Reasonable Potential Process for Copper Using the Biotic Ligand Model

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1 Background

A new Oregon aquatic life water quality standard for copper was approved by EPA in January 2017. The new standard states that the copper criteria are to be based on the Biotic Ligand Model (BLM), which is a metal bioavailability model that uses water characteristics to develop site-specific instantaneous water quality criteria. The following discussion provides an overview of the procedures to determine if the discharge from a permitted facility has a reasonable potential to cause or contribute to exceedances of the model-based criteria.

The OAR 340-041-8033 endnote N states "BLM results from Instantaneous Water Quality Criteria (IWQC) based on sufficient measured input parameter data are more accurate and supersede results based on estimates or default values." IWQC are the protective criteria for Clean Water Act Purposes calculated by the copper BLM from a set of input parameters from a water sample. Ideally, complete, paired sets of input parameter data measured from the effluent and ambient environment upstream of the discharge are available to calculate the applicable IWQC.

Required BLM input parameters:
Temperature (°C)
pH (Standard Units)
Dissolved Organic Carbon (DOC) (mg/L)
Calcium (mg/L)
Magnesium (mg/L)
Sodium (mg/L)
Potassium (mg/L)
Sulfate (mg/L)
Chloride (mg/L)
Alkalinity (mg/L $CaCO_3$ equivalent)

For the purposes of a reasonable potential analysis (RPA) using the BLM, these data sets would be collected over a long enough period to characterize the range of both the upstream ambient receiving waterbody and the effluent copper water chemistry conditions and include the most bioavailable conditions. If the input parameter data is incomplete or unavailable, DEQ will substitute conservative estimates or default values for input parameters to determine protective instantaneous copper criteria and to complete the copper RPA. Substitution of input parameters will be completed based on this procedure using available guidance materials.

2 Purpose

The purpose of this document is to provide DEQ staff a procedure and methodology for evaluating the potential of a point source discharge permittee to exceed the water quality standards for copper. The current water quality criteria for copper are listed in OAR 340-041-8033 table 30 and endnote N.

3 Applicability

a. Reasonable potential to exceed the water quality criteria for copper must be determined for a facility if any one of the following applies:

    i. The facility is required to monitor for copper under existing permit conditions (e.g. is required to perform toxics monitoring).

    ii. When DEQ determines that copper is a pollutant of concern. See RPA IMD for how to determine pollutants of concern.

b. Permittees for which copper is a pollutant of concern must submit a minimum of monthly concurrent samples collected over a two-year period to evaluate the Copper BLM for initial evaluation of site-specific conditions.

    i. Due to variability in local water chemistry conditions, there needs to be enough data to capture the most sensitive of bioavailable conditions. The data should capture both seasonal and inter-annual variability which must be balanced with the length of a permit cycle.

    ii. All data intended to be used to evaluate copper using the BLM will be submitted to DEQ using the specified electronic data delivery method.

c. DEQ has identified copper subject matter experts (SME) who coordinate with water quality permitting and standards staff to refine and implement this methodology. The Copper SMEs are responsible for completing the RPA in accordance with this IMD and providing a memo to the permit writer that includes analytical results, fact sheet language, and permit requirements.

    i. It is the responsibility of the permit writer to determine whether copper is a pollutant of concern and to submit a request to the copper SME for determination of reasonable potential to exceed the water quality criteria.

    ii. Individual point source discharge permittees must provide at minimum concurrent samples of temperature, pH, DOC, specific conductance, and copper from the upstream ambient receiving waterbody and effluent streams. Missing input parameters or parameters rejected due to data quality concerns will be substituted with defaults according to OAR 340-041-8033 Table 30 Endnote N.

    iii. Smaller data sets may be used by the SME when limited data is available or a smaller data set is determined to be sufficient through best professional judgement.

    iv. See monitoring section for monitoring frequency requirements in subsequent permit renewals.

