

**STS CONSULTANTS, LTD.**



**Engineering Evaluation of the  
Estabrook Park Dam on the  
Milwaukee River  
Milwaukee, Wisconsin**

Milwaukee County  
Department of Public Works

STS Project No. 5-87996



September 8, 2006

Mr. Stevan M. Keith, P.E.  
Managing Engineer, Environmental Services  
Milwaukee County Department of Public Works  
City Campus – Room 216  
2711 West Wells Street  
Milwaukee, WI 53208

RE: Engineering Evaluation of the Estabrook Park Dam located on the Milwaukee River,  
Milwaukee, Wisconsin - STS Project No. 5-87996

Dear Mr. Keith:

We have completed our evaluation of the current physical condition of the Estabrook Park Dam on the Milwaukee River. The attached report details the results of the condition evaluation and stability analysis, provides recommended repairs that were identified as a result of our evaluation, and details our opinion of probable costs for recommended repairs.

Our scope of work consisted of performing a visual inspection of the dam, a diving inspection of the upstream and downstream sides of the gated spillway section to address concerns raised by the Wisconsin Department of Natural Resources (WDNR) regarding possible scour and undermining, an evaluation of cracking on piers and the under side of the concrete deck of the gated spillway section by a structural engineer, and developing an opinion of probable construction cost for the recommended repairs.

We appreciate the opportunity to be of service to you. If you have questions with regard to the attached report, or if we can be of further assistance, please call.

Respectfully,

STS CONSULTANTS, LTD.

  
Richard J. Anderson, P.E.  
Associate

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- Appendix C – Structural Evaluation of Gated Spillway Section
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## EXECUTIVE SUMMARY

In general, the condition of the structural elements of Estabrook Park Dam is fair and with preventive maintenance, can likely remain in-service for 25+ years. In our opinion, there were no deficiencies identified during our study which were an immediate concern to dam safety, that is, if not corrected immediately may lead to uncontrolled loss of the impoundment. However, a number of repair items were identified which need to be addressed to ensure continued safe operation of the dam.

Conclusions of our study and recommended repairs are summarized as follows:

- Remove and replace deteriorated concrete on abutments, operating bridge deck, and piers of the gated spillway section.
- Repair the expansion joints on the spillway operating deck and replace the missing expansion joint material.
- The cracking observed on the spillway piers and identified by the WDNR in their November 2004 inspection report was evaluated by a structural engineer and was not considered to be the result of overstressing or indicative of a stability problem.
- The spillway gates should be sandblasted and painted with a water-based urethane paint, suitable for this application. Drain holes should also be drilled in the horizontal cross members to promote drainage.
- A diving inspection found no evidence of scour or undermining either upstream or downstream of the gated spillway section. Direct visual inspection of the downstream toe of the overflow spillway section also indicated no scour or undermining. The upstream side of the overflow spillway has a heavy accumulation of debris and could not be directly observed.
- There is minor erosion and undercutting occurring downstream of the gated spillway along the left bank. There is also some minor undercutting along the left and right banks

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just upstream of the gated spillway. Additional rip rap should be placed at these locations to prevent further undercutting.

- The overflow spillway flashboards should be replaced and the bent supports repaired. Surface repair of deteriorated concrete on the overflow weir crest should be performed.
- The gated spillway section was found to be stable for overturning and sliding under normal pool conditions. Under full pool conditions with ice loading, the section was found to be unstable. We, therefore, recommend the current operation practice of drawing down the impoundment during the winter months be continued and that the ice breakers be maintained to prevent impact to the gated spillway by large debris or ice rafts.
- The ice breakers do not require an extensive rebuild, only repair of deterioration at the tops.
- The large accumulation of woody debris upstream of the overflow spillway section should be removed. We recommend that the County study measures to facilitate periodic debris removal.

Our opinion of probable cost for implementing all of the repairs recommended above is as follows:

Construction cost:	\$618,000
Engineering and construction contract administration cost:	<u>\$138,000</u>
Total:	\$756,000

This includes a 20-percent construction cost contingency and a 15-percent cost contingency for engineering and construction contract administration cost. Our estimate does not include any costs associated with the handling or removal of possible contaminated sediments in the impoundment.

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## 1.0 INTRODUCTION

STS Consultants Ltd. (STS) was contracted by the Milwaukee County Department of Public Works (County) to perform an engineering evaluation of the Estabrook Park Dam located on the Milwaukee River within the limits of the City of Milwaukee. The purpose of this study was to evaluate the current physical condition of the dam and develop cost estimates for recommended repairs identified as a result of our condition evaluation and stability analysis.

Our scope of work consisted of performing a visual inspection of the dam, a diving inspection of the upstream and downstream sides of the gated spillway section to address concerns raised by the Wisconsin Department of Natural Resources (WDNR) regarding possible scour and undermining, an evaluation of cracking on piers and the under side of the concrete deck of the gated spillway section by a structural engineer, and developing an opinion of probable construction cost for the recommended repairs.

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## 2.0 PROJECT DESCRIPTION

### 2.1 Dam Description

Estabrook Park Dam is located on the Milwaukee River approximately 6.7 miles upstream from Lake Michigan and approximately 1,300 feet downstream from the Port Washington Street Bridge. The dam location is shown in Appendix A. The dam was constructed in the late 1930's and was repaired most recently in 1989. From left to right (looking downstream), the dam consists of a gated spillway approximately 220 feet in length, a center island (not considered part of the dam) and a sinuous overflow weir spillway approximately 584 feet in length. The dam weir crest is at elevation 616.6 feet (NGVD, equal to elevation 36.0 feet local datum shown on the design drawings in Appendix B). The structural height is approximately 15 feet and storage capacity at maximum pool is approximately 700 acre-feet according to the WDNR database. The hydraulic height at maximum pool is approximately 8 feet.

The slide gate spillway section contains ten 11'-6" wide gate bays with vertical steel slide gates. The gates are each 7'-6.5" high with a crest elevation at 616.9 NGVD (36.3 feet local elevation). The gate sills are at elevation 609.35 NGVD (28.75 feet local). The gates are numbered sequentially one through ten, with number one being located furthest left. Slide gates one through five and ten are on manual control and are operated from the control building located in a bunker on the bank just left of the spillway. Slide gates six through nine are on automatic float control with the float located in a manhole on the left river bank just upstream of the spillway. Manual override controls for gates six through nine are also located in the control building. The slide gates and hoists were extensively reconstructed in 1989.

Each gate has its own 5 h.p., 25 amp electric motor which drives threaded stem risers on the left and right side of each gate. A horizontal shaft couples the left and right stem drives at each gate. A hand-operated wheel is present on each gate with a manual override lever on the gearbox to permit manual operation in case of power failure.

A line of 28 concrete tripods ("ice breakers") spaced 11'-6" on center is located upstream of the gated spillway section. These are intended to block debris and ice rafts in winter from impacting the gated spillway.

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The overflow spillway section is concrete with rubble stone masonry anchored to the downstream face creating a stepped surface. The overflow weir is at elevation 616.6 feet NGVD (36.0 feet local elevation). According to the original design drawings, the concrete core was anchored to the bedrock foundation with two rows of 1-1/4 inch steel rebars running the entire length of the overflow spillway. The rebars are spaced 6 feet on center and anchored a minimum of 5.5 feet into bedrock. The upstream surface and crest of the section have been overlaid with a layer of gunite at some time in the past. There is a flashboard section near the left end of the overflow spillway section with a total length of 88 feet.

Copies of available design drawings from 1939 and 1988 drawings for the gate reconstruction are contained in Appendix B.

## **2.2 Hazard Classification**

The Estabrook Park Dam has been classified by the WDNR as low hazard. NR 333 requires a low-hazard dam to have a minimum total spillway capacity capable of passing the 100-year flood. According to hydraulic studies performed for the Milwaukee River, the 100-year flood for at the dam site is 14,810 cfs (City of Glendale Flood Insurance Study, date unavailable). According to the WDNR database, the dam has a spillway capacity of 25,800 cfs. The dam therefore has adequate spillway capacity for its current hazard classification.

## **2.3 Gate Operation Procedures**

Typically, the gates are completely raised each year during the first week of November to dewater the impoundment. During the middle of May, the gates are lowered and the impoundment is brought back up to full pool. During normal flow conditions between mid-May and early November, the overflow spillway weir self-regulates pool levels. During high flow conditions, the automatic float control operates gates six through nine to regulate the pool level. During extreme flood events, additional gates can be opened by manual push-button control of the remaining six gates.

Presently, there are no written operation criteria or spillway gate discharge curves which are used to provide the operators with gate opening guidelines.

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### **3.0 CONDITION EVALUATION**

The project was inspected by Richard Anderson, P.E., James Kasper, P.E. (structural engineer) and Steven Weyda, P.E. of STS Consultants on February 3, 2006. Weather conditions on this day were overcast with intermittent rain and temperatures around 40 degrees Fahrenheit. Photographs from the structural evaluation of the gated spillway section field inspection, keyed with figures showing the locations of the observed features, are presented in Appendix C. Inspection photographs of the remaining project structures and features are presented in Appendix D. In addition, an underwater dive inspection was conducted on the upstream and downstream surfaces of the gated spillway section on June 1, 2006. The dive inspection was performed by Seaview Diving Contractors, Inc. of Seymour, WI under subcontract to STS. A copy of the dive inspection report is included in Appendix E.

All elevations used in this condition evaluation are referenced to the local datum shown on the design drawings in Appendix B.

#### **3.1 Gated Spillway Section**

##### **3.1.1 Right Abutment**

The right abutment walls were in overall fair condition with several areas of observed deterioration. The walls at the right end of the abutment near the gate exhibited cracking, efflorescence, and isolated spalling. Both abutment walls running left to right were cracked and spalled at the top of the walls and at the varying top of stair tread elevation on the sides of the walls facing the stairs. Concrete disintegration was present at the top six stair nosings. The downstream right side of the abutment pier exhibited cracking and efflorescence above elevation 34.0'. The left side of the abutment pier exhibited exposed concrete reinforcing steel below concrete cover spalls on the downstream side of the pier. Both exposed walls on the left side of the pier were also cracked, delaminated, and had efflorescence deposits on the surface.

##### **3.1.2 Left Abutment**

The left abutment walls were in overall fair condition. The walls at the left end of the abutment near the gate exhibited cracking, efflorescence, and spalling (spalling was more frequent near the ground line and at the top of the walls). Both abutment walls running left to right were cracked and spalled at the top of the walls and at stair tread levels on the inside walls facing the stairs. All of the concrete stair nosings and treads were severely deteriorated. The right side of the abutment pier exhibited widespread cracking and efflorescence in addition to delamination on the

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upstream side of the pier above elevation 37.75' and spalling on the downstream side of the pier below elevation 34.0'.

### 3.1.3 Expansion Joints

Expansion joints were located in the operating bridge over pier numbers 1, 4, 8, and 11 (piers numbered sequentially from left to right, see Figures 1 and 2 in Appendix C). We observed asphalt board-type filler in place for the wall and operating bridge deck expansion joints. The wall filler material was displaced out of the joint toward the center of the operating bridge at most locations. The joint material extended beyond the surface of the concrete, several inches at some locations. This board-type joint was also in place in the bridge deck portion of the joint, however, the joint filler was absent from at least two bridge deck expansion joints. Measured joint widths in the operating bridge walls are shown in Table 3-1.

**Table 3-1**  
**Measured Expansion Joint Separation at Operating Bridge Walls**

Expansion Joint No. / Pier Number	Operating Bridge Wall	Mean Expansion Joint Width (in.)
1 / P1	Upstream	0.31
	Downstream	0.25
2 / P4	Upstream	1.06
	Downstream	Not Measured
3 / P8	Upstream	1.00
	Downstream	0.88
4 / P11	Upstream	0.81
	Downstream	0.88

Note: Design joint width = 1 inch, per section C-C on structure drawing number 9006-4-8.

### 3.1.4 Operating Bridge Walls

In general, the operating bridge walls were in overall fair condition. STS observed and measured the operating bridge walls rotated from the vertical position as shown in Table 3-2 with the use of a 4-foot level.

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**Table 3-2  
 Measured Operating Bridge Wall Rotation**

Expansion Joint No. / Pier Number	Operating Bridge Wall	Side of Expansion Joint	Rotation (degrees)
1 / P1	Upstream	Left	1.94
		Right	0.38
	Downstream	Left	1.34
		Right	0.57
2 / P4	Upstream	Left	1.64
		Right	0.75
	Downstream	Left	0.37
		Right	0.28
3 / P8	Upstream	Left	0.47
		Right	0.67
	Downstream	Left	0.00
		Right	0.90
4 / P11	Upstream	Left	0.38
		Right	1.04
	Downstream	Left	0.09
		Right	1.49

Note: All upstream operating bridge walls lean upstream; all downstream deck walls lean downstream

### 3.1.4.1 Upstream Operating Bridge Walls

The upstream operating bridge wall was in generally fair condition, with isolated areas of deterioration, as observed from the operating bridge. STS observed top of wall cracking at pier numbers 5 and 11 (see Figure 1 and 2 in Appendix C). There was also a full height wall crack in the upstream operating bridge wall near pier number 2. Vertical wall reinforcement cover spalls were present in the wall on the downstream side near gate number 5 (2 spalls), and pier number 2 (1 spall). STS observed concrete disintegration at the top of the wall at pier number 1. Cracking and delaminations were present over the wall at expansion joint number 1. The downstream face of the wall at the right abutment pier exhibited cracking, efflorescence, and isolated disintegration.

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#### **3.1.4.2 Downstream Operating Bridge Walls**

The downstream operating bridge wall was in generally fair condition, with isolated areas of deterioration, as observed from the operating bridge. STS observed vertical wall reinforcement cover spalls near the bottom of the wall, upstream side, near pier number 9 (3 spalls), pier number 7, (1 spall), and pier number 2 (2 spalls). STS also observed a spall approximately 2 square feet in the area near pier number 4 on the upstream side down to the depth of the wall reinforcement. STS observed disintegration of the top corner of the wall at pier number 1 along with cracking along the expansion joint in the wall. The upstream face of the wall at the right abutment pier exhibited cracking, efflorescence, and isolated disintegration.

#### **3.1.5 Operating Bridge**

The operating bridge appears to be in overall fair to good condition, with isolated areas of top-side deterioration. STS performed an acoustic impact survey of the top side operating bridge surface between the dam abutments as well as the underside of the bridge deck between the right abutment and pier number 1. We detected isolated pockets of top side bridge deck delamination at the following locations:

- immediately left of expansion joint 4,
- immediately right of expansion joint 1 to approximately 3 feet right of the joint,
- between 3 feet right of pier number 1 to the right abutment pier (delamination pockets),
- at former gate hoist base plates of gate numbers 4, 5, 6, and 7, and
- above pier number 5.

Some locations of the bridge deck top side were partially disintegrated between the right abutment and pier number 1. Cracking was observed on the top side of the bridge deck near expansion joints 2 and 4. The underside of the operating bridge deck was typically wet around locations of deck penetrations for the former gate hoist anchor bolts.

#### **3.1.6 Gate Hoist Blocks**

Gate hoist blocks on the top side of the bridge deck appeared in overall fair to good condition, with isolated blocks experiencing deterioration. The left block for gate number 1 was disintegrating near the top of the block. Blocks for gate number 2 had some of the reinforcing bar cover spalled. Blocks for gate numbers 5, 6, and 10 were cracked.

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### **3.1.7 Piers**

Piers between the abutments appeared in overall fair (above elevation 37.75') to poor condition (below elevation 37.75'). Refer to Figures 1 through 24 in Appendix C for additional condition assessment observations, specifically with respect to left and right pier conditions. Common conditions observed by STS include widespread surface repair below elevation 37.75', delaminations, spalls, and cracks. Based on acoustic impact testing performed on pier numbers 1 and 11, it appears that the majority of pier surface covered with surface repair material (e.g. gunite) is delaminated. Multiple piers exhibited areas where former gunite repairs were either partially or fully delaminating from the substrate.

### **3.1.8 Gates**

Gate numbers 1 through 10 were equipped with electrically-operated steel slide gates, installed in 1989. The gates had a steel face plate spanning vertically to horizontal wide flange or channel girders. The gates, as observed from pier numbers 1 and 11, had widespread uniform surface corrosion and water ponding between the upturned flanges of the wide flange horizontal girders. With the permission of the County, STS operated gate numbers 1 through 5 for the apparent full-range of design gate movement and did not observe any sticking or binding resistance during gate movement. The gate guides and side seals appeared to be in fair to good condition.

### **3.1.9 Upstream and Downstream River Banks**

There is some minor erosion and undercutting along the right river bank downstream of the gated spillway. There is also some minor undercutting along the banks just upstream of the gated spillway up to the ice breakers along the left and right banks.

### **3.1.10 Scour Evaluation**

No evidence of scour or undermining of the spillway was found during the June 1, 2006 dive inspection either upstream or downstream of the spillway gates. Sound concrete was found on the river bed between the piers and on the river bed both upstream and downstream for a variable distance along the river bed. The design drawings show the concrete apron extending to the length of the piers. It is uncertain if the concrete beyond the piers was placed during original construction or at some later date.

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### **3.2 Overflow Weir Spillway Section**

The overflow spillway section appears to be overall in fair condition. There has been some deterioration and loss of masonry rubble section downstream of the concrete core. The top row of horizontal rebar anchoring the masonry to the concrete section is exposed in several locations. Loss of masonry stone is particularly evident at the flashboard section where flows are concentrated. However, the loss of masonry material is not considered sufficient to negatively impact overall section stability at this time. The overflow section is broad with low hydraulic head. Stability of the section is not considered an issue.

Spalling and deterioration of the gunite surfacing on the crest of the overflow section is evident in many locations. In addition, there is evidence of some separation of the downstream masonry from the concrete core, probably due to ingress of water and progress freezing and thawing over time. The maximum amount of separation observed was approximately 1 inch.

Several of the flashboards are missing or cracked. The flanges of the flashboard supports are bent at several locations.

The foundation bedrock was visible along the entire length of the downstream toe. No scour holes or undermining of the overflow spillway was evident.

There is a massive accumulation of woody debris along the upstream side of the overflow spillway so the upstream surface of the concrete could not be observed. This debris should be removed. Currently, there are no structures or facilities on the dam for removing the accumulation of debris upstream. We recommend the County study measures to facilitate periodic removal.

The right and left masonry abutments are in good condition. There is no evidence of visible seepage or erosion.

### **3.3 Signage and Warning Systems**

Upstream and downstream dam signs are in good condition. The warning siren operates properly when the spillway gates are operated. The gates restricting access to the spillway deck are in good working order.

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## 4.0 STABILITY ANALYSIS OF SPILLWAY

### 4.1 Introduction

A gravity-type stability analysis was conducted for the gated spillway section of the dam. Loading cases analyzed include normal pool (gates closed, Case 1), and normal water level plus ice (Case 2a). Flood pool conditions (Case 2) were not analyzed since the dam submerges during the regional design flood (100-year event) and little to no differential head exists across the structure. Furthermore, the spillway gates are opened during the winter months and the pool is drawn down. Therefore, the ice loading case is not currently an issue from the standpoint of dam safety. However, we still analyzed ice loading under normal, full pool conditions since there is, to our knowledge, no written order that that pool must be evacuated each winter season.

The concrete weir overflow section is very broad in relation to the head and is anchored into bedrock. As such, it is considered stable by inspection and was not analyzed as part of this study.

### 4.2 Methodology

The stability of the concrete slide gate section was analyzed using the shear friction factor of safety method for evaluating resistance to sliding in accordance with the procedures in U.S. Army Corps of Engineers guideline EM 1110-2-2200 - *Gravity Dam Design* and the Federal Energy Regulatory Commission (FERC) *Engineering Guidelines for the Evaluation of Hydropower Projects, Chapter 3 – Gravity Dams*. The gravity method of analysis was used to evaluate foundation bearing stresses at the concrete/foundation interface, assuming no tensile strength across the assumed cracked base. A two-dimensional static stability analysis method was used to evaluate the stability of the concrete structures.

### 4.3 Material Properties

For the concrete dam stability evaluations, the unit weight of concrete was assumed to be equal to 150 pounds per cubic foot. Concrete at the Estabrook Park Dam was assumed to have a compressive strength of 3,000 psi based on specifications in the original design drawings. A friction angle of 45 degrees with no cohesion was conservatively assumed for the concrete/rock interface, based upon published values (Hunt, 1984).

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**Table 4-1**  
**Summary of Material Properties for Stability Analyses of the Gated Spillway Section**

Analysis Properties	Details
Concrete unit weight	150 pcf
Concrete compressive strength	3,000 psi
Concrete tensile strength	210 psi
Concrete shear strength	109 psi
Allowable bedrock contact pressure	420 psi
Uplift pressure	Linear between full headwater/tailwater pressures

#### 4.4 Key Lateral Dimensions

Key dimensions for the dam section were taken from the project drawings included in Appendix B.

#### 4.5 Summary Table of Computed Factors of Safety and Minimum Required Values

Computations for each loading case are included in Appendix F. The results are summarized as follows:

**Table 4-2**  
**Summary of Structure Stability Analyses**

Section/Case Description	Sliding Factor of Safety		Overturning Resultant w/in middle third?
	Required*	Computed	
<b>GATED SPILLWAY</b>			
1. Normal Pool	2.0	3.31	Yes – o.k.
2a. Normal Pool with Ice**	1.7	0.93	No - unstable

\*Minimum recommended factor of safety, U.S. Army Corps of Engineers (EM 1110-2-2200, 1995)

\*\*5000 lb/lf ice loading assumed per FERC Guidelines for Gravity Dams (2002)

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#### **4.6 Conclusions**

The gated spillway section is stable for Case 1 – normal pool loading conditions, but is not stable for Case 2a – normal pool with full ice loading. We therefore recommend that the current mode of operation of fully drawing down the pool in winter be continued. If a full pool is desired in winter, the County will need to consider the installation of heaters or agitators along the upstream side of the gated spillway section to prevent the build-up of ice upstream of the gates. In addition, we recommend that the ice breakers be maintained to prevent debris and ice loading against the face of the spillway.

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## 5.0 REPAIR RECOMMENDATIONS

In general, the condition of the structural elements of Estabrook Park Dam is fair and with preventive maintenance, can likely remain in-service for 25+ years. In our opinion, there were no deficiencies identified during our study which were an immediate concern to dam safety, that is, if not corrected immediately may lead to uncontrolled loss of the impoundment. A number of repair items were identified which need to be addressed to ensure continued safe operation of the dam.

Our repair recommendations and timetable for implementation are summarized by structure as follows:

### 5.1 Gated Spillway Section

#### 5.1.1 Abutments

Most elements of both dam abutments are showing signs of their age, including the walls, stairs, and piers. Much of the pier surfaces are extensively cracked and delaminated. In our opinion, none of the deterioration we observed poses a concern with respect to the immediate safety of the dam. However, if the County allows conditions to remain as-is, we expect the severity of the deterioration will advance over time to a condition where structure safety will become an issue.

STS recommends that the County reconstruct the access stairs on the left and right sides of the dam and budget for complete abutment surface reconstruction within the next five years.

#### 5.1.2 Expansion Joints and Operating Bridge Walls

The rotation of the operating bridge walls appears to be driven by ingress of moisture and progressive freeze-thaw cycles between overlapping sections of bridge wall. The shaded cells in Table 3-2 (page 6) indicate the side of the joint where the greater amount of rotation occurs. The magnitude of the wall rotation appears to be symmetrical about the left/right center of the dam, with the greater rotation occurring on the wall that overlaps the expansion joint. The freeze-thaw phenomenon also explains why the asphalt board joint material was displaced out of the joint, toward the center of the operating bridge - the path of least resistance would be toward the side of the joint without concrete.

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Expansion joint number 1 appears to be receiving movement in excess of the joint's intended design (joint widths closed 75% from design joint width in winter month). We expect, and as evidenced by the concrete disintegration around the joint, that the joint will close further in warmer months and that deterioration around the joint will continue, as fractured concrete and debris that has fallen into the joint in the cooler months serves as a mechanism to fracture "sound" concrete around the joint. This joint may be receiving all expansion and contraction movement for the leftmost 46.25' of the operating bridge due to the left side of expansion joint number 2 not functioning as intended.

STS recommends that the County immediately replace the joint material in all expansion joints, implement measures to prevent runoff ingress between sections of bridge wall, and monitor rotation of the walls at and in-between the expansion joints on a quarterly basis. Expansion joint 1 be should be repaired immediately and possibly retrofit with a joint system capable of accommodating all expansion and contraction from the leftmost 46.25' of the operating bridge. We also recommend that the County address locations of bridge wall cracking, disintegration, and spalling by implementing partial to full depth repair of the spillway operating bridge walls within the next five years to prevent further decay.

### **5.1.3 Operating Bridge Deck**

The operating bridge deck between the right abutment and pier number 1 was severely deteriorated, experiencing cracking, delamination, and isolated disintegration. The top side deterioration does not appear to have advanced to impact the bottom side condition of the deck. However, if left unattended, the deterioration will likely manifest through the thickness of the deck.

STS recommends that the County immediately perform partial to full depth repair of the operating bridge deck between the right abutment and pier 1. We also recommend that the County implement partial depth repair to the operating bridge deck at other areas of decay either within the next five years or during the time repairs are made to the expansion joints.

### **5.1.4 Piers**

With the exception of pier numbers 1 and 11, the portion of the piers above elevation 37.75' appear to be in overall fair condition and may not need extensive maintenance, based on the scope of this condition assessment. Below elevation 37.75', the majority of the piers appear to have a combination of failed surface repairs, cracking, spalling, and other decay.

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The cracking of an 8-inch wide portion of the pier between elevation 36.75' and 38.25' at piers numbers 1 through 11 does not appear to impact the strength and stability of the dam. According to structure drawing 9006-4-8, there were to be two 1/2-inch diameter bars in the upper portion of this section of concrete. It does not seem likely that the cracks would have formed as a result of hydrostatic or ice loading on the piers as the 8-inch wide elements are below the design top of water and ice load elevations of 36.0' and 35.0', respectively (structure drawing M-1, dated May, 1988), and there is a large resisting mass of concrete below this elevation

STS recommends that the County budget for complete lower pier surface reconstruction below elevation 37.75' within the next five years. STS also recommends the dam owner immediately perform partial depth repair to the upper portion of pier numbers 1 and 11 between the "column" portions of the piers and below the bridge deck.

#### **5.1.5 Gates and Hoists**

The gates appeared to be in overall fair condition for their age. We recommend the dam owner install a pair of adequately-sized drain holes in the web of the wide flange horizontal girders at each gate within the next five years to promote drainage of water between the flanges. While the gate skin plates have a layer of surface rust, we did not observe any significant loss of section. Within the next five years, STS recommends that the County have the gates sand blasted and repainted with water-based urethane paint suitable for this application. No existing paint was visible on the gate surfaces so lead should not be an issue. Sand blasting and painting can probably be performed most economically in the field as opposed to removal to an off-site shop.

#### **5.2 Ice Breakers**

The tops of these tripod concrete structures have deteriorated due to freeze-thaw action. The tops should be repaired within the next five years. A major reconstruction, as recommended by the WDNR in their 2004 inspection report, does not appear necessary. Woody debris which has accumulated upstream of the ice breakers should be removed.

Milwaukee County Department of Public Works  
STS Project No. 5-87996  
September 8, 2006

### **5.3 Overflow Spillway**

#### **5.3.1 Flashboard Section**

STS recommends that the County immediately replace broken or missing stop logs, and repair or replace bent stop log guides. STS also recommends re-evaluating the rubble masonry within five years. If additional significant loss of masonry is observed, the County should proceed with developing plans for a complete concrete overlay of the overflow weir section.

#### **5.3.2 Overflow Section**

Some minor loss of masonry blocks from the top surface downstream of the concrete core. In addition, there is evidence of some separation of the downstream masonry from the concrete core – probably due to ingress of water and progress freezing and thawing over time. This joint should be filled with a suitable elastomeric crack filler to prevent the ingress of water. The loss of masonry material and movement of masonry is not considered sufficient to negatively impact overall section stability at this time. STS recommends repairing areas of deteriorated concrete on the overflow weir crest within the next five years. We also recommend re-evaluating the condition of the rubble masonry within five years. If additional significant loss of masonry is observed, the County should proceed with developing plans for a complete concrete overlay of the overflow section.

We also recommend immediate removal of accumulated woody debris upstream of stop log and overflow sections. The County should develop a means to more readily remove this accumulated material on a regular basis.

### **5.4 Slope Protection**

There is some minor erosion and undercutting along the right river bank downstream of the gated spillway. There is also some minor undercutting along the banks just upstream of the gated spillway along the left and right banks. We recommend that suitably-sized rip rap be placed in both of these locations within the next five years.

Milwaukee County Department of Public Works  
STS Project No. 5-87996  
September 8, 2006

## 6.0 OPINION OF PROBABLE CONSTRUCTION COST

Recommended repairs are summarized as follows:

- Remove and replace deteriorated concrete on abutments, operating bridge deck, deck walls, steps, and piers of the gated spillway section.
- Repair the expansion joints on the spillway bridge deck.
- Sandblast the spillway gates and paint with a water-based urethane paint, suitable for this application. Drain holes should also be drilled in the horizontal cross members to promote drainage.
- Place additional rip rap downstream of the gated spillway along the left bank, and upstream of the gated spillway along the left and right banks.
- Replace the overflow spillway flashboards and repair the bent guides and supports. Remove and replace areas of deteriorated concrete on the overflow weir crest.
- Repair concrete deterioration evident on the tops of the ice breakers.
- Remove the large accumulation of woody debris upstream of the overflow spillway section.

Based upon the above recommendations, our opinion of probable costs for construction and engineering are as follows:

Construction cost:	\$618,000
Engineering cost:	<u>\$138,000</u>
Total:	\$756,000

This includes a 20-percent construction cost contingency and a 15-percent engineering cost contingency.

These opinions are based upon 2006 unit prices for similar projects, engineering judgment, and/or published cost data. Actual bids and total project costs may vary based upon contractor's perceived risk, site access, season, market conditions, and prevailing wage and unit prices at the time of bidding. No warranty concerning the accuracy of costs presented herein are expressed or implied.

## **Appendices**

Appendix A – Location Map

Appendix B – Design Drawings

Appendix C – Structural Evaluation of Gated Spillway Section

Appendix D – Project Photographs

Appendix E – Dive Inspection Report

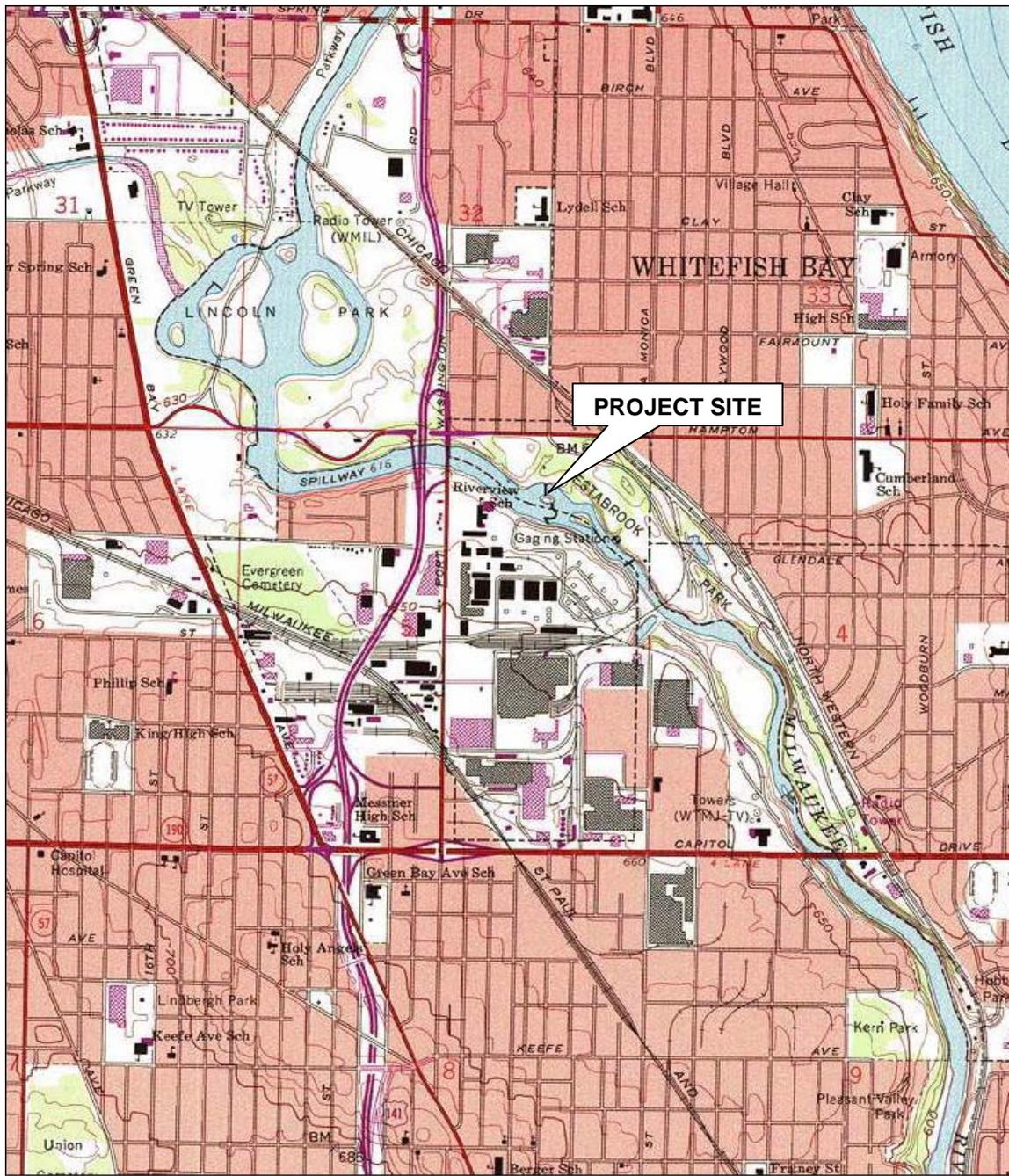
Appendix F – Stability Analysis of Gated Spillway Section

Appendix G – Opinion of Probable Cost for Dam Repair

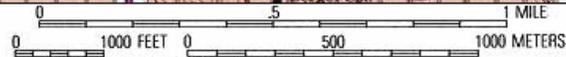


**APPENDIX A**  
Location Map





MN TN  
3°



Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)



STS Consultants  
2821 Dairy Drive, Suite 5  
Madison, WI 53718  
608-224-7231  
[www.stsconsultants.com](http://www.stsconsultants.com)  
Copyright©2004, By: STS Consultants, Ltd.

## SITE LOCATION DIAGRAM

### Estabrook Park Dam

### Milwaukee County, Wisconsin

Drawn: LJE 07/21/2006

Checked: RJA 07/21/2006

Approved: RJA 07/21/2006

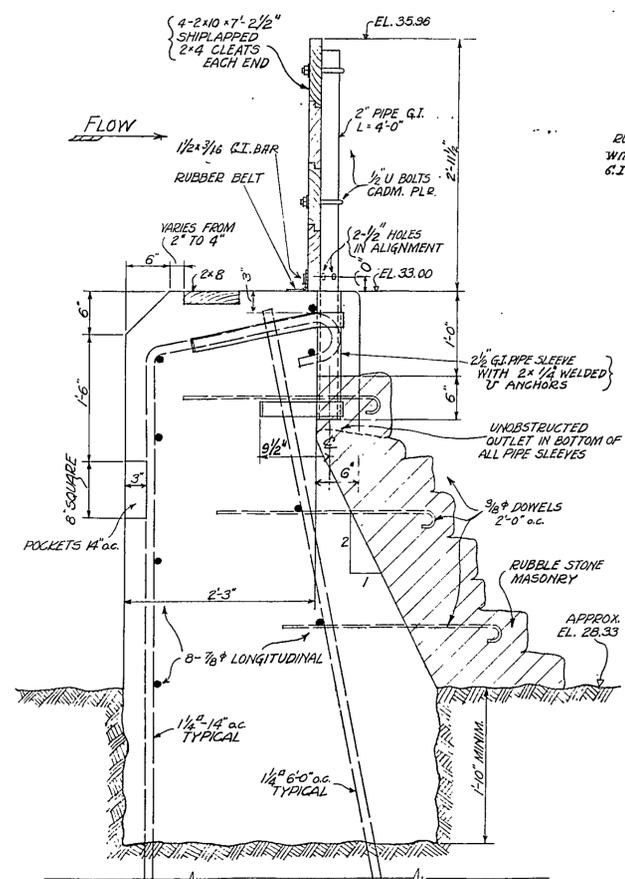
PROJECT NUMBER 5-87996

FIGURE NUMBER A-1

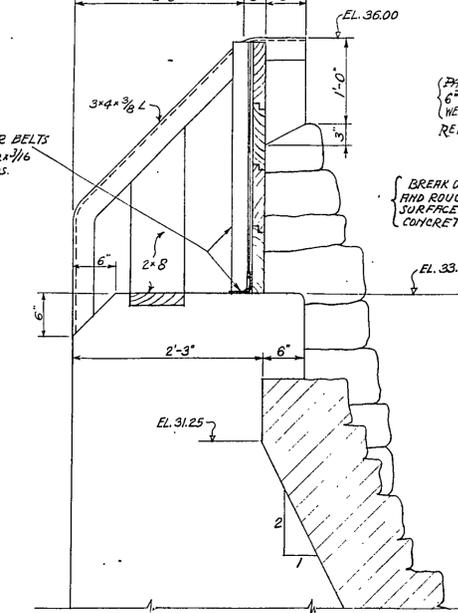
## APPENDIX B

Design Drawings





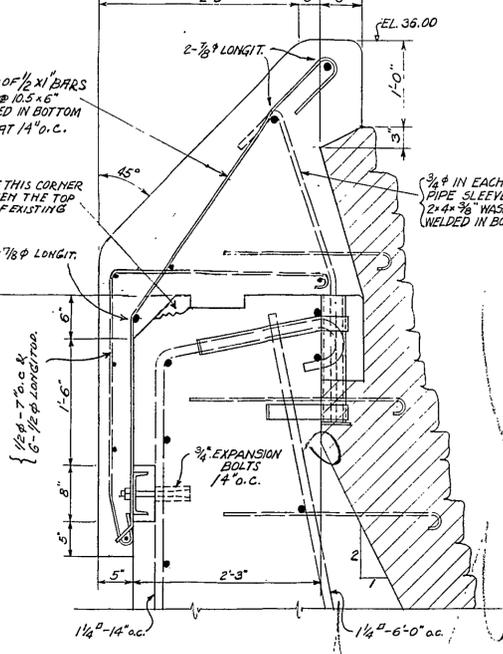
SECTION A-A (TYPICAL)  
SCALE 1"=1'-0"



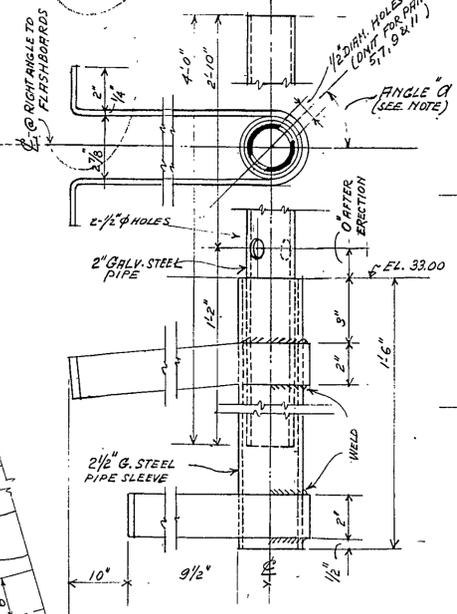
SECTION B-B  
SCALE 1"=1'-0"  
REINFORCING AS IN SECTION A-A

QUANTITIES OF MATERIALS.

- LUMBER - 600 B.M.
- GALV. PIPE - 2" - 100 F.
- " - 2 1/2" - 40 F.
- BAR 2x1/4 - 140 F.
- BOLTS 1/2" U WITH WASHERS - 48 BOLTS
- RUBBER BELT - 6x3/16 - 160 F.
- GALV. WOOD SCREWS - 1/2" SIZE - 3 GROSS WITH WASHERS
- 3x4x3/8 L - BENT - 10 F.
- 1/2x3/16 G.I. BARS - 160 F.

