COLORADO
Water Quality Control Division
Department of Public Health & Environment

User Guide

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Domain: https://erams.com/cdphe

CDPHE Tools: Low Flow Analysis

CATENA ANALYTICS

Software developed in collaboration with:

ONE WATER SOLUTIONS INSTITUTE
COLORADO STATE UNIVERSITY

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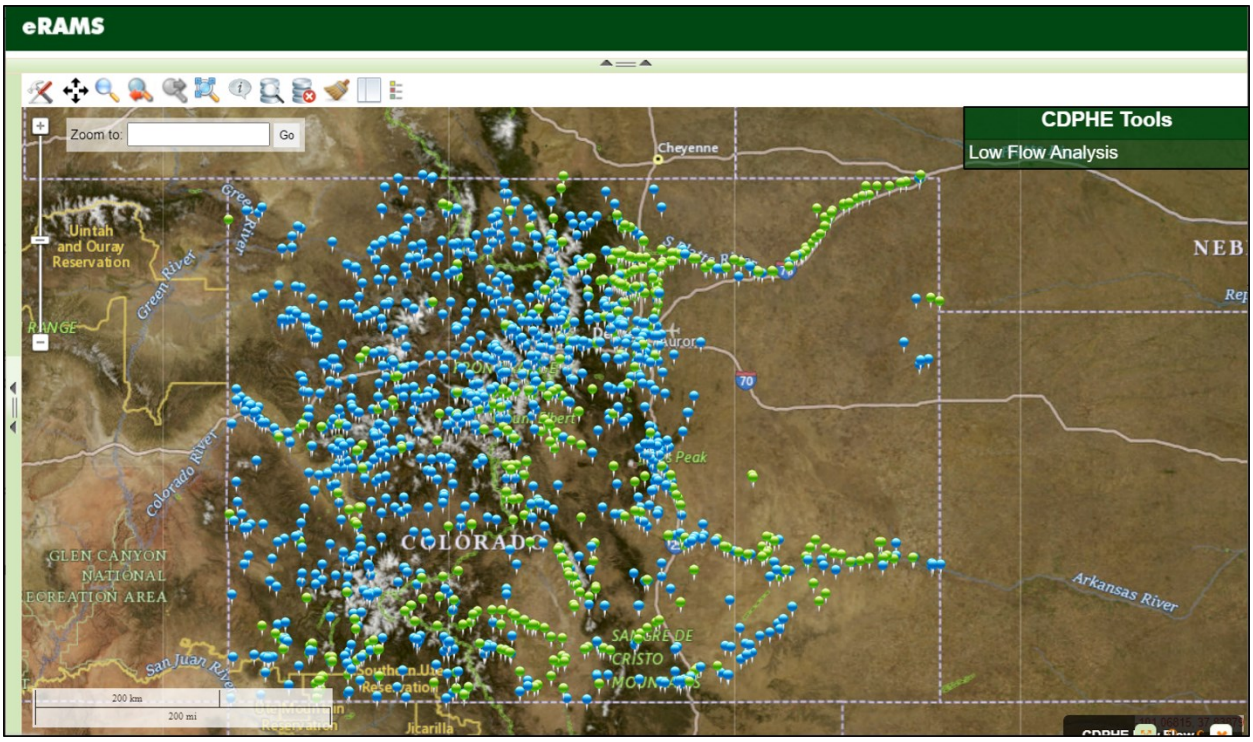
INTRODUCTION



PURPOSE

The Colorado Department of Public Health and Environment's (CDPHE) Low Flow Analysis tool queries, analyzes, and organizes stream flow data with various options for design low flows (e.g., extreme-value, biologically based, human-health or Regulation 31).

DESCRIPTION

The Low Flow Analysis tool was developed in conjunction with Colorado State University's One Water Solutions Institute and the Colorado Department of Public Health and Environment's Water Quality Control Division.

The tool uses publicly available and/or user supplied data to analyze various aspects of streamflow data including multiple assessment methodologies for low flow conditions. The low flow analyses are based on DFLOW developed by the U.S. Environmental Protection Agency and aid in designing state discharge permits.