4 Methodology

a. In accordance with DEQ's Regulatory Mixing Zone Internal Management Directive Part 1and Part 2, acute criteria must be met at the edge of the zone of initial dilution (ZID) and chronic criteria at the regulatory mixing zone (RMZ). Additionally, DEQ will determine whether chronic criteria are met at 100% mix to ensure that copper toxicity does not occur outside of the RMZ. The standard methodology for determining whether a discharge has a reasonable potential to cause or contribute to exceedances of toxic water quality criteria is to first determine the applicable acute and chronic criteria, and then to determine whether the expected concentrations of the toxic pollutant in the effluent have a reasonable potential to exceed these criteria during site specific scenarios. BLM generated instantaneous water quality criteria are developed using input parameter data covering a range of environmental (for receiving waterbody ambient) and operational (for effluent) conditions. From these data sets, DEQ derives acute and chronic instantaneous water quality criteria that are protective of water quality beneficial uses.

b. To derive sets of instantaneous water quality criteria, measured or conservative estimates of mixed concentrations of BLM input parameters must be determined. The RPA will use a simple mass-balance equation to determine the mixed concentration of the BLM input parameters for the ZID, RMZ, and at 100% mix.

    i. For detailed instructions on inputs and outputs used for the BLM, refer to specific instructions embedded into the RPA worksheet

c. All analysis must be conducting using approved EPA methods according to 40 CFR part 136

d. General procedure:

    i. Permittees provide two years of concurrent monthly samples for copper and BLM input parameters for both the effluent and the receiving water.

        1. Minimum BLM input parameters required will be temperature, pH, specific conductance and DOC. The permittee may collect the additional geochemical ion and alkalinity input parameters if desired.

        2. In the event 24 months of concurrent monthly samples are not available, follow the directions for "incomplete data sets" and "no data sets" below. Permit writers will not delay permit development to wait for data collection.

    ii. Dilutions used in the mixed value calculations are identified by the mixing zone SME and represent a conservative value developed using low flow conditions for the Z ZID, RMZ, and at 100% mix.

    iii. Calculate concentration of copper and each required input parameters by mass balance for each set of monthly samples at the edge of ZID, RMZ, and at 100% mix:

    iv. Calculate the IWQC using the BLM model for each set of samples at the edge of the ZID, RMZ, and at 100% mix

    v. Compare the mixed copper concentration to the corresponding IWQC at the edge of the ZID (acute), RMZ (chronic), and 100% mix (chronic) for that sampling date.

vi. A dissolved copper concentration exceeding the corresponding IWQC indicates reasonable potential to exceed the IWQC. Because the criteria is in the dissolved fraction, the use of total recoverable copper will not be used to determine reasonable potential. If dissolved copper is not available, total recoverable copper may be used to determine if additional monitoring is needed (see Monitoring section).

5 Data analysis

a. Determine reasonable potential for pollutant to exceed water quality criteria using a paired data set. This analysis assumes permittees submit all 24 samples of copper and required BLM input parameters measured in the field for effluent and upstream ambient receiving waterbody.

   a. Data requirements:

Paired Data Set[1]	
Ambient Data	**Effluent Data**
• Concurrent BLM input parameters for the ambient upstream[2] of the discharge location • Data must be collected at the same time and location for all BLM input parameters a. pH b. DOC c. Temperature d. Dissolved[3] major ions or specific conductance e. Dissolved and total copper • 24 months[4] of data are available and concurrent with effluent data	• Concurrent BLM input parameters for the effluent stream • Data must be collected at the same time and location for all critical BLM input parameters: a. pH b. DOC c. Temperature d. Dissolved[3] major ions or specific conductance e. Dissolved and total copper • 24 months[4] of data are available and concurrent with ambient upstream data

   b. Calculate[5] the BLM input parameter concentrations at edge of ZID, RMZ, and at 100% mix for each paired data set.

   c. Enter the respective input parameter concentrations into the BLM software to calculate a set of instantaneous water quality criteria.

