# Appendix E
# National Hydrography Requirements and Benefits Study
# Business Uses

This section describes each of the 25 Business Uses (BUs) included in this study, summarizes each BU, provides an example activity for each BU, shows a map of the spatial extents of the areas of interest of the Mission Critical Activities (MCAs) for which the BU as reported as the primary BU, and summarizes the requirements and benefits of each BU.

The 25 Business Uses are listed in Table 1 below. Appendix B (Federal agencies), Appendix C (states), and Appendix D (associations) include full details of the MCAs.

*Table 1. Business Uses*

| BU # | Business Use |
|---|---|
| 1 | River and Stream Flow Management |
| 2 | Natural Resources Conservation |
| 3 | Water Resource Planning and Management |
| 4 | Water Quality |
| 5 | River and Stream Ecosystem Management |
| 6 | Coastal Zone Management |
| 7 | Forest Resources Management |
| 8 | Rangeland Management |
| 9 | Wildlife and Habitat Management |
| 10 | Agriculture and Precision Farming |
| 11 | Geologic Resource Assessment and Hazard Mitigation |
| 12 | Resource Mining |
| 13 | Renewable Energy Resources |
| 14 | Oil and Gas Resources |
| 15 | Flood Risk Management |
| 16 | Sea Level Rise and Subsidence |
| 17 | Wildfire Management, Planning, and Response |
| 18 | Homeland Security, Law Enforcement, and Disaster Response |
| 19 | Marine and Riverine Navigation Safety |
| 20 | Infrastructure and Construction Management |
| 21 | Urban and Regional Planning |
| 22 | Health and Human Services |
| 23 | Real Estate, Banking, Mortgage, and Insurance |
| 24 | Education K-12 and Beyond |
| 25 | Recreation |

## BU #1 River and Stream Flow Management

BU #1, River and Stream Flow Management, was described in the questionnaire as including the following types of MCAs: monitoring river flows, runoff, groundwater, and streamflow simulation, and stormwater management.

A total of 44 MCAs were characterized as having BU #1 as their primary BU with a total annual program budget of $763,578,092 for programs supported by hydrography data, a total of $220,066,228 to $220,091,228 in estimated annual benefits from the currently available hydrography data, and $154,730,307 in estimated future annual benefits from enhanced hydrography data. Eleven MCAs also noted BU #1 as an ancillary BU.

**BU #1 Highlights:**

**Number of MCAs:** 44
**Estimated annual program budget:** $763,578,092
**Estimated current annual benefits:** $220,066,228 to $220,091,228
**Estimated future annual benefits:** $154,730,307

These 44 MCAs were reported by seven Federal agencies, two not-for-profits, two private entities, 12 regional or local government agencies, 20 state agencies, and one tribal government.

Among Federal agencies, the MCAs included hydrologic modeling and water budgets, water resources management, streamflow networks and flood/coastal modeling and studies, bi-national cooperation between the U.S. and Canada to protect shared waters, and water resources forecasting.

Among the non-Federal entities, the MCAs included stormwater management, water rights, water flow management, water quality monitoring, hydraulic modeling, surface water mapping, watershed protection, and climate impacts on streamflow.

**Areas of Interest**

Figure 1 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #1 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

Most states and many county or local entities likely have river and streamflow management as one of their missions; however, because of the varied representation of state and local agencies, and because the BUs were self-selected, it is likely that additional areas across the U.S. would have an interest in river and streamflow management. Note also that the International Joint Commission has requirements for hydrography data to cover all shared watersheds with Canada. The International Boundary and Water Commission, which was not represented in this study, is likely to have similar requirements for data extending into Mexico.

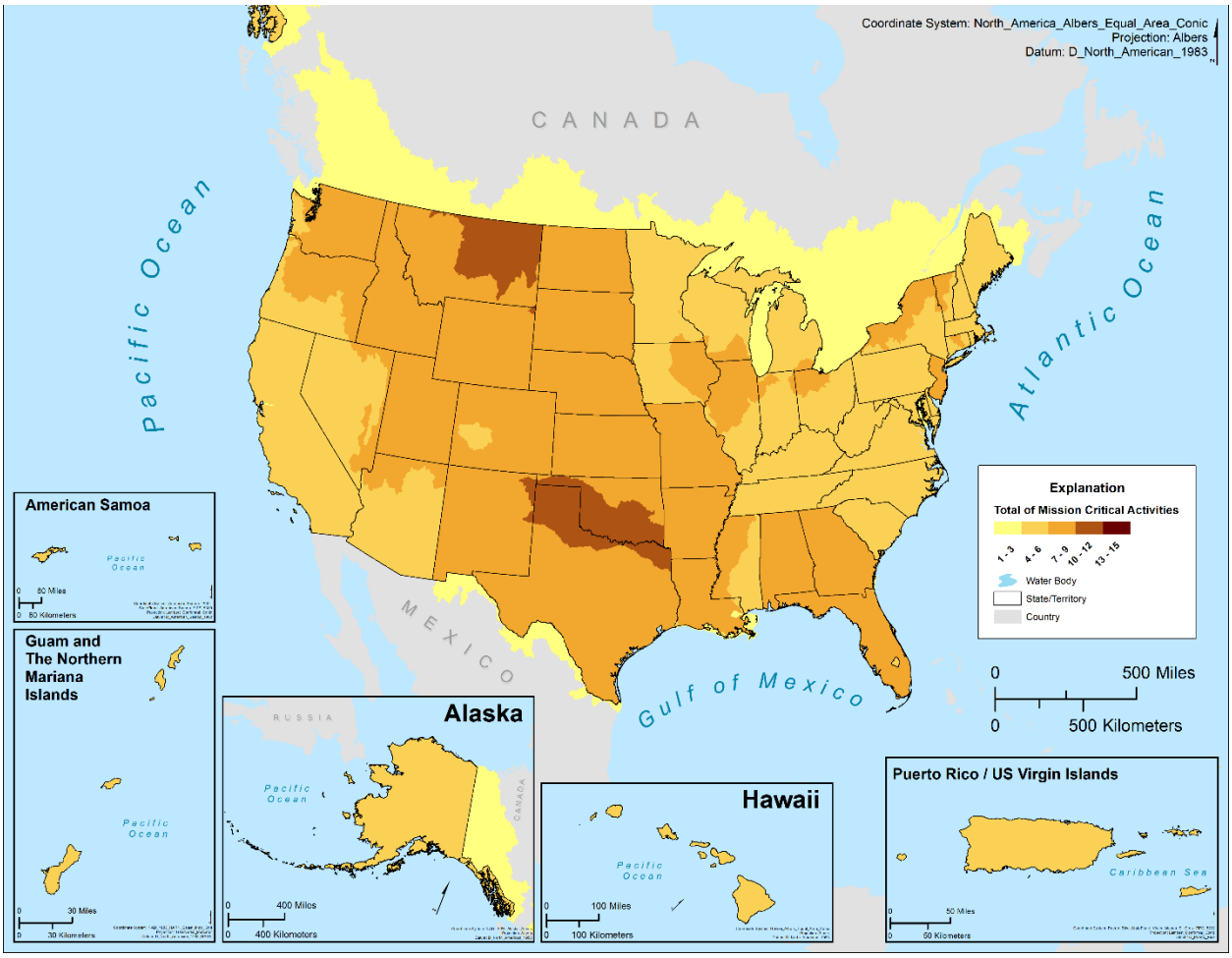



*Figure 1. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #1 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

## Requirements

Table 2 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #1 as their primary BU, and the most frequently-requested requirements by category.

*Table 2. Requirements for enhanced hydrography data reported for BU #1*

| Requirement | Most Frequently Reported Requirement | Percent of MCAs |
|---|---|---|
| **Update Frequency** | Annually/4-5 Years | 39% each |
| **Positional Accuracy** | +/- 3 feet, 90% (1:1,200-scale) | 39% |
| **Stream Density** | 5.0 miles of channel per square mile/2.5 miles of channel per square mile | 39% each |
| **Smallest Contributing Watershed** | 6 acres | 34% |
| **Smallest Mapped Waterbody** | Less than an acre | 43% |
| **Post-Event Update** | Highly Desirable | 36% |
| **Level of Detail** | Best Available | 52% |

The requirements for characteristics and analytical functions for BU #1 are shown in Table 3.

*Table 3. Requirements for characteristics and analytical functions for BU #1*

| Required Characteristics/Analytical Functions | Number of MCAs (of 44) | Percent of MCAs |
|---|---|---|
| Calculate drainage area | 39 | 89% |
| Delineate catchment | 34 | 77% |
| Find upstream or downstream feature within watershed | 33 | 75% |
| Linkages to stream gage observations | 33 | 75% |
| Navigate up or downstream on network | 33 | 75% |
| Calculate stream distance to points | 28 | 64% |
| Flood stage | 28 | 64% |
| Accumulate upstream or downstream features | 27 | 61% |
| Linkages to cross section geometry | 27 | 61% |
| Floodplain boundary | 26 | 59% |
| Riverine bathymetry | 26 | 59% |
| Calculate distance on network | 25 | 57% |
| Velocity or time of travel | 25 | 57% |
| Flow periodicity | 24 | 55% |
| Determine downstream flood area | 23 | 52% |
| Diversion points | 23 | 52% |
| Left/right bank delineation | 23 | 52% |
| Find upstream or downstream points | 22 | 50% |
| Mash-ups | 22 | 50% |
| Wetlands | 22 | 50% |
| Bridges, culverts | 21 | 48% |
| Diversion lines | 21 | 48% |
| Find events or features on network | 20 | 45% |
| Preset symbolization | 19 | 43% |
| Calculate time of travel to points | 18 | 41% |
| User defined symbolization | 18 | 41% |
| Leakage at points | 17 | 39% |
| Coastlines | 15 | 34% |
| Leakage along lines | 15 | 34% |
| Estuaries | 14 | 32% |
| Coastal bathymetry | 13 | 30% |
| Animation of time-series | 12 | 27% |
| Deltas | 8 | 18% |
| Other (please specify) | 4 | 9% |
| Badlands | 3 | 7% |

**Future Annual Benefits**

An estimated $154,730,307 in future annual benefits from enhanced hydrography data was reported for the MCAs categorized as having BU #1 as their primary BU.

Figure 2 shows the estimated future annual benefits provided by the MCAs categorized as having BU #1 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

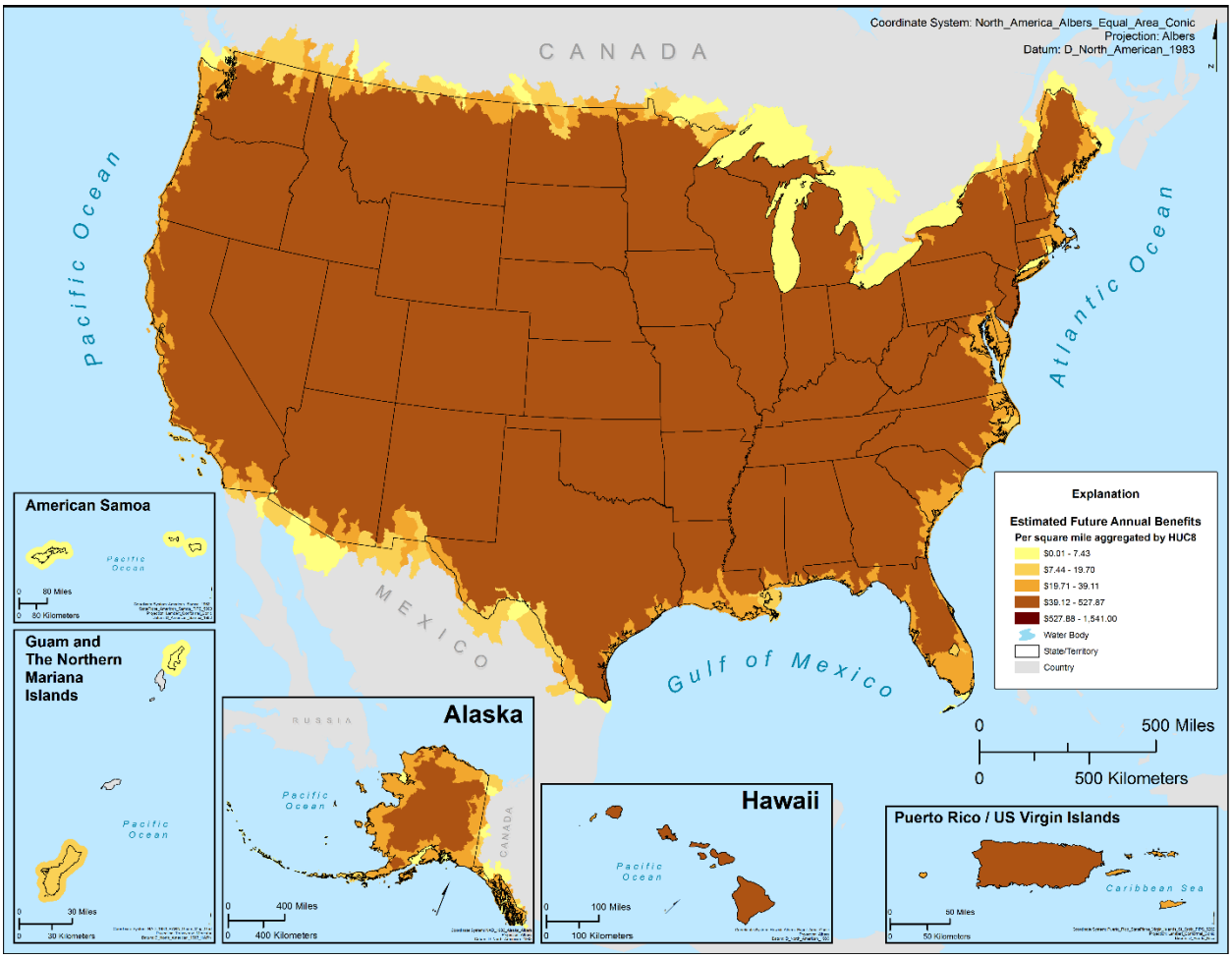



*Figure 2. Estimated future annual benefits reported for MCAs with BU #1 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 4 lists the qualitative benefits reported for BU #1.

*Table 4. Qualitative benefits reported for BU #1*

| | Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 13 | 21 | 17 | 13 | 12 | 9 | 12 | 2 |
| **Moderate** | 18 | 12 | 15 | 15 | 13 | 14 | 12 | 7 |
| **Minor** | 6 | 4 | 3 | 7 | 6 | 10 | 11 | 8 |
| **N/A** | 0 | 1 | 2 | 1 | 3 | 2 | 1 | 16 |
| **Don't Know** | 3 | 2 | 3 | 4 | 6 | 5 | 4 | 7 |

| | Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **No Answer Provided** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| **Total** | 44 | 44 | 44 | 44 | 44 | 44 | 44 | 44 |

These benefits would be realized due to reduced costs for lidar and bathymetric data collection, increased efficiency, better modeling, improved communication with stakeholders, improved reservoir operations, less time spent finding data, more reliable results, and improved decision-making.

**Example River and Stream Flow Management Activities**

Local resolution hydrography data can be used to model stormwater runoff from pervious and impervious surfaces including rooftops which collect a lot of stormwater. Stormwater monitoring needs also involve proper siting of Best Management Practices (BMPs) such as rooftop gardens, bioretention, and other green infrastructure practices including riparian buffers to mitigate the runoff. BMPs support the goals of improving impaired waterbodies (such as the Chesapeake Bay) by improving the water clarity and overall health of the waterbody, as well as goals for improving local water quality in the contributing watersheds.

After conducting demonstration projects to evaluate the performance and benefits of green roofs on reducing rainfall runoff and pollutants into the Anacostia River, the District of Columbia Department of Energy and Environment (DOEE) identified green roofs as a BMP to minimize pollution transport from stormwater under the NPDES. According to the Chesapeake Bay Foundation, urban runoff is the largest source of pollution to urban waterways such as the Anacostia River, and one of the largest sources of pollution in the Chesapeake Bay. Additionally, during heavy rains, the sewers in the downtown area (a combined sanitary and stormwater system) can become overburdened. Thus, the need to reduce stormwater runoff in the District is of great importance.

Green roofs hold and delay rainfall runoff flows that can trigger combined sewer overflows, filter pollutants (especially nitrogen) that ultimately make their way into rivers, reduce sewage treatment requirements, and save energy in buildings. According to a paper published by the Chesapeake Bay Foundation in 2008, a typical green roof will retain about one inch of rainfall. Using this as a guide, a green roof that covers half of a building's rooftop area would satisfy the District's BMP size requirement.

Figure 3 shows large buildings in District of Columbia that might be candidates for green roof installation. The light pink area in the center of the image shows large impervious surfaces, including roofs, in an area targeted for green roofs by virtue of being in both the Anacostia River watershed and the combined sewer area.

http://geospatial.dcgis.dc.gov/templates/dcfinder/s2.html?appid=0a6e58b700024e9c954896dacb1b7e29

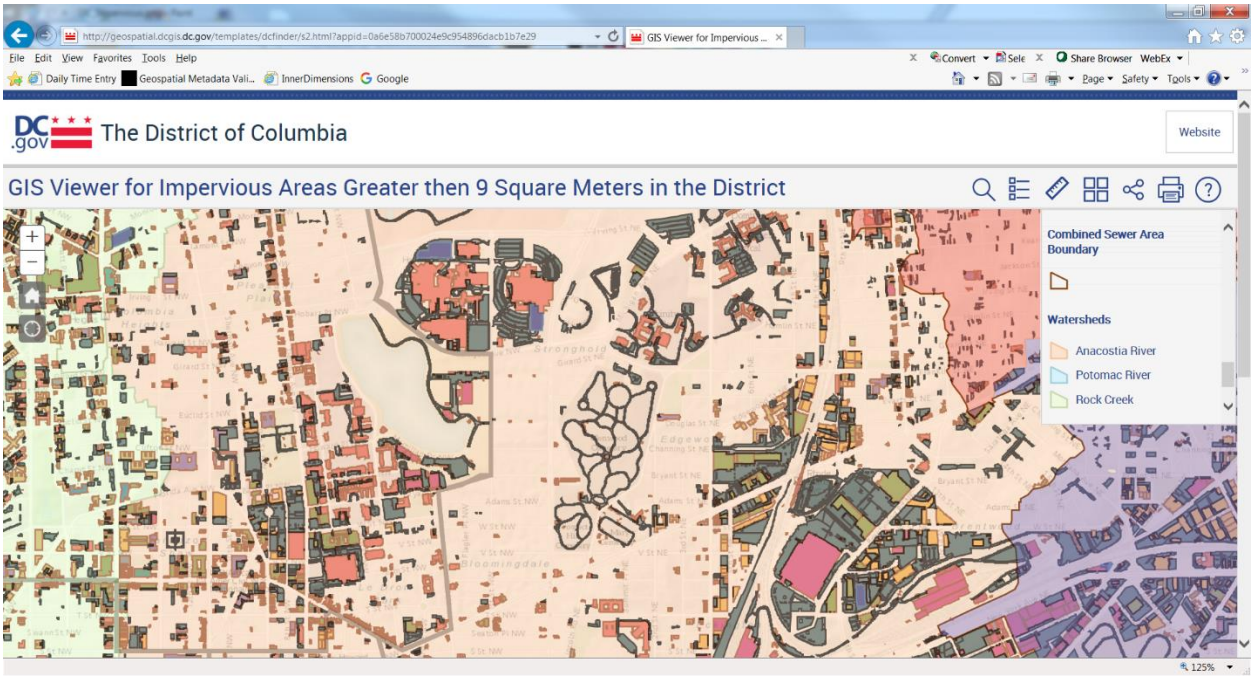



*Figure 3. Impervious areas in the District of Columbia. Image courtesy of the District of Columbia.*

The District provided the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for watershed management activities.

*Table 5. District of Columbia qualitative benefits from use of enhanced hydrography information for watershed management activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Don't Know | Moderate | Don't Know | Don't Know | Don't Know | Don't Know | Don't Know | Don't Know |

## BU #2 Natural Resources Conservation

BU #2, Natural Resources Conservation, was described in the questionnaire as including the following types of MCAs: conservation engineering, soils mapping, wetlands mapping and characterization, and assessment of biological carbon stocks.

**BU #2 Highlights:**

**Number of MCAs:** 34
**Estimated annual program budget:** $6,956,803,333
**Estimated current annual benefits:** $10,173,000
**Estimated future annual benefits:** $17,755,000

A total of 34 MCAs were characterized as having BU #2 as their primary BU, with a total annual program budget of $6,956,803,333 for programs supported by hydrography data, a total of $10,173,000 in estimated annual benefits from the currently available hydrography data, and $17,755,000 in estimated future annual benefits from enhanced hydrography data. Additionally, two MCAs noted BU #2 as an ancillary BU.

These 34 MCAs were reported by eight Federal agencies, six not-for-profits, two private entities, two local or regional government agencies, and 16 state agencies. These MCAs include conservation planning; biological conservation; conservation of ecosystems; wetland habitat mapping and protection; natural resources management; water quality monitoring and flood control; watershed management; geology, topography, hydrography, and land use/land cover data management and mapping; and resource management to include stormwater management, floodplain management, and environmental assessment.

**Areas of Interest**

Figure 4 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #2 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

Most states and many county or local entities likely have natural resources conservation as one of their missions; however, because of the varied representation of the state and local agencies, and because the BUs were self-selected, it is likely that additional areas across the U.S. would have an interest in natural resources conservation.

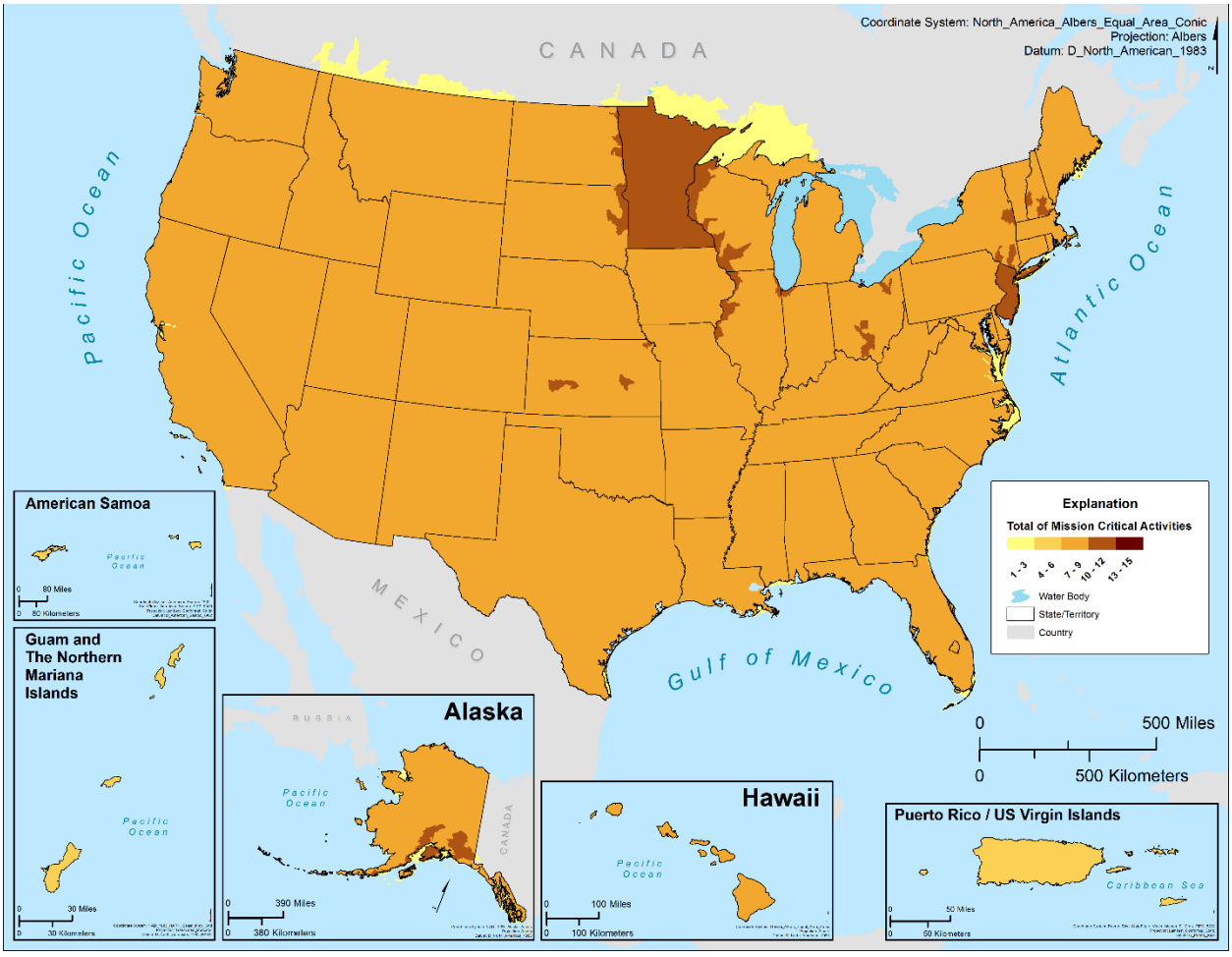



*Figure 4. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #2 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

**Requirements**

Table 6 lists the requirements for enhanced hydrography data that were reported for the MCAs categorized as having BU #2 as their primary BU, and the most frequently requested requirements by category.

*Table 6. Requirements for enhanced hydrography data reported for BU #2*

| Requirement | Most Frequently Reported Requirement | Percent of MCAs |
|---|---|---|
| **Update Frequency** | 2-3 Years | 35% |
| **Positional Accuracy** | 7 feet, 90% (1:2,400-scale) | 38% |
| **Stream Density** | 5.0 miles of channel per mile (1:5,000-scale mapping) | 50% |
| **Smallest Contributing Watershed** | 60 acres/1 square mile (640 acres) | 24% each |
| **Smallest Mapped Waterbody** | Less than an acre | 50% |
| **Post-Event Update** | Highly Desirable | 47% |
| **Level of Detail** | Best Available | 59% |

The requirements for characteristics and analytical functions for BU #2 are shown in Table 7.

*Table 7. Requirements for characteristics and analytical functions for BU #2*

| Required Characteristics/Analytical Functions | Number of MCAs (of 34) | Percent of MCAs |
|---|---|---|
| Wetlands | 28 | 82% |
| Calculate drainage area | 25 | 74% |
| Floodplain boundary | 21 | 62% |
| Delineate catchment | 20 | 59% |
| Find upstream or downstream feature within watershed | 20 | 59% |
| Bridges, culverts | 18 | 53% |
| Estuaries | 18 | 53% |
| Flow periodicity | 18 | 53% |
| Navigate up or downstream on network | 18 | 53% |
| Coastlines | 17 | 50% |
| Linkages to stream gage observations | 17 | 50% |
| User defined symbolization | 17 | 50% |
| Accumulate upstream or downstream features | 16 | 47% |
| Calculate stream distance to points | 16 | 47% |
| Riverine bathymetry | 16 | 47% |
| Determine downstream flood area | 15 | 44% |
| Flood stage | 14 | 41% |
| Preset symbolization | 14 | 41% |
| Diversion lines | 13 | 38% |
| Mash-ups | 13 | 38% |
| Calculate time of travel to points | 12 | 35% |
| Coastal bathymetry | 12 | 35% |
| Deltas | 12 | 35% |
| Find upstream or downstream points | 11 | 32% |
| Left/right bank delineation | 11 | 32% |

| Required Characteristics/Analytical Functions | Number of MCAs (of 34) | Percent of MCAs |
|---|---|---|
| Velocity or time of travel | 11 | 32% |
| Find events or features on network | 10 | 29% |
| Calculate distance on network | 9 | 26% |
| Diversion points | 9 | 26% |
| Linkages to cross section geometry | 9 | 26% |
| Animation of time-series | 7 | 21% |
| Leakage along lines | 7 | 21% |
| Leakage at points | 7 | 21% |
| Other (please specify) | 5 | 15% |
| Badlands | 4 | 12% |

**Future Annual Benefits**

An estimated $17,755,000 in future annual benefits from enhanced hydrography data was reported for the MCAs categorized as having BU #2 as their primary BU.

Figure 5 shows the estimated future annual benefits provided by the MCAs that were categorized as having BU #2 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

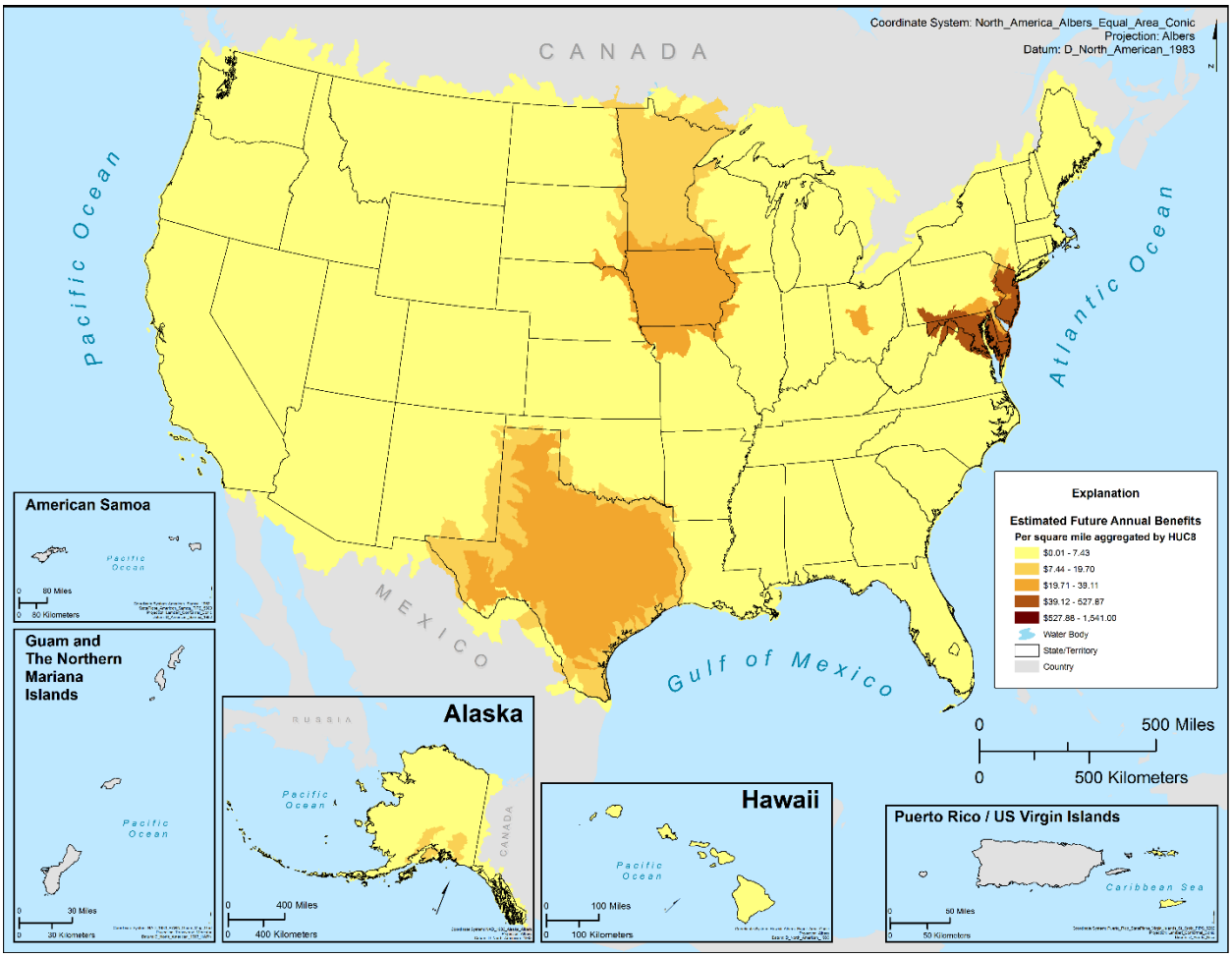



*Figure 5. Estimated future annual benefits reported for MCAs with BU #2 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 8 lists the qualitative benefits reported for BU #2.

*Table 8. Qualitative benefits reported for BU #2*

| | Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 18 | 15 | 16 | 12 | 11 | 10 | 16 | 2 |
| **Moderate** | 6 | 9 | 8 | 10 | 9 | 9 | 9 | 2 |
| **Minor** | 4 | 5 | 5 | 6 | 7 | 7 | 4 | 3 |
| **N/A** | 0 | 0 | 1 | 2 | 3 | 4 | 1 | 20 |
| **Don't Know** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| **No Answer Provided** | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 5 |
| **Total** | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |

These benefits would be realized due to improved spatial accuracy, completeness, availability, and attribution of hydrography and wetlands data to include hydrologic relation to other features, which would result in cost savings from not having to search for relevant datasets; not having to maintain local datasets; improved mapping; more efficient and higher-quality modeling and analysis, which will lead to greater environmental benefits, particularly to water quality and wildlife habitat; faster response times for data users; improved public outreach and understanding regarding conservation programs; and more informed decision-making.

**Example Natural Resources Conservation Activities**

An estimated 46% of endangered or threatened species are associated with wetlands. The National Wetlands Inventory (NWI) was established by the U.S. Fish and Wildlife Service (FWS) to conduct a nationwide inventory of U.S. wetlands to provide biologists and others with information on the distribution and type of wetlands to aid in conservation efforts.

According to the FWS, "wetlands are an essential component of the Nation's surface water network and it is widely accepted that wetlands and hydrology are closely linked either through exchange of water, nutrient cycling or other ecological processes." Wetlands are traditionally identified and mapped using orthoimagery, soils, vegetation types, and hydrography data. However, more recently, hydrography has proved to provide valuable insight where no wetlands were identified from imagery signatures. FWS has begun using NHD data to identify and map hydrologic connections between wetland areas. And the NWI is presently incorporating all surface water and wetland features into a single database, the NWI Version 2. This will allow the dataset to be used for adaptive management, geospatial summaries, and modeling.

The Surface Waters and Wetlands product (NWI Version 2) was created by retaining the wetland and deepwater polygons that composed the original NWI digital wetlands spatial data layer. These wetlands and deepwater features were supplemented by reintroducing any linear wetland or surface water features that were orphaned from the original NWI hard copy maps and converting them to narrow polygonal features. The NWI wetland classification is retained for these narrow features. Additionally, the data are supplemented with hydrography data as a secondary source for any single-line stream features not mapped by the NWI and to complete segmented connections. These features are given a wetland classification and buffered to become polygonal features.

The NWI Version 2 dataset provides a substantially more comprehensive inventory of wetland and associated water bodies. The difference between these two datasets has important implications for past wetland data summaries and modeling that has been generated using the legacy NWI map data.

https://www.fws.gov/wetlands/Data/Wetlands-V2-Product-Summary.html


*Figure 6. Mapped waterbodies in Minnesota. Open water bodies and wetlands are shown in NWI Version 2 (left) and NHD (right). Images courtesy of FWS and USGS.*

FWS provided the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for wetland habitat identification, protection, and conservation activities.

*Table 9. FWS qualitative benefits from use of enhanced hydrography information for wetland habitat identification, protection, and conservation activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Major | Major | Major | Major | Major | Major | Major | Not Applicable |

## BU #3 Water Resource Planning and Management

BU #3, Water Resource Planning and Management, was described in the questionnaire as including the following types of MCAs: management of drinking water sources and water rights administration.

**BU #3 Highlights:**

**Number of MCAs:** 69
**Estimated annual program budget:** $988,879,580 to $990,904,580
**Estimated current annual benefits:** $98,113,000 to $98,513,000
**Estimated future annual benefits:** $115,876,000 to $115,946,000

A total of 69 MCAs were characterized as having BU #3 as their primary BU, with a total annual program budget of $988,879,580 to $990,904,580 for programs supported by hydrography data, a total of $98,113,000 to $98,513,000 in estimated annual benefits from the currently available hydrography data, and $115,876,000 to $115,946,000 in estimated future annual benefits from enhanced hydrography data. Additionally, 12 MCAs noted BU #3 as an ancillary BU.

These 69 MCAs were reported by four Federal agencies, three not-for-profits, four private entities, 11 local or regional government agencies, 66 state agencies, and one tribal government. The primary MCA description is water supply management and protection, both for drinking water and agricultural uses. Additional MCAs include groundwater modeling and studies; water quality; watershed management;

wetlands management; flood risk mapping; stormwater management; and geospatial data coordination and management.

**Areas of Interest**

Figure 7 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #3 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

Most states and many county or local entities likely have drinking water management as one of their missions; however, because of the varied representation of the state and local agencies, and because the BUs were self-selected, it is likely that additional areas across the U.S. would have an interest in water resource planning and management. Water rights issues are more prevalent in the Western states, so a greater concentration of areas of interest in these states is expected.

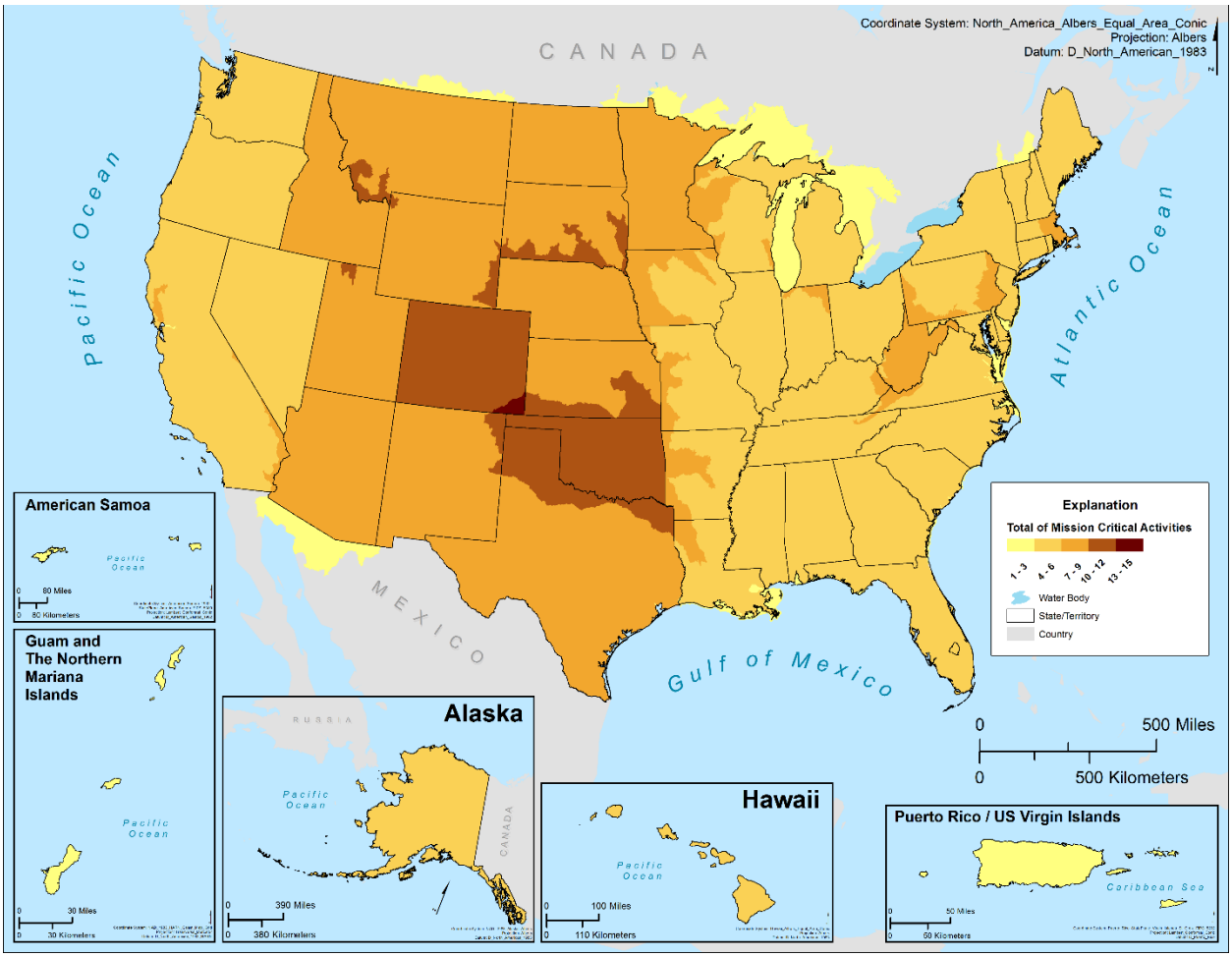



*Figure 7. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #3 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

**Requirements**

Table 10 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #3 as their primary BU, and the most frequently requested requirements by category.

*Table 2. Requirements for enhanced hydrography data reported for BU #3*

| Requirement | Most Frequently Reported Requirement | Percent of MCAs |
|---|---|---|
| **Update Frequency** | Annually | 45% |
| **Positional Accuracy** | +/- 40 feet, 90% (1:24,000-scale) | 29% |
| **Stream Density** | 2.5 miles of channel per mile (1:24,000-scale mapping) | 46% |
| **Smallest Contributing Watershed** | 1 square mile (640 acres) | 26% |
| **Smallest Mapped Waterbody** | 1 acre | 30% |
| **Post-Event Update** | Nice To Have | 42% |
| **Level of Detail** | Best Available | 73% |

The requirements for characteristics and analytical functions for BU #3 are shown in Table 11.

*Table 31. Requirements for characteristics and analytical functions for BU #3*

| Required Characteristics/Analytical Functions | Number of MCAs (of 69) | Percent of MCAs |
|---|---|---|
| Calculate drainage area | 57 | 83% |
| Linkages to stream gage observations | 57 | 83% |
| Find upstream or downstream feature within watershed | 49 | 71% |
| Delineate catchment | 44 | 64% |
| Flow periodicity | 44 | 64% |
| Calculate stream distance to points | 43 | 62% |
| Navigate up or downstream on network | 43 | 62% |
| Wetlands | 43 | 62% |
| Diversion lines | 42 | 61% |
| Diversion points | 42 | 61% |
| Floodplain boundary | 39 | 57% |
| Accumulate upstream or downstream features | 38 | 55% |
| Riverine bathymetry | 35 | 51% |
| Bridges, culverts | 34 | 49% |
| Linkages to cross section geometry | 34 | 49% |
| Calculate time of travel to points | 33 | 48% |
| Velocity or time of travel | 33 | 48% |
| Determine downstream flood area | 32 | 46% |
| Calculate distance on network | 31 | 45% |
| Find upstream or downstream points | 31 | 45% |
| User defined symbolization | 31 | 45% |
| Find events or features on network | 30 | 43% |
| Preset symbolization | 30 | 43% |
| Left/right bank delineation | 29 | 42% |
| Leakage at points | 28 | 41% |
| Flood stage | 27 | 39% |
| Mash-ups | 25 | 36% |
| Leakage along lines | 24 | 35% |
| Coastlines | 22 | 32% |
| Animation of time-series | 20 | 29% |

| Required Characteristics/Analytical Functions | Number of MCAs (of 69) | Percent of MCAs |
|---|---|---|
| Estuaries | 19 | 28% |
| Other (please specify) | 14 | 20% |
| Coastal bathymetry | 12 | 17% |
| Deltas | 12 | 17% |
| Badlands | 7 | 10% |

**Future Annual Benefits**

An estimated $115,876,000 to $115,946,000 in future annual benefits from enhanced hydrography data was reported for the MCAs categorized as having BU #3 as their primary BU.

Figure 8 shows the estimated future annual benefits provided by the MCAs categorized as having BU #3 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

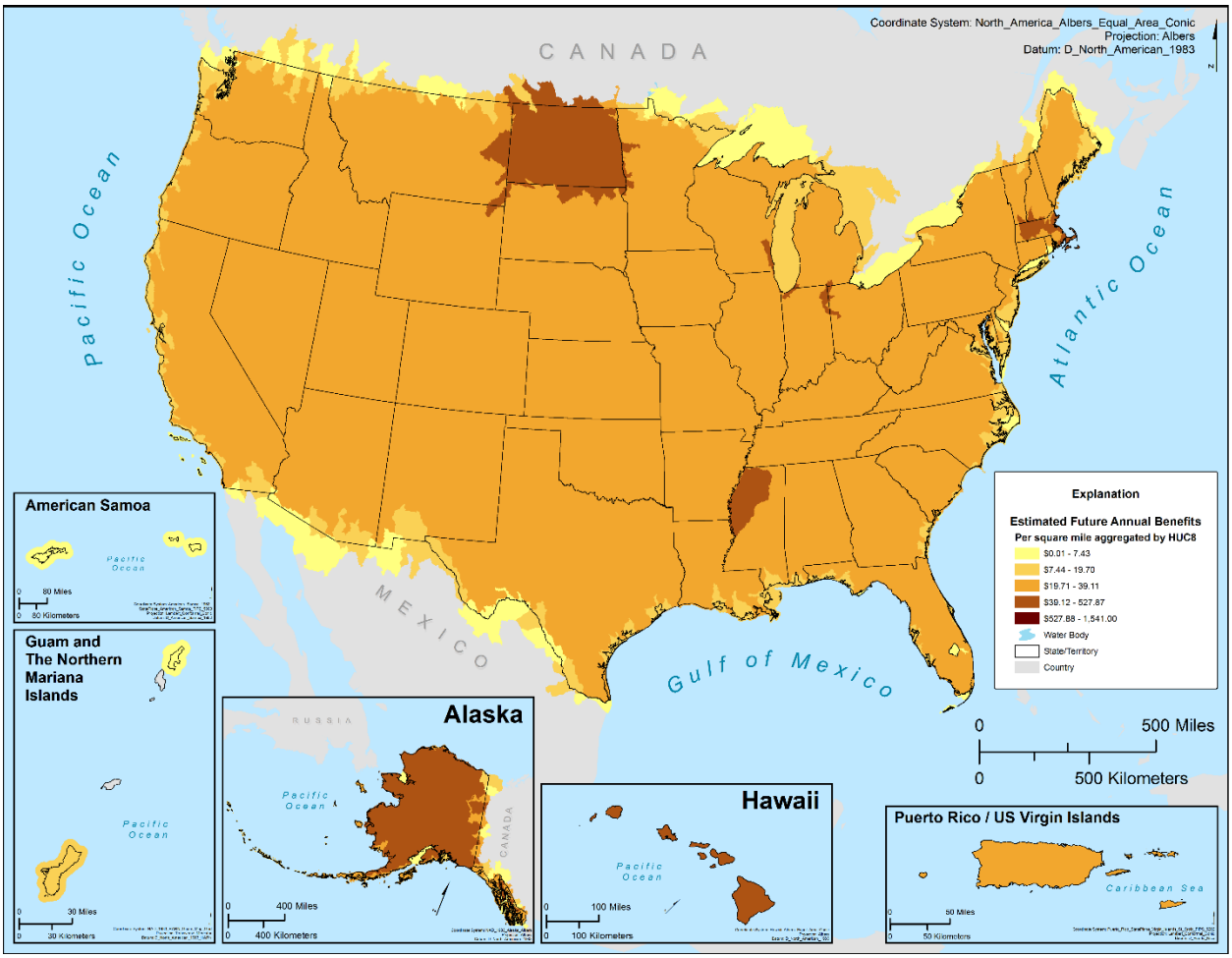



*Figure 8. Estimated future annual benefits reported for MCAs with BU #3 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 12 lists the qualitative benefits reported for BU #3.

*Table 42. Qualitative benefits reported for BU #3*

| | Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 31 | 25 | 23 | 21 | 18 | 11 | 15 | 6 |
| **Moderate** | 20 | 24 | 23 | 21 | 26 | 27 | 25 | 9 |
| **Minor** | 12 | 14 | 15 | 20 | 15 | 19 | 18 | 13 |
| **N/A** | 0 | 1 | 1 | 1 | 3 | 4 | 3 | 23 |
| **Don't Know** | 1 | 0 | 2 | 1 | 2 | 3 | 3 | 13 |
| **No Answer Provided** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **Total** | 69 | 69 | 69 | 69 | 69 | 69 | 69 | 69 |

These benefits would be realized due to improved spatial accuracy, currency, attribution, and availability of hydrography linked to groundwater, soils, geology, and discharge data. More stream gage stations, especially if more water quality data were available at the gages, would also provide benefits. These improvements would result in time and cost savings from not having to search for and assemble relevant datasets; less time needed for field visits; not having to maintain local-scale datasets; less time needed to prepare datasets for modeling and analysis; less possibility of errors that may result from the use of disparate datasets; more frequent and detailed analyses; better ability to accomplish mission; more timely customer response; and improved mapping, all of which will lead to greater environmental benefits, particularly to conservation and protection of water resources; improved public outreach and understanding regarding water quality and quantity (including flood warnings); and more informed decision-making. Having a more accurate authoritative data source that could be cited for regulatory actions would also reduce time spent resolving disputes.

**Example Water Resource Planning and Management Activities**

Water resource planning and management includes ensuring the availability of water where and when required and ensuring that drinking water is safe. Many Federal and state agencies and nongovernmental organizations are responsible for water resource planning and management. Hydrography data are used to develop water availability assessments that describe components of the water budget including consumptive use from irrigated agricultural lands, diversion-point locations, and their impact throughout the network including river depletion.

Groundwater is another important component to studying water availability. Groundwater and coupled groundwater/surface-water modeling studies are used to assess and manage groundwater and surface water. Groundwater pumpage impacts on surface water, and losing stream contributions to groundwater are two critical considerations when using a water budget approach to estimate water availability. Information that facilitates the connection between surface water and groundwater information and models is critical to understanding these interactions. Understanding how surface water can inform critical groundwater recharge and management is of critical importance during prolonged drought.

