UV DISINFECTION COST STUDY

Cost Study Report

FOR

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

VOLUME 1 OF 2

NORTH SIDE WATER RECLAMATION PLANT

January 31, 2008

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MWRDGC Project No. 07-026-2P
CTE Project No. 60026610

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EXECUTIVE SUMMARY

Introduction

The Technical Memorandum 1WQ Disinfection Evaluation (TM1-WQ) was completed in August 2005 for the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC or District) as part of the comprehensive Infrastructure and Process Needs Feasibility Study (Master Plan) for the North Side Water Reclamation Plant (NSWRP) and a Water Quality (WQ) Strategy for affected Chicago Area Waterways. The TM1-WQ reviewed the alternative disinfection technologies available for use at the District's North Side, Calumet and Stickney Water Reclamation Plants and provided an initial estimate of possible construction cost for the facilities. On the basis of that report the District requested further investigation into UV disinfection. The findings of the Preliminary Cost Opinion for Ultraviolet (UV) Disinfection Facilities Study at the North Side Water Reclamation Plant are presented in this Report.

Objectives

This evaluation is based upon the TM1-WQ, the comments received from the USEPA as part of the Use Attainability Analysis (UAA) evaluations, and new information obtained since the previous work. The primary objectives of the evaluation presented in this report are:

- To describe the conceptual facilities developed as part of this study including their basis of design and the assumptions used for their development
- To develop a Level 3 Preliminary Opinion of Probable Construction Cost per the Association for the Advancement of Cost Engineering recommended practices for the proposed facilities at NSWRP
- To develop annual maintenance and operations (M&O) costs for the facilities
- To use the costs developed for NSWRP UV Disinfection Facilities to project the costs for similar facilities at the Calumet Water Reclamation Plant (CWRP)

Proposed Facilities

The study reviewed the proposed facilities for the UV Disinfection Alternative included in TM-1WQ including the four primary components: site work, a low lift pump station, tertiary filters, and UV disinfection. Through that review, it was determined that the low lift pump station and the tertiary filters required re-evaluation.

At the time TM-1WQ was developed, very little information was available regarding the water quality of the plant effluent as it related to ultraviolet light transmissivity, and the that data was available indicated low transmissivity levels. Because of the conceptual nature of TM-1WQ, tertiary filters were included in initial proposed facilities in order to improve disinfection effectiveness by removing water components that would inhibit the disinfection process, although costs were also provided without tertiary filters. Since that time, additional water quality data has been collected by the District and review of that data indicates that UV transmissivity is within the minimum range necessary for UV disinfection without filtration. Therefore, tertiary filters are not included in the proposed facilities presented in this report. However, the exclusion of tertiary filters from this report should not suggest that tertiary filters would not be required in the future to meet stricter suspended solids or phosphorous limits, or that tertiary filters would not improve the effectiveness of a UV disinfection process. As concluded in the NSWRP Master Plan, space would be reserved on the site for future tertiary filter facilities.

Because tertiary filters would not be required to be added as part of the implementation of UV disinfection, the need for a low lift pump station was questioned. Additional pumping would be required only if the head losses added by the UV Disinfection Facilities and associated flow conduits and flow splitting structures exceed the available head at the plant. To determine the additional head losses, a hydraulics evaluation was performed**.**

Hydraulics

The hydraulic model developed for the Master Plan was modified to include the additional effluent conduits, gate structures, and UV channels/reactors. The model was used to determine the actual head losses expected following implementation of the UV Disinfection Facilities. The results of this evaluation showed conclusively that projected head loss through the plant exceeded the available head at the plant by over 1.5 feet and, therefore, identified the need for a Low Lift Pump Station (LLPS) in order to treat peak flows at the 100-year flood elevation once the UV disinfection system was installed.

Disinfection Technology

The Trojan UV4000™Plus system was used to develop the basis of design for the UV disinfection system at the NSWRP due to the lower number of lamps required compared to other systems and the recommendations of a team of disinfection experts that evaluated the available technologies during the Master Plan effort. During this study, the details of the implementation of this UV technology were updated by consultation with the manufacturer and incorporated into the basis of design. In addition, a phone survey of other facilities of similar size and source water quality was conducted. This survey revealed several important conclusions including the following:

- When using ferric salt addition for improved settleability of solids in the treatment process upstream of UV disinfection (similar to the NSWRP Master Plan's recommendation for future phosphorous removal), an increase in the fouling rate was experienced.
- The level of maintenance and operations efforts was highly variable and site specific, even with plants using the same technology and source water.
- The most effective method of power control for the UV system is highly site specific and has a great impact on the disinfection effectiveness and the energy effectiveness of the system.

Due to the size of the proposed NSWRP UV Disinfection Facilities, which would be among the largest continually-operating UV disinfection systems in the world, CTE recommends the District undertake an extensive design program which includes review of system specific independent validation studies, collimated beam testing, UV transmittance testing, and a reasonably sized pilot facility. This program would determine, among other factors, the following information in-situ:

- Appropriate control sequences and optimization for the UV disinfection equipment, including appropriate sensing equipment to allow advanced power management
- In-situ disinfection performance including fouling rates or the lamps with and without ferric salt addition
- Actual M&O requirements in terms of labor and consumables as well as space requirements to complete required maintenance activities

Site Constraints

As part of the study, a proposed layout of the disinfection facilities at NSWRP was developed including the Low Lift Pump Station, UV Disinfection Facilities, related gate structures/effluent conduits, and space reserved for future tertiary filters (See **Figure ES-1** and Volume 2 of this report). Due to existing constraints of the site, several significant civil improvements would be required. At the NSWRP, the proposed facilities would extend into the existing CTA railway embankment and therefore, temporary sheeting and a permanent retaining wall would be required to support the railway embankment. These works would need to be coordinated with the CTA to minimize disruption. In addition, due to existing geotechnical conditions in the area available for the UV Disinfection Facilities, deep foundations would be required for the proposed structures. These required civil improvements add significant complexity and cost to the proposed project.

Preliminary Cost Opinion

The preliminary opinion of probable construction cost (OPCC) for NSWRP and CWRP UV Disinfection Facilities is shown in **Table ES-1** below. As shown, the projected construction cost for the NSWRP UV Disinfection facilities is $108.8 million and the projected construction cost for the CWRP UV Disinfection facilities is $109.4 million.

Due to the essential similarities between the proposed disinfection facilities for the two sites, the OPCC was developed for NSWRP and then adjusted for the CWRP. To estimate the costs for the UV Disinfection Facilities at CWRP, CTE deducted the costs for the deep foundations required at NSWRP, multiplied the remaining capital cost estimate by the ratio of 480 MGD to 450 MGD, and added the cost for demolishing the existing chlorine contact chambers. The details of the basis of design for the proposed facilities and the methods of developing the OPCC are presented in the body of this report.

Table ES-1 – NSWRP & CWRP UV Disinfection Facilities Preliminary OPCC and M&O Costs

Capital Cost Estimates			
	North Side WRP	**Calumet WRP**	**Total**
NSWRP UV Pilot Plant	$2,200,000	-	$2,200,000
ComEd Service Upgrade	$2,900,000	$130,000	$3,030,000
A. General Sitework	$27,200,000	$27,800,000	$55,000,000
B. Low Lift Pump Station	$27,000,000	$28,800,000	$55,800,000
C. Disinfection System	$49,500,000	$52,800,000	$102,300,000
Total Capital Cost	$108,800,000	$109,530,000	$218,330,000
Maintenance & Operations Cost Estimates			
A. General Sitework	$130,000/yr	$130,000/yr	$260,000/yr
B. Low Lift Pump Station	$1,100,000/yr	$890,000/yr	$1,980,000/yr
C. Disinfection System	$3,590,000/yr	$3,490,000/yr	$7,090,000/yr
Total Annual M&O Cost	$4,830,000/yr	$4,520,000/yr	$9,330,000/yr
Total Present Worth M&O Cost	$111,900,000	$104,600,000	$216,000,000
Total Present Worth	$220,700,000	$214,100,000	$434,800,000

All costs in 2007 dollars.

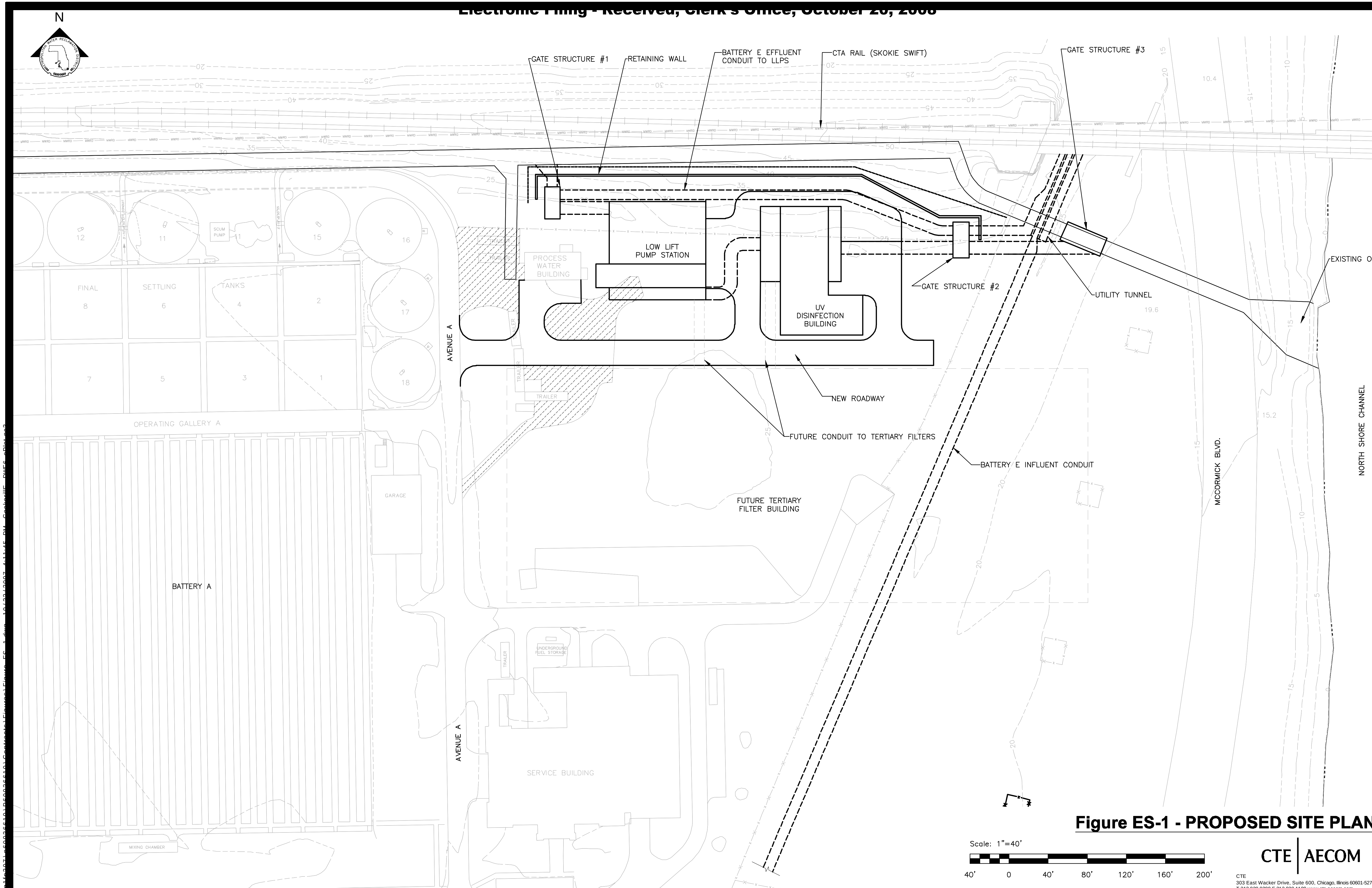

Figure ES-1 - PROPOSED SITE PLAN

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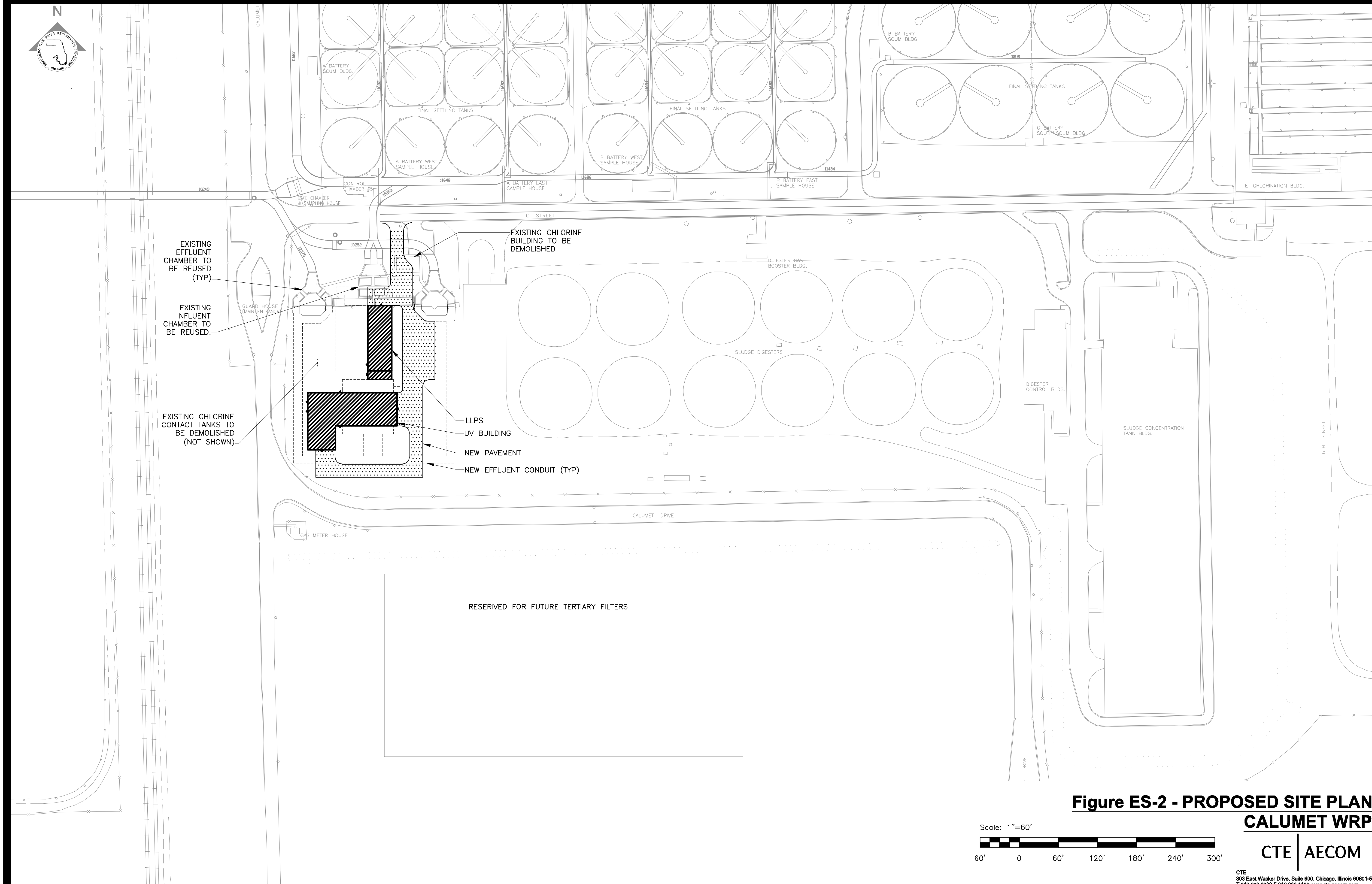

Figure ES-2 - PROPOSED SITE PLAN
CALUMET WRP

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1.0 INTRODUCTION

1.1 Background

This report has been developed to present the findings of the Preliminary Cost Opinion for Ultraviolet (UV) Disinfection Facilities Study at the Metropolitan Water Reclamation District of Greater Chicago's (MWRDGC, or District) North Side Water Reclamation Plant (NSWRP) in Skokie, Illinois. This memorandum continues the work began in TM1-WQ, which was developed previously as part of the comprehensive Infrastructure and Process Needs Feasibility Study (Master Plan) for the NSWRP and a Water Quality (WQ) Strategy for affected Chicago Area Waterways.

The TM1-WQ documented the results of a CTE study of effluent disinfection alternatives for the District's North Side, Calumet and Stickney WRPs. In that study, a task force of national experts (referred to as the Blue Ribbon Panel) reviewed available disinfection technologies and their range of pathogen destruction efficiency, disinfection byproducts and impacts upon aquatic life and human health. Their investigation also included an examination of the environmental and human health impacts of the energy required for the operation of the facility and for the processing and production of process chemicals. Based on economic and non-economic evaluation of alternatives, ozone disinfection and UV disinfection were selected and preliminary design and cost estimates were developed. Based on the results of that subsequent evaluation, the District has determined that UV disinfection is the most cost-effective alternative.

1.2 Objective

Per the District's request, further evaluation of the UV disinfection technology is required. This additional evaluation is based on the TM-1WQ, the comments received from the United States Environmental Protection Agency (USEPA) as part of the Illinois Environmental Protection Agency's (IEPA) Use Attainability Analysis (UAA) evaluations, and new information obtained since the previous work. The primary objectives of the evaluation presented in this report are:

- To describe the conceptual facilities developed as part of this study including their basis of design and the assumptions used for their development
- To develop a Level 3 (per the Association for the Advancement of Cost Engineering) Preliminary Opinion of Probable Construction Cost for the proposed facilities at NSWRP and Calumet WRP
- To develop annual maintenance and operations (M&O) costs for the facilities
- To use the costs developed for the NSWRP UV Disinfection Facilities to project the costs for similar facilities at the Calumet Water Reclamation Plant (CWRP)

1.3 General Design Standards

Where applicable, the latest version of the codes and standards from the following institutions/organizations would govern the design:

1. State of Illinois, Illinois Recommended Standards for Sewage Works, Title 35.C.II.370.

2. Great Lakes – Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, Recommended Standards for Wastewater Facilities (Ten States Standards)

3. National Fire Protection Association Standard 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities

4. International Building Code, 2003

5. Metropolitan Water Reclamation District of Greater Chicago Standard Specifications

1.4 Organization of this Report

The Cost Study Report is divided into two volumes. Volume 1 is the text and backup materials presenting the findings of the additional evaluation of the cost of implementation of UV disinfection at the North Side WRP and Calumet WRP. Volume 2 is the conceptual level drawings presenting the preliminary layout and some details of the proposed facilities from which the preliminary opinion of construction cost was developed.

The basis of this evaluation is the proposed facilities necessary for UV Disinfection Facilities and related ancillary improvements at the NSWRP. The sections of Volume 1 are organized as follows:

Section 2 – Discussion of the hydraulic analysis that was performed based on updated information and that forms the basis of decisions regarding the need for a low lift pump station and the general layout of the facilities.

Sections 3 through 8 – Discussion of the basis of design for the proposed facilities by design discipline and the assumptions necessary for development of the conceptual design presented in Volume 2.

Section 9 – Discussion of areas that require further analysis during the preliminary design of the proposed facilities due either to their critical nature regarding design decisions or their large impact on potential construction or operating costs.

Section 10 - Summary of the Preliminary Opinion of Probable Construction Cost (OPCC) and annual operating costs as well as discussion of the assumptions used to develop those costs.

Section 11 – Presents the projected schedule of implementation of the proposed facilities if the decision to proceed is made in the future.

The final section – **Section 12** – projects the capital and operating costs for implementation of identical facilities at the Calumet WRP. Due to their similar size, it was determined that the detailed evaluation of the costs for implementation at North Side WRP could be used for development of costs for the Calumet WRP. To develop this estimate, the costs estimated for NSWRP were adjusted for site specific costs at each site and multiplied by the ratio of peak design capacities at the two plants. Section 12 details these adjustments and presents the summary of the costs at CWRP.

2.0 HYDRAULICS

2.1 Recommended Alternative from Disinfection Cost Study Hydraulic Evaluation

Various disinfection layout alternatives were considered in the Disinfection Cost Study Hydraulic Evaluation. All alternatives included a Low Lift Pump Station (LLPS) and UV Disinfection Building (UV). A discussion of the need for the LLPS is included later in this section. For a full analysis of the alternatives considered and the evaluation process, see Appendix A. The recommended alternative minimizes the number of pumping facilities required and is the most easily modified to accommodate the possible future addition of tertiary filters if required for more stringent effluent limitations on suspended solids or phosphorous. A schematic for the recommended alternative is included as **Figure 2.1-1.**

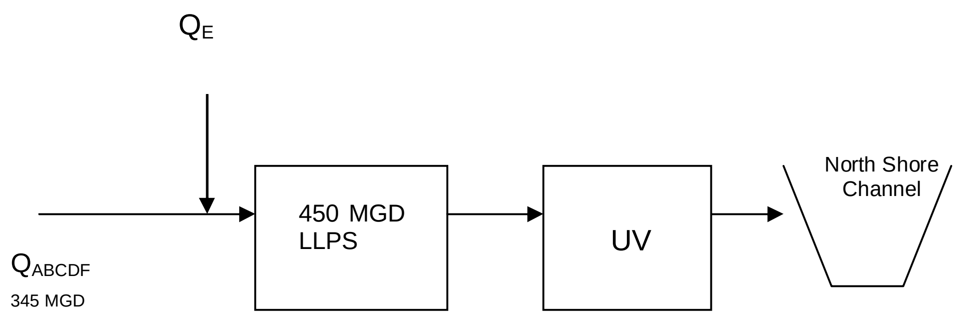


Figure 2.1-1 – Recommended UV Disinfection Facilities Arrangement

2.2 Hydraulic Analysis of the UV Disinfection Facilities

2.2.1 Objectives

For this study, modifications were made to the preliminary hydraulic model created under the Master Plan in order to provide a more detailed hydraulic analysis of the UV Disinfection Facilities. These modifications included adding the additional effluent conduits, gate structures, UV channels and reactors, and Low Lift Pump Station to provide a more comprehensive hydraulic evaluation of the UV disinfection facilities.

2.2.2 Overview

The hydraulic analysis was completed using a spreadsheet utilizing standard open channel and closed conduit flow equations to represent the NSWRP. The hydraulics evaluated were for the year 2040 conditions, including both infrastructure and permit-related improvements. A peak flow of 450 mgd was used. Flow in excess of 450 mgd is diverted to the TARP system. Return activated sludge flows were added to the influent where appropriate. In order to reflect the nutrient removal processes, internal mixed liquor recycled flows were used in the hydraulic analysis of the activated sludge aeration tanks.

Similar to the analysis performed previously as part of TM1-WQ, critical flow paths were identified as those which would result in the greatest total headloss through the facility. Other flow paths through the facility experience lower headloss and, as such, further evaluation of these flow paths is not warranted because changes along these flow paths will not change the results of the evaluation. These critical flow paths were modeled from the North Shore Channel Outfall to immediately upstream of the coarse bar screens in the Pump and Blower House. The two flow paths identified as critical flow paths for this study are as follows:

1. Critical flow path through Battery A

2. Critical flow path through Battery E

2.3 Assumptions

Due to the preliminary nature of the selected site plan, assumptions were made in the development of the hydraulic model. These assumptions are as follows:

1. All NSWRP drawings obtained from MWRDGC are on the same datum, known as the Chicago City Datum (CCD).
2. The CCD has not changed since the plant was originally constructed in the 1920's.
3. Flow through future Battery E is 105 MGD and it is treated as a base loaded plant. Flow through existing Batteries A, B, C, D, and F is the remainder and will be 345 MGD at peak flow. Flow over 450 MGD is diverted to TARP.
4. Return flow from the Grit Dewatering System and Scum Concentration Tanks as well as supernatant from the Sludge Concentration Tanks are negligible.
5. Flow reduction as a result of primary sludge removal is negligible.
6. The 100-year flood elevation the North Shore Channel is 12.30 CCD, as calculated in the Chicago Canal System Model, UNET. Appendix A provides selected pages from the USACE's Chicago Underflow Plan (CUP) Design Report presenting these results. Pre-Stage 1 (Stage 1 of McCook Reservoir Construction) values are used since the USACE's current estimate for completion of Stage 1 construction is 2020 or later.
7. Hydraulics through the existing Meter Building will control flow splits among Battery A, B, C, D, and future F proportional to the battery volumes.
8. Flow splits evenly based on aeration tank volume within each battery.
9. Flow splits evenly among the aerated grit channels located in the Grit Building.
10. Return Activated Sludge (RAS) flows were calculated to be 55% of total influent flow.
11. Internal recycle flow for total nitrogen removal was calculated to be 150% of total influent flow per battery.
12. Baffle walls (for TN removal) were assumed to be mounted where mixed liquor flows from underneath one baffle wall to the top of the next baffle wall, creating a "up and down" flow pattern.
13. The longest flow path through each treatment process was used.
14. Tank geometry downstream of the aeration tank effluent weirs (Operating Gallery and Final Settling Tanks) in Battery A was assumed to be similar to that of existing Battery D.
15. Geometry of Batteries E and F were assumed to be similar to that of existing Battery D.
16. Proposed primary settling tank geometry was assumed to be similar to that of the existing circular primary settling tanks.
17. Velocity in Disinfection Influent and Effluent Distribution Chamber is zero

18. Battery E is to be pumped via the proposed low-lift pump station on the existing (southern) NSWRP site.
19. Battery E influent flows by gravity from downstream of the Grit Building to the north site resulting in the facilities being lower in elevation than the same facilities on the existing site.
20. Disinfection channel effluent weir gate is assumed to be downstream water surface elevation (WSE) + 0.5'.
21. Tertiary Filters Are excluded from the model, but the LLPS pumps can be modified to accommodate the additional head associated with this process.
22. The following modeling equations were used:

a. Pressure Flow – Hazen Williams Equation
b. Open-Channel Flow – Manning's Equation
c. Flow junctions – Pressure Momentum Analysis
d. Hydraulic coefficients used in developing this model include:
    1. Hazen Williams, C – 110 (concrete)
    2. Manning's, n
        i. Regular channel – 0.013
        ii. Aerated channel – 0.035

2.4 Results

After calculation of head losses through the plant by evaluating each existing and proposed unit process, the preliminary hydraulic analysis shows that over 15.5 feet of headloss is required to convey flow through the NSWRP given the existing facilities in Battery A and the proposed facilities in Battery E. Only 14.54 feet of head is available to convey the flow entirely by gravity through the same flow paths.

Table 2.4-1 presents the total headloss through various portions of the plant for Battery A and Battery E for comparison. Tertiary filters are not included in the hydraulic analysis. The hydraulic profiles show the estimated WSEs at the maximum flow of 450 mgd. Flow that exceeds 450 mgd is diverted into the TARP system.

Table 2.4-1 – Summary of Headloss through the Unit Processes at NSWRP (Proposed)

Process/Flow Area	Battery A	Battery E
Pump and Blower House Discharge to Aerated Grit Discharge Chamber	2.03	2.03
Aerated Grit Discharge Chamber to PSTs	1.03	2.39
Primary Settling Tanks	1.83	2.44
Aeration Basins and Final Settling Tanks	5.98	2.72
Effluent Conduit to Low Lift Pump Station Wet Well	0.67	1.96
LLPS Discharge to UV Disinfection Effluent Chamber	3.36	3.36
UV Disinfection Effluent Chamber to Outfall	.66	.66
Total	15.56	15.56

Notes: Values in feet of headloss.
Does not include head dissipated due to minimum pump head requirements.

Table 2.4-2 presents the final water surface elevations (WSE's) through the plant including the Low Lift Pump Station (LLPS) and UV Disinfection Building. Note that the WSE provided hear take into account the headloss summarized in Table 2.4-1 above as well as including the LLPS and the head gain that is provided by that facility. Due to the constraints of the pumping equipment, the head gain is greater than the minimum required to convey the flow through the remainder of the process train.

Table 2.4-2 – Summary of Proposed WSE including UV Disinfection Facilities

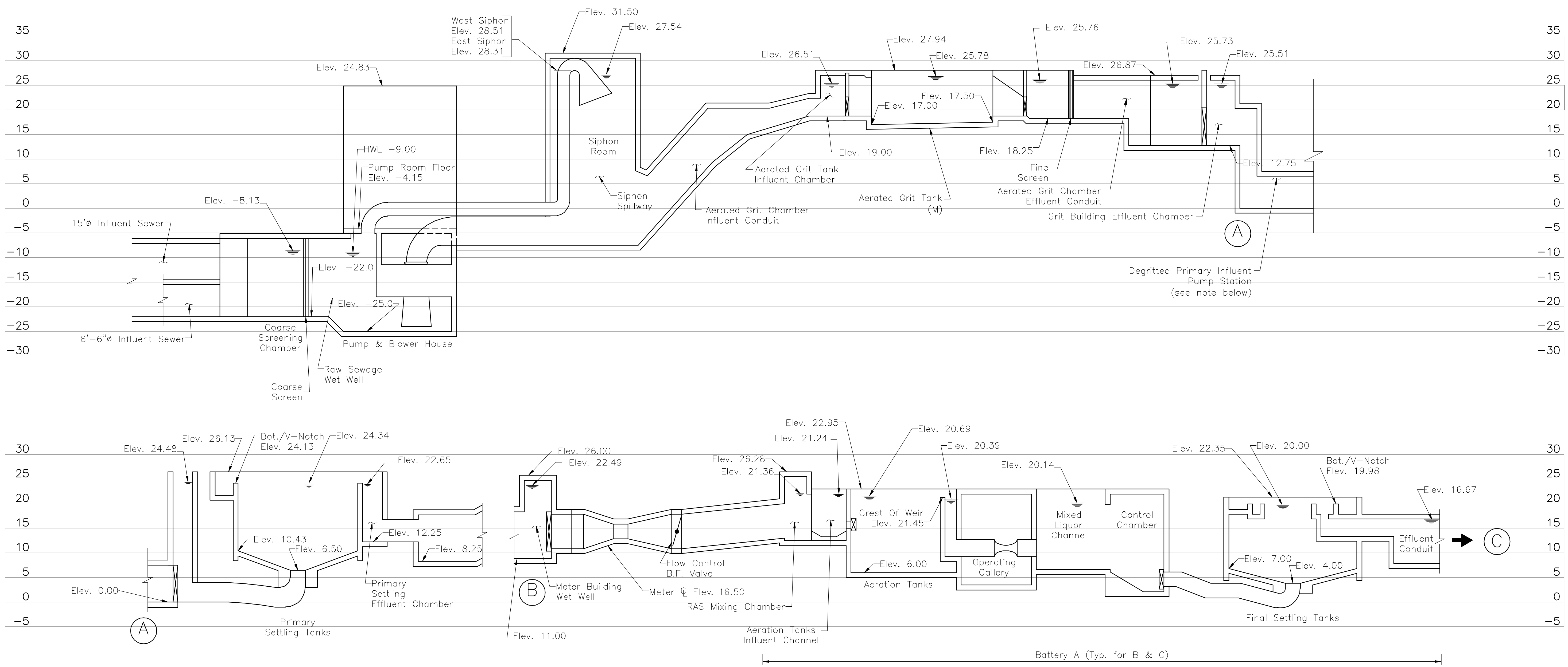
Location	Combined	Battery A	Battery E
North Shore Channel 100-yr Flood Elevation	12.30	--	--
D/S WSE @ New Surge Chamber*	12.96	--	--
U/S WSE @ New Surge Chamber*	15.96	--	--
WSE @ Disinfection Effl Channel	16.52	--	--
WSE just U/S of Weir Gate	18.03	--	--
WSE just D/S UV Reactor	18.08	--	--
WSE just U/S UV Reactor	18.83	--	--
WSE just D/S of influent gate	18.87	--	--
WSE in LLPS Discharge Channel	19.88	--	--
LLPS Wet Well High Water Level (HWL)	16.00	--	--
Final Settling Tank Effluent Chambers	--	16.67	17.96
Aeration Tank Effluent Chambers	--	20.39	18.88
Aeration Tanks	--	20.69	19.62
Primary Tank Effluent Chambers	--	22.65	20.68
Grit Building Effluent Chamber	25.51	--	--
U/S of Fine Screens	25.76	--	--
Aerated Grit Tank Influent Chamber	26.51	--	--
Siphon Room	27.54	--	--

Notes: All WSE in CCD.
* Includes approximately 2.5 of head dissipated due to min pumping requirements.
WSE – Water Surface Elevation
D/S – Downstream
U/S – Upstream

Figure 2.4-1 and 2.4-2, on the following pages, contain hydraulic profiles of the two critical flow paths with the UV disinfection facilities and the available freeboard at the locations where water surface elevations (WSEs) were calculated at the maximum day flow.

2.5 Conclusion

Based on the preliminary hydraulic analysis performed as part of this study, the total head required to convey flow through the Northside WRP with the proposed UV disinfection process is 15.56 feet at the peak flow rate of 450 mgd. From the effluent channels of Batteries A and E, 3.36 feet of total head is required to convey the flow to the surge chamber. The pumping station is required to provide approximately 1 foot of head to convey the flow through the UV disinfection process. Due to the minimum discharge pressure requirements of the pumping equipment, approximately 2.88 feet of head is actually provided. The excess head would be dissipated at the surge chamber.



Legend

(A) – Flow diversion from Headworks to Batteries on Existing Site and North Site Battery E. (Existing Site – 345 mgd, Battery E – 105 mgd)

(B) – Flow split at Meter Building Wet Well to Batteries A & F

FIGURE 2.4–1
HYDRAULIC PROFILE FOR BATTERIES A–F
AFTER IMPLEMENTATION OF UV DISINFECTION FACILITIES

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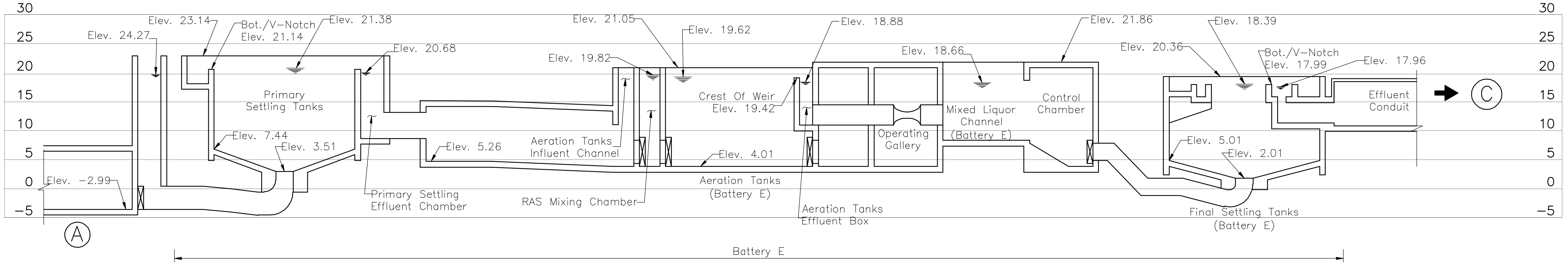

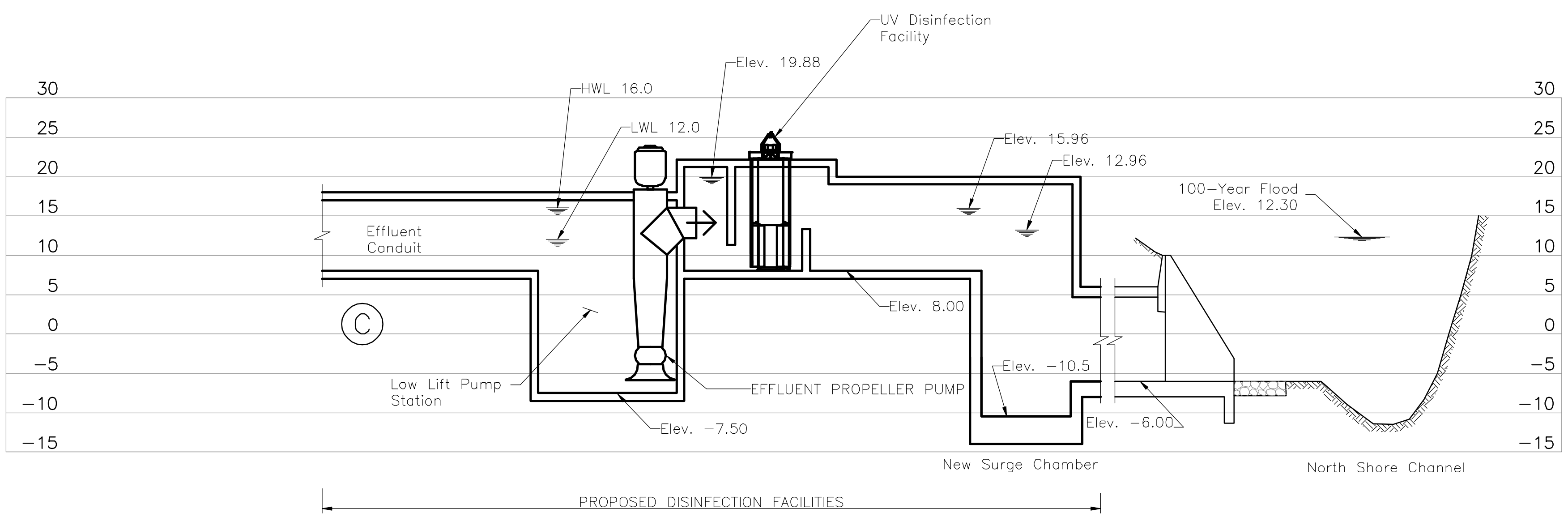

Legend

(A) – Flow diversion from Headworks to Battery E [Q (Battery E) = 105 mgd]

(C) – Flow junction from Batteries A, E, & F. (Total Q = 450 mgd)

FIGURE 2.4-2
HYDRAULIC PROFILE FOR BATTERIES E
AFTER IMPLEMENTATION OF UV DISINFECTION FACILITIES

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3.0 NSWRP DISINFECTION PROCESS

3.1 Introduction

The District has preliminarily selected the medium-pressure high-intensity (MP-HI) UV disinfection technology for disinfection of final effluent at the NSWRP. This section presents the results of further evaluation of the MP-HI UV disinfection technology per the District's requirement. In the following discussion, the basis of design of the MP-HI UV system is presented and a preliminary basis of design of the UV system to be used at the NSWRP is provided. The low-lift pump station's basis of design, operation and layout are provided later in this section.

3.2 UV Disinfection System

3.2.1 Background

The Technical Memorandum on the UV Disinfection Technology, included in Appendix B, incorporates the following:

- Information from literature including technical proceedings from the Water Environment Federation (WEF), Water Environment Research Foundation (WERF), proceedings from the latest Disinfection conference series undertaken by WEF, American Water Works Association (AWWA), and International Water Association (IWA). This information provided the latest updates in the UV disinfection technology.

- Updated recommendations on the UV system from four manufacturers – Trojan Technologies, Aquionics, Calgon Carbon, and Severn Trent Services (STS)/Quay.

- Reference information on experience of UV disinfection at five selected facilities – Racine WWTP (Racine, WI), R.L. Sutton WRF (Cobb County, GA), Grand Rapids WWTP (Grand Rapids, MI), Jacksonville WWTP (Buckman, FL), and Valley Creek WWTP (Valley Creek, AL). A summary of the information collected through the phone survey is provided in Appendix B, and important inferences from the phone survey are as follows.

    1. Fouling due to iron in the effluent has been a problem at the Racine, Sutton, and Grand Rapids facilities. Fouling results in lower then expected disinfection performance, higher operating costs, and higher M&O efforts. The iron in the effluent at all three plants was primarily from the chemical phosphorus removal using Ferric Chloride. At Grand Rapids WWTP, the chemical addition is upstream of the secondary treatment process; staining of sleeves was found only when the chemical addition was in the secondary clarifiers. At the Sutton WRF, fouling of lamps due to iron is observed although chemical addition is upstream of secondary process and sand filters are used upstream of the UV disinfection system. At the Racine WWTP, fouling may be due to ferric chloride addition and/or due to the additional iron brought by the ferric sludge from another water treatment plant, although operational controls are used to prevent both sources from occurring simultaneously.

2. Calcium fouling due to hardness in the source water is not a significant problem because of the automatic mechanical/chemical cleaning system that dissolves and wipes away any scales. The lack of calcium hardness was observed in all five plants including the Racine and Grand Rapids utilities which have Lake Michigan source water and is attributed to the automatic cleaning system performance.

3. The frequency of cleaning and changing of the cleaning solution is specific to the utility and would have to be determined only by experience.

4. Labor requirements varied amongst facilities, with some facilities requiring more labor to handle the fouling caused by iron salt addition.

5. As long as other processes in the plant are performing as desired, all five facilities were satisfied with the UV disinfection system because it met their disinfection goals.

In conclusion, the phone survey had revealed that fouling of the quartz sleeves is a concern for this application, particularly if iron salts are added for phosphorous removal in the future. In addition, the phone survey results suggest that the manufacturer's recommended labor assumptions for routine maintenance including cleaning and inspection of the lamps is too low for this application. Using this information and the updated information available from manufacturers, a preliminary basis of design of the MP-HI UV disinfection system has been developed for disinfection of the final effluent at the NSWRP.

3.2.2 Basis of Design

The MP-HI system involves sending the secondary or tertiary effluent through channels containing banks of MP-HI UV lamps. Refer to the process drawings included in Volume 2 of this report. The Trojan UV4000™Plus system is used here to develop the basis of design for the UV disinfection system. The system consists of a power supply, an electrical system, a reactor, MP-HI lamps, a mechanical and chemical cleaning system, and a control system. The MP-HI UV lamps are enclosed in individual quartz sleeves for protection against dirt and breakage. Reactor chambers (open channels) hold the lamps in a horizontal configuration. The effluent weirs and level sensors are used to keep the lamps submerged under the effluent water. This submergence ensures that the lamps do not overheat, thereby preventing lamp life reduction or burnout.

The UV system is assumed to operate from March to November each year. During the winter months, the equipment would sit idle as the flow is bypassed around the LLPS and UV Disinfection Building. However, due to the size of the facility including five reactors and over 1600 lamps, maintenance activities would be conducted every working day from March to November and periodically during the winter months. It is reasonable to expect that the area would continue to experience normal weather patterns for the Chicago area including extreme weather during all four seasons. In order to protect the safety of the M&O staff, ensure operational and maintenance-related productivity, and protect the UV equipment from adverse weather common to the Chicago area including high winds, rain, lightning, snow, and extreme temperatures, the UV system would be enclosed in a building.

3.2.2.1 Influent Characteristics

The water quality characteristics that affect UV transmittance include iron, hardness, suspended solids, humic materials and organic dyes. These effluent constituents have a tendency to absorb UV light and thus impact the disinfection process. The UV transmittance generally needs to be above 65% for effective disinfection. The water quality testing done at the NSWRP and CWRP as part of the UV disinfection technology trials conducted by the District during 2006-2007 showed an average transmittance above this minimum value. Refer to Appendix B for more information regarding the influent characteristic testing. The total suspended solids limit is projected to be 15 mg/L for the purposes of sizing the UV system.

3.2.2.2 Reactor Configuration and Hydraulics

An open channel is used as a reactor. Each channel has one reactor with two banks each. Each bank includes stainless steel UV modules with the MP-HI lamps mounted on them and arranged in a linear configuration to increase intensity along the linear axis by avoiding UV emission losses due to self absorption, reflection or refraction that can occur if a UV lamp were twisted into loops or spirals. The lamps are positioned horizontally and parallel to the flow.

The optimum hydraulic scenario for this system involves turbulent flow with mixing while minimizing head loss. Reactor design, including inlet and outlet flow distribution is done so that the unit operates close to a plug flow. Inlet conditions are designed to distribute the flow and equalize velocities. Sufficient length is provided in the channel upstream of the reactor to allow equalization of the flow. A motorized weir gate is provided downstream of each reactor to control the water level at a constant level with little fluctuation within the UV disinfection reactor.

3.2.2.3 Lamps and UV Intensity Control

The MP-HI lamps produce polychromatic radiation, which is concentrated at select peaks throughout the germicidal wavelength region. The IEPA requires a minimum UV dose of 40 mW-s/cm^2 that was considered during the design of the UV system. It may be possible to document a lower required dose to the regulating body (IEPA) during design development, but lacking such data, this study does not deviate from the required minimum dose.

Each lamp is enclosed in a quartz sleeve because quartz effectively protects the lamps while minimizing any UV transmission losses. Electronic ballast for each lamp is used to control the power to the lamp. If the UV dose is to be reduced, the variable output electronic ballast regulates the power to the lamp from 100% to 30%. Entire banks can also be turned off if there is no flow. This allows dose-pacing based on the secondary or tertiary effluent flow and quality, which helps save power and lamp life and hence reduce costs.

3.2.2.4 Lamp Fouling and Cleaning

The MP-HI lamps operate at a temperature range of 600 to 900 degree C. These warm temperatures promote fouling on the surface of the quartz sleeves when the lamps are placed directly within the wastewater stream. Iron is the most abundant metal in these scales along with other mineral salts and oil, grease, suspended solids deposits, and biofilms. If no tertiary treatment is provided, physical debris may contribute to fouling as well.

