Trow

DAM SAFETY REVIEW
WILTON ROAD DAM

CATARAQUI REGION
CONSERVATION AUTHORITY

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MAY 2006

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EXECUTIVE SUMMARY

In the fall of 2005, as a follow-up to the Safety and Maintenance Assessment undertaken in July 2004, a data collection and dam inspection program was conducted to record and document information on the Wilton Road Dam and the general site conditions.

Hydrologic evaluations were undertaken to determine watershed characteristics, flows and runoff volumes for various return frequency snowmelt events. The model of the watershed was provided by the Cataraqui Region Conservation Authority. The dam stage-discharge-storage relationships were updated and combined with the hydrologic model of the watershed regime to determine the lake water levels and outflows from the dam for various return frequency events.

The dam Hazard Potential Classification was determined to be “Low” with an associated Inflow Design Flood (IDF) of the Regulatory Flood (100 year flood). Based on the hydrotechnical assessments, it was determined that the dam has sufficient capacity to safely convey the flow from the IDF.

Stability assessments undertaken have concluded that the dam meets the draft Ontario Dam Safety Guidelines. The north overflow weir does not meet the minimum factors of safety for sliding; however as it is joined to the control structure piers as well as the Wilton Road bridge, it is considered to be stable.

In general, Wilton Road Dam is in good condition. A few deficiencies have been identified with respect to operator/public safety (e.g. inadequate handrail height and signage) and normal dam operations (e.g. clogging of the low flow gate valve and a damaged staff gauge). A capital plan has been developed to address these deficiencies. The plan, inclusive of capital and engineering costs, is estimated to be $62,000.

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1.0 INTRODUCTION

1.1 GENERAL

In October 2005, the Cataraqui Region Conservation Authority (CRCA) retained Trow Associates Inc. to undertake a Dam Safety Review of Wilton Road Dam.

The Dam Safety Review involved:

1. Collection and review of background information

2. Site reconnaissance and dam inspection

3. Hydrotechnical assessments of the watershed response and hydraulic performance of the dam for various hydrologic simulated flood events

4. Determination of the Hazard Potential Classification and Inflow Design Flood

5. Stability evaluation

6. Dam rehabilitation measures

7. Preparation of a report documenting the project procedures, assumptions, findings and recommendations to assist in the implementation of the rehabilitation of the dam.

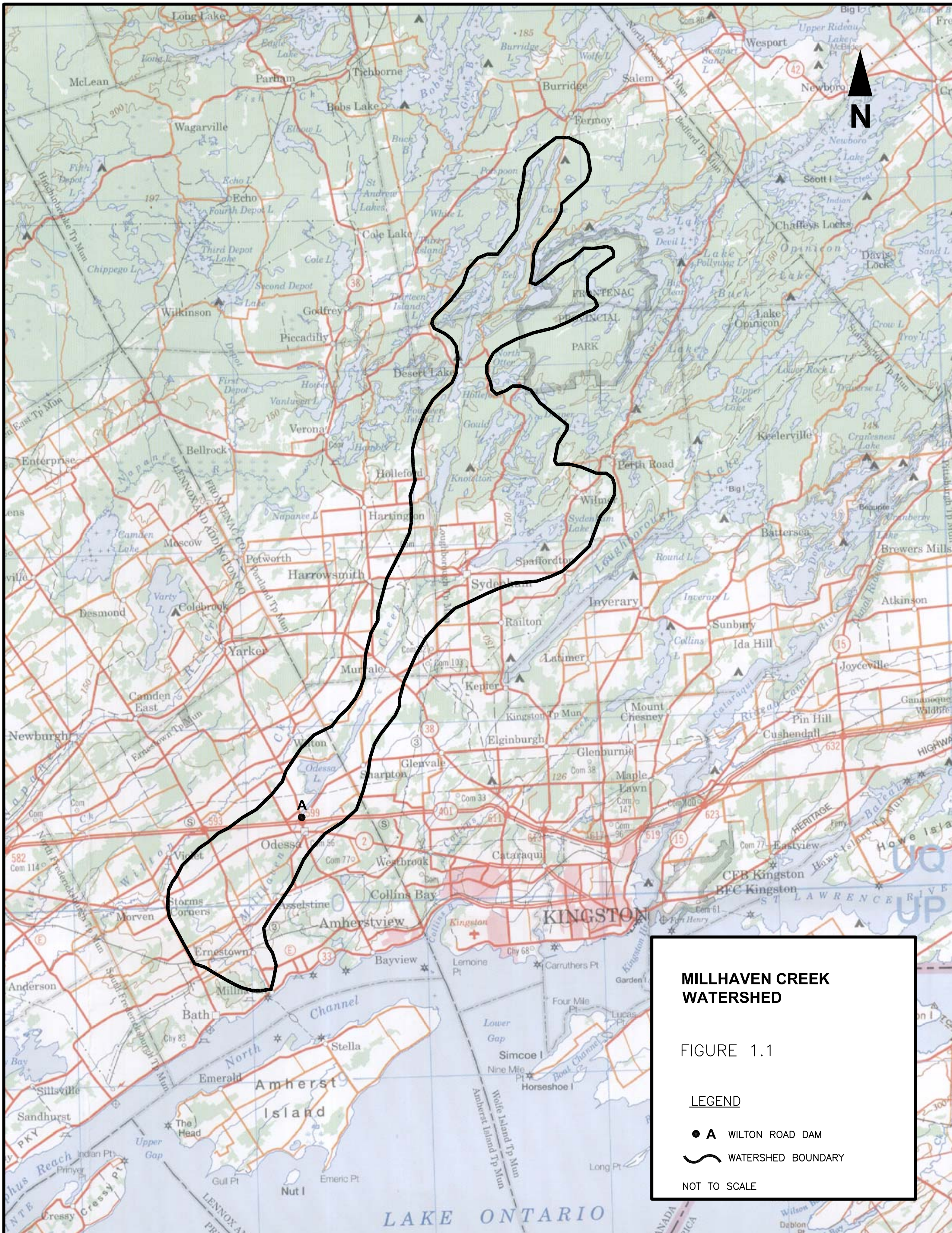
1.2 MILLHAVEN CREEK WATERSHED

Millhaven Creek at Wilton Road Dam (see Figure 1.1) drains an area of 123 km^2. Wilton Road Dam is located outside the Village of Odessa, immediately north of Highway 401. The dam controls a wetland complex which forms Mud (Odessa) Lake.

Millhaven Creek drains in a primarily southwest direction through three municipalities (South Frontenac Township, City of Kingston and Loyalist Township) towards Lake Ontario. The headwaters of Millhaven Creek are located at Gould Lake. From here the creek flows into Sydenham Lake which is controlled by the Sydenham Lake Dam. The creek continues through the Town of Sydenham and into a wetland. Following Wilton Road Dam, the creek flows through Potters Dam (just upstream of Highway 2), and then past the Babcock Mill Dam (south of Highway 2). Wilton Road Dam controls flows within the middle one-third of the watershed.

1.3 GEOLOGY

Geological mapping indicates that the dam site is underlain by the Gull River limestone formation, belonging to members B, C, and D. Soils mapping shows that the soils are mainly loams and organics, either Farmington loam, Lincoln clay or Renfrew clay.



MILLHAVEN CREEK WATERSHED

FIGURE 1.1

2.0 SITE RECONNAISSANCE AND BACKGROUND INFORMATION

2.1 SITE RECONNAISSANCE

2.1.1 General

In November 2005, Trow and CRCA personnel undertook a site reconnaissance of the Wilton Road Dam located in the Millhaven Creek Watershed.

The dam (Figure 2.1) is located in Loyalist Township. It can be reached from Kingston by traveling approximately 15 km west on Highway 401 to the Village of Odessa. Take the Wilton Road exit (Exit #599) and travel 0.5 km north to the dam.

The reconnaissance was undertaken to digitally photograph the dam and surroundings to establish the requirements for site surveys and a dam inspection.

Pertinent photographs of the dam are included in Appendix A.

2.1.2 Wilton Road Dam

The Wilton Road Dam is also known as both the Millhaven Dam and the Odessa Dam. The dam is a reinforced concrete structure immediately upstream of the bridge crossing at Wilton Road. The control structure has been constructed similar in shape to a horseshoe and consists of four gated bays and a low flow gate valve facing the lake.

These gates are overshot and the valve is undershot. The flow is adjusted by lowering and raising the gate either by winch structures or a threaded rod and wheel. The gates are used solely in the summer months and are raised for the winter. The low flow valve is used for augmenting downstream flows during the summer months.

There are spillways on each end of the dam that extend between the control structure and the bridge abutments.

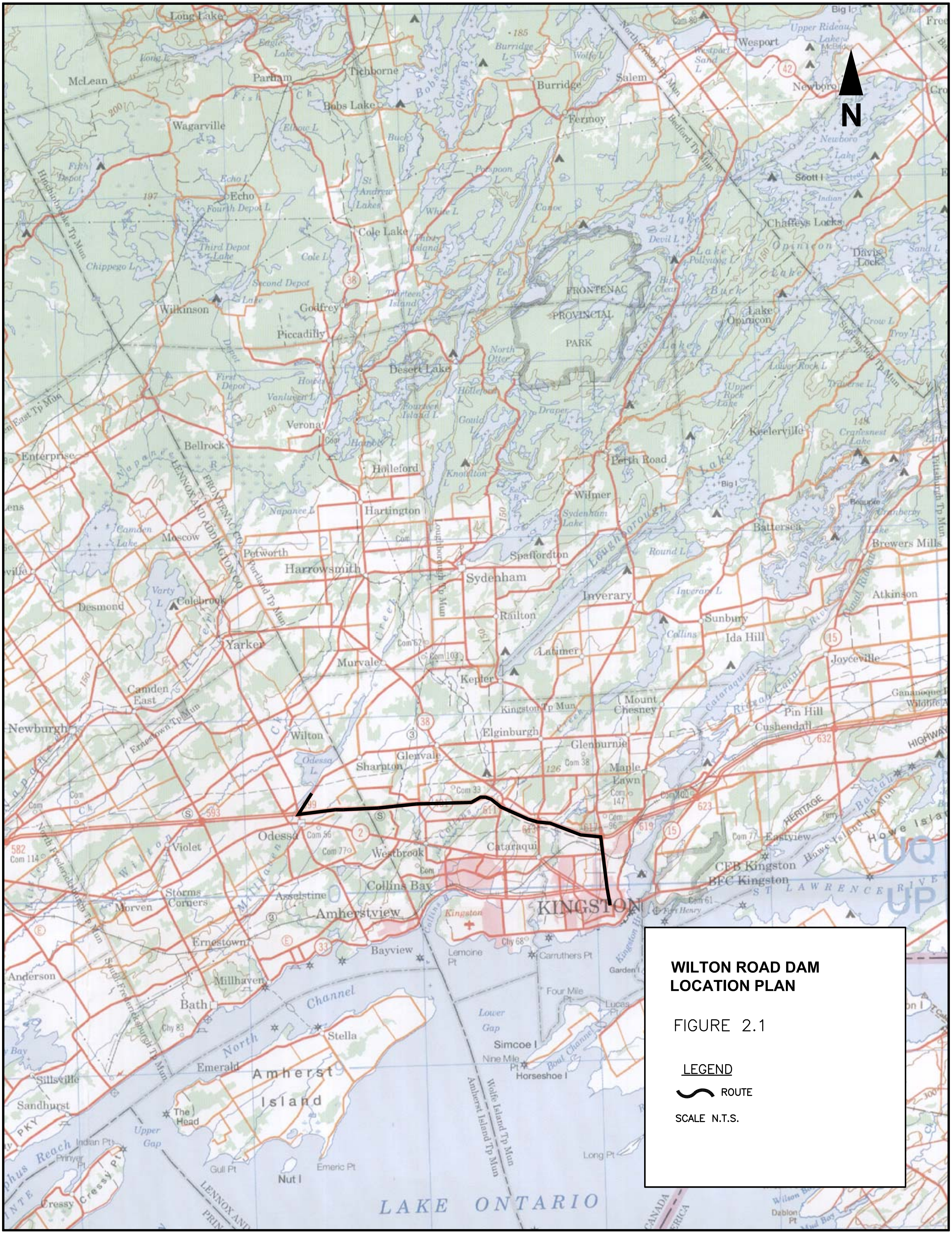
The Wilton Road bridge is a separate concrete structure, has a clear span, and is maintained by Loyalist Township. The outlet channel from the dam flows through the bridge to the downstream natural channel.

The dam is situated within the middle one-third of the watershed. There are occasional downstream beaver dams and other obstructions that could create backwater effects, possibly limiting dam discharge. There is a bedrock outcrop downstream of the Highway 401 that controls water levels at the dam during winter periods.

A recreational Conservation Area is located upstream of the dam and provides paddling opportunities, as well as creating habitat for fish and waterfowl. Downstream of the structure, there are residential developments and road crossings.

