APPENDIX L

CLEAR WATER RESERVOIR CT CALCULATION MEMORANDUM

BLACK & VEATCH

MEMORANDUM

B&V Project 97260.500
SLO CT Calculation April 27, 2001

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From: Jessica Edwards
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The USEPA has set forth requirements for disinfection of unfiltered surface waters in the SWTR and has given recommendations for disinfection of filtered waters in the Guidance Manual. The degree of chemical disinfection is assessed in terms of CT, in which C is the residual concentration of the disinfectant in mg/L, and T is the time in minutes for which the water and disinfectant chemical were in contact. The product of these parameters is compared to required standards to determine compliance. CT values for inactivation of *Giardia lamblia* cysts and enteric viruses are listed in the Guidance Manual for free chlorine, chloramine, chlorine dioxide, and ozone. The relative effectiveness of these chemical disinfectants for inactivating *Giardia* and viruses can be inferred from the published CT values. The Lopez WTP has been granted a 2.5 log removal credit for *Giardia* and a 2-log removal credit for viruses. A 0.5-log inactivation is required for *Giardia* and a 2-log inactivation is required for viruses.

The quality of the raw water will impact treatment performance. Selected raw water delivered to the Lopez WTP through Lake Lopez is summarized in Table 1. Source water protozoa concentrations in Lake Lopez have not yet been determined. Note that the CT required for 0.5-log *Giardia* inactivation will vary with seasonal temperature, pH, and chlorine residual.

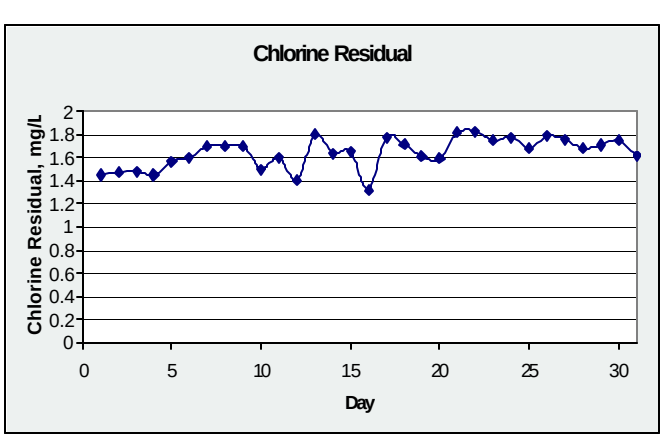
Table 1. Raw Water

Constituent	Range	Median
Turbidity*	0.52 - 3.6	1.25
Temperature, °C*	11 - 24	
TDS	386 - 614	480
Hardness, mg/L	303 - 420	345
pH*	7.8 - 8.5	8.0
Alkalinity, mg/L	220 - 320	268
TOC, mg/L	4.0 - 5.5	
Manganese, µg/L*	12 - 63	

*Data from 2000 Influent water quality (Daily log.xls)

A Lopez Project CT report for March 2001 was used to show CT results during normal plant operations. According to this report, chlorine applied at the combined filter effluent clearwell currently provides adequate CT credit. Additionally, the plant takes credit for chlorination from the flash mixer to a "recarbonation chamber;" however the CT ratio is normally below 1. Ammonia is then applied to the delivered water to form chloramines, and sufficient CT credit is achieved through the bypass vault to the first customer turnout. The total CT is greater than the USEPA requirement. Figures 1a and 1b show the chlorine and chloramine residuals over the 31 days of March and the CT ratio achieved during that time. *(Note: Tracer Study data from the March 2001 report was used to determine CT values.)*

