Brown AND Caldwell

PNCWA 2010

Put Your Lights On:

Design and Construction of a Large UV Facility at Central Valley WRF, Utah

by Cynthia L. Bratz, P.E.

CVWRF

October | 2010

Agenda

- Team and Client
- Background
- Equipment evaluation
- Construction
- Start-up

Team and Client

- BC Project Manager: Phil Heck, P.E., SLC
- BC Technical Advisor: Dave Murray, P.E., Portland OR
- BC Technical Advisor: Cyndy Bratz, P.E., Boise ID
- Large client with engineering expertise
  - Active in decision making and guiding the project
  - Used BC expertise “efficiently”

Background

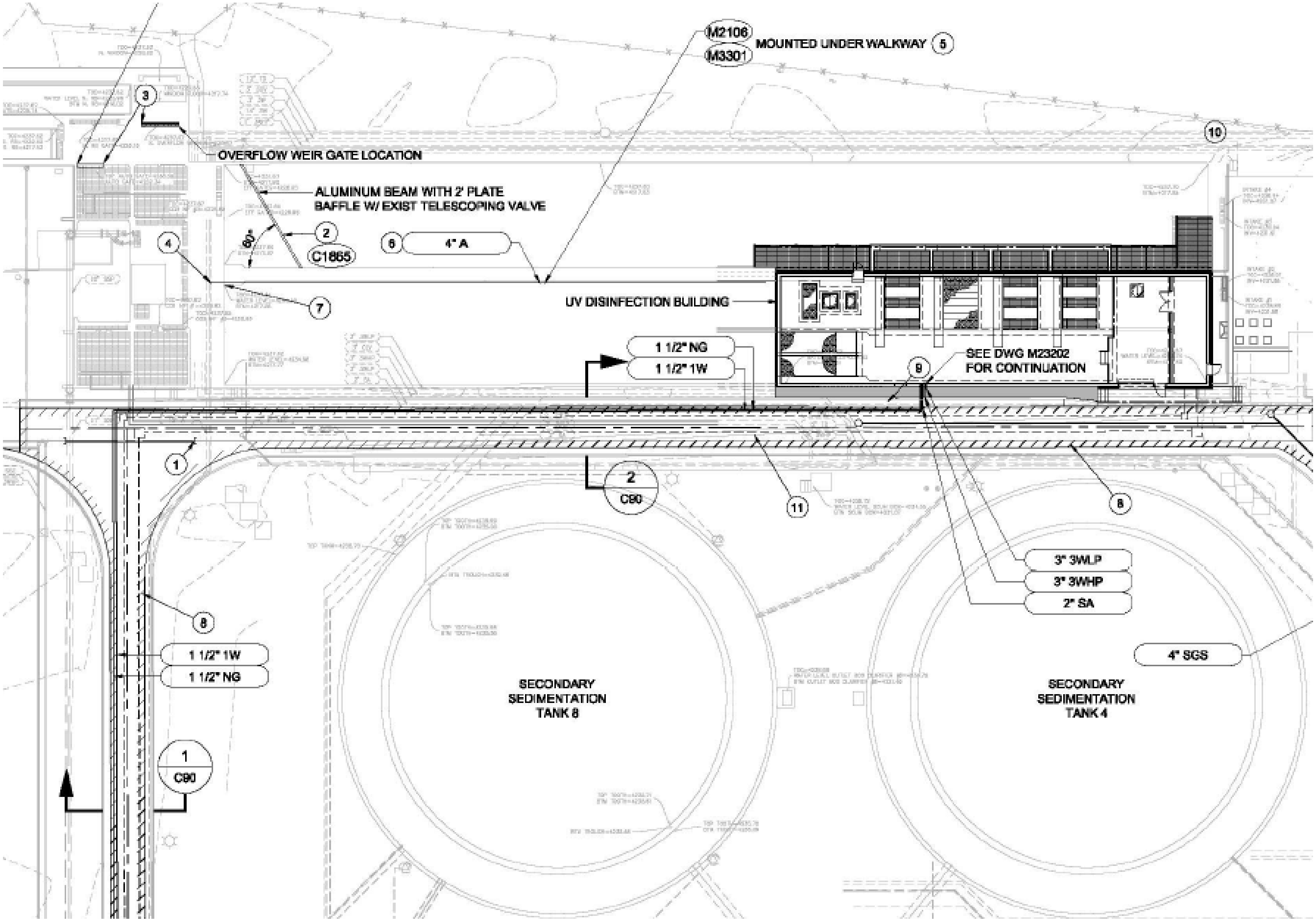
- Trickling Filter/Solids Contact WWTP
- Existing ADF = 55 mgd
- Existing PHF = 120 mgd