Access to the dam is along the road embankment and climbing over the guard rail of the Wilton Road bridge. The access is open to traffic and can be slippery during winter conditions. Concrete steps have been constructed on the north side of the dam parallel to the bridge headwall to gain access to and for reading the staff gauges.

There is signage warning of fast moving water. There are also handrails enclosing the control structure.



WILTON ROAD DAM LOCATION PLAN

FIGURE 2.1

LEGEND

ROUTE

SCALE N.T.S.

2.2 BACKGROUND INFORMATION

2.2.1 General

During the course of conducting the study and the reconnaissance survey of the dam, Trow obtained the following background information on the Wilton Road Dam:

1. Digital drawings by Totten Sims Hubicki Associated Limited, dated 1974, illustrating plans, elevation and section of the dam. The survey of the dam was carried out in December 1997.

2. General information concerning regulated water levels, operations, and dam elevations, dated 2000-2004.

3. ***Draft Wilton Road Dam Operations Manual***, July 2001.

4. Dam Inspection Reports dated 1985, 1995 and 2000-2005 for Wilton Road Dam, carried out by Cataraqui Region Conservation Authority. Evaluations were done for the safety equipment, structure and control mechanism and recommendations made if deficiencies were identified.

5. ***Safety and Maintenance Assessment Study for Water Control Structures***, July 2004.

In addition, Trow obtained the following information for carrying out the hydrotechnical assessments:

1. Hard copies of the 1:250,000 topographic mapping

2. Hard copies of the 1:50,000 topographic mapping.

3. Hard copies of the 1:10,000 Ontario Base Mapping in the vicinity of the dam.

4. Flood risk maps for Millhaven Creek in the vicinity of the dam (1:2,000 scale).

2.2.2 Safety and Maintenance Assessment Report

In 2003-2004, the CRCA retained Trow to undertake a Safety and Maintenance Assessment Study of eleven water control structures, including Wilton Road Dam. Ten of the structures were owned and operated by the CRCA while one is owned and operated by Loyalist Township.

The study focused on evaluating the structures with respect to their current conditions to identify any safety and maintenance deficiencies. Deficiencies were identified with respect to operations, maintenance, materials and safety. Recommendations were made to address the deficiencies with prioritization based on those deficiencies most urgently needed for public and operator safety.

It was also recommended that a full Dam Safety Review be undertaken at each applicable site according to the draft Ontario Dam Safety Guidelines. The review was to be undertaken in order of the Hazard Potential Classification, beginning with those structures having a “High” hazard potential. Dams with a High Hazard Potential Classification would also require a dam break analysis in order to generate flood inundation mapping. Wilton Road Dam was identified as “High” based on work by the Conservation Ontario committee responsible for the Water and

Erosion Control Infrastructure database.

2.2.3 Operations

Wilton Road Dam was constructed in 1975 to provide a dependable source of water for the Village of Odessa's water treatment and sewage treatment plants. These two plants were constructed in 1970. It was found that Millhaven Creek was prone to drying up in the fall and could not meet the demand of the plants. The dam was built to store water from the spring freshet and augment flow through the drier months. In 2000, the Village of Odessa converted to Lake Ontario water for its water supply. The dam currently augments flow for the sewage treatment plant only.

The dam is a reinforced concrete structure (deck elevation 126.64 m) with four steel gates (width 4.57 m or 15 ft) and a 1.22 m (4 ft) wide by 1.83 m (6 ft) high aluminum plate low flow gate valve. The sill elevation for the gates is 122.83 m GSC (403.00 ft). There are also two overflow weirs (4.17 and 9.14 m long) on the north and south side of the structure with a crest elevation of 124.36 m (408.00 ft).

The operation of Wilton Road Dam is as follows:

	Gauge Reading (feet)	Water Level (metres GSC)	(feet)
Maximum Acceptable Level	3.5	124.80	409.50
Maximum Desirable Level	3.0	124.60	409.00
Minimum Level (Winter)	0.17	123.80	406.17
Normal Level (Summer)	2.0	124.36	408.00

Fall / Winter Operation

As winter approaches, generally late-September to mid-October, the four main gates and low flow gate are raised over the course of a few weeks to equalize the water level on either side of the dam. The timing depends on the water level of the lake. However, the process should be completed by the end of November. The gates are left open throughout the winter months.

Spring Operation

As the lake level rises during the spring freshet, the gates are lowered (again over the course of days or weeks) to obtain a lake water level of 124.36 m GSC (408.00 ft) by May 1st. It has been suggested by CRCA that the reservoir store as much water as possible in the spring, making allowance for flooding and ice problems.

Summer Operation

There is a requirement for a minimum flow downstream of the dam over the summer months to provide dilution for the sewage treatment plant. Generally the low flow gate valve is used to provide this flow. It is opened once the lake level reaches 124.39 m (408.10 ft) to provide a continuous minimum discharge of 170 L/s. Depending on the year, the amount of rain, evaporation, and the lake levels, more than this minimum amount may be provided. In the event of an exceptionally dry year, it may be necessary to supplement the flow by discharging water from the upstream Sydenham Lake Dam. Flows in excess of the capacity of the low flow gate valve is passed over the four overshot gates.

There has been a problem with floating wetland bog materials collecting in the low flow gate, reducing the outflow from the dam. During the summer months, a visit by the dam operator once or twice a week is needed to completely open the low flow gate, flush the debris, and reset the gate.

2.2.4 Inspection Reports

Yearly inspections of Wilton Road Dam have been undertaken infrequently until recently based on the background information provided by the CRCA. A detailed inspection report is prepared during the inspection. Recommendations are made as a result of the inspection and they are implemented prior to the next inspection.

Typical problems experienced by Wilton Road Dam are:

- Safety issues (i.e. fencing, signage, etc.)
- Debris and sediment
- Embankment erosion
- Lubrication of mechanical components
- Rusting and faded paint of metal components
- Concrete cracking

3.0 FIELD SURVEYS, DRAWINGS, INSPECTIONS AND DEFICIENCIES

3.1 FIELD SURVEYS AND DRAWINGS

Field surveys were conducted to:

1. Provide North American Datum 1983 (NAD83) UTM coordinates (X, Y) at the dam.
2. Provide a Geodetic Survey of Canada (GSC) 1928 vertical coordinate (Z) at the dam site.
3. Verify dam dimensions and elevations.
4. Obtain sufficient horizontal and vertical data to supplement existing site plans.

Global Positioning Systems (GPS) technology was used to establish the NAD83 UTM coordinates at the centre of the dam. Two dual frequency receivers and associated software were used to derive the UTM coordinates of the dam and the GSC vertical control elevation. The coordinates of any point established on the control structure were determined by measuring the vectors from selected points in the Provincial database (COSINE) with known X, Y, and Z. Similarly, an orthometric (Mean Sea Level – MSL) elevation can be transferred from known vertical points in the Provincial database to a point on the control structure.

After GPS derived data were established at reference sites at the dam, conventional total station survey technology was used to obtain horizontal and vertical data of the site and surroundings. The survey data along with relevant information from the original existing drawings were used to prepare appropriate scaled digital metric drawings for the site. These drawings included border-titled drawings and illustrate a plan of the site, upstream and downstream profiles, section details and text notes for clarification.

The site drawings are provided in hard copy and digital format in accordance with CRCA requirements. Full-scale drawings numbered WIL-01EX to WIL-03EX have been forwarded to the CRCA for record purposes. The reduced scale drawings are presented in Appendix A.

3.2 REQUIREMENTS FOR DAM OPERATIONS, MAINTENANCE AND SAFETY

3.2.1 Operations

The dam should be operated with knowledge of the stage-discharge-storage relationships. The dam should also have a “rule curve” for the operation of the structure.

An Operation, Maintenance and Surveillance (OMS) Manual should be available with written protocol that can be used by all staff. The plan needs to contain information on the sequence of operations depending on the level of the reservoir as well as upstream and downstream conditions. It should address operations during flood conditions and reference a separate Emergency Preparedness Plan. According to the draft Ontario Dam Safety Guidelines (ODSG), the OMS Manual should also contain information on the maintenance of minimum flows and water levels within specified limits during certain times of the year. The OMS Manual should be updated as necessary.

The staff gauge for the dam should be metric and set to a geodetic datum. However, it must be located at a sufficient distance from the dam that its readings are not impacted by drawdown at the dam.

Adequate and up-to-date records should be kept at the dam utilizing current digital drawing and management systems.

3.2.2 Maintenance and Materials

The draft ODSG requires that the dam be maintained in a safe and fully operable condition. A good maintenance program will protect against deterioration and prolong the dam's life span. Inspections of concrete structures should look for the following material deficiencies.

3.2.2.1 Concrete Structures

Concrete Cracks

Cracking in a concrete dam occurs when tensile stresses exceed the tensile strength of the concrete. These stresses may occur because of imposed loads on the dam or because of volumetric changes in the concrete.

There are several types of cracking. The direction or orientation of a crack can be described using one of the following terms:

1. Longitudinal: A longitudinal crack runs parallel to the crest of the dam.
2. Transverse: A transverse crack runs perpendicular to the crest of the dam.
3. Horizontal: A horizontal crack runs along the same elevation of the dam.
4. Vertical: A vertical crack runs up and down the face of the dam.
5. Diagonal: A diagonal crack runs on an inclined plane between horizontal and vertical.

Cracking in concrete dams generally falls into the following categories (definitions are provided in Appendix C):

1. Structural
2. Cracks along joints
3. Shrinkage
4. Thermal
5. Pattern
6. D-cracking

3.2.2.2 Embankments – Crest and Slopes

Embankments can be constructed of homogeneous materials (select earth fill) or a combination of materials (select earth fill and rock fill). The design of the embankment typically takes into account available materials for construction, dam operations, foundation conditions and siting. Most dam embankments are generally homogeneous. In addition, measures may be installed to enhance structural stability by controlling seepage and erosion. These measures may include cutoff walls (clay, concrete or sheet pile), toe drains and relief wells, and riprap. Dam operation can impact stability should water levels in the reservoir be drawn down quickly.

Visual signs of material stress at an embankment include cracking, slumping / bulging and settlement. Signs of seepage include visible flow at the toe, standing water or wet soil conditions and lush vegetation compared to the surrounding area. Other concerns are erosion gullies, excessive or deep-rotted vegetation and animal burrows. Riprap that is improperly sized (mass and gradation) or its placement (thickness and extent) can increase the erosion potential.

3.2.3 Safety

Both operator and public safety are important at a dam site. However, a higher level of safety should be considered for a dam site that is situated at or near a public area.

Danger and warning signs should be located at the dam. These signs typically have red letters on a white background and are reflective in appearance. Danger signs identify areas of fast flowing water and changes in depth of flow. They should be visible from a minimum distance of 50 metres (164 feet) of the dam. Warning signs identify areas of no trespassing, no boating, no swimming, etc. To restrict boating and swimming in the area of the dam, a combination of signage and buoys should be considered. However buoys may not be useful in areas with significant debris.

According to the Occupational Health and Safety Act (OHSA), where a worker is exposed to a fall into water with a risk of drowning, a life jacket should be worn and equipment available to ensure the worker's rescue from the water.

A fall protection system is required under OHSA for a worker exposed to a fall height of at least 3 metres (9.8 feet) or a fall height of 1 metre (3 ft) into water. There are degrees of protection to be provided. The hierarchy is as follows: avoidance, travel restrict, travel restraint, fall restrict, fall arrest and a safety net. Travel restrict is provided through a barrier such as a handrail. Travel restraint according to the OHSA definition is a harness or safety belt attached by a lifeline/lanyard to a fixed support that prevents access to any hazard/fall areas. A fall restrict system is a system that is attached to a fixed support that limits a worker's free fall. A fall arrest system consists of a full body harness and lanyard equipped with a shock absorber attached to a fixed point.

Handrails that are acting as a safety barrier should be continuous and visible. They should be securely anchored and of sufficient height, typically taken as 1070 millimetres (3.5 feet) according to the Occupational Health and Safety Act. Loading forces on the handrails must be considered as well.

3.3 DAM INSPECTION

In November 2005, Trow undertook a detailed dam inspection of the Wilton Road Dam to:

1. Obtain a digital photographic record of the dam, material deficiencies and important features found at the site.

2. Identify, locate and measure any material deficiencies.

3. Review dam operation and safety features.

The digital photographs taken during the dam inspection are presented in Appendix B. The photographs identify the site and the location/view. The dam inspection summary forms are presented in Appendix C.

3.3.1 Operational Deficiencies and Issues

The dam is operated with knowledge of the stage-discharge-storage relationships as well as a rule curve.

A draft Operations Manual (July 2001) exists for Wilton Road Dam, but requires updating to conform to the draft ODSG. The manual must document the requirements for operation, maintenance and surveillance of the dam (i.e Operation, Maintenance and Surveillance (OMS) Manual). Copies of the OMS should be placed at the CRCA Administrative Offices as well as the Little Cataraqui Creek Conservation Authority Workshop. Any changes to the construction or operation of the dam should be documented in a revised OMS, as well any changes to personnel or organization.

