November 20, 2015

Moulton Niguel Water District
27500 La Paz Road
Laguna Niguel, CA 92677

Re: California Data Collaborative Project: Phase One Pilot

To: California Water Agencies:

This Letter of Agreement ("Agreement") documents the understanding between the California Water Agencies (individually referred to as "Agency" and collectively as "Agencies") that have executed this Agreement as indicated by the signatures below of their duly authorized representatives.

Project Description

A statewide data collaborative effort is currently underway involving water agencies throughout California, working in partnership with UC Davis, to collect and share data among utilities to improve efficiencies, refine demand management strategies and promote long-term sustainable solutions that build on the water/energy nexus. A cloud-based, secure infrastructure will be built through a non-profit mechanism to house data from agencies and facilitate statewide analysis. The envisioned effort is a three-phase, "bottom-up" approach to providing meaningful input and recommendations that will help shape future water management decisions that have statewide impacts.

- **Phase One Pilot:**

Phase One Pilot will conduct statewide conservation analytics to illustrate the value proposition of this data collaborative approach. A group of retail agencies as identified in this Agreement will work with Patrick Atwater, Project Manager of the Phase One Pilot and a signatory to this Agreement, to share utility and consumption level data. Using various utility and customer level data sets, the pilot group will perform analysis, evaluate data gaps, and determine data needs in an effort to demonstrate the value and effectiveness of demand management programs at the local and statewide level. Participating wholesale agencies may elect to have one retail water utility in their service area provide data and participate in the Pilot Project.

The agencies will participate in monthly meetings, which will be scheduled and facilitated by the Moulton Niguel Water District (MNWD) as part of its In-Kind Contribution as set forth below. It is anticipated that said meetings will commence on or about the January, 2016 and will continue through the

completion of the Phase One Pilot which is estimated to be completed on or about October 2016. The purpose is to better understand the unique characteristics of communities, impact of various demand management strategies, and develop tools to assist agencies collect/analyze data. A report of the pilot and samples of work will be generated during the pilot.

- **Phase Two Pilot:**

Phase Two Pilot will demonstrate a secure, cloud-based platform for sharing water utility data and performing analytics. The cloud-based platform was developed by Professor Frank Loge at UC Davis, who is also a signatory to this Agreement. The Phase Two Pilot will be conducted by CAWaterData.org, a not-for-profit company incorporated with the intent of scaling the platform statewide at the completion of the Phase Two Pilot.

Phase Two will focus on (1) uploading participating agency data into the cloud-based platform; (2) defining agency specific policies for data access, sharing, security, and privacy; (3) customizing the cloud architecture to reflect the specified policies; (4) finalizing a trust framework, a document that describes the laws, regulations, policies, and best practices associated with the cloud-based platform; (5) educating utilities and other stakeholders on the functionality and operation of the platform; and (6) defining the long-term funding model for CAWaterData.org.

The participants for the Phase Two Pilot are expected to include the agencies involved in the Phase One Pilot as well as additional California water agencies that UC Davis has been working with in collecting and analyzing water utility data. Once the value of the data collaborative and the integrity of the platform have been established, the goal is to make the data collaborative available to all water agencies in California in coordination with various State agencies.

- **Phase Three:**

Phase Three is the full implementation of the statewide data collaborative. The terms of participation and the detailed scope of the effort remains to be developed based on the results of Phase One and Two Pilots as well as coordination with water utilities and state agencies.

Scope of the Agreement

This Agreement and the terms contained within as agreed upon by the signatories only pertain to the Phase One Pilot of the overall statewide data collaborative. Signing onto this Agreement does not bind any of the signatories to further pursue Phase Two Pilot or Phase Three. Further participation beyond Phase One Pilot will be established through a separate agreement.

Phase One Pilot Team

The Phase One Pilot team is led by Patrick Atwater, who will serve as the Project Manager. Christopher Tull will serve as the Civic Data Scientist and Eric Schmitt will be the Consulting Statistician, working under Patrick Atwater's direction.

Frank Loge of UC Davis will support the efforts of the Phase One Pilot group to assist in the development of the value proposition.

