Cause No. 45545
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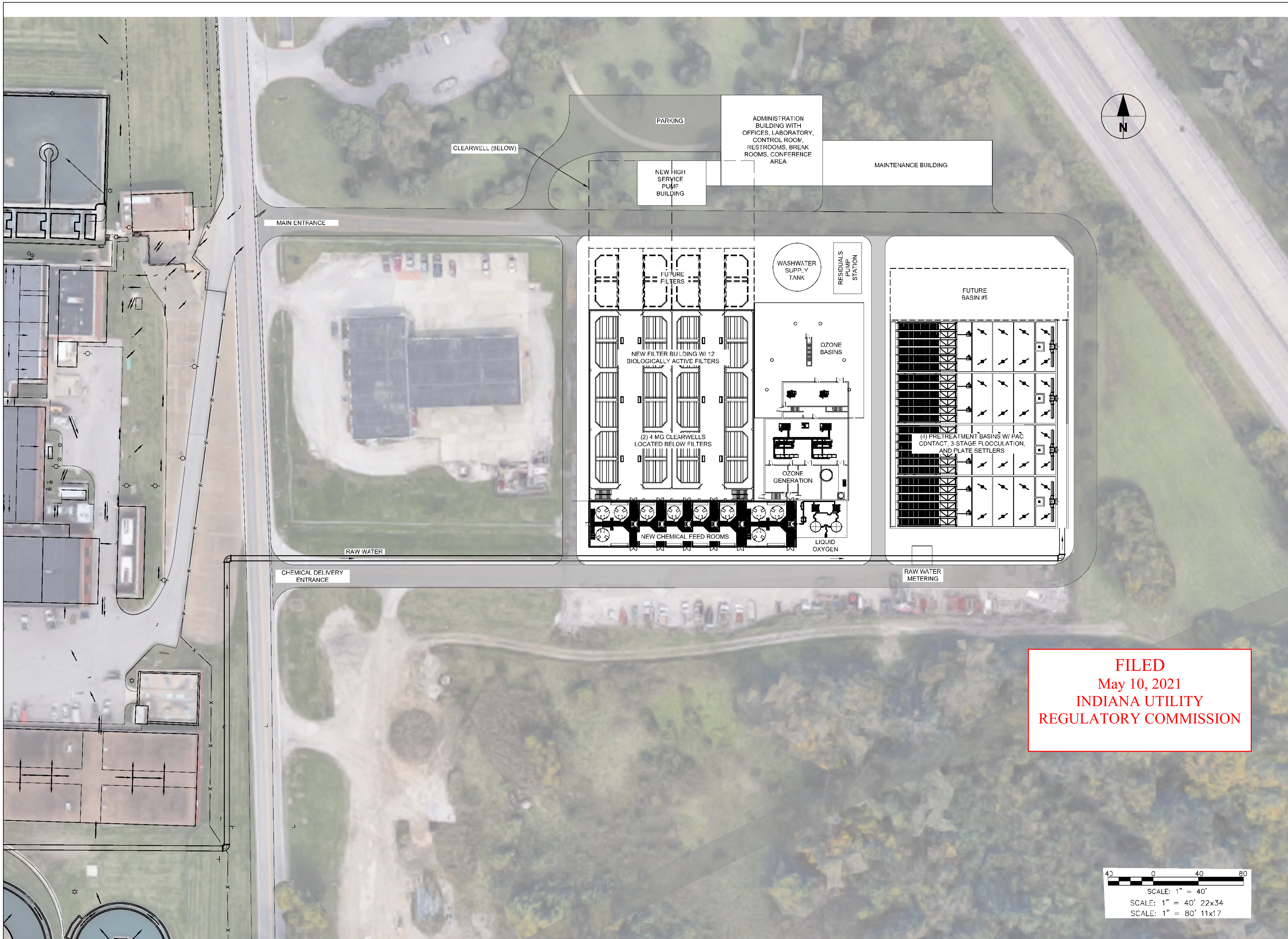

FILED
May 10, 2021
INDIANA UTILITY REGULATORY COMMISSION

AECOM

PROJECT

EVANSVILLE WATER PLANT ADVANCED FACILITY PLAN

1301 Water Works Rd
Evansville, IN 47713

CLIENT

EVANSVILLE WATER & SEWER UTILITY

1 NW Martin Luther King Jr Blvd.
Evansville, IN 47708
(812) 436-7846

CONSULTANT

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VS Engineering
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CTL Engineering
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REGISTRATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION
1	JULY 2020	DRAFT REPORT

PROJECT NUMBER

Evansville: U1032
AECOM: 60613867

SHEET TITLE

PLANT ALTERNATIVE 2B PROPOSED SITE PLAN

SHEET NUMBER

FIGURE A6-8

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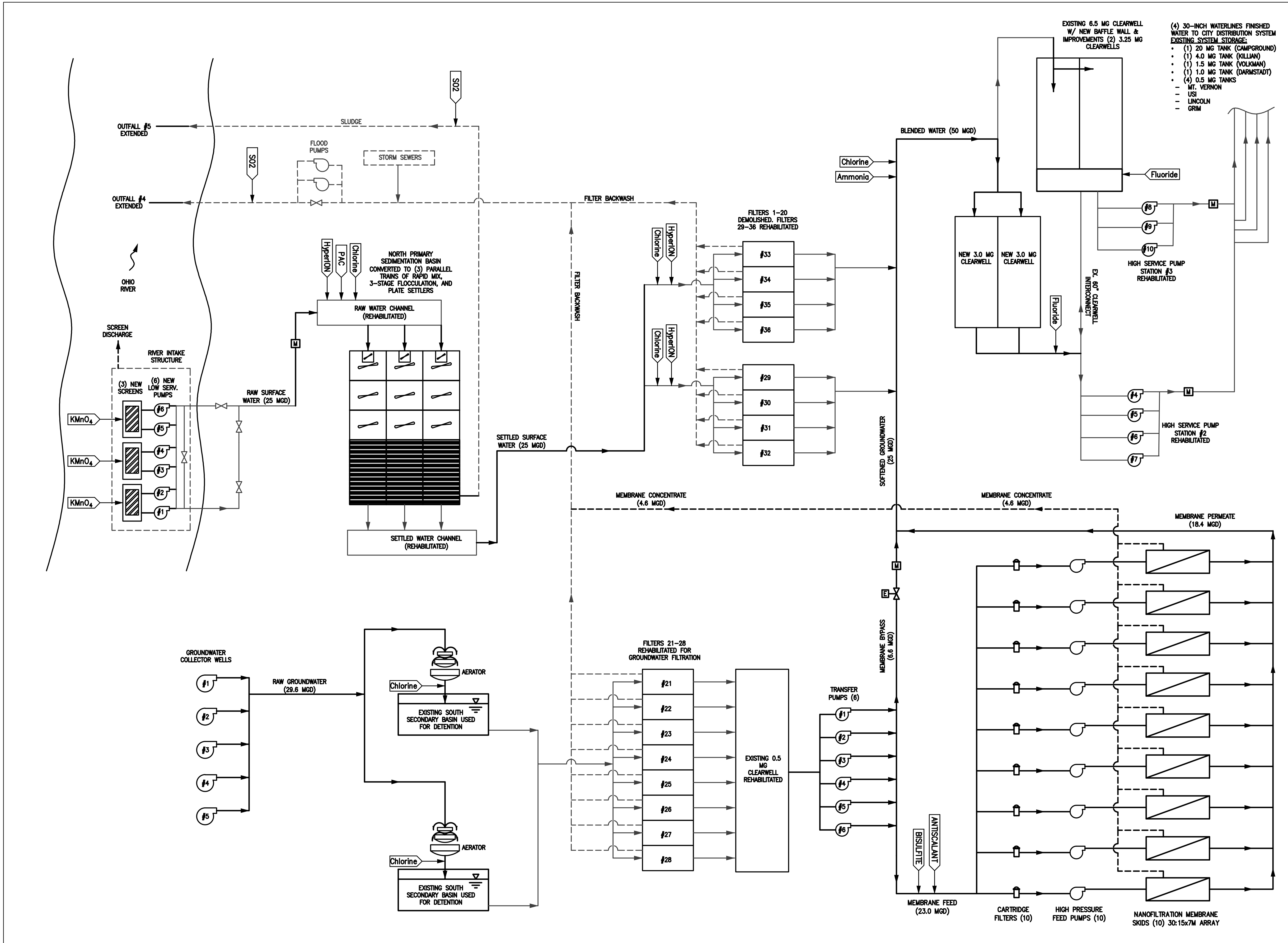
Last saved by: JOHN.KRINKS Last Plotted: 2020-12-29
Project Management Initials: Designer: ### Checked: ### Approved: ### ARCH D 22" x 34"



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1	JULY 2020	DRAFT REPORT

PROJECT NUMBER

Evansville: U1032
AECOM: 60613867

SHEET TITLE

PLANT ALTERNATIVE 3
PROCESS FLOW DIAGRAM

SHEET NUMBER

FIGURE A6-9

ARCH D 22" x 34"
Project Management Initials: Designer: ### Checked: ### Approved: ###
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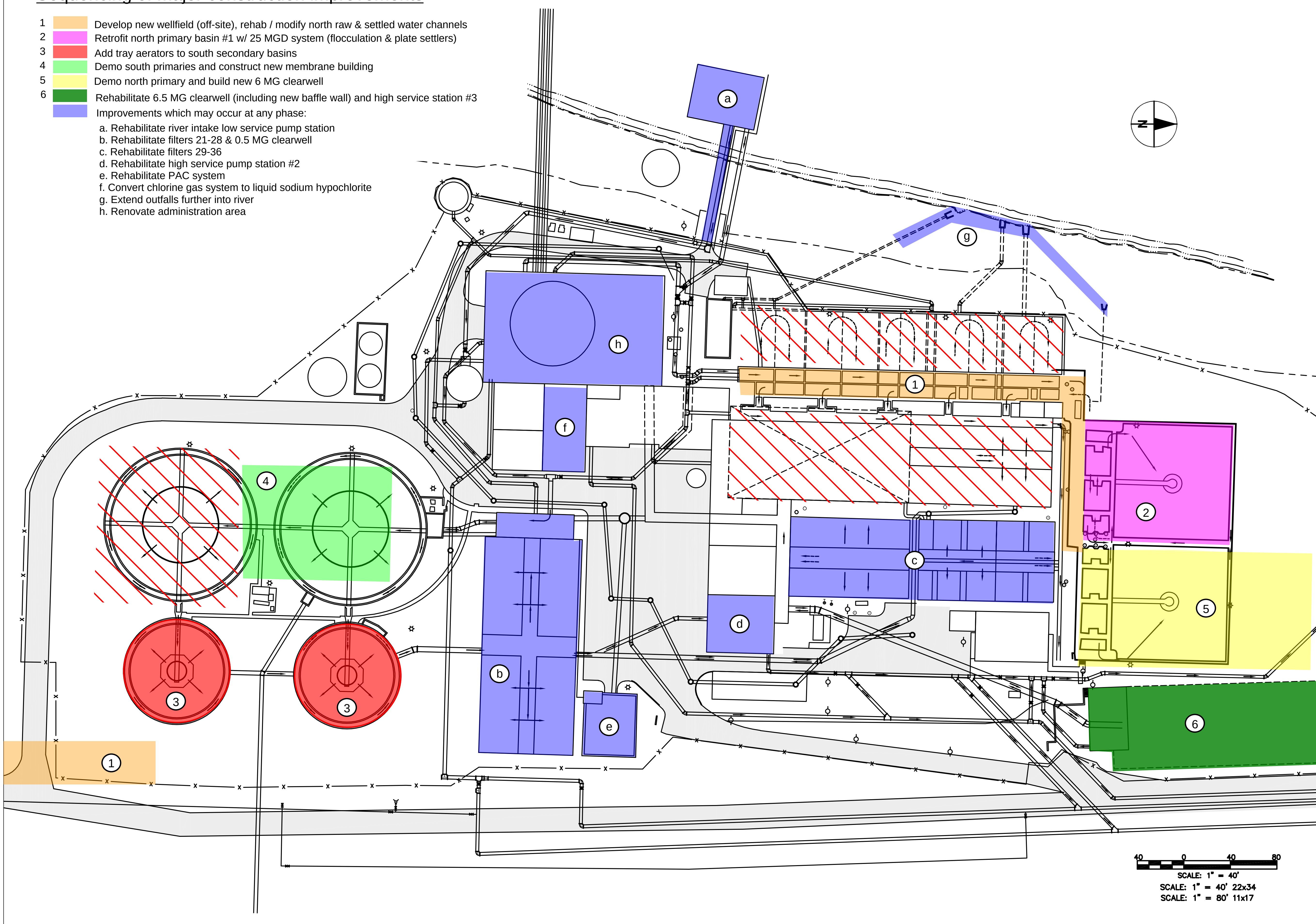
Last saved by: JOHN.KRINKS Last Plotted: 2020-11-11

Sequencing of major construction improvements

1 Develop new wellfield (off-site), rehab / modify north raw & settled water channels
2 Retrofit north primary basin #1 w/ 25 MGD system (flocculation & plate settlers)
3 Add tray aerators to south secondary basins
4 Demo south primaries and construct new membrane building
5 Demo north primary and build new 6 MG clearwell
6 Rehabilitate 6.5 MG clearwell (including new baffle wall) and high service station #3
Improvements which may occur at any phase:
- a. Rehabilitate river intake low service pump station
- b. Rehabilitate filters 21-28 & 0.5 MG clearwell
- c. Rehabilitate filters 29-36
- d. Rehabilitate high service pump station #2
- e. Rehabilitate PAC system
- f. Convert chlorine gas system to liquid sodium hypochlorite
- g. Extend outfalls further into river
- h. Renovate administration area



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1	JULY 2020	DRAFT REPORT
I/R	DATE	DESCRIPTION

PROJECT NUMBER

Evansville: U1032
AECOM: 60613867

SHEET TITLE

PLANT ALTERNATIVE 3
DEMOLITION AND PHASING PLAN

SHEET NUMBER

FIGURE A6-10

ARCH D 22" x 34"
Approved: ###
Checked: ###
Designer: ###
Project Management Initials:

Filename: L:\DCS\PROJECTS\WTR\60613867_EVANSVILLE\900-CAD-GIS\910-CAD\20-SHEETS\CIVIL\A6-2 5 8 PHASING TEMPLATE.DWG
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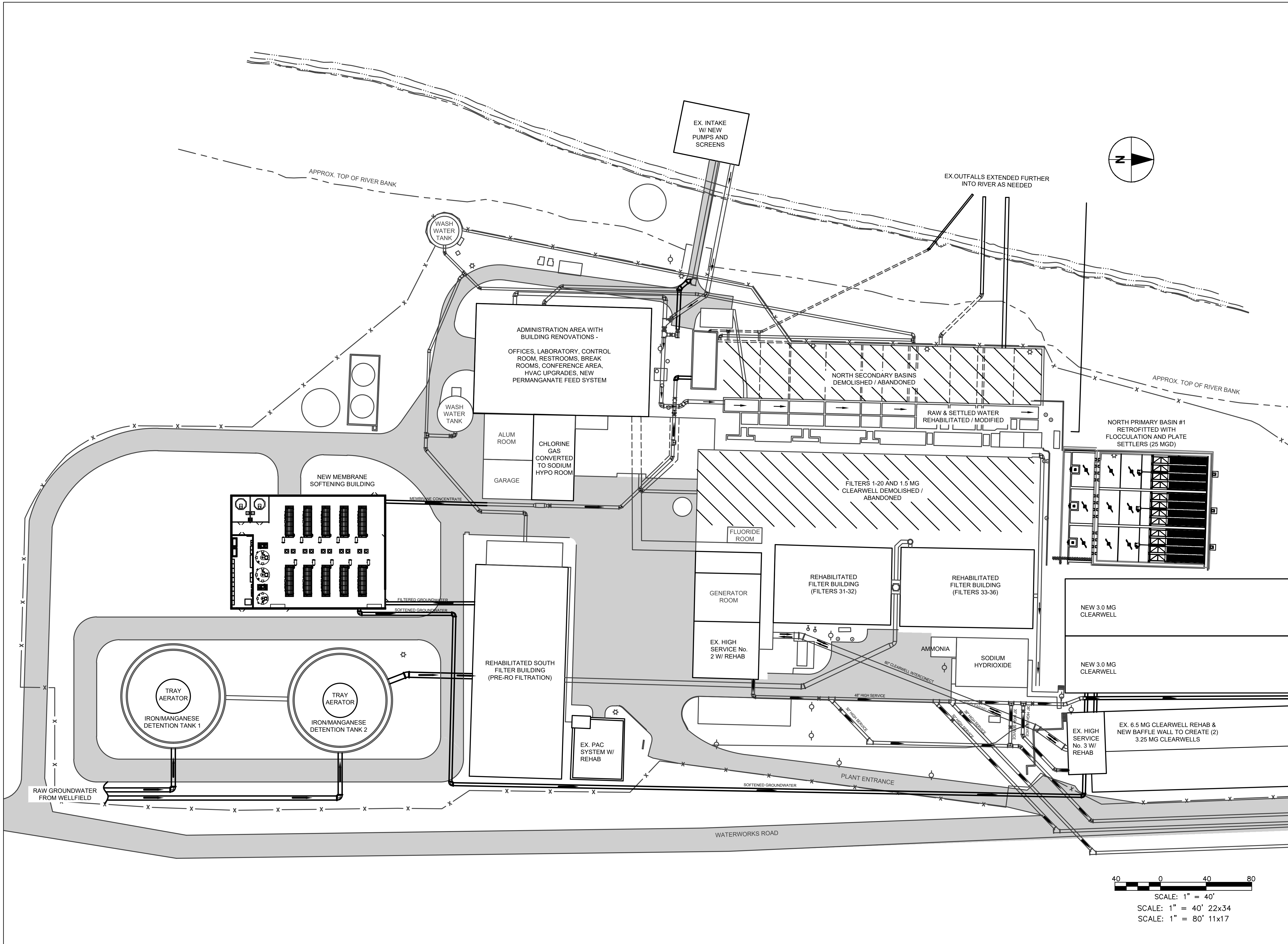

