The Climate Registry

DRAFT

WATER-ENERGY-GHG METRICS

PERFORMANCE METRICS FOR WATER MANAGERS IN SOUTHERN CALIFORNIA

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ABBREVIATIONS AND ACRONYMS

AF	Acre-foot or acre-feet
CEC	California Energy Commission
CH_4	Methane
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CHP	Combined heat and power
CPUC	California Public Utilities Commission
CRIS	Climate Registry Information System
DWT	Drinking Water Treatment
DWR	California Department of Water Resources
EPS	Electric Power Sector
ICLEI	International Council for Local Environment Initiatives
GHG	Greenhouse gas
GRP	TCR's General Reporting Protocol
GVP	TCR's General Verification Protocol
GW	Groundwater
LGO	Local Government Operations
kWh	Kilowatt hour
MG	Million Gallons

N_2O	Nitrous oxide
POTW	Publicly-owned treatment works
SAWPA	Santa Ana Watershed Project Authority
SEMs	Simplified Estimation Methods
SCF	Standard Cubic Feet
SWP	State Water Project
TCR	The Climate Registry
UWMP	Urban Water Management Plan
VB	Verification Body
WEG	Water-energy greenhouse gas
WMA	Water Management Agency
WWT	Wastewater Treatment

PERFORMANCE METRICS FOR WATER MANAGERS IN SOUTHERN CALIFORNIA

INTRODUCTION

The Climate Registry (TCR) is a non-profit entity that assists organizations in measuring, reporting and verifying (MRV) the carbon in their operations in order to manage and reduce it. TCR supports these organizations by operating voluntary greenhouse gas (GHG) reporting programs and a calculation tool (known as CRIS) built on GHG accounting and reporting best practices. TCR's GHG reporting requirements and guidance are developed and maintained through consensus-based processes that include input from TCR directors, members, and relevant sector experts.[1]

The Water-Energy GHG (WEG) Metrics provide a standard for water management agencies (WMAs) in Southern California to report the GHG footprint of a unit volume of water. These metrics provide transparent and consistent tools for accurately tracking the emissions intensity of water over time, and communicating trends to customers, policymakers, funders, and the public.

It is optional to report or publicly disclose one, some, or all of the WEG Metrics. However, TCR Members that choose to report WEG Metrics shall follow the methodologies outlined here.

BACKGROUND AND CONTEXT

A significant[2] portion of California's electricity consumption is associated with water and wastewater management, but less is known about the emissions associated with these operations.

Previously, WEG Guidance Version 1 (WEG 1.0)[3] established a series of WEG Metrics to assess the emissions associated with delivering raw water or drinking water to customers in Southern California. WEG 1.0 was published in December 2015, and then TCR piloted the guidance with 15 Southern California WMAs. This pilot highlighted a need to better understand the emissions trends of water management practices, beyond raw and drinking water deliveries, in order to accurately track the emissions associated with Southern California's diverse strategies for long-term water reliability.

To address this need, TCR and SCE developed WEG Version 2.0 (WEG 2.0) through an open stakeholder process that considers extensive feedback from TCR members, Cool Planet participants, California state agencies, technical experts in the water sector, and other relevant SCE business customers. WEG 2.0 now considers a more complete water use cycle that includes drinking water, wastewater, recycled water and groundwater (GW) management.

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[1] TCR provides General GHG Reporting and Verification protocols, and sector-specific guidance. As of 2018, sector-specific guidance includes the Electric Power Sector (EPS) Protocol, the Local Government Operations (LGO) Protocol, the Oil & Gas Production Protocol, and Performance Metrics for Transit Agencies.

[2] Water management operations account for nearly eight percent of CA electricity demand (CPUC, 2010).

[3] Water-Energy GHG (WEG) Guidance version 1.0: http://www.theclimateregistry.org/wp-content/uploads/2015/12/Water-Energy-GHG-Guidance-December-2015.pdf

TYPES OF WEG METRICS

WEG 2.0 provides guidance for developing both efficiency metrics (system-wide or process-specific) and delivery metrics (system-wide or product-specific).

Efficiency metrics compare emissions from operations to the total output of the system to communicate the efficiency of those operations with respect to emissions. Delivery metrics compare the total emissions associated with delivering a distinct product to the amount of product delivered. Delivery metrics consider both in-house and upstream emissions, and can be used by customers to estimate the emissions embedded in products they purchase[4].

Table 1 presents the WEG 2.0 metrics. WEG Metric A is an efficiency metric, while WEG Metrics B through F are delivery metrics.

Table 1: WEG 2.0 Metrics

WEG Metrics	
A	System Average
B	System & Supply Average
C	GW Basin Average
D	Water Product
E	Biosolid Product
F	Biogas Product

THE WATER USE CYCLE

The water use cycle refers to the activities of the built environment that 1) divert water from its natural cycle, 2) ensure that it is safe for use, 3) ensure that it can be safely returned to nature after use, and/or 4) support the long term reliability of water sources and environments.

In general, delivering water to customers in Southern California requires transporting raw water supplies over significant distances and elevation change, treating those supplies, managing waste and then distributing water products. After water is consumed by end users, raw wastewater is formed[5], which must be collected and then treated to environmental quality standards before being discharged as treated wastewater. Treated wastewater is increasingly reclaimed for beneficial use, rather than being discharged, and may be treated even further to expand its potential uses (recycled water products).

Waste that is generated in the water use cycle may also require treatment, dewatering, storage, incineration, flaring, and/or hauling to be safely disposed of. Like treated wastewater, these wastes are increasingly collected and refined for beneficial use and/or sale (co-products), rather than disposed of.

Figure 1 illustrates the water use cycle relevant to WEG 2.0[6], which considers all the water management processes relevant to Southern California. Table 2 provides additional context about these processes. Because the WEG Metrics are a tool for WMAs to track and communicate the GHG intensity of their operations or deliveries, water end-uses (e.g., heating, cooling, etc.) are not included.

[4] To the extent possible, delivery metrics, rather than efficiency metrics, should be used to calculate emissions embedded in purchased products. Efficiency metrics may omit upstream emissions from the procurement or processing of deliveries. If efficiency metrics must be used, WMAs should estimate and include any omitted emissions from the water use cycle.
[5] Wastewater results from domestic, industrial, and agricultural activities, or storm water runoff.
[6] Processes related to biosolids or biogas treatment or disposal are indicated with dashed gray arrows. Additional waste management processes may be required throughout the water use cycle, and should be considered in WEG metrics.

WEG Metrics can be developed by WMAs that own or operate any of the water management activities included in the water use cycle. System-wide metrics consider all processes from the water use cycle that a WMA controls, while process- or product-specific metrics examine a subset of water use cycle processes that contribute to a specific product or treatment stream.