Participating agencies include East Bay Municipal Utility District, Eastern Municipal Water District, Inland Empire Utilities Agency, Irvine Ranch Water District, Las Virgenes Municipal Water District, Moulton Niguel Water District, and Santa Margarita Water District.

Separate Non-Disclosure Agreement

Participation by each Agency shall be contingent upon a separate non-disclosure agreement or similar arrangement by and between each participating Agency and each Phase One Pilot team member, which provides for the security, privacy, and nondisclosure of the data provided by the Agency. The terms and conditions upon which the data will be provided by each Agency, and the content and extent of such data, shall be determined in the sole discretion of each Agency.

Level of Participation

Financial Contribution - Each Agency that wishes to take part in this Phase One Pilot is required to execute this Agreement and provide financial contributions as set forth below.

Eastern Municipal Water District - $25,000

Inland Empire Utilities Agency - $25,000

Irvine Ranch Water District - $25,000

Las Virgenes Municipal Water District - $25,000

Moulton Niguel Water District - $25,000

Santa Margarita Water District - $25,000

MNWD will be the repository of funds contributed by the Agencies and will then facilitate the applicable payments to the Phase One Pilot team and provide the Agencies with copies of any written receipts or acknowledgements to the Agencies on a timely basis. MNWD will be the general administrative liaison on behalf of the Agencies in regard to funding as well as for communications and other purposes as determined by all the Agencies.

In-Kind Contribution – Each Agency that wishes to participate via in-kind services in the Phase One Pilot is required to execute this Agreement as set forth below:

Frank Loge, UC Davis - will work closely with the Phase One Pilot team and participating agencies to support the development of the value proposition.
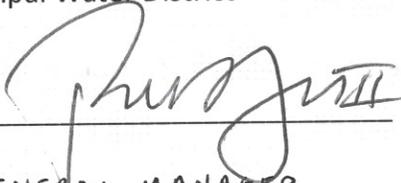
East Bay Municipal Utility District (EBMUD) - Richard Harris, Water Conservation Manager will provide project guidance and support. Working with project staff, EBMUD may provide customer-level usage along with other customer characteristic and turf rebate data to facilitate a statewide study of turf market transformation dynamics expanding on the MNWD turf rebate study published by Bloomberg Data for Good in October this year.

Electing To Engage In the Second Phase Pilot and Larger Statewide Project (Phase Two and Phase Three)

The results of the Phase One Pilot will help the Agencies determine the potential benefits of a statewide data collaborative and how best to leverage available data and analyses in future project phases.

Nothing in this Letter shall be deemed to be a binding obligation of any Agency to provide any further financial contribution, in-kind services, data or otherwise take part in any activities beyond this Phase One Pilot.   Each Agency may decide whether to participate further, and those Agencies that elect to engage in the next phase will enter into a separate agreement. This document can be signed in counterparts, each of which shall constitute an original. It is anticipated that upon full execution, copies of each signature page will be circulated to all parties.

Eastern Municipal Water District

By: _____

Title: GENERAL MANAGER

Inland Empire Utilities Agency

By: _____

Title: _____

Las Virgenes Municipal Water District

By: _____

Title: _____

Santa Margarita Water District

By: _____

Title: _____

East Bay Municipal Utility District

By: _____

Title: _____

Irvine Ranch Water District

By: _____

Title: _____

Moulton Niguel Water District

By: _____

Title: _____

University of California, Davis

By: _____

Title: _____

Eastern Municipal Water District

By: _____

Title: _____

Inland Empire Utilities Agency

By: _____

Title: _____

Las Virgenes Municipal Water District

By: _____

Title: _____

Santa Margarita Water District

By: _____

Title: _____

East Bay Municipal Utility District

By: _____

Title: <u>Manager of Water Conservation</u>

Irvine Ranch Water District

By: _____

Title: _____

Moulton Niguel Water District

By: _____

Title: _____

University of California, Davis

By: _____

Title: _____

East Bay Municipal Utility District (EBMUD) - Richard Harris, Water Conservation Manager will provide project guidance and support. Working with project staff, EBMUD may provide customer-level usage along with other customer characteristic and turf rebate data to facilitate a statewide study of turf market transformation dynamics expanding on the MNWD turf rebate study published by Bloomberg Data for Good in October this year.

