The GLMRIS Report

Appendix I - Structural Engineering

USACE
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CONTENTS

LIST OF ENCLOSURES

FIGURES

TABLES

I.1 INTRODUCTION

This Appendix of the GLMRIS Report provides the structural features of the alternative plans considered in the study. Specifically, the structural features discussed herein relate to the Technology and the Hydrologic Separation Alternatives. The level of structural design or analyses at this phase of the study has been kept to a minimum concept level as needed to establish project structural features to form a basis for the cost estimate. Further detailed studies and design will be required.

The four primary locations for the structures related to the Technology Alternative are the Chicago Harbor Lock, O'Brien Lock and Dam, Brandon Road Lock and Dam, and Wilmette Pumping Station. As discussed in the main report, these locations were selected to create a buffer zone bounded by these locations. At Chicago Harbor Lock, O'Brien Lock and Dam, and Wilmette Pumping Station, the structures must be modified for control of aquatic nuisance species (ANS) transferring from Lake Michigan into the buffer zone or Chicago Area Waterway System (CAWS). At Brandon Road Lock and Dam, the structures must be modified to control certain species from transferring into the buffer zone or CAWS from the Illinois Waterway. This Appendix discusses the necessary structural modifications or new structures at these locations required to create and or maintain the buffer zone.

The structures related to the Hydrologic Separation Alternatives included in this Appendix are physical barriers or concrete dams. These structures will be located in the vicinity of Wilmette (IL), Chicago (IL), Stickney (IL), Alsip (IL), Calumet City (IL), and Hammond (IN). The Stickney and Alsip locations are for the Mid-System Hydrologic Separation Alternative and the remaining locations are for the Lakefront Separation Alternative. These structures provide a physical barrier to form the separation between Lake Michigan and the CAWS.

I.2 RELEVANT USACE GUIDANCE

- EM 1110-2-2602, Planning and Design of Navigation Locks
- EM 1110-2-1604, Hydraulic Design of Navigation Locks
- EM 1110-2-1404, Hydraulic Design of Deep Draft Navigation Projects
- EM 1110-2-1610, Hydraulic Design of Lock Culvert Valves
- EM 1110-2-2104, Strength Design for Reinforced-Concrete Hydraulic Structures
- EM 1110-2-2703, Lock Gates and Operating Equipment
- EM 1110-2-2503, Design of Sheet Pile Cellular Structures, Cofferdams and Retaining Structures
- EM 1110-2-2906, Design of Pile Foundations
- EM 1110-2-2502, Retaining and Floodwalls
- EM 1110-2-2100, Stability Analyses of Concrete Structures
- EM 1110-2-1612, Ice Engineering
- EM 1110-2-2000, Standard Practice for Concrete for Civil Works Structures
- EM 1110-2-2007, Structural Design of Concrete Lined Flood Control Channels
- EM 1110-2-2400, Structural Design and Evaluation of Outlet Works
- EM 1110-2-1614, Design of Coastal Revetments, Seawalls and Bulkheads

I.3 STRUCTURAL FEATURES FOR TECHNOLOGY ALTERNATIVES

The structural features for the Technology Alternative consist of new locks, lock rehabilitation, electrical barrier structures, new controlling works structures, and modifications to an existing pump station. Table I.1 provides a summary of these structural features.

TABLE I.1 Structural Features – Technology Alternative with a Buffer Zone

Location	Feature	Purpose	Description
Chicago Harbor Lock	New Lock	New lock provided to accommodate filling and emptying system, dual chambers, and to locate electrical barrier farther from Navy Pier traffic. Dual chambers reduce demand on ANS treatment volume, i.e., one deep lock, one shallow.	Dual 80-ft chambers with sector gates and filling and emptying system. 700 ft long × 280 ft wide. Provide rip rap along south guide for overtopping protection. Remove portion of Southwest guide wall to accommodate new lock opening. Abandon existing lock.
	New Electrical Barrier	New electric barrier to address transfer of Lake Michigan fish species into the CAWS buffer zone during lockages.	950 ft long × 280 ft wide. Barrier width 200 ft inside to inside of new guide walls. All non-metallic features within 400 ft of electrical barrier. Concrete guide walls, chamber floor, parasitic structure, electrical barrier, and barrier building.
	New ANS Treatment Plant	Provides treatment facility for lock exchange water.	New ANS Treatment Plant and new guide walls to create plant footprint. Approximately 650 ft long revetment wall for the east wall closure and for the two lock closure walls.
	New Sluice Gate Structure at North Basin Wall	Address transfer of Lake Michigan fish species into the CAWS during backflow events thru sluice gates.	Remove and replace 216 ft North Basin wall with new sluice gate structure to accommodate 12 10ft × 15 ft screened sluice gates. Provide features for self-cleaning screens.
	Abandon existing sluice gate facilities on North Breakwater Access	Address transfer of Lake Michigan fish species into the CAWS.	Close off gate openings with concrete. May require cofferdam. Abandon gate equipment/facilities.

TABLE I.1 (CONT.)

Location	**Feature**	**Purpose**	**Description**
O’Brien Lock and Dam	New Lock	New lock provided to accommodate extensive rehabilitation of filling and emptying system and lock walls to address ANS transfer.	New lock similar in dimensions to existing with new filling and emptying system.
	New Electrical Barrier	New electric barrier to address transfer of Lake Michigan fish species into the CAWS buffer zone during lockages.	950 ft long × 190 ft wide. Barrier width 110 ft inside to inside of new guide walls. All non-metallic features within 400 ft of electrical barrier. Concrete guide walls, chamber floor, parasitic structure, electrical barrier, and barrier building.
	New ANS Treatment Plant	Provides treatment facility for lock exchange water.	Construct new ANS Treatment Plant
	New Controlling Works Structure	Address transfer of Lake Michigan fish species into the CAWS during backflow events thru sluice gates.	Remove and replace existing 60 ft controlling works structure and portion of dam with new 100 ft long controlling works structure. Provide 6 10 ft × 15 ft screened sluice gates. Provide features for self-cleaning screens.
	New Guide wall	Navigation aid.	Provide new landside upper guide wall approximately 1,200 ft long.
Brandon Road Lock and Dam	New Lock Filling and Emptying System	Flush lock with CAWS water.	Rehabilitate and upgrade existing lock filling and emptying system.
	New Guide Walls	To provide approach area for barges to re-configure prior to lockage.	Extend existing guide walls by 1,350 ft for 2,700 ft of new 40-ft-wide guide walls.
	New Electrical Barrier	New electric barrier to address transfer of fish species into the CAWS buffer zone during lockages.	950 ft long x 190 ft wide. Barrier width 110 ft inside to inside of new guide walls. All non-metallic features within 400 ft of electrical barrier.
Wilmette Pumping Station	Pump Station Rehabilitation	Address transfer of Lake Michigan fish species into the CAWS during backflow events thru sluice gates.	Perform major rehabilitation of pump station (North Shore Channel) to replace existing pump station structure with a sluice gate structure to accommodate four 10 ft × 15 ft screened sluice gates. Provide features for self-cleaning screens.
	Screen Existing Gates	Address transfer of Lake Michigan fish species into the CAWS during backflow events thru sluice gates.	Screen three existing 8 ft × 17.5 ft gates. Provide features for self-cleaning screens.
	ANS Treatment Plant	Water quality.	Construct new ANS Treatment Plant.

I.3.1 Lock Structures

As indicated in Table I.1, new locks are shown at Chicago Harbor Lock and O'Brien Lock and Dam. This is primarily based on the amount of work required to upgrade these locks to accommodate new filling and emptying systems that will work with the new ANS Treatment Plants. Brandon Road Lock and Dam is shown for rehabilitation only since there is an existing side port filling and emptying system in place. Further discussion is included below for each specific lock location.

Site-specific soil conditions have not been evaluated for each new lock structure and is considered beyond the scope of this study. Since new locks would be located at sites of existing lock facilities, it is reasonable to assume that soil conditions will allow for a range of typical foundation types found at new lock facilities.

Only conceptual layout of the locks has been performed at this time to determine general overall lock dimensions and lock features consistent with the level of detail for costing purposes. Detailed future studies would be required to determine optimal chamber and guide wall locations and approach angles to meet all navigation requirements. Additionally, detailed studies of construction staging would be required to minimize impacts to navigation during construction of the new locks and lock upgrades.

I.3.1.1 Chicago Harbor Lock

The existing Chicago Harbor Lock is located in Chicago, Illinois, adjacent to Navy Pier at the entrance to Lake Michigan in downtown Chicago. The Chicago Harbor Lock was originally constructed in the late 1930s and consists of a navigation lock and a controlling works structure. The navigation lock structure consists of a 600 ft long × 80 ft wide lock chamber with two sets of sector gates. The sector gate blocks are mass concrete structures founded on timber piles, while the lock walls consist of concrete monoliths founded on sheet pile cells. The lock chamber floor consists of 8 in. precast concrete floor slabs. The controlling works structure is located on the North Basin Wall and houses four 10 ft × 10 ft sluice gates for flood control. See Enclosure A for reference drawings of the Chicago Harbor Lock structure.

The Chicago Harbor Lock is considered a low-lift lock and has an end filling and emptying system by means of sector gates only. No existing culvert or port system is present to perform filling and emptying operations.

In addition to its navigation function, the Chicago Harbor Lock is also used as a flood control structure to allow backflows into Lake Michigan during severe flood events in the Chicago area. During severe flood events in Chicago, the sector gates are opened to lower the level of the Chicago River and prevent flooding in downtown Chicago. This operation is called a “backflow” event.

A new lock is planned adjacent to the existing Chicago Harbor Lock as part of the Technology Alternative, as illustrated in Figure I.1.

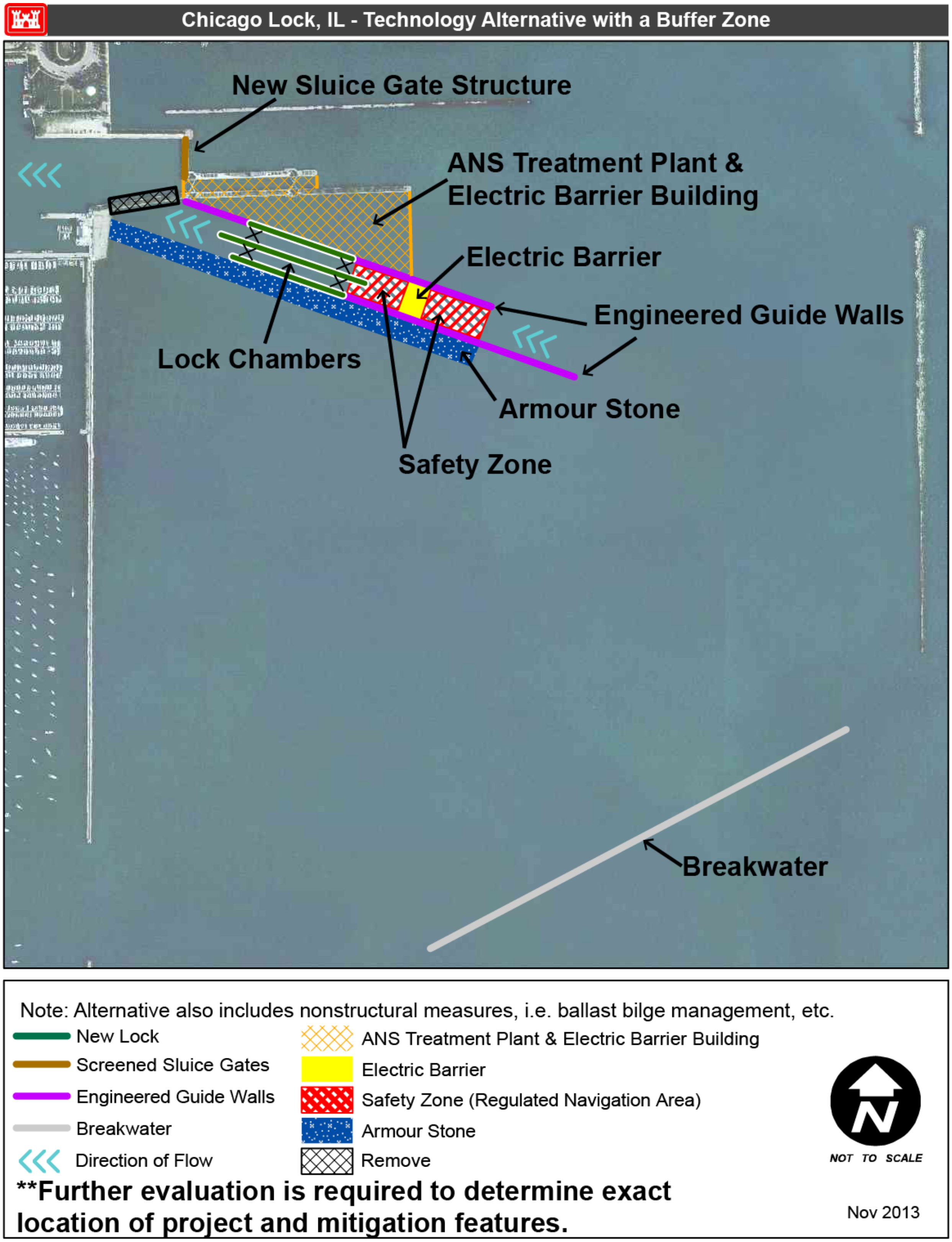


FIGURE I.1 New Chicago Harbor Lock Facility Conceptual Plan

A new lock facility was selected for this site for several reasons. First, extensive rehabilitation of the lock chamber, guide walls, and lock floor is anticipated to accommodate a complex filling and emptying system to exchange water with the ANS Treatment Plant. New filling and emptying culverts and a port system are required to support the filling and emptying operation working in conjunction with the ANS Treatment Plant. Since the lock has already exceeded its 50-year design life, extensive rehabilitation to the lock chamber existing structures does not appear to be a sound investment. Secondly, a new lock structure allows for the relocation of the electric barrier farther from activity congestion at Navy Pier. This improves safety concerns with operating an electric barrier in a congested area and reduces stray current concerns by moving the electrical barrier farther from existing structures. Finally, construction of a new lock will allow the chamber volumes to be optimized to reduce demand on the ANS treatment facility. With the Chicago Harbor Lock being one of the busiest locks in the USACE, the ability to optimize the chamber configuration for the volume of water to be exchanged with the ANS Treatment Plant is a significant advantage.

Figure I.1 shows the Chicago Harbor Lock to be orientated in a Northwest alignment. This alignment is shown only to indicate one possible alignment and arrangement of the lock chamber. This general alignment was selected to minimize the turn radius for vessels entering the Chicago River and to locate the electric barrier farther from Navy Pier as discussed above. Other possible alignments would include arranging the lock chamber parallel to and south of the existing chamber to allow for a straight entry into the Chicago River. For this alignment, safety concerns with placing an electric barrier closer to Navy Pier and stray current concerns associated with electrical barriers would be more critical.

Dual 80 ft × 600 ft chambers are shown for the new Chicago Harbor Lock. One chamber depth would be shallower (approximately one-half the existing lock depth) to minimize volume of water to be exchanged with the ANS Treatment Plant while allowing the majority of vessels to pass. The other chamber would match the existing chamber depth to allow infrequent deep-draft vessels to pass.

The new lock would incorporate a filling and emptying system designed to work with the ANS Treatment Plant. Engineer Research and Development Center (ERDC) experts on filling and emptying systems were consulted to determine the feasibility of performing lock flushing in conjunction with the ANS Treatment Plant. Initial studies by ERDC concluded that reasonable flushing times could be achieved considering the volumes of the existing lock chambers. Further studies would be required to determine optimal flushing requirements, lock operation procedures to replace a water mass within a lock, and methods to minimize vessel impacts during water exchanges. Details on the type of filling and emptying system to be incorporated would be developed in future studies.

Sector gates would be required at the Chicago Harbor Lock due to the potential for reverse heads and to operate the gates during backflow events for flood control.

Armor stone is shown along the entire south wall of the Chicago Harbor Lock to address overtopping into the lock chamber and potential transfer of ANS species. The breakwater is shown to create navigable conditions for vessels approaching the lock chamber with the northwest orientation.

I.3.1.2 O’Brien Lock and Dam

The existing Thomas J. (T.J.) O’Brien Lock and Dam is located in the southeastern portion of Chicago, Illinois, near where the Calumet River enters Lake Michigan. It is located approximately 326 miles above the confluence of the Illinois River with the Mississippi River at Grafton, Illinois. The O’Brien Lock and Dam was originally constructed in the 1950s. The O’Brien Lock and Dam consists of a 1,000 ft long by 110 ft wide navigation lock and a 300 ft long dam. The dam has a controlling works structure that houses four 10 ft × 10 ft sluice gates for flood control. The navigation lock has two sets of sector gates on each end housed in mass concrete gate blocks. The lock walls consist of granular filled sheet pile cells with a concrete surface on the chamber side face. The lock chamber floor consists of a 12 in. concrete slab. See Enclosure A for reference drawings of the O'Brien Lock and Dam structure.

The O'Brien Lock is considered a low-lift lock with an end filling and emptying system by means of the sector gates. As shown in Enclosure A, the O'Brien lock does have a simple loop culvert filling and emptying system on the lake side gate block area only, which can also be used for filling and emptying the lock chamber. No filling and emptying ports are present in the lock chamber.

In addition to its navigation function, the O'Brien Lock is used as a flood control structure to allow backflows to Lake Michigan during severe flood events in the Chicago area. During severe flood events in Chicago, the sector gates are opened to lower the level of the Calumet River for flood control purposes. This operation is called a "backflow" event.

A new lock is planned to replace the O'Brien Lock as part of the Technology Alternative with a Buffer Zone, as illustrated in Figure I.2.

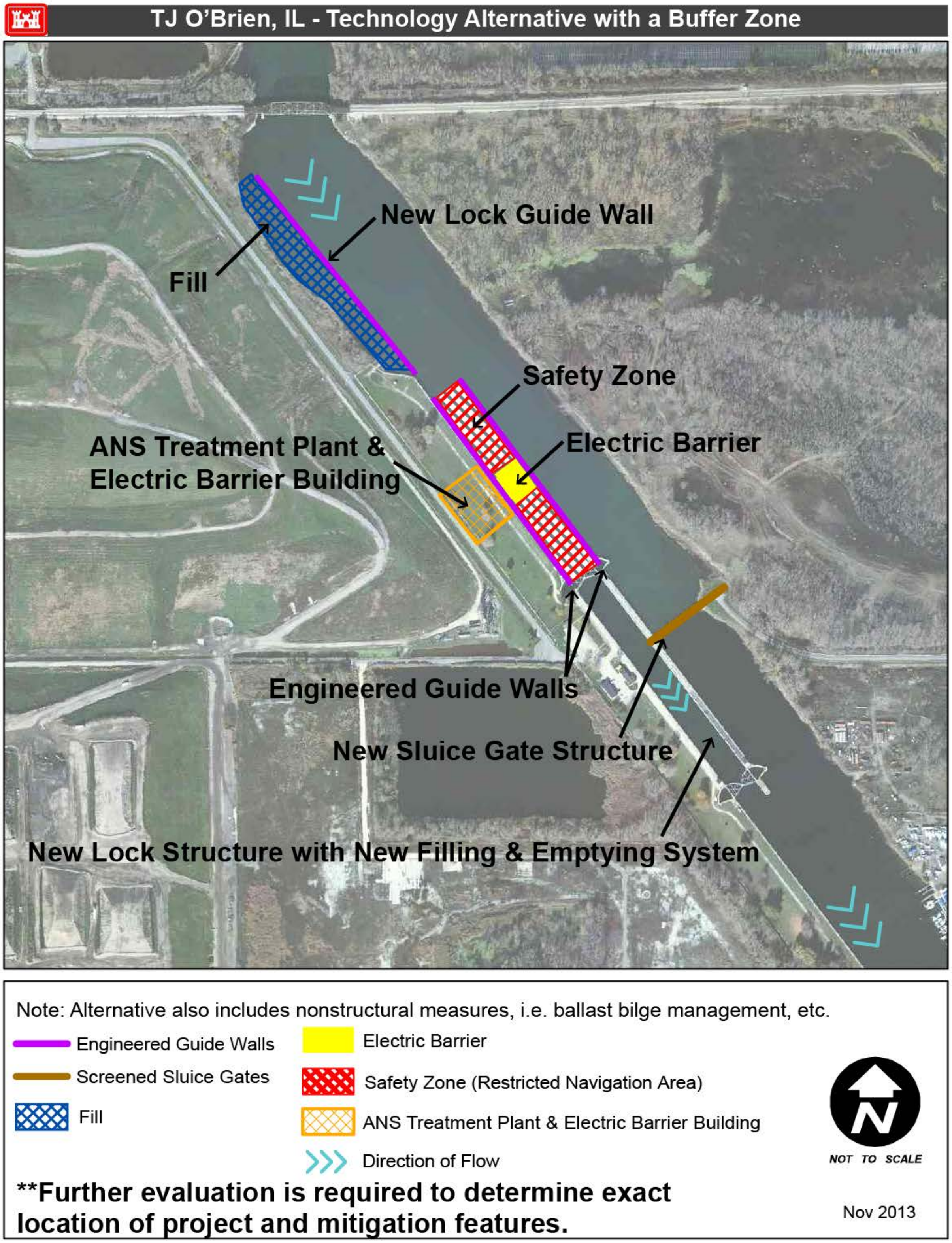
A new lock facility was selected for this site due to the anticipated extensive rehabilitation of the lock chamber, guide walls, and lock floor to accommodate a complex filling and emptying system to exchange water with the ANS Treatment Plant. New filling and emptying culverts and a port system is required to support the filling and emptying operation working in conjunction with the ANS Treatment Plant. Rehabilitation of the upstream river wall is also required to seal the sheet pile walls that are common to the lock chamber and Lake Michigan, where ANS transfer could potentially occur. While rehabilitation of the lock structure to accommodate a filling and emptying system does appear possible, a new lock is recommended since the lock has already exceeded its 50-year design life and an extensive investment would be required to rehabilitate the lock chamber. Future studies should include a detailed life-cycle cost analyses to support this determination.

As shown in Figure I.2, the new O'Brien Lock is shown in approximately the same location as the existing lock and dam. A detailed study will be required to determine the optimal location, alignment, and construction sequencing to minimize impacts to navigation. The new lock may require relocation farther downstream to maintain navigation during construction. Another option would be to construct the new lock chamber landward of the existing lock chamber to minimize disruptions to navigation and to optimize navigation alignments.

The new O'Brien lock chamber is 1,000 ft long × 110 ft wide, identical to the existing chamber size. A new 1,200-ft upstream guide wall has been added to facilitate safe alignment and staging of barges prior to entering the electrical barrier.

The new lock would incorporate a filling and emptying system designed to work with the ANS Treatment Plant. ERDC experts on filling and emptying systems were consulted with to determine the feasibility of performing lock flushing in conjunction with the ANS Treatment Plant. Initial studies by ERDC concluded that reasonable flushing times could be achieved considering the volumes of the existing lock chambers. Further studies would be required to determine optimal flushing requirements, lock operation procedures to replace a water mass within a lock, and methods to minimize vessel impacts during water exchanges. Details on the type of filling and emptying system to be incorporated would be developed in future studies.

Sector gates would be required for O'Brien Lock due to the potential for reverse heads and to operate the gates during backflow events for flood control.



TJ O'Brien, IL - Technology Alternative with a Buffer Zone

Note: Alternative also includes nonstructural measures, i.e. ballast bilge management, etc.

****Further evaluation is required to determine exact location of project and mitigation features.**

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FIGURE I.2 New O'Brien Lock and Dam Facility Conceptual Plan

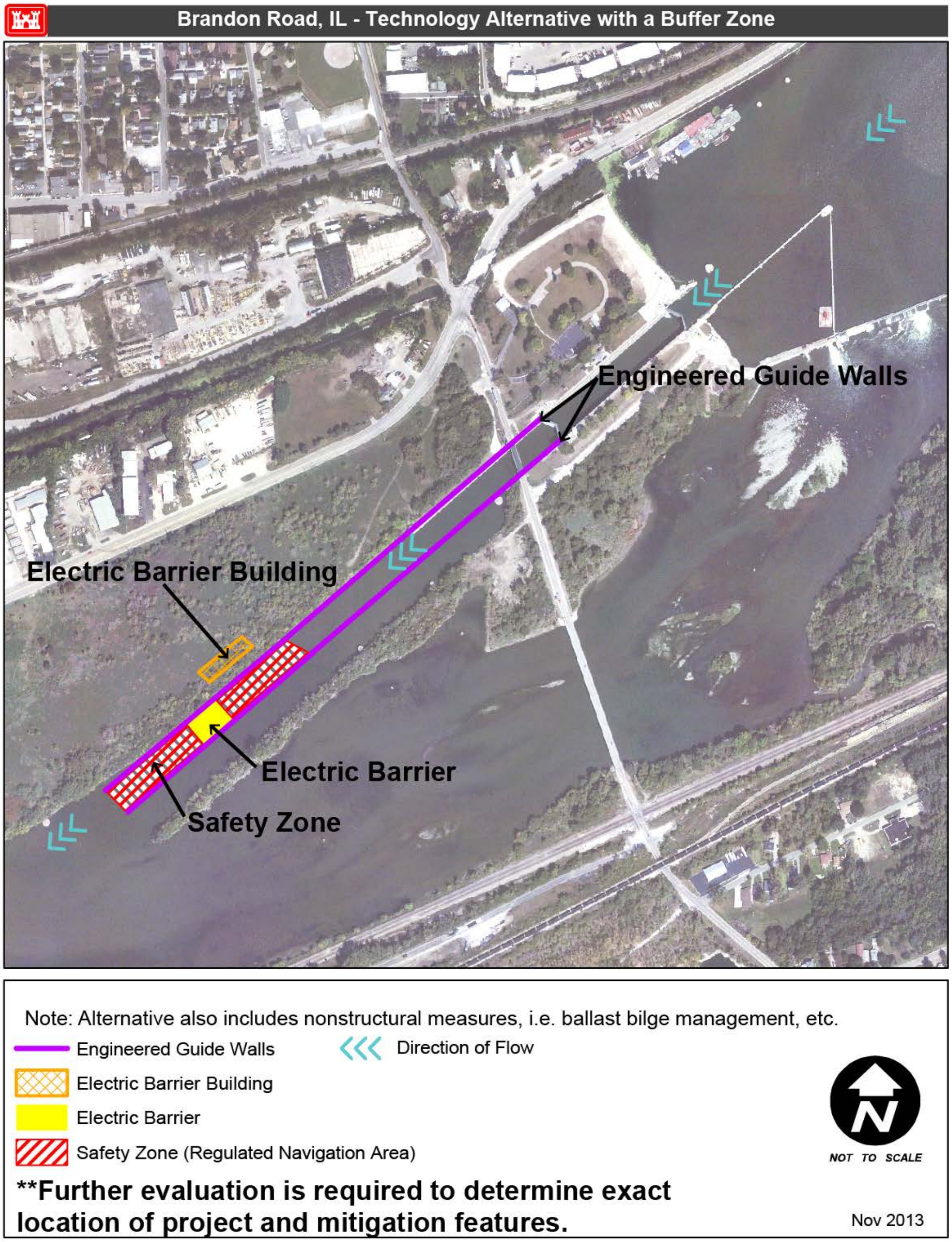
I.3.1.3 Brandon Road Lock and Dam

The existing Brandon Road Lock and Dam is located 27 miles southwest of Chicago and 2 miles southwest of Joliet, Illinois. It is located approximately 286 miles above the confluence of the Illinois River with the Mississippi River at Grafton, Illinois. Construction was completed on the Brandon Road Lock and Dam the 1930s. The Brandon Road Lock and Dam consists of a 600 ft long by 110 ft wide navigation lock and a 2,391-ft-long dam. The dam has 21 operating tainter gates, 6 sluice gates, and 16 pairs of head gates. The 6 sluice gates are closed with concrete bulkheads and there are only 8 operating head gates, with the other 8 headgate bays closed with concrete bulkheads. The navigation lock has two sets of miter gates. The lock walls consist of mass concrete gravity walls founded on rock. The lock floor is primarily unlined rock with a 17'-wide concrete apron slab chamber side of each concrete gravity wall. The Brandon Road Lock has a lift of 34 ft with an average filling time of 19 minutes and emptying time of 15 minutes with a side port filling and emptying system. There are 12-foot-diameter filling and emptying culverts in each lock wall, with 10 rectangular side ports (5 feet wide by 3 feet 6 inches high) located along the bottom of each lock wall. See Enclosure A for reference drawings of the Brandon Road Lock and Dam structure.

Rehabilitation of the lock is planned as part of the Technology Alternative with a Buffer Zone, as illustrated in Figure I.3.

Rehabilitation of the existing lock chamber filling and emptying system is anticipated at Brandon Road. The presence of two 12–ft-diameter culverts with a side port filling and emptying system make Brandon Road more amenable to rehabilitation than the O'Brien and Chicago Locks. Rehabilitation in the lock chamber will be limited to upgrades to the filling and emptying system to perform lock flushing.

In addition to upgrades to the lock filling and emptying system, the downstream guide walls will be extended an additional 1,350 ft to connect to the new electrical barrier, as shown in Figure I.3. This is required to provide adequate length for reconfiguring of barges downstream of the lock chamber in the area between the new electrical barrier and the lock chamber. These guide walls are anticipated to be mass concrete gravity walls similar in construction to the east and west lower approach walls at the existing lock. Note that the Brandon Road guide walls were retrofitted with rock anchors in the 1980s. See Enclosure A for typical cross sections of the Brandon Road lower approach walls.



Note: Alternative also includes nonstructural measures, i.e. ballast bilge management, etc.

****Further evaluation is required to determine exact location of project and mitigation features.**

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FIGURE I.3 Brandon Road Lock and Dam Facility

I.3.2 Electrical Barrier Structures

Electrical Barriers are required at Chicago Harbor Lock, O'Brien Lock and Dam, and Brandon Road Lock and Dam as part of the Technology Alternative to address migration of fish species into the CAWS buffer zone while still maintaining a navigable waterway. The major structural features for the electrical barriers include concrete guide walls, concrete floor, parasitic structure, electrode support structure, and barrier facilities building. Many of these features can be extrapolated from the existing USACE Fish Barrier facilities currently in operation in Romeoville, Illinois.

The overall length required for the electrical barrier channel was determined to be 950 ft. Based on experience at the Romeoville facility, this allows for a 400-ft length where the electric field can reach. The 950 ft allows for an additional 275 ft on each side of the electric field. The width of the electric barrier channel is 200 ft at the Chicago Harbor Lock, 110 ft at O'Brien Lock, and 110 ft at Brandon Road Lock. See Figures I.1 thru I.3 for electrical barrier locations and layout.

The primary structural feature for the electrical barrier structures are the guide walls forming the electrical barrier channel. At the Chicago and O'Brien Locks, it is anticipated these guide walls will consist of mass concrete guide walls on drilled shafts. At Brandon Road Lock, the guide walls will be mass concrete gravity wall on rock. The floors of all electrical barriers are anticipated to be concrete with non-metallic reinforcement. A 2-ft thickness of concrete for the floors can be assumed at this time. Nonconductive materials are required to be used in the 400-ft electric field length and may need to be considered over the entire 950-ft length. The extent of use of non-conductive materials will be based on the effectiveness of the electrical isolation inside the electrical barrier chamber.

The facilities building for the electrical barriers should be based on the existing and planned buildings to be constructed at the Romeoville site.

Containment of stray current is a key consideration in the design of the electrical barrier facility. Careful consideration of materials used for the guide wall and floor materials will be required to ensure containment of stray current. The locations shown for the electrical barriers have been such to avoid nearby metal structures that could be affected by stray currents. Any conductive structures in the areas of the electrical barriers may require relocation. ERDC's Construction Engineering Research Laboratory (CERL) was contacted to determine safe distances for operation or the location of steel lock gates. ERDC indicated that, with proper electrical isolation within the barrier chamber, there will not be any stray current problems with the operation of the mechanical and electrical systems at the gates given the dimensions of the electrical barrier shown.

At the Chicago and O'Brien Locks, backflow events will be required during severe flooding. This will produce high-velocity flows thru the lock and electrical barrier chambers. This will necessitate the electrodes to be recessed or securely supported to the chamber floor to ensure stability during such events.

I.3.3 Controlling Works Structures

As part of the Technology Alternative, to address transfer of Lake Michigan Species into the CAWS buffer zone, structural rehabilitations of three existing controlling works structures will be required. These include the Chicago Harbor Lock Controlling Works, the O'Brien Lock and Dam Controlling Works, and the Wilmette Pumping Station. At each of these three locations, sluice gates are operated during backflow events to release flood waters into Lake Michigan. During backflow events, as the heads equalize and flow velocities decrease, certain targeted species will be capable of passing thru the existing unscreened gates.

As part of the Technology Alternative, to address ANS transfer between Lake Michigan and the CAWS buffer zone, all sluice gates will require installation of screen structures with 0.4-inch maximum openings. Introduction of screens of this size requires that the total cross sectional area of the sluice gates be increased to compensate for the head loss across the screen. It is estimated that 2.2 times the area of existing gates will be required to compensate for the head loss associated with the addition of 0.4 inch screens. This 2.2 factor does not account for blockage due to debris. Accounting for blockage due to debris will be required during final design after selection of the screen system and considering the effectiveness of the screen cleaning/raking system. Any debris blockage can be accommodated by increasing the screen and/or gate area. See Enclosure B for the basis for determination of the new number of gates. A summary of the increase in number of gates is included in Table I.2.

TABLE I.2 Summary Sluice Gate Rehabilitation

Location	**Existing Number of Gates**	**New Number of Gates Required (with 0.4 in. screens)**	**Required Rehabilitation**
Chicago Harbor Lock Controlling Works	Eight 10 ft ×10 ft sluice gates (4 on Chicago Lock North Basin Wall and 4 on North Breakwater Access Wall)	12 10 ft × 15 ft sluice gates at Chicago Lock North Basin Wall	Remove existing sluice gate structure on North Basin Wall and replace with new 216 ft-long sluice gate structure consisting of 12 10 ft × 15 ft self-cleaning screened sluice gates. Abandon and seal off 4 gate openings on North Breakwater Access Wall.
O’Brien Lock and Dam Controlling Works	Four 10 ft × 10 ft sluice gates	Six 10 ft × 15 ft sluice gates	Remove existing sluice gate structure and replace with a new 100 ft-long sluice gate structure consisting of six 10 ft × 15 ft self-cleaning screened sluice gates.
Wilmette Pumping Station	Three 8 ft × 17.5 ft roller gates Nine 9 ft × 10.5 ft slide gates	Three 8 ft × 17.5 ft gates (existing) four 10 ft × 15 ft sluice gates	Install self-cleaning screens on three existing 8ft × 17.5 ft gates. Perform major rehabilitation of the pump station (North Shore Channel side) to replace existing structure with sluice gate structure to accommodate four 10 ft × 15 ft sluice gates. Install self-cleaning screens on all gates.

The design of the screen structures are beyond the scope of this study, however, it is anticipated they will be substantial structures to ensure no blockage or head loss thru the gates. The screens will be required to form a tight seal with the concrete. The screens will incorporate self cleaning mechanical features to address blockage and minimize maintenance. As required, wide mesh trash racks with proper raking systems can be incorporated to protect the screen structure from damage due to large debris. Some of the existing sluice gates currently have 2-inch bar screens without a trash raking or cleaning system installed to address potential transfer of Asian carp from the rivers to Lake Michigan. No major debris issues have been reported. Future detailed design efforts will be required to optimize the design of the screen structure and trash rack/rake system working in conjuction with the sluice gates. The final number and sizes of sluice gates can be adjusted as necessary based on the final configuration, head loss, and any anticipated blockage across the screen structure.

To confirm the viability of providing a screen structure which will not adversely impact the operation of the sluice gates or create head loss thru the gates, a value engineering study was performed by Portland Distict. The study focused on screening options at O'Brien Lock and Dam for potential application to other locations. The study is provided in Enclosure C. The study evaluated 11 alternatives for screening the sluice gates and recommended a Vee screen concept for future development. The Vee screen concept consists of sceens arranged in large Vee formations to allow the screen flow area to be larger than the gate flow area, allowing a reduction in head loss across the screens. Debris collection and removal is performed by having a cleaning system that has a travelling cleaning device to sweep debris to the apex of the vee and a debris removal device to pull the debris up and out of the apex and into a truck or conveyor. The sweeping device could be a brush or a water jet. The debris removal device could be an inclined travelling screen or a raking device. It should be noted that this study was performed prior to finalizing the number of gates required at O'Brien Lock and Dam; thus, the study assumed that more than six sluice gates would be present in the dam. As the study indicates, the concepts can be applied to more or fewer sluice gates.

I.3.3.1 Chicago Harbor Lock Controlling Works

The Chicago Harbor Lock controlling works consists of four 10 ft ×10 ft sluice gates at the Chicago Lock North Basin Wall and four 10 ft × 10 ft sluice gates on the North Breakwater Access Wall. As part of the Technology Alternative, these existing sluice gates will be replaced with 12 10 ft × 15 ft sluice gates, all located on the North Basin Wall. The existing gates at the North Breakwater Access Wall will be sealed and abandoned.

The existing controlling works structure on the North Basin Wall would be completely removed and replaced with a 200-ft-long new controlling works structure housing 12 10 ft × 15 ft sluice gates. The entire 216-ft-long North Basin Wall would be rebuilt to house the new controlling works structure. The existing structure is shown in Enclosure B and consists of a mass concrete gate block over timber piles for the sluice gate cross section and a concrete monolith over sheet pile cells for the balance of the wall. The new structure would likely consist of a concrete gate block over drilled shafts or steel H-piles similar in construction to the existing sluice gate cross section. The gate block is currently shown as 40 feet wide and will likely need to be widened to 60-80 feet to accommodate the screen structure and associated mechanical features.

I.3.3.2 O'Brien Lock and Dam Controlling Works

The O'Brien Lock and Dam controlling works consists of four 10 ft × 10 ft sluice gates housed in a 60-ft-long controlling works structure located within the 300-ft-long dam. The gate block is a mass concrete structure over bearing piles with sheet pile cutoff. The remainder of the dam consists of concrete monoliths over sheet pile cells. See Enclosure B for general layout and location of the existing controlling works structure.

The existing sluice gates, gate block, and a portion of the dam would be removed to construct a new approximately 100-ft long by 60- to 80-ft wide controlling works structure to accommodate the screen structure and associated mechanical features. The new controlling works structure would consist of a concrete gate block over drilled shafts or steel H-piles similar in construction to the existing sluice gate cross section.

I.3.3.3 Wilmette Pumping Station

The existing Wilmette Pumping Station overall plans, sections, and gate arrangement are shown in Enclosure B. The pump station is divided into two sides: the Diversion Channel Side and the Pump Station Side. The Diversion Channel Side houses three 8 ft wide × 17.5 ft tall roller gates. The Pump Station Side has four 9 ft wide × 10.5 ft tall slide gates on the Lake Michigan side and four 9 ft wide × 10.5 ft tall slide gates on the North Shore Channel side of the pump station.

On the Diversion Channel Side, the existing roller gates would remain but would be required to be screened to address ANS transfer from Lake Michigan into the CAWS buffer zone. Sufficient room exists upstream or downstream of the existing roller gates to accommodate a self-cleaning screen system. Selection of screen location will occur in future studies and will depend on the screen type and debris handling requirements. Existing concrete sills exist upstream and downstream of the existing roller gates and could be considered as possible locations for the new screen structure.

On the Pump Station Side, the pumps would be abandoned and the pump station would be rehabilitated for use only as a gate structure for flood control. Future pumping at this location for water quality would occur thru a new planned ANS Treatment Plant. Four new sluice gates would be required on the pump station side. Since the existing gates are all 9 feet wide, 9 ft × 16 ft-8 in. sluice gates are assumed for this location to allow for maximum re-use of the existing gate block and concrete walls. The lakeside sill has the lowest elevation at 13.5 ft and would be the preferred location for the new taller gates. Selection of screen location will occur in future studies and will depend on the screen type and debris handling requirements. Possible locations of the screen structure include the North Shore Channel side sill or just upstream or downstream of the new gate location. The lakeside sill may require an extension lake-ward to accommodate a screen structure. Conveyance thru the existing pump station is thru four tunnels. All tunnels are 9 ft in diameter except for tunnel 2, which has been lined with shotcrete to 7 ft diameter. Removal of the tunnels and major rehabilitation of the pump station may be required to reconfigure the channel to obtain the required conveyance.

I.3.4 ANS Treatment Plants

See other portions of the report for general features of the ANS Treatment Plants. No detailed facility layout has been performed as part of this study, but the processes and general facility requirement have been based on similar sized Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) wastewater treatment facilities.

The only site-specific structures anticipated for the ANS Treatment Plants are at the Chicago Harbor Lock where the ANS treatment facility is located adjacent to the Lock (see Figure I.1). A shoreline revetment wall approximately 650 feet long is required to form the closure walls for the plant facility. Design of this wall may require consideration for stray current due to the close proximity to the electric barrier. In this case, a rubble mound or mass concrete wall over drilled shafts could be considered to eliminate conductive sheet pile or H-Pile materials typical of shoreline revetment structures.

I.4 STRUCTURAL FEATURES FOR THE HYDROLOGIC SEPARATION ALTERNATIVES

As part of the Hydrologic Separation Alternative, physical barriers will be required to separate Lake Michigan from the CAWS. Four lakefront locations and two mid-system locations were selected as follows:

- Lakefront locations – Wilmette (IL), Chicago (IL), Calumet City (IL), and Hammond (IN)
- Mid system locations – Stickney (IL) and Alsip (IL).

Only general locations of the physical barriers have been determined at this time. Specific site locations will be determined in later studies. For the purposes of performing a concept level structural evaluation of the physical barriers, a location was assumed in order to obtain hydraulic requirements, soil conditions, and site layout requirements. This was done only to determine approximate structure dimensions and to verify that a physical barrier structure is feasible.

The physical barrier structures are anticipated to be concrete dam structures on pile foundations with sheet pile cutoff walls. Enclosure D includes concept-level stability calculations and plates showing the approximate dimensions for the concrete dams. It is anticipated that pile foundations will be required for all the dams, since rock is not shallow at the locations investigated. These pile foundations would need to be designed in accordance with EM 1110-2-2906.

All barriers were evaluated as simple concrete dams. The design headwater, tail water, and channel bottom elevations were provided by hydraulics. These values are listed below under each individual dam location. The heights are based on a storm event with a 0.2% probability of exceedance.

1. Wilmette (river side is high side)
2. Chicago (lake side is high side)
3. Stickney (lake side is high side)
4. Alsip (lake side is high side)
5. Calumet City (lake side is high side)
6. Hammond (east/lake side is high side)

I.4.1 Wilmette – At the Existing Pumping Station

The river side is the high side. Headwater height is 587.2 ft North American Vertical Datum of 1988 (NAVD88), tail water height is 575 ft NAVD88, and channel depth is 567 ft NAVD88. The barrier location assumed is in the vicinity of the existing Wilmette Pump Station. Future studies could consider constructing it on the existing controlling works structure, but this will require analyzing its strength for the larger event as well designing methods to close the various penetrations through the structure. At this stage in the study, the dam at Wilmette is assumed to be an independent pile-supported mass concrete structure.

I.4.2 Chicago – Chicago River

The lake side is the high side. Headwater height is 585.9 ft NAVD88, tail water height is 575 ft NAVD88, and channel depth is 553 ft NAVD88. A location away from the lakefront in the vicinity of the Michigan Avenue Bridge is assumed for this structure. A structure at the lakefront, such as at the western opening of the Chicago Harbor Lock, would be subjected to wave overtopping and require the structure to be much higher than the 0.2% exceedance storm event. At any separation point between the river and the lake — such as the North Pier Tunnel on the north, North Basin Wall on the east, or Southwest Guide Wall on the south — the new structure would be required to much higher and all of the existing structures would require height increases.

I.4.3 Stickney – Chicago Ship and Sanitary Canal

The lake side is the high side. Headwater height is 587.2 ft NAVD88, tail water height is 575 ft NAVD88, and channel depth is 558 ft NAVD88. This location was selected to minimize flood impacts. Placement of the dam is assumed just east of the Stickney Outfall. This location will minimize impacts to water quality in the lake caused by sewage treatment outflow to the lake.

I.4.4 Alsip – Cal-Sag Canal

The lake side is the high side. Headwater height is 588.1 ft NAVD88, tail water height is 575 ft NAVD88, and channel depth is 564 ft NAVD88. Placement of this dam is assumed to be west of the Natalie Creek Confluence. Placement west of the Natalie Creek Confluence will address fish bypass during a large flood event between Natalie Creek and Midlothian Creek. Fish bypass would be possible if the barrier were located east of the Natalie Creek Outfall.

I.4.5 Calumet City – Calumet River

The river side is the high side. Headwater height is 585.9 ft NAVD88, tail water height is 575 ft NAVD88, and channel depth is 562 ft NAVD88. Placement of this dam is assumed to be in the vicinity of the Bishop Ford Expressway, west of the O’Brien Lock and Dam.

I.4.6 Hammond – Little Calumet River

The lake side is the high side. Headwater height is 603.4 ft NAVD88, tail water height is 575 ft NAVD88, and channel depth is 586 ft NAVD88. Placement of this dam is assumed to be on the west side of the Hart Ditch control structure.

I.5 TUNNELS GENERAL

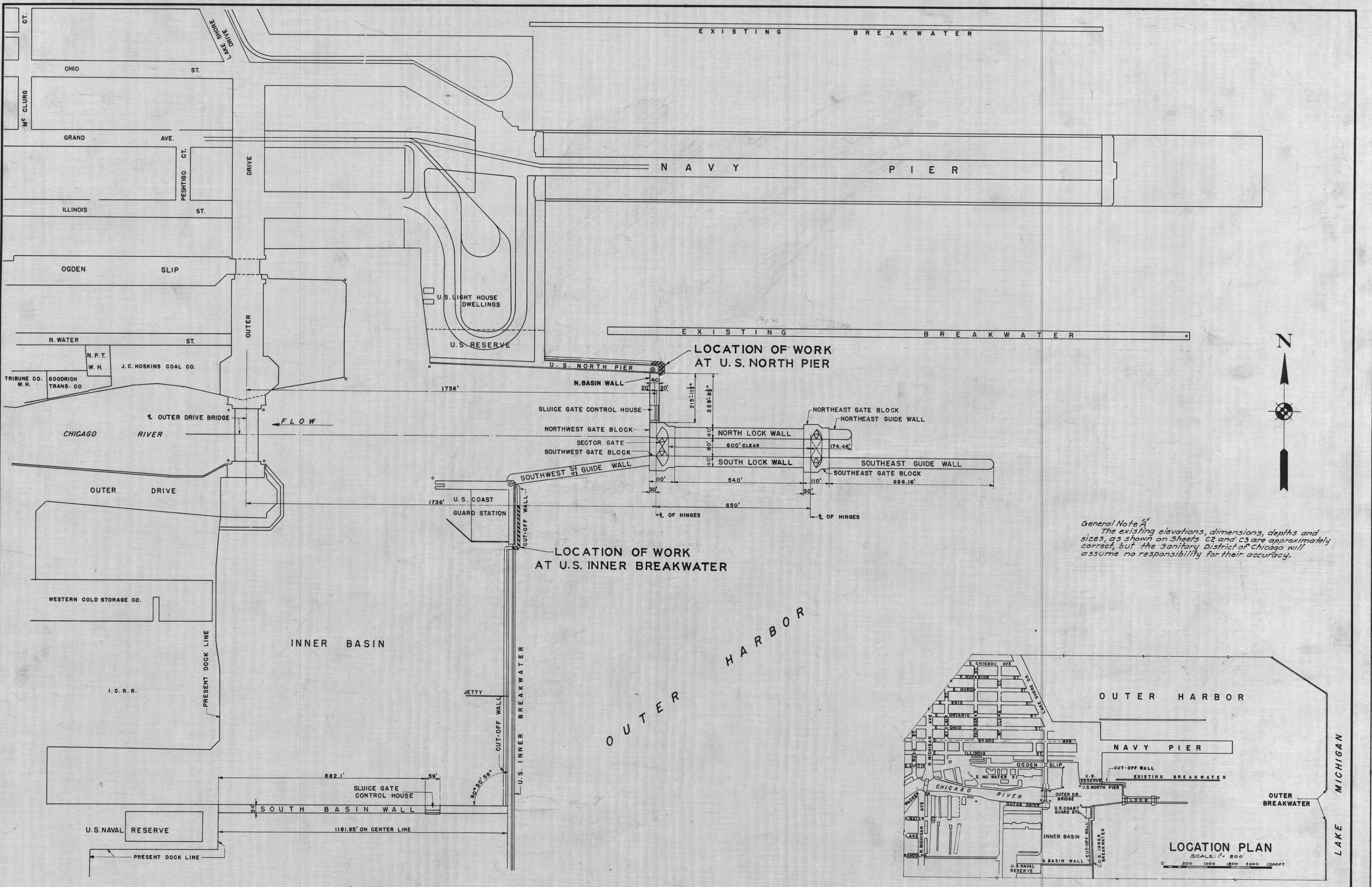
The Technology and Hydrologic Separation Alternatives have tunnels of varying diameters as part of the plans. These tunnels range from 14 ft to 42 ft in diameter and have been sized for the conveyance required. Preliminary hydraulic modeling for the tunnel diameters indicates that the velocities are below 20 ft/s.

The major structural features for the tunnels will include concrete-lined tunnels, drop and access shafts, inlet structures, and gate structures. Structural design of these features is beyond the scope of this study. For costing purposes, use of costing data from past tunnel projects in the Chicago area, including the McCook Reservoir Project, Thornton Reservoir Project, and other Tunnel and Reservoir Plan (TARP) projects, would be appropriate. An example of a 30–ft-diameter TARP system is the Indiana and 140th Street tunnel legs of the Calumet Tunnel System included in Enclosure E. This system was evaluated to determine frequency and quantity of shafts present in a typical tunnel leg primarily for real estate evaluation purposes. The types of shafts present in this tunnel leg include construction shafts, access shafts, work shafts, and drop shafts. Over a length of approximately 7 miles, there are 13 shafts requiring real estate at the shaft access point. Enclosure E shows typical real estate required for such shafts.

ENCLOSURE A

EXISTING LOCK DRAWINGS

1. Chicago Harbor Lock
2. O'Brien Lock and Dam
3. Brandon Road Lock and Dam



General Note "A"
The existing elevations, dimensions, depths and sizes, as shown on Sheets C2 and C3 are approximately correct, but the Sanitary District of Chicago will assume no responsibility for their accuracy.

PLOT PLAN

SCALE: 1" = 150'

0 50' 100' 150' 300' 450' 600' FT.

LOCATION PLAN

SCALE: 1" = 800'

0 500 1000 1800 2000 2500 FT.

