Commonwealth of Massachusetts

Executive Office of Technology Services and Security (TSS)

Cross-Boundary Collaboration

New England Hydrography Initiative

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EXECUTIVE SUMMARY

The Bureau of Geographic Information (MassGIS), within the Executive Office of Technology Services and Security (TSS), helped launch a first-of-its-kind regional collaboration to modernize hydrography data across New England through implementation of the U.S. Geological Survey's 3D National Hydrography Program (3DHP). Recognizing that watersheds extend beyond political boundaries, Massachusetts partnered with Connecticut, Maine, New Hampshire, Rhode Island, and Vermont to coordinate cross-border data acquisition, standards development, and watershed prioritization in support of a shared regional water data infrastructure.

Supported through federal matching grants and state investment, the initiative is modernizing hydrographic mapping using high-resolution lidar elevation data to create interconnected three-dimensional stream networks, updated watershed boundaries, wetlands delineation, and stormwater infrastructure data. The project significantly improves the accuracy and completeness of water-related geospatial information, helping communities better predict flooding, design more resilient roads and stormwater infrastructure, improve emergency preparedness, and protect natural resources. As climate-driven weather events become more frequent across New England, the initiative provides a critical foundation for smarter planning and faster response across state and local government.

Implementation required extensive collaboration among federal, state, municipal, academic, nonprofit, and private-sector partners. The initiative also includes direct engagement with all 351 Massachusetts municipalities to collect and improve local stormwater infrastructure data, creating one of the largest municipal geospatial collaboration efforts undertaken by the Commonwealth. Massachusetts established a stakeholder working group through the Massachusetts Geospatial Information Coordinating Council (MaGICC) to guide governance, prioritization, and technical standards, while municipalities, Regional Planning Agencies, the University of Massachusetts Amherst GIS Support Hub, and the Massachusetts Department of Environmental Protection contributed to enhanced data collection and integration efforts.

Massachusetts is currently in Year 2 of a five-year implementation effort and has completed statewide QL1 lidar acquisition, completed the pilot watershed modernization effort and modernization of three additional watersheds, and begun expansion into additional priority watersheds.

The initiative has already improved statewide hydrography accuracy and established a scalable framework for long-term regional collaboration and data sharing. Based on national benefit estimates commissioned by USGS, full implementation of 3DHP capabilities is projected to provide nearly $24 million annually in economic and operational

benefits to Massachusetts through improved decision-making, reduced flood risk, and enhanced environmental stewardship.

IDEA

Water does not stop at state boundaries, but historically the data used to map rivers, streams, wetlands, and watersheds has been created and maintained independently by individual states. This fragmented approach limited the ability of governments to understand flood risk, manage water resources, and coordinate climate resilience efforts across New England. The Bureau of Geographic Information (MassGIS), located within the Massachusetts Executive Office of Technology Services & Security (Office of the State CIO), is working to update the Commonwealth's existing hydrography data to the USGS 3D National Hydrography Program (3DHP) standard. This project is a collaborative effort undertaken with the other New England states of Connecticut, Maine, Massachusetts, Rhode Island, New Hampshire, and Vermont, in coordination with USGS. The implementation of 3DHP marks the start of a new era of water data - the first systematic remapping of the Nation's hydrography since the original USGS 1:24,000-scale topographic mapping program was active from 1947 to 1992. Community-wide coordinated investments will contribute toward a consistent set of national water data to answer the most demanding water resource questions.

The collaboration on 3DHP among the New England states represents the first time that multiple states have worked together across their borders as part of a USGS program for data acquisition. The decision was made by the states to work together with the recognition that political boundaries are immaterial to the flow of water. USGS recently selected this collaborative project for a matching grant award. Each state is expending significant additional state resources on the project.

Figure 1: Graphic showing the improved alignment possible in the 3D Hydrography Program by deriving hydrography data from high-quality lidar elevation data

The 3DHP project significantly improves the level of detail, currency, and content of hydrography data by creating three-dimensional stream network datasets and watersheds using high-quality lidar elevation data. Lidar means Light Detection and Ranging and is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) from the sensor in an airplane to the Earth. 3DHP includes improvements such as improved accuracy, increased number of mapped water features, accounting for more components of the hydrologic cycle, and more effective maintenance of data. The 3DHP

project improves the ability to track information related to water as it moves through the hydrologic cycle by connecting surface-water features to data about wetlands, stormwater infrastructure, and subsurface groundwater.

