Environment and Natural Resources Trust Fund
2021 Request for Proposal

General Information

Proposal ID: 2021-183

Proposal Title: Supporting Integrated Resource Management through Upgraded Lidar Products

Project Manager Information

Name: Alison Slaats

Organization: Minnesota IT Services

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Project Basic Information

Project Summary: Minnesota's landscape is changing. Foundational data that describes natural and built environments are aging. Using new lidar, this project delivers comprehensive data updates and training to practitioners and decision makers.

Funds Requested: $3,200,000

Proposed Project Completion: 2024-06-30

LCCMR Funding Category: Foundational Natural Resource Data and Information (A)

Project Location

What is the best scale for describing where your work will take place?
> Region(s): NE

What is the best scale to describe the area impacted by your work?
> Region(s): NE

When will the work impact occur?
> During the Project and In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Much of the lidar data used to make decisions to manage Minnesota's resources is more than 10 years old, based on dated technology, and no longer meets the state's expanded business needs. Additionally, over the last decade Minnesota's landscape has experienced significant changes, including natural disasters, invasive species, and urban and rural development, that are not reflected in the existing data. MnGeo and the Geospatial Advisory Council's (GAC) 3D Geomatics Committee (3DGeo) published the Minnesota State Lidar Plan as a framework to acquire new, more detailed, high density (HD) lidar data by 2025. The Plan's first phase begins in spring 2021 with lidar acquisition in the Rainy Lake Block of Northeastern Minnesota. However, acquiring lidar data is only a partial solution. Many data analysts, natural resource managers, and decision makers rely on value-added derivatives to solve real-world problems. Fundamental lidar derivatives like hydro-modified digital elevation models (hDEMs) and forest inventory models are used together to address comprehensive watershed scale resource management, conservation, and protection efforts. A data sharing tool and an education program are needed to enable practitioners in all stakeholder-sectors to access and use this data effectively.

What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

Guided by the GAC 3DGeo Committee, this project addresses the problems described above by transforming Minnesota's new HD lidar data into information - providing key derivatives usable by data analysts, resource managers, and decision makers in all sectors. Additionally, the problems of providing access and understanding of the lidar data and its derivative products are addressed through the creation of a lidar education program and a data storage and sharing solution.

The development of hydro-modified DEM lidar derivatives are proposed so below-grade flow of water, such as flow through culverts, can be represented to correctly model real-world hydrology and connectivity of surface waters. Forest inventory metrics and statistical analyses are proposed lidar derivatives to produce accurate representations of forest and habitat structure. An education program is proposed to ensure all stakeholders can use the new lidar and products effectively for their needs. Finally, a data storage and dissemination solution is proposed so raw lidar data and derived products can be viewed and downloaded easily. This proposal builds upon ongoing lidar data collection efforts by creating the appropriate and necessary suite of derived data products, educational programming, and data delivery tools to meet Minnesota's current and future business needs.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

Lidar data and derived products have numerous applications critical to the state's mission to protect, conserve, preserve, and enhance natural resources. This project will deliver comprehensive and foundational information for practitioners and decision makers addressing natural resource concerns including watershed management, climate change adaptation and mitigation, and conservation planning. Specific outcomes include:
• The ability to model the flow of water more realistically across the landscape, which supports work on watershed management, water quality initiatives, and flood mitigation planning.
• Accurate forest inventory models that will improve forest management, reduce fieldwork costs, and enable shared land stewardship and coordination.

Activities and Milestones

Activity 1: Conduct forestry fieldwork, produce lidar-derived statistical data layers, develop empirical forest inventory models, and create comprehensive all-lands forest inventory dataset

Activity Budget: $554,136

Activity Description:

Based on the findings from an ENTRF funded pilot project, the DNR Resource Assessment Program has begun to implement a paradigm shift in forest inventory on state lands using a lidar-based model assisted approach. To create viable models, fieldwork is always necessary; it is determined that approximately one plot per every 1500 forested acres across a regular grid is needed. While the DNR fully supports the fieldwork on 1000+ plots on state land, this project proposes to cooperatively coordinate the necessary fieldwork across an additional 1000 plots on other public lands in the Rainy Lake Block. The forest inventory plots are fixed radius tenth acre area, measuring tree height, diameter, species, alive-dead status, and canopy class.

