water that is used for fracking is being linked to many ground-water wells drying up and the depletion of aquifers; situations that have been exacerbated by a drought that has plagued much of the United States over the past three years.[181] The fracking process draws a lot of water from many different sources and results in a waste water product that needs to be captured, and either recycled or disposed of, so as not to cause environmental damage.

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178 Marstel-Day LLC, "Army Water Security Strategy" (Army Environmental Policy Institute, December 2011), 22, http://www.aepi.army.mil/docs/whatsnew/ArmyWaterStrategy.pdf.

179 Ibid.

180 Boudet et al., "'Fracking' Controversy and Communication"; Stefanie Penn Spear, "Fracking, Fracking and More Fracking," *Huffington Post*, June 25, 2013, http://www.huffingtonpost.com/stefanie-penn-spear/fracking-fracking-and-more-fracking_b_3492120.html.

181 Spear, "Fracking, Fracking and More Fracking."

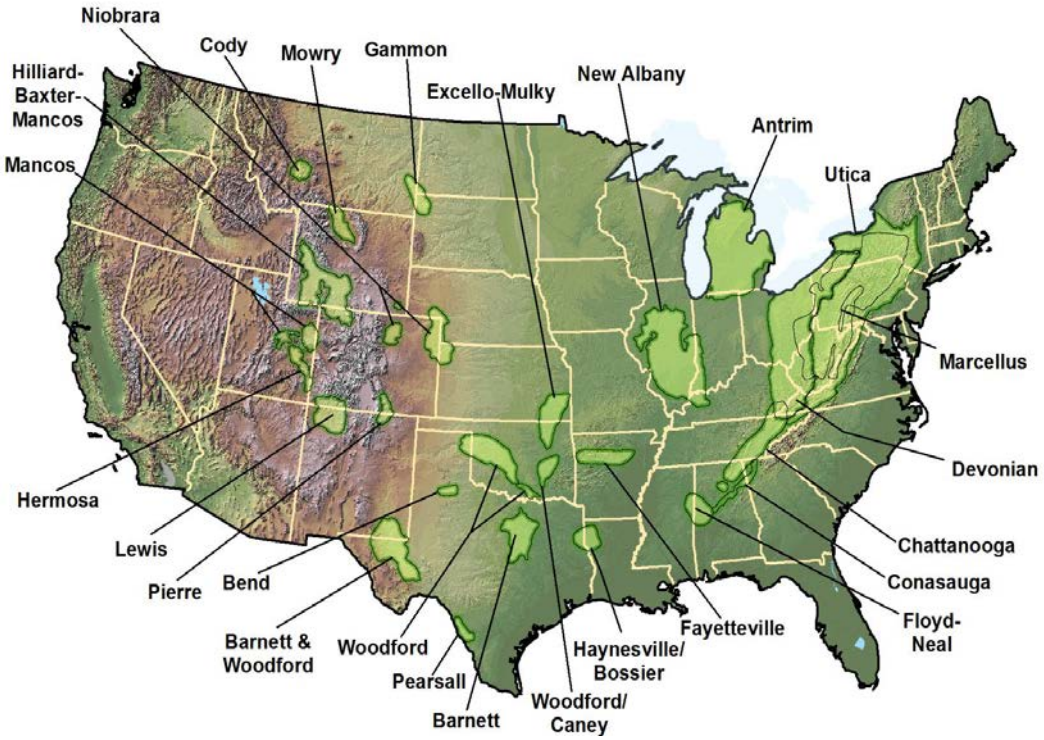

Figure 19. Shale Basins in the U.S. (from Groundwater Protection Council and ALL Consulting, 2009)

Another developing issue with fracking is the uncertain long-term impacts on the environment. Fracking involves drilling vertically below the water table, and then horizontally up to 10,000 feet.[182] The process involves high pressure injections into rock formations to get them to break apart and release trapped gas. These injections are akin to large explosions. There are several reports of wells near fracking sites being contaminated with methane gas. Although these reports have not been scientifically linked to hydraulic fracturing, the USEPA continues to study environmental impacts from the fracking process.[183] Figure 19 shows the locations of known shall gas basins within the United States.[184] Of note are the Marcellus, Gammon, New Albany, Excello-Mulky,

182 Karen Charman, "Trashing the Planet for Natural Gas: Shale Gas Development Threatens Freshwater Sources, Likely Escalates Climate Destabilization," 76.

183 Howard Rogers, "Shale Gas-the Unfolding Story," *Oxford Review of Economic Policy* 27, no. 1 (2011): 133.

184 Ground Water Protection Council and ALL Consulting, *Modern Shale Gas Development in the United States: A Primer*, ES–2.

and Fayettville basins, since they are under the surface of the Mississippi River watershed. Additionally, the shale basins in Texas, Oklahoma and Kansas lie under the Ogallala aquifer, and gas drilling may be another reason for the drop in that aquifer level.[185] Shale gas development needs to be included as part of a national water strategy, otherwise we may be depleting one resource to exploit the extraction of another.

3. Irrigation

For the purposes of this thesis, the author is including irrigation use as a sub-set of the industrial uses section. The Midwestern farmland relies on irrigation water in order to grow the corn, wheat, soybeans and other products that our nation relies on both for consumption and for exports. This water comes from both surface and groundwater sources, and is a significant percentage of the total water used in the United States. "Approximately 27 percent of the irrigated land in the United States is in the High Plains and about 30 percent of the groundwater used for irrigation in the U.S. is pumped from the High Plains aquifer."[186]

The use of water for irrigation is subject to water laws of the state in which the farm is located. The application of pesticides and fertilizer is not subject to federal jurisdiction, or the Clean Water Act, even though runoff may include these chemicals enters the rivers of the watershed.[187] Sediment and chemicals that are carried away by water runoff are then deposited throughout the watershed. Some of this runoff will eventually make it through the entire drainage of the watershed and be deposited into the Gulf of Mexico. As discussed in Chapter III and shown in Figure 20, this causes an area

185 *Water Symposium* (Washington, DC: Government Printing Office, 2005), 35.

186 U.S. Geological Survey (USGS), "High Plains Aquifer System."

187 Committee on the Mississippi River and the Clean Water Act, National Research Council, *Mississippi River Water Quality and the Clean Water Act: Progress, Challenges, and Opportunities*, 3–4.

of hypoxia to form in the Gulf of Mexico.[188] The depletion of oxygen essentially forms a dead zone, and does not allow fish and aquatic life to thrive.[189]

Figure 20. Watershed Basins and Hypoxia Zone (from U.S. EPA)

President Obama issued Executive Order (EO) 13547 in July 2010, requiring federal agencies to work together, under a newly formed National Ocean Council, to implement the recommendations of the Interagency Ocean Policy Task Force.[190] The EO required the formation of regional planning bodies (RPB), comprised of federal, tribal, state, and local agencies working together to develop marine plans for each of nine regions covering the coasts, Great Lakes, and the Gulf of Mexico. The Gulf of Mexico RPB may decide to look at how this dead zone forms, and work to take action to regulate

[188] U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, "Mississippi River Gulf of Mexico Watershed Nutrient Task Force," accessed January 16, 2014, http://water.epa.gov/type/watersheds/named/msbasin/subbasin.cfm. Note: the term sub-basin in the USEPA figure is synonymous with the definition of basin in this thesis. USEPA refers to the Mississippi River watershed as the Mississippi River Basin.

[189] Committee on the Mississippi River and the Clean Water Act, National Research Council, *Mississippi River Water Quality and the Clean Water Act: Progress, Challenges, and Opportunities*, 4.

[190] Barack Obama, "Executive Order 13547--Stewardship of the Ocean, Our Coasts, and the Great Lakes" (The Office of the White House, July 19, 2010), 1, http://www.whitehouse.gov/files/documents/2010stewardship-eo.pdf.

watershed activities that are causing it. This is because of the way the final recommendations of the National Ocean Policy Task Force was written, giving RPB's the ability to go inland as far as necessary within each agencies authority.[191] While the implementation plan does not go as far as the final recommendations, there is language about reducing the coastal and inland impacts from water pollution.[192] This is not fair to the inland states who do not have a seat at RPB meetings.

C. CONCLUSION

Water is a finite natural resource, and is often taken for granted in the United States. This chapter showed the sources of water—ground and surface—and how municipalities and industries use these various sources. This chapter also showed the interconnectedness of the watershed to other bodies of water, specifically the Gulf of Mexico. Looking at how industrial uses of the watershed impact water quality is important to downstream municipalities and the Gulf of Mexico. Implementing possible solutions must first start with identification of the problem.

This chapter builds on Chapter III, which highlighted the impacts on water from environmental concerns. The use of water by municipalities and industries must be done with water quality in mind, since their interaction with water may have adverse consequences on downstream users. When these uses impact other users, either through overconsumption or pollution, conflict is formed. Resolving these conflicts locally may have additional impacts on other regions of the watershed. A systems approach to watershed management would allow these conflicts to be managed with a holistic approach, rather than the current piecemeal approach.

The next chapter will look at how water laws impact water in the United States. It will also explore how this chapter and the previous two impact, and are impacted by, the geopolitical environment throughout the watershed. Geopolitical considerations will

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191 Council on Environmental Quality, *Final Recommendations of the Interagency Ocean Policy Task Force*, 49.

192 National Ocean Council, "National Ocean Policy Implementation Plan" (The National Ocean Council, April 2013), 16, http://www.whitehouse.gov/administration/eop/oceans/implementationplan.

show how the watershed is viewed locally, setting the stage for how to implement a system-wide view of the Mississippi River watershed.

V. GEOPOLITICS

This chapter will focus on the geopolitical aspects of the watershed, and begin to explore the relationships between the components and basins. Before beginning, it is important to have a basic understanding of the water laws of our nation, and how state and federal government must work together to ensure sustainability of water resources. This chapter will briefly touch on the rights and role of the states, although "the federal government has a role in determining how the nation allocates and uses its water resources, despite the extent of the states' jurisdiction over water."[193]

One recommendation of the four National Water Dialogues, held between 2002 and 2008, was to use a watershed management approach when federal actions are to be coordinated with state and local entities.[194] This recommendation is based on a more narrow definition of watershed than used in this thesis. A State that is located within the Mississippi River watershed may have multiple watersheds using this smaller defined subset. This recommendation is synonymous with a basin-wide approach, as defined in this thesis. The basin-wide approach is working successfully in places like the Delaware River Basin Commission with discussions underway for possible regional policy dialogues.[195] Aligning project funding with agency budgets is complicated, because "jurisdiction over water resources policy is fragmented among at least thirteen Congressional committees, twenty-three Congressional subcommittees, eight Cabinet level departments, six independent agencies and two White House offices."[196]

There is recognition that federal efforts to deal with navigation, flooding, and environmental issues is beneficial and contributes to the greater good. By way of example, USACE "systems for navigation, flood and storm damage reduction projects,

193 Congressional Budget Office, "How Federal Policies Affect Water Allocation," 13.

194 Richard A. Engberg, "Setting a Direction for U.S. Water Policy" (presented at the U.S. Army Corps of Engineers 2009 Water Planning Workshop, St. Louis, MO, June 24, 2009), http://www.building-collaboration-for-water.org/Documents/Engberg_DirectionForUSWaterPolicy.pdf.

195 Ibid.

196 Deason, Schad, and Sherk, "Water Policy in the United States," 189.

and efforts to restore aquatic ecosystems contribute to our national welfare."[197] The question is whether this makes it a federal system or a national system. The following definitions are used in this thesis.

Federal: a top-down government approach with a U.S. executive branch agency tasked with leading the effort.

National: a collaborative, whole-of-government approach, that does not give the federal government priority.

A. WATER LAWS

Water laws in the United States developed over time as the country was settled from east to west. Water has generally been considered a common resource, with two water law systems—riparian and prior appropriation—developed over the past century to determine how "to "divide" the commons."[198] These two concepts were introduced in Chapter IV and will be explored further in this chapter. These laws generally follow the idea that riparian law exists in the eastern U.S., and prior appropriation in the west. The following definitions will be used in this thesis.

Riparian water rights: "limits water use to lands adjoining or overlying the water resource, requires water to be used "reasonably" and provides for a pro rata sharing of available water supplies."[199] Although non-riparian landowners do not possess a right to this water, "some states have chosen to establish permit programs for riparian and non-riparian water users."[200] This doctrine generally worked well in the eastern U.S. where water resources are relatively abundant.

Prior Appropriation water rights: this doctrine means that the person who claims the water first, has the right to that water with certain provisions. "The "first-in time, first-in-right" concept of the prior appropriation doctrine reflects the relative scarcity of

197 *Discussion on Agricultural Transportation and Energy Issues*, 13.

198 Deason, Schad, and Sherk, "Water Policy in the United States," 177.

199 Ibid.

200 Marstel-Day LLC, "Army Water Security Strategy," A–25.

water in the western states and provides certainty in times of shortage."[201] The prior appropriation doctrine generally fits with the climate and history of the western U.S., where water scarcity limits the amount of water available for sharing. "Water rights holders can be forced to relinquish their rights if the state determines that the water allocation is not being put toward a beneficial use, such as agricultural irrigation."[202]

Figure 21 shows how states are generally aligned with either a riparian or prior-appropriation doctrine.[203] The dividing line is generally through the geographic center of the country, with eastern states following riparian law, and western states following the prior appropriation doctrine. There are two states within the watershed, Iowa and Mississippi, which have blended doctrines, meaning states "at one time recognized riparian rights, but later converted to a system of appropriation while preserving existing riparian rights."[204]

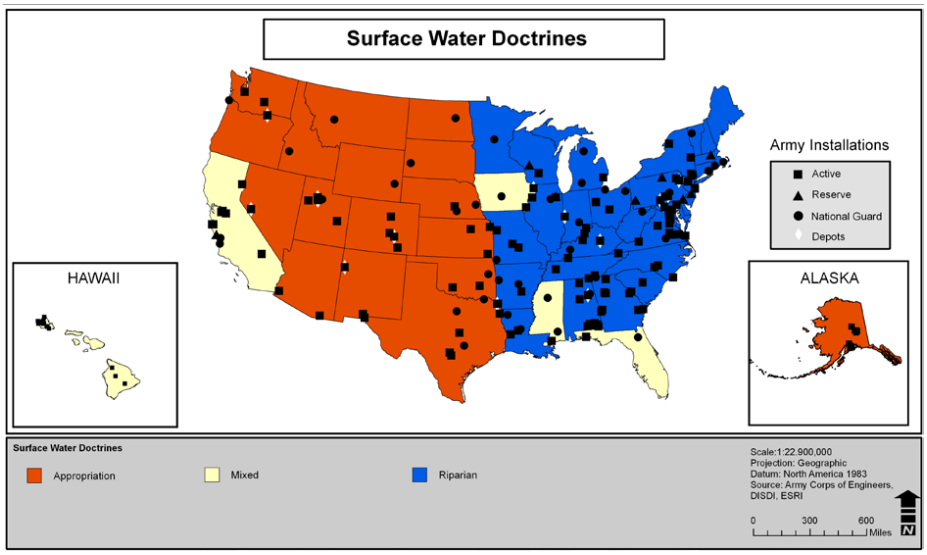

Figure 21. Surface Water Doctrines in the U.S. (from Marstel-Day, LLC, 2011)

201 Deason, Schad, and Sherk, "Water Policy in the United States," 177.

202 Marstel-Day LLC, "Army Water Security Strategy," A–26.

203 Ibid., A–25.

204 Ibid., A–26 See also U.S. Army, Army Water Rights and the Judge Advocate, 1992, 4–5. and U. S. Army Corps of Engineers (USACE), Army Installation Water Assessment, 2009, 22–23.

Both of the doctrines have been criticized. The prior appropriation doctrine has been challenged for being too rigid, "especially with regard to new water uses having junior priorities."[205] The riparian doctrine does not quantify water rights, and is therefore subject to interpretation by owners, downstream users, and the courts. A quantification process is necessary to understand the extent to which a property owner or permit holder can go to transfer water.[206] As a result, many eastern states are now passing "new laws that either amend or supersede the riparian doctrine."[207] There is a general trend within the United States to blend these doctrines to one that is more applicable nationwide. "The resulting "conceptual confluence" finds the eastern states adopting some aspects of the prior appropriation doctrine while the western states temper that doctrine by adopting certain concepts that historically are riparian in origin."[208] It is important to understand how these changes will be impacted by climate change and reduced aquifer levels, as a result of irrigation, fracking, and other uses.

In addition to the need to determine quantities for private use, there is a need to protect water availability for common use. Common uses of the watershed include navigation, flood control, and municipal water supply. Water to support the authorized 9 foot deep by 300 foot wide channel may be needed from pooled storage, in order to keep the economic advantage of the watershed intact. In addition, the release of water to prevent flooding is necessary so as not to overflow the storage basins. All of these issues come to the core of the geopolitical struggle, the need to balance law and policy with science, technology, and local culture.[209]

B. CONGRESSIONAL MEMBER ORGANIZATIONS (CMO)

This section will begin to explore the political subtexts that exist in order to implement the recommendations contained in Chapter VII. These subtexts include Congressional Member Organizations (CMO) and stakeholder groups, each having

205 Deason, Schad, and Sherk, "Water Policy in the United States," 177.

206 Ibid., 179.

207 Ibid., 178.

208 Ibid.

209 Ibid., 176.

particular interests and focus areas dealing with at least one aspect of the watershed. Congressional member organizations (CMO), sometimes referred to as a caucus, are a means for like-minded congressional members to discuss items of mutual interest. This is not tied to the committee structure of Congress, and does not have anything to do with their leadership positions.