IMPLEMENTATION

To implement the 3DHP project in Massachusetts, the Commonwealth completed acquisition of statewide, high quality QL1 lidar data at 8 points per square meter. The other states either had existing QL1 lidar or are in the process of acquiring it. In the first year of the Massachusetts five-year hydrography project, 2024, the surface water features in one watershed were upgraded to the 3DHP data standard by transforming their locations based on the new lidar elevation data. This initial effort was used by all states in New England as a regional pilot project to determine the appropriate resource levels needed to improve and maintain the accuracy of mapped waters across the region.

A Massachusetts stakeholder work group was formed in December 2023 to guide the state project. The group consists of representatives from federal, state, local, higher education, non-profit and private sector organizations. The group evaluated other watersheds and helped determine prioritization for proceeding beyond the pilot project, including selection of watersheds that cross state boundaries with the other New England states, as well as watersheds that lie wholly within Massachusetts. The stakeholder group is a subcommittee of the Massachusetts Geospatial Information Coordinating Council (MaGICC) that serves as the policy making body for geospatial data management in the Commonwealth, providing advice to the State CIO.

From the beginning of the project in Massachusetts, it was determined that several additional data elements would be created as enhancements to the 3DHP data features. Those enhancements include wetlands delineation, stormwater infrastructure, identifying the top of bank for rivers, updating watershed boundaries based on lidar, and applying additional attributions to the stream network including flow accumulation, channel slope, and stream order. In addition, road, railroad, culvert, and land cover data sets were used to assist in placing surface water features in their proper location in areas where lidar data was insufficient to accurately locate those features.

The selection of cross-border watersheds was done in close collaboration with the other New England states. Each state had their own process for determining which cross-border watersheds would be best for inclusion in the regional project. For the most part, each state is collecting data about the same enhancements, with a few differences based on higher level state priorities and strategic direction.

Massachusetts contracted with USGS for production of the 3DHP data and all data enhancements, as did all other New England states. USGS used a pre-approved contractor to conduct the work. USGS has undertaken contract management for the project and

performs quality control on the 3DHP data. The states perform quality control on all the data enhancements.

For the wetlands delineation, the Massachusetts Department of Environmental Protection (DEP) worked closely with the USGS contractor, NV5, to determine the best approach. Ultimately, the technique developed by the Geospatial Services group at Saint Mary's University was adopted. This employs a comprehensive, multi-layered approach to accurately identify and delineate wetland features across the state. It aligns with the federally recognized National Wetlands Inventory (NWI) schema. This foundational NWI data is subsequently cross-walked to the Massachusetts DEP wetland schema. This dual-schema approach ensures that high-resolution ecological and hydrological details are captured during the mapping phase while also meeting the specific classification schema of Massachusetts.

Stormwater infrastructure data is being gathered, or in some cases created, for all 351 Massachusetts municipalities. For those municipalities that do not have digital stormwater infrastructure data, a collaborative approach is being used to create that data, involving the GIS Support Hub at the University of Massachusetts at Amherst, several small businesses, the Regional Planning Agencies, and several state agencies that provide stormwater mapping grants. For the hydrography update project, we are collecting pipe sizes, inlet and outfall locations. That data is all being ingested into the 3DHP project by the USGS contractor to complete the hydrographic network.

Metadata in the form of a collection report was produced detailing procedures used in the data creation process, including:

1. A listing of data sources used, with spatial reference and resolution of source data
2. The process steps used, including versions of any tools or software
3. Any problems encountered
4. Procedures for analysis, accuracy assessment, and validation of the project data

The data is available as the statewide hydrography dataset for Massachusetts in the MassGIS data repository, all in the public domain. The 3DHP data and some of the enhancement data is available in the national 3DHP dataset at the USGS website.

IMPACT

More accurate hydrography data will help Massachusetts communities better predict flooding, design safer roads and culverts, improve emergency response planning, and make more informed investments in climate resilient infrastructure. Existing hydrography data was often incomplete, inconsistent across state boundaries, and unable to support modern climate resilience and flood mitigation efforts.

State agency staff and contractors will use hydrographic mapping to identify and mitigate flooding and economic risks due to the increased severity of weather events across New England. This updated data will also directly improve water flow modeling as part of planning for and designing stormwater infrastructure by contractors working in communities across New England.

As documented in the National Hydrography Requirements and Benefits Study (Dewberry, 2016) commissioned by USGS, the 3DHP data and capabilities will allow scientists to more fully model the hydrologic cycle, engineers to make better decisions, water suppliers to improve water quality and availability, disaster response planners to better mitigate natural disasters, and natural resource managers to better protect the environment. When fully implemented nationally, the study indicated that 3DHP is estimated to have the potential to provide more than $1.14 billion annually in benefits to Federal, State, Tribal, Territorial, and local governments and to private and nonprofit organizations, in addition to myriad societal benefits.