AECOM

PROJECT

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ISSUE/REVISION

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PROJECT NUMBER

Evansville: U1032
AECOM: 60613867

SHEET TITLE

PLANT ALTERNATIVE 3
PROPOSED SITE PLAN

SHEET NUMBER

FIGURE A6-11

APPENDIX B

COST ESTIMATE DETAILS

City of Evansville, Indiana
Life Cycle Present Worth Costs

Alternative	Capital Cost	O&M Costs	Replacement Costs	Salvage Costs	Present Worth 30 Year LCC
River Intake Alternative 1: Rehabilitation	$ 6,752,000	$ 12,343,000	$ 629,000	$ (315,000)	$ 19,409,000
River Intake Alternative 2: New Construction	$ 12,978,000	$ 12,046,000	$ 761,000	$ (381,000)	$ 25,404,000
Pretreatment Alternative 1: Conventional with Rehabilitation	$ 13,610,000	$ 26,510,000	$ 767,000	$ (384,000)	$ 40,503,000
Pretreatment Alternative 2: Conventional with New Construction	$ 17,377,000	$ 26,687,000	$ 816,000	$ (408,000)	$ 44,472,000
Pretreatment Alternative 3: Ballasted Flocculation with Rehabilitation	$ 19,189,000	$ 38,979,000	$ 1,162,000	$ (581,000)	$ 58,749,000
Pretreatment Alternative 4: Ballasted Flocculation with New Construction	$ 24,044,000	$ 38,979,000	$ 1,162,000	$ (581,000)	$ 63,604,000
Filtration Alternative 1: Conventional with Rehabilitation	$ 17,125,000	$ 11,011,000	$ 1,804,000	$ (902,000)	$ 29,038,000
Filtration Alternative 2: Conventional with New Construction	$ 31,569,000	$ 6,898,000	$ 1,320,000	$ (660,000)	$ 39,127,000
Filtration Alternative 3: Ozone & BAF with Rehabilitation	$ 34,060,000	$ 16,132,000	$ 2,229,000	$ (1,115,000)	$ 51,306,000
Filtration Alternative 4: Ozone & BAF with New Construction	$ 53,626,000	$ 12,050,000	$ 3,497,000	$ (1,749,000)	$ 67,424,000
Filtration Alternative 5: MGF with Rehabilitation	$ 48,025,000	$ 18,195,000	$ 1,558,000	$ (779,000)	$ 66,999,000
Filtration Alternative 6: MGF - New Construction	$ 50,823,000	$ 18,190,000	$ 1,603,000	$ (802,000)	$ 69,814,000
Disinfection Alternative 1: Chlorine Gas	$ 1,616,000	$ 11,367,000	$ 87,000	$ (44,000)	$ 13,026,000
Disinfection Alternative 2: Bulk Delivery of Sodium Hypochlorite	$ 2,092,000	$ 11,772,000	$ 158,000	$ (79,000)	$ 13,943,000
Disinfection Alternative 3: Onsite Generation of Sodium Hypochlorite	$ 5,602,000	$ 10,800,000	$ 275,000	$ (138,000)	$ 16,539,000

EWSU WATER PLANT ALTERNATIVES ANALYSIS
INTAKE ALTERNATIVE 1 - REHABILITATE EXISTING SYSTEM
LIFE CYCLE COST ANALYSIS (30 YEARS)

Capital Costs			Capital Cost 2020$
Total Capital Cost			**$ 6,752,000**
O&M Costs	**Current $ Annual**		**30 Yr Life Cycle Cost 2020$**
Chemicals & Consumables	**$ 67,835**		**$ 2,035,058**
Potassium Permanganate (3300 lb bins)	$ 67,835		$ 2,035,058
PAC (incl. in Pretreatment costs)	$ -		$ -
Energy Costs	**$ 318,081**		**$ 9,542,431**
Screens & Backwash Water	$ 1,742		$ 52,259
Low Service Pumps & Drives (6@150HP)	$ 313,552		$ 9,406,558
KMNO4 System (PAC in Pretreatment)	$ 697		$ 20,903
HVAC (A.C. for VFD only)	$ 2,090		$ 62,710
(Insignificant for controls)	$ -		$ -
			$ -
Equipment Maintenance Costs	**$ 25,500**		**$ 765,000**
River Sediment Removal (Est 2X in 30 Yrs)	$ 16,000		$ 480,000
Traveling Screens & Backwash Water	$ 5,000		$ 150,000
Low Service Pumps & Motors & Valves	$ 4,500		$ 135,000
Total O&M Costs	**$ 411,416**		**$ 12,343,000**
Replacement Costs	**Useful Life in Years**	**Times Replaced**	**30 Yr Life Cycle Cost 2020$**
Roof Replacement	20	1	$ 50,000
Process Piping	20	1	$ 20,900
Pumps	20	1	$ 200,400
Screen Replacement	20	1	$ 195,000
Potassium Permanganate System	15	2	$ 112,500
HVAC	15	2	$ 23,000
Electrical and I&C	15	2	$ 26,800
Total Replacement Costs			**$ 629,000**
Salvage Value 2020$ to Reflect Remaining Useful Life at Year 30			
Roof Replacement	20	Years	$ (25,000)
Process Piping	20	Years	$ (10,450)
Pumps	20	Years	$ (100,200)
Screen Replacement	20	Years	$ (97,500)
Potassium Permanganate System	15	Years	$ (56,250)
HVAC	15	Years	$ (11,500)
Electrical and I&C	15	Years	$ (13,400)
Total Salvage Value of Remaining Useful Life			**$ (315,000)**
Total Present Worth 30 Year Life Cycle Cost			**$ 19,409,000**

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EWSU WATER PLANT ALTERNATIVES ANALYSIS
INTAKE ALTERNATIVE 2 - NEW INTAKE SYSTEM
LIFE CYCLE COST ANALYSIS (30 YEARS)

Capital Costs			Capital Cost 2020$
Total Capital Cost			**$ 12,978,000**
O&M Costs	**Current $ Annual**		**30 Yr Life Cycle Cost 2020$**
Chemicals & Consumables	**$ 67,835**		**$ 2,035,058**
Potassium Permanganate (3300 lb bins)	$ 67,835		$ 2,035,058
PAC (incl. in Pretreatment costs)	$ -		$ -
Energy Costs	**$ 318,196**		**$ 9,545,867**
Perforated Screens & Compressors	$ 1,742		$ 52,259
Vertical Turbine Pumps/Drives (6@150HP)	$ 313,552		$ 9,406,558
KMNO4 Feed System	$ 697		$ 20,903
HVAC System (A.C. for Elec Room only)	$ 2,205		$ 66,147
(Insignificant for controls)	$ -		$ -
			$ -
Equipment Maintenance Costs	**$ 15,500**		**$ 465,000**
River Sediment Removal (Est 1X in 30 Yrs)	$ 8,000		$ 240,000
Perforated Screens & Compressors	$ 3,000		$ 90,000
Vertical Turbine Pumps & Motors & Valves	$ 4,500		$ 135,000
Total O&M Costs	**$ 401,531**		**$ 12,046,000**
Replacement Costs	**Useful Life in Years**	**Times Replaced**	**30 Yr Life Cycle Cost 2020$**
Process Piping	20	1	$ 41,000
Valves, Meters, Etc.	20	1	$ 29,800
Pumps	20	1	$ 199,050
Intake Screens	20	1	$ 195,000
Potassium Permanganate System	15	2	$ 112,500
Hydroburst System	20	1	$ 20,550
Plumbing	20	1	$ 1,850
HVAC	15	2	$ 30,200
Electrical and I&C	15	2	$ 131,000
Total Replacement Costs			**$ 761,000**
Salvage Value 2020$ to Reflect Remaining Useful Life at Year 30			
Process Piping	20	Years	$ (20,500)
Valves, Meters, Etc.	20	Years	$ (14,900)
Pumps	20	Years	$ (99,525)
Intake Screens	20	Years	$ (97,500)
Potassium Permanganate System	15	Years	$ (56,250)
Hydroburst System	20	Years	$ (10,275)
Plumbing	20	Years	$ (925)
HVAC	15	Years	$ (15,100)
Electrical and I&C	15	Years	$ (65,500)
Total Salvage Value of Remaining Useful Life			**$ (381,000)**
Total Present Worth 30 Year Life Cycle Cost			**$ 25,404,000**

EWSU WATER PLANT ALTERNATIVES ANALYSIS
PRETREATMENT ALTERNATIVE 1 - CONVENTIONAL, REHAB NORTH PLANT
LIFE CYCLE COST ANALYSIS (30 YEARS)

Capital Costs			Capital Cost 2020$
Total Capital Cost			**$ 13,610,000**
O&M Costs	**Current $ Annual**		**Life Cycle Cost 2020$**
Chemicals & Consumables	**$ 830,250**		**$ 24,907,500**
Powdered Activated Carbon (PAC)	$ 9,000		$ 270,000
HyperIon Coagulant	$ 821,250		$ 24,637,500
Energy Costs	**$ 50,865**		**$ 1,525,953**
1st Stage Flocculators	$ 12,542		$ 376,262
2nd Stage Flocculators	$ 8,361		$ 250,842
3rd Stage Flocculators	$ 8,361		$ 250,842
Sludge Collectors	$ 4,181		$ 125,421
Rapid Mixers	$ 12,542		$ 376,262
Coagulant Feed Pumps	$ 4,877		$ 146,324
Equipment Maintenance Costs	**$ 2,550**		**$ 76,500**
Chemical Feed Pumps	$ 250		$ 7,500
Mixers	$ 1,800		$ 54,000
Sludge Collection Equipment	$ 500		$ 15,000
Total O&M Costs	**$ 883,665**		**$ 26,510,000**
Replacement Costs	**Useful Life in Years**	**Times Replaced**	**Life Cycle Cost 2020$**
Process Piping	20	1	$ 10,000
Flocculators & Mixers	20	1	$ 138,300
Settlement Equipment	20	1	$ 509,850
Slide Gate w/Operator	20	1	$ 18,000
Electrical & I&C	15	2	$ 90,400
Total Replacement Costs			**$ 767,000**
Salvage Value 2020$ to Reflect Remaining Useful Life at Year 30			
Process Piping	20	Years	$ (5,000)
Flocculators & Mixers	20	Years	$ (69,150)
Settlement Equipment	20	Years	$ (254,925)
Slide Gate w/Operator	20	Years	$ (9,000)
Electrical & I&C	15	Years	$ (45,200)
Total Salvage Value of Remaining Useful Life			**$ (384,000)**
Total Present Worth 30 Year Life Cycle Cost			**$ 40,503,000**

EWSU WATER PLANT ALTERNATIVES ANALYSIS
PRETREATMENT ALTERNATIVE 2 - CONVENTIONAL WITH NEW CONSTRUCTION
LIFE CYCLE COST ANALYSIS (30 YEARS)

Capital Costs			Capital Cost 2020$
Total Capital Cost			**$ 17,377,000**
O&M Costs	**Current $ Annual**		**Life Cycle Cost 2020$**
Chemicals & Consumables	**$ 830,250**		**$ 24,907,500**
Powdered Activated Carbon (PAC)	$ 9,000		$ 270,000
Hyperlon Coagulant	$ 821,250		$ 24,637,500
Energy Costs	**$ 57,356**		**$ 1,720,670**
PAC Mixers	$ 916		$ 27,489
Coagulant Feed Pumps	$ 3,484		$ 104,517
Rapid Mixers	$ 8,361		$ 250,842
1st Stage Flocculators	$ 16,723		$ 501,683
2nd Stage Flocculators	$ 11,149		$ 334,455
3rd Stage Flocculators	$ 8,361		$ 250,842
Sludge Collectors	$ 8,361		$ 250,842
Equipment Maintenance Costs	**$ 1,950**		**$ 58,500**
Chemical Feed Pumps	$ 250		$ 7,500
Mixers	$ 1,200		$ 36,000
Sludge Collection Equipment	$ 500		$ 15,000
Total O&M Costs	**$ 889,556**		**$ 26,687,000**
Replacement Costs	**Useful Life in Years**	**Times Replaced**	**Life Cycle Cost 2020$**
Process Piping	20	1	$ 27,000
Flocculators & Mixers	20	1	$ 174,150
Settlement Equipment	20	1	$ 508,500
Slide Gate w/Operator	20	1	$ 11,800
Electrical & I&C	15	2	$ 93,600
Total Replacement Costs			**$ 816,000**
Salvage Value 2020$ to Reflect Remaining Useful Life at Year 30			
Process Piping	20	Years	$ (13,500)
Flocculators & Mixers	20	Years	$ (87,075)
Settlement Equipment	20	Years	$ (254,250)
Slide Gate w/Operator	20	Years	$ (5,900)
Electrical & I&C	15	Years	$ (46,800)
Total Salvage Value of Remaining Useful Life			**$ (408,000)**
Total Present Worth 30 Year Life Cycle Cost			**$ 44,472,000**

EWSU WATER PLANT ALTERNATIVES ANALYSIS
PRETREATMENT ALTERNATIVE 3 - BALLASTED FLOCCULATION WITH REHAB
LIFE CYCLE COST ANALYSIS (30 YEARS)

Capital Costs			Capital Cost 2020$
Total Capital Cost			**$ 19,189,000**
O&M Costs	**Current $ Annual**		**Life Cycle Cost 2020$**
Chemicals & Consumables	**$ 1,295,625**		**$ 38,868,750**
Powdered Activated Carbon (PAC)	$ 9,000		$ 270,000
Hyperlon Coagulant	$ 410,625		$ 12,318,750
Ballasted Flocculation	$ 876,000		$ 26,280,000
Energy Costs	**$ -**		**$ -**
Coagulant Feed Pumps	*Incl in chemical costs*		$ -
Sludge Collectors	*Incl in chemical costs*		$ -
Centrifugal Sludge Return Pumps (2 per tank	*Incl in chemical costs*		$ -
Coagulation & Maturation Tank Mixers	*Incl in chemical costs*		$ -
Equipment Maintenance Costs	**$ 3,650**		**$ 109,500**
Chemical Feed Pumps	$ 250		$ 7,500
Mixers	$ 2,400		$ 72,000
Sludge Collection Equipment	$ 500		$ 15,000
Centrifugal Sludge Return Pumps	$ 500		$ 15,000
Total O&M Costs	**$ 1,299,275**		**$ 38,979,000**
Replacement Costs	**Useful Life in Years**	**Times Replaced**	**Life Cycle Cost 2020$**
Process Piping	20	1	$ 39,700
Valves, Meters, Etc	20	1	$ 7,400
Flocculators & Mixers	20	1	$ 15,150
Settlement Equipment	20	1	$ 549,300
Slide Gate w/Operator	20	1	$ 12,000
Pumps	20	1	$ 87,900
Chemical System Equipment	20	1	$ 270,400
HVAC	15	2	$ 18,200
Plumbing	20	1	$ 2,200
Electrical and I&C	15	2	$ 159,600
Total Replacement Costs			**$ 1,162,000**
Salvage Value 2020$ to Reflect Remaining Useful Life at Year 30			
Process Piping	20	Years	$ (19,850)
Valves, Meters, Etc	20	Years	$ (3,700)
Flocculators & Mixers	20	Years	$ (7,575)
Settlement Equipment	20	Years	$ (274,650)
Slide Gate w/Operator	20	Years	$ (6,000)
Pumps	20	Years	$ (43,950)
Chemical System Equipment	20	Years	$ (135,200)
HVAC	15	Years	$ (9,100)
Plumbing	20	Years	$ (1,100)
Electrical and I&C	15	Years	$ (79,800)
Total Salvage Value of Remaining Useful Life			**$ (581,000)**
Total Present Worth 30 Year Life Cycle Cost			**$ 58,749,000**

EWSU WATER PLANT ALTERNATIVES ANALYSIS
PRETREATMENT ALTERNATIVE 4 - BALLASTED FLOCCULATION WITH NEW CONSTRUCTIOI
LIFE CYCLE COST ANALYSIS (30 YEARS)

Capital Costs			Capital Cost 2020$
Total Capital Cost			**$ 24,044,000**
O&M Costs	**Current $ Annual**		**Life Cycle Cost 2020$**
Chemicals & Consumables	**$ 1,295,625**		**$ 38,868,750**
Powdered Activated Carbon (PAC)	$ 9,000		$ 270,000
Hyperlon Coagulant	$ 410,625		$ 12,318,750
Ballasted Flocculation	$ 876,000		$ 26,280,000
Energy Costs	**$ -**		**$ -**
Coagulant Feed Pumps	*Incl in chemical costs*		$ -
Sludge Collectors	*Incl in chemical costs*		$ -
Centrifugal Sludge Return Pumps (2 per tank	*Incl in chemical costs*		$ -
Coagulation & Maturation Tank Mixers	*Incl in chemical costs*		$ -
Equipment Maintenance Costs	**$ 3,650**		**$ 109,500**
Chemical Feed Pumps	$ 250		$ 7,500
Mixers	$ 2,400		$ 72,000
Sludge Collection Equipment	$ 500		$ 15,000
Centrifugal Pumps	$ 500		$ 15,000
Total O&M Costs	**$ 1,299,275**		**$ 38,979,000**
Replacement Costs	**Useful Life in Years**	**Times Replaced**	**Life Cycle Cost 2020$**
Process Piping	20	1	$ 39,700
Valves, Meters, Etc	20	1	$ 7,400
Flocculators & Mixers	20	1	$ 15,150
Settlement Equipment	20	1	$ 549,300
Slide Gate w/Operator	20	1	$ 12,000
Pumps	20	1	$ 87,900
Chemical System Equipment	20	1	$ 270,400
HVAC	15	2	$ 18,200
Plumbing	20	1	$ 2,200
Electrical and I&C	15	2	$ 159,600
Total Replacement Costs			**$ 1,162,000**
Salvage Value 2020$ to Reflect Remaining Useful Life at Year 30			
Process Piping	20	Years	$ (19,850)
Valves, Meters, Etc	20	Years	$ (3,700)
Flocculators & Mixers	20	Years	$ (7,575)
Settlement Equipment	20	Years	$ (274,650)
Slide Gate w/Operator	20	Years	$ (6,000)
Pumps	20	Years	$ (43,950)
Chemical System Equipment	20	Years	$ (135,200)
HVAC	15	Years	$ (9,100)
Plumbing	20	Years	$ (1,100)
Electrical and I&C	15	Years	$ (79,800)
Total Salvage Value of Remaining Useful Life			**$ (581,000)**
Total Present Worth 30 Year Life Cycle Cost			**$ 63,604,000**