Since lamp fouling significantly reduces the effectiveness of UV disinfection by blocking the UV rays, calculation of the UV dose incorporates a term called the “fouling factor”, which allows the designer to estimate the effects of fouling on performance of the disinfection process. To combat fouling, a chemical and mechanical cleaning system is proposed for the MP-HI UV disinfection system. The latest technology uses a system of mechanical wipers and sleeves containing cleaning chemicals surrounding the lamp. The cleaning solution contains some acidic solution that prevents fouling. This cleaning system can be programmed to clean at a set frequency without the need for disrupting the disinfection process. The cleaning solution needs to be replaced periodically depending on the type of solution used and characteristics of the effluent water quality. Similar facilities using Lake Michigan as source water have found that changing the cleaning solution on a monthly basis is required for adequate performance.

Due to the mechanical and chemical features of the Trojan automatic cleaning system, the IEPA accepts the default value of 100% for the fouling factor in the UV_{dis} software package (dosage modeling software) for sizing the equipment. Based on the phone survey results that indicated a higher potential for fouling in the event of Lake Michigan source water with ferric salt addition, the District has elected to incorporate a safety factor of 10% by using a fouling factor of 90%.

3.2.3 Process Control

An automated process control must be provided to facilitate online pacing of the UV dose to prevent overdosing that wastes electricity and to avoid under-dosing that would not meet the disinfection regulatory requirements and goals. The process control should also allow the dose-pacing to be interfaced with the plant’s overall supervisory control and data acquisition (SCADA) system. The flow, lamp output, and water conditions are measured in pacing of the dose, and an algorithm is developed based on long-term measurements to predict necessary system adjustments, maintenance, and component replacements.

Programmable logic control (PLC) technology must be used for dose pacing in the MP-HI UV disinfection system. The PLC interacts with the ballasts, sensors, and online monitoring technology for each disinfection unit. The PLC then interacts with the plant’s overall control system to allow remote monitoring and adjustment of the system. The PLC should be supplied by the manufacturer of the unit.

3.2.4 Safety

The high voltage power supplies for the MP-HI UV disinfection system may pose an issue as the lamps are submerged in the water most of the time and compliance with electrical safety codes is required. In addition, UV light poses a risk to personnel and can cause damage to skin or eyes upon exposure. Submerging a lamp in water, even if it is just a few inches below the surface, greatly reduces the intensity. During operation the system should be covered by hatches and should be designed to ensure constant water levels to minimize the risk of UV exposure.

3.2.5 Proposed Design Criteria for UV Disinfection Equipment

Based on a review of the information provided by the UV equipment manufacturers and the experience of five other facilities (Appendix B), it is observed that Trojan Technologies provides a widely-used low-maintenance solution for final effluent disinfection. The design of the MP-HI UV disinfection system for the North Side WRP is based on the Trojan UV4000™Plus equipment provided by Trojan Technologies. The basis of design is given in **Table 3.2-1**.

Table 3.2-1 – Design Parameters for UV Disinfection Unit at NSWRP

Parameter	Design Value
Capacity and Water Quality	
Design flow, mgd	450
Average flow, mgd	333
Maximum TSS[a], mg/L	15
Pre-Disinfection Effluent E.Coli Count[b], cfu/100 mL, maximum (Assumed)	200,000
Post-Disinfection Effluent E.Coli Count Target[c], cfu/100 mL	1030
Effluent hardness[d], mg/L as $CaCO_3$	270
Dosage	
UV transmittance, minimum, %	65
UV intensity[e], W/lamp	4,000
Lamp Life, hours	5,000
Fouling factor, %	90
Lamp aging factor, %	89
UV dose, mW-s/cm^2	40
Physical Characteristics	
Channel dimensions, WxD	106” x 172”
Number of channels	5 (4 plus 1 standby)
Number of reactors per channel	1
Number of banks per reactor	2
Number of modules per bank	7
Number of lamps per module	24
Total number of lamps	1680
Total power requirement, kW	5376
Average power requirement, kW	2903
Hydraulics	
Headloss, UV reactor only	9”
Velocity in each channel, V, ft/s	1.74
Liquid level control in channel	Motorized Weir Gate

[a] Monthly permit limit 12 mg/L
[b] Annual average
[c] Future requirement (monthly geometric average)
[d] Mean value
[e] 100% intensity at 100 hours of lamp use

The above design criteria are assumed based on available information and the current state of ultraviolet disinfection technology. A more extensive technology evaluation should be conducted prior to final design of the facility. Due to the extraordinary scale of this facility, CTE recommends the District undertake the following design process for selection and design of the UV disinfection equipment if final design is initiated:

1. Request and evaluate independent, full-scale validation data (also known as biodosimetry data) from manufacturers of candidate disinfection systems for similarly sized units or the largest size for which the manufacturer has data available. This evaluation would provide an initial level-of-confidence that the candidate systems can achieve the target disinfection levels. Data should be from systems using the same bulb, ballast, and control technology as proposed for the full-scale system.

2. Conduct a collimated beam testing program. This program would use site specific effluent and bacteria to determine the sensitivity of the site specific bacteria and pathogens to UV disinfection. The data would be used to size the UV lamps and reactors.

3. Increase frequency of UV transmittance testing at each plant to at least once per day for a period of one year or more to collect data on seasonal variability, daily variability, diurnal variability, and to capture the frequency of events that might reduce transmissivity such as wet weather and infrequent industrial discharges.

4. Conduct a more detailed life cycle cost analysis of the candidate disinfection systems based on the data collected during steps 1 through 3 above.

5. Construct a pilot testing facility (approximately 20 MGD, subject to change) designed to match lamp spacing, velocity profile and other design parameters of the proposed full scale units. The pilot testing facility would be used to determine:

    a. Appropriate control sequences and optimization for the UV disinfection equipment, including appropriate sensing equipment to allow advanced power management.

    b. In-situ disinfection performance including fouling rates of the lamps with and without ferric salt addition.

    c. Design life of lamps and other UV system parts.

    d. Actual M&O requirements in terms of labor and consumables as well as space requirements to complete required maintenance activities.

    e. Performance of alternate equipment manufacturers, if alternates are available at the time of piloting.

    f. Accuracy of life cycle cost analysis prior to final design of the full-scale system.

6. Conduct post-construction full-scale validation testing (biodosimetry testing) to confirm performance and determine operating parameters.

Using a program as described above, it may be possible to demonstrate the effective UV dosages to the regulators and optimize the equipment sizing criteria. For this study, reduction in the Illinois requirements for UV system sizing is not assumed based on the lack of data similar to that described above.

A budgetary cost ($2,200,000) for a 20 mgd pilot facility has been included in the costs for implementation of the UV Disinfection Facilities. Costs for other portions of the design program are assumed to be

3.3 Low Lift Pump Station

Based on the analysis of hydraulics of the proposed improvements described in Section 2 above, it is estimated that the low lift pumps would be required to raise the water approximately 7 feet (including static and friction losses) to the UV disinfection system influent, including estimated head to allow flow through the UV system. Should tertiary filtration become necessary in the future, these pumps would need to be modified to enable an increased head to approximately 11 feet (TDH) or more.

3.3.1 Basis of Design

Table 3.3-1 provides a summary of the basis of design for the Low Lift Pump Station.

Table 3.3-1 – Low Lift Pump Station Basis of Design

Peak Flow, MGD	450
Average Flow, MGD	333
Minimum Flow, MGD	160
Pumps	
Type	Axial Flow
Number	6 total (N+1+1)
Pumping Rates, gpm/pump	78,000
Total Dynamic Head, ft.	7
Motor, hp	250
Submergence, minimum, ft	14
Peak Power Demand, kW	515
Average Power Demand, kW	375
Wet Well	
Length, ft.	86
Width, ft.	101

3.3.2 Pump Type

Several pump types were considered for this high flow (78,125 gpm) low head (7 feet TDH) application. Pump types considered included screw pumps, vertical turbine pumps, centrifugal pumps, and axial flow pumps. Many pump manufacturers found it difficult to recommend a pump that would operate efficiently for this application due primarily to the low head. Screw pumps and axial flow pumps appear to have the best operating performance for this condition.

Initially the Low Lift Pump Station would lift 450 MGD a total of 4 feet with a Total Dynamic Head (including station losses) of approximately 7 feet. However, if tertiary filtration is constructed in the future, the TDH would increase to approximately 11 feet (flow would remain the same). Screw pumps would not easily accommodate this change in head, without significant structural modifications to the pump station. However, axial pumps can be modified for future head conditions. Structural modifications to the pump station to accommodate these changes, if required, should be minimal. Therefore, axial flow, propeller type pumps are recommended. Vertically mounted units are readily available from manufacturers and were used for station layout. Horizontal units are also available, but are not as available as the vertical type.

3.3.3 Proposed Operational Description

The pump station would have a total of six pumps, with four duty pumps, one standby and one out of service (N+1+1). Four pumps would be driven by constant speed motors, two would be variable speed driven. In order to provide operational flexibility, the pump station would be divided into two wet wells, each containing three pumps. Normal wet well levels would be 14 to 16 feet Chicago City Datum (CCD). Design average flow (333

MGD) can be handled by two constant speed and one variable speed pumps, leaving three pumps on standby. Peak flow (450 MGD) can be handled by four pumps, leaving two on standby. Minimum flow (160 MGD) would be handled by one constant speed pump and one variable speed pump at a low wet well level (~12-13 feet CCD) or two variable speed pumps at a normal wet well level. Typically, at least one variable speed pump would operate at all times, to handle fluctuations in flow. **Table 3.3-2** illustrates an example of pump operation at minimum, design average flow, and peak flow:

Table 3.3-2 – Examples of Pump Operation

Flow, MGD	Pump Drive Type	Pump Flow, gpm	TDH, ft	Pump Eff.	Power Demand, kW
160 (5-year minimum)	Constant speed	74,000	7	84%	126
	Variable speed	39,000	2	80%	17
333 (Design Average)	Constant speed	78,125	7	84%	126
	Constant speed	78,125	7	84%	126
	Variable speed	75,000	6.5	83%	119
450 (Peak)	Constant speed	78,125	7	84%	126
	Constant speed	78,125	7	84%	126
	Constant speed	78,125	7	84%	126
	Variable speed	78,125	7	84%	133

In order to eliminate vortices, pumps require a minimum submergence as a function of pump suction bell diameter. For this flow condition, a 96-inch suction bell is required, which requires a minimum submergence of 168 inches, or 14 feet. Submergence requirements should be verified by the pump manufacturer during final design.

Level sensors in the wet well would relay a signal to turn pumps on and off. Other control inputs that need to be monitored include discharge pipe pressure, flap gate position, and motor alarms.

3.3.4 Proposed Layout

Refer to Sheet C-102 for a proposed site layout of the LLPS and UV Disinfection Building. The space available for the construction of these facilities is constrained by the need to reserve space to the south for future tertiary filters and to the north by the CTA rail embankment. Flow would enter the pump station at the north end of the wet well, where it would be directed perpendicularly to the south through four 96-inch slide gates. Pumps are located at the south end of the pump station. An ideal pump intake approach per Hydraulic Institute standards was not possible due to the prohibitively long approach length required.

To accommodate the non-ideal pump intake approach, design features, which have been shown to be effective in other installations, were incorporated in this design in order to meet HI standards. For example, perforated plates, curtain walls, and floor and back wall splitters have been incorporated into the conceptual design. (See Volume 2 for a plan and section of the proposed layout). Sizing and details of these types of features are normally determined by physical scale modeling during detailed design. Furthermore, based on the total flow and flow per pump, the Hydraulic Institute recommends physical scale modeling.

4.0 NSWRP CIVIL

Due to constraints of the site related to the proposed location of the disinfection facilities, several significant civil improvements would be required. Those improvements include the following:

1. Temporary sheeting to support a railroad embankment

2. Construction of a permanent concrete retaining wall to allow locating the proposed facilities farther to the north

3. Construction of new roadways to access the new facilities and future tertiary filters

4. Construction of three gate structures and effluent conduits connecting the LLPS, UV Disinfection Building, and gate structures

5. Construction of associated utilities including stormwater collection, city water, effluent water, plant drain, electrical duct bank, and steam/condensate return.

In addition, available soil borings from previous projects indicate areas of concern related to the structure foundations. A discussion of the findings is also described below.

4.1 Basis of Design

Refer to the civil drawings in Volume 2 of this report for a layout of the proposed facilities on the site. The basis of design of each of the civil related improvements is presented below.

4.1.1 Temporary Sheeting

In order to support the existing rail embankment during construction of the retaining wall and connection to the existing effluent conduit upstream of Gate Structure #1, sheeting would be required to be installed along the embankment. The sheeting would be approximately 40-50 feet deep to support a cut into the embankment with a depth of up to 15 feet. It is assumed sheeting would be installed by vibratory pile drivers on weekends to minimize disruption to the CTA operating schedule. Additional shoring is assumed to be required to prevent movement of the sheeting and potential settlement of the rail. It is assumed that the sheeting would be abandoned in place.

4.1.2 Retaining Wall

In order to fit the proposed facilities onto the site, a cut would be required into the embankment. The embankment would be permanently supported by a 15 foot high concrete retaining wall. Soil anchors are likely to be required to provide additional support.

4.1.3 Roadways and Other Site Improvements

Proposed roadways associated with the UV Disinfection Facilities are intended to provide access to the structures and site for normal operations as well as allow access to heavy construction vehicles and delivery vehicles. The roadway would be constructed in accordance with District guidelines. It would be designed for AASHTO H-20 loading with an assumed reinforced portland cement concrete thickness of 12 inches. Curb and gutter (standard 12 inch wide gutter with 6 inch curb) would be provided to facilitate maintenance and stormwater collection.

The existing site fence along the rail embankment and running south along the previous railroad right-of-way would be demolished to facilitate construction activities. A new 12' high, barbed wire, chain-link fence would be installed along McCormick Boulevard from the Pump and Blower House to the CTA rail abutment to enclose the new facilities.

The northern-most radio antenna would be relocated to the south to accommodate the new facilities and construction activities. It is assume that the cost for relocation would be borne by others.

4.1.4 Gate Structures/Effluent Conduits

Final effluent conduits connecting the various facilities associated with the UV Disinfection Facilities would be constructed along with the primary facilities. For the purposes of this study, the final effluent conduits are assumed to be square and 8' x 8' for the Battery E effluent to the LLPS and 11' x 11' for all other conduits. All effluent conduits would be cast-in-place concrete construction designed for open channel flow. Due to the comparatively low weight of the conduits and water contained therein compared to the soil excavated, no deep foundations are anticipated at this time. In most cases, the conduits would be designed for 2' or less cover and to handle H20 traffic loading with the exception of the conduit downstream of proposed Gate Structure #3, which is between 10 and 15 feet below grade to match the existing outfall conduit in that location. Where possible, common wall construction with adjacent structures is assumed to be utilized.

It should be noted that the LLPS Discharge Conduit would initially be designed for open channel flow, as are the remaining flow conduits. However, in the future, this conduit would be under pressure when the LLPS pumps are replaced to allow pumping to the tertiary filtration facility when it is constructed. As such, this conduit would be designed for pressure of approximately 15 feet of head above the top slab. In addition, two bonneted slide gates would be provided, in lieu of conventional slide gates, to account for this future change to the system operation. One would be on the conduit to the UV Disinfection Building and the other would be on the stub to the south for the future connection to the tertiary filtration facility.

Construction of the connection to the existing effluent conduit upstream of proposed Gate Structure #1 is assumed to require hand mining and extensive sheeting and shoring to allow exposure of the existing conduit. Underpinning of the existing and new conduits would be completed to prevent unexpected strain on the structure. A cast-in-place sleeve would be constructed around the existing conduit. The final connection would be made "in the wet" by removing the top of the existing concrete and inserting a pre constructed bulkhead along one side of the conduit. A water tight seal around the bulkhead is not likely to be possible and dewatering pumping is assumed necessary. It is assumed that plant flow would be controlled to maintain a narrow range of flows during this construction by diverting flows in excess of dry weather flow to TARP temporarily. The final connection would be made by sawcutting the opening and repairing the exposed surfaces before removal of the bulkhead and completion of the top of the connecting sleeve. Backfill would be structural fill and flowable fill if necessary. During this work, it is assumed that the CTA rail operation would be halted for a period of two weeks and alternate means of public transportation (bus) would be provided for that period. That cost is not included in this study.

Three gate structures would be constructed to permit combining flows and facilitate flow control as follows:

Gate Structure #1

Gate Structure #1 is intended to combine flow from Battery A, B, C, D, and F on the existing site with flow from Battery E on the north site and direct it to the LLPS wet well. Motorized fabricated stainless steel slide gates (one on each flow source) would be provided to permit isolation of either flow source or to shut down the wet well. No aboveground structure would be associated with the gate structure, though its top would be 6 inches above grade. Guard rails and/or concrete bollards would prevent traffic over the gate structure to protect the motor actuators.

During the disinfection period (March to November) the gates would be normally open to permit flow to pass through the LLPS and UV Disinfection Building. During the winter period (November to April), the gates would be normally closed to allow bypass around the disinfection facilities. An access hatch would be provided to allow access to the structure.

Construction of Gate Structure #1 would be cast-in-place concrete. Due to the weight of the concrete and gates, pile foundations are assumed necessary. Where possible, common wall construction with adjacent structures would be utilized.

Gate Structure #2

Gate Structure #2 is intended to allow Battery E flow to bypass the LLPS and UV Disinfection Building. The structure is divided into two halves with a bypass connection between them; the north half directs Battery E flow from the east to Gate Structure #1 to the west and the south half directs UV Disinfection Building effluent to Gate Structure #3 to the east. Two motorized fabricated stainless steel slide gates, one on the downstream side of the Battery E conduit and one on the bypass connection, would be provided to allow bypass operation. No aboveground structure would be associated with the gate structure, though its top would be 6 inches above grade. Guard rails and/or concrete bollards would prevent traffic over the gate structure to protect the motor actuators.

During the disinfection period (March to November) the gate on the downstream side of the Battery E conduit would be normally open and the bypass connection gate would be normally closed. During the winter period (November to April), the gate positions would reverse to allow bypass around the disinfection facilities. Two access hatches, one on each half of the structure, would be provided to allow access to the structure.

Construction of Gate Structure #2 would be cast-in-place concrete. Due to the weight of the concrete and gates, pile foundations are assumed necessary.

Gate Structure #3

Gate Structure #3 connects the new UV Disinfection Building effluent conduit to the existing plant outfall conduit. This structure would also be used to convey flow through the UV Disinfection Facilities when required. A motorized fabricated stainless steel slide gate on the upstream side of the existing outfall conduit would be provided. No aboveground structure would be associated with the gate structure, though its top would be 6 inches above grade. Guard rails and/or concrete bollards would prevent traffic over the gate structure to protect the motor actuator.

During the disinfection period (March to November) the gate would be normally closed to force flow from the existing site to be directed into the LLPS wet well through Gate Structure #1. During the winter period (November to April), the gate would be normally open to allow bypass of existing site flow around the disinfection facilities. An access hatch would be provided to allow access to the structure.

Construction of Gate Structure #3 would be cast-in-place concrete. Due to the weight of the concrete and gates and the soil conditions, pile foundations are assumed necessary. The base of the structure would form the connection to the existing plant outfall conduit. Underpinning of the existing and new conduits would be completed to prevent unexpected strain on the structures. The gate structure base would be constructed around the existing conduit. The final connection would be made “in the wet” by removing the top of the existing concrete and inserting a pre constructed bulkhead along one side of the conduit. A water tight seal around the bulkhead is not likely to be possible and dewatering pumping is assumed necessary. It is assumed that plant flow would be controlled to maintain a narrow range of flows during this construction by diverting flows in excess of dry weather flow to TARP temporarily. The final connection would be made by sawcutting the opening and repairing the exposed surfaces before removal of the bulkhead.

Following the final completion of the connection, a second and third full pipe diameter bulkhead would be constructed upstream and downstream of the proposed gate in the existing plant outfall conduit to allow its installation. Plant flow would be diverted through the UV Disinfection Facilities during this work. Underwater construction techniques would be required to make the insertion and sealing of the bulkheads. Following installation of the gate, the bulkheads would be removed and the gate structure would be completed to grade.

Costs for the gate structures and special connections have been included in the opinion of probable construction cost included in Appendix F.

4.1.5 Site Utilities

Site utilities would be demolished, rerouted, and constructed to support the new facilities. The following utilities would be demolished or rerouted as shown on Sheet C-103:

1. Wash Water Supply – Rerouted
2. Non-Potable Water Supply – Rerouted
3. Plant Effluent – Rerouted
4. Site Sprinkler – Demolished and Capped
5. Miscellaneous Site Drainage – Demolished

The following site utilities would be added to support various functions within the new UV Disinfection Facilities:

1. Steam and Condensate Return Piping – Constructed from Battery A service tunnel to head of LLPS and UV Disinfection Buildings

2. City Potable Water – Routed from current location near Process Water Building to LLPS and UV Disinfection Building for potable water use.

3. Non-Potable Water – Routed from existing piping (rerouted to accommodate new facilities) to LLPS and UV Disinfection Building for non-potable water use (wash down).

4. Plant Drain – New plant drain installed along south side of UV Disinfection Facilities to existing 6'-6" interceptor along eastern side of existing site and connected to LLPS and UV Disinfection System.

5. Stormwater Collection – Installed to collect stormwater runoff from new buildings and roadway and routed to plant drain.

6. Electrical Duct Bank – Routed from new power substation on Battery E site to UV Disinfection Building for power distribution.

4.1.6 Geotechnical Information

The project team has reviewed the two sets of boring logs (1969 and 1977) for the proposed site of UV Disinfection Facilities. These logs were used to understand the general subsurface soil conditions at the proposed site and provide a preliminary opinion on suitable foundation type for the proposed facilities. See Appendix E for copies of the referenced boring logs.

The quality of the boring logs is poor, and the properties of soils such as unit weights and consolidation are not reported. Boring logs show that soil conditions are highly variable across the proposed site (e.g., thickness of soft silty clay layer is 19 feet at B-1 and 40 feet at B-2; both B-1 and B-2 are close to each other). In general, fill and topsoil are encountered near the ground surface. A stiff silty clay layer underlies the fill/topsoil layer. Below the stiff silty clay layer, a very soft silty clay layer (with very low unconfined compressive strength and high moisture content) is encountered to depths ranging from 30 to 53 feet below the ground surface. Inter-bedded silt and sand layers and hardpan are encountered before finally experiencing auger refusal (apparent top of the bedrock) at depths ranging from 55 to 58 feet.

The proposed structures would be located 15 to 20 feet below the existing grade. This means that the base of the structures would be located within the soft silty clay layer. Approximately 25 to 35 feet of soft clay would remain below the base of the proposed structures. If a slab foundation is proposed, a detailed analysis for bearing capacity and settlement is warranted. Since the thickness of soft clay and underlying soils are widely varying, a detailed assessment of differential settlement is also necessary. Such analysis is not possible now based on very limited information presented on the boring logs.

As the proposed structures are large and heavy, and also the maximum allowable settlement should be less than one inch, it is appropriate at this level of design development to assume a deep foundation system extending into the hardpan or to the top of the bedrock. Either drilled shafts or pile foundations are suitable to use. However, there may be potential squeeze-in problems in the soft clay layer during the construction of drilled shafts, even though some preventive measures (e.g. use of casing) may be taken to avoid such problems. In our opinion, a pile foundation system should be considered for cost estimate purposes.

It is assumed for this analysis that the effluent flow conduits would be significantly lighter than the other structures and approximate the weight of the soil to be removed.

A detailed subsurface investigation is recommended to characterize the soft silty clay layer and underlying soil layers. Both strength and consolidation properties of these soils should be determined by field and laboratory testing. These data would be necessary for the final selection and design of the foundation system.

5.0 NSWRP STRUCTURAL AND ARCHITECTURAL

5.1 Introduction

The objective of this Section is to document the design criteria for the structural, architectural components of this project, including recommendations, allowable stresses, and loadings that would be used in designing the new project structures and modifying existing structures. Refer to the structural and architectural drawings in Volume 2 of this report.

5.1.1 Codes and Specifications

The following codes would be used in addition to the general design standards listed in Section 1.2:

- The International Building Code 2003 (IBC) – Village of Skokie
- The International Fire Code 2003 (IFC)
- NPFA 101, Life Safety Code, 1997 Edition
- OSHA, United States Department of Labor, Occupational Safety and Health Administration, Latest Edition
- Building Code Requirements for Structural Concrete, (ACI 318-02) and Commentary, (ACI 318R-02).
- Code Requirements for Environmental Engineering Concrete Structures, ACI 350-01) and Commentary (ACI 350R-01).
- Seismic Design of Liquid Containing Concrete Structures, (ACI 350.3-01), and Commentary, (ACI 350.3R-01).
- ACI "Manual of Concrete Practice", 2005, American Concrete Institute, Detroit, MI.
- ACI Committee 315, "Details and Detailing of Concrete Reinforcement, ACI 315-99.
- Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design, Ninth Edition, June 1, 1989
- Manual of Steel Construction Allowable Stress Design, Ninth Edition, 1989
- Building Code Requirements for Masonry Structures and Commentary, ACI 530-02, ASCE 5-02/TMS 402-02 and Specification for Masonry Structures and Commentary, ACI 530.1-02/ASCE 6-02/TMS602-02.
- American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures, ASCE 7-02.

- American Association of State Highway and Transportation Officials, AASHTO, Standard Specifications for Highway Bridges, Seventeenth Edition, 2002
- Soil Boring Logs in Contract 78-020-CP For Secondary Treatment Facilities at the North Side Sewage Treatment Works.
- The Illinois Accessibility Code 2004.
- The Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) “Standard Specifications”.
- The MWRDGC Design and Construction Manual, “Engineering Standards”.
- United States Naval Facilities Command (NAVFAC), September 1986, “Design Manual 7.02, Foundations and Earth Structures”.
- CFR 29 Parts 1900-1910.999 and Part 1926, OSHA
- American Society for Testing Materials (ASTM) Standards.
- American Welding Society, ANSI/AWS D1.1-98, “Structural Welding Code – Steel”

5.1.2 Loads

The following design loads would be used for the proposed structures:

Tanks, Channels and Structures Below Grade:

- Hydrostatic liquid pressure-operating water level/flood water level – 62.4 psf.
- Lateral earth pressure for active, at-rest and passive conditions – Per Geotechnical Report (lateral load due to surcharge loading of H-20 truck would be added).
- Surcharge Load – 3 feet of soil.
- Frost depth – Minimum 3′-6” below finished grade.
- Design high ground water table elevations. All new structures would be checked for buoyancy for the case of high ground water table at finished grade and dead load of the structure only and is described in Part 6.1.4 below.

Roof Slab at or below Grade:

- DL: Weight of concrete slabs
- SDL: Backfill and other superimposed dead loads including underhung ancillary equipment and piping
- LL: The equivalent of 3 feet of soil or H-20 truck loading whichever governs

Buildings and Miscellaneous Structures:

- Loadings for design of the building would be obtained from appropriate codes; however, certain minimum loads would be used as shown in Part 6.1.2.3 below.

Minimum Uniform Live Loads:

- Checkered Plate 150 psf
- Grating 100 psf
- Stairs and catwalks 100 psf
- Electrical control rooms: 250 psf - Estimate support area and equipment weights and assume loads

- applied anywhere in area
- Heavy Equipment rooms 300 psf
- Dismantling and storage
- Storage areas: 150 psf - Determine reasonable stacking height and type of stored material
- Shop floors: 150 psf
- Garage floors: 150 psi
- Truck wheel loads per AASHTO and as appropriate
- All other: 150 psf
- Fastest mile wind speed (miles per hour): 75 mph
- Snow (minimum): 30 psf - Snow drift loads would be checked where applicable in addition to all top supported and under hung ancillary equipment and piping
- Underhung piping and equipment in addition to the required: 50 psf minimum live load
- Equipment live load plus 50 psf on adjacent areas, or minimum uniform live load, whichever is greater

Seismic Requirements – Cook County:

Buildings and Non-Liquid Containing Structures (IBC):

- Seismic use group Group II
- Seismic design category B
- Seismic Importance Factor 1.25
- Spectral response acceleration for short period (SDS) 0.192
- Spectral response acceleration for 1 second period (SD1) 0.10
  - Soil profile name Stiff soil profile
  - Site class D

Liquid Containing Structures (ACI 350.3-01):

- Seismic zone factor 0

5.1.3 Design Stresses

The following stresses would be used for design of the structures:

Concrete and Reinforcing Steel:

Liquid Containing Structures:

- Use ACI 350-01, Code Requirements for Environmental Engineering Structures (ACI 350-01) and Commentary (ACI 350R-01) and Seismic Design of Liquid Containing Concrete Structures (ACI 350.3-01) and Commentary (ACI 350.3R-01).
- Concrete compressive strength at 28 days : fc' = 4,500 psi
- Reinforcing steel (A 615, Gr. 60) flexural stress: fy = 60,000 psi

Building and Non-Liquid Containing Structures:

- Use Strength Design Method of Building Code Requirements for Structural Concrete (ACI 318-02) and Commentary (ACI 318R-02).
- Concrete compressive strength at 28 days: fc' = 4,500 psi
- Reinforcing steel (A 615, Gr. 60) flexural stress: fy = 60,000 psi

Structural Steel

- Conform to the AISC Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design, Ninth Edition, 1989, and the Manual of Steel Construction, Allowable Stress Design utilizing the following materials.
- ASTM A 992 for W shapes, unless otherwise specified
- ASTM A 36 for angles plates and bars
- ASTM A 325 high strength bolts
- ASTM A 307 or A 36 bar stock for anchor bolts

5.1.3 General Design

The following reinforced concrete structures would contain continuous PVC waterstops at all vertical and horizontal construction and expansion joints in walls and slabs:

1. All fluid containing structures.
2. All basements and below ground structures with one surface in contact with soil or water and the opposite surface dry and exposed.

Fluid applied waterproofing would be applied to the exterior surfaces of all walls with one surface in contact with soil and the opposite surface dry and exposed.

All structures below grade, including, but not limited to, basements, tanks, and other buried structures, would be designed to resist buoyancy for a groundwater table at finished grade. Only the dead weight of the concrete structure below ground and soil on the foundation footings around the outside of buildings, tanks, and other buried structures would be relied on to resist buoyancy. Pressure relief valves and/or perimeter drains and sump pits with pumps would not be used to resist buoyancy.

All access hatches would be stainless steel. Handrails would be stainless steel.

5.1.4 Foundation Design

The foundation design for the various structures was based on existing available borings and interpretations of these borings by an independent Geotechnical Engineer for use in estimating foundation costs for this preliminary phase of work. Based on this information, it was determined that a pile foundation is required to support the UV Facility and the Low Lift Pump Station, and for the purposes of this study, it would be assumed that 40 ton capacity, concrete filled pipe piles would be required for the support of the UV Facility and the Low Lift Pump Station.

Prior to final design, a detailed subsurface investigation should be undertaken to characterize the soils, including soil borings, interpretation of the borings and for the final selection of the type of foundation that would be required.

5.2 NSWRP UV FACILITY

The new UV Facility would be a one story reinforced concrete building with five (5) channels for the five (5) UV Reactors, an electrical room, a storage room, a control room and an effluent sampling room. The exterior wall construction would be a non-load bearing composite cavity wall composed of concrete masonry units, airspace, insulation and an exterior face brick. The exterior masonry materials and detailing would be similar to existing onsite masonry structures.

The roof structure would be constructed using one-way, cast-in-place reinforced concrete slabs spanning cast-in-place reinforced concrete beams. The beams would be supported by cast-in-place reinforced concrete columns. The roofing would be composed of fully adhered cold applied roofing membrane over tapered rigid insulation. The roof drainage would be directed to scupper boxes at the perimeter of the building. The scupper boxes would connect to downspouts leading drainage to grade. Aluminum skylights would be provided over each reactor to permit natural light into work areas. An aluminum framed window would be provided in the control room for visual access to the UV reactor room.

Personnel doors would be stainless steel frames and doors. The double doors in the electrical room would have a removable transom to provide access for large equipment. The overhead door would be an insulated aluminum coiling door. Specialty floor hatches would be provided to accommodate the UV equipment maintenance. The interior floor finish in the building would be hardened concrete outside of the control room and effluent sampling room. The control room and effluent sampling room would have suspended acoustic ceilings and resilient tile flooring. Interior partitions and concrete structure would be painted.

The entire substructures, including channels and foundation grade beam/walls would be constructed of cast-in-place reinforced concrete supported on concrete filled pipe piles. Gratings in the UV Reactor Room would be galvanized steel with galvanized steel perimeter angles and supports.

5.3 LOW LIFT PUMP STATION

The new LLPS would be a 40'+ steel supported building (one story) with a pump room and an electrical room. The exterior wall construction would be a non-load bearing composite cavity wall composed of concrete masonry units, airspace, insulation and an exterior face brick. The exterior masonry materials and detailing would be similar to existing onsite masonry structures.

The roof structure would be constructed using standard galvanized roof decking to span the steel support beams. The beams would be supported by steel columns. The roofing would be composed of fully adhered cold applied roofing membrane over tapered rigid insulation. The roof drainage would be directed to scupper boxes at the perimeter of the building. The scupper boxes would connect to downspouts leading drainage to grade. Removable, double hip-type, aluminum, structural skylights would be provided over each pump to permit natural light into work areas and removal of the pumps by crane in the future.

Personnel doors would be stainless steel frames and doors. The double doors in the electrical room would have a removable transom to provide access for large equipment. The overhead door would be an insulated aluminum coiling door. The interior floor finish in the building would be hardened concrete. Interior walls and concrete structure would be painted.

The entire substructures, including channels and foundation grade beam/walls, would be constructed of cast-in-place reinforced concrete supported on concrete filled pipe piles.

6.0 NSWRP ELECTRICAL

6.1 Codes/Standards

The following codes and standards are required for this project.

- NFPA-70 National Electrical Code, 2002 or latest adopted by the Village of Skokie.
- NFPA-820 Fire Protection in Wastewater Treatment and Collection Facilities, 2003.
- Institute of Electrical and Electronics Engineers (IEEE).
- MWRDGC GS, February 1997.
- MWRDGC GSE, March 1994.
- Underwriters Laboratories (UL).
- National Electrical Manufacturer's Association (NEMA).
- Insulated Power Cable Engineers (IPCEA).
- Illuminating Engineering Society (IES).

6.2 Electric Service

A redundant electric service to the UV Disinfection Facility and the Low Lift Pump Station would be provided. A new electric service transformer yard is planned for the new Battery E to the north of the Chicago Transit Authority right of way. Facilities would be provided at the Battery E service from ComEd for service to UV Disinfection Facility.

A medium voltage cable in underground ductbank would be provided from the Battery E service location to supply the UV Disinfection Facility.

In addition, per ComEd policy, the District would be responsible for costs to upgrade ComEd transmission system improvements required to provide the new electrical power to the new transformer yard near Battery E. ComEd improvements would include:

1. Protective device adjustment at TSS-85 (substation immediately north of existing WRP site).

2. Underground conduit and cable to provide service to the new District transformer yard adjacent to the proposed location for Battery E.

3. New overhead power transmission line from intersection of Skokie Boulevard and Oakton Street to provide redundant power service from separate substation (TSS-88 located in Skokie, Illinois at Church Street and I-94).

4. Protective device adjustment at TSS-88.

The proportional costs for UV disinfection for the ComEd improvements and the new electrical service transformer yard are included in the overall estimate for disinfection as shown in Section 10. The proportional cost would be 70% of the total cost based on the UV power demand of 5 MVA versus the total power demand of 7 MVA (5 MVA for UV disinfection + 1 MVA for Battery E + 1 MVA for future improvements).

6.2 System Grounding

Electrical systems shall be solidly grounded. Grounding shall be in accordance with the National Electrical Code and the Chicago Electrical Code for equipment grounding and bonding conductors for grounding raceway and equipment.

6.3 Conduit

Exposed conduit shall be PVC coated Rigid Galvanized Steel Conduit. Conduits in non-finished areas shall be installed either exposed on the surface of the structure or concealed in concrete floor slabs or below grade. Conduits below grade outside of the building shall be rigid steel and shall be encased in reinforced concrete. Ductbanks shall have 50 percent spare conduits.

Conduits shall conform to MWRDGC General Specifications: Electrical (GSE) Table 1 (Page GSE-8).

Spacing of supports for exposed conduit shall conform to MWRDGC GSE Table 3 (Page GSE-10).

6.4 Wire

600 volt Insulated copper conductors in conduit shall be provided for all power, control, alarm, instrumentation, signal, lighting and grounding installations, unless otherwise indicated. The insulation shall meet ANSI/NFPA 70. The wire and cable shall conform to the MWRDGC GSE Table 4 (Page GSE-10).

Medium voltage cable shall be ethylene propylene rubber (EPR) insulated cable, U.L. listed and labeled MV-90, 133% insulation level, single conductor copper, Class B strand.

6.5 Motors

Motors 1/2 horsepower and larger shall operate on 480 volt, 3-phase, AC power supplies, and motors smaller than 1/2 horsepower shall operate on 120 volts, single phase, AC power supplies.

6.6 Emergency Systems

The emergency system for new areas would be supplied from the existing emergency supply. Emergency lights would have unit batteries to provided final reserve source of current supply.

Emergency lighting and exit signage would be provided as per code requirements to illuminate the path of ingress/egress in emergency situations. Separate emergency lighting panels (EP) would be provided as per the Village of Skokie electrical code.

6.7 Lightning Protection

New structures shall be protected by a lightning protection system. The system shall be a conductor system protecting the entire building and consisting of copper air terminals on the building roof parapets; grounding electrodes; and copper interconnecting conductors.

The system shall be designed in accordance with ANSI/NFPA 780 - Lightning Protection Code and shall have a UL Master Label. The lightning protection system components shall conform to ANSI/UL 96 - Lightning Protection Components.

6.8 Specific Electrical Equipment

The basis of specific design equipment is described below.

6.8.1 Medium Voltage Switchgear

Table 6.8.1-1 describes medium voltage switchgear. **Table 6.8.1-2** describes the criteria to be used for circuit breakers.

Table 6.8.1-1
Medium Voltage Switchgear Criteria

Item	Criteria
Type	Medium Voltage Metal-clad Draw-out Switchgear
Standards	▪ NEMA SG.5 ▪ ANSI C37.20.2
Rated Voltage	13,200 Volts
Number of phases	3
Bus Material	Tin plated copper
Rated BIL	95,000 Volts, to be coordinated with surge arrester rating
Minimum Main Bus Rated Ampacity	2,000 Amperes
Minimum interrupting capacity	500 MVA
Manufacturer	▪ Cutler Hammer. ▪ ABB - ASEA Brown Boveri. ▪ Siemens Energy and Automation. ▪ Approved equal.
Metering Type	Solid State Multifunction
Metering Location	Main circuit breaker and other critical feeder circuit breakers
Relaying Type	Solid state multifunction
Relaying Manufacturer	Schweitzer Engineering Laboratories, SEL Areva NP Co. Approved equal
Enclosure Rating	NEMA 1

Table 6.8.1-2
Circuit Breaker Ratings and Features Criteria

Item	Criteria
Type	▪ Draw-out carriage type with racking mechanism. ▪ Circuit breakers shall be vacuum type.
Operator Voltage	Electric, 125 Vac
Controls	Manually operated electric controls with piston grip switches and indicator lights. Location would be coordinated with Arc Flash analysis.
Minimum circuit breaker frame current rating.	1,200 Amperes
Manufacturer	Same as Switchgear manufacturer

6.8.2 Pad Mounted Transformers

Table 6.8.2-1 provides the design criteria for pad-mounted transformers.

Table 6.8.2-1
Pad-Mounted Transformer Criteria

Item	Criteria
Type	Outdoor, Oil-filled Power Transformer
Primary connection type	Elbow Type terminators
Primary Voltage	13,200 Volts
Primary Number of phases	3
Primary wiring configuration	Delta connection, 3-wire
Secondary Connection type	Bolt-on type bushing
Secondary Voltage	480/277 Volts
Secondary Number of phases	3
Secondary wiring configuration	4-wire, grounded
Efficiency	Peak efficiency point of pad mounted transformers to be at 50% of efficiency rating.
Capacity	2,000 kVA or as required
Primary BIL	95,000 Volts, to be coordinated with surge protection rating
Secondary BIL	30,000 Volts, to be coordinated with surge protection rating
Nominal Impedance	5.75 percent
Temperature Rise	55/65 Degrees C
Transformer insulating oil	Non-flammable, environmentally safe insulating fluid
Manufacturers	▪ ABB - ASEA Brown Boveri ▪ Cooper Power Systems (RTE) ▪ Square D ▪ General Electric ▪ Approved equal

6.8.3 Secondary Unit Substation

Table 6.8.3-1 summarizes the design criteria for secondary unit substation. **Table 6.8.3-2** provides the criteria to be used for the low voltage distribution.

Table 6.2.3-1
Secondary Unit Substation

Item	Criteria
Type	Radial Secondary Unit Substation with close coupled air terminal compartment and close coupled Secondary Low Voltage Switchgear
Standards	NEMA 210
Transformer Type	Dry type
Transformer insulation system	Vacuum pressure impregnation with polyester resin (VPI)
Primary equipment	Air terminal compartment
Primary Voltage	13,200 Volts
Primary Number of phases	3
Primary wiring configuration	Delta connection, 3-wire
Secondary Connection type	Bolt-on type bushing
Secondary Voltage	480/277 Volts
Secondary Number of phases	3
Secondary wiring configuration	4-wire, grounded
Efficiency	Peak efficiency point of transformers to be at 50% of efficiency rating.
Capacity	1,500-2,000 kVA or as required
Primary BIL	95,000 Volts, to be coordinated with surge protection rating
Secondary BIL	10,000 Volts, to be coordinated with surge protection rating
Winding Material	Copper
Nominal Impedance	5.75 percent
Temperature Rise	80 Degrees C
Minimum K factor	K4
Accessibility	Front and rear
Enclosure Rating	NEMA 1
Manufacturers	▪ Cutler-Hammer. ▪ ABB - ASEA Brown Boveri ▪ Square D ▪ General Electric ▪ Approved equal

6.8.4 Low Voltage Switchgear

Table 6.8.4-1 provides the design criteria for low voltage switchgear. **Table 6.8 .4-2** lists the criteria for circuit breakers.

Table 6.8.4-1
Low Voltage Switchgear Criteria

Item	Criteria
Type	Type DS, Metal-Enclosed Drawout Switchgear
Enclosure Rating	NEMA 1
Standards	NEMA SG-5 ANSI C37.20.1 UL 1558
Rated Voltage	480 Volts
Number of phases	3
Bus Material	Tin plated copper
Minimum Main Bus Rated Ampacity	3000 Amperes
Minimum interrupting capacity	100 kA
Accessibility	Front and rear
Manufacturer	Cutler Hammer
Metering Type	Digital Solid State multifunction meters
Metering Location	Main circuit breaker and other critical feeder circuit breakers
Relaying Type	Solid state multifunction
Relaying Manufacturer	Schweitzer Engineering Laboratories, SEL Areva NP Approved equal

Table 6.8.4-2
Circuit Breaker Ratings and Features Criteria

Item	Specifications
Type	Draw-out carriage type with racking mechanism.
Standards	NEMA SG-3 ANSI C37.13, C37.16, C37.17 UL 1066
Operators	Manual
Controls	Manual with position indicator lights.
Minimum circuit breaker frame current rating.	800 Amperes
Manufacturer	Same as Switchgear manufacturer

6.8.5 Motor Control Centers

The design criteria for motor control centers are summarized in **Table 6.8.5-1**.

Table 6.8.5-1
Motor Control Center Criteria

Item	Criteria
Rated Voltage	480 Volts
Number of phases	3
Main bus minimum current rating	600 Amperes
Bus Material	Tin-plated Copper
Minimum short circuit rating	100,000 Amperes
Accessibility	Front only
Wiring class	NEMA Class II-S, Type B.
Overload Protection type	Solid State Type.
Metering type	Digital Solid State multifunction meters.
Enclosure type	NEMA 12
Manufacturer	▪ Cutler-Hammer. ▪ Allen Bradley. ▪ Square D Corp. ▪ Siemens Energy and Automation. ▪ Approved equal

7.0 NSWRP INSTRUMENTATION SYSTEM

The control of the process equipment shall be integrated into the existing DCS System which is provided by ABB.

The monitoring and control of the Low Lift Pump Station and the UV Disinfection Facility would be provided via the plant DCS System. Manual local control of the equipment would be provided. See Section 4.0 for a description of the control philosophy for the LLPS pumps and the UV Disinfection System.

