# Aquatic Ecological Logger Processing App Instructions

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Regional Monitoring Network

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Table of Contents


- Main UI Components 3
- Required Inputs and Configuration File 4
- Ecological Data Types and QC Thresholds 5
- App Sections
  - About 6
  - Configuration
    - Programs, Waterbodies, and Stations 7
    - QC Settings 10
    - Logger File Definitions 13
    - Export Options 16
    - Save Configuration File 19
  - Processing and QC
    - Setup/Processing 20
    - Visual QC 24
    - Data Summary 30
    - Export 31

# Main UI Components

## Sidebar

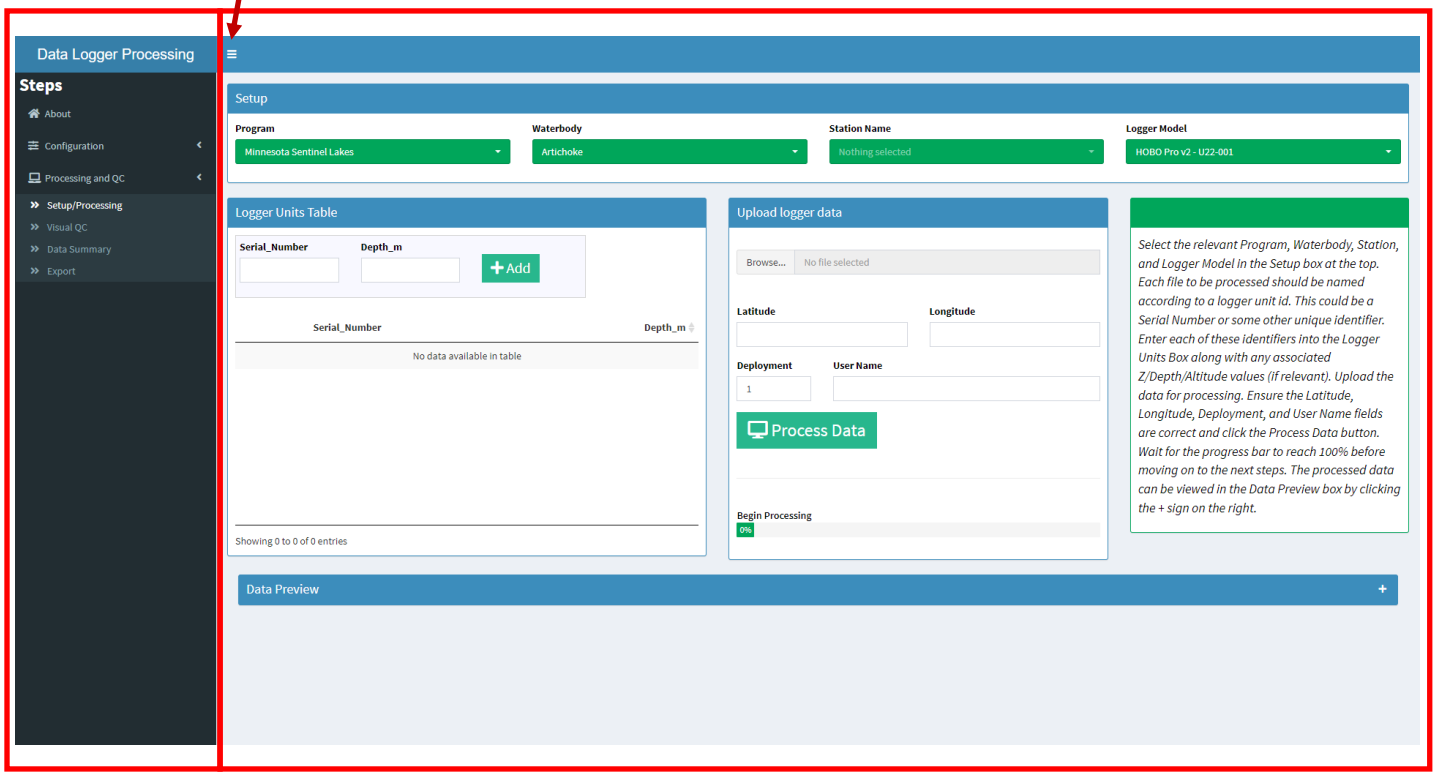
Contains navigation tabs used to access the different sections of the app.

## Show/Hide Sidebar

Button used to hide or reveal the sidebar.

## Main

Contains the components of the app that are used to process the data.



## Required Inputs and Configuration File

This is a list of information that will be needed to configure, setup, and process the data

- Program Name
- Waterbody Name
- Waterbody Identifier (optional)
- Station Name
- Station Identifier (optional)
- Latitude (optional)
- Longitude (optional)
- Quality Control Thresholds (if defaults not used)
- Input data table structure and formats
- Export table structure and formats
- Unique identifiers for each logger unit
- Z values (depth/altitude) of the logger units (optional)
- Logger data table in csv format

### Configuration File

The app uses a background configuration file which stores all of these inputs (except for the actual logger data) along with processing metadata. This file can be downloaded from the app by itself and/or as a part of the final download. If the app is accessed via the web it will not have persistent storage; therefore, after the web page is closed it can lose all of the input information. The app has the option of uploading the configuration file generated in previous uses adding all of the previously entered information into the app.

## Ecological Data Types and QC Thresholds

### Data Types

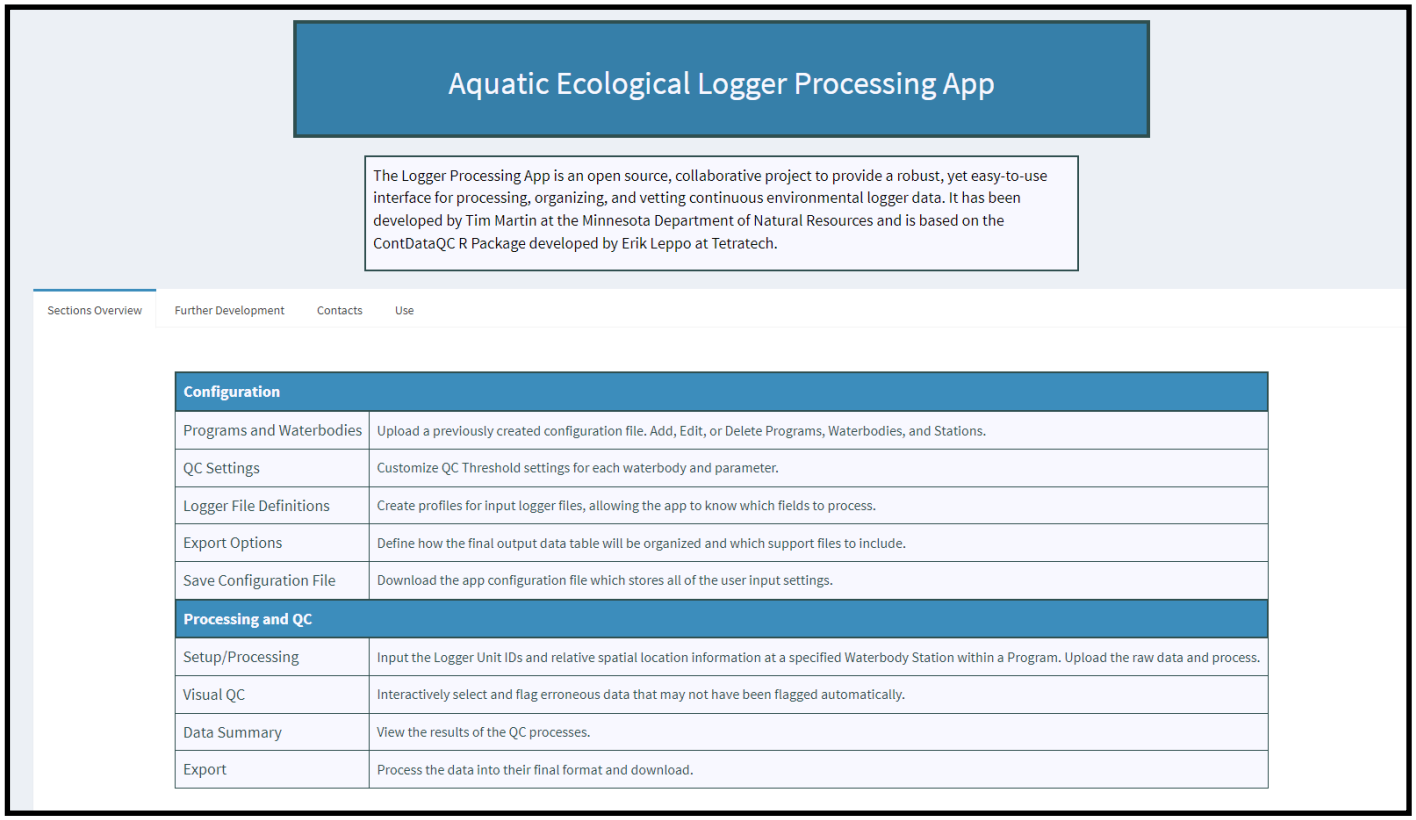
| Data Type | Alternative Name | Units |
|---|---|---|
| Air Pressure | AirBP | psi, Pa, hPa, mm Hg, in Hg, atm |
| Air Temperature | AirTemp | C, F |
| Chlorophyll A | Chlorophylla | g/cm3, g/L, mg/L |
| Conductivity | Cond | uS/cm |
| Discharge | Discharge | ft3/s, m3/s |
| Dissolved Oxygen | DO | g/cm3, g/L, mg/L |
| pH | pH | SU |
| Turbidity | Turbidity | NTU |
| Water Level | WaterLevel | ft, in, m, cm |
| Water Pressure | WaterP | psi, Pa, hPa, mm Hg, in Hg, atm |
| Water Temperature | WaterTemp | C, F |

### Thresholds

| Threshold | Description | Values |
|---|---|---|
| Gross Range | Test if data point exceeds sensor or user defined min/ max | Fail Max, Fail Min, Suspect Max, Suspect Min |
| Spike | Test if data point exceeds a user defined threshold relative to the previous data point | Fail, Suspect |
| Rate of Change | Test if a data point exceeds a number of standard deviations from the previous data points over a user defined time period | SDs, Hours |
| Flat Line | Test if a data point is within a user defined threshold from previous data points over a user defined range | Fail, Suspect, Tolerance |

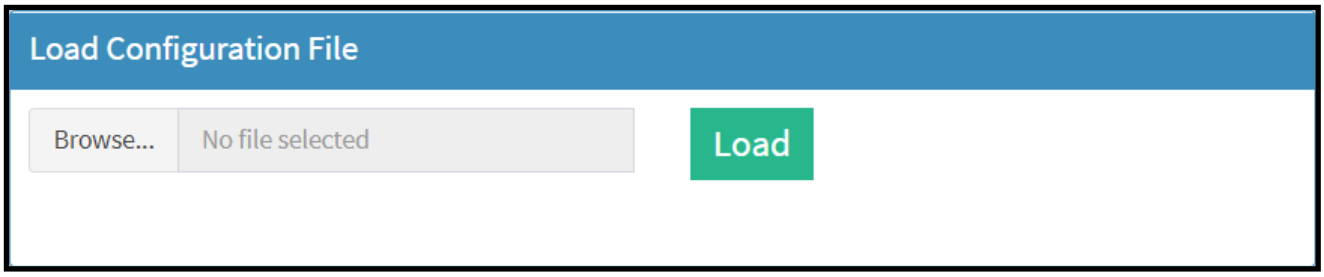
## About

The About section is the first screen that appears when opening the application. It does not contain any processing functions, but rather provides the user with information about the app including short descriptions of the different sections, ideas for further development, who to contact if you have questions about the app, and a statement about using the app.



