

# Instructions for BOD<sub>5</sub> to CBOD<sub>5</sub> Substitution in NPDES Permits

Revision 3.0



**Water Quality Policy  
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## 1. Intent/Purpose/Statement of Need

This directive clarifies DEQ’s policy and implementation procedures on the substitution of five-day carbonaceous biochemical oxygen demand (CBOD<sub>5</sub>) for five-day biochemical oxygen demand (BOD<sub>5</sub>) in technology-based effluent limits in NPDES permits.

## 1.1 Authority

Under 40 CFR 133.102, DEQ, at its discretion, may substitute CBOD<sub>5</sub> limits for BOD<sub>5</sub> limits to meet federal secondary treatment standards. Under Oregon Administrative Rules (OAR), including OAR 340-041-0007(15), DEQ has the authority to establish NPDES permit limits to implement state minimum design criteria. Also, under 40 CFR 133.105, where data exist to establish CBOD<sub>5</sub> limits, DEQ may substitute CBOD<sub>5</sub> limits for BOD<sub>5</sub> limits to meet federal equivalent to secondary treatment standards.

## 1.2 Applicability

This directive provides instructions to Oregon NPDES permit development staff for evaluating and setting technology-based effluent limits in NPDES individual permits for the following conditions:

- The existing permit contains CBOD<sub>5</sub> limits or the facility requests a substitution of CBOD<sub>5</sub> limits for the existing BOD<sub>5</sub> limits;<sup>1</sup> and
- The limits are based on either federal secondary standards, federal equivalent to secondary standards or state basin-specific design standards.

This IMD is not directly applicable to the implementation of BOD wasteload allocations (WLAs) associated with TMDLs, or any BOD water quality-based effluent limits that are more stringent than the applicable technology-based effluent limits.<sup>2</sup>

## 1.3 Definitions

- **BOD<sub>5</sub>** (five-day biochemical oxygen demand) means a measurement of the amount of oxygen used by the bacteria as they stabilize the organic matter over a five-day period at 20°C.
- **CBOD<sub>5</sub>** (five-day carbonaceous biochemical oxygen demand) means a measurement of the amount of oxygen demand over a five-day period exerted by organic (carbonaceous) compounds, excluding the oxygen demand exerted by the nitrogenous compounds.
- **NOD** (nitrogenous biochemical oxygen demand) means the oxygen demand exerted by nitrogenous compounds.
- **Conversion factor** means an arithmetic multiplier for converting a quantity expressed in BOD<sub>5</sub> into an equivalent expressed in CBOD<sub>5</sub>.

## 2. Summary

The Clean Water Act requires that wastewater treatment plants provide a minimum level of treatment. For publicly owned treatment works (POTWs), federal regulations establish Secondary Treatment Standards for BOD<sub>5</sub>, suspended solids (SS) and pH. Problems have arisen with the use of the BOD<sub>5</sub> testing at some municipal secondary facilities. When sufficient numbers of nitrifying-bacteria are present in the test sample, they can exert a significant nitrogenous oxygen demand (NOD) in the BOD<sub>5</sub> test that would not be exerted in their absence.<sup>3</sup> This may lead to inaccurate assessment of compliance with federal

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<sup>1</sup> This could be for either the scenario where the existing permit already includes the substitution, or where the existing permit contains BOD<sub>5</sub> limits.

<sup>2</sup> Any effluent limit associated with a TMDL WLA will need to be consistent with the TMDL.

<sup>3</sup> From Federal Register/Vol.49, No. 184/Sept. 20, 1984, page 36988:

<https://cdn.loc.gov/service/ll/fedreg/fr049/fr049184/fr049184.pdf>.

secondary standard limitations and state design criteria. To address this concern regarding secondary standards, 40 CFR 133.102(a)(4) and 40 CFR 133.105(e) provide the permitting authority (DEQ) the option to substitute the BOD<sub>5</sub> effluent limit with a CBOD<sub>5</sub> limit.