Approved R. R. Loffler
Engr of Struct. Design

Approved H. H. Ramey
Asst Chief Engineer

Approved W. A. Trubans
Chief Engineer

APPROVED AS WORKING PLAN
7-17-44 BY R.R.L.
REVISIONS OF WORKING PLAN

THE SANITARY DISTRICT OF CHICAGO
CHICAGO RIVER CONTROLLING WORKS
IN CHICAGO HARBOR
CONTRACT 44-41 (CRC-ST)

LOCATION AND PLOT PLAN

SCALE: 1" = 150'
1" = 800'

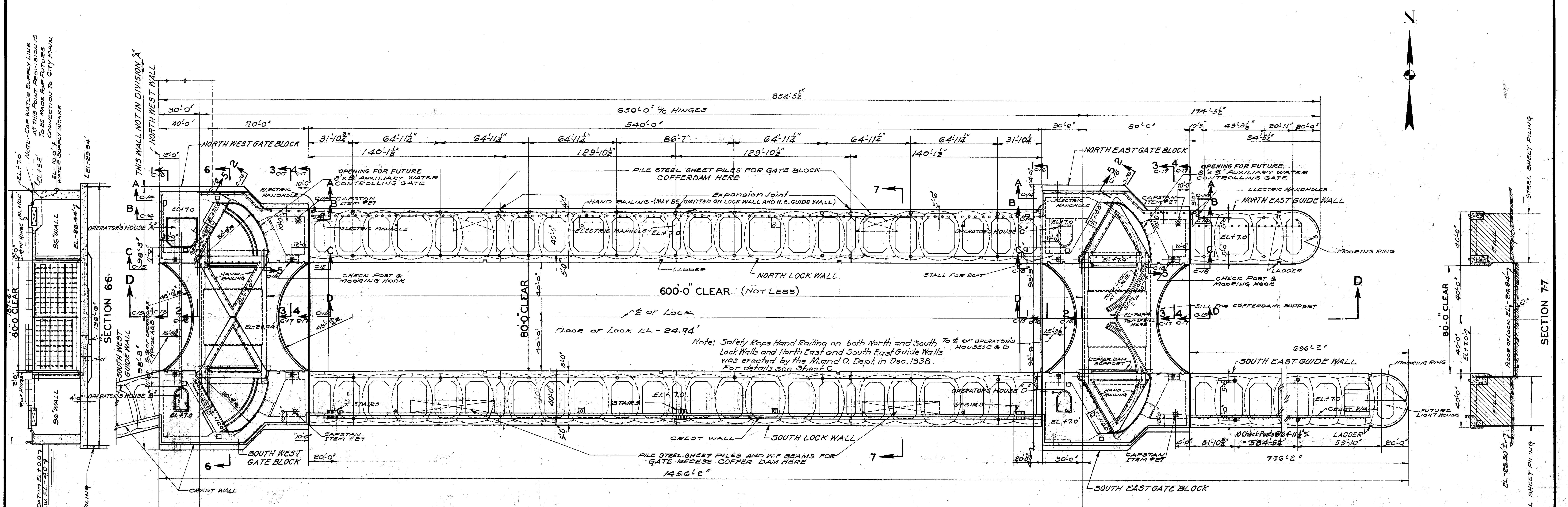
FILE NO. 50-L1
SHEET NO. C1

996
5650

DRAWN BY F. WOLF
TRACED BY F. WOLF
CHECKED BY M.P.
EXAMINED BY

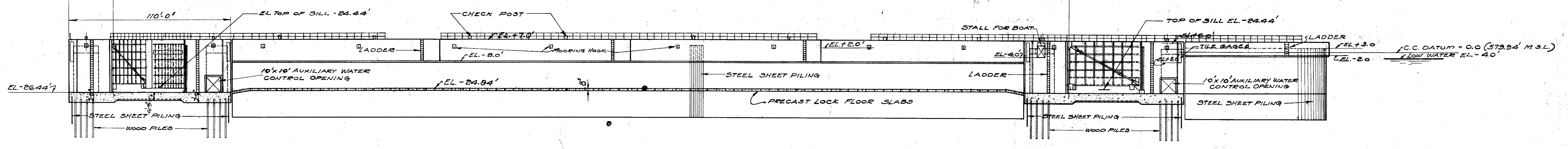
MP 4/7/77

3



Note: Safety Rope Hand Railing on both North and South Lock Walls and North East and South East Guide Walls was erected by the M. and O. Dept. in Dec. 1938. For details see Sheet C

PLAN OF LOCK



LONGITUDINAL SECTION D-D

Note "A"

The following notes apply on sheets C3 to C39 inclusive.

This Note "A" will be supplemented by additional notes as the individual sheets may require.

All dimensions and elevations on "C" plans refer to concrete faces.

The Engineer in charge of the construction work shall consult with the Designing Engineer relative to the location of pouring lines and construction joints.

For openings and inserts in the concrete required for architectural and steel work see "C" and "S" plans.

For electrical work see Section 20 of General Specification.

All exposed edges of concrete shall have a ½ inch chamfer as shown here, except where shown otherwise on drawings.

The following abbreviations are used in locating the reinforcement bars:- "B" denotes Bottom. "T" denotes Top. "N.F." denotes Near Face. "F.F." denotes Far Face. "E.F." denotes Each Face.

Bottom reinforcement bars in bottom slab shall have the clear distance of concrete below bars as follows:- 4" if slab is resting on soil. 1" above top of piles, if slab is supported by piles.

Reinforcement Bars in all walls (except crest wall) and in top of bottom slab shall have 4" clear covering of concrete from face to which they are adjacent. Reinforcement bars in all other slabs over 18" thick shall have 2" and in slabs under 18" shall have 1½" clear covering of concrete from face to which they are adjacent and in crest wall 2" clear.

Main reinforcement bars in beams below datum (El. 0.0) shall have 3" Clear covering and in beams above datum 2" Clear covering of concrete from face to which they are adjacent.

For details of keys and steel chairs see sheet C11

See specifications for limits of pay for excavation.

For location of Hand Rails on gate blocks and walls see sheet C24

Welding: See Specifications. All welds shall be continuous fillet welds except as noted. Size of welds shall equal the thickness of the minimum section welded unless otherwise noted.

No jetting will be permitted in the driving of any wood or steel sheet piles under this contract.

DRAWN BY E.A.N.
TRACED BY H.J.CECKA.
CHECKED BY R.P.V.M.
EXAMINED BY

LIST OF DRAWINGS

SHEET NO	TITLE
C 1	LOCATION PLAN
C 2	SOUNDING "
C 3	INDEX DRAWING OF LOCK
C 4	SUGGESTED COFFERDAM PLAN FOR LOCK
C 5	LOCK WALLS BETWEEN GATE BLOCKS
C 6	" FLOOR " " " AND CREST WALL
C 7	GUIDE WALLS, NORTH EAST AND SOUTH EAST WALLS
C 8	" WALL, SOUTH WEST WALL
C 9	GATE BLOCK, PLAN OF FOUNDATION USING 20 TON PILES
C 10	" " , " " " SHOWING REINFORCEMENT
C 11	" " , " AT EL. - 26.44
C 12	" " , " " " - 24.44 AND + 3.00
C13 & C13A	" " , " " " + 7.00 (WEST & EAST GATE BLOCK)
C 14	" " , LONGITUDINAL SECTIONS A-A AND B-B
C 15	" " , " " C-C " D-D
C 16	" " , TRANSVERSE SECTIONS 1-1 " 2-2
C 17	" " , " " 3-3 " 4-4
C 18	" " , " " 5-5
C 19	" " , TILE GAGES
C 20	" " , MISCELLANEOUS STEEL DETAILS
C 21	" " , " " "
C 22	" " , SECTOR GATE TRACKS
C 23	" " , OPERATING MACHINERY TRACKS
C 24	HAND RAILS AND DETAILS
C 25	GATE RECESS AND BLOCK COFFERDAMS
C 26	PLAN, ELEVATIONS, AND DETAILS OF OPERATOR'S HOUSE "A"
C 27	PLANS, " " " " " HOUSES "B", "C", & "D"
C 28	OPERATOR'S HOUSE DETAILS & FIELD OFFICE
C 29	EL. MANHOLES & HANDHOLES IN N. LOCK WALL & N.E. GUIDE WALL
C 30	DETAILS OF CREST WALLS
C 31	LOCK WALL REINF. PANEL LOCATIONS & LAMPPOST BRACKET DETAILS
C 32	GUIDE WALL REINF. PANEL LOCATIONS
C 33	REINF. DETAILS PANELS CB1, CB2, P1, P2, P3, P4, P4A
C 34	" " " P5, P5A, P6, P7, P8, P9, P9A, CB3, CB34
C 35	" " " P10, P11, P12, P13, P14
C 36	" " " P15, P16 & LIGHTHOUSE BEAMS LHB1
C 37	" " " P17, P18, P19, CB5
C 38	" " " P20, P21, P22
C 39	TYPICAL CROSS SECTIONS OF WALLS & BEAMS
C 13-1	WEST GATE BLOCK PLAN AT ELEVATION +7.00 SHOWING REINFORCEMENT STEEL.
C13A-1	EAST GATE BLOCK PLAN AT ELEVATION +7.00 SHOWING REINFORCEMENT STEEL.
C4A	REVISED THEORETICAL CELL (SEPT. 21, 1936)
C 40	DETAILS OF SAFETY ROPE HAND RAILING

0 5' 10' 20' 30' 40' 50' 60' 70' 80' 90'
1" = 30'-0"

Approved R. R. Leffler
Engr. of Struct. Design

Approved
Assistant Chief Engineer

Approved
Acting Chief Engineer

APPROVED AS WORKING PLAN
8-10-36 BY R.R.L.
REVISIONS OF WORKING PLAN
11-16-36, Sheet C4A added to List of drawings.
1-13-37 Gate Block Cofferdam sills location revised.
4-18-39, Revised as built.

THE SANITARY DISTRICT OF CHICAGO
CHICAGO RIVER CONTROLLING WORKS
IN CHICAGO HARBOR
DIVISION A

FILE NO. 50-L1

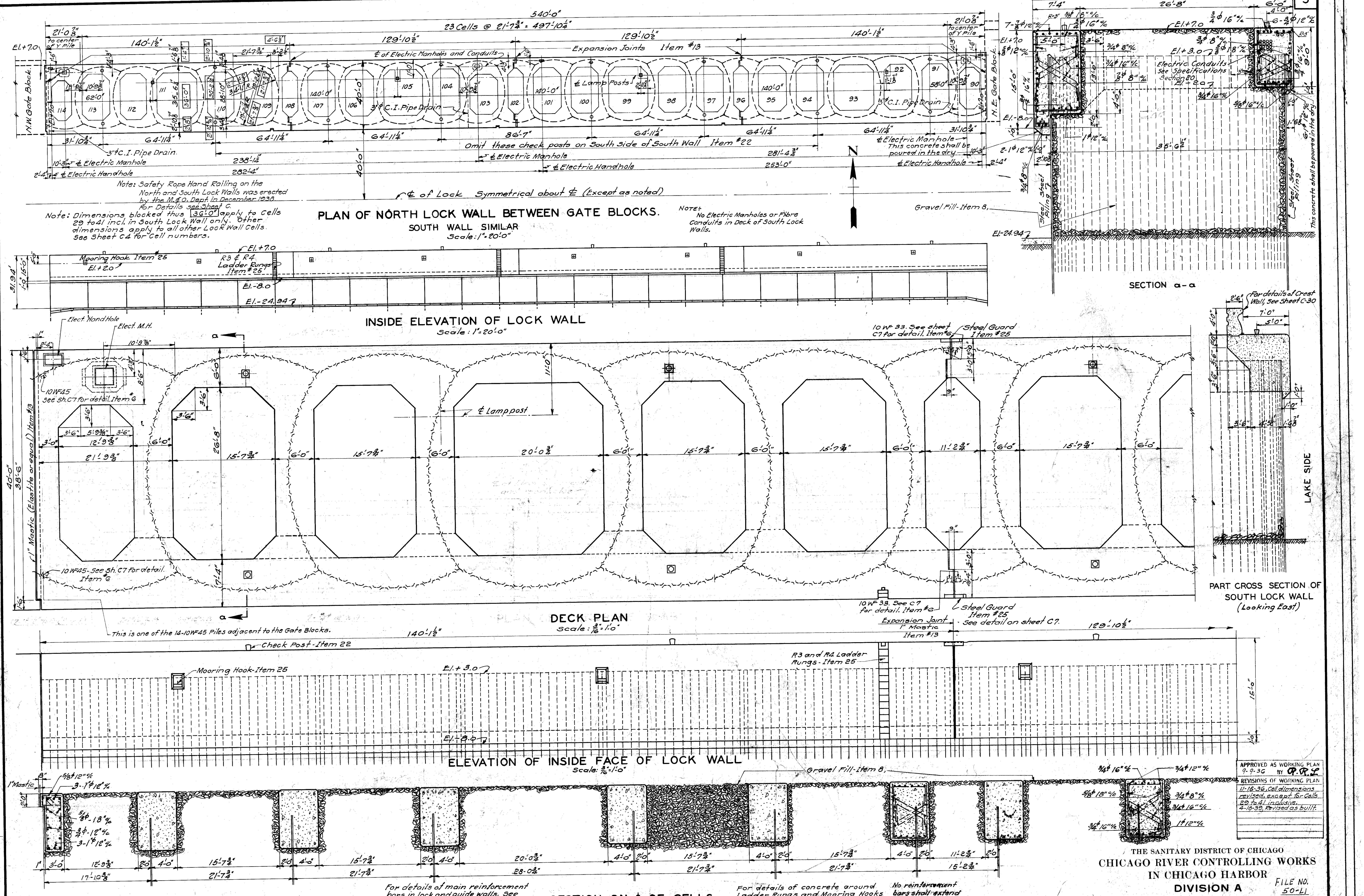
INDEX DRAWING OF LOCK

SCALE: 1" = 30'-0"
0 5 10 15 25 50'

MAY 1936

SHEET NO. C3 947/5626

REFERENCE DRAWING R1



PLAN OF NORTH LOCK WALL BETWEEN GATE BLOCKS.

SOUTH WALL SIMILAR
Scale: 1" = 20'-0"

Note: Safety Rope Hand Railing on the North and South Lock Walls was erected by the M.&O. Dept. in December 1938. For Details see Sheet C.

Note: Dimensions blocked thus 36'-0" apply to Cells 29 to 41 incl. in South Lock Wall only. Other dimensions apply to all other Lock Wall Cells. See Sheet C4 for Cell numbers.

NOTE: No Electric Manholes or Fibre Conduits in Deck of South Lock Walls.

INSIDE ELEVATION OF LOCK WALL

Scale: 1" = 20'-0"

SECTION a-a

PART CROSS SECTION OF SOUTH LOCK WALL

(Looking East)

DECK PLAN

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

ELEVATION OF INSIDE FACE OF LOCK WALL

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

SECTION ON ℄ OF CELLS.

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

GENERAL NOTES:
Note "A" on sheet C3 applies to this sheet.
All expansion joints shall be 1" Mastic (Elastite or equal) the full depth of section. Payment for mastic shall be included in the unit price for Item 13, Concrete.
Payment for work on this sheet paid for as follows:
Steel Sheet Piling, Items #5 and #6.
Fill, Item 8; Concrete, Item 13;

For details of main reinforcement bars in lock and guide walls, See Sheets C31 to C39 inclusive.
Reinforcement Bars, Item #14.
For detail of and payment for Ladder Rungs, Mooring Hooks and Check Posts, see Sheets C17 and C21.
Sheet Piling:- All Sheet Piling in wall cells shown on this drawing shall be Illinois Steel Co's Section M-112 or equal. See sheet C7 for location of handling holes.

The Concrete to be measured for payment shall be the theoretical volume within the outlines shown on the drawing. See specifications.
For Typical Detail of "Y" Pile see sheet C7.

For details of concrete around Ladder Rungs and Mooring Hooks see Sheet C-17.
For Details of Electric Manholes and Handholes see Sheet C-29.
All steel sheet piles in lock and guide walls shall penetrate to at least El. -50.00 with El. -55.00 as a maximum.
For Details of Lamppost Brackets, see Sheet C-31.

No reinforcement bars shall extend through expansion joints. Horizontal bars may be shifted slightly longitudinally where necessary.

DRAWN BY Lillard & Randall
TRACED BY E.A.H.
CHECKED BY R.P.K.M.
EXAMINED BY

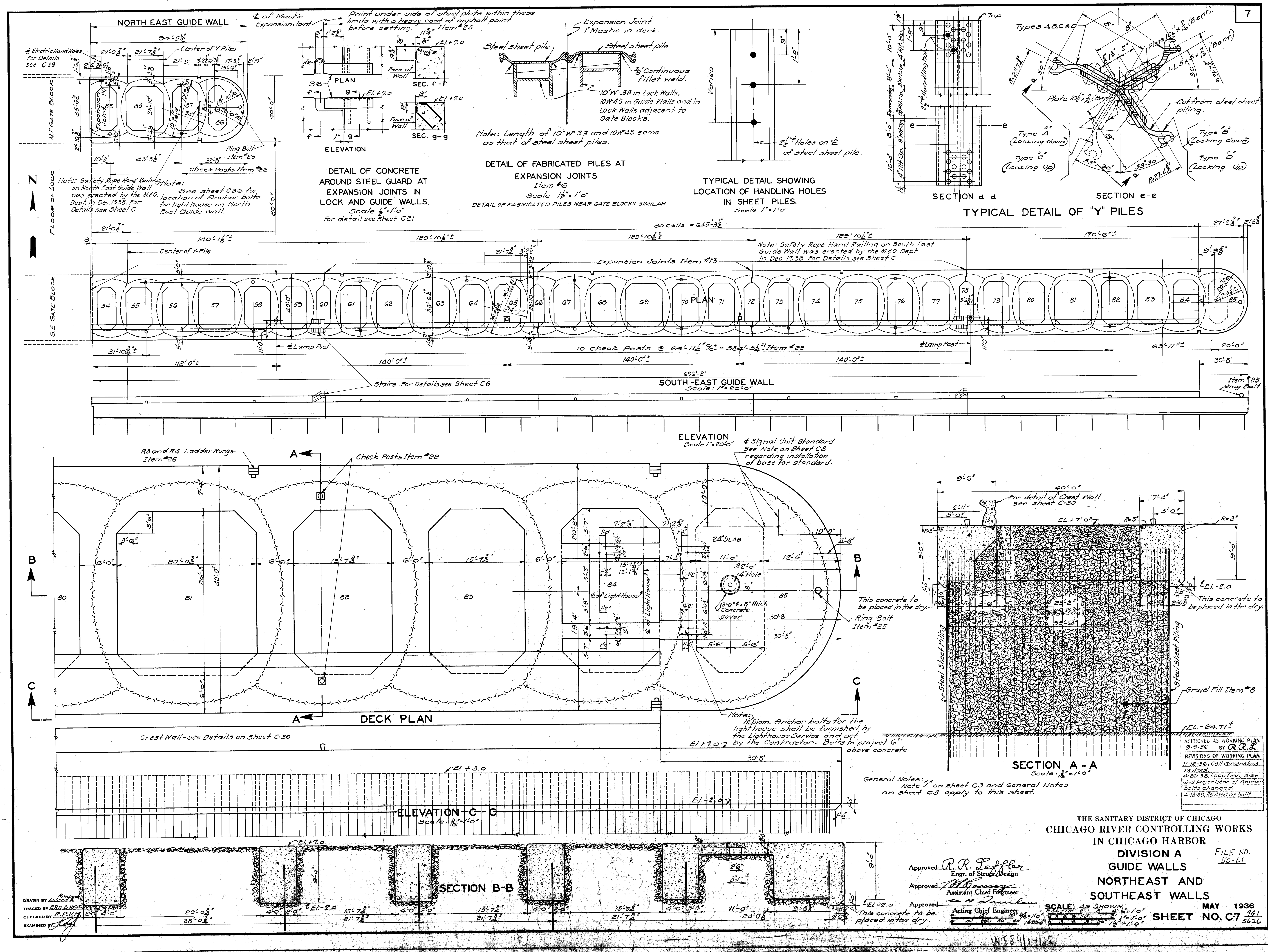
APPROVED AS WORKING PLAN
9-9-36 BY R.R.L.
REVISIONS OF WORKING PLAN
11-16-36, Cell dimensions revised, except for Cells 29 to 41 inclusive.
4-18-39, Revised as built.

Approved R. R. Laffler
Engr. of Struct. Design
Approved
Assistant Chief Engineer
Approved
Acting Chief Engineer

THE SANITARY DISTRICT OF CHICAGO
CHICAGO RIVER CONTROLLING WORKS
IN CHICAGO HARBOR
DIVISION A
LOCK WALLS
BETWEEN GATE BLOCKS

FILE NO. 50-L1

SCALE: As Shown 3/16" = 1'-0" 1" = 20'-0"
MAY 1936
SHEET NO. C-5 947



General Notes: Note "A" on Sheet C3 and General Notes on sheet C5 apply to this sheet.

APPROVED AS WORKING PLAN 9-9-36 BY R.R.L.

REVISIONS OF WORKING PLAN

11-16-36, Cell dimensions revised.
4-26-38, Location, size and Projections of Anchor Bolts changed.
4-18-39, Revised as built.

THE SANITARY DISTRICT OF CHICAGO
CHICAGO RIVER CONTROLLING WORKS
IN CHICAGO HARBOR
DIVISION A
GUIDE WALLS
NORTHEAST AND
SOUTHEAST WALLS

FILE NO. 50-L1

Approved R. R. Leffler
Engr. of Struct. Design
Approved
Assistant Chief Engineer
Approved
Acting Chief Engineer

SCALE: AS SHOWN

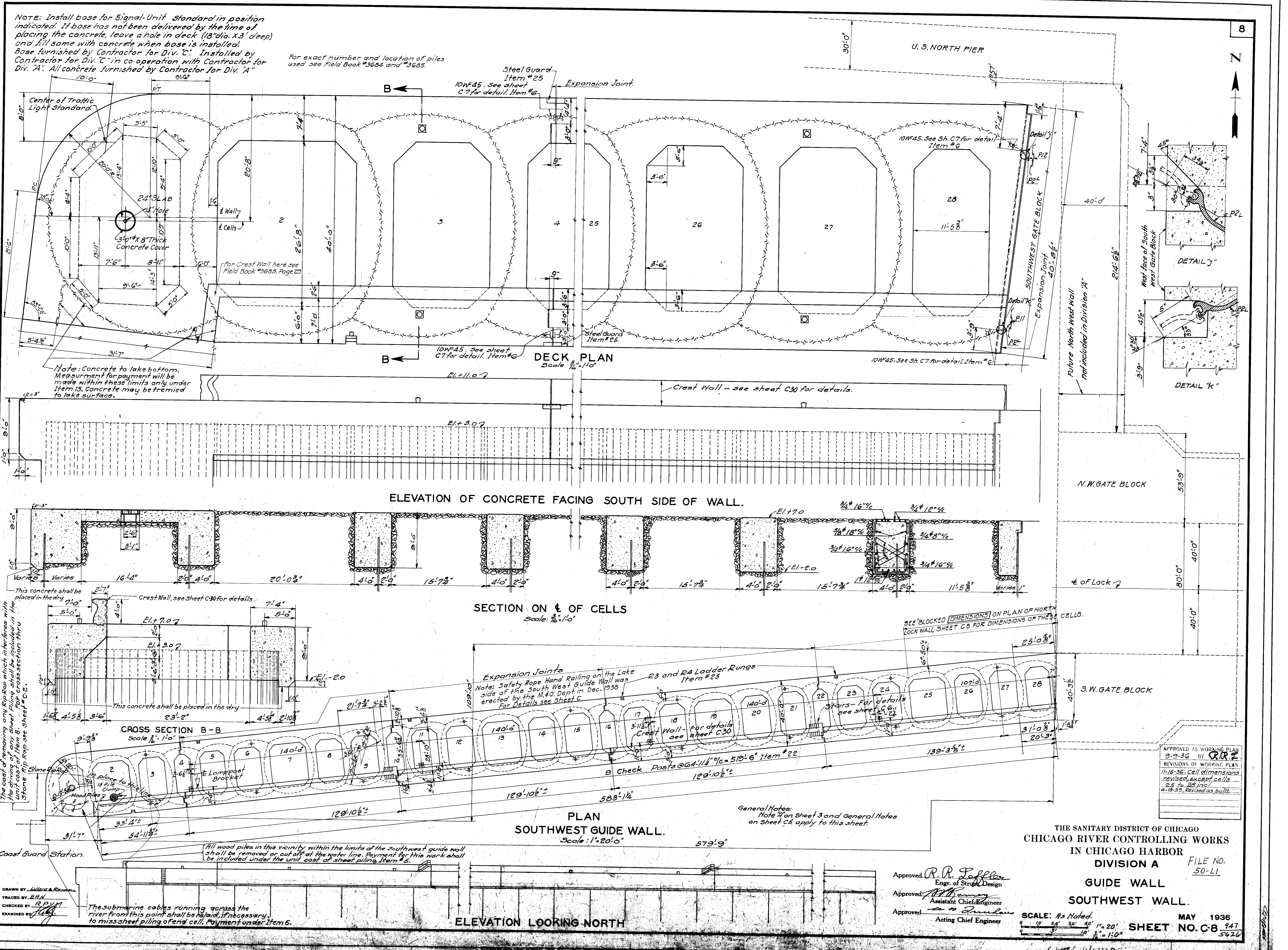
MAY 1936

SHEET NO. C-7 947/5626

DRAWN BY Lillard & Randall
TRACED BY E.A.H. & H.J.G.
CHECKED BY R.P.V.M.
EXAMINED BY

WTS 9|14|2

8



NOTE: Install base for Signal-Unit Standard in position indicated. If base has not been delivered by the time of placing the concrete, leave a hole in deck (18" dia. X 3' deep) and fill same with concrete when base is installed. Base furnished by Contractor for Div. "C". Installed by Contractor for Div. "C" in co-operation with Contractor for Div. "A". All concrete furnished by Contractor for Div. "A"

For exact number and location of piles used see Field Book #3684 and #3685.

Note: Concrete to lake bottom. Measurment for payment will be made within these limits only under Item 13. Concrete may be tremied to lake surface.

The cost of removing any Rip Rap which interferes with the driving of any Sheet Piling shall be included in the unit cost of Item 8. For cross section thru stone Rip Rap see Sheet "C-2."

Note: Safety Rope Hand Railing on the Lake side of the South West Guide Wall was erected by the M. & O. Dept in Dec. 1938. For Details see Sheet C

General Notes: Note "A" on Sheet 3 and General Notes on Sheet C5 apply to this sheet.

All wood piles in this vicinity within the limits of the southwest guide wall shall be removed or cut off at the water line. Payment for this work shall be included under the unit cost of sheet piling, Item #5.

The submarine cables running across the river from this point shall be relaid, if necessary, to miss sheet piling of end cell. Payment under Item 5.

APPROVED AS WORKING PLAN 9-9-36 BY R.R.L.

REVISIONS OF WORKING PLAN
11-16-36, Cell dimensions revised, except cells 25 to 28 incl.
4-18-39, Revised as built

DRAWN BY Lillard & Randall
TRACED BY E.A.H.
CHECKED BY R.P.V.M.
EXAMINED BY

Approved R. R. Loffler
Engr. of Struct. Design
Approved
Assistant Chief Engineer
Approved
Acting Chief Engineer

THE SANITARY DISTRICT OF CHICAGO
CHICAGO RIVER CONTROLLING WORKS
IN CHICAGO HARBOR
DIVISION A
GUIDE WALL
SOUTHWEST WALL.

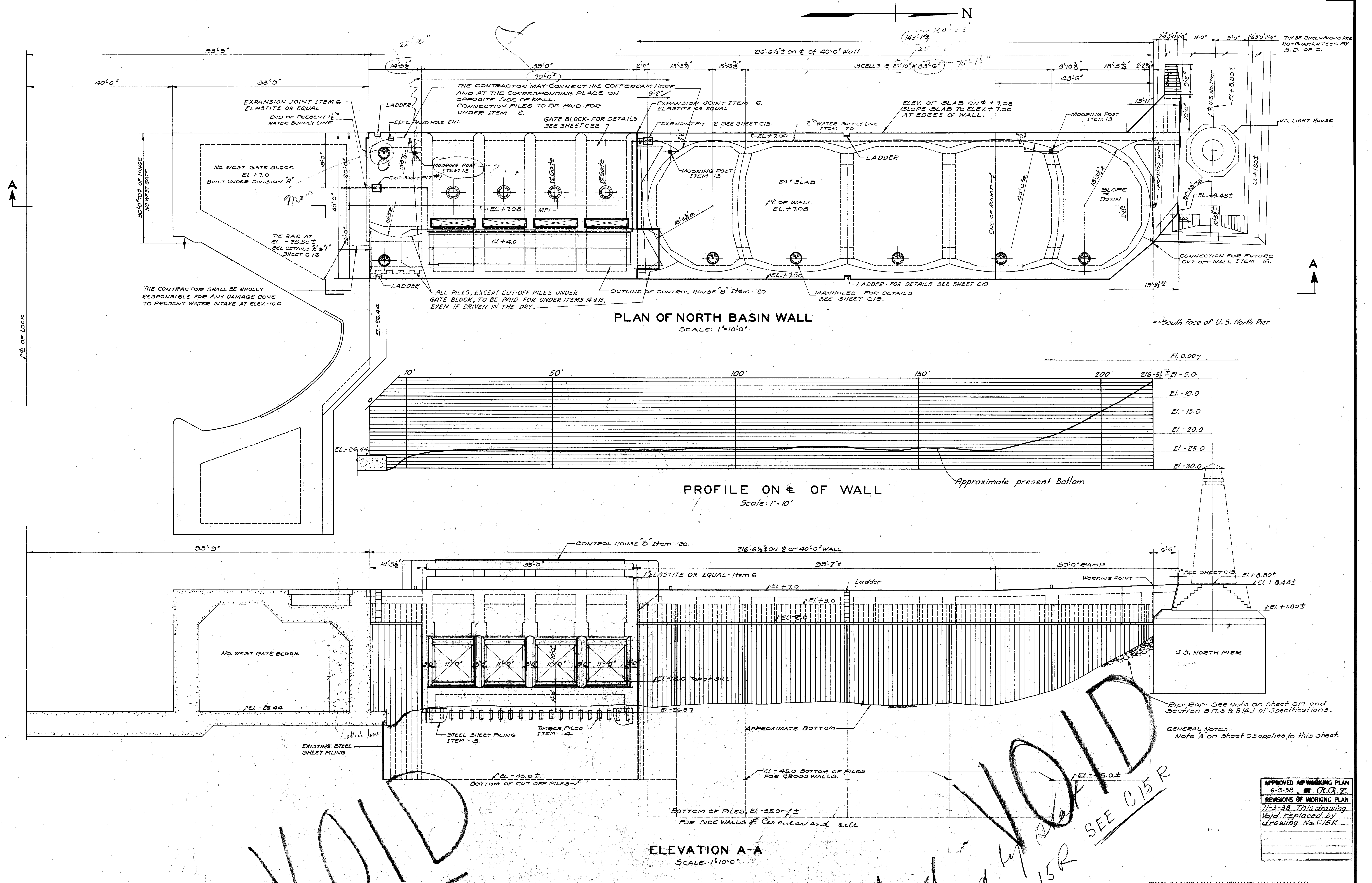
FILE NO. 50-L1

SCALE: As Noted. 1"=20' 3/16"=1'-0"

MAY 1936

SHEET NO. C-8 947/5626

✓ W.T.S. 9/14/38



PLAN OF NORTH BASIN WALL

SCALE:- 1" = 10'-0"

PROFILE ON ℄ OF WALL

Scale: 1" = 10'

ELEVATION A-A

SCALE:- 1" = 10'-0"

GENERAL NOTES:-
Note "A" on Sheet C3 applies to this sheet.

VOID

VOID

Void Replaced by Sheet C15R

SEE C15R

APPROVED AS WORKING PLAN 6-9-38 BY R.R.L.
REVISIONS OF WORKING PLAN
11-3-38 This drawing Void replaced by drawing No. C15R

THE SANITARY DISTRICT OF CHICAGO
CHICAGO RIVER CONTROLLING WORKS
IN CHICAGO HARBOR
DIVISION B

NORTH BASIN WALL,
GENERAL LAYOUT

VOID

948
5629

Correct R. R. Leffler
Engr. of Structural Design

Approved
Asst. Chief Engineer

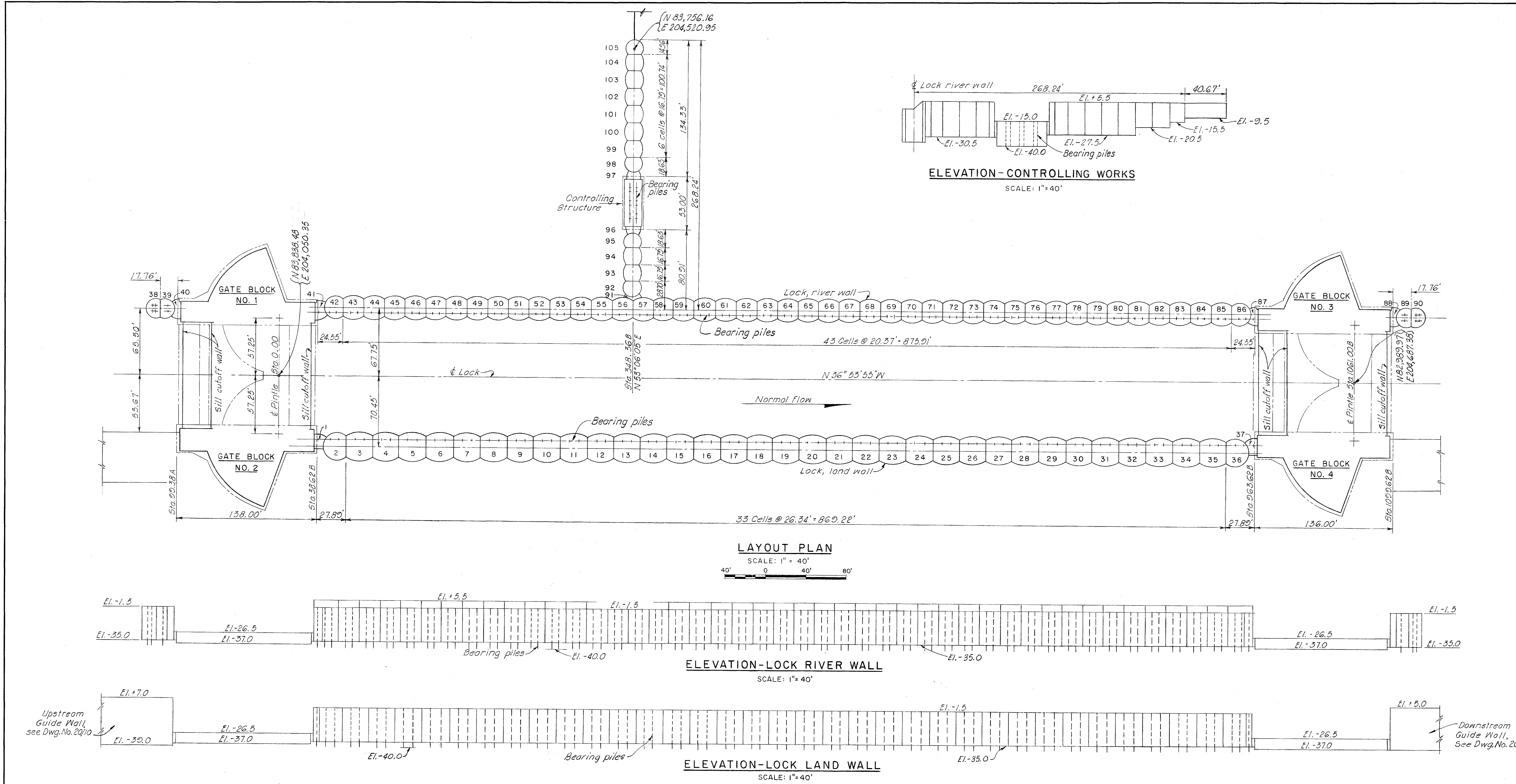
Approved W. S. Trinkaus
Chief Engineer

SCALE: 1" = 10'-0"
0 5' 10' 20' 30'

FEBRUARY, 1938
SHEET NO. C15

FILE NO. 50-L1

DRAWN BY E.A.N.
TRACED BY H.J.C.
CHECKED BY A.W.J.
EXAMINED BY

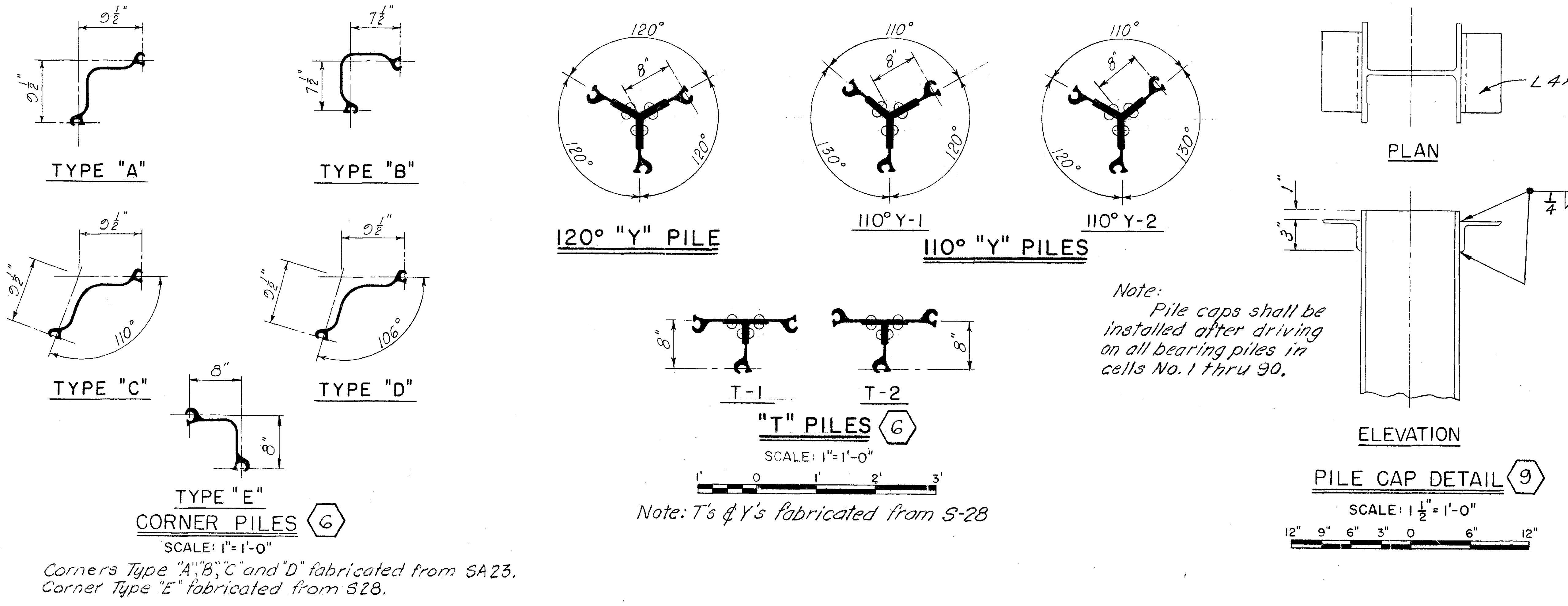


ELEVATION-CONTROLLING WORKS
SCALE: 1"=40'

LAYOUT PLAN
SCALE: 1" = 40'

ELEVATION-LOCK RIVER WALL
SCALE: 1"= 40'

ELEVATION-LOCK LAND WALL
SCALE: 1"=40'



CORNER PILES Ⓖ
SCALE: 1"=1'-0"

Corners Type "A","B","C" and "D" fabricated from SA23.
Corner Type "E" fabricated from S28.

"T" PILES Ⓖ
SCALE: 1"=1'-0"

Note: T's & Y's fabricated from S-28

Note:
Pile caps shall be installed after driving on all bearing piles in cells No. 1 thru 90.

PILE CAP DETAIL ⑨
SCALE: 1½"=1'-0"

NOTES

For general notes, see Dwg No. 20/1.

All steel sheet piling and steel bearing piles shown on Dwgs. Nos. 20/5 thru 20/11 to be furnished by the Government.

Lengths and stationing of walls are based on theoretical driving width of piling.

All bearing piles shall be bonded to the nearest sheet pile cell or continuous sheet pile wall by means of a No. 8 reinforcement rod. Rods shall be welded to each pile with a minimum of 6" of ¼" fillet weld.

△1 All sheet piles shall be positively bonded together with a mild steel bar welded to each sheet pile with a minimum of 6" of ¼" fillet weld except upstream and downstream guide walls (anchor walls for guide walls shall be bonded as specified above) See Sheet Pile Bonding Detail on Dwg. No. 20/6.

REVISION	DATE	DESCRIPTION	BY
△1	19 May '58	Revised in accordance with Addendum No. 3	L.D.

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
BUFFALO DISTRICT
BUFFALO, NEW YORK

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
CHICAGO DISTRICT
CHICAGO, ILLINOIS

DRAWN BY: T.E.T.
CHECKED BY: M.A.S.
SUBMITTED BY: R. J. Brown
CHIEF, DESIGN BR., BUFFALO DISTRICT
APPROVAL RECOMMENDED:
CHIEF, ENG. DIV., BUFFALO DISTRICT
APPROVAL RECOMMENDED:
COL., C. E. DIST. ENGR., BUFFALO DIST.
APPROVED: E. Hoffmann
CHIEF, DESIGN BRANCH
APPROVED:
ASS'T. CHIEF, ENG. DIV.
APPROVED: N. W. Wightman
for CHIEF, ENGINEERING DIVISION

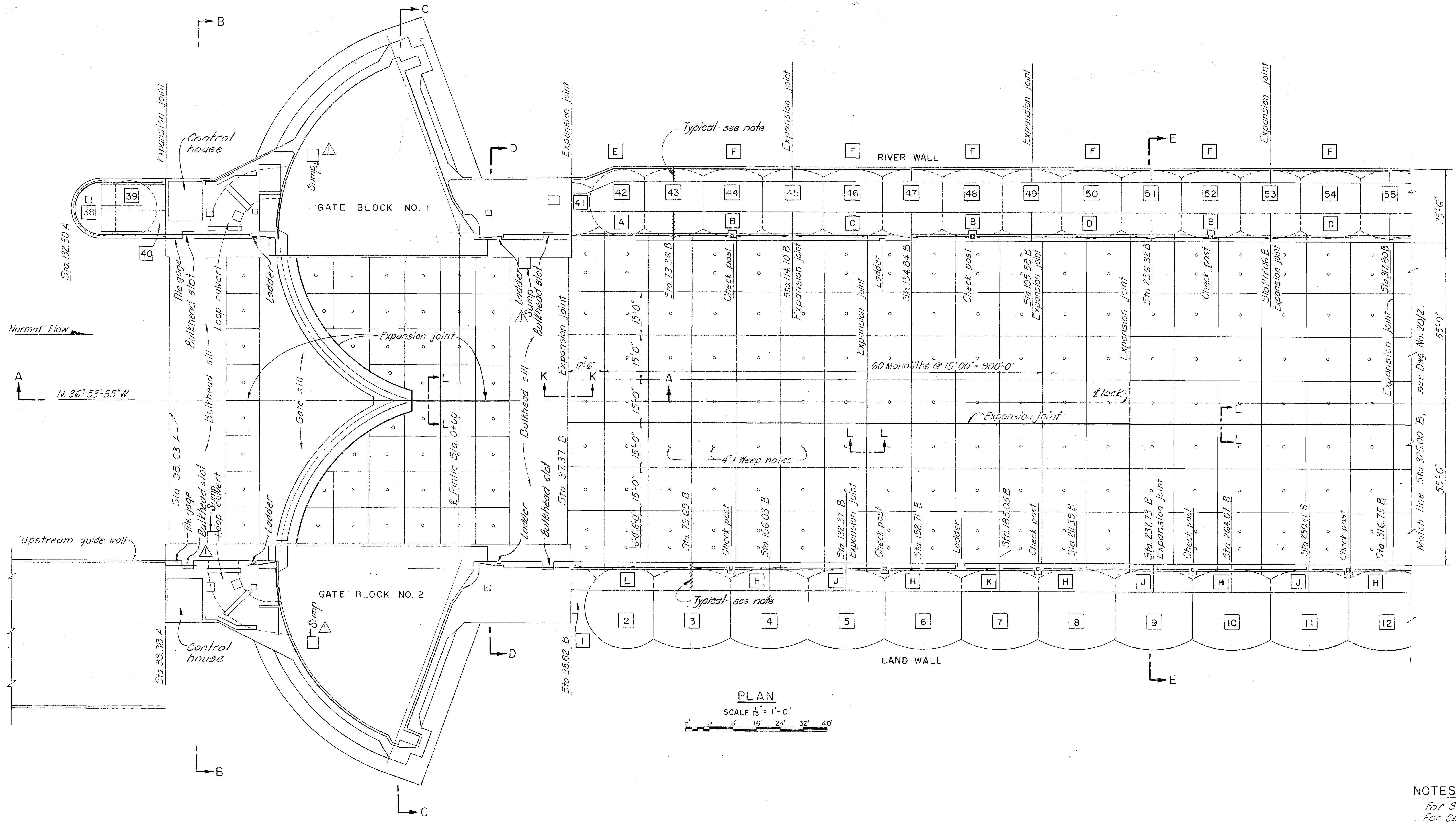
CALUMET-SAG NAVIGATION PROJECT
CALUMET RIVER
LOCK & CONTROLLING WORKS
PILING LAYOUT
GENERAL PLAN

DATE: 15 NOV. 1957
SCALE: AS SHOWN
CIVENG-II-032-58-7
FILE NO. 9-LI-3/3
SHEET 17

TJ600019.TIF
20/5.1

8/6 Added bearing pile designation

PLATE 2



PLAN
SCALE 1/16" = 1'-0"

GENERAL NOTES:

Numbers in squares designate steel sheet pile cells. For details see Dwgs. Nos. 20/5 thru 20/9.

Letters in squares designate type of concrete walkway, monoliths and handrail, see Dwgs. Nos. 20/29 and 20/30.

All exposed concrete edges shall have a 3/4" chamfer unless otherwise shown.

Construction joints are shown thus (C.J.). Construction joints shown on the drawings are mandatory.

All elevations are referenced to Chicago City Datum. Zero for Chicago City Datum = 579.88 M.T.N.Y., 1935.

Numbers in hexagons designate item numbers under which payment will be made.

Welding symbols conform to "Joint Army-Navy Standard for Welding Symbols", (JAN-STD-19, 13 Nov. 1947.)

All reference to catalog numbers or trade names are for descriptive purpose only.

Stations upstream and downstream of the upper sector gate pintle denoted by "A" and "B" respectively.

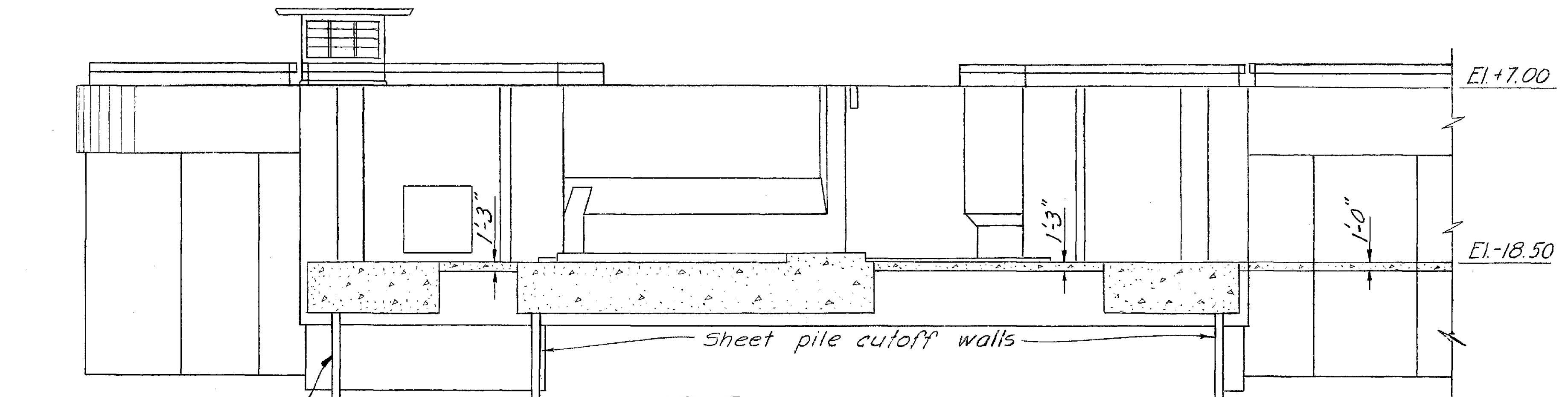
Unless otherwise noted, all vertical joints in concrete cap walls shown on Dwgs. Nos. 20/1 thru 20/4 are monolith joints. For joint details see Dwg. No. 20/23.

⬡ Indicates payment item number.

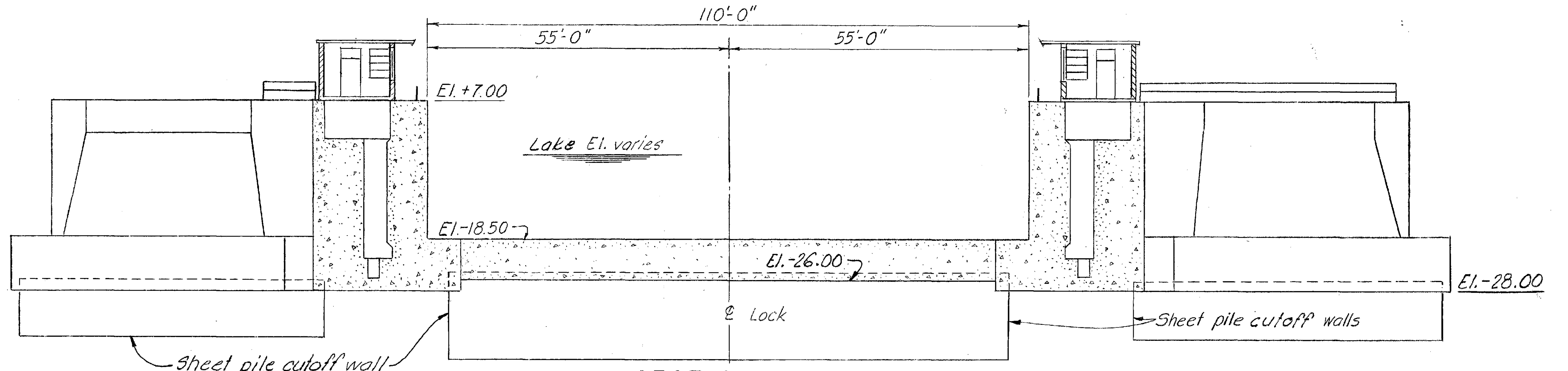
NOTES:

For Section C-C, see Dwg. No. 20/3.
For Section E-E, see Dwg. No. 20/2.
For Section K-K and L-L, see Dwg. No 20/23.