SOFTWARE AVAILABILITY

Domain

https://erams.com/cdphe

Documentation URL

https://erams.com/catena/tools/colorado-collaborative/cdphe-low-flow/

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System Requirements

A modern web-browser is required to connect and run LFA. Browser options include: Google Chrome v.69, Mozilla Firefox v.62, Safari v.11.1, and Microsoft Edge v.17.

QUICK START

STEP 1 – SELECT STATION

Locate Stations

The Low Flow Analysis (LFA) interface provides several methods to search and identify stream monitoring stations. Users can search for a station using keywords (e.g., station name) or by where it is located on the map. In addition, you can select a buffer radius and search around an area, shape, or line.

1. Enter search criteria to locate stations and click "Submit" to return stations
2. Results will appear and corresponding station markers will appear on the map
   - USGS NWIS stations
   - Colorado Division of Water Resource (CDWR) stations

   ***Note**: to access station specific metadata, click the colored station pin to display a dialogue box with more information (Figure 1).*
3. Select the desired station from the results list and click "Next" to open the LFA interface and station summary information

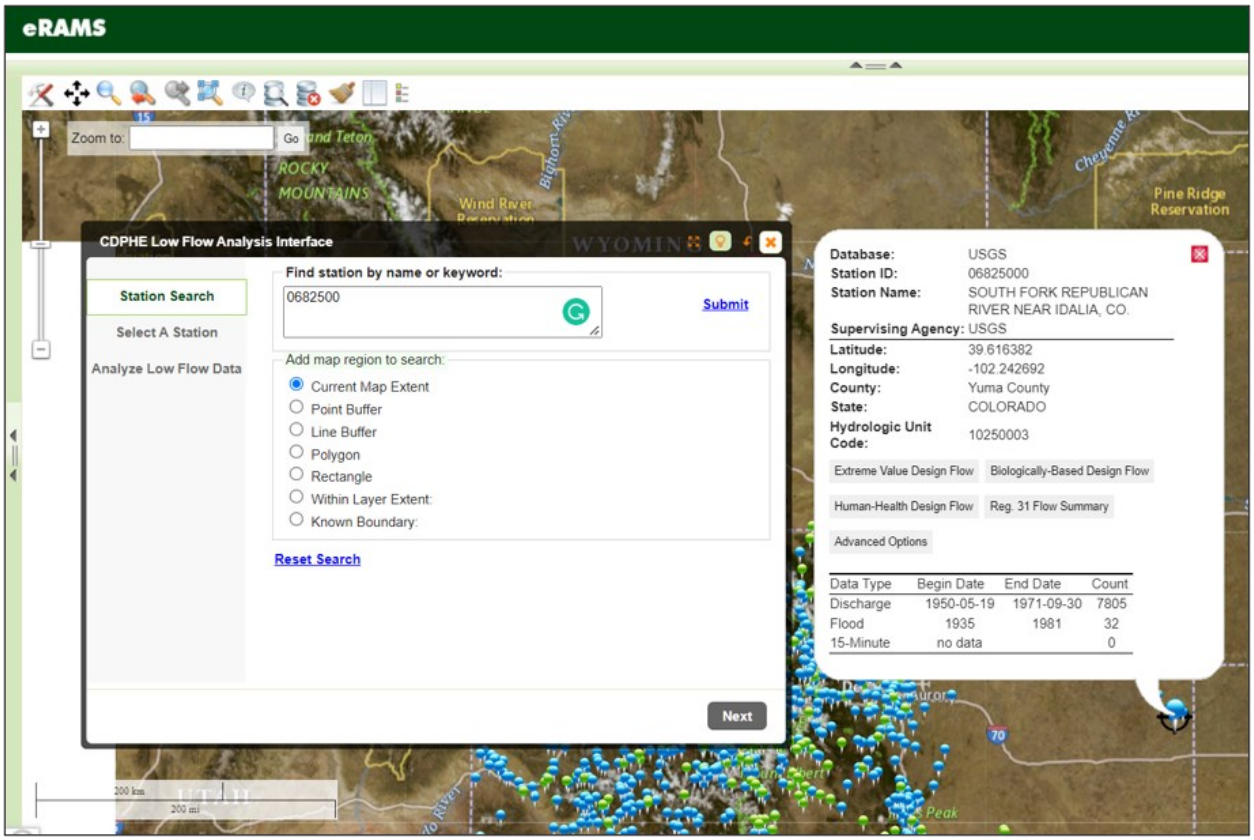


Figure 1: Select station of interest

Step 2 – Select Inputs

