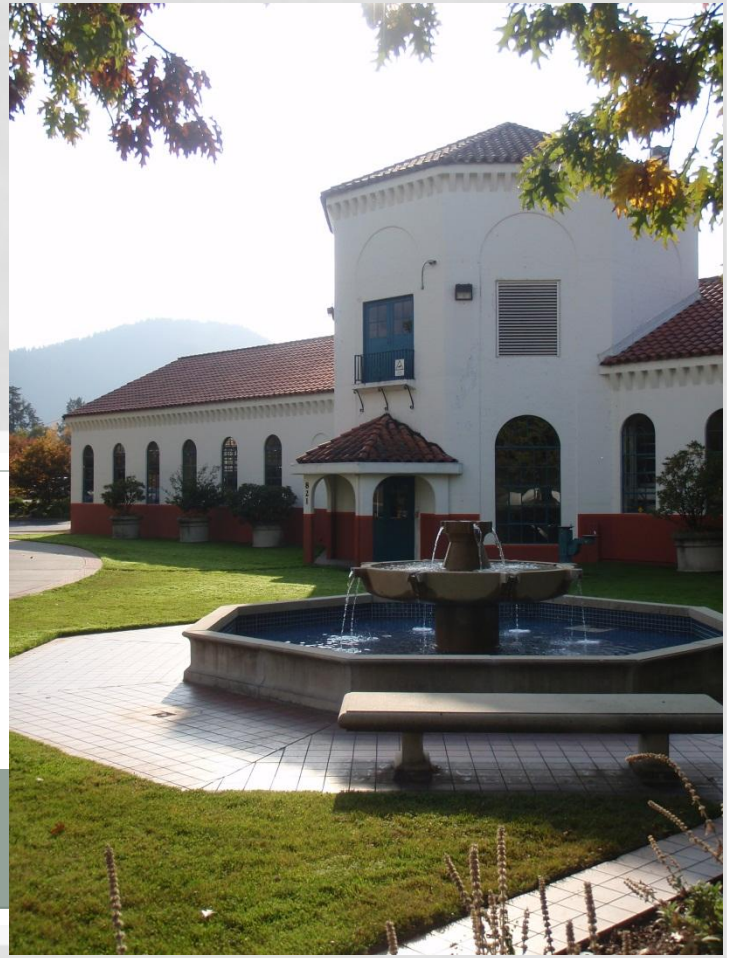
TRACER STUDIES

AN OPERATORS GUIDE TO TRACER STUDIES AND WHAT THEY CAN TELL YOU



…YOUR SPEAKER

- Water Treatment Plant Superintendent for the City of Grants Pass
- 17 Years experience at a "semi" conventional water treatment plant

WHAT WE ARE GOING TO COVER

- Reasons to perform a tracer study
- Step Dose vs. Slug Dose
- Where and how to inject
- Where and how often to collect the data
- Processing the data
- What can be learned

REASONS FOR TRACER STUDY

- Regulatory Compliance
  - Baffling/Flocculation Changes?
  - New Basins?
- Want to change application points of disinfectants?
- Impacts of sludge blankets on basin detention times?
- Impacts of flow changes
- Validating numbers obtained in previous studies

TRACER STUDY PLAN

- If the tracer studies are being performed for compliance reasons…
  - Plan must be submitted and approved by the regulating agency.
  - Must contain:
    - What tracer element will be used
    - How it will be injected
    - What expected T10 Results
    - Sample protocol (where, why, how often)
    - How results will be calculated

STEP DOSE VS SLUG DOSE

- Step Dose
  - Adjust Chemical up/down
  - Advantageous if using a chemical that is already being fed
  - Tests can be run in fairly fast succession
- Slug Dose
  - Inject a volume of chemical to illicit a change
  - Typically used if injecting a chemical that isn't used in the treatment process
  - Takes longer between tests as all of tracer element must be eliminated from process stream before next test.

