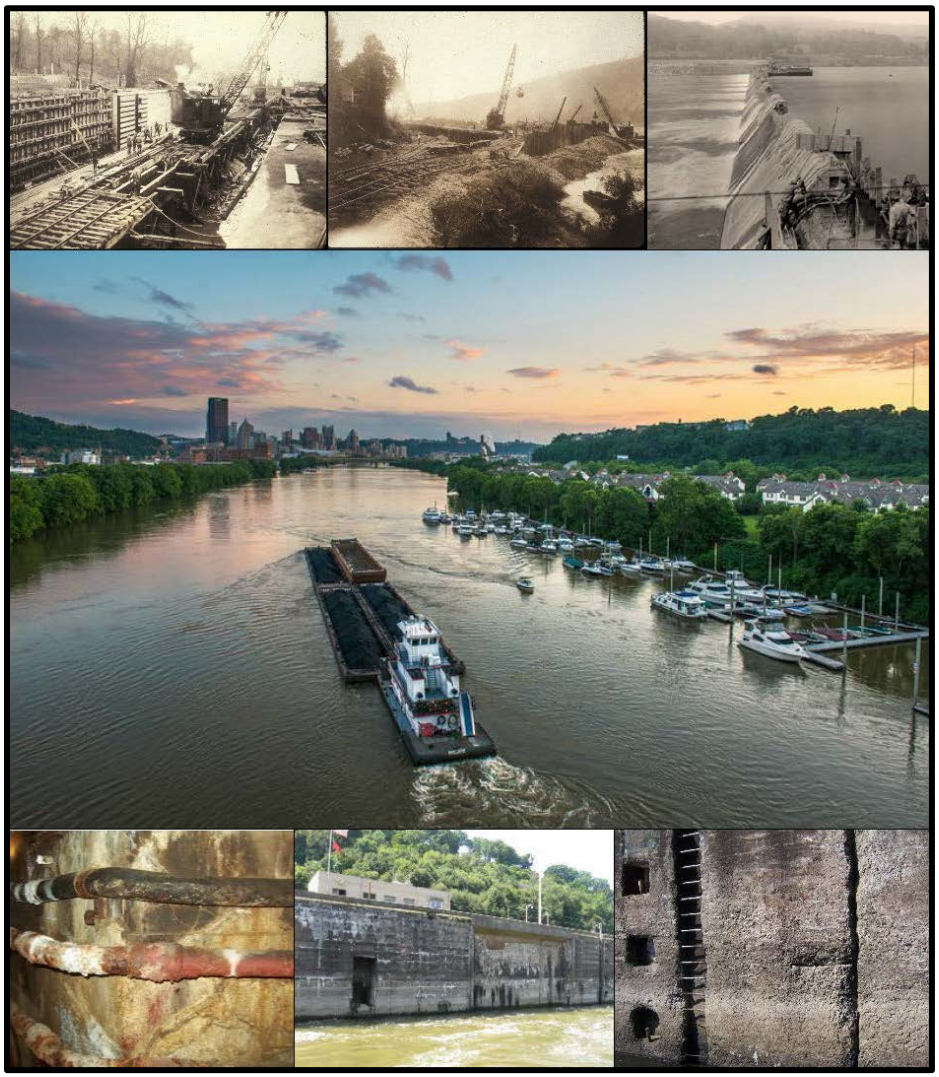
US Army Corps of Engineers ®
Pittsburgh District

MAY 2018

UPPER ALLEGHENY RIVER STUDY
LOCKS AND DAMS 5, 6, 7, 8, AND 9
ARMSTRONG COUNTY, PENNSYLVANIA

Completed Under Section 216 of the River and Harbor Act of 1970 (Public Law 91-611)
Disposition of Completed Works



EXECUTIVE SUMMARY

The Upper Allegheny River study analyzes potential changes to Allegheny River Locks and Dams (L/D) 5, 6, 7, 8, and 9 in response to downward trends in commercial navigation at the projects over the last 20 years. This study assesses whether sufficient federal interest exists to maintain these projects for their sole authorized purpose of commercial navigation, and to evaluate alternatives in response to changed conditions. Alternatives considered include multiple operations and maintenance funding levels, transfer, mothball, abandonment or removal of the projects. Study analysis is based on an evaluation and comparison of the benefits, costs, risks and impacts of continued operation, maintenance, repair, replacement, and rehabilitation.

The report developed is consistent with the U.S. Army Corps of Engineers (Corps) Planning Guidance Notebook and 2016 Disposition Study Implementation guidance. The document is intended to provide a complete, usable informational report that inventories current conditions, evaluates alternatives, compares costs, and discusses potential environmental and socioeconomic impacts. Components of this study have been scaled to the extent possible based on the scope and budget restrictions of the study. . A determination that this would be transmitted as a negative report was made in coordination with the vertical team and the project delivery team. This document provides findings, without a recommendation for federal action. Without a recommendation for federal action, some requirements were reduced or excluded from the final report.

Key findings in this study include:

- At current operations and maintenance funding levels all projects except L/D 5 operate with a net negative economic impact, and trends show that L/D 5's economic positive impact is declining.
- There are currently no suitable transfer partners for any of the projects.
- No Action or continued operations at any funding level considered in the study, without significant reinvestment, will most likely result in project failure prior to the end of the 50 year study period. Critical maintenance backlog is increasing at all projects and systems are rated as failed or failing for one or more component systems at each project.
- Alternatives that will significantly impact the ecosystem cannot be recommended at this time, under this authority. Future investigations into environmental impacts and mitigation strategies would be required.

Under the disposition study guidance no federal action could be recommended. A negative report under the disposition study implementation guidance does not mean that the alternatives considered in this study would not be suitable for implementation. The study found viable alternatives, however they would need further investigation and potentially an environmental impact statement to address mitigation for environmental and socio-economic concerns or benefits. The findings of this report may be used as a basis for further consideration and refinement of these alternatives under a full feasibility study or

other authority that can fully study impacts and recommend mitigation in conjunction with a selected alternative. As conditions change at the facilities this negative report could be used to further develop a report recommending federal action at one or more of the projects.

UPPER ALLEGHENY RIVER STUDY
LOCKS AND DAMS 5, 6, 7, 8, AND 9
ALLEGHENY RIVER, PENNSYLVANIA

TABLE OF CONTENTS

1 STUDY PURPOSE AND SCOPE 1

1.1 Scope 1

1.2 Authority 1

1.3 Study Area Defined 1

2 PROJECT AUTHORIZATION AND HISTORY 4

2.1 Authorization 4

2.2 System Projects 4

2.3 Projects Under Consideration 5

3 FEDERAL INTEREST IN DISPOSITION 7

3.1 Eligibility for Disposition 7

3.2 History of Performance 7

4 AFFECTED ENVIRONMENT 9

4.1 Socioeconomic Resources 9

4.2 Environmental Resources 15

4.3 Cultural Resources and Historic Properties 27

4.4 Future Without Project Condition 28

5 PROJECT DESCRIPTION – CURRENT CONDITIONS 35

5.1 Operation and Maintenance History 35

5.2 Critical Maintenance 36

5.3 Existing Safety Evaluation 42

5.4 Summary of Asset Holding 44

6 DESCRIPTION OF INTERESTED PARTIES 44

6.1 Description of the Entity 44

6.2 Capability of Entity to Assume Ownership 45

7 PLAN FORMULATION 45

7.1 Problems and Opportunities 45

7.2 Alternatives Description 47

7.3 Grouping of Alternatives at a System Level 53
7.4 Alternatives Considered but Eliminated 54
7.5 Socio-Economic Impacts 55
7.6 Environmental Impacts 60
7.7 Cultural Resources and Historic Properties 78
7.8 Comparison of Alternatives..... 80
8 ENVIRONMENTAL COMPLIANCE CONSIDERATIONS..... 84
9 FINDINGS 88
10 RECOMMENDATION 89
11 REFERENCES 90
Appendix A. Additional Maps and Figures. 1
Appendix B. Economic Appendix. 1
Appendix C. Real Estate Appendix. 1
Appendix D. Environmental Appendix. 1
Appendix E. Climate Change Analysis. 1

FIGURES

Figure 1. Allegheny River watershed map. 2
Figure 2. Planning alternative study area map. 3
Figure 3. Allegheny River Navigation System Existing Profile 5
Figure 4. Aerial photographs of Allegheny River L/Ds 5 through 9 6
Figure 5. Commercial Vessel Traffic at Allegheny L/D 5-9..... 7
Figure 6. Recreational Vessel Traffic at Allegheny L/D 5-9..... 10
Figure 7. Forecasted Recreational Vessel Traffic at Allegheny L/D 5-9 for 2016 - 2065 10
Figure 8. Population information for Armstrong County. 14
Figure 9. Landcover data for a one-mile corridor surrounding the river in the study area. .. 16
Figure 10. Dissolved Oxygen (mg/L) above and below the L/Ds. 23
Figure 11. Dissolved Oxygen (mg/L) depth profiles above and below the L/Ds. L/D 8 and 6 pools show summer time low flow vertical stratification. 24
Figure 12. L/D 5 Forecast 32
Figure 13. L/D 6 Forecast 33
Figure 14. L/D 7 Forecast 33
Figure 15. Grouping of Alternatives at a System Level..... 54
Figure 16. Mid channel profile depths at an average annual flow with the No Action alternatives (blue) and the Removal alternative (red). 62
Figure 17. Map of reclaimed lands within the project area with removal of all 5 L/Ds. 64
Figure 18. Conceptual Risk of Alternatives 84

TABLES

Table 1. IMTS guidelines for LoS 5
Table 2. Allegheny River L/Ds 5-9, Background Information. 5
Table 3. Tonnage of Commodities Moved through Allegheny L/D 5-9. 8
Table 4. Estimated Average Annual Costs to Shipper with Loss of Commercial Navigation.... 8
Table 5. Boat Access Sites by Allegheny River Pool. 9
Table 6. Existing Hydropower Facilities. 11
Table 7. Permitted Water Withdrawals. 12
Table 8. Future Forecasted Water Withdrawals for all Pools 12
Table 9. Demographic information for Armstrong County (EPA 2016b). 13
Table 10. USGS station numbers for gage height measurements. Corps station numbers for water quality collection. Located above and below each lock in the study location. 22
Table 11. Allegheny River – Historical Tonnage 29
Table 12. Allegheny River Low Forecasted Tonnage and Commodity Values 31
Table 13. Allegheny River Middle Forecasted Tonnage and Commodity Values 31
Table 14. Allegheny River High Forecasted Tonnage and Commodity Values 32
Table 15 Estimated Average Annual O&M costs for 2011-2015 36
Table 16. OCA ratings for Navigation Projects. 37
Table 17. OCA for Each L/D in the Study Per Asset Category. 38
Table 18. Dam Safety Action Classification System Ratings 42
Table 19. Current DSAC Ratings 43
Table 20 Safety Concerns at L/Ds 5-9. 43
Table 21. Real Estate Value of Facilities 44
Table 22. Number of Real Estate Tracts 44
Table 23. Marinas and Public Boat Ramps in the Project Area. 58
Table 24. O&M Scenario Costs (April 2017 Dollars) 80
Table 25. Constructed Alternatives Costs (April 2017 Dollars) 80
Table 26. Alternative Comparison by Evaluation Criteria 82
Table 28 ..... **Error! Bookmark not defined.**

UPPER ALLEGHENY RIVER STUDY
LOCKS AND DAMS 5, 6, 7, 8, AND 9
ARMSTRONG COUNTY, PENNSYLVANIA

---

1 STUDY PURPOSE AND SCOPE

1.1 Scope

This Disposition Study analyzes potential changes to Allegheny River Locks and Dams (L/Ds) 5, 6, 7, 8, and 9, managed by the US Army Corps of Engineers (Corps). This study was initiated in response to downward trends in commercial navigation at the included projects over the last 20 years. The purpose of this Study is to explore whether sufficient federal interest exists to retain these projects for their authorized purpose of commercial navigation, or whether a change in current levels of Operations and Maintenance (O&M) funding is appropriate. The study will also explore options including deauthorizing and disposing of real property and Government-owned improvements such as abandonment, transfer to a non-federal partner, or project removal. Study analysis is based on an evaluation and comparison of the benefits, costs, risks and impacts of continued operation, maintenance, repair, replacement, and rehabilitation.

1.2 Authority

Section 216 of the Flood Control Act of 1970 authorizes the Secretary of the Army to review operations of completed projects, when found advisable due to changed physical, economic, or environmental conditions.

> "The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to the significantly changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest."

Disposition studies are a specific type of 216 study. These studies are conducted using only federal funds; there is no non-federal sponsor.

1.3 Study Area Defined

The study area includes the entire Allegheny River Navigation System, 70 miles of navigable channel from Brady's Bend, Pennsylvania (PA), to river mouth at Pittsburgh, PA. The study area also includes the surrounding region impacted by river-dependent transportation, industry and population centers that derive benefit from the Allegheny River (Figure 1). Within the context of the entire Allegheny River Navigation System, the planning study alternatives are limited to address L/Ds 5, 6, 7, 8, and 9 (Figure 2).

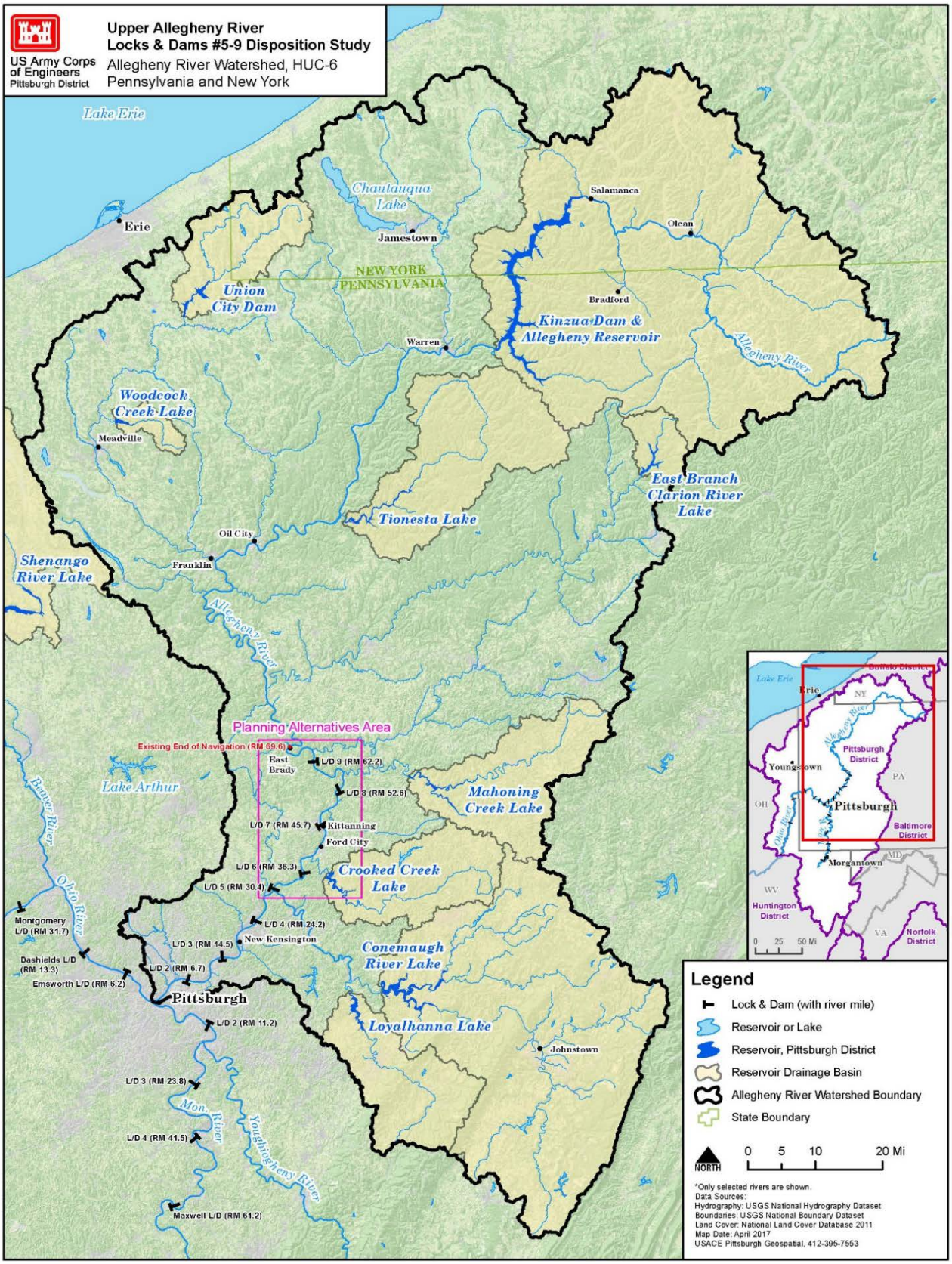


Figure 1. Allegheny River watershed map.

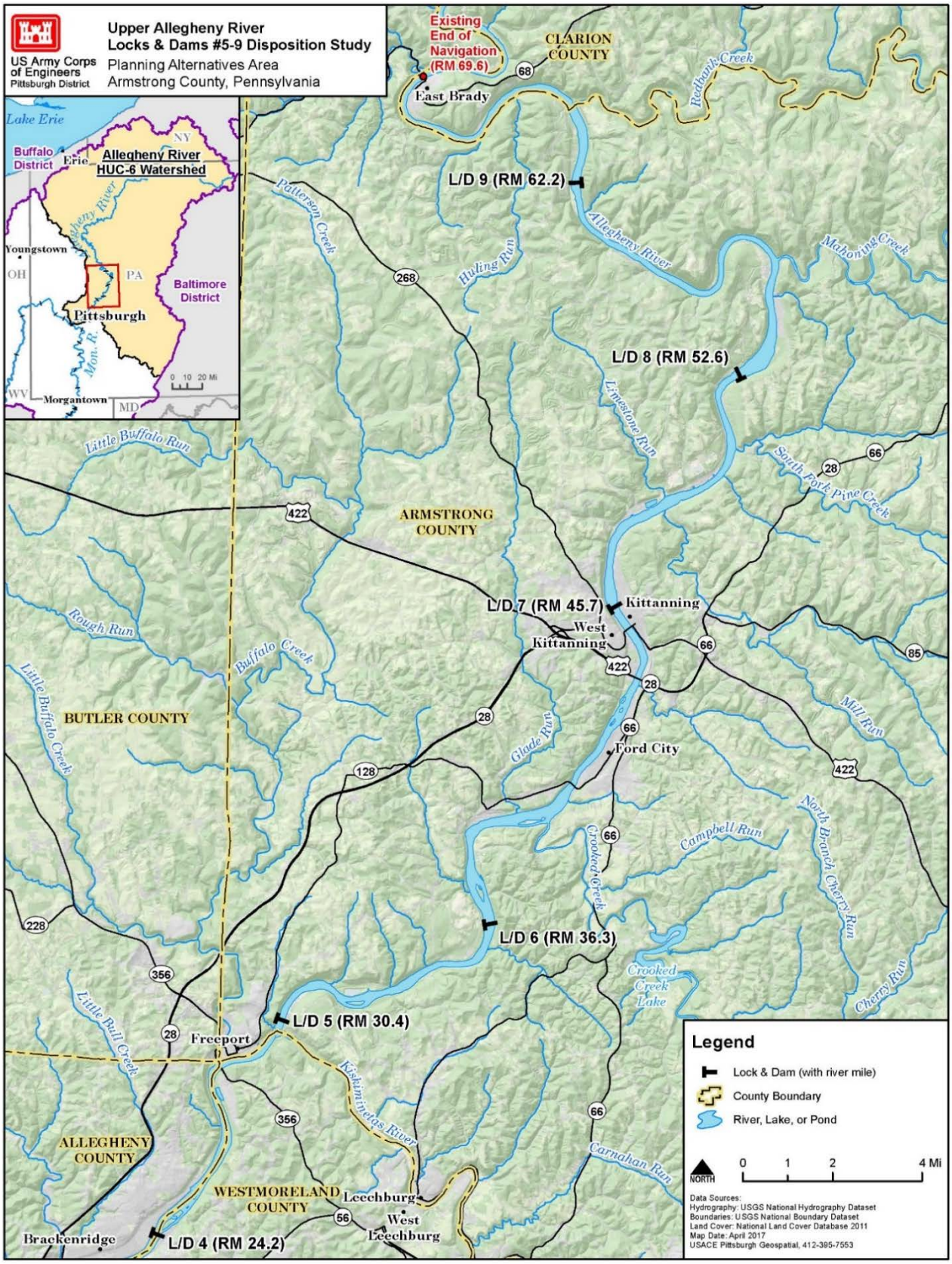


Figure 2. Planning alternative study area map.

2 PROJECT AUTHORIZATION AND HISTORY

2.1 Authorization

Federal interest in Allegheny River navigation dates to the first federal Allegheny River surveys of 1828 and 1835. Both surveys included recommendations for structural improvements to the river to provide 3 ½ feet of depth for navigation. No further federal action occurred until federal surveys were again conducted in 1875, 1878, and 1879. The Rivers and Harbors Act of 1879 authorized construction of the Allegheny River Open Channel Project, a series of wing dams and back channel dams between river miles (RM) 6 and 209 to provide a minimum 3 ½ feet of depth.

The first slackwater navigation structure was authorized in the Rivers and Harbors Act of 1886. The Herr's Island L/D (L/D 1) was constructed at RM 1.7, the head of backwater created by the newly completed Davis Island L/D on the Ohio River. The Rivers and Harbors Act of 1896 authorized L/Ds 2 & 3. These three original structures were completed on the lower 15 miles of the river from 1902 – 1906, and provided six feet of navigable depth.

The L/Ds comprising the present Allegheny River Navigation System were authorized between 1912 and 1935 under four separate public laws. The Rivers and Harbors Act of 1912 (PL 62-241) authorized construction of L/Ds 4-8. The Rivers and Harbors Act of 1930 (PL 71-520) authorized replacement of original L/D Nos. 1-3 and increased the authorized navigation channel depth to 9 feet on the lower 70 miles of the Allegheny River. The Rivers and Harbors Act of 1935 (PL 74-409) provided further authorization for L/D 8 and authorized construction of L/D 9.

The completion of L/D 9 in 1938 and removal of L/D 1 following the raising of the Pittsburgh Pool in the same year finalized what is now the present Allegheny River Navigation System. The sole authorized purpose of the navigation system was and remains commercial navigation.

2.2 System Projects

There are eight L/D facilities (numbered 2 – 9) along the navigable portion of the Allegheny River that provide 72 river miles of navigable water. All eight navigation facilities feature a single lock chamber and a fixed crest dam. Each dam maintains a minimum 9-foot deep pool to accommodate commercial navigation throughout the length of the pool (Figure 3). The navigation pool extends from the City of Pittsburgh to the Township of Brady's Bend in Armstrong County.

The Inland Marine Transportation System (IMTS) guidelines are used nationally to determine the appropriate level of service (LoS) for the inland navigations system based on usage. This system ensures that the Corps evaluates fiscal responsibilities and provides opportunities to prioritize operational funding and resourcing from low usage locks to high usage locks where critical maintenance can be addressed and corrected to help maintain the project and reduce lock outages. IMTS guidelines consist of six LoS based on the average amount of commercial and recreational lockages at each project, see Table 1.

Currently L/D 5 is operated at a LoS 3 “Limited Service – Single Shift” and L/Ds 6-9 are operated at a LoS 6 “Service by Appointment”.

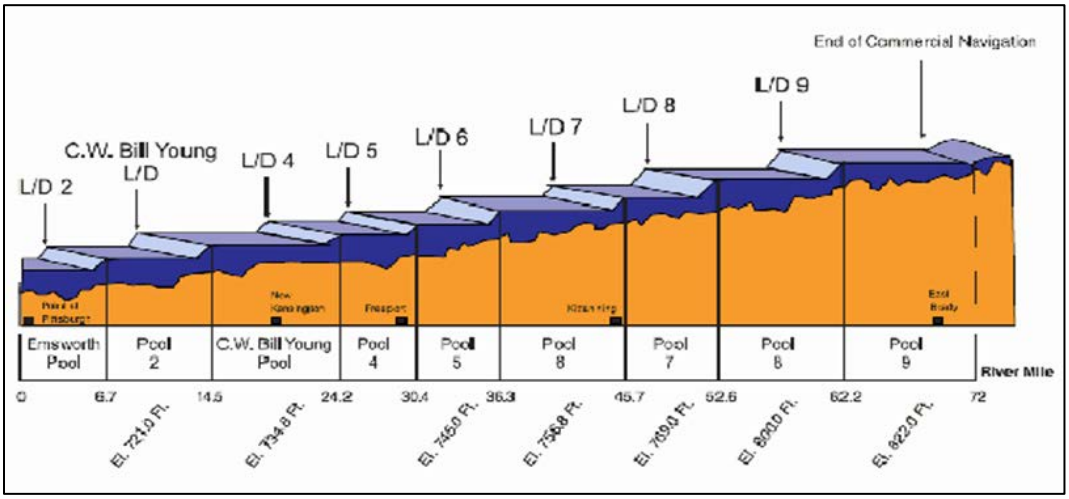


Figure 3. Allegheny River Navigation System Existing Profile

Table 1. IMTS guidelines for LoS

Level #	Title	Guideline for Range of Lock Operation Data
1	Full Service 24/7/365	More than 1,000 commercial lockages per year.
2	Reduced Service-Two Shifts Per Day	Between 500 to 1,000 commercial lockages per year.
3	Limited Service – Single Shift	Less thanb 500 commercial lockages per year or greater than 1,000 recreational lockages per year.
4	Scheduled Service – Set times per day	Limited commercial and/or substantial recreational traffic, more consistent daytime pattern of lockage.
5	Weekends & Holidays	Little to no commercial lockages with significant recreational lockages (500 or more per year).
6	Service by Appointment	Limited commercial traffic with no consistent pattern of lockage.

2.3 Projects Under Consideration

L/D 5 – 9 are similar in design, each having a concrete fixed crest dam and a single concrete lock chamber. Beginning in 1988, some of these facilities were modified to support a Federal Energy Regulatory Commission (FERC)-licensed, non-federal hydropower project (Table 2).

Table 2. Allegheny River L/Ds 5-9, Background Information.

Project Data	L/D 5	L/D 6	L/D 7	L/D 8	L/D 9
Nearest Community	Freeport	Clinton	Kittanning	Templeton	Rimer
Date Placed in Operation	1927	1928	1930	1931	1938

River Mile	30.4	36.3	45.7	52.6	62.2
Lock Length (ft)	360	360	360	360	360
Lock Width (ft)	56	56	56	56	56
Dam Length (ft)	632	992	916	933	918
Dam Lift (ft)	11.6	12.4	13.0	17.8	22.0
Commercial Hydropower	Yes	Yes	No	Yes	Yes
IMTS LoS	3	6	6	6	6

Figure 4. Aerial photographs of Allegheny River L/Ds 5 through 9

3 FEDERAL INTEREST IN DISPOSITION

3.1 Eligibility for Disposition

The Allegheny River Navigation System was authorized solely for the purpose of commercial navigation. Due to the decline in usage of L/Ds 5, 6, 7, 8, and 9 on the system by commercial navigation vessels, only 160 vessels total among all five locks in 2015, there is federal interest in considering deauthorization and disposal of these facilities. Federal investment in O&M of these facilities has declined in recent years as a lower priority has been placed on this system and due to national pressures on O&M funding.

3.2 History of Performance

Industrial activity along the Allegheny River has declined since the mid-20th century. Resource extraction operations, including lumber, coal and oil in the upper portions of the river have declined, or transportation of materials is taking place over land rather than by river. This study looks at traffic through navigation facilities from 1993 to 2015. This 23 year record is considered a suitable time period to show long term trends in river traffic.

Commercial traffic on Allegheny River L/D 5 through 9 during this period peaked in 2003 with 2,574 vessels total. However, the system has seen a significant reduction in traffic across the system over the last two decades (Figure 5): specifically, an 87% reduction in commercial traffic from 1993 to 2015 and a 94% reduction from 2003 to 2015. Commercial traffic through Allegheny Locks 6 to 9 is almost non-existent, and traffic through Lock 5 has dropped substantially since its peak in 2004, although traffic briefly spiked again from 2009 to 2012.

Changes in commercial usage, such as the closure of the Armstrong Power Station, and Glacial Sand and Gravel suspending dredging operations in Pool 8, have driven reductions in commercial vessels at these facilities. Since 1993 there has been a 93% decline in tonnage with a 97% decline since the peak in 2003. Trends in tonnage of commodities moved through the facilities is included in the table below.

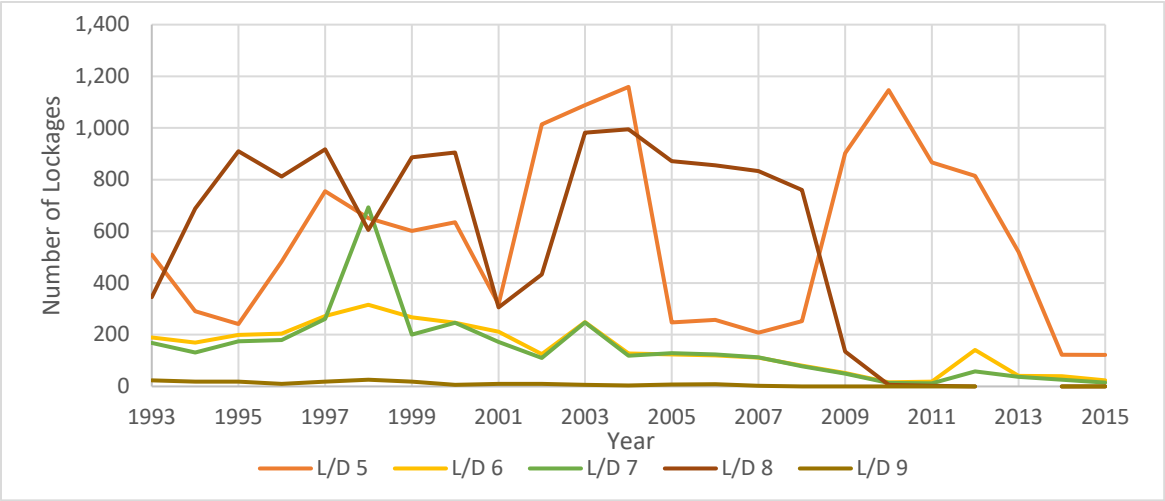


Figure 5. Commercial Vessel Traffic at Allegheny L/D 5-9

Table 3. Tonnage of Commodities Moved through Allegheny L/D 5-9.

Calendar Year	Lock 5	Lock 6	Lock 7	Lock 8	Lock 9	
1993	303,000	124,000	109,000	256,000	0	
1994	204,000	117,000	89,000	516,000	0	
1995	132,000	113,000	98,000	579,000	0	
1996	391,000	135,000	143,000	632,000	0	
1997	728,000	154,000	136,000	711,000	0	
1998	757,000	179,000	471,000	463,000	0	
1999	766,000	161,000	134,000	673,000	0	
2000	692,000	137,052	134,217	702,600	0	
2001	176,323	119,925	104,925	229,000	0	
2002	787,292	65,015	55,565	328,250	0	
2003	910,000	243,000	240,000	797,000	0	
2004	860,000	74,000	64,000	767,000	0	
2005	151,688	82,880	84,580	678,402	0	
2006	129,694	60,492	64,444	623,000	0	
2007	107,680	63,275	63,275	601,711	0	
2008	136,440	52,940	52,720	542,200	0	
2009	606,400	16,950	12,900	82,600	0	
2010	822,425	11,300	9,900	5,000	0	
2011	868,100	11,600	10,800	5,100	0	
2012	697,550	32,110	27,750	0	0	
2013	415,153	23,253	26,300	0	0	
2014	75,330	20,575	13,500	0	0	
2015	45,840	6,570	6,100	0	0	

The cost consequences to commercial navigation of complete project closure are shown in Table 4 and were estimated using data from 2011-2015. These are the additional costs to shippers for using alternative modes of transportation for cargo as calculated by the Shipper Carrier Cost (SCC) model, representing the economic value of commercial navigation benefits over this period of time.

Table 4. Estimated Average Annual Costs to Shipper with Loss of Commercial Navigation

Project	Economic Value
L/D 5	$5,167,000
L/D 6	$230,000
L/D 7	$204,000
L/D 8	$62,000
L/D 9	$0

4 AFFECTED ENVIRONMENT

4.1 Socioeconomic Resources

4.1.1 Recreation

Water-based recreation activities on the Allegheny River include motorized and non-motorized pleasure-boating and fishing. In 2016, 4,675 recreational vessels used L/D 5-9. The recreational usage of the L/Ds has fluctuated significantly since. From 1993 to 2004, the number of recreational vessels that utilized the L/Ds decreased by 52.7%. However, this number increased by 40.8% from 2004 to 2010. Over the past six years, recreational usage decreased by 17%; the lowest number of recreational users was in 2013-2014. These low numbers correspond with the 2012 reduction in service levels to LoS 3, "Limited Service – Single Shift" for L/D 5 and LoS 6, "By Appointment Only" for L/D 6-9. In 2015, the Allegheny River Development Corporation (ARDC) began voluntarily contributing funds to the Corps to ensure the locks were operated for recreational traffic on weekends and holidays from Memorial Day through October using Section 1017 of the Water Resources Reform Development Act (WRRDA) of 2014. The approximate amount of funds contributed annually is $200,000.

Boat registrations within the area have also declined in recent years. The PA Fish and Boat Commission displays trends in boats registered with the Pennsylvania Fish and Boat Commission from 2000-2015 showing an overall decline in registrations of 16% over this period (See Appendix B).

In addition, the following table provides the estimated number of sites that provide boat access (both public and private) by navigation pool upstream of each L/D. The private boat dock numbers were estimated via boat in 2012, with the exception of pool 9 which was estimated based on aerial imagery from September 2012.

Table 5. Boat Access Sites by Allegheny River Pool.

Pool	Ramps, Landings, Harbors	Marinas & Boat Clubs	Private Docks
L/D 5	2	1	118
L/D 6	4	1	49
L/D 7	2	0	104
L/D 8	3	3	113
L/D 9	2	3	125

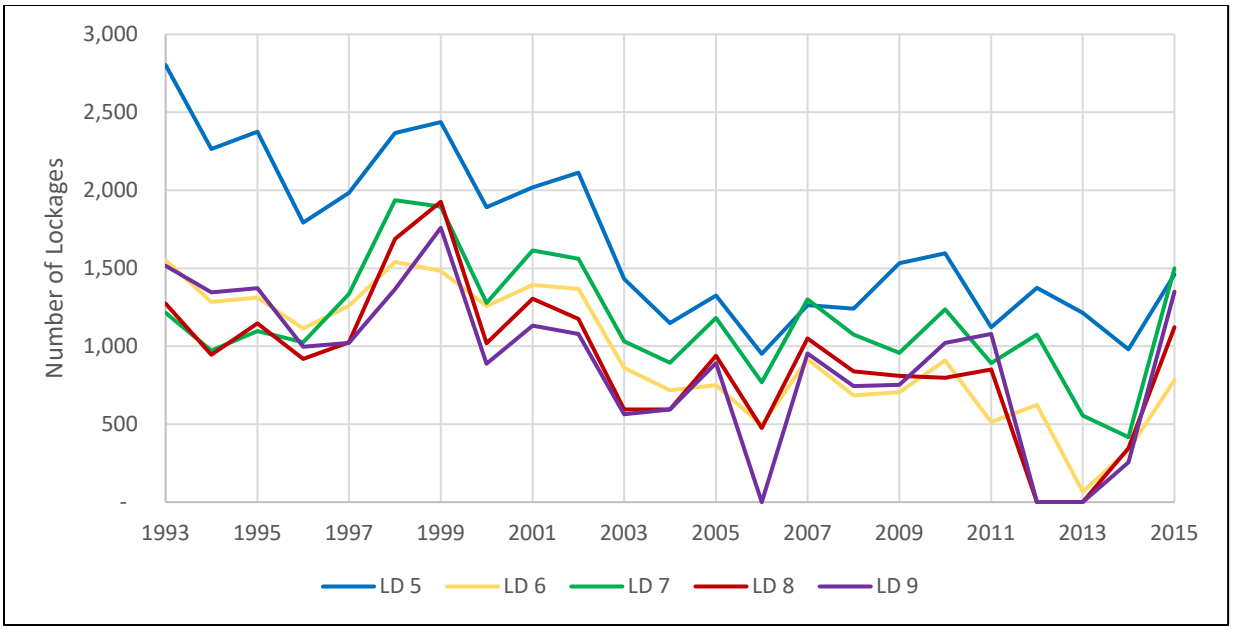


Figure 6. Recreational Vessel Traffic at Allegheny L/D 5-9

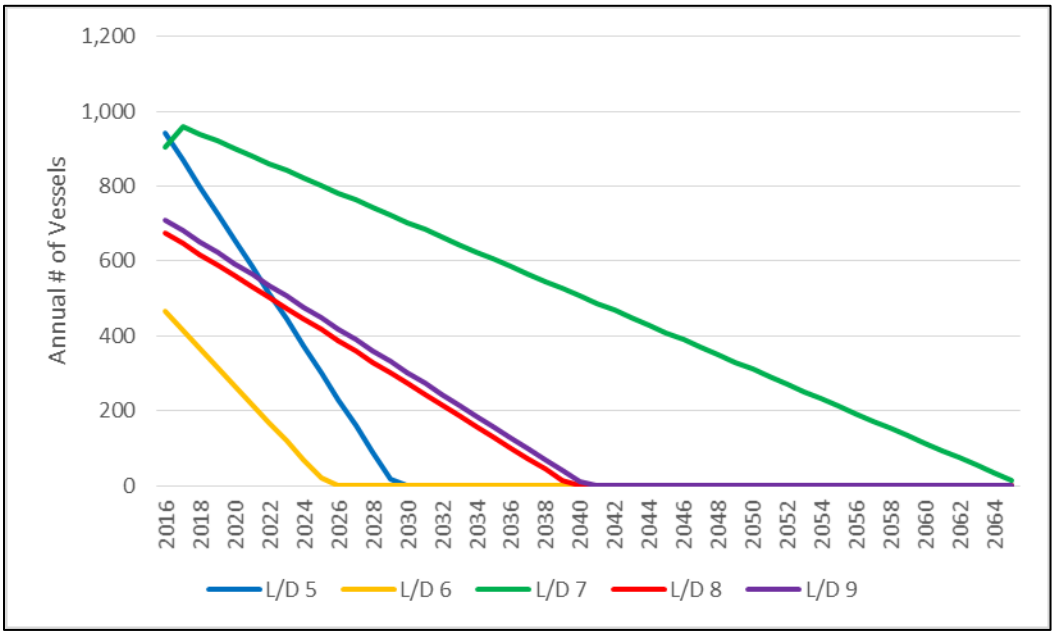


Figure 7. Forecasted Recreational Vessel Traffic at Allegheny L/D 5-9 for 2016 - 2065

Figure 7 is an approximated forecast of recreation trends for the five L/Ds. The forecast is based on Lock Performance Monitoring System annual data from 1993 through 2015. Data from the years 2012 and 2013 were excluded from the forecast due to closures at L/D 8 and 9. L/Ds 5, 6, 8, and 9 all reach zero recreational traffic within the study period. Although L/D 7 does not reach zero annual recreational vessels, if the other four L/Ds are experiencing no recreational traffic, the number of vessels utilizing L/D 7 would decrease more rapidly than displayed in Figure 7. The downward trend for each L/D is severe, but traffic may continue

to decrease if the L/Ds are only open on holidays and weekends through a contributed funds agreement.

Fishing license sales within the area have also declined. Fishing license sales from the Pennsylvania Fish and Boat Commission from 2004-2015 show an overall decline in sales of 19% over this period (See Appendix B).

4.1.2 Hydropower

Four of the five projects within the project area include hydropower facilities with a total installed capacity of 48.5 MW (megawatts) and an average annual generation of 260 million kWh (kilowatt hours). This is enough energy to power approximately 23,800 homes, or 2.6% of the homes in the Pittsburgh Metropolitan Statistical Area. The FERC issues 50-year licenses for installation and operation of hydropower at federal facilities. The licensee is charged a fee for usage of the property and provides free electricity for the operation of the facility. The below table shows a breakdown of energy production at Corps facilities on the Allegheny.

Table 6. Existing Hydropower Facilities.

Corps Project	Licensee	Avg. Annual Generation (Millions)	Installed Capacity	Year Operation Began
L/D 5	All Dams Generation	30 kWh	8.6 MW	1988
L/D 6	Allegheny Energy	35 kWh	9.5 MW	1988
L/D 8	Allegheny Hydro LLC	195 kWh*	13 MW	1990
L/D 9	Allegheny Hydro LLC		17.4 MW	1990
*Generation reports for L/Ds 8 and 9 are submitted jointly on a single license, annual generation shown is the combined total for both facilities.				

Electricity produced at these facilities is sold on the Mid-Atlantic power grid, which has a retail value of 12.3 cents per kWh. The average output has a commercial value of $31,980,000 based on 2016 retail electricity pricing (USEIA 2017b).

4.1.3 Water Intakes

Permits are issued for water intake installation within each pool. The Armstrong Power station, the largest permitted withdrawal in the study area, is currently inactive. Changes to the pool level would most likely impact placement of the existing water intakes, and could pose a threat to year round water supply at commercial facilities in the upper reaches of the Allegheny River. The value of water withdrawals are estimates based on Pennsylvania American Water Company (2017) residential usage rates. Table 7 below shows an approximate amount of water withdrawn and the value of said water based on 2015 data (newest currently available). Table 8 is an approximation of future forecasted withdrawals based on population trends for Armstrong County (based on 50 years of decennial census data) and the 2015 withdrawal data presented in Table 7. Commercial facilities are assumed to continue with the same level of withdrawals, as the only time this is likely to

change is in the event of a closure, of which none are currently scheduled. The municipal withdrawals were decreased to reflect the trend of decreasing population within the county. Each ten-year increment in Table 7 reports an amount of water withdrawn for municipal intakes, a total amount of water withdrawn (municipal and commercial), and a total value for the water withdrawn based on the 2015 value of water.

Table 7. Permitted Water Withdrawals.

Pool	Water Facility	Facility Type	Total Water Withdrawal 2015 (gallons)	Value of Withdrawn Water ($3.37 per 1,000 gallons)
6	PA American Water Co, Kittanning	Public Water Supply	164,597,000	$554,692
7	Kittaning Sub Joint Water Authority	Public Water Supply	206,685,600	$696,530
7	MDS Energy	Oil and Gas	2,262,418	$7,624
7	Penn Energy Resources	Oil and Gas	18,779,800	$63,288
7	Snyder Brothers	Oil and Gas	52,978,148	$178,536
8	PA American Water Co, Butler	Public Water Supply	1,074,987,000	$3,622,706
Total			**1,520,289,966**	**$5,123,376**

Table 8. Future Forecasted Water Withdrawals for all Pools

Year	Pop.	%±	Withdrawal (Municipal)	Withdrawal (Total)	Value
2020	68,065	-1.3%	1,427,895,547	1,501,915,913	$5,061,457
2030	63,424	-2.7%	1,388,876,534	1,462,896,900	$4,929,963
2040	61,432	-2.8%	1,349,857,521	1,423,877,887	$4,798,468
2050	59,441	-2.9%	1,310,838,507	1,384,858,873	$4,666,974
2060	57,449	-3.0%	1,271,819,494	1,345,839,860	$4,535,480
2066	56,454	-1.5%	1,252,309,987	1,326,330,353	$4,469,733
2070	55,458	-3.1%	1,213,889,519	1,287,909,885	$4,340,256

4.1.4 Population Profile (Environmental Justice)

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, instructs federal agencies to make environmental justice part of its mission by identifying and addressing disproportionately high and adverse impacts to minority and low income populations. “Low-income” is defined as the number or percent of a census block group’s population in households where the household income

is less than or equal to twice the federal poverty level. “Minority” is defined as all groups but Non-Hispanic White Alone (EPA 2016b).

