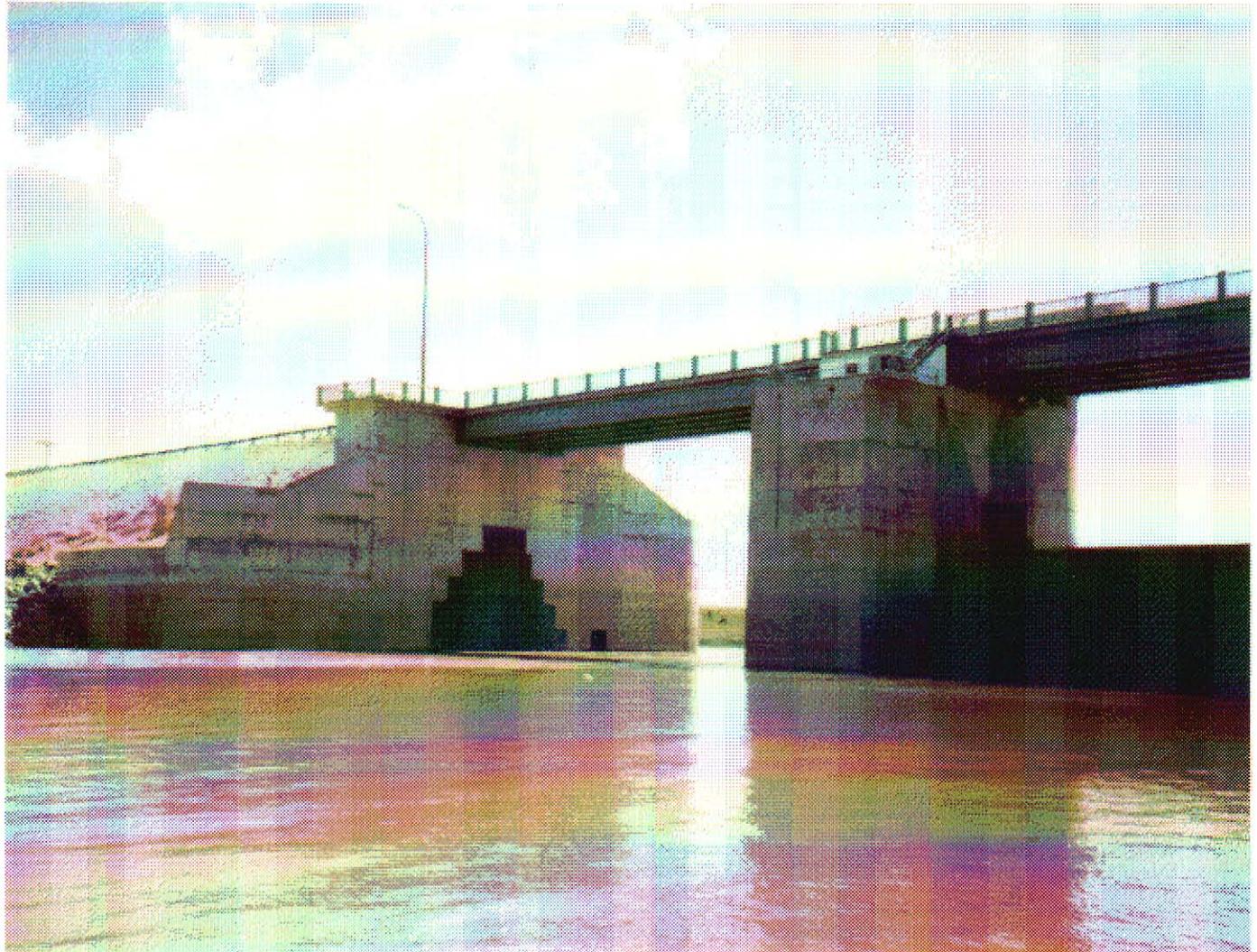




## RED RIVER FLOODWAY INLET CONTROL STRUCTURE INSPECTION AND ASSESSMENT REPORT



Submitted by:

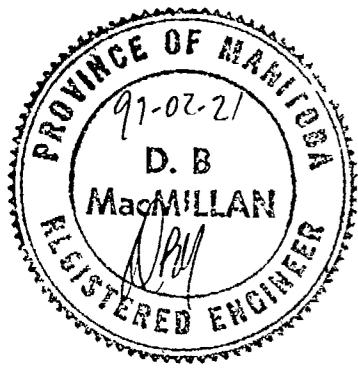
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**KONTZAMANIS . GRAUMANN . SMITH . MACMILLAN INC.**  
*CONSULTING ENGINEERS & PROJECT MANAGERS*

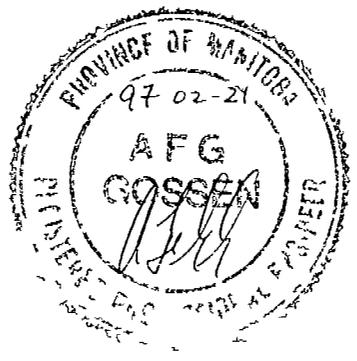
# MANITOBA NATURAL RESOURCES

## RED RIVER FLOODWAY INLET CONTROL STRUCTURE

### INSPECTION AND ASSESSMENT REPORT FEBRUARY, 1997



Civil and Structural



Mechanical



Electrical



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CONSULTING ENGINEERS & PROJECT MANAGERS

February 21, 1997

File No 96-311-01

Department of Natural Resources  
1577 Dublin Avenue  
Winnipeg, Manitoba  
R3E 3J5

ATTENTION Mr Frank Barlishen  
Head, Provincial Waterways

RE Floodway Inspection and Assessment Report

Dear Mr Barlishen

Please find enclosed three (3) copies of our final report on the Red River Floodway Inlet Control Structure Inspection and Assessment. The study concludes that, although the Floodway structural and mechanical systems are generally in good condition, a number of components of the Floodway Structure required upgrading, maintenance or rehabilitation to extend the life of the facility for another 30 years. Principally, the identified items are deteriorated sidewalk and roadway elements, hatches, access ladders and platforms, hydraulic piping, hoists, desilting of the gate recesses, electrical conduits, and gate controls.

The estimated cost of to complete the work is \$2,163,000 (1996 Dollars), and it is anticipated that the work will be completed over a period of two years. The work has been divided into two categories, namely surface works (\$914,000) which can be completed without cofferdams and work requiring a cofferdam to complete the work (\$1,249,000).

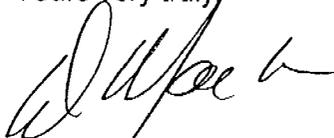
As a part of the overall work program, platforms and access ladders within the gate have been recommended to facilitate inspection and maintenance of the gate. It is likely that these new structures will in part be welded to the existing members. The gate is complex structure, in the manner in which forces are distributed and the fact that its skin plates are subject to biaxial stresses. As such, the structure can be detrimentally affected if appropriate welding and fastening procedures are not used to install the platforms and access ladders. In this regard, additional stresses incurred as a result of this work must be carefully assessed in the context of the overall structure integrity.

In addition to the components to be rehabilitated noted above, the main gate seals were installed as a part of the original gate system and are still considered an important element to maintain the overall performance of the gates. Due to economic constraints, the replacement or modification of the seals has not been included in the work program. It is, however, recommended that consideration be given to replacing them in the future, as dewatering of the gate for routine inspection and/or maintenance will have to be completed with the assistance of divers.

Page 2  
Mr Barlshen

Please contact the undersigned if you have any questions or comments

Yours very truly



David B. MacMillan, P Eng  
Principal

RSCB/ks

c \ File/EW/AG/RSCB

REPORTS #21C WGS\REPORTS\INLETCON RPT

**EXECUTIVE  
SUMMARY**

## EXECUTIVE SUMMARY

The Manitoba Department of Natural Resources operates the Floodway Inlet Structure located on the Red River immediately south of St. Norbert. The Inlet Structure is used to divert a portion of the Red River flow into the Floodway and around the City of Winnipeg during spring flood events. Operation of the Inlet Control Structure and the use of the Floodway allows the river levels and flows through Winnipeg to be controlled at levels below natural conditions. The Inlet Structure was first available for operation in 1969 and has been operated in approximately 60 percent of the years since that time. In February 1996, KGS Group was retained to conduct a detailed inspection and assessment of the Floodway Inlet Control Structure. As part of this comprehensive review, a program of work to repair, remediate and modernize the facility for a minimum projected life of thirty years was developed.

In March 1996, the east gate was dewatered and inspected. This work was done with the assistance of divers to seal the gate as the existing seals are no longer functioning. The remainder of the structure was inspected in July 1996. Operational testing of the gates was also conducted at this time. The results of the inspections are documented in Section 2.0 of the report, "Inspection Results". Section 3.0 of the report, "Assessment of Required Work Items", considers the assessment of the structure's condition and operation, and identifies recommended remedial work. Identification of deficiencies and potential upgrades are based on the interpretation of inspection results, safety requirements, conformance to present day codes or standards, and work required to extend the facility life an additional 30 years. In addition to the recommended work, Section 3.0 describes the development of preliminary designs and cost estimates. Section 4.0 develops a work program for the completion of repairs and upgrades.

The investigation, assessment and work program have been organized into three categories, namely civil and structural components, mechanical systems and electrical systems. The work identified in the Study has been prioritized into work required over the next two to three years, and work required in the long term.

In addition to the inspection work, KGS Group had identified a potential concern with extreme loading conditions for the radial gate at the proposal stage. On this basis, KGS Group were authorized to conduct a finite element analysis of the gate to assess the extreme load conditions.

The thirty year old Floodway Inlet Control Structure is in relatively good condition based on the results of the Study. The deficiencies of the Structure are primarily associated with the deterioration and corrosion of components, changes in maintenance methods, the need for ongoing maintenance and inspection as the facility ages, and some wear and damage associated with the operation of the Structure.

### ***Civil and Structural Components***

The proposed civil work principally consists of repairs required to ensure reliable operation, improvements to prevent further deterioration, routine maintenance, as well as improved or safer access throughout the Structure for maintenance and inspection. The emphasis on maintenance and inspection access will allow staff to keep abreast of the condition of the Structure and address issues before they become detrimental or costly. Consideration has also been given to increasing the safety of the Structure as a facility accessible by the public.

The inspection of the Structure found that support structures, access hatches, ladders, and platforms in several locations had deteriorated significantly due to the infiltration of salt laden water from the bridge structure. This deterioration was especially significant at the hydraulic cylinder hoist supports. The current capacity of this support structure is impacted by the deterioration and repairs are required to ensure that the anchor bolts can restrain the forces applied to the main gates through the hoists. This work should be addressed as soon as possible. The most significant civil costs are associated with the replacement of the main gate seals and repainting of the skinplates and liner plates which requires the installation of a cofferdam upstream and downstream of each gate. Due to high costs, repairs to the gate seals have been deferred indefinitely. As such, dewatering of the gates for maintenance will be by divers.

As it is necessary to maintain river flow only one gate can be completed at a time and, it will require a minimum of two seasons of construction to complete this work. In addition, a number of upgrades and repairs to the main gates and deck areas have been identified.

Several areas within the Structure are difficult to access for inspection and maintenance. Consequently their condition is either not known or the areas cannot be properly maintained. New access ladders and platforms are proposed for the gate interiors and for desilting and hydraulic cylinder maintenance within the cylinder pits. Additional work is also proposed to address the deterioration of sidewalk and service duct covers.

In addition to the repairs identified routine preventative maintenance, such as the repainting of the bridge girders and handrails, replacement of the Control Room roof and placement of new riprap on the dykes adjacent to the Structure is recommended.

Based upon the results of the finite element analysis of the radial gate it was concluded that

- The finite element model of the radial control gate reasonably predicts the overall behaviour of the gate structure.
- Steel gate stresses for normal and extreme load conditions were found to be within acceptable limits for structures of this type.
- For the condition of one hoist cylinder failed, the calculated reaction at the remaining lifting beam support exceeds the theoretical capacity of the lifting hoist. The consequence of this overload was assessed in the mechanical section of the report and it was concluded that a relief valve could be adjusted manually if and when this unlikely event occurs. This would remedy the concern by temporarily increasing the lower cylinder pressure.
- Maximum trunnion loads exceed the additional post tension force provided after the gate was installed. The implication of the over-stressed condition should be reviewed again when the trunnions are inspected.

### ***Mechanical Systems***

The proposed mechanical work focuses on upgrades, repairs and maintenance to the main gate and bulkhead gate hoisting systems, which are considered critical to the operation of the Structure. Deterioration of these systems has occurred mainly in the form of corrosion on piping and machinery in areas removed from the centre pier mechanical room. The hydraulic piping is corroded in certain areas and should be replaced immediately. A portion of this piping was in fact replaced in 1994 due to corrosion-related failure. Upgrading to stainless steel piping with a greater wall thickness is recommended. The hydraulic cylinders are in relatively good condition, but still require some preventive maintenance. This work can be performed without removing the cylinders from their positions, which would be a relatively large task. The hydraulic power units are in good condition and require only minor maintenance work. The bulkhead gate electric hoists have suffered a significant amount of corrosion and require complete overhaul or replacement to return them back to a reliable condition. One of the hoists is currently inoperable. The trashrack hoists should also be repaired or replaced, as they are both currently inoperable.

In addition to the gate hoisting systems, the proposed mechanical work addresses the need to remove a significant amount of silt which has accumulated in the gate recesses. Removal of the silt is necessary for proper maintenance and inspection of these areas. An arrangement of manpower equipped with washdown hoses and pumping equipment is presented as the most feasible alternative for this task, and since desilting will need to be performed repeatedly over time, upgrades to the Structure are proposed to facilitate the procedure.

Additional minor deficiencies in the mechanical services of the Structure have been addressed in the proposed mechanical work.

### ***Electrical Systems***

The proposed electrical work principally consists of repairs to the bulkhead gate guide heating, improved security of the control structure, repair/upgrade of the main gate position indication system, and the development of a new electrical distribution scheme to allow abandonment of the embedded conduit system to the end piers of the structure.

The main electrical switchgear located in the control room is in good condition and can be readily accessed for repair and maintenance as required. Accordingly, no remedial action is recommended.

### **Work Program**

The terms of reference for the rehabilitation and upgrading of the Structure is to extend the operational life of the facility for at least an additional 30 years. To maintain this life span it is recommended that the work be scheduled in such a manner as to minimize current construction costs. To do so, the proposed work has been categorized into work that is required over the next 2 to 3 years and work that can be scheduled for the longer term.

The total costs of all work proposed is \$2,163,000 over the next 2 to 3 years. Of this total \$1,249,000 will consider work that requires cofferdamming and/or gate dewatering. The remaining \$914,000 will involve surface work that does not require cofferdamming or dewatering. A breakdown of the work is detailed in the table below.

	<b>2 - 3 Year Work Program</b>	
	<b>Cofferdam/Gate Dewatering Required</b>	<b>Surface Work</b>
Civil and Structural Work	\$ 1,042,300	\$ 595,900
Mechanical Work	\$ 206,250	\$ 216,300
Electrical Work		\$ 102,300
<b>Totals</b>	<b>\$ 1,248,550</b>	<b>\$ 914,500</b>

A significant portion of the proposed work will be completed concurrently. This has been scheduled to reduce the mobilization and administration costs associated with the construction, and specifically to make the best utilization of the cofferdams which are required initially. If funding permits, the

majority of the work can be completed over the 1997 and 1998 fall and winter with a cofferdam at the east and west gate respectively. The remaining short term work can begin in the spring of 1998 and be completed later that year. Less critical work will be completed at intervals over the next ten to fifteen years to maintain the condition of the structure.

The cost estimates for all of the work are based on 1996 dollars and represent the total value of the work with no adjustments for present value associated with work completed in the future. The cost estimates have been based on preliminary designs and the anticipated sequence of work. The estimates include allowances for design, contract administration and contingencies.

### ***Conclusions and Recommendations***

Based upon the results of the Study it is concluded that the Floodway Inlet Control Structure is in relatively good condition for its age of 30 years. The principal deficiencies associated with the Structure are attributed to the corrosion and deterioration of components, changes in how the Structure is maintained, the need for ongoing maintenance and inspection, and finally some damage associated from normal operations. The desilting system has been inoperable for a number of years and it is recommended that a manual operation be utilized to remove accumulated silt.

The detailed inspection and assessment of the condition of the Structure indicates that a program of repairs, upgrades and maintenance to maintain its operation and reliability is required. Several deficiencies were found which require immediate attention to maintain the performance of the Structure. The repair of these components is recommended as soon as possible while the remaining deficiencies can be addressed over the subsequent years. The systematic work program of repairs and upgrades will provide reliable and safe operation of the Structure for at least an additional 30 years.

It is recommended that the Department of Natural Resources proceed with the work program as outlined in the report.

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**SECTION 1 0**  
**INTRODUCTION**

## 1 0 INTRODUCTION

The Manitoba Department of Natural Resources operates the Floodway Inlet Structure located on the Red River immediately south of St. Norbert. The inlet structure is used to divert a portion of the Red River flow into the Floodway and around the City of Winnipeg during spring flood events. Operation of the Inlet Structure and use of the Floodway allows river levels and flows through Winnipeg to be controlled at levels below natural conditions. The Inlet Structure was first available for operation in 1969 and has been operated in approximately 60 percent of the years since that time.

KGS Group was retained to conduct an inspection and assessment of the Floodway Inlet Structure. As part of this comprehensive review, a program of work to repair, remediate, or modernize the facility for a minimum projected life of thirty years is to be developed.

The first phase of the inspection program included a review of existing reports (see references) and an inspection of the existing gate. The inspection was performed on the dewatered east gate in March of 1996 (KGS Group, Red River Floodway Inlet Structure, Dewatered East Gate Inspection Report, May 1996). This report is included in Appendix D. The second phase of the program presents the findings from inspections and operational testing of the Floodway Inlet Structure conducted during the month of July 1996. The inspections during this period considered portions of the structure not included in the dewatered gate inspection and are summarized in Section 2.0 of the report. Section 3.0 describes the assessment of the adequacy of existing structures and operating systems based on the interpretation of inspection results, safety, conformance to present day codes or standards, and works required to achieve a projected life extension of the facility of thirty years. Preliminary engineering designs and cost estimates are also presented. The recommended work program is presented in Section 4.0. Conclusions and recommendations for implementation are given in Section 5.0.

**SECTION 2 0**  
**INSPECTION**  
**RESULTS**

## **2 0 PART I - INSPECTION**

The Floodway Inlet Control Structure was inspected in two stages. Initially, in March 1996, the interior of the main gates were inspected by dewatering their interior. In addition, divers provided a report on their findings of the main gate seals. In July 1996, a detailed inspection of the structure above water level was conducted. This included raising each of the main gates, inspecting and testing all mechanical and electrical systems.

### **2 1 STRUCTURAL AND CIVIL COMPONENTS**

The Red River Floodway Inlet Control Structure consists of two in channel hydraulically operated gate, associated concrete pier and abutments, and a steel girder bridge. For the purposes of the inspection, the Structure was broken down into the following sections:

- roadway bridge and its associated components
- central pier including the Control Centre and Machine Room
- abutments including bulkhead gates and trashracks
- main gates including seals
- adjacent earthfill dams

In addition, a review of the aspects associated with the safety and security of public users, the security of the facility, and the dewatering methods used in the past have been discussed. Figures 1 and 2 show the location of each of these components.

#### **2 1 1 Roadway Bridge**

The bridge over the Red River consists of two steel girder spans. Each span is simply supported with fixed rocker bearings at the center pier, and roller bearings at each abutment. There are five steel girders per span, braced with steel diaphragms. The girders support a concrete deck with an integral sidewalk and service duct. The bridge deck is two lanes wide, with a sidewalk along each curb.

The inspection of the bridge consisted of a visual inspection of all accessible components without the use of a bridge inspection vehicle or suspended platforms. All inspections were conducted from the bridge deck, abutments, or the Machine Room.

### ***Bearing Seats***

The bridge structure and bearings are supported by the two abutments and central pier. At each end of each span, a shelf or recess has been cast in the concrete to permit the bearings to rest on the pier or abutment walls.

A visual inspection of the concrete below the bearings adjacent to the Machine Room windows indicate some hairline cracking slightly behind and below the bearings. A detailed inspection of all the central pier bearing seats was not possible due to the limited access to the bearing shelf.

The concrete forming the central pier bearing seats appeared to be in good condition and without visible deterioration. Some accumulation of pigeon nests and debris was present.

The bearing seats at the abutments were not inspected as there was no readily available access.

### **2 1 1 1      Bearings**

The bridge structure is supported on fixed bearings at the central pier, while the differential movement of the abutments and pier is accommodated by a rocker bearing capable of horizontal and rotational displacement. The bearing assemblies at the central pier can accommodate rotational movement of the girder end.

The central pier bearings were inspected visually from the Machine Room windows, while the rocker bearings were not accessible. The central pier bearing appeared in good condition with only superficial coating failure and some rusting. There was no evidence of movement at the bearing, which is expected as the degree of bearing rotation is very small.

## **2 1 1 2      Girders**

The bridge girders were inspected visually from the Machine Room windows. The protective coating appears in good condition with no visible failures. The girders appear to have experienced no corrosion nor distress.

## **2 1 1 3      Roadway Deck**

The bridge roadway deck is a layered pavement system with the original concrete slab cast integral to the girders. The upper coarse is a high density concrete pavement layer. The high density topping course has a regular network of cracks across it. There is no staining from rust or pop outs visible. The cracks are typically less than 0.5 millimeters wide.

## **2 1 1 4      Sidewalk**

The sidewalk on the bridge is of the original concrete construction. At the curb level and at the top surface, numerous pop outs were observed. Most coincided with insufficient concrete cover on reinforcing steel as shown in Photograph No. 1. In many cases the concrete cover on the reinforcing was less than 12 mm. Original drawings indicate 20 mm of concreted cover was specified. The penetration of salts and moisture to the reinforcing steel causes localized corrosion which leads to cracking and pop outs as the corrosion products are volumetrically larger than the original steel. The exposed steel showed no signs of epoxy coating or galvanizing. The exposure of the reinforcing steel has caused some minor corrosion of reinforcing steel in the curbs and sidewalk.

## **2 1 1 5      Service Duct**

The interior of the service duct was not accessible as the duct covers have been sealed in place. To prevent infiltration of water from the service duct to the Machine Room, the service duct cover slabs have been sealed in place with a urethane sealant. In general, this sealant appears in good condition. The concrete duct covers have significant surface deterioration caused by pop outs and corrosion of reinforcing steel as illustrated in Photograph No. 2. Again, the cause appears to be insufficient cover on reinforcing steel. The exposed steel is slightly rusted and in some locations the bond to the concrete has been lost completely. The covers are not at a stage of significant

deterioration although visibly rust stained. At one cover, an earlier attempt to seal the reinforcing steel with a clear epoxy sealant proved ineffective. The corrosion of reinforcing steel continued below the plastic sealant, ultimately lifting the sealant off the concrete. The service duct covers have lifting loops which are filled with sand and grit. The lifting loops are generally in good condition.

#### **2 1 1 6          Handrails & Barrier Rails**

Handrails and barrier rails are generally in good condition, with approximately 10% of the surface having some rust. The protective coating appears to have functioned well, although its present age is unknown. The steel components are generally in good to very good condition with almost no corrosion losses. Several barrier posts have distressed bases. The corrosion of post anchors has resulted in the edge of the sidewalk slab cracking outwards. This is shown in Photograph No. 3. Although the barrier post appears rigid, its structural integrity with the sidewalk deck may have been lost.

#### **2 1 1 7          Lighting**

The original light standards on the bridge have been removed. In their place, two street luminaires have been installed at the downstream parking areas. At the time of inspection, the lens and bulb from one fixture had been smashed, apparently through the use of a gun. Consequently, only one light fixture was operational. Additional light fixtures on the bridge are for local lighting of doorways and have no influence on lighting of the roadway.

#### **2 1 1 8          Drainage**

The bridge deck is crowned with a slope towards both curblines and a very slight slope towards each abutment. Drainage from the sidewalks and deck occurs through the original deck drains which in turn spill directly into the river below. At the time of inspection, there was no evidence of ponding although it had just rained.

## **2 1 1 9      Expansion Joints**

The bridge deck expansion joints were reconstructed when the bridge deck was rehabilitated. At the time of inspection, the seals were grit and sand filled. A section of each seal was cleaned and inspected. Generally, the self-cleaning seal arrangement appeared to be functioning properly and in good condition.

At the downstream end of the east abutment expansion joint, a crack extends from the joint to the adjacent corner. This appeared to be caused by binding of the seal applying excessive force to the concrete. Across the roadway, the expansion joint at the central pier appeared to be functioning properly, as there was no evidence of leakage or corrosion on the underside of the deck at the bearing seats. At the curb level, an attempt to repair the joint using large amounts of caulking was noted.

At the sidewalk and curb levels, several of the expansion joints showed signs of distress, and repeated attempts to properly seal the joint using large amounts of caulking. At the west side expansion joint above the central pier, a section of concrete has spalled away from the curb at the joint, which has been caulked extensively in an attempt to repair the deterioration, as shown in Photograph No. 4.

Also, at several locations where expansion joints crossed sidewalks at the abutments, the cover plates had been lost, and the resulting exposed joint had been sealed with urethane caulking. Attempts to remediate the poor performance of expansion joints at curbs and transitions with large amounts of caulking have had limited success.

## **2 1 1 10      Conduit Access**

At the time of the inspections, the access hatches at each abutment had been sealed by fillet welding the hatch cover to the frame. The original arrangement was to fasten the hatch to the frame with countersunk screws. Weldments were used to prevent unauthorized access to the rocker bearings. In general, the hatches and frames were moderately rusted, although no pitting was noted. The protective coating had completely failed, and the hatch and frame were subject to weathering. The condition of the hatch interiors and interior frame components was not accessed.

## **2 1 2 Central Pier**

The Central Pier of the Floodway Inlet Control Structure consists of a hollow concrete pier which supports the bridge spans and the Control Centre (shown in Figures 1 and 2). Just below the bridge deck, the central pier contains the Machine Room, which houses all the controls and pump machinery for the Structure. At the downstream face of the Central Pier, an observation platform extends from the rear of the Machine Room. Below the observation platform and Machine Room are three vertical shafts. Two of the shafts are for the main gate hydraulic cylinders and for access into the main gates. The other shaft acts as a sump pit and contains pumps and other equipment.

### **2 1 2 1 Control Centre**

The Control Room roof is constructed using a 4 ply bituminous built up roofing with a protective aggregate covering. The roof did not show evidence of leaks based on the lack of stains or marks on interior ceilings. Inspection of the roof showed it to be in good condition with some loss of aggregate cover due to wind action along the north roof edge. The flashings all appeared in good condition and are securely fixed to the underlying concrete.

Roof penetrations consisted of a plumbing stack vent and what appeared to be the vent cover for the bathroom ventilation fan. The penetrations appeared in good condition and only the plumbing stack vent had a minor amount of corrosion.

The interior finishes in the Control Room appeared in good condition with no noticeable defects. The infill panels used to replace windows were also in good condition. All the windows in the Control Room were intact and uncracked. The operable windows were also in good condition. The expanded metal mesh used to protect the remaining windows had a small amount of rust staining suggesting the onset of coating failure.

The floor also appeared in good condition with all ceramic tile in good condition and firmly bonded to the concrete floor. Above the Control Room door, a diagonal crack originated at the east upper corner and extended up to the ceiling. The crack had been painted over and did not appear active.

The exterior of the Control Centre facing the river appeared in good condition with no obvious deterioration or damage. The rear exterior wall facing the roadway has been graffitied repeatedly and subsequently repainted to cover the vandalism. This is shown on Photograph No 5 where graffiti lies overtop the recently repainted wall. Operating staff indicate that this is an ongoing problem occurring on all parts which can be reached by arm's length.

Despite the vandalism of the building exterior it appeared in good condition. The concrete walls were essentially uncracked and showed no deterioration.

The exterior door to the Control Centre has been the subject of repeated vandalism and has been repaired and upgraded several times. At the time of the inspection the deadbolt lock and handset had been damaged using a rock as a instrument in an attempt to break the locks open. The deadbolt was undamaged however the handset had been bent out of place.

The condition and performance of washroom and water supplies are discussed in Section 2.2.6.3.

## **2.1.2.2 Machine Room**

The interior finishes of the Machine Room appeared in good condition. Some cracking in the concrete walls adjacent to the windows was noticed although this does not appear to have been the result of local deterioration or structural movements.

The ceiling of the machine room was insulated with rigid closed cell foam insulation fastened with mechanical fasteners. Originally the ceiling was uninsulated. The foam insulation is not in conformance to the current building code requirements which require plastic foam products to be protected from open flames by a suitable flame spread barrier such as drywall.

The ceiling adjacent to the Machine Room roof hatch was stained with rust and at the time of the inspection water was dripping from the ceiling and hatch. The condition of the hatch is discussed below in Section 2.1.2.7.

The lifting loops installed in the roof slab above the machine room consist of 20 mm (0 75 ) diameter reinforcing steel bend into a loop approximately 150 mm (6 ) in diameter. The steel appeared to be in good condition. The condition of the steel and concrete above the foam insulation could not be assessed as the foam was mechanically fastened to the concrete and was not removed.

### **2 1 2 3      Cylinder Pits**

Both cylinder pits were inspected visually. The condition of the ladders and platforms are discussed below. The concrete was inspected visually and appeared in good condition. Several construction joints had opened slightly with some secondary cracking. Some accumulation of calcite at construction joints at lower levels within the cylinder pit was observed.

Some spalling of the concrete adjacent to a vertical construction joint was identified. The concrete walls appeared in good condition with no cracking apparent.

### **2 1 2 4      Sump Pit**

The ladders and platforms are discussed below. As with the cylinder pits, several horizontal construction joints were open slightly and had buildup of calcite below the joint. No cracking was noted. Photograph No. 6 illustrates a construction joint within the sump pit which has significant buildup of calcite from the leaching of carbonates in solution along the joint.

### **2 1 2 5      Downstream Observation Platform**

The original use of this platform area on the downstream face of the pier was for access to cylinder pits by operating staff and observation of river flow behind the Control Structure. Presently, the platform gate is left open during operation of the Floodway to allow the public to use the platform for watching the river flow over the gates. Figure 2 shows the location of this downstream platform.

The deck consists of a series of precast concrete panels equipped with recessed lifting lugs. Many of these recesses are filled with grit and dirt and do not drain freely as intended. The floor panel joints are unsealed, which results in runoff from the platform passing through the joint to the pier interior. This appears to be the cause of the corrosion of embedded steel members.

The concrete slabs and deck are in good condition with only some minor cracking at curbs. The handrail and stairs to the platform are discussed in Section 2.1.6.2.

#### **2.1.2.6 Roadway**

The roadway above the central pier is discussed as part of the discussion on the condition of the bridge deck.

#### **2.1.2.7 Hatches**

The hatches on the central pier consist of a frame with a drainage trough embedded into the concrete. A hinged checker plate hatch with welded channel stiffeners on the underside of the plate makes up the rest of the hatch. The hatches are locked with padlock loops mounted on one side of the hatch. The hatches over the cylinder shafts are a two piece design. The drainage trough around the frame drains directly through the slab. At the time of inspection, the hatch cover plates were moderately corroded, with more serious corrosion on the interior members. The drainage troughs were partially filled with dirt and grit, and were also seriously corroded.

The hatch above the Machine Room appears to have been permanently sealed. It presently shows significant corrosion and leakage. At the time of the inspection, water was dripping from the framing of the hatch and the machine room ceiling adjacent to the hatch, as shown in Photograph No. 7. Inspection of the hatch from the roadway indicates that it is not properly sealed, and is significantly corroded. It was not possible to open the hatch and inspect the condition of the frame. The interior face of the hatch had been covered over by a sheet of plate suspended in place by a bolted in frame. This interior plate and support frame were in good condition, with very little rust staining.

#### **2.1.2.8 Platforms and Ladders**

The original protective coating on handrails and platforms has failed in most locations, and most metal components are corroded to some extent. Photograph No. 8 illustrates the extent of the corrosion. This included embedded components and anchors. All platforms and ladders are shown on Figures 1 and 2.

The condition of ladders and interior platforms in the cylinder and sump pits vary significantly depending on elevation. The platforms and ladders near the top of the pits are generally in good condition with only moderate corrosion of some components. Platforms at lower levels are seriously corroded and several have reached an unsafe condition as shown on Photograph No. 9. Photograph No. 10 shows the underside of a bar grating platform which has corroded significantly and subsequently failed when operating staff stepped down onto it. The platform has been temporarily repaired by placing a sheet of plywood over the platform.

The ladders do not extend to the underside of the hatch covers which makes ingress and egress from the ladders awkward. The relative position of the ladders near the center of the hatches also increases the potential for fall or injury.

The arrangement and spacing of ladders, cages, handrails, and platforms appears adequate for fall protection and for ease of access. Several areas within the cylinder pits and sump pit were not accessible as there are no platforms. Access to the hydraulic cylinder piping is accomplished by placing planks from the adjacent platform to the top of the guide slot. Maintenance and inspection must then be done off these planks. As a result, close and regular inspection is not normally done.

### **2.1.3 Abutments**

Both earthfill embankments on either side of the Structure are retained by the Abutments. An upstream and downstream retaining wall contain the earthfill embankments and protect them from erosion. Each abutment also supports one end of a bridge span. At the top of each abutment, two parking spots exist for operating staff and to allow access through hatches to equipment within the Abutments. Within the abutments are the bulkhead gates, trashracks, and main gate hydraulic cylinders. The interior of the Abutments consist of a series of interconnected chambers for access and equipment operation.

#### **2.1.3.1 Bulkhead Gates**

The bulkhead gates allow the control of water inflow into the main gate interiors. During operation of the main gates, upstream water is allowed to enter the gate interior to reduce hydraulic forces on the gate. The bulkhead gates are closed and sealed to permit dewatering of the gate interiors.

A temporary plywood seal has been used by Operators for additional sealing of the inlet opening. This may be the consequence of an accumulation of debris or silt on the sill beam or within the gate guide.

At the time of inspection, only the west gate could be raised sufficiently to be inspected in detail. The gate was in very good condition overall. The coating system had failed in only a few locations, with only light rust on the metal. The skinplate did not appear pitted or damaged. The seals were in good condition, with only some minor permanent deformation on the seal bulb. These deformations appeared to be less than 1 mm (0.04") deep. No lower sill seal was visible. A review of available drawings indicates there is no lower seal.

The gate interior was filled with accumulations of silt. It appeared to have been in place for a long period and has almost completely filled the space between beams.

All the gate rollers appeared to be seized in position, based on the accumulation of silt on the top surface and some indications that flat spots had been worn into the roller (Photograph No. 11). It was not possible to rotate the rollers manually. A review of available drawings indicates that the bearings are a self-lubricating bearing.

A flat spot had been worn in the bolt heads along the seal bars on the north edge of the gate. This appeared to be ongoing wear from the gate rubbing against the guide as it was raised and lowered. The wear appeared to have removed the stamp marks off the bolt head and worn 1 to 2 mm (0.04" to 0.08") of metal off.

### **2.1.3.2 Bulkhead Gate Guides**

Direct inspection of the gate guides was not possible. The guides appeared in good condition, with no indication of significant corrosion or wear. It may be implied from the wear on the seal bar bolts that a corresponding amount of wear may have occurred in the gate guides.

### **2 1 3 3      Trashracks**

A removable trashrack is upstream of the bulkhead gate to prevent the inflow of large objects into the gate interior. The trashrack consists of a steel frame with vertical bars forming a grating. The trashracks are installed in a slot to allow removal using a chain hoist.

During the March 1996 inspection, the trashrack was briefly inspected visually from outside the abutment. It appeared in good condition and undamaged.

During the July 1996 inspection, the trashracks were not inspected as the chain hoists were not functioning correctly, and it was considered unsafe to attempt to raise the trashracks without properly functioning hoists.

### **2 1 3 4      Trashrack Guides**

Direct inspection of the trashrack guides was not possible. The guides appeared in good condition with no indication of significant corrosion or wear.

### **2 1 3 5      Cylinder Pits**

The cylinder pits are shown in Figure 2. Photograph No. 12 illustrates the general state of corrosion of the anchors on the abutment cylinder supporting bridges. The head frame on the east abutment cylinder had one anchor clearly failed due to corrosion, while the other visible anchor was suspect due to the extensive corrosion.

### **2 1 3 6      Hatches**

The hatches on both abutments appeared to be very corroded and in poor condition. The use of deicing salts on the roadway and over the parking areas has resulted in more corrosion of embedded components and hatch components than at the central pier. Inspection of the hatch at the southeast parking area showed that the internal hatch members had been seriously corroded, cleaned, and repainted. Several members were very thin and had complete penetrations due to corrosion.

### **2 1 3 7          Ladders and Platforms**

The upper ladder and platforms in both abutments were moderately corroded. This appeared to be caused by the use of deicing salts on the parking areas and roadway above. The runoff then accumulated around hatches and drained into the abutments.

The conditions were similar to other ladders and platforms which vary with elevation. Several lower platforms had loose bearing bars and were in poor condition. It was noted that large pieces of rust were breaking off the platforms as they were being walked on by inspectors. For example, the bearing bars on one platform deformed permanently under the weight of one person. This was immediately identified to operating staff as a safety risk.

### **2 1 3 8          Upstream Retaining Walls**

The upstream retaining walls were inspected visually on those portions that were accessible without a boat. Photograph No. 13 illustrates a tension crack at the radius in the upstream retaining wall. The crack has uniform width through the thickness of the wall. The crack appears to extend down for several feet from the top of the wall. It was not possible to determine how far the crack extended down. This crack appeared on both upstream retaining walls at the same location.

### **2 1 3 9          Structural Concrete**

The concrete appeared in generally good condition with some cracks and isolated spalling. A significant area of concrete spalled off the outside face of the east abutment above the bulkhead gate inlet. The spall is estimated at being 75 mm (3 ) deep, 400 mm (16 ) wide, and 400 mm (16 ) high. In addition, a smaller area had spalled away below the above area.

On the north face of the west abutment, a construction joint has opened up to approximately 20 mm (0.8 ) in width. This does not appear to be caused by structural movement, but rather by the deterioration of soft or improperly placed concrete.

A vertical crack was visible on the downstream portion of the abutment walls where the top surface of the wall becomes horizontal. This crack is not uniform, but does appear to start at the top of the

wall and go vertically to the water surface. The crack appears at approximately the same location on both abutments. Photograph No. 14 shows this crack on the west abutment.

### **2 1 3 10      Parking Areas**

Four parking areas exist over the abutments and are large enough for one vehicle at a time. Generally, the southeast parking spots are used by Operating Staff during the operation of the Control Structure. They are also used regularly by the public. The condition of the deck and curbs are similar to the condition of the curbs and deck on the bridge. Although drainage pipes have been installed at the curbline, it appears that all drainage enters the abutments through access slabs and hatches.

The corrosion of reinforcing steel along the curbs and sidewalk has resulted in pop outs and staining of the concrete, similar to the sidewalk.

### **2 1 3 11      Transformer Pad**

The transformer pad consists of a monolith concrete slab and surrounding walls directly adjacent to the west abutment and the roadway. The slab is partially undermined along the north east edge. Erosion of rockfill appears to have caused the formation of a cavity below the slab (Photograph No. 15). The cavity appeared to be at least one meter under the slab and 1.2 meters wide at its widest. The slab appeared to have been originally cast in place against the rockfill and was now partially unsupported. A review of available drawings did not identify the foundation type or construction.

### **2 1 4    Main Gates**

The Floodway Inlet Control Structure main gates consist of two hinged steel bottom lift gates. Each gate segment is hinged on a series of trunnions and is raised out of a recess in the foundation by hydraulic cylinders. Each gate has a planar upstream skinplate and a downstream curved skinplate. The perimeter of the gate has bulb seals to control inflow and the outflow of water during operations or dewatering. On the face of the Central Pier and the Abutments, embedded mild steel plates have been installed to act as sliding surfaces for the seals.

Inspection of the main gates were conducted by divers working over the gate upstream skinplate and seals in preparation for the March 1996 dewatering and the internal inspection of the gate interior during the dewatering of the gate in March 1996. The results of these two inspections are contained in the interim report prepared by KGS Group and can be found in Appendix D. As well the gate was inspected during the raising of the gates on July 24 and 25 1996 during an overall detailed site inspection. This inspection allowed observation of the condition of both the upstream and downstream skinplates protective coatings and to a limited extent the seals. The results of the July 24 and 25 1996 observations are summarized below.

#### **2 1 4 1        Seals**

Rubber seals have been used around the perimeter of the main bottom lift gates to maintain a watertight seal both to permit dewatering of the gate interiors for repairs and maintenance and to contain water during operation of the gates. Direct inspection of the seals has not been possible without the complete dewatering of the entire main gate bay.

A number of methods were used to assess the condition of the seals in place. The first method was by direct observation by divers working on sealing the gate seals prior to the March 1996 dewatering and inspection. During dewatering for inspections it was clear that the seals do not function as per their design intent. As a result of previous inspections and operational practice it has been concluded that the seals cannot be used to dewater the gate and that divers are required to seal the gate. The results from the divers inspections and dewatering procedures are included in Appendix D. As well the seals were assessed by observation of the air and water leakage and water flow patterns while the gates were being raised and lowered.

The third method was visual during the raising of the gate above water level during the July 1996 inspection. During the operation of the gates on July 24 and 25 1996 there was a very obvious flow of water from the downstream seal while the gates were raised. This implies substantial leakage through the seals either from damage to the seals themselves or from debris jammed between the seals and gate preventing a proper seal.

#### **2 1 4 2 West Gate**

As the west gate was lowered back into its recess air was observed escaping from the side seals of both gates as shown in Photograph No 16 The west gate also had air escaping from a series of holes through the downstream skinplate just below the trailing edge of the upper skinplate The holes appeared to follow a regular pattern at approximately every 600 millimeters (24 ) The west gate also had a significant amount of air escaping from the upstream side seal near the axis of gate rotation There was also a release of air near the downstream seal immediately adjacent to the pier and abutment seal plates This release of air while the gate was being forced downwards suggest that the seals have deteriorated significantly or are unable to seal due to debris

#### **2 1 4 3 East Gate**

The east gate had been retrofitted with a rubber flap and clamping plate along the trailing edge of the upper skinplate The intent of this retrofit was to protect the downstream seal from debris The protective rubber flap was found to be torn sections missing and generally uneven and rippled when the gate was raised on July 24 1996

Some lighter coloured gravel or debris was visible in the gap between the upstream skinplate and the seal plates mounted on the abutment and pier These rocks appeared jammed between the gate and the abutments and pier The accumulation of gravel and silt within that gap was also confirmed by the divers during their earlier inspection

#### **2 1 4 4 Seal Heaters**

Seal Heaters were not inspected due to lack of access The heaters must be accessed by removal of the seal assemblies The condition of the elements are discussed separately in Section 2 3 Electrical Systems

## **2 1 4 5 Skin Plates**

The upstream and downstream skinplates were inspected visually during the July 24 and 25 operation of the gates. Visual examination (via telephoto lens of video camera) of the upstream skinplate suggests that the plate is deformed inward slightly between each internal support. This may be the result of local bending caused by ice and debris impact during spring floor operation. The upstream skinplate also showed some significant loss of protective coating and corrosion within those areas. The corrosion appeared as an extensive pitting especially along the edges of the gate as shown in Photograph No. 16. This appeared clearly on video recordings of the skinplate.

The downstream skinplate has varying degrees of corrosion. At both the upper and lower edge the protective coating appears intact while the mid portion of the downstream skinplate is fairly uniformly corroded. Also on the downstream skinplate are several abrasion marks which are caused by debris jammed in the seals rubbing against the gate as it is operated. Photograph No. 17 shows the general state of corrosion of the downstream skinplate and the wear pattern caused by debris caught in the seal assembly below the water line. This piece of debris was partially visible when the gate was breaking above the water surface. It was also confirmed by the earlier diver's report which described it as a street sign.

The different states of corrosion may be the result of scouring and rapid flow over the upper skinplate while the downstream skinplate is subject to slow, possibly negligible flow over it when the Gate 15 is not in operation. The downstream skinplate is subject to rubbing and wear from trapped debris. This may result in distinct corrosion mechanisms and deterioration of the coating system.

## **2 1 4 6 Internal Structure**

During the March 1996 inspection the protective coatings and steel members were found to be in good condition. An examination of member thickness confirmed that there was no apparent metal loss due to corrosion. The condition of internal members is discussed in the Interim Inspection Report found in Appendix D.

#### **2 1 4 7 Trunnions**

Due to the location of the trunnions and post tensioned anchors it was not practical to inspect these components. Due to the condition within the gate and the difficulty in dewatering the entire gate inspection by divers will not provide a visual condition and may not identify deterioration and failure.

During the 1986 cofferdamming and dewatering of the main gate the trunnions were inspected and found to be in good condition however a detailed inspection is necessary to adequately assess their condition from inside and below.

#### **2 1 4 8 Pier and Abutment Seal Plates**

The seal plates were inspected visually from the water surface to the top of the seal plates. Generally the plates are in good condition. Some wear from the movement of the seals against the plates is visible. Only the west abutment plates shown any significant loss of protective coating or wear. A bare portion of steel is visible at the top of the gate travel on the west abutment seal plates.

On all margins of the pier and abutment seal plates there is evidence of concrete spalling away from the edge of the seal plates. This concrete consists of the last pour places behind and around the plates during installation. The loss of concrete does not appear to affect the operation of the gates.

Photograph No 18 illustrates the wear on one of the seal plates and the loss of secondary concrete adjacent to the seal plate edges.

#### **2 1 4 9 Maintenance Access**

The access into the gates is presently very difficult and potentially unsafe due to the significant accumulation of silt within the gates. The accumulation of silt and the difficulty in dewatering the gates has permitted very little or no maintenance within the gates. The procedures required to enter the gate during the March 1996 inspection are described in Appendix D.

During the March 1996 inspection the silt had accumulated to a depth of 1.2 to 1.8 meters (4 to 6 ft) within the gate recess which required the use of inflatable flotation devices to gain access into the gate recess. It is also not possible to reach the underside of the upper skinplate as there are no access platforms or ladders installed on the gate interior.

Also there are no provisions for ventilation of the gate interiors during inspection or maintenance. During past inspections and maintenance oxygen levels were tested and found to be acceptable however current Workplace Health and Safety requirements may require a fresh air supply into a confined space such as the gate interior.

### **2.1.5 Adjacent Earthfill Dams**

The Floodway Inlet Control Structure is bounded on either side by earthfill dams or dykes. Each is constructed from a layered system of impervious clay and granular material layers. The outer face of the dams are protected from erosion by large boulders and rip rap. Along the crest of the dam an asphalt paved road and shoulders have been constructed.

The inspection of the dams consisted of a visual inspection by walking along the roadway and toe of each dam. Although outside of this study terms of reference it is included for future reference. A detailed discussion of downstream erosion is contained in KGS's 1995 report entitled Red River Floodway Inlet Control Structure Erosion Study.

#### **2.1.5.1 Roadway**

The existing approach roads consist of bituminous asphalt pavement on compacted granular material. An inspection of the road surfaces indicates that the pavement is in good condition and is not suffering from deterioration associated with poor drainage or subgrade material. The pavement does have some cracks which have been sealed with bitumen.

#### **2.1.5.2 Drainage**

Runoff from the roadway tends to occur as sheetflow as the road is uniformly crowned. Once the water reaches the shoulder the flow begins to transform in rill flow and to a limited extent to

gullying Gullying is very evident at the abutments where flow from the abutment slab and roadway spill off the pavement to a steep slope of granular material (Photograph No. 19). Runoff elsewhere on the dykes does not appear to cause gully formation or ponding.

### **2.1.5.3 Roadway Erosion Protection**

The outer face of the earthfill dykes are protected with varying sizes of granular material. Larger cobbles and boulders have tended to prevent erosion and retain and control a significant amount of runoff. As noted above, some gully formation has occurred adjacent to the abutments. In this case, poor placement of large cobbles or boulders may have resulted in the exposure of finer erodible material. A significant component of erosion on both the upstream and downstream faces of the dykes has been due to the action of people walking up and down the slope along certain pathways. Granular material has been displaced and the smaller erodible materials remains exposed. This is especially evident on the downstream faces where many people use the abutment retaining walls for fishing locations.

### **2.1.6 Public Security**

A number of areas were identified as potential risks to the Public who use the Structure and Bridge for various purposes. It is common for the Inlet Control Structure to have a large gathering of people on and around it while the gates are raised and the Floodway is in use. The surge and rush of water is a particular attraction and many people gather on abutment walls, sidewalks, and the central pier platform to observe the water.

#### **2.1.6.1 Vertical Drop at Abutment Walls**

The abutment retaining walls pose a potential safety hazard for people in these areas, particularly during operations, the surge of flood waters is high. The drop off the walls to still water is as high as 6 m (20 ft) while at the toe of the dyke slope a 3 m (10 ft) drop off to rocks and water below exists. The rock and gravel covered slope also makes this area dangerous for sight seekers.

### **2 1 6 2 Handrails and Stair to Downstream Observation Platform**

The stairs from the bridge sidewalk to the Central Pier platform is constructed of open smooth surfaced gratings. The handrails have balustrades at approximately 0.9 m (3 ft) centers. The handrail around the platform also consists of a smooth pipe handrail with balustrades at 1.8 m (4 ft) centers.

### **2 1 6 3 Sidewalks on Bridge**

The sidewalk width on the downstream side of the bridge is 0.7 m (2.3 ft) which does not make it accessible for wheel chairs, cyclists, or for two pedestrians to pass each other without stepping onto the roadway. The width of the upstream sidewalk is 1.3 m (4.3 ft). After heavy snowfall, the sidewalks are generally not cleaned to a passable condition.

### **2 1 6 4 Traffic Barrier Curb**

Presently, the sidewalks are directly adjacent to the roadway, separated only by a difference in elevation of 270 mm (10.5"). There is a potential for injury to pedestrians from projections on a passing vehicle, or from a vehicle losing control and traversing the sidewalk.

### **2 1 6 5 Lighting**

In general, lighting on and around the Structure is minimal. Bridge deck lighting is provided by two street luminaires, while security lighting is provided by three small, vandal-resistant fixtures mounted adjacent to doorways.

### **2 1 6 6 Warning Signs**

At the time of inspection, the only signage visible were speed control signs above the water, which had been damaged in previous flood events. The change in flow speed, depth of channel, and the potential risk during the operation of the gates is not identified as a danger to the public. Also, there is no warning to the public of the danger of water surge and turbulence downstream of the Structure near shore.

## **2 1 6 7      Warning Lights on Upstream Face**

Although the Red River and Floodway are considered dangerous waters during flood events there is a potential for water craft to operate on either waterways during floods. As such there is no visible warning that the main gates are raised and the resulting drop in water level and turbulence present. Floodlights used during operation of the Control Structure may not provide sufficient visible warning of the danger.

## **2 1 7   Facility Security**

The Floodway Inlet Control Structure is a fundamental component of a flood protection system which has prevented extensive flooding and damage since its construction. Being such a vital component of the system the protection of the Structure is considered essential. As with most public buildings especially in its isolated location it has been subject to vandalism and malicious damage. Several systems are essential for its ongoing protection which include locks lighting security systems and especially staffing of the Structure by Operating Personnel.

The inspection of these components was done by visual inspection and through conversations with Operating Personnel on site during the inspection. Operating personnel identified many ongoing problems with vandalism and damage.

### **2 1 7 1      Hatch Locks**

Through discussions with operating staff and during the inspection of the Structure the vandalism of locks on hatches is very frequent. Vandalism ranges from complete destruction and removal of the lock to gain entry into the Cylinder Pits or the abutment Gate Chambers to spray painting of the locks. Often damaged locks must be cut off the access hatches to permit inspection and maintenance.

Operating staff indicated that locks were replaced at a rate as high as two per week. Conversely long time periods would elapse without vandalism.

### **2 1 7 2 Door Locks**

At the time of the inspection the Control Centre door dead bolt lock and door knob had been vandalized. The damage consisted to bending the door knob and attempting to break the dead bolt with a rock.

Locks originally installed on the Machine Room doors had been abandoned due to repeated vandalism and unauthorized entry. The locks have since been abandoned and replaced with keeper bars with anti lifting pins removable only from the interior.

### **2 1 7 3 Protection of Operators**

Presently the operating staff use the Machine Room to operate the Structure and use the Control Centre to escape from the machinery noise and to perform other duties. Operators have limited visibility of the Structure from the Control Centre windows. Many windows have been replaced in the past by plywood panels to reduce damage by vandalism.

Presently visitors to the Control Centre enter via the roadway door by knocking to get the attention of the Operators. The Operators have no means of determining who is on the opposite side of the door and must unlock and open the door to acknowledge visitors. The incidence of forced entry into occupied buildings raises the potential for malicious operation of the Structure regardless of the presence of operating staff.

Operators described several instances in which windows or panels had been pierced with bullets. Although the intent is not likely focused at the Staff the potential for injuries exist. Consequently there is potential risk to the Operating Staff during the long period of time they occupy and operate the Structure.

### **2 1 7 4 Protection of Power Supply**

Presently the transformers are protected from vandalism and malicious intent by standard padlocks and the protective casing supplied with the transformers. At the time of the inspection the transformers had been painted with graffiti but not physically damaged.

Operating staff indicated that physical damage and intrusion into the transformer casings had not occurred in the past. This may be due to the perceived danger of electrocution which may result from intrusion. Malicious damage to the transformers may occur regardless of perceived danger if the intent is to disable the transformers. This may result in the inability to raise and lower the main gates until the emergency power supply is connected.

### **2 1 7 5 Prevention of Malicious Operation**

The Floodway Inlet Control Structure is staffed continuously every Spring and at other times when river levels may require operation of the Floodway. Despite being staffed continuously, staff are required to leave the structure at regular intervals to conduct water level measurements and inspection other duties.

As originally designed, full control of the Structure is possible from within either the Machine Room or Control Centre. Although raising of the gate will result in the raising of upstream water levels and the reduction of flows downstream, significant damage can result if the gates are lowered during a flood event. Presently, there are no controls or procedures that may prevent such intentional lowering of the gates.

### **2 1 8 Dewatering Methods**

Since the original construction, the ability to dewater and maintain the gates from the interior has continued to deteriorate as equipment and seals deteriorated or were damaged. Recently, only two methods have allowed dewatering of the gate interiors, and only one method has allowed complete dewatering. The first method required extensive work by divers, while the second method occurred naturally as an extremely low river flow year during which the water levels in the Red River were low enough to permit the construction of sandbag dykes upstream and downstream of the lowered gate. This occurred in 1986. Both methods are discussed below.

### **2 1 8 1 Diver Placed Seals and Caulking**

If routine maintenance or emergency work is required on the gate interiors divers must be used to form seals between the Structure and the skinplates. By working during winter under the ice divers must install and maintain temporary seals using ethafoam gasket rods oakum and lengths of pipe to seal the gate in place. This was required for the March inspection of the east gate interior.

### **2 1 8 2 Sandbag Dykes During Low Water Levels**

In 1986 the rate of flow in the Red River dropped to a significantly low level which was sufficient to allow a sandbag dyke or cofferdam to be constructed upstream and downstream of the east main gate. This method was dependant on the weather and permits the closure of only one gate at that time.

## **2 2 MECHANICAL SYSTEMS**

Inspection of the Floodway Inlet Structure mechanical components proceeded on a mechanical systems basis. The systems included the following:

- main gate hydraulic hoisting system
- bulkhead gate and trashrack hoists
- dewatering and desilting system
- compressed air system
- cylinder well de-icing heaters
- building mechanical systems

### **2 2 1 Hydraulic Hoisting System**

The east and west flood gates are each equipped with a hydraulic hoisting system. Each system consists of a self contained hydraulic power unit and two hydraulic cylinders with associated piping and valving. The cylinders are located at either end of the gates, two in the centre pier and in each abutment. The valving arrangement allows for the east hydraulic power unit to operate the west gate cylinders and vice versa, but under normal conditions the two systems operate independently. Figures 1 and 2 illustrate the general arrangement of the hydraulic hoisting system components.

Inspection of the east and west hydraulic hoisting systems was performed on July 25 and 26 1996. This included visual inspection of all accessible system components (without disassembly), operational testing, and hydraulic oil sample analysis. Operation of the gates during testing was performed by MNR personnel. Pritchard Machine (Hydra Motion Division) provided services for oil sample analysis and assistance with inspection items. In addition to this inspection, operation of the hydraulic systems was monitored on April 24 1996 during the spring flood period.

The cylinder support guides were considered a part of the hydraulic hoisting system for the purposes of this inspection. The support guides, located on either side of each cylinder, consist of I beams fastened and partially embedded into the shaft walls. The crosshead assembly of each cylinder slides up and down inside the support guides during cylinder motion.

#### **2 2 1 1 Visual Inspection**

All accessible components of the east and west hydraulic hoisting systems were visually inspected for signs of deterioration. This did not include disassembly of any system components.

#### **Hydraulic Units and Valves**

In general, the east and west hydraulic power units and valves appeared to be in good condition with the original paint showing little evidence of deterioration. Photos 20 and 21 show general views of the east and west hydraulic units, respectively. A slight oil leak occurred at a tubing connection on the east unit during operational testing (see following section: Operational Testing).

#### **Hydraulic Piping**

Sections of hydraulic piping accessible for this inspection included piping inside the mechanical room and inside the cylinder wells. Sections of piping inside the bridge deck were inaccessible and were not inspected. In addition to testing performed on July 25 and 26 1996, the performance of the hydraulic hoisting system was monitored on April 24 1996 during the spring flood period.

Hydraulic piping inside the mechanical room is in good condition similar to the hydraulic units with original paint intact as shown in Photo 22. The piping in the abutment cylinder wells however shows evidence of corrosion. Photos 23 and 24 show the piping in the east abutment cylinder well where much of the paint on the horizontal pipes is gone and the metal underneath is badly corroded. Sections of the west abutment cylinder well piping were replaced in 1994 due to corrosion related pipe leakage. The new piping has begun to show evidence of corrosion as shown in Photo 25. A sheet metal cover has been placed over the pipes in the abutment pier cylinder wells to protect them from road salt leaking through the bridge deck during the spring.

### **Cylinders**

For the purposes of this inspection the hydraulic cylinders were each divided into two parts the piston rod and the cylinder barrel. Each cylinder barrel was visually inspected down to water level beyond which the barrel was submerged. The submerged sections of the east gate cylinder barrels were inspected during the dewatered east gate inspection (Appendix D) and were generally found to be in good condition.

Photos 26, 27, 28 and 29 show the gland areas of the four hydraulic cylinders. These pictures were taken during various stages of the operational tests (see following section). The piston rods have been coated with a white grease compound as part of a regular maintenance procedure. Over time an appreciable amount of this grease has accumulated at the gland area of each cylinder. The grease was noted to contain flakes of rust which likely has come from corroding structural components in the cylinder wells (platforms, ladders, cylinder supporting bridges, etc.). During raising of the cylinder barrels this accumulation of grease and rust scale may cause contamination of the gland wiper and seal and could cause damage to the gland bushing and piston rod surface. The chrome coating of the piston rods were examined in areas where the grease had been wiped away by the piston rod wiper. In general the surfaces of all four piston rods appeared to be in good condition with no observable deterioration (see Photo 30). The operators indicated that the procedure of greasing the cylinder rods and support guides (see following section) will no longer be performed under current conditions as access to these components is difficult and creates a potential fall safety hazard.

The cylinder barrels were generally observed to be in good condition but there are isolated spots where the protective paint coating has peeled and the metal underneath has corroded. This is most pronounced on the west gate centre pier cylinder (see Photo 31). The cylinders were all inspected for oil leakage during the operational tests. One slight leak (slow dripping) was observed occurring at the gland area of the east gate centre pier cylinder (see Photo 32). This leak stopped after about five minutes.

### **Cylinder Support Guides**

The cylinder support guides have been coated with a white grease compound similar to the cylinder piston rods. During the operational tests (see below) cylinder travel wiped this grease off the guide beams exposing the metal underneath. These metal surfaces appeared to be in good condition and free from rust (see Photos 30 and 33). As mentioned in the previous section the greasing procedure will no longer be performed under current conditions because of concern for worker safety.

### **2 2 1 2 System Operation During Spring Flood, 1996**

The hydraulic hoisting system performance was monitored on April 24, 1996 during raising of the east and west gates. Reading of pressure and elapsed time were recorded while each gate was raised from 6.8 m (22.2 ft) to 7.0 m (23.1 ft). Original specifications indicate that the gates should raise at a speed of 0.2 m (0.6 ft) per minute. Normal and extreme operating pressures are listed in the specifications at 7580 kPa (1100 psi) and 10 700 kPa (1550 psi) respectively. The following information was recorded during the operation:

The east gate rose at 0.2 m (0.66 ft) per minute taking 1 minute 22 seconds to complete the raise of 0.3 m (0.9 ft). The pressure during this time was 8960 kPa (1300 psi). (The operators later noted that the east gate pressure reached a maximum of 9650 kPa (1400 psi) at a gate position of approximately 26 ft).

The west gate rose at 0.18 m (0.6 ft) per minute taking 1 minute 30 seconds to complete the raise of 0.3 m (0.9 ft). The pressure during the raise was 5860 kPa (850 psi).

The operators noted that between the intermittent gate raises the east gate tended to lower slightly about 60 mm (0.2 ft) in a 24 hour period. Figure 35 shows the flow of water over the east gate on April 24, 1996. The gate position is 7.0 m (23.1 ft).

### **2 2 1 3      Operational Testing   July 24 and 25 1996**

Operational tests of the flood gate hydraulic hoisting system were performed on July 24 and 25 1996 by raising and lowering the east and west gates one at a time. Figure 34 shows the east gate near the fully raised position midway through the testing. During the tests the following information was recorded:

- gate raising/lowering speeds
- system operating pressure
- hydraulic unit electric motor current draw

In addition to the above data, occurrences of excessive noise or vibration in the machinery were noted. As part of the operational tests, the relief bypass setting of each hydraulic unit was checked by running the unit with the supply shutoff valve closed. Calibration gauges were used to check the accuracy of the hydraulic unit pressure gauges.

During the periods of gate testing, the waterway around the structure was patrolled by the City of Winnipeg Harbour Patrol. This measure was taken to prevent boat traffic from inadvertently colliding with one of the partially raised gates.

#### **Gate Raising/Lowering Speeds**

Raising and lowering speeds for the east and west gates were determined by monitoring gate positions at time intervals of 2 to 5 minutes. The results of the gate position monitoring are illustrated in Graph 1 (Appendix B) which shows plots of east and west gate positions versus time for raising and lowering. The original specifications indicate that gate raising and lowering speeds should be 0.6 ft per minute and 0.4 feet per minute, respectively. The following items regarding motion of the gates are noted:

- the east gate rose at roughly 0.2 m (0.6 ft) per minute. At approximately 60 minutes it reached a maximum height of 11.4 m (37.5 ft) at which point the position limit switch stopped the hydraulic power unit motor.

- The west gate rose at the same rate as the east gate, 0.6 feet per minute, for the first 30 minutes, then slowed slightly to a rate of 0.15 m (0.5 ft) per minute. At 1 hour 15 minutes the west gate reached a maximum height of 12.4 m (40.8 ft) at which point the position limit switch stopped the hydraulic power unit.

The east gate lowered at roughly 0.09 m (0.3 ft) per minute which was approximately 40% slower than its raising speed. It took just over 2 hours and 16 minutes to lower the east gate from its maximum height of 11.4 m (37.5 ft) to a position of 0.2 m (0.6 ft) at which point the hydraulic unit was manually shut off. The bypass valve on the unit was then opened allowing the gate to lower the remaining 0.2 m (0.6 ft) under its own weight.

The west gate lowered at a rate of approximately 0.15 m (0.5 ft) per minute, nearly the same rate as its lifting speed. It took 1 hour 22 minutes to lower from 12.4 m (40.8 ft) to 0.09 m (0.3 ft) at which point the position limit switch shut the power unit off. The gate was then allowed to lower under its own weight for the remaining distance.

### **System Operating Pressures**

System operating pressures were recorded at the same time intervals as gate position readings. The pressures developed during gate raising and lowering are plotted as a function of time in Graph 2 (Appendix B). Normal and extreme operating pressures stated in the original specifications are 7580 kPa (1100 psi) and 10 700 kPa (1550 psi) respectively. The following are notable items regarding system pressures:

The east gate hoisting system ran at approximately 6550 kPa (950 psi) at the beginning of the raise. The pressure increased gradually to a maximum value of 8750 kPa (1270 psi) at a gate position of 8.0 m (26.5 ft). The pressure reduced slightly and remained relatively constant at 8540 kPa (1240 psi) for the remainder of the raise. This pressure is slightly (5%) less than the operating pressure observed on April 24, 1996 (see previous section).

The west gate system generally ran at pressures 1030 kPa (150 psi) higher than the east gate system during gate raising. The west system pressure began at 7480 kPa (1100 psi) and gradually increased to 9650 kPa (1400 psi) at a gate position of 6.2 m (20.4 ft) where it remained relatively constant for the remainder of the raise. This pressure is significantly (65%) higher than the west gate pressure observed on April 24, 1996 (see previous section).

During gate lowering, east gate system pressure ran at a constant 350 kPa (50 psi). The west gate system ran at a relatively constant pressure of 1380 kPa (200 psi). The higher pressure in the west system explains why the west gate lowered at a faster rate. The reason for the low pressure in the east gate system during gate lowering cannot be explained with certainty. A possible explanation is malfunction of the east hydraulic system directional valve which controls the direction of cylinder operation.

### **Pressure Relief Bypass Setting**

The pressure relief bypass settings for the east and west hydraulic units were checked by operating each unit with the supply line isolation valve closed. The resulting pressures were 9990 kPa (1450 psi) for both the east and west units. During this test a calibrated pressure gauge was temporarily installed on each hydraulic unit to check the accuracy of the unit gages. Each gauge read within 350 kPa (50 psi) of the calibration gauge which is considered an acceptable level of accuracy for gauges of this pressure range.

### **Motor Amperages**

Motor amperages were recorded at the same time intervals as position and pressure measurements during the operational tests. Graph 3 (Appendix B) illustrates motor amperages as a function of gate position for gate raising and lowering. In general the peak amperages during gate raising were 93 to 97 percent of the motor rating (20.5 A). The motors were therefore operating at nearly 100% of their capacity during the gate lifts. During gate lowering amperages ran at approximately 50 percent of the rated value.

### **Machinery Noise/Vibration**

Both the east and west hydraulic unit pumps intermittently produced a sharp knocking sound during raising and lowering of the gates. This was presumably caused by air bubbles in the system passing through the pumps. The knocks typically repeated every few seconds at initial pump startup then became less frequent occurring once every 1 to 10 minutes throughout the test.

### **2.2.1.4 Oil Cleanliness Analysis**

Oil samples were taken from the east and west hydraulic unit reservoirs for cleanliness analysis. The analyses were performed by Pritchard Machine and the analysis reports are included in Appendix C. In brief the oil samples from both hydraulic units were found to have acceptable cleanliness ratings for hydraulic oil as determined using the Pall Filtration method. In this procedure the oil sample is passed through a filter paper which is then examined under magnification. The oil cleanliness is determined according to the number of contaminant particles

observed on the filter paper. One notable comment is that the oil taken from the east hydraulic unit contained a significant amount of silica particulate. This may be due to inadvertent contamination caused by wiping internal components with paper towels or rags. The source of the silica contamination in the east unit should be identified.

## 2.2.2 Bulkhead Gate and Trashrack Hoists

The east and west bulkhead gates and trashracks are located in the abutments of the Floodway Inlet Structure as shown in Figures 1 to 3. The function of the bulkhead gates is to equalize the hydrostatic pressure on the flood gates by allowing upstream water to flow into the flood gate recesses during raising of the gates. The trashracks, which are located immediately in front of each bulkhead gate, prevent floating debris from entering the bulkhead gate water passage. The trashracks are each lifted by means of a manual block and tackle chain hoist.

Each of the bulkhead gates weighs approximately 1360 kg (3000 lbs) and is lifted by means of a wire rope hoist with a four part reeving arrangement. Each hoist is made up of the following main components:

- 5 hp electric motor
- shafting and couplings
- pivoted shoe drum brake
- 8.37 : 1 gear reducer (small reducer)
- 73 : 1 gear reducer (large reducer)
- wire rope drum 400 mm (16 ") pitch diameter (approximate field measure)
- wire rope 20 mm (0.75 ") diameter (approximate field measure)
- sheave block
- equalizer sheave
- position indicator
- position limit switch
- slack rope limit switch

Photo 36 and 37 show a general views of the east and west bulkhead gate hoists respectively. Figure 4 schematically illustrates the general arrangement of the bulkhead gate hoist components.

## **2 2 2 1 Visual Inspection**

Inspection of the east and west bulkhead gate and trashrack hoists was broken down according to the hoist components. In general, rust is evident to varying degrees on all the components located on the hoist platform. Review of the Drawings and Specifications revealed that the hoists were designed for indoor operation. There is evidence, however, of significant moisture leakage into the hoist chamber from the bridge parking space above. Observations of individual hoist components are included below.

### **Hoist Motor**

The bulkhead gate hoist motors appear to be in generally good condition. There is some rust evident on the motor housings (see Photos 36-38).

### **Shafting and Couplings**

Surface rust was evident on the shafting and couplings (see Photos 36-37).

### **Hoist Brake**

The brake drum on both bulkhead gate hoists was found to be extremely rusted to the point where pitting has occurred on the brake drum surface. The brake shoes were also badly rusted. Surface rust was evident on the other brake components (see Photos 36-38).

### **Gear Reducers**

Surface rust was evident on the gear reducers (see Photos 36-38).

### **Wire Rope Drum**

The wire rope drum had been coated with a white grease compound. The drum appeared to be in good condition. Some rust was evident on the ends of the drum where the surfaces were not coated with grease (see Photos 36-37).

### **Position Indicator Limit Switch and Slack Rope Limit Switch**

The bulkhead gate hoist position indicator system consists of a shaft mounted dial indicator driven by a small worm gear reducer coupled to the wire rope drum. In general, these components were badly rusted on both the east and west hoists (see Photo 39).

The sprocket and chain driven position limit switches on both hoists were not operable, as both have rusted completely off their mounting bases (see Photo 39).

The slack rope limit switches on both hoists were not operable. The switch lever mechanisms have rusted in place.

### **Wire Rope**

The wire rope on both bulkhead gate hoists was observed to be in generally good condition, with some evidence of rusting.

### **Sheave Block**

The west bulkhead gate sheave block was inspected by lifting the gate partially out of the gain (see Photo 40). During lifting and lowering, one of the running sheaves (the one on the downstream side) was observed to be stuck and not rotating, resulting in the wire rope sliding through the sheave groove. This increases wear and will reduce the life of the wire rope and the sheave. Apart from this, the sheave block appeared to be in good condition, but a layer of mud on the components made a detailed examination difficult. The east bulkhead gate sheave block was not closely inspected because the gate was not lifted from the gain; the wire rope had previously slipped off one of the sheaves and became jammed in the sheave block during the lift (see Photo 41). To avoid damage to the hoisting components, the lift was not continued past 4.8 m (16 ft), the height at which the wire rope had become jammed.

### **Equalizer Sheave**

The equalizer sheaves appeared to be in good condition.

## Trashrack Hoists

The manual block and tackle hoists used to raise the trashracks were found to be intact but inoperable. The block and tackle device rusted and was not functioning properly.

### 2.2.2.2 Operational Testing

Operational tests were performed on the bulkhead gate hoists by raising and lowering the gates while recording hoist speed, motor current draw, and noting braking speed. As noted in the previous section, the west bulkhead gate was able to be raised all the way to the desired level (nearly complete removal from the gain) while the east gate was not raised above the gain due to the wire rope becoming jammed in the sheave block.

Operating speeds of the west bulkhead gate hoist drum were observed to be 2.7 rpm. This speed was assumed to be typical of both hoists. The speed remained approximately constant throughout the operational test. With the four-part reeving arrangement, the gate travel speed was calculated to be approximately 1.5 m (5 ft) per minute, or one-half of the drum pitch line speed. This agrees with the gate speed listed in the original hoist specifications. During braking in the downward motion, the west bulkhead gate slowed from its operating speed to rest in approximately 4 seconds.

Motor current draw for the east and west hoist motors during gate raising were 3.0 A and 2.5 A, respectively. The east gate hoist was likely experiencing a greater load than the west hoist because of the wire rope riding outside the sheave, as noted in the previous section. The rated current of the hoist motors is 5.3 A, therefore the motors were running at 47 to 57 percent of their rated load during the operational tests.

As noted in the previous section, the position limits on both hoists were not operational. The position indicator for the east gate was functioning, while the west gate indicator operated up to a gate position of 2.7 m (9 ft) and then stopped. The operators currently estimate the positions of both gates according to the number of wraps of wire rope on the hoist drums.

During the operation of both bulkhead gate hoists the general noise level emanating from the machinery seemed to be excessively high. This could be a result of poor lubrication in the gear reducers.

### **2 2 2 3 Bulkhead Gate Gear Reducer Oil Analysis**

The lubricating oil in the large gear reducers of the bulkhead gate hoists were sampled and analyzed by Pritchard Machine using the Pall filtration method similar to the analysis of the floodgate hoisting system hydraulic oil. The analysis reports are included in Appendix C. In summary, contamination levels in the gear reducer oil samples are beyond acceptable levels. The contaminants, which included metal and rust particles, may be an indication of internal component deterioration. These contaminants will cause increased wear of the internal gears and will shorten the life of the reducers.

### **2 2 3 Dewatering and Desilting System**

Inspection of the dewatering and desilting systems during the current inspection phase was limited primarily to visual inspection. The dewatering system underwent an operational test during the dewatered east gate inspection in March 1996. The system was prone to blockage by silt and debris during the dewatering, particularly as the water level in the gate recess dropped to low levels. Otherwise the dewatering pump functioned well. For details of this operational test, see the dewatered east gate inspection report (KGS Report May 1996 Appendix D). Piping in the centre pier dewatering sump was generally in good condition in the upper portion of the sump well, but showed appreciable pitting corrosion at the lower level near the sump water surface. The desilting system is currently not in operation, and much of the system piping has been removed, however the original piping manifold in the mechanical room is intact and appears to be in good condition (see Photo 42). The butterfly isolation valves were each checked for range of motion. All were found to be in working order, except for valve no. 4 (east) and valve no. 6, which were stuck in the closed position.

## **2 2 4 Compressed Air System**

The compressed air system consists of two compressors air receiver and associated piping The compressors are each rated for 1 7 m<sup>3</sup>/min @ 690 kPa (60 cfm @ 100 psi) Inspection of the compressed air system included visual inspection of accessible components and an operational test of one of the compressors

### **2 2 4 1 Visual Inspection**

All components of the compressed air system in the mechanical room appear to be in good condition (see Photo 43) All isolation valves on the compressor discharge manifold were able to be turned freely by hand

### **2 2 4 2 Operational Test**

An operational test was performed on air compressor no 1 by closing the valve on the air receiver discharge and allowing the compressor to run up to peak pressure A maximum pressure of 760 kPa (110 psi) was reached in 1 minute 45 sec

## **2 2 5 Cylinder Well De Icing System**

The bulkhead cylinder wells are equipped with forced air heating systems to prevent ice from forming around the cylinder barrels during winter The typical system consists of a 5 kw portable fan heater The heaters were not in place at the time of the inspection as they had been removed to prevent them from being submerged during elevated floodwater levels The fan motor housings are corroded (see Photo 44) but otherwise the heaters appear to be in good condition as do the heater mounting flanges and flexible ducting in the abutment surge chambers (see Photo 45) MNR personnel reported that the heaters operated properly during their last usage

## **2 2 6 Building Mechanical Systems**

The following Control Structure Building mechanical systems were visually inspected and operational checks were performed where applicable

heating system  
ventilation system  
water and septic systems

### **2 2 6 1 Building Heating System**

The control structure building heating system consists of four 5 kW electric unit heaters in the mechanical room and one electric unit heater in the control room. Each unit heater is controlled by its own thermostat. All the unit heaters appeared to be in good condition and were in working order.

### **2 2 6 2 Ventilation System**

The control structure ventilation system consists of an exhaust fan with backdraft dampers and an air intake louver in the mechanical room and a bathroom exhaust fan in the control room. The mechanical room fan and intake louver are manually operated and were found to be in working order. The bathroom exhaust fan is either not functioning or has been removed.

### **2 2 6 3 Water and Septic Systems**

The control structure water supply system includes a submersible well pump, hydro-pneumatic tank, electric water heater and associated hot and cold water piping. The water well is located in the centre pier. The accessible components all appeared to be in good condition and in working order. However, a sign has been placed in the bathroom indicating that the water is not potable.

The control structure septic system is a gravity system with a holding tank beneath the mechanical room floor and a drain pipe to the river. The drain pipe is no longer in use due to past problems with pipe freezing. The holding tank is periodically pumped out as required. All septic system plumbing upstream of the holding tank appeared to be in good condition and in working order.

## **2 3 ELECTRICAL SYSTEMS**

### **2 3 1 General**

Westinghouse Service Division was retained by KGS to undertake various electrical tests and perform a thermal scan on various key electrical components. Results of their tests can be found in Appendix E. KGS staff witnessed the testing and also performed a visual inspection of the electrical systems.

### **2 3 2 Incoming 600 V Power Cables**

#### **2 3 2 1 General**

Two 600 V feeders bring power into the structure. These originate at the secondaries of the Utility's transformers and terminate at an automatic transfer switch. One source originates at St Norbert Substation and the other at the Perimeter South Station. The cables are direct buried on the earth bank portion of the run and run in rigid steel conduit embedded in the concrete structure itself.

#### **2 3 2 2 Visual Inspection**

As these are direct buried or in conduit visual inspection was not possible. Many of the existing embedded conduits have deteriorated and/or the insulation on the wiring inside has congealed to make removal of the wire impossible. It is likely that this is the case with these cables as well.

#### **2 3 2 3 Test Results**

The cable insulation was tested with a 1000 V megger with a satisfactory reading.

### **2 3 3 Main Breaker/ Robonic Transfer Switch**

#### **2 3 3 1 General**

Two 400A 600 V 3 pole molded case main breakers which are part of a 400 A 600 V Westinghouse Robonic Automatic Transfer Switch (ATS) assembly form the main service entrance isolation and protection function. The ATS will transfer to an alternate supply if the normal supply fails.

#### **2 3 3 2 Visual Inspection**

The transfer switch is in good condition with little evidence of rust or corrosion.

#### **2 3 3 3 Test Results**

A thermal scan of the ATS including these breakers was performed while a gate was in operation and no hot spots were found.

The breaker overload and overcurrent trip characteristics were tested and were within acceptable tolerance.

The transfer operation was tested and the ATS operation performed as desired.

### **2 3 4 Motor Control Center**

#### **2 3 4 1 General**

A six section back to back motor control center houses combination magnetic starters and feeder breakers for the various motors and loads in the structure. The motor control center is shown on Photograph No. 46.

## **2 3 4 2 Visual Inspection**

The motor control center is in good condition with little evidence of rust or corrosion

## **2 3 4 3 Test Results**

A thermal scan of the starters and breakers was performed while the equipment was in operation and no hot spots were discovered

The insulation on the power wiring to the motors/loads was tested using a 1000 V megger with satisfactory results of 600 to 1000 meg ohms

## **2 3 5 Motors**

### **2 3 5 1 General**

There are nine major 600 V induction motors in the structure. These are generally associated with the gate hoisting equipment and related auxiliaries

### **2 3 5 2 Visual Inspection**

Motors located in the mechanical room were generally in good shape showing little signs of corrosion or wear. Motors located on bulkhead gate hoists showed some indication of corrosion and generally reflect the conditions reported in the mechanical section. The dewatering pump motor is part of the submersible pump and was not accessible

### **2 3 5 3 Test Results**

The insulation of the motors and the associated power cables were tested. Polarization index tests were performed on motors with satisfactory results

## **2 3 6 Dry Type Transformers**

### **2 3 6 1 General**

There are two dry type transformers in the structure. One with 600 120/208 V windings serves the general lighting and power distribution. The other with 600 133/230 V is associated with the gate heaters.

### **2 3 6 2 Visual Inspection**

The transfer switch is in good condition with little evidence of rust or corrosion.

### **2 3 6 3 Test Results**

A thermal scan of the transformers was performed while the equipment was in operation and indicated there were no hot spots.

The insulation of the transformer windings was tested using a 1000 V megger with satisfactory results.

## **2 3 7 Panelboard**

### **2 3 7 1 General**

There is one 120/208 V 3ph lighting and power panel in the structure which serves lighting and small power loads. The panel is shown in Photograph No 47.

### **2 3 7 2 Visual Inspection**

The panel is in good shape showing little sign of corrosion.

### **2 3 7 3 Test Results**

A thermal scan of the panels was performed while the equipment was in operation and indicated that there were hot spots. Breakers 1 14 18 21 & 23 in Panel A were all identified as too hot.

The insulation resistance of the branch circuits was meggered with satisfactory results with the exception of circuits 1 8 16 and 26.

### **2 3 8 Gate Heating Equipment**

#### **2 3 8 1 General**

There is one switchgear assembly housing the electrical protection and control components for the gate heating equipment and the structure space heating. This equipment operates at 133/240 V grounded wye.

Electric trace heating is installed on the following areas:

- On the gate guides of the bulkhead gates

- Along the side downstream and upstream seals of the gate bodies to keep ice from bonding across the gate to the piers

Electric space heating is installed in the following areas:

- In the wells which house the gate hoist hydraulic cylinders

- In the balancing duct (concrete passageway which allows the water pressure to equalize across a raised gate)

- In the wells of the wingwall which house the gate hoist hydraulic cylinders

The individual heater feeders are equipped with ammeters. These can be used by operational staff to determine if the heaters are working.

### **2 3 8 2 Visual Inspection**

Much of the trace heating is no longer functional

### **2 3 8 3 Test Results**

A thermal scan of the switchgear equipment was performed while the equipment was in operation and indicated there were no hot spots. As many of the heater circuits are not functional and hence not drawing current this test is not as thorough as anticipated.

The ammeter circuits (current transformer and meter) were checked and found to be accurate.

The heat tracing circuits were checked for continuity and insulation resistance and generally failed. Details are shown in Westinghouse's report.

### **2 3 9 Unit Heaters**

#### **2 3 9 1 General**

There are six unit heaters for space heating located in the control room and the structure.

#### **2 3 9 2 Visual Inspection**

The heaters are generally in good condition with little evidence of rust and corrosion.

#### **2 3 9 3 Test Results**

The resistor elements were tested for open circuits or shorted coils. No problems were identified.

## **2 3 10 Gate Hoist Controls**

### **2 3 10 1 General**

There is a common gate hoist control panel in the control room (see Photograph No. 48) housing controls for both gates. From this location the hydraulic pumps can be started and stopped and the two gates can be raised and lowered.

Control of a pneumatic alarm horn, used to warn any individuals in the area of an imminent gate movement, is also located here.

Lastly, a selsyn type gate position indication system reports both gate positions.

### **2 3 10 2 Visual Inspection**

With the exception of the remote gate positioning equipment, all equipment appears in good shape and functions well. The gate position circuit no longer functions.

## **2 3 11 Building Lighting**

### **2 3 11 1 General**

The interior lighting generally consists of incandescent fixtures. The exterior lighting consists of flood lights which illuminate the gate area to facilitate visual inspection of the gate and two pole-mounted fixtures for roadway lighting.

No emergency lighting system exists.

### **2 3 11 2 Visual Inspection**

The exterior lighting levels could be improved, principally to improve security at the site. Areas of interior lighting, such as cylinder wells, are also poorly lit.

## **2 3 12 Fire Alarm System**

### **2 3 12 1 General**

A single zone fire alarm system consisting of manual pull stations and smoke/heat detectors is installed and protects the control room and machine room area only. A fire alarm or trouble on the system reports back to a central reporting station over the telephone system.

### **2 3 12 2 Visual Inspection**

The fire alarm system appears in good operating condition and the operation staff indicated there were no problems with its operation.

## **2 3 13 Security Alarm System**

### **2 3 13 1 General**

A security monitoring system consisting of three door switches monitors unauthorized intrusion to the machine room and control room. A security alarm reports back to a central reporting station via telephone lines.

### **2 3 13 2 Visual Inspection**

The security system appears in good operating condition and the operation staff indicate there were no problems with its operation.

## **2 3 14 Communication Systems**

### **2 3 14 1 General**

Telephones connected to the Manitoba Telephone System allow communication to and from the structure. During operations in the spring, staff also carry two way radios.

## **2 3 14 2 Visual Inspection**

Site staff indicate the telephones work well

## **2 3 15 Water Level Recording**

### **2 3 15 1 General**

There is one water level monitoring device in the structure. It monitors the upstream water levels near the central pier. This is manually read and there are no chart recorders or remote monitoring facilities.

There are also two water level monitoring stations outside of the structure. These are of the nitrogen bubbler type and are equipped with a chart recorder and a telephone dial up which allows remote reading of the level. One recorder is located on the east earth dam downstream of the structure. The second is located a significant distance upstream of the structure on the west bank.

### **2 3 15 2 Visual Inspection**

## **2 3 16 Embedded Conduit Systems**

### **2 3 16 1 General**

Much of the wiring for the power and distribution systems including the trace heating circuits is via embedded conduit.

### **2 3 16 2 Visual Inspection**

Many of the existing embedded conduits have deteriorated and/or the insulation on the wiring inside has congealed to make removal of the wire impossible. If any repair or replacement of systems which are wired via embedded conduit is required a new wiring system will need to be installed.

The Floodway Inlet Control Structure was inspected in two stages. Initially in March 1996 the interior of the main gates were inspected by dewatering their interior. In addition divers provided a report on their findings of the main gate seals. In July 1996 a detailed inspection of the structure above water level was conducted. This included raising each of the main gates inspecting and testing all mechanical and electrical systems.

**SECTION 3 0**  
**ASSESSMENT**

### **3 0 ASSESSMENT OF REQUIRED WORK ITEMS**

Results from inspections of the Floodway Inlet Control Structure have been presented in Section 2 0 of this report. The following section identifies deficiencies in the Control Structure based on interpretation of inspection results and addresses them with alternatives for repair, replacement or improvement. Cost estimates including allowances for design, contract administration and contingencies, are listed for each alternative, with detailed breakdowns presented in Appendix F, where appropriate. The recommended work items are prioritized into a proposed work program in Section 4 0 of this report.

### **3 1 STRUCTURAL AND CIVIL COMPONENTS**

The assessment of the structural and civil components of the Red River Floodway Inlet Control Structure considers a review of existing documentation associated with the current repairs and maintenance of components, and an evaluation of their current condition and function. The current condition was reviewed in Section 2 0 Inspection Results. Deficiencies in function, and serviceability have been identified in addition to proposing several repairs or remediation measures for each. The following sections address the major components of the Inlet Control Structure and their deficiencies. The general arrangement of the structure is shown on Figure 1 and 2.

#### **3 1 1 Roadway Bridge**

The roadway bridge is the joint responsibility of the Department of Highways and the Department of Natural Resources. Based on correspondence concerning the 1985 roadway deck repairs, the Department of Highways assumes responsibility for inspection and maintenance of the components directly associated with the roadway, which are the bearing assemblies, girders, deck, guardrails, and paved approaches. The remaining components appear to be the responsibility of the Department of Natural Resources, which includes the lighting, service ducts, sidewalks and parking areas, and embedded services. Ultimately, definition of responsibility of work would need to be determined. Figures 1 and 2 illustrates the extent of the roadway over the structures.

### 3 1 1 1      **Bearing Seats**

#### *Problem/Deficiency*

The visual inspection of the bearing seats identified small cracks below the fixed bearing assemblies. This may suggest that the bearings may be frozen, and have since transferred longitudinal thermal forces from the bridge girders into the bearing seats as horizontal shear. This may significantly affect the life and load capacity of the bridge.

#### *Alternatives for Repair/Replace*

- A      Perform detailed inspection of the bearings and bearing seat to confirm extent of cracks. During the inspection, determine if the assemblies are frozen and not functioning as designed. Also perform a detailed assessment of the bearing seat to assess its ability to resist this thrust from the bridge.