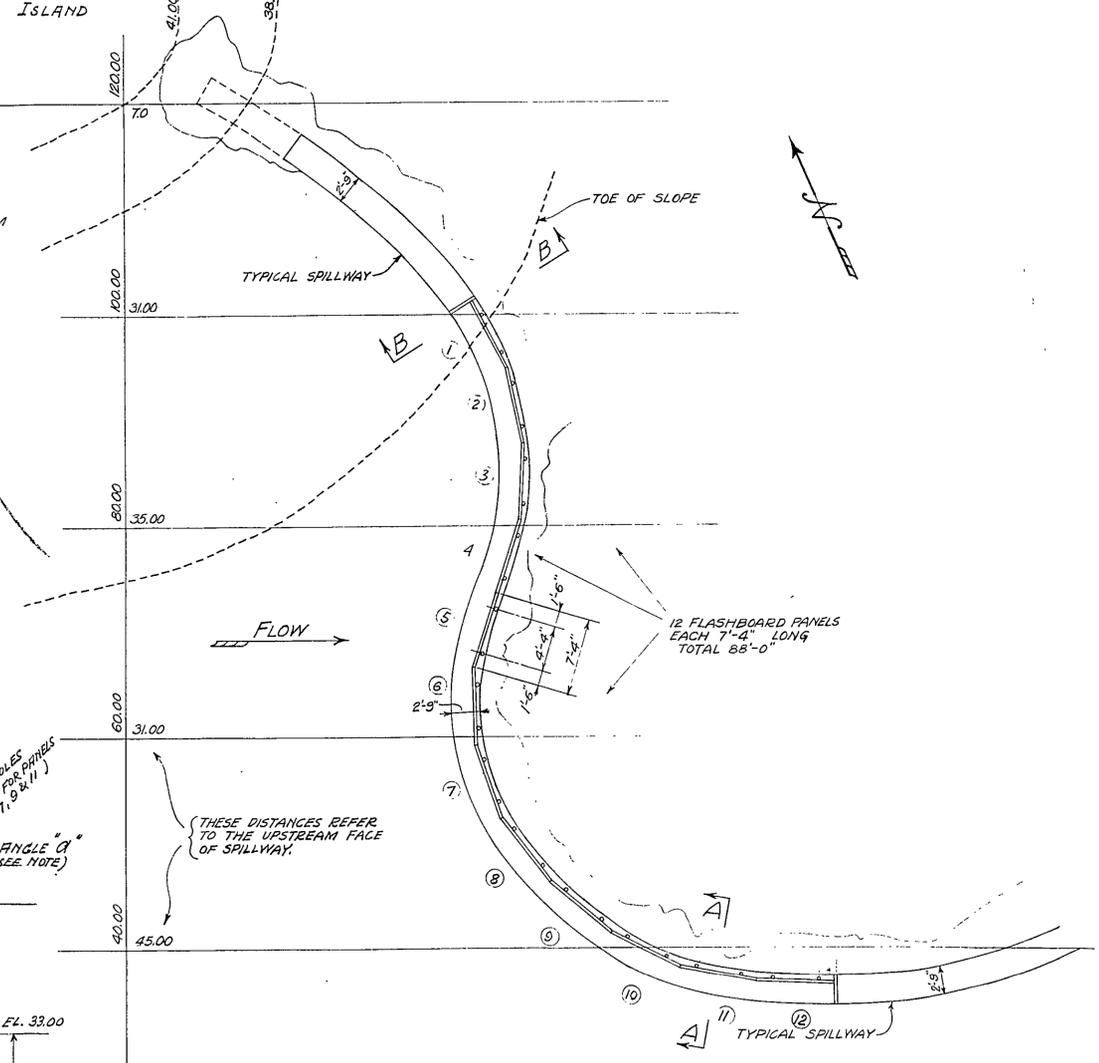


FUTURE SPILLWAY ALTERNATE  
SECTION A-A  
SCALE 1"=1'-0"

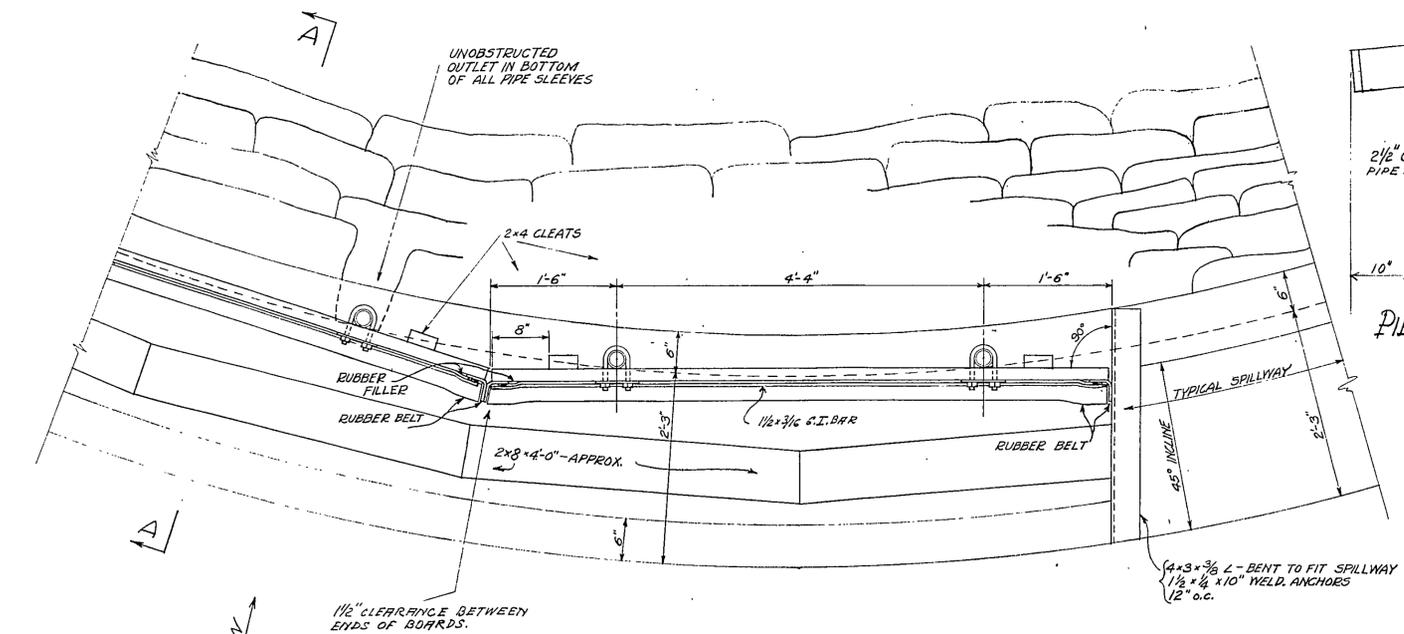


PIPE STANCHION DETAIL  
SCALE 1/4"=1"

NOTE:  
FOR ITEMS NOT SHOWN ON THIS PLAN SEE SHEET S.P. WIS-9006-3-6  
FLASHBOARD STANCHIONS SHALL BE MADE OF A 2" PIPE HAVING AN ULTIMATE STRENGTH OF 70,000 LBS./SQ. IN.  
THE ANGLE "A" SHOWN ON THE STANCHION DETAIL SHALL BE 0° (ZERO) FOR PANELS 1, 2, 3 & 4 & 45° FOR PANELS 6, 8, 10 & 12. OMIT THE ANGLES FOR PANELS 5, 7, 9 & 11. IF THE STRENGTH OF PIPE MATERIAL VARIES FROM 70,000 LBS./SQ. IN THE ANGLE "A" SHALL BE CHANGED SO AS TO MAINTAIN THE SAME RESISTING MOMENT AT THE BASE OF 2" PIPE.  
THE 1/2" TYPICAL BENT BARS IN THE SPILLWAY WITH FLASHBOARDS SHALL BE REBENT IN TOP TO FORM AN 80° ANGLE IN PLACE OF 45° 75 OF THOSE BARS ARE REQUIRED.  
ALL RUBBER BELTS SHALL BE 6"x3/16" WITH DUCK BACKING, FATTENED TO FLASHBOARDS BY G.I. SCREWS MAIN 3/8" & 1/2"x3/16" G.I. BARS. RUBBER FILLERS SHALL FILL THE VOIDS BETWEEN BELTS TO FORM A WATERTIGHT JOINTS.  
ALL FLASHBOARDS SHALL BE MADE OF SPRUCE OR REDWOOD. THEY SHALL RECEIVE 1 COAT OF PRIMER AND 2 COATS OF PAINT. NUMBERS SHOWN ON PLAN SHALL BE PRINTED ON EACH PANEL IN FIGURES 6" HIGH.  
THE TOP PORTION OF SPILLWAY AS SHOWN ON FUTURE SPILLWAY ALTERNATE SHALL HAVE A 28 DAY STRENGTH OF NOT LESS THAN 3000 LBS./SQ. IN.  
THE QUANTITIES OF MATERIALS DO NOT INCLUDE MATERIALS CALLED FOR ON THE ORIGINAL PLANS THAT CAN BE USED IN THE REVISED SPILLWAY SECTION.  
PRIOR TO INSERTING THE PIPE STANCHIONS INTO THE SLEEVES THEY SHALL BE BOTH COATED WITH HEAVY LUBRICATING OIL.



GENERAL PLAN OF SPILLWAY WITH FLASHBOARDS  
SCALE 1/8"=1'-0"



PART PLAN VIEW  
SCALE 1"=1'-0"

DESIGNED BY *M. B. Coffey*  
CONSULTING ENGINEER

MILWAUKEE COUNTY REGIONAL PLANNING DEPARTMENT	
LANDSCAPE DESIGN SECTION	ENGINEERING DESIGN SECTION
Landscape Architect	<i>Ray B. Schwan</i> Senior Asst. Civil Engineer
Survey	Approved: <i>William J. ...</i> Date: 5/3/39 Supervising Engineer
Plan	Approved: <i>William J. ...</i> Date: 7/6/39 Highway Commissioner & Planning Engineer
Tracing	
Checked	
UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE COOPERATING WITH MILWAUKEE COUNTY PARK COMMISSION	
DRAWN BY	PLAN NO.
DESIGNED BY	SCALE
CHECKED BY	S.P.
	DATE
PREPARED BY <i>Jerome ...</i>	DATE
RECOMMENDED	INSPECTOR
RECOMMENDED	REGIONAL OFFICER
APPROVED BY	ASSISTANT DIRECTOR



BILL OF REINFORCING BARS

MARK	NO.	SIZE	LENGTH	SPACING	LOCATION	REMARKS
1	459	1/4"	16-3	14"	CURVED SPILLWAY	
2	90	1/4"	14-3	6'-0"	"	
3	24	1/4"	16-0	14"	"	ABUTMENTS
4	4	1/4"	14-6	6'-0"	"	"
5	170	7/8"	30-0	"	"	LONGITUDINAL
6	164	3/8"	30-0	2'-0"	"	MASONRY DOWELS CUT IN FIELD
7	84	1/4"	10-9	"	ICE GUARDS	
8	224	3/4"	11-9	"	"	
9	112	3/4"	11-0	"	"	
10	644	3/8"	3-6	12"	"	TIES
11	28	1/2"	7-6	"	"	
12	28	1/2"	6-6	"	"	
13	28	1/2"	5-3	"	"	
14	28	1/2"	4-3	"	"	
15	91	1/4"	12-0	"	PIERS	DOWNSTREAM END
16	78	1/4"	14-9	"	"	CENTER
17	91	1/4"	15-9	"	"	UPSTREAM END
18	56	3/4"	16-9	16"	3'-8" PIERS	LOWER 4 ROWS
19	28	3/4"	9-6	16"	"	INTERMID. 2 ROWS
20	14	3/4"	5-6	16"	"	TOP ROW, UPSTREAM END
21	48	3/4"	17-9	16"	4'-6" PIERS	LOWER 4 ROWS
22	24	3/4"	10-0	16"	"	INTERMID. 2 ROWS
23	12	3/4"	6-0	16"	"	TOP ROW, UPSTREAM END
24	143	1"	15-6	"	PIERS ON DOWNSTREAM END	
25	21	1"	19-0	"	"	BELOW RAILING IN 2'-10" PIERS
26	24	1"	19-6	"	"	BELOW RAILING IN 3'-8" PIERS
27	109	1"	12-9	"	PIERS ON UPSTREAM END	
28	21	1"	16-3	"	"	BELOW RAILING IN 2'-10" PIERS
29	24	1"	16-9	"	"	BELOW RAILING IN 3'-8" PIERS
30	112	1/2"	12-3	12"	PIERS ON DOWNSTREAM SIDE	2'-10" PIERS
31	32	1/2"	14-9	12"	"	3'-8" PIERS
32	64	1/2"	11-9	12"	"	2'-8" PIERS
33	77	3/8"	8-3	10"	"	10" PIERS
34	77	3/8"	3-9	10"	"	"
35	16	1/2"	19-6	"	"	3" THICK EXTERIOR NEAR EXPANSION JOINTS
36	124	1/2"	6-3	12"	PIERS	"
37	16	1/2"	16-9	"	PIERS ON UPSTREAM END	"
38	31	1/2"	10-0	12"	"	2'-10" PIERS
39	26	1/2"	12-6	12"	"	3'-8" PIERS
40	52	1/2"	9-6	12"	"	2'-8" PIERS
41	56	1/2"	7-6	"	RAILING OVER 2'-10" PIERS	
42	80	1/2"	6-6	"	8" WALLS BETWEEN PIERS	
43	12	1/2"	10-0	"	8" WALLS IN ABUTMENT PIERS	
44	116	3/4"	8-3	"	BEAMS INTO TOP OF PIERS	
45	110	1/2"	6-0	"	RAILING OVER PIERS	
46	16	1/2"	2-9	"	RAILING RETURN OVER ABUTMENT PIERS	
47	102	3/4"	30-0	12" O.C.	BOTTOM SLAB	
48	94	3/4"	14-9	16" O.C.	"	
49	188	1/2"	9-6	12"	TOP SLAB BETWEEN PIERS	ALTERNATE 49 AND 50 - BARS THAT WOULD CROSS THE GATE OPENING SHALL BE PLACED NEXT TO IT.
50	138	1/2"	17-6	12"	"	
51	280	1/2"	5-0	12"	RAILING BETWEEN PIERS	
52	40	3/4"	17-0	"	BOTTOM OF RAILING	AT SPILLWAY PLACE BARS IN 2 LAYERS
53	40	3/4"	18-0	"	TOP OF RAILING	
54	40	5/8"	17-0	"	SLAB BELOW RAILING	
55	130	1/2"	17-0	6"	SLAB	LONGITUDINAL
56	10	1/2"	10-0	"	"	IN LINE WITH CHAIN OPENINGS
57	30	1/2"	16-3	6"	"	END PANELS LONGIT.
58	60	1/2"	13-0	"	BASES FOR SHAFT BEARINGS	

MARK	NO.	SIZE	LENGTH	SPACING	LOCATION	REMARKS
59	120	1/2"	17-0	12"	RAILING	LONGITUDINAL
60	68	3/8"	8-0	"	UNDER PILLOW BLOCKS	HORIZ. ENDS AND BEND UP IN FIELD
61	34	1/4"	13-0	20" x 36"	ABUTMENTS	
62	136	1/2"	19-6	12"	"	HORIZ. IN SIDE WALLS
63	88	1/2"	18-0	12"	"	VERT. IN SIDE WALLS. SHALL BE CUTTER IN FIELD
64	48	1/2"	19-6	12"	"	"
65	128	1/2"	6-6	6"	"	SLAB AND STAIRS
66	12	1/2"	20-0	12"	"	"
67	12	5/8"	8-6	12"	"	STIFFENER WALL
68	32	5/8"	7-0	12"	"	BENT LIKE 65
69	12	1/2"	13-0	12"	"	END WALL VERTIC.
70	24	1/2"	7-6	12"	"	" - BENT LIKE 65
71	24	1/2"	4-6	12"	"	"
72	12	1"	14-0	"	SPILLWAY AT THE ENDS OF GATE SECTIONS	
73	24	3/4"	13-6	"	"	
74	14	3/4"	13-6	16"	"	
75	14	1/2"	10-0	16"	"	
76	30	1/2"	7-0	10"	TOP OF SLAB UNDER HOISTS	SEE NOTE ON SHEET NE2
77	98	1/2"	9-0	6"	TOP OF SLAB OVER 2'-10" PIERS	
78	40	3/8"	4-6	8"	"	AT EXPANSION JOINTS
79	62	3/8"	6-0	10"	10" PIER ON DOWNSTREAM END	
80	62	3/8"	1-9	10"	"	
81	24	1/2"	16-6	12"	RAILING AT END PANELS	LONGIT.
82	16	3/4"	16-6	"	"	TOP & BOTTOM
83	8	5/8"	16-6	"	"	SLAB BELOW
84	35	1/2"	6-6	24"	PIERS ON DOWNSTREAM SIDE	2'-10" PIERS
85	20	1/2"	2-0	"	"	3'-8" PIERS
86	20	1/2"	2-3	"	"	3'-8" PIERS

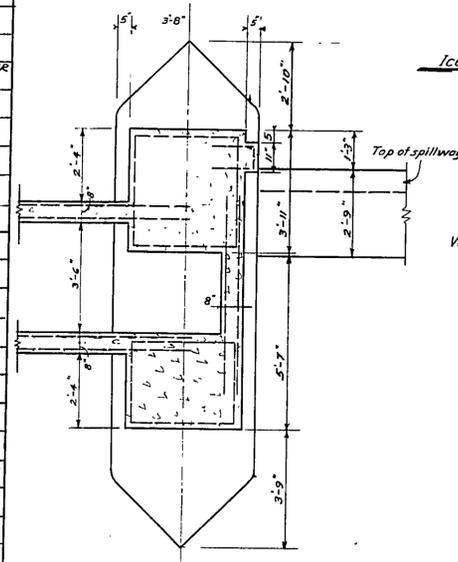
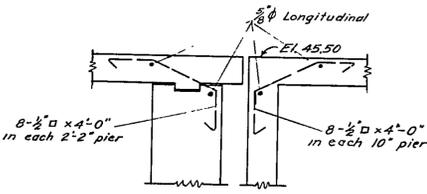
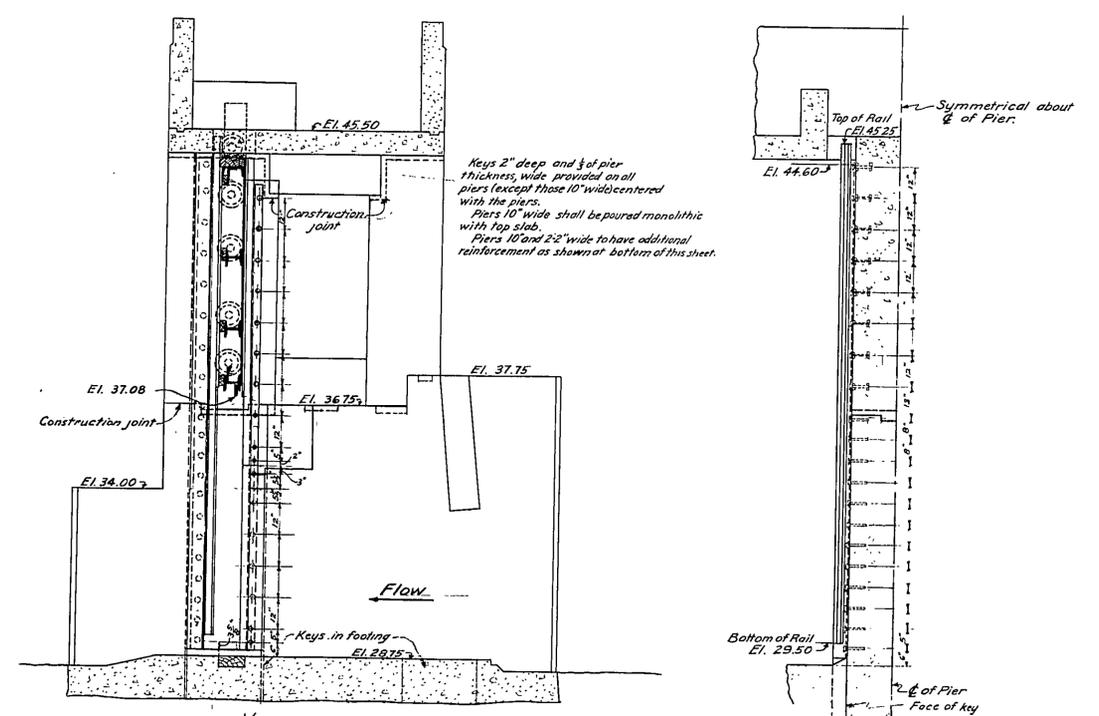


DIAGRAM OF FORCES APPLIED TO SPILLWAY SCALE 1/2" = 1'-0"

END PIER - SECTIONAL PLAN AT ELEVATION 40.00 Reinforcement as called for in 3'-8" piers



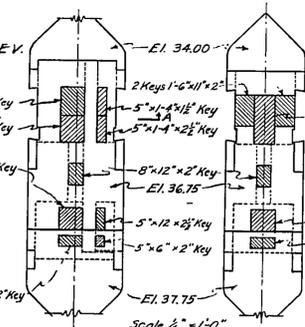
ADDITIONAL STEEL IN 2'-2" AND 10" PIERS



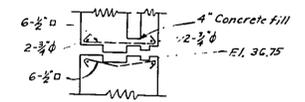
VERTICAL SECTION BETWEEN PIERS WITH GATE RAISED TO MAX. ELEV. SCALE 3/8" = 1'-0"

VERTICAL SECTION THRU GATE PIER AT GATE GUIDE SCALE 3/8" = 1'-0"

$M_1 = 10,000 \times 8.5 = 85,000$  Foot pounds  
 $M_2 = 2,000 \times 4.16 = 8,320$  " "  
 $M_3 = 2,000 \times 0.5 = 1,000$  " "  
 $R_1 = 12,000 \times 1.08 = 13,000$  " "  
 Total overturning moment per linear foot = 79,320 Foot pounds



ARRANGEMENT OF KEYS AT CONSTRUCTION JOINT IN PIERS



SECTION AA SHOWING INTERLOCKING OF KEYS

Designed by M. B. Coifman Consulting Engineer

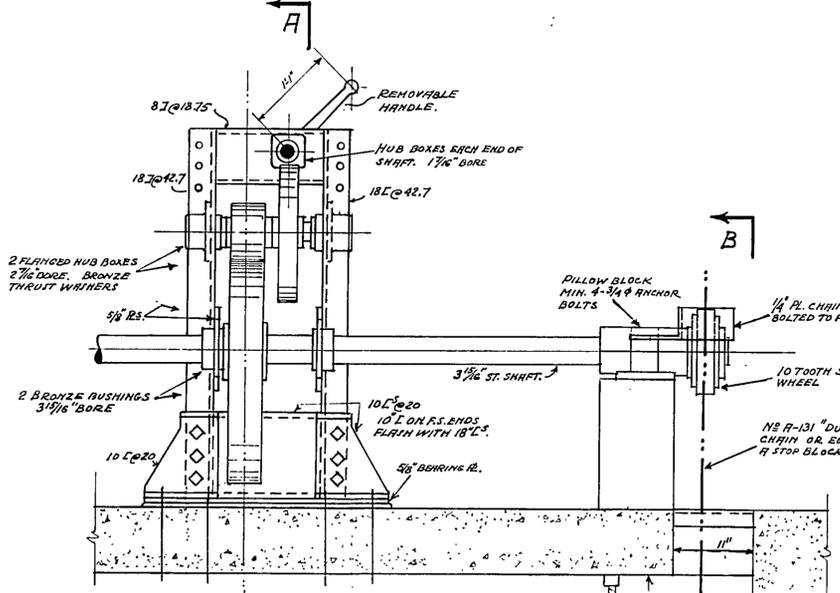
MILWAUKEE COUNTY REGIONAL PLANNING DEPARTMENT

ESTABROOK PARK DAM REINFORCING STEEL LIST - TYPICAL SECTIONS

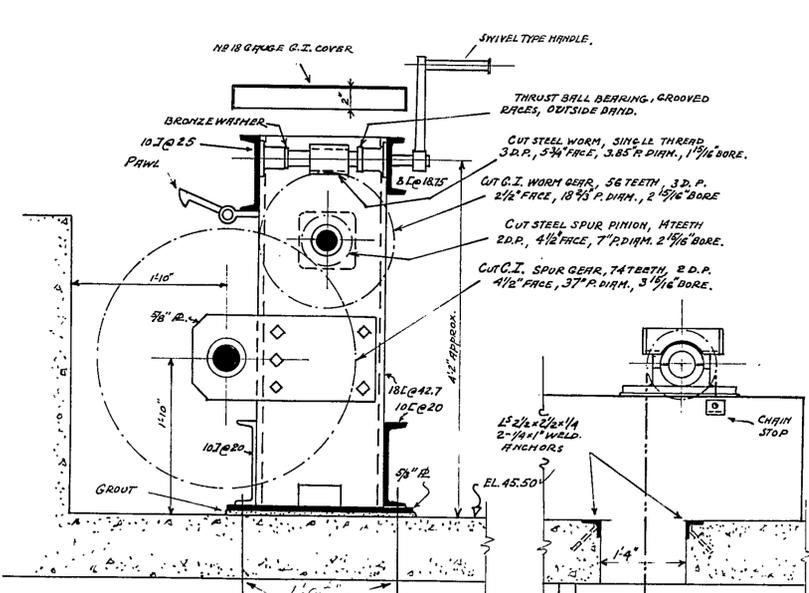
LANDSCAPE DESIGN SECTION <u>Alfred Boun</u> Landscape Architect	ENGINEERING DESIGN SECTION <u>Ray E. Schum</u> Senior Asst. Civil Engineer
Survey.....	Approved: <u>E. A. How</u> Date <u>4/24/37</u>
Plan.....	Supervising Engineer
Tracing.....	Approved: <u>W. L. C...</u> Date <u>5/20/37</u>
Checked.....	Highway Commissioner & Planning Engineer

DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE AND MILWAUKEE COUNTY PARK COMMISSION CO-OPERATING

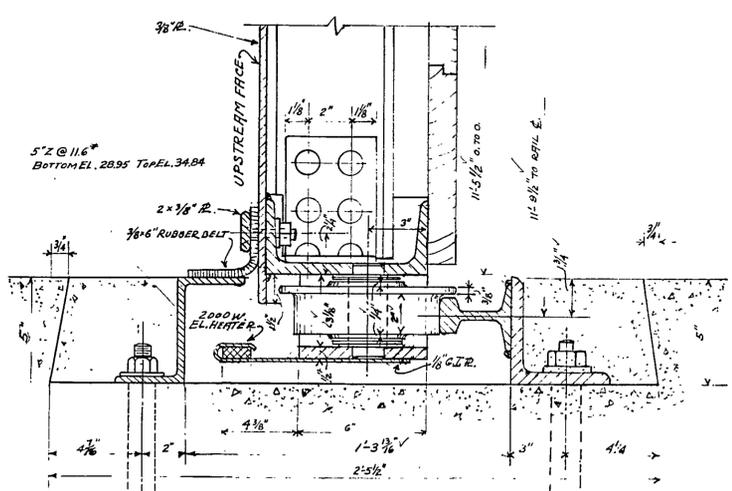
Prepared by <u>James D...</u> Date .....	Secretary Milwaukee County Park Commission
Recommended by <u>W. L. C...</u> Date <u>5/21</u>	Inspector
Approved: _____ Date .....	Regional Office



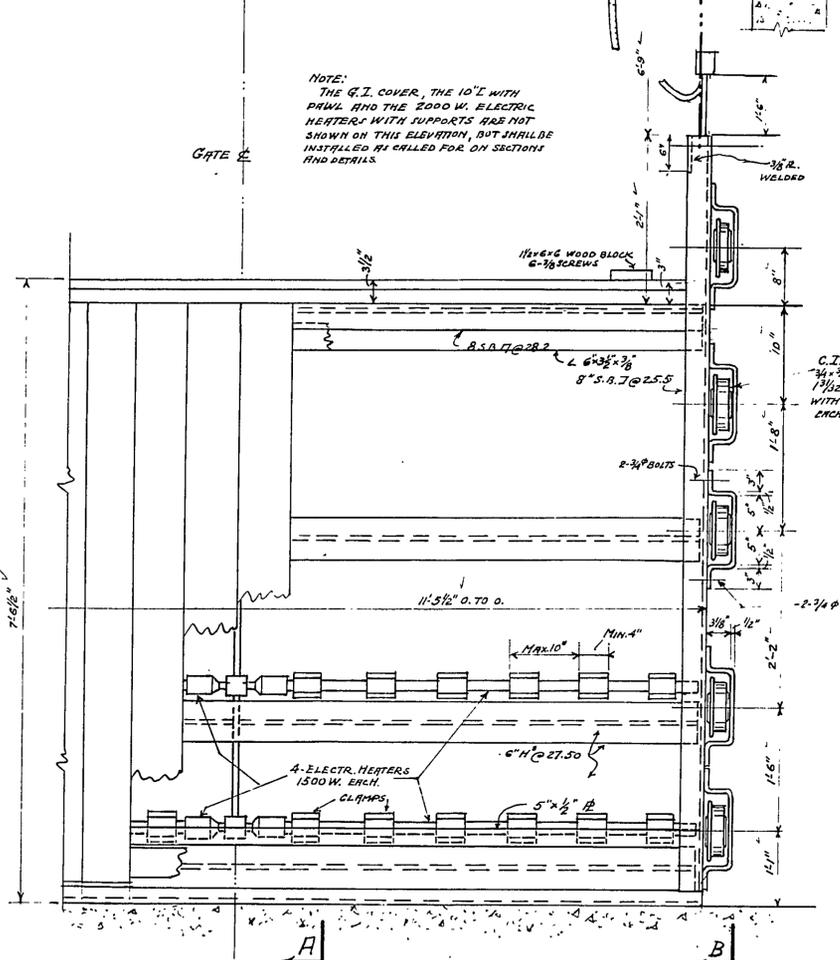
NOTE:  
THE G.I. COVER, THE 10" I WITH  
PINN AND THE 2000 W. ELECTRIC  
HEATERS WITH SUPPORTS ARE NOT  
SHOWN ON THIS ELEVATION, BUT SHALL BE  
INSTALLED AS CALLED FOR ON SECTIONS  
AND DETAILS.



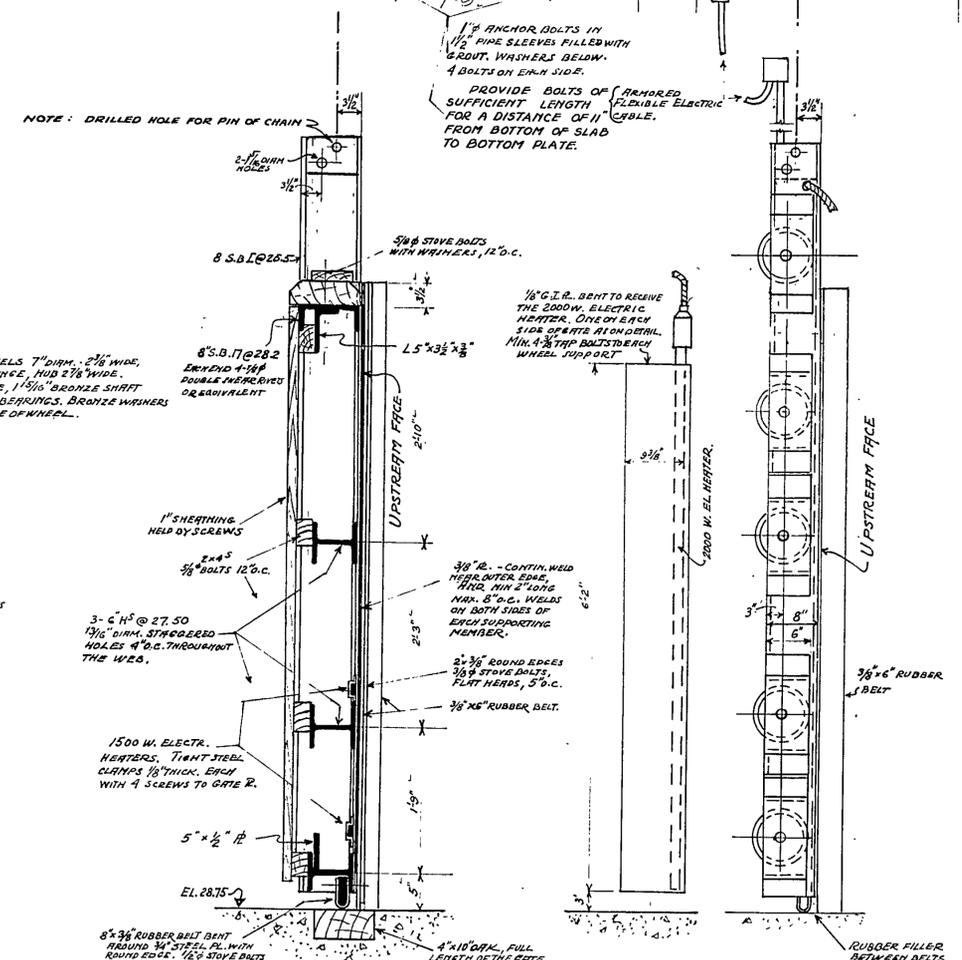
NOTE: DRILLED HOLE FOR PIN OF CHAIN  
1/2" ANCHOR BOLTS IN  
1/2" PINN SLEEVES FILLED WITH  
GROUT. WASHERS BELOW.  
4 BOLTS ON EACH SIDE.  
PROVIDE BOLTS OF ARMORED  
SUFFICIENT LENGTH FOR A DISTANCE OF 11"  
FROM BOTTOM OF SLAB  
TO BOTTOM PLATE.



TYPICAL GATE BEARING BELOW EL. 34.75  
SCALE 3"=1'-0"

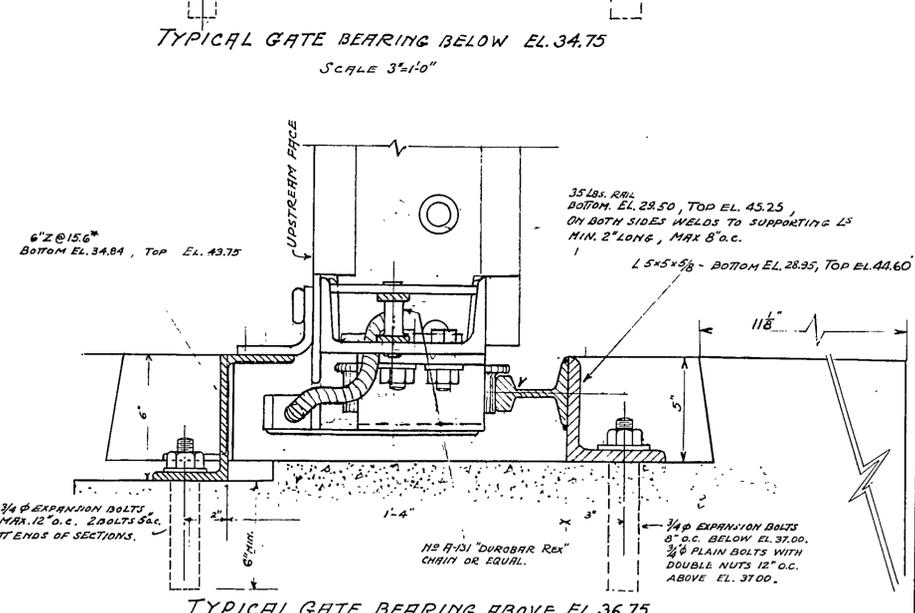


DOWN STREAM ELEVATION  
SCALE 1/4"=1'-0"



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

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



TYPICAL GATE BEARING ABOVE EL. 36.75  
SCALE 3"=1'-0"

NOTE:  
GATES, HEATERS AND ACCESSORIES ARE SYMMETRICAL  
ABOUT GATE E, EXCEPT THAT ELECTRIC CONNECTION FOR  
HEATERS IS AT NORTH END OF EACH GATE.  
TEN GATES WITH ALL ACCESSORIES AS SHOWN SHALL  
BE INSTALLED ON THE DAM.  
ALL BOLTS, NUTS, SCREWS AND WASHERS SHALL BE CADMIUM  
PLATED AFTER FABRICATION OF EACH, EXCEPT THOSE IN GATE GUIDES  
WELDED CONNECTIONS OF EQUIVALENT STRENGTH CAN  
BE USED IN PLACE OF RIVETS.  
ALL ELECTRIC WIRING ON THE GATES AND CONNECTIONS  
SHALL BE ENTIRELY WATERPROOF.  
ALL WOOD USED IN GATE CONSTRUCTION SHALL BE  
CREOSOTED.  
ALL BOLTS SHALL HAVE WASHERS AND HEXHEAD NUTS.  
BOLTS, NUTS & WASHERS HOLDING THE GATE GUIDES SHALL BE HOT  
DIP GALVANIZED AND THE NUTS SHALL HAVE OVERSIZE THREADS  
TO ASSURE EASY OPERATION AND THE STRENGTH OF STANDARD NUTS.

IN THE HOIST ALL HOLES SHALL BE REAMED AND BOLTS  
CONNECTING STRUCTURAL MEMBERS MIN. 7/8" DIAM.  
ALL SHAFT BEARINGS OF THE HOIST SHALL BE BRONZE OR  
BRONZE AND SHALL BE PROVIDED WITH "FLEEMITE" OR GREASE  
FITTINGS.  
ALL GEARS SHALL BE STANDARD MAKE OF A SINGLE  
MANUFACTURER AND SHALL BE EQUAL TO THOSE MADE  
BY D. O. JAMES CO., W. A. JONES CO. OR FOSTER BROS.  
CHAINS AND SPROCKET WHEELS SHALL BE STANDARD MAKE  
OF A SINGLE MANUFACTURER AND EQUAL TO THOSE MADE  
BY CHAIN BELT CO., LINK BELT CO. OR JEFFREY MFG. CO.  
PROVIDE SUITABLE KEYS AND SCREWS TO HOLD IN  
PROPER POSITION ALL GEARS, WHEELS AND SHAFTS UNDER  
THE MAXIM. STRESS THAT THESE MEMBERS CAN RESIST.  
GUIDES FOR THE GATES SHALL BE SHIP-DRAFTED AND HOT-DIP  
GALVANIZED AFTER FABRICATION.  
LINKS AND NUTS: ALL EXPOSED EDGES CUT SHARP  
SHALL BE ROUNDED OUT.