There are several caucuses that have a nexus to water resources policy and Mississippi River watershed issues. It is through an understanding of these caucuses that a better understanding of the political environment can be attained. Congress has recognized the growing needs for better coordination of Mississippi River basin issues and formed the Mississippi River caucus in the Senate and the Mississippi River and Tributaries caucus in the House of Representatives.[210] A consolidated listing of caucus members that outlines who in Congress is interested in these issues, and what their focus areas are, was not found. This may seem unusual, but it is within the CMO rules of each chamber, which stipulates what must be done procedurally and legally to employ staff time and office resources towards advancing the work of the CMO.[211]

There are additional caucuses which will have interests in watershed legislative issues. A listing of these and their primary focus areas is included:

- Congressional Clean Water Caucus: "will primarily spotlight cutting-edge technologies and innovative techniques and approaches in the clean water sector—including green infrastructure, water reuse and reclamation, energy production and conservation, resource recovery, resiliency, and more—through a series of Congressional Briefings in 2014."[212]

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[210] Bill Lambrecht, "Second Mississippi River Caucus Organized in Congress," *The Big River Works: Healthy. Sustainable. Mississippi System.*, February 11, 2013, http://bigriverworks.org/second-mississippi-river-caucus-organized-in-congress/; Rep. Rodney Davis (R-IL), "Press Release: Davis Forms Bi-Partisan Mississippi River Valley and Tributaries Caucus," *United States Congressman Rodney Davis*, February 5, 2013, http://rodneydavis.house.gov/media-center/press-releases/davis-forms-bi-partisan-mississippi-river-valley-and-tributaries-caucus.

[211] Robert Jay Dilger and Jessica C. Gerrity, *Congressional Member Organizations: Their Purpose and Activities, History, and Formation* (Washington, D.C.: Congressional Research Service, September 24, 2013), http://www.fas.org/sgp/crs/misc/R40683.pdf.

[212] Adam Krantz, "Bipartisan Clean Water Caucus to Advance Utility of the Future Priorities," *NACWA The Water Voice: Perspectives on Water Policy From the Experts*, December 11, 2013, http://blog.nacwa.org/bipartisan-clean-water-caucus-to-advance-utility-of-the-future-priorities/.

- Congressional Water Caucus: "will work with experts in the private and public sector to identify issues affecting water quantity and quality, as well as develop long-term strategies to ensure a sustainable water supply."[213]
- Northeast-Midwest (NEMW) Congressional Coalition: Members have been working together to advance bipartisan legislation on the 18 states that make up the NEMW region.[214] This caucus has been working since 1976 on these issues. There is also a Northeast Midwest Initiative (NEMWI) that is focused on the same geographic region.
- Ports, Opportunity, Renewal, Trade, and Security (PORTS) Caucus: "promote the importance of our ports to the nation's economy and the need to secure them."[215]
- Ohio River Basin Congressional Caucus: "dedicated to addressing critical economic, infrastructure, agricultural, environmental, and community issues within the entire Ohio River Basin and watershed."[216]
- Army Corps of Engineers Reform Caucus: This caucus was formed in the House, and is focused on trying to reform the Corps of Engineers to be more responsive and responsible for environmental and fiscal stewardship.[217]
- Congressional Invasive Species Caucus: serves "to raise awareness about invasive species, support local communities who are bearing the brunt of this problem, and promote efforts to prevent and control the spread of invasive species."[218]

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213 "News Releases: Sens. Moran and Pryor Establish Bipartisan Senate Water Caucus -," *Jerry Moran United States Senator for Kansas*, July 5, 2012, http://www.moran.senate.gov/public/index.cfm/news-releases?ContentRecord_id=9c84680e-f52d-468b-a290-a7e08b437182.

214 Northeast-Midwest Institute, "Northeast-Midwest Congressional Coalition," *Northeast-Midwest Institute*, January 2014, http://www.nemw.org/index.php/congressional-coalitions-and-task-forces/northeast-midwest-congressional-coalition.

215 Robert Kellar, "Hahn and Poe Found Bipartisan PORTS Caucus," *Congresswoman Janice Hahn (D-CA)*, October 25, 2011, http://hahn.house.gov/press-release/hahn-and-poe-found-bi-partisan-ports-caucus.

216 Jonathan Coffin, "Press Release: Reps. Capito and Driehaus Announce Bipartisan Ohio River Basin Caucus," n.d., http://www.ohioriverbasin.org/wp-content/uploads/2010/10/caucuspressrelease4.pdf.

217 "Congressional Member and Staff Organizations," accessed January 11, 2014, http://cha.house.gov/member-services/congressional-memberstaff-organizations; Nicole T. Carter, *Army Corps of Engineers: Reform Issues for the 107th Congress* (Washington, D.C.: Congressional Research Service, April 2001), CRS–1, http://research.policyarchive.org/1188.pdf.

218 Rep. Mike Thompson (D-CA), "Press Releases: Rep. Mike Thompson Founds Bipartisan Invasive Species Caucus," *U.S. Congressman Mike Thompson*, July 10, 2013, http://mikethompson.house.gov/news/documentsingle.aspx?DocumentID=342054.

There are numerous watershed issues and concerns discussed in Chapters II–IV. There are a number of CMO that advocate for and try and advance knowledge of their area of interest within Congress. The inability to find dedicated member lists for each CMO was a little surprising given the democratic principles of our country. It left the reader wondering what was being hidden. Additional research into the history of CMO's revealed that early 1990s ethics issues played a role in the current guidelines, including their function and operating procedures. This is likely the main reason for the inconsistent approach to transparency taken by the CMO's.

C. STAKEHOLDER ORGANIZATIONS

There are many quasi-government and non-government organizations (NGO) that offer advocacy for various user groups and initiatives within the watershed. Understanding the constituents, issues and challenges of each organization is essential to identifying their focus areas and how to work with these groups to effect change. These groups are viewed as a sounding board for new ideas, and for creating the grassroots effort necessary to implement this thesis. NGO groups also participate in the public comment process on projects advertised in the Federal Register. Although this section will explore a few of these groups, the list is by no means exhaustive. The initiatives and groups were chosen based on the author's familiarity with them.

The Northeast-Midwest Institute (NEMWI) is a private non-profit organization based in Washington, DC that focuses on "economic vitality, environmental quality, and regional equity" for the Midwest and northeastern United States.[219] The NEMWI's main focus area within the watershed is in the Upper Mississippi River basin, and follows closely the Great Lakes Mississippi River Interbasin Study (GLMRIS). One initiative that the NEMWI is developing is the Mississippi River Cities and Towns Initiative (MRCTI).

The MRCTI is an example of an effort to draw attention to issues surrounding the watershed. As a result of a grant from the Walton Family Foundation, the NEMWI developed the MRCTI "to create a new and influential voice for the Mississippi River, dramatically increasing demand for effective river protection, restoration, and

219 "Northeast-Midwest Institute," accessed November 2, 2013, http://www.nemw.org/.

management."[220] This initiative was recently launched, and its role in advancing economic vitality began with an Economic Summit with many Mississippi River mayors in attendance.[221]

The American Waterway Operators (AWO) is an advocacy group to advance the interests of the commercial towing industry on the inland waterways. This group is active in all issues pertaining to the inland waterways including those that reduce pollution, improve reliability and efficiency of the inland waterway system, and provide jobs for hard-working citizens.[222]

The Upper Mississippi River Basin Association (UMRBA) was formed in 1981 after the federally-authorized Upper Mississippi River Basin Commission was disbanded by Executive Order.[223] The governors of Wisconsin, Illinois, Minnesota, Iowa, and Missouri subsequently formed the UMRBA and each assign an appointed person to represent their state's interests in basin issues. According to the UMRBA website, federal agencies participate in UMRBA activities as non-voting members and advise on issues pertaining to navigation, flood control, invasive species, habitat restoration, water quality, inter-basin diversions, pollution, and hydropower considerations.

The American Water Resources Association (AWRA) was founded in 1964 to advance water resources issues in the United States.[224] It has been an advocate to advance multi-discipline approaches to water issues and led four National Policy Dialogues between 2002 and 2008. The AWRA continues to engage in water resources discussions and participates in national forums and conferences.

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220 Ibid.

221 Northeast-Midwest Institute, "Mississippi River Cities and Towns Initiative," *Northeast-Midwest Institute*, accessed January 12, 2014, http://www.nemw.org/index.php/current-initiatives-16859/mississippi-river-cities-and-towns-initiative.

222 "About AWO: The American Waterways Operators," *The American Waterways Operators*, accessed January 16, 2014, http://www.americanwaterways.com/about.

223 "About UMBRA," *Upper Mississippi River Basin Association*, accessed January 25, 2014, http://www.umrba.org/.

224 American Water Resources Association, "AWRA Mission, Promise and Objectives," accessed January 16, 2014, http://www.awra.org/about/index.html.

D. MISSISSIPPI RIVER GULF OUTLET

Geopolitics plays an important role within a state and region. The author has chosen to highlight this issue using the Mississippi River Gulf Outlet (MRGO) in Southeast Louisiana. The "Mister Go" as it was known locally, served the eastern shipping approaches to New Orleans and shortened the route for certain deep draft vessels' transits into New Orleans by nearly 40 miles from the Gulf of Mexico. The MRGO afforded ships the opportunity to make a more direct run through a man-made canal, rather than take the nearly 100 mile trip up the winding Mississippi River. However, this canal was cut through a wetland area that was home to many plant and wildlife. In addition, the wetland afforded some flood and storm surge protection that was lost with the development of the MRGO project that began in 1956 and was completed in 1968.[225]

This project partially contributed to the flooding in portions of New Orleans following Hurricane BETSY in 1965 and Hurricane KATRINA in 2005.[226] The flooding following Hurricane KATRINA brought the criticism of the USACE handling of the MRGO to a head. The benefit to navigation was obvious, but the deleterious effect on the environment and southeast Louisiana became painfully obvious to others, after Hurricane KATRINA struck the area in 2005. This resulted in the needed momentum to permanently close the MRGO in 2009.[227]

E. RESILIENCY

Part of the geopolitical discussion on the watershed is the sociological and psychological aspects of disasters. One of the concepts explored by Jerry Monier in his master's thesis is the psychology of flooding on the Mississippi River and how that

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225 U.S. Army Corps of Engineers New Orleans District, "History of MRGO," *Mississippi River Gulf Outlet-Ecosystem Restoration Plan Feasibility Study*, accessed January 14, 2014, http://www.mrgo.gov/MRGO_History.aspx.

226 "MRGOing, Going, Gone?," Documentary (New Orleans, LA: Public Broadcasting Service (WYES-TV), October 20, 2013), http://www.wyes.org/local/mrgo/.

227 U.S. Army Corps of Engineers New Orleans District, "MRGO Navigation Channel Closure," *Mississippi River Gulf Outlet-Ecosystem Restoration Plan Feasibility Study*, accessed January 14, 2014, http://www.mrgo.gov/MRGO_Closure.aspx.

concept applies to resilience. This is worth exploring in the context of this thesis because there are many possible traumas that people can experience as a result of the watershed. Some of these traumas include earthquakes, floods, drowning, ecological devastation from an invasive species, and an environmental catastrophe from a chemical or petroleum spill. "The Mississippi River Flood of 1927 resulted in significant population shifts from the Mississippi Delta region of the United States. This event established the need to construct and strengthen a system of levees and control structures to prevent a similar event."[228]

F. TRANSBASIN DIVERSIONS

Transbasin diversions of water are another geopolitical aspect to the watershed. The discussions on physically diverting water from one basin to another has been and will likely continue to be an issue. The movement of water between basins is a matter of law and policy, and may well play out in court. Given the previous discussions on riparian and prior appropriation laws, it is important to understand the melding together of these two concepts as it applies to transbasin diversions.

As explored by Deason et.al. (Water Policy, 2001), the concepts of transbasin diversion are impacted by the location, climate, law and common use needs. The complexity of these issues will continue to be explored and developed as the need for water increases with population and climate change impacts. "Difficult political choices will be necessary regarding future economic and environmental uses of water and the best way to encourage the orderly transition to a new equilibrium."[229] While this is a pertinent sentiment from the Western Governors Association, it appears to treat water as a political bartering chip. Instead, a science-based approach to how we look at water could reveal a better way to study the economic and environmental uses of water. The time is now, since "fresh water supplies are limited and many if not most surface water

228 Jerry T. Monier Jr, "Clarifying Resilience in the Context of Homeland Security" (Master's Thesis, Naval Postgraduate School, Center for Homeland Defense and Security, 2013), 54, https://calhoun.nps.edu/public/handle/10945/32872.

229 Western Governors' Association, *Water Needs and Strategies for a Sustainable Future* (Denver, CO: Western Governors' Association, June 2006), 4, www.westgov.org/wga/publicat/Water06.pdf.

and ground water sources are fully appropriated or otherwise reserved for myriad uses."[230]

G. FISCAL CONSIDERATIONS

The economic impacts need to be factored into this discussion at some point. Water prices in the U.S. remain very low and do not suffer the same volatility that energy sources do. Any policy shifts that result in additional water costs will need to be explained. One example is the use of water for shale gas extraction. This process is creating jobs and a booming economy in several areas of the watershed including West Virginia and North Dakota. However, a cost-benefit analysis was not done that took into account the impacts on the environment. With the local economy satisfied with employment opportunities and local businesses thriving, they are not looking at the potential long-term impacts to their region. This is why it is important to look at long-term and cumulative consequences of our actions.

In a 2005 hearing on energy and transportation issues, then Colorado Senator Ken Salazar noted that problems with high fuel costs extend far outside Colorado's borders, and have "a severe impact not only on producers' ability to harvest this year, but also in their ability to secure financing to operate for the next year."[231] Fuel costs also impact the commercial towing industry, which moves farm products to market through the inland marine transportation system. Higher fuel costs result in less profit.

The federal budget is a significant topic of literature and discussion with regards to watershed management. Budgets are generally broken down into operations and maintenance (O&M) and construction categories, with the O&M budget of the USACE and USBOR exceeding their construction budgets.[232] This problem impacts water supply and navigation, as the USACE cannot keep up with the demand for dredging resources, and has an aging infrastructure that needs significant capital investment.

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230 Ibid., 7.

231 *Discussion on Agricultural Transportation and Energy Issues*, 6.

232 Western Governors' Association, *Water Needs and Strategies for a Sustainable Future*, 3.

Public-Private cost shares for projects are a significant issue facing the navigation and flood control infrastructure. The current rate of new projects authorized for investigation by the USACE is outpacing the rate of appropriations to construct, with navigation, flood control, and ecosystem restoration projects getting priority in the past two Administrations.[233] Federal navigation infrastructure and dredging projects are funded through a cost-share by the federal government and industry through the Harbor-Maintenance Trust Fund (HMTF), which is funded partly by a tax on cargo.[234] In addition, the inland waterways shown in Figure 22 are covered by the Inland Waterways Trust Fund (IWTF) that is funded by a fuel tax that provides for a 50/50 cost share between the federal government and the IWTF.[235]

Figure 22. Fuel Taxed Inland Waterway System (from Stern, 2013)

233 Carter and Stern, *Army Corps of Engineers Water Resource Projects: Authorization and Appropriations*, October 18, 2013, 7.

234 Frittelli, *Harbor Maintenance Finance and Funding*, 1.

235 Charles V. Stern, *Inland Waterways: Recent Proposals and Issues For Congress* (Washington, D.C.: Congressional Research Service, May 3, 2013), 3, http://www.fas.org/sgp/crs/misc/R41430.pdf.

In addition to the appropriations shortfalls for USACE water infrastructure, the USEPA documented a $298.1 billion need for capital investment enhancements to wastewater and storm water runoff systems to improve watershed quality.[236] The cost-share between federal, state, and private land owners has been a difficult problem for Congress to resolve. Determining priorities between water resources needs, funding for grant programs, and federal agency budgets often involves trade-offs within the congressional appropriation process.

Determining the equitable cost share for citizens is also an issue for Congress. One example is the Biggert-Waters Flood Insurance Reform Act of 2012 (P.L. 112–141), that was designed to ensure equitable costs for private flood insurance. Thinking they were doing the right thing, Congress required FEMA to accurately assess risk and assign cost for flood protection to homeowners. This resulted in the loss of a federal subsidy for homeowners living in low lying areas, like much of coastal Louisiana. As a result, many homeowners are unable to afford flood insurance through the National Flood Insurance Program. Many of these homeownwers had been victimized by Hurricane KATRINA in 2005 and Hurricane ISAAC in 2012.

Representative Maxine Waters (D-CA) toured the Hurricane ISAAC-ravaged area of Plaquemines Parish, Louisiana in November 2013, after reports of the Act's impact on Louisianans reached her office. As a result of her visit, she agreed to revisit the language to try and right the wrong imposed on many Louisianans. Some would say that having these homeowners pay their fair share is important, especially since one in ten homes that suffered severe repetitive loss have been reimbursed more than the cost of their home.[237]

The economics of energy is another geopolitical concern. It is becoming clear that energy demand, and issues with the economics of energy, are driving many decisions. The U.S. energy policy is in a rudderless state, much like water policy. Citizens, States,

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[236] U.S. Environmental Protection Agency Office of Wastewater Management, "CWNS 2008 Report to Congress," September 12, 2013, v, http://water.epa.gov/scitech/datait/databases/cwns/2008reportdata.cfm.

[237] Richard L. Skinner, *FEMA's Implementation of the Flood Insurance Reform Act of 2004* (Department of Homeland Security Office of Inspector General, March 2009), 4, www.oig.dhs.gov/assets/Mgmt/OIG_09-45_Mar09.pdf.

and local governments are conflicted by the desire to have good paying jobs, but they don't like the impacts of energy production on their environment. This is playing out in coastal Louisiana as evidenced by what transpired after the April 2010 DEEPWATER HORIZON explosion and subsequent spill of national significance. It is also playing out in western North Dakota, which is one of the fastest growing areas of the country due to gas drilling in the Gammon shale basin.