The results of this investigation will determine if either repair of the existing bearings or additional reinforcing below bearing seat is required. The investigation may also find that no further work is required, and the cracking is not consequential.

Estimated cost of Option A    \$7 000

- B      Install monitoring pins across the cracks and record any movement if any occurs. If movement is identified then proceed with further investigation of the distress.

Estimated cost of Option B    \$1 900

- C      Do nothing and visually monitor the cracking until movement is obvious.

Estimated cost of Option C    No initial cost

*Preferred Option*      A , and B

Cracking below the bearing assemblies may reflect frozen bearings. This may develop forces exceeding the design capacity of some components. A detailed investigation and monitoring can determine if this distress is a concern.

### 3 1 1 2      **Bearings**

#### *Problem/Deficiency*

There is no record of detailed inspection of the bearing assemblies. The potential accumulation of paint on rocker surfaces may be inhibiting movement. Detailed inspection of pin and rocker is necessary. Frozen bearings may result in large forces being transferred into the abutment or central pier.

*Alternatives for Repair/Replace*

- A Perform a detailed inspection, and recommend action to preserve proper function of pin and rocker bearings as required. Do detailed analysis of rocker and pin bearing. Propose upgrades or repairs as required to maintain function.

Estimated cost of Option A \$8 250

- B Do nothing, and assume bearing are functioning as designed.

Estimated cost of Option B No initial cost

*Preferred Option* A

The proper operation of the bearings is important to ensure the behaviour of the bridge as designed and to ensure that the bridge will perform as currently rated. Frozen bearings may also contribute to accelerated fatigue and deterioration of components.

**3 1 1 3 Girders**

*Problem/Deficiency*

There are no apparent problems with girders. Portions of the girders were repainted in 1985 by the Department of Highways as required after the original coating remained in service for 20 years. At that time no paint on the interior faces of members was required.

*Alternatives for Repair/Replace*

- A Do nothing. Review paint on bridge girders every 5 years.

Estimated cost of Option A No initial cost

- B Plan to repaint all steel work on bridge in approx 20 years. This will include sandblasting of all steel work and the application of a high quality coating system. Review of all protective coatings every five years.

Estimated cost of Option B \$198 000

*Preferred Option* B

By scheduling painting of the structure, it allows for maintaining the current rating, and ensuring the long term performance of the bridge structure.

### 3 1 1 4      **Roadway Deck**

#### *Problem/Deficiency*

The high density concrete deck overlay constructed in 1985 by Department of Highways is in good condition. The cracking found during the inspection is not considered significant, or detrimental at this time. The condition of the roadway deck will likely continue to remain in good condition for many years; however, it is anticipated that a traffic wear course will be required some time in the future. The method of repair will be determined by the Department of Highways following their internal guidelines. As is the current arrangement, resurfacing will be handled by the Department of Highways.

#### *Alternatives for Repair/Replace*

- A      Do nothing. Department of Highways will continue to perform regular inspections of the deck and overlay as required by their maintenance inspection program.

Estimated cost of Option A      No initial cost

- B      Monitor condition of cracks and evidence of reinforcing steel corrosion or delamination. Perform a condition survey every 5 years over the entire roadway surface.

Estimated cost of Option B      No initial cost

- C      Apply concrete crack sealer to high density wear surface to protect reinforcing steel, and reduce the likelihood of deck deterioration.

Estimated cost of Option C      \$6,000

*Preferred Option*                      A

The current condition of the roadway deck does not warrant detailed inspection. Routine inspection will identify an increase in deterioration or the requirement for further detailed inspections.

### 3 1 1 5      **Sidewalks**

#### *Problem/Deficiency*

The inspection of the sidewalk identified large amounts of popouts and exposed reinforcing steel. In many areas, the concrete was stained with rust due to the corrosion of steel below the concrete surface. Photographs of the sidewalk taken by the Department of Highways in 1985 indicate that the deterioration of the concrete has approximately doubled in the last 10 years.

A review of the original engineering drawings indicate that the protective concrete cover on the reinforcing steel was specified as 19 mm (0.75") which is not considered sufficient by current standards. Consequently, the sidewalk will continue to deteriorate by this mechanism.

The concrete adjacent to several of the handrail posts have cracked outwards which may suggest that the corrosion of the post metal or the freezing of water within the post base is exerting sufficient force to crack the concrete. This results in a loss of support for the post and accelerated deterioration of the sidewalk.

The downstream sidewalk width 0.6 m (2 ft) clear is also relatively narrow by current standards. The sidewalks also do not have approach ramps which would allow them to be used for bicycles, wheelchairs, and other users. As such, the sidewalks are not considered adequate for potential users.

#### *Alternatives for Repair/Replace*

- A Do nothing. Monitor the condition of sidewalk and reassess when the damage is significant and at that time reassess the need for work.

Estimated cost of Option A No initial cost

- B Selective repairs. Remove unsound concrete, expose bars, epoxy paint and concrete patching compound over top. Cover sidewalk with sealer and coating to improve traction and provide protection to the reinforcing steel.

Estimated cost of Option B \$75,000

- C Complete reconstruction. Remove surface of entire sidewalk and curb. Extend width of concrete sidewalk to 3' clear width. epoxy paint exposed reinforcing, add new surface concrete coarse over existing and reinstall guardrails with new bases.

Estimated cost of Option C \$216,000

*Preferred Option* B

The limited use of the Structure throughout the year does not warrant complete construction of the sidewalks to meet all the current design criteria for public use. The rehabilitation will preserve the condition with moderate costs.

### **3 1 1 6 Service Duct**

#### *Problem/Deficiency*

The inspection found that there was significant deterioration of the concrete and exposure of the reinforcing steel on the service duct covers due to lack of protective cover on original construction. There is also a problem with the formation of frost inside the duct originating from the moist air within the interior of Machine Room which results in seepage into the Machine Room. As the service duct cover forms part of the sidewalk, its surface and integrity must be adequate for public use.

*Alternatives for Repair/Replace*

- A Do nothing Monitor the condition and reassess covers when they have deteriorated to the state of complete penetration or present a hazard to pedestrians

Estimated cost of Option A No initial cost

- B Selective repairs Leave duct covers in place, Remove deteriorated concrete and epoxy paint the exposed bars after sandblasting Patch concrete afterwards and replace caulking around the covers

Estimated cost of Option B \$11,500

- C Complete reconstruction Remove existing covers, construct new covers, and install Design new covers to current standards Install the new covers in place and caulk around opening As discussed below, the piping within the service duct also requires replacement, which will require removal of the existing covers

Estimated cost of Option C \$36 000

- D Construct insulated bulkhead at each end to reduce frost formation inside cold duct After replacement of pipes, and conduit Install foamed-in-place product to seal service duct from Machine Room

Estimated cost of Option D \$1,150

*Preferred Option* C and D

These two options effectively replace the service duct covers and reduce the likelihood of future deterioration of the covers piping, and address the inflow of water or the accumulation of frost

Selective repairs are not as effective as reconstructing the covers due to the lower cost in completely removing the covers and casting replacements offsite

**3 1 1 7 Handrails & Barrier Rails**

*Problem/Deficiency*

The handrails and posts are slightly rusted, and the coating applied by the Department of Highways in 1985 is beginning to fail To preserve the condition of the handrails and posts, it will be necessary to repaint the components and to complete minor repairs in the future

The existing handrails are not adequate for the collision forces currently part of design codes Consequently the handrails would be seriously damaged by a vehicle collision and may fail completely during impact

The sidewalks are not separated from the roadway by a traffic barrier curb. Previous requirements found that a 150 mm to 200 mm (6" to 8") square curb was sufficient to protect pedestrians; however, current practice is to separate the sidewalk from the roadway to protect pedestrians using a low concrete wall.

Stairs to downstream observation deck is not adequate for public use due to the use of smooth surfaced treads and open railings. As the public is often permitted to use this area, the stairs must adequately provide protection according to the National Building Code.

*Alternatives for Repair/Replace*

- A Do nothing now. Plan for repainting in future to include sandblasting all steel, and repainting. Repair the post bases as required as soon as possible.

Estimated cost of Option A \$4,000 for the repair of post bases  
\$40,400 for sandblasting and repainting

- B Do nothing. Monitor the condition of handrails and do repairs when complete failure of coating or post bases is evident. This is anticipated to be within 10 years.

Estimated cost of Option B No initial cost. Approximately \$100,000 in future.

- C Reconstruct new upgraded handrail with new posts and handrails. This would include an upgrade of the handrails and posts to current standards.

Estimated cost of Option C \$158,400

- D Do nothing to upgrade observation deck. Close gate at roadway and do not permit the public to use this area at anytime.

Estimated cost of Option D No initial cost

- E Remove the existing stair treads and replace with serrated surface treads and new handrails with vertical bars at 100 mm (4") on center. Also, provide horizontal bars below and between treads to prevent object larger than 100 mm (4") from going through. Replace existing handrail around the deck with handrail in accordance with National Building Code (Balustrades at 4" on center).

Estimated cost of Option E \$7,500

*Preferred Option* E

The current bridge handrails are adequate for its current use and without the necessity for a complete rehabilitation of the bridge, it is not feasible to consider significant upgrades to the handrails and posts due to the cost of reconstruction.

The replacement of the handrails around the observation deck does have merit considering the volume of public use of the stair and deck when the deck is open.

### 3 1 1 8      Roadway Drainage

#### *Problem/Deficiency*

Drainage off the deck appears to function properly. The gratings were upgraded in 1985 during construction of new high density overlay on the roadway. The inspection indicated that the leader pipe to the underside of the bridge has some corrosion but is in good condition.

#### *Alternatives for Repair/Replace*

A      Do nothing. Repair and maintain drains only as required.

Estimated cost of Option A      No initial cost, ongoing maintenance cost.

B      Replace drains with new basins, gratings and leaders during any roadway deck repairs required in the future.

Estimated cost of Option B      \$13,980.

*Preferred Option*                      A

Since the drainage off the roadway deck is functioning adequately, it is not considered necessary to upgrade or replace it within the service life of the roadway deck.

### 3 1 1 9      Sidewalk Expansion Joints

#### *Problem/Deficiency*

The inspection of the sidewalk expansion joints found concrete cracking and deterioration near the ends of joints, and over the conduit due to thin concrete cover. The details of the expansion joint ends is not considered adequate, and caulking has been used to replace properly installed joint assemblies. The damage and loss of sidewalk expansion joint covers accelerates the deterioration and damage to the joint assemblies themselves (see Figure 5).

#### *Alternatives for Repair/Replace*

A      Do nothing. Maintain joints with caulking as required during the lifetime of the bridge deck.

Estimated cost of Option A      No initial cost.

B      Repair cracked concrete adjacent to roadway expansion dam, replace the expansion joint covers, and repair the expansion joints with caulking as required.

Estimated cost of Option B      \$13,000.

- C Proceed with the complete reconstruction of all expansion joints in distress. Use expansion joints installed by the Department of Highways in 1985 as they are and extend the seals around the remainder of the joint. Remove and replace concrete and expansion joint covers as required.

Estimated cost of Option C \$26 050

*Preferred Option* C

The expansion joints and seals provide protection to the bearing assemblies, the electrical and hydraulic services within the service duct, and to the bridge deck itself. Replacement of the deteriorating assemblies will provide continued protection to those systems through the lifetime of the Bridge. The reconstruction of the remainder of the expansion joint will likely be the responsibility of the Department of Natural Resources as the Department of Highways was responsible for the rehabilitation of the roadway joints in 1985.

### 3 1 1 10 Electrical Conduit Access Hatches

As the conduits are recommended for abandonment, it is not necessary to perform any remedial work.

### 3 1 1 11 Bridge Bearing Inspection Access

#### *Problem/Deficiency*

The bearings at the central pier are not readily accessible. The bearing shelf on neither the central pier nor abutments is wide enough to allow ready access. In addition, the electrical conduit access hatches at the abutments are welded shut and not suitable for use as an access for inspection of the bearings. This prevents routine inspection and maintenance as required to maintain the proper operation of the bearing assemblies.

#### *Alternatives for Repair/Replace*

- A Do nothing. Assume all bearing assemblies in good condition and operating as intended. Use Department of Highways inspection truck to access bearings to allow inspection and maintenance.

Estimated cost of Option A No initial cost

- B Strengthen the bridge girders to handle TAC B-Train configuration truck (62 500 kg GVW) if required by Department of Highways as future upgrade This vehicle represents a tractor semitrailer pulling two full size trailers It is not anticipated that this vehicle will use this crossing in the near future

Estimated cost of Option B \$180 000

*Preferred Option* A

Posting of ratings is normally done automatically by the Department of Highways after performing ratings of structures, and the structure has the potential for overloading due to traffic patterns The current use of the bridge is likely adequate for the foreseeable future It is not considered necessary to post load ratings or strengthen the bridge

### 3 1 2 Central Pier

#### 3 1 2 1 Control Room

##### *Problem/Deficiency*

The built-up asphalt roof is good condition but the loss of aggregate cover along the north edge will result in accelerated deterioration It is anticipated that there is at least 10 years life still available in existing the roof system The position and arrangement of the control room is shown in Figures 1 and 5

##### *Alternatives for Repair/Replace*

- A Do nothing with existing roof system Plan to replace the roof with similar system in future (approximately 10 years) as required including new vent covers and edge flashings

Estimated cost of Option A \$3,700

- B At the end of the useful life of the current built-up roof, replace with fully bonded synthetic roof membrane and new flashings May require the construction of a parapet or curb, and scuppers

Estimated cost of Option B \$5,850

*Preferred Option* B

The application of a synthetic roof membrane to the concrete substrate will extend the lifetime of the roof system to in excess of 30 years This will produce a cost effective roof system which can be easily repaired or maintained

- B In coordination with the proposed abandonment and removal of existing electrical conduit remove the welded access hatch covers. Remove the lower conduit cover and properly inspect rocker bearings to confirm their condition and operation. After inspection modify and reinstall the lower conduit cover and replace the access hatches and reweld. Inspect the central pier bearings by installation of safety lines or scaffolding as required. At the time of this inspection, the bearing assemblies should all be cleaned and serviced as required.

Estimated cost of Option B \$12 000

- C In coordination with the proposed abandonment of the electrical conduits repair access hatches on abutment covers and provide adequate locking arrangement to prevent access. Remove the lower conduit cover plate at the abutments. Construct guard rails or platforms along bearing shelf to allow access to the bearings at both the central pier and abutments.

Estimated cost of Option C \$42,000

*Preferred Option* A

The routine maintenance of the bearing assemblies is necessary for their proper function, but this can not be accomplished without access. As with other bridge structures inspection and maintenance can be performed with the use of an inspection vehicle.

### 3 1 1 12 Load Rating

#### *Problem/Deficiency*

The bridge load rating was recently completed by the Department of Highways due to an internal request. The current load rating is below maximum potential vehicle (Transportation Association of Canada defined vehicle called a B-Train, ie a double trailered highway tractor with a G V W of 62 500 kg )

In 1994 a load rating was completed by Department of Highways which indicates the bridge is adequately rated for a Semi-Tandem truck configuration (47 500 kg G V W ) This represents a tractor semitrailer with a triple rear axle. This does not allow the maximum allowable highway vehicle to use the bridge but it would appear to be adequate for the current use.

#### *Alternatives for Repair/Replace*

- A As the rating for the Bridge has been upgraded from its design rating it is not necessary to take any action on the rating.

Estimated cost of Option A No initial cost

*Problem/Deficiency*

A potential risk exists due to the location and significance of the Control Room. Wire mesh over windows protects against stones and other objects from breaking windows. Additional protection is not considered necessary as the risk from smaller objects is not considered significant.

*Alternatives for Repair/Replace*

- A Add layer of Lexan (projectile resistant plastic) to interior of windows to add protection for interior. Add layer of steel plate to interior of infilled windows to complete protection. Repaint and replace wire mesh on exterior of windows.

Estimated cost of Option A \$5,600

- B Do nothing to upgrade control Room for protection from projectiles. These must be considered rare and unlikely event to cause injury or significant damage.

Estimated cost of Option B No initial cost

*Preferred Option* B

Injury or damage from a projectile entering the Control Room is a very unlikely occurrence and should not be regarded as a significant concern. Regardless of the measures taken, there will always be some risk to the staff from this sort of situation. It is not practical to fortify the Control Room given the risk level.

*Problem/Deficiency*

The wall and exterior door at the north side of the Control Room is subject to regular vandalism. The spray painting of the wall can not be readily deterred, although options do exist. This has required regular repainting of the wall to cover the graffiti. Discussions with several organizations within the City indicate that there are numerous solutions, however only a few have proven of any success.

*Alternatives for Repair/Replace*

- A Do nothing to prevent graffiti on the Structure. This will require routine repainting as currently is the practice by the Department of Natural Resources.

Estimated cost of Option A No initial cost ongoing maintenance cost

- B Paint a suitably designed mural with the assistance of the local high school on all accessible walls. Upon completion of the mural, application of a coating of anti-graffiti coating to protect the mural. Experience by the Exchange District Business Improvement Zone, and Take Pride Winnipeg indicate this option is currently the most successful approach to this problem.

Estimated cost of Option B \$3,050

- C Select a grey coloured, low cost stucco paint to be used for covering of the graffiti as required This method is the current philosophy of the City of Winnipeg

Estimated cost of Option C \$300 likely twice annually

- D Apply antigrffiti coatings to all accessible walls and remove graffiti as it occurs with a pressure washer This coating is typically good for only two washdowns must be recoated

Estimated cost of Option D \$800 annually

*Preferred Option* A

Continue to paint over graffiti as required

#### *Problem/Deficiency*

The attempts to break into the Control Center through the exterior door result in regular and costly repairs to the door hardware and locks

#### *Alternatives for Repair/Replace*

- A The existing door and lock arrangement have been upgraded several times in the past to resist the damage caused by vandals The existing system can be assumed to be adequate and will require routine maintenance as damage occurs

Estimated cost of Option A No initial cost

- B Remove the existing door and frame and replace with a multilayered door and frame, with an outer layer of steel plate and a reinforced interior frame The locks and hinges should be integral to the system to allow protection

Estimated cost of Option B \$2,000

*Preferred Option* A

Although being damaged regularly the current door and frame appear to be holding up well despite damage, and occasional repairs The use of deadbolt locks and concealed hinges adequate secures the door

### **3 1 2 2 Machine Room**

#### *Problem/Deficiency*

Originally the Machine Room (Figure 2) was an uninsulated concrete room, with the Roadway above forming the roof, and all walls being exterior walls Consequently rigid foam insulation was mechanically attached to the ceiling to provide some insulation to the room, and perhaps to deal with the formation of frost on the interior ceiling Present fire protection requirements state, however that all exposed foam insulation must be protected by a suitable product to prevent the

spread of flames. This protection must then be mechanically fastened to the framing or structure beyond the foam. This is clearly stated in Clause 3.1.5.11 (Combustible Insulation and its Protection) of the 1995 National Building Code which states

*4) Combustible insulation having a flame-spread rating more than 25 but not more than 500 on any exposed surface or any surface that would be exposed by cutting through the material in any direction, is permitted in the interior walls, within ceilings and within roof assemblies of a building required to be of noncombustible construction provided the insulation is protected from adjacent space in the building other than adjacent concealed spaces within wall assemblies, by a thermal barrier as described in Sentence (2) except*

Sentence 2 states

*2) Foamed plastic insulation having a flame-spread rating not more than 25 on any exposed surface or any surface that would be exposed by cutting through the material in any direction is permitted in a building required to be of noncombustible construction provided the insulation is protected from adjacent space in the building other than adjacent concealed spaces within wall assemblies by a thermal barrier consisting of,*

- a) not less than 12.7 mm thick gypsum board mechanically fastened to a supporting assembly independent of the insulation,*
- b) lath and plaster mechanically fastened to a supporting assembly independent of the insulation,*
- c) masonry*
- d) concrete or*
- e) any thermal barrier that meets the requirements of classification B when tested in conformance with CAN4-S124-M*

#### *Alternatives for Repair/Replace*

A Place one layer of fire resistance drywall on the ceiling to cover insulation, using mechanical fasteners

Estimated cost of Option A \$1,850

B Do nothing at this time which may result in a citation for violation of Fire Code requirements

Estimated cost of Option B No initial cost

C Remove the foamed plastic insulation from the ceiling of the Machine Room

Estimated cost of Option C \$1,850

D Remove foamed plastic insulation and replace with acceptable non-combustible insulation

Estimated cost of Option D \$4 150

*Preferred Option* A

The protection of the insulation permits the insulation to remain in place for the lowest cost  
It is not acceptable to allow the insulation to remain unprotected

*Problem/Deficiency*

Cracking of concrete was found in the inspection adjacent to windows and at other joints in the Machine Room There is no evidence of movement of the structure, or of local deterioration of the concrete which would result in this type of cracking

*Alternatives for Repair/Replace*

A Use suitable crack injection compound and seal the cracks from the interior

Estimated cost of Option A \$5 000

B Install monitoring pins and crack gauges across significant cracks Perform regular monitoring of any movements to identify persistent movement or static condition

Estimated cost of Option B \$1,000

C Do nothing Evaluate visually the cracking at regular intervals in future

Estimated cost of Option C No initial cost

*Preferred Option* C

The cracking does not appear to be causing any distress in the Structure or equipment A visual assessment, and possibly annual photographic records could allow monitoring of the cracks without measurements being required This is the most appropriate method of addressing this deficiency

**3 1 2 3 Cylinder Pits**

*Problem/Deficiency (Cylinder Hoist Supports)*

The seepage of runoff into the cylinder pits has resulted in corrosion of the cylinder support bridge members which support the main gate hydraulic cylinders, as shown in Figures 2 3 and 6 The condition of several of the anchor bolts is poor and a review of installation details suggest that the bolts may be susceptible to hidden corrosion

This is of particular concern as the cylinder support bridges are required to resist an upward force when the main gates are pushed down. The gates and hydraulic system are configured to accommodate the loss of one cylinder; however, the sudden failure of the support bridge anchors may result in damage to the cylinders or piping. These components must be repaired to maintain the reliability of the Structure.

*Alternatives for Repair/Replace*

- A Remove and replace corroded cylinder support bridge members including new anchor bolts on all cylinders. To replace the support bridge, it will be necessary to support the hydraulic cylinders on temporary beams while the support bridge is removed and replaced.

Estimated cost of Option B \$61,400 for four bridges

- B Remove all anchor bolts, sandblast and repaint all support bridge members; install new corrosion resistant anchors. Repair seriously deteriorated bridge members as required. To adequately repair the bridge, it may be necessary to support the cylinders on temporary beams while the support bridge is removed and repaired.

Estimated cost of Option C \$18,400 for four bridges

*Preferred Option* A

Complete replacement of the cylinder support bridge is the most reliable method of rehabilitating the support bridges. It is considered necessary to repair the support bridge to ensure its structural capacity is available during operation of the main gates.

*Problem/Deficiency (Access and Maintenance)*

The practice of greasing the cylinder support guides is being discontinued due to the risk involved; however, the greasing has proven to be beneficial. Safer access for maintenance personnel would be required to maintain this procedure.

In addition, it has been very difficult to inspect the piping and cylinder end due to its position. The 1994 failure of hydraulic piping above the cylinder end suggests that this area should be inspected and maintained regularly. This also suggests that safer access is also required to allow routine inspection.

*Alternatives for Repair/Replace*

- A Discontinue greasing of cylinder support guides and replace with regular inspections of these areas approximately every five years.

Estimated cost of Option A No initial cost

- B Provide a safe method of accessing the entire length of the cylinder support guides with a portable or movable platform. The platform would be located at a particular elevation and allow safe access to grease and inspect the cylinder shaft annually. Figure 6 illustrates this arrangement.

Estimated cost of Option B \$71 000

- C Do nothing to provide access to the cylinder end and associated piping. Construct temporary platforms or scaffolding to reach the work areas. Do complete inspections and maintenance every five years or as required.

Estimated cost of Option C \$12,000 for each use

- D In conjunction with repairs being made to the cylinder support bridge, provide access platform to the cylinder head and piping from the existing ladders and platforms. This is illustrated in Figure 6.

Estimated cost of Option D \$36 800 for two pier locations  
\$48 400 for two abutment locations

- E In conjunction with the repairs or replacement of platforms and ladders within the cylinder pits, it is possible to access most of the cylinder support guides by installing hinged platforms onto the new platforms. Maintenance staff would be able to drop a platform into place, work on the cylinder guides as required, and then pull the platform into its stored position. The cost of this option is based on the assumption that new platform and ladders will be constructed in the pier and abutments. The cost is based on the assumption that new platforms and ladders are installed to replace the existing ones.

Estimated cost of Option E \$49,300 for central pier (two locations)  
\$49 300 for two abutment locations

*Preferred Option* D and E

The steel components of the cylinder truck guide and the cylinder support guides require regular maintenance to provide a protective coating of grease. This has proven very successful for mitigating corrosion. Consequently, the procedure of greasing the surfaces has significant merit. Providing access platforms will ensure access is available for ongoing maintenance and inspection.

### 3 1 2 4 Sump Pit

#### *Problem/Deficiency*

Several construction joints show signs of opening or slight movement which in turn have allowed the seepage of water into the Sump Pit. The river water carries sufficient carbonates to allow the formation of calcite formations on the Sump Pit walls in combination with the concrete constituents. Although this does not impede operations, and is not a significant concern, the presence of the open joints may lead to eventual deterioration of the concrete adjacent to those joints. Figure 2 shows the location of the sump pit.

#### *Alternatives for Repair/Replace*

- A Do nothing to prevent the formation of calcite and the presence of open joints. Inspect the joints at regular intervals to assess any deterioration.

Estimated cost of Option A No initial cost

- B Perform crack injection with a suitable crack filling agent after cleaning up calcite accumulations on the walls.

Estimated cost of Option B \$9,000

*Preferred Option* A

Many construction joints within the Structure appear have moved slightly or are open. As there appears to be no noticeable deterioration adjacent to the joints and cracks, remediation is not essential. To preserve the integrity of the Structure for an additional 30 years, it may be necessary to address this problem in the future.

#### *Problem/Deficiency*

As with other locations, the combination of humid environment and wet-dry cycles on coatings and steel framing has resulted in extensive corrosion of some platforms and portions of some ladders. Several platforms have corroded to the extent that they are unsafe and require immediate repairs. The ladders and platforms are illustrated in Figure 2.

#### *Alternatives for Repair/Replace*

Replace interior platforms and ladders using galvanized components or aluminum to prevent corrosion. Sandblast all embedded plates and assess their condition. If their condition is acceptable, then reuse them, otherwise remove and replace.

Estimated cost of work \$25,000

- B Sandblast all existing platforms, handrails and ladders and apply a zinc rich paint to protect existing members. Replace all components which are significantly corroded or repair as required. Remove all existing grating and replace with galvanized or aluminum serrated edge gratings.

Estimated cost of Option B \$8 000

*Preferred Option* A

Rehabilitation of the existing steel platforms will not adequately prevent further deterioration and hidden corrosion from continuing. Replacement with hot dipped galvanized components will ensure a long term corrosion resistant ladder and platform system.

### 3 1 2 5 Downstream Observation Platform

#### *Problem/Deficiency*

The removable floor panels are not sealed and allow runoff from the observation platform into the cylinder pits below. In addition, the lifting lug recesses drain to the interior. Consequently, the steel framing around the deck panels is corroded and deteriorating (see Figure 5).

The runoff also contributes to the corrosion of hydraulic piping, steel framing for platforms, hatches and ladders. As the runoff could be diverted away from the access panels, this could be mitigated.

#### *Alternatives for Repair/Replace*

- A Do nothing with the panels and monitor their condition and replace as deterioration warrants it. Upgrade design of panels as they are replaced. Replacement would be necessary within 15 years due to corrosion of the embedded members.

Estimated cost of Option A No initial cost

- B Remove the existing panels, sandblast the steel framing and paint with a zinc rich paint. Sandblast and repaint all embedded framing as well. Enlarge the existing drain holes in the lifting lug recesses and install small lengths of pipe to provide a drip edge. Upon reinstallation of the panels, install waterproof gaskets and caulking material around the panels.

Estimated cost of Option B \$24 150 for Central Pier Lift-Off Covers  
\$31 200 for Abutment Lift-Off Covers

- C Construct new panels with galvanized components and redesigned lifting lugs. Crown the panels to prevent water accumulations. After replacing the panels, install waterproof gaskets and caulking material.

Estimated cost of Option C \$34 800

*Preferred Option* B

The current condition of the lift-off panels allows for their rehabilitation through the application of corrosion inhibiting coatings and revised installation details including waterproof seals. Although replacement is an option, its cost is prohibitive in comparison to rehabilitation.

#### *Problem/Deficiency*

Graffiti on the downstream wall of the Machine Room is also an ongoing problem similar to the downstream wall of the Control Room. Repainting of the wall is required regularly and must be resolved in a manner similar to the Control Room wall.

#### *Alternatives For Repair*

- A Do nothing to prevent graffiti on the Structure. This will require routine repainting as currently is the practice by the Department of Natural Resources.

Estimated cost of Option A No initial cost, ongoing maintenance cost

- B Paint a suitably designed mural with the assistance of the local high school on all accessible walls. Upon completion of the mural, application of a coating of anti-graffiti coating to protect the mural. Experience by the Exchange District Business Improvement Zone, and Take Pride Winnipeg indicate this option is currently the most successful approach to this problem.

Estimated cost of Option B \$3 050

- C Select a grey coloured, low cost stucco paint to be used for covering of the graffiti as required. This method is the current philosophy of the City of Winnipeg.

Estimated cost of Option C \$300 per application. Likely \$600 per year.

- D Apply anti-graffiti coatings to all accessible walls, and remove graffiti as it occurs with a pressure washer. This coating is typically good for only two pressure washings before being recoated.

Estimated cost of Option D \$800 annually

*Preferred Option* A

Continue doing ongoing maintenance to deal with vandalism.

### 3 1 2 6 Hatches

#### *Problem/Deficiency*

The condition of the Machine Room roof hatch indicates that the hatch is not in use and does not provide a weatherproof seal. It will be necessary to improve the seal of this hatch and prevent further deterioration. Photograph No. 7 illustrates the level of deterioration. The hatch is identified on Figure 5.

#### *Alternatives for Repair/Replace*

- A Disassemble the hatch, sandblast all metal components, repair components only as necessary, paint with a suitable zinc rich paint, install gaskets and reassemble hatch and seal it.

Estimated cost of Option A \$3,220

- B Remove existing hatch, and install new hatch with adequate seals, drainage, and more robust locking mechanism. Install on the interior an insulated door and secondary seal.

Estimated cost of Option B \$3,800

- C Remove existing hatch and infill hatch opening with concrete. Replace the capacity to remove large components (pumps, motors, etc.) from the machine with a monorail beam which can be extended out the Machine Room doors to the downstream observation deck where the components could be removed by a truck mounted hoist.

Estimated cost of Option C \$3,680

#### *Preferred Option B*

The replacement of the roof hatch is more economical than the installation of monorail beams and the closure of the hatch opening permanently. The access for equipment installation or removal is easier through the existing hatch than through the Machine Room doors.

Repair or replacement is necessary as the condition of the existing hatch will continue to deteriorate, thereby allowing water to seep into the Machine Room. The hatch will require repairs in the near future to prevent further deterioration, and ensure security.

In addition, the hatch above the Sump Pit is required to allow the potential removal and replacement of piping and pumps within the Sump Pit.

#### *Problem/Deficiency*

The access hatches into the cylinder pits are moderately corroded as they were originally protected against corrosion by standard paint systems. The corrosion of the hatches has reduced their ability to seal properly and support expected deck loads. Improper sealing allows runoff to enter the cylinder pits below and contribute to corrosion within.

In addition to the deterioration of the hatches the current method of locking the hatches using an exposed padlock has not been effective due to vandalism of the locks. To provide proper security, the method of locking the hatches should also be upgraded.

*Alternatives for Repair/Replace*

- A Sandblast the existing hatches in place and repaint with zinc rich paint with suitable top coat. Repair hatches only as required, and install new lock hasps.

Estimated cost of Option A \$5,000 for two pier hatches only  
\$5,000 for two abutment hatches only

- B Remove existing hatch, and install new hatch with adequate seals, drainage, and more robust locking mechanism. This option assumes the lift-off panel does not get replaced.

Estimated cost of Option B \$11,000 for two pier hatches only  
\$20,000 for four abutment hatches only

*Preferred Option* B

The condition of the hatches dictate that repaint and repairs will be required within five years and will not adequately improve the hatches to prevent seepage into the cylinder pits, nor prevent illegal entry.

**3 1 2 7 Platforms and Ladders**

*Problem/Deficiency*

Egress and ingress from the deck to the ladder is awkward because of the placement of hatches in relationship to the position and orientation of the ladder. The depth of the hatch framing also places the ladder's top rung well below the deck elevation.

The combination of humid environment and wet-dry cycles on coatings and steel has resulted in extensive corrosion of some platforms and portions of some ladders. Several platforms have corroded to the extent that they are unsafe and require immediate repairs.

*Alternatives for Repair/Replace*

- A Replace interior platforms and ladders using galvanized components or aluminum to prevent corrosion. Sandblast all embedded plates and assess their condition. If their condition is acceptable, then reuse them, otherwise remove and replace. Figure 6 shows an arrangement similar to the proposed arrangement.

Estimated cost of Option A \$49,800 for pier cylinder pits  
\$50,000 for abutment cylinder pits

- B Sandblast all existing platforms handrails and ladders and apply a zinc rich paint to protect existing members Replace all components which are significantly corroded, or repair as required Remove all existing grating and replace with galvanized or aluminum serrated edge gratings

Estimated cost of Option B \$15 400 for pier cylinder pits  
\$16,000 for abutment cylinder pits

*Preferred Option* A

In conjunction with the desire to access the cylinder ram and the cylinder truck guides the platforms should be replaced to provide a new configuration which will allow access and will replace the corroded and failing steel members

Rehabilitation of the existing steel platforms will not adequately prevent further deterioration and hidden corrosion from continuing Replacement with hot dipped galvanized components will ensure a long term corrosion resistant ladder and platform system

### 3 1 3 Abutments

#### 3 1 3 1 Bulkhead Gates

##### *Problem/Deficiency*

The inspection of the bulkhead gate (Figures 2 and 6) found the rollers frozen in place and evidence that the rollers had been sliding rather than rolling for some time The downstream face of the frozen rollers were worn flat This may be caused by the corrosion of the brass washers and the cast iron rollers, axles and bushings The expansion of the corrosion products may have jammed the roller in place on the axle Due to the accumulation of silt it was not possible to confirm this

##### *Alternatives for Repair/Replace*

- A Do nothing with the gate rollers The excess capacity of the hoist is capable of overcoming the sliding friction of the frozen rollers

Estimated cost of Option A No initial cost

- B Disassemble the rollers and axles Clean and adjust rollers as necessary to return the existing rollers to service The existing rollers will require machining to remove the flat spot The bumpers will require adjustment

Estimated cost of Option B \$22,600

- C Remove and replace the axles thrust washers, bearings and rollers with new components  
The bumpers will require adjustment to suit the new roller position

Estimated cost of Option C \$45,500 for both gates

*Preferred Option* C

The frozen rollers will continue to wear with use. Once the hardened outer layer of the rollers is lost, the wear rate will increase. Ultimately, this may result in binding or jamming of the bulkhead gate in place. Rehabilitation of the existing rollers is not recommended due to the relative cost and the original selection of roller and washer material. Both materials are very susceptible to corrosion, and will likely result in freezing of the rollers in place in the future. A long term solution to ensuring roller performance is the complete replacement of the assemblies with components designed to current standards.

#### *Problem/Deficiency*

The inspection found the bulkhead gate to be heavily laden with silt. This is likely the result of having the gates immersed in the water for extended periods. This accumulation of silt adds to the weight of the gate significantly, although does not exceed the existing capacity of the existing hoist arrangement.

#### *Alternatives for Repair/Replace*

- A The silt accumulation can be washed off the bulkhead gates on a regular basis through the installation of a pressure wash station, which is discussed in detail in the section on desilting arrangements.

Estimated cost of Option A Cost is associated with desilting system proposed within Section 3.2.3

- B A downstream skinplate can be added to the gate which may reduce the accumulation of silt within the gate. The resulting chambers within the gate would require drainage and regular inspection to ensure that corrosion did not develop.

Estimated cost of Option B \$9,000 for both gates

- C The flanges of the main beams of the gate may be drilled through to allow water to flow freely from the recesses formed by the horizontal beam flanges. This may assist in flushing the silt off the gate.

Estimated cost of Option C \$1,000 for both gates

*Preferred Option* A

The availability of the pressure wash station within the abutment can be easily used to clean the bulkhead gates. This will allow complete inspection, and ease maintenance of the gates without additional cost, or maintenance effort.

*Problem/Deficiency*

During past use of the bulkhead gate for dewatering the main gates it was necessary for a plywood bulkhead to be installed over the inlet opening to permit dewatering. The gate was apparently ineffective in properly sealing the entrance. There may be several explanations for this occurrence. The most likely is the accumulation of small debris, such as gravel or silt on the sill below the gate. Upon lowering the gates, the lower edge of the gate would rest on the debris, thereby preventing a proper seal.

*Alternatives for Repair/Replace*

- A As the flow rates over the sill are not sufficient to ensure the flushing of material, it may be necessary to use divers to clear the sill before using the gate for dewatering. This will require raising of the trash rack to allow the diver to reach the bulkhead gate sill.

Estimated cost of Option A \$2 000 for both gates on every occasion that dewatering is required, which is likely less than once per year.

- B The seal across the sill may be improved through the installation of a rubber knife-edged seal. This will accommodate smaller objects resting on the sill.

Estimated cost of Option B \$12 700 for both bulkhead gates.

- C An air burst system may be used to clear the sill prior to lowering the gate into place. A burst of compressed air is released from nozzles mounted on the gate. The resulting boil of water dislodges and moves debris on the sill, allowing proper placement on the sill. Currently, there are no examples of this system in use although it has been discussed theoretically in relevant literature.

Estimated cost of Option C \$20 000.

*Preferred Option* B

The installation of a lower sill seal is the most cost effective method for attempting to improve the sealing of the gate. The use of divers or an air burst system may be employed if the rubber sill seal proves ineffective due to the accumulation of debris.

*Problem/Deficiency*

The inspection of the gate showed that the protective coating was in very good condition, although there were large surface areas which were not visible due to the accumulation of silt. Based on the recommendation for repairs to the rollers and sill and the age of the existing protective coating (30 years), it is advisable to also replace the coating system on the gates. Due to the small size of the gates they could be transported to the contractor's facilities to allow sandblasting and painting under controlled conditions.

Estimated cost of repainting bulkhead gates while being repaired \$4,000.



*Alternatives for Repair/Replace*

A Do nothing concerning the trash racks under the assumption that they are in good condition

Estimated cost of Option A No initial cost

B During replacement of the chain hoist (discussed below) the trash racks could be removed from the structure transported to a fabricators facility for sandblasting and repainting This would also permit a detailed inspection and any repair work on a contingency basis

Estimated cost of Option B \$6,500 for both trash racks

C During the replacement of the chain hoist, the trash racks will be raised sufficiently to allow complete inspection and determine if damage or corrosion warrant repairs or to permit the trash racks to be returned to service as they are

Estimated cost of Option C \$2,000 for both trash racks

*Preferred Option* B or C

The condition of the trash racks should be determined by inspection to prevent any potential for problems with raising or lowering of the trash racks or bulkhead gates The construction of the trash racks is sufficiently robust as to assume it is in serviceable condition

**3 1 3 4 Trash Rack Guides**

As with the bulkhead gate guides the guides for the trash racks were not inspected adequately due to safety concerns The recommendations and options for addressing the condition of the trash rack guides are similar to those of the bulkhead gate guides

The estimated cost of the inspection is \$6,000

**3 1 3 5 Cylinder Pits**

The arrangement of the cylinder pits (Figure 6) in the abutments are similar to those in the central pier with the following exception The cylinder pits are directly below the parking areas on the roadway above Consequently, the runoff from vehicles and roadway tends to contain salts Therefore the rate of corrosion of the hydraulic piping support bridge and steel components is much higher The deterioration has progressed significantly in both abutments

The options for repairs and rehabilitation of components within the cylinder pits are identical to the central pier cylinder pits

The costs for rehabilitating the cylinder support bridge is listed in Section 3 1 2 The access platforms for the maintenance and inspection of the cylinder and ram are also listed in Section 3 1 2

### **3 1 3 6 Hatches, Ladders and Platforms**

As noted above the condition of hatches in the abutments is worse than those in the central pier It is recommended that the existing hatches, ladders, and platforms be removed, and replaced Figure 6 illustrates the proposed arrangement of new access ladders and platforms for within the abutment

The cost associated with the replacement or rehabilitation of the hatches, ladders, and platforms are previously discussed in Sections 3 1 2

### **3 1 3 7 Upstream Retaining Walls and Downstream Abutment Wall**

#### *Problem/Deficiency*

The identification of cracks at the upstream rounded corners of the upstream retaining wall to the abutment wall suggests some manner of distress within that portion of the Structure These cracks occur on both sides of the Structure in the identical location The similarity in location implies the same mechanism caused the cracking Unfortunately no prior record of this cracking has been made

As the Abutment and retaining walls are founded on bedrock the possibility of settlement is unlikely However, due to geometry there is a potential for cracking due to shrinkage of the concrete or temperature stresses within the walls At present, there appears to be no cause for concern, and it is not possible without a detailed investigation to determine the cause or recommend suitable remediation methods

#### *Alternatives for Repair/Replace*

- A Do nothing about cracking Assume future inspection of structures will determine if cracks are enlarging and to what extent

Estimated cost of Option A No initial cost



- B Stabilize the Transformer Pad through the installation of a deep foundation. The installation of cast-in-place piles may be accomplished by the cutting of openings through the transformer pad and excavating embankment material while placing a steel casing to support the hole. The casing can then be removed while the hole is being filled with concrete thus completing the pile. This may be accomplished without interrupting service to the Floodway Structure.

Estimated cost of Option B \$40,000

- C During a normal late summer shutdown, disconnect service, remove existing transformers and remove the existing transformer pad. Once removed, excavate to the face of the abutment and construct new transformer pad supported off brackets attached to the abutment. Replace the conduits, transformers and backfill.

Estimated cost of Option C \$17,000

- D Use a suitable soil improvement technique such as insitu grouting to improve the stability of the slope and physical properties of the soil. This method will not require significant excavations or costs, but may not completely address the problem.

Estimated cost of Option D \$10,000

*Preferred Option* C

The risk of an eventual power disruption can be readily offset by attaching the transformer pad to the abutment structure, thereby providing a new foundation to the pad without significant excavation. Due to the difficulty in constructing a deep foundation in layered riprap, the demolition of the transformer pad and construction of a new pad supported off the abutment structure is considered more easily constructed.

Manitoba Hydro confirmed that ownership of the Transformer Pad is with the Department of Natural Resources, and the transformers are the responsibility of the utility. Consequently, the Department of Natural Resources would be responsible for its repair and maintenance.

### 3.1.4 Main Gates

#### 3.1.4.1 Main Gate Seals

*Problem/Deficiency*

The gate seals are primarily required for dewatering the gates. With the gates down and sealed, the gate chamber can be effectively dewatered for routine maintenance or inspection. To maintain this original design function, the gate seals will have to be restored.

According to statements from various sources the original seals installed in the main gates operated properly for a long period of time but leakage tended to increase over the years. This was confirmed by an earlier report (Acres, 1988) which stated that dewatering required two days in 1970 but increased to about one week by 1979. Currently the seals are ineffective in sealing the gates to allow dewatering.

During the raising and lowering of each gate, it was noted that at each of the upstream and downstream corners of the gates a noticeable amount of leakage was occurring through the seals. In a 1988 inspection report (Acres), the leakage was reported at the upstream corners only. It can be concluded that the condition of the seal corner details has deteriorated more than the body of the seals since construction. This may be due to the use of rectangular block seals which have a greater tendency to bind than bulb seals.

The inspection of the seals by divers in March 1996 indicate that the seals vary in condition from good and intact to damaged and in poor condition. The divers reported that small gaps exist between the seals and abutment wall. These gaps were reported to range between 3 mm (0.125") and 5 mm (0.2"). Several pieces of debris were reported stuck in the downstream seal.

Based on these reports, it appears the original seal configuration worked adequately. A review of the seal design also suggests that the seal arrangement was adequately designed and detailed.

Available as-built drawings indicate that some modifications of the downstream seal were required to overcome a "bulge" in the downstream skinplate. A shim plate was installed on the top edge of the gates to provide a proper seal when the gates were lowered to their proper position. This may allow a gap to exist between the seal and the downstream skin plate when the gates are raised any amount. This may be the cause of the debris (sticks, signs) being caught in the East Gate downstream seal.

The protective rubber flap installed along the top downstream edge upstream skinplate of the East Gate has proven ineffective, and is seriously damaged. The intent of the rubber flap was to protect the downstream seal from debris and silt accumulations while the gate is lowered. The loss of bolts securing the flap are contributing significantly to the inflow of water into the gate.

#### *Alternatives for Repair/Replace*

There are two philosophies for the dewatering of the main gates based on the current condition and known performance of the present seal configuration.

- A The first approach for dewatering of the main gates is to completely abandon the existing seals and to perform the necessary sealing of the main gate by employing divers to place pipes, gaskets, and oakum as required to permit dewatering. This would be required each time the gate were to be inspected or the silt within the gate recess removed.

Estimated cost of Option A \$37,500 to seal two gates for 4 months

- B The second approach assumes that the existing seals will be removed, and new brass clad seal assemblies installed on the gates. The assemblies would then be readjusted and all other penetrations through the skinplates repaired as required. It is assumed that replacing the seals would make it possible to dewater the main gates with minimal diver intervention.

It is assumed that the new brass clad seals would deteriorate more slowly and require replacement in approximately 25 years. Brass clad seals are recommended for applications in which the seals are subject to sliding over a rough surface.

If the system of seals around the gate is to be maintained, there are three options, which are listed below:

Estimated cost of Option B is the lowest of the following three options: \$403,600

- a The seals themselves may be replaced without any change to the configuration of the seals or gate. This will require dewatering to install, repair, or maintain the seals since access to the seals must be from above and below the dewatered gate.

Estimated cost of Option a: \$403,600 for both gates

- b The seal arrangements can be used again, but with changes to the installation arrangements, which will allow all the seal assemblies to be removed to the exterior of the gate without working from the interior. This would significantly ease the repair or replacement of seals. This is illustrated in Figure 8.

Estimated cost of Option b: \$439,200 for both gates

- c Completely re-examine the design and installation of the seals. It is felt that the bulkhead inlets would permit sufficient water flow into the gate to offset any leakage through the downstream seals. The current configuration and condition of the seals closely represents this condition. The principle need for the gate seals is to permit dewatering of the gate. This may be accomplished by the use of actuated seals or inflatable seals. A conceptual arrangement of the inflatable seal is illustrated in Figure 9.

When dewatering is required, the seals would be inflated to provide an adequate seal against the gate. This approach is conceptual as there are no examples of this method to our knowledge. Although the option is presented in concept only at this time, we are confident that the details could be refined at the prototype stage. A similar type of inflatable seal has been used to seal STRAFLO turbines in the stationary position. Significant advantages associated in long term would be achieved with an actuated seal arrangement as the seal would only be activated when required and could effectively extend the life indefinitely.

Estimated cost of Option c: \$624,000 for both gates

*Preferred Option* B with replacement seal arrangement - Option b

Option B is presented as the preferred option at this time. At the final design stage the inflatable seal alternative would be re-evaluated and utilized if all parties were satisfied as this alternative has the potential to significantly reduce the long-term maintenance. Costs differentials for the inflatable seal option would also have to be evaluated.

Discussions with Ministry of Natural Resources indicate that they are prepared to accept using divers to seal the gate when necessary. This will limit access to the gate to planned dewatering events or to a delay of 1 to 2 weeks in an emergency. As such, costs associated with restoring the seals will be postponed indefinitely.

### **3 1 4 2      Skin Plates**

#### *Problem/Deficiency*

The visual inspection of the upstream and downstream skinplates indicate that they have been subject to localized impact loads, and to various forms of corrosion. The corrosion is very evident along the edges of the upstream skinplate, and appears as pitting and general corrosion. The downstream skinplate is also corroded and has abrasion marks from debris caught in the downstream seal. This deterioration is unavoidable to some extent due to the location and operating environment of the gates.

#### *Alternatives for Repair/Replace*

A      The skinplates can be repaired to address more significant pitting and wear. The skinplates can then be sandblasted and repainted with a wear resistant protective coating.

Estimated cost of Option A    \$125,500 for both gates

B      The skinplates can be sandblasted and only very serious damage or corrosion repaired based on the condition of the steel after sandblasting. After completing the required repairs the entire gate surface would be coated with an abrasion resistant protective coating.

Estimated cost of Option B    \$96,500 for both gates

#### *Preferred Option      A*

Repairing or replacing the entire skin plate is not practical due to the large area requiring work and because of the length of time required to complete the work. The most appropriate alternative would be the inspection, performance of only necessary repairs, and repainting of the skinplates.

### 3 1 4 3 Internal Main Gate Steel Structure

The structural integrity of the gates and supports have been reviewed separately and the results are documented in Appendix H of this report. Any necessary structural modifications and overall performance are discussed separately within Appendix H.

#### *Problem/Deficiency*

During dewatering of the gate interiors, foam insulation from the underside of the top skinplate partially plugged the intake screen (installed in 1988). This problem has occurred in past dewatering operations. It can be assumed that this will continue to hamper dewatering operations.

Due to the nature of the gate structure, the foam insulation of the gate top skinplate interior is of limited insulation value, and due to its deterioration has developed into an ongoing maintenance problem.

#### *Alternatives for Repair/Replace*

- A Remove all insulation mechanically from the interior of the skinplate and remove the debris from the gate interior. This may be done with a light sandblasting which will remove the foam and some of the interior protective coating. Alternately, the foam may be removed by manually scrapping the foam off, which reduces the damage to the protective coatings.

Estimated cost of Option A \$30 500 for both gates

- B Leave the foam in place and remove it as opportunity permits during routine inspections and maintenance. This may allow additional foam to break free and congest the sump pit intakes.

Estimated cost of Option B No initial cost, ongoing maintenance cost

#### *Preferred Option A*

The foam insulation has been an ongoing problem with the dewatering pumps, and should be removed when possible. As other work on the gates, this is recommended for the near future as the incremental cost for removal of the foam is relatively small.

### 3 1 4 4 Trunnions

#### *Problem/Deficiency*

The trunnions were last inspected in 1987/1988 and have not been adequately inspected for an extended period of time. Access to the trunnions is very difficult because of the limited space and current difficulties with dewatering and desilting. As noted in the 1988 inspection report (Acres), the trunnion bearings should be greased regularly to flush dirt and debris off the bearing surfaces. This is not necessarily required as the bearings are of a self-lubricating (Lubrite) type. With good access this need can be assessed.

The trunnions are anchored through two sets of anchors. The first set of anchors is a series of embedded anchor bolts installed during the original construction. A second set of post-tensioned anchors was installed immediately after construction of the gates. This second set of anchors employ small transfer beams and an anchor head assembly which is exposed to corrosion. Due to the importance of these anchors to the integrity of the gates, it is necessary to check their condition regularly.

Peak trunnion loads (Finite Element Analysis - Appendix H) were found to exceed the applied post-tensioning force of the second set of anchors. Although the total capacity of both sets of anchors are adequate, some of the trunnions will be stressed to a higher capacity than the design loads. These should be prioritized for inspection and review.

#### *Alternatives for Repair/Replace*

- A The present method of maintaining and inspecting the trunnions consists of erecting a ladder in the gate recess below the lowered and dewatered gate. This method is very difficult, and consequently very unreliable and rarely complete.

Estimated cost of Option A No initial cost

- B The only alternative for providing access to the trunnions is by providing a small platform between the trunnions and attached to the gate structure. This access platform is accessed through openings in the intermediate skinplate between the upper and lower skinplates.

Maintenance staff would need to dewater the gate, climb onto the lowered gate via a new ladder. From this ladder, a second set of ladders would access a small walkway installed near the trunnions. This walkway would allow access along the full length of the gate and to each of the trunnion inspection platforms.

This arrangement is illustrated on Figure 11. It would be constructed in conjunction with the access platforms required for desilting and inspection of the gate interior.

Estimated cost of Option B \$92,400 for both gates

#### *Preferred Option* B

Maintenance and inspection access are required within the gate to allow desilting, inspection, and repairs to be made as required. The cost of providing access to the trunnions is relatively small once a commitment to construction of the desilting platforms are made. By providing access to the trunnions, the condition can be readily assessed as well as providing access to conduct any anchor or bearing repairs as may be necessary over the remaining life of the Structure.

### 3 1 4 5 Pier and Abutment Liner Plates

#### *Problem/Deficiency*

Visual inspection of the pier and abutment embedded mild steel liner plates indicates there is some spalling of the concrete adjacent to the plates. This may be caused by differential thermal movement between the plates and the underlying concrete, or the effect of water freezing in the joints between the plates and concrete. Either effect may result in cracking of the secondary concrete.

Spalling of the secondary concrete from around the liner plates may result in eventual deterioration and distortion of the plates due to the infiltration and freezing of water within the confined space behind the liner plates and the concrete.

A visual inspection of the liner plates indicates that wear and corrosion are relatively limited. Some corrosion is very apparent on the west abutment. The liner plates appear in relatively good condition.

The proper functioning of the gate side seals requires that the seal embedded plates are within acceptable tolerance. As a detailed inspection and check for straightness has not been made since construction, it should be considered an option if opportunity permits. If the gate side seals are to be replaced, the plates should also be inspected to ensure the seals have the necessary tolerance to accommodate surface irregularities.

A detailed inspection will allow assessment of the visible wear on the embedded plates, determine the extent of corrosion, and the need for a new protective coating. If excess wear or corrosion is identified, suitable repairs will be recommended.

#### *Alternatives for Repair/Replace*

A Do nothing to the side embedded liner plates. Assume condition is adequate for continued operation of the gate.

Estimated cost of Option A No initial Cost

B Repair spalled concrete by selective demolition and sandblasting. Place new concrete with suitable bonding agent and use dowels as required to ensure bond of larger areas.

Estimated cost of Option B \$17,750

C Inspect side seal plates for condition and tolerance. Remove all sharp edges by grinding, and fill recesses or pitting with weldments. Grind the welds to smooth finish as required.

Estimated cost of Option C \$12,500

D Sandblast entire side seal embedded plates. Coat plates with low friction, wear resistant protective coating suitable as seal face.

Estimated cost of Option D \$37,900

*Preferred Option* A (Short Term) B C & D (Long Term)

If the gates are to be cofferdammed to effect other repair work, the embedded plates could be readily inspected and the necessary concrete and steel repairs made using suspended platforms or scaffolding. This would ensure proper performance of the gate side seals and may extend their lifetime by allowing minor repairs and proper adjustment of seals.

If the seals are not replaced then there will be no requirement to sand blast and coat the plates (ie Option A)

### 3 1 4 6 Maintenance Access

#### *Problem/Deficiency*

Through discussions with operating staff and KGS inspectors during the July 1996 inspection it was found that maintenance within the gate and of gate components was very difficult because of the accumulation of silt in the gate recesses, on internal skinplates, and on internal members. The proposed methods of desilting requires access throughout the gate interior to permit washing down of the members and of the recess to flush out the silt.

#### *Alternatives for Repair/Replace*

A Provide an access ladder onto the lower skinplate within the gate using a ladder at each lift beam from the concrete pedestal. From the top of the ladder, an open platform would extend through the gate. The new platforms and ladders would be attached to the existing steel, and would not require any significant structural modifications. Figure 11 illustrates the arrangement for access into the gate interior.

Estimated cost of Option A \$80 000

B Do not provide access into the gate for desilting, washing down the interior or inspection. Desilting must be accomplished from the recess floor below the gate. Washing down the gate interior would be accomplished by climbing the existing steel work.

Estimated cost of Option B No initial cost

*Preferred Option* A

The installation of an access platform into the gate while it is lowered will permit inspection and maintenance throughout the gate interior. This will assist in preserving the gates' condition through the remainder of its useful life. In conjunction with additional platforms it will permit access to most of the gate interior and permit full access and utilization of a manual desilting system.

If platforms are being installed within the gates the installation of an access hatch on the upstream skinplate would assist construction. The new hatch would be of a water tight bulkhead style, with flush fasteners and other hardware. This would allow access by crane or hoist into the gate from the bridge above during any cofferdammed work on the gates. The estimated cost of this hatch is \$4 000 for both gates, however would like reduce the cost of construction within the gates.

The access hatch through the upper skinplate would allow construction access directly into the gates. It would allow equipment, components, and laborers to enter and exit readily. During any future rehabilitation work on the gate, the hatch would also be very beneficial.

*Problem/Deficiency*

Access into the abutments, which are expected to be the predominant entrance into the gate recesses, is via two ladders and a platform. This makes the movement of tools and equipment difficult and time consuming.

*Alternatives for Repair/Replace*

- A Remove the existing ladder from the access hatch and replace with a new ladder. Construct a new intermediate platform with new ladder to the bulkhead hoist platform and a new stair to the floor of the Surge Chamber. The access hatch to the Surge Chamber should be replaced with a new hatch with improved accessibility.

Estimated cost of Option A \$60,260

The installation of a new hatch, ladder, intermediate platform, and stairs to the Surge Chamber will improve access into the abutments. This will ease maintenance, inspection, and other operator duties.

*Problem/Deficiency*

Access into the gate recesses has been difficult due to the depth of silt within the recesses. Manual desilting of the gate recess requires an intermediate platform above the silt to permit washing down and pumping out of the silt without endangering staff.

*Alternatives for Repair/Replace*

- A Do nothing. Desilting crews will need to begin desilting from the upper levels of the access ladder or temporary platforms erected within the recess.
- B Provide a platform within the gate recess which would allow access to the desilting pump, monorail, hose connections, and provide an area for equipment storage. Desilting would begin by setting up the equipment on the platform and beginning operations from above.

Estimated Cost of Option B \$42,900 for four platforms (2 per gate recess)

Preferred Option B

Providing an intermediate platform is a necessary component in any manual desilting system. It will allow desilting crews to have a mobilization area and a starting point. As well, it will allow safe access to the gates for inspections.

### 3 1 4 7 Downstream Structural Concrete

#### *Problem/Deficiency*

The concrete downstream of the main gates was previously inspected in detail in 1986 and 1987 (Acres March 1988), and previously in 1980/81. During the last inspection, the erosion of the concrete had not progressed significantly since 1980/81. The erosion had extended to a maximum depth of 125 mm (5") On the west gate the erosion had extended to 25 mm (1") below the embedded anchor bolts. As discussed in the 1988 inspection report the erosion is likely due to recirculation of rocks and debris within the submerged roller which forms when the gate is raised.

This erosion is a threat to the integrity of the embedded seal components. Failure of the downstream seal assembly may overload the gate hoists or interfere with its proper operation. Consequently the erosion must be repaired to prevent further deterioration or failure.

#### *Alternatives for Repair/Replace*

- A With the gates dewatered completely remove all loose or damaged concrete from the area downstream of the gates to a minimum depth of 200 mm (8") Install dowels to ensure mechanical bonding of the repair slab to the Structure. Clean all concrete surfaces by sandblasting and pressure washing. Apply a suitable bonding agent and place a high density granite aggregate concrete in the repair area.

Estimated cost of Option A \$34,900

- B With the gates dewatered completely remove all concrete from the area downstream of the gates to a point 3 m (10 ft) downstream to a minimum depth of 200 mm (8") Install dowels to ensure mechanical bonding of the repair slab to the Structure. Clean all concrete surfaces by sandblasting and pressure washing. Apply a suitable bonding agent and place a high density granite aggregate concrete in the repair area with a finished roughened surface. Install 12 mm (0.5") armour plates over new concrete with anchors. Grout void between armour plates and new concrete. This is illustrated in Figure 7.

Estimated cost of Option B \$140,900 for both gates

- C Install 12 mm (0.5") inch armor plates over damaged concrete and fasten with grouted anchors. Grout void below armored plate and existing concrete with grout.

Estimated cost of Option C \$107,000 for both gates

*Preferred Option* B

The area immediately downstream of the gates must be protected against erosion to prevent the failure of the embedded fixed seal assembly. Failure of this seal may cause a pressure imbalance which will threaten the gate structure.

### **3 1 5 Adjacent Earthfill Dams**

#### **3 1 5 1 Roadway**

At present the agreement between the Department of Natural Resources and Department of Highways places responsibility for the maintenance and repair of the roadways with the Department of Highways. Consequently their routine inspection of the roadway will permit repaving and maintenance of the approach roads as required. It is anticipated that the roadway will require reconstruction a number of times over the next 30 years.

#### **3 1 5 2 Surface Drainage**

##### *Problem/Deficiency*

Runoff from the approach slab on each abutment collects and concentrates at several locations. As a result of this concentrated flow the shoulders are eroded and gullied, especially adjacent to the abutments. This erosion does not directly affect the structure but results in premature deterioration of the asphalt approach slabs.

##### *Alternatives for Repair/Replace*

- A Do nothing to prevent concentration of runoff. Repair shoulders and roadway as required.  
Estimated cost of Option A No initial cost
- B Construct swales along either side of the roadway using asphalt. Channel runoff to a riprap lined gully away from the Structure.  
Estimated cost of Option B \$12 000
- C Provide additional riprap to protect the locations where erosion has occurred.  
Estimated cost of Option C \$3 800

*Preferred Option* A The Swale can be constructed at some time in the future

### 3 1 5 3      **Surface Erosion Protection**

#### *Problem/Deficiency*

The inspection of the Structure also identified some erosion of embankment material along several locations. The principal cause of this erosion is from people walking up and down the slope along several defined paths. These tend to develop into gullies, which erode more rapidly. There is no significant concern over this, although it may initiate some undermining of the roadway above eventually. The roadway and embankments are identified on Figure 5.

#### *Alternatives for Repair/Replace*

- A      Do nothing and permit erosion to continue. Place additional material when required to maintain the slope face.

Estimated cost of Option A    No initial cost

- B      Place coarse rip rap over areas of erosion, and provide limestone blocks forming crude stairs down the embankment slope.

Estimated cost of Option B    \$12,000

*Preferred Option*      A

### 3 1 5 4      **Downstream Embankment and Channel Erosion**

#### *Problem/Deficiency*

Several surveys (1975, 1976, 1979, 1994) conducted by divers of the channel bottom immediately downstream of the Structure indicates significant erosion of riprap during large flood events. As recommended by KGS in 1995 (Red River Floodway - Inlet Control Structure Erosion Study), the reinstallation of a scour protection blanket and protection of the shore is necessary.

Additional details are contained within the report.

#### *Alternatives for Repair/Replace*

- A      Placement of riprap downstream of the Structure to a volume of 6,000 m<sup>3</sup> (7,800 m<sup>3</sup>)

Estimated cost of Option A    \$1,028,000

- B      Placement of a concrete mat overlay covering an area of 1,500 m<sup>2</sup> (55,000 ft<sup>2</sup>)

Estimated cost of Option B    \$670,000

Short term remediation of the scour hole through the placement of a small volume of riprap, or other method immediately adjacent to the Structure

Estimated cost of Option C \$73 000

The original report recommended the installation of the concrete mat overlay to provide the necessary scour protection. A detailed discussion of this system is contained within that report therefore the associated costs have not been addressed herein.

### 3 1 6 Public Security

#### *Problem/Deficiency*

Along many of the retaining walls at each abutment, the distance from the top of the wall to the water or rocks below is relatively high. During operations when flows are rapid and turbulent, the danger is greater. As discussed in the inspection results, the danger to sight seekers can be considered significant. There are also many occasions in which sportsmen use the retaining walls to fish from.

#### *Alternatives for Repair/Replace*

A The areas which are considered dangerous could be fenced off with an eight foot high chain link fence. The fence would need to be constructed to commercial standards to ensure strength and longevity.

Estimated cost of Option A \$13 000

B Signs can be posted clearly identifying the danger using a multilingual sign. The responsibility for safe use of the structure would then lie with the public.

Estimated cost of Option B \$1,500

C The entire perimeter of the structure could be fenced off to the public. This would entail fences installed about the maximum flood level to extend from the bridge hand railing to the waterline some distance away from the structure. The public would then be able to use only the roadway and shoulders in the vicinity of the Structure.

Estimated cost of Option C \$45,000

*Preferred Option* A

The installation of warning signs can not be considered sufficient to adequately protect the public. Signs are not visible unless illuminated or of all possible languages. Also it is not practical to try to fence such a large area especially with the potential damage to the fences by flood waters or river ice. Therefore the most efficient solution is the installation of fences at the areas considered dangerous, as shown on Figure 5.

It may also be prudent to install life preserver rings as found on many City of Winnipeg bridges. The preserver rings will provide a suitable lifesaving mechanism in the event of a person falling off the Structure.

*Problem/Deficiency*

The present navigable waterways license does not require illuminated channel markers. As with current practice, navigation lighting is important for the safety of boaters who may be operating at night or in fog.

*Alternatives for Repair/Replace*

- A As the present operating license states, there is no requirement for navigation lighting being provided on the Structure.

Estimated cost of Option A No initial cost

- B Each navigation channel will be marked with two colour coded lights on the upstream and downstream faces to clearly identify the navigable channel. This will require the installation of eight light fixtures. Each light fixture will then be suspended below a removable access panel in the bridge sidewalk to allow maintenance.

Estimated cost of Option B \$24,000

*Preferred Option* A

As stated above, there is no requirement for the installation of navigation lighting. Providing the lighting is purely a prudent measure for the benefit for a small portion of the public.

*Problem/Deficiency*

There is no indication on or near the Structure of the danger due to rapid and turbulent water. Consequently, there is a potential for liability to the public because of the lack of warning of these dangers. Although signs do not completely remove liability or responsibility, it is prudent to provide some form of warning regardless.

*Alternatives for Repair/Replace*

- A Place suitable signs adjacent to the Structure to clearly indicate the danger of fast water. The signs would be required in both official languages and symbolical illustrations.

Estimated cost of Option A \$4,900

As there have been no occurrences of injury or deaths around the Structure from either drowning or falling into the water it may be assumed that the dangers are obvious and apparent to the public

Estimated cost of Option B No initial cost

*Preferred Option* B

The relatively low cost of installing and maintaining warning signs adjacent to the Floodway Inlet Control Structure is reasonable for the degree of protection provided by the public and is consistent with current practice with similar situations

### 3 1 7 Facility Security

#### 3 1 7 1 Hatch Locks

##### *Problem/Deficiency*

As noted in the inspection report vandalism of hatches is an ongoing problem throughout the Structure. The entry of unauthorized persons into the Structure presents risks to them and to other users. Consequently it is necessary to prevent access into the surge chambers and cylinder pits. The chief problem with the lock arrangement on the hatches is ease of access. The lock can be easily damaged with rock and other objects because the locks are exposed. Originally the locks were more traditional deadbolt style locks which were likely unreliable due to corrosion and contamination. These repairs will be required if the hatches are not replaced as described above.

##### *Alternatives for Repair/Replace*

- A Replace existing hasps with new hasps welded in place to the hatch frames and covers. Use new high security locks to replace the existing laminated plate locks.

Estimated cost of Option A \$1 500

- B Replace all lock and hasp arrangements with modified bolts to secure the hatches. The bolts can only be removed with a tool matching the bolt head shape and pattern.

Estimated cost of Option B \$2 950

- C Remove all existing lock hasps. Attach new padlock recesses into the hatch covers by welding. Replace existing locks with high security padlocks. The recess will be sized to mitigate vandalism.

Estimated cost of Option C \$1,800

*Preferred Option* Do Nothing

Locking mechanism will be replaced when the hatch is rehabilitated

### 3 1 7 2 Door Locks

As noted above in the discussion of the Control Room the use of commercial deadbolt locks is the only method of protecting door locks against vandalism. The present systems used on the Machine Room doors, and the Control Room door appear effective.

Alternately, a digital pass card system could be installed in conjunction with a security system. Use of a security card could eliminate the need for keys for entry into the Control Room. The security system would then unlock the door latch to allow entry.

### 3 1 7 3 Protection of Operators

#### *Problem/Deficiency*

The operators of the Structure are important to the proper operation of the Structure. However, they do not have the resources available to ensure the protection of their parked vehicles, the outside of the Structures, or themselves. There are no specific items that can be considered requiring repair or replacement. As such, only a number of items are suggested which may assist the operators in performing their job safely.

#### *Alternatives for Repair/Replace*

- A Provide closed circuit cameras with a view of the Structure from outside. This will allow monitoring of the exterior without the need to go outside periodically.

Estimated cost of Option A See Section 3 3 12

- B Close off the Structure to the public during operation. Using fences and gates, close both the roadway and any access by foot to the Structure. There is a precedent for having the bridge open at all times, and especially allowing the public to watch its operation during floods. Although closing the Structure is within the powers of the Department, it will be opposed by the public users.

Estimated cost of Option B \$15,000

- C As discussed throughout this report, there is a need for additional lighting on the Structure for various reasons. They have been addressed in Section 3 3 10 as necessary.

- D The lighting within the Structure, on ladders and platform, should be supplied to a level of 55 lux by Workplace Health and Safety. This will require the installation of additional light fixtures and wiring as required to provide it. The lighting within the main gates and other closed spaces should be 25 lux as well. Since the lighting within the gates would only be required during maintenance and inspection, it is not necessary to supply permanent

fixtures however it may be easier for the operators to have power supply cables and suitable temporary light fixtures supplied on site

Estimated cost of Option D See Section 3 3 10

All of the options above are recommended however several are relatively costly to install or supply The decision of the appropriate improvement in security must be based on current policy towards Department personnel and the facility

### **3 1 7 4 Prevention of Malicious Operation**

#### *Problem/Deficiency*

The operation of the Structure is controlled from the instrument panel in the Control Room and from controls in the Machine Room As discussed in the inspection results, it is possible to have the gates operated by unauthorized personnel given the right circumstances

#### *Alternatives for Repair/Replace*

- A The controls on the hydraulic and electrical systems can be locked using keyed switches which remain with the operators at all times A key would be required to allow the gate to be raised or lowered Once the key were removed the changing of gate position would not be possible Changes of this type are considered operational and have not been addressed in the cost estimate
- B A remote control and monitoring system could be employed at the Structure This would consist of instrumenting the gate position all motors and valves The system could then be controlled or simply monitored from a remote location to confirm proper authorized operation The cost of instrumenting the entire gate operating system is relatively high, and would require modifications to many systems while the installation of a high security key switch would effectively allow no unauthorized access or operation (see Section 3 3 15)

### **3 1 8 Upstream And Downstream Cofferdams**

As with most water management structures the Floodway Inlet Control Structure will require significant rehabilitation throughout its life to maintain its operation, and to extend its useful life To effectively complete this work there is a need for assessing methods for installing a cofferdam upstream and downstream of the Structure The position and extent of the cofferdam is illustrated on Figure 10





- The east unit hydraulic oil sample contained a high amount of silica particles. This should not pose a problem to the hydraulic system as long as the oil filter is changed as required. The silica may have been inadvertently introduced into the system by cleaning internal components with rags or paper towels.
- The east gate lowering speed observed during operational testing was approximately 25% slower than the design lowering speed. The pressure in the east gate system was also very low at 350 kPa (50 psi) during gate lowering. This may be caused by malfunction or incorrect setting of the lowering relief valve on the east hydraulic unit.

*Recommendations for Repair/Replacement*

Perform routine maintenance on the hydraulic units annually or prior to spring use. Replace the leaking fitting on the east hydraulic unit. Change filters on both units when required and try to identify the source of silica contamination in the east hydraulic unit. Check the setting on the east unit lowering relief valve and inspect the valve for proper operation.

Estimated Cost of Above Work      \$1,100

**3 2 1 2      Hydraulic Piping**

*Problems/Deficiencies*

- The carbon steel piping is corroded in areas outside the mechanical room. This is most apparent in the east abutment cylinder well. The sequence valves above the cylinders are also corroded.
- Sections of the original piping in the west abutment cylinder well were replaced in 1994 due to corrosion-related failure. Examination of the removed piping sections and review of existing drawings reveal that the original piping is of standard schedule 40 wall thickness. The rod end and blind end ports on the cylinders, however, are schedule 160 and schedule 80 couplings, respectively.

*Alternatives for Repair/Replacement*

A      Replace the existing hydraulic piping components between the hydraulic units and the cylinders (including piping inside the mechanical room) as follows:

Outside mechanical room	replace existing schedule 40 steel piping with schedule 80 stainless steel piping with socket weld connections
Inside mechanical room	replace existing schedule 40 steel piping with schedule 80 steel piping

As part of the hydraulic piping replacement the sequence valves above all four cylinders should be removed for shop testing and inspection and repaired or replaced as necessary. Stainless steel piping is recommended in lieu of carbon steel with a protective coating because of the maintenance liabilities associated with the carbon steel pipe protective coating.

Estimated Cost of Option A \$83,000

- B Replace piping only outside the mechanical room with stainless steel piping as listed in Option A, but leave the existing piping inside the mechanical room since it shows no sign of corrosion. This option would leave the piping inside the mechanical room at a lower pressure rating than the outside piping. Repair or replace the sequence valves as noted in Option A.

Estimated Cost of Option B \$70,000

*Recommended Alternative* Option A

The piping inside and outside of the mechanical room should be replaced in order to achieve consistent pipe pressure ratings throughout the system. The general arrangement of the hydraulic piping replacement is shown in Figure 12.

### 3 2 1 3 Cylinders

#### *Problems/Deficiencies*

- The gland area of all four cylinders (where the piston rod enters the cylinder barrel) has accumulated a significant amount of grease and silt. This buildup may damage the piston rod wiper and prevent it from properly cleaning the rod during cylinder retraction (gate raising). This can lead to contamination of the gland packing, which can impart damage to the piston rod and cause oil leakage from the gland.
- A slight oil leak was noted at the east centre pier cylinder gland.
- The cylinder barrels are carbon steel and rusting in localized areas. This is most predominant on the west centre pier cylinder barrel above water level.
- During operation in the spring of 1996, operators noted that the east gate tended to drift down 50 to 70 mm (2" to 3") from set position over a 24 hour period. This minor deficiency may be an indication of slight oil leakage around the piston packing in one or both of the east gate cylinders. It is not known whether the gate position restoring device was operable to restore gate position.

*Alternatives for Repair/Replacement*

- A Perform refurbishment work without removing the cylinders from the cylinder wells. This includes cleaning each cylinder gland area, unfastening the cylinder head and replacing the gland packing and piston rod wiper. These components are illustrated in Figure 13 which shows a typical section of a hydraulic cylinder. The cylinder barrels should also be cleaned and re-painted in rusted areas, which will require the gates to be dewatered to allow for access to the lower areas of the barrels.

Estimated Cost of Option A \$25,250

- B Remove the cylinders from the wells for refurbishment work. In addition to the work covered by Option A above, this will allow for the piston rods to be removed from the barrels for internal inspection and replacement of the packing around the pistons.

Estimated Cost of Option B \$74,000

*Recommended Alternative* Option A

There do not appear to be any significant deficiencies that require cylinder removal at this time.

**3 2 1 4 Cylinder Support Guides**

*Problems/Deficiencies*

The current platform arrangement in the cylinder wells does not provide proper access to the cylinder support guides for detailed inspection and maintenance. Viewed from the existing platforms, the rust-coloured appearance of the grease coating the guides suggests that the grease is not very clean. Apart from this, the guides themselves appeared to be in good condition when the grease was wiped off by motion of the cylinder crosshead assembly during operational testing. The grease therefore appears to be adequately protecting the guides from corrosion. Access to the guides will need to be improved so that the cylinder support guides can be properly inspected and grease application can continue as a regular maintenance procedure.

*Alternatives for Improvement*

Access to the cylinder support guides can be improved with a new platform arrangement in the cylinder wells, which is discussed in Section 3 1 2.

### **3 2 1 5      Hydraulic System Overload**

#### *Problems/Deficiencies*

The analysis presented in Appendix H of this report reveals a potential for hydraulic system overload caused by buoyant forces of 1500 kN (336 kips) acting on each flood gate. This overload would occur in the event of a single cylinder failure. The remaining cylinder would be able to provide only 1015 kN (228 kips) of downward thrust because a relief valve in the system limits the oil pressure in the bottom ends of the cylinders to 4140 kPa (600 psi). An upward force on the gate in excess of 1015 kN (228 kips) would cause the relief valve to open, thereby allowing the oil to flow back to the reservoir, and the cylinder and gate to rise uncontrolled.

#### *Recommended Action for Remediation*

The relief valves in question are currently set at 4140 kPa (600 psi), but have a 1035 kPa (150 psi) to 6900 kPa (1,000 psi) adjustable spring range. Adjusting each valve to 6200 kPa (900 psi) would allow each cylinder to provide enough downward thrust to counteract the calculated upward lifting force. This increased pressure is within the design limits of the hydraulic system.

If the cylinders are refurbished and the hydraulic piping is replaced as described in previous sections of this report, the risk of sudden cylinder failure is assumed to be remote. For this reason, it is recommended that the relief valves not be adjusted at this time. In the event of a cylinder failure, operating staff may adjust the appropriate valve to obtain an increased relief pressure as required.

### **3 2 2      Bulkhead Gate and Trashrack Hoists**

#### **3 2 2 1      Bulkhead Gate Wire Rope Hoists**

#### *Problems/Deficiencies*

- all hoist components on the hoist platform are rusted to some degree. The severity of corrosion damage ranges from surface rust to complete failure of components (see below). Review of the Drawings indicates that the hoists were designed for indoor service, while in fact the equipment has been exposed to moisture leaking from the bridge deck above.
- the following components have failed due to rust corrosion (parts seized in place or completely rusted off): the position limit and slack rope limit switches on both hoists, and the position indicator on the west hoist.
- the lubricating oil samples taken from the large gear reducers were found to be contaminated beyond acceptable levels by a variety of particles, including metal and rust particles.
- the wire rope on the east gate hoist was not riding on one of the lower sheaves during the operational test of the gate. As a result, wire rope became jammed in the sheave block and the hoist could no longer operate properly.

- one of the lower sheaves on the west gate hoist was not turning and the wire rope was sliding on the sheave during gate motion

*Alternatives for Repair/Replacement*

A Remove and dismantle the hoists for a detailed inspection and if possible, refurbish the existing hoists to a condition in which they can continue to operate for the next thirty years. This will involve likely overhaul of the existing hoist equipment and replacement of some components, as listed below

- dismantle all of the gear reducers and bearings for inspection of internal components perform any necessary repairs and replace lubricating fluids
- dismantle the sheave blocks and repair to working condition
- Replace the wire ropes on both hoists with galvanized wire rope. The rope on the east hoist may have been damaged when it jammed in the lower sheave block during operational testing
- re-paint all of the hoist components including support frames
- replace the hoist position limit switches and position indicators. The existing devices are currently not operable

Estimated Cost for Option A \$68 000 (\$34 000 per hoist)

B Replace the existing 12 ton hoists with new units, complete with galvanized wire ropes and water resistant sheave blocks. Each new unit will be weatherproof (the existing hoists were designed for indoor operation) and will come equipped with a position indicator, position limit switch, and slack rope limit switch. The hoist support platform will be modified to suit the new hoists

Estimated Cost for Option B \$117,500 (\$58 750 per hoist)

*Recommended Alternative* Option A

Recommendation of Option A assumes that costs of refurbishment will not exceed the estimated amount. Estimation of these costs is difficult without dismantling the hoist components for inspection. Therefore to be conservative, the estimated cost of Option B will be applied to bulkhead gate hoist remediation

### 3 2 2 2 Trashrack Manual Chain Hoists

*Problems/Deficiencies*

The trashrack manual chain hoists (5 ton capacity) were found to be inoperable. The hoist mechanisms were badly rusted.

### *Alternatives for Repair/Replacement*

- A Remove the manual chain hoists for detailed inspection and refurbish them back to working condition if possible

Estimated Cost for Option A \$3 000 (\$1 500 per hoist)

- B Replace the manual chain hoists with new units

Estimated Cost for Option B \$12,600 (\$6 300 per hoist)

*Recommended Alternative* Option A

Similar to the bulkhead gate hoists, the trashrack hoists will not need to be replaced if they can be repaired at a reasonable cost. This cost is however difficult to estimate without dismantling the hoists for inspection. The estimated cost of trashrack hoist remediation is therefore taken as the replacement cost in order to be conservative.

## **3 2 3 Dewatering and Desilting Systems**

### **3 2 3 1 Dewatering System**

#### *Problems/Deficiencies*

During the east gate dewatering in March of 1996, the dewatering pump was observed to operate well during most of the dewatering procedure. As the water level within the gate recess reached a low level near the end of dewatering, the pump was prone to blockage from collection of debris at the pump inlet, which needed to be removed manually. The major source of this debris was chunks of foam insulation which had torn loose from the upper skinplate inside the gate. In addition, higher amounts of silt entering the centre pier sump near the end of the dewatering process appeared to cause blockage in the dewatering system. This necessitated frequent backflushing of the dewatering pump.

#### *Alternatives for Repair/Replacement*

The dewatering system itself does not appear to be deficient. Problems encountered during dewatering can be largely attributed to other deficiencies including excessive leakage through the gate seals, deterioration of the upper skinplate foam insulation, and the lack of a functioning desilting system (discussed in the following section).

### 3 2 3 2 Desilting System

#### *Problems/Deficiencies*

The original desilting system is no longer in use and the original desilting pumps have been removed. With no desilting system in operation, accumulations of silt in the east gate recess and access chambers ranged from four to eight feet in depth after dewatering in March 1996, making access into the recess difficult.

Review of the Drawings and the Inlet Control Structure Operation and Maintenance Manual indicates that the desilting system was designed to agitate collected silt deposits into suspension by recirculating water from the centre pier sump through a series of nozzles (24 nozzles per gate) located along the floor of the gate recess and access chambers. With the nozzles providing agitation, the dewatering pump was to operate with the bulkhead gate open. This would remove silt-laden water while clean water entered the gate recess through the open bulkhead gate. The system reportedly has not functioned well in the past due to pipe blockage from silt accumulation and freezing. Little can be done to correct these problems because the pipes are embedded in the concrete of the structure. In addition, the system was designed to provide agitation only at the floor level of the gate recesses and access chambers. This arrangement would probably not prevent silt from accumulating in other areas such as the dogging device chambers and along steel members inside the gates (these areas were noted to contain accumulations of silt during the dewatered east gate inspection). It appears that even if the desilting system were currently able to operate, it would not have sufficient flow capacity to significantly reduce silt accumulations observed during the dewatered east gate inspection in March 1996 (the nozzles were completely buried under 1.2 m to 2.4 m (4 to 8 feet) of silt). Removal of silt inside the gate recesses would probably require manual washdown hosing following dewatering, even if the current desilting system were refurbished back into operation.

#### *Alternatives for Repair/Improvement*

Given the problems experienced with the original desilting system, it does not appear feasible to refurbish the system back to an operable condition. Instead, it is recommended that the desilting procedure be performed following gate dewatering using a manual washdown hose and portable desilting pump to remove accumulated silt. The time and expense required for such an operation will depend on the amount of silt accumulated in the gate recess. The equipment required would include the following:

- submersible desilting pump, lowered down the cylinder well, to pump silt from the gate recess. The pump would be small and light enough to be maneuvered inside the gate recess.
- a source of high pressure water for washdown hoses (alternatives for providing washdown water are described below)
- washdown water hose with adjustable flow nozzle
- desilting pump discharge hose
- hoisting equipment
- generator set to provide power to equipment (not required if power supply is available from the Structure which is discussed in Section 3.3)

The cleanup operation described above could be performed using temporary rented equipment only without making any modifications or additions to the Control Structure. This would require a submersible pump to provide washdown water from the river. Lengths of hose would be required to run washdown water from the river into the gate recess, and to transport silt out of the recess back to the river. Based on silt accumulations observed during the dewatered east gate inspections, the gate recess contained an estimated 340 m<sup>3</sup> (12 000 ft<sup>3</sup>) of silt. It is estimated that a three person crew equipped with a desilting pump and washdown hose would take eight full days (192 hours) to completely remove the silt from one dewatered gate recess.

Estimated Cost of Above Operation \$92,500 (includes both gates)

Measures to facilitate and reduce the cost of the gate desilting operation are described below

- A Install a piping system to handle washdown water supplied from the submersible pump in the river. This system is illustrated in Figures 14 and 15. A hose coupling on the outside wall of the mechanical room would provide for connection of the pump hose on the centre pier downstream observation deck. A valve station inside the mechanical room would allow the washdown water flow to be directed to any one of the cylinder wells. Piping to the abutments would run below the bridge deck. Air connections in the system would allow for the pipes to be completely drained between periods of use. Washdown hose stations could be installed inside the abutment surge chambers as part of this system for cleaning the surge chambers and the raised bulkhead gates and trashracks.

Estimated Cost of Option A \$80 000

- B Install a second groundwater well pump system in the Control Structure centre pier sump to provide a permanent source of clean washdown water, as shown in Figure 14. This system would be tied into the piping system described above in Option A and would allow washdown water to be supplied either from the well pump or a submersible pump in the river. The feasibility of this option depends on whether a second well can provide adequate water flow for this purpose, approximately 340 L/min (90 gpm).

Estimated Cost of Option B \$56,000 (implementation requires option A)

- C Install a 1/2 ton monorail beam with a removable manual trolley hoist within each gate access chamber. This would facilitate movement of a sludge pump along the chamber length and would allow for a larger pump with increased capacity. An access platform is also provided and is discussed in Section 3.1.4.6.

Estimated Cost of Option A \$30,000

- D Install a pipe with valving inside each cylinder well to handle silty water discharge from the desilting pump. The bottom end of the pipe would contain a coupling for connection to the desilting pump discharge hose. The top end of the pipe would run through the wall of the cylinder well above water level and discharge to the river. This arrangement would reduce the length of the desilting pump discharge hose.

Estimated Cost of Option D \$60 000

*Recommended Alternatives* A (Short Term) B (Long Term)

Option B should be considered as part of the long term work program for the structure

### **3 2 4 Compressed Air System**

*Problems/Deficiencies*

- Although the compressors were verified to be working properly during inspections in July, 1996 the compressed air piping nozzles at the bottom of the gate recesses and access chambers are reportedly not functioning. The nozzles form part of a bubbler system designed to prevent formation of ice inside the gate recesses and cylinder wells, and therefore should be maintained in operation. The nozzles in the east gate recess were covered by silt during the dewatered east gate inspection in March 1996, and therefore could not be inspected. It is likely that the nozzles are plugged by silt but they will need to be inspected with the gates dewatered and desilted to confirm this.

*Alternatives for Improvement*

- During a future gate dewaterings with the gate recesses cleared of silt, inspect the compressed air nozzles and exposed piping sections and repair, or replace them as required.

Estimated Cost of Above Operation \$8 500

### **3 2 5 Cylinder Well/Abutment Surge Chamber Heaters**

*Problems/Deficiencies*

The cylinder well and abutment surge chamber heaters are rusted but otherwise are reported to be operable.

*Alternatives for Improvement*

Although replacement of the heaters is not recommended at this time, it will likely need to be performed at some time within the next ten years. At such a time consideration should be given to a radiant heating system as a replacement, as it may prove to be more efficient than forced air heating.

### **3 2 6 Building Mechanical Systems**

#### **3 2 6 1 Heating System**

The building unit heaters were all found to be in working order. The only action necessary is to monitor their operation and repair or replace as necessary. See Section 3 3 8 as well.

#### **3 2 6 2 Ventilation System**

##### *Problems/Deficiencies*

The washroom fan is either missing or is not functioning. The fan should be replaced or repaired as necessary.

Estimated Cost of New Fan, Installed        \$200

#### **3 2 6 3 Domestic Water System**

##### *Problems/Deficiencies*

The domestic water supply from the centre pier well was not tested as part of this inspection, but it is reportedly not potable. Since the Control Structure is manned on a 24 hour basis during parts of the year, a supply of potable water should be made available.