Based on Massachusetts' population proportionate to the national population, the potential benefit of a fully implemented 3DHP would almost $23.8 million annually for the Commonwealth (details in Table 1 below). The 3DHP initiative would directly support better decision making across myriad applications by providing more accurate, complete, and integrated information.

Table 1: Estimated annual hydrographic mapping benefits for Massachusetts

Based on Massachusetts proportion of the projected national benefit for the 3DHP implementation

Benefit	Estimated Annual Benefit
1. Water Quality & Quantity Management	$19,000,000
2. Flood Risk Management	$2,800,000
3. Natural Resource Management	$1,010,000
4. Climate Resilience	$440,000
5. Urban Planning & Infrastructure Planning	$340,000
6. Public Health & Recreation	$180,000
7. Emergency Management	$12,300
8. Agriculture & Precision Farming	$7,600
TOTAL	**$23,789,900**

The 3DHP will support an information infrastructure to share and discover water-related data based on the connectivity and flows represented in the improved stream network. The USGS will develop and implement an operational system, including a modernized data model, to support this vision. In line with the Geospatial Data Act of 2018, 3DHP datasets will emphasize being FAIR—Findable, Accessible, Interoperable, and Reusable, which supports the Governor's priorities related to accessibility and equity.

The 3DHP data and capabilities will allow scientists to more fully model the hydrologic cycle, engineers to make better decisions, water suppliers to improve water quality and availability, emergency response planners to mitigate natural disasters, and natural resource managers to better protect the environment. When 3DHP data are widely available, further private sector and government innovations will follow.

As climate-driven flooding and severe weather events become more frequent across New England, state and local governments need more accurate information about how water moves across the landscape. By integrating high-quality elevation, hydrography, and hydrologic data, 3DHP improves flood mapping, strengthens emergency preparedness, and enables more accurate modeling of flood and storm surge impacts. Communities can use these insights to better predict inundation, prioritize infrastructure investments, and improve evacuation planning to better protect residents when disasters occur. New England is also rich with natural resources and a great diversity of habitat, landscapes, plant life, and wildlife, and 3DHP data will enable state, regional, and local governments to more effectively implement natural resource conservation practices such as healthy forests, grade stabilization, dam safety, habitat easements, pipelines, terracing, and wetland restoration, while providing additional cost savings to the public. Accurate 3DHP data will increase New England's ability to protect natural resources and steward related recreational opportunities, both of which have a great impact on the region's economy.

	Appendix A **State/Municipal Programs & Activities Dependent on 3DNTM Mapping[1]**								
Use for More Detailed Elevation Mapping	**Cities/Towns**	**MassDOT**	**DEP**	**DCR**	**DFG**	**CZM**	**MBTA**	**State Geologist**	**EOPSS**
Hydrologic modeling for culvert/bridge replacement/upgrade projects	**X**	**X**		**X**			X		
Hydrologic analysis for protecting public drinking water supplies and wastewater treatment facilities by creating or raising barriers to keep out river/stream flood water	**X**								
Modeling coastal storm surge and river/stream flooding (more detailed topography ensures correct structure-level modeling) to assess vulnerability of property, buildings, and public infrastructure (e.g., wastewater treatment plants, water distribution systems, transportation)	**X**	**X**	**X**			**X**	**X**		
Preparing bid documents for water main replacement	**X**								
Design work for sizing new drainage systems	**X**	**X**		**X**			X		
Flood modeling for dam break analysis				**X**					**X**
Planning/implementation for coastal resiliency: analyzing shoreline vulnerability, identifying at-risk infrastructure, mitigating risk	**X**		**X**						
Makes it much easier to identify geologic features that indicate locations with high potential for high yield water wells								**X**	
Reveals old stream/river channels which enables better modeling of what properties and structures are at risk from river and stream channel migration that can occur abruptly during major rainstorms								**X**	
Assessing the impact of sea level rise on coastal wetlands; these wetlands are important as nurseries for economically valuable fisheries and as buffers against storm surges.						X			
Water quality planning and assessment									
Water quality restoration activities			**X**						
Evaluating ecological benefit of dam removals			**X**		**X**				
Planning for habitat projects, having detailed 3DNTM data: 1) saves 100s of hours annually because it's easier to identify cultural and physical resources that inform project design; 2) enables more effective layout of skid roads and log landings and related efficiencies and safeguard in equipment use.					**X**				

[1] Based on ROI study by the State of Ohio