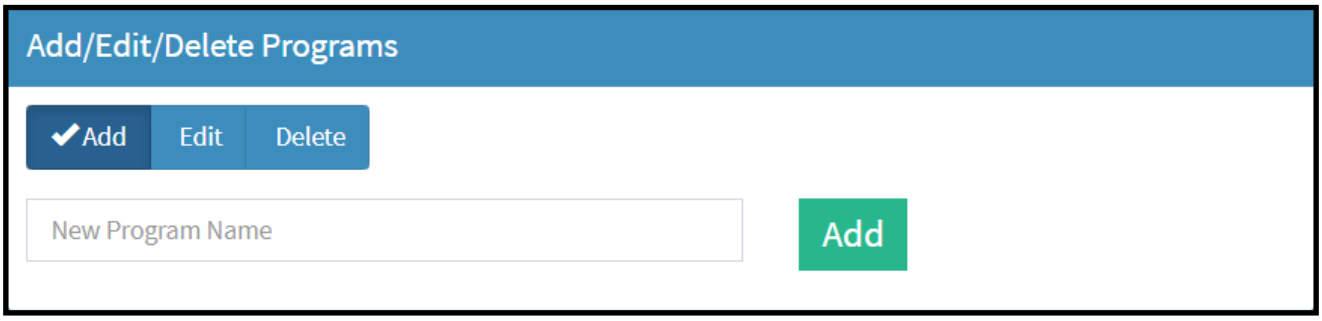
## Programs, Waterbodies, and Stations

- Load Configuration File
    - If you are using a configuration file created during a previous session it can be uploaded into the app here.



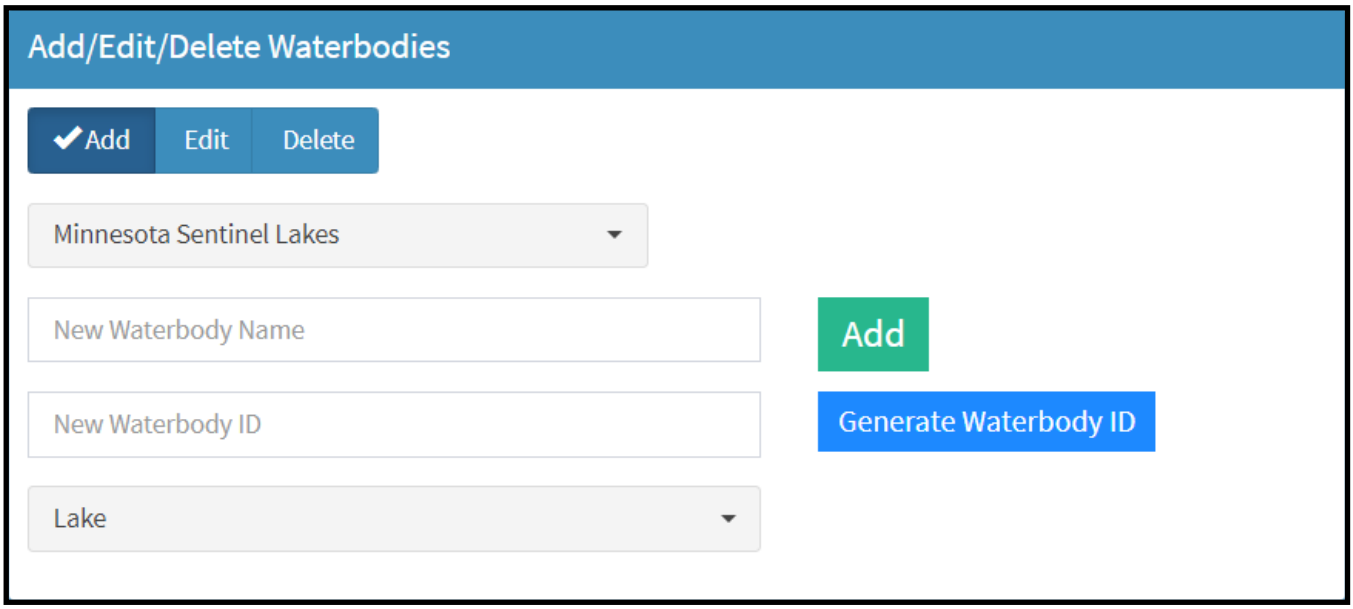

Every processed logger needs an associated Program, Waterbody, and Station. Each program can contain multiple waterbodies and each waterbody can contain multiple stations. These can all be added, edited, and deleted as needed. Note that if an entry is deleted, all associated entries lower in the hierarchy will be deleted as well. For example, if a waterbody is deleted, all stations associated with that waterbody will be deleted.

- Add/Edit/Delete Programs
    - Create new Programs, change the name of existing Programs, or remove existing Programs.



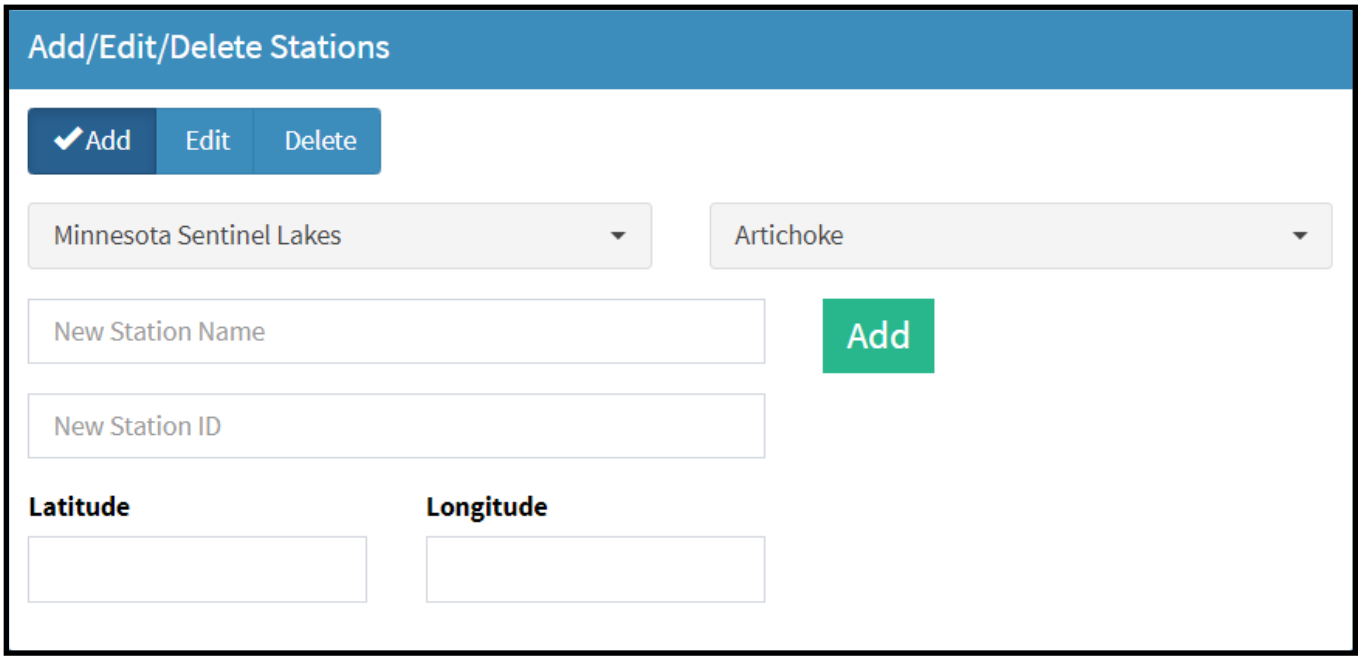
## Programs, Waterbodies, and Stations (continued)

- Add/Edit/Delete Waterbodies
    - Create new Waterbodies under the selected Program.
    - A name must be added for each waterbody. If applicable, a unique waterbody identifier can be included as well, but is not necessary. The Generate Waterbody ID will create a unique randomly generated string for the Waterbody if needed.
    - The Waterbody Type is also entered in here. This currently does not affect any of the app functions, but it will be saved in the metadata. In the future it may be possible to create specialized processing and/or qc techniques depending upon the waterbody type.
    - All of these values can be edited after they have been entered. Deleting the waterbody will remove all of this information from the app.



## Programs, Waterbodies, and Stations (continued)

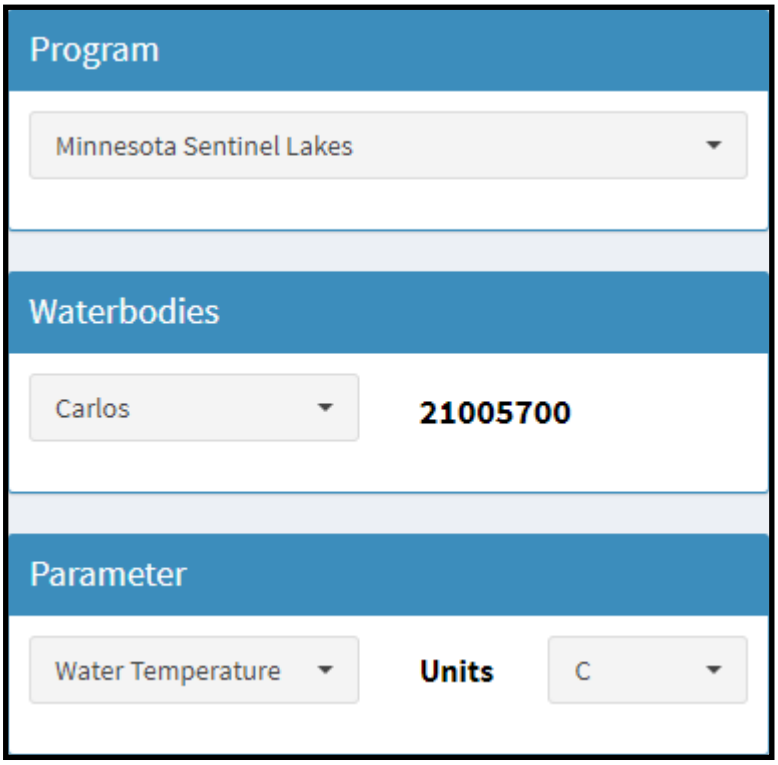
- Add/Edit/Delete Stations
    - Like the waterbodies section, a station name is required, while a station identifier is optional.
    - Latitudinal and longitudinal coordinates, indicating the spatial location of the station, can also be included, though they are not required.
    - All of these values can be edited and deleted the same as the other sections.