The section pertaining to maintenance has been combined with surveillance requirements and should be broken into two sections. The maintenance log in the draft manual is actually a record of the annual inspection at the dam. A maintenance log would generally be more detailed and provide dates of completion. The section pertaining to Emergency Operations should be placed in a separate Emergency Preparedness Plan. There are also some discrepancies with water levels in the report (e.g. listing the winter water level lower than the downstream rock outcrop which determines the winter water level).

Flow measurements have been taken by CRCA at a channel reach downstream of the Wilton Road Dam. However, it is necessary that the dam gate settings and associated lake water levels be recorded during the seasonal periods as well as flood events. The records need to be reviewed from time to time to ensure that the Operations Manual is being followed and that it is effective for both seasonal periods and flood events.

The present methodology of suspending the gates on the winch cables during the winter period needs to be reviewed. This provides stress on the cables. A device to lock the gates in the fully open position would provide the cable with a longer life expectancy and reduce the likelihood of damage as a result of vandalism (i.e. persons cutting the cable).

The low flow gate valve is difficult to operate as a result of debris accumulation at the face. This may be overcome by creating a raised crest around the gate to a height below the summer water level. A bar trash rack could be placed on top of the crest to the summer water level. The structure should not impede flow at the bays and be sturdy enough to resists pressure from the floating bog materials.

3.3.2 Material Deficiencies and Issues

Deficiencies identified during the visual inspection have been illustrated on drawing WIL-03D in Appendix D.

3.3.2.1 Concrete

In general, the concrete of Wilton Road Dam is in good condition. The control structure (deck, upstream and downstream sides) and abutments did not exhibit cracks that were sufficiently long, wide and deep enough to suggest any structural concerns. The concrete shows neither pervasive pattern cracking nor visible signs of efflorescence.

The concrete at the water level shows some surface abrasion due to flow. As a result of the wetland, the water from the lake may be slightly acidic and this may result in a chemical attack on the concrete encouraging the surface abrasion.

A small area of concrete at winch pedestal 3 has been repaired. This patch has a drummy sound and the patch has not bonded to the underlying concrete.

3.3.2.2 Embankments

The Safety and Maintenance Assessment report prepared by Trow in 2004 indicated the presence of seepage moving from the lake downstream through the road embankment. CRCA staff has stated that no signs of seepage has been noticed during the 2006 spring season.

3.3.2.3 Gates, Winches, Gains, Gain Covers, Low Flow Valve and Staff Gauge

There is a vertical steel gate set into a steel gain between each pier, which appear to have been refurbished since the dam's construction. Wilton Road Dam has four gates in total. These gates have been modified by raising the crest to maintain a higher water level in the lake. The gates were raised for the winter period during the inspection so Trow was unable to determine if seepage at the gate edge is an issue.

The winches are in good condition and have covers that are locked. CRCA staff indicated that the gates could be manipulated by a lone operator if necessary. However the draft Operations Manual recommends two operators conduct any gate manipulation.

The steel gains appear to have a protective coating and show little deterioration or rust at the waterline.

The gain covers are grid steel plate and are hinged with lockdown straps. A single operator can raise the cover.

The low flow valve is an aluminum gate set at the south end of the structure in its own bay. The gate slide mechanism rises to the height of the handrail, as does the operating stem. The wheel is chained to the handrail. A small inspection / maintenance platform has been constructed at the north side of the gate between the handrail and the winch pedestal to provide the operator a location to inspect the gate and remove debris from the trash rack. The valve is difficult to operate as a result of debris accumulating against the gate. A trash rack has been installed in front of the gate. Trash build-up on the screen restricts flow entry to the gate. Removal of the trash rack for cleaning generally results in the rack not being able to be set to the lowest position and an increased possibility of debris blocking the valve.

Two staff gauges are located at the Wilton Road dam site. One is located on the north pier facing the concrete steps. This gauge is tied to a geodetic datum, but has been damaged by ice. Its needs to be repaired and mounted in a location that is not impacted by drawdown at the weir and gate. The second gauge is on the downstream side of the southerly pier of Bay 1 which can be affected by flow over the gates.

3.3.2.4 Signage, Access Gate and Handrails

Warning signage is identifying "Danger, Dam Ahead, Stay Back" is mounted to the identification signage at the control structure and a "No Trespassing" sign is mounted on the upstream handrail. CRCA is in the process of upgrading signage at the dam and the table below outlines the additional types of signage and proposed locations.

Signage	Proposed Location
Dam Ahead	Replace existing sign on the control structure
Dam Ahead	Regulatory buoy placed upstream of the dam in the reservoir
Keep Away – Dangerous Currents May Occur	Low flow valve
No Trespassing	Placed on the outside if the railing where the public might enter
Dam Identification	Replace existing sign on the control structure
Dam Upstream (2)	One for immediately downstream of the dam and one further downstream near Babcock Mill in Odessa

There are no lockable gates at the control structure that would restrict public access; however the road and bridge guard rail acts as a barricade.

There is a continuous handrail on the dam deck. It is a two rail construction with middle and top rails of 1010 mm height. The handrail is painted black. Wire mesh fencing has been fastened to the handrail on the downstream side of the dam.

3.3.2.5 Debris Boom

There is no debris boom at the Wilton Road Dam. The floating bog materials would likely make any boom ineffective.

3.3.3 Maintenance Deficiencies and Issues

There are no significant maintenance issues at the dam. As stated previously, debris regularly accumulates at the trash rack of the low flow valve and needs to be removed regularly.

Inspection of the gates needs to be done yearly in the winter months when they are in the open position. The gains should be checked at the same time. When the gates are fully closed during low flow, they should be inspected for leakage.

Maintenance should be scheduled on a set basis.

3.3.4 Safety Deficiencies and Issues

There is no fall arrest system on the control deck. However, a fall arrest system is not necessary for Wilton Road Dam as the lake level is generally shallow and maintenance is performed in the water during low flow conditions. It should be noted that the Wilton Road Dam Operations Manual recommends the use of a fall arrest system. In place of a fall arrest system, personnel can attach themselves to the handrails but the handrails were not designed for this purpose (i.e. loading) and are currently deficient in height with respect to the Occupational Health and Safety Act (OHSA).

Access to the Wilton Road Dam is along the shoulder of the road. Staff members park their vehicles on the gravel shoulder. A portable flashing light set on the roof of the vehicle should be turned on in this instance. Preferably, vehicles should be parked off the road at a farm or other entrance. Operators should wear safety vests. Warning signage should be set beyond the limits of the dam should maintenance staff be making several trips between the vehicle and the dam. Staff members are required to step over the guide rail to access the dam. A support (post or railing) should be installed at the guide rail to reduce the likelihood of slippage during wet or icy conditions.

4.0 HAZARD POTENTIAL CLASSIFICATION AND INFLOW DESIGN FLOOD

Determination of the potential Inflow Design Flood and the preliminary Hazard Potential Classification was undertaken by using the draft Ontario Dam Safety Guidelines and the Lakes and Rivers Improvement Act (LRIA).

The hazard potential of a dam is the potential for loss of human life, property damage and/or adverse environmental impacts in the event of failure or incorrect operation of a dam. The Hazard Potential Classification system is based on the incremental losses (i.e. those over and above which might have occurred under natural conditions had the dam not failed) which a failure might inflict on downstream or upstream areas or at the dam. The HPC shall be based on the highest category determined independently for loss of life, property damage and environmental consequences.

The LRIA, dated May 1997, is used by the Ministry of Natural Resources (MNR) for the design and construction of new dams. Considering the Wilton Road Dam as a new dam, the minimum IDF for the dam would be based on the Hazard Potential Classification and either the dam height or reservoir volume in accordance with *Table 6.2: Design Flood for Hazard, Dam Height and Reservoir Storage* (LRIA).

The draft ODSG, dated August 1999, is still under review by various stakeholders and the Crown. However, *Figure 1-7: Hazard Classification for Dams – Selection Criteria* involving loss of life, economic and social losses, and environmental losses leads to an IDF determination using *Figure 4-1: Minimum Inflow Design Floods for Dams*.

In order to use either of the above references, pertinent facts and assumptions need to be stated:

1. The size of Odessa Lake has the potential to attenuate the flood peaks. In fact it is preferable to flood the lake as opposed to the downstream channel. The time between the initiation of the flood-producing storm event and the creation of conditions that would result in dam failure is sufficient to warn anyone at risk to flooding and therefore, the potential for loss of life during a dam failure is none or none expected. The land use is predominantly rural / agricultural from the dam to about 600 metres downstream. Development is prevalent beyond this reach.

2. The dam height is about 4.0 m and the available storage volume is estimated at 2.51 x 10^6 m^3. Although the dam is less than 7.5 m in height (i.e. small in height), the lake storage is greater than 1 million cubic metres. Therefore, the size category of the dam is LARGE accordingly to Table 6.2 (LRIA) and Figure 4.1 (ODSG).

3. The incremental environmental losses could have a range as follows:

   a) LOW - There would be no significant loss or deterioration of fish and/or wildlife habitat. Loss of marginal habitat only. Feasibility and/or practicality of restoration or compensating in kind is high.

      OR

   b) SIGNIFICANT - There would be loss or significant deterioration of important fish and/or wildlife habitat. Feasibility and/or practicality of restoration or compensating in kind is high.

   The Wilton Road Dam maintains a Class 1 wetland upstream with associated fish and wildlife habitat; however this wetland has not been classified as Provincially Significant so it should be capable of regenerating following restoration / rebuilding of the dam. The maximum decrease in water level is approximately 0.5 metres (408.0 feet minus 406.3 feet = 1.7 feet).

4. The incremental economic damage could have a range as follows:

    a) LOW - Minimal damage – Estimated losses do not exceed $1,000,000.

    OR

    b) SIGNIFICANT - Appreciable damage – Estimated losses do not exceed $10,000,000.

    There are three road crossings downstream of the dam; the most notable is the Highway 401 culvert crossing. It is not expected that significant damage would occur to any of these structures during a dam failure. The Water and Erosion Control Infrastructure Database indicates that 10 properties are located within the flood plain. The economic damage is deemed to be low. The loss of the dam and upstream reservoir would create economic loss by not being able to provide low flow augmentation for the downstream sewage treatment plant. In 2000, the water treatment plant changed its source of supply to Lake Ontario. Odessa reservoir no longer provides a source of water supply to the Village of Odessa and there will be no economic loss with respect to water supply.

In reviewing either the LRIA or draft ODSG, the IDF of Wilton Road Dam would fall into one of the following hazard potential categories.

Lakes and Rivers Improvement Act (LRIA)		
Size of Dam	**Hazard Potential**	**IDF**
Large	Low	100 Year Flood

<table>
<tr><th colspan="5">Draft Ontario Dam Safety Guidelines (ODSG)</th></tr>
<tr><th rowspan="2">Size of Dam</th><th colspan="3">Hazard Potential</th><th rowspan="2">IDF</th></tr>
<tr><th>Loss of Life</th><th>Economic and Social Loss</th><th>Environmental Losses</th></tr>
<tr><td rowspan="4">Large</td><td colspan="4">Low</td></tr>
<tr><td>None</td><td><$1,000,000</td><td>No Significant Loss or Deterioration of Fish and/or Wildlife Habitat</td><td>Regulatory Flood (RF) to Probable Maximum Flood (PMF)</td></tr>
<tr><td colspan="4">Significant</td></tr>
<tr><td>None expected</td><td><=$10,000,000</td><td>Loss or Significant Deterioration of Important Fish and/or Wildlife Habitat</td><td>Probable Maximum Flood (PMF)</td></tr>
</table>

Although the IDF in the hazard categories are the same, the draft ODSG, in addition to that provided in the LRIA, uses descriptive environmental losses and incremental dollar amounts in the economic and social categories to help in identifying the Hazard Potential Classification.

Having narrowed the Hazard Potential Classification to either "Low" or "Significant" based on no loss of life and environmental losses, the economic category will decide the classification and hence the IDF.

The incremental hazard evaluation through a dam break analysis would confirm with certainty as to whether the category is "Low" or "Significant" with a corresponding IDF of Regulatory Flood to PMF. Should the evaluation find that the incremental flood flow dam break results in an incremental economic damage of closer to $10,000,000 then the category would be "Significant" and the IDF would be the PMF. Conversely, should the incremental economic damage be closer to $1,000,000, then the category would be "Low" and the IDF would be the Regulatory Flood.

It is our opinion that the preliminary Hazard Potential Classification for the Wilton Road Dam is "Low". There should be no loss of life and the economic losses are considered to be less than $1,000,000. Therefore, the IDF of the dam in the LARGE category is the Regulatory Flood (100 year flood).

5.0 HYDROTECHNICAL ASSESSMENTS

5.1 HYDROLOGIC ASSESSMENT

5.1.1 General

In accordance with the draft Ontario Dam Safety Guidelines (ODSG), the hydrologic assessment was completed to establish peak inflows and outflows at the dam, change in lake volume and flood duration for various return frequency events. From the Hazard Potential Classification of the dam, the Inflow Design Flood (IDF) was established as provided in Section 4.0 as the Regulatory Storm.