Electing To Engage In the Larger Statewide Project (Phase Three)

The results of the Phase One Pilot will help the Agencies determine the potential benefits of a statewide data collaborative and how best to leverage available data and analyses in future project phases.

Nothing in this Letter shall be deemed to be a binding obligation of any Agency to provide any further financial contribution, in-kind services, data or otherwise take part in any activities beyond this Phase One Pilot. Each Agency may decide whether to participate further, and those Agencies that elect to engage in the next phase will enter into a separate agreement.

Eastern Municipal Water District

By: _____

Title: _____

Inland Empire Utilities Agency

By: _____

Title: _____

Las Virgenes Municipal Water District

By: _____

Title: _____

Santa Margarita Water District

By: _____

Title: _____

East Bay Municipal Water District

By: _____

Title: _____

Irvine Ranch Water District

By: _____

Title: _____

Moulton Niguel Water District

By: _____

Title: _____

University of California, Davis

By: _____

Title: _____

Eastern Municipal Water District

By: _____

Title: _____

Inland Empire Utilities Agency

By: _____

Title: _____

Las Virgenes Municipal Water District

By: _____

Title: _____

Santa Margarita Water District

By: _____

Title: _____

East Bay Municipal Utility District

By: _____

Title: _____

Irvine Ranch Water District   *Approved as to form*

By: _____

Title: *General Manager*

Moulton Niguel Water District

By: _____

Title: _____

University of California, Davis

By: _____

Title: _____

Eastern Municipal Water District

By: _____

Title: _____

Inland Empire Utilities Agency

By: _____

Title: _____

Las Virgenes Municipal Water District

By: *David W. Pedersen* _____

Title: *General Manager* _____

Santa Margarita Water District

By: _____

Title: _____

East Bay Municipal Utility District

By: _____

Title: _____

Irvine Ranch Water District

By: _____

Title: _____

Moulton Niguel Water District

By: _____

Title: _____

University of California, Davis

By: _____

Title: _____

Eastern Municipal Water District

By: _____

Title: _____

Inland Empire Utilities Agency

By: _____

Title: _____

Las Virgenes Municipal Water District

By: _____

Title: _____

Santa Margarita Water District

By: _____

Title: _____

East Bay Municipal Utility District

By: _____

Title: _____

Irvine Ranch Water District

By: _____

Title: _____

Moulton Niguel Water District

By: _____

Title: _____ General Manager _____

University of California, Davis

By: _____

Title: _____

Eastern Municipal Water District

By: _____

Title: _____

Inland Empire Utilities Agency

By: _____

Title: _____

Las Virgenes Municipal Water District

By: _____

Title: _____

Santa Margarita Water District

By: *[signature]* _____

Title: General Manager _____

East Bay Municipal Utility District

By: _____

Title: _____

Irvine Ranch Water District

By: _____

Title: _____

Moulton Niguel Water District

By: _____

Title: _____

University of California, Davis

By: _____

Title: _____

Eastern Municipal Water District

By: _____

Title: _____

Inland Empire Utilities Agency

By: _____

Title: _____

Las Virgenes Municipal Water District

By: _____

Title: _____

Santa Margarita Water District

By: _____

Title: _____

East Bay Municipal Utility District

By: _____

Title: _____

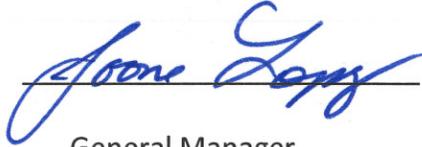Irvine Ranch Water District

By: _____

Title: _____

Moulton Niguel Water District

By: _____

Title: _____

University of California, Davis

By: _Frank Loge_

Title: _Professor_

Exhibit "A" – Scope of Work

Title: Measuring the effectiveness of various conservation programs through a new inter-utility, customer-level water usage dataset

<u>Overall Project Objectives</u>

A statewide data collaborative is currently underway involving water agencies throughout California, working in partnership with UC Davis, to collect and share data among utilities to improve efficiencies, refine demand management strategies and promote long-term sustainable solutions that build on the water/energy nexus. A secure, cloud-based platform will be built through a non-profit mechanism (CAWaterData.org) to house water utility data statewide and to facilitate analyses. This effort is a three-phased, "bottom-up" approach to providing meaningful input and recommendations that will help shape future water management decisions that have statewide impact. The goal is to facilitate informed decisions and aid agencies in meeting the State's goal of demand management through improved understanding of unique characteristics of our communities.