The uses of water for energy production can be hidden by the economic benefits provided to a municipality or a region. Since there is neither a national energy, nor a water policy, economics are driving many of the decisions. This also has an impact in transportation systems. Farm products move by rail, truck, and barge from the Midwest to their distribution points. This intermodal transportation network is relied upon by the nation to meet export demands, and to move commodities to markets within the U.S. Nearly 31% of cargo moved on the Mississippi River by barge is comprised of agricultural products.[238]

When the transportation system is delayed, or fuel prices increase rapidly such as after Hurricane KATRINA, the farmers of the Midwest pay a significant cost of these increased shipping costs. This has national economic impacts as energy costs are a critical driver in the efficiency of U.S. export competitiveness. This places greater importance on the energy cost of transportation, and the economic ties to agricultural and other industries that rely on river transportation. How well we balance these economic impacts with the environmental impacts is crucial to forming a coalition of elected officials to drive change.

H. TRIBAL NEEDS

Tribal issues need to be taken into account within the context of a national or regional approach to water management and policy. While tribal lands belong to them, they impact, and are impacted by, U.S. decisions regarding water quality. The USEPA does not track tribal water needs; however, the Indian Health Service (IHS) does conduct

238 Department of the Army Corps of Engineers Institute for Water Resources, *Waterborne Commerce of the United States: Calendar Year 2011: Part 2 - Waterways and Harbors Gulf Coast, Mississippi River System and Antilles*, 185–186.

a Sanitation Deficiency Survey of tribal water needs, and provides an annual report to Congress.[239]

I. DEMOGRAPHICS AND PSYCHOLOGICAL IMPACTS

Water consumption is impacted by population and can shift with changes in demographics. Predicting future needs based on shifts in U.S. population poses issues for state water managers. These impacts occur with drinking water, wastewater treatment, and energy demands.

Demographic shifts also occur as a result of changes in the watershed. While it appears that many Americans will not leave a geographic region that they call home, there are threats to cultural and linguistic identity within the United States. One example currently exists in coastal Louisiana in the Mississippi River delta.[240] This region, once known for its fishing, is being inundated by petroleum businesses desiring to exploit Gulf of Mexico oil and gas reserves. The paradox for the coastal city of Grand Isle, LA is that this is causing the fishing industry to decline, while at the same time, they need the offshore oil and gas industry in order to flourish.

The people of Grand Isle, Louisiana are also not immune from devastating natural and man-made disasters. They have experienced five hurricanes since 2004, and were on the doorstep of the 2010 DEEPWATER HORIZON explosion and spill of national significance. They are fearful of losing the fight to protect their land from the rising sea, and coastal erosion that has been exacerbated over the years by USACE policies aimed at managing the Mississippi River. "Their angst is further heightened as their elected representatives battle federal officials over revised flood maps and a provision in federal legislation that could impose astounding premiums on some."[241] The result of the

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239 U.S. Environmental Protection Agency Office of Wastewater Management, *Clean Watershed Needs Survey 2008 Report to Congress* (Washington, D.C.: U.S. Environmental Protection Agency), viii, accessed November 3, 2013, http://water.epa.gov/scitech/datait/databases/cwns/2008reportdata.cfm.

240 Susan Saulny, "Holding Out, to Last Tiny Isle, as Cajun Land Sinks Into Gulf," *The New York Times*, August 25, 2008, online edition, sec. US, http://www.nytimes.com/2008/08/25/us/25louisiana.html.

241 Andrea Shaw, "Resilient Grand Isle Frets over Its Future as Population Falls, Insurance Costs Rise," *The Times-Picayune - NOLA.com*, July 20, 2013, online edition, http://www.nola.com/politics/index.ssf/2013/07/resilient_grand_isle_treads_li.html.

Biggert-Waters Act (P.L 112–141) was premiums that skyrocketed for those in flood prone areas, meaning that people could not afford to pay them. This added stress to an area that has already seen its fair share in the recent past. The result is that the community is dwindling. "In the 10-year period after the 2000 census, the island's population fell from 1,541 to 1,296."[242] The net effect is additional stress and depression on an endangered community. This effect likely exists in other areas of the watershed where people are subject to severe high water and flooding from the banks of the rivers, creeks, and tributaries that form the third largest watershed in the world.

Another area of the country where there are psychological implications of government policies is near the confluence of the Mississippi and Ohio Rivers. This area is home to the Birds Point-New Madrid floodway, and is only used when the Army Corps needs to make use of a right of way to divert up to 550,000 cubic feet per second away from the levees of the region, in order to prevent more widespread and catastrophic flooding.[243] The Mississippi River basin flood of 2011 was unique in that it was the first time in history that the USACE operated the Birds-Point-New Madrid Floodway, the Morganza Floodway and the Bonnet Carre´ Spillway in the same year.[244] The system performed very well and enabled the Corps to fight the flood. However, there was a psychological impact to those living along the river as they spent many days trying to protect their property. In addition, those with property on the Birds Point-New Madrid Floodway were evacuated prior to the crevassing of the levee and lost their farms and homes to the water.

Authors Peterson and Posner propose a new U.S. government framework for dealing with international water policy, including two new federal advisory committees under the Federal Advisory Committee Act.[245] The problem with this reorganization of

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[242] Ibid.

[243] Mississippi River Commission, "The Mississippi River & Tributaries Project: Birds Point-New Madrid Floodway."

[244] Henry DeHaan, Jeffery Stamper, and Brett Walters, *Mississippi River and Tributaries System 2011 Post-Flood Report* (U.S. Army Corps of Engineers: Mississippi Valley Division, December 2012), I–1.

[245] Erik R. Peterson and Rachel Posner, *Global Water Futures: A Roadmap for Future U.S. Policy* (Washington, D.C.: Center for Strategic & Intl studies, September 2008), csis.org/files/media/csis/pubs/080915_peterson_globalwater-web.pdf.

the government focused on international water policy ignores the United States' own issues potentially impacting domestic U.S. water policy. Can we solve others problems if we don't fix our own house first? The author argues here that it needs to be done simultaneously. "And targeting water would also yield other geopolitical dividends--including helping remove a serious obstacle to stability and security within states and reducing the possibility for conflict or tension between countries with shared water resources."[246] This same quotation could be said to relieve the stress that currently exists between States within the U.S.

While not a part of the Mississippi River watershed, the Yellowstone River to the west is part of an ongoing legal battle between the states of Montana and Wyoming, "as attorneys for Montana press their case that Wyoming farmers and oil and gas companies are sucking too much water from tributaries of the Yellowstone River."[247] Instances of internal water fights are likely to increase as the demand for water increases and the supply of quality water does not. Lawsuits like this one are likely to increase in numbers as the thirst for surface and ground water grows. Another area of the country that is experiencing water conflict is Texas, where aquifer levels are declining and individual wells are drying up. These could be the result of drought, hydraulic fracturing, or a combination of both. Additional study, and better data, is needed to scientifically link the cause to the effect.

J. CONCLUSION

This chapter explored the geopolitical impacts from water laws, policies, and organizations which make up part of the watershed. The chapter provided an overview of riparian and prior appropriation water laws, and how they impact state law and policy. Additionally, stakeholder groups and Congressional Member Organizations (CMO) were included in a broad overview of possible advocacy and lobbying efforts. These groups are very instrumental in driving public policy discussions, and alignment with their goals,

246 Ibid., 24.

247 Matthew Brown, "Water Fight between Mont., Wyo. Going to Trial," *Bismarck Tribune*, October 15, 2013, http://bismarcktribune.com/news/state-and-regional/water-fight-between-mont-wyo-going-to-trial/article_0566ff7e-356a-11e3-a1a4-001a4bcf887a.html.

values, and objectives will greatly help in implementing a national water strategy and moving towards an integrated water management approach for the watershed.

The next chapter will analyze the findings of the literature and lay out the foundation of a national water strategy, and a framework of how the Mississippi River watershed can be treated as one system. Keeping state water rights at the forefront is a key consideration; however, national vision and leadership is necessary to ensure federal interests are preserved.

VI. ANALYSIS AND FINDINGS

Previous chapters painted a broad, multi-faceted view of the watershed using navigation, flood control, environmental, municipal and industrial uses of water, and geopolitical considerations. This wide-ranging view of the watershed included a focus on the individual components of what is a larger system. The watershed is currently managed by many federal agencies, in coordination with tribal, state, local, and non-government stakeholders as many separate systems. This chapter will examine how watershed planning activities could be structured, in order to look at the watershed as a system that supports a new national water strategy.

In the previous four chapters, watershed management challenges were explored based on individual components of a larger system. The largest impediment with the concept of system-wide watershed management is the complexity of putting the issues together in a single system. The current approach to the watershed separates each of the major tributaries of the Mississippi River into individual basins, and focuses "public and private sector efforts on addressing the highest priority problems that exist within hydrologically-defined geographic areas."[248] The questions I find myself asking is if a national water strategy is needed, and how to manage the entire watershed as a single complex system.

Complexity was defined in Chapter 1 as two or more components interacting with each other in ways that are not predictable or repeatable. Figure 24 is a graphical representation of the complexity of watershed management versus time. The third dimension used in this display, is the responsibility of the USACE. As laws and policies have evolved over the years, additional variables were introduced in water resources management. As discussed in Chapter 3, environmental laws and regulations in the 1970s and 1980s required additional considerations in each USACE authorized project. This added "protection" and "restoration" to the list of USACE responsibilities, in addition to the flood control and navigation responsibilities of "build" and "control." As a result of

[248] Deason, Schad, and Sherk, "Water Policy in the United States," 188.

these interconnected variables, complexity of watershed management continues to increase.

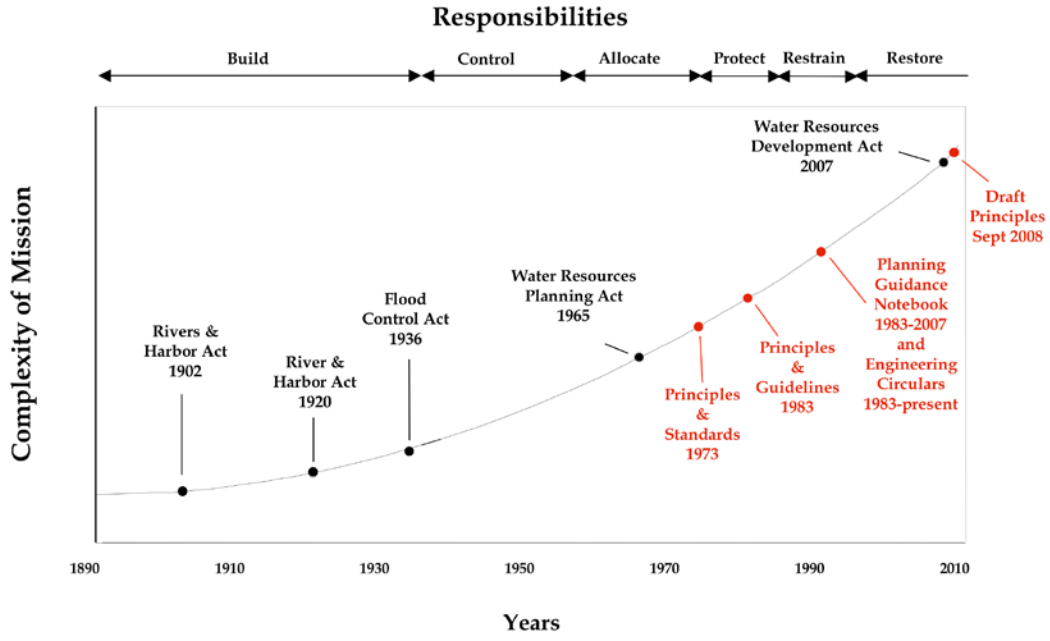

Figure 23. Water Complexity Over Time (from Armah et.al., 2009)[249]

This chapter will build on the previous chapters, explore the interconnected nature of the components, and analyze how to integrate these components into a management framework that looks at the watershed as a system. The first section of this chapter will examine the idea of a national water strategy, and the second section will explore the framework to manage the entire Mississippi River watershed as a single system.

A. WATER IN EXISTING NATIONAL STRATEGIES

There are many national strategies that deal with homeland security related issues. After the 9/11 terrorist attacks, the United States began producing counter-terrorism strategies to look at how to address homeland security issues. In 2004, Congress asked

[249] Jonathan Armah et al., *Principles and Guidelines for Evaluating Federal Water Projects: U.S. Army Corps of Engineers Planning and the Use of Benefit Cost Analysis*, A Report for the Congressional Research Service (Evans School of Public Affairs: University of Washington, August 2009), 6.

the GAO to review the seven existing national strategies, as shown in Table 1, and determine whether they were adequate.[250]

National Security Strategy	National Strategy for Homeland Security
National Strategy for Combating Terrorism	National Strategy to Combat Weapons of Mass Destruction
National Strategy for the Protection of Critical Infrastructure and Key Resources	National Strategy to Secure Cyberspace
2002 National Money Laundering Strategy	

Table 1. Seven National Strategies Reviewed by GAO (after GAO, 2004)

Additional strategies and plans were developed in subsequent years. The *National Strategy for the Marine Transportation Systems* was published in 2008, and supported President Bush's 2004 Ocean Action Plan, that was developed by the 2001–2004 U.S. Commission on Ocean Policy.[251] The Bush-era Ocean Action Plan has since been replaced by the 2013 National Ocean Policy Implementation Plan that calls on federal agencies to work collaboratively with state agencies and other stakeholders for planning water uses in 9 regions as shown in Figure 24.[252] Regional planning bodies (RPB) share responsibility for the oceans, coasts, and Great Lakes, but do not include the inland river system, or the Mississippi River watershed. Each RPB is charged with coordinating an "integrated, comprehensive, ecosystem-based, flexible, and proactive approach to

250 Yim, *Combating Terrorism Evaluation of Selected Characteristics in National Strategies Related to Terrorism*.

251 Committee on the Marine Transportation System, "National Strategy for the Marine Transportation System: A Framework for Action," 4; Ocean Commission Webmaster, "United States Commission on Ocean Policy," February 18, 2005, http://govinfo.library.unt.edu/oceancommission/.

252 Obama, "Ocean Management and Planning in the United States"; National Oceanic and Atmospheric Administration (NOAA), "Coastal and Marine Spatial Planning," accessed January 25, 2014, http://www.marineplanning.org/Policy/USA_Regions.html.

planning and managing sustainable multiple uses across sectors and improve the conservation of the ocean, our coasts, and the Great Lakes."[253]

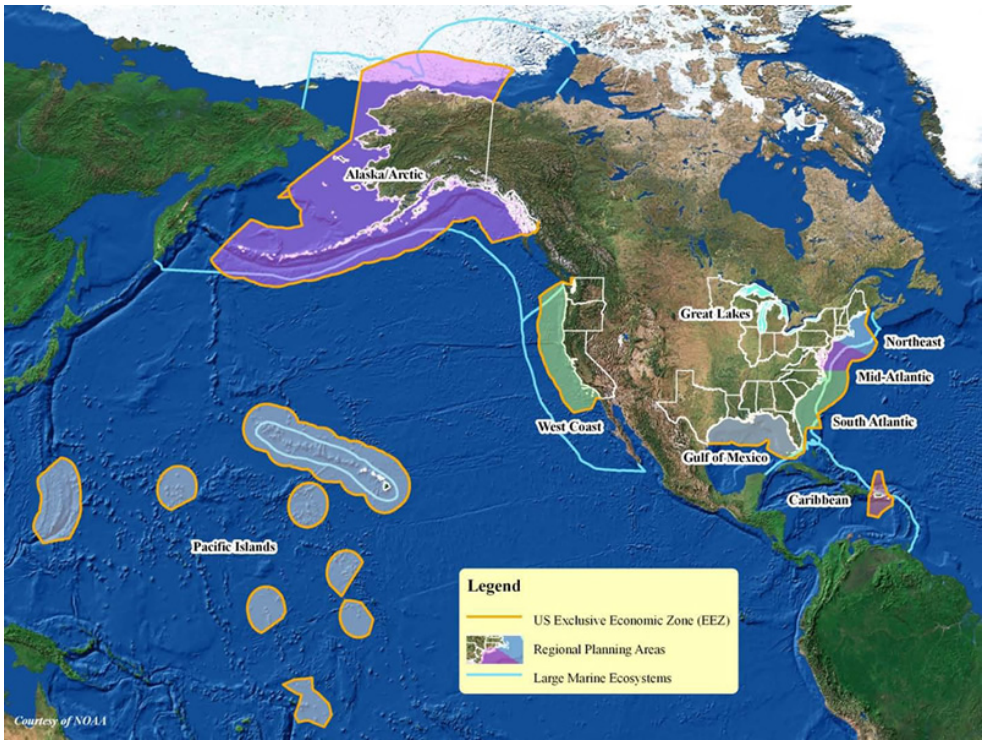

Figure 24. Marine Planning Regions (from NOAA, 2014)

Water and the environment are part of a growing dialogue on the scope of the homeland security enterprise; however, water is only mentioned once in the current *National Security Strategy*.[254] Despite this narrow focus on water as part of homeland security, the National Infrastructure Protection Plan (NIPP) and its 16 supporting annexes address a myriad of water-related infrastructure sectors that were discussed in more detail in Chapters 2–4. These annexes include dam safety, water and waste-water treatment systems, energy, and transportation systems. Each of the 16 annexes covers an infrastructure sector, and is assigned a federal agency as the Sector-Specific Agency (SSA) that is tasked with leading the collaborative process of developing a sector plan

253 Obama, "Ocean Management and Planning in the United States," 1.

254 The Office of the President, "National Security Strategy," 39. The context is about providing enough clean water for basic human needs and survival.

that employs risk-based methodologies to secure the sector.[255] The listing of these annexes and corresponding SSA is included in Appendix H.