To determine the peak of the outflow and lake water level for the various flood events, the stage-discharge-storage relationships of the Wilton Road Dam were calculated based on pre-established static dam settings.

5.1.2 Hydrologic Model

The synthetic unit hydrograph program utilized in the simulation of flows for the various return frequency flood events within the Millhaven Creek watershed was SWMHYMO. SWMHYMO, successor of HYMO, OTTHYMO-83 and OTTHYMO-89, is a complex hydrologic modelling program used for the simulation and management of stormwater runoff in either small or large rural and urban areas.

The Millhaven Creek watershed hydrologic model was provided by the CRCA and were utilized in the 1988 Flood Plan Mapping Study. The model was created using the 1983 version of OTTHYMO. A change to the model was necessary to update it for use in SWMHYMO. The command used to generate runoff in OTTHYMO is “COMPUTE NASHYD” was replaced with the command “CALIB NASHYD” for SWMHYMO. Both commands have similar input parameters.

5.1.3 Storm Events

For the dam safety review, modelling was undertaken for the 15-day 2-year through 100-year snowmelt events to determine flood flows for the Millhaven Creek watershed in the vicinity of the Wilton Road Dam.

As defined by the Provincial Flood Hazard Criteria Zones, the watershed is within Zone 2 where the Regulatory Flood is the 100 Year Flood.

5.1.4 Hydraulic Characteristics

The stage-discharge-storage relationship for the Wilton Road Dam was taken from the 2001 draft Operations Manual which matched the relationship shown in the model (Table 5.1). It was slightly modified to reflect the overflow weirs at the sides of the control structure.

The stage-discharge-storage relationship for Sydenham Lake Dam was also modified from the one used in the model as the relationship in the more recent Operations Manual was different from the one in the model. The relationship from the Operations Manual was utilized (see Table 5.2).

Table 5.1 – Wilton Road Dam
Stage-Discharge-Storage Relationship

Stage		Discharge (m^3/s)	Storage (ha.m)
(m)	(ft)		
123.60	405.51	0.00	0.00
123.75	406.00	2.27	51.81
123.90	406.49	5.66	124.59
124.05	406.99	8.78	192.43
124.21	407.51	12.46	267.68
124.36	408.00	16.99	337.99
124.59	408.76	29.48	458.80
124.65	408.96	37.74	535.30

Table 5.2 – Sydenham Lake Dam
Stage-Discharge-Storage Relationship

Stage		Discharge (m^3/s)	Storage (ha.m)
(m)	(ft)		
130.54	428.28	0.00	0.00
130.61	428.50	0.20	0.10
130.76	429.00	1.30	98.68
130.91	429.50	2.90	197.36
131.06	430.00	4.80	302.36
131.22	430.50	7.10	407.05
131.37	431.00	9.50	505.73
131.52	431.50	12.10	606.86
131.67	432.00	14.80	707.13

5.1.5 Reservoir Routing

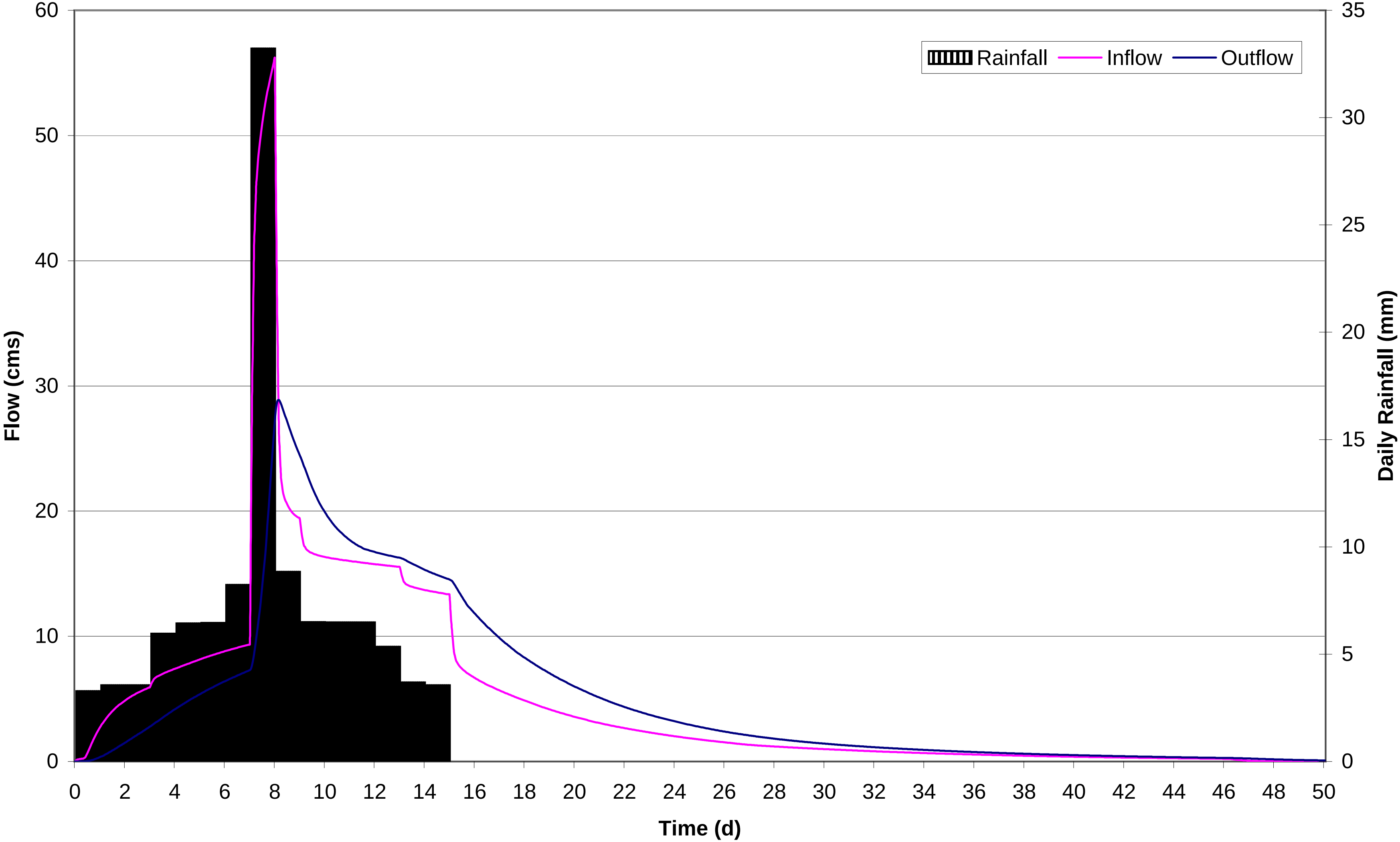
The hydrologic models with the stage-discharge-storage relationships for the Wilton Road Dam was simulated for the 2-year to 100-year flood events. The results of the simulations are presented in Table 5.3. The table provides the simulated flood event, the peak inflow and outflow of the event and the subsequent lake water level.

Table 5.3 – Wilton Road Dam
Results of Reservoir Routing

Event (yr)	Inflow (m^3/s)	Time to Peak (hr)	Outflow (m^3/s)	Time to Peak (hr)	Lake Water Level	
					(m)	(ft)
2	26.47	192.00	10.96	198.00	124.14	407.28
5	34.17	192.00	14.26	198.00	124.26	407.68
10	39.37	191.58	16.90	197.42	124.35	407.97
25	46.10	192.00	21.83	196.00	124.48	408.40
50	51.13	192.00	25.41	196.00	124.55	408.63
100	56.18	192.00	28.88	196.00	124.59	408.76

As was determined in Section 4.0, the Inflow Design Flood (IDF) for the Wilton Road Dam is the 100 year flood. The inflow and outflow hydrographs for the IDF are shown in Figure 5.1.

Figure 5.1 Wilton Road Dam
Inflow Design Flood



The hydrologic modelling reveals that Odessa Lake has significant storage to attenuate peak flows. During winter operations flows are attenuated by 50 to 60%. Flooding in the vicinity of the Wilton Road Dam will not be a concern during the spring snowmelt as the surrounding properties and roadway are at least 2.0 metres above the lake water level for the IDF.

The four main bays and the sluiceway for the low flow valve are capable of carrying flows from the snowmelt events for the more frequent events (i.e. 2 year to 10 year); however water will begin flowing over the two weirs for the 25-year and larger storm events.

5.1.6 Flow Comparison

The results from the simulations with the revised stage-discharge-storage relationships for both Sydenham Lake Dam and Wilton Road Dam were compared with results from the original 1988 Flood Plan Mapping Study. In general, the results for inflow and outflow of the revised simulations were within 5% of the results for the original study.

5.2 HYDRAULIC ASSESSMENT

5.2.1 General

The flood line, or water surface elevation, for the Regulatory flood and other storms is a function of the design flows and the ability of the channel, flood plain and river crossings to carry or pass these flows. In order to establish the water surface elevation at various locations in the watershed, a detailed hydraulic analysis has to be carried out. The channel and flood plain properties, as well as the characteristics of the various structures along the channel have to be considered in this analysis.

5.2.2 Hydraulic Model

The hydraulic model used to compute the water surface profiles was developed at the Hydrologic Engineering Center (HEC) by the U.S. Army Corps of Engineers and is commonly known as HEC-2.

The program computes and plots the water surface profiles for river channels of any cross-section for either sub-critical or supercritical flow conditions. It is capable of analyzing the effects of various hydraulic structures such as bridges, culverts, weirs, embankments and dams. Roughness coefficients can be specified by a number of methods to account for the change in roughness with the depth of flow or the actual location of the flow within the flood plain. Input to the model may be either English or Metric units.

The hydraulic model for Millhaven Creek was provided by CRCA and was created during the 1988 Flood Plain Mapping Study. The model covers the entire watershed from Lake Ontario to the headwaters at Gould Lake.

5.2.3 Backwater Analysis at Wilton Road Dam

The 100 year flood and the various frequency events have been evaluated in accordance with the draft ODSG. As the flows generated in the hydrologic modelling by Trow were generally within 5% of the flows generated under the original study, flow rates in the hydraulic model have not been revised. Water surface profiles were generated for the 2-year to 100-year snowmelt events. The results of the backwater analysis in the vicinity of Wilton Road Dam are given in Table 5.4. The location of the cross-sections are shown on Sheet 33 of 68 of the Millhaven Creek Flood Risk Maps.

Table 5.4 – Wilton Road Dam
Results of Backwater Analysis

Cross-section	Event (yr)	Water Surface Elevation (m)
16.501	2	124.30
	5	124.37
	10	124.41
	25	124.47
	50	124.52
	100	124.57
16.771 Immediately downstream of Highway 401	2	124.35
	5	124.44
	10	124.50
	25	124.58
	50	124.65
	100	124.71
16.890 Immediately upstream of Highway 401	2	124.36
	5	124.45
	10	124.51
	25	124.60
	50	124.67
	100	124.73
16.993 Immediately downstream of Wilton Road Dam	2	124.37
	5	124.46
	10	124.52
	25	124.61
	50	124.68
	100	124.74
17.111 Immediately upstream of Wilton Road Dam	2	124.41
	5	124.52
	10	124.59
	25	124.70
	50	124.78
	100	124.87
17.426	2	124.42
	5	124.53
	10	124.60
	25	124.71
	50	124.80
	100	124.88

5.2.4 Discussion of Results

The backwater analysis of the Milllhaven Creek indicated that backwater effects are not a significant issue at Wilton Road Dam as the gates are opened during the spring snowmelt and normal winter water levels are allowed to equalize both upstream and downstream of the dam.

The results of the backwater analysis indicate summer operating conditions as there is difference between the upstream side of the dam and the downstream side. This is due to the placement of the steel gates within the bays.

Water levels for the various flood events were at least 1.5 metres above the sill of the bays; however they are also at least 1.5 metres below the top of deck. Therefore the dam will not be overtopped during storm events and operations may be performed if necessary. Most storm events (i.e. 10 year and less frequent) will have some water passing over the four steel gates and the two overflow weirs.

5.3 WAVE HEIGHT AND MINIMUM FREEBOARD

5.3.1 General

Wave height is defined as the vertical distance between a crest and the proceeding trough. Wave uprush or runup is defined as the vertical height above the still-water level to which water, from an incident wave, will rush up to on a shoreline or shoreline structure.

Freeboard is defined as the additional height of a structure above design high water level to prevent overflow. It is also the vertical distance between the water level and the top of the structure at a given time.

The draft Ontario Dam Safety Guidelines provides the minimum freeboard for dams of varying reservoir sizes (lengths). For reservoir lengths over 800 m, individual analysis is recommended. The guidelines also state that freeboard should be provided to restrict the percentage of waves which could overtop a dam under specified flood levels and wind conditions. The conditions are:

1. Wave conditions due to wind with a 1/1000 Annual Exceedance Probability (AEP) with the reservoir at its maximum normal level.