Revised MAY 18, 1937  
Revised MAY 19, 1937  
Revised SEPT. 29, 1937  
Revised OCT. 18, 1937  
" NOV. 8, 1937  
" NOV. 30, 1937

Designed by *M. B. Coifman*  
Consulting Engineer

MILWAUKEE COUNTY REGIONAL PLANNING DEPARTMENT

ESTABROOK PARK DAM  
GATES AND ACCESSORIES

LANDSCAPE DESIGN SECTION <i>Robert Bonner</i> Landscape Architect	ENGINEERING DESIGN SECTION <i>Ray Behrens</i> Senior Asst. Civil Engineer
Survey.....	Approved: <i>E. Howard</i> Date: 4/24/37
Plan.....	Approved: <i>W. Howard</i> Date: 5/2/37
Tracing.....	Approved: <i>W. Howard</i> Date: 5/2/37
Checked.....	Approved: <i>W. Howard</i> Date: 5/2/37

DEPARTMENT OF THE INTERIOR  
NATIONAL PARK SERVICE  
AND  
MILWAUKEE COUNTY PARK COMMISSION  
CO-OPERATING

BRANCH OF PLANNING

STATE PARK DIVISION

Prepared by *W. Howard*  
Secretary Milwaukee County Park Commission

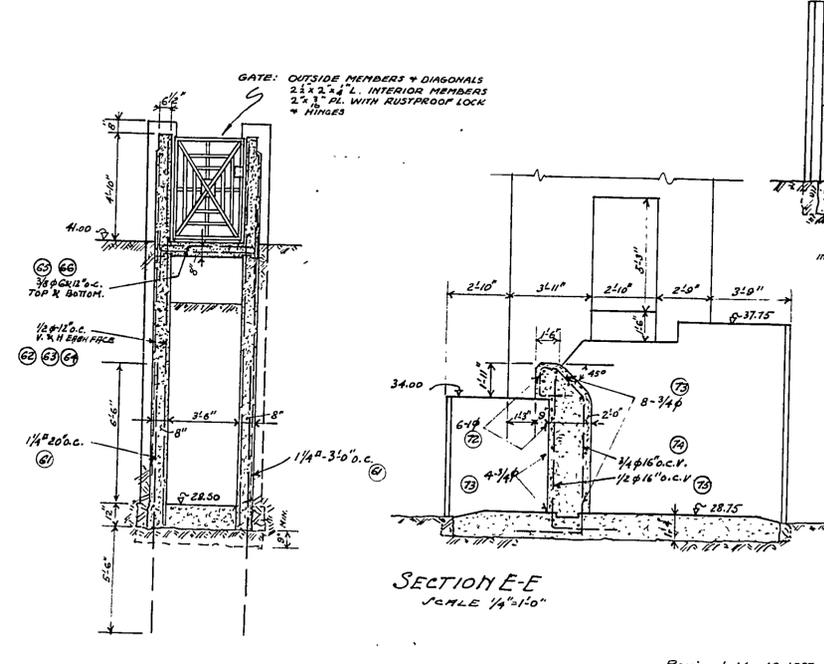
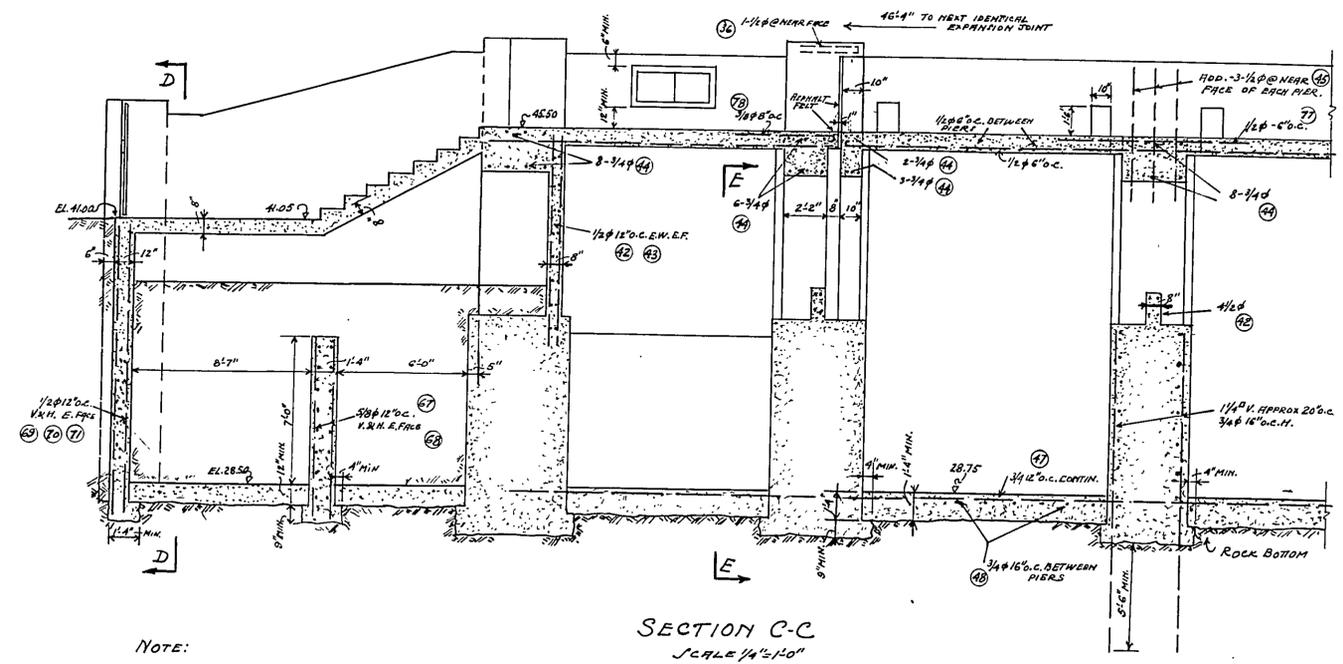
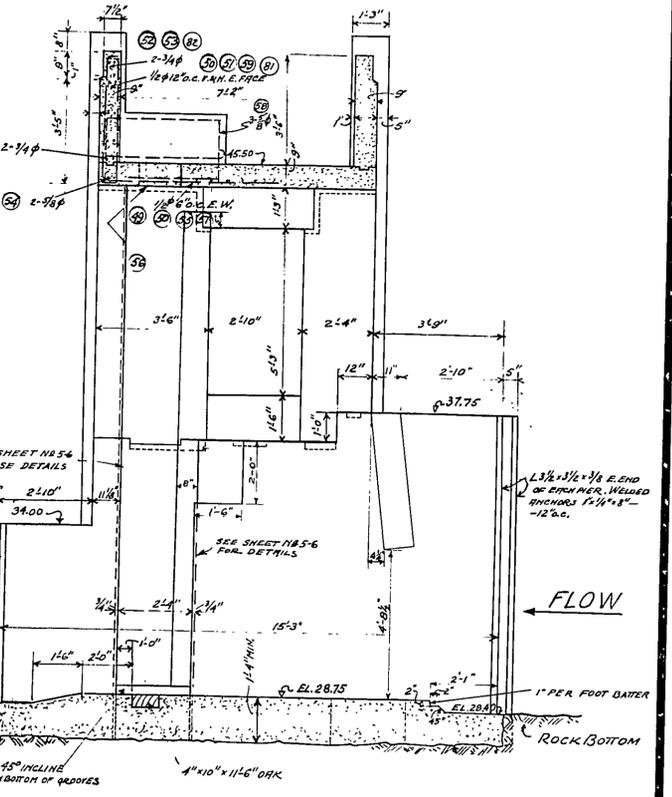
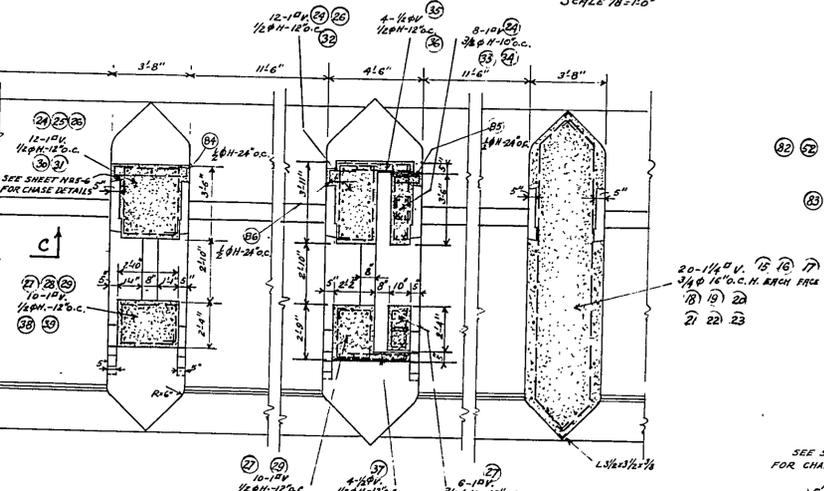
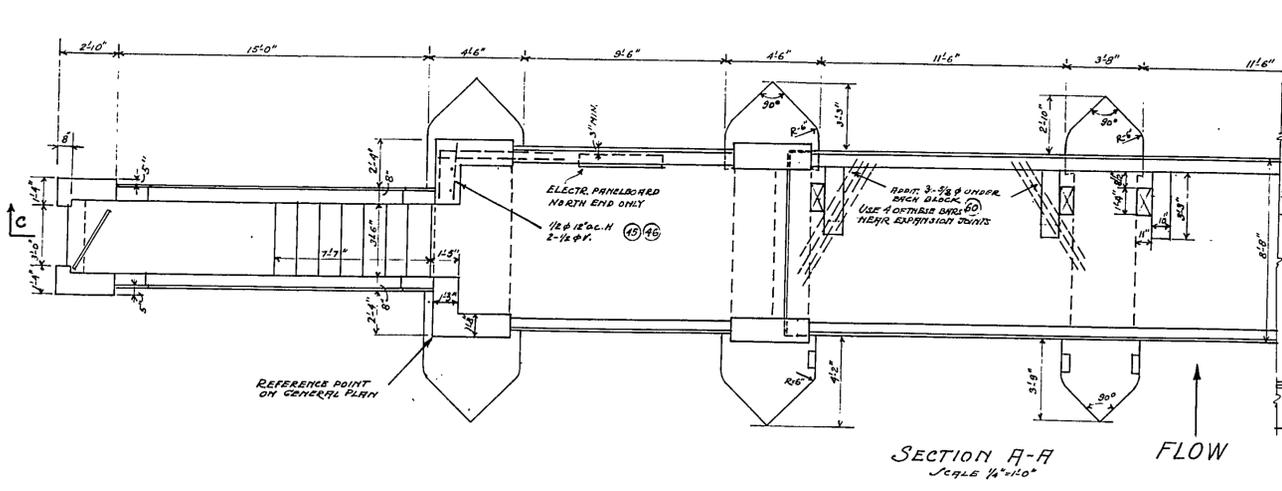
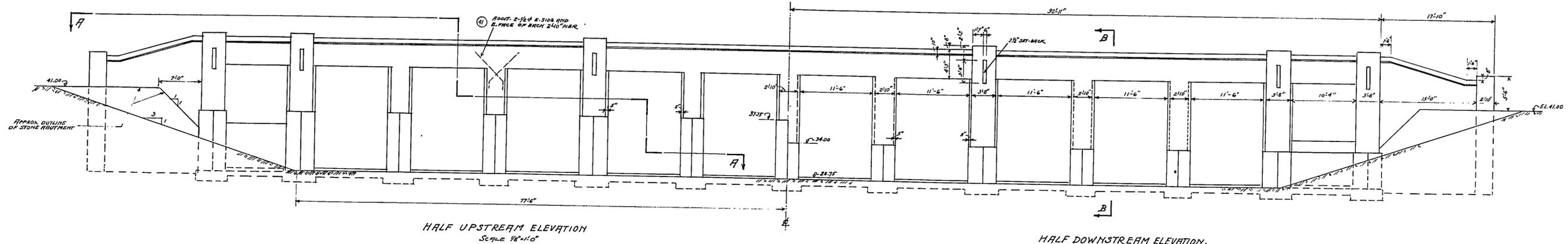
Recommended by *W. Howard* Date: 5/2/37  
Inspector

Approved: *W. Howard* Date: 5/2/37  
Regional Officer

S.P.-WIS  
9006-5-8  
SCALES AS SHOWN

SYMBOL  
NUM. IN  
130  
DAIL

24X  
MICROFILMED



Designed by M. B. Coifman  
Consulting Engineer

MILWAUKEE COUNTY REGIONAL PLANNING DEPARTMENT

**ESTABROOK PARK DAM**  
CONCRETE DETAILS - GATE SECTION

LANDSCAPE DESIGN SECTION <u>Robert Borner</u> Landscape Architect	ENGINEERING DESIGN SECTION <u>Roy Behrens</u> Senior Asst. Civil Engineer
Survey.....	Approved: <u>E. A. Howard</u> Date: <u>4/24/37</u> Supervising Engineer
Plan.....	Tracing.....
Checked.....	Approved: <u>W. A. ...</u> Date: <u>5/3/37</u> Highway Commissioner & Planning Engineer

Revised May 19, 1937.  
Revised May 19, 1937.  
Revised Sept. 29, 1937.  
Revised Nov. 30, 1937.

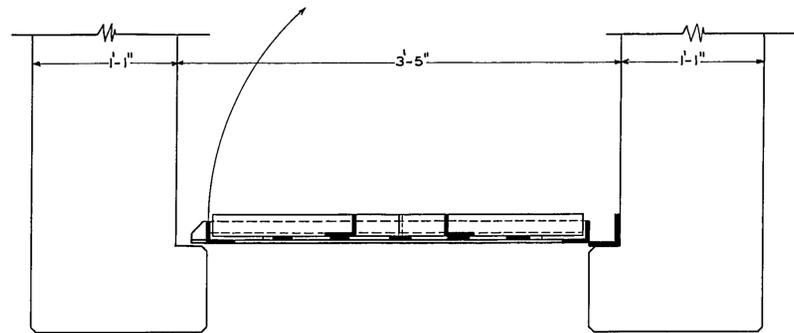
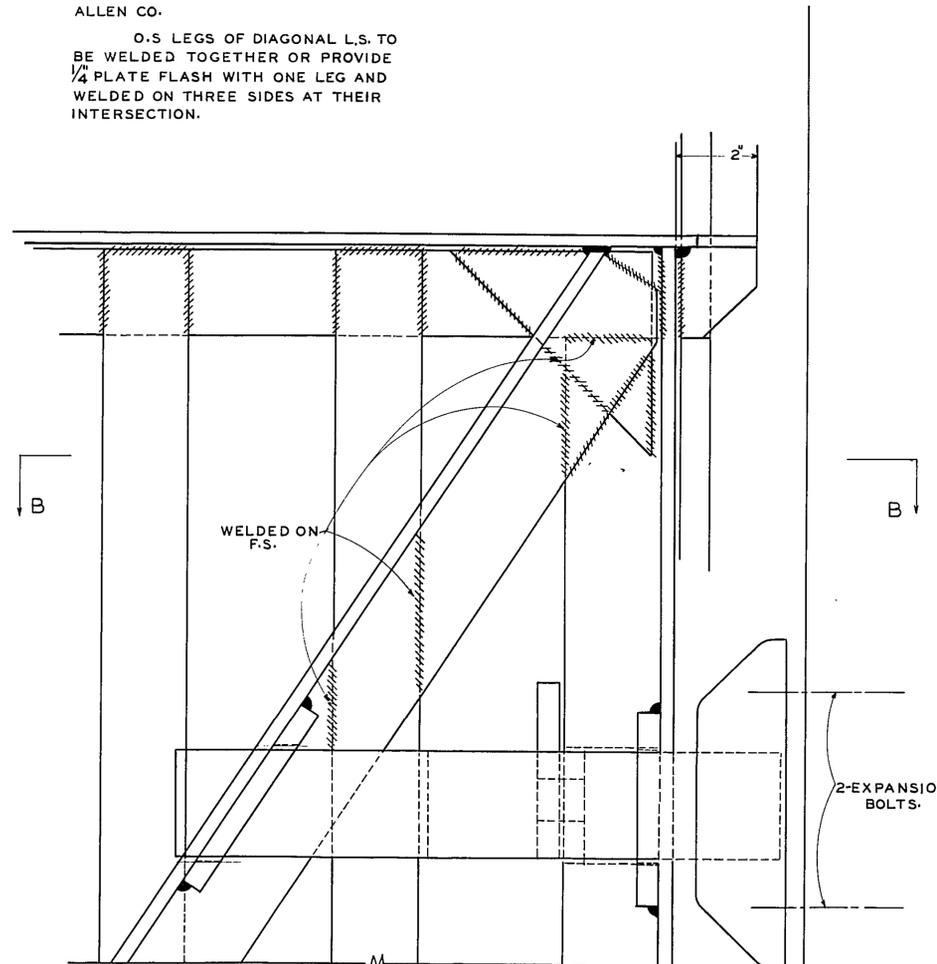
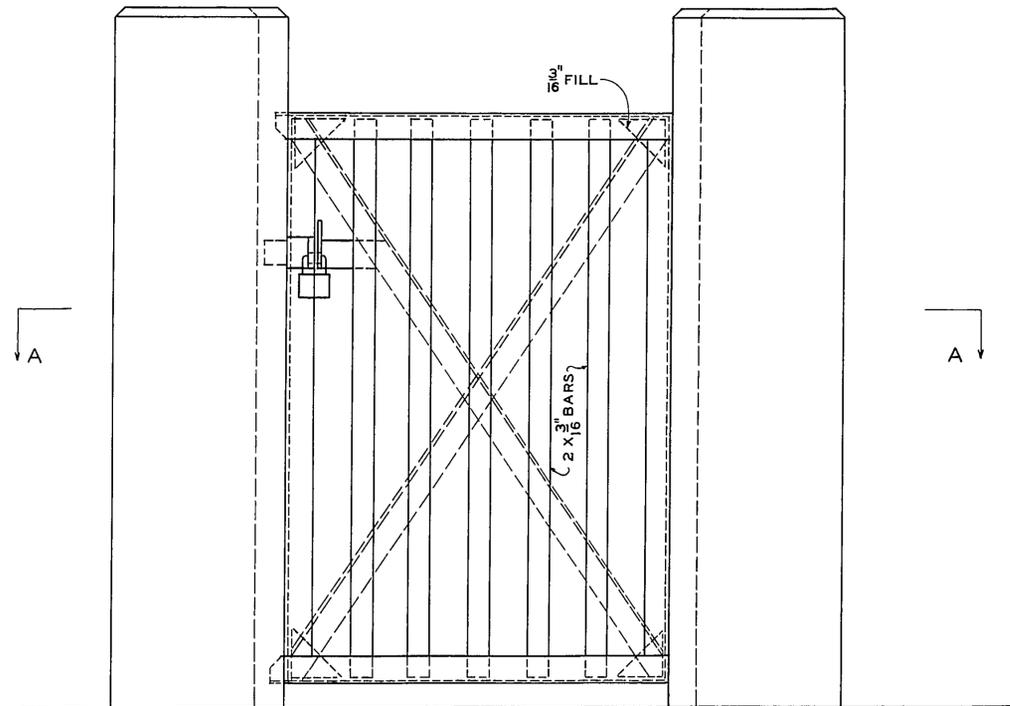
**NOTE:**  
THE GATE SECTION OF THE DAM IS SYMMETRICAL ABOUT THE CENTER LINE EXCEPT THE ELECTRIC PANEL BOARD WHICH IS ON NORTH END ONLY.  
THE TEN CHAINS WITH HOISTS, GUIDES, ANCHOR BOLTS, SLEEVES ETC. ARE NOT SHOWN ON THIS DRAWING, BUT SHALL BE PROVIDED AS CALLED FOR ON SHEET NO. 54.  
PROVIDE A 3/4" CHAMFER ON ALL SHARP CONCRETE EDGES EXCEPT STAIR NOSING WHERE A 3/8" CHAMFER SHALL BE PROVIDED.  
EXPANSION JOINTS AT RIGHT ANGLE TO THE LONGITUDINAL DIRECTION OF THE DAM SHALL BE FILLED WITH 1" ASPHALT FELT. LEAKING SOURCES AT THE EXPANSION JOINTS SHALL BE SEWERED BY HOLES OF BUILDING PAPER.  
IN ABUTMENTS ALL VERTICAL WALLS SHALL BE POURED CONTINUOUS WITHOUT JOINTS UP TO EL. 38.00.

REINFORCING BARS ARE SHOWN MOSTLY IN TYPICAL LOCATIONS, BUT SHALL BE PROVIDED IN ALL SIMILAR LOCATIONS.  
VERTICAL BARS IN PIERS SHALL EXTEND TO 1/2" FROM THE TOP OF THE DAM, EXCEPT THE BARS BELOW REINFORCING WHICH SHALL EXTEND UP TO 2" FROM THE TOP OF THE REINFORCING.  
PROVIDE 3-1/2" x 70" - 10" O.C. EACH WAY UNDER EACH HOIST IN TOP OF THE LABS.

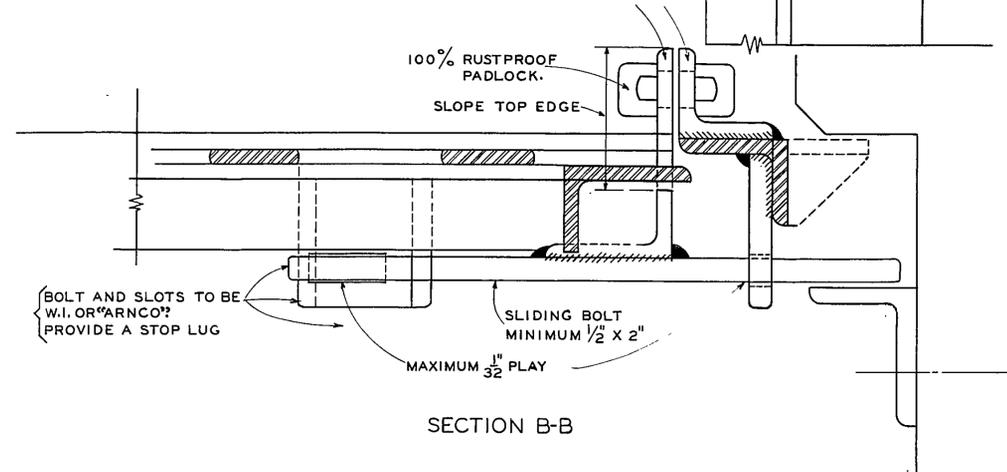
24x  
MICROFILMED

NOTE: - EXCEPT AS SHOWN ON THIS DRAWING FOLLOW SHEET NO 3., CONTRACT 10-781 OF WORDEN-ALLEN CO.

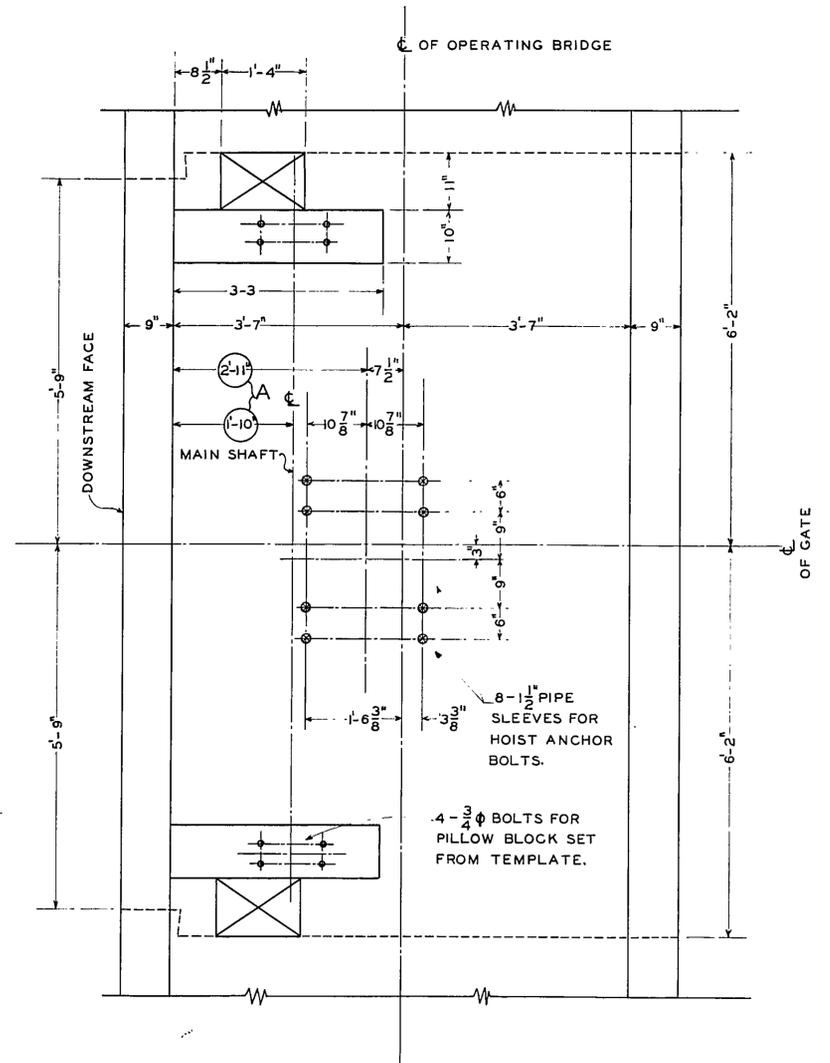
O.S. LEGS OF DIAGONAL L.S. TO BE WELDED TOGETHER OR PROVIDE 1/4" PLATE FLASH WITH ONE LEG AND WELDED ON THREE SIDES AT THEIR INTERSECTION.



SECTION A-A



SECTION B-B



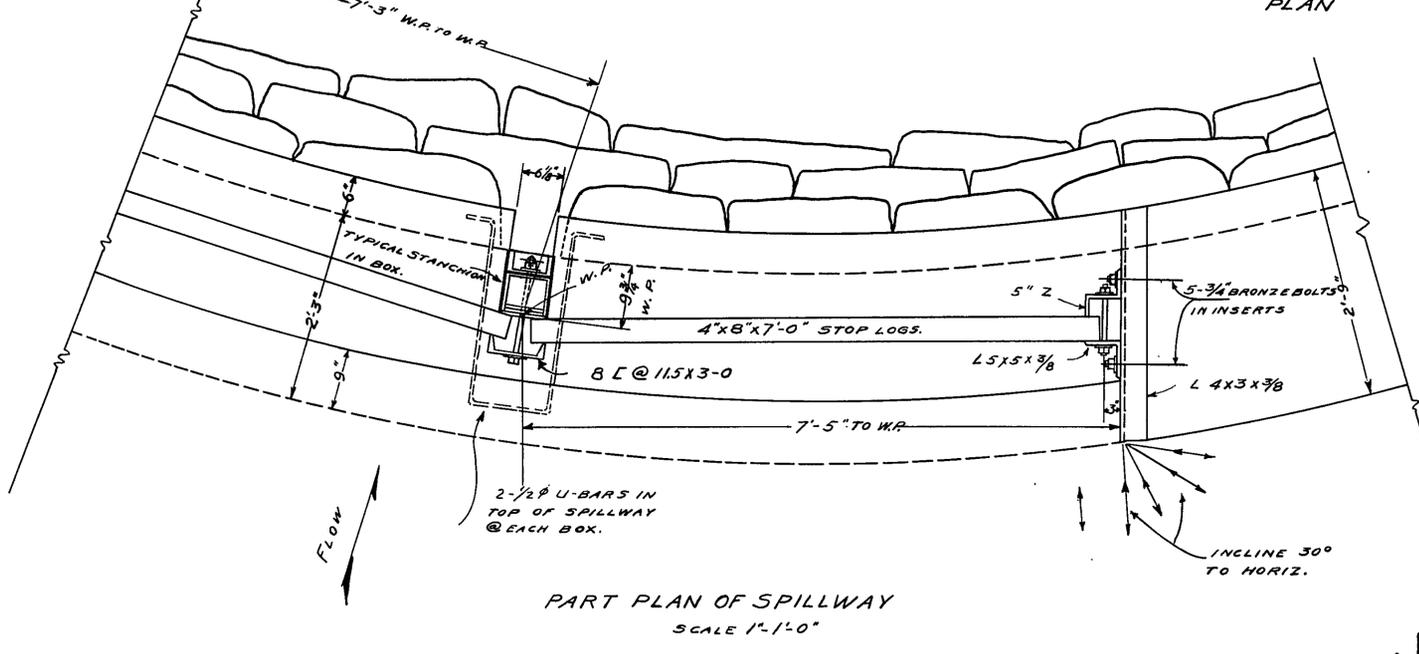
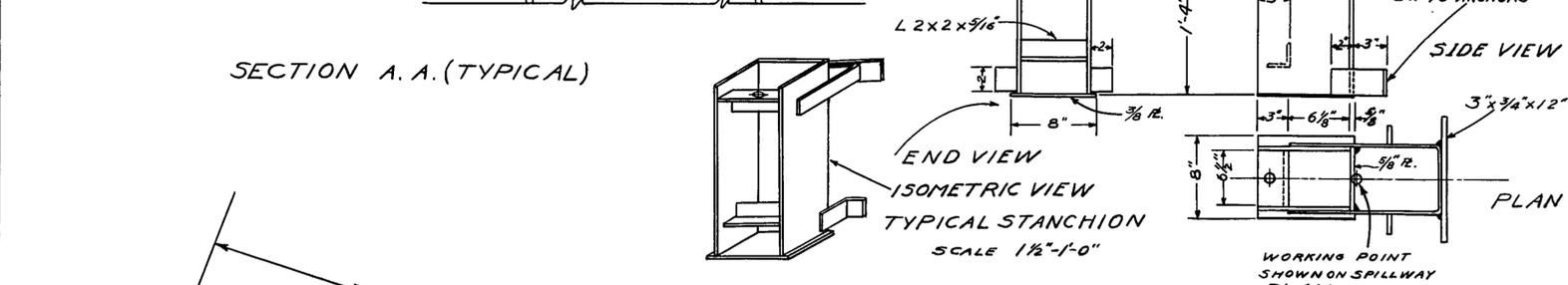
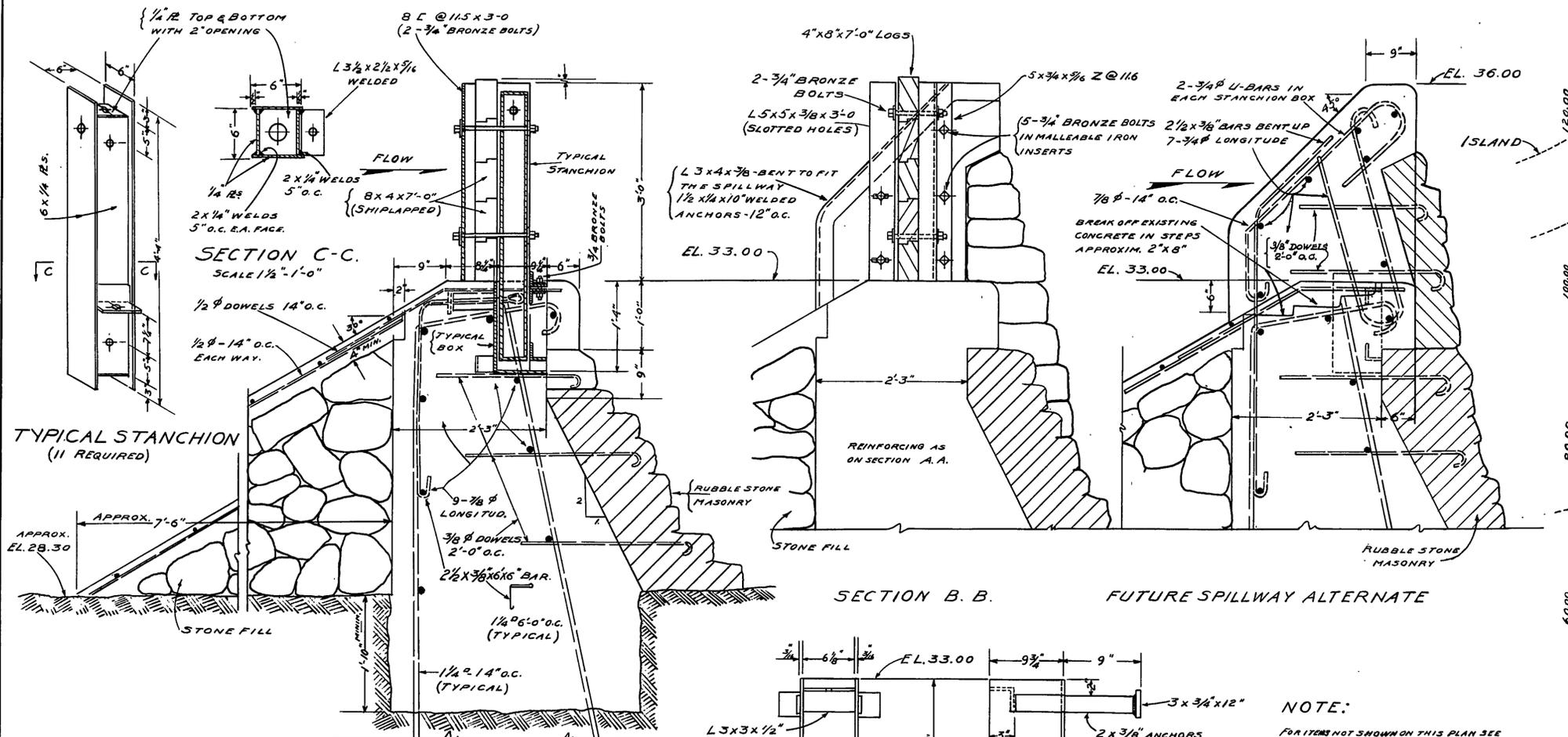
LOCATION OF ANCHOR BOLTS FOR HOISTS  
SCALE: 3/4" = 1'-0"

(A) REVISED FEB. 11-1938.  
(REDUCED BY 1/2")

24x

MILWAUKEE COUNTY

<b>MILWAUKEE COUNTY REGIONAL PLANNING DEPARTMENT</b>			
<b>ESTABROOK PARK DAM</b>			
<b>REVISED ENTRANCE GATES</b>			
<b>AND LOCATION OF ANCHOR BOLTS FOR HOISTS</b>			
SCALE: AS SHOWN		FEBRUARY 11, 1938	
LANDSCAPE DESIGN SECTION		ENGINEERING DESIGN SECTION	
LANDSCAPE ARCHITECT		SENIOR ASS'T. CIVIL ENGINEER	
SURVEY NOTES	APPROVED:	SUPERVISING ENGINEER	DATE:
PLAN M. B. COLEMAN			
TRACING W. R. A. PROJ. NO. 9496	APPROVED:	HIGHWAY COMMISSIONER AND PLANNING ENGINEER	DATE:
CHECKED:			



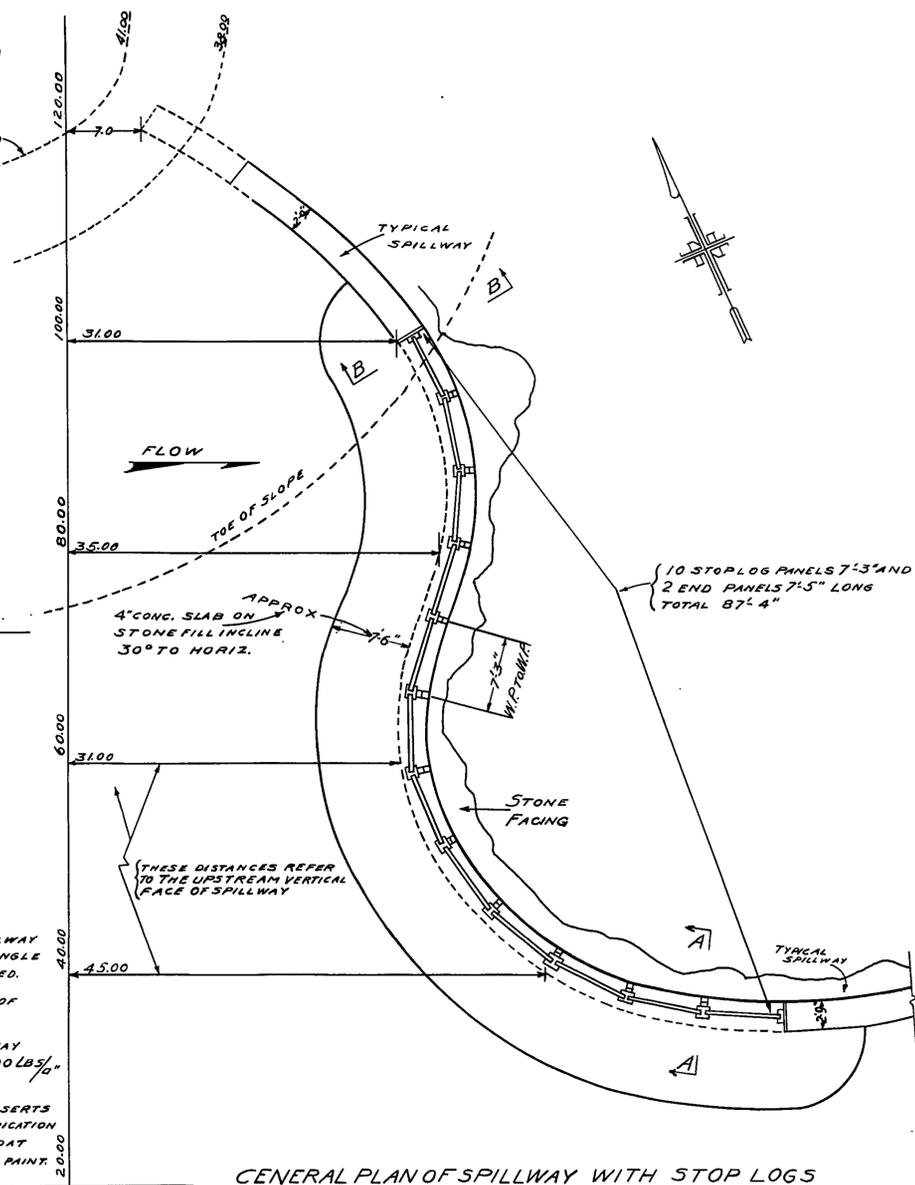
**NOTE:**  
 FOR ITEMS NOT SHOWN ON THIS PLAN SEE SHEET S.P.W.S. 9006-3-6.  
 THE TYPICAL 1/4" BARS IN THE SPILLWAY SHALL BE BENT TO FORM A 80° ANGLE IN PLACE OF 45°-75 BARS ARE REQUIRED.  
 THE 8"x4" STOP LOGS SHALL BE MADE OF CREOSOTED SPRUCE OR REDWOOD.  
 CONCRETE USED FOR FUTURE SPILLWAY SHALL HAVE A MINIMUM STRENGTH OF 3000 LBS. AT THE END OF 28 DAYS.  
 TYPICAL STANCHION BOXES AND BOLT INSERTS SHALL BE HOT DIP GALVANIZED AFTER FABRICATION. ALL OTHER STEEL SHALL RECEIVE ONE COAT OF PRIMER AND 2 COATS OF RUST PROOF PAINT.  
 BRONZE BOLTS AND WASHERS SHALL BE OF "HERCULLOY" OR SIMILAR HIGH STRENGTH ALLOY.  
 PRIOR TO INSERTION INTO BOXES THE LOWER END OF STANCHIONS SHALL BE COATED WITH LUBRICATING OIL.  
 ALL OPEN SPACES BETWEEN STOP LOGS AND BETWEEN CONCRETE AND STOP LOGS SHALL BE FILLED WITH TAR PREFERABLY APPLIED NOT BEFORE ERECTION.  
 THE QUANTITIES OF MATERIALS LISTED BELOW DO NOT INCLUDE MATERIALS CALLED FOR ON THE ORIGINAL PLANS WHICH ARE TO BE USED IN THE REVISED SPILLWAY SECTION.