Despite the inclusion of water and associated infrastructure in the sector-specific plans, it appears that the federal focus on watershed planning is not from a security standpoint, but more from a non-security, programmatic oversight, and regulatory role with agencies such as the Department of Interior, USACE Civil Works Directorate, and Department of Energy. Integrating security considerations of water across all federal agency responsibilities is needed to ensure the long-term sustainability of water resources. Expanding the prominence of water in the *National Security Strategy* would be a good start. The next section will explore the idea of a national water strategy that incorporates the components from Chapters 2–5.

B. NATIONAL WATER STRATEGY

The need for a national water vision was identified during a series of four National Water Policy dialogues that were hosted by the American Water Resources Association between 2002 and 2008.[256] These dialogues included a broad spectrum of government, academic, and non-government organization stakeholders, and contributed to the dialogue through a very busy decade for water resources. This need was reaffirmed by the AWRA in a 2011 policy paper approved by their Board of Directors.[257]

The literature became clear that the current U.S. water policy is not to have a water policy.[258] The reason for this is not nearly as clear, and it takes some analysis of the literature and the language used to understand why this is the case. The key language in the Army Corps national report on building stronger relationships for water resources

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255 Department of Homeland Security, "National Infrastructure Protection Plan," *Homeland Security*, accessed January 28, 2014, https://www.dhs.gov/national-infrastructure-protection-plan.

256 Richard A. Engberg, "AWRA Policy Dialogues 1–4 Summary" (American Water Resources Association, January 2012), http://aquadoc.typepad.com/files/awra_policy_dialogues_1-4_summary-2.pdf.

257 American Water Resources Association, "AWRA Policy Statement: Call for a National Water Vision and Strategy" (American Water Resources Association, January 2011), http://www.awra.org/policy/policy-statements--water-vision.html.

258 Michael Campana, "Summary: AWRA National Water Policy Dialogues 1 – 4," *AWRA Water Blog*, February 9, 2012, http://awramedia.org/mainblog/2012/02/09/summary-awra-national-water-policy-dialogues-1-4/.

is the declarative statement to respect state water rights.[259] As discussed in chapter five, the difference between a federal and national approach is an important distinction to make, especially as it pertains to a national water strategy. For this reason, all discussions will focus on a national approach, although federal agencies will be key participants within their existing authority.

Without a national strategy for water, stakeholders must rely on existing laws, regulations, and individual agency strategy and policy documents. The result has been a patchwork of "34 federal agencies involved in some manner of water planning, development, or regulation" and relying on a collaborative approach to accomplish as much as possible within their authorities and without a consolidated appropriation or authorization process, which further complicates the work of the federal government.[260] Water resources issues are inextricably linked to all aspects of our lives, and as such, a national water strategy is needed to ensure alignment on current and future water resources priorities. This is a necessary first step to prioritizing the annual and long-term plans for water resources.

It is necessary to include water resources and environmental security in the *National Security Strategy* and *National Strategy for Homeland Security*. Whereas 9/11 was a watershed event in our nation's history, we must be prepared for a pending water crisis.[261] We have the ability to properly manage this natural resource. As shown in Appendix H, Dams and Water and Wastewater Systems are two of the 16 sectors of critical infrastructure.[262] These must be physically protected, but we also need to take a long-view to conserving and sustaining the natural resource.

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[259] U.S. Army Corps of Engineers Civil Works Directorate, *Building Strong Collaborative Relationships for a Sustainable Water Resources Future: National Report: Responding to National Water Resources Challenges*, vi.

[260] Committee to Assess the U.S. Army Corps of Engineers Water Resources Project Planning Procedures, "New Directions in Water Resources Planning for the U.S. Army Corps of Engineers" (National Academy Press, 1999), 7.

[261] Homeland Security Council, "National Strategy for Homeland Security," October 2007, 3.

[262] Ibid., 27.

A 2006 Congressional Budget Office report outlined some of the challenges with the current oversight of water allocations and offered three options for how the federal government could facilitate reallocation of water resources. These included facilitating water markets, encouraging the efficient provisioning of water, and encouraging the efficient use of water. The report recognized that state property laws govern water rights, and referred to water rights as being inflexible.[263] Despite this inflexibility of water, "the federal government has a role in determining how the nation allocates and uses its water resources, despite the extent of the states' jurisdiction over water."[264] This role comes from the Commerce Clause of the Constitution.[265]

There have been previous efforts to establish a more prominent federal role in water oversight. The earliest document found that discussed a federal role was a 1950 Executive Order that created the President's Water Resources Policy Commission consisting of a consulting engineer, four academic leaders, the general manager and chief engineer of Los Angeles, and the former President of the Federal Power Commission.[266] A National Water Commission (NWC) was also established by Congress in 1968 and served until 1973. The main difference between the 1950 and the 1968 NWC's were how they were implemented; one by EO and one by Congress. While the 1968 NWC made several recommendations that have been incorporated into future policies, it does not appear that the NWC report was the impetus behind these recommendations.[267]

In establishing the 1950 commission, President Truman wrote that "in many cases, piecemeal or partial approaches to a problem as broad as water resources

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263 Congressional Budget Office, "How Federal Policies Affect Water Allocation," 8.

264 Ibid., 13.

265 Ibid., 14.

266 Roland R. Renne, "The President's Water Resources Policy Commission," *Land Economics* 26, no. No. 3 (August 1950): 295 Note: Members included Morris L. Cooke, Consulting Engineer, Philadelphia, Chairman; Paul S. Burgess, Dean of Agriculture, University of Arizona; Lewis Webster Jones, President, University of Arkansas; Samuel B. Morris, General Manager and Chief Engineer, Department of Water and Power, Los Angeles; Leland Olds, New York, former chairman, Federal Power Commission; Roland R., Renne, President, Montana State College, and Gilbert F. White, President, Haverford College.

267 Betsy Cody and Nicole T. Carter, *35 Years of Water Policy: The 1973 National Water Commission and Present Challenges*, 65.

development tend to confuse, rather than clarify many of the basic, underlying issues."[268] This same comment could be made today by President Obama in establishing a new National Water Commission, especially since water resources, as depicted in Figure 23, are much more complex than they were in 1950. There have been many NGO advocates for a stronger federal leadership role in coordinating national water policies amongst all stakeholders. "The federal government's role in water resources, long seen to be a driving force, must be reevaluated in light of growing state and regional attention and direction of water resource activities, i.e., resting on National, (not federal) Policies"[269]

A Water Resources Council (WRC) existed in the United States during the 1960s and early 1970s and attempted to coordinate federal-level water policies.[270] The WRC had difficulty in completing its mandate because "implementation of coherent and effective federal water policies is severely hampered by the lack of strong involvement of an executive-level body to coordinate agency policies and programs."[271] The recommendation of the Committee to Assess the U.S. Army Corps of Engineers Water Resources Project Planning Procedures was that an executive-level entity within the White House assumes this integration process.

There is an ongoing dialogue about whether an executive-level entity or a new Commission is needed. The White House Council on Environmental Quality released the Principles and Requirements for water resources planning in an attempt to coordinate projects at the executive-level.[272] Congress also considered three bills between 2007 and 2010 that would have established a NWC similar to the 1950 and 1968 NWC's; however, they never became law and have not been reintroduced in subsequent sessions of Congress.

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[268] Renne, "The President's Water Resources Policy Commission," 295.

[269] Engberg, "Setting a Direction for U.S. Water Policy."

[270] "National Water Census website," *USGS*, November 27, 2013, http://water.usgs.gov/watercensus/.

[271] Committee to Assess the U.S. Army Corps of Engineers Water Resources Project Planning Procedures, "New Directions in Water Resources Planning for the U.S. Army Corps of Engineers," 7.

[272] Council on Environmental Quality, "Principles and Requirements for Federal Investments in Water Resources."

- HR 135 – to establish a commission to study and develop recommendations for a strategy to address future water needs.[273]
- S. 2728 – similar – to establish a national water commission.[274]

The concept of a National Water Commission was also the subject of a CRS report in 2009 by Betsy Coder that explored the National Water Commission (NWC) that was in place from 1968–1973. This report was likely an effort to inform Congress on the history of NWC's in our country and to help Congress make decisions regarding the House and Senate bills on a 21st Century Water Commission that was discussed earlier. The reasons for the 1968 NWC disbanding were likely related to the Vietnam War, Watergate, and other social and cultural issues impacting the country at the time.[275] One thing was clear, and that is that the NWC had a good grasp of how the complex water policy issues were evolving at the time. Since then, "shifts in institutional arrangements in general have reduced coordination of federal water agency activities and in many ways have moved away from NWC-recommended multi-objective or river basin planning."[276]

In order to align federal agency efforts, this thesis proposes development of a national water strategy to guide the future of water issues and to ensure water sustainability in the face of climate change and energy independence discussions. This is especially true given the intricacy of the components that make up the Mississippi River watershed. Ensuring water for navigation purposes drives our national economy. Ensuring that flood protection and navigation infrastructure is adequate to protect lives and property, and works together to move commerce, is also a critical component of a shared vision for water.

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273 John Linder, "H.R.135 - 110th Congress (2007-2008): Twenty-First Century Water Commission Act of 2007," legislation, June 4, 2008, http://beta.congress.gov/bill/110th-congress/house-bill/135?q=%7B%22search%22%3A%5B%22hr135%22%5D%7D; John Linder, "H.R.135 - 111th Congress (2009-2010): Twenty-First Century Water Commission Act of 2009," legislation, February 4, 2009, http://beta.congress.gov/bill/111th-congress/house-bill/135?q=%7B%22search%22%3A%5B%22hr135%22%5D%7D.

274 Johnny Isakson, "S.2728 - 110th Congress (2007-2008): Twenty-First Century Water Commission Act of 2008," legislation, August 22, 2008, http://beta.congress.gov/bill/110th-congress/senate-bill/2728?q=%7B%22search%22%3A%5B%22water+commission+2008+%22%5D%7D.

275 Betsy Cody and Nicole T. Carter, *35 Years of Water Policy: The 1973 National Water Commission and Present Challenges*, 5.

276 Ibid., summary.

Water quality is vital to sustain life and ensure proper functioning of power plants and irrigation systems. Quality impacts not only human life, but also the health of the ecosystem made up of wildlife, aquatic species, and plants. Ensuring that new and existing water users do not adversely impact water quality and quantity is a needed component of a water strategy. This means that exemptions to Clean Water Act provisions must be closely scrutinized to ensure protection of the water supply. This brings in the ongoing dialogue on hydraulic fracturing, and whether the practice is dangerous to the health and sustainability of local water supplies. Since gas drilling was excluded from the Safe Drinking Water Act of 2005, and is being looked at as a possible cause of drops in aquifer levels, water quality and quantity are also linked to energy practices.[277]

Energy is another quality of life issue that is impacted by water; therefore, the energy-water nexus must be considered as part of a national water strategy. Trade-offs between competing uses of water and energy need to be accounted for. This is especially the case where policies and investments in energy and water projects may contradict each other. There is a growing body of literature on the impacts of fracking on water quality, especially local water quality. In addition, there is mounting concern for water levels in certain aquifers, such as the Ogallala aquifer, that may be tied to fracking or other causes, such as the persistent drought in the high plains.

Sustainability of water to supply basic human needs must be a concern for homeland security practitioners. The future availability of water is not currently part of the Water and Wastewater Sector-Specific Annex to the National Infrastructure Protection Plan. A close look at future water availability to meet the needs of all Americans should be part of our water security plan. Likewise, a close look at future energy supply and demand should be part of a national environmental and economic security discussion. As discussed in Chapter 4, there is a need for better data to help with science-based decisions.

277 Karen Charman, "Trashing the Planet for Natural Gas: Shale Gas Development Threatens Freshwater Sources, Likely Escalates Climate Destabilization," 77.

The linkage between water quality and energy also impacts navigation issues. Energy products, including natural gas, oil, and other petroleum-based products are shipped by tank ships and barges. Ensuring the safety of people on, or adjacent to the water, should be part of the national strategy. This will involve trade-offs between commerce and environmental quality. These tradeoffs occur on a small scale when it comes to vessel regulations published by the Coast Guard. For example, barges carrying certain cargoes are required to be double-hulled in order to reduce the potential for pollution following a collision, allision, or grounding.

Identifying funding priorities was a recurring theme in the literature. Without a vision, we are not prioritizing funding needs across government, and this leads to a perpetual look at individual programs. In Chapter III, the NRCS grant program for reducing farm runoff was discussed. Without looking at this as part of a systematic approach, it is not known if this funding is the best use of federal appropriations to reduce hypoxia in the Gulf of Mexico, or in improving water quality in downstream municipal water intakes. A system-wide look may identify this as a poor use of federal funding.

The exploration of how to fund navigation infrastructure recapitalization is another significant part of a national water strategy. Ensuring water to sustain the economy needs to include resolution of how to fund navigation infrastructure. The user fees paid by the navigation industry are not enough to meet this need. Determining how to pay for infrastructure improvements and who should pay are the subjects of ongoing debate in Congress. Protecting threatened or endangered species is also a consideration that must be accounted for when rebuilding existing infrastructure.

1. Model for a Future Water Strategy

The GAO published a report in 2005 that evaluated U.S. strategies that were developed after the 9/11 terrorist attacks. In this report, the GAO identifies a framework for what constitutes an effective strategy, and examines whether the strategies were effective using this framework. The desirable characteristics of an effective strategy are

shown in Table 2.[278] These characteristics can be used to develop a national strategy for water. It is important to note that a federal strategy is not recommended and is not the intention of this author. A national vision that takes into account federal, tribal, state, local, and private stakeholders is needed and must be developed collaboratively.

Desirable characteristic	Description
Purpose, scope, and methodology	Addresses why the strategy was produced, the scope of its coverage, and the process by which it was developed.
Problem definition and risk assessment	Addresses the particular national problems and threats the strategy is directed towards.
Goals, subordinate objectives, activities, and performance measures	Addresses what the strategy is trying to achieve, steps to achieve those results, as well as the priorities, milestones, and performance measures to gauge results.
Resources, investments, and risk management	Addresses what the strategy will cost, the sources and types of resources and investments needed, and where resources and investments should be targeted based on balancing risk reductions with costs.
Organizational roles, responsibilities, and coordination	Addresses who will be implementing the strategy, what their roles will be compared to others, and mechanisms for them to coordinate their efforts.
Integration and implementation	Addresses how a national strategy relates to other strategies' goals, objectives, and activities, and to subordinate levels of government and their plans to implement the strategy.

Table 2. Summary of Desirable Characteristics for a National Strategy, from Conception to Implementation (from Yim, 2004)

Under the leadership of either a National Water Commission, or the Council on Environmental Quality, a national water strategy that accounts for the components of the water resources system outlined in Chapters 2–5 should be developed. Taking a long-term view of water will provide for a purpose, scope, and methodology of a national water strategy that incorporates climate change, and sea-level rise adaptation measures, into water resources planning. Sustainability of water resources will incorporate municipal and industrial uses and energy production in future allocation of water resources.

There is a demand for better water data and information. This call is coming from the Western Governors Association and was a recurring theme from the National Water Dialogues, "specifically data on water use, efficiencies and water availability, to facilitate decision making."[279] The first recommendation of the national dialogues was to assess

278 Yim, *Combating Terrorism Evaluation of Selected Characteristics in National Strategies Related to Terrorism*, 11.

279 Western Governors' Association, *Water Needs and Strategies for a Sustainable Future*, 8.

existing water resources, future water needs, and identify gaps that may exist.[280] Although this had previously been done with the release of a 1978 national report, Congress required the Department of Interior, through the USGS, to complete an assessment of water resources as part of the SECURE Water Act (P.L. 111–11). This initiative is known as the national water census and is part of the WaterSMART Initiative.[281]

Water needs are not unique to the western states, but they are currently the most prominent due to the population growth in the west and a persistent drought. As climate change and the search for additional energy sources increases, such as hydraulic fracturing, the consumption of water may outpace the availability of this critical resource. Holistically managing the watershed will help us be prepared for the developing water conflicts. Integrating this data into decision-making processes is a necessity to making science-based decisions. "The National Integrated Drought Information System (NIDIS) is a good model for such integration."[282] The NIDIS is a tool that assists a partnership of federal agencies, including USACE, FEMA, USGS, NOAA, USEPA, and USDA to monitor drought impacts across the nation. Drought impacts are only part of the data needs—surface water inputs and aquifer levels also need to be included—in order to provide the total water picture for the nation. Stream gages are tracked and monitored real time; however, aquifer levels are not. The national water picture is a snapshot that is taken every five years and that is not frequent enough to inform decision makers.

The methodology to develop a strategy is something that could be done within the Executive Branch of the government, but is probably best if initiated by Congress. A National Water Commission was proposed by Congress in 2007 and 2008, but was not created. An act of Congress would likely be accepted better by state governments and other stakeholders fearful of a federal strategy vice a national strategy. Evaluating all water laws and current applicability needs to be a primary objective of a national water strategy .

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280 Engberg, "Setting a Direction for U.S. Water Policy."

281 "National Water Census website."