Information on demographics was gathered through Environmental Protection Agency’s (EPA’s) EJSCREEN tool and through available census data (Table 9 and Figure 8). The tool provides data on not only minority and low-income populations, but also other vulnerable populations such as children and the elderly. The minority population of Armstrong County is approximately 3% which is low in comparison to the state, the surrounding EPA-region, and the country (19th percentile, 12th percentile, and 7th percentile, respectively). The low-income population of the County is 33%, which is slightly higher than average for the state, the surrounding EPA-region, and the country (61st percentile, 63rd percentile, and 52nd percentile, respectively). As seen in Table 9, the population of Armstrong County is considerably older than other communities in the region and country.

Based on these demographic indicators, it appears that there is a low potential for protected populations to be disproportionately impacted by a loss of pool.

Table 9. Demographic information for Armstrong County (EPA 2016b).

Demographic Indicators	Value	State Avg.	%ile in State	EPA Region Avg.	%ile in EPA Region	USA Avg.	%ile in USA
Demographic Index	18%	26%	46	30%	34	36%	25
Minority Population	3%	21%	19	31%	12	37%	7
Low Income Population	33%	31%	61	29%	63	35%	52
Linguistically Isolated Population	0%	2%	56	2%	55	5%	44
Population With Less Than High School Education	11%	11%	59	12%	56	14%	51
Population Under 5 years of age	5%	6%	48	6%	44	6%	40
Population over 64 years of age	19%	16%	72	15%	76	14%	79

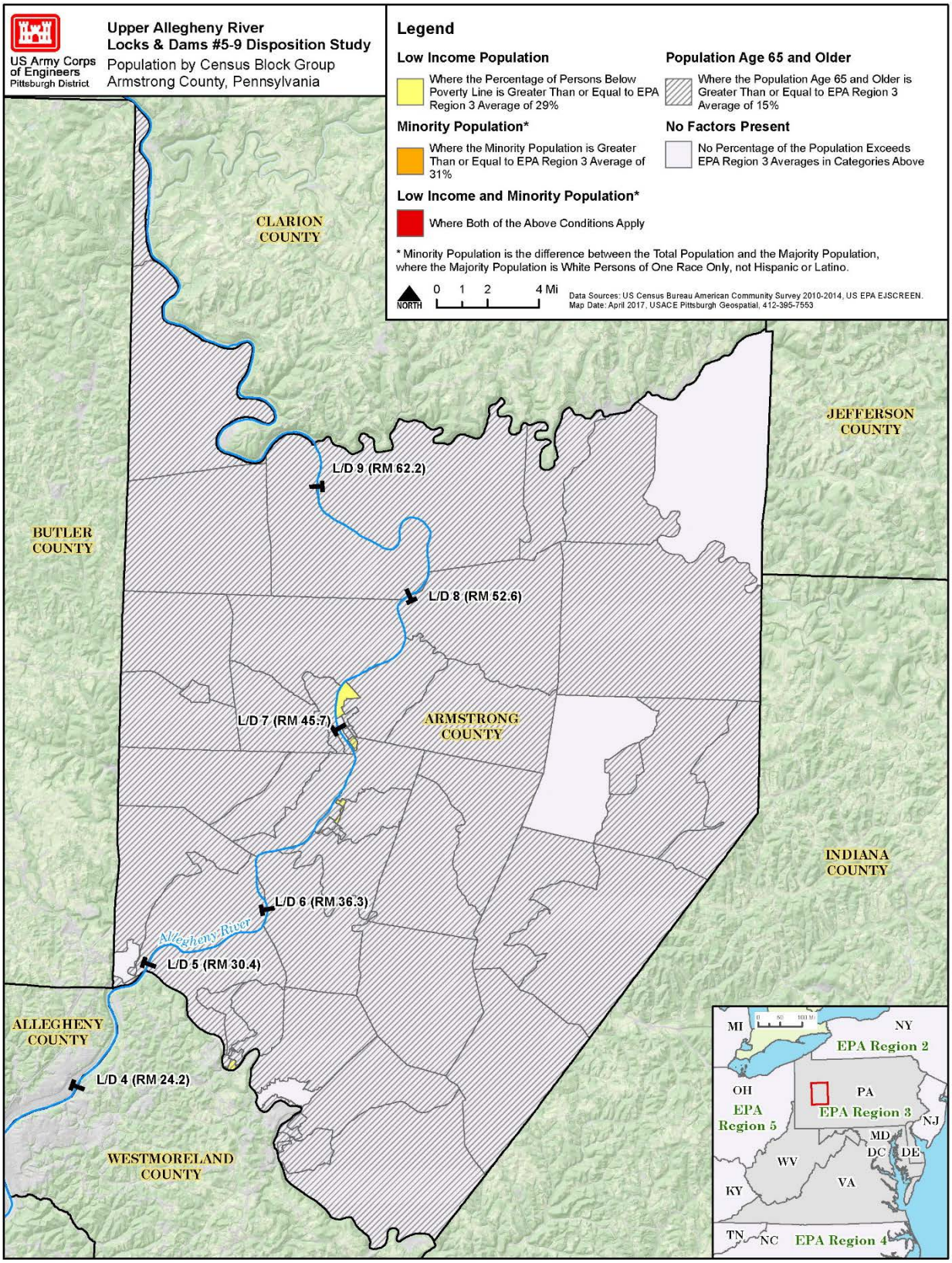


Figure 8. Population information for Armstrong County.

4.2 Environmental Resources

4.2.1 Geography

The Allegheny River originates in Potter County, Pennsylvania, where it flows north into New York and then south back into Pennsylvania. The river length is a total of 325 miles with a drainage basin of approximately 11,747 square miles. In Pittsburgh, the Allegheny River merges with the Monongahela River to form the Ohio River. The river's overall slope from head to mouth is about 5.4 feet per mile. In the L/D 5 to 9 reach (31.8 miles), the average slope based on dam crest elevations is 2.0 feet per mile. L/D 5 to 9 are all located within Armstrong County, PA. The Allegheny River is the major drainage feature in Armstrong County. Significant tributaries to the Allegheny within Armstrong County include Redbank Creek, Mahoning Creek, Crooked Creek, and the Kiskiminetas River.

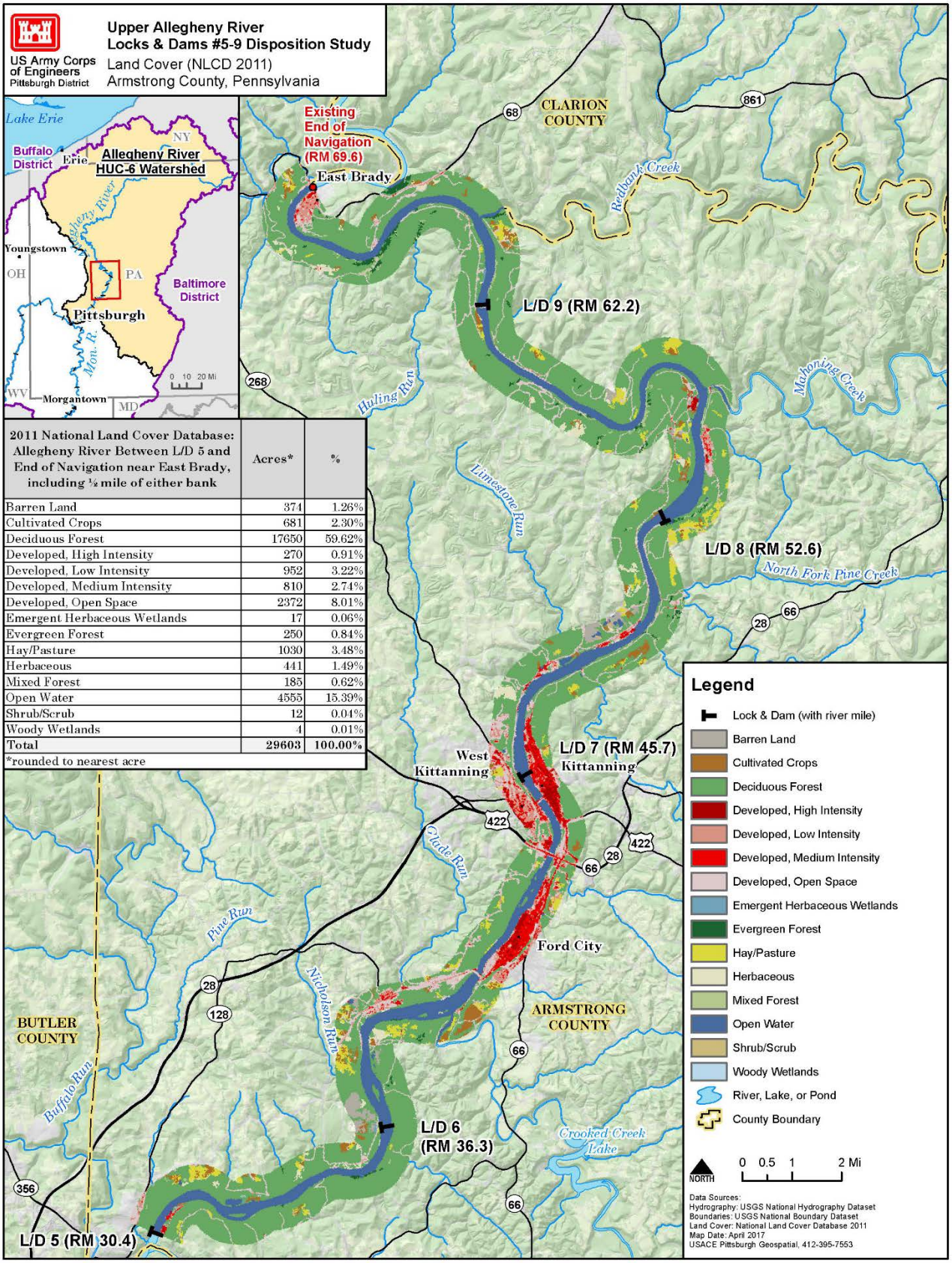
The study area is characterized by smooth to undulating topography with narrow and relatively shallow valleys. The area includes a mix of floodplain forests, industrial development, small towns and cities, agriculture, and major and minor transportation corridors. The area has an early history of timbering and oil extraction, later limestone and coal-mining, and more recently natural gas extraction through hydraulic fracturing. Glacial deposits of sands and gravels in the riverbed have been commercially dredged for decades.

Precipitation is well distributed throughout the seasons, averaging from 35-45 inches, with higher amounts occurring in the mountainous southeastern portion of the watershed. The river floods approximately once a year, typically in the late winter-early spring season though serious flooding has occurred in all seasons of the year. The basin has also experienced periods of drought of various intensity and durations. The most severe and prolonged drought period occurred during the summer and fall of 1930.

Nine Corps reservoirs manage flows in the study area. All nine provide storage for flood reduction, and three (Kinzua, Woodcock and East Branch, Clarion River) also have storage for low-flow augmentation.

The eight L/D facilities along the Allegheny River provide 72 river miles of navigable water. All eight navigation facilities feature a single lock chamber and a fixed crest dam. Each dam maintains a minimum 9-foot deep pool for commercial navigation throughout the length of the pool. The navigation system converted the lower river from a free-flowing riverine environment to a stepped pool structure by inundating riparian and island habitat, along with the natural pool/riffle habitat.

Glacial alluvial gravel and rocks dominate the substrate in the Allegheny River (Freedman et al. 2013a, Freedman et al. 2013b). Commercial gravel dredging has occurred throughout most of the navigation pools (Freedman et al. 2013a, Smith and Meyer 2010). Dredged portions can exceed 65 ft in depth. The deep depressions can have limited water circulation with reduced oxygen levels and finer silts and debris (Smith and Meyer 2010). Commercial dredging ended in 2013, however Smith and Meyer (2010) noted that the existing deep depressions in the river left from gravel mining could take decades or more to recover.



2011 National Land Cover Database: Allegheny River Between L/D 5 and End of Navigation near East Brady, including ½ mile of either bank	Acres*	%
Barren Land	374	1.26%
Cultivated Crops	681	2.30%
Deciduous Forest	17650	59.62%
Developed, High Intensity	270	0.91%
Developed, Low Intensity	952	3.22%
Developed, Medium Intensity	810	2.74%
Developed, Open Space	2372	8.01%
Emergent Herbaceous Wetlands	17	0.06%
Evergreen Forest	250	0.84%
Hay/Pasture	1030	3.48%
Herbaceous	441	1.49%
Mixed Forest	185	0.62%
Open Water	4555	15.39%
Shrub/Scrub	12	0.04%
Woody Wetlands	4	0.01%
Total	29603	100.00%

*rounded to nearest acre

Figure 9. Landcover data for a one-mile corridor surrounding the river in the study area.

4.2.2 Vegetative Cover

Land use in Armstrong County has affected the landscapes and waterways. The most significant impacts have resulted from logging, agriculture, surface and deep mining, residential and industrial development, and transportation. Agriculture continues to be a major land use in the county. Within 0.5 miles of the river on both banks, the predominant land cover is forest (61%). About 6% of this one-mile corridor surrounding the river is crops or pasture lands and approximately 15% is developed (Figure 9).

4.2.2.1 Forest Communities

Due to logging, most of the forest cover in Armstrong County is second and third generation growth. Few large forested areas remain, but the remaining forests provide important water quality and habitat functions for native species of plants and animals. The Pennsylvania Natural Heritage Program (PNHP) notes that steep hillsides and ravines hold the largest contiguous blocks of forest in the county, due to inaccessibility for logging (PNHP 2010). The understory is often dominated by shrubs from the heath family−blueberries, huckleberries (*Vaccinium* spp.), rhododendron (*Rhododendron maximum*), and mountain laurel (*Kalmia latifolia*). These pockets of forested land are fragmented by roads, artificial clearings, and utility rights-of-way. Connectivity between habitat patches and maintenance of natural corridors between forests, wetlands, and waterways is of critical importance for many species. PNHP (2010) notes that maintaining and improving the forested riparian buffer along the Allegheny River is critical to preserving habitat for 25 species of concern that use the waterway.

4.2.2.2 Wetland Communities

Wetland communities occupy a comparatively small portion of the natural landscape, but are of particular value to the county's biodiversity because of the species they support. In Armstrong County, many of the wetlands are associated with floodplain forests along rivers and streams in low-lying areas (PNHP 2010). These locations are periodically inundated by floodwaters resulting from spring runoff and intense storm events. Floodplain forest communities are adapted to receive periodic disturbances such as erosion from floodwaters, scouring by ice and debris, and deposition of considerable quantities of sediment.

4.2.2.3 Grassland Communities

The scour areas along the shoreline of the Allegheny River and its larger tributaries support grassland communities. These grasslands typically occur in linear strips in areas where ice and water are able to provide the necessary disturbance needed to keep these areas dominated by grasses and herbaceous plants. Fluctuations in the water level in the free-flowing reaches of the Allegheny River create cobbly scoured areas along the shoreline. This continual disturbance creates habitat that is primarily suitable for herbaceous plant species. A Pennsylvania species of concern (proposed threatened), the blue false-indigo (*Baptisia australis*) is adapted to these conditions, as it cannot compete once woody species colonize an area. In Armstrong County, these communities are mostly found above

Allegheny River Pool 9. The L/D system does not allow the natural fluctuations in water level necessary for the maintenance of these grasslands (PNHP 2010).

4.2.2.4 Species of Special Concern

One federally-listed plant, the small whorled-pogonia (*Isotria medeoloides*), uses habitat within the vicinity of the study area (PNHP 2017). Many state species of concern also occur in the study area, a full list is provided in the Environmental Appendix (PNHP 2017). Of these, redhead pondweed is known to occur within the Pools 8 and 9 on the Allegheny River (PNHP 2010). This aquatic plant grows rooted in river cobbles, within pools and flowing waters.

4.2.2.5 Invasive Species

Invasive species are those that do not naturally occur in an area and are likely to cause harm to the environment. Invasive plant species of particular concern in the study area include plants such as Japanese honeysuckle (*Lonicera japonica*), oriental bittersweet (*Celastrus orbiculatus*), Japanese knotweed (*Falopia japonica*), giant knotweed (*Falopia sachalinense*), purple loosestrife (*Lythrum salicaria*), and tree of heaven (*Ailanthus altissima*).

4.2.3 Fish and Wildlife

4.2.3.1 Aquatic Species

Anthropogenic changes to the ecological character of the Allegheny River were noticeable by the early 1900s (Ortmann 1909). Placement of navigation features, bank stabilization efforts, and water pollution from a variety of industrial sources degraded the habitat for many species. While fish and mussel populations have rebounded as a result of water quality improvements, there are still a number of contributors that continue to impact the study area.

Common fish species in the Armstrong County reach of the Allegheny River include channel catfish (*Ictalurus punctatus*), sauger (*Sander canadensis*), freshwater drum (*Aplodinotus grunniens*), walleye (*Stizostedion vitreus*), quillback carpsucker (*Carpiodes cyprinus*), smallmouth buffalo (*Ictiobus bubalus*), river redhorse (*Moxostoma carinatum*), mooneye (*Hiodon tergisus*), white crappie (*Pomoxis annularis*), longnose gar (*Lepisosteus osseus*), and brook silverside (*Labisthesthes sicculus*; PNHP 2010).

The Allegheny River is free-flowing for more than 100 miles from the Kinzua Reservoir in Warren County to the navigational pools beginning near East Brady. The L/Ds on the river have restricted movement between the pools and reduced aquatic habitat diversity including the abundance of spawning habitat (sand and gravel bars). Many freshwater mussels have also lost major portions of their habitats due to the pools created by the L/D system. Prior to construction of these dams the lower Allegheny consisted primarily of shallow riffles and runs (Ortmann 1909). The free-flowing sections of the upper and middle Allegheny provide important habitat for aquatic species that require well-oxygenated, fast moving water, including many species of mussels and fish. Nearly 40 species of freshwater mussels were historically known from the Allegheny River (PNHP 2010). Since 1990 only approximately 30 species have been recorded, with 26 species known in Armstrong County

(PNHP 2010). The middle and upper sections of the Allegheny River continue to provide globally important habitat for mussel species, including several federally endangered species (PNHP 2010, Smith and Meyer 2010). Smith and Meyer (2010) found several areas within the existing pools that harbor federally-protected mussels. They also found that mussel diversity within the existing pools was highest in the upper pools, where flows and dissolved oxygen levels mimic free-flowing river conditions.

Several fish consumption advisories exist for the Allegheny River (PFBC 2017). The river from Kinzua Dam to St George (approximately 32 miles upstream of the project area) has an advisory for smallmouth bass and walleye due to PCB contamination, recommending consumption of less than 2 meals per month. Pool 6 (L/D 6 to L/D 7) within the project area has an advisory for carp and pools 5 and 4 (L/D 4 to L/D 6) have an advisory for carp and channel catfish due to PCB contamination, recommending consumption of less than 1 meal per month.

4.2.3.2 Terrestrial Species

Armstrong County is generally characterized by broad and rolling uplands. Much of the county remains forested, but is fragmented by agriculture, mineral extraction, and community development and is transected by moderately steep stream and river valleys. The Allegheny River and its major tributaries in the study area provide increasingly important riparian habitat corridors as upland habitat becomes more developed and fragmented.

Mammal species are largely those typical of western Pennsylvania. Common game species within the study area include white-tailed deer, black bear, eastern cottontail rabbit, grey and red squirrels. Common furbearers include raccoon, opossum, fox, beaver, muskrat, and mink. Bats are a common group of mammals found in the summer months along the stream and river corridors, as well as the forests and the wetlands of Armstrong County (PNHP 2010). During the summer, floodplain forests may provide roost sites for many bat species as they raise their young. During the winter, several large mines in the county provide important habitat for hibernating bats, including rare and endangered species (PNHP 2010).

The formerly extirpated fisher (*Martes pennanti*) and the river otter (*Lontra canadensis*) have recently been re-introduced or translocated by the Pennsylvania Game Commission to portions of their range in Pennsylvania where habitat necessary for their existence still occurs. The coyote is becoming more abundant in all of western Pennsylvania as a species adaptable to human occupation.

The Pennsylvania Society for Ornithology (2017) lists 127 breeding bird species in Armstrong County. In Pennsylvania, 56 percent of all state bird species of concern are wetland obligate species and an even higher percentage of species of concern use wetlands at some point during their life cycle. Armstrong County's wetlands, floodplain forests, and the largest blocks of forested habitat are found along the Allegheny River and its tributary corridors. Certain avian species are dependent upon the presence of large forested blocks, including a variety of owls, hawks, woodpeckers, thrushes, vireos, and warblers. Of these, certain

species also require the added presence of riparian corridors and wetlands, such as the Acadian flycatcher, cerulean warbler, red-shouldered hawk, and Louisiana waterthrush. Wetland dependent species breeding in Armstrong County include alder flycatcher, willow flycatcher, American black duck, bald eagle, belted kingfisher, great blue heron, and green heron. Wetland areas provide breeding and foraging habitat for various raptors such as osprey and bald eagle. The Allegheny River is also an important avian migration corridor.

The Pennsylvania Natural Heritage Program (2010) describes the rich and diverse reptile and amphibian community of Armstrong County as being unique to Pennsylvania. The County is home to many common reptile and amphibian species including eastern hellbender, mudpuppy, numerous salamander and newt species, eastern American toad, Fowler's toad, northern cricket frog, northern cricket frog, gray treefrog, mountain chorus frog, northern spring peeper, bullfrog, northern green frog, pickerel frog, northern leopard frog, wood frog, snapping turtle, painted turtle, spotted turtle, wood turtle, eastern box turtle, eastern spiny softshell, northern fence lizard, five-lined skink, northern black racer, northern ringneck snake, black rat snake, eastern milk snake, northern water snake, queen snake, northern brown snake, eastern garter snake, and northern copperhead.

While these species occur in many different habitats throughout the entire state, there are several less common species of reptiles and amphibians with restricted ranges and specific habitat requirements, primarily ties to the County's remaining forested tracts and numerous waterways and wetlands.

4.2.3.3 Species of Special Concern

A full list of federal- and state-listed species of special concern is provided in the Environmental Appendix. Nine federally-listed mussels, eight listed as endangered and one as threatened, are known to occur in watersheds within the study area (TNC 2017, PNHP 2017, Smith and Meyer 2010). Of these, three endangered mussels are known to use the pools within the project area: clubshell (*Pleurobema clava*), northern riffleshell (*Epioblasma torulosa rangiana*), and rayed bean (*Villosa fabalis*; Smith and Meyer 2010). Two federally-listed reptiles (bog Turtle [*Glyptemys muhlenbergii*], threatened and Eastern Massasauga [*Sistrurus catenatus catenatus*] threatened) and two federally-listed bats (Indiana bat [*Myotis sodalist*], endangered and northern long-eared bat [*Myotis septentrionalis*], threatened) are also known to use habitats in the project vicinity (PNHP 2017). Many state species of concern, including mussels and fish, use the pools in the project area (PNHP 2010, Smith and Meyer 2010).

4.2.3.4 Invasive Species

Invasive species in the study area include rusty crayfish (*Orconectes rusticus*), zebra mussels (*Dreissena polymorpha*) and Asiatic clams (*Corbicula fluminea*).

4.2.4 Water Quality

The Allegheny River has a watershed area of 11,778 square miles. The lower 72 miles of river is navigable by barges, with depths maintained by eight fixed-crest navigation dams. Major tributaries to the study channel include Crooked Creek (292 square mile watershed),

Mahoning Creek (425 square mile watershed) and Redbank Creek (605 square mile watershed). While the Kiskiminetas River is one of the largest basin drainages (1,890 square miles), it has no effect on the study area due to the confluence being located below L/D 5.

Major influences (both beneficial and detrimental) on water quality within the Allegheny River Basin are:

1. Mineral extraction activities (oil and gas and surface, underground, reclaimed, and abandoned coal mines,
2. Impoundments and maintenance of navigation channels,
3. Increased urban development, and
4. Reductions in industrial activity, and coal production.

Pennsylvania has noted several water quality impairments in the study area, including caustic pH, metals, aluminum, iron, manganese, acidity, suspended solids, siltation, turbidity, and nutrients. Nutrient pollution from run-off and point sources, as well as shale gas impacts to water quality have increased within the Allegheny River Basin.

River flows within the study area are largely controlled by Allegheny Reservoir, which is located approximately 133 miles upstream of the study area, near the town of Warren, PA. The Allegheny Reservoir is authorized primarily for flood control, flow augmentation, fish and wildlife, and water quality control. The U.S. Geological Survey (USGS) maintains real-time gaging stations measuring discharge and gage height on the river. The following locations are monitored for discharge: Parker (03031500) above L/D 9, L/D 7 upper pool at Kittanning (03036500), and L/D 4 upper pool at Natrona (03049500). Annual median flows in the upper portion of the study area are approximately 5,810 cubic feet per second (cfs; based on a period of record of 84 years [10-01-1932 to 09-30-2017]) and 8,650 cfs (based on a period of record of 78 years [10-01-1938 to 09-30-2017]) in the lower portion of the study area (calculations based on a complete record of averaged daily discharge). Gage height is monitored above and below each of the L/D within the project site. The USGS location numbers are contained in Table 10.

The Corps monitors water quality conditions above and below each L/D within the study area (Table 10). These locations have been sampled annually since 1973 during the summer low-flow season. Monitoring includes whole water analysis for metals, nutrients, alkalinity, acidity, pH, salts, solids, hardness, color, turbidity, algae, and chlorophyll; random organic and radioisotope analyses; and field parameters such as: Secchi Disk depth, incident light, water temperature, pH, dissolved oxygen, specific conductance, turbidity, chlorophyll, and blue-green algae.

Table 10. USGS station numbers for gage height measurements. Corps station numbers for water quality collection. Located above and below each lock in the study location.

	Upper Pool USGS Station ID	Upper Pool Corps Station ID	Lower Pool USGS Station ID	Lower Pool Corps Station ID
L/D 9	03033000	RMP 1002	03033001	RMP 1201
L/D 8	03036150	MGP 1002	03036151	MGP 1201
L/D 7	03036500	KTP 1002	03036501	KTP 1201
L/D 6	03039035	CWP 1002	03039036	CWP 1201
L/D 5	03039040	FRP 1002	03039041	FRP 1201

Some water quality parameters within the Allegheny River have improved during the past several decades. Corps data shows a decreasing trend in acidity, sulfate, and metal concentrations since 1973. This decreasing trend is a result of reductions in acid mine drainage impacts which can be attributed to improved treatment of mining discharge, mitigation measures such as the release of dilution water from Corps reservoirs, improved mining techniques, and the demise of some of the large industries along the river. It is important to note that while there has been an overall reduction, the legacy of mining on the landscape from abandoned mines is still present. For example, within the Allegheny watershed, mined drainage basins have five times the concentration of sulfate, manganese, and iron as compared to similarly situated unmined drainage basins.

In contrast, nutrient and thermal pollution within the Allegheny River has been increasing over the past several decades. Corps data show an increasing trend in nutrients (total nitrogen and total phosphorus) from 1973 to the present. Also, increases in water temperature significantly above ambient conditions are prevalent and spatially distributed in areas throughout the entire river. The environmental demands of increasing urbanization through combined sewer overflows, municipal waste water effluent, industrial point source discharges, as well as non-point source run-off are driving these observed increasing trends in nutrient. Water temperatures are also elevated because there are many power plants and other industries that discharge heated water.

For the purposes of this study, we compared upper and lower pool water quality constituents to determine impacts caused by each individual L/D. Analytes were averaged over the period of record and decadal scale. All metals and nutrients were log-transformed to improve normality and homoscedasticity. All other parameters were normally distributed and thus did not require transformation. ANOVA and Tukey-Kramer HSD statistical tests for all parameters were used to determine differences above and below each L/D.

Our analysis showed no statistically significant difference between upper and lower pools for any analyte with the exception of dissolved oxygen (DO) (mg/L) ($F_{7, 2839}=20.4667$, $P= <0.0001$), temperature (°C) ($F_{7, 2839}=11.7741$, $P= <0.0001$), and pH (mV) ($F_{7, 924}=7.7758$, $P= <0.0001$). However, for both temperature and pH the significant differences occurred between individual L/D rather than above and below a particular L/D. We attribute differences in temperature and pH to local tributary drainage influences and point source impacts, whose effects can be highly localized to an individual pool.

DO (mg/L) was higher below each lock in the study area, with the exception of L/D 7 (Figure 10). In natural rivers, DO in the water comes from aeration at the water surface. This surface aeration is higher when turbulence is higher and depths are shallower. Within the study area turbulence has been decreased and depth increased by the navigation L/Ds. Due to this, the amount of surface aeration is low. As a result, the aeration of water as it spills over the dams is a critical source for DO replenishment within the navigation channel of the Allegheny River. In contrast, L/D 7 provides little aeration, due to the apron on the downstream side, which keeps water from plunging as far below the surface after cresting the dam as it does at other similar dams within the project area.

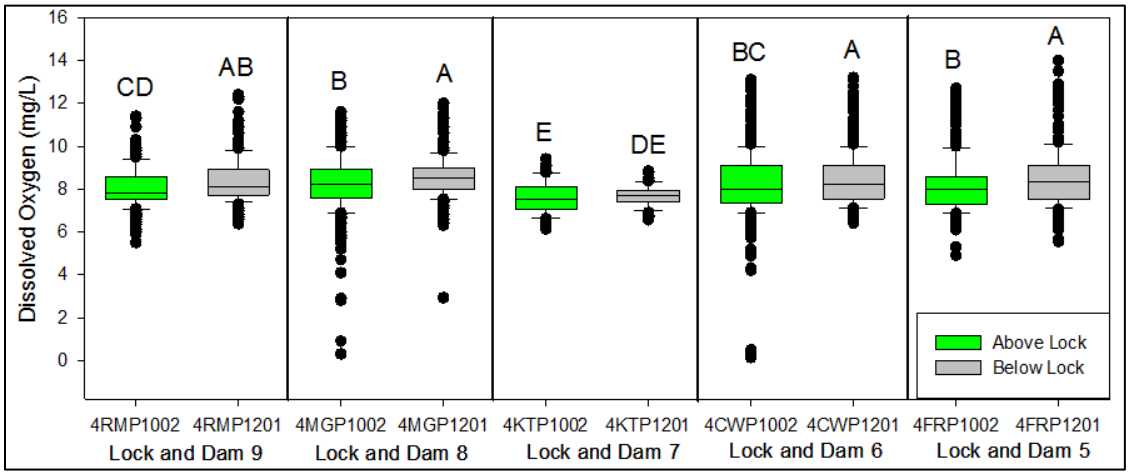


Figure 10. Dissolved Oxygen (mg/L) above and below the L/Ds.
Letters above each boxplot are the results of ANOVA and Tukey-Kramer HSD analysis. Statistically significant difference is indicated by different letters. The same letter indicates no difference with similar values.

In addition, Corps data show decreasing DO concentrations (vertical stratification) through the water column to depth, during summer low flow conditions for some pools within the study area (Figure 11). Pool DO vertical stratification is highly localized and depends upon surrounding local urbanization. Discharges from major point and nonpoint sources in the pool cause increased biochemical oxygen demand, organic and nitrogenous compounds that biodegrade rapidly, resulting in reduced DO concentrations.

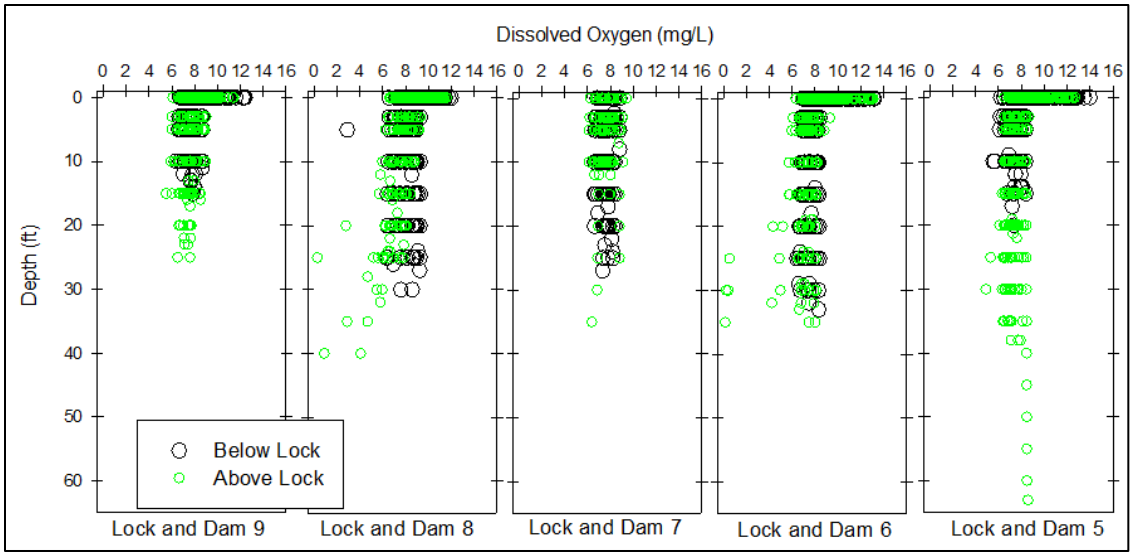


Figure 11. Dissolved Oxygen (mg/L) depth profiles above and below the L/Ds. L/D 8 and 6 pools show summer time low flow vertical stratification.

4.2.5 Air Quality/Greenhouse Gases/Climate Change

The Clean Air Act, as amended in 1990, requires the U.S. Environmental Protection Agency (USEPA) to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. NAAQS have been set for six principal pollutants, known as criteria pollutants: nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone, lead, carbon monoxide (CO), particulate matter less than 2.5 microns in diameter (PM2.5), and particulate matter less than 10 microns in diameter (PM10). These standards are based on concentrations averaged over various time periods. Standards for pollutants with acute health effects are based on relatively short-term periods (1-hour, 3-hour, 8-hour, or 24-hour), while additional standards are based on relatively long time periods to gauge chronic effects (annual and quarterly). Individual states are responsible for regulating pollution sources.

The USEPA evaluates NAAQS compliance. Attainment areas have concentrations of criteria pollutants below NAAQS, and non-attainment areas have concentrations above NAAQS. Maintenance areas are attainment areas that had a history of nonattainment but have since been reclassified as attainment.

Armstrong County is a nonattainment area for Sulfur Dioxide and 8-Hr Ozone (EPA 2017a). A portion of the County within the study area is also a maintenance area for PM2.5. The Air Quality Index for the County in 2016 (preliminary data; EPA 2017b) showed 5 days of the year as rated unhealthy for sensitive groups, 70 days of moderate quality, and 220 days as good quality.

Greenhouse gases (GHGs), as defined in Executive Order 13514 (*Federal Leadership in Environmental, Energy, and Economic Performance*), include carbon dioxide (CO_2), methane, nitrous oxide (N_2O), hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. These gases effectively trap heat in the lower atmosphere and are thought to contribute to global

climate change. Each has a different global warming potential. To compare emissions, they are often converted to CO_2-equivalents. For example, releasing 1 kg of methane is considered the equivalent of 25 kg of CO_2, and 1 kg of nitrous oxide is equivalent to 298 kg of CO_2 (Climate Change Connection 2017). In 2016, the Council on Environmental Quality (CEQ) issued final guidance on inclusion of greenhouse gas emissions in NEPA documents, recommending that agencies quantify direct and indirect GHG emissions.

The Northeast has experienced a general temperature increase of almost 2°F and an increase of 5 inches of annual precipitation since 1895 (Melillo et al. 2014). With continued global emissions, projections show continued warming (3 to 10°F by the 2080s; Melillo et al. 2014). Precipitation changes are less certain, ranging from 5 to 20% increase in winter precipitation by the end of the century with only small summer and fall changes. Frequency of heavy downpours and the risk of seasonal drought are both also predicted to increase (Melillo et al. 2014).

4.2.6 Hazardous, Toxic, and Radioactive Waste

Hazardous, Toxic and Radioactive Waste (HTRW) substances may be present within the study area, such as contaminated sediment from historic hazardous material releases or spills and/or the potential introduction of existing hazardous materials that could impact sediment, soil, and air or water quality, if released.

In waterways with an industrial, agricultural, or urban history, there is a potential for contaminants to be present in accumulated sediment (Bountry et al. 2009). The Allegheny River has historically had and continues to have some industries along its shoreline, including mining and manufacturing facilities. Discharge or spill releases and/or runoff from these facilities may have potentially impacted sediment and water quality in the Allegheny River. In addition to industries along the waterfront, runoff from historical or present agricultural areas could also contribute to contamination of sediments, including introduction of pesticides (Evans 2015).

With the enactment of several environmental regulations, conditions in the Allegheny River have steadily improved since the 1970s. However, many contaminants that may have been introduced decades ago can persist due to very slow or non-existent degradation in an aquatic environment (EPA 2005).

Studies in the area for other purposes have touched on sediment quality issues, and indicate a potential for contamination. Sediment quality data for the Allegheny River was summarized in an Environmental Impact Statement (EIS) by the Corps in 2006 in conjunction with granting and extending permits for proposed commercial dredging operations in the Allegheny River from L/D 2 through 9. A report provided to the Pennsylvania Department of Conservation and Natural Resources (PADCNR) in 2005 provides sediment quality information upstream of L/D 5. Results of these cursory studies indicate that lead, zinc, copper, polychlorinated biphenyl (PCB) and polycyclic aromatic hydrocarbons (PAHs) were detected in sediment from Pool 5 samples collected in 1998. However, the values were below published state toxicity threshold levels and therefore indicated little or no toxicity. Sampling for this study was limited and data is now close to

20 years old and should therefore be viewed only as a cursory assessment of what contaminants may be present within the study area. Current bottom-dwelling fish consumption advisories as discussed in Section 4.2.3 also indicate some level of PCB contamination in sediment within Pools 4 through 6 (L/D 4 though L/D 7).

The Corps and PADCNR studies indicate that sediment contaminants, if present, could be resuspended in the water column if sediment is disturbed. However, for much of the upper Allegheny River (Pool 5 and upstream), the likelihood of contaminated sediments appears unlikely due to fewer potential sources (PADCNR 2005). The studies also indicate that in general, sediment contamination is considered to be a relatively minor issue; sediment is primarily sand, gravel and cobble and does not readily absorb or concentrate contaminants.

Contaminant testing for sediment removed during routine Corps maintenance dredging operations along the Allegheny River near L/D 5 through 9 was not conducted, but sediment testing is not always required. The Corps elected to treat material dredged from these locations as regulated fill under state regulations and disposed of it in a suitable facility.

Previous sediment quality sampling and studies conducted downstream of the study area along the Allegheny River indicate greater potential for contamination. Results indicate elevated PCBs and chlordane downstream in Pool 2 (L/D 2 to L/D 3) and elevated dichlorodiphenyltrichlorethane (DDT), chlordane, dieldrin, dichlorodiphenyldichloroethane (DDD) and PCBs in some sediment samples at L/D 3 near New Kensington. Slight contamination at threshold toxicity levels for lead, zinc, copper, DDT and PAHs in Pool 3 (L/D 3 to L/D 4) were also noted in a limited USGS sampling program in 1996 (Corps EIS, 2006). Due to the location downstream of the study area, this data indicates general trends for the Allegheny River and the type of contaminants that may be present, but not necessarily representative of the study area. In general, data collected downstream of the study area is indicative of a more industrial region along the Allegheny River between L/Ds 2 and 4 and unlikely to represent conditions upstream (L/Ds 5 through 9) where fewer potential contamination sources are present.

Corps routine maintenance dredging activities are expected downstream of the study area at L/D 3 in 2017. Sediment collected will be tested for possible contamination in accordance with applicable policies and regulations. Sediment samples at this location will also be analyzed for metals, organics, and other contaminants to document long term pollution trends.

Project operations at L/D 5 through 9 includes storage or use of some hazardous materials and petroleum products. Minor amounts (one gallon or less) of chemical solvents, oil, grease and paint are stored at each of L/Ds facilities. In addition, five 55-gallon drums of hydraulic oil are stored at each of the L/D properties and one 55-gallon drum of industrial cleaner is stored at L/D 6. Herbicides are applied to each of the five the properties once per year.

Several above-ground fuel storage tanks (ASTs) are on located at each project. The ASTs store diesel or gasoline (ranging from 250 to 1,500 gallons). All five locations also have onsite septic systems. L/D 6 through 9 also contain 400 gallon and 1,000 gallon capacity

reservoirs for hydraulic fluid. These reservoirs are occasionally located below water during high water events and leaks from the pipes or reservoirs into the Allegheny River (ranging from approximately 150 to 250 gallons) have occurred at each of the facilities (Interview D. Basile, 2017).

All five of the subject L/D facilities were constructed in the 1920s and 1930s. As such, asbestos and creosote and/or lead (primarily in lead-based paint or pipes), may be present in some of the buildings and/or infrastructure on the property.

L/D 5, 6, 8, and 9 also have hydropower facilities and likely include storage of petroleum-based oils or other hazardous substances used for operation of the turbine units and transformers. The hydropower facilities also likely have stored fuel for generators.

4.3 Cultural Resources and Historic Properties

Prehistoric occupation of the Ohio River Basin is generally divided into four temporal periods: (1) the Paleoindian period (prior to 8,000 B.C.); (2) the Archaic period (8,000-1,000 B.C.); (3) the Woodland period (1,000-1,600 A.D.); and (4) the Protohistoric period (1,600-contact). The Paleoindian period is characterized by highly mobile bands of hunter-gatherers traversing the landscape in search of food and high- quality stone tool material. Archaeological sites from this period are generally rare because of their age and ephemeral nature.

The Archaic and Woodland periods are characterized by a change in subsistence strategy as people began relying on smaller game and increased their reliance on plant materials. Although the Archaic period is not well understood in this region, archaeological sites dating to this period have been found in the Ohio River Basin. Woodland peoples used uplands and smaller streams more frequently than their Archaic ancestors, and their habitation sites, commonly located along floodplains, tended to be more permanent. By the end of the Woodland period, people were predominantly relying on agriculture supplemented by hunting and gathering. Changes in burial patterns, the construction of mounds, and material culture suggest changes in ceremonialism and social complexity during this period.

Little is known about the Protohistoric period (seventeenth century) in southwestern Pennsylvania. Archaeological evidence indicates that much of the area was abandoned during this time, possibly due to wars to monopolize the new fur and European goods trade, or due to impacts of diseases introduced by Europeans.

The French and British began to settle along the rivers west of the Allegheny Mountains around 1730. This settlement led to increased tension among the British, French, and Native Americans as they sought control over land and economic opportunities. The tensions in the Ohio River area and northeastern North America in general led to the French and Indian War in the 1750s. The Ohio River and its tributaries were again a pivotal battle location during the Revolutionary War as the Americans held this position and used it to launch an offensive against the British and their Native American allies for control of the western extent of the Ohio River.

After the Revolutionary War, settlement increased in western Pennsylvania. The Allegheny, Ohio, and Monongahela Rivers were integral to transporting resources throughout the area. Although the rivers initially moved settlers, agricultural crops, livestock, and other commercial products, coal became the predominant commodity moved after the 1840s. Railroads were constructed along these rivers after the mid-nineteenth century, but the rivers continued to be important for regional transportation.

Early river navigation was significantly impeded by natural features, e.g. low flows, snags and sandbars, and by early mill dams. Pennsylvania government had an interest in improving navigation. In the late 1830s, the private Monongahela Navigation Company received a state-charter to improve the Monongahela in Pennsylvania with a L/D system. The success of these facilities led to further authorizations for the first three L/Ds on the lower Allegheny River. The abundance of regional coal led to intense river-based iron and steel manufacturing facilities that made Pittsburgh nationally important as the "Steel City" and the "Arsenal of the Allies."

The L/D of the Allegheny River Navigation System are historic properties listed on the National Register of Historic Places. The Corps nominated these properties to the National Park Service in 2000 for their contribution to the history of navigation and transportation in the Ohio Valley, and for their engineering significance. Any actions that would have an adverse effect on these facilities, or remove them from federal ownership, will require compliance with Section 106 of the National Historic Preservation Act.

