San Elijo Water Reclamation Facility
Chlorine Contact Basin Tracer Study Final Report

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EXECUTIVE SUMMARY

The San Elijo Joint Powers Authority (SEJPA) is in the process of expanding the San Elijo Water Reclamation Facility (SEWRF) by adding 0.5 MGD of reverse osmosis (RO) membrane treatment capacity. RO membranes are being added to reduce the recycled water salinity, while expanding the peak flow capacity from the existing 2.48 MGD to a peak flow of 3.0 MGD. As required by the California Department of Public Health (CDPH), a chlorine contact basin must be able to provide a modal contact time of at least 90 minutes when producing disinfected recycled water. Trussell Technologies was hired by the SEJPA to assist in performing contact basin tracer studies to determine (1) the maximum allowable flow rate, and (2) modal contact times at various flow rates and the corresponding required chlorine residuals. In April 2009, a modal contact time of 98 minutes was demonstrated during a tracer test at flow rate of 3.02 MGD (Trussell Technologies, 2009). After the first test, it was decided that three additional tests would be completed such that (1) an engineer from CDPH could be present during testing to observe that the protocol is followed, and (2) minimum chlorine residual requirements could be determined for flow rates less than 3.02 MGD.

A tracer study protocol was submitted to CDPH on April 9, 2010 (Trussell Technologies, 2010), which followed the same procedures that were used in the April 2009 test. Rhodamine WT dye was spiked into the chlorine contact basin as a pulse and dye concentrations were measured in the contact basin effluent. Effluent samples were collected at frequencies of up to every 30 to 60 seconds as the dye concentration in the contact basin effluent started to peak. Fluorescence was measured onsite using a handheld fluorometer. An engineer from CDPH (Alan Tell) was present at the San Elijo Water Reclamation Facility to observe the tracer study at 2.60 MGD.

Three addition tests were conducted in April 2010 at flow rates of 0.84, 1.72, and 2.60 MGD. The testing conditions, data, and findings from these tests are document in this report. Results from the 2009 test at 3.02 MGD are also included in this analysis for comparative purposes. All tracer tests were completed successfully, where dye recoveries exceeded 90% and modal contact times exceeded 90 minutes in all tests. The modal contact times from the 0.84, 1.72, 2.60, and 3.02 MGD tests were 221, 166, 114, and 98 minutes, respectively.

The results from the 2009 test at 3.02 MGD fit well with the test results from the 1.72 and 2.60 MGD tests completed in 2010. This fit indicates that the hydraulics through the chlorine contact basin do not change much in the 1.72 to 3.02 MGD flow range. The dye concentration profile from the 0.84 MGD test was different from the other three tests, indicating that at flows less than 1.72 MGD, short-circuiting increases through the SEWRF contact basin. The modal contact time at 0.84 MGD is still more than double the 90 minutes required by the California Water Recycling Criteria.

The actual maximum capacity of the SEWRF chlorine contact basin allowable under the California Water Recycling Criteria exceeds 3.02 MGD, as the modal contact time provided at this flow exceeds 90 minutes. However, because CDPH does not allow extrapolation of results from tracer tests, the flow rate through the SEWRF chlorine contact basin should be limited to 3.02 MGD at this time. At this maximum flow, a minimum chlorine residual of 4.60 mg/L should be met. The minimum chlorine residual required for various flows in the range of 0.84 and 3.02 MGD can be determined using Figure 8 in this report. For flow rates less than 0.84 MGD (the minimum flow tested) the chlorine residual should be at minimum 2.1 mg/L.

1. BACKGROUND

The San Elijo Joint Powers Authority (SEJPA) is in the process of adding a reverse osmosis (RO) membrane system to decrease the total dissolved solids (TDS) of the final product water and expand the overall capacity of the San Elijo Water Reclamation Facility (SEWRF). Currently, the SEWRF is permitted to produce a maximum flow of 2.48 MGD and SEJPA is planning to expand the product flow by 0.54 MGD (to 3.02 MGD). Before constructing additional disinfection capacity, SEJPA decided to evaluate the actual capacity of the existing chlorine contact basin (CCB).

The existing CCB receives flow from tertiary granular-media filters. Sodium hypochlorite is dosed into the process flow as it enters the rapid mix chamber. The water then flows through the four-pass chlorine contact basin, where each channel has a length to width ratio of 10:1 (88 ft long by 8.83 ft width). The CCB effluent weir, which is at a fixed height, sets the water level in the channel. The design sidewater depth is 8.83 ft. The water level varies slightly as a function of flow rate, but because of the fixed weir, remains constant at any given flow (higher water level at higher flows; see Table 1). Thus the theoretical volume varies slightly with flow, and is approximately 215,000 to 220,000 gallons for flows tested in this study and theoretical hydraulic residence times are 367, 180, 122, and 105 minutes, for flow rates of 0.84, 1.72, 2.60, and 3.10 MGD, respectively.

The California Title-22 water recycling regulations require that when using chlorine disinfection to produce "disinfected tertiary recycled water", the CT (chlorine residual multiplied by the modal contact time) must be at least 450 mg/L-min and the modal contact time be at least 90 min (based on peak dry weather design flow; CCR 2009). The modal contact time, as defined by the California Water Recycling Criteria (CCR 2009), is:

> *"…the amount of time elapsed between the time that a tracer, such as salt or dye, is injected into the influent at the entrance to a chamber and the time that the highest concentration of tracer is observed in the effluent from the chamber."*

The first test to determine the capacity of the SEWRF CCB was performed on April 22, 2009 at a flow rate of 3.02 MGD. The tracer test used a pulse addition of rhodamine WT dye, following the same approach used for the tracer tests described in this report. The peak dye concentration was observed at 99 minutes after dye addition, and using the "n-1" approach for determining the modal contact time, the modal contact time was 98 minutes. The results from this study were reported to the California Department of Public Health (CDPH) in September 2009 (Trussell Technologies, 2009). CDPH notified SEJPA that additional tests at other flow rates would be needed to (1) allow an engineer from CDPH to be present during the test to observe that the protocol is followed, and (2) determine minimum required chlorine residuals for flows less than 3.02 MGD.

2. TRACER STUDY PROCEDURE

Three additional tracer tests were completed between April 20 and April 22, 2010, at flow rates of 0.84, 1.72, and 2.60 MGD. A test protocol was submitted to the CDPH for review on April 9, 2010 (Trussell Tech 2010) and a representative from CDPH (Alan Tell) was present at the tracer test on April 20, 2010. After being present at the April 20, 2010 test, CDPH was satisfied that the protocol was being followed and did not require being present for the subsequent tests. Select photographs from the 2010 tracer tests are shown in Figure 1.

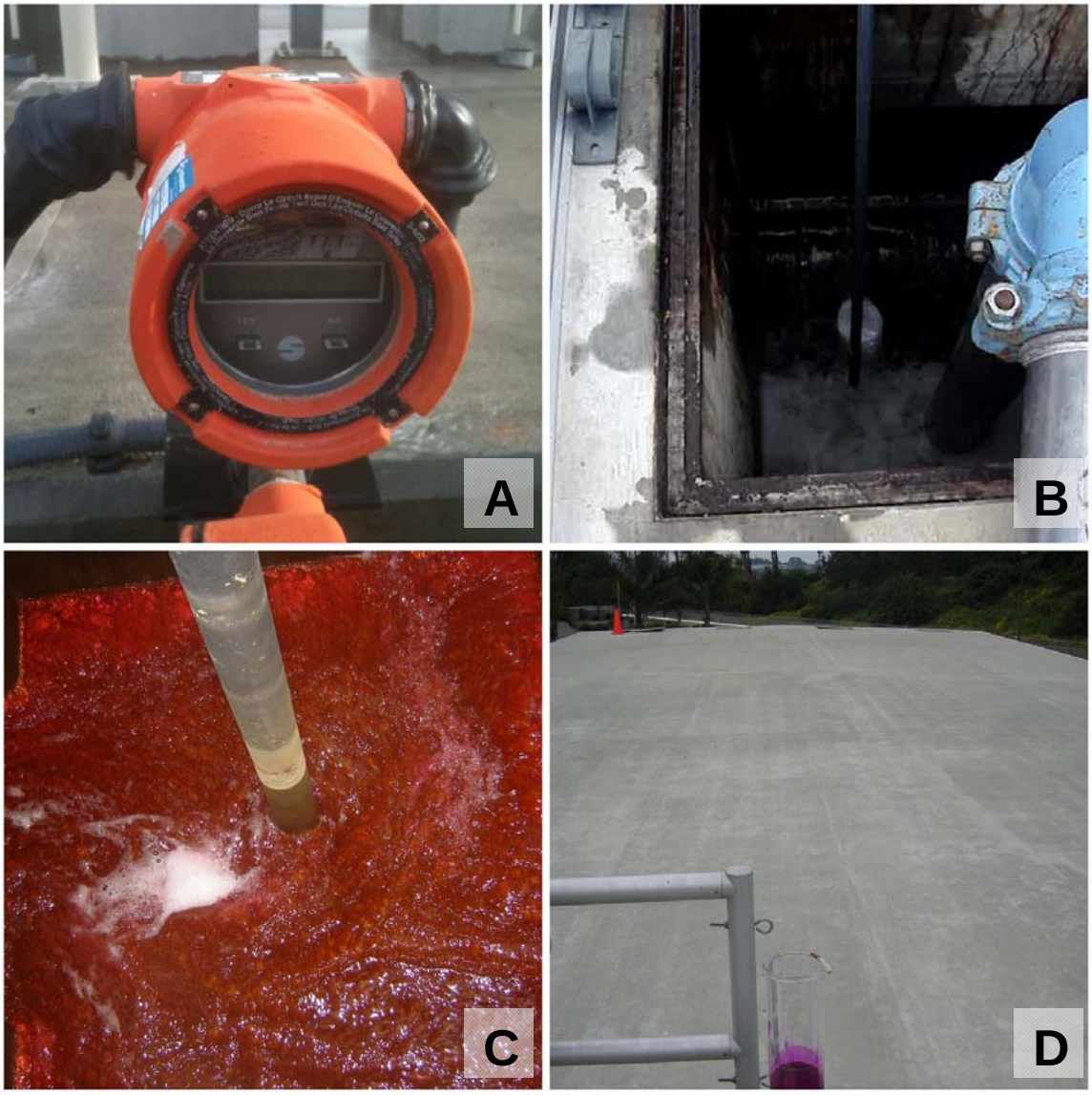

Figure 1 – Photographs from 2010 SEJPA tracer studies, showing (A) TigerMag flow meter, (B) bird's eye view of CCB effluent weir and sampling location (with sample stick), (C) rapid mix chamber seconds after rhodamine WT spike, and (D) CCB basin as viewed from the top (concrete cover).

As detailed in the test protocol, rhodamine WT dye was used as the tracer and injected as a pulse. Grab samples were collected at frequencies ranging from 30 seconds to 5 minutes, depending on concentration of dye exiting the CCB; as the dye concentration started to peak, the sample collection frequency increased. Samples were analyzer within 5 minutes of sample collection using the *Aqua*fluor handheld fluorometer (Turner Designs, Sunnyvale, CA; see Trussell Technologies, 2009 for additional details). Background fluorescence was monitored prior to each tracer test and was subtracted from the raw fluorescence measurements. The flow through the chlorine contact basin was determined using the filter feed magnetic flow meter (TigerMag FM655; calibrated on April 12, 2010) and subtracting off the near-constant backwash rate (82-86 gpm). To avoid distributing the recycled water during the tracer tests, a temporary bypass pump was installed to pump water from the CCB effluent wet-well to unused aeration and clarifier basins. The water produced during the test was eventually discharged through the ocean outfall.

The only deviation from the protocol was during the low-flow test, where samples were collected between 2 and 10 minutes apart (with one sample at 745 min taken after 15 minutes). The sample frequency was slowed down due to the lower flow rate. This changed was discussed with the CDPH engineer (Alan Tell) the day before the low-flow test. This change did not diminish the resolution relative to the other tests, because the low-flow was less than half the next highest flow.

There was one noteworthy incident during the low-flow tracer test, when at 585 minutes into the test, a plant control system shutdown the flow to the chlorine contact basin. The flow was restored within 11 minutes. This event did not diminish the validity of the test because the disruption occurred after the modal contact time and more than 90% of the dye was recovered. This is discussed further in the tracer test results section.

3. TRACER STUDY RESULTS AND ANALYSIS

Three additional tracers tests were performed to determine chlorine residual requirements at various operating flows applicable to the SEWRF. This section details the operating conditions, tracer test results, and the chlorine residual requirements for various flows through the SEWRF CCB. For the purpose of comparison, the results from the previously reported 2009 tracer test at 3.02 MGD are also included in this section.

3.1. OVERVIEW OF TESTING CONDITIONS

A summary of the conditions for all tracer tests in shown in Table 1. The three 2010 SEJPA tracer tests were conducted on three consecutives days (April 20, 21, and 22). The raw fluorescence data are shown in the Appendix (Tables A1, A2, and A3). The tertiary flow rate was maintained nearly constant in all tests, with the flow rate staying within $\pm$ 0.5% of the average flow at all times (probability plots in Appendix; Figure A1). The water level was periodically measured during each test (Appendix Table A8) and remained unchanged for all measurements at a given flow. The consistency of the water level was due to the tight flow control and the fixed effluent weir level.