2. Wave conditions due to the most severe reasonable wind conditions for the reservoir at its maximum extreme level based on the selected IDF. For large reservoirs and/or large basins, the mean maximum annual wind is normally used.

The Atmospheric Environment Services (AES) was retained by Trow to calculate the mean annual wind speed and the 1/1000 AEP wind speed, from the period of records collected from 1970 to 1994 at the Kingston weather station. The 1/1000 AEP wind speed was 110 kph (68.35 mph) and the mean maximum annual wind speed was 65.04 kph (40.41 mph).

For the Wilton Road Dam, the unobstructed water length L was estimated to be 1500 m (0.93 mile) and the average reservoir width W was found to be 100 m (0.06 mile).

5.3.2 Discussion of Results

The regulated lake water level is 124.36 m (408.00 ft). The 1/1000 year wave height is 0.48 m (1.58 ft). The deck of the dam, at an elevation of 126.64 m (415.48 ft), would not be overtopped with the regulated water level and a 1/1000 year wave. The freeboard is 1.80 m (5.91 ft).

The lake water level created by the IDF is 124.59 m (408.76 ft). The mean maximum annual wave height is 0.28 m (0.91 ft). The freeboard in this scenario is 1.78 m (5.84 ft).

6.0 STABILITY ASSESSMENT

6.1 BACKGROUND INFORMATION AND REFERENCE SOURCES

1. Drawings WIL-01EX to WIL-03EX

6.2 GEOLOGICAL SUMMARY

Geological mapping indicates that the dam site is underlain by the Gull River limestone formation, belonging to members B, C, and D.

6.3 GEOTECHNICAL PARAMETERS AND ASSUMPTIONS

The geotechnical parameters are based on conservative values relating to limestone bedrock contact.

1. The friction angle is taken as 32°.

2. Derived coefficient of friction of 0.67 based on the tangent of the friction angle.

6.4 HYDROLOGY ASSUMPTIONS

Water Level	Minimum - H_w (winter)	Normal - H (summer max operating range)	Regulatory Flood*
Headwater Elev. (m)	123.80	124.36	124.96
Tailwater Elev. (m)	123.80	varies	124.70

* Taken from floodplain mapping

Analysis at winter loading conditions has been ignored as all lateral loads are equalized since the water level is the same on both sides.

6.5 DAM SAFETY REVIEW

The Dam Safety Review has been completed using the work outline as provided in *Draft Ontario Dam Safety Guidelines, Section 7, Concrete Structures*. The loading combinations reviewed are as contained in *Section 7.4 Load Combinations*.

Analytical methodology is as recommended in *Section 7.5 Design and Analysis*. The dam sections are assessed by static analysis. Earthquake response is determined by pseudostatic analysis.

The performance of the structure is assessed and discussed on the basis of the criteria as outlined in *Section 7.6 Performance Indicators and 7.7 Acceptance Criteria.* Detailed calculations are presented in Appendix E Stability Evaluation.

6.6 SYMBOLS / DEFINITIONS

D Dead load of permanent structure:

a) The weight of the dam is assumed to be transferred directly to the foundation without shear stress between adjoining blocks. The force acts at the centroid of the section.

b) Hydrostatic force produced by the water in the reservoir may be resolved into horizontal and vertical components.

H Maximum operating headwater with most critical concurrent tailwater (summer with/without earthquake).

H_F Maximum flood headwater with concurrent tailwater at IDF.

U Uplift pressure:

a) Hydrostatic uplift acting under the base of the dam is assumed to vary linearly from that created by the headwater level in the reservoir at the upstream face of the concrete or the stop logs, to that created by the tailwater at the downstream toe or ground surface at the toe, as applies.

T Temperature induced loads (cconsidered for buttress and arch structures only).

Q Loading at maximum design earthquake MDE:

a) Seismic data was provided by Natural Resources Canada, Geological Survey of Canada (GSC) which provides a probabilistic assessment of earthquake frequency of 0.010 (1 per 100 years) to 0.001 (1 per 1000 years). The evaluation earthquake has been provided based on the draft Ontario Dam Safety Guidelines requirement for significant structures, which requires selection of a probabilistic value between 1/100 and 1/1000.

b) Lateral seismic force $V_l = 0.097D$

c) Vertical seismic force is assumed equal to 50% the lateral seismic force acting concurrently.

d) Hydrodynamic seismic forces are not considered where $g < 0.10g$.

e) Load acts vertically and horizontally through the centroid of the structure.

6.7 ACCEPTANCE CRITERIA

The draft *Ontario Dam Safety Guidelines* provides safety factors for concrete gravity and buttress dams. The factors are as follows:

Type of Analysis	Usual Loading	Flood Loading	Earthquake Loading	Unusual Loading
Concrete Residual Sliding Factor	1.5	1.1	1.1	1.3

6.8 PERFORMANCE INDICATORS

6.8.1 Position of Resultant Force

The position of the resultant force for the control structure under summer and quake loading conditions was found to be outside the middle third of the structure. However on bedrock, this is not critical.

The position of the resultant force for the south weir was found to be in the mid one-third under all loading conditions while the position for the north weir was outside the mid one-third under normal and quake loading. Again, as the north weir is situated on bedrock, this is not considered critical.

6.8.2 Sliding Factors

Sliding factors were calculated for the dam (see Appendix E). The results are tabulated as follows:

Condition Designation	Usual Loading		Flood Loading	Temperature Loading	Earthquake Loading	Unusual Loading
Load combinations	D+H+ S+U summer	$D+H_w+$ I+S+U winter	$D+H_F+$ $S+U_F$	D+H+ I+S+U+T	D+H+ S+U+Q	D+H+S + $U_{post\ quake}$
Control Structure (Section C)	2.21	N/A	10.63	N/A	1.41	N/A
South Weir (Section D)	1.65	N/A	8.30	N/A	1.12	N/A
North Weir (Section E)	0.73	N/A	0.74	N/A	0.57	N/A

On this basis, the control structure and south weir meet the safety factors for all the loading cases considered. The north weir does not meet the safety factor for sliding under any of the loading conditions. However as the weir is short and anchored to both the bridge and control structure piers, it is considered to be stable.

7.0 EMERGENCY PREPAREDNESS PLAN

A separate Emergency Preparedness Plan (EPP) does not exist for the Wilton Road Dam. However, a small section pertaining to operations under emergency conditions is included in the draft Operations Manual. This information could be included in the EPP. An EPP is a formal written plan that identifies the procedures and processes that the dam operations would following in the event of an emergency at the dam (e.g. slope failure, medical emergencies, etc.). The report should also be site-specific.

According to the draft ODSG, an EPP should contain the following information:

- Procedures for emergency identification and evaluation
- Preventative actions
- Notification procedures and flowchart
- Details on internal and external communication systems
- Description of access to the site
- Response to emergencies during periods of darkness and adverse weather
- Sources of equipment and stockpiles of supplies required during emergencies
- Any warning systems (if used)
- Appendices such as a site plan or dam drawings

8.0 REHABILITATION OF DAM

8.1 GENERAL

An office review of the engineering drawings and reports was undertaken. This was followed by a field component consisting of a site reconnaissance and inspection in November 2005. This database along with detailed structural and hydraulics calculations were used to determine and assess dam stability and dam operational, material, maintenance and safety requirements.

Operational deficiencies considered such items as the dam operator and public safety as set out in the draft Ministry of Natural Resources Water Control Structure Safety Guidelines.

Having identified these deficiencies, the following rehabilitation measures are proposed. These measures are outlined in Rehabilitation drawings WIL-01R and WIL-03R (Appendix F).

8.2 MEASURES TO MEET DRAFT ONTARIO DAM SAFETY GUIDELINES

Wilton Road Dam does not meet the draft Ontario Dam Safety Guidelines with respect to an up-to-date Operations, Maintenance and Surveillance Manual and a separate Emergency Preparedness Plan. The requirements are listed in Section 3.2.5. and Section 7.0.

8.3 MEASURES TO ADDRESS DEFICIENCIES

8.3.1 Operations

Digital records should be created to document the gate settings of the Wilton Road Dam and water levels on Odessa Lake, as well as downstream stream flows. A correlation of these settings with flows obtained from the downstream flow monitoring station should be undertaken to ensure the dam is operating as designed.

A device should be used to lock the gates in the open position during winter conditions that reduces the stresses on the winch cables and thereby lengthen their lifespan. A ring would be installed at each end of the gates and matching holes cut in the gain covers. When the gates are lifted, the ring would pass through these holes and then an angled bar placed inside that extends over the gain cover. This would create slack in the winch cables. A diagram of the device is provided in drawing WIL-03R.

The problem with debris accumulating around the low flow gate may be overcome by creating a concrete box around the gate to a height below the summer water level, perhaps 0.6 m below to account for evaporation. A hinged bar trash rack could be placed on top of the crest in the direction of flow to the summer water level. The structure should not impede flow at the bays and be sturdy enough to resist pressure from the floating bog materials.

8.3.2 Materials and Maintenance

Any cracking throughout the dam and areas of surface abrasion at the water line should be monitored. CRCA is undertaking this monitoring through spring and fall inspections of the dam. If the cracks increase in size or the surface abrasion deepens to expose rebar, repairs should be undertaken.

The area of drummy concrete in the vicinity of winch pedestal three should be repaired.

The upstream staff gauge on the north pier that has been damaged by ice needs to be replaced with a metric gauge mounted in a location that is not impacted by drawdown at the weir and gate. Consideration should be given to moving the downstream staff gauge to a location further downstream where readings won't be affected by flow over the gains.

8.3.3 Safety

The handrails require replacement to ensure they meet the current height requirements of the Occupational Health and Safety Act.

While the road guard rail acts as a barrier to the public from accessing the control structure, the guard rail also posses an accessibility problem for the dam operators. A support (post / rail) should be installed on either the guardrail or the dam handrail to assist dam operators in stepping over the guard rail during wet and icy conditions.

8.4 IMPLEMENTATION SCHEDULE

Any rehabilitation works recommended by Trow for Wilton Road Dam should be completed by CRCA in accordance with the following implementation schedule and in the listed order of priority:

8.4.1 Measures to Address the draft Ontario Dam Safety Guidelines – To be completed by 2008

1. Update the draft Operations Plan to create an Operations, Maintenance and Surveillance Manual. Digital records to document the gate settings and water levels on Odessa Lake, as well as downstream flows should be completed at the same time.

2. Creation of a separate Emergency Preparedness Plan for Wilton Road Dam.

8.4.2 Measures to Address Deficiencies – To be completed by 2010

1. Handrail replacement to meet the Occupational Health and Safety Act.

2. Installation of a support on the guard rail to assist operators in slippery conditions.

3. Replacement and relocation of the upstream staff gauge.

4. Concrete repairs in the vicinity of winch pedestal 3.

5. Installation of devices to lock the four main gates in the open position during winter conditions.

6. Creation of a concrete structure with trash rack surrounding the low flow gate valve.

8.5 CAPITAL AND ENGINEERING COSTS

The following estimated rehabilitation costs are identified for Wilton Road Dam:

Item #	Item Description	Estimated Cost
1	Preparation of an Operations, Maintenance and Surveillance Manual	$ 3,500.00
2	Preparation of an Emergency Preparedness Plan	$ 3,500.00
3	Handrail Replacement (includes loading testing)	$ 18,900.00
4	Installation of Guard Rail Support	$ 300.00
5	Replacement and Relocation of Staff Gauge in Reservoir	$ 2,500.00
6	Concrete Repairs	$ 1,000.00
7	Installation of Gate Locks	$ 4,000.00
8	Low Flow Gate Inlet & Trash Rack	$ 28,300.00
	Total	$ 62,000.00

9.0 RECOMMENDATIONS

9.1 GENERAL

Dam records and record keeping practices of the Cataraqui Region Conservation Authority need to be updated to current document management systems.

RECOMMENDATION **Update the CRCA dam document and recording systems.**

9.2 WILTON ROAD DAM

The dam safety assessment has identified that the dam does not meet the draft Ontario Dam Safety Guidelines (ODSG) with respect to having an Operations, Maintenance and Surveillance Manual as well as an Emergency Preparedness Plan for Wilton Road Dam. A number of material and operation, maintenance and safety deficiencies / issues are also present. The deficiencies and the manner in which they need to be rehabilitated and/or addressed are outlined in Sections 3.0 and 8.0, respectively.