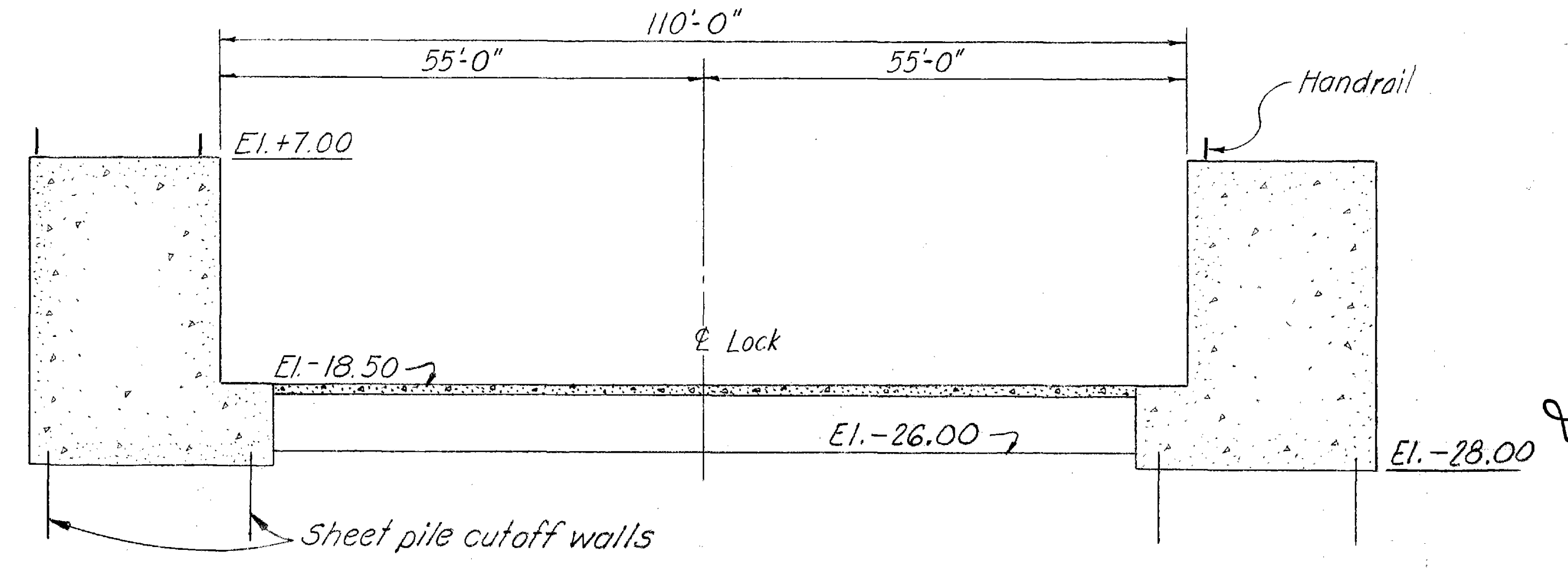
Note: Concrete caps on land and river walls poured from expansion joint to expansion joint. No construction joints.



SECTION A-A



SECTION B-B



SECTION D-D

REVISION	DATE	DESCRIPTION	BY
1	9 Mar. 59	Added sumps in bulkhead sills and gate blocks 1 & 2	L. D.

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
BUFFALO DISTRICT
BUFFALO, NEW YORK

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
CHICAGO DISTRICT
CHICAGO, ILLINOIS

DRAWN BY: R.S.C.
CHECKED BY: F.A.D.
SUBMITTED BY: G. J. Brown
CHIEF, DESIGN BR., BUFFALO DISTRICT
APPROVAL RECOMMENDED:
CHIEF, ENG. DIV., BUFFALO DISTRICT
APPROVAL RECOMMENDED:
COL., C. E. DIST. ENGR., BUFFALO DIST.
APPROVED: E. Hoffmann
CHIEF, DESIGN BRANCH
APPROVED:
ASS'T. CHIEF, ENG. DIV.
APPROVED: R. W. Wightman
For CHIEF, ENGINEERING DIVISION

CALUMET-SAG NAVIGATION PROJECT
CALUMET RIVER
LOCK & CONTROLLING WORKS
LOCK GENERAL PLAN & SECTIONS
UPSTREAM END

DATE: 15 NOV. 1957
SCALE: 1/16" = 1'-0"
CIVENG - 11 - 032 - 58 - 7
FILE NO. 9-LI-3 / 3
SHEET 13

TJ600015.TIF

20/1.1

8/6 Extended joints to sheet pile cells.
10/22 - Added expansion joints and changed location of light foundations.

PLATE 3

No.	Revision	Date	Initial
R1	Elevationsill, Upper Gate, corrected	2-7-30	

Contract No. 5

STATE OF ILLINOIS
DEPARTMENT OF PURCHASES AND CONSTRUCTION
DIVISION OF WATERWAYS
THE ILLINOIS WATERWAY

BRANDON ROAD LOCK & DAM
GENERAL DRAWING

SUBMITTED: June 23-1925
Walter M. Smith
CHIEF DESIGNING ENGINEER

RECOMMENDED: Sep. 2-1927
Wm. F. Mulvihill
SUPERVISOR ILLINOIS WATERWAY CONSTRUCTION

APPROVED: June 23-1925
M. Barnes
CHIEF ENGINEER

ADOPTED: Sept. 27, 1927
Leslie Small
DIRECTOR

⑤

Drawn W.M.S.Jr. 11-3-21
Traced C.R.H. 11-21-21
Checked W.M.S. 6-23-25

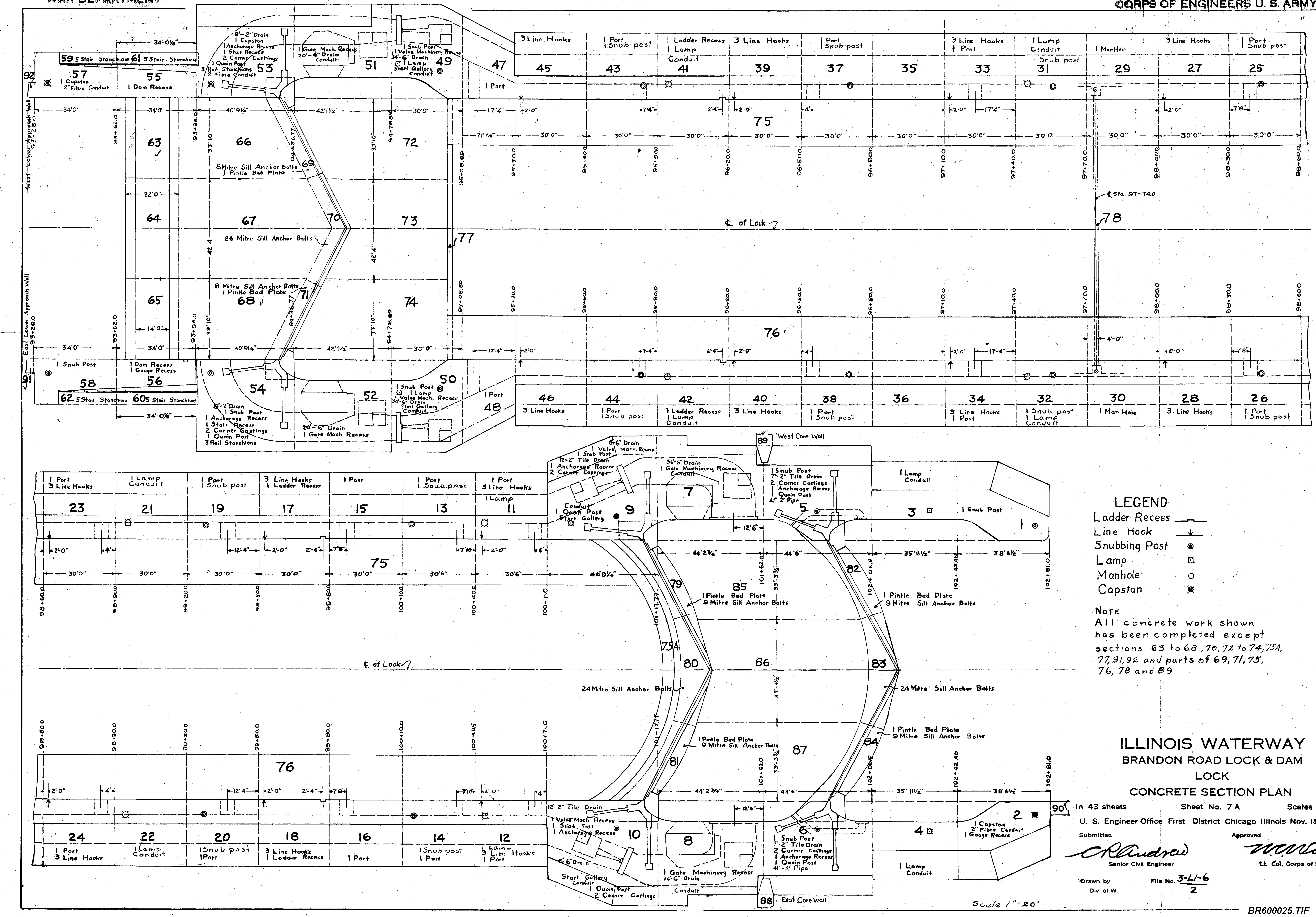
BR600171.TIF

3-21-6/17.1

PLATE 4

WAR DEPARTMENT

CORPS OF ENGINEERS U. S. ARMY



LEGEND

Ladder Recess	⌐¬
Line Hook	↓
Snubbing Post	◉
Lamp	⌑
Manhole	○
Capstan	✱

NOTE
All concrete work shown has been completed except sections 63 to 68, 70, 72 to 74, 75A, 77, 91, 92 and parts of 69, 71, 75, 76, 78 and 89

ILLINOIS WATERWAY
BRANDON ROAD LOCK & DAM
LOCK
CONCRETE SECTION PLAN

In 43 sheets Sheet No. 7 A Scales as shown

U. S. Engineer Office First District Chicago Illinois Nov. 15, 1930

Submitted
C R Andrews
Senior Civil Engineer

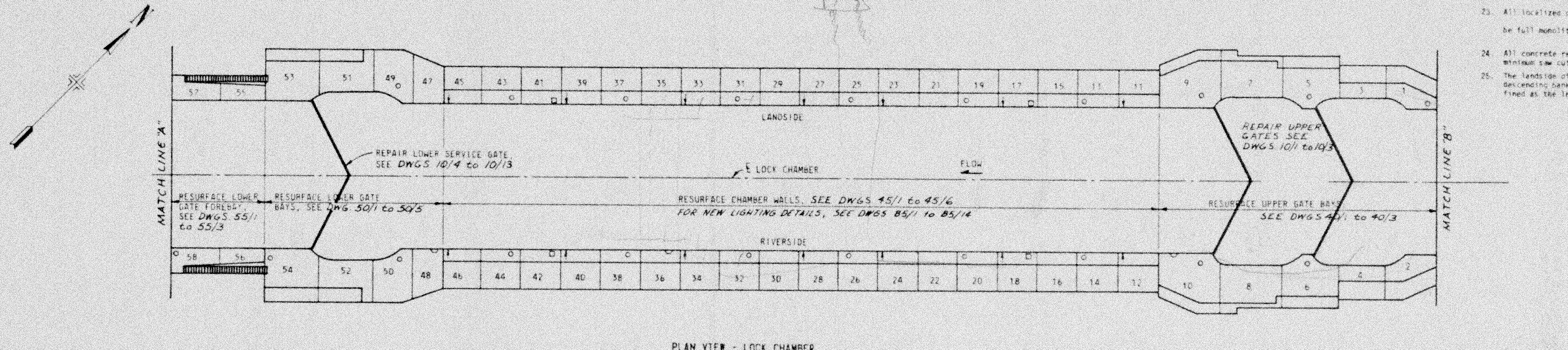
Approved
W. M. Wilcke
Lt. Col. Corps of Engineers

Drawn by
Div of W.

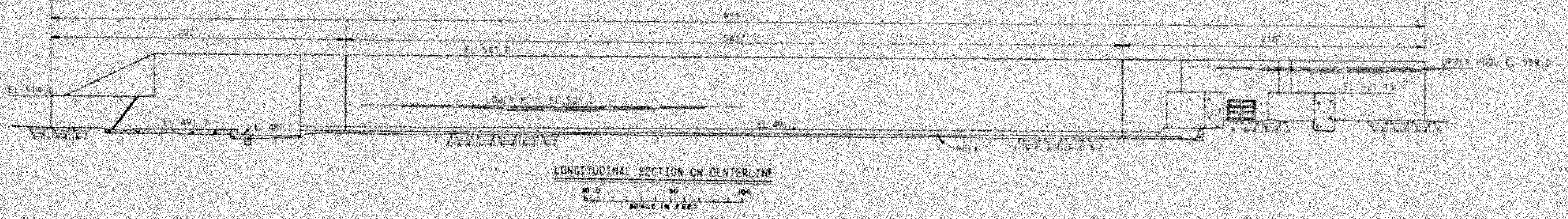
File No. 3-L-6
2

BR600025.TIF

PLATE 5



PLAN VIEW - LOCK CHAMBER



LONGITUDINAL SECTION ON CENTERLINE

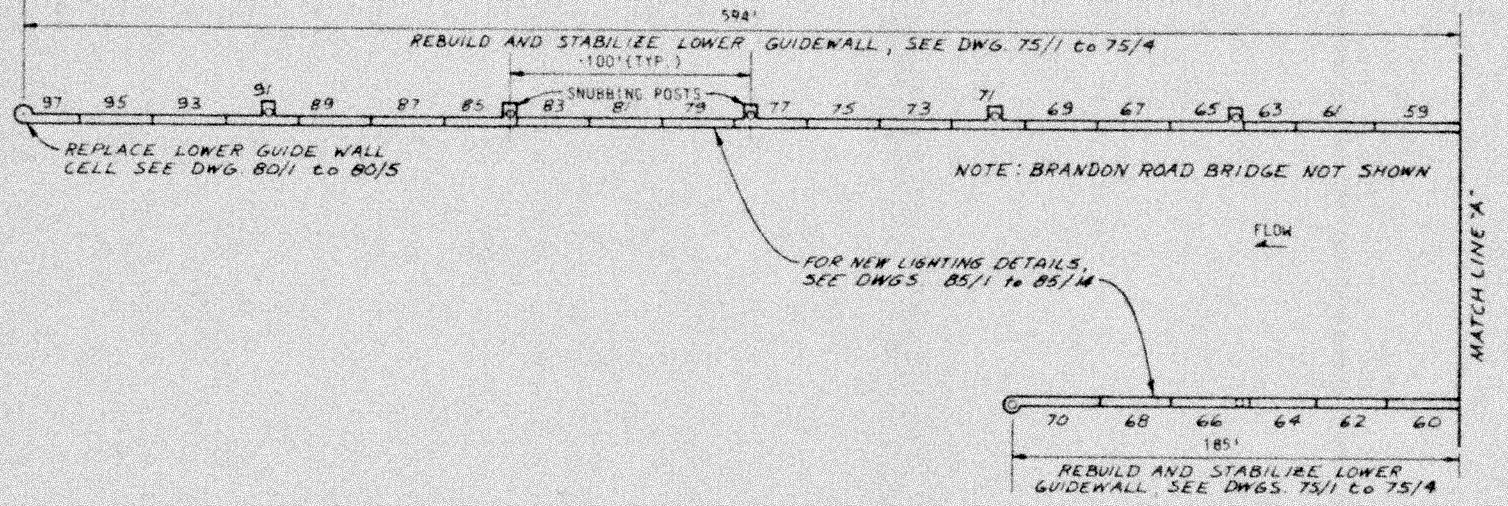
LEGEND (EXISTING)

○ CHECK POST

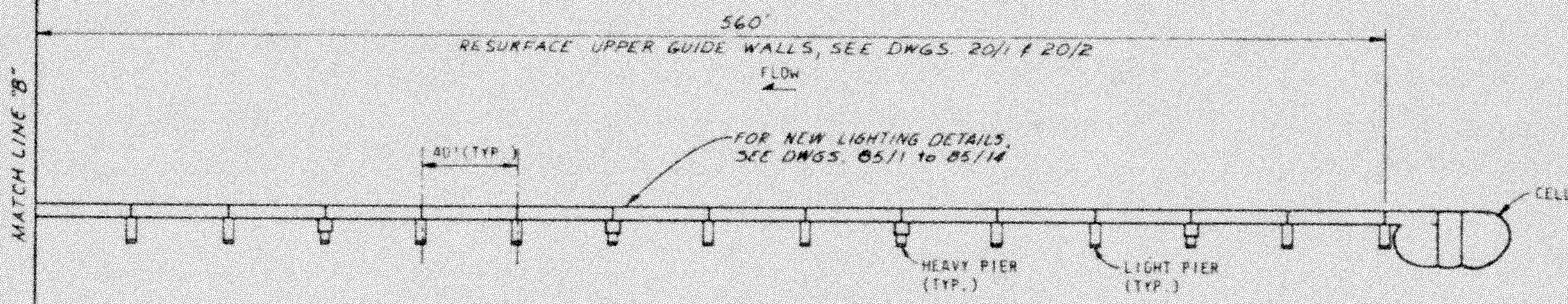
⊤ LINE HOOKS

□ LADDER RECESS

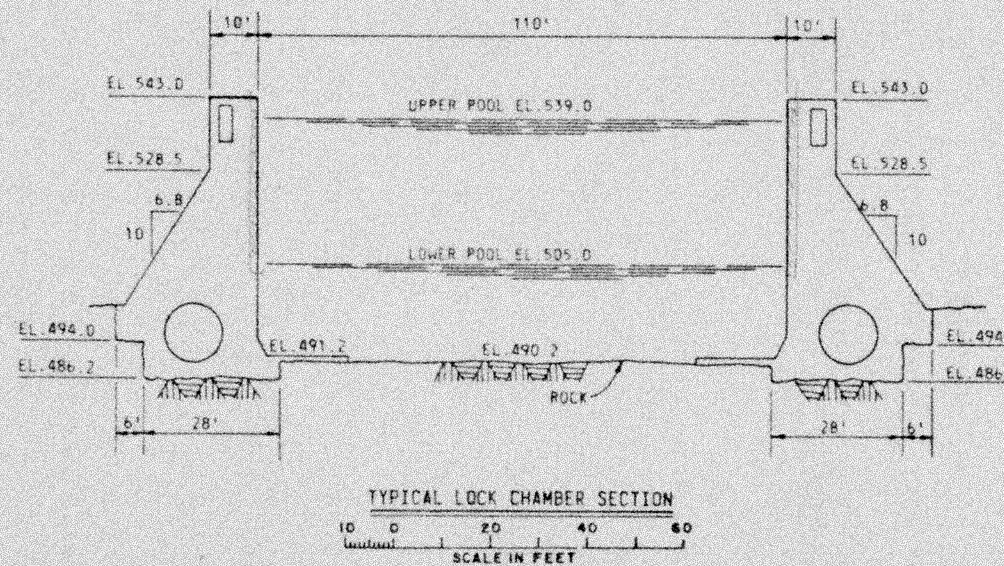
▽ FLOATING MOORING BITT RECESS



PLAN - LOWER GUIDE WALL



PLAN - UPPER GUIDE WALL



TYPICAL LOCK CHAMBER SECTION

General Notes:

1. All elevations on these drawings are USGS 4th General Adjustment (1912)
2. The Brandon Road Lock and Lockport Lock shall be closed down to navigation traffic from 5 July 1984 to 8 Sept. 1984. All work requiring dewatering of the lock shall be done at this time. See specifications for details on lock closure.
3. The Government will supply the bulkheads required for dewatering the lock. The contractor will be required to install the lower bulkheads. The upper guard gates will be used to seal off the upper end of the lock. The contractor shall also be responsible for dewatering the lock and maintaining a dry lock chamber. See Spec's.
4. The control houses and miscellaneous lock features are not shown on the General Plan.
5. All elevations and dimensions shall be verified in the field before work begins.
6. See drawing 0/2 for Spoil Area location.
7. Reference drawings are drawings of record and are included solely for the contractors benefit. No work under this contract is shown on the reference drawings. The drawings are not As-Builts and do not necessarily represent actual field conditions.
8. All fillet welds shall be 5/16" unless otherwise shown or noted.
9. Unless otherwise shown or specified all welding shall conform to the American Welding Society, AWS 1.1-83, the Structural Welding Code - Steel Electrode shall be E70XX: Low Hydrogen.
10. Welding symbols conform to the standard welding symbols of the American Welding Society.
11. All groove welds shall be full penetration.
12. All structural steel shall be ASTM designation A36 unless otherwise shown or noted.
13. All 90° #6 bent bars shall be bent prior to installation. Cold bending in the field after installation will not be permitted.
14. Security fencing and handrails may be removed in work areas during construction as long as safety is maintained and replacement made to its original location and condition, or as directed by Contracting Officer.
15. All concrete is type C unless otherwise designated.
16. Weight of Government furnished bulkheads: Pickup Strongback = 13 tons, Section of Bulkhead = 30 tons.
17. Approximate weight of: Lower Miter Gates = 290 tons per leaf; Upper service Gates = 90 tons per leaf; Upper Guard Gates = 90 tons per leaf.
18. Government owned utilities will not be made available to the contractor.
19. Concrete anchors and reinforcing steel shall be field adjusted to clear wall and corner armor.
20. Existing armor within the limits of concrete replacement shall be removed unless otherwise noted. Armor outside the concrete removal limits shall remain in place.
21. Cofferdams as required for the removal and replacement of concrete at the upper and lower guidewalls shall be designed by the contractor and submitted for approval to the contracting officer. Concrete forms will not be used as cofferdams.
22. Removal of lock operating equipment prior to lock shutdown requires approval from the contracting officer.

General Notes Continued

23. All localized cofferdams for upper and lower guidewalls shall be full monolith widths.
24. All concrete removal shall be preceeded by a 3-inch minimum saw cut unless otherwise specified.
25. The landside of the lock is defined as the right descending bank. The riverside of the lock is defined as the left descending bank.

Revisions

Symbol	Descriptions	Date	Approved
1	Amd #1 - Added Notes 24, 25 Minor Revisions	11 Jan 84	

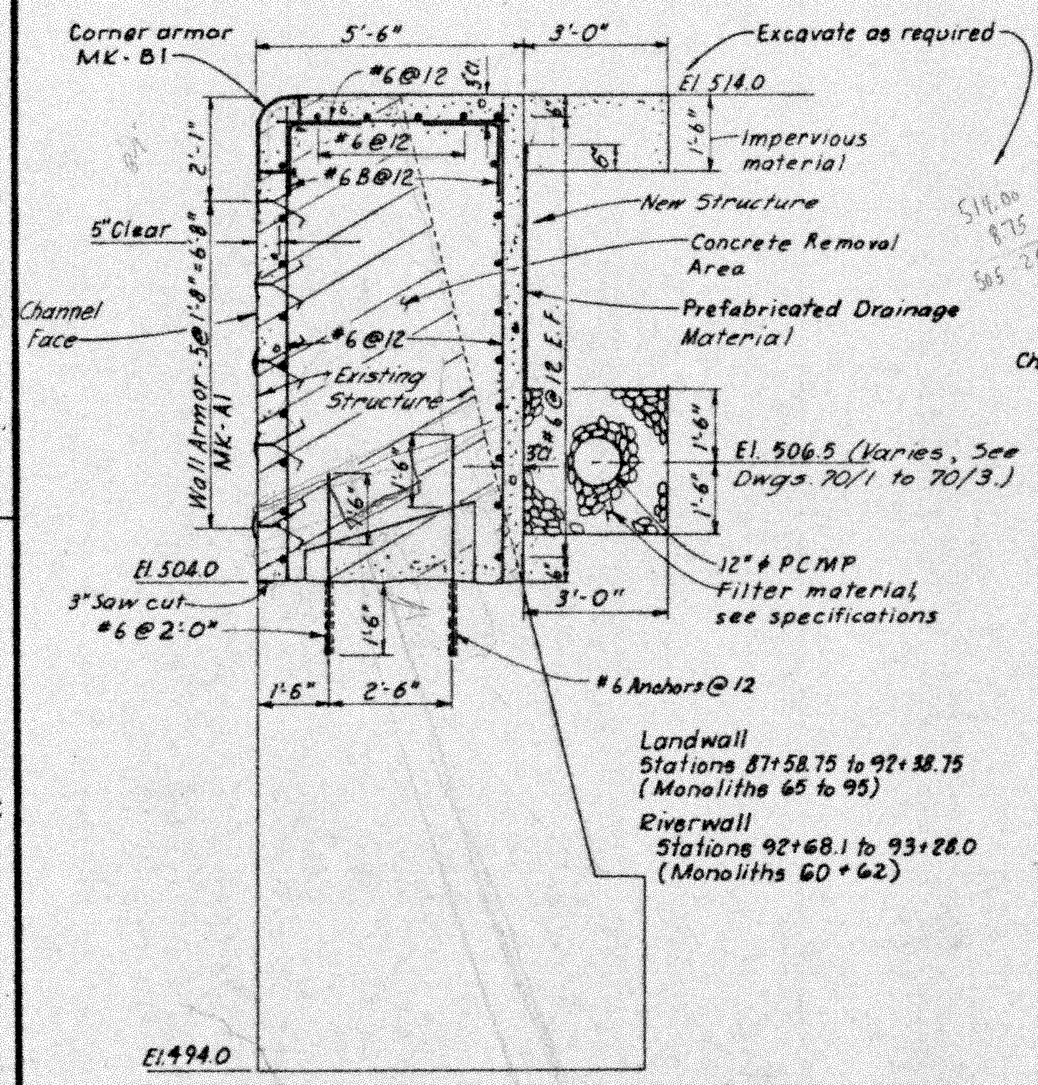
U. S. ARMY ENGINEER DISTRICT, ROCK ISLAND
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

US Army Corps of Engineers

ILLINOIS WATERWAY
BRANDON ROAD LOCK & DAM
LOCK REHABILITATION
STAGE I

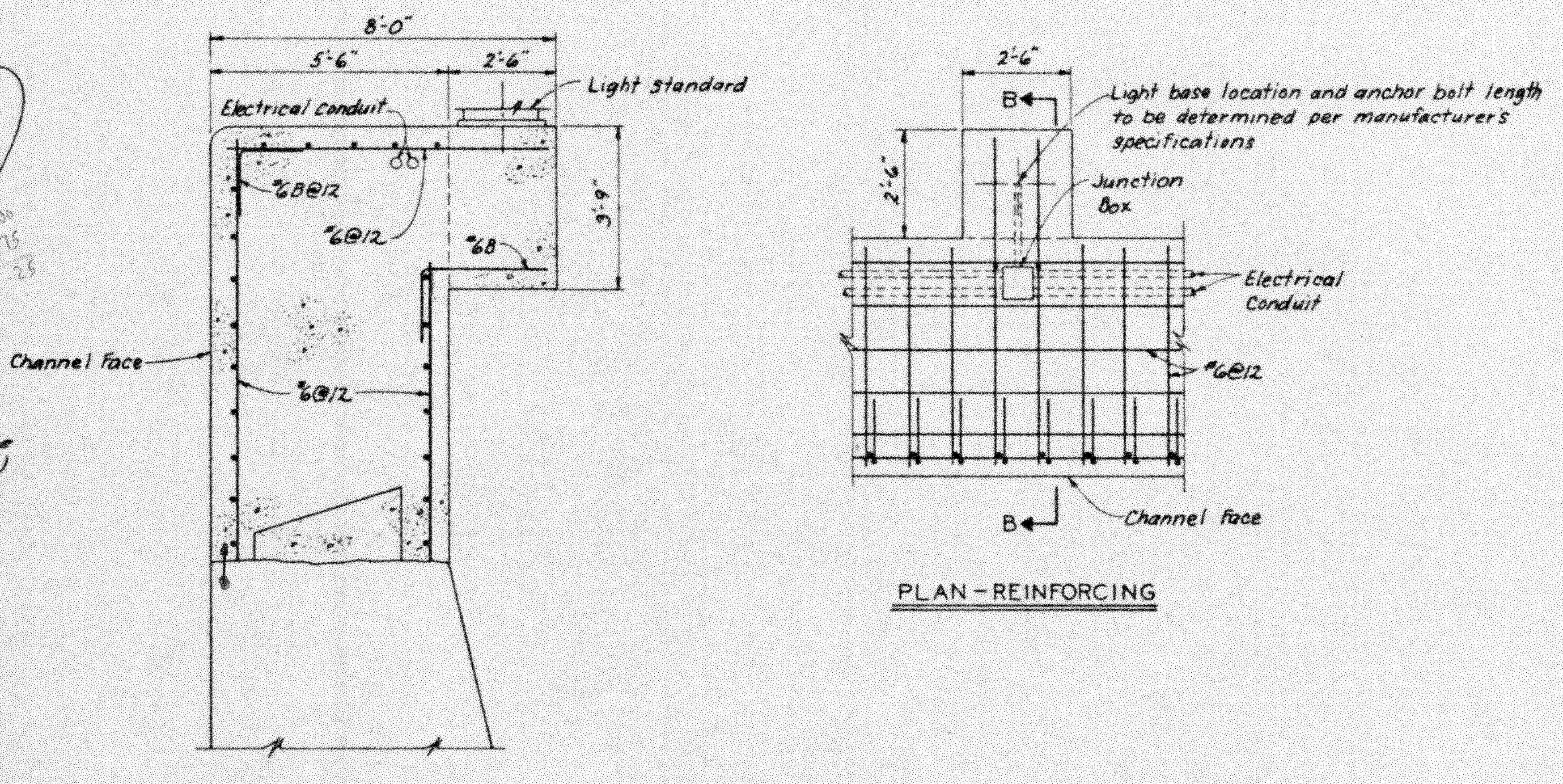
GENERAL PLAN

Designed by: D.A.L.
Drawn by: J.Q.
Checked by: AEL
Submitted by: CHIEF DESIGN BRANCH
Approved by: P.E. CHIEF ENGINEERING DIVISION
Scale: SCALE AS SHOWN
Date: 5 DEC 83
INVITATION NO. DACW25-84-B-0007
Drawing number: 3-LI-6 87 0/3
Sheet 3 of



TYPICAL WALL SECTION

1/2"=1'-0" 0 2 4 6 SCALE



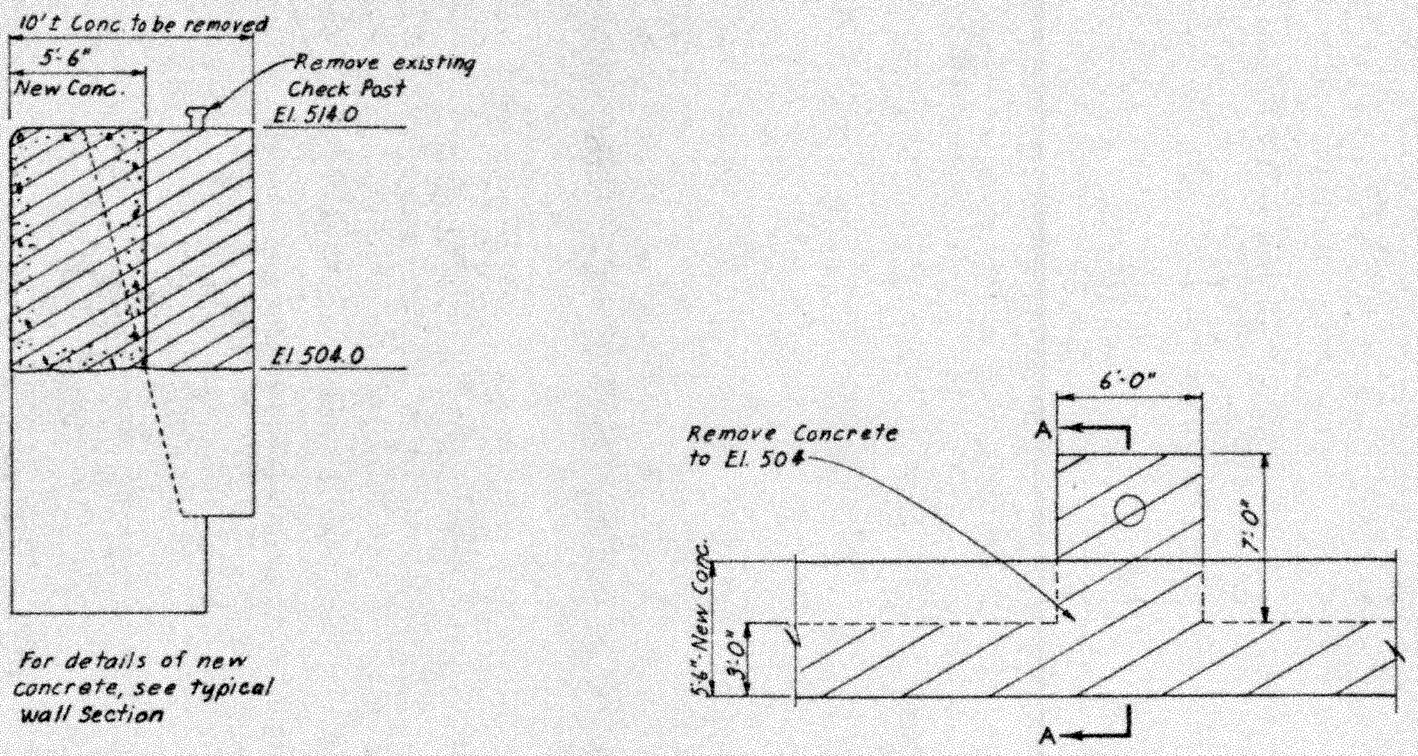
PLAN-REINFORCING

SECTION B-B

NEW LIGHT POLE BASE

Monoliths 60, 62, 65 to 95

1/2"=1'-0" 0 2 4 6 SCALE



SECTION A-A

PLAN

TYPICAL-EXISTING CHECK POST PIER AND LIGHT STANDARD

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

References:
1. For new check post details, See Dwg. 90/5
2. For armor details, See Dwg. 90/1 to 90/6
3. For electrical details, see Dwg. 85/1 to 85/14

Revisions

Symbol	Descriptions	Date	Approved
1	Amd. #1- Revised References	11 Jan 84	

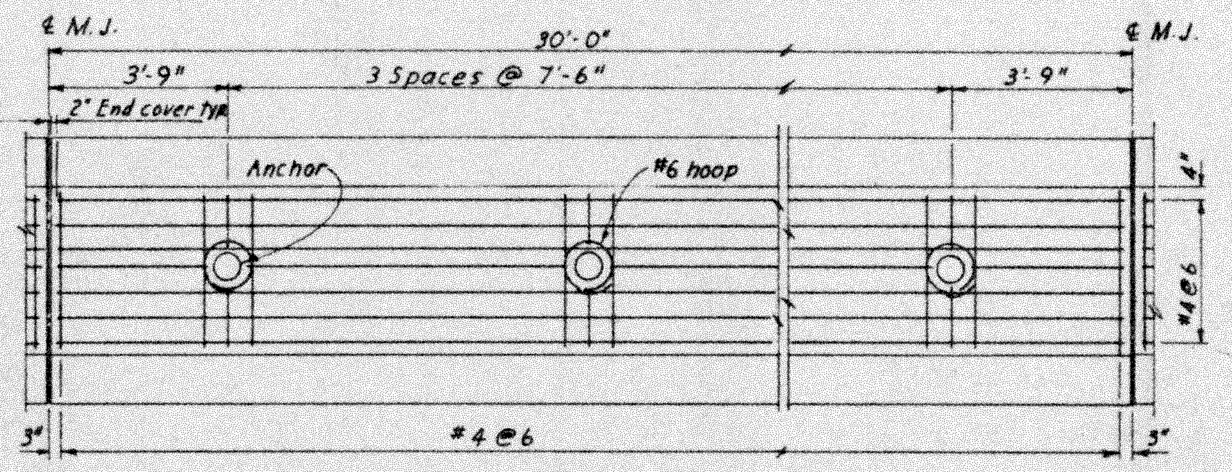
U. S. ARMY ENGINEER DISTRICT, ROCK ISLAND
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by:
Drawn by: J.R.K. g.w.c.
Checked by: DLL
Submitted by: CHIEF DESIGN BRANCH
Approved by: CHIEF ENGINEERING DIVISION

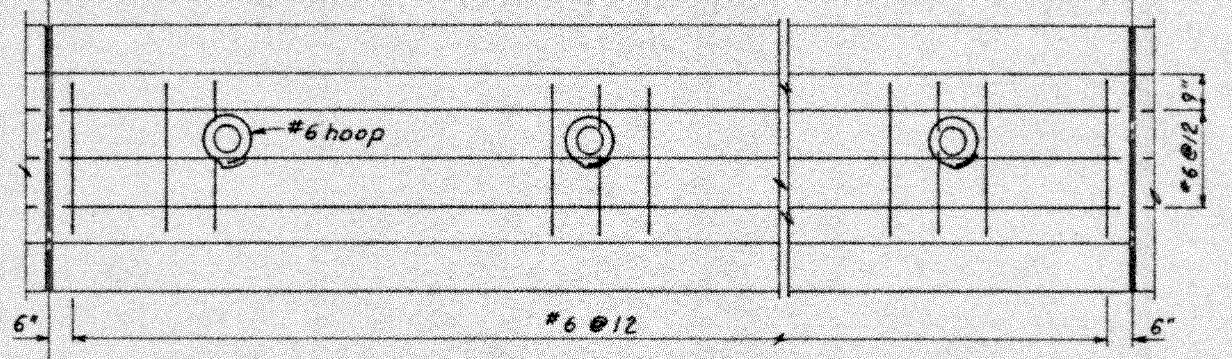
US Army Corps of Engineers

ILLINOIS WATERWAY
BRANDON ROAD LOCK & DAM
LOCK REHABILITATION
STAGE I
LOWER GUIDE WALLS
MASONRY & REINFORCING DETAILS

Scale: AS SHOWN
Date: 5 DEC 83
INVITATION NO. DACW25-84-B-0007
Drawing number: 3-LI-6 87 75/1
Sheet _49_ of _



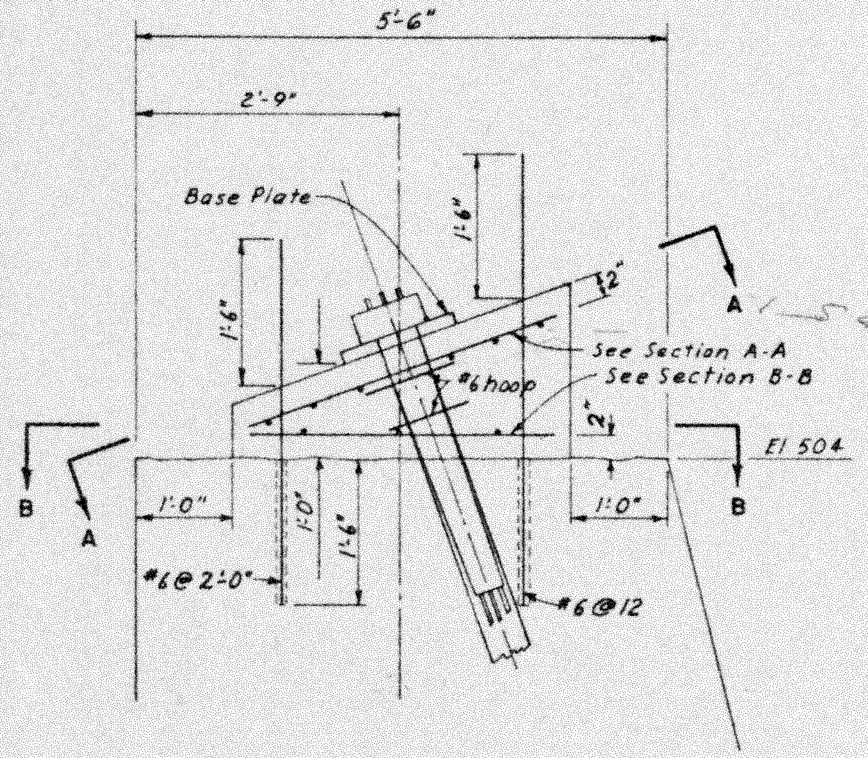
SECTION A-A – TOP STEEL



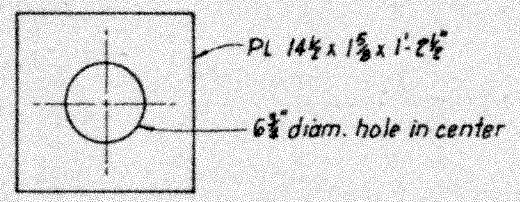
Note: Min. end cover 2" all bars, top & bottom.
Field cut bars as required to clear anchors.

SECTION B-B – BOTTOM STEEL

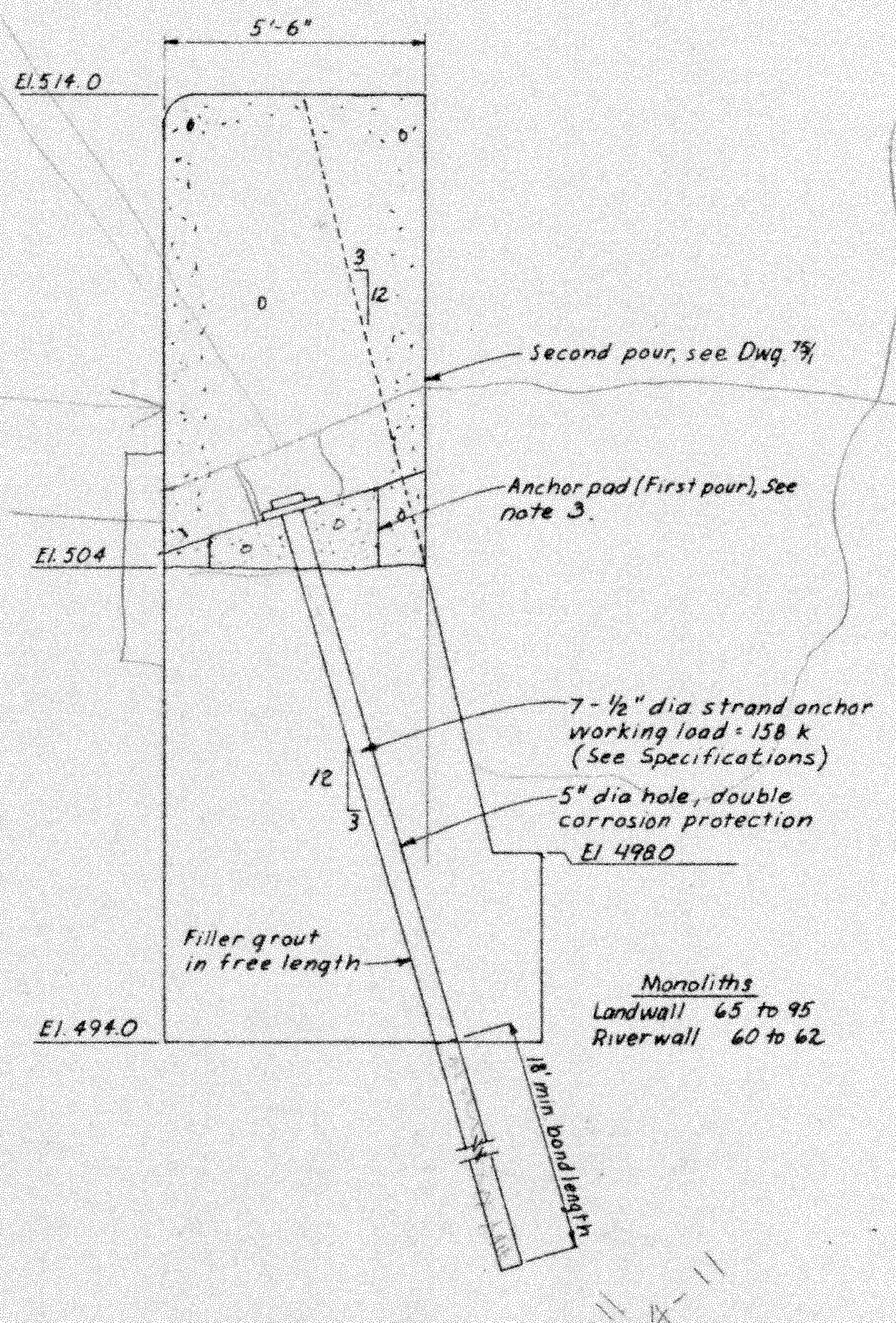
ANCHOR PAD REINFORCING



ANCHOR PAD DETAIL



BASE PLATE



ROCK ANCHOR

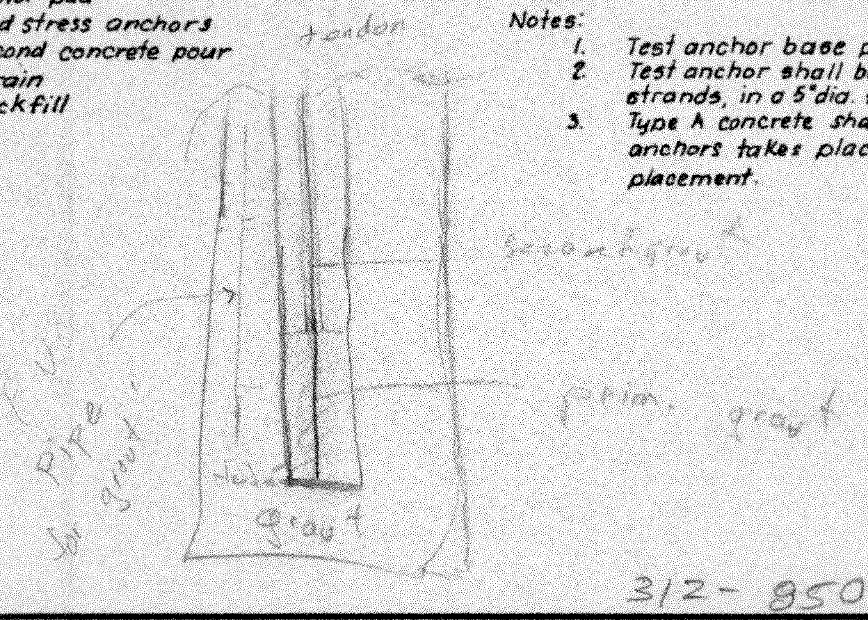
all 65 4-11
4½%
3%

F.S. 71

Suggested Construction Sequence
1. Remove concrete as shown
2. Drill anchor holes
3. Pour anchor pad
4. Place and stress anchors
5. Make second concrete pour
6. Place drain
7. Place backfill

References:
1. For anchor & test anchor locations. See Dwgs. 70/1 to 70/3.

Notes:
1. Test anchor base plates shall be 16½ x 2 x 1'-4½".
2. Test anchor shall be loaded to 316k, with 10-½" 7 wire strands, in a 5" dia. single corrosion resistant hole.
3. Type A concrete shall be used if stressing of the strand anchors takes place less than 28 days from initial placement.