Figure 1: Water Use Cycle

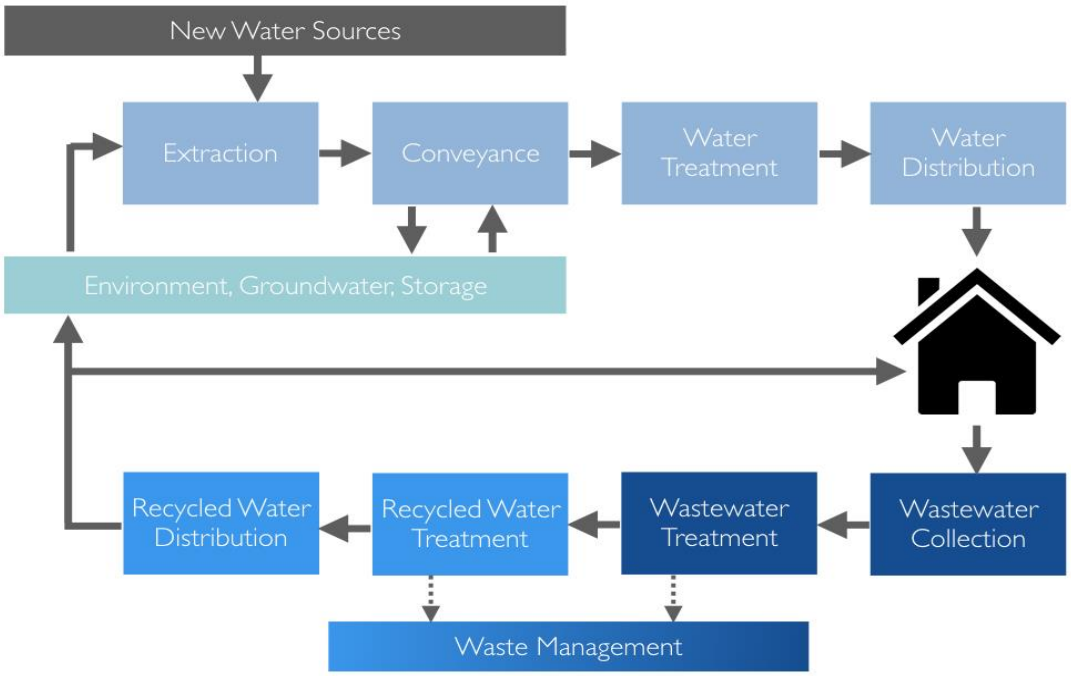

Table 2: Water Management Processes Included in the Water Use Cycle

Process	Definition
Extraction	Removal of environmental water from its natural course, such as through groundwater well pumping, surface water diversions, or ocean water intake.
Conveyance	Transportation of environmental or stored waters to point of treatment or out of a system's control (e.g. delivery of untreated, raw water to another agency).
Storage	Management of storage sites (circulation, emissions from reservoirs).
Treatment	Treatment of drinking water prior to distribution to customers; treatment of wastewater to environmental quality for discharge; advanced treatment of wastewater for beneficial reuse (e.g., recycled water products).
Distribution	Transportation of treated water to its end point (e.g., to customers for use; to a long term storage site).
Collection	Transportation of raw wastewater to a treatment facility.
Waste Management	Biosolids collection, treatment, dewatering, incineration or delivery; biogas collection, treatment, flaring or delivery[7]; discharge of treated wastewater.

[7] Additional waste management activities (e.g. brine management), should also considered in WEG metric calculations.

WATER PRODUCTS AND CO-PRODUCTS

Product-specific WEG delivery metrics can be developed for each water quality treatment standard (water product) delivered, and for each type of biosolid or biogas product sold (wastewater co-products). WMAs interested in developing product-specific delivery metrics will need to gather delivery data for each distinct product in terms of acre feet, dry tons, or energy content (btu) delivered, depending on the product[8].

WATER PRODUCTS

For the purposes of WEG delivery metrics, WMAs may define delivered water products with the name or customer category of their choosing. For example, a WMA may deliver a "Carbon-Free Water," a retail drinking water product, to some retail customers and a "Recycled Water (Tertiary Disinfected)" product to others. Common examples of water products are provided in Table 3.

Table 3: Example Water Products

Type	Classification	Description
Drinking Water	Potable Drinking Water	Water treated to a quality that is considered safe to drink or use in food preparation without health risk
Recycled Water	Advanced	Disinfected wastewater treated with advanced processes like reverse osmosis, micro- or nano- filtration, ozonation, and advanced oxidation.
	Tertiary Disinfected	Oxidized, filtered, and disinfected wastewater to achieve both bacterial and virus removal
Wastewater	Secondary Disinfected MPN 2.2	Oxidized and disinfected wastewater with total coliform bacteria <2.2 MPN/100mL
	Secondary Disinfected MPN 23	Oxidized and disinfected wastewater with total coliform bacteria <23 MPN/100mL
	Undisinfected Secondary	Oxidized wastewater
Environmental/ Raw Waters	Environmental or non-potable waters	Waters of indeterminate quality procured from various sources (surface-, ground-, storm-water etc.)

Source: CA Department of Water Resources (DWR) Title 22 water quality standards

WASTEWATER CO-PRODUCTS

Wastes produced from wastewater treatment that are collected and refined for beneficial use (i.e., waste streams that gain economic value and can be sold) are the "co-products" of wastewater.

For the purposes of WEG delivery metrics, WMAs may also define co-products with the name, customer category or treatment stream of their choosing when developing WEG delivery metrics. For example, a WMA that treats biosolids may develop a product-specific metric for "Biosolids fertilizers" or "Biosolids compost," while a WMA that refines biogas for vehicle fueling may develop a product-specific metric for "Renewable Natural Gas (RNG)." Examples of wastewater co-products are provided in Table 4.

[8] Apply consistent organizational boundaries for emissions (mt), water (AF), biosolids (dry ton), and/or biogas (btu) data.

Table 4: Example Water Co-products

Type	Classification	Description
Biosolids	Biosolids fertilizer	Biosolids that are treated to various environmental quality standards for land application
	Biosolids compost	Biosolids that are composted and sold as soil treatment
Biogas	Self-consumed	Biogas that is treated for combustion on-site
	Renewable Natural Gas	Biogas that is treated and compressed for use as a vehicle fuel
	Exported biogas	Biogas that is treated and compressed to quality standards necessary for pipeline injection or export for sale

EMISSIONS FROM THE WATER USE CYCLE

Emissions that result from any of the processes in the water use cycle are considered directly related to water management.[9] WEG efficiency metrics include Scope 1, Scope 2, and biogenic emissions[10] that result from each WMA's own water management operations. WEG delivery metrics also include Scope 3 emissions from the upstream water supply chain[11].

Therefore, the first step in developing WEG Metrics is to identify the Scope 1, 2, and biogenic emissions from a WMA's entity-wide inventory that are related to water management. Where data granularity is lacking, this may require allocating emissions between processes tracked on a single meter. WMAs interested in developing delivery metrics for their customers will then need to calculate upstream Scope 3 emissions related to water management.

Finally, WMAs that deliver multiple products and wish to develop product-specific metrics will need to identify the Scope 1, 2, 3 and biogenic emissions associated with delivering each distinct product. This may require allocating emissions from water management operations or supplies that contribute to the delivery of multiple products.

IDENTIFY SCOPE 1, 2, AND BIOGENIC EMISSIONS RELATED TO WATER

WMAs should rely on TCR's existing protocols to develop an entity-wide inventory that includes all Scope 1, Scope 2[12] and direct or indirect biogenic emissions under their organization's operational control[13]. After developing an inventory, WMAs must identify emissions related to water management.

[9] Emissions from managing waste produced in the water use cycle and wastewater co-products are "related to water" and should be included in WEG Metrics. The many other activities WMAs complete that contribute to water operations (e.g., administration, infrastructure maintenance, training, planning, and human resources) are not directly related to water.

[10] Scope 1 refers to direct anthropogenic emissions from stationary and mobile combustion. Scope 2 refers to indirect anthropogenic emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling. Direct or indirect biogenic CO_2 emissions are generated during the combustion or decomposition of biomass materials.

