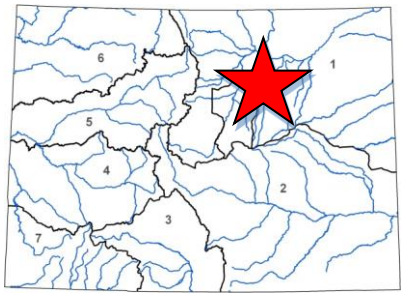
COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Regional Land Cover Project

Denver Regional Council of Governments

March 2021 Board Meeting

Water Plan Grant Application



LOCATION
County/Counties: Adams, Arapahoe, Boulder, Broomfield, Clear Creek, Denver, Douglas, Gilpin, portion of Weld
Drainage Basin: Metro/South Platte

DETAILS	
Total Project Cost:	$202,206
Water Plan Grant Request:	$101,103
Recommended Amount:	$101,103
Other CWCB Funding:	$
Other Funding Amount:	$71,103
Applicant Match:	$30,000
Project Type(s): Other-Data	
Project Category(Categories): Conservation and Land Use	
Measurable Result: progress towards 400KAF goal	

DRCOG proposes creating a high-resolution land cover dataset for the 10-county region around Denver (approximately 6,000 square miles). The product would use imagery and lidar collected in 2020 and would leverage findings from a previous pilot project that identified stakeholder data needs.

The product will define nine regional classes at 1-meter resolution. Currently, the only publicly accessible data source for the region is a 30-meter resolution product that is released every 5 years. While this product is useful for large scale planning, it is not adequate for detailed analysis. This project is a good example of providing multiple benefits for various areas of water management. A land cover dataset in the DRCOG region would cover more than 3,000 miles of waters in the South Platte River watershed, including portions of the South Platte River, Boulder Creek, Clear Creek, and Cherry Creek; irrigation canals, such as Fulton, Bull, and O'Brian canals; and numerous water storage reservoirs along the South Platte River. Additionally, the project will leverage CWCB's Fluvial Hazard Mapping and LIDAR work. Finally, with the addition of pervious surface and irrigated area classifications, the project will help assess irrigated urban demands for much of the Denver Metro area. This data will help with the next technical update and does not exist at this scale or coverage at present time.

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Last Updated: June 2020

Colorado Water Conservation Board

Water Plan Grant Application

Instructions

To receive funding for a Water Plan Grant, applicant must demonstrate how the project, activity, or process (collectively referred to as "project") funded by the CWCB will help meet the measurable objectives and critical actions in the Water Plan. Grant guidelines are available on the CWCB website.

If you have questions, please contact CWCB at (303) 866-3441 or email the following staff to assist you with applications in the following areas:

Water Storage Projects	Matthew.Stearns@state.co.us
Conservation, Land Use Planning	Kevin.Reidy@state.co.us
Engagement & Innovation Activities	Ben.Wade@state.co.us
Agricultural Projects	Alexander.Funk@state.co.us
Environmental & Recreation Projects	Chris.Sturm@state.co.us

FINAL SUBMISSION: Submit all application materials in one email to *waterplan.grants@state.co.us*
in the original file formats [Application (word); Statement of Work (word); Budget/Schedule (excel)]. Please do not combine documents. In the subject line, please include the funding category and name of the project.

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Water Project Summary	
Name of Applicant	Denver Regional Council of Governments (DRCOG)
Name of Water Project	Regional Land Cover Project
CWP Grant Request Amount	$101,103
Other Funding Sources: Mile High Flood District	$54,903
Other Funding Sources: Local governments including City of Boulder, City and County of Broomfield, Town of Castle Rock, Town of Erie, City of Greenwood Village, City of Wheat Ridge	$16,200
Applicant Funding Contribution: DRCOG	$30,000
Total Project Cost	$ 202,205

Applicant & Grantee Information
Name of Grantee(s): Denver Regional Council of Governments
Mailing Address 1001 17th Street, Suite 700, Denver CO 80202
FEIN
Organization Contact Ashley Summers
Position/Title Information Systems Manager
Email asummers@drcog.org
Phone 303-480-6746
Grant Management Contact Ashley Summers
Position/Title Information Systems Manager
Email asummers@drcog.org

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Phone 303-480-6746
Name of Applicant (if different than grantee)
Mailing Address
Position/Title
Email
Phone

Description of Grantee/Applicant
Provide a brief description of the grantee's organization (100 words or less).
The Denver Regional Council of Governments (DRCOG) is a regional planning organization that convenes key stakeholders to plan for a collective future. DRCOG is guided by Metro Vision, a plan developed and unanimously adopted by local governments in the region that outlines such shared values as promoting responsible land-use practices and protecting and restoring natural resources. DRCOG provides a forum for collaboration as well as information at the regional and local level to help stakeholders plan effectively. To this end, DRCOG supplies foundational datasets such as imagery, elevation, built environment features, and population forecasts that provide context for decision-making.

Type of Eligible Entity (check one)	
X	**Public (Government):** Municipalities, enterprises, counties, and State of Colorado agencies. Federal agencies are encouraged to work with local entities. Federal agencies are eligible, but only if they can make a compelling case for why a local partner cannot be the grant recipient.
	Public (Districts): Authorities, Title 32/special districts (conservancy, conservation, and irrigation districts), and water activity enterprises.
	Private Incorporated: Mutual ditch companies, homeowners associations, corporations.

	Private Individuals, Partnerships, and Sole Proprietors: Private parties may be eligible for funding.
	Non-governmental organizations (NGO): Organization that is not part of the government and is non-profit in nature.
	Covered Entity: As defined in Section 37-60-126 Colorado Revised Statutes.

Type of Water Project (check all that apply)	
	Study
	Construction
	Identified Projects and Processes (IPP)
X	Other: Data

Category of Water Project (check the primary category that applies and include relevant tasks)	
	Water Storage - Projects that facilitate the development of additional storage, artificial aquifer recharge, and dredging existing reservoirs to restore the reservoirs' full decreed capacity and Multi-beneficial projects and those projects identified in basin implementation plans to address the water supply and demand gap.. *Applicable Exhibit A Task(s):*
X	Conservation and Land Use Planning - Activities and projects that implement long-term strategies for conservation, land use, and drought planning. *Applicable Exhibit A Task(s):* Development of a high-resolution land cover dataset in the Denver Region that would support macro and micro-level analysis for various use cases.
	Engagement & Innovation - Activities and projects that support water education, outreach, and innovation efforts. Please fill out the Supplemental Application on the website. *Applicable Exhibit A Task(s):*
	Agricultural - Projects that provide technical assistance and improve agricultural efficiency. *Applicable Exhibit A Task(s):*

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	Environmental & Recreation - Projects that promote watershed health, environmental health, and recreation. *Applicable Exhibit A Task(s):*	
	Other	Explain:

Location of Water Project

Please provide the general county and coordinates of the proposed project below in **decimal degrees**.

The Applicant shall also provide, in Exhibit C, a site map if applicable.