The Sonoma County Water Agency supplies water to over 600,000 people in Sonoma and Marin Counties, CA. Its responsibilities include water supply, flood control, sanitation, and power generation/renewable energy development. In order to maintain water supply during drought, the agency is developing an integrated water resource management program that includes a groundwater-level monitoring program to assess seasonal and long term trends. The agency has found that while shallow-zone wells are generally stable and above sea level, there are areas of declining groundwater levels occurring, mainly in deeper-zone wells where groundwater elevations are below sea level due to extensive pumping. The agency has developed and is implementing management strategies to address groundwater depletion to include conservation, use of recycled water, and recharging groundwater basins through banking of winter/spring river water and stormwater.

http://www.scwa.ca.gov/svgroundwater/

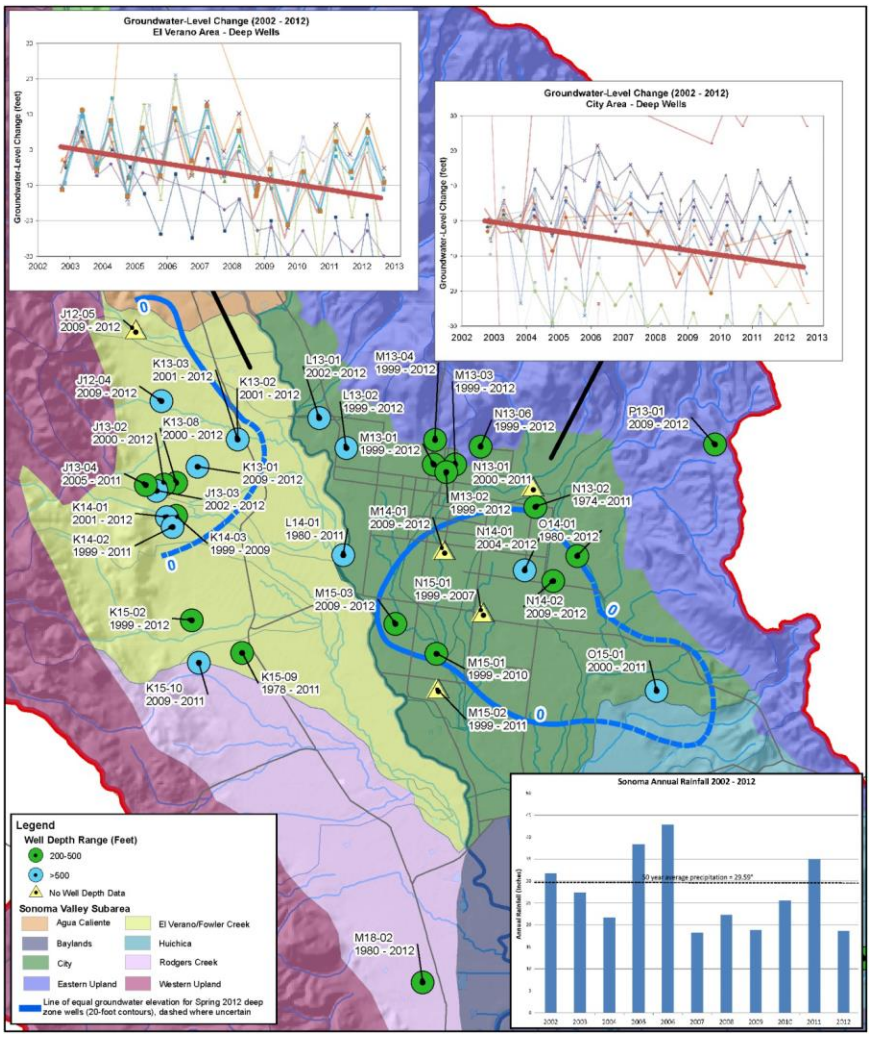



*Figure 9. Groundwater monitoring locations showing groundwater level declines from 2001 to 2012 in deep-zone wells in Sonoma Valley. Image courtesy of the Sonoma County Water Agency.*

The Sonoma County Water Agency provided the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for water supply management and delivery activities.

*Table 53. Example qualitative benefits from use of enhanced hydrography information for water supply management and delivery activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Moderate | Minor | Minor | Don't Know | Not Applicable | Not Applicable | Minor | Not Applicable |

## BU #4 Water Quality

BU #4, Water Quality, was described in the questionnaire as including the following types of MCAs: fate and transport of contaminants; and pollution risk mitigation.

**BU #4 Highlights:**

**Number of MCAs:** 79
**Estimated annual program budget:** $1,672,406,025 to $1,677,406,025
**Estimated current annual benefits:** $115,460,728
**Estimated future annual benefits:** $121,479,227

A total of 79 MCAs were characterized as having BU #4 as their primary BU, with a total annual program budget of $1,672,406,025 to $1,677,406,025 for programs supported by hydrography data, a total of $115,460,728 in estimated annual benefits from the currently available hydrography data, and $121,479,227 in estimated future annual benefits from enhanced hydrography data. Additionally, 11 MCAs noted BU #4 as an ancillary BU.

These 79 MCAs were reported by six Federal agencies, three not-for-profits, two private entities, 14 local or regional government agencies, 52 state agencies, and two tribal governments. The primary MCA description is water quality assessment and monitoring. Additional MCAs include soil and water research, watershed management, flood risk management, base mapping, and transportation planning.

**Areas of Interest**

Figure 10 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #4 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

Most states and many county or local entities likely have water quality as one of their missions; however, because of the varied representation of state and local agencies, and because BUs were self-selected, it is likely that additional areas across the U.S. would have an interest in water quality.

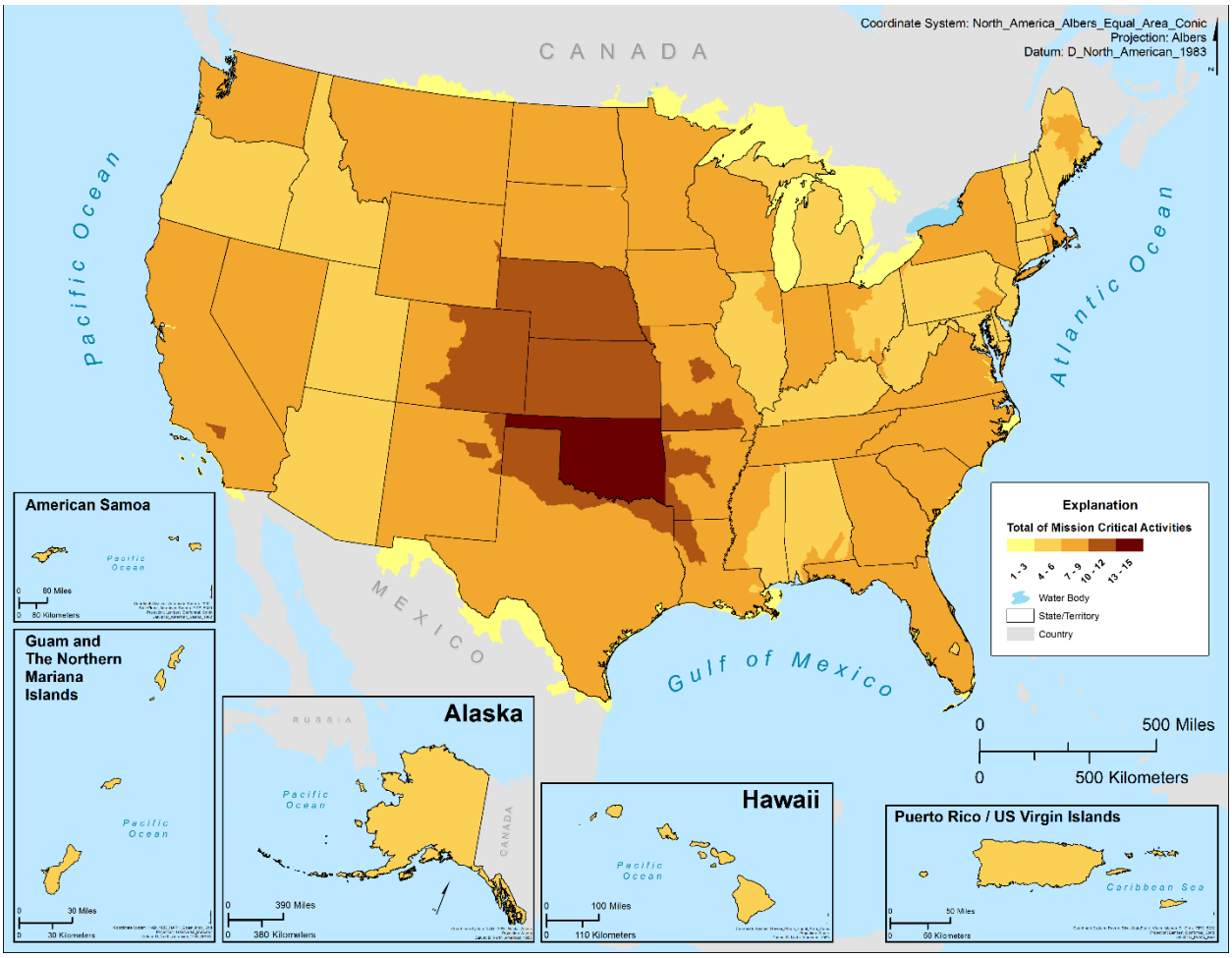



*Figure 10. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #4 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

### Requirements

Table 14 lists requirements for enhanced hydrography data reported for the MCAs categorized as having BU #4 as their primary BU, and the most frequently requested requirements by category.

*Table 64. Requirements for enhanced hydrography data reported for BU #4*

| Requirement | Most Frequently Reported Requirement | Percent of MCAs |
|---|---|---|
| **Update Frequency** | 2-3 Years | 37% |
| **Positional Accuracy** | +/- 40 feet, 90% (1:24,000-scale) | 30% |
| **Stream Density** | 2.5 miles of channel per mile (1:24,000-scale mapping) | 44% |
| **Smallest Contributing Watershed** | 6 acres | 34% |
| **Smallest Mapped Waterbody** | Less than an acre | 30% |
| **Post-Event Update** | Nice To Have | 43% |
| **Level of Detail** | Best Available | 61% |

The requirements for characteristics and analytical functions for BU #4 are shown in Table 15.

*Table 15. Requirements for characteristics and analytical functions for BU #4*

| Required Characteristics/Analytical Functions | Number of MCAs (of 79) | Percent of MCAs |
|---|---|---|
| Calculate drainage area | 73 | 92% |
| Flow periodicity | 65 | 82% |
| Delineate catchment | 59 | 75% |
| Find upstream or downstream feature within watershed | 59 | 75% |
| Navigate up or downstream on network | 56 | 71% |
| Wetlands | 55 | 70% |
| Calculate stream distance to points | 54 | 68% |
| Calculate distance on network | 48 | 61% |
| Linkages to stream gage observations | 48 | 61% |
| Find upstream or downstream points | 43 | 54% |
| Accumulate upstream or downstream features | 42 | 53% |
| Velocity or time of travel | 41 | 52% |
| Diversion lines | 40 | 51% |
| Find events or features on network | 40 | 51% |
| Bridges, culverts | 39 | 49% |
| Calculate time of travel to points | 35 | 44% |
| Flood stage | 34 | 43% |
| Left/right bank delineation | 34 | 43% |
| User defined symbolization | 33 | 42% |
| Estuaries | 32 | 41% |
| Linkages to cross section geometry | 32 | 41% |
| Mash-ups | 32 | 41% |
| Preset symbolization | 32 | 41% |
| Coastlines | 31 | 39% |
| Floodplain boundary | 31 | 39% |
| Riverine bathymetry | 28 | 35% |
| Determine downstream flood area | 26 | 33% |
| Diversion points | 26 | 33% |
| Other (please specify) | 17 | 22% |
| Leakage along lines | 16 | 20% |
| Leakage at points | 15 | 19% |
| Animation of time-series | 11 | 14% |
| Coastal bathymetry | 11 | 14% |
| Deltas | 8 | 10% |
| Badlands | 4 | 5% |

**Future Annual Benefits**

An estimated $121,479,227 in future annual benefits from enhanced hydrography data was reported for the MCAs categorized as having BU #4 as their primary BU.

Figure 11 shows the estimated future annual benefits provided by the MCAs categorized as having BU #4 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

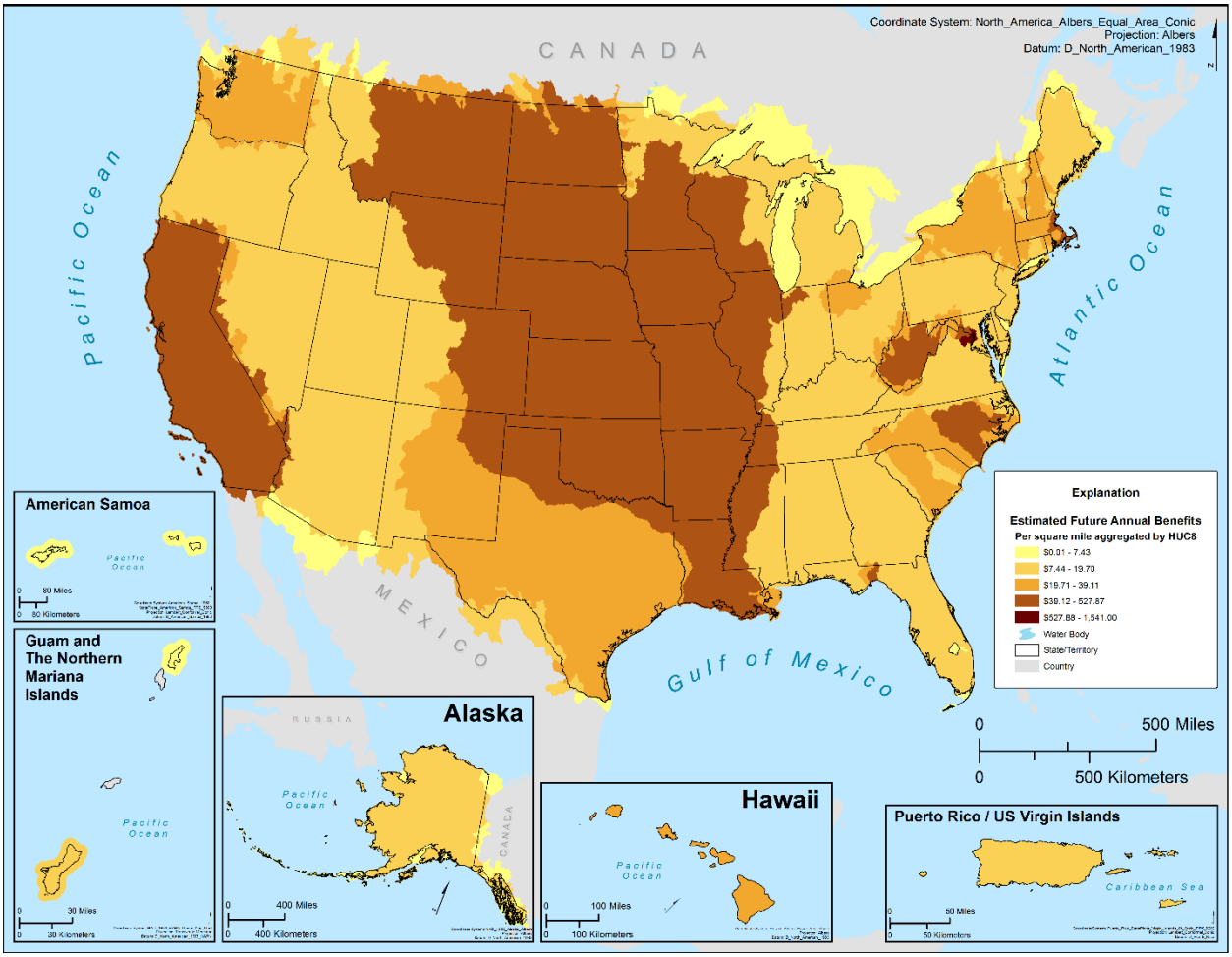



*Figure 11. Estimated future annual benefits reported for MCAs with BU #4 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 16 lists qualitative benefits reported for BU #4.

*Table 76. Qualitative benefits reported for BU #4*

| | Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 33 | 31 | 26 | 15 | 15 | 13 | 29 | 5 |
| **Moderate** | 36 | 38 | 37 | 44 | 39 | 36 | 33 | 11 |
| **Minor** | 7 | 6 | 11 | 12 | 13 | 16 | 10 | 10 |

| | Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **N/A** | 1 | 0 | 2 | 4 | 7 | 8 | 2 | 46 |
| **Don't Know** | 1 | 3 | 2 | 3 | 4 | 5 | 4 | 6 |
| **No Answer Provided** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Total** | 79 | 79 | 79 | 79 | 79 | 79 | 79 | 79 |

These benefits would be realized due to improved spatial accuracy, completeness, consistency, currency, availability, and attribution of hydrography data linked to landscape, soils, human infrastructure, and water quality data. These improvements to hydrography data would result in time and cost savings from more efficient field visits; not having to search for and assemble relevant datasets; less possibility of errors that may result from the use of disparate datasets; not having to maintain local datasets; improved mission compliance; improved mapping; more efficient and higher-quality modeling and analysis, which will lead to greater environmental benefits, particularly to water quality, pollution monitoring, and coastal restoration; more efficient documentation of compliance with water quality standards; greater confidence in analysis results; more transparency of the permitting process; faster response times for data users; improved public outreach and understanding regarding water quality and flood hazards; and more informed decision-making.

**Example Water Quality Activities**

Recent EPA guidance requires states to prioritize watersheds for multiple Safe Drinking Water Act and Clean Water Act programs. Hydrography data coupled with water quality data are used to characterize waters, identify trends over time, identify emerging problems, determine whether pollution control programs are working, help direct pollution control efforts to where they are most needed, and respond to emergencies such as floods and spills. Watershed level data used for prioritization are based on hydrology and landscape condition. Indicators of ecological condition, stressors, and social aspects are compiled and aggregated by WBD HUC12s. Indicators are derived from hydrology, land cover, transportation, and use other related hydrography data products.

Hydrography data are also used to support other water quality activities such as effluent permitting, drinking water protection, underground injection control, watershed protection, wetlands protection and mitigation, enforcement and inspections authorized by the Clean Water Act and its implementing regulations. River reach addresses are used as the central index key for water quality and pollutant source locations.

State and local agencies use hydrography data to perform their regulatory activities including enacting water quality standards, generating required EPA reports, remediation, understanding environmental quality for species of concern, and understanding the quality of drinking water and wetland environments. Modeling point source and nonpoint source pollution of water and designing appropriate pollution control

and environmental cleanup strategies (e.g. TMDL program) require robust hydrography and related datasets.

The California Stream Pollution Trends Monitoring Program (SpoT) monitors trends in sediment toxicity and sediment contaminant concentrations in selected large rivers throughout California, and relates contaminant concentrations and toxicity to watershed land uses. It is designed to improve the understanding of watersheds and water quality by monitoring changes in both over time, evaluating impacts of development, and assessing the effectiveness of regulatory programs and conservation efforts at the watershed scale.

The overall goal of this long-term trends assessment is to detect meaningful change in the concentrations of contaminants and their biological effects in large watersheds at time scales appropriate to management decision making. Sediment toxicity and a suite of pesticides, trace metals, and industrial compounds have been analyzed from 100 sites annually since 2008.

http://www.waterboards.ca.gov/water_issues/programs/swamp/spot/

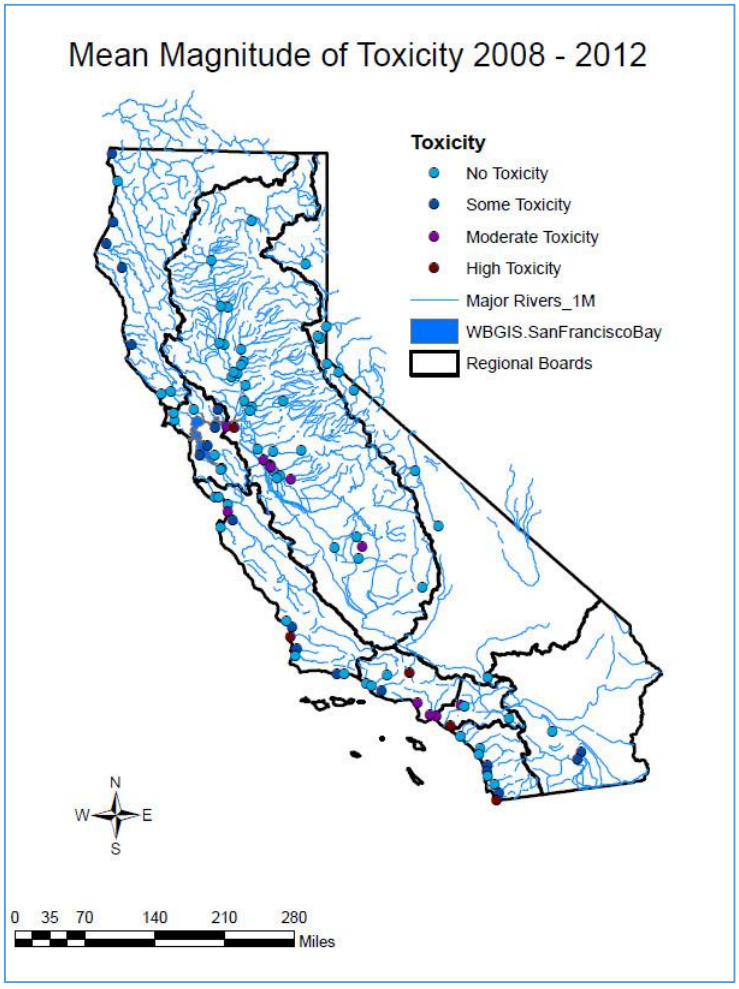



*Figure 12. California water quality monitoring sites and toxicity levels. Image courtesy of the California State Water Resources Control Board.*

The California Water Resources Control Board estimated $10 million in future annual benefits from reduced staff time needed to delineate catchments and perform stream analyses resulting from use of enhanced hydrography data. Additionally, the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for water quality enforcement activities was provided by the California Water Resources Control Board.

*Table 87. California Water Resources Control Board qualitative benefits from use of enhanced hydrography information for water quality enforcement activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Major | Major | Moderate | Major | Major | Don't Know | Major | Not Applicable |

## BU #5 River and Stream Ecosystem Management

BU #5, River and Stream Ecosystem Management, was described in the questionnaire as including the following types of MCAs: aquatic habitat management, stream restoration, and fisheries management.

**BU #5 Highlights:**

**Number of MCAs:** 34
**Estimated annual program budget:** $1,000,716,100
**Estimated current annual benefits:** $13,955,000 to $14,135,000
**Estimated future annual benefits:** $67,000,000 to $67,440,000

A total of 34 MCAs were characterized as having BU #5 as their primary BU, with a total annual program budget of $1,000,716,100 for programs supported by hydrography data, a total of $13,955,000 to $14,135,000 in estimated annual benefits from the currently available hydrography data, and $67,000,000 to $67,440,000 in estimated future annual benefits from enhanced hydrography data. Additionally, nine MCAs noted BU #5 as an ancillary BU.

These 34 MCAs were reported by five Federal agencies, three not-for-profits, 24 state agencies, and two tribal governments. These MCAs include habitat management; clean water analysis and permitting; watershed management; resource management to include stormwater management, floodplain management, environmental assessment, and hydrologic and hydraulic modeling for analysis and restoration; and water resources education.

**Areas of Interest**

Figure 13 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #5 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

Most states and many county or local entities likely have river and stream ecosystem management as one of their missions; however, because of the varied representation of the state and local agencies, and because the BUs were self-selected, it is likely that additional areas across the U.S. would have an interest in river and stream ecosystem management. The Bureau of Reclamation and the Bureau of Land Management, both of which have the Western states as their main focus, also account for some of the weighting of the Western states.

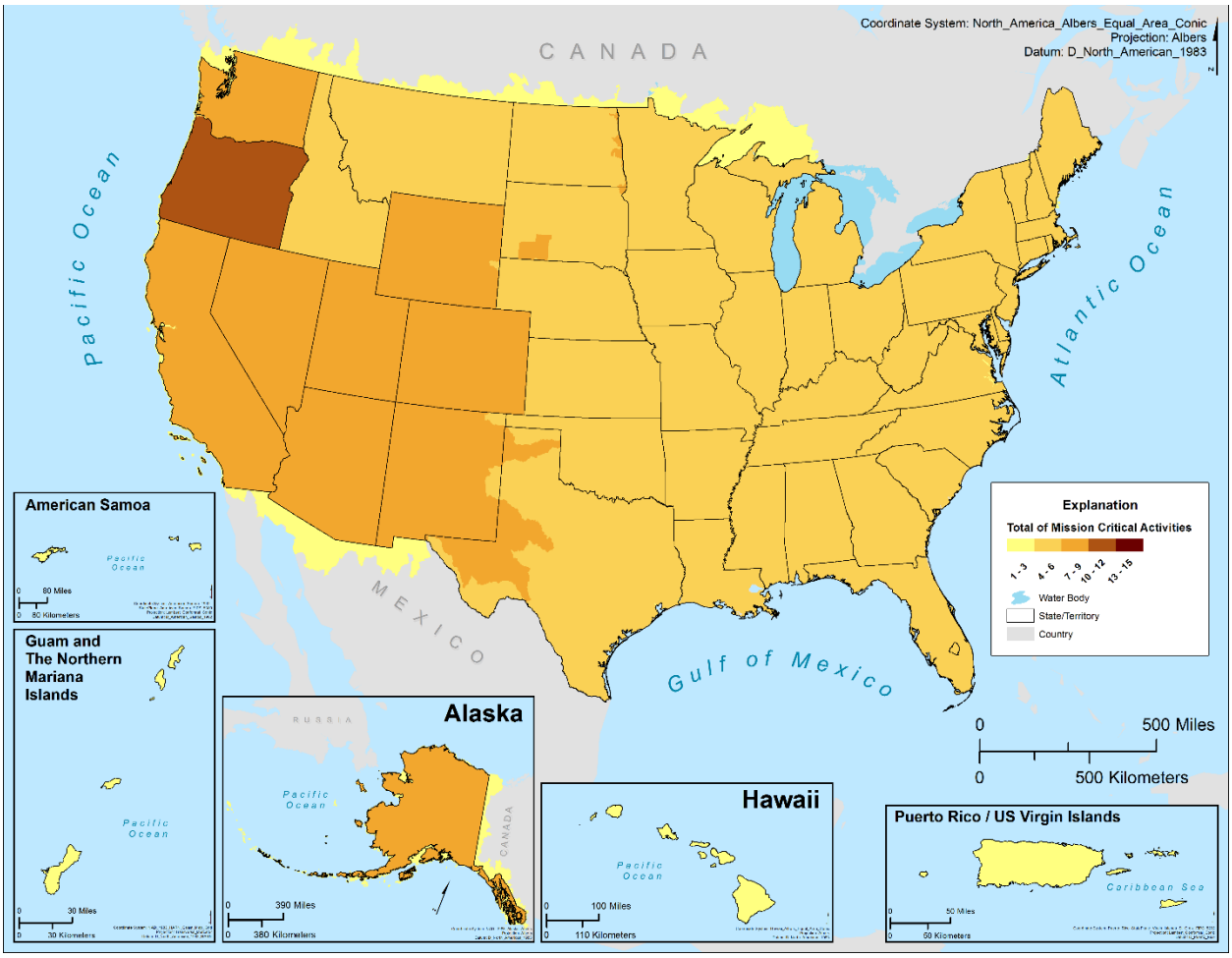



*Figure 13. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #5 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

## Requirements

Table 18 lists requirements for enhanced hydrography data reported for the MCAs categorized as having BU #5 as their primary BU, and the most frequently requested requirements by category.

*Table 9. Requirements for enhanced hydrography data reported for BU #5*

| Requirement | Most Frequently Reported Requirement | Percent of MCAs |
|---|---|---|
| **Update Frequency** | Annually | 32% |
| **Positional Accuracy** | +/- 40 feet, 90% (1:24,000-scale) | 38% |
| **Stream Density** | 2.5 miles of channel per mile (1:24,000-scale mapping) | 47% |
| **Smallest Contributing Watershed** | 60 acres | 35% |
| **Smallest Mapped Waterbody** | Less than an acre | 41% |
| **Post-Event Update** | Nice To Have | 41% |
| **Level of Detail** | Best Available | 71% |

The requirements for characteristics and analytical functions for BU #5 are shown in Table 19.

*Table19. Requirements for characteristics and analytical functions for BU #5*

| Required Characteristics/Analytical Functions | Number of MCAs (of 34) | Percent of MCAs |
|---|---|---|
| Navigate up or downstream on network | 26 | 76% |
| Find upstream or downstream feature within watershed | 25 | 74% |
| Flow periodicity | 25 | 74% |
| Calculate drainage area | 24 | 71% |
| Wetlands | 22 | 65% |
| Calculate stream distance to points | 21 | 62% |
| Delineate catchment | 20 | 59% |
| Floodplain boundary | 19 | 56% |
| Linkages to stream gage observations | 19 | 56% |
| Accumulate upstream or downstream features | 18 | 53% |
| Find upstream or downstream points | 18 | 53% |
| Riverine bathymetry | 18 | 53% |
| Flood stage | 17 | 50% |
| Mash-ups | 17 | 50% |
| Calculate distance on network | 16 | 47% |
| Left/right bank delineation | 16 | 47% |
| Linkages to cross section geometry | 16 | 47% |
| User defined symbolization | 16 | 47% |
| Bridges, culverts | 14 | 41% |
| Calculate time of travel to points | 14 | 41% |
| Preset symbolization | 14 | 41% |
| Diversion lines | 13 | 38% |
| Find events or features on network | 13 | 38% |
| Velocity or time of travel | 13 | 38% |
| Diversion points | 12 | 35% |
| Determine downstream flood area | 11 | 32% |
| Coastlines | 9 | 26% |
| Estuaries | 9 | 26% |
| Leakage at points | 9 | 26% |
| Leakage along lines | 8 | 24% |
| Other (please specify) | 8 | 24% |
| Animation of time-series | 7 | 21% |
| Deltas | 7 | 21% |
| Coastal bathymetry | 5 | 15% |
| Badlands | 4 | 12% |

**Future Annual Benefits**

An estimated $67,000,000 to $67,440,000 in future annual benefits from enhanced hydrography data was reported for the MCAs categorized as having BU #5 as their primary BU.

Figure 14 shows the estimated future annual benefits provided by the MCAs categorized as having BU #5 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

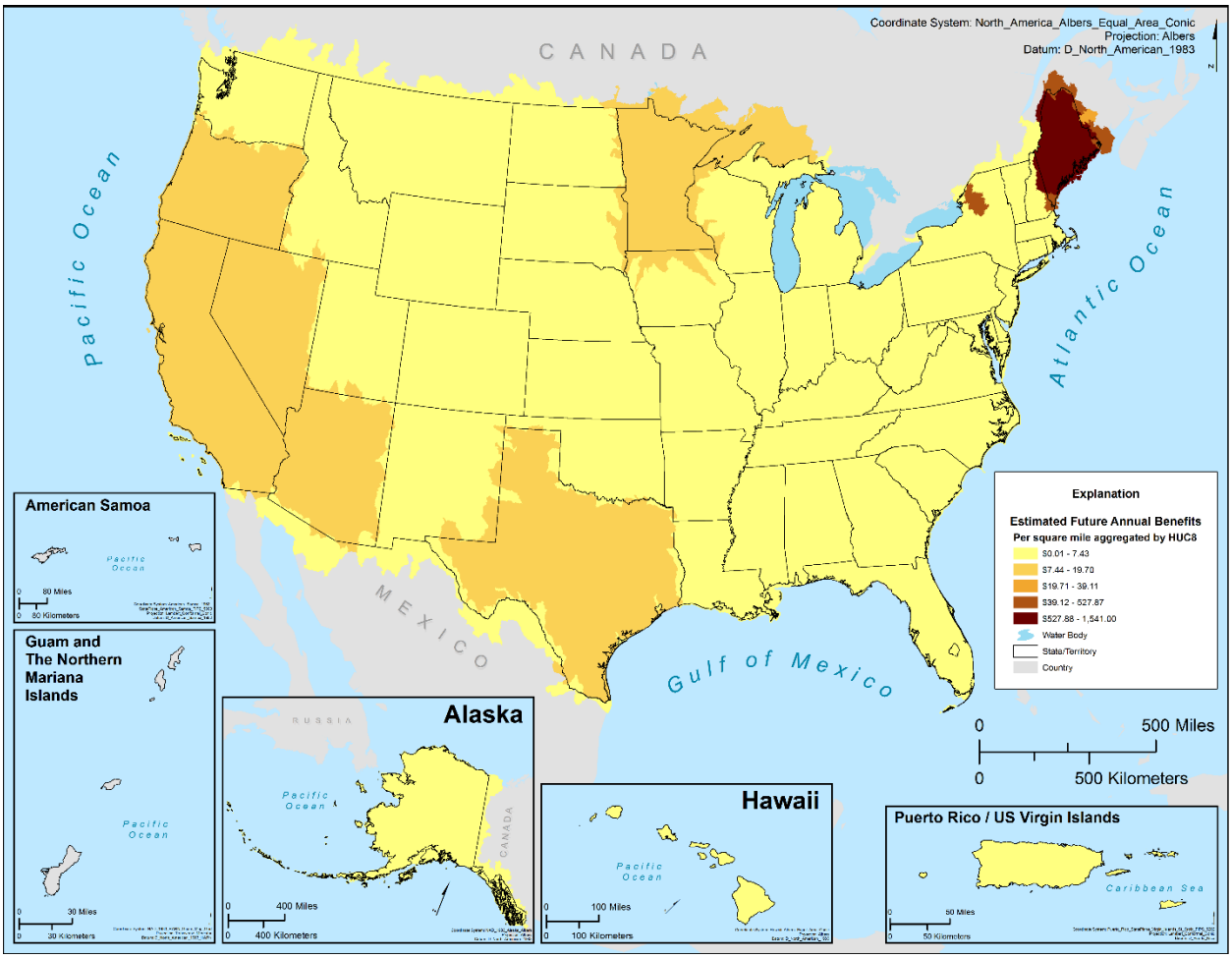



*Figure 14. Estimated future annual benefits reported for MCAs with BU #5 as their primary BU .Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 20 lists the qualitative benefits reported for BU #5.

*Table 10. Qualitative benefits reported for BU #5*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 24 | 21 | 18 | 10 | 12 | 7 | 19 | 2 |
| **Moderate** | 4 | 7 | 6 | 12 | 8 | 13 | 7 | 1 |
| **Minor** | 3 | 4 | 4 | 7 | 7 | 4 | 3 | 4 |
| **N/A** | 0 | 0 | 3 | 2 | 4 | 7 | 1 | 19 |
| **Don't Know** | 1 | 0 | 1 | 1 | 1 | 1 | 2 | 6 |

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **No Answer Provided** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **Total** | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |

These benefits would be realized due to improved spatial accuracy, currency, and attribution of hydrography data, which would result in time and cost savings from less field work; not having to search for relevant datasets; not having to maintain local datasets; more accurate mapping; more efficient and higher-quality modeling and analysis, including hydrologic analyses, watershed assessment, fish habitat modeling, analysis of water usage and habitat impacts, impervious surface modeling, and total maximum daily load (TMDL) modeling; greater confidence in mapping and modeling results; improved public outreach and understanding regarding water quantity, quality, and flood hazards; and more informed decision-making and policy development.

**Example River and Stream Ecosystem Management Activities**

River and stream ecosystem management focuses on aquatic habitat management, to include fisheries. Federal agencies, associations, and state and local government all have responsibilities for aquatic habitat management. Aquatic habitat relies on properly functioning stream channels that facilitate channel and flow stability and good water quality.

Hydrography data are a key component of aquatic habitat conservation planning, science, and restoration. Hydrography datasets are used to make high-resolution stream maps describing freshwater resources and fish habitat distribution; to quantify the pattern of those resources within jurisdictions including counties, states, national forest boundaries, and other public lands; to identify important conservation and restoration opportunities based on key stream attributes such as periodicity (perennial vs. intermittent), stream flow, stream order, and slope; for conducting hydrological and stream connectivity modelling; and for performing scientific research related to the habitat requirements and distributional patterns of fish species such as trout and salmon.

Hydrography data are also used for inventorying fish passage barriers; planning, designing and installing fish passage to restore anadromous fisheries; for various activities aimed at improving stream connectivity and protection and restoration of riparian buffers in order to support fish and wildlife management; and for tracking of aquatic invasive species in freshwater lakes, ponds, rivers and streams.

Maine's *Fish Passage Policy and Design Guide*—a groundbreaking design manual developed in 1999-focuses on stream-corridor passage for fish but not on passage for land-based wildlife. As traffic loads and road density are increasing, Maine's highways inevitably impact wildlife and their habitat by breaking larger habitat units into smaller ones and either contributing to animal-vehicle collisions or discouraging animals from trying to cross busy roads

The Maine Department of Transportation (DOT) staff now screen highway projects for potential impact on habitat connectivity using GIS maps that show such details as the location of vernal pools and the habitats of spotted turtles. These maps were created by the state's Department of Inland Fisheries and Wildlife through its "Beginning with Habitat" program. Beginning with Habitat partners created a statewide predictive habitat connectivity model and are mapping key overland connections between large, undeveloped blocks of land and target species' habitats in three pilot areas throughout the state. By depicting these areas in the context of maps, Maine DOT staff will be able to identify habitat connections of concern. From this, Maine DOT will be able to incorporate design measures from the outset, improve the accuracy of cost predictions, and reduce costs associated with the redesign of crossing structures.

http://www.beginningwithhabitat.org/the_maps/index.html

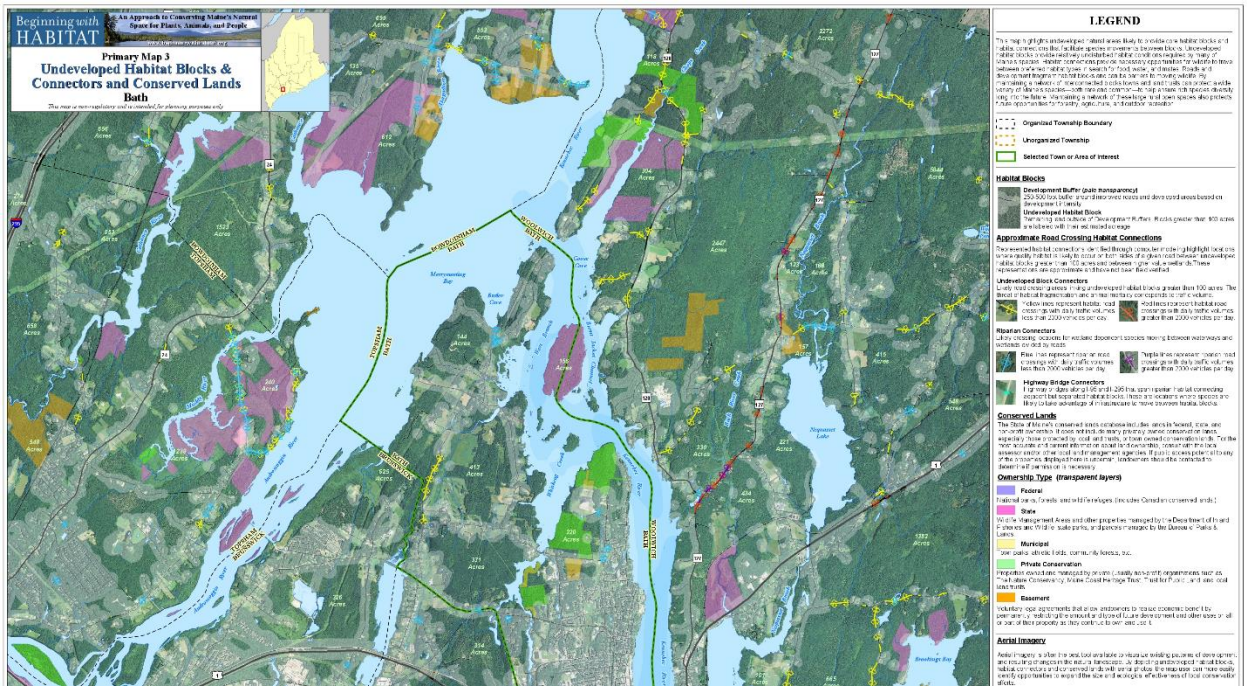



*Figure 15. Maine Beginning with Habitat map showing undeveloped habitat connections. Image courtesy of Beginning with Habitat.org.*

The Maine DOT estimated $50 million in future annual benefits from improved assessment of stream flow and more accurate watershed delineations resulting from use of enhanced hydrography information. Additionally, the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for hydrologic and hydraulic (H&H) design activities was provided by Maine DOT.

*Table 2111. Maine DOT qualitative benefits from use of enhanced hydrography information for H&H design for transportation activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Minor | Major | Major | Minor | Minor | Not Applicable | Major | Not Applicable |

## BU #6 Coastal Zone Management

**BU #6 Highlights:**

**Number of MCAs:** 8
**Estimated annual program budget:** $63,300,000
**Estimated current annual benefits:** $10,710,000 to $15,710,000
**Estimated future annual benefits:** $5,550,000 to $7,050,000

BU #6, Coastal Zone Management, was described in the questionnaire as including the following types of MCAs: coastal mapping and modeling, coastal hazards mitigation, tsunami modeling, and coastal land use and environmental planning.

Eight MCAs were characterized as having BU #6 as their primary BU, with a total annual program budget of $63,300,000 for programs supported by hydrography data, a total of $10,710,000 to $15,710,000 in estimated annual benefits from the currently available hydrography data, and $5,550,000 to $7,050,000 in estimated future annual benefits from enhanced hydrography data. Additionally, four MCAs noted BU #6 as an ancillary BU.

These eight MCAs were reported by six state agencies (Alaska, American Samoa, Connecticut, Maryland, Mississippi, and Texas), one local agency (Harrison County, MS), and one not-for-profit agency (Lake Ponchartrain Basin Foundation) responsible for coastal resources. These MCAs were described as being for the evaluation and analysis of coastal areas, including flood hazard analysis and mapping, storm surge inundation prediction and mapping, preparation for shoreline change and sea level rise, and environmental protection.

**Areas of Interest**

Figure 16 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #6 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

More states than represented by this map likely have coastal zone management as one of their missions; however, because of the varied representation of the state and local agencies and because the BUs were self-selected, it is likely that additional coastal areas of the U.S. would have an interest in coastal zone management.

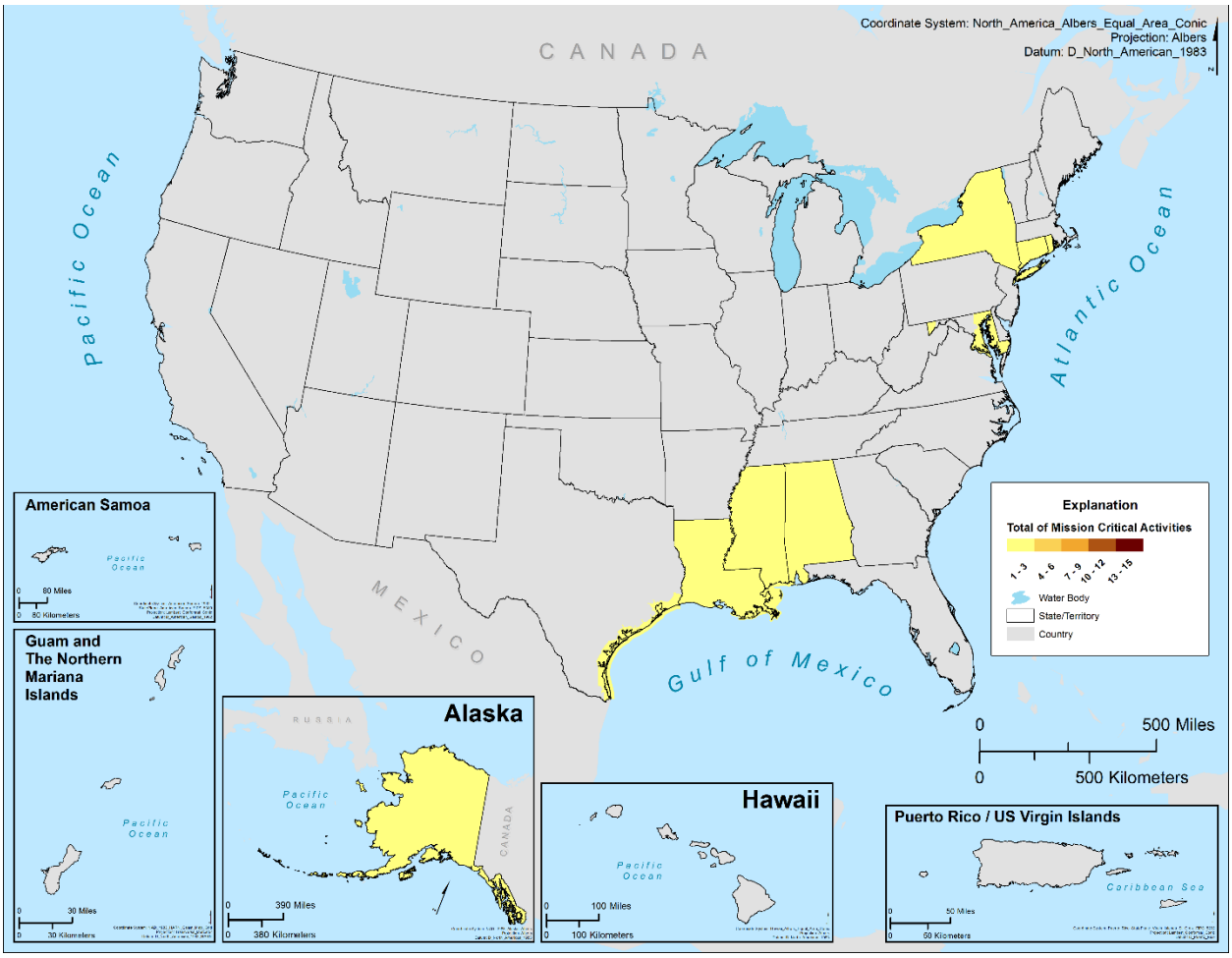



*Figure 16. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #6 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

## Requirements

Table 22 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #6 as their primary BU, and the most frequently requested requirements by category.

*Table 122. Requirements for enhanced hydrography data reported for BU #6*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | 2-3 Years | 50% |
| **Positional Accuracy** | +/- 3 feet, 90% (1:1,200-scale) | 75% |
| **Stream Density** | 2.5 miles of channel per mile (1:24,000-scale mapping) | 38% |
| **Smallest Contributing Watershed** | 6 acres | 50% |
| **Smallest Mapped Waterbody** | Less than an acre | 50% |
| **Post-Event Update** | Required | 63% |
| **Level of Detail** | Consistent Level of Detail | 63% |

The requirements for characteristics and analytical functions for BU #6 are shown in Table 23.

*Table 13. Requirements for characteristics and analytical functions for BU #6*

| Required Characteristics/Analytical Functions | Number of MCAs (of 8) | Percent of MCAs |
|---|---|---|
| Coastal bathymetry | 8 | 100% |
| Coastlines | 7 | 88% |
| Wetlands | 7 | 88% |
| Flood stage | 6 | 75% |
| Floodplain boundary | 6 | 75% |
| Accumulate upstream or downstream features | 5 | 63% |
| Animation of time-series | 5 | 63% |
| Deltas | 5 | 63% |
| Determine downstream flood area | 5 | 63% |
| Estuaries | 5 | 63% |
| Find upstream or downstream feature within watershed | 5 | 63% |
| Linkages to stream gage observations | 5 | 63% |
| Mash-ups | 5 | 63% |
| Navigate up or downstream on network | 5 | 63% |
| Velocity or time of travel | 5 | 63% |
| Bridges, culverts | 4 | 50% |
| Calculate time of travel to points | 4 | 50% |
| Delineate catchment | 4 | 50% |
| Flow periodicity | 4 | 50% |
| Linkages to cross section geometry | 4 | 50% |
| Riverine bathymetry | 4 | 50% |
| Calculate drainage area | 3 | 38% |
| Calculate stream distance to points | 3 | 38% |
| Find events or features on network | 3 | 38% |
| Left/right bank delineation | 3 | 38% |
| User defined symbolization | 3 | 38% |
| Calculate distance on network | 2 | 25% |
| Diversion lines | 2 | 25% |
| Diversion points | 2 | 25% |
| Find upstream or downstream points | 2 | 25% |
| Other (please specify) | 2 | 25% |
| Preset symbolization | 2 | 25% |
| Leakage along lines | 1 | 13% |
| Leakage at points | 1 | 13% |
| Badlands | 0 | 0% |

**Future Annual Benefits**

An estimated $5,550,000 to $7,050,000 in future annual benefits from enhanced hydrography data was reported for the MCAs categorized as having BU #6 as their primary BU.

Figure 17 shows the estimated future annual benefits provided by the MCAs categorized as having BU #6 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

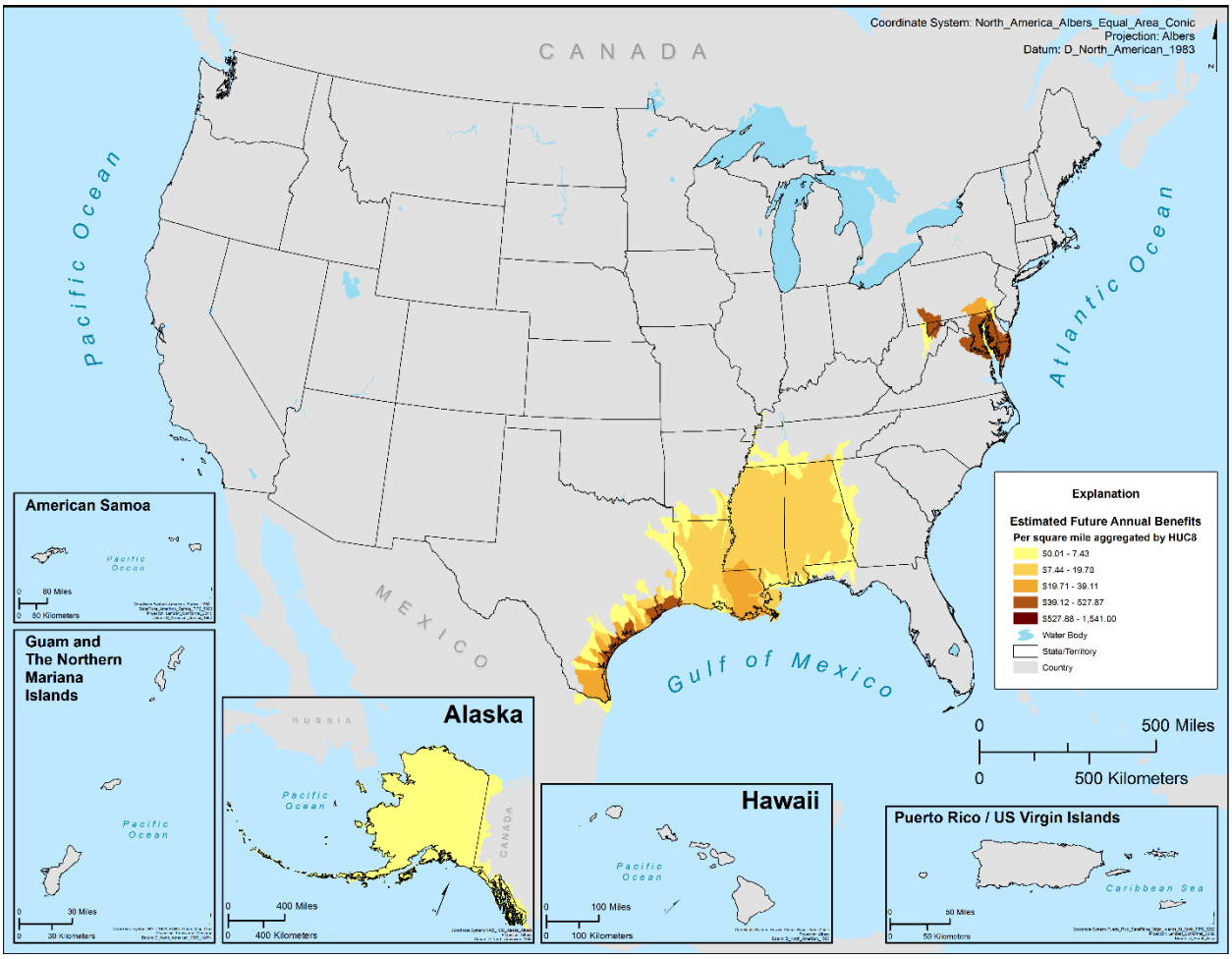



*Figure 17. Estimated future annual benefits reported for MCAs with BU #6 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 24 lists the qualitative benefits reported for BU #6.