The Phase One Pilot of the project brings together water retailers to consolidate customer level water usage data to proactively share information, ideas, tools, solutions and challenges in an effort to provide a collective input that can showcase how California can achieve water efficiency statewide through smart, bottom up collaborative mechanisms. The purpose is to demonstrate the benefits of a statewide data collaborative in assisting the agencies and decision makers statewide. The Phase Two Pilot of the project will demonstrate a secure, cloud-based platform for sharing water utility data and performing analytics. Upon completion of Phase One and Two Pilot, the Phase Three will be ready for launch, offering a positive, proactive approach to work collaboratively together as a water community across California to achieve water efficiency smartly statewide.

California's worst drought in recorded history demands visionary leadership. Throughout our state's history, water utilities have come together to pioneer new physical infrastructure to ensure a safe and reliable supply for the people of California. This project will honor that tradition and California's world renowned "pioneering spirit" by boldly building the world's first data utility to manage cutting edge data infrastructure. Climate change, demographics, and thousand year hydrological records suggest water scarcity will be the new normal in twenty first century. Yet while the future is ultimately uncertain, by working smartly and collaboratively, we can prepare to adapt to whatever the future holds.

Project Task 1: Statewide analysis of conservation program effectiveness

The goals of this component of the project include:

1.1 Analyze unique characteristics of different parts of California and its diverse communities

> 1.1.1   Collect, organize, clean, and generate a statistical dataset from the sources listed below this task specification.

1.1.2 Develop analyses of various conservation programs effectiveness on reducing water usage. Aggregate impact of individual water conservation programs on agency water demand and revenues

1.1.3 District-level averages as well as results for various socio-economic and demographic groupings, environmental characteristics, and neighborhood characteristics.

1.2 Learn from successes and challenges of different demand management programs

1.2.1 Write a summary report and present results to agency personnel and board members. Report articulating statewide water efficiency benefits and succinct value proposition of robust granular water data. This report is anticipated to include the following key sections incorporating analyses developed in project task one:
- Baselining water usage trends and patterns:
- Water usage trajectory quantiles by customer segment for each participating utility from as long as is feasibly available and including at least 2013 – 2015.
- Those trajectories will be overlaid with conservation actions taken by utilities (dates of public education campaigns, rate shifts, etc.) to better understand "what works" to achieve water efficiency.
- Those trajectories will be compared that with what the state "sees" in residential gallons per capita per day and other statewide metrics.
- Scope how smart "bottom up" water efficiency projects enabled by this data infrastructure can scale statewide.
- Discuss lessons learned for future demand management and potential statewide water efficiency targets.

1.3 Conducting preliminary statistical analysis into the effectiveness of turf rebates by expanding the MNWD Turf Rebate Study published by Bloomberg Data for Good.

Each financially contributing retail water agency will be responsible for providing customer-level water usage data. Participating wholesale water agencies may provide this conservation analytics service at no charge to up to one retail agencies in their service area. Further wholesale agencies with parcel-level irrigable area will provide said data along with as granular water usage data as is available.
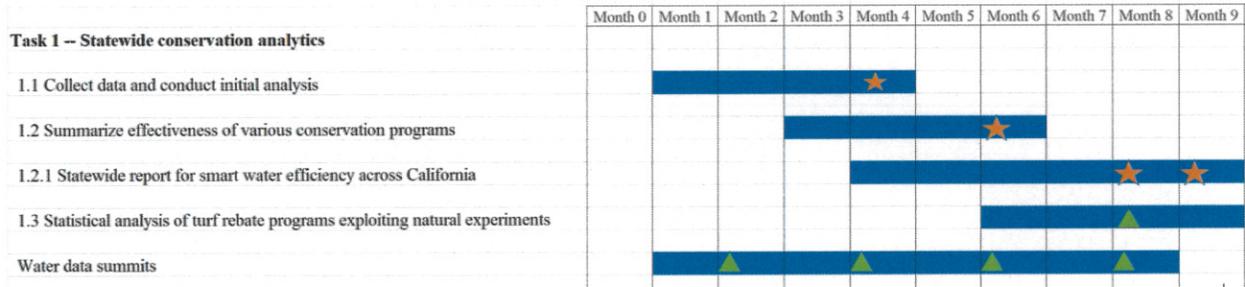
Contingency: In the event that the State Water Resources Control Board elects to provide statewide Clean Drinking Water metered usage data at the customer class level, the Phase One Pilot team will include said data in their analysis of statewide conservation programs.