Background

- Past disinfection method was gaseous chlorine
- 20-year old chlorination equipment
- Chlorine transported by Rail Car
- Large chlorine gas leak in 2007

2007 Disinfection Study

- New 150 mgd UV facility to replace gaseous chlorination
- Considered new UV facility located next to chlorine contact basins
  - Lower cost than retrofitting existing chlorine contact basins
- District Board preferred to make efficient use of existing tankage


M2106
M3301
MOUNTED UNDER WALKWAY
5
10
3
OVERFLOW WEIR GATE LOCATION
ALUMINUM BEAM WITH 2' PLATE
BAFFLE W/ EXIST TELESCOPING VALVE
2
C1865
4
6
4" A
7
UV DISINFECTION BUILDING
1 1/2" NG
1 1/2" 1W
9
SEE DWG M23202
FOR CONTINUATION
1
2
C90
11
8
3" 3WLP
3" 3WHP
2" SA
8
1 1/2" 1W
1 1/2" NG
4" SGS
SECONDARY
SEDIMENTATION
TANK 8
SECONDARY
SEDIMENTATION
TANK 4
1
C90

Design Criteria

Parameter	Units	Design	Ultimate
Design Average Annual Daily Flow (AADF)	mgd	75	100
Design Peak Hour Flow (PHF)	mgd	150	200
Design Peak Hour Flow per Channel	mgd	50	50
Average Influent SS	mg/L	25	25
Design UV Transmission (UVT)	%	65	65
Design Dose	mJ/cm^2	30	30
Effluent Monthly Average, E-coli Coliform	MPN/100 ml	126	126
Effluent Weekly Average, E-coli Coliform	MPN/100 ml	158	158

Equipment Evaluation

- Site visits to Detroit area
  - Ozonia Aquaray 40HO and Siemens.
  - No operational Ozonia 3X at the time (2007)
- Site visits to California
  - Wedeco TAK 55 and Trojan UV3000 Plus
- Client preferred vertical-lamp systems
  - Better turndown capability
  - Dose pace by row and modulate power to lamps
  - Easier to access lamps (and ballasts), easier maintenance

Equipment Comparison

Parameter	Units	Ozonia 3X	Siemens
Lamp Type		**Low pressure, high output**	**Low pressure, high output**
Total Number of Lamps	**No.**	**972**	**1600**
Power Input per Lamp	Watts	406	350
Lamp Output	Watts	160	105
Lamp Efficiency	%	39	30
Dose Pacing		By row Power modulation	Bank on/off

O&M Cost Estimate and Comparison

Consumables

		Number of Lamps at Avg Flow	Power Consumption per Lamp (kw)	Number of Hours in Operation[1]	Power Cost	Total Ozonia 3X	Total Siemens
Power	**Ozonia**	324	0.406	8760	$ 0.0545	$ 62,802	
	Siemens	700	0.35	8760	$ 0.0545		$ 116,968
Cleaning Chemicals					**Chemical Cost per Year[2]**		
	Ozonia				$ 100	$ 100	
	Siemens				$ 100		$ 100
					Subtotal Consumables	$62,902	$ 117,068