## QC Settings

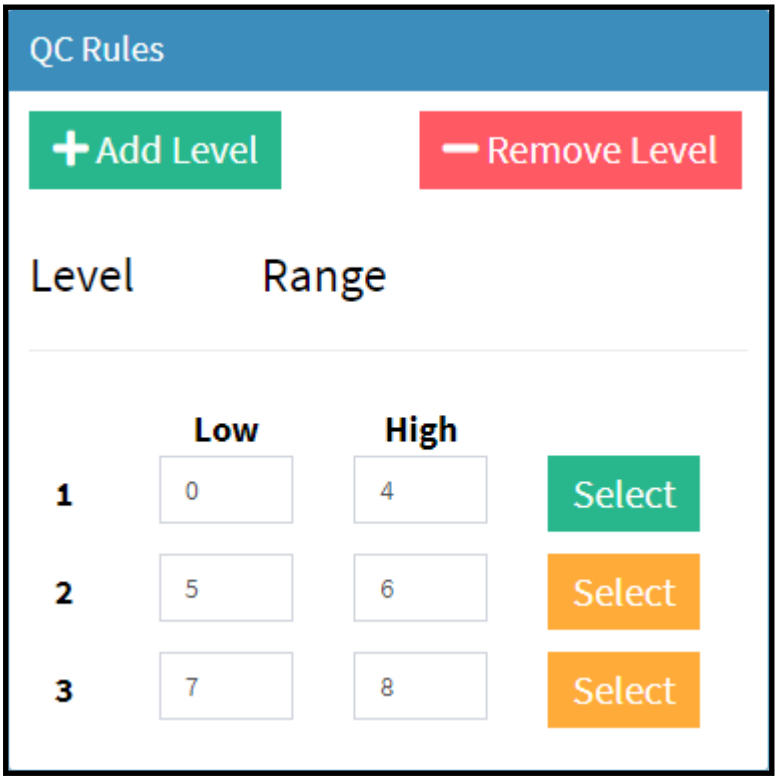
In this app, the data are checked against a variety of quality control thresholds. These thresholds can be customized for each waterbody and data type. Additionally, if multiple loggers are processed, these thresholds can be stratified according to their vertical location. Contact Tim Martin (tim.martin@state.mn.us) or Jen Stamp (jen.stamp@tetratech.com) for R code that will assist in determining what these thresholds should be based upon existing data.

- Select the relevant Program and Waterbody. If the Waterbody has an associated ID it will show up next to the name.
- Select the relevant Data Types and Units. If units are changed, the values will be converted in the QC Configuration box.



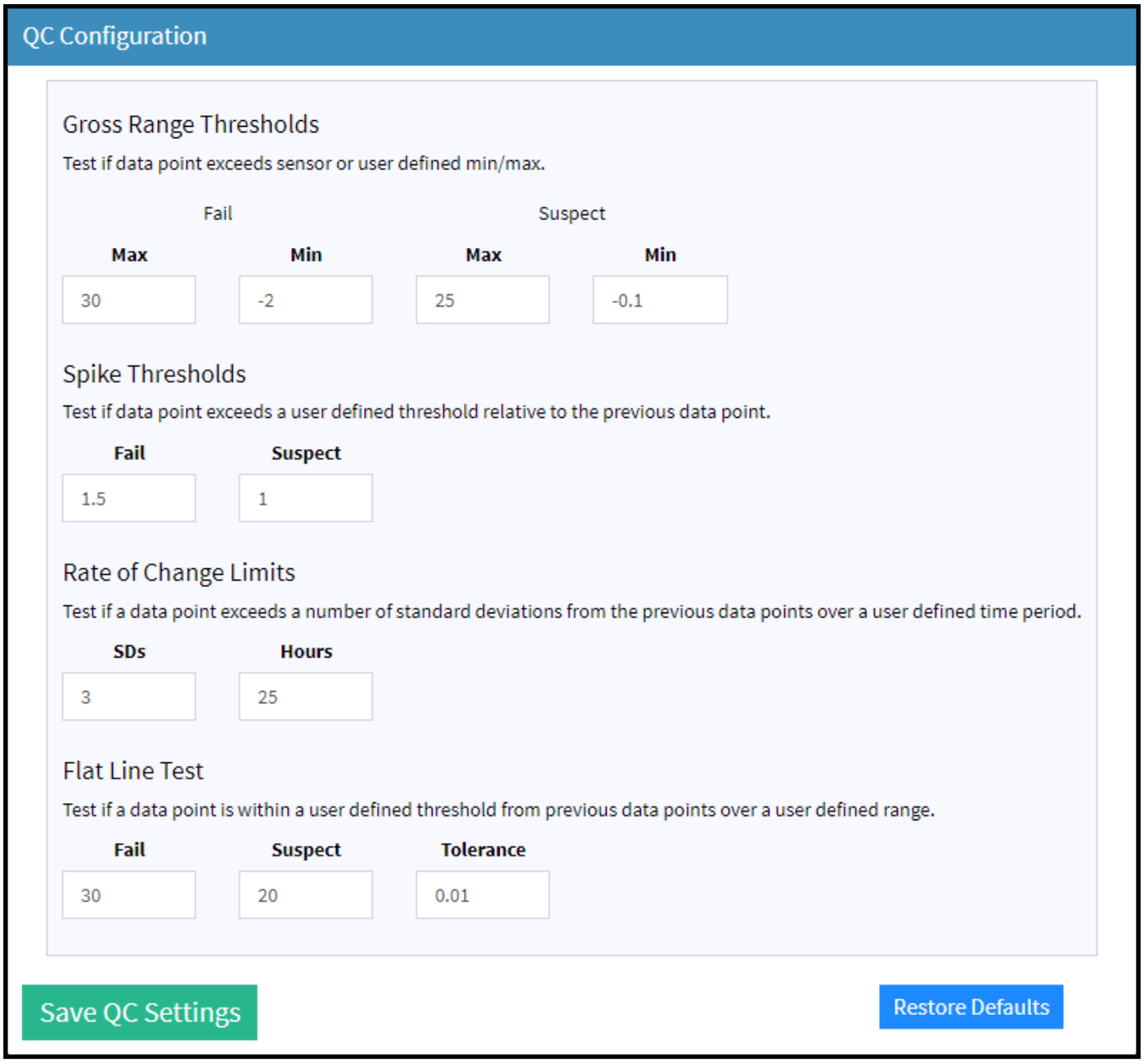
## QC Settings (Continued)

- If the thresholds have been divided into multiple levels, these can be designated in the QC Rules box.
- There can be up to five different levels. Levels can be added or removed using the Add Level and Remove Level buttons. Keep in mind, if a level is removed all information associated with it will be deleted.
- Each level needs to have Low and High values entered. These values define the range of vertical measurements. For example, if four loggers are located at depths of 1,3,5, and 7 m, and three levels are created with lows and highs of 0 and 4, 5 and 6, and 7 and 8 respectively, the loggers located at 1 and 3 m will be evaluated using the first level thresholds, the logger at 5 m will use the second level thresholds, and the logger at 7 m will use the third level thresholds.
- Ensure that the ranges for the levels do not overlap as it may cause errors when processing the data.
- To set the thresholds for a particular level, click on the Select button for the corresponding Level. The green button indicates which level is currently select. The rest of the buttons will be yellow.



## QC Settings (Continued)

- Once levels have been created (if needed), the thresholds can be set in the QC Configuration box.
- After filling out the thresholds, click the Save QC Settings button. If you are filling out different thresholds for different levels, make sure to click this button before selecting another level or all of the values will be lost.
- To reset the thresholds to default for the selected level, click the Restore Defaults button.

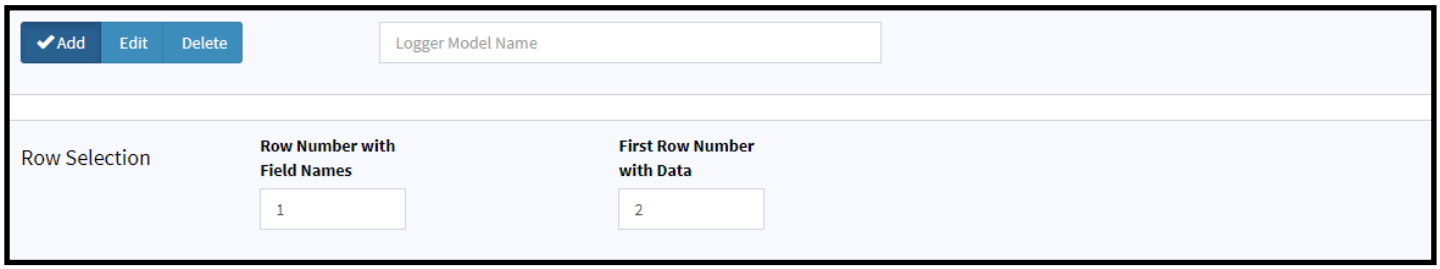


## Logger File Definitions

In order for the app to know how to process the input data, you will need to enter in the structure of the data tables to be processed.  Please note that the input data must be in the csv format and all field names in the data must be exactly the same as they are defined in the app.

As it is one of the most commonly used logger models in the monitoring community, the HOBO Pro V2-U2-001 water temperature sensor has already been included in the app . Please note that when exporting to csv in the HOBOware program, the  default settings will result in field names unique to that particular logger. To ensure this does not happen, in HOBOware go to File > Preferences > General and uncheck all of the checkmarks associated with the Column Headers section. If the app has issues with processing data from this logger, ensure that the information in the app matches with what is in the data file as there may be other circumstances that cause the file to not align with the default app settings.

- In the Manage Logger Models box, you can add, edit, and delete logger model data table settings.
- Each logger model must have a name, which can be added in the first box.
- Different data tables can have different formats. This section provides flexibility by letting you set which row the field names are on and which row the actual data begin. For example, the csv from the HOBO Pro V2-U22-01 loggers has field names on the first row of the table and the data starts on the second row. For another logger model, the PME miniDOT DO logger, the fields names are on the second row, while the data actually starts on the third row. The second row contains additional field-related metadata that are not required to process the data.