##### *Alternatives for Improvement*

- A     The domestic water from the Control Structure well should be tested for contaminants (if it has not already) to assess whether or not it is potable. A potable water treatment system may be purchased and installed if necessary.

Estimated Cost of Option A    \$3,000

- B     Purchase a water cooler and have bottled water supplied to the Control Structure as required.

Estimated Cost of Option B    \$ 400 plus cost of bottled water

*Recommended Alternative*    Option B

A bottled water dispenser should provide an adequate and inexpensive potable water supply for operating staff.

### **3 2 6 4      Septic System**

#### *Problems/Deficiencies*

The septic system reportedly does not function as originally designed, as the drain pipe from the holding tank to the river freezes in cold weather. The septic tank is periodically pumped out as required.

#### *Alternative For Improvement*

It is recommended that the original septic drain piping to the river be capped and abandoned to avoid drainage of sewage into the river. The septic tank should continue to be pumped out periodically as required.

Estimated Cost      \$200, plus cost of periodic pump-out

### **3 3      ELECTRICAL SYSTEMS**

#### **3 3 1      Incoming 600 V Power Cables**

These cables had satisfactory insulation test results. While it would be unusual to expect the 600 volt cable to provide 60 years of service (30 years to date plus 30 years of future life) no remedial action is recommended for this cabling at this time. This recommendation is based on the following observations:

- The cable is normally very lightly loaded (compared to its design capacity) for the bulk of the year and has therefore not been subjected to anywhere near its designed normal operating temperature for any length of time. Temperature is a significant factor in aging cables.
- There is an alternate feeder available and a failure of a cable in one feeder will not adversely effect the ability to operate the control structure.

#### **3 3 2      Main Breaker/Robonic Transfer Switch**

No problems were noted as a result of the inspection and no remedial action is recommended. As with the 600 volt power cable the expectation of 60 years of life (ie an additional 30 years) is perhaps optimistic. However, the transfer switch is readily accessible and spare parts to replace its components are still readily available. Therefore it can be repaired or replaced at moderate cost if and when needed.

### **3 3 3 Motor Control Center**

The motor control centre showed no signs of deficiencies requiring remediation at this time. The equipment can be maintained without difficulty.

### **3 3 4 Motors**

Motors were found to be in working condition with no apparent deficiencies. If the need arises in the future, they can be repaired or replaced without difficulty.

### **3 3 5 Dry Type Transformers**

The inspections revealed no problems with the dry type transformers. This equipment can be repaired or replaced at moderate cost if and when needed.

### **3 3 6 Panelboard**

Only minor problems with six small circuit breakers which are operating at elevated temperatures were noted as a result of the inspection. These may be readily repaired/replaced within the normal maintenance budget. The panel itself is in good shape and no major remedial action is recommended. As with the 600 volt power cable the expectation of 60 years of life (ie an additional 30 years) is perhaps optimistic. However, the panel is readily accessible and spare parts to replace its components are still readily available. Therefore, it can be repaired or replaced at moderate cost if and when needed.

### **3 3 7 Gate Heating Equipment**

#### **3 3 7 1 Main Gates Seal Path Heating**

##### *Problems/Deficiencies*

Major problems exist on both gates with the present electrical trace heating cables which heat the upstream, downstream, and both side gate seal paths. The cables are either short circuited or open circuited and are not functional. This has been the situation for a number of years.

*Alternatives For Repair*

- A This option assumes that it is technically possible to pull out the existing heating cables and simultaneously draw in a new pull wire. The length of these cables is significant and summarized in the table below. It may not be possible to pull out the cable from the large U-shape embedded conduit in which it is located while also pulling through a new pull wire.

DESCRIPTION	EMBEDDED CONDUIT SIZE/ LENGTH	COLD LEAD LENGTH (FT)	HEATED LENGTH (FT)	OVERALL LENGTH OF CABLE (FT)	OVERALL PULL LENGTH (FT)
East Side Gate Heater	2	60	45	105	165
West Side Gate Heater	2	60	45	105	165
Downstream Gate Heater	2	60	112	172	232
Upstream Gate Heater	2	60	112	172	232

Estimated Cost of Option A \$30 000

- B If it is not possible to pull in new cable repair would then necessitate the removal of a sufficient quantity of concrete in the piers and the spillway apron to install new embedded conduit.

Estimated cost of Option B \$40 000 for both gates (requires Option A)

- C Do nothing as trace heating is not required with the current operation of the gates.

Estimated cost of Option C No Cost

*Preferred Option C*

In reviewing the operating practices for the gates, the requirement for this trace heating is difficult to justify. Although the water elevation at the structure in the late winter and spring has been low enough to almost expose the downstream sill, it is not necessary to operate the gates when the water level is this low. Whenever the river level is high enough to warrant operation of the gates, the gate seals are normally submerged a minimum of seven feet under the surface. The ice on the river has typically broken up and it is reasonable to expect the seals to be free of ice at this time. Thus operationally the trace heating does not appear necessary. This has been discussed with operating personnel and they concur.

In the unlikely case where a condition does arise where operation of the gate is required in the winter, say for maintenance purposes, temporary facilities such as a portable steam generator could be brought in to help remove any ice on the seal paths. Significant measures would be required to free the gate surface of ice in any case.

Based on the above, no remedial work is recommended on the main gate seal path heating.

### **3 3 7 2 Bulkhead Gates Gate Guide Heating**

#### *Problems/Deficiencies*

The trace heating for the guides does not work

#### *Alternatives For Repair/Replace*

- A Replace heaters with new trace heaters in existing conduits Change voltage on heaters to match new 600 Vac distribution brought to wingwalls discussed later in this report

Estimated Cost of Option A \$6,000 for both bulkhead gates

- B Do nothing Operate as at present and either wait for ice to clear or remove ice with temporary steam source when required

Estimated Cost of Option B No Initial Cost

#### *Preferred Option A*

Operationally the bulkhead gates are normally kept in the open position and are positioned so the gate body is above the river level and is not subjected to any ice Only when the main gate is being dewatered is there a requirement to lower the bulkhead gate There is a reasonable operational requirement to dewater a main gate in the late winter early as spring for inspection purposes and at this time ice is likely on the submerged guides Accordingly, it is desirable to have this gate guide heating functional

### **3 3 8 Space heating**

Space heating inside the control room and machine room are provided by unit heaters These unit heaters are in good shape and no remedial action is recommended

### **3 3 9 Main Gate Hoist Controls**

The principle problem with the gate controls located in the control room is the remote gate position indication which is not functional This requires that the gate be operated from the Machine Room the only location where gate position monitoring is presently available The Machine Room is quite noisy when the hydraulic equipment is operating and it is therefore not considered desirable to operate the gates from this location The balance of the control desk equipment and the controls on the hydraulic power equipment are in good condition and no remedial work is recommended for this equipment

### *Alternative For Repair*

- A Install a new absolute encoder on the existing take-up pulley. This encoder will measure the cylinder truck elevation and display it on a digital display located on the control desk in feet (eg 748.4 ft)

Estimated Cost of Option A \$20,000 for both gates

- B Provide a PLC module capable of accepting the cylinder truck position as an input and calculating the main gate tip position as an output. Provide a digital readout on the control desk showing the main gate tip position calibrated in feet (eg 752.3 ft)

Estimated Cost of Option B \$ 9,000 for two gates

- C Provide a dial-up modem to relay the main gate tip position to a remote location

Estimated Cost of Option C \$ 5 000 for two gates

*Preferred Option* A B C

By maintaining a mechanical readout at the pulley/encoder location, the calibration of the system can always be readily checked. By having the cylinder truck automatically converted to a main gate tip position, the chance for errors are minimized. Having the main gate tip position available remotely on demand will enhance operations.

## **3 3 10 Building Lighting**

### **3 3 10 1 Interior**

The interior lighting in the Control Room and Machine Room generally consists of incandescent fixtures and is in good condition. This form of lighting is inefficient by today's standards, however the limited use of interior lighting over the course of the year does not justify its replacement on an economic basis. Any failure of individual light fixtures can be repaired or replaced at moderate cost if and when needed. Therefore no remedial action is recommended for this equipment. Replacement should be with more efficient type light sources.

The lighting inside the cylinder well areas presently consists of an incandescent fixture located at the top of the well near the access hatch. There is also a convenience outlet located here. As portions of the well are submerged under water during the course of a year a permanent lighting system for the cylinder well is not practical. Presently Maintenance staff have advised that they have a cord assembly of lighting fixtures which they power from the receptacle and which provides adequate lighting for their needs.

Temporary lighting inside a dewatered gate is also required to facilitate inspection and repair work. An assembly of portable cords and light fixtures is recommended to accomplish this. The estimated costs for such an assembly is included with the costs for a new desilting system.

### 3.3.10.2 Exterior

#### *Problem/Deficiency*

The exterior lighting consists of floodlights on the center pier under the roadway deck to illuminate the main gates and two lamp standards arranged with their luminaries pointed downstream to light up the centre pier landing. The lamp standards provide some light on the roadway.

The floodlights perform adequately and because of their location underneath the bridge structure are not subject to a great deal of vandalism. The lamp standards illuminate the centre pier adequately but do not adequately light the roadway. The lamp standards because of their exposed location fixtures are more subject to vandalism (rifle shots). Ongoing maintenance is costly and difficult to arrange for.

#### *Alternatives For Repair*

- A KGS approached Manitoba Hydro to determine if they were willing to own and maintain the roadway lighting as they do for other highways and roadways. Manitoba Hydro indicated they were willing. They will install their own equipment lamps, luminaries, power supply wiring etc. to facilitate their maintenance. Two luminaries will be supplied on each pole, one to light the roadway and one to continue lighting the downstream centre pier.

Estimated Cost of Option A                      \$12,600

Estimated Operating Cost of Option A        \$16/month/luminaire

- B Continue to maintain the luminaries as installed and accept the ongoing maintenance cost

Preferred Option        A

The primary purpose of the lighting is to enhance security. Addition of improved roadway lighting also enhances safety of motor traffic on the roadway. Manitoba Hydro is better equipped with staff and equipment to perform ongoing maintenance and therefore lighting system will be operable a higher percentage of time.

**NOTE** KGS Group spoke to Department of Highways to see if they had any intention of lighting the bridge. They indicated they don't and this would be a low priority location.

### 3.3.11 Fire Alarm System

No deficiencies or problems were noted with the fire alarm system and no remedial action is recommended.

### 3.3.12 Security System

No deficiencies or problems were noted with the existing security system which consists of intrusion alarms into the Control Room or the Machine Room. Accordingly, no remedial action is recommended. General vandalism at the control structure is an ongoing problem, however.

#### *Alternatives For Repair*

A A CCTV camera mounted in a weatherproof hardened enclosure on a pole located on the roof of the Control Structure could help address this concern. The camera could be equipped with pan tilt and zoom features and report to a monitor located in the control room. It would be retractable so it could be stored indoors during the balance of the year.

Estimated Cost for Option A           \$10,000

B The signal could also be relayed over a modem to a central monitoring facility if necessary. Due to limitations of the telephone system, the refresh rate on the remote monitor is approximately once a second. This is considered adequate for security surveillance. Such a system would also incur the added operational costs of staffing the remote monitoring facility and the cost of a leased telephone line.

Estimated Cost For Option B           \$35,000

*Preferred Option     A*

The cost of remote monitoring is significant. Simply having the camera there during the periods of operation of the structure is likely to act as a deterrent.

### 3.3.13 Communication Systems

No shortcomings were found and no remedial action is recommended.

### **3 3 14 Embedded Conduit Systems**

#### *Problem/Deficiency*

As discussed in Section 2 3 the embedded conduit systems can no longer be relied upon as a raceway to pull in new wire/cable or to replace existing wire/cable. The various conduit systems are reviewed as follows:

#### **3 3 14 1 Embedded Conduit to the East Pier**

The following embedded conduit circuits can be abandoned:

- Embedded conduit and cable to the east gate's east side and upstream seal path heating

The following embedded conduits circuits must be maintained:

- The circuit to the east gate bulkhead gate hoist
- The circuit to the east gate bulkhead gate gain heaters
- The circuit to the lighting and convenience receptacles in the bulkhead gate hoist room and cylinder
- The circuit to the portable cylinder well and balancing duct space heaters
- A 120 V circuit for the roadway lamp standards may also be required

Power for the following new loads must be brought to the east pier:

- Portable Desilting pump
- Temporary lighting and convenience outlets for the cylinder well and gate chamber

#### **3 3 14 2 Embedded Conduit to the West Pier**

The same embedded conduit systems exist to the west pier and the same solution is recommended.

### *Alternatives For Repair*

- A To allow for ease of replacement of the circuits listed above and to power the new loads a new raceway system is recommended. A new 100 Amp 600 Vac TECK armored cable would be installed inside the same concrete covered trench which houses the hydraulic pipes serving the east gate east cylinder. The cable would be routed down the cylinder well, across the balancing duct, and up near the east bulkhead gate hoist. It would terminate in a splitter box. From this splitter, existing loads could be readily re-fed if and when required and new loads would be added. See Figure 16.

Estimated Cost of Option A \$47,500 for both end piers

*Preferred Option* A

### **3.3.15 Automation**

Two aspects of the operation of the Control Structure are candidates for automation. These are

- 1 Automate the collection of and processing of the data required to determine the appropriate setting of the main gates. The setting determined by the automation equipment could be validated by being reviewed by experienced personnel and the setting could then be relayed to the operational staff at the structure.

Such a system would have the following advantages

- Once the computer program has been suitably "debugged" it would act as a check on manual calculations and minimize the possibility of errors.
- A record of the calculations and input data and gate setting could be accurately achieved. This information together with what actually occurs would be helpful in tuning the methodology used to determine the gate setting.
- It would allow the Department to become less reliant on the experience of long time staff members for decision making.
- More regular (say every half hour) data input and calculation of the appropriate floodway gate position would allow more precise control of the Red River water levels upstream and downstream of the floodway inlet structure.

- 2 Operation of the gates from a remote location.

While it is difficult to see any economic or operational benefit at this time, modifications could be made to control gate motions from a remote location.

Both aspects of automation are considered to be beyond the scope of this assignment and were not investigated further.

### 3 3 16 Power For Desilting Equipment

Power for the desilting equipment discussed in the mechanical section of this report may be provided by one of the following options

A Provide power from a generator set provided on a rental basis

Estimated Cost of Option A \$5,000 per use

B Provide power from the Structure power supply A multiple-outlet portable power board could be constructed for this purpose to allow for convenient equipment power hookup on the central pier observation platform

Estimated Cost of Option B \$20,000

*Recommended Alternative* A

### 3 4 CONFINED SPACE ENTRY REQUIREMENTS

Confined space entry procedures should be followed whenever the gate recesses are entered for inspection maintenance, or construction work Provisions for future work inside the gate recesses should include the following

- atmosphere monitoring equipment
- forced air ventilation equipment (if atmosphere monitoring indicates ventilation is required)
- worker safety equipment, including
  - supplied-air breathing apparatus (if atmosphere monitoring indicates it is required)
  - fall restraint system with self-recovery features
  - worker hoist/retrieval system
  - lighting equipment

It is recommended that temporary equipment be used as required for confined space entry The addition of platforms and ladders in the gate recesses, as described in Section 3 1 will aid in confined space entry by greatly improving access in these areas

### **3.5 SUMMARY OF RECOMMENDED REPAIRS, REMEDIATION, AND UPGRADES**

The work described above is summarized in Tables 3.1, 3.2, and 3.3 below. Each discipline is listed separately with the work categorized into repairs, remediation, and upgrades.

Work defined as repairs, is that work which is required to return a component or system to a safe or usable condition. Remediation work is work associated with preserving the condition of a component or system prior to it becoming unsafe or unusable. Upgrades consider all work which updates or improves the usefulness or safety of a component or system.

**Table 3 1**  
**Summary of All Civil Work**

Section	Item	Type of Work	Cost	Comments
<b>3 1 1</b>	<b>Roadway Bridge</b>			
3 1 1 1A	Detailed Inspection of Bearing Seats	Remediation	\$7 000	
3 1 1 1B	Installation of Monitoring Pins below Bearing Seat	Remediation	\$1 900	
3 1 1 2	Detailed Inspection of Bearing Assemblies	Remediation	\$8 250	
3 1 1 3	Repaint Girders within 20 years	Remediation	\$198 000	
3 1 1 5	Selective Repairs on all Sidewalks on Bridge	Repairs	\$75 000	
3 1 1 6C	Complete Reconstruction of Service Duct Covers	Repairs	\$36 000	
3 1 1 6D	Installation of Insulated Bulkheads in Service Duct	Upgrade	\$1 150	
3 1 1 7A	Repair Post Bases and Repaint Handrail	Repair	\$7 500	
3 1 1 7E	Replace stair and handrails to D/S deck	Upgrade	\$7 500	
3 1 1 9	Rehabilitate Remainder of Expansion Joints	Remediation	\$26 050	
<b>3 1 2</b>	<b>Centre Pier</b>			
3 1 2 1	Apply new synthetic roof membrane	Upgrade	\$5 850	
3 1 2 2	Install fire resistant drywall on Machine Room ceiling	Upgrade	\$1 850	
3 1 2 3	Replace Cylinder Hoist Support Bridges	Repair	\$61 400	
3 1 2 3	Access platforms to Cylinder Bridge and Piping (Pier)	Upgrade	\$36 800	
3 1 2 3	Access platforms to Cylinder Bridge and Piping (Abutment)	Upgrade	\$48 400	
3 1 2 3	Access drop platforms to Cylinder shaft	Upgrade	\$49 300	Assumes new platforms
3 1 2 4	Sump Pit Ladders and Platforms	Repair	\$25 000	
3 1 2 5	Rehabilitate the lift off covers over Cylinder Pits (Pier)	Remediation	\$24 150	
3 1 2 6	Remove and Replace Machine Room Hatch	Repair	\$3 800	
3 1 2 6	Remove and Replace Cylinder Pit Hatches (Pier)	Repair	\$11 000	
3 1 2 7	Replace interior ladders and platforms in Pier	Repair	\$49 800	Dewatering necessary
<b>3 1 3</b>	<b>Abutments</b>			
3 1 3 1	Replace bulkhead gate roller assemblies	Upgrade	\$45 500	
3 1 3 1	Pressure wash used to maintain bulkhead Gate	Upgrade	n a	See Mechanical
3 1 3 1	Install sill seal and new seals on bulkhead gate	Upgrade	\$12 700	
3 1 3 2	Inspection of bulkhead gate roller paths and guides	Remediation	\$6 000	Dewatering Necessary
3 1 3 3	Trash Rack inspection and repainting	Remediation	\$6 500	
3 1 3 4	Detailed inspection of Trash Rack Guides	Remediation	\$6 000	Dewatering Necessary
3 1 3 6	Remove and Replace Cylinder Pit Hatches	Repair	\$20 000	

Section	Item	Type of Work	Cost	Comments
3 1 3 6	Replace interior ladders and platforms in Abutment	Repair	\$50 000	Dewatering Necessary
3 1 3 7	Install monitoring pins on Retaining Walls and Assessment	Remediation	\$1 900	
3 1 2 5	Repair lift off panels	Repair	\$31 200	
3 1 2 3	Access drop platforms to cylinder shaft	Upgrade	\$49 300	Dewatering Necessary
3 1 2 3	Access platform to top of cylinder and piping	Upgrade	\$48 400	
3 1 4 7	Concrete repairs downstream of Gate	Repair	\$140 900	Cofferdam Required
3 1 3 8	Selective Repairs to Parking Areas	Repair	\$65 500	
3 1 3 9	Reconstruct Transformer Pad	Repair	\$17 000	
<b>3 1 4</b>	<b>Main Gates</b>			
3 1 4 1	Replace existing seals and revise installation details	Repair	\$439 200	Cofferdam Required
3 1 4 2	Selective Repairs and Repainting of skinplates	Remediation	\$125 500	Cofferdam Required
3 1 4 3	Remove insulation from inside gate	Remediation	\$30 500	Dewatering Necessary
3 1 4 4	Trunnion Maintenance and Inspection Platforms	Upgrade	\$92 400	Dewatering Necessary
3 1 4 5	Selective Repairs and Repainting of Liner Plates	Remediation	\$68 150	Cofferdam Required
3 1 4 6	Maintenance Platforms within Gates	Remediation	\$75 190	Cofferdam Required
3 2 3 2	Access platform at each end of each gate recess	Upgrade	\$42 900	Dewatering Necessary
<b>3 1 6</b>	<b>Public Security</b>			
3 1 6	Construct security fence where required	Upgrade	\$13 000	
<b>3 1 8</b>	<b>Upstream and Downstream Cofferdams</b>			
3 1 8	Cofferdam Installation and Maintenance for 120 Days	Upgrade	\$253 200	Both Gates
3 1 8	Diver Installed Caulking and Seals for Dewatering Gate	N A	37 500	N R if C/D is used

Total Civil **\$2,364,140**

NOTES Costs are based on anticipated cost of materials labour overhead contingency (10%) and engineering services (15%) for the proposed work

**Table 3 2**  
**Summary of All Mechanical Work**

Section	Item	Type of Work	Cost	Comments
<b>3 2 1</b>	<b>Hydraulic Hoisting System</b>			
3 2 1 1	Perform maintenance on east hydraulic unit	Remedial	\$1 100	
3 2 1 2	Replace hydraulic piping	Remedial	\$83 000	
3 2 1 3	Perform maintenance work on cylinders	Remedial	\$25 250	
<b>3 2 2</b>	<b>Bulkhead Gate and Trashrack Hoists</b>			
3 2 2 1	Overhaul bulkhead gate hoists	Remedial/Repair	\$117 500	
3 2 2 2	Overhaul trashrack hoists	Repair	\$12 600	
<b>3 2 3</b>	<b>Dewatering and Desilting Systems</b>			
3 2 3 2	Desilt gate recesses with washdown hoses and pumps	Remedial	\$92 500	
3 2 3 2	Install piping for washdown water	Upgrade	\$80 000	
<b>3 2 4</b>	<b>Compressed Air System</b>			
3 2 4	Repair/Replace compressed air piping and nozzles in gate recesses	Repair	\$8 500	
<b>3 2 6</b>	<b>Building Mechanical Services</b>			
3 2 6	Mechanical Upgrade/Repairs	Upgrade/Repairs	\$2 100	

Total Mechanical Costs

\$422 550

**NOTES** Costs are based on anticipated cost of materials labour overhead contingency (10%) and engineering services (15%) for the proposed work

**Table 3 3**  
**Summary of All Electrical Work**

Section	Item	Type of Work	Cost	Comments
3 3 7	<b>Gate Heating Equipment</b>			
3 3 7 2	Replace Bulkhead Gates Guide Heating	Repair	\$6 500	
3 3 9	<b>Main Gate Hoist Controls</b>			
3 3 9	New Main Gate Hoist Controls	Upgrade	\$37 500	
3 3 10	<b>Building Lighting</b>			
3 3 10 2	Install roadway lighting on bridge deck	Upgrade	\$12 600	
3 3 12	<b>Security System</b>			
3 3 12	Enhance Security with CCTV (dummy)	Upgrade	\$10 000	Long Term
3 3 14	<b>Embedded Conduit Systems</b>			
3 3 14	Replace the Embedded conduits to the wingwalls with new cabling in hydraulic pipe trench	Upgrade	\$47 500	
3 3 16	<b>Power For Desilting Equipment</b>			
3 3 16	Provide power supply board for desilting equipment	Upgrade	\$20 000	Long Term

Total Electrical Costs \$134 100

**NOTES** Costs are based on anticipated cost of materials labour overhead contingency (10%) and engineering services (15%) for the proposed work

SECTION 4 0  
PROPOSED WORK  
PROGRAM

## 4 0 PROPOSED WORK PROGRAM

The schedule for completing the scope of work identified in Section 3 0 is described below. It is assumed that the total scope of work will be completed over a number of years. On this basis, the work program is presented in Table 4 1 and was developed by prioritizing work items into two categories:

work required immediately and in the short term (2 to 3 years)

work that can be completed over the long term (10 to 15 years)

The priority for the work has been assigned on the basis of several criteria. Those criteria are:

Reliability of the Structure

Safety during operations and of the Structure

Safety to operating personnel

Prevention of further deterioration of components

Preventative maintenance

Upgrades to enhance operations

Upgrading necessary for maintenance and inspection

In addition, the work has been grouped into those items that should be done at the same (ie, all work completed within the cofferdam) to minimize costs and to take advantage of the sequence of work. Group numbers have been assigned to each task to indicate which work items should be coordinated in order to take advantage of the sequence of work. Group 1 work items require full dewatering of the gates and gate areas within the cofferdams. Group 2 items require normal gate dewatering, which does not require cofferdams. Group 3 items can be performed without gate dewatering.

Work program items are detailed on Table 4 1 and are summarized below. References to the figures illustrating the work areas are given in the tables as well.

#### **4 1 SHORT TERM WORK PROGRAM**

A number of the deficiencies within the Structure require some form of repair or 2 3 year remediation as soon as possible to prevent the deterioration to unsafe or unserviceable conditions. The work principally involves repair or replacement of deteriorated components such as the hydraulic piping the cylinder support bridges the bulkhead gate and trashrack hoists the bulkhead gate guide heaters some platforms and maintenance on the hydraulic cylinders and power units. Other work which should be addressed as soon as possible includes safety related items (exposed foam insulation platforms) and minor problems with building mechanical systems.

A significant portion of the work required immediately is dictated by the desire to have similar groups of work completed together. This is especially important for work to be done within the cofferdam.

Proposed work that should be performed in the short term (2 to 3 years) consists of a variety of repairs and upgrades to the Structure. Many represent repairs to deteriorated or corroded components which will eventually become unserviceable such as hatches ladders and platforms. Minor problems with the gate cylinder truck position indication should also be addressed in the near future. A large portion of the work consists of repairs to the gates including painting some modifications to the existing facility and improved access. Other work includes a thorough desilting of the gate recesses and installation of washdown water piping to facilitate desilting.

The scope of this work and the associated costs are shown on Table 4 1 and the total estimated cost for the proposed items is \$2 163 000.

#### **4 3 LONG TERM UPGRADES AND REPAIRS**

The work recommended for the long term consists principally of replacement of the main gate seals to a properly functioning arrangement painting components of the bridge painting and repair of liner plates and installation of upgrades to facilitate de silting. Further work to stabilize some slope erosion is also suggested.

The scope of this work is shown on Table 4 1 as well.

**Table 4 1**  
**Summary of All Priorized Work Items**

Section	Work Item	Type of Work	Group (†)	2 3 Year Work Program		Long Term Work Program	Reference Figure No	Comments	
				Cofferdam Req d /Gate Dewatered	Surface Works				
Civil and Structural Works	<b>3 1 1</b>	<b>Roadway Bridge</b>							
	3 1 1 A	Detailed Inspection of Bearing Seats	Remediation	3		\$7 000	5		
	3 1 1 B	Installation of Monitoring Pins below Bearing Seat	Remediation	3		\$1 900			
	3 1 1 2	Detailed Inspection of Bearing Assemblies	Remediation	3		\$8 250	5		
	3 1 1 3	Repaint Girders within 20 years	Remediation	3			✓	5	
	3 1 1 5	Selective Repairs on all Sidewalks on Bridge	Repairs	3		\$75 000		5	
	3 1 1 6C	Complete Reconstruction of Service Duct Covers	Repairs	3		\$36 000		5	
	3 1 1 6D	Installation of Insulated Bulkheads in Service Duct	Upgrade	3		\$1 150		5	
	3 1 1 7A	Repair post bases and repaint handrail	Repair	3			✓	5	
	3 1 1 7E	Replace stair and handrails to D/S deck	Upgrade	3		\$7 500		5	
	3 1 1 9	Rehabilitate Sidewalk Expansion Joints	Remediation	3		\$26 050		5	
	<b>3 1 2</b>	<b>Central Pier</b>							
	3 1 2 1	Apply new synthetic roof membrane to Control Room Roof	Upgrade	3		\$5 850		5	
	3 1 2 2	Install fire resistant drywall on Machine Room ceiling	Upgrade	3		\$1 850		2	
	3 1 2 3	Replace Cylinder Hoist Support Bridges	Repair	3		\$61 400		6	
	3 1 2 3D	Access platforms to Cylinder Bridge and Piping	Upgrade	3		\$36 800		6	
	3 1 2 3E	Access drop platforms to Cylinder shaft	Upgrade	2	\$49 300			6	Assumes new platforms
	3 1 2 4	Sump Pit Ladders and Platforms	Repair	3		\$25 000		2	
	3 1 2 5	Rehabilitate the lift off covers over Cylinder Pits	Remediation	3		\$24 150		5	
	3 1 2 6	Remove and Replace Machine Room Hatch	Repair	3		\$3 800		5	
	3 1 2 6	Remove and Replace Cylinder Pit Hatches	Repair	3		\$11 000		5	
	3 1 2 7	Replace interior ladders and platforms in Pier	Repair	2	\$49 800			6	Dewatering necessary
	<b>3 1 3</b>	<b>Abutments</b>							
	3 1 3 1	Replace Bulkhead Gate roller assemblies	Repair	3		\$45 500		6	Assumes Gates are removed from Guides
	3 1 3 1	Pressure wash used to maintain Bulkhead Gate	Upgrade	3		n a			See Mechanical Works
	3 1 3 1	Install sill seals on Bulkhead Gates	Upgrade	3		\$12 700		6	
	3 1 3 2	Inspection of Bulkhead Gate roller paths and guides	Remediation	1	\$6 000				Dewatering Necessary
	3 1 3 3	Trash Rack inspection and repainting	Remediation	3		\$6 500			Assumes Trash Racks removed from Guides

**NOTES**

- 1 Costs are based on anticipated cost of materials labour overhead contingency (10%) and engineering services (15%) for the proposed work
- †2 Group 1 Work requiring cofferdam dewatering
- Group 2 Work requiring normal dewatering
- Group 3 Work not requiring dewatering

**Table 4 1**  
**Summary of All Priorized Work Items**

Section	Work Item	Type of Work	Group (†)	2 3 Year Work Program		Long Term Work Program	Reference Figure No	Comments	
				Cofferdam Req d /Gate Dewatered	Surface Works				
Civil and Structural Works ( Continued )	3 1 3 4	Detailed inspection of Trash Rack Guides	Remediation	1	\$6 000			Dewatering Necessary	
	3 1 3 6	Remove and Replace Cylinder Pit Access Hatches	Repair	3		\$20 000	5		
	3 1 3 6	Repair Lift off Panels	Repair	3		\$31 200	5		
	3 1 3 6	Replace interior ladders and platforms in Abutment	Repair	2	\$50 000			Dewatering Necessary	
	3 1 3 7	Install monitoring pins on Retaining Walls and Assessment	Remediation	3		\$1 900			
	3 1 3 6	Access Drop Platforms to Cylinder Shaft	Upgrade	2	\$49 300		6		
	3 1 3 6	Access Platform to Top of Cylinder & Piping	Upgrade	3		\$48 400	6		
	3 1 3 8	Selective Repairs to Parking Areas	Repair	3		\$65 500			
	3 1 3 9	Reconstruct Transformer Pad	Repair	3		\$17 000			
	3 1 4 6	Access Improvements into Surge Chamber	Upgrade	2	\$25 000		6		
	3 1 4	<b>Main Gates</b>							
	3 1 4 1	Replace existing seals and revise installation details	Repair	1			\$439 200	8 9	Cofferdam Required
	3 1 4 2	Selective Repairs and Repainting of skinplates	Remediation	1	\$125 500				Cofferdam Required
	3 1 4 3	Remove insulation from inside gate	Remediation	1	\$30 500				Dewatering Necessary
	3 1 4 4	Trunnion Maintenance and Inspection Platforms	Upgrade	1	\$96 400			11	Dewatering Necessary
	3 1 4 5	Selective Repairs and Repainting of Liner Plates	Remediation	1			✓		Cofferdam Required
	3 1 4 6	Maintenance Platforms within Gates	Remediation	1	\$80 000			11	Cofferdam Required
	3 1 4 6	Desilting Platforms at each end of each recess	Upgrade	2	\$42 900			6	
	3 1 4 7	Downstream Concrete Repairs	Repairs	1	\$140 900			7	Both Gates
	3 1 5	<b>Adjacent Earthfill Dams</b>							
	3 1 5 2	Construct swales along roadway to control runoff	Remediation	3			✓		
	3 1 6	<b>Public Security</b>							
	3 1 6	Construct security fence where required	Upgrade	3		\$13 000		5	
	3 1 6	Provide Life Preserver Rings on Bridge Deck	Upgrade	3		\$1 500			
	3 1 8	<b>Upstream and Downstream Cofferdams</b>							
	3 1 8	Cofferdam Installation and Maintenance for 120 Days	Upgrade	1	\$253 200			8	\$126 600 Per Gate
	3 1 8	Diver Installed Caulking and Seals for Dewatering Gate	n a	2	\$37 500				For Both Gates Not req d if C/D use for all work
<b>TOTALS FOR CIVIL/STRUCTURAL WORK</b>					\$1 042 300	\$595 900			

**NOTES**

- 1 Costs are based on anticipated cost of materials labour overhead contingency (10%) and engineering services (15%) for the proposed work
- †2 Group 1 Work requiring cofferdam dewatering
- Group 2 Work requiring normal dewatering
- Group 3 Work not requiring dewatering

**Table 4 1**  
**Summary of All Priorized Work Items**  
**(Continued)**

Section	Work Item	Type of Work	Group (†)	2 3 Year Work Program		Long Term Work Program	Reference Figure No	Comments
				Cofferdam Req d /Gate Dewatered	Surface Works			
Mechanical Works	<b>3 2 1</b>	<b>Hydraulic Hoisting System</b>						
	3 2 1 1	Perform maintenance on east hydraulic unit	Remedial	3		\$1 100	3 12	
	3 2 1 2	Replace hydraulic piping	Remedial	3		\$83 000	12	
	3 2 1 3	Perform maintenance work on cylinders	Remedial	2	\$25 250		12 13	
	<b>3 2 2</b>	<b>Bulkhead Gate and Trashrack Hoists</b>						
	3 2 2 1	Overhaul bulkhead gate hoists	Remedial/Repair	3		\$117 500	6	
	3 2 2 2	Overhaul trashrack hoists	Repair	3		\$12 600	6	
	<b>3 2 3</b>	<b>Dewatering and Desilting Systems</b>						
	3 2 3 2	Desilt gate recesses with washdown hoses and pumps	Remedial	2	\$92 500		15	Should be scheduled prior to any other work inside gate recesses
	3 2 3 2	Install piping for washdown water	Upgrade	2	\$80 000		15	
	3 2 3 2	Install well in centre pier for washdown water supply	Upgrade	3			✓	
	3 2 3 2	Install Electrical power supply board	Upgrade	3		n a	16	See Electrical Works
	<b>3 2 4</b>	<b>Compressed Air System</b>						
		Repair/replace compressed air piping & nozzles in gate recesses	Repair	2	\$8 500			
	<b>3 2 6</b>	<b>Building Mechanical Services</b>						
	Mechanical Upgrades/Repairs	Upgrade/Repair	3		\$2 100			
<b>TOTALS FOR MECHANICAL WORKS</b>					\$206 250	\$216 300		

**NOTES**

- 1 Costs are based on anticipated cost of materials labour overhead contingency (10%) and engineering services (15%) for the proposed work
- †2 Group 1 Work requiring cofferdam dewatering
- Group 2 Work requiring normal dewatering
- Group 3 Work not requiring dewatering

**Table 4.1**  
**Summary of All Priorized Work Items**  
**(Continued)**

Section	Work Item	Type of Work	Group (†)	2-3 Year Work Program		Long Term Work Program	Reference Figure No	Comments
				Cofferdam Req'd / Gate Dewatered	Surface Works			
Electrical Works	<b>3.3.7 Gate Heating Equipment</b>							
	3.3.7.2 Replace Bulkhead Gates Guide Heating	Repair	3		\$6,500			
	<b>3.3.9 Main Gate Hoist Controls</b>							
	3.3.9 New Main Gate Hoist Controls	Upgrade	3		\$35,700			
	<b>3.3.10 Building Lighting</b>							
	3.3.10.2 Install Roadway Lighting on Bridge Deck	Upgrade	3		\$12,600			
	<b>3.3.12 Security System</b>							
	3.3.12 Enhance Security with local CCTV (Dummy)	Upgrade	3			✓		
	<b>3.3.14 Embedded Conduit Systems</b>							
	3.3.14 Replace the Embedded conduits to the wingwalls with new cabling in hydraulic pipe trench	Upgrade	3		\$47,500		16	
<b>3.3.16 Power for Desilting Equipment</b>								
3.3.16 Provide power supply board for desilting equipment upgrade	Upgrade	3			✓	16		
<b>TOTALS FOR ELECTRICAL WORKS</b>					\$102,300			

<b>Total Costs</b>	<b>\$1,248,550</b>	<b>\$914,500</b>
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**NOTES**

- 1 Costs are based on anticipated cost of materials, labour, overhead, contingency (10%) and engineering services (15%) for the proposed work.
- †2 Group 1 Work requiring cofferdam dewatering  
 Group 2 Work requiring normal dewatering  
 Group 3 Work not requiring dewatering

**SECTION 5 0  
CONCLUSIONS &  
RECOMMENDATIONS**

## **5 0 CONCLUSIONS AND RECOMMENDATIONS**

Based upon the results of the study the following conclusions and recommendations are presented

### **5 1 STRUCTURAL AND CIVIL COMPONENTS**

#### **5 1 1 Roadway Bridge**

The roadway bridge is generally in good condition. Some concerns have been identified regarding the condition of the bearings and bearing seats. Detailed inspection of these components is recommended at the detailed design stage. As well, maintenance/repairs are recommended for the girder (painting), handrails (base repairs and painting), roadway deck (sidewalk expansion joint replacement) and selective repairs to the sidewalks and service ducts.

The load rating recently completed by the Department of Highways has concluded that the bridge load rating is adequate for its current use.

#### **5 1 2 Central Pier**

A number of maintenance and code related issues were identified in the Control Room and Machine Room which should be addressed. These include asphalt roof repairs, painting over graffiti along the walls of control room and protection of rigid foam insulation in the Machine Room.

Seepage and runoff from the road deck has corroded the cylinder support structures to a level at which their ability to resist the hoist loads is questionable. It is recommended that the anchor bolt supports be replaced as soon as possible.

Access hatches, platforms and access for inspection have either corroded due to service conditions in the vicinity of the deck or are substandard for the intended use. It is recommended that these be rehabilitated and upgraded for future use.

#### **5 1 3 Abutments**

Seepage and runoff from the road deck has corroded the cylinder support structures to a level at which their ability to resist the hoist loads is questionable. It is recommended that the anchor bolt supports be replaced as soon as possible.

Access hatches, platforms and access for inspection have either corroded due to service conditions in the vicinity of the deck or are substandard for the intended use. It is recommended that these be rehabilitated and upgraded for future use.

#### *Main Gates*

The main gates are functioning well for their intended use and no major deficiencies have been identified. The gate seals have, however, not been functioning properly for a number of years and it is not presently possible to dewater the gate without the use of divers. This is not desirable for the long term reliable operation of the gate and it is recommended that the seals be replaced. KGS Group have presented two alternatives for the seal replacement. The first option considers conventional replacement of the seals, whereas the second alternative considers a deflatable seal arrangement. Following a review of the work program, Manitoba Natural Resources decided that costs for seals would be deferred indefinitely as the system can function without them. Dewatering for maintenance and inspection will, however, be effected with the aid of divers.

The skin plates have lost their protective coating due to abrasion and corrosion over their existing life. It is recommended that the gate be repainted to maintain their condition with no future loss of material thickness.

The gate structure and trunnion support loads were assessed by a finite element analysis of the entire structure. Gate stresses and trunnion loads were found to be within acceptable limits. For the extreme load condition, the capacity of the hoist was found to be exceeded. Requirements associated with this deficiency are addressed in the mechanical section of the report. As well, trunnion loads exceed the post tension force applied at their supports. In this regard, it is recommended that the trunnion loads should be inspected in detail when each gate is cofferdammed.

#### *Liner Plates*

The side liner plates are in relatively good condition with some localized wear and deterioration. Some secondary concrete has spalled from around the perimeter of the plates. The main gate seals slide across these plates each time the gate is operated. Consequently, repairs and painting with a low friction coating have been recommended to improve seal longevity and reduce seal friction. Other repairs and an overall inspection are recommended to maintain the condition of the liner plates. If the seals are not replaced, then work to the liner plates can be postponed.

#### *Maintenance Access*

Throughout the inspection of the Structure, it was apparent access to many components was very difficult or time consuming. As a result, many portions of the gates, trunnions, hoist cylinders are not routinely inspected or maintained. It is recommended that a system of new platforms be installed within the gates, and new platforms be installed adjacent to the hydraulic hoist cylinders. Additional platforms are recommended to allow access to hydraulic piping and assist with desilting the gate recesses within the Structure.

#### **5 1 4 Earthfill Dams**

Erosion due to runoff and public traffic along the faces of the earthfill dams has resulted in some gully formation. It is recommended that shallow ditches be constructed along the roadway shoulders to direct the runoff to rock lined swales as necessary. The most significant area of concern for erosion is the river channel immediately downstream of the Structure. As recommended in an earlier report, the placement of a concrete filled blanket over the scour holes was found to be the most efficient solution.

#### **5 1 5 Public Security**

During operations, the Structure attracts the Public. During the remainder of the year, the Public is a regular user of the Structure. Several locations on the Structure are significant vertical walls without handrails or fences. It is recommended that a security fence be placed along the areas of greatest risk to the public. Additional changes to the handrails and stairs at the downstream observation deck are also recommended to improve the safety for the Public.

### **5 2 MECHANICAL SYSTEMS**

#### **5 2 1 Hydraulic Hoisting System**

The condition of the existing hydraulic piping has been identified as the most serious problem within the hydraulic hoisting system. The piping should be replaced as soon as possible.

The hydraulic power units and hydraulic cylinders are generally in good condition. Some necessary maintenance work on these items has been identified.

The cylinder support guides are in relatively good condition but should be maintained on a yearly basis. Provisions for new platforms to improve access to the guides are presented in this report as a civil/structural work item.

The situation of hydraulic system overload under the loads presented in Appendix H will result in the opening of a system relief valve and subsequent loss of gate position control. This situation may be remedied by temporarily increasing the relief pressure of this valve to regain control of the gate. In doing so, the pressure will still be within the system design limits.

## **5 2 2 Bulkhead Gate and Trashrack Hoists**

The bulkhead gate hoists require removal for major overhaul work or replacement to restore them to a reliable condition. The limit switches and position indicating devices are not functioning and one of the hoists became inoperable during the inspections.

The trashrack hoists are not operable and need to be removed and overhauled or replaced to restore them to a working condition.

## **5 2 3 Dewatering and Desilting Systems**

The dewatering pump was observed to function properly but accumulations of silt at the pump inlet tend to cause blockage. These silt accumulations need to be removed from the gate recesses and utilization of manpower with washdown hoses and portable desilting pumps is presented as the most feasible alternative for this task. A number of upgrades to the Structure are proposed in order to facilitate the job of desilting which should be performed as a regular maintenance procedure.

## **5 2 4 Compressed Air System**

The air compressors are functioning properly but the compressed air bubbling system inside the gate recesses is reportedly inoperational. The air nozzles and exposed piping should be examined during future gate dewatering and repaired or replaced as required.

## **5 2 5 Cylinder Well/Abutment Surge Chamber Heaters**

The forced air heaters used to heat the cylinder wells and abutment surge chambers are reportedly functioning properly. When these heaters need replacement the implementation of a radiant heating system should be examined as this may prove to be more efficient than forced air heating.

## **5 2 6 Building Mechanical Systems**

A number of deficiencies exist in the Control Structure building mechanical systems. These problems and their associated remediation costs are relatively minor.

### **5 3 ELECTRICAL SYSTEMS**

The electrical systems physically within the Control Room and the Machine Room are generally in good condition principle due to the dry indoor environment and the fact that the equipment is only called on to operate for short periods of time each year. While it may not be realistic to expect all these systems to have another 30 years of life it is also not improbable. It is not considered to be reasonable to replace these components on the basis of an anticipated failure. The cost to repair future failures of individual components are anticipated to be modest principally due to the accessibility of these components. Repairs can likely be handled within a maintenance budget. Accordingly no work has been recommended for these systems.

#### **5 3 1 Main Gate Seal Path Heating**

The main gate seal path heating no longer functions. It is recommended that this heating system be abandoned as it no longer is required with the present mode of operation.

#### **5 3 2 Bulkhead Gate Guide Heating**

The guide heating on both gates no longer functions. It is recommended that they be replaced.

#### **5 3 3 Main Gate Position Indication System**

The main gate cylinder position indication system [selsyn system] no longer functions. It is recommended that a new system consisting of an absolute encoder with a digital readout device located at the control desk be installed. It is further recommended that this cylinder position signal be automatically converted to a main gate tip elevation and also be displayed at the main control desk and available on a dial up modem.

#### **5 3 4 Embedded Conduit System**

The one electrical systems requiring extensive repair/modification is the embedded circuit systems from the Machine Room located in the centre pier to both end piers. Due to corrosion and congealing of conductor insulation these are no longer useable. Some circuits located in these conduits have already failed and it is likely additional failures will occur over the next 30 years. A new raceway system is recommended to bring power to the end piers.

#### **5 3 5 CCTV System**

The addition of a camera and monitor with pan/tilt/zoom features is recommended to enhance operator/structure security during periods when the structure is operated.

### **5 3 6 Exterior Lighting**

To improve security and operator/public safety it is recommended that the Department of Natural Resources make arrangements with Manitoba Hydro to own and operate the lighting provided by the pole mounted fixtures

## REFERENCES

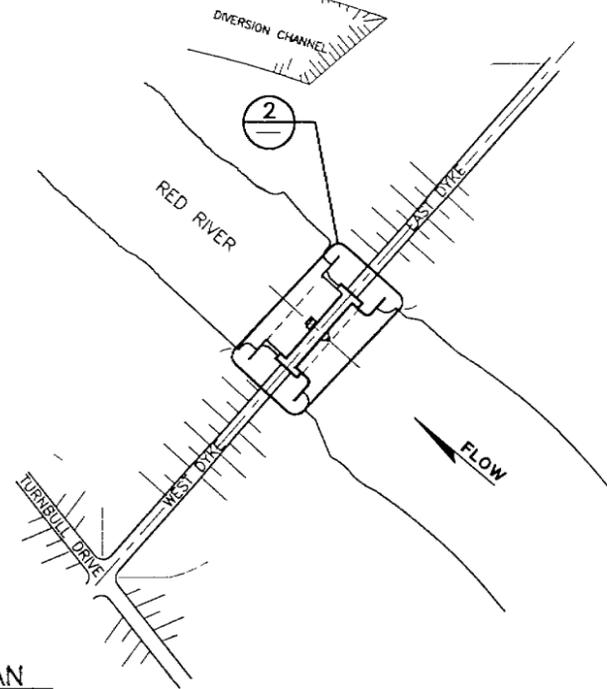
*Red River Floodway Instructions for Operation of Inlet Control Structure Gates* Water Resources Board Manitoba Department of Natural Resources November 1981

*Red River Floodway Inlet Control Structure Erosion Study* KGS Group Inc November 1995

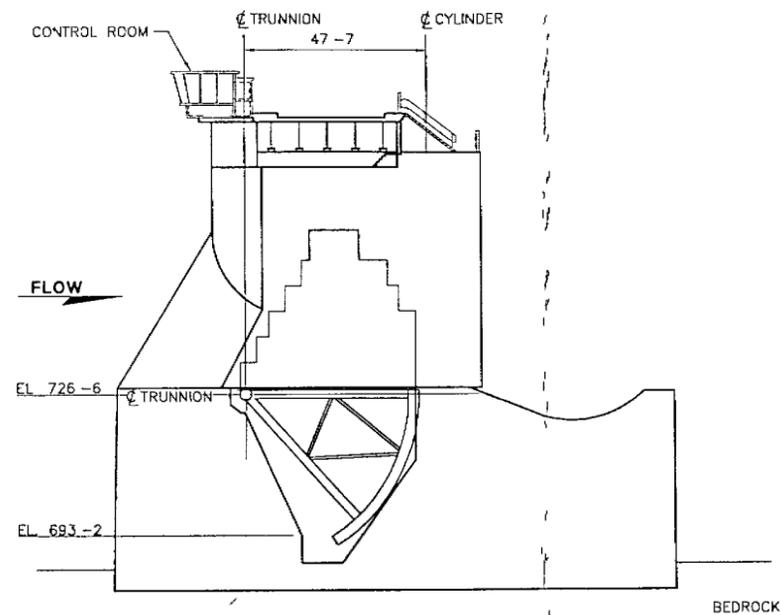
*Investigation of the Red River Floodway Inlet Gate Seal and Concrete Deterioration* Acres International Limited March 1988

*Waterway Maintenance Program Greater Winnipeg Floodway and Portage Diversion Working Paper No 7* M M Dillon Limited & I D Engineering Canada Inc 1992

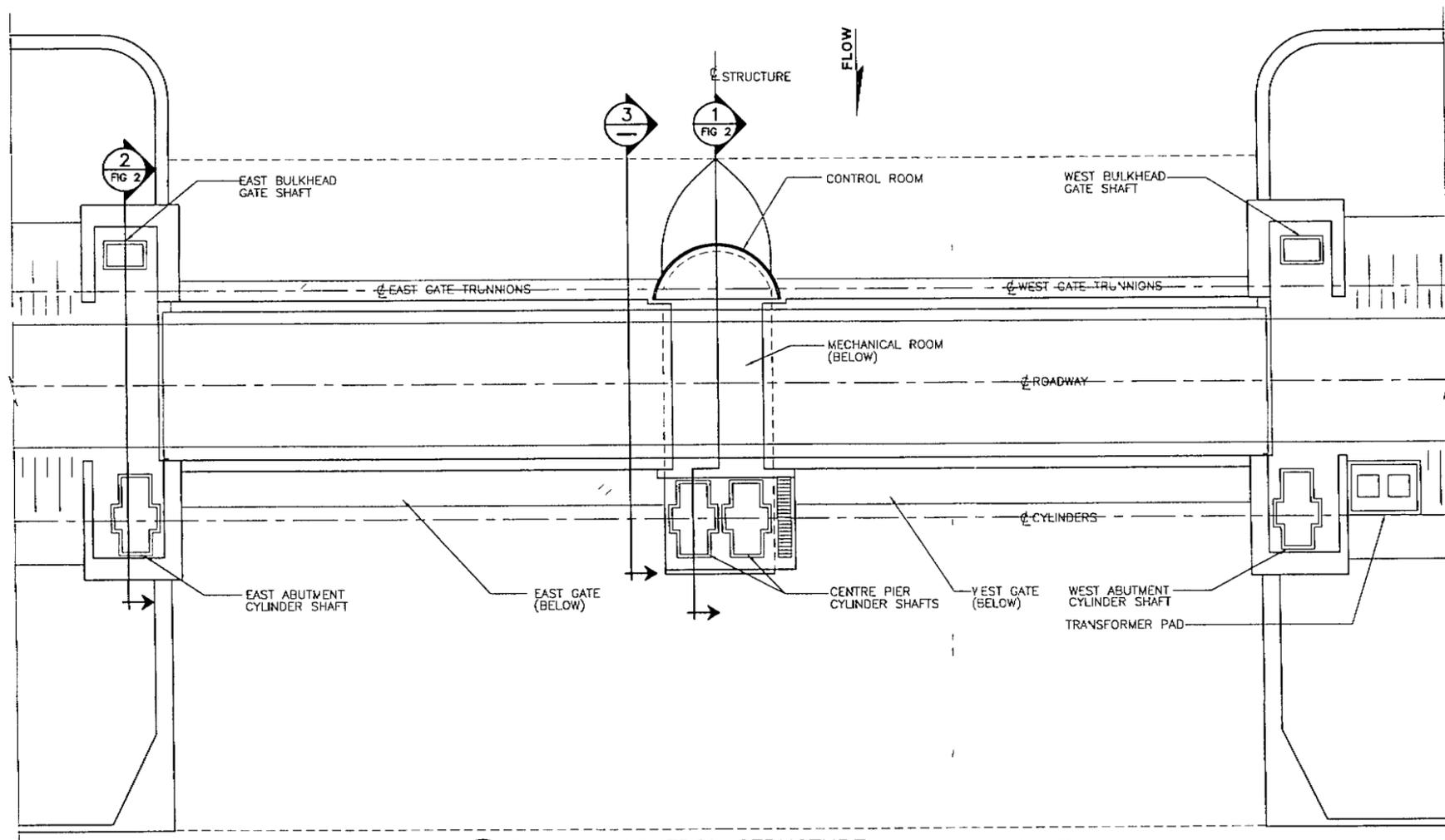
FIGURES



1 SITE PLAN  
SCALE N.T.S.



3 SECTION-CONTROL STRUCTURE  
HOR SCALE 1" = 20'



2 PLAN - CONTROL STRUCTURE  
HOR SCALE 1/8" = 1'-0"

B	21/02/97	ISSUED FOR FINAL REPORT	RSCB
A	30/08/96	ISSUED FOR DRAFT REPORT	RSCB

REVISIONS / ISSUE	
A	SECTION LETTER OR DETAIL NUMBER IS DRAWN
B	DRAWN, WHERE SECTION OR DETAIL WAS INDICATED
- SECTION OR DETAIL SHOWN ON SAME DRAWING	

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**Manitoba NATURAL RESOURCES**

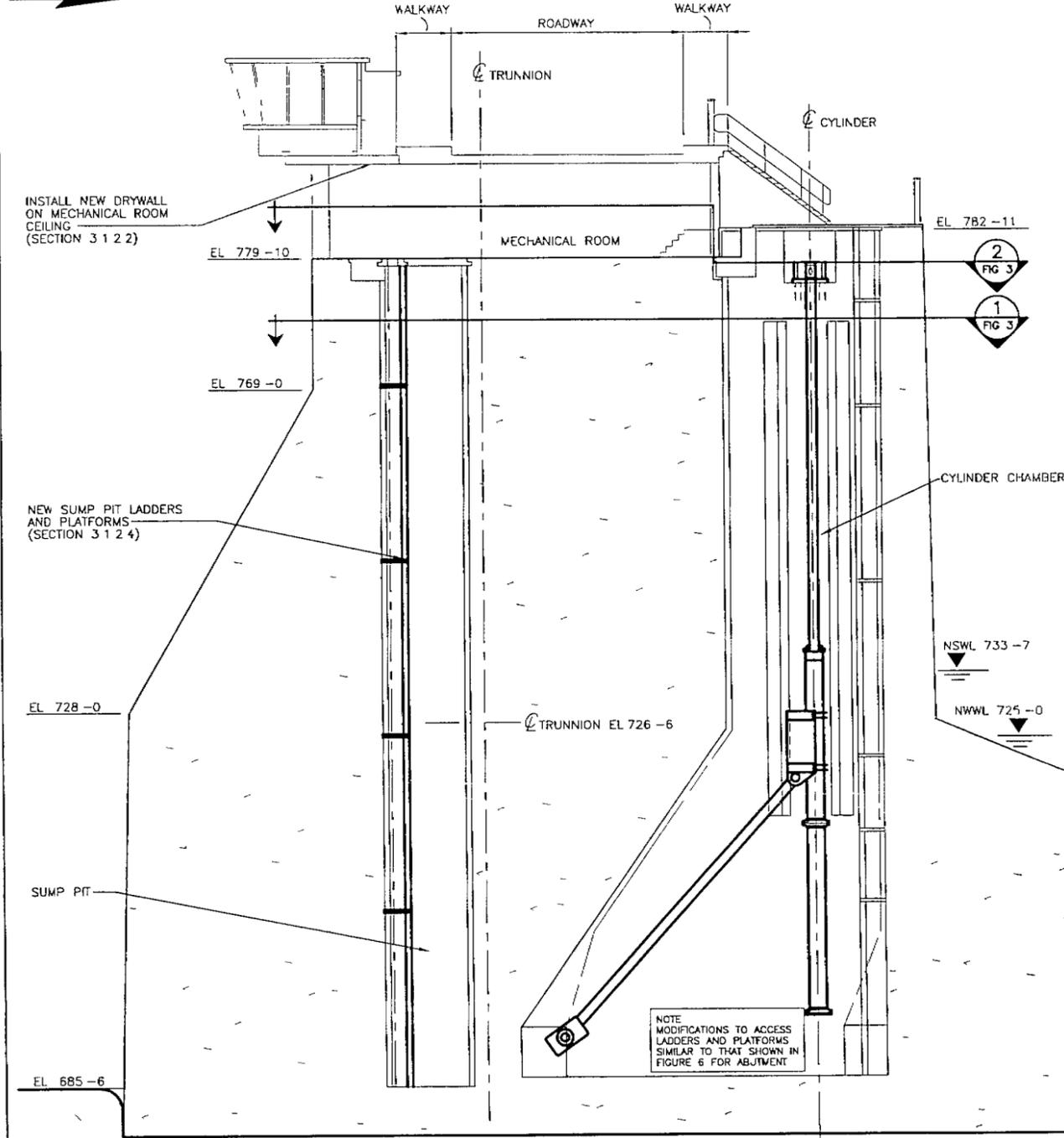
RED RIVER FLOODWAY INLET STRUCTURE

SITE PLAN  
CONTROL STRUCTURE SITE PLAN  
GENERAL ARRANGEMENTS AND SECTIONS

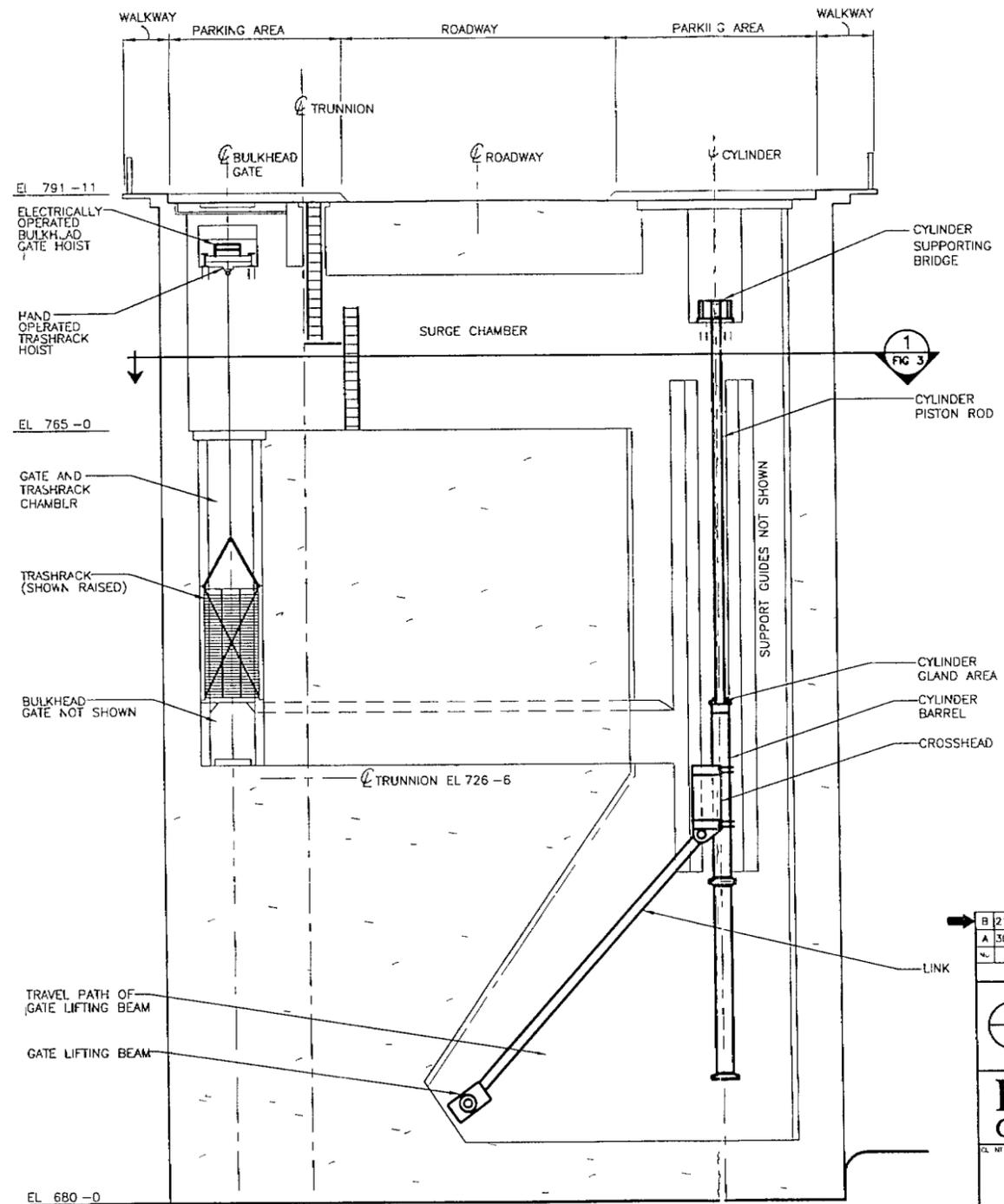
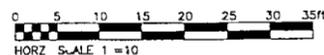
DATE	DRAWN	CHECKED
	JRM/EJN	RSCB
SCALE	AS NOTED	F'B/97
FIGURE	1	

KGS FILE NO 96-311-01 FIGURE 1 DWG  
24 35 PLOT SCALE 2:40

FLOW



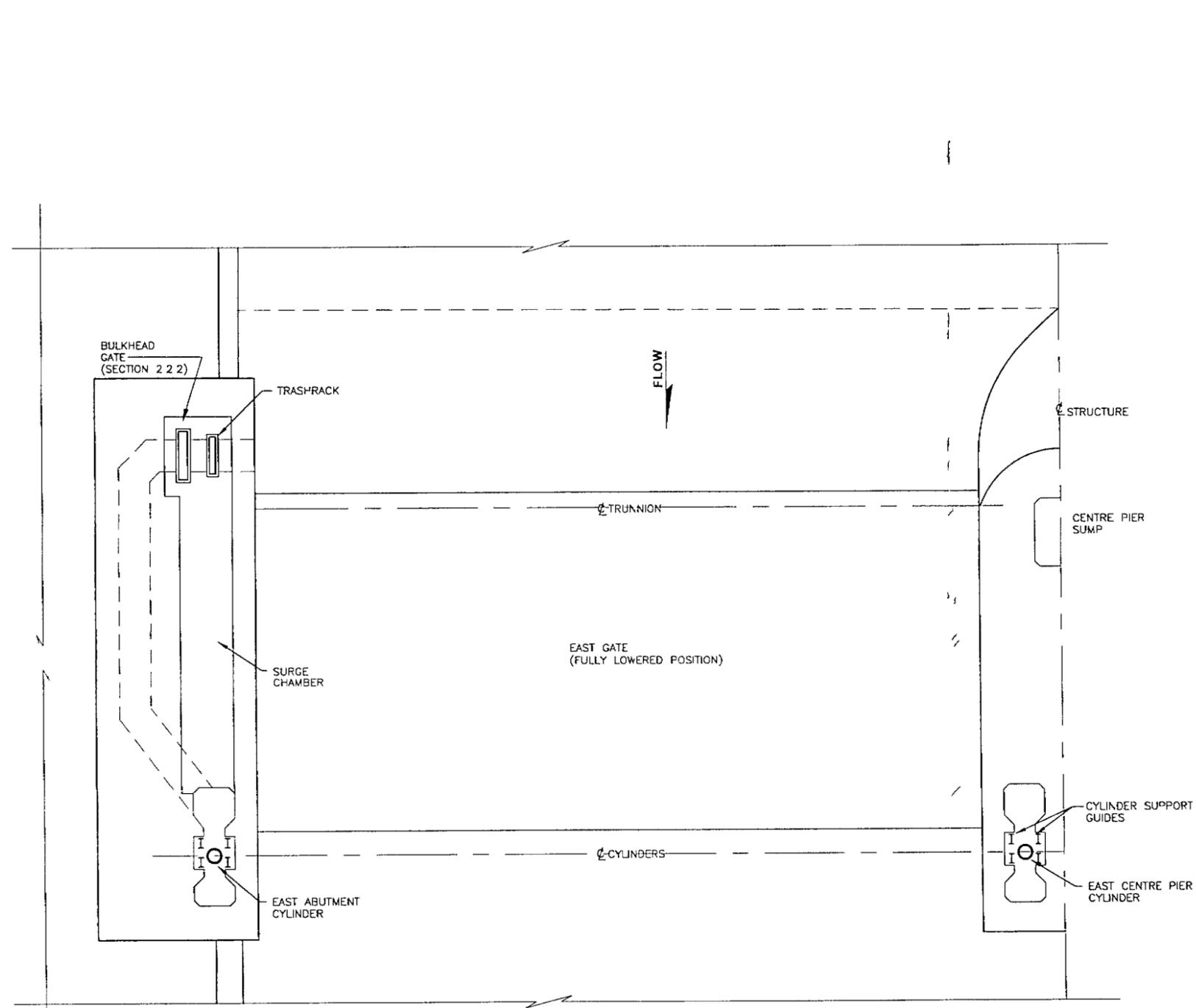
1 SECTION - CENTRE PIER (GATE FULLY DOWN)



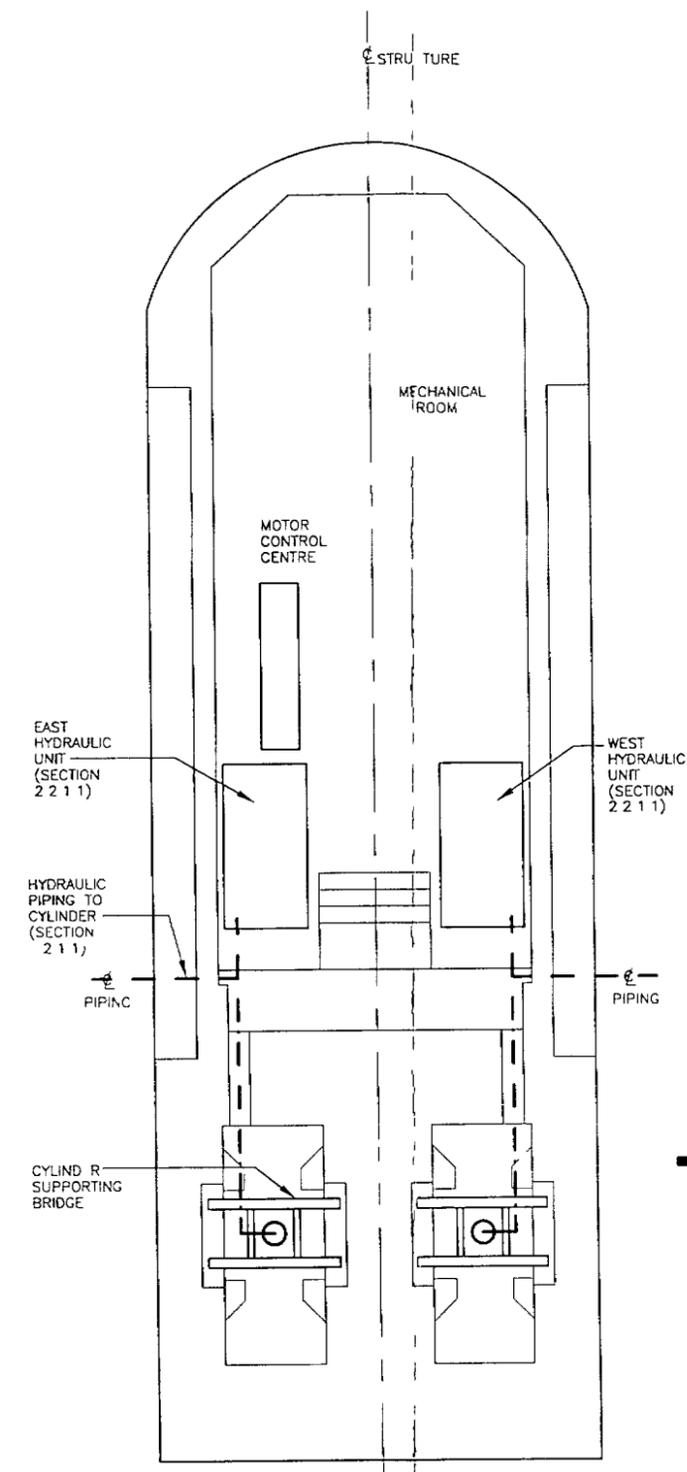
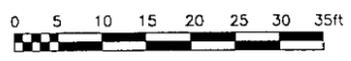
2 SECTION - EAST ABUTMENT (GATE FULLY DOWN)



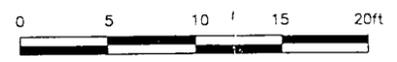
B	21/02/97	ISSUED FOR FINAL REPORT	
A	30/08/96	ISSUED FOR DRAFT REPORT	RSCB
REVISIONS / ISSUE			
A	SECTION LETTER OR DETAIL NUMBER		A
B	DRAWING WHERE SECTION OR DETAIL IS DRAWN		
	OR		
	DRAWING WHERE SECTION OR DETAIL WAS INDICATED		
--- SECTION OR DETAIL SHOWN ON SAME DRAWING			
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<b>Manitoba</b>			
NATURAL RESOURCES			
RED RIVER FLOODWAY INLET CONTROL STRUCTURE			
CENTRE PIER AND EAST ABUTMENT SECTIONS GATE HOISTING MECHANISMS			
DR	STW	DE	VC
		EJN	RSCB
SCALE	AS NOTED		FEB / 97
FIGURE 2			



2 PARTIAL PLAN - CONTROL STRUCTURE EAST SIDE



2 PARTIAL PLAN - CENTRE PIER



B	21/02/97	ISSUED FOR FINAL REPORT	S
A	1/09/96	ISSUED FOR DRAFT REPORT	JS

REVISIONS / ISSUE			
A	SECTION LETTER OR DETAIL	DESCRIPTION OR DETAIL	DATE
(A)	RAWI	WHERE DETAIL SHOWN ON	(A)
(B)	RAWI	WHERE DETAIL SHOWN ON	(B)

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 41 NIP (04) 09  
 111 ER BA (807) 345-2233

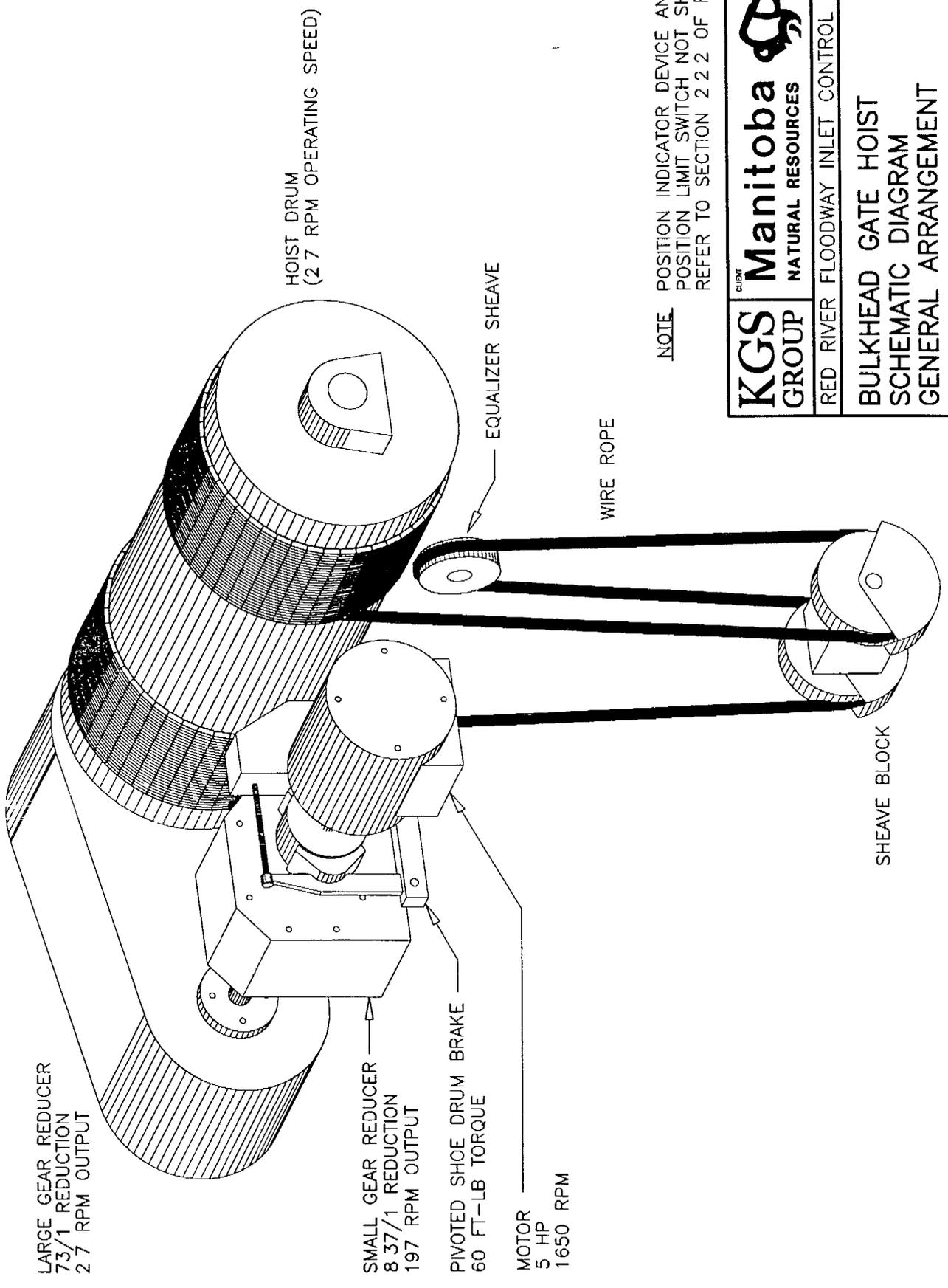
**Manitoba** NATURAL RESOURCES

RED RIVER FLOODWAY INLET STRUCTURE

EAST SIDE AND CENTRE PIER GATE HOISTING MECHANISMS PARTIAL PLANS

DESIGN	JS	DATE	
SCALE	AS NOTED	DATE	FEB/97

FIGURE 3

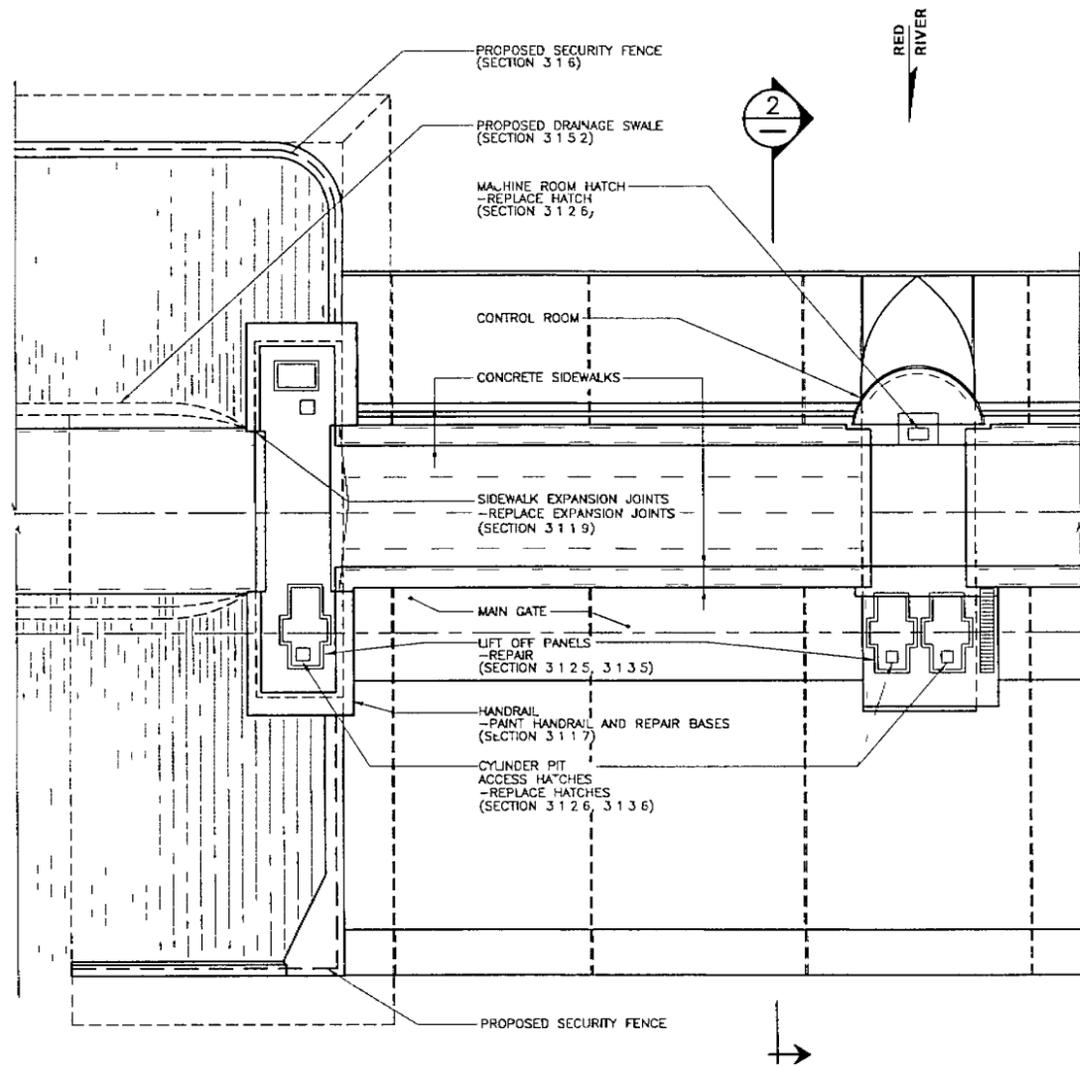


NOTE: POSITION INDICATOR DEVICE AND  
POSITION LIMIT SWITCH NOT SHOWN  
REFER TO SECTION 2.2.2 OF REPORT

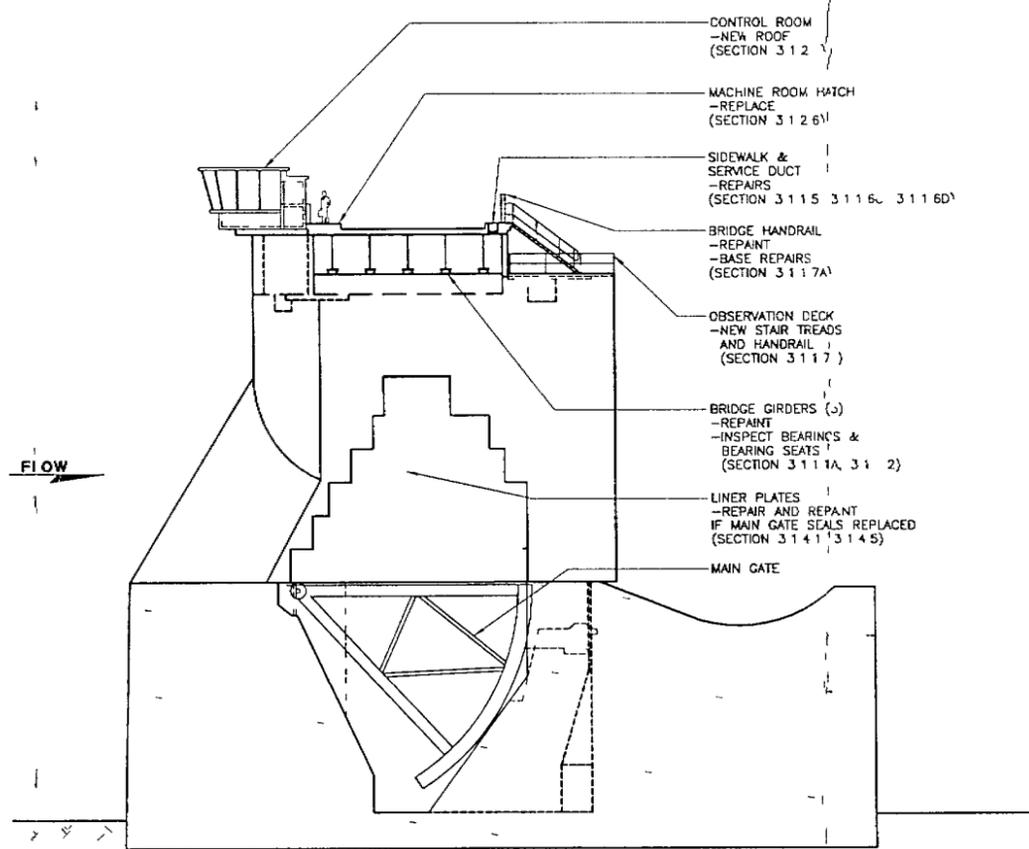
<b>KGS GROUP</b>	<b>Manitoba</b> NATURAL RESOURCES
RED RIVER FLOODWAY INLET CONTROL STRUCTURE	
BULKHEAD GATE HOIST SCHEMATIC DIAGRAM GENERAL ARRANGEMENT	

FEB /97

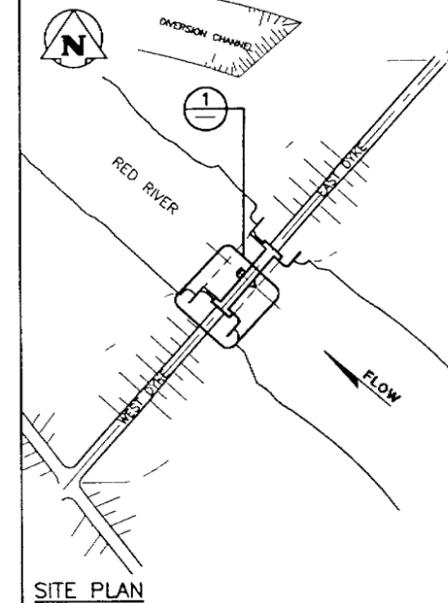
FIGURE 4



1 PLAN - CONTROL STRUCTURE  
NTS



2 SECTION  
NTS



B	21/02/97	ISSUED FOR FINAL REPORT	
A	01/11/96	ISSUED FOR DRAFT REPORT	

REVISIONS / ISSUE	
A	SECTION LETTER OR DETAIL NUMBER
B	DRAWING WHERE SECTION OR DETAIL IS DRAWN
A	DRAWING WHERE SECTION OR DETAIL WAS INDICATED
- SECTION OR DETAIL SHOWN ON SAME DRAWING	

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THUNDER BAY (807) 345-2233

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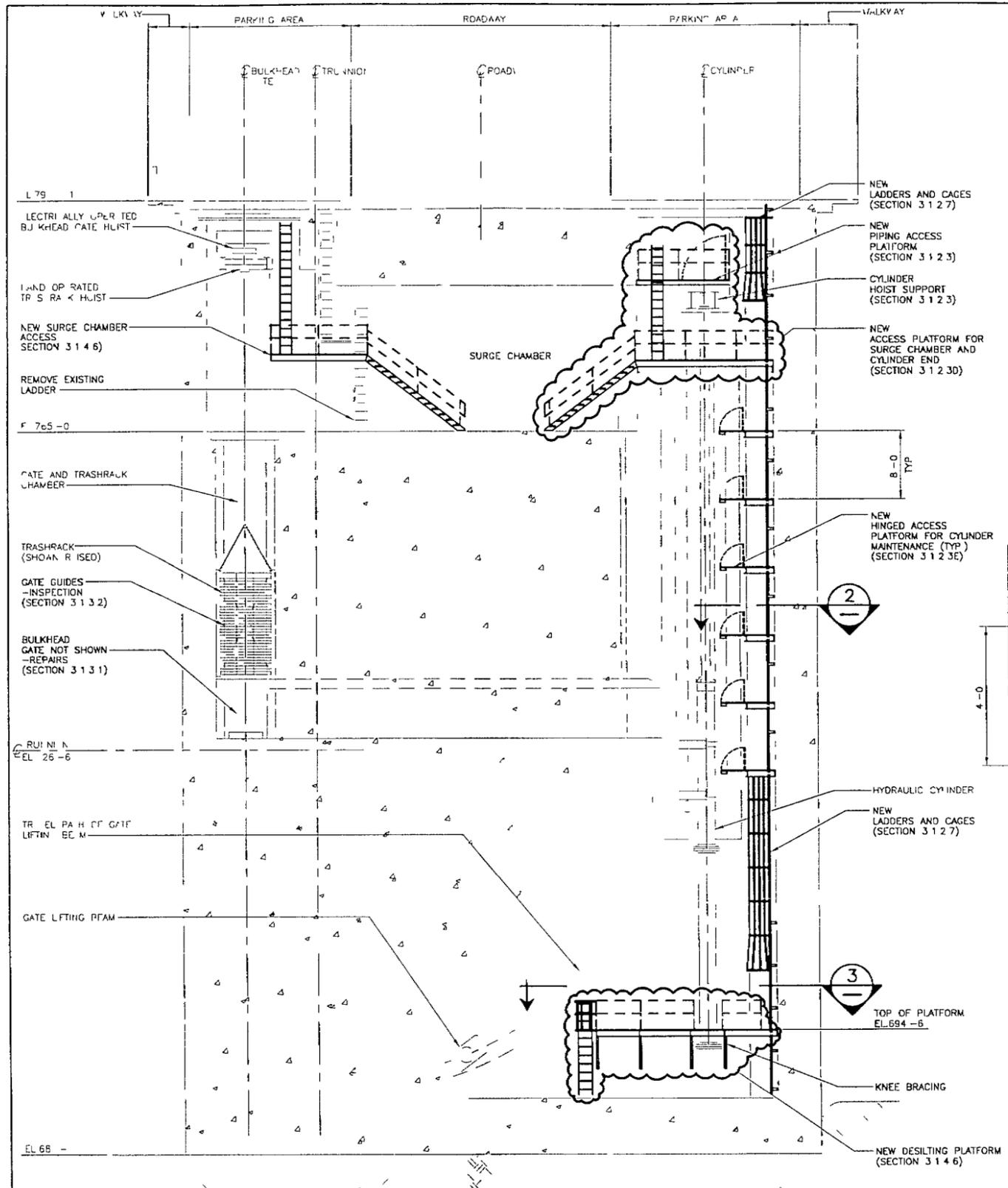
RED RIVER FLOODWAY  
INLET CONTROL STRUCTURE  
INSPECTION AND ASSESSMENT REPORT

GENERAL ARRANGEMENT

SITE PLAN PLAN AND SECTION

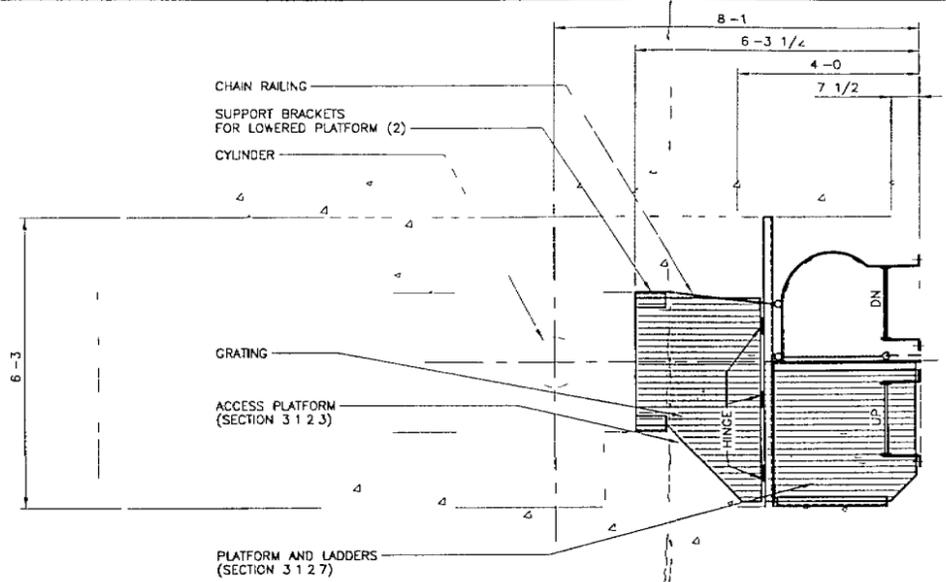
DESIGNED BY	DR	TV	CHECKED BY	DBM
APPROVED				
SCALE		DATE		
AS NOTED		FEB /97		