**QUANTITIES OF MATERIALS**

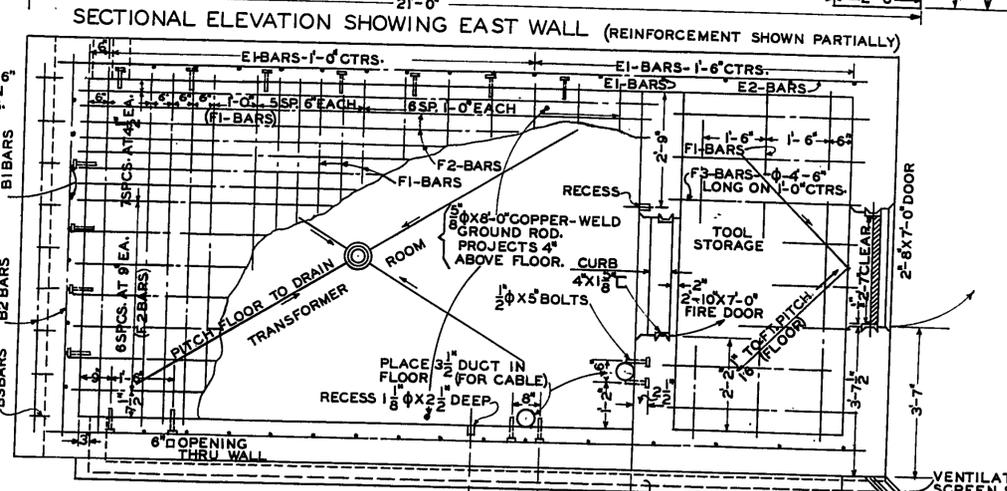
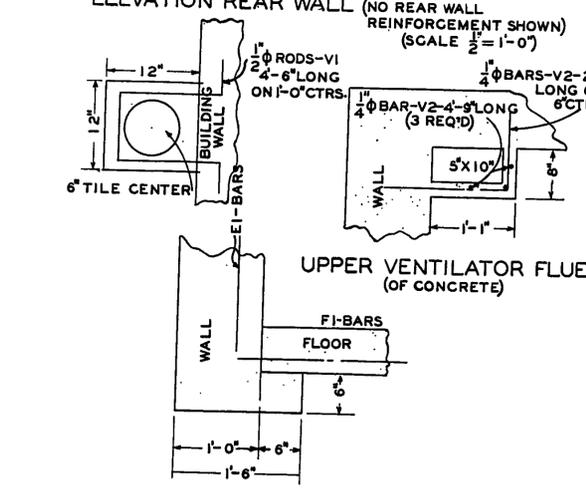
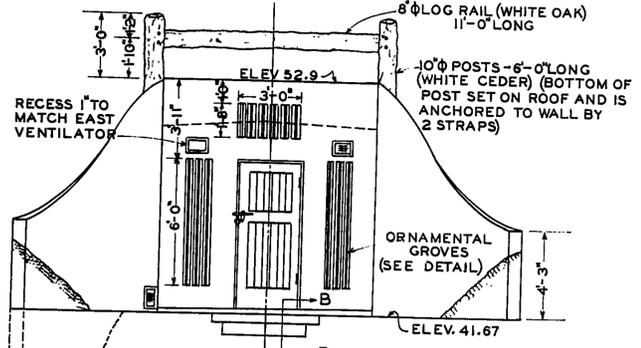
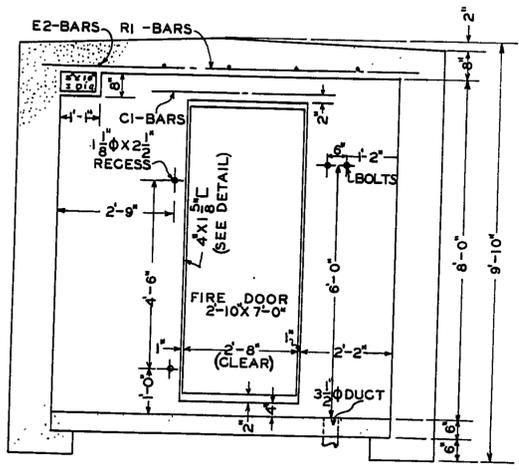
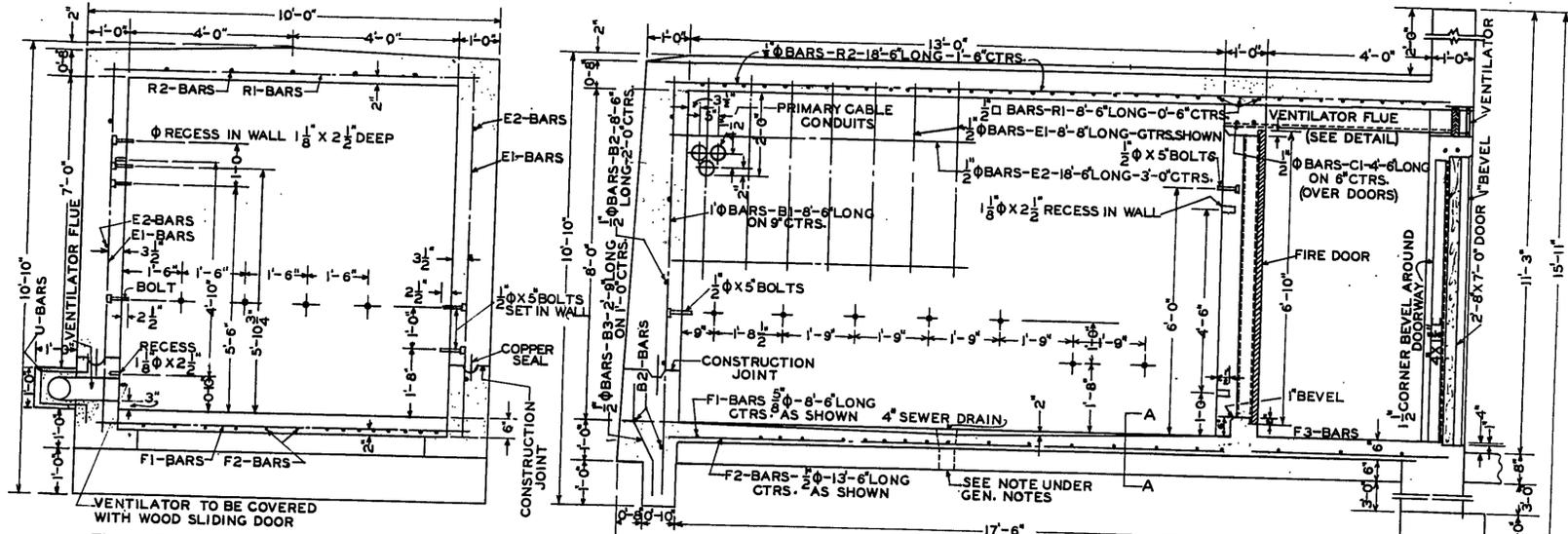
LUMBER 8x4 - 1200 B.M.
STANCHIONS AS SHOWN - 11 UNITS
BOXES FOR STANCHIONS - 11 UNITS
3x4x3/8 L BENT - 10 F.
3/4x2 1/2 BRONZE BOLTS WITH WASHERS AND INSERTS - 10
3/4x1 1/4 " " " " " " - 22
3/4x2 1/2 " " " " " " - 11
3/4x10 " " " " " " - 4
5x5x3/8 L - 6 F.
5x3/4 Z BAR @ 116 - 6 F.
8 L @ 11.5 - 33 F.
2 1/2x3/8x6-6" BARS - 74 - 480 F. - 1520 LBS.
1/2" BARS - 1900 F. - 1270 LBS.

24x

MICROFILMED

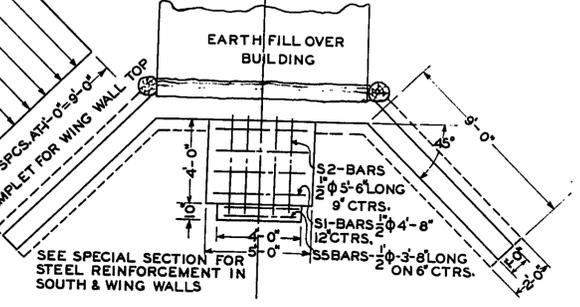
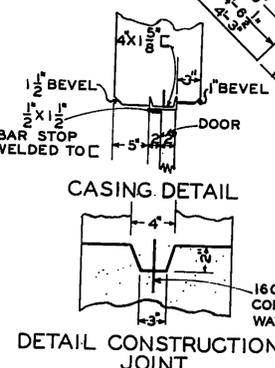
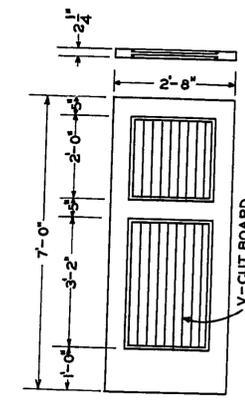


<b>MILWAUKEE COUNTY REGIONAL PLANNING DEPARTMENT</b>	
LANDSCAPE DESIGN SECTION	ENGINEERING DESIGN SECTION
Landscape Architect	Senior Ass't. Civil Engineer
Survey	Approved: <i>W. W. W.</i> Date: 1/10/39
Plan	Supervising Engineer
Tracing W. R. A. PROJ. NO. 9496	Approved: <i>W. W. W.</i> Date: 1/10/39
Checked	Highway Commission Planning Engineer
<b>MILWAUKEE COUNTY (WISCONSIN) PARK COMMISSION</b>	
UNITED STATES	
DEPARTMENT OF THE INTERIOR	
NATIONAL PARK SERVICE	
COOPERATING	
DRAWN BY	ESTABROOK PARK DAM
DESIGNED BY	SPILLWAY REVISION
CHECKED BY	PLAN NO.
PREPARED AND	SCALE AS SHOWN
APPROVED BY	DATE
PLANNING CONCURRENCE	DATE
RECOMMENDED	DATE
PLANNING CONCURRENCE	DATE
RECOMMENDED	DATE

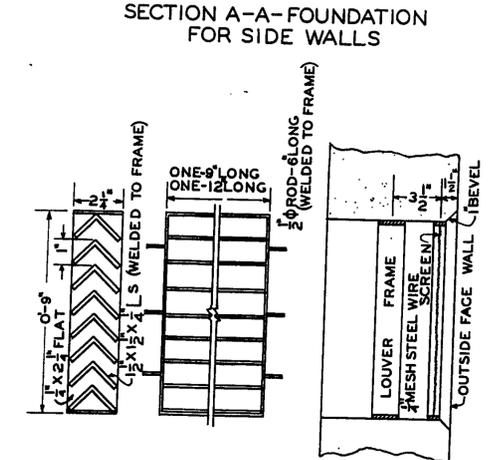


ELEVATION OF SOUTH WALL OF TRANSFORMER ROOM (LOOKING SOUTH) (STEEL REINFORCEMENT SHOWN) (SCALE 1/2" = 1'-0") IN ROOF & OVER DOOR

FRONT OR SOUTH ELEVATION (SCALE 1/4" = 1'-0")



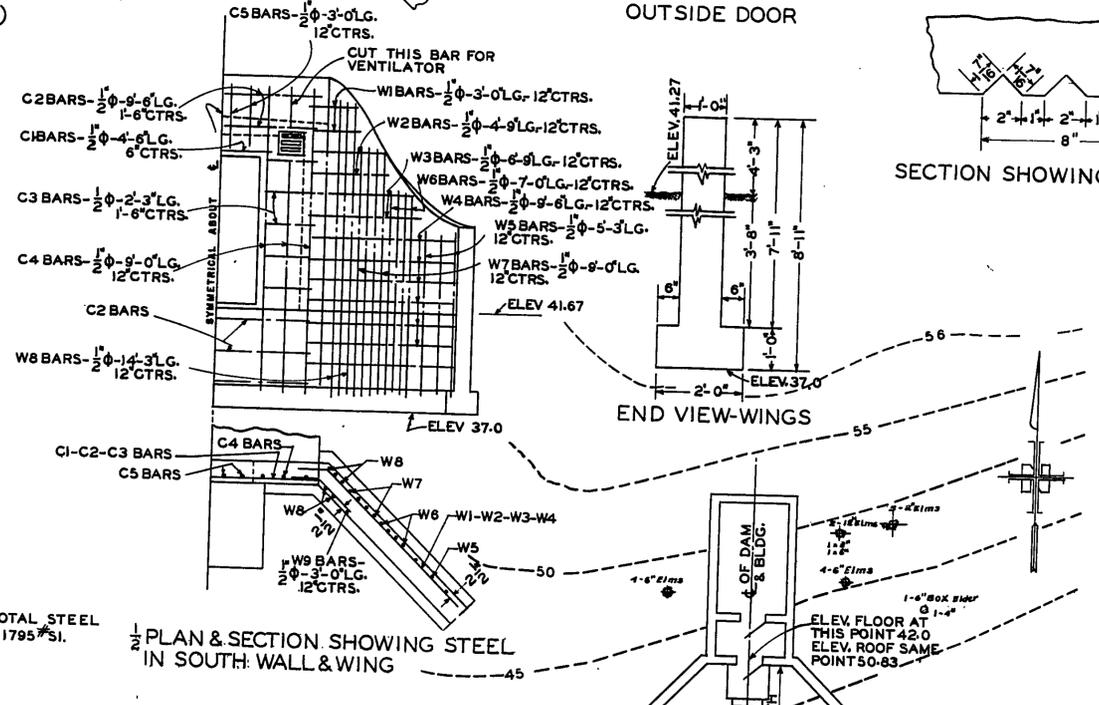
PLAN - ENTRANCE STEP (REINFORCEMENT FOR STEPS SHOWN) (SCALE 1/4" = 1'-0")



LOUVER DETAIL (2 REQUIRED)

WALL SETTING OF LOUVER & SCREEN

MARK	NO	SIZE	LENGTH	SPACING	LOCATION & DETAIL
B1	10	1" φ	8'-6"	9"	NORTH WALL 9"
B2	6	1/2" φ	8'-6"	2'-0"	B3 1/2" 45° BEND
B3	8	"	2'-9"	12"	
C1	4	1/2" φ	4'-6"	6"	SOUTH WALL
C2	5	"	9'-6"	1'-6"	
C3	10	"	2'-3"	1'-6"	
C4	6	"	12'-0"	12"	
C5	4	"	3'-0"	12"	
E1	32	1/2" φ	8'-6"	SHOWN	SIDE WALL
E2	6	"	18'-6"	3'-0"	
F1	20	5/8" φ	8'-6"	SHOWN	FLOOR
F2	14	1/2" φ	13'-6"	"	
F3	8	"	4'-6"	12"	
R1	36	1/2" φ	8'-6"	6"	ROOF
R2	5	"	18'-6"	1'-6"	
S1	4	1/2" φ	4'-6"	12"	STOOP 4'-0"
S2	5	"	3'-6"	9"	S2
S3	2	"	3'-6"	6"	45° BEND
W1	4	1/2" φ	3'-0"	12"	WING WALL W1-W2-W3-W4 45° BEND
W2	4	"	4'-9"	"	
W3	4	"	6'-9"	"	
W4	16	"	9'-6"	"	
W5	6	"	8'-3"	"	
W6	8	"	10'-0"	"	
W7	8	"	12'-0"	"	
W8	10	"	14'-3"	"	
W9	26	"	3'-0"	"	
V1	20	1/2" φ	4'-6"	12"	VENTILATOR
V2	9	1/4" φ	2'-6"	6"	



TOTAL STEEL 1795# SI.

1/2 PLAN & SECTION SHOWING STEEL IN SOUTH WALL & WING

LOCATION DIAGRAM (SCALE 1" = 10')

**GENERAL NOTES**  
 ROOF shall be covered with a primer coat, 3 ply membrane fabric and 4 moppings of asphalt. Use 140# asphalt per 100 square feet.  
 SIDE & BACK WALL Place fabric over construction joint and coat with 1 coat primer and 2 coats hot asphalt for waterproofing.  
 INSIDE opening of VENTILATOR to be covered with sliding wood door. Use no metal.  
 FLOOR is to be poured integral with walls to insure water tight seal.  
 VENTILATOR screens to be made of 1/4 mesh steel wire set in metal frame and cast into concrete.  
 LANTING & LANDSCAPE work shown on another plan.  
 OLTS to be set in walls are to be threaded SAE for entire projecting length of 2 1/2 inches.  
 FLOOR DRAINS Outlet pipe to be 4" sewer tile and run to water in river. Distance approximately 5FT. Outlet must be screen protected.  
 ROUND RODS are to be 5/8" φ x 8'-0" long and projecting 4 inches above floor. Use copper clad rods.

**DOORS** Use 3 hinges on each door. Padlock latches required for both doors.

LANDSCAPE DESIGN SECTION      ENGINEERING DESIGN SECTION

Survey: Landscape Design      Senior Asst. Civil Engineer

Plan: R. F. DAGGETT      Approved:      Supervising Engineer      Date:     

Tracing: W. R. A. P. R. Q. No. 3406      Approved:      Highway Commissioner & Planning Engineer      Date:     

Checked:     

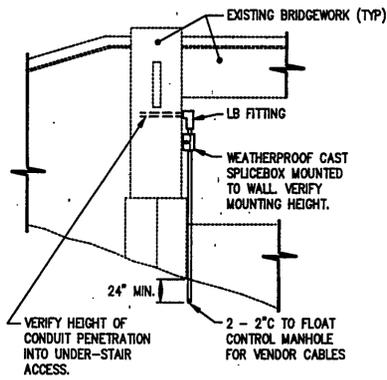
UNITED STATES  
 DEPARTMENT OF THE INTERIOR  
 NATIONAL PARK SERVICE  
 COOPERATING WITH  
 MILWAUKEE COUNTY PARK COMMISSION

ESTABROOK PARK DAM  
 TRANSFORMER BUILDING

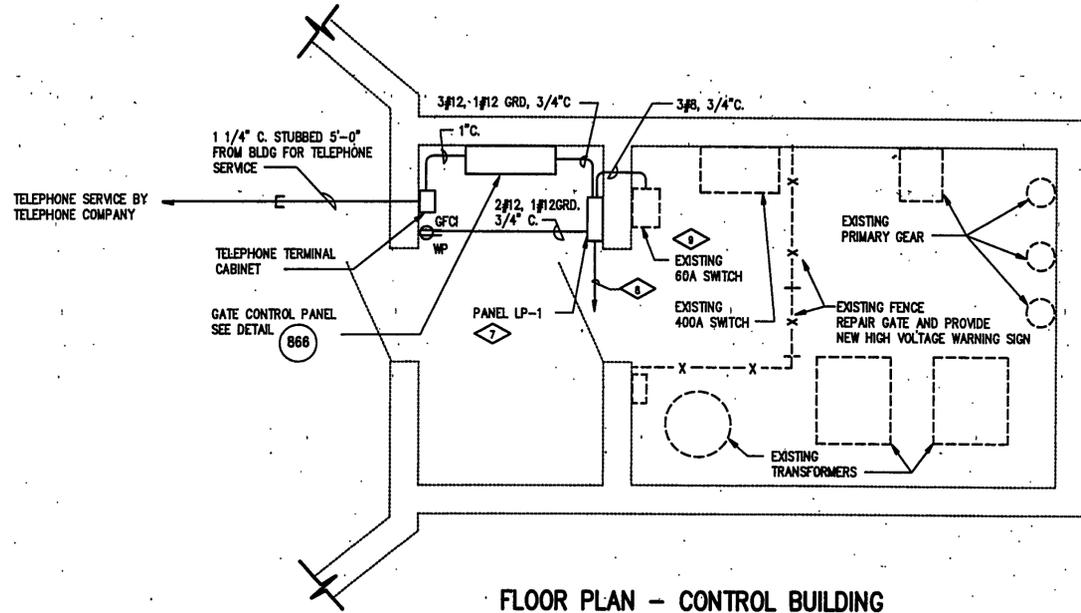
SCALE AS SHOWN  
 S.P.  
 DATE NOV, 1938.

DRAWN BY:      DESIGNED BY:      CHECKED BY:      PREPARED BY:      RECOMMENDED BY:      APPROVED BY:      DATE:      DATE:      DATE:      DATE:



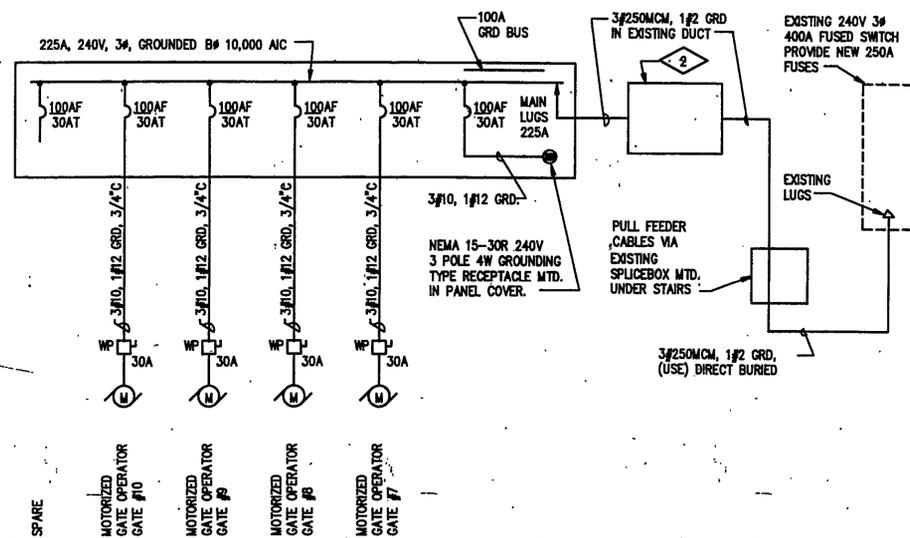


**SPlicebox Detail** 940  
NTS



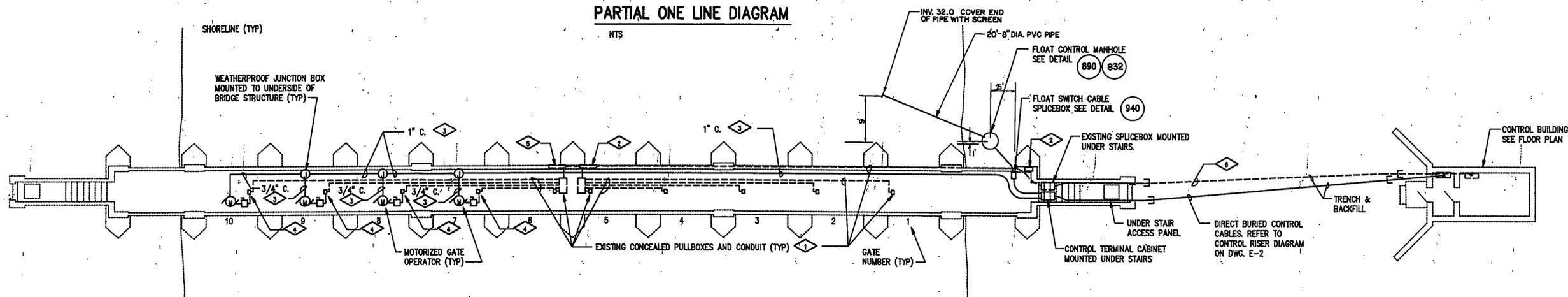
**FLOOR PLAN - CONTROL BUILDING**

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



**PARTIAL ONE LINE DIAGRAM**

NTS



**ELECTRICAL SITE PLAN**

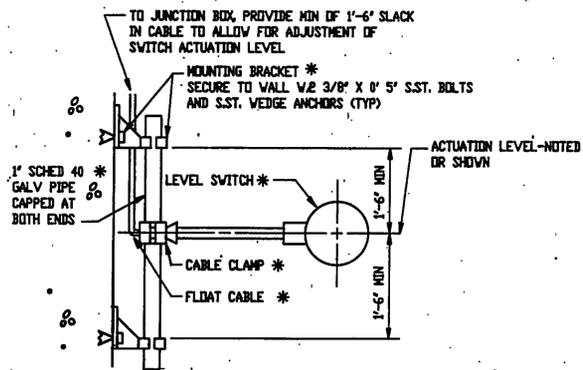
NTS

**PLAN NOTES**

1. DISCONNECT AND REMOVE EXISTING WIRE, CABLE, AND TERMINATIONS BACK TO SOURCE.
2. DISCONNECT AND REMOVE EXISTING ELECTRICAL EQUIPMENT AND ASSOCIATED WIRING IN RECESSED PANEL. PROVIDE NEW WEATHERPROOF COVER AND DRIP SHIELD.
3. ROUTE CONDUIT ON UNDERSIDE OF EXISTING BRIDGEWORK. DO NOT ROUTE ON VERTICAL BRIDGE FACES. REFER TO CONTROL RISER DIAGRAM ON DRAWING E-2.
4. PROVIDE WEATHERPROOF CONNECTION TO EXISTING PULLBOX UNDER BRIDGE. ROUTE CABLES IN EXISTING CONCEALED RACEWAY TO PANEL.
5. DISCONNECT AND REMOVE EXISTING ELECTRICAL EQUIPMENT AND ASSOCIATED WIRING IN RECESSED PANEL. PROVIDE NEW 225A, 240V, 3φ, 3W PANEL IN EXISTING BOX. REFER TO ONE LINE DIAGRAM THIS SHEET. PROVIDE NEW WEATHERPROOF COVER AND DRIP SHIELD.
6. REMOVE AND REPLACE EXISTING BURIED POWER CABLE. PULL CABLES VIA EXISTING SPLICEBOX MOUNTED IN UNDER STAIR ACCESS.
7. 120/240V, 1φ, 3W SQUARE D TYPE QO CIRCUIT BREAKER LOAD CENTER WITH 100A MAIN LUGS AND MINIMUM OF 12 - 1 POLE CIRCUITS. PROVIDE WITH 10 - 20A 1 POLE CIRCUIT BREAKERS.
8. PROVIDE CONDUIT, WIRE, AND CIRCUIT BREAKERS TO RECONNECT EXISTING 120V CIRCUIT(S) IN CONTROL BUILDING.
9. DISCONNECT AND ABANDON EXISTING LOAD SIDE TERMINATIONS. PROVIDE NEW 50A FUSES AND CONNECT TO NEW PANEL LP-1.



Scale	NOTED	Date	5/9/88	Designer	DRT	Drawn	RSR	Checker	JCM	Approver	DJS	No.	Revisions	By	Date
<p><b>Donohue</b> Engineers &amp; Architects COMPUTER AIDED DESIGN/MARKETING</p>															
<p>MILWAUKEE COUNTY ESTABROOK PARK DAM RESTORATION PROJECT No. 88-06-4684</p>															
<p>ELECTRICAL PLAN AND DETAILS</p>															
<p>Sheet No. 2 OF 3 File No. WA-1515 Project No. 16070 F-1 Drawing No.</p>															

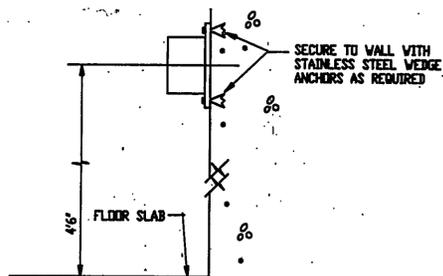


- NOTES**
- \* DENOTES ITEMS FURNISHED BY SWITCH MFR
  - INSTALL ALL FLOAT SWITCHES ON SEPARATE 1" SCHED 40 GALVANIZED PIPE. THE FIVE PIPES SHALL BE MOUNTED WITH EVEN SPACING ON CIRCUMFERENCE OF FLOAT CONTROL MANHOLE WALLS. FLOAT ACTIVATION LEVELS ARE 36.1', 36.3', 36.5', 36.7', AND 36.9' ABOVE MILWAUKEE DATUM. PIPE SHALL EXTEND 1'-6" MIN ABOVE AND BELOW SWITCH ACTIVATION LEVEL. PROVIDE SUFFICIENT SLACK IN EACH SWITCH CABLE TO LOWER CLAMP 1'-6" BELOW ACTIVATION LEVEL. ALL SWITCHES SHALL BE INSTALLED SO AS NOT TO ALLOW INTERFERENCE WITH OPERATION OF ANY OTHER SWITCH.

**FLOAT TYPE LEVEL SWITCH**

NTS

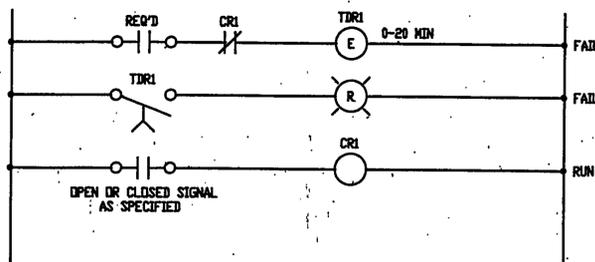
832



**WALL MOUNTED INSTRUMENT INSTALLATION**

NTS

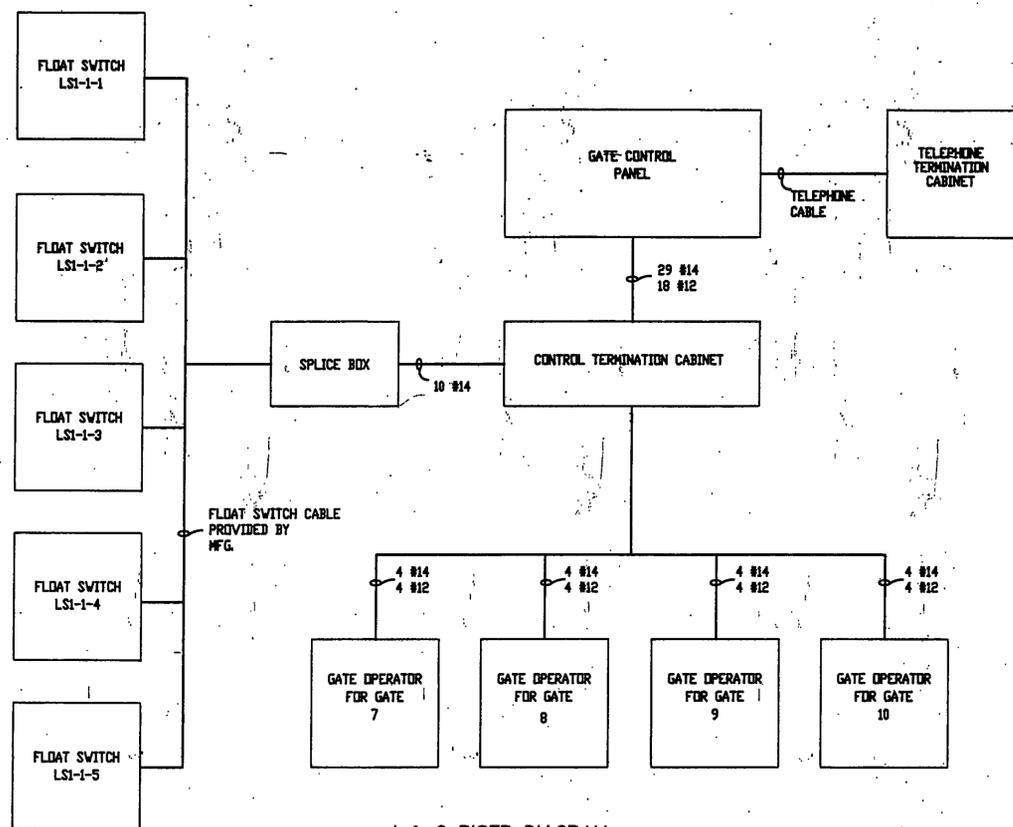
866



**TYPICAL RUN/FAIL CIRCUIT**

NTS

870



**I & C RISER DIAGRAM**

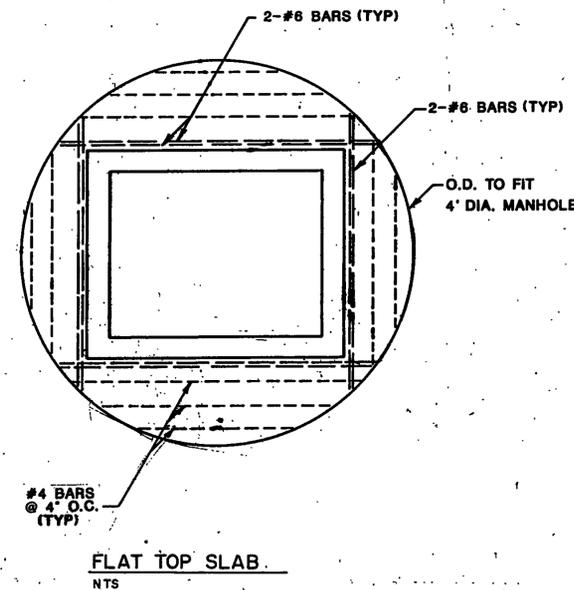
**LEGEND**

- ( ) #12 (QUANTITY) #12 THWN CONDUCTORS
- ( ) #14 (QUANTITY) #14 THWN CONDUCTORS
- ( ) SH. PR. (QUANTITY) SHIELDED PAIR

**GENERAL NOTES**

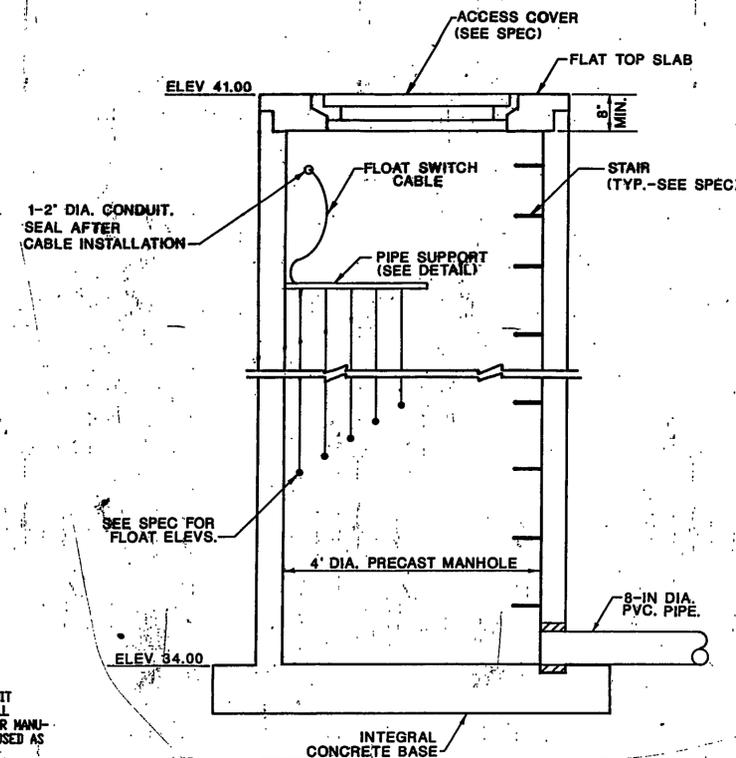
- THIS DRAWING SHOWS PROCESS INSTRUMENTATION AND CONTROL WIRING REQUIREMENTS ASSOCIATED AC POWER AND GROUNDING CONDUCTORS ARE NOT SHOWN. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL WIRING, WHETHER SHOWN OR NOT, NECESSARY FOR A COMPLETE AND OPERABLE SYSTEM.
- THIS DRAWING SHOWS RELATIVE LOCATIONS OF DEVICES AND PANELS AND IS NOT DRAWN TO SCALE.
- ALL SHIELDED AND UNSHIELDED CONDUCTORS SHALL BE RUN IN CONDUIT. SHIELDED CONDUCTORS SHALL NOT BE COMBINED WITH UNSHIELDED CONDUCTORS IN ANY CONDUIT. NEITHER SHIELDED OR UNSHIELDED CONDUCTORS SHALL BE INCLUDED IN THE SAME CONDUIT AS THREE PHASE POWER.

NOTE: SIZE & LOCATE OPENING TO ACCOMMODATE FRAME OF COVER SPECIFIED



**FLAT TOP SLAB**

NTS



**FLOAT CONTROL MANHOLE**

NTS

890

- THIS DRAWING DOES NOT SHOW CONDUIT SYSTEMS. PROVIDE, AS A MINIMUM, PULL BOXES AS RECOMMENDED BY CONDUCTOR MANUFACTURER. CONDULET SHALL NOT BE USED AS PULL BOX.
- CONDUIT SHALL BE SIZED FOR CONDUCTORS SHOWN PLUS REQUIRED SPARES.
- SHIELDED AND UNSHIELDED CONDUCTORS SHALL HAVE A MINIMUM OF 6" SEPARATION BETWEEN CONDUIT ON PARALLEL RUNS.
- SHIELDED CONDUCTORS SHALL BE SEPARATED FROM UNSHIELDED CONDUCTORS BY STEEL BARRIERS IN ALL TERMINAL AND PULL BOXES.
- FOR EACH CONDUIT CONTAINING MORE THAN TWO CONDUCTORS, PROVIDE A MINIMUM OF TWO CONDUCTORS OR 10% OF TOTAL CONDUCTORS IN CONDUIT, WHICHEVER IS GREATER AS SPARES. TAG BOTH ENDS OF EACH SPARE. TERMINATE EACH END OF SPARE CONDUCTOR AT TERMINALS WHENEVER POSSIBLE.
- CONDUCTORS SHALL NOT BE SPLICED EXCEPT AT TERMINALS.

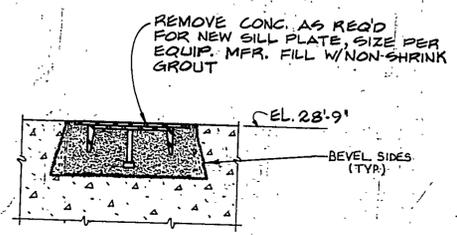
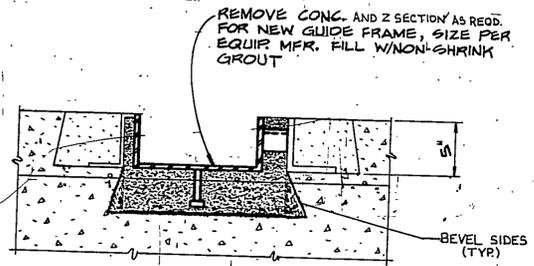
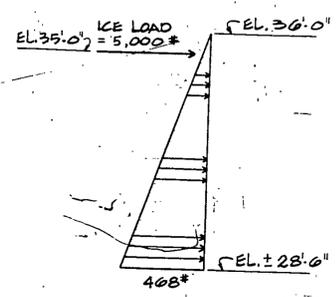
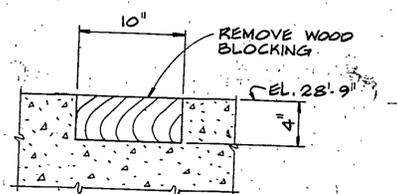
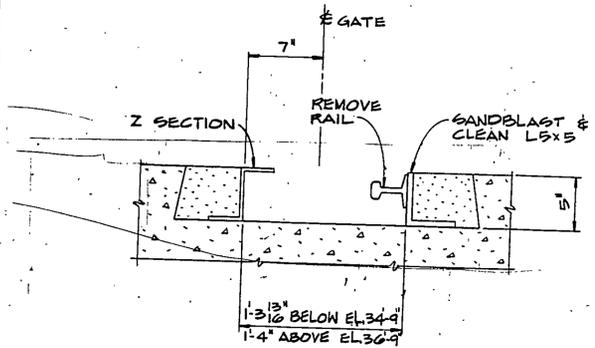
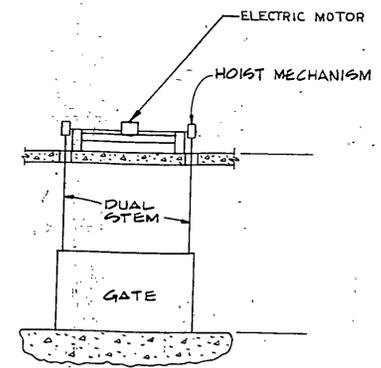
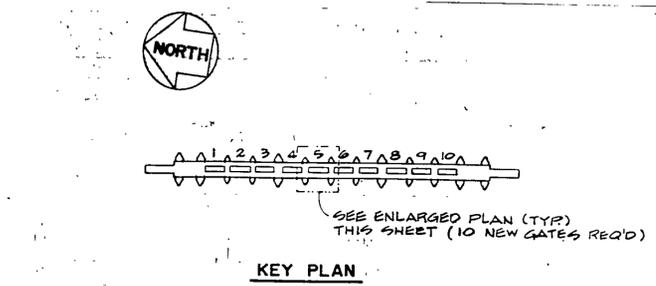
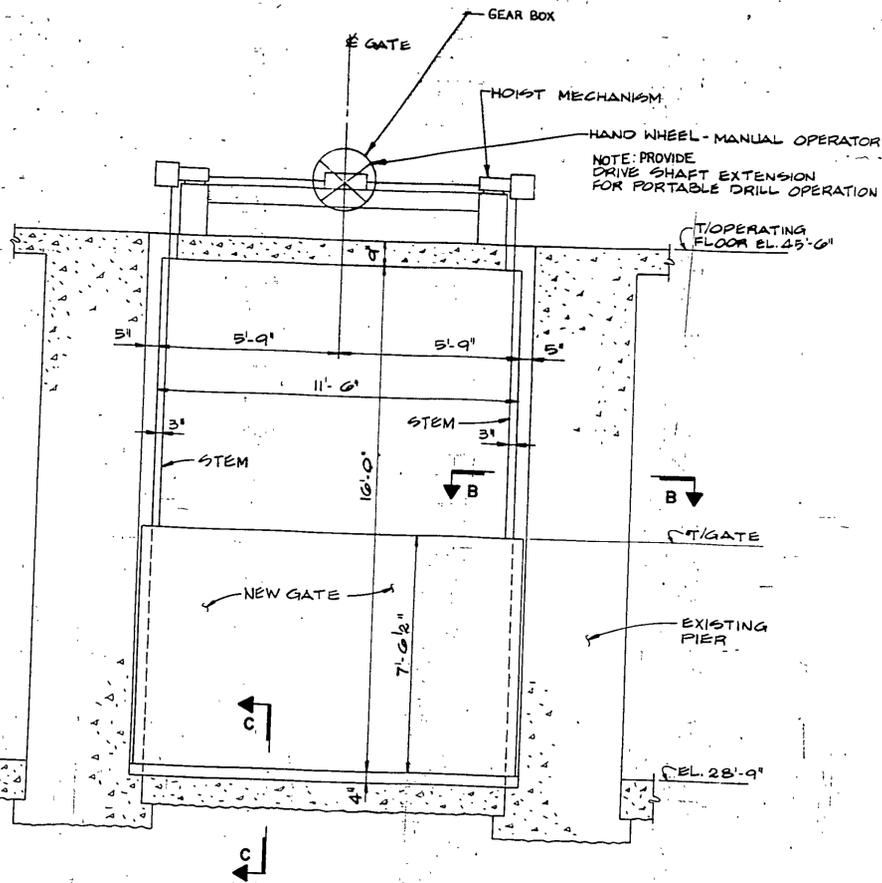
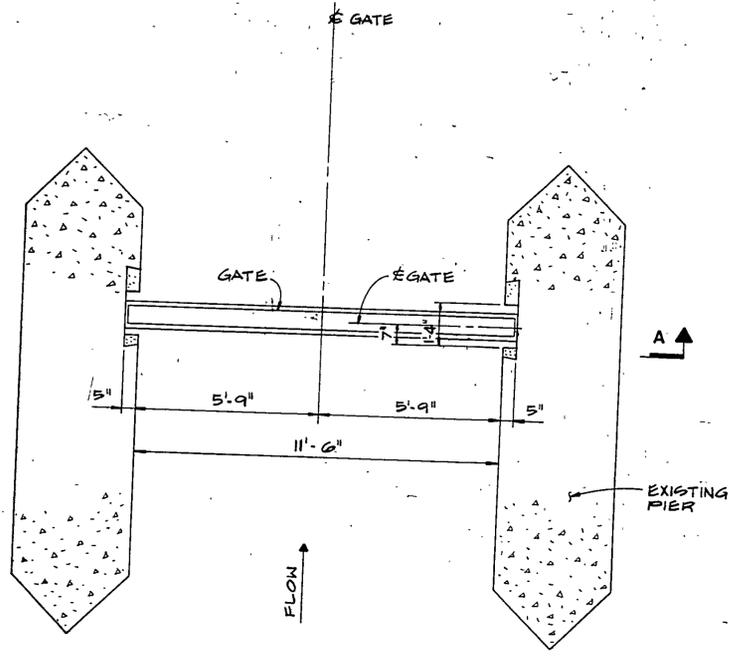
Scale	Date	Designer	Drawer	Checker	Approver	No.	Revisions	By	Date
None	5/10/88	R.N.	R.N.	A.P.	A.P.				

