M E M O R A N D U M

MWH

To:	Kevin Martin (HEI) Michelle Klose (NDSWC)	**Date:**	February 29, 2008
		Reference:	1690125.01090060
From:	Ed Cryer (MWH)		
Subject:	**Draft** NAWS Water Treatment without Flocculation and Sedimentation		

We were asked to provide an estimated conceptual cost for including UV disinfection along with chloramination (as proposed) at the Max Booster Pump Station. This would only include UV and chemical disinfection and not flocculation and sedimentation as pretreatment. This approach would be justified given the high quality of raw Lake Sakakawea water that was observed during our 2006 – 2007 pilot scale study at the Snake Creek Pump Station. The UVT, a measurement that is used to establish the UV criteria necessary to provide a desired UV dose, was in the 60 – 80 percent range for the entire pilot scale test period when the UVT meter was in proper calibration. Modern UV equipment can be designed to meet the required dose at UVT levels as low as 40 – 50 percent. As presented in our pilot study report, we suspect that the actual UVT of the water, throughout the study, was in the 70 – 80 percent range.

During the pilot scale study, the UVT level in the raw water and the treated settled water chemical flocculation and sedimentation (floc/sed) was very similar (see Figure 13 in the pilot scale study). This demonstrated that the pretreatment (floc/sed) did not have a significant effect on the UV treatability of the Lake Sakakawea water at Snake Creek. The only significant changes seen in the raw and treated water UVT (May – July 2006) were a result of fouling of the HACH meter before we adopted a more rigorous and scheduled cleaning routine.

The ability to deliver an effective UV dose without the necessity to pretreat for removal of total suspended solids (TSS), organics and color removal can significantly reduce the cost of the overall project. Locating the UV equipment at the Max Pump Station as opposed to building a new large scale 26 mgd plus treatment facility in the Snake Creek or Max area, as identified in the pilot study, would also be cost effective.

The current design for the Max Pump Station facility includes the chlorine contact chambers (5) supplied by a raw water distribution header, the five pumps in separate chambers (cans) and the chemical feed and support facilities for booster pumping to Minot and chloramination. The UV treatment facility would be installed prior to the distribution piping at chlorine addition/contact chambers for several reasons:

- Flow from the intake pump station would be sufficient to satisfy supply requirements
- Ease of operation prior to the chlorine contact chambers where the flow is split
- By using UV prior to chlorine addition, the chlorine dose will be reduced (2-3 mg/l as opposed to 4.5 mg/l originally proposed) which will reduce long-term operating cost. The amount of ammonia used for quenching the chlorine in the chloramination process would likewise be reduced.

We have recently solicited and/or met with several manufacturers of UV equipment to develop up-to-date costs for the latest commercially available (2008) UV equipment that would be applicable for this project.

What I would envision is a separate UV facility at the southwest end of the chlorine contact chamber prior to the distribution header piping. Since this supply is relatively hard water and will have a significant scaling potential (even with an automatic cleaning system incorporated in the UV equipment), an open channel vertical or horizontal low pressure high intensity UV system would be proposed. These units can be removed for external cleaning (a weak acid submersion bath) when necessary. These are typical of wastewater or water reuse water units but they will be more appropriate for this application.

We have assumed a relatively high delivered UV dose of 60,000 – 80,000 $\mu Ws/cm^2$ to account for the unknown organisms and treatment of 100 percent of the flow to provide a level of conservatism. For concept design purposes, we have selected two separate UV trains (15 mgd max flow each to allow for 10 percent out of service at any one time). Each system will have a number of UV units made up of multiple lamps. Individual units can be removed during maintenance and cleaning periods so the full capacity of the system will always be on-line.

In October of 2007, we provided updated conceptual cost estimates for the Max Booster Pump Station facilities. We have reviewed the basic assumptions and information that went into the 2007 estimate and based upon the recent and rather dramatic decline in the construction inflation rates and the renewed interest to bid public works projects by many contractors that were not in that market previously, we believe that the October 2007 numbers are generally valid. We have made several alterations to the cost tables and updated the UV system costs to reflected known changes and proposed modifications.

Tables 1 through 4 provide our opinion of conceptual cost during the first quarter of 2008 for the following located at the Max facility:

Table 1 – UV/Chloramine
Table 2 – Clearwell/Pump Well
Table 3 – Booster Pump Station
Table 4 – Summary Max Booster Pump Station Facility

For this application, we looked at two possible UV equipment options that are marketed by several equipment suppliers. We only considered low pressure high intensity lamps but we costed out both conventional mercury as well as the new higher output amalgam lamps. We did not consider high pressure very high intensity lamp systems due to a number of operational concerns, but these could be evaluated for final design.

As required, we have not gone into a great deal of detail in presenting technical information on UV equipment operational theory, design construction or operation, but I would like to briefly define the two lamp/system options since they may have cost implications.

