

Integrated Reporting Improvements

Data Aggregation in Assessment Units

To: Stakeholder Work Group
From: DEQ IR Improvement Project Team

Date: Thursday, Oct. 5, 2017

Introduction

DEQ's Integrated Report is the state's opportunity to utilize scientifically and statistically valid information to assess waterbodies, list those waterbodies that are impaired and prioritize the waterbodies and pollutants for TMDL development. During DEQ's WQ assessment process, three data reviews are performed sequentially:

1. A review of all available data in accordance with the QA/QC criteria outlined in DEQ's *Call for Data* document.
 - **(output #1:** only data meeting QA/QC requirements are retained for further review)
2. Data that meets QA/QC criteria (output #1) are reviewed within each unique assessment unit (AU) and sample results are pooled. Data that have a spatial and temporal bias are aggregated.
 - **(output #2:** the data resulting from this review may contain an aggregation of the assessment data from output #1)
3. The third and final data review is the evaluation of results from output #2 against water quality criteria to determine beneficial use attainment status for each AU.
 - **(output #3:** after this step, each AU is assigned a categorical designation per beneficial use)

This paper describes the data aggregation process to be used during the second sequential data review to develop data output #2. Since this step requires taking all data and reviewing it within each AU, a brief background is provided on DEQ's revised AU development approach.

Historically, DEQ defined assessment units (reported as waterbody segments) based on the monitoring stations where data were available for the assessment cycle and where changes in attainment status between these stations occurred. These waterbody segments were delineated to include all consecutive stations with the same status for each parameter. The approach created many challenges and did not facilitate a biennial, repeatable process to assess data and generate an IR.

The challenges included, overlapping AUs for different parameters, or splitting of an existing AU to create a break between attaining and non-attaining stations. Assessment units (segments) varied in length based on the stations available and were difficult to track though time. Additionally, the overlapping of non-attaining AUs created an overestimation of the number of miles of impaired waters, as the same river miles were counted multiple times for different exceeding parameters. Because of the over estimation, Oregon appears to have more miles of impaired waters than total stream miles actually assessed.



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DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.

In 2016, DEQ began efforts to significantly improve the IR - both in its infrastructure as well as the process by which DEQ evaluates data and reaches assessment conclusions. As a component of DEQ's IR improvement efforts, AUs are being redefined into unique, environmentally relevant reaches. Each AU may contain one or more monitoring stations. Water quality monitoring data derived from sampling efforts within an AU will be pooled. Resultant data will be used to assess whether the beneficial use(s) associated with the AU are supported. The intent of pooling data is to establish a robust dataset that uses all available data to reach an assessment conclusion. In addition during this process, steps need to be taken to eliminate both the potential for spatial and temporal bias.

Development of Assessment Units

Oregon's AUs were re-defined into permanent units in order to incorporate the best available geospatial stream network, increase clarity and transparency, allow for trend analysis, and improve reporting. This redefinition of AUs will result in instances of multiple sampling stations contained within the boundaries of a single AU. DEQ recognizes that a method must be outlined for defining a unique sample result within an AU. The method must include steps to aggregate samples collected within close proximity and at similar times.

Aggregation of spatially/temporally discreet data

Former Practice

In the 2012 IR methodology, DEQ defined AUs based on a combination of previous assessment conclusions and the beneficial uses designated in the WQS. The previous method is summarized below. A more detailed description is found beginning on page 15 of [Oregon's 2012 Assessment Methodology](#).

- Data was assessed at each station individually
- Data at individual sampling sites were evaluated for each specific pollutant or standard and the station was assigned a separate assessment status category for each individual pollutant or standard
- Segments were then delineated based on consecutive stations of matching status
- Portions of segments would be listed based on where exceedances occurred

This approach led to multiple overlapping segments and listings, with a unique segment for each pollutant (Figure 1) and is incompatible with EPA's new ATTAINS reporting requirements of the status of water bodies and accurate number of assessed stream miles in Oregon. The revised approach will result in unique AUs for each water body and overlapping AUs will not occur (Figure 2).