**Donohue**  
Engineers & Architects  
COMPUTER AIDED DESIGN/DRAFTING

**CONTROL PLAN AND DETAILS**

MILWAUKEE COUNTY  
ESTABROOK PARK DAM  
RESTORATION  
PROJECT No. 88-06-4684

Sheet No.	3 OF 3
File No.	VA-1516
Project No.	16070
Drawing No.	E-2



- NOTES**
- ALL EXISTING INFORMATION FOR THE DAM IS OBTAINED FROM SHEETS 3, 4, 5, 6, 7 OF 13 PROVIDED BY MILWAUKEE COUNTY. CONTRACTOR SHALL VERIFY ALL FIELD CONDITIONS AND DIMENSIONS AND REPORT ANY DISCREPANCIES TO THE ENGINEER BEFORE PROCEEDING WITH WORK.
  - ALL WORKS ON THIS PROJECT SHALL CONFORM TO THE FOLLOWING LATEST SPECIFICATIONS:
    - A. AMERICAN CONCRETE INSTITUTE
    - B. AMERICAN INSTITUTE OF STEEL CONSTRUCTION
    - C. AMERICAN WELDING SOCIETY
    - D. AWWA SLUICE GATE SPECIFICATIONS

**REFERENCE DRAWINGS**

THE CONTRACTOR SHALL REFER EXISTING DRAWINGS FOR THE DAM, AVAILABLE AT THE OFFICE OF MILWAUKEE COUNTY, DEPARTMENT OF PUBLIC WORKS



**Donohue**  
Engineers & Architects

GATE PLAN AND DETAILS

MILWAUKEE COUNTY  
ESTABROOK PARK DAM  
RESTORATION  
PROJECT No. 88-06-4684

Scale	1"=10'
Date	5-8-88
Designer	PKM
Drawer	
Checker	BE
Appr. Over	
No.	
Revisions	
By	
Date	

Sheet No. 3 OF 3  
File No. WWA-1513  
Project No. 88-06-4684

M-1  
Drawing No. 1

## APPENDIX C

### Structural Evaluation of Gated Spillway Section





X587996-Photo 001



X587996-Photo 002



X587996-Photo 003



X587996-Photo 004



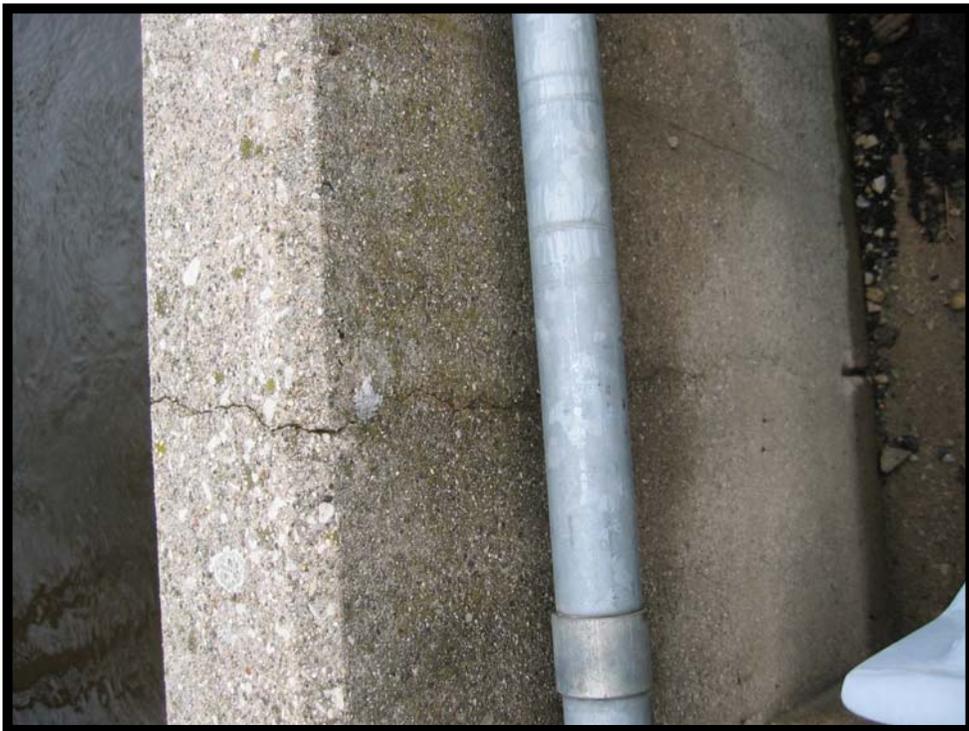
X587996-Photo 005



X587996-Photo 006



X587996-Photo 007



X587996-Photo 008



X587996-Photo 009



X587996-Photo 010



X587996-Photo 011



X587996-Photo 012



X587996-Photo 013



X587996-Photo 014



X587996-Photo 015



X587996-Photo 016



X587996-Photo 017



X587996-Photo 018



X587996-Photo 019



X587996-Photo 020



X587996-Photo 021



X587996-Photo 022



X587996-Photo 023



X587996-Photo 024



X587996-Photo 025



X587996-Photo 026



X587996-Photo 027



X587996-Photo 028

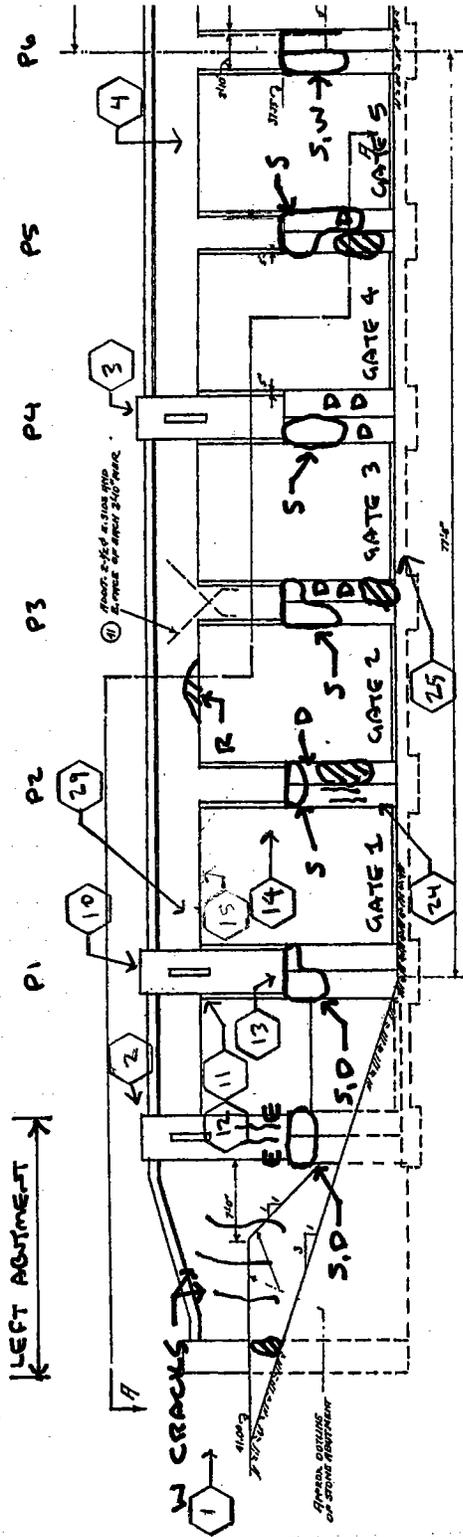


X587996-Photo 029

FIGURE 1

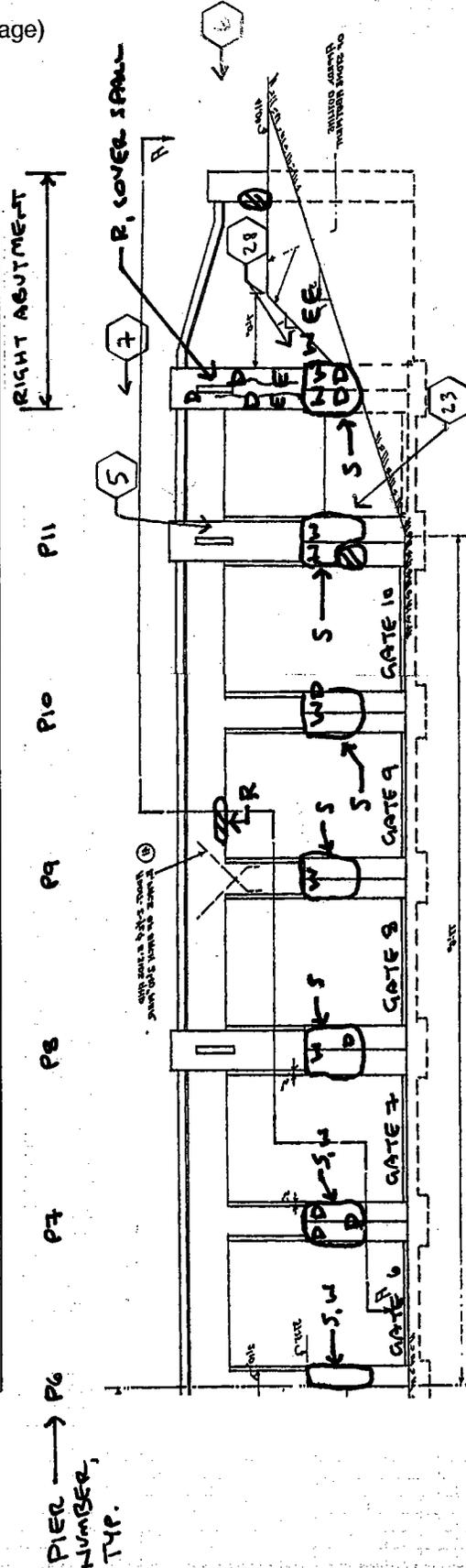
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	SUBJECT <b>UPSTREAM CONDITION OBSERVATIONS</b>			SHEET NO. <b>1 OF 1</b>	
ORIGINATED BY <b>JMK</b>	DATE <b>FEB. 3, 2006</b>	CHECKED BY	DATE	CALC. NO.	REV. NO.
STS Consultants Ltd. CALCULATION SHEET					

Reference: Structure Drawing No. 9006-4-8; (right half reverse image)



**CONCRETE CONDITION ASSESSMENT LEGEND**

W	Wet or Apparent Wet Surface	D	Delamination or Apparent Delamination
R	Concrete Reinforcing Steel Exposed	G	Disintegration
E	Efflorescence	C	Scaling
S	Existing Surface Repair (e.g. Shotcrete)	⬡	Cracking
⬡	Spall	⬡	Photograph Number and Location



PIER NUMBER, TYP.

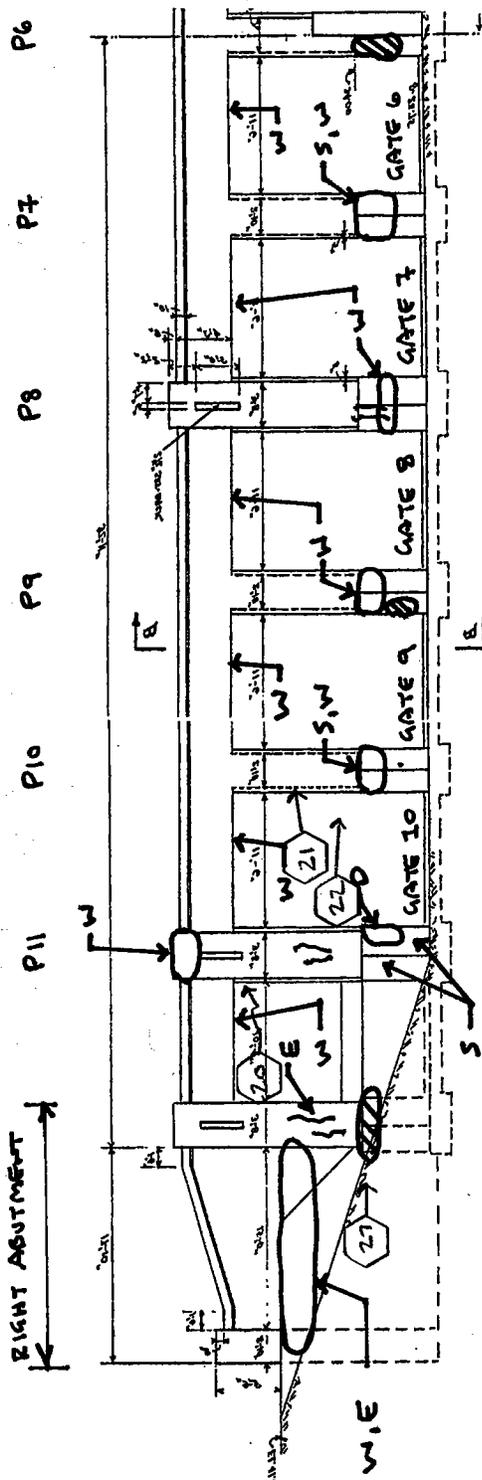
FIGURE 2



STS Consultants Ltd.  
CALCULATION SHEET

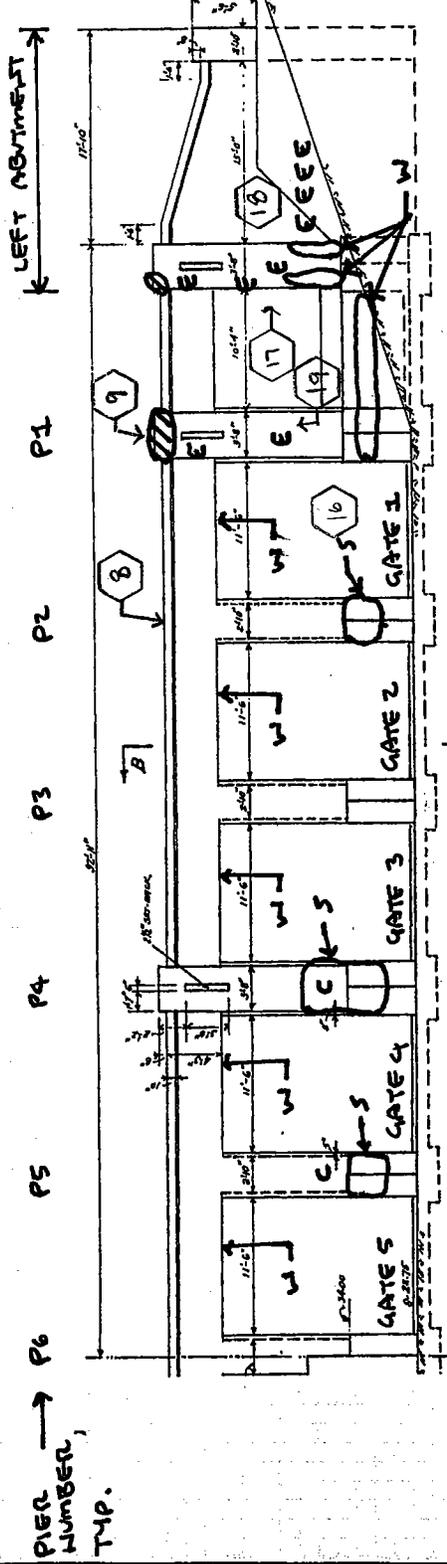
PROJECT <b>ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN</b>				STS JOB NO. <b>X587996</b>	
SUBJECT <b>DOWNSTREAM CONDITION OBSERVATIONS</b>				SHEET NO. <b>1</b> OF <b>1</b>	
ORIGINATED BY <b>JMK</b>	DATE <b>FEB. 3, 2006</b>	CHECKED BY	DATE	CALC. NO.	REV. NO.

Reference: Structure Drawing No. 9006-4-8, (left half reverse image)



**CONCRETE CONDITION ASSESSMENT LEGEND**

<p>W Wet or Apparent Wet Surface</p> <p>R Concrete Reinforcing Steel Exposed</p> <p>E Efflorescence</p> <p>S Existing Surface Repair (e.g. Shotcrete)</p> <p>Spall</p>	<p>D Delamination or Apparent Delamination</p> <p>G Disintegration</p> <p>C Scaling</p> <p>Cracking</p> <p>Photograph Number and Location</p>
------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------



SIMUL SPILLWAY TO RIGHT OF DAM

MATCH

FIGURE 3



STS Consultants Ltd.  
CALCULATION SHEET

PROJECT  
**ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN**

STS JOB NO.  
**X587996**

SUBJECT  
**PIER 1 - LEFT SIDE CONDITION OBSERVATIONS**

SHEET NO.  
**1** OF **1**

ORIGINATED BY  
**JMK**

DATE  
**FEB. 3, 2006**

CHECKED BY

DATE

CALC. NO.

REV. NO

Reference: Structure Drawing No. 9006-4-8, Section C-C

**CONCRETE CONDITION ASSESSMENT LEGEND**

- W Wet or Apparent Wet Surface
- R Concrete Reinforcing Steel Exposed
- E Efflorescence
- S Existing Surface Repair (e.g. Shotcrete)
- Spall
- D Delamination or Apparent Delamination
- G Disintegration
- C Scaling
- Cracking

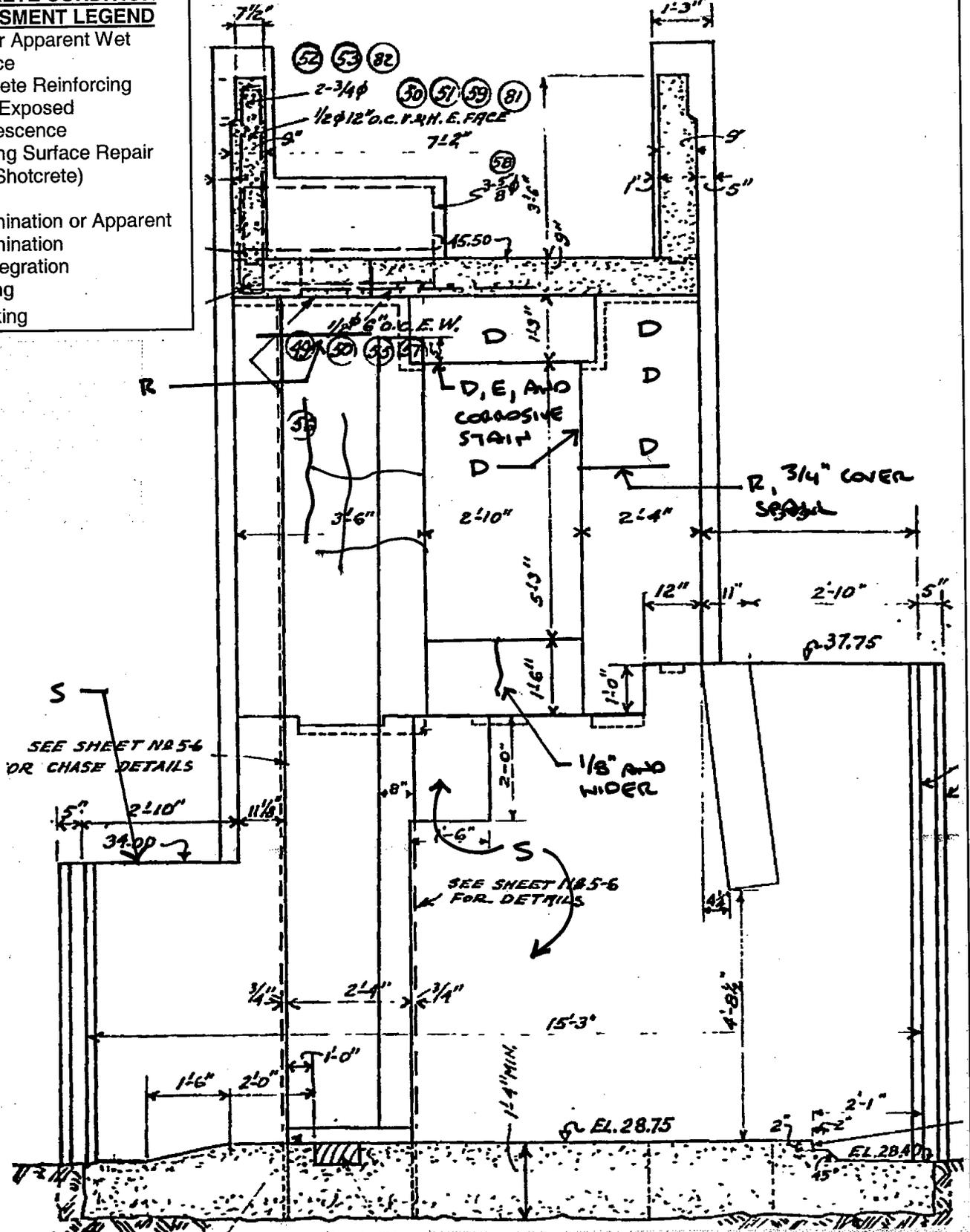


FIGURE 4

 <b>STS Consultants Ltd.</b> CALCULATION SHEET	PROJECT <b>ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN</b>		STS JOB NO. <b>X587996</b>		
	SUBJECT <b>PIER 2 - LEFT SIDE CONDITION OBSERVATIONS</b>		SHEET NO. <b>1</b> OF <b>1</b>		
ORIGINATED BY <b>JMK</b>	DATE <b>FEB. 3, 2006</b>	CHECKED BY	DATE	CALC. NO.	REV. NO.

Reference: Structure Drawing No. 9006-4-8, Section C-C

**CONCRETE CONDITION ASSESSMENT LEGEND**

- W Wet or Apparent Wet Surface
- R Concrete Reinforcing Steel Exposed
- E Efflorescence
- S Existing Surface Repair (e.g. Shotcrete)
- Spall
- D Delamination or Apparent Delamination
- G Disintegration
- C Scaling
- Cracking

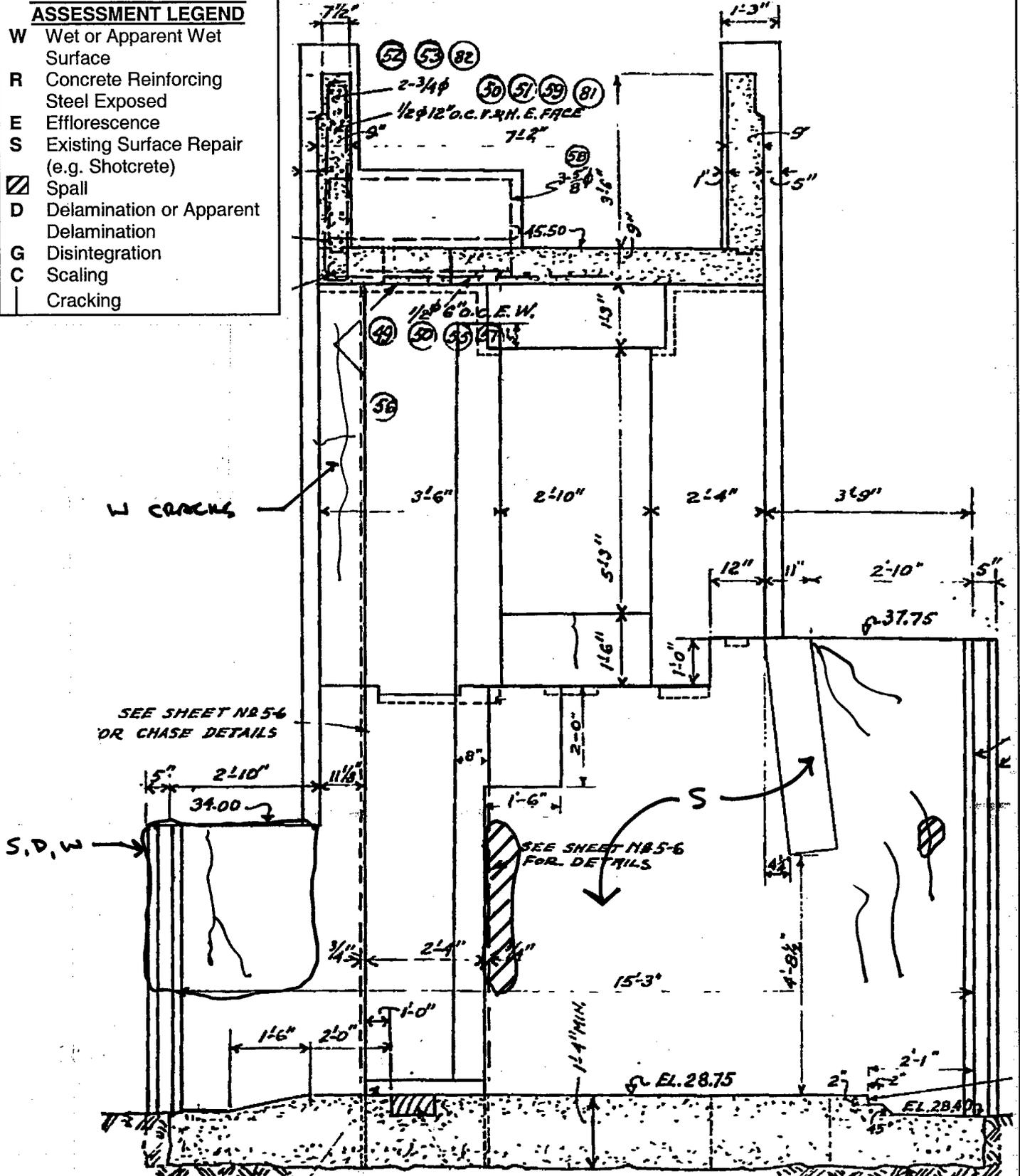


FIGURE 5

 <p><b>STS Consultants Ltd.</b> CALCULATION SHEET</p>	PROJECT <b>ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN</b>				STS JOB NO. <b>X587996</b>	
	SUBJECT <b>PIER 3 - LEFT SIDE CONDITION OBSERVATIONS</b>				SHEET NO. <b>1</b> OF <b>1</b>	
	ORIGINATED BY <b>JMK</b>	DATE <b>FEB. 3, 2006</b>	CHECKED BY	DATE	CALC. NO.	REV. NO.

Reference: Structure Drawing No. 9006-4-8, Section C-C

**CONCRETE CONDITION ASSESSMENT LEGEND**

- W Wet or Apparent Wet Surface
- R Concrete Reinforcing Steel Exposed
- E Efflorescence
- S Existing Surface Repair (e.g. Shotcrete)
- Spall
- D Delamination or Apparent Delamination
- G Disintegration
- C Scaling
- | Cracking

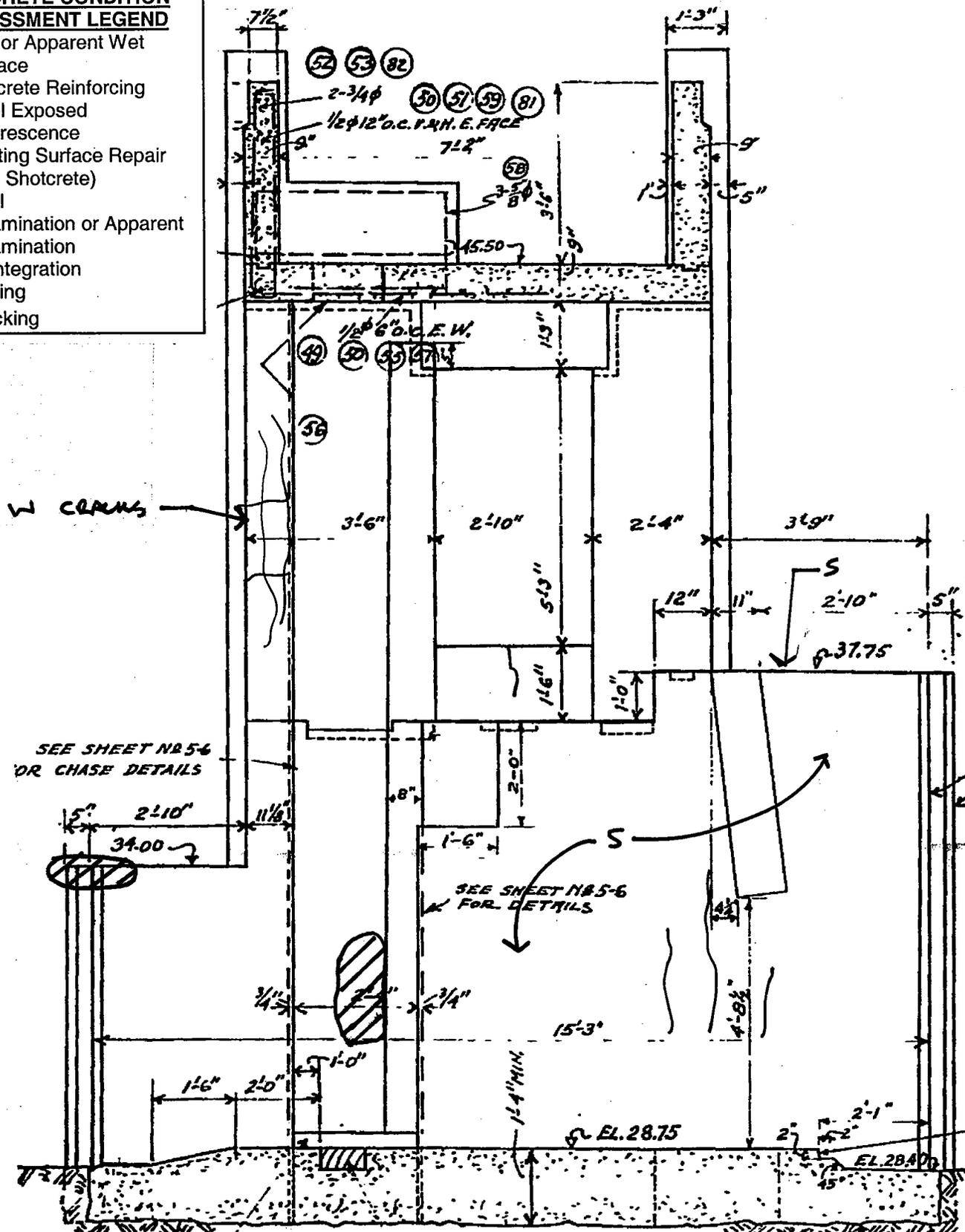


FIGURE 6



STS Consultants Ltd.  
CALCULATION SHEET

PROJECT  
ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN

STS JOB NO.  
X587996

SUBJECT  
PIER 4 - LEFT SIDE CONDITION OBSERVATIONS

SHEET NO.  
1 OF 1

ORIGINATED BY  
JMK

DATE  
FEB. 3, 2006

CHECKED BY

DATE

CALC. NO.

REV. NO.

Reference: Structure Drawing No. 9006-4-8, Section C-C

**CONCRETE CONDITION ASSESSMENT LEGEND**

- W Wet or Apparent Wet Surface
- R Concrete Reinforcing Steel Exposed
- E Efflorescence
- S Existing Surface Repair (e.g. Shotcrete)
- Spall
- D Delamination or Apparent Delamination
- G Disintegration
- C Scaling
- Cracking

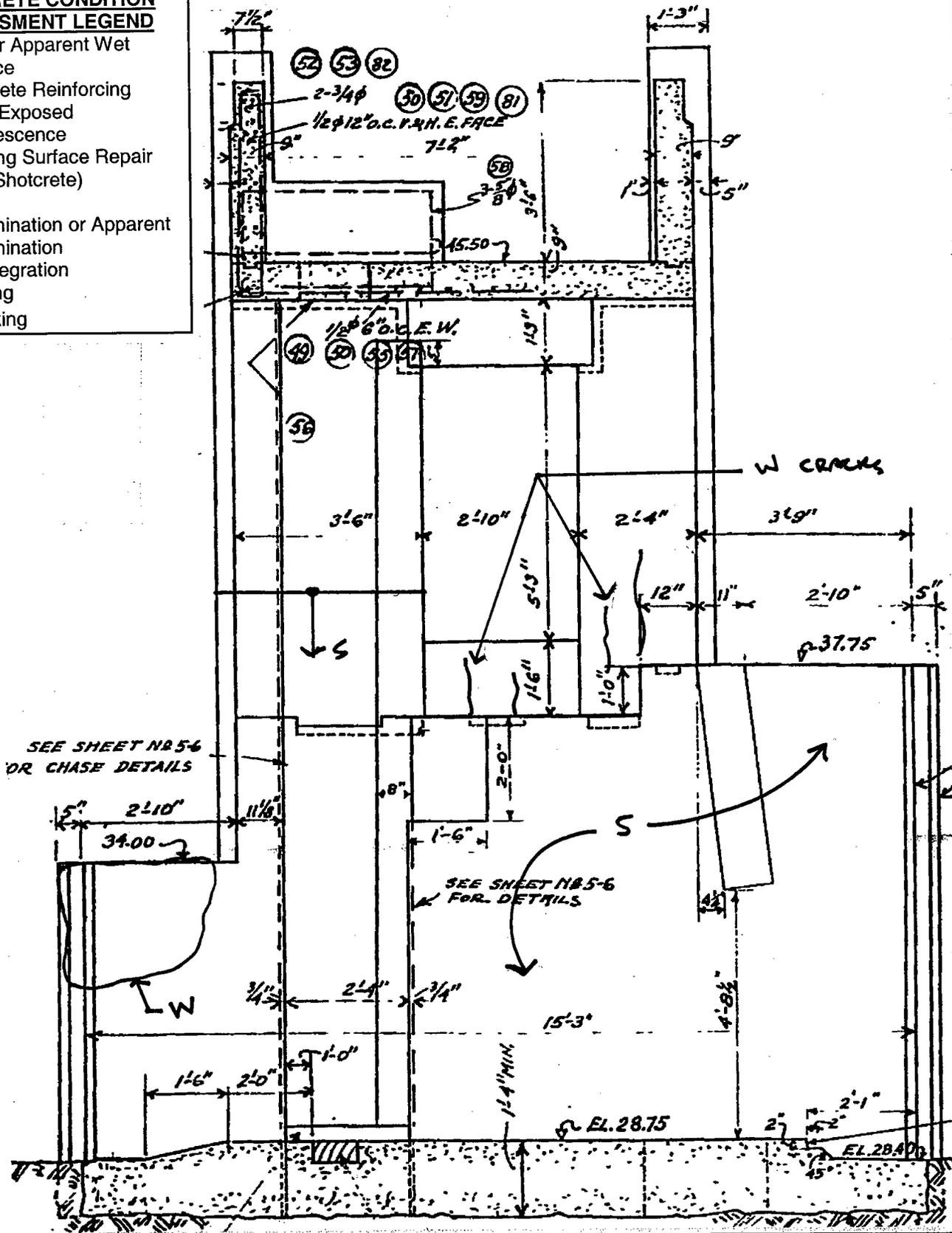




FIGURE 8

 <p><b>STS Consultants Ltd.</b> CALCULATION SHEET</p>	PROJECT <b>ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN</b>				STS JOB NO. <b>X587996</b>	
	SUBJECT <b>PIER 6 - LEFT SIDE CONDITION OBSERVATIONS</b>				SHEET NO. <b>1</b> OF <b>1</b>	
	ORIGINATED BY <b>JMK</b>	DATE <b>FEB. 3, 2006</b>	CHECKED BY	DATE	CALC. NO.	REV. NO.

Reference: Structure Drawing No. 9006-4-8, Section C-C

**CONCRETE CONDITION ASSESSMENT LEGEND**

- W Wet or Apparent Wet Surface
- R Concrete Reinforcing Steel Exposed
- E Efflorescence
- S Existing Surface Repair (e.g. Shotcrete)
- Spall
- D Delamination or Apparent Delamination
- G Disintegration
- C Scaling
- | Cracking

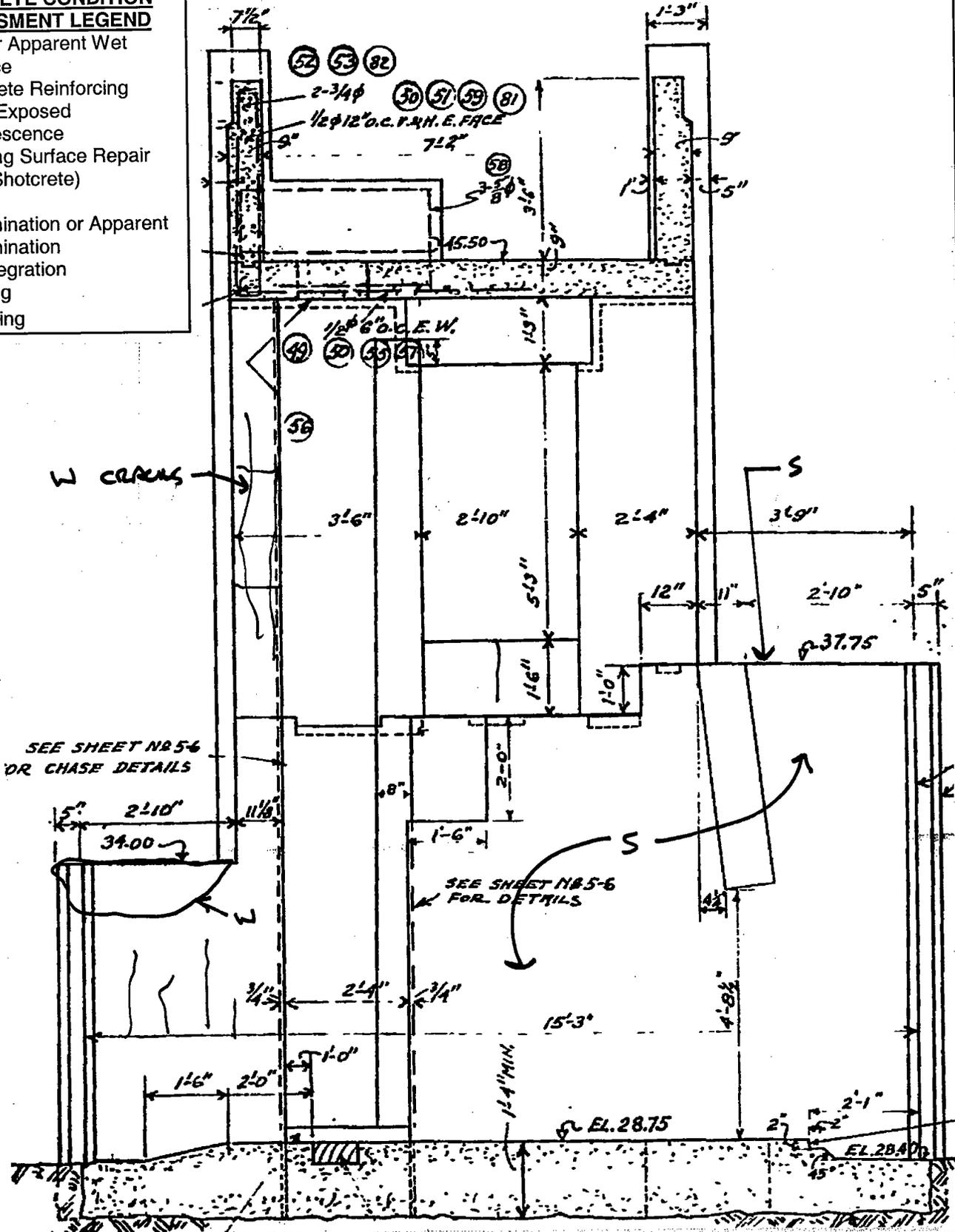


FIGURE 9



STS Consultants Ltd.  
CALCULATION SHEET

PROJECT  
ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN

STS JOB NO.  
X587996

SUBJECT  
PIER 7 - LEFT SIDE CONDITION OBSERVATIONS

SHEET NO.  
1 OF 1

ORIGINATED BY  
JMK

DATE  
FEB. 3, 2006

CHECKED BY

DATE

CALC. NO.