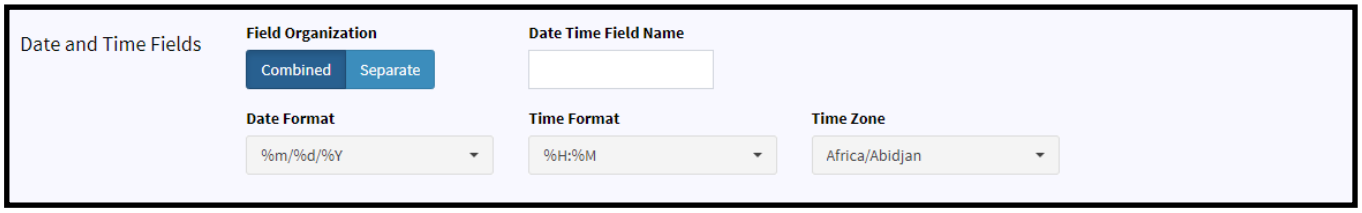
## Logger File Definitions (Continued)

- Dates and Times may have been recorded in either the same field or separate fields. If they are collected in the same field, the Combined option must be selected. If they are in separate fields the Separate option must be selected. In the Date Time Field Name text box (in the case of separate fields, the Date Field Name and Time Field Name text boxes) enter in the field name exactly as it appears in the data table.
- If the data has a date or time format not included in the app, please contact the developers so the format can be added.
- The Date and Time Format options tell the app how these data are organized in the table. Do not rely on the format as displayed in Excel as this program automatically standardizes the dates and formats which may not reflect the actual date and time formats in the data.

| Date Format | Example |
|---|---|
| %m/%d/%Y | 03/04/2022 |
| %m/%d/%y | 03/04/22 |
| %b/%d/%y | Mar/04/22 |
| %Y-%m-%d | 2022-03-04 |
| %y-%m-%d | 22-03-04 |

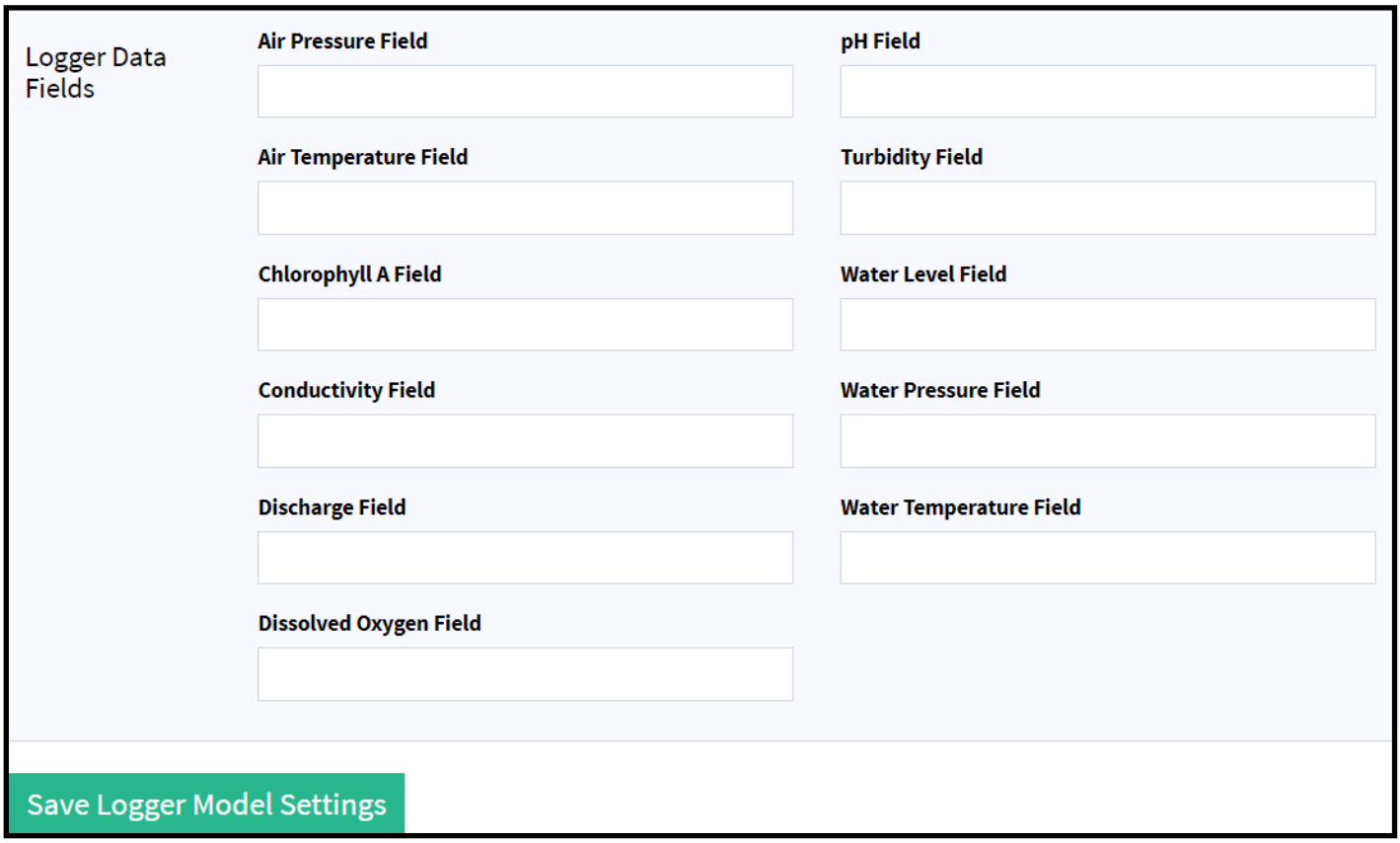
| Time Format | Example |
|---|---|
| %H:%M | 17:30 |
| %H:%M:%S | 17:30:00 |
| %I:%M %p | 5:30 pm |
| %I:%M:%S %p | 5:30:00 pm |

- Select the time zone the data are in.



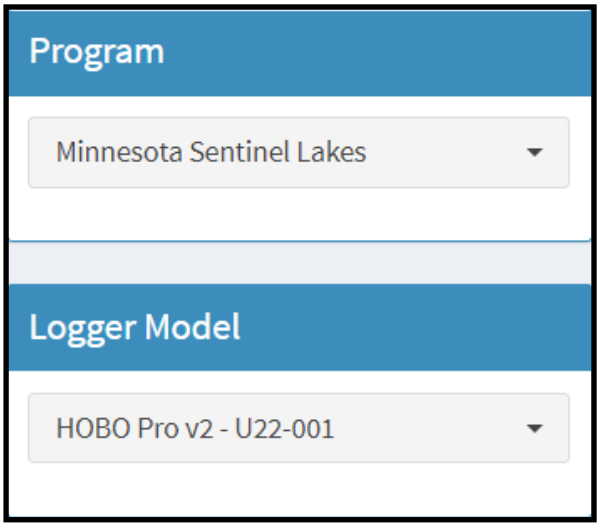
## Logger File Definitions (Continued)

- There are a total of twelve data types (listed earlier in this document) that this app can process. Enter the field names that contain the respective data into the relevant text box in the Logger Data Fields section. Multiple data types can be filled out for processing. Once all relevant information have been filled out, click the Save Logger Model Settings button.

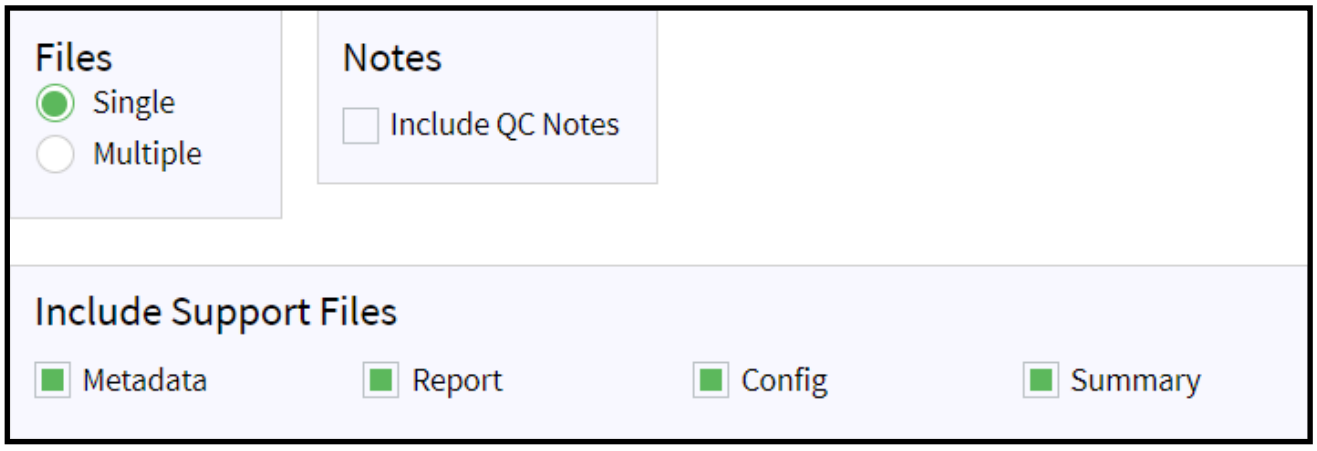


## Export Options

Custom export settings can be set for each Logger Model for each Program. There are a number of options to determine how the data are exported and what fields and field names they contain as well as what support files are included.