Table 1 – Summary of testing conditions for tracer tests#

Parameter	Units	0.84 MGD	1.72 MGD	2.60 MGD	3.02 MGD
Date		4/21/10	4/22/10	4/20/10	4/22/09
Chlorine shut off time		4:15 AM	N/A[1]	6:45 AM	10:07 AM
Start time		7:05 AM	8:09 AM	8:49 AM	11:09 AM
Stop time		8:12 PM	2:15 PM	12:59 PM	2:30 PM
Test Duration	min	787	366	250	201
Water level at start	ft	9.0	9.1	9.2	9.2
Water level at finish	ft	9.0	9.1	9.2	9.2
Average Turbidity	NTU	1.2	1.2	1.1	1.5
Average Cl_2 residual[2]	mg/L	0.1	0.1	0.1	0.6
Temperature at test start[3]	°C	21.3	21.3	22.5	20.3
Temperature at test completion[3]	°C	21.4	22.4	22.8	23.1
Pulse addition time	sec	10	10	10	4[4]
Volume rhodamine WT dye added	mL	150	150	150	150
Mass of active rhodamine added	g	36.0	36.0	36.0	36.0
Mass of active rhodamine recovered	g	32.7	34.3	34.4	33.2
Tracer recovery efficiency	%	90.8%	95.4%	95.6%	92.2%[4]

[1] No chlorine was added between tests on April 21 and April 22, 2010.
[2] Values averaged from the leading edge of the tracer curve to the test completion (*i.e*. only for the water that had dye in it)
[3] As measured at the chlorine contact basin effluent.
[4] After the pulse addition in the first test, residual dye remaining in the graduated cylinder was not rinsed out into the rapid mix chamber, resulting in the (a) shorter addition time and (b) lower dye recovery. The graduated cylinder was rinsed and added to the rapid mix within 10 seconds for the 2010 test.

The water quality was acceptable in terms of avoiding inference with the fluorescence measurements. The turbidity of the test water was less than 2 NTU for all of 2010 tests, and only exceeded 2 NTU during 1 minute of the 2009 test. Consistent with the protocol, the chlorine addition was turned off at least one hour prior to adding the rhodamine WT dye. The chloramine residual in the tracer water was on average less than 1 mg/L, which was low enough as to not avoid degradation of the rhodamine WT fluorescence during the test (Deaner, 1973)[1]. Plots of turbidity and chlorine residual are plotted along with the effluent dye concentration versus time in the Appendix (Figures A2 through A5).

3.2. TRACER TEST RESULTS

The tracer test profiles from all the tracer tests are provided in Figures 2 through 5. The plots of dye concentration versus time for flows of 1.72, 2.60, and 3.02 all share a similar profile that indicates dispersion and mixing were relatively low in the contact basin and the baffling efficiency was high. The lowest-flow test at 0.84 MGD had a

[1] Deaner (1973) reported that with free-chlorine residual of 11 mg/L, no reduction in rhodamine WT fluorescence was measured over 4 hour time period. For rhodamine WT, the first measurable effects of chlorine show up at CT values of ~4000 mg/L-min. The highest CT exposure during any of the tests was <180 mg/L-min.

distinctly different profile from the other three tests at higher flow rates, where, relative to the other tests, the peak dye concentration and baffling efficiency were lower, and the tail on the dye curve was longer. The raw data from the 2010 tests are shown in the Appendix (raw data from the 2009 test can be found in Trussell Technologies, 2009).

Low-Flow Test (0.84 MGD)

The low-flow test began at 7:05AM on April 21, 2010. The leading edge was detected at 180 minutes into the test, and the concentration of the dye rapidly increased until the peak concentration of 63.1 μg/L was detected at 223 minutes into the test (Figure 2). During this point in the test, grab samples were being collected every 2 minutes, so the modal contact time was 221 min (using the CDPH "n-1" method for determining the modal contact). The low-flow tracer test lasted another 9.5 hours after the peak concentration was observed, until the dye concentrations in the water exiting the basin was near background levels. A total of 132 samples were collected after the dye was spiked.

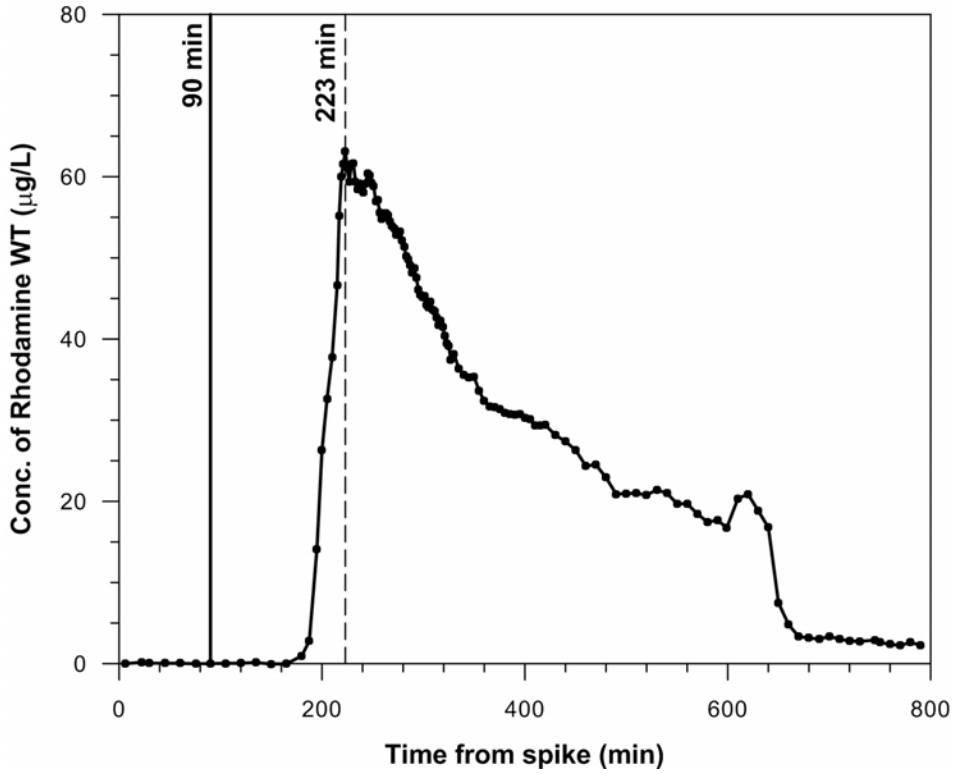

Figure 2 – Rhodamine dye curve from lowest flow tracer test at 0.84 MGD (4/21/10)

As previously mentioned, at 585 minutes into the low-flow test, flow to the CCB was stopped. An automated controls system shutdown flow to the CCB, because water demands could be met with the water in the recycled water storage. It took 11 minutes to bypass the control and returned the flow to normal. During that period, only 46% of the flow that was expected to go through the chlorine contact basin actually did. This was during the tail end of the tracer test, and the mixing induced by the rapid flow changes caused an immediate increase in the dye concentration (see the late hump on

Figure 2 at 600 minutes) and back-mixing (see sharp drop off at 640 minutes). The back-mixing sent dye backwards in the contact basin, artificially extending the tail of the curve. Fortunately, this incident occurred approximately 6 hours *after* the peak dye concentration was observed, and thus for the purposes of determining the modal contact time it has no bearing on the findings of the test.

Intermediate Flow Tests (1.72 and 2.60 MGD)

Two tests were conducted at intermediate flows of 1.72 and 2.60 MGD. The 1.72 MGD test was started at 8:09AM on April 22, 2010. The leading edge of the dye profile appeared at 104 minutes into the test and the peak concentration in the effluent (91.5 μg/L) was detected at 166.5 minutes (Figure 3). The sampling frequency near the peak concentration was every 30 seconds, such that modal contact time ("n-1" method) was 166 min. The tracer test continued for another 3.5 hours until the fluorescence levels in the contact basin effluent exiting the basin were at background concentrations. A total of 155 samples were collected after the dye was spiked.

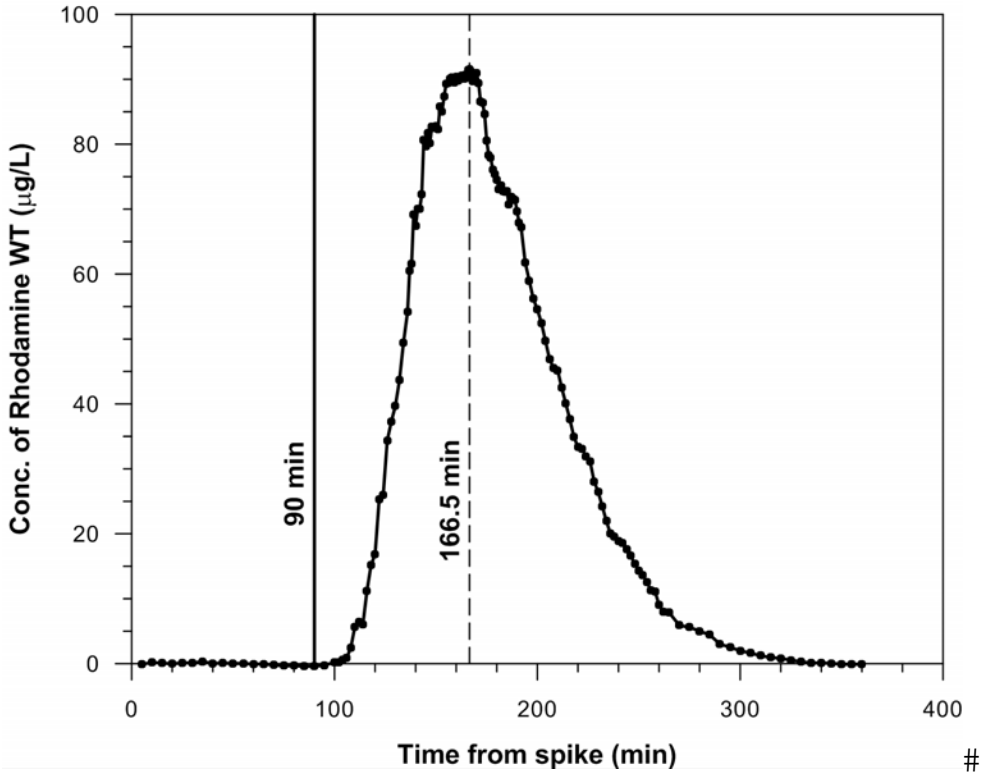

Figure 3 – Rhodamine dye curve from mid-flow tracer test at 1.72 MGD (4/22/2010)

The 2.60 MGD was the test witnessed by Alan Tell (CDPH) and started at 8:49 AM on April 20, 2010. The leading edge of appeared at 70 minutes into the test and the peak dye concentration (88.6 μg/L) was observed at 115 minutes (Figure 4). Samples were collected every 1-minute around the time the peak concentration was observed, thus the modal contact time ("n-1" method) was 114 minutes. The test continued for another 2 hours, until the fluorescence in the CCB effluent reached background levels. A total of 102 samples were collected after the dye was spiked.

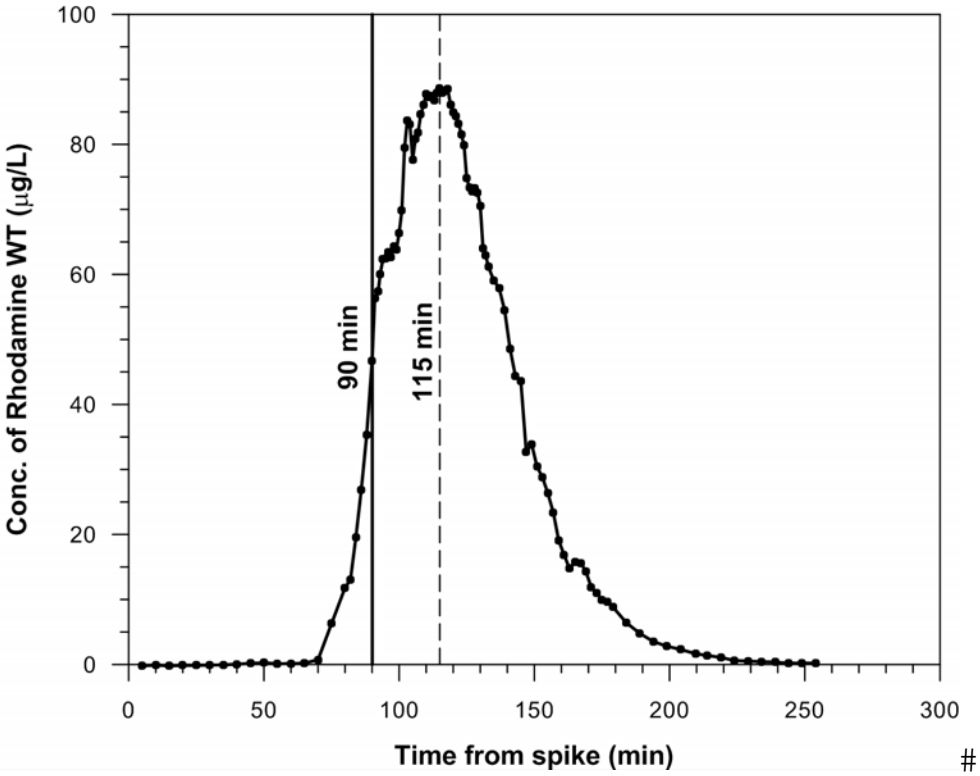

Figure 4 – Rhodamine dye curve from mid-flow tracer test at 2.60 MGD (4/20/2010)

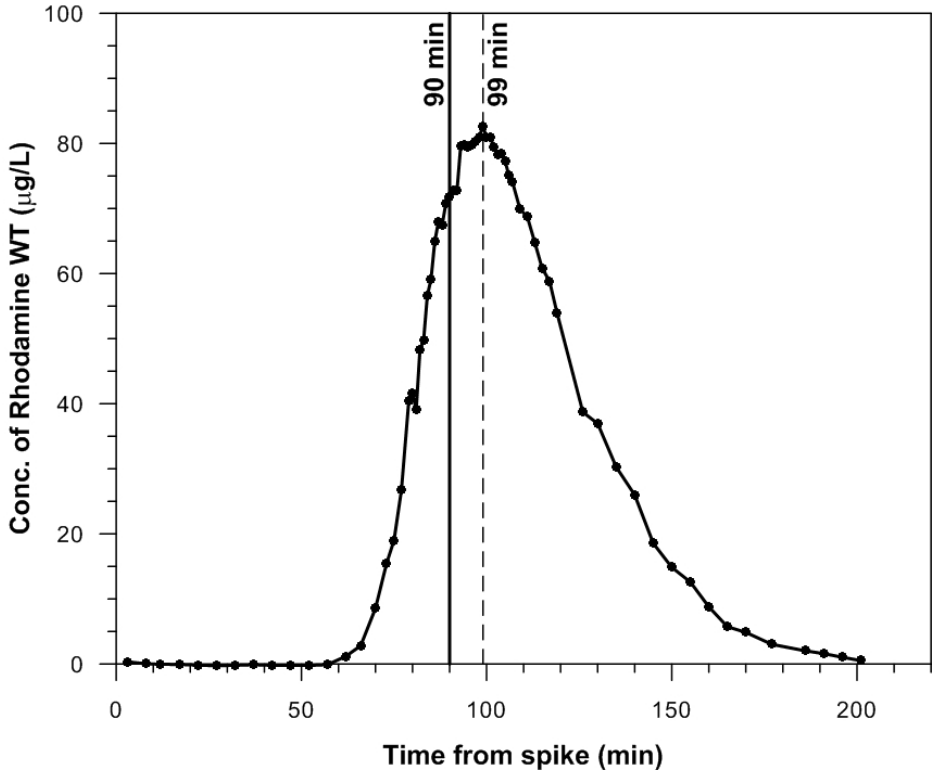

Figure 5 – Rhodamine dye curve from tracer test at 3.02 MGD (4/22/2009; from Trussell Technologies, 2009)

Maximum Flow Test (3.02 MGD)

The highest rate test was conducted on April 22, 2009 and was discussed in an earlier report submitted to CDPH (Trussell Technologies, 2009). The results from that test are repeated here for comparative purposes (Figure 5). After the leading edge was detected (at 66 min), sampling frequency increased to every 2 min and eventually to every 1 min. The maximum dye concentration (82.6 ug/L) was observed 99 minutes after dye injection. Thus, the modal contact time (using the "n-1" method) was 98 minutes. Sampling and measurements continued until the fluorescence readings returned to background levels. A total of 68 samples were collected after the dye was spiked.