7.1 Applicable Codes and Standards

Where applicable, the latest version of the codes and standards from the following institutions/organizations would govern the design:

- National Electrical Code (NFPA 70) – with Village of Skokie local amendments.
- National Fire Protection Association (NFPA) standards:
- NFPA 820 Fire Protection in Wastewater Treatment and Collection Facilities
- Underwriter's Laboratories (UL)
- Illuminating Engineering Society of North America (IESNA)
- Institute of Electrical and Electronic Engineers (IEEE)
- National Electrical Manufacturers Association (NEMA)
- National Electrical Contractors Association (NECA)
- MWRDGC Standard Details and Specifications
- Variable Frequency Drives Reference Standards
- American National Standards Institute (ANSI)
- ANSI/IEEE 519 – IEEE Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

- ANSI/IEEE 597 – IEEE Practices and Requirements for General Purpose Thyristor DC Drives.
- National Electrical Manufacturers Association (NEMA)
- NEMA ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems.
- NEMA ICS 7 - Industrial Control and Systems: Adjustable Speed Drives.

8.0 NSWRP MECHANICAL AND PLUMBING

8.1. Mechanical Codes

Where applicable, the latest version of the codes and standards from the following institutions/organizations would govern the design:

- The International Mechanical Code 2003
- The International Plumbing Code 2003
- National Fire Protection Codes (NFPA), Section 820, 2007
- American National Standards Institute (ANSI)
- American Society For Testing Materials (ASTM)
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- SMACNA – HVAC Duct Construction Standards
- International Building Code 2003

8.2 Basis of Design

The UV Disinfection Building and the LLPS would follow the International Building Codes for fire protection pending future direction by the District.

8.2.1 Ventilation Rates

The ventilation rates are selected based upon the need to conform to the recognized national standards applying to wastewater treatment plants. Specifically, NFPA 820, "Standard for Fire Protection in Waste Water Treatment and Collection Facilities" and the "International Fire Code" are used for the design.

8.2.2 Design Temperatures

Design temperatures are based upon local climatic data found in the latest edition of ASHRAE Handbook of Fundamentals

<u>8.2.2.1 Heating</u>

The design space temperature for all process areas would be 55ºF with an outdoor air temperature of -10ºF. The design space temperature for occupied areas would be 70ºF.

<u>8.2.2.2 Air Conditioning</u>

The design space temperature and humidity conditions for areas requiring air conditioning would be 78ºF DB, 50% RH with an outdoor air condition of 91ºF DB, 75ºF WB. Summer ventilation only spaces would have a maximum design space temperature rise of 15ºF.

8.2.3 Plumbing

The plumbing systems for the UV Disinfection Building and LLPS would be designed to the "International Plumbing Code", 2003.

8.2.3.1 Potable Water

Potable water would be supplied to the wash sink in the UV Disinfection Building from plant potable water distribution system.

8.2.3.2 Effluent Water (aka Plant Service Water)

Effluent water would be available from the plant effluent water distribution system. Effluent water would be provided for equipment wash down in the UV Disinfection Building and the LLPS.

8.2.3.3 Sanitary Drainage

General floor drainage would be provided in all rooms as required by codes. Drainage from the wash sink and the effluent water sampling sink would be routed to the plant sanitary drain. Floor traps and sink traps would be vented.

8.2.3.4 Fire Protection

The fire protection system would consist of portable fire extinguishers and fire hydrants, in accordance with the requirements of NFPA 820 and local code requirements.

8.3 Proposed Mechanical and Plumbing System

The following section details the proposed equipment and operation.

8.3.1 UV Disinfection Facility

Air-conditioning would be provided for the operator control room. Heating for the electrical room would be provided by electric unit heaters. Heating for process and storage rooms would be provided by steam unit and space heaters.

Summer ventilation for the electrical room and filter room would be designed for a maximum space temperature increase of +15ºF over ambient. Temperature control would consist of cycling exhaust fans that are interlocked with outside air intake dampers. Summer ventilation for the effluent sampling room and storage room would consist of 4 air changes per hour. Exhaust fans for the electrical room would consists of two exhaust fans at 50% design capacity and one standby exhaust fan. Exhaust fans for the UV disinfection room would be sized for 2/3 design capacity.

Effluent hydrants and hose reels would be provided for wash down of the UV system at the north and west doors. Potable water would be provided to the wash sink at the west door. An inline instant water heater would be provided for domestic hot water.

8.3.2 Low Lift Pump Station

Heating for the electrical room would be provided by electric unit heaters. Heating for the pump room would be provided by steam unit heaters.

Summer ventilation rates for the electrical room and the pump room would be designed for a maximum space temperature increase of +15ºF over ambient. Temperature control would consist of cycling exhaust fans that are interlocked with outside air intake dampers. Exhaust fans for the electrical and pump room would consists of two exhaust fans at 50% design capacity and one standby exhaust fan.

9.0 NSWRP AREAS REQUIRING FURTHER ANALYSIS

The following areas require further analysis as part of a preliminary design effort prior to final design of the proposed facilities.

1. A detailed subsurface investigation is recommended to characterize the soft silty clay layer and underlying soil layers. Both strength and consolidation properties of these soils should be determined by field and laboratory testing. This data would be necessary for the final selection and design of the foundation system by a qualified geotechnical engineer.

2. More complete investigation of rail embankment and methods required for construction of the retaining wall and connection to the existing plant effluent conduit is recommended. Specifically, depending on the method of construction and fill material of the embankment, dewatering efforts could be substantially greater than those assumed for this report.

3. A more detailed evaluation of the layout and location of the gate structures and flow conduits is recommended. A more optimal arrangement that may consolidate several functions could be developed during preliminary design.

4. A more detailed evaluation of potential pump types and arrangements for the LLPS. Historically, horizontal arrangements, similar to the existing Wilmette Lock pumps, have been used in flood control projects that might be applicable here.

5. A more detailed evaluation of large-scale M&O requirements for the selected UV technology is recommended to ensure the appropriate equipment spacing, operations rooms, and storage space is provided in the new facilities. Existing large-scale facilities are either based on older technology or are operated intermittently as wet weather facilities. A pilot facility is recommended to provide this information. Estimated construction cost is $2,200,000 not including operational costs or performance evaluation.

6. Physical scale modeling during preliminary design of the LLPS is strongly recommended per Hydraulic Institute Standards for a pump station of this size and given the deviation from the ideal inlet configuration.

7. Costs for addition of a ComEd Substation are not currently included in the costs for implementation of the UV Disinfection Facilities, although a new substation on the north site would be required.

10.0 NSWRP PRELIMINARY COST OPINION

A preliminary opinion of probable construction (OPCC) of the North Side WRP UV Disinfection Facilities is estimated at approximately $108.8 million including engineering and administrative costs as shown in **Table 10.0-1**, which also presents annual operating costs and a 20-year net present worth value for the project. Annual operating costs are based on the facilities operating from March to November each year. Appendix F provides detailed line item summary tables for capital and M&O estimates.

The estimated construction cost is based on June 2007 dollars represented by an Engineering News Record (ENR) Construction Cost Index (CCI) of 7983.

Table 10.0-1 – NSWRP UV Disinfection Facilities Preliminary OPCC and M&O Costs

Capital Cost Estimates	
NSWRP UV Pilot Plant	$2,200,000
ComEd Service Upgrade Charge	$2,900,000
A. General Sitework	$27,200,000
B. Low Lift Pump Station	$27,000,000
C. Disinfection System	$49,500,000
Total Capital Cost	$108,800,000
Maintenance & Operations Cost Estimates	
A. General Sitework	$130,000/yr
B. Low Lift Pump Station	$1,100,000/yr
C. Disinfection System	$3,590,000/yr
Total Annual M&O Cost	$4,830,000/yr
Total Present Worth M&O Cost	$111,900,000
Total Present Worth	$220,700,000

All costs in 2007 dollars.

Per District guidelines, this opinion is categorized as a Level 3 as defined by the Association for the Advancement of Cost Engineering Recommended Practice No. 18R-97 and represents a conceptual estimate with an expected deviation range from actual cost of -15% to +30% assuming no substantial change in scope or extraordinary events and not including escalation from the date of this report to the start of construction.

10.1 Basis of Opinion of Capital Cost

The assumptions made used to develop the capital costs for the proposed facilities are summarized below and/or described in the previous sections:

- Design Flow: Maximum design flow was used (NSWRP = 450 mgd).
- Proposed Effective Disinfection Limit (E. Coli, cfu/100 ml): 400 monthly geo-mean for North Side.
- UV Disinfection:
  - UV Transmission: 65% minimum per IEPA standard
  - UV Dosage: 40 mJ/cm^2 per UV_{dis} sizing software
- Each plant would disinfect effluent from March 1 through November 15. During the remaining months, the disinfection facilities, including LLPS, would be bypassed.
- Cost opinions were divided into the following categories:
  - Site Work
  - Low Lift Pump Station
  - UV Disinfection Building
- Costs for major equipment were obtained from the following vendors:

Technology/Process	Vendor
UV Reactors	Trojan Technologies, Inc.
Axial Flow Pumps	Sulzer Pump, Morrison Pump
Flap Gates	Rodney Hunt
Slide Gates (various sizes)	Rodney Hunt, Whipps

- UV channels were enclosed in a UV building.

- Redundancy
  - UV – multiple channels were used to meet the effluent limit at peak flow with one channel out of service.
  - Pumps were provided with N+1+1 redundancy per the District's standard guidelines.

10.2 Basis of Operation and Maintenance Costs

The assumptions used to develop the maintenance and operating costs are presented below:

- A power cost of $0.0684/kW-hr was used as a composite rate based on the District's 2007 power supply contract.
- Labor rates were developed based on the results of the phone survey of similar facilities, discussions with the manufacturer, and recommendations by the District.
- UV Disinfection Building and the LLPS would operate from March 1 to November 30 each year.
- Annual UV lamp replacement and disposal costs were based on the following replacement schedule:
  - Lamps replaced each year (100% per year)
  - Ballasts replaced every five years (20% per year)
  - Quartz sleeves replaced every 10 years (10% per year)
  - Wipers replaced every 3 years (33% per year)
  - Lamp disposal costs are included in the costs of the new lamps
- Miscellaneous parts and supplies assumed to be 5% of equipment costs including pumps, valves, piping, HVAC equipment, electrical equipment, etc. UV equipment not included.
- Labor rates were developed based on the data received from the District.
- The labor requirements presented in **Table 10.2-1** were assumed for the three components of the facilities.

Table 10.2-1 – M&O Labor Requirements

Activity	Labor Type	Number	Hours per Week per Worker
Site Work			
Routine Maintenance (Gates, Roads, Conduit, Utilities, Landscaping)	Laborer	1	10
Low Lift Pump Station			
Routine Maintenance (Pumps, Valves, Electrical Equipment)	Laborer	1	10
	Electrician	1	5
Operations	Operator	1	40
UV Disinfection Building			
Routine Maintenance	Electrician	1	2
Lamp Replacement	Electrician	2	8
Lamp Inspection/Cleaning	Electrician	2	40
Operations	Operator	2	40

10.3 Basis of Net Present Value Calculation

In order to develop a net present worth valve for comparison to other alternatives with differing M&O costs, a present worth factor of 23.17 was used for all present worth calculations, based on a nominal 4.875% interest rate for 20 years with a 3.0% inflation factor.

The interest rate is the 2007 nominal discount rate published by authority of the Water Resources Development Act of 1974. The use of this discount rate mirrors the United States Army Corps of Engineers policy related to calculation of life cycle costs for comparative analysis. The current annual rate can be obtained from the US Department of Agriculture, Natural Resources Conservation Service (http://www.economics.nrcs.usda.gov/cost/priceindexes/rates.html).

The inflation rate was developed by comparison of three common inflation indicators. Those indicators are:

1. Gross Domestic Product Deflator
2. Consumer Price Index (CPI)
3. Producer's Price Index (PPI)

As of the end of August 2007 (most recent available data), the three indicators have a 10-year rolling average inflation of 2.6%, 2.9%, and 2.6% respectively. Data for the GDP Deflator is available from the US Department of Commerce, Bureau of Economic Analysis, Table 1.1.9 (http://www.bea.gov/national/nipaweb/SelectTable.asp). Data for the CPI and PPI is available from the US Department of Labor, Bureau of Labor Statistics (http://www.bls.gov/home.htm). Therefore, a value of 3.0% was selected to provide a reasonable, yet conservative, estimate of inflation.

10.4 Discussion of Cost Estimate Line Items

The preliminary opinion of probable construction cost was developed based on the drawings developed as part of this study (see Volume 2), CTE's knowledge of local construction market, CTE's experience with similar projects, specific budgetary quotes from equipment suppliers, and industry standard practices. The quantities for each item included in the cost estimate were measured from the drawings or estimated based on CTE's understanding of probable means and methods of construction.

In general, unit costs for each line are considered assembly costs including labor and materials for that item plus ancillary items normally associated with that item unless included elsewhere. For example, concrete costs are given including formwork, rebar, and concrete, but not including excavation and backfilling, which are included as separate line items. While an explanation of all line items included in the estimate is not provided, specific line items that warrant additional information are described below in **Table 10.4-1**.

Table 10.4-1 – OPCC Selected Line Item Description

Line Item	Description/Additional Information
General Requirements	General requirements include project specific insurance (such as payment and performance bonds) and other project specific overhead costs (i.e. field personnel labor, field trailers, field office supplies, general quality control testing, shop drawing preparation, O&M manual preparation, and permit fees). It is assumed to be 15% of the total project direct costs.
Sheeting/Shoring (Site Work)	Cost for installation of sheeting for work on rail embankment including installation by vibratory pile driver on weekends only.
Hand Mining/Connection/ Bulkheading at U/S Connection to Existing Final Effluent Conduit	This line item is a lump sum estimate of the cost to make the connection to the existing final effluent conduit upstream of Gate Structure #1 including hand mining, shoring, demolition, bulkheading, restoration, and backfilling with substantial costs for overtime due to the critical nature of the connection and the need to minimize shutdown of the CTA rail operation. No costs for alternate CTA transportation are included.
Bulkheading and Removal at Gate Structure #3	This line item is a lump sum estimate of the cost to make the connection to the existing final effluent conduit at Gate Structure #3 including demolition, dewatering, bulkheading, restoration, and backfilling.
Utility Items (Site Work)	Assembly costs for utility line items include trenching, shoring, materials, installation, backfilling and placement of topsoil per linear foot of the utility.
Conduits (Site Work)	Assembly costs for conduit line items include excavation, shoring, formwork, rebar, concrete, backfilling and placement of topsoil per linear foot of the conduit.
Pile Mobilization, Piles, Pile Load Test	Costs for installation of 12” concrete piles to support LLPS, UV Disinfection Building, and gate structures. Assumed depth of piles is 50 feet to reach hardpan or bedrock.
Concrete (Base Slabs, Walls, and Elevated Slabs)	Assembly costs for concrete installation including rebar, formwork, and concrete. Does not include excavation or backfill.
Interior walls (masonry)	Assembly costs for construction of masonry interior wall including block, mortar, installation and ancillary costs. Does not include coatings.
Exterior walls (masonry)	Assembly costs for construction of masonry exterior wall including block, insulation, brick, mortar, installation and ancillary costs. Does not include coatings.
Pumps	Budgetary equipment costs from suppliers plus 25% for installation. Includes delivery, startup, and training services.
UV Reactors	Budgetary equipment costs from supplier plus 15% for installation. Includes delivery and installation certification services. Startup and M&O training included separately.
Escalation	Escalation is assumed to be 5% per year. Construction period is assumed to be 35 months. Therefore, escalation to the mid-point of construction is 7.5%.
Contractor’s Markup on Subcontractors	Contractor’s markup on subcontractors is assumed to be 5%. This markup is applied to all direct project costs except the general conditions line item.
Contractor’s Overhead and Profit	Contractor’s overhead of 5% includes general contractor overhead including front office costs and project manager’s time. Profit is assumed to be 10%.
Contingency	Consistent with AACE guidelines and District policy, a contingency factor of 30% has been added to the OPCC to cover unknown costs associated with the project. Contingency does not include escalation from the point of time of estimate to beginning of construction, extraordinary events, or changes to the scope of the project.

11.0 NSWRP SCHEDULE OF IMPLEMENTATION

The anticipated schedule for implementation of the design of North Side WRP UV Disinfection Facilities is approximately 8 years, assuming no delay between activities after commencement of Preliminary Design. **Table 11.0-1** provides a summary of the anticipated activities and their durations.

Table 11.0-1 – Projected Schedule of Implementation

Activity	Duration
Design of Pilot Facility and Concurrent Collimated Beam Testing Program	12 months
Regulatory Review of Pilot Facility Design	6 months
Construction of Pilot Facility	9 months
Operation of Pilot Facility/Evaluation of Technology and Scale-up	18 months
Design of Full-Scale Facility	12-18 months
Regulatory Review of Full-Scale Design	6 months
Construction of Full-Scale Facility	24-30 months
Commissioning/Startup	3 months
TOTAL	90-102 months

12.0 CALUMET WRP PRELIMINARY COST OPINION

The proposed UV Disinfection Facilities at the CWRP are essentially equivalent to those proposed at the NSWRP. While an evaluation to the level equivalent to the evaluation of the proposed facilities at NSWRP was not completed as part of this study, it can be assumed that the costs for implementation of UV Disinfection at the CWRP would be largely commiserate with the costs for the same facilities at NSWRP. The facilities would be generally identical to the NSWRP facilites with the following exceptions:

1. Existing information on soils in the CWRP area indicates that there is no need for deep foundations to support the proposed structures, nor for the upstream and downstream connections to the existing effluent (assumed to reuse existing chlorine contact chamber gates).

2. The arrangement of the CWRP facilities, specifically the digesters, chlorine contact chambers (out-of-service), and final effluent conduits create a constrained site with no space available to locate the proposed disinfection facilities. Therefore, it is assumed that the chlorine contact chambers would be demolished to provide space for the UV Disinfection Facilities. However, it is assumed that only the walls would be demolished and the void filled with common fill or structural fill as appropriate. The existing base slab would be left in place.

3. The ComEd power transmission system improvements are based on the transmission system specific to CWRP. Per ComEd representatives, the only expected improvements would be adjustment to existing protective devices at the ComEd transformer yard at CWRP.

4. The peak design flow for CWRP is 480 mgd compared to 450 mgd for the NSWRP.

It should also be noted that the CWRP is currently experiencing restrictions in plant capacity during wet weather events due to backwater effects in the plant outfall. Therefore, a LLPS is assumed necessary at the CWRP.

To estimate the costs for the UV Disinfection Facilities at CWRP, CTE deducted the costs for the deep foundations and special connections to effluent conduits, multiplied the remaining capital cost estimate by the ratio of 480 mgd to 450 mgd, and added the cost for demolishing the existing chlorine contact chambers. **Table 12.0-1** provides a summary of those actions.

Table 12.0-1 – Summary of CWRP UV Disinfection Facility Cost Development

NSWRP Site Work	$27,170,000
DEDUCT Deep Foundations	$5,760,000
Subtotal	$21,410,000
MULTIPLY by Ratio of Flows	1.067
Subtotal	$22,840,000
ADD Chlorine Contact Chamber Demolition	$4,980,000
CWRP Site Work	**$27,800,000**
NSWRP LLPS	$27,010,000
MULTIPLY by Ratio of Flows	1.067
CWRP LLPS	**$28,800,000**
NSWRP UV Disinfection	$49,490,000
MULTIPLY by Ratio of Flows	1.067
CWRP UV Disinfection	**$52,800,000**
CWRP Total	**$109,400,000**

Table 12.0-2 provides the preliminary opinion of probable construction cost for the UV Disinfection Facilities at the Calumet Water Reclamation Plant. Annual M&O costs are also provided assuming the same labor costs as NSWRP but increased energy, parts, and supplies costs per the same ratio as used for the capital costs.

Table 12.0-2 – CWRP UV Disinfection Facilities Preliminary OPCC and M&O Costs

Capital Cost Estimates	
ComEd Service Upgrade Charge	$130,000
A. General Sitework	$27,800,000
B. Low Lift Pump Station	$28,800,000
C. Disinfection System	$52,800,000
Total Capital Cost	$109,530,000
Maintenance & Operations Cost Estimates	
A. General Sitework	$130,000/yr
B. Low Lift Pump Station	$890,000/yr
C. Disinfection System	$3,490,000/yr
Total Annual M&O Cost	$4,520,000/yr
Total Present Worth M&O Cost	$104,600,000
Total Present Worth	$214,100,000

All costs in 2007 dollars.

Volume 2 of the Cost Study Report

for

DISINFECTION COST STUDY
UV DISINFECTION FACILITIES

NORTH SIDE WATER RECLAMATION PLANT
Chicago, Illinois

Contract 07-026-2P

Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago

Room 508, 100 East Erie Street

Chicago, Illinois 60611

2008

Electronic Filing - Received, Clerk's Office, October 20, 2008

Contract 07-026-2P
List of Contract Plans

Rev.	Description	Appr.	Date

PAGE NO.	SHEET NO.	ADDENDUM NO.	TITLE OF SHEET
			GENERAL DRAWINGS
1	G-000	–	COVER SHEET
2	G-001	–	LIST OF CONTRACT PLANS
3	G-002	–	LEGEND AND GENERAL NOTES
			CIVIL DRAWINGS
4	C-101	–	LOCATION PLAN
5	C-102	–	OUTSIDE PIPING AND CONDUIT PLANS AND DETAILS
6	C-103	–	UTILITY PLAN
7	C-104	–	ROADWAY/GRADING PLANS
8	C-901	–	CALUMET WRP SITE LAYOUT
			STRUCTURAL DRAWINGS
9	S-101	–	GATE STRUCTURES #1 AND #3 PLANS AND SECTIONS
10	S-102	–	GATE STRUCTURE #2 PLANS AND SECTIONS
11	S-201	–	UV DISINFECTION FACILITY GRADE LEVEL PLANS
12	S-202	–	UV DISINFECTION FACILITY ROOF FRAMING PLAN
13	S-203	–	UV DISINFECTION FACILITY SECTIONS
14	S-301	–	LOW LIFT PUMP STATION FOUNDATION PLAN
15	S-302	–	LOW LIFT PUMP STATION GRADE LEVEL PLAN
16	S-303	–	LOW LIFT PUMP STATION SECTION
17	S-304	–	LOW LIFT PUMP STATION ROOF FRAMING PLAN
			ARCHITECTURAL DRAWINGS
18	A-201	–	UV DISINFECTION FACILITY PLANS
19	A-202	–	UV DISINFECTION FACILITY SECTIONS
20	A-203	–	UV DISINFECTION FACILITY ELEVATIONS 1
21	A-204	–	UV DISINFECTION FACILITY ELEVATIONS 2
22	A-205	–	UV DISINFECTION FACILITY ROOF PLAN
23	A-301	–	LOW LIFT PUMP STATION LOWER PLAN

NOTE:
THE SCALES WHICH MAY APPEAR ON SOME OF THE CONTRACT PLANS ARE THOSE TO WHICH THE ORIGINAL, FULL SIZE PLANS WERE DRAWN. THEY ARE NOT CORRECT FOR REDUCED-SIZE PLANS. REDUCED CONTRACT PLANS SHOULD NOT BE SCALED FOR DIMENSIONS. TO SCALE DIMENSIONS USE GRAPHIC SCALES WHERE THEY APPEAR ON THE PLANS.

PAGE NO.	SHEET NO.	ADDENDUM NO.	TITLE OF SHEET
			ARCHITECTURAL DRAWINGS (CONT)
24	A-302	–	LOW LIFT PUMP STATION UPPER PLAN
25	A-303	–	LOW LIFT PUMP STATION SECTIONS
26	A-304	–	LOW LIFT PUMP STATION ELEVATIONS 1
27	A-305	–	LOW LIFT PUMP STATION ELEVATIONS 2
28	A-306	–	LOW LIFT PUMP STATION ROOFING PLAN
			PROCESS DRAWINGS
29	P-101	–	NSWRP PROPOSED HYDRAULIC PROFILE – BATTERIES A, B, C, D, AND F
30	P-102	–	NSWRP PROPOSED HYDRAULIC PROFILE – BATTERY E/DISINFECTION FACILITIES
31	P-103	–	UV DISINFECTION FACILITIES PROCESS FLOW DIAGRAM
32	P-201	–	UV DISINFECTION BUILDING PLAN
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34	P-301	–	LOW LIFT PUMP STATION LOWER PLAN
35	P-302	–	LOW LIFT PUMP STATION UPPER PLAN
36	P-303	–	LOW LIFT PUMP STATION SECTION
			MECHANICAL DRAWINGS
37	M-001	–	MECHANICAL LEGEND AND ABBREVIATIONS
38	M-201	–	UV DISINFECTION FACILITY PLANS AND DETAILS
39	M-301	–	LOW LIFT PUMP STATION PLANS AND DETAILS
			ELECTRICAL DRAWINGS
40	E-001	–	ELECTRICAL LEGEND
41	E-002	–	ELECTRICAL ABBREVIATIONS
42	E-101	–	SINGLE LINE DIAGRAM
43	E-102	–	OVERALL ELECTRICAL FACILITIES SITE PLAN
44	E-201	–	UV DISINFECTION FACILITY ELECTRICAL PLANS
45	E-301	–	LOW LIFT PUMP STATION ELECTRICAL PLANS
46	IC-001	–	INSTRUMENTATION SYMBOLS LEGEND
47	IC-002	–	INSTRUMENTATION SYMBOLS ABBREVATIONS AND NOTES
48	IC-201	–	UV DISINFECTION FACILITY PROCESS & INSTRUMENTATION DIAGRAM
49	IC-301	–	LOW LIFT PUMP STATION PROCESS & INSTRUMENTATION DIAGRAM

PLOT DATE: 1/17/2008 10:52 AM PLOTTED BY: COCKERILL, ERIC

PROCESS UNDERGROUND UTILITIES

Line	Description
A	Air
AL	Alum
AM	Ammonia
CD	Carbon Dioxide
C	Centrate
CF	Chemical Feed
F	Filtrate
FC	Ferric Chloride
GD	Gas–Digester
GN	Gas–Natural
GR	Grit
HPA	High Pressure Air
HC	Hypochlorite
LPA	Low Pressure Air
LO	Lubrication Oil
ML	Mixed Liquor
PO	Polymer
PD	Plant Drain
RAS	Return Activated Sludge
RSL	Return Sludge
SC	Scum
SP	Sewage–Primary Treated
SPN	Sewage–Raw
SS	Sewage–Secondary Treated
ST	Sewage–Tertiary Treated
SL	Sludge
S&WR	Sludge & Waste Water Ret
SLC	Sludge–Concentrated
SLD	Sludge–Digested
SLP	Sludge–Primary
SLS	Sludge–Secondary
SB	Sodium Bisulfite
S	Steam
SR	Steam Condensate Return
SBN	Subnatant
SPN	Supernatant
TE	Tertiary Effluent
WAS	Waste Activated Sludge
WW	Wastewater or Washwater
WC	Water–Cooling
WNP	Water–Plant (Non–potable)
WP	Water–Potable

SITE UTILITIES

Symbol	Description
CTV	Cable Television
+	City Electric
E	Electric
	Street Light Control Box
	Light Post
	Light Pole
	Power Pole
	Power Pole Light
	Guy Pole
	Transmission Tower
E	Electrical Vault
FO	Fiber Optics
G	Gas (supply)
G	Gas Valve Box
UNK	Other (Unknown)
P	Petroleum
T	Telephone
	Telephone Pole
T	Telephone Vault
	Traffic Signal
	Traffic Signal Controller
	Traffic Signal Post
	Utility Pole
	Rail Road
RR	RR Crossing
	RR Flashing Signal
x	Fence
X	Fence Corner
	Gate
	Guardrail
	Guardpost
	Sheet Piling Wall
	Drain Tile
	Sewer – Combined
	Sewer – Sanitary
	Sanitary Manhole
	Sewer – Storm
	Inlet
	Catch Basin
	Storm Manhole
	Curb Inlet
	Culvert End Section
W	Water (supply)

SITE UTILITIES

Symbol	Description
	Yard Hydrant
	Fire Hydrant
W	Water Valve Vault
V	Water Valve Box
B.B	B. Box
	Thrust Block

SITE SYMBOLS

Symbol	Description
755	Existing Contour
755	Proposed Contour
×	Existing Grade
754.0	Proposed Grade
	Drainage Direction
	Ditch Flow
	Summit
	Temporary Silt Fence
	Erosion Control
	Ditch Check
	Benchmark
	Soil Boring
	Dbl Pole Sign
	Sngl Pole Sign
	Mail Box
P.C.	Property Corner
P	Property Line
C	Centerline
	Handicap
	Exist. Traffic Flow
	Prop. Traffic Flow
	Deciduous Tree
	Evergreen Tree
	Bush
	Shrub
	Stump
	Hedge

GENERAL LEGEND

Symbol	Description
	Existing Piping, Equipment, Structures And Paving
	New Piping, Equipment, Structures And Paving
	Existing Piping, Equipment, Structures And Paving To Be Removed

ABBREVIATIONS

Abbreviation	Meaning
ABBR	Abbreviation
ABS.	Absolute
AL OR ALUM	Aluminum
APPROX.	Approximate
A	Air (compressed)
AC	Acre
AR	Acid Resistant
AVG.	Average
B–B	Back to Back of Curb
B.F.	Butterfly
B.G.V.	Bonneted Gate Valve
BHP	Brake Horsepower
Bit.	Bituminous
BLDG	Building
B.M.	Bench Mark
BOTT.	Bottom
BTU	British Thermal Units
BTUH	Btu Per Hour
BOL	Bottom Of Louver
BOD	Bottom Of Duct
BOP	Bottom Of Pipe
B.V.	Butterfly Valve
B/W	Back of Walk
BW	Back Wash Water
BWR	Boiler Water Return
BWS	Boiler Water Supply
C	Degree Centigrade
C.&G.	Curb And Gutter
CAP.	Capacity
C.B.	Catch Basin
CCD	Chicago City Datum
CENR	Centrate Return
CFM	Cubic Feet Per Minute
CFS	Cubic Feet Per Second
C.I.	Cast Iron
℄	Center Line
CLG	Ceiling
CL.	Class
CMP	Corrugated Metal Pipe
CMU	Concrete Masonry Unit
CP	Control Point
CU. FT.	Cubic Feet
CONC.	Concrete
CONN.	Connection
CONT.	Continuation
CONTR.	Contractor
CO	Cleanout
DB	Dry Bulb
DEG	Degree
Depr.	Depressed
DET.	Detail
DIAG.	Diagram
DIA.	Diameter
DAMP	Damper
DIFF	Difuser
D.I.P.	Ductile Iron Pipe
DN	Down
DR	Drain
DS	Downspout
DWG	Drawing
E	External Distance
EA.	Each
E–E	Edge To Edge Of Pavement
ECC.	Eccentric
EFF.	Efficiency
E.J. OR EXP. JT.	Expansion Joint
ELEV OR EL.	Elevation
E.A.T.	Entering Air Temp.
EF	Exhaust Fan
E.O.P.	Edge Of Pavement
E.P.	Explosion Proof
EQUIP.	Equipment
ESEW	Emergency Shower & Eyewash
EXH	Exhaust
Exist.	Existing
F/D	Fire Damper
F/C	Face of Curb
FCA	Flanged Coupling Adapter
FD	Floor Drain
FEW	Final Effluent Water
FE	Fire Extinguisher
F–F	Face to Face of Curb
FH	Fire Hydrant
FIG	Figure
FLR	Floor
FLEX.	Flexible
FPM	Feet Per Minute
FP	Fire Protection
F&RD	Filter & Rewash Drain
FLG.	Flanged
F.M.	Force Main
F&T	Float And Thermostatic Trap
FT. (')	Feet or Foot
FTW	Filter To Waste
FW	Filtered Water
GALV	Galvanized
GA	Gauge
GRF	Glass Fiber & Resin Fabrications
GND.	Ground
GPM	Gallons Per Minute
HB	Hose Bibb
HD	Head
HGT	Height
Horz.	Horizontal
HP	Horse Power
H.P.	High Point
HR	Hour
HV	Hose Valve
HV	Heating And Ventilating Units
HWR	Hot Water Return
HWS	Hot Water Supply
I.D.	Inside Diameter
IDOT	Illinois Department Of Transportation
INV.	Invert
INV. EL.	Invert Elevation
I.P.	Iron Pipe
KW	Kilowatt
KWH	Kilowatt Hour
LB OR #	Pound
L.F.	Lineal Foot
L.P.	Low Point
LT.	Left
MAX	Maximum
MH	Manhole
MIN	Minimim Or Minute
MISC	Miscellaneous
ML	Mixed Liquor
MFG.	Manufacturer
N.C.	Normally Closed
NO.	Number
N.O.	Normally Open
NIC	NOT IN CONTRACT
OA	Outside Air
O.C. OR OC	On Center
OCS	Order Control System
O.D.	Outside Diameter
OF	Overflow
OPNG.	Opening
O.S.D.	Open Site Drain
PAVT.	Pavement
P.C.	Point of Curvature
P.C.C.	Portland Cement Concrete
PENTHSE	Penthouse
P.I.	Point of Intersection
ℙ	Property Line
P.P.	Power Pole
PROP.	Proposed
PRV	Pressure Reducing Valve
PS	Primary Sludge
PSIG	Pounds Per Square Inch Gauge
PSI	Pounds Per Square Inch
PT.	Point
PVC	Polyvinyl Chloride
P.T.	Point of Tangency
PW	Protected Water
R	Radius
RA	Return Air
RAS	Return Activated Sludge
RCP	Reinforced Concrete Pipe
RD.	Road
RD	Roof Drain
RED.	Reducer
REF.	Reference
REQ'D	Required
RM	Room
R.O.W.	Right–Of–Way
R.R.	Railroad
R&R	Remove and Replace
RS	Raw Sludge
RT.	Right
RW	Raw Water
SAN.	Sanitary
SCD	Screened
SD	Sludge Dewatering
SEC	Second
SHT.	Sheet
SPECS	Specifications
S.P.	Static Pressure
SPN	Supernatant
SQ.	Square
SR	Sludge Recirculation
STORM	Storm Sewer
SST OR SS	Stainless Steel
ST	Sludge Transfer
STA.	Station
STD.	Standard
S.Y.	Square Yard
S/W	Sidewalk
T/C	Top Curb
TBM	Temporary Bench Mark
TD	Tank Drainage
TDH	Total Dynamic Head
TEMP.	Temperature
TYP.	Typical
UH	Unit Heater
UCP	Unitized Control Panel
U.O.N.	Unless Otherwise Noted
WAS	Waste Activated Sludge
WM	Water Main
WNP	Water Plant (Non–Portable)
W.P.	Work Point
WW	Wash Water
WWTP	Waste Water Treatment Plant

Note:
These Are The Standard Abbreviations, And Not All Information Shown Is Necessarily Used On This Project

Discipline specific abbreviations shall supersede abbreviations shown here on those sheets.

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Approved: MWRD Assistant Chief Engineer

Correct: ANTHONY BOUCHARD

CTE AECOM

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Designed by: E.COCKERILL | Checked by: XX | Drawn by: E.COCKERILL | Reviewed by: XX | Date: 1/2008 | Scale: NTS

CONTRACT 07–026–2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

GENERAL NOTES, LEGEND, AND ABBREVIATIONS

Seal

Sheet Number: G–002

Page Number: 3

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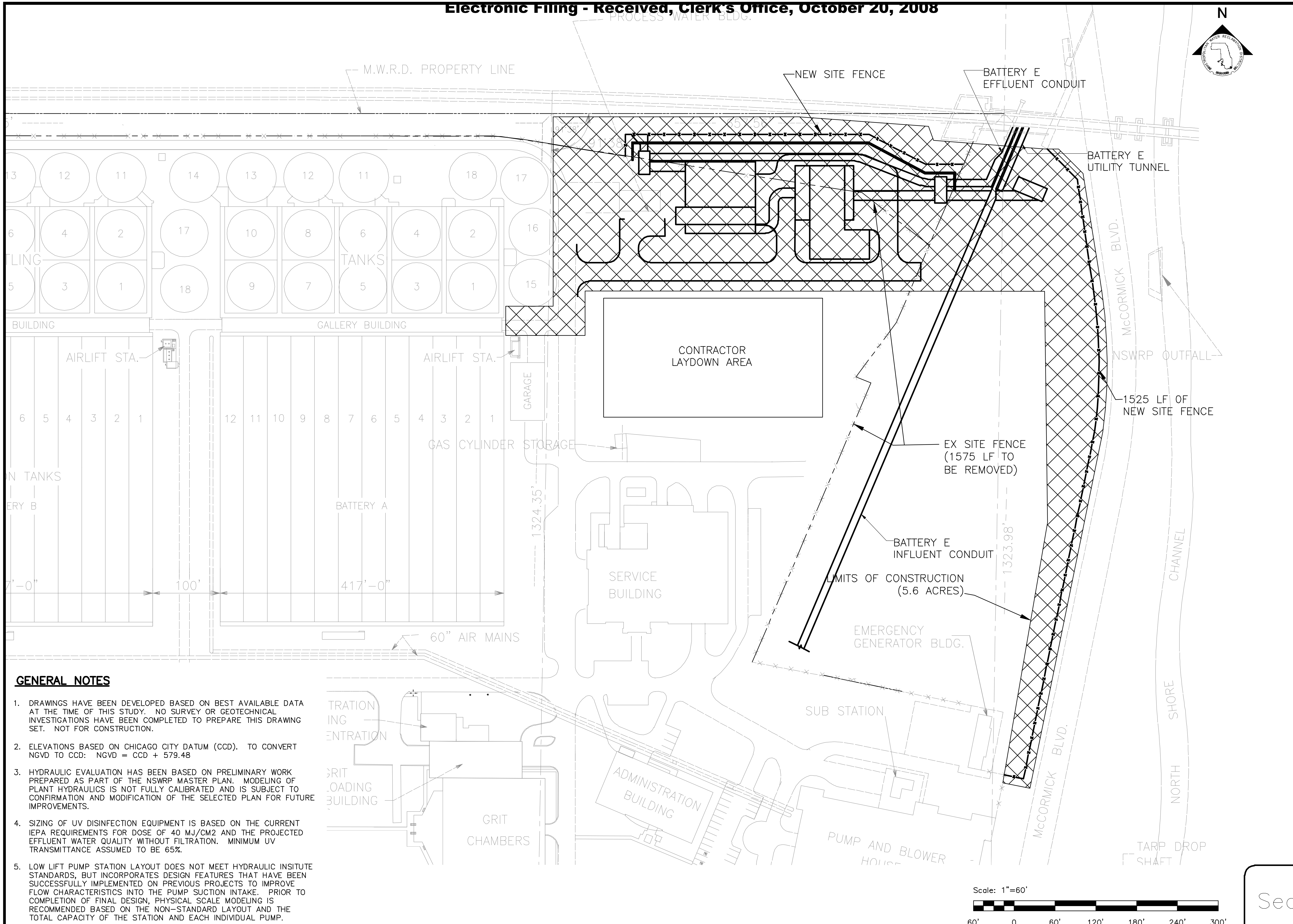
Electronic Filing - Received, Clerk's Office, October 20, 2008



GENERAL NOTES

1. DRAWINGS HAVE BEEN DEVELOPED BASED ON BEST AVAILABLE DATA AT THE TIME OF THIS STUDY. NO SURVEY OR GEOTECHNICAL INVESTIGATIONS HAVE BEEN COMPLETED TO PREPARE THIS DRAWING SET. NOT FOR CONSTRUCTION.

2. ELEVATIONS BASED ON CHICAGO CITY DATUM (CCD). TO CONVERT NGVD TO CCD: NGVD = CCD + 579.48

3. HYDRAULIC EVALUATION HAS BEEN BASED ON PRELIMINARY WORK PREPARED AS PART OF THE NSWRP MASTER PLAN. MODELING OF PLANT HYDRAULICS IS NOT FULLY CALIBRATED AND IS SUBJECT TO CONFIRMATION AND MODIFICATION OF THE SELECTED PLAN FOR FUTURE IMPROVEMENTS.

4. SIZING OF UV DISINFECTION EQUIPMENT IS BASED ON THE CURRENT IEPA REQUIREMENTS FOR DOSE OF 40 MJ/CM2 AND THE PROJECTED EFFLUENT WATER QUALITY WITHOUT FILTRATION. MINIMUM UV TRANSMITTANCE ASSUMED TO BE 65%.

5. LOW LIFT PUMP STATION LAYOUT DOES NOT MEET HYDRAULIC INSITUTE STANDARDS, BUT INCORPORATES DESIGN FEATURES THAT HAVE BEEN SUCCESSFULLY IMPLEMENTED ON PREVIOUS PROJECTS TO IMPROVE FLOW CHARACTERISTICS INTO THE PUMP SUCTION INTAKE. PRIOR TO COMPLETION OF FINAL DESIGN, PHYSICAL SCALE MODELING IS RECOMMENDED BASED ON THE NON-STANDARD LAYOUT AND THE TOTAL CAPACITY OF THE STATION AND EACH INDIVIDUAL PUMP.

PLOT DATE: 12/27/2007 11:52 AM PLOTTED BY: COCKERILL, ERIC

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: E.COCKERILL	Checked by: XX
Drawn by: E.COCKERILL	Reviewed by: XX
Date: 1/2008	Scale: 1:60
Correct: ANTHONY B. BOUCHARD	Approved: MWRD Assistant Chief Engineer

CTE AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION FACILITIES LOCATION PLAN

Seal

Sheet Number: C-101

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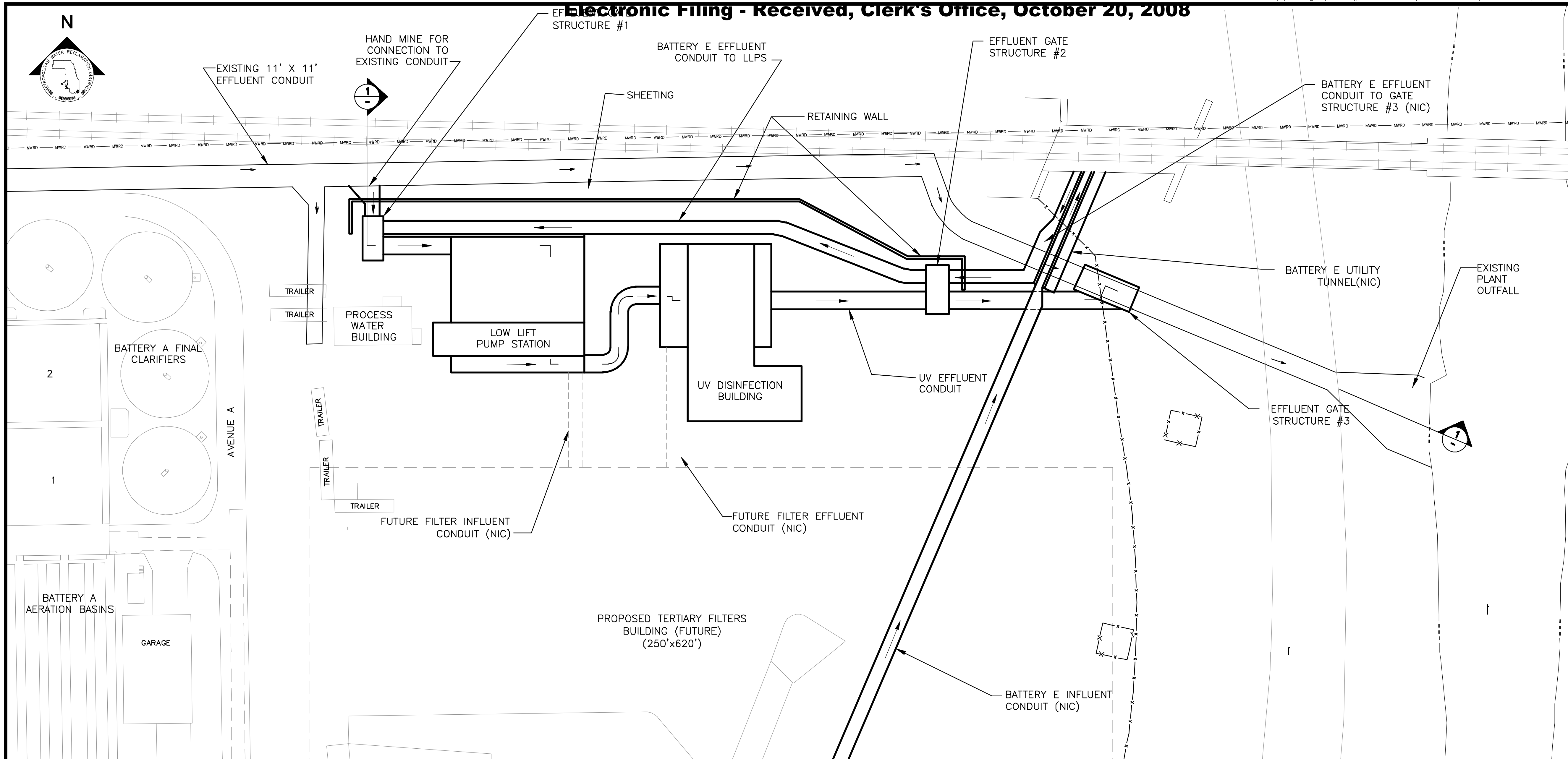
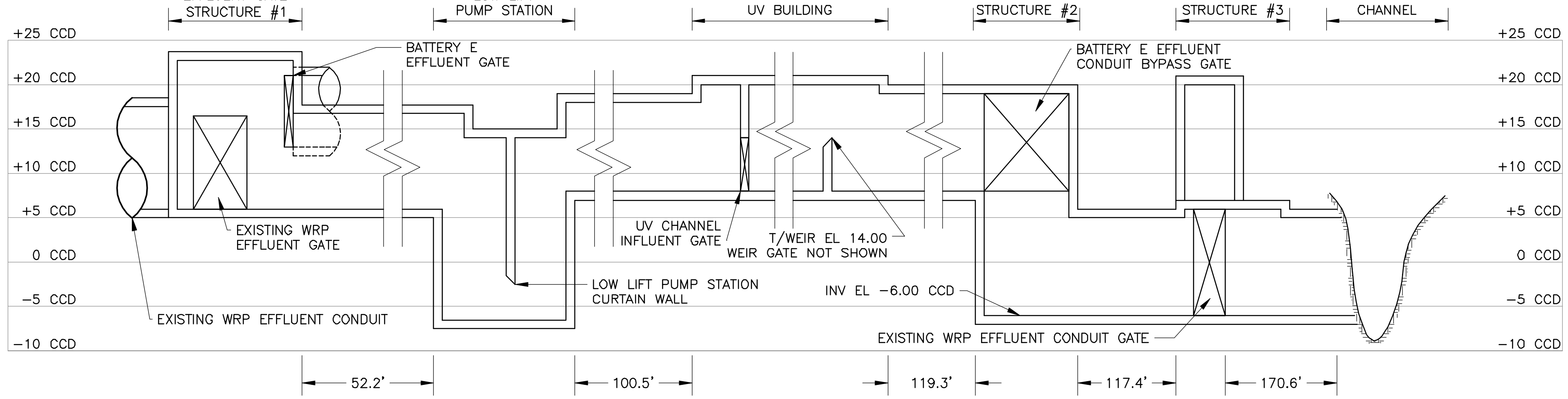


PLAN
EFFLUENT CONDUITS
1:40

NOTES:
1. CONDUIT INSTALLATION SHALL INCLUDE 2' OVER EXCAVATION AND BACKFILL WITH STRUCTURAL FILL FOR SOIL TABILITY.
2. SEE SHEET S-101 AND S-102 FOR GATE STRUCTURES.
3. STRUCTURES/FACILITIES NOTED AS NOT IN CONTRACT (NIC) ARE NOT INCLUDED IN THE ESTIMATED CONSTRUCTION COST FOR THE UV DISINFECTION FACILITIES.