4.4 Future Without Project Condition

4.4.1 Commercial Navigation

Traffic through L/Ds 5 to 9 on the upper Allegheny River has been declining in recent years. The decrease in overall traffic can be attributed to a combination of factors; a prohibition of dredging for aggregates in the Allegheny River, closure of remaining commercial terminals and river dependent industry, and a lack of new investment in river dependent industry over the last 30 years. There has been no indication that the lack of commercial investment will change in the near term. Future traffic demand and potential traffic, given no lock constraints, reflect this situation. In developing traffic forecasts for these projects the district economist reached out to the Planning Center of Expertise for Inland Navigation for guidance on the forecasting methodology. As a new methodology was still in development at the time, it was decided that the district would develop forecasts with PCXIN oversight. High-, mid- and low-range estimates were developed for each project based on the methodology below and based on the assumptions that lost traffic would not be returning in the future and no major future investments are planned.

4.4.1.1 Mid-Range Forecast

The mid-range forecasts were calculated using the averages of the high and low forecasts, resulting in all projects becoming constant in the year the low forecast reaches zero, 2021 for L/D 5, 2017 for L/D 6 and 7). This results in L/D 5 traffic going up slightly from 2015 to eventually remaining at around the same tonnage level as 2015. For L/D 6 and 7 traffic

decreases slightly and remains at that level. Commercial traffic at L/D 8 and 9 is already at zero so it shows no anticipated traffic for any level of forecast.

4.4.1.2 Low-Range Forecast

The low range forecasts were calculated using the trend of historical traffic from 2006 to 2015 for all projects with the exception of L/D 5, which is more unique than the others due to the higher traffic levels falling in the middle of this time period. For L/D 5, the traffic is reduced by 39.1% of the 2015 tonnage (17,923.44) for each year until it reaches zero. This is the same percentage that traffic dropped from 2014 to 2015. For the remaining projects, L/D 6, L/D 7, L/D 8, and L/D 9 the tonnage values for 2006-2015 are used with the "trend" function in Excel to produce expected traffic tonnage throughout the study period. These forecasts result in each of the three projects with traffic in recent years reaching zero tons locked through in the next three years (L/D 5 in 2018, L/D 6 in 2017, and L/D 7 in 2016).

4.4.1.3 High-Range Forecast

The high range forecasts were calculated using the average of the previous three years' worth of tonnage through the projects (2013, 2014, and 2015) divided in half. The three-year-average itself does not accurately represent the downward trend in traffic, so half of this average shows a slight increase in traffic over 2015 for L/D 6 and L/D 7 and an increase in traffic over 2014 and 2015 for L/D 5. These values are held constant across all future years assuming industry demands will remain constant at this level.

4.4.1.4 Tables and Graphics

The historical traffic is presented below from 1980 to 2015 to show that tonnage through the upper Allegheny locks has fluctuated greatly over the last 35 years, with L/D 5 reaching nearly 1.4 million tons.

Table 11. Allegheny River – Historical Tonnage

Year	L/D 5	L/D 6	L/D 7	L/D 8	L/D 9
1980	1,390,000	50,000	40,000	-	-
1981	990,000	620,000	10,000	130,000	-
1982	900,000	740,000	50,000	490,000	0
1983	740,000	720,000	50,000	-	-
1984	830,000	690,000	110,000	470,000	-
1985	1,050,000	970,000	60,000	590,000	-
1986	650,000	100,000	110,000	420,000	-
1987	600,000	160,000	150,000	0	-
1988	510,000	210,000	210,000	440,000	-
1989	240,000	210,000	170,000	570,000	20,000
1990	134,000	92,000	76,000	517,000	30,000
1991	178,000	131,000	114,000	534,000	0
1992	314,000	176,000	171,000	18,000	0
1993	303,000	124,000	109,000	256,000	0

1994	204,000	117,000	89,000	516,000	0
1995	132,000	113,000	98,000	579,000	0
1996	391,000	135,000	143,000	632,000	0
1997	728,000	154,000	136,000	711,000	0
1998	757,000	179,000	471,000	463,000	0
1999	766,000	161,000	134,000	673,000	0
2000	692,000	137,052	134,217	702,600	0
2001	176,323	119,925	104,925	229,000	0
2002	787,292	65,015	55,565	328,250	0
2003	910,000	243,000	240,000	797,000	0
2004	860,000	74,000	64,000	767,000	0
2005	151,688	82,880	84,580	678,402	0
2006	129,694	60,492	64,444	623,000	0
2007	107,680	63,275	63,275	601,711	0
2008	136,440	52,940	52,720	542,200	0
2009	606,400	16,950	12,900	82,600	0
2010	822,425	11,300	9,900	5,000	0
2011	868,100	11,600	10,800	5,100	0
2012	697,550	32,110	27,750	0	0
2013	415,153	23,253	26,300	0	0
2014	75,330	20,575	13,500	0	0
2015	303,000	124,000	109,000	256,000	0

Since 2010, traffic has gone down significantly with 2015 experiencing the lowest historical tonnages for all five projects. Table 12, Table 13, and Table 14 below display the forecasts for each scenario (low, middle, and high, respectively) from 2016 to 2021, the year in which all projects at all forecast levels have hit a constant expected tonnage, and then shows 10 year increments through 2065. Table 12, Table 13, and Table 14 also show the value of the commodities that pass through each of the projects in the forecasted years for those same scenarios (low, middle, and high). The initial values used were developed in 2010 and indexed up to October 2016 price level using the consumer price index. The 2010 values were calculated at the commodity level, so each forecasted year is assumed to use the same percentage of commodities that the 2015 total was comprised of. The individual commodity values were then summed to provide the total value of commodities processed through each lock in 2016 dollars.

Table 12. Allegheny River Low Forecasted Tonnage and Commodity Values

	Tonnage					Value of Commodities				
Year	L/D 5	L/D 6	L/D 7	L/D 8	L/D 9	L/D 5	L/D 6	L/D 7	L/D 8	L/D 9
2016	27,917	345	0	0	0	$6,057,219	$81,064	0	0	0
2017	9,993	0	0	0	0	$2,168,265	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0
2025	0	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0	0
2045	0	0	0	0	0	0	0	0	0	0
2055	0	0	0	0	0	0	0	0	0	0
2065	0	0	0	0	0	0	0	0	0	0

Table 13. Allegheny River Middle Forecasted Tonnage and Commodity Values

	Tonnage					Value of Commodities				
Year	L/D 5	L/D 6	L/D 7	L/D 8	L/D 9	L/D 5	L/D 6	L/D 7	L/D 8	L/D 9
2016	63,455	4,372	3,825	0	0	$13,768,147	$1,028,121	$903,391	0	0
2017	59,296	4,200	3,825	0	0	$12,865,780	$987,589	$903,391	0	0
2018	55,137	4,200	3,825	0	0	$11,963,414	$987,589	$903,391	0	0
2019	50,978	4,200	3,825	0	0	$11,061,047	$987,589	$903,391	0	0
2020	46,819	4,200	3,825	0	0	$10,158,681	$987,589	$903,391	0	0
2021	44,694	4,200	3,825	0	0	$9,697,427	$987,589	$903,391	0	0
2025	44,694	4,200	3,825	0	0	$9,697,427	$987,589	$903,391	0	0
2030	44,694	4,200	3,825	0	0	$9,697,427	$987,589	$903,391	0	0
2035	44,694	4,200	3,825	0	0	$9,697,427	$987,589	$903,391	0	0
2040	44,694	4,200	3,825	0	0	$9,697,427	$987,589	$903,391	0	0
2045	44,694	4,200	3,825	0	0	$9,697,427	$987,589	$903,391	0	0
2050	44,694	4,200	3,825	0	0	$9,697,427	$987,589	$903,391	0	0
2055	44,694	4,200	3,825	0	0	$9,697,427	$987,589	$903,391	0	0
2060	44,694	4,200	3,825	0	0	$9,697,427	$987,589	$903,391	0	0
2065	44,694	4,200	3,825	0	0	$9,697,427	$987,589	$903,391	0	0

Table 14. Allegheny River High Forecasted Tonnage and Commodity Values

	Tonnage					Value of Commodities				
Year	L/D 5	L/D 6	L/D 7	L/D 8	L/D 9	L/D 5	L/D 6	L/D 7	L/D 8	L/D 9
2016	89,387	8,400	7,650	0	0	$19,394,854	$1,975,179	$1,806,782	0	0
2017	89,387	8,400	7,650	0	0	$19,394,854	$1,975,179	$1,806,782	0	0
2018	89,387	8,400	7,650	0	0	$19,394,854	$1,975,179	$1,806,782	0	0
2019	89,387	8,400	7,650	0	0	$19,394,854	$1,975,179	$1,806,782	0	0
2020	89,387	8,400	7,650	0	0	$19,394,854	$1,975,179	$1,806,782	0	0
2021	89,387	8,400	7,650	0	0	$19,394,854	$1,975,179	$1,806,782	0	0
2025	89,387	8,400	7,650	0	0	$19,394,854	$1,975,179	$1,806,782	0	0
2030	89,387	8,400	7,650	0	0	$19,394,854	$1,975,179	$1,806,782	0	0
2035	89,387	8,400	7,650	0	0	$19,394,854	$1,975,179	$1,806,782	0	0
2040	89,387	8,400	7,650	0	0	$19,394,854	$1,975,179	$1,806,782	0	0
2045	89,387	8,400	7,650	0	0	$19,394,854	$1,975,179	$1,806,782	0	0
2050	89,387	8,400	7,650	0	0	$19,394,854	$1,975,179	$1,806,782	0	0
2055	89,387	8,400	7,650	0	0	$19,394,854	$1,975,179	$1,806,782	0	0
2060	89,387	8,400	7,650	0	0	$19,394,854	$1,975,179	$1,806,782	0	0

The figures below show 9 years of historical traffic (2006 through 2015) and 50 years of forecasted traffic (2016 through 2065) at the high, middle, and low levels graphed together for L/Ds 5 (Figure 12), 6 (Figure 13), and 7 (Figure 14).

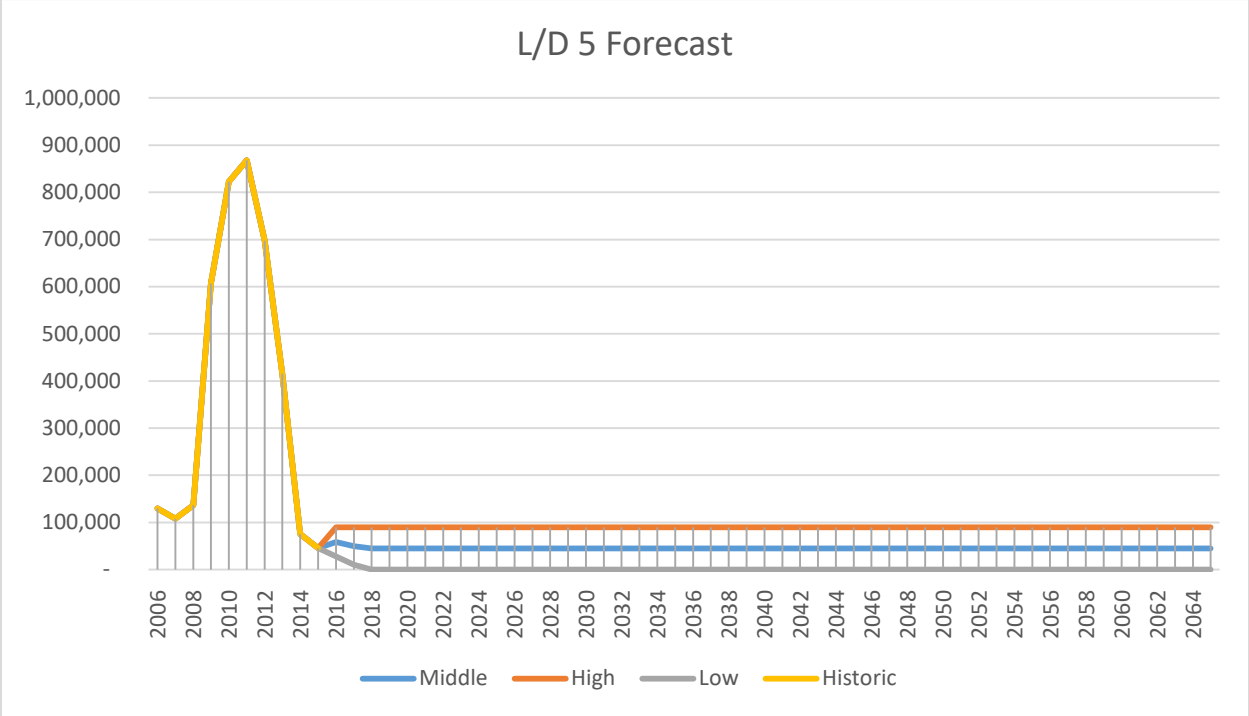


Figure 12. L/D 5 Forecast

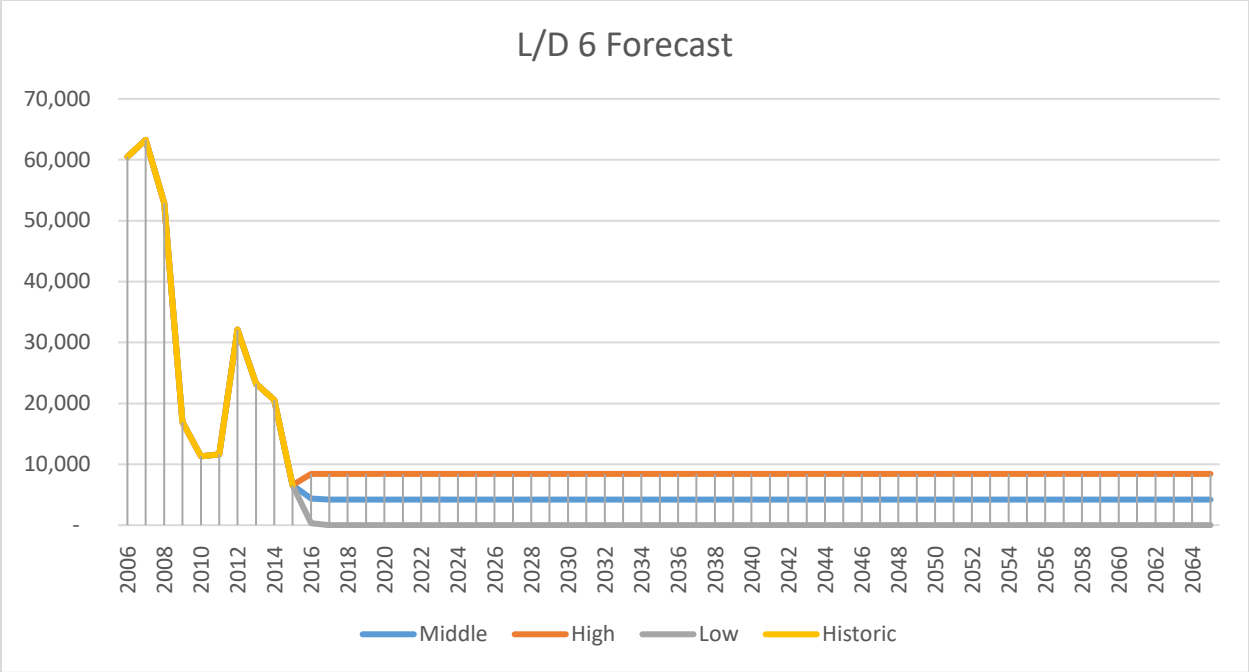


Figure 13. L/D 6 Forecast

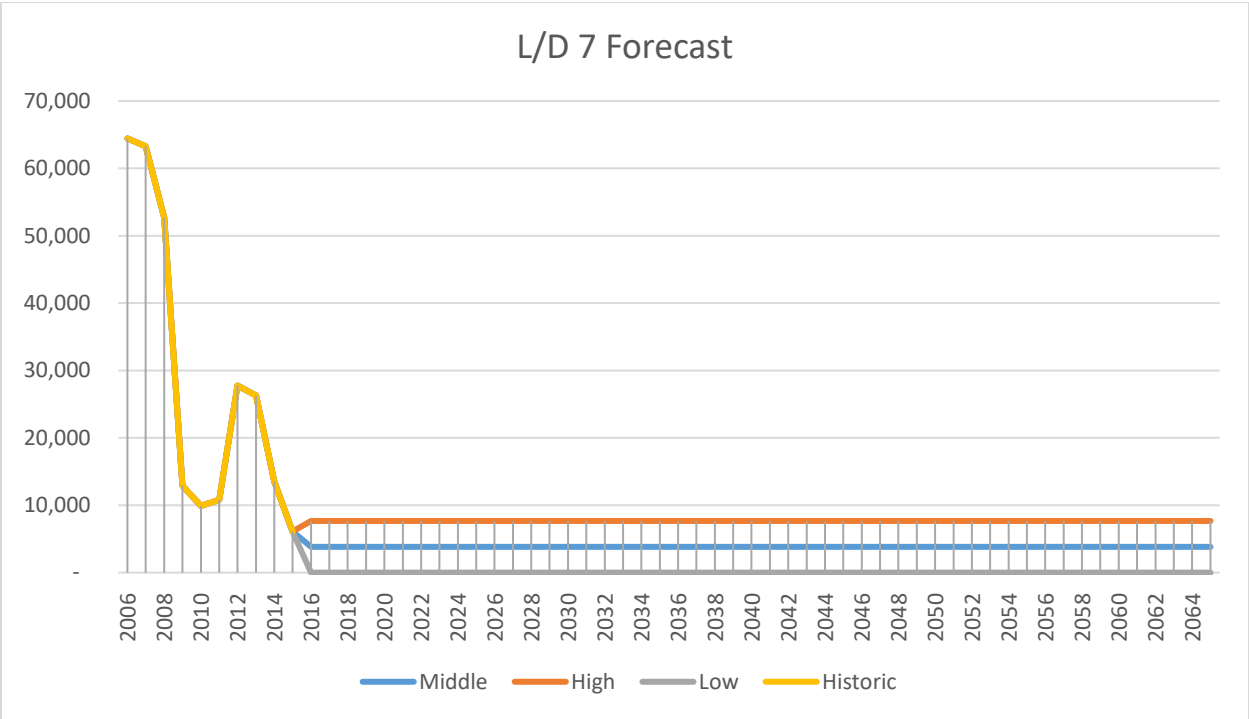


Figure 14. L/D 7 Forecast

4.4.2 Hydropower

There is an additional proposal for a 16.5 MW hydropower facility at L/D 7 by Free Flow Power Corporation; however it is not proposed for implementation in the near term (next

1-2 years). If this additional facility is installed, annual generation would increase by approximately 89,000 MWh with an approximate commercial value of $10,947,000.

4.4.3 Socioeconomic Trends

A brief discussion of recreation trends can be found in Section 4.1.1; a detailed analysis of recreation benefits can be found in Appendix B, Section 1.

As discussed in Section 4.1.3, the L/D pools serve as a water supply to a portion of Armstrong County. It is estimated that the water supply from the L/Ds serves a total of 23,624 customers.

Since these L/Ds were put into service, Armstrong County has experienced an overall 15% decline in population (1930-2015). The population of Armstrong County peaked in roughly 1940 with 81,087 residents. The current estimate of the population as of 2015 is 67,052, which is a 2.7% decline from 2010. When forecasting the future population growth of this area, it is reasonable to assume the trends since 1980 are likely to continue. By this time, many of the steel mills and other large plants had closed in the county. From 1980 – 2015, the population of the county decreased from 77,768 to 67,052, which is an annual rate of population decline of 0.42%. If this trend continues, by 2065 the population of the county would decline to approximately 54,250.

4.4.4 Environmental Resources

Climate change is impacting urban and rural built and natural environments and will continue to do so throughout the project life. The anticipated longer growing seasons and warmer winters are expected to increase weed and pest pressure (Melillo et al. 2014) in the region. Earlier arrival and increased populations of some insect pests have already been seen. Also, the expected increase in atmospheric carbon dioxide favors aggressive weeds, such as kudzu, over crop species. Wildflowers and woody perennials are blooming earlier and migratory birds are arriving sooner (Melillo et al. 2014). Species distribution shifts, including bird and insect range expansion, have been ongoing and are expected to continue. The Hemlock woolly adelgid is one such species. Suitable habitat for some native species is expected to shrink (such as coldwater fish like brook trout) while others will expand (such as warmwater fish like bass). Some northern hardwood trees may have increased productivity with the longer growing season, but summer droughts may offset this potential benefit (Melillo et al. 2014).

In 2011, the Pennsylvania Natural Heritage Program led a study to identify the species in the state that are most vulnerable to climate change. Amphibians and mussels were found to be the most vulnerable groups. Threatened and endangered mussels in the Allegheny River have benefited from past water quality improvements. However, Ganser et al (2013) suggest that many freshwater mussels are currently living near their upper thermal limits and that future trends in warmer water could significantly impact native mussels. The Allegheny River is one of the Ohio River Subbasins at greatest risk from climate change due to the significant number of sensitive aquatic organisms in the river (Drum et al. 2017).

Drum et al. (2017) note that the greatest changes expected for the Allegheny basin include more water overall, larger spring flood events, and periodic droughts. Results of these changes include expected increases in scour, water level increases during sensitive mussel reproduction periods, and periodically lowered baseflow. The study offers adaptations that could be made to decrease impacts of climate change to the aquatic ecosystem, including reconnection of floodplains and wetland restoration efforts.

There has been generally progressive and substantial declines in the intensity of acid mine drainage pollution in the Allegheny River basin over the past three decades or longer (Koryak et al 2004). In the Conemaugh River, this improvement in water quality has been shown to have significant impacts to fisheries. Between 1986 and 1990, with continually declining acid mine drainage, the number of species of fish collected increased 470% (3 to 14 species) and the number of fish collected per unit sample effort increased 4,000% (3.6 to 143.6 fish/hr), and the total wet biomass collected per unit effort increased 11,000%(147 to 16,844 g/hr) (Corps 1991 in Koryak et al. 2004). While water quality improvements have occurred slowly over time, this rapid restoration of biological resources occurred once critical water quality mileposts had been achieved for sustaining aquatic life (Koryak et al 2004).

In contrast to reduced acid mine pollution, nutrient and thermal pollution within the Allegheny River has been increasing over the past several decades, likely due to increasing urbanization of the watershed. With the expected increases of air temperature due to climate change and the continued nutrient pollution, overall dissolved oxygen levels in the river are also likely to decrease (Melillo et al. 2014). Dissolved oxygen in streams is controlled by several factors, including water temperature, air temperature, hydraulic characteristics, photosynthetic activity and the amount of organic matter in the water. As discussed in Section 4.2.4, dissolved oxygen varies within the pools both with depth and with distance from the dam. This stratification is likely to continue and intensify.

5 PROJECT DESCRIPTION – CURRENT CONDITIONS

5.1 Operation and Maintenance History

Numerous additional modifications and maintenance activities have taken place on the L/Ds since their completion. In 1940, the upper guide wall of L/D 5 was extended 200 feet. In 1986, the abutment on the left descending bank was modified to accommodate a private hydropower facility. In 1993, its lock walls underwent rehabilitation. In 2009, scour protection was placed downstream of the dam. L/D 6 was first modified in 1988 to accommodate development of a private hydropower facility at this site. In 2009, scour protection was also placed downstream of this L/D. From 1988 to 1989, the dam apron at L/D 7 was extended 28 feet. L/D 8 was modified in 1990 to accommodate a private hydropower facility. Both L/Ds 8 and 9 received electrical upgrades in 2009.

Available information on O&M costs for L/Ds 5 through 9 from 2011-2015 was used to calculate average annual O&M costs. These figures include a proportional amount of the Allegheny System O&M costs that were distributed based on the percentage of total O&M costs for L/Ds 2 through 9 that were attributable to each specific L/D. It should be noted

that many of these L/Ds were underfunded during this period, so these figures may not represent the minimal amount needed to maintain these facilities. Also, beginning in 2012, the level of service for Lock 5 was reduced to a "Limited Service – Single Shift" which only operates 8 to 12 hours per day (7 days a week, 365 days per year), while the level of service for L/Ds 6 through 9 was reduced to service by appointment only.

Table 15 Estimated Average Annual O&M costs for 2011-2015

	Maintenance	Operations	Total
L/D 5	$ 9,287	$ 565,965	$ 575,252
L/D 6	$ 35,263	$ 285,395	$ 320,658
L/D 7	$ 8,283	$ 122,335	$ 130,618
L/D 8	$ 2,162	$ 84,784	$ 86,946
L/D 9	$ -	$ 54,456	$ 54,456

The Allegheny River is considered a "low-use waterway" by the Corps since the implementation of IMTS ratings in 2012 because of low volumes of commercial traffic, which has resulted in budget reductions. Certain steps have already been taken to reduce the costs of operating and maintaining the projects including: 1) eliminating scheduled de-watering for inspections and repairs; 2) reducing the number of shifts; 3) reducing service by reducing the number of hours per day, days per week and/or the number of months per year of operation; and 4) reducing or eliminating maintenance items. Future projections for total O&M for the Allegheny River (including L/Ds 2, 3 and 4 in addition to L/D 5 through 9 which are the focus of this study) are $5.0M annually for the foreseeable future. $4.2M or 84% is estimated for operating labor, and the remaining $0.8M or 16% is projected for annual maintenance labor. These projections do not account for the potential for emergency repairs that could require unscheduled major maintenance.

5.2 Critical Maintenance

The Operation Condition Assessment or OCA program that was developed and used for asset management practices was utilized to capture the condition of critical components of the facilities. The failure of these components would directly affect mission, safety, security and compliance requirements.

Condition classification for navigation projects has been standardized using the following rating scale:

Table 16. OCA ratings for Navigation Projects.

Rating		Definition
A	Excellent	1) Component is fully functional, 2) No documented critical design flaw in terms of structural/operational capacity or functionality, 3) No documented or observed deficiencies by definition, 5) No indication of wear.
B+ B B-	Good	1) Component is fully functional, 2) No documented critical design flaw in terms of structural/operational capacity or functionality, 3) Documentation, testimonies and/or observations concluded that a deficiency by definition exists, 4) A clear mode of failure cannot be confirmed, 5) The component's performance is not affected by the deficiency, 6) The feature mission requirements are not affected by the deficiency, 7) Normal operating procedures and routine maintenance requirements are not affected by the deficiency, 8) Safety of personnel and end users are not affected by the deficiency, 8) There are indications of normal wear as documented, reported or observed .
C+ C C-	Poor	1) Component is fully functional, 2) A critical design flaw potentially exist in terms of structural/operational capacity or functionality, but must be further substantiated by owning District, 3) Documentation, testimonies and/or observations conclude that a deficiency by definition exists, 4) Documentation, testimonies, and/or observation can confirm a progressing degradation of the component's condition, 5) A clear mode of failure cannot be confirmed, 6) The componen'ts performance is not presently affected by the deficiency, but is likely due to the substantiated progress in degradation, 7) The feature mission requirements are not presently affected by the deficiency, but likely due to the substantiated progress in degradation, 8) Normal operating procedures and routine maintenance requirements are not presently affected by the deficiency, but likely due to the substantiated progress in degradation, 9) Safety of personnel and end users are not presently affected by the deficiency.
D+ D D-	Inadequate	1) Component is functional, 2) Documentation, testimonies and/or observations conclude that a deficiency by definition exists, 3) Documentation, testimonies, and/or observation can confirm that the deficiency is significant by any of the following criteria: a. A clear mode of failure exists, b. The component's performance is presently affected, c. Feature mission requirements are presently affected, d. Normal operating procedures are presently affected, e. Routine maintenance requirements are presently affected, 4) A recent unsatisfactory performance or failure of service due to the deficiency cannot be confirmed by documentation or testimonies, 5) It is not likely that an imminent failure of the component will occur, 6) A critical life safety concern to personnel or end users does not exist.
F+ F F-	Failing	1) Component is functional, 2) Documentation, testimonies and/or observations conclude that a deficiency by definition exists, 3) Documentation, testimonies, and/or observation can confirm that the deficiency is significant by any of the following criteria: a. A clear mode of failure exists, b. The component's performance is presently affected, c. Feature mission requirements are presently affected, d. Normal operating procedures are presently affected, e. Routine maintenance requirements are presently affected, 4) In addition to the effect the deficiency has on performance and operation, a recent unsatisfactory performance or failure of service due to the deficiency can be confirmed by documentation or testimonies, 5) In addition to the effect the deficiency has on performance and operation, it is likely that an imminent failure of the component will occur, 6) In addition to the effect the deficiency has on performance and operation, a critical life safety concern to personnel or end users exists.
CF	Completely Failed	Component is presently out of service or not functional.

Table 17. OCA for Each L/D in the Study Per Asset Category.

[redacted]

5.2.1 Lock and Dam 5

[redacted]

5.2.1.1 Lock Structure

[redacted]

5.2.1.1 Lock Gates and Operating Systems

[redacted]

5.2.1.2 Filling, Emptying Valves and Operating Systems

[redacted]

5.2.1.3 Signage

[redacted]

5.2.2 Lock and Dam 6

[redacted]

5.2.2.1 Lock Structure

[redacted]

5.2.2.2 Lock Gates and Operating Systems

[redacted]

5.2.2.3 Central Hydraulic Systems

[redacted]

5.2.2.4 Signage

[redacted]

5.2.3 Lock and Dam 7

[redacted]

5.2.3.1 Lock Structure

[redacted]

5.2.3.2 Lock Gates and Operating Systems

[redacted]

5.2.3.3 Central Hydraulic Systems

[redacted]

5.2.4 Lock and Dam 8

[redacted]

5.2.4.1 Lock Structure

[redacted]

5.2.4.2 Lock Gates and Operating Systems

[redacted]

5.2.4.3 Central Electric Systems

[redacted]

5.2.4.4 Central Hydraulic Systems

[redacted]

5.2.5 Lock and Dam 9

[redacted]

5.2.5.1 Lock Structure

[redacted]

5.2.5.2 Lock Gates and Operating Systems

[redacted]

5.2.5.3 Central Electric Systems

[redacted]

5.2.5.4 Central Hydraulic Systems

[redacted]

5.3 Existing Safety Evaluation

The Corps dam safety program uses a risk classification system named Dam Safety Action Classification (DSAC) to help guide key decisions within the program. This classification system portrays the need for urgency of action and the priority for responding to risk associated with Corps dams. Table 11 provides descriptions and definitions of the Corps DSAC Rating System. Table 19 shows the DSAC ratings obtained through the SPRA process for L/D 5 to 9.

Table 18. Dam Safety Action Classification System Ratings

URGENCY OF ACTION (DSAC)	ACTIONS FOR DAMS IN THIS CLASS***	CHARACTERISTICS OF THIS CLASS
VERY HIGH (1)	Take immediate action to avoid failure. Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Implement interim risk reduction measures, including operational restrictions. Ensure the emergency action plan is current and functionally tested for initiating event. Conduct heightened monitoring and evaluation. Expedite investigations to support remediation using all resources and funding necessary. Initiate intensive management and situation reports.	CRITICALLY NEAR FAILURE: Progression toward failure is confirmed to be taking place under normal operations. Dam is almost certain to fail under normal operations to within a few years without intervention. OR EXTREMELY HIGH INCREMENTAL RISK**: Combination of life or economic consequences with likelihood of failure is very high. USACE considers this level of life-risk to be unacceptable except in extraordinary circumstances.
HIGH (2)	Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Implement interim risk reduction measures, including operational restrictions as warranted. Ensure the emergency action plan is current and functionally tested for initiating event. Conduct heightened monitoring and evaluation. Expedite confirmation of classification. Give very high priority for investigations to support the need for remediation.	FAILURE INITIATION FORESEEN: For confirmed and unconfirmed dam safety issues, failure could begin during normal operations or be initiated as the consequence of an event. The likelihood of failure from one of these occurrences, prior to remediation, is too high to assure public-safety. OR VERY HIGH INCREMENTAL RISK**: The combination of life or economic consequences with likelihood of failure is high. USACE considers this level of life-risk to be unacceptable except in extraordinary circumstances.
MODERATE (3)	Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Implement interim risk reduction measures, including operational restrictions as warranted. Ensure the emergency action plan is current and functionally tested for initiating event. Conduct heightened monitoring and evaluation. Prioritize investigations to support the need for remediation informed by consequences and other factors.	MODERATE TO HIGH INCREMENTAL RISK**: For confirmed and unconfirmed dam safety issues, the combination of life, economic, or environmental consequences with likelihood of failure is moderate. USACE considers this level of life-risk to be unacceptable except in unusual circumstances.
LOW (4)	Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Conduct elevated monitoring and evaluation. Give normal priority to investigations to validate classification, but do not plan for risk reduction measures at this time.	LOW INCREMENTAL RISK**: For confirmed and unconfirmed dam safety issues, the combination of life, economic, or environmental consequences with likelihood of failure is low to very low and the dam may not meet all essential USACE guidelines. USACE considers this level of life-risk to be in the range of tolerability but the dam does not meet all essential USACE guidelines.
NORMAL (5)	Continue routine dam safety activities and normal operations, maintenance, monitoring, and evaluation.	VERY LOW INCREMENTAL RISK**: The combination of life, economic, or environmental consequences with likelihood of failure is low to very low and the dam meets all essential USACE guidelines. USACE considers this level of life-safety risk to be tolerable.

*At any time for specific events a dam, from any action class, can become an emergency requiring activation of the emergency plan.
** INCREMENTAL RISK is used to inform the decision on the DSAC assignment; NON-BREACH RISK is not reflected in this table.
***DSAC 1 and 2 dams with no life loss will be referred to the appropriate business line program and are given lower priority in the dam safety program.

Table 19. Current DSAC Ratings

[redacted]

Periodic inspections (PIs) are recurring engineering inspections conducted at dams and other civil works structures to ensure their structural stability, safety, and operational adequacy. Periodic Inspections of the projects are scheduled to be conducted at five-year intervals. Table 20 lists the dates of the most recent PIs conducted at the Allegheny River projects along with some of the significant safety concerns that were noted.

Table 20 Safety Concerns at L/Ds 5-9.

Project	PI Date	Safety Concerns
L/D 5	2012	[redacted]
L/D 6	2012	[redacted]
L/D 7	2014	[redacted]
L/D 8	2014	[redacted]
L/D 9	2014	[redacted]

Currently, all of the locks on the upper Allegheny River are operational. This is due, in part, to past maintenance and repair activities. However, the equipment and structural facilities are beyond their expected operating life and many of the facilities' redundancies have failed. Without redundant systems continued operations could be halted by unanticipated failures of equipment without any notice. A similar risk exists for the structural stability of the various components.

Because these facilities are not staffed 24 hours a day, 7 days a week trespassing is a safety concern. Limited staffing also increases the potential duration of an unintended release of oils or hydraulic fluids downstream of project sites in the event of a system failure.

5.4 Summary of Asset Holding

The Real Estate holdings at each project include the lock, dam and any other associated building or major piece of machinery (e.g. generators). The current estimate of site betterments and property value are shown in the tables below.

Table 21. Real Estate Value of Facilities

	Lock	Dam	Other	# of Structures	Total Value
L/D 5	$ 5,797,967	$ 938,797	$ 604,581	4	$ 7,341,346
L/D 6	$ 615,959	$ 3,074,803	$ 439,781	5	$ 4,130,544
L/D 7	$ 4,925,958	$ 677,566	$ 348,391	3	$ 5,951,919
L/D 8	$ 1,455,377	$ 1,398,190	$ 112,765	2	$ 2,966,335
L/D 9	$ 1,286,781	$ 1,254,211	$ 82,673	2	$ 2,623,668
Total Value					**$ 23,013,813**

Table 22. Number of Real Estate Tracts

Project	Fee tracts	Ease Tracts	Total tracts	Total Acres
L/D 5	2	0	2	6
L/D 6	1	4	5	49
L/D 7	1	0	1	2.6
L/D 8	2	20	22	81
L/D 9	5	8	13	38

6 DESCRIPTION OF INTERESTED PARTIES

6.1 Description of the Entity

Potential transfer partners were identified through current users who receive benefit from the facilities other than commercial navigation. The study area includes municipal water supply users, recreation, and non-federal hydropower operators.

Allegheny River Development Corporation (ARDC): The Allegheny River Development Corporation is a recreational users group based out of Armstrong County who currently

provides contributed funds for the continued operations of L/D 6-9 during the summer on holidays and weekends.

Cube Hydro Partners: Cube Hydro is the current operator at Allegheny L/D 5 and 6, installed in 1989, with a combined capacity of 18 MW.

Free Flow Power: Free Flow Power holds the FERC permit for development of a hydropower facility at L/D 7.

Allegheny Energy Partners: Allegheny Energy is the current operator at Allegheny L/D 8 and 9, with an installed capacity of 30.4 MW.

Municipal Water Suppliers: There are a variety of municipal water suppliers in pools 5-9. However no single entity would have an interest in taking control of infrastructure if minimum flows can be met or intake relocation could provide a similar level of water supply.

6.2 Capability of Entity to Assume Ownership

The hydropower operators have expressed interest in continued discussion on a potential transfer of facilities. They are the only entities under consideration that have ability to hold property and the financial capability to maintain the dams. Transfer to a non-federal hydropower partner would likely result in the permanent closure of the locks. Free Flow Power is not considered a viable transfer alternative because they do not have a concrete timeline for installation of a unit or final approval from FERC.

Both potential transfer partners have only expressed interest in taking over the facility if there was no other option to keep the dam in place. It is still unclear if ongoing maintenance of the dam would impact profitability enough to make continued operations unsustainable.

7 PLAN FORMULATION

7.1 Problems and Opportunities

7.1.1 Problems

- Commercial navigation from 1993 to 2015 on the five most upstream locks on the Allegheny River has declined by 94% since its peak in 2003. In 2015 all five locks combined had only 160 commercial lockages. Lock 9 has had no commercial navigation since 2008, and Lock 8 has had no commercial navigation since 2012.
- L/Ds on the Allegheny River are generally in fair condition due to their age and a lack of maintenance funding. As these facilities continue to age and maintenance continues to be underfunded, the risk of failure of one or more facilities increases.
- Operating and Maintaining the L/Ds on the Allegheny River is costly and these L/Ds are underfunded due to a national shortage of O&M funds and a lower priority due to low usage.

- Reduction in services at navigation facilities has resulted in a decrease in the number of recreational lockages taking place, however, boaters still use the pools created by the dams for recreation without passing into other pools. The recreational boater community is active in promoting continued operation of the locks for recreational purposes.
- Navigation relies on the system of locks and dams acting together, such that any management decisions should consider the impact to the full system. For system level decision making, consideration of a measure that restricts navigation in some manner at one L/D, also would require de facto implementation of a similarly (or more) restrictive measure at all upstream L/Ds.
- The existing system of L/Ds divides the Allegheny River into a series of pools as opposed to a free-flowing river, which inhibits movement of aquatic species as well as natural riverine processes such as sediment transport, floodplain connectivity and dynamics, changes to riparian habitat, and sand and gravel bar formation. This limits movement of native fish and mussel species from the Ohio River into the upper Allegheny River, and vice versa. This negatively affects species of concern.
- Alternatively, the existing system of L/Ds presents a partial barrier for aquatic invasive species such as species of Asian carp. Removal of one or more of the L/Ds may require further consideration of how to limit the spread of invasive aquatic species in order to fully realize the benefits for native species.
- Locks on the Allegheny River reduce the dissolved oxygen that would naturally be generated in a free-flowing river. The reduction in dissolved oxygen is due to the transformation from a riverine to a lacustrine environment. In the historic river, reaeration would have been generated by water flowing over rock-riffles and waterfalls. Today the loss of this process is compensated for by water falling over the dam to supersaturate the upstream end of the next pool.
- Invasive plant species such as Japanese knotweed have infested many areas along the river and will likely continue to infest both disturbed and natural areas.

7.1.2 Opportunities

- Transfer of facilities has the potential to reduce the overall O&M burden on the federal government and, if properly maintained by the new owner, reduce potential for future failures or outages.
- Removal or breach of the dams would reduce the overall O&M burden on the federal government and could restore a higher functioning riverine ecosystem.
- Restoring run of river flows to one or more river segments could result in improved aquatic habitat, restoration of natural riverine process, improved water quality, increased riparian habitat, and restored habitat connectivity for species of concern and support the ecosystem restoration mission.
- The system has the potential for increased hydropower generation. There is currently a proposal to put a private hydropower facility at L/D 7 which would increase hydropower generation on the system by approximately 89,000 MWh annually.

- Transfer of the facilities to private hydropower operators who would then operate the L/Ds to maximize hydropower generation, has the potential to increase annual generation.
- Increasing the LoS at the locks, or removal of the project has the potential to enhance recreation in the project area by providing consistent service at existing locks or providing a larger stretch of river for unimpeded boating.

Automation of facilities that still serve authorized navigational needs may reduce operations costs, while still providing benefits to both recreation and commercial interests.

7.1.3 Study Objectives

The following planning objectives summarize the future conditions the alternatives for this study are seeking to consider based on the identified problems and opportunities.

- Identify potential transfer partners who current receive non-authorized, secondary benefits from the project and may have an interest in continuing lock operations or maintenance of the project pool independently.
- Evaluate alternatives for the long term disposition of the projects, considering costs, stakeholder input, and socio-economic and environmental impacts.
- Assess the current conditions of the projects to identify risks associated with structural and operational failure with continued operations of the project.

7.2 Alternatives Description

7.2.1 No Action – Flat Funding

The Flat Funding Alternative describes a continuation of the current levels of O&M funding provided on average over the last 5 years Current funding provides for an IMTS LoS 6 for L/Ds 6, 7, 8, and 9 and LoS 3 for L/D 5. Commercial vessels are able to lock through the system by appointment only at L/D 6-9 and during daily single shift operations at L/D 5. Seasonal hours for recreational boating are funded by contributed funds provided in partnership with user groups. Maintenance activities are minimal, recurring and preventative maintenance is not done. Deferred maintenance is documented but cannot be completed without supplemental funds. In the event of a system failure, the lock would become inoperable with a low likelihood of rehabilitation.

7.2.1.1 Hydraulics and Hydrology

Results of the No Action-Flat Funding scenario shows no change to the current navigable river channel. The minimum 9-foot navigational channel depth is maintained through the study area from L/D 5 at the downstream end up past L/D 9 at the upstream extent. The maintained navigation channel extends upstream to RM 69.808 on the Allegheny River. The No Action scenario represents current conditions of the Allegheny River and the analysis results are used for comparison against the other scenarios analyzed.

7.2.1.2 Discussion of Operational and Structural Risk

Risk Level: Moderate to High (risk is dependent on the amount of maintenance performed)

Risk Projection: A moderate but increasing level of operational and structural risk over time

The Flat Funding alternative is likely not sustainable over the 50 year study period. Operational failure is likely during that period though short-term environmental and socio-economic impacts would be neutral. Risk of operational and structural failure would increase over time as preventive and corrective maintenance efforts are significantly reduced and continually deferred.

7.2.2 No Action – Reduced Funding

The Reduced Funding Alternative would reduce the current level of O&M funding at all facilities. The current LoS 3 project at L/D 5 would be downgraded to LoS 6 'by appointment only' for commercial lockages. Contributed funds operations would be discontinued due to reduced staffing and maintenance requirements as outlined in the LoS 6 definition. Overall system costs would be reduced by nearly 50% as compared to the Flat Funding scenario. Risk of operational or structural failure would increase over time as recurring, preventive and corrective maintenance efforts are continually deferred.

7.2.2.1 Hydraulics and Hydrology

Results of the No Action-Reduced Funding scenario shows no change to the current navigable river channel. The minimum 9-foot navigational channel depth is maintained through the study area from L/D 5 at the downstream end up past L/D 9 at the upstream extent. The maintained navigation channel extends upstream to RM 69.808 on the Allegheny River.

7.2.2.2 Discussion of Operational and Structural Risk

Risk Level: High, (minimal to no maintenance performed)

Risk Projection: A moderate and rapidly increasing level of operational and structural risk over time

This scenario, like Flat Funding, is not considered sustainable over the 50 year study period. Risk of operational failure at the LoS 6 facilities would remain the same, while risk of failure for the LoS 3 facilities would increase from the flat funding scenario. Risk of operational or structural failure would be similar between the Flat Funding and Reduced Funding alternatives.

7.2.3 No Action - Sustainable Funding

The Sustainable Funding Alternative would increase the current level of O&M funding at all facilities and therefore increase current funding levels. Facilities would be operated at LoS 5 for current LoS 6 facilities (L/D 6, 7, 8 and 9) or a continuation of LoS 3 (L/D 5). Upgrade to LoS 5 would no longer require contributed funds from user groups to operate facilities for recreation. Maintenance activities would be increased allowing for deferred maintenance to be rectified and would include recurring, corrective, and preventive maintenance at each project. Corrective maintenance at the projects would be limited to those items that have

the highest risk of operational failure. Risk of operational or structural failure would increase slowly over time because of increased maintenance activities.