282 Western Governors' Association, *Water Needs and Strategies for a Sustainable Future*, 9.

The second phase of the GAO strategy recommendation is to define the problem and assess risks. Chapters 2–5, in addition to this chapter, outline some of the problems that exist with how individual components of water resources are currently managed. While there has been significant progress in federal collaboration in the past 5–10 years, water is not being managed holistically. One example of improving coordination is the federal toolbox created by the USACE. This is a voluntary tool for federal agencies to share water-related information and data, but it does not provide the necessary oversight of water processes. By relying solely on Integrated Water Resources Management (IWRM), and without a national water vision or strategy, the inter-agency collaborative process "suffers from a lack of clear definition, the lack of standard measures to track the success of Integrated Water Resources Management plans and projects, and the absence of guidance for those involved in planning and project development."[283] The problem is compounded by water that doesn't follow agency or political boundaries.

The third phase is to establish goals, subordinate objectives, activities, and performance measures. As previously mentioned, the first goal should be to preserve water rights. Additional goals need to include sustainable water resources in both quality and quantity. In order to accomplish this, better data is needed to identify water withdrawals. Increasing the frequency of water reports by the USGS would help quantify fluctuations due to weather patterns and enable a better data set to determine impacts on water replenishment. With a better understanding of water consumption, goals and objectives for irrigation, municipal, industrial, and energy uses can be established with an eye towards conservation.

Performance measures that drive improvements in water sustainability and quality also need to be developed. An example of a how a performance measure could be used to improve water quality is the dead zone that forms in the Gulf of Mexico as a result of runoff from the Mississippi River. If a goal was established to reduce the size of the dead zone by 50%, corresponding subordinate objectives might consist of reducing pollutants

283 American Water Resources Association, "AWRA Policy Statement: Integrated Water Resources Management in the US" (American Water Resources Association, January 2011), http://www.awra.org/policy/policy-statements-IWRM.html.

from municipal, industrial, and farm sources. This may lead to an increase in funding for the NRCS Healthy Watersheds Initiative. Increasing research and development funding to explore environmentally friendly fertilizers and pesticides may also lead to reduced hypoxia in the Gulf. This would also lead to better water quality for municipal users and may help protect threatened and endangered species. This would benefit farmers who want to protect the environment and also coastal residents who desire a healthy and sustainable fish stock.

Identifying the resource needs for a national water strategy is the next step in the process. The authoritative source for identifying costs of legislation is the Congressional Budget Office (CBO) which published a report in 2006 on federal involvement in water resources issues, and a cost estimate on implementing H.R. 135, "Twenty-First Century Water Commission Act of 2007." The cost of the Water Commission proposed H.R. 135 was estimated to be $12 million over a 5-year period, and included support for 11 commissioners.[284] This proposal did not include any funding for state and local governments to participate in the federal commission. The inclusion of the states to participate in developing a national water strategy will be a necessity. Using 2007 costs for 11 commissioners and interpolating for 50 state representatives, this will add a cost of about $54.5 million over 5 years. Due to inflation, it is estimated that the total 2013 cost to implement a similar National Water Commission today, with the addition of 50 state representatives, would cost $75 million over the next 5 years.[285]

Given the myriad federal agencies involved in water resources management, the Office of Management and Budget could establish an agency tax of nominal value to pay for development of a national water strategy , or require agencies to participate without asking Congress for additional money. Either option would spread costs across the government. This is how many inter-agency action teams get started. One example is the Committee on the Marine Transportation System (CMTS) that was discussed in Chapter

284 Tyler Kruzich, Neil Hood, and Amy Petz, "Cost Estimate H.R. 135: Twenty-First Century Water Commission Act of 2007" (Congressional Budget Office, May 22, 2008), http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/93xx/doc9305/hr135.pdf.

285 "Inflation Calculator: Bureau of Labor Statistics," accessed January 25, 2014, http://www.bls.gov/data/inflation_calculator.htm.

2. The CMTS originally started as an inter-agency coordinating body in 1999, but was elevated to a chartered cabinet-level committee following approval of the 2004 Ocean Action Plan, requiring federal agencies to participate without additional funding.[286] One result of this cabinet-level committee was development of the 2008 *National Strategy for the Marine Transportation System*.

There are some risks with developing a strategy without involving Congress. The biggest risk is that Congress could prohibit the expenditure of funds for activities to support the strategy once it is approved. In the case of the CMTS example, Congress subsequently authorized the activities of the CMTS through the Coast Guard and Maritime Transportation Act of 2012 (P. L. 112–213), that was signed by President Obama on December 22, 2012. This officially recognizes the CMTS and gives the "interagency Partnership new authority, new responsibilities, and new opportunities."[287] The objective of developing a water resources strategy should be to take a whole of government approach that is properly resourced and affords better integration of water resources actions between federal agencies and congressional committees.[288] In order to accomplish this, an act of Congress is recommended; however, a federal agency partnership could lay the groundwork similar to the work of the CMTS. The Congressional Water Caucus, comprised of almost 50 members of Congress, could be leveraged as a possible way to expand interaction with Congress.[289]

Investments are needed in nearly all aspects of water resources. Infrastructure investments are critically needed throughout the water sector as evidenced by the ASCE Infrastructure report.[290] Navigation infrastructure is breaking at an alarming rate and adds to the cost of an industry that is paying for the infrastructure through a cost-share

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286 Committee on the Marine Transportation System, "National Strategy for the Marine Transportation System: A Framework for Action," 57; Norman Mineta et al., "Charter for the Committee on the Marine Transportation System," August 11, 2005, 4, http://www.cmts.gov/downloads/Final_CMTS_Charter_110305.pdf.

287 "CMTS Directives," *Committee on the Marine Transportation System*, accessed January 29, 2014, http://www.cmts.gov/About/Directives.aspx.

288 Engberg, "Setting a Direction for U.S. Water Policy."

289 "News Releases: Sens. Moran and Pryor Establish Bipartisan Senate Water Caucus -."

290 American Society of Civil Engineers, *2013 Report Card for America's Infrastructure*.

agreement. Aquifers that supply municipalities, industrial facilities, and farms are being drawn down without a similar replenishment of water. A full understanding of the causes is needed.[291]

Climate change is either impacting, or will impact, nearly all aspects of water resources. Further research and development funding is needed, along with tools to better understand water consumption and replenishment. By investing in tools to capture data for better management, we will be positioned to manage risk across the water spectrum and make the necessary investments. A national water strategy needs to account for risks across the water spectrum.

Another aspect of the GAO model strategy is the clear delineation of organization roles, responsibilities and coordination. Drawing on the CMTS Charter as an example, an interagency team should be established from all executive departments with responsibilities for water resources. Leveraging the collective authorities and jurisdictions of each department is necessary to develop a strategy for national water resources.

Lastly, the model strategy has an integration and implementation section that outlines how the strategy will be employed. There are few risks to implementing a national water strategy, depending on the process used to establish the strategy. Development of the strategy needs to include the stakeholders in an open and transparent process. If the effort is driven by federal agencies, other stakeholders will claim that this is an effort to assume federal control of water resources, and that the federal government is infringing on state water rights. The federalism issue is the key to the successful implementation of a national water strategy.

C. WATERSHED AS ONE SYSTEM

In a 2011 hearing following the devastating floods on the Missouri River, Congresswoman Donna Edwards (D-MD) made a prescience comment about being "baffled by why there isn't a more kind of comprehensive management strategy under

291 Karen Charman, "Trashing the Planet for Natural Gas: Shale Gas Development Threatens Freshwater Sources, Likely Escalates Climate Destabilization," 74.

one authority for the entire river basin."[292] Understanding how the watershed and its basins are currently being managed is an important task that was made difficult due to inconsistent definitions of watershed, basin, and river basin in the literature. This became evident during review of the Army Corps of Engineers (USACE) Civil Works Directorate strategic plan that calls for the need to manage their water resources projects at the watershed level.[293]

It was not readily apparent what definition the USACE uses for watershed, but it became apparent in the research, that the March 2013 Principles and Requirements (P&R) and USACE documents use watershed in a broad sense to mean the same or very similar manner to the way the term basin is used in this thesis.[294] Although the USACE water resources planning process is being re-crafted under the leadership of the Council on Environmental Quality (CEQ), the USACE currently uses Principles and Guidelines (P&G) for project planning. "The Water Resources Planning Act of 1965, which created the authority for the existing P&G, draws a distinction between Level C (project) and Level B (basin scale) planning."[295] This gives a very strong indication that current planning efforts by the USACE are done at a level that is no broader than the basin level. This thesis proposes to expand that view to the watershed level.

The USACE Civil Works Directorate published a 5-year Strategic Plan in 2011, outlining their role in implementing IWRM as a strategic objective.[296] "Although, the U.S. Army Corps of Engineers has been highly successful in achieving their goals, they

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292 *The Missouri River Flood: An Assessment of the River Management in 2011 and Operational Plans for the Future*, 98.

293 U.S. Army Corps of Engineers, "Sustainable Solutions To America's Water Resources Needs; Civil Works Strategic Plan 2011–2015," September 2011, 15, http://planning.usace.army.mil/toolbox/library/Misc/Sustainable_Solutions-2011-15.pdf.

294 "Watershed is a land area that drains to a common waterbody." Council on Environmental Quality, "Principles and Requirements for Federal Investments in Water Resources," 16.

295 Shabman and Scodari, *Towards Integrated Water Resources Management: A Conceptual Framework for U.S. Army Corps of Engineers Water and Related Land Resources Implementation Studies*, 4; Council on Environmental Quality, "Principles and Requirements for Federal Investments in Water Resources," 14. The Council on Environmental Quality released final Principles and Requirements (P&R) that will replace the P&G 180 days after the CEQ publishes final Interagency Guidelines. This will be a significant change to the way the federal government coordinates water projects.

296 U.S. Army Corps of Engineers, "Sustainable Solutions To America's Water Resources Needs; Civil Works Strategic Plan 2011–2015," 3.

stand as an example of how detrimental top-down planning can be when the agency does not have a holistic set of priorities."[297] It was also noted in a 2009 CRS report by Betsy Coder and Nicole Stern that we have gone further away from the 1968–1973 NWC recommendations.[298] The 2011 strategy of the Corps appears to move back towards the IWRM language contained in the 1968–1973 National Water Commission recommendations. "Such integration is essential for the future success of the Civil Works program given the Nation's multi-layered governance system that crosses watershed boundaries and the interdependent relationship between the natural and built environment."[299]

The USACE strategic plan is based on their collaboration with other federal agencies using integrated water resources management (IWRM). IWRM involves all levels of the government working together to manage the basin, based on each agencies authority and jurisdiction. For the purpose of the problem space in this thesis, the collaborating agencies include the USACE, USGS, NOAA, EPA, FERC, Bureau of Indian Affairs, and the USCG. The six areas that comprise the problem space are discussed in Chapters II–V, and include navigation, flood control, environmental, industrial uses, municipal uses, and geopolitical concerns. The Sector-Specific Agencies (SSA) responsible for each of the critical infrastructure sectors are listed in Appendix F. These generally align with the primary agency responsibilities outlined in chapters 2–4, with the exception being the Dams Sector, which is the responsibility of the Department of Homeland Security and not the USBOR or USACE.

The interconnectedness of the components and the complexity of water rights and laws make this issue challenging to resolve. When looking at a river basin, the problem is more manageable since it aligns closely with USACE and other agency jurisdictions, project funding parameters discussed in chapter two, and water rights split in the middle of the country. In developing a watershed management framework, similar terminology

297 Heard, "Deconstructing the Mississippi River," 22.

298 Betsy Cody and Nicole T. Carter, *35 Years of Water Policy: The 1973 National Water Commission and Present Challenges*, summary.

299 U.S. Army Corps of Engineers, "Sustainable Solutions To America's Water Resources Needs: Department of the Army Corps of Engineers Civil Works Strategic Plan 2011–2015," 5.

and language as used by the USACE strategy could be used; however, "state-federal tensions over proper and respective roles continue to cloud resolution of difficult water resource issues and complicate coordination efforts."[300] A collaborative effort involving federal, tribal, and state governments, and other stakeholders is needed to ensure successful implementation of a watershed framework.

While looking for models to evaluate how to integrate multiple government levels, agencies, and NGO stakeholders into a management framework, I found the implementation plan that resulted from the National Ocean Policy Task Force report from 2009. This report was a result of many years of study and work done to ensure the sustainability of our oceans, coasts and Great Lakes. Executive Order (EO) 13547 requires federal agencies to coordinate marine planning activities with states and other stakeholders through regional planning bodies which were to be established for the oceans, Gulf of Mexico, and Great Lakes.

The inland waterways, including the watershed, are excluded from the marine planning process that is tasked with developing a science-based master plan for the multiple uses of ocean and coastal water resources.[301] It is presumed by the author that this was for the same federalism issues discussed earlier, and the desire of the federal government to leave water issues to the states; however, a watershed that drains water from parts of 31 states should be managed as a national resource. Likewise, aquifers that cross multiple state lines cannot be managed strictly by state and local water districts. Water is a national asset and something that should be managed with a national vision. This section will explore the concept of the Mississippi River watershed as a system, including outlining the interconnectedness between the components and problems discussed in Chapters II–V.

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[300] Betsy Cody and Nicole T. Carter, *35 Years of Water Policy: The 1973 National Water Commission and Present Challenges*, summary.

[301] Obama, "Ocean Management and Planning in the United States" Marine Planning was formerly known as Coastal and Marine Spatial Planning (CMSP) but has since been renamed by the National Ocean Council.

1. Navigation / Flood Control / Environment / Geopolitics

The nexus between navigation, flood control, and environmental considerations may not appear obvious. Safe navigation of vessels through the rivers of the watershed relies on the series of locks, dams, and levees to maintain the river width and depth. In many cases, navigation and flood control were the initial authorized purposes for an infrastructure project.[302] Each navigation and flood control project to be constructed in the watershed must be reviewed against NEPA criteria, and provide for an overall net positive benefit.

Environmentally, the watershed is a system—an ecosystem—that relies on compliance with environmental laws and regulations. Environmental impacts are felt by wildlife, water quality, and freedom of navigation. Oil and chemical spills result in the need to boom river sections in order to collect, and clean up, the spilled substance. This usually results in short to long-term river closures, which stop or slow down the movement of cargo. Due to the interconnectedness of the environmental issues, they must be part of the dialogue on a national water strategy, and on a watershed management framework that takes into account IWRM principles.

The intersection of the physical construction with the environment has been the subject of public debate that began before NEPA came into effect in 1969, but has intensified since then. We are learning more about the environmental impacts of constructing levees, locks, dams, and other structures in the river system. One impact is ecosystem degradation for plants, wildlife, and fish. We are now seeing more threatened and endangered species from throughout the watershed as a result of lower water quality, altered spawning habitat, and invasive species.

The policies of the 1800s and early 1900s that drove construction of the marine highway to facilitate commerce, failed to take a long-term view of the overall impacts of the navigation system. As a result, mitigation measures are needed in many USACE projects. This leads to the discussion of how to balance funding between restoring the

302 Bray, Murphree, and Dager, *Toward A Full Accounting of the Beneficiaries of Navigable Waterways*, 3.

environment and improving the efficiency and performance of the flood control and transportation systems. In a 2011 hearing on the Missouri River flooding, Congressman Bob Gibbs (R-Ohio) raised this line of questioning with Brigadier General McMahon, Commander of the USACE Northwest Division, and noted the disparity between navigation funding in 2011 ($15 million) compared to restoration ($87 million).[303] This example is not intended to question the priorities of the Administration or Congress, but to point out the relationship between the ecosystem, navigation, and flood control. Given the increased focus on environmental laws since the 1960s, these three uses of the watershed are now inextricably linked.

The previous example centered on the Missouri River basin; however, the entire watershed has documented environmental impacts caused by navigation and flood control structures. A 2011 Government Accountability Office (GAO) report notes disagreements between professional researchers and USACE experts over river training systems and whether they actually create additional flooding.[304] The USACE does not believe there is a higher risk of flooding, because wing dams and other training apparatus have their greatest impact when the water levels are low.[305] As the water levels increase, the effect of the structures should become negligible. The GAO identified several sources that agree in theory with the USACE on the minimal affects of one training structure; however, these sources cannot agree with the USACE correlation of these minor impacts from one structure to the cumulative effects of repetitive training structures.[306] Hydrology experts generally agree with the GAO recommendation for the USACE to

303 *The Missouri River Flood: An Assessment of the River Management in 2011 and Operational Plans for the Future*, 70, 90–92.

304 Government Accountability Office, *Mississippi River Actions Are Needed to Help Resolve Environmental and Flooding Concerns about the Use of River Training Structures*, GAO (Washington, DC: GAO, December 2011), http://www.gao.gov/products/GAO-12-41. A training apparatus is a project constructed by the Army Corps to increase water velocity, usually around a bend in the river, to increase water velocity to reduce the amount of sediment deposited and the frequency of dredging.

305 Ibid., 37.

306 Nicholas Pinter et al., "Cumulative Impacts of River Engineering, Mississippi and Lower Missouri Rivers," *River Research and Applications* 26, no. 5 (2010): 546–571, doi:10.1002/rra.1269; Nicholas Pinter, Russell Thomas, and Joseph H. Wlosinski, "Assessing Flood Hazard on Dynamic Rivers," *Eos, Transactions American Geophysical Union* 82, no. 31 (2001): 333–339, doi:10.1029/01EO00199; Jonathan W.F. Remo and Nicholas Pinter, "Retro-Modeling the Middle Mississippi River," *Journal of Hydrology* 337, no. 3–4 (April 30, 2007): 421–435, doi:10.1016/j.jhydrol.2007.02.008.

model river training structures to determine their impacts on river levels at extreme high water.[307] This disagreement over impacts of river training projects is further confounding the issue of congressional authorization for specific projects. For this reason, the GAO report accurately calls for further research and modeling in order to reach a definitive conclusion.[308]

Quantifying the costs and benefits to construction projects has proven to be a difficult process. This is made more complicated by how to identify and quantify social and environmental costs.[309] Social and Environmental impacts have led to the formation of many NGO that polarize around a set of key special interest categories. This often pits different groups against one another. For example, the navigation industry group, AWO, advocates for the maritime industry and is constantly seeking improvements to the navigation system of locks. This industry is one that pays for infrastructure through a cargo tax and deserves to have that money spent on improving navigation infrastructure. On the contrary, there are environmental groups that focus on the harm to the environment from large navigation projects.