[11] For WEG metrics, upstream Scope 3 refers to indirect anthropogenic emissions (that are not reported in Scope 2) from water use cycle processes that contribute to delivering a distinct water supply to the reporting entity.

[12] Inventories measured according to both the location- and market-based Scope 2 accounting methods are reported as two overall emissions totals: a location-based and a market-based. WMAs must disclose which total is used in WEG Metrics.

Table 5 can be used as a resource for identifying typical emissions source from the water use cycle.

In situations where a single meter is used to track multiple activities, WMAs must use their best judgement to allocate emissions or energy consumption between those activities in order to identify emissions related to water management. For example, if a single energy meter at a treatment facility tracks energy demand for both the water treatment process and any onsite office spaces, the energy demand from that meter will need to be allocated between those activities in order to identify the emissions directly related to water management.[14]

Table 5: Example of Water-Related Emissions Sources

GHG Type	Example Emissions Sources	GHG
Direct Emissions (Scope 1)		
Stationary Combustion	Water-related equipment powered by gas or other fuel combustion (pumps, boosters, wells, digesters, CHP units that generate energy for onsite water management processes), emergency and backup generators, incineration, flares	CO_2, CH_4, N_2O
Process Emissions	Anaerobic and facultative treatment lagoons, centralized wastewater treatment, nitrification or denitrification, sludge treatment, effluent discharge, biosolids disposal	CO_2, CH_4, N_2O
Fugitive Emissions	Sewer systems, reservoirs (optional), composting (optional)	CO_2, CH_4
Direct Emissions (Biogenic)		
Stationary Combustion	Water-related equipment powered by combustion of biogas or other biomass fuel (pumps, boosters, wells, digesters, CHP units that generate electricity for onsite water management processes), incineration, flares	CO_2
Indirect Emissions (Scope 2)		
Purchased or consumed electricity, heating, steam, or cooling	Water-related equipment powered by purchased or imported electricity, heat, steam or cooling (pumps, boosters, wells, digesters)	CO_2, CH_4, N_2O
Indirect Emissions (Biogenic)		
Purchased or consumed electricity, heating, steam, or cooling	Water-related equipment powered by purchased or imported electricity, heat, steam or cooling that was generated via biogas or biomass sources (pumps, boosters, wells, digesters)	CO_2
Indirect Emissions (Scope 3)		
Upstream emissions from water supplies	Water use cycle processes that occur in the upstream water supply chain in order to deliver a distinct water supply	CO_2, CH_4, N_2O

[13] The operational control approach is discussed in the Inventory Boundaries module of TCR's GRP. If a different boundary is already applied to the entity-wide inventory, WMAs should use the existing boundary when developing WEG Metrics. WMAs are not required to apply the same boundaries as other WMAs in the supply chain. Consistent with DWR's Guidance for Energy Intensity Metrics (UWMP, Appendix O, 2015).

[14] WMAs may either 1) allocate total emissions to one process or the other consistently over time, or 2) allocate a share of the total emissions to each process. WMAs should apply the second approach (apportion emissions between processes) where possible, and provide justification of the allocation percentages applied.

CALCULATE UPSTREAM SCOPE 3 EMISSIONS RELATED TO WATER

WMAs interested in developing WEG delivery metrics must calculate Scope 3 emissions related to water management that occur in the upstream water supply chain. Where possible, the Scope 3 emissions embedded in each supply should be determined by multiplying the total volume of water received (or extracted) by the emission factor specific to that supply (product-specific or basin-specific[15] WEG delivery metrics).

If emissions factors (WEG delivery metrics) are not available for one or more upstream supply, WMAs should rely on available energy intensity metrics to estimate the upstream Scope 3 emissions associated with those supplies.[16]

WMAs that do not have access to relevant emission factors or energy intensity metrics should disclose any upstream emissions that are omitted, or provide justification that upstream emissions associated with a given supply are negligible.

CALCULATE UPSTREAM SCOPE 3 WITH WEG METRICS (EMISSION FACTORS)

WEG delivery metrics are emission factors in terms of GHG per acre foot (AF) of water. WEG delivery metrics developed by WMAs may be used by downstream customers to calculate the upstream Scope 3 emissions embedded in the products they purchase. [17] Emission factors relied on for Scope 3 calculations should correspond with the year being reported.[18]

WEG delivery metrics that are reported and third-party verified to TCR's program requirements may be published on TCR's website. WMAs may also be able to obtain emission factors for the products they purchase by requesting them from suppliers directly, or via regulatory databases like the DWR's State Water Project Website.[19]

CALCULATE UPSTREAM SCOPE 3 WITH ENERGY INTENSITY METRICS

WMAs without access to emission factors should obtain the most accurate energy intensity metric available for each supply, according to the hierarchy below (most to least accurate):

1. Product- or pressure-zone specific energy intensities from upstream suppliers;

[15] WMAs that extract water from basins that are not actively managed by a single entity may not be able to determine a basin-specific metrics. WMAs in this situation may 1) provide justification for assuming that upstream emissions related to basin recharge or management are negligible, 2) rely on regional intensity metrics for recharge water supplies as a proxy, or 3) disclose the potential omission of upstream emissions related to GW basin recharge.

[16] Although the majority of emissions from water management are associated with fossil fuel based energy demand, relying on energy intensity metrics to calculate Scope 3 emissions will inherently omit non-energy emissions sources, and may lead to incorrect representations of the emissions attributes of embedded energy. It is accepted that data accuracy in Scope 3 may be lower than Scope 1 and Scope 2 data.

[17] Product-specific delivery metrics or GW basin-specific recharge metrics should be used in place of system-wide averages or DWR recycled water product efficiency metrics where possible. Third-party verified metrics should be used where possible.

[18] See: https://water.ca.gov/Programs/All-Programs/Climate-Change-Program/Water-Energy-Nexus

[19] If an emission factor is not yet available for the year being reported, emissions factors from a previous year that closely matches the water availability and hydrology of the year being reported may be used as a substitute. WMAs in your supply chain may provide this information, and should provide supporting documentation that justifies the choice of "like water year" chosen as a substitute.

2. Entity-specific or site-specific energy intensities from upstream suppliers[20];
3. Hydrologic region-specific default energy intensities[21]; or
4. California-specific default energy intensities.

To calculate Scope 3 emissions using energy intensity metrics, first determine the amount of energy embedded in each supply by applying the appropriate energy intensity metric to the amount of each supply purchased or received. Then, multiply the appropriate energy emission factor by the amount of energy embedded in the supply.[22]

IDENTIFY PRODUCT-SPECIFIC EMISSIONS

Once all emissions related to water have been collected, WMAs that manage multiple products will need to identify the emissions related to each distinct product to develop product-specific metrics.

To avoid double counting in product-specific delivery metrics, and to accurately reflect the emissions profile of each product and co-product, allocation of emissions from shared processes may be required. Shared processes are operations from the water use cycle that contribute to the delivery of multiple water products or co-products. It may also be necessary for WMAs to allocate upstream Scope 3 emissions from supplies between multiple products that rely on those supplies. Allocation should be completed by apportioning emissions from operations or supplies based on the volume of water that contributes to each product.