7.2.3.1 Hydraulics and Hydrology

Results of the No Action- Sustainable Funding scenario shows no change to the current navigable river channel. The minimum 9-foot navigational channel depth is maintained through the study area from L/D 5 at the downstream end up past L/D 9 at the upstream extent. The maintained navigation channel extends upstream to RM 69.808 on the Allegheny River.

7.2.3.2 Discussion of Operational and Structural Risk

Risk Level: Moderate (dependent on the amount of deferred maintenance performed)

Risk Projection: A moderate and slowly increasing level of operational and structural risk over time

This alternative would allow for a substantial reduction in current risk of operational or structural failure, especially at the facilities upgraded to LoS 5. Even at higher levels of annual spending this alternative would still likely result in an operational or structural failure over the 50 year period without significant reinvestment and replacement of component systems. Risk of operational or structural failure would be slightly lower than the Flat Funding and Reduced Funding alternatives.

7.2.4 Transfer

The Transfer Alternative will identify current users who receive a benefit from the project that is not currently authorized. Potential transfer partners include hydropower, recreational users, water supply, or state interests. The transfer alternative will describe the costs and timeline associated with disposal of a project through the General Services Administration (GSA). The estimated cost includes only USACE actions to prepare legal descriptions, appraisals, disposal reports and NEPA review in preparation of transfer to GSA for disposal.

The transfer alternative is a form of decommissioning the project by removing the project from Corps responsibility and control to mitigate long term operational and structural risk. This alternative will not include dam safety requirements and there will be no operational or maintenance costs as the project will be maintained and under the control of the transfer partner.

7.2.4.1 Hydraulics and Hydrology

The Transfer Funding scenario would remove Corps from controlling upstream facilities along the Allegheny River system. The current navigable river channel would not be maintained by the transfer partner. Therefor the channel may not meet current minimum 9-foot navigational channel depth as currently maintained through the study area from L/D 5 to the upstream extent of L/D 9. The maintained navigation channel extends upstream to RM 69.808 on the Allegheny River.

7.2.4.2 Identification of transfer partner

The district also reached out to entities including PENNDOT, the Allegheny River Development Corp., Rye Development, Allegheny Energy, All Dams Generation, and Allegheny Hydro LLC to discuss interest and ability in assuming the properties. Water supply, recreation, and state interests were unwilling to commit to a transfer agreement. Current hydropower operators at L/Ds 6, 8, and 9 have indicated that they need further time to analyze business impacts, and would only consider a transfer as a last resort. There are concerns that increased maintenance costs from ownership of the dams may reduce or eliminate profitability at these sites making transfer unviable. Rye Development has also expressed interest in continued transfer discussions, but they currently have no installed hydropower facilities on the Allegheny which reduces the likelihood of a successful long term transfer.

7.2.4.3 Discussion of Operational Risk and Structural Risk

Risk Level: Moderate to Low, (risk of the operational or structural integrity of the project are removed, however it would impact the river system)

Risk Projection: N/A

Risk of project failure under this alternative is low as Corps would not have ownership. A non-federal owner would have the responsibility to maintain the project, and would most likely have financial incentives to ensure the long term viability of the structure. Without a specific transfer partner identified it is difficult to anticipate long term risk, however, a change in profitability, significant maintenance expenses or a change in conditions could all affect a transfer partner's long term ability to operate the project. The largest source of short term uncertainty with this alternative is variability in operation by the transfer partner. Risk of operational or structural failure would not be applicable to Corps. Concerns for long-term safety and liability with this alternative are related to the continued operation of downstream facilities still responsible for maintaining LoS 1 operations.

7.2.5 Mothball

The Mothball Alternative considers short-term sustainment of facilities with the option to re-open a project should economic development trends indicate a return of river dependent industry. Mothballing will consider three costs; initial investment to prepare the project for decommissioning for short term storage, annual costs to maintain and inspect the project, and costs associated with bringing a project back online. Unlike the other alternatives considered, Mothballing is not considered for the full 50 year study period. This alternative will be evaluated for a 5 year and 10 year period. Beyond 10 years, this alternative would move to a state of de facto abandonment.

The mothball alternative is a form of decommissioning with recovery. It consists of securing or removing critical components out to the ten year milestone to mitigate operational and structural risk.

Operational maintenance of signage, buoys, and security would be maintained. Miter gates would be secured in miter position, and filling and emptying valves would be closed.

Mechanical systems would be coated with protective coatings drained of fluids and prepared for long term storage and electrical systems would be disconnected to prevent accidental use of equipment. The project pool would continue to be maintained by the fixed concrete dam. After ten years this alternative would mirror the abandon alternative requiring additional funding to prepare the facility for safe abandonment. This alternative would remove operational risk while in a mothball status but not structural risk of project failure. By not performing maintenance or critical repairs the projects would experience adverse effects and increase the likelihood of operational or structural failure.

7.2.5.1 Hydraulics and Hydrology

The Mothball Funding scenario would maintain the normal pool elevations, however the minimum 9-foot navigational channel depth would not be maintained as no maintenance dredging would be done. The maintained navigation channel extends upstream to RM 69.808 on the Allegheny River.

7.2.5.2 Discussion of Operational and Structural Risk

Risk Level: Moderate

Risk Projection: Moderate with increasing costs as well as increasing operational and structural risk over time

Risk of project failure during the mothball period is low. The largest source of uncertainty with this alternative is variability in cost to recover the project within the 10 year term. Recovery costs were estimated with an assumed rate of deterioration. Changed conditions or vandalism during the mothball period would significantly increase the costs associated with returning the facilities to an operational state.

Concerns for long-term safety and liability with this alternative are related to ongoing scour and stability of monoliths during the mothball time period. These processes should be monitored and the data collected and analyzed on a periodic basis for potential impacts to any compromised foundation conditions.

7.2.6 Abandonment

The Abandonment Alternative consists of one time costs associated with ensuring structural stability and physical security at the project sites. Abandonment will define the least cost methods for site preparation that would limit long-term liability. While abandonment is not an alternative that USACE would consider an acceptable end state, deauthorization of a project without a transfer partner or other disposal method would result in a de-facto abandonment of the project as additional federal funds could not be appropriate to modify or maintain the project at any level.

The abandonment alternative is a form of decommissioning the project and consists of securing or removing critical components to mitigate long term risk, responsibility and liability. Under this alternative a higher level of risk is considered acceptable, therefore no dam safety requirements will be captured in the cost. An estimate of these dam safety costs, including Periodic Inspections, Periodic Assessments, Scour and Deformation Surveys, is $47,000 annually per project. Operational maintenance of signage, buoys, and security

would still be required. Miter gates and filling and emptying valves would be removed along with all mechanical and electrical systems. Fuel and Hydraulic storage systems would be drained, lock appurtenant items would be removed. All removed items would be evaluated for reuse at other similar projects. A lock closure structure would be installed and the project pool would continue to be controlled by the remaining concrete fixed crest dam. This alternative would remove operational risk but not structural risk of project failure. By not performing maintenance or critical repairs the projects would experience adverse effects and increase the likelihood of structural failure.

7.2.6.1 Hydraulics and Hydrology

The Abandonment Funding scenario would maintain the normal pool elevations, however the minimum 9-foot navigational channel depth would not be maintained as no maintenance dredging would occur. The maintained navigation channel extends upstream to RM 69.808 on the Allegheny River.

7.2.6.2 Discussion of Operational and Structural Risk

Risk Level: High (structural risk only)

Risk Projection: A rapidly increasing level of structural risk over time

Abandonment of the project would lead to a higher risk of unplanned loss of pool due to dam failure. While each project has identified dam safety issues, none are considered critical at this time. Continued degradation of the dam structures over time without any further investment would lead to failures at all facilities, likely within the 50 year study period.

7.2.7 Removal

The Removal Alternative will identify all project features to be removed and disposed of to mitigate long-term risk, responsibility and liability. Under this alternative the Corps would abandon its flowage easements and lands associated with the project not owned in fee. Any assets, such as land and equipment, associated with the project would be disposed of.

The removal alternative is an extreme form of decommissioning the project and consists of removing key project features to mitigate long term risk, responsibility and liability. This alternative has no dam safety requirements and no operational or maintenance responsibilities as the project would be removed from the river system. Miter gates, bulkheads, filling and emptying valves and all mechanical and electrical systems would be removed. Additionally, the fixed crest dam, dam derrick stone, lock walls (not including the land wall), lock approach walls (land approach only if surrounded by water), pile foundation systems, buildings, mooring cells, bridges, fuel and hydraulic storage systems and lock appurtenant items would be removed. This alternative would remove all operational risks and significant if not all structural risk of project failure.

7.2.7.1 Hydraulics and Hydrology

The Removal Funding scenario would lower the normal pool elevations changing the current navigable river channel. The minimum 9-foot navigational channel depth would not

be maintained. The maintained navigation channel extends upstream to RM 69.808 on the Allegheny River.

7.2.7.2 Discussion of Operational and Structural Risk

Risk Level: Low

Risk Projection: N/A

This alternative removes future liability from the Corps and returns the study area to a free flowing river. There is a high potential for short-term negative socio-economic and environmental impacts. Long-term environmental impacts would be net positive. Mitigation for socio-economic impacts could also significantly reduce their severity over time.

7.3 Grouping of Alternatives at a System Level

The individual management measures are applied to each project to determine a final alternative grouping. The development of alternative packages allows for project specific decisions at each project, while considering a system level approach to the final status of the river. Management measures include No Action, mothball, abandonment, and removal (listed from least to most restrictive future state for navigation). The selection of a management measure is made moving upstream with all measures considered at the first project. Once a project has been downgraded to a more restrictive alternative only the current or more restrictive alternatives are considered at the next project upstream (i.e. once abandonment is selected as the preferred measure for a project all upstream projects would be limited to abandonment or removal). For purposes of system level decision making the transfer alternative would mirror the No Action (if continued operation of the lock is anticipated) or Abandonment (if the lock would no longer be in use). Should a transfer partner be found for a project, their proposed usage would potentially dictate upstream decision making on projects not considered for transfer.

This constraint assumes that the final formation of the river system should not fragment navigability or pool levels though the study area. The river acts as a system and any benefits to a fragmented navigational pool with some projects opened and others closed would lead to diminished value due to its disconnectedness from downstream markets and constraints on future commercial investment in river dependent industries, at a greater cost over the study period. The range of alternatives presented are only those combinations of management measures considered implementable under this methodology.

Figure 15 shows a visual representation of possible groupings of alternatives at a system level according to the constraints defined above.

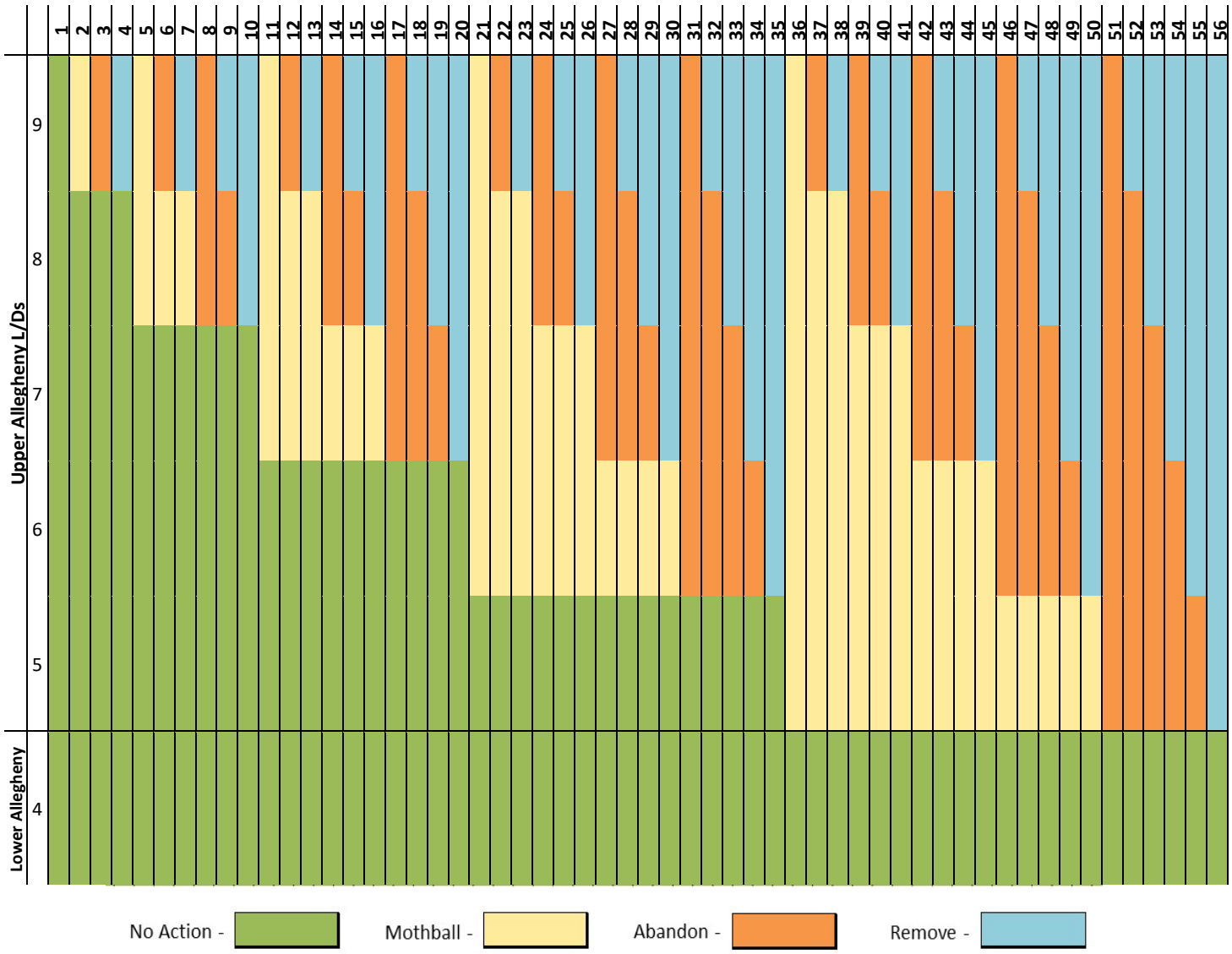


Figure 15. Grouping of Alternatives at a System Level

7.4 Alternatives Considered but Eliminated

7.4.1 Major Rehabilitation

Major rehabilitation of the projects would entail significant reinvestment in the project to repair all deficiencies and replace all systems to return them to full operability. Major rehabilitation would also require ongoing O&M at a higher level than current O&M allocations.

This alternative was eliminated due to the high initial cost for limited economic benefit. Justification of a major rehabilitation would require a positive benefit to cost ratio, however with existing economic conditions this is unlikely. Current forecasts and existing benefits

(even to include secondary benefits) would have to increase beyond the most optimistic expectations to make this alternative viable.

7.4.2 Reauthorization for a Purpose Other Than Commercial Navigation

Although commercial navigation at the L/Ds is minimal, other public services are provided by the facilities. Reauthorization for non-federal hydropower, water supply and/or recreation was considered, but not included in the final array of alternatives due to lack of current authority of the Corps to operate a project solely for those identified secondary purposes.

ER 1105-1-100 provides guidance on authorized purposes for Corps projects, and specifically addresses the secondary purposes listed above.

- Recreation: If there is no non-federal recreation sponsor, facilities or project modifications may not be recommended unless justified by other project purposes, in which case recreation benefits are considered incidental.

  Budget Policy generally precludes using Civil Works resources to implement recreation oriented projects in the Civil Works program. An exception is where a project is formulated for other primary purposes and average annual recreation benefits are less than 50 percent of the average annual benefits required for justification (i.e., the recreation benefits that are required for justification are less than an amount equal to 50 percent of project costs).

- Water Supply: National policy regarding water supply states that the primary responsibility for water supply rests with states and local entities. The Corps is authorized to provide storage in multipurpose reservoirs for municipal and industrial water supply and for agricultural irrigation.

- Hydropower: Corps development of single purpose hydropower is precluded. In addition, before hydropower can be included in a multiple purpose project, the project must be economically justified based on other outputs (e.g., flood damage reduction or navigation).

7.5 Socio-Economic Impacts

The Planning Center of Expertise for Inland Navigation and Risk-Informed Economic Decisions (PCXIN-RED) informed the Pittsburgh District that a quantitative analysis of business forecasts would not be possible due to time constraints and lack of data associated with this level of study. If this document leads to a feasibility study, the PCXIN-RED stated there are two alternatives for business forecasting: an economic model and formal surveying. From the economic model and/or surveys, revenue losses and unemployment could be estimated. For purposes of this study, the PCXIN-RED performed a qualitative analysis to address socio-economic impacts.

The average annual recreation benefits for Allegheny L/Ds 5 through 9 can be found in Appendix B, Section 1. A brief analysis of employment trends in Armstrong County can be found in Appendix B, Section 2. A brief analysis of impacts to property values can be found in Appendix B, Section 3.

7.5.1 No Action – Flat Funding

There would be no impacts to businesses or recreation benefits for this alternative in the short-term. However in the long-term, operational failure of the L/Ds is likely and this would result in negative impacts. If a dam failure occurs, there would be a rapid loss of pool, which would result in a loss of water supply and potential life safety impacts. The Allegheny River is the source of water supply for 23,624 customers; if the dam fails, each customer would lose access to their water supply for an extended amount of time. Additionally, in the event of an unplanned loss of pool there is a high potential for riverbank erosion, which could result in damage to personal property, roads, and railroad tracks located along the river banks. Docks and boats along the river would likely be damaged or destroyed due to the rapid loss of pool. This would cause an immediate loss of recreation benefits because fewer consumers would be able to use the river for motorized boating. This is the scenario that results in the highest loss of recreation benefits in the short term. Additionally, marinas are more likely to permanently shut down if the dam fails due to the decrease of boats in the county. If roads and railroad tracks are damaged, this would impact businesses who rely on truck and rail. Additionally, if dam failure occurs while there are vehicles on the roads/tracks, there could be potential injury or loss of life. The chances of loss of life occurring during the dam failure are extremely low, but should be noted.

7.5.2 No Action – Reduced Funding

In the short term, reduced funding would result in decreased recreation benefits. Allegheny L/D 5 would be downgraded to LoS 6, which is by appointment only for commercial lockages. Additionally, the contributed funds agreement in place with user groups would be discontinued due to reduced staffing and maintenance requirements. The long-term impacts for this alternative are identical to those discussed above for the No Action – Flat Funding alternative.

7.5.3 No Action – Sustainable *Funding*

In the short term, sustainable funding would increase the reliability and availability of the L/Ds which could cause recreation benefits to increase. L/D 6 through 9 would be upgraded to LoS 5; Allegheny L/D 5 would remain at LoS 3. Contributed funds from user groups would no longer be required to operate facilities for recreation. The long-term impacts for this alternative are identical to those discussed above for the No Action – Flat Funding alternative because, as stated in section 7.2.3.2, the long-term risk of a structural or operational failure remains.

7.5.4 Transfer

If the L/Ds are transferred from Corps to another entity, it is highly likely that the locks would no longer be operated, and therefore would become unavailable to recreation and

commercial traffic. If the locks become unavailable, Armstrong County and its major population center, Kittanning, would likely be impacted. The residents of Armstrong County and the Armstrong Tourist Bureau state that the navigable waterways are its main tourist attraction and they informed the Corps that the county relies on tourism for economic stability. The L/Ds indirectly generate revenue for the county, add jobs to the local economy, and give an incentive to visit Armstrong County. Restaurants, marinas, motorized river recreational companies, and terminals sectors are directly impacted by the L/Ds. Most of these businesses rely on recreational boaters as a source of revenue and income.

The Allegheny River is easily accessible to the public; there are several boat ramps along the river. Each month from May through September, Arts on the Allegheny holds a concert at a L/D, which attracts a high volume of recreational boaters. Tourists mainly come from Clarion County, Allegheny County, and Butler County. Local residents informed the Corps that groups of recreational boaters would travel from Pittsburgh to Kittanning (locking through L/D 2 through 7). These recreational boaters that travel to Kittanning are considered tourists and factor into tourism spending. According to the Armstrong Tourist Bureau, tourists spent $90.9 million in the county in 2014. This included $17 million spent on food and beverage, $4 million spent on lodging, $13.3 million spent on retail, $25.7 million spent on recreation, and $30.8 million spent on transportation.

The Tourist Bureau only lists six other tourist attractions within the county. However, none of these attractions generate large amounts of revenue due to low admission prices. This indicates that the river is likely what is attracting tourists; their boating trips are resulting in additional consumer spending. According to the 2000 Corps report, *Allegheny River Recreation Benefits*, recreational boaters spend an average of $36.09 (updated from June 2000 dollars to May 2017 dollars using a Consumer Price index of 1.42) per person per boating trip. The recreational boaters increase overall annual spending for the local economy of Kittanning and Armstrong County. If the locks become unavailable to recreational boaters, it is likely that there would be a decrease in consumer spending, which could result in negative economic growth.

The annual recreation benefits for the five L/Ds is approximately $563,000, on average (Appendix B, Section 1). This number does not account for non-motorized vessels due to lack of data. If the L/Ds become unavailable, some recreation benefits would likely be lost, though not all. Motorized vessels would be able to use the pools between L/Ds, but they would no longer be able to lock through the L/Ds.

Many restaurants positioned themselves on the river and constructed docks in order to gain a competitive advantage over inland restaurants. During boating season, the riverfront restaurants claim to see a positive spike in revenue due to recreational boaters. If the L/Ds become unavailable to recreational boaters, riverfront restaurants would likely see a decrease in revenue. The decrease could be severe enough to cause the restaurants to shut down, resulting in higher unemployment and negative economic growth for the county.

If the locks become unavailable to recreational and commercial navigation, marinas and public boat ramps would also be negatively impacted. Each marina and public boat ramp is listed below in Table 23. The local marinas in the county rely on these boat owners for

consistent revenue. However, if the L/Ds become unavailable, the boat owners may migrate out of the county and sell their property. This leads to fewer consumers in the county, which leads to less spending in the county's economy. Furthermore, as the population of boat owners decreases, local marinas would experience negative economic impacts; some marinas would possibly relocate to another county or state, but most marinas would permanently close. In either alternative, the county would incur higher unemployment and negative overall economic growth.

Table 23. Marinas and Public Boat Ramps in the Project Area.

	Marinas and Public Boat Ramps
Pool 5	Schenley Marina
Pool 6	Rosston Marina
	Ramp at Kittanning Riverfront Park
	2 docks located in Applewood
Pool 7	Kittanning Marina
	Allegheny Marina Dock
	Cowanshannock Boat Launch
Pool 8	Nautical Mile Campground and Marina

Freeport Paddleboarding Company, LLC and The River's Edge Canoe & Kayak, LLC are non-motorized river recreation companies located in Armstrong County. Both companies are located within close proximity to the L/Ds and could be positively impacted if the locks become unavailable. Motorized boating would likely decrease. In the long-term, recreation is expected to shift towards non-motorized vessels. The River's Edge Canoe & Kayak, LLC is located in Armstrong County along the Kiskiminetas River. The company offers kayaks, canoes, tubes, and paddleboards to rent or purchase. Additionally, they offer daily river trips, however, all trips are restricted to the Kiskiminetas River. The decrease in motorized boating on the Allegheny River could be an opportunity for the company to expand and offer services on the Allegheny River. Both non-motorized river recreation companies would likely see an increase in revenue over the long term.

Terminals within the county are situated on river banks within close proximity to the L/Ds. There are other warehouses and terminals located inland, but only a few along the Allegheny that have readily available access to the waterways. The riverfront terminals' competitive advantage is the navigable waterway. Inland warehouses can only offer truck and rail transportation to its customers. One terminal disclosed its revenue totaled approximately $2.5 million in 2016. Only 10% of its 2016 revenue did not involve barge traffic. If the L/Ds become unavailable, commercial navigation vessels could not access the upper Allegheny River, which would cause the terminal's revenue to quickly decrease. If the terminal's revenue decreases to 10% of 2016 levels, it may permanently shut down.

Additionally, if the terminals are resilient, they may diversify towards truck and rail transportation only. Even if the terminals diversify quickly, they would likely see a short-term drop in revenue.

If the locks become unavailable, motorized boating is expected to decrease. There is a potential for the decrease in motorized boating on the Allegheny River to be offset by increased motorized boating on Crooked Creek Lake, which is about 13 miles southeast of downtown Kittanning. However, there are no marinas at the lake and only one boat ramp, and the travel time from Kittanning is about 25 minutes. Boaters in close proximity to L/D 8 or 9 would experience a travel time of about 45 minutes with no traffic, which indicates they are less likely to use the lake resulting in lost recreation benefits.

7.5.5 Mothball

The impacts of this alternative are identical to those discussed above for the Transfer alternative. However, if the mothballed L/Ds are restored, recreation and commercial navigation would be available again on the upper Allegheny River. This indicates that over time, the recreation benefits would return to its annual average and commercial navigation would return to this portion of the Allegheny River.

7.5.6 Abandonment

Short-term impacts of this alternative would be identical to those impacts discussed above for the Transfer alternative. If the L/Ds are abandoned and decommissioned, there is a high chance that they would fail in the long-term. The long-term impacts for this alternative are identical to the long-term impacts discussed above in the No Action – Flat Funding alternative.

7.5.7 Removal

Socioeconomic impacts of this alternative would be almost identical to impacts discussed above for the Transfer alternative. There are slight differences in recreation benefits when compared to the Transfer alternative. Much like the Transfer alternative, motorized vessels would still be able to use the river (in pools between L/Ds), but to an even lesser degree. If the L/Ds are removed, some areas of the river may be too shallow or too narrow for larger vessels. However, the Removal alternative results in a more natural flowing river. Non-motorized vessel users would likely view a natural flowing river as a positive impact. This may cause recreation to shift more rapidly towards non-motorized vessels, which could offset the majority of the lost benefits from motorized vessels. Additionally, this may cause an increase in revenue for Freeport Paddling Company, LLC and The River's Edge Canoe and Kayak, LLC; other companies (rafting, kayaking, etc.) may enter the market, which would result in positive economic growth for the county.

7.6 Environmental Impacts

7.6.1 Geography

7.6.1.1 No Action - Flat Funding

With the implementation of the Flat-Funding Alternative, no impact to the geography of the Allegheny River is expected. Operational failure of a project (loss of the ability to run the locks) is likely under this alternative, however structural failure is not anticipated. The river would maintain its existing stepped pool structure.

7.6.1.2 No Action – Reduced Funding

Impacts to geography from this alternative would be identical to those described for the Flat Funding Alternative.

7.6.1.3 No Action - Sustainable Funding

With the implementation of the Increased O&M Funding Alternative, no impacts to the geography of the Allegheny River would be expected. The river would be maintained with its existing stepped pool structure. Sustainable funding would be expected to maintain the existing condition indefinitely.

7.6.1.4 Transfer

Under this alternative, the impact to geography is expected to be similar to the No Action Alternatives. Overall, it is expected that a transfer recipient would maintain the dam indefinitely. The locks may not be maintained as usable facilities, but this would have no impact on the geography of the river or the surrounding lands. The river would maintain the existing stepped pool structure.

7.6.1.5 Mothball

The Mothball Alternative is considered only in the short term as the project would either be reinvigorated in 5 to 10 years or, beyond 10 years, would move to a state of de facto abandonment. Over the short term of this alternative, no impact to geography would be expected. The river would maintain its existing stepped pool structure.

7.6.1.6 Abandonment

Initially, no impact to geography is expected. However abandonment is considered unsustainable over the long term. With this alternative, there is a high risk that within the 50 year project life, failure of one or more of the facilities may occur, leading to the uncontrolled loss of the pool(s).

Failure of a L/D would include changes to the river both upstream and downstream of the project. The locks range in height from 11.6 ft to 22 ft. As such, the drop in water elevation would be significant in some locations. The unplanned loss of the pool(s) behind each project would re-establish riverine morphology through a portion of that reach (similar to Figure 16), including an increase of water velocities and decrease of water depths. Models have shown a few locations where this could create rapids in place of the existing stepped pools.

Sediment that has accumulated within the pools behind the dams would be mobilized downstream. Rates of sediment erosion and downstream aggradation is dependent on the sediment characteristics (grain size, cohesion, and spatial variability). This sediment movement through the system could reduce recovery time for the river from the past gravel mining operations, leading to more natural depths throughout the river. Without prior investigation, failure of a dam could mobilize contaminants in the sediments behind the dams or trapped within dredge holes. See Section 7.6.6 below for more information on contaminants.

The river channel through the project area may be unstable for a number of years following a dam failure as sediments shift (Doyle et al 2004). The sudden lowered water levels would expose large areas of unvegetated bank. Emergency bank stabilization, likely with armoring, may be needed to protect infrastructure. Figure 17 shows the anticipated dewatered lands and Appendix A provides closer images for more detail. Likely impacts to geography would include: grain size increase in the channel bed with water velocity increases; dewatering of existing fringe wetlands coupled with the natural establishment of wetlands along the new channel alignment; restoration of riffle/run and pool/glide channel features; exposure, expansion, or creation of mid-channel islands and gravel bars; and re-establishment of a more natural seasonal hydrograph throughout the reach.

7.6.1.7 Removal

Removal of L/Ds 5 through 9 would include changes to the river morphology throughout the project area as discussed above for a dam failure. However the Removal Alternative allows for planning and implementation of mitigation activities to reduce negative impacts on the ecosystem and surrounding communities. Pre-removal investigation could ensure that mobilization of the sediments behind the dams or trapped within dredge holes would not mobilize contaminants. Bank stabilization actions could begin before or during removal to reduce risk to infrastructure and allow for use of softer stabilization methods such as riparian plantings. Slow draw-down of the water levels could also reduce risk of bank failures.

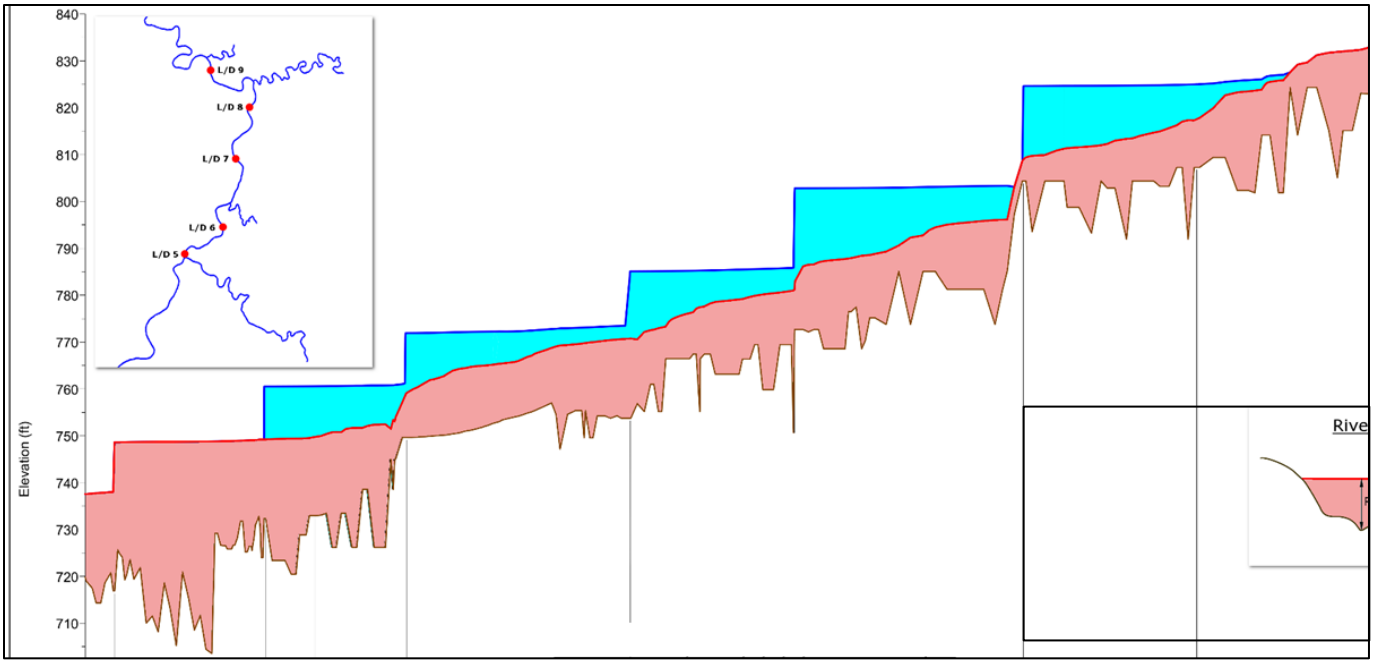


Figure 16. Mid channel profile depths at an average annual flow with the No Action alternatives (blue) and the Removal alternative (red).

7.6.2 Vegetative Cover

7.6.2.1 No Action - Flat Funding

With the implementation of the Flat-Funding Alternative no impact to the vegetation along or within the Allegheny River is expected. Operational failure of a project (loss of the ability to run the locks) is likely under this alternative, however structural failure is not anticipated. The river would maintain its existing stepped pool structure.

7.6.2.2 No Action – Reduced Funding

Impacts to vegetation from this alternative would be similar to those described for the Flat Funding Alternative.

7.6.2.3 No Action - Sustainable Funding

With the implementation of the Sustainable Funding Alternative no impact to the vegetation along or within the Allegheny River would be expected.

7.6.2.4 Transfer

With the implementation of the Transfer Alternative no impact to the vegetation along or within the Allegheny River would be expected. No change in the status quo that would lead to a change in vegetation is expected.

7.6.2.5 Mothball

Impacts of the Mothball Alternative on vegetation would be identical to those discussed above for the No Action Alternatives.

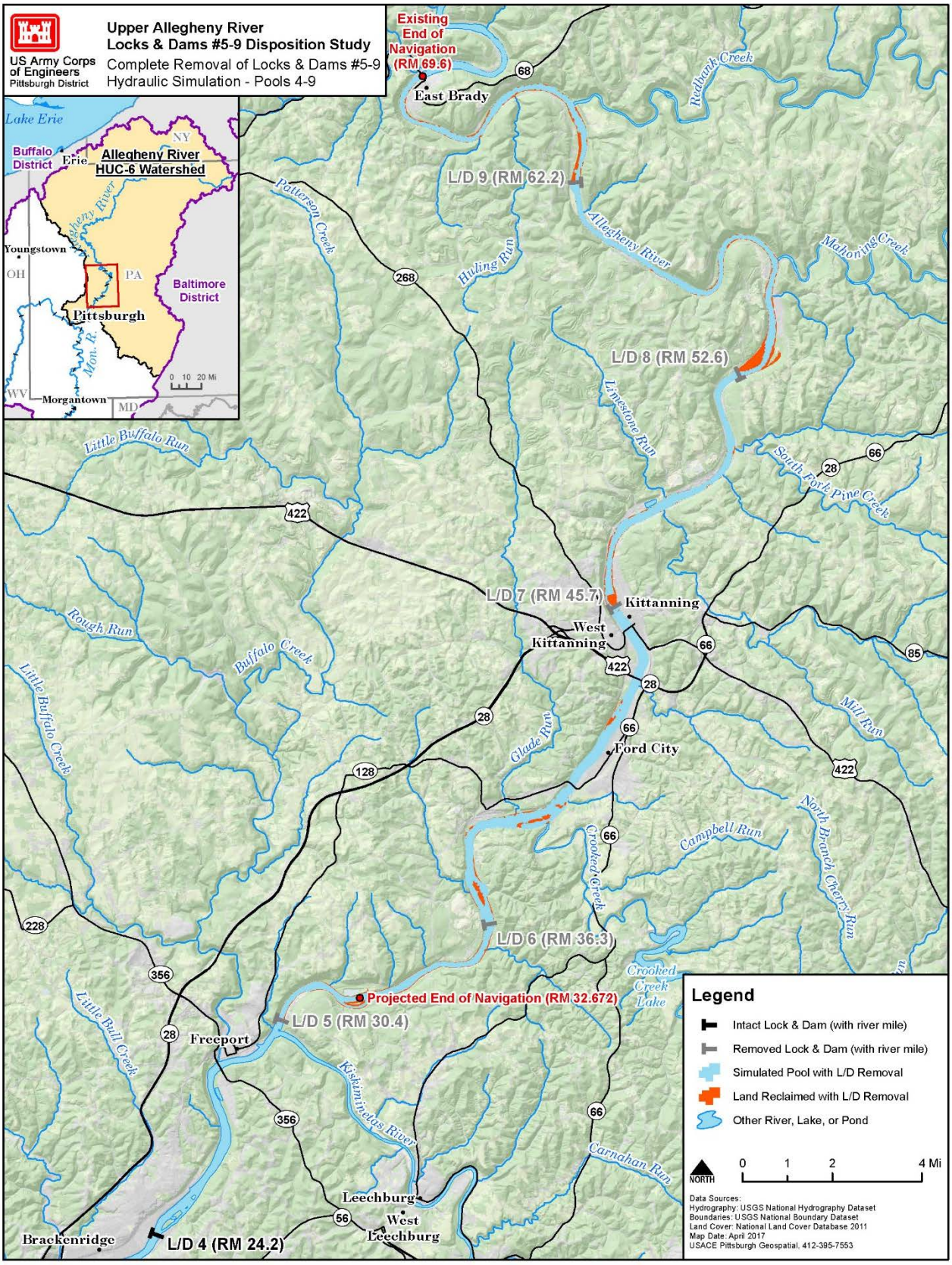


Figure 17. Map of reclaimed lands within the project area with removal of all 5 L/Ds.

7.6.2.6 Abandonment

Initially, impacts to vegetation of the Abandonment Alternative would be similar to the No Action Alternatives. However the Abandonment Alternative is considered unsustainable over the long-term. With this alternative, there is a high risk that within the 50 year project life, failure of one or more of the facilities may occur, leading to the uncontrolled loss of the pool(s).

The uncontrolled loss of the pool from the impacted project upstream to the next dam would dewater many acres of land in the affected area (Figure 17). Initially, this new land would be unvegetated. The bare soils would be quickly colonized by weedy, pioneer species, some of which would be nonnative species (Orr and Stanley 2006, Tullos et al. 2016). In a review of data from 25 dam removals around the world, Tullos et al. (2016) found that the proportion of nonnative to native plants on former reservoir sites was similar to many riparian floras around the world, though the range was quite varied. Orr and Stanley (2006) found that in Wisconsin, introduced species were a regular and abundant component of plant communities on former reservoir sites. Without intervention, establishment of monocultures of aggressive nonnative plants could impede the succession of some sites to diverse riparian forested habitats.

Additionally, newly dewatered bare river banks could be vulnerable to erosion. Banks that occur next to infrastructure may require emergency stabilization, likely via the use of armoring. Construction of the armored banks would require vegetation removal and the placed rock may also have longer-term impacts on vegetation establishment on the hardened bank.

Lowered water levels could dewater the existing wetlands within the project area. Additionally, lowered water levels can cause mortality to riparian vegetation along the former pool margin for species sensitive to the water table (Shafroth et. al 2002). The USFWS National Wetlands Inventory shows approximately 62 acres of primarily forested and shrub wetlands associated with the mainstem Allegheny River in the project area. Although these may be negatively affected by reduced water levels with the loss of the existing pools, the long-term expectation is that the naturalized river would result in more wetland habitat through the project area. On average, the free-flowing river from the area above the L/D 9 pool to the Kinzua Dam has 7 acres of wetland per river mile (USFWS 2017a). This includes mid-channel islands as well as wetlands directly along the river banks. The river from L/D 5 to the end of the pool at L/D 9 averages only 1.5 acres of wetland per river mile (USFWS 2017a). Mid-channel islands and shallow edge habitat as seen above the pools currently would likely emerge throughout the impacted area when a dam failure occurred. This could result in an increase in wetlands within the impacted area over the project life, if the dam were not reconstructed.

Grassland communities along the river could expand. As noted previously in Section 4.2.2.3 these habitats rely on scour caused by the natural fluctuations in the water level, as occurs in the free-flowing reaches of the Allegheny River upstream of L/D 9. The restoration of riverine morphology within the impacted area would increase the area available to this

vegetative community. Species of concern requiring these conditions, such as blue false-indigo, would benefit from this expansion.

7.6.2.7 Removal Alternative

The removal alternative would result in the dewatering of approximately 705 acres of land throughout the entire project area (Figure 17). As described in the Abandonment Alternative, without intervention, the establishment of monocultures of aggressive nonnative plants could impede the succession of some sites to diverse riparian forested habitats. However, the Removal Alternative allows for mitigation planning to minimize these impacts. A planting plan and weed control efforts could reduce colonization by a high percentage of non-native invasive species. Given the surrounding landcover being predominantly forested (Figure 9), seed sources for riparian recovery are readily available.

Impacts to wetlands and riparian habitats for this alternative are similar to those described for the Abandonment alternative. Although there would be initial negative impacts, an overall increase in wetlands within the project area over the project life is likely. With plant management, to reduce expansion of invasive nonnatives, the expansion of wetlands could benefit several state species of concern that are associated with wetland habitats.

As noted above, the lowering of the pool could allow for the expansion of grassland communities along the banks. The restoration of riverine morphology along the 41.6 river miles within the project area would benefit this community. Species of concern requiring these conditions, such as blue false-indigo, would also benefit.

7.6.3 Fish and Wildlife

7.6.3.1 No Action - Flat Funding

With the implementation of the Flat-Funding Alternative no impact to wildlife in the project area is expected as the status quo would be largely maintained. Operational failure of a project (loss of the ability to run the locks) is likely under this alternative, however structural failure is not anticipated. The complete loss of the operability of the locks would block the movement of fish within the project area. This impact would need to be further explored in order to determine significance, based on a better understanding of how fish are currently able to use the locks, particularly during important migratory seasons. Similarly, use of the locks by species of fish specifically used as hosts for mussel larvae would need to be further studied. Current use of the locks for upstream passage is likely limited due to the lack of attractant flows within the locks and presence of competing attractant flows on the opposite riverbank from the locks. The river would maintain its existing stepped pool structure and overall habitat impacts would be negligible.

7.6.3.2 No Action – Reduced Funding

Impacts to fish and wildlife from this alternative would be similar to those described for the Flat Funding Alternative. The removal of recreational lockages would reduce fish passage in the system and the decreased funding could lead to operational failure and complete fish passage blockage more quickly than the Flat Funding Alternative.

7.6.3.3 No Action - Sustainable Funding

With the implementation of the Increased O&M Funding Alternative no new impact to the fish and wildlife in the project area is expected. No change in the status quo is expected. With the continued decrease in commercial lockages anticipated over the 50 year project life, some decrease in fish passage would be anticipated. Lockages for recreation, through contributed funds, would be expected to continue to provide some continuity and passage opportunity for fisheries during the summer months.

7.6.3.4 Transfer

The Transfer Alternative would be expected to have only minor impacts on wildlife in the project area. The existing pools and terrestrial habitat would be maintained. It is likely under this alternative that hydropower would be developed at L/D 7, which would cause temporary construction impacts such as noise, emissions, and turbidity which could impact nearby wildlife. Impacts to fisheries, discussed below, could also impact prey base for some wildlife, and birds.

For fisheries resources, the transfer alternative may have significant negative impacts. The facilities, as currently run by the Corps, maintain a non-degradation standard for water quality. The locks and their pools reduce dissolved oxygen in the river due to the transformation from a riverine to a more lacustrine environment. In a free-flowing river, aeration is generated by water flowing over rock-riffles and waterfalls. The Corps operates the locks on the Allegheny River to compensate for the lack of naturally generated dissolved oxygen by releasing water over the dam to supersaturate the upstream end of the next pool. The assumption with the Transfer Alternative is that the facilities would be transferred to hydropower operators. As such, FERC licenses may be renegotiated within the 50-year project life to allow the hydropower operators to increase the amount of water directed through the turbines (and decrease that released over the dam) to increase the power generation of the facilities. During re-licensing, the required water quality standards for the facilities could be reduced to the state minimum. This is likely to result in reduced dissolved oxygen levels downstream of the dams, particularly during periods of low flow.