The plot-level observations are correlated to derivatives of the lidar point cloud to create empirical models. Stand-level and grid-based forest inventory models will be produced for key metrics, including: standing volume, above ground biomass, cover type, basal area, mean diameter, site index, trees per acre, and age. These metrics provide the foundational information for assessment of multiple ecological values, including but not limited to: habitat assessment, carbon stocks, water resource protection, invasive species and forest health monitoring, climate change mitigation, and other emerging challenges.

Activity Milestones:

Description	Completion Date
Develop a coordination plan for fieldwork and dissemination of forest inventory results.	2021-11-30
Create a suite of derived data layers representing statistical analyses of the lidar point cloud.	2022-01-31
Conduct coordinated forestry fieldwork across a gridded network of plots (begin summer 2021).	2022-09-30
Develop model assisted forest inventory metrics using empirical models from fieldwork and derived variables.	2023-06-30
Disseminate forest inventory results and conduct stakeholder engagement workshops.	2023-11-30

Activity 2: Develop hydro-modified DEMs and derived products to support integrated land-water-vegetation resource management and decision making at the watershed scale

Activity Budget: $1,470,000

Activity Description:

While lidar-derived DEMs are excellent products to characterize Earth's surface/topography with high accuracy and detail, these foundational data cannot serve many water-related business needs because raw lidar-DEMs do not represent complete landscape hydrology and hydrologic connectivity. Lidar-mapped landscape features, such as road and railroad grades, act like dams in the DEM surface where culverts and bridges exist underneath. These synthetic digital dam barriers must be breached to replicate true landscape hydrologic connectivity. Termed DEM hydrologic modification, this process involves augmenting source lidar elevation data with information about drainage connections at the surface and subsurface of the landscape. This digital-topographic alteration allows modeled water to accurately flow downstream, resulting in a special hydrologic DEM surface called a hydro-modified DEM (hDEM).

Under this activity, vendors will conduct the hDEM development work within watershed work units one square mile-section at a time. This section-by-section approach ensures hydro-modified DEM work achieves level-3 status (h3DEM),

which means all digital dams have been removed and accurate DEM flow is established. Completed project deliverables will be presented to the state for quality assessment and certification. Certified data will be built into authoritative datasets for publication on state administered systems for end-user application statewide.

Activity Milestones:

Description	Completion Date
MNIT-DNR Lidar Hydrography Development Group (LHDG) develops competitive hDEM contract and releases Request For Proposal.	2021-08-31
The 3D Geomatics Steering Committee reviews submitted proposals based on criteria and ranks RFPs.	2021-09-30
MnGeo/State awards the contract(s) and initiates the contract(s) with Vendors.	2021-12-31
Awarded contractor initiates the contract and completes hDEM work achieving level-3 DEM hydro-modification (h3DEM) work.	2023-09-30
LHDG provides support, guidance, and conducts QA/QC review of contractors deliverables per the RFP specifications.	2023-12-31
Certification work not meeting h3DEM requirements is returned to vendor to bring into h3DEM compliance.	2024-02-28
All h3DEM work is complete and delivered to the State and made publicly available.	2024-05-31

Activity 3: Design, develop and deploy an education program for understanding and effectively using lidar data and lidar derivative products

Activity Budget: $499,956

Activity Description:
Interest in statewide lidar training has been driven by the advancement of HD lidar technology that captures our natural and built environments with astonishing 3D realism.   Given the lack of authoritative training on lidar-related topics over the past decade in Minnesota, educators and trainers from local, state, and federal agencies, as well as higher-education institutions throughout the state have demonstrated need for a variety of lidar training modules delivered across various media platforms.