County/Counties	Adams, Arapahoe, Boulder, Broomfield, Denver, Clear Creek, Douglas, Gilpin, Jefferson, and a portion of Weld
Latitude	Northernmost point – 40.3199191°N Southernmost point – 39.11699996°N
Longitude	Easternmost point – 103.6835469°W Westernmost point – 105.9359093°W

Water Project Overview

Please provide a summary of the proposed water project (200 words or less). Include a description of the project and what the CWP Grant funding will be used for specifically (e.g., studies, permitting process, construction). Provide a description of the water supply source to be utilized or the water body affected by the project, where applicable. Include details such as acres under irrigation, types of crops irrigated, number of residential and commercial taps, length of ditch improvements, length of pipe installed, and area of habitat improvements, where applicable. If this project addresses multiple purposes or spans multiple basins, please explain.

The Applicant shall also provide, in Exhibit A, a detailed Statement of Work, Budget, Other Funding Sources/Amounts and Schedule.

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DRCOG proposes creating a high-resolution land cover dataset for the 10-county region around Denver (approximately 6,000 square miles). The product would use imagery and lidar collected in 2020 and would leverage findings from a previous pilot project that identified stakeholder data needs.

The product will define nine regional classes at 1-meter resolution. Currently, the only publicly accessible data source for the region is a 30-meter resolution product that is released every 5 years. While this product is useful for large scale planning, it is not adequate for detailed analysis.

A land cover dataset in the DRCOG region would cover more than 3,000 miles of waters in the South Platte River watershed, including portions of the South Platte River, Boulder Creek, Clear Creek, and Cherry Creek; irrigation canals, such as Fulton, Bull, and O'Brian canals; and numerous water storage reservoirs along the South Platte River.

The grant will match local contributions to hire a vendor to perform the classification and produce the deliverable.

Measurable Results

To catalog measurable results achieved with the CWP Grant funds, please provide any of the following values as applicable:

0	New Storage Created (acre-feet)
0	New Annual Water Supplies Developed or Conserved (acre-feet), Consumptive or Nonconsumptive
0	Existing Storage Preserved or Enhanced (acre-feet)
Estimated 3 to 5 miles affected annually	Length of Stream Restored or Protected (linear feet) - MHFD restores 3 to 5 miles of stream annually and the land cover data product will be used to assess stream functions in targeted project reaches and estimate post-project functional improvements.
0	Efficiency Savings (indicate acre-feet/year OR dollars/year)
0	Area of Restored or Preserved Habitat (acres)

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0	Quantity of Water Shared through Alternative Transfer Mechanisms	
Approximately 3.3 million people live in the area covered by the proposed data	Number of Coloradans Impacted by Incorporating Water-Saving Actions into Land Use Planning	
0	Number of Coloradans Impacted by Engagement Activity	
6,000 square miles	Other: Area covered by land cover data	Explain: The deliverable is a foundational data product that supports a variety of use cases including but not limited to scenario planning, climate change studies, urban stream assessments, setting conservation priorities, water quality analysis, and municipal water planning.

Water Project Justification

Provide a description of how this water project supports the goals of Colorado's Water Plan, the most recent Statewide Water Supply Initiative, and the applicable Roundtable Basin Implementation Plan and Education Action Plan. The Applicant is required to reference specific needs, goals, themes, or Identified Projects and Processes (IPPs), including citations (e.g. document, chapters, sections, or page numbers). The proposed water project shall be evaluated based upon how well the proposal conforms to Colorado's Water Plan Framework for State of Colorado Support for a Water Project (CWP, Section 9.4, pp. 9-43 to 9-44;)

Shared Goals and Values

There are several common themes between DRCOG's Metro Vision Plan and the Colorado Water Plan. For example, both highlight the importance of a healthy natural environment, the value of collaboration to develop infrastructure, and both acknowledge that success is found at the nexus of sustainable cities, productive agriculture, a vibrant economy and responsible water management.

In support of these values, Metro Vision commits DRCOG to bringing together local governments and other stakeholders to facilitate collaborative efforts that promote water conservation (CWP, Section 6.3.3, pp. 6-85). Metro Vision further notes the importance of coordinated local and regional investment in datasets to improve forecasting and other analysis capabilities related to greenhouse gas emissions, water demand and surface water runoff. The proposed project to develop a regional land cover dataset is an example of pursuing these commitments – understanding shared requirements for a product and creatively leveraging resources to acquire foundational data for conserving and managing water in our region.

Process to Develop Project

DRCOG's process to develop this project adhered to the CWP Framework by involving multiple participants from various perspectives, giving them meaningful opportunities to provide input on their requirements, and ultimately pooling their funding to leverage this state grant (CWP, Section 9.4, pp. 9-44).

Since the fall of 2018, DRCOG has convened six meetings, issued four surveys, and conducted a pilot project to better understand stakeholder needs. These exercises included data users from local, state, and federal government, universities, conservation organizations and public utilities. In anticipation of

this regional project, land cover experts at USGS also proactively created a crosswalk from the DRCOG proposed classification scheme to the lower-resolution National Land Cover Dataset, which is commonly used. This will aid future analysis by allowing the datasets to be used in conjunction, if desired. In collaboration with interested stakeholders, we have also already executed a competitive bid process per DRCOG's standard procedures wherein we selected a vendor with the technical expertise, local familiarity, and resource availability to do the work in the timeframe proposed.

Through DRCOG's experience developing foundational datasets for the region for the past 20 years, we have come to value collaborative data projects as a best practice. In comparison to stakeholders doing projects on their own, these regional data projects are cost-effective because, due to economies of scale, the large areas covered allow us to benefit from lower costs per square mile. The products that result are of consistent quality across a large spatial extent which enables accurate, comparable analysis between areas of interest and the development of common metrics (CWP, Section 6.6, pp. 6-178). Finally, DRCOG's data projects also place the burden of management on DRCOG staff, thereby allowing local stakeholders to direct their resources to their own priorities. The land cover project will leverage this model of collaboration to produce foundational data.

Several local stakeholders have committed to contributing funding to this project (Mile High Flood District, DRCOG, City and County of Broomfield, Boulder Open Space and Mountain Parks, Town of Castle Rock, Town of Erie, City of Greenwood Village, and the City of Wheat Ridge) and many more have indicated they would be interested in using the land cover dataset in their work (e.g.; The Nature Conservancy, Metro Denver Nature Alliance, and ICLEI - Local Governments for Sustainability).

Extensive and Varied Use Cases

Foundational data like land cover is valuable because it addresses more than one type of need (CWP, Section 9.4, pp. 9-43) and can be used by various stakeholders addressing water and natural resource conservation from different angles. The following use cases are illustrative but not exhaustive examples of how high-resolution land cover data could or will be applied.

The land cover data will deliver a critical product identified by regional stakeholders that came together in 2019 and 2020 to identify strategies to reduce greenhouse gas (GHG) emissions and to better understand our region's specific climate vulnerabilities. Those stakeholders expressed interest in coordinated local and regional investment in datasets to improve forecasting and other analysis capabilities related to air quality and greenhouse gas emissions. DRCOG also intends to use the land cover data for scenario planning (CWP, Section 6.1, pp. 6-14). In consultation with local governments and other stakeholders, DRCOG develops and publishes small-area household and employment forecasts for the Denver region. DRCOG's land use model (CWP, Section 6.3.3, pp. 6-84) incorporates local growth policies and observable natural constraints that enable or limit future development in efforts to co-develop, with local stakeholders, a shared understanding of future growth. A high-resolution land cover dataset will make scenario analysis more robust by enabling exploration – and even quantification – of urbanization, agriculture, and forestry. Additionally, this dataset would serve as a baseline upon which to measure change.