Figure 1a



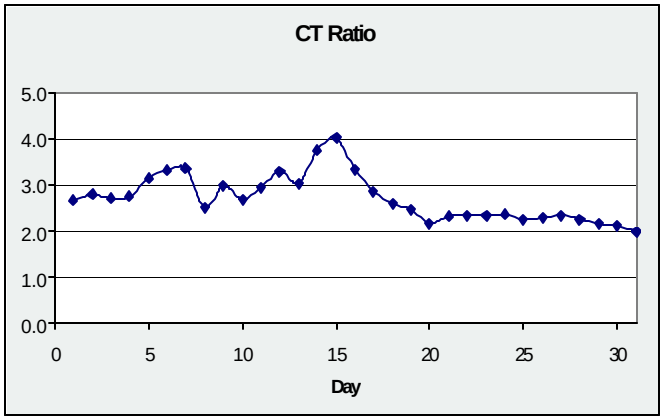
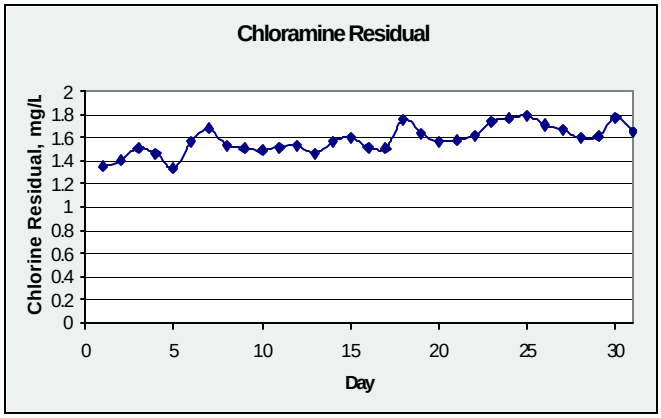
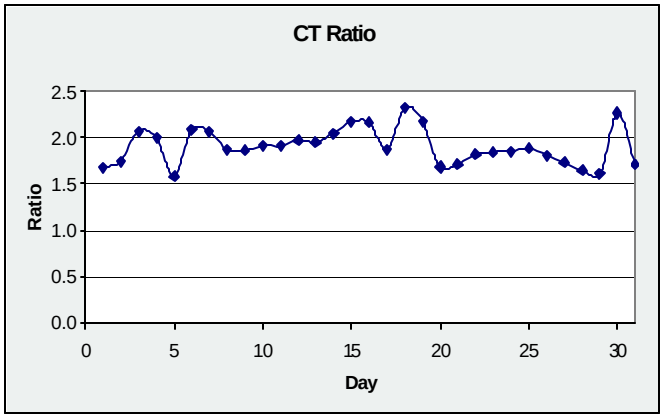


Figure 1b





The current design of the Lopez WTP includes a 2.1 million gallon clear water reservoir. This reservoir acts as a holding tank for chlorinated finished water; the reservoir currently

does not have a pipeline to the distribution system. All of the potential improvement alternatives listed in this report include an upgrade of the clear water reservoir that would allow the finished water to flow into the reservoir and out a distribution pipeline. All the potential improvement alternatives, with the exception of the "Do Nothing New" alternative, include chlorine dioxide as a replacement for chlorination as a preoxidant. The use of chlorine dioxide can provide disinfection, but the Lopez WTP would not assume credit for disinfection if this process were implemented. Options for disinfection are 1) provide required disinfection across the clear water reservoir with chlorine or 2) provide required disinfection using chloramine through the delivered water meter to the first customer turnout (Edna Turnout).

A nearby water treatment plant, State WTP, has a tie-in pipeline directly to the clear water reservoir and to the transmission main pipeline, prior to the meter vault. The State WTP may add as much as 2 mgd. The State WTP uses chloramine as a secondary disinfectant, but will breakpoint chlorinate for periods as long as a month. The State WTP is larger than the Lopez WTP and dictates when breakpoint chlorination should occur.

It was requested that the State WTP tie-in pipelines remain intact; therefore, it is important that the Lopez WTP and the State WTP finished water remain compatible. The outcome of this is while the State WTP is using chloramine, the Lopez WTP finished water will bypass the clear water reservoir (as it does currently). During the times when the State WTP returns to chlorination for disinfection, the State WTP finished water can be piped to the clear water reservoir and distributed to the meter vault (Figure 2). As a result of this, CT values during the chlorination and chloramination periods should be determined based on the requirements of the State WTP.