EPA has established CBOD standards for cases where secondary treatment standards or equivalent to secondary treatment standards are applied. However, implementation of Oregon's Minimum Design Criteria<sup>4</sup> may result in BOD<sub>5</sub> limits for treated sewage<sup>5</sup> that are more stringent than the applicable federal secondary standards. The federal rules do not address this situation. When including permit limits based on these design criteria, the DEQ permit writer may use the guidance in this IMD to substitute CBOD<sub>5</sub> for BOD<sub>5</sub> in accordance with the methods described in this IMD.

## 3. Background

In 1984, EPA promulgated rule revisions allowing for the substitution of CBOD<sub>5</sub> for BOD<sub>5</sub> when implementing federal secondary and equivalent to secondary standards. The federal register promulgating these rule revisions<sup>6</sup> explained the rationale for the changes:

*The Agency is allowing substitution of the CBOD<sub>5</sub> parameter for the BOD<sub>5</sub> parameter, because it believes that this parameter is a better reflection of the understood meaning of secondary treatment in terms of measuring the removal of carbonaceous organic materials by secondary treatment for certain POTWs. In addition, the Agency believes that implementation of CBOD<sub>5</sub> test procedures should eliminate the counter-productive operating practices that were noted above since incidental nitrification will no longer affect test results.<sup>7</sup>*

The rule revisions pertain to the implementation of both secondary standards for BOD<sub>5</sub>, and equivalent to secondary standards for BOD<sub>5</sub>. These rules and their implementation are discussed in more detail below.

In addition to the federal secondary standards for BOD<sub>5</sub>, OARs contain general and basin-specific minimum design criteria for the treatment and control of sewage wastes. These design criteria include BOD<sub>5</sub> concentrations and may be implemented in permits as either CBOD<sub>5</sub> or BOD<sub>5</sub> limits. These rules and their implementation are discussed in more detail below.

## 4. Directive

### 4.1 Implementing Federal Secondary Standards

#### Secondary Standards

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<sup>4</sup> OAR 340-041-0007(15).

<sup>5</sup> "Sewage" is defined in OAR 340-041-0002(57) as the water-carried human or animal waste from residences, buildings, industrial establishments, or other places together with such groundwater infiltration and surface water as may be present. The admixture with sewage of industrial wastes or wastes, as defined in this rule, may also be considered "sewage" within the meaning of this division.

<sup>6</sup> Federal Register/Vol.49, No. 184/Sept. 20, 1984 <https://cdn.loc.gov/service/ll/fedreg/fr049/fr049184/fr049184.pdf>.

<sup>7</sup> Ibid, page 36988.

Under federal regulations and guidance,<sup>8</sup> a permit writer may substitute CBOD<sub>5</sub> for BOD<sub>5</sub> when applying federal secondary standards. This substitution should take place if a permittee requests the substitution, or if a permit containing CBOD<sub>5</sub> limits is being renewed and the permittee has not requested BOD<sub>5</sub> limits.<sup>9</sup> The monitoring requirements included in permits to determine compliance with the CBOD<sub>5</sub> limits must be for CBOD<sub>5</sub>.

The CBOD<sub>5</sub> limits to be included in these permits are:

- 25 mg/L as a monthly average
- 40 mg/L as a weekly average
- 85% removal as a monthly average

These limits are substitutes for the 30 mg/L (monthly average), 45 mg/L (weekly average), 85% removal (monthly average) BOD<sub>5</sub> limits used to address federal secondary standards. The substitution may be applied seasonally or year-round.

### **Equivalent to Secondary Standards**

Federal regulations and guidance also allow permit writers to substitute CBOD<sub>5</sub> for BOD<sub>5</sub> when applying federal equivalent to secondary standards. However, the applicable regulation<sup>10</sup> only allows this substitution “(w)here data are available to establish CBOD<sub>5</sub> limitations ...”. The federal register promulgating these rule revisions explains that the required data are expected to be parallel CBOD<sub>5</sub> and BOD<sub>5</sub> data submitted by the permittee. These data would be used by DEQ to help establish CBOD<sub>5</sub> limits when applying federal equivalent to secondary standards. The regulations state that the resulting CBOD<sub>5</sub> limits may not be less stringent than the following:

- 40 mg/L as a monthly average
- 60 mg/L as a weekly average
- 65% removal as a monthly average

In order to substitute CBOD<sub>5</sub> for BOD<sub>5</sub> when applying federal equivalent to secondary standards, the permittee should request the substitution, and submit parallel CBOD<sub>5</sub> and BOD<sub>5</sub> effluent data. The data should be collected during periods of cool weather and while the facility is achieving at least the 45 mg/L (monthly average), 65 mg/L (weekly average), and 85% removal (monthly average) BOD<sub>5</sub> limits. DEQ permitting staff will then analyzed the data to determine the relationship between the CBOD<sub>5</sub> and BOD<sub>5</sub> data, and then develop a conversion factor to be used to establish appropriate CBOD<sub>5</sub> limits.<sup>11</sup> The substitution may be applied seasonally or year-round.

## **4.2 Implementing State Design Criteria**

As noted above, the implementation of Oregon’s Minimum Design Criteria<sup>12</sup> may result in BOD<sub>5</sub> limits for treated sewage<sup>6</sup> that are more stringent than the applicable federal secondary standards. The federal rules do not address the substitution of CBOD<sub>5</sub> limits for BOD<sub>5</sub> limits when applying these criteria.

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<sup>8</sup> 40 CFR 133.102 and U.S EPA’s *NPDES Permit Writer’s Manual*, September 2010, page 5-10.

<sup>9</sup> As explained in the federal register promulgating these rule revisions, no facility-specific data or information is required to implement this substitution (Federal Register/Vol.49, No. 184/Sept. 20, 1984, p. 36999).

<sup>10</sup> 40 CFR 133.105(e).

<sup>11</sup> These requirements are based on the data collection and analysis process EPA used to determine the CBOD<sub>5</sub> limits for secondary standards. The process is explained in Federal Register/Vol.49, No. 184/Sept. 20, 1984, p. 37000.

<sup>12</sup> OAR 340-041-0007(15) and associated basin-specific criteria in OAR 340-041.

It is DEQ's policy that permit writers may substitute CBOD<sub>5</sub> for BOD<sub>5</sub> when including permit limits to implement Oregon's Minimum Design Criteria. This substitution may take place if a permittee requests the substitution, or if a permit containing CBOD<sub>5</sub> limits is being renewed and the permittee has not requested BOD<sub>5</sub> limits. The substitution may be applied seasonally or year-round. As with substitution of CBOD<sub>5</sub> for BOD<sub>5</sub> for federal standards, the permit must include CBOD<sub>5</sub> (nitrogen inhibited) monitoring .

When including CBOD<sub>5</sub> limits to implement Oregon's Minimum Design Criteria, the use of a CBOD<sub>5</sub>/BOD<sub>5</sub> conversion factor is necessary. The two options for calculating and assigning a conversion factor are:

- **Default Conversion Factor (CBOD<sub>5</sub>:BOD<sub>5</sub>).** Based on the ratios of the CBOD<sub>5</sub> to BOD<sub>5</sub> concentrations used in the implementation of federal secondary standards.
  - 0.8 for the 30-day average limit, derived from the federal substitution relationship of 25 mg/L CBOD<sub>5</sub> to 30 mg/L BOD<sub>5</sub>
  - 0.9 for the 7-day average limit, derived from the Federal substitution relationship of 40 mg/L CBOD<sub>5</sub> to 45 mg/L BOD<sub>5</sub>
- **Site-specific Conversion Factor.** A site-specific conversion factor may be determined based on a parallel monitoring study or engineering study to quantify the CBOD<sub>5</sub>/BOD<sub>5</sub> concentration relationship. The derivation of this conversion factor should generally follow the same process used by EPA for deriving the conversion factor related to the federal equivalent to secondary standards.

## 5. Record of Revisions to IMD

Revision	Date	Changes	Editor
1.0	8/17/2017	First Version	Spencer Bohaboy
2.0	2/1/2018	Final Version	Jeff Navarro
3.0	5/13/2021	Corrections to ensure consistency with rules and guidance	Rob Burkhart