Once the LFA interface is launched, users can specify desired analysis components (e.g., period, water year, statistical low flow, etc.). Users can also upload their own data and combine it with available data from the USGS and CDWR databases by following the upload prompts at the top of the LFA interface (Figure 2).

The user will need to specify which design low-flow to calculate, a description of each is provided below. The tool also includes the option to select all available analyses from the drop-down options.

> ***Note:*** *the LFA station interface will assume default values and calculate flows based on the entire flow record. From the station pop-out, user can also select a design flow analysis (gray boxes in pop-out).*

After providing desired inputs, click the "Run Model" button on the bottom of the interface to display results.

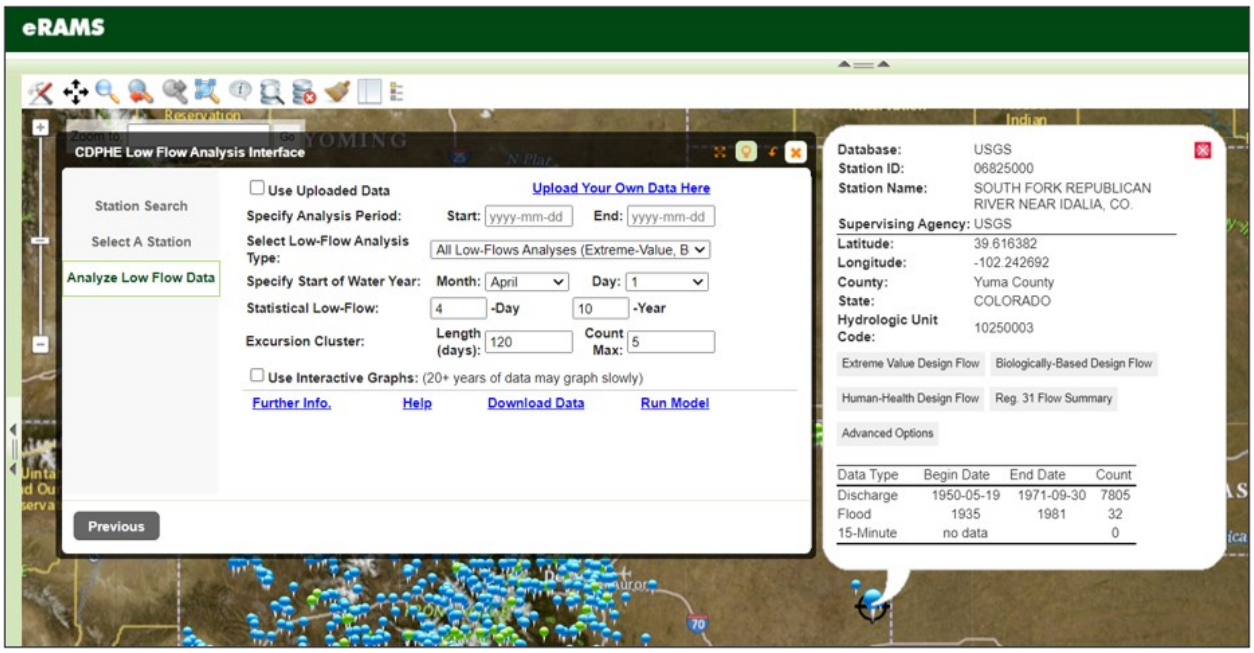


Figure 2: Select Low Flow Analysis inputs

Extreme Value Design Flows

An extreme-value design flow is computed as the lowest m-day arithmetic average flow, where 'm' is a user-supplied flow averaging period (default is 7-days), who's probabilyt of not being exceeded is 1/R, where R is the user-supplied return period (default is 10-years). This is calculated from the sample of lowest m-day average flows for each water year in the record (default water year start is April 1st). A Log-Pearson Type III probability distribution is then fitted to this dataset of m-day low-flows and the flow with a non-exceedance value = 1/R is calculated based on the parameters of the distribution (mean, standard deviation, and skewness).