Ralph Reetz
stressTeck
312-850-9333

Symbol	Descriptions	Date	Approved
1	Amd. #1 - Minor Revision	11 Jan 84	

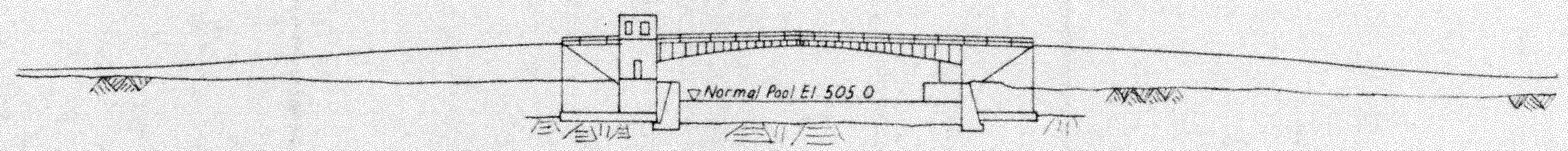
U. S. ARMY ENGINEER DISTRICT, ROCK ISLAND
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: JKJ
Drawn by: J.R.K.
Checked by: DCL

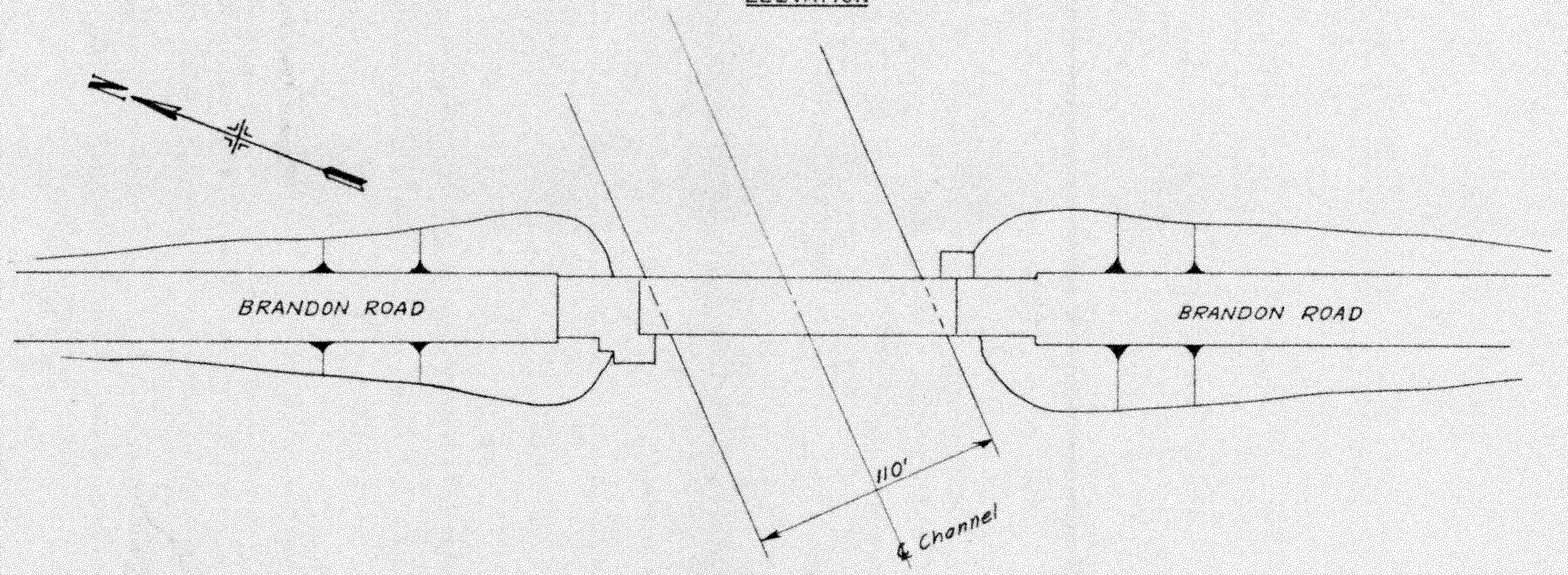
ILLINOIS WATERWAY
BRANDON ROAD LOCK & DAM
LOCK REHABILITATION
STAGE I

ROCK ANCHOR DETAILS

Submitted by: CHIEF DESIGN BRANCH
Approved by: PE CHIEF ENGINEERING DIVISION
Scale: AS SHOWN
Date: 5 DEC. 83
Drawing number: 3-LI-6 87 75/2
INVITATION NO. DACW25-84-B-0007
Sheet -50- of -



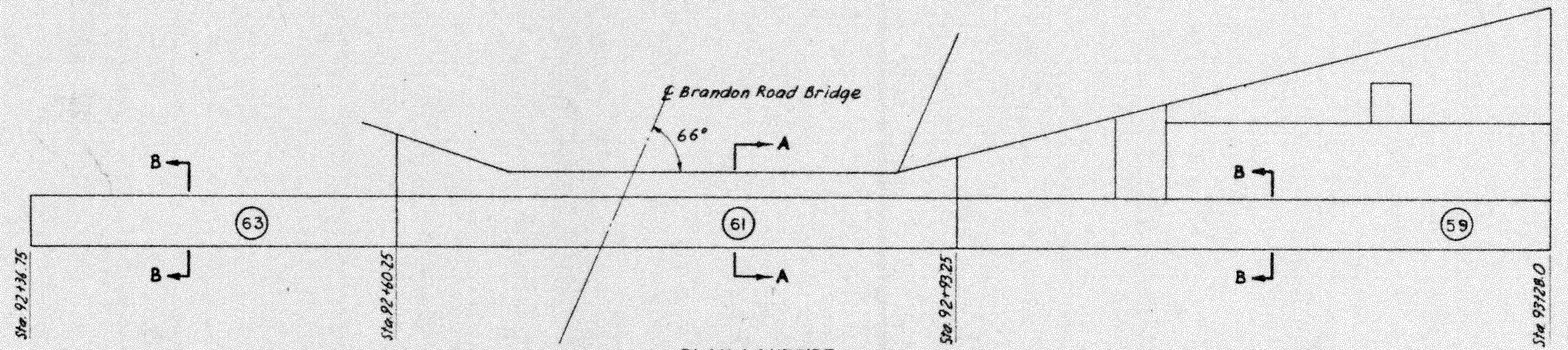
ELEVATION



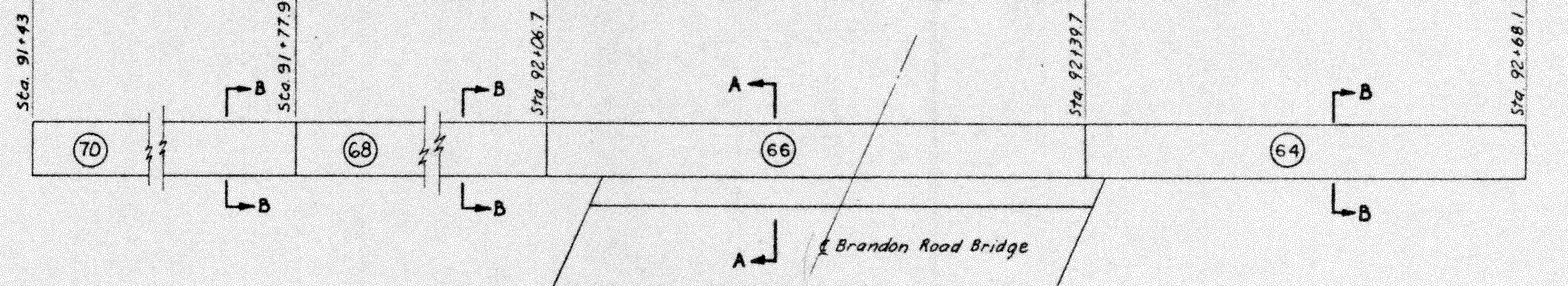
PLAN

BRANDON ROAD BRIDGE

NO SCALE



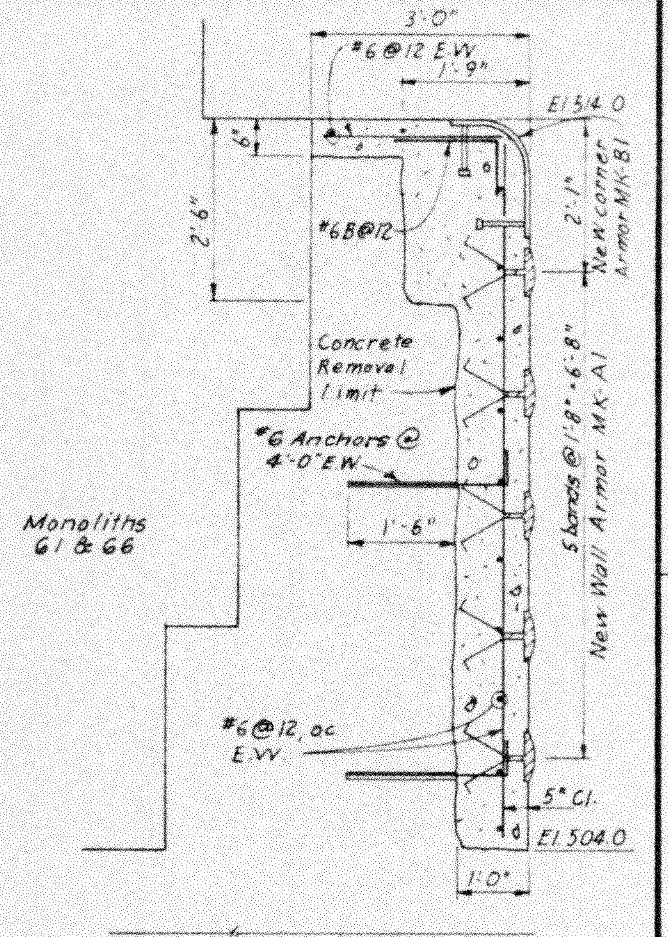
PLAN-LANDSIDE



PLAN-RIVERSIDE

LOWER GUIDEWALL

0' 4' 8' 12'
SCALE



SECTION A-A

0' 1' 2 3' 4
SCALE

Notes:
1. No blasting will be allowed for concrete removal on Monoliths 59-63 (odd) & 64-70 (even).
2. Vertical clearance of Power Lines downstream of Brandon Road bridge is 66.4 feet above normal pool.

References:
1. For Section B-B, see Dwg. 75/4.

Revisions			
Symbol	Descriptions	Date	Approved
1	Amd #1 - Minor Revision	11 Jan 84	

U. S. ARMY ENGINEER DISTRICT, ROCK ISLAND
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

US Army Corps of Engineers

ILLINOIS WATERWAY
BRANDON ROAD LOCK & DAM
LOCK REHABILITATION
STAGE I
LOWER GUIDEWALL
DETAILS AT BRANDON ROAD BRIDGE I

Designed by: TAJ
Drawn by: J.R.K.
Checked by: DCL
Submitted by: CHIEF DESIGN BRANCH
Approved by: CHIEF ENGINEERING DIVISION
Scale: As Shown
Date: 5 DEC 83
Drawing number: 3-LI-6 87 75/3
INVITATION NO DACW25-84-B-0007
Sheet 51 of

ENCLOSURE B

SLUICE GATE BACKGROUND INFORMATION

US Army Corps of Engineers Chicago District	PROJECT TITLE: GLMRIS - TECH ACT	COMPUTED BY:	DATE: 7/24/13	SHEET: 1 of 6
	STRUCTURE TITLE: SLUICE GATES	CHECKED BY:	DATE:	CONTRACT NO:

PURPOSE

THIS CALCULATION DETERMINES SLUICE GATE REQUIREMENTS AT CHICAGO LOCK, OBRIEN LOCK, & WILLMETTE PUMPING STATION BASED ON TS-D-HH REQUIREMENTS FOR SCREENED GATES (SEE ATTACHMENT 1). THESE CALCULATIONS ARE CONCEPT LEVEL ONLY, INTENDED TO PROVIDE BASIS FOR COST ESTIMATES.

AS INDICATED IN ATT. 1, SCREENING OF GATES WITH .4" SCREENS WILL REQUIRE 2.2x THE NUMBER OF EXISTING GATES.

ASSUMPTIONS

1. BACKFLOW EVENTS THRU THE LOCKS WILL STILL OCCUR DUE TO PRESENCE OF THE ELECTRIC BARRIERS AT OBRIEN AND CHICAGO LOCK.
2. PROVIDE 2.2 x NUMBER OF EXISTING GATES, i.e. 2.2 TIMES EXISTING CROSS SECTIONAL AREA TO ACCOUNT FOR .4" SCREENS.
3. USE 10'x15' GATES @ CHICAGO LOCK & OBRIEN LOCK
USE 9'x16'-8" GATES @ WILMETTE P.S.

ATTACHMENTS

1. TS-D-HH EMAIL/MEMO DATED 4/3/13
"GLMRIS - SCREENS FOR CONTROLLING WORKS GATES & LOCKS"

US Army Corps of Engineers Chicago District	PROJECT TITLE: GLMRIS - TECH ALT.	COMPUTED BY:	DATE: 7/24/13	SHEET: 2 of 6
	STRUCTURE TITLE: CHICAGO LOCK SLUICE GATES	CHECKED BY:	DATE:	CONTRACT NO:

DETERMINE NUMBER OF NEW GATES @ CHICAGO LOCK

USE 10'×15' GATES

THERE ARE 8 - 10'×10' SLUICE GATES EXISTING,
4 @ NORTH BASIN WALL AND 4 @ NORTH BREAKWATER

$$A_{EXIST} = 100 \frac{\text{sq ft}}{\text{gate}} \times 8 = 800 \text{ FT}^2$$

W/ .4" SCREENS PROVIDE 2.2 TIMES AREA (ATT 1)

$$A_{NEW} = 800 \text{ FT}^2 \times 2.2 = 1760 \text{ FT}^2$$

$$\text{\# GATES REQ'D} = \frac{1760 \text{ FT}^2}{(10 \times 15)} \Rightarrow 11.7$$

∴ PROVIDE 12 - 10'×15' GATES

US Army Corps of Engineers Chicago District	PROJECT TITLE: GLMRIS - TECH ACT	COMPUTED BY:	DATE: 7/24/13	SHEET: 3 of 6
	STRUCTURE TITLE: CHICAGO LOCK SLUICE GATES	CHECKED BY:	DATE:	CONTRACT NO:

DETEMINE LENGTH OF STRUCTURE REQUIRED

EXISTING CONTROLLING WORKS STRUCTURE HAS FOUR 10' WIDE GATES AND IS 60' LONG.

NEED 12 GATES $\therefore$ NEED $\frac{12 \text{ GATES}}{4 \text{ GATES}}\left(60'\right) = 180'$

THE EXISTING NORTA BASIN WALL IS 216' LONG.

$\therefore$ ASSUME ENTIRE NORTH BASIN WALL WILL BE REPLACED WITH A NEW CONTROLLING WORKS STRUCTURE.

CURRENT WIDTH OF WALL IS 40'. THIS WALL MAY REQUIRE WIDENING TO ACCOMODATE SCREEN STRUCTURE ≈ 60'-80' WIDE.

STRUCTURE WILL LIKELY BE SIMILAR TO EXISTING STRUCTURE i.e. MASS CONCRETE GATE BLOCK OVER PILE'S.

US Army Corps of Engineers Chicago District	PROJECT TITLE: GLMRIS - TECH ALT.	COMPUTED BY:	DATE: 7/24/13	SHEET: 4 of 6
	STRUCTURE TITLE: OBRIEN LOCK SLUICE GATES	CHECKED BY:	DATE:	CONTRACT NO:

DETERMINE NUMBER OF NEW GATES @ OBRIEN LOCK

USE 10'×15' GATES

EXISTING GATES ARE 4 - 10'×10' SLUICE GATES

$$A_{EXIST} = \left(100 \frac{sq\,ft}{gate}\right) \times 4 = 400 \text{ FT}^2$$

W/.4" SCREENS PROVIDE 2.2 TIMES AREA (ATT 1)

$$A_{NEW} = (400 \text{ FT}^2)(22) = 880 \text{ FT}^2$$

$$\# \text{ GATES REQ'D} = \frac{880 \text{ FT}^2}{(10 \times 15)} = 5.86$$

∴ PROVIDE 6 - 10'×15' GATES

US Army Corps of Engineers
Chicago District

PROJECT TITLE: GLMRIS - TECH ALT.
STRUCTURE TITLE: OBRIEN LOCK SLUICE Gates
COMPUTED BY:
DATE: 7/24/13
SHEET: 5 of 6
CHECKED BY:
DATE:
CONTRACT NO:

DETERMINE LENGTH OF NEW CONTROLLING WORKS STRUCTURE

EXISTING STRUCTURE = 60' LONG w/4 10' WIDE GATES

NEED 6 GATES ∴ NEED $\frac{6 \text{ GATES}}{4 \text{ GATES}}(60') = 90'$

ASSUME 100' LONG NEW CONTROLLING WORKS STRUCTURE

WIDTH OF NEW STRUCTURE TO ACCOMODATE SELF CLEANING SCREEN STRUCTURE WILL BE 20' TO 40' WIDER. ASSUME 60'-80' TOTAL WIDTH. STRUCTURE WILL BE SIMILAR TO EXISTING, i.e. MASS CONCRETE OVER PILES.

US Army Corps of Engineers
Chicago District

PROJECT TITLE: GLMRIS - WILMETTE	COMPUTED BY:	DATE: 7/24/13	SHEET: 6 of 6
STRUCTURE TITLE: WILMETTE GATES	CHECKED BY:	DATE:	CONTRACT NO:

DETERMINE NUMBER OF NEW GATES @ WILMETTE

DIVESION CHANNEL HAS THREE EXISTING 8' WIDE × 17.5' TALL ROLLER GATES. ASSUME THESE WILL REMAIN. PUMP STATION SIDE GATES ARE 9'×10.5' AND WILL BE REPLACED W/ LARGER SLUICE GATES.

EXISTING AREA OF Roller Gates = $3 \times 8' \times 17.5' = 420\ FT^2$

PROVIDE 2.2 TIMES = $420\ FT^2 \times 2.2 = 924\ FT^2$ REQ'D

ADDITIONAL TO PROVIDE = $(924 - 420)\ FT^2 = 504\ FT^2$

ASSUME 9' WIDE GATES TO BE ADDED ON NORTH SHORE CHANNEL (PUMP STATION) SIDE.

TRY 4- 9' × 16'-8" SLUICE GATES ON P.S. SIDE

$$AREA = 4(9')(16.7') = 600\ FT^2 > 504\ FT^2$$

---- OK

PROVIDE 4 - 9' × 16'-8" GATES
ON PUMP STATION SIDE

PUMP STATION WILL REQUIRE MODIFICATION TO ACCOMODATE 4 NEW GATES. MODIFY TUNNELS AS REQ'D FOR CONVEYANCE.

Attachment 1

US Army Corps of Engineers Chicago District	PROJECT TITLE: CONTROLLING WORKS	COMPUTED BY:	DATE: 7/24/13	SHEET:	
	STRUCTURE TITLE: SCREEN/GATE REQMT'S	CHECKED BY:	DATE:	CONTRACT NO:	

PER TS-D-HH, THE FOLLOWING ARE THE APPROXIMATION OF GATE REQUIREMENTS WITH ADDITION OF SCREENS:

Per calculations based on information from the University of Illinois 3D model study of the Chicago controlling works gates (10'x10' each) and an assumed bar screen spacing of 0.4 inches, 2.2 times (1013 cfs/470 cfs w/3 ft head) the number of gates are needed to provide the same head loss for the same flow rate.

At Chicago CW:
2.2 x 8 = 18 gates total

At O'Brien CW:
2.2 x 4 = 9 gates total

At Wilmette
2.2* x 3 = 7 gates total (note: assume using the size of the new gates being constructed by MWRD rather than 10' x 10'. *The original study assumed 10'x 10', so 2.2 multiple is the best available data and will be used at this point)

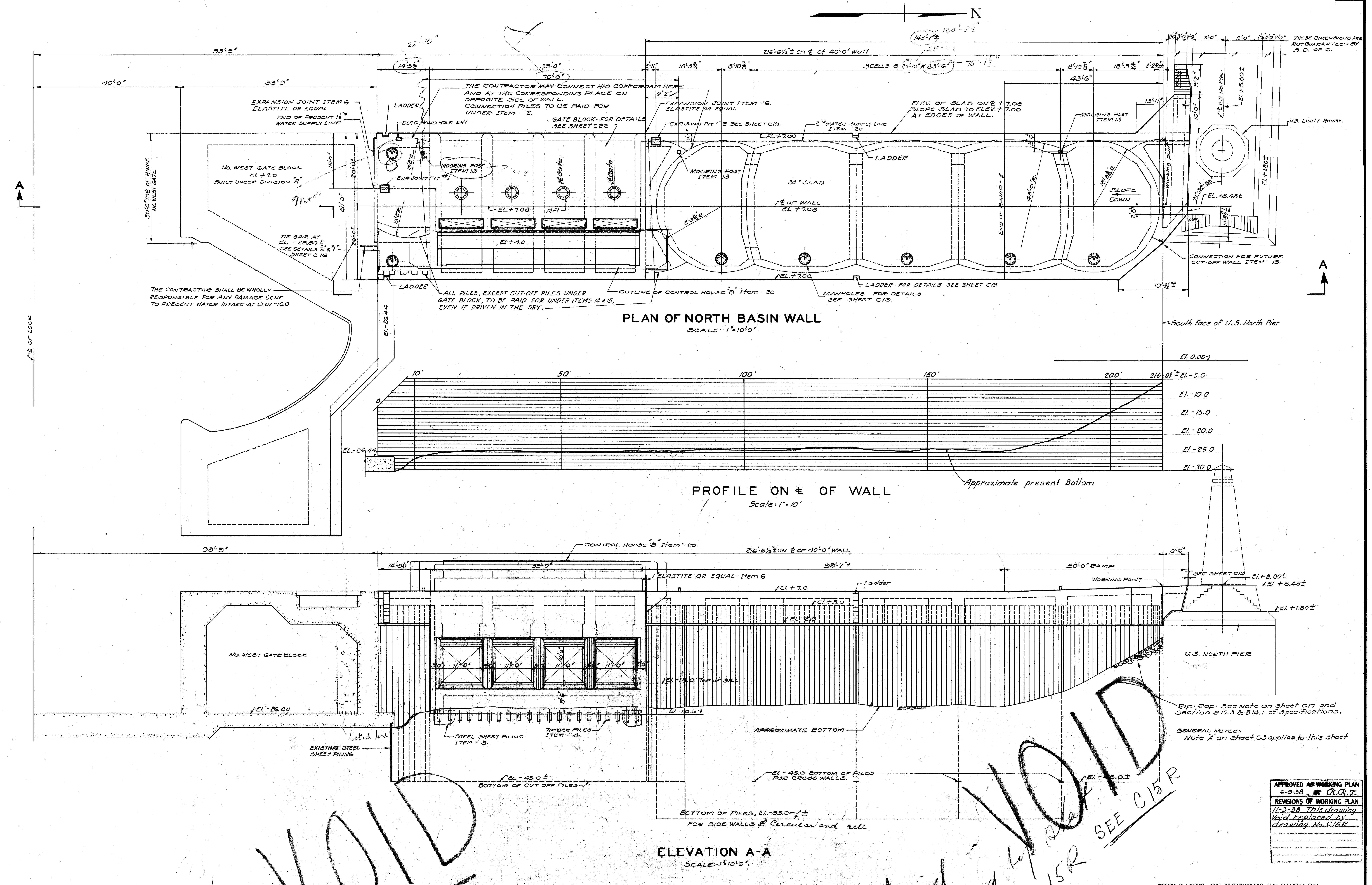
based on the study data the Chicago Lock flow capacity = 26,151 cfs

26,151/470 = 56 - 10'x10' screened gates would be needed to replace the Chicago Lock.

The study did not include the O'Brien Lock, but the 500 yr flow in the baseline condition CAWS model was 19,574 cfs. 19,574/470 = 42 - 10'x10' screened gates would be needed to replace the O'Brien Lock.

If 10' wide by 15' high screens are used in lieu of 10' x 10' gates at Chicago or O'Brien, 2/3rds of the number of gates would be required.

NCC Form 1272-1 08 Mar 00



GENERAL NOTES:
Note "A" on Sheet C3 applies to this sheet.

APPROVED AS WORKING PLAN
6-9-38 BY R.R.L.
REVISIONS OF WORKING PLAN
11-3-38 This drawing Void replaced by drawing No. C15R

Void Replaced by Sheet C15R

THE SANITARY DISTRICT OF CHICAGO
CHICAGO RIVER CONTROLLING WORKS
IN CHICAGO HARBOR
DIVISION B

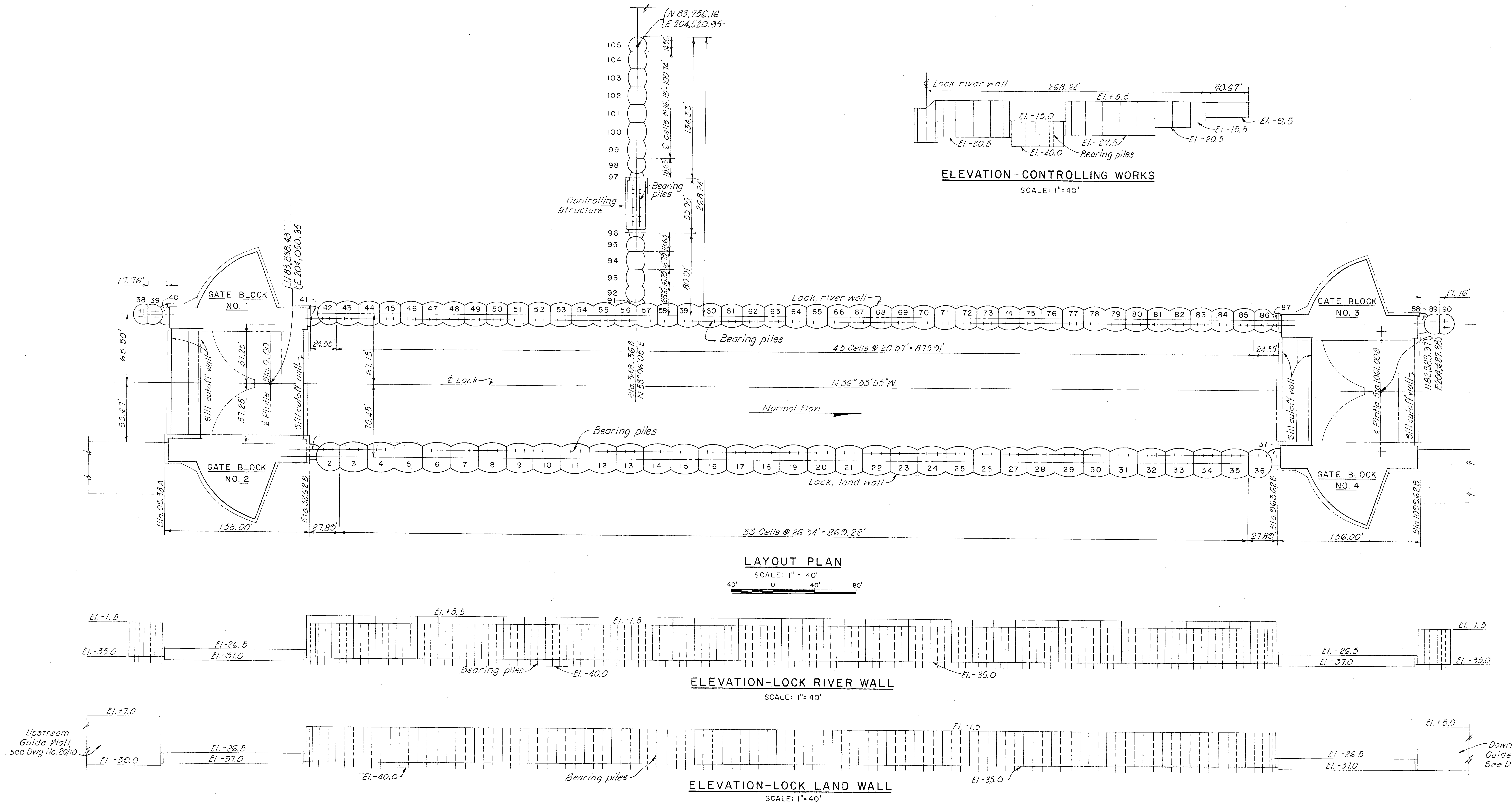
NORTH BASIN WALL,
GENERAL LAYOUT
VOID

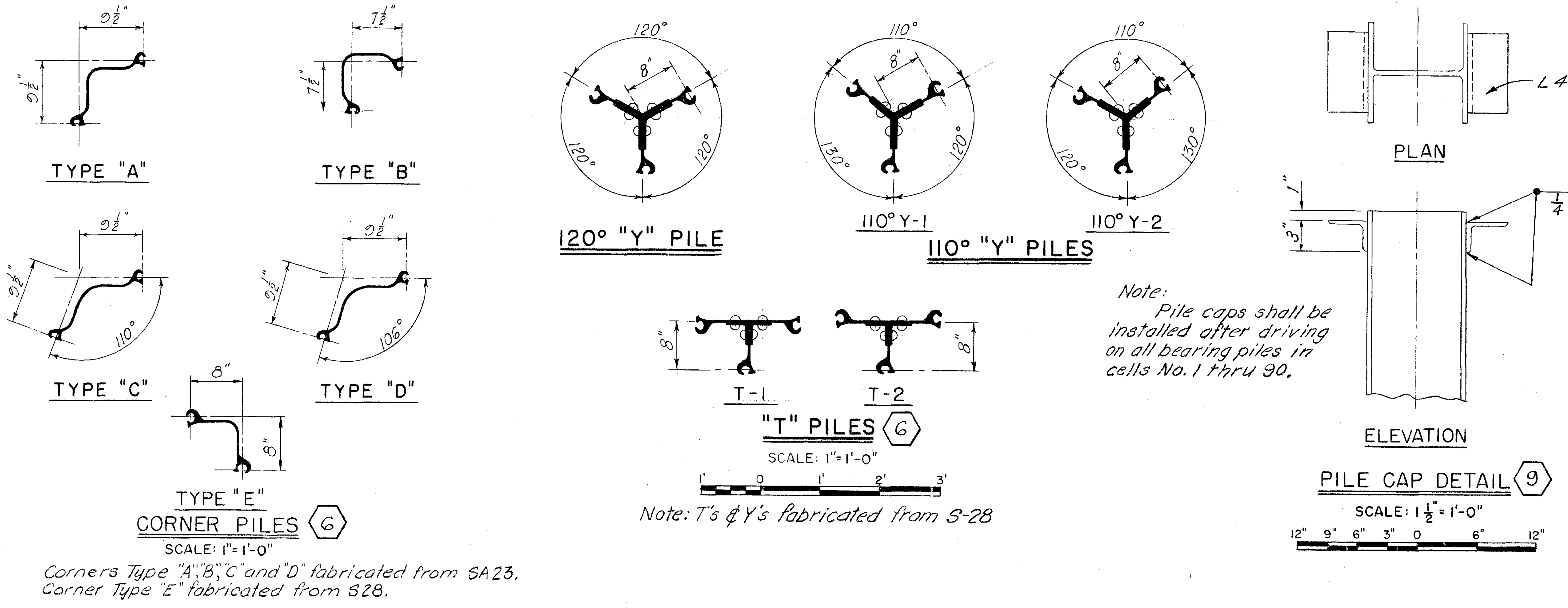
948
5629

Correct R. R. Leffler
Engr. of Structural Design
Approved ______
Asst. Chief Engineer
Approved W. S. Trinkaus
Chief Engineer

SCALE: 1" = 10'-0"
0 5' 10' 20' 30'
FEBRUARY, 1938
SHEET NO. C15
FILE NO. 50-L1

DRAWN BY E.A.N.
TRACED BY H.J.C.
CHECKED BY A.W.J.
EXAMINED BY





Corners Type "A", "B", "C" and "D" fabricated from SA23.
Corner Type "E" fabricated from S28.

NOTES

For general notes, see Dwg No. 20/1.

All steel sheet piling and steel bearing piles shown on Dwgs. Nos. 20/5 thru 20/11 to be furnished by the Government.

Lengths and stationing of walls are based on theoretical driving width of piling.

All bearing piles shall be bonded to the nearest sheet pile cell or continuous sheet pile wall by means of a No. 8 reinforcement rod. Rods shall be welded to each pile with a minimum of 6" of 1/4" fillet weld.

△1 All sheet piles shall be positively bonded together with a mild steel bar welded to each sheet pile with a minimum of 6" of 1/4" fillet weld except upstream and downstream guide walls (anchor walls for guide walls shall be bonded as specified above) See Sheet Pile Bonding Detail on Dwg. No. 20/6.

REVISION	DATE	DESCRIPTION	BY
△1	19 May '58	Revised in accordance with Addendum No. 3	L.D.

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
BUFFALO DISTRICT
BUFFALO, NEW YORK

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
CHICAGO DISTRICT
CHICAGO, ILLINOIS

DRAWN BY: T.E.T.
CHECKED BY: M.A.S.
SUBMITTED BY: R. J. Brown
CHIEF, DESIGN BR., BUFFALO DISTRICT
APPROVAL RECOMMENDED:
CHIEF, ENG. DIV., BUFFALO DISTRICT
APPROVAL RECOMMENDED:
COL., C. E. DIST. ENGR., BUFFALO DIST.
APPROVED: C. Hoffmann
CHIEF, DESIGN BRANCH
APPROVED:
ASS'T. CHIEF, ENG. DIV.
APPROVED: N. W. Wightman
for CHIEF, ENGINEERING DIVISION

CALUMET-SAG NAVIGATION PROJECT
CALUMET RIVER
LOCK & CONTROLLING WORKS
PILING LAYOUT
GENERAL PLAN

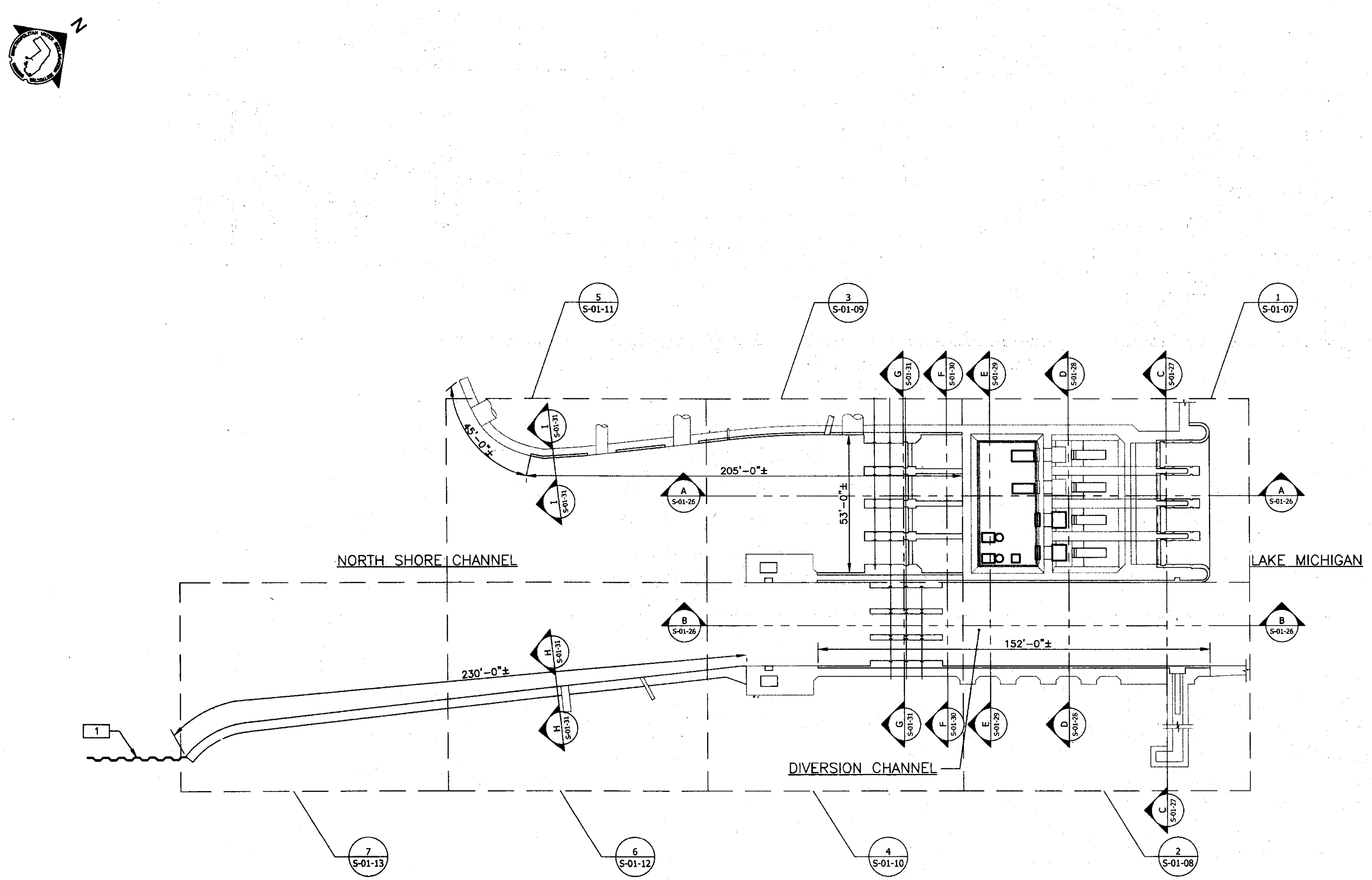
DATE: 15 NOV. 1957
SCALE: AS SHOWN
CIVENG-11-032-58-7
FILE NO. 9-LI-3 / 3
SHEET 17

TJ600019.TIF

20/5.1

PLATE 2

8/6 Added bearing pile designation



OVERALL INTERMEDIATE PLAN

SCALE = 1"=20'-0"
ELEVATION = +3'-0" CCD

KEY NOTES:

1 SHEET PILE WALL. SEE C-01-20.

LICENSE EXPIRES:
11/30/12
12/1/2010

FARHAD REZAI
081-004891

SCALE: 1" = 20'
20 0 20 40

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT
OF GREATER CHICAGO

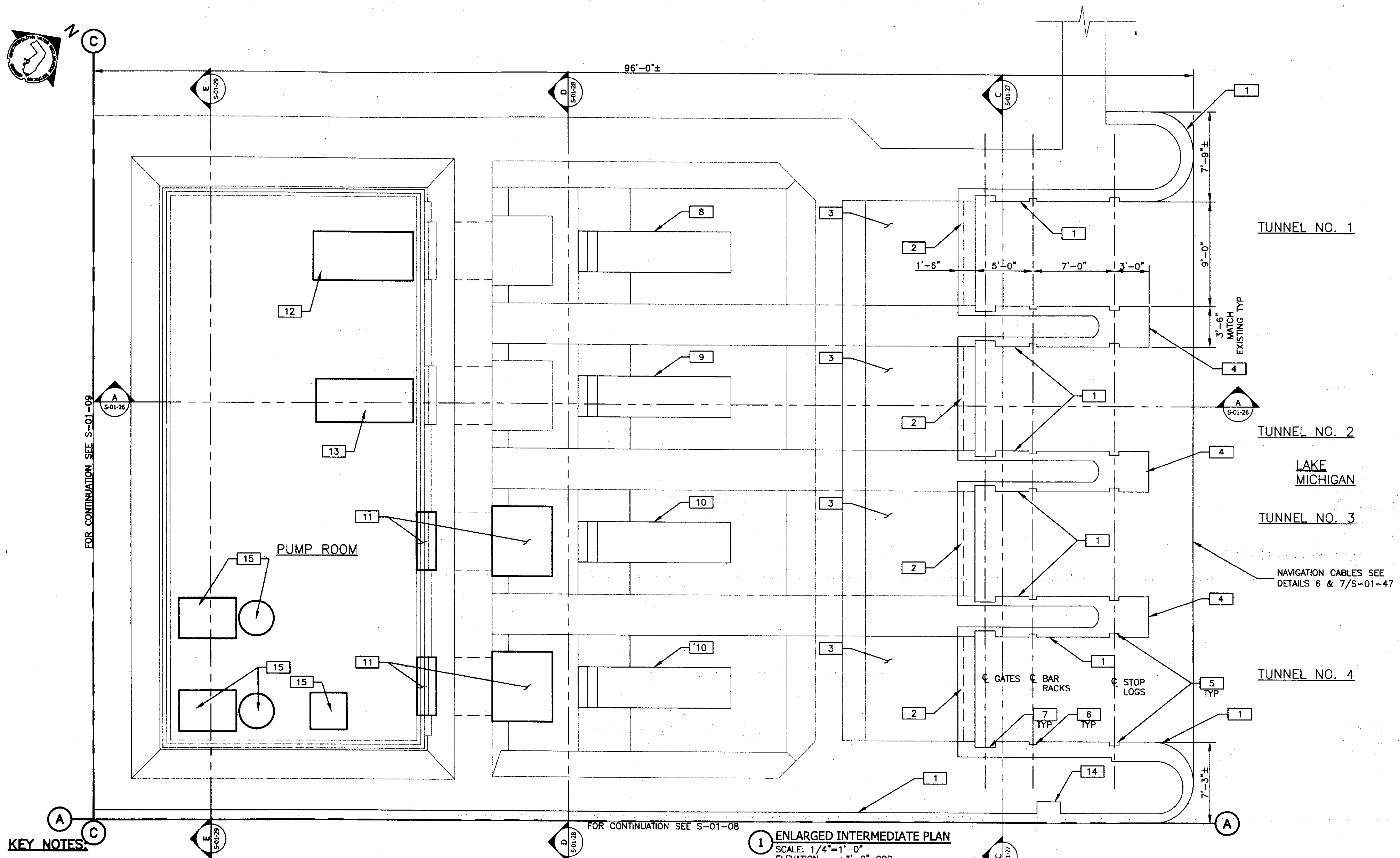
Designed by: H. JELEN
Checked by: F. REZAI
Correct: Project Manager
Approved: MWRD Assistant Director of Engineering
Drawn by: R. WEENUM
Reviewed by: P. ENGLEBERT
Date: DEC 2010
Scale: 1"=20'-0"

AB&H A DONOHUE GROUP

RME Rubinos & Mesia Engineers, Inc.

NORTH SERVICE AREA
CONTRACT 06-023-3P
STOP LOGS & DIVERSION PUMPS AT WILMETTE
PS & EVANSTON PS REHABILITATION
WILMETTE PUMP STATION
OVERALL INTERMEDIATE PLAN

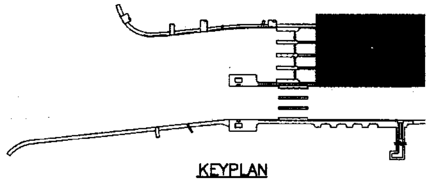
Sheet Number:
S-01-06
Page Number: 69



① **ENLARGED INTERMEDIATE PLAN**
SCALE: 1/4"=1'-0"
ELEVATION = +3'-0" CCD
(S-01-06)

KEY NOTES:

1	CONCRETE WALL ANCHORED TO EXISTING CONCRETE. FACE OF NEW WALL TO LINE UP WITH EXISTING WALL – SEE DETAIL 1/S-01-38.
2	18" THICK CONCRETE WALL. SEE DETAIL 1/S-01-41.
3	FILL AREA BETWEEN NEW TOP SLAB AND TOP OF TUNNEL WITH FLOWABLE FILL.
4	WALL EXTENSION TO LINE UP WITH EXISTING WALL. SEE DETAILS 1, 2 & 3/S-01-40.
5	STOP LOG GUIDE – SEE DETAIL 2/S-01-39.
6	BAR RACK GUIDE – SEE DETAIL 4/S-01-39.
7	GATE GUIDE – SEE DETAIL 1/S-01-39.
8	SAND BLAST, CLEAN AND RECOAT EXISTING COVER AND FRAME.
9	TUNNEL COVER. SEE DETAIL 1/S-01-44.
10	FILL EXISTING OPENING WITH CONCRETE. SEE DETAIL 2/S-01-44.
11	CLOSE PUMP SHAFT OPENING WITH CONCRETE – ANCHOR W/#5x12" EW ALONG EXPOSED FACES INTO SOLID CONCRETE – FILL WITH CONCRETE. SEE DETAIL 4/S-01-47 SIMILAR.
12	CONCRETE PAD FOR LAKE PUMP NO. 1 SEE TYPICAL PAD DETAIL 9/S-01-47. COORDINATE WITH PUMP MANUFACTURER.
13	CONCRETE PAD FOR LAKE PUMP NO. 2 SEE TYPICAL PAD DETAIL 9/S-01-47. COORDINATE WITH PUMP MANUFACTURER.
14	FILL GUIDE AREA WITH CONCRETE, SEE DETAIL 6/S-01-38 SIMILAR.
15	CONCRETE PAD FOR AIR COMPRESSOR EQUIPMENT. SEE TYPICAL PAD DETAIL 9/S-01-47. COORDINATE WITH AIR COMPRESSOR EQUIPMENT MANUFACTURER. CONTRACTOR TO REMOVE FLOOR TILE AS REQUIRED FOR EQUIPMENT PADS.


KEYPLAN

LICENSE EXPIRES: 11/30/12

FARHAD REZAI 081-004891

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

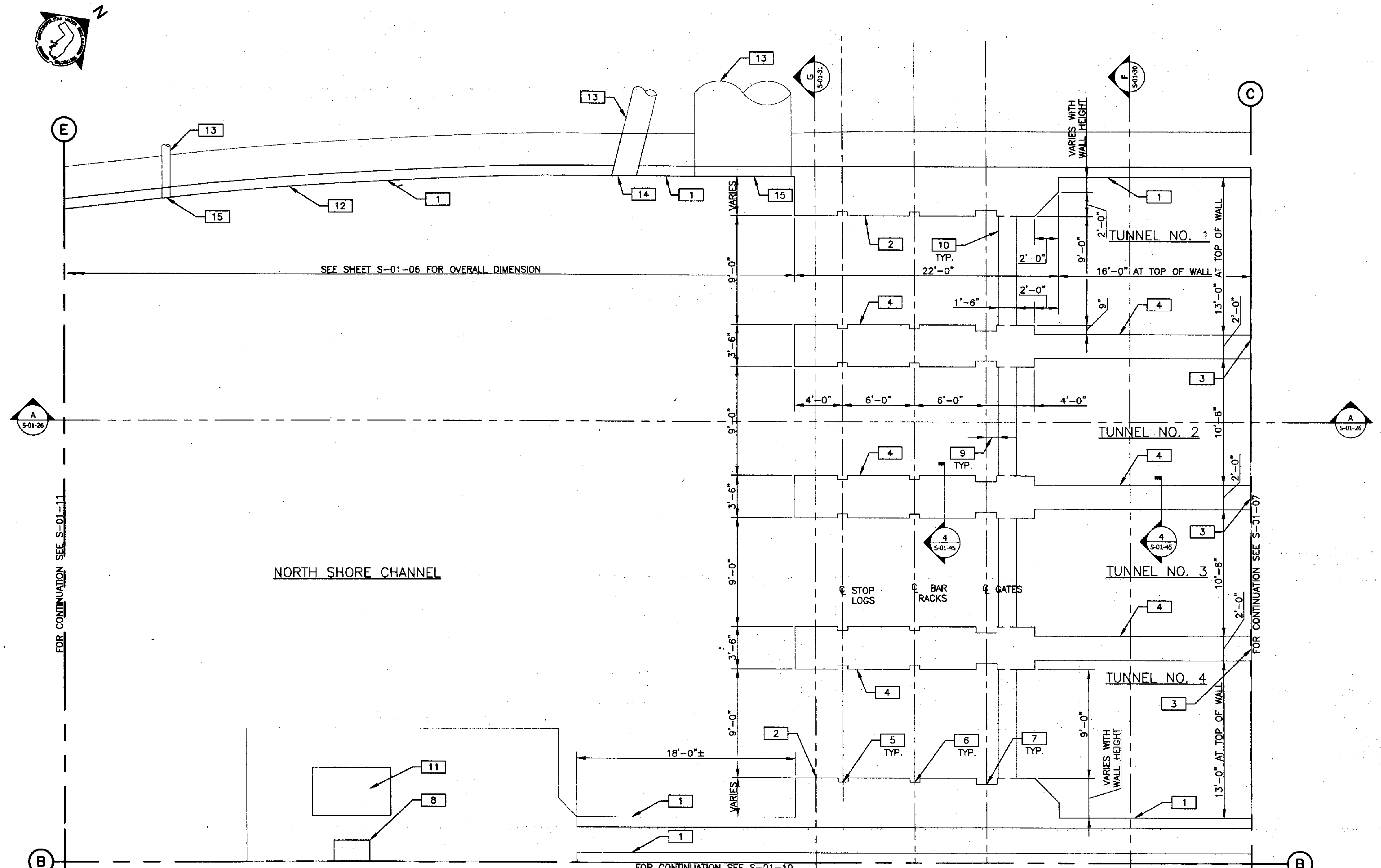
Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: H. JELEN	Checked by: F. REZAI	Correct: Project Manager
Drawn by: R. WEENUM	Reviewed by: P. ENGLEBERT	Approved: MWRD Assistant Director of Engineering
Date: DEC 2010	Scale: 1/4"=1'-0"	AB&H A DONOHUE GROUP · RME Rubinos & Mesia Engineers, Inc.

NORTH SERVICE AREA
CONTRACT 06-023-3P
STOP LOGS & DIVERSION PUMPS AT WILMETTE
PS & EVANSTON PS REHABILITATION
WILMETTE PUMP STATION
ENLARGED INTERMEDIATE PLAN

Sheet Number: S-01-07
Page Number: 70

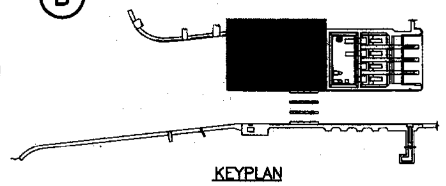


3 ENLARGED INTERMEDIATE PLAN

SCALE: 1/4"=1'-0"
ELEVATION = +3'-0" CCD
(S-01-06)

KEY NOTES:

1 CONCRETE WALL ANCHORED TO EXISTING CONCRETE. FACE OF NEW WALL TO LINE UP WITH EXISTING WALL – SEE DETAIL 1/S-01-38.
2 CONCRETE WALL – SEE DETAIL 2/S-01-38 (SIMILAR).
3 ANCHOR NEW WALL TO EXISTING CONCRETE WALL – SEE DETAIL 5/S-01-48.
4 CONCRETE WALL – SEE DETAILS 3 & 4/S-01-45.
5 STOP LOG GUIDE – SEE DETAIL 2/S-01-39, TYP.
6 BAR RACK GUIDE – SEE DETAIL 4/S-01-39, TYP.
7 GATE GUIDE – SEE DETAIL SHEET 1/S-01-39, TYP.
8 FILL ROLLER GATE BLOCKOUT WITH CONCRETE, SEE DETAIL 6/S-01-38.
9 WALL LOCATION TO BE COORDINATED WITH GATE MANUFACTURER.
10 18" THICK WALL – SEE DETAIL 1/S-01-41 SIMILAR.
11 FILL COUNTERWEIGHT PIT WITH CONCRETE.
12 WHERE ENCOUNTERED PRESERVE EXISTING WEEP HOLES IN WALL AND EXTEND THROUGH NEW CONCRETE.
13 EXISTING PIPE – SEE CIVIL DRAWINGS.
14 PLUG 24" PIPE FULL DEPTH OF WALL, SEE 4/S-01-47 SIMILAR.
15 FORM CONCRETE WALL TO MATCH PIPE DIAMETER.



KEYPLAN

12/3/2010
LICENSE EXPIRES:
11/30/12

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

FARHAD REZAI
081-004991

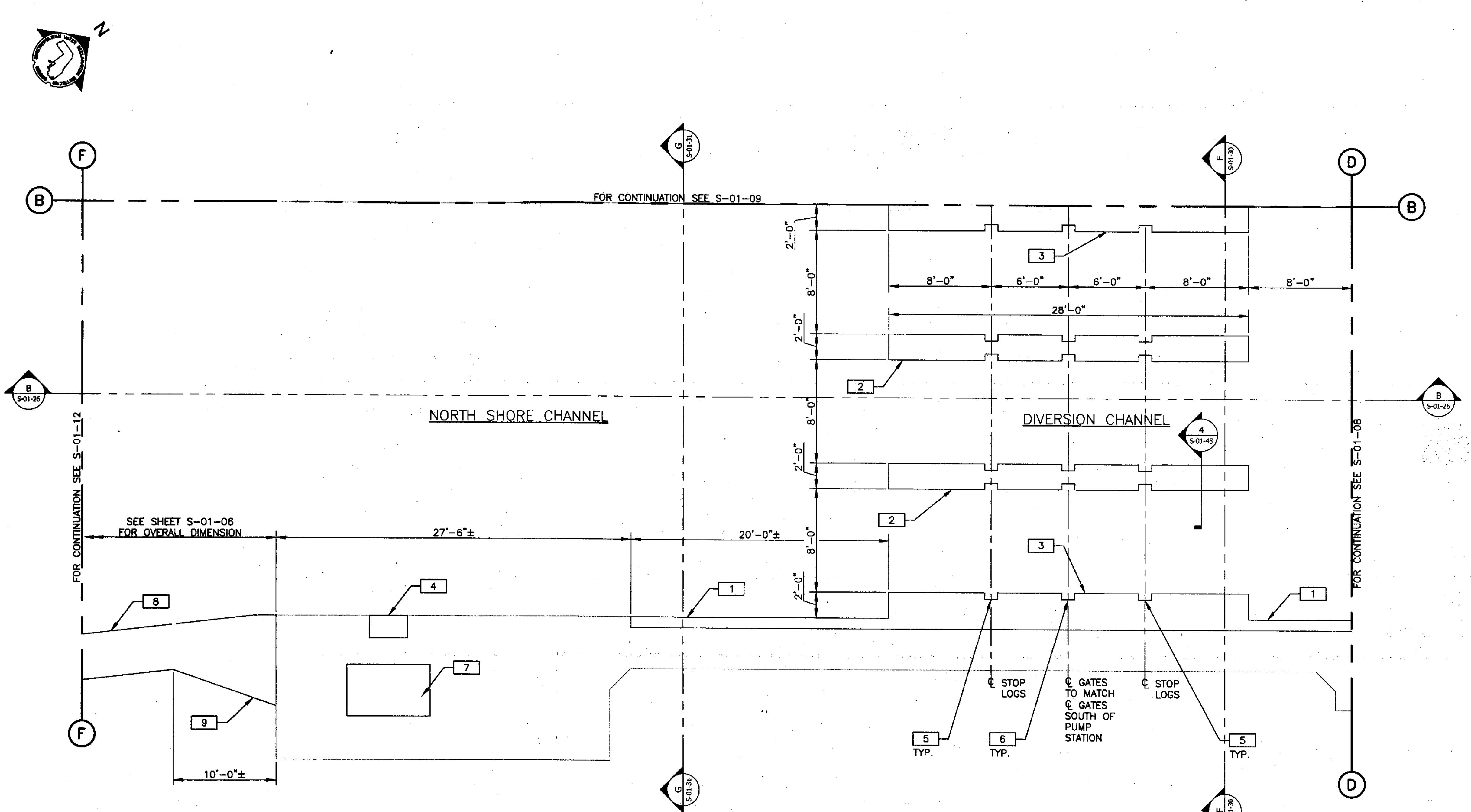
Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT
OF GREATER CHICAGO

Designed by: H. JELEN	Checked by: F. REZAI	Correct: Project Manager	Approved: MWRD Assistant Director of Engineering
Drawn by: R. WEENUM	Reviewed by: P. ENGLEBERT	AB&H A DONOHUE GROUP	R M E Rubinos & Mesia Engineers, Inc.
Date: DEC 2010	Scale: 1/4"=1'-0"		

NORTH SERVICE AREA
CONTRACT 06-023-3P
STOP LOGS & DIVERSION PUMPS AT WILMETTE
PS & EVANSTON PS REHABILITATION
WILMETTE PUMP STATION
ENLARGED INTERMEDIATE PLAN

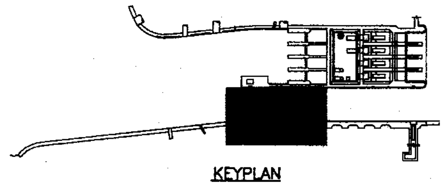
Sheet Number: S-01-09
Page Number: 72



④ **ENLARGED INTERMEDIATE PLAN**
SCALE: 1/4"=1'-0"
ELEVATION = +3'-0" CCD
(S-01-06)

KEY NOTES:

1 CONCRETE WALL ANCHORED TO EXISTING CONCRETE. FACE OF NEW WALL TO LINE UP WITH EXISTING WALL – SEE DETAIL 1/S-01-38.
2 CONCRETE WALL – SEE DETAILS 3 & 4/S-01-45.
3 CONCRETE WALL TO BE ANCHORED TO EXISTING CONCRETE WALL. NEW WALL TO BE MINIMUM 10" THICK. SEE DETAIL 2/S-01-38.
4 FILL ROLLER GATE BLOCKOUT WITH CONCRETE, SEE DETAIL 6/S-01-38.
5 STOP LOG GUIDES – SEE DETAIL 2/S-01-39, TYP.
6 ROLLER GATE GUIDES – SEE DETAIL 3/S-01-39.
7 FILL COUNTERWEIGHT PIT WITH CONCRETE.
8 NEW CONCRETE WALL. SEE SECTION H-H/S-01-31 FOR DETAILS.
9 ADJUST WALL THICKNESS TO MATCH EXISTING.