[1] Paired data refers to concurrent samples that have been taken from two locations (upstream ambient and effluent) within 24 hours of each other.
[2] Preferred upstream location is one that does not include permitted discharges, major confluences and is appropriate for safe sampling procedures. Alternate locations may be considered for safety, accessibility or existing monitoring stations that collect appropriate data. Best professional judgement may be used for upstream locations that are not preferred or alternate locations and must be representative of the conditions at or near the outfall.
[3] Dissolved results are preferred, total recoverable results may be used.
[4] Smaller data sets may be used if the data is adequate to represent the variability of the stream and seasonal conditions; rationale must be included in the permit fact sheet.
[5] Calculations are described and listed in detail in the copper BLM RPA worksheet.

1. See *Implementation of the Freshwater Aquatic Life Water Quality Standards for Copper and Software instructions* for guidance on entering data into the copper BLM software.

2. Compare each day's IWQC to the corresponding effluent copper concentration by dividing the mixed concentration (ZID, RMZ, and 100% mix) by the IWQC. The result is a toxic unit.

3. Toxic units greater than 1.0 that can be attributed to the effluent copper concentration indicate reasonable potential to exceed the water quality criteria.

b. Determine reasonable potential for pollutant to exceed water quality criteria using an incomplete data set. This analysis incorporates the use of established defaults and statistical estimates in place of missing BLM input parameters

    a. Note that this scenario is for situations where some data are available but not complete (e.g. have effluent data but no ambient data or have paired ambient and effluent data set but are missing input parameters). If the data set is paired, but is less than 24 samples, an analysis will be done only with the data available (e.g. if 18 data sets are available, then the analysis is run with the 18 and with no use of defaults to make up the remaining six samples). The presence of paired copper data is the deciding factor in whether a data set will be included in an analysis.

b. Data requirements:

Incomplete Data Sets[6]	
Ambient Data	**Effluent Data**
• When ambient data is either not concurrent, or is concurrent but missing input parameters follow the input parameter substitution and estimation procedures outlined in Endnote N (1) and (2) of Table 30: a. If there is no pH data use 10th percentile from closest representative data source[7]. b. If there is no temperature data use the monthly mean temperature from closest representative data source[7] c. If data is non-detect: use defaults if MRL is above default, or use ½ DL if MRL is below default.	• When effluent data is either not concurrent, or is concurrent but missing input parameters follow the input parameter substitution and estimation procedures outlined in Endnote N(1) and (2) of Table 30: a. DOC, use default specified below. b. If no pH data, use 10th percentile from DMR data c. If no temperature data, use monthly mean temperature from DMR data d. If data is non-detect: use defaults if MRL is above default, use ½ DL if MRL is below default. • Where concurrent effluent data is not available: a. Follow the input parameter substitution and estimation procedures outlined in Endnote N(1 and 2) of Table 30

a. Calculate the BLM input parameter concentrations at edge of ZID, RMZ, and at 100% mix for each data set.

b. Enter the respective input parameter concentrations into the BLM software to calculate a set of IWQCs.

1. When effluent DOC values are not available for domestic facilities, use 6.46 mg/L as a default.

(a.) Rationale: The DOC default is based on the 20th percentile of DOC data from domestic wastewater sources in Oregon (see the ORDEQ Memo "DOC Default for Domestic POTW Majors").

c. Compare each day's IWQC to the corresponding effluent copper concentration by dividing the mixed concentration (ZID, RMZ, and 100% mix) by the IWQC. The result is a toxic unit. Toxic units greater than 1.0 that can be attributed to the effluent copper concentration indicate reasonable potential to exceed the water quality criteria.