EWSU WATER PLANT ALTERNATIVES ANALYSIS
FILTRATION ALTERNATIVE 1 - CONVENTIONAL WITH REHAB
LIFE CYCLE COST ANALYSIS (30 YEARS)

Capital Costs			Capital Cost 2020$
Total Capital Cost			**$ 17,125,000**
O&M Costs	**Current $ Annual**		**30 Yr Life Cycle Cost 2020$**
Chemicals & Consumables	**$ 165,300**		**$ 4,959,000**
Filter Media Replace (25 Yrs, Annualized)	$ 12,000		$ 360,000
Backwash Water (incl. pump energy costs)	$ 153,300		$ 4,599,000
Energy Costs	**$ 27,871**		**$ 836,138**
HVAC / Dehumidifiers	$ 27,871		$ 836,138
Lighting & Controls (Minor & Similar for All)	$ -		$ -
Equipment Maintenance Costs	**$ 4,968,500**		**$ 5,215,000**
Backwash Tanks	$ 1,000		$ 30,000
Control Valves	$ 7,500		$ 225,000
Replace Current Underdrains at 10-15 yrs	$ 4,960,000		$ 4,960,000
HVAC, Lighting & Control Systems	Maint. Costs Similar for All		$ -
Total O&M Costs	**$ 5,161,671**		**$ 11,011,000**
Replacement Costs	**Useful Life in Years**	**Times Replaced**	**30 Yr Life Cycle Cost 2020$**
Filtration Equipment	20	1	$ 907,500
Process Piping	20	1	$ 69,000
HVAC	15	2	$ 352,000
Electrical	15	2	$ 475,200
Total Replacement Costs			**$ 1,804,000**
Salvage Value 2020$ to Reflect Remaining Useful Life at Year 30			
Filtration Equipment	20	Years	$ (453,750)
Process Piping	20	Years	$ (34,500)
HVAC	15	Years	$ (176,000)
Electrical	15	Years	$ (237,600)
Total Salvage Value of Remaining Useful Life			**$ (902,000)**
Total Present Worth 30 Year Life Cycle Cost			**$ 29,038,000**

EWSU WATER PLANT ALTERNATIVES ANALYSIS
FILTRATION ALTERNATIVE 2 - CONVENTIONAL WITH NEW CONSTRUCTION
LIFE CYCLE COST ANALYSIS (30 YEARS)

Capital Costs			Capital Cost 2020$
Total Capital Cost			**$ 31,569,000**
O&M Costs	**Current $ Annual**		**30 Yr Life Cycle Cost 2020$**
Chemicals & Consumables	**$ 165,300**		**$ 4,959,000**
Filter Media Replace (25 Yrs, Annualized)	$ 12,000		$ 360,000
Backwash Water (incl. pump energy costs)	$ 153,300		$ 4,599,000
Energy Costs	**$ 56,904**		**$ 1,707,116**
Positive Displacement Blowers	$ 29,033		$ 870,978
HVAC / Dehumidifiers	$ 27,871		$ 836,138
Lighting & Controls (Minor & Similar for All)	$ -		$ -
Equipment Maintenance Costs	**$ 7,725**		**$ 231,750**
Backwash Tanks	$ 1,000		$ 30,000
Positive Displacement Blowers	$ 225		$ 6,750
Control Valves	$ 7,500		$ 225,000
HVAC, Lighting & Control Systems	Maint. Costs Similar for All		$ -
Total O&M Costs	**$ 229,929**		**$ 6,898,000**
Replacement Costs	**Useful Life in Years**	**Times Replaced**	**30 Yr Life Cycle Cost 2020$**
Process Piping	20	1	$ 122,500
Valves, Meters, Etc	20	1	$ 83,300
Filtration Equipment	20	1	$ 647,850
Hoists & Cranes	20	1	$ 7,350
Plumbing	20	1	$ 10,200
HVAC	15	2	$ 227,800
Electrical and I&C	15	2	$ 221,000
Total Replacement Costs			**$ 1,320,000**
Salvage Value 2020$ to Reflect Remaining Useful Life at Year 30			
Process Piping	20	Years	$ (61,250)
Valves, Meters, Etc	20	Years	$ (41,650)
Filtration Equipment	20	Years	$ (323,925)
Hoists & Cranes	20	Years	$ (3,675)
Plumbing	20	Years	$ (5,100)
HVAC	15	Years	$ (113,900)
Electrical and I&C	15	Years	$ (110,500)
Total Salvage Value of Remaining Useful Life			**$ (660,000)**
Total Present Worth 30 Year Life Cycle Cost			**$ 39,127,000**

EWSU WATER PLANT ALTERNATIVES ANALYSIS
FILTRATION ALTERNATIVE 3 - OZONE & FILTRATION WITH REHAB
LIFE CYCLE COST ANALYSIS (30 YEARS)

Capital Costs			Capital Cost 2020$
Total Capital Cost			**$ 34,060,000**
O&M Costs	**Current $ Annual**		**30 Yr Life Cycle Cost 2020$**
Chemicals & Consumables	**$ 180,250**		**$ 5,407,500**
Filter Media Replace (25 Yrs, Annualized)	$ 16,000		$ 480,000
Backwash Water (incl. pump energy costs)	$ 186,150		$ 5,584,500
Liquid Oxygen	$ 164,250		$ 4,927,500
Ozone Quenching (Sodium Bisulfite)	$ 44,603		$ 1,338,090
Energy Costs	**$ 152,449**		**$ 4,573,470**
Ozone Generation Systems	$ 93,223		$ 2,796,676
Ozone Injection Pumps	$ 41,807		$ 1,254,208
Ozone Cooling Water Pumps	$ 13,936		$ 418,069
Compressor for Nitrogen	$ 3,484		$ 104,517
Equipment Maintenance Costs	**$ 4,999,700**		**$ 6,151,000**
Backwash Tanks	$ 1,000		$ 30,000
Replace Current Underdrains at 10-15 yrs	$ 4,960,000		$ 4,960,000
Ozone Generation & Quenching Systems	$ 15,000		$ 450,000
Ozone Electrolytic Cells	$ 15,000		$ 450,000
Ozone Injection Pumps (6@30 HP)	$ 900		$ 27,000
Ozone Cooling Water Pumps (6@10 HP)	$ 300		$ 9,000
Control Valves	$ 7,500		$ 225,000
HVAC, Lighting & Control Systems	Maint. Costs Similar for All		$ -
Total O&M Costs	**$ 5,332,399**		**$ 16,132,000**
Replacement Costs	**Useful Life in Years**	**Times Replaced**	**30 Yr Life Cycle Cost 2020$**
Process Piping	20	1	$ 40,300
Valves, Meters, Etc.	20	1	$ 17,500
Filtration Equipment	20	1	$ 272,250
Ozone Equipment	15	2	$ 1,349,400
LOX Vaporizor, Tank, Station	15	2	$ 267,300
Plumbing	20	1	$ 3,500
HVAC	15	2	$ 51,800
Electrical and I&C	15	2	$ 226,800
Total Replacement Costs			**$ 2,229,000**
Salvage Value 2020$ to Reflect Remaining Useful Life at Year 30			
Process Piping	20	Years	$ (20,150)
Valves, Meters, Etc.	20	Years	$ (8,750)
Filtration Equipment	20	Years	$ (136,125)
Ozone Equipment	15	Years	$ (674,700)
LOX Vaporizor, Tank, Station	15	Years	$ (133,650)
Plumbing	20	Years	$ (1,750)
HVAC	15	Years	$ (25,900)
Electrical and I&C	15	Years	$ (113,400)
Total Salvage Value of Remaining Useful Life			**$ (1,115,000)**
Total Present Worth 30 Year Life Cycle Cost			**$ 51,306,000**

EWSU WATER PLANT ALTERNATIVES ANALYSIS
FILTRATION ALTERNATIVE 4 - OZONE & BAF WITH NEW CONSTRUCTION
LIFE CYCLE COST ANALYSIS (30 YEARS)

Capital Costs			Capital Cost 2020$
Total Capital Cost			**$ 53,626,000**
O&M Costs	**Current $ Annual**		**30 Yr Life Cycle Cost 2020$**
Chemicals & Consumables	**$ 180,250**		**$ 5,407,500**
Filter Media Replace (25 Yrs, Annualized)	$ 16,000		$ 480,000
Backwash Water (incl. pump energy costs)	$ 186,150		$ 5,584,500
Liquid Oxygen	$ 164,250		$ 4,927,500
Ozone Quenching (Sodium Bilsulfite)	$ 44,603		$ 1,338,090
Energy Costs	**$ 181,482**		**$ 5,444,447**
Positive Displacement Blowers	$ 29,033		$ 870,978
Ozone Generation Systems	$ 93,223		$ 2,796,676
Ozone Injection Pumps	$ 41,807		$ 1,254,208
Ozone Cooling Water Pumps	$ 13,936		$ 418,069
Compressor for Nitrogen	$ 3,484		$ 104,517
Equipment Maintenance Costs	**$ 39,925**		**$ 1,197,750**
Backwash Tanks	$ 1,000		$ 30,000
Positive Displacement Blowers	$ 225		$ 6,750
Ozone Generation & Quenching Systems	$ 15,000		$ 450,000
Ozone Electrolytic Cells	$ 15,000		$ 450,000
Ozone Injection Pumps (6@30 HP)	$ 900		$ 27,000
Ozone Cooling Water Pumps (6@10 HP)	$ 300		$ 9,000
Control Valves	$ 7,500		$ 225,000
HVAC, Lighting & Control Systems	Maint. Costs Similar for All		$ -
Total O&M Costs	**$ 401,657**		**$ 12,050,000**
Replacement Costs	**Useful Life in Years**	**Times Replaced**	**30 Yr Life Cycle Cost 2020$**
Process Piping	20	1	$ 142,950
Valves, Meters, Etc	20	1	$ 92,050
Filtration Equipment	20	1	$ 722,850
LOX Vaporizor, Tank, Station	15	2	$ 267,300
Ozone Equipment	15	2	$ 1,349,400
Hoists & Cranes	20	1	$ 7,350
Plumbing	20	1	$ 158,000
HVAC	15	2	$ 298,400
Electrical and I&C	15	2	$ 457,800
Total Replacement Costs			**$ 3,497,000**
Salvage Value 2020$ to Reflect Remaining Useful Life at Year 30			
Process Piping	20	Years	$ (71,475)
Valves, Meters, Etc	20	Years	$ (46,025)
Filtration Equipment	20	Years	$ (361,425)
LOX Vaporizor, Tank, Station	15	Years	$ (133,650)
Ozone Equipment	15	Years	$ (674,700)
Hoists & Cranes	20	Years	$ (3,675)
Plumbing	20	Years	$ (79,000)
HVAC	15	Years	$ (149,200)
Electrical and I&C	15	Years	$ (228,900)
Total Salvage Value of Remaining Useful Life			**$ (1,749,000)**
Total Present Worth 30 Year Life Cycle Cost			**$ 67,424,000**

EWSU WATER PLANT ALTERNATIVES ANALYSIS
FILTRATION ALTERNATIVE 5 - MGF WITH REHAB
LIFE CYCLE COST ANALYSIS (30 YEARS)

Capital Costs			Capital Cost 2020$
Total Capital Cost			**$ 48,025,000**
O&M Costs	**Current $ Annual**		**30 Yr Life Cycle Cost 2020$**
Chemicals & Consumables	**$ 571,400**		**$ 17,142,000**
Membranes - Replace @ 25 Yrs, Annualized	$ 440,000		$ 13,200,000
Backwash Water (incl. pump energy costs)	$ 131,400		$ 3,942,000
Chlorine & Dechlor (see below at Maint.)	$ -		$ -
Energy Costs	**$ 21,774**		**$ 653,233**
Air Scour Blower Systems	$ 21,774		$ 653,233
HVAC (Minor & Similar for All)	$ -		$ -
Lighting & Controls (Minor & Similar for All)	$ -		$ -
Equipment Maintenance Costs	**$ 13,300**		**$ 399,000**
Backwash Tanks	$ 1,000		$ 30,000
Air Scour Blower Systems	$ 300		$ 9,000
Membrane Systems	$ 3,000		$ 90,000
Membrane Cleaning (Chlorine) & Maint.	$ 1,500		$ 45,000
Backwash Tanks	$ 1,000		$ 30,000
Control Valves	$ 7,500		$ 225,000
HVAC, Lighting & Control Systems	Maint. Costs Similar for All		$ -
Total O&M Costs	**$ 606,474**		**$ 18,195,000**
Replacement Costs	**Useful Life in Years**	**Times Replaced**	**30 Yr Life Cycle Cost 2020$**
Process Piping	20	1	$ 61,100
Membrane Filtration Equipment	20	1	$ 1,029,400
Air Scour Blowers	20	1	$ 44,400
HVAC	15	2	$ 176,000
Electrical and I&C	15	2	$ 246,800
Total Replacement Costs			**$ 1,558,000**
Salvage Value 2020$ to Reflect Remaining Useful Life at Year 30			
Process Piping	20	Years	$ (30,550)
Membrane Filtration Equipment	20	Years	$ (514,700)
Air Scour Blowers	20	Years	$ (22,200)
HVAC	15	Years	$ (88,000)
Electrical and I&C	15	Years	$ (123,400)
Total Salvage Value of Remaining Useful Life			**$ (779,000)**
Total Present Worth 30 Year Life Cycle Cost			**$ 66,999,000**

EWSU WATER PLANT ALTERNATIVES ANALYSIS
FILTRATION ALTERNATIVE 6 - MGF WITH NEW CONSTRUCTION
LIFE CYCLE COST ANALYSIS (30 YEARS)

Capital Costs			Capital Cost 2020$
Total Capital Cost			**$ 50,823,000**
O&M Costs	**Current $ Annual**		**30 Yr Life Cycle Cost 2020$**
Chemicals & Consumables	**$ 571,400**		**$ 17,142,000**
Membranes - Replace @ 25 Yrs, Annualized	$ 440,000		$ 13,200,000
Backwash Water (incl. pump energy costs)	$ 131,400		$ 3,942,000
Chlorine & Dechlor (see below at Maint.)	$ -		$ -
Energy Costs	**$ 21,774**		**$ 653,233**
Air Scour Blower Systems	$ 21,774		$ 653,233
HVAC (Minor & Similar for All)	$ -		$ -
Lighting & Controls (Minor & Similar for All)	$ -		$ -
Equipment Maintenance Costs	**$ 13,150**		**$ 394,500**
Backwash Tanks	$ 1,000		$ 30,000
Air Scour Blower Systems	$ 150		$ 4,500
Membrane Systems	$ 3,000		$ 90,000
Membrane Cleaning (Chlorine) & Maint.	$ 1,500		$ 45,000
Backwash Tanks	$ 1,000		$ 30,000
Control Valves	$ 7,500		$ 225,000
HVAC, Lighting & Control Systems	Maint. Costs Similar for All		$ -
Total O&M Costs	**$ 606,324**		**$ 18,190,000**
Replacement Costs	**Useful Life in Years**	**Times Replaced**	**30 Yr Life Cycle Cost 2020$**
Process Piping	20	1	$ 84,250
Valves, Meters, Etc	20	1	$ 40,250
Membrane Filtration Equipment	20	1	$ 1,029,400
Air Scour Blowers	20	1	$ 22,200
Hoists & Cranes	20	1	$ 21,900
Plumbing	20	1	$ 6,200
HVAC	15	2	$ 138,600
Electrical and I&C	15	2	$ 259,800
Total Replacement Costs			**$ 1,603,000**
Salvage Value 2020$ to Reflect Remaining Useful Life at Year 30			
Process Piping	20	Years	$ (42,125)
Valves, Meters, Etc	20	Years	$ (20,125)
Membrane Filtration Equipment	20	Years	$ (514,700)
Air Scour Blowers	20	Years	$ (11,100)
Hoists & Cranes	20	Years	$ (10,950)
Plumbing	20	Years	$ (3,100)
HVAC	15	Years	$ (69,300)
Electrical and I&C	15	Years	$ (129,900)
Total Salvage Value of Remaining Useful Life			**$ (802,000)**
Total Present Worth 30 Year Life Cycle Cost			**$ 69,814,000**

EWSU WATER PLANT ALTERNATIVES ANALYSIS
DISINFECTION ALTERNATIVE 1 - CHLORINE GAS SYSTEM
LIFE CYCLE COST ANALYSIS (30 YEARS)

Capital Costs			Capital Cost 2020$
Total Capital Cost			**$ 1,616,000**
O&M Costs	**Current $ Annual**		**30 Yr Life Cycle Cost 2020$**
Chemicals & Consumables	**$ 369,482**		**$ 11,084,466**
Chlorine at 5 mg/l	$ 100,375		$ 3,011,250
Sodium Hydroxide at 8 mg/l	$ 262,800		$ 7,884,000
Unsoftened Carrier Water	$ 6,307		$ 189,216
Energy Costs	**$ 4,390**		**$ 131,692**
Chlorinators, Scales & Crane/Trolley	$ 732		$ 21,949
Eductors and Carrier Water Systems	$ -		$ -
Ventilation Systems	$ 1,568		$ 47,033
Sodium Hydroxide Feed Pumps	$ 2,090		$ 62,710
Equipment Maint. & Calibration Costs	**$ 5,000**		**$ 150,000**
Chlorinators, Scales & Crane/Trolley	$ 500		$ 15,000
Eductors and Carrier Water Systems	$ 500		$ 15,000
Ventilation, Controls, Detectors & Alarms	$ 4,000		$ 120,000
Total O&M Costs	**$ 378,872**		**$ 11,367,000**
Replacement Costs	**Useful Life in Years**	**Times Replaced**	**30 Yr Life Cycle Cost 2020$**
Process Piping	20	1	$ 2,700
Chemical System Equipment	20	1	$ 21,300
Hoists & Cranes	20	1	$ 5,700
Fire Protection (Wet System)	20	1	$ 2,200
Plumbing	20	1	$ 1,600
HVAC	15	2	$ 12,400
Electrical and I&C	15	2	$ 40,200
Total Replacement Costs			**$ 87,000**
Salvage Value 2020$ to Reflect Remaining Useful Life at Year 30			
Process Piping	20	Years	$ (1,350)
Chemical System Equipment	20	Years	$ (10,650)
Hoists & Cranes	20	Years	$ (2,850)
Fire Protection (Wet System)	20	Years	$ (1,100)
Plumbing	20	Years	$ (800)
HVAC	15	Years	$ (6,200)
Electrical and I&C	15	Years	$ (20,100)
Total Salvage Value of Remaining Useful Life			**$ (44,000)**
Total Present Worth 30 Year Life Cycle Cost			**$ 13,026,000**