KEYPLAN

12/3/10
LICENSE EXPIRES:
11/30/12

FARHAD
REZAI
081-004891

4 3 2 1 0 4 8
SCALE: ⅛" = 1'-0"

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: H. JELEN	Checked by: F. REZAI	Correct: Project Manager
Drawn by: R. WEENUM	Reviewed by: P. ENGLEBERT	Approved: MWRD Assistant Director of Engineering
Date: DEC 2010	Scale: 1/4"=1'-0"	

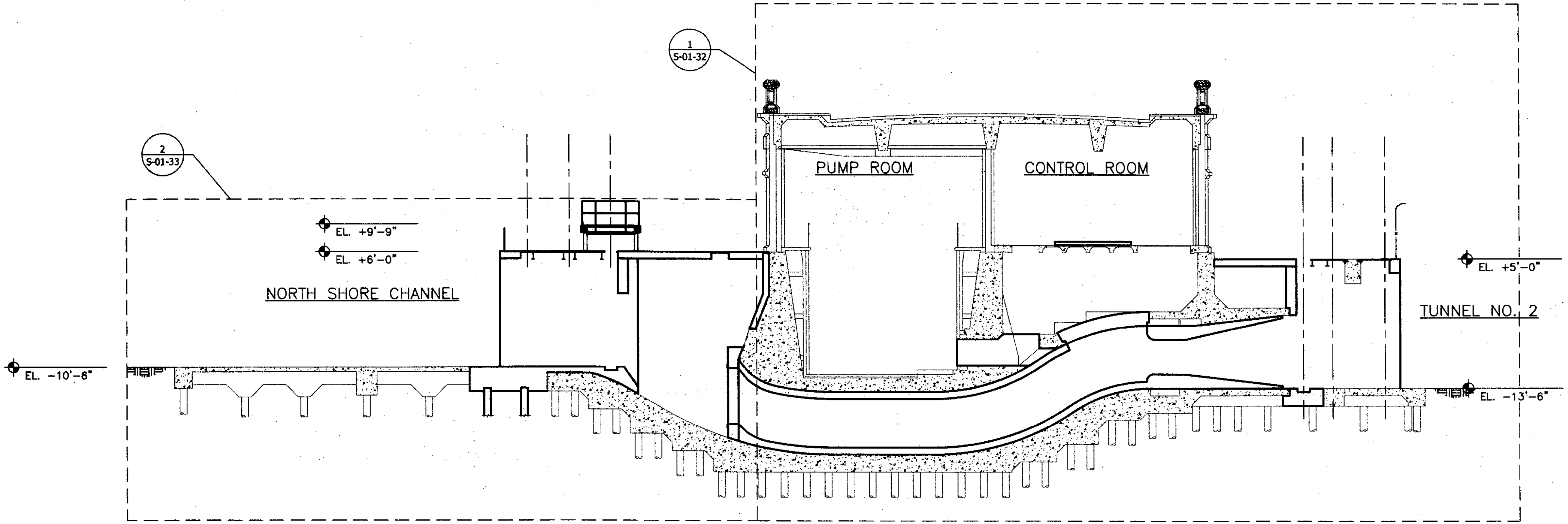
AB&H
A DONOHUE GROUP

R M E
Rubinos & Mesia Engineers, Inc.

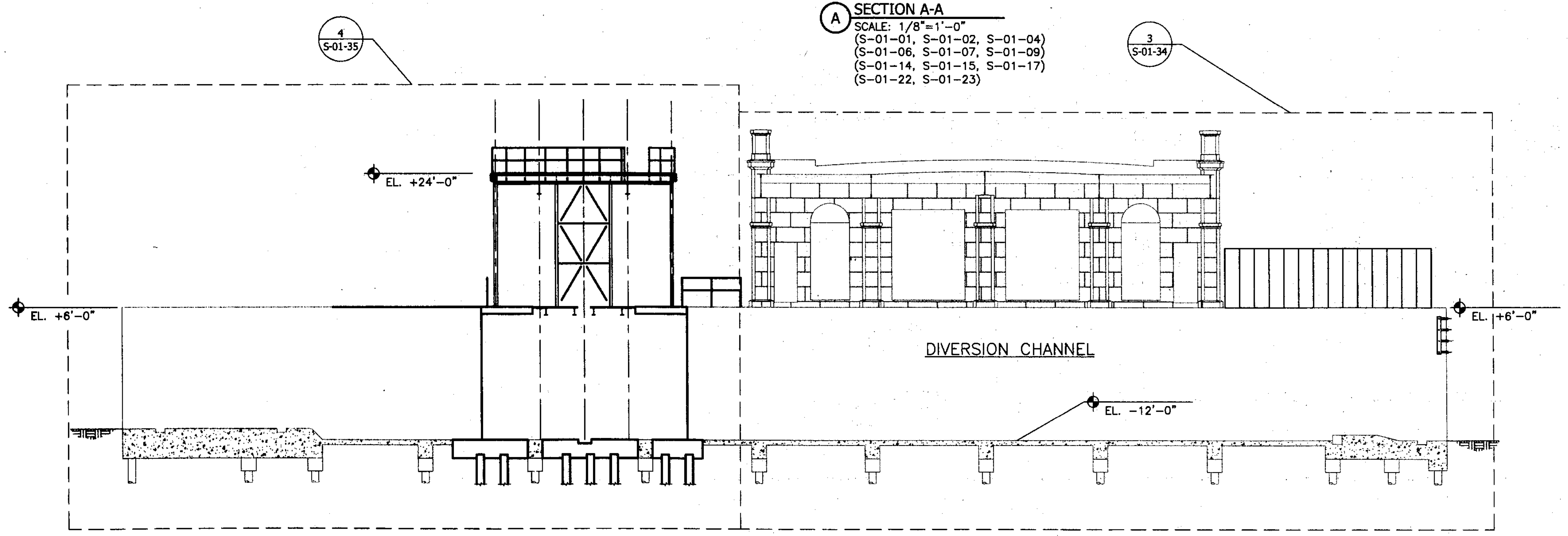
NORTH SERVICE AREA
CONTRACT 06-023-3P
STOP LOGS & DIVERSION PUMPS AT WILMETTE
PS & EVANSTON PS REHABILITATION
WILMETTE PUMP STATION
ENLARGED INTERMEDIATE PLAN

Sheet Number:
S-01-10
Page Number: 73

PLOT DATE: 12/1/2010 9:25 AM PLOTTED BY: BERTRAM, NORA



Ⓐ **SECTION A-A**
SCALE: 1/8"=1'-0"
(S-01-01, S-01-02, S-01-04)
(S-01-06, S-01-07, S-01-09)
(S-01-14, S-01-15, S-01-17)
(S-01-22, S-01-23)



Ⓑ **SECTION B-B**
SCALE: 1/8"=1'-0"
(S-01-01, S-01-03, S-01-05)
(S-01-06, S-01-08, S-01-10)
(S-01-14, S-01-16, S-01-18)
(S-01-22, S-01-24, S-01-25)

GENERAL NOTE:

1. THIS SHEET IS TO INDICATE LOCATION OF INFORMATION.

LICENSE EXPIRES:
11/30/12
12/3/2010

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

FARHAD REZAI
081-004981

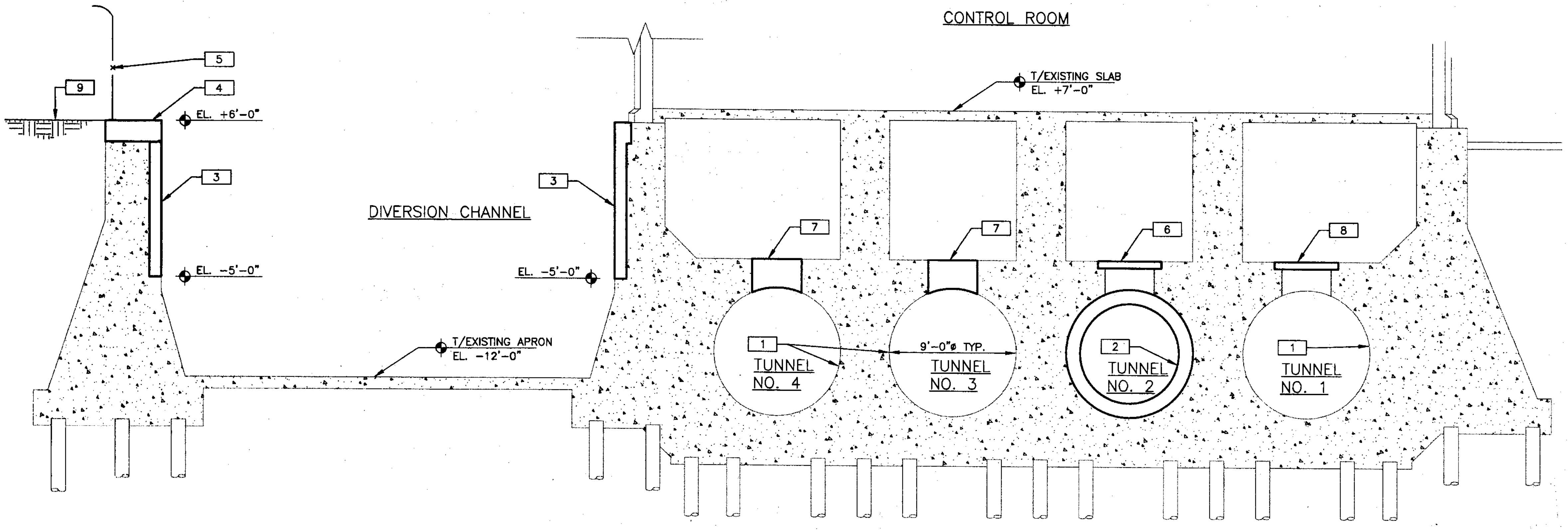
Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT
OF GREATER CHICAGO

Designed by: H. JELEN	Checked by: F. REZAI	Correct: Project Manager
Drawn by: R. WEENUM	Reviewed by: P. ENGLEBERT	Approved: MWRD Assistant Director of Engineering
Date: DEC 2010	Scale: 1/8"=1'-0"	AB&H A DONOHUE GROUP R M E Rubinos & Mesia Engineers, Inc.

NORTH SERVICE AREA
CONTRACT 06-023-3P
STOP LOGS & DIVERSION PUMPS AT WILMETTE
PS & EVANSTON PS REHABILITATION
WILMETTE PUMP STATION
SECTIONS

Sheet Number:
S-01-26
Page Number: 89



D SECTION D-D
SCALE: 1/4"=1'-0"
(S-01-01, S-01-02, S-01-03)
(S-01-06, S-01-07, S-01-08)
(S-01-14, S-01-15, S-01-16)

KEY NOTES:

1 TUNNELS NO. 1, 3, 4 – LOCALIZED AREAS OF SECTION LOSS TO BE CLEANED AND REPAIRED WITH REPAIR MORTAR AND FOAM INJECTION. SEE DETAIL 1/S-01-45.

2 TUNNEL NO. 2 – RELINE WITH SHOTCRETE TO REDUCE THE TUNNEL DIAMETER TO 7'-0", COORDINATE WITH PUMP MANUFACTURER. SEE DETAIL 2/S-01-45.

3 CONCRETE WALL ANCHORED TO EXISTING CONCRETE. FACE OF NEW WALL TO LINE UP WITH EXISTING WALL – SEE DETAIL 1/S-01-38.

4 CONCRETE SLAB OVER EXISTING WALL – SEE DETAIL 1/S-01-38.

5 8'-0" ORNAMENTAL STEEL FENCE.

6 NEW TUNNEL COVER PLATE. SEE DETAIL 1/S-01-44.

7 TUNNELS NO. 3 & 4 – CLOSE TUNNEL AS SHOWN BY FILLING WITH CONCRETE. SEE DETAIL 2/S-01-44.

8 SAND BLAST CLEAN AND RECOAT TUNNEL COVER PLATE AND FRAME. REINSTALL COVER PLATE.

9 SEE 1/C-01-19 FOR BACKFILL AND DRAIN TILE.

F. Rezai
12/3/2010
LICENSE EXPIRES:
11/30/12

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

FARHAD REZAI
061-004891

Rev.	Description	Appr.	Date

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Designed by: H. JELEN	Checked by: F. REZAI	Correct: Project Manager
Drawn by: R. WEENUM	Reviewed by: P. ENGLEBERT	Approved: MWRD Assistant Director of Engineering
Date: DEC 2010	Scale: 1/4"=1'-0"	AB&H A DONOHUE GROUP / R M E Rubinos & Mesia Engineers, Inc.

NORTH SERVICE AREA
CONTRACT 06-023-3P
STOP LOGS & DIVERSION PUMPS AT WILMETTE
PS & EVANSTON PS REHABILITATION
WILMETTE PUMP STATION
SECTION

Sheet Number: S-01-28
Page Number: 91

PROCESS PUMP SCHEDULE

TAG NUMBER	NAME	LOCATION	PUMP TYPE	RATED POINT CAPACITY (GPM)	RATED POINT CAPACITY (CFS)	RATED POINT HEAD (FT)	RATED POINT SHUTOFF HEAD (FT)	RATED POINT MINIMUM EFFICIENCY	MINIMUM FLOW (GPM)	IMPELLER DIAMETER (IN)	MAX MOTOR RPM	SEAL TYPE	CONFIG-URATION	SPEC SECTION	DRIVE HP	DRIVE TYPE	POWER SUPPLY (V)	RATING	REMARKS
100-M-0101	LAKE PUMP NO. 1	WMPS PUMP ROOM	HORIZONTAL AXIAL FLOW	112,208	250	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	108	1200	PACKING	HORI-ZONTAL	11305	150	VAR SPEED	480	UNRATED	EXISTING PUMP TO REMAIN, TO BE PROVIDED WITH NEW VARIABLE FREQUENCY DRIVE, MOTOR AND GEAR REDUCER
100-M-0102	LAKE PUMP NO. 2	WMPS PUMP ROOM	HORIZONTAL AXIAL FLOW	67,325	150	5	8.5	85%	40,000	58.5 (*)	1200	PACKING	HORI-ZONTAL	11311	150	VAR SPEED	480	UNRATED	N/A

SLIDE GATES – SPECIFICATION SECTION 11286

TAG NUMBER	NAME	LOCATION	OPENING SIZE WxH (IN)	MAX SEATING HEAD (FT)	MAX UNSEATING HEAD (FT)	GUIDE FRAME INVERT (FT-CCD)	TOP OF GUIDE FRAME (FT-CCD)	FRAME TYPE	CLOSURE TYPE	SEAL LOCATION TOP AND SIDE	SEAL LOCATION BOTTOM	OPERATOR TYPE	MOTOR (MAXIMUMS) HP	MOTOR (MAXIMUMS) POWER SUPPLY (V)	MOTOR (MAXIMUMS) RPM (MAX)	MOTOR (MAXIMUMS) RATED AMP DRAW	STEM	REMARKS
100-G-0131	LAKE SIDE GATE NO. 1	WMPS NORTH SIDE	108x126	18.5	7.5	-13.5	5.0	EMBEDDED	FLUSH	GATE	GATE	ELECTRIC	6.4	480	1800	10	RISING	SELF-CONTAINED
100-G-0132	LAKE SIDE GATE NO. 2	WMPS NORTH SIDE	108x126	18.5	7.5	-13.5	5.0	EMBEDDED	FLUSH	GATE	GATE	ELECTRIC	6.4	480	1800	10	RISING	SELF-CONTAINED
100-G-0133	LAKE SIDE GATE NO. 3	WMPS NORTH SIDE	108x126	18.5	7.5	-13.5	5.0	EMBEDDED	FLUSH	GATE	GATE	ELECTRIC	6.4	480	1800	10	RISING	SELF-CONTAINED
100-G-0134	LAKE SIDE GATE NO. 4	WMPS NORTH SIDE	108x126	18.5	7.5	-13.5	5.0	EMBEDDED	FLUSH	GATE	GATE	ELECTRIC	6.4	480	1800	10	RISING	SELF-CONTAINED
100-G-0111	CHANNEL SIDE GATE NO. 1	WMPS SOUTH SIDE	108x126	16.5	9.0	-10.5	9.75	EMBEDDED	FLUSH	GATE	GATE	ELECTRIC	6.4	480	1800	10	RISING	SELF-CONTAINED, HEAVY DUTY IMPACT RESISTANCE (SEE NOTE 1).
100-G-0112	CHANNEL SIDE GATE NO. 2	WMPS SOUTH SIDE	108x126	16.5	9.0	-10.5	9.75	EMBEDDED	FLUSH	GATE	GATE	ELECTRIC	6.4	480	1800	10	RISING	SELF-CONTAINED, HEAVY DUTY IMPACT RESISTANCE (SEE NOTE 1).
100-G-0113	CHANNEL SIDE GATE NO. 3	WMPS SOUTH SIDE	108x126	16.5	9.0	-10.5	9.75	EMBEDDED	FLUSH	GATE	GATE	ELECTRIC	6.4	480	1800	10	RISING	SELF-CONTAINED, HEAVY DUTY IMPACT RESISTANCE (SEE NOTE 1).
100-G-0114	CHANNEL SIDE GATE NO. 4	WMPS SOUTH SIDE	108x126	16.5	9.0	-10.5	9.75	EMBEDDED	FLUSH	GATE	GATE	ELECTRIC	6.4	480	1800	10	RISING	SELF-CONTAINED, HEAVY DUTY IMPACT RESISTANCE (SEE NOTE 1).

NOTES:
1. HEAVY DUTY IMPACT RESISTANCE DEFINED IN SPECIFICATION SECTION 11286.

ROLLER GATES – SPECIFICATION SECTION 11287

TAG NUMBER	NAME	LOCATION	GATE SIZE WxH (IN)	MAX SEATING HEAD (FT)	MAX UNSEATING HEAD (FT)	GUIDE FRAME INVERT (FT-CCD)	TOP OF GUIDE FRAME (FT-CCD)	FRAME TYPE	CLOSURE TYPE	SEAL LOCATION SIDE	SEAL LOCATION BOTTOM	OPERATOR TYPE	MOTOR (MAXIMUMS) HP	MOTOR (MAXIMUMS) POWER SUPPLY (V)	MOTOR (MAXIMUMS) RPM (MAX)	MOTOR (MAXIMUMS) RATED AMP DRAW	STEM	REMARKS
100-G-0121	DIVERSION CHANNEL GATE NO. 1	DIVERSION CHANNEL	96x210	17.5	17.5	-12.0	24.0	EMBEDDED	FLUSH	GATE	GATE	ELECTRIC	23	480	1800	36	RISING	SELF-CONTAINED, HEAVY DUTY IMPACT RESISTANCE (SEE NOTE 1). WIND LOAD = 130 MPH.
100-G-0122	DIVERSION CHANNEL GATE NO. 2	DIVERSION CHANNEL	96x210	17.5	17.5	-12.0	24.0	EMBEDDED	FLUSH	GATE	GATE	ELECTRIC	23	480	1800	36	RISING	SELF-CONTAINED, HEAVY DUTY IMPACT RESISTANCE (SEE NOTE 1). WIND LOAD = 130 MPH.
100-G-0123	DIVERSION CHANNEL GATE NO. 3	DIVERSION CHANNEL	96x210	17.5	17.5	-12.0	24.0	EMBEDDED	FLUSH	GATE	GATE	ELECTRIC	23	480	1800	36	RISING	SELF-CONTAINED, HEAVY DUTY IMPACT RESISTANCE (SEE NOTE 1). WIND LOAD = 130 MPH.

NOTES:
1. HEAVY DUTY IMPACT RESISTANCE DEFINED IN SPECIFICATION SECTION 11287.

STOP LOGS – SPECIFICATION SECTION 11284

LOCATION	NUMBER OF LOG SETS	NUMBER OF FRAMES	OPENING WIDTH (IN)	STOP LOG SET HEIGHT (IN)	GUIDE FRAME INVERT (FT-CCD)	MAXIMUM UNBALANCED HEAD (FT)	TOP OF GUIDE FRAME (FT-CCD)	FRAME MOUNTING	REMARKS
LAKE SIDE	1	4	108	222	-13.5	18.5	+5.0	EMBEDDED	NONE
CHANNEL SIDE	1	4	108	198	-10.5	16.5	+6.0	EMBEDDED	NONE
DIVERSION CHANNEL	2	6	96	204	-12.0	18.0	+6.0	EMBEDDED	NONE
WEST SIDE DOUBLE LOORS	2	2	120	24	N/A	2.0	2 FT ABOVE CURB	SURFACE MOUNTED	PROVIDE LOCKING HASP/MECHANISM

FLAP GATES – SPECIFICATION SECTION 11288

LOCATION	SEATING HEAD (FT)	UNSEATING HEAD (FT)	OPENING DIAMETER (IN)	REMARKS
TUNNEL NO. 1	18.5	5	96	SEATING/UNSEATING HEAD IS MEASURED FROM INVERT OF GATE.
TUNNEL NO. 2	18.5	5	96	SEATING/UNSEATING HEAD IS MEASURED FROM INVERT OF GATE.

AIR COMPRESSOR – SPECIFICATION SECTION 11372

TAG NUMBER	TYPE	LOCATION	RATED POINT RATED FLOW (SCFM)	RATED POINT RATED PRESSURE (PSI)	MOTOR HP	MOTOR POWER SUPPLY (V)	MOTOR RATED AMP DRAW	REMARKS
100-AC-0201	ROTARY SCREW COMPRESSOR	WMPS PUMP ROOM	65	125	25	480	34	240 GALLON RECEIVER
100-AC-0202	ROTARY SCREW COMPRESSOR	WMPS PUMP ROOM	65	125	25	480	34	240 GALLON RECEIVER

GENERAL NOTES:

1. THE CHANNEL/OPENING WIDTH SHOWN IN SCHEDULES DOES NOT INCLUDE THE PORTION OF THE GATE OR STOP LOG EXTENDING INTO THE FRAME. THIS ONLY OUTLINES THE ACTUAL CHANNEL WIDTH OR OPENING WIDTH OF THE STRUCTURE.
2. RATED AIR FLOW LISTED FOR THE COMPRESSORS IS FLOW REQUIRED AT DISCHARGE POINT, ACTUAL REQUIRED FLOW FROM COMPRESSORS MAY BE HIGHER, DEPENDENT ON DESICCANT AIR PURGE REQUIREMENTS.
3. EXISTING AIR COMPRESSOR AND VOLUME TANK, USED FOR THE LEVEL BUBBLER SYSTEM IS TO BE REUSED. COMPRESSORS LISTED ARE TO BE USED FOR FREEZE PROTECTION BUBBLERS, AND ARE INDEPENDENT OF LEVEL BUBBLER SYSTEM.

Michael J. Hickey
4/15/11
LICENSE EXPIRES:
11/30/11

MICHAEL J. HICKEY
062-043794

Rev.	Description	Appr.	Date
1	ADDENDUM NO. 7	MJH	04/05/11

METROPOLITAN WATER RECLAMATION DISTRICT
OF GREATER CHICAGO

Designed by: N. BERTRAM
Checked by: G. CRESSEY
Correct: Michael J. Hickey Project Manager
Approved: MWRD Assistant Director of Engineering
Drawn by: N. BERTRAM
Reviewed by: M. HICKEY
Date: DEC 2010
Scale: NOT TO SCALE

AB&H A DONOHUE GROUP

NORTH SERVICE AREA
CONTRACT 06-023-3P
STOP LOGS & DIVERSION PUMPS AT WILMETTE
PS & EVANSTON PS REHABILITATION
WILMETTE PUMP STATION
EQUIPMENT SCHEDULES

Sheet Number: P-01-01
Page Number: 114

L:\Projects\11505\Dwg\Process\P-01-01-rev1.dwg 3/31/2011

PLOT DATE: 3/31/2011 9:00 AM PLOTTED BY: BERTRAM, NORA

ENCLOSURE C

PORTLAND DISTRICT DESIGN CHARRETTE REPORT AND MANUFACTURER CATALOGS FOR TRAVELING SCREENS

O’Brien Lock Aquatic Nuisance Species

Deterrent Design
Charrette/VE Study

June 27, 2013

Portland District

Design Charrette Report
Aquatic Nuisance Species Deterrent Systems
for the O'Brien Lock and Water Control

1 Purpose

1.1 The purpose of this Document is to present the results of the O'Brien Lock Aquatic Nuisance Species Design Charrette conducted in Portland, Oregon on June 27th, 2013 with members of the Portland District with relative background information provided by members of Chicago District. The out brief presentation provided several alternatives was held by webinar on June 28th, 2013

1.2 The Charrette information will be used in development of the future plans and specifications to provide a viable solution to an exclusion system for the O'Brien Lock and Water Control Structures adjacent to the lock.

2 Background

2.1 The O'Brien Lock Design Charrette project is but one component of the larger Great Lakes & Mississippi River Inter-basin Study, hereinafter to be called (GLMRIS).

2.2 The overall GLMRIS Study's purpose is intended to provide a broad range of options and technologies available to address the spread of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River Basins. The study has two primary focus areas, Focus Area 1 is the Chicago Area Waterways, and Focus Area 2 includes all other pathways.

2.3 Goals of the study include: 1) identification of aquatic pathways that may exists between the Great Lakes and Mississippi River Basins 2) provisions for the inventory of current and future potential aquatic nuisance species; and, 3) to analyze possible ANS controls available for use between basins, via aquatic pathways.

3 Scope

3.1 The scope of the design charrette is to analyze possible ANS controls to address ANS transfer between basins at the O'Brien Lock and Water Controls through the use of various means to exclude ANS during flood water flows from the North Little Calumet River into Lake Michigan.

3.2 Design Criteria. Design considerations utilized during the alternatives development process included: debris loading, ice loading at 5 kips/ft; screen size opening limited to 0.4 inch;

maintaining the current flood control water surface elevations up to the 500 year event; hold as primary the water surface elevation below the authorized flood protection limits and consider lake fish exclusion as secondary to the primary mission function of the O'Brien Structures; and, lock operations as less important than fish exclusion.

4 Various Alternative Options

4.1 The results from the design charrette include recommendations for design consideration of both technology and physical type exclusion system. A number of alternative concepts were explored by the team including:

a) Massive Screens
b) Pumped forced flow
c) Electric barrier
d) Sonic barrier
e) Netting
f) Velocity barrier
g) Weir System
h) Aeration system
i) Using the Lock to pass flow
j) Add more sluice gates screened/unscreened
k) Add surcharge storage

4.2 The team primarily focused on physical deterrents, although consideration should be given to utilize technological features to supplement the designs to create more effective deterrent system. In all, the team developed 9 alternative concept options to add to the two options initially received from Chicago District. Alternatives were developed to concept level and require calculations and engineering design to determine details of feasibility and cost. The general feasibility and ranking of the concepts are based on the team's previous experience with screen system design, not on detailed calculations or engineering at this level. The team focused primarily on screen type deterrents. A description of each of those is listed below.

4.3 Other considerations taken into account by the team in developing various alternative concepts included the use of bubbler system where needed in dead zones and for ice control. To assist with phased construction and funding constraints while acquiring the project, the team considered stage exclusion methods in the alternative development. Due to the potential damages due to ice impacts, the team assumes that ice would be blocked by durable physical barrier and not just the screens. The team further assumed that there was no need to provide ice passage over the barrier.

4.4 Conceptual sketches of team developed alternatives are also included within Appendix C of this report. Note that these sketches are "not to scale" and very rough.

5 **Description of Alternatives**.

5.1 Alternative 1

Alternative 1 was presented to the team as an option by LRC. This alternative requires modification to the existing dam by adding approximately 510 lineal feet on to the east end of the water control structure to accommodate 34 screened gates. In order to construct the additional gate structures, a significant amount of channel excavation is required. Excavation of the magnitude could require significant dewatering efforts during the construction phase. To construct the dam extension, the foundation for the structure may require piling to match the existing foundation of the water control structure. The East Bank Access Road would also require relocating to tie-in to the end of the new structure.

5.2 Alternative 2

Alternative 2 was also presented to the team as an option by LRC. This alternative requires modification to the existing dam to add more gates and screens along the east bank of the controlling works and to the north, effectively creating an "L" shaped flow pattern through the structure. In order to construct the additional gate structures, a significant amount of channel excavation (approximately half as much as Alternative 1) is required. Dewatering would still be of concern for this alternative due to the proximity of the river and unknown substrata in and around the Lock and Water Control Structure. To construct the dam extension, the foundation for the structure may require piling to match the existing foundation of the water control structure. The new channel section would allow flow from the Calumet River on the river side of the O'Brien Lock and Water Control Structure into the new gate structures. The East Access Road will need to be extended northward along the east bank to provide access to the new gates allowing maintenance equipment onto the new gate structures.

5.3 Alternative 3

Alternative 3 is a modification of alternatives 1 and 2. This alternative requires modification of the existing dam to add screens to the existing sluice gates and construct adequate screened sluice gates in the remainder of the existing dam footprint. Any additional screened gates required for capacity would be installed in a reconstructed lakeside navigation lock east wall. The lakeside navlock east wall screens would be utilized with the CAWS side lock sector gates OPEN and the Lakeside sector gates CLOSED. The navlock east wall gates would only be used when the river gated structure capacity was exceeded. All screened sluice gates are submerged to allow the screens not to be damaged by ice impact. This alternative has the potential to have debris and ice from the flood event in the lock chamber.

5.4 Alternative 4

Alternative 4 is a variation of alternatives 3. This alternative requires modification of the existing dam to add screens to the existing sluice gates and construct adequate screened sluice gates in the remainder of the existing dam footprint. Any additional screened gates required for capacity would be installed in a reconstructed CAWS side navigation lock east wall. The CAWS navlock east wall screens would be utilized with the CAWS side lock sector gates CLOSED and the Lakeside sector gates OPEN. The navlock east wall gates would only be used when the river gated structure capacity was exceeded. All screened sluice gates are submerged to allow the screens not to be damaged by ice impact. This alternative prevents debris and ice from being in the navlock chamber during a flood event.

5.5 Alternative 5a

Alternative 5a is a modification of alternative 3 to separate the screen structure from the gated structure. This alternative requires modification of the existing dam to add submerged sluice gates in the remainder of the existing dam footprint. Any additional sluice gates required for capacity would be installed in a reconstructed lakeside navigation lock east wall. The lakeside east navlock wall screens would be utilized with the CAWS side lock sector gates OPEN and the Lakeside sector gates CLOSED. The navlock east wall gates would only be used when the river gated structure capacity was exceeded. A separate screening structure would be attached to the lakeside navigation lock wall angling north at an angle adequate to provide appropriate area such that the screens do not exceed their differential head capacity at maximum flow and to allow a sweeping velocity to allow accumulation of trash at the north end of the screen structure. Any ice during flood events would be retained at the dam and within the navigation lock.

5.6 Alternative 5b

Alternative 5b is a modification of alternative 4 to separate the screen structure from the gated structure. This alternative requires modification of the existing dam to add submerged sluice gates in the remainder of the existing dam footprint. Any additional sluice gates required for capacity would be installed in a reconstructed CAWS side navigation lock east wall. The lakeside east navlock wall screens would be utilized with the CAWS side lock sector gates CLOSED and the Lakeside sector gates OPEN. The navlock east wall gates would only be used when the river gated structure capacity was exceeded. A separate screening structure would be attached to the lakeside navigation lock wall angling southeast (or north depending on the most advantageous location for debris collection) at an angle adequate to provide appropriate area such that the screens do not exceed their differential head capacity at maximum flow and to allow accumulation of trash at the end of the screen structure. Any ice during flood events would be deflected to the debris handling location.

5.7 Alternative 6

The intent of this concept is to use 18 to 20 sluice gates in the dam structure and a swing screen inside the navigation lock to provide full flow capacity for the 500 year event. The sluice gates would be screened individually at the dam. The swing screen inside the navigation lock would require a debris removal system to sweep debris to the downstream end of the swing screen. A collection point would be located on the east wall of the navigation lock. This alternative was not evaluated in the matrix due to potentially significant issues with debris collection inside the navigation lock.

5.8 Alternative 7

The intent of this concept is to use 18 to 20 sluice gates in the dam structure, and a separate screen structure located to the Lake Michigan side of the sluice gates. The reason for separating the screen from the sluice gates is to increase the available screen flow area significantly over the area available through the gates. By increasing the screen area, the head drop across the screens can be reduced, so that flood capacity can be met with the screen system in place. The screen structure would consist of a series of vee-screens with the downstream apexes connected by an access bridge. Debris would be swept downstream by a debris removal system and handling would be done at collection points located at the apexes of the vee screens. Debris would be removed via the access bridge. The vee screens would be sized such that the head drop is low enough that the majority of the 500 year flood flow of 21600 CFS can be passed through the sluice gates, and the remainder would be screened and passed through the navigation lock. The navigation lock would have a swing screen on the north end of the lock. Debris would be swept downstream by a debris removal system to a debris collection point on the west bank. Collecting debris on the inside of the swing side of the swing screen for the navigation lock may pose a potential navigation issue if the swing screen closure were to be blocked by debris or ice.

5.9 Alternative 8

The intent of this concept is to use 18 to 20 sluice gates in the dam structure, and a separate screen structure located to the CAWS side of the sluice gates. The reason for separating the screen from the sluice gates is to increase the available screen flow area significantly over the area available through the gates. By increasing the screen area, the head drop across the screens can be reduced, so that flood capacity can be met with the screen system in place. The screen structure would consist of a series of vee-screens with the downstream apexes located at the dam. Debris would be swept downstream by a debris removal system and handling would be done at collection points located at the apexes of the vee screens at the dam. The vee screens would be sized such that the head drop is low enough that the majority of the 500 year flood flow of 21600 CFS can be passed through the sluice gates, and the remainder would be screened and passed through the navigation lock. The navigation lock would have a swing screen on the south end of the lock. When the navigation lock swing screen is in use, debris would be swept downstream by a debris removal system to the westernmost vee screen for collection at the dam.

5.10 Alternative 9

The intent of this concept is to use 18 to 20 sluice gates in the dam structure, and a screen that is in front of the sluice gates. The reason for separating the screen from the sluice gates is to increase the screen flow area to substantially larger than the flow area through the gates. By increasing the screen area, the head drop across the screens can be reduced. By placing the screen structure on the CAWS side of the dam and gate structure, the debris handling would be done at collection points located at the apexes of the vee screens, which are at the dam. Debris handling is done at the dam structure. The vee screens would be sized such that the head drop is low enough that the entire 500 year flood flow of 21600 CFS can be passed through the gates, and the navlock would not be used any longer for flood flow passage.

5.11 Alternative 10

This idea assumed that approximately 18 to 20 gates are installed in the dam structure. The screen structure is separate from the gate structure, and is located on the Lake Michigan side of the gates. Vee screens are proposed, and although three vees are shown, the number could be increased. Debris collection and removal is done by having a cleaning system that has a travelling cleaning device to sweep debris into the apex of the vee and then a debris removal device that pulls the debris up and out of the apex and into a truck or conveyor. The sweeping device could be a brush or a water jet device. The debris removal device could be an inclined travelling screen or a raking device. The vee screens are proposed so that the screen flow area can be larger than the gate flow area, allowing a reduction in head loss across the screens. The screen structure consists of a bridge at the Lake Michigan end of the screens and the CAWS end of the screens are tied to the dam. By connecting the tips of the vee screens to the dam, the structure can be either constructed or operated in stages, and the screen structure can be accessed from either the bridge at the downstream end, or the dam at the upstream end. During a large flood event, a swinging or vertically hinged screen would swing out and provide protection for the navlock, which would be opened to pass flow. Further calculations may show that the screen for the navlock may not need to be as large as it is shown here, possibly even a floor-mounted screen that lies flat on the bottom of the lock when retracted, and swings up from a horizontal hinge at the screen's upstream end when deployed. One benefit of an angled screen with vertical hinge is that debris and ice would be passed around the navlock and over to the adjacent vee screen just downstream of the gate structure. The floor mounted screen would be transverse to the flow, and debris handling would seem to be more difficult.

5.12 Alternative 11

This alternative looked at a velocity barrier. The idea here is to build a gated ogee crest structure in place of the existing dam. We looked at a rough order of magnitude for the head requirements and found that it was not likely to be reliable enough to ensure adequate velocities under all conditions. We looked at augmenting the velocity with pumped flow and a venturi device, but the horsepower requirements were unreasonably large. To accelerate the 21,000 CFS to 11 feet per second would have required roughly between 1,000 and 4,000 water horsepower, or potentially as much as 5 megawatts of electrical power. Another problem is the fixed crest height, which eliminates the possibility of passing flows via the velocity barrier at water levels below the crest. This concept does not have the flexibility with respect to operation at varying water levels that the gated structure has. This idea was not considered feasible and was not evaluated.

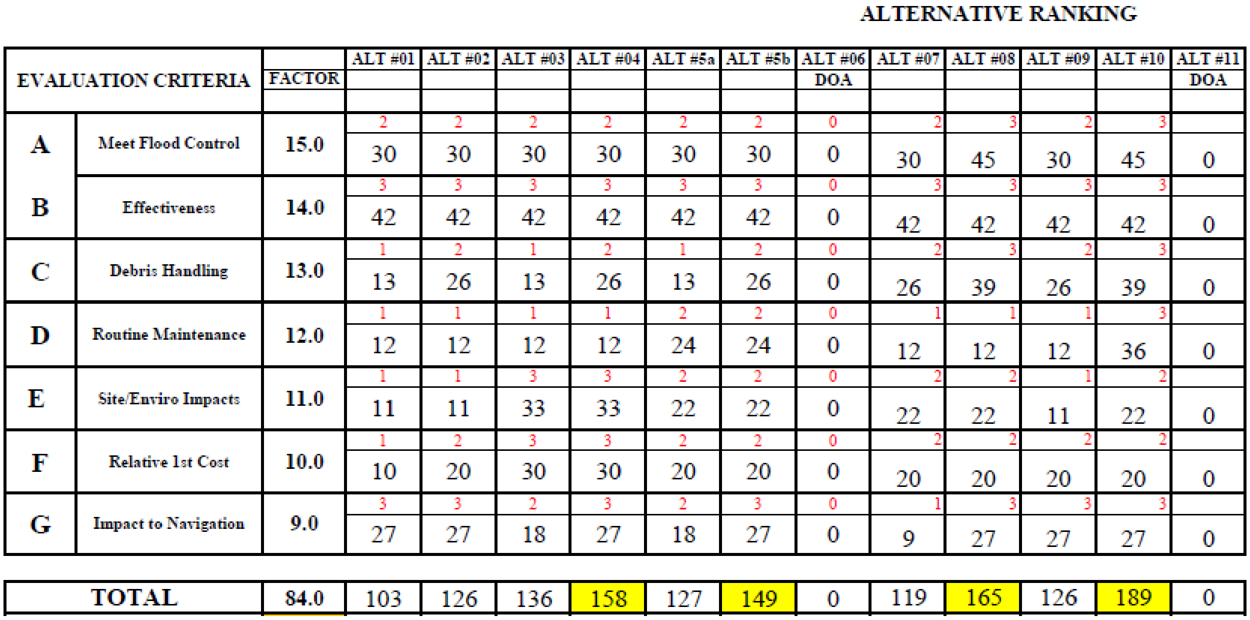
6 Evaluation Criteria

6.1 The team developed a set of evaluation criteria based on the functions required for the project and the established design criteria conveyed to the team during the project overview presented by Chicago District PDT members. The evaluation criteria considered 7 primary elements inherent it to a design that would meet the challenge of the scope and continued mission requirements of the facilities.

6.2 There were two other considerations for criteria that were dismissed by the team. Staged capacity was considered as an evaluation factor but was dismissed because the team felt it was already covered in operation and maintenance criteria. Socio-economic Impacts was also considered but the team felt they were unable to determine these due to lack of local and political knowledge of the project.

6.3 The team ranked the evaluation criteria on the basis of relative importance. Each criterion was given the ranking factor and alternatives were paired against each other for comparative assessment. The criterion was rated on a scale of 1 to 3 based on: 1 rating for Poor; 2 rating for Good; and 3 rating for Better.

6.4 The Evaluation Matrix shown on the next page provides a summary of the highest ranked alternatives that the team evaluated. Noted on the basis of ratings for each alternative are provided in Appendix E. Two of the alternatives Alternative No's 6 and 11 were dismissed and labeled "DOA" for various reasons. Alternative No. 6 was perceived to be not efficient requiring a system inside the navigation lock that may have significant impact to navigation. For Alternative No. 11, the team had concerns about the ability to pass flows to meet flood control requirements and maintain a velocity barrier. Several types of weirs, partial pumped flow, and other drop head velocity barriers were discussed. Lack of driving head dismissed this alternative option.



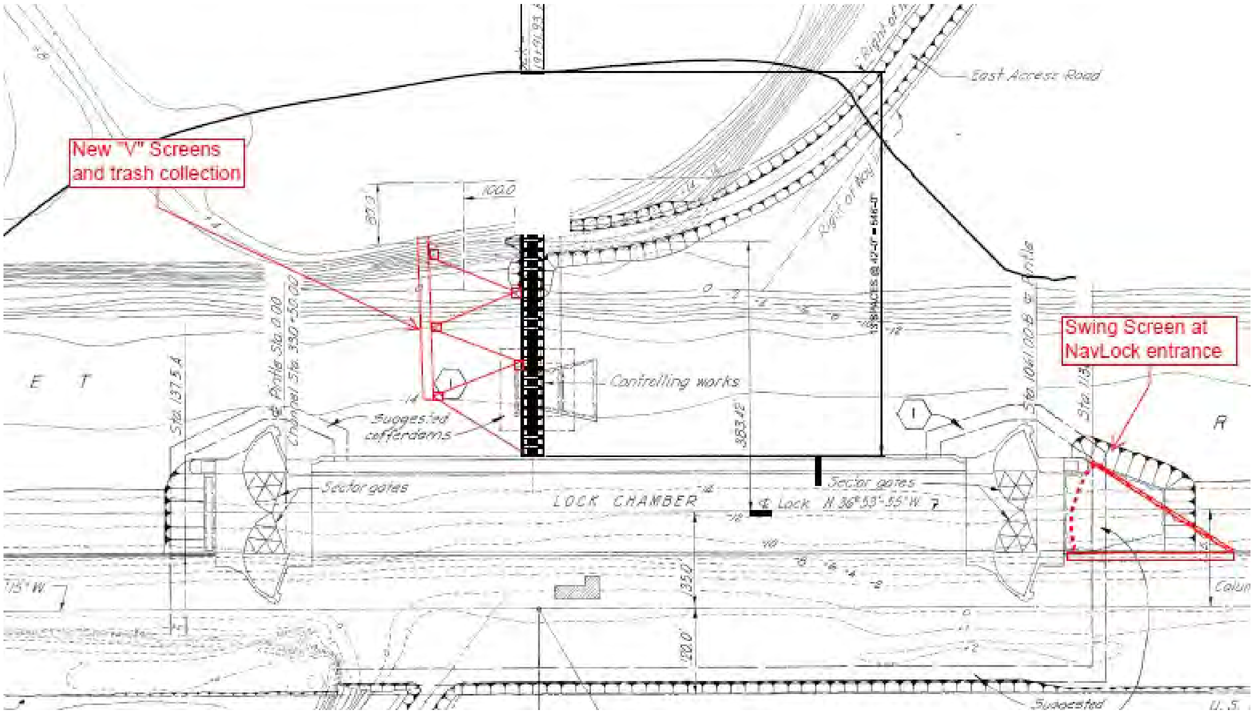
ALTERNATIVE RANKING

EVALUATION CRITERIA		FACTOR	ALT #01	ALT #02	ALT #03	ALT #04	ALT #5a	ALT #5b	ALT #06	ALT #07	ALT #08	ALT #09	ALT #10	ALT #11
									DOA					DOA
A	**Meet Flood Control**	**15.0**	2	2	2	2	2	2	0	2	3	2	3	
			30	30	30	30	30	30	0	30	45	30	45	0
B	**Effectiveness**	**14.0**	3	3	3	3	3	3	0	3	3	3	3	
			42	42	42	42	42	42	0	42	42	42	42	0
C	**Debris Handling**	**13.0**	1	2	1	2	1	2	0	2	3	2	3	
			13	26	13	26	13	26	0	26	39	26	39	0
D	**Routine Maintenance**	**12.0**	1	1	1	1	2	2	0	1	1	1	3	
			12	12	12	12	24	24	0	12	12	12	36	0
E	**Site/Enviro Impacts**	**11.0**	1	1	3	3	2	2	0	2	2	1	2	
			11	11	33	33	22	22	0	22	22	11	22	0
F	**Relative 1st Cost**	**10.0**	1	2	3	3	2	2	0	2	2	2	2	
			10	20	30	30	20	20	0	20	20	20	20	0
G	**Impact to Navigation**	**9.0**	3	3	2	3	2	3	0	1	3	3	3	
			27	27	18	27	18	27	0	9	27	27	27	0
TOTAL		**84.0**	103	126	136	158	127	149	0	119	165	126	189	0

6.5 The team's focus was on exclusion of adult fish ANS. Given the burst speed of the ANS fish species of concern, the team focused primarily on physical barriers with velocity and screened opening size as an effective means to control egress from water back-flowing into Lake Michigan. While considering effective exclusion alternatives, meeting flood control was assumed to be a priority.

7 Proposed Alternative for Further Development

The team's proposed alterative for further development is Alternative 10 shown below. It ranked the highest based on the criteria ranking developed by the team.



