Downloaded Water Supply Report Output Package Description and Methodology

The Water Availability Tool (WAT) has been developed following the guidelines outlined in the Policy for Maintaining Instream Flows in Northern California Coastal Streams. This document describes the materials produced and exported following the successful creation of a water supply report in the WAT.

Acronyms:

WAT - Water Allocation Tool
WSR - Water Supply Report
USGS - United States Geological Survey
POD - Point of Diversion
POA - Point of Analysis
PRISM - Parameter-elevation Regressions on Independent Slopes Model
NHD - National Hydrography Dataset
CFS - Cubic Feet per Second
GIS - Geographic Information System
CDA - Cumulative Diversion Analysis

Overview

Following the completion of a Water Supply Report (WSR), users can download a zip file named "output.zip" which contains a variety of files. These files are intended to be compiled by the user into a written document and supplementary spreadsheets, describing the project itself, for submission in support of a new application for a water right to the regulator. The files included in the download package are:

- Editing the Downloaded Water Supply Report (WSR) Senior Diverters Table.pdf
    - Guidance document for WAT users when editing the senior_diverters_unedited.csv, to ensure accurate information is provided on senior diverters.
- Watershed Candidates.pdf
    - Document describing the process by which candidate gages were identified and recommended for use in extrapolating flows for the project.
- wsr_project_information.txt
    - A summary of the data entered for this project.
- gage_streamflow.csv
    - The table contains a historical time series of flow observations from the selected USGS gage.
- senior_diverters_unedited.csv

    - This table contains a list of the senior diverters within the watershed, which are upstream of the most downstream senior diverter located the farthest downstream on the identified flow path. It encompasses all the necessary fields essential for conducting seasonal demand calculations. The tool sources the data for this table from https://data.ca.gov/dataset/water-rights and https://data.ca.gov/dataset/california-water-rights-uses-and-seasons.
- senior_diverters_edited.csv
    - A user-edited version of senior_diverters_unedited.csv. Additional table definitions and descriptions are found in *Editing the Downloaded Water Supply Report (WSR) Senior Diverters Table.pdf*.
- senior_diverters_with_seasonal_demand_calculation.csv
    - This table contains the data from senior_diverters_edited.csv, supplemented with tool-generated fields. These additional fields include both seasonal demand and intermediary fields utilized in the derivation of seasonal demand. The inclusion of these extra fields is intended to enhance transparency regarding the methodology applied in calculating seasonal demand. Additional table definitions and descriptions are found in *Editing the Downloaded Water Supply Report (WSR) Senior Diverters Table.pdf*.
- WSR Map.png
    - A map showing the locations of the senior diverters in the watershed. The map is large enough to trace the watershed from the proposed project down to one of the following, depending on the water flow path: (1) the nearest flow-regulated river, or (2) the Pacific Ocean.
- summary.csv
    - This table details the analysis of unappropriated water to supply the proposed project. Includes analysis at the proposed point of diversion (POD) as well as any senior diverter located on the downstream flow path between the proposed POD and either the Pacific Ocean or a flow-regulated river.
- WSR Downstream Map.png
    - A map showing the locations of the senior diverters in the watershed. The map is zoomed into the downstream flow path and all senior diverters are labeled with 'application_number'.
- Flow frequency analysis tables:
    - flow_frequency_analysis_<Proposed POD>_<proposed season>.csv
    - flow_frequency_analysis_<application_number>_<proposed season>.csv
        - These tables contain historical records filtered to the proposed season from the selected gage scaled to the proposed POD and scaled to the senior diverter with the lowest percentage of remaining unappropriated water after the proposed POD, and any senior diverters where the percentage of remaining unappropriated water after the proposed POD is less than 50%. Average unimpaired flows during the proposed season for each year were ranked from high to low, and the frequency of occurrence was calculated using the Weibull distribution.
- Flow frequency analysis charts

- flow_frequency_analysis_<Proposed POD>_<proposed season>.png
- flow_frequency_analysis_<application_number>_<proposed season>.png
  - The frequency of occurrence is plotted against the seasonal unimpaired flows, using the same data as contained in the flow_frequency_analysis tables.

Data Sources & Preprocessing

The contents of the output package are derived from streamflow records from the United States Geological Survey (USGS). Only records from gages within or nearby and representative of the policy area are used. Gages on irrigation canals, conveyances around powerhouses, rivers with very large catchment basins, or with less than 10 water years are excluded. The streamflow records included in the final results are filtered to only include data that make up complete water years from October 1 to September 30.

Candidate gages for watersheds were chosen using a variety of datasets, including average annual precipitation data from 1991-2020 from PRISM. More information about how candidate gages were selected can be found in the *Watershed Candidates Calculations* document.

The base hydrography used in this project is the NHDPlus high-resolution data set[1]. For further guidance, a user manual is available[2]. Watershed boundaries contained within the WAT have been derived from the NHDPlus high-resolution data by the project team.

Gage Streamflow

Table name: gage_streamflow.csv
Table description: The table contains the historical time series of flow observations from the user-selected USGS gage. The gage has at least 10 complete water years as per policy section B.1.1.

