CII
TOOL SERIES

A Practical Guide to Measuring Landscape Areas with Dedicated Irrigation Meters in CII Sectors

CALIFORNIA DATA COLLABORATIVE

CALIFORNIA WATER EFFICIENCY PARTNERSHIP
A Chapter of the Alliance *for* Water Efficiency

PARTNERS FOR A WATER-EFFICIENT CALIFORNIA

A Practical Guide to Measuring Landscape Areas with Dedicated Irrigation Meters in CII Sectors

OCTOBER 2024

San Diego County Water Authority

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GLOSSARY OF TERMS

TERM	DEFINITION
Annual Water Use Report	The annual water use report, which an urban supplier must submit to both the State Water Board and the Department of Water Resources, compares a supplier's actual water use to its Urban Water Use Objective, including both quantitative and qualitative data.
CII	Commercial, Industrial, and Institutional. CII meters serve non-residential and non-agricultural customers.
CII-LAM-LUCD	The CII Landscape Area Measurement and Land Use Classification Dataset (CII-LAM-LUCD) will be provided to suppliers by DWR beginning in the final months of 2024 and will include CII irrigated landscape area measurements, delineations of functional and non-functional turf areas within the CII landscape area, and estimates of both CII and residential parkway strip landscape areas.
CII Water User	A CII Water User is a water user meeting any of the definitions in Water Code section 10608.12: • (f) "Commercial water user" means a water user that provides or distributes a product or service. • (p) "Industrial water user" means a water user that is primarily a manufacturer or processor of materials as defined by North American Industry Classification System (NAICS) code sectors 31 to 33, inclusive, or an entity that is a water user primarily engaged in research and development. • (q) "Institutional water user" means a water user dedicated to public service. This type of user includes, among other users, higher education institutions, schools, courts, churches, hospitals, government facilities, and nonprofit research institutions.
DIM	Dedicated Irrigated Meter (DIM) means a water meter that is operated and maintained by the supplier that exclusively measures the water a customer uses for irrigation.
DWR	California Department of Water Resources
eAR	The electronic Annual Report (eAR) is a survey of public water systems that must be submitted to the State Water Resources Control Board annually by water suppliers per Health & Safety Code Section 116530.
GIS	Geographic Information System (GIS) typically refers to software capable of creating, managing, analyzing, and mapping different spatial data types. Examples include the proprietary ArcGIS and the free, open-source QGIS. These programs can be used to connect data (e.g., meter number) to a point on a map (e.g., meter location), integrating location data with descriptive information that scientifically analyzes and enhances the understanding of patterns and relationships in a geographic context.
GDB	Geodatabase (GDB) is an electronic file structure used for storing, editing, and managing spatial data. It can be accessed by GIS software.

TERM	DEFINITION
Heuristic	Heuristic is a loosely defined rule discovered through trial and error.
In-Lieu Technology	In-Lieu Technologies are technologies that support landscape water use efficiency improvements by means other than the direct measure of water use, including but not limited to, water-budgets, Advanced Metering Infrastructure (AMI), and remote sensing.
Keys	Keys are values that uniquely identify a meter, location, or account and are common across different datasets (e.g., a unique identifier could be a service location number). The service location number becomes a Linking Key when it is available as a field in both the Geodatabase of all meters and the DIM spreadsheet.
LAM	Landscape Area Measurement (LAM)
Large Landscapes	Large landscapes are Commercial, Industrial and Institutional landscape areas that are ½ acre in size or larger.
LEF	Landscape Efficiency Factor (LEF) means a factor applied at the supplier-level that adjusts net reference evapotranspiration for plant factors and irrigation efficiency, which are two major influences on the amount of water that is applied to the landscape.
MSA	Meter Service Area (MSA) means the total geographic area served by a meter. A MSA may include buildings, hardscapes, as well as irrigated and non-irrigated landscapes.
MUM	Mixed-Use Meter (MUM) means a water meter that is operated and maintained by the supplier that measures the volume of water a customer uses indoors and outdoors.
NFT	Non-Functional Turf (NFT) is any turf area that serves no practical purpose beyond aesthetics (hence not functional) and includes turf located within street rights-of-way and parking lots. Functional turf means a ground cover surface of turf located in a recreational use area or community space. Turf enclosed by fencing or other barriers to preclude human access for recreation or assembly is not functional turf.
Parkway	A parkway is an area of land, usually narrow strips bordering a street, that are irrigated by a meter but may be located outside of the primary parcel corresponding to that meter.
Premise	A premise is a multimeter service area that encompasses the meters associated with a single customer in a contiguous area. The area includes all landscape areas associated with the customer, including parkway strips and tree canopies (e.g., 2 meters on the same property of a single grocery store chain location).
Remote Sensing	Remote sensing is a scientific process of detecting characteristics or obtaining information about objects from a distance without physical contact. Specifically, within the context of landscapes and vegetation, remote sensing technology measures objects' emitted and reflected radiation in order to identify or gather data about the object.

TERM	DEFINITION
SLA	Special Landscape Area (SLA) is an area of the landscape dedicated solely to edible plants, recreational areas, areas irrigated with recycled water, or water features using recycled water. For CII landscapes with DIMs, SLAs also include: (A) Slopes designed and constructed with live vegetation as an integral component of stability; (B) Ponds or lakes receiving supplemental water for purposes of sustaining wildlife, recreation, or other public benefit, excluding water reported to the Board supporting a variance for ponds and lakes for sustaining wildlife required to be maintained by regulation or local ordinance; (C) Plant collections, botanical gardens, and arboretums; (D) Public swimming pools and similar recreational water features; (E) Cemeteries built before 2015; and (F) Landscapes irrigated with recycled water.
Spatial Resolution	Spatial resolution is usually used in conjunction with aerial or satellite imagery referring to the area on Earth that each digital pixel covers. A pixel is the smallest spot visible to the sensor on the satellite or aircraft. The smaller the area each pixel covers, the sharper/clearer the image.
Urban Water Supplier	An urban water supplier is a supplier that provides water for municipal purposes to more than 3,000 customers (connections) or supplies more than 3,000 acre-feet of water annually.
UWUO	An Urban Water Use Objective (UWUO) is an estimate of aggregate efficient water use (also known as an efficiency target) calculated in gallons per year. It is unique to each urban water supplier and factors in water use efficiency standards and service area characteristics like population and climate.
The Water Use Efficiency Regulation *(also known as the "Making Conservation a California Way of Life" Regulation)*	The Water Use Efficiency Regulation (WUE Regulation) was adopted in July 2024 by the State Water Board. It establishes unique efficiency goals for each urban retail water supplier in California and provided those suppliers flexibility to implement locally appropriate solutions. As part of the regulation, urban retail water suppliers – not individual households or businesses – are held to an UWUO.

SECTION 1: INTRODUCTION

This guidebook is designed for urban water suppliers or their consultants to support compliance with the State's Water Use Efficiency Regulation. It specifically addresses the requirements under the *Commercial, Industrial, and Institutional Dedicated Irrigation Meter (CII-DIM) Standard*, which necessitates urban water suppliers (suppliers) to identify and measure the landscape area associated with CII-DIMs.

The steps outlined in this guidebook may also assist suppliers in meeting similar requirements under the *CII Threshold for Converting CII Mixed-Use Meters (MUM) to DIMs*. Under this requirement, suppliers must identify which of their CII-MUM connections meet the large landscape area threshold, which is defined as ½ acre or greater in regulation Section 969(2).

Included in the guidebook are three approaches that provide options and guidance for:

1) Identifying both CII-MUMs and CII-DIMs; and
2) Measuring CII landscape areas with MUMs or DIMs given various levels of data analysis expertise, accessible data sets, and agencies' resources.

The three approaches described in this guidebook are driven by lessons learned working with three urban water suppliers in San Diego County. Each water agency provided key data sets that were used to develop and document approaches to CII-DIM landscape area measurement (LAM) and identification performed by the California Data Collaborative (CaDC). These suppliers have service area populations ranging from 40,000 to 224,000, CII connections ranging from 1,000 to 3,500, and total connections ranging from 12,000 to 50,000. These suppliers had not previously identified or measured CII landscape areas with DIMs. or MUMs.

1.1 – Guidebook Objective

The Department of Water Resources (DWR) is not required in statute to provide CII LAM to urban water suppliers. DWR recognized the need for this technical assistance and has undertaken an effort that will provide urban water suppliers with a solid foundation to start measuring their CII-DIMs and CII-MUMs. DWR will provide urban water suppliers with its CII landscape classification data set; however, it will not distinguish the landscape area associated with CII-DIMs nor CII-MUMs as DWR does not have access to supplier's meter data. Instead, the responsibility to measure CII-DIMs and CII-MUMs falls solely on the urban water supplier.

The goal of this guidebook is to provide urban water suppliers with practical methodologies and insights on how to effectively integrate state-provided CII-LAM data with their own customer data or develop their own data. By leveraging these strategies, urban water suppliers will be equipped to measure the landscape areas served by CII-DIMs and CII-MUMs, thereby supporting compliance with the Water Use Efficiency Regulation.

The objective of this guidebook is to present three comprehensive approaches to identifying and measuring CII DIM landscapes. These approaches will demonstrate how urban water suppliers can utilize this data to:

- Determine landscape areas for CII-DIMs;
- Distinguish and measure landscape areas for CII-MUMs; and
- Develop actionable insights that support compliance with the Water Use Efficiency Regulation, ultimately contributing to more sustainable water management practices.

SECTION 2: BACKGROUND

2.1 – Legislation

Senate Bill 606 and Assembly Bill 1668, signed in 2018, set a regulatory framework to "Make Conservation a California Way of Life." This framework directed the State Water Board to establish long-term standards for efficient water use that apply to suppliers.