The economic value of the cargo and what that means to local economies is an important geopolitical concern that drives the quality of life throughout the watershed. Without the efficiency of the marine transportation system, other modes of transportation would be used. This would significantly add to the number of trains and trucks that currently ply the nation's rails and highways. This added congestion would ultimately lead to more highway deaths, and higher fuel consumption, and increased emissions of carbon dioxide (CO2).

A study done by the Center for Ports and Waterways at the Texas Transportation Institute evaluated the benefits of marine transportation, and compared them to rail and truck transportation. The results show the significant economic and environmental benefit

307 Government Accountability Office, *Mississippi River Actions Are Needed to Help Resolve Environmental and Flooding Concerns about the Use of River Training Structures*, 46.

308 Ibid., 37–46.

309 Jonathan Armah et al., *Principles and Guidelines for Evaluating Federal Water Projects: U.S. Army Corps of Engineers Planning and the Use of Benefit Cost Analysis*, 13.

that marine navigation has over other modes of cargo transportation. The following statistics are graphically represented in Appendix I, with CO2 emissions tied to climate change.[310]

- One 15-barge tow carries the same capacity as 216 rail cars pushed by 6 locomotives and 1,050 large tractor-trailers.
- For every one fatality in marine navigation, there are 18.1 rail and 132 highway transportation-related deaths.
- Marine navigation released 16.41 tons of CO2 per million ton miles, with railroads at 21.35 tons, and tractor-trailer at 171.83 tons.

2. Municipal / Industrial / Environment / Geopolitics

The relationship between municipal and industrial users, the environment, and geopolitical concerns is also difficult to discern without a closer examination of how the watershed is used for each purpose. Chapters III and IV outlined the individual components of municipal and industrial users, and the environment. Chapter V explored the geopolitical considerations on a macro scale. This section will explore the interconnectedness of each of them and why it is important to look at these as one system.

Municipal and industrial uses and users rely on both water quality and quantity, in order to meet their needs. The quality of the water is one concern for municipal water supplies, especially in the lower areas of the basin. The runoff from farms, and the discharges from power plants, hydraulic fracturing sites, wastewater treatment plants, and marine accidents all contribute to lower water quality. The holistic measurement of water quality appears to be the measure of the size of the annual dead zone that forms in the Gulf of Mexico as a result of pesticides and fertilizers used in farming. Reducing the size of the dead zone will lead to improved water quality for users throughout the watershed. However, balancing the cost of this concept should be weighed against the cost of other uses and users of the watershed.

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310 "Facts on the Industry," *The American Waterways Operators*, August 6, 2013, http://www.americanwaterways.com/media/fact-sheets/facts-industry; C. James Kruse, Annie Protopapas, and Leslie E. Olson, *A Modal Comparison of Domestic Freight Transportation Effects on the General Public: 2001–2009* (Texas Transportation Institute: The Texas A&M University System, February 2012), http://www.nationalwaterwaysfoundation.org/study/FinalReportTTI.pdf.

Quantity of water available is also a concern for municipal and industrial users. Much of the watershed faced a drought during 2012 as a result of upper Midwest weather patterns. As a result, water levels in the watershed were down, negatively impacting all users. As drought conditions persist, water in the rivers decreases, while demand for irrigation increases. This increases the stress on the water system and leads to increased usage of the watershed and aquifers. As discussed earlier in this chapter, we are currently seeing a drawdown of some aquifers for undetermined reasons. This is another reason why timely and relevant water resources data is needed.

Threatened and endangered species are included as one consideration in USACE river control manuals. As water stresses increase, so does the stress on the wildlife. Accounting for impacts to these species is a necessary consideration, but quantifying the specific impacts is challenging to U.S. Fish and Wildlife Service (USFWS) personnel. Looking at cumulative impacts throughout the system would allow the USFWS to ensure holistic management practices are in place for critical habitat.

Users also need to have adequate facilities to be able to discharge clean water back into the river when no longer needed. For example, wastewater treatment plants need to be able to discharge water in accordance with their NPDES permit. This is proving to be more difficult as the age of infrastructure increases. Responsibility for funding infrastructure recapitalization and improvements has generally been left to the facility owner, although there are various grant and other federal programs. Prioritization of federal funding for these programs should be based on data that shows the cost-benefit.

A much closer look at the energy-water nexus is needed throughout the watershed. Fracking is a controversial topic in the context of water, the environment and U.S. energy policy. There is currently not a definitive source that quantifies the environmental impact from fracking, although local municipalities and residents have reported changes to their drinking water quality and taste. With 1,069 mostly negative public comments received on a USCG proposal to allow carriage of shale gas extraction wastewater by barge, it is becoming clear that many do not want the byproduct of fracking to be transported by barge through their back yard for disposal elsewhere, although this is still being considered by the USCG.

The lack of an energy strategy is a geopolitical concern. The nexus between energy and water has been discussed briefly in this thesis, but further quantitative research is needed to identify how energy projects impact water quality and quantity. Energy demands water, and water demands energy—the two go hand in hand. As a result, a water strategy must include an energy component, and vice versa. Since water and energy are both needed to sustain life, this is a growing concern, especially with demographic shifts within United States. Understanding the inter-connectedness of water, energy and demographics is necessary to the future of some regions of the country.

D. CONCLUSION

This chapter outlined the findings and analysis of the literature with regards to the need for a National Water Commission that will develop a national water strategy . The complexity of adapting existing policies to the changing environment is overwhelming the existing organizational structure. The time is right to step back, evaluate the current state of water, and develop a national strategy to ensure a sustainable water resource for future generations.

The concept of a managing the Mississippi River watershed as a single system was also explored in this chapter. Economics and water laws drive many of the geopolitical influences that exist within the Mississippi River watershed in every facet of navigation, flood control, municipal and industrial uses, and environmental considerations. There are also geopolitical concerns from outside the watershed that have the potential to impact how the watershed is managed. Due to a persistent drought in the western states putting pressure on water resources, there may be a renewed call for water diversion.

Management of the Mississippi River watershed poses many challenges and opportunities in the years to come. How well we adapt to those will dictate how successful our nation is at ensuring sustainable water for navigation, municipal and industrial uses, and restoring a healthy ecosystem to return threatened and endangered species to healthy numbers. Chapter VII will lay out the recommendations for how to do this.

VII. RECOMMENDATIONS

Watershed management is about the health and viability of the ecosystem, and creating a balance amongst related, but seemingly competing, interests. Reducing demand and increasing supply used to be the goal of most water resource planners, but this paradigm needs to be re-evaluated to ensure long-term sustainability.[311] This thesis calls for the creation of a national water strategy as a homeland security imperative. The author has laid out the intricacies of the Mississippi River watershed and how these relate to national water issues. Managing the Mississippi River watershed as a system will ensure the long-term sustainability of the watershed, and allow it to meet the demands of its many users and uses, while also abiding by environmental mandates. This chapter will summarize the recommendations that follow the analysis and findings from Chapter 6.

A. WATER COMMISSION

Similar to what President Truman did in 1950, a National Water Commission is needed to develop a national water strategy. One of the commission members wrote that "the time is ripe for a thorough re-appraisal of water resources policy."[312] The time is ripe for another re-appraisal of water resources policy, since one hasn't been done since the 1968–1973 Water Commission. There is an increasing need to reconcile the ad-hoc, and often disjointed, federal laws pertaining to water resources development.[313] Many of the nation's water laws were written in the 20th century and were written for a different time.

Federal agencies have been working on collaborative approaches to water resources management, as evidenced by the National Ocean Policy Implementation Plan, the CEQ-released Principles and Requirements (P&R), and the 2011 Memorandum of

311 Juliet Christian-Smith, Peter H. Gleick, and Heather Cooley, "US Water Policy Reform," in *The World's Water* (Springer, 2011), 153–154, http://link.springer.com/chapter/10.5822/978-1-59726-228-6_7; Peter H. Gleick, "The Changing Water Paradigm: A Look at Twenty-First Century Water Resources Development," *Water International* 25, no. 1 (March 2000): 127.

312 Renne, "The President's Water Resources Policy Commission," 299.

313 Engberg, "AWRA Policy Dialogues 1–4 Summary," 5.

Understanding (MOU) between the USACE, NOAA, and USGS. These are just a few of the efforts being taken by federal agencies to work together; however, these efforts are not coordinated across all of government.

The 1950 National Water Commission was implemented by Executive Order. In contrast, the 1968 National Water Commission was created by Congress. As discussed briefly in Chapter 6, many of the recommendations that came out of the 1968–1973 NWC have been implemented. Despite two failed attempts at establishing a NWC in 2008 and 2009, it is recommended that a new commission be established by Congress, with a funded mandate and legislative oversight. If this is implemented properly, this new commission could lead to a transformative process for integrated water resources management in the U.S. and lead efforts to integrate policy development, budgeting, and performance measurement.

B. NATIONAL WATER STRATEGY

Regardless of whether a NWC is established, the United States needs to develop a national water strategy. Chapters II–V examined the complexity of the Mississippi River watershed, and the interconnectedness of the watershed to the Great Lakes and the Gulf of Mexico. In addition, the energy-water nexus was explored in Chapters III and IV. Although much has been written on the environmental impacts of fracking, additional research is needed. The consumption of water for fracking and the potential adverse impacts on water quality are two areas where the federal government needs better data.

Water conflicts exist in the west due to persistent drought conditions. Given the unknowns on the future impacts of climate change, the time is ripe for developing a strategy to ensure sustainable fresh water supplies for the growing population. Additionally, there are water disputes in many states, with courts having to rule on ownership claims. One case discussed briefly in Chapter V involves Montana suing Wyoming claiming that farmers, and oil and gas drillers are using too much water.[314] Another current water conflict in the United States exists between Georgia, Florida, and Alabama. Georgia is trying to protect enough water for the Atlanta metro area, while

[314] Brown, "Water Fight between Mont., Wyo. Going to Trial."

Florida and Alabama are trying to protect their needs downstream.[315] A national water strategy is needed to stem the tide of current litigation, and to prevent the coming water wars. The challenges are likely to increase due to climate change, population growth, and the consumption of water for energy production.

Based on the complexity of watershed issues, this thesis recommends a national water strategy that incorporates the following principles:

- preserves state water rights within a national strategy
- ensures safe and secure marine transportation system
- sustains water resources
- preserves and restores the ecosystem
- balances energy-water considerations
- expands the focus of water in the National Security Strategy

The use of the GAO framework on what constitutes an effective strategy is recommended in developing a national water strategy. As shown in Table 2 in Chapter VI, it is essential that the strategy include the following six elements:[316]

- purpose, scope, and methodology
- definition of the problem and risk assessment
- goals, subordinate objectives, activities, and performance measures
- resources, investments, and risk management
- organizational roles, responsibilities, and coordination
- integration and implementation.

In a 2005 hearing titled *Water Symposium*, Mr. Dennis Underwood of the Metropolitan Water District of Southern California proposed a national water strategy.[317] That sounds like a promising recommendation, especially if using the GAO evaluation of what constitutes an effective strategy. The development of a national strategy is

315 Southern Environmental Law Center, "Tri-State Water Wars (AL, GA, FL)," accessed February 17, 2014, http://www.southernenvironment.org/cases/tri_state_water_wars_al_ga_fl/.

316 Yim, *Combating Terrorism Evaluation of Selected Characteristics in National Strategies Related to Terrorism*, 11.

317 *Water Symposium*, 35.

challenging, because there are not many people who understand the importance of water issues, and are not actively engaging their elected representatives.[318] Water pricing in the United States remains very low, and as long as there is water from the tap, Americans appear content to wait for problems to arise. This continues our nation on a path of disjointed policies in practice that are not integrated and are not balanced so that all users feel empowered to make positive improvements.

Key word searches can be used in documents to find indicators of relative importance and balance. The current *National Security Strategy* only mentions water once, while climate change is mentioned 23 times. This is an example of the lack of balance in how issues are discussed at the national level, and gives an indication that the nation may not be ready to consider water as a security issue.

Water allocations are done at the state level; however, there are federal interests and commerce clause impacts. America needs to have a national discussion on the importance of water for our future security. Climate change impacts and the energy-water nexus need to be better understood, and incorporated into the homeland and national security dialogue.[319] In the 2010 *National Security Strategy*, water is mentioned once; in the context of having clean water as part of meeting basic human needs. The dialogue needs to include the future of water resources to the importance of our national security. Therefore, it is recommended that the next revision of the *National Security Strategy* have an expanded treatment of water and environmental considerations.

C. WATERSHED REGIONAL PLANNING BODY

In addition to developing a national water strategy, this thesis proposes management of the Mississippi River watershed as a single system comprised of the six river basins. In putting together a system that covers the six basins, and each of the components discussed in Chapters 2–5, it became clear that preserving state water rights and collaboration with all stakeholders was the key to implementing a system-wide

318 Ibid., 29.

319 James D. Ramsay and Terrence M. O'Sullivan, "There's a Pattern Here: The Case to Integrate Environmental Security into Homeland Security Strategy," *Homeland Security Affairs* 9 (May 2013): 3–9, http://www.hsdl.org/?abstract&did=737776.

approach to watershed management. The challenge became identifying a framework for how the system should be managed.

It has been stated that state water and land use roles need to be preserved within any national strategy and water management framework that is developed. In the 2005 Water Symposium hearing, then Senator Salazar indicated that we do not need another federal commission to allocate water, as that is a state issue, while many of the initiatives recommended by the state and local witnesses involved federal agency roles and interactions.[320] It is not as simple as saying it is a state issue, when the states are clamoring for federal leadership and funding. This is difficult to fix and this is precisely why the states are asking for federal leadership; water issues are inherently challenging, and our future security depends on it.

The Mississippi River watershed is the largest in the U.S. and is hydrologically connected to the Great Lakes and the Gulf of Mexico. The Great Lakes and Mississippi River Interbasin Study (GLMRIS), released in January 2014, is indicative of the complexity of watershed issues in the U.S. and the importance of a national water policy. In the case of the Great Lakes, there are international interests with Canada. It is presumed that for this reason, the Great Lakes were included in National Ocean Policy Implementation Plan requirements for a regional planning body (RPB). The Mississippi River watershed is not included in the implementation plan, presumably because of federalism issues or the work of the Mississippi River Commission (MRC) discussed in Chapter 2. However, when breaking down the goals and objectives of the National Ocean Policy Implementation Plan, it became apparent that it may be a good framework for watershed planning efforts involving federal, tribal, state, and local government agencies.

As discussed in Chapter 6, EO 13547 required the formation of nine RPB's to develop marine plans for each of the nine regions along the coasts, Great Lakes, and Gulf of Mexico. Expanding on this EO, this thesis recommends the addition of the Mississippi River watershed to the required regional plans. Under the leadership of the federal and

320 *Water Symposium.*

state co-chairs, the Mississippi River watershed RPB would be responsible for addressing each of the challenges raised in Chapters 2–5.

D. IMPLEMENTATION

Implementation of a watershed RPB can be successful because of the evolving nature of water resources management within the United States, and the collaboration currently being shown by federal agencies. The concepts of IWRM expanded during four water policy dialogue sessions hosted by the American Water Resources Association (AWRA) between 2002–2008, that also included many government agencies, non-governmental entities, contractors and academia.[321] The release of the Army Corps of Engineers Civil Works Strategic Plan 2011–2015 lists IWRM as the overarching strategy for water resources management.[322] Combining this trend with the myriad complex issues facing the Mississippi River watershed, leads to treating the entire watershed as a system, vice individual basins.

This thesis proposes the next step in this progression. Due to the complexity of environmental issues, water usage, and current and forecasted funding challenges, the entire watershed needs to be managed as a system. Recognition that the entire Mississippi River watershed is one system is a key step. It is recognized as a system by the commercial maritime industry; however, it is not being managed as a system by the federal government. While it is hard to implement an integrated approach to watershed management, it is necessary. The first step is to develop a national water strategy in order to unify all levels of government with a common purpose.

The second step is to develop a regional planning body (RPB) for the Mississippi River watershed that treats the entire watershed as one system. Using the National Ocean Policy Implementation Plan as a guide, the watershed RPB would be led by federal and state co-chairs, and have representatives from every state impacted by the watershed. Identifying the process for choosing a state co-chair for the watershed RPB will likely be

321 Engberg, "AWRA Policy Dialogues 1–4 Summary."

322 U.S. Army Corps of Engineers, "Sustainable Solutions To America's Water Resources Needs: Department of the Army Corps of Engineers Civil Works Strategic Plan 2011–2015," 3.

the most contentious decision. It is recommended that a lottery system be used to choose the first state co-chair, with a rotation set up for all states that desire to be included. This whole-of-government approach to watershed management is needed to address the challenges that have arisen from the complexity of cross-jurisdictional boundaries of many agencies, and oversight by multiple congressional committees with the Mississippi River watershed.

There are many stakeholders in the six river basins that make up the entire Mississippi River watershed system, and they often have competing interests and needs. As a result, the author anticipates that there will be both proponents and opponents to this call for a national water strategy and proposed RPB for the Mississippi River watershed. Preserving water rights will be the most important objective of a national strategy and integrated water management framework.