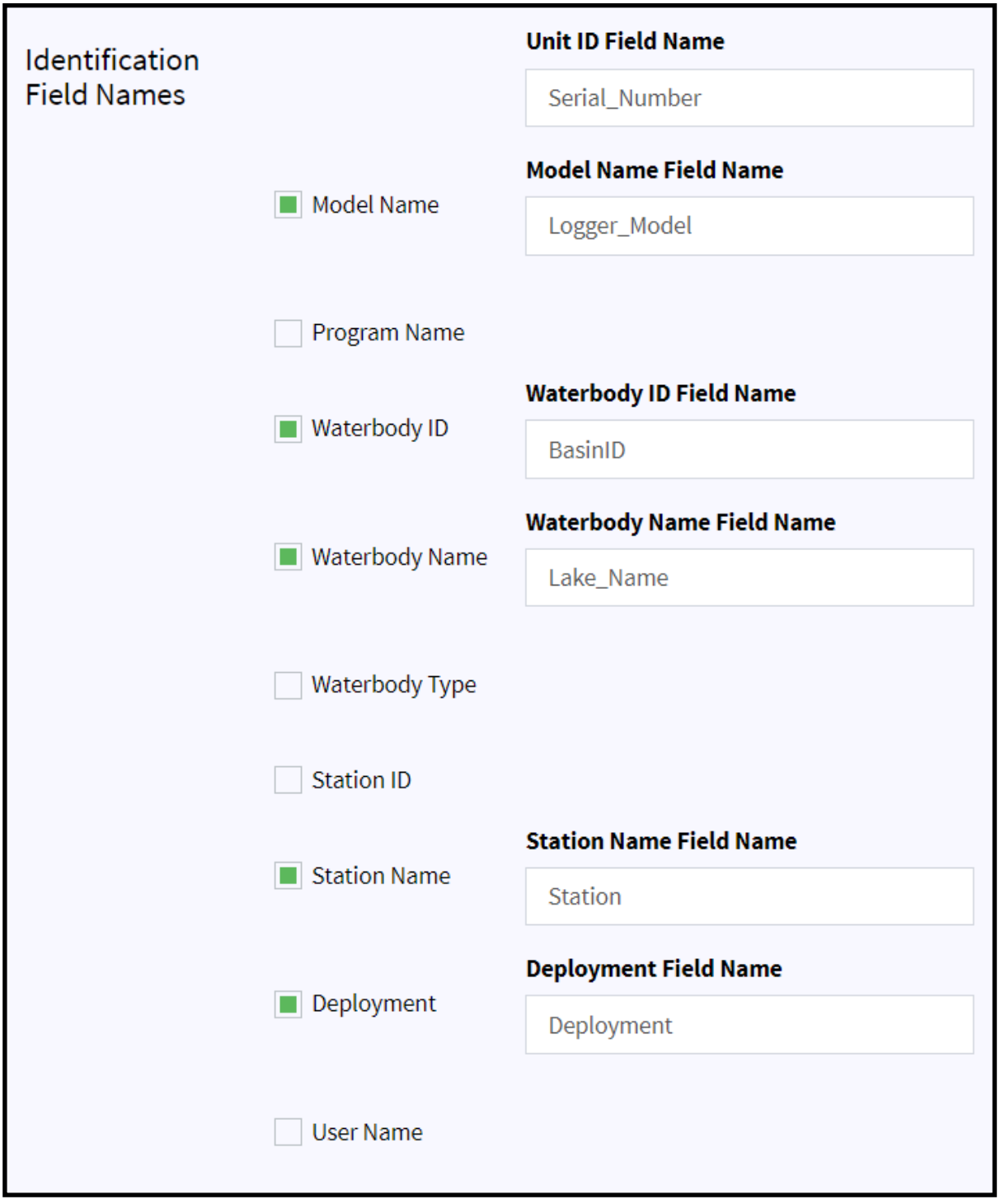

- If there are multiple data types being processed, the data can be exported as either a single file that will contain all of the data types with their associated qc flags or as individual files for each data type.
- A notes field can be included in the data. This field allows the user to add notes to individual data points during the Visual QC step.
- There are a number of support files that can also be added to the final export.
    - Metadata - a table with metadata information about the processed data
    - Report - a summary report with various metadata and statistics about the processed data
    - Config - a copy of the configuration file for the app with all of the information entered up to that point.
    - Summary - a table with daily statistics such as daily mean, max, min of the processed data.



## Export Options (Continued)

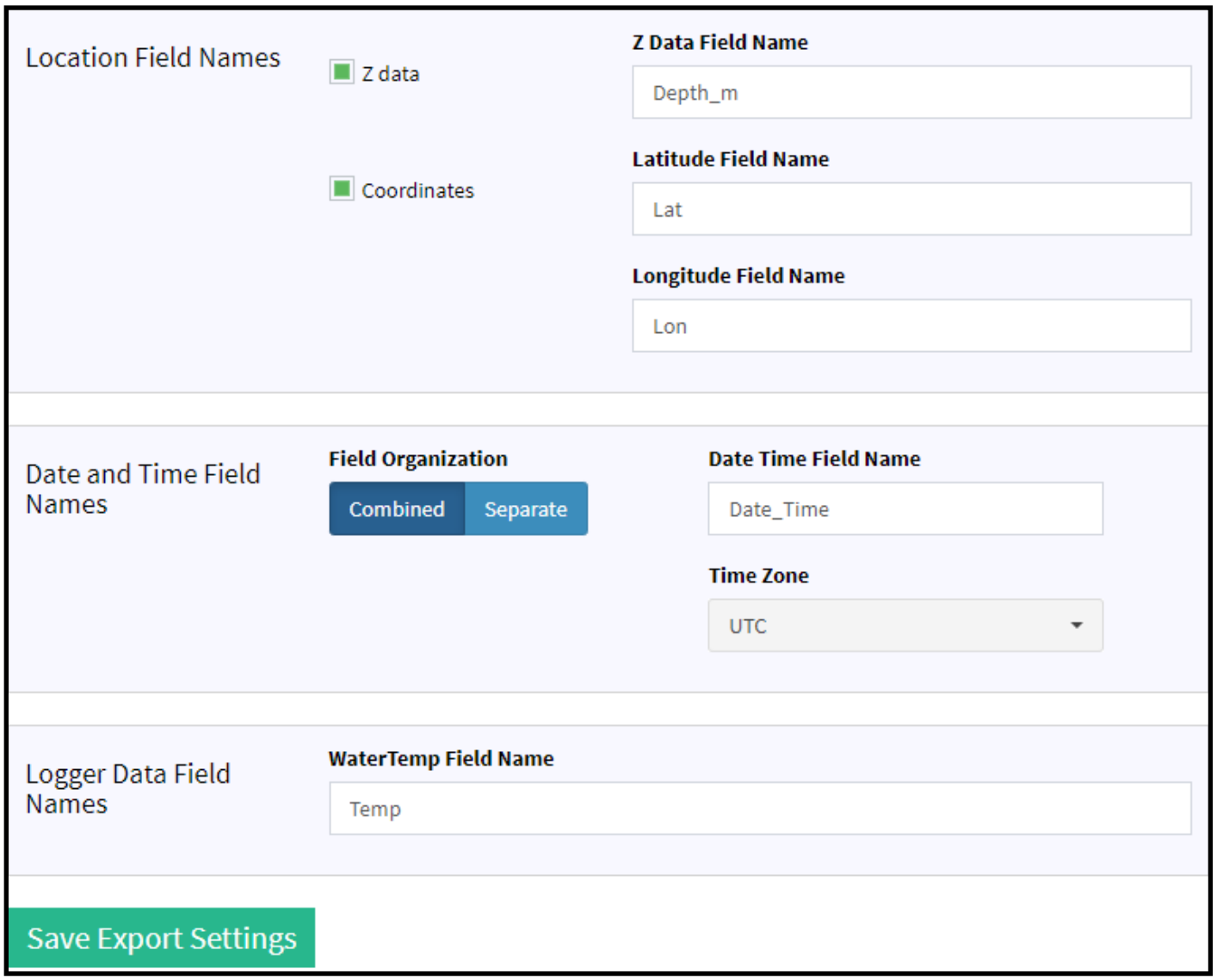
There are a number of Identification Fields that can be added into the final export.

- A Unit ID Field Name is required for all processed data. This helps the app and the user differentiate between the different units that are processed. A field name is required to be entered. This field name is how the field will appear in the final export.
- The remaining identifying fields are optional. The user can toggle these fields by clicking on the box next to the field description. If a field is selected a text box will appear for entering the desired field name.



## Export Options (Continued)

- The next part allows you to add location related fields. The Z data field refers to the vertical location of the loggers. The Coordinates field will include the coordinates entered in the Stations section of the Programs, Stations, and Waterbodies screen.
- The Date and Time Field Names box allows you to select whether the dates and times will be in separate fields or in a single field, what it should be named, and which time zone these data should be. These are required settings.
- Finally, the Logger Data Field Names box provides text boxes for entering field names for each of the data types collected by the logger model, as indicated in the Logger File Settings screen. Only the data types with field names in the Logger Files Settings screen will appear here.
- After all information has been added, click the Save Export Settings button.



## Save Configuration File

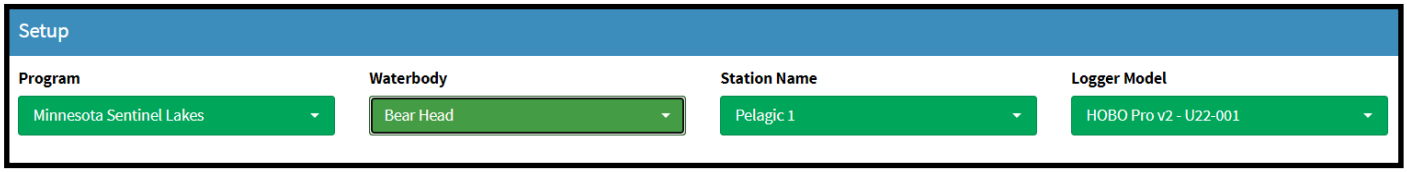
After all of the configuration settings are filled out, it is a good idea to save the configuration file, especially if this is the first time you have used the app. This will ensure that if any errors or issues occur when processing the data, you will have a copy of these settings which can be easily uploaded into the app instead of having to manually re-enter them.

- Enter a name for the configuration file in the Configuration File Name text box and click the Save Configuration download button.

## Setup/Processing

This section, along with the Visual QC section are where all of the processing and QC occurs. At a basic level, this is where you tell the app about the  data that is going to be processed, upload those data, and begin the processing.

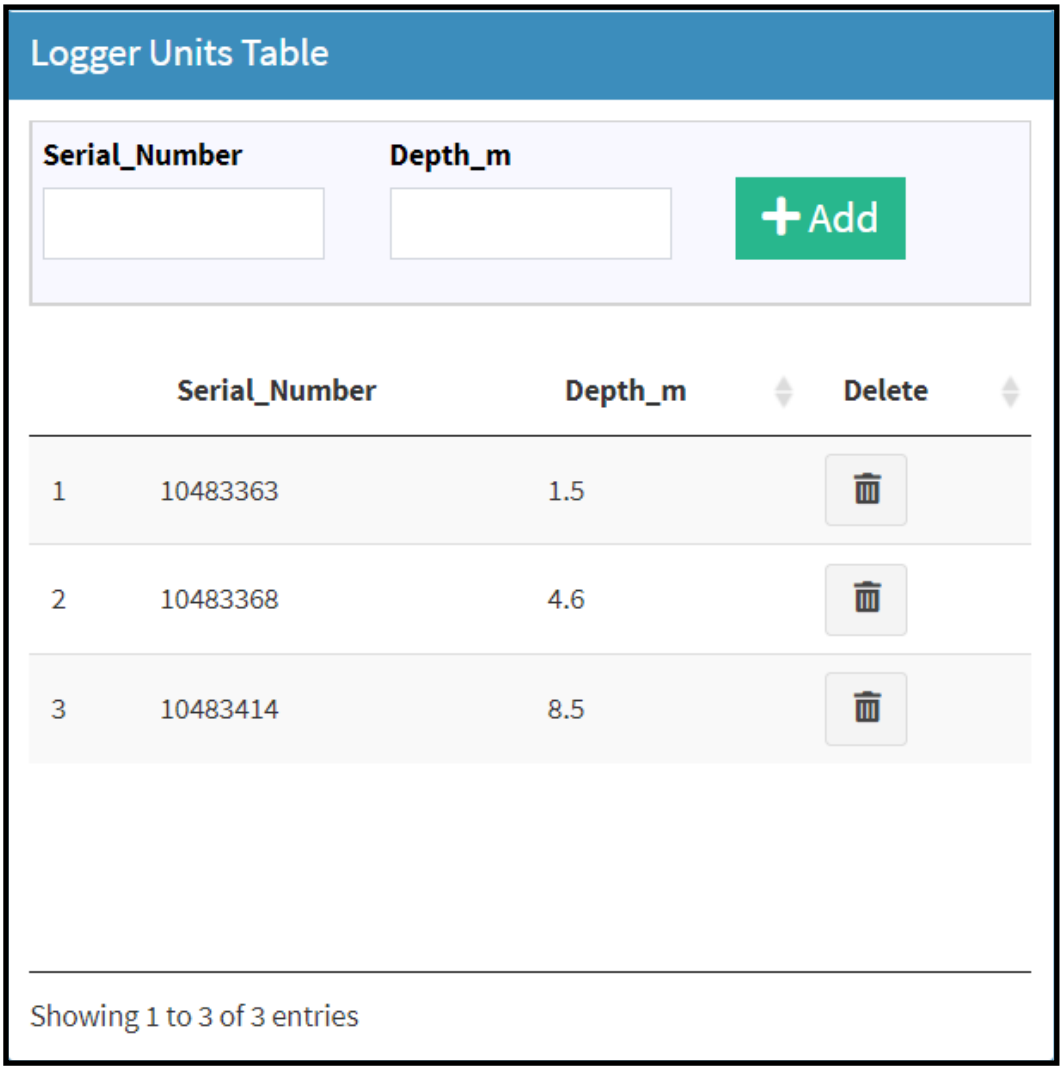
- Select the relevant Program, Waterbody, Station Name, and Logger Model for the data about to be processed. All of these must be selected in order to complete this task. Ensure that all of the relevant sections in the Configuration part of the app have been completed or a warning or error may occur.