EWSU WATER PLANT ALTERNATIVES ANALYSIS
DISINFECTION ALTERNATIVE 2 - BULK SODIUM HYPOCHLORITE DELIVERY
LIFE CYCLE COST ANALYSIS (30 YEARS)

Capital Costs			Capital Cost 2020$
Total Capital Cost			**$ 2,092,000**
O&M Costs	**Current $ Annual**		**30 Yr Life Cycle Cost 2020$**
Chemicals & Consumables	**$ 377,447**		**$ 11,323,395**
Sodium Hypochlorite	$ 369,563		$ 11,086,875
Softened Carrier Water (incl salt & power)	$ 7,884		$ 236,520
Energy Costs	**$ 4,923**		**$ 147,677**
Day Tank Scale	$ 52		$ 1,568
Carrier Water Softening System (incl above)	$ -		$ -
Peristaltic Metering Pumps (up to 8 ea)	$ 2,787		$ 83,614
Ventilation & Air Conditioning	$ 2,083		$ 62,496
Equipment Maintenance Costs	**$ 10,000**		**$ 300,000**
Tanks, Scale, Ventilation & Controls	$ 4,000		$ 120,000
Carrier Water Softening System	$ 3,000		$ 90,000
Peristaltic Metering Pumps (up to 8 ea)	$ 3,000		$ 90,000
Total O&M Costs	**$ 392,369**		**$ 11,772,000**
Replacement Costs	**Useful Life in Years**	**Times Replaced**	**30 Yr Life Cycle Cost 2020$**
Process Piping	20	1	$ 5,300
Pumps	20	1	$ 45,000
Chemical System Equipment	20	1	$ 26,850
Fire Protection (Wet System)	20	1	$ 2,900
Plumbing	20	1	$ 2,100
HVAC	15	2	$ 22,000
Electrical and I&C	15	2	$ 53,000
Total Replacement Costs			**$ 158,000**
Salvage Value 2020$ to Reflect Remaining Useful Life at Year 30			
Process Piping	20	Years	$ (2,650)
Pumps	20	Years	$ (22,500)
Chemical System Equipment	20	Years	$ (13,425)
Fire Protection (Wet System)	20	Years	$ (1,450)
Plumbing	20	Years	$ (1,050)
HVAC	15	Years	$ (11,000)
Electrical and I&C	15	Years	$ (26,500)
Total Salvage Value of Remaining Useful Life			**$ (79,000)**
Total Present Worth 30 Year Life Cycle Cost			**$ 13,943,000**

EWSU WATER PLANT ALTERNATIVES ANALYSIS
DISINFECTION ALTERNATIVE 3 - ONSITE SODIUM HYPOCHLORITE GENERATION
LIFE CYCLE COST ANALYSIS (30 YEARS)

Capital Costs			Capital Cost 2020$
Total Capital Cost			**$ 5,602,000**
O&M Costs	**Current $ Annual**		**30 Yr Life Cycle Cost 2020$**
Chemicals & Consumables	**$ 339,678**		**$ 10,190,344**
Raw Salt for Brine & Softened Water	(incl. in next line below)		(incl. below)
Cost for On-Site Gen of Hypochlorite	$ 339,678		$ 10,190,344
Softened Carrier Water (incl salt & power)	$ 7,884		$ 236,520
Energy Costs	**$ 6,305**		**$ 189,158**
Hypochlorite Generators (2 each)	(incl. in total hypo cost above)		(incl. above)
Water Heaters & Brine Tank Heat Trace	$ 2,473		$ 74,189
Carrier Water Softening System (incl above)	$ -		$ -
Peristaltic Metering Pumps (up to 8 ea)	$ 2,787		$ 83,614
HVAC (nothing extra for Hydrogen)	$ 1,045		$ 31,355
Equipment Maintenance Costs	**$ 14,000**		**$ 420,000**
OSG System, Controls & HVAC	$ 5,000		$ 150,000
Water Softening System (OSG & Carrier)	$ 4,000		$ 120,000
Hypo. Electrolytic Cells	$ 2,000		$ 60,000
Peristaltic Metering Pumps (up to 8 ea)	$ 3,000		$ 90,000
Total O&M Costs	**$ 359,983**		**$ 10,800,000**
Replacement Costs	**Useful Life in Years**	**Times Replaced**	**30 Yr Life Cycle Cost 2020$**
Process Piping	20	1	$ 11,900
Pumps	20	1	$ 45,000
Chemical System Equipment	20	1	$ 105,850
Fire Protection (Wet System)	20	1	$ 3,100
Plumbing	20	1	$ 2,500
HVAC	15	2	$ 19,800
Electrical and I&C	15	2	$ 86,400
Total Replacement Costs			**$ 275,000**
Salvage Value 2020$ to Reflect Remaining Useful Life at Year 30			
Process Piping	20	Years	$ (5,950)
Pumps	20	Years	$ (22,500)
Chemical System Equipment	20	Years	$ (52,925)
Fire Protection (Wet System)	20	Years	$ (1,550)
Plumbing	20	Years	$ (1,250)
HVAC	15	Years	$ (9,900)
Electrical and I&C	15	Years	$ (43,200)
Total Salvage Value of Remaining Useful Life			**$ (138,000)**
Total Present Worth 30 Year Life Cycle Cost			**$ 16,539,000**

APPENDIX C

IMMEDIATE NEEDS MEMORANDUM:

TREATMENT EQUIPMENT INFRASTUCTURE

EVANSVILLE
WATER AND SEWER UTILITY
EVANSVILLE, INDIANA

WATER TREATMENT PLANT ADVANCED FACILITY PLAN

PROCESS TECHNICAL MEMO

HNTB

DECEMBER 2019

EVANSVILLE WATER AND SEWER UTILITY
EVANSVILLE, INDIANA

WATER TREATMENT PLANT ADVANCED FACILITY PLAN

PROCESS TECHNICAL MEMO

DECEMBER 2019

Prepared by

The HNTB Companies
Infrastructure Solutions

HNTB

111 MONUMENT CIRCLE
INDIANAPOLIS, INDIANA 46204-5178
(317) 636-4682

HNTB Job No. 74086-PL-001

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LIST OF ABBREVIATIONS

AFP	Advanced Facility Plan
EWSU	Evansville Water and Sewer Utility
HSP	High Service Pump
HSPS	High Service Pump Station
IDEM	Indiana Department of Environmental Management
LSPS	Low Service Pump Station
MG	Million Gallons
MGD	Million Gallons per Day
ORSANCO	Ohio River Valley Sanitation Commission
PAC	Powder Activated Carbon
USACE	US Army Corps of Engineers
WTP	Water Treatment Plant

CHAPTER 1
INTRODUCTION AND BACKGROUND

1.1 BACKGROUND

The Evansville Water and Sewer Utility (EWSU) surface water treatment plant (WTP) treats raw surface water from the Ohio River and supplies drinking water to the City of Evansville, the majority of Vanderburgh County, and portions of Gibson and Warrick Counties. The WTP is located approximately one (1) mile upstream of downtown Evansville and draws raw water from the Ohio River which is pumped to one (1) of the two (2) interconnected treatment systems, the North Plant and the South Plant. The raw water is chemically conditioned, coagulated, flocculated, and clarified in the primary and secondary sedimentation basins. The settled water enters filtration for removal of small particles and microorganisms, then chemically conditioned and disinfected, and finally sent to storage in one (1) of the three (3) clearwells on-site before being pumped into the distribution system from two (2) high service pump stations. A site plan of the treatment facility is shown in **Figure 1-1.**

1.2 PURPOSE

The purpose of the memo is to evaluate the existing current process systems, review the proposed projects included in EWSU's water rate case, review prior master planning projects, and summarize the recommended critical infrastructure improvement projects needed to maintain operation of the WTP over the next five (5) years while the advanced facility plan (AFP), final WTP design, and construction are completed.

1.3 ASSUMPTIONS AND REFERENCES

This technical memorandum was developed based on information gathered from recent meetings with EWSU staff and referencing previously submitted planning reports. Previous reports utilized for this memorandum included the following:

- EWSU's 2019-2021 Water Rate Case;
- Water Master Plan, previously prepared by HNTB Corporation, 2016;
- Preliminary Engineering Report, HSP Station and Clearwell, Project No. 25, prepared by HNTB Corporation as part as the VS Engineering team, 2018 and;
- Electrical and I&C Technical Memo, concurrently prepared with this tech memo by HNTB Corporation as part of the AECOM Team, 2019.

Projects were largely identified from either the *Water Master Plan*, EWSU's 2019-2021 water rate case, or staff recommendations as discussed during recent site meetings.

Projects were selected based on the criticality of keeping the plant in operation over the next five (5) years. Cost was not considered in selecting projects. Once projects were selected, they were categorized using the following four (4) justification criteria:

- Regulatory Driven;
- Safety;
- Failure Mitigation; and
- Critical Equipment Preventative Maintenance

Chapter 2 details the evaluation of the existing process treatment systems. Please note, this memo excludes the electrical, instrumentation and control systems associated with the process. The evaluation of these systems can be found in the *Electrical and I&C Technical Memo*.

Chapter 3 provides a summary of projects recommended to be completed in the next five (5) years. Each project is sorted by area of the WTP and assigned a priority ranking of 1) Critical 2) High 3) Medium or 4) Low.

FIGURE 1-1
Site Plan of the Water Treatment Plant

CHAPTER 2
PROCESS AND FACILITIES OVERVIEW

The WTP consists of two (2) interconnected treatment systems, the North Plant and South Plant, each with a hydraulic capacity of 36 and 24 million gallons per day (MGD), respectively. **Table 2.1** summarizes the existing treatment processes comprising each plant and their associated hydraulic capacities. A process flow diagram is located in **Appendix A.**

TABLE 2.1
Water Treatment Plant Capacities

Unit Process	*North Plant*[1]	*South Plant*[1]	*Total Capacity*	*Firm Capacity*[2]
River Intakes[3]			**90-140 MGD**	**70 MGD**
Low Service Pumping[4]	**86 MGD**	**60 MGD**	**146 MGD**	**126 MGD**
Mixing	**36 MGD**	**24 MGD**	**60 MGD**	**42 MGD**[5]
Flocculation	**36 MGD**	**24 MGD**	**60 MGD**[6]	**42 MGD**[6]
Primary Sedimentation	**36 MGD**	**24 MGD**	**60 MGD**[6]	**42 MGD**[6]
Secondary Sedimentation	**36 MGD**	**24 MGD**	**60 MGD**[6]	**42 MGD**[6]
Gravity Filtration[8]	**36 MGD**	**24 MGD**	**60 MGD**	**57 MGD**
Filters 13-20	12 MGD			
Filters 21-28		24 MGD		
Filters 29-32	12 MGD			
Filters 33-36	12 MGD			
Finished Water Storage	**8.0 MG**[9]	**0.5 MG**	**8.5 MG**	**2.0 MG**[10]
High Service Pumping	**85 MGD**	**0 MGD**	**85 MGD**	**70 MGD**
HSP Station 2 (Pumps 4-7)	40 MGD			
HSP Station 3 (Pumps 8-10)	45 MGD			
Plant Firm Capacity			**60 MGD**	**42 MGD**[6]

Notes:
[1] Capacity figures are based on previous engineering reports and analyses.
[2] Firm capacity based on largest single unit being out of service under worst-case conditions (such as high raw turbidity and high system demand).
[3] Capacity estimates vary based on river elevations and actual pipe velocities.
[4] Pump capacities based on 53 ft. TDH.
[5] Plant functioned adequately without rapid mixer until 1997; coagulation may be impacted, but it is not recommended to limit overall plant capacity by the firm capacity of mixing process.
[6] Total and firm capacities are based on nominal design overflow rates; operational information and historical experience indicate an operational capacity of approximately 48 MGD.
[7] South primary clarifiers are flocculating clarifiers with 18-percent of volume and surface area for flocculation and 82-percent for clarification.
[8] Filters 1-12 are currently out of service.
[9] All 3 clearwells are interconnected via finished water channel between the Diesel Room and Filters 29-32 Building.
[10] Although plant firm capacity is not based on firm clearwell capacity, risk of failure/emergency closure of 6.5 MG clearwell poses significant potential impact to plant capacity and disinfection capabilities.

Chapter 2 summarizes the condition of each process in greater detail with respect to the following justification criteria 1) Regulatory Driven 2) Safety 3) Failure Mitigation or 4) Critical Equipment Preventative Maintenance as described in **Chapter 1**.

2.1 INTAKE AND LOW SERVICE PUMP STATION

Unit Process Description

Both the North Plant and South Plant are supplied with raw water by the Low Service Pump Station (LSPS) referenced on **Figure 1-1, Area 11**. The pump station houses three (3) traveling screens, six (6) vertical turbine low service pumps, an air compressor, and a potassium permanganate feed system. The traveling screens, shown in **Figure 2-1**, remove debris from the river intake water prior to pumping for treatment. The six (6) vertical turbine pumps, **Figure 2-2**, pump raw water from the river to both the North and South Plants. The air compressor powers the pneumatically actuated discharge valves. From the pumping station, raw water is delivered to the treatment units in the North and South Plants via two (2) 42-inch low service discharge mains.

FIGURE 2-1
Traveling Screen

FIGURE 2-2
Low Service Pumps

Recommended Projects

The critical equipment in the LSPS required to keep the plant in operation include the traveling screens and the low service pumps. Additionally, the riverside perimeter of the pump station requires periodic dredging to clear the intake screens of sediment buildup from the river. The pumps are typically on a six (6) year rebuild cycle, where two (2) pumps are rehabilitated every two (2) years. The traveling screen rehabilitation typically consists of one (1) screen rebuild each year to prevent failure. The maintenance of each of these items should continue at the intervals currently approved within the water rate case. Additional concerns within the intake area include interior and exterior piping and miscellaneous metal coating corrosion. Additionally, a high-water line on the wall in the lower level likely caused from either a leaking connection or sump pump failure is evident. A back-up sump pump within the lower level for redundancy is recommended. There are also operational and reliability issues with the pneumatic actuators due to age. It is recommended that the discharge valve pneumatic actuators and air compressor be replaced with electric actuators for ensured reliability.

2.2 NORTH PLANT RAW AND SETTLED WATER FLUMES

Unit Process Description

Raw water is pumped to the North Plant and first enters the raw water flume shown on **Figure 1-1, Area 8** and **Figure 2-3**, prior to flocculation and primary clarification treatment. Carbon and chlorine are fed within the channel, if needed. The concrete channel was constructed in the early 1950's as part of the North Plant expansion.

Recommended Projects

Due to age, material, and exposure to the elements, the roof drains discharging into the raw water flume, shown in **Figure 2-4**, are heavily corroded. Staff mentioned the corrosion of the downspouts and potential replacement should be considered to avoid a possible overhead safety issue. Handrails and walkways are also showing signs of heavy corrosion and should be inspected and recoated or replaced with new to extend their useful life.

FIGURE 2-3
Raw Water Flume

FIGURE 2-4
Corroded Roof Drain Downspout

2.3 NORTH PLANT RAPID MIX AND FLOCCULATION

Unit Process Description

Coagulant is injected at the raw water flume for the rapid mixing and flocculation process to adsorb natural organic compounds and taste and odor compounds in the flocculation basins shown in **Figure 1-1, Area 3**. In the North Plant, there are six (6) vertical flocculators immediately downstream of the rapid mixer. The rapid mixer was installed in the early 1990's and the flocculation basins were constructed in the early 1950's as part of the North Plant expansion.

Recommended Projects

The North Plant flocculation basin tank walls, shown in **Figure 2-5**, are showing signs of concrete surface deterioration. It is recommended to clean the tanks, perform a structural inspection, and apply a protective coating to the concrete walls to mitigate chemical attack and extend the life of the structure. The bridges and submerged support structures are also showing signs of corrosion. Following inspection, rehabilitation and coating of these items should be completed to extend their useful life. Two (2) of the drives were replaced in 2015. The remaining four (4) flocculator drives were included within the master plan to be replaced in the 2022-2026 timeframe, beyond the five (5) year outlook.

FIGURE 2-5
Flocculation Basins

2.4 NORTH PLANT PRIMARY SEDIMENTATION

Unit Process Description

Water from the flocculation basins travels to the Primary Sedimentation Basins shown on **Figure 1-1, Area 2** and shown in **Figure 2-6**. Within the primary sedimentation basins, the suspended material, or flocs, settle by gravity which is then removed from the basins by the sludge collector mechanisms and discharged to the Ohio River outfall by way of the North Plant sludge pumps. There are two (2) interconnected primary settling basins, both constructed in 1950's. V-notched weirs around the outside perimeter of the sedimentation basins control the flow of water out of the clarifier allowing the floc particles the proper settling time. The weirs were replaced in 2015 along with the clarifier center drive units in both basins. In early 2019, the support column of Basin No. 1, which was not replaced as part of the 2015 project, failed and caused the basin to be taken out of service. A replacement support column was fabricated and installed. It is likely that Basin No. 2 exhibits the same corrosion issues as Basin No. 1.

Recommended Projects

The center support column and other submerged ferrous components in Basin No. 2 should be replaced similar to the work completed for Basin No. 1. The concrete tank walls are showing signs of concrete surface deterioration. Previous concrete patches are also shown in **Figure 2-7**. To mitigate the risk of structural issues, the concrete structures should be drained, cleaned and inspected for structural integrity with corrective action taken if needed. The bridge within Basin No. 2 is showing signs of corrosion as shown in **Figure 2-8** and should be inspected, repaired, and recoated.

FIGURE 2-6
North Plant Primary Settling Basin

FIGURE 2-7
Concrete Surface Deterioration (Previously Repaired)

FIGURE 2-8
Support Column and Bridge Corrosion

2.5 NORTH PLANT SECONDARY SEDIMENTATION

Unit Process Description

After the water flows over the primary settling basin weirs, it travels by way of the settled water flume, located adjacent to the raw water flume, to the five (5) buried secondary settling basins shown on **Figure 1-1, Area 9**.