FIGURE 5

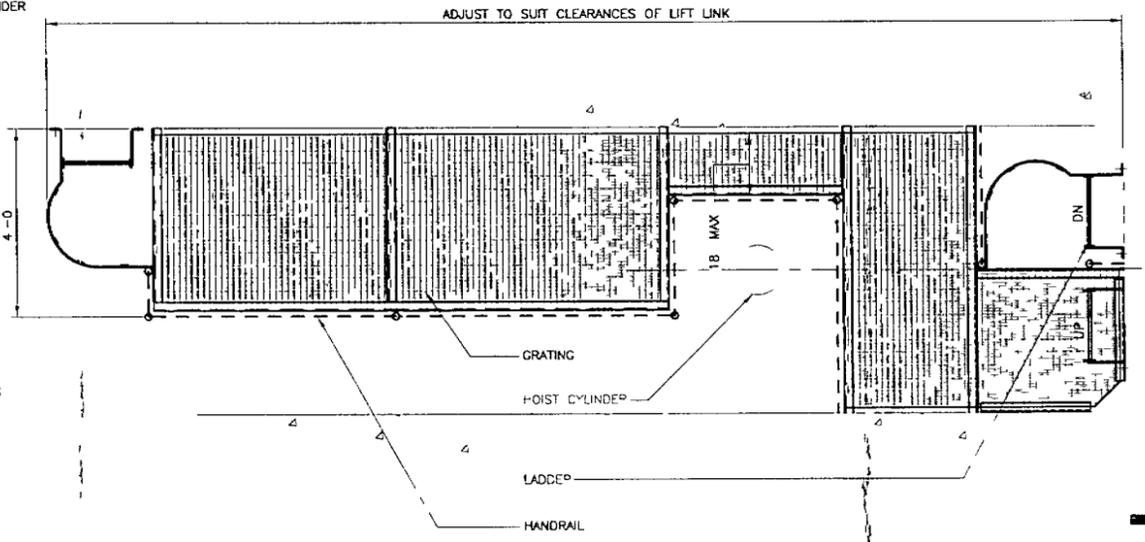


**1** SECTION  
NTS

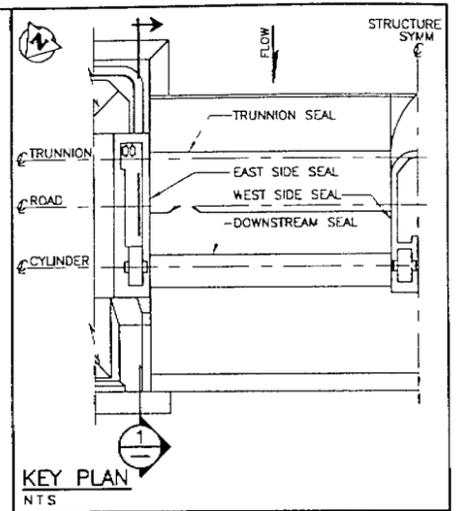
NOTE  
SIMILAR MODIFICATIONS TO ACCESS  
PLATFORMS AND LADDERS ON  
CENTRAL PIER SEE DWG FIGURE 2



**2** SECTIONAL PLAN OF WING WALL (ABUTMENT) &  
CENTRE PIER PLATFORMS  
SCALE 1/4" = 1'-0"



**3** SECTIONAL PLAN OF PLATFORM AT BOTTOM  
OF ABUTMENT (CENTRAL PIER SIMILAR)  
SCALE 1/4" = 1'-0"



KEY PLAN  
NTS

B	21/02/97	ISSUED FOR FINAL REPORT	
A	01/11/96	ISSUED FOR DRAFT REPORT	
		DESIGNED BY	

REVISIONS / ISSUE	
A	SECTION LETTER OR DETAIL NUMBER
B	DRAWING WHERE SECTION OR DETAIL IS DRAWN
	OR DRAWING WHERE SECTION OR DETAIL WAS INDICATED
	SECTION OR DETAIL SHOWN ON SAME DRAWING

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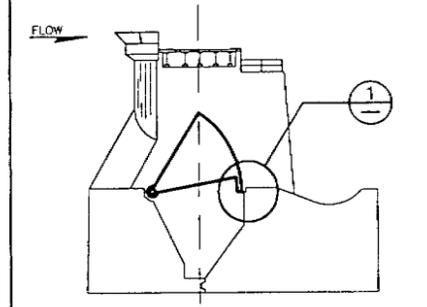
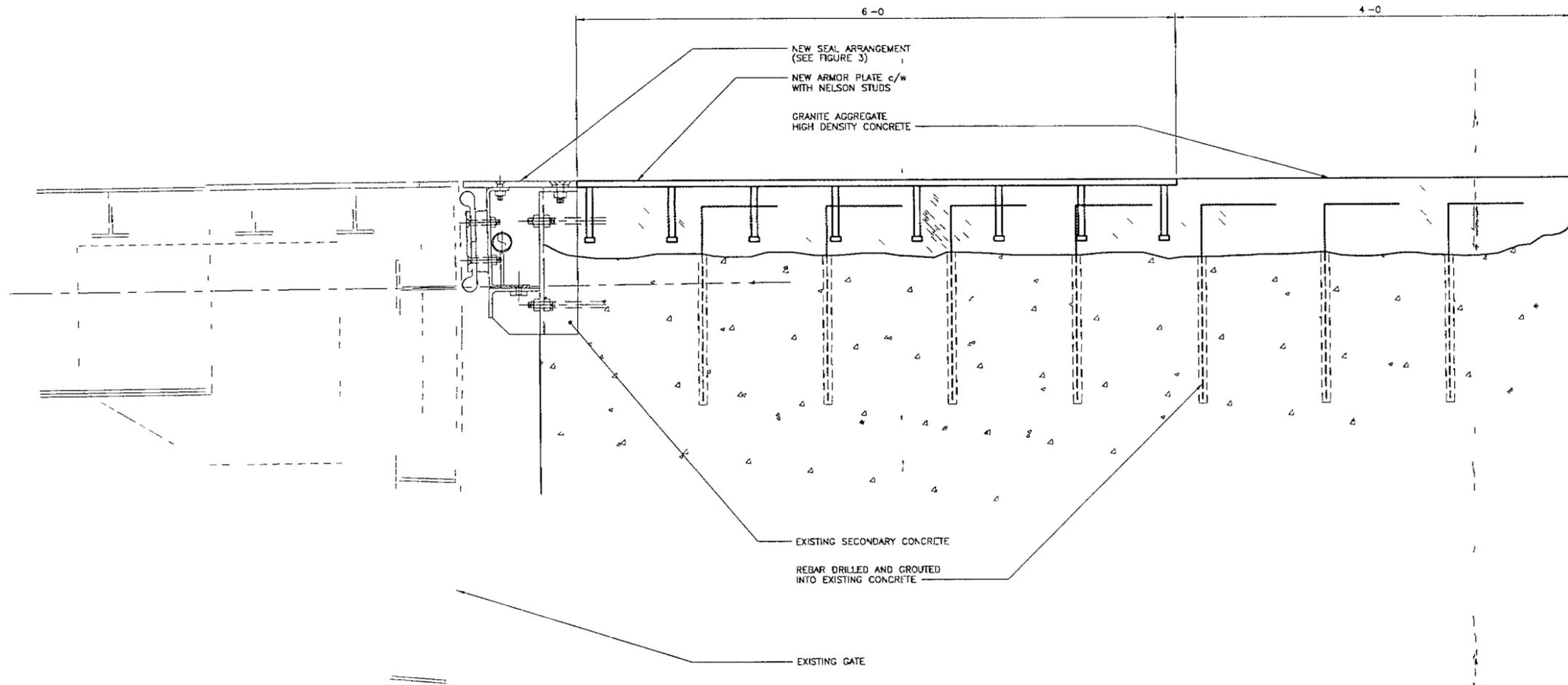
RED RIVER FLOODWAY INLET CONTROL STRUCTURE INSPECTION AND ASSESSMENT REPORT

NEW PLATFORM ARRANGEMENTS FOR ABUTMENT SECTIONS

DESIGNED	RSCB	DATE	2	CHECKED	DBM
SCALE	AS NOTED	DATE	FEB /97		

FIGURE 6

FLOW



KEY SECTION  
NTS

B	21/02/97	ISSUED FOR FINAL REPORT
A	01/11/96	ISSUED FOR DRAFT REPORT
SC IP ID#		

REVISIONS / ISSUE	
A	SECTION LETTER OR DETAIL NUMBER
B	DRAWN WHERE SECTION OR DETAIL IS DRAWN
	OR
	DRAWING WHERE SECTION OR DETAIL WAS INDICATED
---	SECTION OR DETAIL SHOWN ON SAME DRAWING

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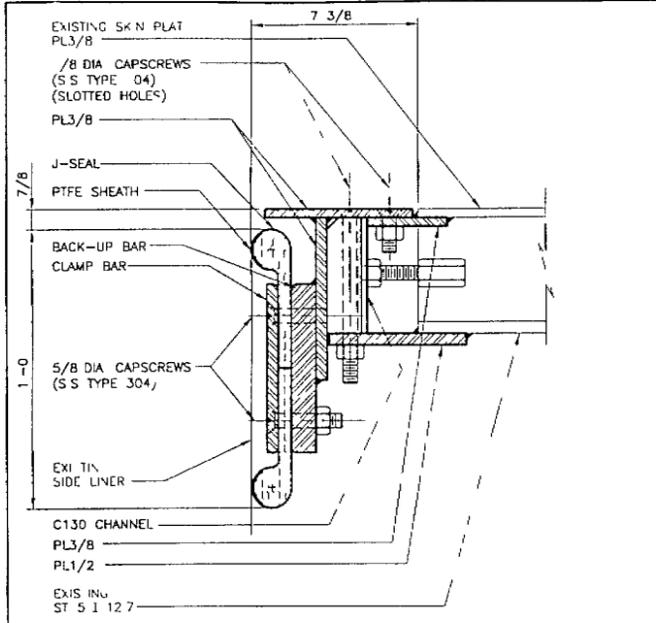
**Manitoba** NATURAL RESOURCES

PROJECT: RED RIVER FLOODWAY INLET CONTROL STRUCTURE

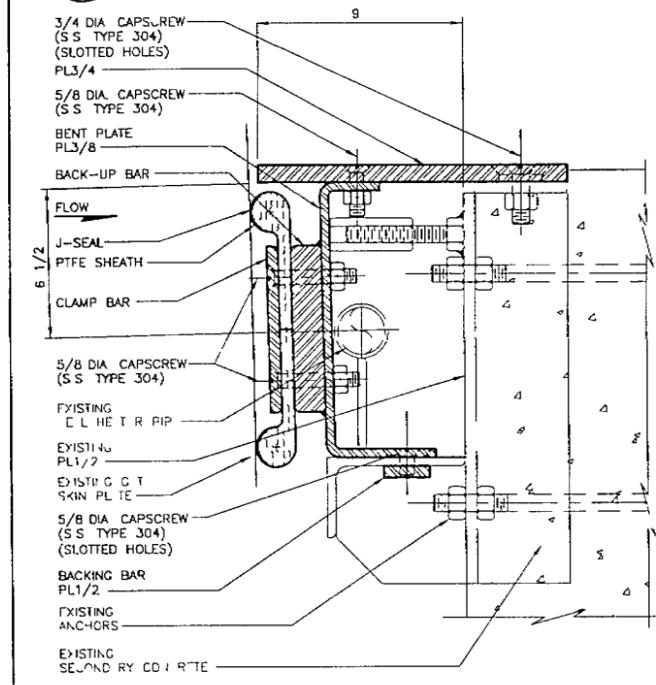
CONTRACT: REPAIRS TO CONCRETE DOWNSTREAM OF GATES SECTION (SECTION 3 1 4 7)

DESIGNER	DATE	CHECKED
R S C B	J J F	R
SCALE	DATE	
AS NOTED	FEB /97	
FIGURE 7		

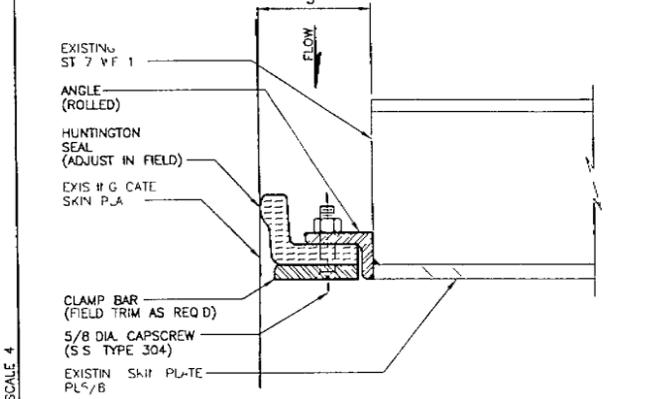
SECTION THRU CONCRETE  
DOWNSTREAM OF GATES  
SCALE 3/4 = 1-0



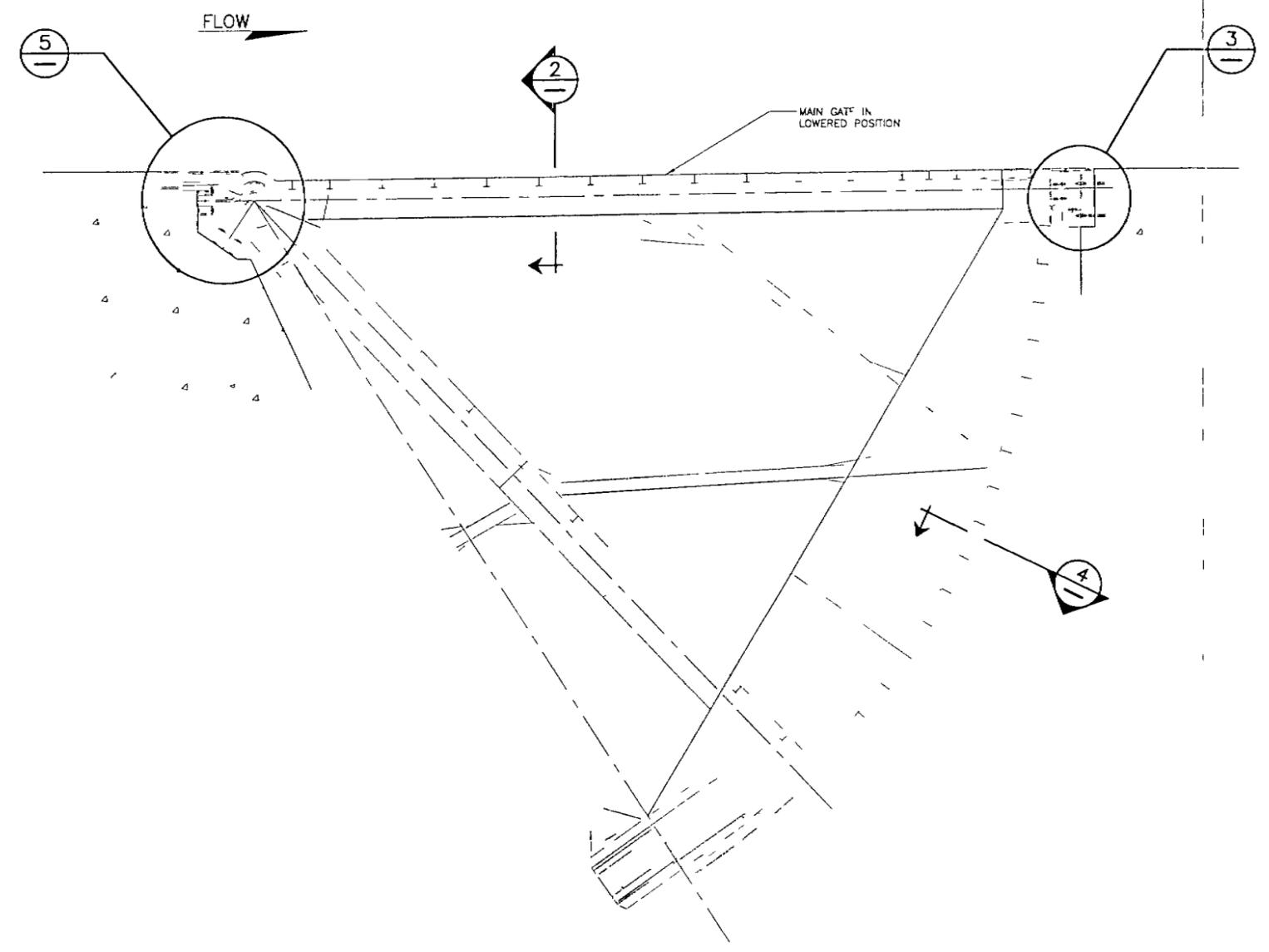
**2 SECTION**  
SCALE 1 1/2 = 1-0



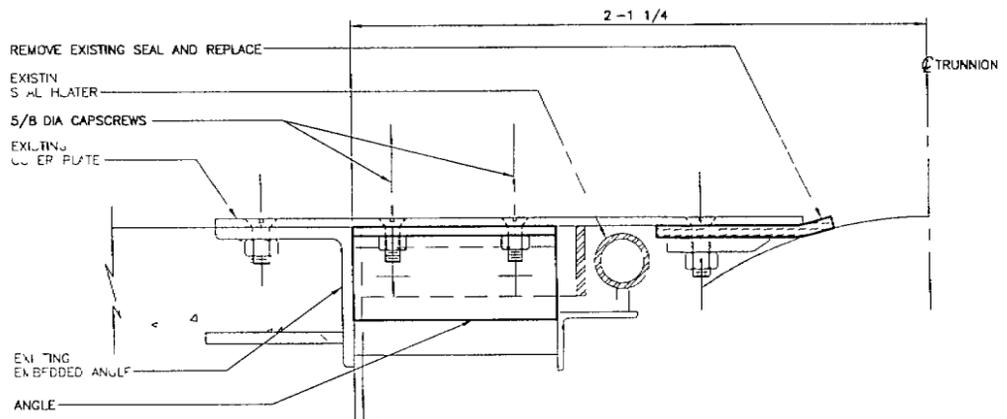
**3 DETAIL**  
SCALE 1 1/2 = 1-0



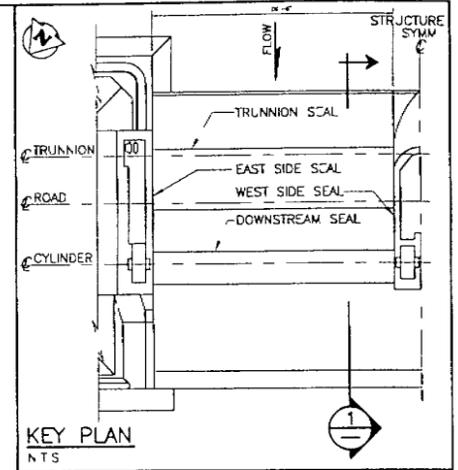
**4 SECTION**  
SCALE 1 1/2 = 1-0



**1 SECTION**  
NTS



**5 DETAIL**  
SCALE 1 1/2 = 1-0



B	21/C2/97	ISSUED FOR FINAL REPORT	
A	01/11/96	ISSUED FOR DRAFT REPORT	
NO	/ /	DESCRIPTION	BY

REVISIONS / ISSUE	
A	SECTION LETTER OR DETAIL NUMBER IS DRAWN
B	DRAWING WHERE SECTION OR DETAIL WAS INDICATED
-	SECTION OR DETAIL SHOWN ON SAME DRAWING

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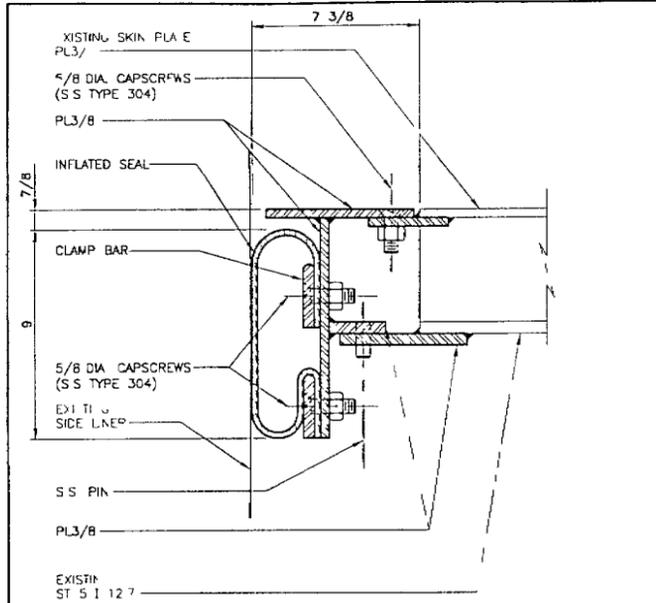
RED RIVER FLOODWAY  
INLET CONTROL STRUCTURE

MAIN GATE (OPTION 1)  
CONCEPTUAL SEAL ARRANGEMENTS  
SECTIONS AND DETAILS

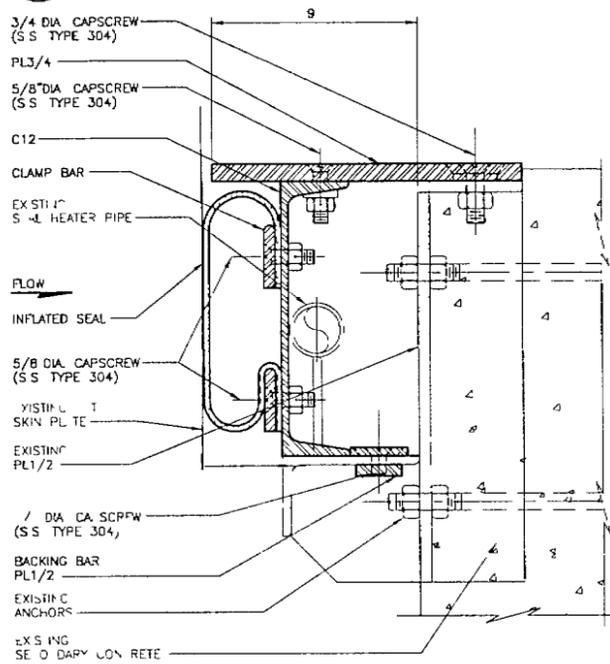
DESIGNED	RSCB	DRAWN	PC	CHECKED	DBM
SCALE	AS NOTED		DATE	FEB /97	

FIGURE 8

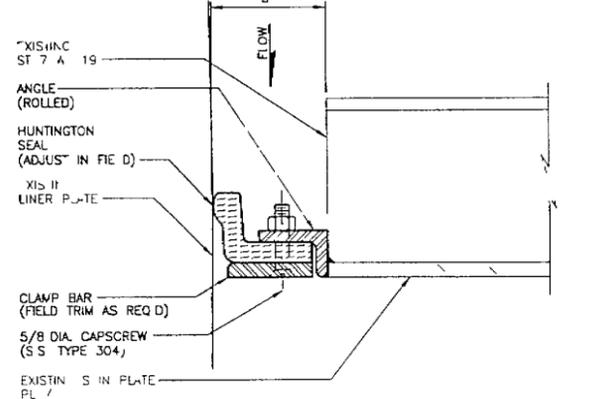
REFER TO SECTION 3 1 4 1  
FOR SEAL OPTION  
DISCUSSION



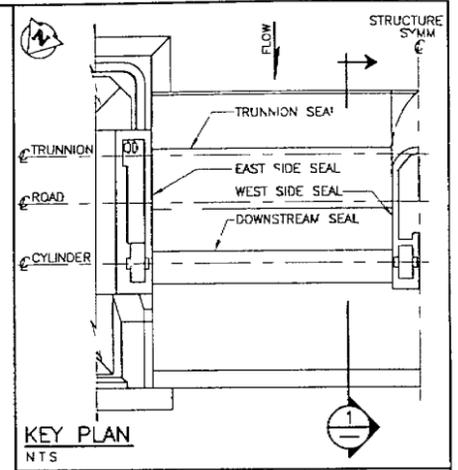
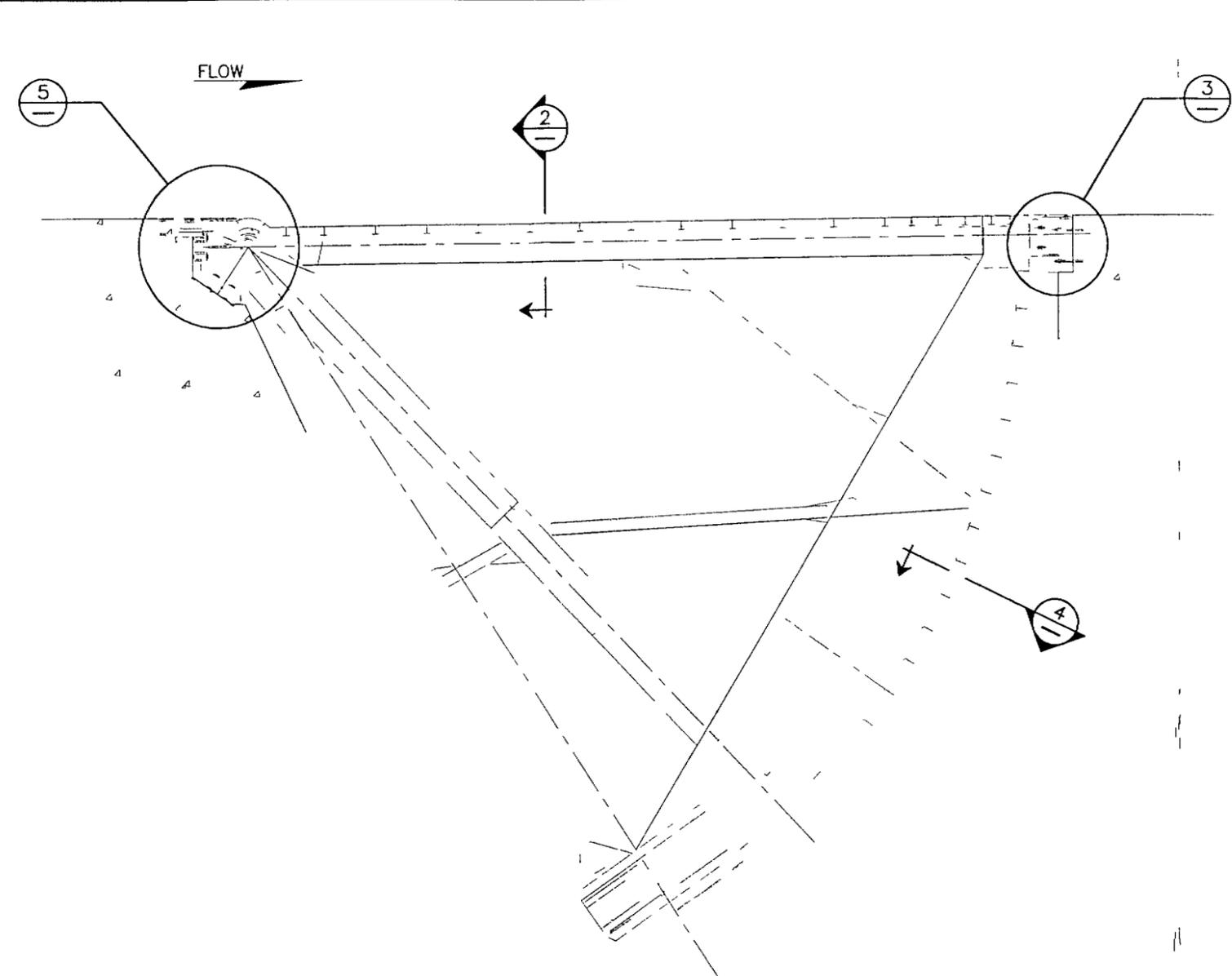
**2 SECTION**  
SCALE 1 1/2 = 1 - 0



**3 DETAIL**  
SCALE 1 1/2 = 1 - 0

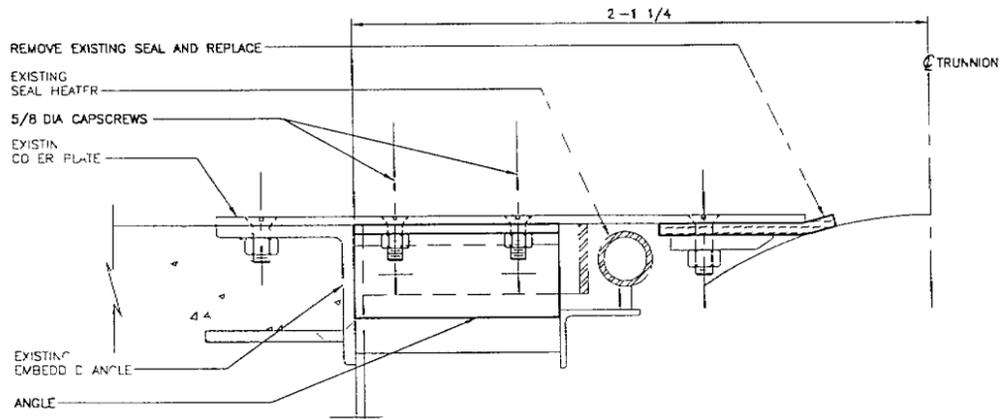


**4 SECTION**  
SCALE 1 1/2 = 1 - 0



KEY PLAN  
NTS

**1 SECTION**  
NTS



**5 DETAIL**  
SCALE 1 1/2 = 1 - 0

REFER TO SECTION 3 1 4 1 FOR SEAL OPTION DISCUSSION

B 21/0 /97	ISSUED FOR FINAL REPORT
A 01/11/96	ISSUED FOR DRAFT REPORT
D / /	SC 07

REVISIONS / ISSUE	
A	SECTION LETTER OR DETAIL NUMBER
B	DRAWING WHERE SECTION OR DETAIL IS DRAWN OR DRAWING WHERE SECTION OR DETAIL WAS INDICATED
-	SECTION OR DETAIL SHOWN ON SAME DRAWING

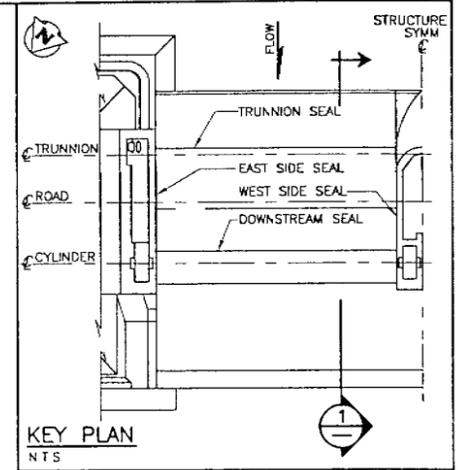
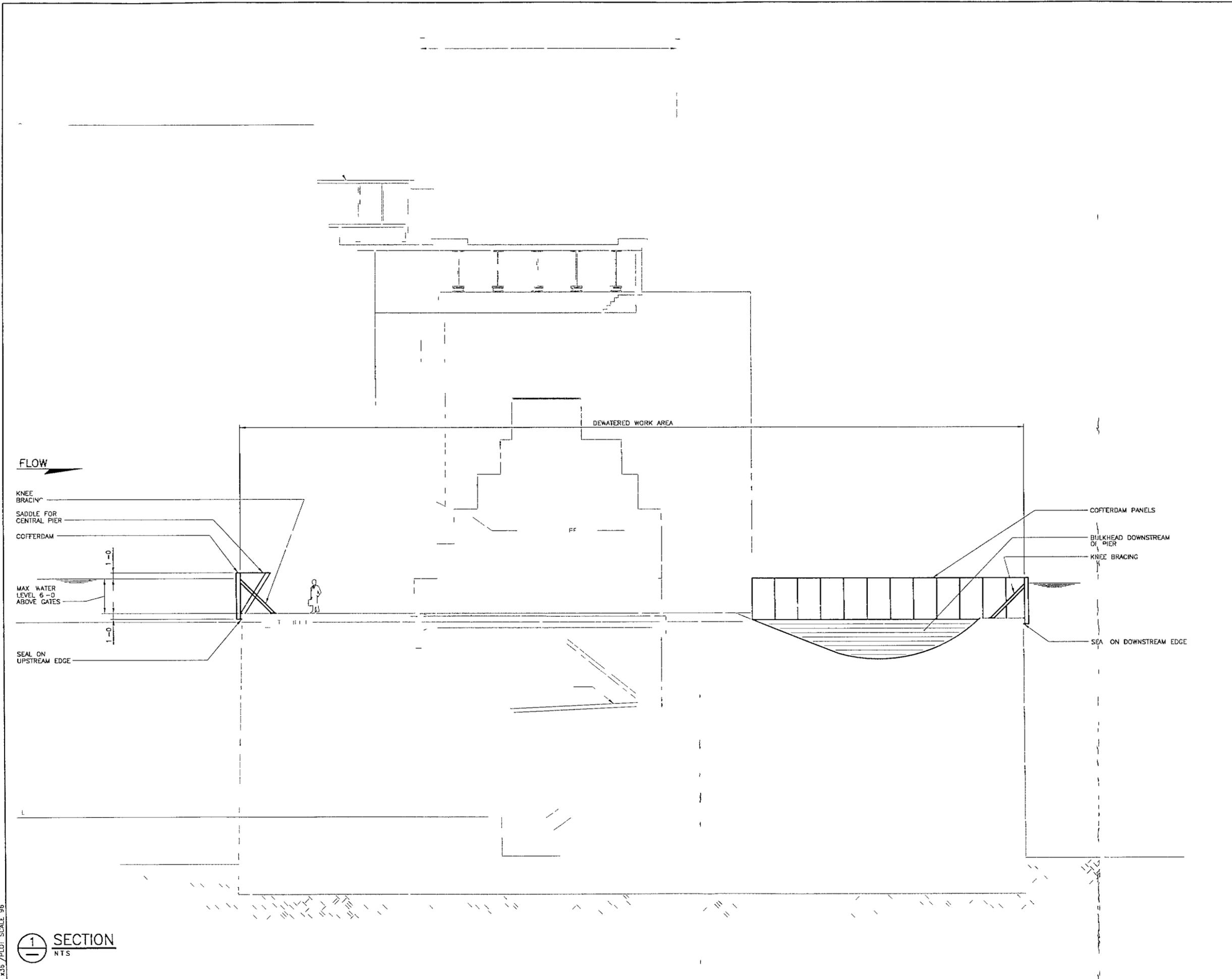
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RED RIVER FLOODWAY  
INLET CONTROL STRUCTURE

MAIN GATE (OPTION 2)  
CONCEPTUAL SEAL ARRANGEMENTS  
SECTIONS AND DETAILS

DATE	DESIGNED	DRAWN	CHECKED
	RSCB	DBM	
SCALE	AS NOTED	DATE	FEB /97
FIGURE 9			



KEY PLAN  
NTS

FLOW

KNEE BRACING  
SADDLE FOR CENTRAL PIER  
COFFERDAM  
MAX WATER LEVEL 6'-0" ABOVE GATES  
SEAL ON UPSTREAM EDGE

DEWATERED WORK AREA

COFFERDAM PANELS  
BULKHEAD DOWNSTREAM OF PIER  
KNEE BRACING  
SEA ON DOWNSTREAM EDGE

B	21/02/97	ISSUED FOR FINAL REPORT	
A	01/11/96	ISSUED FOR DRAFT REPORT	
SC	/ /	S. PB	BY

REVISIONS / ISSUE	
A	SECTION LETTER OR DETAIL NUMBER IS DRAWN
B	DRAWING WHERE SECTION OR DETAIL WAS INDICATED
A	DRAWING WHERE SECTION OR DETAIL WAS INDICATED
-	SECTION OR DETAIL SHOWN ON SAME DRAWING

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RED RIVER FLOODWAY  
INLET CONTROL STRUCTURE

COFFERDAM ARRANGEMENT  
(SECTION 3.1.8)  
SECTION

DESIGNED BY	RSCB	CHECKED BY	JJF	DATE	FEB 97
APPROVED BY					
SCALE	AS NOTED				

FIGURE 10

KGS FILE NO. 98-311-01 FIGURE 10 DWG  
24 X 35 / PLOT SCALE 96

SECTION  
NTS

FLOW

MAIN GATE SHOWN IN LOWERED POSITION

ACCESS PLATFORM FOR LUBRICATION AND MAINTENANCE OF TRUNNIONS (SECTION 3 1 4 4)

SHIPS LADDER

TRUNNION ACCESS PLATFORM CONTINUOUS ACROSS GATE INTERIOR (SECTION 3 1 4 4)

SHIPS LADDER OR STAIR WITH HANDRAIL (PART OF TRUNNION ACCESS PLATFORMS)

EXISTING GATE

NOTE PLATFORMS AND LADDERS SIMILAR ON OPPOSITE SIDE OF GATE

TRUNNION ACCESS PLATFORMS AND LADDERS

MAINTENANCE SHIPS LADDER

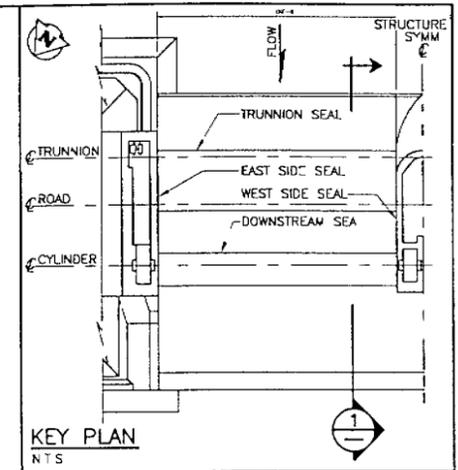
NEW HANDRAIL

MAINTENANCE ACCESS PLATFORM CONTINUOUS ACROSS GATE INTERIOR (SECTION 3 1 4 6)

MAINTENANCE SHIPS LADDER (SECTION 3 1 4 6)

EXISTING GATE PEDESTAL

SECTION 1  
SCALE 3/8 = 1'-0" 24 x 36  
3/16 = 1'-0" 11 17



REVISIONS / ISSUE	
B	21/02/97 ISSUED FOR FINAL REPORT
A	101/11/96 ISSUED FOR DRAFT REPORT
	DESCRIPTION

A SECTION LETTER OR DETAIL NUMBER  
B DRAWING WHERE SECTION OR DETAIL IS DRAWN OR DRAWING WHERE SECTION OR DETAIL WAS INDICATED  
- SECTION OR DETAIL SHOWN ON SAME DRAWING

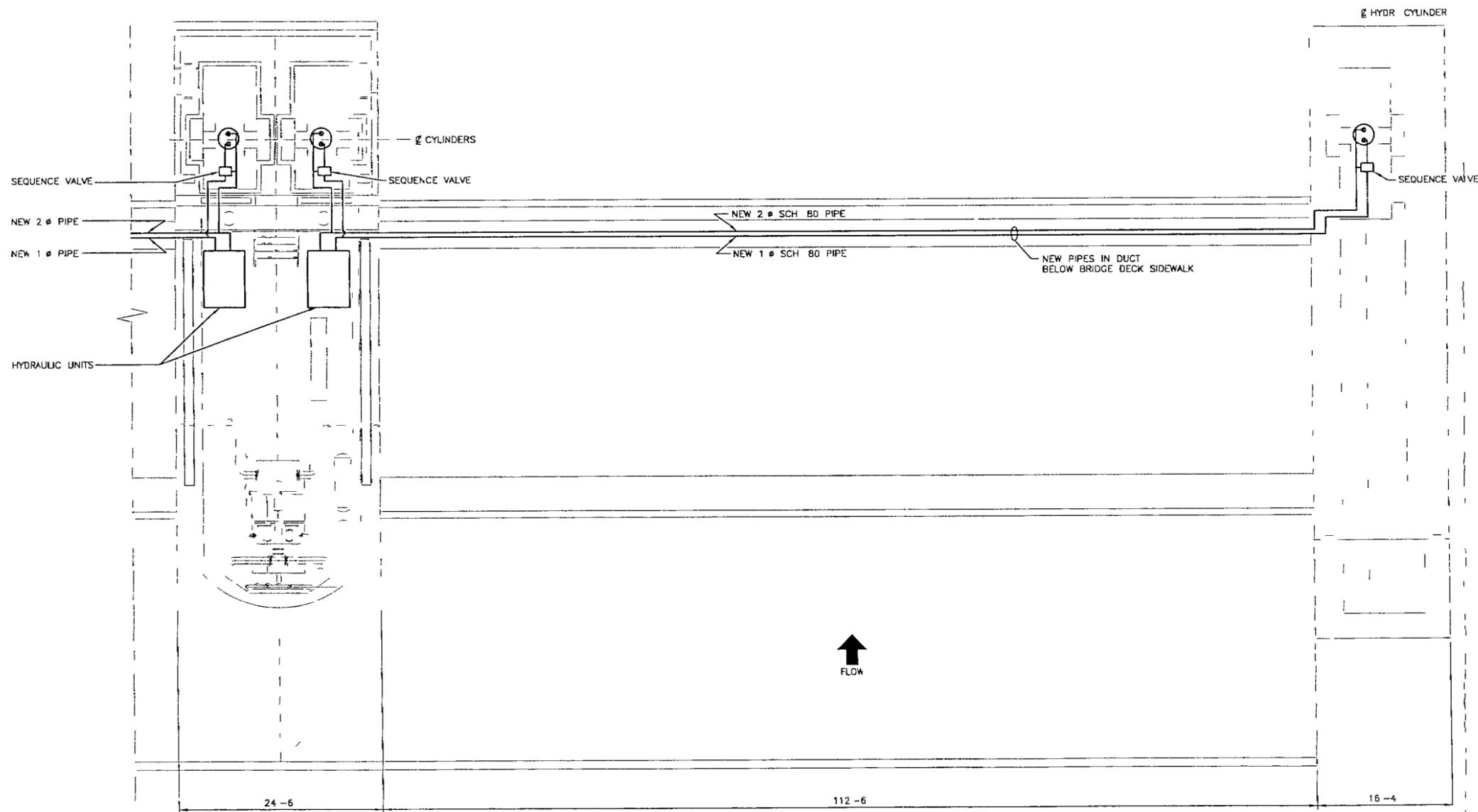
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CLIENT  
**Manitoba** NATURAL RESOURCES

PROJECT  
RED RIVER FLOODWAY  
INLET CONTROL STRUCTURE

DESIGNER  
MAIN GATE  
PROPOSED ACCESS PLATFORMS  
SECTION

ENG	DES	PRO	DATE	SCALE	DATE
RSCB		PC	DBM	AS NOTED	FEB /97
APPROVED			SCALE	DATE	
			AS NOTED	FEB /97	
DRAWING NO			REV	FIGURE 11	



↑  
FLOW

1 PART PLAN  
SCALE 1/8"=1'-0"

KGS FILE NO 98-311-01 FIGURE 12 DWG  
24 35 / PLOT SCALE 98

B	21/02/97	ISSUED FOR FINAL REPORT	
A	31/10/96	ISSUED FOR DRAFT R PORT	
		DESCRIPTION	BY

REVISIONS / ISSUE	
A	SECTION LETTER OR DETAIL NUMBER
B	DRAWING WHERE SECTION OR DETAIL IS DRAWN
	OR DRAWING WHERE SECTION OR DETAIL WAS INDICATED
-	SECTION OR DETAIL SHOWN ON SAME DRAWING

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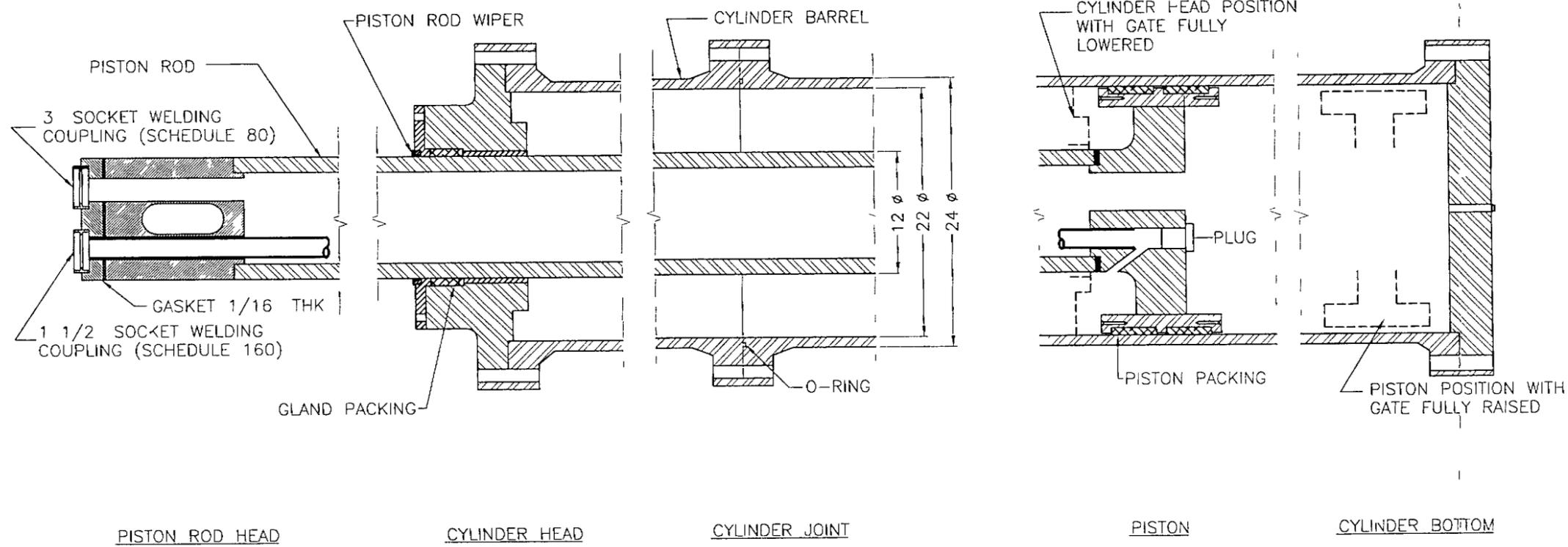


RED RIVER FLOODWAY  
INLET CONTROL STRUCTURE

HYDRAULIC PIPING REPLACEMENT  
OPTION A - COMPLETE REPLACEMENT  
GENERAL ARRANGEMENT

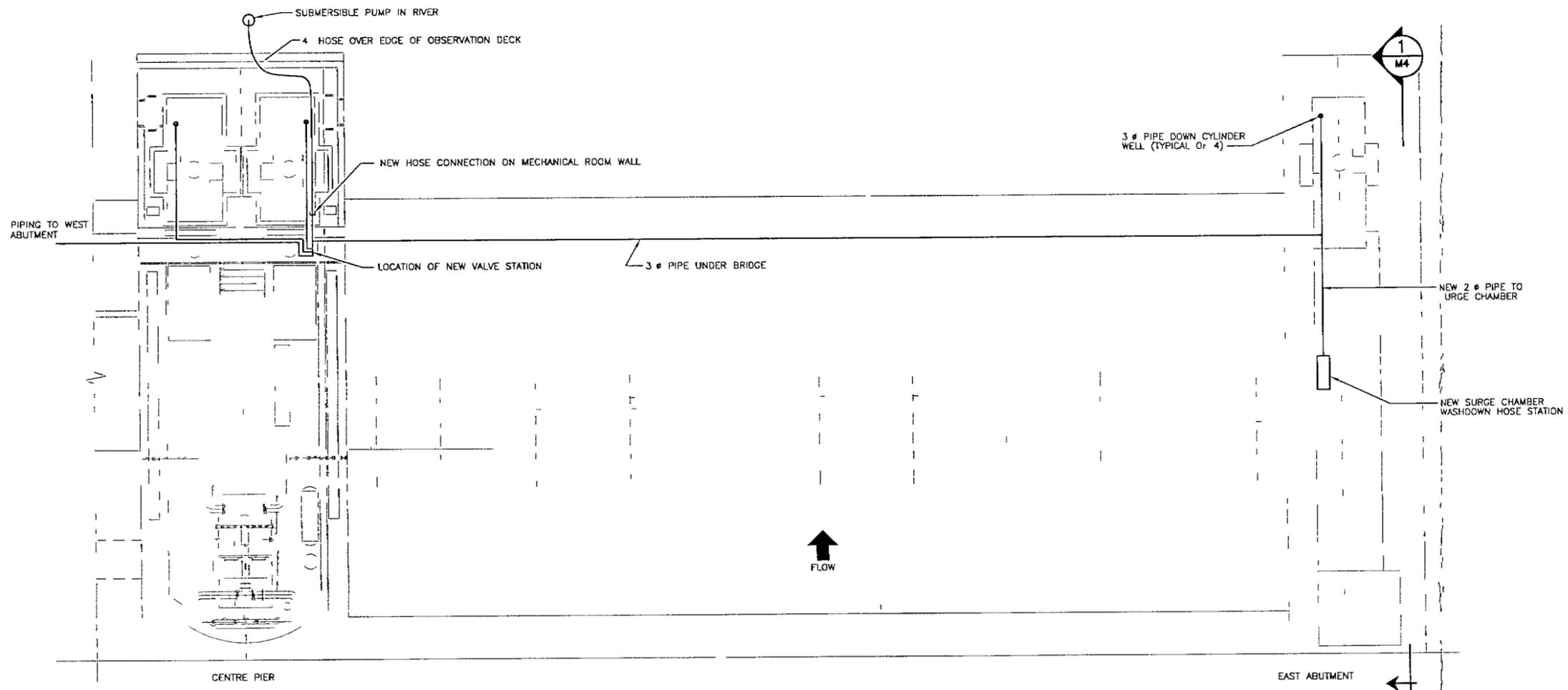
DESIGN	JS	CHKD	AS/MH	DATE	AFG
SCALE	N 5		FEB /97		

FIGURE 12



B	21/02/97	ISSUED FOR FINAL REPORT		
A	31/10/96	ISSUED FOR DRAFT REPORT		
REVISIONS / ISSUE				
A. SECTION LETTER OR DETAIL NUMBER				
B. DRAWING WHERE SECTION OR DETAIL IS DRAWN				
OR				
DRAWING WHERE SECTION OR DETAIL WAS INDICATED				
--- SECTION OR DETAIL SHOWN ON SAME DRAWING				
A			A	
B				
<b>KGS GROUP</b> CONSULTING ENGINEERS & PROJECT MANAGERS				
WINNIPEG (204) 896 1209 THUNDER BAY (807) 345-2233				
<b>Manitoba</b> NATURAL RESOURCES 				
RED RIVER FLOODWAY INLET CONTROL STRUCTURE				
MAIN GATE HOISTS HYDRAULIC CYLINDER (TYPICAL OF 4)				
DESIGNED BY	DRAM	MM	HE	
SCALE	NTS		DATE FEB /97	
FIGURE 13				

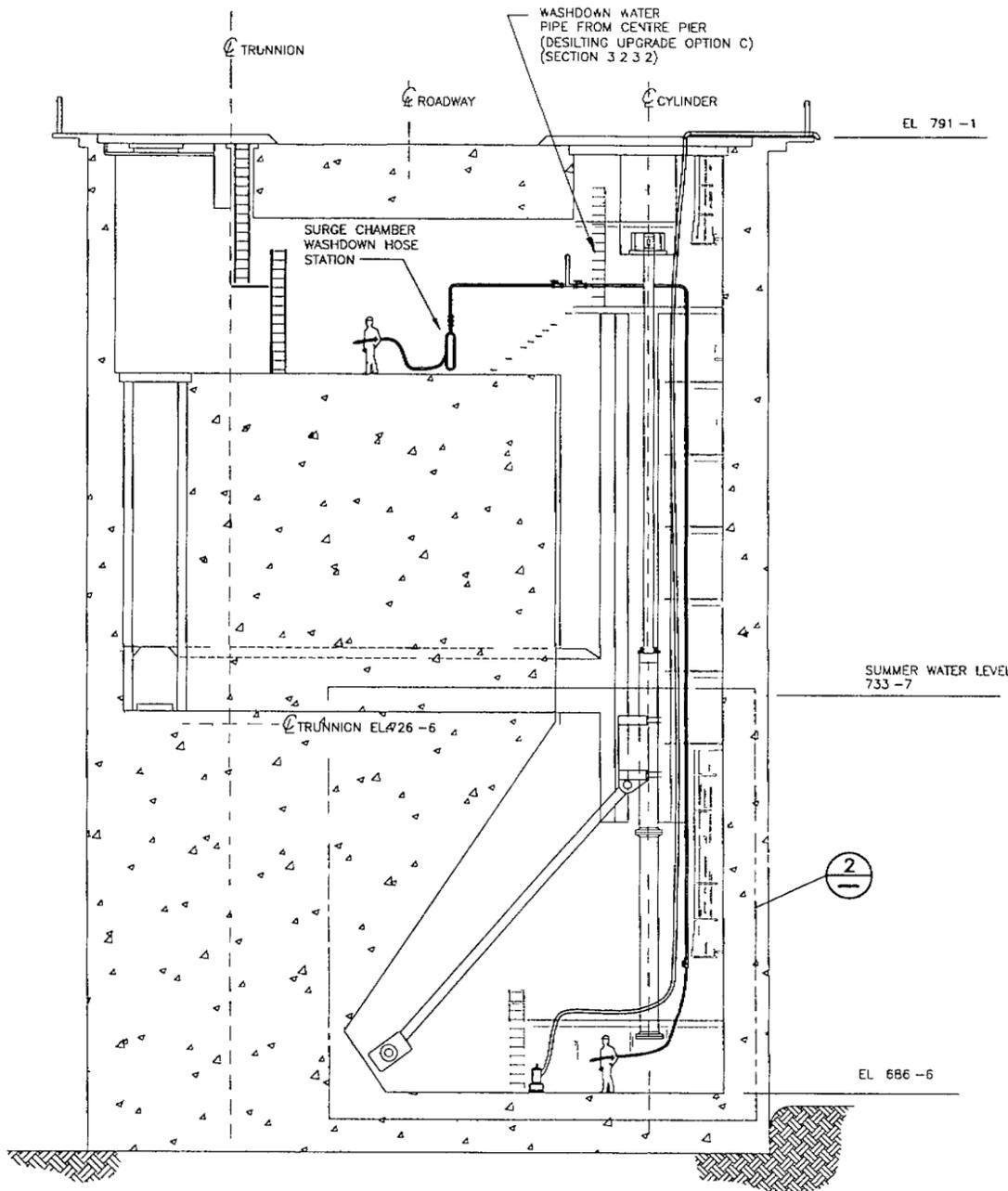
KGS FILE NO 96-311-01 FIGURE 13 DWG 24 36 / PLOT SCALE 1



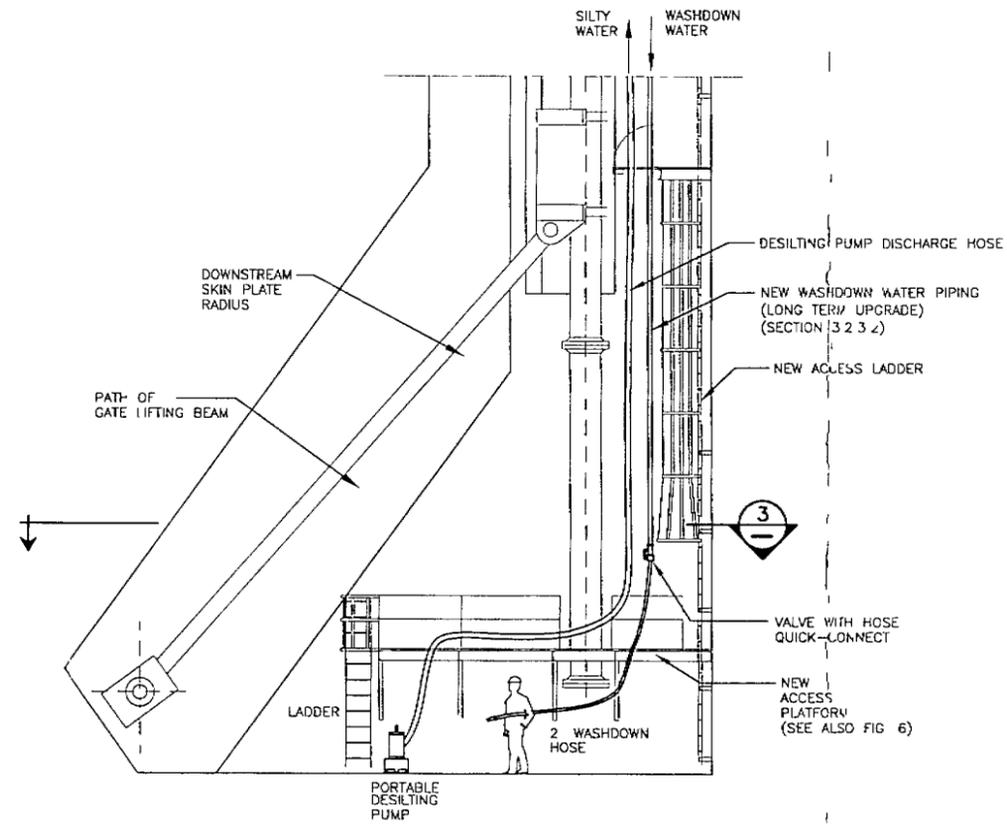
1 PART PLAN  
SCALE: N.T.S.

B	21/02/97	ISSUED FOR FINAL REPORT		
A	31/10/96	ISSUED FOR DRAFT REPORT		
REVISIONS / ISSUE				
A. SECTION LETTER OR DETAIL NUMBER B. DRAWING WHERE SECTION OR DETAIL IS DRAWN OR DRAWING WHERE SECTION OR DETAIL WAS INDICATED — SECTION OR DETAIL SHOWN ON SAME DRAWING				
A B				A —
<b>KGS GROUP</b> CONSULTING ENGINEERS & PROJECT MANAGERS WINNIPEG (204) 896-1209 THUNDER BAY (807) 345-2233				
<b>Manitoba</b> NATURAL RESOURCES				
PROJECT <b>RED RIVER FLOODWAY INLET STRUCTURE</b>				
DRAWING TITLE <b>DESILTING SYSTEM UPGRADE WASHDOWN WATER PIPING GENERAL ARRANGEMENT</b>				
DESIGNED BY	ES. ED.	DRAWN BY	CHECKED BY	DATE
	JS	AS/VJH	AFG	
SCALE: N.T.S.				
DATE: FEB / 97				
FIGURE 14				

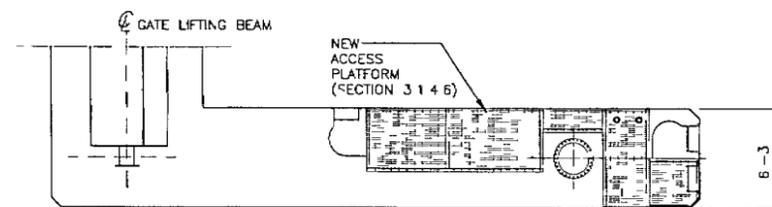
KGS FILE NO. 98-311-01 FIGURE 14 DWG 24 3/8 PLOT SCALE 98



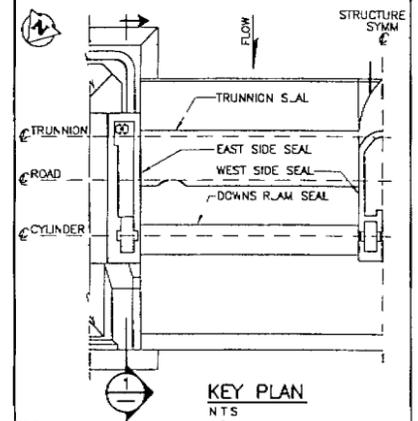
1 SECTION - EAST ABUTMENT (GATE FULLY DOWN)



2 SECTION DETAIL - GATE ACCESS CHAMBER (TYPICAL OF 4)



3 PARTIAL PLAN - GATE ACCESS CHAMBER



KEY PLAN  
NTS

REVISIONS / ISSUE	
B	21/02/97 ISSUED FOR FINAL REPORT
A	1/10/96 ISSUED FOR DRAFT REPORT

REVISIONS / ISSUE	
A	A. SECTION LETTER OR DETAIL NUMBER
B	B. DRAWING WHERE SECTION OR DETAIL IS DRAWN
A	A. SECTION LETTER OR DETAIL NUMBER
B	B. DRAWING WHERE SECTION OR DETAIL WAS INDICATED
- SECTION OR DETAIL SHOWN ON SAME DRAWING	

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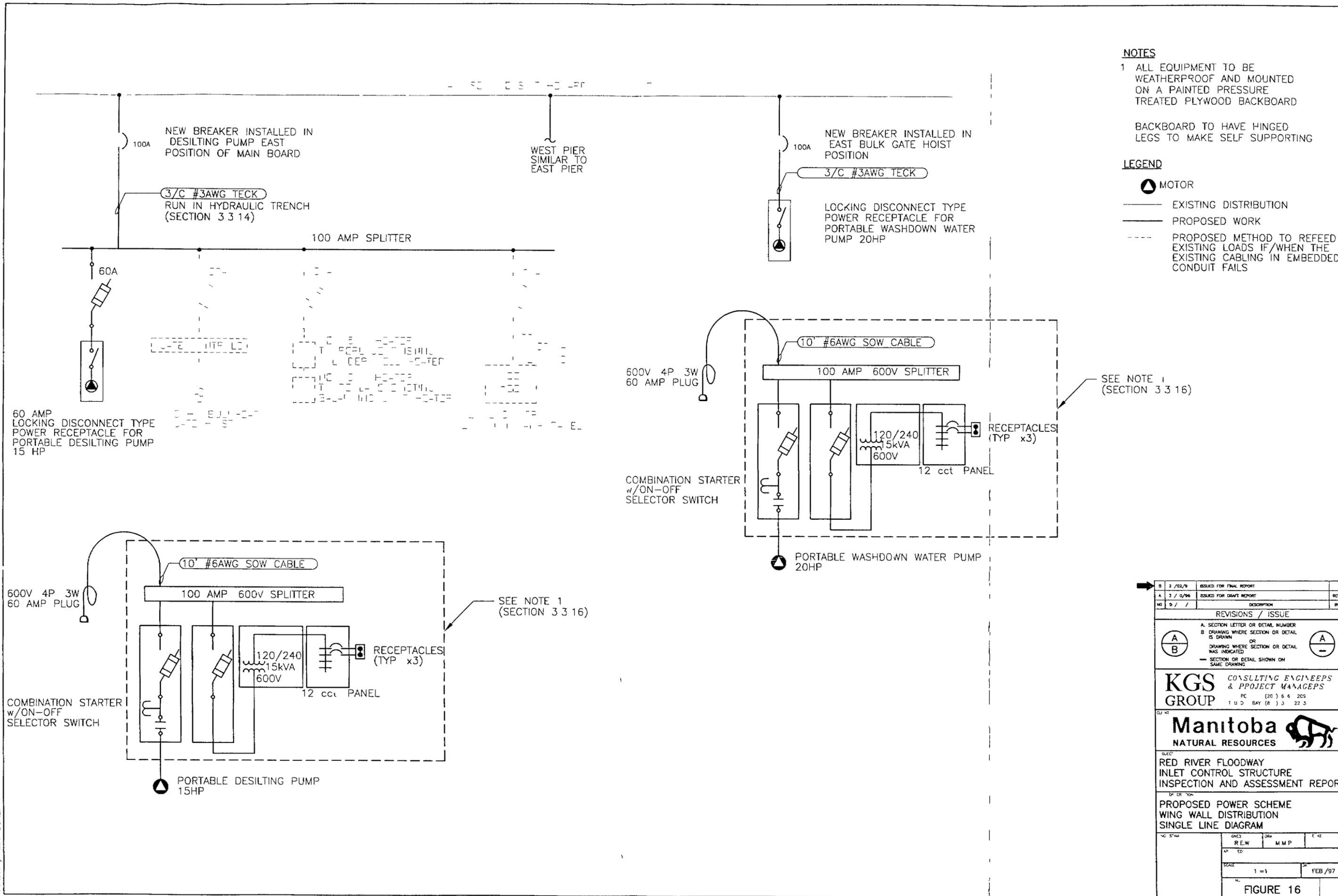
RED RIVER FLOODWAY INLET CONTROL STRUCTURE

EAST ABUTMENT SECTION PROPOSED DESILTING ARRANGEMENT

DESIGNED BY	JS	CHECKED BY	JS	DATE	A.G.
APPROVED BY					
DRAWN BY	NTS	SCALE		DATE	FEB/97

FIGURE 15

KGS FILE NO. 96-311-01 FIGURE 16 DWG  
11 x 17 PLOT SCALE 1



- NOTES**
- 1 ALL EQUIPMENT TO BE WEATHERPROOF AND MOUNTED ON A PAINTED PRESSURE TREATED PLYWOOD BACKBOARD
- BACKBOARD TO HAVE HINGED LEGS TO MAKE SELF SUPPORTING
- LEGEND**
- ⊙ MOTOR
  - EXISTING DISTRIBUTION
  - PROPOSED WORK
  - - - - PROPOSED METHOD TO REFEED EXISTING LOADS IF/WHEN THE EXISTING CABLING IN EMBEDDED CONDUIT FAILS

NO.	DATE	DESCRIPTION	BY
B	2 / 02 / 9	ISSUED FOR FINAL REPORT	
A	3 / 0 / 96	ISSUED FOR DRAFT REPORT	REV
REVISIONS / ISSUE			
A. SECTION LETTER OR DETAIL NUMBER B. DRAWING WHERE SECTION OR DETAIL IS DRAWN OR DRAWING WHERE SECTION OR DETAIL WAS INDICATED — SECTION OR DETAIL SHOWN ON SAME DRAWING			
<div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center;">A</div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center;">B</div>		<div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center;">A</div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center;">-</div>	
<b>KGS GROUP</b> CONSULTING ENGINEERS & PROJECT MANAGERS PE (20) 5 6 205 1 U 3 BAY (8) 3 22 3			
<b>Manitoba</b> NATURAL RESOURCES			
RED RIVER FLOODWAY INLET CONTROL STRUCTURE INSPECTION AND ASSESSMENT REPORT <small>OF OR 704</small>			
<b>PROPOSED POWER SCHEME WING WALL DISTRIBUTION SINGLE LINE DIAGRAM</b>			
NO.	DESIGNED	DRAWN	CHECKED
	RE.W	M.M.P	
SCALE		DATE	
1 = 1		FEB / 97	
<b>FIGURE 16</b>			

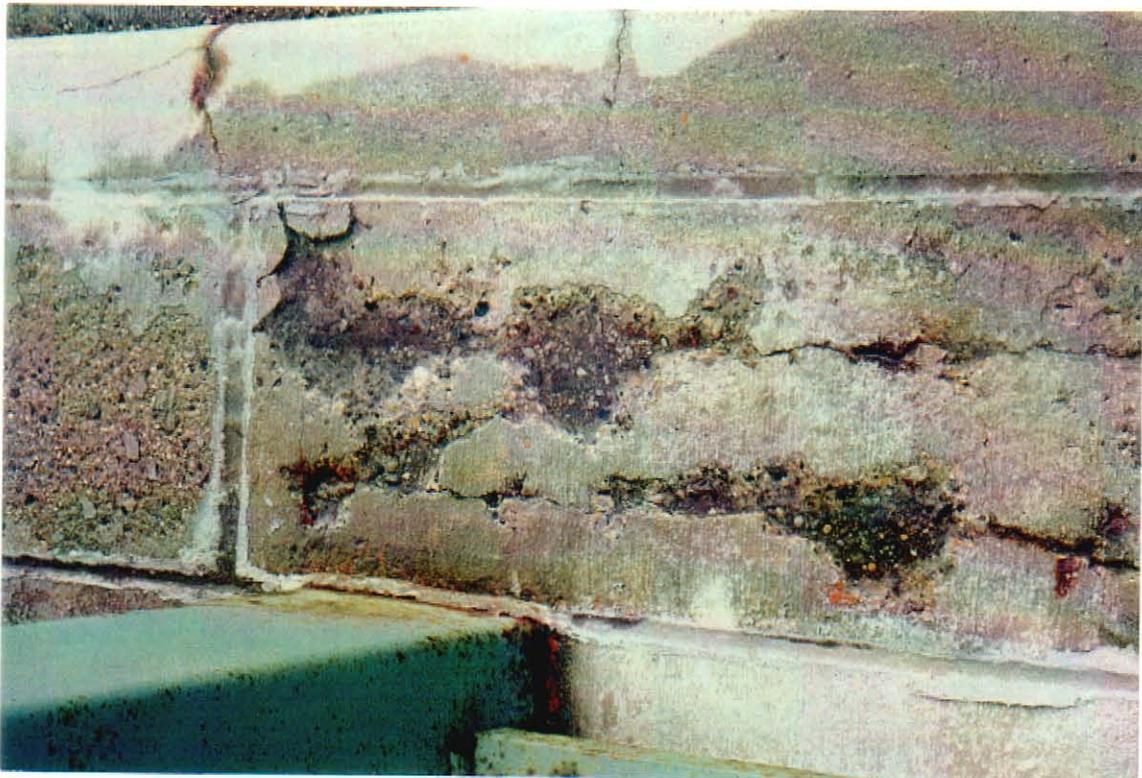


**APPENDIX A  
INSPECTION  
PHOTOGRAPHS**

**APPENDIX A**  
**SELECTED SITE PHOTOGRAPHS**  
**JULY 1996 INSPECTIONS**



Photograph No. 1: Deterioration at Abutment Curb



Photograph No. 2: Deterioration of Duct Covers at Roadway



Photograph No. 3: Cracking Around Barrier Post and Extent of Corrosion



Photograph No. 4: Missing Cover Plate and Repair Using Caulking



Photograph No. 5: Graffiti on Control Centre



Photograph No. 6: Calcite Formation on Walls of Sump Pit



Photograph No. 7: Machine Room Hatch in Ceiling Showing Rust Staining



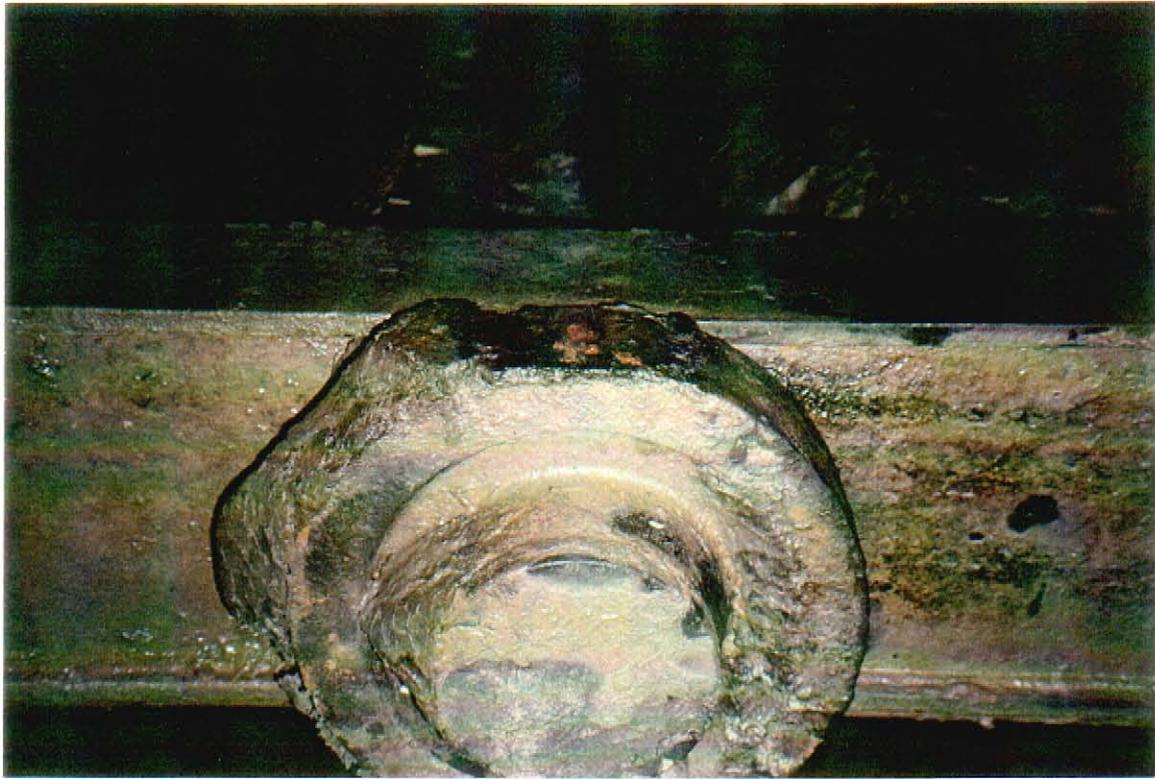
Photograph No. 8: Extent of Corrosion of Platform Support Channel



Photograph No. 9: Partially Failed Grating in Sump Pit



Photograph 10: Corrosion and Failure of Platform Grating (West Abutment)



Photograph No. 11: Flat Spot Worn on Bulkhead Gate Roller



Photograph No. 12: Corrosion of Cylinder Support Bridge



Photograph No. 13: Cracking of Upstream Abutment Wall



Photograph No. 14: Crack in Downstream Abutment Wall



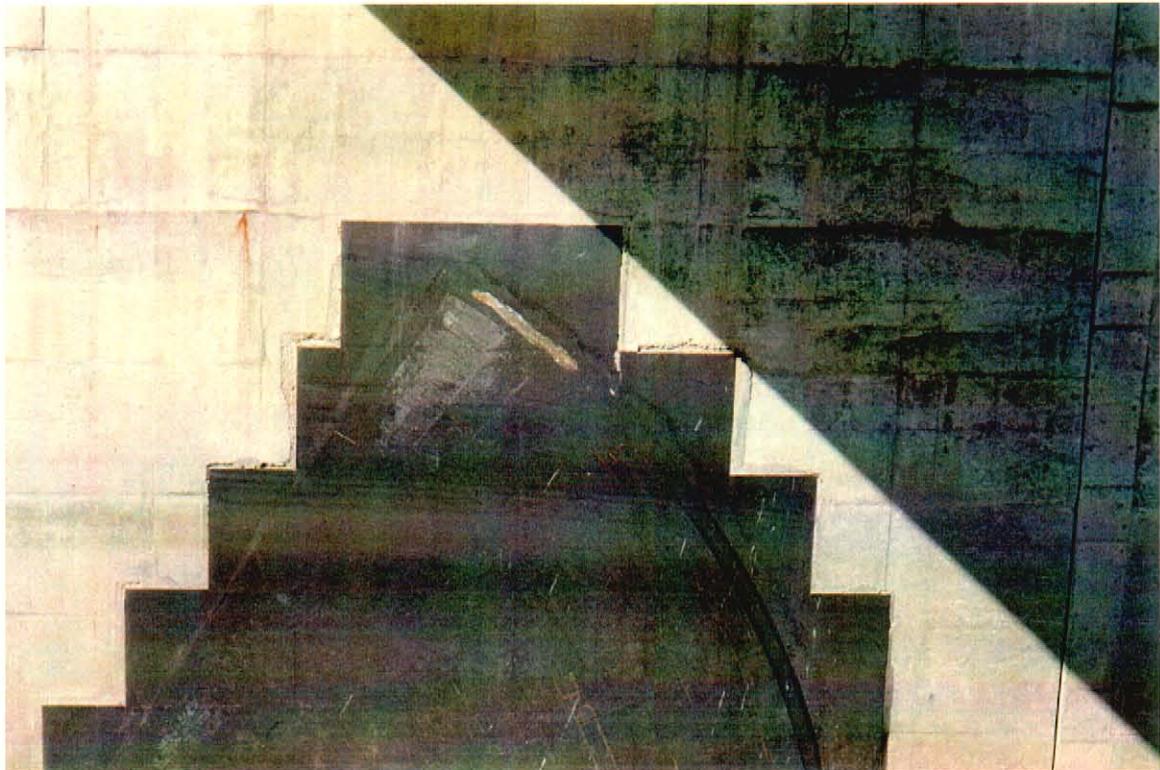
Photograph No. 15: Undermining of Transformer Pad



Photograph No. 16: West Gate Upstream Skin Plate



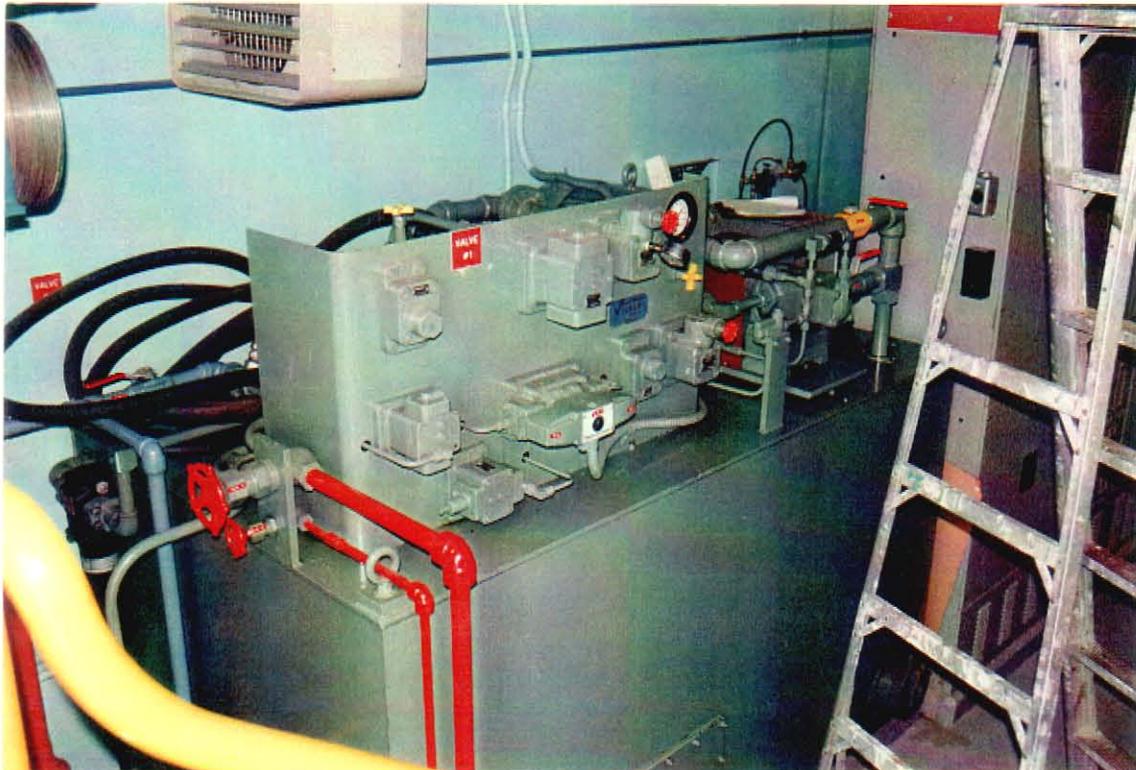
Photograph No. 17: Corrosion of Gate Downstream Skinplate



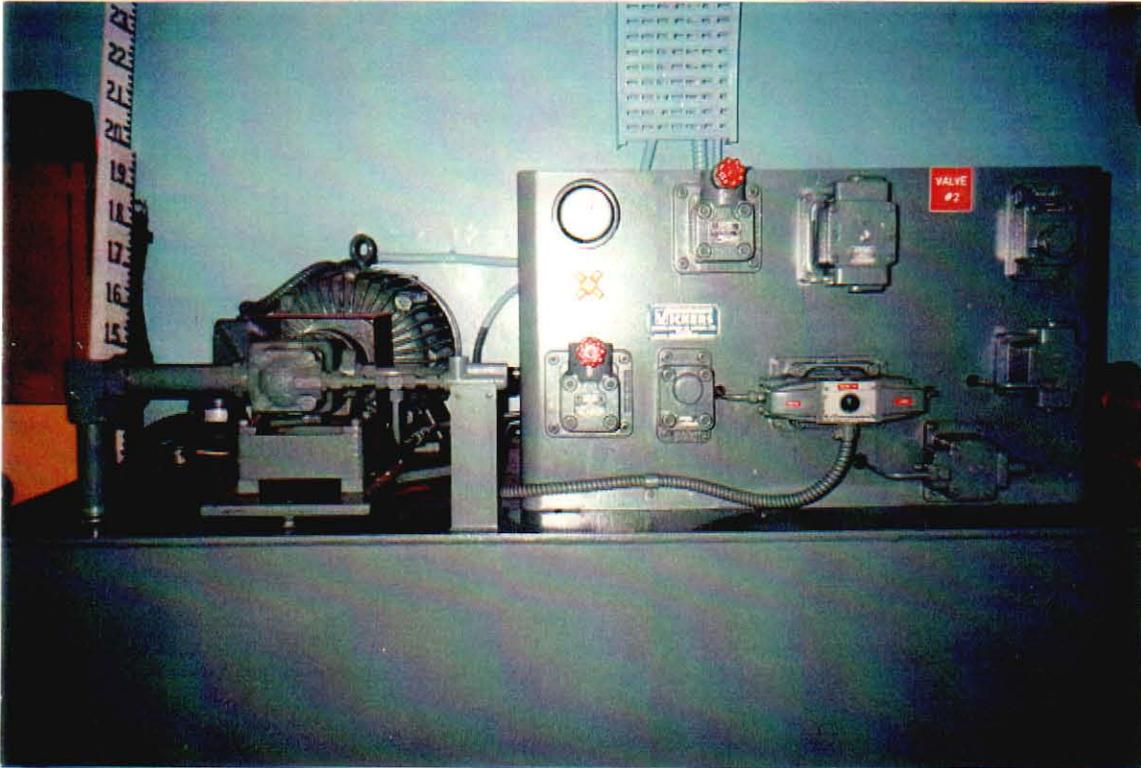
Photograph No. 18: Deterioration and Wear of Side Seal Plates



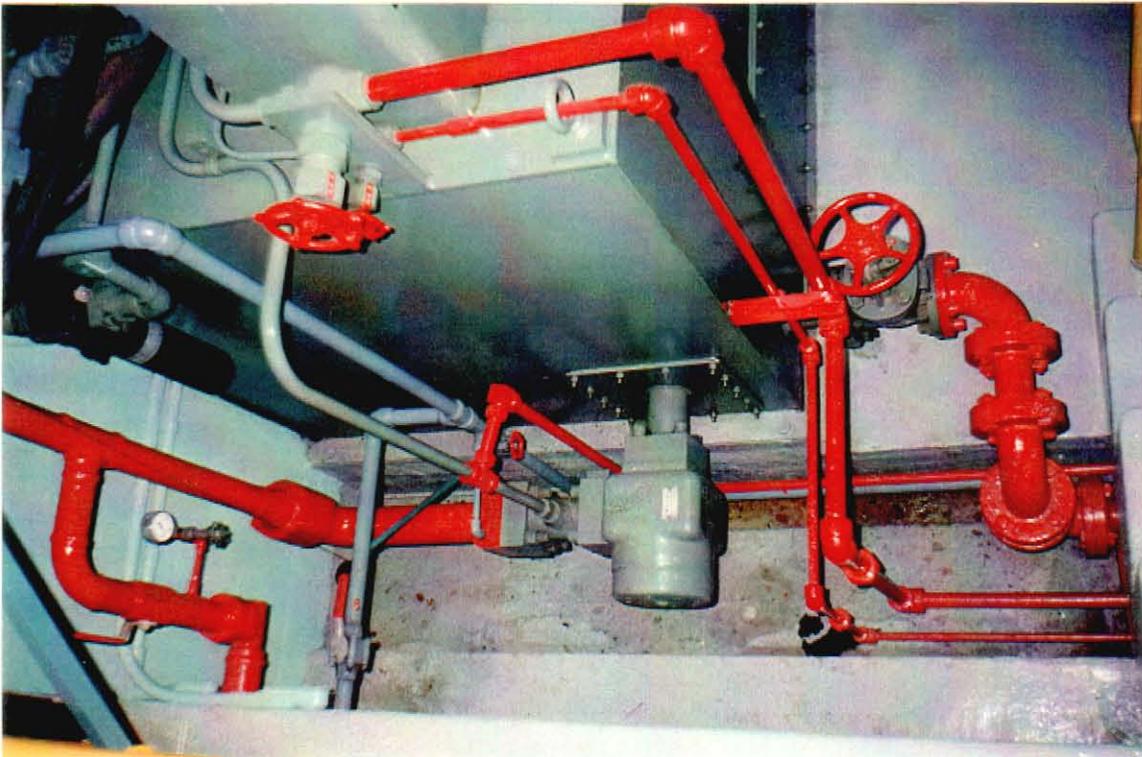
Photograph No. 19: Erosion Adjacent to Roadway



Photograph No. 20: East Hydraulic Unit



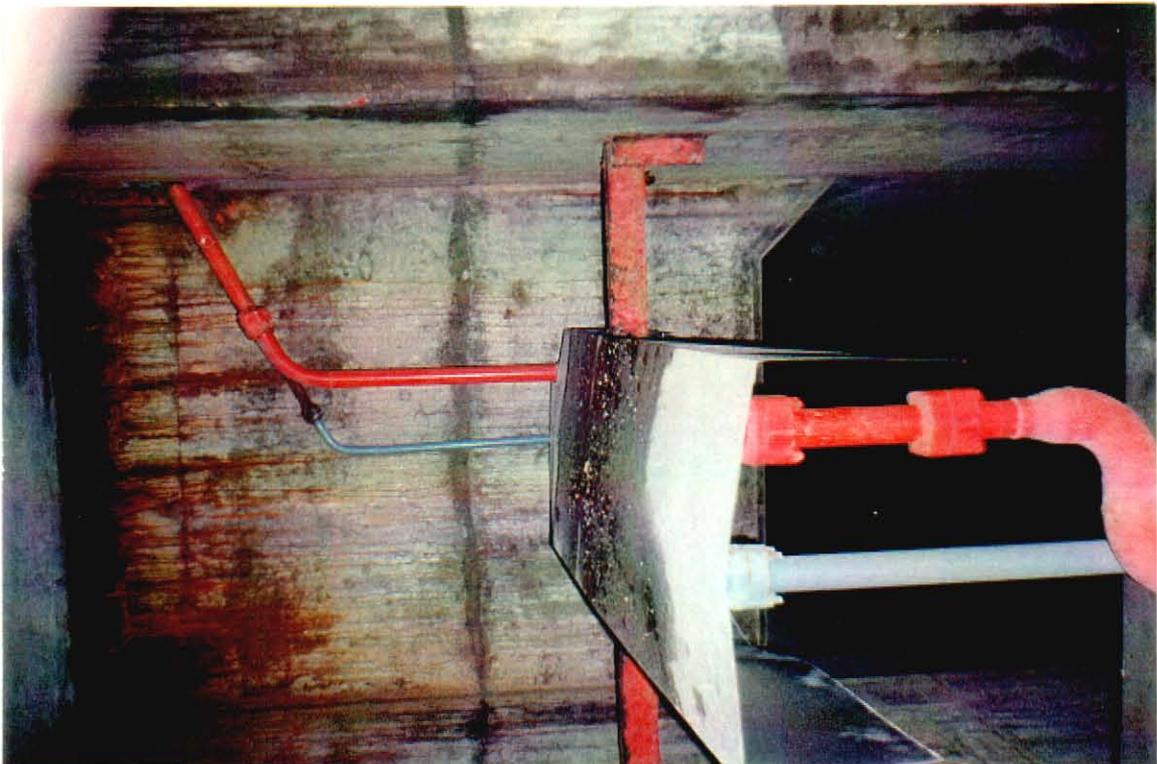
Photograph No. 21: West Hydraulic Unit



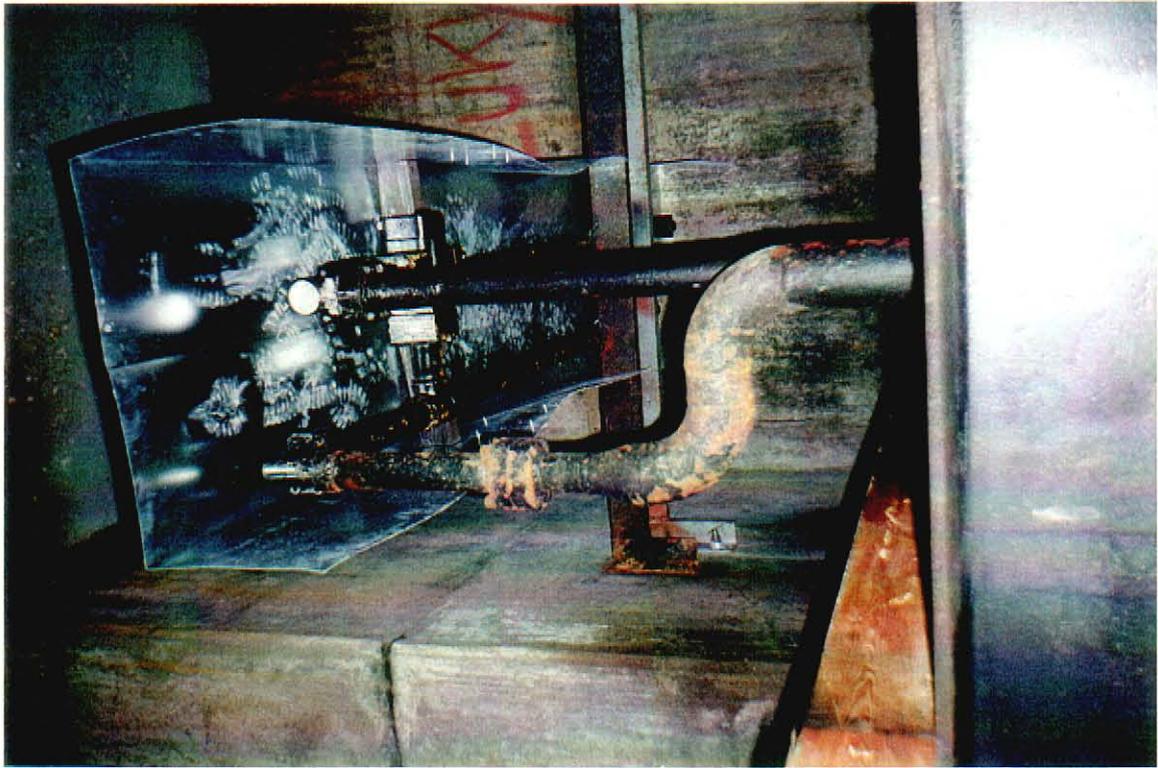
Photograph No. 22: Hydraulic Piping Inside Mechanical Room