1 EFFLUENT CONDUIT PROFILE
SCALE: VERTICAL: 1/8"=1'-0"
HORIZONTAL: NTS

PLOT DATE: 12/27/2007 11:52 AM PLOTTED BY: COCKERILL, ERIC

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: E.COCKERILL | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer
Drawn by: M.BEGORA | Reviewed by: XX
Date: 1/2008 | Scale: 1:40

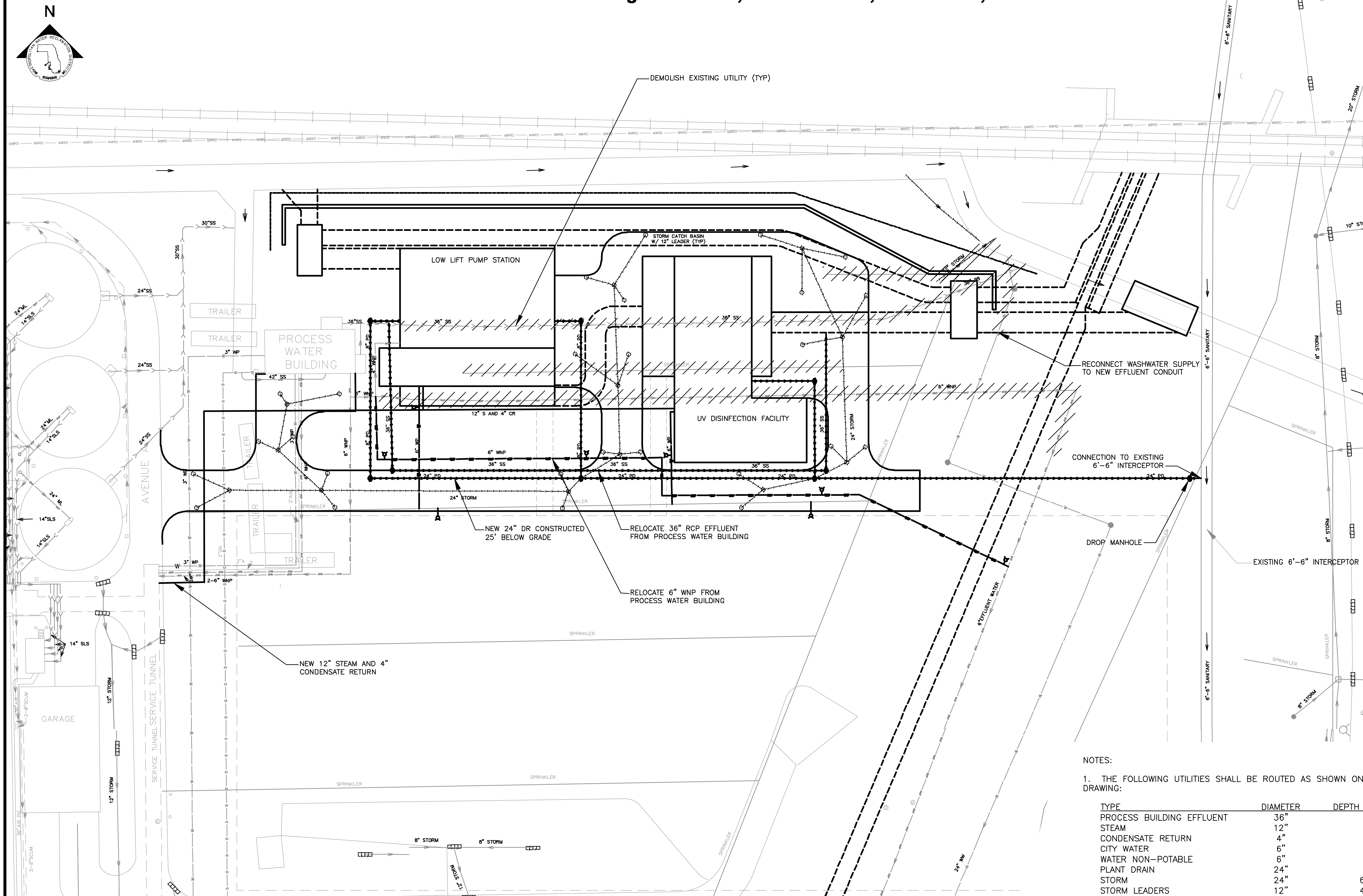
CTE AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION FACILITIES
EFFLUENT CONDUIT PLAN

Seal

Sheet Number: C-102
Page Number: 5



NOTES:

1. THE FOLLOWING UTILITIES SHALL BE ROUTED AS SHOWN ON THIS DRAWING:

TYPE	DIAMETER	DEPTH OF COVER
PROCESS BUILDING EFFLUENT	36"	10'
STEAM	12"	5'
CONDENSATE RETURN	4"	5'
CITY WATER	6"	5'
WATER NON-POTABLE	6"	5'
PLANT DRAIN	24"	25'
STORM	24"	6'-8'
STORM LEADERS	12"	4'-6'

2. DEMOLISH OTHER UTILITIES AS SHOWN. CAP AT LIMIT OF DEMOLITION.

Scale: 1"=30'

30' 0 30' 60' 90' 120' 150'

Seal

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: EPC | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer

Drawn by: MB | Reviewed by: XX

Date: 1/2008 | Scale: 1:30

CTE AECOM

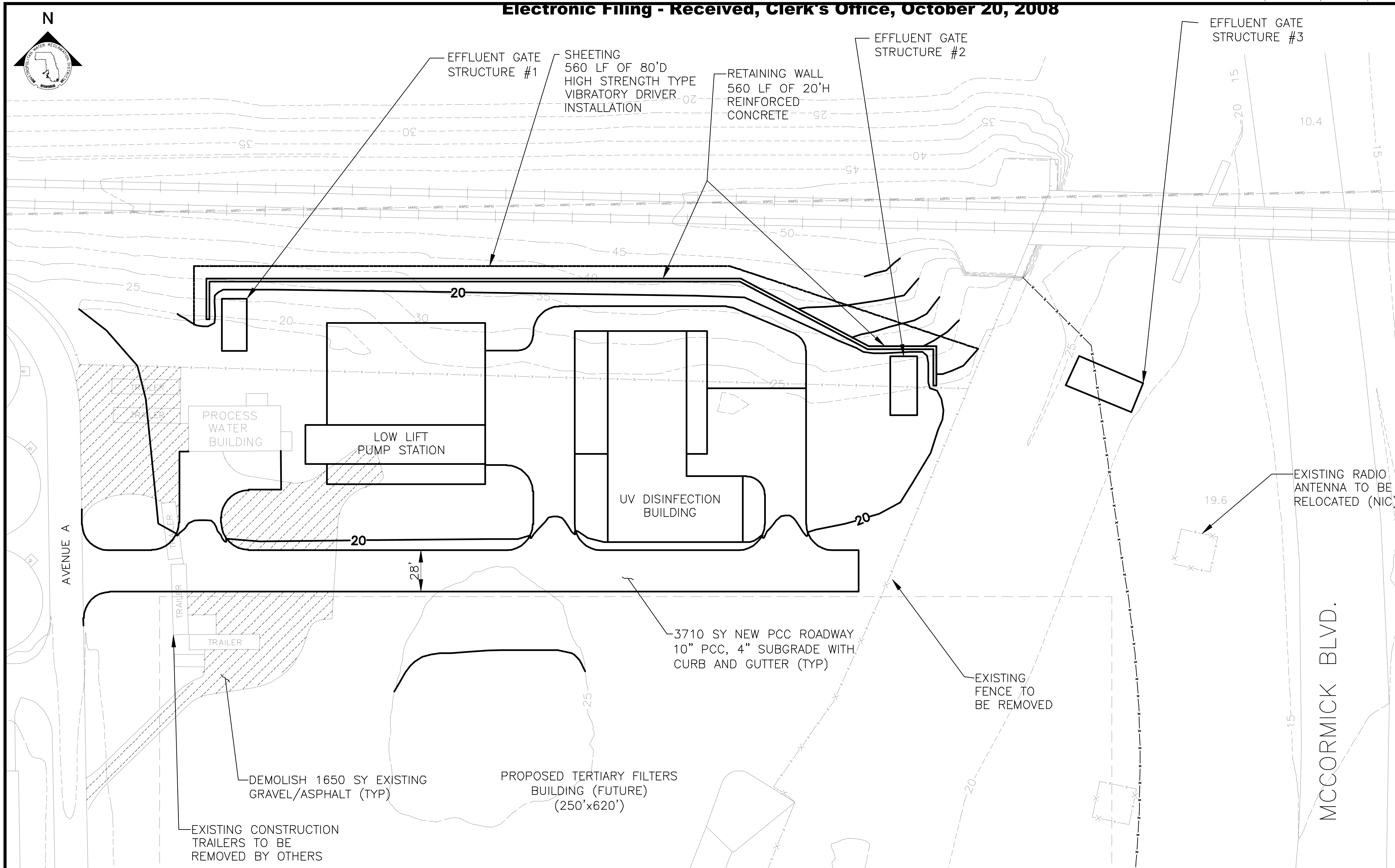
CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

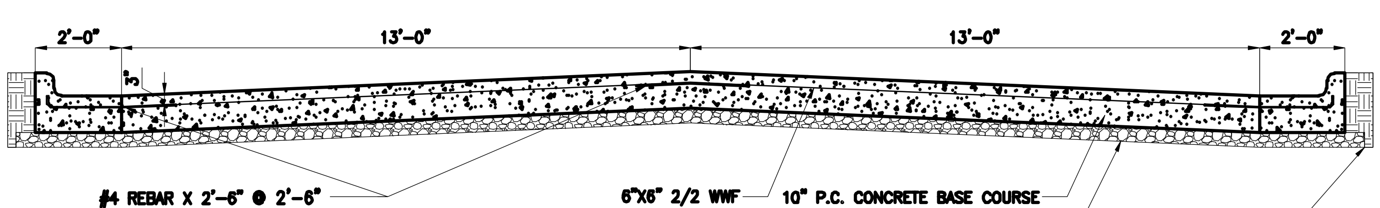
UV DISINFECTION FACILITIES
UTILITY PLAN

Sheet Number: C-103

Page Number: 6

PLOT DATE: 1/16/2008 11:07 AM PLOTTED BY: COCKERILL, ERIC





1 TYPICAL ROADWAY CROSS-SECTION
SCALE: 1/2"=1'

NOTES:

1. ROADWAYS TO BE DESIGNED FOR H20 LOADING.

Scale: 1"=30'

30' 0 30' 60' 90' 120' 150'

Seal

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: EPC | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer

Drawn by: EPC | Reviewed by: XX

Date: 1/2008 | Scale: 1:30

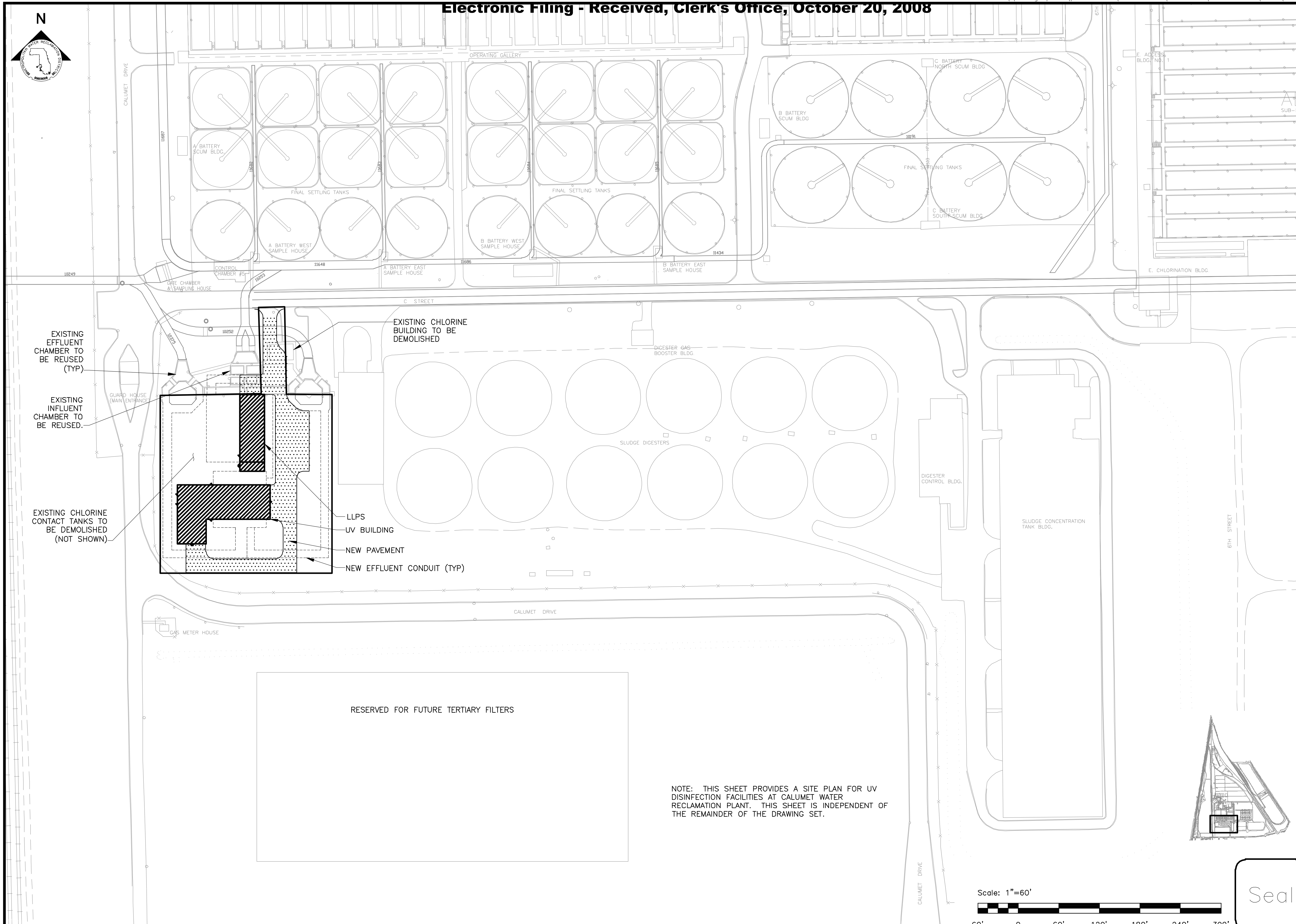
CTE | AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION FACILITIES ROADWAY/GRADING PLAN

Sheet Number: C-104

Page Number: 7



NOTE: THIS SHEET PROVIDES A SITE PLAN FOR UV DISINFECTION FACILITIES AT CALUMET WATER RECLAMATION PLANT. THIS SHEET IS INDEPENDENT OF THE REMAINDER OF THE DRAWING SET.

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: PP	Checked by: EPC	Correct: ANTHONY BOUCHARD
Drawn by: PP	Reviewed by: EPC	Approved: MWRD Assistant Chief Engineer
Date: 1/2008	Scale: 1:60	

CONTRACT 07-026-2P
CALUMET RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

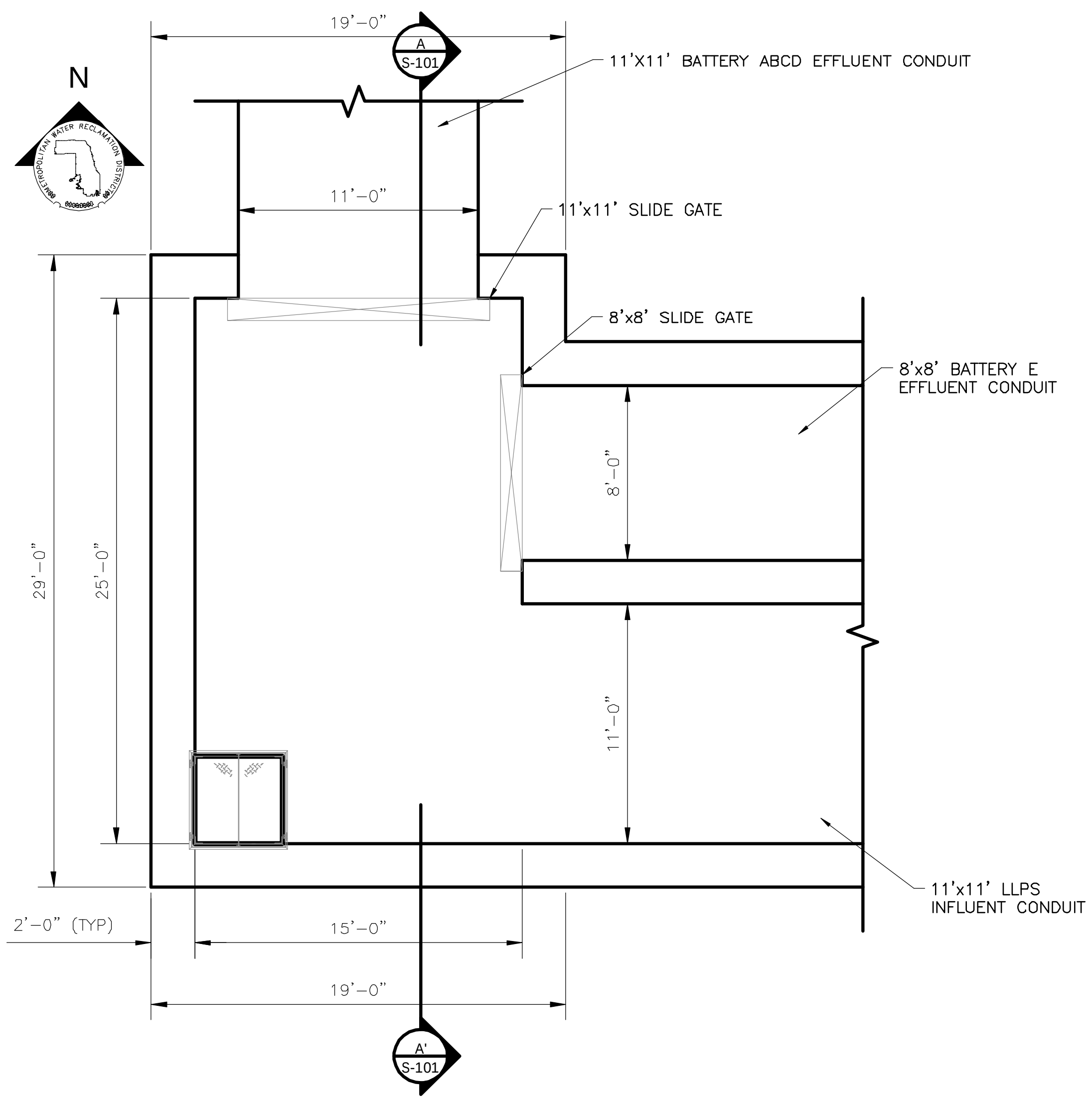
UV DISINFECTION FACILITIES SITE LAYOUT

Seal

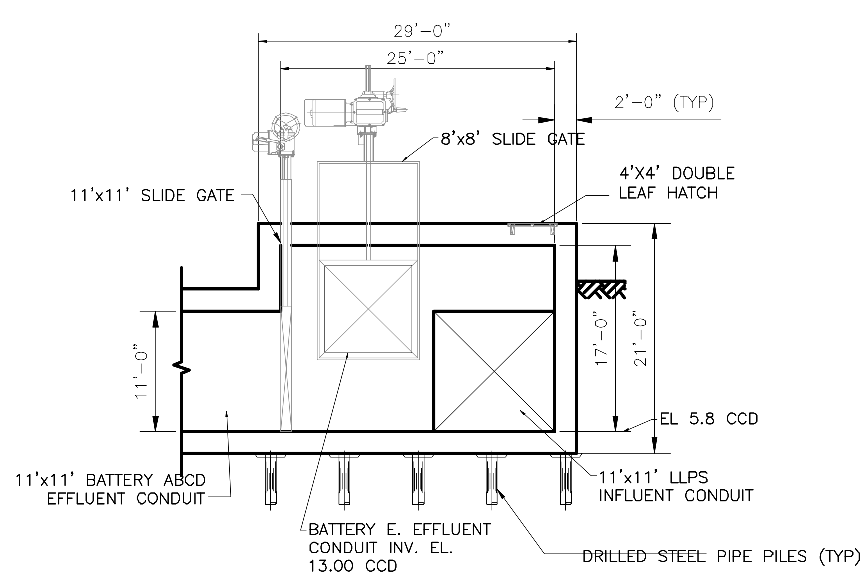
Sheet Number: C-901

Page Number: 8

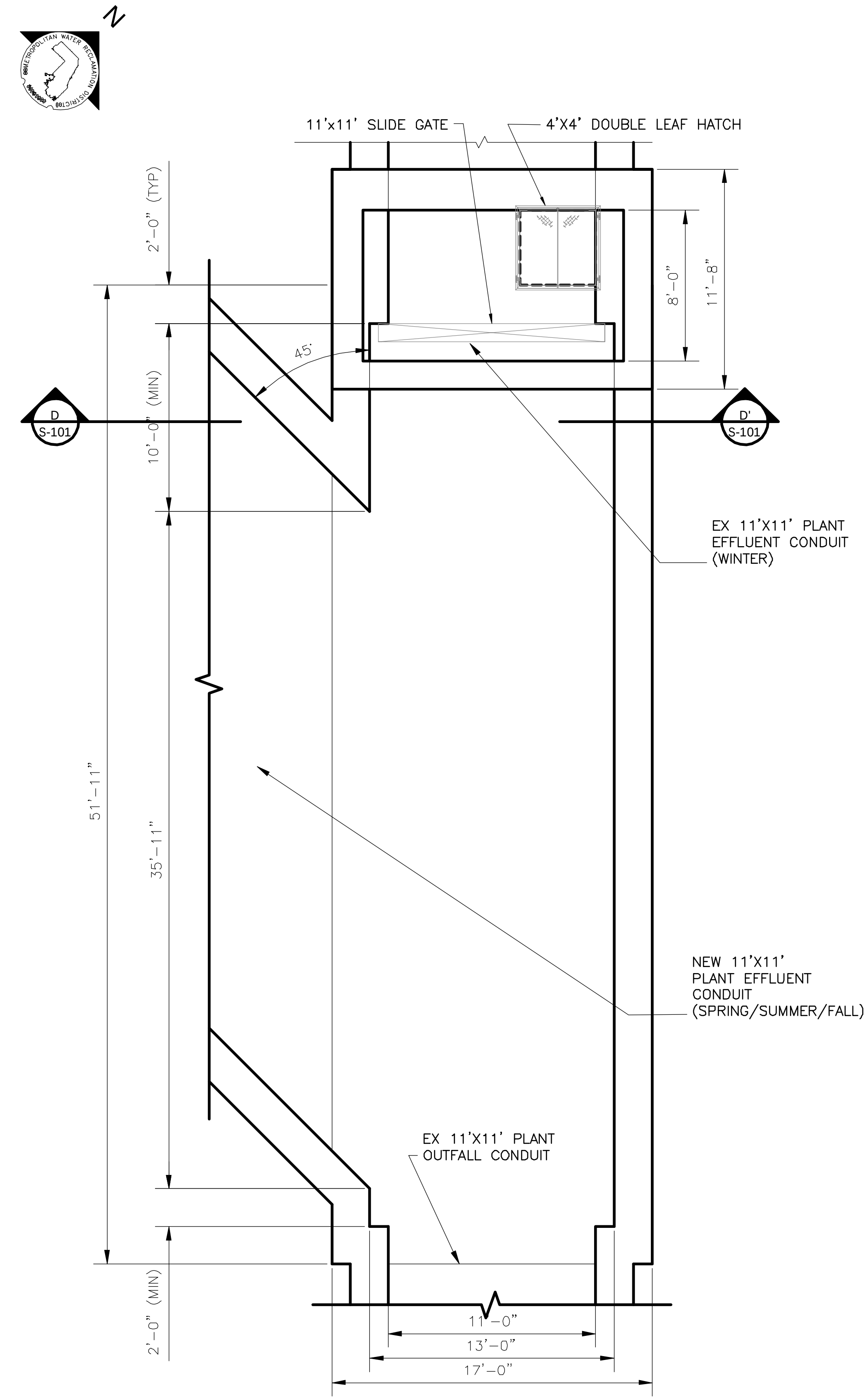
\\Uschg1fp207\p60026610\P60026610\Contracts\07-026-2P\STRUCTURAL\S-101_102.dwg 12/26/2007 11:09 AM



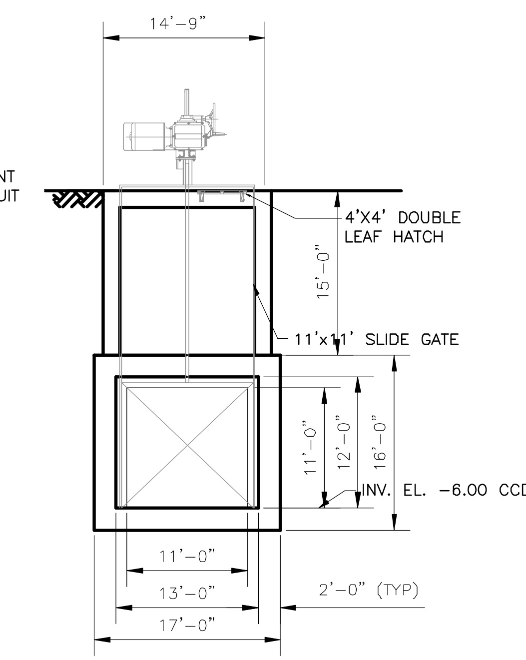
1 GATE STRUCTURE #1
SCALE: 1/4"=1'-0"



A SECTION
SCALE: 1/8"=1'-0"



3 GATE STRUCTURE #3
SCALE: 1/4"=1'-0"



D SECTION
SCALE: 1/8"=1'-0"

NOTES:
1. ALL GATES ON THIS SHEET ARE MOTOR ACTUATED.

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: S.TRIVEDI | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer
Drawn by: M.BEGORA | Reviewed by: XX
Date: 1/2008 | Scale: AS NOTED

CTE AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

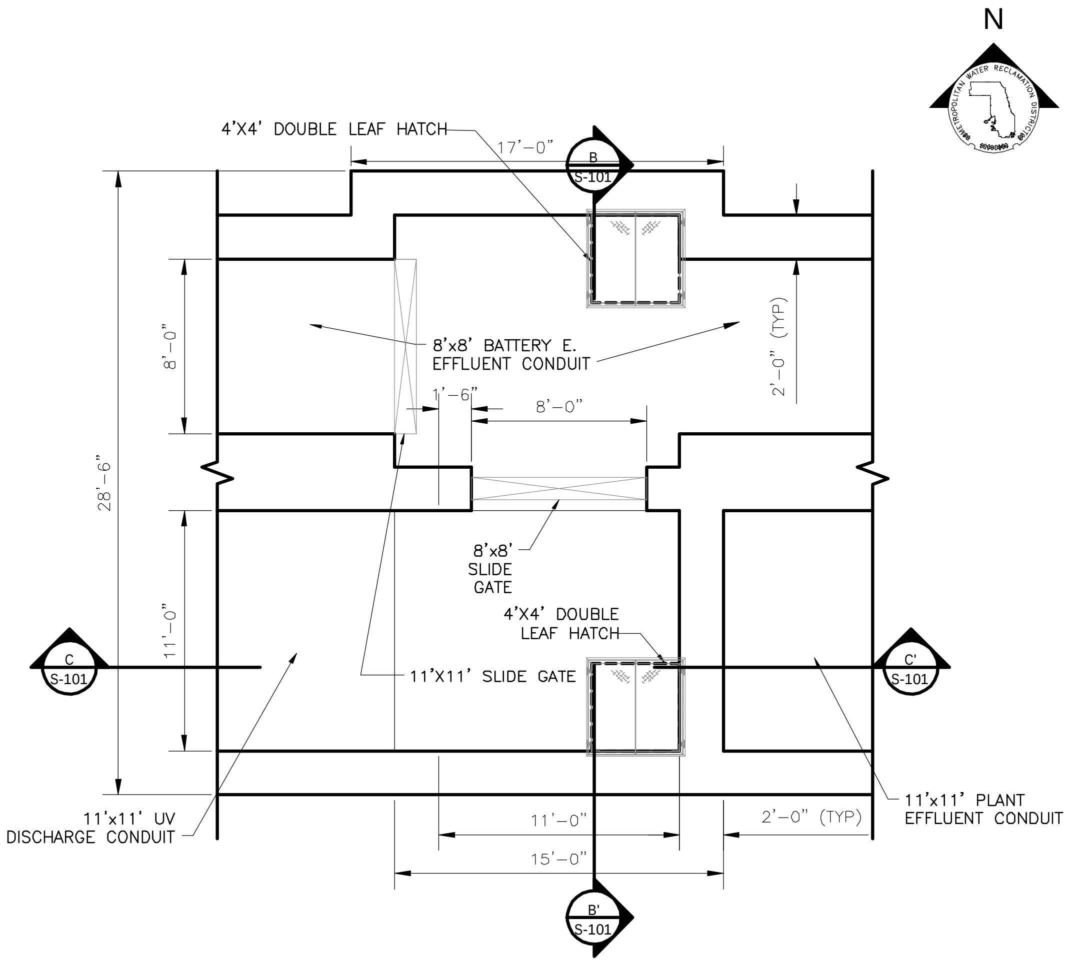
EFFLUENT GATE STRUCTURES #1 AND #3
PLAN AND SECTIONS

Seal

Sheet Number: S-101
Page Number: 9

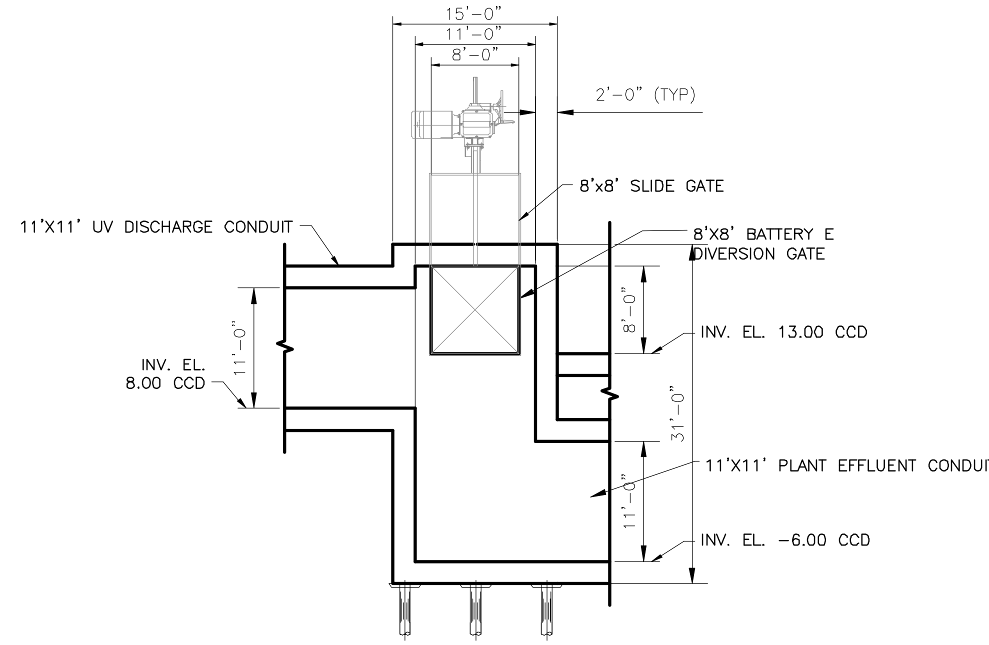
PLOT DATE: 12/26/2007 11:20 AM PLOTTED BY: COCKERILL, ERIC

Electronic Filing - Received, Clerk's Office, October 20, 2008



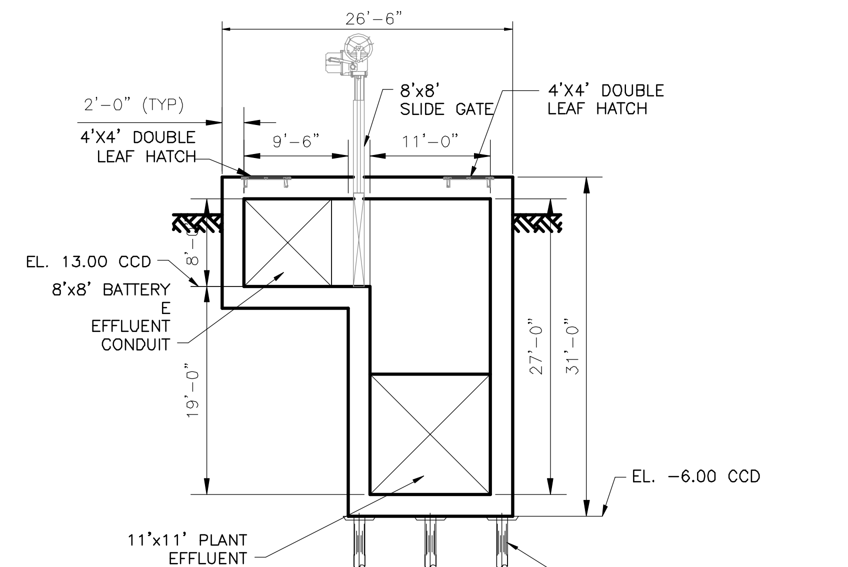
2 GATE STRUCTURE #2

SCALE: 1/4"=1'-0"



B SECTION

SCALE: 1/8"=1'-0"



C SECTION

SCALE: 1/8"=1'-0"

NOTES:
1. ALL GATES ON THIS SHEET ARE MOTOR ACTUATED.

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: S.TRIVEDI
Checked by: XX
Correct: ANTHONY BOUCHARD
Approved: MWRD Assistant Chief Engineer
Drawn by: M.BEGORA
Reviewed by: XX
Date: 1/2008
Scale: AS NOTED

CTE AECOM

CTE
303 East Wacker Drive, Suite 600, Chicago, Illinois 60601-5276
T 312.938.0300 F 312.938.1109 www.cte.aecom.com

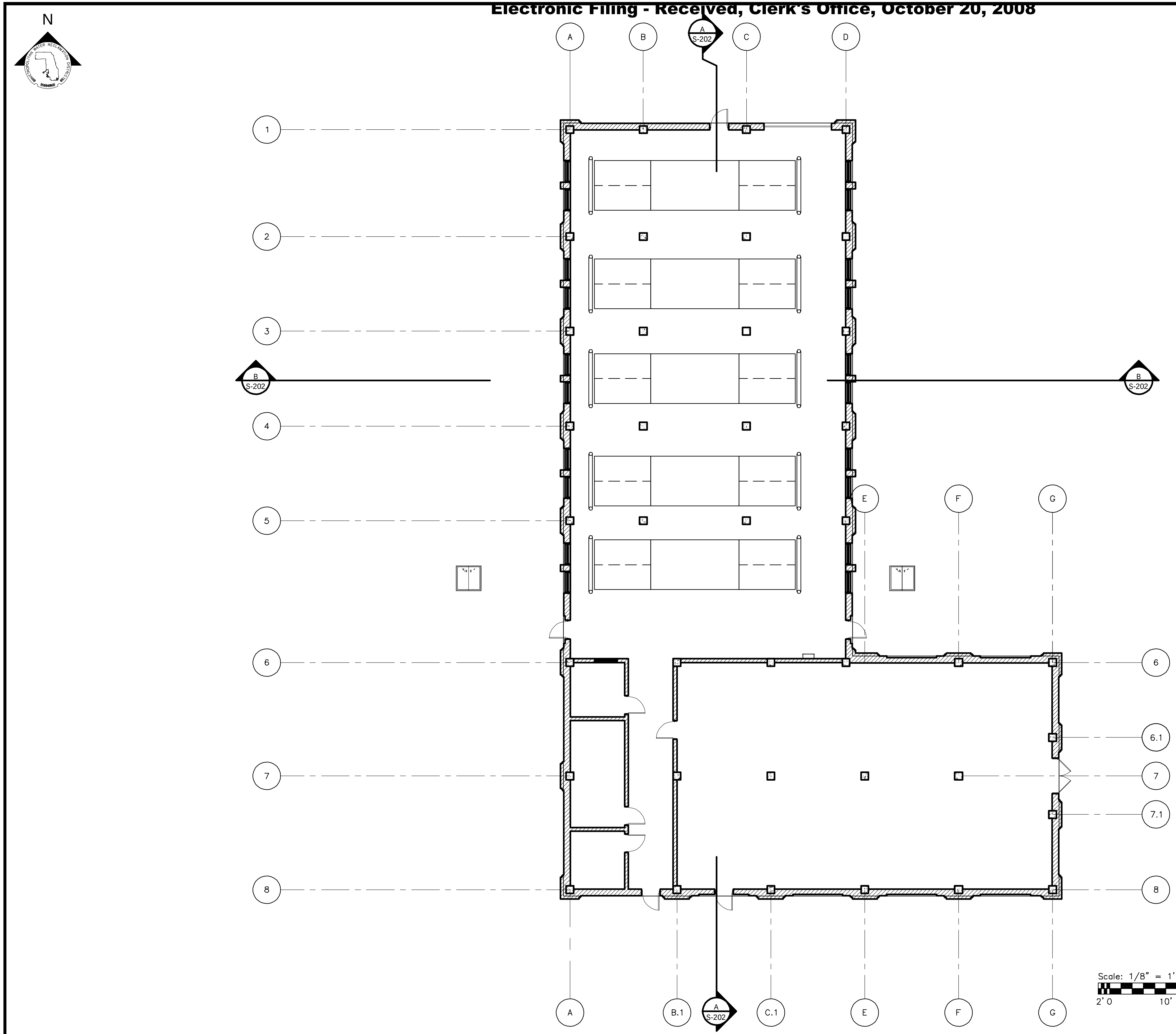
CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

EFFLUENT GATE STRUCTURE #2
PLAN AND SECTIONS

Seal

Sheet Number: S-102

Page Number: 10



NOTE:

BASED ON DISCUSSIONS WITH AN INDEPENDENT GEOTECHNICAL ENGINEER AND HIS REVIEW OF EXISTING AVAILABLE SOIL BORINGS DRILLED IN 1977, IT WAS DETERMINED THAT A DEEP FOUNDATION WOULD BE REQUIRED FOR SUPPORT OF THE UV FACILITY. THE OPINION OF PROBABLE CONSTRUCTION COST WAS BASED ON THE USE OF 320, 40 TON CAPACITY, 12-INCH DIAMETER CONCRETE FILLED PIPE PILES, 50 FEET LONG, FOR A TOTAL OF 16000 LINEAL FEET OF PILES.