## Setup/Processing (Continued)

The Logger Units Table box will look different depending on the settings entered into the Export Settings section. In the screenshot below, the Serial_Number text box relates to the Unit ID Field name designated in the Export Settings. Therefore, whatever was entered in that section will appear as the text box name here. Please note that the file names of all of the data files need to be the same as the values entered in this box. The Depth_m text box refers to the Z Data Field Name in the Export Settings. If that field was not selected for inclusion in the final export, this text box will not be included in this box.

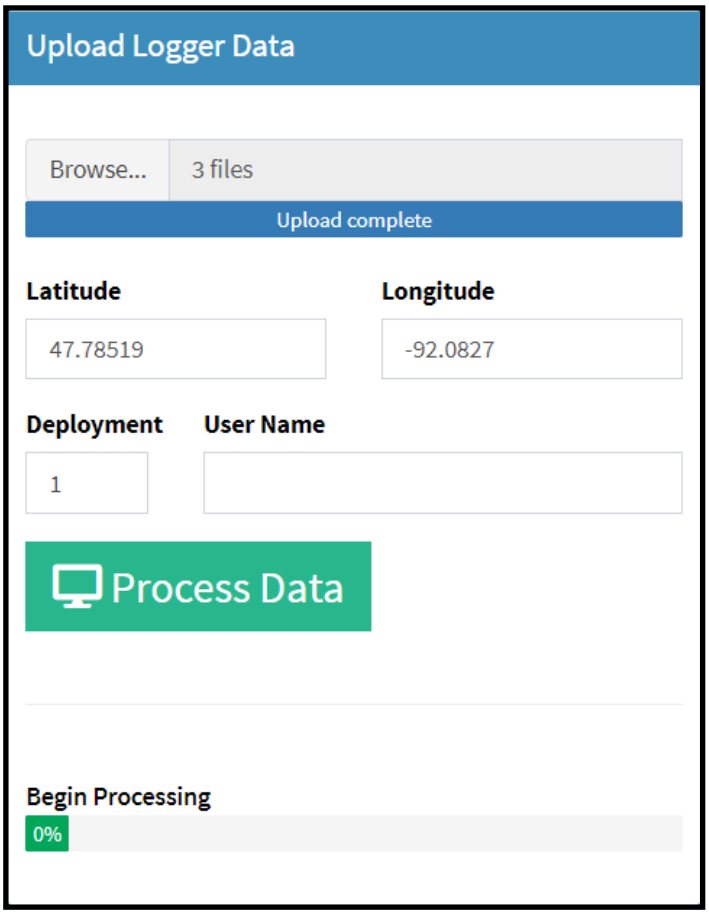
- Enter the UnitID in the first text box and if applicable, the corresponding Z value in the second text box and click the Add button.
- These values are added to the table below.
- Data from a single logger unit or multiple logger units that were deployed at the same time at the same location can all be processed at the same time by adding multiple logger units in to the Logger Units Table.
- Entries that have been added to the table can be removed by clicking the trash can symbol next to the corresponding row under the delete heading.



## Setup/Processing (Continued)

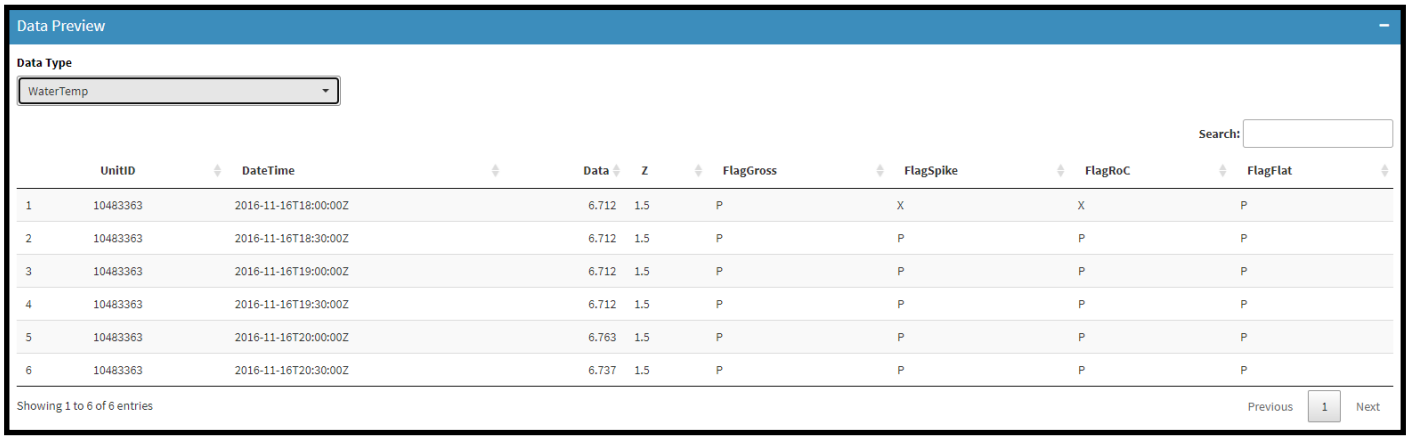
The Upload Logger Data box is where you upload the data, verify the latitude and longitude, keep track of the deployment, and add a user name for the person or organization that is running the process.

- Upload the logger data csv files, making sure that the file names are the same as entered in the Logger Units Table, by clicking the Browse… button and selecting the relevant files.
- If the coordinates of the loggers have changed since the last deployment, they can be changed here. This will also update the coordinates for the station in the configuration file.
- This app operates under the assumption that loggers are going to be continuously deployed, retrieved, and then re-deployed. The Deployment text box indicates the sequential iteration of the current deployment. If the configuration file is continuously saved and used for each Deployment, the app will keep track of the Deployment number. For example, as this is the first deployment of this logger model at this station, the Deployment number is "1." After these data are processed, this number will automatically be updated to "2" in anticipation for processing the next deployment of this logger model at this station. If needed, the Deployment number can be changed manually. The app will default to the largest stored deployment number.
- The User Name is an optional field where the user can enter a name. This can help keep track of who processed what.
- Once all of this information is entered, Click the Process Data button. The progress bar will update, showing where in the process the app is.



## Setup/Processing (Continued)

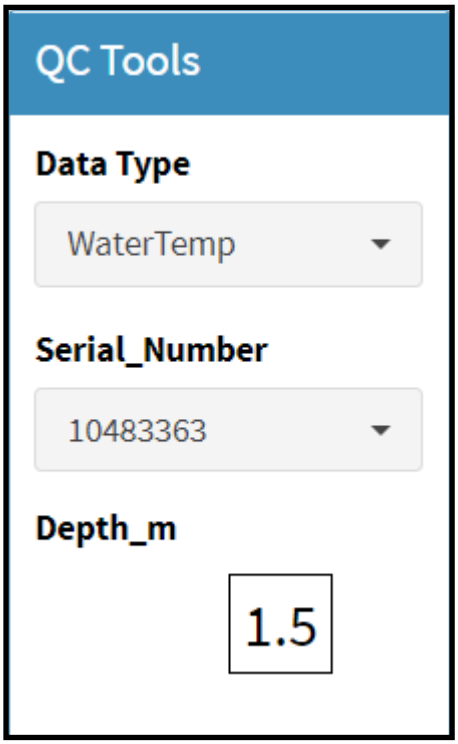
- Once the data are processed the Data Preview box below the Logger Units Table and Upload Logger Data boxes can be expanded.
- This shows the first six rows of the data as they currently are stored in the app. If multiple data types have been processed, the data type can be changed in the dropdown box in the upper left of the box.
- This table can be used to see if the data look as expected up to that point and to make sure there are no obvious errors.



## Visual QC

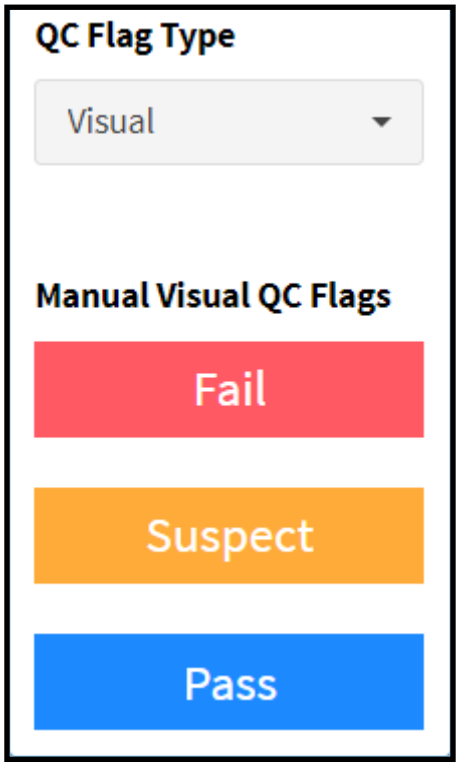
The Visual QC tool  is an interactive plot that allows you to select data points individually or as a group and apply a Visual QC Flag. If enabled in the Export Options screen, Notes can also be added at this time.

