

## Appendix D. Water Treatment Plant Condition Assessment

**BLACK & VEATCH CORPORATION**  
**Lincoln Water System**  
**2020 Facilities Master Plan Update**  
**Water Treatment Plant Condition Assessment**

**B&V Project Number 401472**  
**January 31, 2020**

To: File  
From: Tim Malcolm, Black & Veatch  
Reviewed By: Andrew Hansen, Black & Veatch

## **Water Treatment Plant Condition Assessment**

### **Summary**

A high level condition assessment was conducted on 10/10/19 and 10/11/19 to identify the current condition of existing facilities, determine improvements needed within the next 12 years, and further evaluate the feasibility of expanding the West Plant in comparison to expansion at the East Plant.

The *2014 Facilities Master Plan* had identified the next plant expansion to occur at the West Treatment Plant by means of filter rehabilitation with the hopes of increasing the filter loading rate from 5.0 gpm/sf to 6.0 gpm/sf. Throughout the condition assessment activities, concerns were identified by staff, primarily regarding the ability to physically process over 70 mgd through the facility, based upon previous operational knowledge from the 1980's. Specifically, when the West WTP was pushed to rates around 70 mgd, a bypass was utilized which circumvented the entire treatment process including aeration, chlorine contact, and filtration. This operational practice was subsequently discontinued as the safe drinking water act (SDWA) was amended and the bypass has been removed.

In light of these restrictions, in order to expand the West WTP some other modifications would be required in addition to the filter rehabilitation. Other recommended improvements include replacement of the existing clearwell transfer pumps (which would increase capacity and simply CT calculation), addition of a fourth aerator and contact basin, chemical feed modifications, and an allowance for hydraulic improvements to ensure the facility could convey the flows. The total capital cost for expansion of the West WTP by 12 mgd is summarized in Table D-1. The planning level opinion of probable capital cost is \$10,749,000 for a 12 mgd expansion, which equates to an expansion cost of \$0.90/gallon.

In addition to the hydraulic concerns, there is considerable apprehension with respect to filter performance when the media is replaced. It is believed that all the filter media within the facility is original. An alternative concept to replacing all filters would be to replace media in only two filters. Pilot testing should be performed in advance to compare alternative media configurations and confirm manganese removal. Given our experience at the facility, and the need to develop a manganese oxide coating on the media, it may be determined that media will need to be "pre-treated" prior to installation.

**Table D-1 West Water Treatment Plant Expansion Opinion of Probable Cost**

West Plant Expansion - 12 MGD				
Item	Quantity	Unit	Unit Cost	Total Costs
West Water Treatment Plant Rehab				
Rehab Fourteen Filters with Dual Media				
Media Removal	23400	CF	\$20	\$468,000
Filter Coatings	14	EA	\$25,000	\$350,000
Filter Underdrain Removal and Replacement	5200	SF	\$150	\$780,000
Media Installation	23400	CF	\$30	\$702,000
Rehab Surface Wash	14	EA	\$7,500	\$105,000
Skim, Test, Disinfect	14	EA	\$15,000	\$210,000
Trough and Crack Repair	1	LS	\$100,000	\$100,000
Replace Transfer Pumps to Increase Capacity (Wetwell to N. Res)	2	EA	\$750,000	\$1,500,000
Add 4th Aerator	1	LS	\$500,000	\$500,000
Add Contact Basin and Yard Piping	1	LS	\$1,000,000	\$1,000,000
Chemical Feed (Chlorinator)	1	LS	\$150,000	\$150,000
Hydraulic Improvements (Allowance)	1	LS	\$500,000	\$500,000
Piloting and Testing	1	LS	\$50,000	\$50,000
General Allowance	1	LS	\$250,000	\$250,000
Subtotal				\$6,665,000
General Requirements		12%		\$799,800
Subtotal				\$7,464,800
Contingency		20%		\$1,492,960
<b>TOTAL CONSTRUCTION COSTS</b>				<b>\$8,957,760</b>
Engineering, Legal, Administration		20%		\$1,791,552
<b>TOTAL CAPITAL COSTS</b>				<b>\$10,749,000</b>

The other alternative for plant expansion is to expand the filtration capacity at the East WTP. The East WTP currently has a capacity of 60 mgd (originally 50 mgd prior to filter re-rating). The plant was configured such that 16 additional filters can be added to provide additional capacity of 120 mgd. As part of the study B&V provided costing analysis of adding either two filters (15 mgd) or four filters (30 mgd). The cost to add only two filters was not deemed to be in the City's best interest as it would be inefficient with respect to building walls, foundations, ozone system expansion, etc. Therefore, we would recommend that the next expansion of the East Water Treatment Plant should be 30 mgd. The planning level opinion of probable capital cost for this expansion would be \$24,804,000 which equates to \$0.83/gallon. Expansion of the East WTP would also be more beneficial from a treatment perspective as the City will add one or two more collector wells in the interim, increasing their reliance on water which is under the influence of surface water.