Emissions attributed to the management of co-products originate at the point of separation of each co-product from the primary wastewater or sludge stream.[23] For example, sludge treatment is attributed to the biosolids product, but biogas collection and refinement is attributed to the biogas product; none of these emissions are assigned to recycled water products. Co-products without economic value are considered waste (e.g., brine management, incineration, landfilling, flaring) and, hence, no emissions are allocated to these streams (i.e., brine, biosolids, or biogas produced and not sold is waste). Emissions associated with waste management should be attributed to sold products (allocated as necessary between multiple products), and included in system-wide metrics[24].

[20] Data sources may include: supplier websites, Urban Water Management Plan (UWMPs), TCR's website, or CPUC embedded energy in water studies

[21] Data sources may include: CPUC embedded energy in water studies or DWR's Water-Energy Nexus Resources

[22] WMAs should refer to the emissions factor hierarchies provided for each Scope 2 method in the emissions quantification module of TCR's GRP to choose an energy emission factor for calculating Scope 3 emissions from energy. The same method (location- or market-based) must be used for any Scope 2 and 3 emissions from energy included in WEG Metrics. Energy emission factors are available in TCR's Default Emission Factor Database (grid average, utility-specific, fuel specific).

[23] WMAs interested in developing efficiency metrics for recycled water products may follow the guidance provided by DWR for developing energy intensity metrics (UWMP Guidebook Appendix O, 2015), which suggests that only the emissions associated with processes *beyond* those required by environmental discharge permits be considered in recycled water metrics.

[24] System-wide emissions from water management should be the aggregate of all product- and coproduct-specific emissions. For example, if a WMA sells Secondary Disinfected wastewater and biosolids for land application, the system-wide emissions related to water should be equal to the emissions related to delivering the wastewater product plus emissions related to delivering the biosolids co-product. If the biosolids co-product is not sold for beneficial use, emissions associated with biosolids management should be attributed to the delivery of the wastewater product and included in the system-wide metric.

WMAs that collect and refine biogas for use in CHP units, which then provide energy to power onsite water management operations, must allocate the emissions from the CHP unit between its multiple outputs (electricity and heat/steam)[25]. This ensures that emissions from each type of energy use (electricity and heat/steam) can be appropriately attributed to the delivery of distinct water products.

Identifying Emissions from Recycled Water Products:

WMAs that manage recycled water products have the option to report product-specific WEG delivery metrics and/or DWR efficiency metrics. The type of product-specific intensity metric developed will dictate the emissions considered in the metrics, and the allocation of emissions from shared processes that may be necessary.

Recycled water product *efficiency* metrics should only include emissions that result from processes beyond those that are required for safe discharge or disposal of wastewater or biosolids (e.g., only emissions associated with tertiary or advanced treatment processes and purple pipe distribution). This is consistent with DWR's guidance for measuring the energy intensity of recycled water (UWMP Guidebook Appendix O, 2015). Environmental regulations and permit requirements dictate the processes that are considered required for each WMA.

Recycled water product *delivery* metrics must include all emissions from the water use cycle associated with delivery of the water product, including emissions from wastewater collection, treatment and any waste management activities. This may require allocation of emissions from shared processes.

Delivery metrics should always be used to calculate upstream Scope 3 emissions where possible.

DEVELOP WEG METRICS

WEG metrics describe the annual GHG emissions associated with water systems, products, and coproducts by considering the emissions from the entire water use cycle in a year. These emissions are normalized to the amount of water, biogas, or biosolids delivered in that year.

Efficiency metrics communicate the emissions intensity of specific water-management operations, processes or treatment streams for a single WMA or territory. Delivery metrics communicate emissions from the complete water use cycle associated with procuring, managing and delivering products.

Table 6 summarizes the WEG Metrics. Quantification methods are described in the sections that follow.

Table 6: Summary of WEG Intensity Metrics

WEG Metric	Title	**Description**	**Unit**

[25] Guidance for allocating emissions from CHP can be found in TCR's GRP and EPS Protocol.

A	System Average	Annual GHGs from all water-related operations per unit of total water delivered in the year	mt GHG / AF water delivered
B	System & Supply Average	Annual GHGs from all of water-related operations, plus emissions embedded in supplies, per unit of total water delivered in the year	mt GHG / AF water delivered
C	Groundwater Basin Average	Annual GHGs from GW basin management operations, plus emissions embedded in supplies, per unit of water recharged to the basin in the year	mt GHG / AF water recharged
D	Water Product	Annual GHGs from a WMA's operations related to producing a specific water product per unit of water product delivered in the year	mt GHG / AF of water product delivered
E	Biosolid Product	Annual GHGs from a WMA's operations related to producing biosolid for beneficial reuse per unit of treated biosolid waste produced in the year	mt GHG / Dry short ton of biosolid sold
F	Biogas Product	Annual GHGs from a WMA's operations related to producing biogas for beneficial reuse per unit of biogas produced in the calendar year	mt GHG / btu of biogas sold

Please note: Each metric must be reported by GHG (e.g. CO_2, CH_4, N_2O, or biogenic CO_2) and CO_2e. For WEG Metric D, E, and F there will also be separate metrics for each discrete product delivered.

WEG METRIC A – SYSTEM AVERAGE

The System Average is an entity-wide efficiency metric, which normalizes a WMA's own GHG emissions related to water management against its total volume of delivered water. It provides a transparent, system-specific metric to track the emissions intensity of a WMA's operations over time.

To calculate a System Average efficiency metrics, first determine the total emissions related to water management and the total delivered water.

WMAs that manage both drinking water and wastewater or recycled water systems should develop separate metrics for each system, and therefore will need to identify the emissions and water volumes specific to each distinct system (e.g. potable water management versus wastewater management).

DETERMINE TOTAL EMISSIONS RELATED TO WATER MANAGEMENT

The numerator of the System Average includes emissions from all processes in the water use cycle that a WMA controls. Add the Scope 1, Scope 2, and biogenic emissions, by GHG, that result from any of the processes outlined in the water use cycle, including waste management (see Emissions from the Water Use Cycle).

	System-wide Emissions from Water Management
Total Emissions from Water (mt GHG)	= Scope 1 + Scope 2 + Biogenic emissions

DETERMINE TOTAL DELIVERED WATER

The denominator of the System Average is the total volume of water moved to its final point of delivery in the year being reported[26]. To calculate the total water delivered, aggregate all volumes delivered across all products. This total should include all deliveries to other agencies, long-term storage[27], environmental recharge or discharge, and the retail distribution system (deliveries to end-users[28]).

CALCULATE WEG METRIC A - SYSTEM AVERAGE

To calculate a System Average Metric, divide the total emissions related to water management (mt GHG) by the total water delivered (AF).

	WEG Metric A – System Average
System Average (mt GHG/AF)	$= \frac{\text{Total Emissions related to water management}}{\text{Total Volume of water delivered}}$

WEG METRIC B – SYSTEM & SUPPLY AVERAGE

The System & Supply Average is an entity-wide water delivery metric, which reflects the wider GHG impacts of water delivery by considering both in-house and upstream operations related to the production and delivery of water. To achieve this, the System & Supply Average normalizes the total GHG emissions related to the delivery of water (Scope 1, 2, 3, and biogenic) against the total volume of water delivered in the year. It provides a transparent, system-specific delivery metric to track the emissions intensity of a WMA's deliveries over time.

To calculate System-wide delivery metrics, first determine the upstream Scope 3 emissions related to water management. Then, incorporate the Scope 3 emissions from the water supply chain into the calculation completed for Metric A – System Average.