This activity will focus on new lidar content geared towards HD lidar in up to eight specific topic areas (Basics, Advanced, Manager's Training, Wetlands, Hydrology, Forestry, and Soils/Landscapes) delivered to stakeholders and end-users as in-person, static video, and instructor-led online workshops. Serving as a centralized coordination center for lidar education, the 3DGeo Education and Outreach Workgroup (https://www.mngeo.state.mn.us/committee/3dgeo/education/) will guide the development and delivery of these training modules across Minnesota.

Activity Milestones:

Description	Completion Date
Develop a lidar training program for several topic areas for in person and online delivery	2022-06-30
Deploy lidar education and training program via in-person, static video, and instructor-led online workshops	2024-06-30

Activity 4: Design, develop and implement lidar data and derivative product storage and dissemination system

Activity Budget: $433,916

Activity Description:
The data storage and dissemination activity will result in an online solution for lidar data and derivative storage and

dissemination. This activity includes three phases: research, design, and deployment. In the research phase, user needs will be solicited and documented. This phase will include research into existing state-of-the-art solutions, off-the-shelf options as well as custom-built options. The design phase will synthesize the research into a solution and design specific for Minnesota's users. System design and documentation will be created in this phase regardless of whether the solution will be built in-house, or purchased, or a combination of the two. Regardless of the strategy selected, the specifications will include the ability for the solution to be scalable in order to extend its use beyond the data from the Rainy Lake area to data for the entire state of Minnesota. The deployment phase of this activity will be the build out and deployment of the solution, including loading of the Rainy Lake lidar data and lidar-derivative datasets. Additionally, this phase will include testing and documentation. The deployed solution will result in lidar data and derivatives being available to the public in an easy-to-use online solution.

Activity Milestones:

Description	Completion Date
Solicit and document user needs and research solutions for a data storage and dissemination solution	2022-06-30
Design a storage and dissemination solution for raw lidar data and lidar-derived data products	2022-09-30
Build a storage and dissemination solution for raw lidar data and lidar-derived data products	2023-06-30
All lidar and derived products shared and available publicly using the storage and dissemination solution	2024-06-30

Activity 5: Overall Project Management

Activity Budget: $241,992

Activity Description:
Overall project management to include coordination of all activities such as communication, meeting organization, documentation, financial summaries and other tasks as needed.

Activity Milestones:

Description	Completion Date
Ongoing project activity coordination and teams communication.	2024-06-30
Project Documentation (quarterly, or as required by LCCMR)	2024-06-30

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Sean Vaughn and Rick Moore	MNIT DNR	Contingent on DNR Ecological and Water Resources anticipated biennium request of Clean Water Funds (CWF), EWR will contribute $261,000 of CWF to MNIT staff as an in-kind contribution. These DNR hydrography data stewards are the States' leading experts in DEM hydro-modification; they will manage Activity#2 - hDEM project work.	No
Kate Carlson	U-Spatial – U of MN	Coordinate existing U of MN training resources in cooperation with 3D Geomatics Education Workgroup	Yes
Joel Nelson	U of MN	Lead coordination of 3D Geomatics Education Workgroup to facilitate curriculum development and training dissemination	Yes
Sean Vaughn and Gerry Sjerven (chairs)	Geospatial Advisory Council's 3D Geomatics Committee	Lead multi-sector coordination of Geospatial Advisory Committee workgroups to promote and plan for funding, acquisition, and management of three-dimensional geomatic data and derived products.	No
Sandi Stroud	Minnesota Geospatial Information Office (MnGeo)	Contributed $10,000 for 9291 square miles of lidar data collection in the Rainy Lake Block of Northeastern MN	Yes

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?
This project builds the foundation for the State Lidar Plan and will help inform the lidar derivatives needed for completion of the state, starting with the Rainy Lake Block. As efficiencies are gained and partnerships strengthened, the project data and program maintenance will continue to be pursued collaboratively using a funding approach similar to the first phase of data collection in the Plan, with contribution from the USGS 3D Elevation Program (3DEP) and many local, state, and federal partners. The effort will be facilitated by MnGeo and the 3DGeo Committee, which includes representation from several public and private sector members.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Development of Innovative Cost-Saving Methodology for Forest Inventory	M.L. 2016, Chp. 186, Sec. 2, Subd. 03o	$800,000