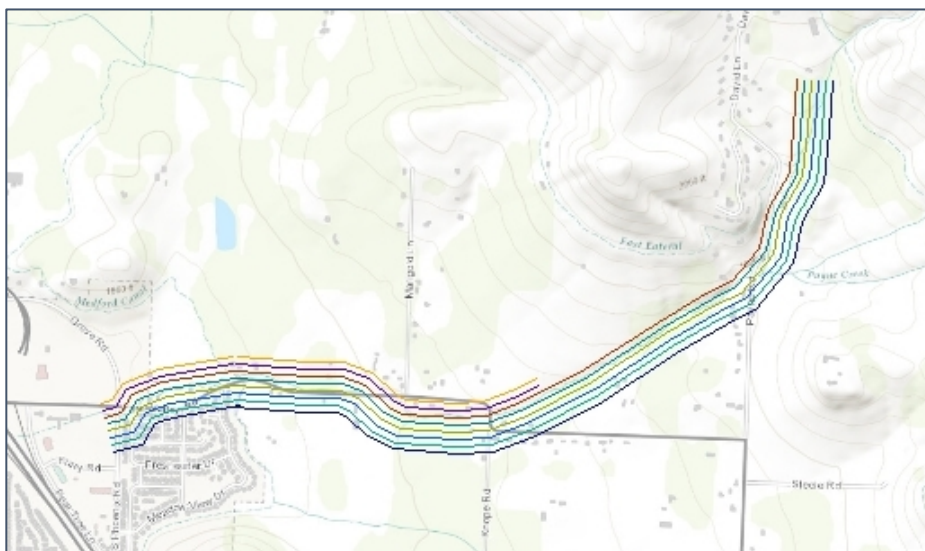


Figure 1. Old AU segmentation

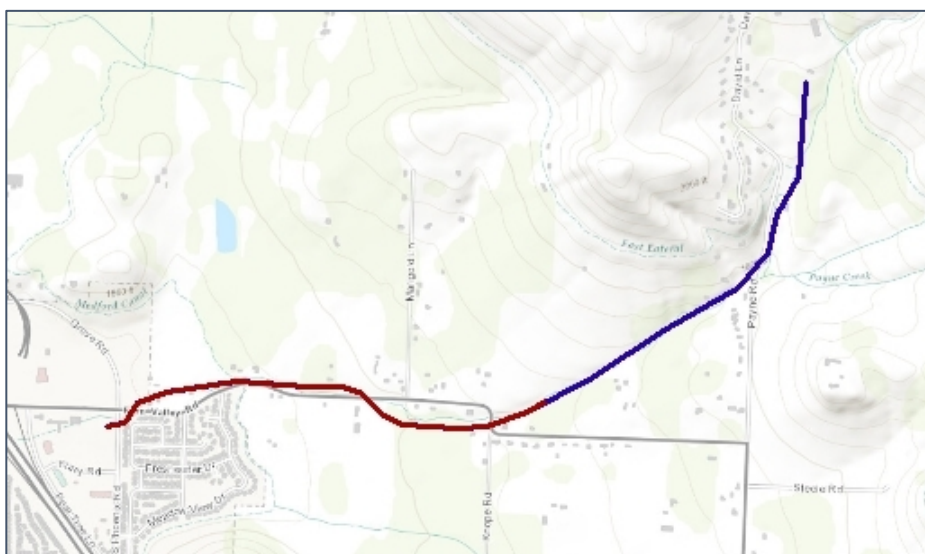


Figure 2. New AUs

Data aggregation methods employed by other states

States employ different methods to account for data collected at multiple sampling stations within an AU. For some states, where multiple stations exist within an AU, and conflicting impairment information occurs, AUs are subdivided into new permanent AUs with only one station. Oregon's decision is to retain unique AUs and not split based on results as was done in the past. As part of DEQ's decision-making process, a cross-section of methodologies employed by other states that do not split AUs based on results are summarized below:

Colorado – Colorado applies assessment techniques that seek to reduce the effects of biased sampling. The median of multiple samples taken in an AU within a seven day period will be used to represent that time period, and information gathered during synoptic (sampling at many locations at the same time) sampling events may be assessed separately. Water quality data may be evaluated differently on a case by case basis if it is determined that data within a seven day period may not be representative of the given seven day sample period (https://www.colorado.gov/pacific/sites/default/files/303d_LM_2018.pdf).

Florida – Except in cases where there is a tributary, point-source discharge, or other significant hydrographical changes nearby, Florida considers samples collected within 200 meters of each other to be the same station. Samples collected from multiple stations within an AU assessed as separate samples, regardless of being collected at the same time. To address this temporal bias, samples collected at the same location less than four days apart are considered as one sample, and the median value is used to represent the sampling period. In addition, any parameter with individual values exceeding acute toxicity level will use the worst case value to represent the sampling period. This worst case value is the maximum value for most parameters, the minimum value for dissolved oxygen, and both the minimum and maximum for pH (<http://www.dep.state.fl.us/legal/Rules/shared/62-303/62-303.pdf>).