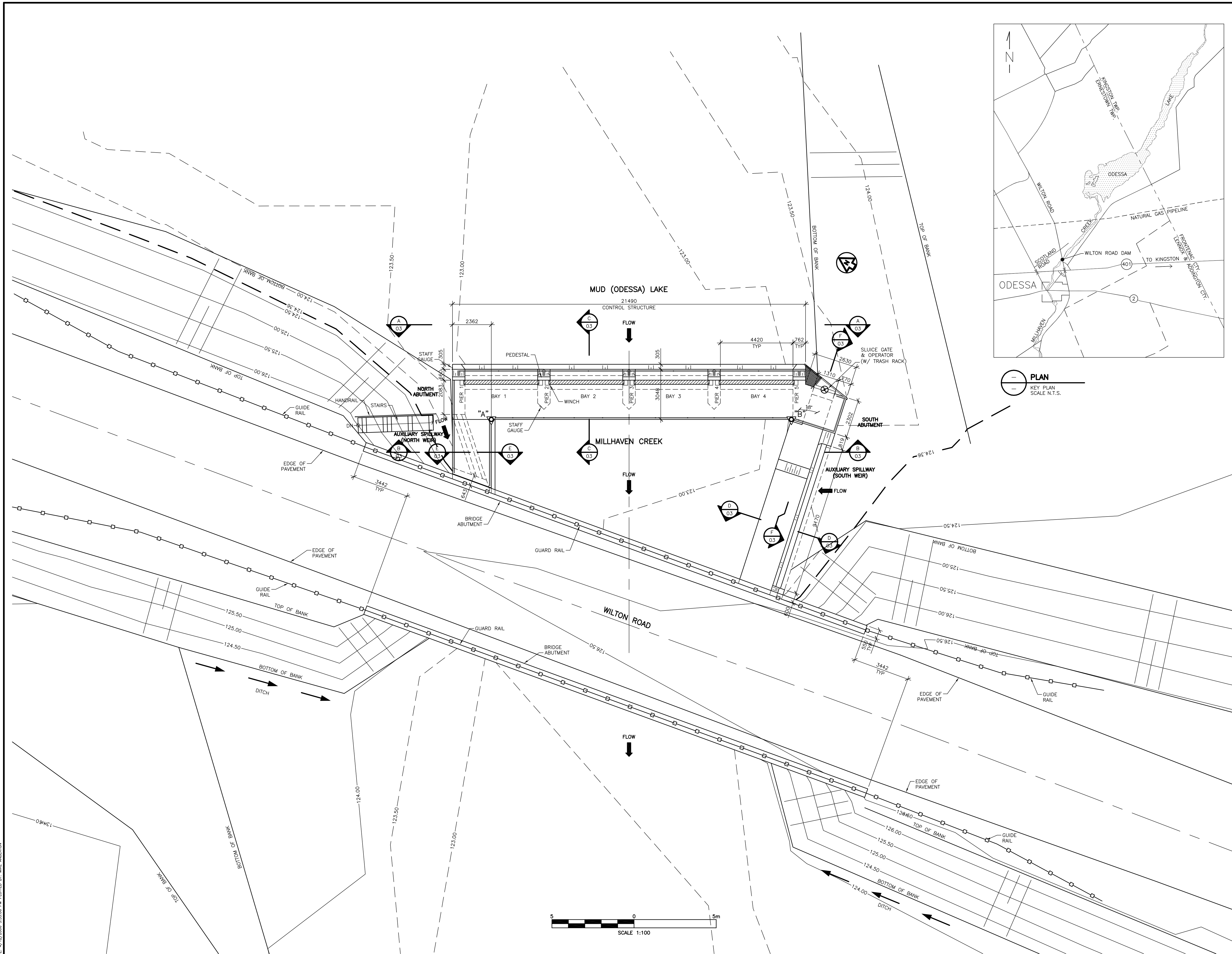
RECOMMENDATIONS

1. **The CRCA implement the rehabilitation measures outlined in Section 8.**
2. **The CRCA implement the measures required to meet the draft ODSG within 2 years.**
3. **The CRCA implement all the remaining measures within a 4 year period.**

Dams with a Low Hazard Potential Classification should be subject to a Dam Safety Review every ten years to determine whether the hazard potential has changed and to determined whether a change in the Hazard Classification is necessary.

4. **The CRCA review the Hazard Potential Classification of Wilton Road Dam in ten years.**

Appendix A
Drawings – Existing Conditions



GENERAL NOTES:

1. PLANS, ELEVATIONS & SECTIONS ARE BASED ON DRAWINGS PREPARED BY TOTTEN SIMS HUBICKI ASSOCIATES LIMITED PROJECT No. 1781. DATED: MARCH 1974.
2. CONTOURS & ELEVATIONS BASED ON SURVEY CONDUCTED BY TROW ASSOCIATES INC. DATED: NOV. 24 2005.
3. REFERENCE CONTROL POINTS:
   STATION "A" N:4904993.50 E:363029.61 Z:126.56
   STATION "B" N:4904977.75 E:363039.03 Z:126.58

No.	REVISION	DATE	APPD.
A	RELEASED FOR INFORMATION	JAN. 2006	---

SEAL

LICENSED PROFESSIONAL ENGINEER
M.H. NELSON
PROVINCE OF ONTARIO

DESIGNED:
CHECKED:
DATE:

CATARAQUI REGION CONSERVATION AUTHORITY
1641 Perth Road, P.O. Box 160 Glenburnie, Ontario K0H 1S0
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Trow Associates Inc.
1595 CLARK BOULEVARD
BRAMPTON, ONTARIO L6T 4V1
FAX: (905) 793-0641 TEL: (905) 793-9800

PROJECT
WILTON ROAD DAM

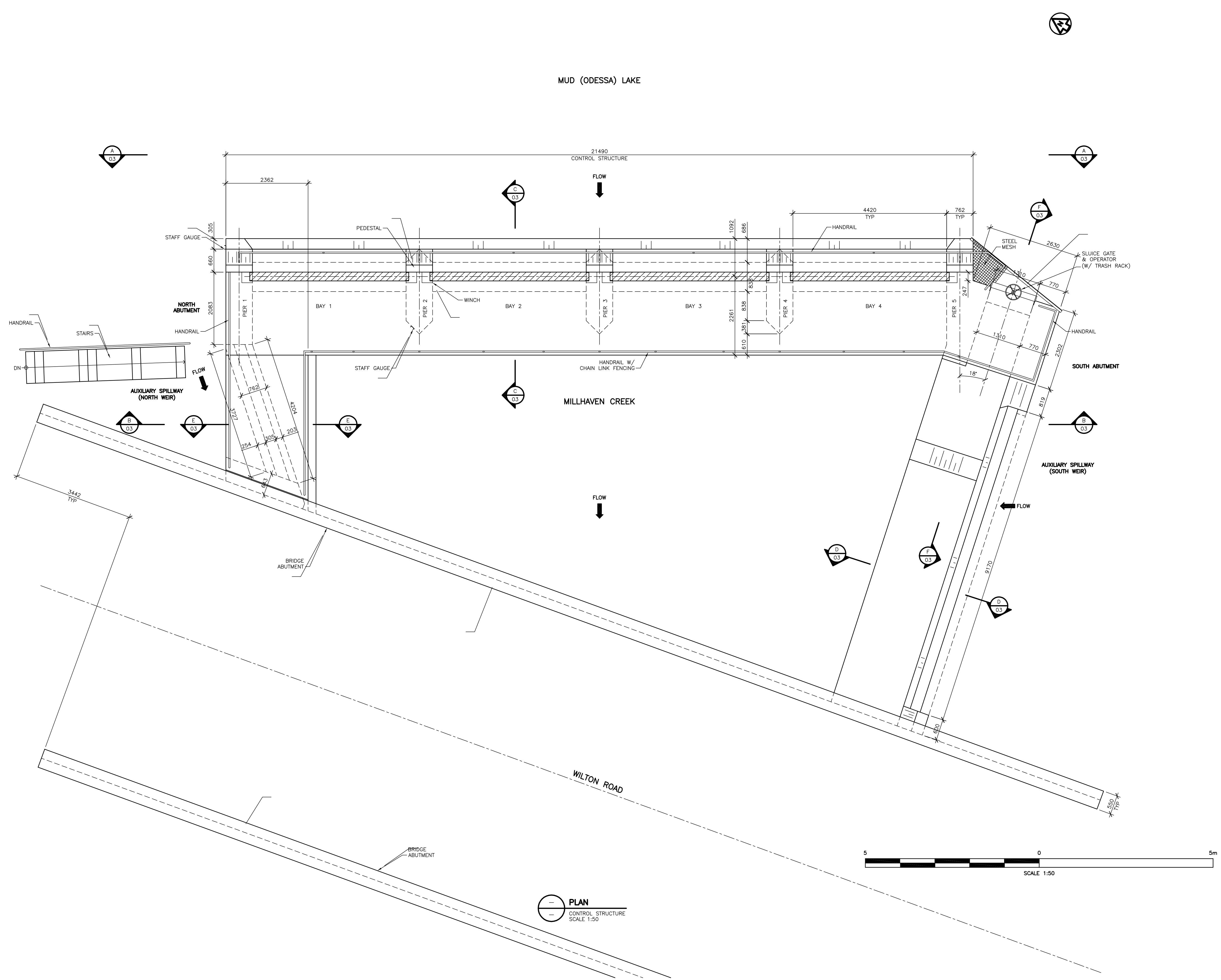
LOCATION
ODESSA, ONTARIO

TROW PROJECT NO. BRIF00194757A
CLIENT PROJECT NO. ---

DRAWING TITLE
EXISTING SITE PLAN

SCALE 1:100	DATE JANUARY 2006
DRAWN BY M.S.A.	REV. NO. A
DESIGNED BY ---	DRAWING NO. WIL-01EX
CHECKED BY M.H.N.	

DATE: 4/12/2006 5:35:06 PM PLOTTED BY: MIKE ANDERTON



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SEAL

LICENSED PROFESSIONAL ENGINEER
M.H. NELSON
PROVINCE OF ONTARIO

DESIGNED:
CHECKED:
DATE:

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PROJECT
WILTON ROAD DAM

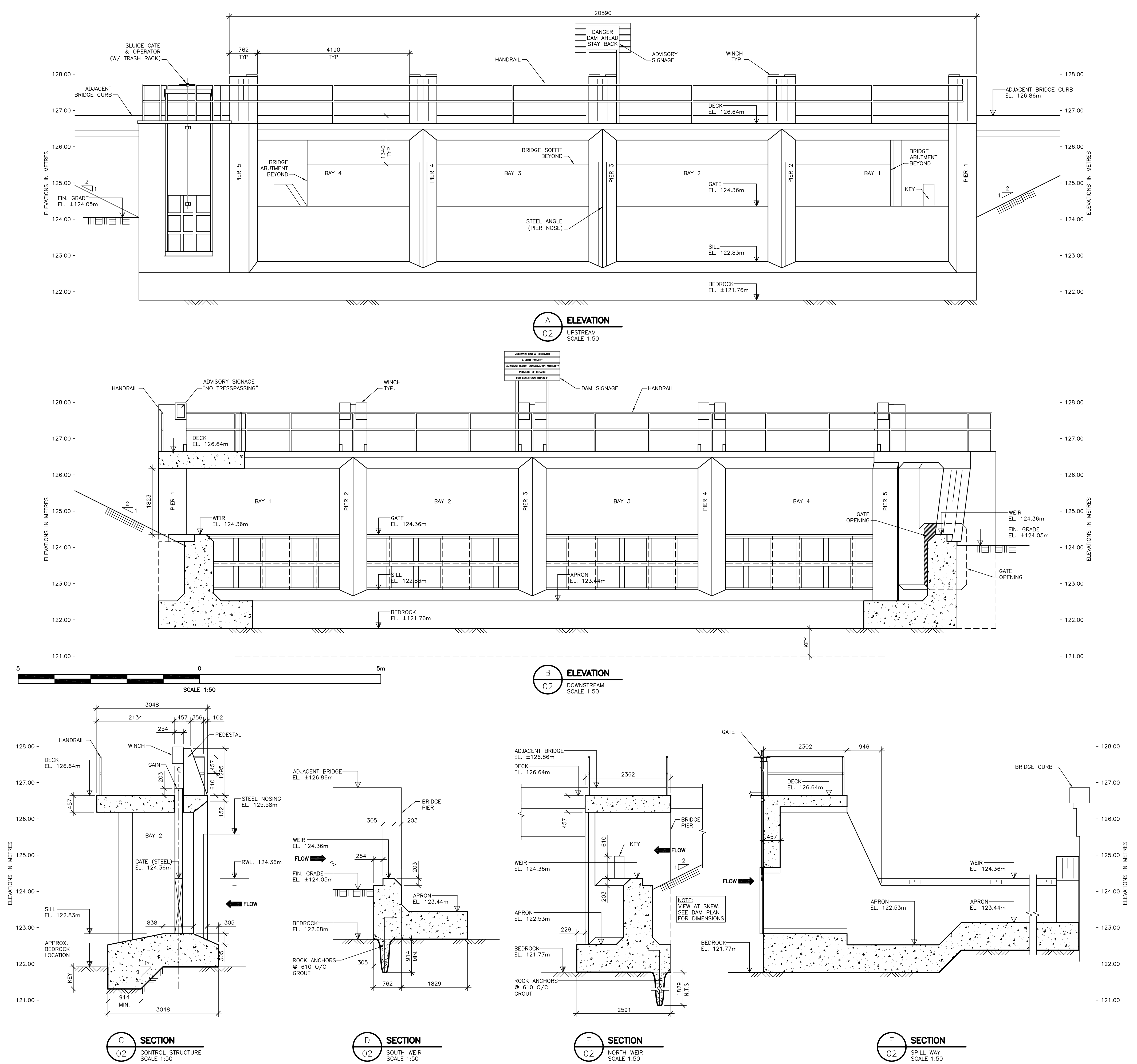
LOCATION
ODESSA, ONTARIO

TROW PROJECT NO. BRIF00194757A
CLIENT PROJECT NO. ---

DRAWING TITLE
EXISTING PLAN

SCALE 1:50	DATE JANUARY 2006
DRAWN BY M.S.A.	REV. NO. A
DESIGNED BY ---	DRAWING NO. WIL-02EX
CHECKED BY M.H.N.	