3.3. RHODAMINE DYE RECOVERY AND QA/QC

The same mass of rhodamine WT dye was added in all tests (150 mL of 20% active dye, which is 36.0 grams of active rhodamine). The fraction of tracer recovered was calculated for both tracer tests using the following equation:

$$\frac{M_{out}}{M_{in}} = \frac{\sum_{\text{all } i} Q c_{i,avg} \Delta t_i}{M_{in}}$$

Where M_{out}/M_{in} is the fraction of tracer recovered, Q is the flow rate during the tracer test, $c_{i,avg}$ is the average concentration between two consecutive samples, Δt_i is the elapsed time between those two sample points, and M_{in} is the total mass of tracer injected. At least 90% of the dye injected must be recovered for a tracer study to be considered reliable (AwwaRF, 1996). For all of the SEWRF tracer studies, the dye recoveries exceeded 90%: recoveries of 90.8%, 95.4%, 95.6% and 92.2%, were calculated for the 0.84, 1.72, 2.60, and 3.02 MGD tests, respectively (Table 1). The calculations used to determine the dye recovery for all four tests are shown the Appendix (Tables A4, A5, A6, and A7). The recovery during the 0.84 MGD test was less than the others, most likely due to the previously discussed flow disruption 6 hours into the test, which caused the remaining dye in the basin to mix backwards in the basin. Continuing the test for another six hours would have likely increased the dye recovery by a few percent.

The *Aquafluor* handheld fluorometer was calibrated in the morning prior to the start of the each tracer test using two-points for calibration (standard for Turner Designs fluorometers; calibration standards of 0 ug/L and 120 ug/L were prepared in the lab using DI water and the same stock rhodamine WT dye used in the spike). For all tests, it was verified that the calibration was in the linear range of the instrument by measuring diluted concentrations of the rhodamine standard at the time of calibration (Table 2 and Figure 6)[2]. The concentrations observed during the tracer test were all within the linear range of the fluorometer.

[2] Calibration data from 3.02 MGD test used different dilutions and were presented in Trussell Technologies (2009): expected concentrations of 120, 60, 30, and 0 μg/L were observed as 119.8, 59.2, 20.3, and 0.0 μg/L.

Table 2 – Fluorometer calibration data from 2010 tracer tests[2]

Overall dilution factor (µg/L)	Expected Concentration (µg/L)	Calibration Check (µg/L)		
		4/20/10 (2.60 MGD)	4/21/10 (0.84 MGD)	4/22/10 (1.72 MGD)
$2.0x10^6$	120	119.6	119.6	119.7
$3.0x10^6$	80	82.6	81.6	80.5
$9.0x10^6$	40	42.9	42.4	42.1
0	0	0.2	0.1	0.0

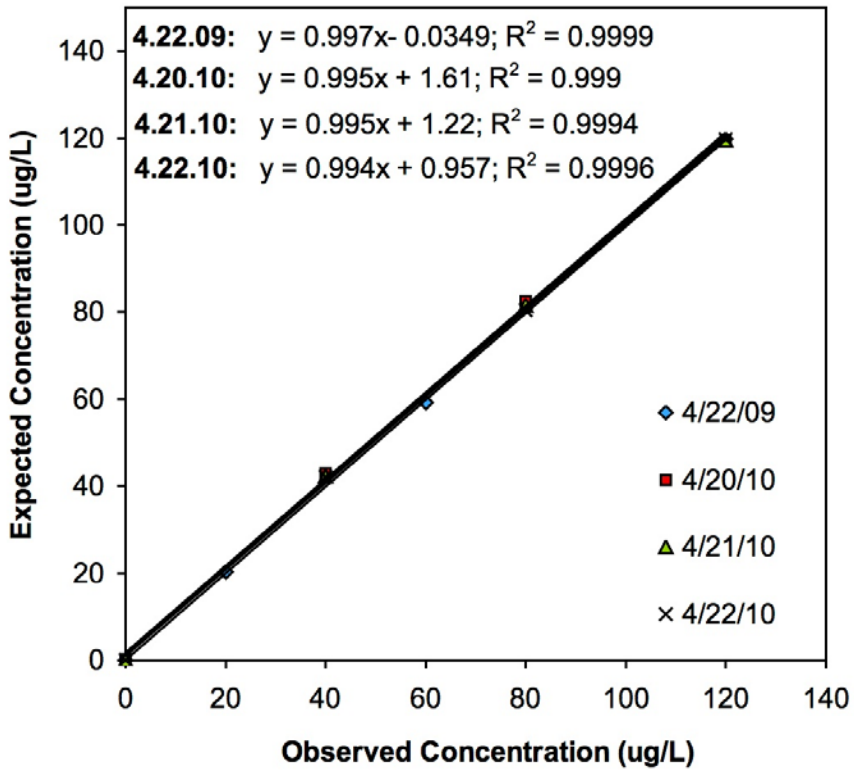

Figure 6 – Fluorometer calibration and linear range verification

3.4. COMPARISON BETWEEN TEST FLOW RATES

The results from all four tests were normalized and are plotted together in Figure 7. The sample time (t) was normalized by the mean residence time observed in the basin (t_{mean}), and the dye concentration (C_{adj}) was normalized by multiplying valves by the observed volume of the basin (V_{CCB}) and dividing by the total mass of dye recovered (M_{out}). The index of modal contact time (*i.e.* baffling efficiency), which is calculated by dividing the modal time (t_{modal}) by t_{mean}, were 0.58, 0.93, 0.93, and 0.89 for flows of 1.72, 2.60, and 3.02 MGD, respectively.

In Figure 7, the narrower the curve and greater, the more the reactor is behaving like an ideal plug flow, whereas an earlier peak and greater spread of data indicates a more

mixed reactor. The tracer tests at flows of 1.72, 2.60, and 3.02 MGD indicate that the hydraulics through the CCB behave similarly over this flow range. Figure 7 and the similarities in baffling efficiencies indicate that the results from the 2009 test line up closely with the results from the higher flow tests completed in 2010.

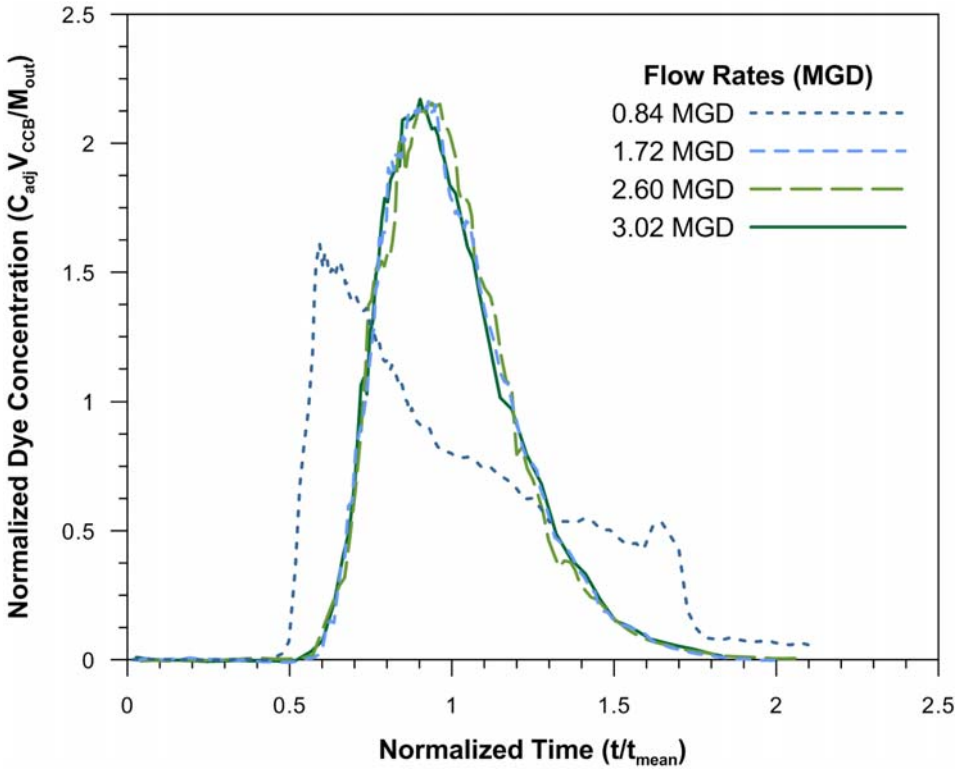

Figure 7 – Comparison on tracer curves on a normalized basis (both axis are dimensionless)

However, the test at 0.84 MGD indicated that for lower flows (less than 1.72 MGD) the relative amount of mixing increases, resulting in short-circuiting of some of the flow. Short-circuiting can be characterized by a peak concentration occurring significantly earlier than the t_{mean}, a long tail, and a low baffling efficiency. The curve at 0.84 MGD illustrates that short-circuiting becomes much more significant at lower flows. Typically, the baffling efficiency is expected in be the worst at the highest flows, however, this phenomenon of a poorer baffling efficiency has been seen elsewhere. For example the worst baffling efficiency was at the lowest flow in San Diego's Otay Water Treament Plant, as documented in *Tracer Studies in Water Treatment Facilities: A Protocol and Case Studies* (AwwaRF 1996).

4. CAPACITY OF SEWRF CHLORINE CONTACT BASIN

The modal contact from each test was determined using the "n-1" method, where because grab sampling is used, the modal contact time reported to CDPH is the sample time of the sample taken just prior to peak concentration sample. The sampling frequencies at the time of the peak concentration were 2, 0.5, 1, and 1 min, for the flows of 0.84, 1,72, 2.60, and 3.02, respectively. The modal contact times observed in the

SEWRF tracer tests along with the corresponding minimum chlorine residuals required to achieve a 450 mg/L-min CT are summarized in Table 3. A curve of the required chlorine residual to meet the 450 mg/L-min CT requirement as a function to CCB flow is shown in Figure 8.

Table 3 –Minimum chlorine residual required to meet a 450 mg/L-min CT at various SEWRF flow rates#

CCB Flow Rate (MGD)	Modal Contact Time (min)	Minimum Cl_2 Residual (mg/L)
0.84	221	2.04
1.72	166	2.72
2.60	114	3.95
3.02	98	4.60

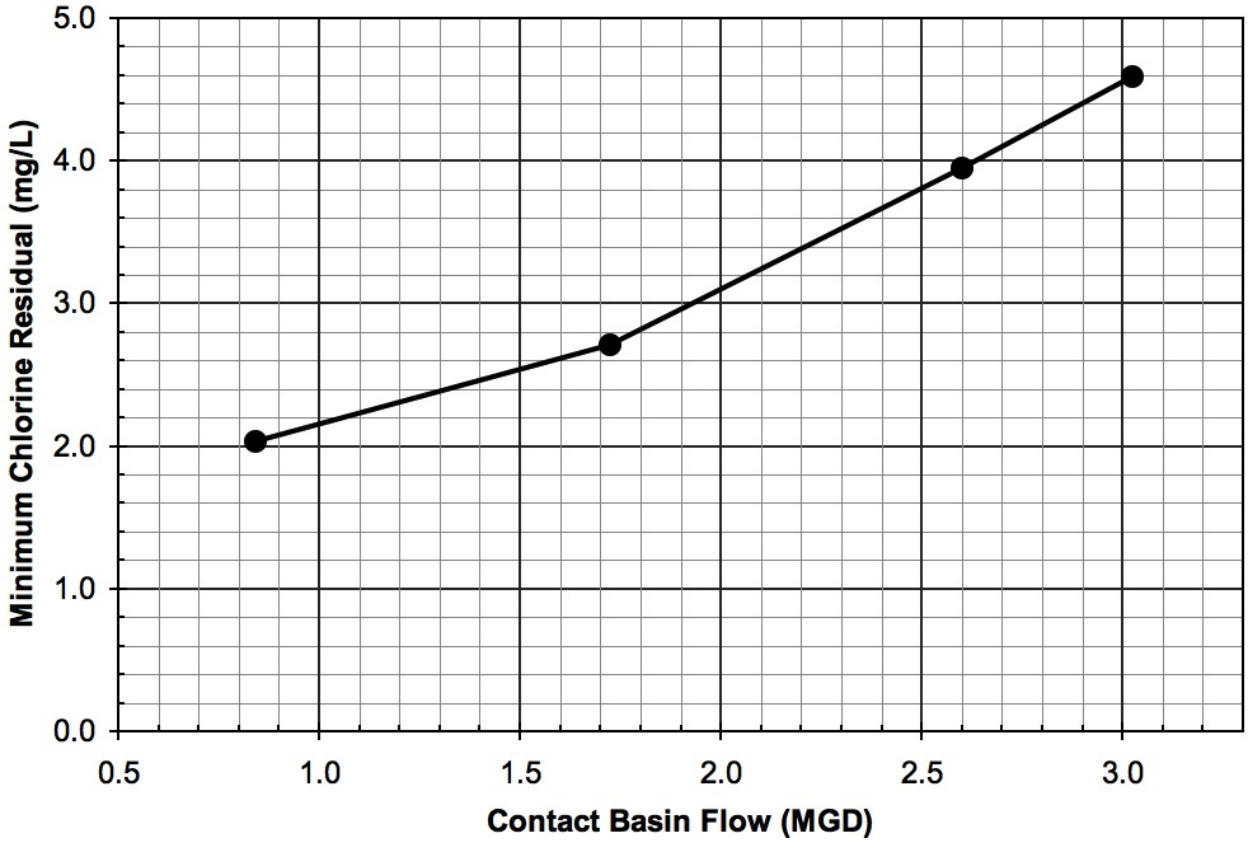

Figure 8 – Curve of minimum chlorine residual required to meet a 450 mg/L-min CT value between SEWRF flow rates of 0.84 to 3.02 MGD.