High-resolution land cover data is foundational to regional climate action because it enables monitoring critical drivers of water supply and demand (CWP, Section 6.1, pp. 6-14) through such means as impervious surface analysis, urban tree analysis, and identification of strategic lands. For example, building permits in the Denver metro area indicate that infill development is increasing impervious surface, which has management implications for stormwater and flood events. A land cover dataset could help visualize and quantify this challenge. Regarding urban trees, National Land Cover data is not captured at a high enough resolution to see small stands of trees outside of forests. A high-resolution dataset would enable identification of isolated urban trees that could factor into carbon load modeling. Also, a high-resolution land cover dataset paired with factors related to carbon emissions and removal would inform decisions on what tracts of land should be maintained, preserved, or enhanced to further carbon sequestration.

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Mile High Flood District plans to use the land cover dataset in their urban stream assessment procedure. The District will use the land cover data to determine the extent and quality of riparian vegetation along streams and drainageways. Assessments will be completed as part of master planning to identify and prioritize stream restoration projects and for specific project reaches to document baseline conditions and identify opportunities to improve stream functions. Additionally, the District intends to use the land cover data to improve its hydrology and floodplain modeling. Mile High Flood District's intended use of the data is consistent with several goals and projects in the South Platte Basin Implementation Plan (SPBIP), including Water Quality (SPBIP Section 1.9.5 E&R, MO#1), Channel Restoration (SPBIP Section 4.5.2.2), and Cooperative and Multi-purpose Projects (SPBIP Section 4.5.2.5).

The Nature Conservancy and the Metro Nature Denver Alliance plan to use the data as part of the Regional Conservation Assessment - a novel scientific analysis and suite of decision-making tools to identify high-priority places in the metro Denver region to protect, connect, restore, and enhance for people and nature. Typically, riparian corridors and their associated streams are priority targets for conservation (SPBIP Section 1.9.7, E&R MO#1 (iv)). Riparian corridors are especially difficult to analyze with existing land cover data due to lack of detail (i.e. 30-meter resolution National Land Cover data). The 1-meter resolution DRCOG land cover data will support detailed analysis of these areas.

Two local conservation partners, Biohabitats and the High Line Canal Conservancy, used DRCOG's 2019 land cover pilot data to evaluate habitat connectivity, habitat quality, and riparian vegetation in their study area. A regional dataset would allow them to expand on their preliminary findings, including performing change detection (SPBIP Section 1.9.7, E&R MO#1 (iv)). Another goal of the High Line Canal Conservancy is to transform portions of the High Line Canal into water quality facilities for stormwater runoff. The land cover data will enable more accurate modeling of water quality benefits that would be gained from the transformation (SPBIP Section 1.9.5, E&R MO#1).

Local governments have indicated interest in using a high-resolution land cover dataset for such work as planning trails on recreational lands and stormwater analysis. Additionally, Colorado's Water Plan sets a measurable objective that by 2025 that 75 percent of Coloradans will live in communities that have incorporated water-saving actions into land-use planning (CWP, Executive Summary). In March 2020, Governor Polis signed HB 20-1095: Local Governments Water Elements In Master Plans into law. HB 20-1095 does not require that local governments incorporate a water element into their comprehensive plan, but it does establish an important nexus between water conservation policies designed and implemented locally and state water goals. The proposed development of the high-resolution land use dataset covering numerous communities in the Metro/South Platte basins will equip these high-growth communities, and their water partners, with a resource to better inform water conservation policies and watershed protection plans, including associated regulatory and monitoring approaches.

Related Studies

Please provide a list of any related studies, including if the water project is complementary to or assists in the implementation of other CWCB programs.

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CWCB Fluvial Hazard Mapping Program
The land cover data will be combined with fluvial hazard mapping to allow Mile High Flood District and local government partners to make better land use decisions to reduce flood risk.

CWCB Lidar Program
CWCB has been working to acquire lidar throughout the State (CWCB Newsletter, August 2019). DRCOG and CWCB partnered in early 2020 to collect lidar in the Denver Region. This elevation data is helpful for understanding water flows and flood risk. It is also useful for differentiating land cover classes, specifically forests and shrubland. The DRCOG land cover dataset would leverage and complement CWCB's investment in lidar data in the Denver region.

DRCOG Metro Vision Plan
DRCOG's Metro Vision plan anticipates a safe and resilient built and natural environment with clean air and water, where people are connected to healthy and diverse natural resources, and the risks and effects of disasters are reduced. The adopted plan suggests the following initiatives that DRCOG and our partners pursue that align with the development of high-resolution land cover dataset:

Coordinate stakeholders to monitor land-use changes in basins with adopted water quality plans and programs.

Provide data and tools that help local and regional partners connect people to open space, trails and other natural resource and recreational areas.

Previous CWCB Grants, Loans or Other Funding

List all previous or current CWCB grants (including WSRF) awarded to both the Applicant and Grantee. Include: 1) Applicant name; 2) Water activity name; 3) Approving RT(s); 4) CWCB board meeting date; 5) Contract number or purchase order; 6) Percentage of other CWCB funding for your overall project.

Applicant name: Denver Regional Council of Governments
Water name activity: N/A
Contract number: CMS 139577

The funding granted through CMS 139577 contributed to a regional lidar project which is in the process of developing elevation data for the Denver Region, a foundational dataset for understanding topography and water flow. This data will be an input into the Regional Land Cover Project, as it will help distinguish between classifications like forest and shrubland.

Please note that while the lidar and land cover projects are complementary, they have been scoped independently and include separate and distinct funding commitments from project partners.

Taxpayer Bill of Rights

The Taxpayer Bill of Rights (TABOR) may limit the amount of grant money an entity can receive. Please describe any relevant TABOR issues that may affect your application.

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The TABOR Amendment is subject to many interpretations, but the Denver Regional Council of Governments (DRCOG) has a legal opinion that it is not a "local government" subject to TABOR in part because it has no authority to tax or to issue general obligation debt.

Submittal Checklist	
x	I acknowledge the Grantee will be able to contract with CWCB using the Standard Contract.
Exhibit A	
x	Statement of Work(1)
x	Budget & Schedule(1)
x	Engineer's statement of probable cost (projects over $100,000)
x	Letters of Matching and/or Pending 3rd Party Commitments(1)
Exhibit C	
x	Map (if applicable)(1)
x	Photos/Drawings/Reports
	Letters of Support (Optional)
x	Certificate of Insurance (General, Auto, & Workers' Comp.) (2)
x	Certificate of Good Standing with Colorado Secretary of State(2)
x	W-9(2)
NA	Independent Contractor Form(2) (If applicant is individual, not company/organization)
Engagement & Innovation Grant Applicants ONLY	
NA	Engagement & Innovation Supplemental Application(1)

(1) Required with application.
(2) Required for contracting. While optional at the time of this application, submission can expedite contracting upon CWCB Board approval.

ENGAGEMENT & INNOVATION GRANT FUND SUPPLEMENTAL APPLICATION

Last Updated: June 2020

Introduction & Purpose

Colorado's Water Plan calls for an outreach, education, public engagement, and innovation grant fund in Chapter 9.5.