TRACER ELEMENTS

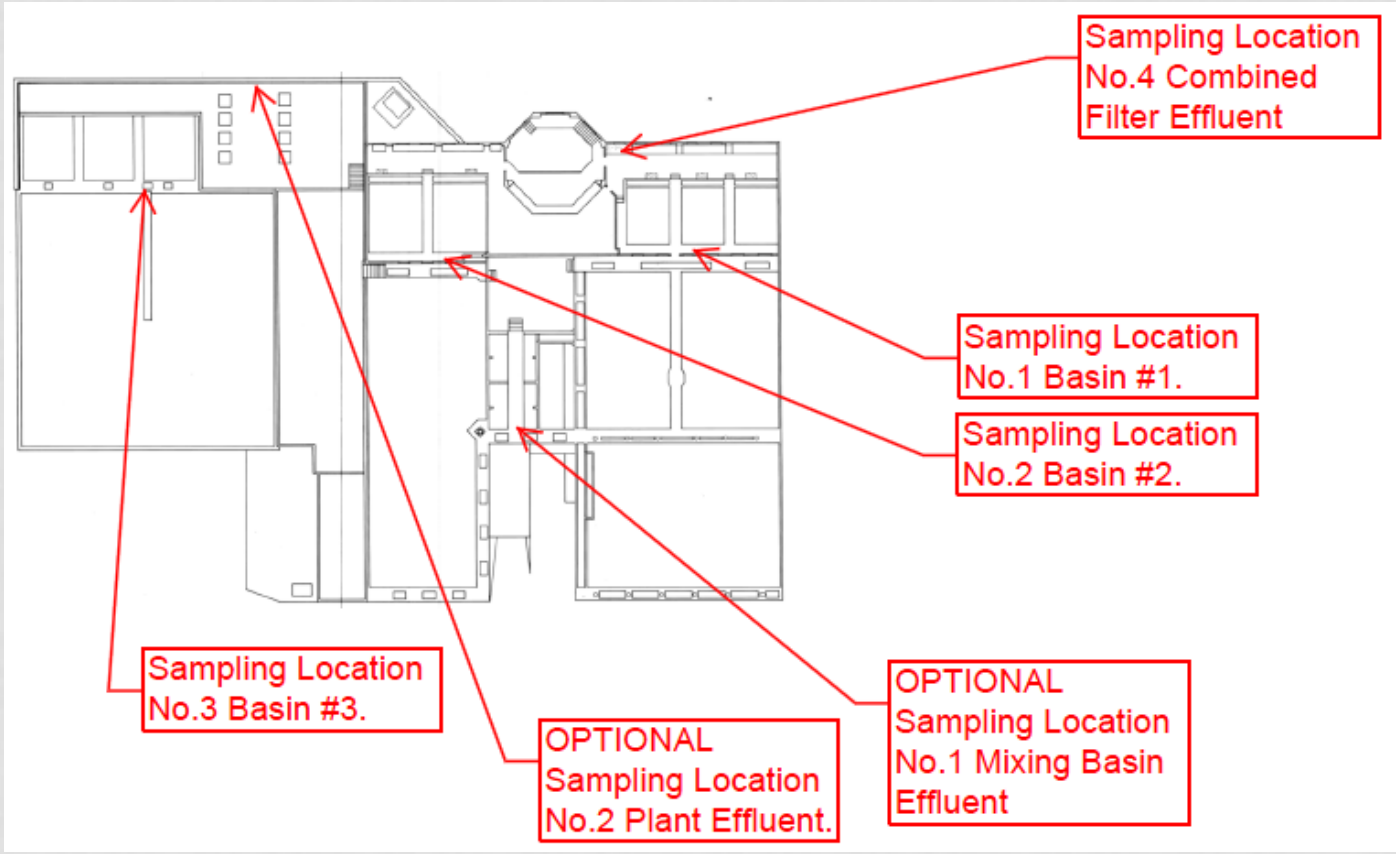
- Most Common:
  - Fluoride
    - Relatively easy to measure
    - May already being added/available
    - May be some consumption in raw water applications
    - Hazardous to handle
    - Online
  - Conductivity Agents
    - Easy to measure
    - Safe to handle and feed
    - Little or no consumption in raw water applications