Project Manager and Organization Qualifications

Project Manager Name: Alison Slaats

Job Title: MnGeo Program Manager

Provide description of the project manager's qualifications to manage the proposed project.
Alison is a collaborative leader and technical problem solver in the Minnesota geospatial community. Alison worked in the GIS and IT field for 25 years. She has worked for Minnesota IT Services (MNIT) since 2012 and has been focused on the use of GIS and IT to help people solve real world problems with patience and good humor. The threads of her work

and influence can be seen in many successful projects across our professional landscape. Her contributions include, but are not limited to: Representing State Agencies on the Geospatial Advisory Council; Co-creating and leading the State Agency GIS Collaborative; Serving as GIS/LIS Board Treasurer and leading an organizational audit; Leading the development of the MetroGIS DataFinder; Frequently presenting at regional GIS community conferences; Leading Minnesota's GIS 2015 Avian Influenza response; and Championing the 3DGeomatics Remote Sensing Acquisition Working Group, including spearheading the State Lidar Plan document authorship and an application to the USGS 3D Elevation Program Broad Agency Announcement which resulted in the recommendation of federal funding of more than $2.7M. Alison's efforts have clearly improved geospatial practices, standards, and policies, creating significant and tangible value for the citizens of Minnesota. Alison will lead the efforts of this LCCMR proposal.

Organization: Minnesota IT Services

Organization Description:
The MNIT Minnesota Geospatial Information Office (MnGeo) provides coordinated, affordable, reliable, and effective use of geospatial technology to state agencies and to the broader Minnesota geospatial community. MnGeo's experience and portfolio, including complex projects between many agencies and contractors, is ample evidence of the organization's qualifications. The Geospatial Advisory Council (GAC) advises MnGeo and serves as a coordinating body for the Minnesota geospatial community. MnGeo and the GAC's 3D Geomatics Committee (3DGeo), with representation from several State, Local, and Federal agency members, created the Minnesota State Lidar Plan. This LCCMR proposal will be managed by MnGeo, but with the support of the Minnesota geospatial community through the GAC 3DGeo Committee.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Alison Slaats		Project Manager			25%	1.5	X	$241,992
							Sub Total	**$241,992**
Contracts and Services								
Competitively Bid Contractor	Professional or Technical Service Contract	Activity 2 Competitively-Bid Contractor work - DEM Hydromodification Including Digital Dam identification and Breaching for Hydrological Enforcement				0		$1,470,000
DNR Resource Assessment	Sub award	Activity 1 work - Forest Inventory Metrics and Analyses, Forest Inventory Field Work, Coordination, and Analyses. DNR's Resource Assessment Unit is able to charge professional service rates. See Statutes: https://www.revisor.mn.gov/statutes/cite/84.025 https://www.revisor.mn.gov/statutes/cite/89.421				0		$554,136
MNIT MnGeo and/or Competitively Bid Contractor	Professional or Technical Service Contract	Building the lidar data and derivative storage and dissemination system in Activity 4 may be done by MNIT MnGeo, or by a contractor. The cost includes funds for the web-based server hosting of the system only for the LCCMR project duration. System development: $256,782; System hosting: $113,380.				0		$370,162
University of Minnesota	Sub award	Deliver training curriculum in a variety of platforms; Provide equal resources across the state to ensure understanding of new datasets; Deliver training remotely and to local GIS Professionals; Provide hard-copy reference materials at workshops. Staff: $370858; Portable storage: $1125; Services: $98963; Travel (36 Minnesota locations): $22010; Printed materials: $7000.				0		$499,956
MNIT MnGeo	Internal services or fees (uncommon)	The user needs evaluation and research of Activity 4 is led by MnGeo with input from the GAC 3D Geo committees. Needs are documented, and custom-built and vendor solutions are evaluated. The result is to recommend an in-house built system or an RFP to solicit a vendor solution.				0		$63,754