O&M Cost Estimate and Comparison

Replacement

Lamps		**Number of Lamps at Avg Flow**	**Replacement Hours[3]**	**Number of Lamps Replaced Per**	**Cost per Lamp**	**Ozonia 3X**	**Siemens**
	Ozonia	324	12000	237	$175	$ 41,475	
	Siemens	700	12000	511	$145		$ 74,095
Ballast		**Number of Ballast at Avg Flow**	**Replacement Years[3]**	**No. of Ballast Replaced/yr**	**Cost per Ballast**		
	Ozonia	162	5	33	$285	$ 9,405	
	Siemens	350	3	117	$350		$ 40,950
Wiper Rings		**Number of Wiper Rings**	**Replacement Years[3]**	**No. of Wiper Rings Replaced/yr**	**Cost per Wiper Ring**		
	Ozonia	1400	1.3	1077	$3.5	$ 3,770	
	Siemens	3200	2	1600	$0.5		$ 800
Sleeve		**Number of Sleeves**	**Replacement Years[4]**	**No. of Sleeves Replaced/yr**	**Cost per Sleeve**		
	Ozonia	700	5	140	$75	$ 10,500	
	Siemens	1600	5	320	$65		$ 20,800
UV Sensor		**Number of Sensors**	**Replacement Years[4]**	**No. of Sensors Replaced/yr**	**Cost per Sensor[4]**		
	Ozonia	27	5	6	$120	$ 720	
	Siemens	40	5	8	$120		$ 960
					Subtotal Replacement Parts	**$ 65,870**	**$ 137,605**

O&M Cost Estimate and Comparison

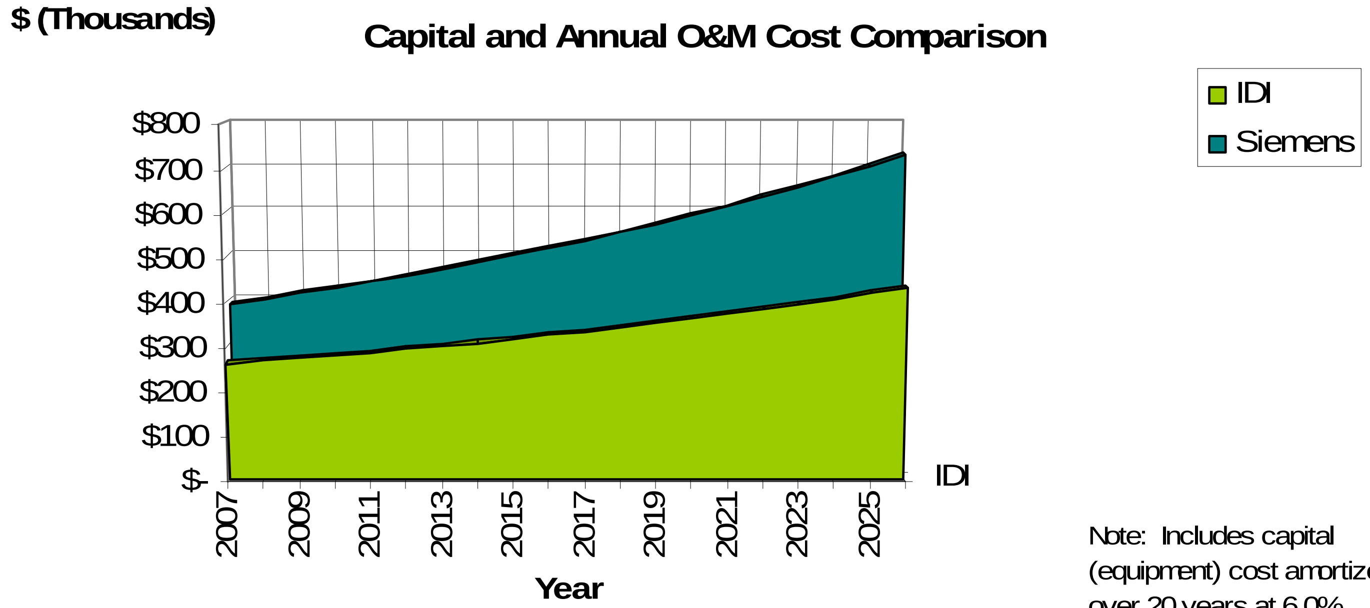
Labor Costs

Cleaning Labor		**Cleaning Frequency (no./yr)**	**No. of Hours per Module**	**No. of Modules**	**Labor Rate Per Hour**	**Ozonia 3X**	**Siemens**
	Ozonia	6	1	27	$ 45	$ 7,290	
	Siemens	6	1	40	$ 45		$ 10,800
Relamping Labor		**No. of Lamps**	**No. of Minutes per Lamp**	**No. of Hours Per Year**	**Labor Rate Per Hour**		
	Ozonia	237	5	20	$ 45	$ 889	
	Siemens	511	5	43	$ 45		$ 1,916
Ballast Replacement Labor		**No. of Ballast**	**No. of Minutes per**	**No. of Hours Per Year**	**Labor Rate Per Hour**		
	Ozonia	33	5	3	$ 45	$ 124	
	Siemens	117	10	20	$ 45		$ 878
Wiper Replacement Labor		**No. of Lamps**	**No. of Minutes per Lamp**	**No. of Hours Per Year**	**Labor Rate Per Hour**		
	Ozonia	237	2	8	$ 45	$ 356	
	Siemens	511	5	43	$ 45		$ 1,916
					Subtotal Labor	**$ 8,658**	**$ 15,510**