Column Name	Column Type	Description
date	Date, format YYYY-MM-DD E.g. 1950-10-01	The date of the observation.
gage_flow_cfs	Double precision E.g. 439.25	Observed flow in cubic feet per second.
included_in_analysis	Boolean E.g. TRUE, FALSE	The column provides information on whether a record was included in the analysis. The possible values are TRUE, indicating inclusion, or FALSE, indicating exclusion. Two scenarios

[1] https://pubs.usgs.gov/publication/ofr20191096
[2] https://pubs.usgs.gov/of/2019/1096/ofr20191096.pdf

		result in a FALSE value: first, if the record date falls outside the user's proposed season of diversion, and second if the record was part of an incomplete water year (October - September). The latter case is guided by a policy stipulating that streamflow gauges must have at least 10 years of complete data for inclusion. This ensures adherence to The Water Availability Tool's methodology, where the calculation of the average seasonal unappropriated flow volume (B.2.1.3) relies exclusively on complete water years.

Senior Diverters Unedited

Table name: senior_diverters_unedited.csv
Table description: This table contains a list of the senior diverters within the watershed upstream of the most downstream senior diverter that is located the farthest downstream on the identified flow path. It encompasses all the fields required for conducting seasonal demand calculations.
The following steps reflect the data source of this table:

1. Data is sourced and combined from https://data.ca.gov/dataset/water-rights and https://data.ca.gov/dataset/california-water-rights-uses-and-seasons. Also, as an additional data source for riparian water rights, the reported data from https://data.ca.gov/dataset/california-water-rights-water-use-reported is integrated. The linkage between the datasets is established through the 'application_number' and ‘wr_water_right_id’ columns.
2. All “senior diverters” within the watershed upstream of the most downstream segment of the downstream flow path of the selected proposed POD are selected using a spatial intersect GIS function.
3. All stream segments on the downstream flow path are identified and given the ‘analysis_label’ = ‘Downstream Flow path’ and all stream segments that branch off the downstream flow path are given the ‘analysis_label’ = ‘Upstream of Downstream Flow path’. All stream segments are given incrementing integers from upstream to downstream in the ‘order_upstream_to_downstream’ column.
4. All clipped “senior diverters” are then associated with a stream segment from step 3 by the following rules; if the senior diverter is within 1 mile of a stream segment and the senior diverter “source_name” is similar to the stream segment “gnis_name”, then it is associated with the matching stream segment, otherwise, the “senior diverter” is snapped to the nearest stream segment.
5. All clipped “senior diverters” from step 2 that are only within the upstream watershed of the proposed POD are identified and appended to a temporary table and given the

'analysis_label' = 'Upstream of POD' and a new incrementing integer starting at 1 overwrites the 'order_upstream_to_downstream' column.

6. The proposed POD is then appended to the temporary table from step 5 and given the 'analysis_label' = 'Proposed POD' and the next incrementing integer in the 'order_upstream_to_downstream' column.
7. All remaining clipped "senior diverters" not in step 5 or 6 are appended to the temporary table with the 'analysis_label' and 'order_upstream_to_downstream' given in step 3.
8. The column "order_upstream_to_downstream" is overwritten with a new serialized incrementing 'order_upstream_to_downstream' column starting from 1 in the temporary table order to remove gaps.
9. As a post-processing step, water rights with water_right_status as one of "Cancelled", "Closed", "Completed", "Rejected", "Revoked" or "Withdrawn" are filtered out of the table, and the "order_upstream_to_downstream" is re-indexed
10. Comments are added addressing edge cases with Riparian, Frost Protection, Irrigation, and Inactive water rights. See "comments" column below.

Column Name	**Column Type**	**Description**
analysis_label	Text E.g. Upstream of POD	This is a tool-generated column. This column is primarily used by the tool to identify relative locations of senior diverters upstream of the proposed POD, senior diverters which are along the downstream flow path, and senior diverters which are upstream of the senior diverters along the flow path. This column can also be thought of as a way to describe the position of the point of diversion relative to the proposed POD and the senior diverters along the flow path. The field supports the water supply report requirement to perform analysis at the Proposed POD as well as at senior diverters along the downstream flow path. There are 5 possible values for 'analysis_label': ● Upstream of POD ○ Label assigned for senior diverters upstream of the Proposed Point of Diversion (POD). ● Proposed POD ○ Label assigned and populated with the selected Proposed POD. ● Downstream Flow path ○ POA stands for Point of Analysis. This label is assigned if the tool considers the senior diverter to be on the downstream flow path (therefore a WSR Point of Analysis). The tool automatically considers senior diverters on the downstream flow path if the senior diverter is either within 1 mile of the downstream flow path and the senior diverter 'source_name' is similar to the downstream flow path stream

Column Name	Column Type	Description
		name, or, the downstream flow path is the nearest stream to the senior diverter. ● Upstream of Downstream Flow path ○ The label is assigned if the tool determines that the senior diverter is upstream of another senior diverter with the 'analysis_label' of 'Downstream Flow path'. ● Inside Project Extent ○ Label assigned if the senior diverter is within the watershed upstream of the most downstream segment of the downstream flow path but not upstream of any identified senior diverter with an 'analysis_label' of 'Downstream Flow path'. Senior diverters with this label will not be used in any subsequent senior seasonal demand calculations. Water rights with this 'analysis_label' have been included in this table for completeness. For example, in case the tool has assigned an 'analysis_label' incorrectly, they are included and it is up to the user to relabel them appropriately so they are used in the calculations correctly.
order_upstream_to_downstream	Integer E.g. 1	This column is auto-populated with an ordered, unique integer representing the order of the senior diverter from furthest upstream to furthest downstream. This field is required to calculate upstream demand accurately at the Proposed POD and all senior diverters along the flow path (also known as the Points of Analysis). The tool prioritizes the ordering of senior diverters as follows: those with an 'analysis_label' of 'Upstream of POD' first, followed by 'Proposed POD', and then the remaining senior diverters with 'analysis_label's of 'Upstream of Downstream Flow path', 'Downstream Flow path', and 'Inside Project Extent' are appended in their respective order.
application_number	Text E.g. A000016	Automatically populated by the tool using data from https://data.ca.gov/dataset/water-rights.
appl_pod	Text E.g. A000016_01	Automatically populated by the tool using data from https://data.ca.gov/dataset/water-rights.