WHERE AND HOW TO INJECT

- Select locations where good mixing will be attained
  - Should mimic actual conditions as much as possible.
- Inject as fast as possible if testing for slug dose method
- Be creative
  - Simple as dumping in buckets of prepared solution
  - Complex as adding piping and valves
- This is when knowing your plant pays off!

WHERE AND HOW TO COLLECT DATA

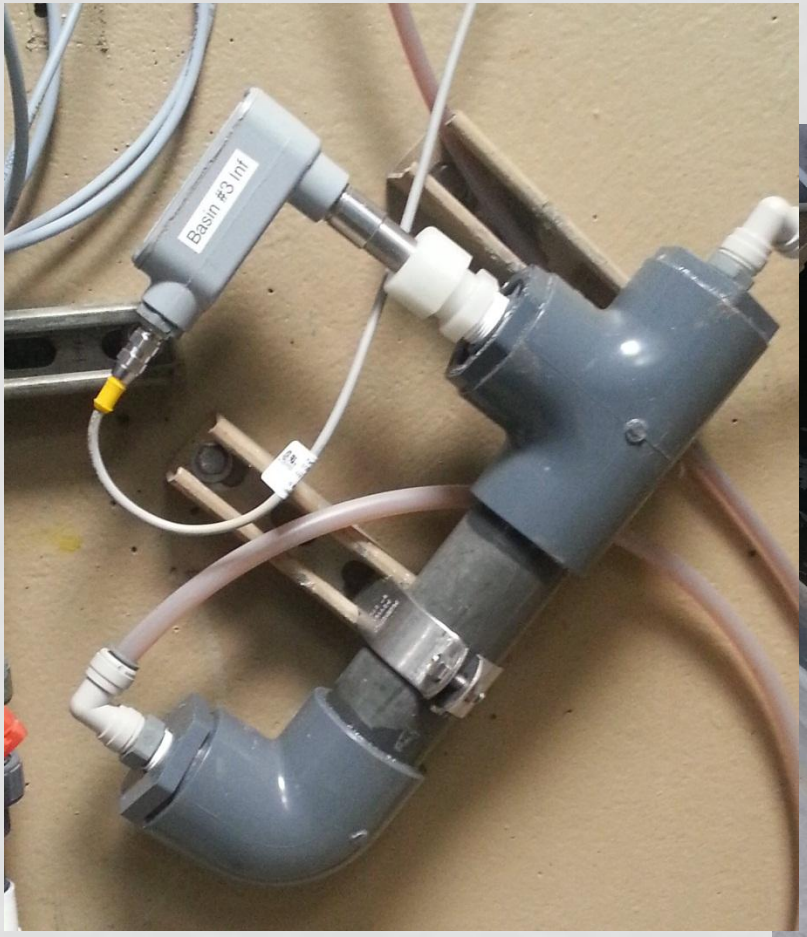
- Depends on the goals of the study
  - Monitor the end point of each unique segment



WHERE AND HOW (CONT'D)

- Think about Where you can get a sample
  - Do you have to pump? (not preferred)
  - Can you "dip" a sample
  - Can the instrument be inserted into the flow stream
- There may be a LOT of samples to process if you are analyzing samples in the lab
  - For a test expected to last 2 hours you may end up needing close to 100 sample bottles!

WHERE AND HOW



HOW MUCH DATA IS COLLECTED

- Depends on the flow rate and expected T10
- This is where automatic samplers pay off!
- Be prepared to start grabbing samples shortly after injection.
- When chemical is detected sample every minute to be able to detect the "peak".
  - The more samples the better at this point
- After the level begins to decrease reduce sampling frequency to 3-5 minutes.
  - Sample until levels return to background levels

WHAT IT LOOKS LIKE

- This is really where the work starts…
  - Up until now it has been just fun stuff!