Recommended Projects

The effluent flumes and discharge weir boxes to the secondary settling basins were originally constructed with surface grating along with handrails providing a means of safety for accidental falling. Presently, the grating has either corroded beyond repair and are no longer in place. These covers should be replaced due to the safety concerns. In addition, there is a known crack in the wall between Basins Nos. 1 and 2. To mitigate the risk of concrete structural issues, these structures should be drained, structurally inspected and repaired as necessary. The roof of the basins also has access hatches with handrail that should be replaced for safety and venting risk mitigation.

2.6 SOUTH PLANT PRIMARY SEDIMENTATION

Unit Process Description

Raw water is pumped from the LSPS to the South Plant as shown on **Figure 1-1, Area 20**. Raw water sent to the South Plant is distributed through a 42-inch pipe around the plant to the South Plant Primary Sedimentation Basins. Coagulant is added to the raw water prior to entering the primary clarifier and beginning the coagulation and flocculation process. The South Plant primary settling basins are shown in **Figure 2-9**. Unlike the North Plant, the coagulation and flocculation process are combined (picket fence style unit) in the sedimentation basin where flocculation is performed in the center of the basin and primary clarification occurs in the outer circle of the clarifier. The units were constructed in the early 1970's. Minor structural modifications to the center column supports, walkways, and ancillary equipment were replaced approximately 10 years ago; however, no work was completed on the mechanical drive unit or motor.

FIGURE 2-9
South Plant Primary Settling Basins

Recommended Projects

As shown in **Figure 2-10**, the flocculator drives and motors are in poor condition and should be replaced. Additionally, the concrete walls of the settling basins shown in **Figure 2-11** should be inspected for structural integrity. The basins should be drained, cleaned, and submerged ferrous structural and mechanical equipment should be inspected for damage.

FIGURE 2-10
Primary Clarifier Flocculator Drive

FIGURE 2-11
Primary Clarifier Concrete Degradation

2.7 SOUTH PLANT SECONDARY SEDIMENTATION

Unit Process Description

Water flows over the weirs of the primary clarifiers and travels to one of the two secondary clarifiers shown on **Figure 1-1, Area 21** and shown in **Figure 2-12.** Chlorine is injected into the Parshall flume separating the primary and secondary basins. After secondary clarification, the water travels to the south filters through a 54-inch pipe. A static mixer vault is located outside of south filter building where ammonia and caustic are fed.

Recommended Projects

The concrete basins are generally in good condition. It is recommended to drain the tanks and inspect the submerged metal walkway supports, center support column, and steel baffles and if required, repair and recoat to extend life of the assets.

FIGURE 2-12
South Plant Secondary Clarifier

2.8 SOUTH PLANT SLUDGE PUMP STATION

Unit Process Description

The South Sludge Pump Station shown on **Figure 1-1, Area 22**, is located in the center of the four (4) existing sedimentation basins. The pump station draws sludge from the bottom of the four (4) sedimentation basins and discharges to the Ohio River outfall.

Recommended Projects

It is recommended to install a backup sump pump at the station to mitigate basement flooding due to age of existing system. One (1) of the two (2) sludge pumps has been replaced in the last

10 years, it is recommended to replace the second pump and associated electrical controls. The existing condition of the sludge pump is shown in **Figure 2-13.** It is also recommended to structurally inspect, clean and recoat (replace if necessary) corroded piping and ferrous metal stairs, handrail, hatches, supports and similar within the building.

FIGURE 2-13
South Sludge Pump Station Pump Corrosion

2.9 FILTRATION

Unit Process Description

Settled water from both the north and south secondary sedimentation basins flows into one (1) of 36 conventional filter beds. The filter media consists of anthracite, sand, and stone. Currently, there are 16 active gravity filter beds in the North Plant. North Plant filters include filters 13-20, filters 29-32, and filters 33-36 shown on **Figure 1-1, Areas 6, 7, and 10**. Filters 1-12 shown on **Figure 1-1, Area 23**, have been taken out of service because they do not meet 10-States Standards for depth. The remaining filters 21-28 shown on **Figure 1-1, Area 19**, serve the South Plant. Filters are washed from an on-site backwash tank and connected yard piping. A portion of the yard piping is located on the river side of the concrete floodwall posing risk to the wall if the main was to fail.

Recommended Projects

In 2016, the plant started a filter media replacement project as referenced in the water rate case, with the intent to replace filter media in four (4) of the plant's 24 active filters each year to meet the media life-expectancy timeframe. The filter rehabilitations that have occurred within the past three (3) years have shown that many of the clay underdrains are also in poor condition. The plant is now replacing the underdrains as the filter media is exchanged. The plant should continue to complete this annual maintenance until all the filter beds have been rehabilitated to continue efficient operation of the plant and avoid filter bed failures.

It is recommended that the main (yard piping) between the backwash holding tank and each of the filters be relocated outside of the limits of the flood wall so the entirety is located inside the plant facility.

Filters 1-12 have been decommissioned as the filter bed depth is not suitable for use as conventional sand or mixed media filters per 10-States Standards. Wall coating failures in this area are wide spread. Coatings are believed to be a lead-based and, if fully decommissioned or area re-purposed, will need to be abated.

Filters 33-36 are relatively new and require no major repairs within the next five (5) years, however, each of the respective piping galleries associated with filters 13-32 exhibit similar repair needs associated with excessive corrosion of filter gallery piping, actuators, and miscellaneous metals as shown on **Figures 2-14 through 2-16.** The extent of corrosion in each of the galleries is largely a result of inadequate ventilation and humidity control. Additionally, in filters 13-20, there is a cross-connection associated with the vent for the adjacent 1.5 MG clearwell that vents directly into this pipe gallery, contributing to the excessive moisture and chlorine levels in the pipe gallery. Recent air monitoring by staff have shown low available oxygen levels in the pipe gallery of 13-20. For each of the 13-32 filter galleries, dehumidification improvements are recommended to be included as part of the filter gallery upgrade. Piping and equipment showing significant corrosion (in some cases the entire gallery) should be blasted and recoated to extend service life and prevent possible failure.

FIGURE 2-14
Filters 13-20

FIGURE 2-15
Corrosion in Pipe Gallery

FIGURE 2-16
Corrosion in Pipe Gallery

2.10 OUTFALL AND FLOODWALL SYSTEM

Unit Process Description

The plant outfall system consists of five (5) river outfalls with four (4) of these still actively used. The outfalls are the means by which the plant discharges primary and secondary sludge, filter backwash, filter to waste, and on-site stormwater to the river. Under normal river elevations, flow exits the plant via gravity but during elevated river levels a gate is closed in the wetwell, and discharge must be pumped out of the plant. The outfall pump station is located adjacent to filters 13-20 and SCADA controlled discharge gates are modulated based on river levels. Both flood pumps are currently on VFDs. In 2018, an Indiana Department of Environmental Management (IDEM) inspection resulted in the requirement to extend the outfalls to be typically submerged. A project to extend the outfalls was identified and included within the water rate case for completion. The plant is bordered on the river side of the facility by a concrete floodwall that is connected to the earthen levee system extending north and south of the plant site. In the last 10 years the concrete wall was elevated as mandated by the US Army Corps of Engineers (USACE).

Recommended Projects

The outfall extensions are required to comply with IDEM requirements. The status of this project is currently in review with the USACE. The four (4) active outfalls will be extended to the face of the intake structure. The top of each outfall will be approximately two-feet under normal pool elevation of the river.

It is also recommended that the flood pumps be maintained and rehabilitated on a recurring maintenance cycle. The flood pumps are critical to plant operations during periods of high river levels and due to their infrequent use need to have a routine maintenance schedule.

An additional project was included in both the Water Master Plan and the water rate case to line the 36-inch Outfall No. 4; however, this project is no longer recommended as EWSU performed CCTV inspection within the past year and the line appeared to be in satisfactory condition with no rehabilitation required during the five (5) year timeframe.

The concrete floodwall extension cap completed in the last 10 years is showing signs of damage and should be inspected and rehabilitated as necessary to meet future USACE inspections.

2.11 CHEMICAL FEED SYSTEMS

Unit Process Description

For raw water conditioning, the plant uses potassium permanganate, coagulant (Hyper+Ion), caustic (sodium hydroxide), and powder activated carbon (PAC). Potassium permanganate is introduced into the raw water for taste and odor control, reduction of organisms such as zebra mussels, and minimization of disinfection by-product formation. Coagulant is added before the primary sedimentation basins and utilized for the coagulation and flocculation processes. Chlorine is added after the primary sedimentation basins and ammonia and caustic are added after the secondary sedimentation basins to achieve chloramine disinfection and pH adjustments. Caustic is injected into the water prior to entering the filters to remove carbonate and non-carbonate hardness. PAC may be added as an emergency absorbent during spill events on the Ohio River. The existing condition of the Hyper+Ion and caustic chemical feed system are shown in **Figures 2-17 through 2-19**.

FIGURE 2-17
Coagulant Chemical Feed System

FIGURE 2-18
Coagulant Day Tank

FIGURE 2-19
Leaking Caustic Chemical Feed System

For finished water conditioning and disinfection, the plant utilizes ammonium hydroxide, fluoride, and chlorine. Chlorine and ammonia are used for disinfection as previously described. Chlorine is also added to the clearwells to maintain chlorine residual in the finished water discharging into the distribution system via the high service pumps. Fluoride is added to the suction side of the high service pumps. The fluoride day tank and metering pumps are shown in **Figures 2-20 and 2-21**. Both are showing signs of deterioration due to chemical attack. The existing condition of the chlorine and ammonia chemical feed systems are shown in **Figures 2-22 through 2-24**.

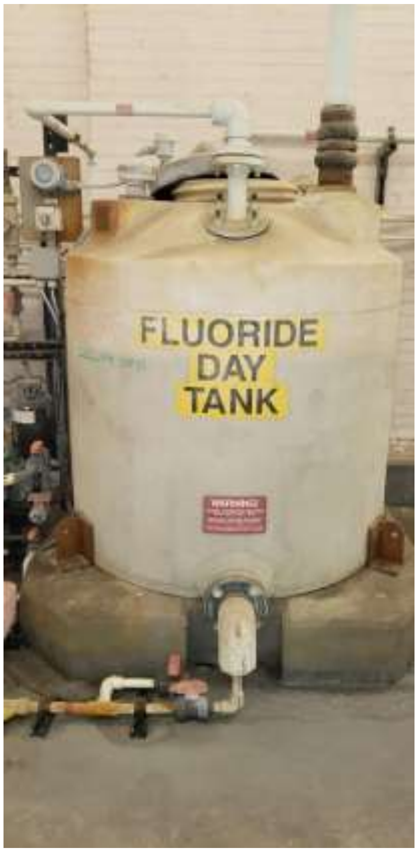


FIGURE 2-20
Fluoride Day Tank

FIGURE 2-21
Fluoride Feed System

FIGURE 2-22
Chlorine Storage Tanks

FIGURE 2-23
Chlorine Feed System

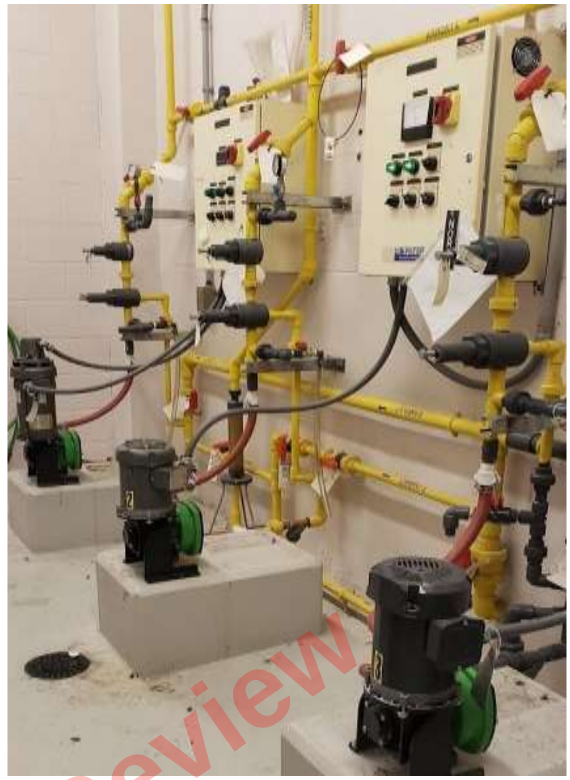


FIGURE 2-24
Ammonia Feed System

Sulfur dioxide is used to dechlorinate backwash discharge. The existing sulfur dioxide chemical feed system is shown in **Figure 2-25**. A sodium chlorite chemical system exists at the treatment plant; however, this chemical has not been used for the past few years.

FIGURE 2-25
Sulfur Dioxide Chemical Feed System

Recommended Projects

With the exception of the chlorine room, all major components of the chemical storage and feed systems have been replaced in the last 12 years and are generally in good shape. It is recommended to continue to monitor each of the chemical feed systems and complete routine maintenance as required. The water master plan has each system scheduled for replacement or rehabilitation in twenty-year timelines which places each system just beyond the five (5) year planning period of this tech memo.

2.12 HIGH SERVICE PUMP STATION NO. 2

Unit Process Description

High Service Pump (HSP) Nos. 4 through 7 are located in High Service Pump Station (HSPS) No. 2 and are shown on **Figure 1-1, Area 14** and shown in **Figure 2-26**. HSP No. 6, shown in **Figure 2-27**, and No. 7 were rebuilt in 2015 and HSP No. 4 was rebuilt in 2018.

FIGURE 2-26
High Service Pump Station No. 2

FIGURE 2-27
High Service Pump No. 6

Recommended Projects

The rebuild of HSP No. 5 is included in the water rate case and should be completed within the next five (5) years. The rehabilitation includes the replacement of the impeller wear rings, repairing the motor (if testing necessitates), and recoating the pump casing and base. Other recommended improvements within HSPS No. 2 include an additional sump pump, recoating the stairs and handrails, and recoating the corroded process piping and equipment as needed.

2.13 HIGH SERVICE PUMP STATION NO. 3

Unit Process Description

HSP Nos. 8 through 10 are located in HSP Station No. 3 as shown on **Figure 1-1, Area 4**. HSP No. 8 was rebuilt in 2006 and HSP No. 9 was rebuilt in 2015, which included the installation of a new motor and replacement of the bowl assembly, shafts, bearings, and couplings. The existing condition of HSPS No. 3 and discharge piping is shown in **Figures 2-28** and **2-29**.

Recommended Projects

It is recommended that the pump and motor rebuild of HSP No. 10 be completed within the next five (5) years. Currently, there is an across-the-line starter for HSP No. 10. It is recommended to replace the current motor starter with a variable frequency drive or eddy current drive as space permits.

Additional improvements to HSPS No. 3 include recoating of the corroded process piping, and equipment as needed, recoating the stairs and handrails, and upgrading or replacing the flow meters on the discharge piping.

FIGURE 2-28
High Service Pump Station No. 3

FIGURE 2-29
Effluent Piping in High Service Pump Station No. 3

2.14 FINISHED WATER STORAGE

Unit Process Description

The plant has three (3) clearwells with capacities of 0.5 million gallons (MG), 1.5 MG, and 6.5 MG. The 0.5 MG clearwell is located below filters 21-28 in the South Plant. The 1.5 MG clearwell is located below the abandoned filters 1-12 in the North Plant and the 6.5 MG clearwell is located underground immediately north of HSPS No. 3. The three (3) clearwells are hydraulically connected via piping allowing water to free flow between them and to HSPS Nos. 2 and 3.

Currently, the 1.5 MG clearwell vents to the filter pipe gallery for filters 1-20. There is poor ventilation in the gallery, resulting in the high chlorine levels and severe corrosion of the pipes. The condition of the filter pipe gallery is a substantial concern as described in the filter section of this chapter. Not only is the piping and mechanical equipment nearing structural failure, there is a significant safety concern for plant staff to do work within the pipe gallery given the low available oxygen levels.

Recommended Projects

As referenced in the 2018 preliminary engineering report, the 6.5 MG clearwell is suspected to have structural concerns. The 6.5 MG clearwell should be inspected for structural damage and repaired as necessary to seal any cracks within the structure. Additionally, it is recommended that the 0.5 MG and 1.5 MG clearwells be inspected to identify repairs to maintain service for the five (5) year period of study.

The vent for the 1.5 MG clearwell needs to be extended to vent exterior to the building. This will mitigate some of the humidity and chlorine level concerns within the pipe gallery for filters 13-20.

2.15 LABORATORY

The laboratory facilities are located in the central complex of buildings. Currently most of the lab equipment such as the mass spectrometer is provided and maintained by the Ohio River Valley Sanitation Commission (ORSANCO) in exchange for being a sampling site and providing data back to ORSANCO.

At this time, there are no recommended projects or major needs associated with the lab beyond typical equipment replacements and any changes required per future regulations over the next five (5) years.

2.16 BOILER / STEAM SYSTEMS

Unit Process Description

The plant heating is comprised of a converted natural gas-fired centralized boiler system located in the head house and electric unit heaters. The boiler/steam heating system consists of two (2) boilers, five (5) condensate pumps, an estimated 36-unit heaters, and all associated piping and valves required for operation. The boilers, as shown in **Figure 2-30**, are manufactured by Cleaver Brooks with one being manufactured in 1963 and the other in 1976. The larger boiler is out of service and no longer used.

FIGURE 2-30
Boilers

Recommended Projects

Many of the components of this system are beyond the intended useful life but are readily available if replacements are needed. The boiler is serviced annually and in general working order. The boiler manufactured in 1963 has been decommissioned. Although no recommendations are proposed to replace the boiler in the next five (5) years, it is recommended to replace the aged and corroded piping and unit heaters shown in **Figures 2-31 and 2-32**.

FIGURE 2-31
Condensate Pump and Steam/Condensate Piping in South Filter Gallery

FIGURE 2-32
Unit Heater in South Filter Building

2.17 STRUCTURAL BUILDING IMPROVEMENTS

Unit Process Description

The majority of the plant building rooftops were replaced in 2006-2007. A synthetic slate roofing was installed at the time and has a 50-year warranty.