5. CONCLUSIONS

SEJPA successfully completed four tracer tests studying the SEWRF chlorine contact basin at flow rates of 0.84, 1.72, 2.60, and 3.02 MGD (summary results shown in Table 3). The following conclusions can be drawn from these tests:

- The modal contact time at 3.02 MGD was 98 minutes, but because CDPH does not allow extrapolation of results from tracer tests, **the maximum allowable flow rate through the SEWRF CCB, as determined by these tests, is 3.02 MGD**. At this flow, a minimum chlorine residual of 4.6 mg/L must be met.
- Because the results of the test cannot be extrapolated, a minimum chlorine residual of 2.1 mg/L should be maintained at flows less than 0.84 MGD.
- The actual maximum capacity of the SEWRF chlorine contact basin allowable under the California Water Recycling Criteria (meeting a minimum 90 minute modal contact time) exceeds 3.02 MGD, and slightly higher flows may be allowable through further tracer tests at higher flow rates.
- Results from the 2009 test at 3.02 MGD fit well with the results from the 2010 tests (see Figures 7 and 8).
- The hydraulic behavior of flow through the SEWRF CCB is consistent in the 1.72 to 3.02 MGD flow range.
- At flows less than 1.72 MGD, the amount of short-circuiting increases.
- The minimum chlorine residual required for various flows in the range of 0.84 and 3.02 MGD can be determined using Figure 8.

6. REFERENCES

California Code of Regulations (CCR 2009), Title-22, Division 4, Chapter 3, Water Recycling Criteria §60301

Deaner, D.G. (1973). “Effect of chlorine on fluorescent dyes.” Journal of Water Pollution Control Federation. 45(3) pp. 507-514.

Teefy, S. (AWWARF 1996). *Tracer Studies in Water Treatment Facilities: A Protocol and Case Studies*. American Water Works Association Research Foundation (AWWARF).

Trussell Technologies (2009). “San Elijo Water Reclamation Facility Chlorine Contact Basin Tracer Study August 2009.” Prepared for the San Eljio Joint Powers Authority. Submitted to CDPH (Sean Sterchi) on September 4, 2009.

Trussell Technologies (2010). “San Elijo Water Reclamation Facility Chlorine Contact Basin Tracer Study Protocol.” Prepared for the San Eljio Joint Powers Authority. Submitted to CDPH (Sean Sterchi) on April 9, 2010.

US Environmental Protection Agency (USEPA 1991). *Guidance manual for compliance with the filtration and disinfection requirements for public water systems using surface water sources*. Washington, D.C., March 1991 Edition.

7. APPENDIX – RAW DATA AND FACILITY CONDITIIONS DATA

- Tables of raw data (Tables A1 - A3)
- Chlorine Contact Basin Water Depth Measurements (Table A8)
- Calculations of the mass of tracer dye recovered (Tables A4 – A7)
- Flow rate probability plots (Figure A1)
- Turbidity and chlorine residual data (Figures A2 – A5)

Table A1 – Raw data from test at 0.84 mgd (April 21, 2010)

San Elijo Chlorine Contact Basin Tracer Study

Date:	4/21/10
Flow Rate:	586 gpm
Volume Dye Injected:	150 mL
Slugs dose add. time:	7:05 AM
Samplers: G. Williams, B. Faulkner	
Background Correction:	1.25 ug/L

Sampling Record

ID	Clock Time	Sample Time (min)	Rhodamine Conc (ug/L)	Corrected Rhodamine Conc (ug/L)
1	7:11 AM	6	1.3	0.0
2	7:27 AM	22	1.4	0.2
3	7:35 AM	30	1.3	0.0
4	7:50 AM	45	1.3	0.1
5	8:05 AM	60	1.3	0.0
6	8:21 AM	76	1.2	0.0
7	8:35 AM	90	1.3	0.0
8	8:50 AM	105	1.3	0.0
9	9:05 AM	120	1.3	0.1
10	9:20 AM	135	1.4	0.1
11	9:35 AM	150	1.2	0.0
12	9:50 AM	165	1.2	0.0
13	10:05 AM	180	2.2	0.9
14	10:12 AM	187.5	4.1	2.8
15	10:20 AM	195	15.4	14.1
16	10:25 AM	200	27.5	26.3
17	10:30 AM	205	33.9	32.6
18	10:35 AM	210	39.0	37.8
19	10:40 AM	215	47.9	46.6
20	10:42 AM	217	56.5	55.2
21	10:44 AM	219	61.2	60.0
22	10:46 AM	221	62.8	61.6
23	10:48 AM	223	64.4	63.1
24	10:50 AM	225	62.3	61.1
25	10:52 AM	227	60.6	59.4
26	10:54 AM	229	62.8	61.6
27	10:56 AM	231	62.9	61.7
28	10:58 AM	233	60.6	59.4
29	11:00 AM	235	59.7	58.4
30	11:02 AM	237	60.4	59.2
31	11:04 AM	239	60.2	59.0
32	11:06 AM	241	59.3	58.0
33	11:08 AM	243	60.4	59.2
34	11:10 AM	245	61.6	60.4
35	11:12 AM	247	61.4	60.2
36	11:14 AM	249	60.5	59.2
37	11:16 AM	251	60.1	58.8
38	11:18 AM	253	58.2	57.0
39	11:20 AM	255	58.4	57.1
40	11:22 AM	257	56.8	55.5
41	11:24 AM	259	56.1	54.8
42	11:26 AM	261	56.6	55.5
43	11:28 AM	263	56.8	55.5
44	11:30 AM	265	56.5	55.2
45	11:32 AM	267	55.7	54.4
46	11:34 AM	269	55.2	53.9
47	11:36 AM	271	54.9	53.6
48	11:38 AM	273	54.1	52.8
49	11:40 AM	275	54.2	52.9
50	11:42 AM	277	54.5	53.2
51	11:44 AM	279	53.4	52.2
52	11:46 AM	281	52.6	51.3
53	11:48 AM	283	51.5	50.2
54	11:50 AM	285	51.1	49.8
55	11:52 AM	287	50.4	49.1
56	11:54 AM	289	49.4	48.2
57	11:56 AM	291	50.0	48.7
58	11:58 AM	293	48.8	47.6
59	12:00 PM	295	47.4	46.1
60	12:02 PM	297	46.7	45.5
61	12:04 PM	299	46.4	45.2
62	12:06 PM	301	46.6	45.3
63	12:08 PM	303	45.5	44.2
64	12:10 PM	305	45.1	43.9
65	12:12 PM	307	45.9	44.6
66	12:14 PM	309	44.9	43.6
67	12:16 PM	311	44.7	43.4
68	12:18 PM	313	43.9	42.6
69	12:20 PM	315	43.0	41.7
70	12:22 PM	317	43.5	42.2
71	12:24 PM	319	42.8	41.5
72	12:26 PM	321	41.7	40.4
73	12:28 PM	323	40.7	39.4
74	12:30 PM	325	40.4	39.1
75	12:32 PM	327	38.7	37.5
76	12:34 PM	329	38.9	37.7
77	12:35 PM	330	39.4	38.2
78	12:40 PM	335	37.6	36.3
79	12:45 PM	340	36.9	35.6
80	12:50 PM	345	36.5	35.3
81	12:55 PM	350	36.6	35.3
82	1:00 PM	355	34.9	33.6
83	1:05 PM	360	33.6	32.4
84	1:10 PM	365	33.0	31.7
85	1:15 PM	370	32.8	31.6
86	1:20 PM	375	32.7	31.4
87	1:25 PM	380	32.2	30.9
88	1:30 PM	385	32.0	30.7
89	1:35 PM	390	31.9	30.7
90	1:40 PM	395	32.0	30.8
91	1:45 PM	400	31.6	30.3
92	1:50 PM	405	31.3	30.1
93	1:55 PM	410	30.6	29.4
94	2:00 PM	415	30.6	29.3
95	2:05 PM	420	30.7	29.4
96	2:15 PM	430	29.4	28.2
97	2:25 PM	440	28.6	27.4
98	2:35 PM	450	27.6	26.3
99	2:45 PM	460	25.6	24.4
100	2:55 PM	470	25.8	24.5
101	3:05 PM	480	24.2	22.9
102	3:15 PM	490	22.1	20.9
103	3:25 PM	500	22.2	21.0
104	3:35 PM	510	22.3	21.0
105	3:45 PM	520	22.0	20.8
106	3:55 PM	530	22.7	21.4
107	4:05 PM	540	22.3	21.0
108	4:15 PM	550	21.0	19.7
109	4:25 PM	560	21.0	19.7
110	4:35 PM	570	19.7	18.5
111	4:45 PM	580	18.7	17.4
112	4:55 PM	590	18.9	17.7
113	5:04 PM	599	18.0	16.7
114	5:15 PM	610	21.6	20.3
115	5:25 PM	620	22.1	20.9
116	5:35 PM	630	20.1	18.8
117	5:45 PM	640	18.0	16.8
118	5:55 PM	650	8.7	7.5
119	6:05 PM	660	6.0	4.8
120	6:15 PM	670	4.8	3.3
121	6:25 PM	680	4.4	3.2
122	6:35 PM	690	4.3	3.0
123	6:45 PM	700	4.6	3.4
124	6:55 PM	710	4.3	3.0
125	7:05 PM	720	4.1	2.8
126	7:15 PM	730	4.0	2.7
127	7:30 PM	745	4.2	2.9
128	7:35 PM	750	3.9	2.6
129	7:45 PM	760	3.6	2.4
130	7:55 PM	770	3.5	2.2
131	8:05 PM	780	3.9	2.6
132	8:15 PM	790	3.5	2.3

Table A2 – Raw data from test at 1.72 mgd (April 22, 2010)

San Elijo Chlorine Contact Basin Tracer Study

Date:	4/22/10
Flow Rate:	1197 gpm
Volume Dye Injected:	160 mL
Slugs dose add. time:	8:09 AM
Samplers:	G. Williams, B. Faulkner
Background Correction:	1.95 ug/L