The overall goal of the Engagement & Innovation Grant Fund is to enhance Colorado's water communication, outreach, education, and public engagement efforts; advance Colorado's water supply planning process; and support a statewide water innovation ecosystem.

The grant fund aims to engage the public to promote well-informed community discourse regarding balanced water solutions statewide. The grant fund aims to support water innovation in Colorado. The grant fund prioritizes measuring and evaluating the success of programs, projects, and initiatives. The grant fund prioritizes efforts designed using research, data, and best practices. The grant fund prioritizes a commitment to collaboration and community engagement. The grant fund will support local and statewide efforts.

The grant fund is divided into two tracks: engagement and innovation. The Engagement Track supports education, outreach, communication, and public participation efforts related to water. The Innovation Track supports efforts that advance the water innovation ecosystem in Colorado.

Application Questions

*The grant fund request is referred to as "project" in this application.

Overview (answer for both tracks)
In a few sentences, what is the overall goal of this project? How does it achieve the stated purpose of this grant fund (above)?
Who is/are the target audience(s)? How will you reach them? How will you involve the community?
Describe how the project is collaborative or engages a diverse group of stakeholders. Who are the partners in the project? Do you have other funding partners or sources?
Describe how you plan to measure and evaluate the success and impact of the project?

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Overview (answer for both tracks)
What research, evidence, and data support your project?
Describe potential short- and long-term challenges with this project.

Please fill out the applicable questions for either the Engagement Track or Innovation Track, unless your project contains elements in both tracks. If a question does not relate to your project, just leave it blank. Please answer each question that relates to your project. Please reference the relevant documents and use chapters and page numbers (Colorado's Water Plan, Basin Implementation Plan, PEPO Education Action Plan, etc.).

Engagement Track
Describe how the project achieves the education, outreach, and public engagement measurable objective set forth in Colorado's Water Plan to "significantly improve the level of public awareness and engagement regarding water issues statewide by 2020, as determined by water awareness surveys."
Describe how the project achieves the other measurable objectives and critical goals and actions laid out in Colorado's Water Plan around the supply and demand gap; conservation; land use; agriculture; storage; watershed health, environment, and recreation; funding; and additional.
Describe how the project achieves the education, outreach, and public engagement goals set forth in the applicable Basin Implementation Plan(s).

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Describe how the project achieves the basin roundtable's PEPO Education Action Plans.

Innovation Track
Describe how the project enhances water innovation efforts and supports a water innovation ecosystem in Colorado.
Describe how the project engages/leverages Colorado's innovation community to help solve our state's water challenges.
Describe how the project helps advance or develop a solution to a water need identified through TAP-IN and other water innovation challenges. What is the problem/need/challenge?
Describe how this project impacts current or emerging trends; technologies; clusters, sectors, or groups in water innovation.

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Colorado Water Conservation Board
Water Plan Grant - Exhibit A

Statement Of Work	
Date:	11/27/2020
Name of Grantee:	Denver Regional Council of Governments
Name of Water Project:	Regional Land Cover Project
Funding Source:	DRCOG, MHFD, local governments

Water Project Overview:

The land cover project includes gathering requirements from stakeholders, performing a pilot study to refine needs, selecting a qualified vendor, and then developing a regional land cover dataset.

In preparation for this grant opportunity, DRCOG worked with stakeholders and vendors to scope the project. We also collected high-resolution imagery and quality level 2 lidar data in 2020, from which land cover data can be derived.

DRCOG plans to contract with Sanborn Map Company, using funds contributed by regional partners and local governments, to develop a land cover dataset.

Work can begin as early as April 2021 and is expected to last one year.

The product will be a high-resolution (1-meter) land cover dataset that classifies the region in to nine distinct land cover types.

Upon project completion, the data will be in the public domain and available from DRCOG.

Project Objectives:

Our primary objective with this project is to provide a foundational dataset that is useful for the greatest number of users and use cases, with priority for land use and water conservation applications.

In support of that goal, DRCOG has identified the following project components that are necessary for success. Several tasks have already been completed by DRCOG so that CWCB grant funding can be applied to our best version of the data development task.

1 – Understand stakeholder needs for a land cover dataset by gathering requirements through meetings and surveys. *Completed by DRCOG.*

2 – Perform a pilot study to demonstrate value and further refine stakeholder requirements. *Completed by DRCOG and the Babbitt Center for Land and Water Policy.*

3 – Through a competitive bid process, select a vendor with expertise in land cover classification and familiarity with the Denver Region. *Completed by DRCOG and stakeholders.*

4 - Produce a foundational high-resolution land cover dataset that supports a wide variety of users and use cases. *This task is where CWCB grant money would be applied.*

5 – Publish and publicize the land cover data for consumption by key stakeholders and the public. *To be completed by DRCOG.*

Tasks

Task 1 – Development of High-Resolution Land Cover Dataset

Description of Task

Sanborn Map Company will develop land cover data per stakeholder requirements at DRCOG's direction.

Sanborn Map Company will perform the data classification and all associated technical work including algorithm development, manual editing, and quality control. They will also develop documentation including an accuracy assessment and detailed metadata that explains their methodology. The deliverable will be a land cover dataset that will cover the DRCOG region with a 9-class, 1-meter resolution product.

As the project manager, DRCOG will manage the contract with the Sanborn Map Company, including overseeing the schedule and budget and ensuring adherence to project requirements. DRCOG will also be the liaison between project stakeholders and the Sanborn Map Company and will be the communication hub between all parties. DRCOG will create progress reports, as requested by the stakeholders and/or required by this grant. DRCOG will also package and distribute the final product for stakeholder and public consumption. DRCOG is not seeking reimbursement staff charges related to project management.

Method/Procedure

Sanborn Map Company responded to a DRCOG request for proposal (RFP) in Q1 2020 with the following methodology. The process outlined below will be piloted in a small area so that the methodology and deliverable can be approved prior to work being done for the entire region.

Step 1: Determine inputs and standards
Three primary data sources will be used as inputs including Denver Regional Aerial Photography Project (DRAPP) 2020 high-resolution imagery collected during leaf-off conditions (provided by DRCOG), 2020 imagery collected during leaf-on conditions such as Maxar/DigitalGlobe WorldView, VDP, HxIP, or Nearmap (provided by Sanborn Map Company), and 2020 lidar point clouds (provided by DRCOG and USGS). Secondary datasets such as DRCOG's planimetric data may also be used. To develop standards, Sanborn Map Company will create an image interpretation key, which will serve as the basis for class identification and will establish minimum mapping units. During this process,

Tasks

training sites will be developed that accurately identify the classes to be extracted and represent them with a variety of textures and band ratios.

Step 2: Automated classification
Sanborn Map Company will utilize object-based imagery analysis (OBIA) to automatically classify the data sources, which focuses on groups of pixels that form meaningful landscape objects and incorporates contextual cues such as contrast and adjacency. A primary classification will be done to separate impervious from pervious classes and then the data inputs will be further segmented into objects that are classified to conform to our preferred classification scheme. Misclassifications at this stage will be addressed with custom-built spectral models. For example, to minimize the impact of shadows in imagery sources, a branching algorithm technique that emphasizes structural information from the lidar source over the spectral information from the imagery sources will be used in dark areas.

Step 3: Manual edits
Trained analysts will review the entire product and make edits were needed. Analysts are trained with examples and written specifications that inform their manual editing.

