MALHEUR RIVER BASIN TMDL

APPENDIX A: BACTERIA TMDL TECHNICAL INFORMATION

Final
September 2010

DEQ
State of Oregon
Department of
Environmental
Quality

Table of Contents

Figures

Tables

LABORATORY BACTERIA ANALYSIS METHODS

E. coli data were used for development of the Malheur River Basin Bacteria TMDL, however, Fecal coliform analyses were performed by DEQ on samples collected prior to 1996 and were used to generate some of the bacteria 303(d) listings. Fecal coliform data were not used in the TMDL development. Methods of *E. coli* bacterial analysis have changed over time, with some DEQ samples analyzed using the Most Probable Number (MPN) technique and some using the membrane filtration technique (MF). Data that were the result of both methods were used in the TMDL development and were considered to be congruent, and were expressed as org./100ml. *E. coli* data from water samples collected by the Malheur Watershed Council and analyzed by the U.S. Bureau of Reclamation (BOR) lab in Boise, ID were also used in TMDL development. The BOR lab used Standard Method 9213D as described in Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WPCF, 20th edition. 1998. Standard Method 9213D is a membrane filtration technique. The available DEQ and BOR *E. coli* data have been combined for this report.

For a number of years, DEQ has used a 30 hour holding time standard from sample collection to analysis (see http://www.deq.state.or.us/lab/techrpts/docs/Ecolimethods.pdf *E. coli* methods and holding time, DEQ, June 2003). *E. coli* sampling currently uses a 6-hour holding time when a local lab is available and practical. If use of a local lab is not available and practical, bacteria samples are analyzed within a 24-hour period. EPA has indicated in a letter to DEQ dated July 1, 2004, that “in our review of the Umpqua Basin bacteria TMDL, and in its general operations EPA has found Oregon DEQ data collection procedures to be sound and appropriate for the uses to which they are applied”. The 24-hour holding time was used on samples collected in the Malheur River Basin Bacteria TMDL, and the holding time for the BOR samples was also 24 hours from the time of sample collection.

E. coli sample results which were below the detection limit of 1 org./100 ml for the method were reported as 1 org./100ml. Sample results which were above the upper detection limit, were reported at the upper detection limit (2,419 org./100 ml for DEQ data, 2,600 org./100 ml for BOR data).

LOAD DURATION CURVES

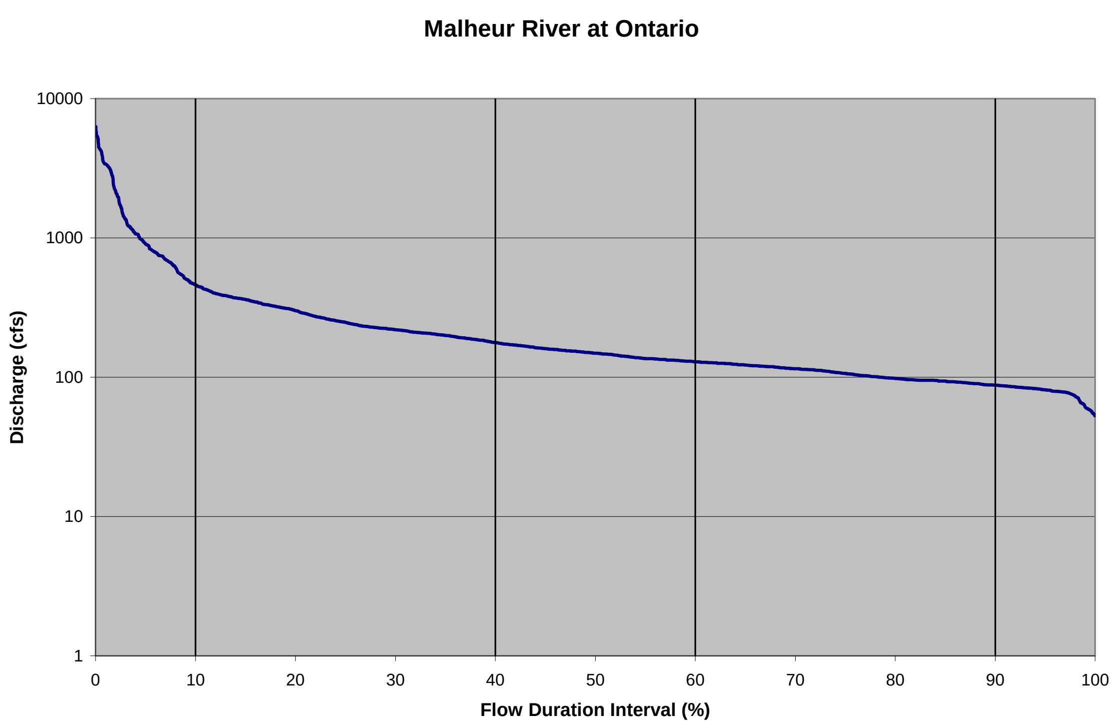
Load duration curves are a method of determining a flow-based loading capacity, assessing current conditions, and calculating the necessary load reduction. The methodology is based on TMDLs completed by Oregon DEQ and the Kansas Department of Health and Environment. The two necessities for a load duration curve are flow data and water quality data at the same location. The following example uses the BOR flow gauge for the Malheur River at the 36th Street Bridge in Ontario, Oregon at approximately River Mile 3, and water quality data from the DEQ ambient water quality sampling station at the Highway 201 bridge located downstream at approximately RM 0.5. There are no major tributaries or water diversions between these two locations so the flow data is considered to be applicable to the sample location.