In addition, Phase One Pilot staff will work with the analytical point persons on the technical working group to provide contextual data sources with clear spatial, temporal and quantitative characteristics to inform inter-utility, customer-level water usage data when available:

- Agency-level factors (Data Sources: participating water agencies)
  - Water pricing policy (i.e., structure and level)
  - Rebate levels
  - Conservation program participation
  - Outreach / media efforts
  - Conservation BMP Reporting (Data Sources:
- Household-level factors (Data Sources: Participating utilities and US Census)
  - Socio-economic factors (e.g., income, education)
  - Demographic factors (e.g., ethnicity, household size)
  - Property characteristics (e.g., lot size, age of house, irrigated area)
  - Customer awareness (through identifying district-level awareness campaigns)
- Community / Environmental Factors (Data Sources: Participating utilities, CIMIS)
  - Neighborhood program participation levels, if available
  - Outreach efforts from other agencies (wholesale and neighboring), if available
  - Methods of community outreach and engagement (e.g., newspapers, agency website, social media, community newsletters, HOA meetings, Chamber of Commerce events, etc.)
  - Biophysical factors (e.g., precipitation, temperature, evapotranspiration)

Exhibit B – Project Schedule

It is anticipated the proposed project will require nine months to complete. The Gantt chart below is intended to be illustrative of the timing of deliverables and events.

	Month 0	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9
Task 1 -- Statewide conservation analytics										
1.1 Collect data and conduct initial analysis		▬	▬	▬	★					
1.2 Summarize effectiveness of various conservation programs				▬	▬	★				
1.2.1 Statewide report for smart water efficiency across California					▬	▬	▬	▬	★	★
1.3 Statistical analysis of turf rebate programs exploiting natural experiments							▬	▬	▲	▬
Water data summits		▬ ▲	▬	▬ ▲	▬	▬ ▲	▬	▬ ▲		

Exhibit C – Phase One Pilot: 9-Month Budget

The total estimated budget for the nine month project is $125,000. In the event that more than five agencies participate, the additional resources will be used to conduct additional turf rebate impact evaluation research (Task 1.3).

Title	Name	Hourly Rate
Project Manager	Patrick Atwater	$80
Civic Data Scientist	Christopher Tull	$60
Consulting Statistician	Eric Schmitt	$150

The project team will conduct work at the above rates. Phase One Pilot team work hours will be conducted on project tasks at the below not to exceed hours.

Title	Task	Hourly Rate	Estimated Budget
Project Manager	1.1 Data collection and organization	$80	$10,000
	1.2 Report on achieving water efficiency smartly statewide		$40,000
	1.3 Statistical Analysis of turf rebate effectiveness exploiting natural experiments		$12,000
Civic Data Scientist	1.1 Data collection and organization	$60	$15,000
	1.2 Report on achieving water efficiency smartly statewide		$25,000
	1.3 Statistical Analysis of turf rebate effectiveness exploiting natural experiments		$14,000
Consulting Statistician	1.3 Statistical Analysis of turf rebate effectiveness exploiting natural experiments	$150	$4,500

The Phase One budget also includes travel (auto mileage and six flights to Sacramento) and office expenses (including for example printing, draft memos, reports, other presentation materials, and co-working space) estimated at approximately $4,500.

Project Manager

Patrick Atwater has over five years of experience in data intensive roles in the water and information technology industries. He ran the numbers for the State Water Contractors on Governor Brown's $13 billion Bay Delta fix and co-authored the feature June 2015 American Water Works Association article on how data science can help water utilities adapt to climate change. Projects include: developing the financial model for the proposed Claremont Colleges 300,000 gallons per day MBR recycled water plant; generating financial analysis at 14 local government agencies with combined budget of over $5 billion; CFO level analysis for a first-of-its-kind securitization structure for a $700 million groundwater treatment facility; and presenting California's first 2010 redistricting GIS analysis to an audience of over 100 municipal managers.