Column Name	Column Type	Description
wr_water_right_id	Integer E.g. 100	Automatically populated by the tool using data from https://data.ca.gov/dataset/water-rights.
water_right_type	Text E.g. Appropriative E.g. Statement of Div and Use	Automatically populated by the tool using data from https://data.ca.gov/dataset/water-rights.
water_right_status	Text E.g. Licensed E.g. Inactive	Automatically populated by the tool using data from https://data.ca.gov/dataset/water-rights. If this value is ““Cancelled”, “Closed”, “Completed”, “Rejected”, “Revoked” or “Withdrawn”, the water right is not included in the senior diverters, as the water right is not actively diverting water. Also, if this value is “Inactive”, a comment is added to the csv indicating further investigation must be performed.
application_primary_owner	Text E.g. EAGLE CREEK PACIFIC, LLC	Automatically populated by the tool using data from https://data.ca.gov/dataset/water-rights.
pod_type	Text E.g. Point of Direct Diversion E.g. Point of Onstream Storage	Automatically populated by the tool using data from https://data.ca.gov/dataset/water-rights.
pod_count	Text E.g. 1	Automatically populated by the tool using data from https://data.ca.gov/dataset/water-rights.
source_name	Text E.g. UNNAMED STREAM	Automatically populated by the tool using data from https://data.ca.gov/dataset/water-rights.
latitude	Numeric E.g. 38.8295	Automatically populated by the tool using data from https://data.ca.gov/dataset/water-rights.
longitude	Numeric E.g. -123.2383	Automatically populated by the tool using data from https://data.ca.gov/dataset/water-rights.

Column Name	Column Type	Description
drainage_area_sqmi	Number E.g. 0.24533	Automatically populated by the tool. It reflects the area of the upstream watershed associated with the stream to which the senior diverter location was snapped. For detailed information on the snapping logic applied to senior diverters and their association with streams, refer to the documentation linked here.
annual_precip_in	Number E.g. 46.125008	Automatically populated by the tool. It reflects the average annual precipitation (1991-2020) of the upstream watershed associated with the stream to which the senior diverter location was snapped. The data source of the precipitation data set is PRISM (https://prism.oregonstate.edu/).
use_codes	Text E.g. 'Domestic It is permissible to include multiple use codes within a single cell. For instance, 'Domestic, Stockwatering' is an acceptable format.	Automatically populated by the tool using the data from https://data.ca.gov/dataset/california-water-rights-uses-and-seasons and https://data.ca.gov/dataset/water-rights related together using 'application_number'.
priority_date	Date of the form yyyy-mm-dd E.g. 1965-01-01	Automatically populated by the tool using data from https://data.ca.gov/dataset/water-rights. Data is pulled from the field priority_date, if it's empty then receipt_date, then finally application_acceptance_date is used for a single diverter.
direct_div_season_start_month	Integer (1-12) E.g. 6	Direct Diversion Season Start Month Automatically populated by the tool using data by extracting **month** from 'direct_div_season_start' within https://data.ca.gov/dataset/water-rights.
direct_div_season_start_day	Integer (1-31) E.g. 30	Direct Diversion Season Start Day Automatically populated by the tool using data by extracting **day** from 'direct_div_season_start' within https://data.ca.gov/dataset/water-rights.
direct_div_	Integer (1-12)	Direct Diversion Season End Month

Column Name	Column Type	Description
season_end_ month	E.g. 1	Automatically populated by the tool using data by extracting **month** from 'direct_div_season_end' within https://data.ca.gov/dataset/water-rights.
direct_div_ season_end_ day	Integer (1-31) E.g. 20	Direct Diversion Season End Day Automatically populated by the tool using data by extracting **day** from 'direct_div_season_end' within https://data.ca.gov/dataset/water-rights.
storage_season _start_month	Integer (1-12) E.g. 1	Storage Season Start Month Automatically populated by the tool using data by extracting **month** from 'storage_season_start' within https://data.ca.gov/dataset/water-rights.
storage_season _start_day	Integer (1-31) E.g. 1	Storage Season Start Day Automatically populated by the tool using data by extracting **day** from 'storage_season_start' within https://data.ca.gov/dataset/water-rights.
storage_season _end_month	Integer (1-12) E.g. 1	Storage Season End Month Automatically populated by the tool using data by extracting **month** from 'storage_season_end' within https://data.ca.gov/dataset/water-rights.
storage_season _end_day	Integer (1-31) E.g. 1	Storage Season End Day Automatically populated by the tool using data by extracting **day** from 'storage_season_end' within https://data.ca.gov/dataset/water-rights.
max_storage_af	Numeric E.g. 100.1	Storage Amount (Acre-feet) Automatically populated by the tool using max_storage from https://data.ca.gov/dataset/water-rights. No unit conversion is performed by the tool as the units are assumed to be in Acre-feet as the column description in the Data Dictionary states: "The maximum annual amount of water requested to be placed into storage in any given year."
face_amount_af	Numeric E.g. 100.1	Maximum annual use limitation when it is less than the face value of the permit of license (Acre-feet)