*Table 14. Qualitative benefits reported for BU #6*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 6 | 4 | 5 | 4 | 3 | 4 | 4 | 2 |
| **Moderate** | 1 | 3 | 2 | 2 | 2 | 3 | 2 | 3 |
| **Minor** | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 2 |
| **N/A** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Don't Know** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **No Answer Provided** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Total** | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |

These benefits would be realized due to improved network connectivity and coastal bathymetry as well as more current shoreline data, which would result in better analyses and mapping, and better decisions regarding coastal resources and coastal hazards. Specifically, improved data would improve development of hydrocoast mapping and related analyses, improve analysis of freshwater discharges into estuary, improve analysis of impacts of diversions, better quantify post-disaster losses, and improve shoreline change and coastal flood vulnerability mapping.

**Example Coastal Zone Management Activities**

Coastal zone management ensures that America's coastal zones sustain economic, recreational and subsistence activities and their other beneficial functions. Coastal protection and restoration involves the modeling of coastal and inland hydrologic processes to understand the impacts of human activities and natural occurrences in order to develop alternative restoration scenarios and further coastal sustainability. These programs use hydrography data along with gage data (including real-time), bathymetry data, and water quality data.

The non-profit Lake Pontchartrain Basin Foundation (LPBF) was formed and is dedicated to restoring and preserving the water quality, coast, and habitats of the entire Pontchartrain Basin. Through coordination of restoration activities, education, advocacy, monitoring of the regulatory process, applied scientific research, and citizen action, LPBF works in partnership with all segments of the community to reclaim the Basin for this and future generations.

LPBF has developed and publishes bi-weekly Hydrocoast maps that show salinity, water quality, weather, habitat, and biology accompanied by a descriptive report. LPBF has a 4-year archive of these maps that can be used to identify trends. The Hydrocoast maps are produced using field data, Moderate Resolution Imaging Spectroradiometer (MODIS), satellite imagery, precipitation data, wind data and permanent monitoring stations in the basin (USGS buoys, Coastwide Reference Monitoring System (CRMS), etc.).

http://www.saveourlake.org/coastal-hydromap.php

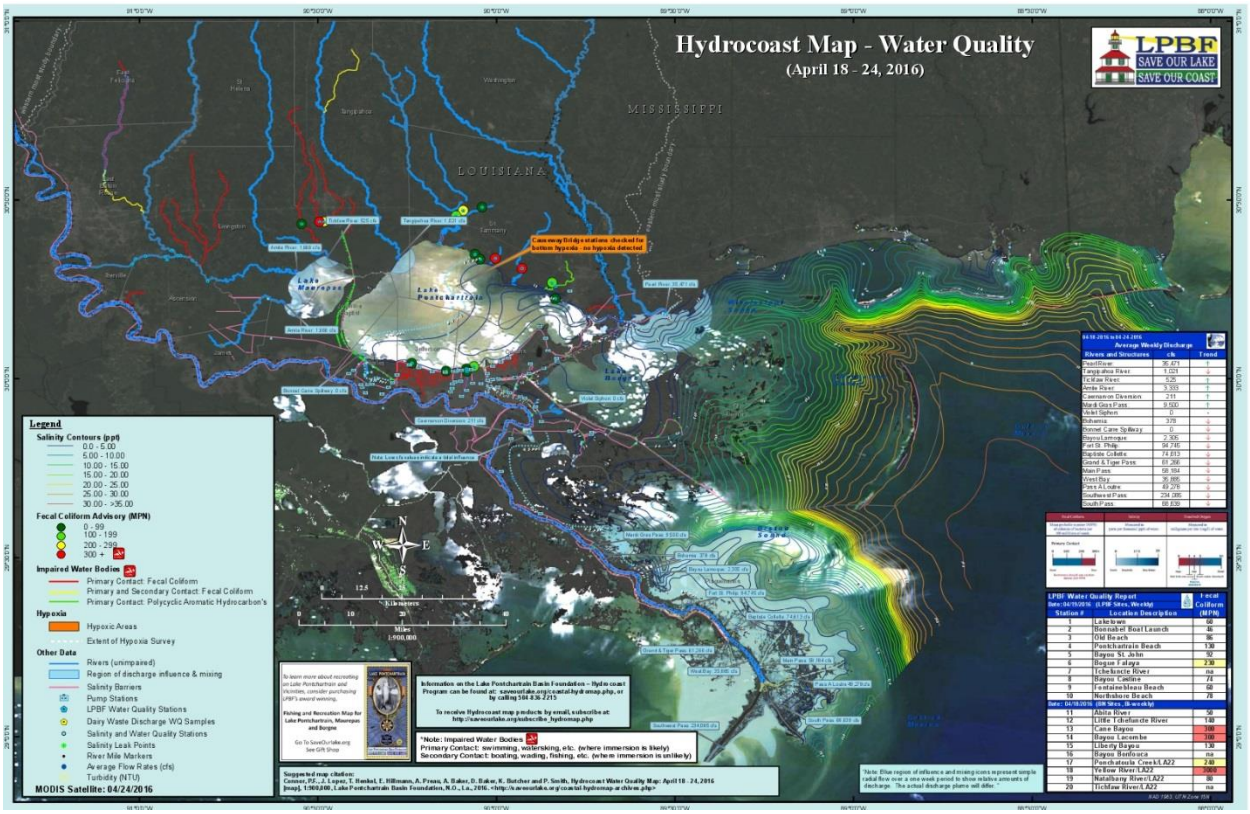



*Figure 18. Lake Pontchartrain Basin water quality for the period of April 18 – 24, 2016. Image courtesy of Lake Pontchartrain Basin Foundation.*

LPBF estimated $250,000 in future annual benefits from improved coastal and estuarine analyses and mapping activities resulting from use of enhanced hydrography information. Additionally, the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for coastal sustainability activities was provided by LPBF.

*Table 15. LPBF qualitative benefits from use of enhanced hydrography information for coastal sustainability activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Major | Major | Major | Major | Minor | Moderate | Moderate | Minor |

## BU #7 Forest Resources Management

BU #7, Forest Resources Management, was described in the questionnaire as including the following types of MCAs: forest inventories, forest resource management, sustainable timberlands, forest species distribution modeling, forest conservation, watershed protection, harvest planning, haul road construction, silvicultural treatments, and post-fire management.

**BU #7 Highlights:**

**Number of MCAs:** 5
**Estimated annual program budget:** $254,385,853
**Estimated current annual benefits:** $1,760,000
**Estimated future annual benefits:** $6,010,000

Five MCAs were characterized as having BU #7 as their primary BU, with a total annual program budget of $254,385,853 for programs supported by hydrography data, a total of $1,760,000 in estimated annual benefits from the currently available hydrography data, and $6,010,000 in estimated future annual benefits from enhanced hydrography data. Additionally, one MCA noted BU #7 as an ancillary BU.

These five MCAs were reported by the U.S. Forest Service (USFS) for land management planning and analysis; the North Carolina Forest Service for protection, management, and promotion of forest resources; the Pennsylvania Department of Conservation and Natural Resources for forest and park management, conservation, and protection; the Utah Department of Natural Resources for management of Utah's sovereign lands, forest health and sustainability, and wildfire response, reduction, and mitigation; and the Washington Department of Natural Resources for planning and regulation of forest practices on state and private forest land.

**Areas of Interest**

Figure 19 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #7 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

More states than shown on this map likely have forest resources management as one of their missions. Additionally, timber companies, which would have a great interest in managing forest resources, were not represented in the study participants; therefore it is likely that there are additional forested areas across the U.S. where forest resources management would be a concern.

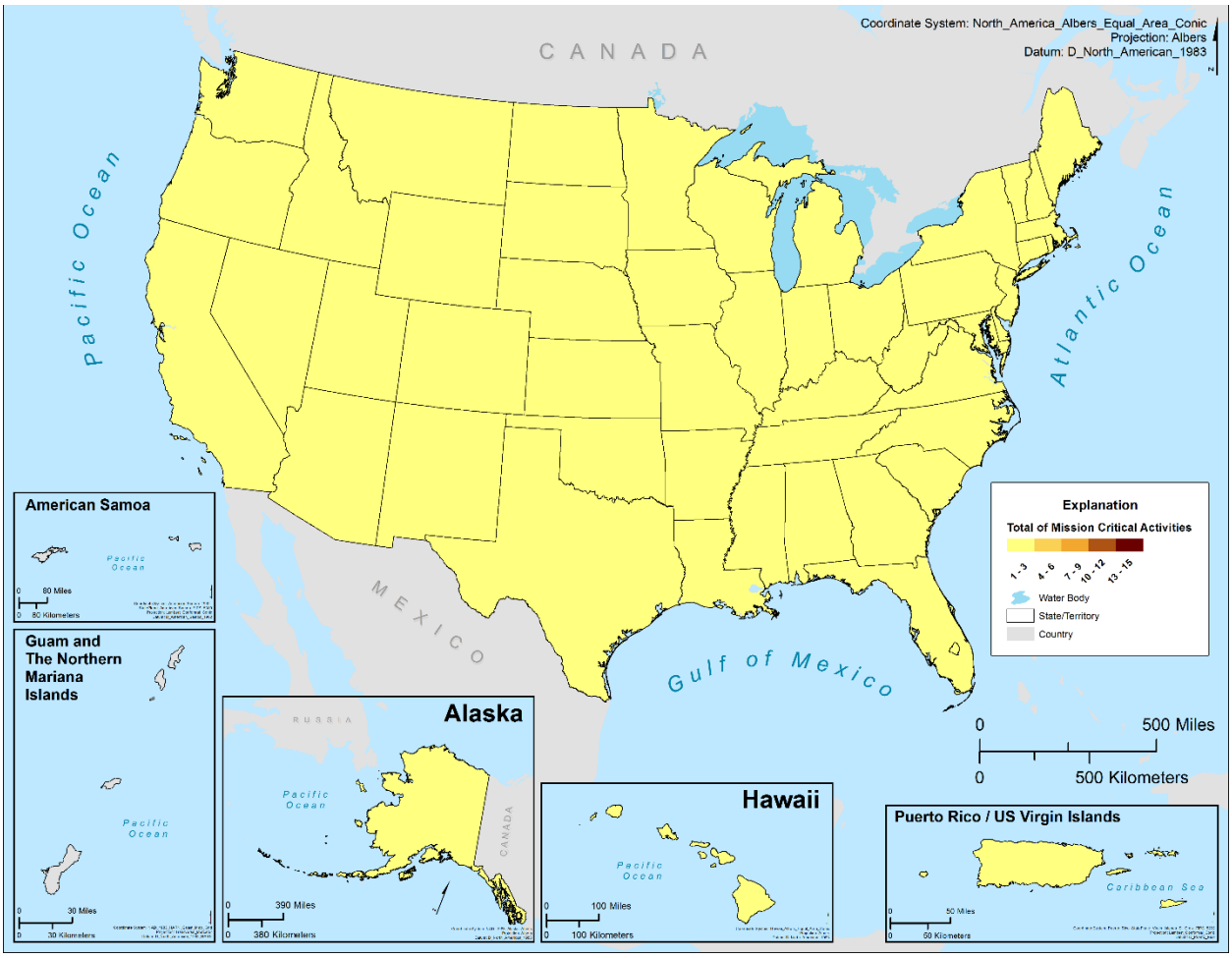



*Figure 3. Spatial extents of the areas of interest represented by the MCAs that were categorized as having BU #7 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

## Requirements

Table 26 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #7 as their primary BU, and the most frequently requested requirements by category.

*Table 166. Requirements for enhanced hydrography data reported for BU #7*

| Requirement | Most Frequently Reported Requirement | Percent of MCAs |
|---|---|---|
| **Update Frequency** | Annually | 60% |
| **Positional Accuracy** | +/- 7 feet, 90% (1:2,400-scale) | 40% |
| **Stream Density** | 5.0 miles of channel per mile (1:5,000-scale mapping) | 80% |
| **Smallest Contributing Watershed** | 6 acres | 60% |
| **Smallest Mapped Waterbody** | Less than an acre | 60% |
| **Post-Event Update** | Highly Desirable | 60% |
| **Level of Detail** | Best Available | 100% |

The requirements for characteristics and analytical functions for BU #7 are shown in Table 27.

*Table 177 Requirements for characteristics and analytical functions for BU #7*

| Required Characteristics/Analytical Functions | Number of MCAs (of 5) | Percent of MCAs |
|---|---|---|
| Calculate drainage area | 5 | 100% |
| Delineate catchment | 5 | 100% |
| Diversion lines | 5 | 100% |
| Flow periodicity | 5 | 100% |
| Left/right bank delineation | 5 | 100% |
| Linkages to cross section geometry | 5 | 100% |
| Mash-ups | 5 | 100% |
| User defined symbolization | 5 | 100% |
| Wetlands | 5 | 100% |
| Accumulate upstream or downstream features | 4 | 80% |
| Bridges, culverts | 4 | 80% |
| Calculate stream distance to points | 4 | 80% |
| Determine downstream flood area | 4 | 80% |
| Find upstream or downstream feature within watershed | 4 | 80% |
| Find upstream or downstream points | 4 | 80% |
| Flood stage | 4 | 80% |
| Floodplain boundary | 4 | 80% |
| Leakage at points | 4 | 80% |
| Navigate up or downstream on network | 4 | 80% |
| Other (please specify) | 4 | 80% |
| Preset symbolization | 4 | 80% |
| Velocity or time of travel | 4 | 80% |
| Calculate distance on network | 3 | 60% |
| Calculate time of travel to points | 3 | 60% |
| Coastlines | 3 | 60% |
| Find events or features on network | 3 | 60% |
| Leakage along lines | 3 | 60% |
| Linkages to stream gage observations | 3 | 60% |
| Riverine bathymetry | 3 | 60% |
| Animation of time-series | 2 | 40% |
| Coastal bathymetry | 2 | 40% |
| Deltas | 2 | 40% |
| Diversion points | 2 | 40% |
| Estuaries | 2 | 40% |
| Badlands | 1 | 20% |

**Future Annual Benefits**

An estimated $6,010,000 in future annual benefits from enhanced hydrography data was reported for the MCAs that were categorized as having BU #7 as their primary BU.

Figure 20 shows the estimated future annual benefits provided by the MCAs that were categorized as having BU #7 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

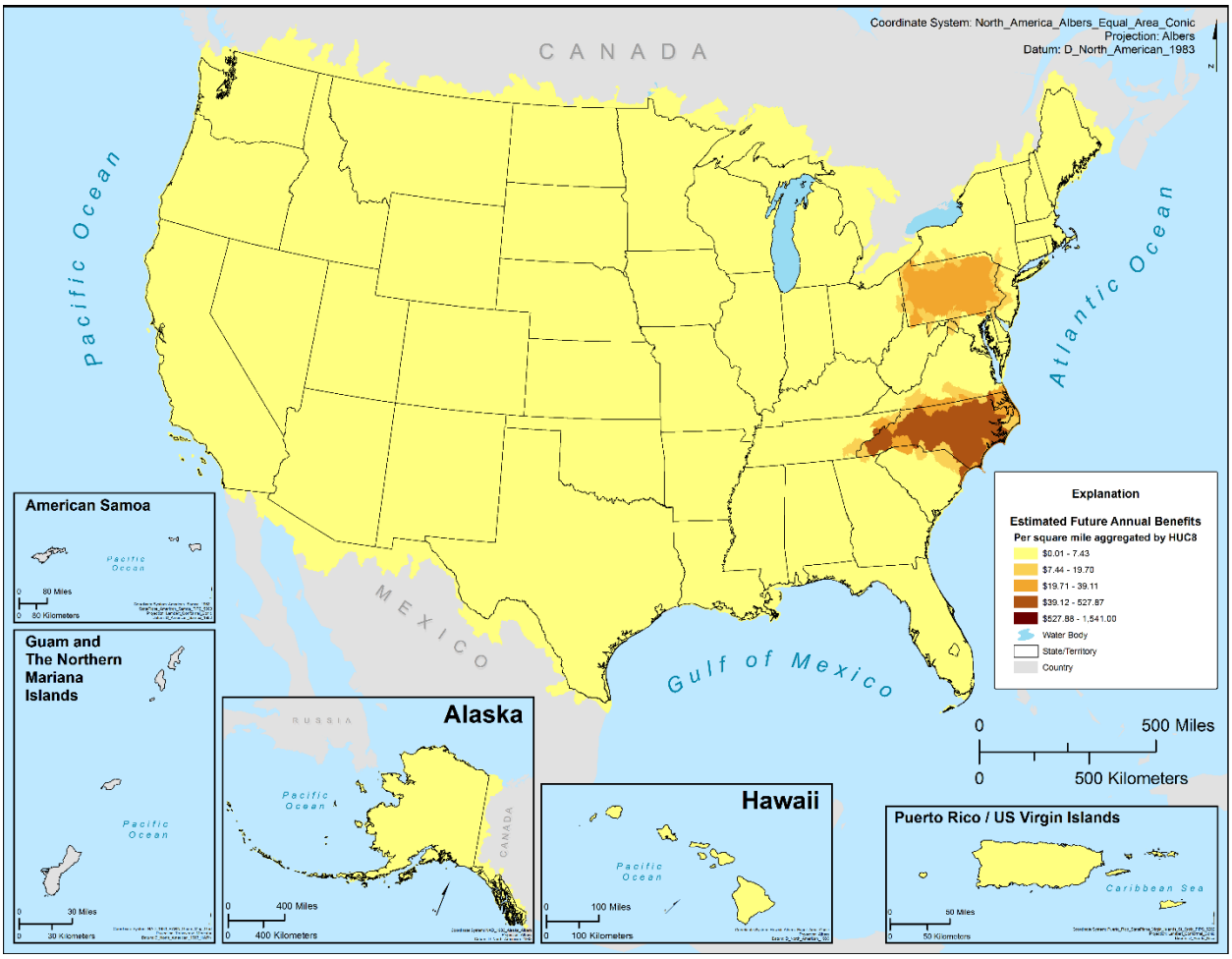



*Figure 4. Estimated future annual benefits reported for MCAs with BU #7 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 28 lists the qualitative benefits reported for BU #7.

*Table 188. Qualitative benefits reported for BU #7*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 0 |
| **Moderate** | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 1 |
| **Minor** | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 4 |
| **N/A** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Don't Know** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **No Answer Provided** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |

These benefits would be realized due to improved accuracy of hydrography data, which would result in time and cost savings for refining and maintaining geospatial data layers and performing analyses; less field work; better forest management; and more timely emergency response, including improved wildfire response water acquisition, better public education about the importance of forests and forestry, and better mapping.

**Example Forest Resources Management Activities**

Forest land management programs involve conducting forest inventories, management of forest resources, watershed protection, flood calculation, bridge design, maintenance of aquatic passage, water diversion upgrades, stream and wetland restoration, riparian management, stream and habitat surveys, watershed condition classification, water quality monitoring, protection of drinking water sources, grazing management, and recreational facility/management, among other activities. Hydrography data including accurate locations of watersheds, streams, lakes, wetlands, seep, springs and other water resources features are needed for all of these activities.

The U.S. Forest Service (USFS) administers 193 million acres of national forests and grasslands. Forests store and filter more than half of the Nation's water supply and absorb approximately 12 percent of the country's carbon emissions.

USFS developed the Watershed Condition Framework (WCF) to provide a consistent approach for classifying the condition of watersheds on the Nation's forests and grasslands. USFS established three watershed condition classes (functioning properly, functioning at risk, and impaired function) to assess, classify, prioritize, and monitor progress toward maintaining or improving watershed condition.

Implementation began in 2011 by classifying 15,034 watersheds that contain substantial acreages of National Forest Service lands as shown in Figure 21. USFS has identified more than 300 priority watersheds. From FY 2011 to FY 2014, 34 watersheds were restored to a fully functioning condition. Plans are for USFS to restore an additional 39 watersheds in FYs 2015 and 2016. Additionally, USFS has collaboratively developed 260 Watershed Restoration Action Plans and implementation schedules with partners for appropriate treatments to restore the condition of priority watersheds nationwide.

http://www.fs.fed.us/biology/watershed/condition_framework.html

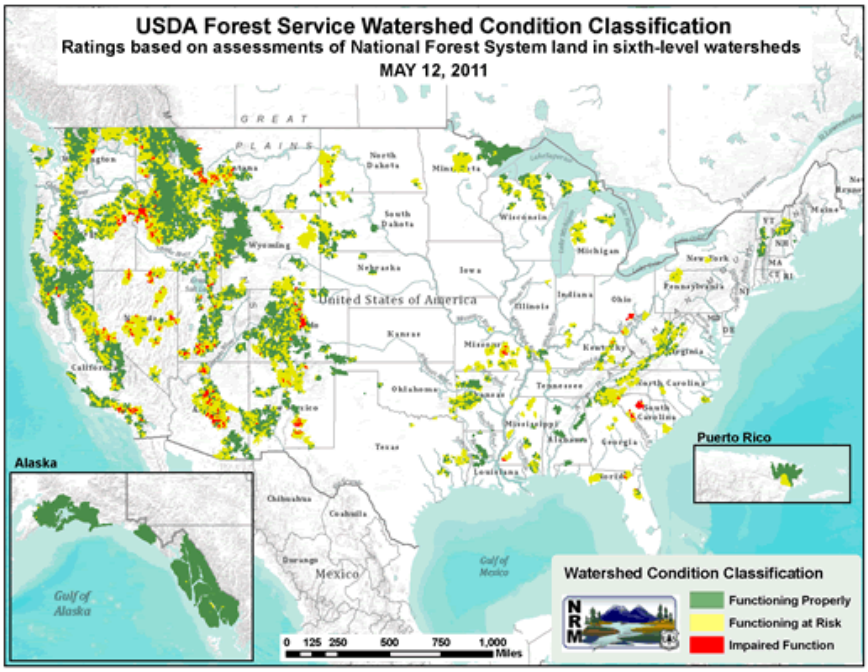



*Figure 21. USFS watershed condition classification of the National Forest System lands. Image courtesy of USFS.*

USFS estimated $2 million in future annual benefits for land management planning and analyses for water quality, stream condition, aquatic habitat, facility planning, and condition assessments. These benefits would be derived from reduced staff time spent maintaining geospatial hydrography layers and conducting analyses. Improved accuracy of hydrography data would improve resource management and resource benefits, and improve use of hydrography data in meeting the USFS mission. Additionally, the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for forest land management activities was provided by USFS.

*Table 19. USFS qualitative benefits from use of enhanced hydrography information for forest land management activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Major | Major | Major | Moderate | Major | Moderate | Moderate | Moderate |

## BU #8 Rangeland Management

BU #8, Rangeland Management, was described in the questionnaire as including the following types of MCAs: preservation and management of rangeland, rangeland stewardship, and rangeland mapping and characterization.

One MCA was characterized as having BU #8 as its primary BU, with a total annual program budget of $20,433,334 for programs supported by hydrography data, unquantifiable annual benefits from the currently available hydrography

**BU #8 Highlights:**

**Number of MCAs:** 1
**Estimated annual program budget:** $20,433,334
**Estimated current annual benefits:** Unquantifiable
**Estimated future annual benefits:** $100,000

data, and $100,000 in estimated future annual benefits from enhanced hydrography data. Additionally, one MCA noted BU #8 as an ancillary BU.

The Agricultural Research Service described this MCA as involving watershed assessments to evaluate the effects of land use changes on water quality.

**Areas of Interest**

Figure 22 shows the spatial extents of the areas of interest represented by the MCA that was categorized as having BU #8 as its primary BU. It is likely that additional areas in the Western states may have an interest in rangeland management.


*Figure 22. Spatial extents of the areas of interest represented by the MCA categorized as having BU #8 as its primary BU*

**Requirements**

Table 30 lists the requirements for enhanced hydrography data reported for the MCA categorized as having BU #8 as its primary BU, and the most frequently requested requirements by category.

*Table 20. Requirements for enhanced hydrography data for BU #8*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | 4-5 Years | 100% |
| **Positional Accuracy** | +/- 40 feet, 90% (1:24,000-scale) | 100% |

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Stream Density** | 2.5 miles of channel per sq. mi. | 100% |
| **Smallest Contributing Watershed** | 6 acres | 100% |
| **Smallest Mapped Waterbody** | 1 acre | 100% |
| **Post-Event Update** | Highly Desirable | 100% |
| **Level of Detail** | Consistent | 100% |

The requirements for characteristics and analytical functions for BU #8 are shown in Table 31.

*Table 21. Requirements for characteristics and analytical functions for BU #8*

| Required Characteristics/Analytical Functions | Number of MCAs (of 1) | Percent of MCAs |
|---|---|---|
| Accumulate upstream or downstream features | 1 | 100% |
| Calculate drainage area | 1 | 100% |
| Delineate catchment | 1 | 100% |
| Determine downstream flood area | 1 | 100% |
| Find upstream or downstream feature within watershed | 1 | 100% |
| Find upstream or downstream points | 1 | 100% |
| Leakage along lines | 1 | 100% |
| Leakage at points | 1 | 100% |
| Left/right bank delineation | 1 | 100% |
| Linkages to cross section geometry | 1 | 100% |
| Linkages to stream gage observations | 1 | 100% |
| Navigate up or downstream on network | 1 | 100% |
| User defined symbolization | 1 | 100% |
| Animation of time-series | 0 | 0% |
| Badlands | 0 | 0% |
| Bridges, culverts | 0 | 0% |
| Calculate distance on network | 0 | 0% |
| Calculate stream distance to points | 0 | 0% |
| Calculate time of travel to points | 0 | 0% |
| Coastal bathymetry | 0 | 0% |
| Coastlines | 0 | 0% |
| Deltas | 0 | 0% |
| Diversion lines | 0 | 0% |
| Diversion points | 0 | 0% |
| Estuaries | 0 | 0% |
| Find events or features on network | 0 | 0% |
| Flood stage | 0 | 0% |
| Floodplain boundary | 0 | 0% |
| Flow periodicity | 0 | 0% |
| Mash-ups | 0 | 0% |
| Other (please specify) | 0 | 0% |
| Preset symbolization | 0 | 0% |
| Riverine bathymetry | 0 | 0% |

| Required Characteristics/Analytical Functions | Number of MCAs (of 1) | Percent of MCAs |
|---|---|---|
| Velocity or time of travel | 0 | 0% |
| Wetlands | 0 | 0% |

**Future Annual Benefits**

An estimated $100,000 in future annual benefits from enhanced hydrography data was reported for the MCA categorized as having BU #8 as its primary BU.

Figure 23 shows the estimated future annual benefits provided by the MCA categorized as having BU #8 as its primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

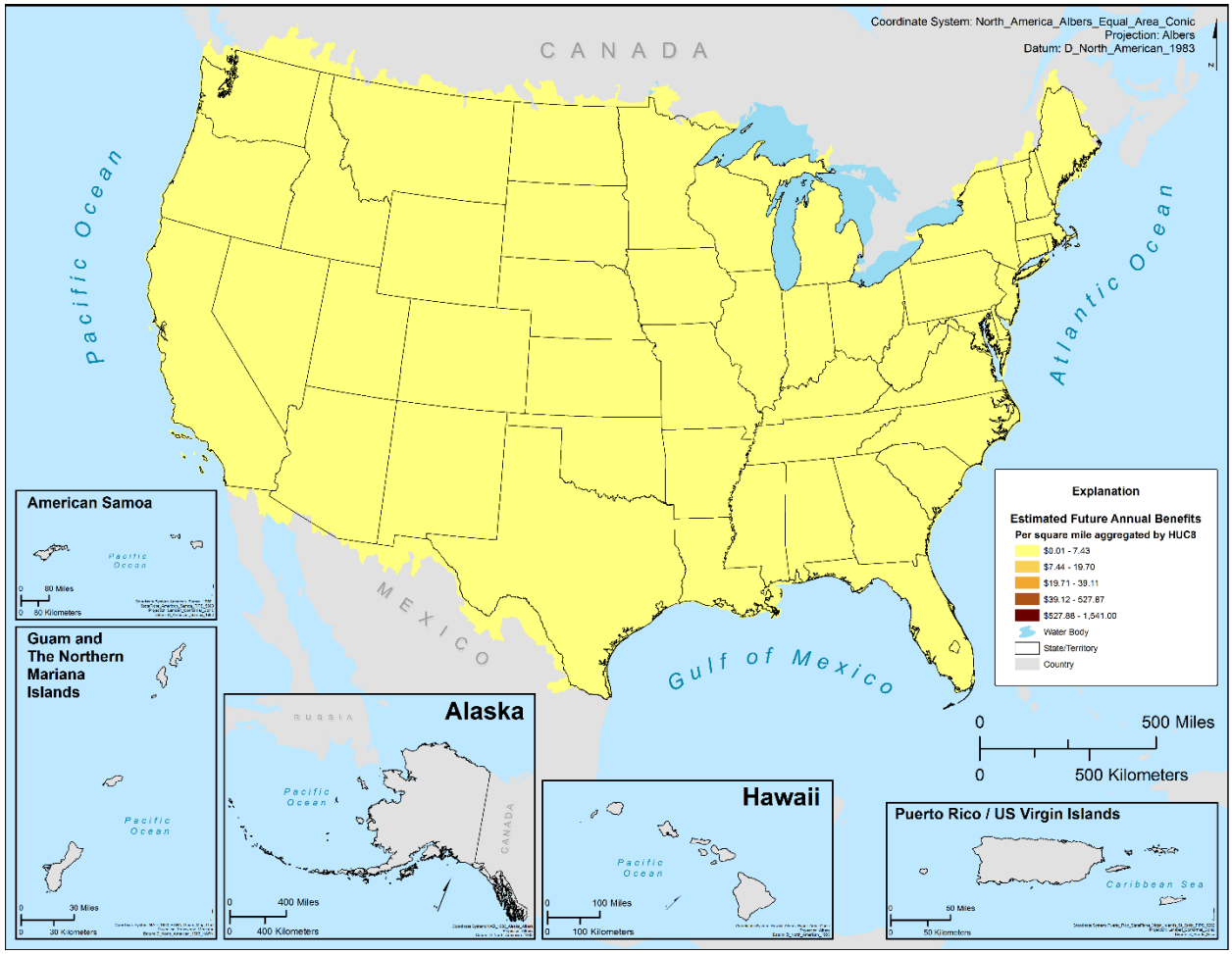



*Figure 23. Estimated future annual benefits reported for the MCA that was categorized as having BU #8 as its primary BU.*

In addition to the estimated future annual dollar benefits, Table 32 lists the qualitative benefits reported for BU #8.

*Table 22. Qualitative benefits reported for BU #8*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Qualitative Benefits** | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate | Major | Don't Know |

These benefits would be realized due to less ambiguity and uncertainty in defining contributing source areas by matching them to headwaters; and less uncertainty with routing when hydrography data match elevation data.

**Example Rangeland Management Activities**

Rangelands across the western United States support productive ecosystems, and hundreds of millions of dollars are invested each year in public and private funds to manage and conserve them. Because rangelands are highly diverse, their accurate assessments depend on understanding how different types of land vary in potential for supporting productive ecosystems while limiting runoff and erosion. According to NRCS, rangelands comprise about 30 percent of the entire land cover of the U.S. and about 2/3 of U.S. rangelands are privately owned.

The Department of Agriculture's Agricultural Research Service (ARS) in conjunction with NRCS, USGS, and BLM developed methodology for collecting National Resources Inventory (NRI) data to monitor western rangelands. Data were collected at a scientifically selected subset of NRI sample points in 17 western states, with limited data also collected in Louisiana and Florida. Assessments were conducted for key indicators for biotic integrity, hydrologic function, soil and site stability, and presence of non-native species. Figure 24 below illustrates the assessment for hydrologic function on non-Federal rangelands.

The study results showed that while soil degradation remains an issue, loss of biotic integrity is more widespread. The quantitative data collected will serve as a baseline for monitoring the effectiveness of policy and management, including responses to climate change.

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/nri/results/?cid=stelprdb1254901

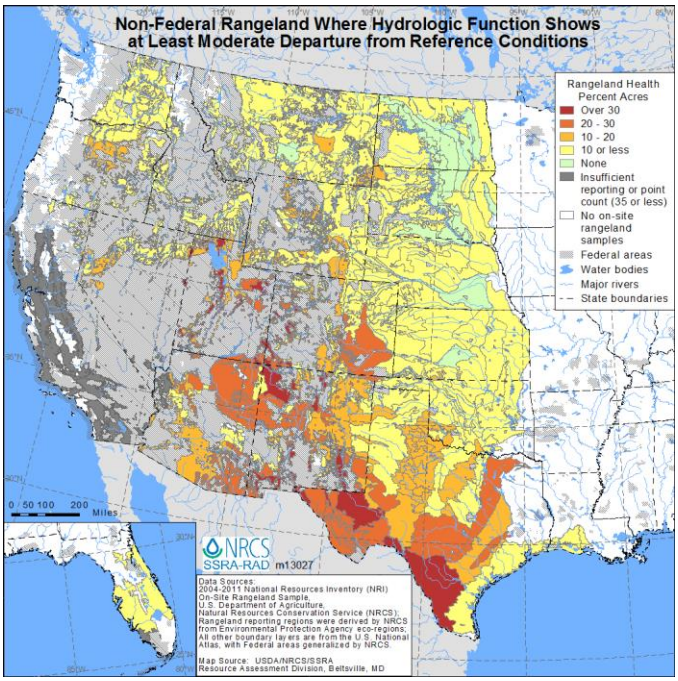



*Figure 24. Non-Federal rangelands with reduced hydrologic function. Image courtesy of USDA.*

ARS estimated $100,000 in future annual benefits from improved watershed assessment activities resulting from use of enhanced hydrography information. Additionally, the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for rangeland watershed assessments was provided by ARS.

*Table 23. ARS qualitative benefits from use of enhanced hydrography information for rangeland watershed assessment activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Moderate | Moderate | Moderate | Moderate | Moderate | Moderate | Major | Don't Know |

## BU #9 Wildlife and Habitat Management

BU #9, Wildlife and Habitat Management, was described in the questionnaire as including the following types of MCAs: conservation planning for wildlife refuges, conservation of critical habitats, and management of diverse migratory bird habitats.

**BU #9 Highlights:**

**Number of MCAs:** 8
**Estimated annual program budget:** $1,041,452,000
**Estimated current annual benefits:** $182,468
**Estimated future annual benefits:** $10,079,251

Eight MCAs were characterized as having BU #9 as their primary BU, with a total annual program budget of $1,041,452,000 for programs supported by hydrography data, a total of $182,468 in estimated annual benefits from the currently available hydrography data, and $10,079,251 in estimated future annual benefits from enhanced hydrography data. Additionally, six MCAs noted BU #9 as an ancillary BU.

These eight MCAs were reported by the U.S. Fish and Wildlife Service (USFWS), Ducks Unlimited, Inc., and five state agencies responsible for fish and wildlife (Arkansas, Florida, Louisiana, Maine, and South Dakota). All were for habitat management and conservation for aquatic and terrestrial species.

**Areas of Interest**

Figure 25 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #9 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

More states and county or local entities than shown on this map likely have wildlife and habitat management as one of their missions; however, because of the varied representation of the state and local agencies, and because the BUs were self-selected, it is likely that additional areas across the U.S. would have an interest in wildlife and habitat management. Note also that Ducks Unlimited, Inc. requires hydrography data for all of North America, to include Canada and Mexico.

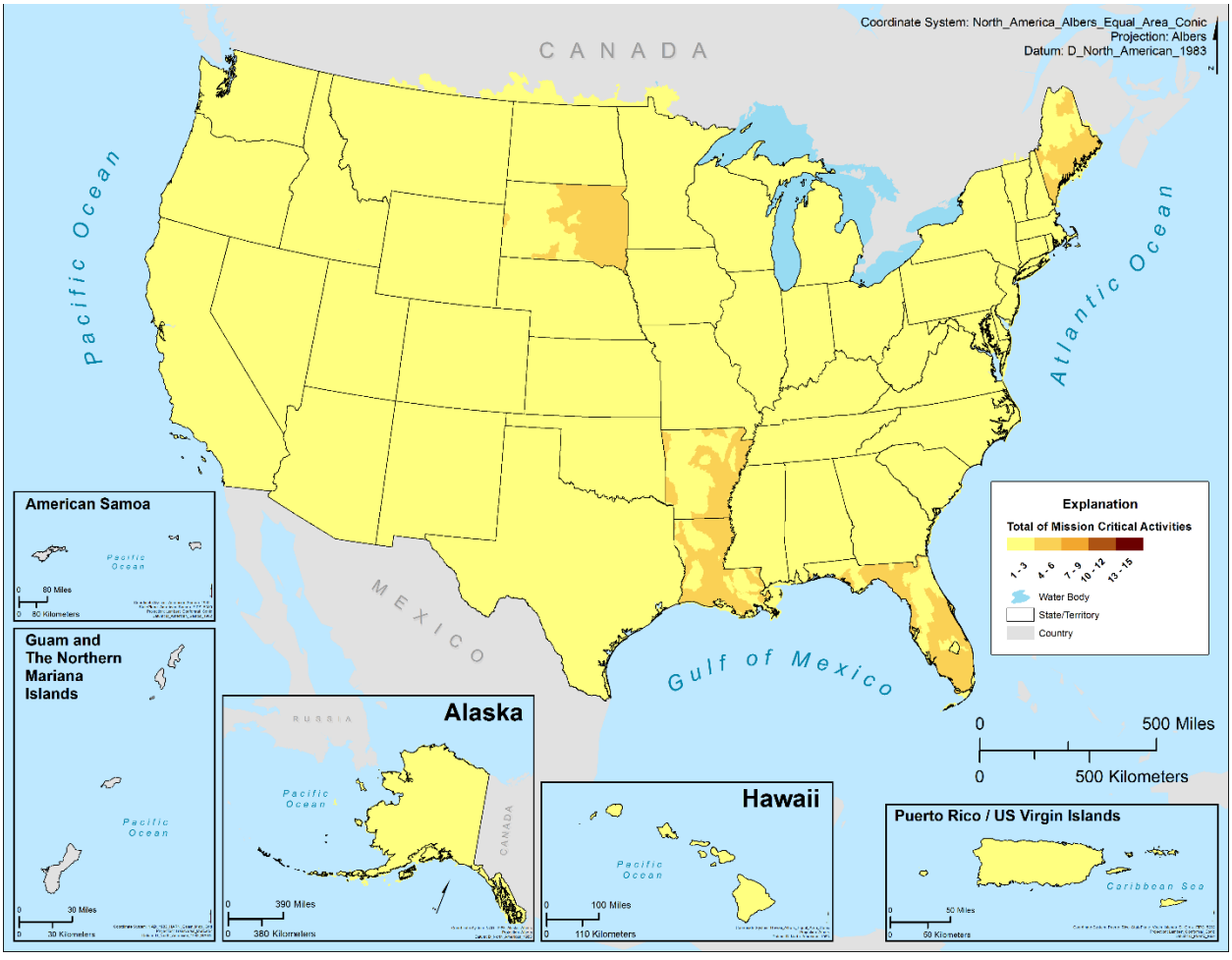



*Figure 25. Spatial extents of the areas of interest represented by the MCAs that were categorized as having BU #9 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

**Requirements**

Table 34 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #9 as their primary BU, and the most frequently requested requirements by category.

*Table 244. Requirements for enhanced hydrography data reported for BU #9*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | 2-3 Years | 38% |
| **Positional Accuracy** | +/- 3 feet, 90% (1:1,200-scale) | 63% |
| **Stream Density** | 5.0 miles of channel per mile (1:5,000-scale mapping) | 50% |
| **Smallest Contributing Watershed** | 6 acres / 60 acres | 25% each |
| **Smallest Mapped Waterbody** | Less than an acre | 50% |
| **Post-Event Update** | Highly Desirable | 50% |
| **Level of Detail** | Best Available | 63% |

The requirements for characteristics and analytical functions for BU #9 are shown in Table 35.

*Table 255. Requirements for characteristics and analytical functions for BU #9*

| Required Characteristics/Analytical Functions | Number of MCAs (of 8) | Percent of MCAs |
|---|---|---|
| Wetlands | 8 | 100% |
| Riverine bathymetry | 7 | 88% |
| Coastlines | 6 | 75% |
| Estuaries | 6 | 75% |
| Floodplain boundary | 6 | 75% |
| Linkages to stream gage observations | 6 | 75% |
| Linkages to cross section geometry | 5 | 63% |
| Accumulate upstream or downstream features | 4 | 50% |
| Bridges, culverts | 4 | 50% |
| Calculate drainage area | 4 | 50% |
| Calculate stream distance to points | 4 | 50% |
| Coastal bathymetry | 4 | 50% |
| Deltas | 4 | 50% |
| Determine downstream flood area | 4 | 50% |
| Find upstream or downstream feature within watershed | 4 | 50% |
| Flood stage | 4 | 50% |
| Flow periodicity | 4 | 50% |
| Leakage along lines | 4 | 50% |
| Leakage at points | 4 | 50% |
| Left/right bank delineation | 4 | 50% |
| Navigate up or downstream on network | 4 | 50% |
| User defined symbolization | 4 | 50% |
| Delineate catchment | 3 | 38% |
| Diversion lines | 3 | 38% |
| Diversion points | 3 | 38% |

| Required Characteristics/Analytical Functions | Number of MCAs (of 8) | Percent of MCAs |
|---|---|---|
| Preset symbolization | 3 | 38% |
| Velocity or time of travel | 3 | 38% |
| Animation of time-series | 2 | 25% |
| Calculate distance on network | 2 | 25% |
| Find events or features on network | 2 | 25% |
| Find upstream or downstream points | 2 | 25% |
| Mash-ups | 2 | 25% |
| Badlands | 1 | 13% |
| Calculate time of travel to points | 0 | 0% |
| Other (please specify) | 0 | 0% |

**Future Annual Benefits**

An estimated $10,079,251 in future annual benefits from enhanced hydrography data was reported for the MCAs categorized as having BU #9 as their primary BU.

Figure 26 shows the estimated future annual benefits provided by the MCAs categorized as having BU #9 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

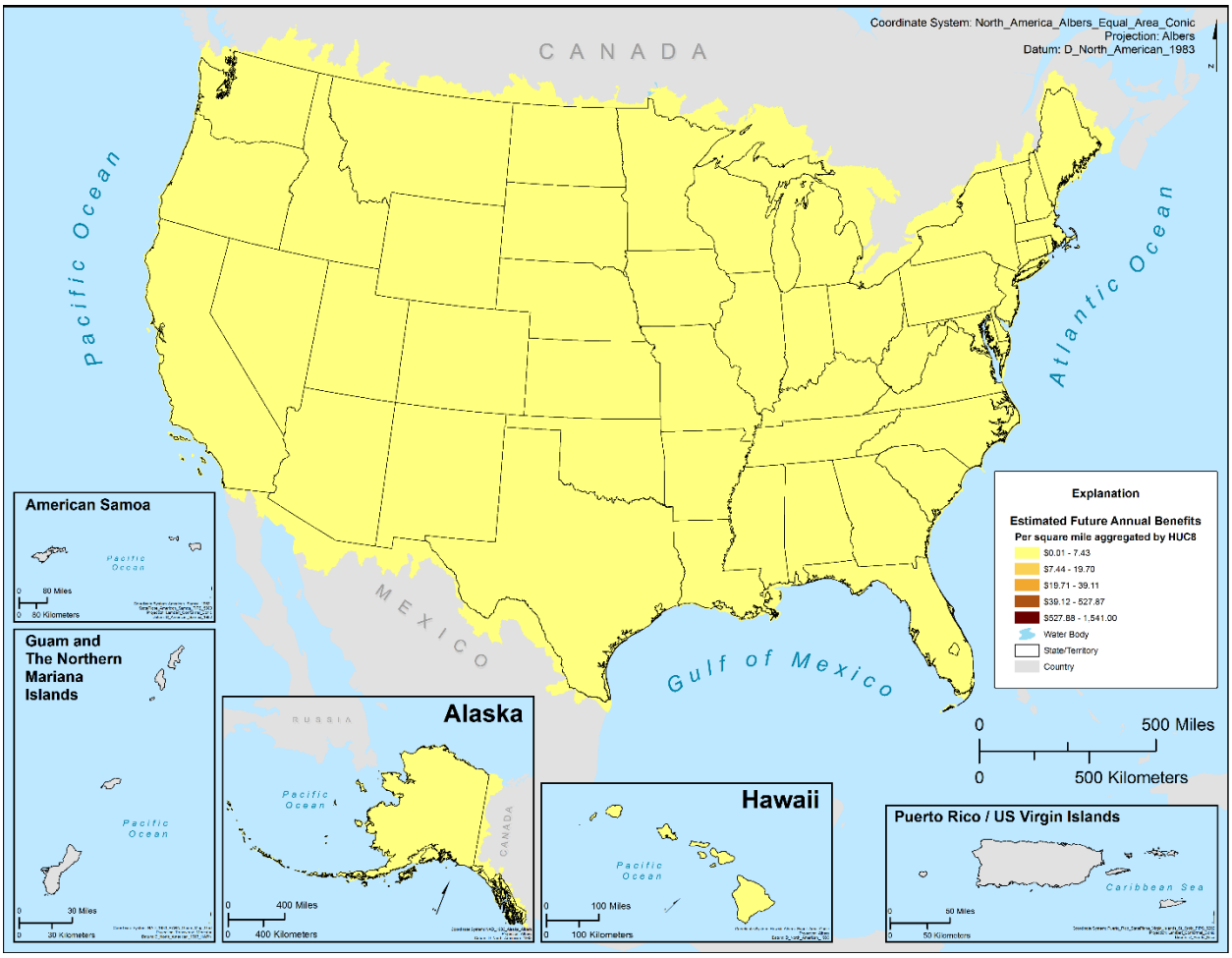



*Figure 26. Estimated future annual benefits reported for the MCAs categorized as having BU #9 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 36 lists the qualitative benefits reported for BU #9.

*Table 266. Qualitative benefits reported for BU #9*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 5 | 5 | 5 | 2 | 1 | 2 | 4 | 0 |
| **Moderate** | 1 | 2 | 3 | 4 | 7 | 5 | 2 | 1 |
| **Minor** | 1 | 0 | 0 | 2 | 0 | 1 | 1 | 2 |
| **N/A** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| **Don't Know** | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 2 |
| **No Answer Provided** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |

These benefits would be realized due to enhanced accuracy and attribution of hydrography data and high-resolution bathymetry, which would result in less time spent aggregating data from multiple sources and adding value to data; less time spent collecting field data; better support for modelling and analysis; improved decision making; better quality maps for public education of water resources issues; and more timely distribution of information to the public.

**Example Wildlife and Habitat Management Activities**

Wildlife and habitat management activities focus on sustaining the economic, recreational, and subsistence activities of land-based wildlife habitats, including migratory birds. Federal agencies, associations, and state and local government all have responsibilities for wildlife and habitat management.

In some parts of the United States, over 90% of the original wetlands were drained. This was done though changing the hydrology of the landscape (mostly through installation of drain tiles). Understanding the hydrology at the regional, watershed, and site specific scales is extremely important for planning wetland conservation and restoration activities. At the watershed scale, hydrography data are used to estimate flow, accumulation, and benefits for habitat restoration activities. At the site specific scale, local resolution hydrography data are needed to plan the restoration activities. Other wildlife and habitat management activities that rely on accurate hydrography and water quality data include identification and prioritization of endangered species' habitats as well as protection and restoration of riparian buffers in order to support fish and wildlife.

According to Ducks Unlimited (DU), "wetlands are among the most productive ecosystems on the planet. They are invaluable not only to waterfowl and scores of other wildlife species, but also to the very quality of life on earth." Historic wetland loss, conversion of lands to development, water quality problems and an expanding human population are great challenges to waterfowl.

For the Saginaw Bay area of the Great Lakes Region, DU created a wetland prioritization scheme to identify areas to target for wetland preservation and conservation. The criteria are based on the land's proximity to existing protected sites (land is more likely to be preserved if it is near existing protected land), distance to development (sites closer to development are less likely to be preserved), wetland density (more contiguous habitat and more dense wetland areas create more likelihood of waterfowl nesting and migration stopovers), and importance for waterfowl habitat (it is more important to preserve wetlands that are most useful to waterfowl). Based on these criteria, DU ranked lands in the Saginaw Bay area for wetland protection. Since conducting this analysis, DU has evaluated the status of the priority lands in order to identify high priority areas that are currently unprotected such that a plan can be developed for protecting these areas.

http://www.ducks.org/conservation/glaro/resource-library#gis

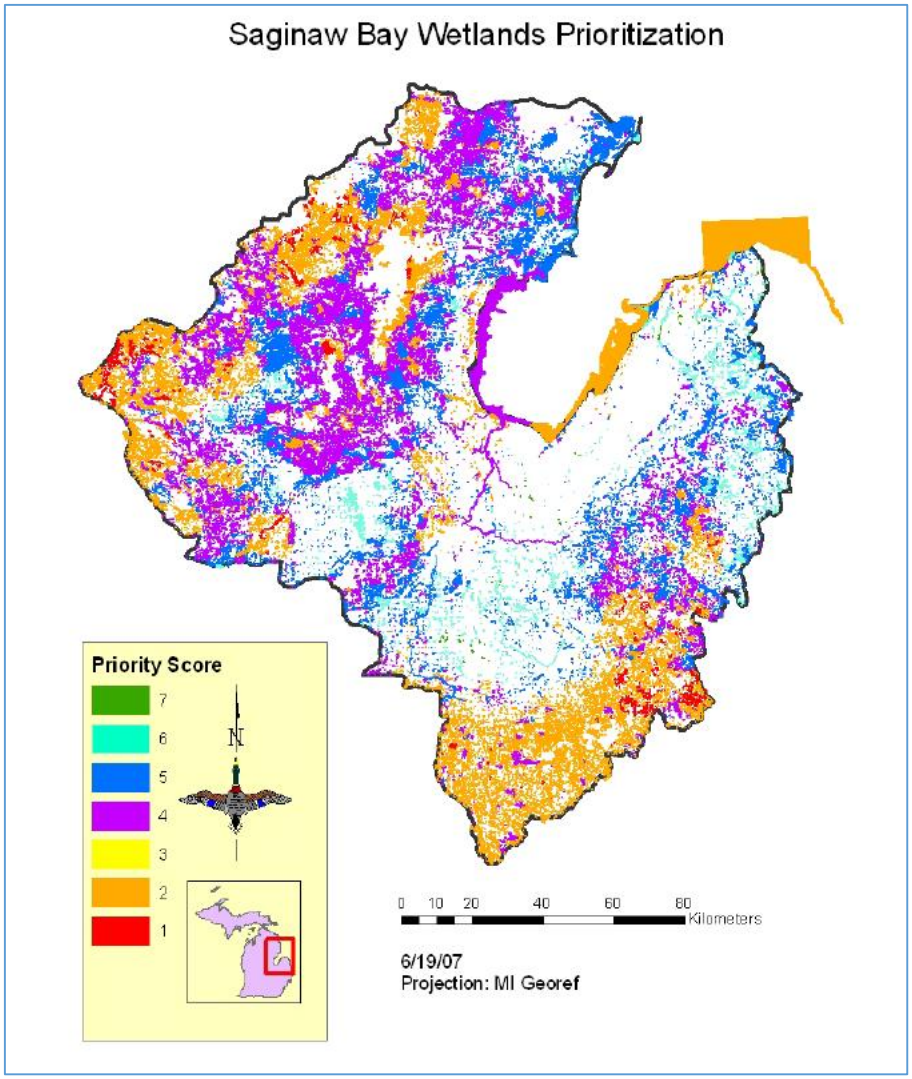



*Figure 27. Saginaw Bay wetlands prioritization map developed by DU. Image courtesy of DU.*

DU estimated $10 million in future annual benefits from reduced time spent collecting field information needed for wetland restoration. Additionally, the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for wetland restoration activities was provided by DU.