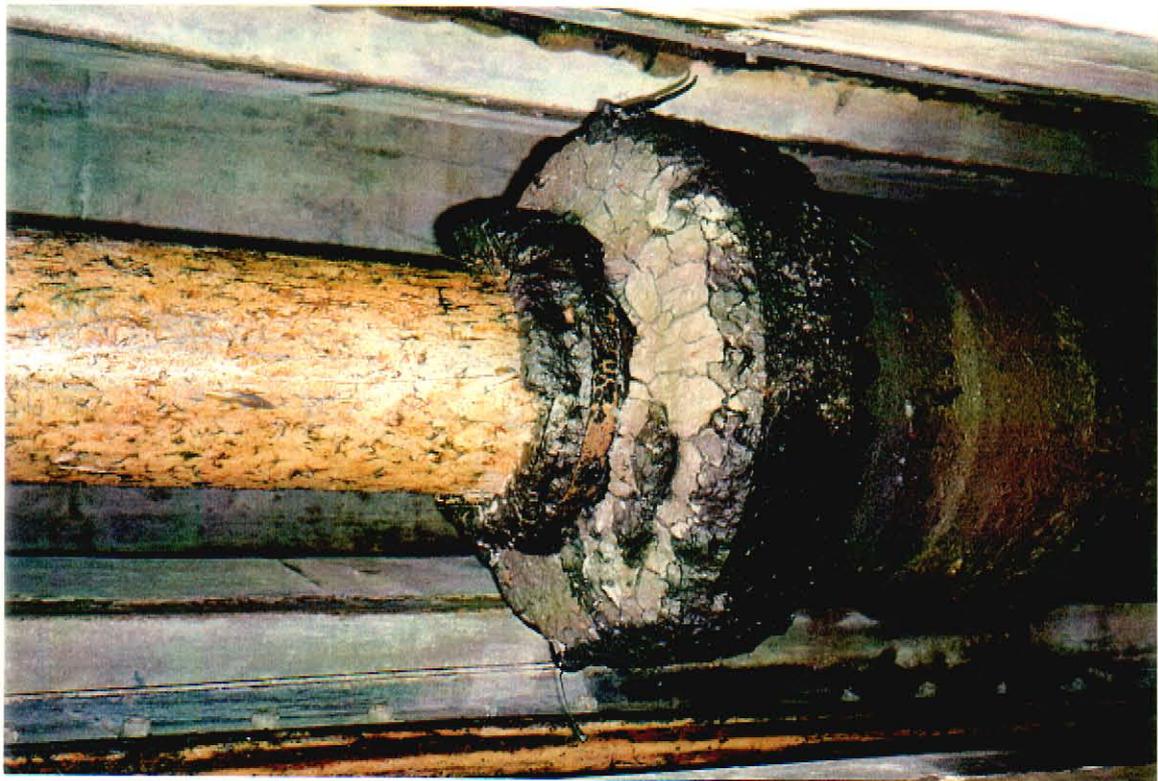
Photograph No. 23: Hydraulic Piping Inside in East Abutment Cylinder Well



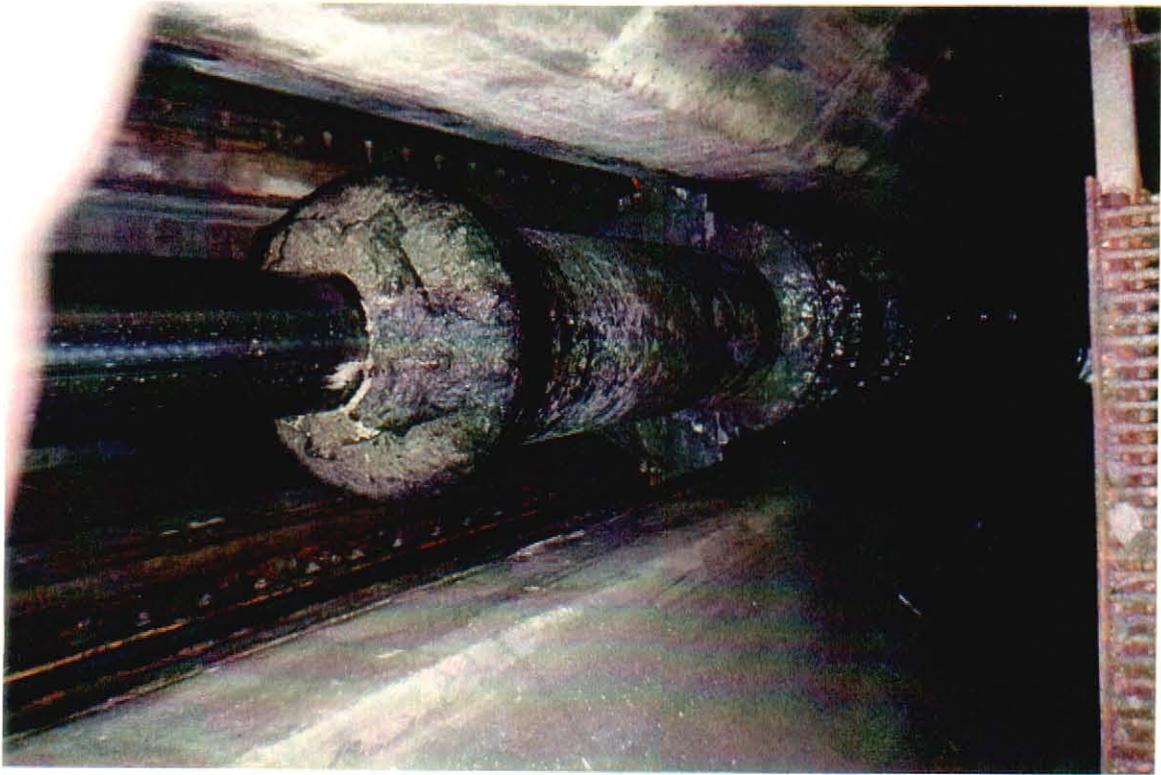
Photograph No. 24: Hydraulic Piping Inside East Abutment Cylinder Well



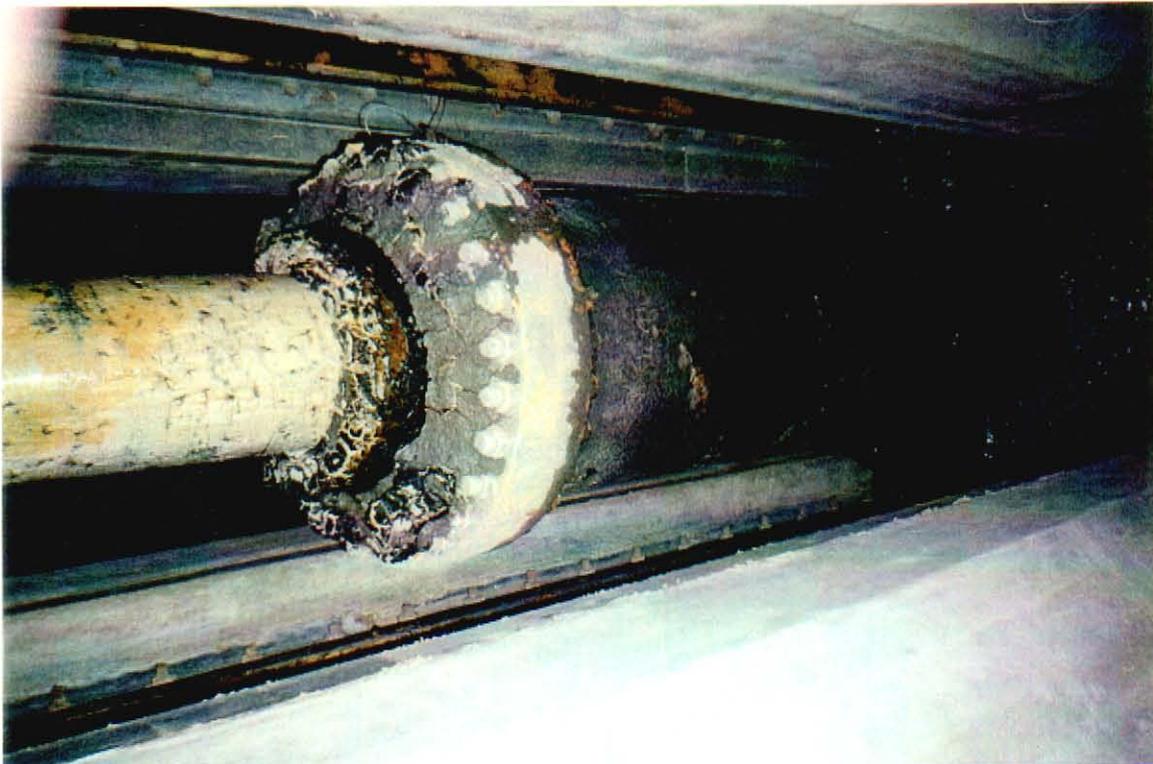
Photograph No. 25: Hydraulic Piping Inside in West Abutment Cylinder Well



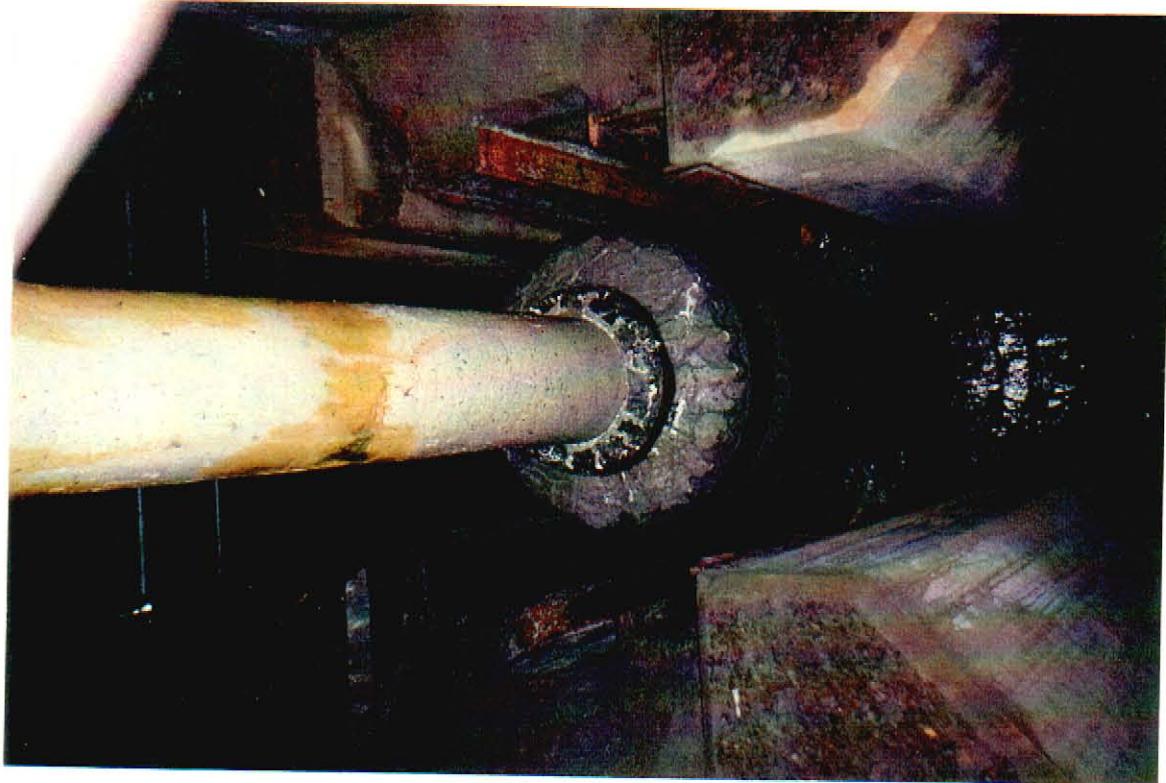
Photograph No. 26: East Centre Pier Cylinder



Photograph No. 27: East Abutment Cylinder



Photograph No. 28: West Centre Pier Cylinder



Photograph No. 29: West Abutment Cylinder



Photograph No. 30: East Centre Pier Cylinder and Support Guide

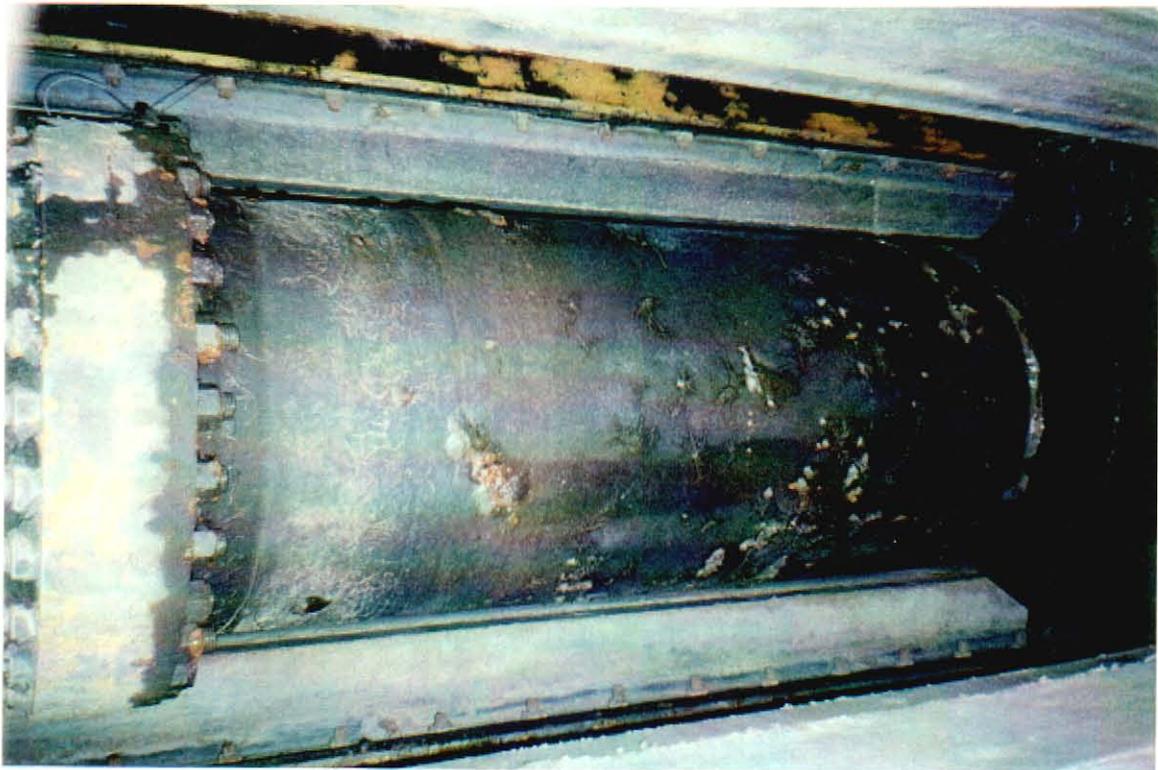
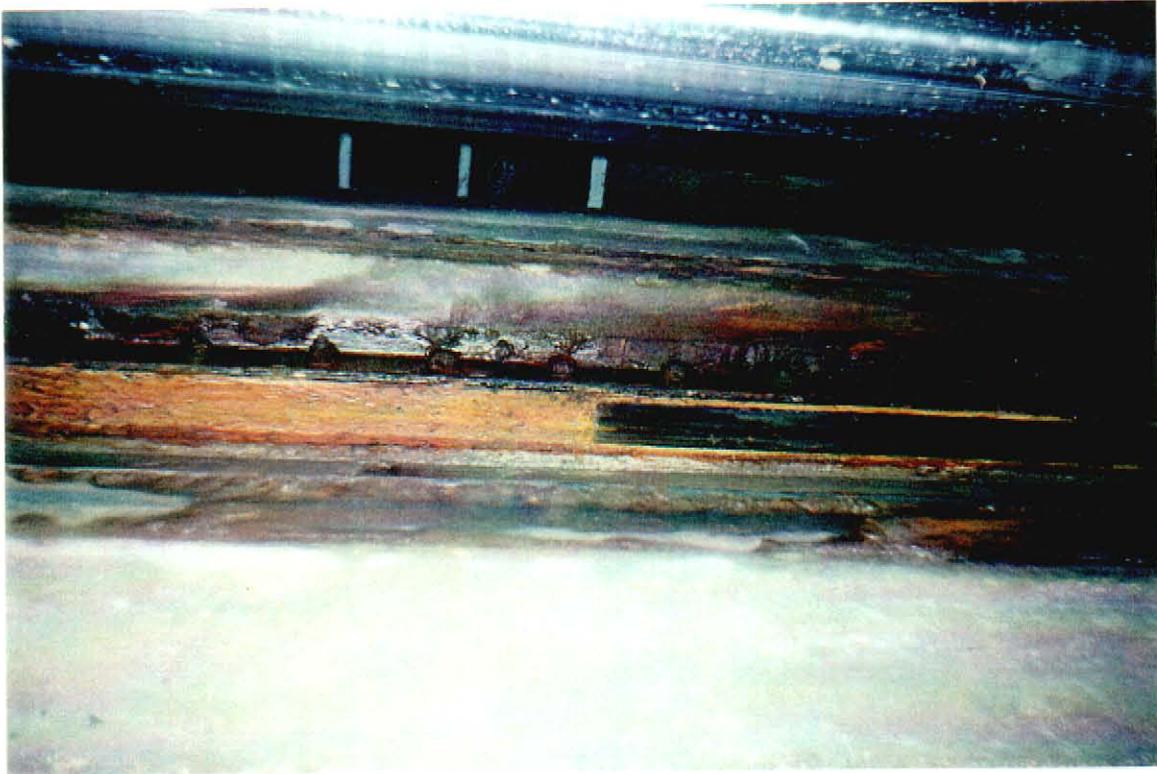


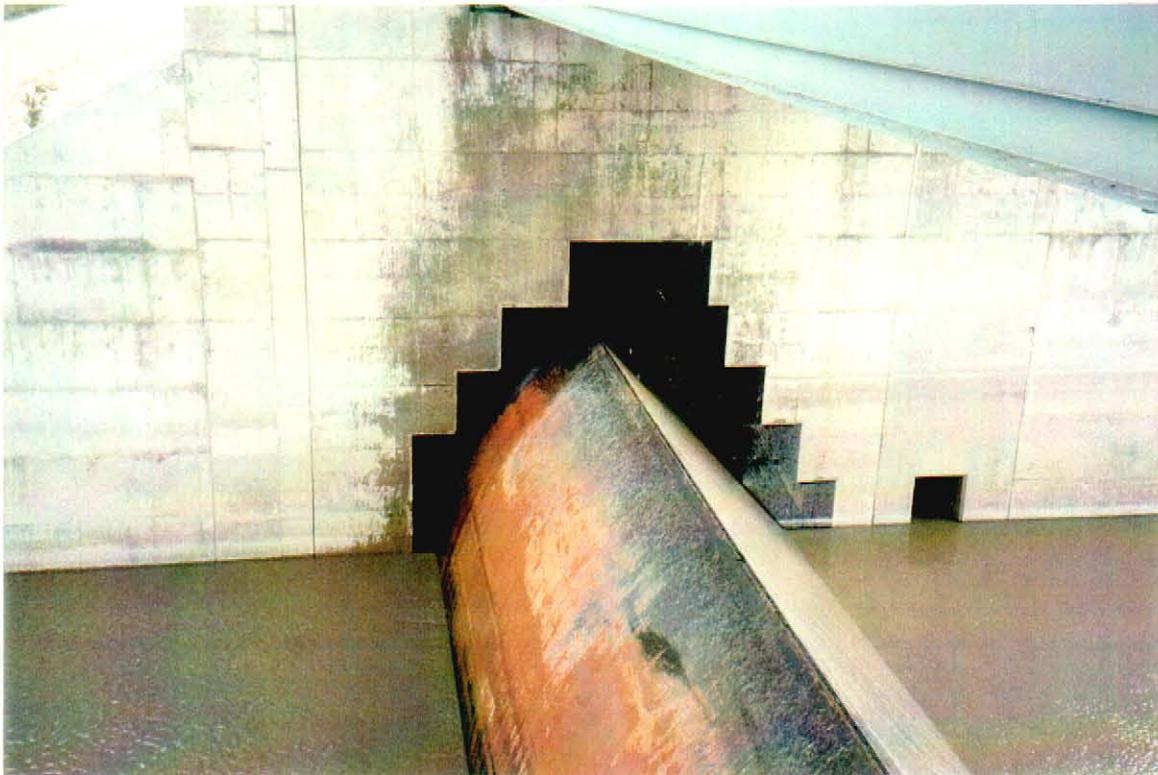
Photo No. 31: West Centre Pier Cylinder Barrel



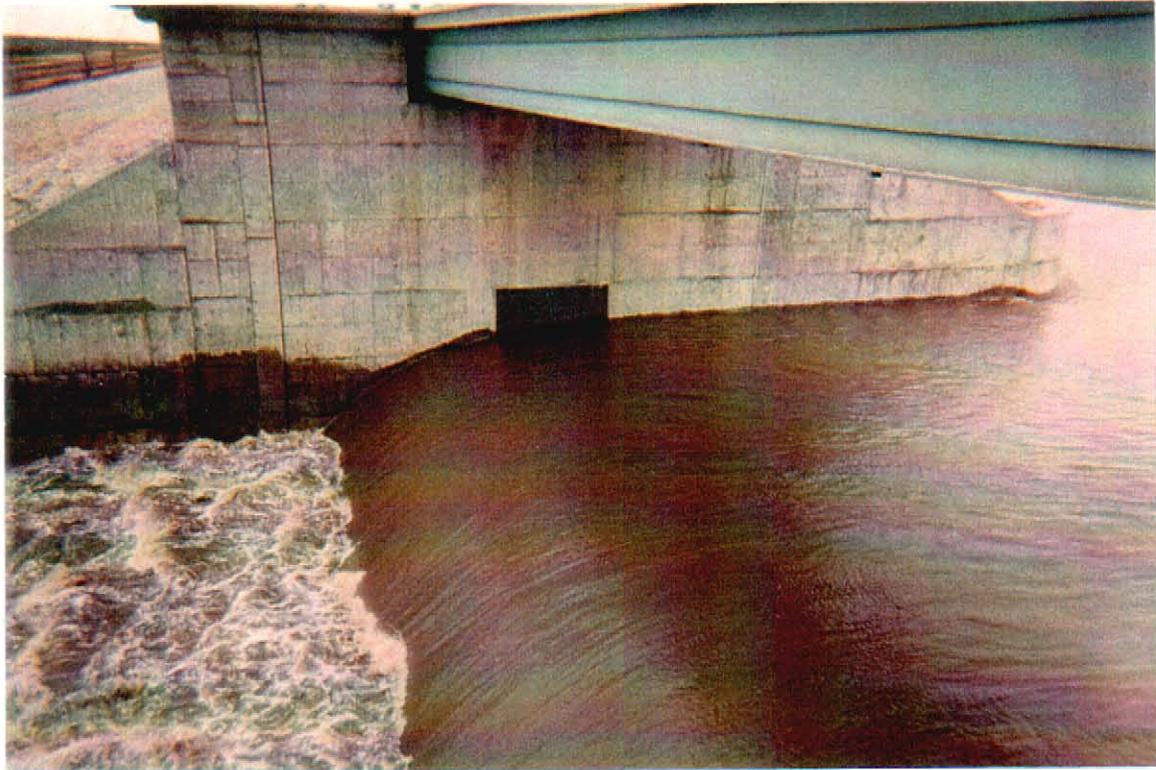
Photograph No. 32: Slow oil Leak at East Centre Pier Cylinder Gland Area



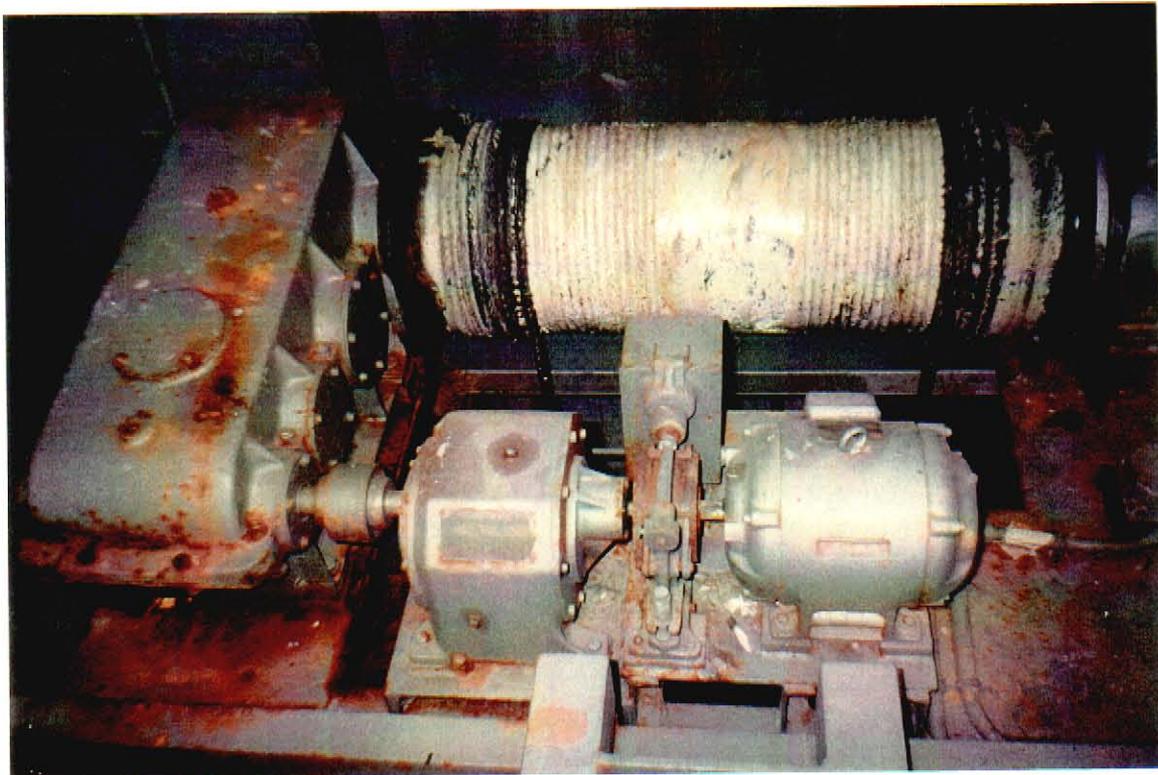
Photograph No. 33: East Abutment Cylinder Support Guide



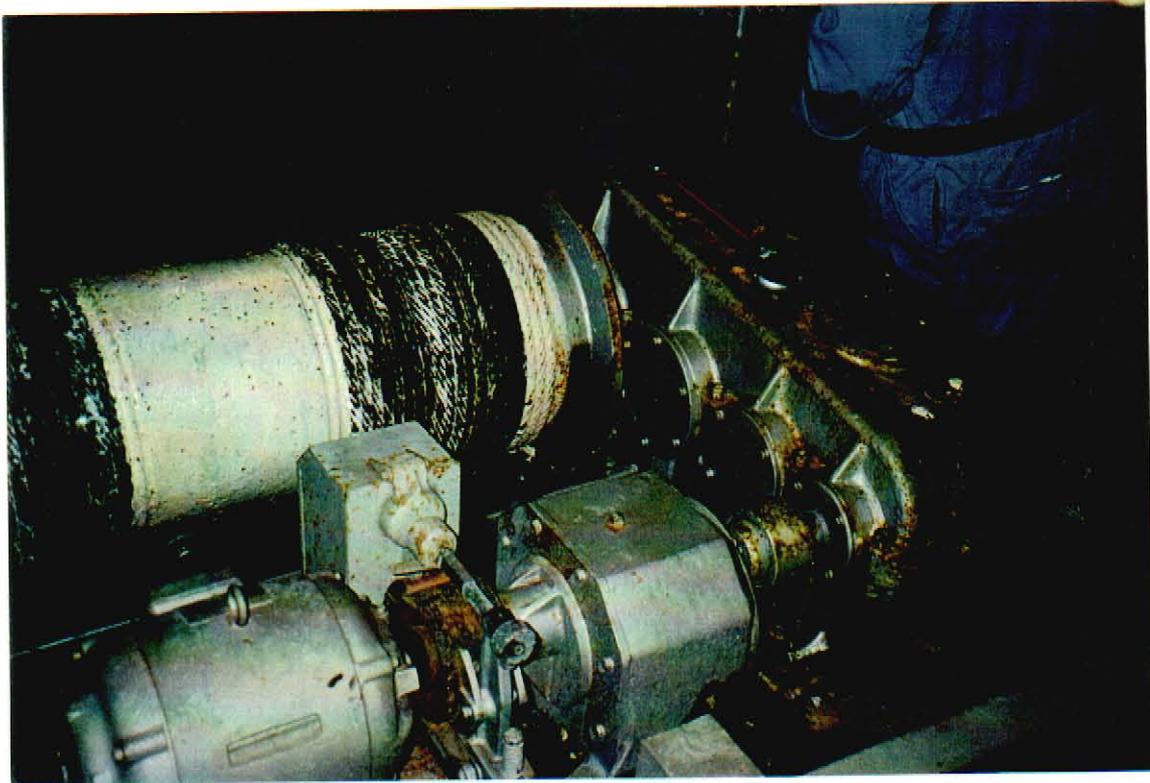
Photograph No. 34: East Gate Midway through Operational Test (July 24, 1996)



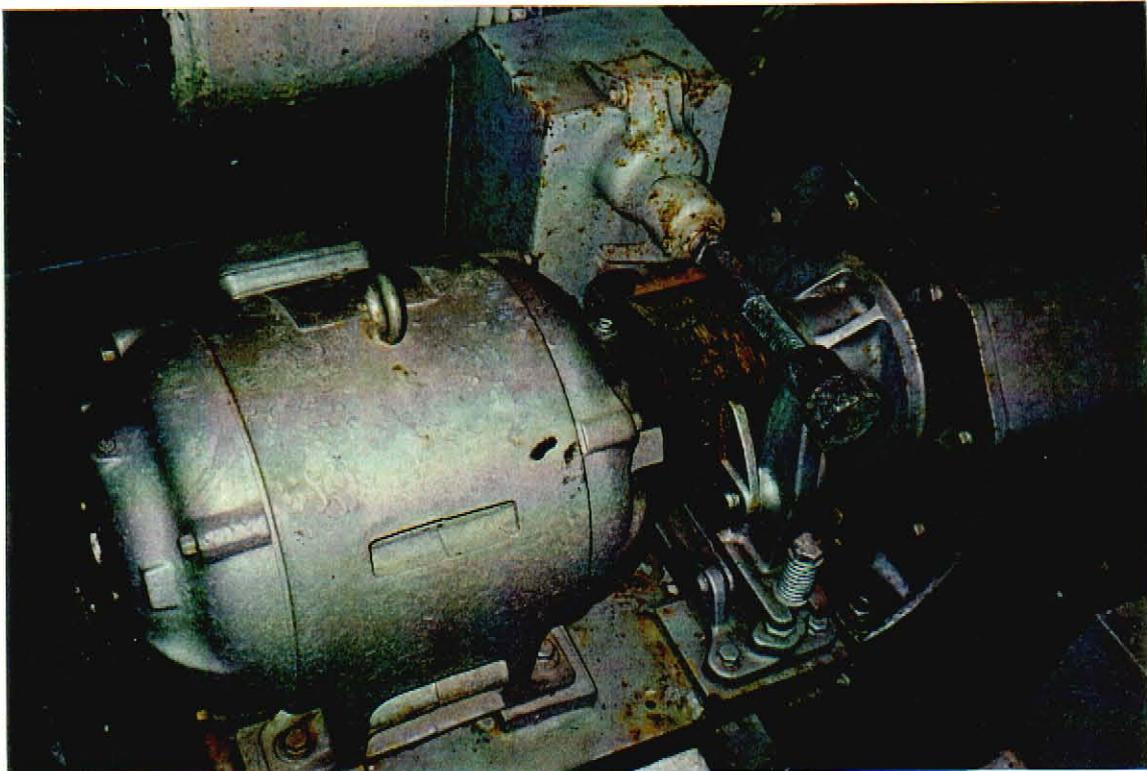
Photograph No. 35: Flow Over East Gate (April 24, 1996) Gate Position = 23.1 feet



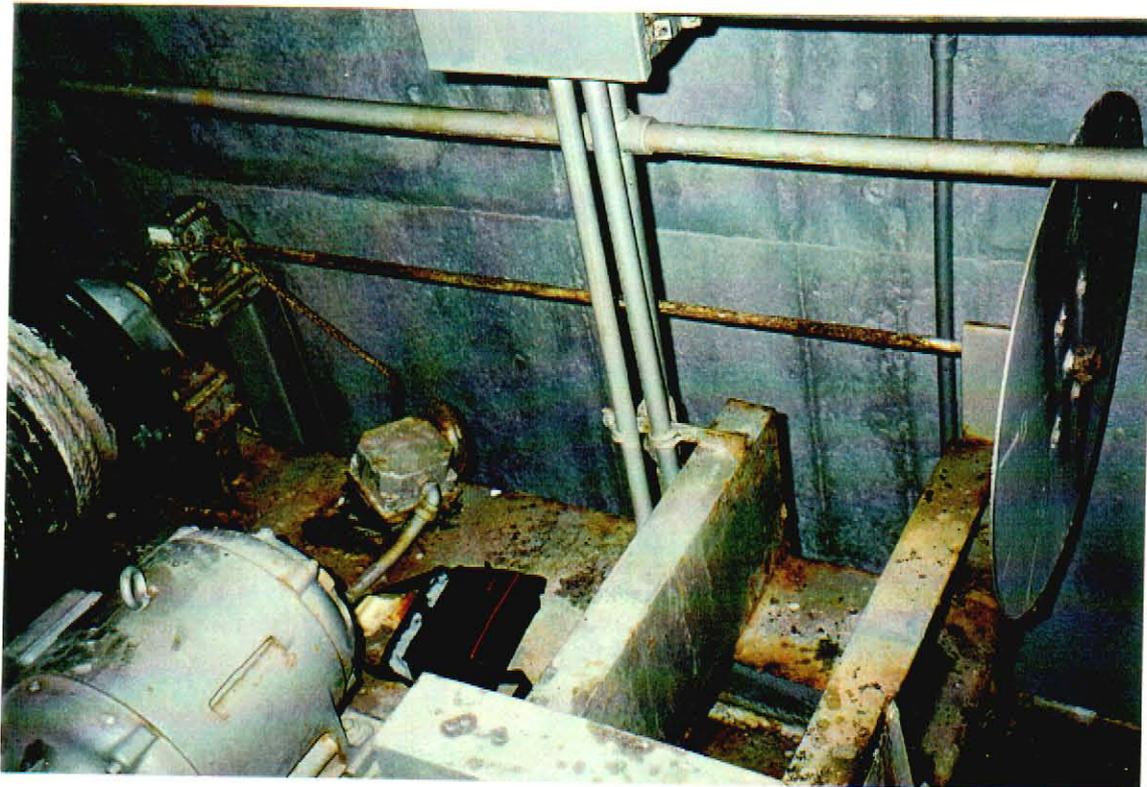
Photograph No. 36: East Bulkhead Gate Hoist



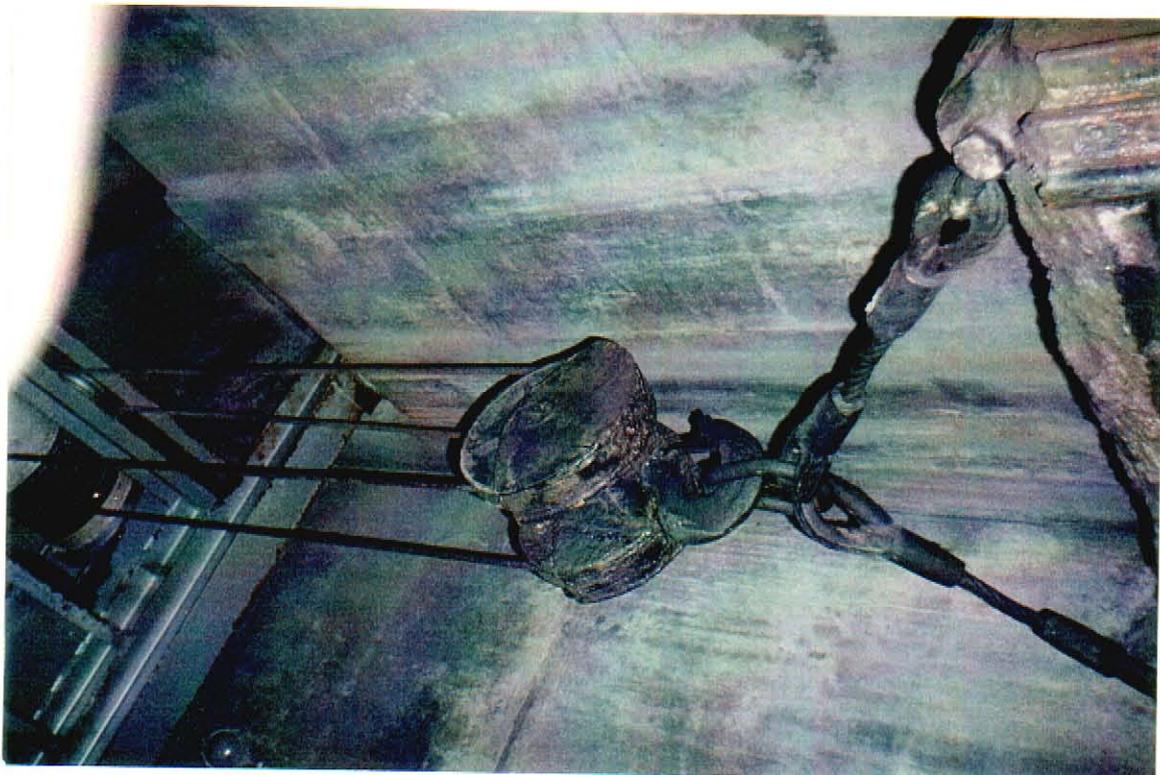
Photograph No. 37: West Bulkhead Gate Hoist



Photograph No. 38: West Bulkhead Gate Hoist Motor, Brake, and Reducer



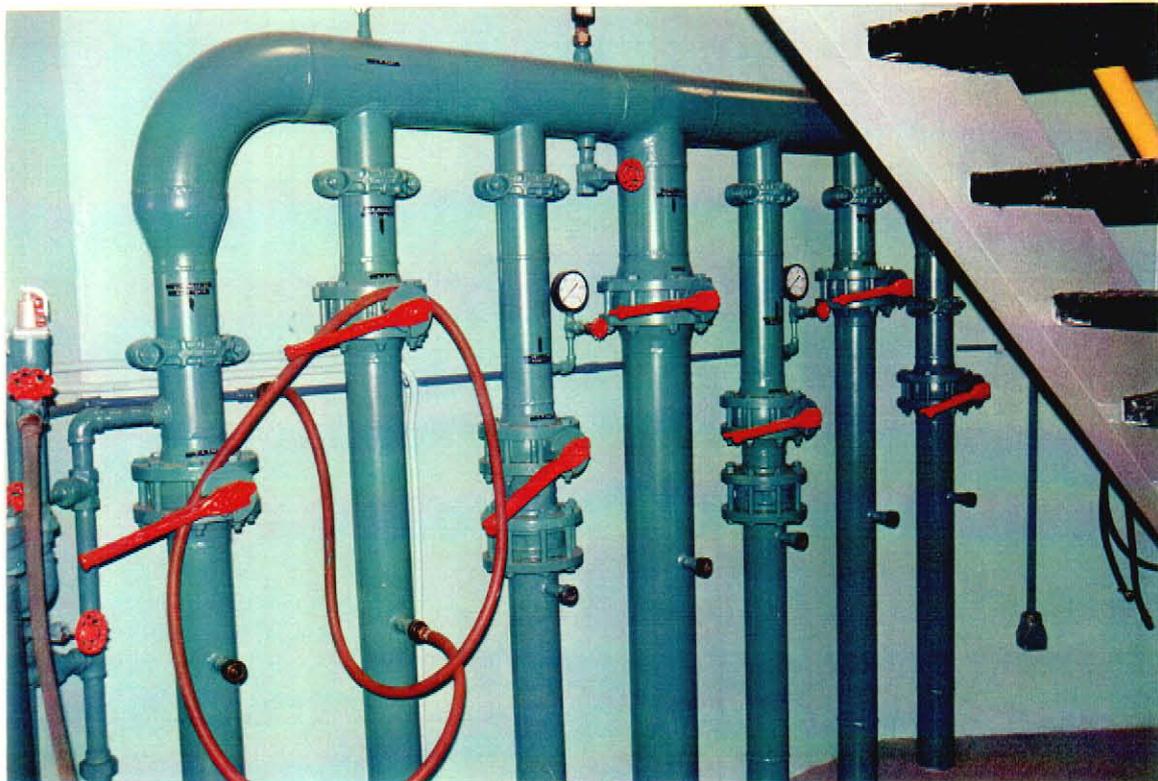
Photograph No. 39: East Bulkhead Gate Position Indicator and Limit Switch



Photograph No. 40: West Bulkhead Gate Sheave Block



Photograph No. 41: East Bulkhead Gate - Wire Rope Jammed in Sheave Block



Photograph No. 42: Desilting System Piping Manifold (Obsolete)

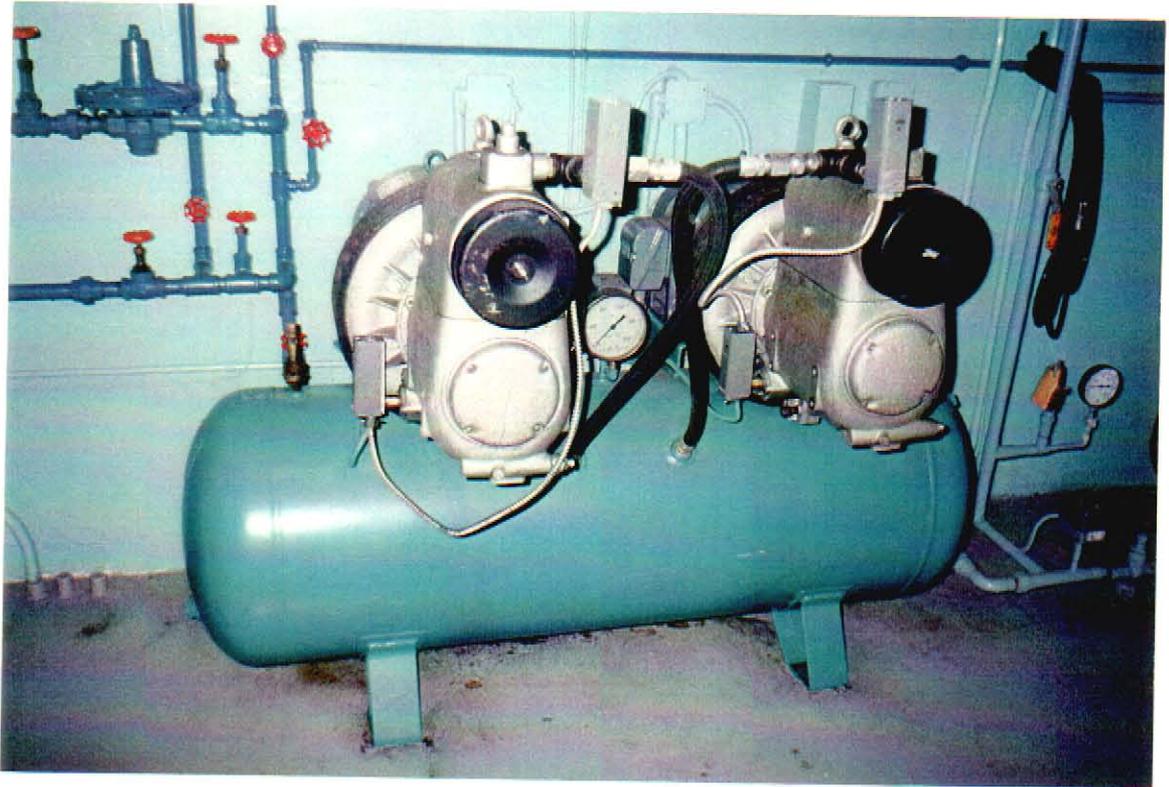
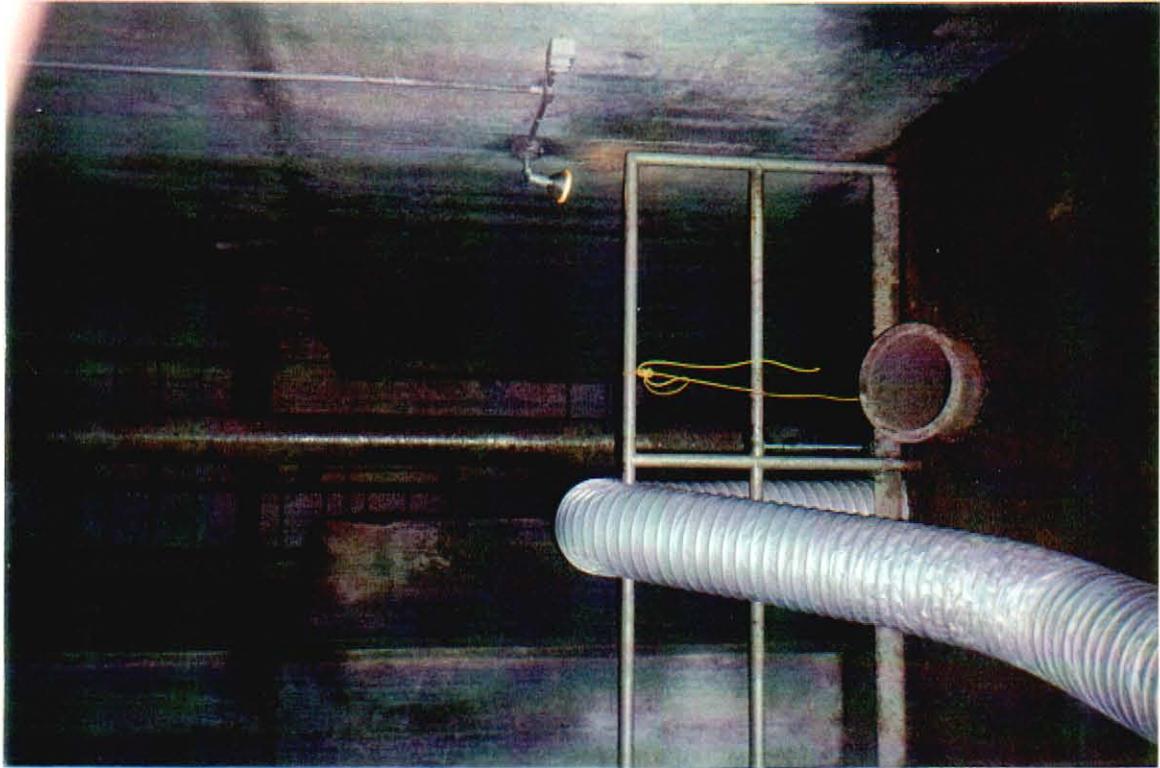


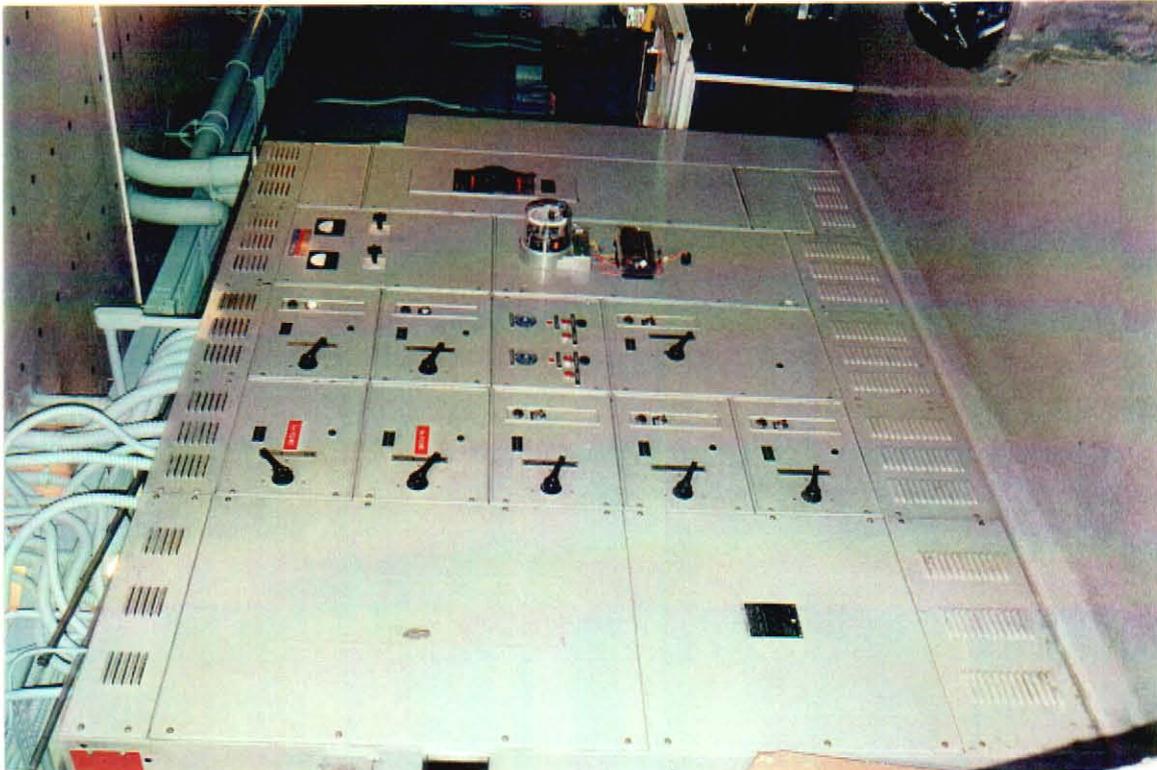
Photo No. 43: Air Compressors



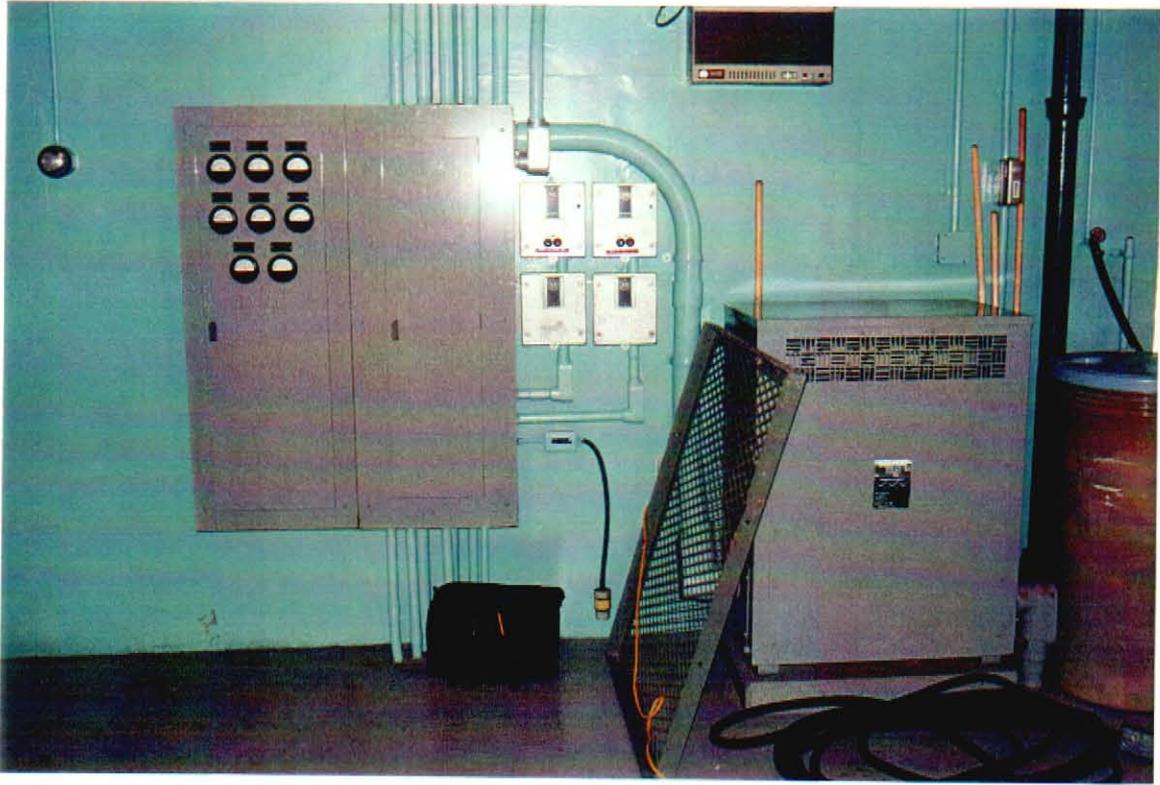
Photograph No. 44: Cylinder Well Heaters (Not installed)



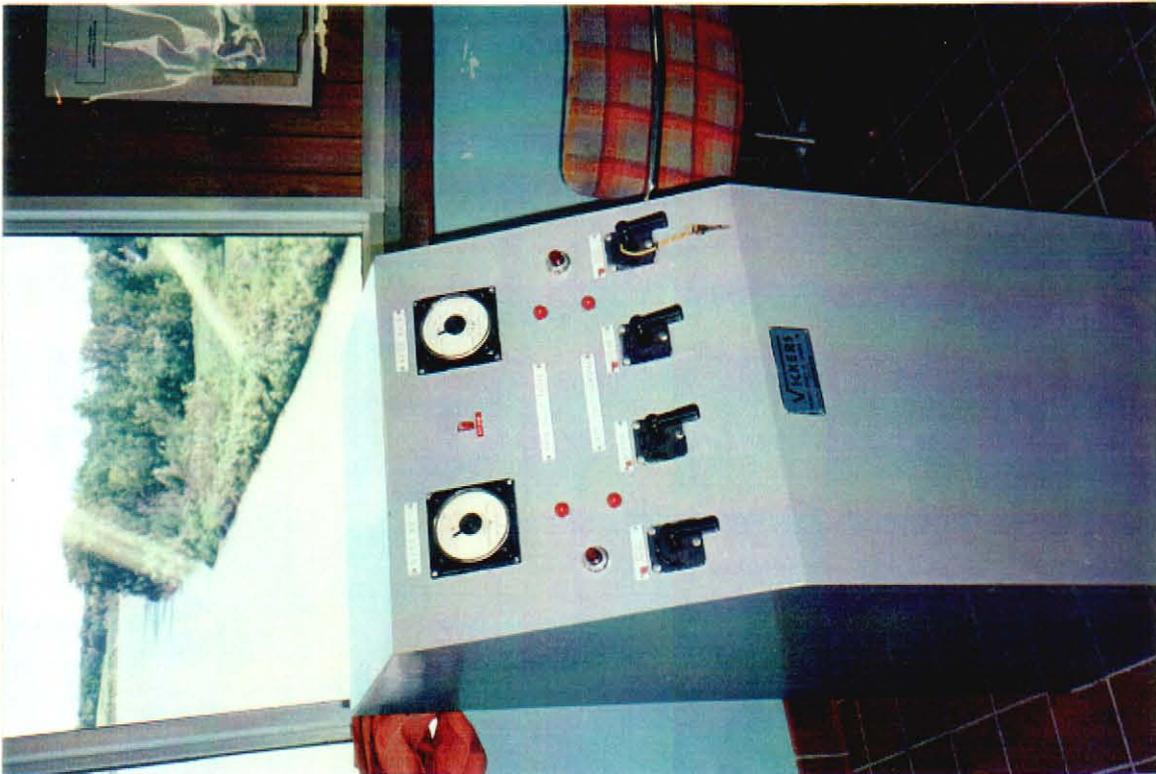
Photograph No. 45: Cylinder Well Heater Flange Mount and Flexible Duct



Photograph No. 46: Motor Control Centre in Mechanical Room



Photograph No. 47: Lighting and Power Panel in Mechanical Room



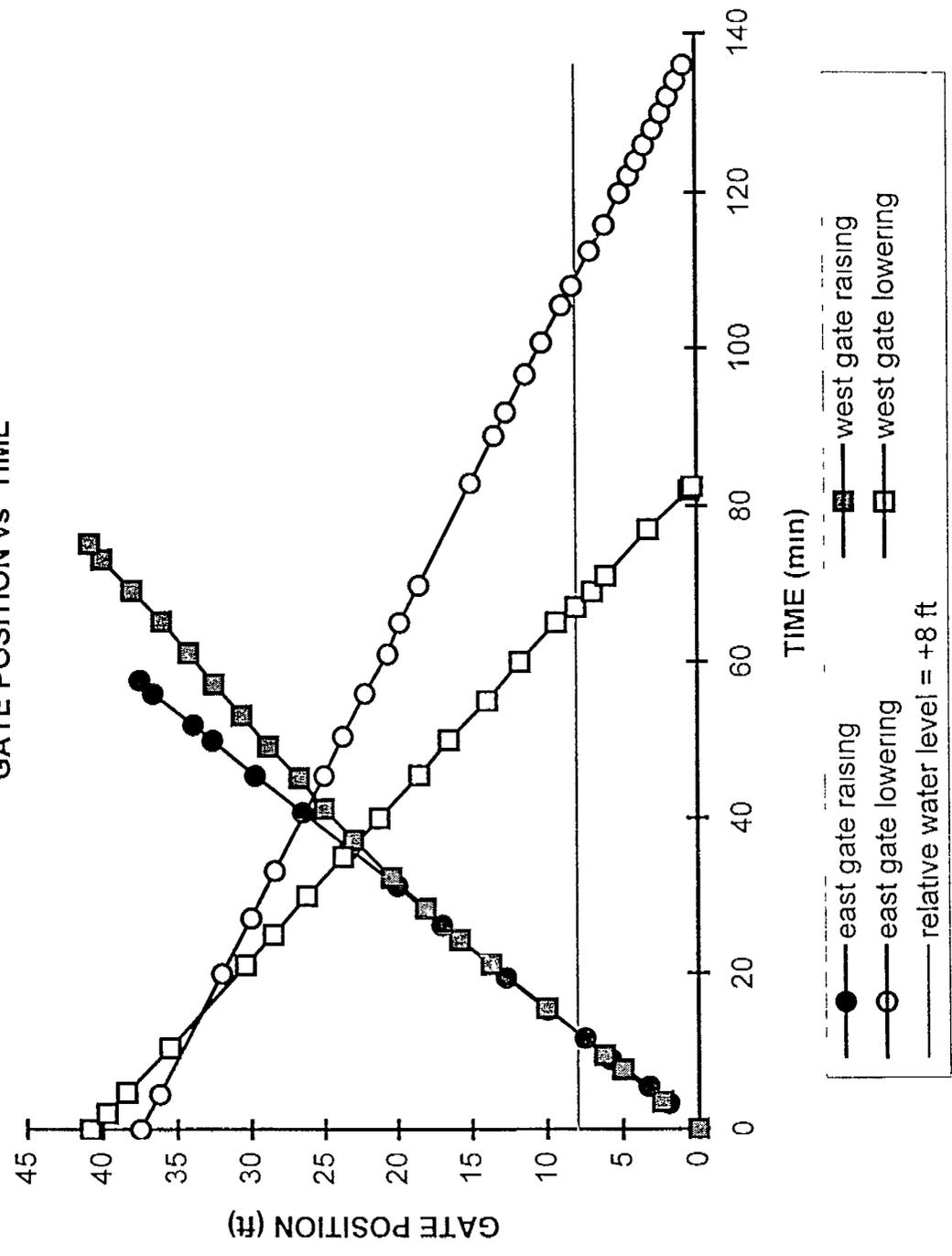
Photograph No. 48: Gate Hoist Control Panel in Control Room

APPENDIX B  
HOIST SYSTEMS  
GRAPHS

**APPENDIX B**

**GATE HOISTING SYSTEM  
PERFORMANCE GRAPHS**

GRAPH 1 FLOODWAY GATE TESTING  
GATE POSITION vs TIME



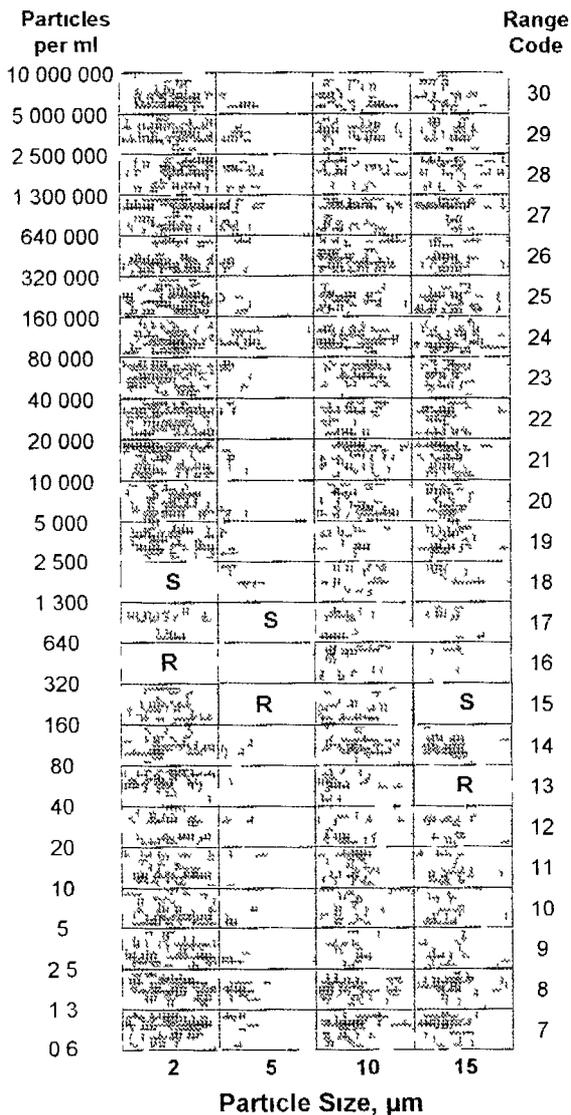
APPENDIX C  
MACHINERY OIL  
ANALYSIS

**APPENDIX C**  
**MACHINERY OIL ANALYSIS REPORTS**



## Fluid Sample Cleanliness Report

### Pall Cleanliness Code Chart



- R = Recommended Level
- S = This Sample
- RS = Sample is at Recommended Level

Date

7/30/96

Prepared For

KGS Group  
St Norbert Floodway Inlet Str

Application

Hydraulic

Sample Point

Reservoir

Filter Supplier

Pall

Filter Rating

6 Micron

<b>Pall</b>	
<b>Cleanliness Code</b>	<b>18 / 17 / 15</b>

Particle Count Summary		
Particle Size	Number per ml Greater than Size	Range Code
2 $\mu\text{m}$	1 300 2 500	18
5 $\mu\text{m}$	640 1 300	17
10 $\mu\text{m}$	---	---
15 $\mu\text{m}$	160 320	15
25 $\mu\text{m}$	---	---



## Contamination Analysis Summary

**Prepared For:** KGS Group  
**Location:** St. Norbert Floodway Inlet Structure  
**Application:** Hydraulic  
**Sampling Point:** Reservoir  
**Sample Volume:** 25ml

**Sample Date:** 7/30/96  
**Contact:** Jason Smith  
**Sample ID#:** East Hyd  
**Sampled By:** Pritchard Machine  
**Pall Cleanliness Code:** 18 / 17 / 15



**Observed Contaminants:**

- |   |  |                               |
|---|--|-------------------------------|
| <input type="checkbox"/> Bright Metal           | <input checked="" type="checkbox"/> Silica | <input type="checkbox"/> Gels |
| <input checked="" type="checkbox"/> Black Metal | <input type="checkbox"/> Fibers            | <input type="checkbox"/> Rust |
| <input type="checkbox"/> Fines                  | <input type="checkbox"/> Precipitate       |                               |
| <input type="checkbox"/> Other (see comments)   |  |                               |

**Comments:**

There is a large amount of silica particulates present in the oil sample. This might be due to external contamination from rags or paper.

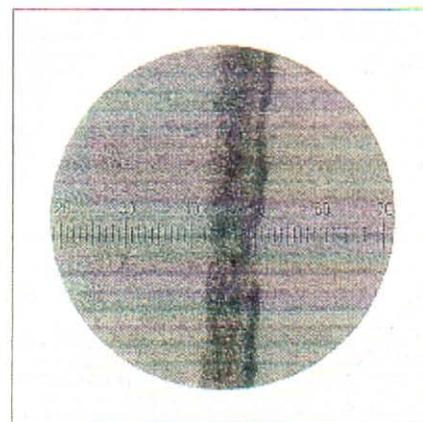
100X Magnification      14 microns/division

**Recommendations**

**Maximum Cleanliness**      16 /15 /13

**Filter Media Grade:**      KN

Identify where the large amount of silica is introduced into the system. Continue to monitor oil cleanliness and change filters upon indication

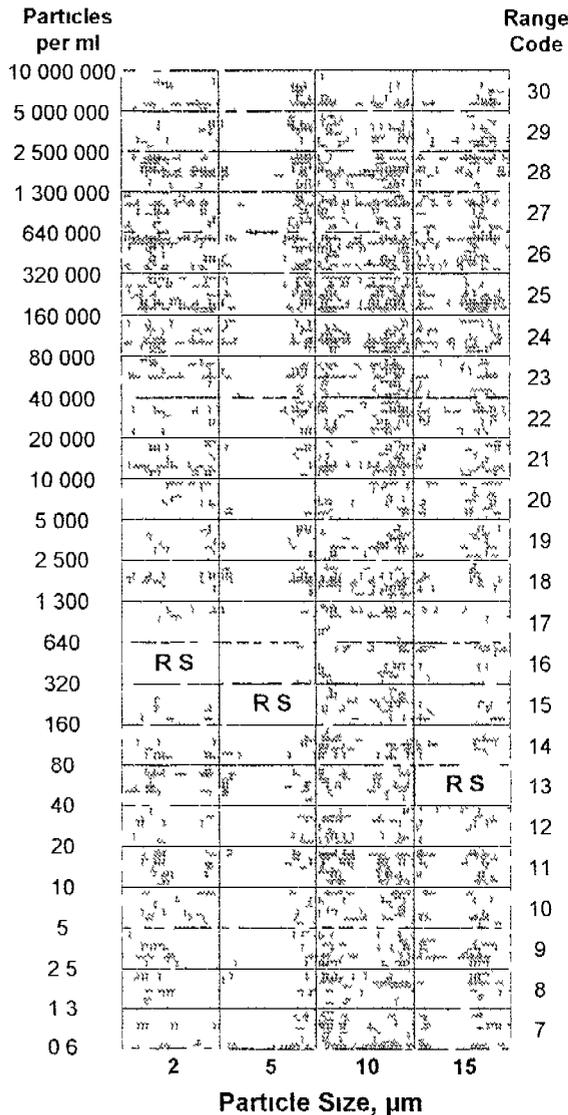


100X Magnification      14 microns/division



## Fluid Sample Cleanliness Report

### Pall Cleanliness Code Chart



Date

7/30/96

Prepared For

KGS Group

St Norbert Floodway Inlet Str

Application

Hydraulic

Sample Point

Reservoir

Filter Supplier

Pall

Filter Rating

6 Micron

Pall  
Cleanliness Code 16 / 15 / 13

### Particle Count Summary

Particle Size	Number per ml Greater than Size	Range Code
2 $\mu\text{m}$	320 640	16
5 $\mu\text{m}$	160 320	15
10 $\mu\text{m}$		
15 $\mu\text{m}$	40 80	13
25 $\mu\text{m}$		

R

= Recommended Level

S

= This Sample

RS

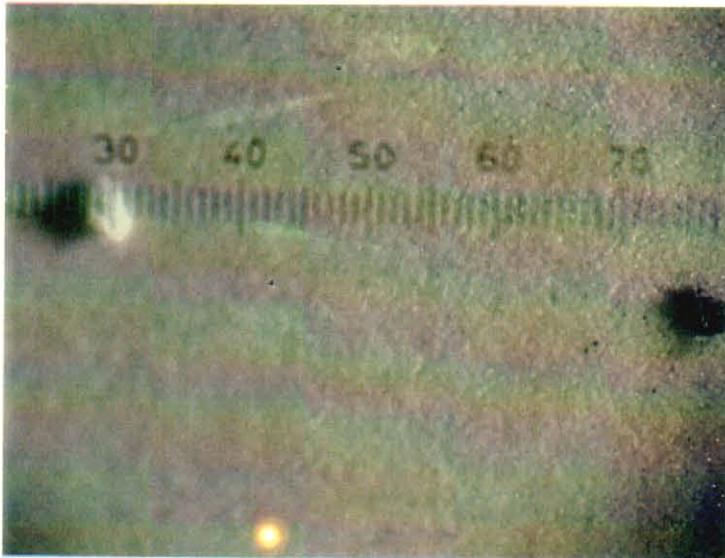
= Sample is at Recommended Level



## Contamination Analysis Summary

**Prepared For:** KGS Group  
**Location:** St. Norbert Floodway Inlet Structure  
**Application:** Hydraulic  
**Sampling Point:** Reservoir  
**Sample Volume:** 25ml

**Sample Date:** 7/30/96  
**Contact:** Jason Smith  
**Sample ID#:** West Hyd  
**Sampled By:** Pritchard Machine  
**Pail Cleanliness Code:** 16 / 15 / 13



WEST

100X Magnification      14 microns/division

### Recommendations

**Maximum Cleanliness**      16 /15 /13  
**Filter Media Grade:**      KN

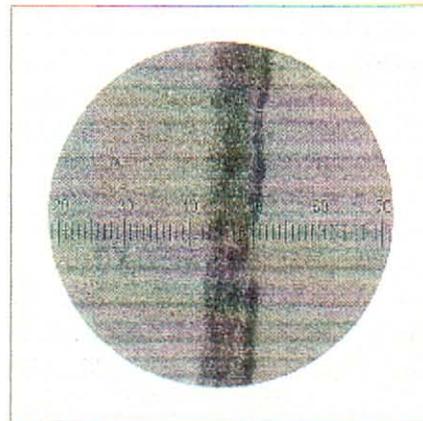
Continue to monitor oil cleanliness and change filters upon indication

### Observed Contaminants:

<input type="checkbox"/> Bright Metal	<input checked="" type="checkbox"/> Silica	<input type="checkbox"/> Gels
<input checked="" type="checkbox"/> Black Metal	<input type="checkbox"/> Fibers	<input type="checkbox"/> Rust
<input type="checkbox"/> Fines	<input type="checkbox"/> Precipitate	
<input type="checkbox"/> Other (see comments)		

### Comments:

A few large silica and black metallic contaminant particles are present in the oil sample.

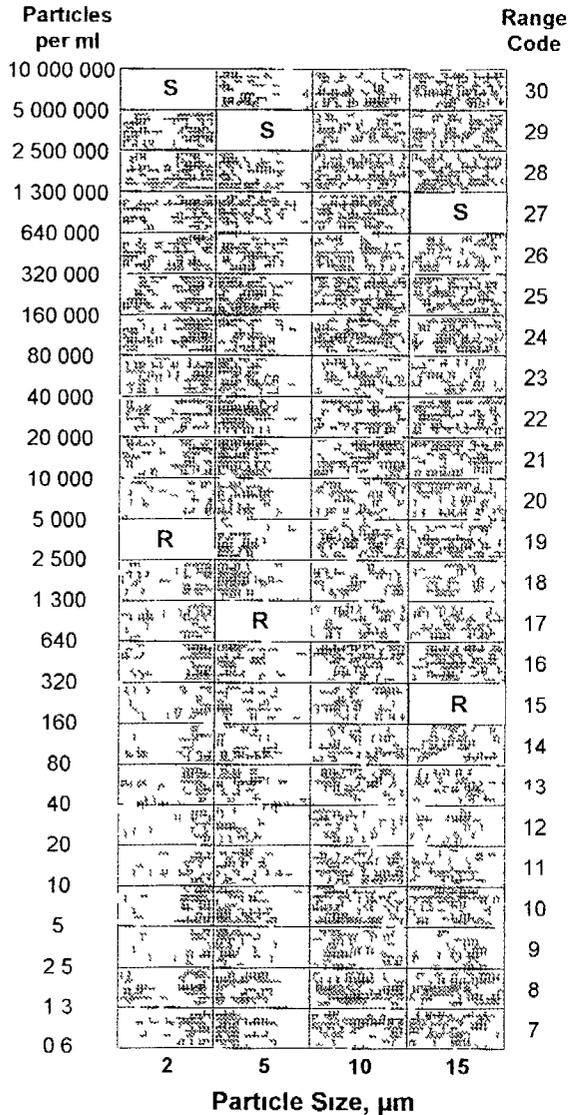


100X Magnification      14 microns/division



## Fluid Sample Cleanliness Report

### Pall Cleanliness Code Chart



Date

8/02/96

**Prepared For**

KGS Group  
St. Norbert Floodway Inlet Str

**Application**

Bulk Head

**Sample Point**

Reservoir

**Filter Supplier**

None

**Filter Rating**

N/A

Pall		
Cleanliness Code	30	/ 29 / 27

Particle Count Summary		
Particle Size	Number per ml Greater than Size	Range Code
2 $\mu\text{m}$	5 000 000 - 10 000 000	30
5 $\mu\text{m}$	2 500 000 - 5 000 000	29
10 $\mu\text{m}$	---	---
15 $\mu\text{m}$	640 000 - 1 300 000	27
25 $\mu\text{m}$	---	---

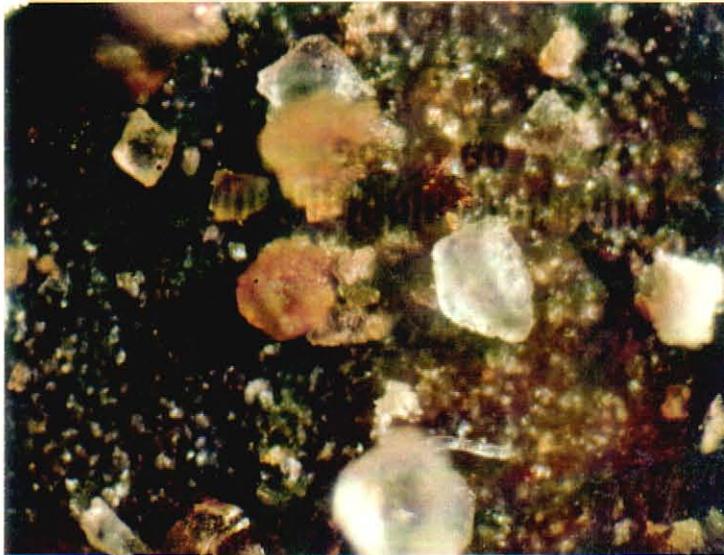
- R = Recommended Level
- S = This Sample
- RS = Sample is at Recommended Level



## Contamination Analysis Summary

**Prepared For:** KGS Group  
**Location:** St. Norbert Floodway Inlet Structure  
**Application:** Bulk Head  
**Sampling Point:** Reservoir  
**Sample Volume:** 25ml

**Sample Date:** 8/02/96  
**Contact:** Jason Smith  
**Sample ID#:** East Bulk Head  
**Sampled By:** Pritchard Machine  
**Pall Cleanliness Code:** 30 / 29 / 27



### Observed Contaminants:

- Bright Metal
- Black Metal
- Fines
- Other (see comments)
- Silica
- Fibers
- Precipitate
- Gels
- Rust

### Comments:

The oil sample is extremely contaminated with all types of contaminants. These include silica, metallic particles, rust, and fibers.

100X Magnification

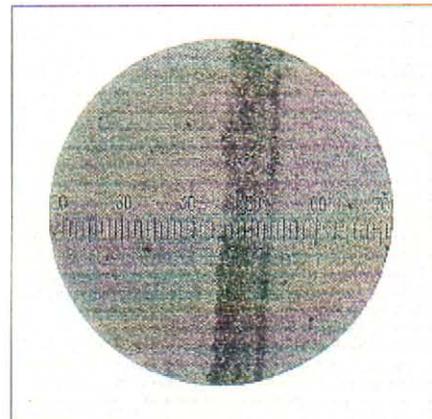
14 microns/division

### Recommendations

**Maximum Cleanliness** 19 /17 /15

**Filter Media Grade:** KT

The cleanliness of this oil is beyond acceptable levels. Immediate actions should be taken to improve the oil cleanliness. Install a 25 micron filter to control contamination. Oil should be changed immediately.

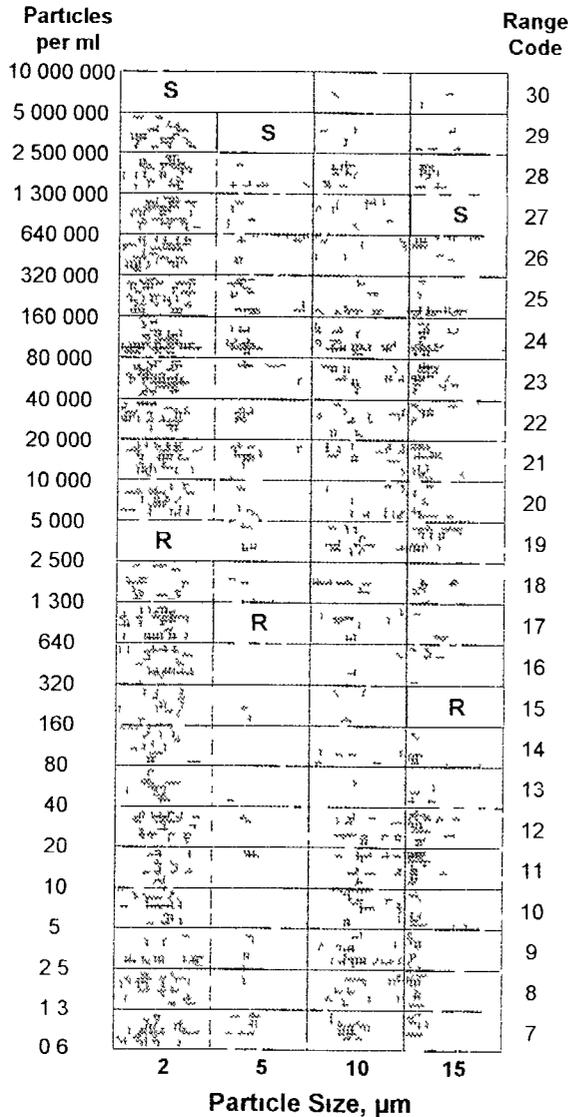


100X Magnification 14 microns/division



## Fluid Sample Cleanliness Report

### Pall Cleanliness Code Chart



Date

8/02/96

Prepared For

KGS Group  
St Norbert Floodway Inlet Str

Application

Bulk Head

Sample Point

Reservoir

Filter Supplier

None

Filter Rating

N/A

Pall		
Cleanliness Code	30 / 29 / 27	

Particle Count Summary		
Particle Size	Number per ml Greater than Size	Range Code
2μm	5 000 000 10 000 000	30
5μm	2 500 000 5 000 000	29
10μm	---	---
15μm	640 000 1 300 000	27
25μm	---	---

- R = Recommended Level
- S = This Sample
- RS = Sample is at Recommended Level



## Contamination Analysis Summary

**Prepared For:** KGS Group

**Location:** St. Norbert Floodway Inlet Structure

**Application:** Bulk Head

**Sampling Point:** Reservoir

**Sample Volume:** 25ml

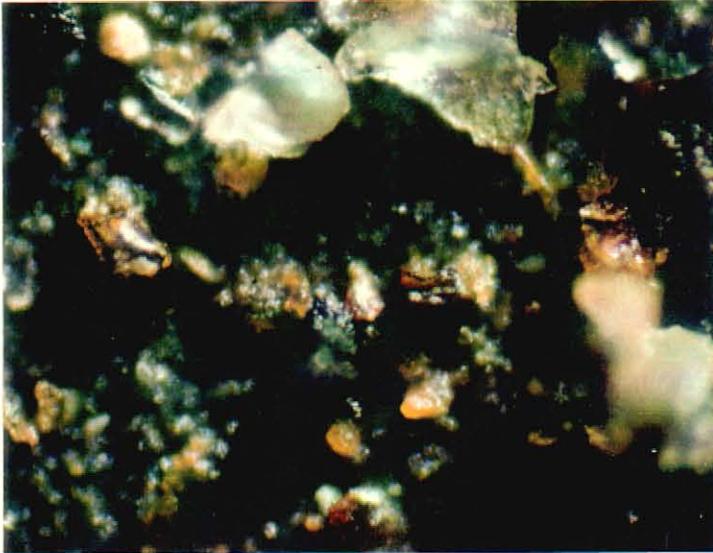
**Sample Date:** 8/02/96

**Contact:** Jason Smith

**Sample ID#:** West Bulk Head

**Sampled By:** Pritchard Machine

**Pall Cleanliness Code:** 30 / 29 / 27



### Observed Contaminants:

- |  |  |  |
|--|--|--|
| <input checked="" type="checkbox"/> Bright Metal | <input checked="" type="checkbox"/> Silica | <input type="checkbox"/> Gels            |
| <input checked="" type="checkbox"/> Black Metal  | <input checked="" type="checkbox"/> Fibers | <input checked="" type="checkbox"/> Rust |
| <input type="checkbox"/> Fines                   | <input type="checkbox"/> Precipitate       |  |
| <input type="checkbox"/> Other (see comments)    |  |  |

### Comments:

The oil sample is extremely contaminated with all types of contaminants. These include silica, metallic particles, rust, and fibers.

100X Magnification

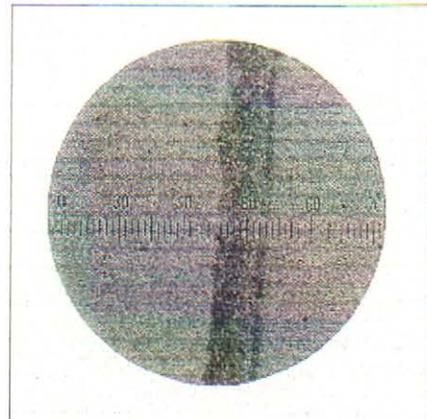
14 microns/division

### Recommendations

**Maximum Cleanliness** 19 /17 /15

**Filter Media Grade:** KT

The cleanliness of this oil is beyond acceptable levels. Immediate actions should be taken to improve the oil cleanliness. Install a 25 micron filter to control contamination. Oil should be changed immediately.



100X Magnification 14 microns/division

**APPENDIX D  
EAST GATE  
INSPECTION**

**APPENDIX D**  
**DEWATERED EAST GATE INSPECTION REPORT**

# MANITOBA NATURAL RESOURCES

RED RIVER FLOODWAY INLET STRUCTURE  
DEWATERED EAST GATE  
INSPECTION REPORT

**KGS**  
**GROUP**

KONTZAMANIS ▪ GRAUMANN ▪ SMITH ▪ MACMILLAN INC  
*CONSULTING ENGINEERS & PROJECT MANAGERS*



KONTZAMANIS ▪ GRAUMANN ▪ SMITH ▪ MACMILLAN INC  
CONSULTING ENGINEERS & PROJECT MANAGERS

May 17, 1996

File No 96-311-01

Manitoba Natural Resources  
1577 Dublin Avenue  
Winnipeg, Manitoba  
R3E 3J5

ATTENTION Mr Rick Hay  
Regional Engineer

RE Red River Floodway Inlet Structure Dewatered Inspection Report

Dear Mr Hay

Enclosed are three (3) copies of the draft report on the Floodway Inlet Structure dewatered east gate inspection for your review and comments. This report includes the portion of the inspection program that was performed during the period in which the gate was dewatered. The remainder of the inspection program will be completed during and after the period of springtime flood operation.

If you have any questions or comments on the enclosed report please do not hesitate to call. We will finalize the report following receipt of comments from the Water Resources Branch.

Yours very truly,

D B MacMillan P Eng  
Principal

DBM/rf  
Enclosure

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## 1 0 INTRODUCTION

KGS Group was contracted to conduct an Inspection and Assessment of the Floodway Inlet Structure. The first part of this program considered inspection of those components which were accessible by dewatering the gate without a cofferdam. The remaining portion of the inspection program will be performed on components accessible without dewatering. Items covered in the dewatered inspection include the following:

- Underwater inspection of the east gate seals and surrounding concrete
- Observation of the east gate dewatering operation
- Inspection of the east gate and gate chamber including access to the gate chamber, visual inspection of structural components, and thickness test results
- Inspection of the east gate hydraulic cylinders, including visual inspection and thickness testing of the cylinder cans. Observations of the cylinder piston rods and gland seal regions, which are accessible without dewatering, are also included
- Visual inspection of the east gate dogging devices

Each of the above items are described in the following sections followed by conclusions and recommendations. Photographs and Figures are included in Appendix A.

## 2 0 UNDERWATER INSPECTION OF GATE SEAL

The existing seals on the gate had deteriorated to the point where they are ineffective. Based upon previous experience it was concluded that the gate could only be dewatered with the assistance of divers. The east gate was selected by Manitoba Natural Resources (MNR) as the gate which would be inspected. Dominion Divers Ltd, was contracted to perform the sealing operations and conduct an inspection of the gate, seals and surrounding concrete. The gate inspection took place in conjunction with the sealing operations where by the divers packed sections of twisted or woven oakum strands, approximately 1 m (3 3 ft) long, into the open crevices between the gate and the concrete structure. A complete diving inspection report for the work performed between March 4 and March 14, 1996 is included in Appendix B. The following summary is presented from the diving report notes made during the inspection and conversations with the divers:

Due to the extremely cold winter season the East Gate channel was completely covered by ice before diving operations commenced. During the diving operations cold temperatures continued throughout the 2 weeks ranging from -10 to -25°C. The ice ranged in thickness from 25 mm to 1 2 m (1 to 48 in), and approximately 90 percent of the ice over the gate was removed to allow the divers safe access to the gate (see Photos 1 to 4). The ice clearing efforts took approximately 6 days, during which the divers operated under adverse conditions. River flow was estimated at 71

cms Although the channel velocity was too high to allow for video inspection of the gate and seals, the divers presented commentary on their findings during the diving operations with the following elements of the gate being inspected

- Upstream seal (Trunnion seal)
- East and west side seals (J-seals)
- Downstream seal
- Surrounding concrete

Figure 1 in Appendix A illustrates the locations of the seals inspected by the divers. The skin plate was not inspected due to the amount of debris on the surface.