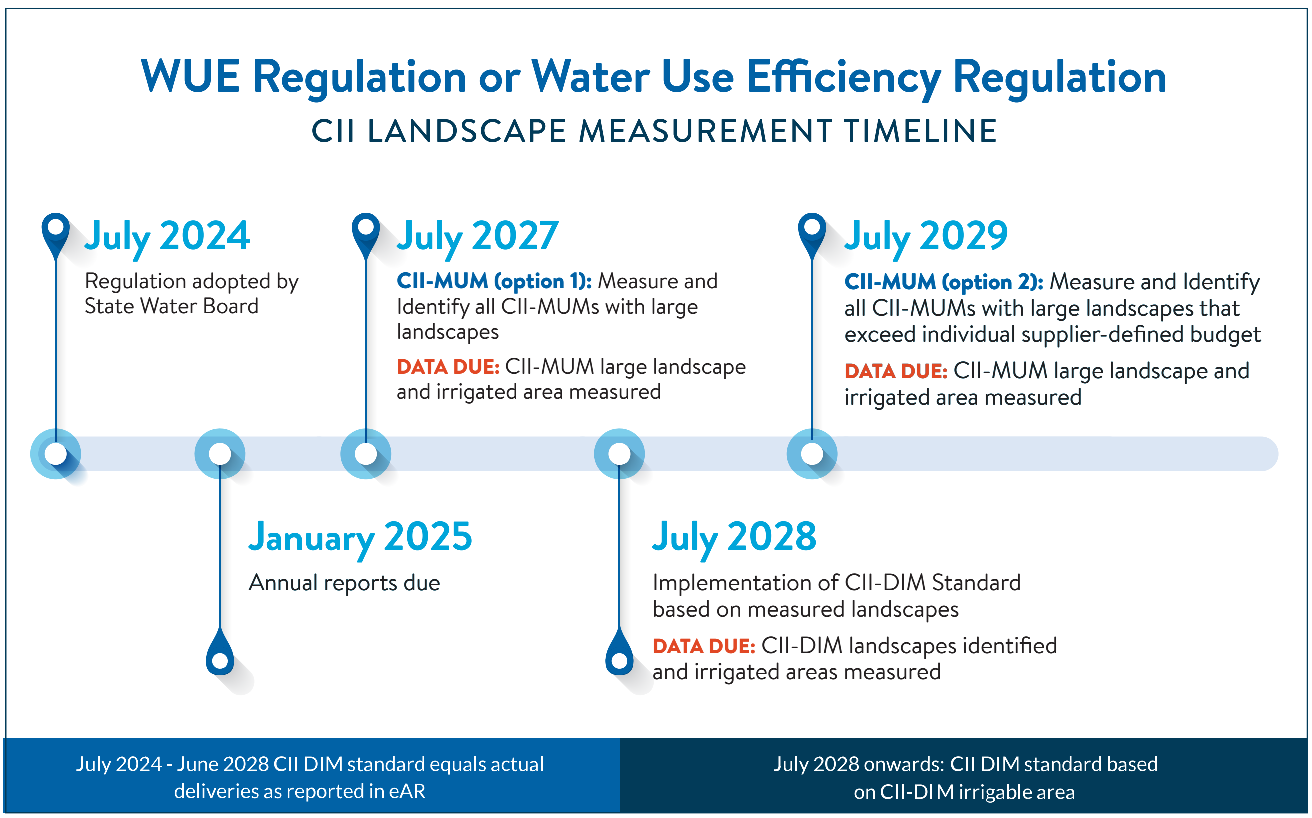
These standards establish specifications for deriving water budgets for residential water use, commercial water use, and water loss, which collectively make up a supplier's unique Urban Water Use Objective. The State Water Board also adopted Performance Measures for CII water use that suppliers must adhere to[1]. The WUE Regulation was adopted on July 3, 2024.

2.2 – CII Requirements

The following is a summary of the regulation sections that address CII landscape area measurement. For a comprehensive summary, refer to CalWEP's Urban Water Use Objective Cutsheet series (http://www.calwep.org/framework-cut-sheets/).

1 Wholesale water providers are not subject to legislation requiring adherence to an Urban Water Use Objective.

Figure 1. CII Landscape Measurement Timeline



Section 969: Commercial, Industrial, and Institutional Dedicated Irrigation Meter (CII-DIM) Standard

By July 1, 2028, suppliers must quantify the total irrigated landscape area in square feet for CII connections with DIMs and describe and substantiate how the irrigated area was quantified. Any new irrigated landscape areas of CII connections with DIMs must be added annually. Prior to July 1, 2028, a supplier's actual deliveries associated with CII landscape irrigation will serve as their CII-DIM water budget (as reported in the Electronic Annual Report (eAR)).

Section 973: Threshold for converting CII landscapes with MUMs to DIMs or employing in-lieu water management technologies

Suppliers are required to identify and measure large landscape areas irrigated by a CII-MUM. A large landscape area is defined as equal to or greater than ½ acre in size. Measurements must occur by one of the following dates:

- **By June 30, 2027:** Identify and measure all CII-MUM connections with large landscapes.
- **By June 30, 2029:** Identify and measure all CII-MUM connections with large landscapes that exceed individual water budgets.

Suppliers may then install DIMs or utilize other in-lieu technologies at each identified CII-MUM connection.

2.3 – Optional Provisions

There are "Special Landscape Areas" (SLAs) within the aggregate landscape areas irrigated by CII-DIMs that affect water requirements for those areas. While suppliers are not required to distinguish SLA measurements from their total CII-DIM landscape area, doing so may allow them to generate more accurate CII-DIM water budgets that are factored into their overall Urban Water Use Objective. Specifically, when calculating the CII-DIM water budget, suppliers can use a landscape efficiency factor (LEF) of 1.0 for SLAs rather than the lower LEF for all other landscapes (see CalWEP's CII-DIM Cutsheet for more details). This will increase the total UWUO for the supplier.

Various landscape types qualify as CII-DIM SLAs and include:

1) Area of the landscape dedicated solely to edible plants
2) Recreational areas
3) Areas irrigated with recycled water, or water features using recycled water
4) Slopes designed and constructed with live vegetation as an integral component of stability
5) Ponds or lakes receiving supplemental water for purposes of sustaining wildlife, recreation, or other public benefit, excluding water reported to the Board supporting a variance for ponds and lakes for sustaining wildlife required to be maintained by regulation or local ordinance
6) Plant collections, botanical gardens, and arboretums
7) Public swimming pools and similar recreational water features
8) Cemeteries built before 2015

In addition to qualifying for a higher LEF, suppliers that irrigate with recycled water may be eligible for an additional variance if the recycled water they irrigate with contains high levels of total dissolved solids (TDS) (see regulation Section 969(e)(2)(B)) and meet the following condition:

- The volume of high TDS recycled water used to irrigate residential landscapes plus the volume of high TDS recycled water used to irrigate CII-DIM landscapes equals 5% or more of a supplier's combined outdoor residential water budget and CII-DIM water budget.

It is the responsibility of the water supplier to provide supporting information to the State Water Board that they have met all of the recycled water variance criteria (see regulation Section 968 (j)(X)). Suppliers must also meet the variance submittal deadlines for the associated water usage to be factored into a supplier's UWUO for a specific reporting year (see regulation Section 968 (j)(1) and (2)). Suppliers that utilize this recycled water variance will need to measure the associated landscapes.

If a supplier meets their UWUO, measuring SLAs and CII landscapes irrigated with recycled water containing high TDS may not be necessary. Since the supplier's water usage is at or below their UWUO, there may not be an immediate water budget benefit to account for other water uses. However, if during future years the supplier is projected to exceed their UWUO, then performing the measurements beforehand for these specific landscape types could be a benefit to the supplier.

Landscape area measurements may also be required for two existing State regulations: Model Water Efficient Landscape Ordinance (MWELO) and AB 1572 (Chapter 849, Statutes of 2023). MWELO Section 493.1 requires a local agency (i.e., city, county, or water supplier that has agreed to implement MWELO for a city or county) to implement conservation programs, such as irrigation audits that include measuring the landscape and providing a water budget, for existing landscapes over one-acre that have a DIM. Check with local municipalities for more information.

2.4 – Overview of Measurement Requirements

The following landscape areas must be identified and measured to meet the WUE regulation requirements:

- CII-DIM
    - All need to be measured
    - Continually identify and measure newly constructed landscapes
- CII-MUM
    - All need to be identified
    - Identify those that likely irrigate ½ acre or larger (aka large landscapes)
    - Measure potential large landscapes identified above (measure all landscapes, if possible)
    - For those ½ acre or larger where a DIM is later installed, move them to the CII-DIM category

Optional CII Landscape areas to measure and/or identify:

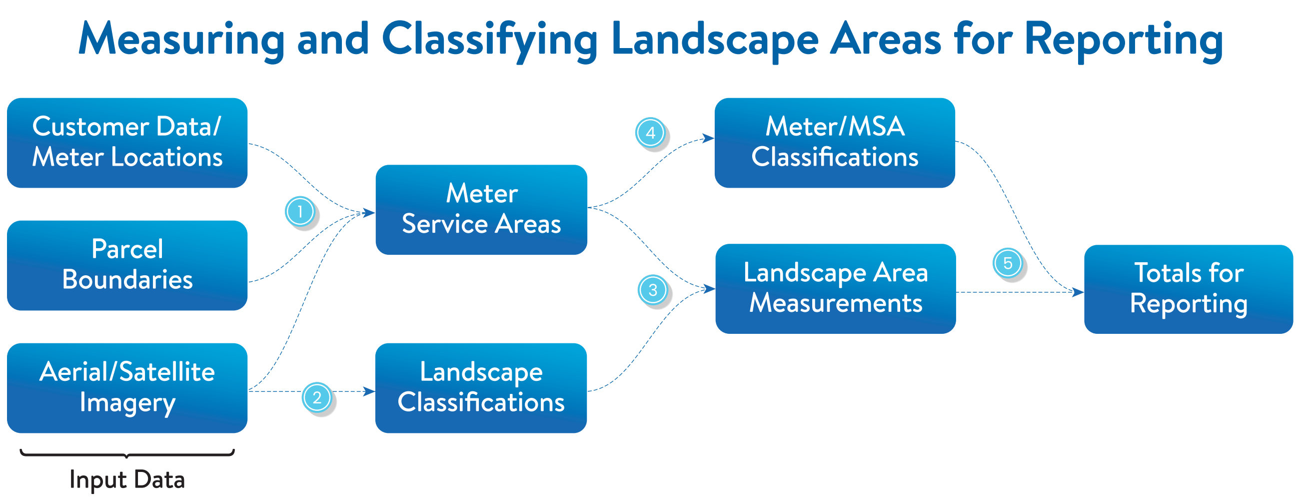
- CII Special Landscape Areas (areas irrigated with recycled water included)
- CII landscapes irrigated with high TDS recycled water (variance)

Optional CII and Residential areas to measure:

- Existing Tree Canopy (to apply for a potential variance)

The high-level process is outlined in Figure 2. Blue boxes represent datasets generated along the way, while the lines connecting the boxes represent processing steps that must be taken. Depending on the level of cost and accuracy desired from the final measurements, some of these steps may be condensed or eliminated.