It was assumed that the clear water reservoir is operated at a minimum level corresponding to a capacity of approximately 1 million gallons of water. Chlorine can still be applied at the combined filter effluent chlorination point currently in use at the plant. The chlorine residual and the pH used to determine the CT through the clear water reservoir were averages of the data from the Lopez Project CT Report for March 2001. Since the clear water reservoir is not baffled, a T_{10}/T factor of 0.1 was chosen. Table 2 summarizes the CT ratios (0.5-log inactivation) for a minimum flow of 3 mgd, the current design capacity flow of 6 mgd and a "worst-case" increased flow of 12 mgd for water temperatures of 10 ^{o}C, 17.5 ^{o}C, 20 ^{o}C, 25^{o}C. The increased flows are a result of the addition of the State WTP finished water. The table shows that at 1.6 mg/L Cl_2 and maximum pH 8.1, the CT required for 0.5-log *Giardia* inactivation is met at all flows and temperatures, except during 12 mgd flow and 10^{o}C. *(Tracer Study detention time values from the March 2001 report were used to determine T_{10})*

Figure 2: Proposed Outlet Piping

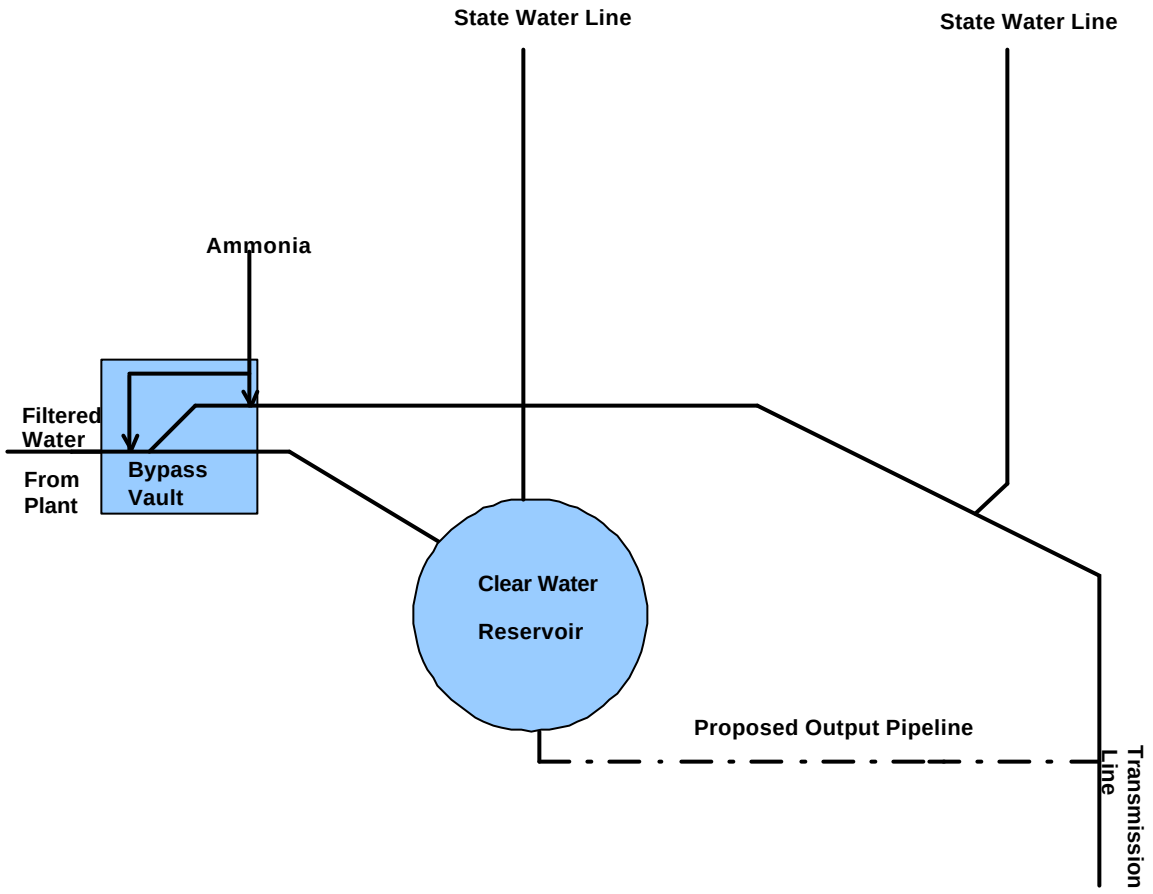
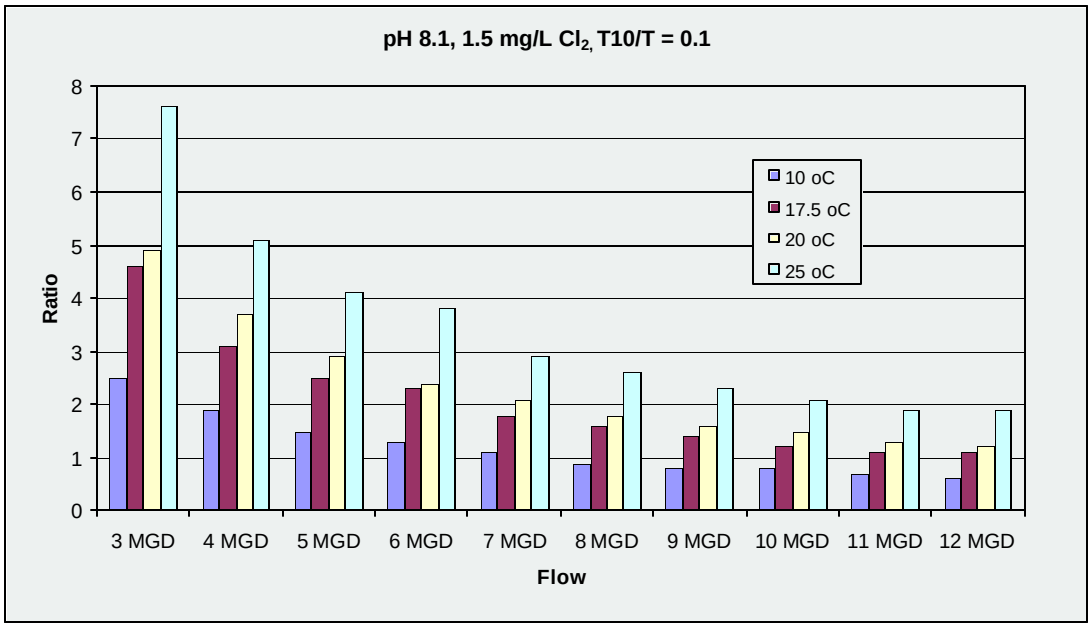