**Table D-2 East Water Treatment Plant Expansion Opinion of Probable Cost**

East Filtration Expansion and Ozone Expansion (30 mgd)				
Item	Quantity	Unit	Unit Cost	Total Costs
Filtration Expansion - East Plant				
Sitework	1	LS	\$331,500	\$331,500
Site Electrical	1	LS	\$37,000	\$37,000
Filter Expansion	1	LS	\$9,650,000	\$9,650,000
Ozone Contactor	1	LS	\$2,251,000	\$2,251,000
LOX Storage and Feed System	1	LS	\$2,960,000	\$2,960,000
Chlorine Feeder	1	LS	\$150,000	\$150,000
<b>Subtotal</b>				<b>\$15,379,500</b>
General Requirements		12%		\$1,845,540
<b>Subtotal</b>				<b>\$17,225,040</b>
Contingency		20%		\$3,445,008
<b>TOTAL CONSTRUCTION COSTS</b>				<b>\$20,670,048</b>
Engineering, Legal, Administration		20%		\$4,134,010
<b>TOTAL CAPITAL COSTS</b>				<b>\$24,804,000</b>

In addition to the plant expansion, the condition assessment activities determined that both the East and West Water Treatment Plants are in need of repairs. The last major work at these facilities was in the late 1980's/early 1990's under the Lincoln Water Consortium. A listing and cost of rehabilitation needs as determined from the condition assessment reviews are as follows in Table D-3 and Table D-4.

**Table D-3      General East Plant Rehabilitation Opinion of Probable Cost**

East Water Treatment Plant Rehab				
Description	Quantity	Unit	Unit Cost	Total Costs
East Water Treatment Plant Rehab				
Replace Ambient Ozone Analyzers	10	EA	\$10,000	\$100,000
Replace Ozone Basin Drain Valves	2	EA	\$20,000	\$40,000
Filter Pipe Gallery - Clean Corrosion and Overcoat all pipe	1	LS	\$150,000	\$150,000
Exterior Maintenance of expansion/contraction joints & flashing	1	LS	\$25,000	\$25,000
Rehab roof drains in filter - Coat or cover with insulation	1	LS	\$50,000	\$50,000
General Allowance	1	LS	\$50,000	\$50,000
<b>Subtotal</b>				<b>\$415,000</b>
General Requirements		12%		\$49,800
<b>Subtotal</b>				<b>\$464,800</b>
Contingency		20%		\$92,960
<b>TOTAL CONSTRUCTION COSTS</b>				<b>\$557,760</b>
Engineering, Legal, Administration		20%		\$111,552
<b>TOTAL CAPITAL COSTS</b>				<b>\$669,000</b>

Table D-4 General West Plant Rehabilitation Opinion of Probable Cost

West Water Treatment Plant Rehab plus Rehab of Two Filters w/ Dual Media				
Description	Quantity	Unit	Unit Cost	Total Costs
West Water Treatment Plant Rehab				
Rehab Two Filters with Dual Media for Full Scale Pilot				
Media Removal	2	EA	\$36,000	\$72,000
Filter Coatings	2	EA	\$25,000	\$50,000
Filter Underdrain Removal and Replacement	2	EA	\$80,000	\$160,000
Media Installation	2	EA	\$40,000	\$80,000
Rehab Surface Wash	2	EA	\$7,500	\$15,000
Skim, Test, Disinfect	2	EA	\$15,000	\$30,000
Replace Air Compressors (2)	2	LS	\$25,000	\$50,000
Miscellaneous Air Piping	1	LS	\$5,000	\$5,000
Remove Shroud from around HVAC Duct - Protect Filters	1	LS	\$30,000	\$30,000
Coating Rehab - Remove from masonry, clean and recoat metals	1	LS	\$300,000	\$300,000
Window glazing, weatherproof louvers	1	LS	\$15,000	\$15,000
Replacement/Maintenance HVAC Equipment (Allowance)	1	LS	\$100,000	\$100,000
Replace Surface Wash Piping Filters 11-14	4	EA	\$20,000	\$80,000
Selective Coating/Touchup Coatings in Pipe Gallery (Allowance)	1	LS	\$100,000	\$100,000
Concrete Repair Filter Influent Flume	1	LS	\$30,000	\$30,000
Selective Valve Replacement (Allowance)	1	LS	\$100,000	\$100,000
Pilot Testing (Optional)	1	LS	\$50,000	\$50,000
Service Water Pump Replacement (West PS)	2	EA	\$25,000	\$50,000
General Allowance	1	LS	\$100,000	\$100,000
<b>Subtotal</b>				<b>\$1,417,000</b>