- If multiple data types were processed, these can be selected with the Data Type dropdown box. If there is only a single data type this box will still be present but only one option will be available.
- Individual logger units can be selected using the dropdown box below the data type dropdown box. The name on this will depend on what was entered into the Unit ID text box in the Logger File Definitions.
- If there is an associated Z value, it will be displayed below the Unit ID text box.



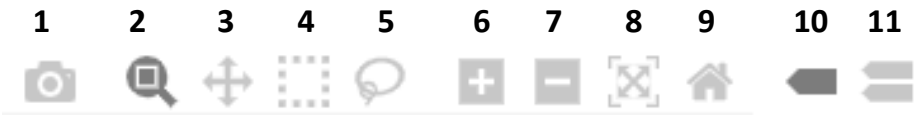
## Visual QC (continued)

- The next dropdown box allows you to select which QC Flat Type is edited. By default this is set to Visual QC Flags. If needed, the remaining QC Flags, Gross, Spike, Rate of Change, and Flat, can also be edited from the automated QC process based upon the set thresholds. Please not that while you have the option of changing these non-Visual QC Flags, updating thresholds may be a more appropriate way to minimize the erroneous flags.
- The Manual Visual QC Flags buttons allow you to change the QC Flag of the selected QC Flag Type for the data points that are selected in the interactive plot.



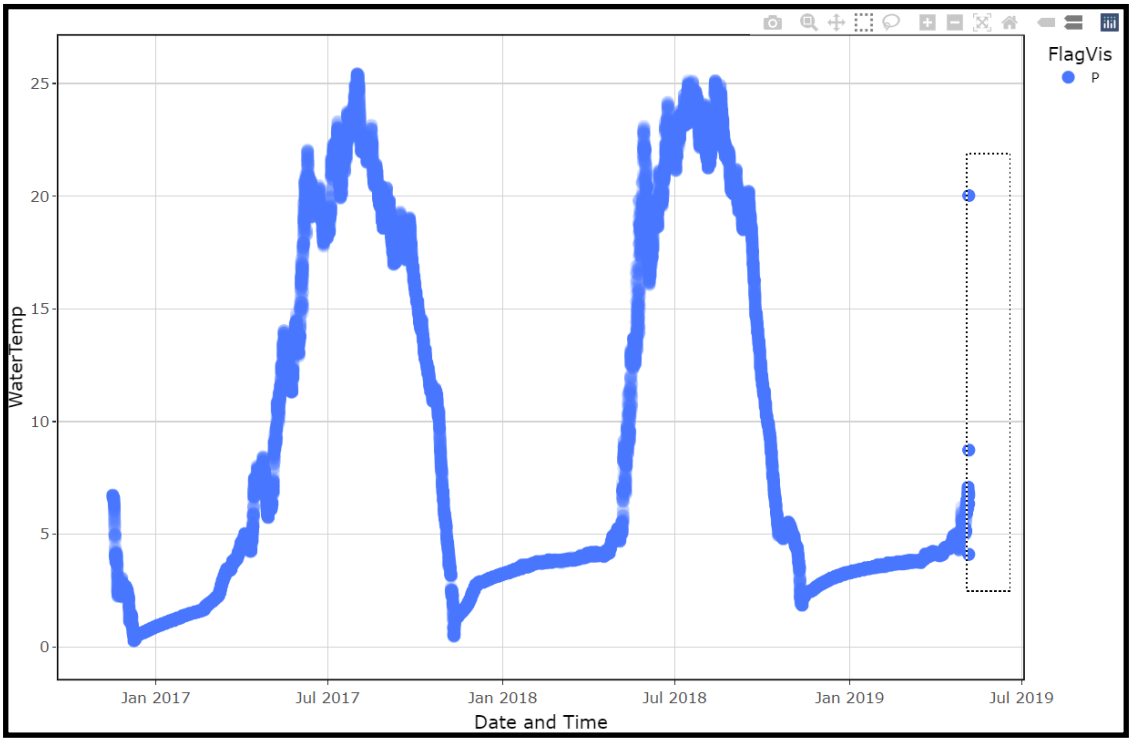
## Visual QC (Continued)

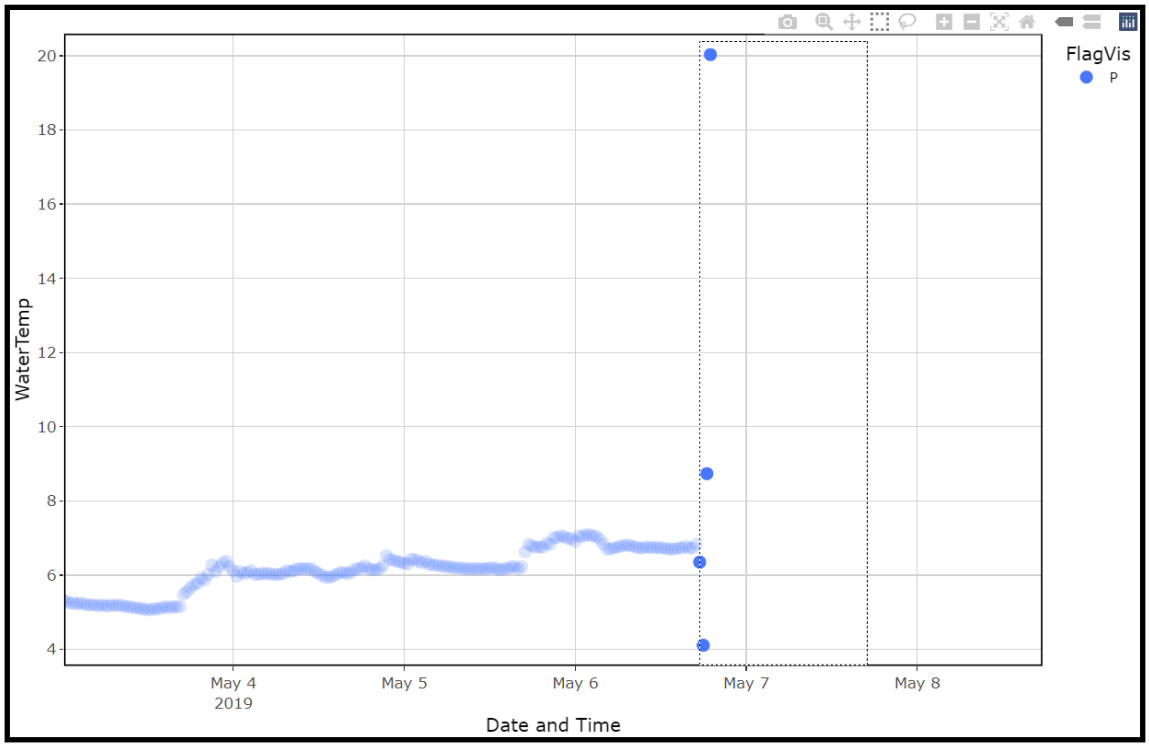
- The tools for the interactive plot are located at the top right side.
    - From left to right
        1. Download plot as a png - saves plot to an image file
        2. Zoom - magnify the selected plot portion by drawing a box
        3. Pan - move around the plot
        4. Box Select - select data points by drawing a box
        5. Lasso Select - select data by drawing a free-form shape
        6. Zoom in - increase the magnification of the entire plot
        7. Zoom out - decrease the magnification of the entire plot
        8. Autoscale - automatically fit all of the data to the plot window
        9. Reset axes - return to original scale
        10. Show closest data on hover - display information by hovering over data points
        11. Compare data on hover - display information of data point at same x-axis



## Visual QC (Continued)

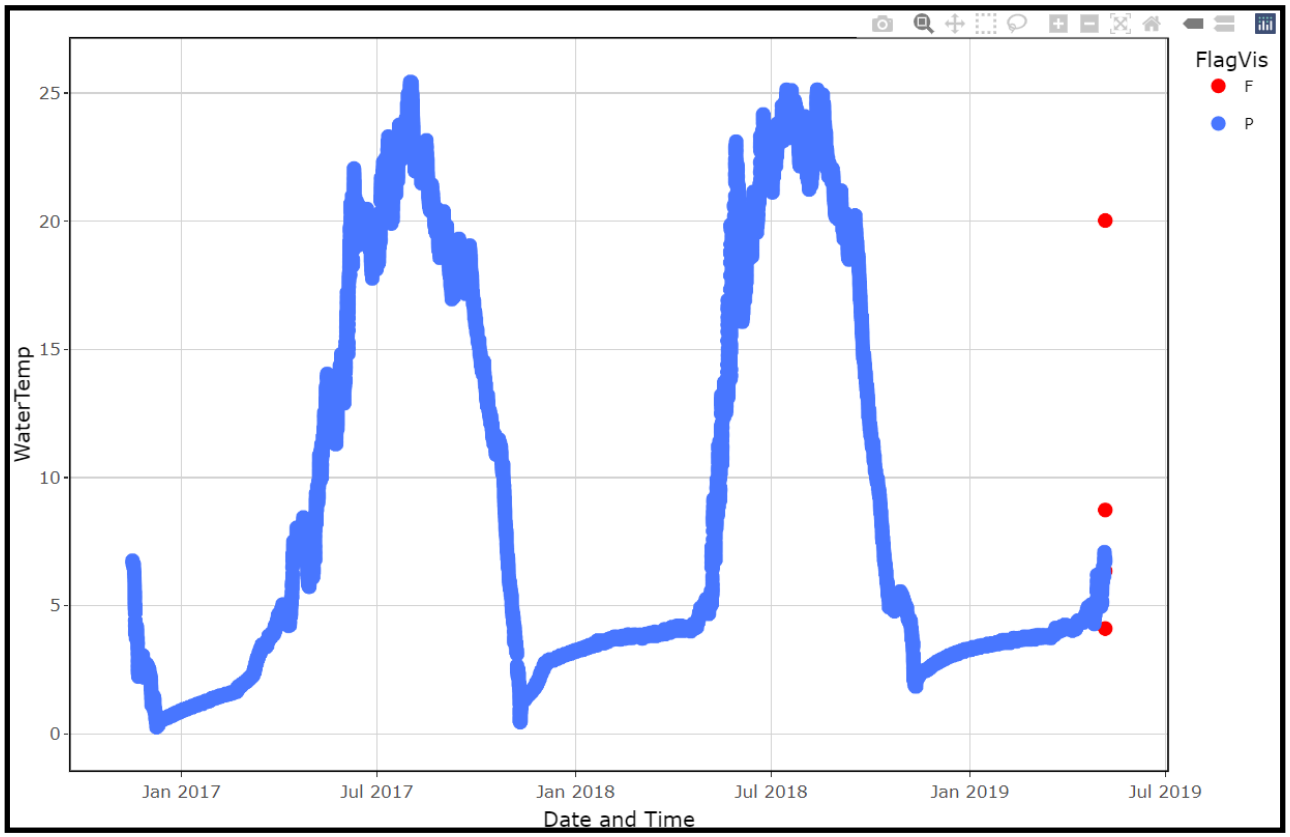
- Use the Box Select or Lasso Select to select the data points that need to be flagged. In the first screenshot below, the data points were collected while the logger was out of the water.
- To change the QC Flag Value, click on one of the Manual Visual QC Flags buttons.
- The data point will then change color to reflect the change in flag.
- For precision, zoom in closer to the points that need to be changed and then select them.