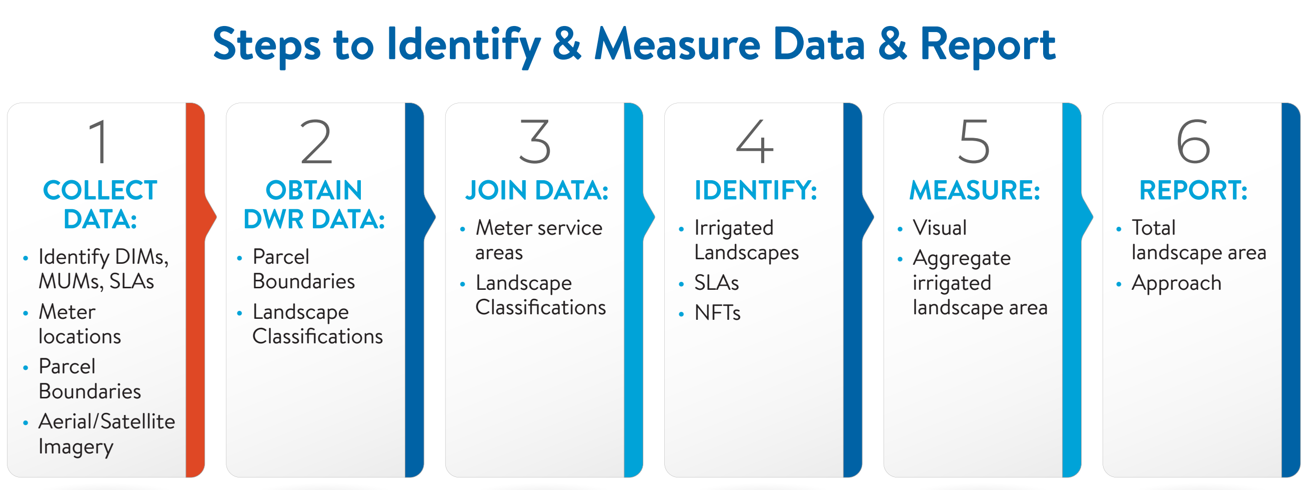
Figure 2. Schematic overview of the process of measuring and classifying landscape areas for reporting



3.1 – Data Inputs

The basic data requirements for landscape measurement are consistent regardless of the desired level of accuracy, but different options exist to select a specific data input that meets your goals.

Figure 3. Steps to Identify and Measure CII DIMs and MUMs and Report

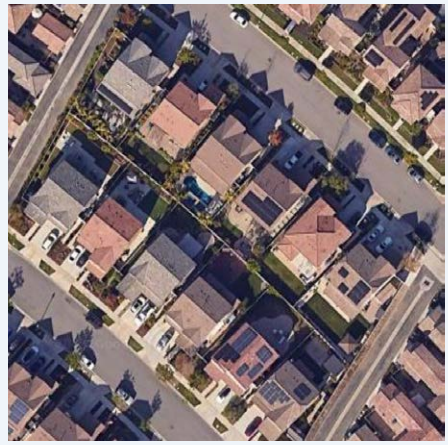


3.1.1 - Aerial/Satellite Imagery

Geometrically corrected aerial or satellite imagery (e.g., "orthophoto") is typically required for landscape measurement. This may include free basemap imagery from Google Maps or higher-quality imagery acquired by the supplier.

DATA SPOTLIGHT

Imagery Options Commonly Used for Landscape Measurement



When automated processing of imagery is desired (as opposed to manual review) to develop detailed landscape classifications to inform landscape measurements, quality of the image is important. To produce results that are meaningful, precise, and accurate, remote images must be high quality. This typically means minimal cloud cover, a high spatial resolution, and usually imagery that includes the near-infrared (NIR) band to aid identification of living vegetation.

For instance, Planet Labs' satellites can produce images at a spatial resolution of 50cm, which means each pixel in the image is 50cm by 50cm. That translates to an area of 2.7 square feet. Agencies must be prepared to pay for such high-quality images. Images can also be obtained freely through the Landsat (US-based) and Sentinel-2 (European Space Agency) programs. However, Landsat offers images at a resolution of 30 meters, which is approximately 9,700 square feet (about twice the area of a basketball court), whereas Sentinel-2 images are at a resolution of 10 meters or 1,100 square feet. Since these satellite sources routinely exceed the size of individual land lots, they are typically not considered for urban landscape classification but are often used for landcover classification on larger scales.

Table 1 summarizes some imagery sources that are commonly available and usable for landcover classification at various scales. Each imagery source is shown with an approximate cost, image resolution, and update frequency. This table is illustrative of the types of imagery available and is not intended to be comprehensive.

Table 1: Examples of types of imagery available

SOURCE		COST	IMAGE RESOLUTION	UPDATE FREQUENCY
Aerial	Assorted aerial image data vendors	Varies	3 in – 12 in *(7.6 cm – 25.4 cm)*	On-demand or from a data library
	Hexagon from State of California Dept. of Technology contract with L3Harris	Free[2]	30 cm	Unknown
	National Agriculture Imagery Program	Free[3]	60 cm by 60 cm or 3.9 sq ft	Every 2 years *(2024 data in progress at time of publishing).*
Satellite	Planet Labs SkySat	$300 for 9.65 square miles (25 square km)[4]	50 cm by 50 cm or 2.7 sq ft	On-demand
	Sentinel-2	Free	10 m by 10 m or 1100 sq ft	Every 5 or 10 days
	Landsat 8 + 9	Free	30 m by 30 m or 9700 sq ft	Every 8 days

There is also the issue of consistency. For example, Southern California experiences climatic seasonality, so the amount of living vegetation varies dramatically throughout the year based on the season. Non-native invasive grasses along hillsides may be green (i.e., irrigable, not irrigated) and alive in February due to precipitation but will have browned by June. To help clarify which landscapes are being actively irrigated (i.e., irrigable irrigated), suppliers should consider using summer imagery for this analysis to better accurately estimate the landscape area measurements.

2 Cities and counties may request from California Department of Technology under contract STP-SW-IDS-20-L3H. Also published via ArcGIS online by the County of Napa https://www.arcgis.com/home/item.html?id=a9d1c3dc79654e679b0cc37dd378d801

3 Available for download from the USDA, but images are also hosted on the California state geoportal https://gis.data.ca.gov/search?q=NAIP

4 Price as of May 2023

Figure 4. II vs INI

Irrigable Irrigated (II) vs Irrigable Not Irrigated (INI)

What's the difference?

II	INI
The II class represents landscape areas of healthy vegetation where the vegetation appears to be in growth, not senesced, and is foliated. The area is presumed to be maintained and managed through active irrigation.	The INI class represents areas of planted and previously maintained vegetation that appears water stressed (brown or leafless plants). These are areas that likely were not irrigated when the imagery was taken, but possibly were irrigated in the past, and may be irrigated again during the year after the imagery was taken.

SOURCE: Recommendations for Outdoor Residential Water Use Efficiency Standard WUES-DWR-2021-02 A Report to the State Water Resources Control Board Prepared Pursuant to California Water Code Section 10609.6(a)(1) September 2022

Even when images are taken at the same time of day and same time of year, images can be difficult to compare across years. For example, imagery taken in late summer of a drought year (such as 2022) is likely to show much less green vegetation, especially in areas that faced irrigation restrictions, which can influence the amount of land cover classified as irrigated. It is therefore important not just to consider the resolution, timing, and recency of an image, but also to consider the broader water management situation at the time the image was taken. The most recent image isn't always the best image suited for a particular task!

3.1.2 – Parcel Boundaries

A geographic dataset that outlines parcel boundaries is recommended as a starting point to develop meter service areas. Parcel data can often be obtained from local counties or from a vendor/aggregator of parcel data. DWR provides data that contains several useful datasets in the shapefile format. This includes a file that represents a baseline. For those with rapidly developing service areas, it may be beneficial instead to seek out a more recent parcel dataset. Parcel data sets from the county and other vendors may come with additional data such as owner or land use type, which may prove useful in this and other analyses.

In all cases, viewing or modifying these files will require some sort of GIS software. Many water suppliers have a license to software such as Esri ArcGIS that would provide this functionality. However, there are free alternatives with robust features, such as Quantum GIS (known as QGIS), that can perform many of the same mapping and spatial analysis functions as proprietary software.

3.1.3 – Customer Data / Meter Locations

Accurate customer data and meter locations are foundational in determining the landscape area associated with these customers. Minimum data requirements include a unique identifier, customer classification, type of service, and point of service location.

When indicating the customer classification (or class), the supplier will need to know which of its meters are DIMs. Sometimes this is clear and well documented, but other times it may require more investigation. For example, there may be a distinct rate or location class indicating which connections are DIMs, or the status of a connection may be marked only by a note in the billing system designating "irrigation." Indicating or noting the type of service can aid suppliers in identifying SLAs and subsequently receiving the 1.0 LEF. For example, identifying a DIM as having a drinking water or recycled water service is an important attribute data to include.

Similarly, connection locations are sometimes clearly documented, for example in a GIS database of assets. Other times, only the street address of the service location is known. In this case, the street addresses will need to be geocoded (i.e. mapped to geographic coordinates such as latitude and longitude) before work can proceed. There are a variety of free and paid services that can perform this step, with paid services tending to produce more accurate results. However, there are instances where DIM service connections have inadequate addresses to be geocoded since they may not be matched to a specific parcel. In this case, a supplier may decide to go out into the field and physically geolocate the DIM connection in a geospatial coordinate system (e.g. latitude and longitude). Devices with a global positioning system (GPS) receiver can accomplish this at varying accuracies (e.g. smartphone 15-30 feet to high-end GPS receivers with sub-inch accuracy).

Figure 5. Example of an HOA aerial orthophoto with parcel boundaries (red) and geocoded customer locations (light blue) overlaid within GIS software.

Imagery based on DWR residential LAM data since CII-LAM-LUCD was not available at the time of publication.

3.2 – Processing

After basic supporting data has been gathered, the next steps are to match connections to the areas that they serve. These meter service areas (MSA) then need to be classified according to the requirements of the WUE Regulation and combined with the landscape classifications to measure the irrigated area served by connections of each type.

3.2.1 – Meter Service Areas

An MSA defines the total geographic area served by a meter, including buildings, hardscapes, and irrigated and non-irrigated landscapes. An important step to obtain landscape area measurements is to determine which areas are served by each meter. However, depending on desired level of accuracy and cost, the complexity of this task can vary widely.

At a minimum, this process would involve using GIS software to visualize where meters are located relative to parcel boundaries, and then to determine which parcels are associated with CII-DIM meters. This makes the simplifying assumption that the MSAs for each DIM are equivalent to a parcel. This may not be the case, but it can serve as a helpful approximation.