Gaining grassroots support will be helpful to successful implementation of a RPB that uses IWRM principles. Stakeholders most affected are the ones that live within or make their livelihood from the watershed. It is important to start with the local users and their issues to drive change, since they are the ones that are most impacted by the decisions made. The most significant issues affecting these users are navigation and flood control.

The key proponents for an integrated management framework are likely to be navigation users who already view the watershed as a system. The commercial towing industry and their industry trade group, the American Waterways Operators (AWO), are advocates for a strategy that looks at the watershed as a system. The AWO has often discussed the need for consistent navigation management approaches between basins. This is one reason why the Waterway Action Plans were implemented and are being used to manage navigation during periods of high and low water.

Flood control is an important social and psychological issue affecting every property owner in the watershed. With the passage of the Biggert-Waters Flood Insurance Reform Act of 2012 (P.L. 112–141; 126 Stat 916), flood insurance rates have gone up dramatically for those in high-risk flooding areas. Congress passed the Biggert-Waters

Act in order to ensure sustainability of the National Flood Insurance Program, since premiums collected from policy holders were not matching claims paid out.[323] This resulted in short-term funding fixes by Congress to ensure claims were paid. Due to the dramatic rise in premiums for those in high risk areas, some members of Congress have introduced legislation to undo changes that the new law had enacted.[324] Extremely high flood insurance rates are particularly troublesome for those along the watershed, since the federal government is largely protected from lawsuits over how the flood control program is managed.[325] Tying this issue to the need for an overall watershed management framework is a first step in winning the geo-political discussion. Given the 2011 and 2013 flood events in Missouri, this state is a good location to start.

Other states also care about watershed management and planning efforts. This is why it is important for state governors, and mayors of cities surrounding the Mississippi River watershed, to align with each other to address mutual needs. There are several examples of this already occurring within the watershed. The Upper Mississippi River Basin Association (UMRBA) was established in 1981 and consists of five states—Illinois, Iowa, Minnesota, Missouri and Wisconsin—that work together on shared interests in that basin.[326] The recently created Mississippi River Cities and Towns Initiative (MRCTI) is a local government-lead initiative focused on river water quality, habitat restoration, flooding and floodplain management, recreation, sustainable economies, and celebration of the river culture and history.[327] These focus areas align with a systems focus on watershed management.

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323 Rawle O. King, *The National Flood Insurance Program: Status and Remaining Issues for Congress* (Washington, D.C.: Congressional Research Service, February 6, 2013), 8, http://oregonrealtors.org/.docs/pg/400/rid/11613/f/CRS-Report-Status-and-Remaining-Issues.pdf.

324 *Biggert-Waters Flood Insurance Reform Act of 2012, 42 USC*, 2012; Senator Mary Landrieu, *A Bill to Improve the National Flood Insurance Program, and for Other Purposes, 42 USC*, vol. 4014, 2013, http://thomas.loc.gov/cgi-bin/bdquery/z?d113:s.00996:.

325 C. M. Brougher, *Federal Liability for Flood Damage Related to Army Corps of Engineers Projects* (Washington, DC: Congressional Research Service, September 4, 2008), http://opencrs.com/document/RL34131/2008-09-04/download/1005/.

326 "About UMBRA."

327 Northeast-Midwest Institute, "Mississippi River Cities and Towns Initiative."

Additionally, all states bordering the watershed have a stake in the management of the watershed to meet current and future water resource needs. States near the downstream end of the watershed may perceive a way to influence others through the process, and may look to leverage this to advance their issues. One example is the state of Louisiana, which may be a vocal advocate for a national strategy, and also a system-wide planning approach due to the annual dead zone that forms in the Gulf of Mexico.[328] Since Louisiana is part of the Gulf of Mexico RPB, they may oppose a watershed RPB, since the National Ocean Policy Implementation Plan allows the Gulf of Mexico RPB to consider inland practices that impact their region.

Environmental groups care about the ecosystem, water quality, and are likely to support a systems approach, since the watershed is a large ecosystem. A watershed RPB would likely expand their reach and influence. By managing the watershed as a system, we will enable the fair and equitable use of the system, while protecting downstream municipalities from potentially damaging practices by those upstream. Providing for a clean and healthy watershed protects endangered species, provides cleaner water for municipal and industrial uses, and reduces water treatment costs. All of these needs and desires should be carefully considered as part of an integrated approach.

A key proponent of a national water strategy is the American Water Resources Association (AWRA). As spelled out in its 2011 issue paper, the AWRA believes a national water vision and strategy are needed.[329] This position culminated from four national water policy dialogues that occurred from 2002–2008 and involved many stakeholders. The AWRA is therefore a key ally in advancing the call for a national water strategy.

Additional supporters of a national water strategy and Mississippi River watershed RPB, are likely to include academics and scientists interested in climate change. With the growing climate change discussion, there is a growing need for problem

328 U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, "Mississippi River Gulf of Mexico Watershed Nutrient Task Force."

329 American Water Resources Association, "AWRA Policy Statement: Call for a National Water Vision and Strategy."

spaces to explore climate change and environmental impacts. The Mississippi River watershed provides a natural drainage basin to explore a larger scale impact of climate change, similar to the work being done to understand climate change on the Amazon River Basin and rain forest.[330]

Changing demographics in our country will continue to put pressure on water resources and lead states and municipalities to explore additional water sources. There are likely to be additional efforts to explore siphoning water from the Mississippi River watershed to address irrigation demands and drought impacts in western states.[331] This issue is one that physical scientists have been monitoring since discussion started the impacts of climate change in the United States.

With the population growing in the southwest U.S. and drought impacting water in the west, the western states formed the Western Governors Association.[332] This alliance of western states is very concerned about water resource issues, and is likely to look to the Missouri River as a potential source.[333] The Missouri River is not currently viewed as part of a broader watershed system, other than to supply its bordering states with navigation, recreation, energy, and industrial use water.[334] Developing a national strategy affords further discussion on water diversions to other areas of the country. By incorporating the Missouri River basin into a Mississippi River watershed framework, the state of Missouri may feel it will be better able to protect their water for its intended uses.

In contrast, the key opponents may include the upstream states if they perceive that this is a federal attempt to share water, or control their local management practices. Additionally, the upstream states may fear the downstream states attempting to control their local practices that impact water quality or consumption. For example, if the state of

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330 United Kingdom Met Office, "Understanding Climate Change Impacts on the Amazon Rainforest," October 25, 2013, http://www.metoffice.gov.uk/research/news/amazon-dieback.

331 Peter H. Gleick, "Diverting the Missouri River to the West: 'Can' Does Not Mean 'Should,'" *Huff Post Green*, December 12, 2012, http://www.huffingtonpost.com/peter-h-gleick/diverting-the-missouri-ri_b_2287594.html.

332 Western Governors' Association, *Water Needs and Strategies for a Sustainable Future.*

333 Peter H. Gleick, "Diverting the Missouri River to the West: 'Can' Does Not Mean 'Should.'"

334 U.S. Army Corps of Engineers, "Missouri River Master Control Manual," I–1–4.

Missouri perceives that this is an attempt to regulate and control farm runoff, power generation, or municipal consumption, it may fight this effort as usurping its state water rights. Additionally, navigation groups, environmental groups, recreational boaters, non-border states such as the Western Governors Alliance, and others could oppose an integrated watershed framework depending on how they perceive the benefits to them. The opposition groups are likely to form and change as implementation discussions take shape.

If states bordering the watershed believe that a national water strategy or watershed management framework is a precursor to possibly diverting water to the arid southwest, they will adamantly oppose this idea. In order to energize state interest in a national strategy, it is very important to frame this discussion as a national effort, involving all levels of government and non-government stakeholders. Any hint of federal control over water will be met with stiff resistance. Trust, communication, and collaboration amongst all stakeholders are three elements that are needed to ensure successful implementation.

E. AREAS FOR ADDITIONAL RESEARCH

Additional areas for research include the use of water resources for other natural disasters, such as forest fires out west, and how to incorporate international agreements into a national water strategy. This primarily impacts the Great Lakes and the Colorado River Basin; however, since the Great Lakes are covered by the Great Lakes Marine Plan, it may not be necessary. Regardless, it is the authors assertion that a national water strategy is needed that takes into account all freshwater resources, including the international agreements with Canada and Mexico.

Recharge of water sources is an area for further research. The long-term implications of demographic changes and municipal and industrial uses on the watershed need to include conservation as a consideration. Irrigation users and urban planners need to identify and incorporate conservation measures into their practices, in order to help with sustainability of the resource. Conservation is the process to reduce the amount of water used for a specific purpose. The need for better data was discussed in Chapter 5.

"Many different federal agencies conduct work associated with water. There should be one user-friendly Webpage that users can visit to find reports and data from all of the federal agencies related to water."[335]

335 *Water Symposium*, 97.

APPENDIX A. MTS MATRIX

The Federal Marine Transportation System (MTS) Matrix depicts, by major category, the broad and complex MTS responsibilities of Federal Departments and agencies. The Federal MTS Matrix was developed by the Committee on the Marine Transportation System (CMTS) to promote awareness and understanding of Federal MTS responsibilities, and to be a foundation of information to identify and investigate opportunities for improved interagency collaboration and coordination. For further matrix information please visit the CMTS website: www.cmts.gov

CMTS Matrix Departments and Agencies:

United States Department of Agriculture (USDA)
Foreign Agricultural Service (FAS)
Farm Service Agency (FSA)
Animal and Plant Health Inspection Service (APHIS)
Natural Resources Conservation Service (NRCS)
Agricultural Marketing Service (AMS)
United States Department of Commerce (DOC)
Bureau of Industry and Security (BIS)
United States Census Bureau (Census)
Economic Development Administration (EDA)
International Trade Administration (ITA)
National Oceanic and Atmospheric Administration (NOAA)
United States Department of Defense (DOD)
United States Army Corps of Engineers (USACE)
United States Navy (Navy)
United States Transportation Command (TRANSCOM)
United States Department of Energy (DOE)
United States Department of the Interior (DOI)
United States Fish and Wildlife Service (USFWS)
Bureau of Ocean and Energy Management (BOEM)
Bureau of Safety and Environmental Enforcement (BSEE)
United States Geologic Survey (USGS)

United States Department of Justice (DOJ)
United States Department of Labor (DOL)
United States Bureau of Labor Statistics (BLS)
Occupational Safety and Health Administration (OSHA)
United States Department of Homeland Security (DHS)
Transportation Security Administration (TSA)
United States Coast Guard (USCG)
Federal Emergency Management Agency (FEMA)
United States Customs and Border Protection (CBP)
United States Department of State (DOS)
United States Department of Transportation (DOT)
Office of the Secretary of Transportation (OST)
Bureau of Transportation Statistics (BTS)
Research and Innovative Technology Administration (RITA)
Saint Lawrence Seaway Development Corporation (SLSDC)
Federal Highway Administration (FHWA)
Maritime Administration (MARAD)
Federal Railroad Administration (FRA)
Department of Treasury (Treasury)
Federal Maritime Commission (FMC)
National Transportation Safety Board (NTSB)
Environmental Protection Agency (EPA)

CMTS

Source: "Committee on the Marine Transportation System," Committee on the Marine Transportation System, accessed December 26, 2013, http://www.cmts.gov/About/Organization.aspx.

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APPENDIX B. STANDARD MATRIX OF THE FEDERAL MARINE TRANSPORTATION SYSTEM (BY DEPARTMENT/AGENCY)

		USDA					DOC					DoD			DOE	DOI				DOJ	DOL		DHS				DOS	DOT						FMC	NTSB	EPA
FEDERAL INTEREST	MAJOR CATEGORIES	FAS	FSA	APHIS	NRCS	AMS	BIS	Census	EDA	ITA	NOAA	USACE	Navy	TRANSCOM		USFWS	BOEM	BSEE	USGS		BLS	OSHA	TSA	USCG	FEMA	CBP		OST	BTS/RITA	SLSDC	FHWA	MARAD	FRA	Treasury	FMC	NTSB	EPA
Enhance Safety	Safety										x	x	x				x	x		x	x	x		x	x			x		x	x	x			x	x
Protect the Environment	Environmental Protection			x	x				x		x	x	x		x	x	x	x	x	x				x	x		x	x			x	x				x
Facilitate Commerce	Trade Facilitation	x	x	x		x	x	x		x	x					x				x				x		x	x	x			x		x	x		
	Trade Promotion	x	x	x		x				x														x				x		x	x			x	x		x
	Vessel Construction																							x		x		x				x	x				
	Vessel Operations										x							x		x				x		x		x		x							x
	Federal Channels, Waterways, and Sea Lanes										x	x			x	x			x	x				x	x		x	x	x	x				x			x
	Port/Modal Transfer Infrastructure								x		x	x			x									x				x			x	x	x	x			x
Ensure National Security	Security										x	x	x	x	x			x		x			x	x	x	x	x	x				x					
Cross-Cutting	Research & Development							x		x	x	x	x		x		x	x	x					x				x	x			x		x			x
	Human Resources										x	x	x					x		x			x	x				x				x					x

www.cmts.gov

Source: Committee on the Marine Transportation System, "CMTS Compendium of Federal Programs in the MTS," accessed February 1, 2014, http://www.cmts.gov/Resources/Compendium.aspx.

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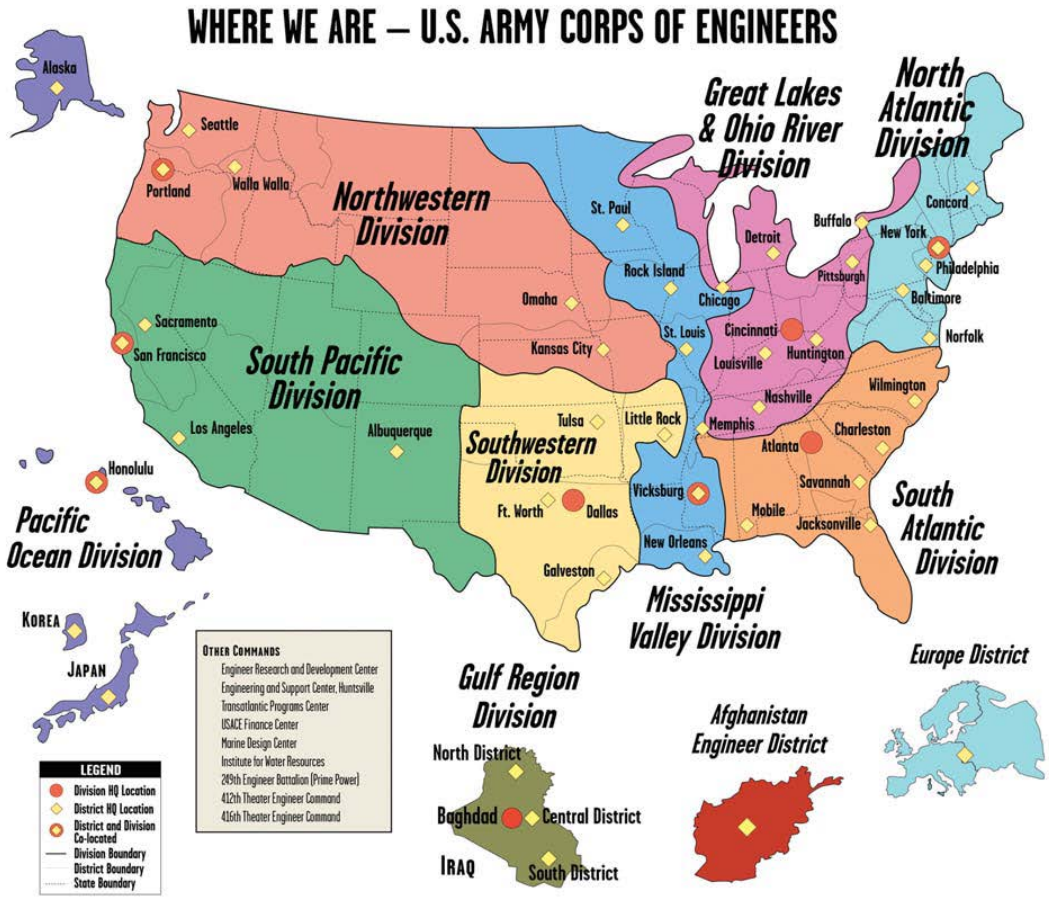
APPENDIX C. U.S. ARMY CORPS OF ENGINEERS DIVISIONS



Source: U.S. Army Corps of Engineers, "Sustainable Solutions To America's Water Resources Needs; Civil Works Strategic Plan 2011–2015," 10.