Sampling Record

ID	Clock Time	Sample Time (min)	Rhodamine Conc (ug/L)	Corrected Rhodamine Conc (ug/L)
1	8:14 AM	5	1.9	-0.1
2	8:19 AM	10	2.1	0.2
3	8:24 AM	15	2.0	0.1
4	8:29 AM	20	1.9	0.0
5	8:34 AM	25	2.1	0.1
6	8:39 AM	30	2.1	0.1
7	8:44 AM	35	2.3	0.3
8	8:49 AM	40	2.0	0.0
9	8:54 AM	45	2.0	0.1
10	8:59 AM	50	2.0	0.0
11	9:04 AM	55	2.0	0.0
12	9:09 AM	60	1.9	-0.1
13	9:14 AM	65	1.9	-0.1
14	9:19 AM	70	1.7	-0.2
15	9:24 AM	75	1.6	-0.3
16	9:29 AM	80	1.6	-0.3
17	9:34 AM	85	1.5	-0.4
18	9:39 AM	90	1.6	-0.4
19	9:44 AM	95	1.7	-0.3
20	9:49 AM	100	2.2	0.2
21	9:51 AM	102	2.2	0.2
22	9:53 AM	104	2.5	0.6
23	9:55 AM	106	2.9	0.9
24	9:57 AM	108	4.4	2.4
25	9:59 AM	110	7.6	5.6
26	10:01 AM	112	8.5	6.4
27	10:03 AM	114	8.0	6.1
28	10:05 AM	116	13.2	11.2
29	10:07 AM	118	17.1	15.2
30	10:09 AM	120	18.6	16.9
31	10:11 AM	122	27.2	25.3
32	10:13 AM	124	27.9	25.9
33	10:15 AM	126	36.3	34.4
34	10:17 AM	128	39.2	37.3
35	10:19 AM	130	41.7	39.7
36	10:21 AM	132	45.6	43.6
37	10:23 AM	134	51.4	49.5
38	10:25 AM	136	56.1	54.2
39	10:26 AM	137	62.5	60.6
40	10:27 AM	138	63.5	61.6
41	10:28 AM	139	71.1	69.1
42	10:29 AM	140	69.4	67.4
43	10:30 AM	141	72.0	70.1
44	10:31 AM	142	72.0	70.0
45	10:32 AM	143	74.2	72.3
46	10:33 AM	144	82.6	80.6
47	10:34 AM	145	81.6	79.7
48	10:35 AM	146	83.7	81.7
49	10:36 AM	147	82.1	80.2
50	10:37 AM	148	84.7	82.7
51	10:38 AM	149	84.5	82.5
52	10:39 AM	150	84.7	82.8
53	10:40 AM	151	84.2	82.3
54	10:41 AM	152	87.8	85.8
55	10:42 AM	153	87.0	85.0
56	10:43 AM	154	89.3	87.3
57	10:44 AM	155	91.2	89.3
58	10:45 AM	156	91.4	89.4
59	10:46 AM	157	92.0	90.1
60	10:47 AM	158	92.3	90.3
61	10:48 AM	159	91.5	89.5
62	10:49 AM	160	92.3	90.3
63	10:50 AM	161	91.7	89.8
64	10:51 AM	162	92.1	90.1
65	10:52 AM	163	92.6	90.6
66	10:53 AM	164	92.0	90.1
67	10:53 AM	164.5	92.3	90.4
68	10:54 AM	165	92.7	90.7
69	10:54 AM	165.5	92.2	90.2
70	10:55 AM	166	93.4	91.4
71	10:55 AM	166.5	93.5	91.5
72	10:56 AM	167	93.3	91.3
73	10:56 AM	167.5	92.9	90.9
74	10:57 AM	168	91.7	89.7
75	10:57 AM	168.5	91.9	89.9
76	10:58 AM	169	92.0	90.0
77	10:58 AM	169.5	91.9	89.9
78	10:59 AM	170	92.9	91.0
79	11:00 AM	171	91.4	89.4
80	11:01 AM	172	88.6	86.6
81	11:02 AM	173	88.3	86.4
82	11:03 AM	174	86.5	84.6
83	11:04 AM	175	82.5	80.6
84	11:05 AM	176	80.3	78.3
85	11:06 AM	177	79.9	77.9
86	11:07 AM	178	78.1	76.1
87	11:08 AM	179	77.4	75.4
88	11:09 AM	180	76.5	74.6
89	11:10 AM	181	75.1	73.1
90	11:11 AM	182	75.6	73.6
91	11:12 AM	183	74.8	72.8
92	11:13 AM	184	74.7	72.7
93	11:14 AM	185	74.7	72.7
94	11:15 AM	186	72.7	70.7
95	11:16 AM	187	73.8	71.9
96	11:17 AM	188	73.5	71.6
97	11:18 AM	189	73.4	71.4
98	11:19 AM	190	71.6	69.6
99	11:20 AM	191	69.9	67.9
100	11:21 AM	192	69.1	67.2
101	11:23 AM	194	63.9	61.8
102	11:25 AM	196	61.0	59.0
103	11:27 AM	198	58.2	56.2
104	11:29 AM	200	56.5	54.6
105	11:31 AM	202	54.4	52.5
106	11:33 AM	204	51.7	49.7
107	11:35 AM	206	48.8	46.9
108	11:37 AM	208	47.5	45.5
109	11:39 AM	210	47.1	45.2
110	11:41 AM	212	44.4	42.5
111	11:43 AM	214	42.0	40.1
112	11:45 AM	216	39.6	37.6
113	11:47 AM	218	36.9	34.9
114	11:49 AM	220	35.3	33.4
115	11:51 AM	222	35.0	33.1
116	11:53 AM	224	33.9	31.9
117	11:55 AM	226	33.1	31.1
118	11:57 AM	228	30.0	28.0
119	11:59 AM	230	28.4	26.4
120	12:01 PM	232	26.2	24.2
121	12:03 PM	234	24.0	22.0
122	12:05 PM	236	22.0	20.0
123	12:07 PM	238	21.5	19.6
124	12:09 PM	240	20.8	18.9
125	12:11 PM	242	20.5	18.6
126	12:13 PM	244	19.6	17.6
127	12:15 PM	246	18.6	16.6
128	12:17 PM	248	17.3	15.4
129	12:19 PM	250	16.3	14.3
130	12:21 PM	252	15.6	13.6
131	12:23 PM	254	14.5	12.5
132	12:25 PM	256	13.3	11.3
133	12:27 PM	258	13.1	11.1
134	12:29 PM	260	11.0	9.0
135	12:31 PM	262	9.9	8.0
136	12:34 PM	265	9.8	7.8
137	12:39 PM	270	7.8	5.9
138	12:44 PM	275	7.6	5.8
139	12:49 PM	280	7.0	5.0
140	12:54 PM	285	6.4	4.4
141	12:59 PM	290	5.0	3.0
142	1:04 PM	295	4.5	2.5
143	1:09 PM	300	3.9	2.0
144	1:14 PM	305	3.6	1.6
145	1:19 PM	310	3.2	1.2
146	1:24 PM	315	2.9	0.9
147	1:29 PM	320	2.8	0.8
148	1:34 PM	325	2.5	0.5
149	1:39 PM	330	2.3	0.3
150	1:44 PM	335	2.0	0.1
151	1:49 PM	340	2.1	0.1
152	1:54 PM	345	2.0	0.0
153	1:59 PM	350	1.9	0.0
154	2:04 PM	355	1.9	0.0
155	2:09 PM	360	1.9	0.0

Table A3 – Raw data from test at 2.60 mgd (April 20, 2010)

San Elijo Chlorine Contact Basin Tracer Study

Date:	4/20/10
Flow Rate:	1805 gpm
Volume Dye Injected:	150 mL
Slugs dose add. time:	8:48 AM
Samplers: G. Williams, B. Faulkner	
Background Correction:	0.56 ug/L

Sampling Record

ID	Clock Time	Sample Time (min)	Rhodamine Conc (ug/L)	Corrected Rhodamine Conc (ug/L)
1	8:53 AM	5	0.4	-0.2
2	8:58 AM	10	0.5	-0.1
3	9:03 AM	15	0.4	-0.2
4	9:08 AM	20	0.4	-0.1
5	9:13 AM	25	0.4	-0.1
6	9:18 AM	30	0.5	-0.1
7	9:23 AM	35	0.5	-0.1
8	9:28 AM	40	0.6	0.0
9	9:33 AM	45	0.7	0.2
10	9:38 AM	50	0.8	0.3
11	9:43 AM	55	0.7	0.1
12	9:48 AM	60	0.7	0.1
13	9:53 AM	65	0.8	0.2
14	9:58 AM	70	1.3	0.7
15	10:03 AM	75	6.8	6.3
16	10:08 AM	80	12.4	11.8
17	10:10 AM	82	13.6	13.1
18	10:12 AM	84	20.1	19.5
19	10:14 AM	86	27.4	26.9
20	10:16 AM	88	35.9	35.3
21	10:18 AM	90	47.3	46.7
22	10:19 AM	91	56.9	56.3
23	10:20 AM	92.25	57.9	57.4
24	10:21 AM	93	60.6	60.0
25	10:22 AM	94	62.9	62.3
26	10:23 AM	95	63.0	62.4
27	10:24 AM	96	64.0	63.4
28	10:25 AM	97	63.2	62.6
29	10:26 AM	98	64.9	64.3
30	10:27 AM	99	64.4	63.8
31	10:28 AM	100	66.9	66.4
32	10:29 AM	101	70.4	69.8
33	10:30 AM	102	80.1	79.5
34	10:31 AM	103	84.2	83.6
35	10:32 AM	104	83.6	83.0
36	10:33 AM	105	78.2	77.6
37	10:34 AM	106	81.4	80.8
38	10:35 AM	107	82.4	81.8
39	10:36 AM	108	85.2	84.6
40	10:37 AM	109	86.6	86.1
41	10:38 AM	110	88.3	87.7
42	10:39 AM	111	87.9	87.3
43	10:40 AM	112	88.0	87.4
44	10:41 AM	113	87.4	86.8
45	10:42 AM	114	88.5	88.0
46	10:43 AM	115	89.2	88.6
47	10:44 AM	116	88.5	87.9
48	10:45 AM	117	88.8	88.2
49	10:46 AM	118	89.0	88.5
50	10:47 AM	119	86.7	86.1
51	10:48 AM	120	85.5	84.9
52	10:49 AM	121	85.0	84.4
53	10:50 AM	122	83.8	83.2
54	10:51 AM	123	82.1	81.5
55	10:52 AM	124	80.4	79.9
56	10:53 AM	125	75.3	74.8
57	10:54 AM	126	73.9	73.3
58	10:55 AM	127	73.3	72.8
59	10:56 AM	128	73.8	73.2
60	10:57 AM	129	73.1	72.5
61	10:58 AM	130	71.1	70.6
62	10:59 AM	131	64.6	64.0
63	11:00 AM	132	63.5	62.9
64	11:01 AM	133	61.7	61.2
65	11:03 AM	135	59.6	59.1
66	11:05 AM	137	58.4	57.9
67	11:07 AM	139	55.1	54.5
68	11:09 AM	141	49.1	48.6
69	11:11 AM	143	44.9	44.4
70	11:13 AM	145	44.2	43.6
71	11:15 AM	147	33.3	32.7
72	11:17 AM	149	34.4	33.9
73	11:19 AM	151	31.0	30.4
74	11:21 AM	153	29.3	28.8
75	11:23 AM	155	26.9	26.3
76	11:25 AM	157	23.9	23.4
77	11:27 AM	159	19.6	19.1
78	11:29 AM	161	17.4	16.9
79	11:31 AM	163	15.3	14.7
80	11:33 AM	165	16.4	15.8
81	11:35 AM	167.25	16.1	15.6
82	11:37 AM	169	14.9	14.3
83	11:39 AM	171	12.5	11.9
84	11:41 AM	173	11.6	11.0
85	11:43 AM	175	10.5	10.0
86	11:45 AM	177	10.2	9.7
87	11:47 AM	179	9.4	8.9
88	11:52 AM	184	7.0	6.4
89	11:57 AM	189	5.3	4.8
90	12:02 PM	194	4.1	3.5
91	12:07 PM	199	3.4	2.8
92	12:12 PM	204	2.9	2.3
93	12:17 PM	209.75	2.2	1.6
94	12:22 PM	214	1.9	1.4
95	12:27 PM	219	1.6	1.1
96	12:32 PM	224	1.2	0.6
97	12:37 PM	229	1.1	0.5
98	12:42 PM	234	1.0	0.4
99	12:47 PM	239	0.9	0.4
100	12:52 PM	244	0.8	0.2
101	12:57 PM	249	0.8	0.2
102	1:02 PM	254	0.8	0.2

Table A4 – Calculation of dye recovery for 0.84 MGD test on April 21, 2010

ID	Clock Time	Sample Time (min)	Adj Rhodamine Conc (ug/L)	Δt (min)	$c_{i,avg}$ (ug/L)	$Q*c_{i,avg}*\Delta t$ (g)
1	7:11 AM	6	0.0	--	--	--
2	7:27 AM	22	0.2	--	--	--
3	7:35 AM	30	0.0	--	--	--
4	7:50 AM	45	0.1	--	--	--
5	8:05 AM	60	0.0	--	--	--
6	8:21 AM	76	0.0	--	--	--
7	8:35 AM	90	0.0	--	--	--
8	8:50 AM	105	0.0	--	--	--
9	9:05 AM	120	0.1	--	--	--
10	9:20 AM	135	0.1	--	--	--
11	9:35 AM	150	0.0	--	--	--
12	9:50 AM	165	0.0	--	--	--
13	10:05 AM	180	0.9	5	0.5	0.01
14	10:12 AM	187.5	2.8	7.5	1.9	0.03
15	10:20 AM	195	14.1	7.5	8.5	0.14
16	10:25 AM	200	26.3	5	20.2	0.22
17	10:30 AM	205	32.6	5	29.5	0.33
18	10:35 AM	210	37.8	5	35.2	0.39
19	10:40 AM	215	46.6	5	42.2	0.47
20	10:42 AM	217	55.2	2	50.9	0.23
21	10:44 AM	219	60.0	2	57.6	0.26
22	10:46 AM	221	61.6	2	60.8	0.27
23	10:48 AM	223	63.1	2	62.3	0.28
24	10:50 AM	225	61.1	2	62.1	0.28
25	10:52 AM	227	59.4	2	60.2	0.27
26	10:54 AM	229	61.6	2	60.5	0.27
27	10:56 AM	231	61.7	2	61.6	0.27
28	10:58 AM	233	59.4	2	60.5	0.27
29	11:00 AM	235	58.4	2	58.9	0.26
30	11:02 AM	237	59.2	2	58.8	0.26
31	11:04 AM	239	59.0	2	59.1	0.26
32	11:06 AM	241	58.0	2	58.5	0.26
33	11:08 AM	243	59.2	2	58.6	0.26
34	11:10 AM	245	60.4	2	59.8	0.27
35	11:12 AM	247	60.2	2	60.3	0.27
36	11:14 AM	249	59.2	2	59.7	0.26
37	11:16 AM	251	58.8	2	59.0	0.26
38	11:18 AM	253	57.0	2	57.9	0.26
39	11:20 AM	255	57.1	2	57.0	0.25
40	11:22 AM	257	55.5	2	56.3	0.25
41	11:24 AM	259	54.8	2	55.2	0.24
42	11:26 AM	261	55.5	2	55.2	0.24
43	11:28 AM	263	55.5	2	55.5	0.25
44	11:30 AM	265	55.2	2	55.4	0.25
45	11:32 AM	267	54.4	2	54.8	0.24
46	11:34 AM	269	53.9	2	54.2	0.24
47	11:36 AM	271	53.6	2	53.7	0.24
48	11:38 AM	273	52.8	2	53.2	0.24
49	11:40 AM	275	52.9	2	52.9	0.23
50	11:42 AM	277	53.2	2	53.1	0.24
51	11:44 AM	279	52.2	2	52.7	0.23
52	11:46 AM	281	51.3	2	51.8	0.23
53	11:48 AM	283	50.2	2	50.8	0.23