Recommended Projects

The roofing of the fluoride room, caustic and ammonia building, the low service and intake structure, and High Service Pump Station 2 will need to be maintained and replaced as needed. These buildings were the only structures that were not rehabilitated during the 2006-2007 roof replacement project.

CHAPTER 3
SUMMARY AND RECOMMENDATIONS

3.1 DEVELOPMENT OF PLAN

The intent of this technical memorandum is to assess the current condition of the existing treatment processes and identify improvements needed for the plant to continue to meet the current and immediate future needs over a five (5) year planning period. As described in **Chapter 1**, the existing water treatment plant was evaluated based on recent visits in addition to reviewing previous reports and the rate case. Projects were prioritized on the basis of items that needs to be completed within the next five (5) years to continue plant operations. Criteria that was used to evaluate projects include: 1) Regulatory Driven 2) Safety 3) Failure Mitigation and 4) Critical Equipment Preventative Maintenance.

3.2 PROPOSED TREATMENT PLANT IMPROVEMENTS

As discussed in **Chapter 2**, most of the existing process infrastructure and mechanical equipment are beyond their intended service life, corroded, or pose structural integrity issues. **Chapter 2** details the evaluation of the process treatment systems and recommended projects for each system. **Table 3.1** summarizes each of the recommended projects proposed, includes the criteria in which projects were analyzed, and identifies the criticality in which projects should be completed.

TABLE 3.1
Project Summary and Recommendations

Area	*Project*	*Description*	*Project Justification Criteria*				*Priority*	*Notes*
			Regulatory Driven	*Safety*	*Failure Mitigation*	*Critical Equipment Preventative Maintenance*		
Low Service Pump Station	Traveling Screen Rebuild	Travelling screen rebuild occurring annually				X	Critical	Rate Case Project
Low Service Pump Station	LS Pump Rebuild	Pump and motor testing and rebuild cycle occurring every 2 years				X	Critical	Rate Case Project
Low Service Pump Station	Intake Dredging	Remove sediment buildup necessary for operation of intake				X	Critical	Rate Case Project

Area	Project	Description	Project Justification Criteria: Regulatory Driven	Safety	Failure Mitigation	Critical Equipment Preventative Maintenance	Priority	Notes
Low Service Pump Station	Actuator Replacement	Replace existing end of life pneumatic actuators with electric actuators			X		High	Staff Request
Low Service Pump Station	Interior Process Coatings	Process piping and valves require structural inspection and coating to extend asset life			X		Low	
Low Service Pump Station	Sump Pump	Back-up sump pump needed to prevent gallery flooding			X		Medium	
Low Service Pump Station	Exterior Structural and Process Coatings	Exterior process piping and walk bridge require structural inspection and coating to extend asset life		X	X		Low	
North Plant Raw Water Flume	Exterior Structural and Process Coatings	Handrail and walk bridge require structural inspection and replacement/coating to extend asset life		X	X		Medium	
North Plant Raw Water Flume	Roof Drain Replacement	Overhead piping extending to flume exhibits severe corrosion		X	X		Medium	Staff Request
North Plant Flocculation Basins	Structural Repair	Handrail and walk bridge require structural inspection and replacement/coating to extend asset life		X	X		Medium	
North Plant Flocculation Basins	Structural Concrete Inspection and Repair	Drain, clean and inspect concrete tanks, perform repairs as necessary			X		Medium	

Area	*Project*	*Description*	*Project Justification Criteria*				*Priority*	*Notes*
			Regulatory Driven	*Safety*	*Failure Mitigation*	*Critical Equipment Preventative Maintenance*		
North Plant Primary Sedimentation Basins	Settling Basin No. 2 Rehabilitation	Replace structural column and submerged ferrous equipment		X	X		Critical	Basin No. 1 failed and repaired in Summer 2019
North Plant Primary Sedimentation Basins	Structural Repair	Handrail and walk bridge require structural inspection and replacement/coating to extend asset life		X	X		High	
North Plant Primary Sedimentation Basins	Structural Concrete Inspection and Repair	Drain, clean and inspect concrete tanks, perform repairs as necessary			X		Medium	
North Plant Secondary Sedimentation Basins	Inlet Covers (at Flume)	Inlet covers exhibit excessive corrosion or are open top and pose safety risk		X	X		High	
North Plant Secondary Sedimentation Basins	Structural Concrete Inspection and Repair	Drain, clean and inspect concrete tanks, perform repairs as necessary			X		Medium	
North Plant Secondary Sedimentation Basins	Roof Grating Replacement	Replace existing tank open roof grating with new safety hatches and venting		X	X		High	
South Plant Primary Sedimentation Basins	Center Column Drive Unit	Center column motor and drive unit replacement			X		Medium	
South Plant Secondary Sedimentation Basins	Corrosion Repair	Drain tanks inspect and repair/coat steel walkway and supports		X	X		Medium	
South Plant Sludge Pump Station	Sump Pump	Backup sump pump required to prevent gallery flooding			X		Medium	

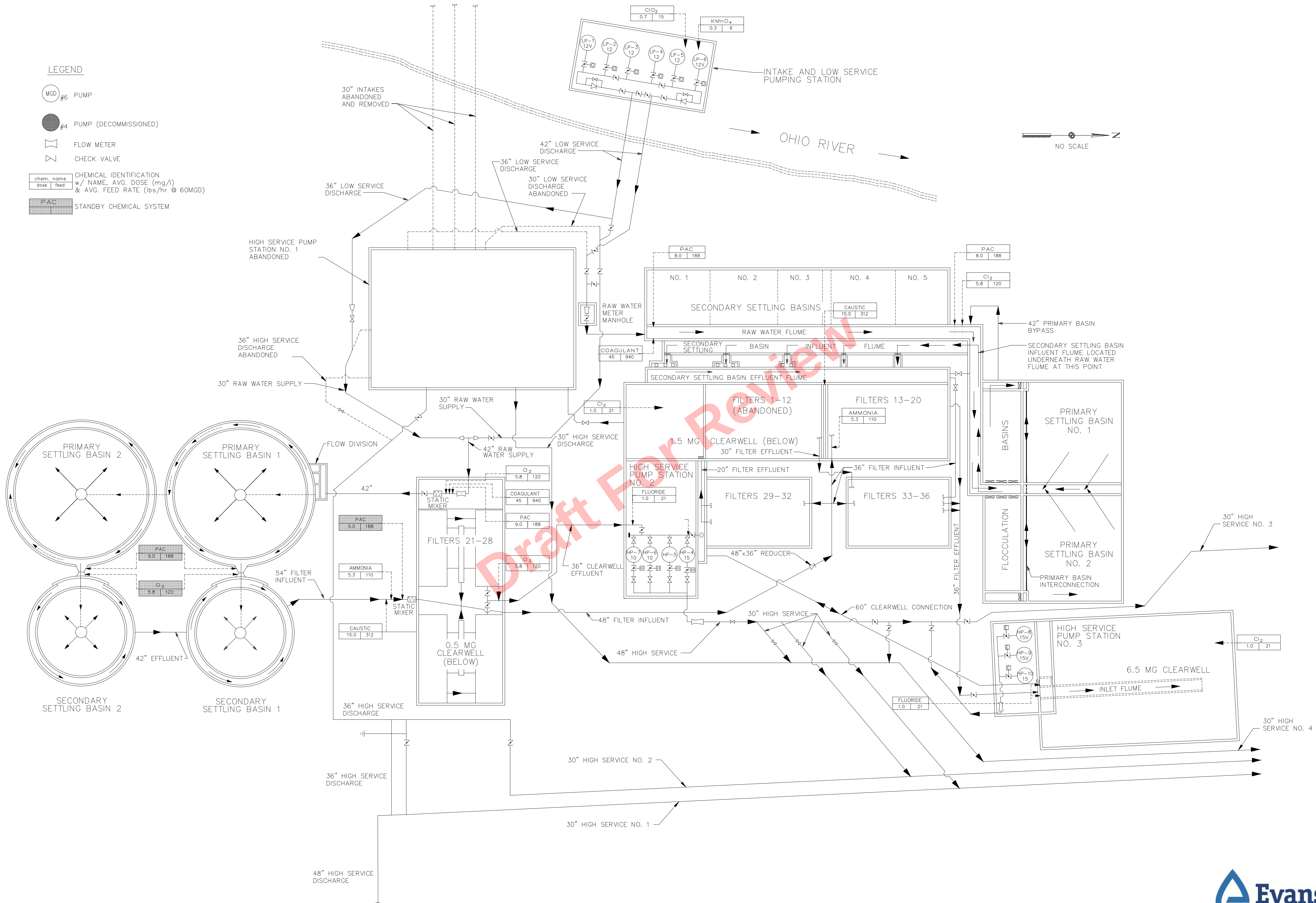
Area	*Project*	*Description*	*Project Justification Criteria*				*Priority*	*Notes*
			Regulatory Driven	*Safety*	*Failure Mitigation*	*Critical Equipment Preventative Maintenance*		
South Plant Sludge Pump Station	Pump Replacement	Replacement of pump and electrical equipment			X		Low	
South Plant Sludge Pump Station	Structural Repair and Process Coatings	Repair or replace structural coatings - handrail, stairs, and hatches		X	X		Low	
Filters 13-20	Media and Underdrain Replacement	Replace aging clay underdrains and remove replace sand and anthracite media			X	X	High	Rate Case Project
Filters 21-28 (South Plant)	Media and Underdrain Replacement	Replace aging clay underdrains and remove replace sand and anthracite media			X	X	High	Rate Case Project
Filter Backwash Watermain	Watermain Relocation	Pothole and replacement of watermain portion partially under levee floodwall		X	X		High	Rate Case Project
Filters 13-20	Ventilation and Dehumidification Equipment	Existing unit non-functioning causing corrosion and chlorine gas exposure		X	X		High	
Filters 13-20	Process Coatings - Piping, Equipment	Piping repair and coating of severely damaged piping			X		High	
Filters 21-28 (South Plant)	Ventilation and Dehumidification Equipment	Existing unit end of life – potential for corrosion and chlorine gas exposure		X	X		Medium	
Filters 21-28 (South Plant)	Process Coatings - Piping, Equipment	Piping repair and coating of corroded piping			X		Medium	
Filters 29-32	Ventilation and Dehumidification Equipment	Existing unit end of life – potential for corrosion and chlorine gas exposure		X	X		Medium	

Area	*Project*	*Description*	*Project Justification Criteria*				*Priority*	*Notes*
			Regulatory Driven	*Safety*	*Failure Mitigation*	*Critical Equipment Preventative Maintenance*		
Filters 29-32	Process Coatings - Piping, Equipment	Piping repair and coating of corroded piping			X		Low	
Filters 33-36	Ventilation and Dehumidification Equipment	Existing unit end of life – potential for corrosion and chlorine gas exposure		X	X		Low	
Filters 33-36	Process Coatings - Piping Equipment	Piping repair and coating of corroded piping			X		Low	
Outfall System	Outfall Extensions	Extend four existing outfalls to 2-feet below normal pool elevation	X				Critical	Rate Case Project
Outfall Pump Station	Flood Pump Maintenance	Pump and motor rebuild required to maintain filter backwash removal during river high levels				X	High	
Floodwall	Concrete Cap Repair	Inspect and repair cracking floodwall cap to comply with future USACE inspections		X	X		High	
High Service Pump Station No. 2	High Service Pump Rebuild	Pump and motor testing and rebuild cycle				X	Critical	Rate Case Project
High Service Pump Station No. 2	Process Coatings - Piping, Equipment	Piping repair and coating of corroded piping			X		Medium	
High Service Pump Station No. 2	Additional Sump Pump	Back-up sump pump required to prevent gallery flooding			X		Medium	
High Service Pump Station No. 2	Structural Coatings - Handrail, Stairs	Handrail and stairs require structural inspection and replacement/coating to extend asset life		X	X		Medium	

Area	Project	Description	Project Justification Criteria: Regulatory Driven	Project Justification Criteria: Safety	Project Justification Criteria: Failure Mitigation	Project Justification Criteria: Critical Equipment Preventative Maintenance	Priority	Notes
High Service Pump Station No. 3	High Service Pump No. 10 Re-Build	Pump and motor testing and rebuild cycle				X	Critical	Rate Case Project
High Service Pump Station No. 3	Process Coatings - Piping, Equipment	Piping repair and coating of corroded piping			X		Medium	
High Service Pump Station No. 3	Flow Metering	Replace end of life flow metering equipment			X		Medium	
High Service Pump Station No. 3	HSP10 Motor Starter	Replace with variable frequency drive or eddy current drive			X		Medium	
High Service Pump Station No. 3	Structural Coatings - Handrail, Stairs	Handrail and stairs require structural inspection and replacement/coating to extend asset life			X		Low	
Clearwells	6.5 MG Structural Inspection and Repair	Inspect and repair as necessary			X		Critical	
Clearwells	1.5 MG Vent Extension	Extend clearwell vent to minimize moisture and chlorine in pipe gallery		X	X		High	Rate Case Project

APPENDIX A

Process Flow Diagram



HNTB

Evansville WATER AND SEWER UTILITY

City of Evansville, IN
Water Treatment Plant Process Flow Diagram

APPENDIX D

IMMEDIATE NEEDS MEMORANDUM:
ELECTRICAL INFRASTUCTURE

EVANSVILLE
WATER AND SEWER UTILITY
EVANSVILLE, INDIANA

WATER TREATMENT PLANT ADVANCED FACILITY PLAN

ELECTRICAL AND I&C TECHNICAL MEMO

HNTB

DECEMBER 2019

EVANSVILLE WATER AND SEWER UTILITY
EVANSVILLE, INDIANA

WATER TREATMENT PLANT
ADVANCED FACILITY PLAN

ELECTRICAL AND I&C
TECHNICAL MEMO

DECEMBER 2019

Prepared by

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(317) 636-4682

HNTB Job No. 74086-PL-001

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Appendix

LIST OF ABBREVIATIONS

AFP	Advanced Facility Plan
EWSU	Evansville Water and Sewer Utility
HDPE	High Density Polyethylene
HSP	High Service Pump
HSPS	High Service Pump Station
HMI	Human Machine Interface
I&C	Instrumentation and Controls
LSP	Low Service Pump
LSPS	Low Service Pump Station
MCC	Motor Control Center
PLC	Program Logic Controller
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
VFD	Variable Frequency Drive
WTP	Water Treatment Plant

CHAPTER 1
INTRODUCTION AND BACKGROUND

1.1 BACKGROUND

The Evansville Water and Sewer Utility (EWSU) surface water treatment plant (WTP) treats raw surface water from the Ohio River and supplies drinking water to the City of Evansville, the majority of Vanderburgh County, and portions of Gibson and Warrick Counties. The WTP is located approximately one (1) mile upstream of downtown Evansville and draws raw water from the Ohio River which is pumped to one (1) of the two (2) interconnected treatment systems, the North Plant and the South Plant. The raw water is chemically conditioned, coagulated, flocculated, and clarified in the primary and secondary sedimentation basins. The settled water enters filtration for removal of small particles and microorganisms, then chemically conditioned and disinfected and finally sent to storage in one (1) of the three (3) clearwells on-site before being pumped into the distribution system from two (2) high service pump stations. A site plan of the WTP is shown in **Figure 1-1**.

1.2 PURPOSE

The purpose of the memo is to evaluate the existing electrical and instrumentation and controls (I&C) systems, review the proposed projects included in the EWSU's water rate case, review prior master planning projects, and summarize the recommended critical improvement projects needed to maintain operation of the WTP over the next five (5) years while the advanced facility plan (AFP), final design, and construction are completed.

The focus of the equipment detailed in **Chapter 2** are the items most critical to WTP operations. The electrical and I&C systems throughout the facility are generally in poor condition with many areas in need of full rehabilitation or replacement. This memo only details the most critical items only and is not a comprehensive listing of all electrical and I&C equipment in need of rehabilitation or replacement.

1.3 ASSUMPTIONS AND REFERENCES

This technical memorandum was developed based on information gathered from recent meetings with EWSU staff and referencing previously submitted planning reports. Previous reports utilized for this memorandum included the following:

- EWSU's 2019-2021 Water Rate Case;
- Water Master Plan, previously prepared by HNTB Corporation, 2016;
- Main Switchgear Emergency Management Plan, prepared by HNTB Corporation, 2016 and;
- Process Technical Memo, concurrently prepared with this tech memo by HNTB Corporation as part of the AECOM Team, 2019.

Projects were largely identified from either the *Water Master Plan*, EWSU's 2019-2021 water rate case, or staff recommendations as discussed during recent site meetings.

Projects were selected based on the criticality of keeping the plant in operation over the next five (5) years. Cost was not considered in selecting projects. Once projects were selected, they were categorized using the following three (3) justification criteria:

- Safety;
- Failure Mitigation; and
- Critical Equipment Preventative Maintenance.

Chapter 2 details the evaluation of the WTP's electrical and I&C systems based upon equipment critical to WTP operations. Please note, this memo excludes the process system and associated mechanical equipment. The evaluation of these systems can be found in the *Process Technical Memo.*

Chapter 3 provides a summary of projects recommended to be completed in the next five (5) years. Each project is sorted by area of the WTP and assigned a priority ranking of 1) Critical 2) High 3) Medium or 4) Low.