Step 4: Accuracy assessment
A dedicated quality control analyst at Sanborn ensures that the product is adhering to standards throughout the process. DRCOG and its stakeholders will also have the opportunity to review deliverables and provide feedback. A formal accuracy assessment will be created at the end of the project to confirm that accuracy specifications have been met. This includes collecting more than 50 photo-interpreted points per class using a proportional sampling scheme. The results are presented in a confusion matrix where rates of misclassification can be seen for each class.

Deliverable

The land cover dataset will cover the DRCOG region with a 1-meter resolution product with an overall classification accuracy of 90% when delineating into the following classes:

1. **Structures**
   Human-constructed objects made of impervious materials that are greater than approximately 2 meters in height. Houses, malls, and electrical towers are examples of structures. MMU = 9 square meters
2. **Impervious Surfaces**
   Human-constructed surfaces through which water cannot penetrate, and that are below approximately 2 meters in height. This includes asphalt, concrete, gravel, pavement, treated lumber (e.g. docks and decks), and dirt roads etc. MMU = 9 square meters, minimum 2 meters wide for linear features
3. **Water**
   All areas of open water, generally with less than 25% cover of vegetation/land cover. This includes water-filled backyard pools, ponds, lakes, rivers, natural tidal pools in wetland areas, and boats that are not attached to docks. MMU = 9 square meters.
4. **Grassland/prairie**
   Large open semi-arid areas composed of perennial grasses and herbaceous vegetation. These lands are often used for ranching and grazing but are not managed beyond these activities. This class also includes unmanaged natural ground cover that is less than a meter tall, such as wetland areas. MMU = 9 square meters.
5. **Shrubland/scrubland**
   Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions. MMU = 9 square meters.
6. **Tree Canopy**

Tasks

Deciduous and evergreen woody vegetation of either natural succession or human planting that is over approximately 5 meters in height. Stand-alone individuals, discrete clumps, and interlocking individuals are included. Includes individual large shrubs. MMU = 9 square meters.

7. **Irrigated lands/turf**
   Turf grass and areas of land that are actively managed and watered that do not fall in the cropland class. Examples of turf: lawns, cemeteries, golf courses, sports fields. MMU = 9 square meters
8. **Barren/rock**
   Areas void of vegetation consisting of natural earthen material regardless of how it has been cleared. This includes beaches, mud flats, bedrock, xeriscaped lawns, and bare ground in construction sites (hard-packed paths/roads in construction sites would be better suited for the impervious class). MMU = 25 square meters
9. **Cropland**
   Large fields generally found in non-urban areas used for the production of various annual crops. These lands can be in active or inactive use but must show visual signs of recent usage such as tilled fields or tire tracks.

The dataset will be delivered in raster and polygon formats and will include FGDC-compliant metadata, including methodology documentation and any assumptions made during the analysis.

Budget and Schedule

This Statement of Work shall be accompanied by a combined Budget and Schedule that reflects the Tasks identified in the Statement of Work and shall be submitted to CWCB in excel format.

Reporting Requirements

Progress Reports: The applicant shall provide the CWCB a progress report every 6 months, beginning from the date of issuance of a purchase order, or the execution of a contract. The progress report shall describe the status of the tasks identified in the statement of work, including a description of any major issues that have occurred and any corrective action taken to address these issues.

Final Report: At completion of the project, the applicant shall provide the CWCB a Final Report on the applicant's letterhead that:

- Summarizes the project and how the project was completed.
- Describes any obstacles encountered, and how these obstacles were overcome.
- Confirms that all matching commitments have been fulfilled.
- Includes photographs, summaries of meetings and engineering reports/designs.

The CWCB will pay out the last 10% of the budget when the Final Report is completed to the satisfaction of CWCB staff. Once the Final Report has been accepted, and final payment has been issued, the purchase order or grant will be closed without any further payment.

Last Updated: June 2020

Payment

Payment will be made based on actual expenditures and must include invoices for all work completed. The request for payment must include a description of the work accomplished by task, an estimate of the percent completion for individual tasks and the entire Project in relation to the percentage of budget spent, identification of any major issues, and proposed or implemented corrective actions.

Costs incurred prior to the effective date of this contract are not reimbursable. The last 10% of the entire grant will be paid out when the final deliverable has been received. All products, data and information developed as a result of this contract must be provided to CWCB in hard copy and electronic format as part of the project documentation.

Performance Measures

Performance measures for this contract shall include the following:
(a) Performance standards and evaluation: Grantee will produce detailed deliverables for each task as specified. Grantee shall maintain receipts for all project expenses and documentation of the minimum in-kind contributions (if applicable) per the budget in Exhibit B. Per Water Plan Grant Guidelines, the CWCB will pay out the last 10% of the budget when the Final Report is completed to the satisfaction of CWCB staff. Once the Final Report has been accepted, and final payment has been issued, the purchase order or grant will be closed without any further payment.
(b) Accountability: Per Water Plan Grant Guidelines full documentation of project progress must be submitted with each invoice for reimbursement. Grantee must confirm that all grant conditions have been complied with on each invoice. In addition, per Water Plan Grant Guidelines, Progress Reports must be submitted at least once every 6 months. A Final Report must be submitted and approved before final project payment.
(c) Monitoring Requirements: Grantee is responsible for ongoing monitoring of project progress per Exhibit A. Progress shall be detailed in each invoice and in each Progress Report, as detailed above. Additional inspections or field consultations will be arranged as may be necessary.
(d) Noncompliance Resolution: Payment will be withheld if grantee is not current on all grant conditions. Flagrant disregard for grant conditions will result in a stop work order and cancellation of the Grant Agreement.

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Colorado Water Conservation Board

Budget and Schedule

Prepared Date: 11/25/2020

Name of Applicant: Denver Regional Council of Governments (DRCOG)

Name of Water Project: Regional Land Cover Project

Project Start Date: April 2021

Project End Date: April 2022

Task No.	Task Description	Sub-task	Task Start Date	Task End Date	Cost per square mile	# Square Miles	Hourly Rate	# Hours	Subtotal	Grant Funding Request	Match Funding	Total
	Development of High-Resolution Land Cover Dataset	Development of land cover in urban area by Sanborn Map Company	April 2021	April 2022	$ 79.39	1184			93,997.76	$ 46,998.88	$ 46,998.88	$93,998
		Development of land cover in rural area by Sanborn Map Company	April 2021	April 2022	$ 22.32	4848			108,207.36	$ 54,103.68	$ 54,103.68	$108,207
				Total						$101,103	$101,103	$202,205

November 30, 2020

Denver Regional Council of Governments
ATTN: Contracts Department
1001 17th St, Suite 700
Denver, CO 80202

Re: Intent to Participate in the 2020 Denver Regional Land Cover Project

Please accept this letter as notification of DRCOG's commitment to participate in the 2020 Regional Land Cover Project (in the event the project is officially approved by the DRCOG Finance and Budget Committee and the project is fully funded).

DRCOG will commit an amount not to exceed $30,000 to this project.

We understand that this letter is legally binding and the fee will provide us with land cover data to support the goals and objectives of our business activities.

We understand that all final data produced from this project will be in the public domain.