[6] Unpaired data set includes a mixture of concurrent, missing and estimated samples taken from upstream ambient and effluent locations. Missing ambient and effluent samples are replaced using substitutions or geo region defaults designated in the *Implementation of the Freshwater Aquatic Life Water Quality Standards for Copper*.
[7] Closest representative data sources are ideally within the same Assessment Unit or the next Assessment Unit upstream

1. If 10% or more of the toxic units are greater than 1.0 and the results are not inconclusive (see item 3 below), there is reasonable potential, and the permittee will be given an effluent limit.

2. The copper SME should carefully evaluate the data when less than 10% of the toxic units are greater than 1.0. If the data is sound (does not fall into the inconclusive category (see 3.b. below)) and there is reasonable potential, then the permittee will be given an effluent limit.

3. When the results are inconclusive, the copper team will indicate that copper is a pollutant of concern and include monitoring for 24 concurrent data sets as described in section 8 (Monitoring). The use of substitutions according to Table 30 Endnote N does not render data to be inconclusive. Inconclusive results include:

   (a.) TUs greater than 1 based on total recoverable copper results (either for effluent or ambient copper).

   (b.) If substitute ambient pH or temperature data used in the RPA is not from the same Assessment Unit the permittee discharges into or the next Assessment Unit upstream.

b. Determine reasonable potential for pollutant to exceed water quality criteria using a 'no data' set

   a. Note that this scenario is for situations where there is no paired copper data, but some effluent copper data or estimate of effluent copper concentrations exist that can be compared to the IWQC.

   b. Data Requirements:

No Data Set	
Ambient Data	**Effluent Data**
• Follow the input parameter substitution and estimation procedures outlined in Endnote N (1) and (2) of Table 30. a. If there is no pH data use 10th percentile from closest representative data source[7]. b. If there is no temperature data use the mean temperature from closest representative data source[7] i. This needs to be done once: subsequent entries will be equal.	• Follow the input parameter substitution and estimation procedures outlined in Endnote N (1) and (2) of Table 30 a. If there is no pH data, use 10th percentile from DMR data b. If there is no temperature data, use the monthly mean temperature from DMR data

c. Use the default action values or substitution criteria to calculate the BLM input parameter concentrations at the edge of the ZID, RMZ, and at 100% mix

    1. When effluent DOC values are not available for domestic facilities, use 6.46 mg/L.

        (a.) Rationale: The DOC default is based on the 20th percentile of DOC data from domestic wastewater sources in Oregon (see the ORDEQ Memo "DOC Default for Domestic POTW Majors").

d. Enter the respective input parameter concentrations into the BLM software to calculate an IWQC.

e. Calculate the maximum estimated effluent concentration using the TSD methodology found in section 3.3.2[8]. For ambient copper, use either the 90th percentile of copper data (if more than 4 samples) or the maximum ambient copper concentration (if fewer than 4 samples) in the Assessment Unit the permittee discharges into or the next Assessment Unit upstream. If there is no ambient copper data within this area, use the average copper value for the HUC 8 watershed.

f. Compare the IWQC to the maximum estimated effluent copper concentration by dividing the mixed concentration (ZID, RMZ, and 100% mix) by the IWQC. The result is a toxic unit.

g. Toxic units greater than 1.0 that can be attributed to the effluent copper concentration where the results are not inconclusive (see item 1 below) indicate reasonable potential to exceed the water quality criteria.

    1. When the results are inconclusive, the copper team will indicate that copper is a pollutant of concern and include monitoring for 24 concurrent data sets as described in section 8 (Monitoring). The use of substitutions according to Table 30 Endnote N does not render data to be inconclusive. Inconclusive results include:

        (a.) TUs greater than 1 based on total recoverable copper results (either for effluent or ambient copper).

        (b.) If substitute ambient pH or temperature data used in the RPA is not from the same Assessment Unit the permittee discharges into or the next Assessment Unit upstream.

6 Develop effluent limits

a. When data analysis results in reasonable potential to exceed the water quality criteria, the copper SME will calculate limits according to the methodology found in the EPA TSD Section 5.4 and 5.5 using the 10th percentile of the IWQC calculated for the acute (ZID) and chronic (RMZ and 100% mix) criteria.