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: AAG/DJ
Checked by: JML
Correct: ANTHONY BOUCHARD
Approved: MWRD Assistant Chief Engineer
Drawn by: MB
Reviewed by: XX
Date: 1/2008
Scale: 1/8"=1'-0"

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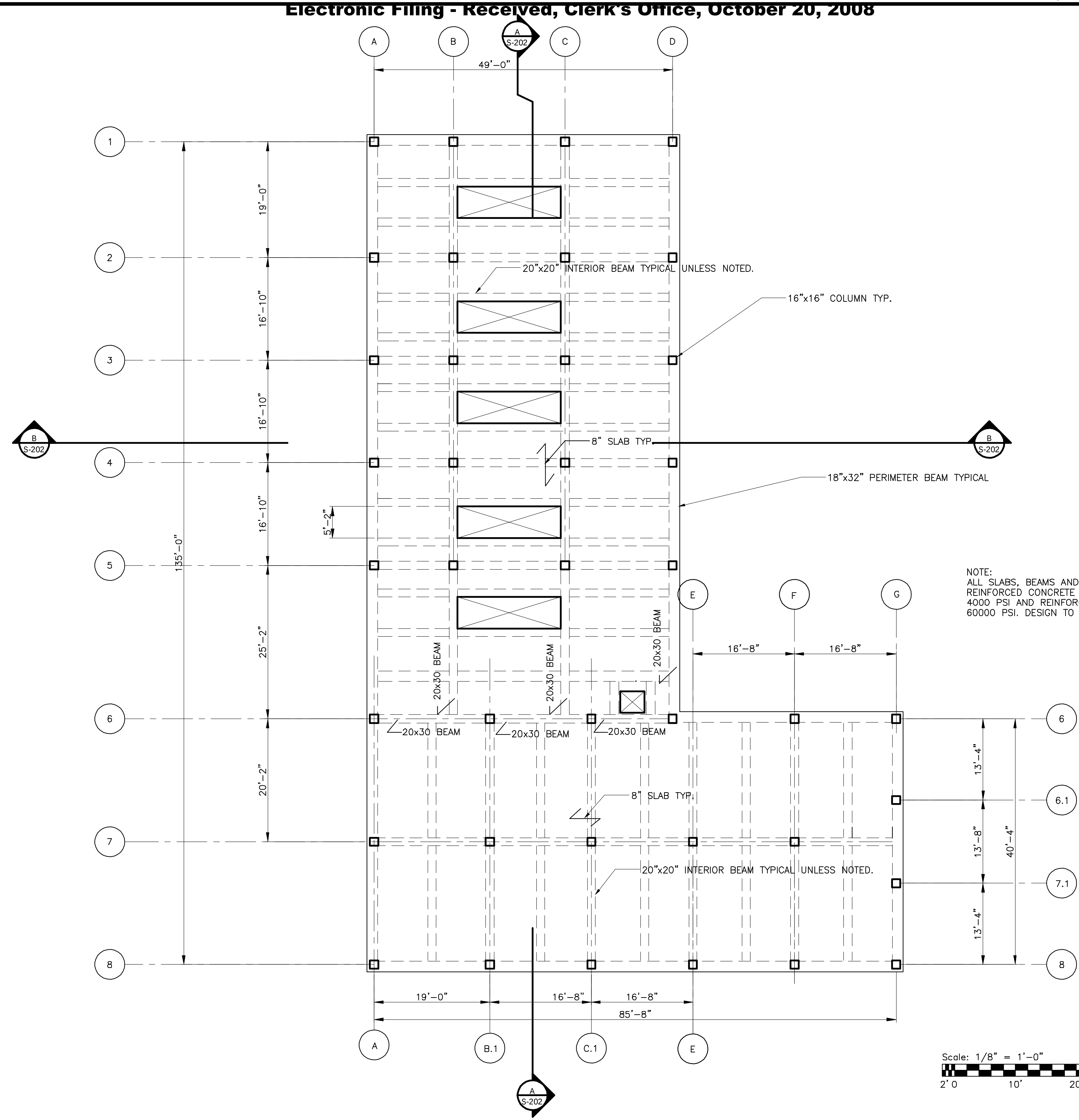
CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION BUILDING
GRADE LEVEL PLAN

Seal

Sheet Number: S-201



NOTE:
ALL SLABS, BEAMS AND COLUMNS TO BE REINFORCED CONCRETE OF CONCRETE STRENGTH 4000 PSI AND REINFORCING BAR GRADE OF 60000 PSI. DESIGN TO CONFORM TO AC1 318

Scale: 1/8" = 1'-0"

2' 0 10' 20' 30' 40'

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

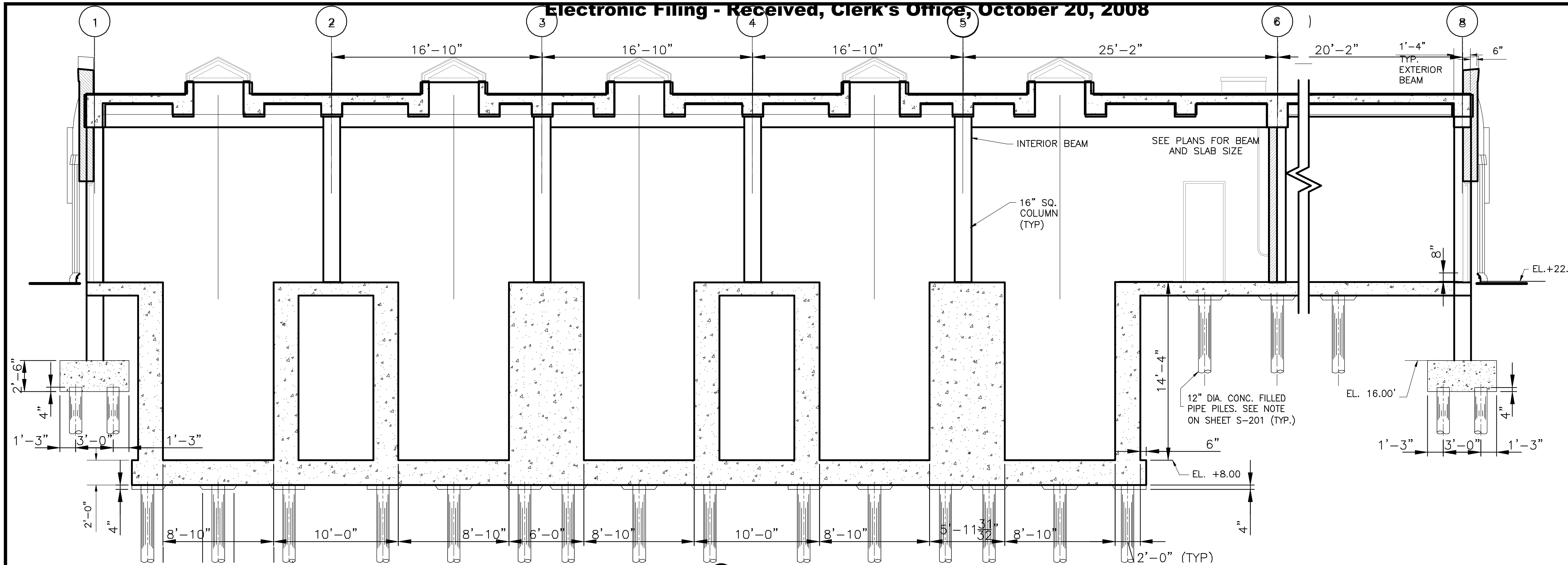
Designed by: AAG	Checked by: JML	Correct: ANTHONY BOUCHARD	Approved: MWRD Assistant Chief Engineer
Drawn by: MB	Reviewed by: XX	CTE AECOM	
Date: 1/2008	Scale: 1/8"=1'-0"		

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

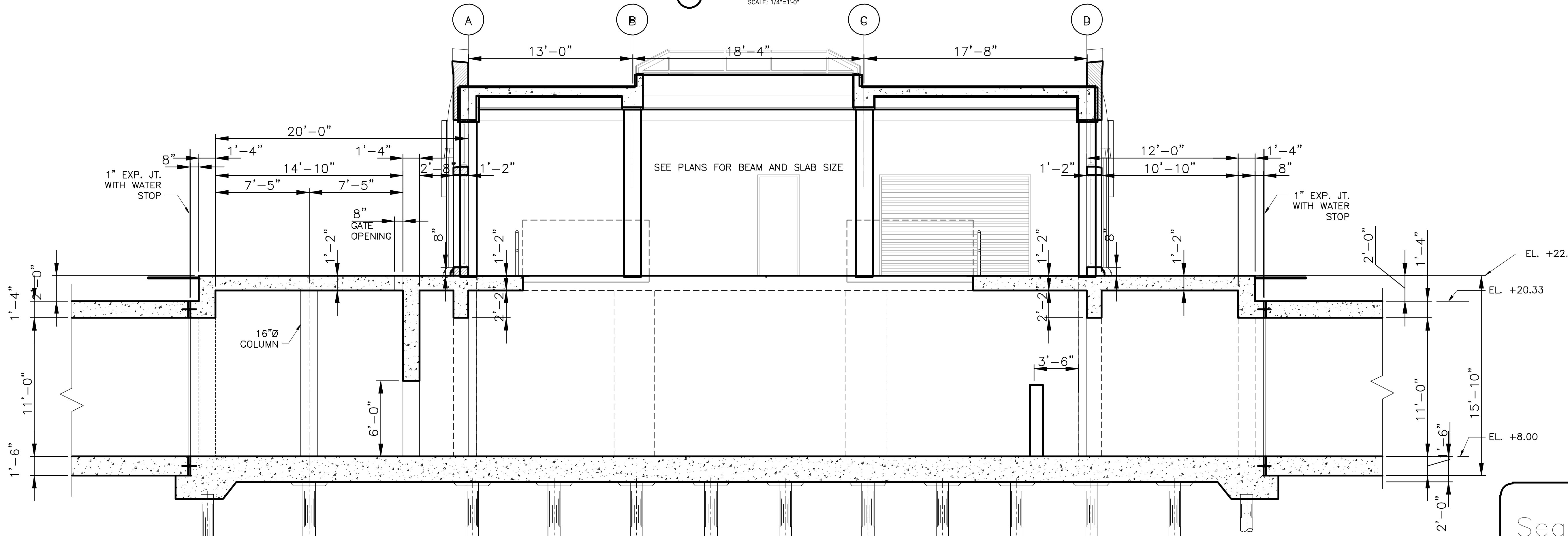
UV DISINFECTION BUILDING ROOF FRAMING PLAN

Seal

Sheet Number: S-202



A SECTION
SCALE: 1/4"=1'-0"



B SECTION
SCALE: 1/4"=1'-0"

Scale: 1/4" = 1'-0"
1' 0 5' 10' 15' 20'

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: AAG/DJ	Checked by: JMG	Correct: ANTHONY BOUCHARD	Approved: MWRD Assistant Chief Engineer
Drawn by: MB	Reviewed by: XX		
Date: 1/2008	Scale: 1/4"=1'-0"		

CTE AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION BUILDING SECTIONS

Seal

Sheet Number: S-203

PLOT DATE: 1/16/2008 2:55 PM PLOTTED BY: COCKERILL, ERIC

Electronic Filing - Received, Clerk's Office, October 20, 2008

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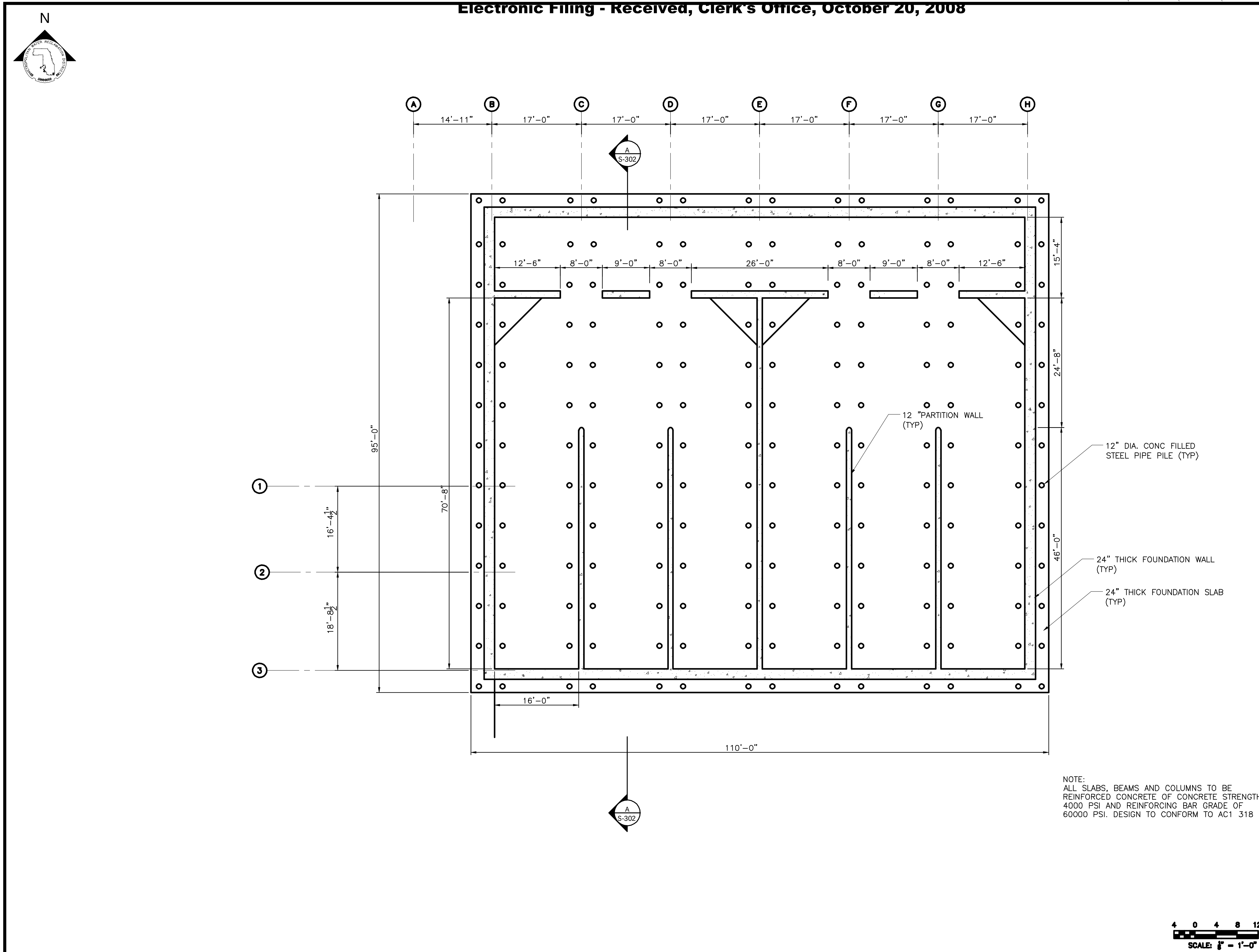

NOTE:
ALL SLABS, BEAMS AND COLUMNS TO BE REINFORCED CONCRETE OF CONCRETE STRENGTH 4000 PSI AND REINFORCING BAR GRADE OF 60000 PSI. DESIGN TO CONFORM TO AC1 318

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Approved: MWRD Assistant Chief Engineer

Correct: ANTHONY BOUCHARD

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Designed by: DJ | Checked by: XX
Drawn by: DJ | Reviewed by: XX
Date: 1/2008 | Scale: 1/8"=1'-0"

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION
FOUNDATION LEVEL PLAN

Seal

Sheet Number: S-301

Page Number: 14

PLOT DATE: 1/16/2008 2:59 PM PLOTTED BY: COCKERILL, ERIC

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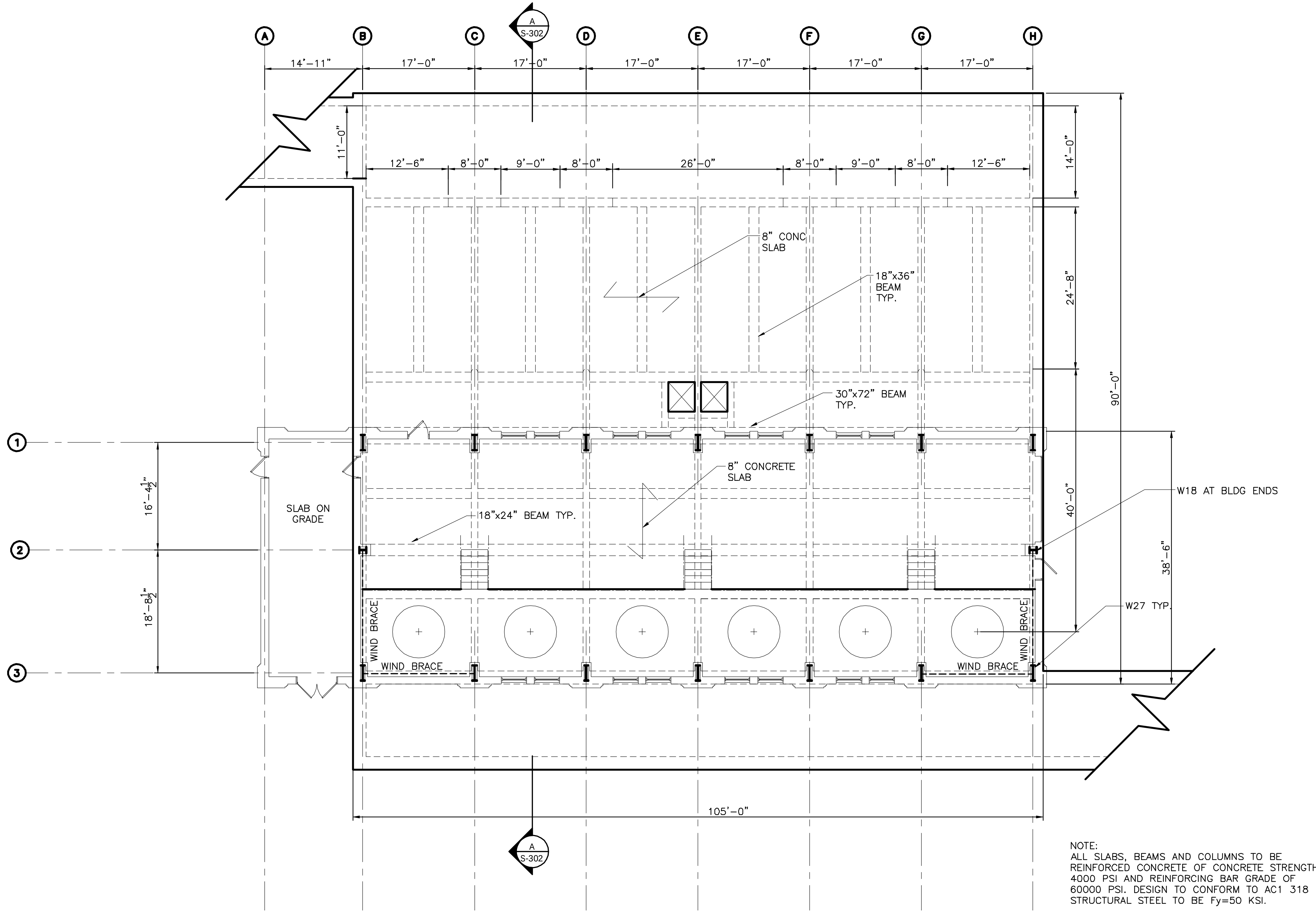


NOTE:
ALL SLABS, BEAMS AND COLUMNS TO BE REINFORCED CONCRETE OF CONCRETE STRENGTH 4000 PSI AND REINFORCING BAR GRADE OF 60000 PSI. DESIGN TO CONFORM TO AC1 318 STRUCTURAL STEEL TO BE Fy=50 KSI.

4 0 4 8 12
SCALE: ⅛" = 1'-0"

Seal

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: DJ | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer

Drawn by: DJ | Reviewed by: XX

Date: 1/2008 | Scale: 1/8"=1'-0"

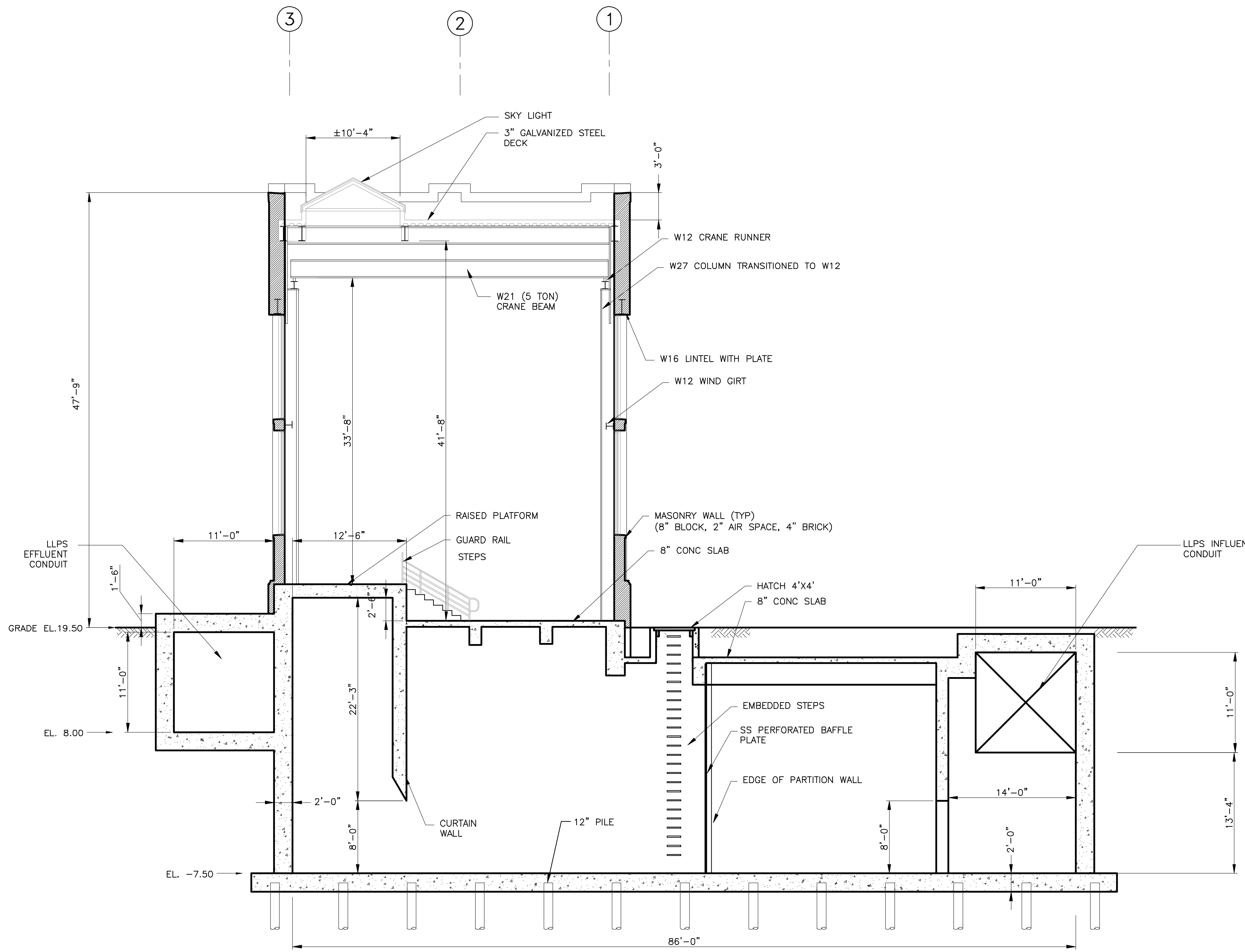
CTE AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION
GRADE LEVEL PLAN

Sheet Number: S-302

Electronic Filing - Received, Clerk's Office, October 20, 2008



4 3 2 1 0 4 8
SCALE: 3/16" 1'-0"

Seal

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: DJ	Checked by: XX	Correct: ANTHONY BOUCHARD	Approved: MWRD Assistant Chief Engineer
Drawn by: DJ	Reviewed by: XX		
Date: 1/2008	Scale: 3/16"=1'-0"		

CTE AECOM

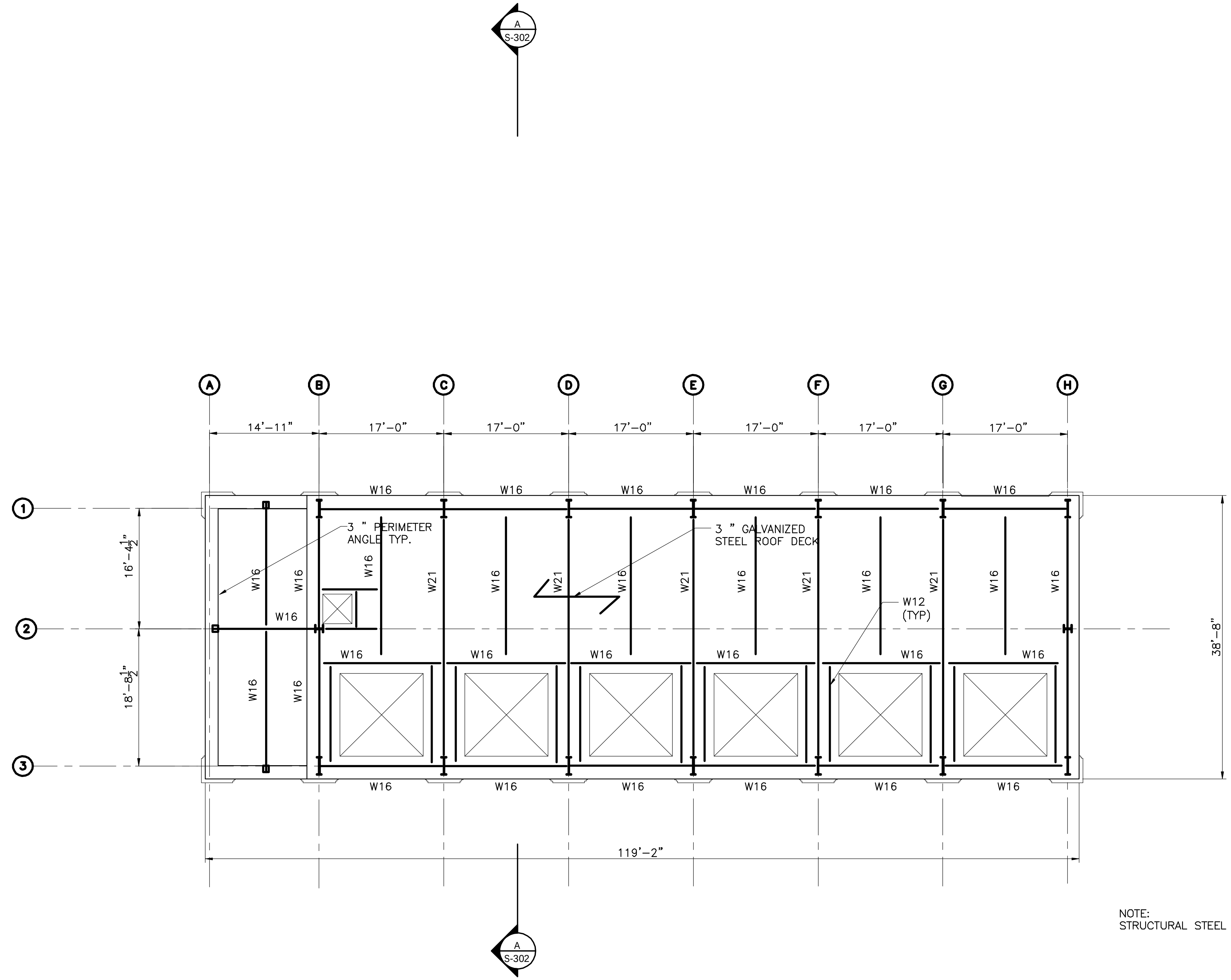
CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION
SECTION

Sheet Number:
S-303

PLOT DATE: 1/30/2008 9:08 AM PLOTTED BY: COCKERILL, ERIC

N



NOTE:
STRUCTURAL STEEL TO BE Fy=50 KSI.

SCALE: ⅛" = 1'-0"

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: DJ	Checked by: XX	Correct: ANTHONY BOUCHARD	Approved: MWRD Assistant Chief Engineer
Drawn by: DJ	Reviewed by: XX	CTE AECOM	
Date: 1/2008	Scale: 1/8"=1'-0"		

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION ROOF FRAMING PLAN

Seal

Sheet Number: S-304

Page Number: 17

PLOT DATE: 1/16/2008 3:20 PM PLOTTED BY: COCKERILL, ERIC

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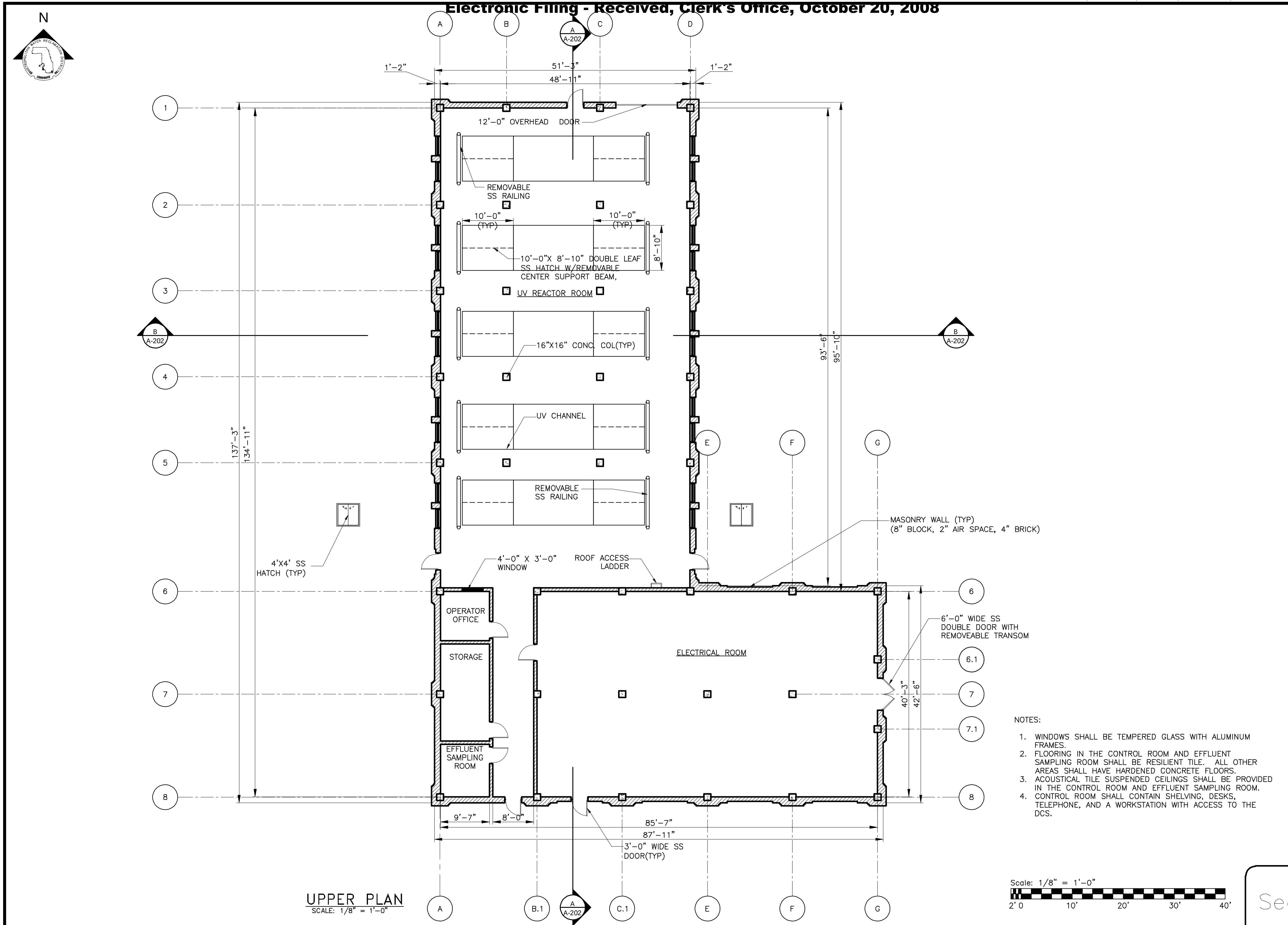


Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: PP | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer

Drawn by: PP | Reviewed by: EPC

Date: 1/2008 | Scale: 1/8"=1'-0"

CTE AECOM

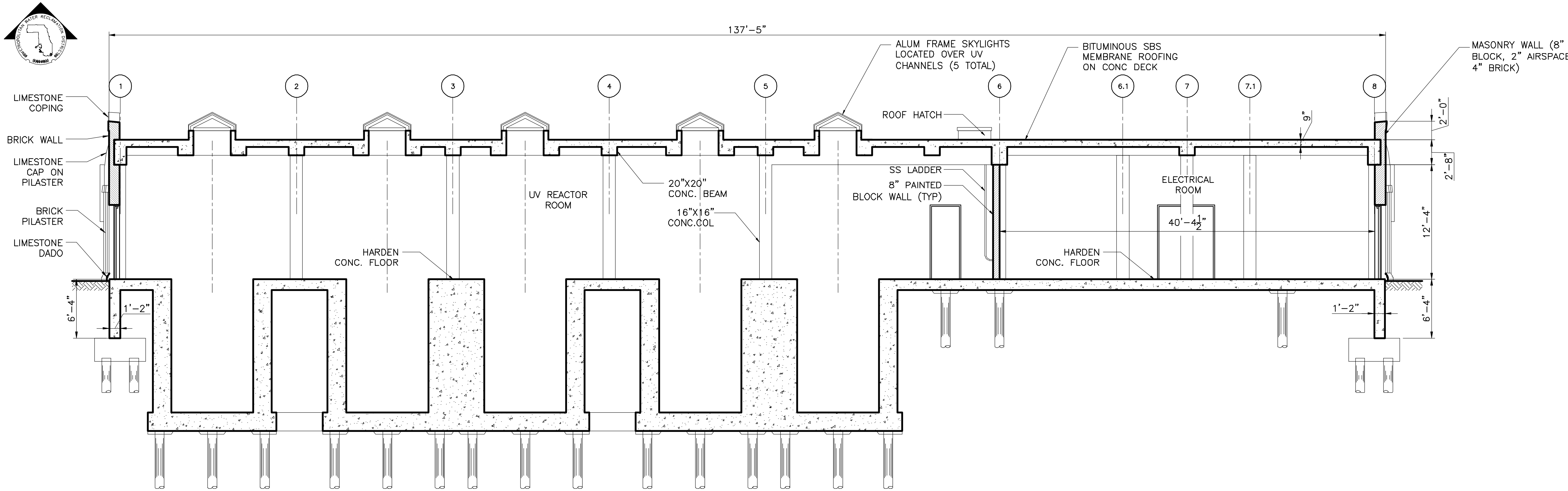
CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION BUILDING
UPPER PLAN

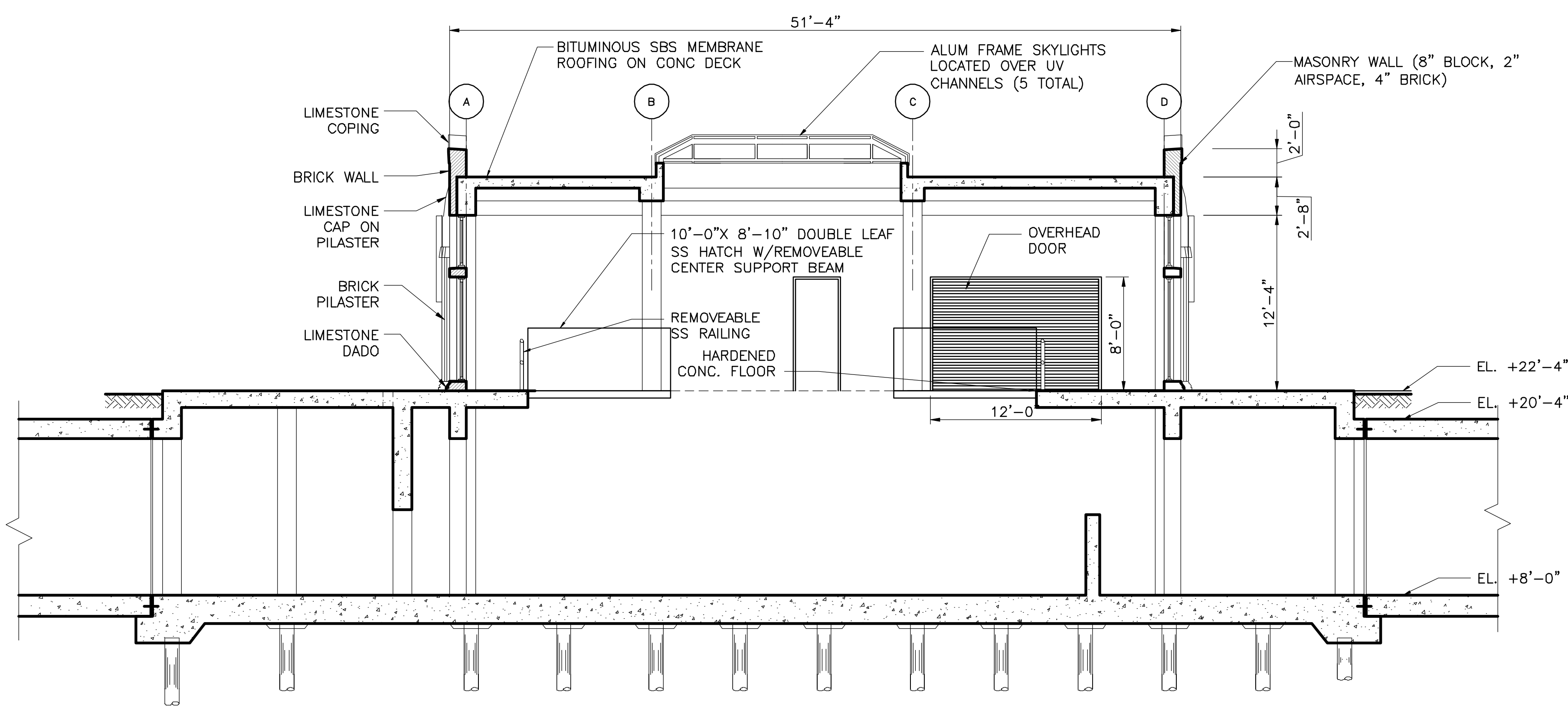
Seal

Sheet Number: A-201

PLOT DATE: 1/16/2008 3:25 PM PLOTTED BY: COCKERILL, ERIC



A SECTION
SCALE: 3/16"=1'-0"



B SECTION
SCALE: 3/16"=1'-0"

NOTES:

1. SPECIALTY DOUBLE LEAF SS HATCHES INCLUDE REMOVABLE CENTER SUPPORT BEAM TO ALLOW LIFTING OF UV MODULE ARMS.

Scale: 3/16 = 1'-0"
1'0 5' 10' 15' 20'

Seal

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: PP | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer
Drawn by: PP | Reviewed by: EPC
Date: 1/2008 | Scale: AS NOTED

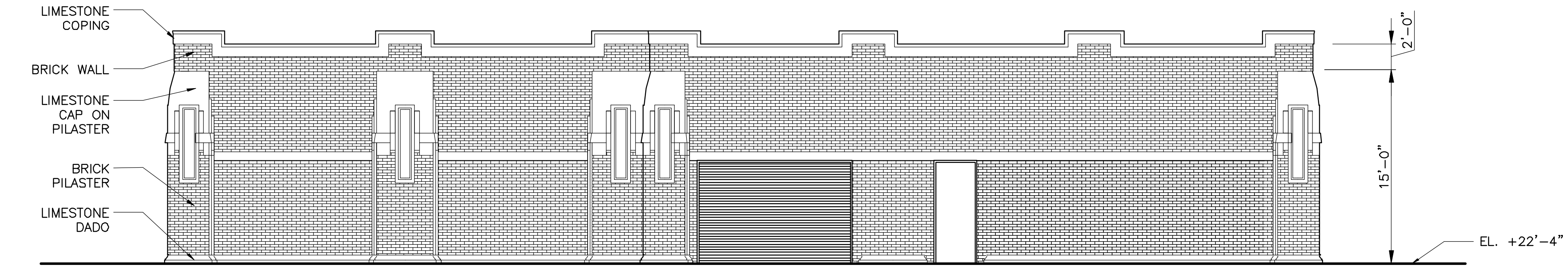
CTE | AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION BUILDING SECTIONS

Sheet Number: A-202
Page Number: 19

N



1 NORTH ELEVATION
SCALE: 3/16"=1'-0"

2 EAST ELEVATION
SCALE: 3/16"=1'-0"

Scale: 3/16 = 1'-0"
1'0 5' 10' 15' 20'

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: PP	Checked by: XX	Correct: ANTHONY BOUCHARD
Drawn by: PP	Reviewed by: EPC	Approved: MWRD Assistant Chief Engineer
Date: 1/2008	Scale: AS NOTED	CTE AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION BUILDING
ELEVATIONS I

Seal

Sheet Number:
A-203

PLOT DATE: 1/30/2008 9:12 AM PLOTTED BY: COCKERILL, ERIC

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1/30/2008 9:12 AM

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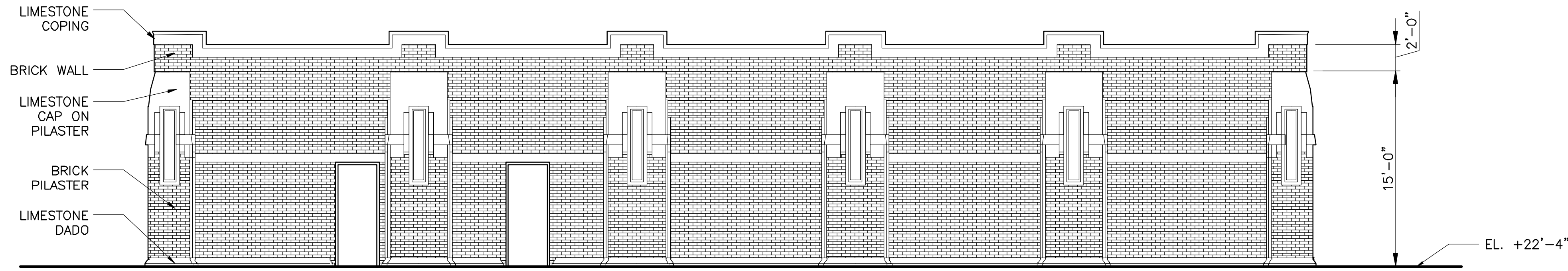


1 SOUTH ELEVATION
SCALE: 3/16"=1'-0"

1 2
SCALE: 3/16"=1'-0"

Scale: 3/16 = 1'-0"
1'0 5' 10' 15' 20'

Seal

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: PP | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer
Drawn by: PP | Reviewed by: EPC
Date: 1/2008 | Scale: AS NOTED

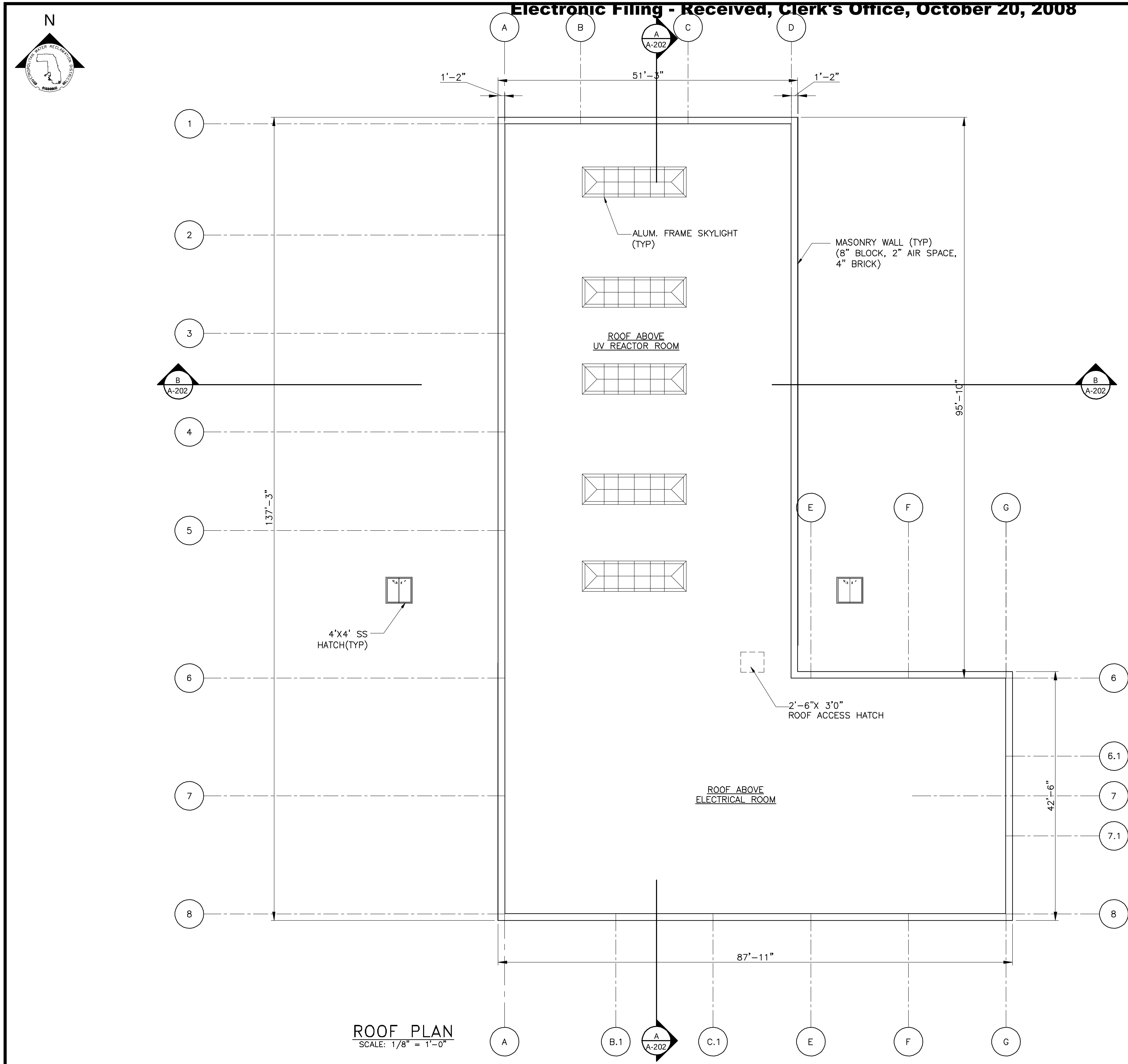
CTE AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION BUILDING
ELEVATIONS

Sheet Number: A-204
Page Number: 21

PLOT DATE: 1/30/2008 9:12 AM PLOTTED BY: COCKERILL, ERIC



ROOF PLAN
SCALE: 1/8" = 1'-0"

Scale: 1/8" = 1'-0"
2' 0 10' 20' 30' 40'

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: PP | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer

Drawn by: PP | Reviewed by: EPC

Date: 1/2008 | Scale: 1/8"=1'-0"