Table A4 – Continued

ID	Clock Time	Sample Time (min)	Adj Rhodamine Conc (ug/L)	Δt (min)	$c_{i,avg}$ (ug/L)	$Q*c_{i,avg}*\Delta t$ (g)
54	11:50 AM	285	49.8	2	50.0	0.22
55	11:52 AM	287	49.1	2	49.5	0.22
56	11:54 AM	289	48.2	2	48.6	0.22
57	11:56 AM	291	48.7	2	48.5	0.21
58	11:58 AM	293	47.6	2	48.2	0.21
59	12:00 PM	295	46.1	2	46.8	0.21
60	12:02 PM	297	45.5	2	45.8	0.20
61	12:04 PM	299	45.2	2	45.3	0.20
62	12:06 PM	301	45.3	2	45.2	0.20
63	12:08 PM	303	44.2	2	44.8	0.20
64	12:10 PM	305	43.9	2	44.0	0.20
65	12:12 PM	307	44.6	2	44.2	0.20
66	12:14 PM	309	43.6	2	44.1	0.20
67	12:16 PM	311	43.4	2	43.5	0.19
68	12:18 PM	313	42.6	2	43.0	0.19
69	12:20 PM	315	41.7	2	42.2	0.19
70	12:22 PM	317	42.2	2	42.0	0.19
71	12:24 PM	319	41.5	2	41.9	0.19
72	12:26 PM	321	40.4	2	41.0	0.18
73	12:28 PM	323	39.4	2	39.9	0.18
74	12:30 PM	325	39.1	2	39.3	0.17
75	12:32 PM	327	37.5	2	38.3	0.17
76	12:34 PM	329	37.7	2	37.6	0.17
77	12:35 PM	330	38.2	1	37.9	0.08
78	12:40 PM	335	36.3	5	37.2	0.41
79	12:45 PM	340	35.6	5	36.0	0.40
80	12:50 PM	345	35.3	5	35.4	0.39
81	12:55 PM	350	35.3	5	35.3	0.39
82	1:00 PM	355	33.6	5	34.4	0.38
83	1:05 PM	360	32.4	5	33.0	0.37
84	1:10 PM	365	31.7	5	32.0	0.36
85	1:15 PM	370	31.6	5	31.6	0.35
86	1:20 PM	375	31.4	5	31.5	0.35
87	1:25 PM	380	30.9	5	31.2	0.35
88	1:30 PM	385	30.7	5	30.8	0.34
89	1:35 PM	390	30.7	5	30.7	0.34
90	1:40 PM	395	30.8	5	30.7	0.34
91	1:45 PM	400	30.3	5	30.5	0.34
92	1:50 PM	405	30.1	5	30.2	0.33
93	1:55 PM	410	29.4	5	29.7	0.33
94	2:00 PM	415	29.3	5	29.3	0.33
95	2:05 PM	420	29.4	5	29.4	0.33
96	2:15 PM	430	28.2	10	28.8	0.64
97	2:25 PM	440	27.4	10	27.8	0.62
98	2:35 PM	450	26.3	10	26.8	0.60
99	2:45 PM	460	24.4	10	25.3	0.56
100	2:55 PM	470	24.5	10	24.4	0.54
101	3:05 PM	480	22.9	10	23.7	0.53
102	3:15 PM	490	20.9	10	21.9	0.49
103	3:25 PM	500	21.0	10	20.9	0.46
104	3:35 PM	510	21.0	10	21.0	0.47
105	3:45 PM	520	20.8	10	20.9	0.46
106	3:55 PM	530	21.4	10	21.1	0.47

Table A4 – Continued

ID	Clock Time	Sample Time (min)	Adj Rhodamine Conc (ug/L)	Δt (min)	$c_{i,avg}$ (ug/L)	$Q*c_{i,avg}*\Delta t$ (g)
107	4:05 PM	540	21.0	10	21.2	0.47
108	4:15 PM	550	19.7	10	20.4	0.45
109	4:25 PM	560	19.7	10	19.7	0.44
110	4:35 PM	570	18.5	10	19.1	0.42
111	4:45 PM	580	17.4	10	18.0	0.40
112	4:55 PM	590	17.7	10	17.6	0.39
113	5:04 PM	599	16.7	9	17.2	0.34
114	5:15 PM	610	20.3	11	18.5	0.45
115	5:25 PM	620	20.9	10	20.6	0.46
116	5:35 PM	630	18.8	10	19.9	0.44
117	5:45 PM	640	16.8	10	17.8	0.40
118	5:55 PM	650	7.5	10	12.1	0.27
119	6:05 PM	660	4.8	10	6.1	0.14
120	6:15 PM	670	3.3	10	4.1	0.09
121	6:25 PM	680	3.2	10	3.3	0.07
122	6:35 PM	690	3.0	10	3.1	0.07
123	6:45 PM	700	3.4	10	3.2	0.07
124	6:55 PM	710	3.0	10	3.2	0.07
125	7:05 PM	720	2.8	10	2.9	0.06
126	7:15 PM	730	2.7	10	2.8	0.06
127	7:30 PM	745	2.9	15	2.8	0.09
128	7:35 PM	750	2.6	5	2.8	0.03
129	7:45 PM	760	2.4	10	2.5	0.06
130	7:55 PM	770	2.2	10	2.3	0.05
131	8:05 PM	780	2.6	10	2.4	0.05
132	8:15 PM	790	2.3	10	2.4	0.05
					$\sum Q*c_{i,avg}*\Delta t$ =	32.92

*At 4:50PM on 4/21/2010 the valve to the chlorine contact basin started to close due to programming in the SCADA system that shuts down the recycled water system when recycled water demands and being met and the reservoir is full. Flow was restored to the target flow by 5:01PM. Over this 11 minute period, 3000 gallons exited the chlorine contact basin, but in the Table 5 calculations, it was assumed that 6446 gallons exited the contact basin. The average adjusted rhodamine concentration during this time was 17.2 μg/L. Thus, the above calculations over estimated the mass of dye recovered by 3446 gallons with 17.2 μg/L, or 0.22 g of rhodamine. **Thus the total amount of dye recovered was 32.79 grams or 90.8% of the dye.**

Fraction of dye recovered = M_{out}/M_{in} = (32.92 g -0.22 g)/36.0 g = 90.8%

Table A5 – Calculation of dye recovery for 1.72 MGD test on April 22, 2010

ID	Clock Time	Sample Time (min)	Adj Rhodamine Conc (ug/L)	Δt (min)	$c_{i,avg}$ (ug/L)	$Q*c_{i,avg}*\Delta t$ (g)
1	8:14 AM	5	-0.1	--	--	--
2	8:19 AM	10	0.2	--	--	--
3	8:24 AM	15	0.1	--	--	--
4	8:29 AM	20	0.0	--	--	--
5	8:34 AM	25	0.1	--	--	--
6	8:39 AM	30	0.1	--	--	--
7	8:44 AM	35	0.3	--	--	--
8	8:49 AM	40	0.0	--	--	--
9	8:54 AM	45	0.1	--	--	--
10	8:59 AM	50	0.0	--	--	--
11	9:04 AM	55	0.0	--	--	--
12	9:09 AM	60	-0.1	--	--	--
13	9:14 AM	65	-0.1	--	--	--
14	9:19 AM	70	-0.2	--	--	--
15	9:24 AM	75	-0.3	--	--	--
16	9:29 AM	80	-0.3	--	--	--
17	9:34 AM	85	-0.4	--	--	--
18	9:39 AM	90	-0.4	--	--	--
19	9:44 AM	95	-0.3	--	--	--
20	9:49 AM	100	0.2	--	--	--
21	9:51 AM	102	0.2	--	--	--
22	9:53 AM	104	0.6	2	0.4	0.00
23	9:55 AM	106	0.9	2	0.7	0.01
24	9:57 AM	108	2.4	2	1.7	0.02
25	9:59 AM	110	5.6	2	4.0	0.04
26	10:01 AM	112	6.4	2	6.0	0.05
27	10:03 AM	114	6.1	2	6.2	0.06
28	10:05 AM	116	11.2	2	8.7	0.08
29	10:07 AM	118	15.2	2	13.2	0.12
30	10:09 AM	120	16.9	2	16.0	0.15
31	10:11 AM	122	25.3	2	21.1	0.19
32	10:13 AM	124	25.9	2	25.6	0.23
33	10:15 AM	126	34.4	2	30.2	0.27
34	10:17 AM	128	37.3	2	35.8	0.32
35	10:19 AM	130	39.7	2	38.5	0.35
36	10:21 AM	132	43.6	2	41.7	0.38
37	10:23 AM	134	49.5	2	46.5	0.42
38	10:25 AM	136	54.2	2	51.8	0.47
39	10:26 AM	137	60.6	1	57.4	0.26
40	10:27 AM	138	61.6	1	61.1	0.28
41	10:28 AM	139	69.1	1	65.4	0.30
42	10:29 AM	140	67.4	1	68.3	0.31
43	10:30 AM	141	70.1	1	68.7	0.31
44	10:31 AM	142	70.0	1	70.0	0.32
45	10:32 AM	143	72.3	1	71.2	0.32
46	10:33 AM	144	80.6	1	76.4	0.35
47	10:34 AM	145	79.7	1	80.1	0.36
48	10:35 AM	146	81.7	1	80.7	0.37
49	10:36 AM	147	80.2	1	80.9	0.37
50	10:37 AM	148	82.7	1	81.5	0.37
51	10:38 AM	149	82.5	1	82.6	0.37
52	10:39 AM	150	82.8	1	82.7	0.37
53	10:40 AM	151	82.3	1	82.5	0.37

Table A5 – Continued

ID	Clock Time	Sample Time (min)	Adj Rhodamine Conc (ug/L)	Δt (min)	$c_{i,avg}$ (ug/L)	$Q*c_{i,avg}*\Delta t$ (g)
54	10:41 AM	152	85.8	1	84.1	0.38
55	10:42 AM	153	85.0	1	85.4	0.39
56	10:43 AM	154	87.3	1	86.2	0.39
57	10:44 AM	155	89.3	1	88.3	0.40
58	10:45 AM	156	89.4	1	89.4	0.40
59	10:46 AM	157	90.1	1	89.8	0.41
60	10:47 AM	158	90.3	1	90.2	0.41
61	10:48 AM	159	89.5	1	89.9	0.41
62	10:49 AM	160	90.3	1	89.9	0.41
63	10:50 AM	161	89.8	1	90.1	0.41
64	10:51 AM	162	90.1	1	90.0	0.41
65	10:52 AM	163	90.6	1	90.4	0.41
66	10:53 AM	164	90.1	1	90.3	0.41
67	10:53 AM	164.5	90.4	0.5	90.2	0.20
68	10:54 AM	165	90.7	0.5	90.6	0.21
69	10:54 AM	165.5	90.2	0.5	90.5	0.21
70	10:55 AM	166	91.4	0.5	90.8	0.21
71	10:55 AM	166.5	91.5	0.5	91.5	0.21
72	10:56 AM	167	91.3	0.5	91.4	0.21
73	10:56 AM	167.5	90.9	0.5	91.1	0.21
74	10:57 AM	168	89.7	0.5	90.3	0.20
75	10:57 AM	168.5	89.9	0.5	89.8	0.20
76	10:58 AM	169	90.0	0.5	90.0	0.20
77	10:58 AM	169.5	89.9	0.5	90.0	0.20
78	10:59 AM	170	91.0	0.5	90.4	0.20
79	11:00 AM	171	89.4	1	90.2	0.41
80	11:01 AM	172	86.6	1	88.0	0.40
81	11:02 AM	173	86.4	1	86.5	0.39
82	11:03 AM	174	84.6	1	85.5	0.39
83	11:04 AM	175	80.6	1	82.6	0.37
84	11:05 AM	176	78.3	1	79.4	0.36
85	11:06 AM	177	77.9	1	78.1	0.35
86	11:07 AM	178	76.1	1	77.0	0.35
87	11:08 AM	179	75.4	1	75.8	0.34
88	11:09 AM	180	74.6	1	75.0	0.34
89	11:10 AM	181	73.1	1	73.8	0.33
90	11:11 AM	182	73.6	1	73.4	0.33
91	11:12 AM	183	72.8	1	73.2	0.33
92	11:13 AM	184	72.7	1	72.8	0.33
93	11:14 AM	185	72.7	1	72.7	0.33
94	11:15 AM	186	70.7	1	71.7	0.32
95	11:16 AM	187	71.9	1	71.3	0.32
96	11:17 AM	188	71.6	1	71.7	0.32
97	11:18 AM	189	71.4	1	71.5	0.32
98	11:19 AM	190	69.6	1	70.5	0.32
99	11:20 AM	191	67.9	1	68.8	0.31
100	11:21 AM	192	67.2	1	67.5	0.31
101	11:23 AM	194	61.8	2	64.5	0.58
102	11:25 AM	196	59.0	2	60.4	0.55
103	11:27 AM	198	56.2	2	57.6	0.52
104	11:29 AM	200	54.6	2	55.4	0.50
105	11:31 AM	202	52.5	2	53.5	0.48
106	11:33 AM	204	49.7	2	51.1	0.46

Table A5 – Continued

ID	Clock Time	Sample Time (min)	Adj Rhodamine Conc (ug/L)	Δt (min)	$c_{i,avg}$ (ug/L)	$Q*c_{i,avg}*\Delta t$ (g)
107	11:35 AM	206	46.9	2	48.3	0.44
108	11:37 AM	208	45.5	2	46.2	0.42
109	11:39 AM	210	45.2	2	45.4	0.41
110	11:41 AM	212	42.5	2	43.8	0.40
111	11:43 AM	214	40.1	2	41.3	0.37
112	11:45 AM	216	37.6	2	38.9	0.35
113	11:47 AM	218	34.9	2	36.3	0.33
114	11:49 AM	220	33.4	2	34.2	0.31
115	11:51 AM	222	33.1	2	33.2	0.30
116	11:53 AM	224	31.9	2	32.5	0.29
117	11:55 AM	226	31.1	2	31.5	0.29
118	11:57 AM	228	28.0	2	29.6	0.27
119	11:59 AM	230	26.4	2	27.2	0.25
120	12:01 PM	232	24.2	2	25.3	0.23
121	12:03 PM	234	22.0	2	23.1	0.21
122	12:05 PM	236	20.0	2	21.0	0.19
123	12:07 PM	238	19.6	2	19.8	0.18
124	12:09 PM	240	18.9	2	19.2	0.17
125	12:11 PM	242	18.6	2	18.7	0.17
126	12:13 PM	244	17.6	2	18.1	0.16
127	12:15 PM	246	16.6	2	17.1	0.16
128	12:17 PM	248	15.4	2	16.0	0.14
129	12:19 PM	250	14.3	2	14.9	0.13
130	12:21 PM	252	13.6	2	14.0	0.13
131	12:23 PM	254	12.5	2	13.1	0.12
132	12:25 PM	256	11.3	2	11.9	0.11
133	12:27 PM	258	11.1	2	11.2	0.10
134	12:29 PM	260	9.0	2	10.1	0.09
135	12:31 PM	262	8.0	2	8.5	0.08
136	12:34 PM	265	7.8	3	7.9	0.11
137	12:39 PM	270	5.9	5	6.9	0.16
138	12:44 PM	275	5.6	5	5.8	0.13
139	12:49 PM	280	5.0	5	5.3	0.12
140	12:54 PM	285	4.4	5	4.7	0.11
141	12:59 PM	290	3.0	5	3.7	0.08
142	1:04 PM	295	2.5	5	2.8	0.06
143	1:09 PM	300	2.0	5	2.3	0.05
144	1:14 PM	305	1.6	5	1.8	0.04
145	1:19 PM	310	1.2	5	1.4	0.03
146	1:24 PM	315	0.9	5	1.1	0.02
147	1:29 PM	320	0.8	5	0.9	0.02
148	1:34 PM	325	0.5	5	0.7	0.02
149	1:39 PM	330	0.3	5	0.4	0.01
150	1:44 PM	335	0.1	5	0.2	0.00
151	1:49 PM	340	0.1	5	0.1	0.00
152	1:54 PM	345	0.0	5	0.1	0.00
153	1:59 PM	350	0	5	0	0.00
154	2:04 PM	355	0	5	0	0.00
155	2:09 PM	360	0	5	0	0.00
					$\sum Q*c_{i,avg}*\Delta t$ =	34.34