Column Name	Column Type	Description
		Automatically populated by the tool using multiple fields from https://data.ca.gov/dataset/water-rights. The tool automatically calculates this number by first determining 'face_value_af,' which involves converting 'face_value_amount' to acre-feet using 'face_value_units.' Subsequently, the tool populates this entry with 'max_dd_ann' when it is not zero and is less than 'face_value_af'; otherwise, 'face_value_af' is used. This calculation follows the policy guidelines which states that the following information is required for each POD associated with each senior diverter: (B.1.2.4) “Maximum annual use limitation when it is less than the face value of the permit of license”
max_rate_of_ diversion_cfs	Numeric E.g. 0.0164872666	Maximum Rate of Diversion (cubic feet per second) Automatically populated by the tool using multiple fields from https://data.ca.gov/dataset/water-rights. The tool automatically calculates this number by first determining 'direct_diversion_rate_cfs' and ‘max_rate_of_diversion_cfs’ which involves converting ‘direct_diversion_rate’ to cubic feet per second using ‘direct_div_rate_unit' and converting ‘max_rate_of_diversion` to cubic feet per second using ‘max_rate_of_div_unit`. Subsequently, the tool populates this entry with ‘max_rate_of_diversion_cfs’ when it is not zero; otherwise, 'direct_diversion_rate_cfs' is used. These steps were taken to follow the policy guidelines which state that the following information is required for each POD associated with each senior diverter: (B.1.2.2) “Direct diversion rate, unless a maximum rate of diversion is imposed as a term on the permit or license, in which case the maximum rate of diversion should be used.”
minimum_ bypass_flow_cfs	Numeric E.g. 0.01	Minimum Bypass Flow (cubic feet per second) if imposed or specified in the water right permit of license. When downloading the csv, this field is unpopulated, as it lacks existence in the data source from which the tool extracts information.
seasonal_ demand_af	Numeric E.g. 230.4	Senior Diverter Seasonal Demand (Acre-feet) within the proposed project’s season of diversion.

Column Name	Column Type	Description
overwrite_ seasonal_ demand_af_ justification	Text E.g. Adjusted seasonal demand to reflect correspondence with a state water board engineer.	Overwrite Seasonal Demand (Acre-feet) justification. This field is provided for the user to justify, detailing the method used to populate the field and the rationale behind overriding the tool's seasonal demand calculation.
comments		This column is designated for user record-keeping purposes. There are a few warnings which are auto-populated to highlight edge cases for the user: - "Warning: Frost Protection in use_codes but senior diverter's diversion season has no overlap with frost season." - "Warning: Irrigation in use codes but senior diverter's diversion and storage season has no overlap with summer irrigation season." - "Warning: Inactive water right. Look into EWRIMS data for more information!" - "Warning: Riparian water right with storage, ensure this is accurate." - "Likely out of order, this WR is on an isolated stream reach and therefore cannot be accurately ordered"

Senior Diverters Edited

Table name: senior_diverters_edited.csv
Table description: This table is the same structure as senior_diverters_unedited.csv, please refer to the previous table description for information on the fields contained within this table. This table corresponds to the version of the table which has been uploaded by the user into the tool, and is the version which has been used for analysis purposes.

Senior Diverters With Seasonal Demand Calculation

Table name: senior_diverters_with_seasonal_demand_calculation.csv
Table description: Consolidated table containing values from the senior_diverters_edited.csv as well as derived values for seasonal demand (the value wr_seasonal_demand_af below). This table can be used as a reference for the seasonal demand calculation for each of the senior diverters. The following list of fields are the same as those in senior_diverters_unedited.csv:

- analysis_label
- order_upstream_to_downstream
- application_number
- appl_pod
- wr_water_right_id
- water_right_type
- water_right_status

- application_primary_owner
- pod_type
- pod_count
- source_name
- latitude
- longitude
- drainage_area_sqmi
- annual_precip_in
- use_codes
- priority_date
- max_storage_af
- face_amount_af
- max_rate_of_diversion_cfs
- minimum_bypass_flow_cfs
- seasonal_demand_af
- overwrite_seasonal_demand_af_justification
- Comments

Additional unique fields in the senior_diverters_with_seasonal_demand_calculation.csv are described below.