525	7/6/2012 8:24	88.23231	18.72927	88.2055				
526	7/6/2012 8:25	88.29826	18.73324	0.092769	0	#DIV/0!	#DIV/0!	#DIV/0!
527	7/6/2012 8:26	88.25442	18.73579	0.048922	1	0.048922	0.048922	7.96E-06
528	7/6/2012 8:27	88.31084	18.73775	0.105349	2	0.105349	0.15427	2.51E-05
529	7/6/2012 8:28	88.33944	18.7397	0.133944	3	0.133944	0.288214	4.69E-05
530	7/6/2012 8:29	88.30519	18.74022	0.099696	4	0.099696	0.38791	6.31E-05
531	7/6/2012 8:30	88.2685	18.74513	0.063006	5	0.063006	0.450915	7.34E-05
532	7/6/2012 8:31	88.30008	18.74729	0.094584	6	0.094584	0.545499	8.88E-05
533	7/6/2012 8:32	88.26527	18.75239	0.059771	7	0.059771	0.60527	9.85E-05
534	7/6/2012 8:33	88.23162	18.75519	0.026126	8	0.026126	0.631395	0.000103
535	7/6/2012 8:34	88.31387	18.75921	0.108371	9	0.108371	0.739766	0.00012
536	7/6/2012 8:35	88.29836	18.76081	0.092868	10	0.092868	0.832634	0.000135
537	7/6/2012 8:36	88.26892	18.7632	0.063426	11	0.063426	0.896059	0.000146
538	7/6/2012 8:37	88.27335	18.76511	0.067851	12	0.067851	0.96391	0.000157
539	7/6/2012 8:38	88.28109	18.76847	0.075595	13	0.075595	1.039505	0.000169
540	7/6/2012 8:39	88.25288	18.7693	0.047389	14	0.047389	1.086893	0.000177
541	7/6/2012 8:40	88.24872	18.77208	0.043223	15	0.043223	1.130116	0.000184
542	7/6/2012 8:41	88.2663	18.77449	0.060801	16	0.060801	1.190916	0.000194
543	7/6/2012 8:42	88.26904	18.779	0.06354	17	0.06354	1.254456	0.000204
544	7/6/2012 8:43	88.27895	18.78207	0.073451	18	0.073451	1.327907	0.000216
545	7/6/2012 8:44	88.22903	18.78615	0.023532	19	0.023532	1.351438	0.00022
546	7/6/2012 8:45	88.23953	18.78614	0.034037	20	0.034037	1.385475	0.000225
547	7/6/2012 8:46	88.32568	18.78899	0.120189	21	0.120189	1.505664	0.000245
548	7/6/2012 8:47	88.40765	18.78914	0.202151	22	0.202151	1.707814	0.000278
549	7/6/2012 8:48	88.34104	18.78955	0.135547	23	0.135547	1.843361	0.0003
550	7/6/2012 8:49	88.37324	18.79488	0.167743	24	0.167743	2.011104	0.000327
551	7/6/2012 8:50	88.51601	18.79784	0.310511	25	0.310511	2.321614	0.000378
552	7/6/2012 8:51	88.52564	18.79772	0.32014	26	0.32014	2.641754	0.00043
553	7/6/2012 8:52	88.55596	18.80133	0.350467	27	0.350467	2.992221	0.000487
554	7/6/2012 8:53	88.62106	18.80452	0.415568	28	0.415568	3.407788	0.000554
555	7/6/2012 8:54	88.75021	18.80637	0.544711	29	0.544711	3.952499	0.000643
556	7/6/2012 8:55	88.83243	18.80816	0.626933	30	0.626933	4.579432	0.000745
557	7/6/2012 8:56	88.96742	18.80924	0.761927	31	0.761927	5.341358	0.000869
558	7/6/2012 8:57	89.14484	18.81264	0.939341	32	0.939341	6.280699	0.001022
559	7/6/2012 8:58	89.28653	18.8164	1.081035	33	1.081035	7.361734	0.001198
560	7/6/2012 8:59	89.45953	18.81892	1.254031	34	1.254031	8.615764	0.001402