Mussels in the study area thrive in the shallow, quick-moving riffle habitat below dams and near sediment deposits that have formed islands in the river (PNHP 2010, Smith and Meyer 2010). Water quality degradation could significantly impact this sensitive group of organisms.

The continued operation of the locks under this alternative is uncertain. As noted above, the loss of the operability of the locks would further restrict the movement of fish within the project area. This impact to fish and mussels would need to be further explored in order to determine significance of this impact. The river would maintain its existing stepped pool structure and overall habitat impacts would be negligible.

7.6.3.5 Mothball

Impacts to fish and wildlife from the Mothball Alternative would include the complete loss of connectivity and fish passage upon implementation of this alternative and cessation of all lockages. The Mothball Alternative has additional risks of spills or leaks of fluids into the

river. Because the facilities are maintained in a state where they could be restarted, some fluids and potentially hazardous materials would remain. A leak or spill could occur from a catastrophic failure, which is not likely over the short mothball period, or from the slow degradation of the project. Without routine inspections, the later situation could lead to an unknown unreported leak that could cause widespread downstream impacts to fish, wildlife and their habitats.

7.6.3.6 Abandonment

Impacts to fish and wildlife from the Abandonment Alternative would include the complete loss of connectivity and fish passage upon implementation of this alternative. With this alternative, there is a high risk that within the 50 year project life, failure of one or more of the facilities may occur, leading to the uncontrolled loss of the pool(s). Failure of a project would include changes to the river both upstream and downstream of the project.

Uncontrolled loss of the pool would create many acres of newly available terrestrial habitat in the affected reach. Impacts to most terrestrial species would be negligible, given the availability of surrounding habitats of similar quality. Species that favor pool habitats, such as waterfowl, would lose habitat in the impacted area. Species, such as amphibians, that benefit from floodplain habitats and wetlands would gain habitat over time. The relative rarity of these habitat types in the project area (PNHP 2010) and the potential for a substantial increase of these habitats could lead to long-term benefits to amphibian populations in the project area. Additional floodplain forest habitat could also increase habitat available to federally-listed species in the region (Indiana bat, northern long-eared bat, and the eastern massasauga).

Short-term negative impacts to aquatic species would be expected with an uncontrolled loss of the pool. Impacts would include the degradation of water quality (increased turbidity), sedimentation/burial of spawning habitats, damage/burial of plants and benthic macroinvertebrates, and stranding of fish and dewatering of mussel beds. Increased sediment movement through the reach can occur for several years, as discussed above (Section 7.6.1; Tullos et al. 2016, Doyle et al 2004).

Without control of the methodology or timing of a pool loss, initial impacts to freshwater mussels would likely be significant. A study in Wisconsin found that a small dam removal caused the loss of 95% of the mussel population in the former impoundment due to desiccation and stranding (Nedeau 2006, Sethi et al. 2004).

Significant long-term benefits to aquatic species could occur if the failed dam were not reconstructed. PNHP (2010) notes that the shoreline of the Allegheny River, especially in the free-flowing section, provides unique habitat for natural communities including many species of special concern. Restoration of free-flowing conditions to a portion of the project area could improve water quality and improve connectivity within the impacted area and all connected tributaries. This would be expected to result in the long-term increase of habitat available to species of concern, most notably several federally-listed endangered and threatened mussels.

Aquatic species assemblages within the impacted area may shift, with a reduction of species that favor warmer lentic habitats to those favoring cooler lotic environments. Fish assemblage changes have been seen within a year after dam removal in some systems, while others have developed over several years (Dorobek et al. 2015). In the Allegheny River, Freedman et al. (2013b) found that fish taxonomic diversity was higher in free-flowing waters than in impounded waters. Smith and Meyer (2010) also found mussel species shifts within the current pools, with the faster waters and higher dissolved oxygen levels at the upstream end of each pool supporting riverine mussel species that were not found at the downstream end of the pool. Failure of a dam, as is likely under the Abandonment Alternative, would be expected to allow the expansion of these existing diverse, lotic assemblages throughout the impacted reach.

The impact to fish passage from a dam failure under the Abandonment Alternative is unknown. Depending on how the failure occurred and the condition of the remaining portions of the dam, passage could be restored or could continue to be blocked.

7.6.3.7 Removal

Removal of the L/Ds would create approximately 705 acres of newly available terrestrial habitat (Figure 17). As noted above, impacts to most terrestrial species would be negligible, given the availability of surrounding habitats of similar quality. Additional wetland and floodplain forest habitat could increase habitat availability for some special status species.

Short-term negative impacts to aquatic species would be expected with the implementation of this alternative. Impacts would include the degradation of water quality (increased turbidity), sedimentation/burial of spawning habitats, damage/burial of plants and benthic macroinvertebrates, and stranding of fish and dewatering of mussel beds. Increased sediment movement through the reach can occur for several years(Tullos et al. 2016, Doyle et al 2004).

With the implementation of the Removal Alternative, as with the Abandonment Alternative, initial adverse impacts to mussels due to the loss of pool could be significant. However with the Removal Alternative mitigation measures can be implemented. Adverse short-term impacts of dam removal on mussel assemblages and fisheries can be minimized with appropriate planning, timing, and removal techniques (Nedeau 2006, Heise et al. 2013). Mussel relocation efforts, particularly for areas known to harbor species of special concern, could reduce impacts of the action (Nedeau 2006).

Significant long-term benefits to aquatic species would be expected. PNHP (2010) notes that the shoreline of the Allegheny River, especially in the free-flowing section, provides unique habitat for natural communities including many species of special concern. Removal of L/D 5-9 would restore free-flowing conditions to over 41 miles of river and improve connectivity between many more miles of tributaries. This would be expected to result in the long-term increase of habitat available to species of concern, most notably several federally-listed endangered and threatened mussels.

Freshwater mussels are one of the most imperiled groups of organisms on the earth (PNHP 2010, Freshwater Mollusk Conservation Society 2017, Smith and Meyer 2010). Of the 300

species of freshwater mussels once in North America, 38 are presumed to be extinct and an additional 77 are considered critically impaired (Freshwater Mollusk Conservation Society 2017). In Pennsylvania, 14 species have been extirpated, and another 24 species are considered threatened or endangered by state agencies (PNHP 2010). The Allegheny River is nationally recognized for its freshwater mussel diversity, however the artificial pools formed by the navigation system have negatively affected these species (Smith and Meyer 2010, PNHP 2010). The removal of dams can have a very positive and significant impact to the future restoration of dwindling populations of mussels by improving water quality (particularly dissolved oxygen levels) and improving fish passage opportunities for host species (NRCS 2007, Sherman and Doyle 2013, Sethi et al. 2004).

Aquatic species assemblages within the project area may shift, with a reduction of species that favor warmer lentic habitats to those favoring cooler lotic environments. Fish assemblage changes have been seen within a year after dam removal in some systems, while others have developed over several years (Dorobek et al. 2015). In the Allegheny River, Freedman et al. (2013b) found that fish taxonomic diversity was higher in free-flowing waters than in impounded waters. Smith and Meyer (2010) also found mussel species shifts within the current pools, with the faster waters and higher dissolved oxygen levels at the upstream end of each pool supporting riverine mussel species that were not found at the downstream end of the pool. The removal alternative would be expected to allow the significant expansion of these existing diverse, lotic assemblages.

Fish can use locks for upstream and downstream migration and population connectivity. However, due to the low number of lockages occurring, particularly during important migration periods, overall fish passage within the project area would be significantly improved with the Removal Alternative. The addition of 41 miles of open, passable habitat and the reconnection of these populations would significantly benefit fish and mussel populations.

The impact of dam removal on invasive species distribution and abundance in the river is uncertain. Because of the limited connectivity, the existing system of L/Ds presents a partial barrier for aquatic invasive species such as Asian carp. As of 2011, Pennsylvania Fish and Boat Commission stated that there were no known occurrences of invasive Asian carp in Pennsylvania, though they were in the Ohio River. Asian carp could be within the Allegheny River within 10 years (Thomas 2016). Removal of the L/Ds could ease the spread of invasive aquatic species throughout the project area. Conversely, zebra mussels, colonization of which is a threat to native freshwater mussels, are sensitive to turbulent forces (Horvath and Crane 2010, Smith and Meyer 2010, Rehmann et al. 2003). These mussels thrive in pooled waters and the restoration of free-flowing conditions could decrease the threat of further colonization within the project area. Johnson et al. (2008) showed that invasive species were significantly more likely to occur in impoundments than in natural water bodies.

7.6.4 Water Quality

7.6.4.1 No Action - Flat Funding and No Action – Sustainable Funding

These alternatives would have negligible impact on current water quality conditions within the study area. The existing impoundments impact water quality through chemical and physical stratification (metals, conductivity, water temp, dissolved oxygen, etc.) and these alternatives maintain the status quo. Water aeration to increase DO in the navigation channel would continue to occur during spillage over each of the L/Ds. Regional effects of climate and localized effects from point sources and non-point sources would continue to influence water quality as discussed above. From the trends seen in the data we would expect pool DO vertical stratification to continue, as well as decreasing trends in acid mine pollution and increasing trends in nutrients and thermal pollution.

7.6.4.2 No Action - Decreased Funding, Abandonment, and Mothball Alternatives

These alternatives are expected to have a slight negative impact on water quality. Although there are few lockages now, further reduction or complete lack of lockages would increase retention times for water in the pools. Coupled with increasing nutrient, sediment, and thermal pollution loads over time, stratification may become more severe and water quality may degrade.

These alternatives could also potentially produce negative impacts to water quality through contamination. All three alternatives have an increased risk for structural failure. During failure there would be a high potential for the resuspension of contaminated sediments which are currently trapped behind each L/D structure. Suspension of sediments into the water can result in the sediments being re-deposited in undesirable locations and in overall short-term column water quality degradation. In addition the mothball alternative would allow for hydraulic fluid, oil and other mechanical fluids to remain in place. Leakage of these fluids without containment would cause serious and detrimental impacts to water quality

7.6.4.3 Transfer

Water quality is a concern in new hydroelectric development at navigation dams because of the reduced mixing of air and water during hydropower operation and the re-suspension of contaminated sediments that may occur during construction of the proposed facilities. FERC licensed non-federal hydropower facilities have been constructed and are operational at L/D 5 (FERC No. 3671), 6 (FERC No. 3494), and 8 and 9 (FERC No. 3021). Article 54 of these licenses stipulates that "…the Licensee shall enter into a Memorandum of Agreement with the Pittsburgh District [Corps] describing the mode of hydropower operation acceptable to the Pittsburgh District." Due to Corps' requirements, these licenses currently require that the bypass flow or spill at these dams be high enough to consistently maintain a minimum downstream DO concentration of 6.5 mg/l. All transfer partners would be governed by the conditions set forth in the FERC license. However, FERC licenses may be renegotiated within the 50-year project life to allow the hydropower operators to increase the amount of water directed through the turbines (and decrease that released over the dam) to increase the power generation of the facilities. During re-licensing, the required

water quality standards for the facilities could be reduced to the state minimum. This is likely to result in reduced dissolved oxygen levels downstream of the dams, particularly during periods of low flow.

7.6.4.4 Removal

Removal of the L/D structures from the Allegheny River would have significant ecological benefits, including the reestablishment of a natural flow regime, temperature regime, oxygen levels and sediment transport. During the L/D removal, temporary increases in turbidity would likely create short-term degradation of water quality downstream from any work sites. Following dam removal, increased water flow in the former pool area would likely re-suspend sediment from that area for some period of time, which would result in increased turbidity and total suspended solids downstream. Over time, this process would result in redistributing the sediment. Eventually, all sediment available for mobilization would be picked up from the former pool area above the dam and redistributed downstream, creating a more natural bed elevation throughout the channel. Increased water velocity in the former pool area would also likely result in increased aeration, reduced stratification, and higher dissolved oxygen levels. A long-term net benefit to water quality would be expected.

7.6.5 Air Quality/Greenhouse Gases/Climate Change

7.6.5.1 No Action - Flat Funding

Continuation of the current levels of O&M within the project area is not expected to significantly impact air quality, greenhouse gases, or climate change. Although operation of the locks may be compromised over the project life, the pool is expected to be maintained and thereby operation of the hydropower facilities is expected to continue. Small levels of emissions generated by the operation of the project would continue per the status quo.

Expected impacts of climate change on this alternative are minimal. Periodic droughts and severe spring flood events may reduce the ability to navigate the river at times. Impacts to the L/Ds from the low or high flow periods or to the increase in water temperatures is expected to be minimal.

7.6.5.2 No Action – Reduced Funding

Impacts to air quality, greenhouse gases, and climate change from this alternative would be identical to those described for the Flat Funding Alternative.

Impacts of climate change on the L/Ds with the implementation of this alternative is similar to that described for the Flat Funding Alternative.

7.6.5.3 No Action - Sustainable Funding

Increased levels of O&M funding is not expected to significantly impact air quality, greenhouse gases, or climate change. Operation of the hydropower facilities is expected to continue. Small levels of emissions generated by the operation of the project would continue per the status quo.

Impacts of climate change on the L/Ds with the implementation of this alternative is similar to that described for the Flat Funding Alternative.

7.6.5.4 Transfer

As noted previously, with implementation of the Transfer Alternative, the facilities would likely be transferred to hydropower operators. As such, FERC licenses may be renegotiated within the 50-year project life to allow the hydropower operators to increase the amount of water directed through the turbines to increase the power generation of the facilities. Increased power generation could allow for an increased percentage of the state's power generation to come from hydropower. As hydropower generation emits extremely low amounts of pollutants, this alternative could result in improved air quality and reduced greenhouse gas emissions within the state. Additionally, under this alternative construction of hydropower at the facilities that do not currently have hydropower (L/D 7) may occur. This would further increase hydropower generation in the project area. The initial construction could create short-term emissions impacts, but the long-term benefit of low-emissions power generation should benefit the region.

Impacts of climate change on the Transfer Alternative could include an increased risk for potential transfer partners. During periods of drought, the hydropower facilities would generate a reduced amount of electricity or potentially would be unable to generate power at all.

7.6.5.5 Mothball

It is expected that the hydropower facilities would continue to operate, despite closure of the L/Ds. Impacts of this alternative would be the same as the No Action Alternatives.

Impacts of climate change on the L/Ds with the implementation of this alternative is similar to that described for the Flat Funding Alternative.

7.6.5.6 Abandonment

It is expected that the hydropower facilities would continue to operate, despite abandonment of the L/Ds. However, with this alternative, there is a high risk that within the 50 year project life, failure of one or more of the facilities may occur, leading to the uncontrolled loss of the pool(s). With the loss of the pool, the hydropower facility would no longer operate. The loss of hydropower generation would lead to an increase in demand for generation from other sources, as discussed further for the Removal Alternative. The impact of this would depend on which dam was affected. The amount of power generated by the facilities at the lower dams is far less than that generated at L/Ds 8 and 9.

Impacts of climate change on the L/Ds with the implementation of this alternative is similar to that described for the Flat Funding Alternative.

7.6.5.7 Removal

Temporary impacts to air quality from the removal project would include the emissions created by the use of heavy equipment to conduct the onsite (demolition and site restoration) work and from trucks used to transport debris or other materials and personnel during construction. This short-term impact would not be significant.

There are four existing hydropower facilities on the L/Ds that would be removed with this alternative. In Pennsylvania, the majority of the net electricity generation is nuclear (41.3%), followed by natural gas (32.2%) and coal (21.9%; USEIA 2016). Hydropower generates 1.6% of Pennsylvania's electricity.

The average annual generation of energy at all four hydropower facilities in the project area is approximately 268 million kWh. Running these facilities generates approximately 6,500 metric tons of CO_2 annually (Schlömer et al. 2014). A switch to the other types of power generation, would generate approximately 90,000 metric tons of CO_2-equivalent annually (Schlömer et al. 2014). Because nuclear and natural gas power generation produce relatively little sulfur dioxide, ozone, and particulate matter, the switch from hydropower to other generation types is not expected to significantly impact the County's ability to attain NAAQS (de Gouw et al. 2014, Nuclear Energy Institute 2017).

Pennsylvania's Alternative Energy Portfolio Standards require 18% of electricity sold by 2021 to come from approved renewable or alternative sources (USEIA 2016). Annual reporting shows that the state is expected to meet this long-term goal (PAPUC and PADEP 2015). The loss of hydropower at the Allegheny L/Ds would reduce the progress toward the goal, however hydropower is a very small portion of the overall alternative energy credits such that this loss would not be expected to impede attainment of the requirement.

EPA (2009) published a rule that established mandatory reporting for sources that emit over 25,000 metric tons of CO_2-equivalent. In 2015, five facilities in Armstrong County reported 9,877,204 metric tons of CO_2-equivalent, with 99% of these emissions from 2 power plants (EPA 2016c). The loss of hydropower would raise the County's reported emissions by approximately 1% annually. In 2015, over 8,000 facilities nationwide reported direct emissions of a total of 3.05 billion metric tons of CO_2-equivalent, which is about half of the nation's total GHG emissions (EPA 2017c).

As plants grow, they sequester carbon from the air through photosynthesis. Sequestration rates of vegetation vary greatly according to the age, composition, location, and the type of soil (Tufts University 2017). Initial vegetation growth would be expected to sequester larger amounts, with the amount decreasing over time as root structures and above ground biomass stabilized (EPA 2017d, Anwar 2001). Although the actual amounts of carbon that would be sequestered are difficult to assess, rough estimates can provide perspective. Using cropland biomass numbers to roughly estimate the annual carbon sequestration for the initial years, 705 acres of new vegetation would sequester approximately 1,423 metric tons of carbon (2.02 tons of carbon sequestered per acre, EPA 2017e). By year 50, assuming all land were to become forested, approximately 747 metric tons would be sequestered annually (1.06 tons of carbon sequestered per acre, EPA 2017e). Although these sequestration numbers are rough guidelines, they show that the newly vegetated land is insufficient to offset the annual addition of CO_2-equivalent into the atmosphere.

Using the EPA (2009) mandatory reporting rule as a general significance threshold, the removal alternative would have a significant impact on greenhouse gases. Annual emissions of an additional 90,000 metric tons of CO_2-equivalent would increase greenhouse gas emissions and thereby have an incremental impact on global climate change.

Impacts of climate change on the Removal Alternative may include the moderation of the potential benefits for sensitive species. Warming trends and increased frequencies of droughts and heavy downpours may stress the aquatic environments, such that the long-term benefits of restoring a riverine system are reduced.

7.6.6 Hazardous, Toxic, and Radioactive Waste

7.6.6.1 No Action - Flat Funding

With implementation of the No Action – Flat Funding Alternative, no impact resulting from HTRW in the project area would be expected as the status quo would be largely maintained. Operational failure of a project (loss of the ability to run the locks) is likely under this alternative, however structural failure is not anticipated. Assuming that hazardous and petroleum products would be removed from any failed facilities, operational failure may have some minor benefit in that occasional minor accidental spills of hazardous materials and petroleum products used for operation of the project would be largely eliminated.

7.6.6.2 No Action – Reduced Funding

With implementation of the No Action – Reduced Funding Alternative, impacts resulting from HTRW would be similar to the No Action – Flat Funding Alternative. Decreased funding could lead to operational failure earlier as compared to the No Action – Flat Funding Alternative. Assuming that hazardous and petroleum products would be removed from the failed facilities, minor benefits may result in that occasional minor accidental spills of hazardous materials used for operation of the project would be largely eliminated.

7.6.6.3 No Action - Sustainable Funding

With implementation of the No Action – Sustainable Funding Alternative, impacts resulting from HTRW would be largely similar to the No Action – Flat Funding Alternative. Some minor benefits may result with sustainable funding in that improved maintenance and potential upgrades to the L/D facilities may result in fewer hazardous material spill incidences, particularly from the hydraulic fuel reservoirs and pipelines.

Increased O&M funding may also provide more opportunities for maintenance dredging of the L/D areas. While some short-term impacts may be expected from disturbance of contaminated sediment during dredging, some long-term benefits may result from the permanent removal of potentially contaminated sediment from the waterway.

7.6.6.4 Transfer

The Transfer Alternative may result in HTRW-related impacts. The assumption with the Transfer Alternative is that the L/D facilities would be transferred to hydropower operators. Currently, hydropower facilities are located at L/D 5, 6, 8, and 9. Assuming that construction of the hydropower facilities would occur in-water at the facilities that do not currently have hydropower (L/D 7), HTRW-related short-term impacts may result from disturbance and downstream migration of potentially contaminated sediment during construction. In addition, flow patterns during operation of the hydropower facility may result in some turbidity/disturbance of contaminated sediments within the study area. This

could result in resuspension and transport of contaminated sediment downstream and/or release of dissolved contaminants into the water column.

Further studies and/or implementation of a sampling and testing program would likely be required to identify and quantify contaminants and characterize the geotechnical and hydraulic properties prior to construction of any new hydropower facilities. If contaminants are present above USEPA sediment screening criteria, a mitigation plan may be required to reduce potential migration of these contaminated materials downstream during construction activities and/or operation of the hydropower facilities. These plans could include potential stabilization of the contaminated sediment (i.e. in-situ treatment, capping or placement of geotextiles) and/or dredging or excavation of contaminated sediments in a controlled manner prior to construction of the hydropower facility. Any contaminated sediment removed from the site would likely involve treatment of the sediment and water and/or transport to a disposal facility (EPA 2005). Short-term impacts to the aquatic resources may still occur from some sediment disturbance associated with mitigation of contaminated sediment prior to implementation of new hydropower facilities. However, long-term benefits would also be expected due to permanent removal and/or stabilization of contaminants that would otherwise potentially continue to impact the waterway.

As mentioned previously, FERC licenses for hydropower facilities may be renegotiated within the 50-year project life to allow the hydropower operators to increase the amount of water directed through the turbines (and decrease that released over the dam) to increase the power generation of the facilities. Changes in flow could increase resuspension of contaminated sediments resulting in short-term and long-term impacts downstream.

Other HTRW-related risks and concerns associated with the Transfer Alternative include the introduction of additional stored fuels, oils and other hazardous materials and petroleum products to be used for operation of the hydropower facility.

7.6.6.5 Mothball

The mothball alternative considers short-term sustainment of facilities with the option to reopen a project. This would require materials and fuels necessary for operation of the project to remain onsite during the period of time that the project is effectively out of commission.

The Mothball Alternative has the risk of spills and/or leaks of potentially hazardous materials and petroleum products into the river. These spills or leaks could occur from a catastrophic failure or from slow degradation of the project. The risk of spills or leaks from the hydraulic reservoirs and pipelines would be especially critical at L/D 6 through 9, as leaks are currently occasionally occurring. Without routine inspections and regular staffing of the facilities, unknown/unreported leaks may occur that could result in widespread downstream impacts to sediment quality, water quality and aquatic resources.

7.6.6.6 -Abandonment & decommissioning

Under the Abandonment and Decommissioning Alternative, there is high risk of structural failure of one or more of the L/D facilities at some point within the 50-year project period.

With any catastrophic failure, HTRW-related risk from migration of any potentially contaminated sediment accumulated behind the L/Dstructures downstream is significant. In addition, the breach of any structure could lead to an uncontrolled loss of pool behind the failed project and therefore could result in significant turbidity and scouring of sediment near or downstream of the project. The result could be a substantial migration of resuspended contaminated sediment and dissolved contaminants downstream; short-term and long-term impacts to aquatic and terrestrial species would be expected to be significant.

Under this alternative, it would be expected that prior to abandonment the facilities would be abated of any potential PCBs, lead, asbestos or creosote in building materials or equipment and that potential hazardous materials or petroleum products would be removed from the site. As a result, catastrophic or gradual failure of the structures would not be likely to result in inadvertent spills or introduction of hazardous materials into the waterway.

7.6.6.7 Removal

As a result of the historic industrial and agricultural nature of the Allegheny riverbank, there is a potential for contaminants to be present in accumulated sediment and materials behind or near L/D structures. Implementation of the Removal Alternative could result in significant disturbance and potential migration of contaminated sediments and materials to downstream locations.

Short-term impacts from the release of accumulated sediment behind L/D structures during removal activities would be expected, including potential resuspension and downstream transport and deposition of contaminated sediment. During resuspension, the release of dissolved contaminants from sediment into the water column may occur resulting in impaired water quality and easier transport of contaminants to destinations even further downstream (EPA 2005).

Depending upon the extent and type of sediment contamination, long-term impacts could also potentially be expected from the downstream release of resuspended sediment and dissolved contaminants. Negative impacts from the disturbance and release of contaminants can affect drinking water quality, aquatic species and potentially terrestrial species in downstream reaches (Bountry et al. 2009). Case studies of previous dam removals/failures have indicated contaminated sediment release can result in serious environmental impacts downstream (Evans 2015 and Hart et al. 2002).

Implementation of the Removal Alternative would likely involve mitigation of HTRW prior to removal of the L/D structures. HTRW-related risk during removal activities could be minimized by identifying the type and extent of sediment contamination. Prior to removal activities, further studies and implementation of a sampling and testing program would likely be required to identify and quantify contaminants and characterize the geotechnical and hydraulic properties at each L/D. The scope of sampling for contaminants would be similar to a Phase II Environmental Site Assessment (ESA) and would include input and criteria as identified by EPA and applicable state regulatory agencies.

If contaminants are present above EPA sediment screening criteria, a mitigation plan would likely be required to reduce potential migration of these contaminated materials downstream during removal activities. These plans could include potential stabilization of the contaminated sediment (i.e. in-situ treatment, capping or placement of geotextiles) and/or dredging or excavation of contaminated sediments in a controlled manner prior to removal of structures. Any contaminated sediment removed from the site would likely involve treatment of the sediment and water and/or transport to a disposal facility (EPA 2005). Short-term impacts to the aquatic resources may still occur from some sediment disturbance associated with mitigation of contaminated sediment prior to removal of the structures. However, long-term benefits would also be expected due to permanent removal and/or stabilization of contaminants that could otherwise potentially continue to impact the waterway.

Other HTRW-related risks and concerns associated with the Removal Alternative include the removal and/or abatement of existing hazardous or contaminated material associated with the L/D facilities. Current operation of the L/D facilities includes storage and/or use of hazardous materials and petroleum products, some of which could potentially impact the environment if a spill or release were to occur. Prior to removal, existing above-ground storage tanks (ASTs) which store petroleum products and hydraulic fuel reservoirs would need to be drained and removed. Similarly, prior to demolition, building materials and equipment at the facilities which contain PCBs, lead, asbestos or creosote would need to be tested and/or identified and would likely be required to be removed and disposed of at a properly permitted facility.

7.6.7 Cultural Resources and Historic Properties

7.6.7.1 No Action - Flat Funding

Under the flat funding scenario, continued deterioration of the project may be considered to be an adverse effect to the historic integrity of the property under Section 106 effect definitions (36 CFR 800.5(a)(2)(vi)). Lacking adequate funding to maintain the project or comply with Section 106 would place the Corps out of compliance.

7.6.7.2 No Action – Reduced Funding

Under the reduced funding scenario, continued deterioration of the project would be considered to be an adverse effect to the historic integrity of the property under Section 106 effect definitions (36 CFR 800.5(a)(2)(vi)). Lacking adequate funding to maintain the project or comply with Section 106 would place the Corps out of compliance.

7.6.7.3 No Action - Sustainable Funding

Under the increased O&M funding scenario, major maintenance work would be subject to Section 106 consultation, and any adverse effects taken into account as part of the work (36 CFR 800.5(a)(2)(ii)). Should a major rehabilitation study be pursued, it would be more likely that Section 106 compliance may lead to a mitigation requirement stipulated in a Section 106 Memorandum of Agreement. Typically these mitigation requirements involve documentation of the original design and historic interpretive products for public

distribution. Neither of these would affect the engineering requirements or construction schedule if appropriately pursued with adequate lead time.

7.6.7.4 Transfer

Transfer of a federal property out of federal ownership, if that property is eligible for listing to the National Register of Historic Places, may be an adverse effect under Section 106 criteria (36 CFR 800.5(a)(2)(vii)). Attaching permanent historic preservation covenants to the deeds is often adequate for Section 106 compliance. If the transfer recipient is unwilling to accept these covenants, some form of mitigation would be necessary.

7.6.7.5 Mothball

While remaining in federal ownership, project deterioration, due to lack of maintenance funding, could be considered to be an adverse effect to the historic integrity of the property under Section 106 effect definitions (36 CFR 800.5(a)(2)(vi)). Section 106 compliance prior to implementation of this alternative may lead to a mitigation requirement stipulated in a Memorandum of Agreement. Typically these mitigation requirements involve documentation of the original design and historic interpretive products for public distribution.

7.6.7.6 Abandonment

While remaining in federal ownership, project deterioration, due to lack of maintenance funding, would be considered to be an adverse effect to the historic integrity of the property under Section 106 effect definitions (36 CFR 800.5(a)(2)(vi)). Section 106 compliance prior to abandonment may lead to a mitigation requirement stipulated in a Memorandum of Agreement. Typically these mitigation requirements involve documentation of the original design and historic interpretive products for public distribution. Marketing for adaptive reuse is a typical requirement with disposal proposals, but given a disposition study finding that there is no willing transfer partner, marketing would not likely be required.

7.6.7.7 Removal

The partial or total removal (deconstruction) of an historic L/D property would be an adverse effect under Section 106 criteria (36 CFR 800.5(a)(2)(i)). Under this alternative, the effects of pool lowerings would also need to be considered through studies to identify and evaluate properties along the affected riverbanks, and determine effect of pool lowering.

7.7 Comparison of Alternatives

7.7.1 Cost Comparison

Table 24. O&M Scenario Costs (April 2017 Dollars)

Alternative	Costs	
No Action - Flat Funding	**Annual**	**50 Year**
Allegheny 5	$752,766	$37,638,300
Allegheny 6-9 (per project)	$114,833	$5,741,650
Total No Action - Flat Funding	**$1,212,098**	**$60,604,900**
No Action - Sustainable Funding	**Annual**	**50 Year**
Allegheny 5	$752,766	$37,638,300
Allegheny 6-9 (per project)	$386,776	$19,338,800
Total No Action - Sustainable Funding	**$2,299,870**	**$114,993,500**
No Action - Reduced Funding	**Annual**	**50 Year**
Allegheny 5-9 (per project)	$114,833	$5,741,650
Total No Action - Reduced Funding	**$574,165**	**$28,708,250**

Table 25. Constructed Alternatives Costs per L/D (April 2017 Dollars)

Alternative	Costs			
	Lump Sum	Annual	Recovery	Total – 5/10 year
Mothball - 5 Year Recovery	$123,100	$71,217	$732,000	$1,211,184
Mothball - 10 Year Recovery	$123,100	$91,217	$1,038,400	$2,073,668
	Lump Sum	Annual	Recovery	Total – 50 Year
Mothball - 10 Year Abandon	$123,100	$71,217	$2,233,817 (Prep for Abandonment)	$3,069,087
Abandon	$2,367,389	$0	N/A	$2,367,389
Remove	$12,650,682	$0	N/A	$12,650,682
Transfer	$233,000	$0	N/A	$233,000

7.7.2 Screening and Selection Criteria

In order to screen alternatives and ultimately select a recommended plan, a set of criteria was developed by the PDT. In addition to the four criteria required by the Principles and Guidelines of completeness, effectiveness, efficiency and acceptability, the team also choose environmental impacts, socioeconomic impacts, budgetability, cost, safety, and risk. Following is a description of each of the criteria and how each criteria is rated for comparison. The full rating of alternatives is located in Section 7.6.

Completeness: The extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects.

Red – High probability planned effects will not be met without significantly higher costs
Amber – Moderate probability planned effect will not be met without higher costs
Green – Low probability that planned effect will not be met without higher costs

Effectiveness: The extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities. The performance against the planning objectives was used to assess effectiveness of alternatives for this study.

Red – Does not resolve the majority of defined problems
Amber – Resolves some defined problems
Green – Resolves or mitigates for all defined problems

Efficiency: The extent to which an alternative plan is the most cost effective means of alleviating the specified problems and achieving the opportunities. A relative comparison of cost effectiveness was conducted based on assumptions and existing information.

Red – Does not achieve majority of identified opportunities
Amber – Achieves some identified opportunities
Green – Meets all or most identified opportunities

Acceptability: The workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations and public policies. The extent to which alternatives avoided planning constraints was used to assess acceptability for this study.

Red – Not acceptable to most stakeholders or not compatible with existing law
Amber – Not acceptable to one or more major stakeholders
Green – Acceptable to all major stakeholders and compatible with existing law

Environmental Impacts: A relative assessment of the potential for environmental impacts and environmental benefits was assessed to include affects to federally listed species and water quality.

Red – Increased environmental degradation within the study area
Amber – Limited or no change to the affected environment
Green – Overall environmental improvement within the study area

Socioeconomic Impacts: This criteria includes assessments of the potential to impact recreation, water supply, hydropower, and other socioeconomic factors.

Red – Socio-economic outlook within the study area is negatively impacted
Amber – Limited or no socio-economic impact
Green – Socio-economic outlook within the study area is improved

Cost: This is a measure of the overall cost to the federal government to implement the alternative over the 50 year period of analysis.

Red – High initial or 50 year costs compared to No Action
Amber – Similar initial and 50 year costs to the No Action Alternative
Green – Lower initial and 50 year costs compared to No Action

Budgetability: This is a measure of the likelihood that the Corps will be able to secure the necessary funding in a timely manner needed to efficiently implement the alternative.

Red – Alternative cannot be budgeted for without changes to the process or law
Amber – Budgeting mechanisms exist but the alternative does not compete favorably
Green – Budgeting mechanism exist and could receive the identified level of funding

Safety: Although improvement to safety is also identified as a study objective, it was included as an evaluation criteria because the potential impacts to public safety as a result of a federal action is an important consideration as to whether or not an alternative is viable.

Red – Increased safety risk compared to current conditions
Amber – Similar safety risk to current conditions
Green – Safety risk decreased or eliminated

Risk: The extent to which an alternative mitigates for, or maintains a maximum threshold of acceptable risk to the agency over time. This criteria is primarily concerned with operational or structural failure at a project site.

Red – Risk is increased or higher than current conditions
Amber – Moderate risk, comparable to current conditions
Green – Long-term risk is low or eliminated

7.7.3 Evaluation

The table below (Table 26) shows a comparison between alternatives based on 10 evaluation criteria. None of the alternatives investigated met/remained neutral (amber) or improved/exceeded (green) in all of the criteria. Four criteria in particular did not meet or degraded current conditions for three or more alternatives: completeness, acceptability, socioeconomic impacts, and risk.

Table 26. Alternative Comparison by Evaluation Criteria

Criteria	NA-Flat	NA-LoS 6	NA-Sust	Transfer	Mothball	Abandon	Remove
Completeness							
Effectiveness							
Efficiency							
Acceptability							
Environmental Impacts							
Socioeconomic Impacts							
Cost							
Budgetability							
Safety							
Risk							

Completeness: With the exception of removal and transfer, none of the alternatives are considered a complete solution to the project status over the 50 year study period. The projects under consideration are 80+ years old. Without significant reinvestment it is

unlikely that the locks would remain functional until 2067. Operational failure is likely even under a sustainable funding scenario. Continued operations under reduced or static funding would likely lead to an operational or structural failure within the next 5-10 years. See the alternative descriptions for more discussion on operational and structural failures and critical maintenance for suspect failures.

Acceptability: There are competing interests on the Allegheny River with different preferred outcomes. Environmental advocacy groups, such as American Rivers, prefer removal and return to a free flowing river. Economic development and recreation groups oppose any alternative that would limit or eliminate the flow of traffic affecting future development of river dependent industry. Finally, hydropower operators need the dams to be maintained for continued operations. Competing stakeholder interests make it impossible to find an alternative that would meet the needs of all interested parties.

Socioeconomic Impacts: Closure and removal of facilities would reduce recreational opportunities and eliminate remaining commercial traffic through the locks. There is also potential to discourage future investment in the region should lock closure negatively impact transportation costs.

Risk: Continued operations of the projects at static or reduced funds creates a high risk of operational failure during the study period. Abandonment would increase the risk of an unplanned loss of pool during the study period as facilities degrade and inspections are reduced. Figure 18 shows a conceptual comparison of risk between alternatives. Without disposal of the projects risk would continue to grow at varying rates as the facilities age until there is a failure or major reinvestment in the project.

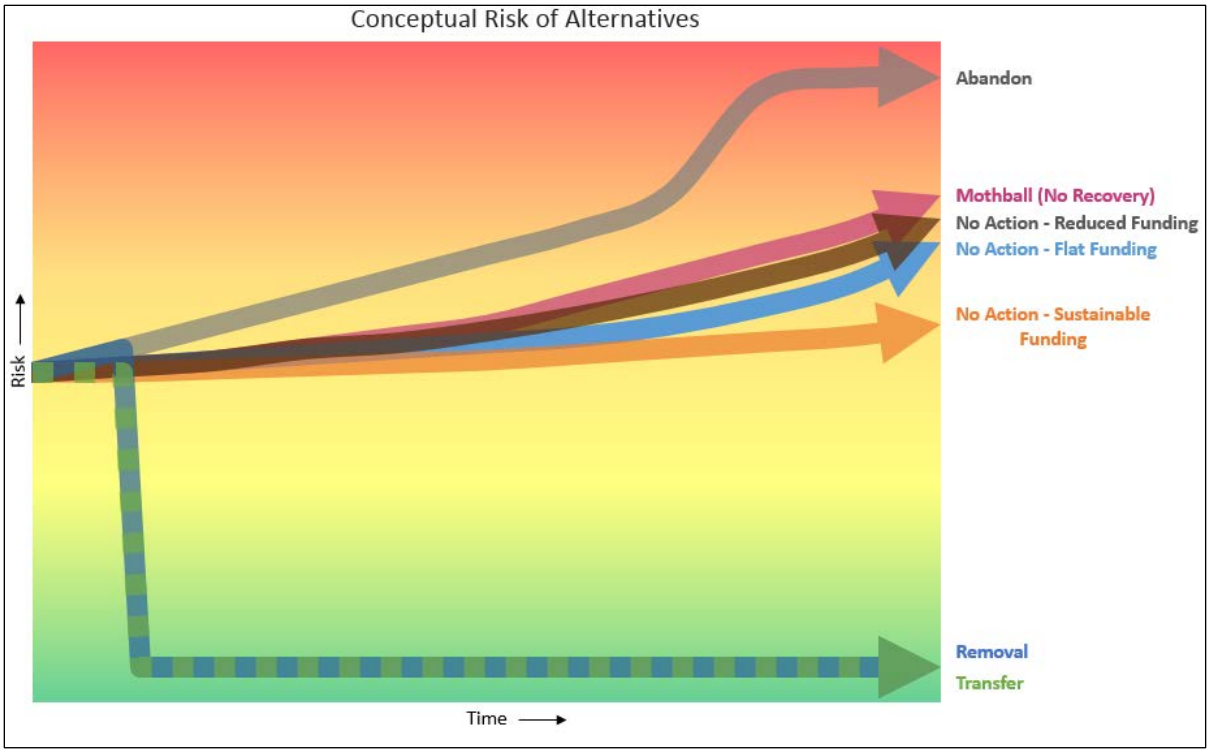


Figure 18. Conceptual Risk of Alternatives

A comparison of alternatives show that none meet all the evaluation criteria used for assessment. Each alternative fails under two or more criteria meaning that further investigation would be needed to develop a mitigation strategy and fully understand the impacts of implementation of any of these alternatives.

8 ENVIRONMENTAL COMPLIANCE CONSIDERATIONS

Federal Laws and Executive Orders	Compliance Considerations
Archaeological and Historic Preservation Act, 16 U.S.C. 469, et seq	The L/Ds of the Allegheny River Navigation System are historic properties listed on the National Register of Historic Places because of their contribution to the history of navigation and transportation in the Ohio Valley, and for their engineering significance. Any actions that would have an adverse effect on these facilities, or remove them from federal ownership, will require further effort to ensure compliance with these laws. Implementation of any alternative that could cause the loss of pool would require
Archaeological Resources Protection Act, 16 U.S.C. 470aa-11, et seq	
Historic Sites Act, 16 U.S.C. 461-467, et seq.	
National Historic Preservation Act, 16 U.S.C. § 470 et seq.	

Native American Graves Protection and Repatriation Act of 1990, as amended, 25 USC 3001-3013	further analysis to identify and evaluate areas vulnerable to increased erosion along the affected riverbanks and possible impacts to protected resources.
Bald and Golden Eagle Protection Act, 16 U.S.C. 668, et seq	One bald eagle nest is known to exist within the project area, 0.8 miles downstream of L/D 9 (USFWS 2017b). This is outside the buffers required under this Act for protection of bald eagles. No impacts to eagles would be expected from implementation of any of the proposed alternatives
Clean Air Act, as amended, 42 U.S.C. 1857h-7, et seq.	Emissions from construction activities associated with various alternative (maintenance activities or demolition) would be de minimis. The potential loss of hydropower would cause an increased demand for electricity generated by other methods, but this shift would not be expected to cause the violation of any existing state implementation plans or any NAAQS. The amount of electricity generated by the hydropower at the sites (268 thousand MWh) is 1.5% of the total production of electricity in the state (16,945 thousand MWh; USEIA 2017a). The shift of this energy production to other generators is unlikely to significantly increase their emissions output.
Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C	The potential exists for contaminated sediment to be located in the study area. Further studies and/or implementation of a sampling program to identify extent of any contaminants would likely be required prior to implementation of any alternative that would disturb sediment in the study area.
Clean Water Act, as Amended, 33 U.S.C. §1251 et seq.	The Removal Alternative would require further analysis for compliance with Sections 404 and 401 as in-water work could include discharge of temporary or permanent fill material into waters of the U.S. Any construction sites which disturb over one acre of ground must control stormwater runoff and receive authorization through a permit for

	compliance with Section 402. A Stormwater Pollution Protection Plan and a Construction General Permit would likely be required from the PADEP prior to construction.
Endangered Species Act of 1973, as amended, 16 U.S.C. §§ 1531-1544	Implementation of any of the action alternatives would require further analysis and consultation with the USFWS to ensure compliance with the ESA. A Biological Assessment could assess impacts from any change in pool, change in river connectivity, potential change of long-term water quality standards, or other impacts associated with the various alternatives. Significant impacts could occur to protected species, including potentially significant benefits. Further refinement of the alternative(s) and analysis of the effects would be required.
Fish and Wildlife Coordination Act, 16 U.S.C. 601, et seq.	Initial scoping letters were sent to the USFWS on 2 February 2017. To date, no response has been received. Implementation of any of the action alternatives would require further consultation with the USFWS to ensure compliance with the FWCA.
Migratory Bird Treaty Act, 16 U.S.C. 703, et seq.	Construction activities (maintenance/repairs or demolition) would seek to avoid nesting periods for any tree removal activities and a survey for nesting activities would be conducted prior to clearing and grubbing to ensure compliance with this act. No significant negative impact to migratory birds is anticipated with any of the alternatives.
National Environmental Policy Act, 42 U.S.C §4321 et seq.	This study suggests that effects to the human environment as a result of various alternatives could be significant for socioeconomics, recreation, navigation, cultural resources, water quality, greenhouse gas emissions, fisheries, and/or species of special concern (including several mussels protected under the ESA). Pursuit or further development of any of the action alternatives would require development of NEPA documentation commensurate with the

	level of proposed impacts. Public participation would also be needed for NEPA compliance.
Rivers and Harbors Act, 33 U.S.C. 401 et seq.	All of the alternatives except the Sustainable Funding Alternative could adversely impact navigation by either removal, lock closing, or probable operational failure. Each of the alternatives is being reviewed for its potential impacts to navigability and other resources. This information is being presented to Corp's decision-makers for their consideration. The final disposition of these facilities would be recommended by the Chief of Engineers and authorized by the Secretary of Army, as required by this Act.
Wild and Scenic Rivers Act, 16 U.S.C. 1271, et seq.	Three sections of the Allegheny River are designated: 7 miles of river from below Kinzua Dam to Route 6 bridge in Warren, 48 miles from Buckaloons Campground to Alcorn Island (by Oil City), and 32 miles from south of Franklin to Emlenton. No impacts to designated portions of the river are expected.
Executive Order 12898, Environmental Justice	Based on the demographic indicators, there is a low potential for protected populations to be disproportionately impacted by this project. Impacts to Environmental Justice would be fully evaluated in any future NEPA document(s)
Executive Order 11988, Floodplain Management	Few impacts to floodplains are expected. Under some alternatives river levels would drop. With this, new lands would be created which could provide additional flood storage capacity in the area.
Executive Order 13112, Invasive Species	The impact of dam removal on invasive animals is uncertain as increased mobility within the river could allow for the spread of some species, while the restoration of natural flow characteristics could decrease other populations. New lands created with some of the alternatives could be colonized by invasive plant species. An adaptive management plan would need to be created if these alternatives were pursued.

Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks	None of the alternatives would disproportionately affect children or increase health or safety risks for children.
Executive Order 11990, Protection of Wetlands	Any alternatives that cause or potentially allow the loss of pool has the potential to dewater existing wetlands. The Corps will coordinate with its regulatory section to ensure compliance with this executive order if any of these alternatives is to be pursued.

9 FINDINGS

This study examined the federal interest in retaining these projects for their authorized commercial navigation purposes, as well as alternatives such as changing the level of project O&M funding, project removal, project transfer to a third-party, or abandonment in-place. Because agency disposition study guidance primarily addresses application of Section 216 requirements to authorize project disposition via a transfer alternative, this report is considered informational in nature only. The report identified alternatives warranting additional consideration in future studies, but no recommendations were made.

Further evaluation of the alternatives identified in this document could occur under a disposition study or a feasibility study, in which each alternative's potential impacts would be subject to National Environmental Policy Act review at a level commensurate with the scope of study's proposed impacts and/or preferred alternative.

Finding 1. The study has identified public and private agencies and organizations that have an interest in maintaining some or all of the project infrastructure. At the time of this report, none of these potential transferees were interested in negotiating a transfer.

Finding 2. This level of study is limited in scope by design. So, it is not appropriate to recommend a specific alternative at one or more project without substantial public involvement, additional analysis (environmental, economic, etc), and further modelling to quantify impacts and develop mitigation strategies.

Finding 3. Comparison of these alternatives against the evaluation criteria show that no alternative meets all criteria. At least one of the proposed alternatives (removal) would require preparation of an environmental impact statement.

Finding 4. The L/Ds have outlived their design life and are in need of significant investment to maintain utility and safety over the next 50 years. And though the need driving the purpose for which the facilities were initially authorized has diminished, the communities surrounding the facilities have developed cultural and economic ties to them.

Finding 5. This study showed that the current commercial use of the facilities and the annual expenditure for maintaining the structures will not produce overall net positive national economic development benefits based on commercial navigation alone. Federal stewardship of these facilities for commercial navigation alone over the next 50 years does not appear to be feasible. However, a comparison between monetary efficiencies and non-monetary benefits (such as cultural desires or environmental lift), is appropriate, but not easily quantified.

Finding 6. Future study is warranted. Any such study should include community outreach, an assessment of transfer partner viability (either to maintain the status quo or to diversify project use), and consideration of returning to a free-flowing river.

10 RECOMMENDATION

This study has included an examination of all potential and practicable alternatives to analyze potential changes to Allegheny River L/Ds 5, 6, 7, 8, and 9, managed by the Corps.

Section 216 of the Flood Control Act of 1970 authorizes the Secretary of the Army to review operations of completed projects, when found advisable due to changed physical, economic, or environmental conditions. Disposition studies are a specific type of 216 study. These studies are conducted using only federal funds; there is no non-federal sponsor.

Under the disposition study guidance no federal action could be recommended. A negative report under the disposition study implementation guidance does not mean that the alternatives considered in this study would not be suitable for implementation. The study found viable alternatives, however they would need further investigation and potentially an environmental impact statement to address mitigation for environmental and socio-economic concerns or benefits. The findings of this report may be used as a basis for further consideration and refinement of these alternatives under a full feasibility study or other authority that can fully study impacts and recommend mitigation in conjunction with a selected alternative. As conditions change at the facilities this negative report could be used to further develop a report recommending federal action at one or more of the projects.

The recommendations contained in this report reflect information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program nor they perspective of higher levels within the Executive Branch. Consequently, the recommendations may be modified before they are approved for implementation.

_____

JOHN P. LLOYD
COL, EN
Commanding

11 REFERENCES

Anwar, A. 2001. Does the age of a tree effect carbon storage? NASA: Goddard Institute for Space Studies. Online at: https://icp.giss.nasa.gov/research/ppa/2001/anwar/

Basile, D. 2017. Interview with Corps Assistant Lock Master for Allegheny L/D 5 through L/D 9.

Bountry, J., B.P Greimann. 2009. Sediment Considerations for Potential Dam Removal Projects. US Department of the Interior, Bureau of Reclamation Technical Service Center Technical Report no. SRH-2009-39.

Climate Change Connection. CO_2 Equivalents. Online at: https://climatechangeconnection.org/emissions/co2-equivalents/

Catalano M.J., M.A. Bozek & T.D. Pellett. 2007. Effects of Dam Removal on Fish Assemblage Structure and Spatial Distributions in the Baraboo River, Wisconsin, North American Journal of Fisheries Management. 27(2):519-530, DOI: 10.1577 M06-001.1

Council on Environmental Quality (CEQ). 2016. Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews. 1 August 2016. Online at: https://obamawhitehouse.archives.gov/sites/whitehouse.gov/files/documents/nepa_final_ghg_guidance.pdf

Cowell, C. M. and R.T. Stoudt. 2002. Dam Induced Modifications to Upper Allegheny River Streamflow Patterns and Their Biodiversity Implications. Journal of the American Water Resources Assoc. 38:1, pg 187

de Gouw, J. A.,D.D. Parrish, G. J. Frost, and M. Trainer. 2014. Reduced emissions of CO_2, NOx, and SO2 from U.S. power plants owing to switch from coal to natural gas with combined cycle technology, Earth's Future, 2, 75–82, doi:10.1002/2013EF000196.

Dorobek, A. S. Mažeika, P. Sullivan, and A. Kautza. 2015. Short-term consequences of lowhead dam removal for fish assemblages in an urban river system. River Systems 21(2-3): 125-139. Online at: https://senr.osu.edu/sites/senr/files/imce/files/CVs/xtraPDFandOtherFiless/Sullivan/Dorobek%20et%20al.%202015_River%20Systems.pdf

Doyle, M.W., E.H. Stanley, A.R. Selle, J.M. Stofleth, and J.M. Harbor. 2003. Predicting the Depth of Erosion in Reservoirs Following Dam Removal Using Bank Stability Analysis. International Journal of Sediment Research, 18(2):115-121

Drum, R. G., J. Noel, J. Kovatch, L. Yeghiazarian, H. Stone, J. Stark, P. Kirshen, E. Best, E. Emery, J. Trimboli, J. Arnold, and D. Raff. 2017. Ohio River Basin–Formulating Climate Change Mitigation/Adaptation Strategies Through Regional Collaboration with the ORB Alliance, May 2017. Civil Works Technical Report, CWTS 2017-01, U.S. Army Corps of Engineers, Institute for Water Resources: Alexandria, VA

Environmental Protection Agency (EPA). 2009. Mandatory Reporting of Greenhouse Gases; Final Rule. 40 CFR Parts 86, 87, 89 et al. Online at:

https://www.epa.gov/sites/production/files/2015-06/documents/ghg-mrr-finalpreamble.pdf

EPA. 2005. Contaminated Sediment Remediation Guidance for Hazardous Waste Sites. Online at: https://www.epa.gov/superfund/superfund-contaminated-sediments-guidance-documents-fact-sheets-and-policies

EPA. 2016a. Technical Guidance for Assessment Environmental Justice in Regulatory Analysis. Online at: https://www.epa.gov/sites/production/files/2016-06/documents/ejtg_5_6_16_v5.1.pdf

EPA. 2016b. EJSCREEN: Environmental Justice Screening and Mapping Tool. Online at: https://www.epa.gov/ejscreen

EPA. 2016c. FLIGHT: Facility Level Information on GreenHouse gases Total. 2015 Greenhouse Gas Emissions from Large Facilities. Online at: https://ghgdata.epa.gov/ghgp/main.do

EPA. 2017. Current Nonattainment Counties for All Criteria Pollutants. Online at: https://www3.epa.gov/airquality/greenbook/ancl.html

EPA. 2017b. Air Quality Index Report. Online at: https://www.epa.gov/outdoor-air-quality-data/air-quality-index-report

EPA. 2017c. Greenhouse Gas Reporting Program (GHGRP): GHGRP Reported Data. Online at: https://www.epa.gov/ghgreporting/ghgrp-reported-data

EPA. 2017d. Greenhouse Gases Equivalencies Calculator. Online at: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator%20

EPA. 2017e. Greenhouse Gases Equivalencies Calculator – Calculations and References. Online at:https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

Evans, J. 2015. Contaminated Sediment and Dam Removals: Problem or Opportunity? EOS, 96. doi: 10.1029/2015EO036385.

Freedman, J.A., B.D. Lorson, R.B. Taylor, R.F. Carline, and J.R. Stauffer Jr. 2013. River of the dammed: Longitudinal changes in fish assemblages in response to dams. Hydrobiologia. 727, 19-33. doi: 10.1007/s10750-013-1780-6

Freshwater Mollusk Conservation Society. 2017. Freshwater Mussels. Online at: http://molluskconservation.org/MC_Ftpage.html

Ganser, A.M., T.J. Newton, and R.J. Haro. 2013. The effects of elevated water temperature on native juvenile mussels: implications for climate change. Freshwater Science 32 (4): 1168-1177.

Hart, D., T. Johnson, K. Bushaw-Newton, R. Horowitz, A. Bednarek, D. Charles, D. Kreeger and D. Velinsky. 2002. Dam Removal: Challenges and Opportunities for Ecological Research and River Restoration. BioScience. Vol 52 No.8.

Heise, R.J, G. Cope, T.J. Kwak, and C. B. Eads. 2013. Short-term effects of small dam removal on freshwater mussel assemblage. WALKERANA, the Journal of the Freshwater Mollusk Conservation Society. 16(1):41-52.

Horvath, T.G. and L. Crane. 2010. Hydrodynamic forces affect larval zebra mussel (Dreissena polymorpha) mortality in a laboratory setting. 5(4):379-385. Online at: http://www.aquaticinvasions.net/2010/AI_2010_5_4_Horvath_Crane.pdf

Johnson, P.T.J., J.D. Olden, and M.V. Zanden. 2008. Dam invaders: impoundments facilitate biological invasions into freshwaters. Frontiers in Ecology and the Environment, 6 (7):357-363

Koryak, M., L.J. Stafford, and R.J. Reilly. 2004 Declining Intensity of Acid Mine Drainage in the Norther Appalachian Bituminous Coal Fields: Major Allegheny River Tributaries. Journal of the American Water Resources. Assoc. June 2004.

Melillo, J.M., T.C. Richmond, and G.W. Yohe, Eds., 2014: Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

Natural Resource Conservation Service (NRCS). 2007. Native Freshwater Mussels. Fish and Wildlife Habitat Management Leaflet Number 46. Online at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_054084.pdf

Nedeau, E. Freshwater Mussels and Dam Removals. Gulf of Maine Times. Online at: http://www.gulfofmaine.org/times/fall2006/mussels.html

Nuclear Energy Institute. 2017. Environment: Emissions Prevented. Online at: https://www.nei.org/Knowledge-Center/Nuclear-Statistics/Environment-Emissions-Prevented

Ortmann, A.E. 1909. The Destruction of the Fresh-Water Fauna in Western Pennsylvania. Proceedings of the American Philosophical Society, Vol. 48 (191): 90-110 (Jan – Apr 1909).

Pennsylvania American Water Company. 2017. Your Water Rates. Online at: https://amwater.com/paaw/customer-service-billing/your-water-rates.

Pennsylvania Department of Conservation and Natural Resources. 2017. Pennsylvania Conservation Explorer – Pennsylvania Natural Diversity Inventory (PNDI). Online at: https://conservationexplorer.dcnr.pa.gov/

Pennsylvania Department of Conservation and Natural Resources Rivers Conservation Program. 2005. Allegheny River Conservation Plan.

Pennsylvania Fish and Boat Commission. 2011. Aquatic Invasive Species (AIS) Action Plan: Asian Carp Complex. Online at: http://www.fishandboat.com/Resource/Documents/ais-action-asian-carp.pdf.

Pennsylvania Natural Heritage Program (PNHP). 2010. Armstrong County Natural Heritage Inventory, prepared for Armstrong County Planning Commission. April 2010. Online at: http://www.naturalheritage.state.pa.us/CNAI_PDFs/Armstrong%20CNHI.pdf

PNHP. 2017. PNHP Species Lists (Middle Allegheny-Tionesta, Middle Allegheny-Redbank, Lower Allegheny). Online at: http://www.naturalheritage.state.pa.us/species.aspx

Pennsylvania Public Utility Commission (PAPUC) and Pennsylvania Department of Environmental Protection (PADEP). 2015. 2015 Annual Report: Alternative Energy Portfolio Standards Act of 2004. Online at: http://www.puc.state.pa.us/Electric/pdf/AEPS/AEPS_Ann_Rpt_2015.pdf.

Pennsylvania Society for Ornithology. 2017. Bird List for Armstrong County. Online at: http://www.pabirds.org/countylists/Armstrong.php.

Rehmann, C.R., J.A. Stoeckel, and D.W. Schneider. 2003. Effect of turbulence on the mortality of zebra mussel veligers. Canadian Journal of Zoology. 81:1063-1069. Online at: http://www.nrcresearchpress.com/doi/pdf/10.1139/z03-090

Schlömer S., T. Bruckner, L. Fulton, E. Hertwich, A. McKinnon, D. Perczyk, J. Roy, R. Schaeffer, R. Sims, P. Smith, and R. Wiser. 2014. Annex III: Technology-specific cost and performance parameters. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Online at: https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_annex-iii.pdf

Sethi, S.A, A.R. Selle, M.W. Doyle, E.H. Stanley, and H.E. Kitchel. 2004. Response of unionid mussels to dam removal in Koshkonong Creek, Wisconsin (USA). Hydrobiologia 525:157-165.

Shafroth, P.B., J.M. Friedman, G.T. Auble, M.L. Scott, J.H. Braatne. 2002. Potential Responses of Riparian Vegetation to Dam Removal: Dam removal generally causes changes to aspects of the physical environment that influence the establishment and growth of riparian vegetation. BioScience. 52(8): 703-712.

Sherman, M and M. Doyle. 2013. Potential impacts of small dam removal on fish and mussel communities in North Carolina. Masters Thesis. Online at: https://pdfs.semanticscholar.org/75ea/85311ee032bee8672ddd68c14e94dad9c713.pdf

Smith, T.A. and E. S. Meyer. 2010. Freshwater Mussel (Bivalvia: Unionidae) Distributions and Habitat Relationships in the Navigational Pools of the Allegheny River, Pennsylvania. Northeastern Naturalist. 17(4):541-564.

Southwestern Pennsylvania Commission (SPC). 2015. Mapping the Future: The Southwestern PA Plan, Report on Environmental Justice, June 2015.

Thomas, M.A. 2016. Invasive carp making way to Allegheny, Mon rivers, threaten local fish. TribLive 22 Dec 2016. Online at: http://triblive.com/local/valleynewsdispatch/11652335-74/carp-fish-river

The Nature Conservancy (TNC). 2017. Briefing Paper: Provisional Ecosystem Flow Recommendations for Allegheny and Clarion Rivers. Submitted to the Corps January 2017.

Tufts University. 2017. Office of Sustainability: Carbon Sequestration. Online at: http://sustainability.tufts.edu/carbon-sequestration/

Tullos, D.D., M.J. Collins, J.R. Bellmore, J.A. Bountry, P.J. Connolly, P.B. Shafroth, and A.C. Wilcox. 2016. Synthesis of Common Management Concerns Associated with Dam Removal. Journal of the American Water Resources Association. 52(5):1179-1206. DOI: 10.1111/1752-1688.12450

U. S. Army Corps of Engineers. 2006. Final Environmental Impact Statement on Commercial Sand and Gravel Dredging Operations in the Allegheny and Ohio Rivers, Pennsylvania.

US Energy Information Administration (USEIA). 2016. Pennsylvania State Energy Profile. Online at: https://www.eia.gov/state/print.php?sid=PA

USEIA. 2017a. Frequently Asked Questions: How much carbon dioxide is produced when different fuels are burned. Online at: https://www.eia.gov/tools/faqs/faq.cfm?id=73&t=11

USEIA. 2017b. Electricity. Online at: http://www.eia.gov/electricity/data.cfm#sales

US Fish and Wildlife Service (USFWS). 2011. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Online at: https://www.census.gov/prod/2013pubs/fhw11-wv.pdf

USFWS. 2017a. National Wetlands Inventory GIS data. Online at: https://www.fws.gov/wetlands/data/data-download.html

USFWS. 2017b. PA Bald Eagle Nest Locations and Buffer Zones. Online at: https://fws.maps.arcgis.com/home/webmap/viewer.html?webmap=bee6bdfd82354b9da9941fe129e91a28

USFWS. 2017c Information for Planning and Conservation. Online at: https://ecos.fws.gov/ipac/

Appendix A. Additional Maps and Figures.

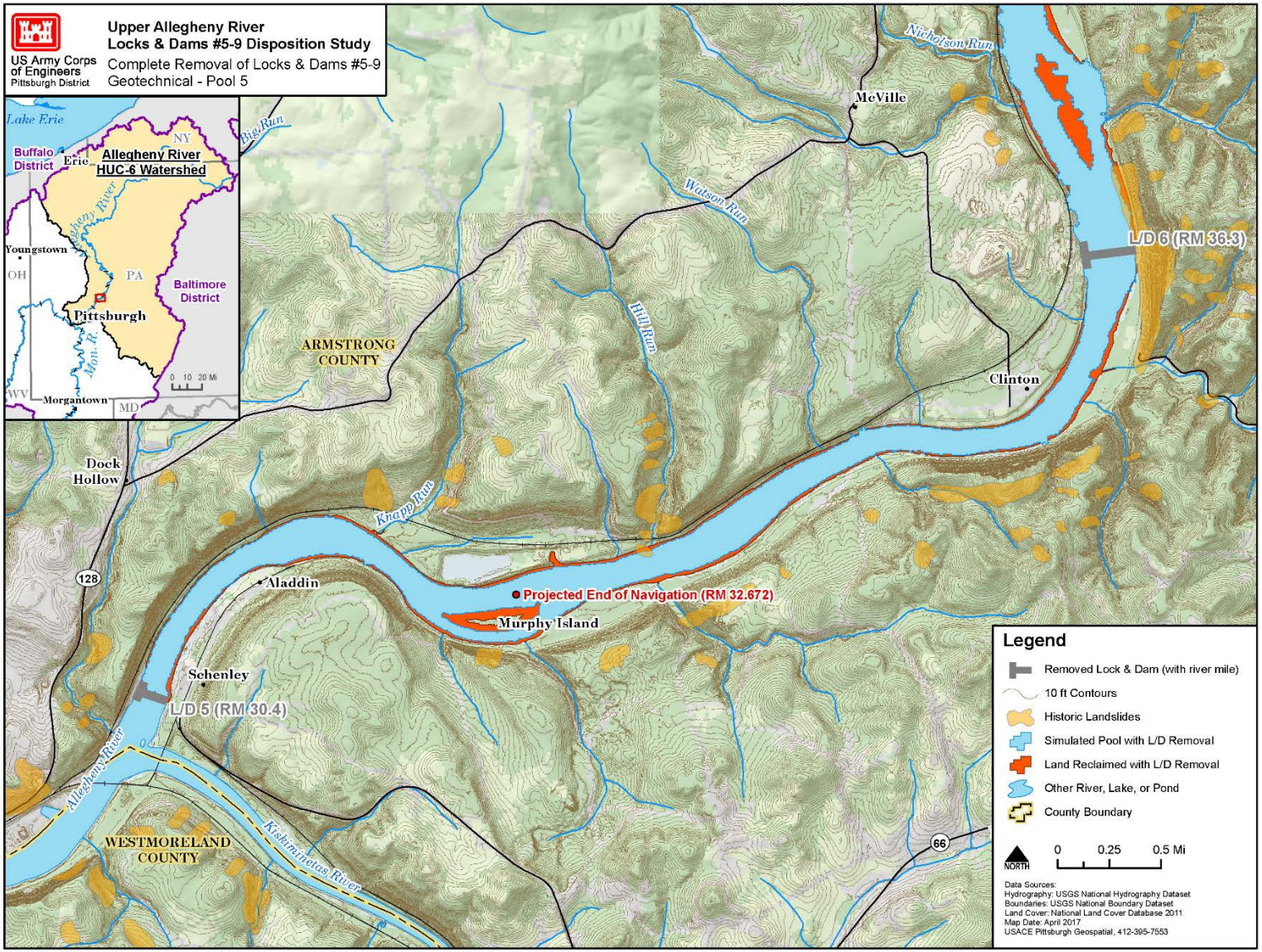


Figure A-1. Reclaimed land anticipated with removal of L/D 5.

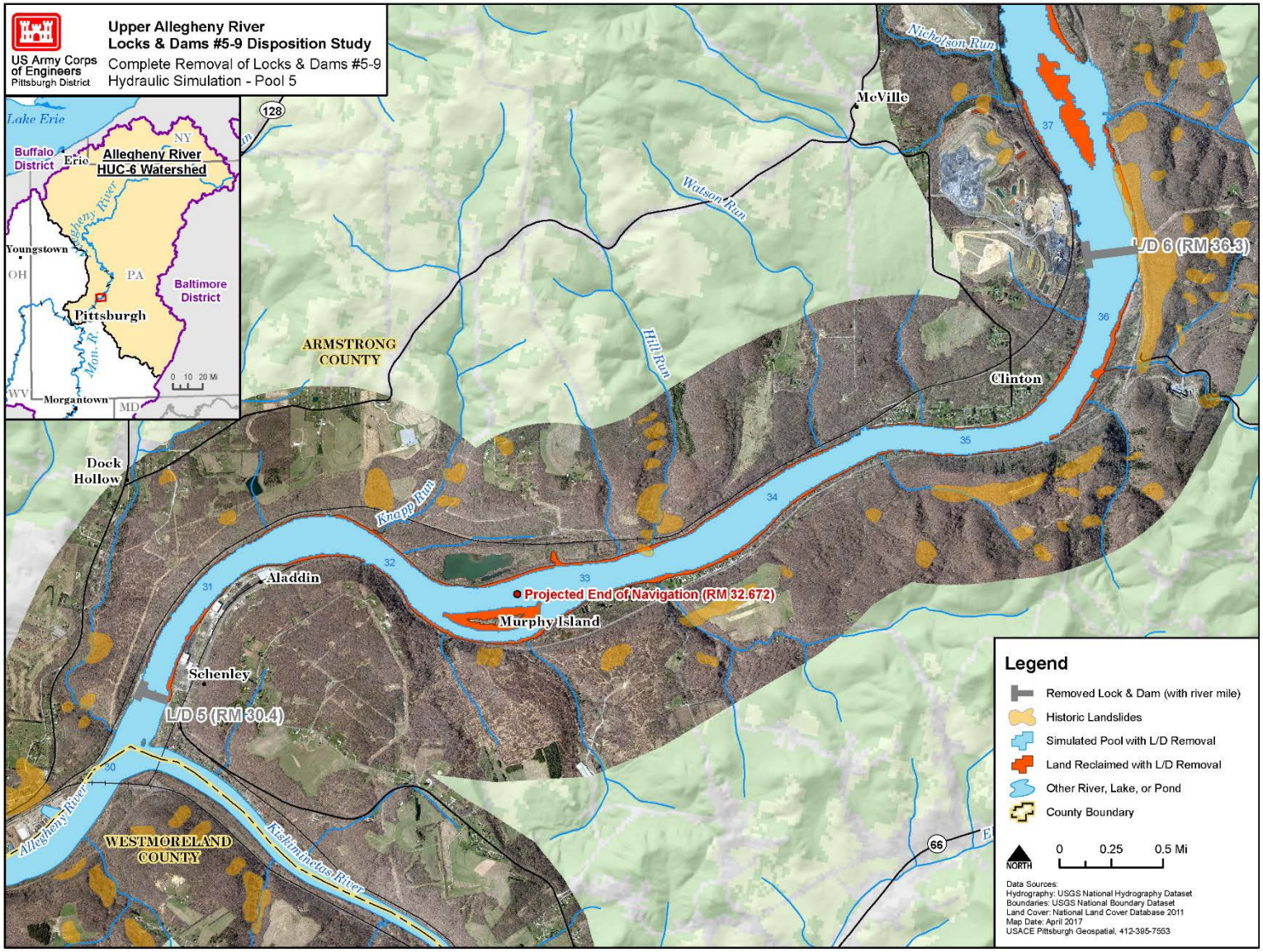


Figure A-2. Reclaimed land anticipated with removal of L/D 5 shown on aerial imagery.

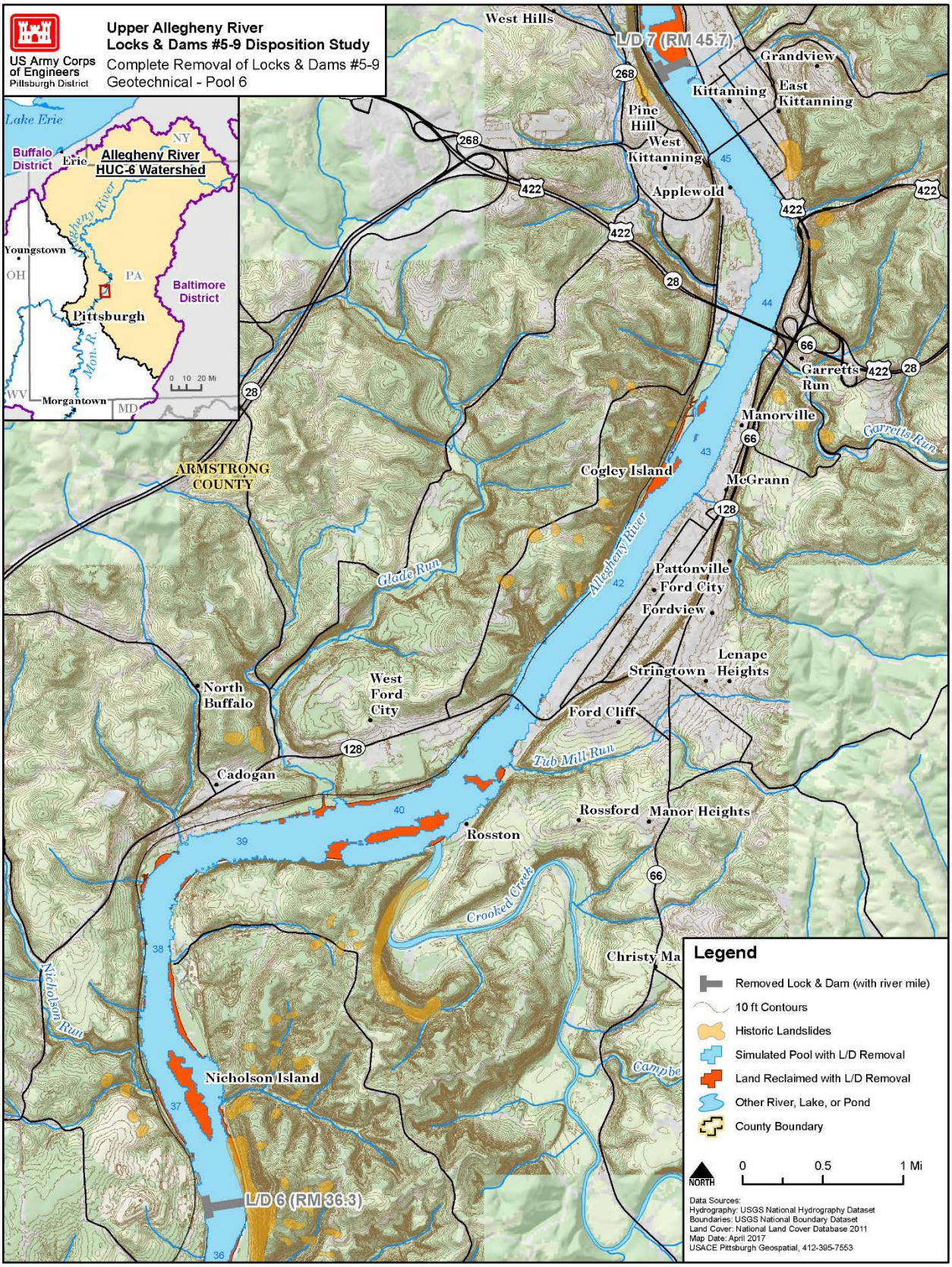


Figure A-3. Reclaimed land anticipated with removal of L/D 6.

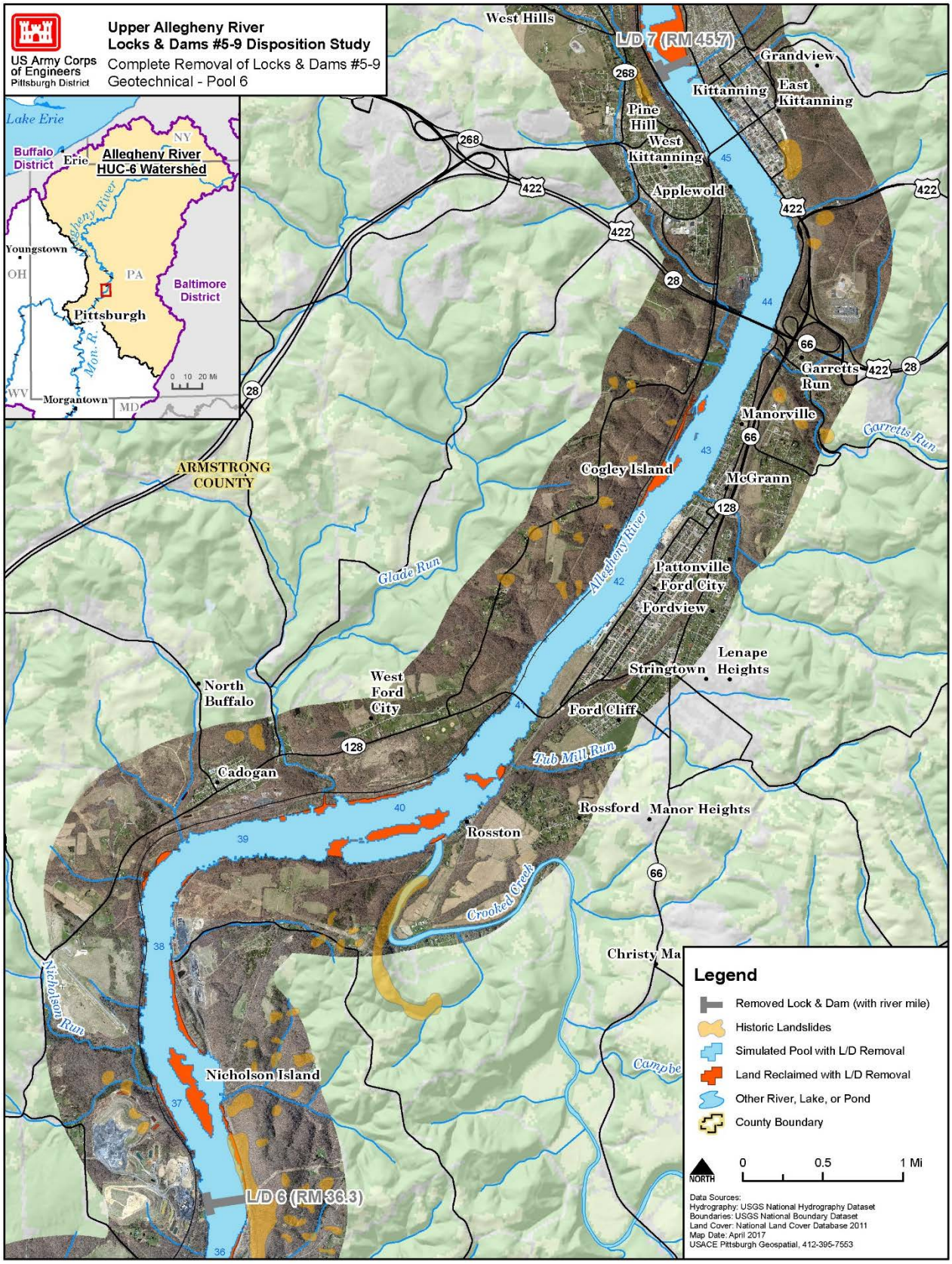
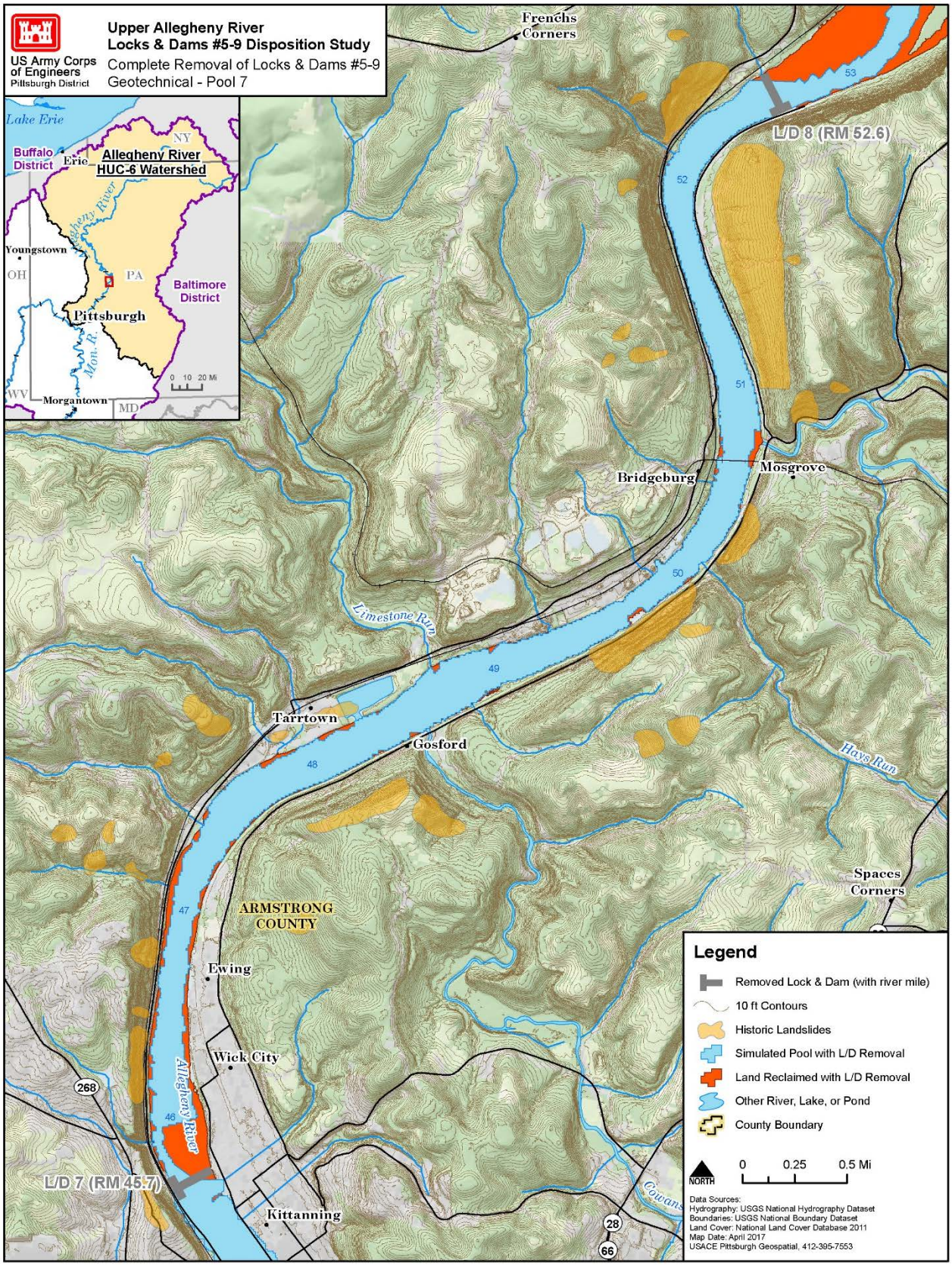
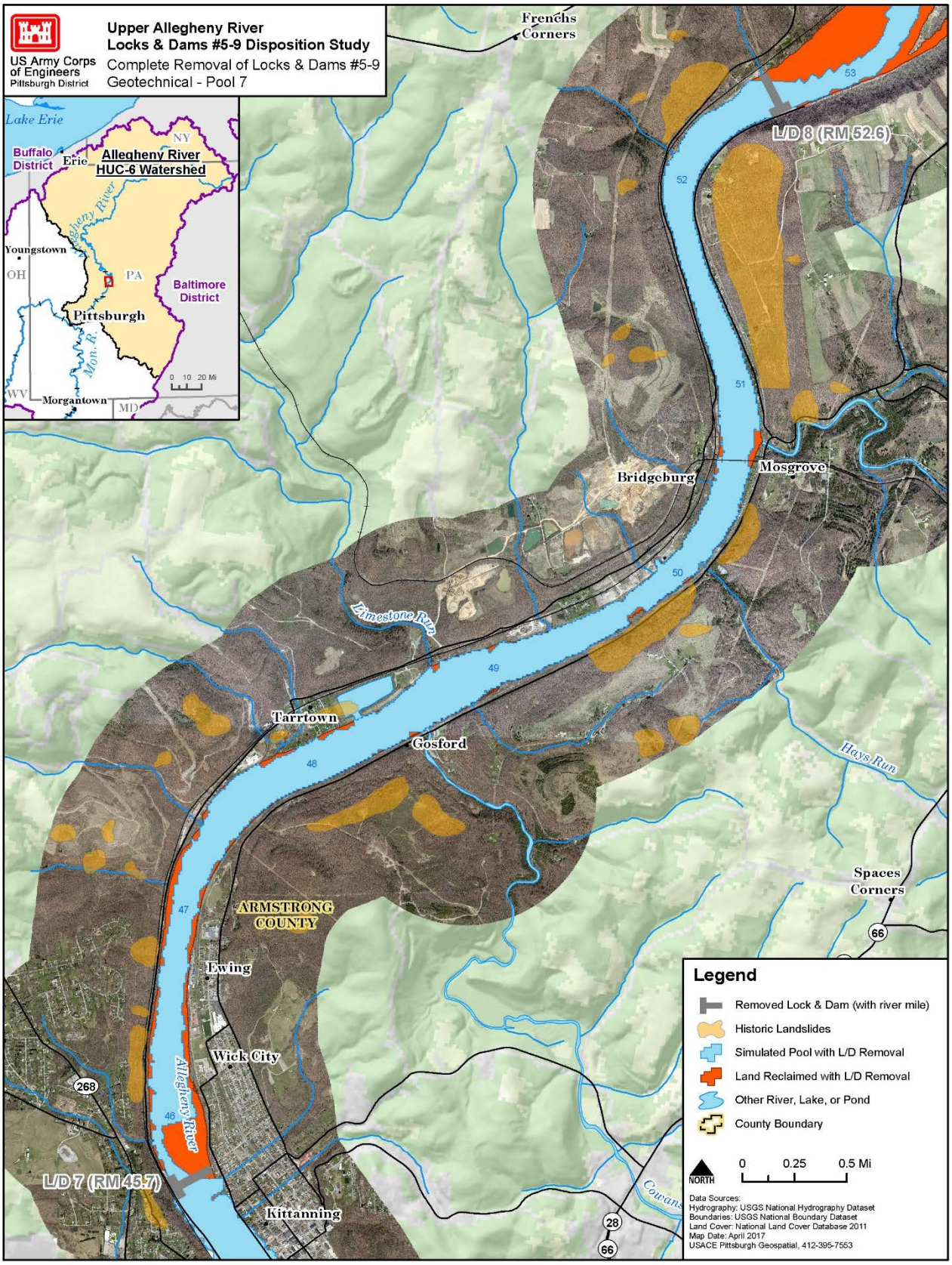


Figure A-4. Reclaimed land anticipated with removal of L/D 6 shown on aerial imagery.



FigureA-5. Reclaimed land anticipated with removal of L/D 7.



FigureA-6. Reclaimed land anticipated with removal of L/D 7 shown on aerial imagery.