Column Name	Column Type	Description
storage_season_start	Date E.g. 12/15/2018	Storage season start date for the senior diverter. Automatically populated by the tool using https://data.ca.gov/dataset/water-rights. Matches with storage_season_start_month and storage_season_start_day from senior_diverters_unedited.csv. The year field is populated so that the storage season always occurs entirely within 2019, or between 2018 and 2019 if in multiple years.
storage_season_end	Date E.g. 03/31/2019	Storage season end date for the senior diverter. Automatically populated by the tool using https://data.ca.gov/dataset/water-rights. Matches with storage_season_end_month and storage_season_end_day from senior_diverters_unedited.csv. The year field is populated so that the storage season always occurs entirely within 2019, or between 2018 and 2019 if in multiple years.

days_of_storage	Numeric E.g. 107	Calculated value as the number of days (inclusive) between storage_season_start and storage_season_end.
direct_div_season_start	Date E.g. 05/01/2019	Diversion season start date for the senior diverter. Automatically populated by the tool using https://data.ca.gov/dataset/water-rights. Matches with direct_div_season_start_month and direct_div_season_start_day from senior_diverters_unedited.csv. The year field is populated so that the storage season always occurs entirely within 2019, or between 2018 and 2019 if in multiple years.
direct_div_season_end	Date E.g. 10/31/2019	Diversion season end date for the senior diverter. Automatically populated by the tool using https://data.ca.gov/dataset/water-rights. Matches with direct_div_season_end_month and direct_div_season_end_day from senior_diverters_unedited.csv. The year field is populated so that the storage season always occurs entirely within 2019, or between 2018 and 2019 if in multiple years.
days_of_diversion	Numeric E.g. 184	Calculated value as the number of days (inclusive) between direct_div_season_start and direct_div_season_end.
diversion_amount_af	Numeric E.g. 22.9	Calculated value as the difference between face_amount_af and max_storage_af. It is assumed that if max_storage_af > face_amount_af, there is no direct_diversion.
diversion_per_day_af	Numeric E.g. 0.1245	Calulated value as the average daily diversion rate (af) as diversion_amount_af divided by days_of_diversion.
overlapping_days_of_proposed_and_policy_season	Numeric E.g. 60	Calculated value as the number of days in overlap between the user-supplied season and the winter policy season. The policy season is defined as being between December 15 and March 31.
overlapping_days_of_storage_and_policy_season	Numeric E.g. 107	Calculated value as the number of days (inclusive) in overlap between the senior diverter storage season and the winter policy season. The policy season is defined as being between December 15 and March 31.

overlapping_days_of_storage_and_proposed_season	Numeric E.g. 60	Calculated value as the number of days (inclusive) in overlap between the senior diverter storage season and the given user season.
overlapping_proposed_and_days_of_direct_diversion	Numeric E.g. 85	Calculated value as the number of days (inclusive) in overlap between the senior diverter direct diversion season and the given user season.
overlapping_days_of_direct_diversion_and_policy_season	Numeric E.g. 72	Calculated value as the number of days (inclusive) in overlap between the senior diverter direct diversion season and the winter policy season. The policy season is defined as being between December 15 and March 31.
overlapping_days_of_proposed_and_frost_season	Numeric E.g. 7	Calculated value as the number of days (inclusive) in overlap between the user-supplied diversion season and the frost season. The frost season is defined as being between March 15 and April 30. If a diverter is only using water for storage during the policy season, the frost demand is only applied during the policy season from March 15th to March 31st.
frost_demand_af	Numeric E.g. 1.785	Calculated value using the max_rate_of_diversion_cfs and overlapping_days_of_proposed_and_frost_season. It is assumed that 10 hours of frost protection diversion happens daily, every other day, for the number of overlapping days. This value is defaulted to 0 if “Frost Protection” is **not** one of the use_codes. To calculate this value, use the spreadsheet function max_rate_of_diversion_cfs * 3600 (seconds per hour) * 10 hours * overlapping_days_of_proposed_and_frost_season / 43560 (cf/acre) * 2 (every other day).

wr_seasonal_ demand_af	Numeric E.g. 10.987	Calculated value describing the total overlapping demand of the senior diverter. There are 3 main contributors to this value. 1. **Storage Demand**. This value represents the overlapping storage water usage of the senior diverter. The storage is said to happen entirely within the policy season if there is **any overlap** between the storage and policy season. Otherwise, the max_storage_af demand is spread equally over the storage season (storage_season_start -> storage_season_end). Storage is then calculated by multiplying the max_storage_af value by the ratio of overlapping days to the days_of_storage. **If in the winter policy season:** Storage demand = max_storage_af * overlapping_days_of_storage_and_proposed_season / overlapping_days_of_storage_and_policy_season **If outside of the winter policy season:** Storage demand = max_storage_af * overlapping_days_of_storage_and_proposed_season / days_of_storage. Also note that division by 0 can occur if there are no days_of_storage, in which case the storage demand value is set to 0. 2. **Direct Diversion Demand**. This value represents the overlapping directly diverted water usage of the senior diverter. The diversion is assumed to occur evenly throughout the diversion season (direct_div_season_start -> direct_div_season_end), unless “Irrigation” is the only use code, or if “Irrigation” and “Frost Protection” are the only use codes. In that case, the diversion demand is said to occur entirely outside of the winter policy season. Essentially, the diversion will occur only between Apr 1 and December 14. Therefore, if the use_codes **do not** only have “Irrigation” or “Irrigation” and “Frost Protection”, the diversion demand is: Diversion demand = diversion_per_day (column AF1) * overlapping_proposed_and_days_of_direct_diversion (column AJ1) *=AF1*AJ1* Otherwise, if the use_codes **do** only have “Irrigation” or only “Irrigation” and “Frost Protection”, the diversion demand is: Diversion demand = diversion_amount_af * overlapping_proposed_and_days_of_direct_diversion / (days_of_diversion - overlapping_days_of_direct_diversion_and_policy_season) 3. **Frost demand.** This value is simply the frost_demand_af value calculated above.