[8] Technical Support Document for Water Quality-based Toxics Control. USEPA Office of Water, EPA/505/2-90-001 PB91-127415, March 1991

b. Limits are required to be in the total recoverable fraction (40 CFR 122.45(c)). Site specific translations from dissolved to total recoverable can be developed according to the EPA guidance "The Metals Translator: Guidance for Calculating a Total Recoverable Permit Limit from a Dissolved Criterion"[9].

    i. In the absence of a site-specific translator, a conservative translator of 1 will be applied to convert limits into the total recoverable fraction[10].

c. Copper monitoring frequency for the effluent limit will be the same as for any other toxic pollutant with limits. See monitoring matrix.

7 Communication with permit writer

Once the RPA is completed, the SME will prepare a memo to the permit writer communicating the rational for the RPA, required schedule B monitoring, draft fact sheet language, schedule A limits (if necessary), and notes regarding any deviations from the process outlined in this document. This memo will be saved in the permit development folder.

8 Monitoring

a. All permittees that have copper as a pollutant of concern will be required to monitor at a minimum for ambient and effluent copper, temperature, pH, DOC, and specific conductance in schedule B of the permit.

b. Once a facility has submitted 24 concurrent sample sets and the evaluation determines there is no reasonable potential to exceed the water quality criteria for dissolved copper, monitoring will be:

    i. Correlated with the priority pollutant toxics sampling (12 samples quarterly over 3 years – see monitoring matrix).

    ii. If dissolved copper was unavailable and a total recoverable copper concentration exceeds the corresponding IWQC, then an additional 24 monitoring events will be required in the new permit beginning in January of the second year of the permit cycle.

c. Deviations from item 8.b must be justified in the fact sheet.

    i. Evaluation of toxic units should be a primary factor in increasing or decreasing monitoring requirements.

    ii. When a seasonal pattern is recognized, the copper SME can require more, or less monitoring during those seasons.

[9] U.S. EPA Office of Water (4305) EPA 823-B-96-007 June 1996

[10] OAR 340-041-8033 Endnote F specifies conversion factors for dissolved to total recoverable metals criteria. However, there is no conversion factor for freshwater copper.

9 Special considerations

a. Currently, there are no established statewide or regional translations between total recoverable and dissolved copper concentrations. Partitioning between total and dissolved copper can change due to changing water quality conditions (e.g. temperature, pH, DOC). Site specific translations can be developed according to the EPA guidance "The Metals Translator: Guidance for Calculating a Total Recoverable Permit Limit from a Dissolved Criterion"[9].

    i. It is not expected that the partitioning between total and dissolved copper will change for domestic discharges.

    ii. For industrial facilities, the partitioning between total and dissolved may be more likely to change depending on how different the industrial discharge is compared to the ambient water.

b. Regional default values should not be used in place of measured data. Because the defaults use the 20th percentile, they may be less conservative in certain scenarios.

c. Additional discharge scenarios

    i. Ocean or saline receiving water – do not run BLM.

        i. DEQ policy is to apply the freshwater criterion in estuarine environments when the 90th percentile salinity is below 1 ppt and to apply the salt water criterion when the 90th percentile salinity is greater than 10 ppt. If the salinity lies between these values, DEQ policy is to run both a freshwater and a saltwater analysis and apply the more conservative limits (if any) resulting from the two analyses.

    ii. No mixing zone

        i. End of pipe analysis.

        ii. Consider potential impacts to the receiving stream

    iii. Seasonal or intermittent dischargers

        i. The permittee is still required to collect 24 concurrent samples for initial evaluation. The permittee will only be required to sample during the months in which a discharge occurs. Note that this will likely take longer than two years and should be accounted for when establishing copper BLM monitoring.

10 Record of revisions to directive

Revision	Date	Changes	Editor
v1.0	9/3/2024	Development of guidance into IMD	Aliana Britson