CTE AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION BUILDING
ROOF PLAN

Seal

Sheet Number: A-205
Page Number: 22

P:\P60026610\Contracts\07-026-2P\ARCHITECTRUAL\A-301.dwg 1/16/2008 3:56 PM

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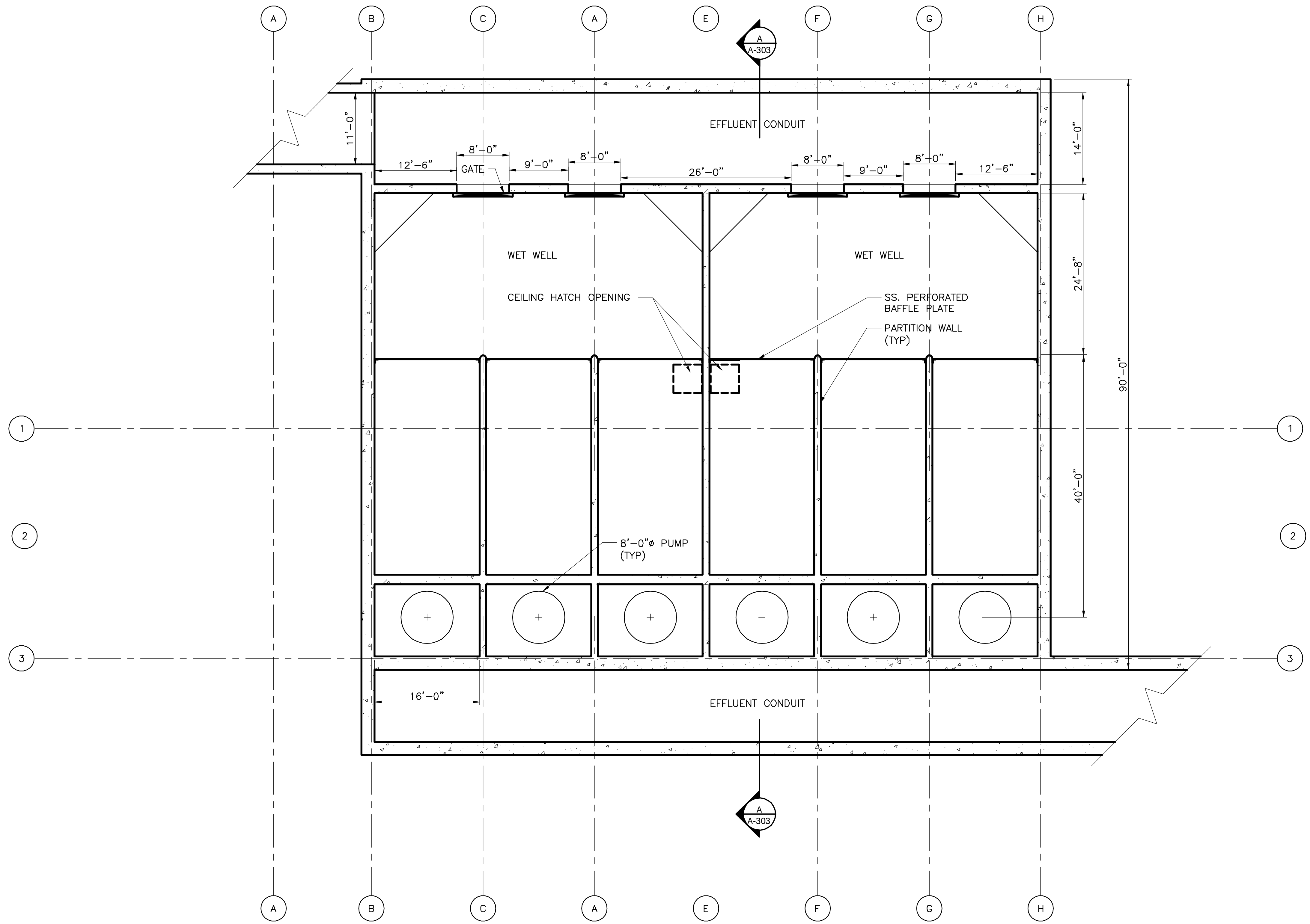

LOWER PLAN

SCALE: 1/8" = 1'-0"

4 0 4 8 12
SCALE: 1/8" = 1'-0"

Seal

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: PP	Checked by: XX	Correct: ANTHONY BOUCHARD
Drawn by: PP	Reviewed by: EPC	Approved: MWRD Assistant Chief Engineer
Date: 1/2008	Scale: 1/8"=1'-0"	CTE AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION LOWER PLAN

Sheet Number: A-301

Page Number: 23

PLOT DATE: 1/16/2008 3:59 PM PLOTTED BY: COCKERILL, ERIC

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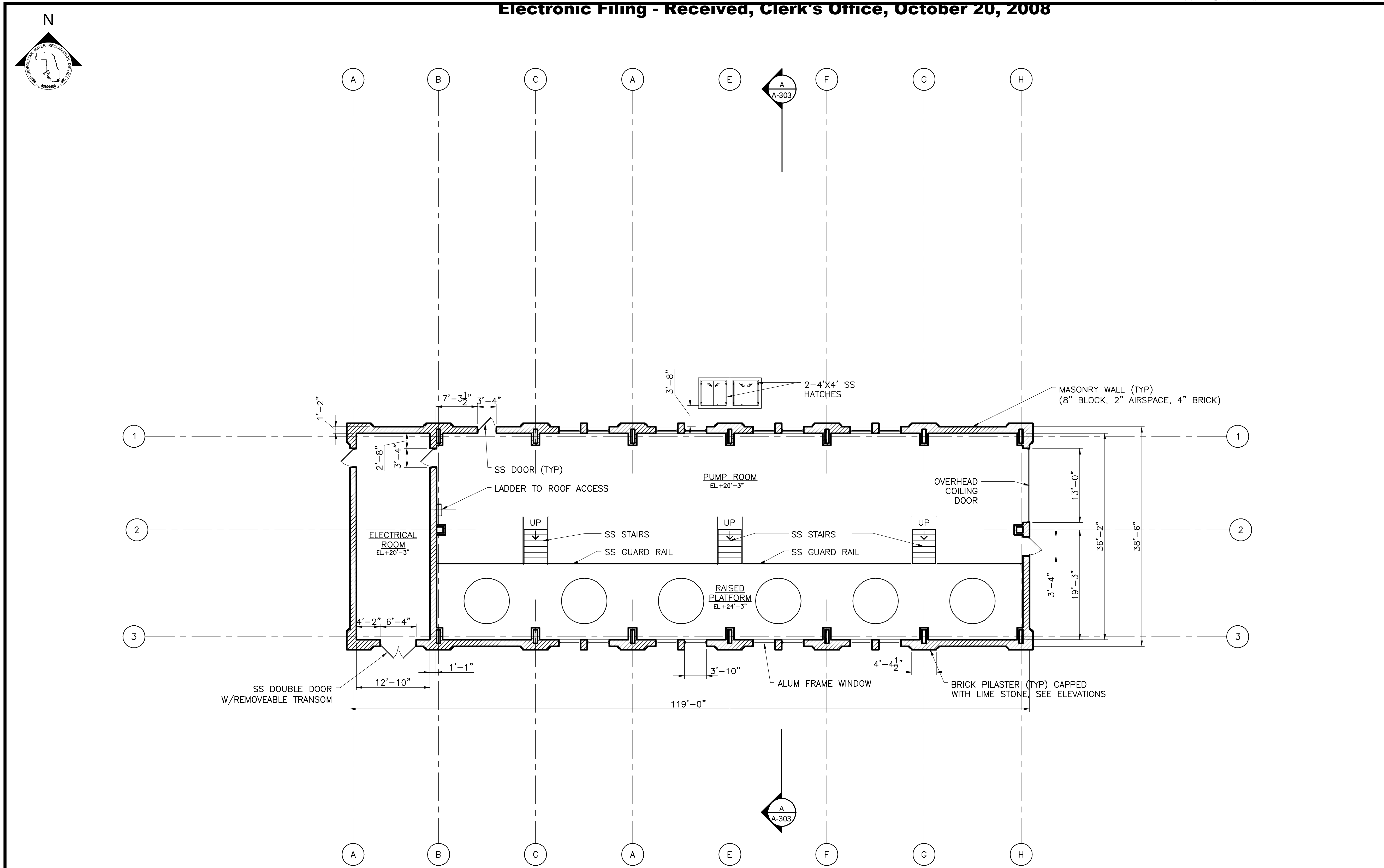


PLOT DATE: 1/30/2008 9:13 AM PLOTTED BY: COCKERILL, ERIC

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: PP
Checked by: XX
Correct: ANTHONY BOUCHARD
Approved: MWRD Assistant Chief Engineer
Drawn by: PP
Reviewed by: XX
Date: 10/2007
Scale: 1/8"=1'-0"

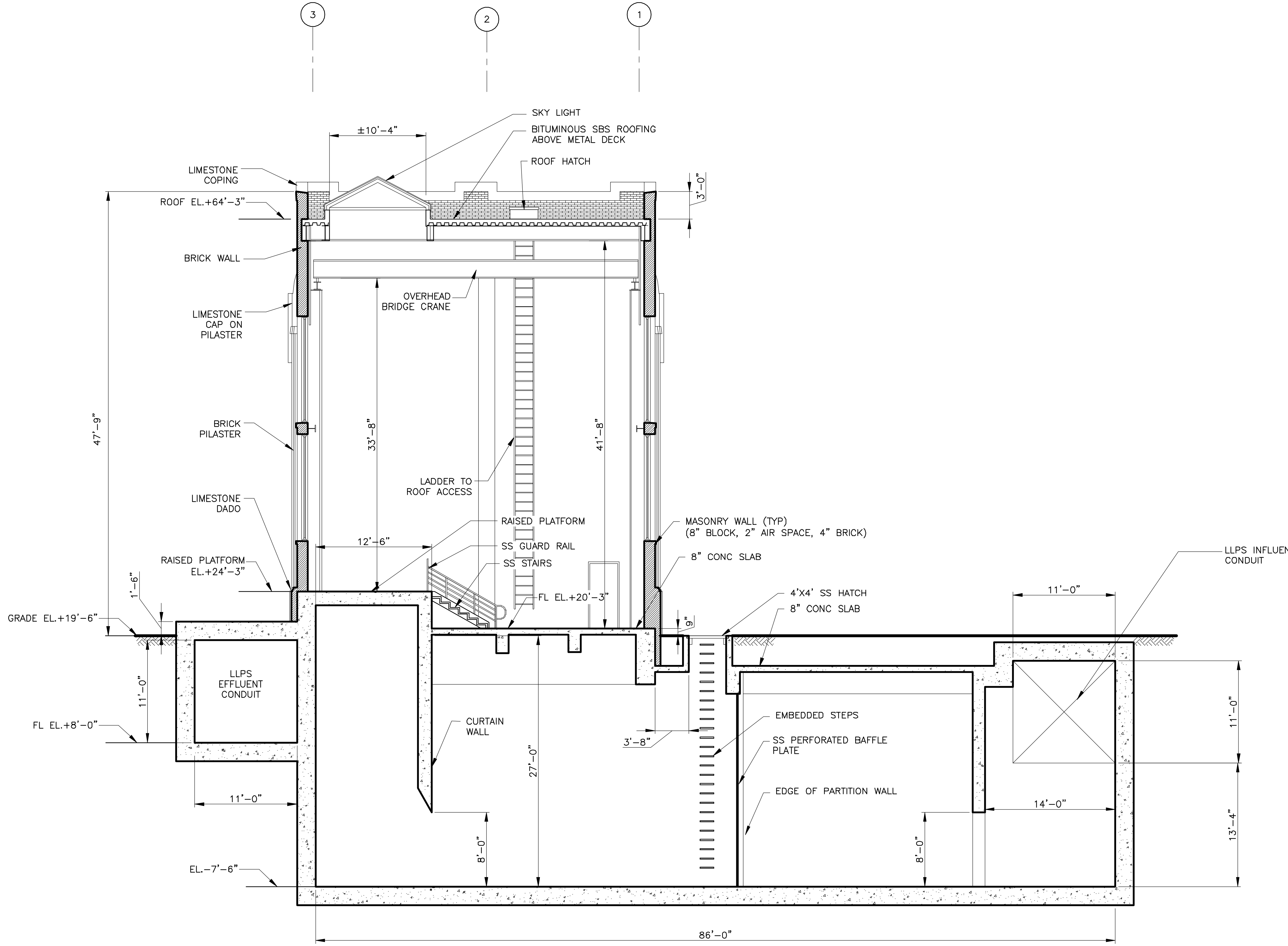
CTE | AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION
UPPER PLAN

Seal

Sheet Number: A-302



SECTION A / A-102
SCALE: 3/16" = 1'-0"

SCALE: 3/16" = 1'-0"

Seal

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: PP | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer

Drawn by: PP | Reviewed by: EPC

Date: 1/2008 | Scale: 1/8"=1'-0"

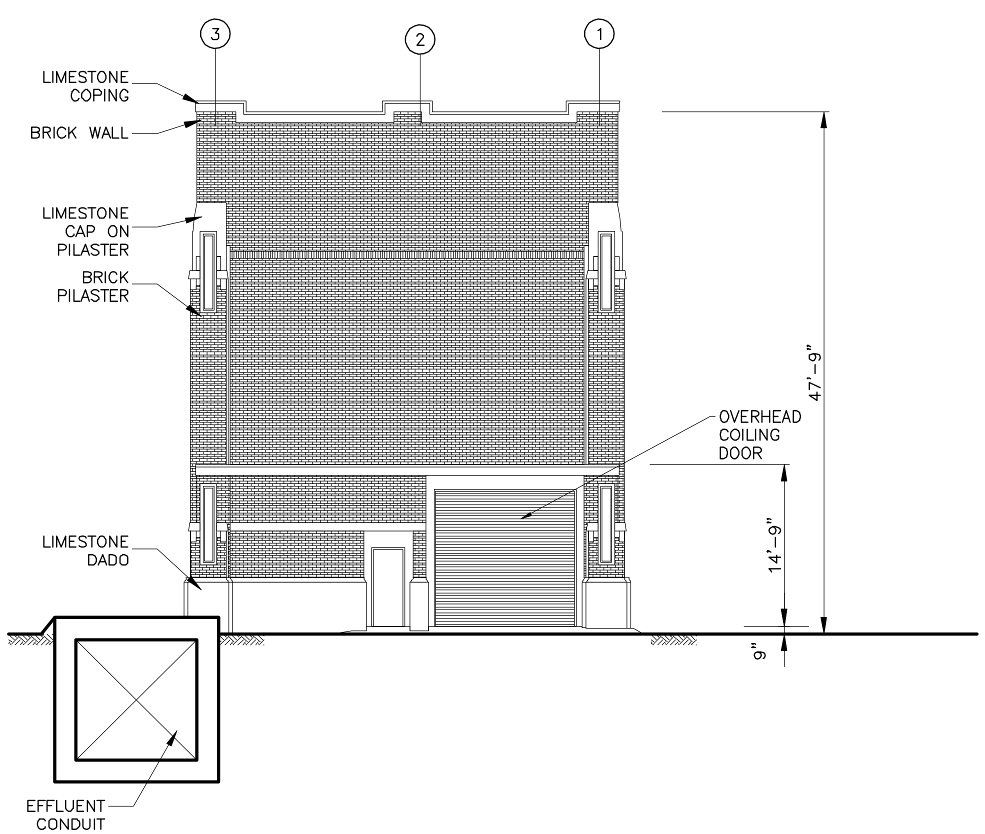
CTE | AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION SECTION

Sheet Number: A-303

1 NORTH ELEVATION
SCALE: 1/8"=1'-0"



2 EAST ELEVATION
SCALE: 1/8"=1'-0"

4 0 4 8 12
SCALE: 1/8" = 1'-0"

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: PP | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer
Drawn by: PP | Reviewed by: EPC
Date: 1/2008 | Scale: 1/8"=1'-0"

CTE AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION
ELEVATIONS I

Seal

Sheet Number: A-304
Page Number: 26

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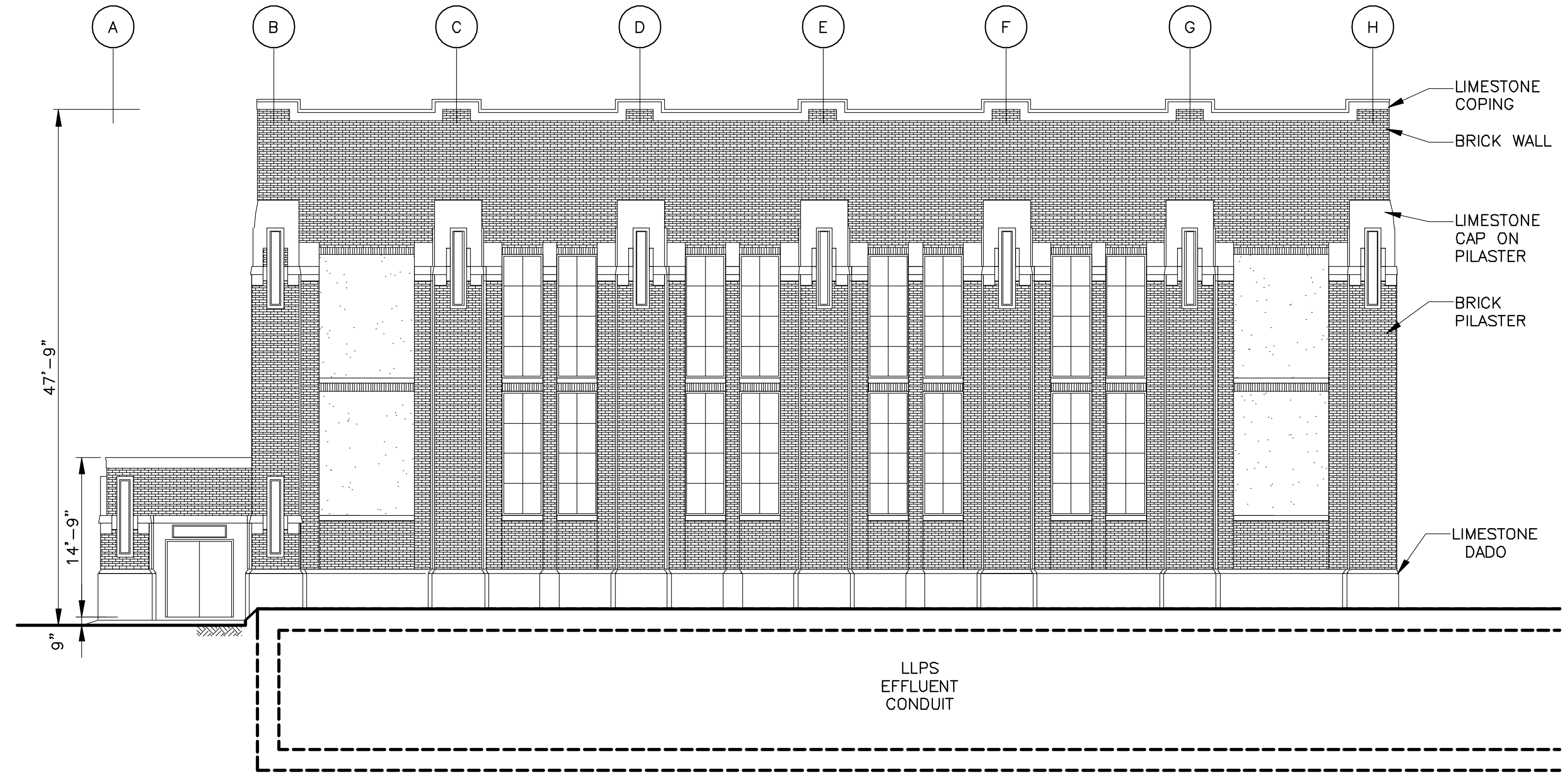

1 **SOUTH ELEVATION**
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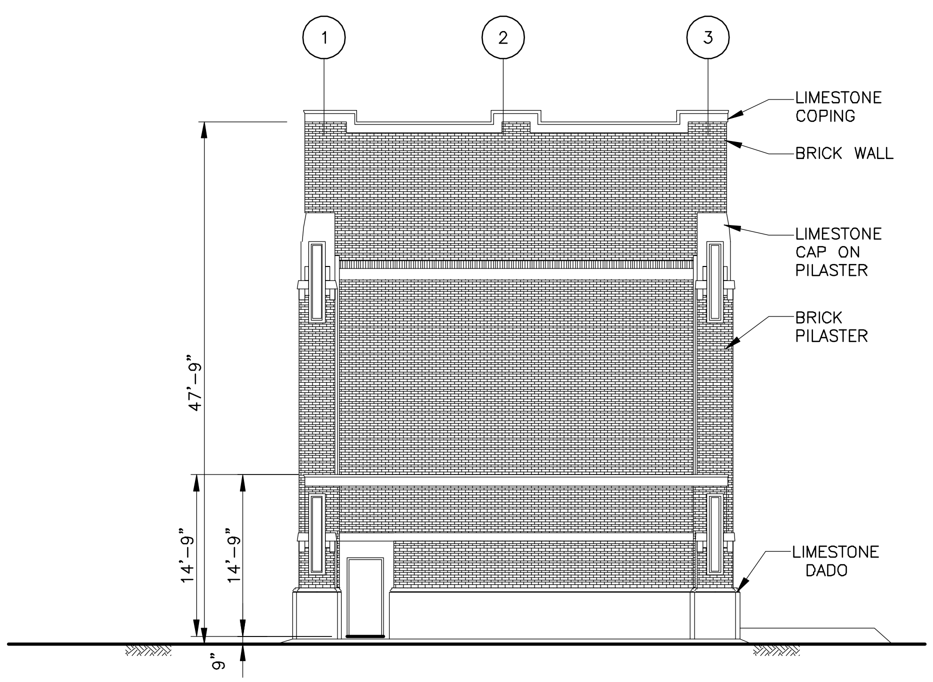

2 **WEST ELEVATION**
SCALE: 1/8"=1'-0"

4 0 4 8 12
SCALE: 1/8" = 1'-0"

Seal

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: PP | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer
Drawn by: PP | Reviewed by: EPC
Date: 1/2008 | Scale: 1/8"=1'-0"

CTE AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION
ELEVATIONS II

Sheet Number: A-305
Page Number: 27

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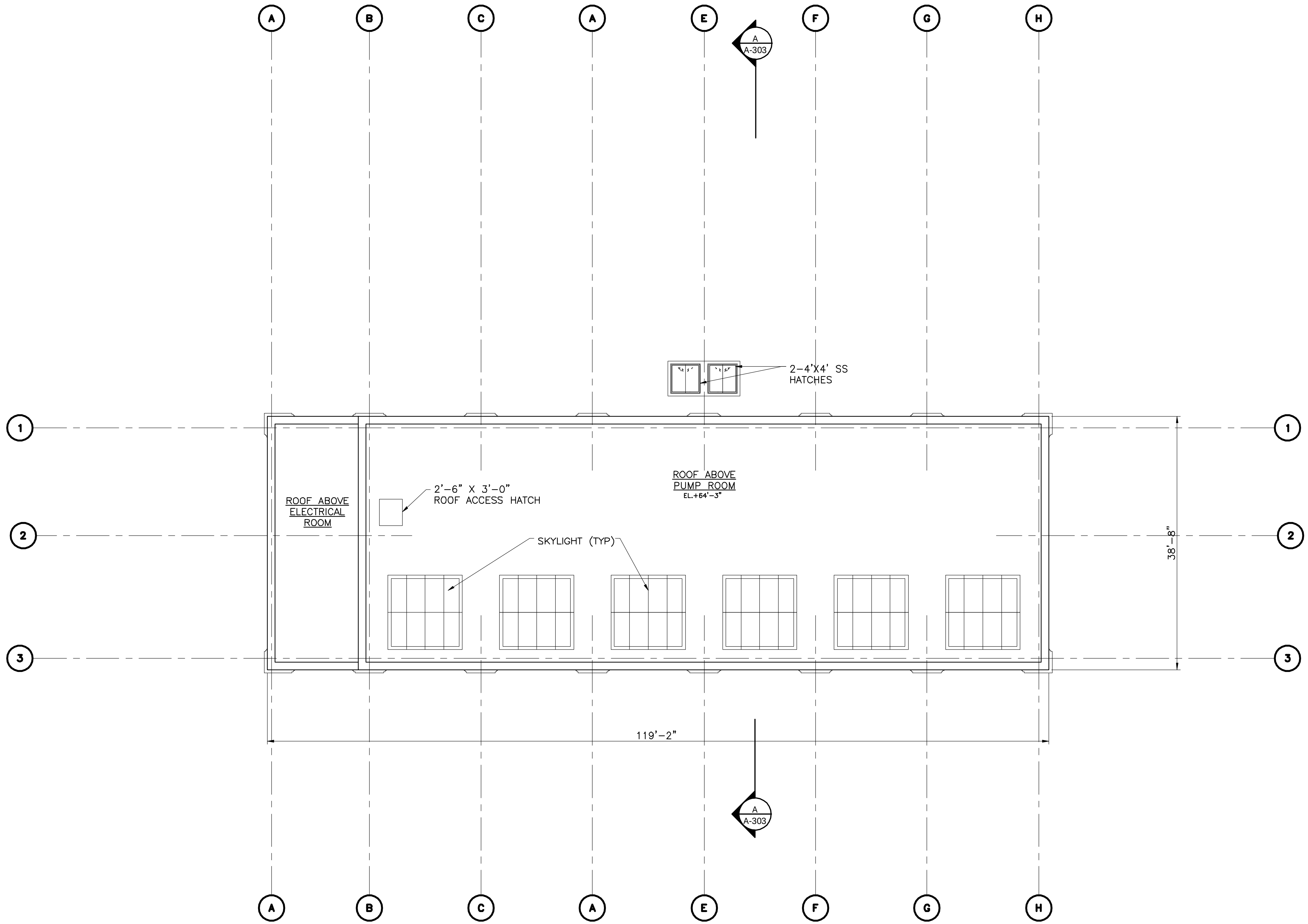


ROOF PLAN

SCALE: 1/8" = 1'-0"

4 0 4 8 12
SCALE: 1/8" = 1'-0"

Seal

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: PP | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer

Drawn by: PP | Reviewed by: EPC

Date: 1/2008 | Scale: 1/8"=1'-0"

CTE AECOM

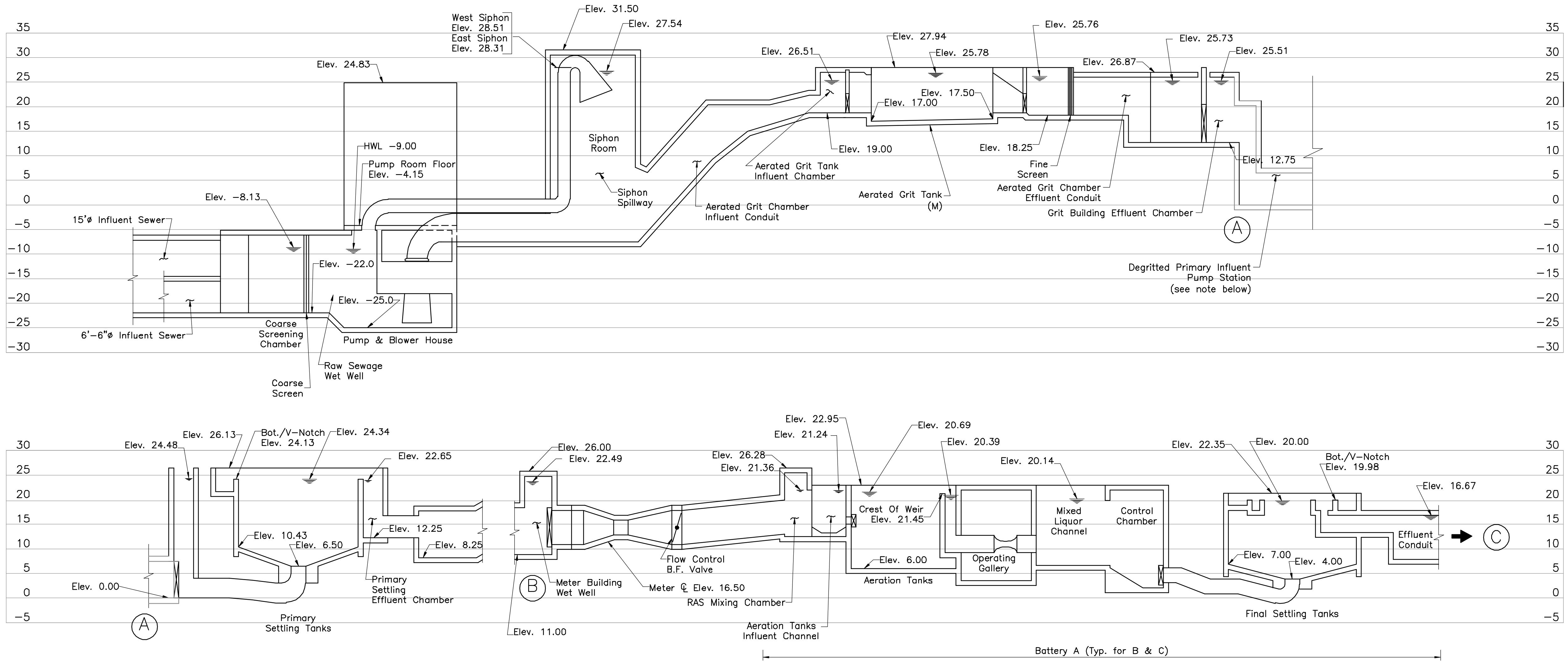
CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION
ROOF PLAN

Sheet Number: A-306

Page Number: 28

Electronic Filing - Received, Clerk's Office, October 20, 2008



Legend

(A) – Flow diversion from Headworks to Batteries on Existing Site and North Site Battery E. (Existing Site – 345 mgd, Battery E – 105 mgd)

(B) – Flow split at Meter Building Wet Well to Batteries A & F

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: EPC | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer

Drawn by: EPC | Reviewed by: XX

Date: 1/2008 | Scale: NTS

CTE | AECOM

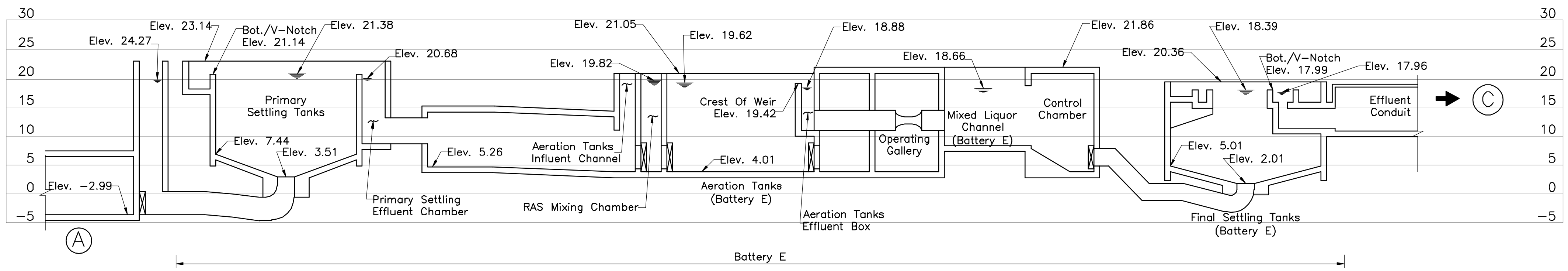
CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

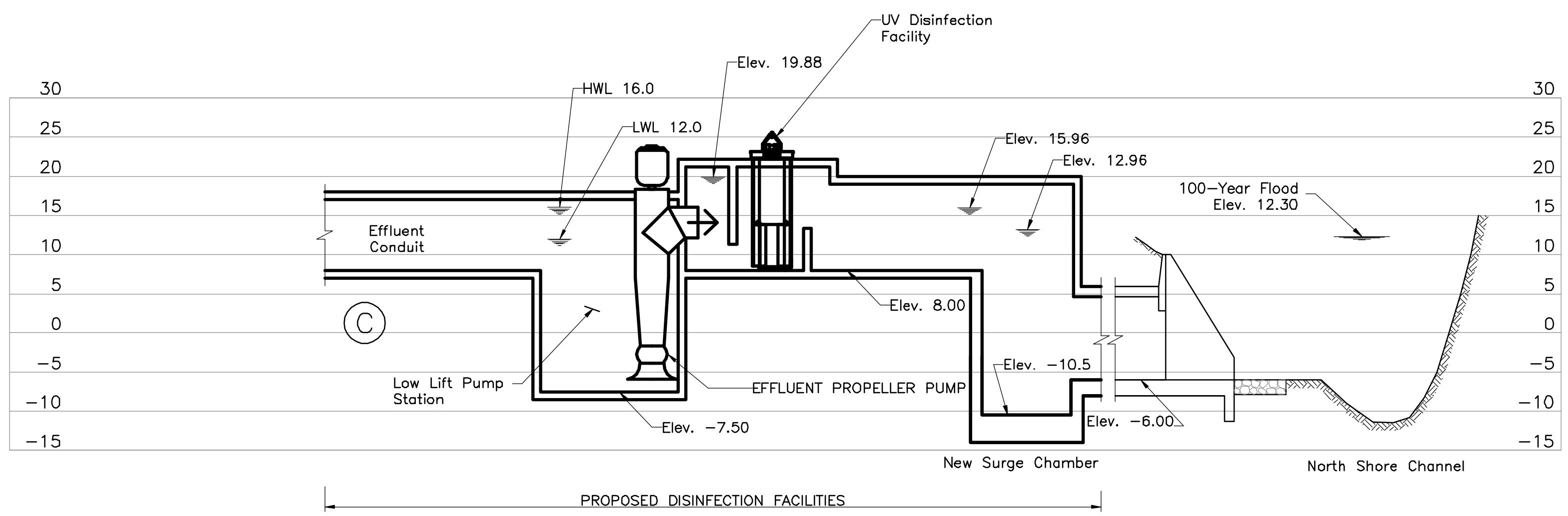
PROPOSED HYDRAULIC PROFILE
BATTERIES A, B, C, D, AND F

Seal

Sheet Number:
P-101

Electronic Filing - Received, Clerk's Office, October 20, 2008





Legend

(A) – Flow diversion from Headworks to Battery E [Q (Battery E) = 105 mgd]

(C) – Flow junction from Batteries A, E, & F. (Total Q = 450 mgd)

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: EPC | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer

Drawn by: EPC | Reviewed by: XX

Date: 1/2008 | Scale: NTS

CTE | AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

PROPOSED HYDRAULIC PROFILE
BATTERY E AND DISINFECTION FACILITIES

Seal

Sheet Number: P-102

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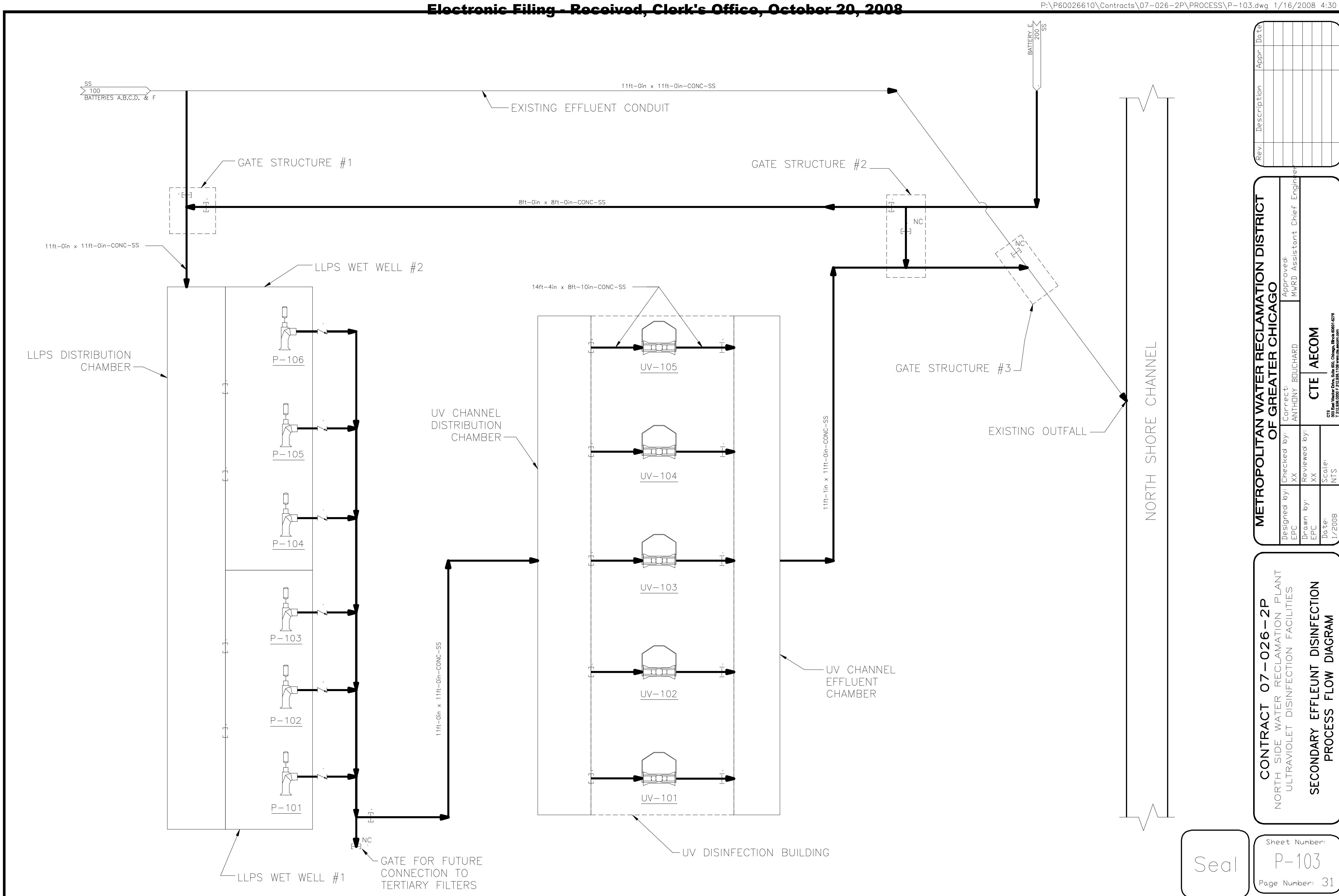
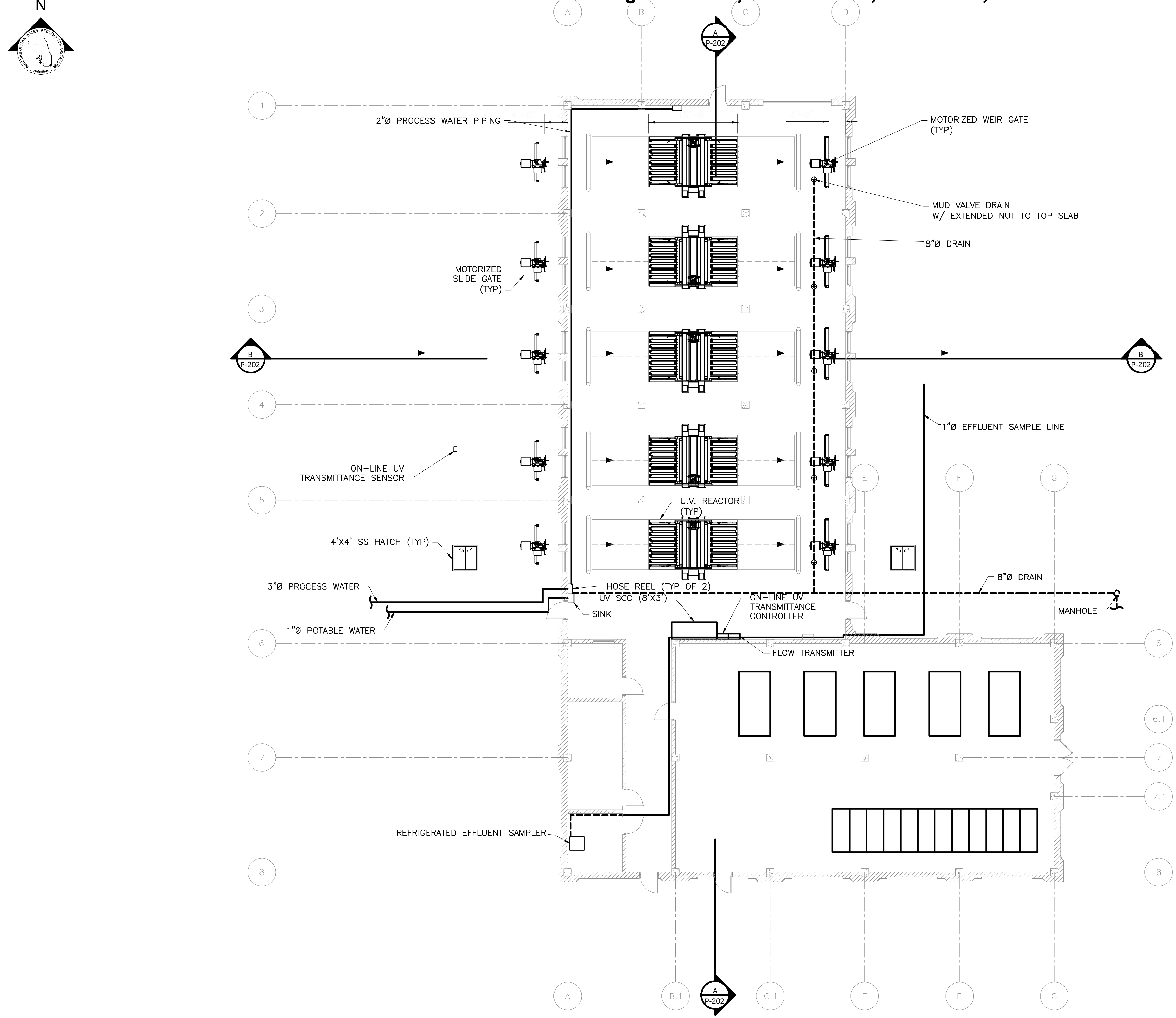


PLOT DATE: 1/16/2008 4:30 PM PLOTTED BY: COCKERILL, ERIC



Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: TT/EPC
Checked by: XX
Correct: ANTHONY BOUCHARD
Approved: MWRD Assistant Chief Engineer
Drawn by: MB
Reviewed by: XX
Date: 1/2008
Scale: 1/8"=1'-0"

CTE AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION BUILDING PLAN

Seal

Sheet Number: P-201

PLOT DATE: 1/16/2008 4:50 PM PLOTTED BY: COCKERILL, ERIC

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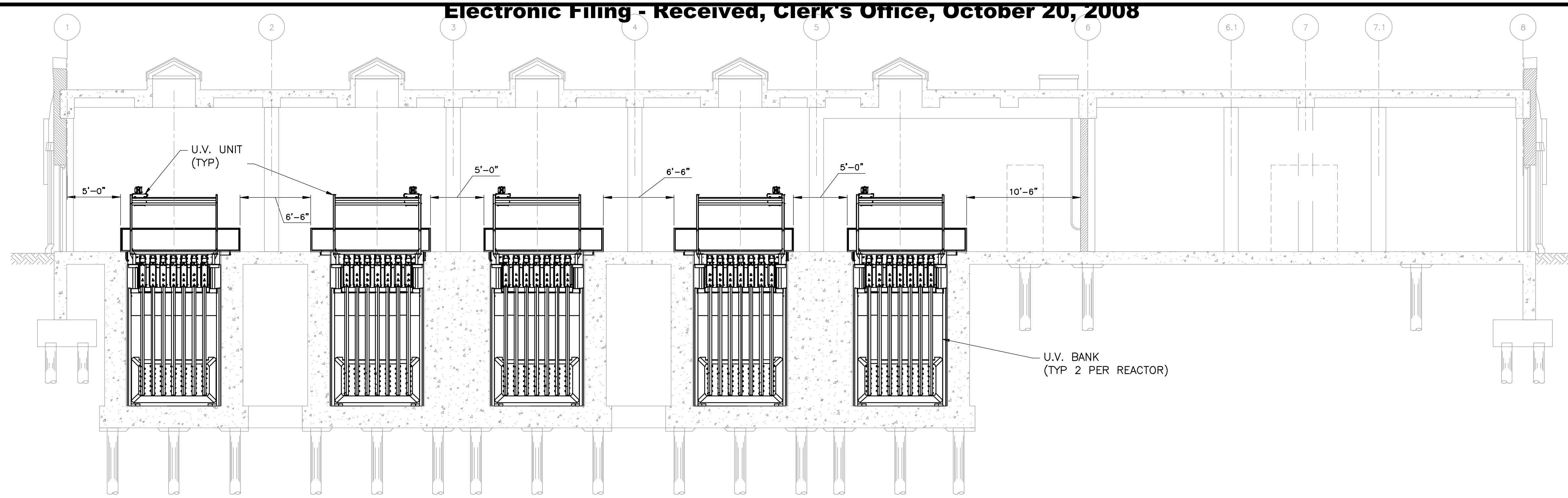
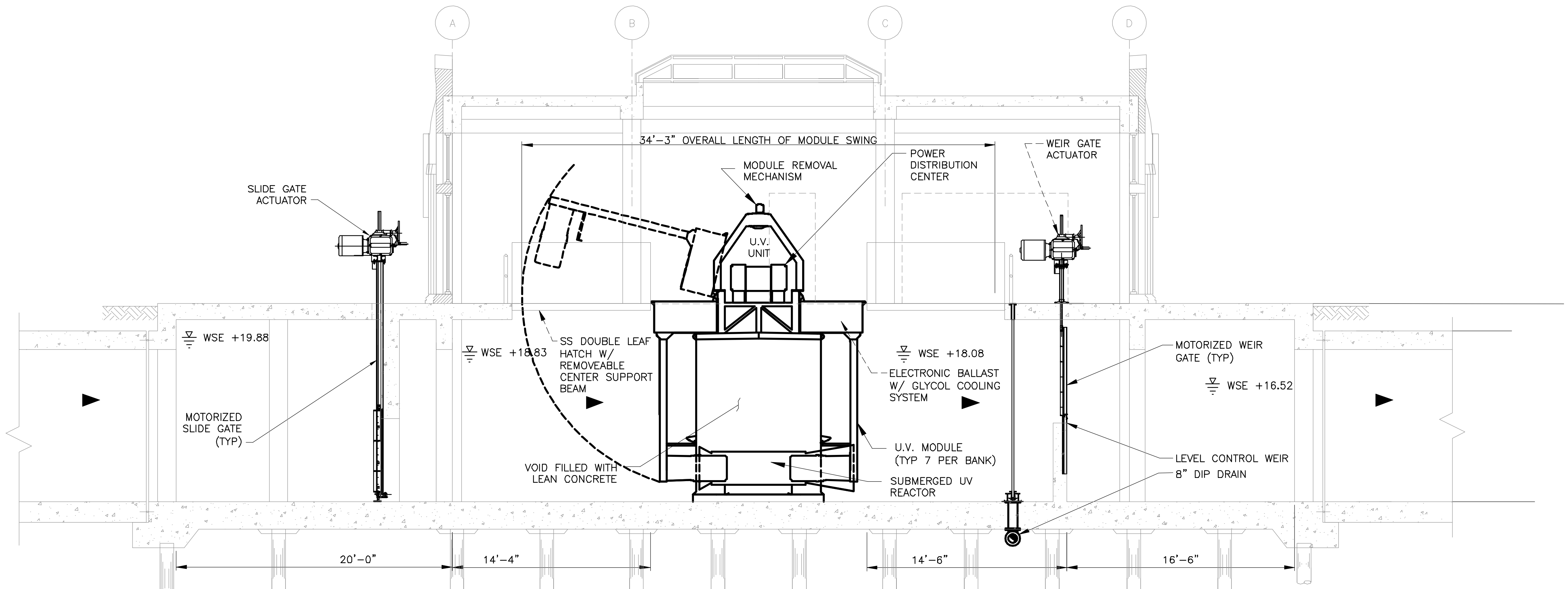