		Wr_seasonal_demand_af is therefore calculated as the sum of the 3 values above.

Description of Equations & Assumptions to Derive Intermediate Values - Seasonal Demand

Introduction

The following section outlines the calculations that are completed to generate intermediate values found in senior_diverters_with_seasonal_demand_calculation.csv. Furthermore, it outlines assumptions that are made when generating these values so applicants and application reviewers can be clear about assumptions and how they change the tool outputs.

Frost Demand in Acre-Feet

Description: Demand associated with frost protection water usage.
Equation:

$$demand = max\_rate\_of\_diversion\_cfs * 3600 * 10\,hours * overlapping\_days/2 \ / 43560\ (cf/acre)$$

Assumptions:
All overestimations of this value cause **less** calculated streamflow to be available at the POD and POIs (more difficult to meet policy) and underestimations cause **more** calculated streamflow to be available(easier to meet policy).

- It is assumed that frost demand is applied every other day between March 15 and April 30th, for 10 hours a day
    - This assumption could cause an underestimation of frost demand in February, the first half of March, and May where there could potentially be diversions for frost

Storage Demand in Acre-Feet

Description: Diverter Demand Associated with Storage
Equation:

If the proposed project is within the winter policy season:

$$dayratio = overlapping\_days\_of\_storage\_and\_proposed \ / \ overlapping\_days\_of\_storage\_and\_policy$$
$$demand = max\_storage\_af * dayratio\ (above)$$

If the proposed project is outside the winter policy season and the diverter storage occurs during the policy season:

$$demand = 0$$

If the proposed project is outside of the winter policy season:
$dayratio = overlapping\_days\_of\_storage\_and\_proposed / days\_of\_storage\ (length\ of\ storage\ season)$
$demand = max\_storage\_af * dayratio\ (above)$

Assumptions:
All overestimations of this value cause **less** calculated streamflow to be available at the POD and POIs (more difficult to meet policy) and underestimations cause **more** calculated streamflow to be available(easier to meet policy).

- Storage demand is applied uniformly over its storage season
    - This could cause an under-or-overestimation of storage demand overlapping the proposed project
- Storage demand is applied only within the policy season if the policy season overlaps the diverter storage season
    - This could cause overestimation of storage demands within the policy season and underestimation of storage demands outside of the policy season
- Reservoirs are empty at the beginning of the storage season and full at the end of the storage season
    - This could cause an overestimation relative to actual storage demands

Direct Diversion Demand in Acre-Feet

Description: Demand associated with water usage for direct diversion. Values for this data point are derived from those in the senior_diverters_with_seasonal_demand_calculation csv.
Equation:
If the diverter use codes use_codes **do not** only have “Irrigation” or “Irrigation” and “Frost Protection”:

$demand = diversion\_per\_day * overlapping\_proposed\_and\_days\_of\_direct\_diversion$

If the diverter use codes use_codes **do not** only have “Irrigation” or “Irrigation” and “Frost Protection”: days_outside_policy

$days\_outside\_policy = days\_of\_diversion - overlapping\_days\_of\_direct\_diversion\_and\_policy\_season$
$dayratio = overlapping\_proposed\_and\_days\_of\_direct\_diversion / days\_outside\_policy\ (above)$
$demand = diversion\_amount\_af * dayratio\ (above)$

Assumptions:
All overestimations of this value cause **less** calculated streamflow to be available at the POD and POIs (more difficult to meet policy) and underestimations cause **more** calculated streamflow to be available(easier to meet policy).

- Diverter demand occurs equally over the course of the senior diverter’s diversion season
    - This could overestimate or underestimate the overlapping demand as diversions may vary on a yearly basis
- Diverters strictly follow irrigation guidelines for only diverting outside of the policy season if irrigating

    - This could overestimate the diversions for the given diverter outside of the policy season and underestimate the value within the policy season
- Diverters do not follow minimum bypass flow requirements or other streamflow-based analyses, they divert up to their maximum over their season
    - This would likely over-estimate the demand, as the water right holder may be bound to leave more water in the stream than the estimated diversion
- Diverter's face_amount_af value (used to derive diversion_amount_af, and diversion_per_day) is accurate and represents the total diversion to both storage and direct diversion
    - Changes in this value could cause under-or-overestimation of diversions. Users are directed to double check this value before submitting senior diverters due to its critical nature

Seasonal Demand in Acre-Feet

Description: Total demand from water used for direct diversion, frost protection, and storage that overlaps the project's diversion season. Values for this data point are derived from those in the senior_diverters_with_seasonal_demand_calculation.csv.
Equation:
This value is derived from the frost demand, storage demand, and direct diversion.

$$seasonal\_demand = frost\_demand + storage\_demand + direct\_diversion\_demand$$
If seasonal demand > face_amount_af, then set to face_amount:
$$seasonal\_demand = face\_amount\_af$$

Assumptions:
All overestimations of this value cause project requirements to be **stricter** (more difficult to meet policy) and underestimations cause project requirements to be **less strict** (easier to meet policy).