*Table 27. DU qualitative benefits from use of enhanced hydrography information for wetland restoration activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Major | Major | Moderate | Moderate | Moderate | Moderate | Major | Not Applicable |

## BU #10 Agriculture and Precision Farming

BU #10, Agriculture and Precision Farming, was described in the questionnaire as including the following types of MCAs: reducing harmful runoff by site-specific application of fertilizer and pesticides, and irrigation water use management.

**BU #10 Highlights:**

**Number of MCAs:** 9
**Estimated annual program budget:** $21,752,667
**Estimated current annual benefits:** $1,253,000
**Estimated future annual benefits:** $2,148,200

Nine MCAs were characterized as having BU #10 as their primary BU, with a total annual program budget of $21,752,667 for programs supported by hydrography data, a total of $1,253,000 in estimated annual benefits from the currently available hydrography data, and $2,148,200 in estimated future annual benefits from enhanced hydrography data. Additionally, two MCAs noted BU #10 as an ancillary BU.

These nine MCAs were reported by the Animal and Plant Health Inspection Service for climate change and environmental monitoring and compliance; the Iowa Soybean Association for watershed protection and water quality improvement; Water District 37 in Idaho for irrigation supply prediction; Fayette County, OH for watershed protection; the Delaware Department of Natural Resources for assessments of location and condition of tax ditches that drain agricultural lands; the Minnesota Department of Agriculture for watershed protection and management, including erosion mapping and surface water hydrologic modeling; South Dakota State University for agricultural water management research; and the Fallon Paiute-Shoshone Tribe of Nevada for management of entitled water rights, irrigation delivery, and agriculture production.

**Areas of Interest**

Figure 28 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #10 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

Note that it is likely that there are additional agricultural lands in the heartland of the U.S. where agriculture and precision farming would be a concern.

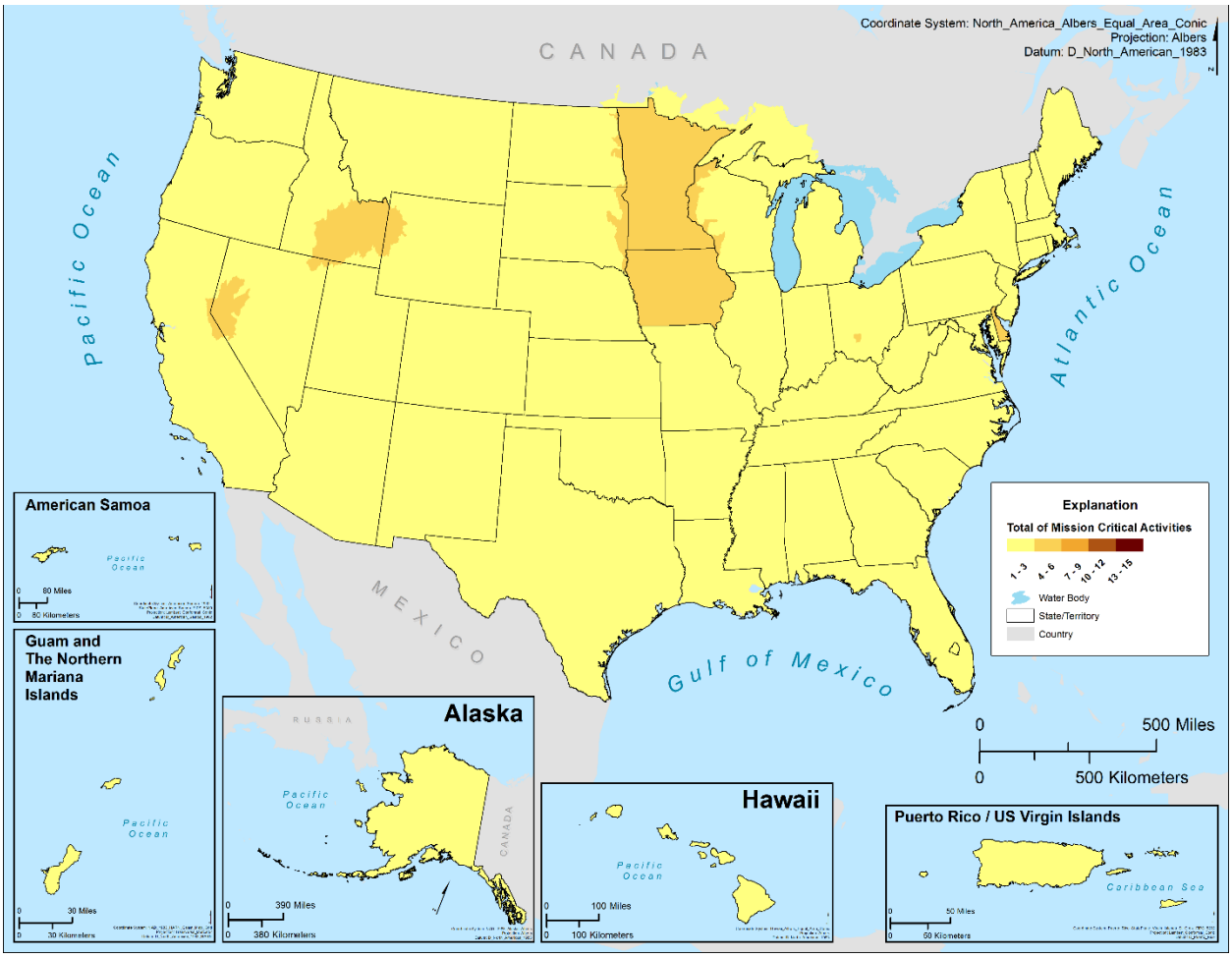



*Figure 28. Spatial extents of the areas of interest represented by the MCAs that were categorized as having BU #10 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

### Requirements

Table 38 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #10 as their primary BU, and the most frequently requested requirements by category.

*Table 28. Requirements for enhanced hydrography data reported for BU #10*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | 2-3 Years / 6-10 Years | 33% each |
| **Positional Accuracy** | 3 feet, 90% (1:1,200-scale) | 44% |
| **Stream Density** | 5.0 miles of channel per mile (1:5,000-scale mapping) | 33% |
| **Smallest Contributing Watershed** | 60 acres | 44% |
| **Smallest Mapped Waterbody** | Less than an acre / 1 acre / 5 acres | 22% each |
| **Post-Event Update** | Nice To Have | 56% |
| **Level of Detail** | Best Available / Consistent | 44% each |

The requirements for characteristics and analytical functions for BU #10 are shown in Table 39.

*Table 39. Requirements for characteristics and analytical functions for BU #10*

| Required Characteristics/Analytical Functions | Number of MCAs (of 9) | Percent of MCAs |
|---|---|---|
| Calculate drainage area | 6 | 67% |
| Flow periodicity | 6 | 67% |
| Find upstream or downstream feature within watershed | 5 | 56% |
| Linkages to stream gage observations | 5 | 56% |
| Wetlands | 5 | 56% |
| Calculate stream distance to points | 4 | 44% |
| Floodplain boundary | 4 | 44% |
| User defined symbolization | 4 | 44% |
| Bridges, culverts | 3 | 33% |
| Calculate distance on network | 3 | 33% |
| Calculate time of travel to points | 3 | 33% |
| Determine downstream flood area | 3 | 33% |
| Diversion points | 3 | 33% |
| Linkages to cross section geometry | 3 | 33% |
| Navigate up or downstream on network | 3 | 33% |
| Other (please specify) | 3 | 33% |
| Velocity or time of travel | 3 | 33% |
| Accumulate upstream or downstream features | 2 | 22% |
| Coastlines | 2 | 22% |
| Delineate catchment | 2 | 22% |
| Deltas | 2 | 22% |
| Diversion lines | 2 | 22% |
| Find events or features on network | 2 | 22% |
| Flood stage | 2 | 22% |
| Leakage along lines | 2 | 22% |
| Left/right bank delineation | 2 | 22% |
| Animation of time-series | 1 | 11% |
| Badlands | 1 | 11% |
| Coastal bathymetry | 1 | 11% |
| Estuaries | 1 | 11% |
| Find upstream or downstream points | 1 | 11% |
| Mash-ups | 1 | 11% |
| Preset symbolization | 1 | 11% |
| Riverine bathymetry | 1 | 11% |
| Leakage at points | 0 | 0% |

**Future Annual Benefits**

An estimated $2,148,200 in future annual benefits from enhanced hydrography data was reported for the MCAs categorized as having BU #10 as their primary BU.

Figure 29 shows the estimated future annual benefits provided by the MCAs categorized as having BU #10 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

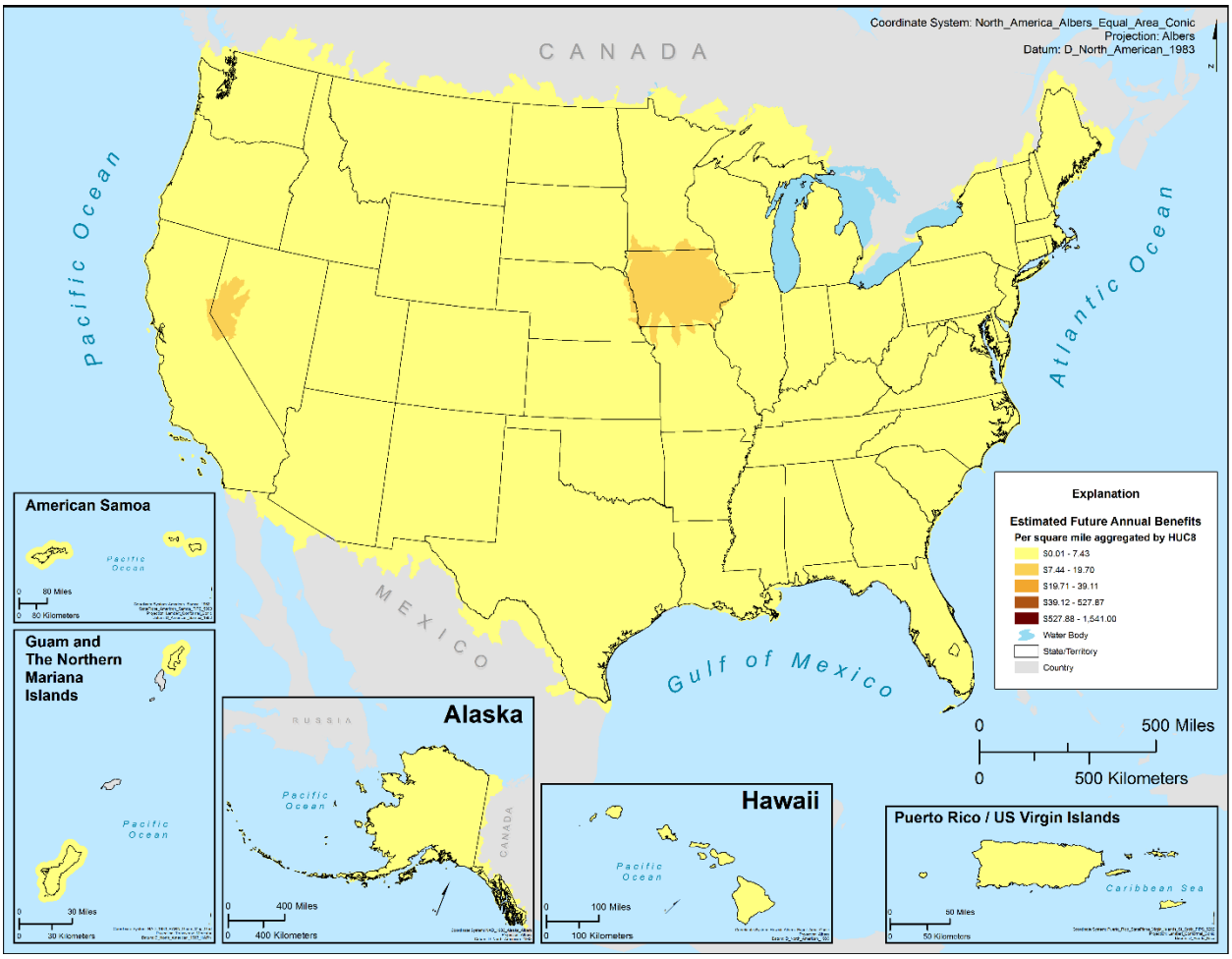



*Figure 5. Estimated future annual benefits reported for the MCAs that were categorized as having BU #10 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 40 lists the qualitative benefits reported for BU #10.

*Table 290. Qualitative benefits reported for BU #10*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 3 | 2 | 3 | 2 | 2 | 2 | 6 | 0 |
| **Moderate** | 4 | 6 | 4 | 5 | 4 | 3 | 1 | 2 |
| **Minor** | 1 | 0 | 0 | 0 | 2 | 2 | 1 | 1 |
| **N/A** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| **Don't Know** | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **No Answer Provided** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Total** | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |

These benefits would be realized due to improved hydrographic data features, consistency, currency, and accuracy/resolution. Improvements to intermittent streams would result in greater understanding of patterns and likely futures of invasive species, pests, and pathogens of plants and animals; more accurate modeling of farm runoff; better analysis and monitoring of pesticide application practices; and in general improved outcomes. It would provide information to improve planning and development of program objectives. The direct benefit to the Fallon Paiute-Shoshone Tribe of Nevada would be to know that revenue-generating functions would be affected by having access to improved hydrographic information.

**Example Agriculture and Precision Farming Activities**

According to NRCS, seventy percent of the agricultural land in the U.S. is privately owned, making stewardship by private landowners absolutely critical to the health of our nation's environment. Conservation efforts by landowners benefit the soil, water, air, plants, and animals leading to more productive lands and healthy ecosystems. Hydrography data are used for agricultural land stewardship activities in concert with numerous other datasets to include lidar data, high resolution imagery, farm field boundaries, land use, and soils inventories.

The Iowa Soybean Association (ISA) was formed in 1964 by a group of Iowa soybean farmers to expand profit opportunities while promoting environmentally sensitive production methods. The ISA designed, installed, and has been operating an extensive water monitoring network for the past decade. This network now includes 105 sites in the Des Moines and Raccoon River Watersheds. An additional 23 monitoring sites are monitored for various watershed and demonstration projects, with more added from time to time.

Samples are collected from these sites by local teams of trained Certified Samplers or by automated samplers with flow meters, triggered by rain events. Collection takes place on most of the sites bi-weekly, April through August, every year. The collected data are analyzed and monitored for Nitrate-N, E. coli, and other pollutants. The process is covered by a DNR/EPA approved Quality Assurance Project Plan. The data gathered at these sites helps inform Watershed Management Plans which address participant concerns for water quality, soil erosion, wildlife habitat, air quality, and social concerns in the watersheds.

http://www.iasoybeans.com/environment/services/water-monitoring-network

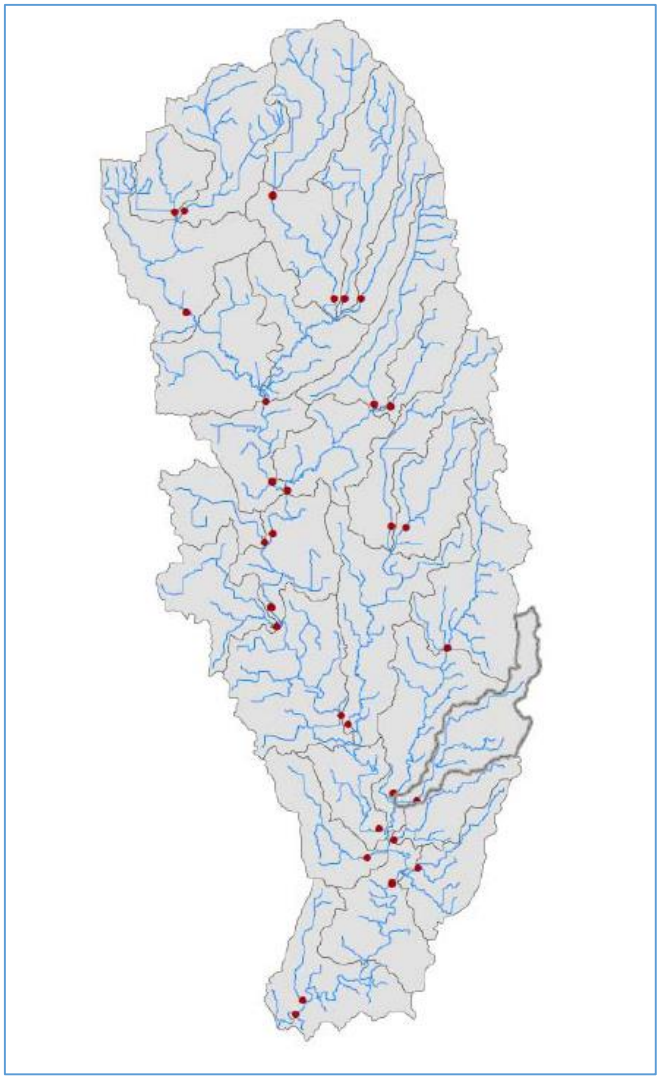


*Figure 30. ISA bi-weekly monitoring sites in the Buck Creek watershed (Hydrologic Unit Code 07000050602) in Iowa. Image courtesy of ISA.*

ISA estimated $1 million in future annual benefits from improved watershed protection and water quality improvement activities resulting from use of enhanced hydrography information. Additionally, the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for water resource planning activities was provided by ISA.

*Table41. ISA qualitative benefits from use of enhanced hydrography information for water resource planning activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Moderate | Moderate | Moderate | Moderate | Minor | Don't Know | Major | Not Applicable |

## BU #11 Geologic Resource Assessment and Hazard Mitigation

BU #11, Geologic Resource Assessment and Hazard Mitigation, was described in the questionnaire as including the following types of MCAs: detailed hydrologic modeling to understand and mitigate landslides.

**BU #11 Highlights:**

**Number of MCAs:** 3
**Estimated annual program budget:** $350,000
**Estimated current annual benefits:** $35,000
**Estimated future annual benefits:** $50,000

Three MCAs were characterized as having BU #11 as their primary BU, with a total annual program budget of $350,000 for programs supported by hydrography data, a total of $35,000 in estimated annual benefits from the currently available hydrography data, and $50,000 in estimated future annual benefits from enhanced hydrography data.

These three MCAs were reported by the Arkansas Geological Survey for landslide hazard susceptibility modeling, flood inundation modeling, and cartography; the Nevada Bureau of Mines and Geology for geologic mapping and geologic hazard assessment and characterization; and the South Carolina Department of Natural Resources for geological mapping.

**Areas of Interest**

Figure 31 shows the spatial extents of the areas of interest represented by the MCAs that were categorized as having BU #11 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

More states than shown on this map likely have geologic resource assessment and hazard mitigation as one of their missions; however, because of the varied representation of the state and local agencies, and because the BUs were self-selected, it is likely that additional areas across the U.S. would have an interest in geologic resource assessment.

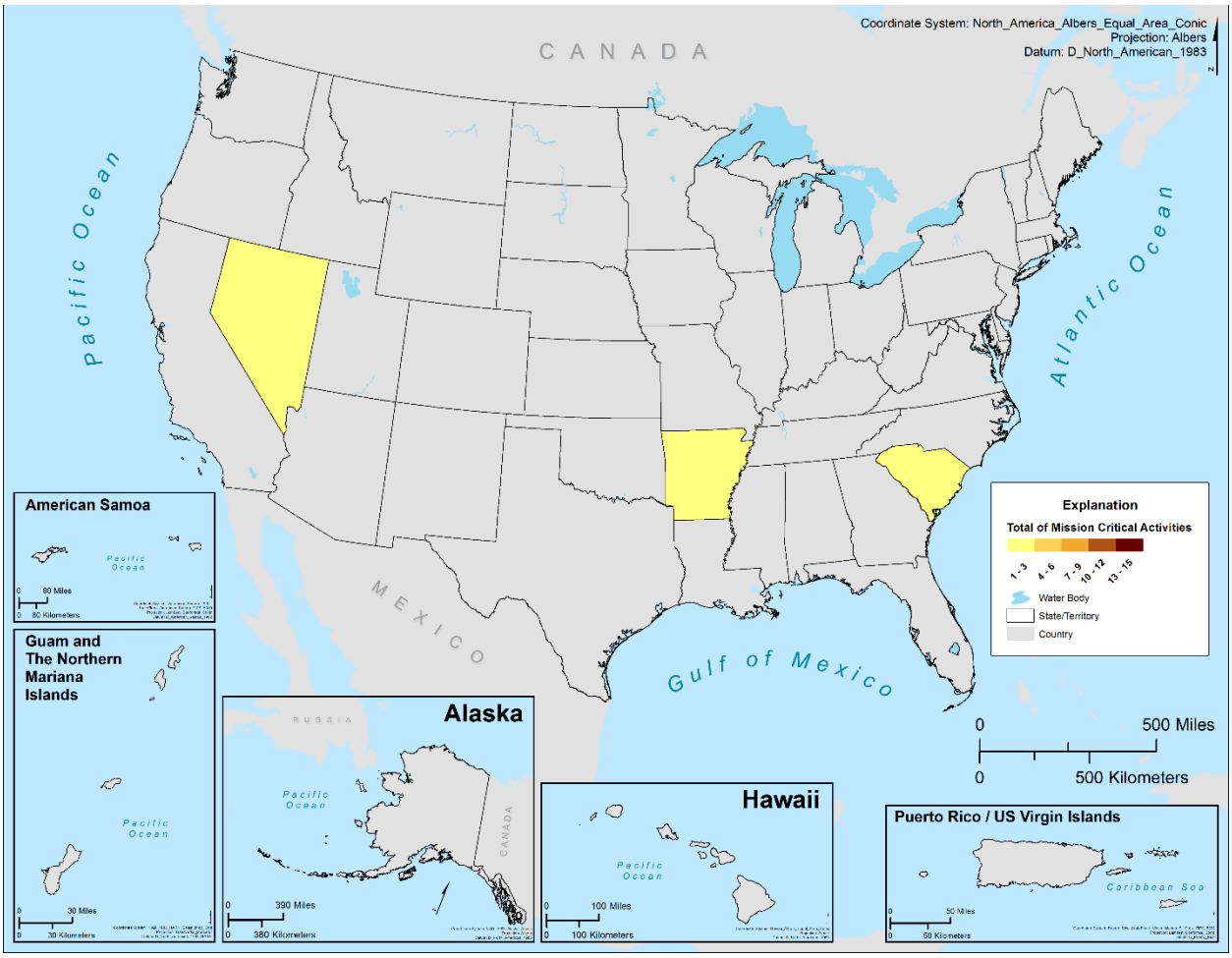



*Figure 31. Spatial extents of the areas of interest represented by the MCAs that were categorized as having BU #11 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

### Requirements

Table 42 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #11 as their primary BU, and the most frequently requested requirements by category.

*Table 30. Requirements for enhanced hydrography data reported for BU #11*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | 4-5 Years | 100% |
| **Positional Accuracy** | +/- 40 feet, 90% (1:24,000-scale) | 67% |
| **Stream Density** | 2.5 miles of channel per sq. mi. | 67% |
| **Smallest Contributing Watershed** | 1 square mile (640 acres) | 67% |
| **Smallest Mapped Waterbody** | 5 acres | 67% |
| **Post-Event Update** | Highly Desirable / Nice to Have / Not Required | 33% each |
| **Level of Detail** | Best Available | 67% |

The requirements for characteristics and analytical functions for BU #11 are shown in Table 43.

*Table 31. Requirements for characteristics and analytical functions for BU #11*

| Required Characteristics/Analytical Functions | Number of MCAs (of 3) | Percent of MCAs |
|---|---|---|
| Delineate catchment | 2 | 67% |
| Determine downstream flood area | 2 | 67% |
| Flood stage | 2 | 67% |
| Floodplain boundary | 2 | 67% |
| Flow periodicity | 2 | 67% |
| Left/right bank delineation | 2 | 67% |
| Linkages to cross section geometry | 2 | 67% |
| Preset symbolization | 2 | 67% |
| User defined symbolization | 2 | 67% |
| Velocity or time of travel | 2 | 67% |
| Accumulate upstream or downstream features | 1 | 33% |
| Animation of time-series | 1 | 33% |
| Calculate distance on network | 1 | 33% |
| Calculate drainage area | 1 | 33% |
| Calculate stream distance to points | 1 | 33% |
| Calculate time of travel to points | 1 | 33% |
| Coastlines | 1 | 33% |
| Diversion lines | 1 | 33% |
| Find events or features on network | 1 | 33% |
| Find upstream or downstream feature within watershed | 1 | 33% |
| Find upstream or downstream points | 1 | 33% |
| Leakage at points | 1 | 33% |
| Linkages to stream gage observations | 1 | 33% |
| Mash-ups | 1 | 33% |
| Navigate up or downstream on network | 1 | 33% |
| Riverine bathymetry | 1 | 33% |
| Badlands | 0 | 0% |
| Bridges, culverts | 0 | 0% |
| Coastal bathymetry | 0 | 0% |
| Deltas | 0 | 0% |
| Diversion points | 0 | 0% |
| Estuaries | 0 | 0% |
| Leakage along lines | 0 | 0% |
| Other (please specify) | 0 | 0% |
| Wetlands | 0 | 0% |

**Future Annual Benefits**

An estimated $50,000 in future benefits from enhanced hydrography data was reported for the MCAs categorized as having BU #11 as their primary BU.

Figure 32 shows the estimated future annual benefits provided by the MCAs categorized as having BU #11 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

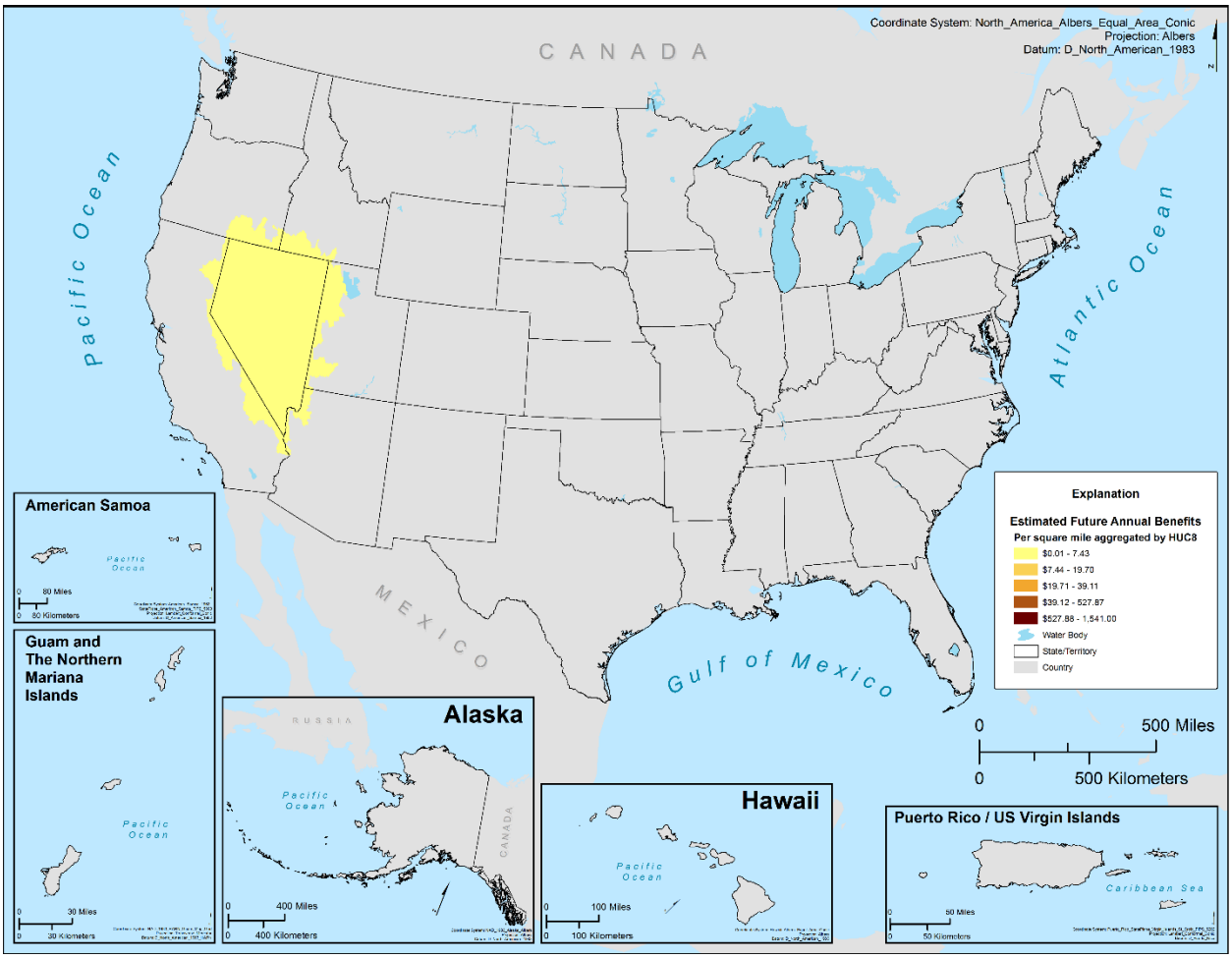



*Figure 32. Estimated future annual benefits reported for the MCAs categorized as having BU #11 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 44 lists the qualitative benefits reported for BU #11.

*Table 32. Qualitative benefits reported for BU #11*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| **Moderate** | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Minor** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| **N/A** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Don't Know** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **No Answer Provided** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Total** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

These benefits would be realized due to increased accuracy of landscape models. Time savings would be realized from less time spent performing data collection and analyses of stream and catchment data during responses to flood events, characterization of flood hazards, and paleo flood studies. Integration of StreamStats would greatly enhance the evaluation of flood risk in un-gaged catchments. Enhanced hydrography data could also be applied to geologic mapping activities, including the characterization of a region's geomorphic setting and surficial geologic deposits.

**Example Geologic Resource Assessment and Hazard Mitigation Activities**

Hydrography data are used for karst research and mapping. Mapping relationships between surface water and groundwater can help identify where surface contamination may impact cave systems and water wells. Hydrography data also can help identify spring, sinkhole, and cave pattern development as well as depression marsh density.

The Kentucky Division of Water has begun integration of the Kentucky Karst Atlas into the NHD. The goal is to improve hydrologic modeling, research and experimentation, and environmental response by developing a more complete hydrography dataset that shows karst influence on regional hydrography, and locates karst deviation from watershed divides. Field work conducted to develop the karst atlas data included tracer tests to identify underground flow patterns. Addition of karst features to NHD results in a more complete understanding of hydrologic connections and a more complete hydrography dataset.

http://water.ky.gov/GIS/Pages/NHDKarstAtlas.aspx


*Figure 33. Kentucky Karst Atlas in NHD. Image courtesy of Kentucky Division of Water.*

The benefits of the use of enhanced hydrography data for geologic resource assessment and hazard mitigation activities such as karst mapping include improved understanding of the relationships between surface water and groundwater and watershed protection and management. Additional benefits include the societal benefits of maintaining well-water quality and in water wells and the potential for reduced risk to human life from landslides and sinkholes.

## BU #12 Resource Mining

**BU #12 Highlights:**

**Number of MCAs:** 2
**Estimated annual program budget:** $500,100,000
**Estimated current annual benefits:** $1,025,000
**Estimated future annual benefits:** $1,100,000

BU #12, Resource Mining, was described in the questionnaire as including the following types of MCAs: regulation and permitting of coal mining activities, reclamation of coal mining areas, and monitoring of post-mining conditions.

Two MCAs were characterized as having BU #12 as their primary BU, with a total annual program budget of $500,100,000 for programs supported by hydrography data, a total of $1,025,000 in estimated annual benefits from the currently available hydrography data, and $1,100,000 in estimated future annual benefits from enhanced hydrography data.

These two MCAs were reported by the Office of Surface Mining Reclamation and Enforcement (OSMRE) for regulation and reclamation of surface coal mining areas and activities; and the Eastern PA Coalition for Abandoned Mine Reclamation (EPCAMR) for mapping and modeling abandoned mine pools.

### Areas of Interest

Figure 34 shows the spatial extents of the areas of interest represented by the MCAs that were categorized as having BU #12 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

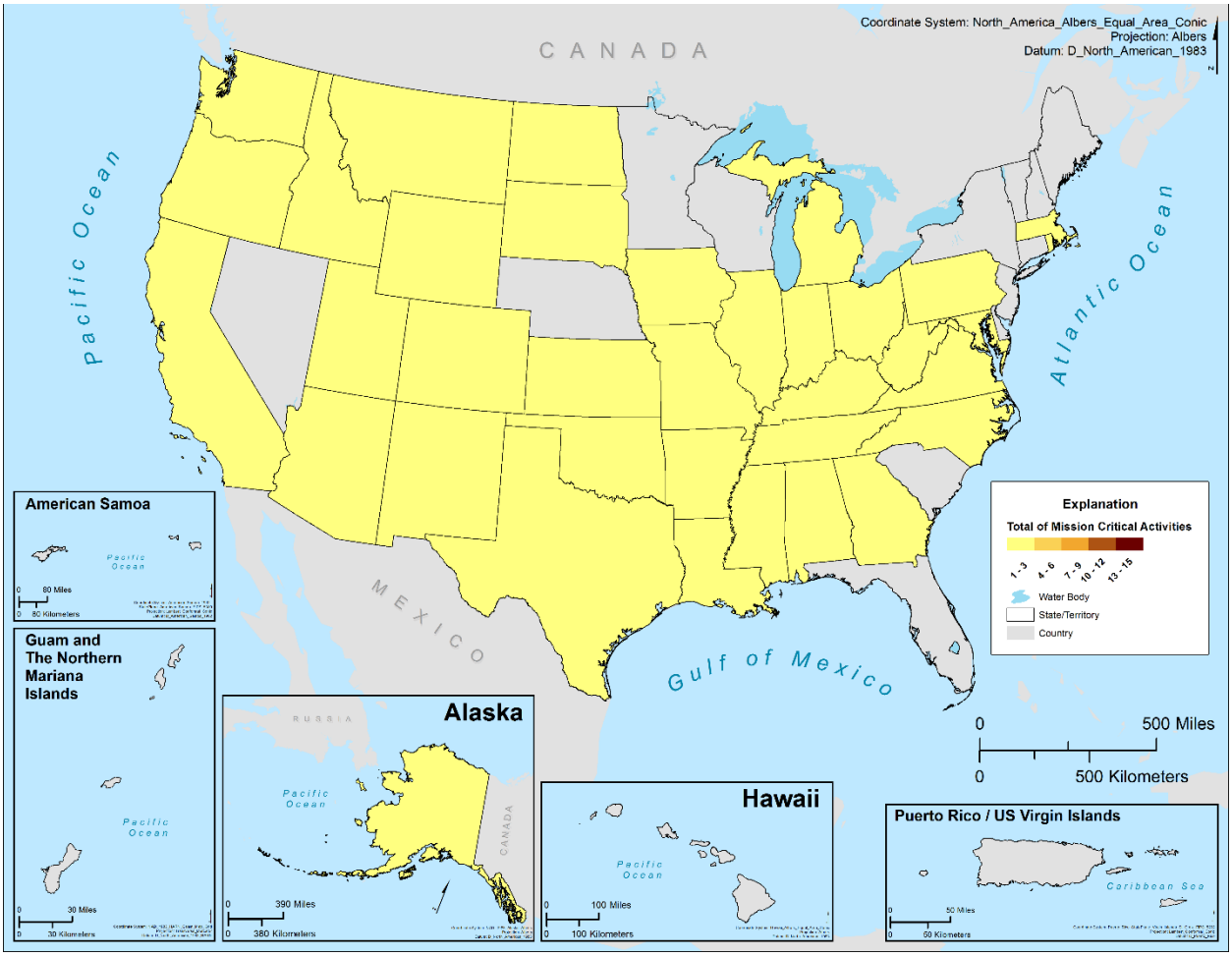



*Figure 34. Spatial extents of the areas of interest represented by the MCAs that were categorized as having BU #12 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

### Requirements

Table 45 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #12 as their primary BU, and the most frequently requested requirements by category.

*Table 335. Requirements for enhanced hydrography data reported for BU #12*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | Annually / 2-3 Years | 50% each |
| **Positional Accuracy** | +/- 3 feet, 90% (1:1,200-scale) | 100% |
| **Stream Density** | 5.0 miles of channel per sq. mi. | 100% |
| **Smallest Contributing Watershed** | 6 acres / 60 acres | 50% each |
| **Smallest Mapped Waterbody** | Less than an acre / 1 acre | 50% each |
| **Post-Event Update** | Nice to Have / Not Required | 50% each |
| **Level of Detail** | Best Available | 100% |

The requirements for characteristics and analytical functions for BU #12 are shown in Table 46.

*Table 346. Requirements for characteristics and analytical functions for BU #12*

| Required Characteristics/Analytical Functions | Number of MCAs (of 2) | Percent of MCAs |
|---|---|---|
| Bridges, culverts | 2 | 100% |
| Calculate distance on network | 2 | 100% |
| Calculate drainage area | 2 | 100% |
| Calculate stream distance to points | 2 | 100% |
| Delineate catchment | 2 | 100% |
| Diversion lines | 2 | 100% |
| Diversion points | 2 | 100% |
| Find events or features on network | 2 | 100% |
| Find upstream or downstream feature within watershed | 2 | 100% |
| Find upstream or downstream points | 2 | 100% |
| Flow periodicity | 2 | 100% |
| Leakage along lines | 2 | 100% |
| Leakage at points | 2 | 100% |
| Linkages to cross section geometry | 2 | 100% |
| Linkages to stream gage observations | 2 | 100% |
| Preset symbolization | 2 | 100% |
| User defined symbolization | 2 | 100% |
| Velocity or time of travel | 2 | 100% |
| Wetlands | 2 | 100% |
| Accumulate upstream or downstream features | 1 | 50% |
| Animation of time-series | 1 | 50% |
| Calculate time of travel to points | 1 | 50% |
| Determine downstream flood area | 1 | 50% |
| Flood stage | 1 | 50% |
| Floodplain boundary | 1 | 50% |
| Left/right bank delineation | 1 | 50% |
| Mash-ups | 1 | 50% |
| Navigate up or downstream on network | 1 | 50% |
| Other (please specify) | 1 | 50% |
| Riverine bathymetry | 1 | 50% |
| Badlands | 0 | 0% |
| Coastal bathymetry | 0 | 0% |
| Coastlines | 0 | 0% |
| Deltas | 0 | 0% |
| Estuaries | 0 | 0% |

**Future Annual Benefits**

An estimated $1,100,000 in future annual benefits from enhanced hydrography data was reported for the MCAs that were categorized as having BU #12 as their primary BU.

Figure 35 shows the estimated future annual benefits provided by the MCAs categorized as having BU #12 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

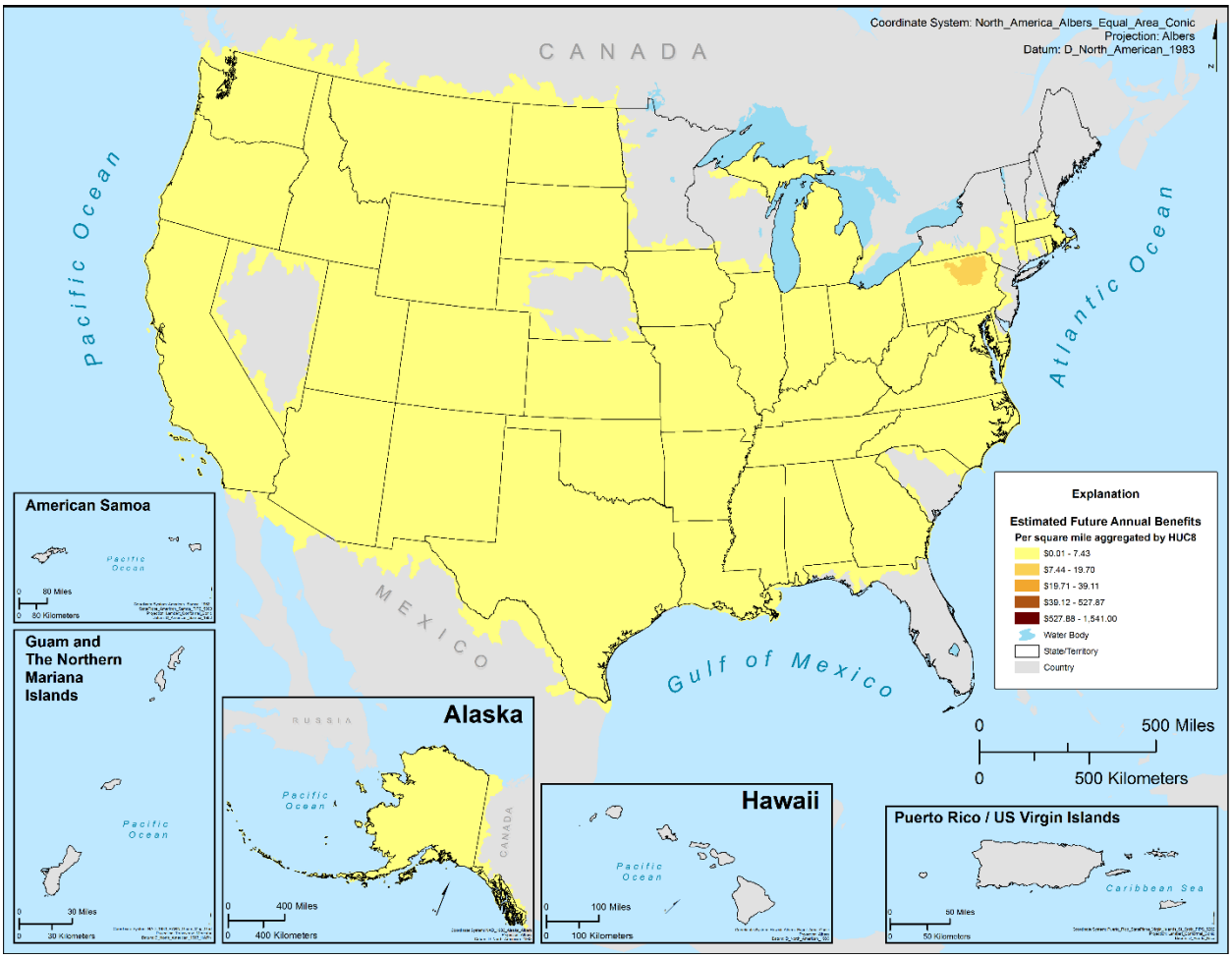



*Figure 35. Estimated future annual benefits reported for the MCAs categorized as having BU #12 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 47 lists the qualitative benefits reported for BU #12.

*Table 357. Qualitative benefits reported for BU #12*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 0 |
| **Moderate** | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| **Minor** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **N/A** | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| **Don't Know** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **No Answer Provided** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

These benefits would be realized due to continuity of normal operations and possible addition of intermittent streams due to proposed rule-making. Additionally, integrated hydrography and elevation data would allow determinations of input (surface water loss) and output (discharge) baselines for mine pools, which in turn would allow identification of the most vulnerable areas for water contamination and subsidence potential.

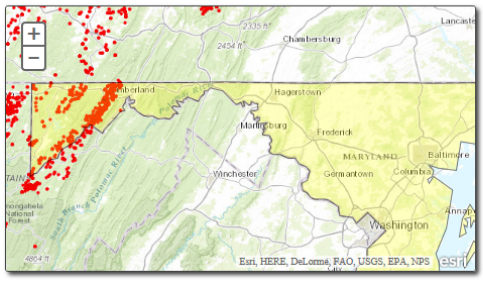
**Example Resource Mining Activities**

Resource mining includes activities that ensure that surface mines are operated in a manner that protects citizens and the environment during mining, and assures that the land is restored to beneficial use following mining. The Office of Surface Mining Reclamation and Enforcement (OSMRE) is responsible for establishing a nationwide program to protect society and the environment from the adverse effects of surface coal mining operations. OSMRE oversees reclamation of land and waters damaged by coal mining prior to 1977 and regulates coal mines to ensure that coal mining operations are conducted in an environmentally responsible manner and that the land is adequately reclaimed during and following the mining process.

OSMRE and the coal mining states it oversees use hydrography data during permit review, as a part of monitoring during mining operations, and during reclamation. As a part of the permit review process, hydrography data are used as a baseline prior to mining to determine what needs to be protected outside the permit area and what condition the permit area needs to be returned to once mining operations are completed. During mining operations, monthly inspections are performed and changes resulting from mining activities are assessed to ensure that the mining plan is being followed. Once mining operations are finished, reclamation of the permit area is monitored for five or more years. Reclamation efforts typically may include re-vegetation, among other activities, to return the land to its pre-mine conditions. Additionally, surface waters in and near abandoned mine lands are monitored for the effects of acid mine drainage.

https://amlis.osmre.gov/Summaries.aspx

**High Priority (Priority 1, 2 & Adjacent Priority 3) Cost Summary**




Select State/Tribe: Maryland

| | Completed | | Funded | | Unfunded | | Total | |
|---|---|---|---|---|---|---|---|---|
| **Problem Type** | **Units** | **Costs** | **Units** | **Costs** | **Units** | **Costs** | **Units** | **Costs** |
| Clogged Stream Lands | 73.6 | $1,777,718 | 5.5 | $119,665 | 42.3 | $1,344,501 | 121.4 | $3,241,884 |
| Clogged Streams | 264.9 | $3,812,786 | 1.2 | $585,000 | 2.8 | $2,322,948 | 268.8 | $6,720,734 |
| Dangerous Highwalls | 74130.0 | $7,363,100 | 5050.0 | $815,000 | 20450.0 | $5,776,853 | 99630.0 | $13,954,953 |
| Dangerous Impoundments | 6.0 | $672,124 | 0.0 | $0 | 6.0 | $164,773 | 12.0 | $836,897 |
| Dangerous Piles & Embankments | 297.1 | $5,887,177 | 6.0 | $85,501 | 95.4 | $2,359,388 | 398.5 | $8,332,066 |
| Dangerous Slides | 123.6 | $6,616,245 | 10.8 | $725,379 | 40.8 | $3,384,100 | 175.2 | $10,725,724 |
| Gases: Hazardous/Explosive | 1.0 | $12,473 | 0.0 | $0 | 0.0 | $0 | 1.0 | $12,473 |
| Gobs | 2.0 | $11,000 | 0.0 | $0 | 0.0 | $0 | 2.0 | $11,000 |
| Hazardous Equip & Facilities | 41.5 | $286,589 | 4.0 | $53,000 | 29.0 | $229,840 | 74.5 | $569,429 |
| Hazardous Water Bodies | 27.0 | $642,913 | 0.0 | $0 | 11.5 | $1,072,539 | 38.5 | $1,715,452 |
| Industrial/Residential Waste | 39.0 | $406,299 | 2.0 | $12,500 | 8.1 | $90,000 | 49.1 | $508,799 |
| Polluted Water: Agricultural & Industrial | 140.0 | $1,480,193 | 1.0 | $68,000 | 2060.0 | $6,278,930 | 2201.0 | $7,827,123 |
| Polluted Water: Human Consumption | 126.0 | $4,630,391 | 0.0 | $0 | 5.0 | $79,756 | 131.0 | $4,710,147 |
| Portals | 83.0 | $789,979 | 2.0 | $0 | 38.0 | $319,824 | 123.0 | $1,109,803 |
| Subsidence | 21.5 | $4,038,230 | 0.0 | $0 | 20.7 | $4,467,021 | 42.2 | $8,505,251 |
| Surface Burning | 1.3 | $191,661 | 0.0 | $0 | 0.0 | $0 | 1.3 | $191,661 |
| Underground Mine Fires | 1.8 | $342,984 | 0.0 | $0 | 13.5 | $3,993,606 | 15.3 | $4,336,590 |
| Vertical Openings | 14.0 | $76,551 | 1.0 | $16,500 | 12.0 | $108,750 | 27.0 | $201,801 |
| Water Problems | 577.0 | $551,300 | 0.0 | $0 | 100.0 | $729,042 | 677.0 | $1,280,342 |
| TOTALS: | $39,589,712.51 | | $2,480,545.00 | | $32,721,870.50 | | $74,792,128.01 | |

*Figure 36. OSMRE online listing of coal mines in Maryland with reclamation activities, to include numerous water resource problems. Image courtesy of OSMRE.*

OSMRE estimated $1 million in future annual benefits from use of enhanced hydrography data to manage and monitor surface coal mining activities. These benefits would realized due to continued time savings during permit reviews and less need for field work. Future rule-making that would require monitoring and remediation of intermittent streams will require enhanced hydrography data as well. Additionally, the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for managing and monitoring surface coal mining activities was provided by OSMRE.

*Table 36. OSMRE qualitative benefits from use of enhanced hydrography information for managing and monitoring surface coal mining activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Major | Major | Major | Major | Major | Major | Major | Moderate |

## BU #13 Renewable Energy Resources

BU #13, Renewable Energy Resources, was described in the questionnaire as including the following types of MCAs: hydropower, offshore wind power, and tidal power.