WMAs that manage both drinking water and wastewater or recycled water systems should develop separate metrics for each system, and therefore will need to identify the emissions (including Scope 3) and water volumes specific to each distinct system (e.g. potable water versus wastewater management, and/or drinking water versus recycled water supplies).

DETERMINE EMISSIONS RELATED TO WATER DELIVERIES

The numerator of the System & Supply Average includes emissions from all processes in the water use cycle that a WMA controls, as well as emissions from the water use cycle that occur in the WMAs upstream water supply chain.

[26] For many WMAs, the total volume delivered will be the total reported in UWMP Table 4-1: Demands for Potable and Raw Water, plus any water placed into long term storage, discharged, or recharged. Wastewater managers should aggregate all treated wastewaters discharged, placed into long term storage, or sold.
[27] For the purposes of the WEG Guidance, long-term storage is defined as storage of greater than one year.
[28] By defining delivered water in this way, water losses that occur within the distribution system are inherently reflected in the WEG intensity metrics without being actively accounted for. If water loss is reduced, this improvement will be reflected in the WEG Metrics as emissions associated with managing those waters should decrease.

To calculate upstream Scope 3 emissions, multiply the volume of each purchased, imported, or extracted supply by an appropriate emission factor (see Emissions from the Water Use Cycle). Then, add Scope 3 emissions to the Scope 1, 2, and biogenic emissions from water operations, by GHG, to calculate the total emissions related to delivering water.

	System & Supply Emissions from Water Management
Upstream Scope 3 from Water (mt GHG)	= (WEG Metric$_{S1}$ x V_{S1}) + (Energy Intensity Metric$_{S2}$ x V_{S2} x EF_{S2}) + …
Total Emissions – Water Deliveries (mt GHG)	= Scope 1 + Scope 2 + Scope 3 + Biogenic Emissions

Where:

Term	Description
V_{SX}	Volume of each distinct water supply (AF)
EF_{SX}	Relevant mission factor for converting embedded energy to Scope 3 emissions where necessary (metric tons GHG/kWh) (e.g., grid average, utility-specific)

DETERMINE TOTAL DELIVERED WATER

The denominator of the System & Supply Average will be the same volume of total delivered water as calculated for Metric A - System Average.

CALCULATE WEG METRIC B - SYSTEM & SUPPLY AVERAGE

To calculate the System & Supply Average Metric, divide the total emissions related to delivering water (mt GHG) by the total water delivered (AF).

	Metric B – System & Supply Average
System & Supply Average (mt GHG/AF)	$= \frac{\text{Total Emissions related to water deliveries}}{\text{Total Volume of water delivered}}$

WEG METRIC C – GROUNDWATER BASIN AVERAGE

Some WMAs extract groundwater (GW) from basins or aquifers that are actively managed and/or recharged. Waters used to recharge these basins may have GHG impacts that should be accounted for as upstream Scope 3 emissions by the WMAs' that later extract the GW supplies. The Groundwater Basin Average is a basin-specific delivery (or recharge) metric, which normalizes the total GHG emissions related to GW basin management and recharge (Scope 1, 2, 3, and biogenic) to the volume of

water recharged to that basin in a year. It provides a means to transparently track and better understand the GHG impacts of groundwater basin management for long-term reliability.

To calculate basin-specific metrics, first determine the emissions from basin-related operations and recharge supplies. Then, determine the total water volume recharged to the basin in the year being reported.

WMAs managing multiple basins should develop metrics for each basin in their portfolio, and therefore will need to identify the emissions and water supplies or recharge volumes specific to each distinct basin. WMAs that extract or recharge water to basins that are not actively managed by a single entity should collaborate with other WMAs in their area to develop basin-specific averages that consider the operations and of all relevant WMAs.

DETERMINE EMISSIONS RELATED TO GW BASIN MANAGEMENT AND RECHARGE

The numerator of the Groundwater Basin Average includes emissions from all GW basin management and recharge processes, across all entities that contribute to basin management, as well as emissions embedded in recharge supplies via the upstream water supply chain.

To determine emissions specific to GW basin management, identify all emissions from the water use cycle that contribute to basin management and recharge, across all WMAs that contribute to the management and recharge of that basin. Then, determine any upstream Scope 3 emissions associated with recharge supplies (see Emissions from the Water Use Cycle). Add all Scope 1, 2, 3, and biogenic emissions, by GHG, from basin management, recharge, and recharge supplies.

	Total Emissions from GW Basin Management and Recharge
Total Emissions from Basin Management (mt GHG)	= Scope 1 + Scope 2 + Biogenic Emissions across all contributing WMAs
Upstream Scope 3 from all Recharge Supplies (mt GHG)	= (WEG $\text{Metric}_{S_1} \times V_{S_1}$) + (Energy Intensity $\text{Metric}_{S_2} \times V_{S_2} \times EF_{S_2}$) + …
Total Emissions from basin management & recharge (mt GHG)	= Emissions from basin management + Emissions from recharge supplies

Where:

Term	**Description**

V_{SX}	Volume of each distinct water supply recharged (AF)
EF_{SX}	Relevant mission factor for converting embedded energy to Scope 3 emissions where necessary (metric tons GHG/kWh) (e.g., grid average, utility-specific)

IDENTIFY RECHARGED WATER VOLUME

The denominator of Groundwater Basin Average is the total volume of water recharged to a single groundwater basin in the year. This will include volumes actively and passively recharged (e.g., spreading, reinjection, sea water barriers, natural surface or diverted storm water recharge, inter-basin underflow[29], and any other contributing flows).

CALCULATE WEG METRIC C - GROUNDWATER BASIN AVERAGE

Divide the emissions related to groundwater basin management and recharge (mt GHG) by the total volume of water recharged to the basin (AF).

	WEG Metric C – Groundwater Basin Average
GW Basin Average (mt GHG/AF)	$= \frac{\text{Total emissions from GW basin management and recharge}}{\text{Total Volume of water recharged to basin}}$

WEG METRIC D – WATER PRODUCT

Some WMAs produce multiple types of water products and these water products may have drastically different GHG profiles. Water Product Metrics are product-specific delivery metrics that normalize the total GHGs emissions from delivering a specific water product (Scope 1, 2, 3, and biogenic) to the volume of that water product delivered. Product-specific delivery metrics communicate the GHG footprint of delivering a specific water product for use or sale.

To calculate product-specific delivery metrics, first determine emissions from the complete water use cycle associated with delivering that product. Then, determine the total volume of water product delivered in the year being reported.

Recycled Water Product Efficiency Metrics

WMAs interested in developing *efficiency* metrics for recycled water products, rather than *delivery* metrics, should only include emissions from water use cycle processes in excess of mandatory activities for safe discharge or disposal of wastewater and biosolids. See Identify Product-Specific Emissions for more information.

[29] Underflows should be estimated using transparent, accepted industry standards when relevant.

WMAs that report Water Product Metrics are required to measure and report a product-specific metric for each water product that they deliver, and therefore will need to identify the emissions and water supply volumes that contribute to the delivery of each product (see Identify Product-Specific Emissions). If data is available, WMAs may also optionally report product-specific metrics for each discrete delivery territory, pressure zone, or treatment stream (e.g., in cases where a single water product is delivered to various locations with distinct GHG intensities due to distance or topography).

DETERMINE WATER PRODUCT-SPECIFIC EMISSIONS

The numerator of Water Product Metric includes all emissions from the water use cycle that can be attributed to delivering a single water product.