DATE: 4/12/2006 5:35:28 PM PLOTTED BY: MIKE ANDERTON



GENERAL NOTES:

1. PLANS, ELEVATIONS & SECTIONS ARE BASED ON DRAWINGS PREPARED BY TOTTEN SIMS HUBICKI ASSOCIATES LIMITED PROJECT No. 1781. DATED: MARCH 1974.
2. CONTOURS & ELEVATIONS BASED ON SURVEY CONDUCTED BY TROW ASSOCIATES INC. DATED: NOV. 24 2005.

No.	REVISION	DATE	APPD.
A	RELEASED FOR INFORMATION	JAN. 2006	---

SEAL

LICENSED PROFESSIONAL ENGINEER M.H. NELSON PROVINCE OF ONTARIO

DESIGNED:
CHECKED:
DATE:

CATARAQUI REGION CONSERVATION AUTHORITY
1641 Perth Road, P.O. Box 160 Glenburnie, Ontario K0H 1S0
Phone: (613) 546-4228 Fax: (613) 547-6474
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Trow Associates Inc.
1595 CLARK BOULEVARD
BRAMPTON, ONTARIO L6T 4V1
FAX: (905) 793-0641 TEL: (905) 793-9800

PROJECT

WILTON ROAD DAM

LOCATION

ODESSA, ONTARIO

TROW PROJECT NO. BRIF00194757A

CLIENT PROJECT NO. ---

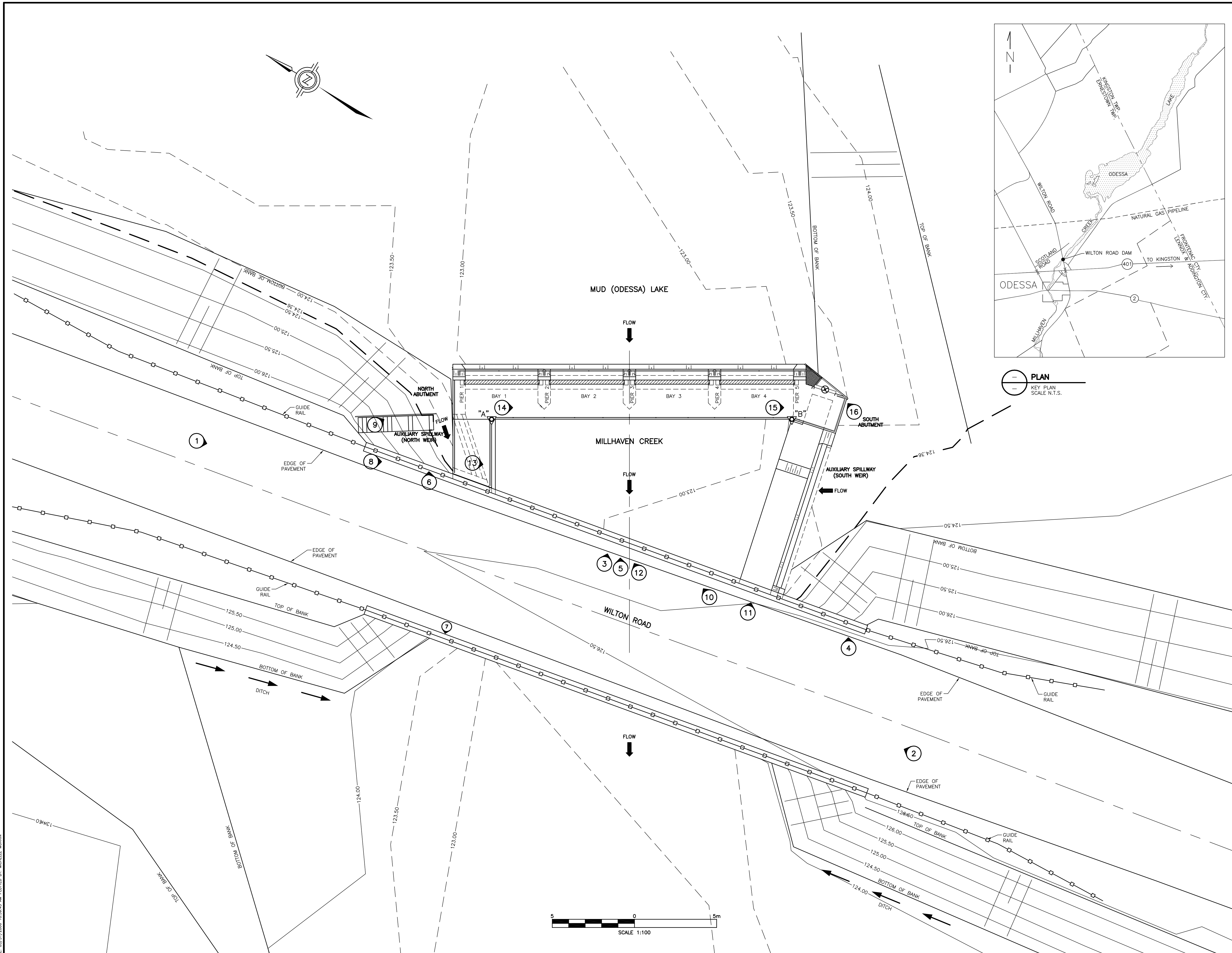
DRAWING TITLE

EXISTING ELEVATIONS & SECTIONS

SCALE	DATE
1:50	JANUARY 2006
DRAWN BY M.S.A.	REV. NO. A
DESIGNED BY ---	DRAWING NO. WIL-03EX
CHECKED BY M.H.N.	

DATE: 4/12/2006 5:35:50 PM PLOTTED BY: MIKE ANDERTON

Appendix B
Photographs



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No.	REVISION	DATE	APPD.
A	RELEASED FOR INFORMATION	MARCH 2006	M.M.

SEAL: LICENSED PROFESSIONAL ENGINEER M.H. NELSON PROVINCE OF ONTARIO

DESIGNED: ______
CHECKED: ______
DATE: ______

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FAX: (905) 793-0641 TEL: (905) 793-9800

PROJECT: WILTON ROAD DAM

LOCATION: ODESSA, ONTARIO

TROW PROJECT NO.: BRIF00194757A
CLIENT PROJECT NO.: ---

DRAWING TITLE: PHOTOGRAPHS SITE PLAN

SCALE	1:100	DATE	MARCH 2006
DRAWN BY	M.S.A.	REV. NO.	A
DESIGNED BY	S.F.	DRAWING NO.	WIL-01P
CHECKED BY	M.H.N.		

DATE: 03/31/2006 10:59:45 AM PLOTTED BY: MICHELLE MURRIN

PHOTO WIL-01: WILTON ROAD, DAM ON LEFT (VIEW SOUTH)

PHOTO WIL-02: WILTON ROAD, BRIDGE IN CENTRE (VIEW NORTH)

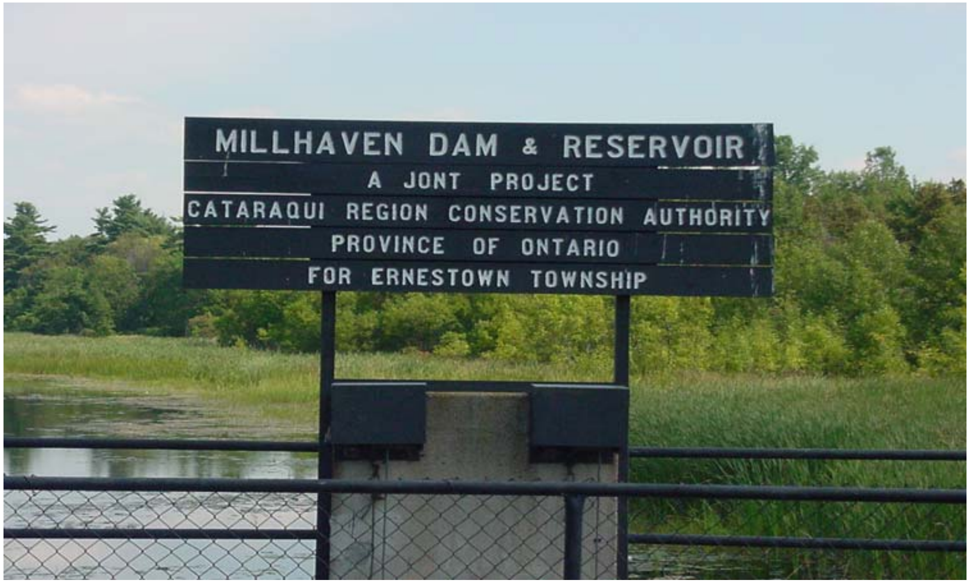


PHOTO WIL-03: DAM IDENTIFICATION SIGNAGE

PHOTO WIL-04: SOUTH SHORELINE (UPSTREAM)

PHOTO WIL-05 : MAIN CHANNEL (UPSTREAM)

PHOTO WIL-06: NORTH SHORELINE (UPSTREAM)

PHOTO WIL-07: DOWNSTREAM CHANNEL

PHOTO WIL-08: DAM DECK
ACCESS OVER GUARD RAIL

DAMAGED UPSTREAM STAFF GAUGE

DOWNSTREAM STAFF GAUGE

PHOTO WIL-09: STAIRS AND STAFF GAUGES

STEEL GATE

PHOTO WIL-10: STEEL GATES IN BAYS

PHOTO WIL-11: LOW FLOW (GATE) VALVE (DOWNSTREAM VIEW)

PHOTO WIL-12: NORTH SIDE WEIR

PHOTO WIL-13: SOUTH SIDE WEIR

PHOTO WIL-14: WINCH PEDESTALS, GAIN COVERS, DECK, HANDRAIL WITH WIRE MESH (DOWNSTREAM SIDE ONLY)

PHOTO WIL-15: LOW FLOW (GATE) VALVE OPERATOR

PHOTO WIL-16: TRASH RACK AT LOW FLOW VALVE

Appendix C
Dam Inspection Report

CONCRETE CRACKING

Cracking in a concrete dam occurs when tensile stresses exceed the tensile strength of the concrete. These stresses may occur because of imposed loads on the dam or because of volumetric changes in the concrete.

There are several types of cracking. The direction or orientation of a crack can be described using one of the following terms:

1. Longitudinal: A longitudinal crack runs parallel to the crest of the dam.
2. Transverse: A transverse crack runs perpendicular to the crest of the dam.
3. Horizontal: A horizontal crack runs along the same elevation of the dam.
4. Vertical: A vertical crack runs up and down the face of the dam.
5. Diagonal: A diagonal crack runs on an inclined plane between horizontal and vertical.

Cracking in concrete dams generally falls into the following categories:

1. Structural
2. Cracks along joints
3. Shrinkage
4. Thermal
5. Pattern
6. D-cracking

Structural cracks are the most serious and are related to a feature of the dam where stress concentrations are located. In appearance, a structural crack may be:

1. Diagonal with abrupt changes in direction.
2. Transverse extending from upstream to downstream.
3. Wide with a tendency to increase in width
4. Adjacent to concrete that is noticeably displaced.

Cracks along joints are typically construction joint cracks or cracks at places where new concrete has been placed against old concrete.

Shrinkage cracks due to drying of the concrete are fine and show no evidence of movement.

Thermal cracking is usually rectangular or blocky. Thermal-induced cracks result from tensile stresses exceeding the tensile strength of the concrete and are deeper than shrinkage cracks.

Pattern cracking is indicated by openings on concrete surfaces in the form of a pattern. Pattern cracking results from a decrease in volume of the material near the surface or increase in volume of the material below the surface or both. Pattern cracks are an indication that a problem associated with freeze-thaw or some type of chemical reaction is occurring in the concrete.

D-cracking results from using sub-standard concrete aggregates that absorb water then crack under freezing conditions. The cracked aggregates encourage cracking in the surrounding concrete.

Concrete Deterioration

Although cracks are a form of concrete deterioration, the following are generally considered the most common types of concrete deterioration:

1. Disintegration
2. Spalling
3. Efflorescence
4. Drummy Concrete
5. Popouts
6. Pitting
7. Scaling

Disintegration is concrete crumbling into small pieces.

Spalling is the loss of pieces or chunks of concrete because of compression, impact or abrasion. Although spalls are confined to the surface of the concrete and thus may not be a serious problem, spalling can lead to exposed reinforcement, create a seepage path around waterstops at joints, create an offset along the flow surface, or develop into a point of structural weakness.