The low pressure high intensity system (conventional mercury lamps) would require approximately 1920 UV lamps and the low pressure higher intensity system (amalgam lamps) requires only 720 lamps to provide 80,000 μ/watts - sec/cm^2 (our assumed conservative dose for this application – to be confirmed) at a 30 mgd (design maximum no units out of service).

We have also assumed that the very cold winter water temperatures in North Dakota, which will impact low pressure lamp output, would be compensated by a longer hydraulic retention time in the UV contactor, by a reduced winter water demand (20 mgd peak winter flow assumed). Our costs are also based on a worst case 60 percent UVT. This would appear to be a very conservative approach for the SWC to use until we develop more specific design criteria for this option.

The low pressure higher intensity amalgam lamps have an energy demand of 400 watts per lamp while the conventional low pressure high units require only 165 watts per lamp. However, the total power demand for the higher output system is only slightly lower (290 vs. 320 kW) than the mercury lamp system working at maximum output. Since the system lamp use (number of lamps in use) and output (power to the lamps) will be controlled by a PLC based on the actual flow and UV intensity required, operating cost is not a big issue. As it turns out both systems have almost an identical capital cost. This is a marketing function and we would expect that the cost of amalgam lamp systems will be reduced with more competition. Table 1 presents the difference in equipment cost between the two options as less than $50,000 based on recent manufactures quotes.

However, the higher intensity system does have a smaller footprint and will reduce the size of the foundation, UV channels and protective building and ultimate cost by approximately 20 - 25 percent.

We have assumed this was the level of information required. Please let me know if we can provide anything else or clarify any issues. Again, these are conceptual opinions of capital cost and should be assumed to have an accuracy of ±35 percent. Once we get into final design, the costs can be developed to a higher level of accuracy.

Regards

Attachment

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TABLE 1

UV/Chloramine SYSTEM CONSTRUCTION COST ESTIMATE
Revised 2/27/08

	Item	Quantity	Units	Unit Cost	Cost
UV System					
(with mercury lamps)	Excavation	2500	CY	$ 6.25	$15,625
	Flow Meter	1	Ea	$ 35,000.00	$35,000
	Structural Fill	370	CY	$ 32.00	$11,840
	Conc. Slab	250	CY	$ 750.00	$187,500
	Conc. Walls	165	CY	$ 800.00	$132,000
	Conc. Elevated Slab	112	CY	$ 1,050.00	$117,600
	Conc. Misc	100	CY	$ 750.00	$75,000
	Building	3000	SF	$ 150.00	$450,000
	UV System Complete	1	Ea	$ 1,950,000.00	$1,950,000
	Pipe/Fittings/Valves	1	LS	$ 173,300.00	$173,300
	Primary Electrical	1	LS	$ 150,000.00	$150,000
	Equipment Electrical/ I&C	1	LS	$ 390,000.00	$390,000
	Misc Metals/ Stairs/Handrails	1	LS	$ 40,000.00	$40,000
	Crane System/ Doors/Windows	1	LS	$ 44,000.00	$44,000
	Plastics and Coatings	1	LS	$ 10,000.00	$10,000
	HVAC	1	LS	$ 40,000.00	$40,000
Cl2/ Chloramine System Revised Cost					
Excavation		340	CY	$6.25	$2,125
Structural Fill		300	CY	$32.00	$9,600
Concrete					
	Footings	24	CY	$500.00	$12,000
	Stem Walls	52	CY	$750.00	$39,000
	Floor Slab	80	CY	$750.00	$60,000
	Stairs	11	CY	$440.00	$4,840
Building					
	Chemical Room Areas	2070	SF	$180.00	$372,600
Cl2 System					
	Cl2 Injectors	2	EA	$5,500.00	$11,000
	Clorinators (250 lb units)	3	Ea	$32,500.00	$97,500
	Cl2 Equip, Pipe Valves, Etc	1	LS	$253,500.00	$253,500
	Cl2 Scrubber	1	Ea	$154,000.00	$154,000
	Electr/ Instrumentation	1	LS	$182,000.00	$182,000
	Yard Pipe, Sitework Misc	1	LS	$100,000.00	$100,000
NH4 System					
	Containment Walls/ Access	1	LS	$12,000.00	$12,000
	HVAC in Storage Room	1	LS	$25,000.00	$25,000
	Storage Tank & Fill System	1	LS	$104,000.00	$104,000
	Meters, Pumps, Valves, Pipe	1	LS	$78,000.00	$78,000
	Misc Equip/ Diffusers	1	LS	$39,000.00	$39,000
	Electr/ Instrumentation	1	LS	$125,000.00	$125,000
Wet Well/Contactor at 50%		1	LS	$919,000.00	$919,000
				Subtotal	**$6,422,030**
Mobilization and Insurance At 7%					$449,542
				Subtotal	**$6,871,572**
Construction Contingency At 30%					$2,061,472
	UV/Chloramination System Total Construction Cost				**$8,933,044**