Capital Costs and Net Present Value Analysis

Lifecycle Cost Comparison (LCC)

Element	Ozonia	Siemens
	Aquaray 3X "HO" VLS	Barrier VEA-40000
Equipment Cost	$ 1,560,000	$ 2,148,000
Equipment Annual O&M	$ 151,140	$ 297,220
20 yr Net Present Value (NPV)	$ 6,768,200	$ 10,680,800



Note: Includes capital (equipment) cost amortized over 20 years at 6.0%

Recommended Equipment Selection

The Ozonia 3X system was recommended for the following reasons:

- Lower capital, lower O&M, and lower 20-year NPV cost of equipment
  - Higher output lamps, so fewer lamps and ballasts to change
  - More efficient lamps (39% vs 30% efficiency)
  - Dose pacing by row of lamps and by modulating power to lamps
- Ballasts easier to change (ballast cards)
- Wiper system is more robust (heavy Teflon wipers instead of light EPDM wipers) and wipers are easier to change
- Manufacturer experience

Aquaray® 3X HO

- Mechanical Sleeve Cleaning System

Sleeve for UV Intensity Sensor

Wiper Plate

Aquaray® 3X HO

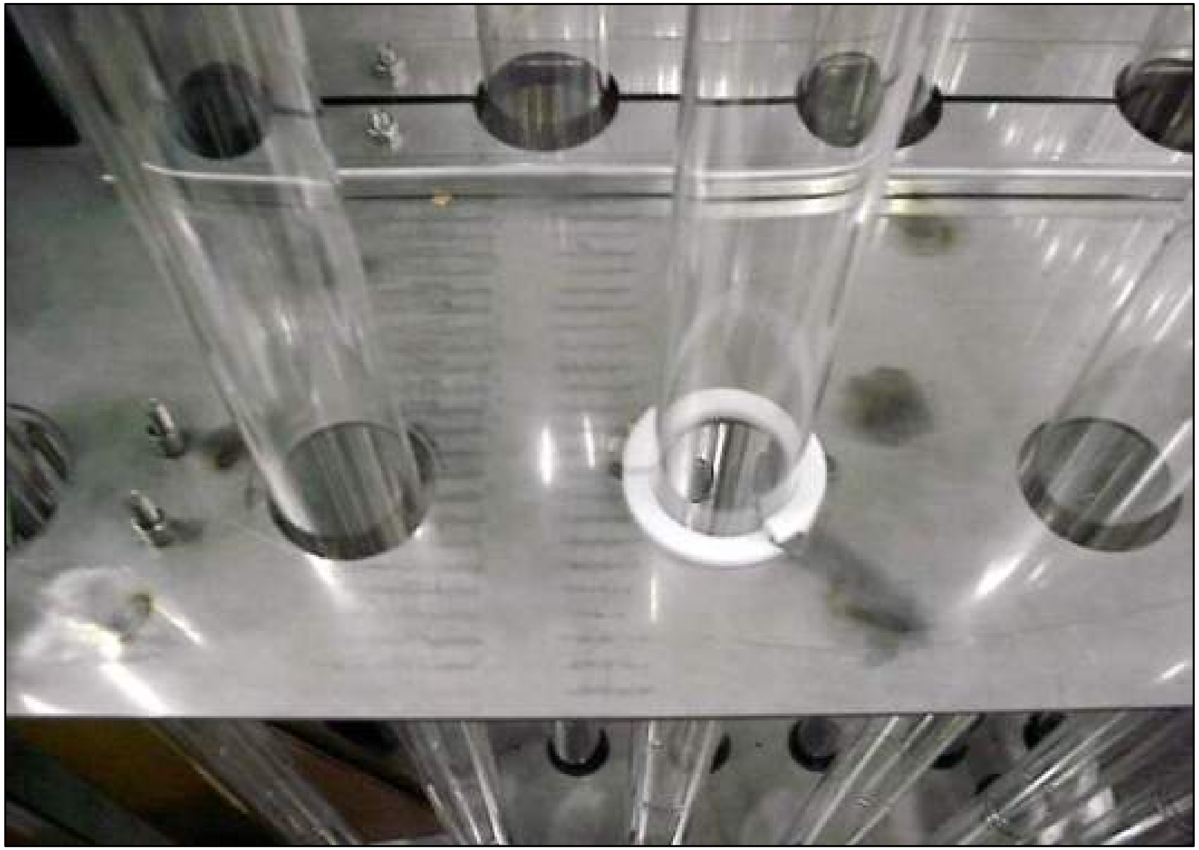
- Mechanical Sleeve Cleaning System
  - Patented Quick Change Wiper Ring