The first step in the process involves the creation of a flow duration curve. The flow duration curve is a plot of discharge verses the frequency that a given flow is exceeded. The average daily flows are ranked from maximum to minimum for the period of January 2000 through December 2006 (**Table A-1**). The exceedance probability (EP) for each flow was computed by: **EP= rank/n+1** where n is the number of flow measurements. The “percent of days flow exceeded or flow duration interval” is the exceedance probability multiplied by 100 (**Figure A-1**).

Table A-1. Example Flow Duration Calculations (portion of table).

Date	Discharge (cfs)	Percent Rank	Rank	Ex Probab	% Exceed
4/7/2006	6282.68	1	1	0.00039093	0.03909304
4/8/2006	5534.04	0.99	2	0.00078186	0.07818608
4/11/2006	5418.08	0.99	3	0.00117279	0.11727912
4/10/2006	5363.16	0.99	4	0.00156372	0.15637217
4/6/2006	5351.22	0.99	5	0.00195465	0.19546521
4/9/2006	5133.95	0.99	6	0.00234558	0.23455825
4/12/2006	5121.75	0.99	7	0.00273651	0.27365129
4/17/2006	4494.45	0.99	8	0.00312744	0.31274433
4/16/2006	4450.35	0.99	9	0.00351837	0.35183737
4/18/2006	4418.80	0.99	10	0.00390930	0.39093041
4/13/2006	4354.94	0.99	11	0.00430023	0.43002346

Figure A-1. Flow Duration Curve, Malheur River at Ontario.



The flow duration curve is transformed into a target load duration curve by multiplying the water quality standard by the flow (Q) and two unit conversion factors. The computed load curve is the load capacity which varies according to flow. For example, the 30-day log mean standard for bacteria is 126 org./100 ml and the loading capacity is calculated using the following formula:

Loading Capacity org/day = 126 org/100ml x Q ft^3/s x 283.2 $100ml/ft^3$ x 86400 s/day

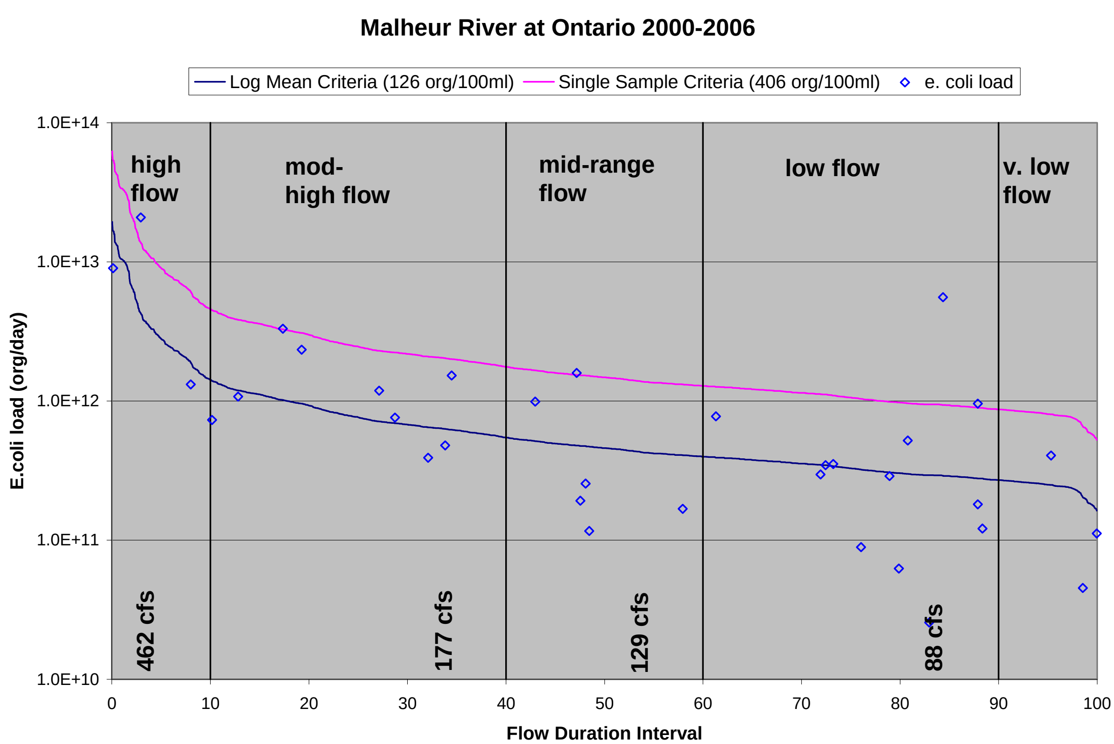
The same approach is used to calculate the loading capacity for the 406 org/100ml single sample criterion:

Loading Capacity org/day = 406 org/100ml x Q ft^3/s x 283.2 $100ml/ft^3$ x 86400 s/day

The loading capacity is then plotted against the corresponding *% exceedance or flow duration interval.* In **Figure A-2**, there are two curves representing the two numeric standards: log mean of 126 org./100ml and no samples exceeding 406 org/100ml. The loading capacity increases with increased flow because of the larger assimilative capacity of the river.

Measured concentrations of *E. coli* are similarly converted into loads by substituting each measured bacteria concentration for the bacteria standard the equation above along with the simultaneous measured flow (Q) from the stream gauge. These event loads are plotted as points along with the standard curves to assess conditions (**Figure A-2**).

Figure A-2. Load duration curves with measured daily loads and selected flow ranges, Malheur River in Ontario. Points located above curves exceed standards. Sample location is Hwy 201 bridge near mouth of river and flow gauge is at 36th Street Bridge, approximately two miles upstream.



Load duration curves and measured loads are summarized by range of flows and the TMDLs are computed (**Table A-2 and A-3**). Percent reductions were calculated where the observed loading exceeded the generalized loading capacity. To calculate the percent reduction needed to meet the log-mean criterion within each flow period, the log-mean of calculated loading capacities for each day, minus a 5% margin of safety, was divided by the log mean of the observed *E. coli* load, and converted to a percentage using the formula in the upper portion of **Table A-2**. An explicit margin of safety was not used in the calculation of the percent reduction needed to meet the single sample maximum criterion. The loading capacity for the day having the maximum observed *E.coli* value was divided by the maximum value and converted to a percentage using the formula in the lower portion of **Table A-2**. Load allocations are discussed in detail in Section 7.7 of the Malheur River TMDL document.

Table A-2. Components for Calculating the TMDL by Flow Regime.

Log-mean critierion:

Loading Capacity (LC)	Log mean of daily loading capacity within flow regime (based on 126 org/100ml. bacteria standard)
Current Load	Log mean of observed loads within flow regime
Margin of Safety (MOS)	LC x 0.05
Load Allocation	LC-MOS
% reduction	(1-load allocation/current load) x 100

Single sample maximum criterion:

Loading Capacity (LC)	loading capacity within flow regime (based on 406 org/100ml. bacteria standard)
Current Load	Maximum value of observed loads within flow regime
% reduction	(1-load allocation/current load) x 100

Table A-3. Example from Lower Malheur River.

126 org/100ml criteria	high flow	mod-high flow	mid-range flow	low flow	very low flow
Loading Capacity (org./day)	3.40E+12	7.94E+11	4.57E+11	3.31E+11	2.40E+11
Current Load (org./day)	**6.28E+12**	**1.05E+12**	3.38E+11	2.14E+11	1.27E+11
5% Margin of Safety (org./day)	1.70E+11	3.97E+10	2.29E+10	1.66E+10	1.20E+10
Load Allocation (org./day)	**3.23E+12**	**7.54E+11**	4.34E+11	3.14E+11	2.28E+11
% Reduction to meet126 org/100ml.	**49%**	**28%**	0	0	0

406 org/100ml criteria	high flow	mod-high flow	mid-range flow	low flow	very low flow
Loading Capacity (org./day)	1.38E+13	3.27E+12	1.54E+12	9.43E+11	8.02E+11
Current Load (maximum of E.coli loads)	**2.08E+13**	**3.31E+12**	**1.59E+12**	**5.56E+12**	4.06E+11
Percent Reduction to meet 406 org/100ml.	**34%**	**1%**	**3%**	**83%**	0