Alternative 10

List of Appendices

Appendix A – Portland Charrette Team and LRC PDT Participant Roster

Appendix B -- Agenda for Design Charrette

Appendix C – Sketches of the Teams Alternatives

Appendix D – Sample Product Photos of Wedge Wire Screens

Appendix E – Evaluation analysis notes

Appendix F – Support Information requested from Chicago District PDT

Appendix G – Permissible Footprint for Electronic Barrier

Appendix A – Portland Charrette Team and LRC PDT Participant Roster

Date: 2013 Jun 27

Design Charette assisting the GLMRIS Study
O'Brien Lock Aquatic Nuisance Species Deterrent
Chicago, Illinois

Name	Organization	Email	Phone
Portland Team			
Liza Roy	CENWP-EC-HD	elizabeth.w.roy@usace.army.mil	503-808-4835
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Matt Hanson	CENWP-EC-DS	matthew.d.hanson@usace.army.mil	503-808-4934
Joe Russell	CENWP-EC-CC	joseph.b.russell@usace.army.mil	503-808-4917
Chicago PDT			
David Wethington	CELRC-PM-PM	david.m.wethington	312-846-5522
David Force	CELRC-TS-DT	david.w.force	312-846-5462
Lauren Fleer	CELRC-TS-D-C	lauren.a.fleer	312-846-5501
Rick Ackerson	CELRC-TS-D-HH	rick.d.ackerson	312-846-5511
Robert Balamut	CEMVR-OD-IV	robert.j.balamut	773-646-2183
Nikki Chaffin	CELRC-TS-DG	joannikki.n.chaffin	312-846-5469

Appendix B – Agenda for Design Charrette

Agenda for O'Brien Lock Design Charrette for Invasive Species Deterrent

Portland District's support for others to Chicago District

27 -28 June 2013

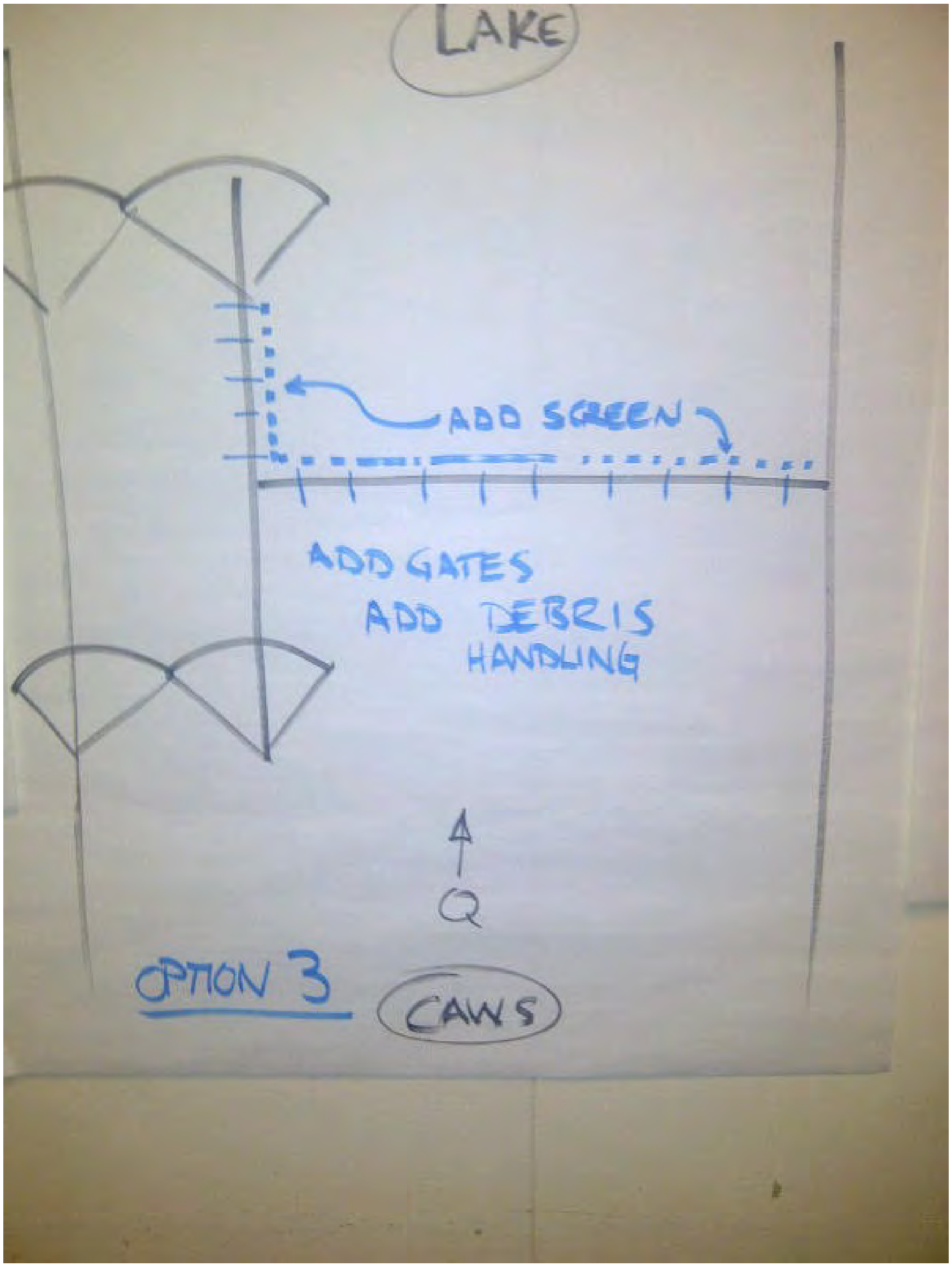
June 27th

7:30–7:45	*Welcome, introductions of participants, (Portland & Chicago) Teleconference*
7:45–8:15	*Chicago District Project Emphasis (expectations and goals) Teleconference*
8:15–9:00	*Portland Team review of Chicago's project information*
9:00–11:00	*Portland Team Analysis of project-specific functions*
	What are the issues/questions, strategies, and actions needed?
	Team discussion of design criteria requirements
	Previous ideas, concepts, & proposals
11:00–11:30	*Lunch*
11:30–12:00	*Back check with Chicago District PDT, TL, and/or PM (Teleconference)*
12:00–2:00	*Team continues brainstorming concepts*
2:00–2:15	*Break*
2:15–4:00	*Evaluation of Brainstorming Concepts*

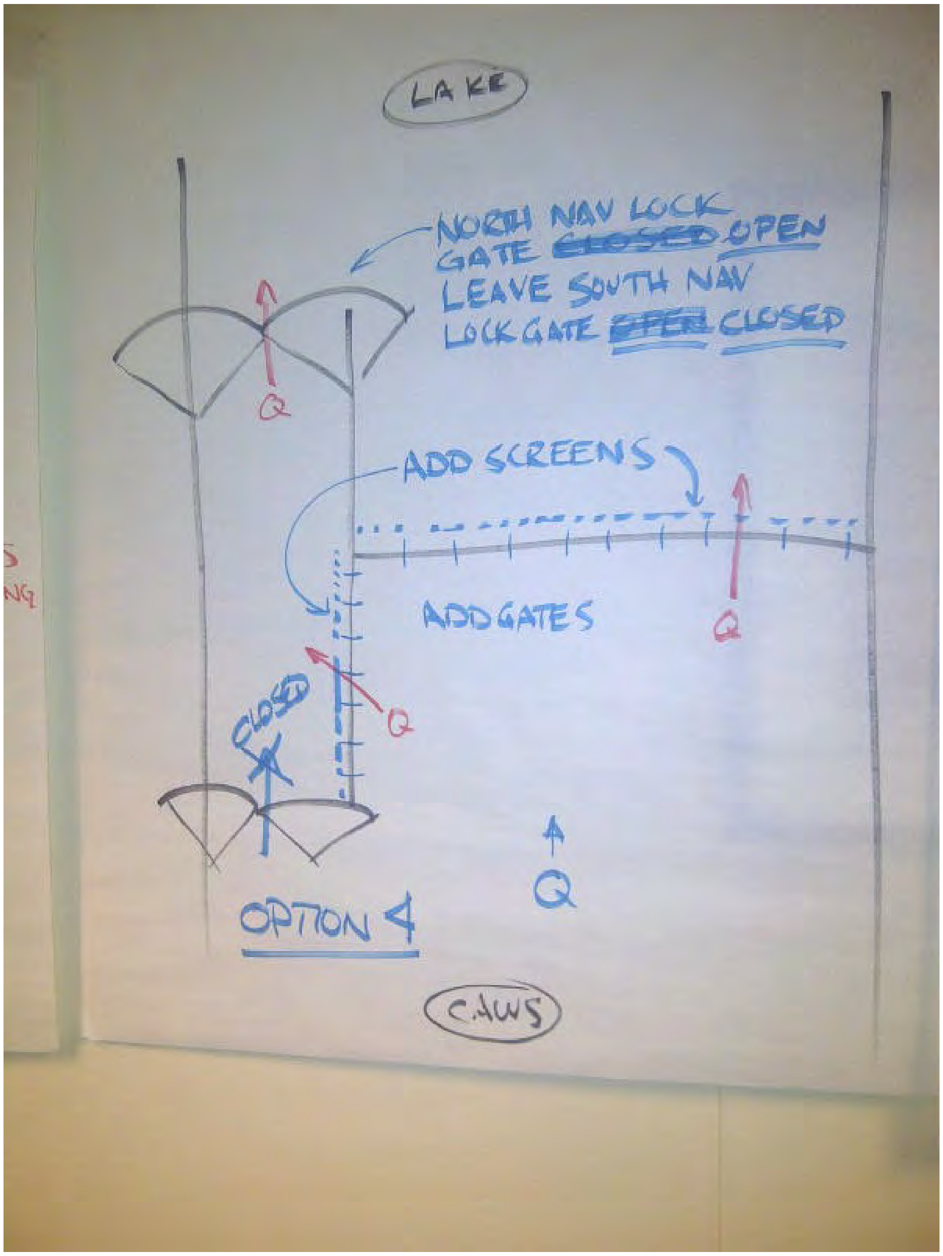
June 28th

8:00–8:30	*Team consensus of goals for path forward for the design focus*
8:30–10:00	*Present Findings through Webinar with Chicago District (Webinar with Chicago)*
	Bulleted items, drawing, and concepts
10:00–10:30	*Reporting out and next steps*

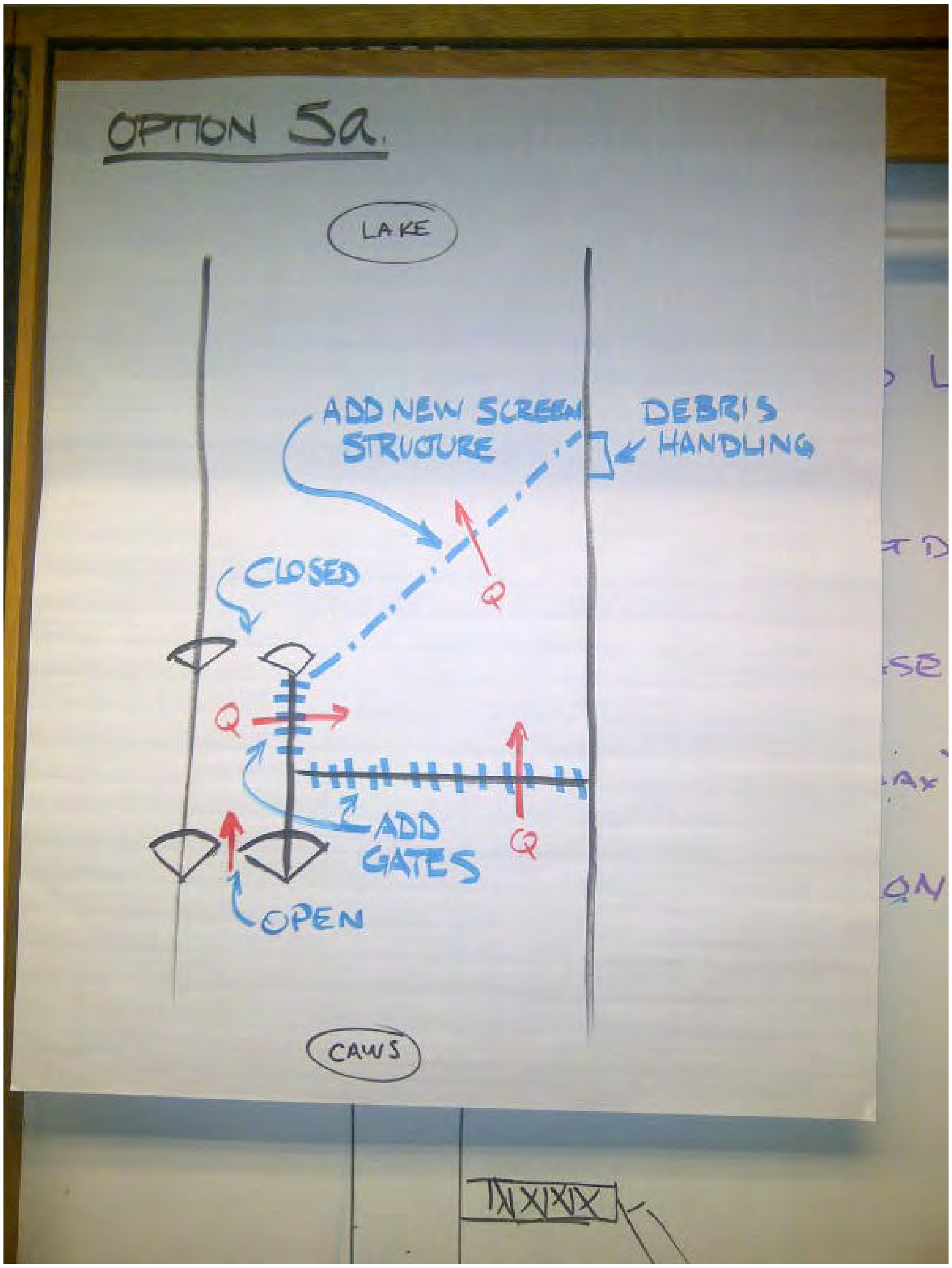
Appendix C – Sketches of the Teams Alternatives



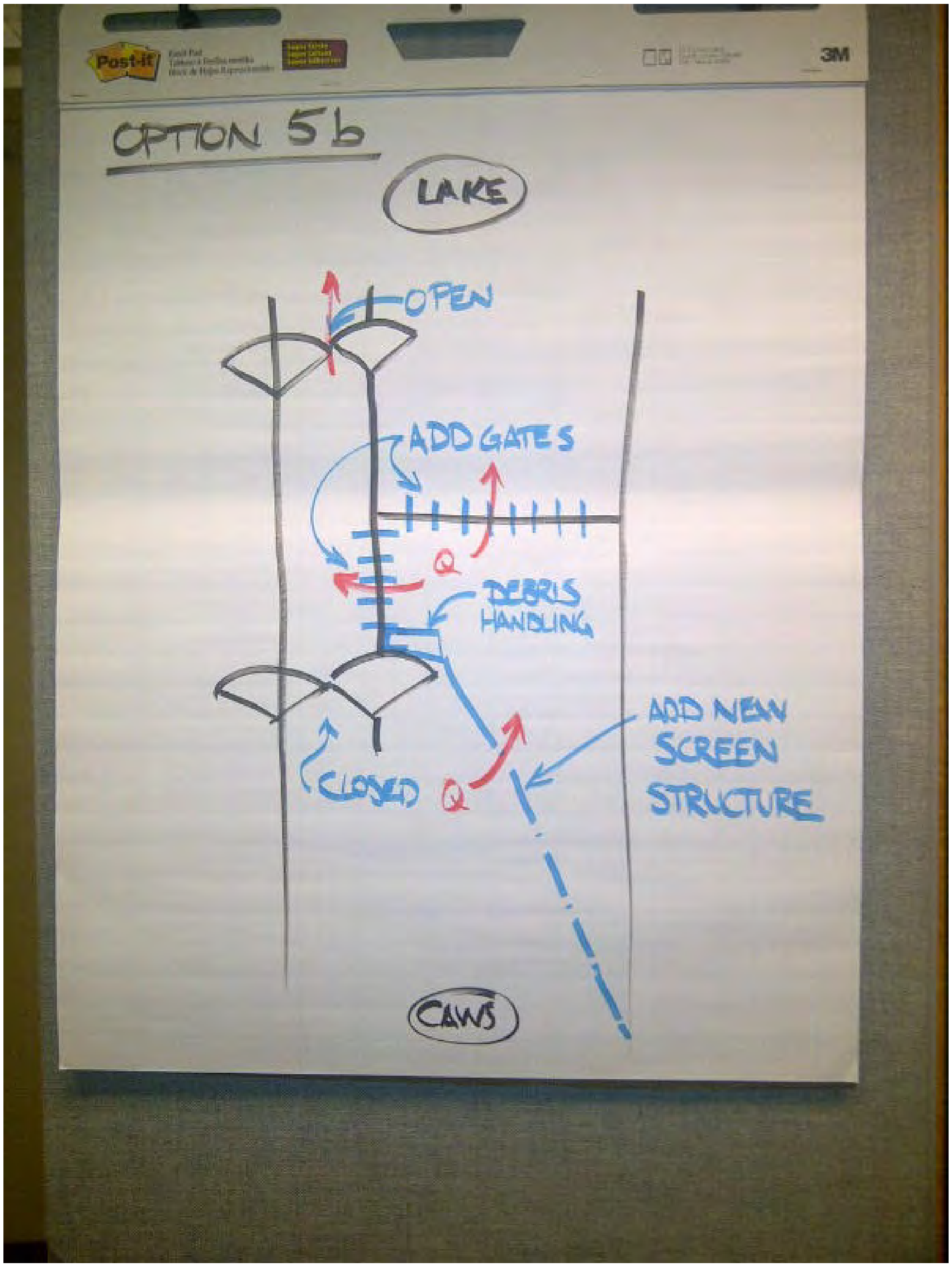
Alternative 3



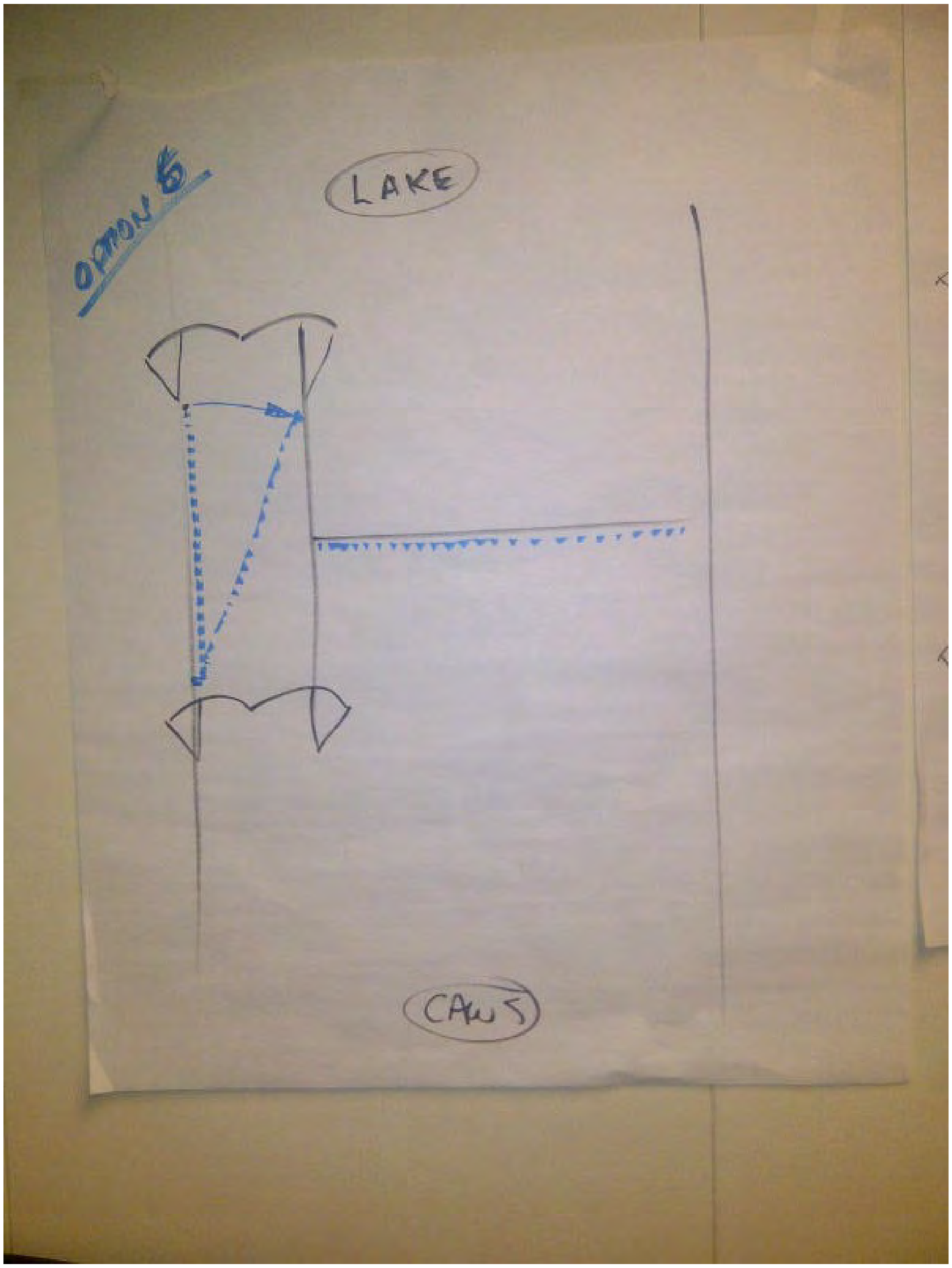
Alternative 4



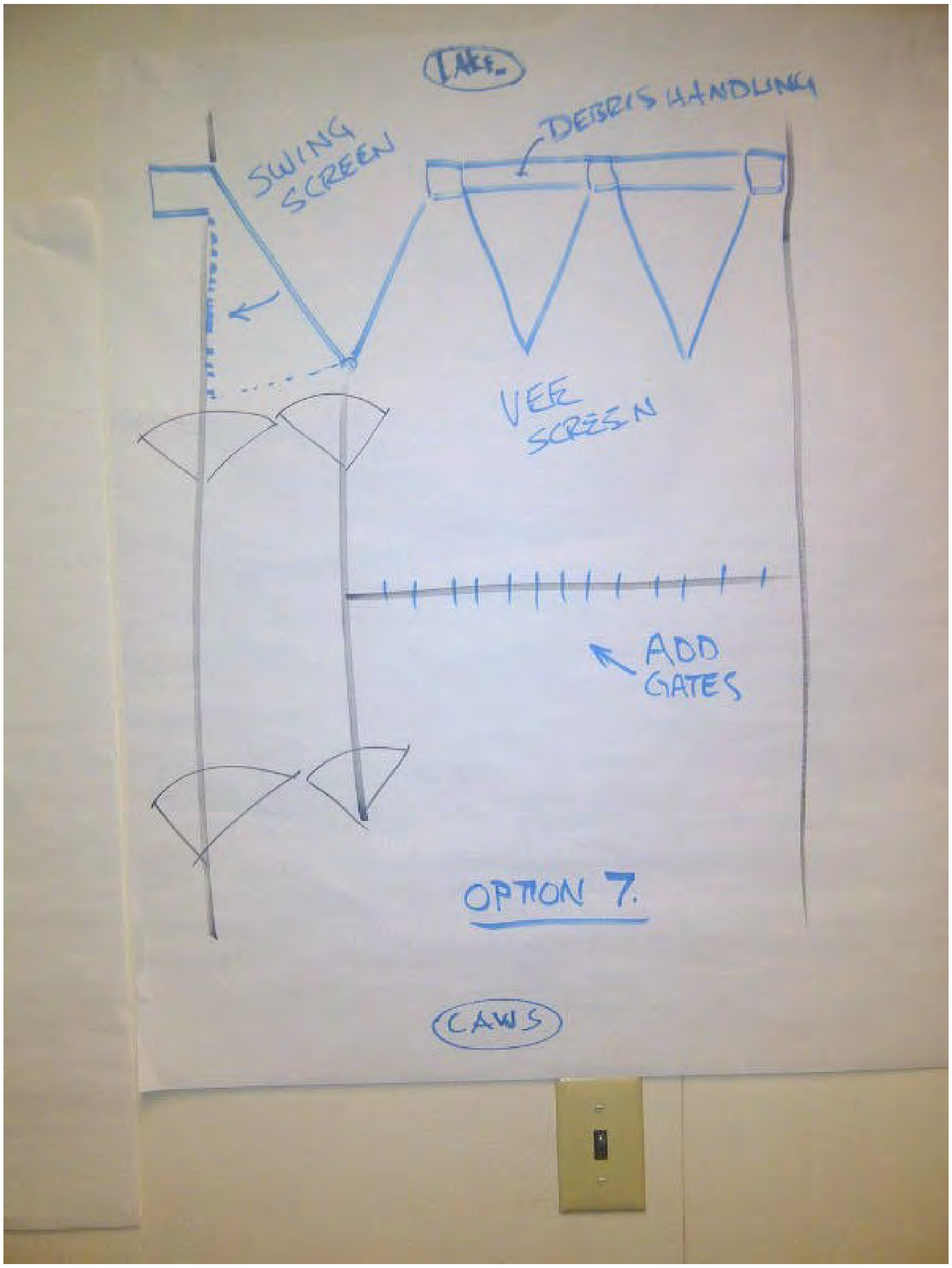
Alternative 5a



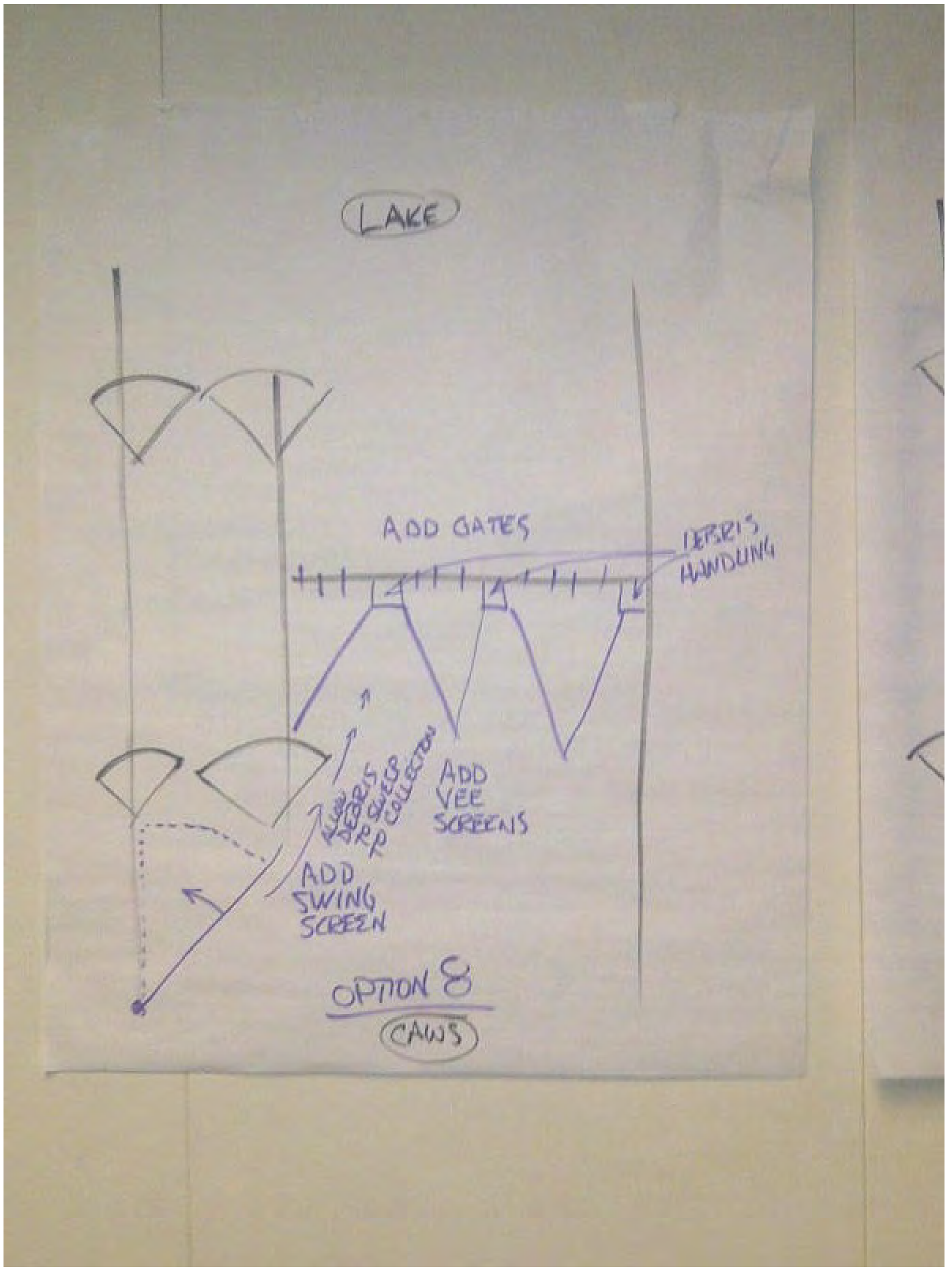
Alternative 5b



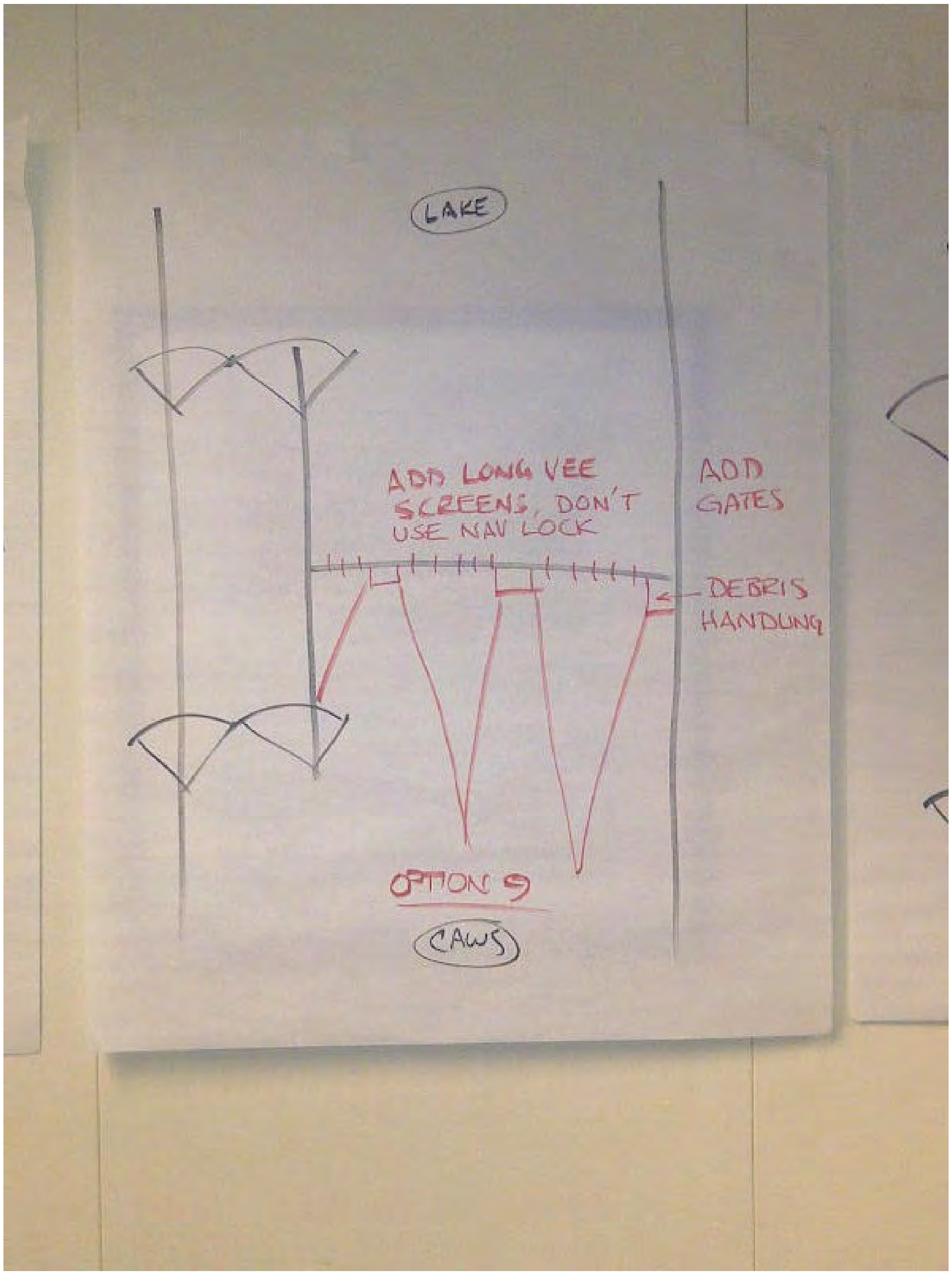
Alternative 6



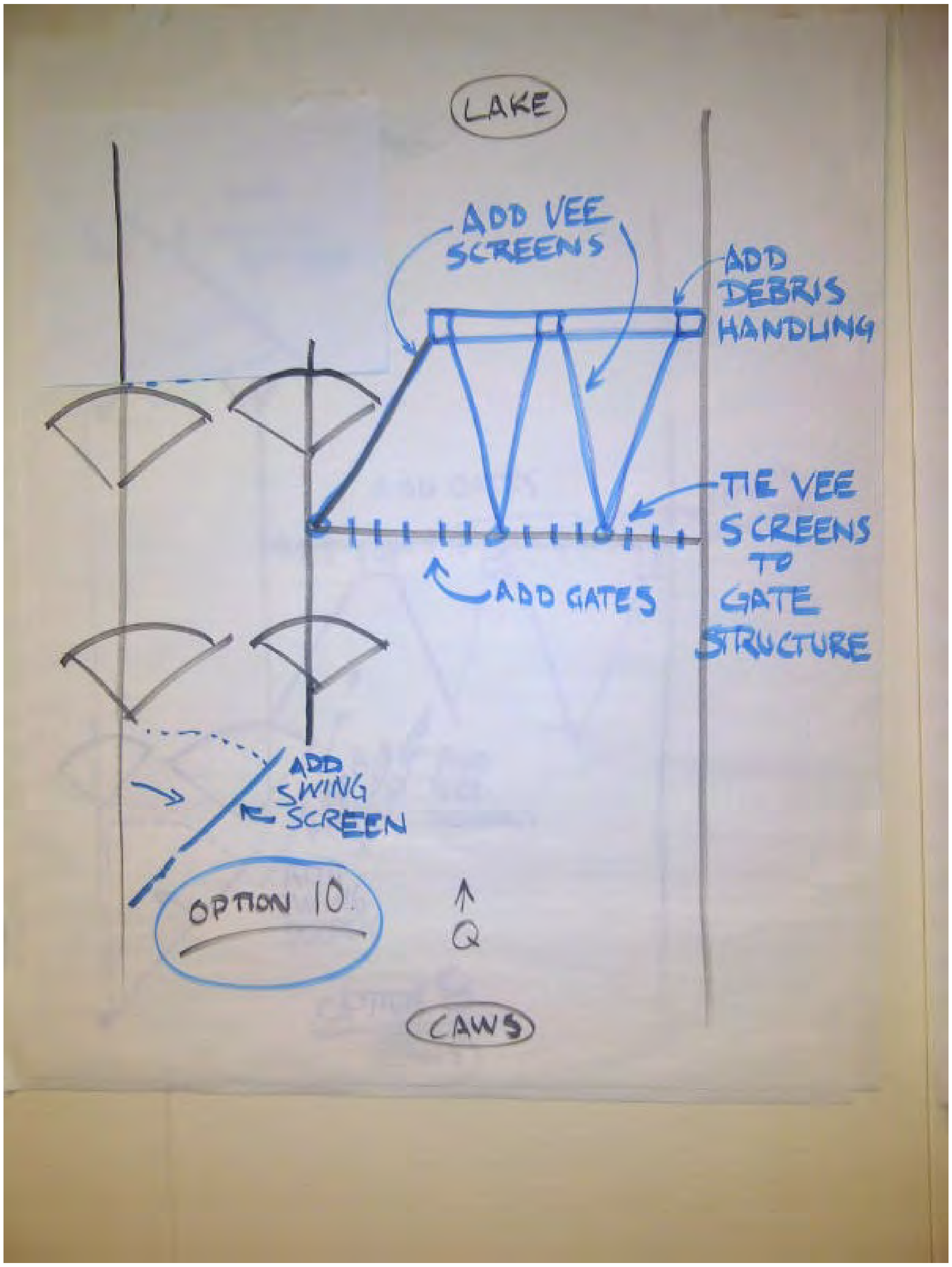
Alternative 7



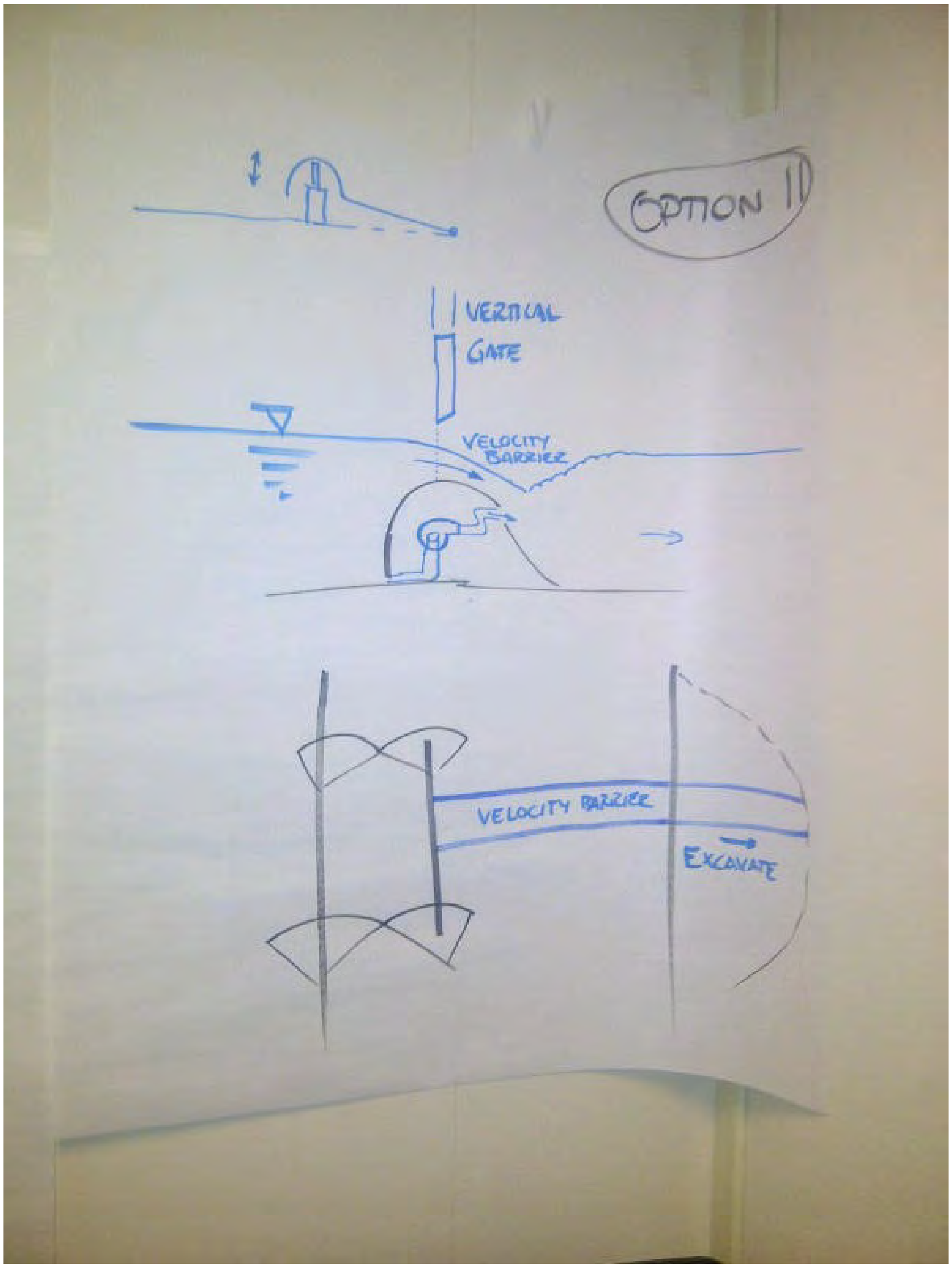
Alternative 8



Alternative 9

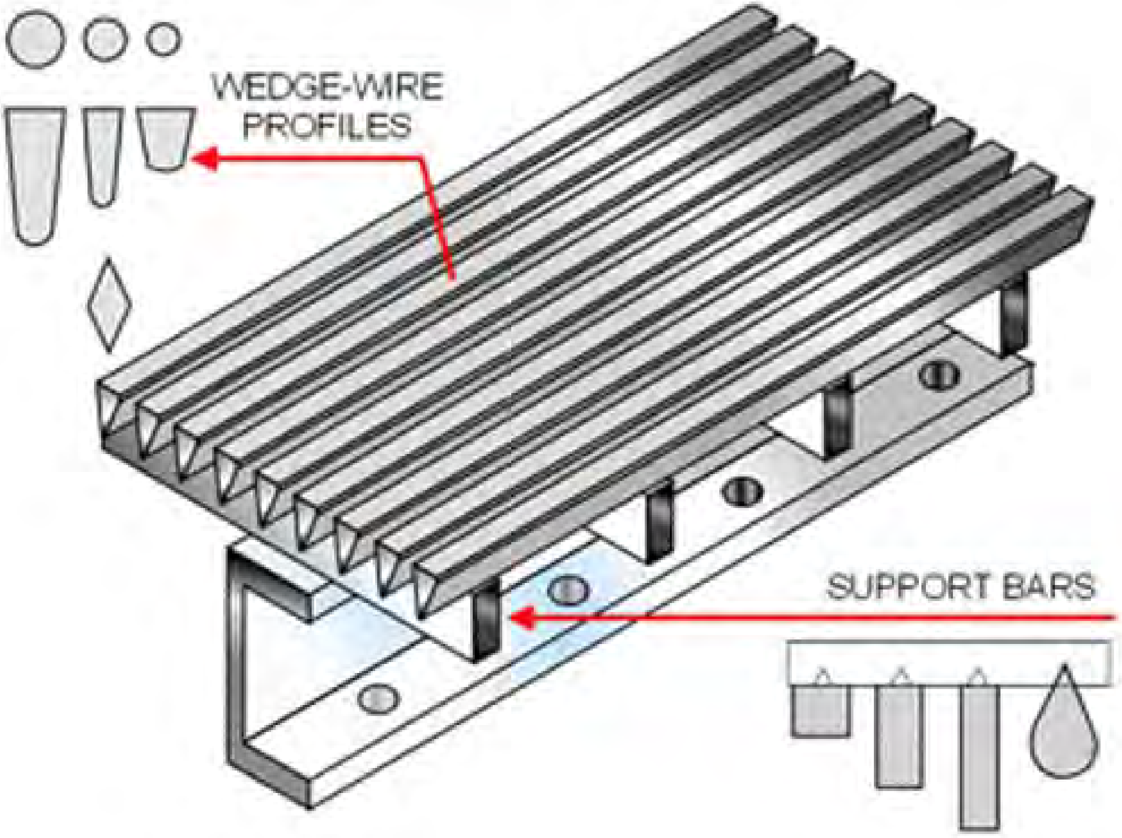


Alternative 10



Alternative 11

Appendix D – Sample Product Photos of Wedge Wire Screens

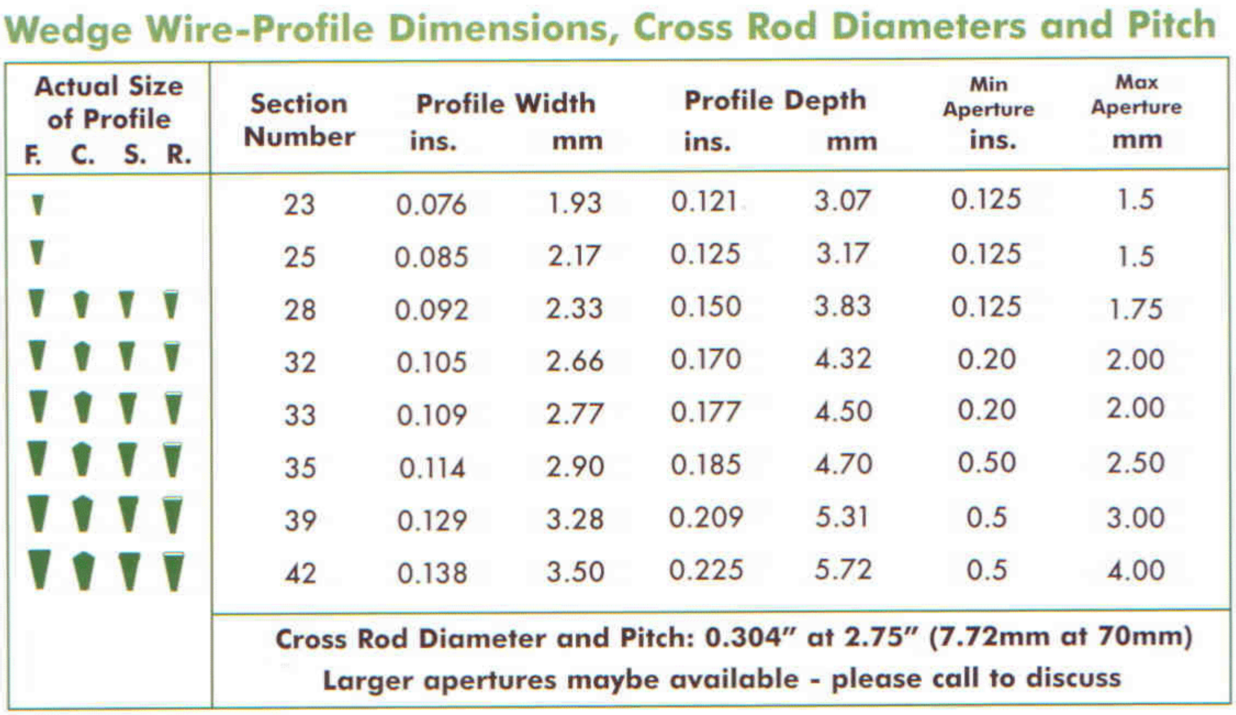


Example of Wedge Wire Screen Materials

Note the different wire profiles

Sample Screen Backbone

Sample Wedge Wire Photo



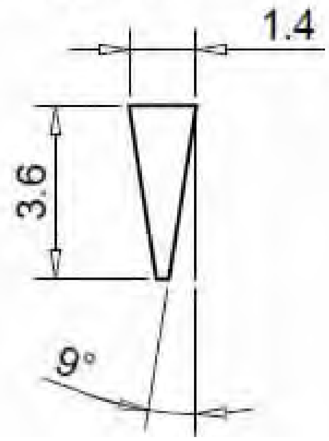
Wedge Wire-Profile Dimensions, Cross Rod Diameters and Pitch

Actual Size of Profile				Section Number	Profile Width		Profile Depth		Min Aperture	Max Aperture
F.	C.	S.	R.		ins.	mm	ins.	mm	ins.	mm
▼				23	0.076	1.93	0.121	3.07	0.125	1.5
▼				25	0.085	2.17	0.125	3.17	0.125	1.5
▼	▼	▼	▼	28	0.092	2.33	0.150	3.83	0.125	1.75
▼	▼	▼	▼	32	0.105	2.66	0.170	4.32	0.20	2.00
▼	▼	▼	▼	33	0.109	2.77	0.177	4.50	0.20	2.00
▼	▼	▼	▼	35	0.114	2.90	0.185	4.70	0.50	2.50
▼	▼	▼	▼	39	0.129	3.28	0.209	5.31	0.5	3.00
▼	▼	▼	▼	42	0.138	3.50	0.225	5.72	0.5	4.00

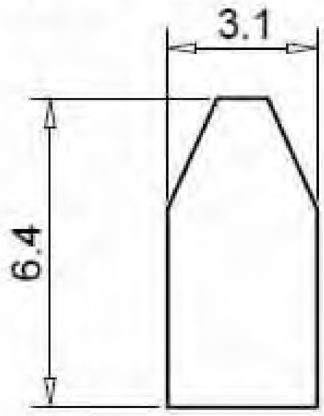
Cross Rod Diameter and Pitch: 0.304" at 2.75" (7.72mm at 70mm)
Larger apertures maybe available - please call to discuss

Chart from ScreenSystems.com

Detail Wedge Profile V - Rod
(Type SH85D)



Detail Support Rods
(Type SR250)



Appendix E – Evaluation analysis notes

Notes from Evaluation	June 27-28 2013	O'Brien Lock and Water Control Structure ANS Deterrent Design Charrette				
Criteria	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**	**Alt 5a**	**Alt 5b**
Meet Flood Control Requirements	Backup for screen system if debris issue is to open the navigation lock.	Backup for screen system if debris issue is to open the navigation lock.	Backup for screen system if debris issue is to open the navigation lock.	Backup for screen system if debris issue is to open the navigation lock.	Backup for screen system if debris issue is to open the navigation lock.	Backup for screen system if debris issue is to open the navigation lock.
Effectiveness	Assuming nav lock is never used to pass flood flows	Assuming nav lock is never used to pass flood flows	Assuming nav lock is never used to pass flood flows	Assuming nav lock is never used to pass flood flows	Assuming nav lock is never used to pass flood flows	Assuming nav lock is never used to pass flood flows
Debris Handling	Assuming screens are in slot, difficult to clean. This alternative could be improved if screens were installed out in front of dam so they were accessible for cleaning.	Debris handling similar to Alt 1 but a little improved, since some debris will end up in the cul de sac area.	Potential for debris to end up in the north end of the lock.	Debris handling similar to Alt 2, sluice gates along nav lock wall will have less debris.	Potential for debris to end up in the north end of the lock.	Debris handling better than single sluice gates with screens, but still large single screen that may have minimal sweeping flow at lower flows
Routine Maintenance	Labor intensive maintenance for debris system. Largest number of sluice gates, increased maintenance.	Labor intensive maintenance for debris system. Largest number of sluice gates, increased maintenance.	Labor intensive maintenance for debris system. Largest number of sluice gates, increased maintenance.	Labor intensive maintenance for debris system. Largest number of sluice gates, increased maintenance.	Largest number of sluice gates, increased maintenance. Screen maintenance should be less intensive than single sluice gate screens.	Largest number of sluice gates, increased maintenance. Screen maintenance should be less intensive than single sluice gate screens.
Site/Environmental Impacts	Significant excavation required	Significant excavation required, but less than Alt 1	On existing lock and dam structure	On existing lock and dam structure	New screen structure requires footprint in river.	New screen structure requires footprint in river.
Relative Cost	Excavation costs and new sluice gates will be significant cost	Similar to Alt 1, but slightly less excavation	New scluice gates required with screens.	New scluice gates required with screens.	New un-screened sluice gates required, plus screen structure.	New un-screened sluice gates required, plus screen structure.
Impact to Navigation	No impact to navigation lock	No impact to navigation lock	Potential for debris to foul the sector gates. No other impacsts assuming the nav lock wall sluice gates would be used at a backflow when navigation is already currently restricted.	No impacts assuming the nav lock wall sluice gates would be used at a backflow when navigation is already currently restricted.	Potential for debris to foul the sector gates. No other impacsts assuming the nav lock wall sluice gates would be used at a backflow when navigation is already currently restricted.	No impacts assuming the nav lock wall sluice gates would be used at a backflow when navigation is already currently restricted.

Notes from Evaluation	June 27-28 2013	O'Brien Lock and Water Control Structure ANS Deterrent Design Charrette				
Criteria	Alt 6 Not evaluated	Alt 7	Alt 8	Alt 9	Alt 10	Alt 11 Not evaluated
Meet Flood Control Requirements		Backup for screen system if debris is to open nav lock swing screen, but orientation may allow debris to prevent full opening.	Backup for screen system if debris issue is to open the navigation lock. Maintaining nav lock as flow route.	Need calculations to confirm number of sluice gates required and size of screen to meet flood control requirements.	Backup for screen system if debris issue is to open the navigation lock. Maintaining nav lock as flow route.	Concerned about ability to pass flows and meet flood control requirements and maintain velocity barrier. Considered several types of weirs, partial pumped flow, other velocity barriers.
Effectiveness			Assume we can design a bumper system to protect the nav lock screen from damage if impacted	Assuming nav lock is never used to pass flood flows		
Debris Handling	Debris handling for this alternative is not efficient and requires a system inside the navigation lock.	Two debris handling locations (separate sides of river)	Debris handling is all from east side of river and from dam.	Debris handling is all from east side of river and from dam, but screens will be very large and require extensive infrastructure for cleaning.	Debris handling is all from east side of river. Can tie into east shore, no debris into nav lock. Some large debris and ice may stay on river side.	
Routine Maintenance		Fewer new sluice gates, but significant screen structure terminating in river without easy access.	Fewer new sluice gates, but significant screen structure terminating in river without easy access.	Fewer new sluice gates, but significant screen structure terminating in river without easy access.	Fewer new sluice gates, screen structure is accessible from east bank bridge or dam structure. Staged capacity allows for less operations and maintenance cost.	
Site/Environmental Impacts		New screen structure requires footprint in river.	New screen structure requires footprint in river.	New screen requires largest footprint in river.	New screen structure requires footprint in river.	
Relative Cost		New un-screened sluice gates required, plus screen structure.	New un-screened sluice gates required, plus screen structure.	New un-screened sluice gates required, plus screen structure.	New un-screened sluice gates required, plus screen structure.	
Impact to Navigation	Debris handling has significant potential to impact navigation.	Potential for nav lock screen to be stuck in open position due to debris.	No significant impact to navigation	No significant impact to navigation	No significant impact to navigation	

Appendix F – Support Information requested from Chicago District PDT

	Information Request for O'Brien Lock Charette		NWP Charette Date 6/27/13 CELRC Responses
Folder			
1	**General & Background**	**Responsible**	**Information Provided**
	Background reports or studies that will give us a big picture of the issue	Ackerson	Master Control Manual
	Project footprint for alternatives (real estate, wetlands, access, or other known constraints to consider)	Chaffin	edit D1_TJOB.pdf in General & Background Folder
	Authorized purposes to be maintained (flood risk management, navigation, etc) and the metric to which they need to be maintained. -In categories below we request details on design Q, metric for providing navigation, metric for biological success.	Wethington	Varying levels of maintenance of authorized purposes are found in the various alternatives. For example, in a hydrologic separation scenario, maintenance of navigation is significantly compromised. Where possible, the Team has developed mitigation measures for adverse impacts to existing uses. We would encourage the VE Team to think "outside the box" and feel free to propose alternative concepts that are unconstrained by existing authorities. In addition, see responses to questions below.
	Previous alternatives considered, including significant alternatives that were discarded.	Force	Two alternatives were previously developed which both involved widening the channel to accommodate 34 - 10'x15' Sluice Gates. These options are shown in files: TJOBRIAN DAM REPLACEMENT GEN PLAN OPTION 1.pdf and TJOBRIAN DAM REPLACEMENT GEN PLAN OPTION 2.pdf. The 34 gate requirement was determined to be required to provide for the same head loss for the same flow if .4" screens are added to the gates, effectively increasing the number of gates by a factor of 2.2. Please see "sluice gate requirements summary and documentation.pdf" for backup for the gate requirements. If the .4" screens were not present or required, a total of only 16 - 10'x15' sluice gates would be required to handle the backflow events at Obrien lock and dam.