### 2.1 Upstream Seal

The upstream seal appeared to be completely intact and in fair condition, but it showed signs of weathering and degradation especially on the exposed edge where the flap was splitting and fraying along the entire edge.

### 2.2 Side Seals

The side seals are attached to the gate structure itself and seemed to be intact along the entire length of the sides. The seals are located approximately 50 mm (2 in) below the edge of the upstream skin plate, and this space was filled with debris along the entire length. Small gaps or cracks 3 mm (1/8 in) in size were noticed between the seal and the walls. These seemed to extend beyond the protective steel side plates and into the concrete upstream of the gate on both sides.

### 2.3 Downstream Seal

A protective rubber flap was installed after the completion of the gate, in order to protect the seal below from damage during operation. The flap is attached to the gate and extends over the downstream side of the seal opening. The flap is in poor condition over the length of the gate. It is torn from the attachment bar in places and rippled throughout. Gate operations of closing and opening the gate in the presence of rocks, sticks and debris have torn the rubber in several places and bent the steel cover plate upwards especially in the vicinity of the centre pier.

The seal below the protective flap appeared to be in reasonable condition except where the following anomalies were reported:

- A 50 mm (2 in) stick, approximately 12 m (40 ft) east of the centre pier was caught under the gate and projected through the seal below.

- A piece of metal approximately 0.6 m (2 ft) wide is folded and lodged between the gate and the seal (the metal appears to be the same thickness and appearance as an old sign) approximately 3 m (10 ft) from the centre pier. The metal extends past the seal and causes the gate to be lifted approximately 20 mm (3/4 in) preventing a proper seal in the vicinity of this obstruction. It is at this location that the protective flap is torn for about 1.5 m (5 ft). The free portion has been drawn into the crevice between the gate and the downstream concrete.

There are two joints in the downstream steel support plate each containing eight bolt holes but no bolts. The divers reported that there was significant water flow through these bolt holes.

In general, the seals did not seem to exhibit any further deterioration than that which was reported in the previous inspection performed in 1986/1987 (see the Acres International report "Investigation of Red River Floodway Inlet Gate Seals and Concrete Deterioration" March 1988, Appendix C).

#### 2.4 Concrete

In general, the concrete was reportedly in good condition throughout the accessible underwater portions of the inspection. However, some spalling and deterioration was noted as listed below.

- Noticeable spalling has taken place on the concrete above the level of the gate just downstream of the bulkhead gate entrance on the east abutment,
- A 50 mm (2 in) diameter hole was found 0.25 m (10 in) upstream of the south-west corner, connected to the aforementioned 3 mm (1/8 in) crack at the side seals.
- The concrete downstream of the downstream seal was found to be the most deteriorated with noticeable spalling throughout. However, the whole area was not accessible because of debris on the structure. This area was extensively surveyed in 1986/1987 during lower flow periods. The report issued by Acres International (March 1988 see Appendix C) describes the deterioration to be "most severe just downstream of the embedded steel member which holds the J-seal and generally tapers out to an insignificant amount a few feet downstream of the seal". The divers did not indicate that the severity of the deterioration had noticeably increased since this inspection.

### 3 0 GATE DEWATERING

As the divers began the sealing operation on March 11, 1996 MNR staff began operating the dewatering pump and isolation valves to dewater the centre pier sump and east gate recess. Once the gate recess began to dewater and throughout the dewatering process, the divers continued to seal in areas that showed signs of excessive leaking. The dewatering pump worked well throughout the initial dewatering procedure as illustrated in Photo 3 showing the flow of water from the centre pier sump. As the water level inside the gate approached the bottom of the gate recess, however, operation of the dewatering pump became increasingly difficult as accumulated silt blocked the pump intake piping. The pump intake was also blocked by some debris, mostly pieces of polyurethane insulation from the upstream skin plate. These problems were overcome by repeatedly backflushing the pump and flushing the centre pier sump with fresh water, as well as physically removing debris at the pump inlet. Following these procedures the sump was completely dewatered by the morning of March 14, 1996°

### 4 0 VISUAL INSPECTION OF EAST GATE AND GATE CHAMBER

#### 4 1 Gate Access

After the gate chamber was completely dewatered, it was possible to gain access to the chamber via the access way through the centre or end pier where the hydraulic hoisting cylinders were located. Access was best from the centre pier because the sediment at the bottom of the centre pier cylinder well was 1.2 to 1.8 m (4 to 6 ft) deep at the bottom of the ladder. The east side was estimated to range from 1.8 to 2.4 m (6 to 8 ft) in depth. The lower portion of the gate was submerged within the sediment, and the gate pedestals were not visible. The operators had reported that the gate was taking 2 to 3 days to "settle" into its final position, and the primary cause of this was thought to be the amount and depth of the sediment especially at the east end of the chamber where the connection of the link to the box cross member was not visible (see Photo 5). This assumption is consistent with the findings inside the gate.

The access ladders are on the downstream side of the gate approximately 15 m (50 ft) from the nearest component of the gate (the gate lifting beam). The sediment was very saturated, and it did not hold the weight of a person. This made it impassable by trying to wade through the mud to the gate structure. After futile attempts to wade across the sediment some water was allowed back into the chamber, and the divers connected a rope from the lifting cylinder to the gate where it connects to the link (see Photos 6 and 7). The gate was then dewatered again and an inner tube was used as a floatation device, whereby an individual sat in the inner tube and pulled themselves to the gate via the connecting rope. Once one was at the gate, he/she could climb onto the gate structure, and complete inspections of any exposed portions could be made.

Given the difficulties gaining access considerations should be given to the construction of a false walkway (above the sediment) upstream of the hoisting cylinder in order to facilitate easier access.

to the gate. This would provide better access and safety to any individuals in the gate chamber, and provide a better method for transporting equipment to the gate for inspection and repair.

Visual inspections were hampered by the amount of leakage around the gate and the humidity and mist in the air. Over the two day inspection period, the leakage around the oakum caulking increased considerably. Silt and mud covered all horizontal and incline portions of the gate members, especially within the I-formations of stiffeners and structural members. Complicated further by the absence of good lighting and cold temperatures, cameras were often ineffective because the mist would diffuse the light from the flash and render pictures smoky and obscured.

Despite difficulties in access to the gate, once one was inside the main portion of the gate, the majority of structural elements were accessible for visual inspection. The inspection reported herein was made over a two day period between March 14 and 15, 1996. The following sections describe the observations made.

#### 4.2 Structural Components

In general, the structure appeared to be in good condition. Most visible surfaces were clean and free from rust, and no major pitting of the steel was evident. The following items, with respect to the structural condition of the gate, were noted:

- The paint on the members is in good to very good condition throughout (see Photos 8 and 9).
- Welded connections were all intact and complete with no visible signs of distress (see Photo 10).
- Bolted connections were in good condition and appeared to be clean and generally free from rust (see Photo 11).
- The lifting link and box cross member assembly was in good condition at the west end of the gate (see Photos 6 and 12). The box cross member was not visible for inspection on the east side because it was submerged in the sediment.
- The Acres 1988 report had indicated the silt had accumulated to a depth of about 7 inches between the stiffeners on the inside of the gate. This occurred on the lower 10 to 12 feet of the downstream skinplate. The submerged weight of the silt is about 5 percent of the hoist capacity. The depth of silt has increased considerably. In some of the interior bays the silt had accumulated to several feet deep at the bottom and all stiffeners on the radial (downstream) skin plate had 150 to 300 mm (6 to 12 in) of accumulated sediment on them.

- The trunnions were inaccessible and were not inspected. The trunnions were visible from the base gate and appeared to be in good condition, however, access to the trunnions directly was only possible by ladder. Due to the amount of sediment and the difficulties in access to the gate, it was not practical to set up a ladder for the trunnion inspections. With easier access to the gate as discussed earlier (via an elevated walkway) inspections of the trunnions may be possible. Otherwise, the trunnions would have to be inspected and serviced from above the gate when the complete bay is dewatered.
- The seals were not accessible and could not be inspected from the interior of the gate chamber.
- All main structural members on interior and exterior trusses appeared to be in good condition.
- The radial (downstream) and rear (interior) skin plates were found to be in good condition showing very little signs of rust and deterioration.
- A condition and structural assessment of the upstream skin plate was not possible because it was insulated with approximately 150 to 200 mm (6 to 8 in) of spray-on styrofoam insulation. Large pieces of the foam were falling from the surface of the skin plate. This created problems with the dewatering pump, as the foam would plug the intake.
- All visible concrete composing the gate chamber appeared to be in good condition. No significant cracking was noted and all surfaces appeared to be free from spalling.

#### 4.3 Thickness Testing

During the second day of the inspection a "weather resistant" ultrasonic thickness tester was used to determine the thicknesses of the accessible structural members and skin plates. In all, nine measurements were taken. The results of these measurements are shown in Table 1. Note that values for measurements 1, 7, and 9 are considered inaccurate because the readings were unstable, probably due to an inability to achieve good surface contact with the thickness transducer. The locations of the thickness measurements are illustrated in Figure 1 in Appendix A.

**Table 1 Structural Components Thickness Testing Results**  
 \* unstable reading - maximum value is shown

No	Truss No	Location Description	Measured Thickness mm (inches)	Original Thickness mm (inches)	Remarks
1	N/A	Back skin plate 2 feet east of westernmost Truss section	4 3 (0 17) *	9 5 (0 375)	Unstable reading
2	3	Bottom of radial member	11 4 (0 450)	9 5 (0 375)	The section consist of 2-3/8 plates welded together
3	2	Vertical web plate approximately 6 feet above the radial member	11 0 (0 433)	9 5 (0 375)	Very clean surface
4	N/A	Radial skin plate below ninth stiffener from the top between truss 2 and 3	16 6 (0 655)	15 9 (0 625)	Fairly clean
5	N/A	Radial skin plate below seventh stiffener from the top between truss 2 and 3	16 3 (0 643)	15 9 (0 625)	
6	N/A	Radial skin plate below fifth stiffener from the top between truss 2 and 3	16 1 (0 635)	15 9 (0 625)	
7	3	Connection plate at lower downstream corner of inner triangle	8 9 (0 35) *	19 1 (0 75)	Unstable reading Virtually no rust
8	3	Radial member below connection plate	10 8 (0 425)	9 5 (0 375)	The section consist of 2-3/8 plates welded together
9	N/A	Gate lifting beam top plate 5 feet east of connection to west link member	8 9 (0 35) *	25 4 (1 00)	Unstable reading Some small pitting evident

## 5 0 INSPECTION OF EAST GATE HYDRAULIC CYLINDERS

The Floodway Inlet Structure east gate is operated by two hydraulic hoisting cylinders located at either end (east and west) of the gate. The cylinders raise the gates by retracting from a fully extended (down) position. The cylinders are located in cylinder wells in the centre pier and east wall respectively. To gain access to the normally submerged lower portion of these cylinders, inspections were performed with the east gate dewatered. When the dewatering procedure was completed, the accumulation of silt in the west cylinder well was approximately 0.3 m (1 ft) below the bottom of the cylinder, allowing for inspection of the bottom flange plate. Silt in the east cylinder well, however, had accumulated approximately 0.3 m (1 ft) above the bottom of the cylinder, and the bottom flange plate could not be inspected.

Inspection of the cylinders included visual inspection and ultrasonic thickness testing. The inspections were performed by Pritchard Machine Ltd. under the direction of KGS Group. An inspection report prepared by Pritchard Machine, including the results of thickness measurements and the east and west cylinder barrels, is included in Appendix D. All of the thickness readings were over 25 mm (1.00 in), which is the original thickness of the cylinder barrels. The following sections describe observations made during the inspections.

### 5.1 Cylinders

In general, the cylinders appeared to be in good condition. Most of the surfaces showed little sign of rust and no major pitting of the steel was observed. Items regarding noticeable conditions are listed below.

- Welded and bolted connections appeared to be in good condition, showing little evidence of deterioration or rust (see Photos 13 and 14).
- On both cylinders there was appreciable accumulation of grease and rust scale at the gland (see Photos 15 and 16), and accumulation of rust scale on the compound coating the cylinder piston rods (See Photo 17). As noted in the report by Pritchard Machine, this could cause contamination of the gland wiper and seal during cylinder retraction and may cause damage to the gland bushing and ram shaft.

### 5.2 Dogging Devices

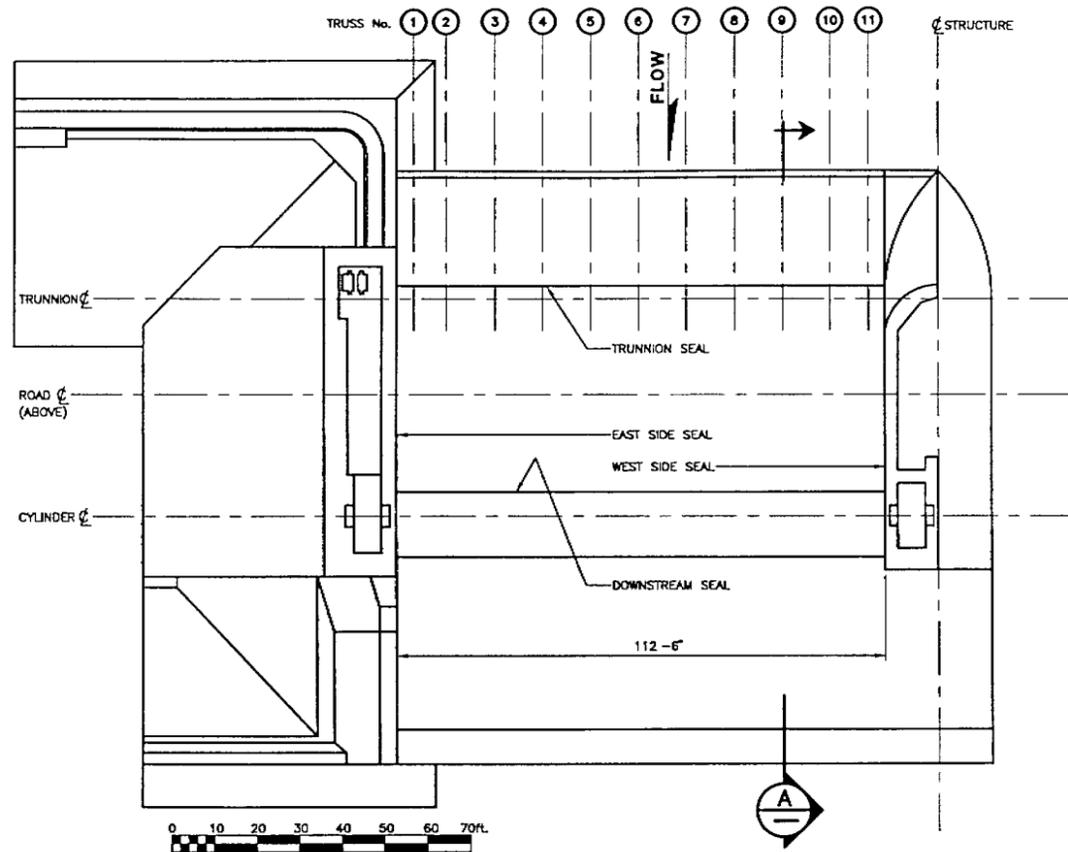
With the east gate dewatered, the gate dogging devices were visually inspected and appeared to be in generally good condition with some signs of rust (See Photos 18 and 19). The west dogging device wheel was able to be rotated manually, while the east wheel was stuck and could not be turned, probably due to a noted accumulation of ice inside the clevis.

## 6 0 CONCLUSIONS

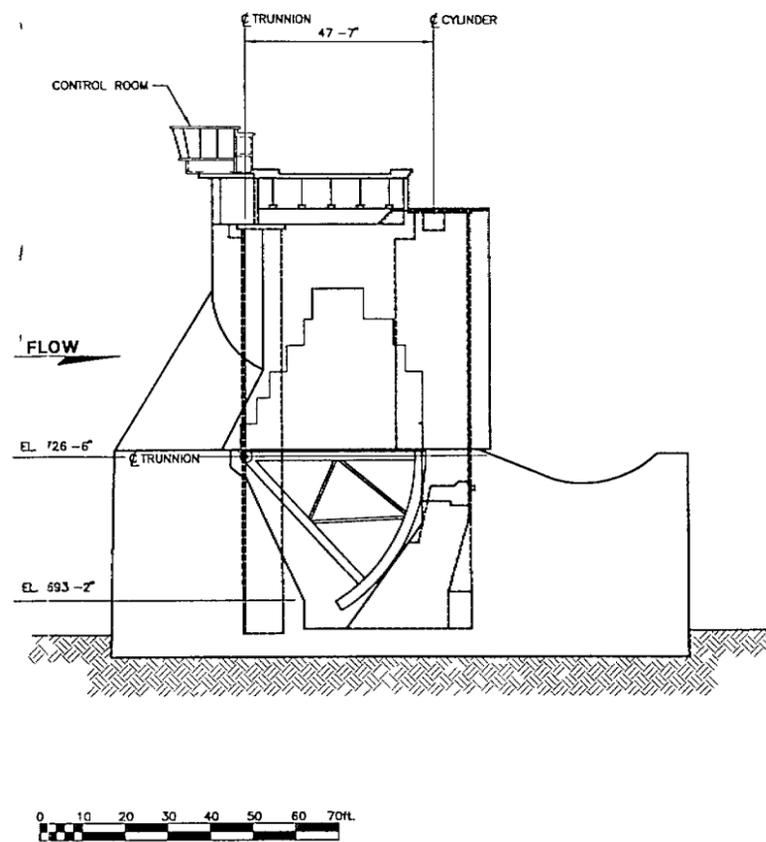
From the observations made during the inspections and the study of previous reports and drawings the following conclusions are presented

- 1 The amount of sediment within the east gate chamber is excessive, and beginning to hamper operation of the gate
- 2 The amount of sediment within the gate chamber has increased significantly since the last inspection in 1986/87. Approximately 1.2 to 1.8 m (4 to 6 ft) of sediment exists at the west end of the gate, and 1.8 to 2.4 m (6 to 8 ft) exists at the east end of the gate
- 3 The amount of sediment is beginning to hamper the operation of the gate which has recently taken considerably more time to "settle" into position
- 4 Operation of the dewatering pump was hampered by accumulation of sediment in the centre pier sump, which tended to plug the pump intake piping. This was particularly evident during the latter stages of dewatering
- 5 The visible structural steel components of the gate appeared to be in good to very good condition with very few signs of rust and deterioration. Structural connections both welded and bolted were examined and determined to be in good condition
- 6 Visual inspection revealed the hydraulic cylinder barrels to be in good condition with little evidence of rust or deterioration. Ultrasonic thickness testing showed no reduction in original thickness of the cylinder barrels. Welded and bolted connections also showed little evidence of corrosion
- 7 There was noted accumulation of grease and rust scale at the hydraulic cylinder glands
- 8 Due to the difficulty presented by the amount of water leaking into the chamber and the amount of mud present several inspection tasks could not be completed, particularly the inspection of the seals and trunnions
- 9 To inspect the trunnions and seals, and to perform adequate thickness testing of the skin plates, the gate chamber will have to be completely sealed, dewatered and cleaned free of sediment
- 10 Access to the gate for inspection and maintenance is extremely difficult due to the presence of silt accumulation. It is recommended that provisions be made to install a walkway through the "corridor" between the base of the stairs and the gate. This will allow good access and provide a safer work area

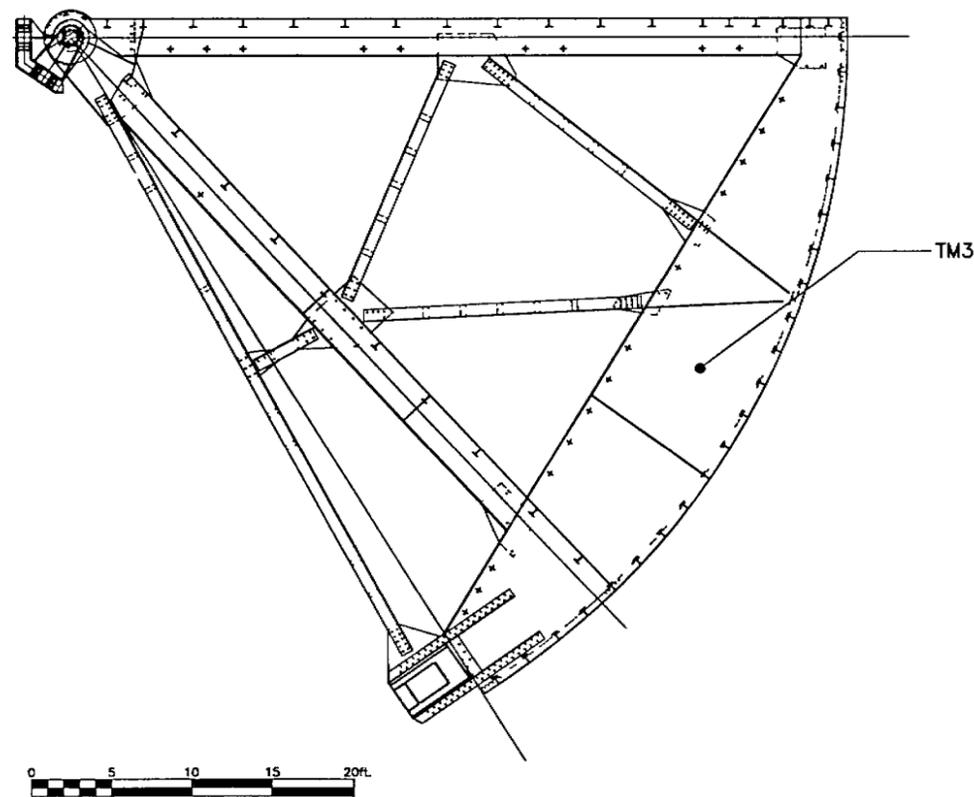
APPENDIX A FIGURES AND PHOTGRAPHS



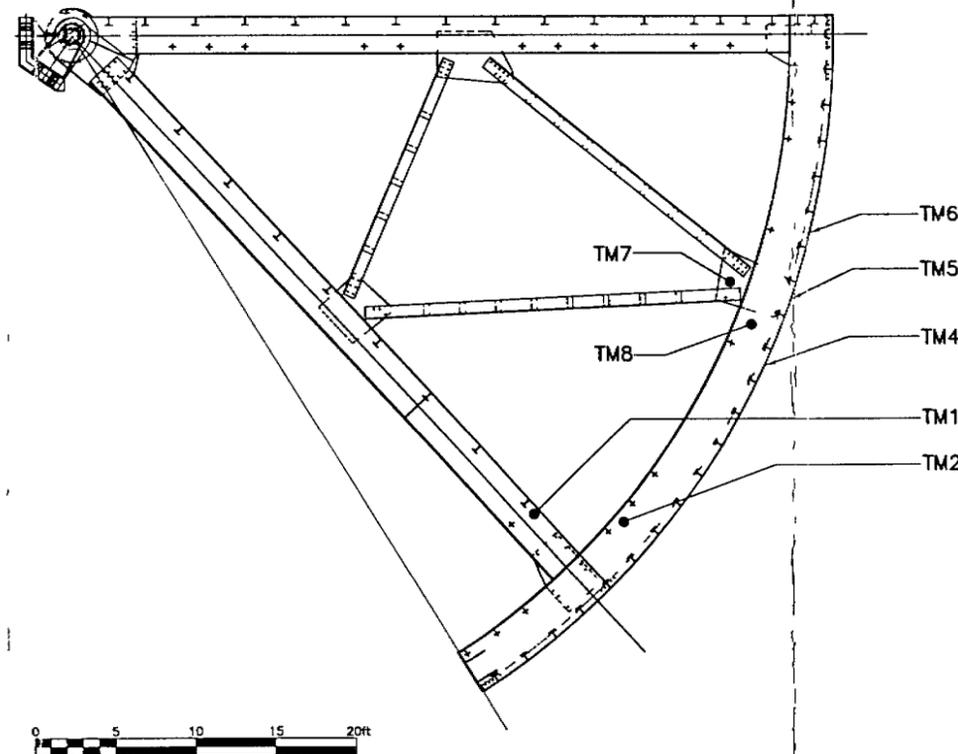
PLAN-CONTROL STRUCTURE EAST GATE



A SECTION-CONTROL STRUCTURE



SECTION-GATE END TRUSSES (NUMBERS 2 AND 10)



SECTION-GATE MIDDLE TRUSSES (NUMBERS 3 TO 9)

THICKNESS MEASUREMENT RESULTS

No	MEASURED THICKNESS	ORIGINAL THICKNESS
TM1	0 17in *	0 375in
TM2	0 45in	0 375in
TM3	0 43in	0 375in
TM4	0 66in	0 625in
TM5	0 64in	0 625in
TM6	0 64in	0 625in
TM7	0 35in *	0 750in
TM8	0 43in	0 375in

\*-UNSTABLE READINGS

NO	DESCRIPTION	BY
	REVISIONS / ISSUE	

A. SECTION LETTER OR DETAIL NUMBER  
 B. DRAWING WHERE SECTION OR DETAIL IS DRAWN  
 OR  
 DRAWING WHERE SECTION OR DETAIL WAS INDICATED  
 - SECTION OR DETAIL SHOWN ON SAME DRAWING

**KGS GROUP** CONSULTING ENGINEERS & PROJECT MANAGERS  
 WINNIPEG (204) 896-1200  
 THUNDER BAY (807) 345-2233

CLIENT: **Manitoba Natural Resources**

PROJECT: RED RIVER FLOODWAY INLET STRUCTURE

DWG. DESCRIPTION: LOCATION OF THICKNESS MEASUREMENTS DURING DEWATERED GATE INSPECTION

DESIGNED:	DRAWN:	CHECKED:
	J R M	
APPROVED:		
SCALE: AS NOTED	DATE: MAY 8/96	
DWG. NO. FIGURE 1	REV. 0	

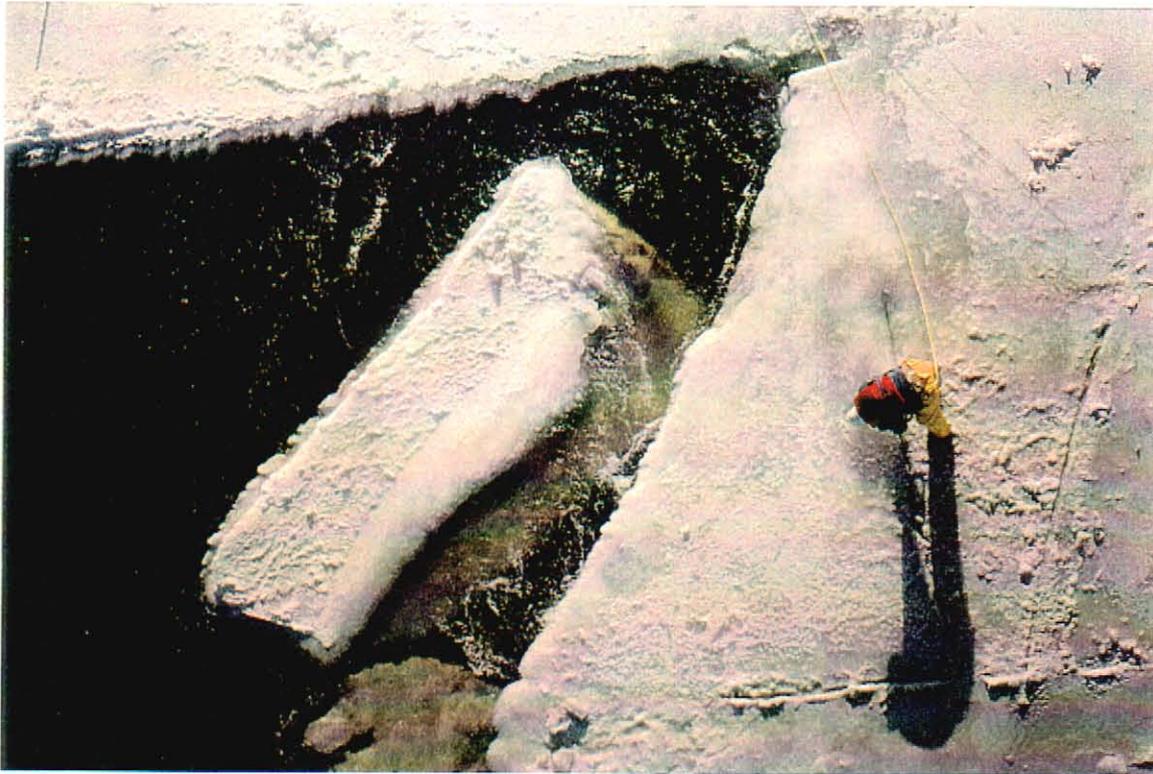


PHOTO 1: DIVERS CUTTING ICE, MARCH 6/96

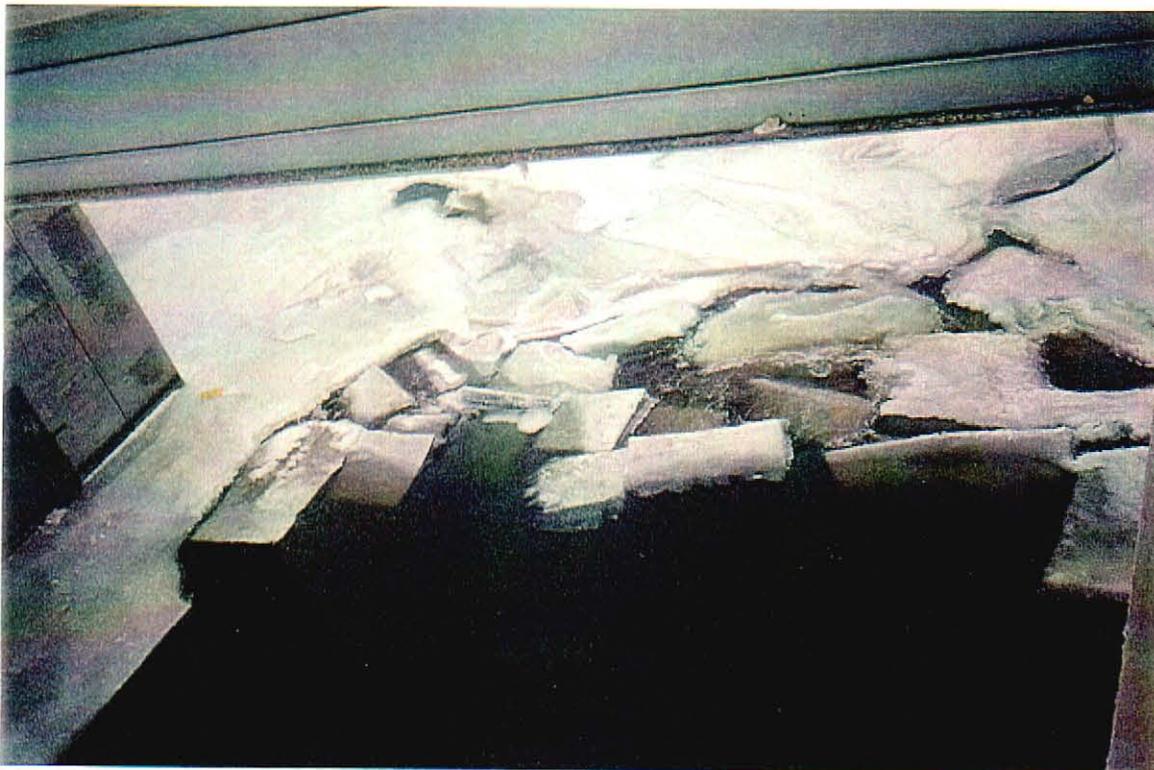


PHOTO 2: OPEN WATER OVER EAST GATE - ICE CUTTING COMPLETE

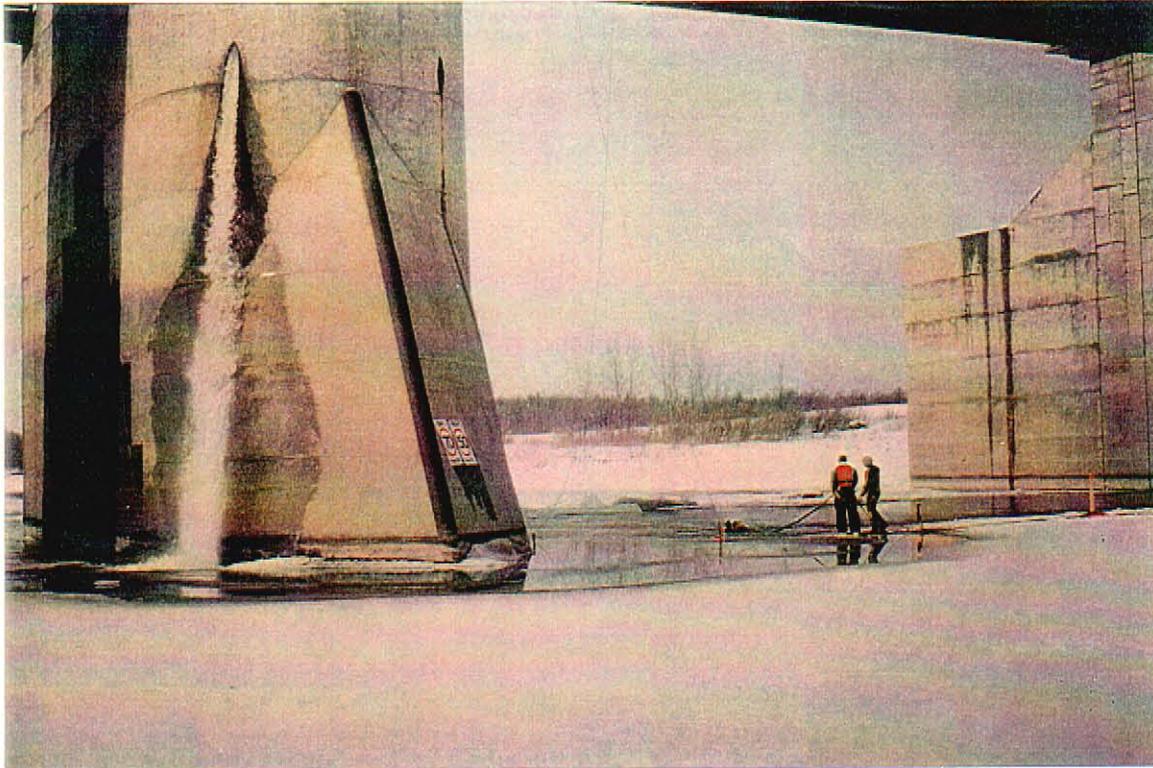


PHOTO 3: SEALING EAST GATE MARCH 11/96 - DEWATERING PUMP OPERATING



PHOTO 4: DIVERS SEALING EAST GATE MARCH 12/96

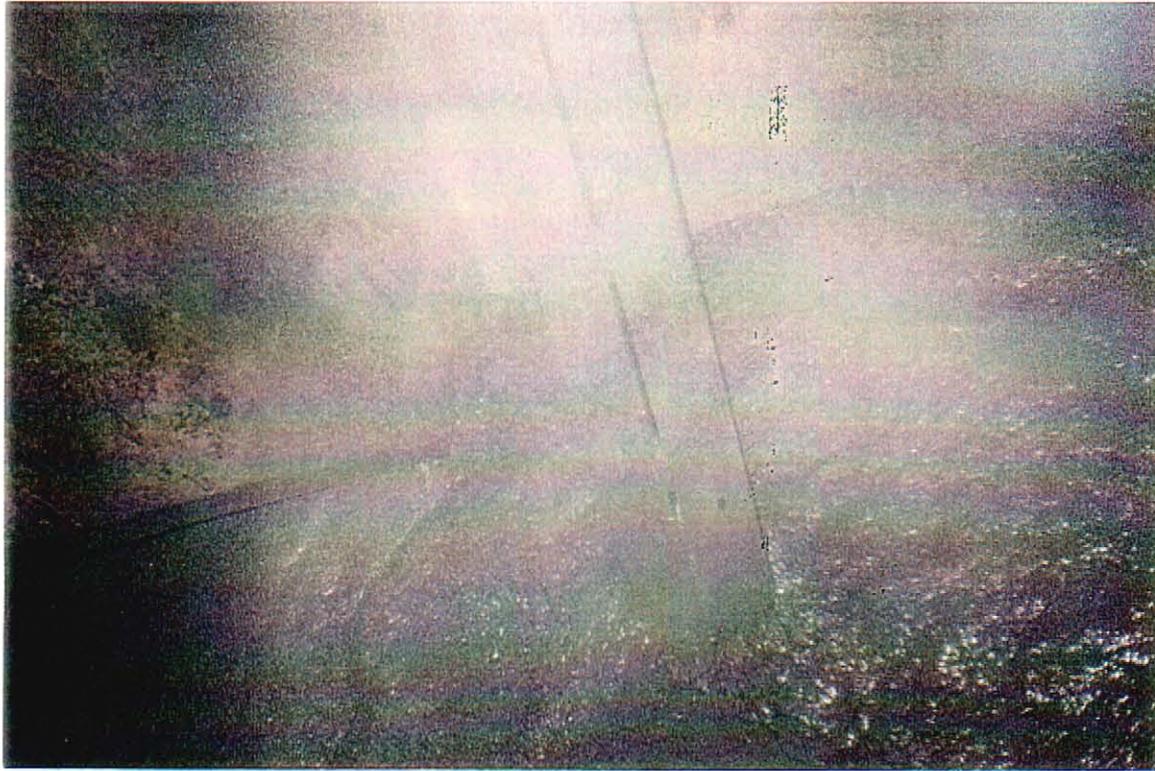


PHOTO 5: EAST END OF GATE, SILT ACCUMULATION 6 - 8 FT. DEEP

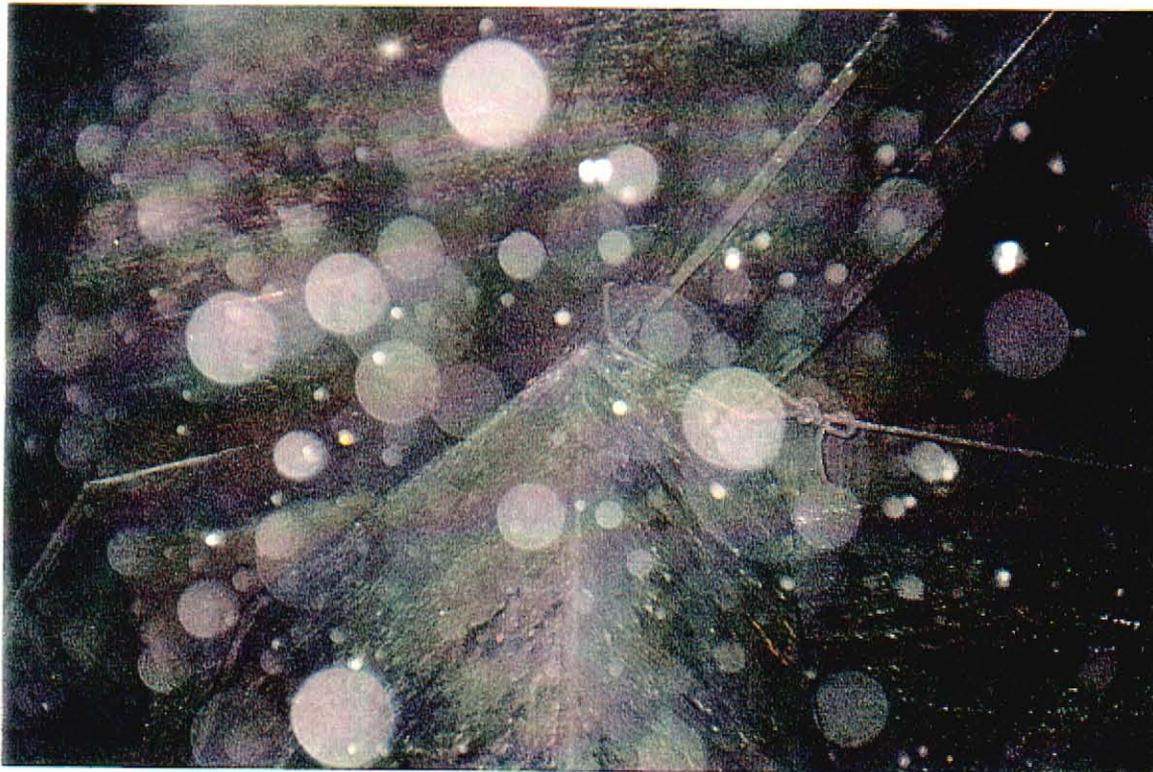


PHOTO 6: LINK MEMBER AT WEST END OF GATE, ACCESS ROPE ATTACHED



PHOTO 7: VIEW FROM WEST END OF GATE TO ACCESS LADDER  
(ACCESS ROPE AND FLOTATION INNERTUBE VISIBLE)

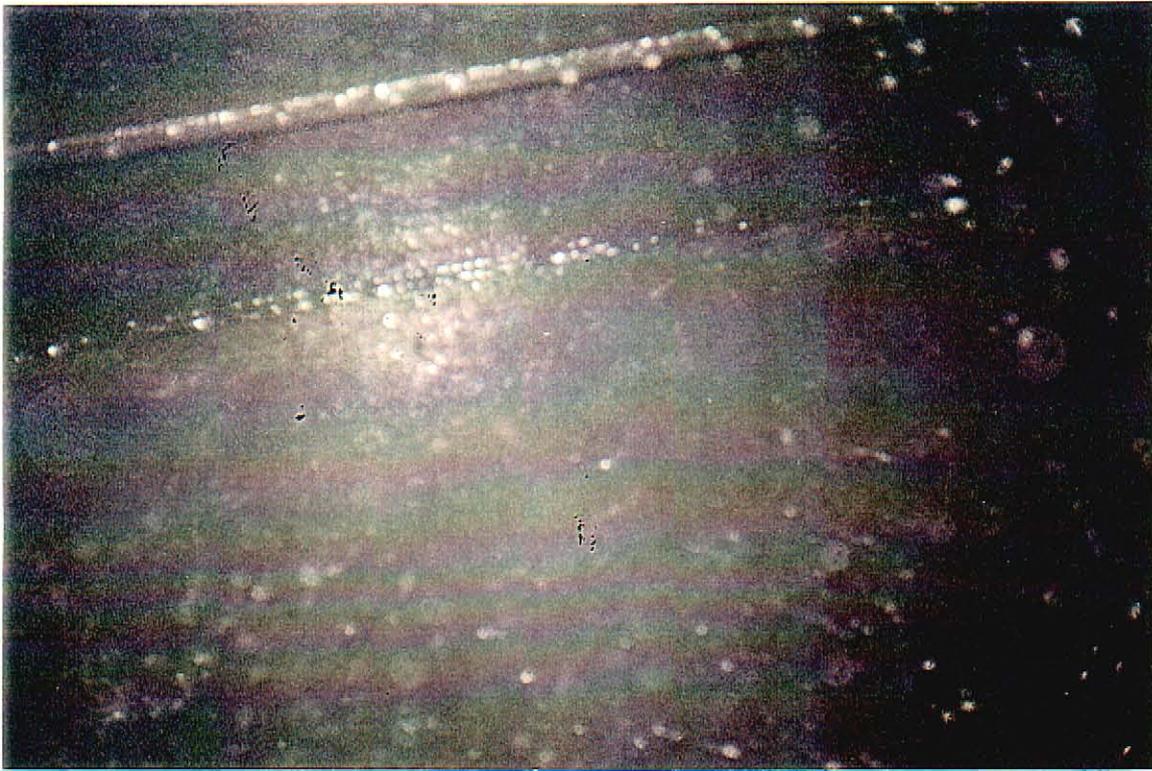


PHOTO 8: CLOSE-UP OF STEEL SURFACE IN WEB OF END TRUSS

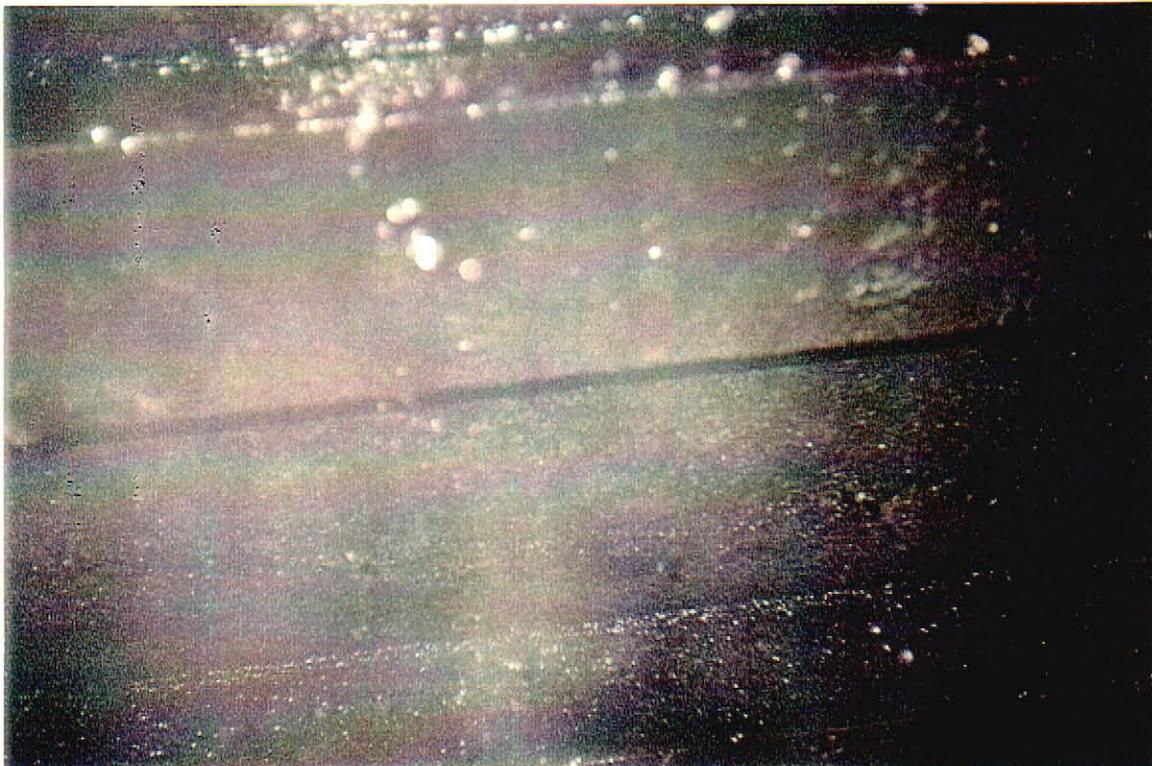


PHOTO 9: CLOSE UP OF RADIAL SKIN PLATE SURFACE

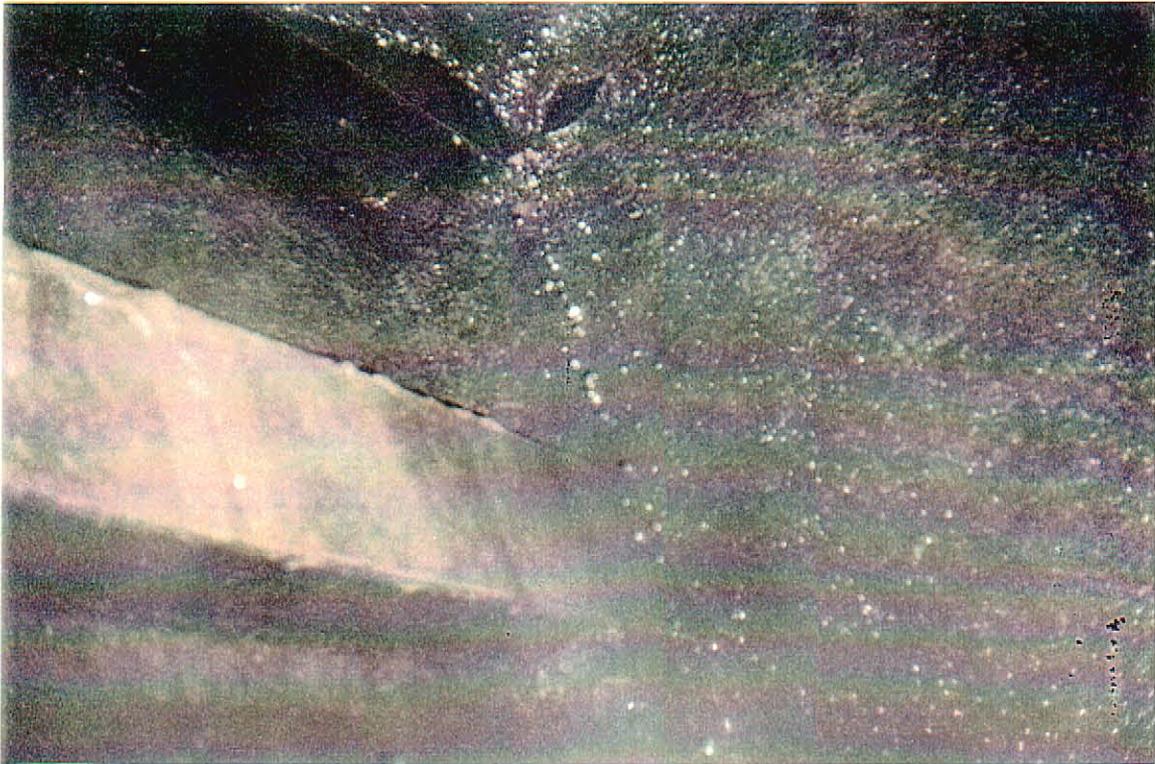


PHOTO 10: RADIAL SKIN PLATE CONNECTION TO TRUSS



PHOTO 11: STIFFENER PLATE CONNECTION



PHOTO 12: LINK MEMBER AT WEST END OF GATE

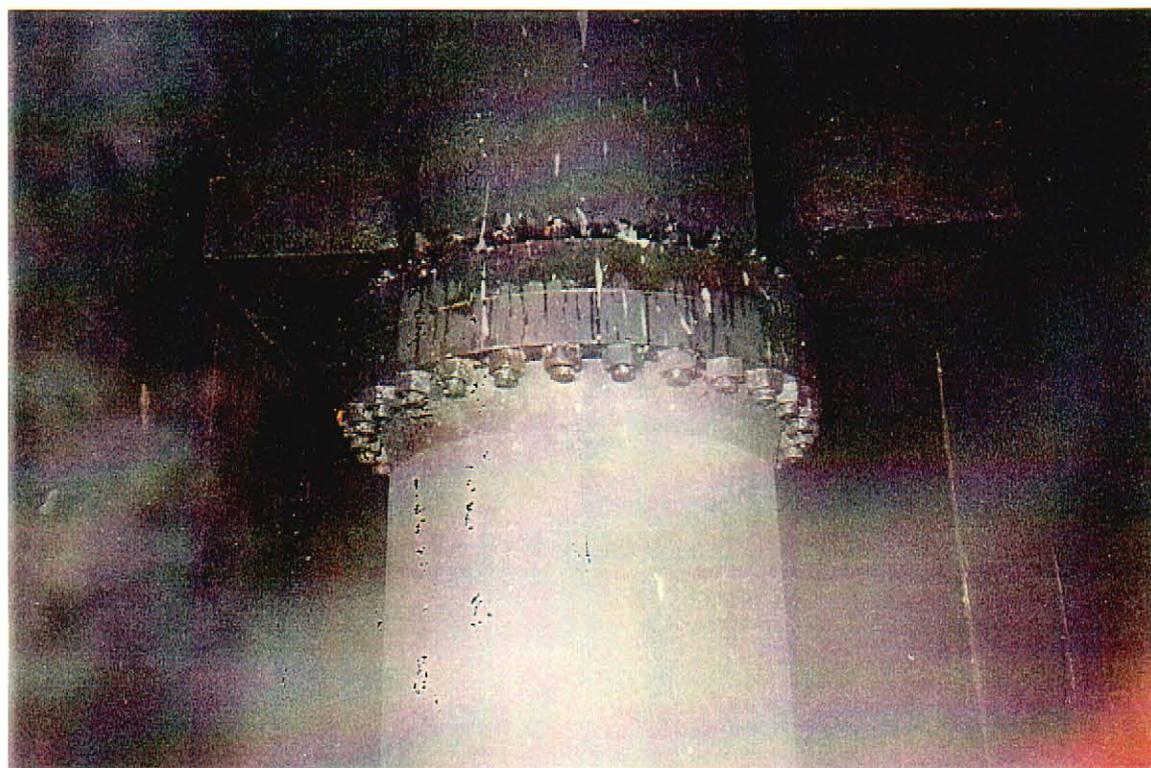


PHOTO 13: FLANGE CONNECTION ON WEST CYLINDER BARREL



PHOTO 14: EAST CYLINDER CROSSHEAD CONNECTION

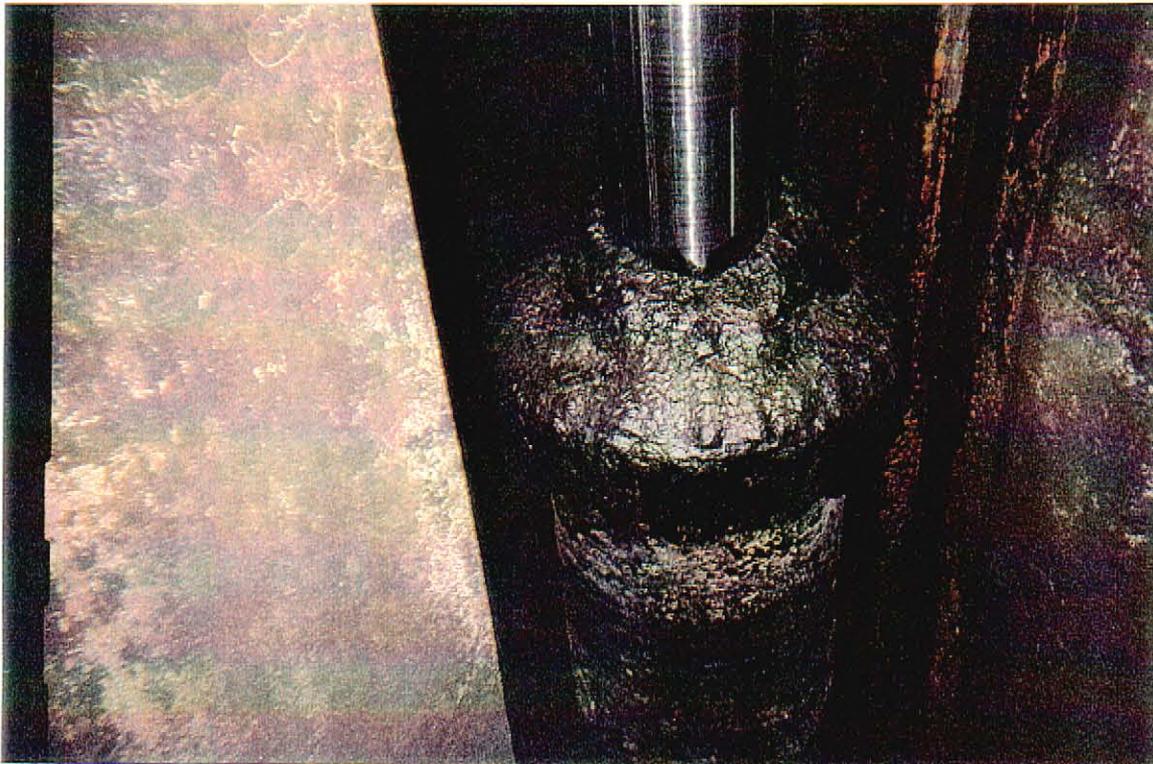


PHOTO 15: EAST CYLINDER GLAND AREA



PHOTO 16: WEST CYLINDER GLAND AREA

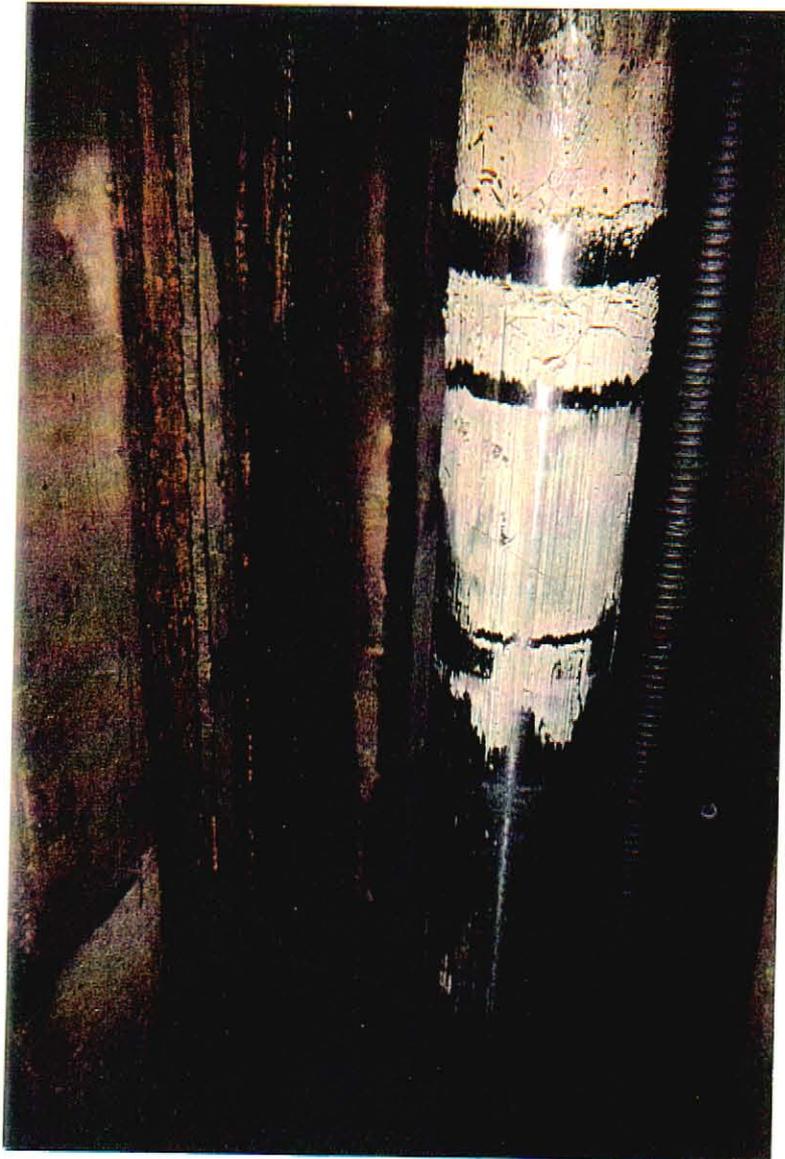


PHOTO 17: EAST CYLINDER PISTON ROD

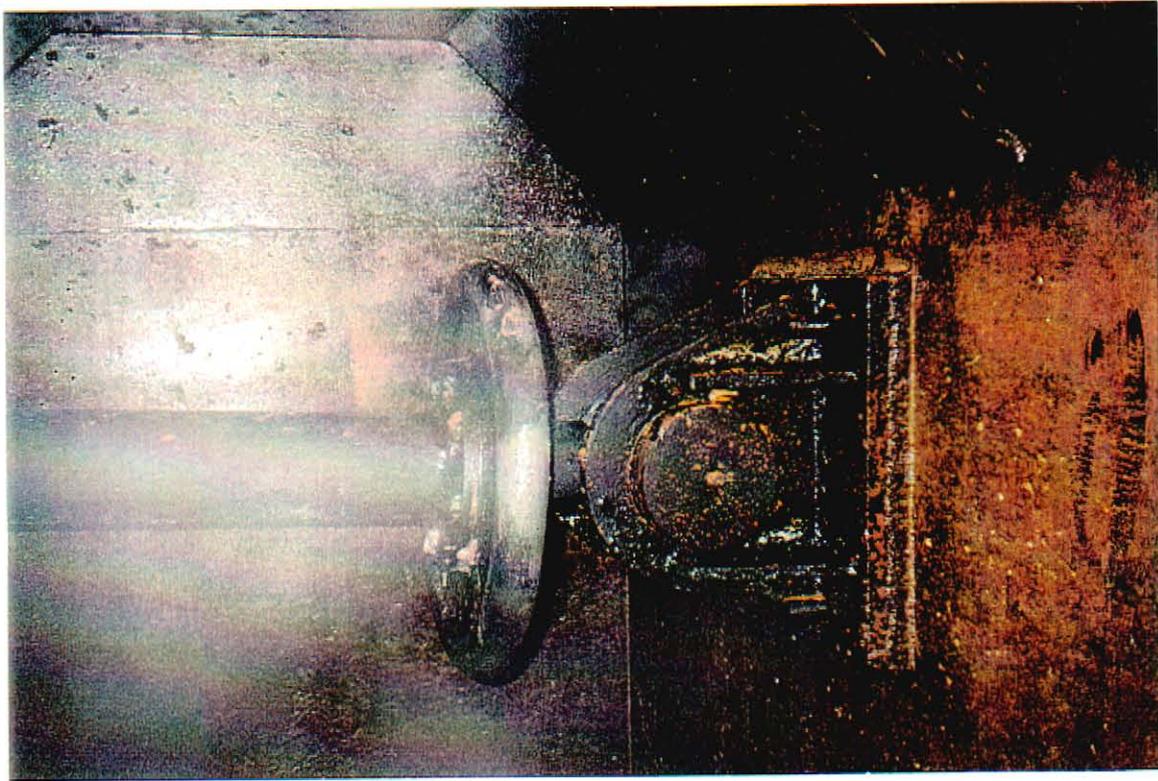


PHOTO 18: DOGGING DEVICE SCREW, WEST END

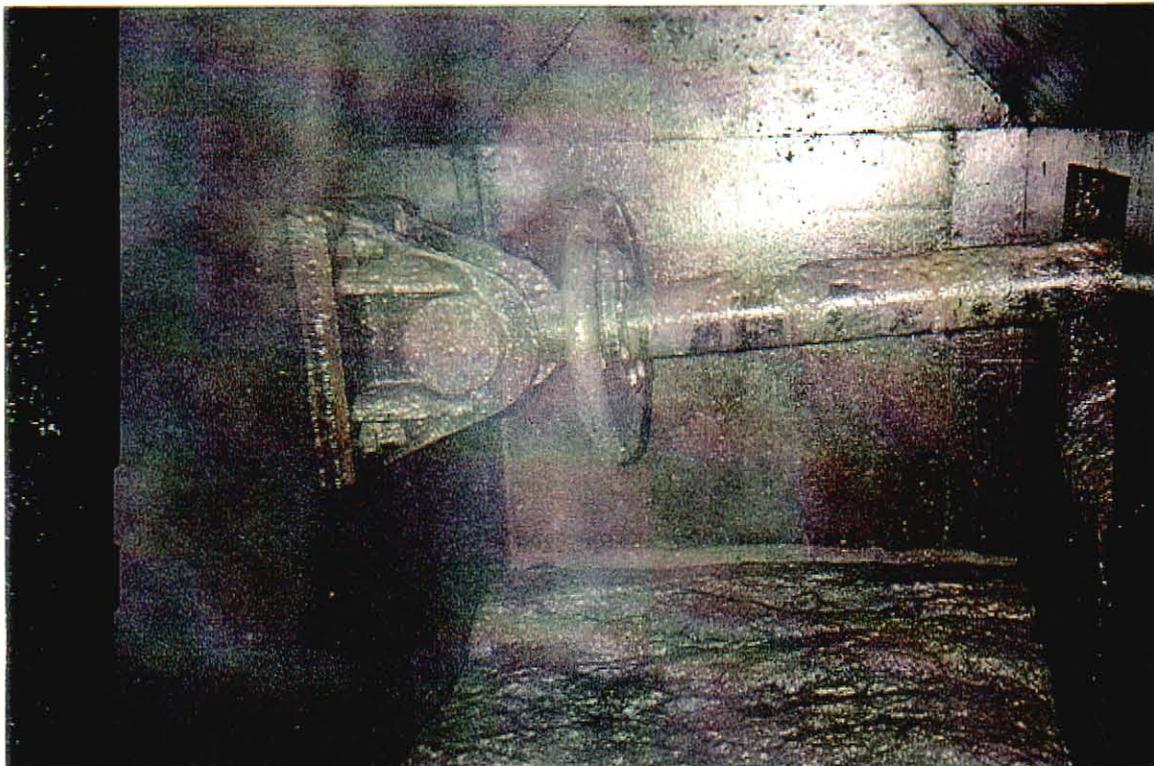
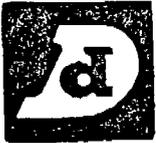


PHOTO 19: DOGGING DEVICE SCREW, EAST END

APPENDIX B DIVING INSPECTION REPORT

MAR 19 1996



# Dominion Divers Ltd.

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COMMERCIAL DIVING CONTRACTORS

David Macmillan  
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Winnipeg Manitoba  
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15-March-1996  
Re Floodway Inlet Diving Inspection

## 1.0 Objectives

Dominion Divers Ltd was contracted by KGS Group to seal the East Floodway gate at St Norbert, for de-watering by the Department of Natural Resources

## 2.0 Observations

### 2.1 Upstream seal

The upstream seal appeared complete and in good condition but showed early signs of degradation. The exposed edge is splitting and fraying along the entire length.

### 2.2 East J-seal

Complete and apparently in good condition. It is situated approximately one to two inches below the level of the gate. This space was filled with rocks, sand, sticks etc.

An eighth inch gap is present between the outer edge of the J-seal and the abutment wall. This gap continued as a crack in the concrete for approximately two feet upstream of the gate.

### 2.3 West J-seal

Complete and apparently in good condition, it is also situated between one and two inches below the gate. The space was also filled with rocks and other debris.

An eighth to three sixteenth inch gap was observed between the outer edge of the J-seal and the pier wall. This gap also extended upstream as a crack in the concrete for approximately one and a half feet.

- PIPE LINE INSTALLATIONS
- P E PIPE JOINING SERVICE
- SUPPLY CONCRETE PIPE WEIGHTS

- INSPECTIONS
- JARVEYS
- CUTY

- CUTTING
- WELDING
- DEMOLITION

## 2 4 Downstream seal

The rubber flap varied in condition from good to poor to missing in places. Past and recent closing of the gate on rocks and sticks and other debris tore the rubber in several places and bent the steel cover plate upwards.

A two inch diameter stick was caught under the gate and through the J-seal, approximately ten feet west of the center of the gate. A one and a half to two foot wide (of unknown length) piece of sheet metal is also caught under the gate and extends through the J-seal, near <sup>the</sup> pier. This is holding the gate up approximately three quarters of an inch, preventing a proper seal in that corner. The rubber flap is torn and about five feet of it is pulled into the gate.

There are two joints in the downstream steel support plate each containing eight bolt holes but no bolts. Water flow through the holes was significant.

## 2 5 Concrete

A two inch diameter hole was found ten inches upstream of the south-west corner, connected to the extending crack.

Under the downstream flap, behind the J-seal, the concrete is worn (eroded) somewhat, and spalled away in places.

## 3 0 Procedure

Dominion Divers Ltd arrived on site on March 4, and began by cutting holes, on the East side near the abutment. The ice thickness was found to be between one inch and three feet. The space below the ice and above the gate ranged between ten inches and two feet, with extremely fast water flowing through it. The water coursing through the cut hole caused it to accumulate on top of the ice and in turn caused the ice to sink, further narrowing the working space. Because of these compounding variables it was decided that work could not be safely be carried out.

The next five days were spent cutting ice and moving the iceflows downstream, to clear the worksite.

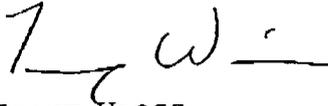
On March 9, we ran out of room to put the ice and it became too thick to cut near the pier (greater than four feet).

March 11 The dewatering pumps were started and we began clearing the rocks and debris from in and under the seals, and placing oakum. Two thirds of the downstream seal, the East J-seal, the entire upstream seal, and half of the West J-seal were completed. The pumps were left on and manned during the night.

March 12 We returned and completing sealing the gate with oakum and backer rod foam. The two inch hole near the pier and the sixteen bolt holes were also sealed as significant flow was evident. Dewatering continued at an accelerated rate.

March 14 Dominion Divers Ltd returned to replace some oakum which had sucked through, and the gate was completely dewatered.

Sincerely,



Terry Wiess  
Dominion Divers Ltd

APPENDIX C ACRES INTERNATIONAL REPORT, 1988

INVESTIGATION OF RED RIVER FLOODWAY  
INLET GATE SEALS  
AND CONCRETE DETERIORATION

ACRES INTERNATIONAL LIMITED  
WINNIPEG, MANITOBA

March 1988

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INVESTIGATION OF RED RIVER FLOODWAY INLET GATE SEALS  
AND CONCRETE DETERIORATION

1 0    INTRODUCTION

The Red River Floodway gates are of the submersible sector type with an upstream hinge. The gates are equipped with seals which permit dewatering of the gate recess for inspection of the underside of the gate, greasing of the trunnions and desilting of the gate well and access gallery. The downstream seals also maintain headwater pressure beneath the gate to reduce the hoisting force required during operation.

The time required to dewater the gates has gradually increased from about two days in 1970 to about a week in 1979, the last year that the gates were dewatered. It has subsequently become impossible to dewater the gates by the normal dewatering procedure.

In early December 1986, the Department of Natural Resources authorized Acres to carry out an investigation of the gate dewatering problems and the concrete erosion downstream of the gates in accordance with the scope outlined in Acres proposal dated September 18, 1986.

The initial field inspection of the east gate commenced December 10, 1986 and was completed as far as possible January 15, 1987 at which time cold weather prevented further effective use of the divers. An interim report was issued in February 1987. The gates were subsequently raised above water level and inspected in October of 1987 when the water level was about 5.8 feet above the gate. The west gate was then dewatered. Marine Diving Services Ltd. carried out the underwater work and provided assistance to

provided assistance to the Department of Natural Resources for dewatering the gates and in attempting to desilt the east gate. The results of the underwater inspection of the east gate are outlined in a report dated January 29, 1987 (See Appendix A)

In November 1988 the river level was abnormally low and it was possible to almost completely dewater the area just downstream of each gate by raising it about 2 feet. The areas downstream of both gates were dewatered one at a time in this way and inspected.

The results of Acres investigation and alternative remedial measures are outlined below.

## 2 0 FIELD INSPECTION

### 2 1 Dewatering Pump Tests

Following an initial visit to the inlet structure on December 10, 1986, operation of the dewatering pump in the centre pier was checked by measuring the change in water level in the sump over a fixed time interval. The tests indicated that the pump performance was reasonably close to the manufacturer's rating curves. Inflow to the sump was also checked by emptying the sump and opening the inlet valve from each of the gates. The rate of inflow indicated that the inlet lines were not blocked.

It was therefore confirmed that the dewatering difficulty was due to excessive leakage into the gate chambers rather than problems with the pumps.

## 2 2 Gate Dewatering Tests and Underwater Inspection

### 2 2 1 Initial Tests

Attempts were made to dewater both the east and west gates in December 1986. During these attempts the river level was about elevation 731 which is three feet over the top of the gate in the lowered position. It was not possible to lower the water level in the cylinder shafts by more than about 1.5 feet for either gate.

During the period when the pump was operating it was observed that some leakage was occurring past the bulkhead gates which are used to seal the conduits supplying head-water pressure to the underside of the gates. The inlets to the conduits were then sealed with wooden bulkheads since the gates could not be sealed with cinders etc. due to the ice present in the inlet. A subsequent attempt to dewater the east gate only produced about a six inch drop in water level in the cylinder shaft. It was therefore confirmed that the leakage was occurring at the main gate seals.

*Send  
bulkhead*

### 2 2 2 Underwater Inspection of East Gate

Marine Diving Services divers carried out an underwater inspection of the east gate seals from the top of the gate in December 1986. The results of this inspection were as follows:

- The upstream flap seal was in good condition with no signs of damage.
- The side seals did not appear to be damaged and appeared to be tight against the pier liners. However, there was

a considerable number of stones, pieces of steel and other debris lodged on top of the seals. The gap between the top skinplate and the piers was 1 to 1 1/2 inches. This is at the upper limit of the gap expected as a result of tolerances on the fabrication and installation of the gate and pier liner plates.

- A flap seal consisting of conveyor belting clamped to the downstream edge of the top skinplate and projecting over the downstream embedded parts has been added to the east gate since its installation. The belting was found to be damaged in some areas, particularly near the west side where the clamp plate is deformed and a length of seal is missing. The seal was not in contact with the embedded parts in several locations due to the presence of gravel or buckling of the seal.
  
- The east gate was raised about 15 feet to permit inspection of the stationary downstream J seals which are mounted on the embedded parts. The inspection indicated the presence of gravel above the seal and a section of seal near the west side was missing. A metal post had apparently been jammed between the gate and embedded parts in this area some time ago. The embedded plate above the downstream seal was bent downwards in several locations. Sixteen bolts were missing from the top of the embedded plate. Apparently about 80 of these bolts had been replaced previously.

Unfortunately the underwater inspection was hampered by the current, failure of the underwater camera, ice which prevented the gate from being raised to better observe the side seals and downstream seal, and by cold weather. As a

result, no information was obtained for the west gate seals and the information on the condition of the east gate seals was too limited to be conclusive

### 2 2 3 Dewatering of East Gate

Following the underwater inspection in late 1986, the downstream seals on the east gate were sealed with oakum while the dewatering pump was operating. Since this did not reduce leakage sufficiently to dewater the gate, oakum was then placed in the side seals. Significant leakage was observed at the side seals while placing the oakum. This gate was then dewatered successfully although some difficulties were experienced due to blockage of the sump inlet pipe. Irregular pieces of foam insulation which had broken free from the underside of the top skinplate appeared to be the main source of blockage.

Inspection of the dewatered gate indicated the following

- ✓ - Leakage through the upstream seal was not excessive
- ✓ - There was significant leakage at the upstream corners of the gate
- No damage was visible on the bottom element of the side seals but visibility was very poor *N/A*
- Silt had accumulated to a depth of about 2 - 4 feet in the gate well and access gallery below the gate. At the time of the inspection, the silt was below the level of the pedestals which support the gate in the lowered position and did not interfere with operation of the gate.

*5-6*  
*Above*

- EMERGENCY  
SKIN PLATE*
- Silt had accumulated to a depth of about 7 inches between the stiffeners on the inside of the gate. This occurred on the lower 10 to 12 feet of the downstream skinplate. The submerged weight of this silt is about 5 percent of the hoist capacity.
  - The 1 1/2 inch galvanized steel nipples between the brass nozzle and the iron elbow in the desilting nozzle pipes were very badly corroded. These were replaced by brass nipples.
  - A very limited examination indicated that the paint on the inside of the gate is in good condition.
  - The foam insulation on the under side of the top skinplate is falling off in some areas. The loose pieces of insulation resulted in blockage of the sump inlet line. ~~A large box shaped inlet screen was subsequently installed over the east sump inlet line.~~

The Department of Natural Resources attempted to desilt the access gallery with the aid of the divers. However, it was not practical to complete this operation due to freezing of the desilting lines and difficulties with alternate pumping arrangements. An attempt was made to grease the gate trunnion bushings but this was not successful due to difficulties in locating the grease fittings which are of the Alemite button head type.

#### 2 2 4 Dewatering of West Gate

In October 1987, an attempt was made to dewater the west

gate after it had been raised above the water for inspection of the side seals. The river level at that time was about 5.8 feet above the top of the gate.

Initially, the downstream seal was caulked with oakum, but this did not reduce leakage into the gate sufficiently to dewater the gate. The side seals were then caulked, but leakage was still found to be excessive. The seals were then recaulked and the gate was dewatered without difficulty.

Inspection of the dewatered gate indicated conditions similar to those observed in the east gate except that the silt buildup was somewhat higher. The silt was within 1 foot of the top of the intermediate gate support pedestals and was over the top of the smaller pedestals at the west end of the gate. However, this did not appear to have interfered with proper closure of the gate which had been raised just prior to dewatering. The silt was generally quite fluid and would not support the weight of a person.

*OK*  
*FOR EAST*

It was not possible to inspect the condition of the desilting nozzles which were covered in silt. A screen was installed over the sump inlet pipe.

#### 2.2.5 Visual Inspection of Gates and Seals

On October 19, 1987 each gate was raised about 5 feet above the water surface which was about elevation 733.8, (i.e. about 5.8 feet over the top of the gate when it is in the

lowered position) The downstream sealing surface and the exposed portion of the side seals were inspected

In November 1987 the water level at the inlet structure had fallen to a level only about 1 foot over the top of the gates. Each gate was raised about 2 feet and the area downstream of the gates, which was almost totally dewatered, was examined. (See attached photographs)

The results of the inspections are as follows

- The steel sealing surface on the downstream face of the gate was coated with silt and there was gravel adhering to the surface. The surface was cleaned with a wire brush and found to be in good condition.
- The side seals generally appeared to be in good condition except at the downstream corners where there was some wear. Gravel was wedged between the seals and the liner plates on the piers. This prevented complete contact between the seals and the liner plate.
- The steel liner plates on the piers were generally in good condition although there was some spalling of grout around the edges of the plates.

#### 2 2 6 Inspection of Concrete Downstream of Gates

Deterioration of the concrete downstream of the east gate had been observed previously during low flow conditions

Prior to this investigation, the last inspection of the damage was in 1980/81

The following inspections were carried out in conjunction with the present investigation

- A survey of the concrete downstream of the gates was carried out by the divers in the winter of 1986/1987. The results of this inspection are summarized in the attached report
- An underwater inspection of the flip bucket was conducted in October 1987
- The area downstream of the gates was inspected while dewatered in November 1987

The results of these inspections indicate that the extent of damage to the concrete has not progressed seriously since 1981. The damage is in the form of erosion of the concrete. It is generally most severe just downstream of the embedded steel member which holds the downstream J seal and generally tapers out to an insignificant amount a few feet downstream of the seal.

The depth of erosion and the downstream limits of appreciable damage are shown on the attached Figures 1 and 2. The damage is generally concentrated in a few areas with a maximum depth of erosion of about 5 inches. The top of the anchor bolts which hold the embedded parts for the seals are exposed in two locations.

The erosion generally did not extend into the second stage concrete beneath the embedded steel support member for the

downstream J-seals. However, on the west gate this second stage concrete was eroded up to 1 inch beneath the embedded steel in a few areas. In one area, a gap which was about 1 inch high by 5 to 6 inches long extended several inches underneath the embedded steel. It is possible that this void was created during placement of the second stage concrete.

It is believed that erosion of the concrete is the result of recirculation of debris when the gates are raised. This is confirmed by the fact that rocks and other debris were found in many of the areas which were most severely eroded.

The inspection of the flip bucket and downstream lip of the structure did not indicate any significant damage to the concrete. However, visibility was very limited and there was a considerable buildup of debris in the flip bucket which prevented inspection of some areas. The level of riprap downstream of the structure varied from more than 6 feet to less than 1 foot below the top of the concrete.

#### 2 2 7 Inspection of Bulkhead Gates

The east bulkhead gate was raised clear of the guides for an inspection of the seals. The seals are in good condition and show no signs of wear. It was not possible to raise the west bulkhead gate clear of the guides since the hinges on the gate shaft covers were seized.

3 0     DISCUSSION

Based on the results of the investigation, the following observations can be made

- (1) The dewatering pump is functioning properly. Inlet screens have been installed over the sump inlet line from both gates to prevent blockage of the line by debris.
- (2) The bulkhead gates appear to be sealing adequately. The seals on the east bulkhead gate were inspected and found to be in good condition.
- (3) The downstream seal on the east gate is missing for a distance of about 20 feet from the centre pier. This damage is probably due to debris which has become jammed in the seals.

Although no significant damage was observed on the side seals, they were a major source of leakage. The leakage may be partially due to mechanical damage and wear at the corners, but the main cause for the leakage appears to be gravel which is jammed between the seal and the liner plates on the piers.

It would appear that both the side seals and the downstream seal would need to be replaced if dewatering is to be accomplished without the aid of divers.

Partial replacement of the downstream seal on the east gate and adjustment of the other seals would be an option. However the cost savings relative to complete replacement would not be large and the benefit is questionable.

Partial replacement of the side seals is not practical since each seal is mounted on a full length member. A full upstream cofferdam would be required if the side seals are either replaced or readjusted since the gate must be lowered to remove the upstream corner and to properly align the seals.

- (4) The upstream seals on the gates appear to be in reasonably good condition at the present time. However, the seal material is a duck reinforced rubber which can be expected to deteriorate over time when exposed to water. Therefore it would be advisable to replace the upstream seal with synthetic reinforced belting if the side seals are to be replaced since the incremental cost would be relatively small.
- (5) The present condition of the seals does not represent a threat to operation of the gates although the increased leakage through the damaged downstream seal will result in more rapid buildup of silt beneath the east gate when it is raised.

Total loss of the downstream seal would result in an unacceptable reduction in pressure beneath the gate during operation. Based on the present information, sudden, total loss of the downstream seal is considered to be highly unlikely since the damage to date appears to have been caused by debris jamming between the gate and the embedded parts. This type of damage can be expected to occur infrequently and to result in fairly local damage. It should be noted that new seals may not be significantly more resistant to this type of mechanical damage than the existing seals.

- (6) The gates can be successfully dewatered in their present condition if divers are used to caulk the downstream and side

seals with oakum. This method can be used successfully for a water level up to 6 feet over the top of the gate. This is the maximum head for which the gate is designed to be de-watered.

In some areas where the seals are missing, caulking with oakum alone should not be relied upon since there would be a risk of sudden failure of the caulking. These areas should either be sealed with sandbags or by using pipe, etc. to reduce the gap and then caulking with oakum.

- (7) The silt on the gates and in the gate wells and access gallery does not represent an immediate threat to gate operation but should be removed as soon as practical since significant additional silt may accumulate if the gates are operated for an extended period of time.
- (8) Greasing of the trunnion bearings is not essential since they are of the self-lubricating type. However, greasing on a regular basis does flush foreign material from the bearings and should extend the bearing life. Therefore the trunnions should be greased as soon as practical since they have not been greased for about 8 years.
- (9) The concrete damage downstream of the gate is most probably the result of erosion from recirculated debris when the gates are operated during floods. The erosion has not progressed to any great extent since 1981. The damage is not presently a threat to operation of the gate, but passage of successive significant floods could result in further erosion which would threaten support of the embedded steel member in some areas. This could result in reduction of pressure beneath the gate and overloading of the gate and hoist. The risk of

jamming the gate in a partially open position also exists. The continuing loss of bolts in the embedded J-seal support member due to vibration is indicative of the forces occurring in this area under some operating conditions.

The concrete should be repaired in the near future. The proposed repair procedure would involve installing cofferdams to dewater the affected area. Concrete in the damaged areas would then be removed to a depth of about 4 inches and the surface would be treated with a bonding agent. High strength concrete would be placed and suitably compacted.

The proposed repair should provide considerably more durability than the original construction.

- (10) Missing bolts in the embedded J-seal support member should be replaced.

#### 4 0 ALTERNATIVE REPAIRS

##### 4 1 General

Costs estimates for alternative repair programs have been developed. It has been assumed that the Department of Natural Resources would be responsible for dewatering the cofferdammed area, desilting the gates, greasing the trunnions and all gate inspection and maintenance other than replacing the seals. It has also been assumed that the existing dewatering pump would be operated to handle leakage during the work.

The cofferdam costs for Alternatives 1 and 2 are based on commencing work in August. This requires a cofferdam height of about 8 feet including freeboard of 1 foot. At this stage it is considered that the cofferdams would either be of wood anchored into the concrete or large sand filled bags. Either alternative would

leave about 7 feet of clear space downstream of the gates for the concrete repairs

#### 4.2 Alternative 1

This alternative involves repair of the concrete and the seals to permit future dewatering of the gate without the aid of divers. It requires full upstream and downstream cofferdams and includes the following work:

- Repair damaged concrete as described above and shown on the attached drawing
- Replace all seals, replace missing bolts and repair damaged embedded parts. The seals would be aligned to the sealing faces with the gate in the closed position.
- Replace nipples on desilting nozzles for west gate.

The estimated cost for this work assuming an outside contractor is used and excluding work done by the Department's staff is:

Mobilization and demobilization	\$ 7,000
Supply and install cofferdams	90,000
Repair concrete	50,000
Supply and install seals	105,000
Miscellaneous repairs	1,000
Engineering and site inspection	<u>25,000</u>
Subtotal	\$278,000
Contingency - 15 percent	<u>42,000</u>
TOTAL	\$320,000

Site work could commence mid-August barring unusually high flows and should be completed on both gates by the end of November at the latest. During the period when the cofferdams are in place in one bay, the upstream water level would be increased by about 4 inches during periods of relatively high flow (5000 cfs).

Alternatively, the work could commence in late October after river levels have been lowered. However, the possible savings in cofferdam costs would be offset by the added cost of winter work.

All seals require access from both above and below the gate to remove the seal mounting members complete with seals. The upstream and side seal members can be removed with the gate in any position, but the gate must be raised to provide access to the lower row of bolts in the downstream seal support member. The upstream and downstream members can be removed in sections. The side seal mounting member is in one length making removal from the gate recess difficult. All the seal members are fastened with stainless steel bolts. A few seal welds must be broken to remove the members.

The side seals must be realigned with the gate in the closed position. The gate must also be closed to accurately establish the required alignment of the downstream seal although the seal would actually be installed with the gate fully raised.

The cost of this alternative would be reduced somewhat if the side seals were only readjusted rather than replaced. However, this would be less effective than replacing the seals.

It should be noted that replacement seals cannot be expected to provide any longer service than the original seals.

4 3 Alternative 2

This alternative would involve repair of the concrete, replacement of missing bolts in the embedded downstream seal support and repair of the desilting nozzles. The gates would be utilized as an upstream cofferdam and therefore it would only be necessary to install a downstream cofferdam.

The estimated costs for this alternative would be as follows:

Mobilization	\$ 5,000
Supply and install cofferdam and seal gates	50,000
Repair concrete	50,000
Miscellaneous	1,000
Engineering and site inspection	<u>17,000</u>
Subtotal	\$123,000
Contingency	<u>19,000</u>
TOTAL	\$142,000

If work commenced in mid-August, it should be completed by the end of October. During this period, upstream water levels would be affected as discussed above.

Since sealing of the gate would not be improved with this alternative, divers would be required to dewater the gate for future maintenance. It has been established that this can be done by caulking the seals with oakum while the dewatering pump is operating. The cost of sealing the gates should not exceed \$6,000 for each operation and may well be less. Use of this dewatering procedure would permit deferral of the additional expenditure required to replace the seals as long as the downstream seals are

sufficiently intact so as not to adversely affect gate operation

The downstream seals could also be repaired as part of Alternative 2. However, it would be difficult to ensure proper alignment of the seals since the gate could not be lowered in the dry to accurately establish the position of the seal bar on the gate. In any case, replacement of only the downstream seal would be of little benefit unless damage to this seal is so severe that operation of the gate is threatened. This is not the case at the present time.

The side seals could be totally replaced by installing upstream cofferdams at each upstream corner. However, these cofferdams would need to be about 20 feet long in order to permit the upstream seal cover plate to be removed as required to replace the complete side seal. Further, it would not be possible to adequately align the side seal since the gate could not be closed.

Based on the above considerations, it was concluded that a fully satisfactory job of replacing the seals to preclude the need for divers in future can only be achieved by installing full upstream and downstream cofferdams.

#### 4.4 Alternative 3

A third alternative which could be considered would be to carry out all necessary design and preparations for repair of the concrete and desilting nozzles and for replacement of missing bolts in the embedded steel seal support, but defer repairs until such time as extreme low flow conditions occur in late fall or winter. This would permit use of the gate and a low downstream cofferdam to dewater the area downstream of the gates. Cofferdam costs

would be reduced relative to the first 2 alternatives. However, these savings would be offset to some degree by the cost of hoarding and heating.