New Mexico – In New Mexico, Assessment Units are designed to represent homogenous water quality. If the attainment conclusions for every station in an AU are not in agreement, it is determined that the AU as currently defined may not represent homogeneous water quality. In this case, the AU breaks are examined and may be split appropriately. The data is then re-assessed based on the newly-defined segments. Stations less than one tenth of a mile (approximately 200 yards) apart are rare. In the instance that data for the same parameter are collected within the same hour from nearby stations, data are considered replicates for the purpose of assessment. Maximum or minimum values should be used for assessment purposes, as appropriate to criteria (<https://www.env.nm.gov/wp-content/uploads/2017/03/FINAL-2018-Main-CALM.pdf>).

Washington – Replicate samples taken at the same time and location are averaged, and only one parameter value per day per segment is used in the assessment. As in previously-described states above, the highest measurement per day is used, except for dissolved oxygen (lowest) and pH (both highest and lowest). Field replicate samples are averaged if they are identified as such. Some parameters may be averaged if they are collected both at the same location and within a specified time frame (example: 24-hour averages for metals). Single grab samples within an averaging period will be assumed to represent the averaging period for both acute and chronic (<http://www.ecy.wa.gov/programs/wq/303d/WQpolicy1-11ch1.pdf>).

Analysis

With the new fixed AUs, maintaining the status quo approach of assessing data at the individual parameter and station level is not a viable option. Moving forward, assessment determinations will be assigned for each beneficial use in an AU, not for individual pollutant parameters. DEQ will need to determine the beneficial use attainment status of AUs when data comes from multiple stations within the AU.

Note: *It is important to make the distinction that this method addresses how data will be pooled to quantitatively represent aggregated parameter data in each environmentally relevant AU. A separate “listing/delisting” methodology will be used to assess the data aggregation results with WQS in order to make the categorical determination for each AU.*

As a component of IR improvements, DEQ will pool data within AUs that contain multiple sampling stations. In most cases, this will create robust data sets based on better spatial representation of water quality conditions in an AU. The vast majority of data from most AUs will simply be pooled. However, in some limited cases, pooling of data within an AU creates the potential for either spatial or temporal bias. Spatial bias occurs when samples are located in close proximity to one another (e.g. 200 meters or other agreed upon distance). Temporal bias occurs when samples occur within a similar timeframe (e.g. the same 24-hour period, or other agreed upon time). One such example is, two monitoring stations collected close together within the same stream AU both record a sample for copper on a particular day. If both of these monitoring stations are considered to represent the water body, then these samples may represent the same

conditions, rather than representing different stream conditions within the assessment unit. In this example, if data were simply pooled DEQ could be double counting results. In this paper, we outline a strategy for data aggregation steps to address potential spatial and temporal considerations.

Updated Aggregation Strategy

DEQ proposes to simply pool data from multiple stations in an AU. However, in limited circumstances, there may be a need to determine whether sample results are spatially or temporally the same. Options and steps for this determination are outlined in the following text, and illustrated in Figure 3.

Step 1:

Pool all of the samples collected within an AU as a single data set. This provides a larger dataset than any of the individual stations, resulting in a more robust dataset for assessment decisions.

However, if two or more stations were sampled at the same time (within the same 24-hour calendar day, or other agreed upon time period), and at locations very close together (e.g. 200 meters or other agreed upon distance), they would count as multiple samples, and, if exceedances occurred, be grounds to list, even though we may consider these to be samples representing the same event or condition in the AU. There is a question of how to define what constitutes a single sample result in the AU (Figure 3).

Step 2:

Evaluate whether the sample locations are in close proximity to one another (e.g. 200 meters or other agreed upon distance). If there are no samples within proximity of one another, continue to assess samples independently. If samples are collected in close proximity to one another, then proceed to Step 3.

Step 3:

Evaluate sample results collected in close proximity to one another. If the samples were collected on the same day, 24-hour period or other agreed upon time period the options for aggregating the samples are: (1) take the average, (2) take either the maximum or minimum (if criteria is expressed as a minimum, or both, as applicable), from the sample results. This would count as a single aggregated unique result. Samples collected outside the time period would be assessed as individual sample results. Proceed to Step 4.

Step 4:

All aggregated values and all other data within the AU will be assessed against water quality criteria and the number of exceedances will be determined. Assessment categorical determinations will be made by following the established listing methodologies.