To determine emissions related to delivering each product, first identify Scope 1, 2, and biogenic emissions from operations that contribute to processing and delivery of the product (see Identify Product-Specific Emissions for guidance on allocating emissions). Then, determine any upstream Scope 3 emissions associated with imported, purchased, or extracted supply volumes that contribute to the delivery of that product (see Emissions from the Water Use Cycle). Add all Scope 1, 2, 3, and biogenic emissions, by GHG, specific to the delivery of each product.

	Total Water Product-Specific Emissions
Product-specific Emissions from Operations (mt GHG)	= Scope 1 + Scope 2 + Biogenic Emissions
Product-specific Upstream Scope 3 from Supplies (mt GHG)	= (WEG $\text{Metric}_{S_1} \times V_{S_1}$) + (Energy Intensity $\text{Metric}_{S_2} \times V_{S_2} \times EF_{S_2}$) + ... OR = (Total Scope 3 from supply) x (% of supply that contributes to product)
Total Product-specific Emissions (mt GHG)	= Product-specific Emissions from Operations + Product-specific Emissions from Supplies

Where:

Term	Description
V_{SX}	Volume of each distinct water supply that contributes to the delivery of each product (AF)
EF_{SX}	Relevant mission factor for converting embedded energy to Scope 3 emissions where necessary (metric tons GHG/kWh) (e.g., grid average, utility-specific)

DETERMINE VOLUME OF WATER PRODUCT DELIVERED

The denominator of the Water Product delivery metrics is the volume of water product delivered to a specific customer category, service territory, environmental recharge, or other use (see Water Products and Co-Products).

CALCULATE WEG METRIC D - WATER PRODUCT DELIVERY

To calculate the Water Product Metric, divide the total upstream and operational emissions related to each water product (mt GHG) by the volume of each water product delivered (AF) in the year.

	WEG Metric D – Water Product
Water Product (mt GHG/AF)	$= \frac{\text{Product-specific Emissions}}{\text{Volume of Water Product Delivered}}$

WEG METRIC E – BIOSOLIDS PRODUCT

Some wastewater management agencies collect and refine biosolids, a co-product of wastewater treatment, for beneficial use. Different biosolid processing activities may produce distinct biosolids products with different GHG profiles. Biosolids Product Metrics are product-specific delivery metrics that normalize the total GHGs emissions from delivering a biosolids product (Scope 1, 2, and biogenic) to the weight of product delivered. Product-specific delivery metrics communicate the GHG footprint of delivering a specific biosolids product for use or sale (biosolids treated for disposal are wastes; emissions associated with waste management are attributed to wastewater or recycled water products, rather than considered as separate biosolids products).

To calculate biosolids delivery metrics, first determine emissions from the complete water use cycle associated with delivering that product, beginning at the point of separation from the wastewater stream (generally clarification). Then, determine the total dry weight of biosolids product delivered in the year being reported.

WMAs that report Biosolids Product Metrics are required to measure and report a product-specific metric for each distinct biosolids product that they deliver. Alternatively, WMAs may develop a single biosolids metric, which normalizes all emissions from operations related to biosolids management against the amount of biosolids produced for beneficial use.

DETERMINE EMISSIONS RELATED TO BIOSOLIDS PRODUCTS

The numerator of Biosolids Product Metric includes all emissions that can be attributed to delivering a single biosolids product. To determine emissions related to biosolids products, identify Scope 1, 2, and biogenic emissions[30] from any operations that take place after biosolids have been separated from the wastewater stream (e.g., sludge transport, digestion, dewatering, composting, incineration, hauling, etc.).

[30] If biosolids supplies are purchased from other entities and then further refined, upstream Scope 3 emissions associated with those supplies should also be considered in the emission related to biosolids product management and delivery.

	Biosolid Product-Specific Emissions
Biosolid Product-specific Emissions (mt GHG)	= Scope 1 + Scope 2 + Biogenic Emissions

DETERMINE WEIGHT OF BIOSOLID PRODUCTS

The denominator of the Biosolids Product metrics is the dry weight (short ton) of biosolids product delivered for use to a specific customer category, service territory, or environmental site (see Water Products and Co-Products). This weight should be consistent with quantities reported to other programs and permitting entities. [31]

CALCULATE WEG METRIC E - BIOSOLID PRODUCT

To calculate the Biosolids Product Metric, divide the total emissions related to each biosolids product (mt GHG) by the weight of each biosolids product delivered (short ton) in the year.

	WEG Metric E – Biosolid Product
Biosolids Product (mt GHG/dry ton)	$= \frac{\text{Biosolids Product-specific Emissions}}{\text{Dry Weight of Biosolids Product Delivered}}$

WEG METRIC F – BIOGAS PRODUCT

Some wastewater management agencies collect and refine biogas, a co-product of sludge treatment, for beneficial use. Different biogas processing activities may produce distinct biogas products with different GHG profiles and fuel characteristics. Biogas Product Metrics are product-specific delivery metrics that normalize the total GHGs emissions from delivering a biogas product (Scope 1, 2, and biogenic) to the energy or heat content of product delivered. Product-specific delivery metrics communicate the GHG footprint of delivering a specific biogas product for use or sale (flared biogas is considered a waste; emissions from waste management are attributed to wastewater, biosolids, or recycled water products, rather than considered as separate biogas products).

To calculate biogas delivery metrics, first determine emissions associated with delivering each product, beginning at the point of separation from the sludge treatment stream (generally digestion). Then, determine the total energy content of biogas product delivered in the year being reported.

WMAs that report Biogas Product Metrics are required to measure and report a product-specific metric for each distinct biogas product that they deliver. If data is available WMAs may also optionally report delivery-specific metrics for each discrete biogas product delivery (i.e. if a single biogas product is delivered to various locations with distinct GHG intensities, or if the same biogas product is produced at multiple facilities with varying refinement processes). Alternatively, WMAs may develop a single biogas

[31] For example, the reporting of tons of biosolid produced to the Southern California Air Quality Management District.

metric, which normalizes all emissions from operations related to biogas management against the total amount of biogas produced and refined for beneficial use.

DETERMINE EMISSIONS RELATED TO BIOGAS PRODUCTS

The numerator of Biogas Product Metric includes all emissions that can be attributed to delivering a single biogas product. To determine emissions related to biogas products, identify Scope 1, 2, and biogenic emissions[32] from any operations that take place after biogas has been emitted and collected from the sludge treatment stream (e.g., removal of water, CO_2, and other impurities, compression, etc.).

	Biogas Product-Specific Emissions
Biogas Product-specific Emissions (mt GHG)	= Scope 1 + Scope 2 + Biogenic Emissions

DETERMINE AMOUNT OF BIOGAS PRODUCT

The denominator of the Biogas Product metric is the energy content (btu) of biogas product delivered to a specific customer category or end use (see Water Products and Co-Products). WMAs should use site-specific data for determining energy content where possible, and must report energy content consistent with quantities reported to other programs and permitting entities[33]. If site-specific data is not available, WMAs may rely on factors provided in TCR's default emission factor database.

Biogas Products Metrics for vehicle fuels may also be reported in terms of diesel gallons equivalent (DGE), and gasoline gallons equivalent (GGE) using the factors provided in Appendix A.

CALCULATE WEG METRIC F – BIOGAS PRODUCT

To calculate the Biosolids Management Metric, divide the total emissions related to the biogas product production (metric tons GHG) by the total energy content of the biogas product delivered or consumed (btu) over the time period being reported.