Chart1 | CFE_07062012_10.5K | CFE_07102012_10.5K_Throttled

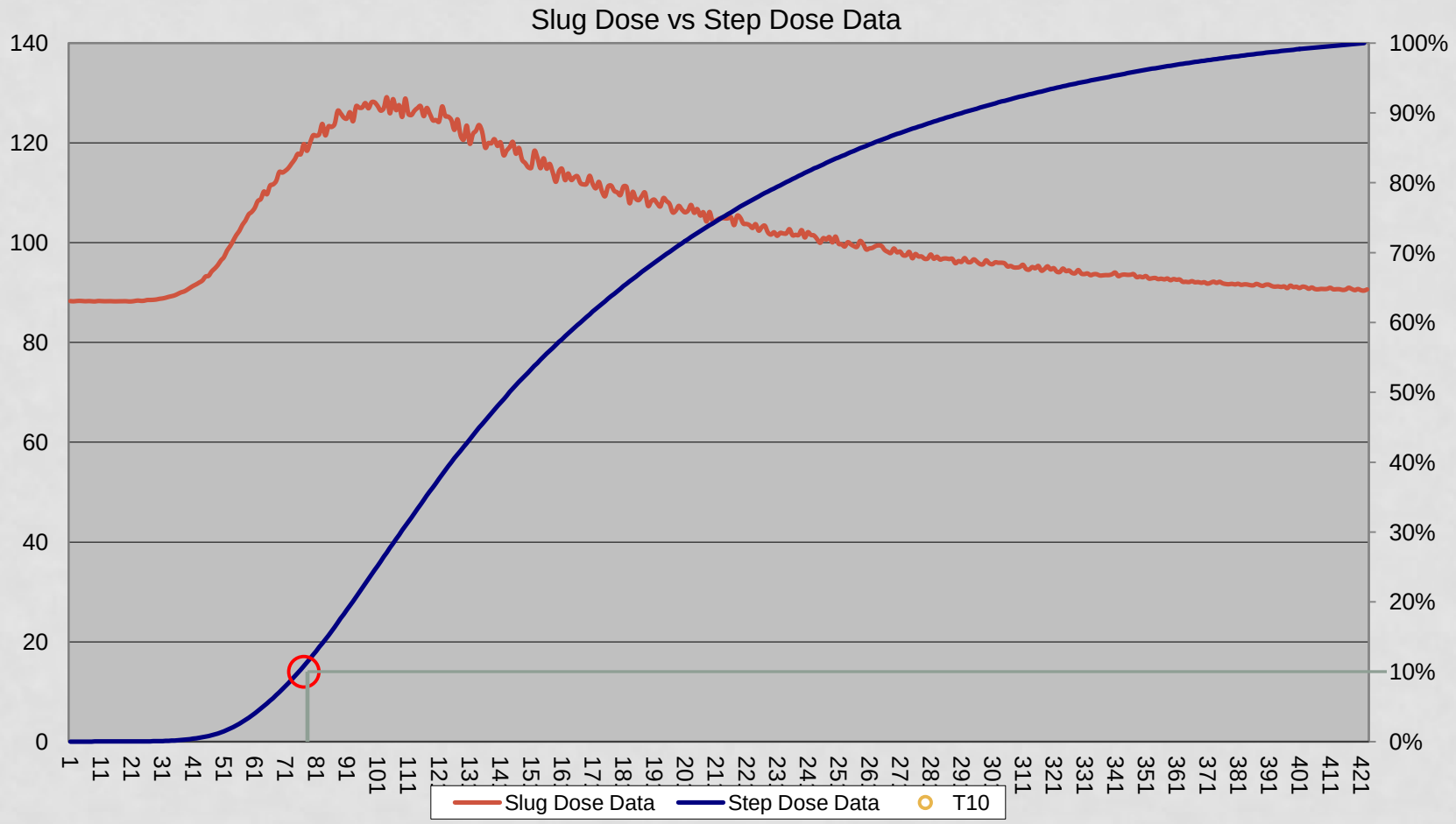
487	7/10/2012 7:47	86.85431
488	7/10/2012 7:48	86.83325
489	7/10/2012 7:49	86.85391
490	7/10/2012 7:50	86.91131
491	7/10/2012 7:51	86.98943
492	7/10/2012 7:52	87.1066
493	7/10/2012 7:53	87.19021
494	7/10/2012 7:54	87.43675
495	7/10/2012 7:55	87.95126
496	7/10/2012 7:56	88.38308
497	7/10/2012 7:57	88.94974
498	7/10/2012 7:58	89.46963
499	7/10/2012 7:59	90.41423
500	7/10/2012 8:00	91.15575
501	7/10/2012 8:01	91.94843
502	7/10/2012 8:02	92.56281
503	7/10/2012 8:03	93.0984
504	7/10/2012 8:04	94.0691
505	7/10/2012 8:05	94.3733
506	7/10/2012 8:06	94.62495
507	7/10/2012 8:07	95.45751
508	7/10/2012 8:08	95.99748
509	7/10/2012 8:09	96.48066
510	7/10/2012 8:10	97.13312
511	7/10/2012 8:11	97.29737
512	7/10/2012 8:12	98.35806
513	7/10/2012 8:13	98.58027
514	7/10/2012 8:14	98.98679
515	7/10/2012 8:15	99.51495
516	7/10/2012 8:16	100.3212
517	7/10/2012 8:17	100.9953
518	7/10/2012 8:18	101.446
519	7/10/2012 8:19	101.7629
520	7/10/2012 8:20	102.5234
521	7/10/2012 8:21	102.8593
522	7/10/2012 8:22	102.9896
523	7/10/2012 8:23	103.4695
524	7/10/2012 8:24	103.9784
525	7/10/2012 8:25	104.2062
526	7/10/2012 8:26	105.1108
527	7/10/2012 8:27	105.0831
528	7/10/2012 8:28	105.8578