REV. NO

Reference: Structure Drawing No. 9006-4-8, Section C-C

**CONCRETE CONDITION ASSESSMENT LEGEND**

- W Wet or Apparent Wet Surface
- R Concrete Reinforcing Steel Exposed
- E Efflorescence
- S Existing Surface Repair (e.g. Shotcrete)
- Spall
- D Delamination or Apparent Delamination
- G Disintegration
- C Scaling
- Cracking

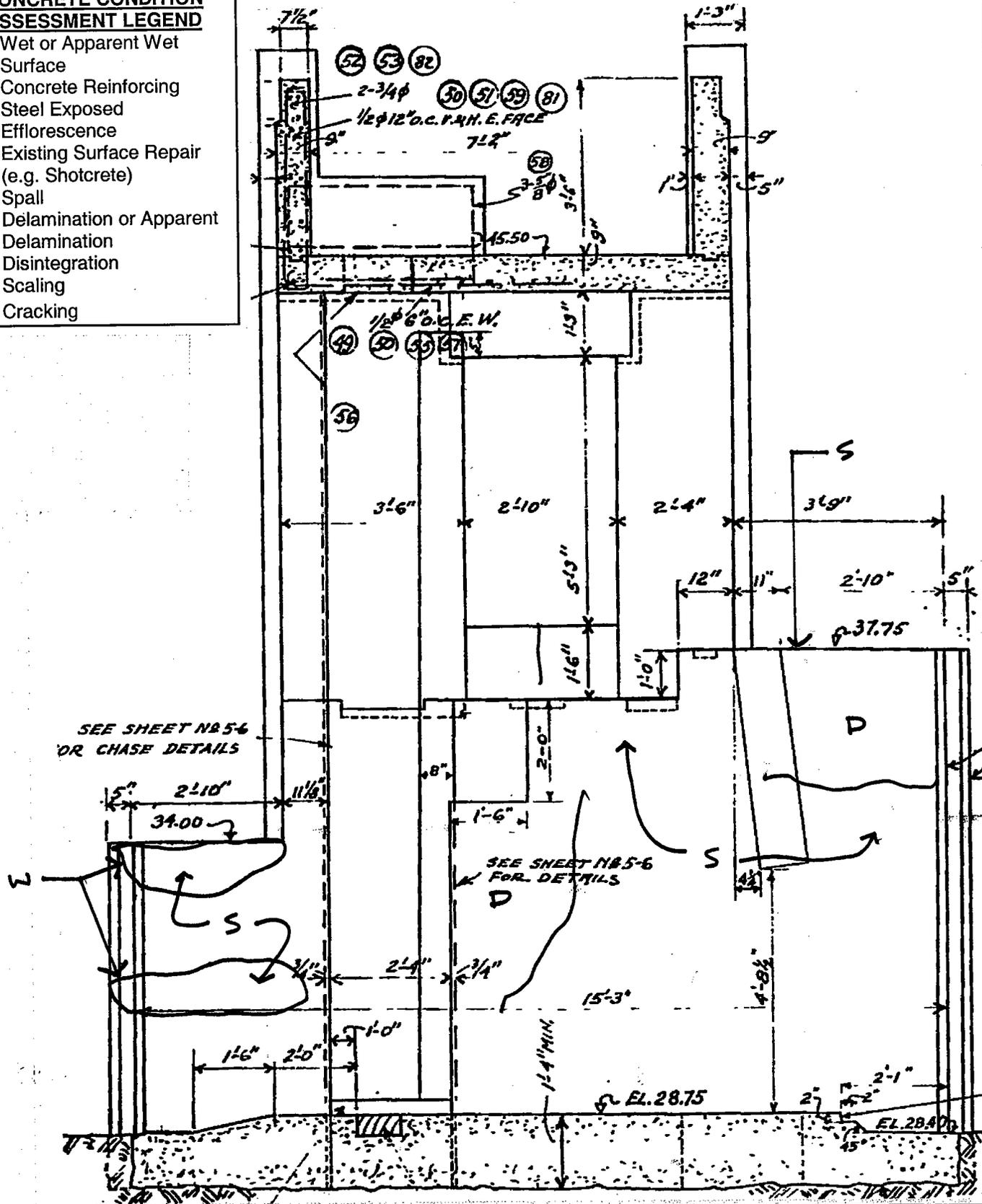


FIGURE 10

 <b>STS Consultants Ltd.</b> CALCULATION SHEET	PROJECT <b>ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN</b>				STS JOB NO. <b>X587996</b>	
	SUBJECT <b>PIER 8 - LEFT SIDE CONDITION OBSERVATIONS</b>				SHEET NO. <b>1</b> OF <b>1</b>	
	ORIGINATED BY <b>JMK</b>	DATE <b>FEB. 3, 2006</b>	CHECKED BY	DATE	CALC. NO.	REV. NO.

Reference: Structure Drawing No. 9006-4-8, Section C-C

**CONCRETE CONDITION ASSESSMENT LEGEND**

- W Wet or Apparent Wet Surface
- R Concrete Reinforcing Steel Exposed
- E Efflorescence
- S Existing Surface Repair (e.g. Shotcrete)
- Spall
- D Delamination or Apparent Delamination
- G Disintegration
- C Scaling
- Cracking

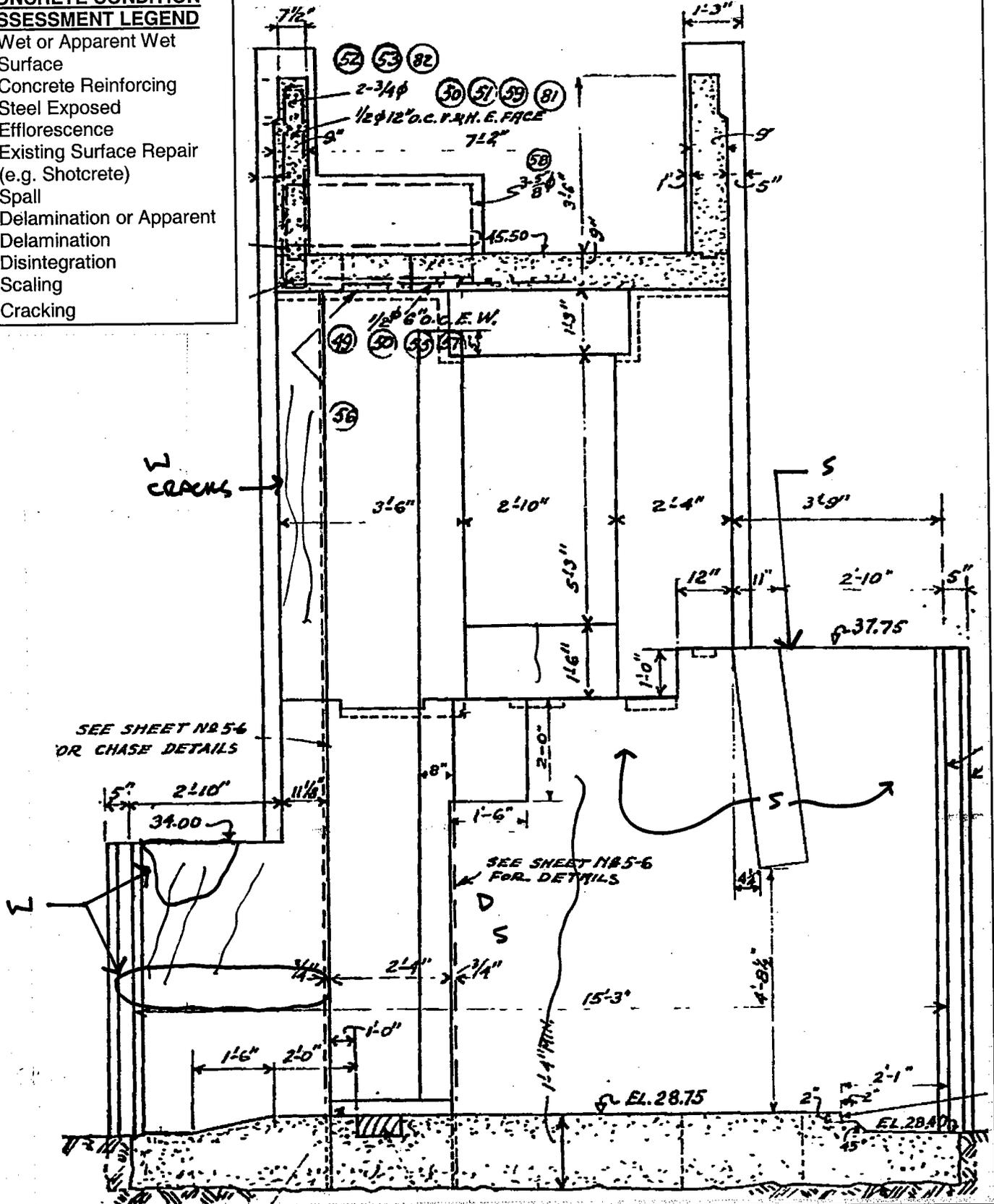




FIGURE 12



STS Consultants Ltd.  
CALCULATION SHEET

PROJECT <b>ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN</b>		STS JOB NO. <b>X587996</b>	
SUBJECT <b>PIER 10 – LEFT SIDE CONDITION OBSERVATIONS</b>		SHEET NO. <b>1 OF 1</b>	
ORIGINATED BY <b>JMK</b>	DATE <b>FEB. 3, 2006</b>	CHECKED BY	DATE
CALC. NO.		REV. NO.	

Reference: Structure Drawing No. 9006-4-8, Section C-C

**CONCRETE CONDITION ASSESSMENT LEGEND**

- W Wet or Apparent Wet Surface
- R Concrete Reinforcing Steel Exposed
- E Efflorescence
- S Existing Surface Repair (e.g. Shotcrete)
- Spall
- D Delamination or Apparent Delamination
- G Disintegration
- C Scaling
- | Cracking

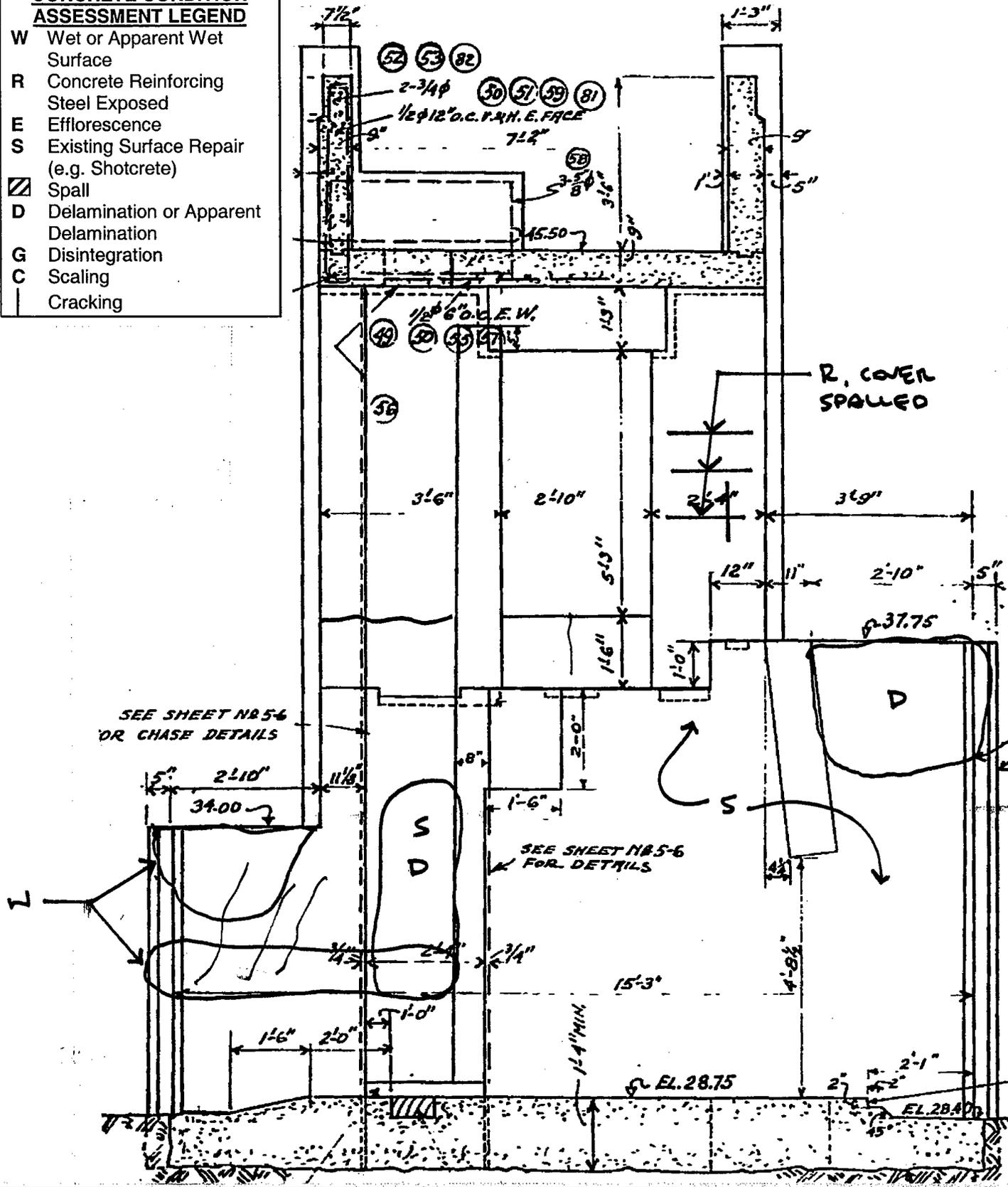




FIGURE 14

 <b>STS Consultants Ltd.</b> CALCULATION SHEET	PROJECT <b>ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN</b>			STS JOB NO. <b>X587996</b>	
	SUBJECT <b>PIER 1 - RIGHT SIDE CONDITION OBSERVATIONS</b>			SHEET NO. <b>1</b> OF <b>1</b>	
	ORIGINATED BY <b>JMK</b>	DATE <b>FEB. 3, 2006</b>	CHECKED BY	DATE	CALC. NO.

Reference: Structure Drawing No. 9006-4-8, Section C-C (reverse image)

<b>CONCRETE CONDITION ASSESSMENT LEGEND</b>	
W	Wet or Apparent Wet Surface
R	Concrete Reinforcing Steel Exposed
E	Efflorescence
S	Existing Surface Repair (e.g. Shotcrete)
	Spall
D	Delamination or Apparent Delamination
G	Disintegration
C	Scaling
	Cracking

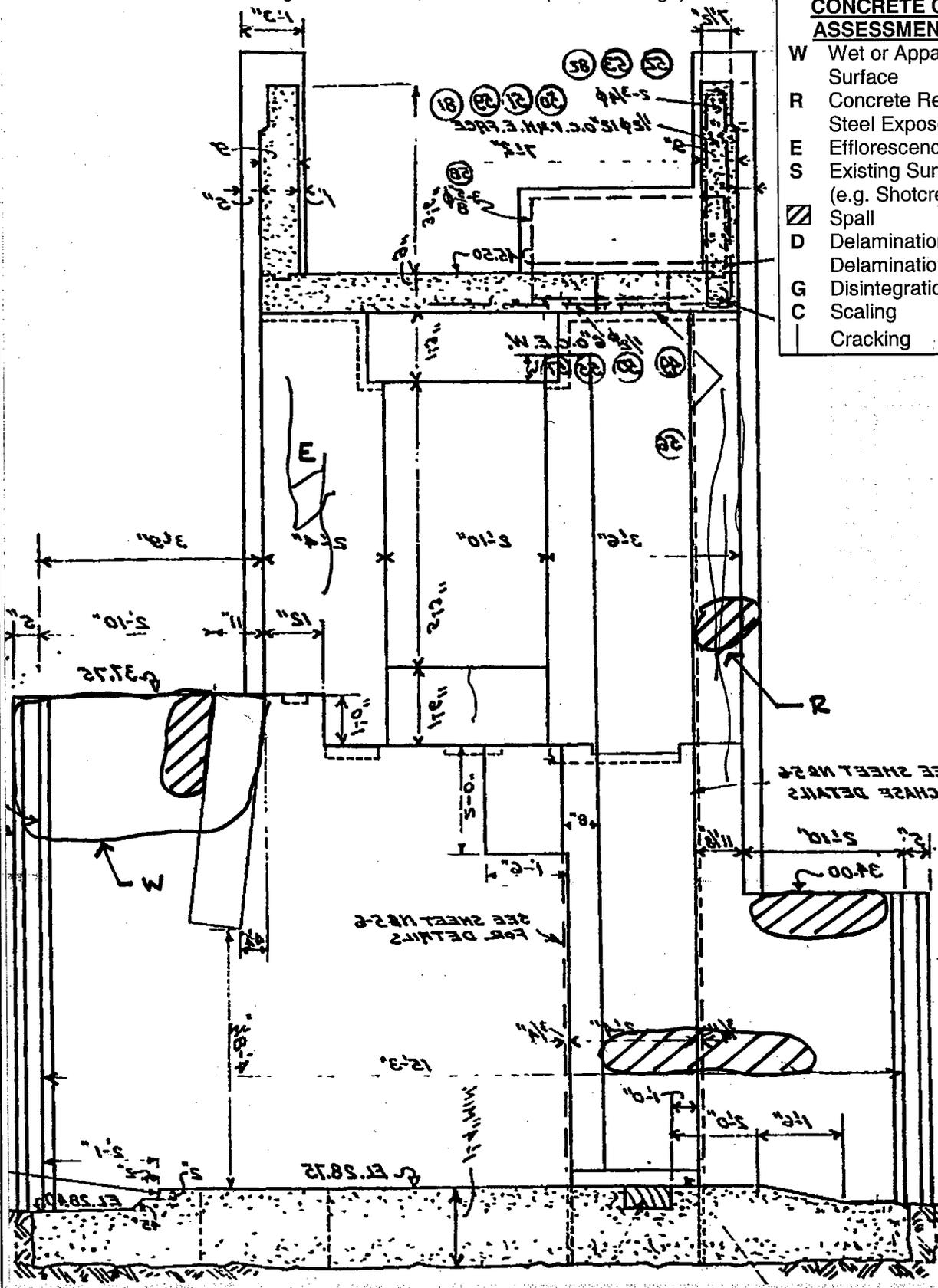




FIGURE 16

 <b>STS Consultants Ltd.</b> CALCULATION SHEET	PROJECT <b>ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN</b>		STS JOB NO. <b>X587996</b>		
	SUBJECT <b>PIER 3 - RIGHT SIDE CONDITION OBSERVATIONS</b>		SHEET NO. <b>1</b> OF <b>1</b>		
	ORIGINATED BY <b>JMK</b>	DATE <b>FEB. 3, 2006</b>	CHECKED BY	DATE	CALC. NO.

Reference: Structure Drawing No. 9006-4-8, Section C-C (reverse image)

CONCRETE CONDITION ASSESSMENT LEGEND	
W	Wet or Apparent Wet Surface
R	Concrete Reinforcing Steel Exposed
E	Efflorescence
S	Existing Surface Repair (e.g. Shotcrete)
	Spall
D	Delamination or Apparent Delamination
G	Disintegration
C	Scaling
	Cracking

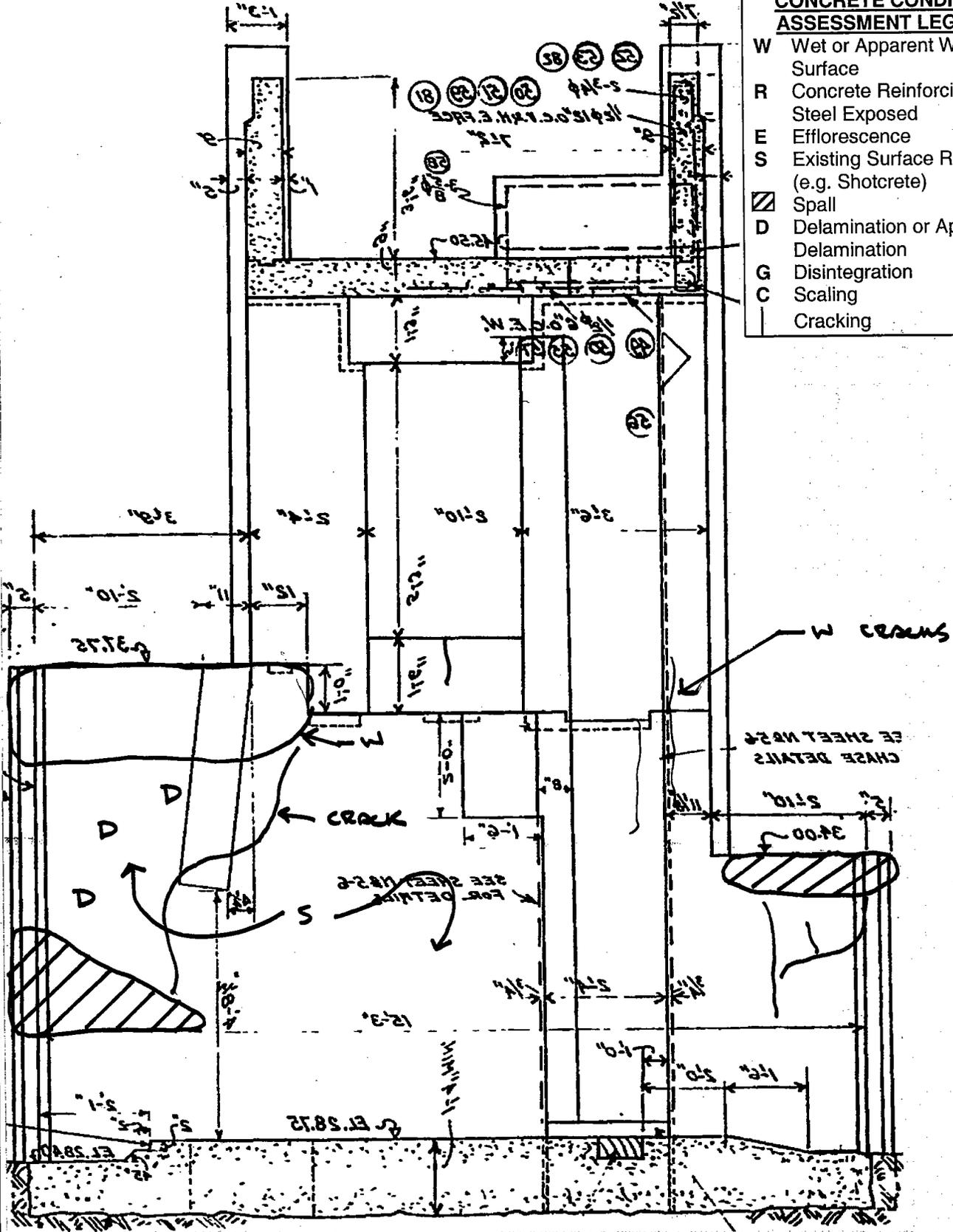


FIGURE 17

 <p><b>STS Consultants Ltd.</b> CALCULATION SHEET</p>	PROJECT <b>ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN</b>				STS JOB NO. <b>X587996</b>	
	SUBJECT <b>PIER 4 - RIGHT SIDE CONDITION OBSERVATIONS</b>				SHEET NO. <b>1</b> OF <b>1</b>	
	ORIGINATED BY <b>JMK</b>	DATE <b>FEB. 3, 2006</b>	CHECKED BY	DATE	CALC. NO.	REV. NO.

Reference: Structure Drawing No. 9006-4-8, Section C-C (reverse image)

<b>CONCRETE CONDITION ASSESSMENT LEGEND</b>	
W	Wet or Apparent Wet Surface
R	Concrete Reinforcing Steel Exposed
E	Efflorescence
S	Existing Surface Repair (e.g. Shotcrete)
	Spall
D	Delamination or Apparent Delamination
G	Disintegration
C	Scaling
	Cracking

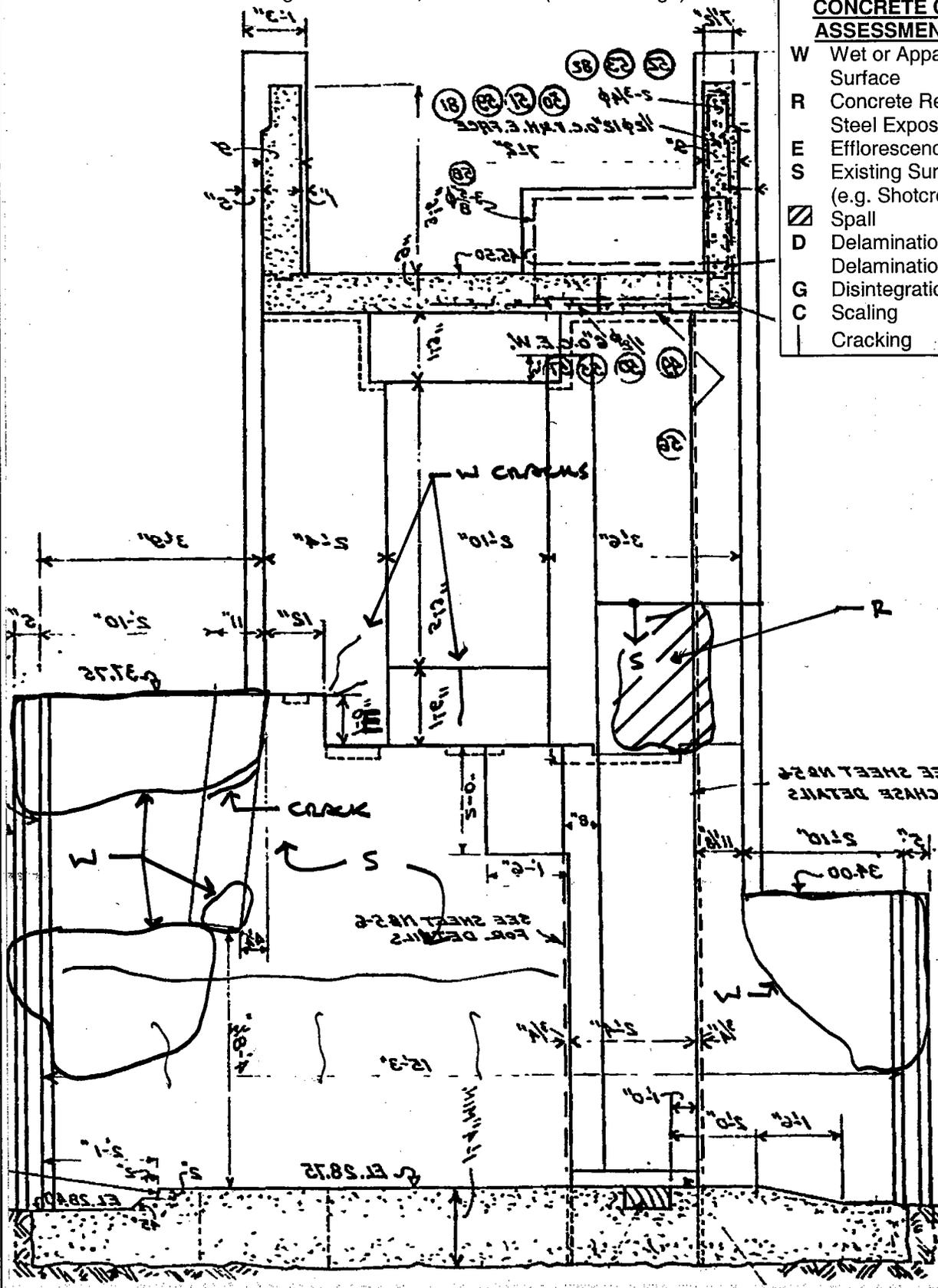


FIGURE 18

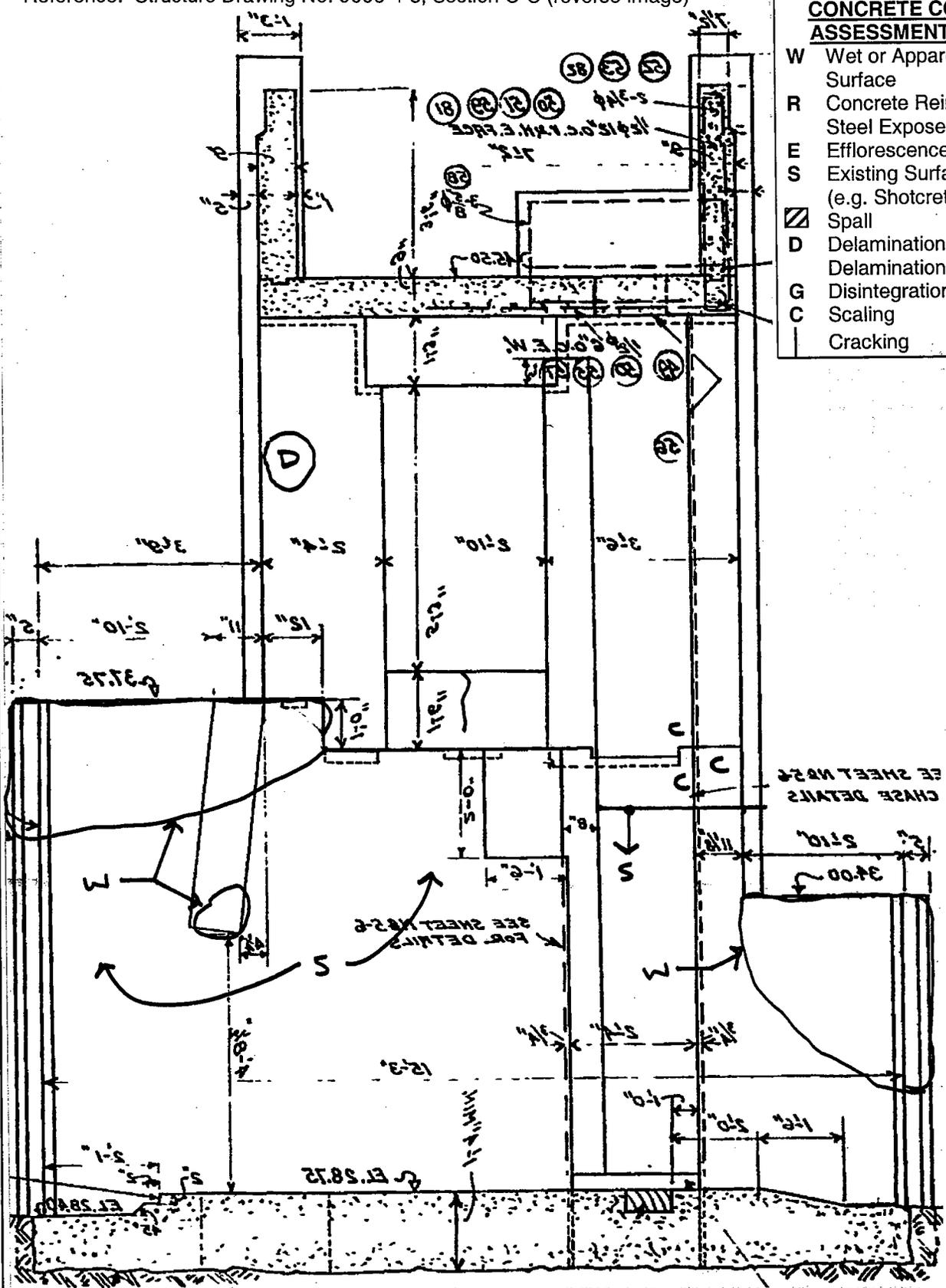


STS Consultants Ltd.  
CALCULATION SHEET

PROJECT <b>ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN</b>		STS JOB NO. <b>X587996</b>	
SUBJECT <b>PIER 5 - RIGHT SIDE CONDITION OBSERVATIONS</b>		SHEET NO. <b>1</b> OF <b>1</b>	
ORIGINATED BY <b>JMK</b>	DATE <b>FEB. 3, 2006</b>	CHECKED BY	DATE

CALC. NO.	REV. NO
-----------	---------

Reference: Structure Drawing No. 9006-4-8, Section C-C (reverse image)



CONCRETE CONDITION ASSESSMENT LEGEND	
W	Wet or Apparent Wet Surface
R	Concrete Reinforcing Steel Exposed
E	Efflorescence
S	Existing Surface Repair (e.g. Shotcrete)
▨	Spall
D	Delamination or Apparent Delamination
G	Disintegration
C	Scaling
	Cracking



FIGURE 20



STS Consultants Ltd.  
CALCULATION SHEET

PROJECT  
ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN

STS JOB NO.  
X587996

SUBJECT  
PIER 7 - RIGHT SIDE CONDITION OBSERVATIONS

SHEET NO.  
1 OF 1

ORIGINATED BY  
JMK

DATE  
FEB. 3, 2006

CHECKED BY

DATE

CALC. NO.

REV. NO

Reference: Structure Drawing No. 9006-4-8, Section C-C (reverse image)

CONCRETE CONDITION ASSESSMENT LEGEND	
W	Wet or Apparent Wet Surface
R	Concrete Reinforcing Steel Exposed
E	Efflorescence
S	Existing Surface Repair (e.g. Shotcrete)
▨	Spall
D	Delamination or Apparent Delamination
G	Disintegration
C	Scaling
	Cracking

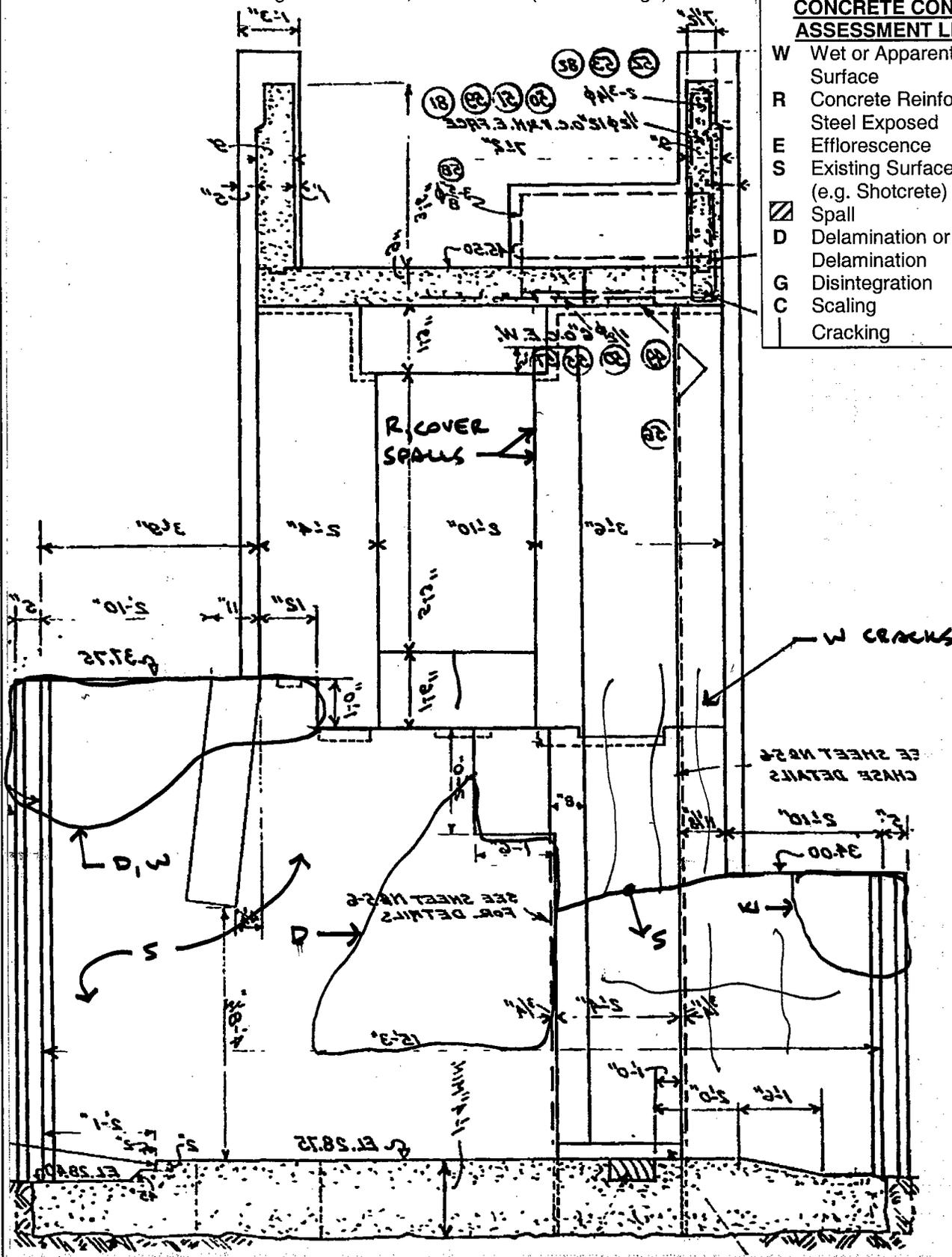


FIGURE 21



STS Consultants Ltd.  
CALCULATION SHEET

PROJECT <b>ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN</b>		STS JOB NO. <b>X587996</b>	
SUBJECT <b>PIER 8 - RIGHT SIDE CONDITION OBSERVATIONS</b>		SHEET NO. <b>1</b> OF <b>1</b>	
ORIGINATED BY <b>JMK</b>	DATE <b>FEB. 3, 2006</b>	CHECKED BY	DATE

CALC. NO.	REV. NO
-----------	---------

Reference: Structure Drawing No. 9006-4-8, Section C-C (reverse image)

**CONCRETE CONDITION ASSESSMENT LEGEND**

- W Wet or Apparent Wet Surface
- R Concrete Reinforcing Steel Exposed
- E Efflorescence
- S Existing Surface Repair (e.g. Shotcrete)
- Spall
- D Delamination or Apparent Delamination
- G Disintegration
- C Scaling
- Cracking

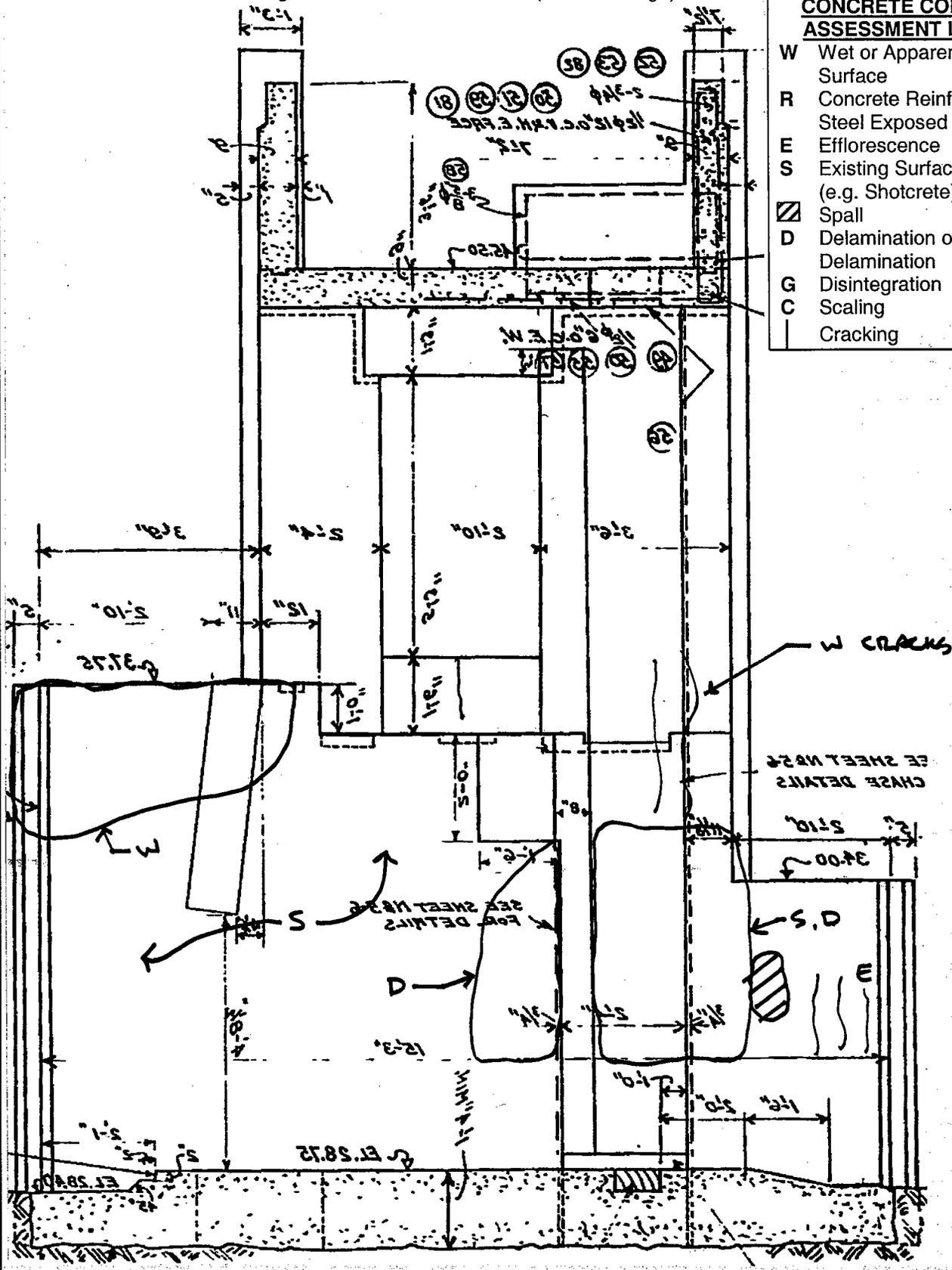


FIGURE 22



STS Consultants Ltd.  
CALCULATION SHEET

PROJECT  
ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN

STS JOB NO.  
X587996

SUBJECT  
PIER 9 - RIGHT SIDE CONDITION OBSERVATIONS

SHEET NO.  
1 OF 1

ORIGINATED BY  
JMK

DATE  
FEB. 3, 2006

CHECKED BY

DATE

CALC. NO.