## Visual QC (Continued)

- After clicking on the Manual Visual QC Flags button, the color of the selected data points will change color to reflect their change of flag status.
- If the flag of a data point is changed incorrectly, simply reselect the data point and click on the correct Manual Visual QC Flags button.



## Visual QC (Continued)

- If Include QC Notes was checked in the Export Options, a Notes box will appear below the interactive plot.
- Notes can be applied to individual data points or multiple data points at the same time.
- In order to add notes to the data, select the data points, type in a note, and click the relevant of the Manual Visual QC Flags buttons.
- Whenever points with notes are selected, the note will display in the notes box. The note can be changed by editing the text and clicking on one of the Manual Visual QC Flags button again.
- If multiple data points are selected with different notes, a warning will appear in the Notes box stating, “WARNING: multiple data points with different notes selected.”

## Data Summary

The Data Summary ssection allows you to review the processed data. It provides a number of statistics about the data and the QC results.

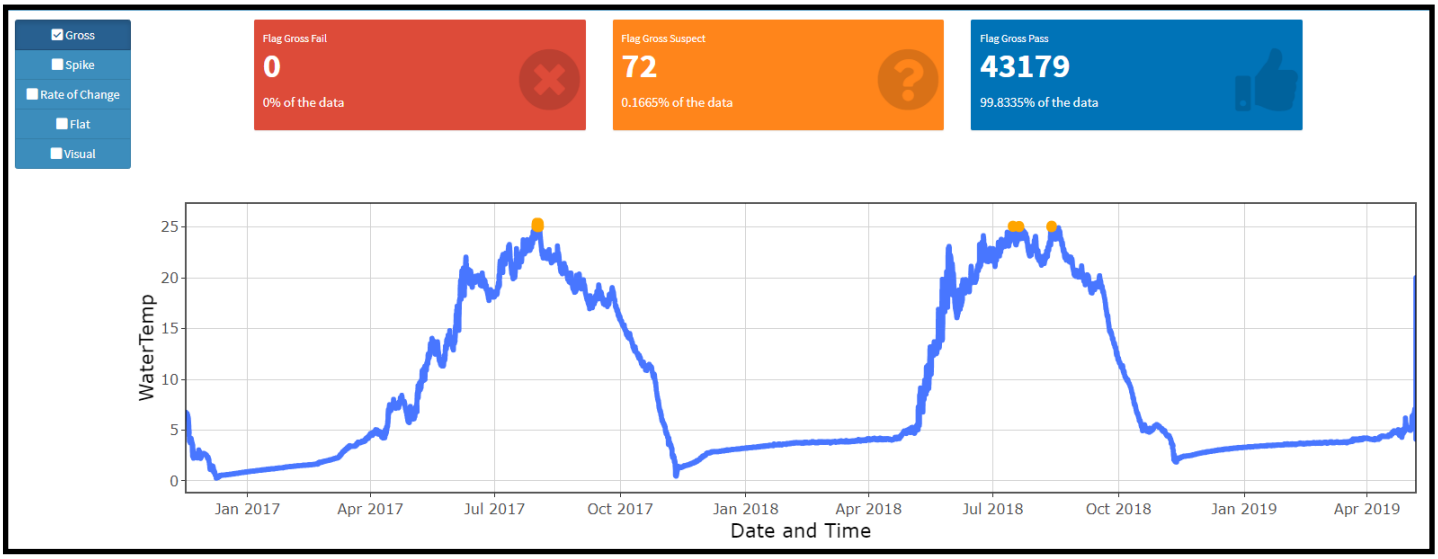
- The top row of the Data Summary displays information about where the data were collected and the equipment used to collect them.

| Program | Waterbody | ID | Type | Station | Location | Logger Model | Deployment Number | Logger Count |
|---|---|---|---|---|---|---|---|---|
| **Minnesota Sentinel Lakes** | **Bear Head** | **69025400** | **Lake** | **Pelagic 1** | **47.78519 , -92.0827** | **HOBO Pro v2 - U22-001** | **1** | **3** |

- The second row provides tools to change the data type and Unit ID to determine the data that are displayed in the box below. It also displays the data's z-value and the start and end dates of all of the data and just the valid data. Valid data refers to the data that passed Visual QC inspection.

| Data Type | Serial_Number | Depth_m | Data Start | Valid Data Start | Valid Data End | Data End |
|---|---|---|---|---|---|---|
| WaterTemp | 10483363 | 1.5 | 2016-11-16 18:00:00 | 2016-11-16 18:00:00 | 2019-05-06 17:00:00 | 2019-05-06 19:00:00 |

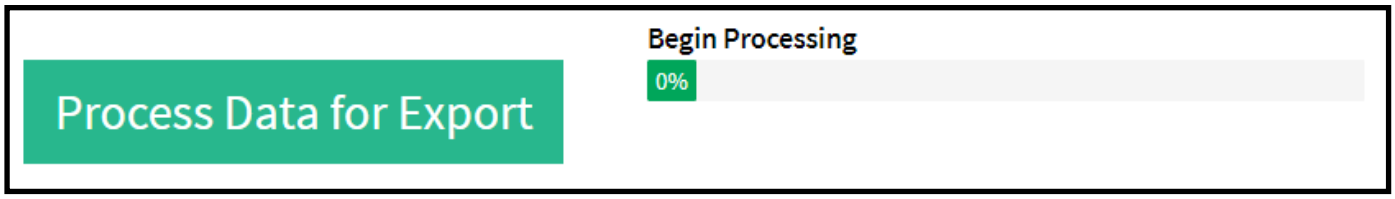
- The bottom part of the screen allows you to select which QC Flag to inspect and provides counts of how many data points were flagged as Fail, Suspect, or Pass for that flag. It also plots the data, showing the location of these flags for the individual logger.



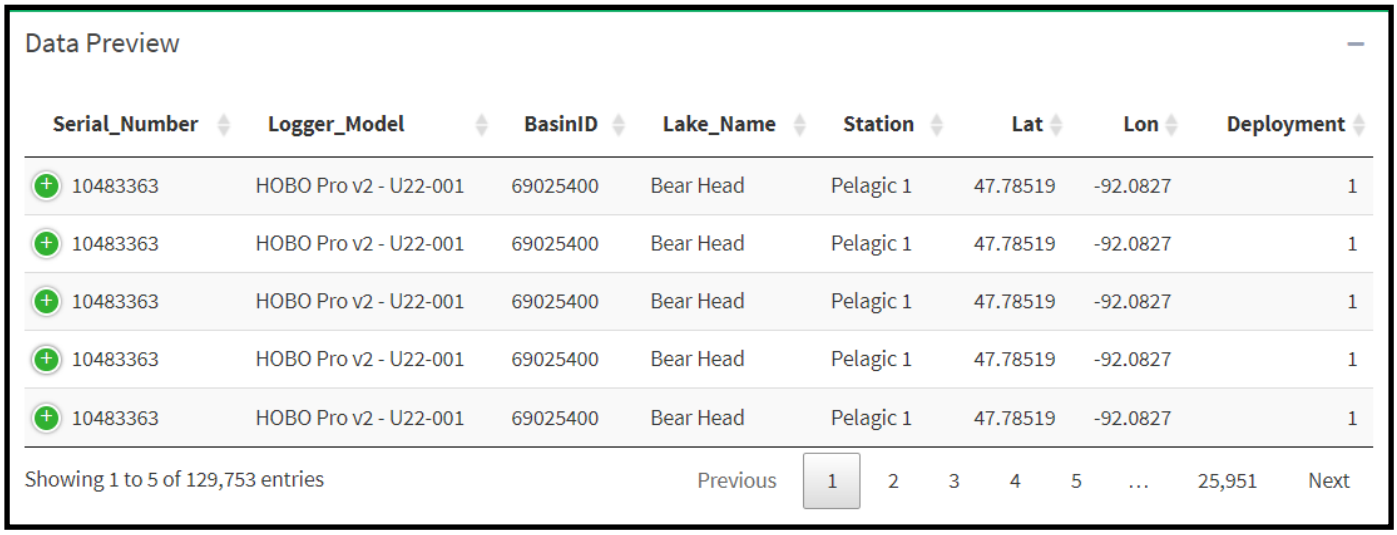
## Export

The export section is the final step in the app. This is where the data are processed for one final review and packaged up for download.

- Click on the Process Data for Export button. The progress bar to the right will begin moving. Note that if the report option has been selected this may take a couple of minutes.

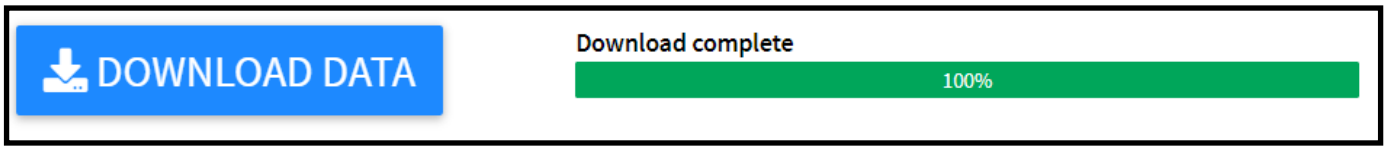



- Once the data processing is complete, the Process Data for Export button will disappear and the Data Preview table will appear. If multiple data types were processed, a dropdown box will appear at the top right of the box allowing you to change between each data type.
- All of the processed data can be explored in the data preview table. Click on the green "+" symbols to view all of the fields for a row.



## Export (Continued)

- After you have reviewed the data, click the Download Data button. The progress bar will indicate which files are being packaged. Once the progress bar reaches 100% the download will be complete.




- The downloaded zip file will be named after the waterbody name and the date the data were processed (e.g. Bear_Head_2022_03_08).
- The files contained in the zip file will depend on the settings selected in the Export Options.
    - App configuration file - baseconfig.RData
    - Processed data file(s) - csv file named after the lake name (e.g. Bear_Head.csv). If multiple data types were processed and the Multiple Files options was selected in the Export Options these files will include the data type (e.g. Bear_Head_Watertemp.csv, Bear_Head_DO.csv)
    - Metadata - csv file containing a variety of metadata relevant to the processed data and named according to the lake name (e.g. Bear_Head_metadata.csv).
    - QC Settings - csv file containing all of the QC Thresholds designated in the QC Settings and named according to the lake name (e.g. Bear_Head_qcsettings.csv).
    - Report - an html file that presents a variety of metadata and statistics about the processed data. It is named according to the lake name (e.g. Bear_Head_report.html).
    - Summary - a csv file containing daily summaries of the processed data. It is named according to the lake name (e.g. Bear_Head_summary.csv).