Furthermore, the distribution's probability is adjusted to compensate for zero-value low-flows as described in the DFLOW documentation.

Biologically Based Design Flows

A biologically-based design flow is structurally similar to an extreme-value design flow (m-day average low-flow, R-year return period) but differs in a few key points. First, the averages used for m-day low-flows are harmonic averages not arithmetic. Furthermore, biologically-based design flows are not calculated from a probability distribution but rather pulled from the dataset itself based on the countin how often a trial design flow is not exceeded by m-day average flows in the historical record. The count of exceedances, or excursions from the design flow, are then compared against the allowed number of occurrences, based on the return period of the flow. Then the trial design flow is adjusted accordingly, Method of False Position, and the count-check process is repeated until the trial design flow converges on a single value.

A caveat to the counting process is combining single excursion periods into excursion clusters based on how closely the excursions occur to one another. If an excursion period occurs within this 'excursion length' (default is 120-days) from another excursion period they are combined into a single excursion and counted, up to a maximum limit (default is 5 excursion period per cluster).

Human Health Design Flows

The overall harmonic mean of flows can serve as a design flow for human health water criteria that are based on lifetime exposures (Rossman, 1990).

Regulation 31 Biological Flow

The Regulation 31 Summary is an application of the Biologically-based design low flow summarized for the one-day five-year median low flow as well as the monthly and annual one-day three-year, seven-day three-year, and 30-day, three-year low flow events.

Step 3 – Analyze Low Flow Data

Once required information is provided, the LFA will run the requisite models and produce a results summary report. The report can be printed (scroll to bottom of interface), and the results can also be downloaded as an excel file or image (Figure 3). All graphs are interactive, hovering over a data point will display more information.

Time Series and Statistics Results

A time series graph is a straight scale graphing of available flow data from oldest to newest date on the y axis. Fifteen-minute (instantaneous) flow data can be useful to identify hydrographs from storm runoff for small time frames (i.e., a few days) while daily average data can be used to analyze larger trends.

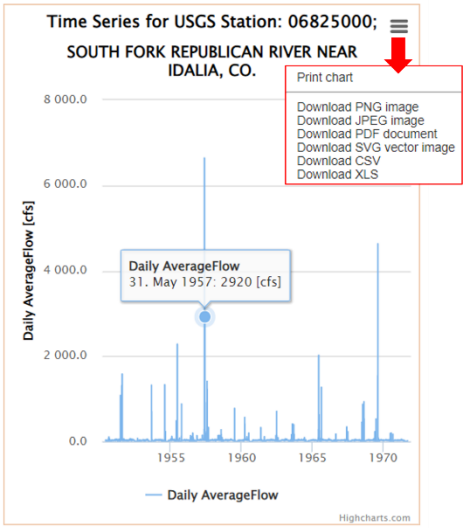


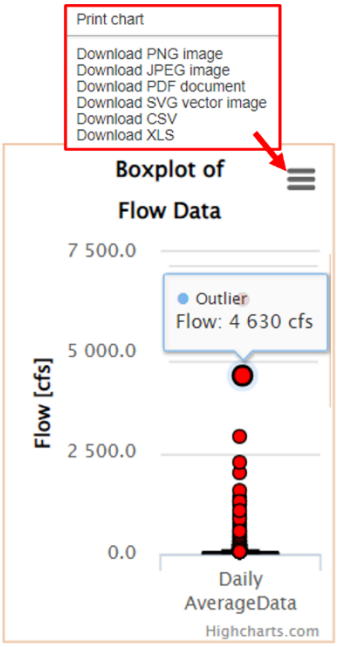
Figure 3: Time series results and download instructions

Analysis Summary

This section summarizes state information including design low-flows (described above in Step 2) and monthly design flows. An interactive box plot of the flow data is also provided. This plot along with associated data can be downloaded in various forms (Figure 4).