**BU #13 Highlights:**

**Number of MCAs:** 3
**Estimated annual program budget:** $1,547,850,000
**Estimated current annual benefits:** $2,802,500
**Estimated future annual benefits:** $580,250

Three MCAs were characterized as having BU #13 as their primary BU, with a total annual program budget of $1,547,850,000 for programs supported by hydrography data, a total of $2,802,500 in estimated annual benefits from the currently available hydrography data, and $580,250 in estimated future annual benefits from enhanced hydrography data. Additionally, one MCA noted BU #13 as an ancillary BU.

These three MCAs were reported by Bureau of Reclamation for water delivery to customers and power generation from hydropower facilities; the Federal Energy Regulatory Commission (FERC) for hydropower license and compliance reviews; and the Western Area Power Administration (WAPA) for marketing, scheduling, and transmitting hydro power.

**Areas of Interest**

Figure 37 shows the spatial extents of the areas of interest represented by the MCAs that were categorized as having BU #13 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

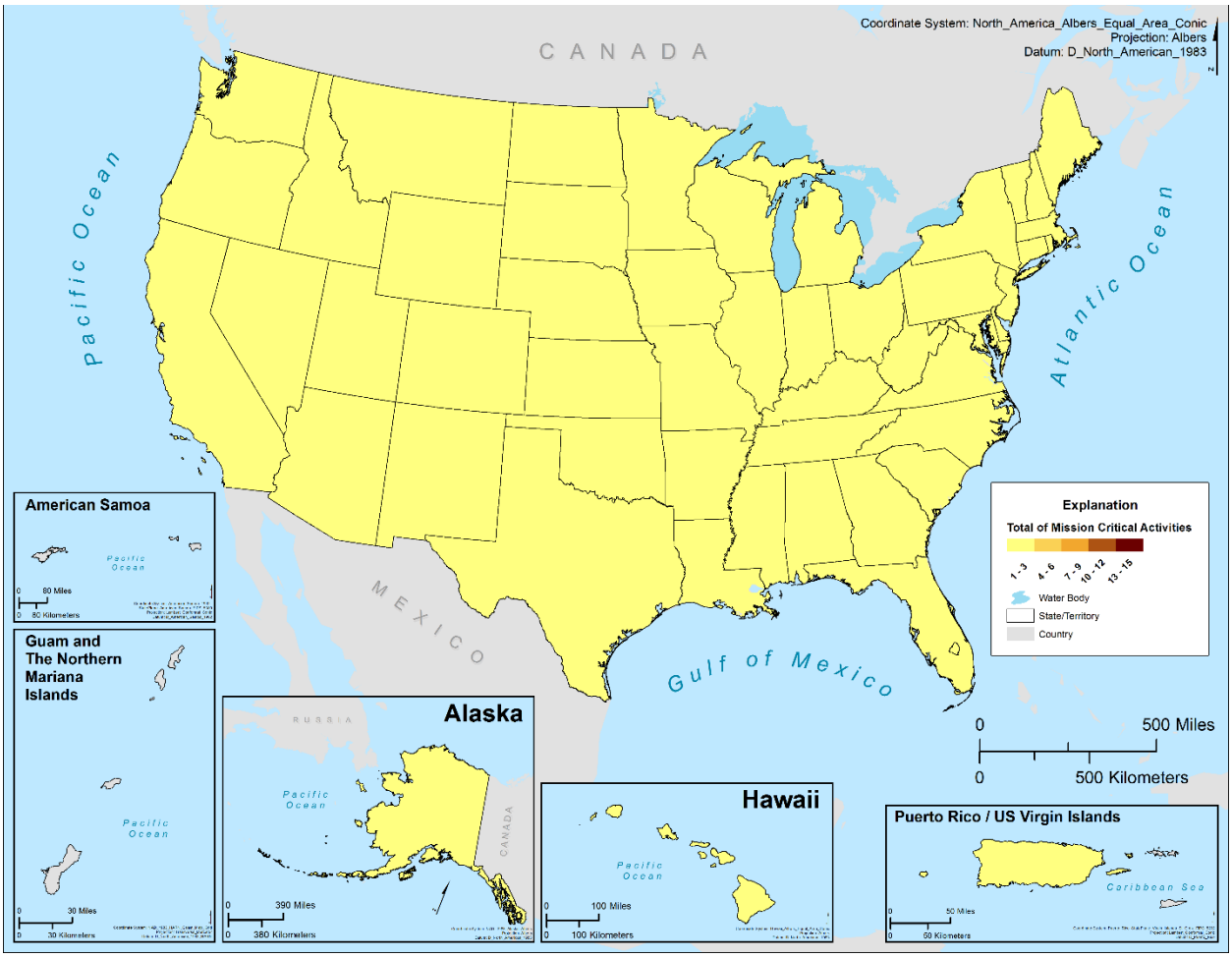



*Figure 37. Spatial extents of the areas of interest represented by the MCAs that were categorized as having BU #13 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

## Requirements

Table 49 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #13 as their primary BU, and the most frequently requested requirements by category.

*Table 49. Requirements for enhanced hydrography data reported for BU #13*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | Annually | 67% |
| **Positional Accuracy** | +/- 33 feet, 90% (1:12,000-scale) / +/- 40 feet, 90% (1:24,000-scale) / +/- 420 feet, 90% (1:250,000-scale) | 33% each |
| **Stream Density** | 2.5 miles of channel per sq. mi. | 67% |
| **Smallest Contributing Watershed** | 1 square mile (640 acres) / 10 square miles (6,400 acres)/ I don't know | 33% each |
| **Smallest Mapped Waterbody** | No response provided | |
| **Post-Event Update** | Nice to Have | 100% |
| **Level of Detail** | Best Available | 100% |

The requirements for characteristics and analytical functions for BU #13 are shown in Table 50.

*Table 370. Requirements for characteristics and analytical functions for BU #13*

| Required Characteristics/Analytical Functions | Number of MCAs (of 3) | Percent of MCAs |
|---|---|---|
| Calculate distance on network | 3 | 100% |
| Diversion lines | 3 | 100% |
| Find events or features on network | 3 | 100% |
| Accumulate upstream or downstream features | 2 | 67% |
| Bridges, culverts | 2 | 67% |
| Calculate drainage area | 2 | 67% |
| Calculate stream distance to points | 2 | 67% |
| Calculate time of travel to points | 2 | 67% |
| Delineate catchment | 2 | 67% |
| Determine downstream flood area | 2 | 67% |
| Diversion points | 2 | 67% |
| Find upstream or downstream feature within watershed | 2 | 67% |
| Find upstream or downstream points | 2 | 67% |
| Floodplain boundary | 2 | 67% |
| Left/right bank delineation | 2 | 67% |
| Linkages to cross section geometry | 2 | 67% |
| Linkages to stream gage observations | 2 | 67% |
| Navigate up or downstream on network | 2 | 67% |
| Preset symbolization | 2 | 67% |
| Riverine bathymetry | 2 | 67% |
| Velocity or time of travel | 2 | 67% |
| Wetlands | 2 | 67% |
| Coastlines | 1 | 33% |
| Deltas | 1 | 33% |
| Estuaries | 1 | 33% |
| Flood stage | 1 | 33% |
| Flow periodicity | 1 | 33% |
| Leakage along lines | 1 | 33% |
| Leakage at points | 1 | 33% |
| Mash-ups | 1 | 33% |
| User defined symbolization | 1 | 33% |
| Animation of time-series | 0 | 0% |
| Badlands | 0 | 0% |
| Coastal bathymetry | 0 | 0% |
| Other (please specify) | 0 | 0% |

**Future Annual Benefits**

An estimated $580,250 in future annual benefits from enhanced hydrography data was reported for the MCAs categorized as having BU #13 as their primary BU.

Figure 38 shows the estimated future annual benefits provided by the MCAs categorized as having BU #13 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

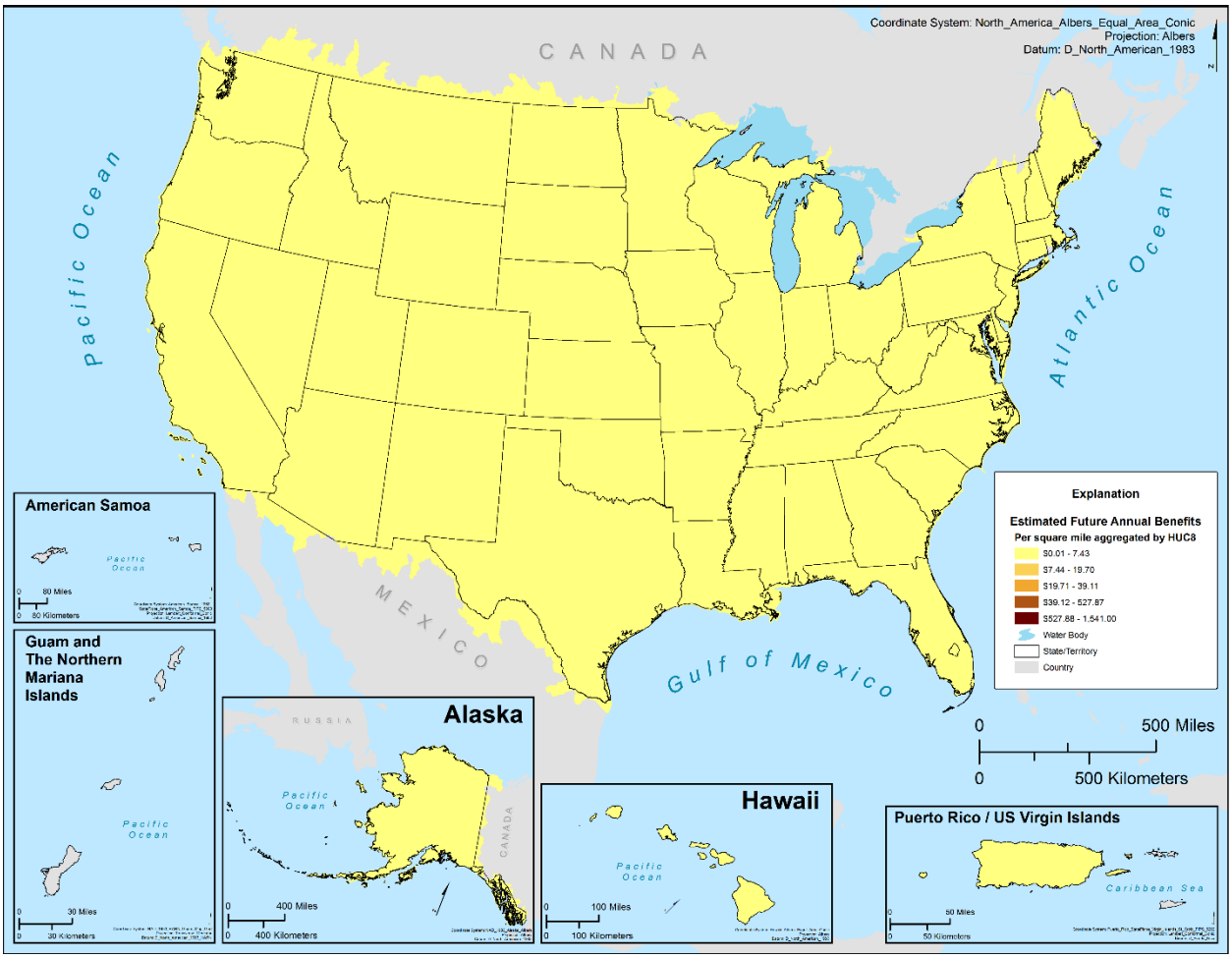



*Figure 38. Estimated future annual benefits reported for the MCAs categorized as having BU #13 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 51 lists the qualitative benefits reported for BU #13.

*Table 38. Qualitative benefits reported for BU #13*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Moderate** | 2 | 2 | 1 | 1 | 1 | 0 | 1 | 0 |
| **Minor** | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 0 |
| **N/A** | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| **Don't Know** | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| **No Answer Provided** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

These benefits would be realized if improved data were provided more quickly to improve decision-making for water releases in real-time events. Time savings would be realized from less time needed to locate external data. Future environmental benefits would be realized from the ability to consider climate change in the flood frequency analyses for the 50-year life of a project's license. Other future benefits would include improved customer coordination with hydropower scheduling, as well as improved mapping.

**Example Renewable Energy Resources Activities**

Surface water is used in a non-consumptive application for hydroelectric power generation in many states. The Federal Energy Regulatory Commission (FERC) licenses all private, municipal, and state hydropower projects. FERC's review of new and renewal licenses and exemptions for hydropower projects consider the extent to which a project is consistent with Federal or state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the project. FERC reviews H&H studies performed by dam owners and ensures that minimum flow requirements and water surface elevations are maintained and that environmental protection measures are enforced. Additionally, FERC determines headwater benefits realized by downstream hydropower projects from any regulation of river flows by upstream storage reservoirs and assesses charges to the downstream beneficiaries.

http://www.ferc.gov/industries/hydropower/enviro/eis/2015.asp

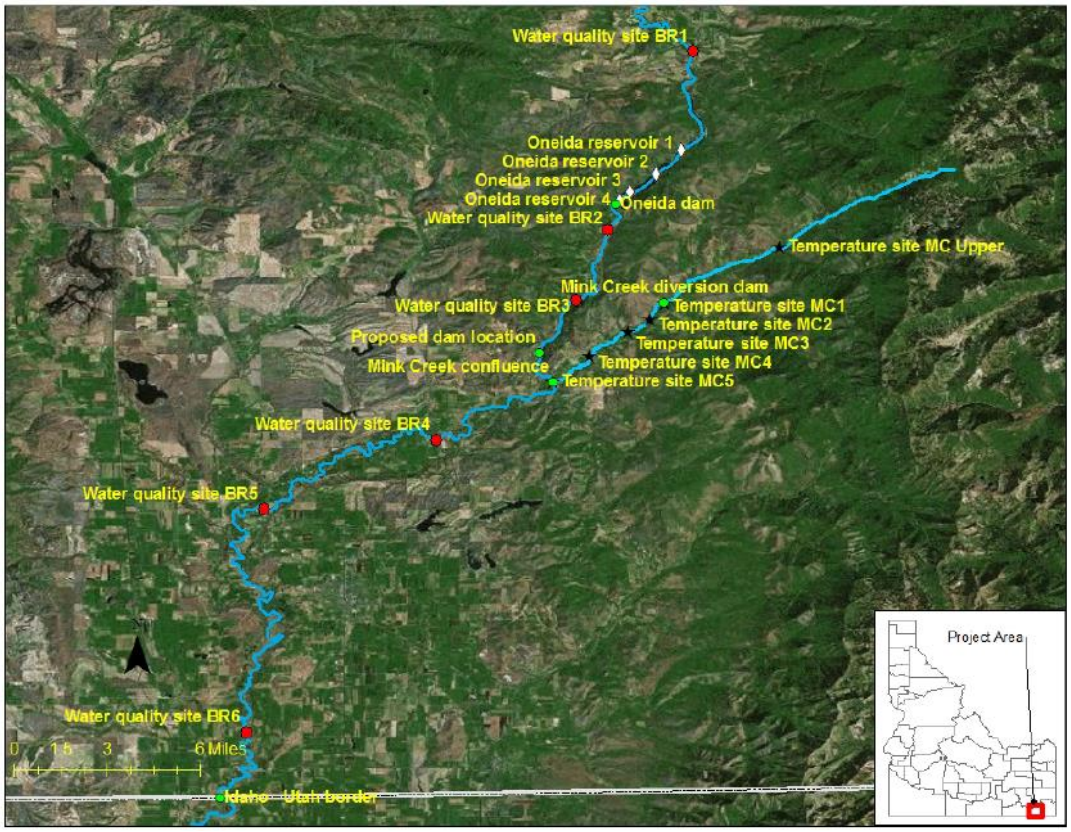



*Figure 6. Map of water quality monitoring sites from an Environmental Impact Statement for a proposed FERC hydropower dam. Image courtesy of FERC.*

FERC estimated $80,250 in future annual benefits from use of enhanced hydrography data for hydropower license and compliance review activities. These benefits would realized due to time and cost savings from availability of suitable data, improved hydrologic and hydraulic analyses, and the future ability to better account for climate change during the review process. Additionally, the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for hydropower license and compliance review activities was provided by FERC.

*Table52. FERC qualitative benefits from use of enhanced hydrography information for hydropower license and compliance review activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Moderate | Moderate | Minor | Minor | Minor | Don't Know | Moderate | Don't Know |

## BU #14 Oil and Gas Resources

BU #14, Oil and Gas Resources, was described in the questionnaire as including the following types of MCAs: pipeline and road route selection, facility siting to mitigate seismic hazards, and regulatory compliance.

Three MCAs were characterized as having BU #14 as their primary BU, with a total annual program budget of $24 million for programs supported by hydrography data, a total of $100,000 in estimated annual benefits from the currently available hydrography data, and $100,000 in estimated future annual benefits from enhanced hydrography data.

**BU #14 Highlights:**

**Number of MCAs:** 3
**Estimated annual program budget:** $24,000,000
**Estimated current annual benefits:** $100,000
**Estimated future annual benefits:** $100,000

These three MCAs were reported by Bureau of Ocean Energy Management (BOEM) for ocean energy management, which includes the management of oil and gas as well as wind energy; the Michigan Department of Environmental Quality for oil, gas, mining, and minerals exploration and production; and the Ohio Department of Natural Resources for oil and gas well permitting, water well permitting, water withdrawal permitting, coal mining permitting, coastal shore structure permitting, and dam safety monitoring.

**Areas of Interest**

Figure 40 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #14 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

More states than shown on this map likely have management of oil and gas resources as one of their missions; however, because of the varied representation of the state and local agencies, and because the BUs were self-selected, it is likely that additional areas across the U.S. would have an interest in geologic resource assessment. Additionally, private oil and gas companies, which would have a great interest in pipeline routing and facility siting as well as regulatory compliance, were not represented in the study participants. Therefore, it is likely that there are additional areas across the U.S. where oil and gas resources would be a concern.

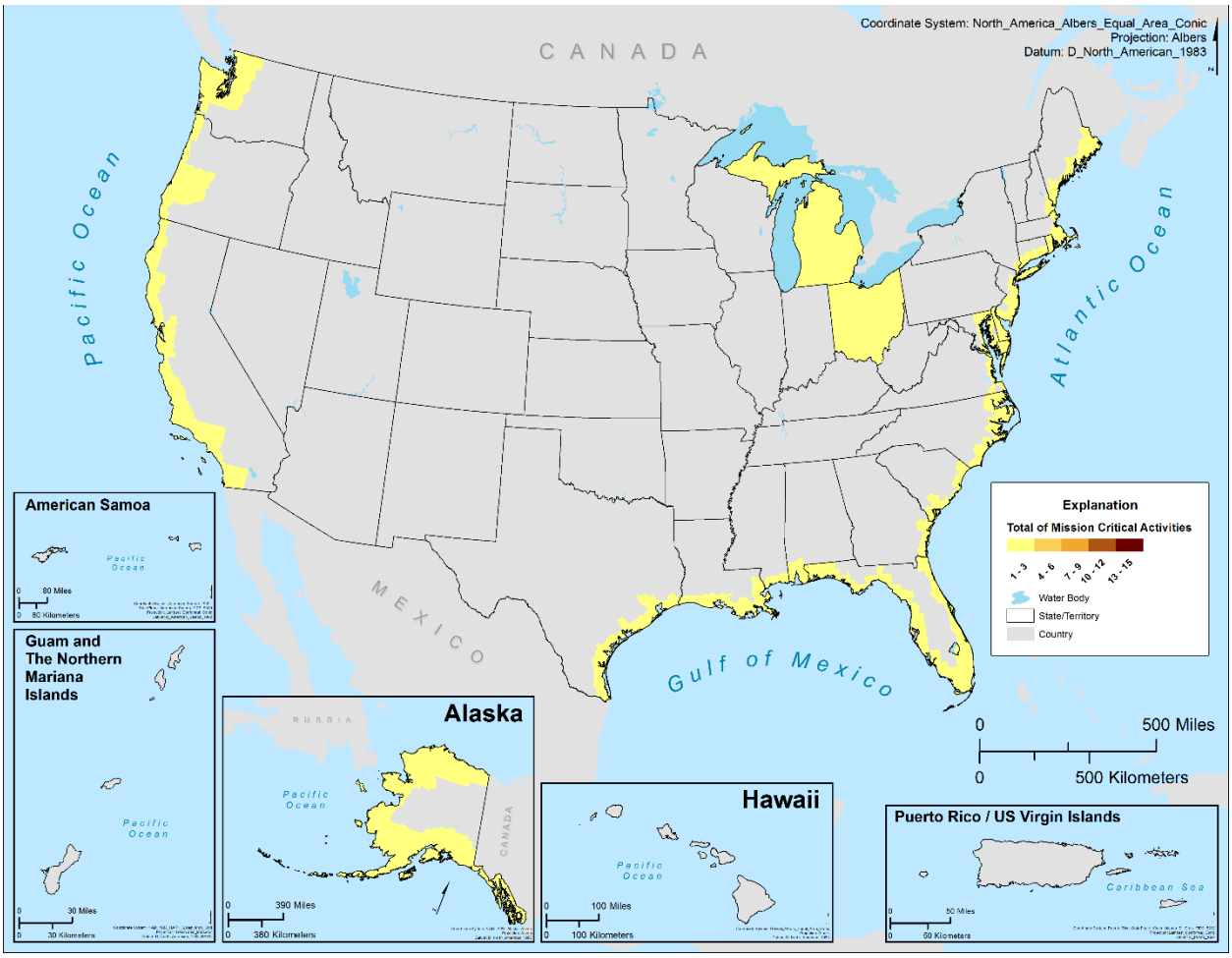



*Figure 40. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #14 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

## Requirements

Table 53 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #14 as their primary BU, and the most frequently requested requirements by category.

*Table 39. Requirements for enhanced hydrography data for BU #14*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | 2-3 Years/4-5 Years/6-10 Years | 33% each |
| **Positional Accuracy** | +/- 3 feet, 90% (1:1,200-scale) | 67% |
| **Stream Density** | 2.5 miles of channel per sq. mi./5.0 miles of channel per sq. mi./No response provided | 33% each |
| **Smallest Contributing Watershed** | 2 acres/6 acres/10 square miles (6,400 acres) | 33% each |
| **Smallest Mapped Waterbody** | Less than an acre/5 acres/20 acres | 33% each |
| **Post-Event Update** | Highly Desirable | 67% |
| **Level of Detail** | Best Available | 100% |

The requirements for characteristics and analytical functions for BU #14 are shown in Table 54.

*Table 40. Requirements for characteristics and analytical functions for BU #14*

| Required Characteristics/Analytical Functions | Number of MCAs (of 3) | Percent of MCAs |
|---|---|---|
| Calculate stream distance to points | 2 | 67% |
| Coastal bathymetry | 2 | 67% |
| Estuaries | 2 | 67% |
| Flood stage | 2 | 67% |
| Floodplain boundary | 2 | 67% |
| Linkages to stream gage observations | 2 | 67% |
| Preset symbolization | 2 | 67% |
| User defined symbolization | 2 | 67% |
| Velocity or time of travel | 2 | 67% |
| Calculate time of travel to points | 1 | 33% |
| Coastlines | 1 | 33% |
| Determine downstream flood area | 1 | 33% |
| Find events or features on network | 1 | 33% |
| Find upstream or downstream feature within watershed | 1 | 33% |
| Leakage at points | 1 | 33% |
| Mash-ups | 1 | 33% |
| Navigate up or downstream on network | 1 | 33% |
| Wetlands | 1 | 33% |
| Accumulate upstream or downstream features | 0 | 0% |
| Animation of time-series | 0 | 0% |
| Badlands | 0 | 0% |
| Bridges, culverts | 0 | 0% |
| Calculate distance on network | 0 | 0% |
| Calculate drainage area | 0 | 0% |
| Delineate catchment | 0 | 0% |
| Deltas | 0 | 0% |
| Diversion lines | 0 | 0% |
| Diversion points | 0 | 0% |
| Find upstream or downstream points | 0 | 0% |
| Flow periodicity | 0 | 0% |
| Leakage along lines | 0 | 0% |
| Left/right bank delineation | 0 | 0% |
| Linkages to cross section geometry | 0 | 0% |
| Other (please specify) | 0 | 0% |
| Riverine bathymetry | 0 | 0% |

**Future Annual Benefits**

An estimated $100,000 in future annual benefits from enhanced hydrography data was reported for the MCAs categorized as having BU #14 as their primary BU.

Figure 41 shows the estimated future annual benefits provided by the MCAs categorized as having BU #14 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

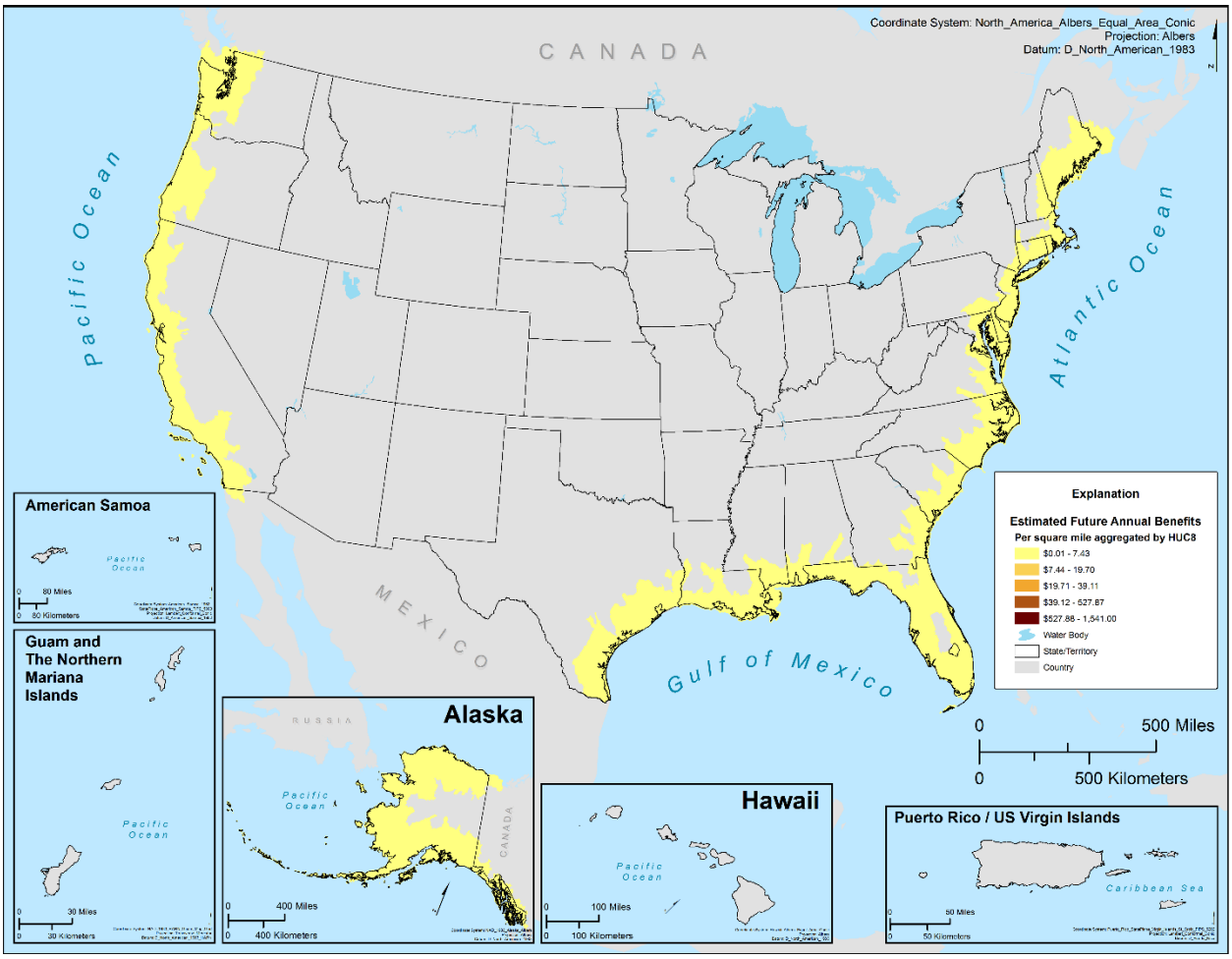



*Figure 41. Estimated future annual benefits reported for the MCAs categorized as having BU #14 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 55 lists the qualitative benefits reported for BU #14.

*Table 41. Qualitative benefits reported for BU #14*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| **Moderate** | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 |
| **Minor** | 1 | 1 | 1 | 1 | 2 | 1 | 0 | 1 |
| **N/A** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Don't Know** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **No Answer Provided** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

These benefits would be realized due to availability of improved data for modeling oil spills, planning responses, and to update water depths in currently used databases. Better data will result in better decisions.

**Example Oil and Gas Resources Activities**

FERC regulates the interstate transmission of natural gas and oil via development of safe, reliable and efficient energy infrastructure that serves the public interest. FERC also reviews proposals to build liquefied natural gas terminals and interstate natural gas pipelines.

FERC uses hydrography data in its reviews of gas pipeline and electric transmission line siting studies that include analyses of stream crossings and wetlands. When projects are submitted for consideration, siting studies that show the alignment of the pipeline relative to features that may be disturbed or otherwise impacted must be shown. Additionally, plans showing mitigation of sensitive areas such as wetlands and vernal pools during and after construction of the proposed pipeline must be included.

http://www.ferc.gov/industries/gas/indus-act/pipelines/approved-projects.asp

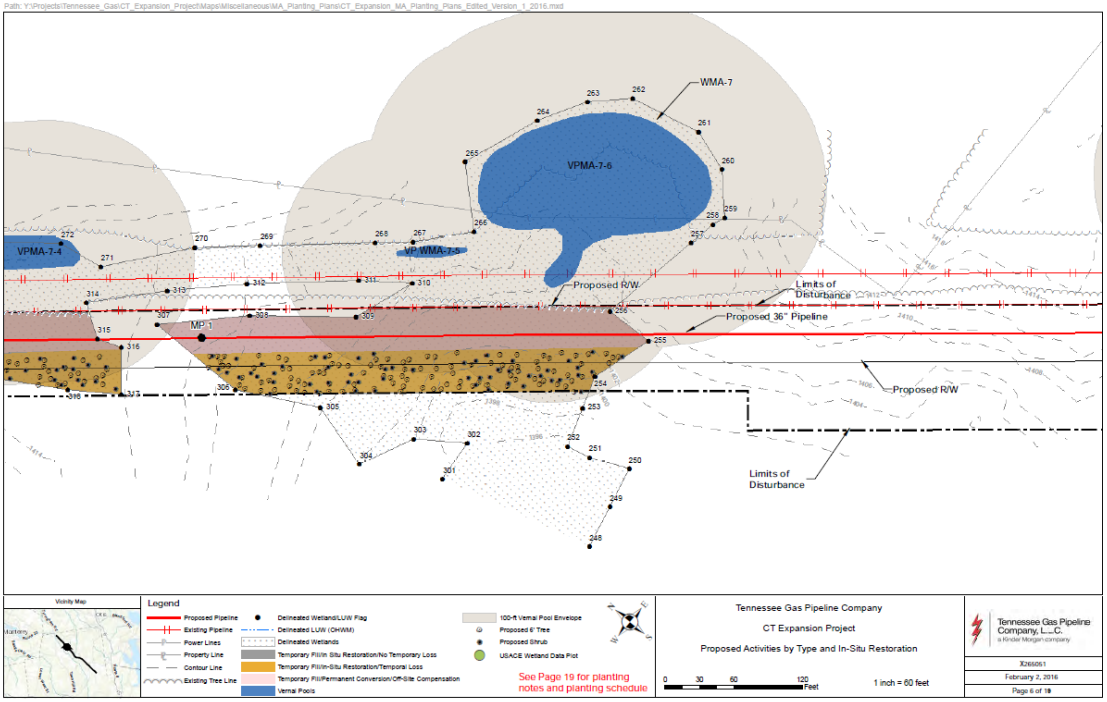



*Figure 42. Alignment and wetland mitigation plan for a section of an approved natural gas pipeline in New England. Image courtesy of FERC.*

## BU #15 Flood Risk Management

BU #15, Flood Risk Management, was described in the questionnaire as including the following types of MCAs: flood risk analysis and floodplain mapping, emergency management, levee safety, flood forecasts, and hydrologic and hydraulic modeling.

**BU #15 Highlights:**

**Number of MCAs:** 54
**Estimated annual program budget:** $636,106,999
**Estimated current annual benefits:** $56,124,500 to $56,174,500
**Estimated future annual benefits:** $75,859,000 to $76,542,000

A total of 54 MCAs were characterized as having BU #15 as their primary BU, with a total annual program budget of $636,106,999 for programs supported by hydrography data, a total of $56,124,500 to $56,174,500 in estimated annual benefits from the currently available hydrography data, and $75,859,000 to $76,542,000 in estimated future annual benefits from enhanced hydrography data. Additionally, eight MCAs noted BU #15 as an ancillary BU.

These 54 MCAs were reported by six Federal agencies, one not-for-profit, six private entities, 18 local or regional government agencies, 22 state agencies, and one tribal government. The primary MCA description was flood risk analysis and mapping. Additional MCAs included emergency response, dam safety, hydrologic and hydraulic analysis, stormwater management, water supply protection, coastal zone management, and watershed protection.

**Areas of Interest**

Figure 43 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #15 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

Most states and many county or local entities likely have flood risk management as one of their missions; however, because of the varied representation of the state and local agencies, and because the BUs were self-selected, it is likely that additional areas across the U.S. would have an interest in flood risk management.

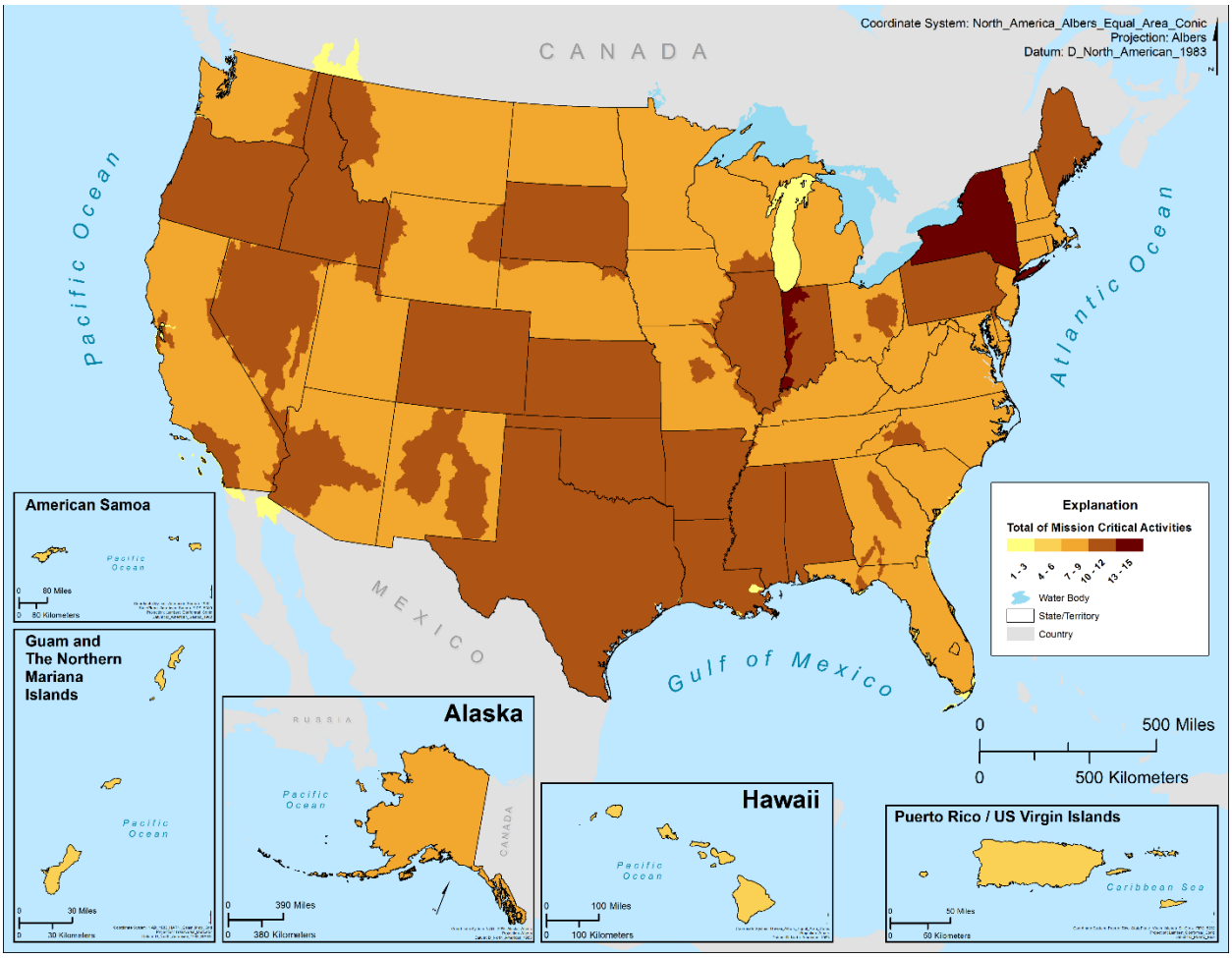



*Figure 43. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #15 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

## Requirements

Table 56 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #15 as their primary BU, and the most frequently requested requirements by category.

*Table 426. Requirements for enhanced hydrography data reported for BU #15*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | 4-5 Years | 37% |
| **Positional Accuracy** | +/- 3 feet, 90% (1:1,200-scale) | 50% |
| **Stream Density** | 5.0 miles of channel per mile (1:5,000-scale mapping) | 65% |
| **Smallest Contributing Watershed** | 1 square mile (640 acres) | 32% |
| **Smallest Mapped Waterbody** | 1 acre | 26% |
| **Post-Event Update** | Highly Desirable | 50% |
| **Level of Detail** | Best Available | 80% |

The requirements for characteristics and analytical functions for BU #15 are shown in Table 57.

*Table 43. Requirements for characteristics and analytical functions for BU #15*

| Required Characteristics/Analytical Functions | Number of MCAs (of 54) | Percent of MCAs |
|---|---|---|
| Floodplain boundary | 45 | 83% |
| Bridges, culverts | 44 | 81% |
| Determine downstream flood area | 43 | 80% |
| Calculate drainage area | 41 | 76% |
| Linkages to stream gage observations | 40 | 74% |
| Delineate catchment | 37 | 69% |
| Linkages to cross section geometry | 37 | 69% |
| Flood stage | 36 | 67% |
| Navigate up or downstream on network | 34 | 63% |
| Calculate time of travel to points | 32 | 59% |
| Diversion lines | 31 | 57% |
| Find upstream or downstream feature within watershed | 31 | 57% |
| Flow periodicity | 31 | 57% |
| Left/right bank delineation | 30 | 56% |
| Riverine bathymetry | 30 | 56% |
| Velocity or time of travel | 30 | 56% |
| Calculate distance on network | 28 | 52% |
| Calculate stream distance to points | 28 | 52% |
| Accumulate upstream or downstream features | 25 | 46% |
| Diversion points | 25 | 46% |
| Mash-ups | 25 | 46% |
| Preset symbolization | 24 | 44% |
| Wetlands | 24 | 44% |
| Coastlines | 23 | 43% |
| Animation of time-series | 21 | 39% |
| Find upstream or downstream points | 21 | 39% |
| Find events or features on network | 20 | 37% |
| User defined symbolization | 19 | 35% |
| Coastal bathymetry | 18 | 33% |
| Estuaries | 14 | 26% |
| Leakage along lines | 13 | 24% |
| Deltas | 12 | 22% |
| Leakage at points | 12 | 22% |
| Other (please specify) | 11 | 20% |
| Badlands | 5 | 9% |

**Future Annual Benefits**

An estimated $75,859,000 to $76,542,000 in future annual benefits from enhanced hydrography data was reported for the MCAs that were categorized as having BU #15 as their primary BU.

Figure 44 shows the estimated future annual benefits provided by the MCAs categorized as having BU #15 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

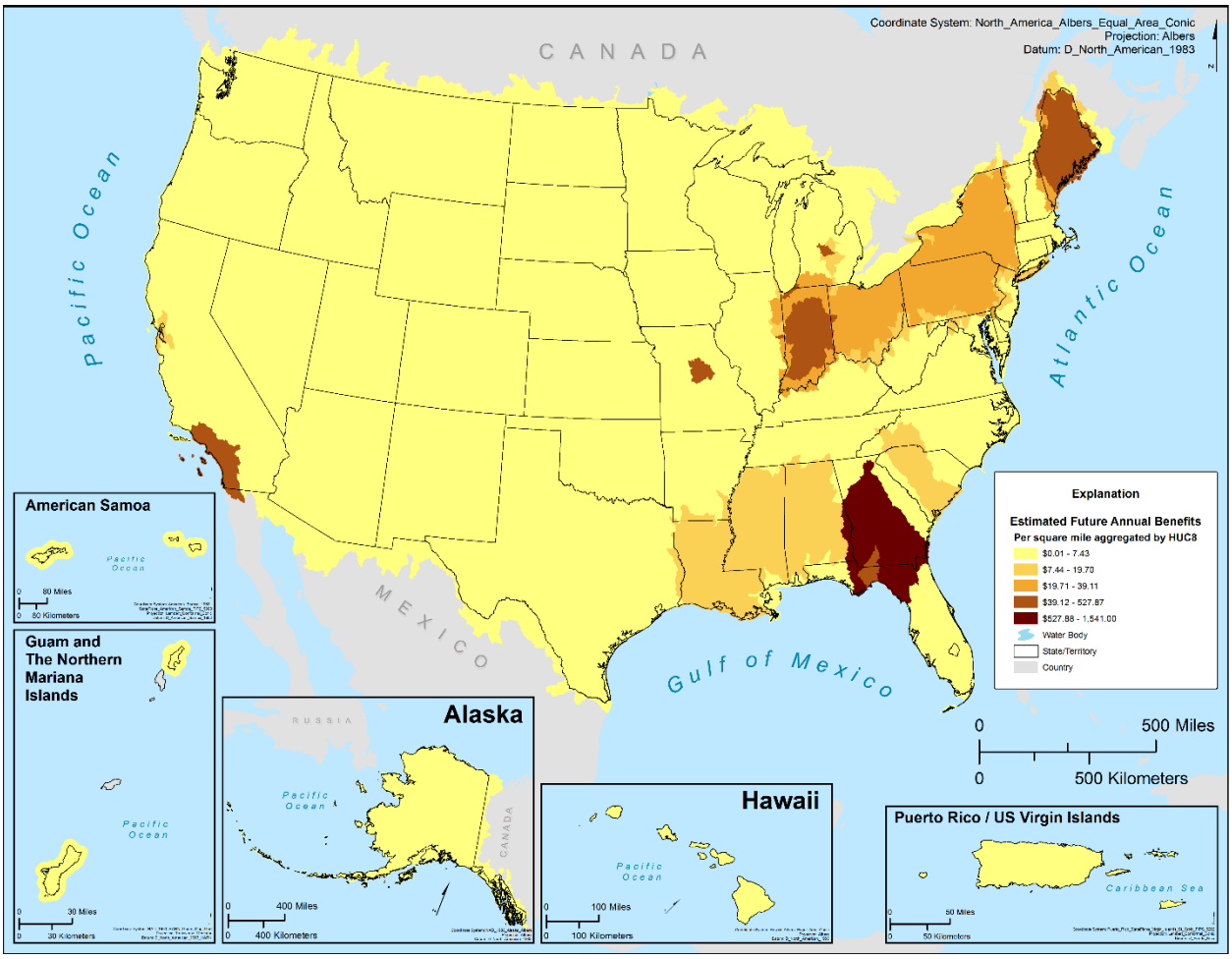



*Figure 44. Estimated future annual benefits reported for the MCAs categorized as having BU #15 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 58 lists the qualitative benefits reported for BU #15.

*Table 44. Qualitative benefits reported for BU #15*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 25 | 34 | 22 | 23 | 16 | 22 | 12 | 18 |
| **Moderate** | 17 | 15 | 21 | 14 | 16 | 16 | 16 | 10 |
| **Minor** | 8 | 0 | 6 | 11 | 12 | 10 | 16 | 13 |
| **N/A** | 0 | 1 | 1 | 2 | 4 | 1 | 5 | 5 |
| **Don't Know** | 4 | 4 | 4 | 4 | 6 | 5 | 5 | 8 |

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **No Answer Provided** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 |

These benefits would be realized due to improved spatial accuracy, completeness, consistency, currency, availability, and attribution of hydrography data, including stream gage data, which would result in time and cost savings from not having to search for relevant datasets; not having to maintain local datasets; more efficient and higher-quality hydrologic and hydraulic modeling and analysis and improved dam breach modeling and analysis, both of which can save property and lives; improved flood forecasting; improved emergency response and post-event recovery; better understanding of multi-hazard risk such as post-wildfire flooding or debris/mud flow; improved public outreach and understanding regarding flood risks and events (e.g. flood warning); improved wetland delineation and permit reviews; and more informed decision making.

**Example Flood Risk Management Activities**

The National Flood Insurance Program (NFIP) was established to reduce future flood damage through hazard identification and mapping, effective community floodplain management, and insurance protection for property owners. FEMA's Flood Insurance Rate Maps (FIRMs) are utilized 20-30 million times a year by communities issuing permits for building in high risk flood zones and mitigation planning; lenders in their enforcement of the insurance purchase requirement; Federal agencies under Executive Order 11988 (Floodplain Management); developers who build in and near the high risk areas; emergency responders and those making decisions on where and how to recover and rebuild after disasters; and individuals who rely on insurance offered by the NFIP as a financial backstop to their most valuable investment, their homes. It is estimated that the NFIP's flood risk identification and floodplain management land use and building standards save the country more than $1 billion in prevented damages each year.

Flood risk studies rely on up-to-date lidar data; hydrologic modeling; and hydraulic modeling which relies on local resolution hydrography data that match the lidar. Also needed for accurate flood risk modeling are stream gage and stream flow data; accurate placement of levees and levee-like structures; location of bridges, culverts, and dams; and high water marks. In coastal areas, additional data are used for modeling including accurate coastlines, bathymetry, and tide gage and storm surge data. These data are needed to support hydrologic and hydraulic modeling, flood mapping, and flood hazard data visualization and dissemination.

http://msc.fema.gov/portal

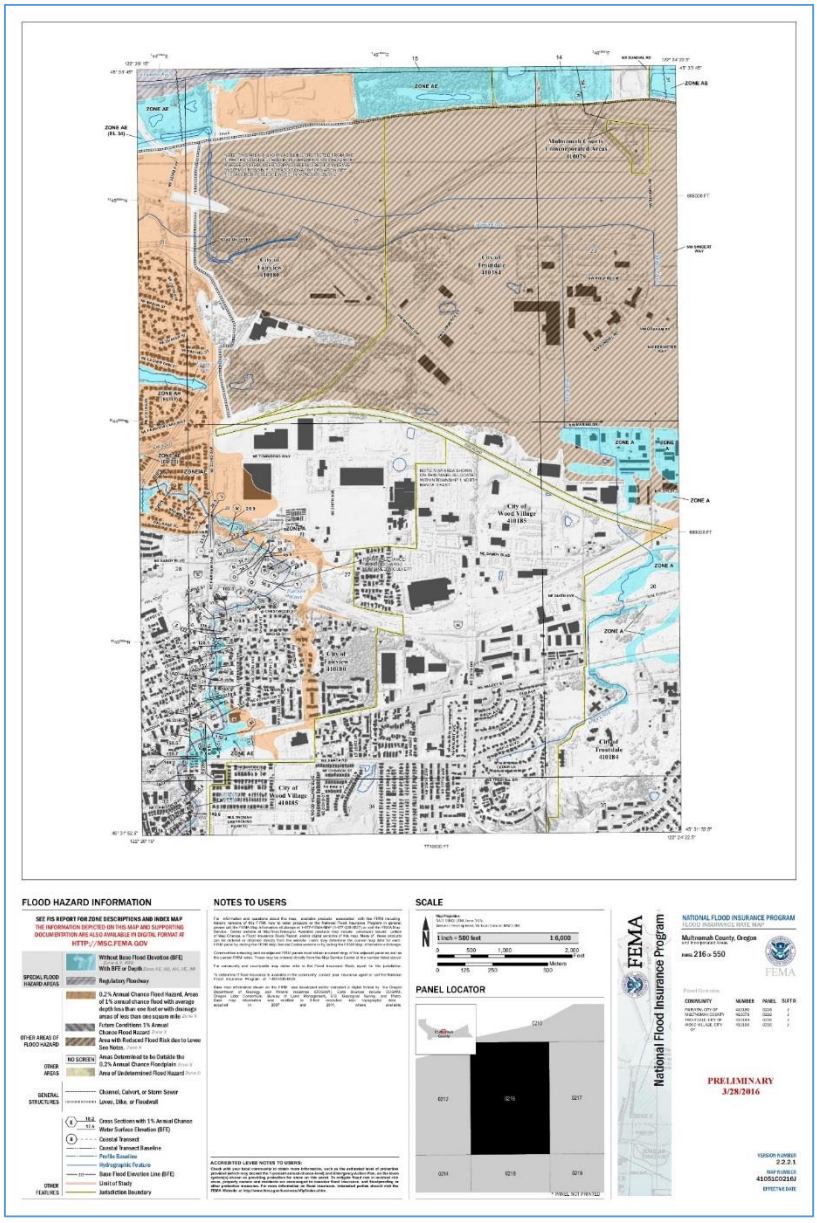



*Figure 45. FEMA Flood Insurance Rate Map depicting streams, flood hazard areas, and orthoimagery. Image courtesy of FEMA.*

Dam safety programs also rely on similar flood hazard modeling studies to ensure that dams are safe. Maintaining dam safety involves review and approval of designs, plans, specifications, and construction of new dams as well as inspections of ongoing operations. Dam inspection frequency is dictated by the hazard potential classification of the dam. Comprehensive inspections and engineering evaluations of high and significant hazard potential dams must be conducted every five years.

FEMA estimated $9 million in future annual benefits from use of enhanced hydrography data. These benefits would be derived from time and cost savings from availability of suitable data for H&H modeling and floodplain mapping. FERC estimated an additional $322,000 to $805,000 in future annual benefits for similar H&H modeling activities for dam safety. Additionally, the following assessment of the estimated

qualitative future annual benefits that could be derived from the use of enhanced hydrography data for flood risk management activities was provided by FEMA.

*Table 45. FEMA qualitative benefits from use of enhanced hydrography information for flood risk management activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Moderate | Minor | Moderate | Moderate | Minor | Moderate | Minor | Minor |

## BU #16 Sea Level Rise and Subsidence

BU #16, Sea Level Rise and Subsidence, was described in the questionnaire as including the following types of MCAs: mapping, modeling, and forecasting the effects of sea level rise; and population and economic vulnerability assessments.