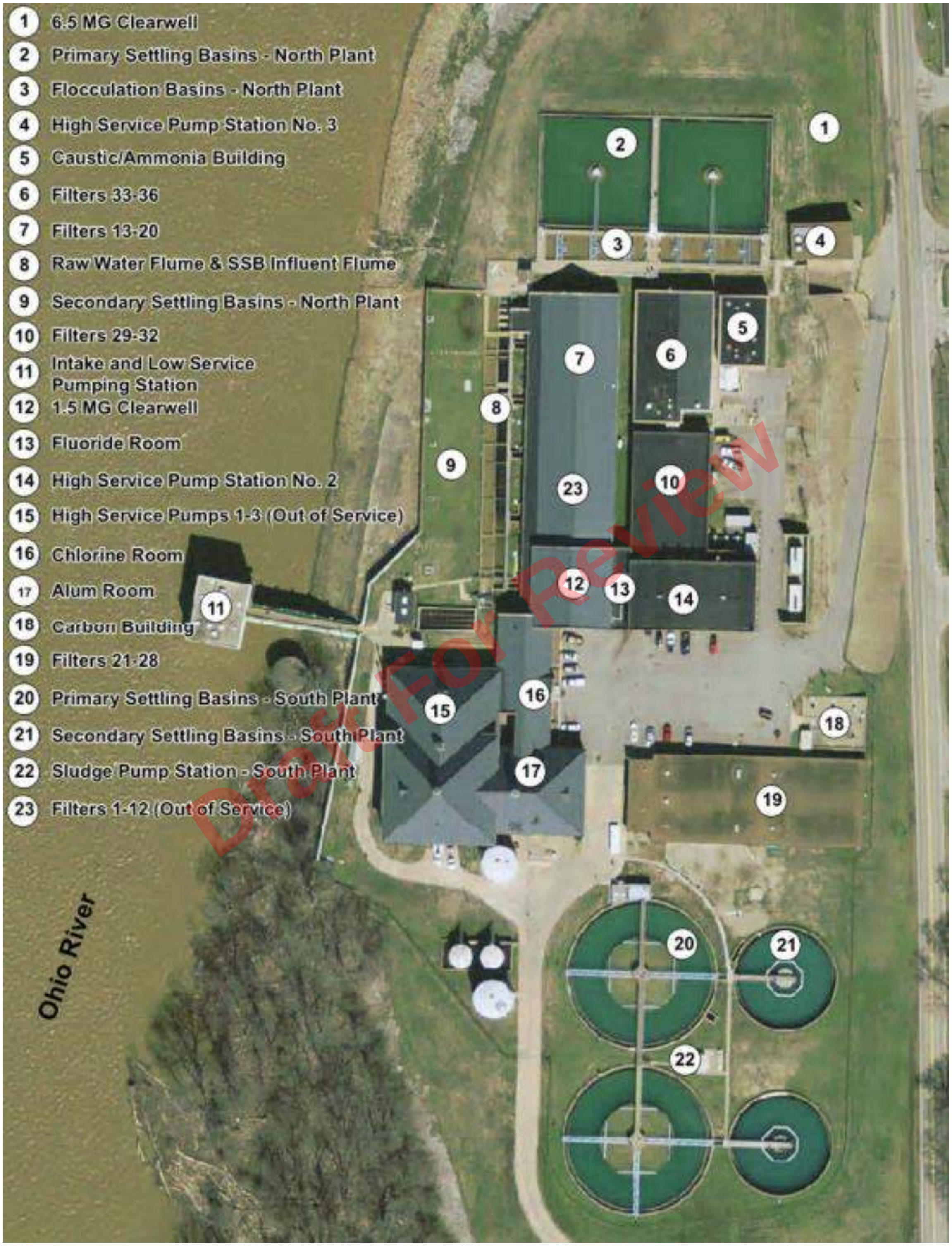


FIGURE 1-1
Site Plan of the Water Treatment Plant

CHAPTER 2
ELECTRICAL AND I&C OVERVIEW

The WTP's electrical and I&C systems consist of infrastructure referenced on **Figure 1-1**. The WTP receives power from two (2) feeds from different substations provided by Vectren Energy through transformers owned and maintained by Vectren Energy. An overview of the electrical system is included in a one-line diagram located in **Appendix A**.

Chapter 2 summarizes the condition of the electrical and I&C equipment in greater detail with respect to the following criteria 1) Regulatory Driven 2) Safety 3) Failure Mitigation or 4) Critical Preventative Maintenance as described in **Chapter 1**.

2.1 MAIN PLANT SWITCHGEAR

Equipment Description

The main 4.16kV plant switchgear (Tag No. MVA) was installed in the 1960's. The main plant switchgear receives power from the dual utility feeds or backup generators and distributes power for all plant equipment.

Recommended Projects

The main plant switchgear is approximately 60 years old and is critical to replace within the next five (5) years. The existing main plant switchgear should be serviced to improve reliability redundancy. It is recommended that the main conductors to and from this switchgear and to the Motor Control Center (MCC) should be tested as well to ensure proper operation.

2.2 MOTOR CONTROL CENTER TRANSFORMERS

Equipment Description

The MCC transformers located in the Low Service Pump Station (LSPS) shown on **Figure 1-1, Area 11** and High Service Pump Station (HSPS) No. 3 shown on **Figure 1-1, Area 4** convert 4160V power to 480V power to be distributed to the building's equipment. The MCCs are composed of legacy or vintage parts that need to be identified and modernized (and spares stored on-site) to increase equipment reliability and mitigate the impact of equipment failure.

Recommended Projects

The MCC transformers are old and due to long equipment replacement lead times, the plant should have a spare transformer onsite to reduce repair times. Providing a spare 300KVA, 4160V/480V dry type transformer allows the plant to continue to operate the MCC without the use of a standby generator. If mounted locally the transformer could be utilized as a backup transformer to some of the smaller 4160V/480V transformers that are in areas not easily accessible.

2.3 GENERATOR AND POWER TRANSFER EQUIPMENT

Equipment Description

The WTP's standby power system is comprised of two (2) 900KVA generators which provide 480V power to the automated generator switchgear power transfer equipment. The automated power transfer system is designed to synchronize the output power of the two (2) generators and supply that power to a 480V to 4160V 2000/2576KVA transformer. This transformer supplies the plant's main switchgear with 4160V power to be distributed to the plant.

Recommended Projects

During a planned Vectren Energy WTP power outage in October 2019, it was discovered the automated power transfer equipment, shown in **Figures 2-1 and 2-2** was inoperable. Due to the age of this equipment and its critical function, this equipment is recommended to be serviced every two (2) years or replaced with more reliable equipment. It is also recommended to purchase or rent a load bank to provide staff with the means to test the functionality of the generator equipment.

FIGURE 2-1
Generator Controls Enclosure

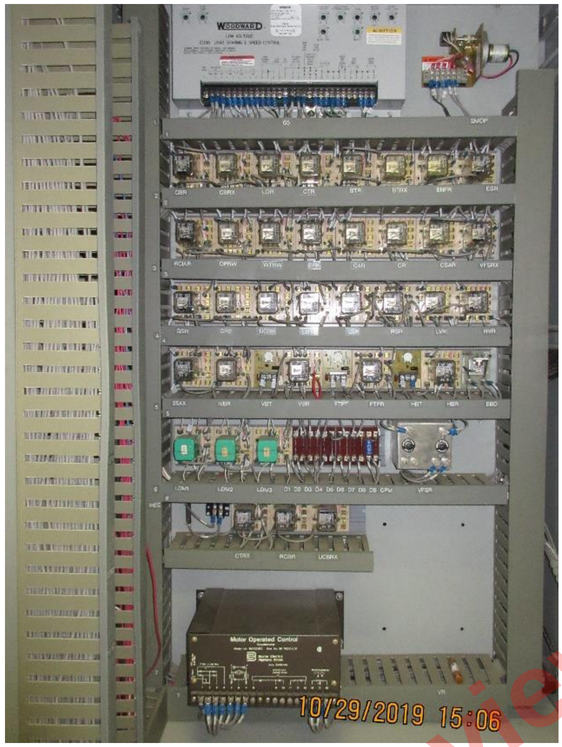


FIGURE 2-2
Generator Control Relays

2.4 BACKUP BATTERY SYSTEMS

Equipment Description

Backup battery systems are located throughout the WTP to provide auxiliary power to the remote terminal units (RTUs). These power supply systems are critical to plant operations during power fluctuations or outages. Staff have reported that the backup battery systems have malfunctioned or have been completely inoperable during recent power fluctuation events. During the planned Vectren Energy power outage in October 2019, several RTU power supplies were damaged do the power fluctuation and required replacement. Many of the RTUs have an uninterruptable power supply attached but are not properly connected. Reference **Figures 2-3 and 2-4** for an example battery backup system for HSPS No. 3.

Recommended Projects

The backup battery systems should be individually tested, evaluated for deficiencies, and repaired or replaced as needed. It is recommended to begin with the systems that directly affect critical plant production processes such as the Supervisory Control and Data Acquisition (SCADA) and RTU backup power supplies. The WTP's RTUs, programmable logic controllers (PLCs), human machine interfaces (HMIs), and analyzer equipment should be provided with enough capacity for a least 6-hours to mitigate the risk of an outage during a catastrophic power systems failure.

The inspections on the backup power supply systems should be completed every six (6) months on backup power supply systems that are five (5) years old or older. Systems that are less than five (5) years old (unless otherwise directed by the manufacturer) should be inspected annually.

FIGURE 2-3
HSPS No. 3's Battery Backup Charging Station

FIGURE 2-4
HSPS No. 3's Batteries for Battery Backup System

2.5 LOW SERVICE PUMP STATION

Electrical Equipment Description

The LSPS switchgear shown in **Figure 2-5**, referenced on **Figure 1-1, Area 11** is utilized both to deenergize electrical equipment for maintenance and to clear downstream faults. The Low Service switchgear feeding the switchboard transformer, Tag No. XFMR MCC-LS, is damaged and in need of repair. Furthermore, the switchgear in this area is not shielded from intrusion of water leaks as shown in **Figure 2-6**. Intrusion of water inside the 4,160-volt switchgear can generate an arc flash capable of extreme injury.

FIGURE 2-5
Low Service Pump Station Switchgear

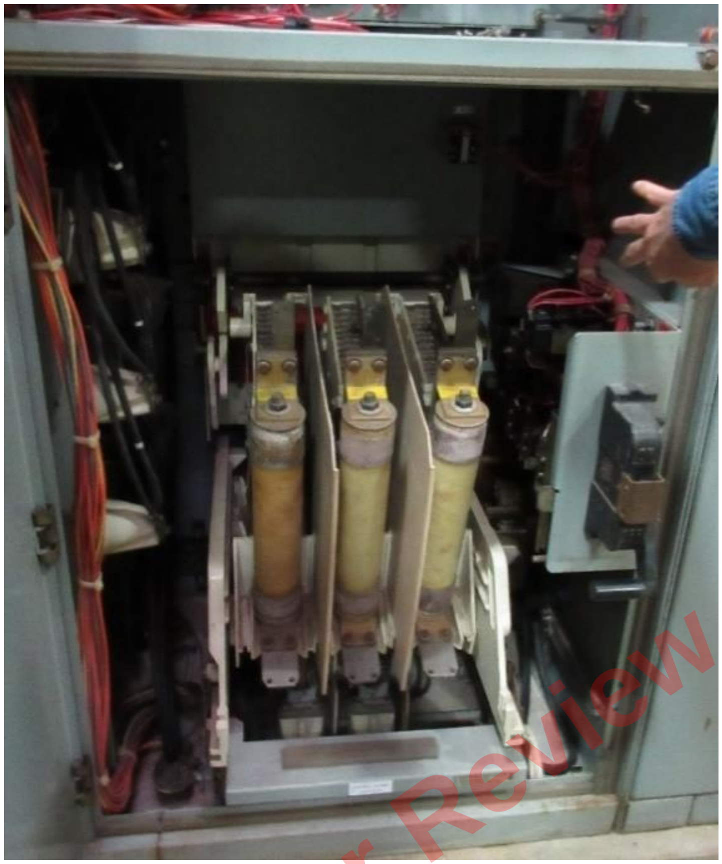


FIGURE 2-6
Possible Water Entry Points During Leak Events

Power for the transformers that supply the LSPS are routed through Switchboard 2A and 2B located in HSPS No. 1 shown on **Figure 1-1, Area 15.** These switchboards are constructed of vintage components that need to be replaced with modern equipment to reliably provide service for the next five (5) years.

Instrumentation & Controls Equipment Description

The pump controls system in the LSPS are over 30 years old and the parts are obsolete and difficult to source. The pump controls are shown in **Figure 2-7**. Due to parts being difficult to source if a part fails, this will leave the station with inoperable controls for extended periods of time. The control system is critical for plant operation and extended failure could directly impact the plant's water production potential.

FIGURE 2-7
Low Service Pump Controls

Recommended Projects

To improve the plant reliability and reduce the risk of arc flash due to water intrusion, the LSPS switchgear should be shielded and upgraded to gas insulated components in place of the existing air insulated components. The installation of active arc mitigation equipment should be considered during this replacement. To improve equipment reliability, the low service MCC should also be serviced.

During a recent inspection, the northern transformer shown in **Figure 2-8** was noticeably warmer to the touch than the other transformer. The temperature difference could be as simple as a low oil level or as severe as a transformer failure. Both transformers should be further evaluated and serviced as required. Additionally, to improve equipment reliability, switchboards 2A and 2B located within HSPS No. 1 should have the equipment replaced with modern components.

FIGURE 2-8
LSPS Transformer

It is recommended to update the obsolete I&C equipment by identifying replacement parts for each control system and then replacing all the components in one (1) pump control panel at a time as they become available for service. Tying in the existing control relay logic with the modern relay control logic will allow staff to continue to maintain the equipment. Another option that may require additional training for staff would be to replace with a single RTU but training is critical to ensure future maintenance and repairs are completed properly.

2.6 NORTH PLANT PRIMARY SETTLING BASINS

Equipment Description

SCADA communication to the North Primary Settling Basin drives is currently being performed through radio equipment. While the distance from the basin transmitter and the RTU receiver is short, there is a considerable amount of signal loss, influencing the accuracy of the data collected to monitor the basins.

Recommended Projects

There are known process and structural issues with Basin No. 2, covered in greater detail in the *Process Technical Memo*. It is recommended that the drive status be closely monitored until replacement has occurred. The signal loss issues should be further identified and resolved to make monitoring status more reliable.

2.7 FILTRATION

Equipment Description

There are 36 filter beds within the treatment plant, 16 of which are active in the North Plant and eight (8) that are active in the South Plant. The North Plant filters include filters 13-20, filters 29-32, and filters 33-36 shown on **Figure 1-1, Areas 6,7, and 10.** Filters 1-12 shown on **Figure 1-1, Area 23**, have been taken out of service. The remaining filters 21-28 shown on **Figure 1-1, Area 19**, serve the South Plant. For the filters, the majority of the electrical and I&C equipment is located within the filter pipe galleries and is extremely critical to the plant in providing SCADA data and monitoring plant operation. Much of this equipment is corroded due to poor ventilation and dehumidification as shown in **Figures 2-9 through 2-11**.

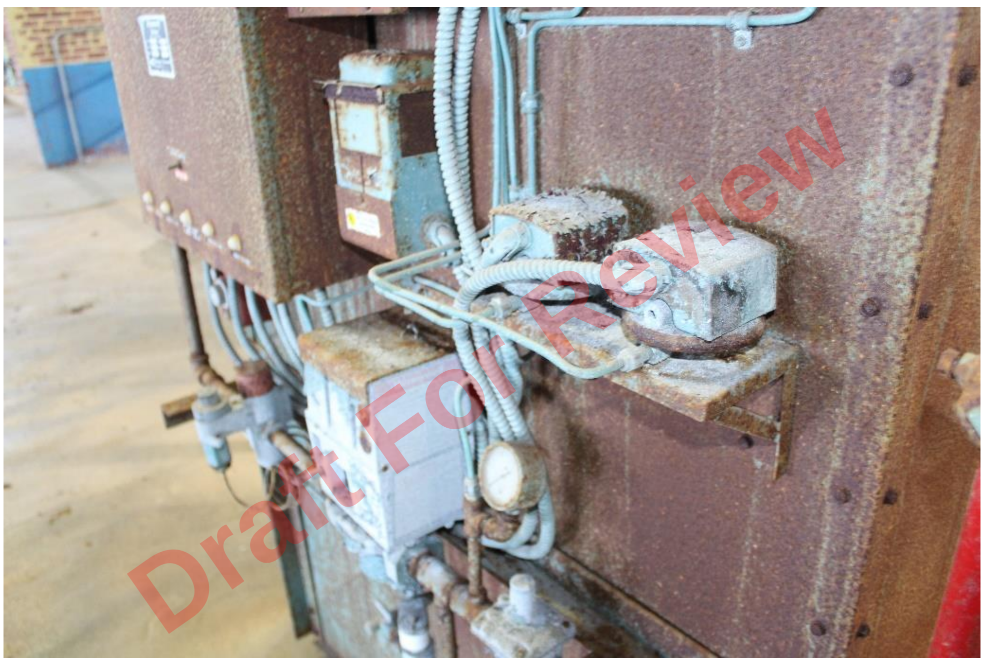


FIGURE 2-9
Exposed Electrical Equipment Corrosion

It was noted that the actuator power supply cables located in the filter galleries do not comply with the NEC Section 400.7 for Flexible Cords and Cables. The supply cables are shown in **Figure 2-12.** Staff have indicated that the power supply cables have failed in the past, likely due to the excessively moist condition of the area. Refer to **Figure 2-13** for an example of one of the cables that have failed.

FIGURE 2-10
Electrical Enclosure Corrosion

FIGURE 2-11
Pipe Gallery Controls Corrosion

FIGURE 2-12
Flexible Cables

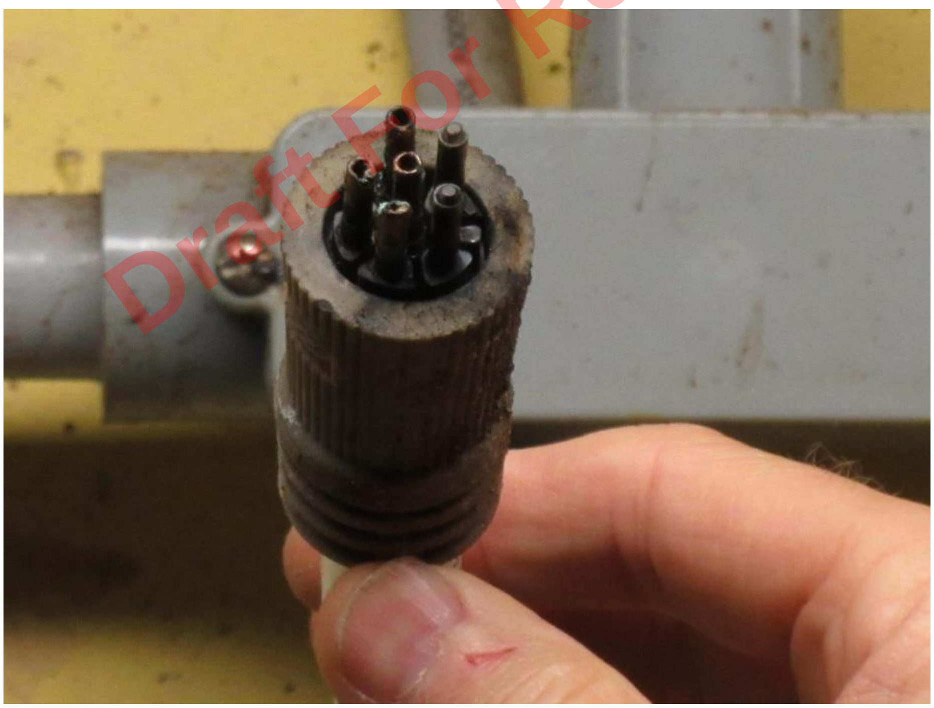


FIGURE 2-13
Flexible Cable Failure

Recommended Projects

The exposed electrical equipment needs to be rehabilitated or replaced once sufficient ventilation systems are installed within the filter pipe galleries. Further discussion of recommended ventilation and dehumidification system improvements can be found in the *Process Tech Memo*. The power supply cables within the pipe gallery should be replaced with the appropriate power supply wiring system to avoid additional cable failures. Spare cables should be considered for emergency situations. Each of the I&C components within the filter and pipe galleries should be evaluated and replaced immediately, to provide adequate and reliable process control and management.