	Stakeholders	Wethington	
	Schedule constraints for construction - construction completion and work period constraints	Wethington	
	Permitting - any significant permitting hurdles that could affect alternative choice? Agencies involved?	Fleer	
2	**Hydrology**		
	System map with direction of flow (is flow one direction through structure? Or is this a bi-directional facility?	Ackerson	Flow is one direction through the proposed structure, towards the lake and only during major flood events
	Design Flow (min and max)	Ackerson	0 CFS to 21,602 (500 yr, 2017 condition)
	Timing and duration of design flows during year	Ackerson	During flood conditions, in general infrequent but can happen at any time of year
	Water surface elevations/gradients for design flows	Ackerson	see DSS hydrographs and historic flood spreadsheets
	Rating curves for outlets	Ackerson	submerged orifice equation
	Velocities during design flows (if available, we can estimate otherwise from other info)	Ackerson	computed Q/A
	Other flow requirements (irrigation/biological flows?)	Ackerson	N/A

3	**Drawings and Site Information**		
	Plan - Dam	Force	See "Plate 2 - T.J.O'Brien 2007 - TJ600019.pdf", "Plate 3 - T.J.O'Brien 2007 - TJ600015.pdf" and "Sluice Gate Cross Section.pdf" - Notes: New sluice gates will be 10'x15' vice 10'x10' shown. Existing Lock gates are typical curved sector gates.
	Plan - Nav Lock	Force	
	Section - Dam	Force	
	Section - Gates	Force	
	Section - Nav lock	Force	
	Details - Filling and emptying valves and conduits	Force	Culvert document2013-04-17-142522.pdf

Details - Gates	Force	See "Sluice Gate Cross Section.pdf. Lock gates are typical curved sector gates.
Bathymetry (or river profile and sections)	Fleer	
Site Photos (aerial and isometric photos of structures)	Balamut	
Known foundation constraints	Force	None known. Obrien Lock is consist of sheet pile cells driven to EL -35 with bearing piles driven to EL -40.
Utilities - are utilities available	Force	Yes. Utilities are available within the Obrien lock and dam area to support the existing lock operations and sluice gate operation.
Public access - required? Security issues?	Force	Access and security issues are typical for a Corps Lock facility. No known special access or security concerns.

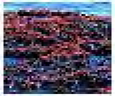
4	**Operations and Maintenance**		
	Navigation lock use requirements -typical frequency, cargo, vessel type/size -times of year -times when use is restricted? Flood flows?	Balamut	
	Use for passage of flood flow	Ackerson	
	Typical lock through time	Balamut	
	Can an alternate navigation route be used or is this the only available route? See next question.	Wethington	
	What is the metric for meeting the navigation mission at this project? Maintaining the lock-through time or some max-lock through time, frequency of scheduled lock availability, etc?	Wethington	
	Debris Handling - what type and quantity of debris is encountered at the site by season (if applicable)	Balamut	

Project operations - remote or on-site operator for sluice gates/nav lock? Additional personnel on site?	Balamut	
Water quality - known issues for corrosivity to materials	Fleer	

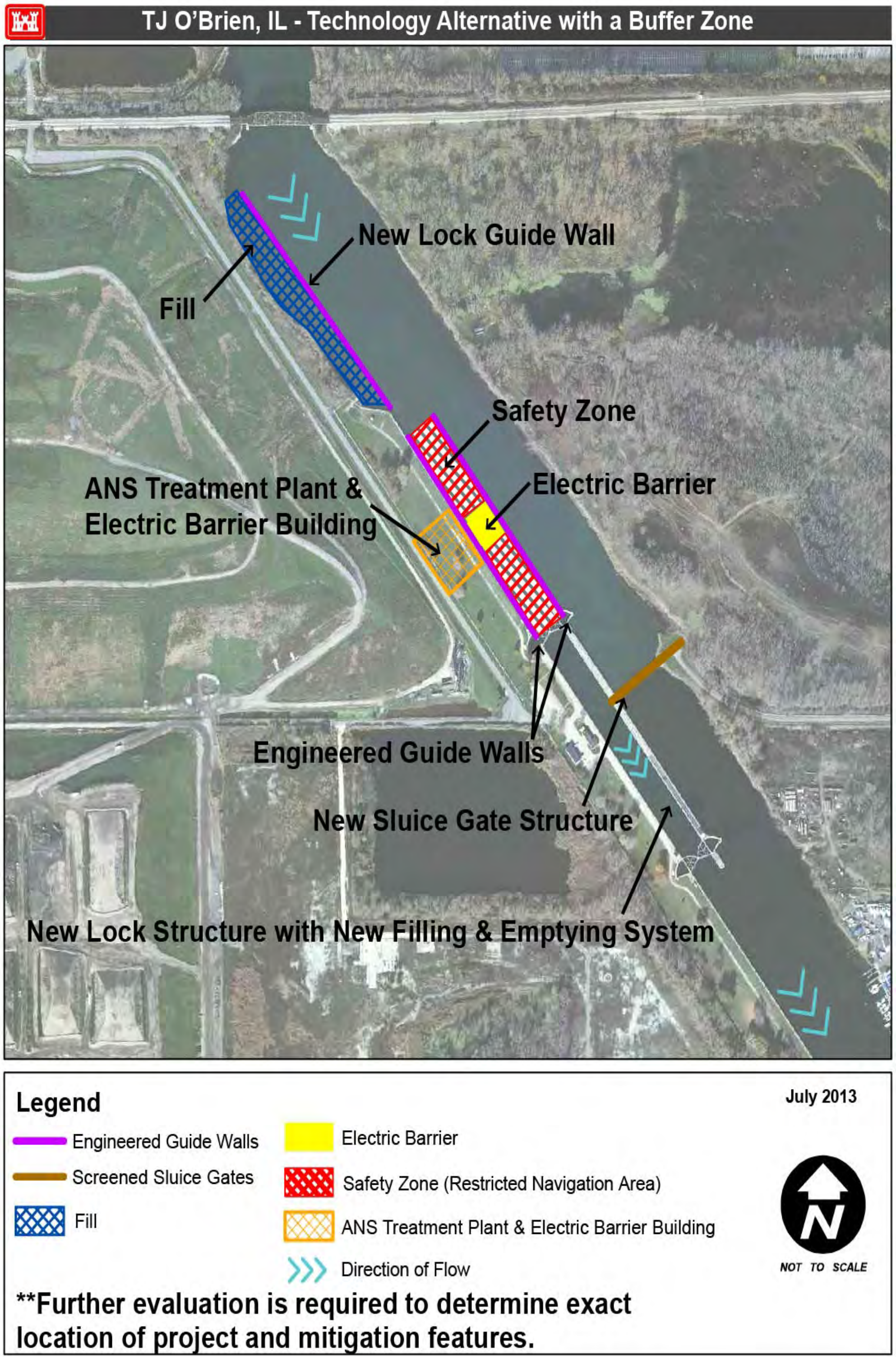
5	**Biological**		
	Species, life stage, size	Wethington - Cornish	ANS Chart for GL species - we are focused on the adult fish. During backflow events, water flows toward Lake Michigan. We are trying to prevent or reduce the risk of ANS interbasin transfer to the maximum extent possible, because it may not be technololgically feasible to achieve an absolute solution. This if for the Lake Michigan species from going past the TJ O'Brien control point and downstream toward the Illinois River. Reviewing the species and life stages identified in the Great Lakes ANS chart, we are only concerned that adult fish may be able to swim against the backflow current and enter the CAWS. Based on the information presented in the chart, we believe 0.4 inches is the required size of the holes in the fish screen. This number is based on a review of the body depths.
	Exclusion criteria - what is the metric for successful exclusion? 100% all times of the year, or something less, or different duration?	Wethington - Cornish	100% during backflow events - flood events
	Exclusion methods appropriate for alternative (screening only or other methods?)	Wethington - Cornish	B/c such large volumes of water, only during flood events, need to treat large volume quickly. Thought screens would be the best option. May also consider vertical drop barrier (http://glmris.anl.gov/documents/docs/anscontrol/VerticalDropBarrier.pdf) or a combination of screens and vertical drop barrier.

If screening, screen constraints -materials -sizing (hole sizing or shape constraints)	Wethington - Cornish	Durability of the material b/c big debris floats, and lots of debris, varied types , electricity requirements - only need during storm events, what happened if power goes out. Don't want people trying to repair specialized equipments in storms while standing over fast flowing water. Needs to be easy to operate, not manually inserting screens. not in operation all the time but needs to be reliable when it is needed. What happens if the screen is fouled under our conditions? Can their be a release such as a vertical drop barrier (http://glmris.anl.gov/documents/docs/anscontrol/VerticalDropBarrier.pdf).
Species distribution in the water column - horizontal and vertical distribution near lock and dam	Wethington - Cornish	concerned with whole channel
Terrestrial or aquatic species of interest to consider -impacts to consider -in water work periods to consider -need to provide passage for native species?	Wethington - Cornish	No need to provide passage for native species. No constraints on water work periods. Do not have to consider impacts on the connectivity of the channel with the addition of the screens.
Water quality constraints	Fleer	

GLMRIS Study Risk Assessment for the Great Lakes ANS Considering the Four Categories to Control Rated as either High or Medium Risk

Current Basin	Organism Type	Species	Dispersal Mechanisms	Picture	Life Stages	Size
Great Lakes	Crustacean	Fishhook Water Flea (*Cercopagis pengoi*)	Passive drift; Hull fouling; Ballast water		Eggs Adult	Resting Eggs - 0.25µm length - 6 to 13 mm with tail
		Bloody Red Shrimp (*Hemimysis anomala*)	Passive drift; Hull fouling; Ballast water		Adult (Eggs carried by adults)	length - 6 to 13 mm
	Algae	Grass Kelp (*Enteromorpha flexuosa*)	Passive drift; Temporary vessel attachment		Spores Adult	flexuosa flexuosa - 0.16 µm flexuosa paradoxa - 3.6mm
		Red Algae (*Bangia atropurpurea*)	Passive drift; Temporary vessel attachment		Spores Adult	spore diameter - 15.5µm filament diameter - 75 µm
		Diatom (*Stephanodiscus binderanus*)	Passive drift; Temporary vessel attachment		Cell	volume - 830µ3
	Plant	Reed Sweetgrass (*Glyceria maxima*)	Passive drift; Temporary vessel attachment		Seeds Rhizome fragments Rooted plant	seeds - 1.5-2mm stem length - 2.5 m high (max)
	Fish	Threespine Stickleback (*Gasterosteus aculeatus*)	Active swimming Burst speed - 4.9 fps Ballast water		Eggs Larvae Adult	Eggs- 1.2mm Larvae- 4.3mm Adult Length - 10 cm (max) Body Depth - 11mm Critical Swim Speed-3.6 ft/s
		Ruffe (*Gymnocephalus cernuus*)	Active swimming Burst speed - 11 fps Ballast water		Eggs Larvae Adult	Eggs- .34-1.3mm Larvae- 3.5-4.4mm Adult Length - 10.2-15.2 cm Body Depth - 28mm Burst Speed- 8.25 ft/s Critical Swim Speed-3.6 ft/s
		Tubenose Goby (*Proterorhinus semilunaris*)	Active swimming Burst speed - 5.3 fps Ballast water		Eggs Larvae Adult	Eggs- 1.3mm Adult Length - 11cm Body Depth - 19mm Critical Swim Speed-3.6 ft/s

Appendix G – Permissible Footprint for Electronic Barrier



**Further evaluation is required to determine exact location of project and mitigation features.

INTERNATIONAL WATER SCREENS

Traveling Water Screens
Traveling Fish Screens
Full Design, Manufacture, Installation and Service Support

IWS — A Female Owned Business
Web Site: internationalwaterscreens.com

Phone: 661-746-7959
Fax: 661-746-7943

Self Cleaning Traveling Screens and Self Cleaning Fish Screens

International Water Screens Co. specializes in designing and manufacturing traveling screens and self-cleaning fish screens for debris removal from your canal, river or reservoir. If you have debris in your water...we can remove it!

- We custom design each traveling screen for the location in question.
- Heavy duty materials of construction. Stainless steel 304-316-and 317 are available. Frames can also be made of aluminum or mild steel appropriately coated for your location.
- All wear surfaces covered with UHMW for long life.
- Internal spray bar with high pressure water that removes the debris from the back side of the screen.

A complete traveling screen system could include:

- Variable speed motor
- Trough or conveyor
- Elevator
- Solenoid
- Submersible pump
- Filter
- Control panel
- Differential level control
- Adjustable timer
- Hand/off/auto controls
- Belt openings as tight as 3/32" and open as 3"

Self Cleaning Fish Screens

International Water Screens also manufactures self cleaning Fish Screens. All Fish Screens are built to meet the specifications for your location. Whether your fish screens require openings no larger than 3/32" to protect fingerlings or your fish screens are designed to keep larger fish like grass eating carp from getting out of your system, we will design and build to your specifications.

Water Screen Applications

IWS Traveling Screens are being used successfully to remove debris from systems such as:

- Secondary water systems
- Cooling tower systems
- Pump inlet
- Canals
- Waste water systems
- Water Treatment facilities
- Power Generation
- Hydroelectric power facilities
- Golf Course Irrigation systems
- Fish Screens
- Nursery Irrigation

Typical Water Pump Inlet

Hoods are very popular for screens located in industrial plants or screens located near residential areas.

11' wide by 80' long vertical fish screens on a dam.

Industrial Cooling Towers/Power Plants

Cooling Tower water can become polluted with debris such as algae, plastics. These items can create problems by plugging the openings in the cooling tower water lines. Removal of the debris is easy with the IWS Traveling Screens.

Secondary Water Systems

Secondary Water systems utilize IWS Traveling Screens to remove debris prior to the water entering the pipeline taking the water to the houses for lawn watering. Debris that would normally plug off sprinklers is simply removed at the source.

Secondary water systems are being designed and built where water is precious. Secondary is normally run-off water which has debris in it. Secondary water delivery systems deliver untreated water to their customers. Removal of the debris from the water is necessary, as most of the secondary water is used for irrigating yards and fields.

Secondary Water Systems (recovered water) utilizes International Water Screens Traveling screens to remove debris such as twigs, limbs, leaves and garbage just prior to reservoirs, pump stations or pipelines.

Whether the secondary water source is a river, canal,or a reservoir, IWS can design a screen for your needs.

It was once necessary to have operations personnel spend their time raking debris from trash racks. IWS Traveling Screens allow operators to spend their working hours more productively, as the Traveling screens will remove the debris from the waterway automatically. A daily visit (for minutes) to the screen is all that is required, where it can take hours of manpower to remove the debris from racks.

International Water Screens designs, builds installs (or supervises installation) of the traveling screens. We will outfit the screen with stainless steel belting with openings as tight (closed) or as large (open) as is required. Your IWS traveling screens will be set on a timer and will come on for a set period of time, and then shut off for a set period of time. Normal run times are 5 minutes on 20 minutes off. These times can be adjusted to fit your needs for the location. If on a particular day, or days you experience extremely heavy debris in the water, simply turn the machine to the on position and the traveling screen will run until you set the machine back into the automatic mode.

Eliminate huge labor costs by installing IWS Traveling Screens in your cooling tower.

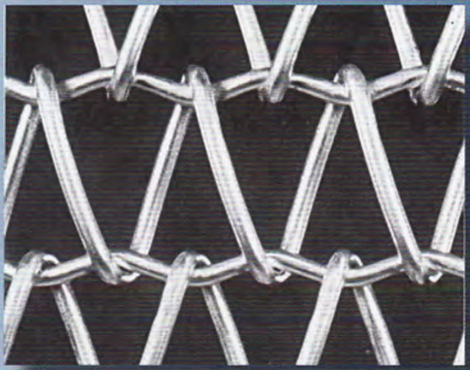
Secondary Water Screen

International Water Screens can design and build a screen that is powered by a generator.

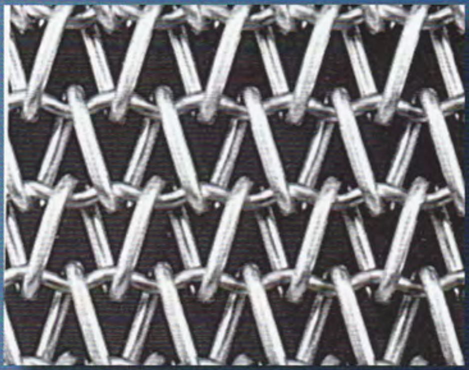
If you have debris in your water
We Can Remove It!

Contact us for complete Design,
Manufacturing, Repair and Installation

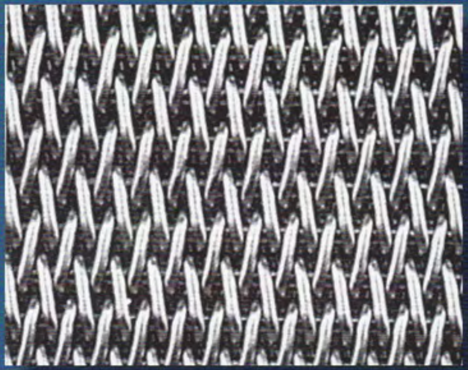
Belt Openings



1" Opening



1/4" Opening



Fish Screen Belt

ENCLOSURE D

HYDROLOGIC SEPARATION ALTERNATIVE, PHYSICAL BARRIER CONCEPT CALCULATIONS AND PLATES

Design of HydroSep Flood Walls

EM 1110-2-2502 Retaining and Flood Walls

Design Considerations:
1. Overturning Stability
2. Sliding Stability
3. Is a Grouting & Draingage Gallery needed?
4. Poor soil or concerns of uplift?
5. Seepage and scour protection

$\gamma_w := 62.4\ \frac{lbf}{ft^3}$ specific weight of water at 4°C

$\gamma_c := 150\ \frac{lbf}{ft^3}$ specific weight of concrete

Locations from North to South
1. Wilmette Pumping Station
2. Chicago Just West of Michigan Ave.
3. Chicago River East of Stickney Outfall
4. Cal-Sag West of Natalie Creek Confluence
5. O'Brien Lock West of the Bishop Ford Expressway
6. Little Cal East of Hart Ditch

Tailwater water height $h_t := 575\ ft$ $i := 1..6$

Overturning Analysis

Resultant location. The overturning stability is calculated by applying all the vertical forces (ΣV) and lateral forces for each loading condition to the dam and, then, summing moments (ΣM) caused by the consequent forces about the downstream toe. The resultant location along the base is:

Maximum Headwater Height at each location $h_h := \begin{bmatrix} 587.2 \\ 585.9 \\ 587.2 \\ 588.1 \\ 585.9 \\ 603.4 \end{bmatrix} \cdot ft$

Channel Depth at each location $h_b := \begin{bmatrix} 567.0 \\ 553.0 \\ 562.0 \\ 558.0 \\ 564.0 \\ 586.0 \end{bmatrix} \cdot ft$

Channel Tailwater Height at each location $h_{t_i} := \max\left(h_{b_i}, h_t\right)$ $h_t = \begin{bmatrix} 575 \\ 575 \\ 575 \\ 575 \\ 575 \\ 586 \end{bmatrix} ft$

Check Overturning Stability (positive counter-clockwise measured at base of dam toe)

$d_s := .8$ Dam slope

$$w_{d_i} := \frac{h_{h_i} - h_{t_i}}{d_s} = \begin{bmatrix} 15.25 \\ 13.625 \\ 15.25 \\ 16.375 \\ 13.625 \\ 21.75 \end{bmatrix} ft$$

width of dam at base per 0.8H to 1V per EM 1110-2-2200 section 4-3a(1)

Find Concrete Dam Area of each Section $j := 1..3$

Area of dam base:

$$A_{i,1} := \left(h_{t_i} - h_{b_i}\right) \cdot w_{d_i} = \begin{bmatrix} 122 \\ 299.75 \\ 198.25 \\ 278.375 \\ 149.875 \\ 0 \end{bmatrix} ft^2$$

Area of dam triangular segment:

$$A_{i,2} := \frac{1}{2} \cdot \left(h_{h_i} - h_{t_i}\right) \cdot \left(w_{d_i} - 5\ ft\right) = \begin{bmatrix} 62.525 \\ 47.006 \\ 62.525 \\ 74.506 \\ 47.006 \\ 145.725 \end{bmatrix} ft^2$$

Area of walkway surface

$$A_{i,3} := \left(h_{h_i} - h_{t_i}\right) \cdot 5\ ft = \begin{bmatrix} 61 \\ 54.5 \\ 61 \\ 65.5 \\ 54.5 \\ 87 \end{bmatrix} ft^2$$

Total Area of each dam

$$A_{T_i} := A_{i,1} + A_{i,2} + A_{i,3} = \begin{bmatrix} 245.525 \\ 401.256 \\ 321.775 \\ 418.381 \\ 251.381 \\ 232.725 \end{bmatrix} ft^2 \qquad A = \begin{bmatrix} 122 & 62.525 & 61 \\ 299.75 & 47.006 & 54.5 \\ 198.25 & 62.525 & 61 \\ 278.375 & 74.506 & 65.5 \\ 149.875 & 47.006 & 54.5 \\ 0 & 145.725 & 87 \end{bmatrix} ft^2$$

Find Concrete Dam Centroid in x direction of each Section from downstream toe

$$X_{A_{i,1}} := \frac{w_{d_i}}{2} = \begin{bmatrix} 7.625 \\ 6.812 \\ 7.625 \\ 8.187 \\ 6.812 \\ 10.875 \end{bmatrix} ft \qquad X_{A_{i,2}} := \frac{\left(w_{d_i} - 5\ ft\right)}{2} = \begin{bmatrix} 5.125 \\ 4.312 \\ 5.125 \\ 5.687 \\ 4.312 \\ 8.375 \end{bmatrix} ft \qquad X_{A_{i,3}} := w_{d_i} - 5\ \frac{ft}{2} = \begin{bmatrix} 12.75 \\ 11.125 \\ 12.75 \\ 13.875 \\ 11.125 \\ 19.25 \end{bmatrix} ft$$

$$X_A = \begin{bmatrix} 7.625 & 5.125 & 12.75 \\ 6.812 & 4.312 & 11.125 \\ 7.625 & 5.125 & 12.75 \\ 8.187 & 5.687 & 13.875 \\ 6.812 & 4.312 & 11.125 \\ 10.875 & 8.375 & 19.25 \end{bmatrix} ft$$

$$A_{i,1} \cdot X_{A_{i,1}} = \begin{bmatrix} 930.25 \\ 2.042 \cdot 10^3 \\ 1.512 \cdot 10^3 \\ 2.279 \cdot 10^3 \\ 1.021 \cdot 10^3 \\ 0 \end{bmatrix} ft^3$$

$$A_{i,2} \cdot X_{A_{i,2}} = \begin{bmatrix} 320.441 \\ 202.714 \\ 320.441 \\ 423.754 \\ 202.714 \\ 1.22 \cdot 10^3 \end{bmatrix} ft^3$$

$$A_{i,3} \cdot X_{A_{i,3}} = \begin{bmatrix} 777.75 \\ 606.312 \\ 777.75 \\ 908.812 \\ 606.312 \\ 1.675 \cdot 10^3 \end{bmatrix} ft^2 \cdot ft$$

Find Concrete Dam Centroid in x direction from downstream toe

$$X_{T_i} := \frac{1}{A_{T_i}} \cdot \sum_{j=1}^{3} A_{i,j} \cdot X_{A_{i,j}} = \begin{bmatrix} 8.262 \\ 7.105 \\ 8.111 \\ 8.633 \\ 7.28 \\ 12.44 \end{bmatrix} ft$$

Determine overturning stability (must be positive)

$$\left(\left(-\gamma_w\cdot\left(h_{h_i}-h_{b_i}\right)^2\cdot\frac{1}{2}\right)\cdot\left(\frac{1}{3}\cdot\left(h_{h_i}-h_{b_i}\right)\right)\right)+\left(\left(\gamma_w\cdot\left(h_{t_i}-h_{b_i}\right)^2\cdot\frac{1}{2}\right)\cdot\left(\frac{1}{3}\cdot\left(h_{t_i}-h_{b_i}\right)\right)\right)+\gamma_c\cdot A_{T_i}\cdot X_{T_i}=\begin{bmatrix}2.239\cdot10^5\\1.68\cdot10^5\\2.479\cdot10^5\\3.092\cdot10^5\\1.791\cdot10^5\\3.795\cdot10^5\end{bmatrix}\,\boldsymbol{lbf}$$

Applied Moment from headwater

Applied Moment from tailwater

Applied Moment from Concrete

Design for Uplift (per EM 1110-2-2200 section 3)

Uplift acts along entire base underside and varies from tailwater to headwater side

$$V_{uplift\_tailwater_i}:=\gamma_w\cdot\left(h_{t_i}-h_{b_i}\right)=\begin{bmatrix}499.2\\1.373\cdot10^3\\811.2\\1.061\cdot10^3\\686.4\\0\end{bmatrix}\frac{1}{ft^2}\cdot\boldsymbol{lbf}$$

$$V_{uplift\_headwater_i}:=\gamma_w\cdot\left(h_{h_i}-h_{b_i}\right)=\begin{bmatrix}1.26\cdot10^3\\2.053\cdot10^3\\1.572\cdot10^3\\1.878\cdot10^3\\1.367\cdot10^3\\1.086\cdot10^3\end{bmatrix}\frac{1}{ft^2}\cdot\boldsymbol{lbf}$$

$$F_{force\_uplift_i} := w_{d_i} \cdot \frac{\left(V_{uplift\_headwater_i} + V_{uplift\_tailwater_i}\right)}{2} = \begin{bmatrix} 1.342 \cdot 10^4 \\ 2.334 \cdot 10^4 \\ 1.818 \cdot 10^4 \\ 2.406 \cdot 10^4 \\ 1.399 \cdot 10^4 \\ 1.181 \cdot 10^4 \end{bmatrix} \frac{1}{ft} \cdot lbf$$

Find centorid of uplift force from toe

$$X_{uplift_i} := \frac{w_{d_i} \cdot \left(2 \cdot V_{uplift\_headwater_i} + V_{uplift\_tailwater_i}\right)}{3 \cdot \left(V_{uplift\_headwater_i} + V_{uplift\_tailwater_i}\right)} = \begin{bmatrix} 8.725 \\ 7.263 \\ 8.437 \\ 8.947 \\ 7.565 \\ 14.5 \end{bmatrix} ft$$

Determine overturning stability (must be positive)

$$\left(\left(-\gamma_w \cdot \left(h_{h_i} - h_{b_i}\right)^2 \cdot \frac{1}{2}\right) \cdot \left(\frac{1}{3} \cdot \left(h_{h_i} - h_{b_i}\right)\right)\right) + \left(\left(\gamma_w \cdot \left(h_{t_i} - h_{b_i}\right)^2 \cdot \frac{1}{2}\right) \cdot \left(\frac{1}{3} \cdot \left(h_{t_i} - h_{b_i}\right)\right)\right) + \gamma_c \cdot A_{T_i} \cdot X_{T_i} - F_{force\_uplift} \cdot X_{uplift} = \begin{bmatrix} -7.083 \cdot 10^5 \\ -7.642 \cdot 10^5 \\ -6.843 \cdot 10^5 \\ -6.23 \cdot 10^5 \\ -7.531 \cdot 10^5 \\ -5.527 \cdot 10^5 \end{bmatrix} lbf$$

Applied Moment from headwater

Applied Moment from tailwater

Applied Moment from Concrete

Chicago Ship and Sanitary Canal, -20ft
CAL-SAG, -20ft
Chicago River, -20ft
O'Brien -20ft
Wilmette -30ft
Little CAL (West of Hart Ditch) -20ft

Sliding Stability along single-plane failure surface page 4-8 EM 1110 2 2200

$\alpha := 0$ for horizontal slope

$$W := A_T \cdot \gamma_c = \begin{bmatrix} 3.683 \cdot 10^4 \\ 6.019 \cdot 10^4 \\ 4.827 \cdot 10^4 \\ 6.276 \cdot 10^4 \\ 3.771 \cdot 10^4 \\ 3.491 \cdot 10^4 \end{bmatrix} \frac{1}{ft} \cdot lbf$$

Weight along ith wedge

$$U := F_{force\_uplift} = \begin{bmatrix} 1.342 \cdot 10^4 \\ 2.334 \cdot 10^4 \\ 1.818 \cdot 10^4 \\ 2.406 \cdot 10^4 \\ 1.399 \cdot 10^4 \\ 1.181 \cdot 10^4 \end{bmatrix} \frac{1}{ft} \cdot lbf$$

Uplift along ith wedge

$$slugs := 32.2 \cdot 1\ lbm \qquad \rho := 1.94\ \frac{slugs}{ft^3} \qquad g := 32.2\ \frac{ft}{s^2} \qquad g_c := \frac{32.2\ lbm \cdot ft}{lbf \cdot s^2}$$

$$p := \frac{\rho \cdot g \cdot \left(h_h - h_t\right)}{g_c} = \begin{bmatrix} 5.292 \\ 4.728 \\ 5.292 \\ 5.683 \\ 4.728 \\ 7.548 \end{bmatrix} \frac{lbf}{in^2}$$

Pressure from water differentential

Browse for Image...

$$H_i := .5 \cdot p_i \cdot \left(h_{h_i} - h_{t_i}\right) = \begin{bmatrix} 4.649 \cdot 10^3 \\ 3.711 \cdot 10^3 \\ 4.649 \cdot 10^3 \\ 5.36 \cdot 10^3 \\ 3.711 \cdot 10^3 \\ 9.456 \cdot 10^3 \end{bmatrix} \frac{1}{ft} \cdot lbf$$

Horizontal force applied to dam

$$H := \gamma_w \cdot \left(h_h - h_t\right)^2 \cdot \frac{1}{2} = \begin{bmatrix} 4.644 \cdot 10^3 \\ 3.707 \cdot 10^3 \\ 4.644 \cdot 10^3 \\ 5.354 \cdot 10^3 \\ 3.707 \cdot 10^3 \\ 9.446 \cdot 10^3 \end{bmatrix} \frac{1}{ft} \cdot lbf$$

$\phi := 20$ Angle of internal friction for clay

$C := 1000 \, \frac{lbf}{ft^2}$ Cohesion on slip plane

$L := w_d$ Length along slip plane

$$FS := \frac{(W \cdot \cos(\alpha) - U + H \cdot \sin(\alpha)) \cdot \tan(\phi) + C \cdot L}{H \cdot \cos(\alpha) - W \cdot \sin(\alpha)} = \begin{bmatrix} 14.562 \\ 25.915 \\ 17.78 \\ 19.226 \\ 17.992 \\ 7.774 \end{bmatrix}$$

ATTACHMENTS:

1. HYDRAulic INPUT
2. Soil INPUT
3. CONCEPT DWG'S

Hydraulic Input 1 of 2

Lakefront Barrier Locations:

1) Wilmette Pumping Station on the North Shore Channel at river mile 340.795/1008

Crest elevation of Barrier based on river level =500 year baseline flood level (River side) + 3 ft freeboard = 584.2 ft NAVD + 3 ft =587.2 ft NAVD

Crest elevation of Barrier based on Lake Level = High Lake level+high set up = 3.7 ft CCD + 3.0 = +6.7 ft CCD = 585.9 ft NAVD

Elevation of the top of the proposed barrier = higher of river or lake = 587.2 ft NAVD

2) Chicago River Controlling Works on the Chicago River at river mile 327.12/1033

Crest elevation of Barrier based on river level =500 year baseline flood level (River side) + 3 ft freeboard = 582.7 ft NAVD + 3 ft =585.7 ft NAVD

Crest elevation of Barrier based on Lake Level = High Lake level+high set up = 3.7 ft CCD + 3.0 = +6.7 ft CCD = 585.9 ft NAVD

Elevation of the top of the proposed barrier = higher of river or lake = 585.9 ft NAVD

3) upstream of O'Brien Lock on the Little Calumet River North at river mile 324.50 (near Bishop Ford Expressway crossing)

Crest elevation of Barrier based on river level =500 year baseline flood level (River side) + 3 ft freeboard = 582.7 ft NAVD + 3 ft =585.7 ft NAVD

Crest elevation of Barrier based on Lake Level = High Lake level+high set up = 3.7 ft CCD + 3.0 = +6.7 ft CCD = 585.9 ft NAVD

Elevation of the top of the proposed barrier = higher of river or lake = 585.9 ft NAVD

Mid System Barrier Locations:

Chicago Sanitary and Ship Canal @ river mile 316.01 (East of Stickney WRP outfall (RS 315.81)

Crest elevation of Barrier based on river level =500 year baseline flood level (River side) + 3 ft freeboard = 584.2 ft NAVD + 3 ft =587.2 ft NAVD

2 of 2

Crest elevation of Barrier based on Lake Level = High Lake level+high set up = 3.7 ft CCD + 3.0 = +6.7 ft CCD = 585.9 ft NAVD

Elevation of the top of the proposed barrier = higher of river or lake = 587.2 ft NAVD

Calumet-Sag Channel @ river mile 315.89 (West of Natalie Creek confluence, river sta 315.91)

Crest elevation of Barrier based on river level =500 year baseline flood level (River side) + 3 ft freeboard = 585.1 ft NAVD + 3 ft =588.1 ft NAVD

Crest elevation of Barrier based on Lake Level = High Lake level+high set up = 3.7 ft CCD + 3.0 = +6.7 ft CCD = 585.9 ft NAVD

Elevation of the top of the proposed barrier = higher of river or lake = 588.1 ft NAVD

Little Calumet River South @ river station 86446 (Approximately 1000 ft west of Hart Ditch)

Crest set at 603.4 ft NAVD (set at the lowest overflow elevation near Hart Ditch)

500 year flood level (River side)= 585.06 ft NAVD

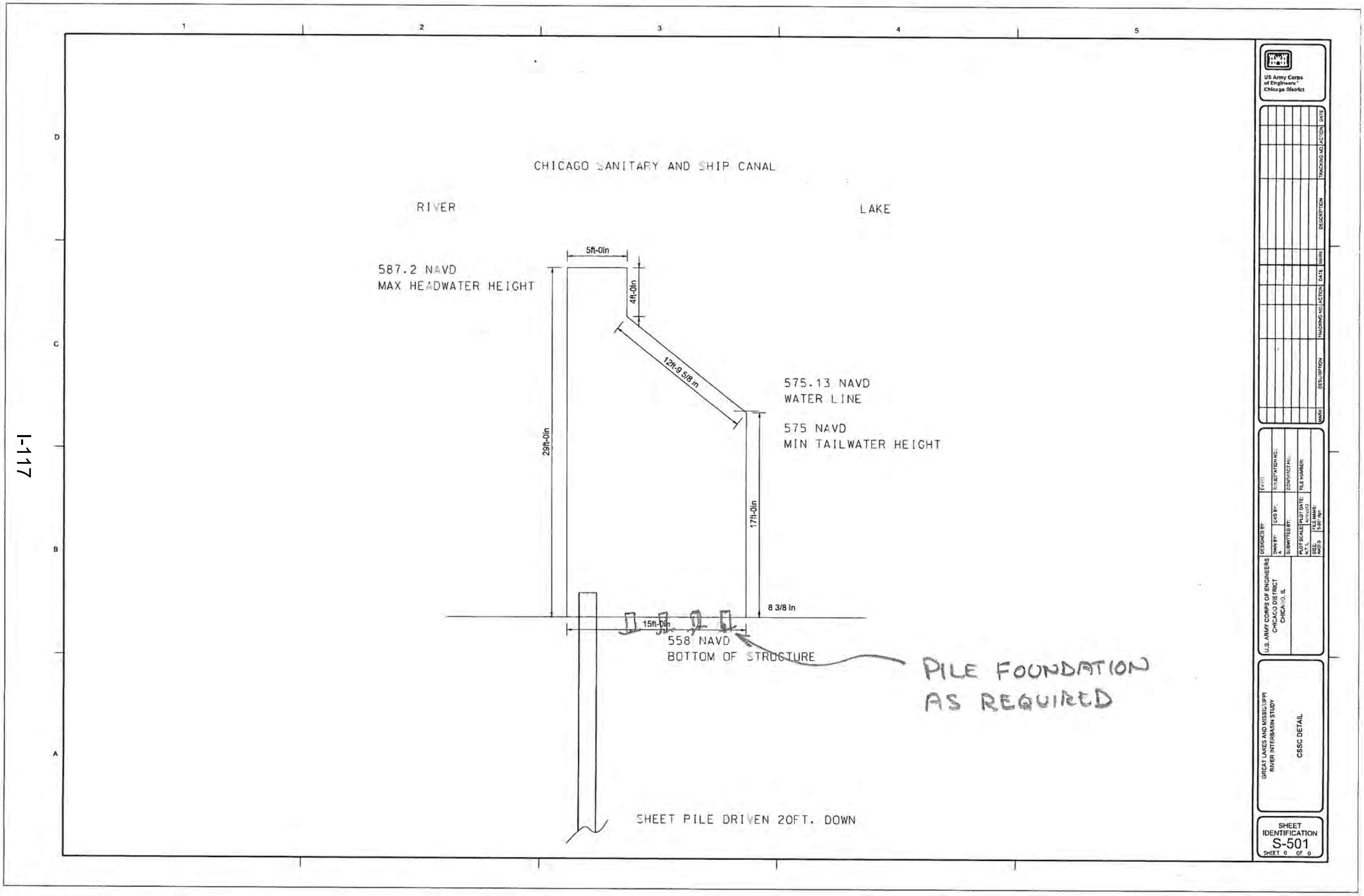
Soils Input 1of 1

Typical Values for Soil Types

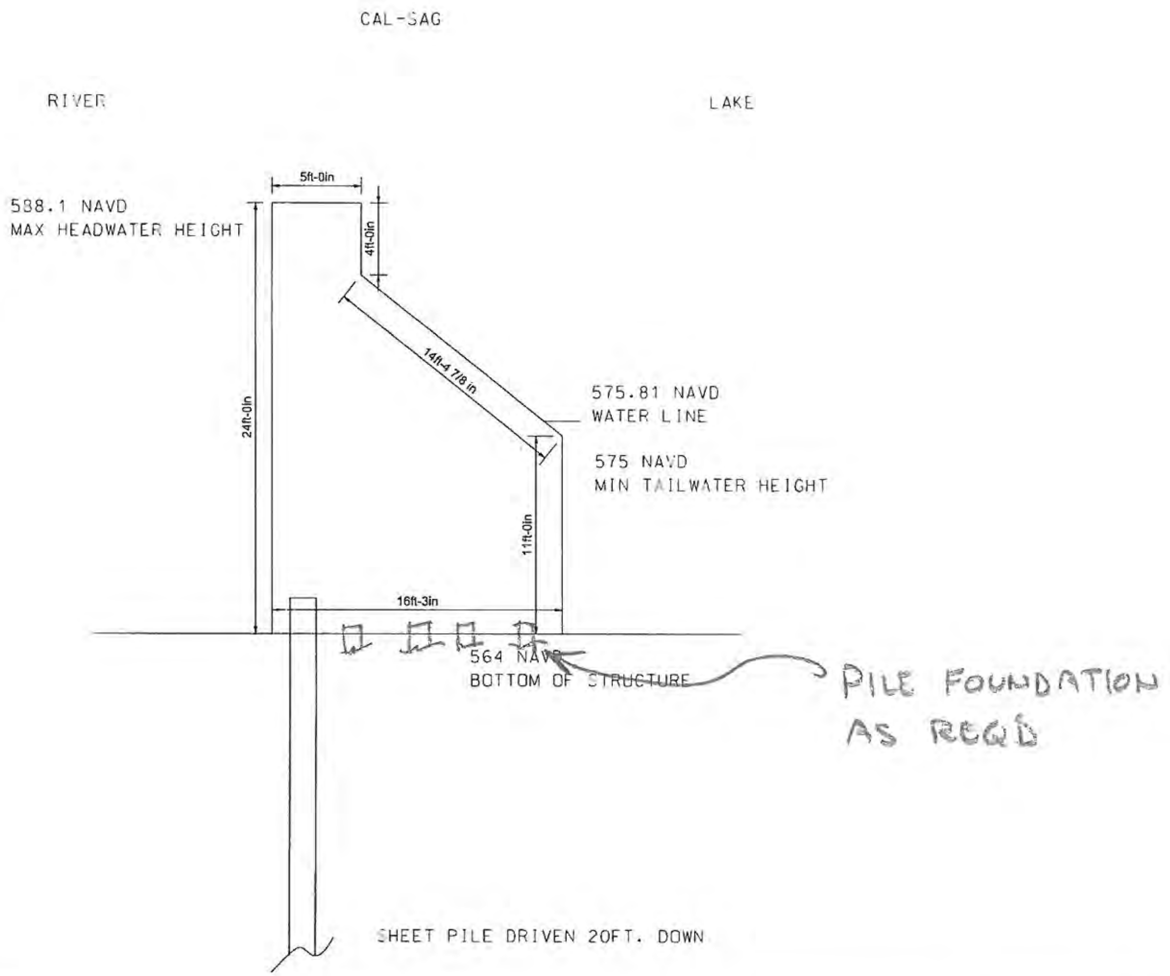
USGS Symbol		Compacted cohesion	Internal friction angle	
GW	well graded gravel	0	clay	20
GP	poorly graded gravel	0	loose sand	30-35
GM	silty gravel	0	medium sand	40
SW	well graded sand	0	dense sand	35-45
SP	poorly graded sand	0	silt	26-35
SM	silty sand	1050		
Sm-SC	Silty clayey sand	1050		
SC	clayey sand	1550		
ML	sandy silt	1400		
ML-CL	sandy silty clay	1350		
CL	clay	1800		
OL	organic silt/ organic clay	0		
MH	highly plastic silt	1500		
CH	high plasticity clay	2150		

Separation Locations	Depth to clay	Notes
Hammond	3-15 bgs	stratifications of clay found as close as 3 ft below the surface. Thicker clay layer typically found around 10-15 ft
Bishop Ford	10-15 ft bgs	a sand layer is typically directly over the clay layer. Top layer varies: silt, clay, sand
Alsip	cant find Thorton borings	Shallow borings near the area indicated clay presence as close to 0.2- 3.5 ft bgs
Stickney	as close as 2.5 bgs	Clay near the surface is stratified with other materials, thicker layers of clay are typically found around 12.5 ft bgs
Chicago	0-25 ft bgs	Silty clay was typically the first material encountered. About 6 ft thick at thinnest
Wilmette	no nearby borings	

CONCEPT DWG'S 1 of 6



2 of6



US Army Corps of Engineers
Chicago District

MARK | DESCRIPTION | TRACKING NO | ACTION | DATE

U.S. ARMY CORPS OF ENGINEERS
CHICAGO DISTRICT
CHICAGO, IL

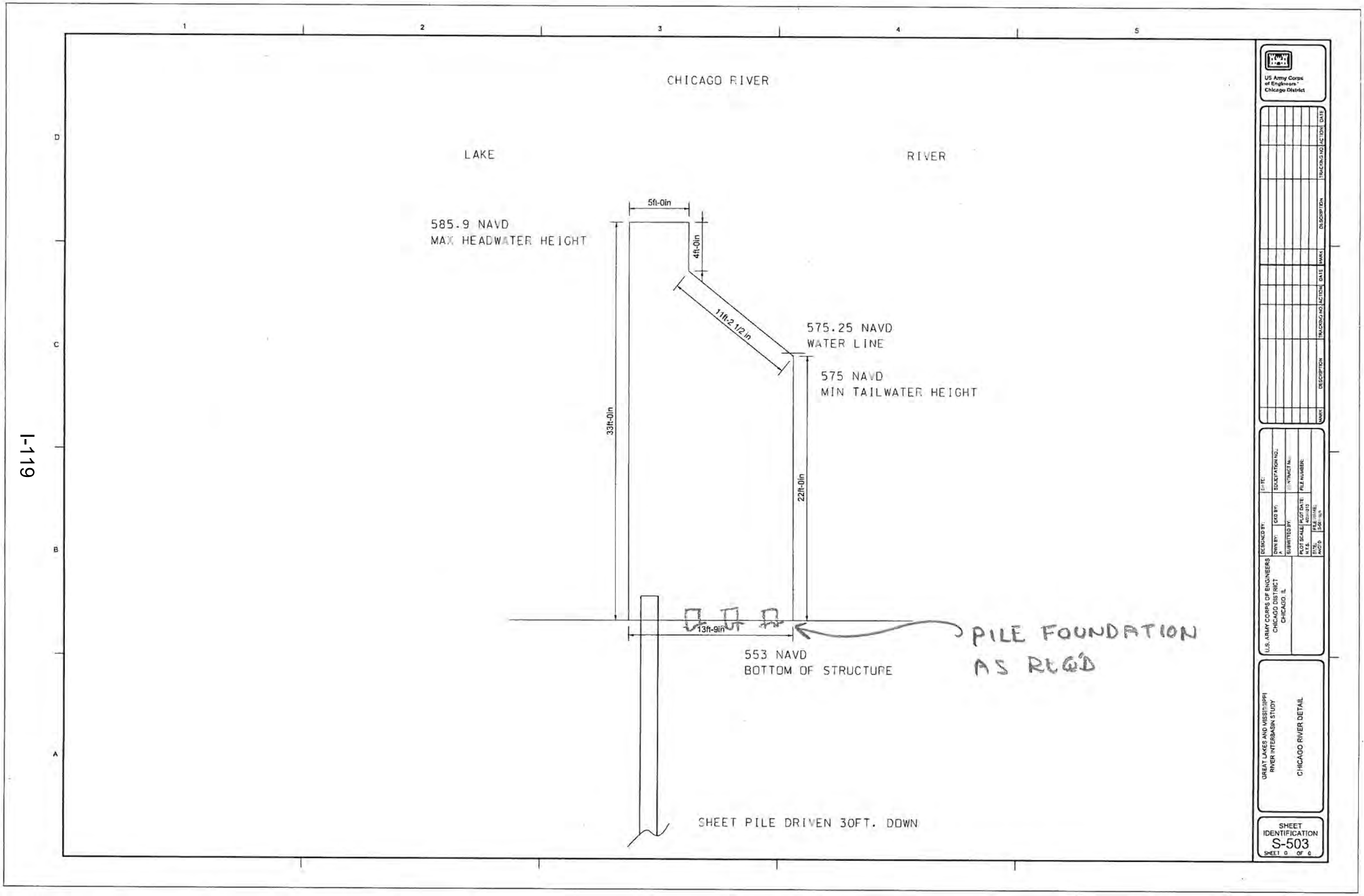
DESIGNED BY:
DATE:
DWN BY: A
CKD BY:
SOLICITATION NO.:
SUBMITTED BY:
CONTRACT NO.:
PLOT SCALE: N.T.S.
PLOT DATE: 4/29/2013
FILE NUMBER:
SIZE: ANSI D
FILE NAME: S-502.dgn

GREAT LAKES AND MISSISSIPPI
RIVER INTERBASIN STUDY

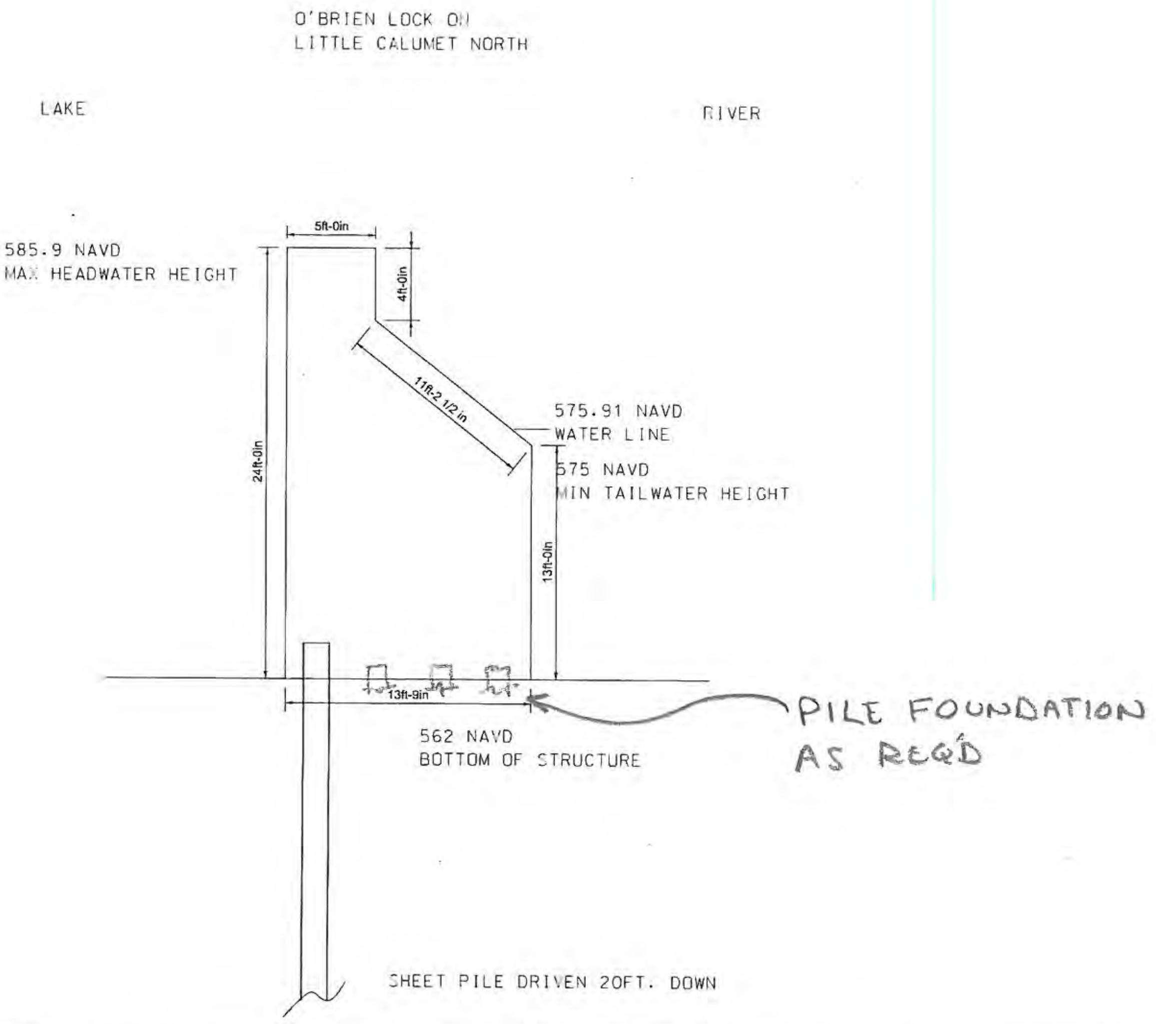
CAL SAG DETAIL

SHEET IDENTIFICATION
S-502
SHEET 0 OF 0

3 of 6


CHICAGO RIVER
LAKE
RIVER
585.9 NAVD
MAX HEADWATER HEIGHT
5ft-0in
4ft-0in
11ft-2 1/2 in
575.25 NAVD
WATER LINE
575 NAVD
MIN TAILWATER HEIGHT
33ft-0in
22ft-0in
13ft-9in
553 NAVD
BOTTOM OF STRUCTURE
PILE FOUNDATION
AS REQ'D
SHEET PILE DRIVEN 30FT. DOWN
US Army Corps of Engineers Chicago District
U.S. ARMY CORPS OF ENGINEERS
CHICAGO DISTRICT
CHICAGO, IL
GREAT LAKES AND MISSISSIPPI RIVER INTERBASIN STUDY
CHICAGO RIVER DETAIL
SHEET IDENTIFICATION
S-503