**BU #16 Highlights:**

**Number of MCAs:** 2
**Estimated annual program budget:** $1,000,000
**Estimated current annual benefits:** $350,000
**Estimated future annual benefits:** $350,000

Two MCAs were characterized as having BU #16 as their primary BU, with a total annual program budget of $1 million for programs supported by hydrography data, a total of $350,000 in estimated annual benefits from the currently available hydrography data, and $350,000 in estimated future annual benefits from enhanced hydrography data. Additionally, three MCAs noted BU #16 as an ancillary BU.

These two MCAs were reported by the Maine Geological Survey for coastal resiliency studies, and the Maryland State Highway Administration (SHA) for GIS support to SHA for TMDL and stormwater planning and mitigation for surface transportation infrastructure.

**Areas of Interest**

Figure 46 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #16 as their primary BU.

More states and regional entities than represented by this map likely have sea level rise and subsidence as one of their missions; however, because of the varied representation of the state and local agencies, and because the BUs were self-selected, it is likely that additional coastal areas of the U.S. along with non-coastal areas subject to subsidence would have an interest in modeling and mapping sea level rise and subsidence.

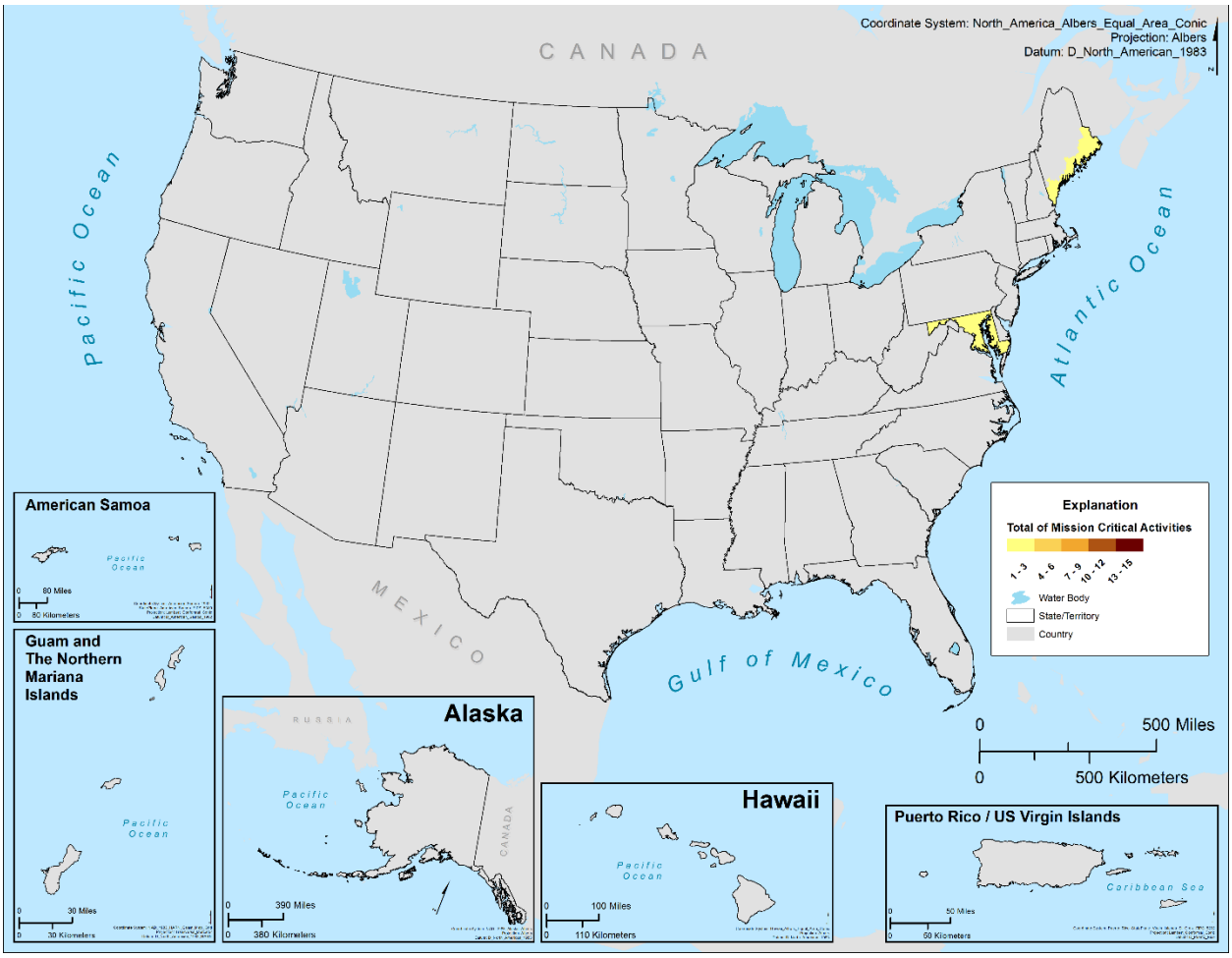



*Figure 46. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #16 as their primary BU.*

### Requirements

Table 60 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #16 as their primary BU, and the most frequently requested requirements by category.

*Table 46. Requirements for enhanced hydrography data reported for BU #16*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | 2-3 Years | 100% |
| **Positional Accuracy** | +/- 7 feet, 90% (1:2,400-scale) | 100% |
| **Stream Density** | 5.0 miles of channel per square mile | 100% |
| **Smallest Contributing Watershed** | 6 acres/1 square mile (640 acres) | 50% each |
| **Smallest Mapped Waterbody** | 1 acre | 100% |
| **Post-Event Update** | Required/Highly Desirable | 50% each |
| **Level of Detail** | Best Available | 100% |

The requirements for characteristics and analytical functions for BU #16 are shown in Table 61.

*Table 47. Requirements for characteristics and analytical functions for BU #16*

| Required Characteristics/Analytical Functions | Number of MCAs (of 2) | Percent of MCAs |
|---|---|---|
| Accumulate upstream or downstream features | 2 | 100% |
| Calculate drainage area | 2 | 100% |
| Calculate stream distance to points | 2 | 100% |
| Calculate time of travel to points | 2 | 100% |
| Coastal bathymetry | 2 | 100% |
| Coastlines | 2 | 100% |
| Delineate catchment | 2 | 100% |
| Determine downstream flood area | 2 | 100% |
| Diversion lines | 2 | 100% |
| Estuaries | 2 | 100% |
| Find upstream or downstream feature within watershed | 2 | 100% |
| Flood stage | 2 | 100% |
| Floodplain boundary | 2 | 100% |
| Linkages to stream gage observations | 2 | 100% |
| Navigate up or downstream on network | 2 | 100% |
| Velocity or time of travel | 2 | 100% |
| Wetlands | 2 | 100% |
| Animation of time-series | 1 | 50% |
| Bridges, culverts | 1 | 50% |
| Calculate distance on network | 1 | 50% |
| Deltas | 1 | 50% |
| Diversion points | 1 | 50% |
| Find events or features on network | 1 | 50% |
| Find upstream or downstream points | 1 | 50% |
| Flow periodicity | 1 | 50% |
| Leakage along lines | 1 | 50% |
| Leakage at points | 1 | 50% |
| Left/right bank delineation | 1 | 50% |
| Linkages to cross section geometry | 1 | 50% |
| Mash-ups | 1 | 50% |
| Preset symbolization | 1 | 50% |
| Riverine bathymetry | 1 | 50% |
| User defined symbolization | 1 | 50% |
| Badlands | 0 | 0% |
| Other (please specify) | 0 | 0% |

**Future Annual Benefits**

An estimated $350,000 in future annual benefits from enhanced hydrography data was reported for the MCAs that were categorized as having BU #16 as their primary BU.

Figure 47 shows the estimated future annual benefits provided by the MCAs categorized as having BU #16 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

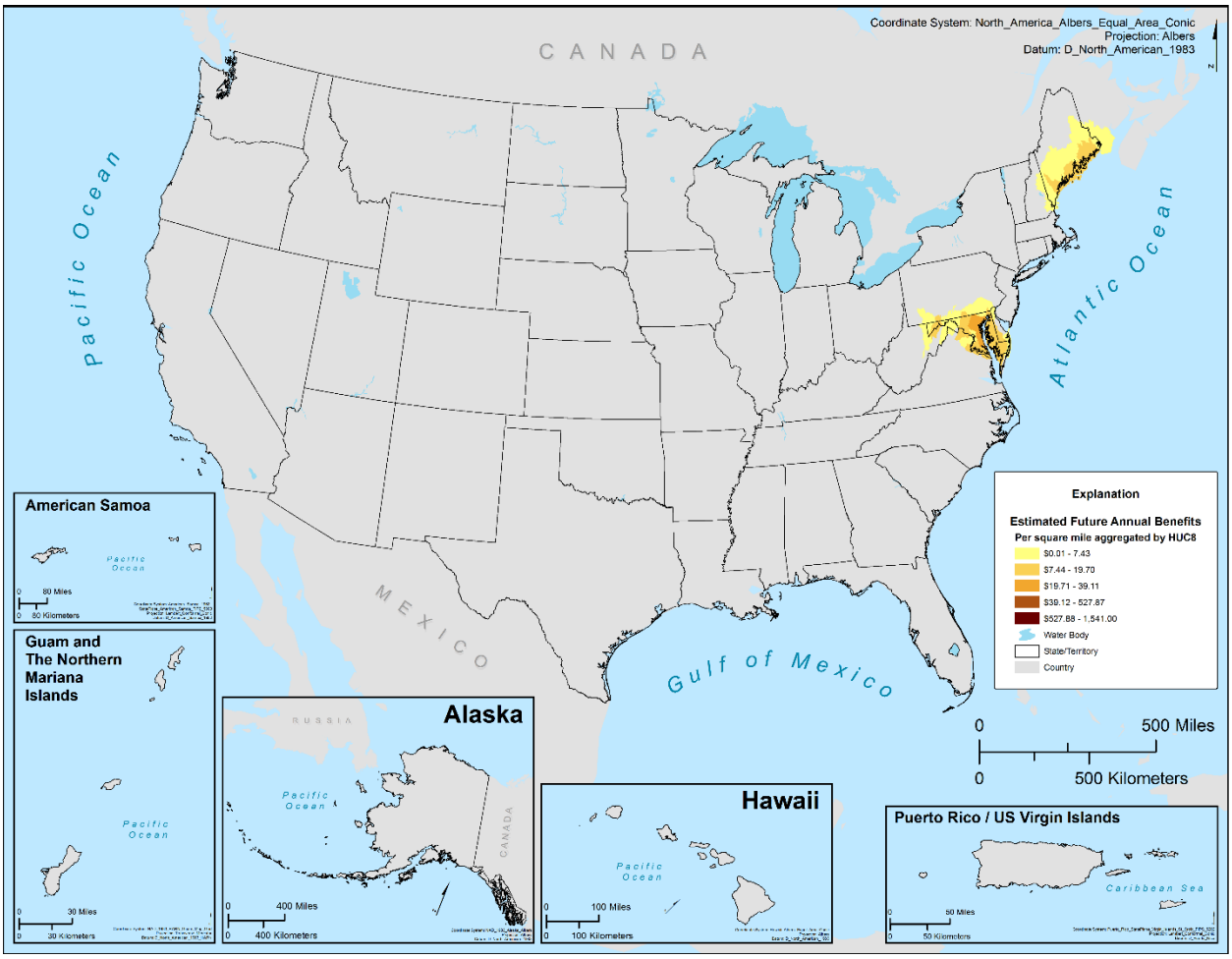



*Figure 47. Estimated future annual benefits reported for the MCAs categorized as having BU #16 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 62 lists the qualitative benefits reported for BU #16.

*Table 482. Qualitative benefits reported for BU #16*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| **Moderate** | 0 | 1 | 1 | 0 | 0 | 2 | 2 | 2 |
| **Minor** | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| **N/A** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Don't Know** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **No Answer Provided** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

These benefits would be realized due to more timely and accurate analysis of storm surge from potential storms and better communication with emergency responders. More accurate data would also improve highway designs, roadway safety, the TMDL program, and hydrologic and hydraulic modeling.

**Example Sea Level Rise and Subsidence Activities**

Coastal areas and facilities, including ports and naval facilities must plan for the potential impacts of future Sea Level Rise (SLR). Additionally, many non-coastal areas are subject to subsidence, both of which require modeling and/or mitigation in order to adapt to the loss of land.

Because of the warming climate, SLR rates are increasing worldwide above the norm for prior centuries. Projected SLR rates vary for the U.S., especially when combined with subsidence. Regardless of the rate, SLR has caused major concerns for coastal states and communities planning for an unstoppable sea threat; Federal and state agencies are working closely together to mitigate this threat, and lidar and accurate shoreline data are both needed for this effort.

NOAA has developed and made available an on-line a Sea Level Rise Viewer that lets users see the potential impacts of sea level rise and coastal flooding with 1-foot to 6-foot inundation scenarios. Communities can use this type of information when developing or updating their Hazard Mitigation Plans and identifying mitigation actions that would address the combination of coastal erosion, floods, hurricanes, nor'easters, tropical storms, and climate change. An example of a new mitigation action involves increased "freeboard," the term used to describe the required elevation of a structure above the FEMA-identified base flood elevation. Increasing numbers of municipalities now require freeboard to better prepare for future sea level rise and coastal inundation. Sea level rise mapping also provides information to municipalities as they plan to mitigate and improve critical facilities vulnerable to inundation.

https://coast.noaa.gov/slr/

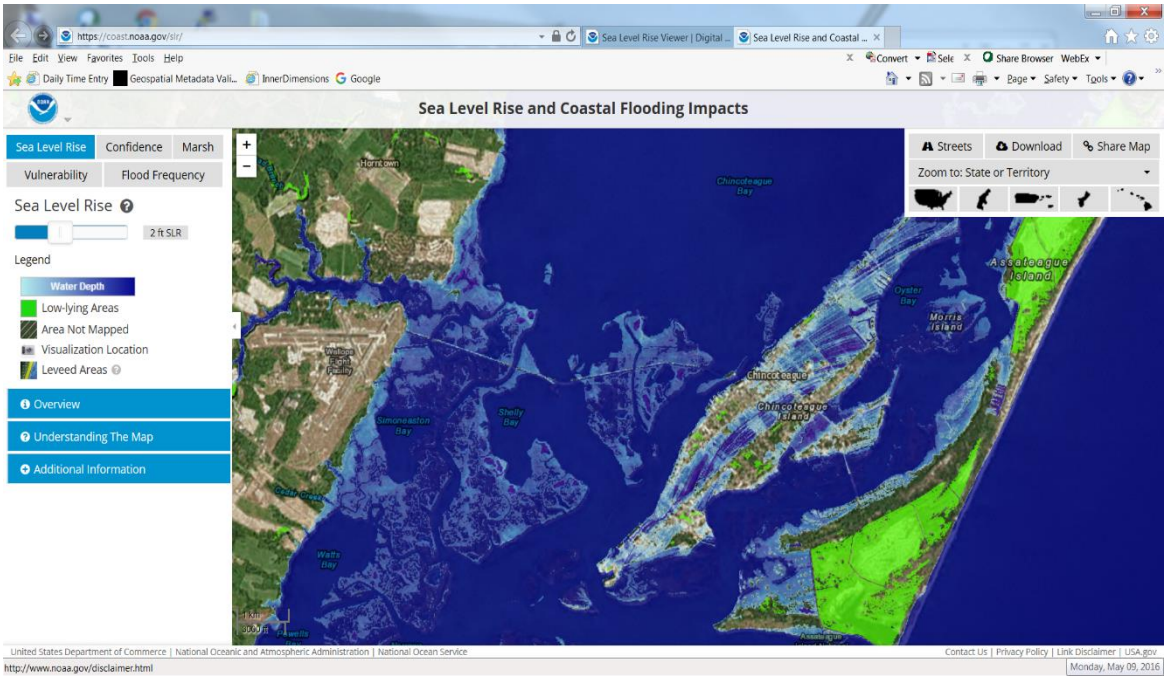



*Figure 48. Coastal areas of the Eastern Shore of the Chesapeake Bay in Maryland with only 2-feet of sea level rise which is in the low to intermediate range of sea level rise scenarios by 2100. Image courtesy of NOAA.*

The Maryland State Highway Administration (SHA) estimated $250,000 in future annual benefits from use of enhanced hydrography data. These benefits would be derived from use of more accurate data for improved highway designs, roadway safety, TMDL program requirements, and H&H modeling. Additionally, the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for sea level rise and subsidence activities was provided by Maryland SHA.

*Table 49. Maryland SHA qualitative benefits from use of enhanced hydrography information for sea level rise and subsidence activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Major | Major | Moderate | Minor | Minor | Moderate | Moderate | Moderate |

## BU #17 Wildfire Management, Planning and Response

BU #17, Wildfire Management, Planning and Response, was described in the questionnaire as including the following types of MCAs: understanding, modeling, and predicting fire behavior; protection of terrestrial ecosystems; and fire-fighting estimations.

One MCA was characterized as having BU #17 as its primary BU, with a total annual program budget of $20 million for programs supported by hydrography data, a total of $10,000 in estimated annual benefits from the currently available hydrography data,

**BU #17 Highlights:**

**Number of MCAs:** 1
**Estimated annual program budget:** $20,000,000
**Estimated current annual benefits:** $10,000
**Estimated future annual benefits:** $10,000

and $10,000 in estimated future annual benefits from enhanced hydrography data. Additionally, one MCA noted BU #17 as an ancillary BU.

The Utah Department of Natural Resources, Division of Forestry, Fire, and State Lands described this MCA as involving wildfire response, mitigation, and reduction.

### Areas of Interest

Figure 49 shows the spatial extents of the areas of interest represented by the MCA categorized as having BU #17 as its primary BU. It is likely that additional areas in the Western states may have an interest in wildfire management, planning, and response.

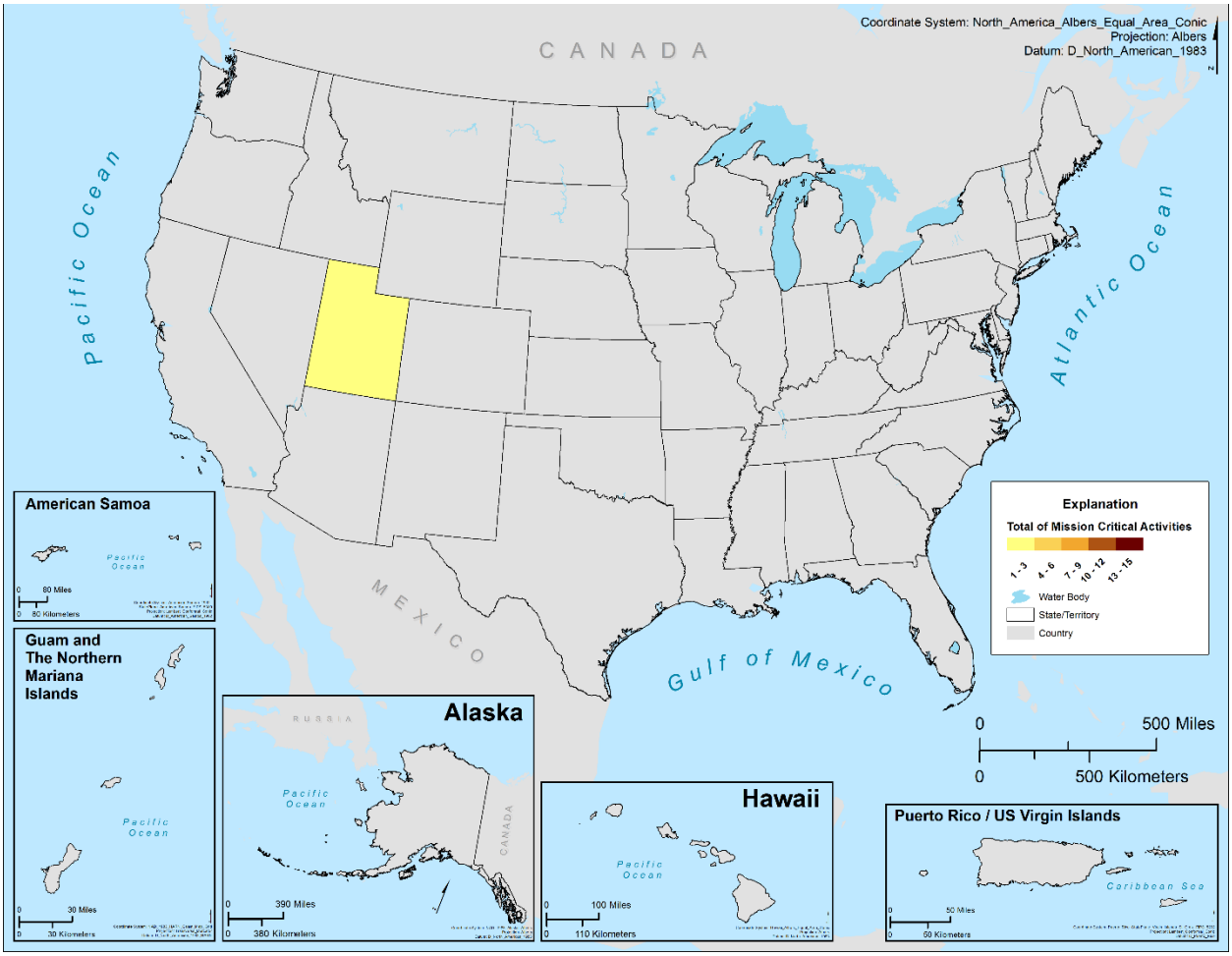



*Figure 7. Spatial extents of the areas of interest represented by the MCA categorized as having BU #17 as its primary BU.*

### Requirements

Table 64 lists the requirements for enhanced hydrography data reported for the MCA categorized as having BU #17 as its primary BU, and the most frequently requested requirements by category.

*Table 504. Requirements for enhanced hydrography data reported for BU #17*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | 6-10 Years | 100% |
| **Positional Accuracy** | +/- 40 feet, 90% (1:24,000-scale) | 100% |

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Stream Density** | I don't know | 100% |
| **Smallest Contributing Watershed** | 6 acres | 100% |
| **Smallest Mapped Waterbody** | Less than an acre | 100% |
| **Post-Event Update** | Nice to Have | 100% |
| **Level of Detail** | Best Available | 100% |

The requirements for characteristics and analytical functions for BU #17 are shown in Table 65.

*Table 51. Requirements for characteristics and analytical functions for BU #17*

| Required Characteristics/Analytical Functions | Number of MCAs (of 1) | Percent of MCAs |
|---|---|---|
| Accumulate upstream or downstream features | 1 | 100% |
| Bridges, culverts | 1 | 100% |
| Calculate distance on network | 1 | 100% |
| Calculate drainage area | 1 | 100% |
| Calculate stream distance to points | 1 | 100% |
| Coastal bathymetry | 1 | 100% |
| Coastlines | 1 | 100% |
| Delineate catchment | 1 | 100% |
| Determine downstream flood area | 1 | 100% |
| Diversion lines | 1 | 100% |
| Diversion points | 1 | 100% |
| Estuaries | 1 | 100% |
| Find events or features on network | 1 | 100% |
| Find upstream or downstream feature within watershed | 1 | 100% |
| Find upstream or downstream points | 1 | 100% |
| Flood stage | 1 | 100% |
| Floodplain boundary | 1 | 100% |
| Linkages to stream gage observations | 1 | 100% |
| Mash-ups | 1 | 100% |
| Preset symbolization | 1 | 100% |
| Riverine bathymetry | 1 | 100% |
| User defined symbolization | 1 | 100% |
| Animation of time-series | 0 | 0% |
| Badlands | 0 | 0% |
| Calculate time of travel to points | 0 | 0% |
| Deltas | 0 | 0% |
| Flow periodicity | 0 | 0% |
| Leakage along lines | 0 | 0% |
| Leakage at points | 0 | 0% |
| Left/right bank delineation | 0 | 0% |
| Linkages to cross section geometry | 0 | 0% |
| Navigate up or downstream on network | 0 | 0% |
| Other (please specify) | 0 | 0% |

| Required Characteristics/Analytical Functions | Number of MCAs (of 1) | Percent of MCAs |
|---|---|---|
| Velocity or time of travel | 0 | 0% |
| Wetlands | 0 | 0% |

**Future Annual Benefits**

An estimated $10,000 in future annual benefits from enhanced hydrography data was reported for the MCA categorized as having BU #17 as its primary BU.

Figure 50 shows the estimated future annual benefits provided by the MCA categorized as having BU #17 as its primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

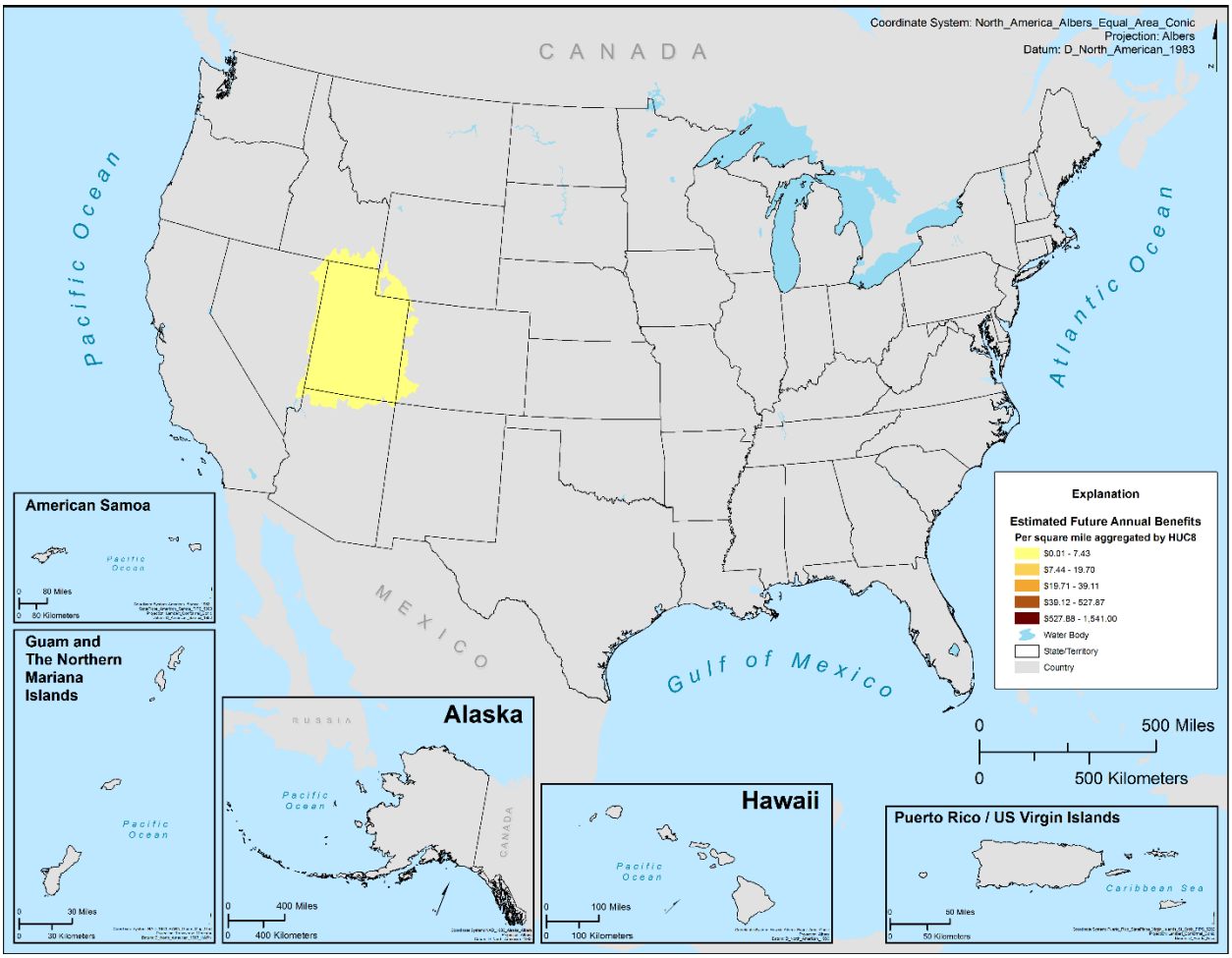



*Figure 50. Estimated future annual benefits reported for the MCA categorized as having BU #17 as its primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 66 lists the qualitative benefits reported for BU #17.

*Table 52. Qualitative benefits reported for BU #17*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Qualitative Benefits** | Moderate | Moderate | Moderate | Major | Moderate | Major | Major | Major |

These benefits would be realized due to better mapping of ponds and large waterbodies, which would be helpful for wildfire response water acquisition.

**Example Wildfire Management, Planning, and Response Activities**

The National Interagency Fire Center (NIFC) supports states and other Federal agencies managing wildfires on lands in their areas of responsibility. Hydrography data are used in wildfire management for identification of suitable water sources for fire-fighting as well as post-fire assessment of flood and landslide risk.

In 2011 the USFS issued its Record of Decision for the Nationwide Aerial Application of Fire Retardant on National Forest System Land EIS. It states that "waterways will be avoided and are given a minimum of a 300-foot buffer, including perennial streams, intermittent streams, lakes, ponds, identified springs, reservoirs, and vernal pools. Buffer areas may be increased based on local conditions in coordination with the FWS and NOAA Fisheries local offices." USFS provides an Aerial Fire Retardant Hydrographic Avoidance Areas map service depicting a buffer around NHD water features as shown in Figure 51.

http://www.arcgis.com/home/webmap/viewer.html?url=http%3A%2F%2Fapps.fs.usda.gov%2Farcx%2Frest%2Fservices%2FEDW%2FEDW_AerialFireRetardantHydrographicAvoidanceAreas_01%2FMapServer&source=sd

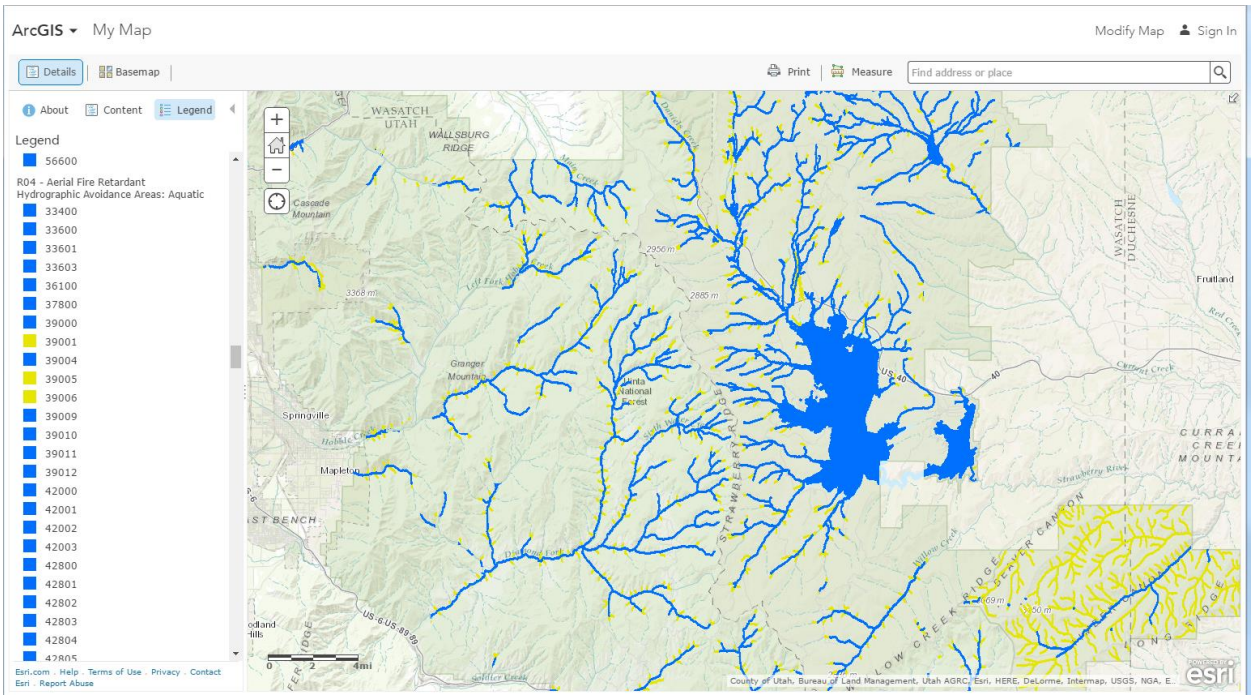



*Figure 8. USFS Aerial Fire Retardant Hydrographic Avoidance Areas in Uinta National Forest, UT. Image courtesy of USFS.*

The Utah Department of Natural Resources (DNR) estimated $10,000 in future annual benefits from use of enhanced hydrography data. These benefits would be derived from use of more accurate data for mapping locations of large water bodies for wildfire response water acquisition. Additionally, the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for wildfire response activities was provided by Utah DNR.

*Table 53. Utah DNR qualitative benefits from use of enhanced hydrography information for wildfire response activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Moderate | Moderate | Moderate | Major | Moderate | Major | Major | Major |

## BU #18 Homeland Security, Law Enforcement, and Disaster Response

BU #18, Homeland Security, Law Enforcement, and Disaster Response, was described in the questionnaire as including the following types of MCAs: infrastructure and border protection, coastal search and rescue, population dynamics, and drinking water protection.

**BU #18 Highlights:**

**Number of MCAs:** 7
**Estimated annual program budget:** $1,753,000
**Estimated current annual benefits:** $100,000
**Estimated future annual benefits:** $5,500,000

Seven MCAs were characterized as having BU #18 as their primary BU, with a total annual program budget of $1,753,000 for programs supported by hydrography data, a total of $100,000 in estimated annual benefits from the currently available hydrography data, and $5.5 million in estimated future annual benefits from enhanced hydrography data. Additionally, one MCA noted BU #18 as an ancillary BU.

These seven MCAs were reported by the U.S. EPA for evidence collection, forensics, and scientific analyses for criminal and civil enforcement of environmental laws; Lake County, Ohio for emergency/disaster planning, mitigation, response, and recovery; the Iowa Homeland Security and Emergency Management Agency for homeland security and emergency management activities; the New Jersey Department of Environmental Protection for critical infrastructure protection and disaster preparedness; the Ohio Environmental Protection Agency for emergency response and drinking water protection; and the Texas Natural Resources Information System for mapping and modeling projects related to public safety and scientific research.

**Areas of Interest**

Figure 52 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #18 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

Most states and many county or local entities likely have disaster response as one of their missions; however, because of the varied representation of the state and local agencies, and because the BUs were self-selected, it is likely that additional areas across the U.S. would have an interest in homeland security, law enforcement, and disaster response.

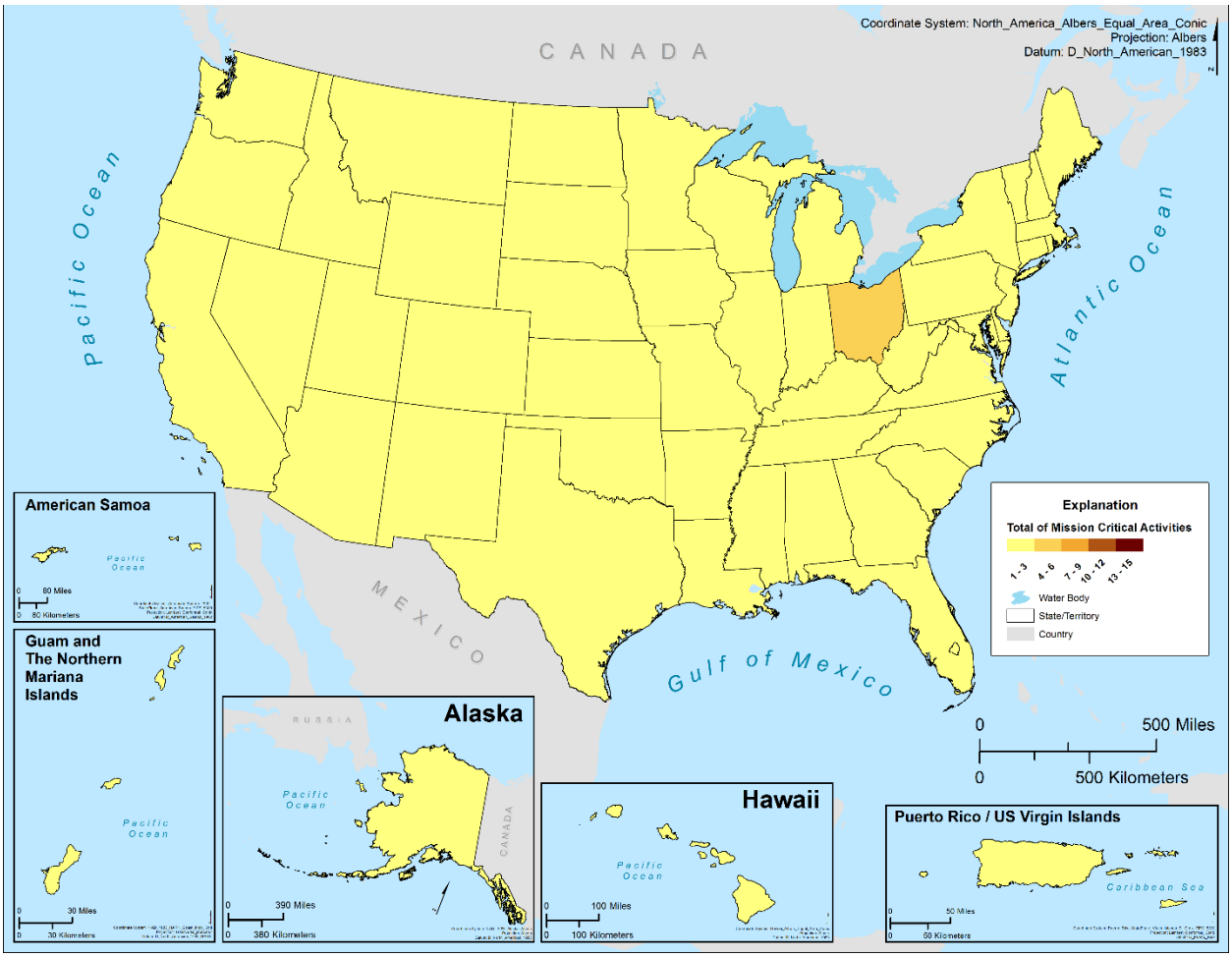



*Figure 9. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #18 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

**Requirements**

Table 68 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #18 as their primary BU, and the most frequently requested requirements by category.

*Table 54. Requirements for enhanced hydrography data reported for BU #18*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | Annually/2-3 Years | 43% each |
| **Positional Accuracy** | +/- 7 feet, 90% (1:2,400-scale) | 71% |
| **Stream Density** | 5.0 miles of channel per mile (1:5,000-scale mapping) | 57% |
| **Smallest Contributing Watershed** | 60 acres | 57% |
| **Smallest Mapped Waterbody** | 1 acre | 57% |
| **Post-Event Update** | Required/Nice to Have | 43% each |
| **Level of Detail** | Consistent Level of Detail | 57% |

The requirements for characteristics and analytical functions for BU #18 are shown in Table 69.

*Table 69. Requirements for characteristics and analytical functions for BU #18*

| Required Characteristics/Analytical Functions | Number of MCAs (of 7) | Percent of MCAs |
|---|---|---|
| Left/right bank delineation | 7 | 100% |
| Linkages to stream gage observations | 6 | 86% |
| Coastlines | 5 | 71% |
| Determine downstream flood area | 5 | 71% |
| Floodplain boundary | 5 | 71% |
| Mash-ups | 5 | 71% |
| Navigate up or downstream on network | 5 | 71% |
| Calculate time of travel to points | 4 | 57% |
| Diversion lines | 4 | 57% |
| Find upstream or downstream feature within watershed | 4 | 57% |
| Flood stage | 4 | 57% |
| Velocity or time of travel | 4 | 57% |
| Bridges, culverts | 3 | 43% |
| Calculate distance on network | 3 | 43% |
| Calculate drainage area | 3 | 43% |
| Calculate stream distance to points | 3 | 43% |
| Find upstream or downstream points | 3 | 43% |
| Linkages to cross section geometry | 3 | 43% |
| Riverine bathymetry | 3 | 43% |
| Badlands | 2 | 29% |
| Delineate catchment | 2 | 29% |
| Diversion points | 2 | 29% |
| Find events or features on network | 2 | 29% |
| Flow periodicity | 2 | 29% |
| Preset symbolization | 2 | 29% |
| Accumulate upstream or downstream features | 1 | 14% |

| Required Characteristics/Analytical Functions | Number of MCAs (of 7) | Percent of MCAs |
|---|---|---|
| Coastal bathymetry | 1 | 14% |
| Deltas | 1 | 14% |
| Estuaries | 1 | 14% |
| Leakage along lines | 1 | 14% |
| Leakage at points | 1 | 14% |
| Other (please specify) | 1 | 14% |
| User defined symbolization | 1 | 14% |
| Wetlands | 1 | 14% |
| Animation of time-series | 0 | 0% |

**Future Annual Benefits**

An estimated $5.5 million in future annual benefits from enhanced hydrography data was reported for the MCAs categorized as having BU #18 as their primary BU.

Figure 53 shows the estimated future annual benefits provided by the MCAs categorized as having BU #18 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

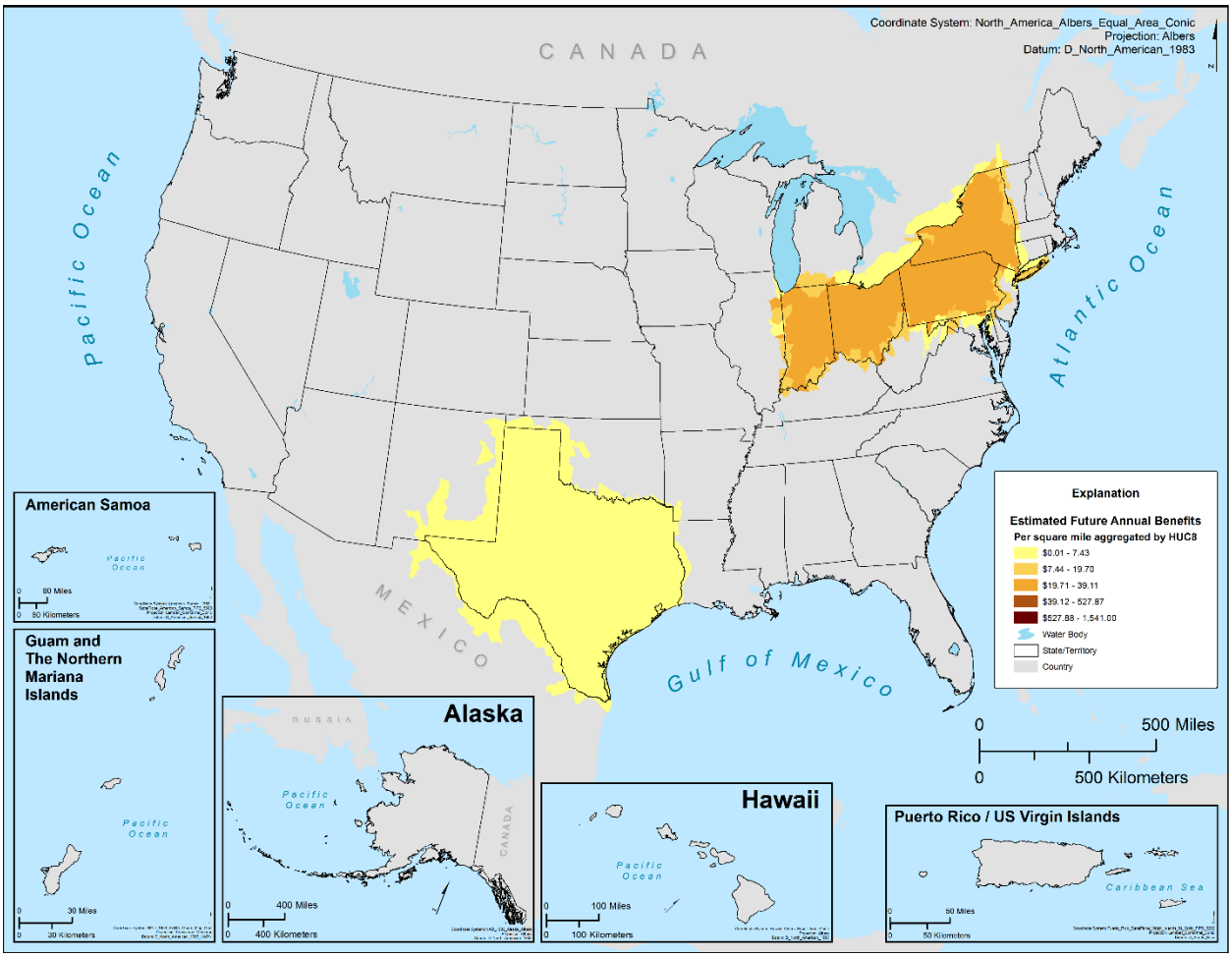



*Figure 53. Estimated future annual benefits reported for the MCAs categorized as having BU #18 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 70 lists the qualitative benefits reported for BU #18.

*Table 55. Qualitative benefits reported for BU #18*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 1 | 1 | 4 | 0 | 1 | 1 | 1 | 1 |
| **Moderate** | 3 | 4 | 1 | 5 | 4 | 4 | 2 | 2 |
| **Minor** | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| **N/A** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| **Don't Know** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |
| **No Answer Provided** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |

These benefits would be realized due to improved accuracy of hydrography data, which would result in time and cost savings for finding or creating geospatial data layers, improved analyses, more accurate planning for mitigation efforts, more accurate assessments post event, and greater criminal fines and penalties collected for violations of environmental laws.

**Example Homeland Security, Law Enforcement, and Disaster Response Activities**

Enforcing environmental laws is a central part of EPA's strategic plan to protect human health and the environment. EPA works to ensure compliance with environmental requirements. When warranted, EPA will take civil or criminal enforcement action against violators of environmental laws. When this is necessary, hydrography data and point discharge data are components of the evidence collection, forensics, and scientific analyses used for criminal and civil enforcement.

Federal, State, and local agencies need updated hydrography as soon as possible after a disaster, such as a flood or hurricane event, for response activities. These activities may include clearing debris, collecting high water mark information, evaluating damaged buildings and other property, finding suitable sites for alternative housing or debris staging, among many other activities.

http://fema.maps.arcgis.com/home/webmap/viewer.html?webmap=307dd522499d4a44a33d7296a5da5ea0

Figure 54 shows an example of a FEMA evaluation of structures that were damaged during Superstorm Sandy and their location relative to the storm surge extent from that event. Most of the structures that were affected fell within the surge extent; however, the amount of damage sustained by individual structures varied, most likely in relation to the structure's pre-existing condition and elevation.

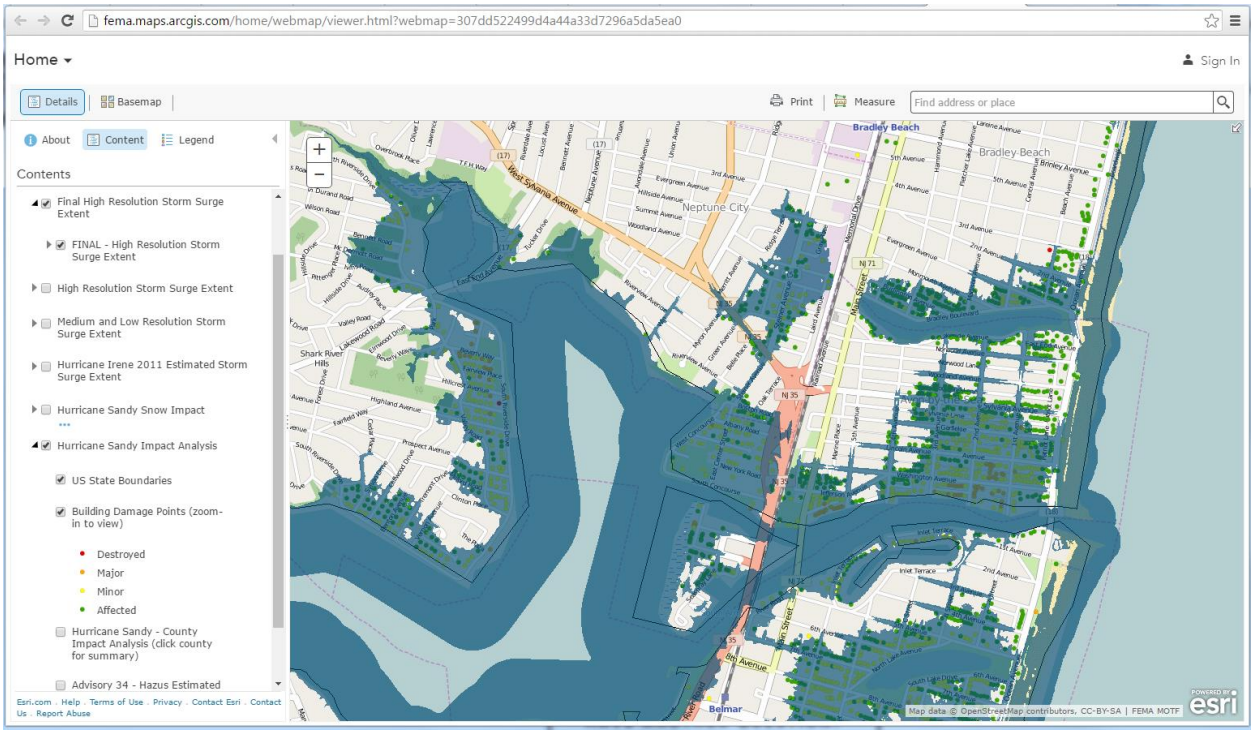



*Figure 54. Superstorm Sandy damaged structures and storm surge extents. Image courtesy of FEMA.*

The New Jersey Office of Homeland Security and Preparedness (OHSP) provided the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for critical infrastructure protection and disaster preparedness activities.

*Table71. NJ OHSP qualitative benefits from use of enhanced hydrography information for critical infrastructure protection and disaster preparedness activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Major | Major | Major | Moderate | Moderate | Moderate | Not Applicable | Moderate |

## BU #19 Marine and Riverine Navigation and Safety

BU #19, Marine and Riverine Navigation and Safety, was described in the questionnaire as including the following types of MCAs: coastal and bathymetric mapping, identification of hazards to navigation, and sediment management at coastal navigation projects.

**BU #19 Highlights:**

**Number of MCAs:** 3
**Estimated annual program budget:** $43,000,000
**Estimated current annual benefits:** $30,000 to $50,000
**Estimated future annual benefits:** $100,000

Three MCAs were characterized as having BU #19 as their primary BU, with a total annual program budget of $43 million for programs supported by hydrography data, a total of $30,000 to $50,000 in estimated annual benefits from the currently available hydrography data, and $100,000 in estimated future annual benefits from enhanced hydrography data. Additionally, one MCA noted BU #19 as an ancillary BU.