West Water Treatment Plant Rehab plus Rehab of Two Filters w/ Dual Media				
Description	Quantity	Unit	Unit Cost	Total Costs
General Requirements		12%		\$170,040
<b>Subtotal</b>				<b>\$1,587,040</b>
Contingency		20%		\$317,408
<b>TOTAL CONSTRUCTION COSTS</b>				<b>\$1,904,448</b>
Engineering, Legal, Administration		20%		\$380,890
<b>TOTAL CAPITAL COSTS</b>				<b>\$2,285,000</b>

## Site Condition Assessment Field Notes

### Pre-walk Discussion:

1. Rick has seen 75 MGD through the West Plant with the “bypass” open. The “bypass” completely bypasses all treatment and used to be done on a regular basis up to the late 1980’s when flows reached approximately 70 MGD. This obviously is no longer an operational procedure that is practiced (due to regulations) and the bypass was physically removed after the East Plant was constructed. This data point is of significance as expanding the west plant to 72 mgd would require modifications to hydraulic capacity not previously accounted for in previous studies.
2. If LWS were to treat 72 MGD through West Plant, they would set a new energy demand or have to use the West Pump Station. The West Plant transfer pumps would have to be replaced to get the capacity needed.
3. If they did this without running West Pump Station, they’d have to run HS Pumps 5, 6, or 7 and would add another 2.5 MW of power.
4. In addition, it may be difficult to get 72MGD of groundwater to the West Plant; in 1973, they had 44 vertical wells which allowed them to get this capacity, but now they only have 40 and are rehabilitating 17 vertical wells.
5. From historical operational experience Staff believes a new aerator will be required to hydraulically get from 60 MGD to 72 MGD, or else they may have to bypass a portion of the flow around the existing aerators.
6. Running between 60-72 MGD would make it very difficult to backwash any filters.
7. Running the vertical wells at rates over 60 mgd would only work for about 4 weeks as the vertical well production would fall off quickly.
8. Staff would like to have a West Plant surface water CT calculator developed in case it is needed in an emergency. Existing groundwater CT calculator is only setup for CT through contact basins. New surface water CT calculator would have to go through filters and clearwells which may be complicated with how water flows through that plant on both ends.
9. West Plant filters have original media and are good at removing iron and manganese (1930-1956)

10. Filters 1-10 are probably clay tile underdrains, 1956 filters are probably pipe lateral underdrains.
11. None of the filters have air scour. Filters 3-10 do not have surface wash, but the rest of the filters do.
12. All filter valve actuators are pneumatic; drain valves are getting replaced with new vane style actuators.
13. Compressors were new in 1995, overhauled in 2005, overhauled again in 2015, need replaced in 2028. The overhauls cost about \$6k/compressor.
14. New receivers were installed in 2017
15. All air piping is original
16. West Plant HVAC is all natural gas, Rick tends to think that is a weakness, but if electric, that would add to demand.
17. The last few valves/actuators were installed in 1980.
18. All electric lineups were 2400v and 480v MCCs have been replaced in 1995.
19. Only one surface wash pump was replaced in 1995.