Advanced approaches use customized or modified parcel data sets to better reflect true MSAs rather than simply reflecting property ownership. This can include steps like subdividing or merging parcel boundaries, extending parcels outward to meet the street centerline, or even creating new boundaries to represent things like Homeowners Association (HOA) common areas or street medians that may not exist in the baseline parcel data. This is the approach that suppliers like Irvine Ranch Water District have taken to develop their "meter to parcel" dataset[5].

Figure 6. Example of an HOA aerial orthophoto with parcel boundaries (red) and geocoded customer locations (light blue) overlaid within GIS software. DIMs are shown as bright blue/green points, and the parcels irrigated by the DIMs are shown outlined in yellow.

Imagery based on DWR residential LAM data since CII LAM LUCD was not available at the time of publication.

5 https://calwep.org/wp-content/uploads/2021/03/IRWD-P2P_2021_Meter_to_Parcel-Final.pdf

To implement truly accurate water budgeting and to make informed irrigation recommendations, it may be desirable to manually trace the area irrigated by a given meter. Some landscapers may even trace specific irrigation zones to help troubleshoot maintenance issues, but this per zone approach is unnecessary for developing customer-level water budgets.

Figure 7. Parcel vs MSA vs Premise

Parcel vs. MSA vs. Premise

What's the difference?

PARCEL

This is your starting point.

A parcel is defined by a series of lines that connect to form a polygon. The polygon feature represents the land area, while the line and point features store the boundary measurements and represent the parcel corners. Historically, a parcel's purpose was to track land ownership.

In residential LAM, the parcel generally is the same as the MSA, however this is not always true for CII properties.

MSA

Meter Service Area (MSA) means the total geographic area served by a meter. An MSA may include buildings, hardscapes, as well as irrigated and non-irrigated landscapes.

While identifying each CII MSA may be time consuming up front, having that specific information may be beneficial for creating detailed water budgets and targeted programs.

PREMISE

A premise is a multimeter service area that encompasses the meters associated with a single customer in a contiguous area. The area includes all landscape areas associated with the customer including parkway strips and tree canopies.

Producing LAM at a "premise" level is an alternative option to creating MSAs. You can designate a single Premise comprised of multiple DIMs, which could simplify the total landscape area measurement.

Source for Definitions: Recommendations for Outdoor Residential Water Use Efficiency Standard WUES-DWR-2021-02
A Report to the State Water Resources Control Board Prepared Pursuant to California Water Code Section 10609.6(a)(1) September 2022

When selecting an approach, keep your supplier's goal in mind, while also thinking about long term compliance. For regulatory compliance, assuming the MSA is equivalent to a parcel may be sufficient. However, if the supplier's aggregate DIM water use is significantly different from its DIM water budget, or if more accurate water budgets for individual customers are desired for programmatic or billing purposes, then it may be worth the effort to invest in developing more accurate MSAs. While a best practice, developing accurate MSAs can be a greater investment and phasing the approach may be more feasible for water agencies.

3.2.2 – Landscape Classifications

In order to go from imagery to square footage of irrigated area, it is required to analyze the aerial or satellite imagery to classify each pixel of the image into classes such as impervious, irrigated, non-irrigated, or open water. Whatever imagery a supplier obtains, they should confirm that the classification details align with DWR's requirements.

Figure 8. Example of a landscape classification data layer with 9 classes.

In this case, the data in Figure 8 is the is the "VoidPoly" data file provided by DWR in the original residential LAM data overlaid on a free basemap provided by Google Maps. Image is viewed within the QGIS software.

To simplify the landscape classification steps, one would use a visual inspection to assign a percentage of irrigated area to an MSA. For example, when looking at an MSA overlaid on an aerial image, a viewer may be able to manually conclude that approximately 80% of the MSA appears irrigated, just as a user would have made a "boots on the ground" irrigation status conclusion and landscape area measurements. While approximate, this sort of measurement has a low barrier to entry and is the sort of analysis that could be conducted by an entry level employee familiar with just the basics of GIS software and typical ornamental landscapes.

If a supplier wants to develop their own landscape area measurements, there are a spectrum of approaches to consider. There are simple pixel-based approaches to identify living vegetation that are straightforward to implement within any standard GIS software provided there is enough image available for analysis. See Appendix A1 (Background on Remote Sensing and Automating Classification of Living Vegetation*)* for details. There are also more complex approaches based on machine learning that can categorize pixels into multiple classes and account for things like image texture and more but implementing these is typically the domain of specialized consultants.

To avoid conducting landscape classifications, a supplier can wait and rely on the landscape classifications being developed by DWR.

DATA SPOTLIGHT

Data Provided by DWR

On May 5, 2023, DWR announced that it will provide urban retail water suppliers with a CII LAM *Land Use Classification Dataset (CII-LAM-LUCD)* that will include the irrigated CII landscape area features. This is a technical resource, not a legislative requirement, provided by DWR to help agencies get started with identifying CII irrigated landscape areas. The *CII-LAM-LUCD* offers more granular data by providing location-specific data with more detailed classification, rather than parcel-level summaries that were included in the residential LAM data. However, it is only a starting point that will require significant additional work to be able to use the data to assist in complying with the regulations and overall landscape management. It should be noted that DWR expects these datasets will need to be modified by agencies and currently, there is no requirement for agencies to inform DWR if the *CII-LAM-LUCD* data is incorrect or otherwise modified. However, suppliers are encouraged to send any updates to DWR or at least inform DWR of any changes so that records can be consistent.

Agencies may wait until DWR provides their data and/or use an approach like the ones outlined in this guidebook. Either way, agencies should clearly document their approach, the data sets used and the reasoning for using that data as part of the reporting requirements.[6]

If agencies decide to wait for DWR data, there are a number of tasks they can do to get started on such as locating which accounts are CII DIM accounts, geolocating meters, and finding contact information so they can turn meters on and check what area is attributable to each meter or group of meters (delineating premises).

DWR data deliverables are provided for feature classes in two formats: 1) a **GIS Geodatabase**, 2) **shapefiles,** along with a **summary report** with service area estimates in square feet based on the CII-LUCD classifications listed below. Both the Geodatabase and shapefiles require GIS software to open and GIS expertise to add additional data sets, such as meter locations, and analyze individual CII DIM or MUM landscapes areas.

The polygon feature classes include:

1. Area of interest (classified as: CII AOI, masked areas, vacant residential parcels, or residential extensions)
2. Parcel layer (parcel boundaries for residential and CII parcels)
3. Residential Extensions - 2018 Imagery (for consistency with the residential LAM)
5. CII-LUCD classification – 2020 Imagery

6 When developing their own datasets or modifying the CII-LAM-LUCD, suppliers are encouraged to follow the data accuracy requirements outlined in the DWR's Guidelines and Methodologies recommendations to the State Water Board available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Water-Use-And-Efficiency/2018-Water-Conservation-Legislation/Performance-Measures/UWUO_GM_WUES-DWR-2021-01B_COMPLETE.pdf.

Data Provided by DWR , Continued

6. Provisional CII Turfgrass classification (functional turf vs. non-functional turf) - 2020 imagery

CII-LAM-LUCD classifications includes these primary (Level 1) layers for areas not identified as residential (e.g., CII, unclassified parcels, void areas without parcels):

1. Impervious
3. Pools
4. Irrigated
5. Irrigable not Irrigated
6. Non-irrigated vegetation
7. Undeveloped/industrial lands mask
8. Horse corrals
9. Open Water
10. Artificial turf
11. Agricultural lands

Each of the Level 1 layers will include sublayers with areas segmented into more specific classification codes such as *Level 1 Irrigated* with a *Level 2 Turfgrass* separated into provisional estimates of functional and non-functional turfgrass. It is important to note that slopes are not included and the Level 2 classification called “canopy” includes any areas with a shadow not just tree canopies, e.g., a building casting a shadow on turfgrass.

Table 2. Description of CII-LAM Land Use Classification Dataset (LUCD) categories and regulatory applicability

DATA	DESCRIPTION	STANDARD/ REGULATION
CII Landscape Area Measurements: • **Irrigated Landscape Area** • **Delineation of functional and non-functional turf**	Individual landscape feature polygons (Source: 2020 imagery). Allows water suppliers to align landscape features with MUMs, DIMs, or other necessary boundary conditions. *(Source: 2020 imagery)*	CII-DIM Standard (Sec. 969) and CII-MUM conversion threshold (Sec. 973) CA Water Code Section 110 (a) - NFT irrigation ban on CII accounts
Provisional CII Extensions	Landscape area for CII properties that could be irrigated by the associated meter that fall outside the CII property lines (Source: 2020 imagery)	CII-DIM Standard (Sec. 969) and CII-MUM conversion threshold (Sec. 973)
Provisional Residential Extensions	Landscape area for residential properties that could be irrigated by residential landowners that fall outside their property lines (Source: 2018 imagery for most suppliers, 2020 imagery for new suppliers that are also getting residential LAM estimates)	Outdoor Residential Standard

3.2.3 – Meter / MSA Classifications

Accurate accounting for calculating the UWUO requires that MSAs be categorized according to criteria such as whether they are served by a DIM, whether they are residential, and whether they include an SLA. This is typically done through a process of manual review in GIS software, but there are ways to focus efforts and obtain a "first pass" that may allow an agency to skip the manual review or at least to focus efforts.

As an example, a spatial join between MSAs and the meters within their boundaries may be sufficient to classify which MSAs are served by DIMs if the source data is high enough quality. Likewise, simply filtering land use codes in the parcel data to those that represent parks and schools may be sufficient as a first pass to identify the largest and most probable SLAs.

Figure 9. Example of an aerial orthophoto showing two MUMs, geocoded to the locations shown by the magenta points.

To a first approximation, both parcels could be labeled as SLA because most of the area corresponds to a park. However, there is landscaping in the center of the left parcel which may not be SLA and there is an area in the lower left which could be NFT.

3.2.4 – Landscape Area Measurements

Data generated at earlier steps will be combined to determine the actual area being irrigated by CII-DIMs.

Each MSA should be classified and associated with either a percentage estimate of irrigated area or a more detailed landscape classification data layer. If percentages are being used, then multiply the percentage of irrigated area by the total area of the MSA. If a detailed landscape classification layer is being used, then the MSAs should be spatially joined with the classification layer, and then the area of irrigated land within each MSA should be totaled up and associated with the MSA.