REV. NO

Reference: Structure Drawing No. 9006-4-8, Section C-C (reverse image)

CONCRETE CONDITION ASSESSMENT LEGEND	
W	Wet or Apparent Wet Surface
R	Concrete Reinforcing Steel Exposed
E	Efflorescence
S	Existing Surface Repair (e.g. Shotcrete)
▨	Spall
D	Delamination or Apparent Delamination
G	Disintegration
C	Scaling
	Cracking

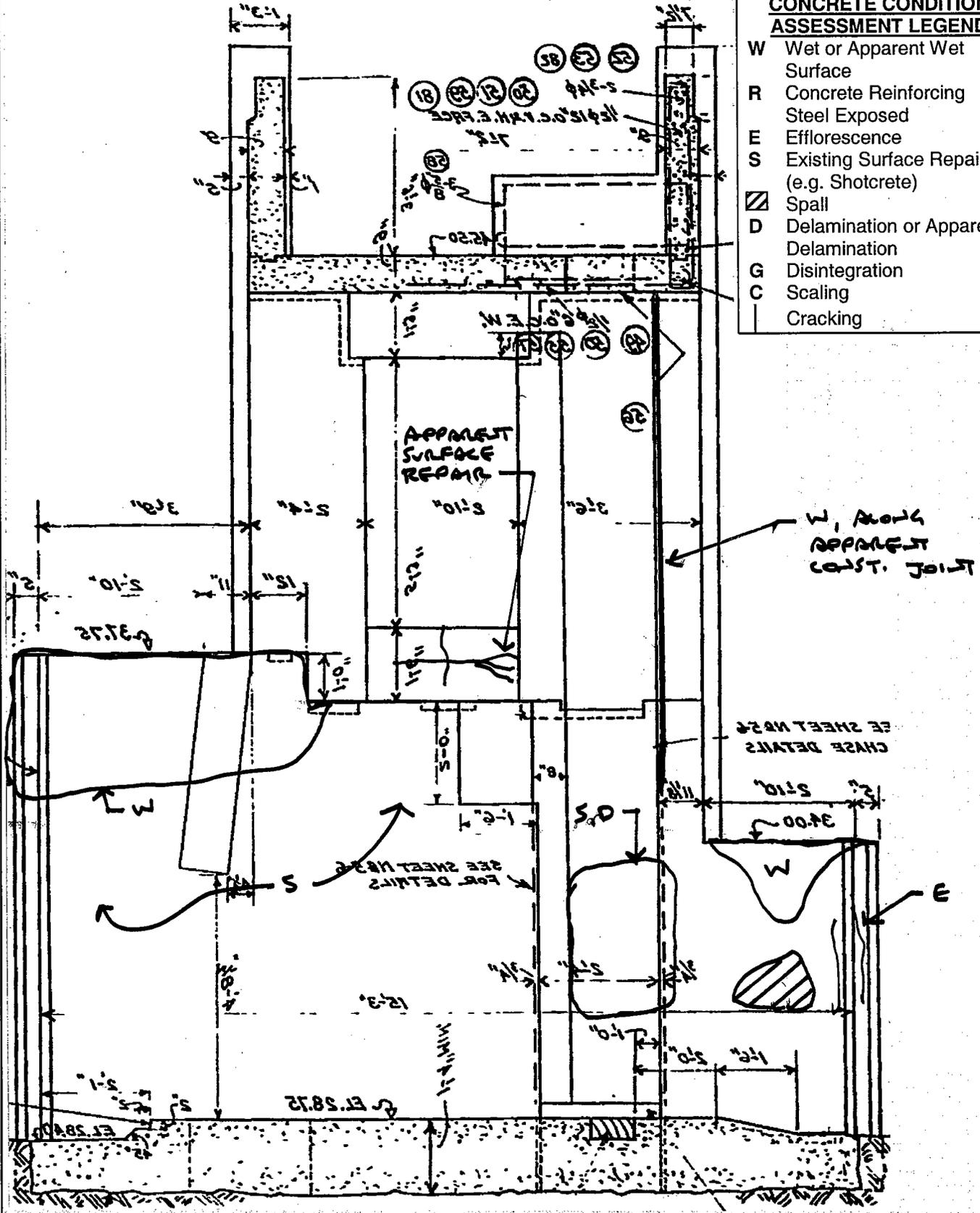


FIGURE 23

 <b>STS Consultants Ltd.</b> CALCULATION SHEET	PROJECT <b>ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN</b>		STS JOB NO. <b>X587996</b>		
	SUBJECT <b>PIER 10 – RIGHT SIDE CONDITION OBSERVATIONS</b>		SHEET NO. <b>1</b> OF <b>1</b>		
	ORIGINATED BY <b>JMK</b>	DATE <b>FEB. 3, 2006</b>	CHECKED BY	DATE	CALC. NO.

Reference: Structure Drawing No. 9006-4-8, Section C-C (reverse image)

<b>CONCRETE CONDITION ASSESSMENT LEGEND</b>	
W	Wet or Apparent Wet Surface
R	Concrete Reinforcing Steel Exposed
E	Efflorescence
S	Existing Surface Repair (e.g. Shotcrete)
▨	Spall
D	Delamination or Apparent Delamination
G	Disintegration
C	Scaling
	Cracking

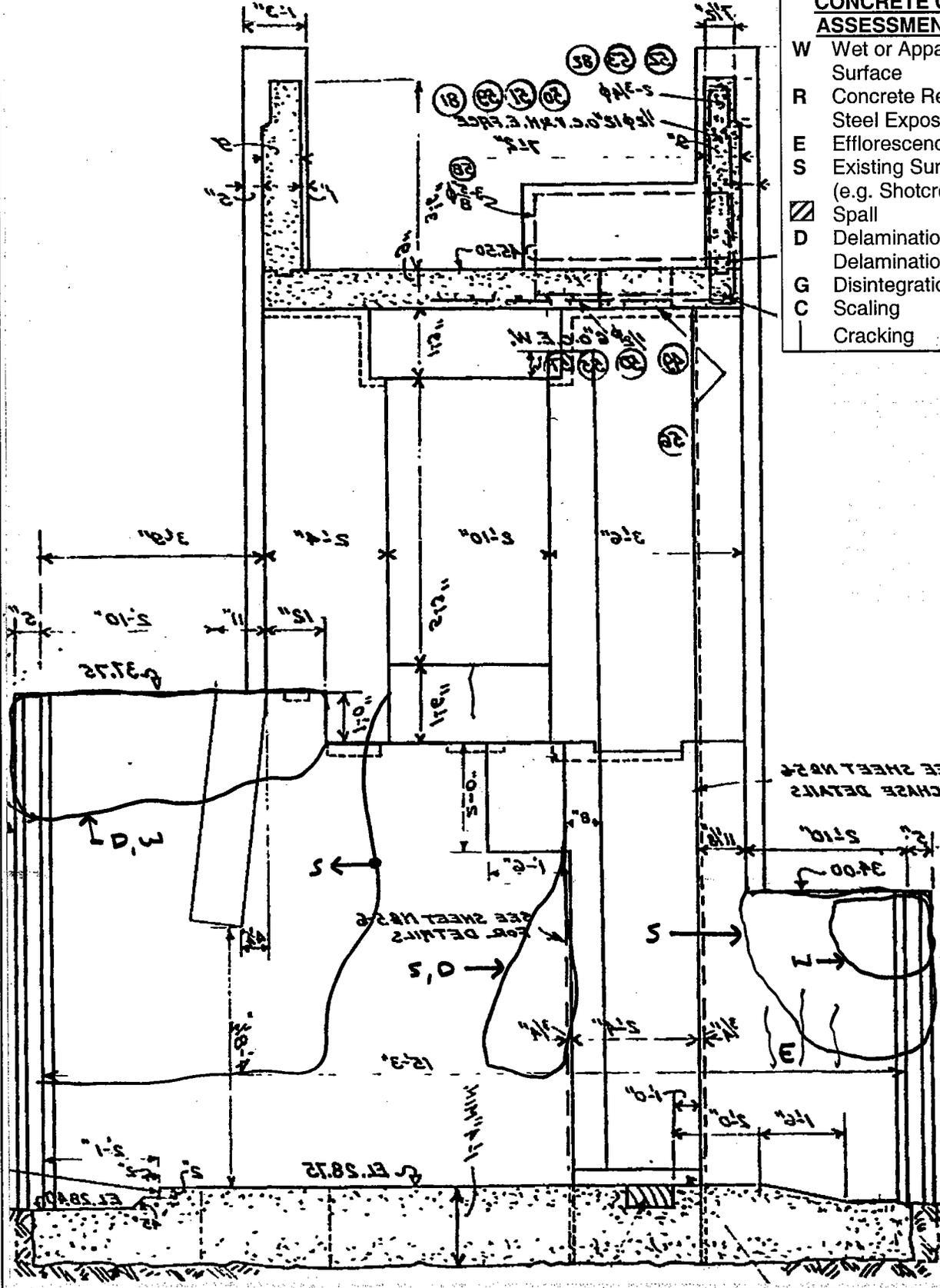


FIGURE 24



STS Consultants Ltd.  
CALCULATION SHEET

PROJECT  
**ESTABROOK PARK DAM, MILWAUKEE, WISCONSIN**

STS JOB NO.  
**X587996**

SUBJECT  
**PIER 11 - RIGHT SIDE CONDITION OBSERVATIONS**

SHEET NO.  
**1** OF **1**

ORIGINATED BY  
**JMK**

DATE  
**FEB. 3, 2006**

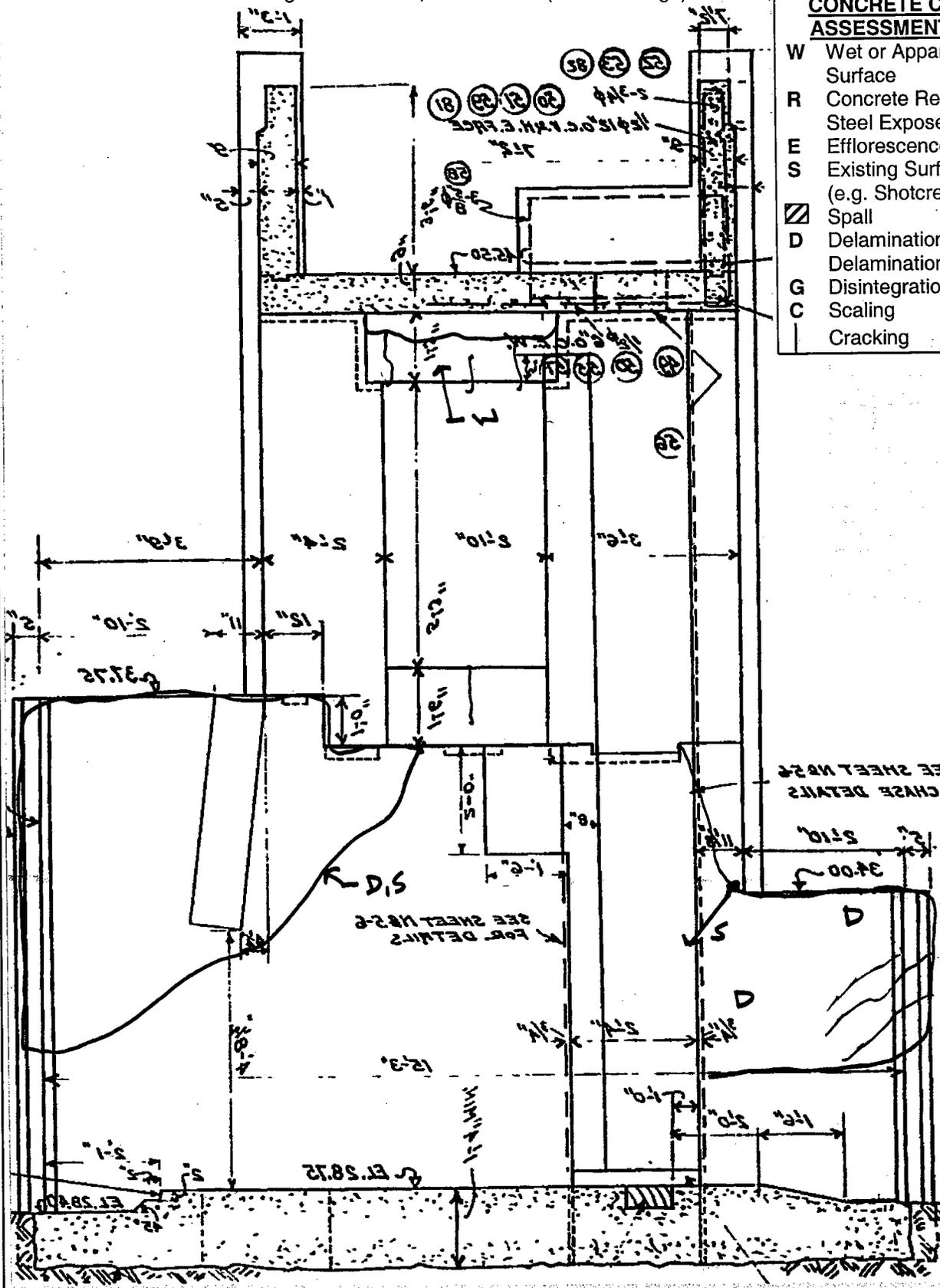
CHECKED BY

DATE

CALC. NO.

REV. NO

Reference: Structure Drawing No. 9006-4-8, Section C-C (reverse image)



<b>CONCRETE CONDITION ASSESSMENT LEGEND</b>	
W	Wet or Apparent Wet Surface
R	Concrete Reinforcing Steel Exposed
E	Efflorescence
S	Existing Surface Repair (e.g. Shotcrete)
▨	Spall
D	Delamination or Apparent Delamination
G	Disintegration
C	Scaling
	Cracking

## APPENDIX D

### Project Photographs





Photograph 1- View of spillway operating bridge deck

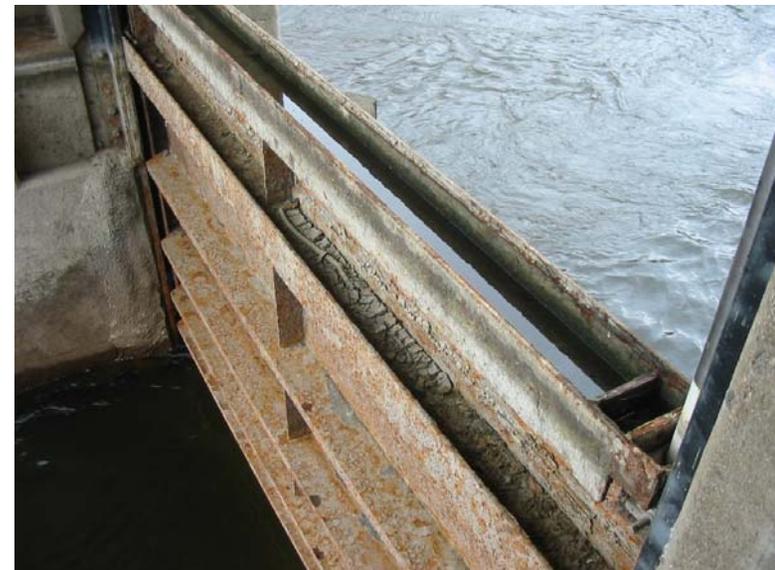


Photograph 2 – View of gate hoist motor

GATE TIME CHART			
Gates 1, 2, 3, 4, 5 & 10 Only			
Inches Open	Minutes	Seconds	Total Seconds
4	0	32	32
8	1	4	64
12	1	36	96
16	2	8	128
20	2	40	160
24	3	12	192
28	3	44	224
32	4	16	256
36	4	48	288
40	5	20	320
44	5	52	352
48	6	24	384
52	6	56	416
56	7	28	448
60	8	0	480
64	8	32	512
68	9	4	544
72	9	36	576
76	10	8	608
80	10	40	640
84	11	12	672
88	11	44	704
91	12	8	728

Gate travels 1" every 8 seconds up or down

Photograph 3 – Gate speed chart. Note that gates travel 1 inch vertically every 8 seconds



Photograph 4 – View of typical slide gate. Note surface rust and water ponding in top channel. Drill drain holes to allow water to drain and sandblast and paint gates.



Photograph 5 – Right side of pier 10. Note gunite on pier surface



Photograph 6 – View of typical concrete surface deterioration on spillway operating bridge deck



Photograph 7 – View of typical area of spalling of gunite overlay on lower part of spillway piers



Photograph 8 – View of gated spillway looking at downstream side

Estabrook Park Dam  
STS Project No. 5-87996  
Photographs taken by RJA



Photograph 9 – View of spillway gate control building



Photograph 10 – View of ice breakers. Note deterioration of concrete at tops and accumulation of woody debris.



Photograph 11 – View of spillway with full pool (taken June 1, 2006)



Photograph 12 – View of ice breakers with full pool (taken June 1, 2006)

Estabrook Park Dam  
STS Project No. 5-87996  
Photographs taken by RJA



Photograph 13 – View of left bank upstream of gated spillway. Note minor undercutting of bank at max. pool level and lack of sufficient slope protection



Photograph 14 – View of right bank (on island) upstream of gated spillway



Photograph 15 – View of right bank (on island) downstream of gated spillway



Photograph 16 – View of left bank downstream of gated spillway



Photograph 17 – View of overflow spillway flashboard section, as taken from left abutment



Photograph 18 – View of flashboards. Note missing boards and penetration by debris. Also note bent flashboard support to the left



Photograph 19 – View of right end of flashboard section



Photograph 20 – View of typical area of concrete deterioration on the weir crest of overflow spillway. Note horizontal rebar anchor exposed on top of rubble masonry.

Estabrook Park Dam  
STS Project No. 5-87996  
Photographs taken by RJA



## APPENDIX E

Dive Inspection Report



# Seaview

## DIVING CONTRACTORS, INC.

Marine Construction

Diving Services

Potable Water

Wastewater Diving

Nuclear Diving

Underwater Cutting

Underwater Welding

Video Inspections

Pipe Penetrations

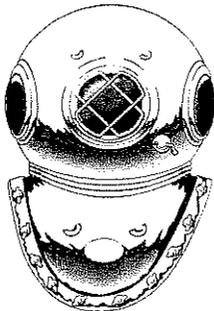
Concrete Restoration

Dam Repairs

Hydrographic Surveys

Zebra Mussel Control

### Commercial Diving Report



[www.seaviewdiving.com](http://www.seaviewdiving.com)

N8867 County Road Y Seymour, WI 54165 920-833-7601 (Fax 920-833-7701)

# Seaview Diving Contractors, Inc.

Pipelines \* Construction \* Burning & Welding \* Salvage \* Inspections \* U/W Video \* Concrete Repairs

N8867 County Road Y  
Seymour, Wisconsin 54165  
920-833-7601  
Fax 920-833-7701  
[www.seaviewdiving.com](http://www.seaviewdiving.com)

**DATE** June 12, 2006

**SUBJECT:** Commercial dive video inspection of both upstream and downstream sides of the **Estabrook Dam**, Milwaukee, Wisconsin on June 1, 2006.

**FOR:** STS Milwaukee  
Attn. Richard Anderson  
11425 W Lake Park Dr.  
Milwaukee, WI 53224

**BY:** Seaview Diving Contractors, Inc.  
N8867 County Rd Y  
Seymour, WI 54165-9150

**JOB#:** 2622

**PO #:** Original # PO63-05638  
Project #X587996

**PREPARED BY:**

Steve Haney  
Commercial Diver

On June 1, 2006, Seaview Diving Contractors Inc. mobilized a three man commercial dive crew to perform a video inspection of the Estabrook Dam which is located on the Milwaukee River in Milwaukee, Wisconsin.

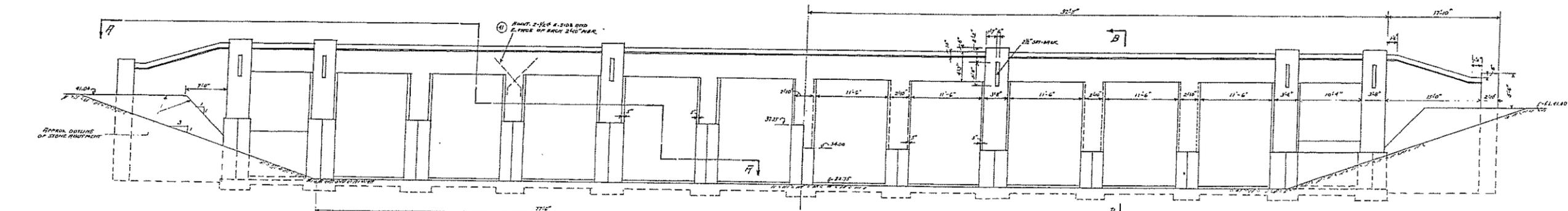
The commercial diver entered the water on the downstream side to begin the inspection, and it was determined that the depth was too shallow for the diver to be dressed in full diving apparatus. To complete the inspection of the downstream side it was necessary for the topside team to follow the diver by walking across the bridge as he verbally reported any crucial findings. The diver reported that gates 1 through 3 had an approximate 1 inch gap between the gate and the concrete bottom due to small debris that was wedged in between. Continuing the inspection the diver moved east to west noting that gates 4 through 10 were uncompromised and in sound condition as well as the concrete below. There was no evidence of undermining existing underneath any of the gates or the concrete below them. The diver however was unable to determine how far out the concrete extended due to the fact that several different concrete pads were poured overlapping each other with gravel over the top of each pad. At one point the diver was about 75 to 100 feet downstream from the dam and was still standing on concrete. After analyzing the downstream side, the diver relocated to the upstream side.

Starting on the east side and moving west, the diver examined each gate and concrete bull nose. Each gate was found to be in good working condition, and the concrete below each gate was in adequate order as well. The diver managed to remove some small debris between gates 1 through 3 but some debris could not be removed. Fairly strong flow was present in gates 1 through 3 due to the gap that was created by the remaining debris between the gates and the bottom concrete. Gates 4 through 10 were found to be tight to the bottom concrete. Several areas in the bull noses had some delamination and exposed aggregate. The diver discovered some voids in the bull noses through out the course of the inspection which are all documented on video. *One area of concern was the cavity that was discovered in the bull nose between gate 4 and gate 5.* The diver was unable to determine just how deep the cavity was because of the fact that it was deeper than the probing tool of 4' he was utilizing not counting his arm length. (Documentation of this cavity can be seen on video and is also reference on the updated diagram also enclosed). After proceeding to the far west side, the diver determined that the overall integrity of this structure was adequate. The inspection was then concluded and the diver exited the water.

### **Recommendations:**

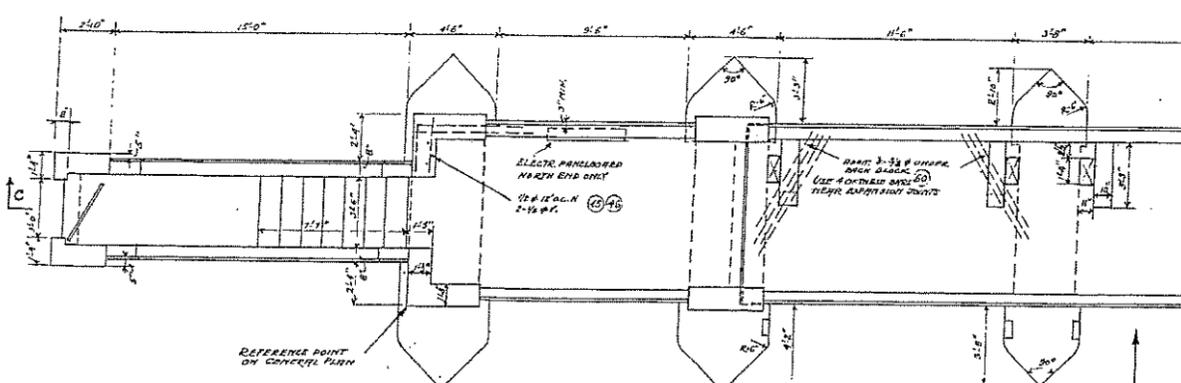
Seaview Diving Contractors Inc. recommends that this dam be inspected on an annual basis to monitor the progression of the damaged concrete bull noses. It should also be noted that Seaview has the ability and the necessary equipment for repairing the cavity between gates 4 and 5 if a repair was to be rendered.

Seaview Diving Contractors Inc. thanks you for the opportunity to service your underwater needs. Please call us at (920) 833-7601 with any questions or concerns you may have.

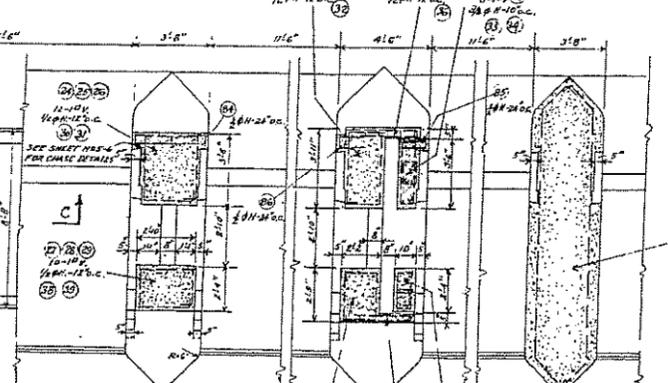


HALF UPSTREAM ELEVATION  
SCALE 1/8"=1'-0"

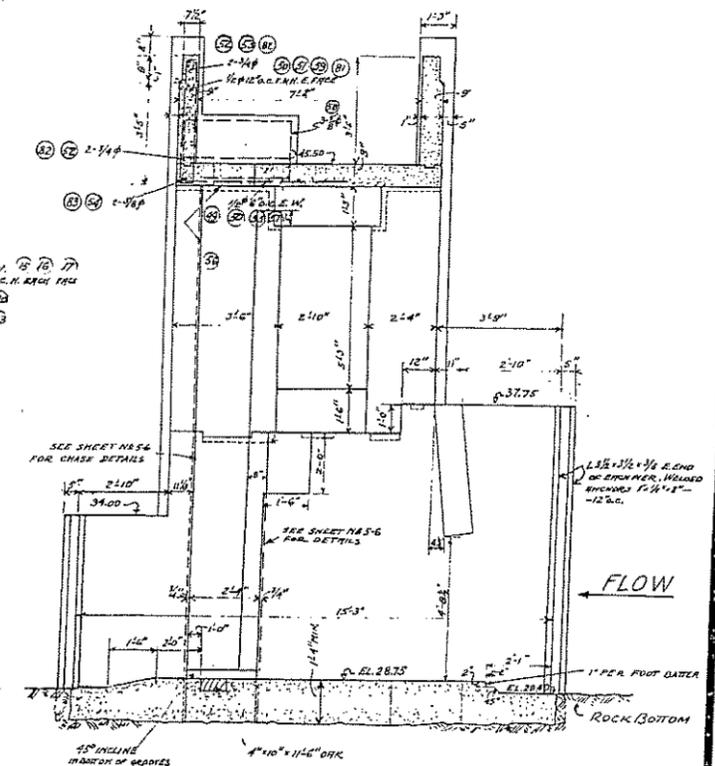
HALF DOWNSTREAM ELEVATION  
SCALE 1/8"=1'-0"



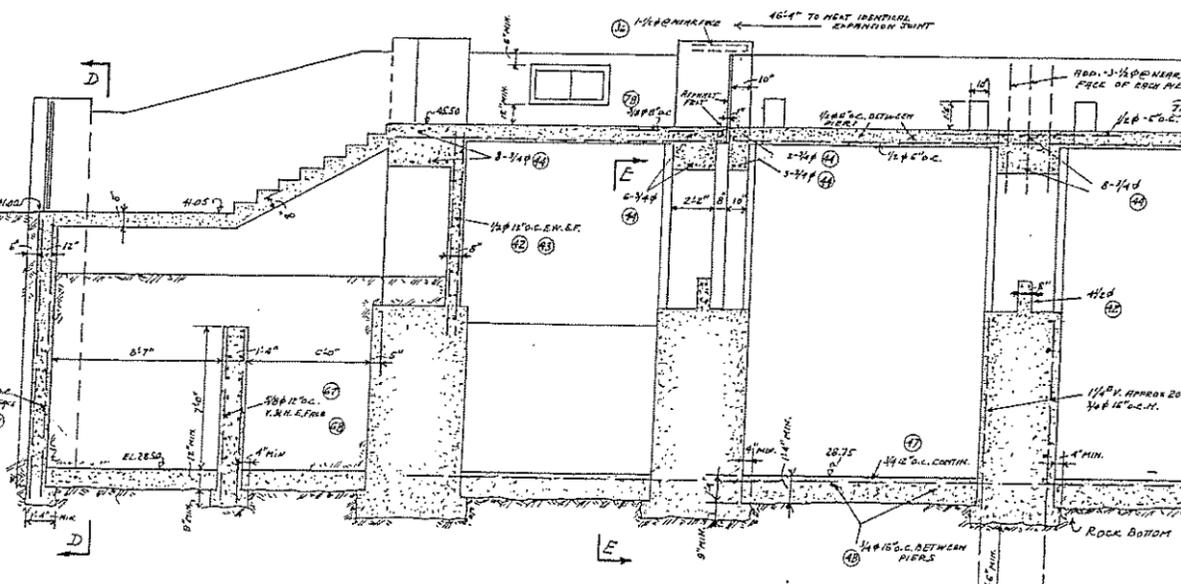
SECTION A-A  
SCALE 1/4"=1'-0"



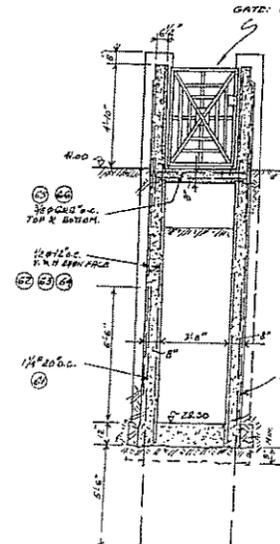
SECTION C-C  
SCALE 1/4"=1'-0"



SECTION B-B  
SCALE 3/8"=1'-0"



SECTION D-D  
SCALE 1/4"=1'-0"



SECTION E-E  
SCALE 1/4"=1'-0"

NOTE:

THE GATE SECTION OF THE DAM IS SYMMETRICAL ABOUT THE CENTER LINE, EXCEPT THE ELECTRIC PANELBOARD WHICH IS ON NORTH END ONLY.  
THE TOP CHUTES WITH HOISTS, GUIDES, ANCHOR BOLTS, SLEEVES ETC. ARE NOT SHOWN ON THIS DRAWING, BUT SHALL BE PROVIDED AS CALLED FOR ON SHEET 13-0.  
PROVIDE A 3/4" CHAMFER ON ALL SHARP CONCRETE EDGES EXCEPT STAIR TISINGS WHERE 1/2" CHAMFER SHALL BE PROVIDED.  
EXPANSION JOINTS AT RIGHT ANGLE TO THE LONGITUDINAL DIRECTION OF THE DAM SHALL BE FILLED WITH 1" SPERMAT FELT, BOUNDING BOLTERS AT THE EXPANSION JOINTS SHALL BE SECURED BY MEANS OF BUILDING PAPER.  
IN ABUTMENTS ALL VERTICAL WALLS SHALL BE POURED CONTINUOUS WITHOUT JOINTS UP TO EL. 38.00.

REINFORCING BARS ARE SHOWN MOSTLY IN TYPICAL LOCATIONS, BUT SHALL BE PROVIDED IN ALL SIMILAR LOCATIONS.  
VERTICAL BARS IN PIERS SHALL EXTEND TO 1/2" FROM THE TOP OF THE SLAB, EXCEPT THE BARS BELOW RAILINGS WHICH SHALL EXTEND UP TO 3" FROM THE TOP OF THE RAILING.  
PROVIDE 3-#10 @ 14" O.C. EACH WAY UNDER EACH HOIST IN TOP OF THE SLAB.

Designed by M. B. Coifman  
Consulting Engineer

MILWAUKEE COUNTY REGIONAL PLANNING DEPARTMENT

ESTABROOK PARK DAM  
CONCRETE DETAILS - GATE SECTION

LANDSCAPE DESIGN SECTION <u>Alfred Bauman</u> Landscape Architect	ENGINEERING DESIGN SECTION <u>Roy Behrens</u> Senior Ass't. Civil Engineer
Survey ..... Plan ..... Tracing ..... Checked .....	Approved: <u>Edmond</u> Date: <u>4/24/37</u> Supervising Engineer Approved: <u>W. J. ...</u> Date: <u>5/2/37</u> Highway Commissioner & Planning Engineer

Revised May 18, 1937.  
Revised May 19, 1937.  
Revised Sept. 29, 1937.  
Revised Nov. 30, 1937.

DEPARTMENT OF THE INTERIOR  
NATIONAL PARK SERVICE  
AND  
MILWAUKEE COUNTY PARK COMMISSION  
CO-OPERATING

BRANCH OF PLANNING	STATE PARK DIVISION
Prepared by <u>James ...</u> Milwaukee County Park Commission	SYMBOL NUMBER 130 DATE
Recommended: <u>W. J. ...</u> Date: <u>7/27</u> Inspector	S.P.-WIS. 9006-4-8 SCALES AS SHOWN
Approved: _____ Date: _____ Regional Office	

24x  
MICROFILMED

## APPENDIX F

### Stability Analysis of Gated Spillway Section



## Estabrook Dam - Gravity Stability Analysis

**Loading Conditions Analyzed:**

- Case 1: Normal Water Levels
- Case 2: Design Flood *(Note: Dam is low hazard and submerges under 100 yr flood - no stability analysis needed)*
- Case 2a: Normal Water Levels Plus Ice

	Case 1 (Usual)	Case 2a (Unusual)
Headwater Level	36.0	36.0
Tailwater Level	30.75	30.75
Ice Level	N/A	35
USACE Minimum FS	2.0	1.7
Resultant location at base	middle third	middle half

**Assumptions:**

- Single bay analysis - conservatively assume no transfer of loads between piers
- Conservatively ignore dead weight of gate, stem, hoist and pillow blocks
- Conservatively ignore weight of concrete spillway apron between piers for sliding computations
- Conservatively ignore passive resistance of bedrock in front of concrete piers
- Conservatively ignore cohesion at concrete / bedrock interface (need cores to verify if cohesion is assumed)

Pier Length =	16.08 ft
Pier Width =	3.67 ft
Section Length (mid gate to mid gate) =	15.17 ft
Rock/Concrete interface elevation =	27.42 ft
phi (concrete / rock interface) =	45 degrees (assumed)
Unit Weight (water) =	0.0624 kcf
Unit Weight (concrete) =	0.15 kcf
Cohesion =	15.12 ksf
Unit pressure of Ice =	5.00 k/Lf

**Dead Loads:**

	Volume (cf)	Unit Weight (kcf)	Forces (kips)		Arm (ft)	Moment (ft kips)	
			V	H		V	H
<b>Section</b>							
1	79.24	0.15	11.89		4.58	54.44	
2	49.92	0.15	7.49		10.33	77.32	
3	10.01	0.15	1.50		7.75	11.63	
4	22.10	0.15	3.31		1.22	4.04	
5	24.15	0.15	3.62		2.33	8.44	
6	277.01	0.15	41.55		6.88	285.67	
7	126.24	0.15	18.94		12.59	238.32	
8	34.69	0.15	5.20		14.86	77.32	
9	38.91	0.15	5.84		3.21	18.71	
10	38.91	0.15	5.84		11.13	64.93	
11	98.64	0.15	14.80		7.17	106.02	
<b>Total</b>	<b>799.83</b>		<b>119.97</b>			<b>946.83</b>	

**Live Loads:**

<b>Unit Weight</b>	<b>Forces (kips)</b>	<b>Arm</b>	<b>Moment (ft kips)</b>			
(kcf)	V	H	(ft)	V	H	
Headwater	All Cases: $H = 0.5 * (36 - 27.42)^2 * 15.17 * 0.0642$					
	0.0624	-34.84	3.75		-130.55	
Tailwater	All Cases: $H = 0.5 * (30.75 - 27.42)^2 * 15.17 * 0.0624$					
	0.0624	5.25	2.00		10.48	
Ice	Case 2a: $H = 5 * 15.17$					
		-75.85	7.58		-574.94	

**Uplift:**

<b>Unit Weight</b>	<b>Forces (kips)</b>	<b>Arm</b>	<b>Moment (ft kips)</b>		
(kcf)	V	H	(ft)	V	H
All Cases:					
	$U = (30.75 - 27.42) * 16.08 * 3.67 * 0.0624$	0.0624	-12.26	8.04	-98.59
	$U = 1/2 * (36.0 - 30.75) * 16.08 * 3.67 * 0.0624$	0.0624	-9.67	10.72	-103.62

### Load Case 1 - Normal Water Levels

#### Load Summary:

Forces (kips)		Moments (ft kips)	
V =	119.97	Mv =	946.83
H =	-29.59	Mh =	-120.06
U =	-21.93	Mu =	-202.22

#### Eccentricity (Overturning Analysis):

$$\mu = (Mv + Mh + Mu) / (V + U)$$

$$e = (B/2) - \mu$$

$$\% \text{ Base} = \mu / B$$

$$Mv + Mh + Mu \text{ (ft kips)} = 624.55$$

$$V + U \text{ (kips)} = 98.04$$

$$\mu \text{ (ft)} = 6.37$$

$$e \text{ (ft)} = 1.67$$

$$\% \text{ Base} = 40\%$$

Resultant falls within the middle third of the base, therefore o.k.