- Diverter's face_amount_af value (used to derive diversion_amount_af, and diversion_per_day) is accurate and represents the total diversion to both storage and direct diversion
    - Changes in this value could cause under-or-overestimation of diversions. Users are directed to double check this value before submitting senior diverters due to its critical nature
- All assumptions from frost, storage, and direct diversion demand apply to this value

Summary

Table name: summary.csv

Table description: This table details the analysis of unappropriated water to supply the proposed project. It includes analysis at the proposed point of diversion (POD) as well as any senior diverter located on the downstream flow path between the proposed POD and the senior diverter which is farthest downstream on the identified flow path.

Column Name	Column Type	Description
POD (Application ID)	Text E.g. Proposed POD, S009642	Labels denoting points of analysis which can be either the Proposed Point of Diversion (POD) or the Application ID (also referred to as application_number) of senior diverters positioned along the downstream flow path from the proposed POD to either the Pacific Ocean or a flow-regulated mainstem river. Refer to the glossary for the tool-specific definition of a flow-regulated mainstem river.
Watershed Area Above Gage (sq mi)	Numeric E.g. 303.6644	Watershed area above the selected candidate gage in square miles.
Avg Annual precip of wshd above Gage (in)	Numeric E.g. 47.175526	Average annual precipitation estimates of the watershed area above the selected candidate gage in inches. Used in adjustment of streamflow records using precipitation-based streamflow model. The precipitation data source is https://prism.oregonstate.edu/ for 1991 - 2020 historical climatology.
Avg Unappropriated Seasonal Flow volume recorded at the Gage (AF) during proposed season	Numeric E.g. 270896.9028	Average seasonal unappropriated flow estimate at the selected candidate gage in acre-feet during the proposed diversion season. Flow estimate data source is USGS via https://waterservices.usgs.gov/ The value in this table was calculated using the contents from gage_streamflow.csv and wsr_project_information.txt. To allow the user to create a functional electronic version of the spreadsheets required by the SWRCB, this estimate can be calculated by performing the following steps within the gage_streamflow.csv table. In preparation, retrieve the “Number of full water years” from the wsr_project_information.txt file. 1) Filter the table where ‘included_in_analysis’ = TRUE. This filter will only include rows within a complete water year (i.e., between Oct 1 of a preceding year to Sept 30, every month has >= 28 days) and the date is within the proposed diversion season. 2) In a new column, e.g. Column D, convert cubic feet per second to cubic feet using

		the following function: a) =Column B*1.98347 3) In a new column, e.g. Column E, sum the cubic feet and divide by the number of years to get the average seasonal flow volume at the gage in acre-feet a) =SUM(Column D)/"Number of full water years"
Watershed Area Above POD (sq mi)	Numeric E.g. 39.4933	Watershed area above the proposed POD and all senior diverters identified along the flow path in square miles.
Avg Annual precip of wshd above POD (in)	Numeric E.g. 49.2338	Average annual precipitation estimates of the watershed area above the POD or point of analysis in inches. Used in adjustment of streamflow records using precipitation-based streamflow model. The precipitation data source is https://prism.oregonstate.edu/ for 1991 - 2020 historical climatology.
Streamflow Scaling Ratio	Numeric E.g. 0.1357	The scaling ratio of watershed area and precipitation from a historical USGS gage to a point of analysis. Calculated as (Watershed Area Above POD / Watershed Area Above Gage) * (Avg Annual precip of wshd above POD / Avg Annual precip of wshd above Gage)
Diversion Season	Text of date range E.g. Dec 15 - Apr 01	The diversion season date range associated with the Proposed Point of Diversion.
Seasonal Unappropriated Flow Volume (AF)	Numeric E.g. 36768.9635	The average unappropriated seasonal flow volume in acre-feet. Calculated as (Watershed Area Above POD (sq mi) / Watershed Area Above Gage (sq mi)) * (Avg Annual precip of wshd above POD (in) / Avg Annual precip of wshd above Gage (in)) * Avg unappropriated Seasonal Flow volume recorded at the Gage (AF) during proposed season
Dec 15 - Apr 01 Seasonal Demand Before proposed POD	Numeric E.g. 0.3208	
Upstream Demand (Dec 15 - Apr 01)	Numeric E.g. 50.3208	Sum of Seasonal Demand Before proposed POD associated with senior diverters upstream (i.e., above) of this row's senior diverter in acre-feet.
Remaining Unappropriated flow, ac-ft, Before proposed POD	Numeric E.g. 36718.9635	Seasonal unappropriated flow volume (Acre-Feet) subtracted by Upstream Demand (Dec 15 - Apr 01) in acre-feet.

Percentage of remaining unappropriated water Before proposed POD	Numeric E.g. 99.864	Remaining unappropriated discharge, ac-ft, Before proposed POD divided by Seasonal unappropriated Flow Volume (AF)
Additional Impairment Caused By proposed POD (AF)	Numeric E.g. 12.34	Proposed diversion quantity over the policy season period in acre-feet.
Remaining Unappropriated Flow, ac-ft, After proposed POD	Numeric E.g. 36741.9635	Remaining unappropriated flow, ac-ft, Before proposed POD subtracted by Additional Impairment Caused By proposed POD (AF) in acre-feet.
Percentage of Remaining Unappropriated Water After proposed POD	Numeric E.g. 99.7280	Remaining unappropriated flow, ac-ft, After proposed POD divided by Seasonal unappropriated Flow Volume (AF) in acre-feet.
Percent Change Caused By proposed POD	Numeric E.g. 0.9987	Percentage of Remaining Unappropriated Water After proposed POD subtracted by Percentage of remaining unappropriated water Before proposed POD
Ratio of Project Demand to Remaining Unappropriated Water Supply at Diverter	Numeric E.g. 0.8543	Total diversion caused by project divided by remaining unappropriated (impaired) water at the POD.