Basin1_EFF_07102012_10.5K_Throt

WHAT IT LOOKS LIKE (CONT'D)

- This is where computers make our jobs easier!
- If testing was performed in SLUG does mode it must be converted to step dose for analysis

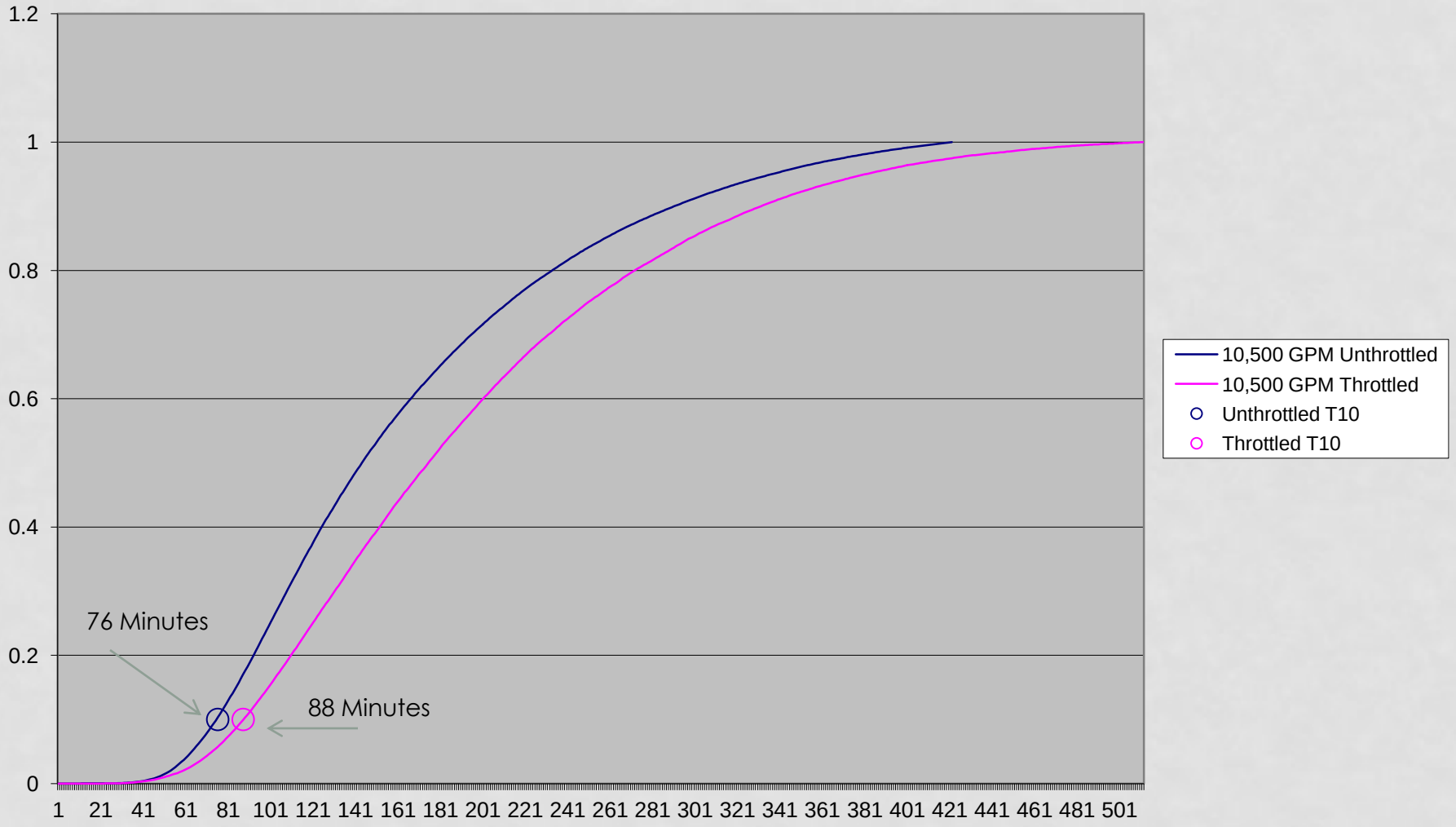
WHAT IT LOOKS LIKE (CONT'D)



EXCEL IS YOUR FRIEND

- If you can use automatic data collection through online instruments:
  - Processing the data and evaluating results takes very little time
  - Multiple tests can be performed in very short periods of time
  - Different operating conditions can be tested with little cost

WHAT THE DATA CAN TELL YOU



RE-TESTING…

- Why you may want to retest…
  - Validate test results
  - Make changes in where samples are taken, or tracer elements are injected
  - Possibility for different results based on water temperatures
    - Lesson Learned: Try to complete all your tests at a similar water temperature! Results did seem to indicate that test results changed based on raw water temperature!

LESSONS LEARNED – GRANTS PASS CASE STUDY

- Calcium Chloride
  - Easy to get and cheap to use
  - IT GETS HOT!
- Performing the tests
  - Don't let too much time lag between tests – water temperature can affect the result
  - Equalize the tracer elements temperature to raw water temp
- Analyze the data
  - CPE was actually pretty darn Close!
  - Expect surprises and anomalies

THANKS!

- Thanks to:
  - Michael McWhirter and Andrew Nishihara – MWH
  - All the staff at MSA and MWH for their help on this project!
- Questions?