4 of 6



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of Engineers
Chicago District

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CHICAGO DISTRICT
CHICAGO, IL

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DATE:
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SOLICITATION NO.:
SUBMITTED BY:
CONTRACT NO.:
PLOT SCALE: N.T.S.
PLOT DATE: 4/29/13
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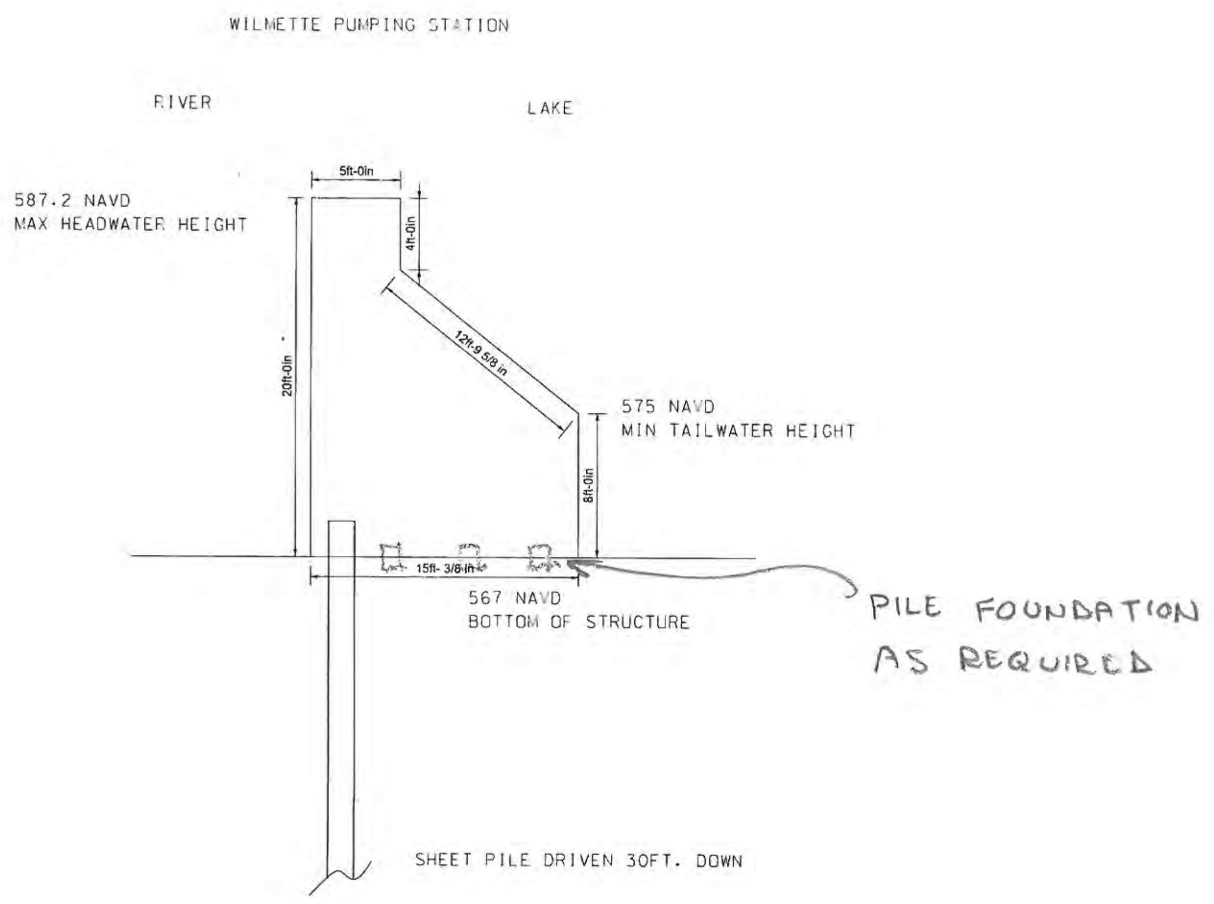
GREAT LAKES AND MISSISSIPPI
RIVER INTERBASIN STUDY

OBRIEN LOCK DETAIL

SHEET
IDENTIFICATION
S-504
SHEET 0 OF 0

5 of 6



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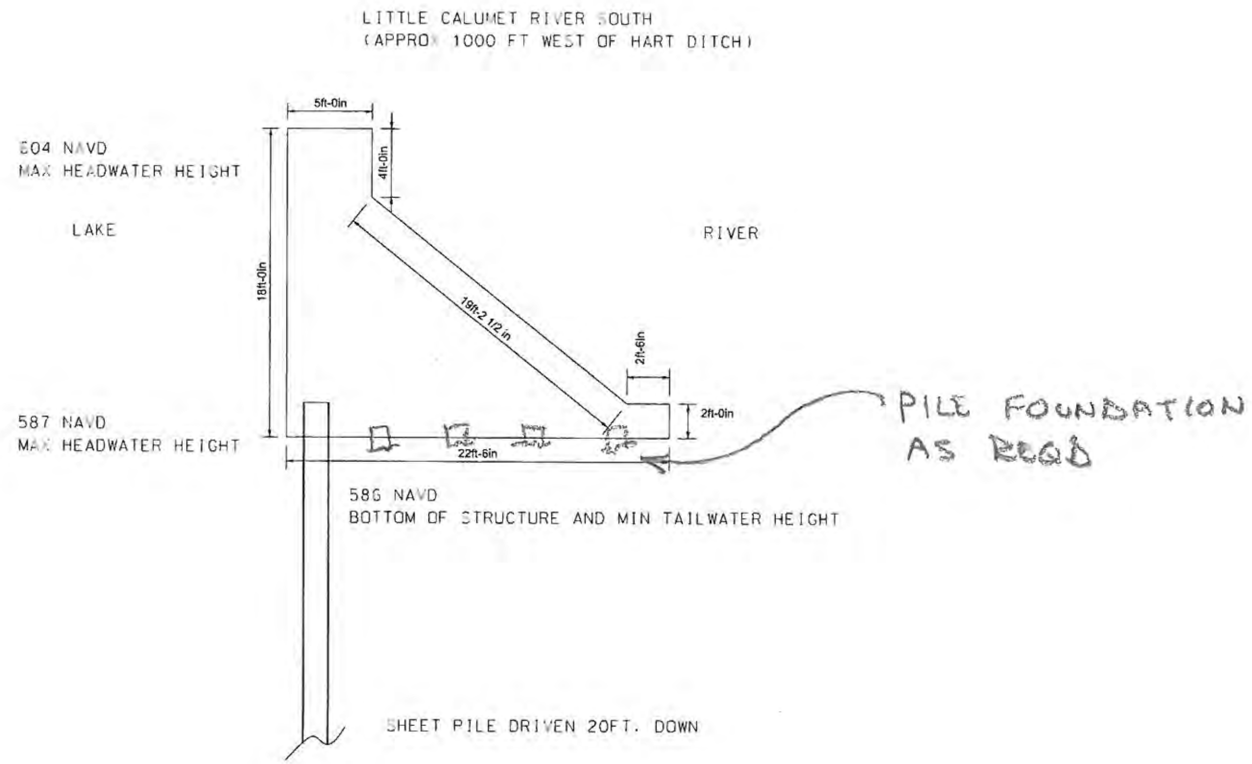
CHICAGO, IL

GREAT LAKES AND MISSISSIPPI
RIVER INTERBASIN STUDY

WILMETTE DETAIL

SHEET IDENTIFICATION
S-505

6 of 6



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Chicago District

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U.S. ARMY CORPS OF ENGINEERS
CHICAGO DISTRICT
CHICAGO, IL

DESIGNED BY:
DATE:
DWN BY: A
CKD BY:
SOLICITATION NO.:
SUBMITTED BY:
CONTRACT NO.:
PLOT SCALE: N.T.S.
PLOT DATE:
FILE NUMBER:
SIZE: ANSI D
FILE NAME: S-506.dgn

GREAT LAKES AND MISSISSIPPI
RIVER INTERBASIN STUDY

LITTLE CALUMET RIVER SOUTH DETAIL

SHEET
IDENTIFICATION
S-506
SHEET 0 OF 0

ENCLOSURE E

TUNNEL SYSTEM EXAMPLE

CALUMET TUNNEL SYSTEM

INDIANA AND 140TH STREET TUNNELS

US Army Corps of Engineers® Chicago District	PROJECT TITLE: TUNNELS - GENERAL	COMPUTED BY:	DATE: 5/29/13	SHEET: of
	COMPUTATION TITLE: SHAFT SPACING	CHECKED BY:	DATE:	

A REVIEW OF THE 30' DIA TUNNELS OF THE CALUMET TUNNEL SYSTEM INDIANA AND 140TH STREET TUNNEL LEGS WAS PERFORMED TO DETERMINE APPROXIMATE SHAFT REQUIREMENTS FOR SUCH A TUNNEL. THIS SERVES AS AN ESTIMATE FOR SHAFT REQUIREMENTS FOR GLMRIS REAL ESTATE REQUIREMENTS.

TOTAL TUNNEL LENGTH (30' DIA) ≈ 38,000'

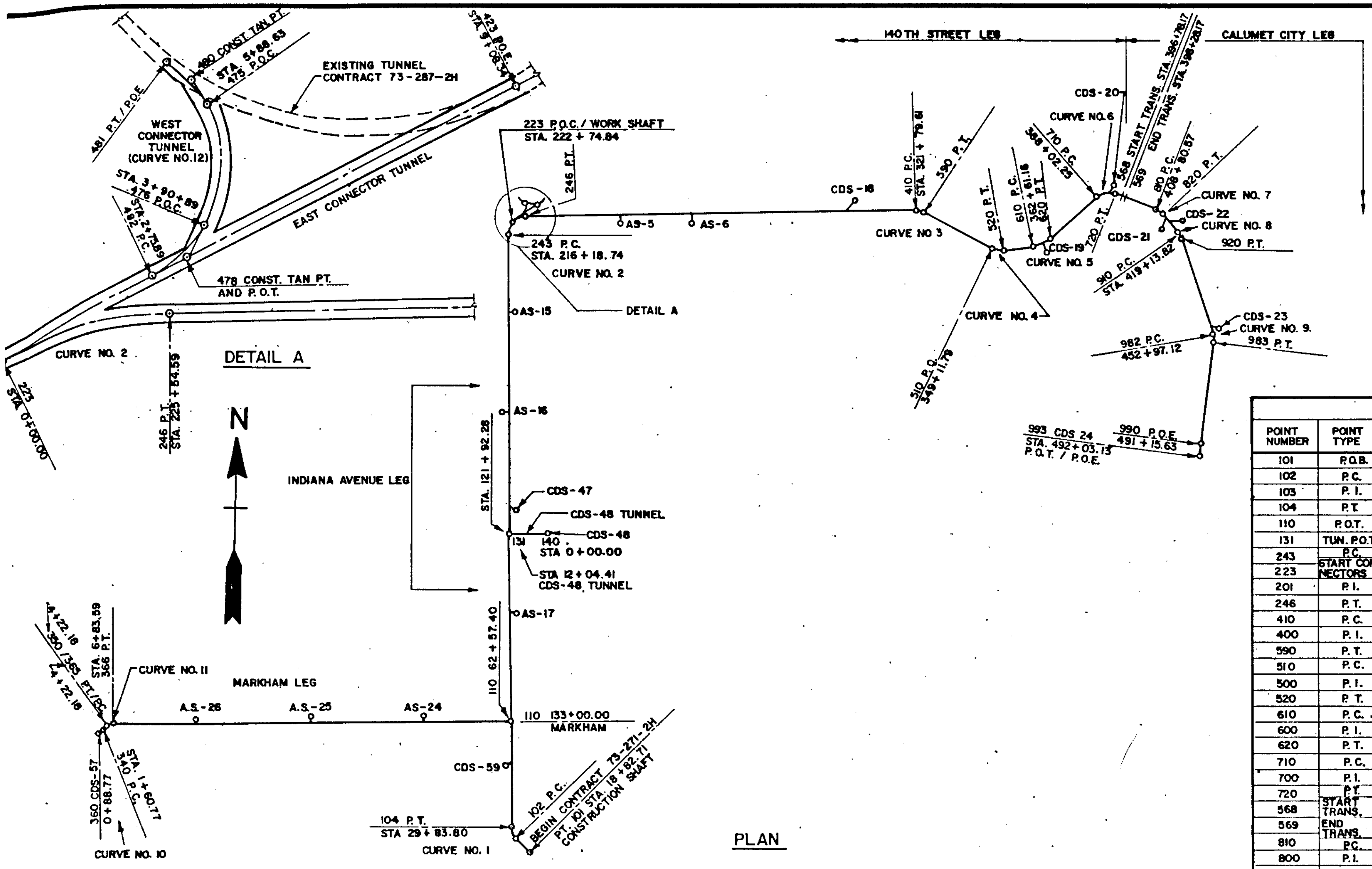
TOTAL # SHAFTS OVER THIS LENGTH = 13

TYPES OF SHAFTS INCLUDE CONSTRUCTION SHAFTS, WORK SHAFTS, ACCESS SHAFTS, AND DROP SHAFTS. DROP SHAFTS APPEAR TO DOUBLE AS ACCESS SHAFTS.

$$\therefore \text{ ASSUME } \frac{38,000'}{13 \text{ SHAFTS}} = 2923 \text{ ft}$$

OR ONE SHAFT EVERY 3000' +/-

TYPICAL EASEMENT & SHAFT DETAILS ARE ATTACHED FOR THE CALUMET TUNNEL SYSTEM 140th ST AND INDIANA AVE LEGS.



ALIGNMENT DATA									
POINT NUMBER	POINT TYPE	STATION	COORDINATES		CURVE DATA				
			NORTH	EAST	CURVE NUMBER	RADIUS	CURVE LENGTH	TANGENT LENGTH	DEFLECTION ANGLE
CDS-48 TUNNEL									
140	CDS-48	0+00.00	1,802,584.00	697,071.00					
131	P.O.T./P.O.E.	12 +04.41	1,802,570.58	695,866.67					
EAST	CONNECTOR TO CONTRACT 73-287-2H BRANCH STATION 0+00.00 = INDIANA AVE. LEG STA.222 + 74.84								
223	P.O.B.	0+00.00	1,812,532.98	696,080.07					
482	P.C.	2 +75.89	1,812,662.44	696,323.70	12 (SEE DATA BELOW)				
478	P.O.T.	3 +35.03	1,812,690.19	696,375.92	(END OF 59.14' TANGENT LENGTH)				
423	P.O.E.	9 +08.34	1,812,959.22	696,882.19	(P.O.C. CONTRACT 73-287-2H = STA. 320 + 29.77)				
WEST	CONNECTOR TO CONTRACT 73-287-2H BRANCH STATION 2+75.89 = 2+75.89 ON EAST CONNECTOR								
482	P.O.B. / P.C.	2 +75.89	1,812,662.44	696,323.70					
478	CONST. TAN. PT. WEST CONNECTOR	3 +31.75	1,812,690.19	696,375.92	(59.14' TANGENT LENGTH FROM P.T. 476 ON CURVE 12)				
476	P.O.C.	3 +90.89	1,812,741.88	696,404.65	12 (END OF 59.14' TANGENT LENGTH)				
474	P.I.	5 +92.12	1,812,810.83	696,602.96	12	200.00'	402.74'	316.23'	115° 22' 37.0"
475	P.O.C.	5 +88.63	1,812,931.65	696,407.12	12 (START OF 49.86' TANGENT LENGTH)				
480	CONST. TAN. PT. ON CURVE CONTRACT 73-287-2H	6 +38.49 (OFFSET FROM CURVE CENTERLINE)	1,812,975.84	696,384.04	(END OF 49.86' TANGENT LENGTH) P.O.C. STA. 315 + 07.98 ON CONTRACT 73-287-2H				
481	P.T./P.O.E.	6 +78.63	1,812,999.54	696,349.19	EQUALS STA. 314 + 65.83 ON CONTRACT 73-287-2H				

NOTES:
1. WORK THIS DRAWING WITH SHEETS C-7 THRU C-30.

ALIGNMENT DATA									
POINT NUMBER	POINT TYPE	STATION	COORDINATES		CURVE DATA				
			NORTH	EAST	CURVE NUMBER	RADIUS	CURVE LENGTH	TANGENT LENGTH	DEFLECTION ANGLE
101	P.O.B.	18 + 82.71	1,792,500.00	696,600.00					
102	P.C.	25+12.56	1,792,940.39	696,149.70	1	600.00'	471.24'	248.53'	45° 0' 0.0"
103	P.I.	27+61.09	1,793,114.15	695,972.01					
104	P.T.	29+83.80	1,793,362.67	695,969.24					
110	P.O.T.	62+57.40	1,796,636.07	695,932.78					
131	TUN. P.O.T.	121+92.28	1,802,570.58	695,866.67					
243	P.C.	216+18.74	1,811,996.46	695,761.66	2	600.00'	935.85'	593.40'	89° 22' 0.2"
223	START CONNECTORS	222+74.84	1,812,532.98	696,080.07					
201	P.I.	222+12.14	1,812,589.82	695,755.05					
246	P.T.	225+54.59	1,812,602.99	696,348.31					
410	P.C.	321+79.61	1,812,816.58	705,970.96	3	600.00'	301.64'	154.08'	28° 48' 16.2"
400	P.I.	323+33.69	1,812,820.00	706,125.00					
590	P.T.	324+81.25	1,812,748.78	706,261.63					
510	P.C.	349+11.79	1,811,625.24	708,416.90	4	600.00'	377.46'	195.21'	36° 2' 40.8"
500	P.I.	351+07.00	1,811,535.00	708,590.00					
520	P.T.	352+89.25	1,811,563.89	708,783.06					
610	P.C.	362+61.16	1,811,707.75	709,744.26	5	600.00'	586.79'	319.26'	56° 2' 3.3"
600	P.I.	365+80.42	1,811,755.00	710,060.00					
620	P.T.	368+47.94	1,812,043.27	710,197.21					
710	P.C.	388+02.25	1,813,807.87	711,037.15	6	600.00'	675.92'	378.91'	64° 32' 45.4"
700	P.I.	391+81.16	1,814,150.00	711,200.00					
720	P.T.	394+78.17	1,814,150.00	711,578.91					
568	START TRANS.	396+78.17	1,814,150.00	711,778.90					
569	END TRANS.	398+28.17	1,814,150.00	711,928.90					
810	P.C.	408+80.57	1,814,150.00	712,981.30	7	600.00'	291.52'	148.70'	27° 50' 17.1"
800	P.I.	410+29.27	1,814,150.00	713,130.00					
820	P.T.	411+72.08	1,814,080.56	713,261.49					
910	P.C.	419+13.82	1,813,734.19	713,917.38	8	600.00'	229.26'	116.05'	21° 53' 34.6"
900	P.I.	420+29.87	1,813,680.00	714,020.00					
920	P.T.	421+43.08	1,813,591.45	714,095.01					
982	P.C.	452+97.12	1,811,184.86	716,133.71	9	600.00'	262.72'	133.50'	25° 5' 18.1"
980	P.I.	454+30.62	1,811,083.00	716,220.00					
983	P.T.	455+59.84	1,810,954.16	716,254.96					
990	P.O.E.	491+15.63	1,807,522.45	717,186.09					
993	CDS-24	492+03.13	1,807,438.00	717,209.00					
MARKHAM LEG									
360	CDS-57	0+88.77	1,796,377.00	682,740.00					
340	P.C.	1+60.77	1,796,377.80	682,812.00	10	600.00'	261.41'	132.81'	24° 57' 45.6"
362	P.I.	2+93.58	1,796,379.28	682,944.80					
350	P.T.	4+22.18	1,796,436.67	683,064.57					
365	P.C.	4+22.18	1,796,436.67	683,064.57	11	600.00'	261.41'	132.81'	24° 57' 45.6"
364	P.I.	5+54.99	1,796,494.06	683,184.35					
366	P.T.	6+83.59	1,796,495.54	683,317.15					
110	P.O.E./P.O.T.	133+00.00	1,796,636.07	695,932.78					

REVISIONS		
NO.	DATE	BY

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

CALUMET TUNNEL SYSTEM
CONTRACT 73-271-2H
TUNNELS, SHAFTS, AND CONNECTING STRUCTURES
140TH STREET AND INDIANA AVENUE LEGS
HORIZONTAL ALIGNMENT

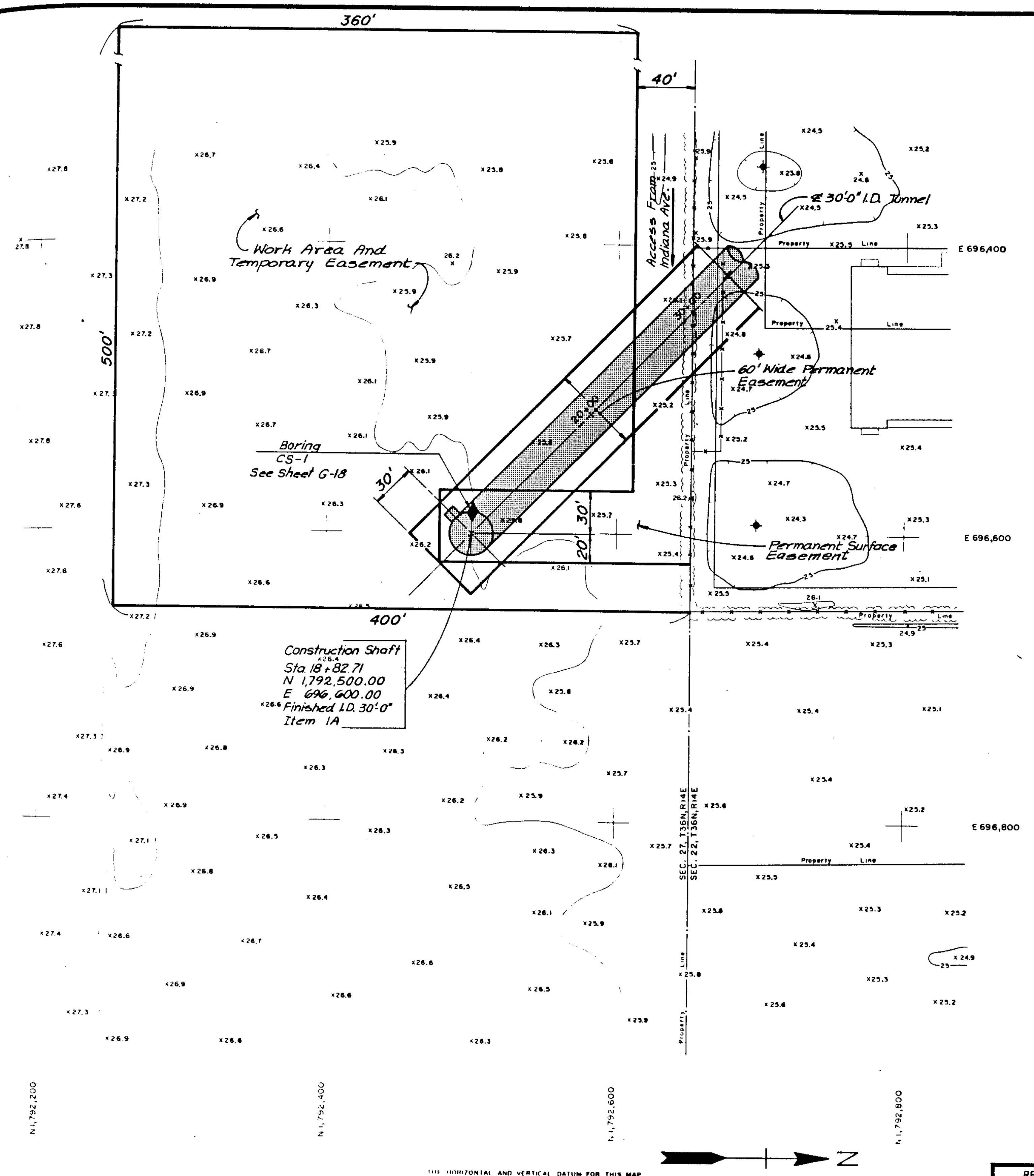
Correct
Engr. of Tunnel and Reservoir Design
Approved
Assistant Chief Engineer
Approved
Chief Engineer

SCALES SHOWN ARE SCALES OF TRACINGS

Drawn
Traced
Checked ~~R~~
DATE
SHEET NO. C-6

PARSONS BRINCKERHOFF
Parsons Brinckerhoff Quade & Douglas, Inc.
Chicago, Il.

ROULA ASSOCIATES, Architects
636 N. ORLEANS CHICAGO, IL 60610



Notes:

1.) For General Notes, Abbreviations and Symbols See Sheet C-3.
2.) For Tunnel Plan and Profile See Sheet C-7.
3.) Work this Drawing with Sheets S-40, M-4, E-14 & E-15.

THE HORIZONTAL AND VERTICAL DATUM FOR THIS MAP IS BASED ON FIELD CONTROL SUPPLIED BY K E I

ELEVATIONS REFER TO CHICAGO CITY DATUM (C C D)

CONVERSION: C.C.D. ELEV. + 579.48 = NEW YORK MEAN SEA LEVEL ELEV., USGS 1929 ADJUSTMENT

PLANIMETRIC DETAIL BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS TAKEN 4/30/89

COORDINATES REFER TO ILLINOIS STATE PLANE COORDINATE SYSTEM.

THIS MAP IS BASED ON THE ILLINOIS PLANE COORDINATE SYSTEM, REFERRED TO THE ARC OF SEA LEVEL SPHEROID GROUND DISTANCE EQUALS MAP DISTANCE MULTIPLIED BY .9999740

Horizontal Scale of Tracing 1" = 40'

40 0 40 80 120

RSONS
NCKERHOFF
ons Brinckerhoff Quade & Douglas, Inc.
go, Il.

Globetrotters.
Engineering Corporation
ENGINEERS • ARCHITECTS
300 South Wacker Drive
Chicago, Illinois 60606

REVISIONS		
NO.	DATE	BY

METROPOLITAN WATER RECLAMATION DISTRICT
OF GREATER CHICAGO

CALUMET TUNNEL SYSTEM
CONTRACT 73-271-2H
TUNNELS, SHAFTS, AND CONNECTING STRUCTURES
140TH STREET AND INDIANA AVENUE LEGS
CONSTRUCTION SHAFT 168TH PLACE (EXT.) - LOCATION PLAN

Drawn ______ Traced ______ Checked ______ DATE

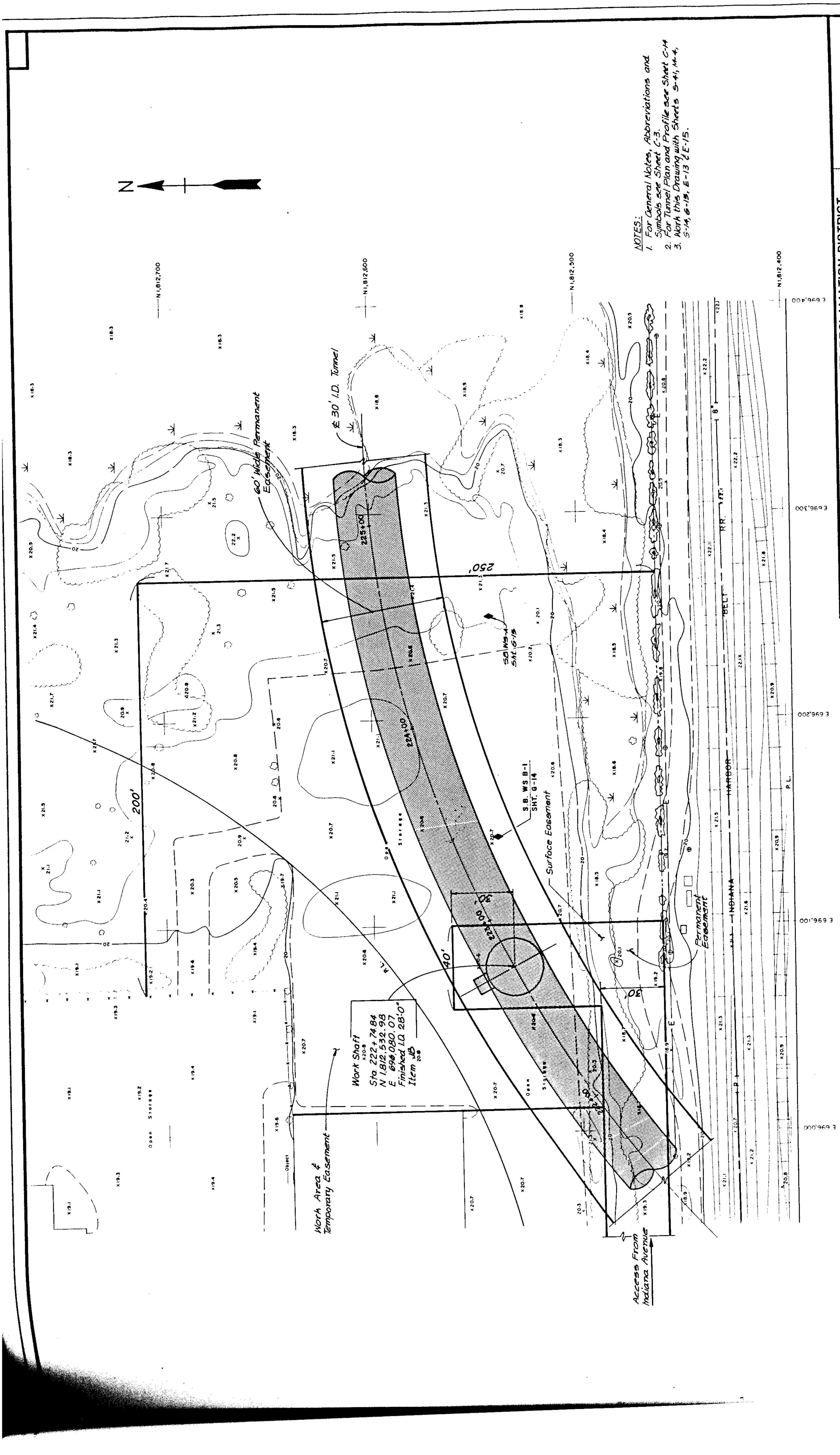
Correct ______
Engr. of Tunnel and Reservoir Design

Approved ______
Assistant Chief Engineer

Approved ______
Chief Engineer

SCALES SHOWN ARE SCALES OF TRACINGS

SHEET NO. C-31



NOTES:
1. For General Notes, Abbreviations and Symbols see Sheet C-3.
2. For Tunnel Plan and Profile see Sheet C-14
3. Work this Drawing with Sheets S-41, M-4, G-14, G-13, E-13 & E-15.

ELEVATIONS REFER TO CHICAGO CITY DATUM (C.C.D.)
CONVERSION: C.C.D. ELEV +579.48 = NEW YORK MEAN SEA LEVEL ELEV, USGS 1929 ADJUSTMENT

PLANIMETRIC DETAIL BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS TAKEN 4/30/89

COORDINATES REFER TO ILLINOIS STATE PLANE COORDINATE SYSTEM.

THIS MAP IS BASED ON THE ILLINOIS PLANE COORDINATE SYSTEM, REFERRED TO THE ARC OF SEA LEVEL SPHEROID GROUND DISTANCE EQUALS MAP DISTANCE MULTIPLIED BY .9999740

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Parsons Brinckerhoff Quade & Douglas, Inc.
Chicago, Il

Globetrotters.
Engineering Corporation
ARCHITECTS

REVISIONS		
NO.	DATE	BY

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

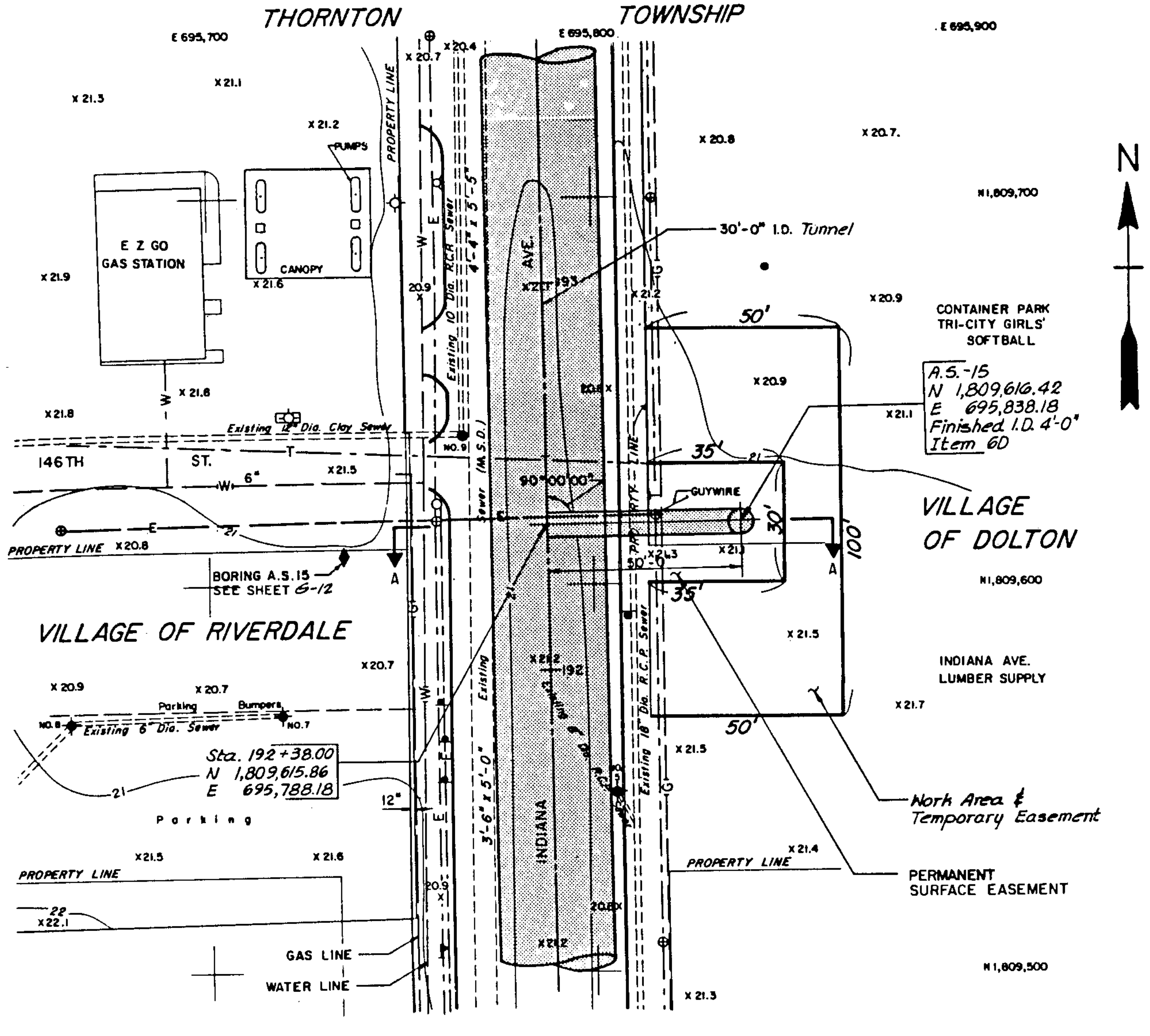
CALUMET TUNNEL SYSTEM
CONTRACT 73-271-2H
TUNNELS, SHAFTS, AND CONNECTING STRUCTURES
140TH STREET AND INDIANA AVENUE LEGS
WORK SHAFT 140TH STREET – LOCATION PLAN

Drawn ____ Traced ____ Checked ____ DATE 6-20-89

Correct ____ Engr. of Tunnel and Reservoir Design
Approved ____ Assistant Chief Engineer
Approved ____ Chief Engineer

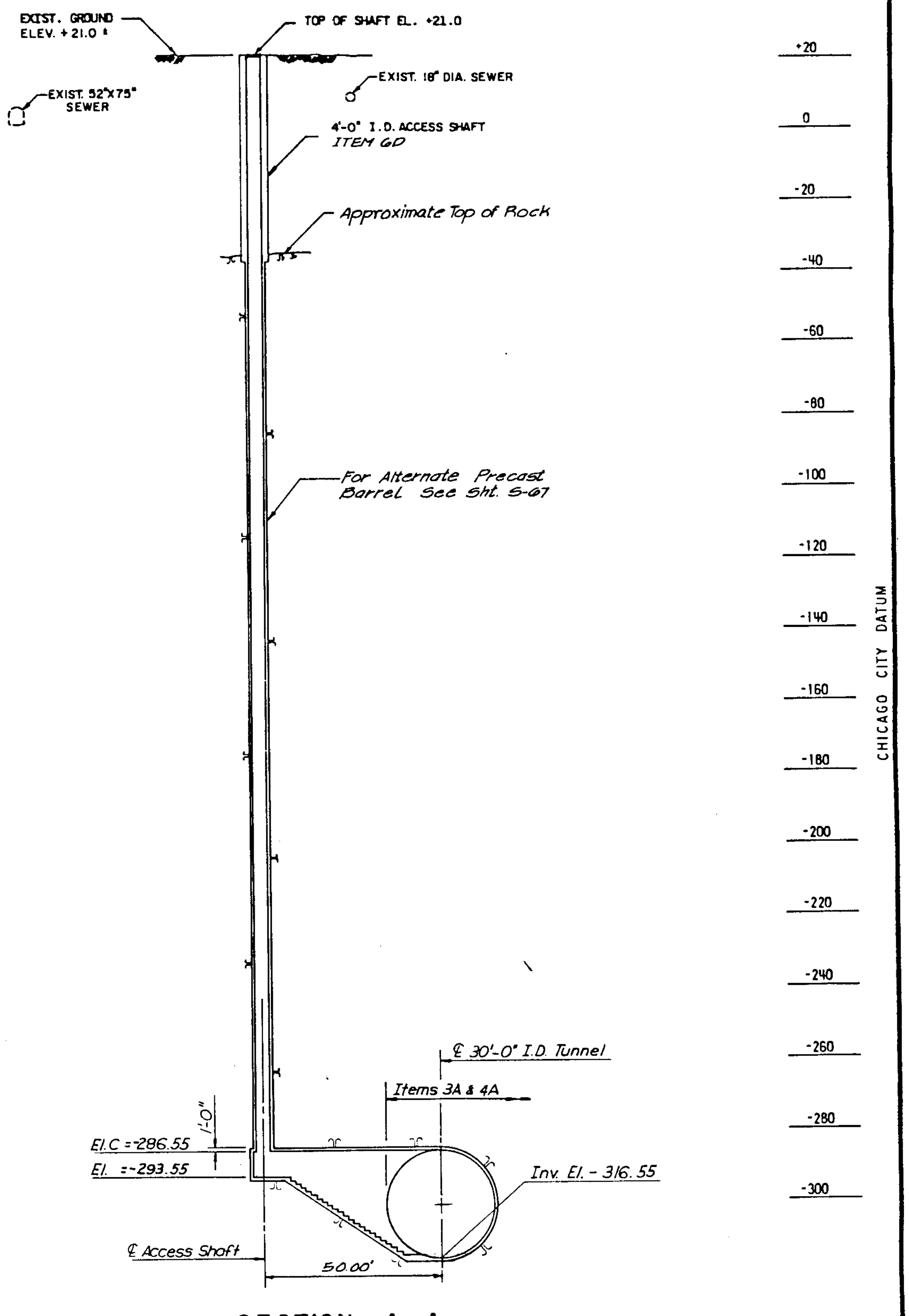
SCALES SHOWN ARE SCALES OF TRACINGS

SHEET NO. C-32



P L A N

SCALE: 1" = 20'



SECTION A - A

SCALE 1" = 20'

NOTES:
1. For General Notes, Abbreviations and Symbols see Sheet C-3.
2. For Tunnel Plan and Profile see Sheet C-15
3. Work this Drawing with Sheets S-35, S-42, S-67 & G-12

Scale of Tracing 1" = 20'-0"
0 10 20 30 40 50 60

ELEVATIONS REFER TO CHICAGO CITY DATUM (C.C.D.)
CONVERSION: C.C.D. ELEV + 579.48 = NEW YORK
MEAN SEA LEVEL ELEV., USGS 1929
ADJUSTMENT

PLANIMETRIC DETAIL BY PHOTOGRAMMETRIC METHODS
FROM AERIAL PHOTOGRAPHS TAKEN — 3/17/76

COORDINATES REFER TO ILLINOIS STATE PLANE
COORDINATE SYSTEM

THIS MAP IS BASED ON THE ILLINOIS PLANE COORDINATE
SYSTEM, REFERRED TO THE ARC OF SEA LEVEL SPHEROID
GROUND DISTANCE EQUALS MAP DISTANCE MULTIPLIED
BY .9999740

REVISIONS		
NO	DATE	BY

METROPOLITAN WATER RECLAMATION DISTRICT
OF GREATER CHICAGO

CALUMET TUNNEL SYSTEM
CONTRACT 73-271-2H
TUNNELS, SHAFTS, AND CONNECTING STRUCTURES
140TH STREET AND INDIANA AVENUE LEGS
AS-15 144TH STREET - LOCATION PLAN

Drawn ____ Traced ____ Checked ____ DATE

Correct ____
Engr. of Tunnel and Reservoir Design
Approved ____
Assistant Chief Engineer
Approved ____
Chief Engineer

SCALES SHOWN ARE
SCALES OF TRACINGS

SHEET NO. C-51

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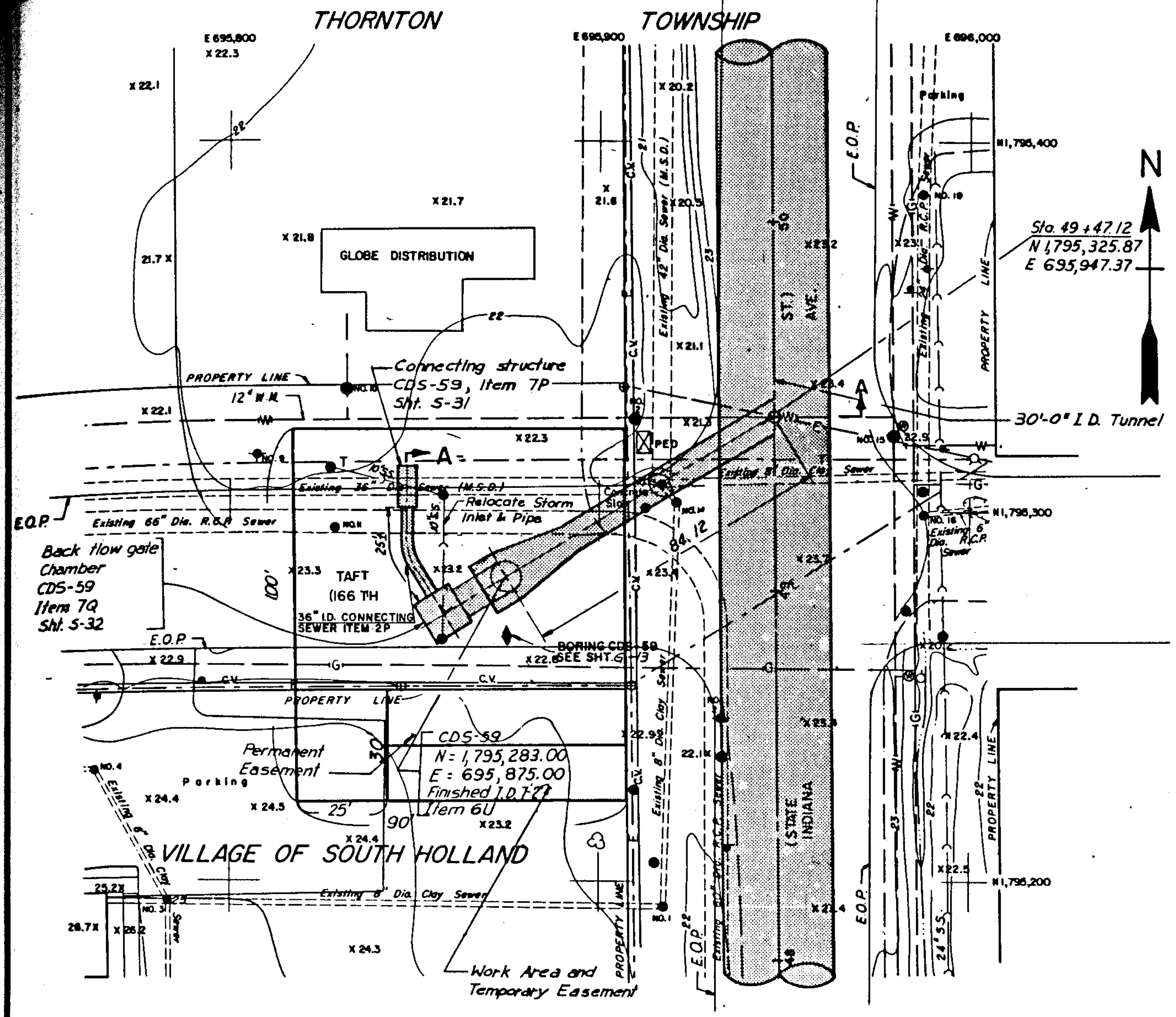
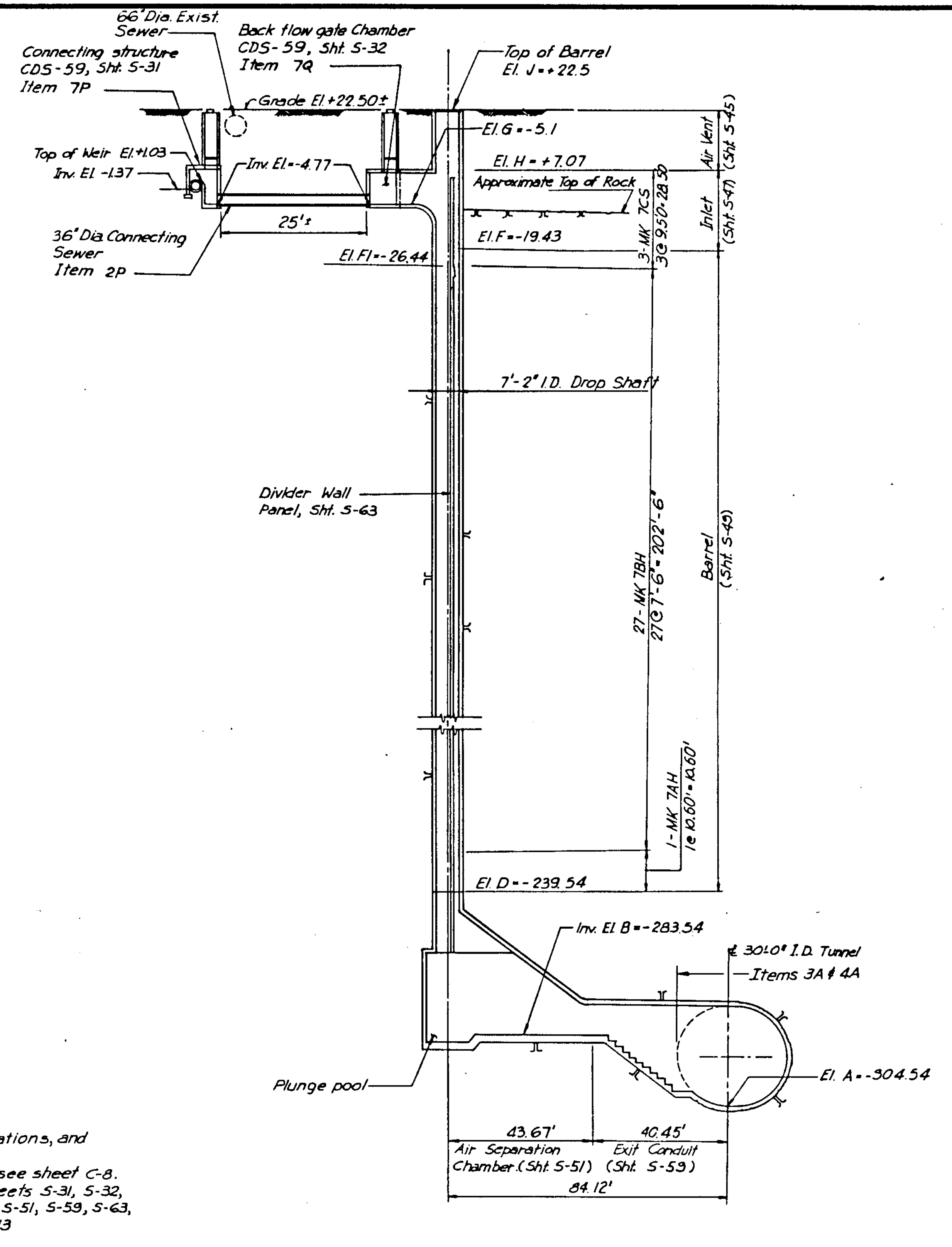
300 South Wacker Drive
Chicago, Illinois 60606



LOCATION PLAN

Scale: 1" = 20'



SECTION A-A

NOTES:

1. For General Notes, Abbreviations, and Symbols see sheet C-3.
2. For Tunnel Plan and Profile, see sheet C-8.
3. Work this drawing with sheets S-31, S-32, S-35, S-37, S-45, S-47, S-49, S-51, S-59, S-63, S-67, S-87, S-88, S-93, G-8 & G-13

4. Regrade area around the manholes to top of manholes.

ELEVATIONS REFER TO CHICAGO CITY DATUM (C.C.D.)
CONVERSION: C.C.D. ELEV + 579.48 = NEW YORK MEAN SEA LEVEL ELEV., USGS 1929 ADJUSTMENT

PLANIMETRIC DETAIL BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS - TAKEN — 3/17/76

COORDINATES REFER TO ILLINOIS STATE PLANE COORDINATE SYSTEM

THIS MAP IS BASED ON THE ILLINOIS PLANE COORDINATE SYSTEM, REFERRED TO THE ARC OF SEA LEVEL SPHEROID GROUND DISTANCE EQUALS MAP DISTANCE MULTIPLIED BY .9999740

Scale of Tracing 1" = 20'-0"
0 10 20 30 40 50 60

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Parsons Brinckerhoff Quade & Douglas, Inc.
Chicago, Il

RUBINOS & MESIA ENGINEERS, INC.

REVISIONS		
NO.	DATE	BY

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
CALUMET TUNNEL SYSTEM
CONTRACT 73-271-2H
TUNNELS, SHAFTS, AND CONNECTING STRUCTURES
140TH STREET AND INDIANA AVENUE LEGS
CDS-59 163RD STREET - LOCATION PLAN

Drawn AVD
Traced
Checked F.R.
DATE

Correct
Engr. of Tunnel and Reservoir Design
Approved
Assistant Chief Engineer
Approved
Chief Engineer

SCALES SHOWN ARE SCALES OF TRACINGS

SHEET NO. C-47