The estimated costs for this alternative would be as follows:

Mobilization	\$ 5,000
Supply and install nominal downstream cofferdam (sandbags), seal gates and provide heating and hoarding	20,000
Repair concrete	50,000
Miscellaneous	1,000
Engineering & site inspection	<u>9,000</u>
Subtotal	85,000
Contingency	<u>13,000</u>
TOTAL	98,000

It is estimated that the work for each gate would require approximately 2 to 3 weeks.

If this option is adopted, the concrete should be inspected each year following the passage of floods to ensure that damage has not progressed to a stage where immediate repairs are required.

#### 5.0 RECOMMENDATIONS

Based on investigation of the gate seals and damage to the concrete downstream of the gates, it is recommended that the following maintenance be done:

- 1 Eroded areas of concrete downstream of the gates should be repaired in the near future. Details of the recommended repairs are shown on Drawing No 6468-A0-0201. These repairs could be carried out most economically during a period of low water levels in the fall or early winter as outlined in Alternative 3. The estimated cost of repairs based on Alternative 3 is \$98,000.

Up until the repairs are carried out, the concrete should be inspected annually.

- 2 At the present time, dewatering of the gates with the aid of divers is a very cost-effective alternative to replacement of the seals and is therefore the recommended alternative. However, the condition of the downstream seals should be checked annually since loss of a major portion of this seal would affect gate operation. Inspection of the seals can be done by the divers in conjunction with dewatering of the gates.
- 3 The silt in the gate wells and access gallery should be removed as soon as practical this year and at regular intervals thereafter. The trunnion bearings should be greased and the corroded nipples on the desilting nozzles should be replaced after desilting. The trunnion bearings should be greased on a regular basis in future to flush the bearings.
- 4 The missing bolts in the embedded steel supports for the downstream J-seal should be replaced in conjunction with the above work.

When the gate is dewatered, it is recommended that the following items be inspected

- Overall condition of the gates and embedded parts
- The condition of the paint on the gates
- The condition of the supplementary anchors added to the trunnions on the west gate

APPENDIX A

JSH *Marine Diving Services Ltd.*  
UNDERWATER CONTRACTORS

RECEIVED

FEB 20 1987

January 21, 1987.

WINNIPEG  MANITOBA

Mr. Alex D. Gerrard, P. Eng  
Staff Engineer, Mechanical  
Acres International Limited  
6th Floor - 500 Portage Avenue  
Winnipeg, Manitoba.  
R3C 3A8

Dear Mr. Gerrard

RE: FLOODWAY SITE STALL C  
(ENCLOSURE IS THE CORRECTED REPORT)

Enclosed please find a report on the procedures used for inspection and related work at the floodway site.

If you have any further questions please do not hesitate to contact me.

kindest regards,

ours sincerely,

*S. Algran*

James S. Algran  
President, Marine Diving Services

JSr/1



JSH *Marine Diving Services Ltd.*  
UNDERWATER CONTRACTORS

Report on Gate Sealing Process and Related Work on Floodway Intake Gates  
FOR  
Department of Natural Resources  
AT  
St. Robert Intake Structure



JSH *Marine Diving Services Ltd.*

UNDERWATER CONTRACTORS

. / 2

Marine Diving Services Ltd. was called to do an inspection of gate seals on floodway gates at the St. Norbert Intake Structure. The following procedures were followed

DECEMBER 16 - Set up

17 - East Gate Inspection

- East side gate seal had an average of  $\frac{1}{2}$  to  $1\frac{1}{2}$  gravel all along seal, and appeared to be in good shape
- Downstream seal had gravel same size under rubber flap and over plate
- The cover plate was bent 8 to 10" long, 15' from west side

18 - Inspection of upstream seal showed small amount of fine gravel under flap and did not appear to be leaking

- West side seal has half the amount of gravel as compared to east seal. Approximately the last 12' of the downstream seal is missing altogether
- Approximately 16 bolts were missing along the downstream cover plate
- Started installing oakum in downstream seal

19 - Completed installing oakum in downstream seal. A drop in water elevation in pit was evident.

22 - A 4' x 8' bulkhead was made and installed over the intake gate opening (east side) to stop leakage. The downstream seal was checked again, as well as the side seals. The side seals now showed definite signs of leakage, oakum was installed on both sides. Two pieces of steel, one bolt and spark plug were removed from seal slots. By 5:00 p.m. water level was down in pit to 720.4.

23 - Ice was removed for placement of intake bulkhead on the east gate. East side ice was 10" thick.

- Ice in waterline ditch was cleared in centre pier. A heavy build up of mud was removed from the curb area

- Effort was made to gain entrance to gate pit, but mud and water level was about 8'



- JANUARY 7 - The first desilting nozzle was removed and capped. The second nozzle was removed and a quick coupler and nose installed
- 8 - One man was supplied to check de-watering valve, inside pit (clear). Checked silt in gate pit, (4') and possibility of capping remaining in downstream nozzles.
- 9 - The remaining 12 nozzles on downstream side were capped. No water was available for jetting due to freezing condition of pipes. Water would still not draw down in pit. De-watering gate valve has a flapper valve and this was removed water level dropped to knee level. At this particular time an attempt was made to get at upstream desilting nozzle, attempt was unsuccessful.
- 12 - Jet pump was set up on ice and jetting inside pit started
- 13 - Jetting in pit was discontinued to allow for flooding procedure
- 14 & 15 - Oakum was removed from east gate and measurements taken of spalded areas on both east and west gates (see following pages)

REPORT Gate Sealing Process  
Department of Natural Resources  
January 29, 1987  
Page 3

EAST GATE MEASUREMENTS OF SEALED AREA  
DOWNSTREAM OF GATE

EAST TO WEST

A = Water Level = 2.68'

	<u>DEPTH</u>	<u>LENGTH</u>
10'	2.74	2'
20'	2.92	4.5'
30'	2.8	3.4'
40'	2.7	1'
50'	2.68	0'
60'	2.98	3'
70'	2.88	5.8'
80'	2.76	2.8'
90'	2.72	1.0'
100'	2.72	5.2'

COMMENTS

- a) 61' from east wall exposed rebar 2"
- b) 65' from east wall exposed rebar 3"

REPORT Gate Sealing Process  
 Department of Natural Resources  
 January 29, 1987.  
 Page 4

WEST GATE MEASUREMENTS OF SPALDED AREAS

DOWNSTREAM OF GATE EAST TO WEST

Water Level 2.68'

	<u>DEPTH</u>	<u>LENGTH</u>
10'	2.74'	2.0'
20'	2.92'	4.5'
20'	2.8'	3.4'
40'	2.7'	1.0'
50'	2.68'	0.00'
60'	2.98'	3.0'
70'	2.88'	5.8'
80'	2.76'	2.8'
90'	2.72'	1.8'
100'	2.72'	5.2'

COINTEGRATIONS East to West

- a) 7' hole .25' deep 4" wide 1.5' long
- b) 70' hole .25' deep 4" wide 1.5' long
- c) 81' hole .25' deep 4" wide 1.5' long

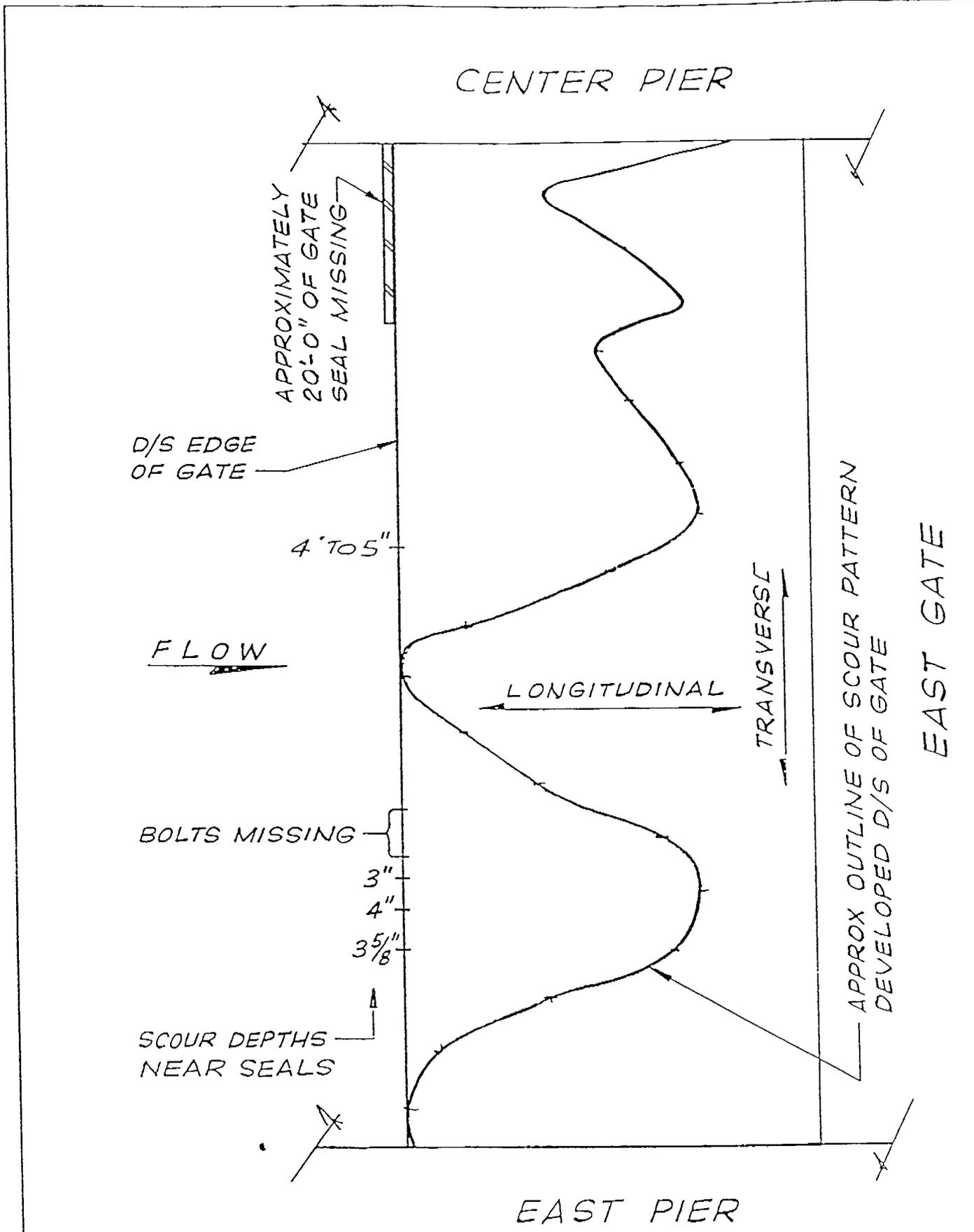
If you have any further questions to the above please do not hesitate to contact me.

Yours sincerely,



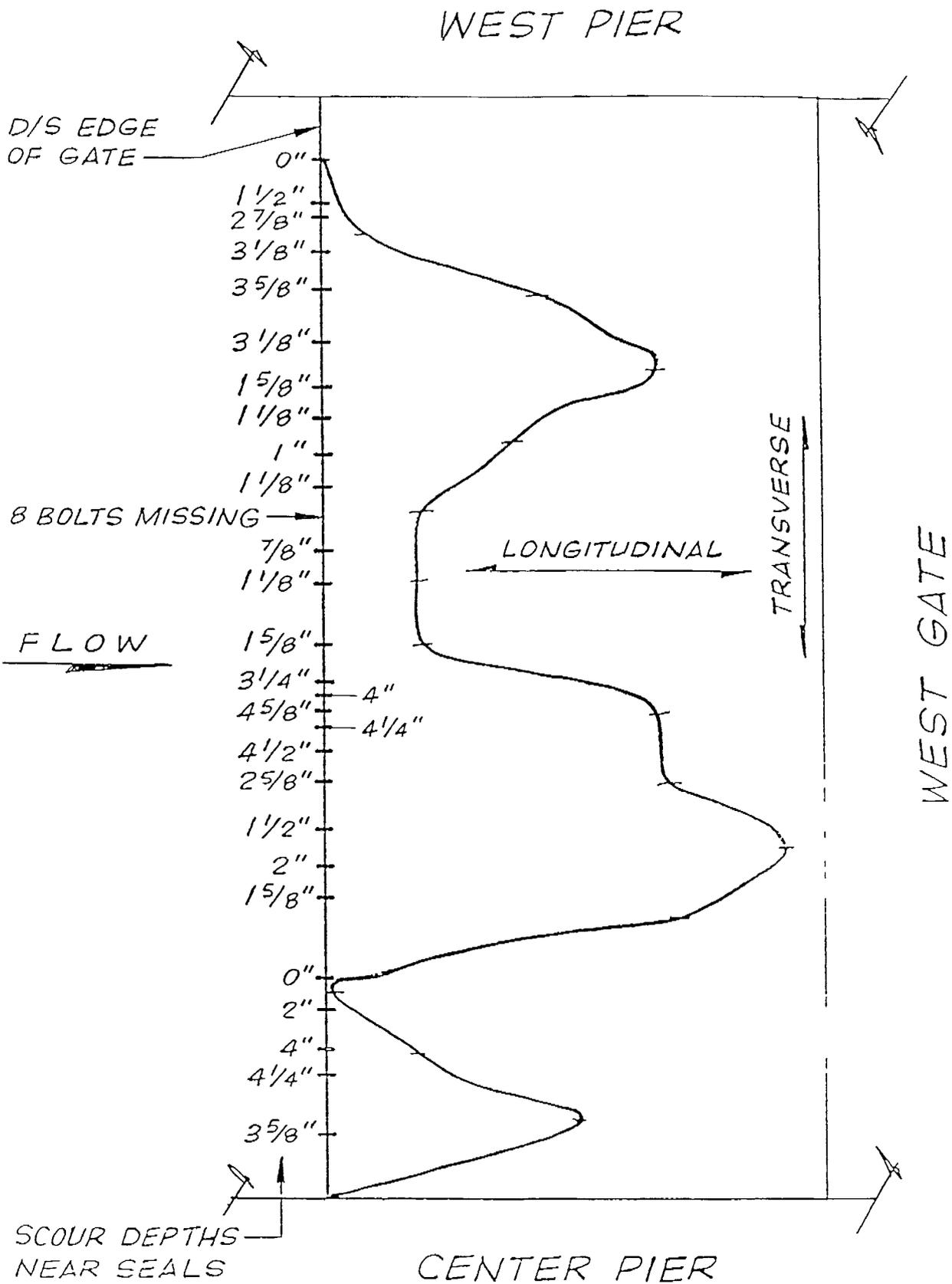
James S. Ignam  
 Resident, Erie Development Services Co.

1/29/87



SCALE: 1" = 15'-0" TRANSVERSE  
 1" = 2'-0" LONGITUDINAL

FIGURE 1



SCALE · 1" = 15'-0" TRANSVERSE  
 1" = 2'-0" LONGITUDINAL

FIGURE 2

REFERENCES (Copies available in Winnipeg Office)

Royal Commission on Flood Cost - Benefit Report 1958

Review of the Red River Floodway, Portage Diversion and Shellmouth Reservoir The Manitoba Water Commission November 1980

Red River Floodway Instructions for Operation of Inlet Control Structure Gates WRB November 1981

Red River Floodway Inlet Control Works Operation & Maintenance Manual H G Acres & Co Ltd April 1968

Red River Floodway Program of Operations WRB October 1984 (File report 84/23)

Red River Floodway Inlet Control Works - Maintenance Instructions & Parts List (Control System, Hydraulic Cylinders and Hoists) H G Acres & Co Ltd and Horton Steel Works Ltd 1965

Red River Floodway Inlet Control Works Interim Report on Fire Damage to West Gate - August 4, 1966 and its Rehabilitation H G Acres & Co Ltd November 1966

Red River Floodway Inlet Control Works Report on Fire Damage and Remedial Measures - West Gate H G Acres & Co Ltd October 1967

Annual Report of the Dyking Commissioner - Winnipeg Dyking System for year ending December 31, 1993

Memo Report Inlet Structure - Corrosion of Bulkhead Hoist Support Beams E&C Geotechnical Section January 1986

Memo Report Inlet Structure - Downstream Sill Concrete Erosion E&C Geotechnical Section March 1991

Red River Floodway - Inlet Control Structure - Erosion Study KGS Group November 1995

*Investigation of Red River Floodway Inlet Control Seal  
& Concrete Deterioration Area Inter-Formal Ltd  
March 1987*

Of Interest - Report on Investigations into Measures for the Reduction of the Flood Hazard in the Greater Winnipeg Area PFRA March 1953

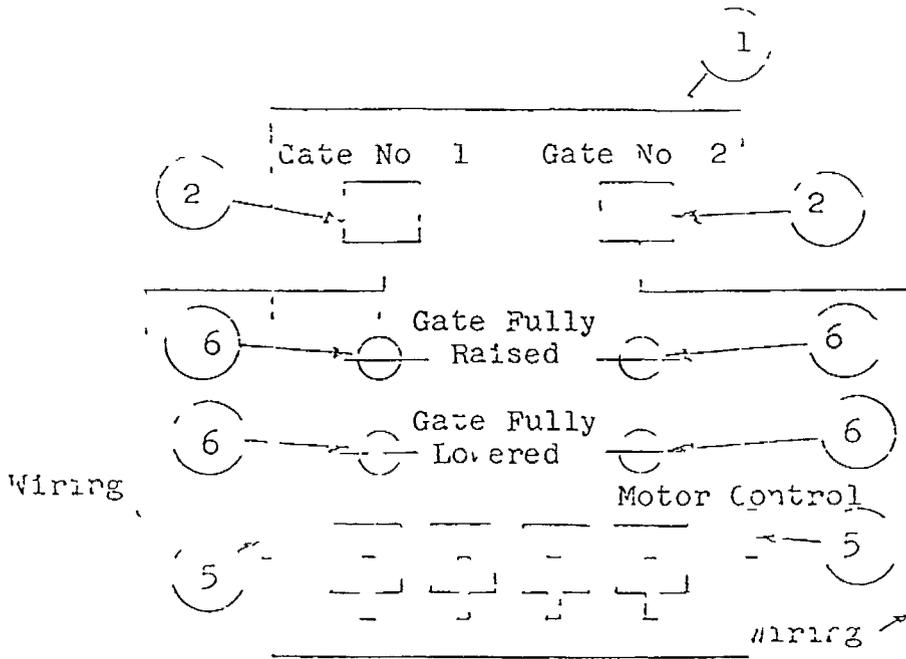
OPERATING INSTRUCTIONS

1 OPERATION & CONTROL OF THE TWO MAIN GATES

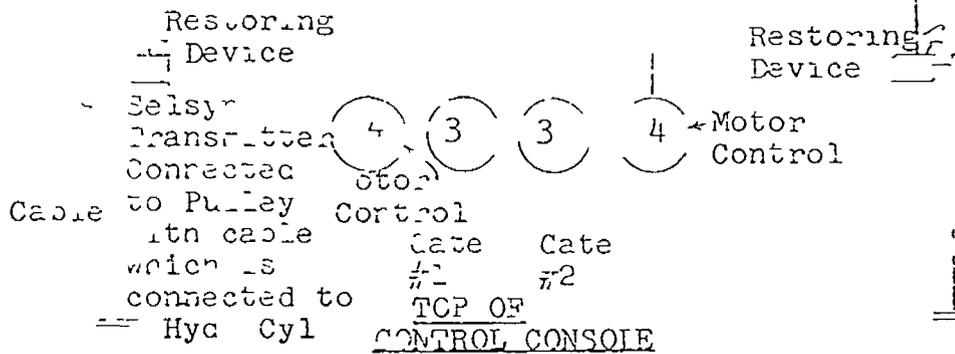
Dwg TJ-430-1 Sheet 13

- 1 Control Console
- 2 G E Selsyn Indicator

This is connected to the Selsyn Transmitter electronically, and in turn is mounted to the Restoring Device. It shows the local "UP" or "DOWN" of each gate automatically.



- 3 Operating Switches for gates "Raise", "Stop" "Lower"
- 4 Operating switches for motors "Normal" "Off", "Run"
- 5 Maintaining switches "Normal", "Off"
- 6 Indicating lamps



Inner Hydraulic Cylinder Gate #1      Inner Hydraulic Cylinder Gate #2

OPERATION

Step 1 - When gate fully lowered, Selsyn indicator (2) points to down position, and (6) are not illuminated, operating switches for gate (3) are in "OFF" position.

\* See page 5

One 2-1/2 (cont)

- \* Step 2 To raise gate, move (4) to "NORMAL" position
- \* Step 3 move operating switch (3) to "RAISE" position and pump motors will start, lamps (6) will become illuminated and Selsyn indicator (2) will start to rise indicating the position in degrees of the gate above the fully lowered position. Gate will continue to rise until it reaches its fully raised position (if desired) at which time the upper limit switch will make contact, the gate will stop rising, the lamps (6) will go out and the Selsyn indicator should show the position of the gate, at the fully raised position
- Step 4 If it is desired, the gate may be stopped at any time by releasing the operating switch (3). The lamps (6) will remain illuminated, in any position between fully raised and fully lowered. This switch is spring centered so that it automatically returns, when released, to the "STOP" position
- Step 5 To lower gate, move operating switch (3) to "LOWER" position. Selsyn indicator (2) should start down and will continue so until switch (3) is released, and returns to "STOP" position, or, if desired, the gate may continue down until stopped by making contact with the lower limit switch which is set so as to stop the gate at a position slightly above the sill
- \*\* Step 6 In the event that the motor or pump of one hydraulic unit is in-operative, the other operating motor or pump will supply oil to the in-operative one by manually opening the 2-1/2" diameter O.S. gate valve in the line running between the two reservoirs, allowing oil to pass

Step 6 cont'd

from one to the other (Normally, this valve is closed) During such operating, the pump remaining in operating shall run continuously. Either pump shall be placed in continuous duty by setting the three-position operating switch (4) in the "RUN" position. Here, it should be noted that the "RUN" position of (4) would only be used in case of a failure of one of the pumps wherein it was necessary to operate both gates from one pump.

Step 7 With the control switch (4) in "OFF" position, both solenoids of the directional control valve shall be de-energised, the valve shall be centered, and the check valves in the hydraulic circuit shall be closed to minimize leakage and drift of the servomotors.

Step 8 Under normal conditions, during raising or lowering of the gate, the releasing of switch (3) will stop the gate and it will be kept in that position by moving switch (5) to maintain "NORMAL" position.

Step 9 The restoring device, connected by means of a cable attached to the top of each hydraulic cylinder, is designed to function during normal or abnormal operating conditions. It will restore the gate to a pre-selected position in the case of normal drift up or down, as well as when abnormal conditions prevail such as may occur due to an accumulation of ice or flood debris on the upstream side of the gate. This device is fully automatic and precise in its functioning.

Step 10 The solenoid on valve K (see W O 89 and Vicker-Soerry drawing A-27-65 43B-Sheet 1) which raises and lowers the gate, is manually operable at the valve itself by depressing the appropriate push button in each solenoid. This must be done, of course, with the hydraulic pump running, in order to have a source of oil to not only operate the valve but to raise and lower the gate.

Step 11 When it becomes necessary to have the gate in the "UP" position for repairs or inspection, a dogging device has been provided. The gate should be raised to its maximum height, as shown on the Selsyn indicator. The lifting beams on each side of the gate should then be high enough to be well clear of the top of the dogging device. From elevation 706 00, manually operate the wheel on the dogging device adjusting section, drawings 1A and 53, to move the dogging beam back forward until it is underneath the lifting beam. When this has been done, the gate may be lowered slowly until it rests on both dogging beam posts, equally. NOTE that some means of communication must be provided between both the points (the control console, and the dogging devices) so that each person involved in this operation can be informed of the progress being made.

Step 12 After completion of the above operation and it is desired to again place the gate in normal use, personnel must again return to their positions at the dogging devices and control console. The gate should be raised to the "TOP" position. The dogging devices will then be retracted by an operator at each device and the gate may now be operated in the normal manner.

3

ADDITIONAL INSTRUCTIONS

- \* See Steps 1, 2 and 3, Page 1 and 2

The red indicator lamp should indicate

- (a) power supply on (at least one lamp lit)
- (b) gate fully down - "Gate fully lowered",  
indicator lamp on
- (c) gate at any intermediate position - both lights on
- (d) gate fully up - "Gate fully raised" -  
indicator lamp on

- \*\* See Step 6, Page 2

In order to operate both units from one hydraulic unit, it is necessary to open valves "T" and "S" (see Vickers-Sperry drawing no 27-65-430) at both units as well as the 2-1/2" gate valve "U" at the No 1 unit

- (1) NOTE - When the two units are re-isolated, the gates should be at the same level in order to equally distribute the oil reserve
- (2) NOTE - It is not intended that the Automatic Restoring Device be used in the event that both gates are operated from one pumping station. The condition would be considered abnormal and operation of the gates, either up or down, would be a Manual Operation from the Control Console, for the gate which is required to be positioned. To put the hydraulic and electrical systems in the condition for operation as above, "stop-off" valves "T", "S", "U", (Vickers-Sperry circuit drawing 27-67-430), must be fully opened control switches "3 I", "U 2", (Vickers-Sperry circuit drawing E-27-64-79) for the unit being isolated, will be positioned

## (2) NOTE (cont'd)

in "OFF" The pump control "SW1" for the operating unit will be positioned in "RUN" The gates can now be operated from the appropriate control panel by selection of switch "SW3" (Vickers-Sperry circuit drawing E27-54-790) This can be achieved either with the pumping units interconnected as in the preceding paragraph, or singularly The pump control switch "SW1" would be in "RUN" position "SW2" in "OFF" position

It should be noted that when manual control at valve "A" is used, the upper and lower maximum travel limit switches will not prevent movement past these extremes, should the operator maintain the valve in the energized position past this point

(3) NOTE - The relief control 'F' (Vickers-Sperry circuit drawing 27-65-43C) is normally set at 1100 PSI The setting of this valve can be increased to 1550 PSI by rotating the control knob in a clockwise direction The 1550 PSI maximum adjustment of this valve is set by internal shimming

(4) NOTE - Valve " " (Vickers-Sperry circuit drawing 27-65-43C) interconnects the rod end and head end of the hydraulic cylinders allowing the cylinders to subside at a controlled rate All electrical controls could be in the "OFF" position during this operation

TO RAISE GATES - NORMAL CONDITIONS

Energising the opposite solenoid of valve K so as to connect port P and B with A open to T, with direct pump flow to the rod end of the cylinders thereby raising the gate. In this case valve M would be held open to allow the discharge oil from the head end of the cylinders to return to tank. The purpose of valve V is to limit the maximum pressure which can be exerted on the head end of the cylinders to 600 PSI.

TO LOWER GATES - NORMAL CONDITIONS

With electric motor running the small cartridge pump delivers oil for pilot pressure, for the operation of solenoid valves K and pilot operated check valve M and L. The pump is included only as a positive means of insuring pilot pressure at all times during the operation of the gate. Energising solenoid valve K such that oil is directed from port P to port A and ports B and T are connected, check valve L will be open and oil will flow into the head ends of both cylinders tending to lower the gate. The oil discharging from the rod end of the cylinders will return through connection 102 and valve L, which is held open, and through port B to tank across valve J. The purpose of J is to prevent the cylinders from extending too quickly and overrunning the flow of oil being delivered by the main pump. In operation valve J will throttle the discharge oil in response to a pressure signal from the pressure line of the pump. Any tendency of the cylinder to run away with an overrunning load and the pressure in the lines on the pump could tend to drop which could tend to close valve J which would throttle the discharge oil from the cylinders.

OPERATION - ABNORMAL CONDITIONS

With the gate in a static position a build up of ice or debris on the gate might cause excessive loading to be placed on the gate when the build up became such that a pressure of 1500 PSI was required to maintain the gate in the static position then valves X1 and X2 would open which would allow the gates to subside at a rate determined by the size of the integral orifice. The gates would continue to subside until the pressure in the rod end line of the cylinders became less than 1500 PSI which would allow the valves X1 and X2 to close. Due to the difference in area between the head and the rod end of the cylinder, when the gate was subsiding under emergency conditions there would be a requirement for oil to flow from the reservoir into the head end of the cylinder. For this reason we have included a large check valve to allow oil to flow from the reservoir into the head end of the cylinder.

STOPPING DEVICE (Electrical Schematic #27-64-79C)

Referring to drawing E27-64-79C when the gate is in a static position a spring centered cam is engaged which will operate one of three limit switches when rotated. Any tendency of the gate to drift from its preset position would allow LS1 to close. A drift of six inches up or down would cause either LS2 or LS3 to be operated which would operate relay 1CR or relay 2CR to energise the pump motor and the appropriate solenoids so as to restore the gate to its original position. This restoring action would continue until LS1 was opened which would de-energise the energised relay and stop the system. This action is fully automatic and operation would be possible. You will note additional switches to select for normal operation or continuous running of the pump motor. A switch is

Restoring Device (cont'd)

included to de-activate the automatic restoring feature and a third switch is included for manual operation of the gate (raising and lowering) Operation of this manual selector switch would automatically energise the restoring clutch solenoid which would disengage the restoring cam from the system Releasing the manual selector would de-energise the clutch would reconnect the mechanical cam with the restoring mechanism Included also in the restoring device are upper and lower limit switches to indicate when the gate is fully open or fully closed A Selsyn transmitter is included in the restoring mechanism with a rating receiver located in the operators console to indicate in degrees from fully closed, the gate position

## BULKHEAD GATES

(Reference - Allen Bradley craning CY-70362 and J. T. Hepburn drawing 26833-A and to Wiring diagram drawing 549B260 - Canadian Westinghouse)

The operation and control of each of the two bulkhead gates is initiated from the platform at elevation 783'0". Controls are located and operation switches marked for the Hoist Motor, Rotary Limit Switch and Slack Rope Limit Switch

1. To Raise or Lower - start the hoist motor. This is a 5 horsepower, 1800 RPM Brooks motor with epoxy resin, encapsulated windings. The hoist is 12 ton capacity, electrically powered. Each hoist has a single drum with spiral grooves for the cables.
2. Rotary Limit Switch - Controls marked are "raise" and "lower". In this connection an indicator has been provided showing the position of the gate. The gate may be stopped at any point in its upward or downward travel by a brake on the motor shaft. Upper and lower limit switches have been provided which automatically restricts the travel between the prescribed limits. Top of gate fully raised is elevation 777'9". Bottom of gate fully lowered is elevation 723'9".
3. Slack Rope Limit Switch - Controls are marked "lower". This switch will automatically prevent the cables from unwinding, should the gate become jarred or lowering.

TRASH RACKS

The operation and control of each of the two trash racks is initiated from either or two places

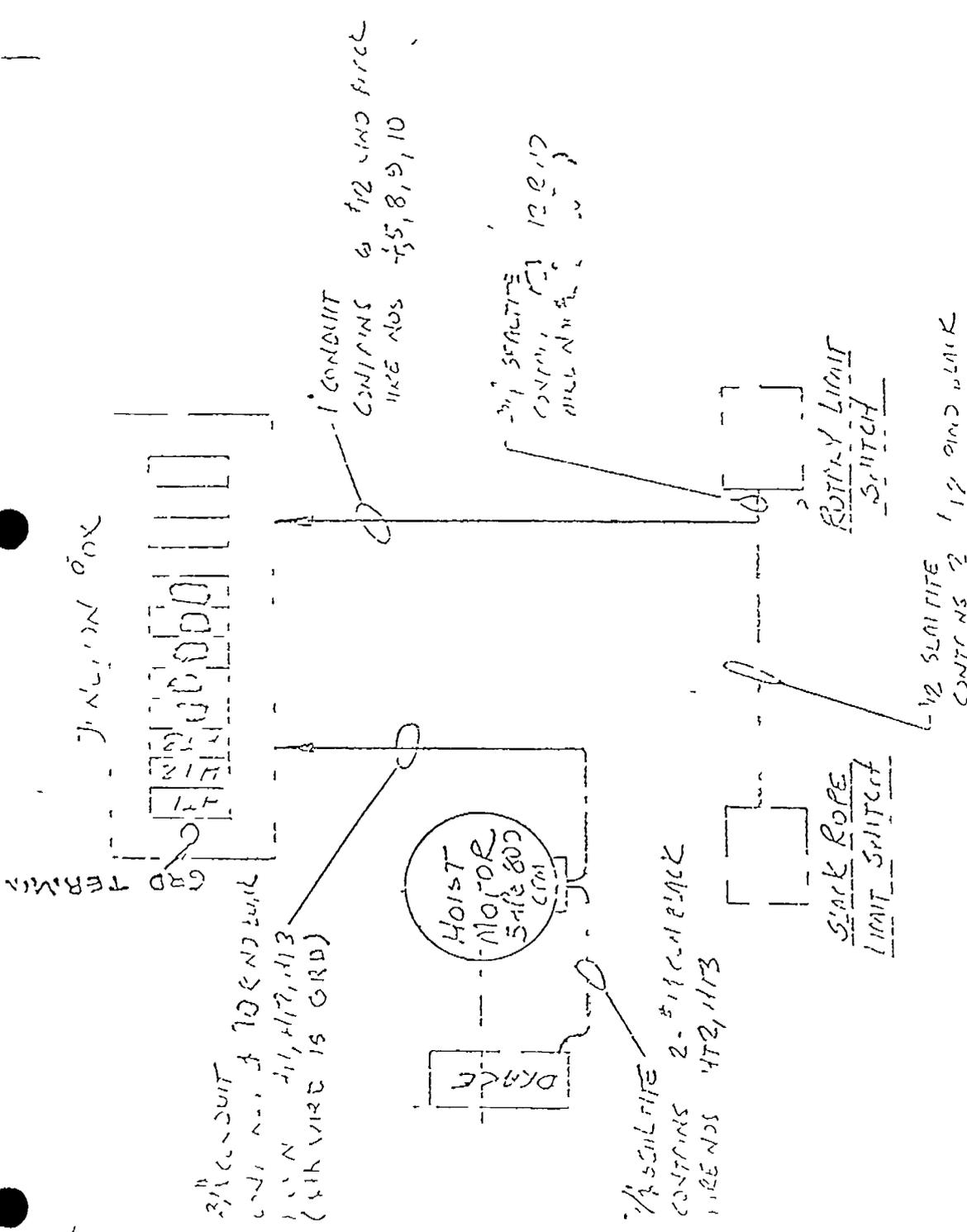
- (1) from elevation 765'0"
- (2) from the platform below the hoist platform at elevation 763'0"

The racks are raised or lowered by means of a Felco chain operated 5 ton hoist. Servicing of the hoist is performed from the platform below the support for the 12 ton and this 5 ton hoist at elevation 783'0"

SPECIAL NOTES FOR BULKHEAD GATES AND TRASH RACKS

The bulkhead gates can be closed only when there is 6' of water or less over the main gates in the fully lowered position. The bulkhead gates will be closed for de-aerating of a main gate, possible during the winter season, to reduce the heat loss from the water in the main gate well.

The trash racks will be normally lowered and would be raised for cleaning and maintenance only at low flow periods.



ALL THE ABOVE DETAILS AND THE PARTS LIST ARE SUBJECT TO CHANGE WITHOUT NOTICE

SCALE	NFS	100	611	73-57-64
DRAWN BY	1111	CHECKED BY	1111	APPROVED
DATE	3/16/65			

JOIN I 1 11

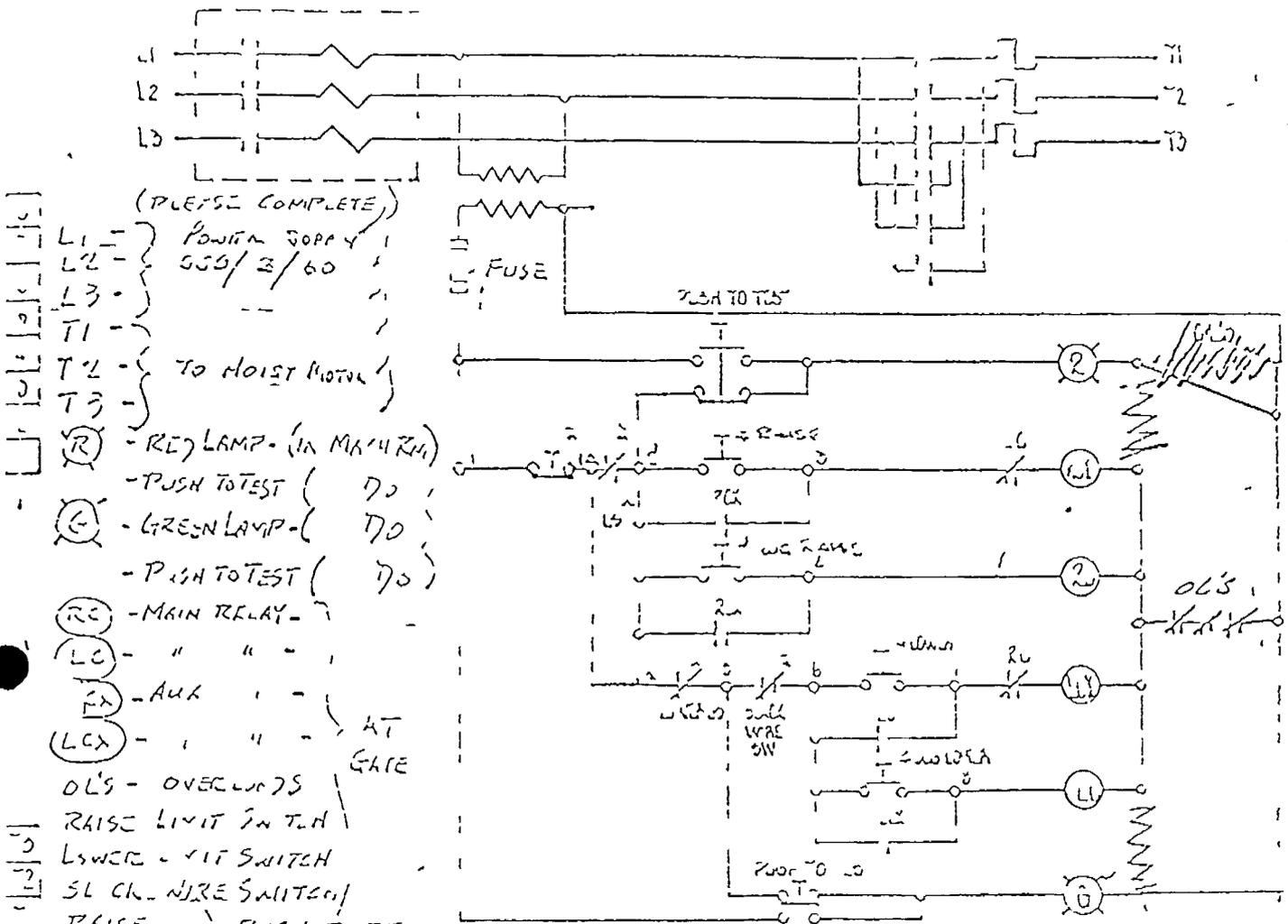
911918 DUN 11

DWG No 1111 5

1111 1111

1111 1111

5493260



- (PLEASE COMPLETE)
- L1 - POWER SUPPLY
  - L2 - 555/3/60
  - L3 - "
  - T1 - "
  - T2 - TO HOIST MOTOR
  - T3 - "
  - (R) - RED LAMP - (IN MAIN RAIL)
  - PUSH TO TEST (DO)
  - (G) - GREEN LAMP - (DO)
  - PUSH TO TEST (DO)
  - (RC) - MAIN RELAY -
  - (LC) - " " -
  - (FA) - AUX " -
  - (LCA) - " " - AT GATE
  - OL'S - OVERLOADS
  - RAISE LIMIT SWITCH
  - LOWER LIMIT SWITCH
  - SL. CH. WIRE SWITCH
  - RAISE PUSH BUTTON,
  - LOWER ON PUSH BUTTON
  - STOP STATION
  - JOG RAISE AT EACH
  - JOG LOWER GATE

LOCATED NEAR JUNCTION

SCHEMATIC

BOX LORTON STEEL WORKS LTD  
PORTER ST

**APPROVED**

SUB. LET. TO CHAN. L. NO. 10

OCT 22 1965

G. AGRESTI

5493260  
1/5/66

IMPORTANT  
THE CONTAINED INFORMATION ON THIS DRAWING IS THE PROPERTY OF CANADIAN WESTINGHOUSE COMPANY LIMITED AND MAY BE USED ONLY FOR THE PURPOSE FOR WHICH IT WAS PREPARED AS IDENTIFIED HEREON



CANADIAN WESTINGHOUSE CO. LTD  
12600 W. 28th St. - Mississauga, Ont. L4W 3G5

SCALE 1:1

5493260



┌ RED RIVER FLOODWAY ┐

MAINTENANCE DATA FOR CONTROL SYSTEM

└

┘

RED RIVER FLOODWAY

## MAINTENANCE DATA FOR CONTROL SYSTEM

General For best protection of the system and in order to insure the most efficient operating performance, we do recommend the following procedure

During start up and while system is in operation, check these areas two or three times a week

- 1 Level of fluid in reservoir
2. External leakage on pipe-joints and valve mountings
- 3 Filter Indicator
4. Unusual noises
5. Variation in cycle time

## Power Unit

Reference Drawing T<sub>J</sub> 429-1 Sheets 1 and 2 - At least four main inspections per year

OIL BATH air filter, item (8) should be cleaned by removing filter element and washing it in a suitable commercial solvent. Fill sump with new oil SAE30 to 50 in hot weather, and SAE10 to 30 in cold temperatures

EXAMINE condition of TELL TALE filter, item (D) and be certain the indicator is in the "Clean Filter" position. If cleaning is required remove cover with attached filter element. This also facilitates the cleaning of the magnets which are located inside the cartridge. Wash cartridge and element in kerosene, or replace element with new one

No draining of the reservoir is required since the submersible filter is equipped with a built in CUT-OFF valve

Further inspect filter (E) and replace its cartridge after approximately 400 operating hours if the system is performing in average atmosphere. However, should a comparatively dirty atmosphere prevail, a cartridge change after every 250 working hours is strongly recommended

Since Filters (D) and (E) provide good protection strainer (P) may be cleaned once a year by washing it in kerosene. To remove the strainer draining of the tank becomes necessary and thus provides an opportunity to sample the oil and to test it for contaminants such as grease, paint, sludge, sand and condensation. Petroleum base fluids become milky in appearance when water is present. WEAR is indicated by a darkening of the colour as compared to new oil and the oil supplier should be consulted for testing of the fluid and for recommending replacements



Power Unit ont'd	Double pump, item (B) as well as valves F G, H I J K, L M, N, and O are internally lubricated by the fluid and their operating life is extensive, provided the oil is kept reasonably clean. However, particular attention should be given to unusual system performance, such as increasing cycle time, above normal fluid temperature, pressure fluctuations or unwarranted noise. These are signs of impending trouble and a trained specialist should be called to perform the necessary repairs before a breakdown may actually occur.
Electrical Console	A SEMI ANNUAL INSPECTION should prove adequate.  Examine relay, and switch contacts and generally safeguard the equipment from contact with condensation.  For information on the SELSYN READ OUT, consult the maintenance section of the attached instruction bulletin on SELSYN DEVICES 3S9 890.
Restoring Device	Ref Drawing TJ431 sheets 1 2 and 3 Inspect this unit at least quarterly.  Check cover Gaskets on top item 58 and on rear item 59 Test teflon split ring item 37 and replace defective parts, also keep replacement items on hand.  Inspect URETHANE RUBBER molding on shaft item 4 and on FRICTION WHEEL item 7, for excessive wear.  Apply a few drops of oxidation resistant mineral oil of about SAE 30 Viscosity to bearings items 10 and 18. If required use a good quality non-caking bearing grease on items 14, 4 and 29.  Test limit switch and electrical terminal connections and protect them from excessive oxidation.  For maintenance of SELSYN TRANSMITTER, item 6, refer to attached INSTRUCTION BULLETIN GEH-2129.
Attached Reference Material	Power Unit Drawing TJ 429-1 Sheets 1 and 2  Restoring Mechanism Drawing TJ 431-1 sheets 1,2 and 3 TJ 431-4, -7 -01  Selsyn Device GEH 2129



APPENDIX D CYLINDER INSPECTION REPORT



111 BANNISTLER RD  
WINNIPEG, MANITOBA R3C 3A1  
204 632 0639  
FAX 204 632 0171

A DIVISION OF  
PRITCHARD ENGINEERING CO. LTD



March 22 1996

KGS Group  
3227 Roblin Boulevard  
Winnipeg, Manitoba  
R3R 0C2

Attn Art Gossen, P Eng

Subject Floodway Inlet Structure - St Norbert

Art,

Enclosed is a preliminary inspection report of the hydraulic cylinders for the St Norbert Floodway Inlet Structure. Listed are the inspections which have been completed to date.

If you have any additional questions or concerns, please feel free to contact me at your convenience.

Regards,

PRITCHARD MACHINE  
A Division of Pritchard Engineering Co Ltd

  
Lauren Bate, Supervisor - Technical Services

cc Jason Smith, P Eng

Encl



111 BANNISTER RD  
WINNIPEG, MANITOBA R3C 3A1  
204 632 0639  
FAX 204 632 0171

A DIVISION OF  
PRITCHARD ENGINEERING CO. LTD.



## INSPECTION REPORT

### ST NORBERT FLOODWAY INLET STRUCTURE

Prepared For Art Gossen P Eng - Senior Mechanical Engineer  
KGS Group

Prepared By Lawren Bate, Supervisor Technical Services  
Pritchard Machine

1) A visual inspection of the Floodway Inlet Control Structure was completed on March 14th and 15th, 1996. The following assessments of this structure were made:

- Cylinders appear in good condition
- Some corrosion was evident on piping above cylinders  
( Pritchard Machine replaced piping on the west cylinder back in January/February 1995)
- During our inspection it was noted that there was an excessive amount of grease and rust scale on the gland areas of all four cylinders. See attached photo. This could result in contamination of the gland wiper and seal, and could cause damage to the gland bushing and ram shaft.

2) Random U/I (Ultrasonic Testing) readings were completed on both the west and east end cylinders of the Floodway Inlet Control Structure on March 14th, and 15th, 1996. The readings varied from a low to a high as indicated in the following chart:

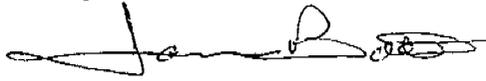
Continued

Page 2

KGS Group

	WEST CYLINDER BARREL	FAST CYLINDER BARREL
LOW	1 035 in	1 045 in
HIGH	1 060 in	1 095 in

Regards,



Lauren Bate, Supervisor - Technical Services

**APPENDIX E**  
**ELECTRICAL**  
**TESTING**

**APPENDIX E**  
**ELECTRICAL TESTING REPORT**

# FACSIMILE COVER SHEET

From WESTINGHOUSE CANADA INC  
ENERGY SERVICES DIVISION  
1460 ELLICE AVENUE  
WINNIPEG, MANITOBA  
R3G 3K3

DATE 19 Jun, 1996

TO Ralph Guppy

AT KGS

**Phil Meister**

No of pages 1  
(Including Cover Sheet)

If there is any difficulty with receiving this transmission please contact

Heather Patterson (204) 783 7378

Our fax number is (204) 772 1540

Job No. S72 \_\_\_\_\_

Subject. Thermographic scan at Floodway Lift Sta

The areas checked during the above job are as follows.

- All operating starters in the MCC panel
- Main breakers and transfer switch
- 30 KVA Dry type transformer
- 150 KVA dry type transformer
- 42 circuit lighting panel
- Heat trace panel breakers.

Regards,

*Phil Meister*  
Phil Meister

JUN 4 - 1996



Westinghouse Canada Inc

Energy Services Division

MAILING ADDRESS P O Bo 340 St to L  
W peg Mb R3H 0Z6

1460 Ellice Avenue  
Winnipeg Manitoba  
R3G 3K3  
Telephone (204) 783 SERV  
(204) 783 7378  
Fax (204) 772 1540

June 13, 1996

KGS Group  
3227 Roblin Blvd  
Winnipeg MB  
R3R 0C2

Attention Ralph Guppy

Reference Thermographic Survey  
Our File S72 8208

Enclosed is the report of the Thermographic Survey done on June 7 Included are the photographs of the hot spots along with our recommendations

In order to maintain safe and trouble free operation, we recommend that these deficiencies be corrected at your earliest convenience

If we can be of further service please contact us at 783-SERV (783 7378)

Sincerely

A handwritten signature in black ink, appearing to read 'Trevor Saler', written over a horizontal line.

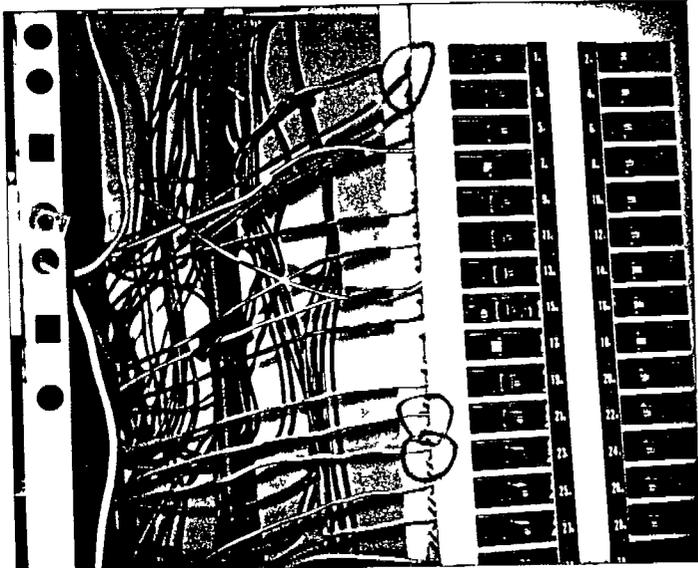
Trevor Saler  
Field Service Representative  
Winnipeg Region  
Services Division



THERMOGRAPHIC SURVEY

SUBSTATION FLOODWAY LIFT STATION

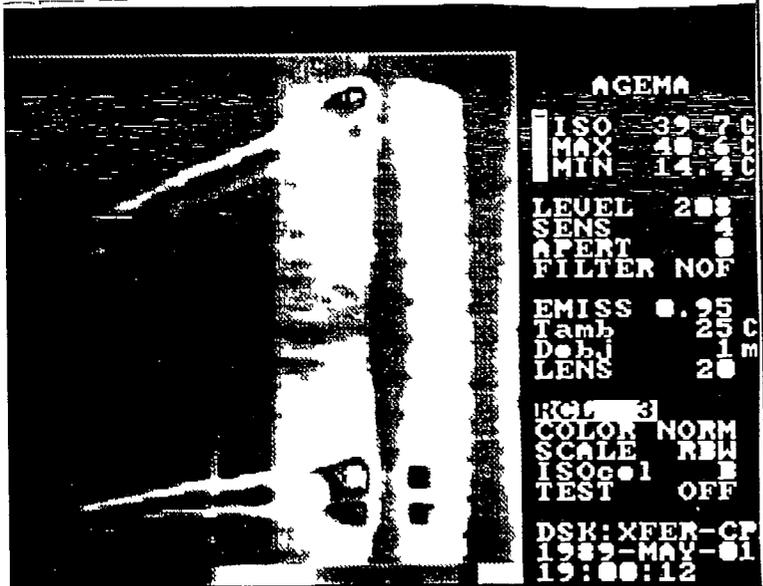
FEEDER CIRCUIT PANEL A



42°C

panel A  
CB's # 1,21,23

①



EQUIPMENT DESCRIPTION

LOCATION PANEL A  
BREAKERS 1,21,23

LOAD

AMBIENT TEMPERATURE C

REFERENCE TEMPERATURE 39 7 C

TEMPERATURE RISE ABOVE REFERENCE C

PROBLEM LOCATION  
LOAD SIDE CONNECTIONS OF  
BREAKERS 1,21,23

RECOMMENDATIONS  
CLEAN AND TIGHTEN CONNECTIONS  
CHECK LOAD ON BREAKERS

TIME

DATE 06/07/96

TESTED BY T SALER

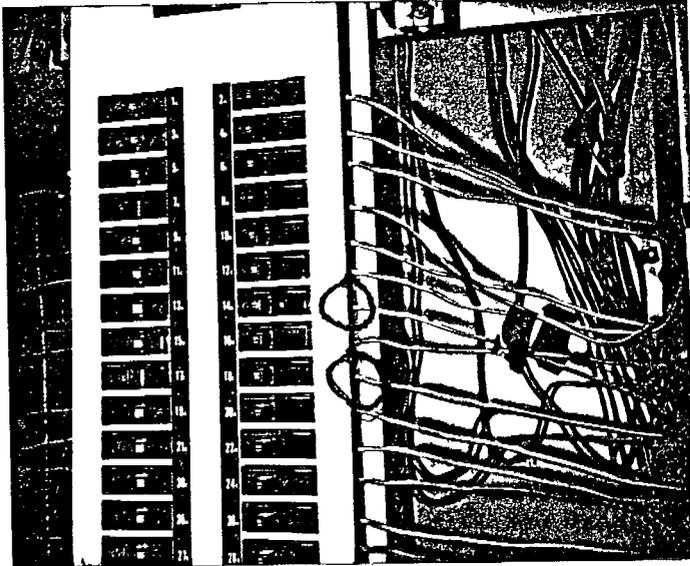
JOB NUMBER S728208



THERMOGRAPHIC SURVEY

SUBSTATION FLOODWAY LIFT STATION

FEEDER CIRCUIT PANEL A



38°C  
②

Panel A  
CB<sub>2</sub> # 14, 18

EQUIPMENT DESCRIPTION

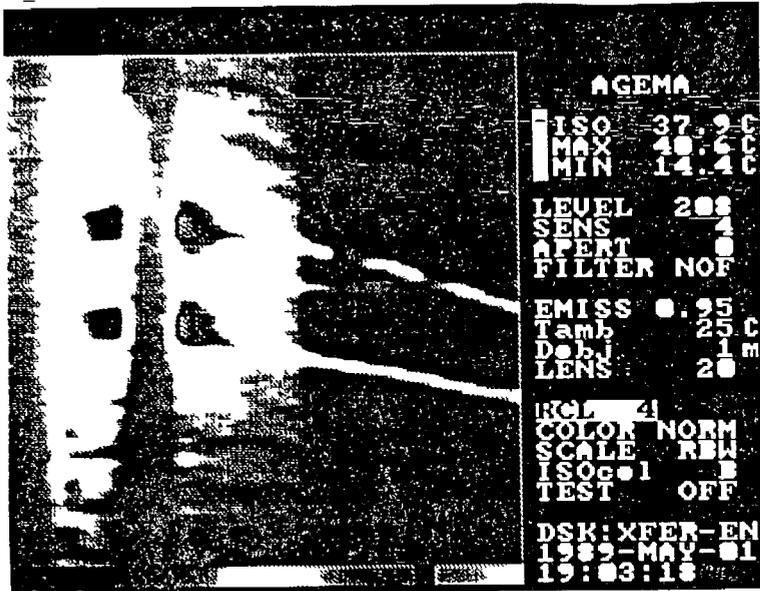
LOCATION PANEL A  
BREAKERS 14, 18

LOAD

AMBIENT TEMPERATURE	C
REFERENCE TEMPERATURE	37.9 C
TEMPERATURE RISE ABOVE REFERENCE	C

PROBLEM LOCATION  
LOAD SIDE CONNECTIONS OF  
BREAKERS 14, 18

RECOMMENDATIONS  
CLEAN AND TIGHTEN CONNECTIONS  
CHECK LOAD ON BREAKERS



AGEMA

ISO	37.9 C
MAX	49.6 C
MIN	14.4 C
LEVEL	208
SENS	4
APERT	0
FILTER	NOF
EMISS	0.95
Tamb	25 C
Obj	1
LENS	20
COL	41
COLOR	NORM
SCALE	RAW
ISO	01
TEST	OFF
DSK	XFER-EN
	1989-MAY-01
	19:03:18

TIME

DATE 06/07/96

TESTED BY T SALER

JOB NUMBER S728208

MAY 0 1996

MAY 0 1996



Westinghouse Canada Inc

Energy Services Division

MAILING ADDRESS P O B 340 ST L  
W i g Mb R3H 0Z6

1460 Ellice Avenue  
Winnipeg Manitoba  
R3C 3K3  
Telephone (204) 783 SERV  
(204) 783 7378  
Fax (204) 772 1540

25 April 1996

KCS Group  
5227 Roblin Boulevard  
Winnipeg, Manitoba  
R3K 0C 7

Attention Emmanuel

Reference Electrical Testing at the Winnipeg Floodway Inlet Structure  
Your P O 96 511 01  
Our File 572 5129

Please find enclosed the test results for electrical testing performed at the above location

In addition to the enclosed test sheets the following tests were done

- The main feeder cables were tested and found to have good insulation resistance values
- The 42 circuit lighting panel circuits were checked and found to have good insulation resistance values except for circuits 1 8 16 and 26 which were grounded

All except one accessible heat trace circuit was found to be grounded

Any other abnormalities found are shown in the comments at the bottom of the appropriate test sheet

If we can be of further service please contact us at 783 SERV (783 7378)

Regards

Phil Meister C E T

Field Services Representative  
Winnipeg Region  
Services Division

encl Test Report



MOLDED CASE CIRCUIT BREAKER  
TEST REPORT

CUSTOMER KGS Group  
 LOCATION Perimeter Floodway Lift Station  
 SUBSTATION Robonic Transfer Switch  
 FEEDER IDENTIFICATION Emergency Breaker

BREAKER TYPE \_\_\_\_\_ MANUFACTURER Westinghouse  
 STYLE NO HLA3400F POLES 3 INST SETTING HI  
 FRAME SIZE 400 TRIP AMPERAGE 400  
 INTERRUPTING CAPACITY \_\_\_\_\_

<u>TEST RESULTS</u>	<u>LIMITS</u>		<u>PHASE</u>		
	<u>MIN</u>	<u>MAX</u>	<u>A</u>	<u>B</u>	<u>C</u>
LONG DELAY TIME (seconds @ 300 % current)	<u>38</u>	<u>190</u>	<u>117</u>	<u>107</u>	<u>84</u>
INSTANTANEOUS PICK-UP (tested at setting <u>HI</u> )			<u>4420</u>	<u>3360</u>	<u>3300</u>
CONTACT RESISTANCE (micro-ohms)			<u>116</u>	<u>131</u>	<u>148</u>

COMMENTS Instantaneous trip limits 3600-4400  
Instantaneous trip tests are slightly out of limits  
for all phases

JOB NUMBER S72-8129 TESTED BY P Meister DATE 04 Apr, 1996



MOLDED CASE CIRCUIT BREAKER  
TEST REPORT

CUSTOMER KGS Group  
LOCATION Perimeter Floodway Lift Station  
SUBSTATION Robonic Transfer Switch  
FEEDER IDENTIFICATION Normal Breaker

BREAKER TYPE \_\_\_\_\_ MANUFACTURER Westinghouse  
STYLE NO HLA3400F POLES 3 INST SETTING HI  
FRAME SIZE 400 TRIP AMPERAGE 400  
INTERRUPTING CAPACITY \_\_\_\_\_

<u>TEST RESULTS</u>	<u>LIMITS</u>		<u>PHASE</u>		
	<u>MIN</u>	<u>MAX</u>	<u>A</u>	<u>B</u>	<u>C</u>
LONG DELAY TIME (seconds @ 300 % current)	<u>38</u>	<u>190</u>	<u>104</u>	<u>98</u>	<u>109</u>
INSTANTANEOUS PICK-UP (tested at setting <u>HI</u> )			<u>4120</u>	<u>3400</u>	<u>3400</u>
CONTACT RESISTANCE (micro-ohms)			<u>129</u>	<u>135</u>	<u>146</u>

COMMENTS Instantaneous trip limits 3600-4400 Phase B and C  
instantaneous trip tests are slightly below limits

JOB NUMBER c72-8129 TESTED BY P Meister DATE 04 Apr, 1996



MCC Starter Insulation Resistance Tests

**Insulation Resistance (Meg Ohms)**

<b>Designation</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>A B</b>	<b>B C</b>	<b>C-A</b>
Servo oil pump #1 Sw #3	1000	1000	1000	1000	1000	1000
Servo oil pump #2 Sw #4	600	600	1000	1000	1000	1000
Water heater	1000	1000	1000	1000	1000	1000
Desilting pump #1	1000	1000	1000	1000	1000	1000
Desilting pump #2	1000	1000	1000	1000	1000	1000
Air compressor #1	1000	1000	1000	1000	1000	1000
Air compressor #2	1000	1000	1000	1000	1000	1000
Dewatering pump	1000	1000	1000	1000	1000	1000
West bulkhead gate hoist Sw #1	1000	1000	1000	1000	1000	1000
East bulkhead gate hoist Sw #2	1000	1000	1000	1000	1000	1000

**Comments**

**Job No** S72 8129

**Tested By** P. Meister

**Date** 03 April, 1996



### Heat Trace Circuit Current and Ammeter Tests

Circuit	Pri Amps	* # Turns	Meter Reading (Amps)
East Gate Upstream	45	3	46
East Gate Downstream	45	3	47
East Gate Side	45	3	46
West Gate Upstream	45	3	45
West Gate Downstream	45	3	46
West Gate Side	45	3	46
East Bulkhead	9	12	93
West Bulkhead	9	12	90

\* Indicates the number of primary turns used for injection test as per C T nameplate

### Heat Trace Circuit Continuity and Insulation Resistance Tests

F or H *	Location	Bkr in 240 V Panel	Resistance (Ohms)	Ins Res (Meg Ohms)
F	1L	note 1	n/a	0
H	1E	note 1	46	0
F	1W	note 1	n/a	0
H	1W	note 1	87	0
F	2N	#3	n/a	50
H	2N	#3	note 2	note 2
F	2S	#5	n/a	3
H	2S	#5	53	0.5
F	3N	#4 or #6	n/a	50
H	3N	#4 or #6	note 2	note 2
F	3S	#4 or #6	n/a	50
H	3S	#4 or #6	note 2	note 2
F	4E	note 1	n/a	0
H	4E	note 1	85	0
F	4W	note 1	n/a	0
H	4W	note 1	5	0

\* F = Heat trace feeder cable H = Heat trace

Note 1 Breaker could not be identified due to grounded cables being impossible to trace

Note 2 Heat trace leads were inaccessible due to severe corrosion

Job No S72 8129

Tested By P M / T S

Date 09 April, 1996



### Unit Heater Resistance Tests

Heater	Resistance (Ohms)
Machine Rm 5 KW East	436
Machine Rm 5 KW West	1016
Machine Rm 10 KW South	428

### Main Panelboard Meter Tests

Meter	Test Value	Expected Reading	Actual Reading
Ammeter	25 amps	200 amps	200 amps
Voltmeter	615 volts	615 volts	615 volts

### Indoor Distribution Transformer Insulation Resistance Tests

Insulation Resistance in Meg Ohms

Size (KVA)	Serial No	H1-Lo+Gnd	Lo-H1+Gnd	H1+Lo-Gnd
150	600688	100	40	30
30	486003	100	100	100

Job No S72 8129

Tested By P M / T S

Date 04 April, 1996

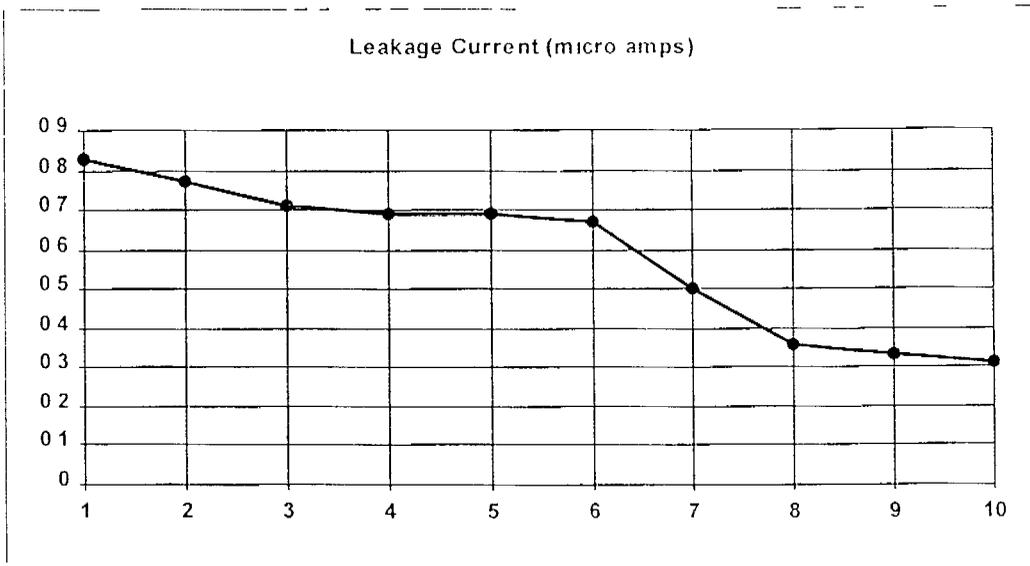


# Motor Polarization Index Test Sheet

Customer: IKCS Group Location: Perimeter Lift Station  
 Motor ID: 36 volt Pump No. 2 Switch No. 4 Serial No:  
 Voltage: 1600 H.P. RPM:  
 Test Voltage: 1000 V D.C.

Time (min)	Leakage Current (micro amps)
1	0.83
2	0.77
3	0.71
4	0.69
5	0.69
6	0.67
7	0.51
8	0.36
9	0.33
10	0.31

Polarization Index = 1 min/10 min  
 = 0.83 / 0.31  
 = 2.68



Job No: 72 8129

Tested by: T. Sailer

Date: 03 April 1996

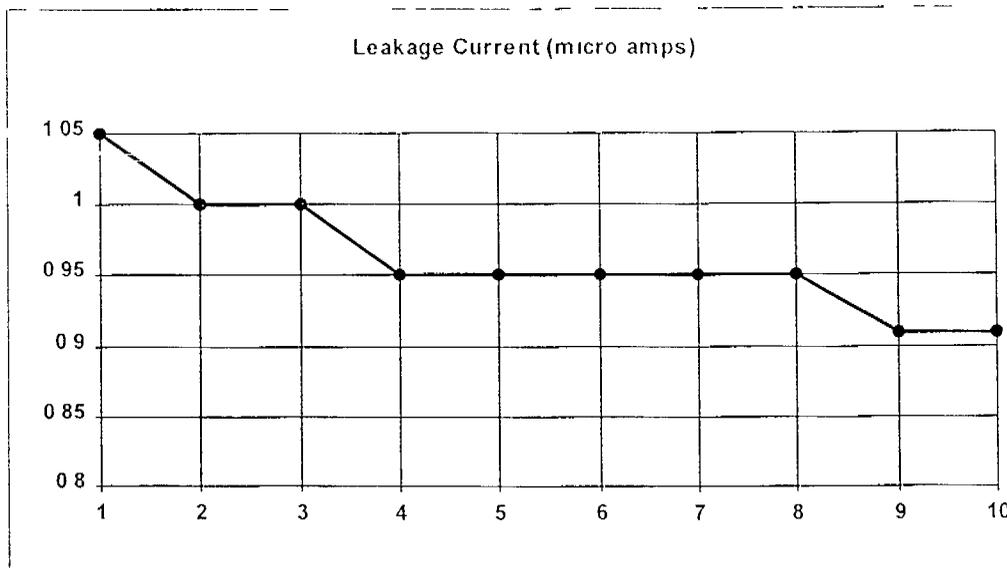


# Motor Polarization Index Test Sheet

Customer	KGS Group	Location	Perimeter Lift Station
Motor ID	Servo oil Pump No. 1 Switch No. 3	Serial No.	
Voltage	600	HP	RPM
Test Voltage	1000	VDC	

Time (min)	Leakage Current (micro amps)
1	1.05
2	1.00
3	1.00
4	0.95
5	0.95
6	0.95
7	0.95
8	0.95
9	0.91
10	0.91

Polarization Index = 1 min/10 min  
 = 1.05 / 0.91  
 = 1.15



Job No 572 8129

Tested by T. Saler

Date 03 April 1996

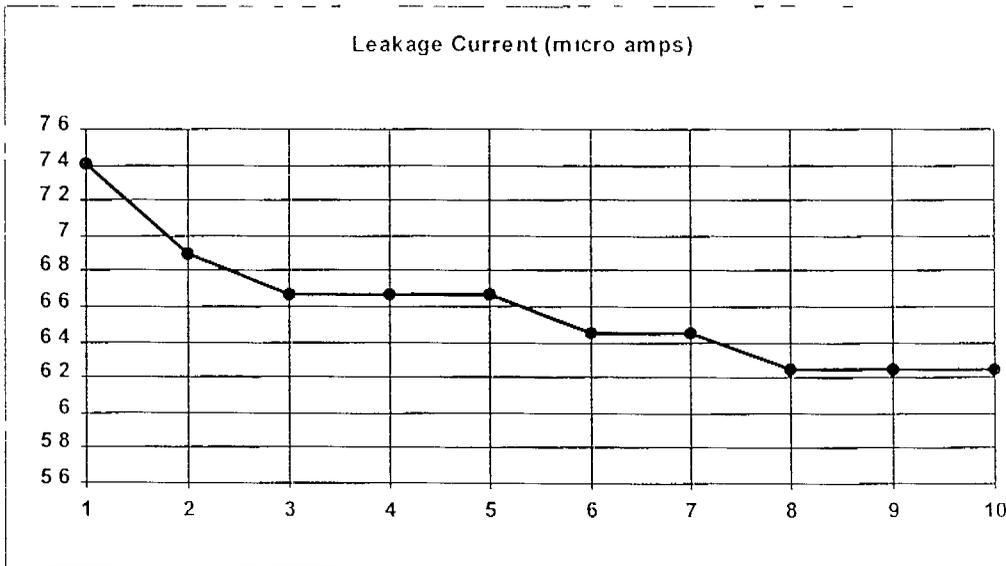


# Motor Polarization Index Test Sheet

Customer | KGS Group | Location | Perimeter Lift Station  
 Motor ID | Dewatering Pump | Serial No |  
 Voltage | 600 | H P | RPM  
 Test Voltage | 1000 | V D C |

Time (min)	Leakage Current (micro amps)
1	7.41
2	6.9
3	6.67
4	6.67
5	6.67
6	6.45
7	6.45
8	6.25
9	6.25
10	6.25

Polarization Index = 1 min/10 min  
 = 7.41 / 6.25  
 = 1.19





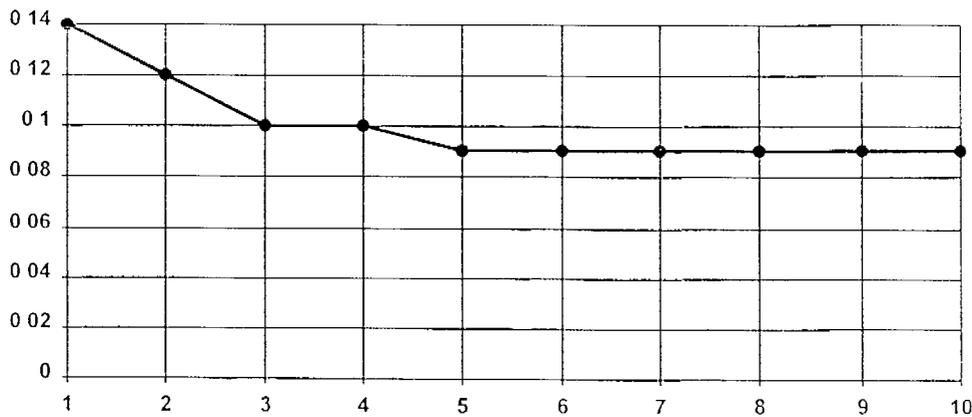
# Motor Polarization Index Test Sheet

Customer: KOC Group      Location: Perpete Lft Station  
 Motor ID: Air Compressor #1      Serial No: 1  
 Voltage: 600 V      HP: 1      RPM:  
 Test Voltage: 1000 V D.C.

Time (min)	Leakage Current (micro amps)
1	0.14
2	0.12
3	0.1
4	0.1
5	0.091
6	0.091
7	0.091
8	0.091
9	0.091
10	0.091

Polarization Index = 1 min/10 min  
 = 0.14 / 0.091  
 = 1.54

Leakage Current (micro amps)



Job No: S/2 8129

Tested by: T. Saler

Date: 03 April 1996

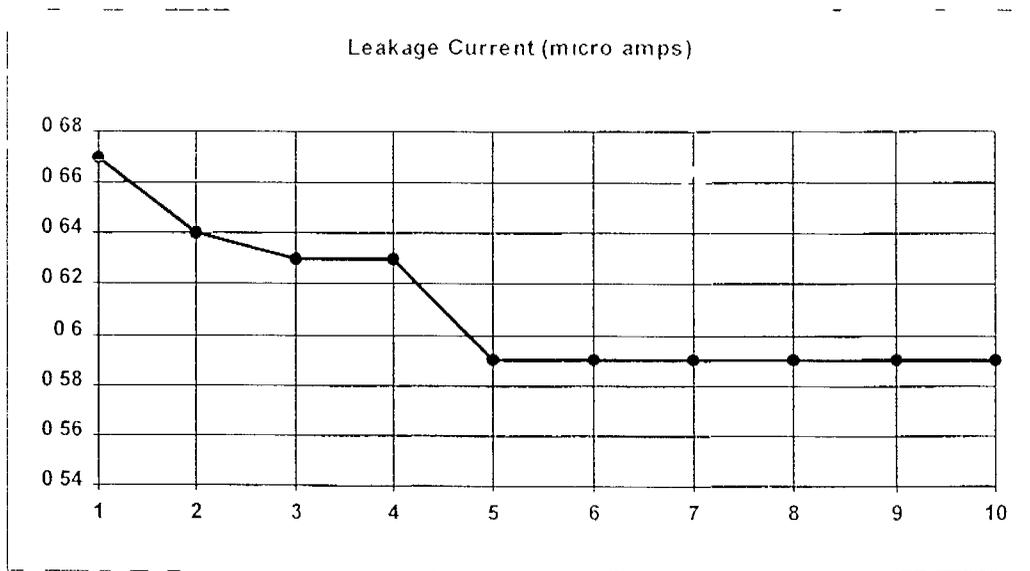


# Motor Polarization Index Test Sheet

Customer: AGS Group Location: Perimeter Life Station  
 Motor ID: Air Compressor #2 Serial N:  
 Voltage: 600 V H F R F M  
 Test Voltage: 1000 V D C

Time (min)	Leakage Current (micro amps)
1	0.67
2	0.64
3	0.63
4	0.63
5	0.59
6	0.59
7	0.59
8	0.59
9	0.53
10	0.59

Polarization Index = 1 min/10 min  
 = 0.67 / 0.59  
 = 1.14



Job No: S72 8129

Tested by: T. Siler

Date: 03 April 1996



# Motor Polarization Index Test Sheet

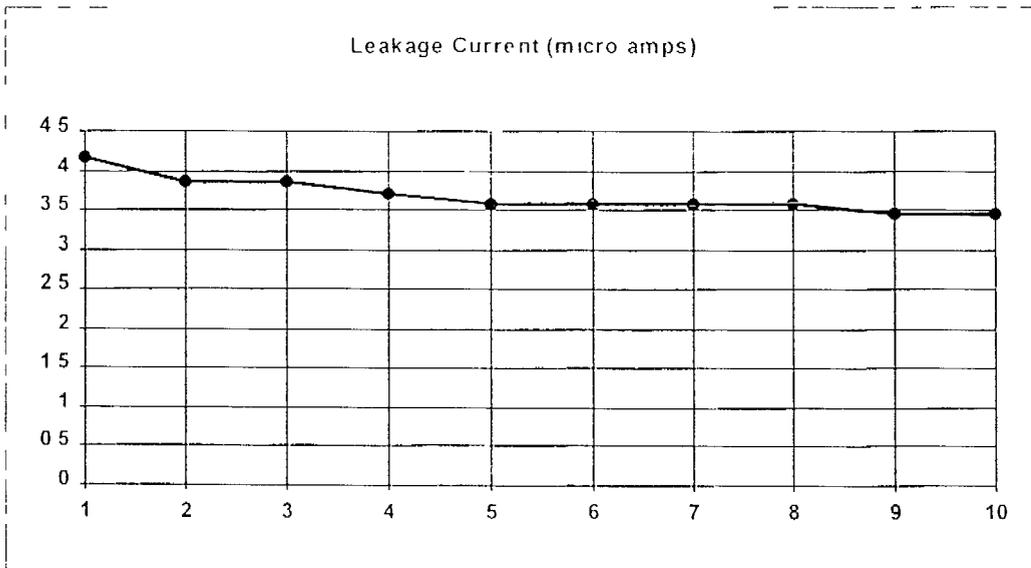
Customer | K G Group | Location | IP meter Lift Station  
 Motor ID | West Bulkhead Gate House #112 | Serial No |  
 Voltage | 600 | H F | RPM |  
 Test Voltage | 1000 | V D C

Time (min)	Leakage Current (micro amps)
1	4.17
2	3.85
3	3.8
4	3.7
5	3.57
6	3.57
7	3.57
8	3.57
9	3.45
10	3.45

Polarization Index = 1 min/10 min

$$= \frac{4.17}{3.45}$$

$$= 1.21$$



Job No | 728123

Tested by | I ale

Date | 03 April 1996



# Motor Polarization Index Test Sheet

Custom r | KC Group | Location | Perimeter Lift | tition  
 Motor ID | Part Bulkhead Cat | Hott Switch #1 | Serial No  
 Voltage 600 | H P | RPM  
 Test Voltage 1000 | V D C

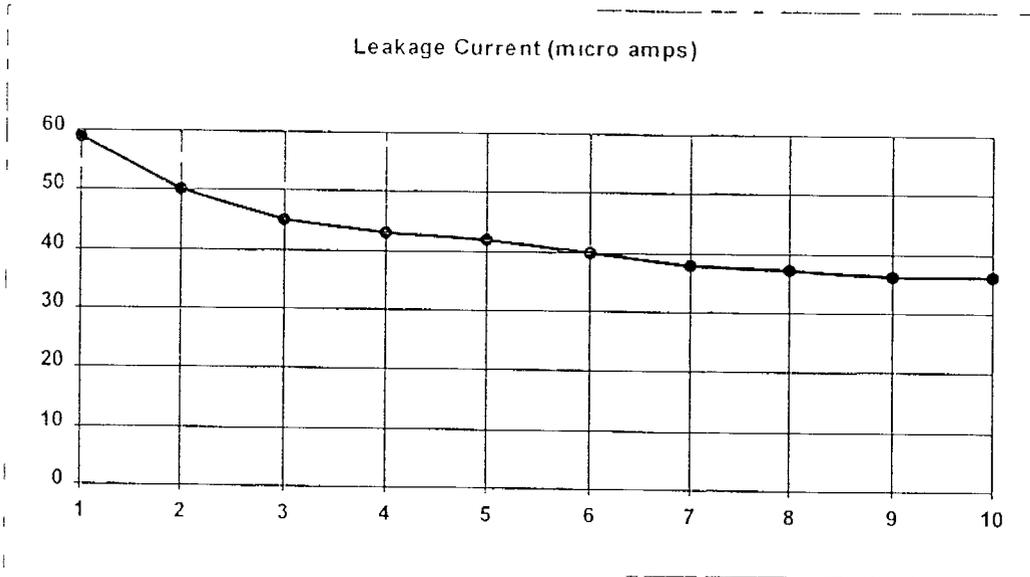
Time (min)	Leakage Current (micro amps)
1	59
2	50
3	45
4	43
6	42
7	40
8	38
9	37
10	36

Polarization Index = 1 min/10 min

= 53.00 / 36.00

= 1.64

Leakage Current (micro amps)



Job No S72 8129

Tested by T Siler

Date 03 April 1996

**APPENDIX F  
EQUIPMENT DATA  
& TEST LOGS**

**APPENDIX F**  
**EQUIPMENT DATA AND TEST LOGS**

KGS GROUP  
RED RIVER FLOODWAY INLET STRUCTURE INSPECTION  
KGS FILE NO 96 311 01  
NAMEPLATE DATA  
DATE JULY 24 1996  
COMPLETED BY JS

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### HYDRAULIC HOISTING SYSTEM

#### MOTOR DATA

Manufacturer	TAMPER	Type	BGK 5424D
Model	326U FBS	Enclosure	T E
Serial no	7365702(E) 7365701(W)	°C	55
Horsepower	20	Time Duty	CONSTANT
RPM	1179	Frame	326U
Amps	20.5	CEMA design	B
Voltage	550	Bearing Shaft End	6311
Frequency	60	Bearing Front End	6309
Phase	3	Amb °C	40

### BULKHEAD GATE HOISTS

#### HOLDING BRAKE

PERIGRIP BRAKE  
14065 TYPE ACP 6  
MAKERS NO G527345/29  
60 FT LB TORQUE  
RATING CONT 90°C  
550 V 60 Hz  
INPUT WATTS 100  
SPRING LENGTH = 2.32  
CLAPPER GAP 1.0 MAX

#### SMALL SPEED REDUCER

HELICON  
ORDER NO 11125 A  
SIZE 30 HD  
9.74 HP RATING  
8.37/1 RATIO  
O/P 209 RPM

#### MOTOR DATA

Manufacturer	BROOK ELECTRIC MOTOR OF CANADA
Type	DP
Code	G
Frame	215
Horsepower	5
RPM	1650
Voltage	550
Amps	5.3/TERM
Phase	3
Frequency	60
Rating	CONT

KGS GROUP  
RED RIVER FLOODWAY INLET STRUCTURE INSPECTION  
KGS FILE NO 96 311 01  
NAMEPLATE DATA  
DATE JULY 24, 1996  
COMPLETED BY JS

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### COMPRESSED AIR SYSTEM

#### COMPRESSOR

Manufacturer HYDROVANE  
Model 55CK  
Serial no #1 17HV383708  
                  #2 17HV383706

#### COMPRESSORS MOTOR DATA

Manufacturer BROOK ELECTRIC MOTORS OF CANADA  
Horsepower 15  
RPM 1730  
Amps 15  
Voltage 550  
Frequency 60  
Phase 3  
Type DP  
Code G  
Rating CONT  
Service Factor 1.5  
Shaft Ext Bearing 310  
Shaft Front Bearing 308

#### AIR RECEIVER

FABWELD  
CPN C3340 1234567890  
MAX WP 200# TEMP 650 °F  
SH 1946 HD 1962  
SFW 65-4449  
SCC A212 B FLGE  
TS 70000

KGS GROUP  
RED RIVER FLOODWAY INLET STRUCTURE INSPECTION  
KGS FILE NO 96 311 01  
NAMEPLATE DATA  
DATE JULY 24, 1996  
COMPLETED BY J S

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#### UNIT HEATERS

**Manufacturer** CHROMALOX  
**Model** BUU 5101  
**Motor** 240 v 1 PHASE 60 Hz 1/20 Hp  
**Control Voltage** 240 v 60 Hz

#### CYLINDER WELL HEATERS

**Manufacturer** WOODS  
230 V 1 PHASE  
12 IMP  
TYPE AF1042 1 1 AMPS  
1750 RPM 0 15 Hp

#### WATER HEATER

CHROMALOX  
VOLTS 575  
WATTS 24 kW  
3 PHASE  
CAT NO NWH 6244

#### RELIEF VALVE

SERIAL NO 8526  
MODEL NO M12 ANS Z21 22  
TEMP RATING 210° F  
500 000 BTU/HR RATING

#### TOP OF FLANGE

CALORITECH INC  
CAT NO CXI624F5M  
S O NO T914078 B92  
3 PHASE 600 V 24 kW

#### HYDRO PNEUMATIC TANK

A O SMITH  
AQUA AIR  
MODEL V260  
SER NO GG 8709 D37

KGS GROUP  
RED RIVER FLOODWAY INLET STRUCTURE INSPECTION  
KGS FILE NO 96 311 01  
NAMEPLATE DATA  
DATE JULY 24, 1996  
COMPLETED BY J S

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WELL PUMP (SUBMERSIBLE)

PLEUGER OF CANADA LTD  
AS 31 11  
NO 18 730  
G P M 20  
FT 154  
STAGES 11  
VOLTS 220  
1 Hp  
3450 RPM  
1 PHASE 60 Hz 220 V  
9 AMPS 0 64 kW

EAST GATE OPERATIONAL TEST RAISING

Gate Position	Pump Discharge Pressure	Motor Current Draw	Excessive Noise/Vibration	Elapsed Time	
ft	psi	A	Yes/No		
0	0 1050 920	20	Y		knocking sound at pump air n system
2	950	14	Yes		knocking less frequent
3 3	950	14		0 05 30	slight leak noted at connection above hydraulic unit
5 8	1050	14	No	0 09 00	
7 5	1100	15	No	0 11 40	gate begins to appear at 8
10	1180	18	No	0 15 20	
12 7	1200	18	No	0 19 30	
17	1220	18	No	0 26 10	
20	1260	19	No	0 31 15	
23 3	1270	19	No	0 36 00	
26 5	1240	19	No	0 40 45	
29 7	1240	19	No	0 45 30	
32 6	1240	19	No	0 50 00	
33 7	1240	19	No	0 51 45	stop test due to overflowing of reservoir
32 7	1240	19	No		lower to 32 7 stop
					oil transferred into reservoir below mechanical room test resumed
33 9	1240	18	No	0 53 47	
36 6	1220	18	No	0 57 47	
37 5				0 59 25	limit switch cut out oil approx male 3 from top of tank

EAST G TE ERATO TESTFLOWE G

G is Postho	P mp D h rg Pre re	Mo C rm Draw	E es Iv No /N/b to	Elap ed T me
ft	p i	A	Y N	
375	50		N	0 00 00
362	50	11	N	0 0 30
32	50		N	0 20 00
30	50	11	N	0 27 05
28.4	50	11	N	0 33 10
25	5		No	0 5 30
237	50	1	No	0 5 30
222	50	11	Y	0 56 00
2 6	50	1	Y	0 00
198	50	11	N	1 05 00
185	50	11	N	1 09 50
15	50	11	N	1 23 00
13.4	50	9	N	1 29 00
12.6	50	9	N	1 32 00
11.3	50	9	N	1 36 45
102	50	9	Y	1 40 45
89	50	9	Y	1 5 30
82	50	9	N	1 8 00
7	50	9	Y	1 52 30
6	50	9	N	55 55
5	50	9	N	2 00 00
4.4	50	9	N	2 02 10
3.9	50	9	Y	2 04 00
3.4	50	9	N	2 06 00
2.8	50	9	No	2 08 00
2.3	50	9	Y	2 0
B	0	9	N	2 12 00
1.3	50	9	N	2 14 0
0.8	50	9	N	2 6 00

fig le pae gl nd pped 5 m

k k g so hom p mp

k g so from P

k ock g d i p 30 ec

k ock g d p 30 sec

k ock g so d i p 30 sec

k g wery po ad Y

ec eey po cnly

WEST GATE OPERATIONAL TEST RAISING

Gate Position	Pump Discharge Pressure ps	Motor Current Draw A	Excessive Noise/Vibration Yes/No	Elapsed Time	
0	0 1220 1050	19	Yes	0	Pump knocking. Noise subsides in around 30 sec
2.4	1100	19	No	0 03 35	
5	1075	19	No	0 07 40	
6.2	1140	18	No	0 09 30	
10	1190	18	No	0 15 30	
13.7	1350	19.5	No	0 21 10	
15.8	1380	19.5	Y	0 24 20	occasional knock about every 2 min
18.1	1390	19.5	No	0 28 20	
20.4	1400	19.5	No	0 32 20	
23	1400	19.5	No	0 37 10	
25	1400	19.5	Yes	0 41 10	occasional knock about every 2 min
26.7	1400	19.5	Yes	0 45 10	occasional knock about every 1 min
28.8	1400	19.5	Yes	0 49 10	knocking 2 per 1.5 min
30.5	1400	19.5	Yes	0 53 10	knocking 2 per 3 min
32.5	1400	19.5	Yes	0 57 10	knocking 1 per 2 min
34.2	1400	19.5	Yes	1 01 10	knocking 1 per 5 min
36	1400	20	Yes	1 05 10	knocking 1 per 3 min
38	1400	20	Yes	1 09 10	knocking 1 per 3 min
40	1400	20	No	1 13 10	
40.8	1400	20	No	1 15 10	limb switch c. to oil approximately 3' from top of tank