Analysis Summary:

Database:	USGS
Station ID:	*06825000*
Station Name:	*SOUTH FORK REPUBLICAN RIVER NEAR IDALIA, CO.*
Supervising Agency:	*USGS*
- Total Observations:	*7804*
- Start Date:	*1950-05-19*
- End Date:	*1971-09-29*
- Units:	*cfs*
Design Low-Flows	
- Averaging Length (M-day flow):	*4*
- Return Period (R-year flow):	*10*
- Extreme-Value Design Flow:	*0.0 cfs*
- Human-Health Design Flow:	*2.36 cfs*
- Biologically-Based Design Flow:	*0.0 cfs*



Monthly Design Flows:

- January (1952):	*16.0 cfs*
- February (1953):	*6.9 cfs*
- March (1953):	*12.0 cfs*
- April (1955):	*0.3 cfs*
- May (1955):	*0.3 cfs*
- June (1953):	*0.1 cfs*
- July (1952):	*0.1 cfs*
- August (1952):	*0.1 cfs*
- September (1959):	*0.1 cfs*
- October (1954):	*0.3 cfs*
- November (1952):	*7.9 cfs*
- December (1951):	*14.0 cfs*

Figure 4: Low flow analysis summary

Cumulative Distribution Function

A cumulative distribution function (CDF) portrays the quantiles of a distribution of sample data (Figure 5). These are sometimes referred to as the empirical distribution of a variable. The particular empirical distribution graphed (Figure 5) uses a Weibull Plotting Position, n / (m + 1), to calculate cumulative frequency.

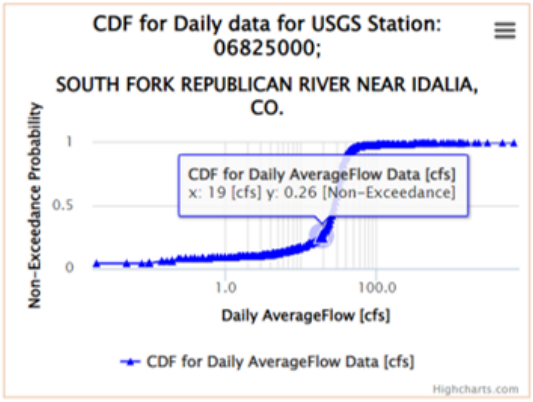


Figure 5: Cumulative distribution function results

DATA

Geospatial Information

The base layer for the Low Flow Analysis tool is a GIS point layer of stream flow and water quality monitoring locations historically or actively maintained by the Colorado Division of Water Resources (http://www.dwr.state.co.us/) and the U.S. Geological Survey (http://waterdata.usgs.gov/nwis).

Public Access Data

The data used in the LFA tool is either auto-extracted from the Colorado Division of Water Resources (http://www.dwr.state.co.us/), U.S. Geological Survey (http://waterdata.usgs.gov/nwis).

User Provided Data

The user is also able to upload and use their data alone or in combination with the public database data. If you wish to use your own data combined with the available USGS or EPA data, upload your file and then check the "Use Uploaded Data" box on the analysis interface and choose whether you desire to analyze your data only or merge it with available USGS/EPA data and then analyze it.

User Data Requirements

The user uploaded data must be in a comma separated value (CSV) file. The first row must contain a label for the columns, for example "date, flow, 00600". The first column must contain dates, in any of the following formats:

yyyy-mm-dd	yyyy-m-dd	yyyy/mm/dd	yyyy/m/dd
yyyy-mm-d	yyyy-m-d	yyyy/mm/d	yyyy/m/d

The remaining columns of the file are to be different datasets, with corresponding labels in the first row:

- If flow data is provided, the label must be "flow" (with units of cfs).
- If water quality data is provided:
    - The label must be the 5-digit USGS code (including zeros) for that type of water quality data
    - The water quality data must be in the units of that USGS code
- If there are dates with no data for one or more columns, please put "null" or "n/a" in the column