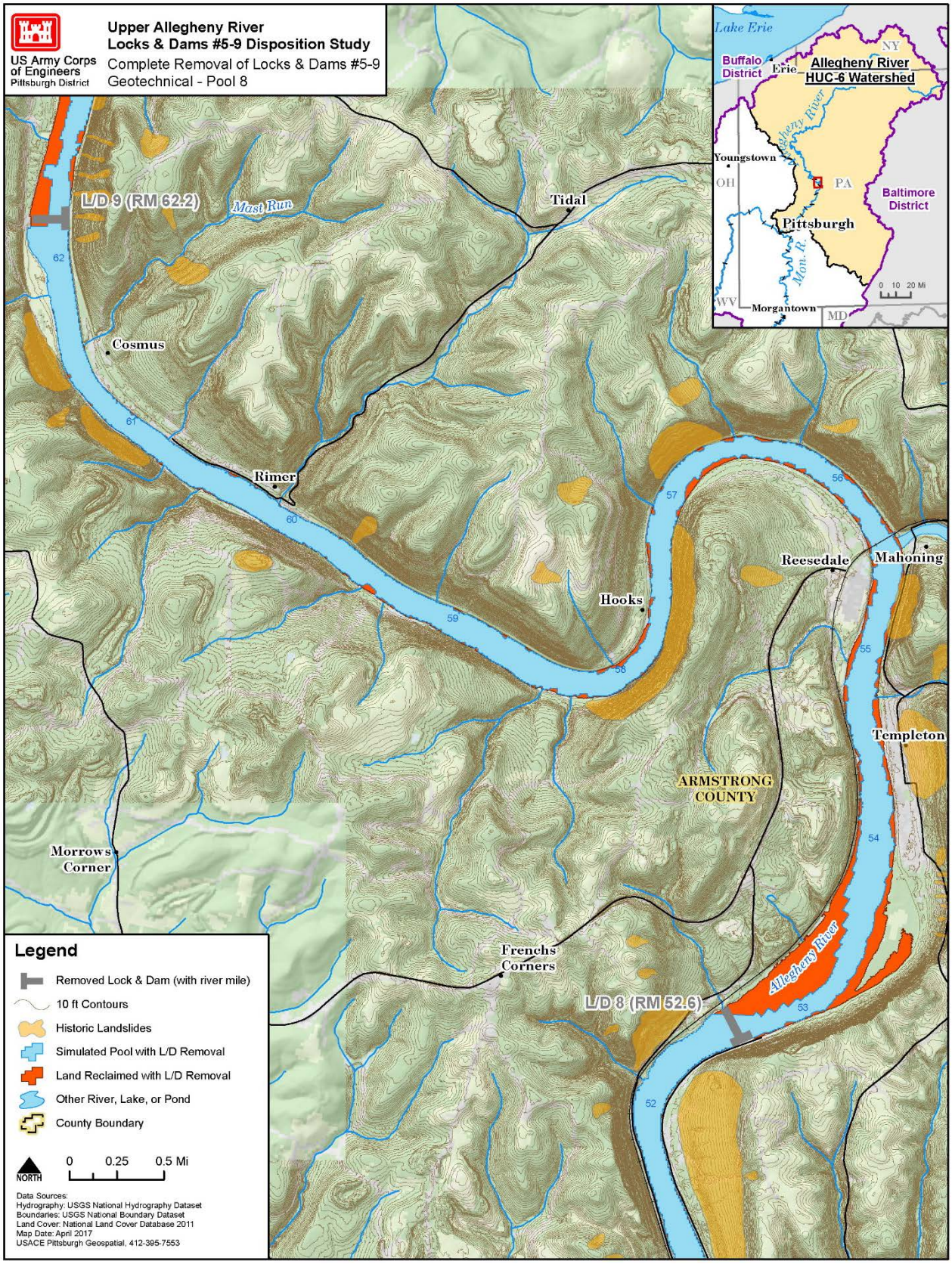
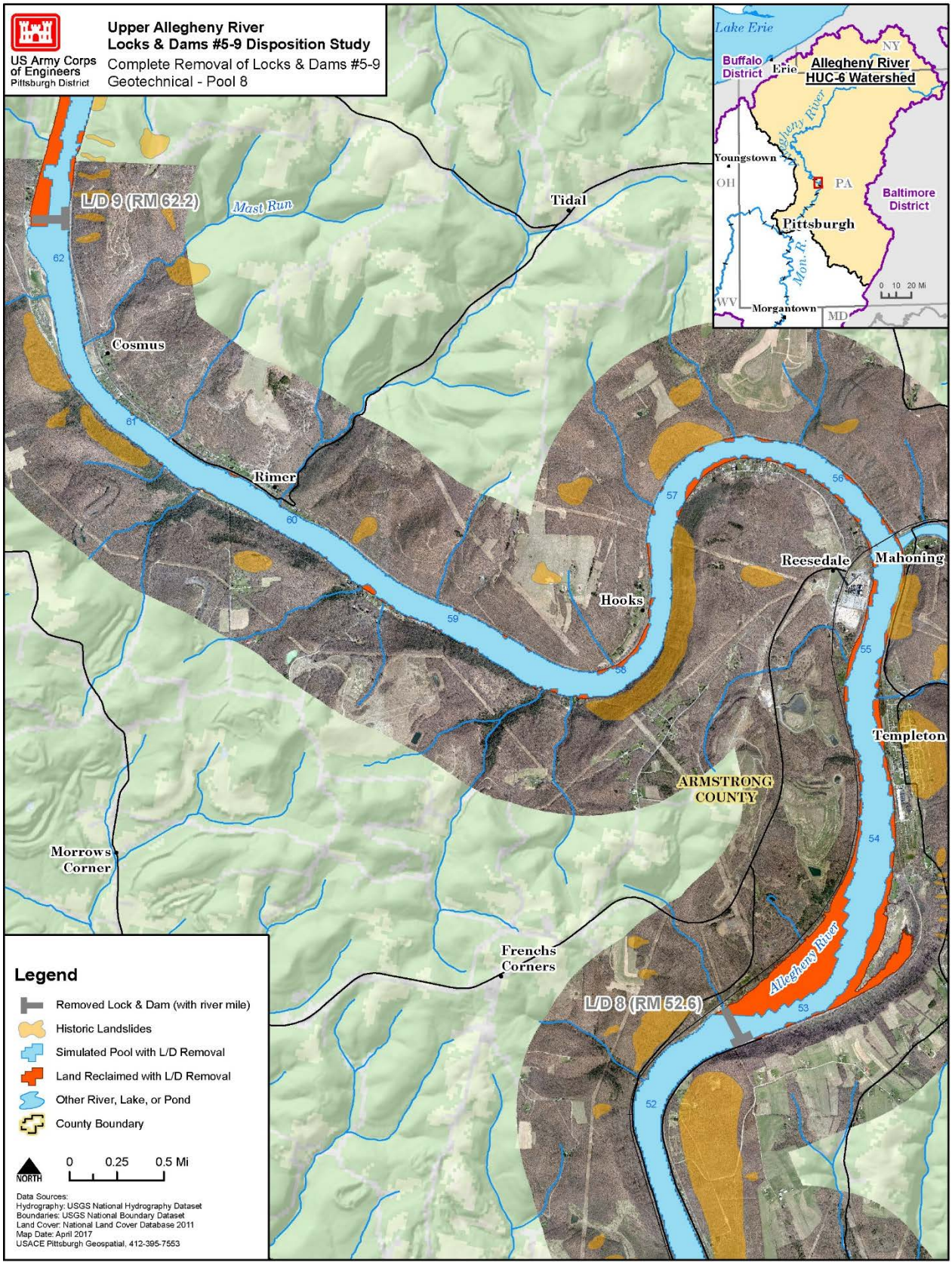


Figure A-7. Reclaimed land anticipated with removal of L/D 8.



FigureA-8. Reclaimed land anticipated with removal of L/D 8 shown on aerial imagery.

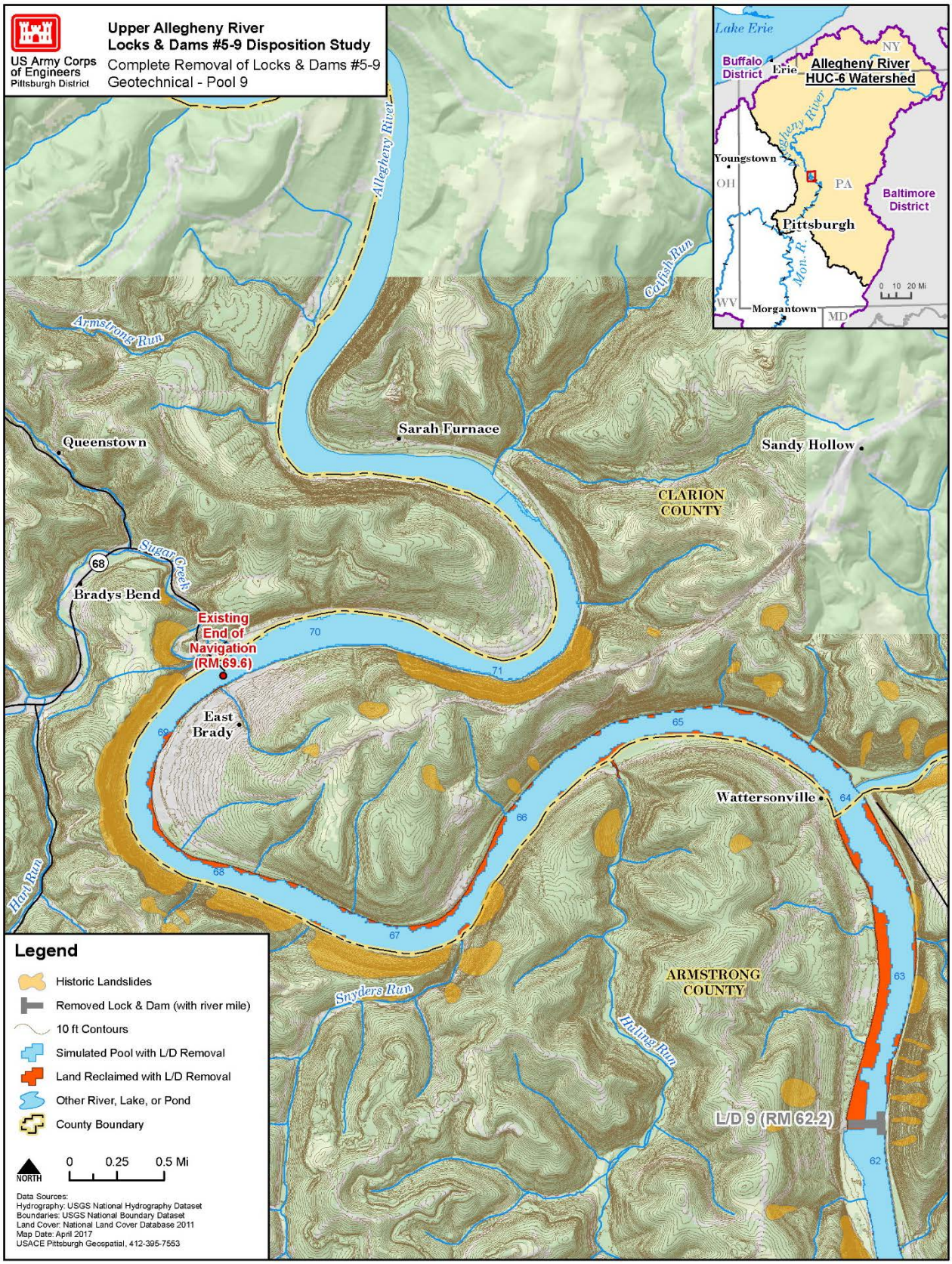


Figure A-9. Reclaimed land anticipated with removal of L/D 9.

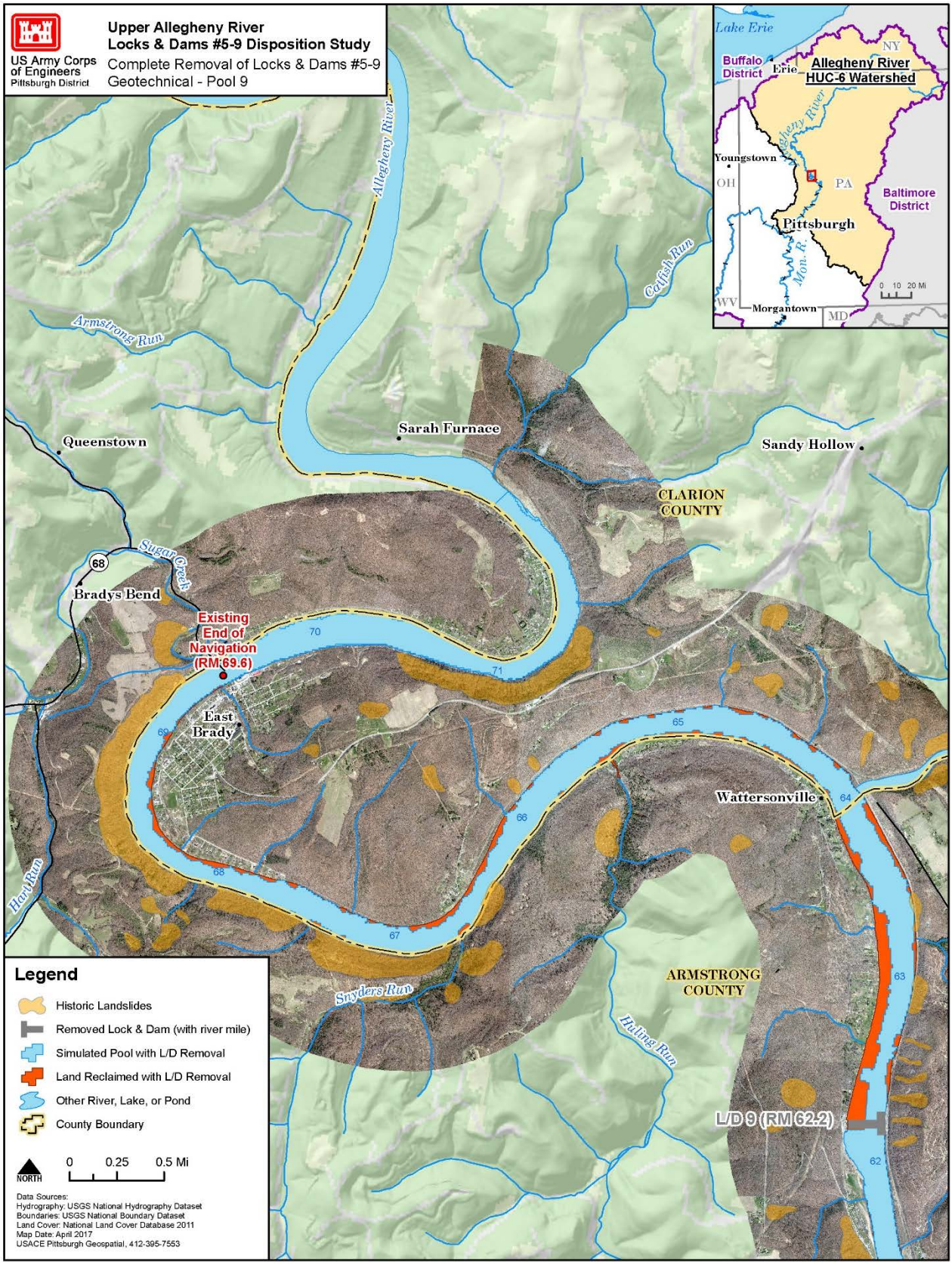


Figure A-10. Reclaimed land anticipated with removal of L/D 9 shown on aerial imagery.

Appendix B. Economic Appendix.

Section 1: Recreation Impacts

Table B-1. Recreation Benefits

		High Estimate			Low Estimate		
L/Ds	Average Annual Amount of Vessels	Number of Unique Vessels	Annual Number of People	Annual Recreation Benefits	Number of Unique Vessels	Annual Number of People	Annual Recreation Benefits
5	1,666	1,203	3,487	$161,447	896	2,598	$121,033
6	935	675	1,956	$91,122	503	1,457	$67,886
7	1,160	837	2,428	$113,104	624	1,809	$84,263
8	987	713	2,067	$96,260	531	1,540	$71,714
9	1,028	742	2,152	$100,254	553	1,603	$74,689
Total:	**5,776**	**4,170**	**12,090**	**$562,187**	**3,107**	**9,007**	**$419,585**

The recreation benefits represent the total value of each L/D to consumers. The estimated recreation benefits for the Upper Allegheny River were based on the average amount of recreational vessels that lock through Allegheny L/Ds 5 through 9. Non-motorized vehicles (i.e. kayaks, canoes, etc.) were not considered in this analysis due to lack of data. The annual recreation data was gathered from the Corps' Lock Performance Monitoring System (LPMS) website. LPMS provides the annual number of recreational lockages and annual number of recreational vessels. The annual recreation benefits for each L/D can be found above in Table B-1.

The first step in determining the annual recreational lost benefits was calculating an average annual amount of vessels. For each L/D, the average annual amount of vessels is an average from 1993 through 2016, excluding years that reported zero recreational lockages due to full-year closures. Using all available data provided allowed for a greater capture all the potential future conditions.

The next step was to determine the number of consumers utilizing the L/Ds. In order to estimate this number, the number of *unique* vessels needed to be determined in order to not overestimate the number of consumers that use the L/D. This was accomplished by accounting for multiple lockages within the estimated average annual amount of vessels. Multiple lockages is defined as a single vessel that locks through multiple L/Ds in a single day, which includes vessels that round trip through the same L/D in a single day. For example, a boat owner lives just north of Kittanning and wants to visit downtown Kittanning via motorized boat. In a single day, the boater would lock through the Allegheny L/D 7, visit downtown, then lock back through Allegheny L/D 7 to return home. This vessel gets counted twice because it locks through two separate times; however, he counts as only one consumer. To account for multiple lockages in a single day, the average annual amount of vessels was adjusted. There is no data on the number of multiple lockages, but a Corps

report, ***Allegheny River Recreation Benefits****, October 2000,* estimates that on average, a single vessel will lock through 1.86 locks per day. There is a level of uncertainty with this figure, which is why this analysis presents a high and a low estimate for recreation benefits loss and economic loss in Table B-1. The 1.86 estimate from the 2000 report assumes that a higher percentage of vessels lock through the L/Ds. However, in 2012, Allegheny L/D 8 and 9 went from level of service 3 (open for at least 8 hours per day, 7 days a week, year round) to level of service 6 (by appointment only; no consistent lock pattern). Allegheny L/D 6 and 7 experienced the same change in 2013. Due to the limited time that the L/Ds are now open, it is less likely that a vessel will have multiple lockages in one day, which indicates that the 1.86 estimate is likely too high. The higher the average number of lockages per day per boat, the lower the annual number of unique vessels. The 1.86 locks per day per boat is used in the low estimate.

$$\frac{Average\ Annual\ Amount\ of\ Vessels}{1.86} = Low\ Estimate's\ Number\ of\ Unique\ Vessels$$

It is highly likely that since the levels of service changed in 2013, fewer boats lock through the L/Ds. Rather than locking through, the vessels remain in-pool (boating between L/Ds) causing a decrease in the number of locks per day per boat. To account for this decrease, a new estimate to capture the current conditions was determined. This new estimate was found by calculating the average annual number of vessels from 2000 through 2012 was calculated for each L/D. The first year of this average is 2000 because the 1.86 locks per day per boat originated in the 2000 ***Allegheny River Recreation Benefits*** report. Then, the average annual numbers of vessels from 2013 through 2016 was calculated for each L/D. Determining the averages for 2000 through 2012 and 2013 through 2016 allows the analysis to estimate how the level of service change in 2013 impacted the annual amount of recreational vessels. Allegheny L/D 5 did not experience a change in its level of service, but was likely impacted by the level of service changes to the other four L/Ds. A ratio of the two averages was then calculated:

$$\frac{2013\ through\ 2016\ average}{2000\ through\ 2012\ average}$$

This ratio represents the percent change in the average annual number of vessels for each L/D following the change in the level service. Then, the average percent change in the average annual number of vessels for each of the L/Ds being studied for possible removal along the Monongahela and the Allegheny was calculated. The Upper Monongahela L/Ds were included to increase the sample size of the averages. These L/Ds include: Morgantown, Hildebrand, Opekiska, and Allegheny L/D 5 through 9. The average ratio for the listed L/Ds is roughly 0.745, which represents a 74.5% decrease in lockages. The average ratio (0.745) was multiplied by the original estimate of average lockages per day per boat (1.86), which results in an updated estimate of 1.39 lockages per day per boat, on average. The 1.39 average number of lockages per day per boat was used in the high estimate.

$$\frac{Average\ Annual\ Amount\ of\ Vessels}{1.39} = High\ Estimate's\ Number\ of\ Unique\ Vessels$$

The number of unique vessels does not fully account for the number of consumers using the L/Ds. The final step in finding the number of consumers who use the L/Ds is determining the number of people per vessel. The ***Allegheny River Recreation Benefits*** report states that an average of 2.9 people are on board each recreational vessel. This number is based on a Corps observation, and is assumed to still accurately represent the number of people on a recreational vessel. The 2.9 people per vessel number was used for both estimates. To determine the lost recreation benefits, 2.9 was multiplied by the number of unique vessels in order to accurately represent the number of consumers using the L/Ds for motorized boating. Below is how the average annual number of consumers was calculated for Allegheny L/D 5's high estimate:

$$\frac{1{,}666}{1.39} = 1{,}202 \ \times 2.9\, people = \ 3{,}487\ Average\ Annual\ Consumers$$

Below is how the average annual number of consumers was calculated for Allegheny L/D 5's low estimate:

$$\frac{1{,}666}{1.86} = 895 \times 2.9\, people = 2{,}598\ Average\ Annual\ Consumers$$

In order to calculate the recreation benefits, a dollar value was assigned to recreation. According to the ***Allegheny River Recreation Benefits*** report, the value of a single boater per day is $46.48 (updated from June 2000 dollars to May 2017 dollars using a Consumer Price Index of 1.42). This estimated value is based on formal surveys. Different boating activities were valued and then assigned a weight to create a single weighted value for recreation. This recreation value of $46.48 was used for this analysis because it assigns a different value to different boating activities, which can be seen in Table B-2. This value was used for both sets of estimates. Each L/D's lost recreation benefits estimate was found by multiplying the value of a single boater ($46.48) by the L/D's Annual Number of Consumers.

Table B-2: Recreation Value from the Allegheny River Recreation Report –

Boating Activity	Percent of Sample	Reported Value	Weighted Value in June 2000 Dollars	Weighted Value in May 2017 Dollars
Boat Fishing	9.5%	$8.02	$0.76	$1.08
Single Day Boating	7.1%	$14.85	$1.05	$1.49
Multi-Day Boating	38.6%	$37.17	$14.35	$20.39
Marina Boating	44.8%	$37.17	$16.65	$23.64
Totals	**100.0%**		**$32.82**	**$46.58**

Table B-3. Lost Recreation Benefits and Economic Losses.

	High Estimate			Low Estimate		
L/Ds	**Annual Lost Recreation Benefits**	**Annual Economic Loss**	**Total**	**Annual Lost Recreation Benefits**	**Annual Economic Loss**	**Total**
5	$161,447	$125,863	$288,310	$121,033	$93,768	$214,791
6	$91,122	$70,601	$161,723	$67,886	$52,598	$120,484
7	$113,104	$87,633	$200,737	$84,263	$65,287	$149,549
8	$96,260	$74,582	$170,842	$71,714	$55,563	$127,277
9	$100,254	$77,677	$177,931	$74,689	$57,869	$132,558
Total	**$562,187**	**$436,356**	**$999,543**	**$419,585**	**$325,085**	**$744,659**

In addition to the annual lost recreation benefits calculation, the annual economic loss for each L/D was also determined. The annual lost recreation benefits and annual economic loss are two separate calculations. This figure was found by multiplying the Annual Number of Consumers by the amount of spending a recreational boater spends per day, on average. The ***Allegheny River Recreation Benefits*** report values this at $36.09 (updated from June 2000 dollars to May 2017 dollars using a Consumer Price Index of 1.42). The annual economic loss indicates how much consumer spending will decrease if the L/Ds become unavailable. The total economic loss for each L/D can be found above in Table B-3. The high estimate provides an annual total loss of $999,543. The low estimate provides an annual total loss of $744,659.

The two estimates represent losing all motorized boating benefits. However, if the lock is no longer operational and the dam is still in place (abandonment, mothball, or transfer), motorized boating can still occur due to minimal changes in pool levels. The losses in this scenario are significantly smaller than the totals listed in the tables. If there is a planned loss of pool with a loss of lock operation (removal), motorized boating can still occur, but to a lesser degree. In each alternative, the pool levels could decrease significantly, which indicates that water skiing, tubing, wakeboarding, and similar activites would no longer occur on the river. This causes higher short-term loss of recreation benefits than if the lock is no longer operational. However, non-motorized vessel usage could increase and could offset motorized boating losses in the long-term. Finally, if there is an unplanned loss of pool and the lock is no longer operational (long term abandoment or no action resulting in dam failure), boats and docks would likely get damaged or destroyed due to the rapid loss of pool. This would cause an immediate loss of recreation benefits because less consumers are able to use the river for motorized boating. This is the scenario that results in the highest loss of recreation benefits in the short-term. However, like the planned loss of pool scenario, motorized boating can still occur, but to a lesser degree, and non-motorized vessel

usage would likely increase, which would offset some of the lost recreation benefits in the long-term.

Section 2: Employment Trends in Armstrong County

In 2014, there were 14,409 paid employees in Armstrong County. As you can see in Figure C-1, most of the employment was based in the health care sector, retail trade, manufacturing sector, and accommodation and food services. The following sectors are not impacted by the L/Ds: the health care sector (23.7% of total employment), and retail trade (14.4%). The following sectors are impacted by the L/Ds: accommodation and food services (8.7%), transportation and warehousing (7.5%), mining, quarrying, and oil and gas extraction (6.3%). Accommodation depends upon tourism demand; the navigable waterways are the driving force in Armstrong County's tourism demand. If tourism demand decreases, the accommodation sector's employment and revenue decreases. A similar, but less severe, trend would be seen in the food services sector. The food services businesses in the county see an increase in sales during the summer months due to recreational boaters.

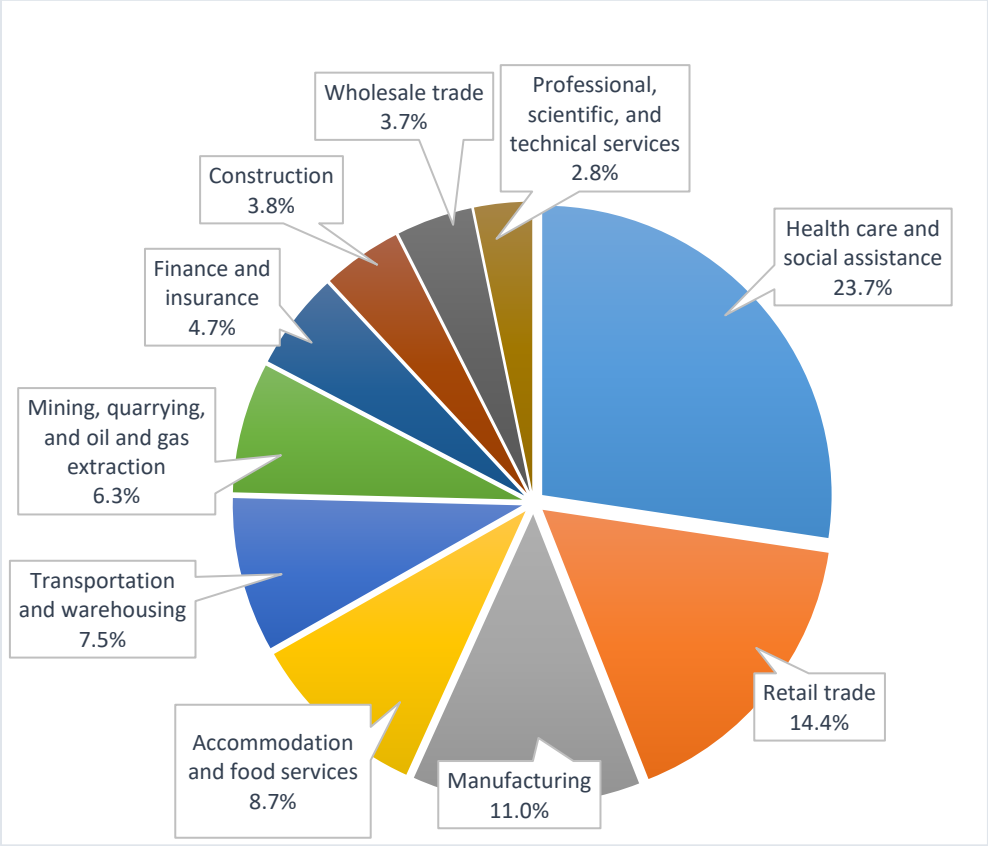


Figure B-1. Top 10 Employment Sectors by Number of Paid Employees
(Source: U.S. Census Bureau: County Business Patterns, 2014)

The transportation and warehousing sector is a conglomerate of subsectors including postal service, couriers and messengers, warehousing and storage, and the following modes of transportation: air, rail, water, truck, transit and ground passengers, pipeline, and scenic

and sightseeing support activities. Warehousing and storage, and water, rail, and truck transportation are the most prevalent subsectors in the county. Terminal businesses within the county are considered to be within all four of these subsectors. These terminals utilize water, rail, and truck transportation. Furthermore, their services include storing commodities.

The local terminals usually receive commodities via barge, store the commodities in warehouses, and then transport the commodities elsewhere by way of rail or truck. If the L/Ds were removed, water transportation within the county would stop. Due to the stoppage of water transportation, the demand for rail and truck would increase. The trucking companies and railroad companies that operate in the county would likely increase prices due to fewer competitors in the transportation market. This increase in prices would negatively impact companies in the area that use rail or truck for transportation needs. The L/Ds would most likely cause the terminals in the county to shut down. If the L/Ds become unavailable, a large portion of the 1,076 persons employed by the transportation and warehousing sector in Armstrong County would likely become unemployed.

Above in Figure B-1, you can see that the mining, quarrying, and oil and gas extraction sector makes up 6.3% of Armstrong County's employment. Below in Table B-4, you can see that Rosebud Mining Company is a top employer; as of December 2016, Rosebud Mining only employs 730 people. Rosebud has four mines in Armstrong County and its headquarters are located in Kittanning. However, the mining company has mines and employees in eastern Ohio and three other counties in Pennsylvania. If the L/D become unavailable, the mining company would likely maintain its mines in Armstrong County, but shift the bulk of its production towards other mines within Pennsylvania or Ohio. Rosebud also owned a trucking company, which at one point maintained 67 trucks. The mission of the trucking business was to haul Rosebud Mining's coal throughout Pennsylvania and Ohio. In 2015, Rosebud closed its trucking division and the Executive Vice President at the time stated, "The coal industry is just slowing a bit." It's likely that since 2015, Rosebud Mining is more dependent upon rail and barge for transporting coal.

Table B-4. Top 10 Employers in Q3 of 2016

1. Armstrong County Memorial Hospital
2. Armstrong School District
3. Armstrong County
4. Wal-Mart Associates, Inc.
5. Allegheny Ludlum LLC
6. Pennsylvania State Government
7. Rosebud Mining Company
8. Federal Government
9. Apollo-Ridge School District
10. Cook Inc.

Source: *PA Dept. of Labor and Industry*

However, if the L/Ds become unavailable, Rosebud Mining will likely utilize rail as its main form of transportation. One of Rosebud's plants, Logansport Prep Plant, has a direct linkage to the Kiski Junction Railroad. Rosebud may increase production at this particular plant, which could cause minimal job losses in the mining industry. Due to the decrease in coal production, the Kiski Junction Railroad relies on tourism and sightseeing tours as their main form of revenue. Rosebud would likely start utilizing the Kiski Junction Railroad, which would increase revenue for the railroad. Additionally, Rosebud Mining among other companies may rely on trucking companies. According to the ***Armstrong County Freight Profile,*** *December 2016*, 81% of Armstrong County's outbound freight was moved by truck in 2011. In the same year, inbound freight relied on multiple modes of transportation, water (33%), rail (23%), and truck (44%). If Rosebud Mining becomes more dependent upon the trucking companies, more jobs could be created in the county's trucking industry.

Section 3: Property Value Impacts:

Many stakeholders expressed concern over riverfront property values depreciating if the L/Ds become unavailable. This analysis exams the difference in assessment values of inland parcels and riverfront parcels within the two study areas. The data used in this analysis was provided by Monongalia County and Armstrong County. Pittsburgh District's Real Estate office aided with obtaining the county parcel data.

Table B-5. Armstrong County – Property Value Assessment.

Location of Parcel	Median Number of Acres	Median Assessment Value per Acre	Expected Parcel Value
Inland	2	$5,567	$11,134
Riverfront	0.25	$83,600	$20,900

Detailed data was extracted from the county parcel data using ArcMap 10.3.1. The Real Estate office used an Allegheny River line shapefile and extended the shape's width (using the Buffer tool in ArcMap) by 1,000 feet. This buffer allowed the river line to touch both sides of the riverbanks and intersect the riverfront parcels. Armstrong County provided the Real Estate office with a shapefile that contained data from every parcel in the county. Real Estate then selected the parcels that touched the river shapefile (using the "select by location" feature in ArcMap) and exported the selected data as a separate shapefile. This shapefile contained approximately 4,500 riverfront parcels, which covered the full extent of the Armstrong County. The attribute table of this shapefile was used in determining the parcel values of riverfront parcels.

To obtain a random sample of inland parcels, a polygon was drawn on the east side of the Allegheny River and a polygon was drawn on the west side of the Allegheny River. These polygons were drawn as to not include any riverfront parcels. Then, the parcels that touched the drawn polygons were selected (using "select by location" feature in ArcMap) and then exported as a separate shapefile. This shapefile contained approximately 4,500 randomly selected inland parcels. This shapefile's attribute table was used in determining parcel values for inland parcels. The attribute tables were copied into an Excel worksheet.

For both sets of parcel data (inland and riverfront) the median assessment value and median acreage was determined, which can be found above in Table B-5.

The average assessment value was first calculated, but there were a few high value parcels that significantly exaggerated the average. The median assessment value was used in order to eliminate outliers; the median value is also more representative of current housing market conditions. The median acreage was multiplied by the median assessment value to show the expected parcel value for both datasets. The expected parcel value allows the riverfront and inland parcels to be compared based on both value and size. Depreciation can be expected for some riverfront property, however property on non-navigable waterways such as the Clarion River, Kiskimentis and Redbank Creeks show higher values than the reported inland parcel rate.

Section 4: Economic Analysis of NED Benefits:

For the purposes of this study the NED benefits for Allegheny L/D 5-9 have been determined to be the navigation related benefits to shippers on the Allegheny River that lock through these projects. Based on the expected consistency of traffic on the waterway from the middle forecasts in section 4.4.1, the most recent calculated navigation benefits for each project have been used for the average annual benefits. These values do not perfectly reflect expected future traffic, but they are relatively close and should reflect similar values to what would be expected from additional model runs. The three "No Action" alternatives are assumed to have the same average annual benefits despite slight differences in the levels of service between alternatives. This is due to uncertainty related to the effects of these level of service changes on shipper responses, so further study would be required to better determine how those changes would alter these benefits. Additional adjustments were made for the "Mothball (5-Year Recovery)" and "Mothball (10-Year Recovery)" alternatives as they would not see full navigation benefits across the 50-year study period. The values presented are likely still high due to the assumption that river traffic would return immediately following the recovery of the projects, but further study would be required to determine the actual benefits that would return in the years immediately following the recovery process. The average annual costs were taken from the tables shown in section 7.7.1. Some additional average annual costs were calculated for the alternatives that did not have them presented in Table 22. Tables B-6 through B-10 below show the average annual costs, benefits, net benefits, and BCRs for each of the five projects under each alternative scenario.

Table B-6. Allegheny L/D 5 Economics by alternative.

	No Action - Flat Funding	No Action - Reduced Funding	No Action - Sustainable Funding	Transfer	Mothball (5-Year Recovery)	Mothball (10-Year Recovery)	Mothball - Abandon	Abandonment	Removal
Benefits	$5,167,000	$5,167,000	$5,167,000	$0	$4,650,300	$4,133,600	$0	$0	$0
Costs	$752,766	$114,833	$752,766	$4,660	$242,237	$207,367	$61,382	$47,348	$253,014
Net Benefits	$4,414,234	$5,052,167	$4,414,234	($4,660)	$4,408,063	$3,926,233	($61,382)	($47,348)	($253,014)
BCR	6.86	45.00	6.86	0.00	19.20	19.93	0.00	0.00	0.00

Table B-7. Allegheny L/D 6 Economics by alternative.

	No Action - Flat Funding	No Action - Reduced Funding	No Action - Sustainable Funding	Transfer	Mothball (5-Year Recovery)	Mothball (10-Year Recovery)	Mothball - Abandon	Abandonment	Removal
Benefits	$230,000	$230,000	$230,000	$0	$207,000	$184,000	$0	$0	$0
Costs	$114,833	$114,833	$386,776	$4,660	$242,237	$207,367	$61,382	$47,348	$253,014
Net Benefits	$115,167	$115,167	($156,776)	($4,660)	($35,237)	($23,367)	($61,382)	($47,348)	($253,014)
BCR	2.00	2.00	0.59	0.00	0.85	0.89	0.00	0.00	0.00

Table B-8. Allegheny L/D 7 Economics by alternative.

	No Action - Flat Funding	No Action - Reduced Funding	No Action - Sustainable Funding	Transfer	Mothball (5-Year Recovery)	Mothball (10-Year Recovery)	Mothball - Abandon	Abandonment	Removal
Benefits	$204,000	$204,000	$204,000	$0	$183,600	$163,200	$0	$0	$0
Costs	$114,833	$114,833	$386,776	$4,660	$242,237	$207,367	$61,382	$47,348	$253,014
Net Benefits	$89,167	$89,167	($182,776)	($4,660)	($58,637)	($44,167)	($61,382)	($47,348)	($253,014)
BCR	1.78	1.78	0.53	0.00	0.76	0.79	0.00	0.00	0.00

Table B-9. Allegheny L/D 8 Economics by alternative.

	No Action - Flat Funding	No Action - Reduced Funding	No Action - Sustainable Funding	Transfer	Mothball (5-Year Recovery)	Mothball (10-Year Recovery)	Mothball - Abandon	Abandonment	Removal
Benefits	$62,000	$62,000	$62,000	$0	$55,800	$49,600	$0	$0	$0
Costs	$114,833	$114,833	$386,776	$4,660	$242,237	$207,367	$61,382	$47,348	$253,014
Net Benefits	($52,833)	($52,833)	($324,776)	($4,660)	($186,437)	($157,767)	($61,382)	($47,348)	($253,014)
BCR	0.54	0.54	0.16	0.00	0.23	0.24	0.00	0.00	0.00

Table B-10. Allegheny L/D 9 Economics by alternative.

	No Action - Flat Funding	No Action - Reduced Funding	No Action - Sustainable Funding	Transfer	Mothball (5-Year Recovery)	Mothball (10-Year Recovery)	Mothball - Abandon	Abandonment	Removal
Benefits	$0	$0	$0	$0	$0	$0	$0	$0	$0
Costs	$114,833	$114,833	$386,776	$4,660	$242,237	$207,367	$61,382	$47,348	$253,014
Net Benefits	($114,833)	($114,833)	($386,776)	($4,660)	($242,237)	($207,367)	($61,382)	($47,348)	($253,014)
BCR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The lack of navigation benefits for all projects during the "Transfer," "Mothball – Abandon," "Abandonment," and "Removal" alternatives are due to commercial navigation being unavailable under those four scenarios. Additionally, L/D 9 currently has no commercial navigation benefits and this is not expected to change during the 50-year period of study, resulting in no benefits for any of the alternatives presented. The "No Action – Flat Funding," "No Action – Reduced Funding," "No Action – Sustained Funding," "Mothball (5-Year Recovery)," and "Mothball (10-Year Recovery)" alternatives all yield positive net benefits for Allegheny L/D 5. The "No Action – Flat Funding" and "No Action – Reduced Funding" alternatives both yield positive net benefits for Allegheny L/D 6 and Allegheny L/D 7. None of the proposed alternatives yield positive net benefits for either Allegheny L/D 8 or Allegheny L/D 9.

Section 5: System of Accounts Evaluation:

The 1983 Principles and Guidelines (P&G) established four accounts to facilitate evaluation of alternatives in Federal water resources planning: National Economic Development (NED), Environmental Quality (EQ); Regional Economic Development (RED); and Other Social Effects (OSE).

The NED account measures contributions to National Economic Development and are the increases in the net value of the national output of goods and services, expressed in monetary units. The net benefits of any plan are the amount that the benefits exceed its costs. Positive net benefits indicate the plan is economically feasible to implement; negative net benefits denote that it is not economically feasible.

The EQ account is a means of displaying and integrating into water resources planning that information on the effects of alternative plans on significant EQ resources and attributes of the NEPA human environment that is essential to a reasoned choice among alternative plans. Significant means likely to have a material bearing on the decision-making process. The purpose of evaluating EQ is to identify significant beneficial and adverse effects of alternative plans on significant EQ resources discussed in section 7.6.

The RED account registers changes in the distribution of Regional Economic Activity that result from each alternative plan. The primary measures used in this account for this study are recreation and recreation-related spending.

The OSE account is a means of displaying and integrating information on alternative plan effects from water resource planning perspectives that are not reflected in the other three accounts. Categories include: hydropower and water supply impacts; life, health, and safety factors; and property and infrastructure impacts.

These accounts are assessed for each of the final plans below.

No Action – Flat Funding

NED: This alternative yields positive net benefits for three of the five projects as mentioned in section 4 above.
EQ: In the short-term, very little environmental impact is expected. Operations of the projects will continue at the current levels and the surrounding environment will not likely incur major positive or negative effects. In the long-term, the possibility of structural or operational failure increases and this would result in many (mostly negative) environmental impacts. Potential impacts are further discussed in section 7.6.
RED: In the short-term, very little impact is expected. In the long-term, the possibility of structural or operational failure increases and the resulting negative impacts (loss of pool, leading to loss of recreation and loss of water supply) could be quite high. Potential impacts are further discussed in section 7.5.
OSE: In the short-term, very little impact is expected. In the long-term, the possibility of structural or operational failure increases and the resulting negative impacts (loss of hydropower and water supply, damage to infrastructure, damage to property, safety risks, and loss of life) could be quite high. Potential impacts are further discussed in section 7.5.

No Action – Reduced Funding

NED: This alternative yields positive net benefits for three of the five projects as mentioned in section 4 above.
EQ: Similar to the flat funding alternative, in the short-term, very little environmental impact is expected. Operations of the projects will continue at slightly different levels of service and the surrounding environment will not likely incur major positive or negative effects. In the long-term, the possibility of structural or operational failure increases and this would result in many (mostly negative) environmental impacts. Other additional negative impacts could result from the reduction in levels of service, such as a reduction in fish passage and degradation of water quality. Potential impacts are further discussed in section 7.6.
RED: In the short-term, a small decrease in recreation benefits is expected due to the reduced levels of service. In the long-term, the possibility of structural or operational failure increases and the resulting negative impacts (loss of pool, leading to loss of recreation and loss of water supply) could be quite high. Potential impacts are further discussed in section 7.5.
OSE: In the short-term, very little impact is expected. In the long-term, the possibility of structural or operational failure increases and the resulting negative impacts (loss of hydropower and water supply, damage to infrastructure, damage to property, safety risks, and loss of life) could be quite high. Potential impacts are further discussed in section 7.5.

No Action - Sustainable Funding

NED: This alternative yields positive net benefits for one of the five projects as mentioned in section 4 above.
EQ: Similar to the flat funding alternative, in the short-term, very little environmental impact is expected. Operations of the projects will continue at slightly different levels of service and the surrounding environment will not likely incur major positive or negative effects. In the long-term, the possibility of structural or operational failure increases and this would result in many (mostly negative) environmental impacts. Some positive impacts could result from the

increase in levels of service, such as an increase in fish passage and improved water quality. Potential impacts are further discussed in section 7.6.
RED: In the short-term, a small increase in recreation benefits is expected due to the increased levels of service. In the long-term, the possibility of structural or operational failure increases and the resulting negative impacts (loss of pool, leading to loss of recreation and loss of water supply) could be quite high. Potential impacts are further discussed in section 7.5.
OSE: In the short-term, very little impact is expected. In the long-term, the possibility of structural or operational failure increases and the resulting negative impacts (loss of hydropower and water supply, damage to infrastructure, damage to property, safety risks, and loss of life) could be quite high. Potential impacts are further discussed in section 7.5.

Transfer

NED: This alternative yields no positive net benefits at any of the projects as mentioned in section 4 above.
EQ: This alternative is likely to have minimal impacts to geography, vegetation, and wildlife with the potential to have positive impacts to air quality and negative impacts to fish and mussels as well as water quality and raising HTRW-related concerns. Potential impacts are further discussed in section 7.6.
RED: The most likely transfer partner would be one interested in hydropower produced by the projects and so this alternative has a high chance of permanently ceasing operation of the locks on these projects. The results would be substantial with negative impacts to recreation due to a loss of mobility between pools, although within pool recreation should remain close to the same or see slightly negative impacts. Furthermore, many businesses located along the river would likely see a decrease in revenue due to the decline of recreation boating. Potential impacts are further discussed in section 7.5.
OSE: Hydropower is not expected to be heavily impacted by a transfer of the projects with the exception of L&D 7, which currently has no hydropower generation, but could in the future under this alternative. Risks to water supply, infrastructure, property, safety, and life loss are not expected to increase as the project will still be operated and maintained by the transferee. Potential impacts are further discussed in section 7.5.

Mothball

NED: This alternative yields positive net benefits for one of the five projects in both the "5-Year Recovery" and "10-Year Recovery" scenarios. It yields no positive net benefits at any of the projects for the "Abandon" scenario. Details can be found in section 4 above.
EQ: In the short-term, this alternative will have impacts similar to, but more negative than, the "No Action – Reduced Funding" alternative, due to the locks no longer being operated. In the long-term, this alternative expects the projects to be brought back online which could result in impacts similar to any of the three "No Action" alternatives (depending on level of funding), which includes the potential impacts of structural or operation failure. Potential impacts are further discussed in section 7.6.
RED: In the short-term, recreation benefits and other regional benefits derived from recreation (river-side businesses, recreation-related businesses, etc.) are expected to decline similar to the "Transfer" alternative. These benefits have the potential to return if the projects are brought back online and recreation returns, but businesses that close in that

period of recreation decline may not return. Potential impacts are further discussed in section 7.5.
OSE: In the short-term, hydropower and water supply benefits would be maintained with little to no impact and risks to infrastructure, property, safety, and life loss are not expected to increase. If the projects are not brought back online, then the expected impacts would be similar to those outlined in the "No Action – Flat Funding" alternative. Potential impacts are further discussed in section 7.5.

Abandonment

NED: This alternative yields no positive net benefits at any of the projects as mentioned in section 4 above.
EQ: This alternative is expected to have impacts similar to the "Mothball" alternative, except that a lack of funding across 50 years is not sustainable, so in the long-term structural or operational failure are much more likely. The failure of these projects would result in impacts similar to the long-term "No Action" alternatives. Potential impacts are further discussed in section 7.6.
RED: In the short-term, impacts of this alternative are identical to the impacts of the "Mothball" alternative. In the long-term, the possibility of structural or operational failure increases and the resulting impacts of this alternative are similar to those outlined in the "No Action – Flat Funding" alternative. Potential impacts are further discussed in section 7.5.
OSE: In the short-term, impacts of this alternative are identical to the impacts of the "Mothball" alternative. In the long-term, the possibility of structural or operational failure increases and the resulting impacts of this alternative are similar to those outlined in the "No Action – Flat Funding" alternative. Potential impacts are further discussed in section 7.5.