Aquaray® 3X HO

- Quick Wiper Change

Aquaray® 3X HO

- Quick Wiper Change



Aquaray® 3X HO

- Quick Wiper Change

Put Your Lights On

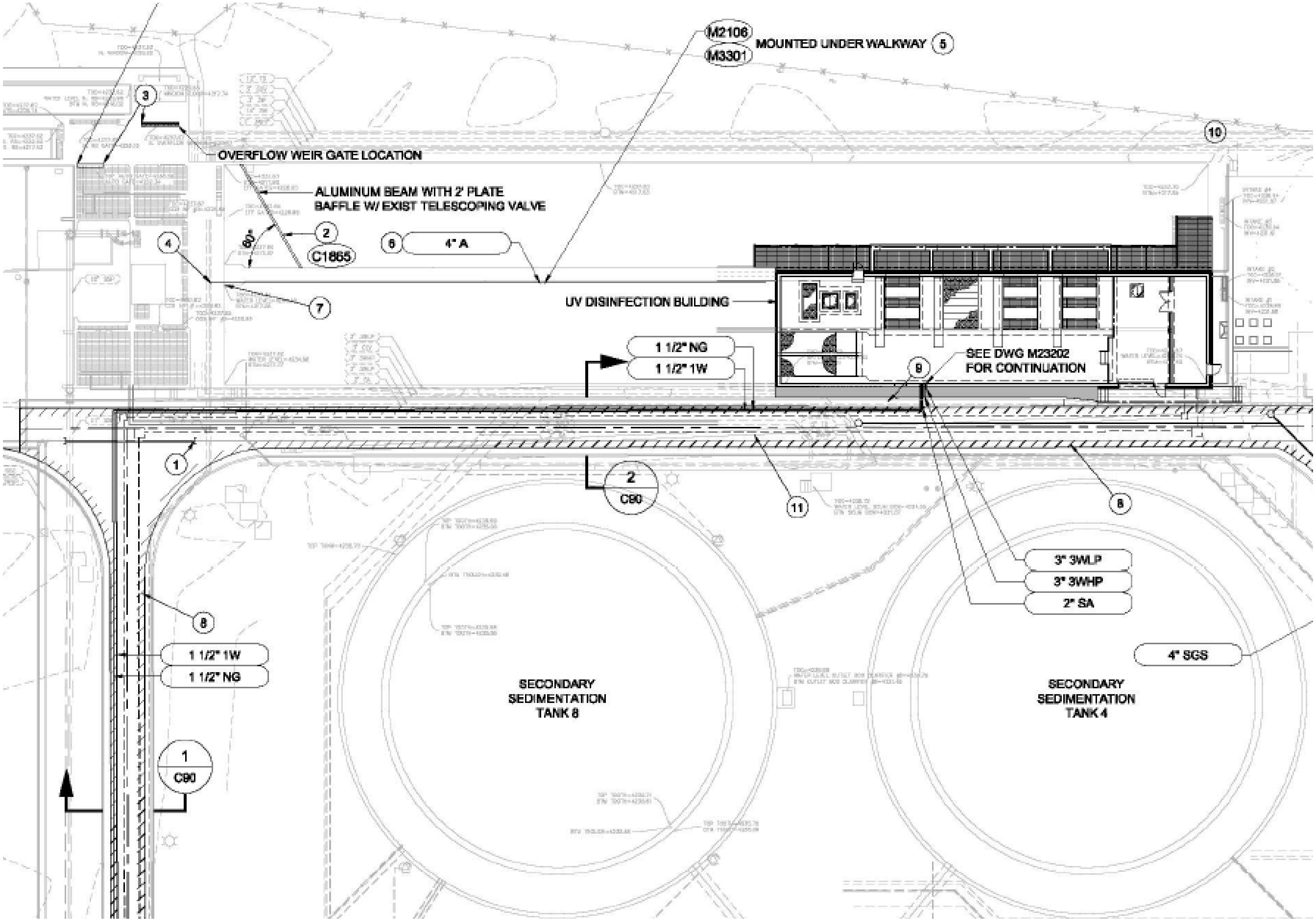
Construction and Start-up

Construction

- Engineer's cost opinion
  - Approximately $8 mil
- Bid opening
  - Winter 2008
- Total project cost
  - Approximately $6 mil
  - Including engineering

Construction

- General Contractor: Peck Ormsby
- Owner performed on-site construction observation
- Little engineering involvement during construction
- Maintained chlorination / dechlorination during construction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Construction

Interesting construction sequencing:

- Maintained south basin on line for chlorination / dechlorination
- Took north basin offline and built effluent boxes
- Sawcut basin center wall but braced in place so channel could be placed back online

Construction

Construction in north basin:

Construction

Interesting construction sequencing:

- Placed north basin back in service
- Then took south basin offline and built UV channels and building
- Chlorine contact basin walls needed additional thickness to support new facilities

Construction

Construction

Construction

The funny thing about having a 300-ton crane on site is that you have to park it somewhere

Construction

Construction

Factory Acceptance Testing

- Standard in BC specs
- I&C engineer and client to visit factory to test PLC programming and controls
- Ensures that programming is complete before PLC is shipped
  - Helps keep manufacturer on schedule
  - Prevents long start-up period with improperly programmed (or not programmed) PLC
- Ozonia was ready for the FAT (barely) and it went well

Start-up– Early 2010

UV Facility

Algae screens:

Algae screens

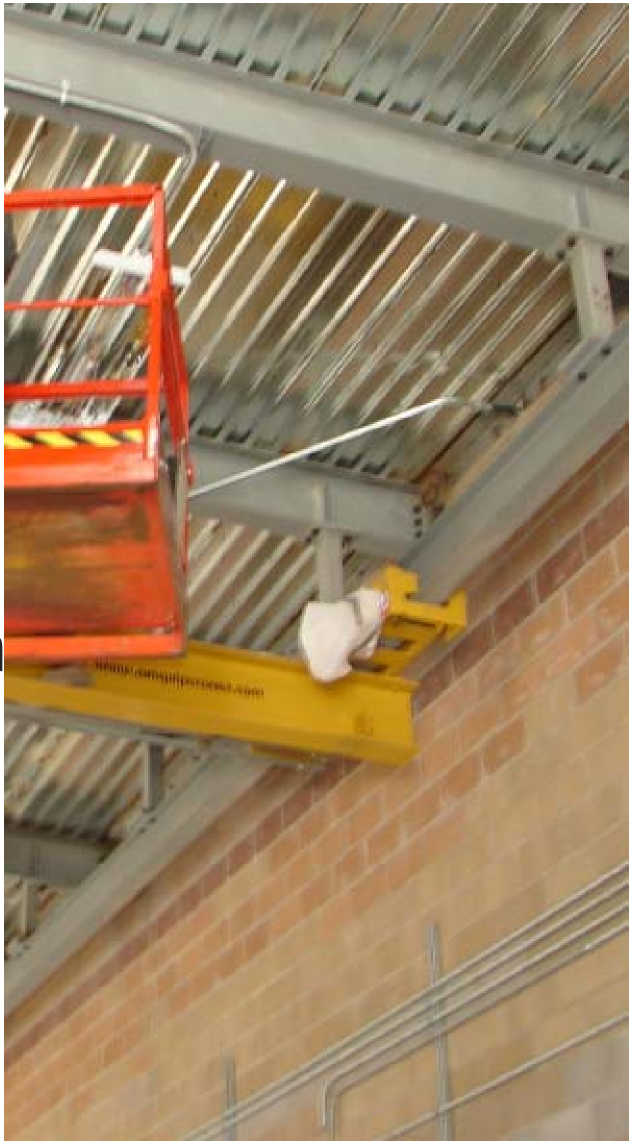
Interesting features of this facility:

- Algae screens by International Water Screens – canal screen
- Needed low headloss screen
- Needed unit which could span a wide channel
- Standard WW screen not necessary
- Lower cost unit desirable

Ballast Enclosures

Underhung Bridge Crane

- Mounted as close to the walls as possible
- Minimize ceiling height
- Many bridge cranes sit on corbels on top of beams



Start-up

Interference with Milltronics level sensors

Start-up

Interference with Milltronics level sensor

Start-up

Interference with Milltronic level sensors

Start-up

Interference from Milltronics level sensors

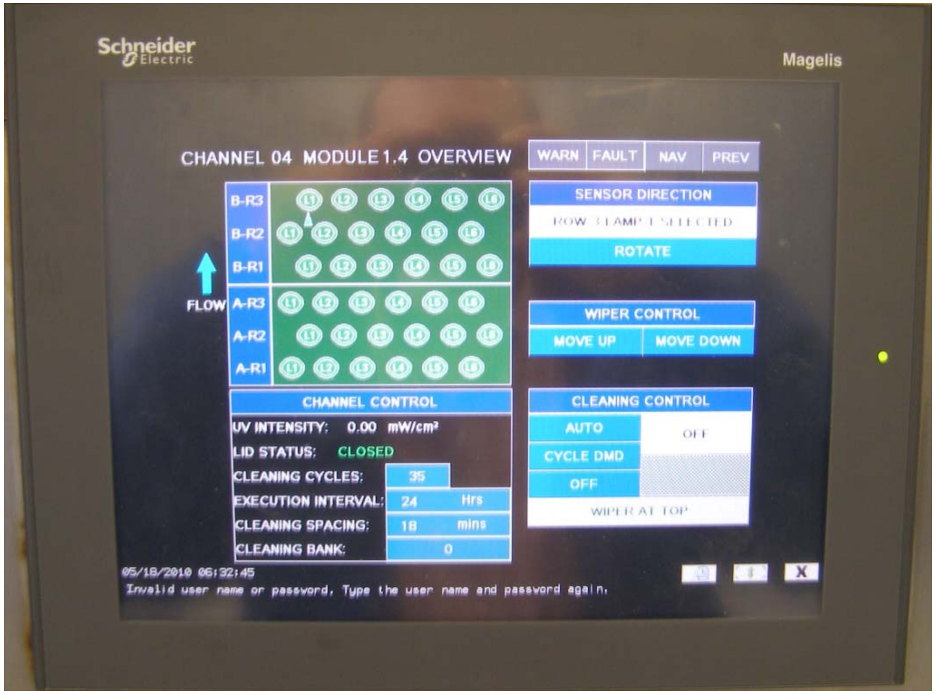
- UV modules emitted an ultrasonic signal which interfered with the Milltronics ultrasonic sensors on the effluent gates (for level control)
- Replaced with a different manufacturer's ultrasonic sensors – no interference

Start-up

Control system

Control System

- PLC programming was in Modicon
- Programming performed by Imalog (Ozonia's sub)



Start-up

- System monitors individual lamps rather than modules
- 23,000 I/O points for this system
- 11,000 I/O points was largest we'd encountered previously
- Issue identified in predesign: typical CPU would get bogged down
- Solution proposed during predesign: provide SCADA workstation in place of HMI
  - Owner decided to proceed with HMI

Start-up

PLC Programming Fix:

- Imalog proposed a solution to CVWRF which they are proceeding with
  - Reconfigure each channel to operate in stand-alone mode
  - Each channel will have a dedicated PLC and HMI which will contain ALL logic for that channel

Follow-up to the Ozonia 3X

Recently called UV installations for a different project

- Humble TX, Ozonia 3X which started up in 2007
- Design Flowrate: 19.6 mgd
- Current ADF: 5 mgd
- Minor problem with undersized fuses at start-up
- Wiper rings were redesigned and replaced (retrofit summer 2009)
- Few premature lamp failures
- No premature ballast failures

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