In Desktop GIS software, this would typically be done by using the Clip tool to overlay the landscape classification layer with the MSA layer, creating a new layer where classifications are clipped to MSA boundaries. Select the MSAs labeled as SLA and the polygons in the classification layer labeled as "Irrigated Area." Use the Intersect tool to combine the selected SLA MSAs with the selected irrigated areas, generating a new layer of intersected polygons. Next, add a field to this new layer's attribute table to calculate each polygon's area. Use the Calculate Geometry tool to compute the area for each intersected polygon. Repeat as needed for non-SLA polygons. Finally, review and export the results as needed.

In a service area with significant hills and elevation change, it may be desirable to incorporate a digital elevation model (DEM) into this process to properly account for sloped areas that may appear smaller than they truly are in a two-dimensional orthophoto.

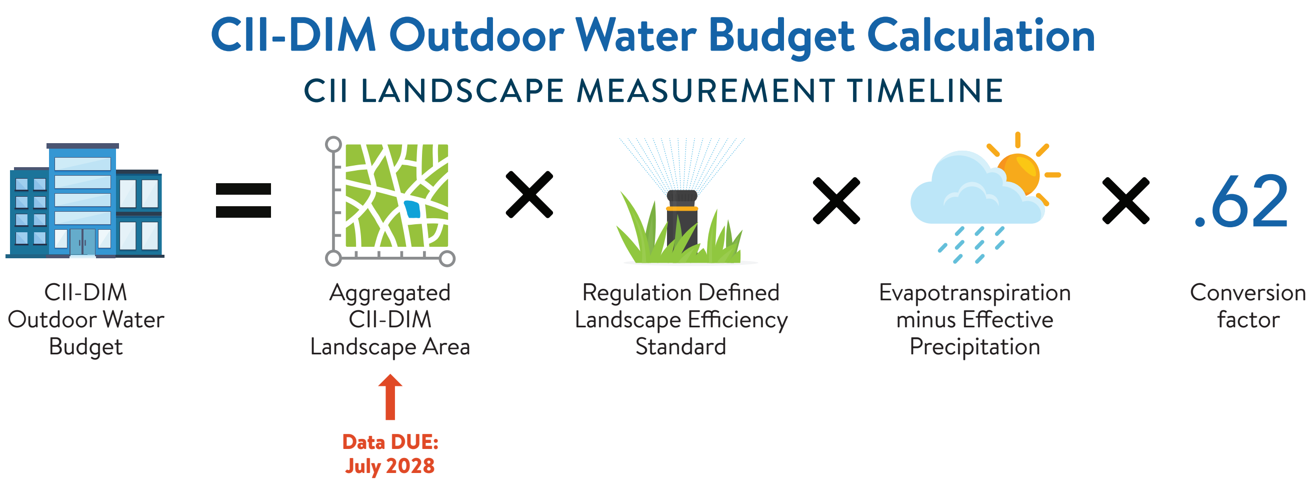
3.2.5 – Totals for Reporting

The final step is to sum up the total area for each category used in reporting and calculating the UWUO. If each MSA polygon has a field representing irrigated area, use tools, such as the Summary Statistics tool found in GIS software, can sum these areas and give the total irrigated area within the polygons.

Landscape areas should be summed up either:

- For all DIMs without incorporating SLA
- For all DIMs including SLAs where the area of SLAs is sub-totaled and non-SLA areas sub-totaled

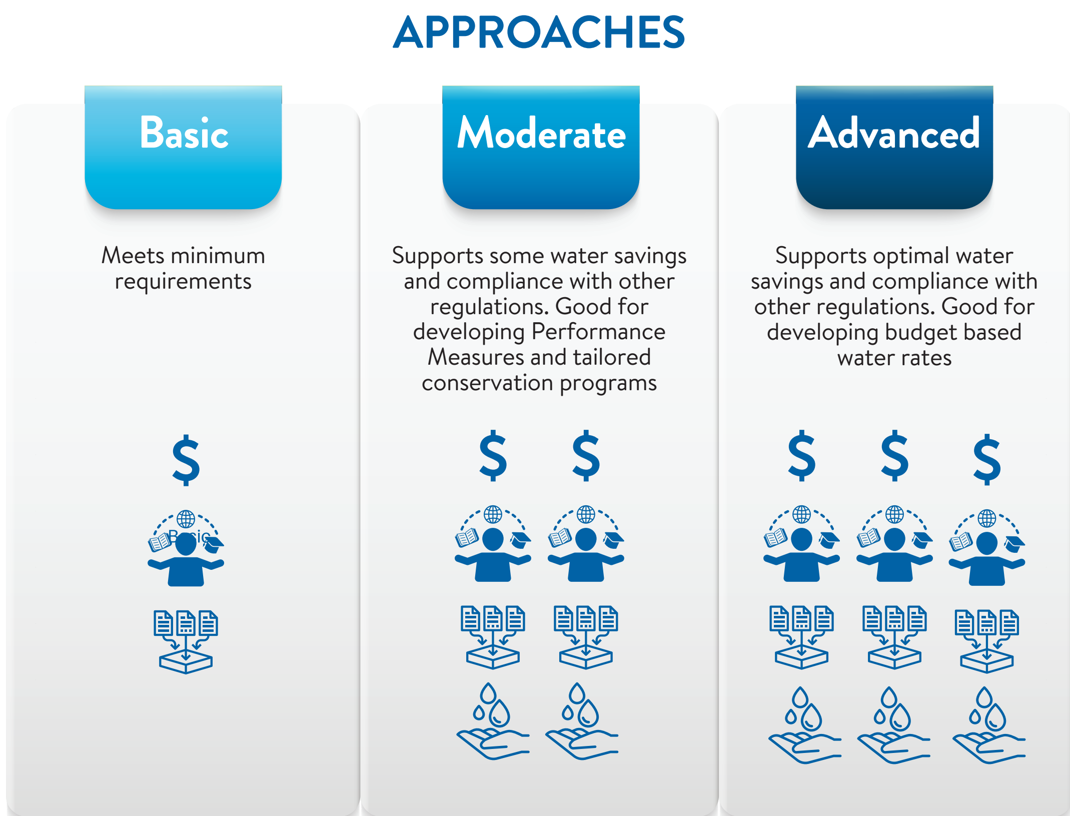
Figure 10. CII-DIM Outdoor Water Budget Calculation



SECTION 4: APPROACHES TO IDENTIFY & MEASURE LANDSCAPES

The CaDC piloted three approaches with participating urban water suppliers based on data expertise, available datasets, and estimated time spent on data collection and analysis: Basic, Moderate, and Advanced. Suppliers are encouraged to review the key characteristics of the approaches offered to identify one that best aligns with their unique conditions including available resources and staffing. General cost information, provided as rough order of magnitude estimates, can also be screened per approach to identify which of the three approaches are feasibly replicable.

Figure 11. Approaches to Identifying and Measuring CII DIMs and MUMs



DWR will provide CII-LAM-LUCD Data which is a starting point that includes shapefiles. Suppliers will need GIS software and staff/consultant expertise to complete the data processing in order to identify and measure CII DIM & MUM landscapes and meet compliance.

Table 3. Data Sets for Different Approaches

NECESSARY DATA TO IDENTIFY & MEASURE	DWR (FREE)	BASIC	MODERATE	ADVANCED
Customer Class Determination	NA	Supplier identifies meters as CII DIMs, MUMs, SLAs	Supplier identifies meters as CII DIMs, MUMs, SLAs	Supplier identifies meters as CII DIMs, MUMs, SLAs
Customer Data + Meter Locations	NA	Supplier + free geocoding service	Supplier + paid geocoding service	Supplier + staff manually geocodes meters
Parcel Boundaries	Provided	Provided by DWR	Provided by DWR	Paid parcel data
Aerial / Satellite Imagery	NA	Supplier + Google Maps or free basemap in GIS software	Supplier + Free NAIP imagery + Google Maps	Paid high resolution 3 inch, 4-band aerial imagery
Meter Service Areas	NA	Assumed to be same as parcel boundaries	Assumed to be same as parcel boundaries	Supplier or paid vendor manually matches each meter to irrigated area with GIS software + field verification
Landscape Classifications	Provided	Provided by DWR	Supplier + Free GIS software algorithms measure landscapes or Provided by DWR	Paid machine learning algorithms create land use classification data
Meter / MSA Classifications	NA	Supplier + Free heuristics classification	Supplier + Free GIS software to manually classify MSA	Staff or vendor assign MSA classification then manually verify with GIS
Landscape Area Measurements	NA	Supplier assigns a percentage of irrigated area then applies to total parcel	Supplier creates MSA + landscape classifications then aggregates	MSA joins landscape classifications then aggregates

These approaches are intended to be representative of paths that a supplier could take. They are not mutually exclusive, and a supplier may choose to mix and match each of the three approaches to produce a method that meets their needs.

One important consideration is that all the approaches assume that a supplier can identify which of their meters are dedicated to landscape irrigation. For some suppliers, with high quality data, this may be as easy as pulling data for all connections classified as irrigation in their billing system. Other suppliers may have some data about which connections are DIMs, but it may not be cleanly exportable. For example, this information may be stored in a notes field of their database, or it may be encoded with the service address string used for a connection (e.g. "123 IRR Green St., Watertown, CA" - the IRR indicates irrigation).

In the absence of any existing information identifying DIMs, it is recommended that water use efficiency staff consult with their field operations staff, who likely have a wealth of undocumented knowledge. Field operations personnel have a unique understanding of the on-ground realities, often recognizing patterns and anomalies that may not be captured in the existing data. Sitting down with field staff to record the location of known or suspected DIMs and then cross-referencing these with billing data should provide a solid starting point for the identification process. This collaborative approach allows for a more accurate assessment of irrigation practices, ensuring that all potential DIMs are accounted for and documented.

Working with field staff to develop a process for verifying or otherwise documenting DIM meter locations as they go about their normal work can create the initial foothold needed to proceed with landscape measurement. This can include incorporating DIM identification into their routine operations, such as meter reading, maintenance, or service calls. Establishing such a process ensures that new or unrecorded DIMs are consistently added to the system, creating a sustainable and ongoing method of data collection.

4.1 – Strategically Choosing an Approach

Figure 12. Choosing an Approach

Figure 12 illustrates steps to defining a supplier's DIM identification and compliance plan. Choosing the right approach for a supplier depends on several factors, as shown in the diagram:

Step 1: Understanding Funding and Level of Effort

Every project begins with understanding the available resources. Staff should start by evaluating the funding available for the DIM identification effort and how that budget aligns with the level of effort required. Determining the extent of funding early on helps establish realistic expectations for project scope and duration. For smaller agencies with limited funding, focusing on high-priority areas first can make a significant impact, while larger agencies may have the resources to take a more comprehensive approach.