#### Sliding Stability Analysis:

Factor of Safety:

Where:  $\tan(\phi) = 1.00$

$C \text{ (ksf)} = 0$

Shear Area

(ft<sup>2</sup>) (base

of pier) = 59.01

Assume only the base area of pier is available to resist sliding

$$\text{Factor of Safety (FS)} = \{(V+U) * \tan(\phi) + (\text{Shear Area} * C)\} / H$$

FS w/o cohesion = 3.31

No cohesion required to meet USACE recommended FS = 2.0, therefore o.k.

Note, for phi (concrete / rock) = 31 degrees, FS = 2.0

## Load Case 2a - Normal Water Levels Plus Ice

### Load Summary:

Forces (kips)		Moments (ft kips)	
V =	119.97	Mv =	946.83
H =	-105.44	Mh =	-695.01
U =	-21.93	Mu =	-202.22

### Eccentricity (Overturning Analysis)

$$\mu = (Mv + Mh + Mu) / (V + U)$$

$$e = (B/2) - \mu$$

$$\% \text{ Base} = \mu / B$$

$$\begin{aligned} Mv + Mh + Mu \text{ (ft kips)} &= 49.61 \\ V + U \text{ (kips)} &= 98.04 \end{aligned}$$

$$\begin{aligned} \mu \text{ (ft)} &= 0.51 \\ e \text{ (ft)} &= 7.53 \end{aligned}$$

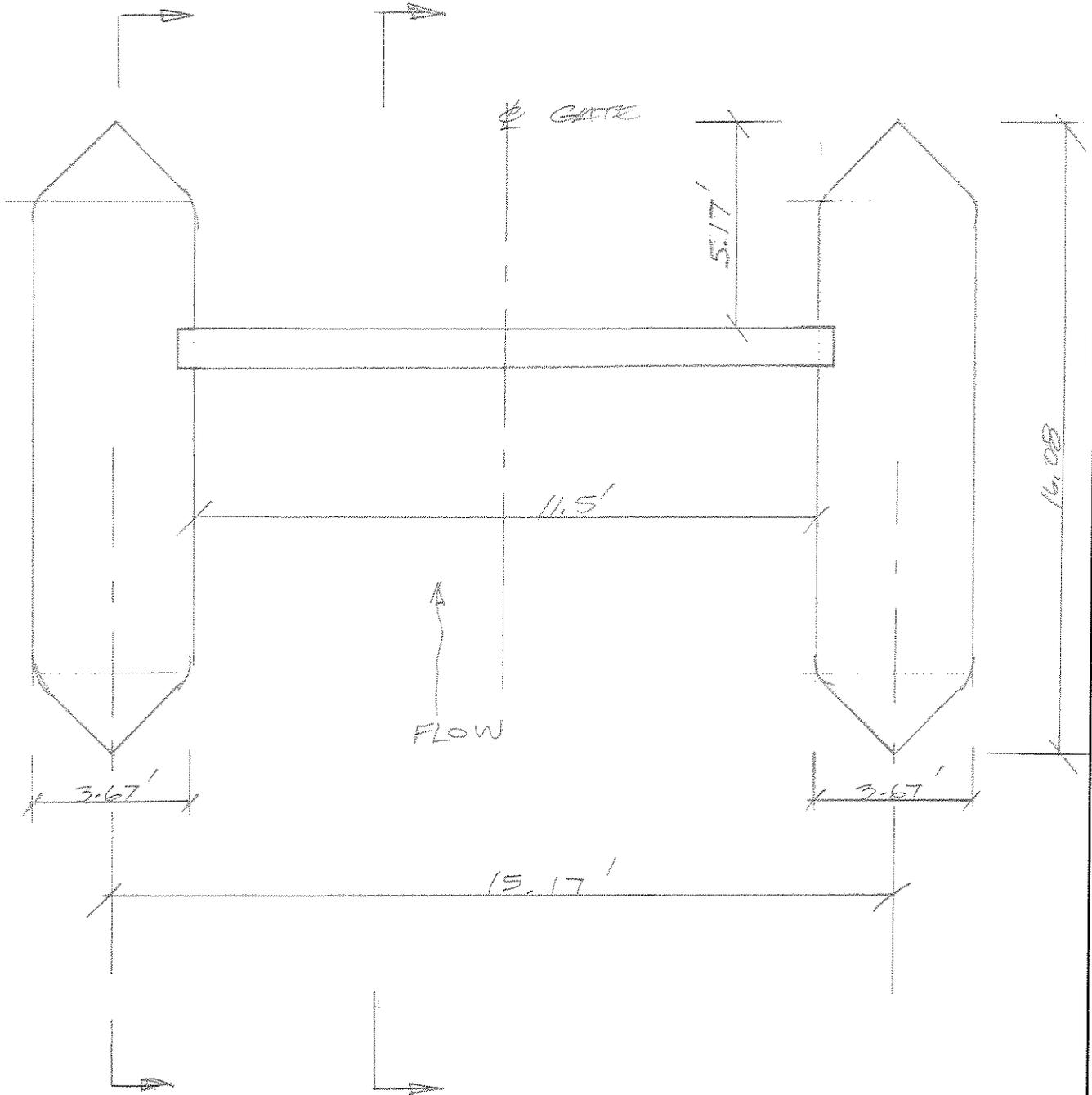
$$\% \text{ Base} = 3\%$$

**Outside of middle 1/2,  
therefore UNSTABLE**



STS Consultants Ltd.  
CALCULATION SHEET

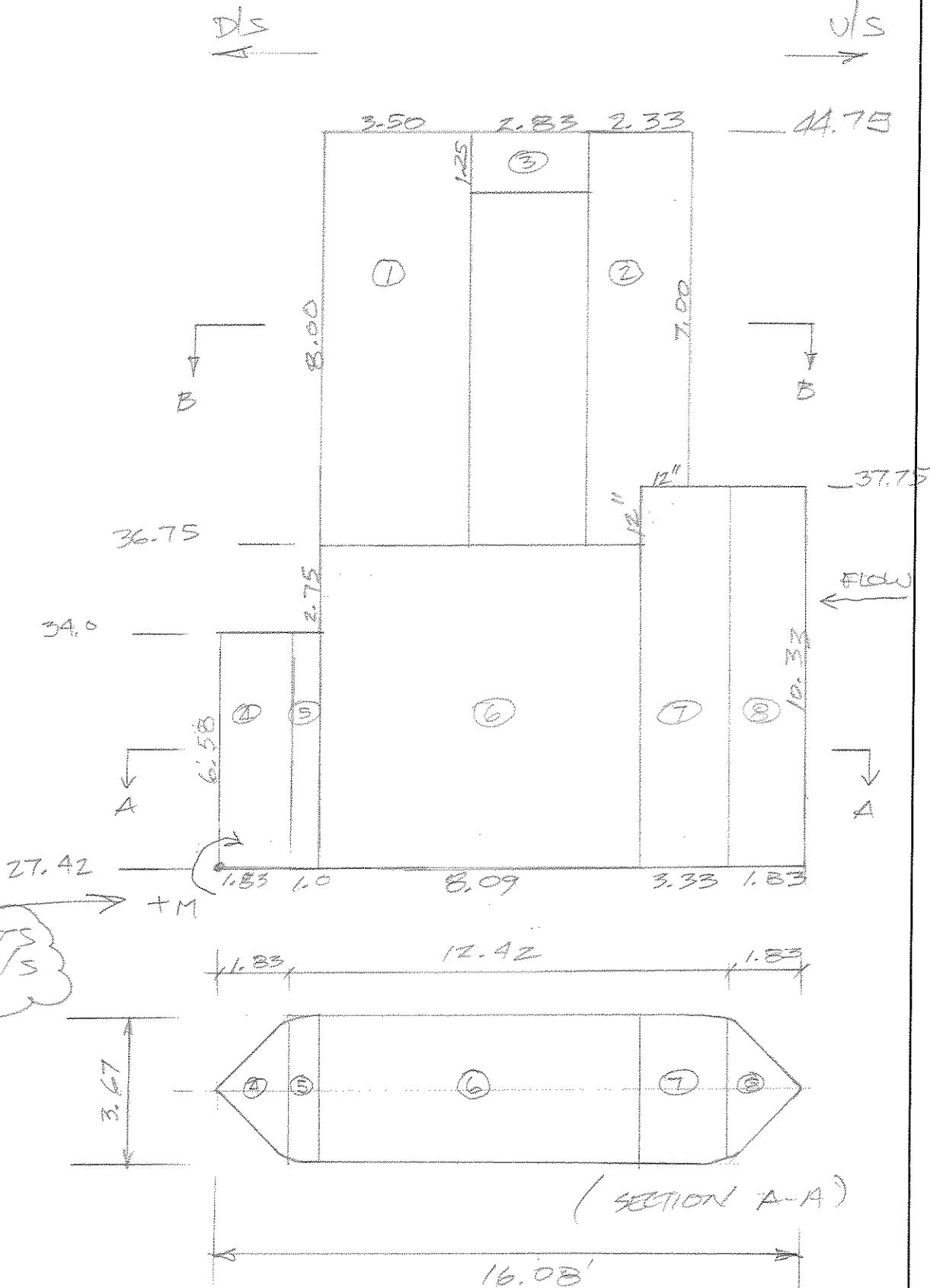
PROJECT <i>ESTABROOK DAM</i>				STS JOB NO. <i>587996</i>	
SUBJECT <i>LOWER SPILLWAY STABILITY</i>				SHEET NO. <i>4</i> OF <i>10</i>	
ORIGINATED BY <i>RJA</i>	DATE <i>7/14/06</i>	CHECKED BY	DATE	CALC. NO.	REV. NO.





STS Consultants Ltd.  
CALCULATION SHEET

PROJECT <i>ESTABLISH DAM</i>		STS JOB NO. <i>587996</i>	
SUBJECT <i>PIER GEOMETRY</i>		SHEET NO. <i>5</i> OF <i>10</i>	
ORIGINATED BY <i>RJA</i>	DATE <i>7/14/06</i>	CHECKED BY	DATE



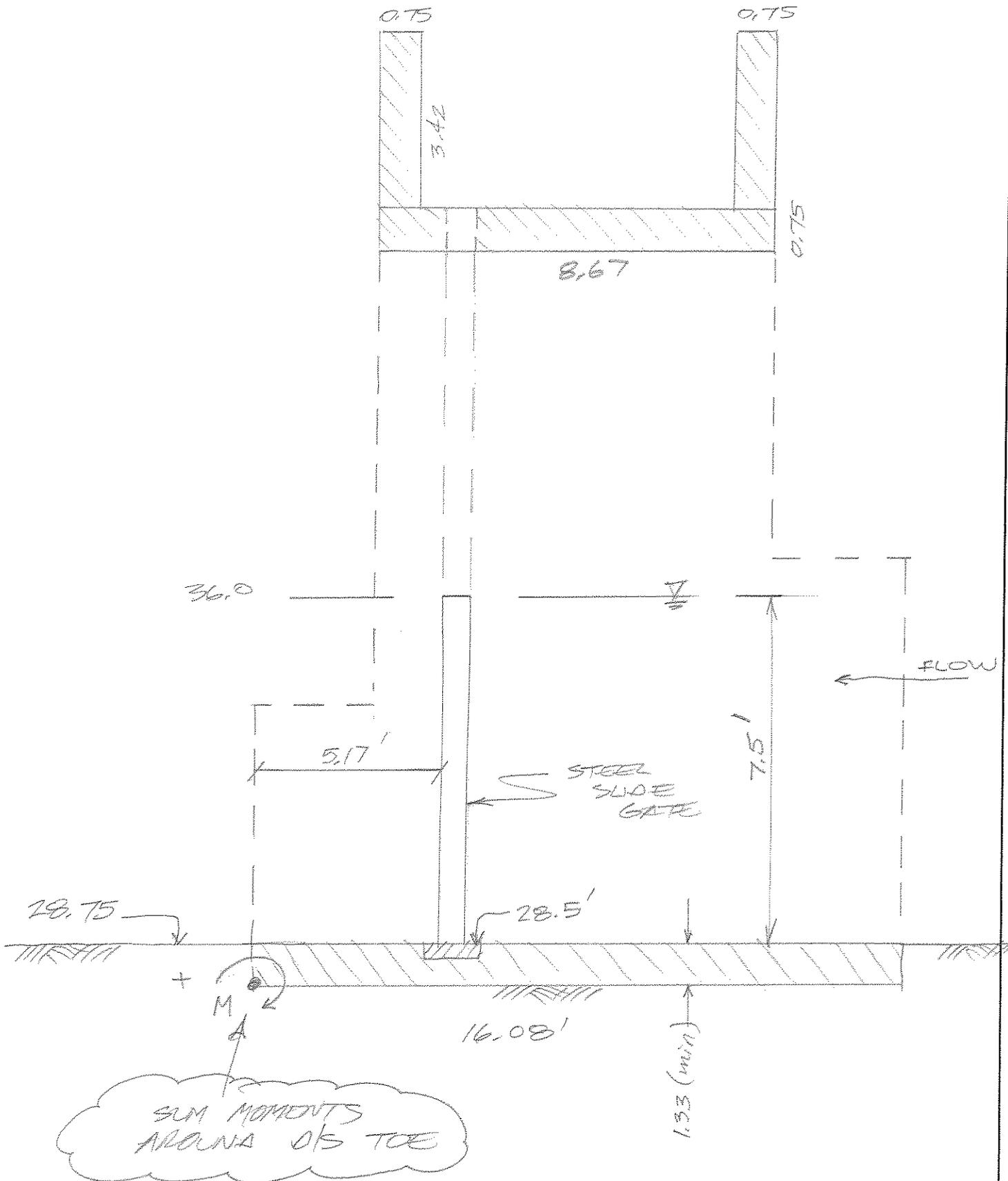
SUM MOMENTS  
AROUND D/S  
TOE

(SECTION A-A)



STS Consultants Ltd.  
CALCULATION SHEET

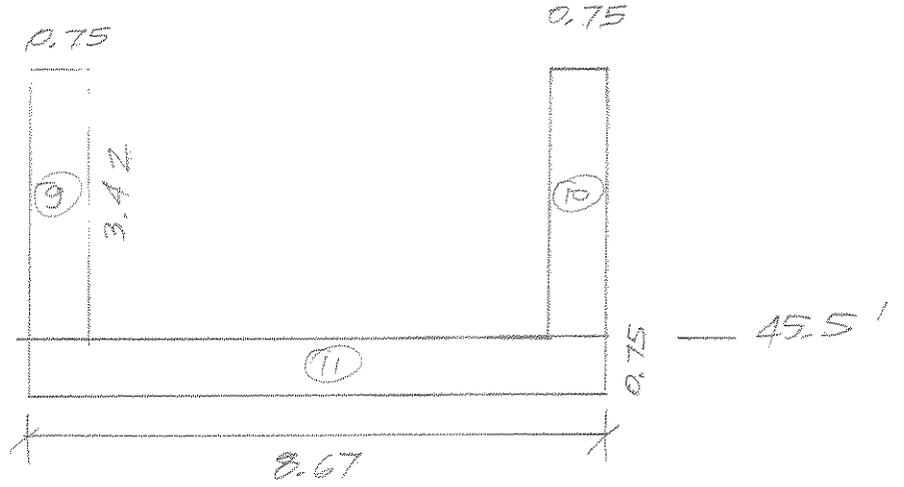
PROJECT <i>ESTABROOK DAM</i>		STS JOB NO. <i>587996</i>	
SUBJECT <i>GATE SECTION</i>		SHEET NO. <i>6</i> OF <i>10</i>	
ORIGINATED BY <i>AJA</i>	DATE <i>7/14/06</i>	CHECKED BY	DATE



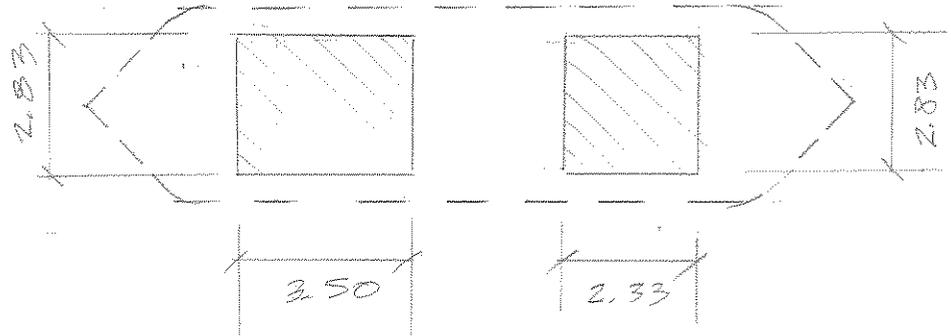


STS Consultants Ltd.  
CALCULATION SHEET

PROJECT <i>ESTABROOK DAM</i>		STS JOB NO. <i>587796</i>	
SUBJECT <i>WALKWAY &amp; PIER SECTIONS</i>		SHEET NO. <i>7</i> OF <i>10</i>	
ORIGINATED BY <i>RJA</i>	DATE <i>7/10/06</i>	CHECKED BY	DATE
CALC. NO.	REV. NO.		



(WALKWAY)



(SECTION B-B)



(SPILLWAY APRON  
BETWEEN PIERS)



STS Consultants Ltd.  
CALCULATION SHEET

PROJECT ESABROOK DAM		STS JOB NO. 587996	
SUBJECT GATED SPILLWAY STABILITY		SHEET NO. 8 OF 10	
ORIGINATED BY REA	DATE 7/14/06	CHECKED BY	DATE
		CALC. NO.	REV. NO.

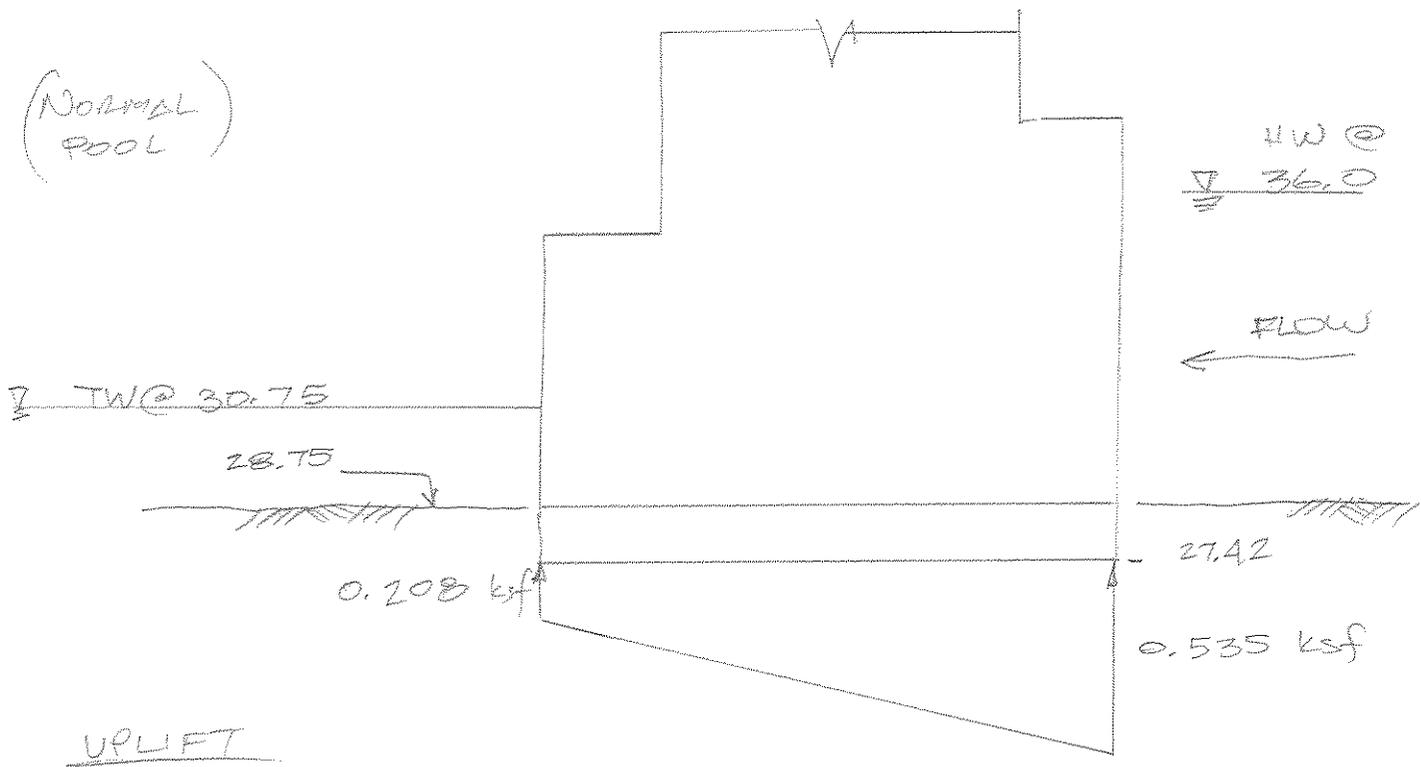
### CONCRETE WEIGHT

- ①  $0.15(8.0)3.5(2.83) = 11.886 \text{ K}$
- ②  $0.15[(7.0)2.33(2.83) + (1.0)1.33(2.83)] = 7.488 \text{ K}$
- ③  $0.15(2.83)1.25(2.83) = 1.502 \text{ K}$
- ④  $0.15(1/2)3.67(1.83)6.58 = 3.314 \text{ K}$
- ⑤  $0.15(1.0)3.67(6.58) = 3.622 \text{ K}$
- ⑥  $0.15(8.09)9.33(3.67) = 41.552 \text{ K}$
- ⑦  $0.15(10.33)3.33(3.67) = 18.937 \text{ K}$
- ⑧  $0.15(1/2)3.67(1.83)10.33 = 5.203 \text{ K}$
- ⑨  $0.15(0.75)3.42(15.17) = 5.837 \text{ K}$
- ⑩  $0.15(0.75)3.42(15.17) = 5.837 \text{ K}$
- ⑪  $0.15(0.75)8.67(15.17) = 14.796 \text{ K}$



STS Consultants Ltd.  
CALCULATION SHEET

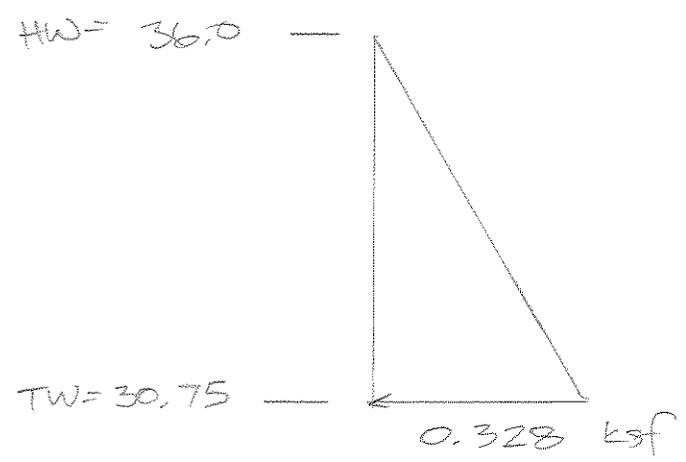
PROJECT ESTOPROCK DAM				STS JOB NO. 587996	
SUBJECT UPLIFT & HYDROSTATIC LOADS				SHEET NO. 9 OF 10	
ORIGINATED BY RJA	DATE 7/14/06	CHECKED BY	DATE	CALC. NO.	REV. NO.

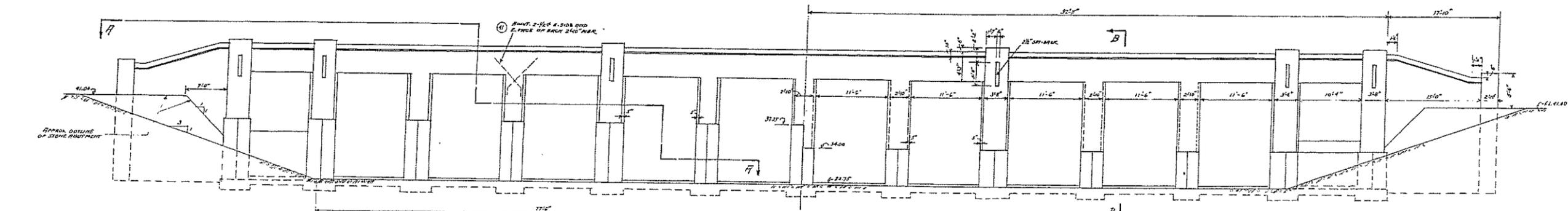


$$u_{u/s} = 0.0624(36.0 - 27.42) = 0.535 \text{ ksf}$$

$$u_{d/s} = 0.0624(30.75 - 27.42) = 0.208 \text{ ksf}$$

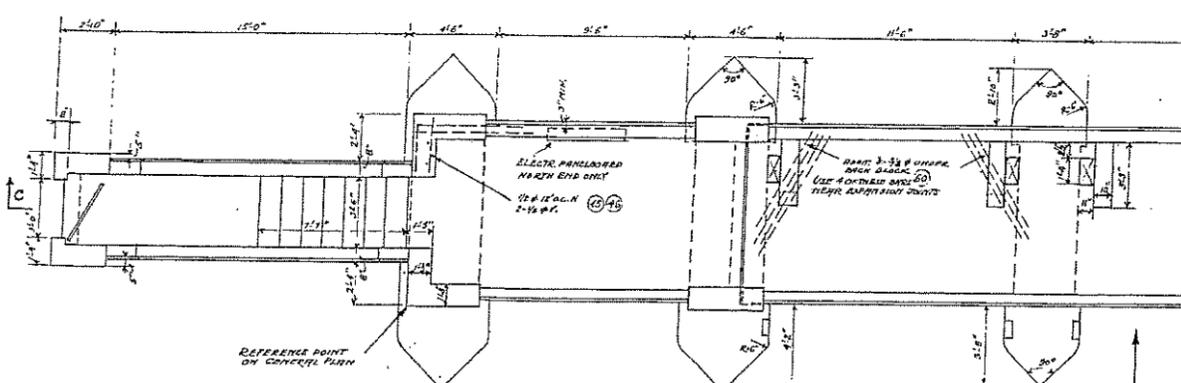
HYDROSTATIC LOADS



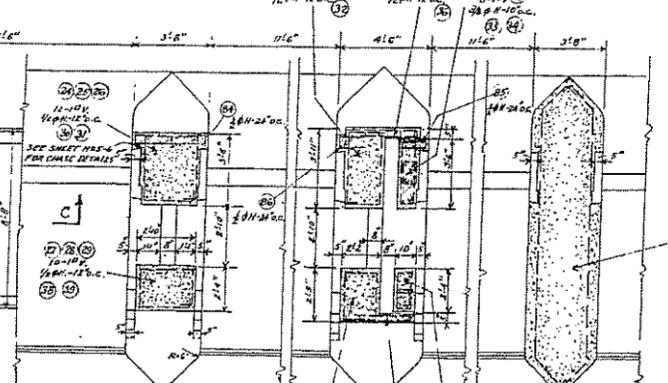


HALF UPSTREAM ELEVATION  
SCALE 1/8"=1'-0"

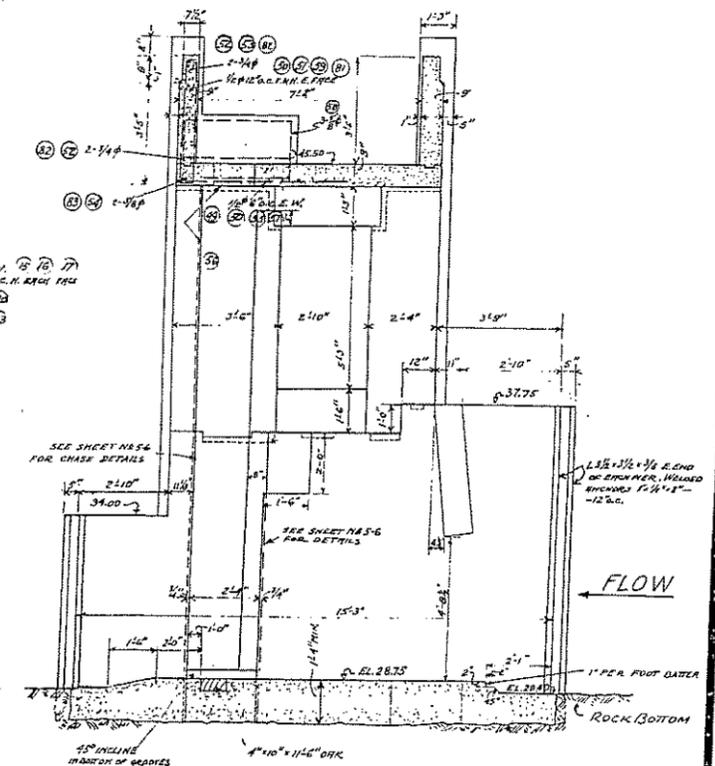
HALF DOWNSTREAM ELEVATION  
SCALE 1/8"=1'-0"



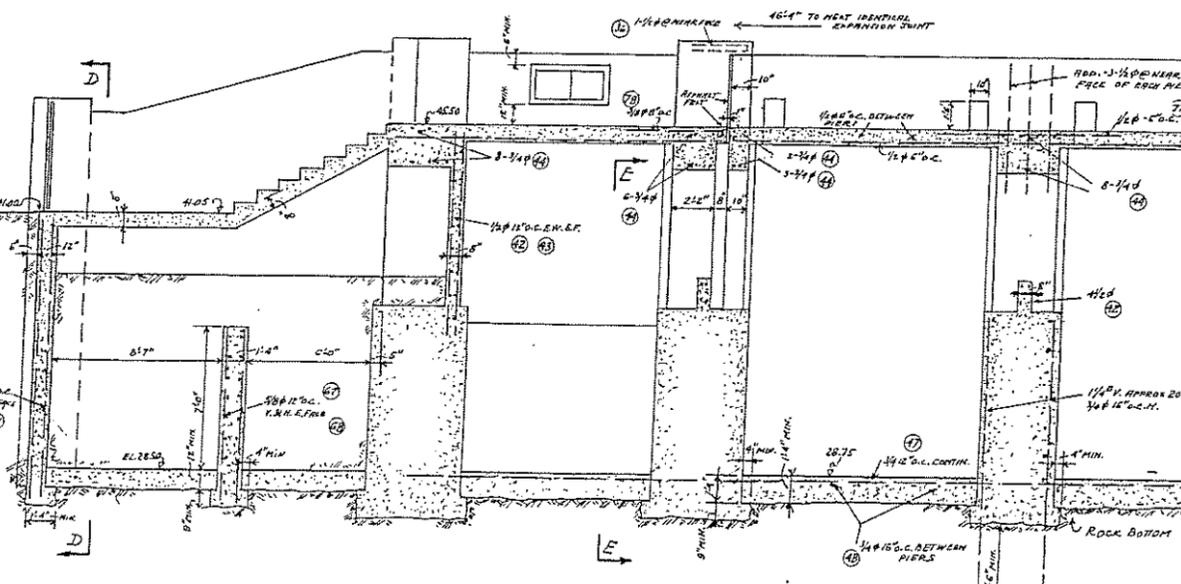
SECTION A-A  
SCALE 1/4"=1'-0"



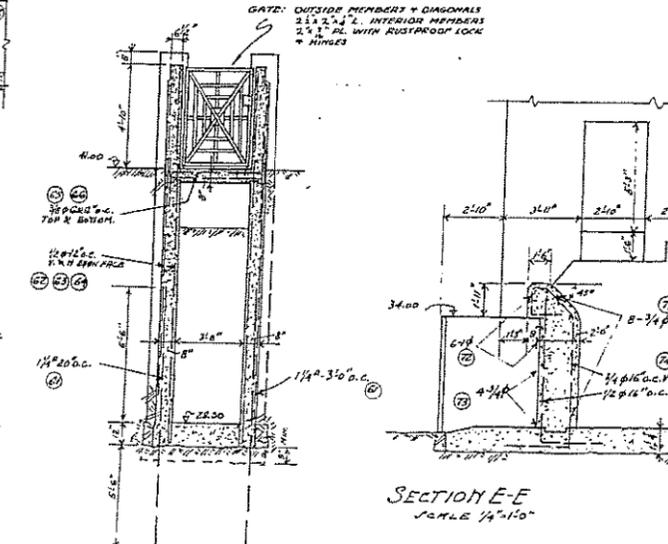
SECTION C-C  
SCALE 1/4"=1'-0"



SECTION B-B  
SCALE 3/8"=1'-0"



SECTION D-D  
SCALE 1/4"=1'-0"



SECTION E-E  
SCALE 1/4"=1'-0"

NOTE:

THE GATE SECTION OF THE DAM IS SYMMETRICAL ABOUT THE CENTER LINE, EXCEPT THE ELECTRIC PANELBOARD WHICH IS ON NORTH END ONLY.  
THE TOP CHUTES WITH HOISTS, GUIDES, ANCHOR BOLTS, SLEEVES ETC. ARE NOT SHOWN ON THIS DRAWING, BUT SHALL BE PROVIDED AS CALLED FOR ON SHEET 24-1.  
PROVIDE A 3/4" CHAMFER ON ALL SHARP CONCRETE EDGES EXCEPT STAIR TISINGS WHERE 1/2" CHAMFER SHALL BE PROVIDED.  
EXPANSION JOINTS AT RIGHT ANGLE TO THE LONGITUDINAL DIRECTION OF THE DAM SHALL BE FILLED WITH 1" SPERMAT FELT, BOUNDING BOLTERS AT THE EXPANSION JOINTS SHALL BE SPACED BY MEANS OF BUILDING PAPER.  
IN ABUTMENTS ALL VERTICAL WALLS SHALL BE POURED CONTINUOUS WITHOUT JOINTS UP TO EL. 38.00.

REINFORCING BARS ARE SHOWN MOSTLY IN TYPICAL LOCATIONS, BUT SHALL BE PROVIDED IN ALL SIMILAR LOCATIONS.  
VERTICAL BARS IN PIERS SHALL EXTEND TO 1/2" FROM THE TOP OF THE SLAB, EXCEPT THE BARS BELOW RAILINGS WHICH SHALL EXTEND UP TO 3" FROM THE TOP OF THE RAILING.  
PROVIDE 3-#10 @ 14" - 10" C.C. EACH WAY UNDER EACH HOIST IN TOP OF THE SLAG.

Designed by M. B. Coifman  
Consulting Engineer

MILWAUKEE COUNTY REGIONAL PLANNING DEPARTMENT

ESTABROOK PARK DAM  
CONCRETE DETAILS - GATE SECTION

LANDSCAPE DESIGN SECTION <u>Alfred Bauman</u> Landscape Architect	ENGINEERING DESIGN SECTION <u>Ray Behrens</u> Senior Ass't. Civil Engineer
Survey ..... Plan ..... Tracing ..... Checked .....	Approved: <u>Edmond</u> Date: <u>4/24/37</u> Supervising Engineer Approved: <u>W. J. ...</u> Date: <u>5/2/37</u> Highway Commissioner & Planning Engineer

Revised May 18, 1937.  
Revised May 19, 1937.  
Revised Sept. 29, 1937.  
Revised Nov. 30, 1937.

DEPARTMENT OF THE INTERIOR  
NATIONAL PARK SERVICE  
AND  
MILWAUKEE COUNTY PARK COMMISSION  
CO-OPERATING

BRANCH OF PLANNING	STATE PARK DIVISION
Prepared by <u>James ...</u> Milwaukee County Park Commission	SYMBOL NUMBER 130 DATE
Recommended: <u>W. J. ...</u> Date: <u>7/27</u> Inspector	S.P.-WIS. 9006-4-8 SCALES AS SHOWN
Approved: _____ Date: _____ Regional Office	

24X  
MICROFILMED

## APPENDIX G

Opinion of Probable Cost for Dam Repair



## Estabrook Park Dam

### Repair Option

July 21, 2006

#### Opinion of Probable Project Costs

Client: Milwaukee County DPW  
Address: 2711 West Wells St, Milwaukee, WI

Description	Units	Unit Cost	Quantity	Total Cost	Comments
1.00 General					
1.1 Mobilization / Demobilization	ls	\$25,000.00	1	\$25,000	segmental barge, small crane, incidental equipment
1.2 Erosion Control	ls	\$2,000.00	1	\$2,000	silt fence and turbidity barriers
1.3 Site Restoration	ls	\$2,500.00	1	\$2,500	repair pavements, grading, seeding and mulching
1.4 Diversion of water	ls	\$5,000.00	1	\$5,000	Porta-dam installation during pier repairs
2.00 Gated Spillway - Concrete Repairs					
2.01 Concrete surface repairs - abutments and stairs	sf	\$70.00	600	\$42,000	reconstruct stairs, complete abutment surface reconstruction
2.02 Concrete surface repairs - bridge deck and walls	sf	\$70.00	500	\$35,000	partial depth repair of deck, partial to full depth repair of walls, sawcut closed expansion joints and replace joint material
2.03 Pier reconstruction - below el. 37.75	sf	\$70.00	2800	\$196,000	complete surface reconstruction below el. 37.75', all 11 piers
2.04 Concrete surface repairs - pier above el. 37.75	sf	\$70.00	800	\$56,000	partial depth repair above el. 37.75 as needed, all 11 piers
3.00 Gated Spillway - Gate Repairs					
3.01 Prepare and paint slide gates	ea	\$2,500.00	10	\$25,000	sandblast, prime and paint all 10 slide gates in place
3.02 Misc. repairs to gates, guides and seals	ls	\$3,000.00	1	\$3,000	as needed based upon inspection after cleaning
4.00 Ice Breakers - Concrete Repairs					
4.01 Concrete surface repairs	ea	\$400.00	28	\$11,200	chip, install anchors, polymer modified concrete
5.00 Overflow Spillway					
5.01 New flashboards	ls	\$3,000.00	1	\$3,000	4"x8"x7'4" timber, includes all labor and materials to remove old flashboards and replace with new ones
5.02 Repair / replace bent supports	ls	\$4,000.00	1	\$4,000	assume 6 - 8 to be repaired
5.03 Concrete surface repairs	sf	\$70.00	500	\$35,000	chipping, anchors, and polymer modified concrete repair of crest
6.00 Slope Protection					
6.01 Riprap	cy	\$60.00	400	\$24,000	24" layer of riprap, left and right banks u/s and d/s of gated spillway
6.02 Geotextile	sy	\$2.25	1,400	\$3,150	
7.00 Debris Removal	ls	\$40,000.00	1	\$40,000	upstream of overflow spillway and ice breakers
8.00 Miscellaneous					
8.01 Repair / replace handrails, fences, gates, etc.	ls	\$3,000.00	1	\$3,000	

Construction Sub-Total:	\$514,850
Construction Contingency: 20%	\$102,970
Construction Estimate:	\$617,820

9.00 Engineering	
9.01 Engineering design	\$60,000
9.02 Resident engineering and contract administration	\$50,000
9.03 Prepare EAP and IOM plans	\$10,000
Engineering Subtotal:	\$120,000
Engineering Contingency: 15%	\$18,000
Engineering Estimate:	\$138,000

**Total Project Cost Estimate: \$755,820**

Information presented on this sheet represent our opinion of probable costs in 2006 dollars. Unit and lump-sum prices are based on costs for similar projects, engineering judgment, and/or published cost data. Actual bids and total project costs may vary based on contractor's perceived risk, site access, season, market conditions, etc. No warranties concerning the accuracy of costs presented herein are expressed or implied.