Sincerely,

Jenny Dock
Director, Administration and Finance

MILE HIGH FLOOD DISTRICT

2480 W. 26th Ave Suite 156-B | Denver, CO 80211
TEL 303 455 6277 | FAX 303 455 7880

www.mhfd.org

Ashley Summers
Denver Regional Council of Governments
ATTN: Contracts Department
1001 17th St, Suite 700
Denver, CO 80202

November 27, 2020

Re: Intent to Participate in the 2020 Denver Regional Land Cover Project

Dear Ms. Summers,

Please accept this letter as notification of Mile High Flood District's commitment to participate in the 2020 Regional Land Cover Project (in the event the project is officially approved by the DRCOG Finance and Budget Committee and the project is fully funded).

The MHFD will commit an amount not to exceed $54,903 to this project.

We understand that this letter is legally binding and the fee will provide us with land cover data to support the goals and objectives of our business activities.

We understand that all final data produced from this project will be in the public domain.

Sincerely,

Ken MacKenzie
Director

City of Boulder Open Space & Mountain Parks

2520 55th St., Boulder, CO 80301; 303-441-3440
http://www.osmp.org

11/20/2020

Denver Regional Council of Governments
ATTN: Contracts Department
1001 17th St, Suite 700
Denver, CO 80202

Re: Intent to Participate in the 2020 Denver Regional Land Cover Project

Please accept this letter as notification of the City of Boulder Open Space & Mountain Parks Department's commitment to participate in the 2020 Regional Land Cover Project (in the event the project is officially approved by the DRCOG Finance and Budget Committee and the project is fully funded).

The City of Boulder Open Space & Mountain Parks Department will commit an amount not to exceed $3,000.00 to this project.

We understand that this letter is legally binding and the fee will provide us with land cover data to support the goals and objectives of our business activities.

We understand that all final data produced from this project will be in the public domain.

Sincerely,

John Morley

John Morley
GIS Supervisor
City of Boulder – Open Space & Mountain Parks

COMMUNITY DEVELOPMENT
One DesCombes Drive • Broomfield, CO 80020 • 303.438.6389 • www.broomfield.org

November 20, 2020

Denver Regional Council of Governments
ATTN: Contracts Department
1001 17th St, Suite 700
Denver, CO 80202

Re: Intent to Participate in the 2020 Denver Regional Land Cover Project

Please accept this letter as notification of Broomfield's commitment to participate in the 2020 Regional Land Cover Project (in the event the project is officially approved by the DRCOG Finance and Budget Committee and the project is fully funded).

Broomfield will commit an amount not to exceed **$5,000** to this project.

We understand that this letter is legally binding and the fee will provide us with land cover data to support the goals and objectives of our business activities.

We understand that all final data produced from this project will be in the public domain.

Sincerely,

Digitally signed by Katie Allen
DN: C=US, E=kallen@broomfield.org, O=City and County of Broomfield, CN=Katie Allen
Date: 2020.11.20 12:53:14-07'00'

Katie Allen, P.E.

City and County Engineer

Division of Innovation and Technology

11/18/2020

Denver Regional Council of Governments
ATTN: Contracts Department
1001 17th St, Suite 700
Denver, CO 80202

Re: Intent to Participate in the 2020 Denver Regional Land Cover Project

Please accept this letter as notification of Castle Rock's commitment to participate in the 2020 Regional Land Cover Project (in the event the project is officially approved by the DRCOG Finance and Budget Committee and the project is fully funded).

Castle Rock will commit an amount not to exceed $3,200 to this project.

We understand that this letter is legally binding and the fee will provide us with land cover data to support the goals and objectives of our business activities.

We understand that all final data produced from this project will be in the public domain.

Sincerely,

Amelia Hart-Dayton 11/18/2020

Amelia Hart-Dayton
GIS Manager
Town of Castle Rock
100 N. Wilcox Street
Castle Rock, CO 80104
Office: 720-733-3550

TOWN OF ERIE
1874

November 16th, 2020

Denver Regional Council of Governments
ATTN: Contracts Department
1001 17th St, Suite 700
Denver, CO 80202

Re: Intent to Participate in the 2020 Denver Regional Land Cover Project

Please accept this letter as notification of the **Town of Erie's** commitment to participate in the 2020 Regional Land Cover Project (in the event the project is officially approved by the DRCOG Finance and Budget Committee and the project is fully funded).

Erie will commit an amount not to exceed **$2000** to this project.

We understand that this letter is legally binding and the fee will provide us with land cover data to support the goals and objectives of our business activities.
We understand that all final data produced from this project will be in the public domain.

Sincerely,

DocuSigned by:
87F1F96B112349C...

David Pasic
Town Engineer

Greenwood Village
ADMINISTRATIVE SERVICES DEPARTMENT
6060 SOUTH QUEBEC STREET • GREENWOOD VILLAGE, COLORADO 80111-4591 • MAIN: (303) 773-0252 • FAX: (303) 804-4108

November 9, 2020

Denver Regional Council of Governments
ATTN: Contracts Department
1001 17th St, Suite 700
Denver, CO 80202

Re: Intent to Participate in the 2020 Denver Regional Land Cover Project

Please accept this letter as notification of the Greenwood Village's commitment to participate in the 2020 Regional Land Cover Project (in the event the project is officially approved by the DRCOG Finance and Budget Committee and the project is fully funded).

Greenwood Village will commit an amount not to exceed $1500 to this project.
We understand that this letter is legally binding, and the fee will provide us with land cover data to support the goals and objectives of our business activities.

We understand that all final data produced from this project will be in the public domain.
Sincerely,

Michael Edwards
Technology Services Manager

City of Wheat Ridge
ADMINISTRATIVE SERVICES

City of Wheat Ridge Municipal Building 7500 W. 29th Ave. Wheat Ridge, CO 80033-8001 P: 303.235.2819 F: 303.234.5924

November 9, 2020

Denver Regional Council of Governments
ATTN: Roberta Cole, Contracts Department
1001 17th St. Suite 700
Denver, CO 80202