WEST GATE OPERATIONAL TEST LOWERING

Gate Position ft	Pump Discharge Pressure psi	Motor Current Draw A	Excessive Noise/Vibration Yes/No	Elapsed Time
40.8	150	12	No	0
39.7	200	11.5	No	0.02 05
38.4	220	11.5	No	0.04 45
35.5	200	11.5	No	0.10 30
30.4	210	11.5	No	0.21 05
28.5	200	11	No	0.25 00
26.2	200	11	No	0.30 00
23.7	200	11	No	0.35 00
21.2	200	11	No	0.40 00
18.5	200	11	No	0.45 30
16.5	200	11	No	0.50 00
13.9	200	11	No	0.55 00
11.7	200	11	No	1.00
9.3	125	11	No	1.05 00
8	150	11	No	1.07 00
6.9	125	11	No	1.09 00
6	150	11	No	1.11 00
3.2	160	11	No	1.17 00
0.5	200	11	No	1.22 00
0.3	25	11	No	1.22 31

shut off autom t c lly

**APPENDIX G**  
**COST ESTIMATES**

**APPENDIX G**  
**COST ESTIMATES**



**KGS GROUP**

Consulting Engineers & Project Managers

**Bridge Components**

Cost Estimate

Rev	Date	By
0		RB
1	Oct 31,96	RB
2	Dec 6,96	RB

Client	Department of Natural Resources
Project	Floodway Inlet Control Structure Work Program
Project No	96 311 01
Location	St Norbert, Manitoba

Item	Description	Qty	Unit	Unit Cost	Labour			Material & Equipment	Total Cost	Notes	Rev
					Man Hours	\$/Man Hour	Cost				
<b>5 0</b>	<b>Sidewalk</b>										
5 1	Selective Repairs	2400	ft2	\$25					\$60 000	Department of Highways	
	Contingency (10% of Total)								\$6 000		
	Engineering Services (15% of Total)								\$9 000		
									<b>\$75 000</b>		
<b>6 0</b>	<b>Service Duct</b>										
6 1	Complete Reconstruction	380	ft2	\$75					\$28 500		
	Contingency (10% of Total)								\$3 000		
	Engineering Services (15% of Total)								\$4 500		
									<b>\$36 000</b>		
6 2	Insulated Bulkheads				5	\$ 70	\$ 350	\$ 500	\$850		
	Contingency (10% of Total)								\$100		
	Engineering Services (15% of Total)								\$200		
									<b>\$1 150</b>		
<b>7 0</b>	<b>Handrails and Barrier Rails</b>										
7 1	Repaint and Minor Repairs									Department of Highways	
	Surface Preparation and Painting	450	ft	\$30					\$13 500		
	Containment and Cleanup	450	ft	\$30	100	\$50	\$5 000	\$1 000	\$19 500		
	Base Repairs				50	\$50	\$2 500	\$1 500	\$4 000		
	Contingency (10% of Total)								\$3 700		
	Engineering Services (15% of Total)								\$5 550		
									<b>\$46 250</b>		
	<b>TOTAL</b>										



**KGS GROUP**

Consulting Engineers & Project Managers

**Central Pier**

**Cost Estimate**

Rev	Date	By
0		RB
1	Dec 6 96	RB

Client	Department of Natural Resources
Project	Floodway Inlet Control Structure Work Program
Project No	96 311 01
Location	St Norbert Manitoba

Item	Description	Qty	Unit	Unit Cost	Labour		Material & Equipment	Total Cost	Notes	Rev
					Man Hours	\$/Man Hour				
<b>1 0</b>	<b>Asphalt roof of Control Room</b>									
1 1	Replace with Synthetic Membrane	1	ea	\$4 100				\$4 100		
	Parapets and Flashings	1	ea	\$500				\$500		
	Contingency (10% of Total)							\$750		
	Engineering Services (15% of Total)							\$5 850		
<b>2 0</b>	<b>Machine Room</b>									
2 1	Install fire resistant gypsum wallboard				25	\$50	\$1 250	\$200		
	Gypsum wallboard installation							\$150		
	Contingency (10% of Total)							\$250		
	Contract Administration (15% of Total)							\$1 850		
<b>3 0</b>	<b>Hydraulic Cylinder Support Bridge</b>									
3 1	Remove and Replace Hoist Supports	4	ea	\$1 000				\$4 000	All four supports considered	
	Remove lift off covers				8	\$75	\$600	\$600		
	Hydraulic Piping							\$20 800		
	Temp Support Arrangement and Installation	4	ea	\$5 200				\$800		
	Remove Existing Anchors				16	\$50	\$800	\$1 200		
	Remove Support Bridge	4	ea	\$300				\$19 500		
	Supply and install new Support Bridge	6500	lbs	\$3				\$2 000		
	Replace lift off covers	4	ea	\$500				\$5 000		
	Contingency (10% of Total)							\$7 500		
	Engineering Services (15% of Total)							\$61 400	All four supports considered	
	<b>TOTAL</b>									







**KGS GROUP**

Consulting Engineers & Project Managers

Cost Estimate

**Abutments**

Rev	Date	By
0		RB
1	Dec 6/96	RB

Client	Department of Natural Resources
Project	Floodway Inlet Control Structure Work Program
Project No	96 311 01
Location	St. Norbert, Manitoba

Item	Description	Qty	Unit	Unit Cost	Labour		Material & Equipment	Total Cost	Notes	Rev
					Man Hours	\$/Man Hour				
<b>1 0</b>	<b>Bulkhead Gates</b>									
1 1	Replace roller components	2	ea	\$500				\$1 000		
	Remove Lift off covers	2	ea	\$1 200				\$2 400		
	Remove Bulkhead Gates	2	ea	\$200				\$400		
	Transportation	2	ea	\$200				\$400		
	Washdown and Cleaning	8	ea	\$500				\$4 000		
	Remove rollers	2	ea	\$1 500				\$3 000		
	Surface Preparation and Painting	8	ea	\$2 500				\$20 000		
	Supply and Install New Rollers	2	ea	\$500				\$1 000		
	Adjustments	2	ea	\$1 000				\$2 000		
	Replace Bulkhead Gates	2	ea	\$500				\$1 000		
	Replace Lift off covers	2	ea	\$500				\$4 100		
	Contingency (10% of Total)							\$6 200		
	Engineering Services (15% of Total)							\$45 500		
									Both Gates	
<b>1 2</b>	<b>Install new sill seal arrangement</b>							\$1 000		
	Remove Lift off Covers	2	ea	\$500				\$2 400		
	Remove Gates	2	ea	\$1 200				\$400		
	Transportation	2	ea	\$200				\$400		
	Backup and Clamping Bar	2	ea	\$200				\$1 600		
	Supply and Install Seal	2	ea	\$800				\$2 400		
	Replace Gate	2	ea	\$1 200				\$2 000		
	Replace Lift off Covers	2	ea	\$1 000				\$1 000		
	Contingency (10% of Total)							\$1 500		
	Engineering Services (15% of Total)							\$12 700		
	<b>TOTAL</b>									



**KGS GROUP**

Consulting Engineers & Project Managers

Client Department of Natural Resources  
 Project Floodway Inlet Control Structure Work Program  
 Project No 96 311 01  
 Location St Norbert Manitoba

**Abutments**

Cost Estimate

Rev	Date	By
0		RB
1	Dec 6/96	RB

Item	Description	Qty	Unit	Unit Cost	Labour		Material & Equipment	Total Cost	Notes	Rev
					Man Hours	\$/Man Hour				
<b>6 0</b>	<b>Access Hatches</b>									
6 1	Replace all existing hatches	4	ea	\$5 000				\$20 000		
6 2	Repair all liftoff panels	8	ea	\$3 900				\$31 200	Similar to Pier	
<b>7 0</b>	<b>Ladders and Platforms</b>									
7 1	Replace all existing platforms	2	ea	\$25 000				\$50 000	Similar to Pier	
<b>8 0</b>	<b>Upstream and Downstream Retaining Walls</b>									
8 1	Install Monitoring Pins	16	ea	\$100	4	\$50	\$200	\$1 900		
<b>9 0</b>	<b>Parking Areas</b>									
9 1	Selective Repairs to Parking Area	2500	ft2	\$ 26				\$65 500	Similar to Bridge Sidewalk	
<b>10 0</b>	<b>Transformer Pad</b>									
10 1	Demolish existing pad and construct new pad supported by abutment	1	LS	\$2 500				\$2 500		
	Shutdown and Disconnect Services	10	yd3	\$150				\$1 500		
	Demolish existing pad and wall	3	yd3	\$300				\$900		
	New Concrete Brackets	10	yd3	\$300				\$3 000		
	New Concrete Pad	1	LS	\$2 000				\$2 000		
	Remove and Reinstall Transformers	1	LS	\$3 000				\$3 000		
	Reconnect Service	10	yd3	\$30				\$300		
	Place granular fill							\$1 700		
	Contingency (10% of Total)							\$2 100		
	Engineering Services (15% of Total)							\$17 000		
	<b>TOTAL</b>									







**KGS GROUP**

Consulting Engineers & Project Managers

Client Department of Natural Resources  
 Project Floodway Inlet Control Structure Work Program  
 Project No 96 311 01  
 Location St Norbert Manitoba

**Main Gate Components**

Cost Estimate

Rev	Date	By
0		RB
1	Dec 6 96	RB

Item	Description	Qty	Unit	Unit Cost	Labour		Material & Equipment	Total Cost	Notes	Rev
					Man Hours	\$ Man Hour				
2.4	Precast Concrete Panel Cofferdam	1	LS	\$30 000				\$30 000	First Time Cost	
	Installation of permanent seal faces	1	LS	\$32 000				\$32 000		
	Installation of cofferdam supports	2200	ft2	\$6				\$13 200		
	Precast Concrete Panels	1	LS	\$35 000				\$35 000		
	Installation of cofferdam components	1	LS	\$15 000				\$15 000		
	Removal of cofferdam components	1	LS	\$15 000				\$15 000		
	Contingency (10% of Total)							\$15 000		
	Engineering Services (15% of Total)							\$75 000		
<b>3.0</b>	<b>Skinplate Deterioration</b>									
3.1	Repairs and Application of protective coating									
	Extensive repairs	1	LS					\$20 000		
	Surface Preparation and Painting	11500	ft2	\$3.00				\$34 500		
	Containment and Cleanup	11500	ft2	\$4.00				\$46 000		
	Contingency (10% of Total)							\$10 000		
	Engineering Services (15% of Total)							\$15 000		
								<b>\$125 500</b>		
<b>4.0</b>	<b>Internal Steel Frame Structure</b>									
4.1	Removal of foam insulation									
	Scaffolding							\$2 000		
	Removal of foam insulation	400			\$50	\$20 000		\$20 000		
	Cleanup and Disposal	40			\$50	\$2 000		\$2 000		
	Contingency (10% of Total)							\$2 500		
	Contract Administration (15% of Total)							\$4 000		
								\$30 500		
	<b>TOTAL</b>									

**KGS GROUP**

Consulting Engineers & Project Managers

Client Department of Natural Resources  
 Project Floodway Inlet Control Structure Work Program  
 Project No 96 311 01  
 Location St Norbert, Manitoba

**Main Gate Components**

Cost Estimate

Rev	Date	By
0		RB
1	Dec 6/96	RB

Item	Description	Qty	Unit	Unit Cost	Labour		Material & Equipment	Total Cost	Notes	Rev
					Man Hours	\$ Man Hour				
<b>5 0</b>	<b>Trunnions</b>									
5 1	Ladders and Platforms for gate interior access	1600	lbs	\$3 60				\$5 760		
	Shps Ladders	19000	lbs	\$3 60				\$69 400		
	Platforms	2000	lbs	\$3 60	40	\$70	\$2 800	\$10 000		
	Openings in Skinplates							\$7 000		
	Contingency (10% of Total)							\$11 000		
	Engineering Services (15% of Total)							<b>\$96 400</b>		
<b>6 0</b>	<b>Pier and Abutment Liner Plates</b>									
6 1	Repair spalling concrete	1	LS	\$4 000				\$4 000	Within Cofferdam	
	Scaffolding	10	yd3	\$150				\$1 500		
	Check alignment and tolerance of plates	1	LS	\$4 000				\$4 000		
	Removal of Loose Concrete	15	yd3	\$350				\$5 250		
	Installation of dowels as required	4500	ft2	\$3 00				\$13 500		
	New secondary concrete	4500	ft2	\$4 00				\$18 000		
	Surface Preparation and Painting							\$6 000		
	Containment and Cleanup							\$9 000		
	Contingency (10% of Total)									
	Engineering Services (15% of Total)							<b>\$93 750</b>		
	<b>TOTAL</b>									









**Cost Estimate**

REV	DATE	BY
0	1 Nov 96	JS
1	31 Jan 97	JS

**KGS GROUP  
Consulting Engineers & Project Managers**

<b>Client</b>	Department of Natural Resources
<b>Project</b>	Floodway Inlet Control Structure Work Program
<b>Project No</b>	96 311 01
<b>Location</b>	St Norbert Manitoba

**Hydraulic Piping Replacement Options**

Item	Description	Qty	Unit	Unit Cost	Labour		Material & Equipment	Total Cost	Notes	Rev
					Man Hours	\$/Man hour				
1 0	<b>Option A Replace all hydraulic piping</b>									
1 1	general conditions mechanical	100 /	l sum	\$14 000			\$14 000	\$14 000		
1 2 1	schedule 80 steel piping inside mechanical room	100	lf	\$3	40	\$45	\$1 800	\$300		
1 3 2	schedule 80 steel piping inside mechanical room	100	lf	\$4	40	\$45	\$1 800	\$400		
1 4 3	schedule 80 steel piping inside mechanical room	10	lf	\$8	20	\$45	\$900	\$80		
1 5 1	schedule 80 stainless steel piping outside mechanical room	450	lf	\$14	160	\$45	\$7 200	\$6 300		
1 6 2	schedule 80 stainless steel piping outside mechanical room	450	lf	\$28	160	\$45	\$7 200	\$12 375		
1 7	sequence valves	4	ea	\$2 500	20	\$45	\$900	\$10 900		
1 8 1	steel ball valves in mechanical room	4	ea	\$150				\$600		
1 9 2	steel ball valves in mechanical room	4	ea	\$300				\$1 200		
	<b>Total</b>							\$65 055 00		
	engineering @15 /							\$9 758		
	contingency @10 /							\$6 506		
	<b>Total for both gates</b>							<b>\$81 319</b>		
2 0	<b>Option B Replace piping only outside mech room</b>									
2 1	general conditions mechanical	100 /	l sum	\$12 000				\$12 000		
2 2 1	schedule 80 stainless steel piping	450	lf	\$14	160	\$45	\$7 200	\$6 300		
2 3 2	schedule 80 stainless steel piping	450	lf	\$28	160	\$45	\$7 200	\$12 375		
2 4	sequence valves	4	ea	\$2 500	20	\$45	\$900	\$10 900		
	<b>Total</b>							\$40 675		
	engineering @15 /							\$8 396		
	contingency @10 /							\$5 598		
	<b>Total for both gates</b>							<b>\$69 969</b>		

**KGS GROUP**

**Consulting Engineers & Project Managers**

<b>Client</b>	Department of Natural Resources
<b>Project</b>	Floodway Inlet Control Structure Work Program
<b>Project No</b>	96 311 01
<b>Location</b>	St. Norbert, Manitoba

**Bulkhead Gate Hoist Options**

**Cost Estimate**

<b>REV</b>	<b>DATE</b>	<b>BY</b>
0	1 Nov 96	JS
1	31 Jan 97	JS

Item	Description	Quantity	Unit	Unit Cost	Labour		Material & Equipment	Total Cost	Notes	Rev
					Man Hours	\$/Man hour				
1 0	Option A. Refurbish Existing Hoists									
	1 1 general conditions	100 /	l sum	\$10 000			\$10 000			
	1 2 complete mechanical overhaul of bulkhead gate hoists	100 /	l sum	\$28 000			\$28 000			
	1 3 new limit switches and position indicators	100 /	l sum	\$10 000			\$10 000			
	1 4 new galvanized wire ropes	400	lf	\$3	40	\$45	\$1 800	\$3 000		
	1 5 repaint hoist support frames	100 /	l sum	\$2 000			\$2 000			
	Total							\$53 000		
	engineering @ 15 /							\$7 950		
	contingency @ 10 /							\$5 300		
	<b>Total for Both Bulkhead Gate Hoists</b>							<b>\$66 250</b>		
2 0	Option B. Install New Bulkhead Gate Hoists									
	2 1 general conditions mechanical	100 /	l sum	\$17 000			\$17 000			
	2 2 new 12 ton hoists installed	2	ea	\$27 000	100	\$45	\$4 500	\$54 000		
	2 3 removal of existing hoists	100 /	l sum	\$2 000			\$2 000			
	2 4 re work platforms to suit new hoists	100 /	l sum	\$5 000			\$5 000			
	total							\$61 000		
	engineering @ 15 /							\$12 375		
	contingency @ 10 /							\$20 625		
	<b>Total for Both Bulkhead Gate Hoists</b>							<b>\$115 500</b>		

**KGS GROUP**  
**Consulting Engineers & Project Managers**

Client Department of Natural Resources  
 Project Floodway Inlet Control Structure Work Program  
 Project No 96 311 01  
 Location St Norbert Manitoba

**Desilting Upgrade Options**

**Cost Estimate**

REV	DATE	BY
0	1 Nov 96	JS
1	31 Jan 97	JS

Item	Description	Quantity	Unit	Unit Cost	Man Hours	\$/Man hour	Labour Cost	Material & Equipment	Total Cost	Notes	Rev
10	Option A Install Piping for Washdown Water	100%	I sum	\$12 000				\$12 000			
	1.1 general cond t ons mechanical	800	lf	\$27	360	\$45	\$16 200	\$21 600	\$37 800		
	1.2 new 3 stainless steel piping for washdown water	150	lf	\$13	60	\$45	\$2 700	\$1 950	\$4 650		
	1.3 stainless steel piping for surge chamber washdown	8	ea	\$696				\$7 168	\$7 168		
	1.4 stainless steel ball valves	2	ea	\$475				\$950	\$950		
	1.5 stainless steel ball valves										
	Total							\$62 568	\$62 568		
	engineering @ 15%							\$9 385	\$9 385		
	contingency @ 10%							\$6 257	\$6 257		
	Total for both gates							\$78 210	\$78 210		
20	Option B Install Well Pump for Washdown Water	100%	I sum	\$8 000				\$8 000	\$8 000		
	2.1 general cond t ons mechanical	20	lf	\$600				\$12 000	\$12 000		
	2.2 drill new 6 dia well (assumed depth 20 ft)	1	ea	\$6 000	20	\$45	\$900	\$6 900	\$6 900		
	2.3 submersible well pump	200	ft	\$60	90	\$45	\$4 050	\$12 000	\$16 050		
	2.4 new 3 stainless steel piping flanged	1	ea	\$896				\$896	\$896		
	2.5 stainless steel ball valve										
	Total							\$43 846	\$43 846		
	engineering @ 15%							\$6 577	\$6 577		
	contingency @ 10%							\$4 385	\$4 385		
	Total for both gates							\$54 808	\$54 808		
30	Option C Install Monorail Beams in Gate Recesses	100%	I sum	\$4 000				\$4 000	\$4 000		
	3.1 general conditions mechanical	4	ea	\$2 000	240	\$45	\$10 800	\$8 000	\$18 800		
	3.2 1/2 ton monorail hoists installed							\$22 800	\$22 800		
	Total							\$3 420	\$3 420		
	engineering @ 15%							\$2 280	\$2 280		
	contingency @ 10%							\$28 500	\$28 500		
	Total for both gates							\$28 500	\$28 500		
40	Option D Install Piping for Silt Discharge	100%	I sum	\$9 000				\$9 000	\$9 000		
	4.1 general conditions mechanical	300	lf	\$66	180	\$45	\$8 100	\$19 800	\$27 900		
	4.2 new 4 stainless steel piping for sludge pump-out	8	ea	\$1 180				\$9 440	\$9 440		
	4.3 4 stainless steel ball valves							\$46 340	\$46 340		
	Total							\$6 951	\$6 951		
	engineering @ 15%							\$4 634	\$4 634		
	contingency @ 10%							\$57 925	\$57 925		
	Total for both gates							\$57 925	\$57 925		
TOTAL	Combined Options A B C & D							\$219 443	\$219 443		



**APPENDIX H**  
**FLOODWAY INLET CONTROL GATE**  
**ASSESSMENT REPORT**

FLOODWAY INLET CONTROL GATE  
ASSESSMENT REPORT

APPENDIX H

OCTOBER, 1996

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## 1 0 INTRODUCTION

The Manitoba Department of Natural Resources operates the Floodway Inlet Structure located on the Red River immediately south of St. Norbert. Although the structure has performed well to date the structure gate seals, mechanical and electrical/control systems are all of original construction (1967). The Department, in consideration of the advancing age of some of these systems and the importance of the inlet structure, has retained KGS Group to assess the floodway inlet structure and components. As a part of this study, a separate analytical assessment of the radial lift control gate was conducted.

The radial control gate was fabricated in 1967 and was to be designed for the condition of operation with one hoist cylinder failed. The gate structure is, however, highly indeterminate and computer analyses were not readily available at the time the gate was designed. On this basis, KGS recommended that trunnions, gate structure and lifting beams be checked to ensure stress levels are within acceptable limits for these extreme load conditions. A finite element model of the gate shell and supporting frames was developed to assess these load conditions. This model considered the skin plate, the frames, and the lifting beams.

The gate was assessed for normal and extreme load conditions. The results are summarized below.

## 2 0 FINITE ELEMENT ANALYSIS

A finite element analysis was conducted by considering the inlet radial gate as an assembly of shell elements on three sides reinforced by frames at 11.3 spacing. The gate is pin supported at the trunnions and at the two lifting points. This structure is subjected to differential pressure loads at various operating and support conditions. Given the complex geometry of the gate, the imposed load conditions and the interaction of the shell surfaces with the structural system, finite element analyses was considered the only method which could provide a representative assessment of the overall gate behavior. The results of the finite element analysis were supplemented with hand calculations at specific locations on the structure.

## 2 1 MODEL DESCRIPTION

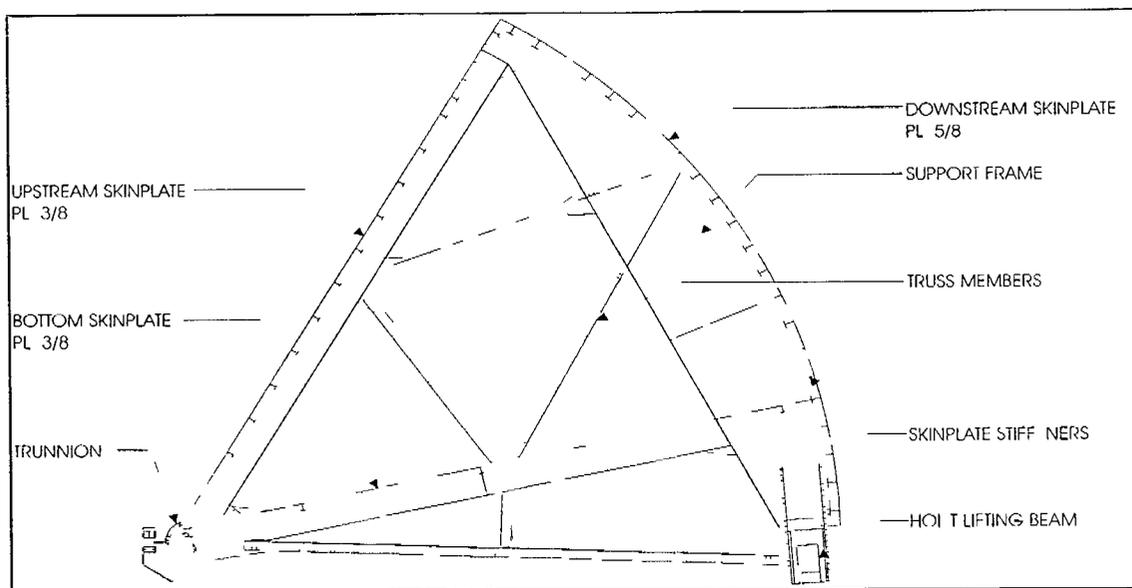
The geometry of the model was taken from drawings supplied by the Department of Natural Resources.

Drawings	940 D-4000	Province of Manitoba Department of Agriculture and Conservation Water Control and Conservation Branch Red River Floodway - Inlet Control Works Gates and Hoists - General Arrangement
	940 D 4001	Province of Manitoba Department of Agriculture and Conservation Water Control and Conservation Branch Red River Floodway - Inlet Control Works Gates and Hoists - Gate - Downstream Elevation and Lifting Beam
	940 D 4002	Province of Manitoba Department of Agriculture and Conservation Water Control and Conservation Branch Red River Floodway - Inlet Control Works Gates and Hoists - Gate - Sections Line 3 to Line 9

940 D 4003 Province of Manitoba  
 Department of Agriculture and Conservation  
 Water Control and Conservation Branch  
 Red River Floodway Inlet Control Works  
 Gates and Hoists Gate Sections Line 2 and Line 10

940 D 4004 Province of Manitoba  
 Department of Agriculture and Conservation  
 Water Control and Conservation Branch  
 Red River Floodway Inlet Control Works  
 Gates and Hoists Gate Sections Line 1 and Line 11

As shown on the figure below the inlet radial gates consist of a 3/8 thick upstream skin plate a 5/8 thick curved downstream skin plate and a 3/8 thick bottom skin plate These skin plates are supported by eleven frames at 11' 3" intervals Angle stiffeners support the skin plate between the frames The structure has an overall length of 112 feet and a radius of 42 feet The structure is supported by the trunnions at the upstream end of each frame Each trunnion pin rotates on self lubricated lubrite bearings through which load is transferred to the support anchors At each of the two lifting points a box beam spanning the two end frames is attached to the hydraulic lifting arm used to raise and lower the gate



The gate structure was modeled using the finite element program Ansys (Figure 2 and 3). Three dimensional shell elements were used to model the curved and flat skin plate shells, the frame sections and the lifting beams. All sections of the gate were considered to be continuously attached to adjacent members. The skin plate tee stiffeners between frames were not considered in the finite element model to simplify the modeling of the gate. For this reason gate loads were applied directly to the frames and the skin plate bending stresses between the frames were calculated by hand. The hand calculations were performed for the skin plate at critical locations and combined with the stresses found from the finite element analysis for an overall stress analysis.

The gate was modeled with pin connections at the trunnions and with the lifting connection support at the same angle that the lifting beam acts on the for the different gate positions.

## 2.2 MATERIAL PROPERTIES

Gate and trunnion member properties are based upon structural steel conforming to ASTM A 36 and CSA G40 21. Allowable stresses are based upon materials shown on the drawings are summarized in Table 1 below and are based upon CSA S16. Although current steel structure design (CSA S16 1 1995) is based upon limit states, gates are normally designed to allowable stress codes with some modified stresses for welds and bolts. Allowable shear stresses for the curved downstream skin plate was based on assessment of buckling strength of a curved shell as calculated by Timoshenko<sup>1</sup>. On this basis, buckling of the stiffened curved skin plate did not govern and shear stresses to CSA S16 were used to calculate the allowable stress.

---

<sup>1</sup> Theory of Elastic Stability: Buckling of Shells, Timoshenko

**Table 1 Summary of material properties and allowable stresses**

	Material Specification	Allowable Stress (ksi)	Comments
<b>Gate and Trunnions</b>			
Steel Plate and Structural Steel	ASTM A36 CSA G40 21	Tension $0.6F_y = 21.6$ Bending $0.6F_y = 21.6$ Shear $0.4F_y = 14.4$	$F_y = 36$ ksi Allowable stresses from S16
<b>Hoists and Embedded Parts</b>			
Steel Plate and Structural Steel	ASTM A36 CSA G40 21	Tension $0.6F_y = 21.6$ Bending $0.6F_y = 21.6$ Shear $0.4F_y = 14.4$	$F_y = 36$ ksi Allowable stresses from S16
Gate Trunnion Anchor Bolts	ASTM A354	Tension $F_u / 3 = 41.7$	$F_u = 125$ ksi
Lubrite Bushings and Washers	ASTM B22 Class E	Bearing $F_p = 4.0$	Bearing manufacturer's recommended average design stress
High Strength Bolts	ASTM A325	Shear $F_v = 15$	Friction fastener Allowable stresses from S16

### 2.3 LOAD CASES

The differential water pressure values used for the finite element analysis were taken from the results of hydraulic model tests of the submersible gates and the inlet control structure conducted by H. G. Acres & Company<sup>2</sup>

Under operating conditions the radial control gates are fully submersed with the gate interior flooded. In the fully raised position the intake bulkhead gates are lifted and the gate interior is pressurized to the upstream head water level above the top elevation of the gate. Under these conditions flow over the top of the gate occurs as shown on Figure 4. As a result of the reduced

<sup>2</sup> Report on Hydraulic Model Tests of the Submersible Gates and Inlet Control Structure H. G. Acres March 1963

pressure flow over the top of the gate and the static head pressure on the inside of the gate the net buoyant force acting on the gate is upward and outwards as shown on Figure 4 This net upwards force is resisted by the hydraulic hoists at the downstream ends of the gate and by the trunnion supports at the upstream end of the gate

When the gate is in the fully lowered position the upstream skin plate is flush with the floodway and a head of at least 6 feet is maintained during the summer months to allow the passage of small craft This head is balanced by pressure inside the gate except when the gate is dewatered Under this condition the upstream skin plate is subject to differential loads of 6 feet of head

The scale model test results showed that the maximum pressure differentials acting on the gate occur with the gate in the fully raised position with a flow of 55 800 cubic feet per second over the top of the gate At this flow condition the top of the gate is at Elevation 762.8 feet the headwater level is at Elevation 778.05 feet and the tailwater level is at Elevation 765.0 feet This load condition results in a maximum net local uplift pressure acting on the skin plate of 24.1 feet of head with a pressure profile acting on the skin plate as shown in Figure 4 Loads derived from this pressure distribution were used for the finite element model analysis of the radial gate

When the gates are in the down position the water level is to be maintained at 6 feet of draft for the passage of small water craft The gate in this position is supported at each frame By inspection this load case was considered to be non critical and was not investigated

It is not clear from the model study report whether or not the pressure differentials take into account the submerged weight of the skin plates. Therefore, the gate models used in this study assume submerged weight for all components of the gate (conservative). Three separate load cases were considered:

- 1 **Operating Conditions** The radial gate in the raised position (gate tip at El. 762.8 ft) differential water pressure acting on the upstream and downstream skin plates. Both lifting hoists are engaged. The net buoyant force on the gate is upward and exceeds the submerged weight of the gate.
- 2 **Failure of One Lifting Hoist** Same loading conditions as Load Case 1 with the radial gate in the raised position differential water pressure acting on the upstream and downstream skin plates. Only one lifting hoist engaged.
- 3 **Gate Jammed** Since maximum force exerted on the lifting beams are in the lifting direction the worst jammed condition is with the gate empty and being lifted on one end with the other end jammed. The maximum cylinder force under this condition is 448 kips upward.

## 2.4 RESULTS OF THE ANALYSIS

The results of the analyses are summarized on Tables 2, 3, and 4. The forces and stresses summarized on these tables were calculated from the results of the finite element analyses and supplemented by hand calculations as described below.

### ***Skin Plate Stresses***

The skin plate stiffeners were not included in the finite element model of the gate to simplify the model. Plots of the downstream skin plate stresses only are shown in the attached figures, as these stresses are higher than the other two skin plates. For the assessment of maximum stresses, each of these plates were evaluated individually.

Upstream and downstream skin plate longitudinal stresses were calculated using the finite element skin plate stresses from the overall behavior of the gate. These were then combined with hand calculations of skin plate stresses at the stiffeners. Combined longitudinal stresses are taken as the sum of the stiffener top skin plate stress and the longitudinal stress from the finite element analysis. These longitudinal stresses are then combined with the skinplate bending stresses between stiffeners (transverse stress at 90° to longitudinal stress) and evaluated in accordance with von Mises Biaxial stress criteria<sup>3</sup>. Maximum skin plate stiffener bottom flange bending stresses were found by hand taking the maximum pressure differential acting on the skin plate and applying this load to a stiffener section spanning between two frames.

The shear stresses on the skin plates due to the overall reaction of the gate were found directly from the finite element analysis.

### ***Trunnion Loads***

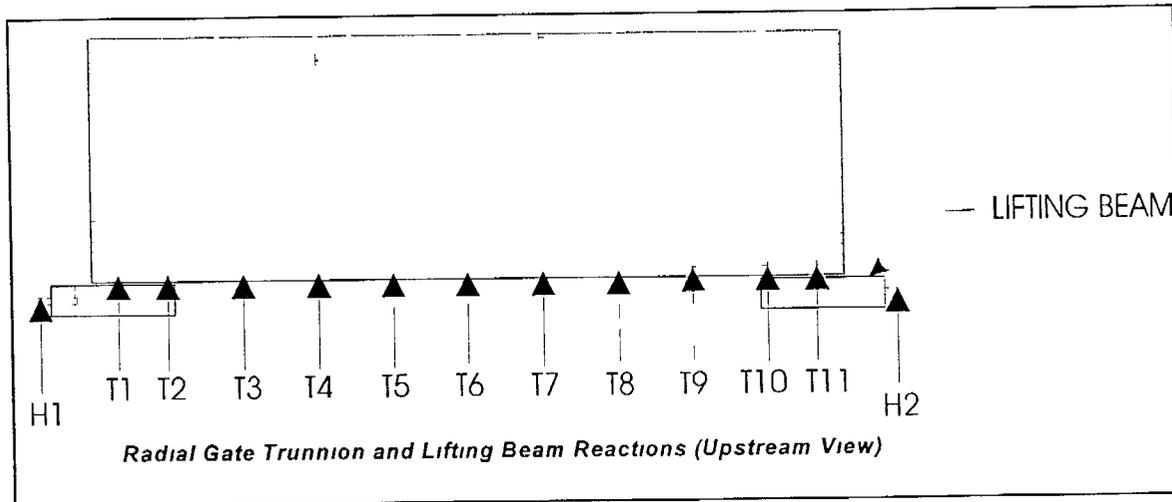
The finite element model of the radial gates calculates the resultant support loads at each trunnion directly. With the maximum trunnion support load, lubric bearing stresses and axial tension stresses through the trunnion supports were calculated. The trunnion anchor stress was calculated assuming that at any given direction of the resultant trunnion force, there are at least 4 of the 8 passive anchor bolts acting in direct tension to resist the force.

---

<sup>3</sup> Theories of Failure J. Marin von Mises stress criteria for two dimensional stress states that at failure the yield strength  $\sigma_y = (\sigma_1 + \sigma_2 + \sqrt{\sigma_1^2 + \sigma_2^2}) / \sqrt{3}$  where in this case  $\sigma_1$  is the longitudinal stress and  $\sigma_2$  is the skin plate bending stress. The allowable combined stress in this case has a safety factor of 1.33 (ie  $F_y/1.33$ )

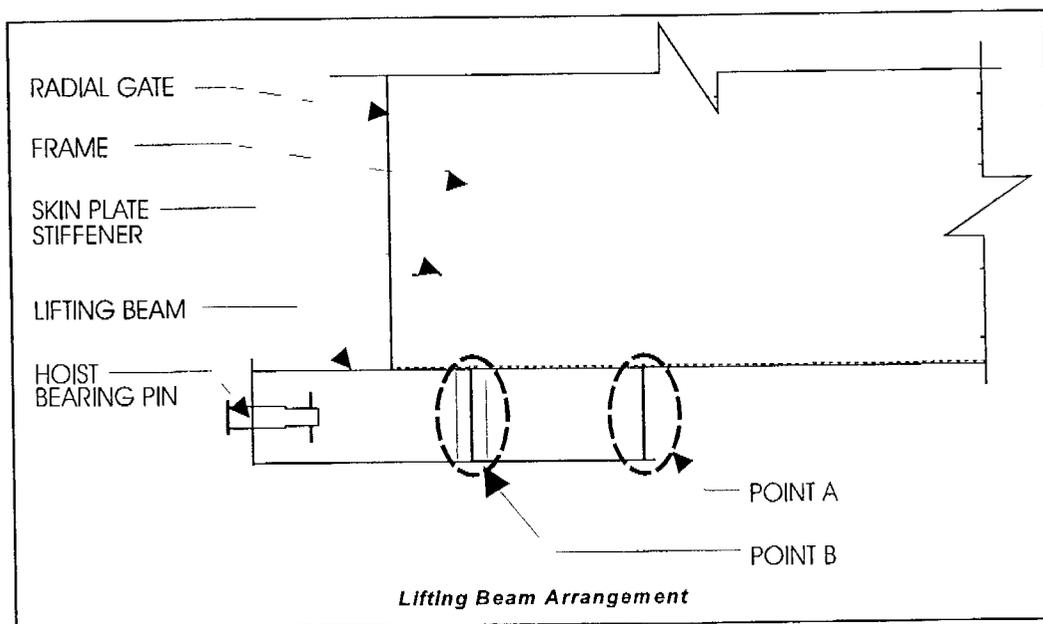
Following the final construction of the gate supplementary trunnion anchors were added. These anchors consisted of two post tensioned cables per trunnion with a total capacity of 370 kips.

The location of the lifting beams and trunnions are shown below.



## Lifting Beam

For each load case the finite element model calculates the resultant force acting on each lifting beam. This hoist force is then used to calculate the bending and shear stresses in the lifting beams, the lifting pin bearing stress, and the bolt stresses through the support connections at Points A & B. The lifting arrangement and critical stress locations are shown below.



As described above, the trunnion and lifting beam support loads, lifting beam splice forces, and critical stresses for the remaining gate components are summarized on Tables 2, 3, and 4 below. Allowable stresses are based upon those given in Table 1 above.

**Table 2 Summary of trunnion and hoist loads**

Support Location	Load Case 1 (Normal) (kips)	Load Case 2 (Extreme) (kips)	Load Case 3 (Extreme) (kips)	Comments
Trunnion 1	272.5	349.9	203.8	
Trunnion 2	330.9	384.7	145.3	
Trunnion 3	395.9	423.3	95.0	
Trunnion 4	433.1	445.2	63.5	
Trunnion 5	452.7	456.2	47.6	
Trunnion 6	458.9	458.9	37.9	
Trunnion 7	452.6	448.9	26.1	
Trunnion 8	433.1	422.0	6.6	
Trunnion 9	395.8	370.0	41.3	
Trunnion 10	330.8	283.6	113.9	
Trunnion 11	272.5	221.3	184.8	
Hoist 1	166.7			Hoist failed Case 2 gate jammed Case 3
Hoist 2	166.7	332.8	400	Maximum hoist uplift force 400 kips Case 3

**Table 3 Lifting Beam Splice Capacity**

Support Location	Load Case 1 (Normal)	Load Case 2 (Extreme)	Load Case 3 (Extreme)	Connection Capacity (kips)	Comments
Support Bolted Connection					<ul style="list-style-type: none"> <li>Total shear force capacity of splice connection bolts</li> <li>Allowable shear capacity based upon allowable force of 11.8 kips per bolt/shear plane (1 diam A325 bolts shear friction)</li> </ul>
• Shear Force at pt A (kips)	220	438	532	566	
• Shear Force at pt B (kips)	385	767	932	1132	

**Table 4 Summary of radial control gate stresses**

	<b>Stress Load Case 1 (Normal) (ksi)</b>	<b>Allowable Stress <math>F_y = 36</math> ksi (Normal) (ksi)</b>	<b>Stress Load Case 2 (Extreme) (ksi)</b>	<b>Stress Load Case 3 (Extreme) (ksi)</b>	<b>Comments</b>
<b>Downstream Skin Plate</b>					
Combined longitudinal	4.69	<b>21.6</b>	4.72	2.37	Finite element results combined with hand calculations for biaxial and longitudinal stresses. Allowable biaxial stress = $F_y/1.33$ . Shear stresses from finite element results. Hand calculations for stiffener bending stresses. Biaxial stresses in tension.
Biaxial	11.93	<b>27.0/21.6</b>	11.86	5.28	
Shear	2.22	<b>14.4</b>	4.33	5.16	
Stiffeners	16.67	<b>21.6</b>	16.70		
bottom flange stress					
<b>Upstream Skin Plate</b>					
Combined longitudinal	7.72	<b>21.6</b>	8.53	1.38	Finite element results combined with hand calculations for biaxial and longitudinal stresses. Allowable biaxial stress = $F_y/1.33$ . Shear stresses from finite element results. Hand calculations for stiffener bending stresses. Biaxial stresses in tension.
Biaxial	9.60*	<b>27.0/21.6*</b>	10.17	7.36	
Shear	1.21	<b>14.4</b>	2.19	2.49	
Stiffeners	7.80	<b>21.6</b>	8.75		
bottom flange stress					
<b>Trunnion</b>					
Axial Tension	17.0	<b>21.6</b>	17.0	7.5	Hand calculations based on finite element trunnion load results.
Pin Bearing	2.53	<b>4.0</b>	2.53	1.1	
Anchor Bolts	36.62	<b>41.7</b>	36.62	16.2	
<b>Lifting Beam</b>					
Bending	10.09	<b>21.6</b>	20.13	24.14	Hand calculations based on finite element hoist load results. Extreme allowable bending stress for load cases 2 and 3 = $1.25(21.6) = 27.0$ ksi.
Shear	2.65	<b>14.4</b>	5.28	6.24	
<b>Lifting Pin Bearing</b>	1.2	<b>4</b>	2.4	2.9	Hand calculations based on finite element hoist load results.

### ***Load Case 1 - Operating Conditions***

The results for the normal operating condition of the radial control gates with both lifting hoists engaged are shown on Tables 2, 3 and 4. As shown on Table 4, the gate stresses are all within allowable stresses for normal load conditions.

The shear stresses for the downstream skin plate are shown in Figure 5 with a maximum of 2.22 ksi. The maximum skin plate stiffener lower flange bending stress was found to be 16.67 ksi on the downstream skin plate.

The upstream and downstream skin plate combined longitudinal stresses were calculated using the finite element overall skin plate stresses of the gate (Figure 6 for the downstream skin plate). These were combined with hand calculations of skin plate bending stresses between the skin plate stiffeners to assess the biaxial conditions. On the basis, maximum biaxial stresses of 11.93 ksi on the downstream skin plate were calculated.

The average trunnion load for this load condition is approximately equal to the additional post tension force applied to the trunnions. The intent of the applied post tension force would be to ensure that the trunnion support does not go into tension. At the maximum trunnion load of 458.9 kips, the trunnion post tension force would be exceeded. Although the trunnion support still has adequate capacity (original passive anchors), the centre trunnions should be inspected thoroughly for fatigue related distress at the trunnions.

The resultant force acting on each lifting beam was calculated by the finite element analysis for each load case. This hoist force was then used to calculate a maximum bending stress of 10.09 ksi and a maximum shear stress of 2.65 ksi in the box shaped lifting beams. As shown on Table 4 these are all within allowable stresses for normal load conditions. The calculated lifting pin bearing stress is 1.2 ksi.

The lifting beam is connected to the gate via two bolted straps at points A and B respectively (see sketch above). The forces through the support connections are 220 kips at Point A and 385 kips at Point B. At Point A forces are resisted by 48.1 A325 bolts (single shear). The maximum capacity of this connection (assuming 11.8 kips/shear plane S16.0) is 566 kips. Similarly at Point B forces are resisted by 70.1 A325 bolts (44 in single shear and 26 in double shear). The maximum capacity of this connection (assuming 11.8 kips/shear plane S16.0) is 1132 kips. In both bases the capacity exceeds the support forces.

### ***Load Case 2 Failure of One Lifting Hoist***

The results for this extreme condition with one lifting hoist failed are shown in Tables 2, 3 and 4. As shown on Table 4 the gate stresses are all within allowable stresses for normal load conditions.

The shear stresses for the downstream skin plate are shown in Figure 7 with a maximum of 4.33 ksi. The maximum skin plate stiffener lower flange bending stress was found to be 16.70 ksi on the downstream skin plate.

The upstream and downstream skin plate combined longitudinal stresses were calculated using the finite element overall membrane skin plate stresses (Figure 8 for the downstream skin plate) in combination with hand calculations of skin plate bending stresses between the skin plate stiffeners with a maximum biaxial stress of 11.86 ksi for the downstream skin plate

The maximum calculated trunnion load was 458.9 kips at the center trunnion. Under these conditions the maximum bearing stress is 2.53 ksi with an average tension stress of 36.6 ksi in the anchor bolts. With the exception of the concern regarding the post tension anchor capacity above these are both acceptable

With the one hoist failed the resultant force acting on the active lifting beam was 332 kips double that for the normal load condition. Under these conditions a maximum bending stresses of 20.13 ksi and a maximum shear stresses of 5.28 ksi in the lifting beam were calculated. As shown on Table 4 these are all within allowable stresses. The lifting pin bearing stress is 2.4 ksi which is also within allowable limits

As shown on Table 3 lifting beam connection forces of 438 kips and 767 kips at Points A and B respectively are within allowable limits

With one lifting hoist failed the capacity of the single cylinder to resist the overall gate buoyant forces is exceeded. The maximum cylinder force capacity with the head end pressure at 600 psi is 228 kips. This is insufficient to hold the gate in position against the uplift forces which requires a restraining force of 336 kips with a single cylinder active. This condition has never been previously experienced and the implications associated with the hoist overload are discussed in the mechanical section of the main report

### *Load Case 3 Gate Jammed*

The results for this extreme condition with the gate jammed on one end and the hoist on the other end lifting the gate with the maximum uplift hoist capacity are shown in Tables 2, 3 and 4

The upstream and downstream skin plate combined longitudinal stresses were calculated using the finite element overall skin plate stresses of the gate (Figure 10 for the downstream skin plate). This load case assumes no skin plate loading. Therefore, no skin plate bending stresses between the skin plate stiffeners are present. As shown on Table 4, maximum calculated biaxial stress of 5.28 ksi on the downstream skin plate are within allowable limits. The shear stresses for the downstream skin plate are shown in Figure 9 with a maximum of 5.16 ksi.

The maximum calculated trunnion load was 203.8 kips at the end trunnion where the gate jams. For this condition, the maximum tension stress in the trunnion supports is 7.5 ksi. The maximum bearing stress is 1.1 ksi with an average tension stress of 16.2 ksi in the anchor bolts. These are within acceptable limits.

With the lifting force of 400 kips applied to one lifting beam with the other end of the gate jammed, a maximum bending stress of 24.14 ksi and a maximum shear stress of 6.42 ksi in the lifting beams was calculated. As shown on Table 4, these are within allowable stresses for the extreme load conditions. The allowable stresses were considered have to be increased by 25% for this extreme condition. The lifting pin bearing stress is 2.9 ksi.

The lifting beam connection forces of 532 kips and 932 kips respectively are within the capacity of the bolted connections at these locations.

### 3 0 ASSESSMENT OF THE RESULTS

The maximum stresses for each load case are shown in Table 4. For all three load conditions maximum skin plate stresses were found on the downstream skin plate. All critical stresses were within the acceptable stress limits for normal and extreme conditions. The downstream skin plate stresses are the highest since this skin plate effectively carries the unbalanced load perpendicular to the gate as a beam to the lifting beams.

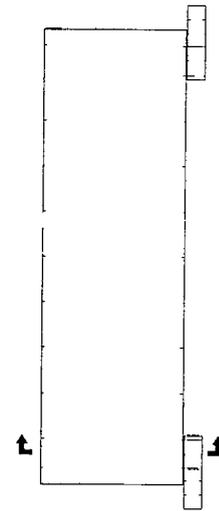
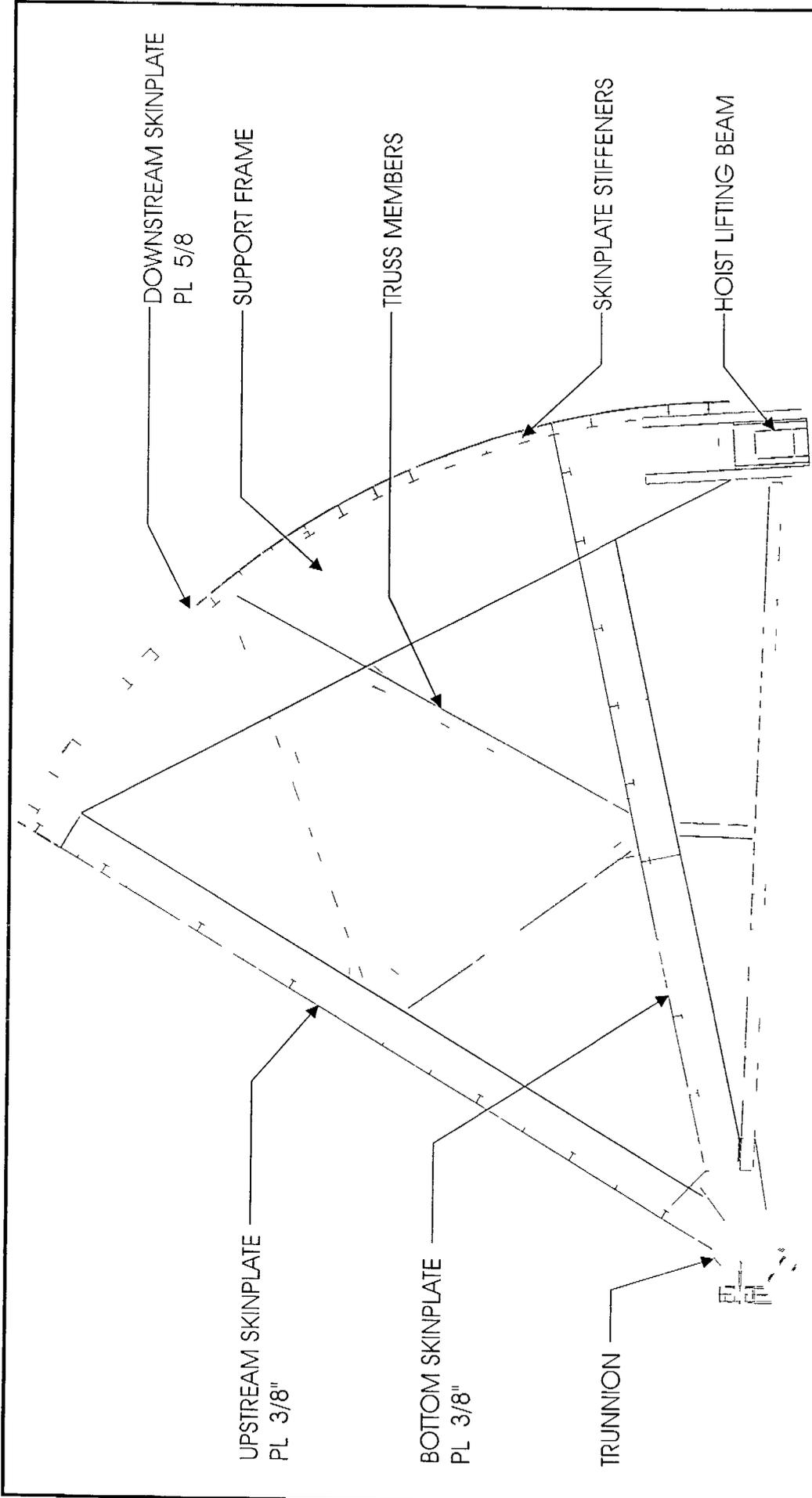
As shown on Figure 4 the net hydraulic force is outward and upward during operating conditions. The majority of the unbalanced force acts radially outwards and is effectively resisted by the radial frames and trunnion support. The trunnion lifting loads for each load case are shown on Table 2. In all cases the maximum trunnion loads were within allowable limits for the anchors and the trunnion bearings. Maximum trunnion loads do however exceed the post tensioning forces added after the gate was constructed as the total post tension force appears to have been sized for the average loads. The highest loaded trunnions should be assessed when the gate is dewatered.

## 4 0 CONCLUSIONS

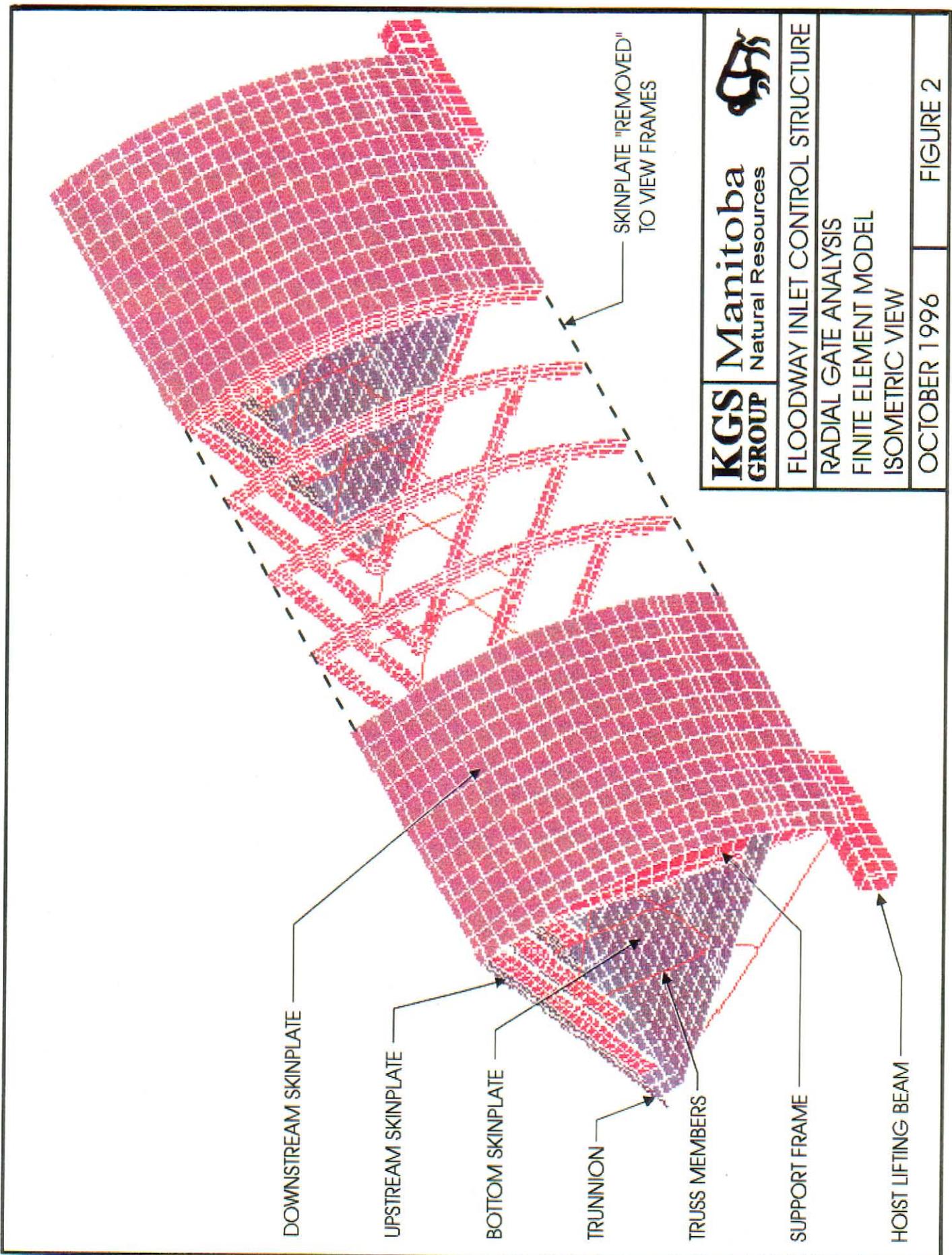
Based upon the results of the finite element analysis of the intake it was concluded that

- The radial control gate was modeled as an assemblage of shell elements and reasonably predicts the overall behavior of this indeterminate structure
- Steel gate stresses for normal and extreme load conditions were found to be within acceptable limits for structures of this type
- For the condition of one hoist cylinder failed the calculated reaction at the remaining lifting beam support exceeds the theoretical capacity of the lifting hoist. The impact of this load result was assessed in the mechanical section of the report
- Maximum trunnion loads exceed the additional post tension force provided after the gate had been installed. This implication of the over stressed condition should be reviewed again when the trunnions are inspected

FIGURES



<b>KGS GROUP</b>	<b>Manitoba</b> Natural Resources	
	<b>FLOODWAY INLET CONTROL STRUCTURE</b>	
<b>RADIAL GATE ANALYSIS</b>		
<b>FINITE ELEMENT MODEL</b>		
<b>GENERAL ARRANGEMENT</b>		
OCTOBER 1996	FIGURE 1	

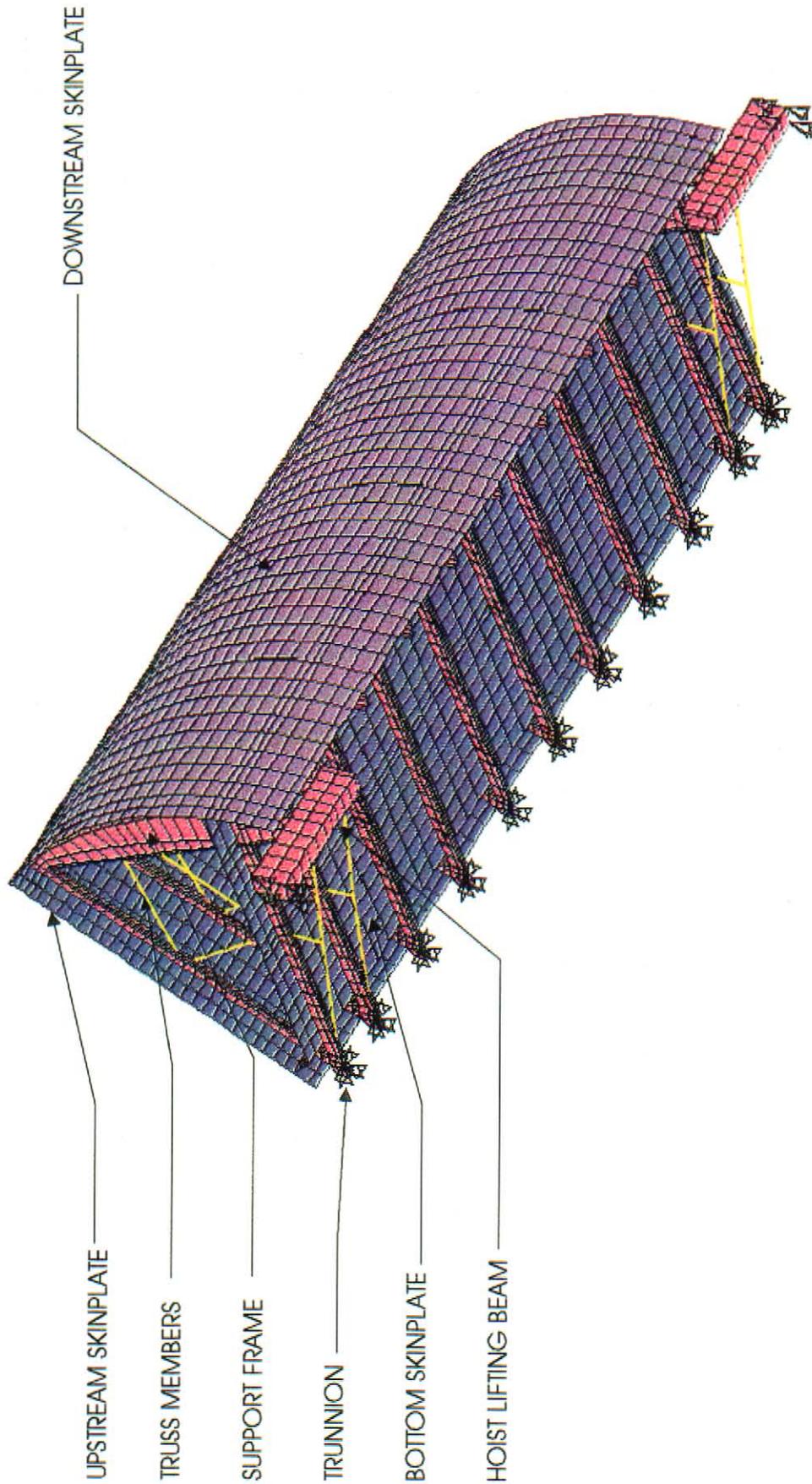


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Natural Resources

FLOODWAY INLET CONTROL STRUCTURE  
 RADIAL GATE ANALYSIS  
 FINITE ELEMENT MODEL  
 ISOMETRIC VIEW

OCTOBER 1996

FIGURE 2



DOWNSTREAM SKINPLATE

UPSTREAM SKINPLATE

TRUSS MEMBERS

SUPPORT FRAME

TRUNNION

BOTTOM SKINPLATE

HOIST LIFTING BEAM

**KGS**  
**GROUP**

**Manitoba**  
Natural Resources



FLOODWAY INLET CONTROL STRUCTURE

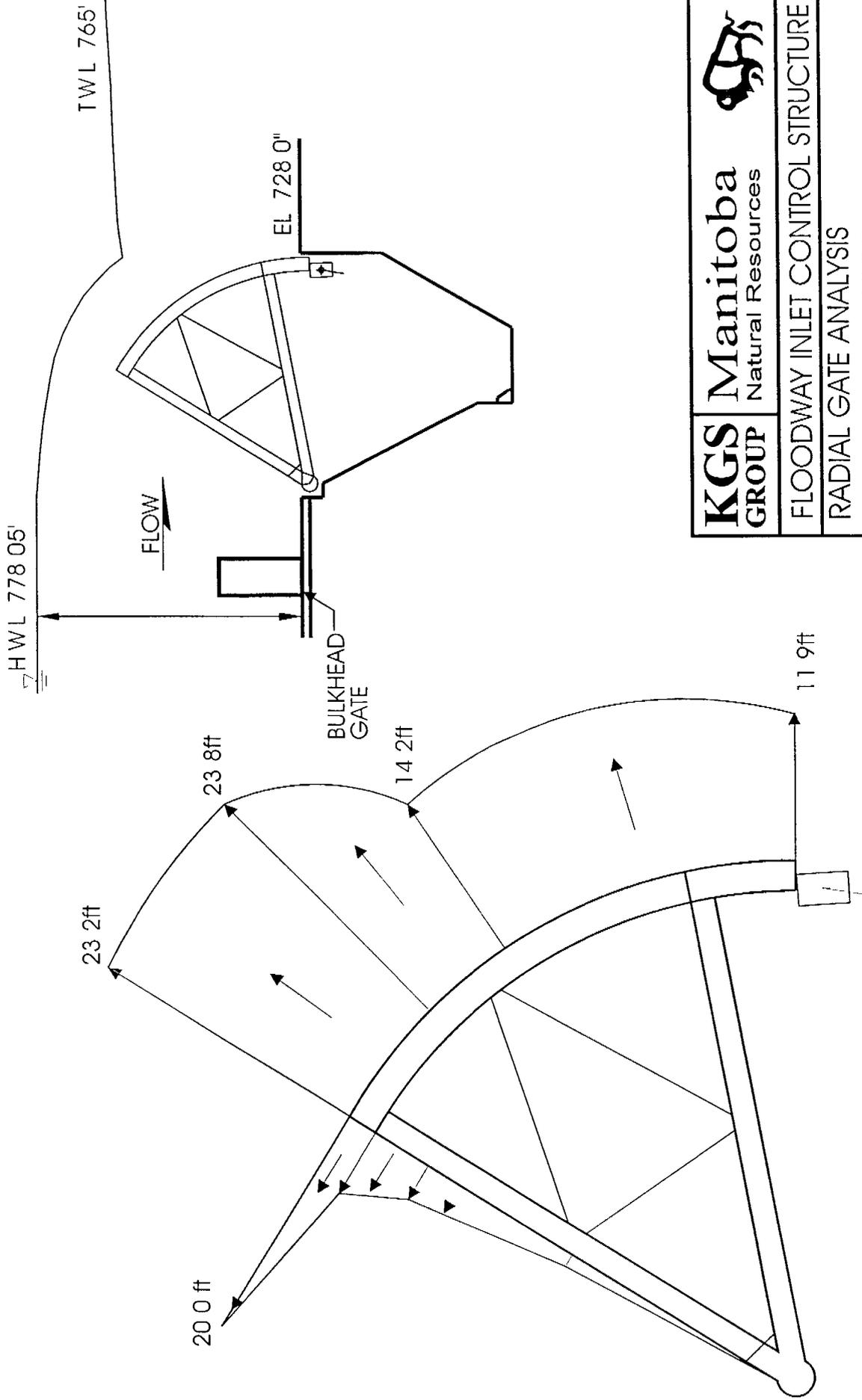
RADIAL GATE ANALYSIS

FINITE ELEMENT MODEL

ISOMETRIC VIEW

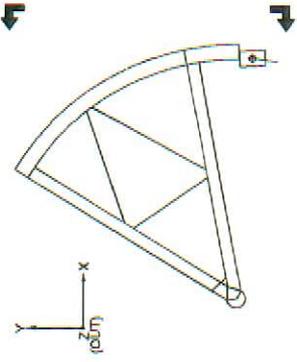
OCTOBER 1996

FIGURE 3



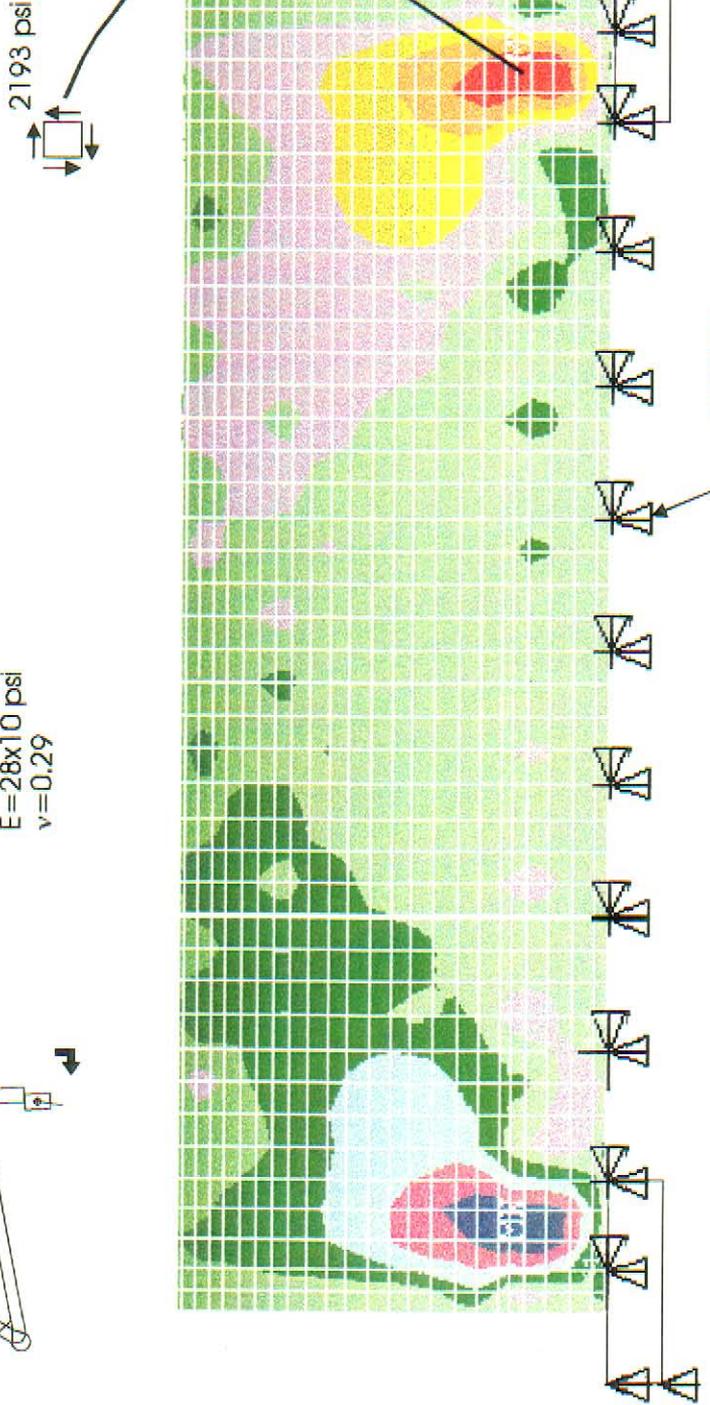
NET BUOYANT FORCE ACTING ON GATE  
(FEET OF HEAD)

<b>KGS GROUP</b>	<b>Manitoba</b> Natural Resources	
FLOODWAY INLET CONTROL STRUCTURE		
RADIAL GATE ANALYSIS		
FINITE ELEMENT MODEL		
NORMAL OPERATING CONDITION		
OCTOBER 1996	FIGURE 4	



**LOAD CASE 1**  
 -BOTH ENDS SUPPORTED  
 -NORMAL OPERATING LOADS

$E=28 \times 10^4 \text{ psi}$   
 $\nu=0.29$

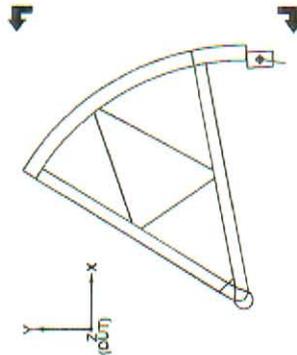


SHEAR STRESS (psi)

-2219
-1729
-1238
-748.232
-258.012
232.207
722.427
1218
1703
2193

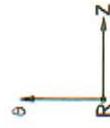
DOWNSTREAM SKINPLATE

<b>KGS GROUP</b> <b>Manitoba</b> Natural Resources		FLOODWAY INLET CONTROL STRUCTURE
		RADIAL GATE ANALYSIS FINITE ELEMENT MODEL LOAD CASE 1 - SHEAR STRESS
OCTOBER 1996	FIGURE 5	

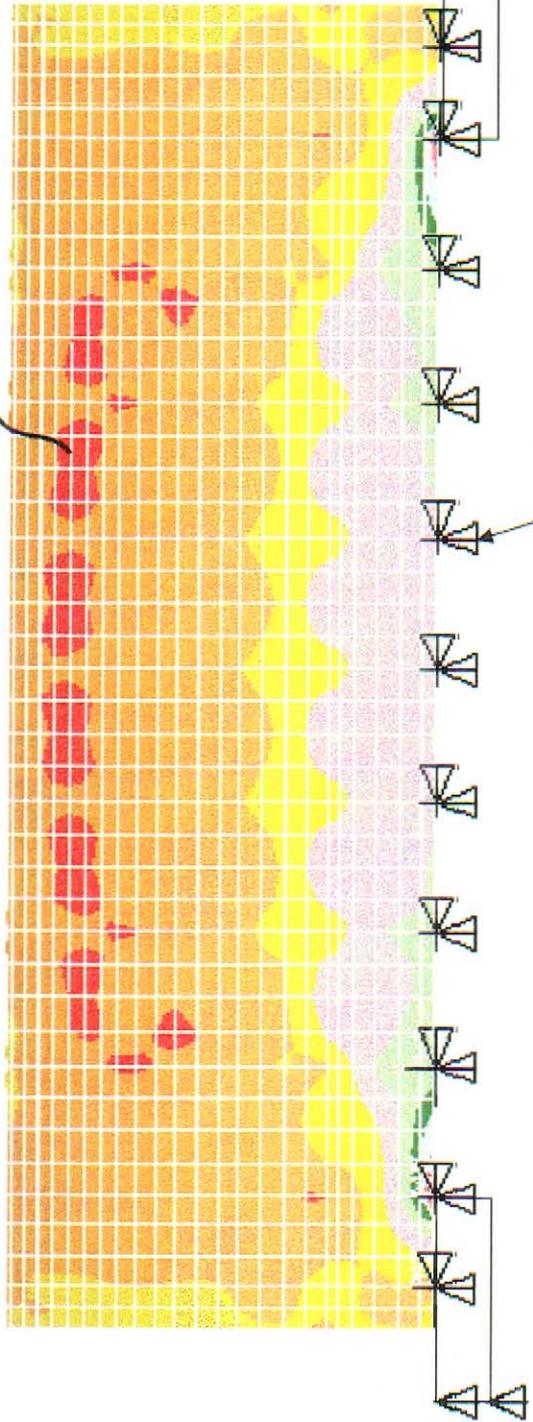


**LOAD CASE 1**  
 -BOTH ENDS SUPPORTED  
 -NORMAL OPERATING LOADS

$E=28 \times 10^4 \text{ psi}$   
 $\nu=0.29$

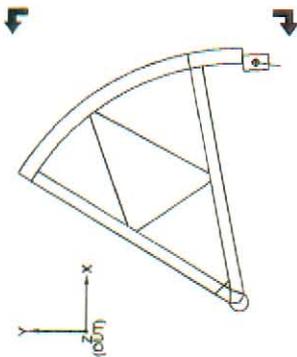


LONGITUDINAL STRESS (psi)



DOWNSTREAM SKINPLATE

<b>KGS GROUP</b>	<b>Manitoba</b> Natural Resources	
FLOODWAY INLET CONTROL STRUCTURE		
RADIAL GATE ANALYSIS		
FINITE ELEMENT MODEL		
LOAD CASE 1 - LONGITUDINAL STRESS		
OCTOBER 1996		FIGURE 6



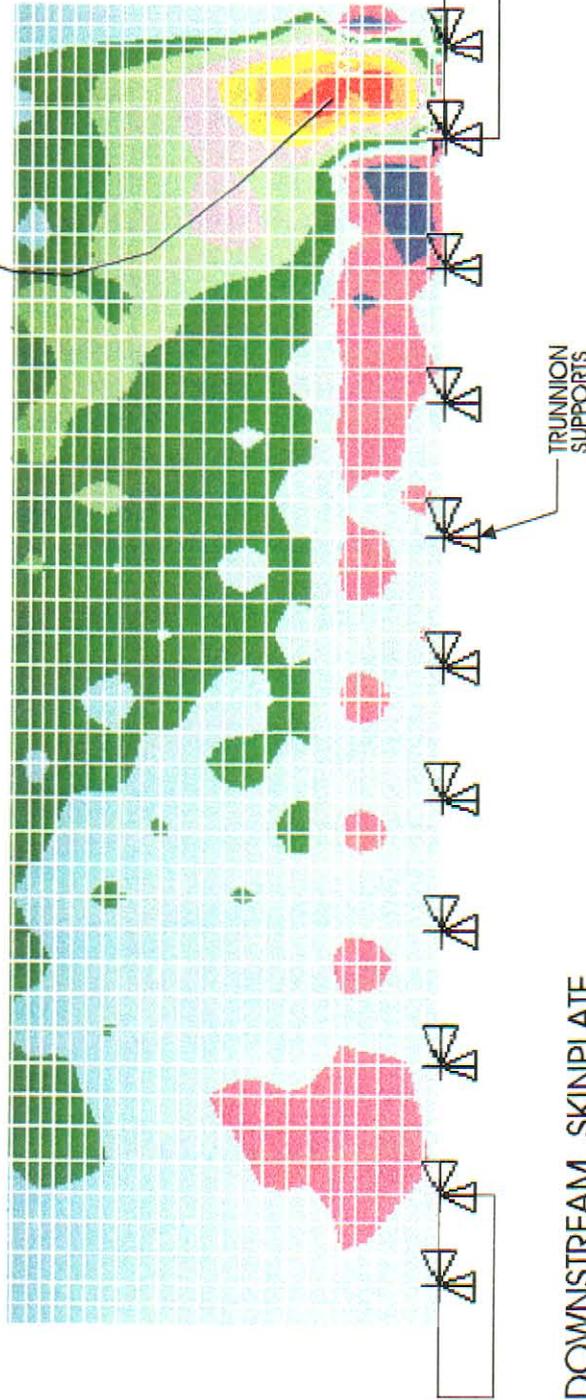
**LOAD CASE 2**  
 -ONE END SUPPORTED  
 -NORMAL OPERATING LOADS

$E=28 \times 10^4 \text{ psi}$   
 $\nu=0.29$

4332 psi



SHEAR STRESS (psi)



DOWNSTREAM SKINPLATE

**KGS GROUP**

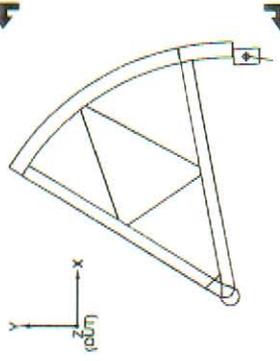
**Manitoba**  
 Natural Resources



FLOODWAY INLET CONTROL STRUCTURE  
 RADIAL GATE ANALYSIS  
 FINITE ELEMENT MODEL  
 LOAD CASE 2 - SHEAR STRESS

OCTOBER 1996

FIGURE 7

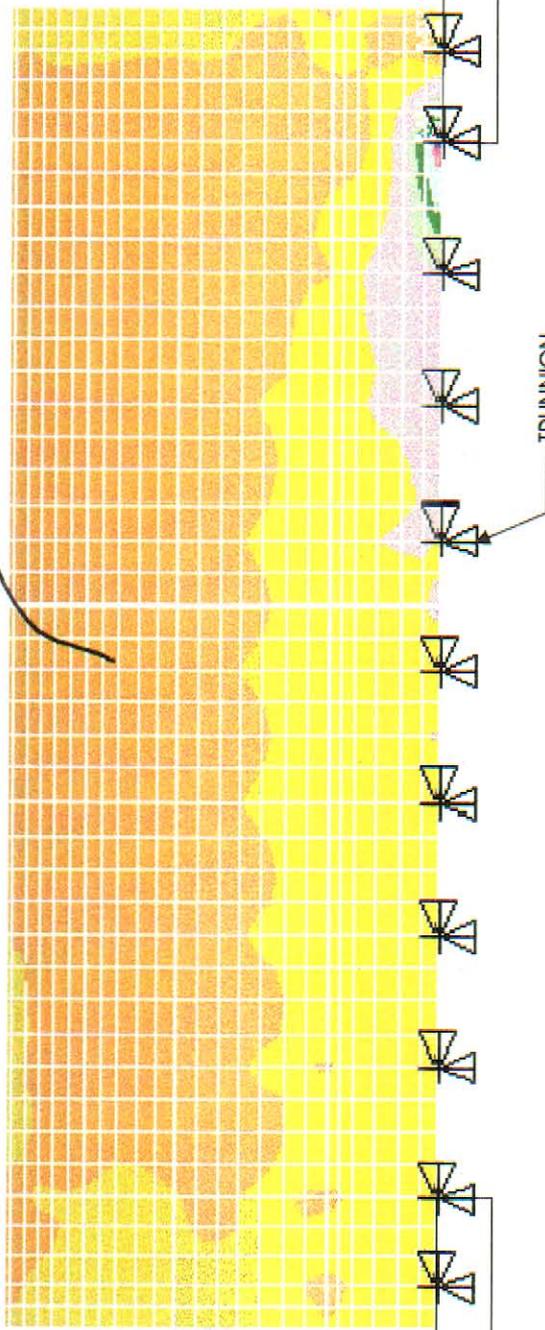


**LOAD CASE 2**  
 -ONE END SUPPORTED  
 -NORMAL OPERATING LOADS

$E = 28 \times 10^6 \text{ psi}$   
 $\nu = 0.29$

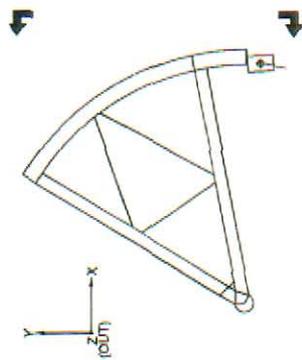


LONGITUDINAL STRESS (psi)



DOWNSTREAM SKINPLATE

<b>KGS GROUP</b>	<b>Manitoba</b> Natural Resources	
FLOODWAY INLET CONTROL STRUCTURE		
RADIAL GATE ANALYSIS		
FINITE ELEMENT MODEL		
LOAD CASE 2 - LONGITUDINAL STRESS		
OCTOBER 1996	FIGURE 8	



### LOAD CASE 3

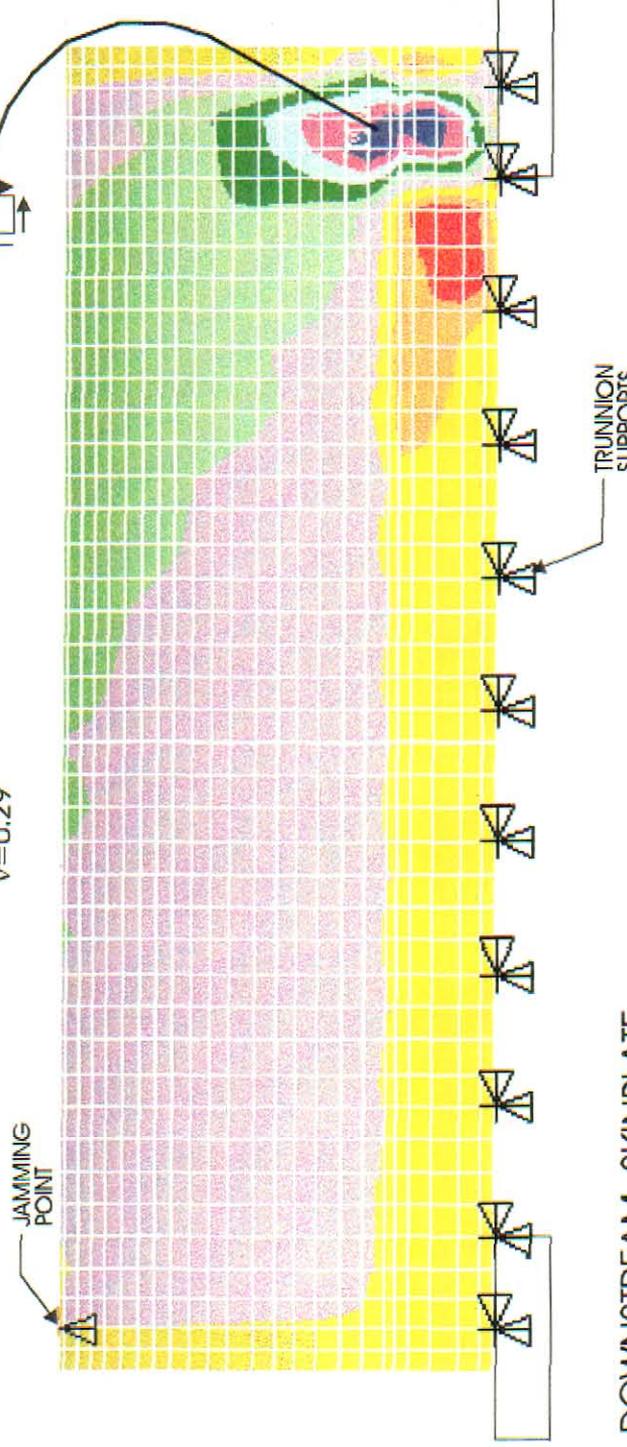
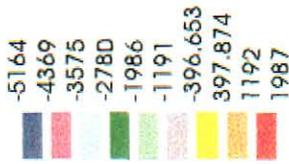
- HOIST LIFTING ONE END
- GATE JAMMED OPPOSITE END
- NO PRESSURE LOAD
- DRY WEIGHT OF GATE

$E = 28 \times 10^4 \text{ psi}$   
 $\nu = 0.29$

5164 psi

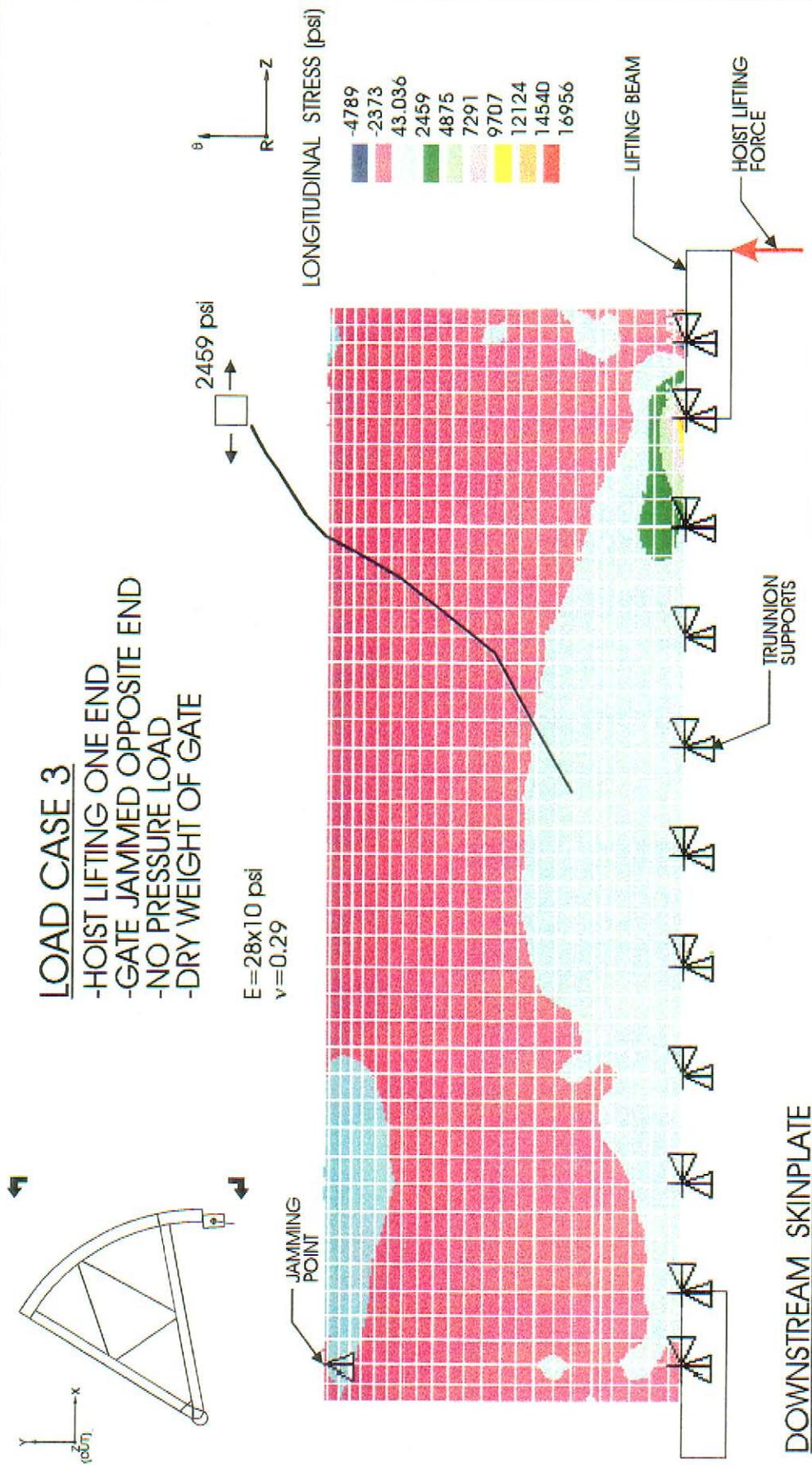


SHEAR STRESS (psi)



DOWNSTREAM SKINPLATE

<b>KGS GROUP</b>	<b>Manitoba</b> Natural Resources	
FLOODWAY INLET CONTROL STRUCTURE		
RADIAL GATE ANALYSIS		
FINITE ELEMENT MODEL		
LOAD CASE 3 - SHEAR STRESS		
OCTOBER 1996	FIGURE 9	



<b>KGS GROUP</b>	<b>Manitoba</b> Natural Resources	
FLOODWAY INLET CONTROL STRUCTURE		
RADIAL GATE ANALYSIS		
FINITE ELEMENT MODEL		
LOAD CASE 3 - LONGITUDINAL STRESS		
OCTOBER 1996		FIGURE 10