**Modeling Considerations Checklist**

**Purpose:** To ensure all critical elements necessary to determine natural water quality conditions are examined when using the performance-based approach, to model a natural condition scenario for a TMDL, or to develop site-specific criteria.

**Instructions:** Elements listed below must be considered when making a natural condition determination. The shaded items are required to be included in the natural condition model or other determination. *If a non-shaded element is deemed not critical, then you must provide scientific rationale why it was not included in the natural conditions analysis.* Other elements included or considered in the analysis must be added to this list, including how the element was applied in the modeling scenario or determination.

Data collection necessary to evaluate the factors in this checklist must be described in the Quality Assurance Project Plan (QAPP) for the study and/or modeling that supports the TMDL or site-specific criteria development. Information from this checklist will be used to document substantiation of a natural condition determination in a TMDL or other supporting report.

Project Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Supporting QAPP: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Minimum Elements** | **How applied** | **Sources/References**  |
| **Boundary conditions**  |  |  |
| **Channel morphology changes** |  |  |
| **Flow reductions or increases**  |  |  |
| **Hydrologic modifications** |  |  |
| **Invasive species**  |  |  |
| **Microclimate** |  |  |
| **Natural nutrient concentrations** *(required only for DO and pH natural conditions determinations)* |  |  |
| **Nonpoint sources** |  |  |
| **Point source effluent** |  |  |
| **System potential shade** |  |  |
| **Any biological measures or indices that indicate the water body has high quality biological integrity (or a narrative of how the water body is achieving its use through temporal use, refugia, etc.)**  |  |  |
| **Discuss how errors and uncertainty in modeling are addressed** |
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| **Describe the model or other predictive method chosen and why it is the most appropriate method** |
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Definitions:

**Boundary conditions –** Considers upstream inputs to the water body or segment being evaluated for natural conditions. Also must ensure downstream uses and criteria are not adversely affected.

**Channel morphology changes –** Considers channel straightening, dredging, levees, aggregation, and incision

**Flow reductions or increases -** Considers groundwater and surface water changes such as withdrawals and inputs

**Hydrologic modifications –** Considers hydrologic controls such as dams and weirs

**Invasive species –** Considers whether other organisms are affecting the biology or chemistry of the water. For example plants influencing DO/pH levels or carp influencing turbidity and sediment oxygen demand

**Microclimate –** Considers changes in temperature and relative humidity due to increased riparian vegetation to the system potential shade level.

**Point source effluent –** Removes all effect of permitted discharges.

**Natural nutrient concentrations** – Considers whether there are natural nutrient sources contributing to the water chemistry and biology or if there is legacy nutrient contamination. This is required only for DO and pH natural conditions determinations.

**Nonpoint sources –** Factors in land use changes, vegetation removal, and diffuse pollution from human activities.

**System potential shade –** Ensures full water body shading possible under a natural condition is applied.

**Checklist with examples of how and where elements have been applied previously provided as guidance only**

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| **Element** | **How applied** | **Sources/References**  |
| **System potential shade** |  | * All temperature TMDLs
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| **Microclimate** | * Hourly air temps decreased by 2°C
 | * [Deschutes,Cap Lake, Budd Inlet multi-parameter TMDL](https://fortress.wa.gov/ecy/publications/SummaryPages/1203008.html) (Pub# 12-03-008) and others
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| **Channel morphology changes****(e.g. channel straightening, dredging, levees, aggregation, incision)** | * Reduced channel width based on increased channel stability expected from mature riparian buffer
* Removed levees from natural conditions scenario by digitizing historic disturbance zone and channel from 1907 survey (pre-levees). Re-ran shade analysis using new disturbance zone, widths, and riparian buffers. Also altered channel geometry by applying rating curves from an upstream area of the existing conditions model with no levees.
 | * [Deschutes,Cap Lake, Budd Inlet multi-parameter TMDL](https://fortress.wa.gov/ecy/publications/SummaryPages/1203008.html) (Pub# 12-03-008) and [Bear Evans TMDL](https://fortress.wa.gov/ecy/publications/summarypages/0810058.html) (Pub# 08-10-058)
* White River pH TMDL (unpublished)
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| **Flow reductions or increases** **(groundwater and surface water)** | * Historic 7Q10 base flows (increased) were evaluated
* Restored base flows based on estimate of net loss from EIA and water management
 | * [Deschutes,Cap Lake, Budd Inlet multi-parameter TMDL](https://fortress.wa.gov/ecy/publications/SummaryPages/1203008.html) (Pub# 12-03-008)
* [Bear Evans MP TMDL](https://fortress.wa.gov/ecy/publications/summarypages/0810058.html) (Pub #08-10-058) and previous research project
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| **Hydromodifications****(hydrologic controls such as dams and weirs)** | * Removed Capitol Lake dam and modeled as an estuary (added channel of grid cells).
 | * [Deschutes,Cap Lake, Budd Inlet multi-parameter TMDL](https://fortress.wa.gov/ecy/publications/SummaryPages/1203008.html) (Pub# 12-03-008)
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| **Point source effluent** | * Remove effluent in the model
* Adjust effluent temperature to stream background condition
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| **Nonpoint sources****(e.g. Land use changes, vegetation removal, diffuse pollution from human activities)** |  |  |
| **Natural nutrient concentrations; legacy contamination** *(required only for DO and pH natural conditions determinations)* | * Inflection point of nutrient concentrations cumulative distribution from sites throughout basin, including reference sites.
* 25th percentile of tributary values; 5% less than existing headwater values
 | * [Wenatchee TMDL](https://fortress.wa.gov/ecy/publications/summarypages/0603018.html) (Pub# 06-03-018)
* White River pH TMDL (unpublished)
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| **Boundary conditions**  |  |  |
| **Invasive species** **(plants influencing DO/pH levels, carp influencing turbidity and SOD)** | * Elodea nuisance growth increased siltation and amplifies impacts of SOD and reduced reareation
 | * [Clarks Creek DO and Sediment TMDL](https://fortress.wa.gov/ecy/publications/SummaryPages/1410030.html) (Pub# 14-10-030)
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| **Any biological measure or indices that indicate water body has high quality biological integrity (or a narrative of how the water body is achieving its use through temporal use, refugia, etc.)** | Not likely a modeling input but may be included as evidence a water body is or is not providing its beneficial uses | * [Biological Monitoring](http://www.ecy.wa.gov/programs/eap/fw_benth/index.htm)
* [Evaluating Physical Habitat and Water Chemistry Data from Statewide Stream Monitoring Programs to Establish Least-Impacted Conditions in Washington State](https://fortress.wa.gov/ecy/publications/SummaryPages/1503011.html)
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| **Discuss how errors and uncertainty in modeling is being addresses** |
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| **Model or other predictive method chosen and description of why it is the most appropriate method** |
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