						Sub Total	$2,958,008
Equipment, Tools, and Supplies							
						Sub Total	-
Capital Expenditures							
						Sub Total	-
Acquisitions and Stewardship							
						Sub Total	-
Travel In Minnesota							
						Sub Total	-
Travel Outside Minnesota							
						Sub Total	-
Printing and Publication							
						Sub Total	-
Other Expenses							
						Sub Total	-
						Grand Total	$3,200,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Personnel - Alison Slaats		Project Manager	**Classified :** The project manager role would be 0.5 FTE per year for 3 years. We anticipate that additional staff would be added to the MnGeo to backfill the part of the classified staff salary proposed to be paid for with these funds.

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
Cash	Office of School Trust Lands	Contributed $100,000 for 9291 square miles of new lidar data collection in the Rainy Lake Block of Northeastern MN. This proposed project builds on lidar data acquired with these funds.	Secured	$100,000
Cash	MN DNR Division of Fish and Wildlife	Contributed $50,000 for 9291 square miles of lidar data collection in the Rainy Lake Block of Northeastern MN. This proposed project builds on lidar data acquired with these funds.	Secured	$50,000
Cash	MnDOT	Contributed $40,000 for 9291 square miles of lidar data collection in the Rainy Lake Block of Northeastern MN. This proposed project builds on lidar data acquired with these funds.	Secured	$40,000
Cash	MN DNR Division of Forestry	Committed $734,000 for 9291 square miles of lidar data collection in the Rainy Lake Block (contributions came from the Cooperative Stand Assessment (224K), Private Forest Management (100K), Resource Assessment (76K), and Fire Prevention (15K)); and in-kind match to this project for fieldwork and analyses in the entire NE region. This proposed project builds on lidar data acquired with these funds.	Secured	$734,000
			State Sub Total	**$924,000**
Non-State				
Cash	USGS 3D Elevation Program	Committed $2,532,057 for 9291 square miles of lidar data collection in the Rainy Lake Block of Northeastern MN. This is anticipated to be an ongoing relationship. This proposed project builds on lidar data acquired with these funds.	Secured	$2,532,057
Cash	USDA Forest Service	Contributed lidar data of high-quality level (QL1) valued at $218,561. Committed $488,560 for 9291 square miles of lidar data collection in the Rainy Lake Block of Northeastern MN. This proposed project builds on lidar data acquired with these funds.	Secured	$707,121
Cash	St Louis County	Contributed $40,000 for 9291 square miles of lidar data collection in the Rainy Lake Block of Northeastern MN.This proposed project builds on lidar data acquired with these funds.	Secured	$40,000
Cash	Lake County	Contributed $10,000 for 9291 square miles of lidar data collection in the Rainy Lake Block of Northeastern MN. This proposed project builds on lidar data acquired with these funds.	Secured	$10,000
Cash	Koochiching County	Contributed $10,000 for 9291 square miles of lidar data collection in the Rainy Lake Block of Northeastern MN. This proposed project builds on lidar data acquired with these funds.	Secured	$10,000

Cash	USDA NRCS	Contributed $70,000 for 9291 square miles of lidar data collection in the Rainy Lake Block of Northeastern MN. This proposed project builds on lidar data acquired with these funds.	Secured	$70,000
			Non State Sub Total	**$3,369,178**
			Funds Total	**$4,293,178**

Attachments

Required Attachments

Visual Component

File: [a7844b8f-9de.pdf](a7844b8f-9de.pdf)

Alternate Text for Visual Component

This document provides a summary of this project proposal activities in text, two maps and an example graphic of lidar data. The first map shows Minnesota and general land cover data (including forest, woody wetlands and crops). Over the land cover, the lidar acquisition areas are shown and the Rainy Lake Block in Northeastern Minnesota is highlighted with a yellow outline. The second map shows the lidar acquisition areas over the hydro DEM completion status. In this map, the Rainy Lake Block is highlighted with a green outline and the completeness shows as "no work or non known" for this area. This map highlights the need for the creation of the hDEM in this project-focus area.