To calculate the Biogas Product Metric, divide the total emissions related to each biogas product (mt GHG) by the energy content of each biogas product delivered (btu) in the year.

	WEG Metric F – Biogas Product
Biogas Product (mt GHG/btu)	$= \frac{\text{Biogas Product-specific Emissions}}{\text{Energy Content of Biogas Product Delivered or Consumed}}$

REPORTING OPTIONS

[32] If biogas supplies are purchased from other entities and then further refined, upstream Scope 3 emissions associated with those supplies should also be considered in the emission related to biogas product management and delivery.
[33] For example, biogas data reported to the California Air Resources Board or local Air Quality Management District

WMAs that develop WEG Metrics are encouraged to report, verify, and publicly disclose metrics as a service to their customers and other stakeholders. When WEG Metrics are publicly disclosed, they must be reported according to the standards described below.

LEVEL OF REPORTING DETAIL

TCR strongly recommends reporting as completely and as granularly as possible, while recognizing that there are challenges to data availability both within and beyond WMA boundaries.

Some WEG Metrics rely on system-wide emissions, water, and coproduct data, while others rely on data specific to each unique product. WMAs may report either system average metrics or product-specific metrics, or both. However, if product-specific metrics are reported, WMAs must report a metric for each product or co-product delivered. WMAs that deliver water products are not required to develop co-product metrics, or vice versa. For example, if a single co-product metric is developed for biogas products, metrics must be developed for each distinct biogas product delivered; if a single water product metric is developed, metrics must be developed for all water deliveries.

WMAs also have the option of developing more granular WEG efficiency metrics specific to each water use cycle process (e.g. metrics can be developed for each water use cycle process that a WMA controls).

TIMESCALE

WEG Metrics must be reported using annual (i.e. calendar or fiscal year) emissions, water, and/or co-product data.

WMAs who are interested in tracking WEG metrics on smaller timescales to better understand the emissions intensity of their operations with respect to seasonal variation in water availability may optionally rely on quarterly or monthly data to calculate WEG Metrics.

OUTPUT UNITS

Emissions related to water or coproduct management shall be reported in metric tons (mt) of each GHG relevant to water management (CO_2[34], CH_4, and N_2O at minimum) before being converted to CO_2e using Global Warming Potentials (GWPs). GWPs can be found in TCR's Default Emission Factor Database.[35] The total metric tons of CO_2e may also be reported.

For the purposes of the WEG Metrics, all delivered water volumes shall be reported in acre-feet (AF), with the exception of wastewater management efficiency metrics, which may be measured in MG.

The amount of biosolid co-product delivered by a WMA shall be reported in terms of total short tons sold in a calendar year. The amount of biogas product shall be reported in terms of energy or heat content of the biogas consumed or sold. WMAs that have measured site-specific data for the fraction of methane and volume of biogas consumed or sold may also report this information. WMAs may convert

[34] This includes both anthropogenic and biogenic CO_2 emissions.

[35] TCR's Default Emission Factors are consolidated from various sources and can be found on our website: https://www.theclimateregistry.org/tools-resources/reporting-protocols/general-reporting-protocol/

Biogas Product metrics from GHG per btu to GHGs per gallon of gasoline or diesel gallon equivalent (GGE or DGE) using the default conversion factors provided in Appendix A.

SUPPLEMENTAL DATA

TCR **requires** its members to publicly disclose the following information alongside WEG metrics:

- The type of intensity metric developed and reported (efficiency or delivery);
- The Scope 2 method (location- or market-based)[36] used to develop WEG Metrics;
- Lack of upstream data if defaults are not available for calculating WEG Metrics B, C or D (or water use cycle processes that may be omitted from emission factors or energy intensity metrics used to calculate Scope 3 emissions); and
- Transparent geographic boundaries, if reporting WEG Metrics for water deliveries to/from locations other than Southern California.

TCR **encourages** members to optionally disclose the following information alongside WEG metrics:

- Map of service area or system;
- Description of water supply sources (name of water basin, incoming water quality, etc.);
- Information on a lack of sufficiently granular data (e.g., lack of sub-meters at a facility);
- Data sources for Scope 3 calculations where applicable;
- Organizational control boundary used by other entities (upstream and/or downstream) in the water supply chain;
- Avoided emissions from operations or products; and,
- Most recent date input water meters were calibrated.

VERIFICATION

TCR strongly encourages the independent verification of WEG Metrics before providing them to customers for use in their own emissions calculations[37]. This third-party review ensures that only credible, high-quality data is placed in the public domain, which in turn lends credibility to emissions calculations that rely on reported WEG Metrics.

To verify WEG Metrics, WMAs should engage their verification body (VB) to request that this review be included in the scope of verification activities, ideally before submitting proposals to potential VBs. All data used to calculate WEG metrics, and reported alongside WEG Metrics, will be subject to third-party verification according to TCR's program requirements. This includes emissions from Scope 1, Scope 2, biogenic CO_2, Scope 3, and the relevant delivery data.[38]

APPLYING METRICS

[36] More information can be found in Chapter 15 of TCR's GRP: http://www.theclimateregistry.org/wp-content/uploads/2014/11/General-Reporting-Protocol-Version-2.1.pdf

[37] An overview of TCR verification is provided in the Chapter 19 of the GRP. Organizations should also consult TCR's General Verification Protocol (GVP) for more detail.

[38] Delivery data is only verifiable if it is also disclosed to another program using a standard methodology. The verification body will conduct a consistency check between the water volumes used to develop WEG Metrics and the water volumes reported to other programs.

The WEG Metrics are intended to provide a useful tool for both 1) customers, to better understand the relative emissions impacts of the water products or co-products they receive, and 2) water managers, to better understand the efficiency of their water management operations.

After WEG Metrics have been developed by WMAs, they may be utilized as a benchmarking tool for tracking emissions over time, as a powerful communications tool for conveying product-related information to stakeholders, as emission factors for upstream Scope 3 emissions calculations, and/or to help improve broad understanding the emissions associated with California's water system.

TRACKING OVER TIME

WEG metrics allow WMAs to better monitor trends in the emissions intensity of the water (and water co-products) they acquire, manage, and deliver or dispose of.

For organizations that are affected by external factors like weather or the population they serve, tracking efficiency metrics over time is helpful for removing some of the annual variability in emissions. For example, entity-wide GHG emissions may increase over time to meet growing demand, or as the result of policy changes or water availability, but if the water system becomes more efficient in terms of emissions resulting from operations, the WEG Metrics will reflect these system improvements regardless of whether entity-wide emissions increase or decrease.

WMAs should use the annual system-wide efficiency metric from their entity-wide base year (if established) to track changes in the emissions intensity of their own operations over time.

COMMUNICATING WITH STAKEHOLDERS

Reported WEG delivery metrics will become a valuable source of emission factors for other organizations to use when calculating their Scope 3 emissions from the water use cycles. WMAs that report product-specific delivery metrics in terms of each GHG will provide a valuable service to their customers, both other WMA and end-use consumers.

Beyond providing valuable emissions factors, WEG Metrics enable WMAs to communicate improvements in the emissions intensity of delivered products, regardless of changes in water availability, public policy, or population served.

Additionally, WEG delivery metrics enable comparisons of emissions, across the complete water supply chain, associated with procuring and delivering distinct products to and from Southern California. For example, WEG delivery metrics enable comparisons between imported water supplies and local groundwater supplies, or desalinated water supplies versus recycled water products, and biogas versus natural gas products.