Re: Intent to Participate in the 2020 Denver Regional Land Cover Project

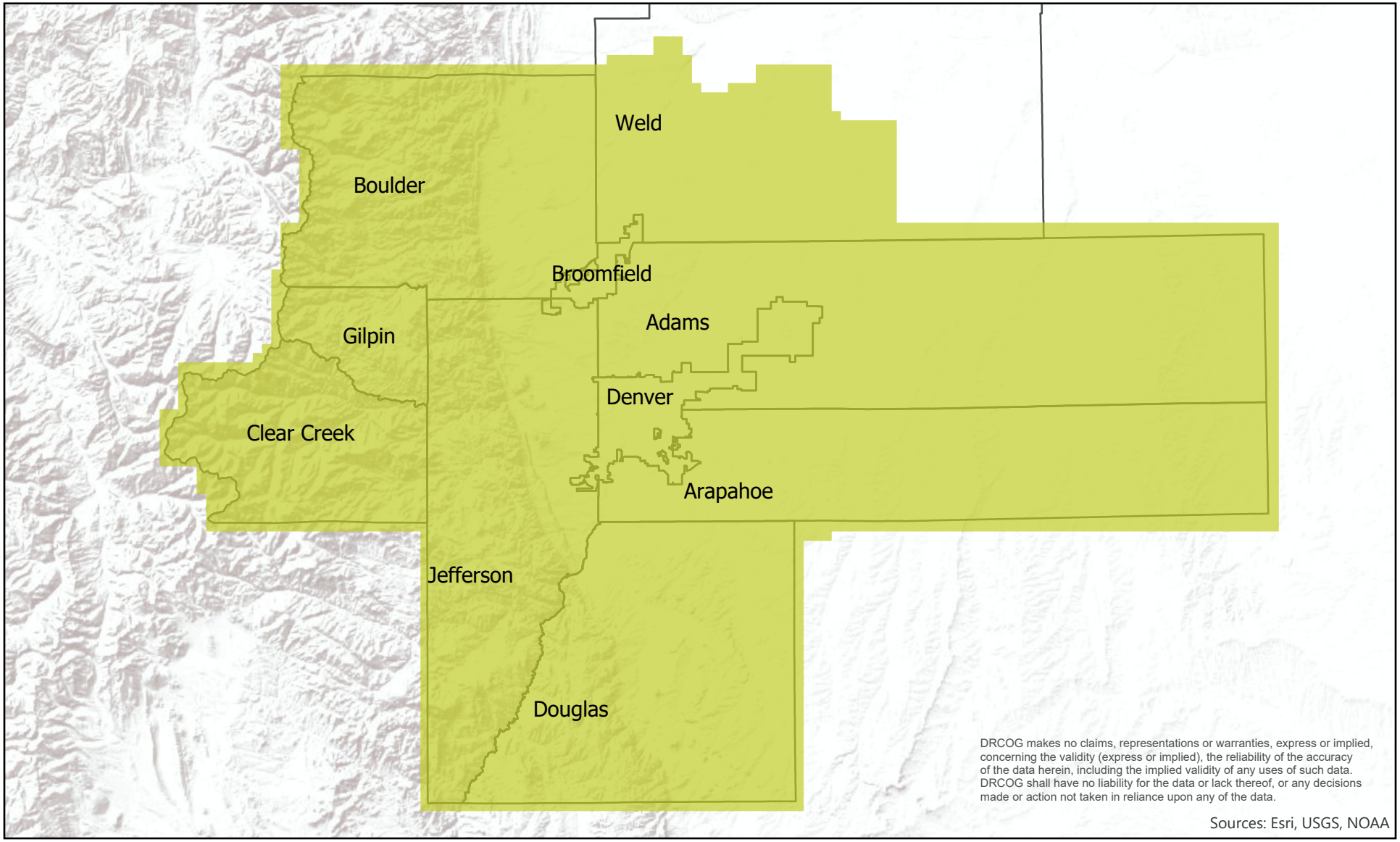
Please accept this letter as notification of the Wheat Ridge's commitment to participate in the 2020 Regional Land Cover Project (in the event the project is officially approved by the DRCOG Finance and Budget Committee and the project is fully funded).

Wheat Ridge will commit an amount not to exceed $1500 to this project.

We understand that this letter is legally binding and the fee will provide us with land cover data to support the goals and objectives of our business activities.
We understand that all final data produced from this project will be in the public domain.
Sincerely,

Michael Steinke
Information Technology Manager

Regional Land Cover Project Extent



Proposed Project Extent

County Boundaries

This map represents the extent of the Denver Regional Aerial Photography Project (DRAPP), the output of which will be used as the basis for the Regional Land Cover Project. The extent includes Adams County, Arapahoe County, Boulder County, City and County of Broomfield, City and County of Denver, Clear Creek County, Douglas County, Gilpin County, Jefferson County, and portions of Weld County.

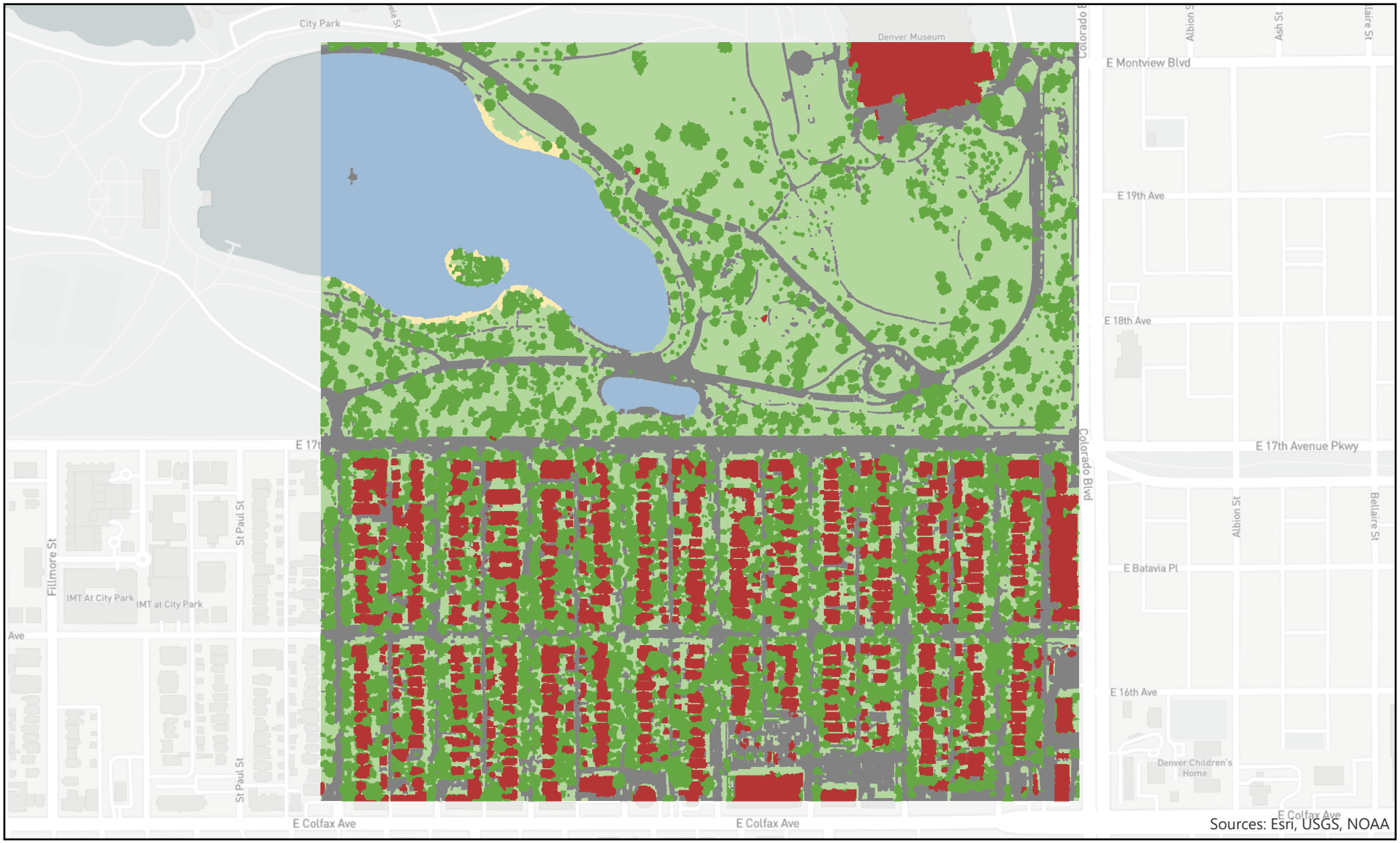
N

0 5 10 15

Miles

SOURCE DATA: DRCOG, ESRI, USGS, NOAA Basemap
Creator: Ashley Summers, 11.28.2020
Location: cogshare\DRAPP\2020\lulc

Land Cover Classification Example



- Buildings
- Impervious
- Tree Canopy
- Bare Soil
- Grass\Shrubs
- Water

This sample was provided by Sanborn Map Company as part of a RFP response. It demonstrates the detail of a high-resolution land cover dataset. Only six classes are shown in this example, but DRCOG's proposed project includes nine classes.