In the lower left an example lidar image shows the Federal Dam in Cass County and part of the nearby forest. An aerial photo shows the same area and a map shows where these images were collected in Cass County. These images illustrate how lidar models the real world and how the derivative hDEM product proposed by this project will allow for modeling the flow of water across the landscape.

Also in the lower area of the page, a chart shows a summary of the return on investment for lidar and lidar derivatives. The cumulative benefits of lidar and derivative data products for various business uses are over $80 million.

Optional Attachments

Support Letter or Other

Title	File
University of Minnesota Proposal Letter of Support	[3f1a9756-8b2.pdf](3f1a9756-8b2.pdf)
Minnesota Forestry Association Letter of Support	[182b9293-93a.pdf](182b9293-93a.pdf)

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have patent, royalties, or revenue potential?

No

Does your project include research?

Yes

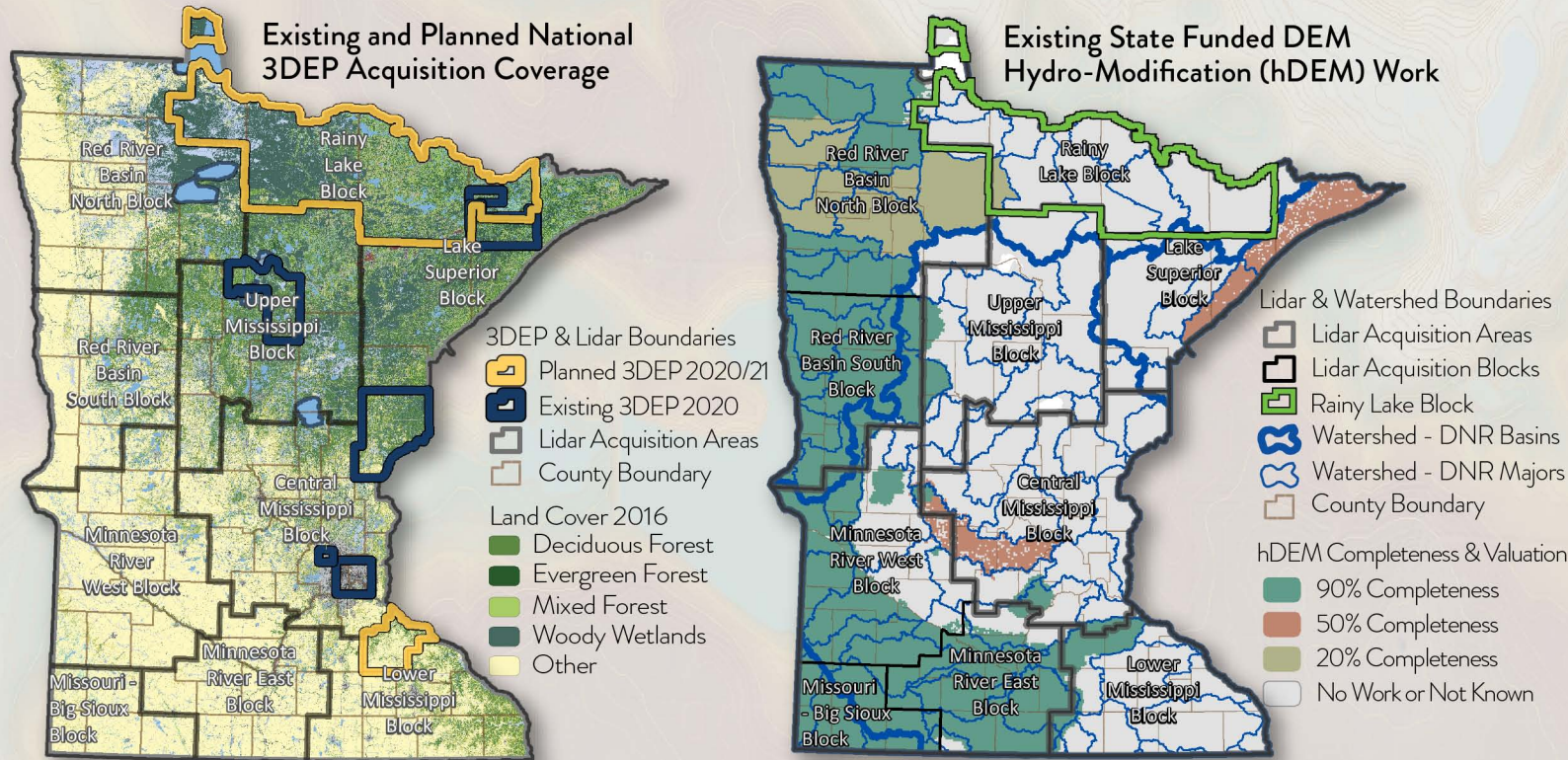**Does the organization have a fiscal agent for this project?**