A SECTION
SCALE: 3/16"=1'-0"



B SECTION
SCALE: 1/4"=1'-0"

PLOT DATE: 1/30/2008 9:17 AM PLOTTED BY: COCKERILL, ERIC

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: TT/EPC
Checked by: XX
Drawn by: MB
Reviewed by: XX
Date: 1/2008
Scale: AS NOTED
Correct: ANTHONY BOUCHARD
Approved: MWRD Assistant Chief Engineer

CTE | AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION BUILDING
SECTIONS

Seal

Sheet Number: P-202

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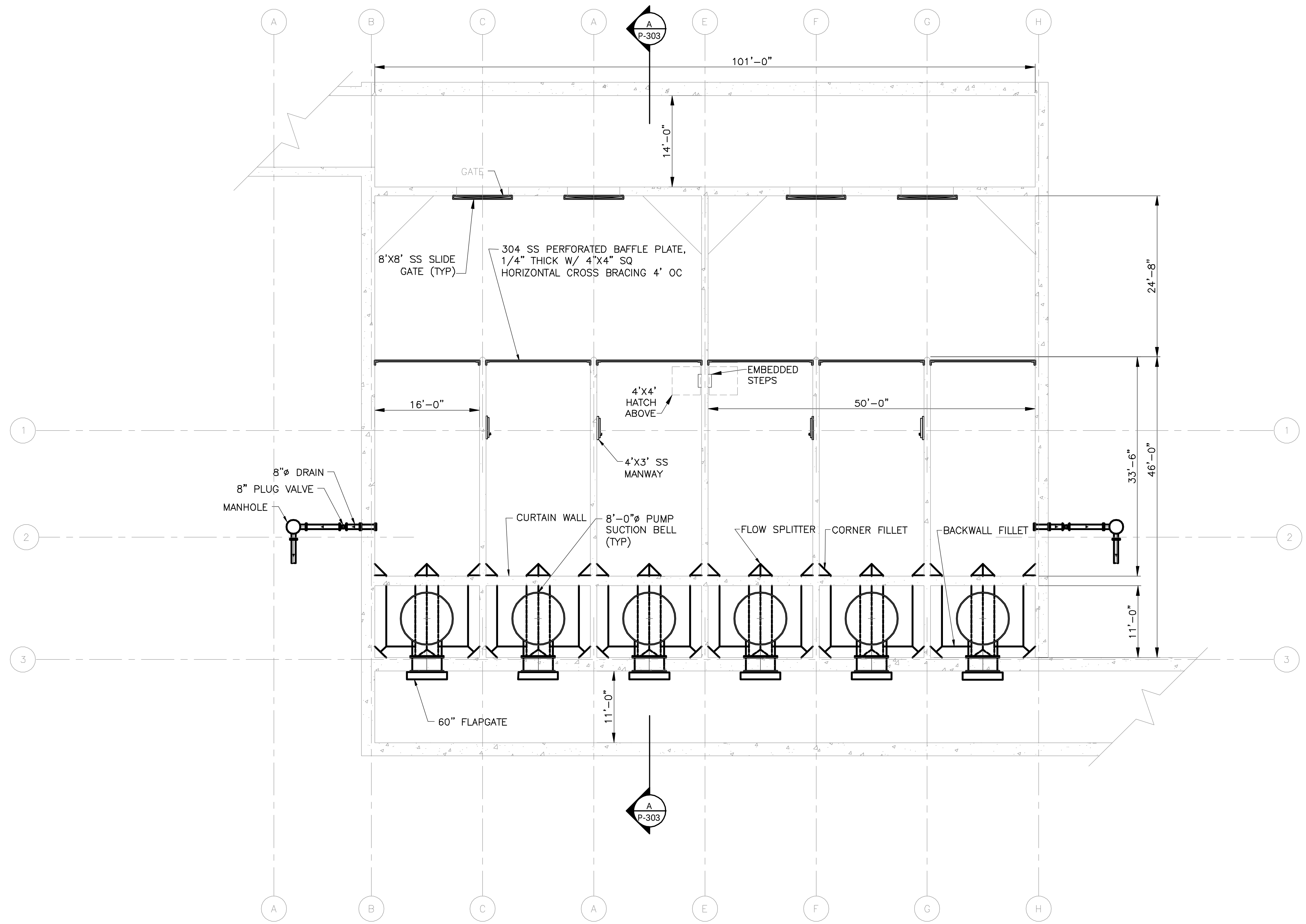

SCALE: 1/8" = 1'-0"

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: CMB	Checked by: XX	Correct: ANTHONY BOUCHARD	Approved: MWRD Assistant Chief Engineer
Drawn by: MB	Reviewed by: EPC		
Date: 1/2008	Scale: 1/8"=1'-0"		

CTE AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION
LOWER LEVEL PLAN

Seal

Sheet Number: P-301

PLOT DATE: 1/30/2008 9:19 AM PLOTTED BY: COCKERILL, ERIC

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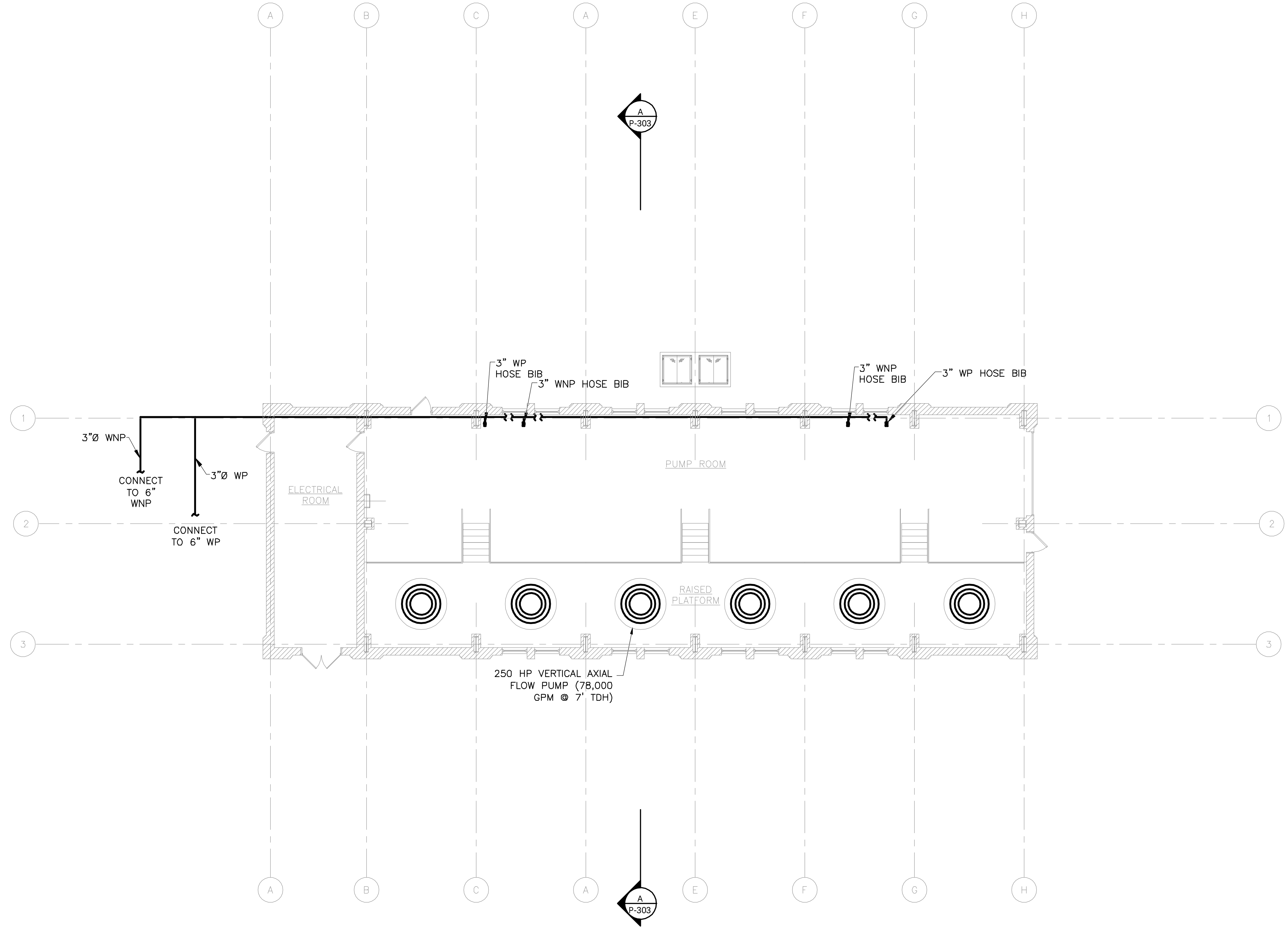

4 0 4 8 12
SCALE: 1/8" = 1'-0"

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: CMB	Checked by: XX	Correct: ANTHONY BOUCHARD	Approved: MWRD Assistant Chief Engineer
Drawn by: MB	Reviewed by: EPC	CTE AECOM	
Date: 1/2008	Scale: 1/8"=1'-0"		

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION
UPPER LEVEL PLAN

Seal

Sheet Number: P-302

Page Number: 35

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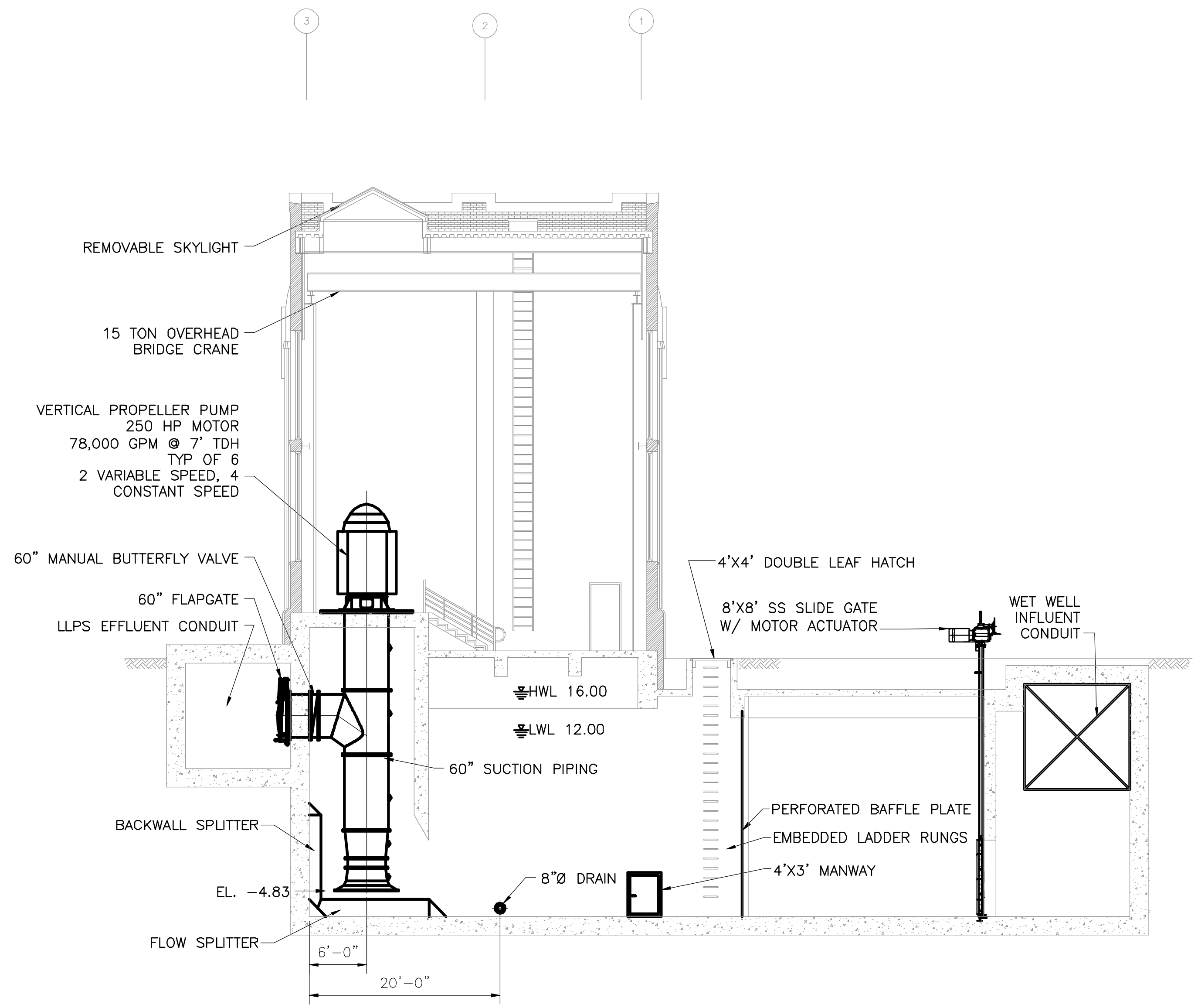

SECTION A / P-303
SCALE: 1/8"=1'

4 0 4 8 12
SCALE: 1/8" = 1'-0"

Seal

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: CMB | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer
Drawn by: MB | Reviewed by: EPC
Date: 1/2008 | Scale: 1/8"=1'-0"

CTE AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION SECTION

Sheet Number: P-303
Page Number: 36

PLOT DATE: 1/17/2008 9:39 AM PLOTTED BY: COCKERILL, ERIC

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HEATING & VENTILATION SYMBOLS

Symbol	Description
GAS	NATURAL GAS
HHWS	HEATING HOT WATER SUPPLY (HHWS)
HHWR	HEATING HOT WATER RETURN (HHWR)
HHWRR	HHW REVERSE RETURN (HHWRR)
HYD	HYDRAULIC (HYD)
SPD	SUMP PUMP DISCHARGE (SPD)
SS	STORM SEWER (SS)
SWD	SOIL, WASTE AND DRAIN (SWD)
VENT	VENT
UH3-1	HORIZONTAL UNIT HEATER
90 CFM OR 90 CFM	QUANTITY AND DIRECTION OF THE AIR FLOW
12X16 OR 12X16	DUCT SIZE (FIRST FIGURE SIZE OF SHOWN, SECOND FIGURE SIZE OF SIDE NOT SHOWN.)
	SUPPLY AIR DUCT – UP
	SUPPLY AIR DUCT – DOWN
	RETURN/EXHAUST AIR DUCT – UP
	RETURN/EXHAUST AIR DUCT – DOWN
	DUCT ELBOW WITH TURNING VANES
	ROUND ELBOW WITH GUIDE VANES
FC	FLEXIBLE CONNECTION
	DIFFUSER
100 CFM OR 100 CFM	8" THROAT DIAMETER CEILING DIFFUSER; AIR FLOW –– 100 CFM
OR	BALANCING OR VOLUME DAMPER (VD)
M OR M	MOTOR OPERATED DAMPER
100 CFM OR 100 CFM	SUPPLY REGISTER OR GRILLE DUCT MOUNTED AIR FLOW –– 100 CFM
100 CFM OR 100 CFM	SUPPLY REGISTER OR GRILLE IN WALL AIR FLOW –– 100 CFM
	FLEXIBLE CONNECTION FAN OR EQUIPMENT
FD	2 HOUR FIRE DAMPER
	WALL LOUVER WITH MOTORIZED DAMPER

HEATING & VENTILATION CONTROL SYMBOLS

Symbol	Description
FS	FREEZE STAT
TS	TEMPERATURE SENSOR
T	THERMOSTAT
S 20	CONNECTION TO EXISITNG 20 PSI (NOMINAL) PNEUMATIC SYSTEM
	PNEUMATIC SIGNAL
	ELECTRICAL SIGNAL

ABBREVIATIONS

ACCU	AIR COOLED CONDENSING UNIT
AHU	AIR HANDLING UNIT
FD	FLOOR DRAIN
VTR	VENT TO ROOF
EF	EXHAUST FAN
UH	TERMINAL UNIT HEATER

GENERAL PIPING SYMBOLS

Symbol	Description
	CONCENTRIC REDUCER
	ECCENTRIC REDUCER
	ORIFICE FLANGE
	CROSSOVER
	PIPE GUIDE
	EXPANSION JOINT (SLIP TYPE)
	EXPANSION JOINT (BELLOWS TYPE)
	AIR ELIMINATOR (AIR VENT)
	PIPE CAP
	STRAIGHT CROSS
	90° ELBOW
	90° ELBOW TURNED DOWN
	90° ELBOW TURNED DOWN
	SIDE OUTLET ELBOW TURNED DOWN
	SIDE OUTLET ELBOW TURNED UP
	LATERAL
	TEE
	TEE OUTLET UP
	TEE OUTLET DOWN
	UNION
	STRAINER
	PIPE ANCHOR
0–100	THERMOMETER (NOS. = RANGE IN °F)
	PRESSURE, VACUUM OR COMPOUND GAUGE
FS	FLOW SWITCH
100 GPM	VENTURI FLOW METER AND FLOW TO BE INDICATED
100 50	PRESSURE REDUCING VALVE (NOS. = INITIAL AND FINAL PRESSURE – PSIG)
	CONNECTION BETWEEN NEW AND EXISTING
	GATE VALVE
	GLOBE VALVE
	BUTTERFLY VALVE
	CHECK VALVE
	ANGLE GATE VALVE
	PLUG VALVE
	MANUAL VALVE (2-WAY)
	MANUAL VALVE (3-WAY)
S	SOLENOID VALVE (4-WAY)
	BALL VALVE
	HOSE BIB (HB)
	CIRCUIT SETTER
	PUMP

LEGEND:

(thin line)	NEW OR EXISTING BACKGROUND
(dashed line)	EXISTING WORK TO REMAIN (OR NEW WORK FURNISHED AND INSTALLED UNDER OTHER CONTRACT ITEMS
(heavy dashed line)	NEW WORK
(dash-dot line)	FUTURE WORK
(hatched area)	REMOVAL WORK

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: EPC
Checked by: XX
Correct: ANTHONY BOUCHARD
Approved: MWRD Assistant Chief Engineer
Drawn by: EPC
Reviewed by: XX
Date: 1/2008
Scale: NTS

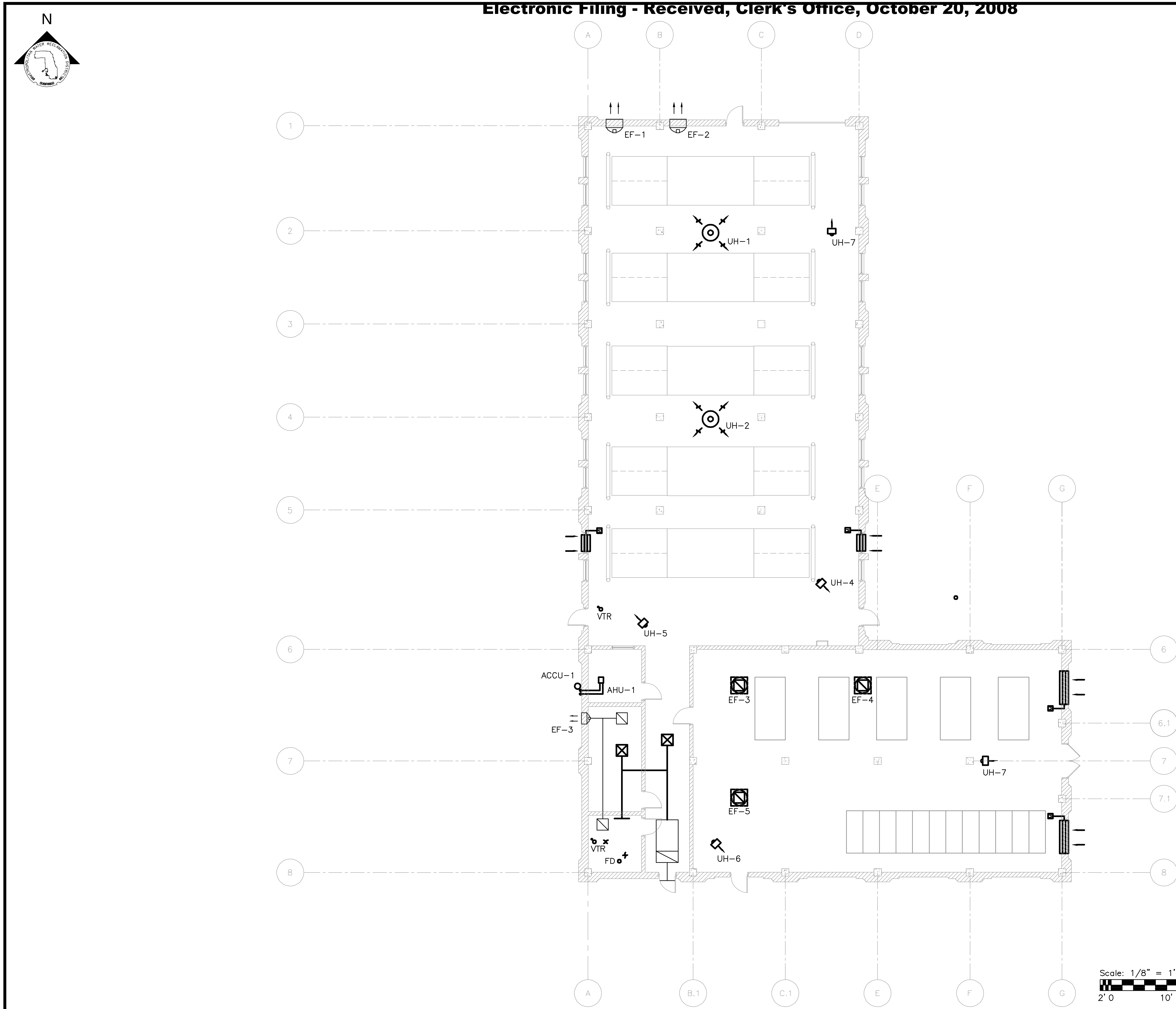
CTE AECOM

CONTRACT 07–026–2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES
UV DISINFECTION BUILDING
MECHANICAL LEGEND/ABBREVIATIONS

Seal

Sheet Number: M–001
Page Number: 37

PLOT DATE: 1/17/2008 9:44 AM PLOTTED BY: COCKERILL, ERIC



NOTES;

1. TERMINAL UNIT HEATERS ARE STEAM TYPE. STEAM ORIGINATES FROM SERVICE TUNNEL AT BATTERY A. SEE C-103 FOR SITE PIPING.

Scale: 1/8" = 1'-0"

2' 0 10' 20' 30' 40'

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: JD | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer

Drawn by: RM | Reviewed by: EPC

Date: 1/2008 | Scale: 1/8" = 1'

CTE AECOM

CTE 303 East Wacker Drive, Suite 600, Chicago, Illinois 60601-5276 T 312.938.0300 F 312.938.1109 www.cte.aecom.com

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION BUILDING
MECHANICAL PLAN

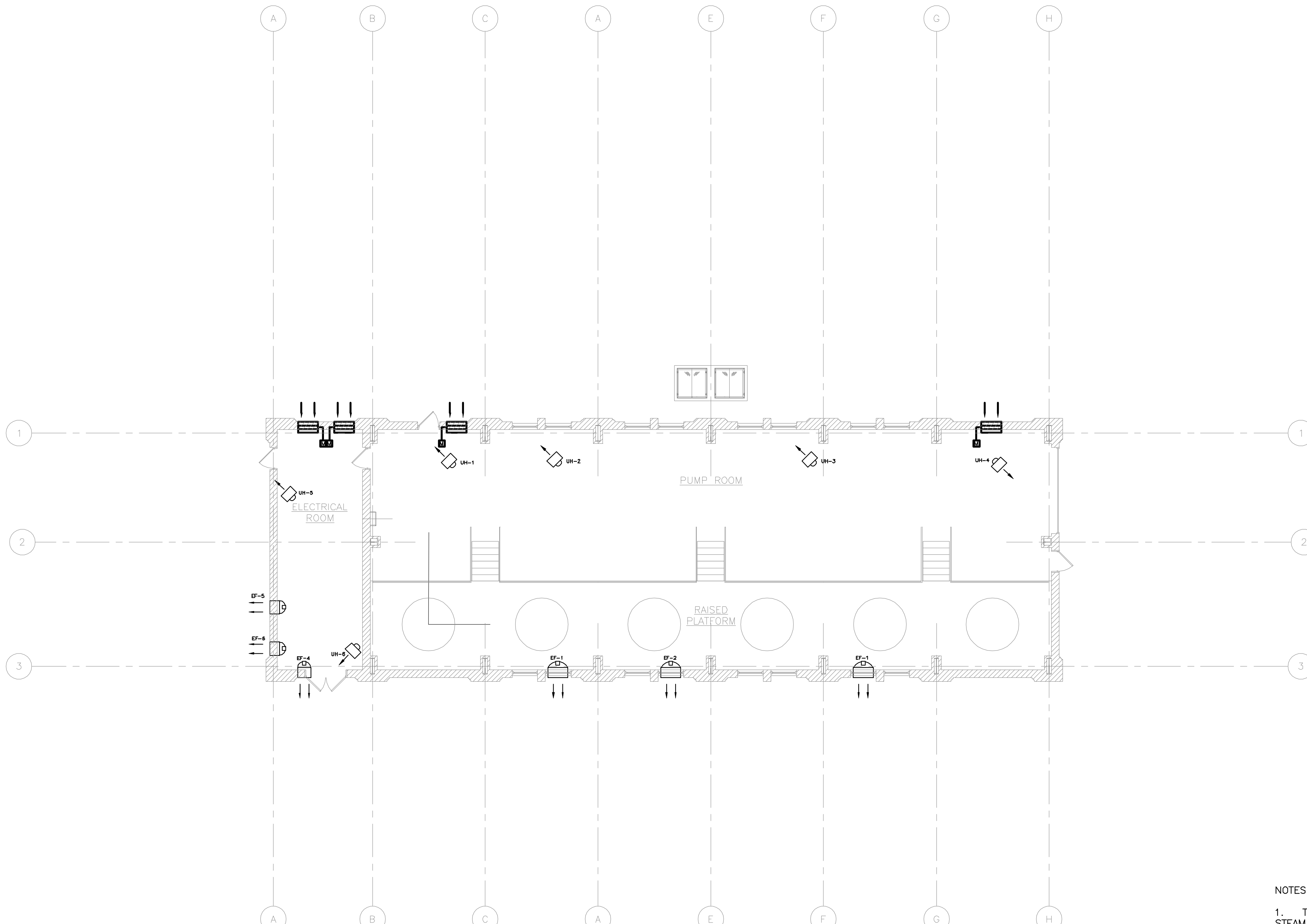
Seal

Sheet Number: M-201

Page Number: 38

PLOT DATE: 1/17/2008 9:51 AM PLOTTED BY: COCKERILL, ERIC

N



NOTES;

1. TERMINAL UNIT HEATERS ARE STEAM TYPE. STEAM ORIGINATES FROM SERVICE TUNNEL AT BATTERY A. SEE C-103 FOR SITE PIPING.

4 0 4 8 12
SCALE: 1/8" = 1'-0"

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: JD | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer

Drawn by: XX | Reviewed by: EPC

Date: 1/2008 | Scale: 1/8" = 1'-0"

CTE AECOM

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CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION PLAN

Seal

Sheet Number: M-301

Page Number: 39

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ELECTRICAL PLAN SHEET

SYMBOLS	DESCRIPTION
	Single Arm Pole Mounted Incandescent Or High Intensity Discharge Fixture As Shown In Fixture Schedule
	Twin Arm Pole Mounted Incandescent Or High Intensity Discharge Fixture As Shown In The Fixture Schedule
	Bracket Mounted Incandescent Or High Intensity Discharge Fixture As Shown In Fixture Schedule
'LPX-X'	Incandescent Or H.I.D Type Fixture As Shown In Fixture Schedule. See Note No. 3.
'LPX-X' F	Fluorescent Lighting Fixture As Shown In Fixture Schedule. See Note No. 3.
	Exit & Directional Sign As Shown In Fixture Schedule
GFI +18	Duplex GFI Receptacle (number Indicates Mounting Height. If No Number Is Shown, See Specifications)
+18	Single Convenience Receptacle (Number Indicates Mounting Height, If No Number Is Shown, See Specifications)
+18	Duplex Convenience Receptacle (Number Indicates Mounting Height, If No Number Is Shown, See Specifications)
+48	Welding Receptacle And Enclosed Fusible Disconnect Switch, 3P-60A, 600V, Nema 4, Unless Noted Otherwise. (Number Indicates Mounting Height, Unless Noted Otherwise.) Crouse-Hinds WSR6351.
	Special Purpose Explosion Proof Receptacle As Shown In Fixture Schedule.
	Duplex Receptacle Installed As Part Of Cabinetry Or Furniture. Connect As Required By Manufacturer
	Floor Mounted Duplex Convinience Receptacle With Adjustable Floor Box, Plate, And Carpet Flange Where Required
W	Voice System Outlet. 'W' Denotes Wall Mounted.
W	Data System Outlet. 'W' Denotes Wall Mounted.
	Telephone Utility System Outlet Installed As A Part Of Cabinetry Or Furniture. Connect As Required By Manufacturer.
T	Telephone
	Lighting Panel
	Remote Telemetry System Cabinet
	Telephone Utility System
	Distribution Panel
	Cabinet Or Pull Box
	Unfused Safety Switch, 3P-30A, 600V, In Nema 4 Stainless Steel Enclosure, Unless Otherwise Noted.
	Fused Safety Switch, 3P-30A, 600V, In Nema 4 Stainless Steel Enclosure, Unless Otherwise Noted.
	Outlet Or Junction Box
	Combination Protective Device And Magnetic Starter
	Single Unit Pushbutton Station
	2-Unit Pushbutton Station
	3-Unit Pushbutton Station
5	Electric Motor – "Number" Indicates Approximate Horsepower, "F" Denotes Fractional Horsepower.
GEN	Generator
A R	Alarm Station Including Relay Enclosure And Alarm Beacon With Horn. 'R' Denotes Remote Alarm Beacon With Horn Only. See Electrical Details.
S	"Hand-Off-Automatic" Selector Switch
V	Vacuum Switch
L	Limit Switch
F	Flow Switch
P	Pressure Switch
D	Door Switch
T	Torque Switch
P	Pneumatic/Electric Switch
P	Safety Pull Cord
C	Control Station (See Electrical Details)
FS	Float Switch
EP	Electro-Pneumatic Valve
S	Solenoid Valve
T	Electric Thermostat
D	Electric Damper Motor
T	Temperature Actuated Device
P	Photocell

SYMBOLS	DESCRIPTION
$ +48	Single Pole Toggle Switch (Number Indicates Mounting Height, If No Number Is Shown, See Specifications)
$ +48 2	2 – Pole Toggle Switch (Number Indicates Mounting Height, If No Number Is Shown, See Specifications)
$ +48 3	3 – Pole Toggle Switch (Number Indicates Mounting Height, If No Number Is Shown, See Specifications)
$ +48 4	4 – Pole Toggle Switch (Number Indicates Mounting Height, If No Number Is Shown, See Specifications)
$ +48 M	Manual Motor Starter Switch W/Overload Protection And Enclosure (Number Indicates Mounting Height, If No Number Is Shown, See Specifications.)
$ D	Single Pole Dimmer Switch (Number Indicates Mounting Height, If No Number Is Shown, See Specifications)
$ K	Key Operated Switch (Number Indicates Mounting Height, If No Number Is Shown, See Specifications)
	Battery Powered Emergency Lighting Fixture
	Unit Heater
H	Alarm Horn
S	Speaker
S	Smoke Detector (Ionization Type)
D	Rate Of Rise Heat Detector
M	Manual Fire Alarm Pull Station
H F	Fire Alarm System Horn
G	Combustible Gas Detector
	Cctv Camera
	Exposed Conduit
	Underground Duct As Noted
	Conduit Concealed In Floor Slab Or Under Floor Slab. (Conduits 1-1/4" Or Larger Shall Be Installed Under Floor Slab). Conduits Run Under Floor Slab Shall Be Encased In Concrete.
"####" or "XXXX"	Homerun As Indicated In Conduit, Cable And Wire Tabulation. "####" Denotes Conduit Number. See Conduit, Cable And Wire Tabulation Sheets For Items Designated With 4 Conduit Number. "xxxx" Denotes The Panel To Homerun To Conduit 1" Or Smaller May Be Installed In Slab. Homeruns To Panels As Indicated Shall Conform To Note No. 3 Below. See Panelboard Schedules And Plan Sheets For Circuiting.
E	Existing Conduit And Wire Shall Remain
R	Existing Conduit, Wire, Boxes, Etc., Which Shall Be Removed.
A	Existing Conduit Which Shall Be Abandoned. Disconnect And Remove Existing Conductors. Cut Off Conduit Flush W/Finished Surface And Fill W/Grout.
E/R	Existing Conduit Which Shall Be Reused. Remove Existing Conductors And Install New Conductors As Indicated Or Noted On Plan.
	Ground Rod
H	Electrical Handhole
M	Electrical Manhole

CONDUIT SYSTEM NOTES

1. Conduits Imbedded In Structural Concrete (Floor Slabs, Etc.) Shall Be So Located As Not To Unduly Impair The Strength Of The Construction And Shall Be Spaced Not Less Than Two Times The Conduit O.D. Between Adjacent Conduits Except Where Crossing Or Otherwise Approved By The Engineer. Spacing Between Adjacent Conduits Of Different Sizes Shall Be Based On The Larger Conduit. Locate Conduits In Center Of Slab. Maximum Conduit O.D. Size Embedded In Concrete Slab And Walls Shall Not Exceed 1/5 Of The Slab Or Wall Thickness. Conduit Shall Not Go Through Beams Or Lintels Over Openings Without Approval Of The Engineer. Spacing Of Conduits For Existing Construction Shall Be As Noted Above For New Construction. Any Structural Modifications Required Shall Be Done At No Cost To The Owner.
2. Any Conduit Without Further Designation, Indicates 2#12 In 3/4 Inch Conduit. Greater Number Of Wires Are Indicated As Follows: —///— (3-wires) —////— (4-wires) Etc. Longer Hatchmark Indicates Neutral Conductor.
3. Wiring For Lighting, Receptacles And Other Miscellaneous Circuits Shall Be 2 #12-3/4" C. (Minimum) And Shall Conform To The Circuiting Indicated On The Drawings With Additional Conductors, Conduits, Arrangement And Routing As Required For A Complete And Functional System. The Wiring Shall Be So Arranged That No More Than Six Current Carrying Conductors Shall Be Installed Per Conduit And Circuits Of Different Panels Shall Be Installed In Separate Raceways.

SCHEMATIC WIRING DIAGRAMS

SYMBOLS	DESCRIPTION
	Contact, Normally Open
	Contact, Normally Closed
L.O.S.	Pushbutton, Lock Out Stop
	Pushbutton, Normally Closed
	Pushbutton, Normally Open
	Selector Switch – "Hand-Off-Auto", Unless Otherwise Noted.
	Pushbutton, Maintained Contact, Double Circuit
OL'S	Overloads
	Fuse
	Switch
	Pilot Light (Push To Test)
	Manual Motor Starter
M	Auxiliary Starter Contacts
	Pressure Switch, Opens On Rise
	Pressure Switch, Closes On Rise
	Limit Switch, Normally Closed
	Limit Switch, Normally Open
	Limit Switch, Normally Open, Held Closed
	Limit Switch, Normally Closed, Held Open
	Temperature Actuated Switch, Opens On Rise
	Temperature Actuated Switch, Closes On Rise
	Vacuum Switch, Opens On Rise
	Vacuum Switch, Closes On Rise
	Flow Switch (Closes With Flow)
	Flow Switch (Opens With Flow)
	Float Operated Switch, Opens On Rise
	Float Operated Switch, Closes On Rise
	Torque Switch (Opens On Increase)
	Torque Switch (Closes On Increase)
	Overload
*	Located Remote
●	Located At Motor
○	New Device To Be Provided
□	Located At Unitized Control Panel (UCP)
△	Located At Process Control Panel
CL M	Motorized Time Delay Relay
TD	Time Delay Relay
M	Starter Coil
R	Control Relay
ETM	Elapsed Time Meter
D	Electric Damper Motor
DS	Ductstat
AT	Adjustable Timer

SINGLE LINE DIAGRAMS

SYMBOLS	DESCRIPTION
V	Voltmeter
A	Ammeter
VS	Voltmeter Switch
AS	Ammeter Switch
MM	Microprocessor Metering Unit
PFR	Phase Fail Relay
WT	Watts Transmitter (Power)
VFC	Variable Frequency Controller
	Transformer, Power Or Control
	Transformer, Grounded
	Capacitor (Three Phase)
	Surge Arrestors (Three)
	Neutral, Motor Or Generator
PF	Power Factor Meter
T	Temperature Meter
VA	Voltammeter
WH	Watthour Meter
WH D	Watthour Demand Meter
S	Instrument Transfer Switch
GF	Ground Fault Relay
K	Key Interlock
15	Thermal Magnetic Circuit Breaker Or Motor Circuit Protector (Number Indicates Trip Rating)
15	Fuse (Number Indicates Ampere Rating)
GF	Zonal Grounding
E	Switch As Specified (E Indicates Electric Operator)
15	Molded Case Circuit "Breaker". Or Motor Circuit Protector, Magnetic Starter, Control Transformer, Aux. Contacts, Etc. As Specified (number Indicates Trip Rating). "F" Indicates Forward And "R" Indicates Reverse Contactor.
15	Fused Switch Magnetic Starter; Control Transformer, Aux. Contacts, Etc. As Specified (Number Indicates Ampere Rating)
(3)50:5	Current Transformer (CT) (Subscript Indicates Quantity And Ratio)
50:5	Current Transformer, Ring Or Doughnut Type. (Number Indicates Ratio)
480/120	Potential Transformer (Number Indicates Ratio)
52	Circuit Breaker (Over 600V.)
	Fuse And Contactor (Over 600V.) With Disconnect Provision
	Separable Connectors
	Cable Terminators
	Indicating Light
	Space Heater
RTD	Resistance Temperature Detector
5	Electric Motor – "Number" Indicates Approximate Horsepower, "F" Denotes Fractional Horsepower.

SINGLE LINE DIAGRAMS

SYMBOL	DESCRIPTION
[*]	Miscellaneous Control, Metering And Instrumentation Devices
(*)	Replace The Asterisk With One Of The Following Letters

25 – Synchronizing Check
27 – Undervoltage
32 – Reverse Power
47 – Phase Sequence
49 – Thermal
50 – Instantaneous Overcurrent
51 – AC Time Overcurrent
52 – AC Power Circuit Breaker
55 – Power Factor
60 – Voltage Or Current Balance
62 – Time Delay
64 – Ground
67 – Directional Overcurrent
86 – Lockout
87 – Differential Current
94 – Transfer Trip

AM	Ammeter
AH	Amper-Hour Meter
C	Coulombmeter
CMA	Contact-Making (Or Breaking) Ammeter
CMC	Contact-Making (Or Breaking) Clock
CMV	Contact-Making (Or Breaking) Voltmeter
CRO	Oscilloscope Cathode-Ray Oscillograph
CS	Breaker Control Switch
DT	Duty Transfer Switch
DB	Db (Decibel) Meter Audio Level/Meter
DBM	Dbm (Decidels Referred To 1 Milliwatt) Meter
DBX	Dead Bus Auxiliary
DM	Demand Meter
DTR	Demand-Totalizing Relay
F	Frequency Meter
FPR	Feeder Protect Relay
G	Device In Ground Circuit
GD	Ground Detector
GSR	Ground Sensing Relay
IR	Interposing
I	Indicating Meter
INT	Integrating Meter
K	Key Interlock
LOR	Lockout Relay
UA	Microammeter
MM	Microprocessor Metering
MMA	Microprocessor Metering And Analyzer
MR	Microprocessor Relay
MS	Metering System
MA	Milliammeter
N	Device In Neutral Circuit
NM	Noise Meter
OHM	Ohmmeter
OP	Oil Pressure Meter
OSCG	Oscillograph, String
PF	Power Factor Meter
PFR	Phase Fail Relay
PH	Phasemeter
PI	Position Indicator
PSR	Phase Sensing Relay
RD	Recording Demand Meter
REC	Recording Meter
RF	Reactive Factor Meter
SY	Synchroscope
SS	Selector Switch
TM	Elapsed Time Meter
TMR	Timer
T	Temperature Meter
THC	Thermal Converter
TLM	Telemeter
TS	Test Switches
TT	Total Time Meter, Elapsed Time Meter
VM	Voltmeter
VA	Volt-Ammeter
VAR	Varmeter
VARH	Varhour Meter
VI	Volume Indicator Audio-Level Meter
VU	Standard Volume Indicator Audio-Level Meter
W	Wattmeter
WH	Watthour Meter
WHD	Watthour Demand Meter
WT	Watts Transducer
X	Auxiliary

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: DES/BMW	Checked by: XX	Correct: ANTHONY BOUCHARD
Drawn by: MB	Reviewed by: EPC	Approved: MWRD Assistant Chief Engineer
Date: 1/2008	Scale: NOT TO SCALE	CTE AECOM

CTE 303 East Wacker Drive, Suite 600, Chicago, Illinois 60601-5276 T 312.938.0300 F 312.938.1109 www.cte.aecom.com

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION FACILITIES ELECTRICAL LEGEND

Seal

Sheet Number: E-001

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ELECTRICAL ABBREVIATIONS

A	Ampere
AC	Alternating Current
ACC	AC Controller
AF	Circuit Breaker Frame Size (Amperes)
AFF	Above Finished Floor
AHU	Air Handling Unit
AIC	Ampere Interrupting Capacity
AM	Ammeter
AP	Auxiliary Panelboard
AS	Ammeter Switch
AT	Circuit Breaker Trip Rating (Amperes)
ATS	Automatic Transfer Switch
AWG	American Wire Gage
B	Boiler
BAS	Building Automation System
BATT	Battery Or Batteries
BFP	Boiler Feed Pump
BP	By Pass
BKR	Breaker Or Breakers
C	Conduit
CB	Circuit Breaker
CCTV	Closed Circuit Television
CEC	Chicago Electrical Code
CKT	Circuit
CLG	Ceiling
COMED	Commonwealth Edison Company
CP	Control Panel
CT	Current Transformer
CTR	Contactor
DC	Direct Current
DCC	DC Controller
DCL	DC Link
DCS	Data Control System
DEH	Dehumidifier
DP	Distribution Panelboard
DN	Down
DP	Distribution Panel
DS	Disconnect Switch
DSS	Door Security System
DT	Day Tank
DWG	Drawing
E	Existing To Remain
EF	Exhaust Fan
EG	Equipment Ground
EL	Elevation
ELEC	Electrical
ELEV	Elevator
ELP	Emergency Lighting Panelboard
EM	Emergency
EMT	Electrical Metallic Tubing
EO	Electrically Operated
EQUIP	Equipment
ER	Existing To Be Relocated
EUH	Electric Unit Heater
EWC	Electric Water Cooler
EWH	Electric Water Heater
EXIST	Existing
EXPL	Explosion Proof

ELECTRICAL ABBREVIATIONS (CONT.)