Table 2. CT Ratios Across Clear Water Reservoir

Conditions pH = 8.1 Cl_2 Residual, mg/L = 1.6 T_{10}/T = 0.1									
Temp (^oC)	Minimum	10	CT Ratio	Median	17.5	CT Ratio	Maximum	25	CT Ratio
Flow (mgd)	Minimum	3	2.5	Minimum	3	4.6	Minimum	3	7.6
	Capacity	6	1.3	Capacity	6	2.3	Capacity	6	3.8
	Maximum	12	0.6	Maximum	12	1.1	Maximum	12	1.9

Figure 3 shows the comparison of CT ratios at varying flow rates through the plant and various temperatures for the same chlorine, pH and baffling conditions.

Figure 3: CT Ratios Across Clear Water Reservoir – Temperature Variations



At times when the State WTP goes to chlorination, ammonia can also still be applied at the bypass vault point currently in use at the plant. The chloramine residual and the pH used to determine the CT through the clear water reservoir were averages of the data from the Lopez Project CT Report for March 2001. It was assumed that the State WTP carries a similar chloramine residual concentration. A T_{10}/T factor of 0.1 was used because ammonia is added during pipeline flow. Table 3 summarizes the CT ratios (0.5-log inactivation) for a minimum flow of 3 mgd, the current design capacity flow of 6 mgd for water temperatures of 10 ^oC, 17.5 ^oC, 20 ^oC, 25^oC. The increased flows are a result of the addition of the State WTP finished water. The table shows that at 1.6 mg/L Cl_2 and maximum pH 8.1, the CT required for 0.5-log *Giardia* inactivation is not met at increased temperatures, but the total CT does meet the requirement.

Table 3. CT Ratios of Delivered Water Meter to Edna Turnout

Conditions pH = 8.1 Chloramine Residual, mg/L = 1.6 T10/T = 1.0									
Temp (^{o}C)	Minimum	10	CT Ratio	Median	17.5	CT Ratio	Maximum	25	CT Ratio
Flow (mgd)	Minimum	3	2.0	Minimum	3	1.0	Minimum	3	0.6
	Capacity	6	2.8	Capacity	6	1.4	Capacity	6	0.8

Figure 4 shows the comparison of CT ratios at varying flow rates through the plant and various temperatures for the same chloramine residual, pH and baffling conditions.

Figure 4: CT Ratios of Delivered Water Meter Vault to Edna Turnout at Varying Temperatures