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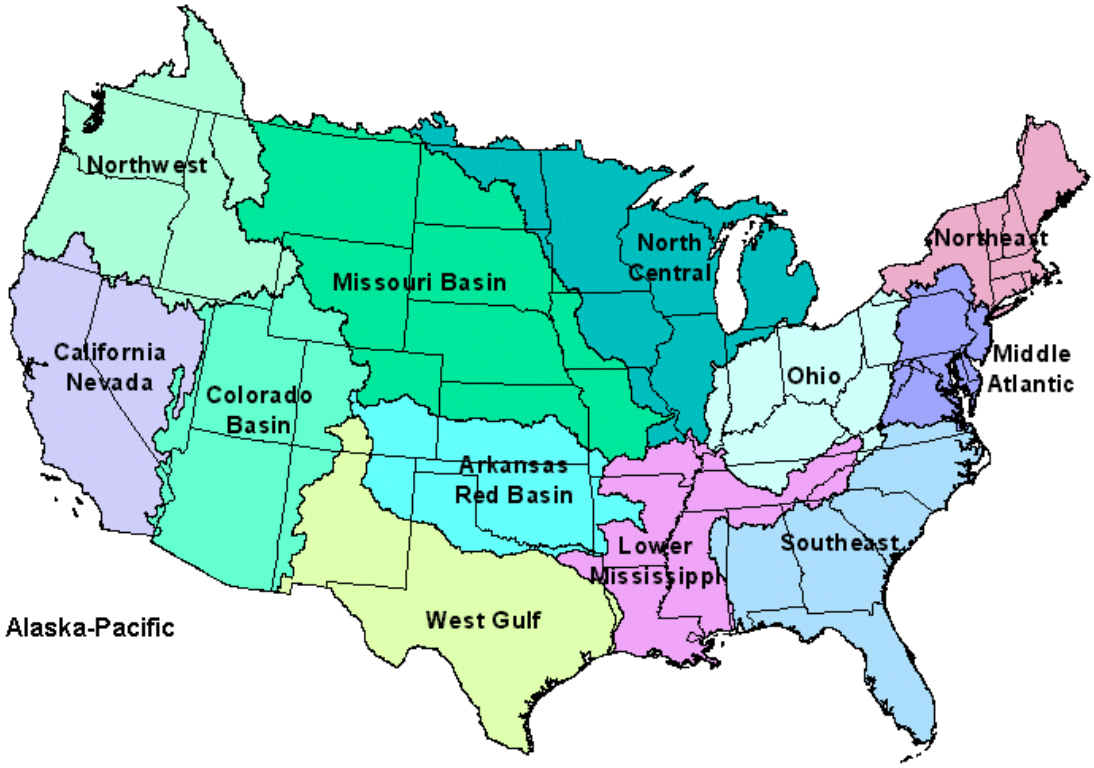
APPENDIX D. NOAA RIVER FORECAST CENTERS



Source: "River Forecast Centers," National Weather Service Advanced Hydrologic Prediction Service, December 8, 2011, http://water.weather.gov/ahps/rfc/rfc.php.

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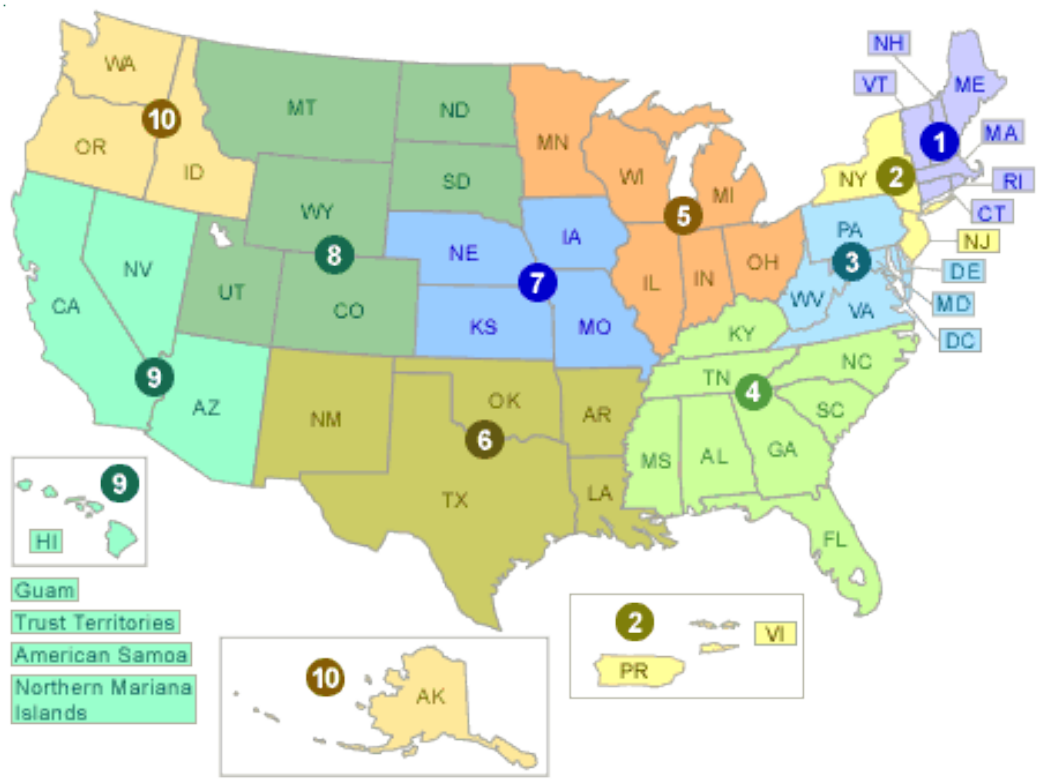
APPENDIX E. EPA REGIONS



Source: "About EPA," EPA: U.S. Environmental Protection Agency, January 30, 2014, http://www2.epa.gov/aboutepa#pane-4.

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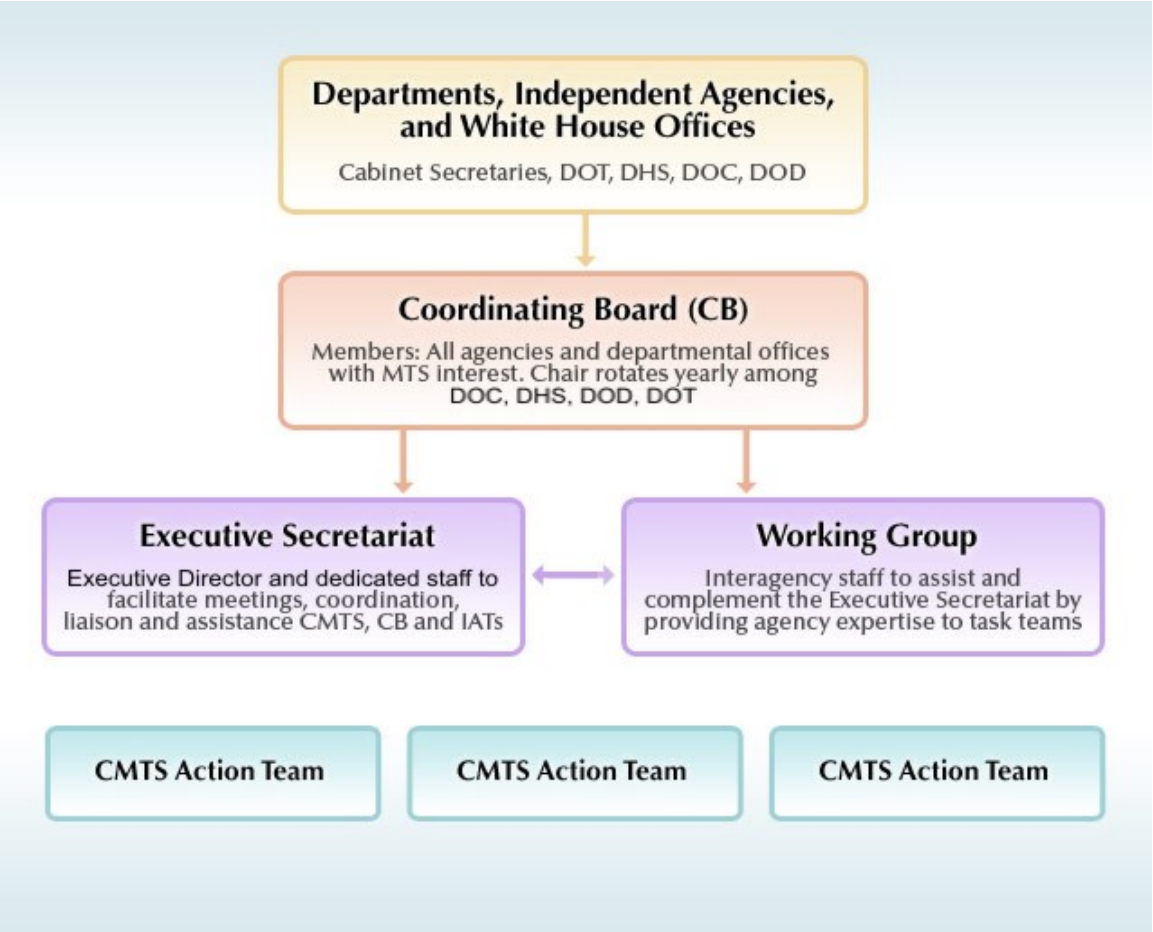
APPENDIX F. COMMITTEE ON THE MARINE TRANSPORTATION ORGANIZATION



Source: Committee on the Marine Transportation System.

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APPENDIX G. OHIO RIVER BASIN STAKEHOLDER LIST

The following list is from the Ohio River Basin Alliance and is available on its website at http://www.ohioriverbasin.org/?page_id=115.

FEDERAL GOVERNMENT

National Park Service

NOAA/NWS/Ohio River Forecast Center

Tennessee Valley Authority

U.S. Army Corps of Engineers

U.S. Coast Guard

U.S. Department of Agriculture, Natural Resources Conservation Service

U.S. EPA

U.S. EPA, National Risk Management Research Laboratory

U.S. Fish and Wildlife

U.S. Forest Service

U.S. Geological Survey

U.S. Maritime Administration

U.S. National Science Foundation

U.S. Office of Surface Mining

STATE GOVERNMENTS

KY Department of Energy

KY Division of Water

KY State Nature Preserves Commission

KY Tourism, Arts, & Heritage Cabinet

KY Transportation Cabinet

Miami Conservancy District

Mid-Ohio Regional Planning Commission

Muskingum Watershed Conservancy District

Ohio Department of Natural Resources

Ohio EPA

Ohio River Valley Water Sanitation Commission (ORSANCO)

PA Department of Environmental Protection

PA Fish & Boat Commission

TN Department of Environment & Conservation

WV Association of Conservation Districts

WV Bureau for Public Health

WV Conservation Agency

WVDHHR/Bureau for Public Health/Office of Environmental Health Services

WV Division of Water & Waste Management

COUNTY GOVERNMENTS

Brooke-Hancock-Jefferson Metro Planning Organization

Hamilton County Soil & Water Conservation District

MUNICIPAL GOVERNMENTS

City of Celina, OH

BUSINESS & INDUSTRY

AEP River Operations

Battelle

Biohabitats, Inc.

Chesapeake Energy Corp.

Coca-Cola of America

DLZ National, Inc.

Duke Energy, Inc.

Electric Power Research Institute

Environmental Science Associates, PLC

Gannett Fleming Engineers

General Electric Aviation

General Electric Water & Processing

HDR Engineering

Ingram Barge Co.

Kieser & Associates

Layne-Christensen GeoConstruction

Marathon Petroleum Co.

Michael Baker Inc.

Prime Engineers & Architects

Performance Site Environmental

Rex Energy Corporation

Tetra Tech

URS Corporation

West Virginia American Water

ACADEMIA

Ohio River Basin Consortium for Research and Education

Ohio State University Center for Resilience

Ohio State University Water Resources Center

Ohio University

Marshall University, College of Science

Thomas More College

University of Cincinnati

University of Tennessee, Center for Transportation Resources

West Virginia University Water Resources Research Institute

NON-PROFIT ORGANIZATIONS

Appalachian Energy & Environment Partnership

Association of Tennessee Valley Governments

Fort Thomas Forest Conservancy

Friends of the Russell Fork

Great Lakes Commission

Marshall University Research Corp.

National Association of Conservation Districts

National Association of State Conservation Agencies

Ohio Environmental Council

Ohio River Foundation

OKI Regional Council of Governments

Rahall Transportation Institute

Restoration Foundation

The Nature Conservancy

The Trust for Public Land

Waterways Council

WV Association of Conservation Districts

WATERSHED GROUPS

Cumberland River Compact

Friends of the Russell Fork

Middle Nolichucky Watershed Alliance

Monday Creek Watershed Group

Morris Creek Watershed

McClure River Restoration Project

Upper TN River Roundtable

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APPENDIX H. SECTOR-SPECIFIC AGENCIES

Presidential Policy Directive 21 (PPD-21): Critical Infrastructure Security and Resilience identifies the following 16 critical infrastructure sectors and assigns federal agencies as the Sector-Specific Agency[336]:

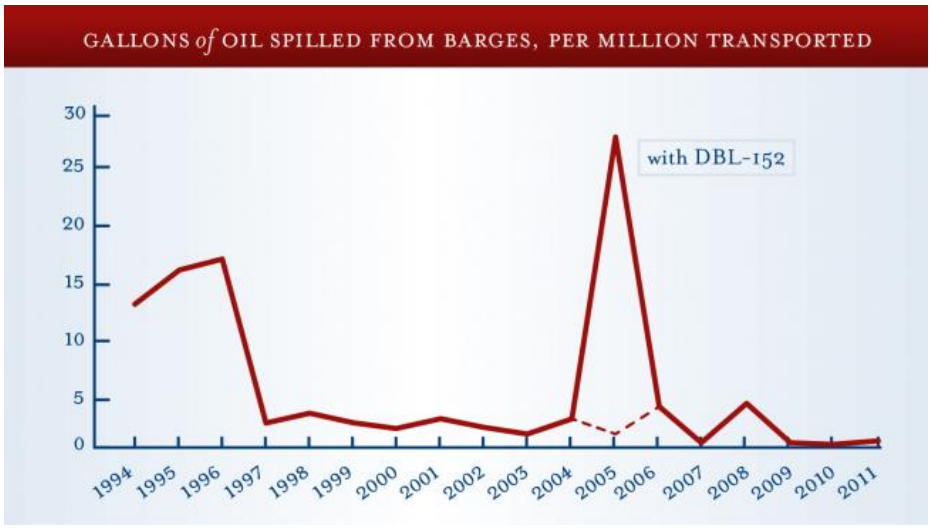
- Chemical Sector: The Department of Homeland Security is designated as the Sector-Specific Agency for the Chemical Sector.
- Commercial Facilities Sector: The Department of Homeland Security is designated as the Sector-Specific Agency for the Commercial Facilities Sector.
- Communications Sector: The Department of Homeland Security is designated as the Sector-Specific Agency for the Communications Sector.
- Critical Manufacturing Sector: The Department of Homeland Security is designated as the Sector-Specific Agency for the Critical Manufacturing Sector.
- Dams Sector: The Department of Homeland Security is designated as the Sector-Specific Agency for the Dams Sector.
- Defense Industrial Base Sector: The Department of Defense is designated as the Sector-Specific Agency for the Defense Industrial Base Sector.
- Emergency Services Sector: The Department of Homeland Security is designated as the Sector-Specific Agency for the Emergency Services Sector.
- Energy Sector: The Department of Energy is designated as the Sector-Specific Agency for the Energy Sector.
- Financial Services Sector: The Department of Treasury is designated as the Sector-Specific Agency for the Financial Services Sector.
- Food and Agriculture Sector: The Department of Agriculture and the Department of Health and Human Services are designated as the Co-Sector-Specific Agencies for the Food and Agriculture Sector.
- Government Facilities Sector: The Department of Homeland Security and the General Services Administration are designated as the Co-Sector-Specific Agencies for the Government Facilities Sector.

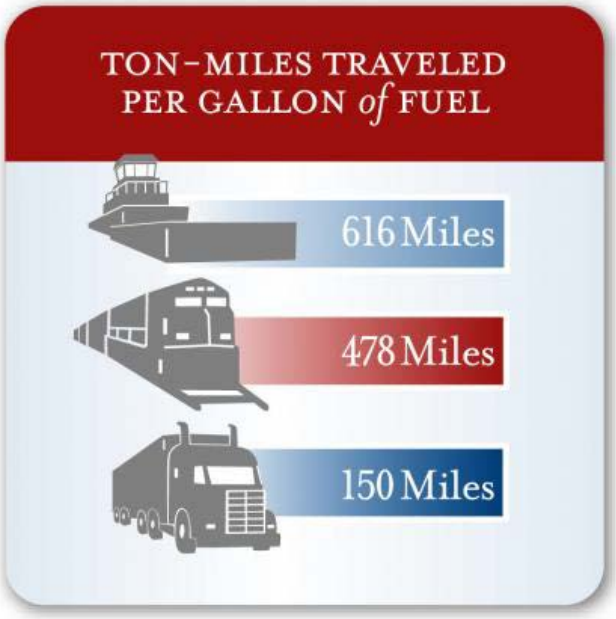
336 "Critical Infrastructure Sectors," accessed January 25, 2014, http://www.dhs.gov/critical-infrastructure-sectors.

- Healthcare and Public Health Sector: The Department of Health and Human Services is designated as the Sector-Specific Agency for the Healthcare and Public Health Sector.
- Information Technology Sector: The Department of Homeland Security is designated as the Sector-Specific Agency for the Information Technology Sector.
- Nuclear Reactors, Materials, and Waste Sector: The Department of Homeland Security is designated as the Sector-Specific Agency for the Nuclear Reactors, Materials, and Waste Sector.
- Transportation Systems Sector: The Department of Homeland Security and the Department of Transportation are designated as the Co-Sector-Specific Agencies for the Transportation Systems Sector.
- Water and Wastewater Systems Sector: The Environmental Protection Agency is designated as the Sector-Specific Agency for the Water and Wastewater Systems Sector.

APPENDIX I. INLAND BARGE TRANSPORTATION BENEFITS

The following is from "Facts on the Industry," The American Waterways Operators, August 6, 2013, and *A Modal Comparison of Domestic Freight Transportation Effects on the General Public: 2001–2009*, by C. James Kruse, Annie Protopapas, and Leslie E. Olson at the Texas Transportation Institute, The Texas A&M University System, February 2012.


GALLONS of OIL SPILLED FROM BARGES, PER MILLION TRANSPORTED
30
25
20
15
10
5
0
with DBL-152
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011


TON-MILES TRAVELED
PER GALLON of FUEL
616 Miles
478 Miles
150 Miles

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