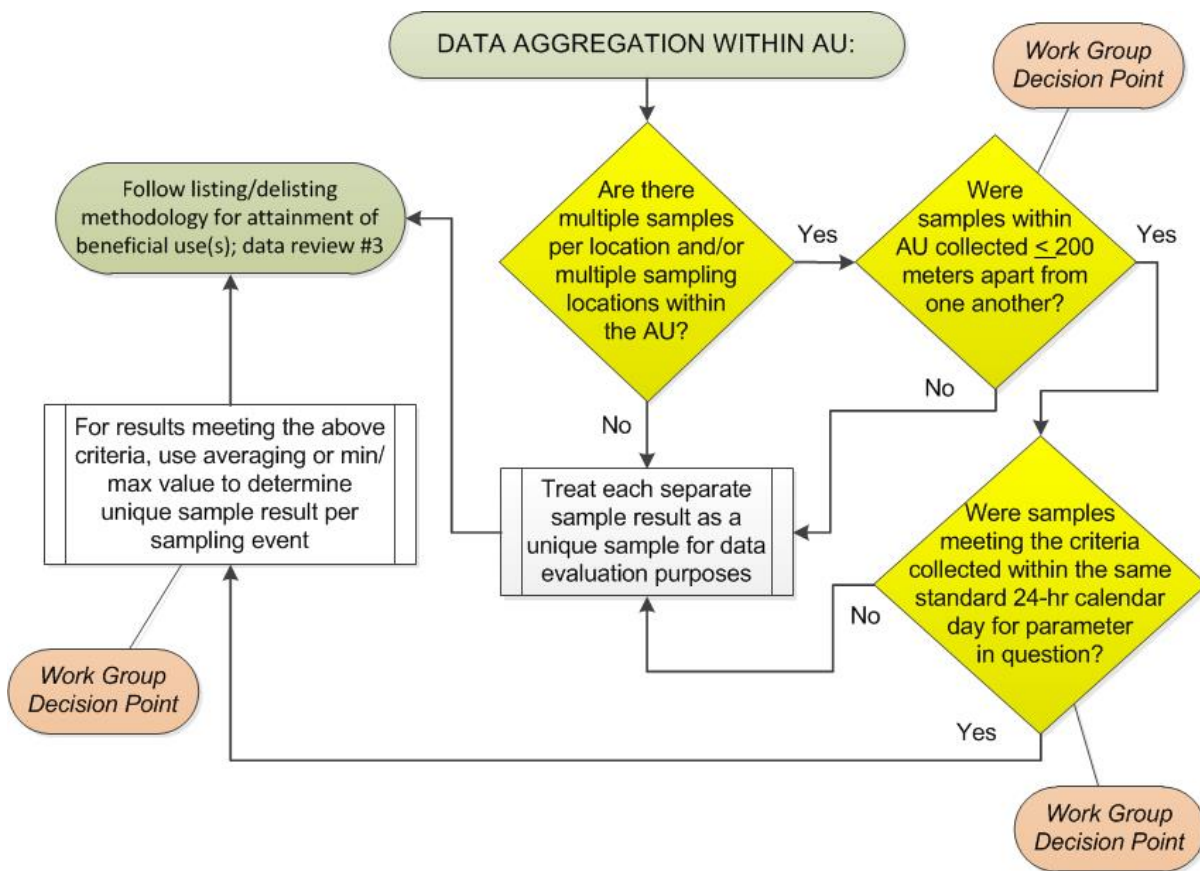


Figure 3. Aggregation decision tree

Conclusion/Recommendation

DEQ is proposing to pool data within Oregon’s new, fixed assessment units. In cases where data exist from multiple stations within an AU, the data will be evaluated hierarchically; first spatially, then temporally (Figure 3). In order to minimize spatiotemporal bias, DEQ proposes to aggregate data collected within a given distance (e.g., 200 meters) along the same flow path and collected within approximately the same time period (24-hour calendar day).

Discussion Points for DEQ Stakeholder Work Group

- Distance between samples to use in defining spatial bias threshold
- Timeframe to use in defining temporal bias threshold
- Method to use for aggregating data points

Alternative formats

Documents can be provided upon request in an alternate format for individuals with disabilities or in a language other than English for people with limited English skills. To request a document in another format or language, call DEQ in Portland at 503-229-5696, or toll-free in Oregon at 1-800-452-4011, ext. 5696; or email deqinfo@deq.state.or.us.