F	Fuse Or Fuses
FAPP	Field Application Panel
FCP	Fire Alarm Control Panel
FDF	Forced Draft Fan
FDR	Feeder
FLUOR	Fluorescent
FO	Fiber Optic
FRE	Fiberglass Reinforced Epoxy
G	Ground Wire
GBC	Generator Battery Charger
GC	Generator Controller
GEN	Generator
GFI	Ground Fault Circuit Interrupter
GFF	Gas Fired Furnace
GMPC	Generator Master Paralleling Controller
GPC	Generator Paralleling Controller
GRD	Ground
GRS	Galvanized Rigid Steel
GSB	Generator Starting Battery
GSLC	Generator Switchgear Logic Controller
HP	Horsepower
HTR	Heater
HZ	Hertz
IDF	Induced Draft Fan
IG	Isolated Ground
INCAND	Incandescent
IP	Instrument Panelboard
I/O	Input/Output
IT	Input Transformer
JB	Junction Box
K	Kirk Key Interlock
kcmil	One Thousand Circular Mils
KV	Kilovolt
KVA	Kilovolt–Ampere
KW	Kilowatt
L	Load
LB	Load Bank
LC	Lighting Contactor
LOS	Lock–Out–Stop
LP	Lighting Panelboard
LS	Limit Switch
LTG	Lighting
M	Meter
MC	Momentary Contact
MF	Motor Field
MM	Microprocessor Metering
MMA	Microprocessor Metering And Analyzer
MCB	Main Circuit Breaker
MCC	Motor Control Center
MLO	Main Lug Only
MSLC	Main Switchgear Logic Controller
MSC	Main Switchgear Console
MTD	Mounted
MTG	Mounting
MTS	Manual Transfer Switch
MTU	Master Telemetry Unit
MVA	Million Volt Ampere

ELECTRICAL ABBREVIATIONS (CONT.)

N	Normal Source
NC	Normally Closed
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NEUT	Neutral
NO	Normally Open
NTS	Not To Scale
OBPC	Output/By–Pass Contactor
OL	Overload
P	Pole
PA	Public Address
PB	Pullbox
PC	Photocell
PF	Power Factor
PGRS	Polyvinyl Chloride Coated Galvanized Rigid Steel
PH	Phase
PLC	Programmable Logic Controller
PM	Pump Motor
PNL	Panel
PP	Power Panelboard
PRI	Primary
PT	Potential Transformer
PVC	Polyvinyl Chloride
PWR	Power
REF	Return/Exhaust Fan
REC	Receptacle
RGS	Rigid Galvanized Steel
RP	Receptacle Panelboard
RR	Existing In Relocated Position
RTU	Remote Telemetry Unit
S	Speaker
SAP	Security Alarm Panel
SB	Stand–By
SBC	Station Battery Charger
SCADA	Supervisory Control And Data Acquisition
SCP	Steam Condensate Pump
SEC	Secondary
SF	Supply Fan
SMP	Sump Pump
SP	Supplemental Panelboard
SS	Stainless Steel
ST	Shunt Trip
STCP	Storage Tank Control Panel
SW	Switch
SWGR	Switchgear
T	Transformer
TEL	Telephone
TB	Termination Box With Termination Strips
TDC	Time Delay Contact
TDR	Time Delay Relay
TEF	Toilet Exhaust Fan
TTB	Telephone Terminal Board
TTC	Telephone Terminal Cabinet
TYP	Typical
UG	Underground

ELECTRICAL ABBREVIATIONS (CONT.)

UH	Unit Heater
UL	Underwriters Laboratories, Inc.
UNO	Unless Noted Otherwise
UPS	Uninterruptible Power System
USS	Unit Secondary Substation
UTP	Unshielded Twisted Pair
V	Volt
VA	Volt Ampere
VFC	Variable Frequency Controller
VFD	Variable Frequency Drive
VFDC	Variable Frequency Drive Controller
VM	Voltmeter
VS	Voltmeter Switch
W	Wire
(W)	Watt
WHM	Watthour Meter
WP	Weatherproof Device
X	Existing To Be Removed

ELECTRICAL EQUIPMENT LEGEND

ATS–XX1	Automatic Transfer Switch
AHU–XX1	Air Handling Unit
B–XX1	Boiler
BFP–XX1	Boiler Feed Pump
DP–XX1	Distribution Panelboard
DS–XX1	Disconnect Switch
EF–XX1	Exhaust Fan
ELP–XX1	Emergency Lighting Panelboard
EUH–XX1	Electric Unit Heater
EWC–XX1	Electric Water Cooler
EWH–XX1	Electric Water Heater
GEN–XX1	Generator
GFF–XX1	Gas Fired Furnace
GCPR–XX1	Gas Compressor
IDF–XX1	Boiler Induced Draft Fan
LP–XX1	Lighting Panelboard
MCC–XX1	Motor Control Center
PACE–XX	Public Address Control Equipment
PM–XX1	Pump Motor
PP–XX1	Power Panelboard
REF–XX1	Return/Exhaust Fan
RP–XX1	Receptacle Panelboard
SCP–XX1	Steam Condensate Pump
SF–XX1	Supply Fan
SP–XX1	Sump Pump
SWGR–XX1	Switchgear
T–XX1	Transformer
TEF–XX1	Toilet Exhaust Fan
UH–XX1	Unit Heater
USS–XX1	Unit Secondary Substation
VFD–XX1	Variable Frequency Drive
VS–XX	Conduit Schedule

Suffix Designation – XX1

- XX = Section/Service
- EM = Emergency
- LB = Load Bank
- UPS = Uninterruptible Power
- SL = Stand–By System, Lighting
- SP = Stand–By System, Power
- 1 = Sequential Equipment Numbering

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: DES/BMW | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer

Drawn by: MB | Reviewed by: EPC | CTE AECOM

Date: 1/2008 | Scale: NOT TO SCALE

CONTRACT 07–026–2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION FACILITIES
ELECTRICAL ABBREVIATIONS

Seal

Sheet Number: E-002

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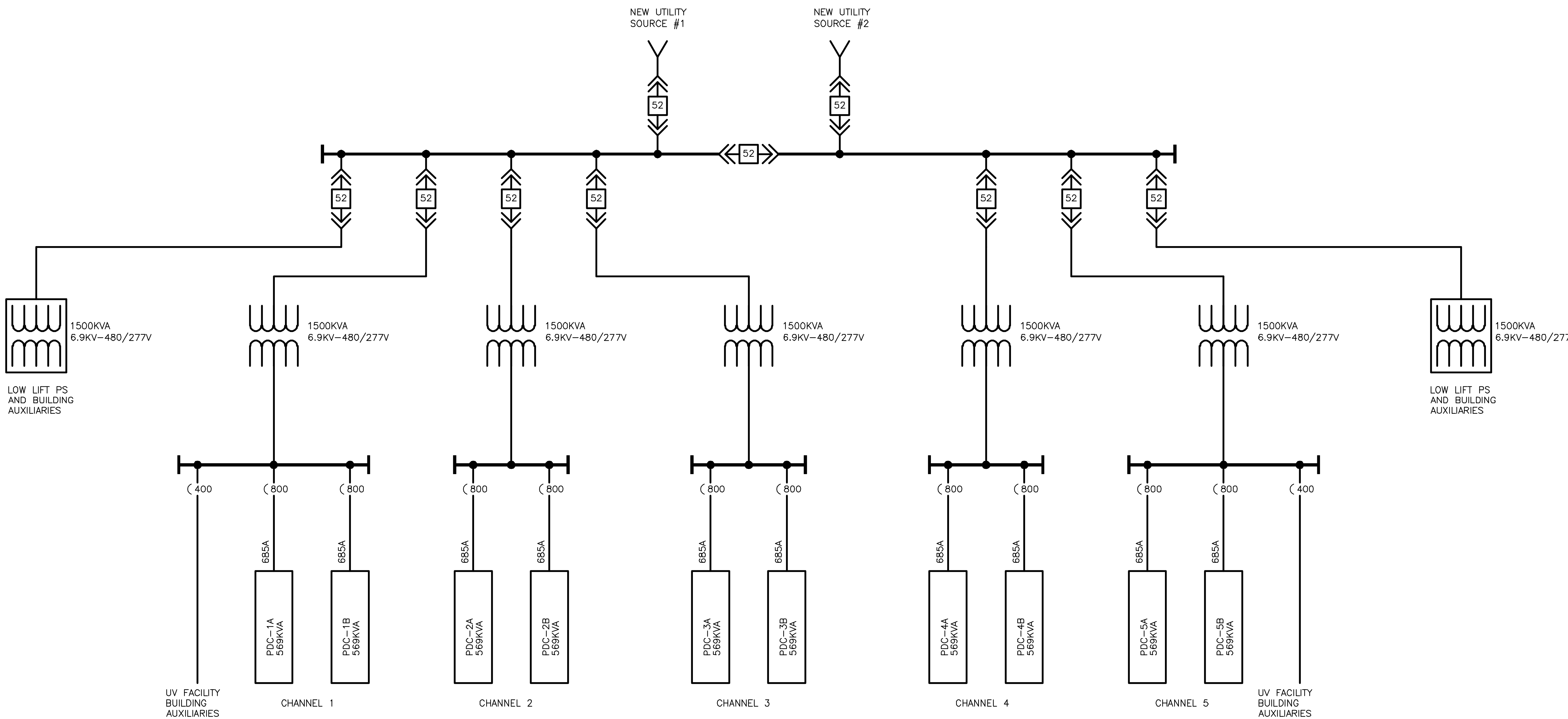

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Date: 1/2008
Scale: NOT TO SCALE

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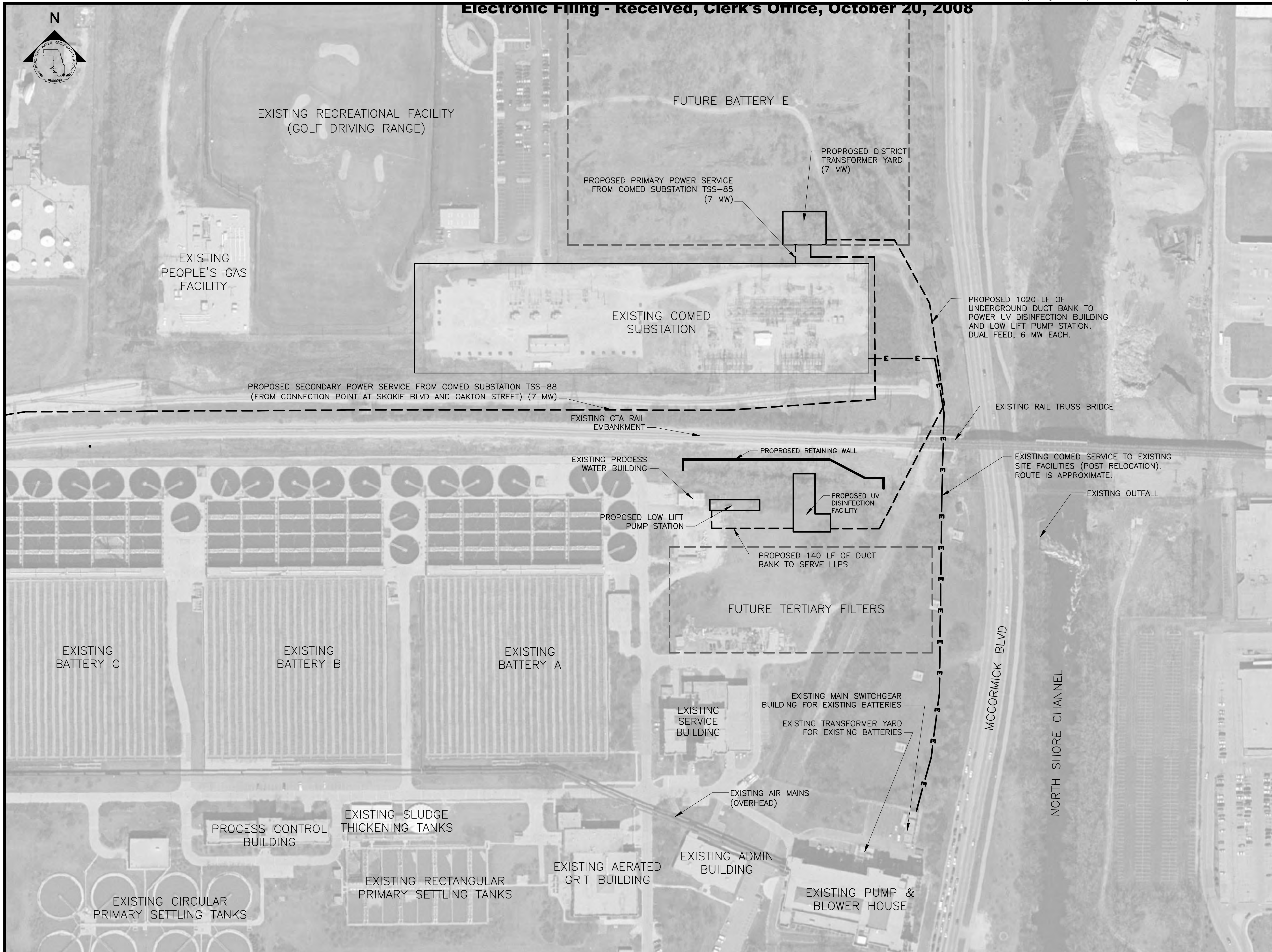
CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION FACILITIES
POWER DISTRIBUTION

Seal

Sheet Number: E-101



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NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION FACILITIES
EFFLUENT CONDUIT PLAN

Seal

Sheet Number: C-102

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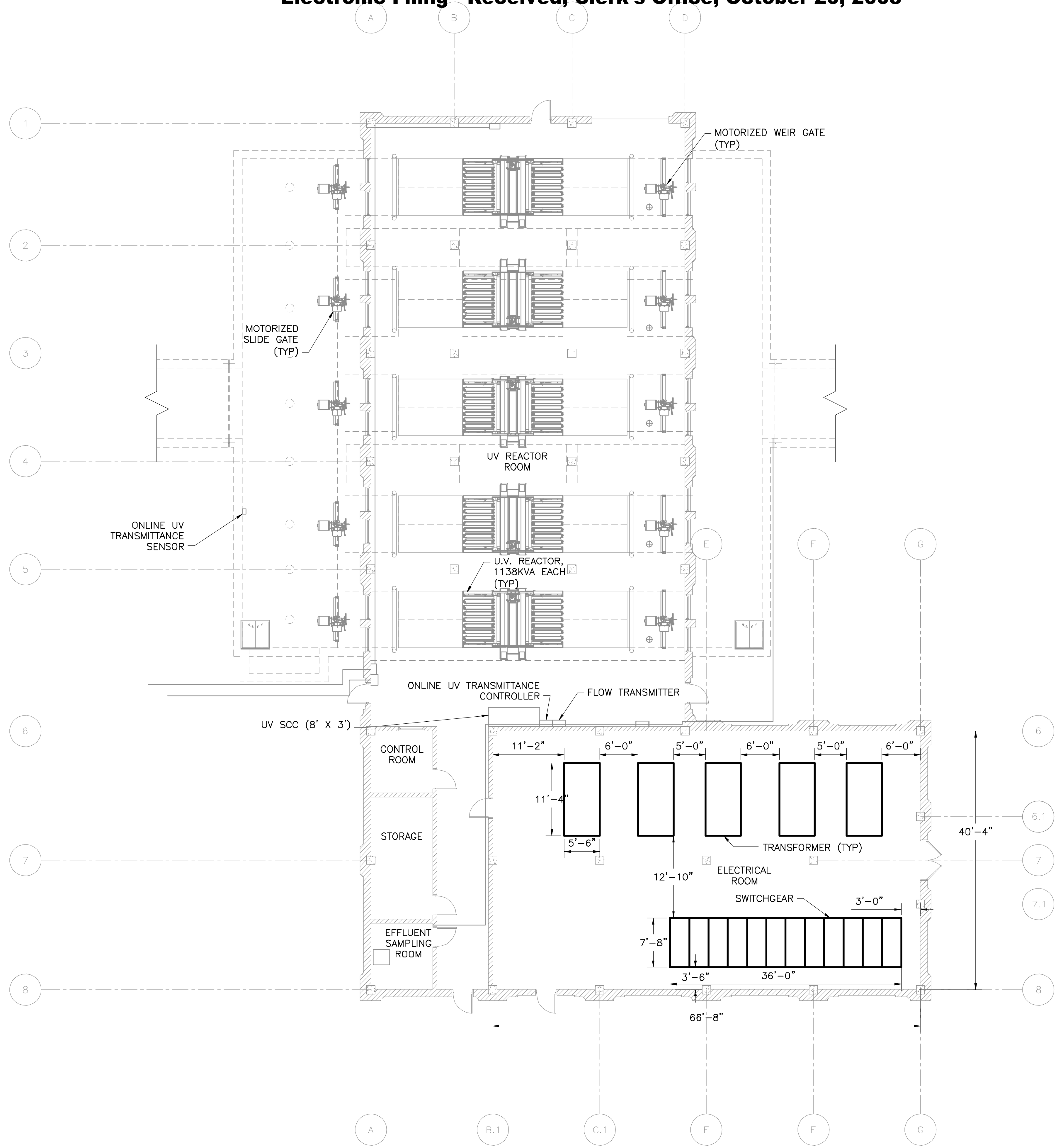

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CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION BUILDING
ELECTRICAL PLAN

Seal

Sheet Number: E-201

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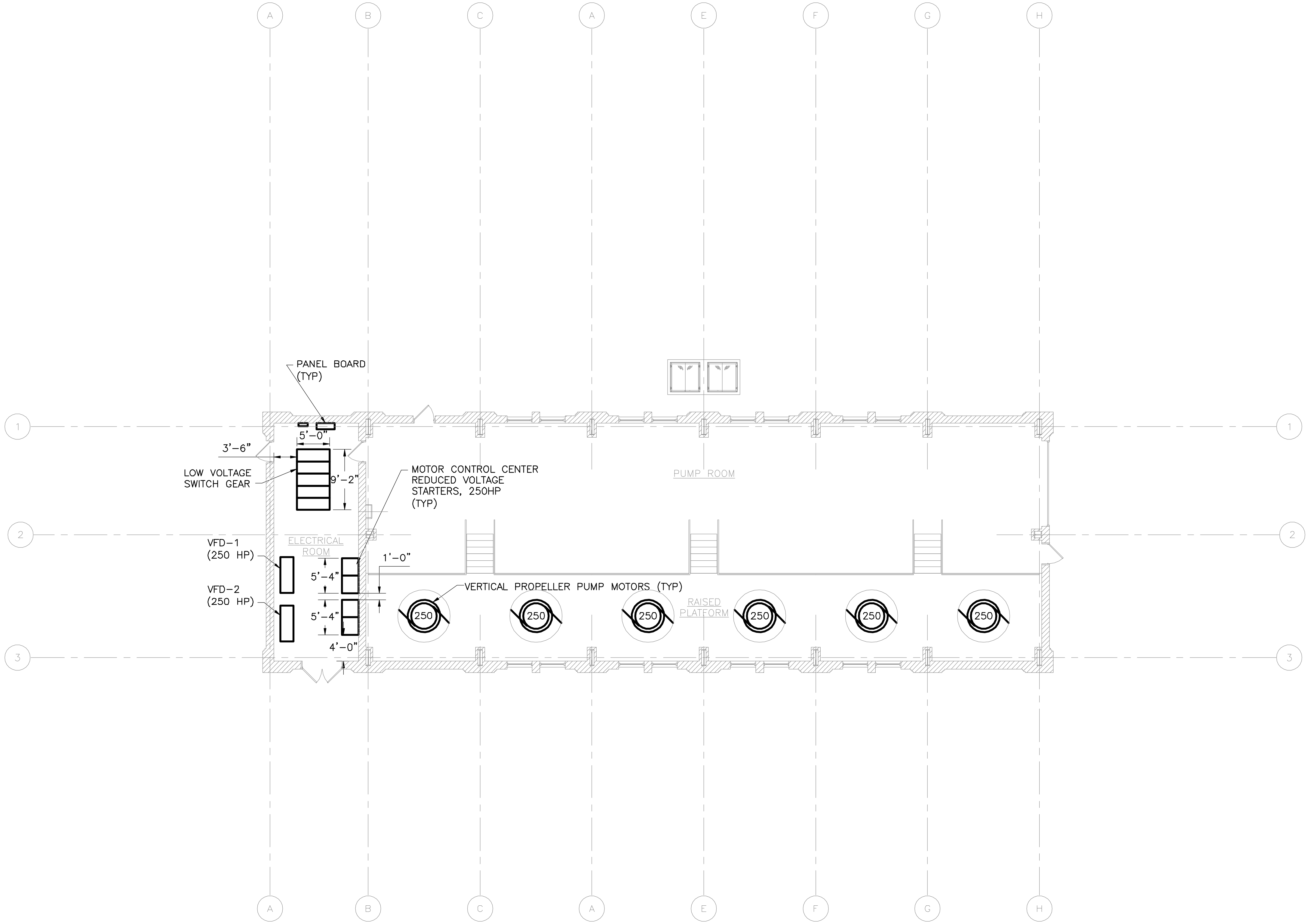

1 UPPER PLAN
SCALE: 1/8"=1'-0"

4 0 4 8 12
SCALE: 1/8" = 1'-0"

Rev.	Description	Appr.	Date

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Drawn by: MB
Reviewed by: EPC
Date: 1/2008
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CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION
ELECTRICAL PLAN

Seal

Sheet Number: E-301

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PUMPS

- Centrifugal – Horizontal Pump
- Centrifugal – Vertical Pump
- Diaphragm Pump
- Double Suction Pump
- Inline Pump
- Metering Pump
- Piston Pump
- Positive Displacement Pump
- Progressive Cavity Pump
- Rotary/Gear Pump
- Screw Pump
- Sump Pump
- Submersible Pump
- Vertical Axial Flow Pump
- Vertical Turbine Pump
- Archimedes Screw Pump
- Peristaltic Pump/Hose Pump

BLOWERS

- Centrifugal Blower
- Rotary Blower
- Centrifugal Compressor
- Reciprocating Compressor

TANKS

- Storage Tank – Vertical
- Storage Tank – Horizontal
- Aeration Tank
- Sand Filter or Trickling Filter
- Flat-top Tank/Reservoir
- Storage Reservoir or Digester – Fixed Cover
- Digester – Floating Cover
- Clarifier/Thickener
- Spheroidal Elevated Tank

MISCELLANEOUS

- Flow (DWG Continuation)
- Interlock
- Selector Switch
- Roll-off Container
- Hopper
- Liquid or Sludge Hauling Truck
- Dump Truck

EQUIPMENT

- Paddle Mixer
- Propeller Mixer
- Turbine Mixer
- Centrifuge
- Grit Classifier
- Compactor
- Belt Conveyor
- Screw Conveyor
- Bucket Elevator
- Belt Filter Press
- Sludge Grinder
- Heat Exchanger – Spiral
- Heat Exchanger – Plate and Frame
- Sampler
- Inline Static Mixer
- Bar Screen
- Fine Screen
- Gravity Belt Thickener
- Open Channel UV Reactor (Med Press)

PIPING

- Blind Flange
- Drain
- Clean Out
- Diaphragm Seal
- Fire Hydrant
- Flexible Connection
- Flexible Hose
- Quick Connect Coupling
- Hose Connection (Threaded)
- Reducer – Concentric
- Reducer – Eccentric
- Rubber Expansion Coupling
- Vent
- Y-Strainer
- Yard Hydrant

INSTRUMENTS/FLOW DEVICES

- Area Velocity Meter
- Averaging Pitot
- Flow Nozzle
- Float Type Level Sensor
- Magmeter
- Parshall Flume
- Pitot Tube
- Propeller/Turbine Meter
- Restrict Orifice
- Rotameter
- Thermal Mass Flowmeter
- Trapezoidal Flume
- Ultrasonic Level Sensor
- Venturi
- V-Notch Weir

VALVES

- Ball Valve
- Butterfly Valve
- Check Valve – Swing
- Cone Valve
- Diaphragm Valve
- Gate Valve
- Globe Valve
- Knife Valve
- Angle Valve
- 3 Way Valve
- 4 Way Valve
- Needle Valve
- Backflow Preventer
- Pinch Valve
- Plug Valve
- Pressure/Air Relief Valve – Angle
- Vacuum Breaker Valve (Air Inlet)
- Pressure Relief Valve – Straight
- Combination Air/Vacuum Valve

GATES

- Slide Gate
- Stop Plate/Logs
- Weir Gate

VALVE OPERATORS

- Pneumatic Operator (Cylinder)
- Diaphragm
- Pressure Regulating Diaphragm
- Differential Pressure Regulating Diaphragm
- Pressure Reducing Diaphragm
- Motor
- Solenoid
- Hydraulic Operator

VALVE NORMAL STATUS

- or NO Normally Open
- or NC Normally Closed

LINE DESIGNATIONS

XX-YYY-ZZZ

- Service Abbreviation
- Line Size (Inches) See Note 2.
- Material Abbreviation

EQUIPMENT TAGS

XX-##

- Identification Number
- Equipment Code

P – Pump	C – Compressor
B – Blower	ET – Elevated Tank
V – Valve	T – Tank
SG – Slide/Weir Gate	MX – Mixer
UVR – UV Reactor	D – Digester
UVM – UV Module	S – Screen

NOTES:

1. Symbology based on Instrument, Systems, Automation Society (ISA) Standards except as modified hereing.
2. Rectangular channel sizes given as X'-Y"xX'-Y"
3. Valves shown without operators shall be assumed to include local manual operators.
4. P&IDs are not intended to show all details of piping, joints, supports, etc. Contractor shall install a complete system per the Contract Documents and as required to provide a fully functioning system.

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

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CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION FACILITIES
INSTRUMENTATION LEGEND

Seal

Sheet Number: I-001

PLOT DATE: 1/17/2008 10:50 AM PLOTTED BY: COCKERILL, ERIC

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TYPICAL LETTER COMBINATIONS

FIRST LETTERS	INITIATING OR MEASURED VARIABLE	CONTROLLERS				READOUT DEVICES		SWITCHES AND ALARM DEVICES[1]			TRANSMITTERS			SOLENOIDS, RELAYS, COMPUTING DEVICES	PRIMARY ELEMENT	TEST POINT	WELL OR PROBE	VIEWING DEVICE, GLASS	SAFETY DEVICE	FINAL ELEMENT
		RECORDING	INDICATING	BLIND	SELF-ACTUATED CONTROL VALVES	RECORDING	INDICATING[2]	HIGH	LOW	COMB.	RECORDING	INDICATING	BLIND							
A	ANALYSIS	ARC	AIC	AC		AR	AI	ASH	ASL	ASHL	ART	AIT	AT	AY	AE	AP	AW			AV
B	BURNER/ COMBUSTION	BRC	BIC	BC		BR	BI	BSH	BSL	BSHL	BRT	BIT	BT	BY	BE		BW	BG		BZ
C	USER'S CHOICE																			
D	USER'S CHOICE																			
E	VOLTAGE	ERC	EIC	EC		ER	EI	ESH	ESL	ESHL	ERT	EIT	ET	EY	EE					EZ
F	FLOW RATE	FRC	FIC	FC	FCV, FICV	FR	FI	FSH	FSL	FSHL	FRT	FIT	FT	FY	FE	FP		FG		FV
FQ	FLOW QUANTITY	FQRC	FQIC			FQR	FQI	FQSH	FQSL			FQIT	FQT	FQY	FQE					FQV
FF	FLOW RATIO	FFRC	FFIC	FFC		FFR	FFI	FFSH	FFSL						FE					FFV
G	USER'S CHOICE																			
H	HAND		HIC	HC						HS										HV
I	CURRENT	IRC	IIC			IR	II	ISH	ISL	ISHL	IRT	IIT	IT	IY	IE					IZ
J	POWER	JRC	JIC			JR	JI	JSH	JSL	JSHL	JRT	JIT	JT	JY	JE					JV
K	TIME	KRC	KIC	KC	KCV	KR	KI	KSH	KSL	KSHL	KRT	KIT	KT	KY	KE					KV
L	LEVEL	LRC	LIC	LC	LCV	LR	LI	LSH	LSL	LSHL	LRT	LIT	LT	LY	LE		LW	LG		LV
M	USER'S CHOICE																			
N	USER'S CHOICE																			
O	USER'S CHOICE																			
P	PRESSURE/ VACUUM	PRC	PIC	PC	PCV	PR	PI	PSH	PSL	PSHL	PRT	PIT	PT	PY	PE	PP			PSV, PSE	PV
PD	PRESSURE, DIFFERENTIAL	PDRC	PDIC	PDC	PDCV	PDR	PDI	PDSH	PDSL		PDRT	PDIT	PDT	PDY	PE	PP				PDV
Q	QUANTITY	QRC	QIC			QR	QI	QSH	QSL	QSHL	QRT	QIT	QT	QY	QE					QZ
R	RADIATION	RRC	RIC	RC		RR	RI	RSH	RSL	RSHL	RRT	RIT	RT	RY	RE		RW			RZ
S	SPEED/ FREQUENCY	SRC	SIC	SC	SCV	SR	SI	SSH	SSL	SSHL	SRT	SIT	ST	SY	SE					SV
T	TEMPERATURE	TRC	TIC	TC	TCV	TR	TI	TSH	TSL	TSHL	TRT	TIT	TT	TY	TE	TP	TW		TSE	TV
TD	TEMPERATURE, DIFFERENTIAL	TDRC	TDIC	TDC	TDCV	TDR	TDI	TDSH	TDSL		TDRT	TDIT	TDT	TDY	TE	TP	TW			TDV
U	MULTIVARIABLE					UR	UI							UY						UV
V	VIBRATION/ MACHINERY ANALYSIS					VR	VI	VSH	VSL	VSHL	VRT	VIT	VT	VY	VE					VZ
W	WEIGHT/ FORCE	WRC	WIC	WC	WCV	WR	WI	WSH	WSL	WSHL	WRT	WIT	WT	WY	WE					WZ
WD	WEIGHT/FORCE, DIFFERENTIAL	WDRC	WDIC	WDC	WDCV	WDR	WDI	WDSH	WDSL		WDRT	WDIT	WDT	WDY	WE					WDZ
X	UNCLASSIFIED																			
Y	EVENT/STATE/ PRESENCE		YIC	YC		YR	YI	YSH	YSL				YT	YY	YE					YZ
Z	POSITION/ DIMENSION	ZRC	ZIC	ZC	ZCV	ZR	ZI	ZSH	ZSL	ZSHL	ZRT	ZIT	ZT	ZY	ZE					ZV
ZD	GAUGING/ DEVIATION	ZDRC	ZDIC	ZDC	ZDCV	ZDR	ZDI	ZDSH	ZDSL		ZDRT	ZDIT	ZDT	ZDY	ZDE	AP	AW			ZDV

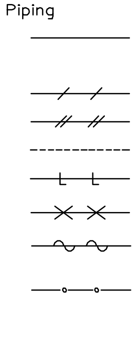
NOTES: This Table is not All-Inclusive.
[1] "S" for Switch can be substituted with "A" for Alarm functions.
[2] "I" for Indicator can be substituted with "L" for Pilot Lights

OTHER POSSIBILE COMBINATIONS

FO	(Restriction Orifice)	PFR	(Ratio)
FRK, HIK	(Control Stations)	KQI	(Running Time Indicator)
FX	(Accessories)	QQI	(Indicating Counter)
TJR	(Scanning Recorder)	WKIC	(Rate-Of-Weight-Loss Controller)
LLH	(Pilot Light)	HMS	(Hand Momentary Switch)

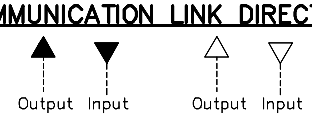
INSTRUMENT LINE SYMBOLS

All Lines To Be Fine In Relation To Process Piping



Instrument Supply Or Connection To Process
Undefined Signal
Pneumatic Signal
Electric Signal
Hydraulic Signal
Capillary Tube
Electromagnetic Or Sonic Signal
Digital Communication Link, Data Highway, Remote I/O, and/or Software Signals
Mechanical Link

COMMUNICATION LINK DIRECTION



INSTRUMENT DESIGNATIONS

XXX – Control Variable (See Table Above)
YYY – Location, Service, and Point Number
Z – Optional Function Character as follows:

A – Start	P – Remote
B – Stop	Q – High Torque Alarm
C – Close	R – Run
E – Emergency Stopped	S – Select
F – Fail	T – High Temperature Alarm
G – Run Forward	U – In Automatic
J – Start Forward	W – Jog Reverse
K – Start Reverse	X – Run Reverse
L – Leak Detection	Y – Full Opened
M – Motion Failure	Z – Full Closed
O – Open	

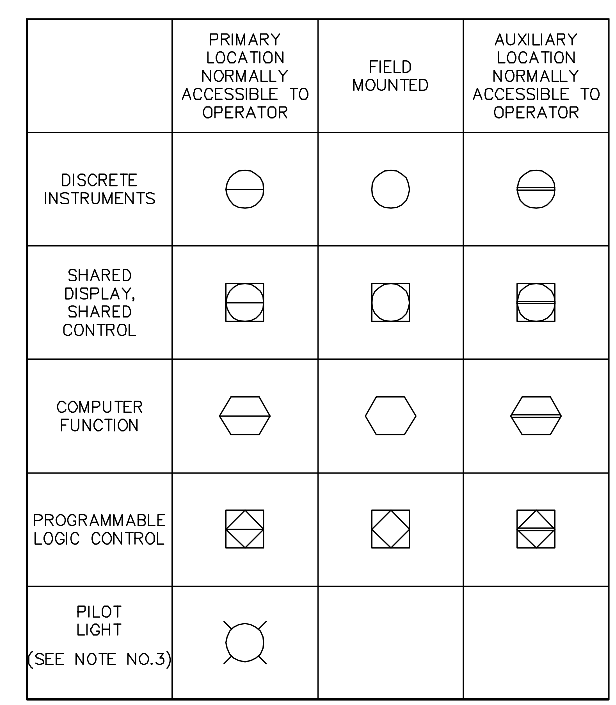
NOTES:

1. The Process And Instrumentation Diagram (P&ID) Drawings Include Field Mounted And Primary Location Devices Which Serve As Input/Output I/O) Points To The Programmable Logic Controller (PLC). The P&ID's Do Not Depict All Local Control Stations And Local Control Panel Components. The Items Depicted Represent The Minimum Requirements Of The I/O Points To Be Integrated Into The System And To Be Displayed On The Process Instrumentation And Control System (PICS) Operator Interface. Refer To Specification Section 13304-System Control For Local Control Station Components, Control Panel Components, Operational Description, Etc. All I/O Shall Be Obtained From The Equipment Manufacturers Control Panel. Provide And Install Auxilliary Relays And Contacts As Required To Obtain I/O To Be Integrated Into The PLC.
2. Refer To Specification Section 13390 – Input/output (I/O) Point List For Listing Of Additional I/O Points.
3. The Pilot Light Symbol Is Used To Depict Event/state/presence Conditions That Are To Be Displayed On The PICS Operator Interface In Addition To The Same Conditions Displayed Locally At The Local Control Station Or Local Control Panel. Refer To Specification Section 13304 – System Control For Local Control Station And Local Control Panel Requirements.

INSTRUMENT MODIFIERS

E/S	Emergency Stop
FOR	Forward/Off/Reverse
HOA	Hand/Off/Auto
HOR	Hand/Off/Remote
L/R	Local/Remote
LOP	Local/Off/PLC
MA	Manual/Auto
MOA	Manual/Off/Auto
OOA	On/Off/Auto
OOR	On/Off/Remote
OOP	On/Off/PLC
OC	Open/Close
OSC	Open/Stop/Close
S/S	Start/Stop
SSA	Start/Stop/Auto

GENERAL INSTRUMENT OR FUNCTION SYMBOLS



Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: EPC | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer
Drawn by: EPC | Reviewed by: XX
Date: 1/2008 | Scale: NOT TO SCALE

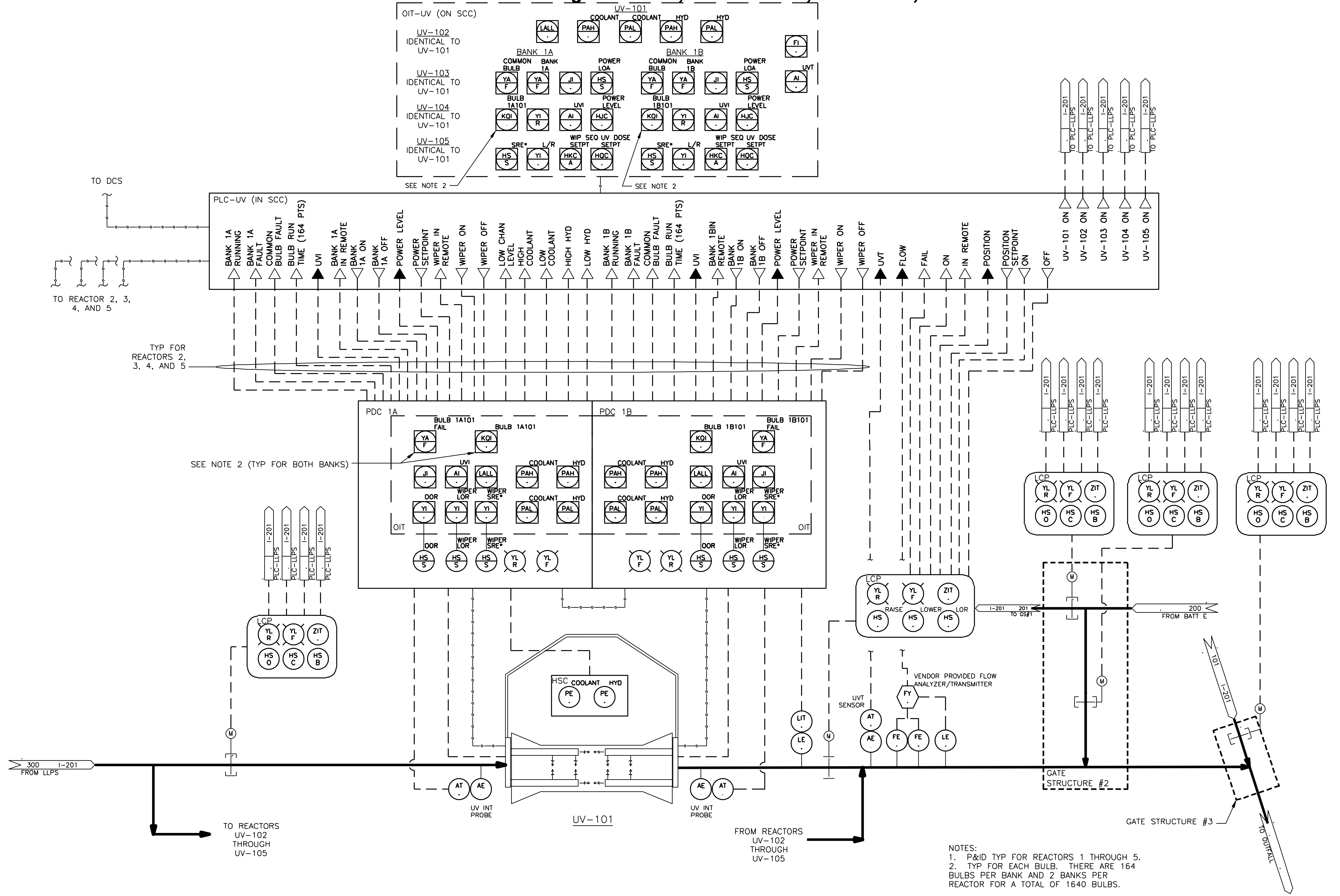
CTE | AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION FACILITIES
INSTRUMENTATION ABBREVIATIONS

Seal

Sheet Number: I-002



NOTES:
1. P&ID TYP FOR REACTORS 1 THROUGH 5.
2. TYP FOR EACH BULB. THERE ARE 164 BULBS PER BANK AND 2 BANKS PER REACTOR FOR A TOTAL OF 1640 BULBS.

* SEQUENCE/RETURN/EXTEND
PDC – POWER DISTRIBUTION CENTER
SCC – SYSTEM CONTROL CENTER
HSC – HYDRAULICS SYSTEM CENTER
UVT – ULTRAVIOLET TRANSMISSIVITY
UVI – ULTRAVIOLET INTENSITY
OIT – OPERATOR INTERFACT TERMINAL

Seal

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: E.COCKERILL | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer
Drawn by: E.COCKERILL | Reviewed by: XX
Date: 1/2008 | Scale: NTS

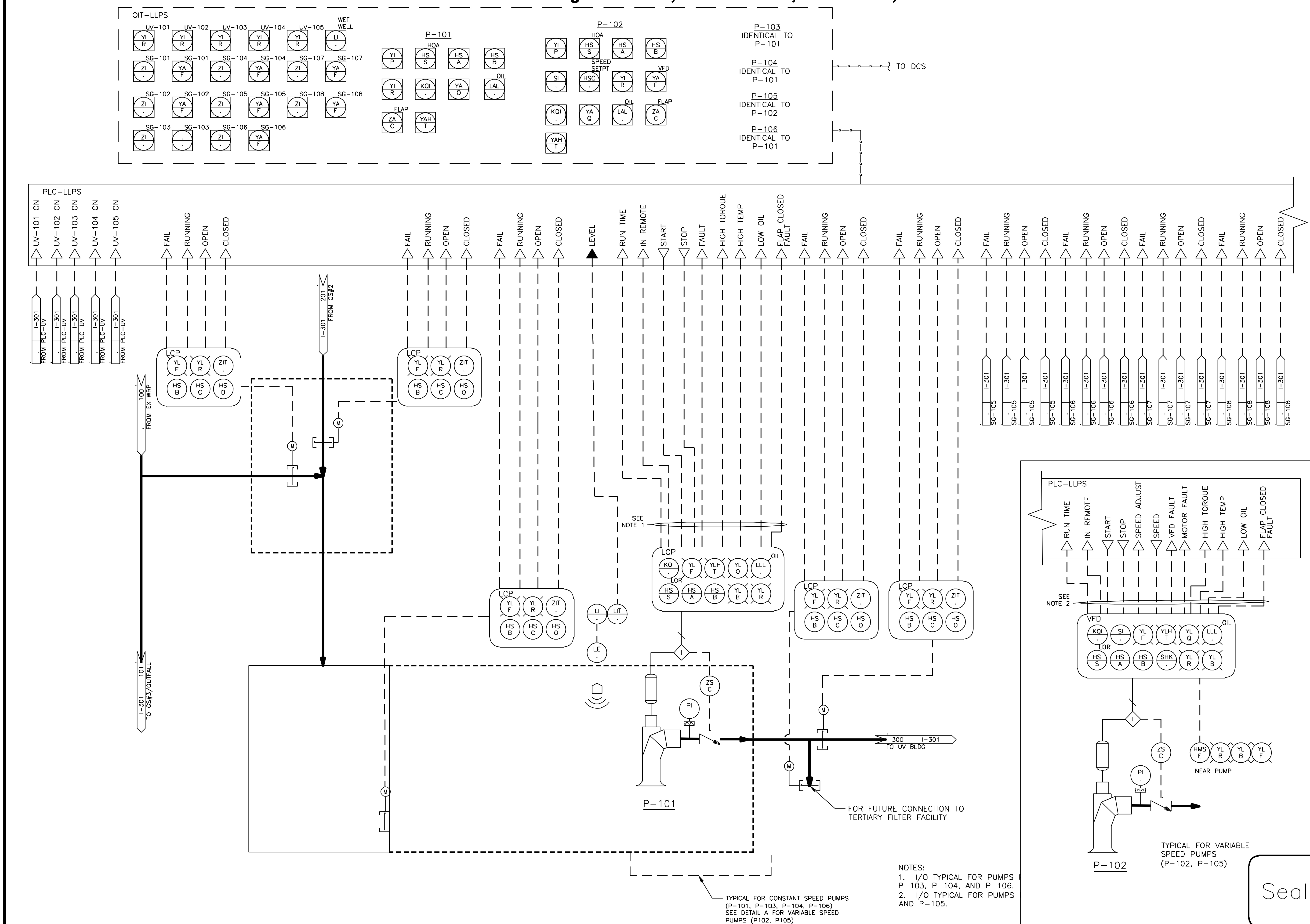
CTE | AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

UV DISINFECTION FACILITY
PROCESS AND INSTRUMENTATION DIAGRAM

Sheet Number: I-201

PLOT DATE: 1/30/2008 9:20 AM PLOTTED BY: COCKERILL, ERIC



Seal

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: E.COCKERILL | Checked by: XX | Correct: ANTHONY BOUCHARD | Approved: MWRD Assistant Chief Engineer

Drawn by: E.COCKERILL | Reviewed by: XX

Date: 1/2008 | Scale: NTS

CTE | AECOM

CONTRACT 07-026-2P
NORTH SIDE WATER RECLAMATION PLANT
ULTRAVIOLET DISINFECTION FACILITIES

LOW LIFT PUMP STATION
PROCESS AND INSTRUMENTATION DIAGRAM

Sheet Number: I-301