Fraction of dye recovered = M_{out}/M_{in} = (34.34)/36.0 g = 95.4%

Table A6 – Calculation of dye recovery for 2.60 MGD test on April 20, 2010

ID	Clock Time	Sample Time (min)	Adj Rhodamine Conc (ug/L)	Δt (min)	$c_{i,avg}$ (ug/L)	$Q*c_{i,avg}*\Delta t$ (g)
1	8:53 AM	5	-0.2	--	--	--
2	8:58 AM	10	-0.1	--	--	--
3	9:03 AM	15	-0.2	--	--	--
4	9:08 AM	20	-0.1	--	--	--
5	9:13 AM	25	-0.1	--	--	--
6	9:18 AM	30	-0.1	--	--	--
7	9:23 AM	35	-0.1	--	--	--
8	9:28 AM	40	0.0	--	--	--
9	9:33 AM	45	0.2	--	--	--
10	9:38 AM	50	0.3	--	--	--
11	9:43 AM	55	0.1	--	--	--
12	9:48 AM	60	0.1	--	--	--
13	9:53 AM	65	0.2	--	--	--
14	9:58 AM	70	0.7	5	0.5	0.02
15	10:03 AM	75	6.3	5	3.5	0.12
16	10:08 AM	80	11.8	5	9.0	0.31
17	10:10 AM	82	13.1	2	12.4	0.17
18	10:12 AM	84	19.5	2	16.3	0.22
19	10:14 AM	86	26.9	2	23.2	0.32
20	10:16 AM	88	35.3	2	31.1	0.42
21	10:18 AM	90	46.7	2	41.0	0.56
22	10:19 AM	91	56.3	1	51.5	0.35
23	10:20 AM	92.25	57.4	1.25	56.9	0.49
24	10:21 AM	93	60.0	0.75	58.7	0.30
25	10:22 AM	94	62.3	1	61.2	0.42
26	10:23 AM	95	62.4	1	62.4	0.43
27	10:24 AM	96	63.4	1	62.9	0.43
28	10:25 AM	97	62.6	1	63.0	0.43
29	10:26 AM	98	64.3	1	63.5	0.43
30	10:27 AM	99	63.8	1	64.1	0.44
31	10:28 AM	100	66.4	1	65.1	0.44
32	10:29 AM	101	69.8	1	68.1	0.47
33	10:30 AM	102	79.5	1	74.7	0.51
34	10:31 AM	103	83.6	1	81.6	0.56
35	10:32 AM	104	83.0	1	83.3	0.57
36	10:33 AM	105	77.6	1	80.3	0.55
37	10:34 AM	106	80.8	1	79.2	0.54
38	10:35 AM	107	81.8	1	81.3	0.56
39	10:36 AM	108	84.6	1	83.2	0.57
40	10:37 AM	109	86.1	1	85.3	0.58
41	10:38 AM	110	87.7	1	86.9	0.59
42	10:39 AM	111	87.3	1	87.5	0.60
43	10:40 AM	112	87.4	1	87.4	0.60
44	10:41 AM	113	86.8	1	87.1	0.60
45	10:42 AM	114	88.0	1	87.4	0.60
46	10:43 AM	115	88.6	1	88.3	0.60
47	10:44 AM	116	87.9	1	88.3	0.60
48	10:45 AM	117	88.2	1	88.1	0.60
49	10:46 AM	118	88.5	1	88.4	0.60
50	10:47 AM	119	86.1	1	87.3	0.60
51	10:48 AM	120	84.9	1	85.5	0.58
52	10:49 AM	121	84.4	1	84.6	0.58
53	10:50 AM	122	83.2	1	83.8	0.57

Table A6 – Continued

ID	Clock Time	Sample Time (min)	Adj Rhodamine Conc (ug/L)	Δt (min)	$c_{i,avg}$ (ug/L)	$Q*c_{i,avg}*\Delta t$ (g)
54	10:51 AM	123	81.5	1	82.4	0.56
55	10:52 AM	124	79.9	1	80.7	0.55
56	10:53 AM	125	74.8	1	77.3	0.53
57	10:54 AM	126	73.3	1	74.0	0.51
58	10:55 AM	127	72.8	1	73.0	0.50
59	10:56 AM	128	73.2	1	73.0	0.50
60	10:57 AM	129	72.5	1	72.9	0.50
61	10:58 AM	130	70.6	1	71.6	0.49
62	10:59 AM	131	64.0	1	67.3	0.46
63	11:00 AM	132	62.9	1	63.5	0.43
64	11:01 AM	133	61.2	1	62.0	0.42
65	11:03 AM	135	59.1	2	60.1	0.82
66	11:05 AM	137	57.9	2	58.5	0.80
67	11:07 AM	139	54.5	2	56.2	0.77
68	11:09 AM	141	48.6	2	51.5	0.70
69	11:11 AM	143	44.4	2	46.5	0.63
70	11:13 AM	145	43.6	2	44.0	0.60
71	11:15 AM	147	32.7	2	38.2	0.52
72	11:17 AM	149	33.9	2	33.3	0.45
73	11:19 AM	151	30.4	2	32.1	0.44
74	11:21 AM	153	28.8	2	29.6	0.40
75	11:23 AM	155	26.3	2	27.5	0.38
76	11:25 AM	157	23.4	2	24.9	0.34
77	11:27 AM	159	19.1	2	21.2	0.29
78	11:29 AM	161	16.9	2	18.0	0.25
79	11:31 AM	163	14.7	2	15.8	0.22
80	11:33 AM	165	15.8	2	15.3	0.21
81	11:35 AM	167.25	15.6	2.25	15.7	0.24
82	11:37 AM	169	14.3	1.75	14.9	0.18
83	11:39 AM	171	11.9	2	13.1	0.18
84	11:41 AM	173	11.0	2	11.5	0.16
85	11:43 AM	175	10.0	2	10.5	0.14
86	11:45 AM	177	9.7	2	9.8	0.13
87	11:47 AM	179	8.9	2	9.3	0.13
88	11:52 AM	184	6.4	5	7.6	0.26
89	11:57 AM	189	4.8	5	5.6	0.19
90	12:02 PM	194	3.5	5	4.2	0.14
91	12:07 PM	199	2.8	5	3.2	0.11
92	12:12 PM	204	2.3	5	2.6	0.09
93	12:17 PM	209.75	1.6	5.75	2.0	0.08
94	12:22 PM	214	1.4	4.25	1.5	0.04
95	12:27 PM	219	1.1	5	1.2	0.04
96	12:32 PM	224	0.6	5	0.8	0.03
97	12:37 PM	229	0.5	5	0.6	0.02
98	12:42 PM	234	0.4	5	0.5	0.02
99	12:47 PM	239	0.4	5	0.4	0.01
100	12:52 PM	244	0.2	5	0.3	0.01
101	12:57 PM	249	0.2	5	0.2	0.01
102	1:02 PM	254	0.2	5	0.2	0.01
					$\sum Q*c_{i,avg}*\Delta t$ =	34.41

Fraction of dye recovered = M_{out}/M_{in} = (34.41)/36.0 g = 95.6%

Table A7 – Calculation of dye recovery for 3.02 MGD test on April 22, 2009

ID	Clock Time	Sample Time (min)	Adj Rhodamine Conc (ug/L)	Δt (min)	$c_{i,avg}$ (ug/L)	$Q*c_{i,avg}*\Delta t$ (g)
1	11:12 AM	3	0.3	--	--	--
2	11:17 AM	8	0.1	--	--	--
3	11:21 AM	12	0.0	--	--	--
4	11:26 AM	17	-0.1	--	--	--
5	11:31 AM	22	-0.2	--	--	--
6	11:36 AM	27	-0.2	--	--	--
7	11:41 AM	32	-0.2	--	--	--
8	11:46 AM	37	-0.1	--	--	--
9	11:51 AM	42	-0.2	--	--	--
10	11:56 AM	47	-0.2	--	--	--
11	12:01 PM	52	-0.2	--	--	--
12	12:06 PM	57	-0.1	--	--	--
13	12:11 PM	62	1.2	--	--	--
14	12:15 PM	66	2.8	4	2.0	0.06
15	12:19 PM	70	8.6	4	5.7	0.18
16	12:22 PM	73	15.5	3	12.0	0.29
17	12:24 PM	75	19.0	2	17.2	0.27
18	12:26 PM	77	26.7	2	22.9	0.36
19	12:28 PM	79	40.5	2	33.6	0.53
20	12:29 PM	80	41.5	1	41.0	0.33
21	12:30 PM	81	39.1	1	40.3	0.32
22	12:31 PM	82	48.26	1	43.7	0.35
23	12:32 PM	83	49.81	1	49.0	0.39
24	12:33 PM	84	56.63	1	53.2	0.42
25	12:34 PM	85	59.16	1	57.9	0.46
26	12:35 PM	86	64.87	1	62.0	0.49
27	12:36 PM	87	68.03	1	66.4	0.53
28	12:37 PM	88	67.47	1	67.7	0.54
29	12:38 PM	89	70.78	1	69.1	0.55
30	12:39 PM	90	71.75	1	71.3	0.57
31	12:40 PM	91	72.71	1	72.2	0.57
32	12:41 PM	92	72.72	1	72.7	0.58
33	12:42 PM	93	79.55	1	76.1	0.61
34	12:43 PM	94	79.86	1	79.7	0.63
35	12:44 PM	95	79.52	1	79.7	0.63
36	12:45 PM	96	79.78	1	79.6	0.63
37	12:46 PM	97	80.35	1	80.1	0.64
38	12:47 PM	98	81.02	1	80.7	0.64
39	12:48 PM	99	82.65	1	81.8	0.65
40	12:49 PM	100	80.93	1	81.8	0.65
41	12:50 PM	101	80.94	1	80.9	0.64
42	12:51 PM	102	79.46	1	80.2	0.64
43	12:52 PM	103	78.24	1	78.8	0.63
44	12:53 PM	104	78.42	1	78.3	0.62
45	12:54 PM	105	77.31	1	77.9	0.62
46	12:55 PM	106	75.11	1	76.2	0.61
47	12:56 PM	107	74.04	1	74.6	0.59
48	12:58 PM	109	69.95	2	72.0	1.14
49	1:00 PM	111	68.73	2	69.3	1.10
50	1:02 PM	113	64.82	2	66.8	1.06
51	1:04 PM	115	60.83	2	62.8	1.00
52	1:06 PM	117	58.84	2	59.8	0.95
53	1:08 PM	119	54.00	2	56.4	0.90

Table A7 – Continued

ID	Clock Time	Sample Time (min)	Adj Rhodamine Conc (ug/L)	Δt (min)	$c_{i,avg}$ (ug/L)	$Q*c_{i,avg}*\Delta t$ (g)
54	1:15 PM	126	38.7	7	46.4	2.58
55	1:19 PM	130	37.0	4	37.8	1.20
56	1:24 PM	135	30.3	5	33.6	1.34
57	1:29 PM	140	26.0	5	28.1	1.12
58	1:34 PM	145	18.6	5	22.3	0.89
59	1:39 PM	150	14.9	5	16.7	0.66
60	1:44 PM	155	12.6	5	13.7	0.55
61	1:49 PM	160	8.8	5	10.7	0.43
62	1:54 PM	165	5.7	5	7.3	0.29
63	1:59 PM	170	4.9	5	5.3	0.21
64	2:06 PM	177	3.0	7	4.0	0.22
65	2:15 PM	186	2.0	9	2.5	0.18
66	2:20 PM	191	1.6	5	1.8	0.07
67	2:25 PM	196	1.1	5	1.3	0.05
68	2:30 PM	201	0.5	5	0.8	0.03
					$\sum Q*c_{i,avg}*\Delta t$ =	33.20

Fraction of dye recovered = M_{out}/M_{in} = (33.20)/36.0 g = 92.2%

Table A8 – Recorded water depth measurements in contact basin from April 2010 tracer tests

0.84 MGD Test (4/21/10)		1.72 MGD Test (4/22/10)		2.60 MGD Test (4/20/10)	
Time	Depth (ft)	Time	Depth (ft)	Time	Depth (ft)
7:00 AM	9.0	7:59 AM	9.1	8:49 AM	9.2
8:31 AM	9.0	8:12 AM	9.1	9:29 AM	9.2
10:18 AM	9.0	9:55 AM	9.1	10:32 AM	9.2
12:27 PM	9.0	11:28 AM	9.1	12:19 PM	9.2
2:06 PM	9.0				
4:07 PM	9.0				
6:52 PM	9.0				