Civic Data Scientist

Christopher Tull recently graduated with a Masters from the Center for Urban Science and Progress, the nation's leading civic data science program founded by ex-Cal Tech provost Steven Koonin and launched as part of the Bloomberg applied sciences initiative. He has worked as a research assistant at the Max Planck Institute for Biological Cybernetics as well as NYU CUSP, where his work on energy-water usage intensity in NY won best paper at the Bloomberg Data for Good Exchange. He is highly proficient in the following programming languages: Python, R, Java, Javascript, C++, C, SQL. In addition, Chris has experience working with the following technologies: ArcGIS, CartoDB, Git, Eclipse, RStudio, IPython Notebook, Excel, Mysql, Postgresql/PostGIS.

Consulting Statistician

Eric Schmitt co-authored the MNWD turf rebate study published by Bloomberg Data for Good in September 2015. Previously, Eric has worked as an economic consultant at NERA Economic Consulting for two years performing econometric analyses on topics ranging from anti-trust to consumer behavior in the tobacco industry. He is completing a PhD in statistics from KU Leuven University and currently works as a statistician at Protix Biosystems, a pioneering technology company creating efficiencies in the water-food nexus through high volume insect products. He has provided statistical consulting services for and spoken before leading companies, such as Mars, Inc. and Tableau Technologies, and is the author of peer-reviewed articles in theoretical and industrial statistics, education, and medicine.

Exhibit E – Phase One Pilot Team Roles and Responsibilities

Phase One Project Team Name	Title	Role
Patrick Atwater	Project Manager	Management / Analysis
Christopher Tull	Civic Data Scientist	Analysis / IT
Eric Schmitt	Consulting Statistician	Research / Analysis

In addition, to the extent available, each participating California water agency will be responsible for providing the following staff to participate in the Technical Working Group (Note, agency staff may fill more than one role):

- Senior Management: attend technical working group meetings and provide feedback on analytical work products.
- Analytical Point Person: respond to questions about water usage data provided and conservation program context (programs implemented, timing, levels, neighboring district programs, etc.).
- IT Staff: ensure timely transfer of data required by the project.

Phase 1B Common Project Tasks

The phase 1B scope of work deepens and builds on the three initial project tasks from the Data Collaborative phase one MOU executed January 21, 2016 to integrate water use data, surface insights on statewide water efficiency and statistically evaluate the effectiveness of water efficiency actions like the turf rebate program.

The Phase 1B scope of work common across all participating agencies focuses on supporting water managers in navigating the rapidly evolving statewide water efficiency landscape by analyzing the implications of the Governor's long term framework, measuring the impact of water efficiency actions, and improving how water data is managed to power that work into the future.

In order to help clearly, accurately, and concisely convey these insights to water managers, this work will develop several visualizations to benchmark water efficiency, measure conservation impact and model rate shifts.

1. **Data Management:** Onboarding new utilities and integrating additional customer use data
    a. Automating water use data ingestion
    b. Develop a legal framework for resharing data that protects customer privacy to operationalize the Trust Framework developed by UC Davis. The goal is to streamline data sharing both technically and legally, but ultimately the decision on how the raw data is shared is up to the discretion of each individual utility providing that data.
    c. Surfacing water data management best practices and feasibility of data integration proposed in the Dodd bill through a UCLA system architecture research fellow.