No

Upgraded Lidar Products for Minnesota

The first phase of the State Lidar Plan begins in spring 2021 with high density lidar acquisition in the Rainy Lake Block. Financial contributions for this lidar data include the USGS 3D Elevation Program (3DEP) and many local, state, and federal partners. However, acquiring lidar data only is only part of the solution - **decision makers rely on value-added derivatives to solve real-world problems**.

This project has four activities that develop key lidar-derived products in the Rainy Lake Block:

1) Forestry: Conduct fieldwork, produce lidar-derived statistical data layers, develop empirical forest inventory models, and create comprehensive all-lands forest inventory dataset;

2) Hydrography: Develop hydro-modified DEMs and derived products to support integrated land-water-vegetation resource management and decision making at the watershed scale;

3) Education: Design, develop and deploy an education program for understanding and effectively using lidar data and derivative products, and;

4) Data Sharing: Design, develop and implement lidar data and derivative product storage and dissemination system.

Existing and Planned National 3DEP Acquisition Coverage

3DEP & Lidar Boundaries
- Planned 3DEP 2020/21
- Existing 3DEP 2020
- Lidar Acquisition Areas
- County Boundary

Land Cover 2016
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Woody Wetlands
- Other

Existing State Funded DEM Hydro-Modification (hDEM) Work

Lidar & Watershed Boundaries
- Lidar Acquisition Areas
- Lidar Acquisition Blocks
- Rainy Lake Block
- Watershed - DNR Basins
- Watershed - DNR Majors
- County Boundary

hDEM Completeness & Valuation
- 90% Completeness
- 50% Completeness
- 20% Completeness
- No Work or Not Known

With value-added derived products, lidar data have a more than 5 to 1 return on investment.
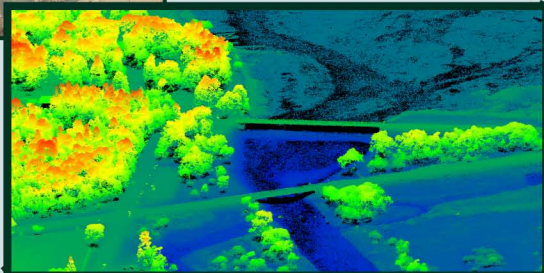
Lidar Point Cloud Example

Federal Dam, Cass County, MN

Oblique Aerial Image

Lidar Point Cloud Data

Financial Benefits of Lidar & Derivatives

Business Use Financial Benefit (Millions) — $0 to $30

Cumulative Benefit (Millions) — $0 to $100

Categories:
- Urban & Regional Planning
- Natural Resources Conservation
- Infrastructure & Construction Mgmt
- Flood Risk Management
- Coastal Zone Management
- Sea Level Rise & Subsidence
- Marine & Riverine Navigation & Safety
- Real Est., Banking, Mortgage, & Ins.
- Law Enforcement & Emergency Mgmt
- Forest Resources Management
- Other