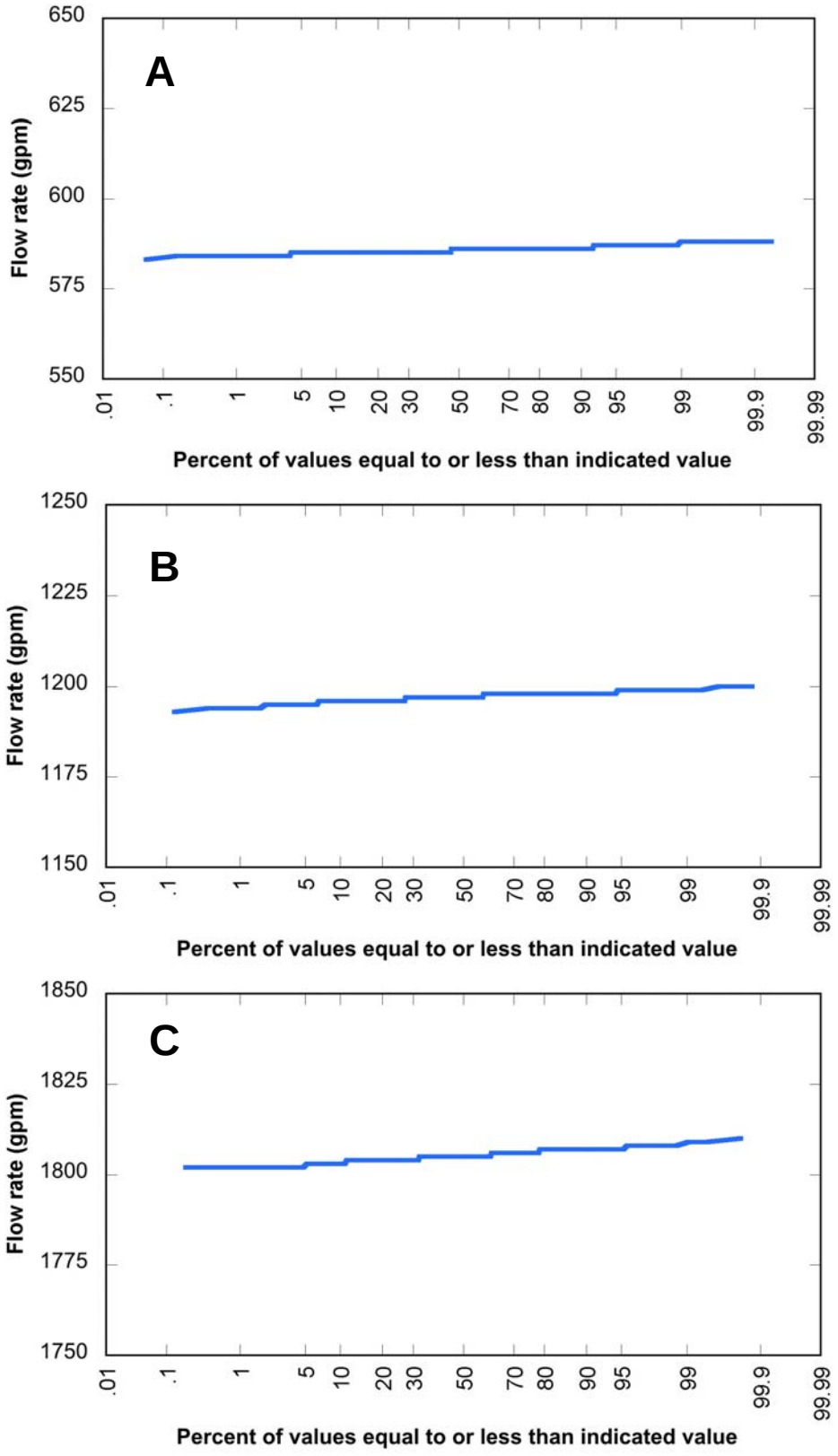

Figure A1 –Flow probability plots for tracer tests (A) 0.84 MGD, (B) 1.72 MGD, (3) 2.60 MGD

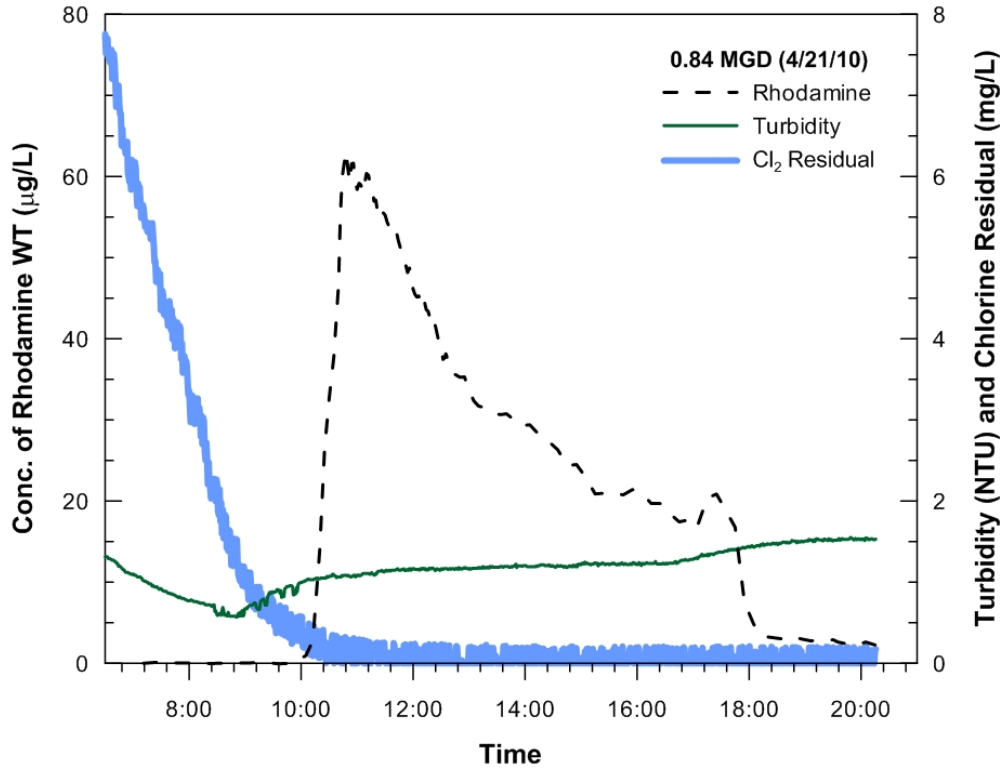

Figure A2 – Turbidity and chlorine residual during the 0.84 MGD tracer test

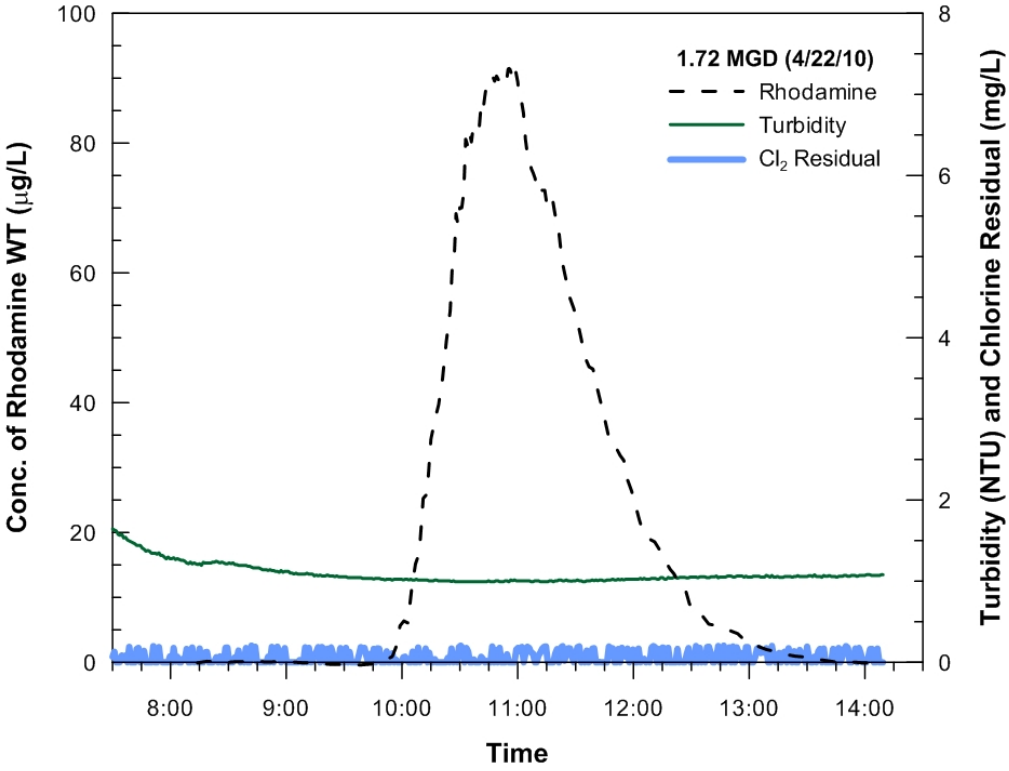

Figure A3 – Turbidity and chlorine residual during the 1.70 MGD tracer test

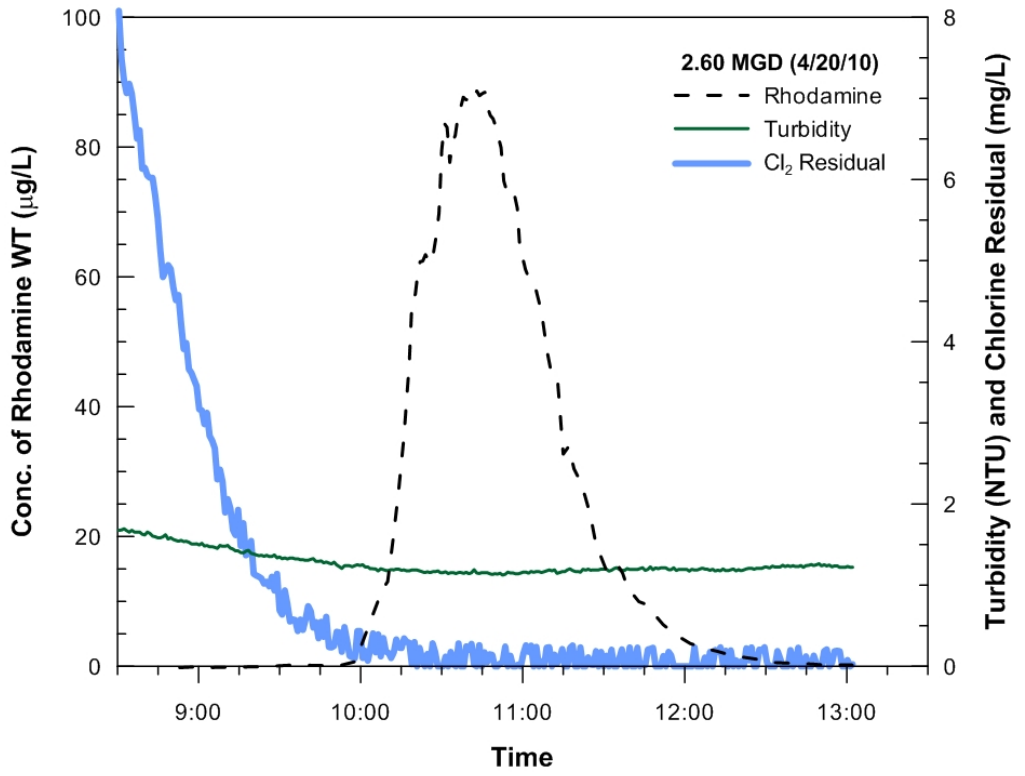

Figure A4 – Turbidity and chlorine residual during the 2.60 MGD tracer test

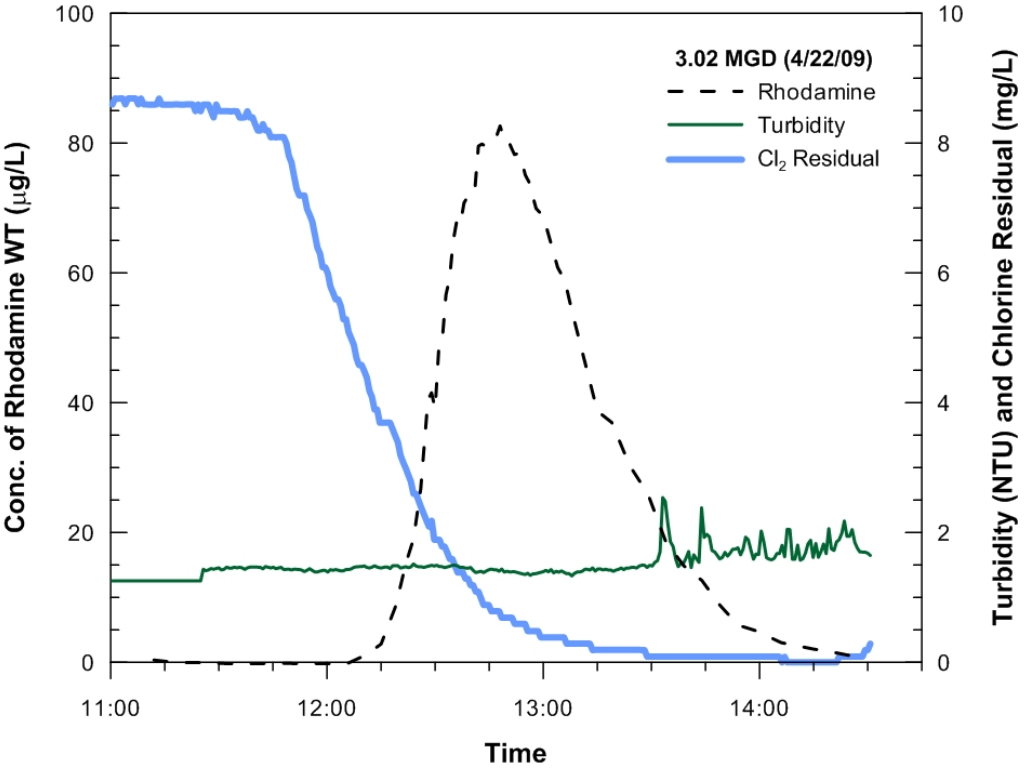

Figure A5 – Turbidity and chlorine residual during the 3.02 MGD tracer test