APPENDIX A. LOADING CAPACITY

Waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources represent the allocated portions of a receiving water's **loading capacity**. The loading capacity is the greatest amount of loading that the river can receive without violating water quality standards. A TMDL must not exceed the loading capacity of a waterbody. To determine the appropriate loading capacity available for allocation requires:

- the **water quality standard** applicable to 2,3,7,8-TCDD and the Columbia River basin.

- the **river flows** used to calculate the loading capacity of the Columbia River basin at key locations.

1. Applicable Water Quality Standards

The pollutant of concern for this TMDL, 2,3,7,8-TCDD, is the most toxic of a group of compounds known as polychlorinated dibenzo-para-dioxins. These compounds are produced as a result of human activities such as the manufacture of chlorinated herbicides, the combustion of domestic and industrial wastes, and the production of chlorine-bleached pulp.

Oregon, Washington, and Idaho have adopted water quality standards for toxic substances which apply to parts of the Columbia River basin including the Snake and Willamette Rivers. Because the purpose of this TMDL is to provide a framework for attaining all applicable water quality standards for dioxin, this multi-state TMDL must be protective of the waters with the most stringent of those standards. A brief description of individual state standards follows.

Oregon has adopted a numeric criterion for 2,3,7,8-TCDD. Oregon Administrative Rules (OAR) Chapter 340, Division 41 summarizes water quality criteria for toxic substances applicable to all basins. This includes the Columbia River from its mouth to river mile 309 and the Willamette River from its mouth to river mile 187. OAR 340-41-205(p)(B), for example, states:

> *"Levels of toxic substances shall not exceed the most recent criteria values for organic and inorganic pollutants established by EPA and published in Quality Criteria for Water (1986). A list of the criteria is presented in Table 20."*

The ambient water concentration listed in Table 20 for protection of human health from carcinogenic effects caused by 2,3,7,8-TCDD is 0.000013 ng/L, or 0.013 parts per quadrillion (ppq). This value represents the 10^{-6} risk level, the concentration at which a lifetime exposure results in a probability of one excess cancer case per one million people. It considers the consumption of contaminated water as well as fish or other aquatic organisms.

Washington has identified the Columbia River from the mouth to river mile (RM) 596.6 as a Class A waterbody and from RM 596.6 to the Canadian border (RM 745) as a Class AA waterbody. Washington has also identified the Snake River from the mouth to RM 176.1 as a Class A waterbody. Washington's rules which apply to toxic substances are found in WAC 173-201-047. The narrative part of the rule indicates that:

> *"Toxic substances shall not be introduced above natural background levels in waters of the state which may adversely affect characteristic water uses, cause acute or chronic conditions to the aquatic biota, or adversely affect public health"*

WAC 173-201-047 also states that appropriate concentrations for toxic substances in Washington are to be determined in consideration with EPA's **Quality Criteria for Water** (1986). In the process of developing its lists of degraded waters as required by §304(l) of the Clean Water Act, Washington interpreted its standard for 2,3,7,8-TCDD in a manner consistent with Oregon's numeric standard, i.e. 0.013 ppq of 2,3,7,8-TCDD as an ambient water concentration needed to protect human health.

Idaho has narrative standards which are intended to protect the beneficial uses of its waters including the Snake River. The standard, found in IDAPA 16.01.2200, states:

> *"As a result of man-caused point or nonpoint source discharge, waters of the State must not contain: 01. Hazardous materials ... in concentrations found to be of public health significance or to adversely affect designated or protected beneficial uses. 02. Deleterious materials ... in concentrations that impair designated or protected beneficial uses without being hazardous."*

In the process of developing Idaho's §304(l) short list, EPA interpreted this standard also in a manner consistent with Oregon's numeric standard.

As stated above, this TMDL has been developed to achieve attainment of the water quality standards of all affected states. Although the wording of the applicable state standards for Idaho, Oregon, and Washington differs, EPA has interpreted these standards as being equally stringent. Even if this is not the case, however, 2,3,7,8-TCDD loading to upstream segments still must be restricted to levels ensuring the attainment of water quality standards applying to downstream segments.[1] Where this document refers to "the standard" or "the criterion" for 2,3,7,8-TCDD, this means the 0.013 ppq criterion at the 10^{-6} risk level and, by implication, the assumptions which form the basis of that criterion as established by EPA. That criterion, adopted by the State of Oregon, is the controlling water quality standard which this TMDL protects.