	Quantity	Units	Unit Cost	Cost
UV System				
(with amalgam lamps)	2000	CY	$ 6.25	$12,500
	1	Ea	$ 35,000.00	$35,000
	296	CY	$ 32.00	$9,472
	200	CY	$ 750.00	$150,000
	145	CY	$ 800.00	$116,000
	100	CY	$ 1,050.00	$105,000
	80	CY	$ 750.00	$60,000
	2400	SF	$ 150.00	$360,000
	1	Ea	$ 2,000,000.00	$2,000,000
	1	LS	$ 173,300.00	$173,300
	1	LS	$ 150,000.00	$150,000
	1	LS	$ 390,000.00	$390,000
	1	LS	$ 40,000.00	$40,000
	1	LS	$ 44,000.00	$44,000
	1	LS	$ 10,000.00	$10,000
	1	LS	$ 36,000.00	$36,000

TABLE 2

CLEARWELL/CONTACTOR CONSTRUCTION COST ESTIMATE

Revised 12/27/08

Item		Quantity	Units	Unit Cost	Cost
Excavation		3500	CY	$6.25	$21,875
Structural Fill		1372	CY	$32.00	$43,904
Concrete					
	Base Slab	300	CY	$750.00	$225,000
	Valve Vault Slab	46	CY	$750.00	$34,500
	Walls	420	CY	$800.00	$336,000
	Elevated Slab	200	CY	$1,050.00	$210,000
	Overflow Box	6	CY	$1,300.00	$7,800
Entrance Pipe & Fittings					
	36x24 T's	5	Ea	$10,000.00	$50,000
	36 " Pipe	50	LF	$350.00	$17,500
	Pipe & Wall Spools	22	Ea	$5,000.00	$110,000
	24" BF Valves	3	Ea	$15,000.00	$45,000
	24" BF Valves W/ MO	3	Ea	$25,000.00	$75,000
	16" BF Valves	2	Ea	$7,000.00	$14,000
	16" BF Valves W/ MO	2	Ea	$12,000.00	$24,000
	Pipe Supports	10	Ea	$1,100.00	$11,000
	30" Flap Gates	2	Ea	$5,500.00	$11,000
	6" BF Valves & Pipe Spools	4	Ea	$2,000.00	$8,000
Misc. Metals & Baffles					
	Al Ladders	1	LS	$8,000.00	$8,000
	Floor Hatches	7	Ea	$6,600.00	$46,200
	Redwood Baffles	5	Ea	$4,400.00	$22,000
				Subtotal	$1,320,779
Mobilization and Insurance At 7%					$92,455
				Subtotal	$1,413,234
Construction Contingency At 30%					$423,970
				Total	$1,837,204

Note: 50% Percent Of CW/Contactor Cost To Be Applied In Tables 1and 3 at	$918,602

TABLE 3

BOOSTER PUMP STATION CONSTRUCTION COST ESTIMATE
Revised 2/27/08

Item	Quantity	Units		Unit Cost	Cost
Excavation	710	CY	$	6.25	$4,438
Structural Fill	1750	CY	$	32.00	$56,000
Concrete					
Footings	31	CY	$	500.00	$15,500
Stem Walls	128	CY	$	750.00	$96,000
Floor Slab	180	CY	$	750.00	$135,000
Building					
General Area	4215	SF	$	150.00	$632,250
Room Areas w/HVAC	715	SF	$	185.00	$132,275
Mechanical					
9 MGD Pumps	3	Ea	$	175,500.00	$526,500
5 MGD Pumps	2	Ea	$	162,500.00	$325,000
Pump Control Valves (16")	3	Ea	$	26,000.00	$78,000
Pump Control Valves (12")	2	Ea	$	19,500.00	$39,000
Pipe, Fittings, Misc.	1	LS	$	140,000.00	$140,000
Valves & meters	1	LS	$	155,000.00	$155,000
Surge Tank/Compressor	1	LS	$	91,000.00	$91,000
Electrical	1	LS	$	1,060,000.00	$1,060,000
Instrumentation	1	LS	$	306,000.00	$306,000
Wet Well/Contactor at 50%	1	LS		$918,602	$918,602
Yard Piping / Site Work	1	LS	$	150,000.00	$150,000
Overflow Basin	1	LS	$	50,000.00	$50,000
Pig Retreival/Piping & Valves	1	LS	$	111,000.00	$111,000
				Subtotal	**$5,021,565**
Mobilization and Insurance At 7%					$351,510
				Subtotal	**$5,373,074**
Construction Contingency At 30%					$1,611,922
Booster PS Total Construction Cost					**$6,984,996**

TABLE 4

Summary of Project Cost Max Booster Pump Station
Revised 2/27/08

Description	Cost Opinion $
Influent Structure and UV/Chloramination	$8,933,000
Booster PumpStation	$6,985,000
Subtotal	$15,918,000
Engineering and Admin. @ 13%	$2,070,000
Total Project Cost	$17,988,000