Description of Equations & Assumptions to Derive Intermediate Values - Summary

Introduction

The following section outlines the calculations that are completed to generate intermediate values found in summary.csv. Furthermore, it outlines assumptions that are made when generating these values so applicants and application reviewers can be clear about assumptions and how they change the tool outputs.

Streamflow Scaling Ratio

Description: Ratio used to scale gaged streamflow to given project or senior diverter POD. Values for this data point are derived from geospatial analysis of NHDPlus high res watersheds and public precipitation datasets.
Equation:

$$streamflow\_scaling\_ratio = wa_{pod}/wa_{gage} * map_{pod}/map_{gage}$$

Where wa = watershed area and map = mean annual precipitation.

Assumptions:
All overestimations of this value cause project requirements to be **less strict** (easier to meet policy due to more assumed flow in the stream) and underestimations cause project requirements to be **stricter** (more difficult to meet policy).

- The NHDPlus high-res dataset is trusted as a source of truth for watershed sizes for catchments, and catchments are broken down based off of intersections with points of diversion and gages for calculations. These intersections are estimated as the closest point on the catchment streamflow to the diverter.
    - Based on the intersection point and the geometry of the river, this could cause an over-or-under-estimation of the watershed for the diverter based on the geometry of the stream segment

Calculating Mean Annual Flow at POD

Description: Using the above streamflow_scaling_ratio, the mean annual flow at a POD on the downstream flow path of the senior diverters is calculated from the gage mean annual flow.

Equation:

$$mean\_annual\_flow_{pod} = streamflow\_scaling\_ratio * mean\_annual\_flow_{gage}$$

Where wa = watershed area and map = mean annual precipitation.

Assumptions:
All overestimations of this value cause project requirements to be **less strict** (easier to meet policy due to more assumed flow in the stream) and underestimations cause project requirements to be **stricter** (more difficult to meet policy).

- The streamflow scaling ratio's assumptions about watershed size carry over into this data point as the scaling ratio is used heavily in the above formula

WSR Map

File name: WSR Map.png
File description: A map showing the locations of the proposed POD, downstream flow path, senior diverters, proposed POD watershed, USGS gage, and downstream watershed.

WSR Downstream Map

File name: WSR Downstream Map.png
File description: The same map as 'WSR Map.png' zoomed into the downstream flow path with the senior diverters on the downstream flow labeled with 'application_number'.

Flow Frequency Analysis Tables

File names:
flow_frequency_analysis_<Proposed POD>_<proposed season>.csv
flow_frequency_analysis_<application_number>_<proposed season>.csv
File descriptions: These flow frequency analysis tables provide the frequency of occurrence of the average seasonal unimpaired flow volumes for each year of record within the proposed season. A table is provided for the proposed POD, the senior diverter with the least remaining unappropriated water and any senior diverter with less than 50% remaining unappropriated water.
Average unimpaired flows during the proposed season for each year were ranked from high to low, and the frequency of occurrence was calculated using the Weibull distribution:

$$F = 1-(m/(N+1)$$

Where:
F = the frequency of occurrence
m = the rank of the average seasonal unimpaired flow volume, with the largest value receiving m =1
N = the length of the gage data record, in years

Column Name	Column Type	Description
application_number	Text E.g. S009642	Proposed diversion and identified senior diverters application IDs
Discharge, acre-ft, at proposed POD	Numeric E.g. 177.9599	Seasonal unimpaired flow volume in acre-feet associated with the location after adjustment of streamflow records from the streamflow gage using a precipitation-based streamflow model, in acre-feet.
rank	Integer E.g. 2	Rank of the application_number's discharge, acre-ft, at Proposed POD, ordered from largest to smallest
frequency	Numeric E.g. 0.9091	Flow frequency of the records' discharge, acre-ft, at Proposed POD, calculated using 1 - (rank / (1 + the number of points of analysis))

Flow Frequency Analysis Charts

File names:
flow_frequency_analysis_<Proposed POD>_<proposed season>.png
flow_frequency_analysis_<application_number>_<proposed season>.png
File Descriptions: These charts show occurrence frequency graphs plotted against the seasonal unimpaired flow found within the flow frequency analysis tables.

Glossary

Flow-regulated mainstem river: In the policy, a flow-regulated mainstem river is defined as “A river or stream in which scheduled releases from storage are made to meet minimum instream flow requirements established by State Water Board Order or Decision.” Through correspondence with Katharine Lee at the State Water Board, it's been ascertained that the water board staff are currently considering the following stream reaches as flow regulated in practice, based on Decision 1610 requirements:

1. Russian River from Confluence with East Fork Russian River to Confluence with Dry Creek
2. Dry Creek, from Warm Springs Dam to confluence with Russian River
3. Russian River, from the confluence with Dry Creek to the Pacific Ocean

As such, The Water Availability tool treats the stream reaches above as flow-regulated mainstem rivers meaning a user cannot produce a Water Availability Analysis (WAA) on those stream reaches and the project extent of a WAA located upstream of those stream reaches will terminate at those stream reaches.