2. **Statewide Efficiency:** Report on lessons learned for statewide efficiency and understanding the implications of the long term framework
    a. Water data summit at Stanford to showcase results for a statewide audience
    b. Interactive web visualization of statewide efficiency using MWELO framework
    c. Improving land cover assessments to estimate the impact of various long term framework scenarios
        i. Open landscape area classification assessment
        ii. Andrew Marx CGU Work to measure landscape area across MWD
        iii. Using Google Earth Engine and NAIP to measure landscape area statewide

3. **Data-driven demand management:** develop and deploy dashboards visualizing future water demand and measuring the effectiveness of conservation actions including rebates, rates and messaging.
    a. Develop a generalizable visualization tool to measure the water savings of any conservation rebate
    b. Deploy prototype interactive 1-4 week ahead demand forecasting visualization developed in partnership with MNWD and DataKind: CaliforniaDataCollaborative.com/future (requires recycled water system data)
        i. See CaliforniaDataCollaborative.com/future for an example
    c. Coordinate with participating agencies to implement surveys of customer conservation motivations and standardize conservation outreach data collection. Collaborate with the water efficiency industry to acquire additional market transformation data.
    d. Develop a rate tool to support agencies in achieving revenue reliability with increased

focus on efficiency
    i. Collaboration with MNWD in developing a flexible rate modeling visualization using R Shiny and implement with participating CaDC agencies.
    ii. Implementation of rate research agenda developed as part of the June 8 technical working group meeting to improve how water sales are forecasted under alternative pricing scenarios in the tool outlined in 3c(i). This ties into our collaboration with our academic partners and ongoing work to improve how data is shared. We are having monthly meetings as part of the follow up with UC Davis CWEE's "Trust Framework" development in-kind contribution.

This updated scope of work common across participating agencies can be supplemented with specific needs from participating agencies. Part of the value of this investment in the underlying data infrastructure is that any tools developed can be repurposed for any agency that participates in the California Data Collaborative.

Phase 1B Custom Remote Sensing Task for the City of Santa Rosa

The CaDC has partnered with remote sensing expert Andrew Marx, Ph.D of Claremont Graduate University to use free, publicly available aerial imagery funded by the U.S. Department of Agriculture to develop landscape area measurements for the Metropolitan Water District. As the City of Santa Rosa does not currently have irrigated or irrigable landscape area measurements, the CaDC will use this novel partnership to develop parcel level remote sensing classifications for the City of Santa Rosa's service area. The integration of the resulting land cover classification data with the CaDC common scope of work and methodology for this remote sensing work is described more below.

The CaDC has a scenario analysis tool described above in Task 2.2 and shown in the following video (https://www.youtube.com/watch?v=Bn9HzxJvIjc) ready to ingest the resulting utility level landscape area classifications as well as an integrated suite of tools (http://californiadatacollaborative.com/analytics) to help water managers achieve their reliability objectives. Those tools are ready to ingest NAIP landscape area classifications, CIMIS evapotranspiration and US Census population data. In addition, those land cover classifications have multiple benefits and could be used as part of an integrated approach to land use by identifying impervious areas and storm water capture opportunities.

This National Agricultural Imagery Program (NAIP) contracts aircraft to fly states at least every two years, making it an invaluable public resource for updating land cover classifications over the long term. The 2016 NAIP imagery is at 60 centimeter resolution, an improvement over the historical NAIP resolution of 1 meter. The NAIP imagery provides four spectral bands including red, green, blue and critically near infrared to enable vegetation differentiation such as irrigated versus artificial turf. Furthermore, improvements to the 2016 NAIP's spatial resolution, as well as new analytical methods developed by Dr. Marx, have produced an inexpensive and accurate way to estimate land cover across California broadly and for the City of Santa Rosa's service area in particular.

Developed at the Claremont Graduate University, CILA (the California Irrigable Landscape Algorithm) produces land cover classifications derived from NAIP imagery. These classifications include, but are not limited to) irrigated turf, irrigable, impervious surface and pool/open water. By being accurate to 60cm, this classification layer produces near-parcel level assessments of land cover. CILA functions by looking not only at the reflectance of the pixel in the four spectral bands of the NAIP imagery (pixel-based analysis), but also through how the groupings of pixels are shaped (object-based) and how different they

are from their neighbors (texture-based) (planned submission Dec 2016, Remote Sensing: Society and Environment).

CILA leverages these characteristics in a high-performance computing environment to create a statistical decision tree, also known as a Support Vector Machine, to determine the landscape classes. Preliminary results show 88% accuracy in test areas of the arid City of Claremont and the wooded City of Folsom. The resulting landscape classifications from this data and algorithm provide the State with the opportunity for an affordable, scalable and updatable source to significantly inform water efficiency-based standards.