Step 2: Assessing Staff Expertise and Capability

The next step is assessing the staff's level of expertise and their programming ability. Knowing whether staff are equipped to handle technical tasks such as data analysis, GIS mapping, or integrating billing systems with DIM records can inform whether external consultant services are necessary. For example, field operations staff may have the experience to identify potential DIMs but might require support from a consultant to document and analyze the data effectively.

Step 3: Aligning with Goals and Priorities

Clarifying the goals and priorities of the DIM identification effort is crucial. Is the primary objective to comply with state water efficiency regulations, or is there a broader goal to optimize irrigation practices and reduce water usage? Establishing clear goals will help guide decision-making throughout the process and ensure alignment with the agency's overall water efficiency strategy.

Step 4: Defining Compliance Strategies

Defining how the agency plans to comply with water efficiency regulations is a key consideration. Different strategies may be employed depending on the available resources and the urgency of compliance requirements. For some suppliers, this may mean investing more upfront to streamline DIM identification and data integration processes, which can set them up for long-term compliance success. Suppliers operating under tight budget constraints may need to prioritize incremental compliance steps, focusing on high-impact areas first.

Step 5: Analyzing Available Data and Accessibility

Finally, the level of success in identifying and managing DIMs often hinges on the availability and accessibility of data. This includes understanding what data the supplier already has, such as historical billing records, GIS data, or any existing field documentation. The more comprehensive the available data, the easier it will be to identify DIMs accurately. Establishing robust data management practices and ensuring that field and office teams have access to the same up-to-date information will streamline the identification and compliance process.

By following these steps to select the right approach, staff can navigate the complexities of DIM identification and compliance with confidence. Collaboration with field staff, careful evaluation of resources, and strategic alignment with organizational goals will help ensure a successful and sustainable outcome.

4.2 – Deeper Dive: Comparing Each Approach

Table 4. Comparison of Approaches

	BASIC APPROACH	MODERATE APPROACH	ADVANCED APPROACH
Preprocessing	None		Initial preprocessing of the datasets with a Python script can help ensure reproducibility. This could range from standardizing addresses from the suppliers' billing database to filtering for CII and Residential connections.
Customer Class Determination	Agencies will have to identify which meters are CII DIMs, MUMs, and SLAs. This likely depends on the rate codes unique to each agency.		
Customer Data / Meter Locations	Meter service addresses geocoded using free service	Meter service addresses geocoded using paid service	Actual meters geolocated by field staff/vendor
Parcel Boundaries	Parcel data provided by DWR		Recent parcel data obtained from County or third-party vendor
Aerial / Satellite Imagery	Google Maps or free basemap in GIS software	Free NAIP imagery combined with Google Maps	High resolution 3 inch, 4-band aerial imagery purchased from a vendor
Meter Service Areas	Assumed to be the same as parcel boundaries		Each meter matched to the area it truly serves by manually adjusting parcel data through intensive GIS work and field verification
Landscape Classifications	DWR CII-LAM-LUCD	Irrigated area measured using simple algorithms out of the box in GIS software. OR waiting for DWR to release their CII-LAM-LUCD data layer.	Advanced machine learning algorithms create a detailed land use classification data layer. CII-LAM-LUCD is an example here.
Meter / MSA Classifications	MSA classifications assigned using heuristics	MSA classifications assigned manually using GIS	MSA classifications assigned using heuristics and then manually verified using GIS

<table>
<tr><th></th><th>BASIC APPROACH</th><th>MODERATE APPROACH</th><th>ADVANCED APPROACH</th></tr>
<tr><td>DIM Landscape Area Measurements</td><td>LAM calculated by best professional judgement each DIM parcel in GIS software and manually assigning a percentage of irrigated area, then multiplying this by the total area of the parcel</td><td>LAM calculated by summing up the total irrigated area within each MSA from the landscape classification layer</td><td>LAM calculated by summing up the total irrigated area within each MSA from the landscape classification layer</td></tr>
<tr><td>MUM Landscape Area Measurements</td><td>LAM calculated by best professional judgement each non-DIM CII parcel in GIS software and manually assigning a percentage of irrigated area, then multiplying this by the total area of the parcel. Parcels with nonzero irrigated area are MUMs, while those with greater than ½ acre are “large landscapes”</td><td>The best professional judgement approach can be complemented with approaches that incorporate water use data. Parcels with very low water use are unlikely to be irrigating more than ½ acre, and parcels with no seasonal trends in consumption may not be irrigating at all</td><td>LAM calculated by summing up the total irrigated area within each MSA from the landscape classification layer. MSAs with greater than ½ acre irrigated area are “large landscapes”</td></tr>
<tr><td>SLA and NFT Identification</td><td colspan="3">See Appendix A2 - Recipe: Identifying Special Landscape Areas (SLAs) and Non-Functional Turf (NFT)</td></tr>
<tr><td>Minimum Required Datasets</td><td colspan="2">• List of active meters (meter serial #) with unique premise identifier (Location ID or Act #).
• For customer class.
• For service type.
» Meter location Geo-coordinates and/or Assessor Parcel Number would be ideal.
» Suppliers with addresses but no coordinates must geocode them to obtain coordinates of the meters.
• Parcels_All.shp from residential LAM data
• Inventory of all parcels in each water district, including non-residential CII.</td><td>• A_UID_Summary.shp
» All measured residential parcels, with the possibility of overlapping parcels and Assessor Parcel Number.
• B_UID_Summary.shp
» All measured residential parcels, without any overlapping parcels, and Assessor Parcel Number.
• Parcels_AB_Relationship.shp
» Crosswalk between A_UID_Summary and B_UID_Summary
» Satellite images from a third-party provider</td></tr>
</table>

<table>
<tr><th></th><th>BASIC APPROACH</th><th>MODERATE APPROACH</th><th>ADVANCED APPROACH</th></tr>
<tr><td>Minimum Required Skillsets</td><td colspan="2">Staff must have the ability to extract data out of supplier billing system to then manipulate in Excel. (Basic info needed: list of active in-ground meters, meter serial #, customer act type, unique premise code or Act #).

Staff must be comfortable with manipulating Excel spreadsheets and using GIS software such as QGIS, ArcGIS Pro, ArcMap, or ArcGIS Online (otherwise a consultant will be required).

At the bare minimum, suppliers will have to know how to load basemaps, shapefiles and spreadsheets into the preferred GIS software, perform a basic Select by Location operation, and edit the attribute table of shapefiles.

Some agencies may also have to be prepared to learn how to geocode addresses within the selected software. In other words, the conversion of addresses to coordinates.</td><td>On top of what is already mentioned for the Basic and Moderate approaches, agencies that are prepared to purchase or download higher resolution images should have staff that are familiar with remote sensing concepts, and some familiarity with statistical programming languages such as Python or R. Agencies must be able to do ingestion, and processing of geospatial data with Python or R.</td></tr>
<tr><td>Estimated Cost (2024 dollars)*</td><td>$10/DIM</td><td>$50/DIM</td><td>$250/DIM</td></tr>
<tr><td>Estimated completion time**</td><td>1-3 months</td><td>6 months – 1 year</td><td>1 to 2 years</td></tr>
</table>

**This varies depending on the size of the service area, parcels, meter to parcel/premise. For instance, a small service area with many CII DIMs could take more time and cost more than a large service area with few CII DIMs. Or for two service areas with an equal number of CII DIMs, one with larger irrigated areas or a more complex arrangement of meters would cost more.*

*** This varies depending on several factors such as staffing levels, expertise using GIS, accessible and accurate data sets (i.e., meter locations).*

FUNDING SPOTLIGHT

Reclamation - Applied Science Grants

Through WaterSMART, Bureau of Reclamation (Reclamation) provides financial assistance on a competitive basis for Applied Science Grants. Through these grants, Reclamation provides cost-shared financial assistance for projects to develop hydrologic information and water management tools and improve modeling and forecasting capabilities. Increased access to information and improved modeling and forecasting capabilities should meet a variety of water management objectives, including: support for water supply reliability, management of water deliveries, water marketing activities, drought management activities, conjunctive use of ground and surface water, water rights administration, ability to meet endangered species requirements, watershed health, conservation and efficiency, and other water management objectives.

Eligible applicants include states, tribes, irrigation and water districts, and other organizations with water or power delivery authority located in the Western United States and territories. Universities, nonprofit research organizations and nonprofit organizations located in the United States are also eligible if they partner with an entity with water delivery authority.

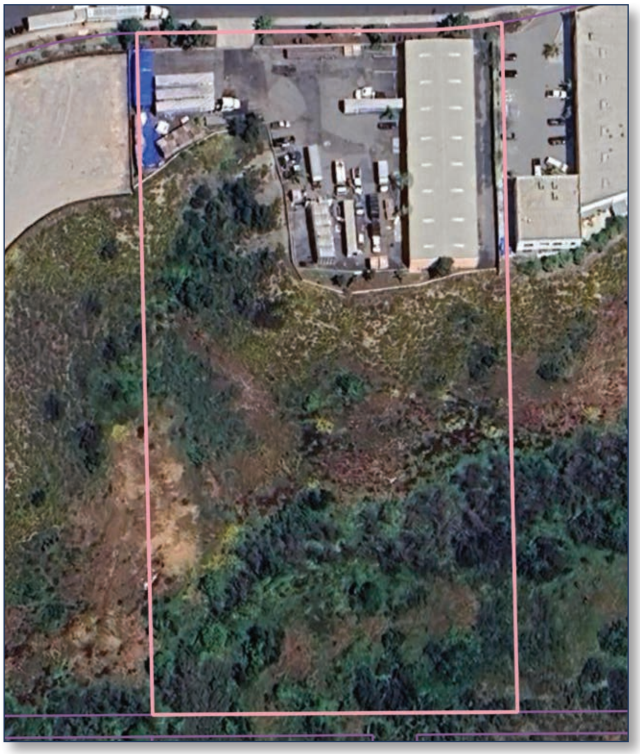
Applied Science Tools activity includes an internal component to build the technical capacity of Reclamation staff that support improved water management and operations. Eligibility includes projects that demonstrate, apply, or improve applied science tools needed to inform specific water management decisions, including improved modeling, forecasting, and water measurement tools, projects to support the use of GIS projects to increase access to water resources data, and projects that support nature-based solutions decision making.

Eligible project types include:

- Improved Hydrologic Modeling
- Improved Forecasting Tools
- Improved GIS and Data Management
- Nature-Based Solution Decision Making Tools

There will be situations that may present challenges during measurement and classification. These "stumpers" are listed below along with suggested solutions.