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[1] The Superior Court of Washington for Thurston County recently found that the manner in which the State applied their water quality standards to the listing under §304(l) of three pulp and paper mills was invalid. EPA believes that this decision does not affect the use of 0.013 ppq as the water quality standard for dioxin in developing this TMDL because all waste load allocations and permit limits must ensure compliance with applicable water quality standards of downstream states [40 CFR §122.4(d)]. Oregon's water quality standard is clearly stated as being 0.013 ppq for 2,3,7,8,-TCDD.

2. River Flow:

The loading capacity of a stream is determined using the water quality criteria value and a design flow for the receiving water. Typically, loads are expressed as chemical mass per time such as pounds per day. In the case of 2,3,7,8-TCDD, loads have been expressed as milligrams (mg) per day and are calculated as follows:

Load (mg/day) = 0.00245 * Concentration (ppq) * Flow (cfs)

The 0.00245 is the factor needed to convert the units of parts per quadrillion (ppq) and cubic feet per second (cfs) to milligrams per day (mg/day)

The design flow significantly affects the determination of the loading capacity. The choice of design flow used to calculate the loading capacity for the Columbia River basin was based on the characteristics of the 2,3,7,8-TCDD water quality criterion. That criterion, 0.013 ppq 2,3,7,8-TCDD, is based on human health concerns over a lifetime. In order to address human health concerns, the harmonic mean flow is recommended as the appropriate stream design flow (**Draft Technical Support Document for Water Quality-based Toxics Control**, U.S. Environmental Protection Agency, 1990).

The harmonic mean flow was used to develop this TMDL because it provides a more reasonable estimate than the arithmetic mean to represent long-term average river flow. Flood periods in naturally flowing rivers bias the arithmetic mean above flows typically measured. This overstates available dilution. The calculation of the harmonic mean, however, dampens the effect of peak flows. As a result, the bias is reduced. The harmonic mean is also an appropriate conservative estimate of long-term average flow in highly regulated river basins, such as the Columbia. In a regulated river basin, the harmonic mean and the arithmetic average are often much closer numerically.

Table A-1 summarizes the loading capacity for 2,3,7,8-TCDD in the Columbia River system at several key locations. A long-term flow record must be used in order to minimize the effect of either droughts or wet years. It is also important to recognize the effect that reservoirs have had on flows in the Columbia basin. Many of the major dams were constructed before 1950. Thus, flow records used to determine the loading capacity in the Columbia River were those reported by the U.S. Geological Survey from 1950 to present.

Table A-1. Loading Capacity for 2,3,7,8-TCDD in the Columbia River

Gage	Location	Drainage Area (sq.mi.)	Harmonic Mean Flow (cfs)	Loading Capacity (mg/day)
12399500	Columbia River at International Boundary	59,700	72,700	2.31
12472800	Columbia River below Priest Rapids	96,000	95,100	3.03
14019200	Columbia River at McNary Dam	214,000	143,000	4.54
14105700	Columbia River at The Dalles	237,000	152,000	4.83
14144700	Columbia River at Vancouver	241,000	159,000	5.04
14222880	Columbia River at Columbia City	254,000	180,000	5.73
14246900	Columbia River below Longview	256,900	188,000	5.97

Flows at three locations on the Columbia River were estimated because of inadequate long-term records. These locations are at Vancouver (gage #14144700), at Columbia City (gage #14222880), and below Longview (gage #14246900). The estimates were based on gaged flows from tributary rivers for the corresponding segments. Average flow yield from the tributaries for a particular segment was used to estimate flow from the ungaged portion of that segment. These gaged tributaries are listed in Table A-2.

Table A-2. Loading Capacity for 2,3,7,8-TCDD in the Columbia River Tributaries

Gage	Location	Drainage Area (sq.mi.)	Harmonic Mean Flow (cfs)	Loading Capacity (mg/day)
13343500	Snake River near Clarkston	103,200	35,700	1.14
13353000	Snake River below Ice Harbor Dam	108,500	37,000	1.18
14113000	Klickitat River near Pitt	1,297	1,207	0.04
14120000	Hood River near Hood River	279	612	0.02
14123500	White Salmon River near Underwood	386	951	0.03
14125500	Little White Salmon River near Cook	134	317	0.01
14128500	Wind River near Carson	225	514	0.02
14142500	Sandy River below Bull Run River	436	1,009	0.03
14143500	Washougal River near Washougal	108	234	0.01
14166000	Willamette River at Harrisburg	3,420	7,600	0.24
14211720	Willamette River at Portland	11,100	17,100	0.54
14220500	Lewis River near Ariel	731	2,396	0.08
14222500	East Fork Lewis River near Heisson	125	196	0.01
14223500	Kalama River near Kalama	198	618	0.02
14243000	Cowlitz River at Castle Rock	2,238	5,721	0.18