#### West Plant Walkthrough:

1. Filters 1-10: LWS would like to close off filter chambers/observation flood from the gallery to help prevent the wet chlorine vapor from corroding elsewhere.
2. All new coatings are needed for ferrous surfaces, floors should probably just have coatings removed as they have a base of red wax paint that they cannot get any coatings to adhere to very well.
3. A few windows/frames/louvers need reglazing or weatherproofing as several leak.
4. The filter area's HVAC had new makeup air units installed in 1995, most gas heaters have been replaced, dehumidification was added in 2010 and has improved the conditioning of the space.
5. Filters 11-14 filter surface wash pipe needs to be replaced.
6. Filters 11-14 filters hit headloss limit faster than F1-10 during the summer (probably because more water run through them as they are closer to the influent hydraulically).
7. For the most part, filter piping is original. It was recoated about 7-8 years ago, but could use an overcoat soon to prevent a total recoat.
8. Filters 11-14 flume had experienced cracking previously and was sealed. A few of the cracks are leaking again and the bottom side of the concrete (exposed in the pipe gallery) is exhibiting spalling in several locations. Rebar is being exposed at those spalling locations.
9. Chlorine analyzers in pipe gallery were replaced two years ago. At that time, they just needed spare parts, but Hach said they no longer serviced the older units and LWS was forced to buy new units.
10. North High Service (NHS) pump 3 was replaced about 8 years ago and had an AFD added at that time.
11. NHS pump 4-6 are original to 1956 installation, motors are also original. The bearings were replaced when they reached 30-40 years of age.

12. NHS discharge pipe and ball valves on pump 3-6 discharge were replaced 10 years ago, the actuators were replaced at the same time.
13. NHS pump 2 has original (1995) valve and actuator.
14. NHS pump 1 has new valve, but original valve actuator.
15. The filter operating floor, transfer pump room, and NHS pump room all have separate air handlers that were new in 1995.
16. The NHS air handler has heat, but no cooling capacity, but the room has additional fans/louvers to help cool if needed.
17. The overhead crane in the NHS pump room had a new crane installed on the trolley about three years ago.
18. Windows and doors in NHS pump room are in good condition.
19. All main electrical gear in NHS are was installed in 1995. New conduit and conductors were run to all existing loads at that point.

#### Ozone Building Walkthrough:

1. Both the ambient and high concentration ozone analyzers have had issues with degradation and then shutting down the generator.
2. Ozone contact basin drain valves have had issues.
3. The air compressor for the ozone system has had scrolls replaced, drier media replaced, and that has helped dry the air. LWS had been experiencing a lot of condensation drainage prior to that.
4. The destruct units have had the catalyst replaced.
5. Ozone analyzers near the destruct units should be replaced.
6. LWS needs to start running the cooling water a day or so prior to starting up the generator. They had previously modified the service water to the cooling water system to run at a lower flow rate as it had been wasting a lot of water. If the generators have been off for a period of time and try to restart when the cooling water tank is at ambient temperature, the service water cannot cool the cooling water tank fast enough and the generators will shutdown on over temperature.

#### East Plant Walkthrough:

1. Filter pipe should be touched up and overcoated within the next 5 years so a total blast and recoat isn't required in 10 years.
2. East Plant exterior needs control and expansion/contraction joints repaired. Maintenance has done some of them near the main entrance.
3. The roof drain piping through the filter operating area has condensation on it continually and has caused it to corrode.
4. A few of the hollow core roof panels appear to have leaked; it is suspected that there was moist air condensing inside of the hollow core and then leaking out and not an actual leak from outdoors to indoors.

### South Pump Station/Reservoir

1. The pump discharge pipe runs through the wetwell and needs to be coated within the next 2 years (this is already in the CIP).
2. HVAC controls are no longer supported and many have been disconnected. Used to be more of an automatic system, but many controls have been removed and they are now using manual controls.
3. The displays on the electrical equipment were very difficult to read (may just need a brightness adjustment?).

### West Transmission Pump Station:

1. Engines had new injectors installed 3 years ago, the emissions/catalytic converters had been gone through before.
2. The right-angle gears and pumps were replaced in 2004 on both engine driven units.
3. The electric powered pump is original to the facility.
4. The existing engine powered units average 100 hours of use per year and burn around 95 gal/hr of diesel.
5. There are several service water valves in the basement that have packing that are leaking. It is suspected that these valves are some API type and the parts are no longer available.
6. There is a large ball valve on the east engine powered pump discharge that has been known to cut its seat due to its construction. After the seat is cut, the valve continues to leak. No known issue currently, but parts availability is unknown.
7. Diesel storage tank is scheduled to be recoated.