N

0 500

Feet

SOURCE DATA: DRCOG, ESRI, USGS, NOAA Basemap
Creator: Ashley Summers, 11.28.2020
Location: cogshare\DRAPP\2020\lulc

sanborn

Corporate Headquarters
1935 Jamboree Drive
Suite 100
Colorado Springs, CO 80920

Phone: 719.593.0093
Toll-Free: 1.866.726.2676
Fax: 719.528.5093
www.sanborn.com

November 30, 2020

Ms. Ashley Summers
Information Systems Manager
Denver Regional Council of Governments
1001 17th Street Suite 700
Denver, CO 80202

Re: Quote for Land Use Land Cover Data

Dear Ms. Summers:

The Sanborn Map Company, Inc. (Sanborn), an ISO 9001:2015 quality certified company, is pleased to submit our letter quote to you in response to the Denver Regional Council of Governments (DRCOG) Request for Land Use Land Cover Data. As professionals and long-time providers of geospatial products and services to municipal government agencies, we appreciate the challenges you face in capturing, updating and managing the infrastructure within DRCOG, and the role that geospatial data plays in this responsibility. Selecting Sanborn as your professional geospatial data provider will place your program in the hands of a firm that has the requisite experience, proven production processes, and knowledge of DRCOG's existing technology. Sanborn's proposed technical details, schedule and fees are provided below.

Technical Details:

- Development of High-Resolution Land Cover Dataset

Sanborn will perform the data classification and all associated technical work including algorithm development, manual editing, and quality control. They will also develop documentation including an accuracy assessment and detailed metadata that explains their methodology. The deliverable will be a land cover dataset that will cover the DRCOG region with a 9-class, 1-meter resolution product.

- Step 1: Determine inputs and standards - Three primary data sources will be used as inputs including Denver Regional Aerial Photography Project (DRAPP) 2020 high-resolution imagery collected during leaf-off conditions (provided by DRCOG), 2020 imagery collected during leaf-on conditions such as Maxar/DigitalGlobe WorldView, VDP, HxIP, or Nearmap (provided by Sanborn Map Company), and 2020 lidar point clouds (provided by DRCOG and USGS). Secondary datasets such as DRCOG's planimetric data may also be used.

  To develop standards, Sanborn Map Company will create an image interpretation key, which will serve as the basis for class identification and will establish minimum mapping units. During this process, training sites will be developed that accurately identify the classes to be extracted and represent them with a variety of textures and band ratios.

- Step 2: Automated classification - Sanborn Map Company will utilize object-based imagery analysis (OBIA) to automatically classify the data sources, which focuses on groups of pixels that form meaningful landscape objects and incorporates contextual cues such as contrast and adjacency. A primary classification will be done to separate impervious from pervious classes and then the data inputs will be further

segmented into objects that are classified to conform to our preferred classification scheme. Misclassifications at this stage will be addressed with custom-built spectral models. For example, to minimize the impact of shadows in imagery sources, a branching algorithm technique that emphasizes structural information from the lidar source over the spectral information from the imagery sources will be used in dark areas.

- Step 3: Manual edits - Trained analysts will review the entire product and make edits were needed. Analysts are trained with examples and written specifications that inform their manual editing.
- Step 4: Accuracy assessment - A dedicated quality control analyst at Sanborn ensures that the product is adhering to standards throughout the process. DRCOG and its stakeholders will also have the opportunity to review deliverables and provide feedback. A formal accuracy assessment will be created at the end of the project to confirm that accuracy specifications have been met. This includes collecting more than 50 photo-interpreted points per class using a proportional sampling scheme. The results are presented in a confusion matrix where rates of misclassification can be seen for each class.

- Deliverable

The land cover dataset will cover the DRCOG region with a 1-meter resolution product with an overall classification accuracy of 90% when delineating into the following classes:

- Structures - Human-constructed objects made of impervious materials that are greater than approximately 2 meters in height. Houses, malls, and electrical towers are examples of structures. MMU = 9 square meters
- Impervious Surfaces - Human-constructed surfaces through which water cannot penetrate, and that are below approximately 2 meters in height. This includes asphalt, concrete, gravel, pavement, treated lumber (e.g. docks and decks), and dirt roads etc. MMU = 9 square meters, minimum 2 meters wide for linear features
- Water - All areas of open water, generally with less than 25% cover of vegetation/land cover. This includes water-filled backyard pools, ponds, lakes, rivers, natural tidal pools in wetland areas, and boats that are not attached to docks. MMU = 9 square meters.
- Grassland/prairie - Large open semi-arid areas composed of perennial grasses and herbaceous vegetation. These lands are often used for ranching and grazing but are not managed beyond these activities. This class also includes unmanaged natural ground cover that is less than a meter tall, such as wetland areas. MMU = 9 square meters.
- Shrubland/scrubland - Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions. MMU = 9 square meters.
- Tree Canopy - Deciduous and evergreen woody vegetation of either natural succession or human planting that is over approximately 5 meters in height. Stand-alone individuals, discrete clumps, and interlocking individuals are included. Includes individual large shrubs. MMU = 9 square meters.
- Irrigated lands/turf - Turf grass and areas of land that are actively managed and watered that do not fall in the cropland class. Examples of turf: lawns, cemeteries, golf courses, sports fields. MMU = 9 square meters
- Barren/rock - Areas void of vegetation consisting of natural earthen material regardless of how it has been cleared. This includes beaches, mud flats, bedrock, xeriscaped lawns, and bare ground in construction sites (hard-packed paths/roads in construction sites would be better suited for the impervious class). MMU = 25 square meters

- Cropland - Large fields generally found in non-urban areas used for the production of various annual crops. These lands can be in active or inactive use but must show visual signs of recent usage such as tilled fields or tire tracks.

The dataset will be delivered in raster and polygon formats and will include FGDC-compliant metadata, including methodology documentation and any assumptions made during the analysis.

Fees and Schedule:

Sanborn understands the project area to include the Denver metro region, project area at two densities, low and high. The table below provide density size in square miles and a cost for each area.

DRCOG Land Cover Mapping Area and Fees		
Project Area Feature Density	**Square Miles**	**Total Fee**
High Density	1184	$ 93,997.76
Low Density	4848	$ 108,207.36
Total	6032	$ 202,205.12

Assuming a Start date of April 2021, Sanborn is committed to providing finalized first time deliveries within 8 months. Incremental deliveries and pilot deliveries can be included within this timeline.

We believe our response has addressed your request; however, should you have questions or need clarification, please contact Mr. Jason Caldwell, Vice President, Business Development and Sales, by phone at (719) 264-5547 or email at jcaldwell@sanborn.com. We appreciate the opportunity to submit these qualifications and look forward to the results of your evaluation.

Sincerely,

Jason Caldwell

Jason Caldwell
Vice President of Business Development and Sales