2.8 HIGH SERVICE PUMP STATION NO. 2

Equipment Description

The electrical equipment within HSPS No. 2 shown on **Figure 1-1**, **Area 14** is exposed to the extreme temperature fluctuations throughout the year. These temperature fluctuations and lack of dehumidification have likely shortened the life of the electrical equipment in the area. Specifically, the variable frequency drive (VFD) for High Service Pump (HSP) No. 5 shown in **Figure 2-14** is beyond its useful life due to the extreme environment in which it resides. The VFDs for HSP Nos. 6 and 7 were installed during the 2014 pump rebuild project.

FIGURE 2-14
VFD for HSP No. 5

The pump flow meters shown in **Figures 2-15 and 2-16** are malfunctioning and are unreliable. Staff does not trust the accuracy of the data provided leading to uncertainty in plant production.

FIGURE 2-15
HSP No. 7's Flow Sensor

FIGURE 2-16
HSP No. 7's Flow Meter

The existing HSP emergency discharge valve closure system shown in **Figure 2-17** is hydraulically operated with an open/close function only. This system has internal leaks and is beyond its useful life. Currently, staff do not have visual confirmation of open/close status for each pump discharge valve to ensure proper operation. The open/close status of the HSP discharge valves is critical to know to avoid prematurely opening valves causing pump wear and system faults. Discharge valves not closing completely can cause the pump to spin backward which may cause pump overload failures or broken input shaft couplers.

FIGURE 2-17
Emergency Valve Closure System Water Storage Tanks

Recommended Projects

It is recommended to replace the VFD for HSP No. 5 to ensure continual pump operability and continue to inspect and maintain the VFD on an annual basis. It would be beneficial to the plant if the equipment within the HSPS No. 2 electrical area was enclosed to better control the temperature conditions and reduce the maintenance on the HSP VFDs. Transformers T1 and T2 have not been serviced per manufactures specification and therefore should be serviced. HSP Nos. 6 and 7s VFDs have not been serviced as per manufacturers specifications and need to be serviced on an annual basis. Switchboard 1 should be serviced to increase reliability. The emergency discharge valve closure system should be replaced and changed to an electric actuator system with an uninterruptable power supply system. This would greatly increase the functionality, reliability, and maintainability of the system. The power panels should be evaluated and serviced as needed. Finally, the seizing Babbitt Bearing on HSP No. 6 grounding needs to be inspected and corrected to reduce bearing wear.

Regarding I&C equipment, the pump flow meters are recommended to be replaced. Without proper flow data the pumps performance cannot be properly assessed and knowing that the pump is discharging provides instantaneous conformation that discharge valves are open and the pump is spinning in the correct direction. Discharge rate in gallons is a better indication of pump wear than pump run time.

The pump discharge valve actuators should be augmented to include proportional position sensors to inform operators when the valves are malfunctioning and be scheduled for routine annual maintenance. Proportional position feedback would allow SCADA to be programed to allow a percentage open and a percentage closed permissive, which would increase pump permissive control reliability. Proportional position feedback would also give operators instantaneous conformation that the valve has started to actuate and continues to actuate in the correct direction. This information could also be utilized by the SCADA alarms to set up alarm urgency based on the valve failed position.

2.9 HIGH SERVICE PUMP STATION NO. 3

Equipment Description

The electrical equipment located in HSPS No. 3 shown on **Figure 1-1**, **Area 4** is located primarily on the upper level of the station. The General Electric Limitamp Model switchgear shown in **Figure 2-18** has exceeded its life and is now obsolete. The main power equipment, Tag No. MVB, is a lineup of medium voltage, 4160 volts, switchgear/MCC units. The switchgear was last shut down for cleaning and maintenance, recommended every 3 to 5 years by the manufacturer. Despite the maintenance performed, staff indicated that the switchgear has cabinet safety interlock issues that should be resolved. Similarly to the LSPS switchgear, the switchgear located within HSPS No. 3 is not shielded from water spray presenting risks of arc flash.

FIGURE 2-18
HSPS No. 3 Switchgear

HSPS No. 3's emergency discharge valve closure systems have exceeded their anticipated useful life. The uninterruptable power supply system is no longer functional. The electric actuators have several issues including being mismatched, limit torque trip issues, and they are heavily worn. Similarly to HSPS No. 2, the pump discharge valve actuators, shown in **Figure 2-19**, do not have a clear indication of valve position to indicate proper valve operability outside of a valve fault.

FIGURE 2-19
HSPS No. 3 Discharge Valve Actuators

HSP Nos. 8, 9, and 10 located within HSPS No. 3, require routine annual maintenance and repairs. The VFD for HSP No. 8 is nearing end of life. HSP No. 9 has an eddy current drive installed in 2014. All three (3) HSPs should be inspected and serviced annually to ensure continuous operation. There are no individual pump discharge flow meters installed on any of the pumps.

The MCC shown in **Figure 2-20** is obsolete and staff deem unreliable. Parts for this MCC are difficult to source and could leave the station with inoperable control systems for extended periods of time. An example of one of the recent failures of this system is in 2018 a timer relay failure on HSP No. 10 rendering the pump inoperable until parts could be sourced to replace the broken equipment.

FIGURE 2-20
HSPS No. 3 Pump Controls

Recommended Projects

It is recommended that the HSPS No. 3 switchgear be replaced to increase safety and equipment reliability. It is also recommended to service the MCC every two years to increase reliability. The VFD for HSP No. 8 should be evaluated and serviced to mitigate the risk of an unexpected drive failure. HSP No. 9's eddy current drive and HSP No. 10 need to undergo the proper annual maintenance to mitigate risk of pump failure. A similar replacement project for the discharge valve closure system as that recommended for HSPS No. 2 should be installed at HSPS No. 3 as well. This replacement project is recommended to include an electrically actuated system with uninterruptable power supply.

Recommendations for the I&C equipment include the installation of individual pump discharge flow meters. The pump discharge valve actuators should be augmented with position proportional feedback to allow staff to verify know the valve position and to verify proper operation. The components within the pump control system shall be further evaluated for condition and if needed, obsolete components shall be replaced with modern parts.

2.10 CHLORINE ROOM

Equipment Description

The chlorine feed rates are currently monitored visually by staff at the individual chlorinators. The chlorinators have the ability to communicate their operational information to SCADA, but this is not currently utilized.

Recommended Projects

The appropriate automation and controls should be added to the chlorinators and monitoring equipment to improve performance and mitigate the safety risk of an error with the set point for each chlorinator.

2.11 SCADA

Equipment Description

The SCADA server is several years old and has no redundancy. While the WTP can be operated manually, due to the size of the WTP and the complex systems in place it would be extremely challenging for staff to undertake should a failure of the SCADA system occur.

Recommended Projects

A backup SCADA server is recommended which will mitigate the risk of an extended SCADA system outage. The SCADA client PCs are several years old and in need of upgrading to efficiently run the systems. It is recommended that the computers and servers associated with the SCADA system be serviced every two years to minimize risk of failure in the future. Backup systems for these computers and servers should be implemented and regularly monitored.

In the event of a catastrophic power system failure, the SCADA battery backup system should have enough capacity for at least a six (6) hour outage. This amount of time will allow for the implementation of the *Main Switchgear Emergency Management Plan*, which will mitigate the loss of SCADA during a crisis.

2.12 HACH SC100 UNIVERSAL CONTROLLERS

Equipment Description

Located throughout the WTP are Hach SC100 universal controllers for the sensors located at the WTP. The controllers provide plant staff with the required process feedback information to allow for the proper process management. The Hach SC100 controllers are obsolete and no longer supported. There are an estimated 18 SC100 units in use remaining at the WTP.

Recommended Projects

It is recommended that all remaining SC100 units be replaced with the newer SC200 units to increase plant water product reliability.

CHAPTER 3
SUMMARY AND RECOMMENDATIONS

3.1 DEVELOPMENT OF PLAN

The intent of this technical memorandum is to assess the condition of the existing treatment plant electrical and I&C systems and identify improvements needed to meet the current and immediate future needs over a five (5) year planning period. As described in **Chapter 1**, the existing water treatment plant was evaluated based on recent visits in addition to reviewing previous reports and the rate case. Projects were prioritized on the basis of items that needs to be completed within the next five (5) years to continue plant operations. Criteria that was used to evaluate projects include: 1) Safety 2) Failure Mitigation and 3) Critical Equipment Preventative Maintenance.

3.2 PROPOSED TREATMENT PLANT IMPROVEMENTS

As discussed in **Chapters 2**, most of the existing electrical and I&C systems and equipment are beyond their intended service life, are obsolete, corroded, or not in compliance with current safety standards. **Chapter 2** details the evaluation of the electrical and I&C systems and recommend projects for each system. **Table 3.1** summarizes each of the recommended projects proposed, includes the criteria in which projects were analyzed, and identifies the criticality in which projects should be completed.

TABLE 3.1
Project Summary and Recommendations

Area	Project	Description	*Project Criteria*			Priority
			Safety	*Failure Mitigation*	*Critical Equipment Preventative Maintenance*	
Main Plant	Main Plant Switchgear	Install new main plant switchgear. Existing switchgear to serve as future backup.	X	X		Critical
Main Plant	Generator Testing	Install Load Bank for Generator Testing		X		High
Main Plant	Main Plant Switchgear	Service existing switchgear.		X		High

Area	Project	Description	*Project Criteria*			Priority
			Safety	*Failure Mitigation*	*Critical Equipment Preventative Maintenance*	
Main Plant	Generator Service	Service generator and generator subsystems		X		High
Low Service Pump Station	Low Service Switchgear	Complete replacement of existing LSPS switchgear	X	X		Critical
Low Service Pump Station	MCC	Service existing MCC to extend life		X	X	High
Low Service Pump Station	Pump Control Systems	Replacement of system. Anticipated as a PLC solution.		X		High
Low Service Pump Station	LSP Drives	Service LSP VFDs at recommended schedule		X	X	Medium
Low Service Pump Station	LSPS Transformers	Service T3 and T4 transformers located along flood wall.	X	X		High
South Plant Sludge Pump Station	Electrical System	Evaluate condition and serviceability of existing electrical systems		X		Medium
Filters 13-20 Pipe Gallery	Enclosure Replacements	Replace corroded electrical enclosures once dehumidification projects completed	X	X		Medium
Filters 21-28 Pipe Gallery	Enclosures	Replace severely corroded electrical enclosures	X	X		High
Filters 21-28 Pipe Gallery	Service MCC	Service existing MCC to extend life		X	X	High
Filters 13-20 and 29-32 Pipe Galleries	Equipment Replacement	Replace corroded electrical enclosures once dehumidification projects completed		X		Low

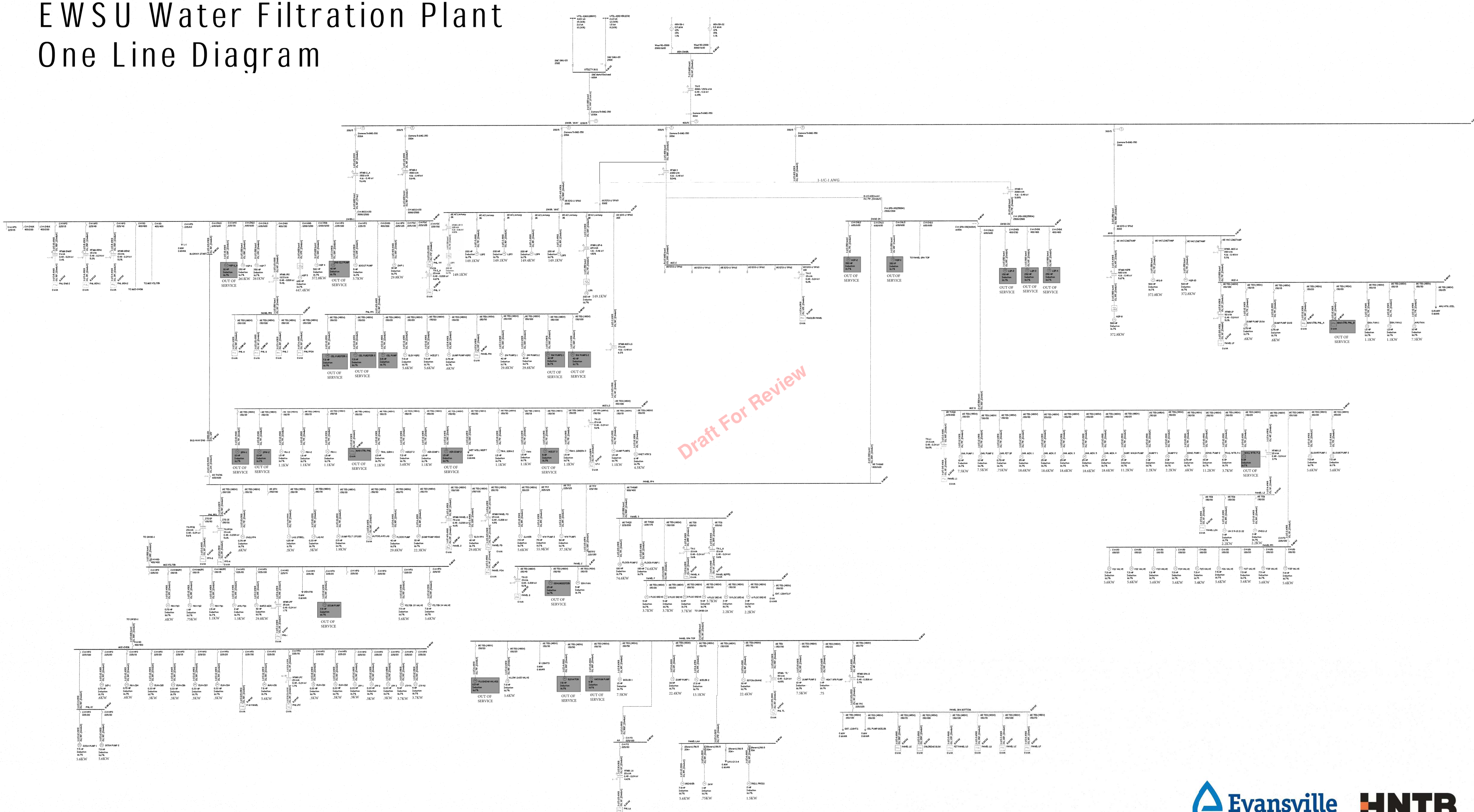
Area	Project	Description	*Project Criteria* *Safety*	*Failure Mitigation*	*Critical Equipment Preventative Maintenance*	Priority
Filters 29-32 Pipe Gallery	Power Cables	Replace flexible power cables with equipment meeting current standards		X		Medium
High Service Pump Station No. 1	Service Switchboards	Service switchboard Nos. 2 A and B		X		Medium
High Service Pump Station No. 2	Emergency Discharge Valve Closure System	Replace hydraulic system with electrically actuated system		X		Medium
High Service Pump Station No. 2	HSP5 Drive	Replace HSP5 VFD		X		Medium
High Service Pump Station No. 2	Service Switchboard	Service switchboard No. 1 to extend life		X		Medium
High Service Pump Station No. 2	Panels	Service panel PP1 to extend life		X		Medium
High Service Pump Station No. 2	VFD and Electrical Equipment	Enclose existing VFDs and electrical equipment for more stable environment		X		Low
High Service Pump Station No. 2	HSPS No. 2 Transformers	Service T1 and T2 transformers		X	X	Low
High Service Pump Station No. 2	HSP6 and HSP7 VFDs	Service VFDs to extend life		X	X	Low
High Service Pump Station No. 3	HSPS No. 3 Switchgear	Complete replacement of existing HSPS No. 3 switchgear	X	X		Critical
High Service Pump Station No. 3	MCC	Service existing MCC to extend life		X	X	High
High Service Pump Station No. 3	Pump Control Systems	Replacement of system. Anticipated as a PLC solution.		X		High

Area	Project	Description	Project Criteria: Safety	Project Criteria: Failure Mitigation	Project Criteria: Critical Equipment Preventative Maintenance	Priority
High Service Pump Station No. 3	Emergency Discharge Valve Closure System	Replace hydraulic system with electrically actuated system		X		Medium
High Service Pump Station No. 3	HSP9 Drive	Service HSP9 eddy current drive at manufacturer recommended schedule		X	X	Medium
High Service Pump Station No. 3	HSP8 Drive	Service HSP8 VFD at manufacturer recommended schedule		X	X	Medium
Operations Office	SCADA System	Upgrade SCADA server and clients. Provide backup server for redundancy		X	X	High
Near Operations Office	Panels	Service Panel PP2		X	X	High
Near Flood Pumps	Panels	Service Panel 3		X	X	High
Near the 1.5MG Clearwell	Panels	Service Panel PP4		X	X	High
Various Locations	Battery Backups	Upgrade SCADA and RTU emergency power systems		X		Critical
Various Locations	Universal Controllers	Replace Hach SC100 units with SC200 units		X		Medium

APPENDIX A

EWSU Water Filtration Plant
One Line Diagram

EWSU Water Filtration Plant One Line Diagram



Evansville WATER AND SEWER UTILITY

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