CALCULATING AVOIDED EMISSIONS

WEG efficiency metrics can be used by WMAs to understand Scope 1 and 2 emissions that are avoided by increasing the efficiency in their own operations, especially by reducing wastes (e.g., reclaiming co-products) that result from the water use cycle, or by choosing less emissions intensive technologies/infrastructure.

WEG delivery metrics can provide a helpful tool for understanding upstream Scope 3 emissions that may be avoided by choosing alternative water supplies, or emissions that may be avoided by choosing biosolids or biogas products instead of conventional products that are more emissions intensive to produce and deliver[39].

Estimates of avoided emissions may optionally be reported separately from WEG metrics or entity-wide inventories to communicate the benefits of specific operations or products, but shall not be included in WEG metric calculations.

UNDERSTANDING SOUTHERN CALIFORNIA'S WEG INTENSITY

WEG Metrics can shed light on the overall efficiency of California's water system when analyzed in aggregate across the water supply chain.

A high-level analysis of reported WEG Metrics may provide additional context around the emissions impacts of dry or wet years on different regions of the State, or help establish regional default metrics specific to distinct topographies or supply types. This broad analysis may also improve understanding of how innovations in water management technology and techniques can help reduce the emissions intensity of California's water system.

An aggregated analysis of WEG metrics specific to each stage of the water use cycle could contribute to the development of statewide default factors that communicate the emissions intensity of specific water management processes.

[39] It is not appropriate to use WEG delivery metrics to calculate emissions associated with the use (or application) of biogas or biosolids products. Delivery metrics communicate the emissions associated with production and delivery of a sold product only. Emissions associated with the use of sold products (including avoided emissions) should be calculated based on the characteristics of the product.

GLOSSARY OF KEY TERMS

Acre-foot[40]	(AF) The volume of water that would cover one acre to a depth of one foot.
Biogenic emissions	Carbon dioxide generated during the combustion or decomposition of biologically-based material.
Consequential hydropower generation[41]	Emissions generated using turbines or other generation devices to generate electricity from falling water where the energy generation is a direct consequence of water delivery. Water passing through the energy generation devices is delivered to users.
Conveyance (step in water use cycle)[42]	Emissions generated from transporting untreated water through aqueducts, canals, and pipelines from its source to a water treatment facility or directly to an end-user. For wholesale WMAs, this does not include emissions generated from conveying State Water Project supplies.
Delivered water	In acre-feet, the total volume of water moved to its final point of delivery in the calendar year being reported (includes water delivered to other agencies, end-users, environmental purposes, recharge, discharge, or long term storage).
Distribution (step in water use cycle)[43]	Emissions generated to transport treated water from the treatment plant or wellhead disinfection point to the point of delivery.
Distribution system[44]	Large networks of pipes (or purple pipes) that deliver water for municipal or agricultural purposes.
Extract & Divert (step in water use cycle)[45]	Emissions generated from removing water from a channel, pipeline, stream, or aquifer.

[40] Definition adapted from CPUC Water-Energy Calculator Version 1.04.
[41] Definition adapted from 2015 Urban Water Management Plan Guidebook for Urban Water Managers, Appendix O: Voluntary Reporting of Energy Intensity, November 2015.
[42] Ibid.
[43] Ibid.
[44] Definition adapted from 2015 Urban Water Management Plan Guidebook for Urban Water Managers, Appendix G: Glossary, November 2015.
[45] Definition adapted from 2015 Urban Water Management Plan Guidebook for Urban Water Managers, Appendix O: Voluntary Reporting of Energy Intensity, November 2015.

Hydrologic region[46]	A geographic region of the state based on the local hydrologic basins. CA DWR divides California into ten regions that correspond to the state's major drainage basins: North Coast, North Lahontan, Sacramento River, San Francisco Bay, Central Coast, San Joaquin River, Tulare Lake, South Coast, South Lahontan, and Colorado River.
Place into Storage[47]	Emissions generated to place water into a storage reservoir or groundwater bank.
Product[48]	Type of water delivered. Examples of water delivery types include: retail potable, retail non-potable, wholesale potable, wholesale non-potable, agricultural, environmental, recycled water, and other deliveries.
Recycled water[49]	Emissions from wastewater that has been treated to a specified quality, enabling it to be reused for a beneficial purpose.
Scope 1 emissions	Direct anthropogenic emissions from stationary and mobile combustion.
Scope 2 emissions	Indirect anthropogenic emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling
Scope 3 emissions	All other non-Scope 2 indirect anthropogenic emissions that occur in the value chain.
Step in the water use cycle[50]	For the purpose of the WEG Guidance, defined as water management processes Extract & Divert, Place into Storage, Conveyance, Treatment, and Distribution.
Treatment (step in water use cycle)	Emissions generated from treating water prior to distribution to customers. Treatment of recycled water and wastewater is not included in this step.
Wastewater[51]	Emissions generated from collecting, treating, and discharging wastewater.

[46] Ibid.
[47] Ibid.
[48] Ibid.
[49] Definition from 2015 Urban Water Management Plan Guidebook for Urban Water Managers, November 2015.
[50] Definition adapted from 2015 Urban Water Management Plan Guidebook for Urban Water Managers, Appendix O: Voluntary Reporting of Energy Intensity, November 2015.
[51] Ibid.

Water-energy intensity	Amount of energy consumed to take a unit volume of water from one step in the water use cycle to another in a specific location, calculated by dividing the quantity of energy consumed by the volume of water entering the distribution system. Energy intensity may refer to part of the water use cycle or the entire water use cycle, depending on the methodology used.
Water loss	Physical water loss from the water distribution system and the supplier's storage facilities up to the point of customer consumption.[52]

[52] Definition from 2015 Urban Water Management Plan Guidebook for Urban Water Managers, November 2015.

APPENDIX A:

This section provides default conversion factors useful for measuring or applying WEG metrics.

	Conversion factors for GHG emissions
1 metric ton (mt) =	1.1023 short tons
1 metric ton (mt) =	1,000 kilograms (kg)
1 metric ton (mt) =	2,204.62 pounds (lb)
	Conversion factors for Water Volumes
1 acre-foot (AF) =	325,851 gallons (gal)
1 acre-foot (AF) =	43,560 cubic feet (ft^3)
1 acre-foot (AF) =	1233.49 cubic meters (m^3)
1 acre-foot (AF) =	1,613.3 cubic yards (y^3)
	Conversion factors for Weight of Biosolids
1 short ton =	0.9072 metric tons (mt)
1 short ton =	907.18 kilograms (kg)
1 short ton =	2,000 pounds (lb)
	Conversion factors for Volume of Biogas
1 standard cubic foot (scf) =	0.0283 standard cubic meters (SCM)
	Conversion factors for Energy
1 British thermal unit (btu)=	8.764E-06 Gasoline Gas Equivalent (GGE) [53]
1 British thermal unit (btu)=	7.783E-06 Low Sulfur Diesel Gas Equivalent (DGE) [54]

Source: US Department of Energy Alternative Fuels Data Center- Gasoline and Diesel Gallon Equivalency Methodology (2018). [55]

[53] This value represents an average of the LHV Range for Gasoline (E10) of between 112,114-116,090 Btu/gal.
[54] This value represents a LHV originally taken from: Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model, version 1. 2013. Input Fuel Specifications. Argonne National Laboratory. Chicago, IL.
[55] Accessed December 2018.Available at https://afdc.energy.gov/fuels/equivalency_methodology.html