These three MCAs were reported by NOAA for shoreline mapping and nautical charting, and the Delaware Department of Natural Resources for permitting near perennial streams.

**Areas of Interest**

Figure 55 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #19 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

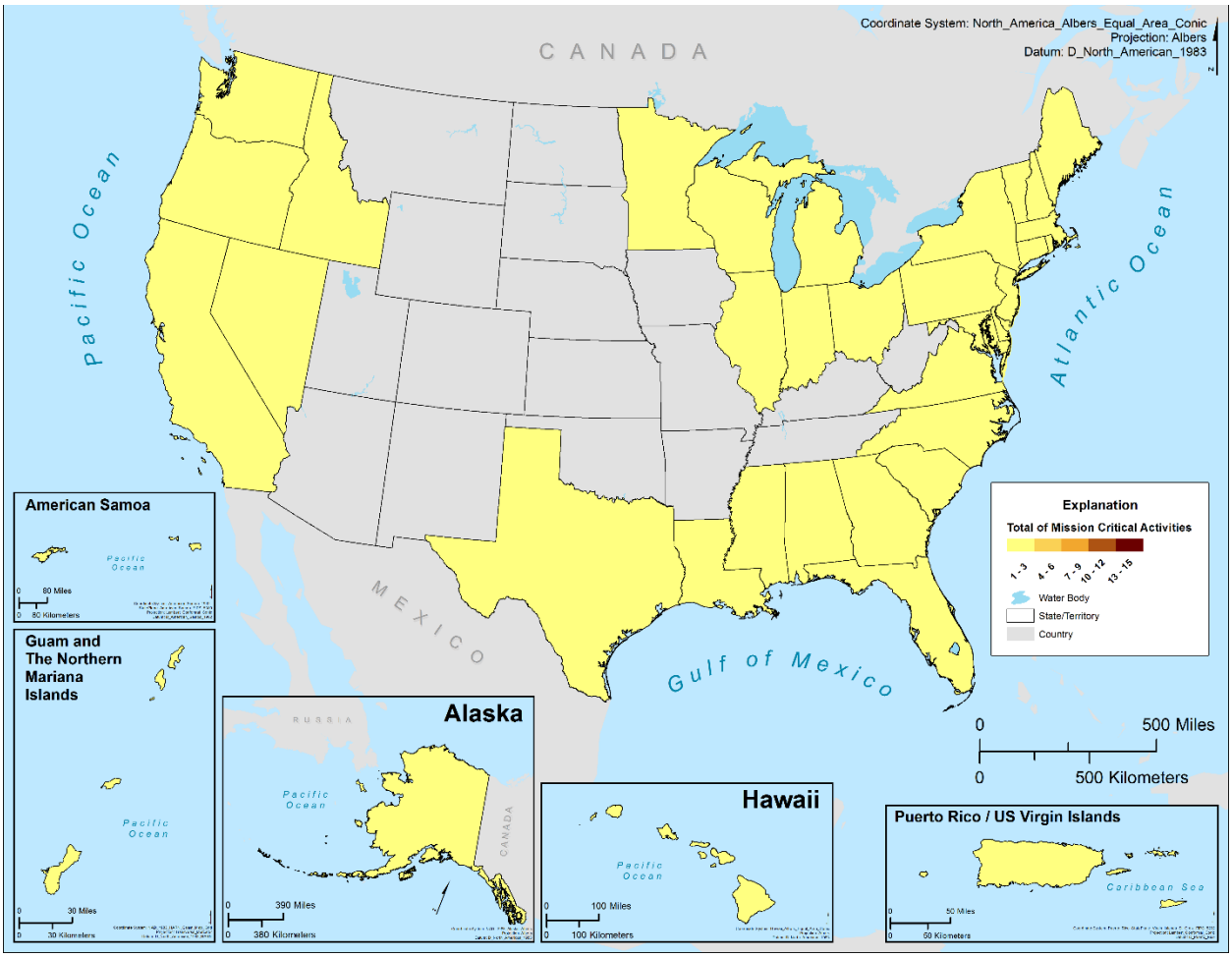



*Figure 55. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #19 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

### Requirements

Table 72 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #19 as their primary BU, and the most frequently requested requirements by category.

*Table 56. Requirements for enhanced hydrography data for BU #19*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | Annually/2-3 Years/4-5 Years | 33% each |
| **Positional Accuracy** | +/- 3 feet, 90% (1:1,200-scale) | 67% |
| **Stream Density** | 2.5 miles of channel per square mile | 67% |
| **Smallest Contributing Watershed** | 6 acres/10 square miles (6,400 acres)/100 square miles (64,000 acres) | 33% each |
| **Smallest Mapped Waterbody** | Less than an acre/1 acre/5 acres | 33% each |
| **Post-Event Update** | Highly Desirable | 67% |
| **Level of Detail** | Best Available | 100% |

The requirements for characteristics and analytical functions for BU #19 are shown in Table 73.

*Table 57. Requirements for characteristics and analytical functions for BU #19*

| Required Characteristics/Analytical Functions | Number of MCAs (of 3) | Percent of MCAs |
|---|---|---|
| Bridges, culverts | 2 | 67% |
| Coastal bathymetry | 2 | 67% |
| Coastlines | 2 | 67% |
| Deltas | 2 | 67% |
| Estuaries | 2 | 67% |
| Flow periodicity | 2 | 67% |
| Linkages to stream gage observations | 2 | 67% |
| Mash-ups | 2 | 67% |
| Riverine bathymetry | 2 | 67% |
| Wetlands | 2 | 67% |
| Accumulate upstream or downstream features | 1 | 33% |
| Calculate drainage area | 1 | 33% |
| Diversion lines | 1 | 33% |
| Diversion points | 1 | 33% |
| Find events or features on network | 1 | 33% |
| Find upstream or downstream feature within watershed | 1 | 33% |
| Flood stage | 1 | 33% |
| Left/right bank delineation | 1 | 33% |
| Linkages to cross section geometry | 1 | 33% |
| Animation of time-series | 0 | 0% |
| Badlands | 0 | 0% |
| Calculate distance on network | 0 | 0% |
| Calculate stream distance to points | 0 | 0% |
| Calculate time of travel to points | 0 | 0% |
| Delineate catchment | 0 | 0% |
| Determine downstream flood area | 0 | 0% |
| Find upstream or downstream points | 0 | 0% |
| Floodplain boundary | 0 | 0% |
| Leakage along lines | 0 | 0% |
| Leakage at points | 0 | 0% |
| Navigate up or downstream on network | 0 | 0% |
| Other (please specify) | 0 | 0% |
| Preset symbolization | 0 | 0% |
| User defined symbolization | 0 | 0% |
| Velocity or time of travel | 0 | 0% |

**Future Annual Benefits**

An estimated $100,000 in future annual benefits from enhanced hydrography data was reported for the MCAs categorized as having BU #19 as their primary BU.

Figure 56 shows the estimated future annual benefits provided by the MCAs categorized as having BU #19 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

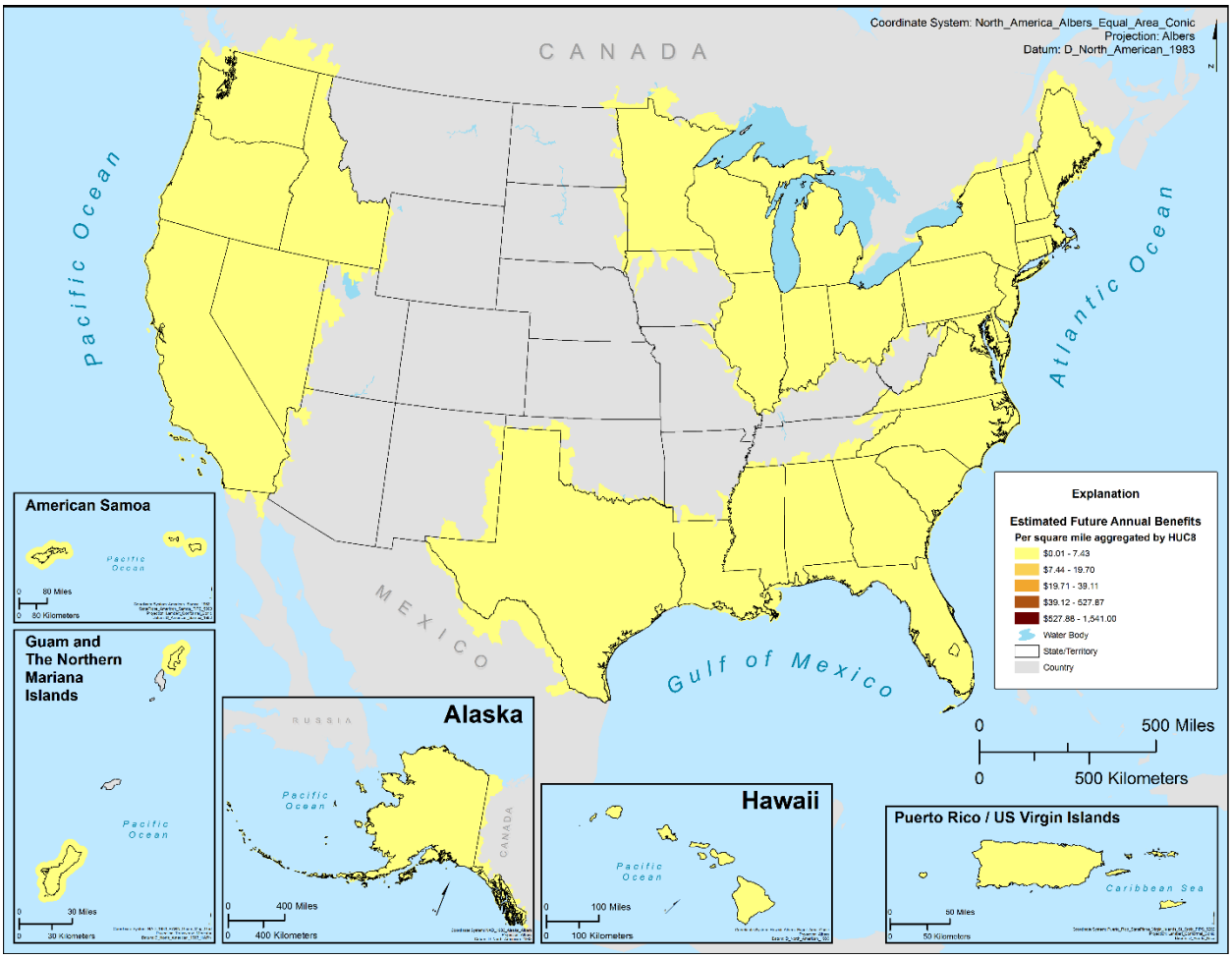



*Figure 56. Estimated future annual benefits reported for the MCAs categorized as having BU #19 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 74 lists the qualitative benefits reported for BU #19.

*Table 58. Qualitative benefits reported for BU #19*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Moderate** | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| **Minor** | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 0 |
| **N/A** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| **Don't Know** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **No Answer Provided** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

These benefits would be realized due to availability of highly accurate data for verifying the positioning of satellite imagery; reduced time and cost to maintain accurate shoreline data; and reduced time spent on site inspection planning and in-field mapping, more efficient permitting, improved jurisdictional determinations, and improved confidence in the results.

**Example Marine and Riverine Navigation Safety Activities**

Navigation, navigation charting, and nautical charting are significant activities for the USACE and NOAA. Figure 57 below shows an example of a nautical chart published by NOAA (image courtesy of NOAA). NOAA's nautical charts include detailed shorelines, bathymetry (depth contours and spot depths), as well as other features of interest for navigation including lights, buoys, rocks, underwater cables and other features, etc. The charts are published in paper and electronic formats, and are updated weekly (if warranted). USACE's Army Geospatial Center publishes inland navigational charts for the 8,200 miles of navigable rivers maintained by the USACE. This system spans 22 states and includes 276 lock chambers with a total lift of 6,100 feet. The USACE navigation charts include similar information to the NOAA charts. They also include detailed information, including diagrams, of bridges that span the rivers.

Neither NOAA nor USGS currently uses USGS hydrography data products for these activities. Rather they rely on local-scale shoreline data and bathymetry. However, one USACE program manager noted that a navigable waterways dataset that could be used to support these activities would be "awesome."

http://www.nauticalchartsonline.com/charts/NOAA

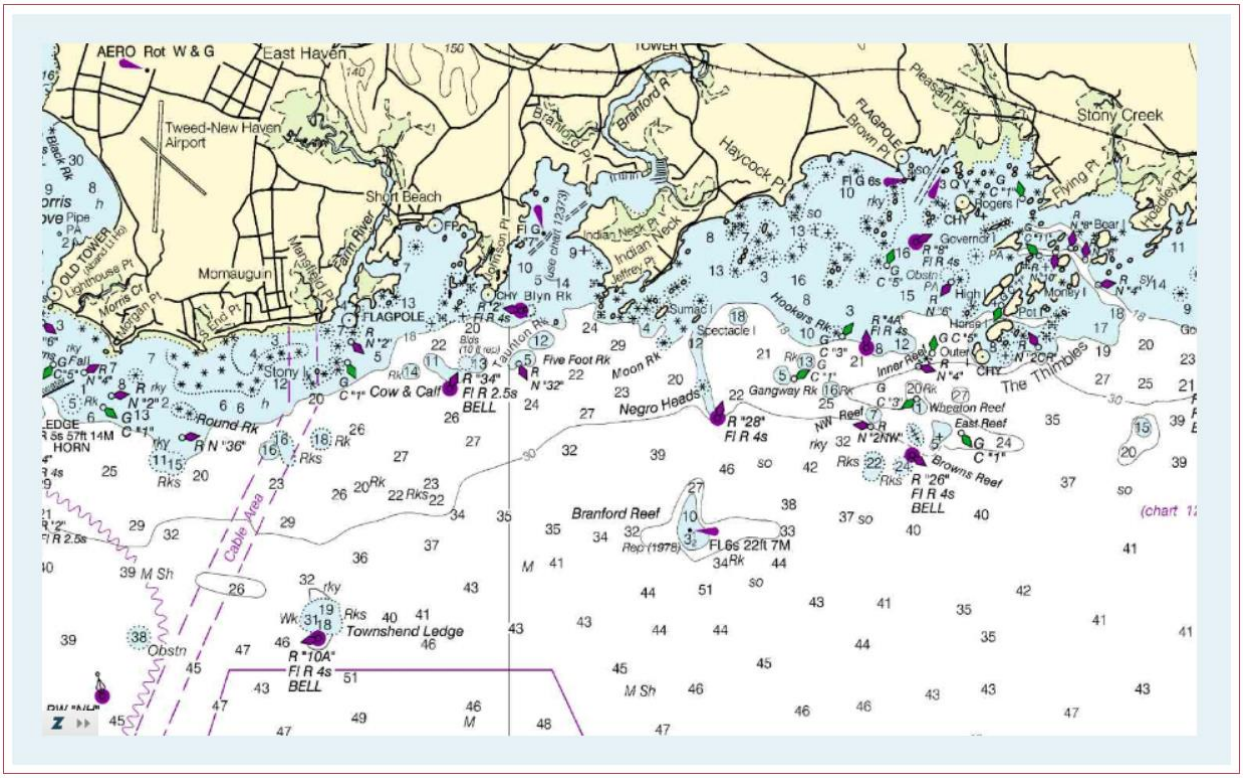



*Figure 57. Portion of a NOAA nautical chart of Long Island Sound. Image courtesy of NOAA.*

NOAA provided the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for nautical charting activities.

*Table 59. NOAA qualitative benefits from use of enhanced hydrography information for nautical charting activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Minor | Minor | Minor | Minor | Minor | Minor | Minor | Not Applicable |

## BU #20 Infrastructure and Construction Management

BU #20, Infrastructure and Construction Management, was described in the questionnaire as including the following types of MCAs: design and placement of water supply and wastewater treatment facilities, storm water management, and bridge design.

**BU #20 Highlights:**

**Number of MCAs:** 18
**Estimated annual program budget:** $1,088,715,250 to $5,088,715,250
**Estimated current annual benefits:** $1,648,000
**Estimated future annual benefits:** $8,730,000

A total of 18 MCAs were characterized as having BU #20 as their primary BU, with a total annual program budget of $1,088,715,250 to $5,088,715,250 for programs supported by hydrography data, a total of $1,648,000 in estimated annual benefits from the currently available hydrography data, and $8,730,000 in estimated future annual benefits from enhanced hydrography data. Additionally, two MCAs noted BU #20 as an ancillary BU.

These 18 MCAs were reported by one not-for-profit, five local or regional agencies, and 12 state agencies, of which eight are Departments of Transportation and four are water resources agencies. These MCAs include transportation system design and operation to include hydraulic design for new and upgraded features, water and wastewater utility infrastructure management, stormwater infrastructure design, and excavation notification services ("Call before you dig").

**Areas of Interest**

Figure 58 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #20 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

All states have a department of transportation with bridge design as one of its missions, and many state, county, or local entities have storm water management as one of their missions; however, because of the varied representation of the state and local agencies and because the BUs were self-selected, it is likely that additional areas across the U.S. than those represented would have an interest in infrastructure and construction management.

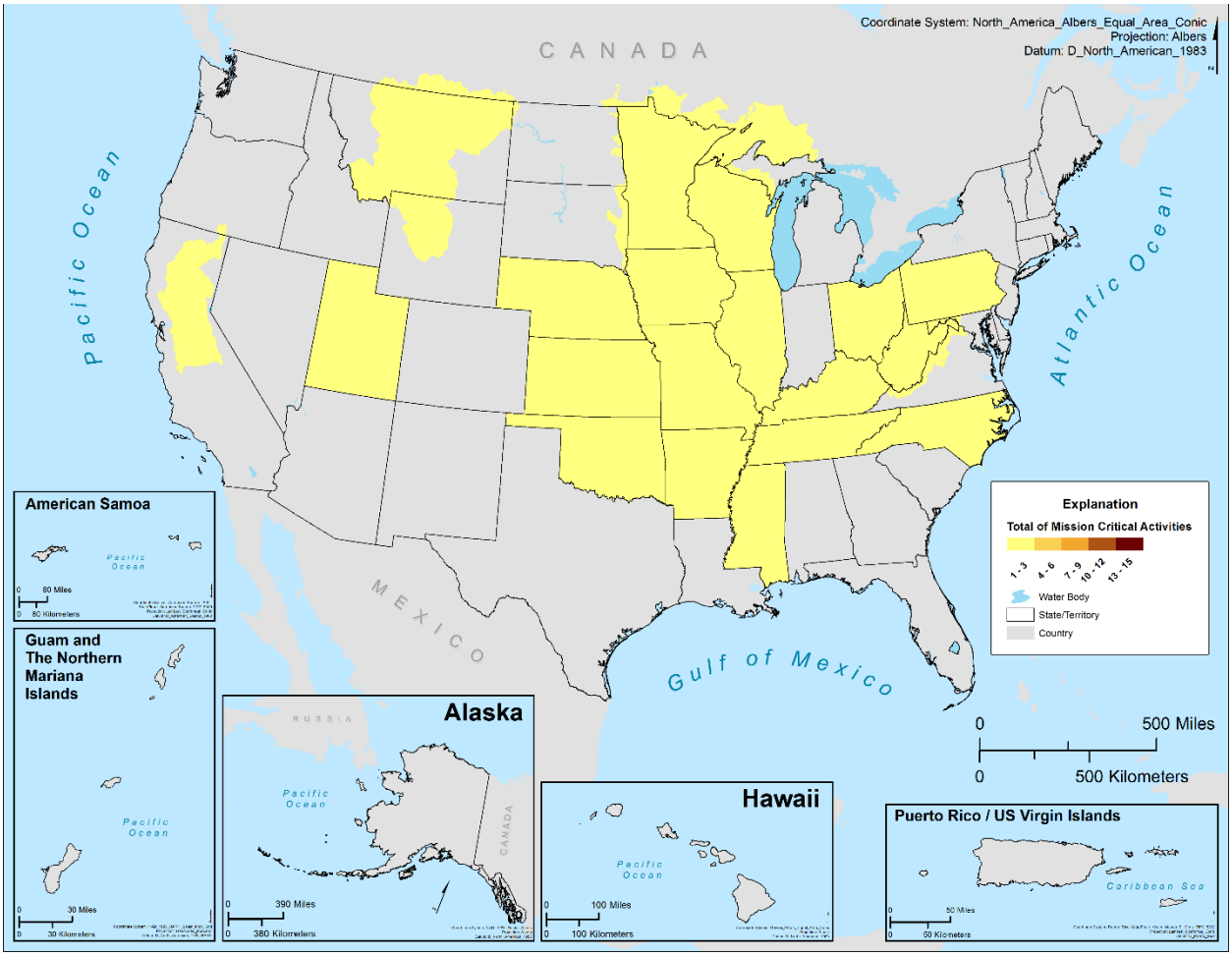



*Figure 58. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #20 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

**Requirements**

Table 76 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #20 as their primary BU, and the most frequently requested requirements by category.

*Table 60. Requirements for enhanced hydrography data reported for BU #20*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | 4-5 Years/6-10 Years | 28% each |
| **Positional Accuracy** | 3 feet, 90% (1:1,200-scale) | 78% |
| **Stream Density** | 5.0 miles of channel per mile (1:5,000-scale mapping) | 39% |
| **Smallest Contributing Watershed** | 6 acres | 33% |
| **Smallest Mapped Waterbody** | Less than an acre | 44% |
| **Post-Event Update** | Nice To Have | 44% |
| **Level of Detail** | Best Available | 83% |

The requirements for characteristics and analytical functions for BU #20 are shown in Table 77.

*Table 61. Requirements for characteristics and analytical functions for BU #20*

| Required Characteristics/Analytical Functions | Number of MCAs (of 18) | Percent of MCAs |
|---|---|---|
| Floodplain boundary | 16 | 89% |
| Calculate drainage area | 15 | 83% |
| Find upstream or downstream feature within watershed | 14 | 78% |
| Navigate up or downstream on network | 14 | 78% |
| Bridges, culverts | 13 | 72% |
| Flow periodicity | 13 | 72% |
| Accumulate upstream or downstream features | 12 | 67% |
| Calculate stream distance to points | 12 | 67% |
| Delineate catchment | 12 | 67% |
| Determine downstream flood area | 12 | 67% |
| Left/right bank delineation | 12 | 67% |
| Linkages to stream gage observations | 12 | 67% |
| Mash-ups | 11 | 61% |
| Wetlands | 11 | 61% |
| Flood stage | 10 | 56% |
| Preset symbolization | 10 | 56% |
| Calculate time of travel to points | 9 | 50% |
| Linkages to cross section geometry | 9 | 50% |
| Riverine bathymetry | 9 | 50% |
| Diversion lines | 8 | 44% |
| Find upstream or downstream points | 8 | 44% |
| User defined symbolization | 8 | 44% |
| Velocity or time of travel | 8 | 44% |
| Calculate distance on network | 7 | 39% |
| Find events or features on network | 6 | 33% |
| Diversion points | 5 | 28% |

| Required Characteristics/Analytical Functions | Number of MCAs (of 18) | Percent of MCAs |
|---|---|---|
| Leakage along lines | 5 | 28% |
| Leakage at points | 5 | 28% |
| Other (please specify) | 5 | 28% |
| Animation of time-series | 4 | 22% |
| Coastal bathymetry | 3 | 17% |
| Estuaries | 3 | 17% |
| Coastlines | 2 | 11% |
| Deltas | 2 | 11% |
| Badlands | 1 | 6% |

**Future Annual Benefits**

An estimated $8,730,000 in future annual benefits from enhanced hydrography data was reported for the MCAs that were categorized as having BU #20 as their primary BU.

Figure 59 shows the estimated future annual benefits provided by the MCAs categorized as having BU #20 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

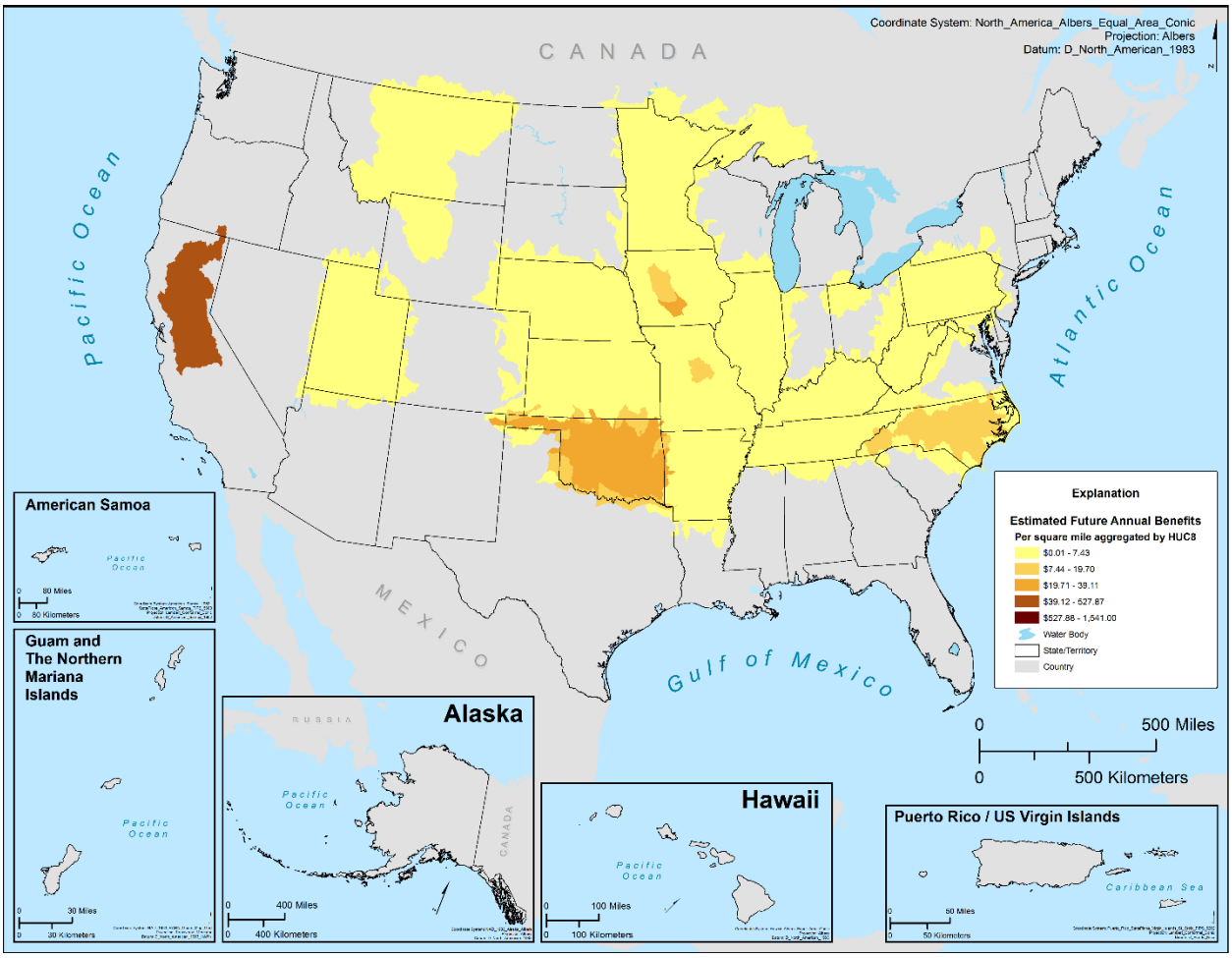



*Figure 10. Estimated future annual benefits reported for the MCAs categorized as having BU #20 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 78 lists the qualitative benefits reported for BU #20.

*Table 62. Qualitative benefits reported for BU #20*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 8 | 7 | 8 | 7 | 4 | 6 | 7 | 2 |
| **Moderate** | 7 | 7 | 7 | 9 | 7 | 5 | 7 | 3 |
| **Minor** | 3 | 4 | 1 | 1 | 5 | 6 | 4 | 7 |
| **N/A** | 0 | 0 | 2 | 1 | 2 | 1 | 0 | 5 |
| **Don't Know** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **No Answer Provided** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |

These benefits would be realized due to improved spatial accuracy, density, and consistency of hydrography data, which would result in time and cost savings from less field survey work; not having to search for relevant datasets; not having to maintain local datasets; greater success in obtaining grant funding for projects to help remediate or protect water resources; greater efficiency in mapping and determinations; improved modeling and analysis, including analysis of stormwater conveyance projects on habitat, analysis for stream and wetland restoration and flood mitigation projects, engineering analysis for capital projects, and 2D modeling for hydraulic design and environmental clearance; improved ability to conduct preliminary design phases more accurately, leading to fewer costly and time-consuming field engineering changes; quicker and more accurate environmental reporting; improved public outreach and understanding regarding water quality and flood hazards; and more informed decision making and policy development.

**Example Infrastructure and Construction Management Activities**

State Departments of Transportation (DOTs) are responsible for transportation planning and design to include design of bridges and stormwater Best Management Practices (BMPs), topographic mapping, emergency response, and flood control. Many of these activities typically rely on local-scale hydrography and lidar datasets. Hydrography data used for bridge design are similar to those used for hydrologic and hydraulic modeling performed for flood risk studies: lidar data; local resolution hydrography data that match the lidar; stream gage and stream flow data; high water marks; accurate placement of levees and levee-like structures; and location of other bridges, culverts, and dams.

http://www.fhwa.dot.gov/engineering/hydraulics/pubs/hif12018.pdf

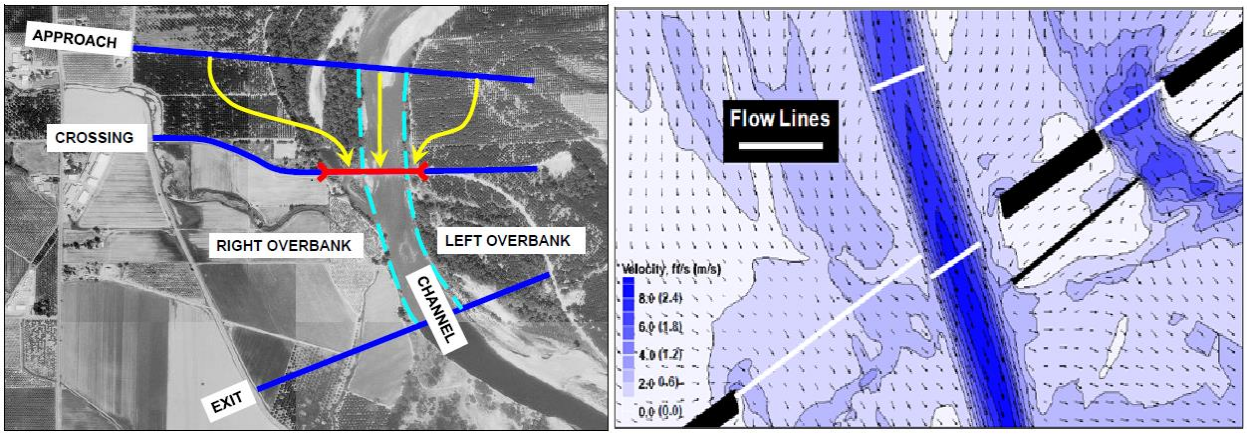



*Figure 60. 1D and 2D hydraulic modeling for bridge design. Images courtesy of Federal Highway Administration.*

Eight state DOTs estimated a total of $3.465 million in future annual benefits from use of enhanced hydrography data. These benefits would be derived from use of more accurate data for H&H modeling for transportation infrastructure design and construction.

## BU #21 Urban and Regional Planning

BU #21, Urban and Regional Planning, was described in the questionnaire as including the following types of MCAs: land development and zoning, municipal mapping of building footprints and impervious surfaces, and parks and transportation planning.

**BU #21 Highlights:**

**Number of MCAs:** 17
**Estimated annual program budget:** $1,763,511,643
**Estimated current annual benefits:** $2,165,000
**Estimated future annual benefits:** $3,415,000

A total of 17 MCAs were characterized as having BU #21 as their primary BU, with a total annual program budget of $1,763,511,643 for programs supported by hydrography data, a total of $2,165,000 in estimated annual benefits from the currently available hydrography data, and $3,415,000 in estimated future annual benefits from enhanced hydrography data. Additionally, one MCA noted BU #21 as an ancillary BU.

These 17 MCAs were reported by the U.S. Census Bureau for maintenance of the MAF/TIGER database, which includes hydrography features to support Census operation; and one not-for-profit, 11 local or regional agencies, and five state agencies for land use planning and permitting, transportation planning, stormwater management, watershed protection, flood hazard mapping, and maintenance of base mapping reference layers.

**Areas of Interest**

Figure 61 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #21 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

Most regional, county, or local entities have zoning and land use mapping and planning as one of their missions; however, because of the varied representation of the state and local agencies, and because the BUs were self-selected, it is likely that additional areas across the U.S. would have an interest in urban and regional planning.

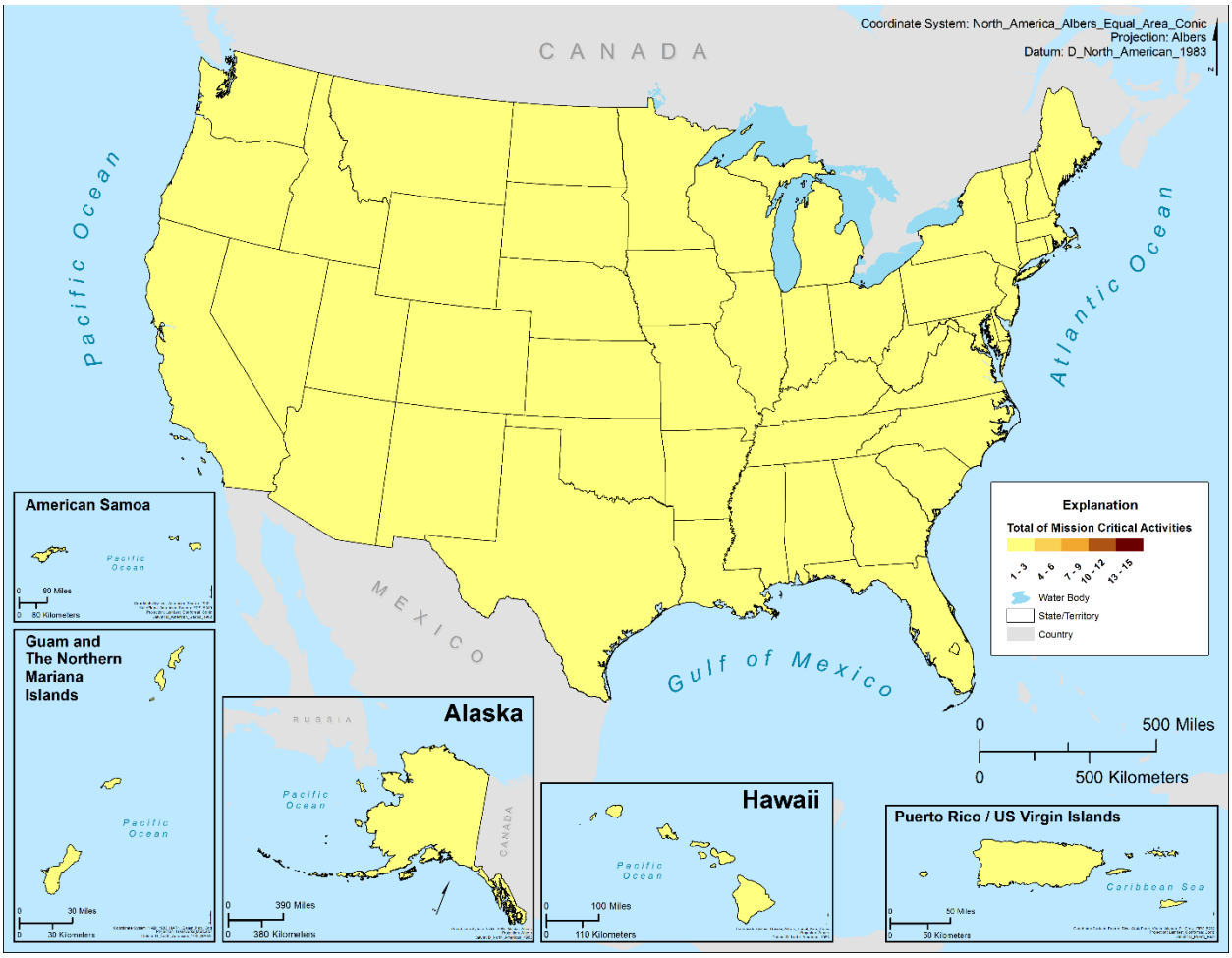



*Figure 61. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #21 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

### Requirements

Table 79 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #21 as their primary BU, and the most frequently requested requirements by category.

*Table 63. Requirements for enhanced hydrography data reorted for BU #21*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | 2-3 Years | 53% |
| **Positional Accuracy** | +/- 3 feet, 90% (1:1,200-scale) | 59% |
| **Stream Density** | 5.0 miles of channel per mile (1:5,000-scale mapping) | 41% |
| **Smallest Contributing Watershed** | 6 acres | 41% |
| **Smallest Mapped Waterbody** | Less than an acre | 59% |
| **Post-Event Update** | Nice To Have | 47% |
| **Level of Detail** | Best Available | 65% |

The requirements for characteristics and analytical functions for BU #21 are shown in Table 80.

*Table 64. Requirements for characteristics and analytical functions for BU #21*

| Required Characteristics/Analytical Functions | Number of MCAs (of 17) | Percent of MCAs |
|---|---|---|
| Wetlands | 16 | 94% |
| Floodplain boundary | 13 | 76% |
| Navigate up or downstream on network | 12 | 71% |
| Bridges, culverts | 11 | 65% |
| Delineate catchment | 11 | 65% |
| Preset symbolization | 11 | 65% |
| User defined symbolization | 11 | 65% |
| Calculate drainage area | 10 | 59% |
| Determine downstream flood area | 9 | 53% |
| Find upstream or downstream feature within watershed | 9 | 53% |
| Find upstream or downstream points | 9 | 53% |
| Flood stage | 9 | 53% |
| Mash-ups | 9 | 53% |
| Diversion lines | 8 | 47% |
| Find events or features on network | 8 | 47% |
| Left/right bank delineation | 8 | 47% |
| Accumulate upstream or downstream features | 7 | 41% |
| Calculate distance on network | 7 | 41% |
| Calculate stream distance to points | 7 | 41% |
| Coastlines | 7 | 41% |
| Diversion points | 7 | 41% |
| Estuaries | 7 | 41% |
| Riverine bathymetry | 7 | 41% |
| Flow periodicity | 6 | 35% |
| Linkages to stream gage observations | 6 | 35% |
| Coastal bathymetry | 4 | 24% |
| Deltas | 3 | 18% |
| Leakage at points | 3 | 18% |
| Linkages to cross section geometry | 3 | 18% |
| Other (please specify) | 3 | 18% |
| Velocity or time of travel | 3 | 18% |
| Animation of time-series | 2 | 12% |
| Calculate time of travel to points | 2 | 12% |
| Leakage along lines | 2 | 12% |
| Badlands | 0 | 0% |

**Future Annual Benefits**

An estimated $3,415,000 in future annual benefits from enhanced hydrography data was reported for the MCAs that were categorized as having BU #21 as their primary BU.

Figure 62 shows the estimated future annual benefits provided by the MCAs categorized as having BU #21 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

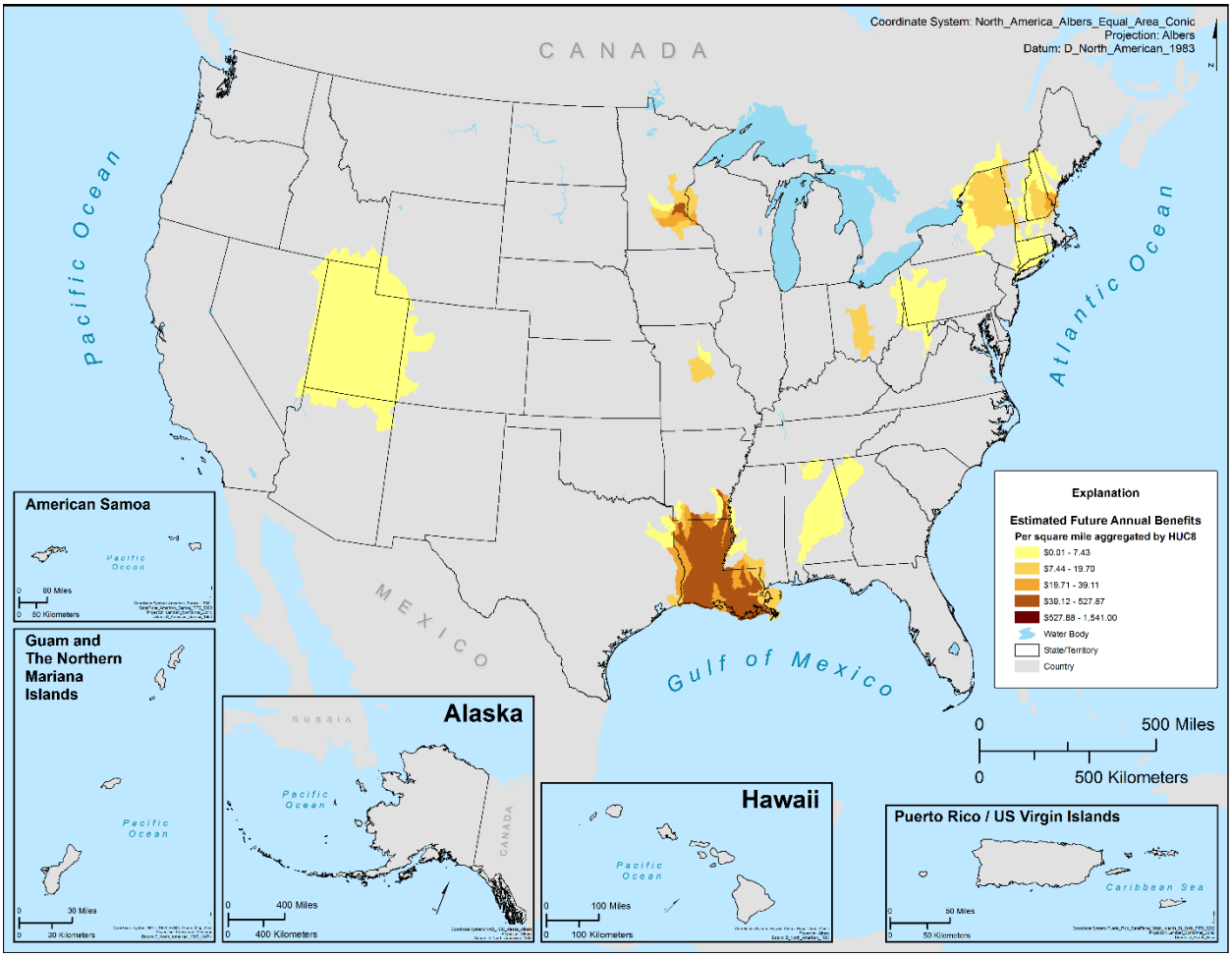



*Figure 62. Estimated future annual benefits reported for the MCAs categorized as having BU #21 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 81 lists the qualitative benefits reported for BU #21.

*Table 65. Qualitative benefits reported for BU #21*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 9 | 10 | 6 | 4 | 2 | 1 | 6 | 1 |
| **Moderate** | 3 | 2 | 5 | 7 | 10 | 10 | 5 | 3 |
| **Minor** | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 4 |

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **N/A** | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 5 |
| **Don't Know** | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 4 |
| **No Answer Provided** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |

These benefits would be realized due to improved spatial accuracy, currency, consistency, and attribution of hydrography data, which would result in time and cost savings from not having to search for relevant datasets; not having to maintain local datasets; cost sharing; greater efficiency in accomplishing mission; improved modeling and analysis to include watershed modeling, flow determination for bridge and flood control design, and storm surge risk assessments; improved permit reviews; improved environmental compliance reviews; improved public outreach and understanding; increased consistency and confidence in land use planning and permitting decisions; and increased public confidence in Census products.

**Example Urban and Regional Planning Activities**

Elevation and hydrography data are critical in urban and regional planning, often because of the need to address potential drainage issues when considering sites for future development. Many states have adopted buffer zones or otherwise regulate construction near perennial streams, the coastline, waterways, wetlands, and habitats designated for preservation. Local resolution hydrography data that can be linked to lidar, parcels, land use, and wetlands as well as other planning related datasets such as historic designated areas, hub zones, and Census data are needed for effective and sensitive urban and regional planning.

The state of Vermont Agency of Natural Resources (ANR) has mapped statewide River Corridors, which encompass the area of land surrounding a river that provides for the meandering, floodplain, and the riparian functions necessary to restore and maintain the naturally stable or least erosive form of a river thereby minimizing erosion hazards over time. They are mapped using calculations that rely on in-field and map based measurements. Lands within and immediately abutting a river corridor are at higher risk to fluvial erosion. Giving rivers room to move is critical in avoiding the stream armoring and berming measures used to protect within-corridor development that so often leads to increases in erosion upstream and downstream and adversely affects public safety, riparian landowners, and river ecosystems.

The River Corridors are used for state regulatory actions and recommendations, planning, and conservation programs. Developer, landowner, and municipal officials use them as a tool when planning new development or land improvement projects, for town planning, designating centers of growth, and implementing zoning bylaws that may include river corridor protections in a consistent townwide manner. The River Corridors are used in addition to the FEMA designated Special Flood Hazard Areas. However, in Vermont FEMA inundation areas have only been mapped for approximately 20 percent of Vermont stream miles and post-flood damage surveys have shown that fluvial erosion, not inundation, is the most common natural hazard type in Vermont.

Vermont decided to develop river corridor maps because they represent a zone for the avoidance and management of erosion hazards.

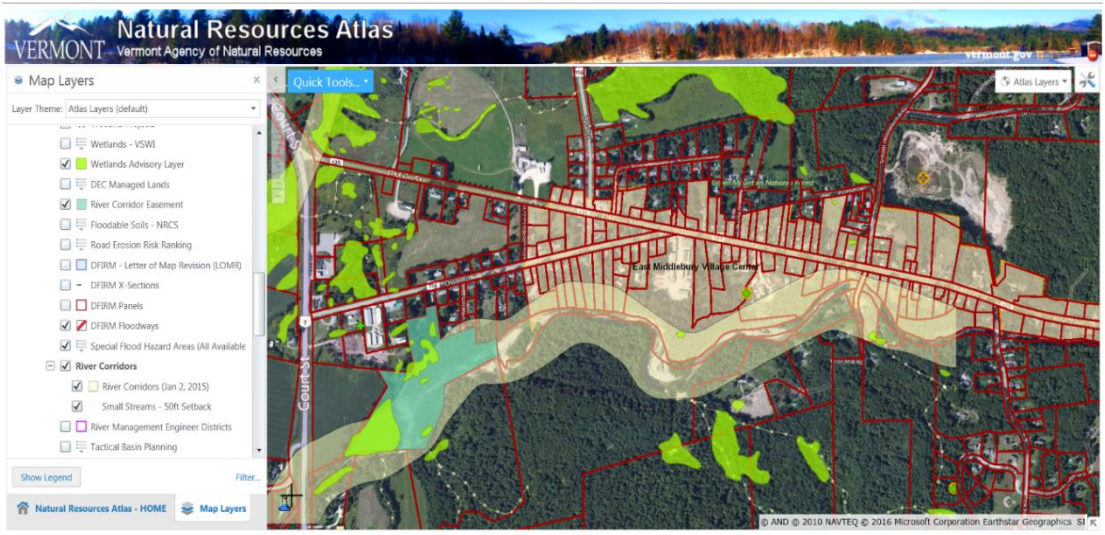



*Figure 63. Vermont River Corridors in addition to wetlands advisory areas, parcels, and other natural resources data used for planning activities. Image courtesy of Vermont Agency of Natural Resources.*

## BU #22 Health and Human Services

BU #22, Health and Human Services, was described in the questionnaire as including the following types of MCAs: health emergency response, habitat modeling and disease prevention, drinking water protection, public health and safety, and prevention of waterborne diseases.

**BU #22 Highlights:**

**Number of MCAs:** 4
**Estimated annual program budget:** $58,450,000
**Estimated current annual benefits:** $500,000
**Estimated future annual benefits:** $500,000

Four MCAs were characterized as having BU #22 as their primary BU, with a total annual program budget of $58,450,000 for programs supported by hydrography data, a total of $500,000 in estimated annual benefits from the currently available hydrography data, and $500,000 in estimated future annual benefits from enhanced hydrography data. Additionally, one MCA noted BU #22 as an ancillary BU.

These four MCAs were reported by the Animal and Plant Health Inspection Service (APHIS) for preparation of environmental documentation for APHIS programs including NEPA, ESA, and FIFRA; the U.S. EPA for monitoring, notification, and remediation of water quality at beaches, and pesticide fate modeling including the effect on drinking water supplies and endangered aquatic species; and the Arizona Department of Environmental Quality for protection of public health and the environment in Arizona.

**Areas of Interest**

Figure 64 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #22 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

Most states and many county or local entities likely have public health and safety as one of their missions; however, representation of state and local agencies varied and the BUs were self-selected. Additionally,

the Centers for Disease Control, which would have an interest in hydrography data as a component of epidemiological research, was not represented in the study participants. Therefore, it is likely that there are additional areas across the U.S. where health and human services would be a concern.