Stumper #1A: Undeveloped Area within Parcel



Most of the lot is not built up. The vegetated area south of the fence line is unlikely to be irrigated as a result. Greenery found in this area should not count towards any landscaping. It would be included in the "not irrigated" category.

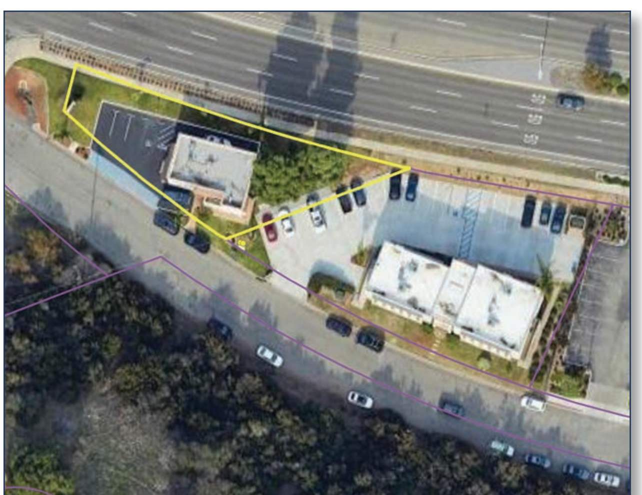
Stumper #1B: Two Properties Sharing an Assessor Parcel Number (APN)

A park and a water treatment plant have the same APN. Their meters should not automatically include the entire area of the parcel and should be restricted to just the area of their respective properties.

Stumper #2: Meters with no clear irrigated parcels:

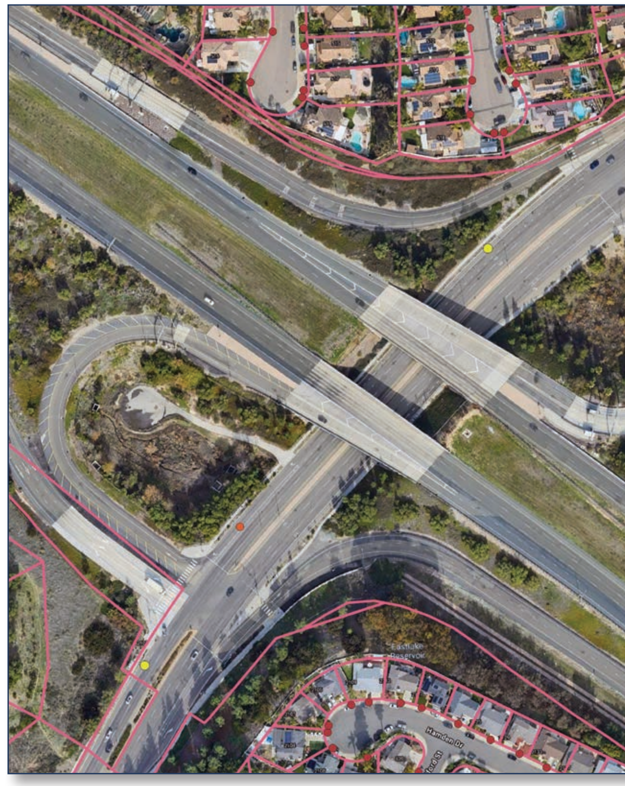
Meters located in areas without any clear destination parcels should not be included. The supplier could investigate the connection and verify that it is active or even has a customer of record. In the case it is active but no customer, consider a "dummy" MSA as a placeholder.

Stumper #3: Discrepancy between the location of the meter and the parcel being irrigated



Meters could be located in a parcel that they do not irrigate or serve. The two meters in yellow are located in Parcel 640-070-29-00. However, based on the address and the GIS Parcel attribute, they serve Parcel 640-070-27-00.

Stumper #4: Uninformative/Ambiguous/ Fictitious Addresses

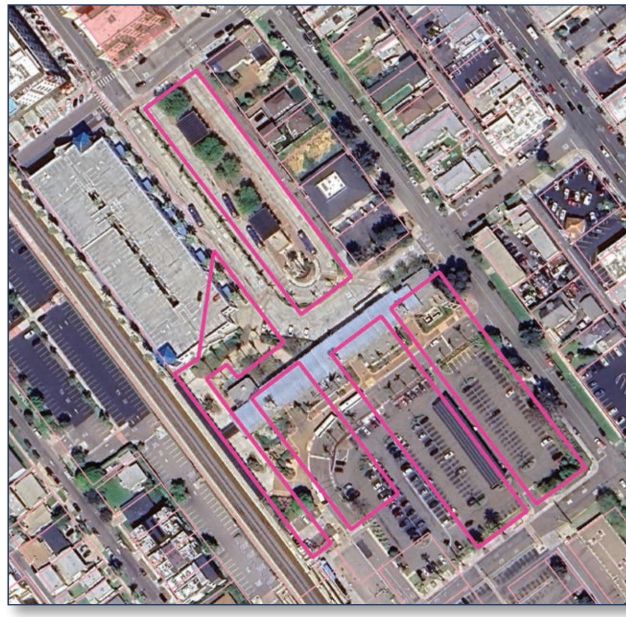


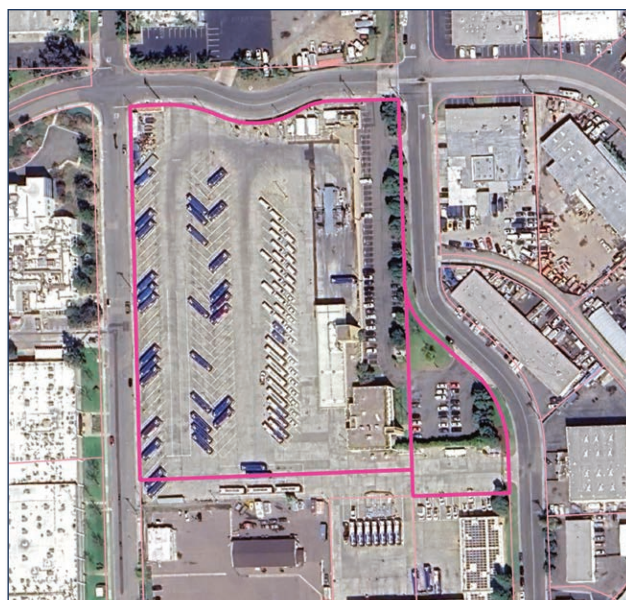
In this example, the 2 meters in yellow have the same street address but are located apart from one another. They do not have any APNs tagged, which makes it even harder to geolocate. These types of meters are very common, especially for irrigation meters that serve HOA common areas or street medians. Some of them do not have an APN tagged either. This makes it difficult to ascertain the parcel that they serve. One solution may be to assign a fictitious address such as "1445 ½ Main Street" to indicate the meter is along the 1400 block of Main St and located either near 1445 Main St or across from an actual property 1446 Main St, but does not actually serve the 1445 Main St or 1446 Main St properties. This is common practice by water suppliers and electric companies, especially for meters serving properties without a building or physical address.

Stumper #5: Community Gardens

Ground verification will be needed for both cases highlighted here as it is difficult to identify community gardens based on aerial images alone.

Stumper #6: Special Landscape Area: Landscaped areas with other primary activities





As a general rule, locations designed for other non-recreational activities should not be designated as Special Landscaped Areas even if their turf seems substantial enough for recreational activities.

Stumper #7: Special Landscape Areas that could be very small in relation to the entire parcel

In this case, using the parcel to approximate a meter service area is not a valid assumption. This parcel covers an entire Marina but there appears to be a small park next to a parking lot. Suppliers could measure the park separately if additional SLA budget is needed to meet the overall objective.

Stumper #8: Community Centers are Special Landscape Areas by definition even if the amount of landscaping is fairly minimal.

Suppliers could measure minimal landscaping separately if increased SLA budget will help meet overall objective.

Stumper #9: Non-Functional Turf

The turf area of this commercial property is too small for any meaningful recreational activities and should not be included.

SECTION 6: PREPARING YOUR ANNUAL REPORT

By January 1, 2025, and each year thereafter, urban retail water suppliers must submit their actual urban water use for the previous state fiscal year to the DWR and the State Water Board.

Specifically, for the CII-DIM Standard, suppliers are required to report the following information:

- Total number of water users associated with large landscapes
- Total aggregate volume of water applied to large landscapes
- The volume of water for CII landscapes with DIMs
- The number of water users associated with large landscapes that have had DIM installed
- Annual reference evapotranspiration and effective precipitation data provided by the DWR, or alternative reference evapotranspiration or effective precipitation data.
- The area of CII landscapes with DIMs measured by the supplier
- Any special landscape area that meets the criteria specified in the regulation
- Any CII landscape area with DIMs associated with new construction that meets the criteria specified in the regulation
- Any landscape area associated with a DIM that the Department classified as residential and included in the residential landscape area, but that the supplier classifies as CII and has therefore subtracted from residential landscape area
- Any additional reporting requirements associated with variances and temporary provisions as outlined in the regulation.

Action Items

- Measure total square footage of the irrigated area of CII landscapes with DIMs (DIM LA) and describe and substantiate how that area was quantified
  - » Annual updates required
- Identify and apply for alternative data sources for reference evapotranspiration and effective precipitation (as applicable)
- Special Landscape Areas
  - » Identify square footage of CII landscapes with DIMs that are special landscape areas (DIM SLA)
- Track and monitor newly constructed CII landscapes square footage
- Document the approach taken and why

SECTION 7: ONGOING DATA MANAGEMENT

While data and ground conditions may not change dramatically year-to-year, suppliers should be prepared for changes and maintain their datasets over time. In addition, as new CII DIM properties are built, agencies should have standards and a plan in place to obtain irrigated area measurements.

Table 5. Ongoing Data

SLAs	Agencies should work with the necessary city/county planning departments to be alerted of any significant changes or works to parcels with identified SLAs. Planning departments are usually involved in parcels with significant SLAs as modifications typically require a permit.
Non-Functional Turf	This could be monitored if there is a permitting system regarding turf. AB 1572 (Chapter 849, Statutes of 2023), which took effect on January 1, 2024, supports the elimination of irrigation of nonfunctional turf with potable water in California.
Meters	Suppliers will have to update their meter classification as and when changes in meter classes happen. Similarly, suppliers will have to update their datasets as they are decommissioned or added to the network.
Meter Service Area	For irrigation meters, this could change if the irrigation systems or landscaped areas change.
Premise	This could increase year-on-year if the service area is undergoing rapid development.
LAM data	Agencies will have to depend on DWR for the latest LAM dataset, unless they choose to acquire their own.