Removal

NED: This alternative yields no positive net benefits at any of the projects as mentioned in section 4 above.
EQ: This alternative would see both positive and negative impacts to the environment and it has greater potential to mitigate certain impacts due to the nature of removing portions of the project instead of allowing them to potentially fail. Potential impacts are further discussed in section 7.6.
RED: This alternative would see impacts to recreation similar to those outlined in the "Transfer" alternative. Motorized recreational boating would likely be more negatively impacted, but the non-motorized recreational boating could increase to the point of offsetting that loss. This alternative also presents other possible positive impacts to recreation-related businesses. Potential impacts are further discussed in section 7.5.
OSE: This alternative would result in the loss of hydropower benefits as well as at least partial loss of water supply benefits. Negative impacts to infrastructure, property, safety, and life loss would be reduced considerably due to the removal of components that would otherwise result in greater negative impacts in the event of a structural or operational failure. Potential impacts are further discussed in section 7.5.

Appendix C. Real Estate Appendix.

Appendix D. Environmental Appendix.

Table E- 1. Federal and State Species of Concern in the project vicinity (PNHP 2017).

	Species		**Federal Status**	**State Status**
Freshwater mussels	clubshell	*Pleurobema clava*	Endangered	Endangered
	northern riffleshell	*Epioblasma torulosa rangiana*	Endangered	Endangered
	rayed bean	*Villosa fabalis*	Endangered	Endangered
	snuffbox	*Epioblasma triquetra*	Endangered	Endangered
	sheepnose	*Plethobasus cyphyus*	Endangered	Threatened
	rabbitsfoot	*Quadrula cylindrica cylindrica*	Threatened	Endangered
	Round Hickorynut	*Obovaria subrotunda*	-	Endangered
	Fanshell	*Cyprogenia stegaria*	Endangered	-
	Pink Mucket	*Lampsilis abrupta*	Endangered	-
	Rough Pigtoe	*Pleurobema plenum*	Endangered	-
Fish	Mountain brook lamprey	*Ichthyomyzon greeleyi*	-	Threatened
	Black bullhead	*Ameiurus melas*	-	Endangered
	Gravel Chub	*Erimystax x-punctatus*	-	Endangered
	Mountain Madtom	*Noturus eleutherus*	-	Endangered
	Tadpole Madtom	*Noturus gyrinus*	-	Endangered
	Northern Madtom	*Noturus stigmosus*	-	Endangered
	Southern Redbelly Dace	*Phoxinus erythrogaster*	-	Threatened
Reptiles and Amphibians	Bog Turtle	*Glyptemys muhlenbergii*	Threatened	Endangered
	Eastern Massasauga	*Sistrurus catenatus catenatus*	Threatened	Endangered
	Northern Cricket Frog	*Acris crepitans*	-	Endangered
	Kirtland's Snake	*Clonophis kirtlandii*	-	Endangered
Birds	Peregrine Falcon	*Falco peregrinus*	-	Endangered
	Short-eared Owl	*Asio flammeus*	-	Endangered
	Long-eared Owl	*Asio otus*	-	Threatened
	Upland Sandpiper	*Bartramia longicauda*	-	Endangered
	American Bittern	*Botaurus lentiginosus*	-	Endangered
	Northern Harrier	*Circus cyaneus*	-	Threatened
	Dickcissel	*Spiza americana*	-	Endangered
	Least Bittern	*Ixobrychus exilis*	-	Endangered
	Osprey	*Pandion haliaetus*	-	Threatened
Mammals	Northern Long-eared Bat	*Myotis septentrionalis*	Threatened	-
	Indiana Bat	*Myotis sodalis*	Endangered	Endangered
	Eastern Small-footed Bat	*Myotis leibii*	-	Threatened

	Species		Federal Status	State Status
	Northern Flying Squirrel	*Glaucomys sabrinus*	-	Endangered
	Allegheny Woodrat	*Neotoma magister*	-	Threatened
Plants	Small-whorled Pogonia	*Isotria medeoloides*	Threatened	Endangered
	Scarlet Ammannia	*Ammannia coccinea*	-	Endangered
	Mountain Bugbane	*Actaea podocarpa*	-	Threatened
	Northern Water-plantain	*Alisma triviale*	-	Endangered
	Small-flowered False-foxglove	*Agalinis paupercula*	-	Endangered
	Northern Water-plantain	*Alisma triviale*	-	Endangered
	Oblong-fruited Serviceberry	*Amelanchier bartramiana*	-	Endangered
	Awned Sedge	*Carex atherodes*	-	Endangered
	Carey's Sedge	*Carex careyana*	-	Endangered
	Lesser Panicled Sedge	*Carex diandra*	-	Threatened
	Prairie Sedge	*Carex prairea*	-	Threatened
	Sterile Sedge	*Carex sterilis*	-	Threatened
	Cattail Sedge	*Carex typhina*	-	Endangered
	Tall Larkspur	*Delphinium exaltatum*	-	Endangered
	Flat-stemmed Spike-rush	*Eleocharis compressa*	-	Endangered
	Slender Spike-rush	*Eleocharis elliptica*	-	Endangered
	Matted Spike-rush	*Eleocharis intermedia*	-	Threatened
	Four-angled Spike-rush	*Eleocharis quadrangulata*	-	Endangered
	Downy Willow-herb	*Epilobium strictum*	-	Endangered
	Harbinger-of-spring	*Erigenia bulbosa*	-	Threatened
	Rough Cotton-grass	*Eriophorum tenellum*	-	Endangered
	Thin-leaved Cotton-grass	*Eriophorum viridicarinatum*	-	Threatened
	Cluster Fescue	*Festuca paradoxa*	-	Endangered
	Bicknell's Hoary Rockrose	*Helianthemum bicknellii*	-	Endangered
	Purple Rocket	*Iodanthus pinnatifidus*		
	Torrey's Rush	*Juncus torreyi*	-	Threatened
	Hispid Gromwell	*Lithospermum caroliniense*	-	Endangered
	Mountain Fly Honeysuckle	*Lonicera villosa*	-	Endangered
	Northern Water-milfoil	*Myriophyllum sibiricum*		
	Bushy Naiad	*Najas gracillima*	-	Threatened
	Tuckerman's Panic-grass	*Panicum tuckermanii*	-	Threatened

	Species		Federal Status	State Status
	Leafy White Orchid	*Platanthera dilatata*	-	Endangered
	Bog Bluegrass	*Poa paludigena*	-	Threatened
	Balsam Poplar	*Populus balsamifera*	-	Endangered
	Grassy Pondweed	*Potamogeton gramineus*	-	Endangered
	Red-head Pondweed	*Potamogeton richardsonii*	-	Threatened
	Tennessee Pondweed	*Potamogeton tennesseensis*	-	Endangered
	Vasey's Pondweed	*Potamogeton vaseyi*	-	Endangered
	Crepis Rattlesnake-root	*Prenanthes crepidinea*	-	Endangered
	Common Hop-tree	*Ptelea trifoliata*	-	Threatened
	Red Currant	*Ribes triste*	-	Threatened
	Autumn Willow	*Salix serissima*	-	Threatened
	Stalked Bulrush	*Scirpus pedicellatus*	-	Threatened
	Few Flowered Nutrush	*Scleria pauciflora*	-	Threatened
	Hooded Ladies'-tresses	*Spiranthes romanzoffiana*	-	Endangered
	White Twisted-stalk	*Streptopus amplexifolius*	-	Threatened
	American Columbo	*Swertia caroliniensis*	-	Endangered
	Rush Aster	*Symphyotrichum boreale*	-	Endangered
	Nodding Pogonia	*Triphora trianthophora*	-	Endangered

Appendix E. Climate Change Analysis.

Allegheny River Disposition Study

Climate Change Impacts Qualitative Analysis

Phase I: Relevant Current Climate and Climate Change

a) Literature Review.
A May 2017 report conducted by the USACE Institute for Water Resources and the Ohio River Basin Alliance (ORB Pilot Study, Drum et al, 2017) summarizes the available literature for the Ohio River Basin (ORB), which includes the Allegheny River basin. The report presents a pilot study based on global circulation models (GCM) produced by the International Panel on Climate Change Fourth Assessment (2007) and Coupled Model Intercomparison Project-Phase 3 (CMIP3) climate and hydrology projections downscaled to the ORB. Three 30-year time periods from 2011-2099 were established for precipitation and temperature modeling. The NOAA Ohio River Forecast Center used the GCM modeling to simulate annual mean and seasonal flow discharges for 25 forecast points within the basin, as well as a range of temperature changes (annual mean, annual maximum, and annual minimum) for those same points.

For the ORB, modeling results indicate a gradual increase in annual mean temperatures between 2011 and 2040 amounting to one-half degree per decade, with greater increases between 2041 and 2099 of one full degree per decade. Hydrologic flow changes show substantial variability across the ORB through the three time periods, with Hydrologic Unit Code-4 (HUC4) sub-basins located northeast, east, and south of the Ohio River expected to experience greater precipitation and thus higher stream flows—up to 50% greater—during most of the three 30-year periods. Conversely, those HUC4s located north and west of the Ohio River are expected to experience ever-decreasing precipitation (especially during the autumn season) resulting in decreased in-stream flows—up to 50% less—during the same periods.

b) The USACE Climate Hydrology Assessment Tool.
Historic trends in instantaneous peak flows at Allegheny River gages were analyzed using the USACE Climate Hydrology Assessment Tool (CHAT) at three gages located upstream, downstream, and within the project area: Allegheny River at Parker, PA (USGS 03031500), Allegheny River at Kittanning, PA (USGS 03036500), and Allegheny River at Natrona, PA (USGS 03049500). Results from the CHAT analysis of annual peak instantaneous streamflow are presented in the figures below. Note that all three gages display **a negative trend** in the annual peak streamflow linear regression that is **statistically significant** (i.e., p-value less than 0.05). This trend may be due in part to the construction of flood control reservoirs within the Allegheny River basin (1940-1973) and the lack of recent basin-wide floods of record.

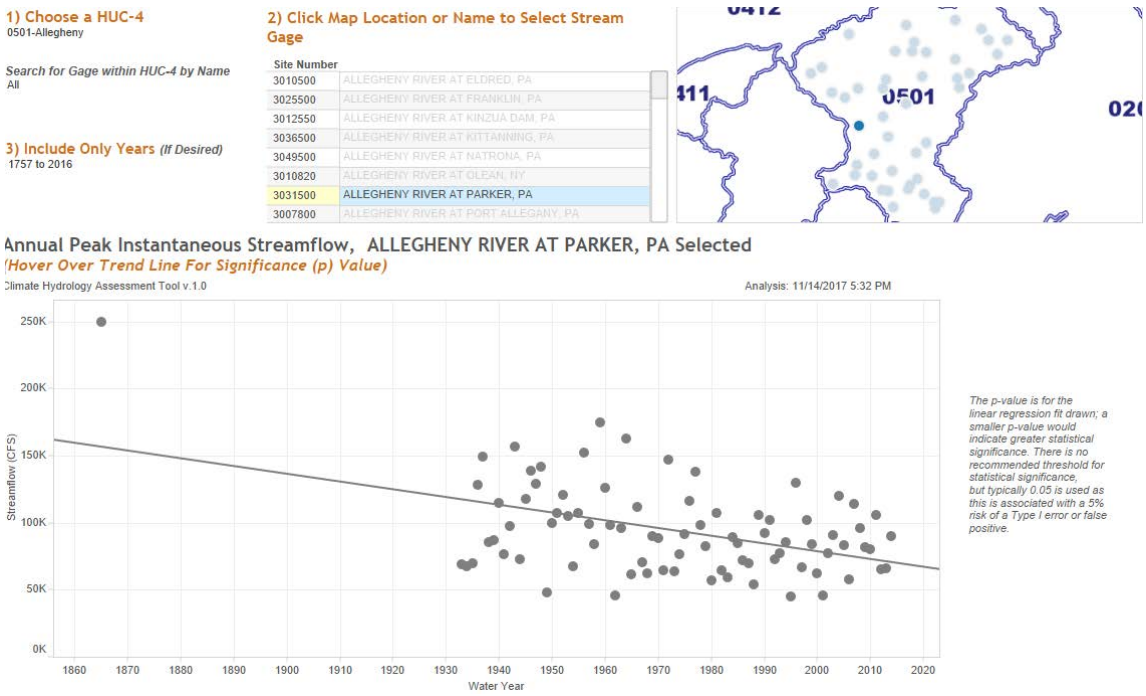


Figure E-1: Annual Peak Instantaneous Streamflow, Allegheny River at Parker, PA
Linear Regression: Value = -578*Water Year + 1234230, R-Squared: 0.203, P-value: <0.0001

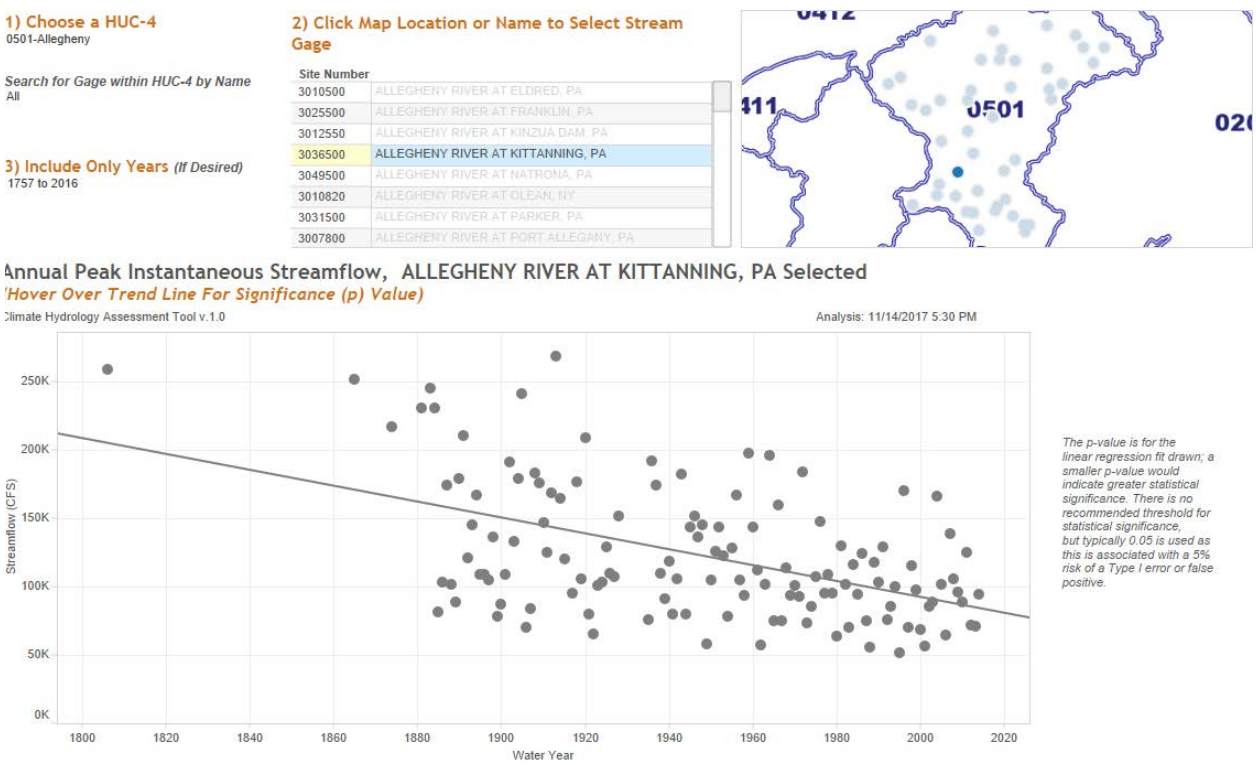


Figure E-2: Annual Peak Instantaneous Streamflow, Allegheny River at Kittanning, PA
Linear Regression: Value = -581*Water Year + 1255450, R-Squared: 0.252, P-value: <0.0001

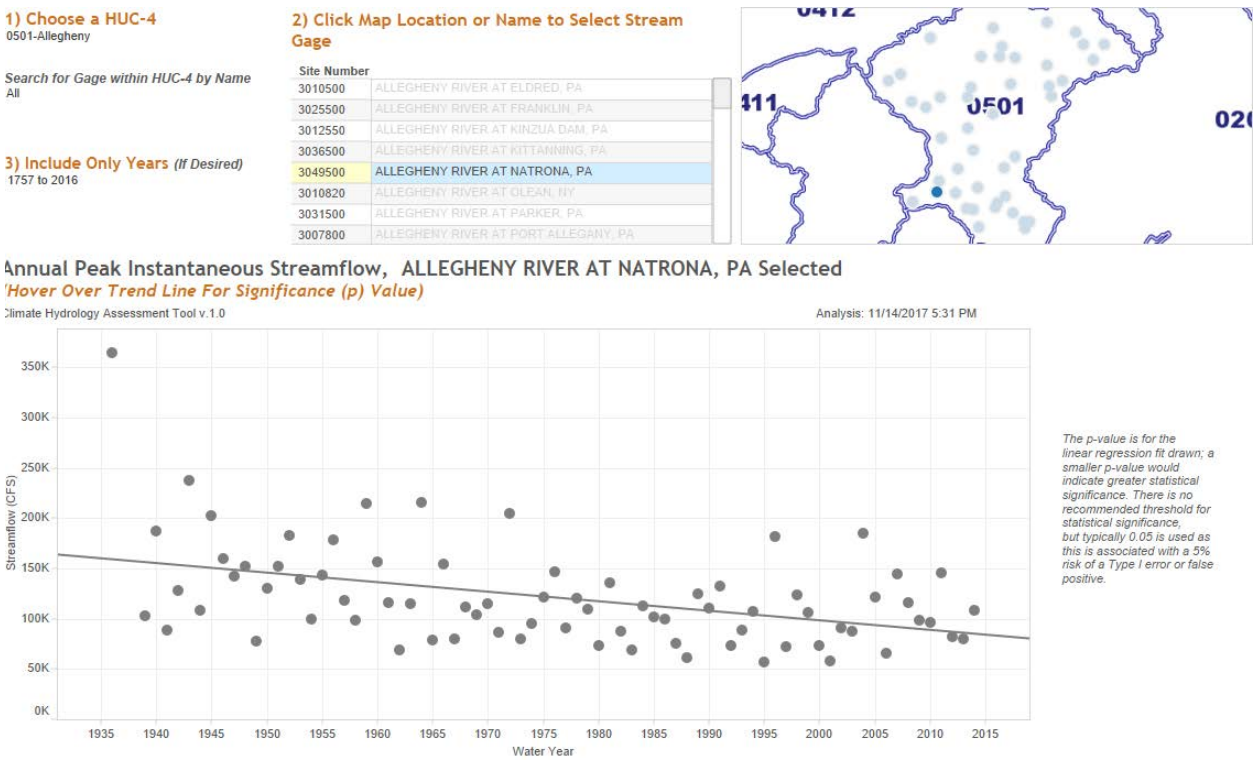


Figure E-3: Annual Peak Instantaneous Streamflow, Allegheny River at Natrona, PA Linear Regression: Value = -949*Water Year + 1995910, R-Squared: 0.183, P-value: 0.0001

c) The USACE Nonstationarity Detection Tool.
The Nonstationarity Tool correctly identified changes to the maximum annual flow due to construction of upstream flood control reservoirs in the Allegheny River basin, most notably Kinzua Dam and Allegheny Reservoir which began operation in 1966. Changes to the mean, standard deviation, and variance were detected for the upstream gage (Parker), while only changes to the mean were detected at the intermediate gage (Kittanning) and the downstream gage (Natrona). A nonstationarity in the 1880's was also identified at the Kittanning gage, but this may be due to the transition between historic and systematic maximum annual flow data. The period of record was limited to 1970-2014 in an effort to isolate the period of regulated flow and there were no periods of nonstationarity detected. The Pittsburgh District Hydrology and Hydraulics Unit is currently planning an evaluation of the nonstationarity of unregulated flows for the Allegheny River at Natrona for FY18Q3.

Results from the Nonstationarity Detection Tool are presented in the figures below. A trend analysis was also completed using this tool and a statistically significant negative trend was detected for all three gages using the full period of record, which

verifies the CHAT results. When the period of record is limited to 1970-2014, no statistically significant trend is detected.

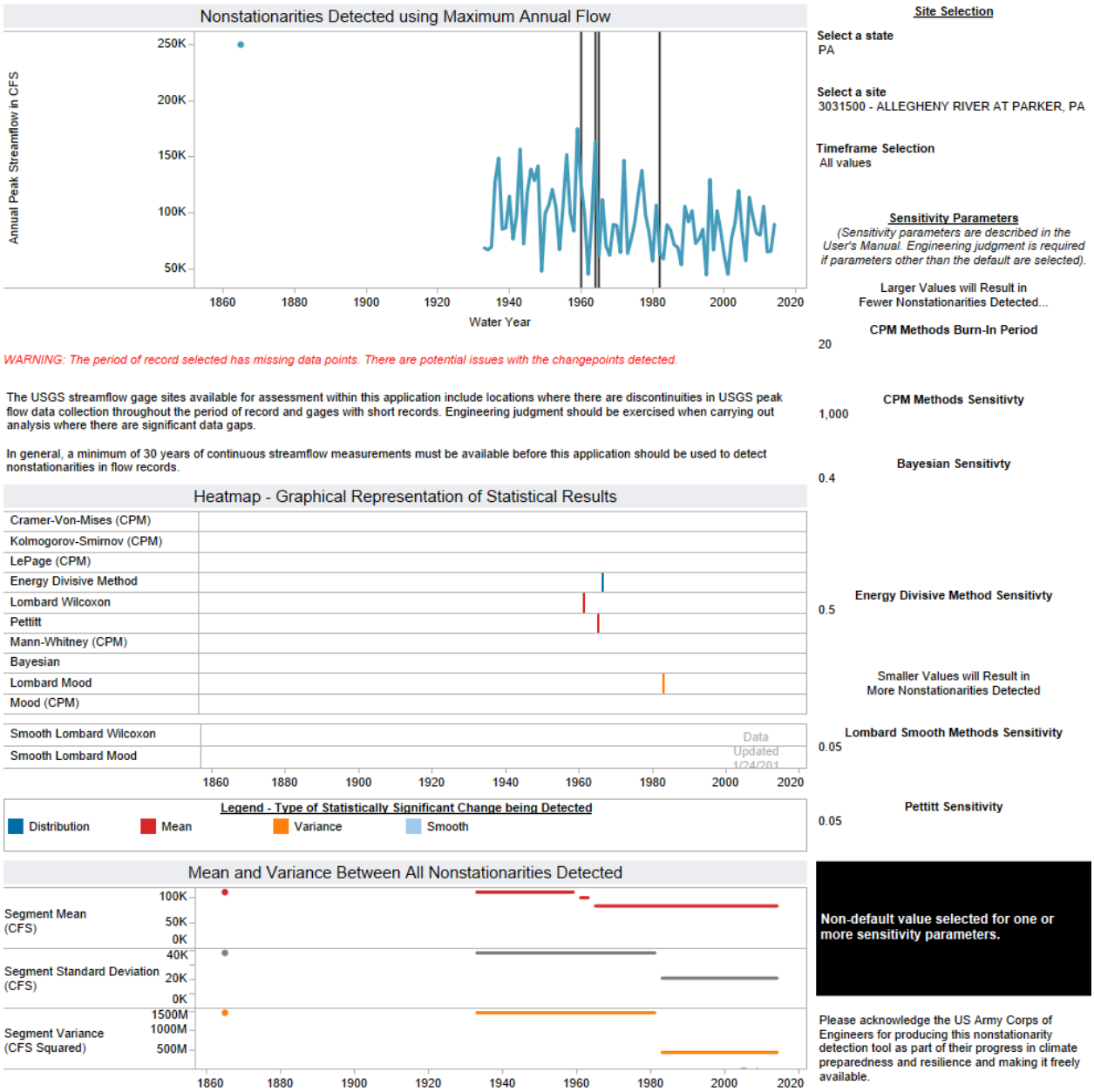


Figure E-4: Nonstationarity Analysis of Maximum Annual Flow, Allegheny River at Parker, PA

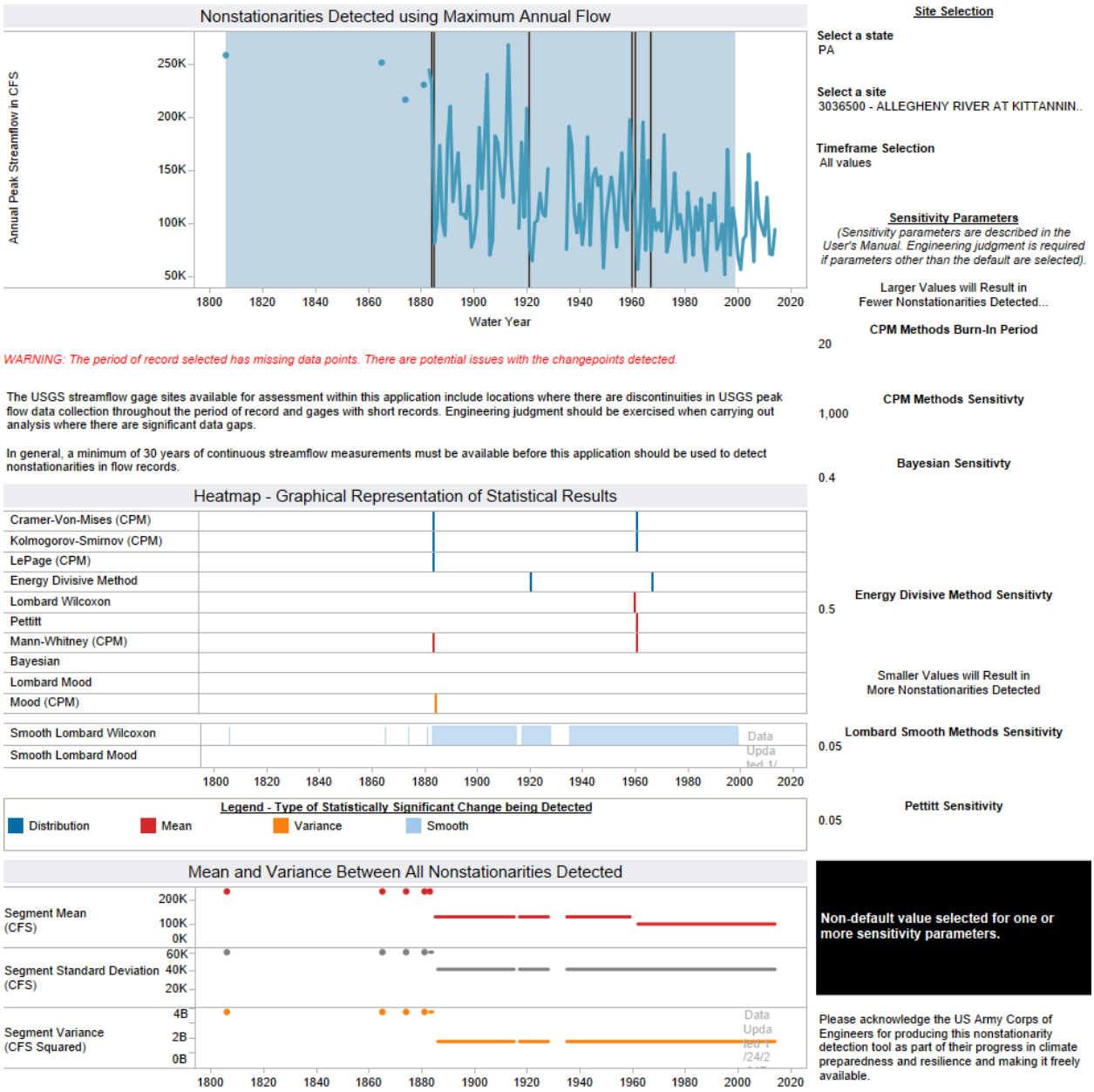


Figure E-5: Nonstationarity Analysis of Maximum Annual Flow, Allegheny River at Kittanning, PA

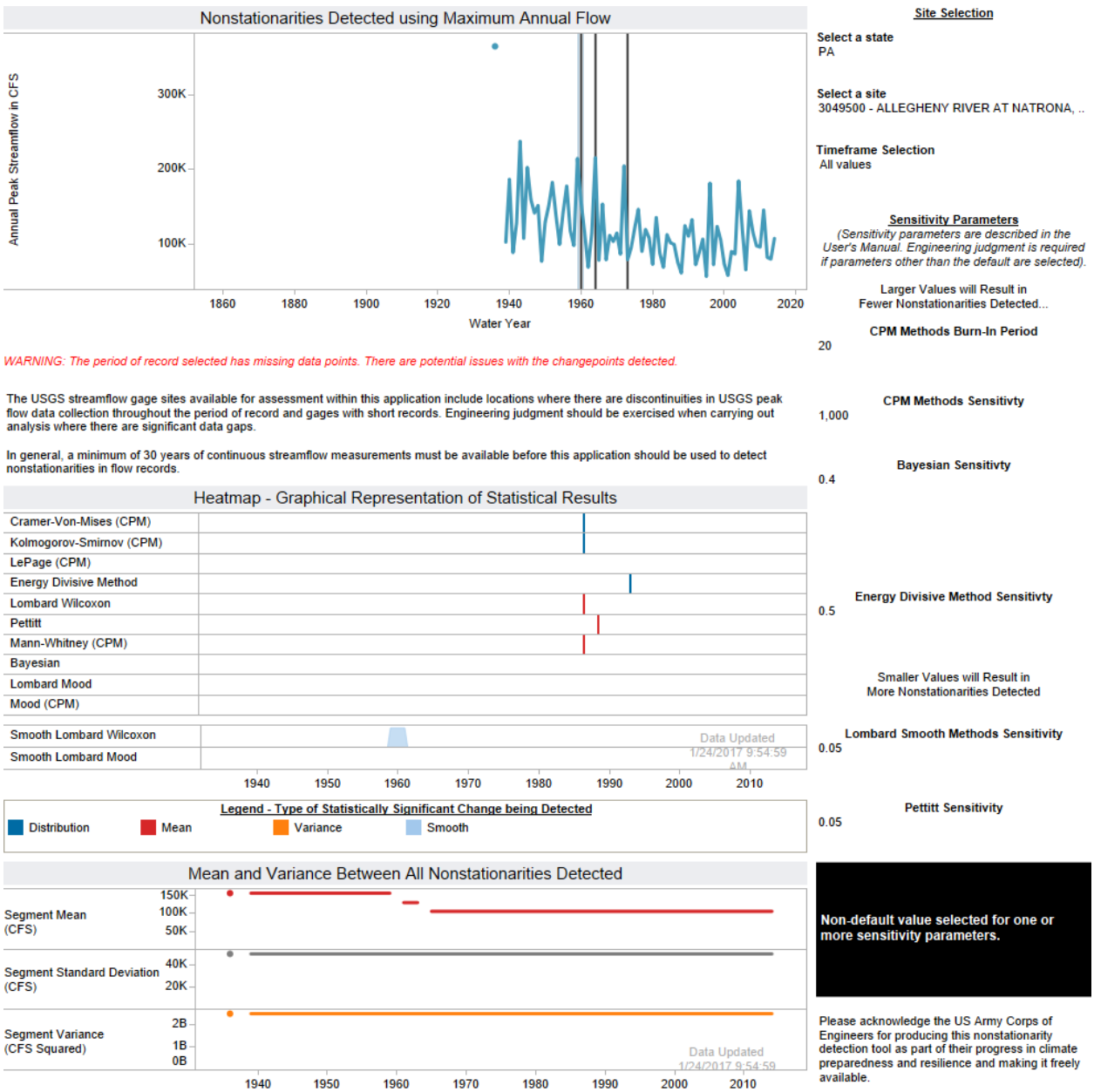


Figure E-6: Nonstationarity Analysis of Maximum Annual Flow, Allegheny River at Natrona, PA

Phase II: Projected Changes to Watershed Hydrology and Assessment of Vulnerability to Climate Change.

a) The USACE Climate Hydrology Assessment Tool.

The CHAT was used to identify projected changes in annual maximum monthly flows for the Allegheny River basin, HUC4 0501. Figure E-7 displays the range of the projected annual maximum monthly streamflows computed by 93 different combinations of GCM/RCP (Representative Concentration Pathways) model projections for a period of 1950 to 2099. Figure E-8 presents a trend analysis of

mean projected annual maximum monthly streamflow, but there is **no statistically significant trend**.

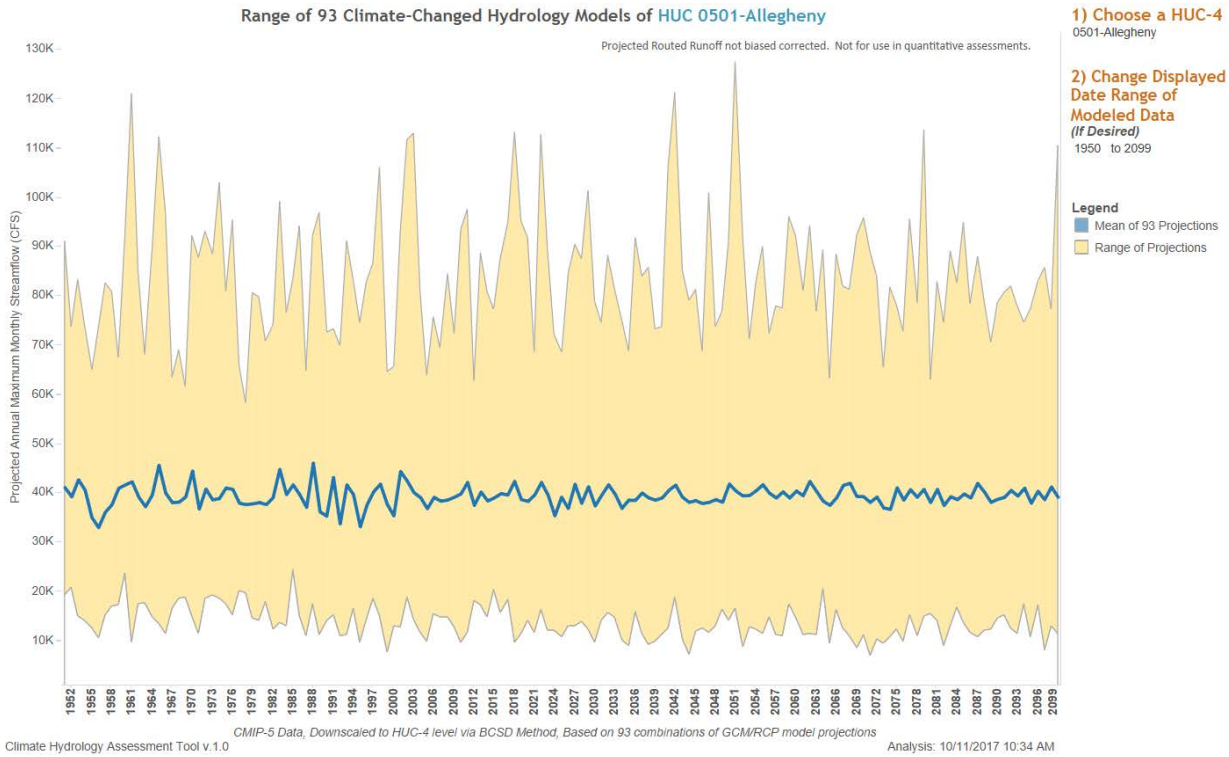


Figure E-7: Range of Projected Annual Maximum Monthly Streamflow using 93 Climate-Changed Hydrology Models, HUC 0501 Allegheny River, Pennsylvania

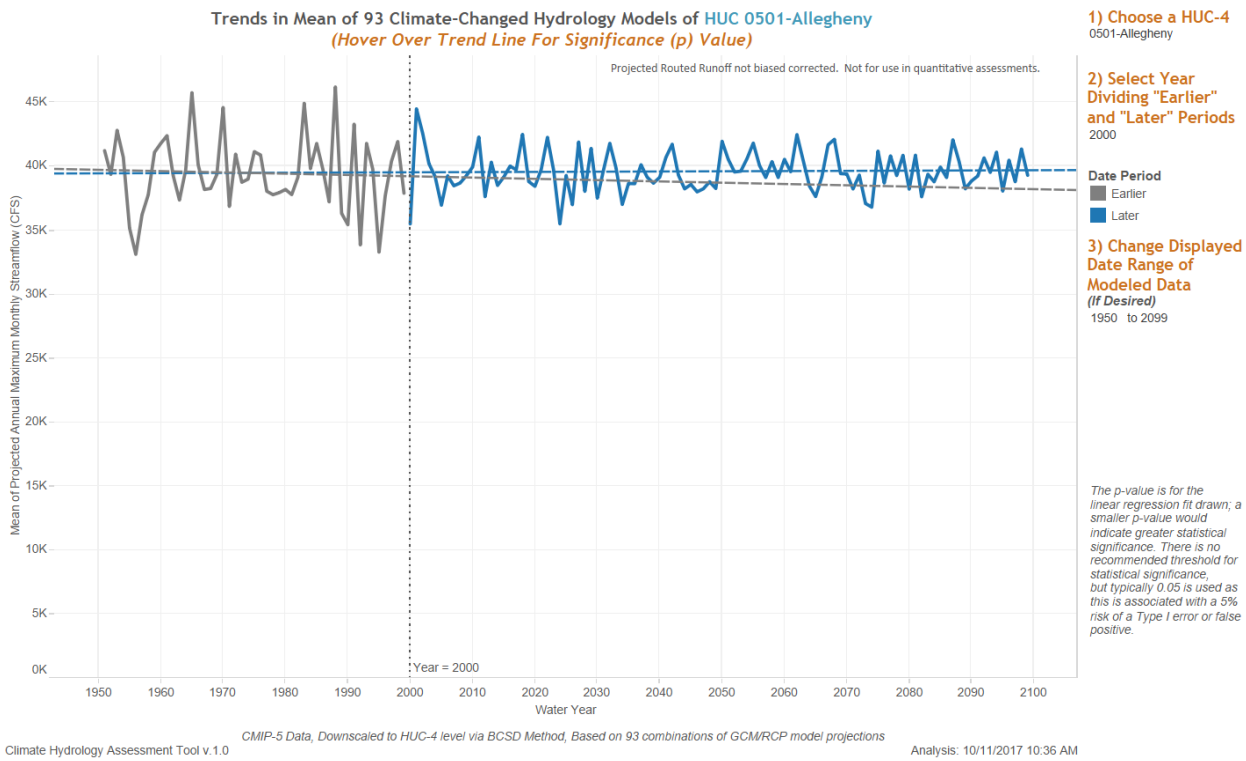


Figure E-8: Mean of Projected Annual Maximum Monthly Streamflow, HUC 0501 Allegheny River, Pennsylvania, Earlier period P-value: 0.74, Later period P-value: 0.77

b) The USACE Watershed Climate Vulnerability Assessment Tool.

The Watershed Climate Vulnerability Assessment (VA) Tool was used to provide information on the relative vulnerability of the Allegheny River basin to climate change using a wider variety of flow variables. The tool enables a VA assessment for each USACE business line within each HUC4 watershed across the United States and provides a Weighted Order Weighted Average (WOWA) score to evaluate composite indices of climate change indicators. This qualitative analysis focused on the Navigation and Recreation business lines for the Allegheny River basin. The primary indicators for the Navigation business line were low flow reduction during the dry scenarios (29% of WOWA score) and flood magnification during the wet scenarios (also 29% of WOWA score). Overall, the Navigation business line does not appear to have high vulnerability in HUC 0501 when compared nationally or divisionally for either the Dry or Wet scenarios. In fact, Pittsburgh District watersheds (HUC4 0501, 0502, and 0503) are not identified as vulnerable for any USACE business lines.

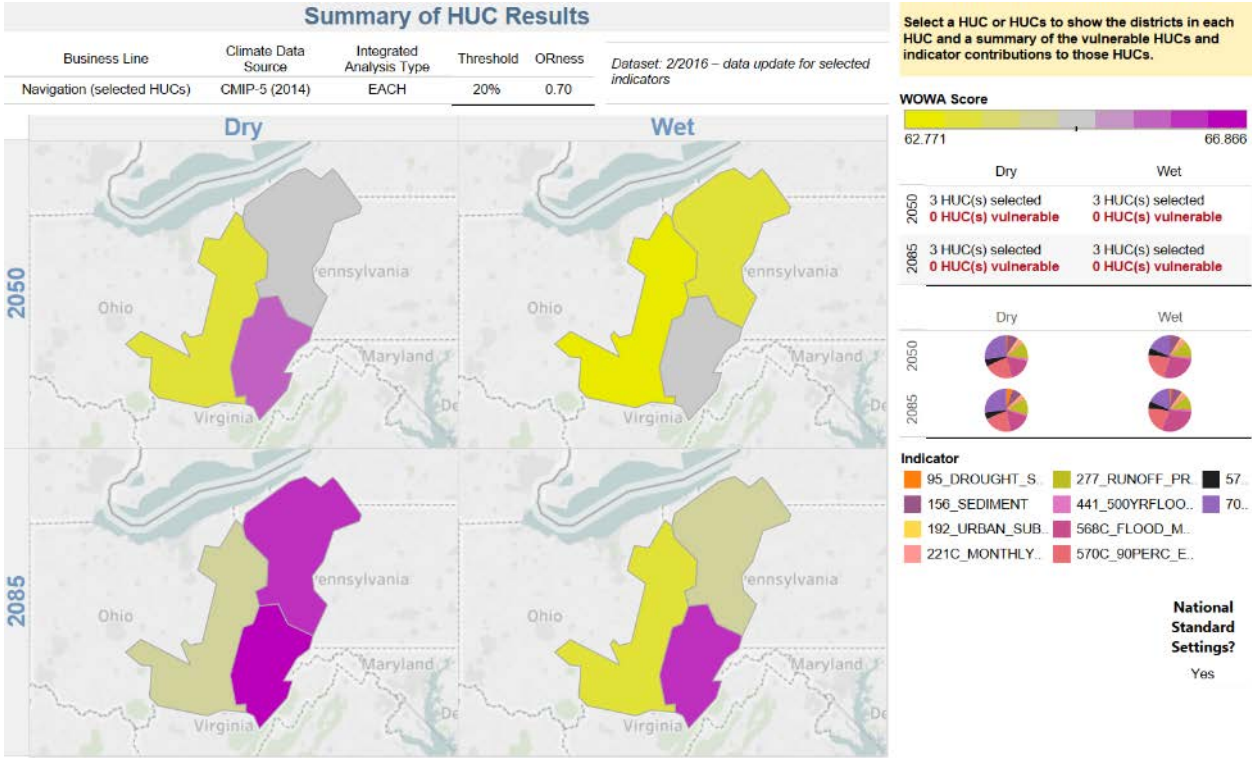


Figure E-9: USACE Watershed Climate Vulnerability Assessment for the Pittsburgh District, Navigation Business Line

Conclusions.

Overall, no strong signal exists within the Allegheny River basin qualitative analysis to indicate what definitive impacts climate change will hold for the river hydrology. While the ORB pilot study indicates that there will be increases in temperature, precipitation, and streamflow, the IWR qualitative tools using available USGS gage data do not display the same increases in streamflow. This may point to the importance of producing an unregulated streamflow record for analysis.

Recommendations.

Based on this assessment, which shows no significant signals, the recommendation is to treat the potential effects of climate change as occurring within the uncertainty range calculated for the current hydrologic analysis. There may be other indicators of climate change, such as changes in biotic communities, but this analysis is focused on changes in climate hydrology. Methods of translating climate change impact uncertainty for an engineering-based analysis do not currently exist. In this analysis, no compelling evidence exists to alter the execution of the project to incorporate climate change.

References.

Drum, R. G., J. Noel, J. Kovatch, L. Yeghiazarian, H. Stone, J. Stark, P. Kirshen, E. Best, E. Emery, J. Trimboli, J. Arnold, and D. Raff (2017), Ohio River Basin–Formulating Climate Change Mitigation/Adaptation Strategies Through Regional Collaboration with the ORB Alliance, May 2017. Civil Works Technical Report, CWTS 2017-01, U.S. Army Corps of Engineers, Institute for Water Resources: Alexandria, VA