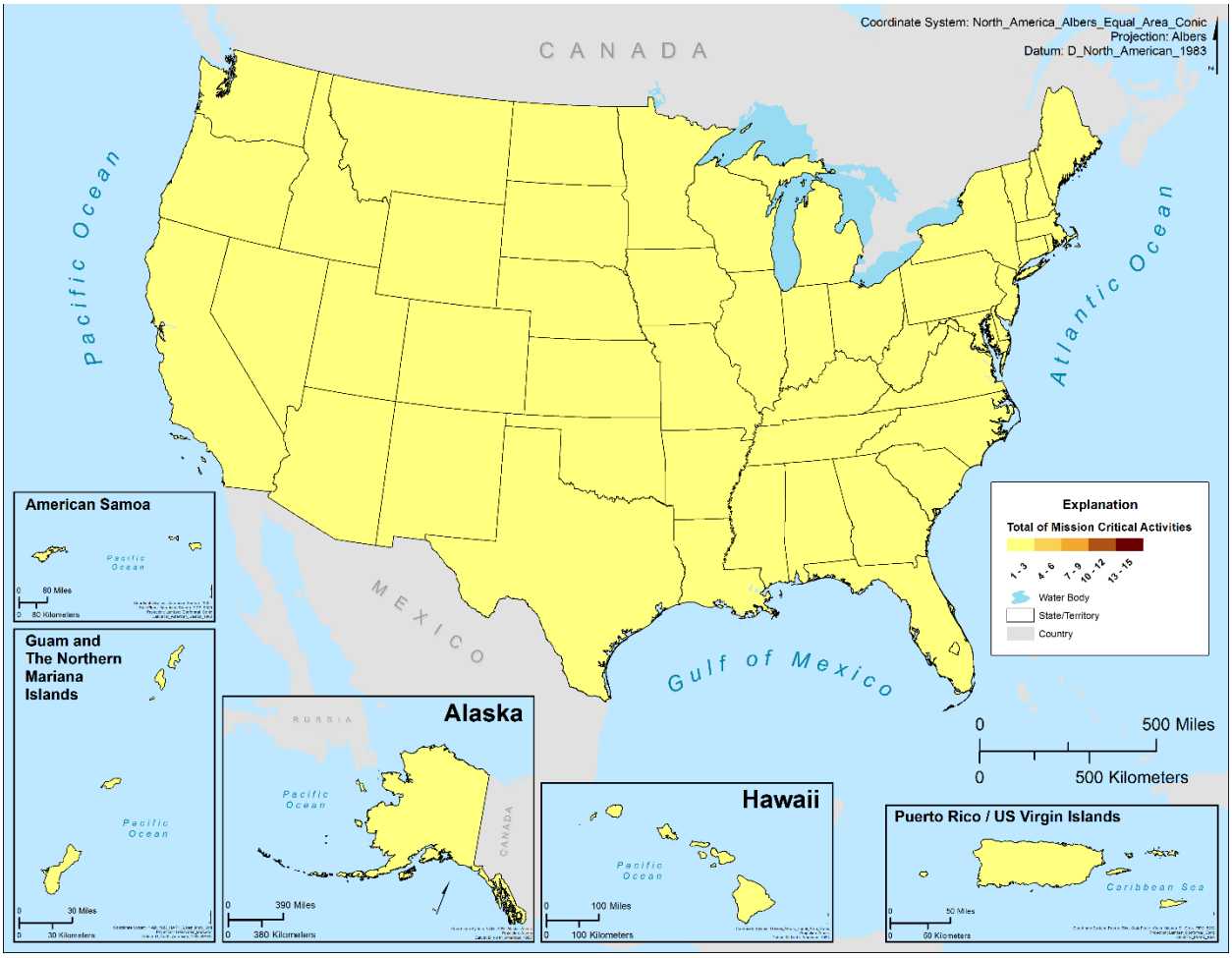



*Figure 64. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #22 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

### Requirements

Table 82 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #22 as their primary BU, and the most frequently requested requirements by category.

*Table 662. Requirements for enhanced hydrography data reported for BU #22*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | Annually | 50% |
| **Positional Accuracy** | 40 feet, 90% (1:24,000-scale) | 100% |
| **Stream Density** | 2.5 miles of channel per mile (1:24,000-scale mapping) | 75% |
| **Smallest Contributing Watershed** | 6 acres | 50% |
| **Smallest Mapped Waterbody** | Less than an acre | 50% |
| **Post-Event Update** | Required | 50% |
| **Level of Detail** | Best Available | 75% |

The requirements for characteristics and analytical functions for BU #22 are shown in Table 83.

*Table 67. Requirements for characteristics and analytical functions for BU #22*

| Required Characteristics/Analytical Functions | Number of MCAs (of 4) | Percent of MCAs |
|---|---|---|
| Calculate drainage area | 4 | 100% |
| Calculate stream distance to points | 4 | 100% |
| Find upstream or downstream feature within watershed | 4 | 100% |
| Linkages to stream gage observations | 4 | 100% |
| Navigate up or downstream on network | 4 | 100% |
| Wetlands | 4 | 100% |
| Diversion lines | 3 | 75% |
| Estuaries | 3 | 75% |
| Floodplain boundary | 3 | 75% |
| Flow periodicity | 3 | 75% |
| Leakage at points | 3 | 75% |
| Left/right bank delineation | 3 | 75% |
| Linkages to cross section geometry | 3 | 75% |
| Mash-ups | 3 | 75% |
| Velocity or time of travel | 3 | 75% |
| Accumulate upstream or downstream features | 2 | 50% |
| Badlands | 2 | 50% |
| Calculate distance on network | 2 | 50% |
| Calculate time of travel to points | 2 | 50% |
| Delineate catchment | 2 | 50% |
| Diversion points | 2 | 50% |
| Find events or features on network | 2 | 50% |
| Leakage along lines | 2 | 50% |
| Other (please specify) | 2 | 50% |
| Preset symbolization | 2 | 50% |
| User defined symbolization | 2 | 50% |
| Animation of time-series | 1 | 25% |
| Bridges, culverts | 1 | 25% |
| Coastal bathymetry | 1 | 25% |
| Coastlines | 1 | 25% |
| Deltas | 1 | 25% |
| Determine downstream flood area | 1 | 25% |
| Find upstream or downstream points | 1 | 25% |
| Flood stage | 1 | 25% |
| Riverine bathymetry | 1 | 25% |

**Future Annual Benefits**

An estimated $500,000 in future annual benefits from enhanced hydrography data was reported for the MCAs that were categorized as having BU #22 as their primary BU.

Figure 65 shows the estimated future annual benefits provided by the MCAs categorized as having BU #22 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

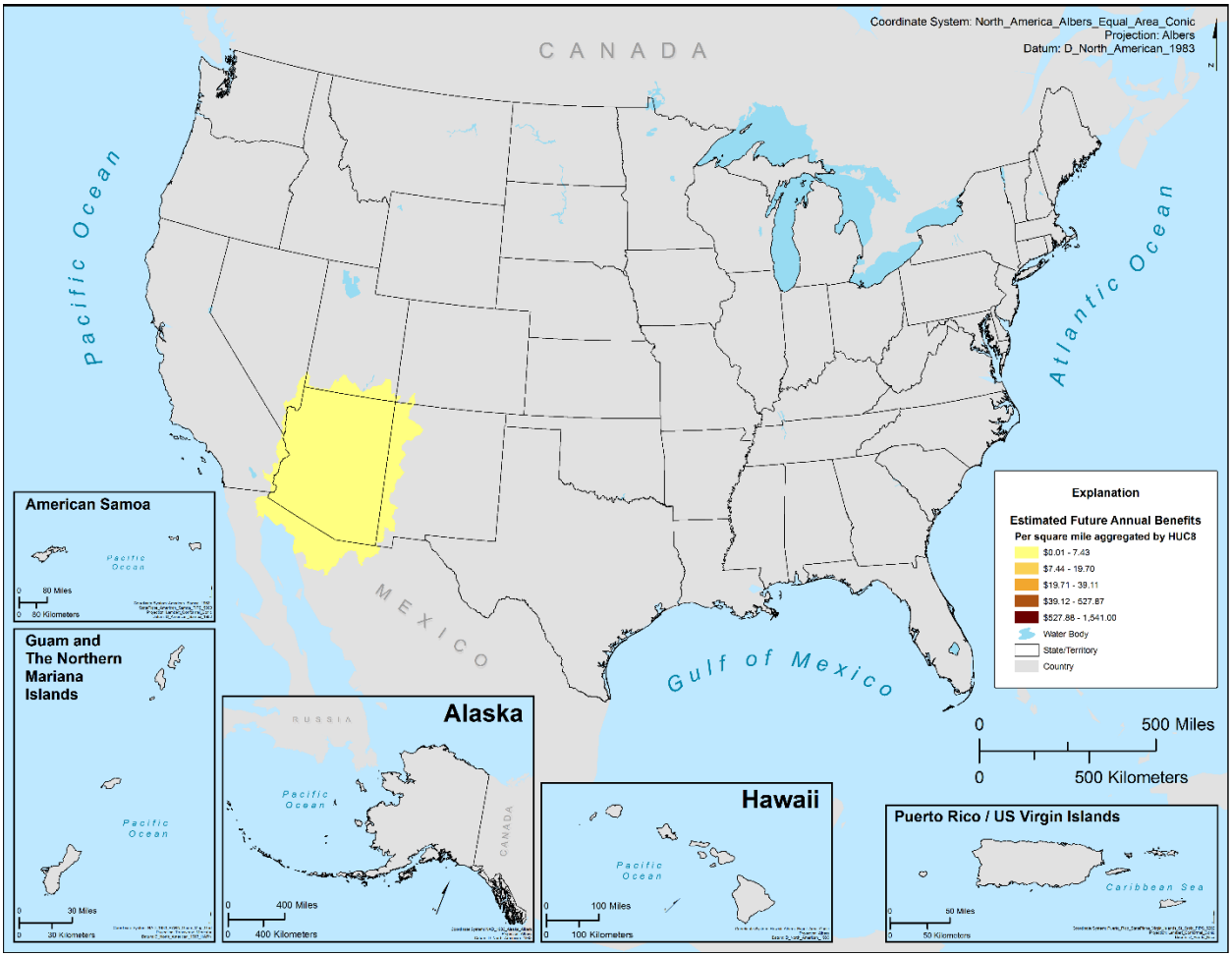



*Figure 65. Estimated future annual benefits reported for the MCAs categorized as having BU #22 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 84 lists the qualitative benefits reported for BU #22.

*Table 68. Qualitative benefits reported for BU #22*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 0 |
| **Moderate** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 |
| **Minor** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **N/A** | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| **Don't Know** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **No Answer Provided** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

These benefits would be realized due to increased detail, accuracy, and currency of data, which would lead to reduced program costs, better environmental modeling, a better informed public, more accurate endangered species assessments, and better decision making.

**Example Health and Human Services Activities**

All pesticides distributed or sold in the United States must be registered (licensed) by EPA and the applicant must show, among other things, that using the pesticide according to specifications "will not generally cause unreasonable adverse effects on the environment.'' Even when the label instructions are carefully adhered to, a small portion of pesticides applied on farm fields sometimes reaches surface and ground water, as evidenced by the detection of pesticides in water quality monitoring studies. Hhydrography data are needed for the fate transport modeling activities used to analyze pesticide concentrations in waterways.

Pesticide loss from farm fields depends on the natural characteristics of an area (soil properties, climate, and terrain), properties of the chemicals used, and farm management practices. The relationships among these factors are complex. Pesticides that leach or runoff on one soil type may not significantly leach or runoff with another soil type. To devise and implement policies for reducing pesticide loss from farm fields, decision-makers need to know where in the country the potential for these losses is the greatest.

NRCS created a National Pesticide Loss Database for use as a look-up table for estimates of pesticide losses from farm fields in leachate and runoff. Estimates are available for specific pesticides, soil groups, and climatic regions. The database is designed for use in conjunction with watershed models to target priority areas that may be in need of additional conservation practices aimed at reducing environmental risk.

Pesticide leaching and runoff losses were estimated using a pesticide fate and transport model that uses as inputs soil parameters, field characteristics, management practices, pesticide properties, and climate to estimate pesticide leaching and runoff losses. Estimates were generated for 243 pesticides applied to 120 generic soils for 20 years of daily weather from each of 55 climate stations. Pesticide runoff was movement beyond the edge of the field, including both pesticides in solution and pesticides adsorbed to soil material and organic matter. Final pesticide loss results are reported as 1) the percentage of total mass of pesticide applied, and 2) the annual concentration of pesticide leaving the field, expressed as the percentage of total mass of pesticide applied per million parts of water or sediment.

Research has shown that, with proper management, most of the potential for pesticide loss can be eliminated. The potential pesticide loss shown in the map does not adjust for reduction in losses resulting from good management practices. The map does show, however, where in the country the need for careful farm management is the greatest, and where the likelihood of water quality impacts from pesticide loss from farm fields is the greatest.

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/ma/home/?cid=nrcs143_014115

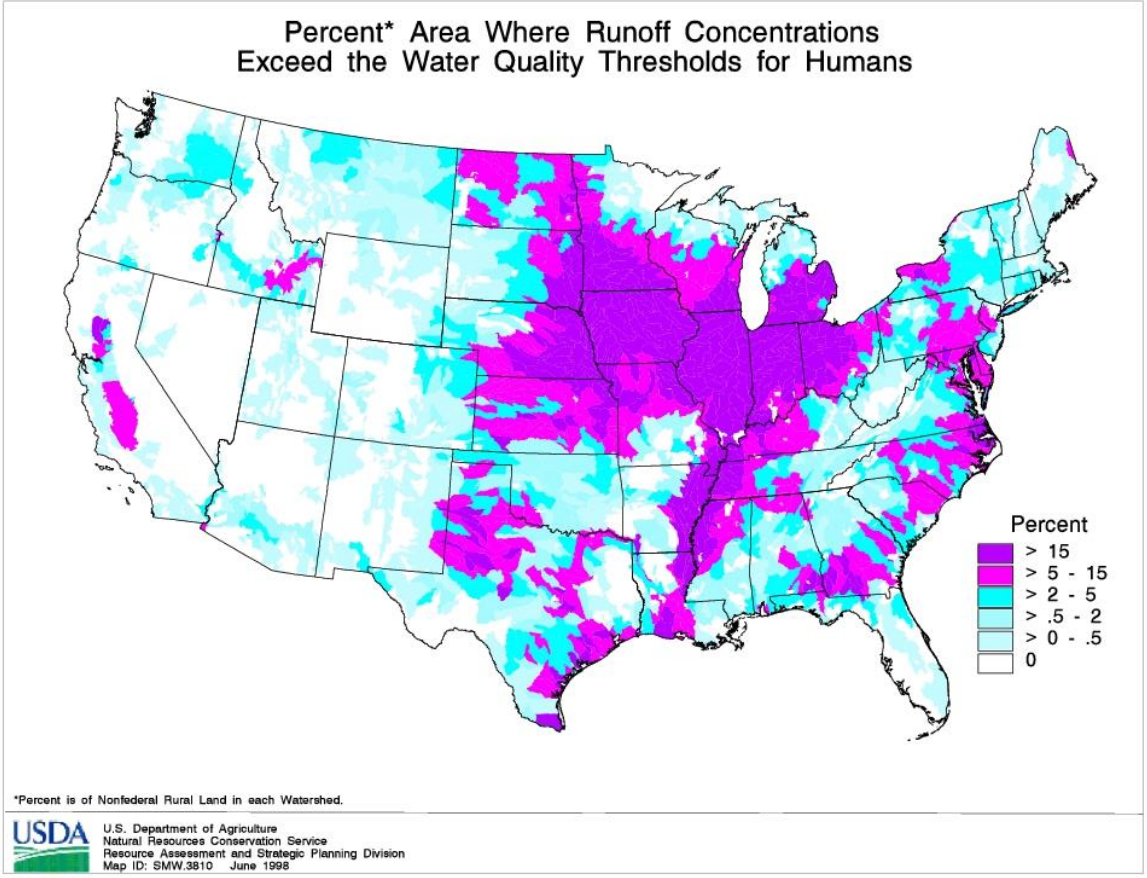



*Figure 66. Modeled pesticide runoff concentrations that exceed water quality thresholds for humans. Image courtesy of NRCS.*

EPA provided the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for pesticide fate modeling activities including the effect on drinking water supplies and aquatic species.

*Table 69. EPA qualitative benefits from use of enhanced hydrography information for pesticide fate modeling activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Major | Major | Major | Major | Major | Not Applicable | Major | Not Applicable |

## BU #23 Real Estate, Banking, Mortgage, and Insurance

BU #23, Real Estate, Banking, Mortgage, and Insurance, was described in the questionnaire as including the following types of MCAs: assessment of risk for natural hazards to inform insurance policy rates and the determination of mandatory insurance.

No MCAs were characterized as having BU #23 as their primary BU. However, two MCAs noted BU #23 as an ancillary BU: FEMA for Flood Risk Mapping, Assessment, and Planning (Risk MAP), and USFWS for refuges.

In order for the real estate, banking, mortgage and insurance industries to properly serve American homeowners, it is important for all to recognize risks from natural disasters, and many of those risks depend on the geographic location, topography of the terrain on which homes are built, and proximity to flooding sources. Local building officials and permitting departments need detailed lidar and hydrography data along with floodplain information for issuing permits for building structures. Also key is linking hydrography data down to the parcel level so that local application of regulations can be engaged effectively.

## BU #24 Education K-12 and Beyond

BU #24, Education K-12 and Beyond, was described in the questionnaire as including the following types of MCAs: understanding continental-scale climate change impacts, land cover monitoring, and development of military training simulators.

**BU #24 Highlights:**

**Number of MCAs:** 9
**Estimated annual program budget:** $1,564,977
**Estimated current annual benefits:** $525,000
**Estimated future annual benefits:** $5,360,000

Nine MCAs were characterized as having BU #24 as their primary BU, with a total annual program budget of $1,564,977 for programs supported by hydrography data, a total of $525,000 in estimated annual benefits from the currently available hydrography data, and $5.36 million in estimated future annual benefits from enhanced hydrography data.

These nine MCAs were reported by six state universities (Alabama, Arkansas, Connecticut, New Hampshire, New Mexico, and South Dakota), one state agency (Oklahoma Water Resources Center), and two local agencies (City of Murfreesboro, TN and Chester County Water Resources Authority, PA). These MCAs were described as being for public education, research, and outreach. Additionally, several MCAs include statewide geospatial data management and distribution.

**Areas of Interest**

Figure 67 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #24 as their primary BU. Areas with darker colors have greater numbers of areas of interest.

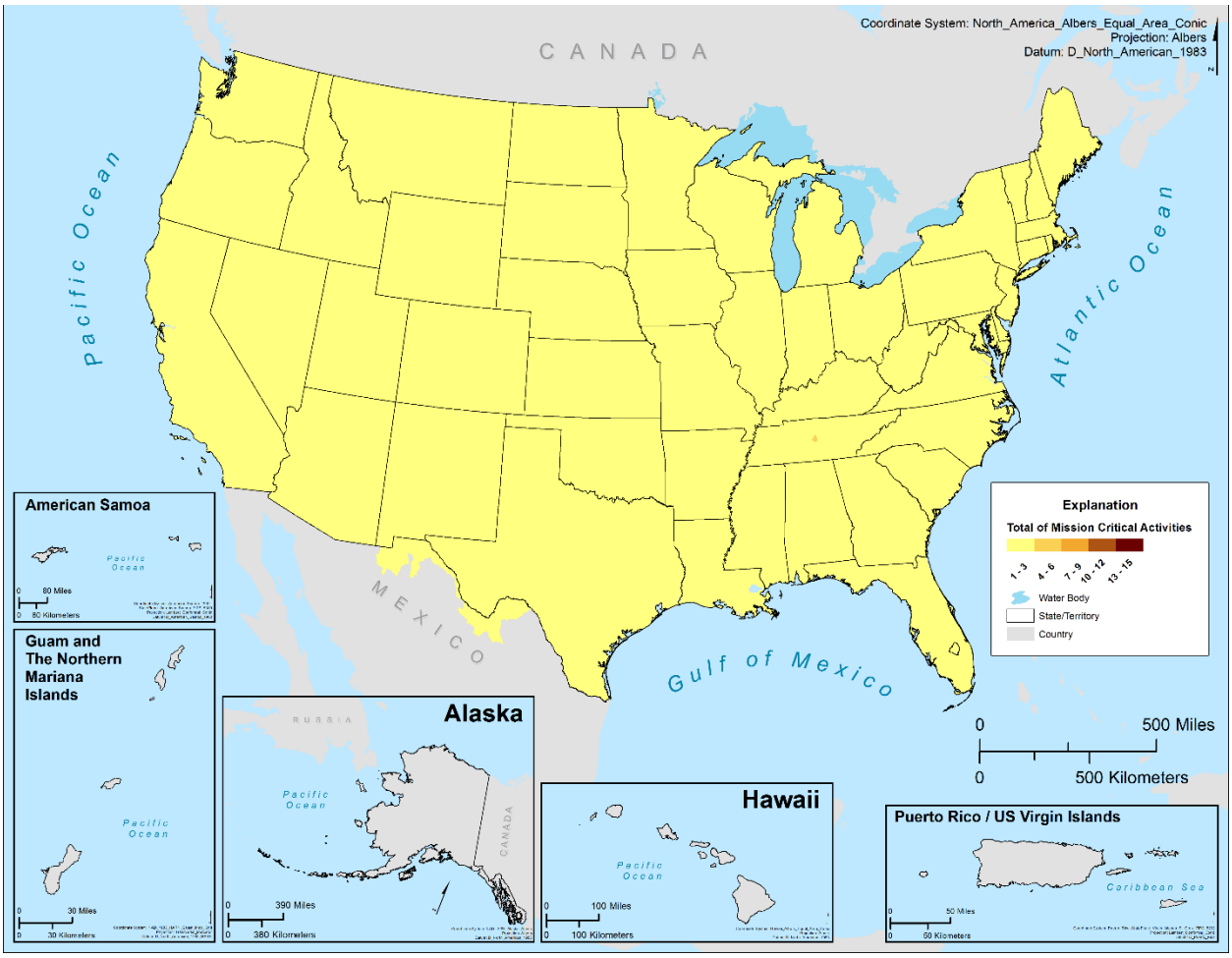



*Figure 67. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #24 as their primary BU. Areas with darker colors have greater numbers of areas of interest.*

### Requirements

Table 86 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #24 as their primary BU, and the most frequently requested requirements by category.

*Table 706. Requirements for enhanced hydrography data reported for BU #24*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | 2-3 Years | 44% |
| **Positional Accuracy** | +/- 33 feet, 90% (1:12,000-scale) | 56% |
| **Stream Density** | 5.0 miles of channel per mile (1:5,000-scale mapping) | 33% |
| **Smallest Contributing Watershed** | 1 square mile (640 acres) | 44% |
| **Smallest Mapped Waterbody** | 5 acres | 33% |
| **Post-Event Update** | Highly Desirable | 44% |
| **Level of Detail** | Best Available | 67% |

The requirements for characteristics and analytical functions for BU #24 are shown in Table 87.

*Table 71. Requirements for characteristics and analytical functions for BU #24*

| Required Characteristics/Analytical Functions | Number of MCAs (of 9) | Percent of MCAs |
|---|---|---|
| Floodplain boundary | 8 | 89% |
| Calculate drainage area | 7 | 78% |
| Flood stage | 7 | 78% |
| Linkages to cross section geometry | 7 | 78% |
| Calculate stream distance to points | 6 | 67% |
| Find upstream or downstream feature within watershed | 6 | 67% |
| Flow periodicity | 6 | 67% |
| Linkages to stream gage observations | 6 | 67% |
| Wetlands | 6 | 67% |
| Bridges, culverts | 5 | 56% |
| Delineate catchment | 5 | 56% |
| Determine downstream flood area | 5 | 56% |
| Diversion lines | 5 | 56% |
| Left/right bank delineation | 5 | 56% |
| Mash-ups | 5 | 56% |
| Navigate up or downstream on network | 5 | 56% |
| Preset symbolization | 5 | 56% |
| Animation of time-series | 4 | 44% |
| Diversion points | 4 | 44% |
| Find upstream or downstream points | 4 | 44% |
| Riverine bathymetry | 4 | 44% |
| Calculate time of travel to points | 3 | 33% |
| Velocity or time of travel | 3 | 33% |
| Accumulate upstream or downstream features | 2 | 22% |
| Calculate distance on network | 2 | 22% |
| Coastal bathymetry | 2 | 22% |
| Coastlines | 2 | 22% |
| Find events or features on network | 2 | 22% |
| Leakage at points | 2 | 22% |
| Other (please specify) | 2 | 22% |
| Estuaries | 1 | 11% |
| Leakage along lines | 1 | 11% |
| User defined symbolization | 1 | 11% |
| Badlands | 0 | 0% |
| Deltas | 0 | 0% |

**Future Annual Benefits**

An estimated $5.36 million in future annual benefits from enhanced hydrography data was reported for the MCAs categorized as having BU #24 as their primary BU.

Figure 68 shows the estimated future annual benefits provided by the MCAs categorized as having BU #24 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

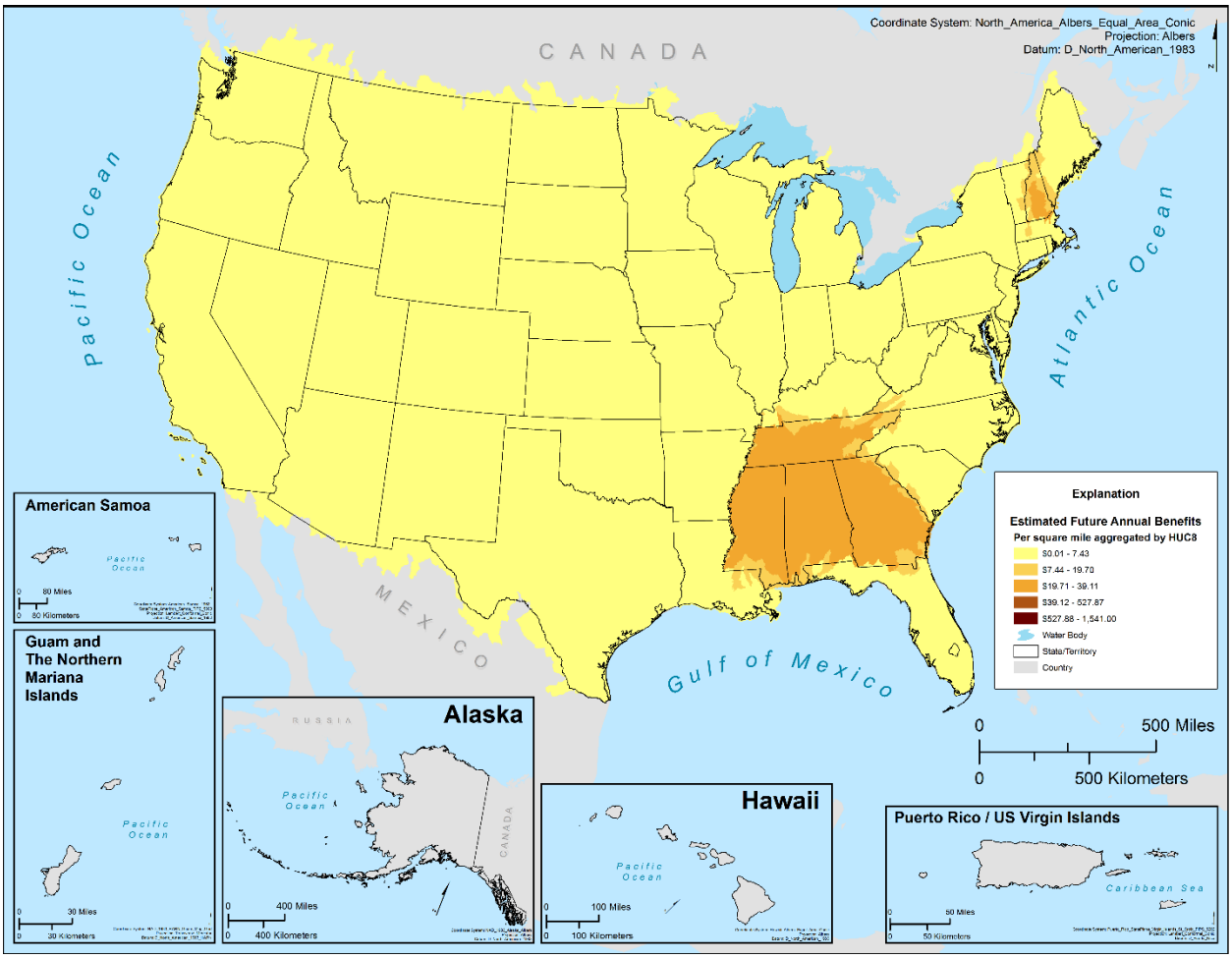



*Figure 68. Estimated future annual benefits reported for the MCAs categorized as having BU #24 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 88 lists the qualitative benefits reported for BU #24.

*Table 72. Qualitative benefits reported for BU #24*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 4 | 3 | 5 | 0 | 1 | 5 | 3 | 0 |
| **Moderate** | 2 | 3 | 3 | 6 | 6 | 3 | 3 | 0 |
| **Minor** | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 3 |
| **N/A** | 1 | 2 | 0 | 1 | 1 | 0 | 0 | 3 |
| **Don't Know** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **No Answer Provided** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Total** | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |

These benefits would be realized due to improved hydrography data, resulting in better water resources education, research, and outreach. Dissemination of the improved hydrography data via state or regional data warehouses and/or online mapping applications would benefit multiple constituents and serve multiple interests.

**Example Education K-12 and Beyond Activities**

Hydrography data are used for university research involving among other things climate and climate change impacts on stream flow; paleo (using tree rings) reconstructions of historic stream flow; and forecasting stream flow, flood preparation/response, and drought frequency. Additionally, a number of educational institutions manage their state GIS repositories of data and in many cases provide on-line services for viewing and/or downloading the data and metadata. These data are widely used by state and local governments, private industry, non-profit organizations, and researchers throughout their states and beyond.

The University of New Hampshire (UNH) is one such university that develops, hosts, and distributes geospatial data to constituents in New Hampshire. Figure 69 shows a view of flood hazard and water resources data in New Hampshire as seen in the UNH Geographically Referenced Analysis and Information Transfer (GRANIT) system.

http://granitviewii.unh.edu/

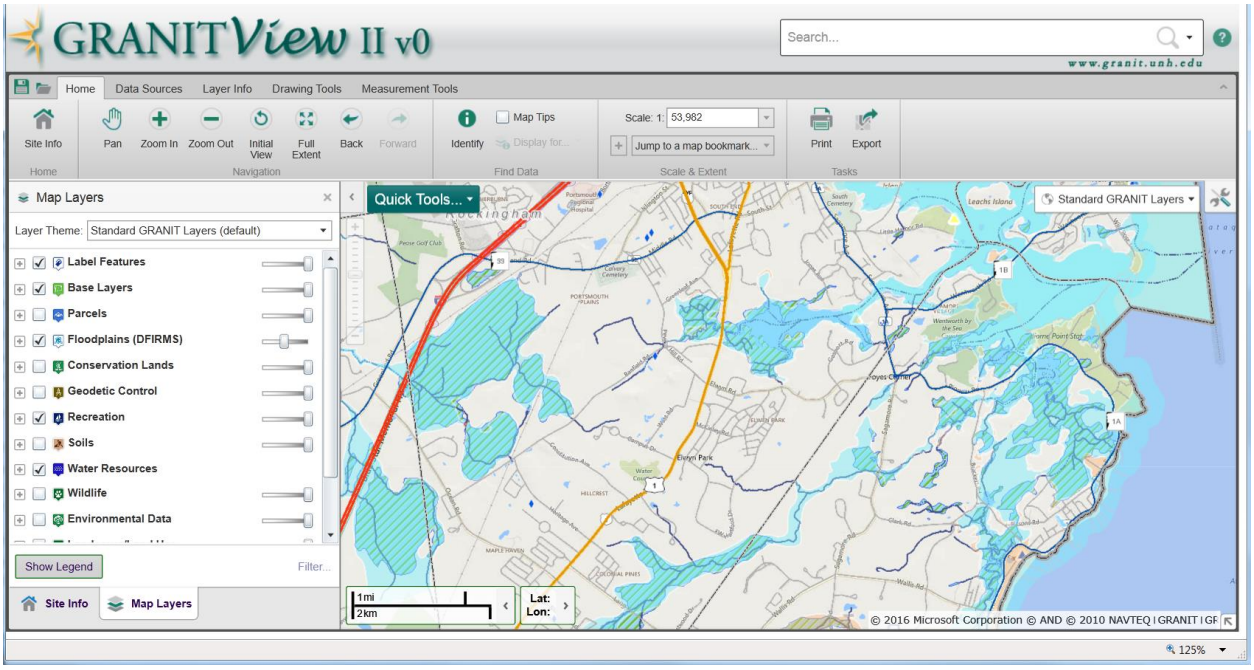



*Figure 11. UNH GRANIT on-line state GIS viewer and download site. Image courtesy of NH GRANIT.*

UNH estimated $250,000 in future annual benefits from use of enhanced hydrography data. These benefits would be derived from use of more accurate data for mapping locations of large water bodies for wildfire response water acquisition. Additionally, the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for geospatial data distribution activities was provided by UNH.

*Table 73. UNH qualitative benefits from use of enhanced hydrography information for geospatial data distribution activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Major | Major | Major | Moderate | Major | Major | Major | Don't Know |

## BU #25 Recreation

BU #25, Recreation, was described in the questionnaire as including the following types of MCAs: development of recreational facilities such as rafting, trails, and fishing areas; and location-based products and services.

**BU #25 Highlights:**

**Number of MCAs:** 3
**Estimated annual program budget:** $2,900,000
**Estimated current annual benefits:** $1,410,000
**Estimated future annual benefits:** $166,000

Three MCAs were characterized as having BU #25 as their primary BU, with a total annual program budget of $2.9 million for programs supported by hydrography data, a total of $1.41 million in estimated annual benefits from the currently available hydrography data, and $166,000 in estimated future annual benefits from enhanced hydrography data. Additionally, one MCA noted BU #25 as an ancillary BU.

These three MCAs were reported by the Muskingum Watershed Conservancy District for recreation, the Pennsylvania Department of Conservation and Natural Resources for recreational opportunities relative to trails/water trails and greenways, and Wyoming State Parks for flood risk management.

**Areas of Interest**

Figure 70 shows the spatial extents of the areas of interest represented by the MCAs categorized as having BU #25 as their primary BU. Many additional states and/or county or local entities likely have an interest in developing and promoting recreation facilities; however, because of the varied representation of the state and local agencies and because the BUs were self-selected, it is likely that additional areas across the U.S. would have an interest in recreation.

Many additional states and/or county or local entities likely have an interest in developing and promoting recreation facilities; however, because of the varied representation of the state and local agencies and because the BUs were self-selected, it is likely that additional areas across the U.S. would have an interest in recreation.

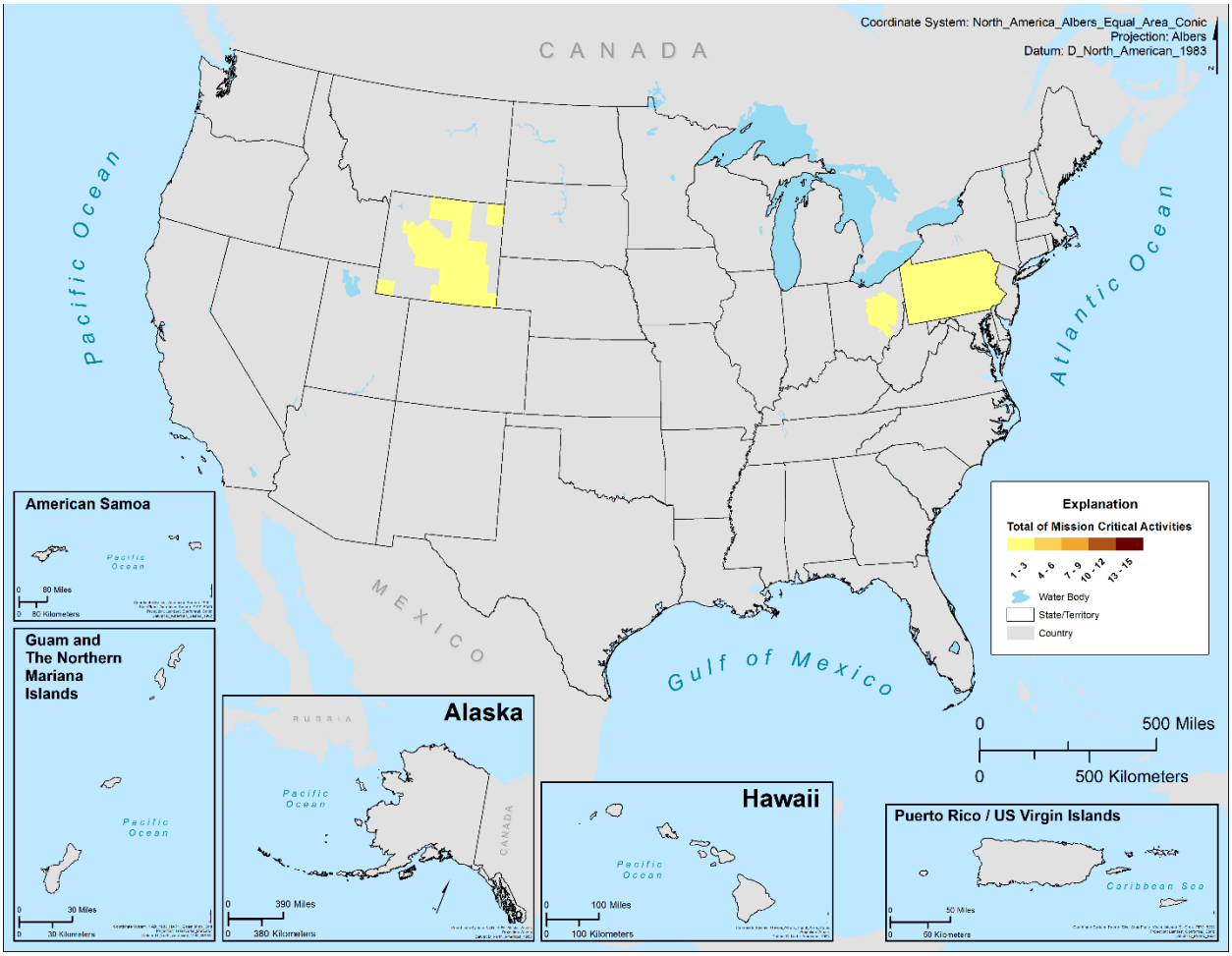



*Figure 70. Spatial extents of the areas of interest represented by the MCAs categorized as having BU #25 as their primary BU.*

**Requirements**

Table 90 lists the requirements for enhanced hydrography data reported for the MCAs categorized as having BU #25 as their primary BU, and the most frequently requested requirements by category.

*Table 74. Requirements for enhanced hydrography data reported for Bu #25*

| Requirement | Most Frequently Reported Requirement | % MCAs |
|---|---|---|
| **Update Frequency** | Annually | 67% |
| **Positional Accuracy** | +/- 7 feet, 90% (1:2,400-scale) | 67% |
| **Stream Density** | 5.0 miles of channel per square mile | 67% |
| **Smallest Contributing Watershed** | 60 acres | 67% |
| **Smallest Mapped Waterbody** | Less than an acre/5 acres/10 acres | 33% each |
| **Post-Event Update** | Highly Desirable | 67% |
| **Level of Detail** | Consistent | 67% |

The requirements for characteristics and analytical functions for BU #25 are shown in Table 91.

*Table 75. Requirements for characteristics and analytical functions for BU #25*

| Required Characteristics/Analytical Functions | Number of MCAs (of 3) | Percent of MCAs |
|---|---|---|
| Bridges, culverts | 3 | 100% |
| Calculate drainage area | 3 | 100% |
| Delineate catchment | 3 | 100% |
| Diversion lines | 3 | 100% |
| Flow periodicity | 3 | 100% |
| Wetlands | 3 | 100% |
| Animation of time-series | 2 | 67% |
| Calculate distance on network | 2 | 67% |
| Determine downstream flood area | 2 | 67% |
| Flood stage | 2 | 67% |
| Floodplain boundary | 2 | 67% |
| Linkages to stream gage observations | 2 | 67% |
| Mash-ups | 2 | 67% |
| Navigate up or downstream on network | 2 | 67% |
| User defined symbolization | 2 | 67% |
| Calculate stream distance to points | 1 | 33% |
| Calculate time of travel to points | 1 | 33% |
| Diversion points | 1 | 33% |
| Find upstream or downstream feature within watershed | 1 | 33% |
| Linkages to cross section geometry | 1 | 33% |
| Other (please specify) | 1 | 33% |
| Preset symbolization | 1 | 33% |
| Riverine bathymetry | 1 | 33% |
| Velocity or time of travel | 1 | 33% |
| Accumulate upstream or downstream features | 0 | 0% |
| Badlands | 0 | 0% |
| Coastal bathymetry | 0 | 0% |

| Required Characteristics/Analytical Functions | Number of MCAs (of 3) | Percent of MCAs |
|---|---|---|
| Coastlines | 0 | 0% |
| Deltas | 0 | 0% |
| Estuaries | 0 | 0% |
| Find events or features on network | 0 | 0% |
| Find upstream or downstream points | 0 | 0% |
| Leakage along lines | 0 | 0% |
| Leakage at points | 0 | 0% |
| Left/right bank delineation | 0 | 0% |

**Future Annual Benefits**

An estimated $166,000 in future annual benefits from enhanced hydrography data was reported for the MCAs categorized as having BU #25 as their primary BU.

Figure 71 shows the estimated future annual benefits provided by the MCAs categorized as having BU #25 as their primary BU. The benefits were apportioned to HUC8 areas per square mile. Areas with darker colors have greater estimated annual dollar benefits.

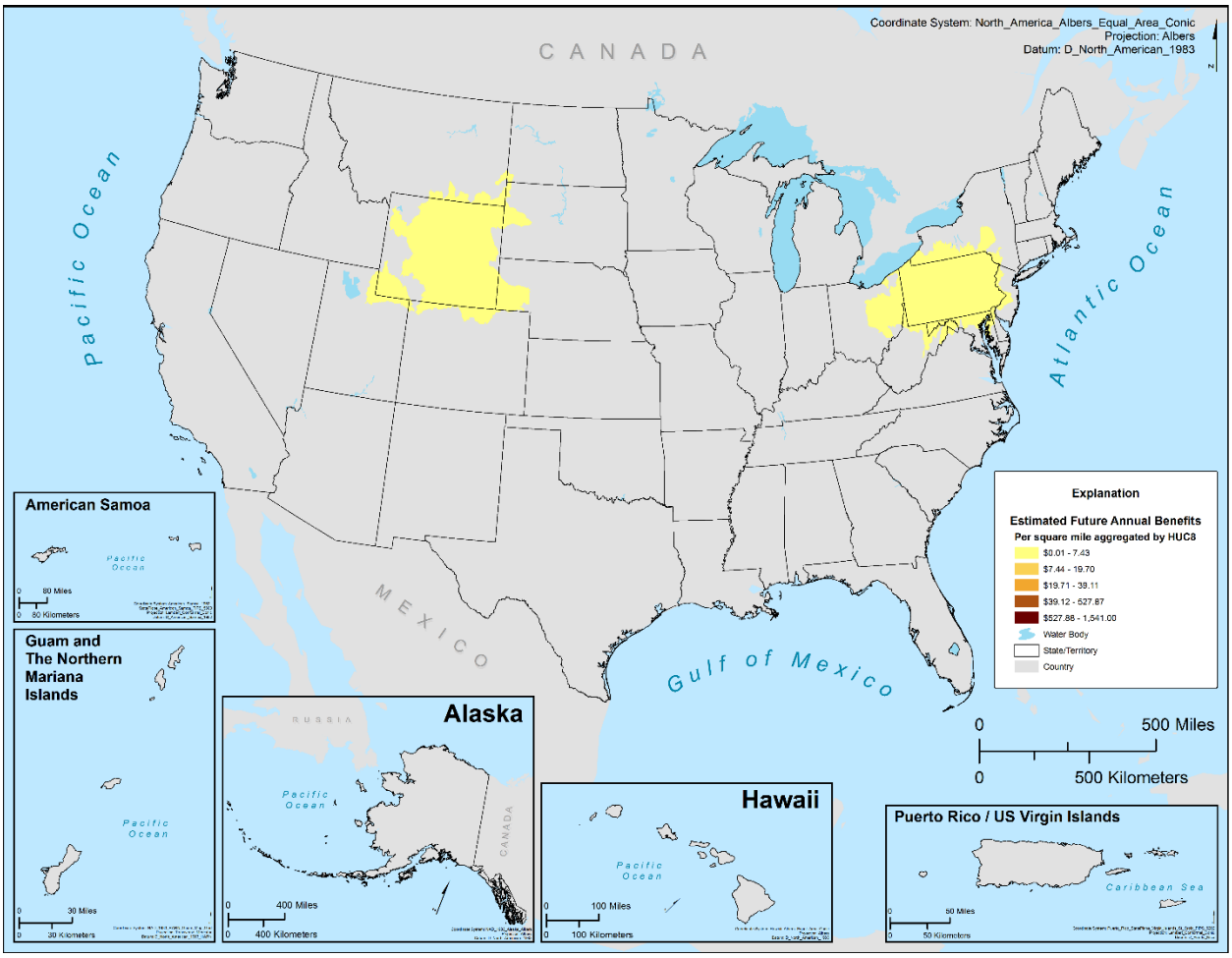



*Figure 71. Estimated future annual benefits reported for the MCAs categorized as having BU #25 as their primary BU. Areas with darker colors have greater estimated annual dollar benefits.*

In addition to the estimated future annual dollar benefits, Table 92 lists the qualitative benefits reported for BU #25.

*Table 76. Qualitative benefits reported for BU #25*

| | Time or Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|---|
| **Major** | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 1 |
| **Moderate** | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |
| **Minor** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| **N/A** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Don't Know** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **No Answer Provided** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

These benefits would be realized due to better data for performing hydro calculations, the enhanced ability to provide for and manage recreational opportunities, time and cost savings, and improved education and safety.

**Example Recreation Activities**

Hydrography data are used in managing park lands overseen by Federal, State, local, and private entities for varied applications including inventory and monitoring, rivers and trails mapping and maintenance, water resources management, and geologic and biologic assessments. Hydrography data are critical to management of threatened and endangered species, flood hazard mitigation, monitoring aquatic ecosystem health, watershed protection, water quality monitoring, fisheries science and research, habitat assessment, park planning, and maintenance of cultural resources for park visitors.

Countless other activities can be impacted by the water resources on public lands including camping, hunting, hiking, all types of winter sports, and visiting natural and cultural heritage sites, just to name a few. To ensure water resources are not negatively impacted by recreational activities, certain areas may require establishment of thresholds for numbers, types, and duration of visitor use, and when those thresholds are reached, development of ways to reduce those impacts and/or possibly limit or relocate use.

The Pennsylvania Department of Conservation and Natural resources (PA DCNR) manages 120 state parks and 2.2 million acres of state forest land. In addition to hiking and biking trails, there are 27 water trails in Pennsylvania, with a total of 2,135 river miles that provide recreational and educational opportunities. PA DCNR, in conjunction with the PA Fish and Boat Commission, Pennsylvania Environmental Council, and the National Park Service formed the PA Water Trails Partnership to manage and promote the water trails in Pennsylvania. According to PA DCNR, “water trails contribute to the protection and restoration of aquatic resources by engaging users and promoting an ethic of stewardship that makes the Commonwealth a better place.”

http://fishandboat.com/watertrails/trailindex.htm

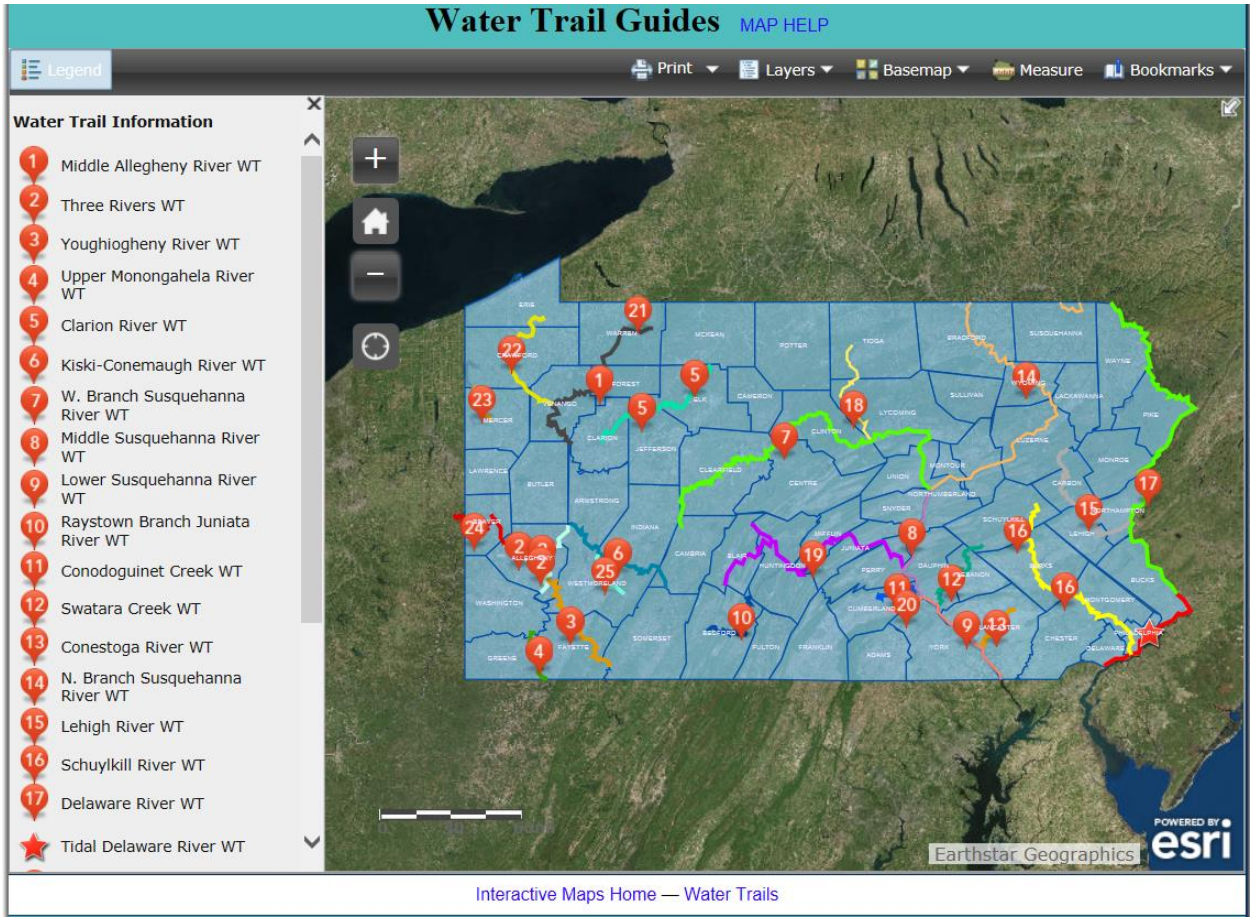



*Figure 72. The 27 water trails in Pennsylvania. Image courtesy of PA DCNR.*

PA DCNR estimated $100,000 in future annual benefits from use of enhanced hydrography data. These benefits would be derived from enhanced ability to provide for and manage recreational opportunities. Additionally, the following assessment of the estimated qualitative future annual benefits that could be derived from the use of enhanced hydrography data for water recreation activities was provided by PA DCNR.

*Table 77. PA DCNR qualitative benefits from use of enhanced hydrography information for water recreation activities*

| Time/ Cost Savings | Mission Compliance | Customer Products or Services | Customer Response or Timeliness | Customer Experience | Education or Public Safety | Environmental | Human Lives Saved |
|---|---|---|---|---|---|---|---|
| Major | Major | Major | Major | Major | Major | Major | Minor |