7.1 – Conclusion

In conclusion, this guidebook provides a resource for suppliers navigating the complexities of the State's WUE Regulation. By presenting three piloted approaches for identifying and measuring landscape areas associated with CII-DIMs and CII-MUMs, the guidebook offers a range of practical, real-world methodologies that suppliers can adapt to their specific circumstances. These approaches, characterized as Basic, Moderate, and Advanced, allow suppliers to select the most appropriate strategy based on their data analysis capabilities, resources, and expertise. While the processes outlined require a commitment of time and resources, starting early and leveraging the guidance provided here can significantly ease the path to compliance, ultimately promoting more effective and sustainable water management practices across California.

APPENDICES:

Appendix 1 – Recipe: Identifying Large Landscape Mixed-Use Meters (MUMs)

OBJECTIVE:

To identify MUMs within a water supplier's service area that serve both indoor purposes and outdoor irrigation, with a focus on those MUMs that irrigate large landscapes (defined as landscapes over half an acre in area).

Step 1: Data Preparation

Data preparation is crucial for setting the foundation for identifying potential MUMs and ensuring all relevant information is accurate and accessible.

1. **Gather Necessary Data:**
   a) **Meter Data:** Obtain a dataset of all non-DIM CII water meters, including attributes such as meter ID, customer classification, and service type.
   b) **Parcel Data:** Acquire a current parcel boundary dataset for the service area, preferably in shapefile format.
   c) **Imagery Data:** Obtain high-resolution aerial or satellite imagery to assist in visual assessment of landscape areas.
2. **Geocode Meter Locations:** If meter locations are not already geocoded (mapped to specific coordinates), use GIS software to geocode them. This will allow you to visualize where each meter is located within the service area.
2. **Clean and Verify Data:** Ensure that meter data is accurate and up to date. Cross-reference with field staff or customer records to resolve any discrepancies, such as missing meter locations or incorrect classifications.

Step 2: Identify Potential MUMs

This step involves narrowing down which meters might be MUMs based on location and water usage patterns, using both visual inspection and optional seasonality analysis.

1. **Initial Identification:** Since agencies may not know if a meter serves irrigation, start by identifying all commercial, industrial, and institutional meters in the dataset.
2. **Visual Inspection:** Overlay the meters on a map and inspect the surrounding areas using high-resolution imagery. Look for large, landscaped areas near the business served by the meter.
   a) **Optional Seasonality Analysis:** Analyze the monthly water usage patterns of these meters. High seasonality (e.g., increased water usage during the summer) could indicate the presence of irrigation, though this step is optional and can be skipped if other methods are more effective.

Step 3: Assess and Measure Landscape Areas

You should now have a list of potential MUMs that needs to be refined. You may choose to measure landscapes for all MUMs, but this is not strictly required. Instead, it may be prudent to focus on MUMs above or close to the half-acre landscaping threshold.

1. **Estimate Landscape Areas:**
   a) For meters that are likely MUMs, assess the landscape area they serve. This does not require high precision if it's evident from imagery that the meter serves little or no landscaping.
   b) If there's a possibility the meter serves a significant landscape, proceed to a more detailed measurement.

2. **Measure Large Landscapes:**

    a) For meters serving significant landscapes, use GIS tools to calculate the landscape area. If it appears close to or exceeds half an acre, field verification may be necessary.

3. **Manual Verification:** If needed, verify these findings by physically visiting the site or consulting with field staff. For example, field staff, with customer permission and/or help, can identify irrigation meters by turning on the system and observing which areas are watered.

Step 4: Document and Report

Accurately documenting and reporting identified MUMs ensures that the necessary data is captured for regulatory compliance and future reference.

2. **Create a Report or Export Data:**

    - Document the identified large landscape MUMs, including relevant details such as meter ID, parcel ID, landscape area, and customer classification. Tracking this information in a billing/CIS system or an existing geodatabase is ideal for long term use. Data permanently managed in a separate spreadsheet is easily lost or goes out of date.

    - Export the data in a format suitable for sharing or for regulatory reporting, such as shapefiles, CSV files, or PDF maps.

2. **Ongoing Monitoring and Updates:** Establish a process for regular updates to the MUM dataset as new meters are added or landscape areas change. Ensure that this data remains current to support ongoing regulatory compliance.

Step 5: Next Steps for Large Landscape MUMs

After identifying large landscape MUMs, staff should determine the best course of action to comply with state regulations, which may include installing dedicated irrigation meters or implementing alternative water management practices.

12. **Reporting Requirements:** Ensure that identified large landscape MUMs are included in the necessary regulatory reports, detailing their landscape area and usage as required.

2. **Consider Additional Actions:**

    a) **Install Dedicated Irrigation Meters (DIMs):** For large landscape MUMs, one option is to install dedicated irrigation meters to separate indoor and outdoor water use. However, in some locations this may be impractical or not cost-effective from a water efficiency lens.

    b) **Best Management Practices (BMPs):** Implement BMPs as required by the regulation, such as those specified in sections 973 and 974, to further enhance water use efficiency.

3. **Compliance with State Regulations:** Ensure all actions taken comply with the regulation's deadlines (e.g., identifying large landscape MUMs by June 30, 2027, or June 30, 2029, and implementing necessary measures by 2039). Track progress and adjust strategies as needed to meet these regulatory milestones.

Appendix 2 – Recipe: Identifying Special Landscape Areas (SLAs) and Non-Functional Turf (NFT)

OBJECTIVE:

To identify again. SLA and NFT within a water supplier's service area to comply with water use regulations and enhance water efficiency management.

Step 1: Data Preparation

Similar to the data preparation steps listed in appendix A1, you will want to work with a high-resolution imagery base-layer (recent data probably better if possible) and layer that with parcels or meter services area polygons, as well as customer locations.

For this step, having access to land use designations from parcel data could be helpful as a quick way to identify all schools and parks. Knowing which customers, if any, are served by recycled water will also be important.

Step 2: Preliminary Identification of SLAs and NFTs

This step involves an initial screening of MSAs to identify potential SLAs and NFTs based on specific criteria.

1. **Identify Potential SLAs:** Ask the following questions to determine if an MSA could be classified as an SLA:

   a) Is the site using recycled water?

   b) Is it a school, community center, recreational facility, or community garden?

   c) Does the landscaped area include features like pools, basketball courts, tennis courts, soccer fields, or golf courses that indicate recreation?

   d) Is the landscaped area large enough for recreational activities like soccer, frisbee, or picnics?

   e) Is there an engineered slope with well-maintained vegetation?

The easiest way to identify SLAs may just be to "zoom out" in the imagery and look for large green areas such as parks and schools. Marking just these areas as SLA could be an easy application of the "80-20 rule". You may capture 80 percent of the irrigated SLAs with only 20 percent of the effort.

It is important to note that identifying landscape areas as "special" is not required, but it can be an important tool to help raise your WUO and therefore make compliance easier.

2. **Identify Potential NFTs:** If none of the above criteria apply and the landscape appears primarily covered with grass that serves no functional purpose, it is likely to be NFT.

3. **Field Verification (where necessary):** Coordinate with field staff to conduct on-site visits for MSAs where imagery alone does not provide sufficient clarity. This step is crucial for confirming landscape types, especially for engineered slopes, mixed-use areas, and nonfunctional turf.

Step 3: Document and Classify SLAs and NFTs

Documenting and classifying SLAs and NFTs ensures that all identified areas are recorded accurately for compliance and reporting purposes.

1. **Update GIS Database:** Ensure the GIS database is updated with the new classifications for each MSA. This will support future water budgeting and management efforts. Tracking this information in a billing/CIS system or an existing geodatabase is ideal for long term use. Data permanently managed in a separate spreadsheet is easily lost or goes out of date.

Step 4: Next Steps for SLAs and NFTs

Once SLAs and NFTs are identified, the next steps involve aligning them with regulatory requirements and exploring options for improved water management.

1. **Regulatory Reporting:** The total area of SLAs will need to be summarized and reported to the state.
2. **Develop a Strategy to Stop Irrigation of NFT:** To comply with regulations, areas of NFT should not be irrigated, so these areas should either be allowed to die off naturally or otherwise should be replaced with low water use landscapes.

Appendix 3 – Background on Remote Sensing and Automating Classification of Living Vegetation

In its most simplified form, automated classification of living vegetation using remote sensing techniques involves the use of the red (ρR and ρNIR) condensed images to ascertain their existence. The spectral reflectance values of these two bands are evaluated as a ratio using the following formula for Normalized Difference Vegetation Index (NDVIρ):

$$NDVI\rho = (\rho NIR - \rho R) / (\rho NIR + \rho R)$$

In terms of accessibility, this formula can be easily calculated with most GIS software such as QGIS and ArcGIS Pro when provided with the imagery. In the case of ArcGIS Pro, it is available as part of the suite of Raster Functions. Within QGIS, this can be operationalized using the Raster Calculator function, which is provided by default. In its rawest form, it returns a value between +1 and -1 from extremely healthy and dense vegetative cover to none.

On the other hand, this is a blunt tool that measures the relative amounts of spectral reflectance and absorption by the leaf canopy. Healthy and living vegetation reflects near-infrared and absorbs red light. Additional parameter tuning and refinement to consider the reflectivity and moisture of soil, as well as type of vegetation, might have to be done. This could add complexity to the operation.

Finally, even though the algorithm can detect the amount of living vegetation, it does not tell analysts and agencies if it is irrigated or not. Agencies and analysts will have to assume that it forms part of the Irrigable Irrigated (II) area. It also does not identify Irrigable Not-Irrigated (INI) areas as they are typically devoid of living, green vegetation.

Hence, image classification algorithms that solely rely on the ratio of the spectral reflectance of the NIR to the red bands are only useful in ascertaining and confirming the amount of living vegetation, and by extension the II area. However, it cannot ascertain the INI area and is constrained by the image's quality and effects of seasonality on the growth of vegetation.

More advanced machine learning approaches don't rely solely on how much a pixel looks like living vegetation. These approaches can do things like consider the spectral mix of the individual pixel, the mix within a group of nearby pixels, and the "texture" of a patch of pixels. Depending on the approach used, an algorithm might even factor in things like how close a patch of landscape is to a nearby building or another patch of irrigated landscape.

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A Practical Guide to Measuring Landscape Areas with Dedicated Irrigation Meters in CII Sectors

OCTOBER 2024

https://thecadc.org/
outreach@thecadc.org

https://calwep.org
hello@calwep.org