Efflorescence is the leaching of calcium compounds from within the concrete and its deposition on the surface due to water leaking through the joints, cracks, or the concrete itself. As calcium is leached from the concrete, cracks become wider leading to increased leakage and faster deterioration.

Drummy concrete is concrete that has a void, separation or other weakness within the concrete and can be identified by striking the concrete structure and listening for a hollow sound. Drummy concrete has a diminished strength and is susceptible to further deterioration.

Popouts are small areas of the concrete surface that break away. Popouts are caused by expansion of deleterious coarse aggregate particles due to wetting/freezing. Popouts leave a shallow conical depression that is subject to further deterioration.

Pitting consists of small cavities in the concrete caused by localized disintegration which are susceptible to further deterioration.

Scaling is flaking or peeling away of concrete or mortar surfaces and these areas are subject to further deterioration.

Shrinkage, thermal stress and freeze-thaw actions are causes of cracking and can also cause concrete deterioration. Other common causes of concrete deterioration are:

1. Faulty Concrete Mixes

2. Chemical Attack
   a) Sulphate
   b) Acid
   c) Alkali-Aggregate

3. Erosion

Faulty concrete mixes can result from improperly graded mixes, improper cement or water content and a lack of the proper degree of entrained air. Even good concrete mixes can become faulty if there is improper use of additives or inadequate mixing, placing, or curing procedures and equipment.

Although **chemical attacks** are very slow processes, they are undesirable reactions that occur over the entire lifetime of the structure requiring ongoing observation and maintenance.

A **sulphate attack** is a chemical reaction between sulphates in soil or groundwater and concrete. The reaction causes expansion of the concrete that leads to further deterioration. Mix designs before 1930 did not consider sulphate attack and are prone to this chemical reaction. Symptoms of sulphate attack include cracking, spalling, scaling and staining.

An **acid attack** is a bacterial action on the calcium hydroxide found in hydrated Portland cement, limestone, or dolomite aggregates. This type of reaction results in the leaching away of water-soluble compounds. Symptoms of an acid attack include cracking, efflorescence, spalling and colour change,

An **alkali-aggregate attack** is a chemical reaction between the soluble alkali in the cement and the aggregate. A concrete mix of low alkali cements and marine sediments or shale from river gravel containing cherts is a good recipe to create an alkli-aggregate chemical attack. This type of reaction causes the expansion of concrete resulting in pervasive pattern cracking. Indicators of alkali-aggregate attack include pattern cracking, efflorescence, incrustation and white rings around aggregate particles. Dams that were built prior to 1940 of low-alkali cements or where designers failed to recognise reactive aggregate are prone to this type of reaction.

Physical **erosion** can occur on spillways, aprons, piers or any other part of a dam that experiences fast flowing water containing abrasive materials. Dams located downstream of riverbeds of gravel and rock fragments with moderate-to-steep gradients are subject to abrasion erosion.

PART 1 - GENERAL

Name of Dam	Date of Inspection	Structure Constructed	Structure Re-Constructed
Wilton Road Dam	November 2005	1975	
Upstream Lake/River	**Lot No.**	**Con. No.**	**Township/County**
Odessa Lake	35	IV	Loyalist
Weather	**Temperature**	**Rain Last 24 Hours**	
Rainy	6°	√ yes ☐ no	
Headpond Elev.	**Tailwater Elev.**	**Snowmelt On-going**	
N/A	N/A	☐ yes √ no	
Dam Owner	**Dam Operator**	**Phone No.**	
Cataraqui Region Conservation Authority	Mara Shaw	613-546-4228	

Inspection Team:

Name	Title	Affiliation
Hugh Nelson	Project Manager and Dam Safety Engineer	Trow Associates Inc.
Peter Lim	Hydrotechnical Engineer	Trow Associates Inc.
Mara Shaw	Watershed Management Coordinator	Cataraqui Region Conservation Authority
Robert Gerrtsen	Conservation Lands Coordinator	Cataraqui Region Conservation Authority

STANDING OPERATING PROCEDURES (SOP)

General	
Issue or Revision Date	June 2001
Are instructions adequate?	√ yes ☐ no
Are instructions understood?	√ yes ☐ no
Any changes needed?	☐ yes √ no

Incremental Consequence Category	
Classification	Low

Site Access	
Description	Dam is located upstream of a municipal road crossing.
Adequacy Under Adverse Conditions	Fair to Good

PART 1 - GENERAL (Continued)

STANDING OPERATING PROCEDURES (SOP) (Continued)

Safety	
Log Booms	None
Signage	Warning signage is minimal.
Gates	No access gates to control structure.
Handrails	√ yes □ no Two rail construction (middle & top rails).

Other Remarks
A rock outcrop downstream of the dam (123.8 metres) controls the water level in the river during the winter months.

Photograph(s): √ digital □ print
See photographs in Appendix A.

WILTON ROAD DAM

PART 2 - EARTH EMBANKMENT

☐ yes √ no Note: The earth embankment is part of the roadway.

Upstream Slope	
Slope Protection	
Erosion-Beaching	
Vegetative Growth	
Settlement/Depression	
Debris	
Cracks with Displacement	
Sinkholes	
Burrows Or Burrowing Animals	
Unusual Conditions	

Downstream Slope	
Sinkholes	
Seepage or Wet Areas	Yes
Seepage/Piping at Concrete Contact	
Cracks with Displacement	
Settlement/Depressions	
Vegetative Growth	
Unusual Conditions	
Channelization	
Condition of Slope Protection	
Burrows or Burrowing Animals	

Crest	
Surface Cracking / Displacement	
Ruts and Puddles	
Vegetative Growth	
Durability	
Settlement/Depression	
Lateral Movement	
Camber	

PART 2 - EARTH EMBANKMENT (Continued)

Seepage and Drainage Summation
Location(s)
Estimated Flow(s)
Colour (staining)
Erosion of Outfall
Toe Drain and Relief Wells

Measurement
Method
Amount
Change in Flow
Clearness of Flow
Colour
Fines
Condition of Measurement
Devices
Records

PART 2 - EARTH EMBANKMENT (Continued)

Instrumentation
Piezometer Well
Well
Frostfloor
Ventilation
Gauges
Piping
Security
Surface Settlement Points
Crossarm Devices (deviation, station, and offset)
Reservoir-Level Gauge
Ice-Prevention System
Other: ____________________ __________________________

Other Remarks

Photograph(s): ☐ digital ☐ print

PART 3 - DAM SEGMENTS

Upstream Face			
Cracks with Displacement	□ yes	√ no	
Cracks	√ yes	□ no	Minor - monitor
Misalignment	□ yes	√ no	
Severe Surface Erosion	□ yes	√ no	
Spalling	□ yes	√ no	
Efflorescence	□ yes	√ no	
Vegetation Growth	□ yes	√ no	

Downstream Face			
Seepage	□ yes	√ no	
Cracks with Displacement	□ yes	√ no	
Cracks	□ yes	√ no	
Misalignment	□ yes	√ no	
Efflorescence	□ yes	√ no	
Vegetation Growth	□ yes	√ no	

Crest			
Offsets	□ yes	√ no	
Roadway	None		
Walks	None		
Parapet Wall	None		
Lighting, etc.	None		
Cracks with displacement	□ yes	√ no	
Cracks	□ yes	√ no	
Misalignment	□ yes	√ no	
Severe Surface Erosion	□ yes	√ no	
Spalling	□ yes	√ no	

Instrumentation			
Reservoir-Level Gauge	√ yes	□ no	Two gauges. One located on the north pier facing the concrete steps. This gauge is tied to a geodetic datum, but is damaged from ice. The second gauge is on the downstream side of the southerly pier of Bay 1.

PART 3 - DAM SEGMENTS (Continued)

Foundation At Downstream Toe Of Dam			
Seepage	□ yes	√ no	
Location			
Amount			
Measurement Methods			
Other: ____________________ _________________________			

Abutments	□ yes	√ no
Seepage	□ yes	□ no
Cracks with Displacement	□ yes	□ no
Cracks	□ yes	□ no
Spalling	□ yes	□ no
Misalignment	□ yes	□ no
Efflorescence	□ yes	□ no
Vegetation Growth	□ yes	□ no

Wingwalls	□ yes	√ no
Seepage	□ yes	□ no
Cracks with Displacement	□ yes	□ no
Cracks	□ yes	□ no
Spalling	□ yes	□ no
Misalignment	□ yes	□ no
Efflorescence	□ yes	□ no
Vegetation Growth	□ yes	□ no

Upstream Waterway			
Vegetation (e.g., trees, etc.)	√ yes	□ no	Wetland upstream.
Debris	√ yes	□ no	Accumulated at the trash rack of the low flow valve.
Slides Above Channel	□ yes	√ no	
Channel Side Slope Stability	Good		
Slope Protection	None		

PART 3 - DAM SEGMENTS (Continued)

Downstream Waterway			
Vegetation (e.g., trees, etc.)	□ yes	√ no	Only along the banks.
Debris	□ yes	√ no	
Slides Above Channel	□ yes	√ no	
Channel Side Slope Stability	Good		
Slope Protection	None		

Other Remarks

Photograph(s): √ digital □ print
See photographs in Appendix A.

PART 4

CONTROL STRUCTURE

Control Structure		
Sill and Apron		
	Surface Condition	Good
	General Condition of Concrete	Good
	Cracks or Areas of Distress	No
	Signs of Movement	None
	Settlement	None
	Joints	Solid
Abutment Walls		
	Surface Condition	
	Movement (offsets)	
	Cracks or Areas of Distress	
	Settlement	

Control Deck			
Surface Condition	Good		
General Condition of Concrete	Good		
Cracks or Areas of Distress	√ yes	□ no	Winch pedestals – repair – drummy concrete
Spalling or Areas of Distress	□ yes	√ no	

Piers		
Piers	√ yes	□ no
Surface Condition	Minor surface abrasion due to flow.	
Cracks or Areas of Distress	No	
Signs of Movement	None	
Settlement	None	

PART 4 (Continued)

STOP LOG CONTROL STRUCTURE (Continued)

Controls For Gates	
Mechanical	√ yes □ no Vertical steel gates
Hoists	Winches on concrete pedestal.
Gains	Show little deterioration or rust at the waterline. Gain covers are grid steel plate with lockdown straps.
Protective Coating	□ yes √ no
Electrical	□ yes √ no
Remote Control	
Power Supply	
Standby Power	
Operation Instructions	

Stop Logs
General Condition
Protective Coating
Seals
Leakage

Bridge □ yes √ no
Condition of Piers
Surface of Roadway Slab
Structural Condition of Slab and Beams
Bridge Bearings
General Condition

Other

PART 4 (Continued)

STOP LOG CONTROL STRUCTURE (Continued)

Other Remarks

Photograph(s): √ digital □ print
See photographs.

PART 4 (Continued)

OUTLET WORKS

Control Gate Or Valve (Repeat For Each Gate Or Valve) √ yes no	
Gate or Valve Housing	
General Condition	Good
Gate(s)	
General Condition	Good
Protective Coating	
Cavitation	
Leakage (closed)	None noted – tailwater covered portion of gate
Exercising Frequency	
Operation of Gates at Time of Inspection	
Valve(s)	
General Condition	Good
Protective Coating	Alumninum
Cavitation	
Leakage (closed)	None noted – tailwater covered portion of valve
Creep	
Exercising Frequency	
Operation of Gates at Time of Inspection	

Downstream Conduit	
Metalwork (dimension)	
General Condition	
Protective Coatings	
Cavitation	
Concrete	
General Condition	
Leakage	
Ventilation	

PART 4 (Continued)

OUTLET WORKS (Continued)

Control System For Gates And Valves
Mechanical
Electrical
Operating Instructions

Other

Other Remarks

Photograph(s): √ digital □ print
See photographs.

PART 5

GEOLOGY

Site Geology	
Dam	Gull River limestone formation, belonging to members B, C and D.
Spillway	
Outlet Works	
Abutments	
Left	
Right	
Reservoir	Farmington loam, Lincoln clay or Renfrew clay.

Seepage	
Dam Site	□ yes √ no
Toe And Abutments	□ yes √ no
Downstream Channel	□ yes √ no
Other: ___________________ ________________________	

Physical Features	
Faulting	□ yes √ no
Clay Seams	□ yes √ no
Depressions	□ yes √ no
Sinkholes	□ yes √ no
Bedding Planes	□ yes √ no
Shear Seams	□ yes √ no
Other: ___________________ ________________________	

Seismicity	
Surface Rupture	□ yes √ no
Ground Tilting	□ yes √ no
Settlement	□ yes √ no

PART 5 (Continued)

GEOLOGY (Continued)

Landslides		
Reservoir	□ yes	√ no
Dam Site	□ yes	√ no
Downstream Channel	□ yes	√ no
Other: ___________________ _______________________		

Other Remarks

Photograph(s): □ digital □ print

PART 6

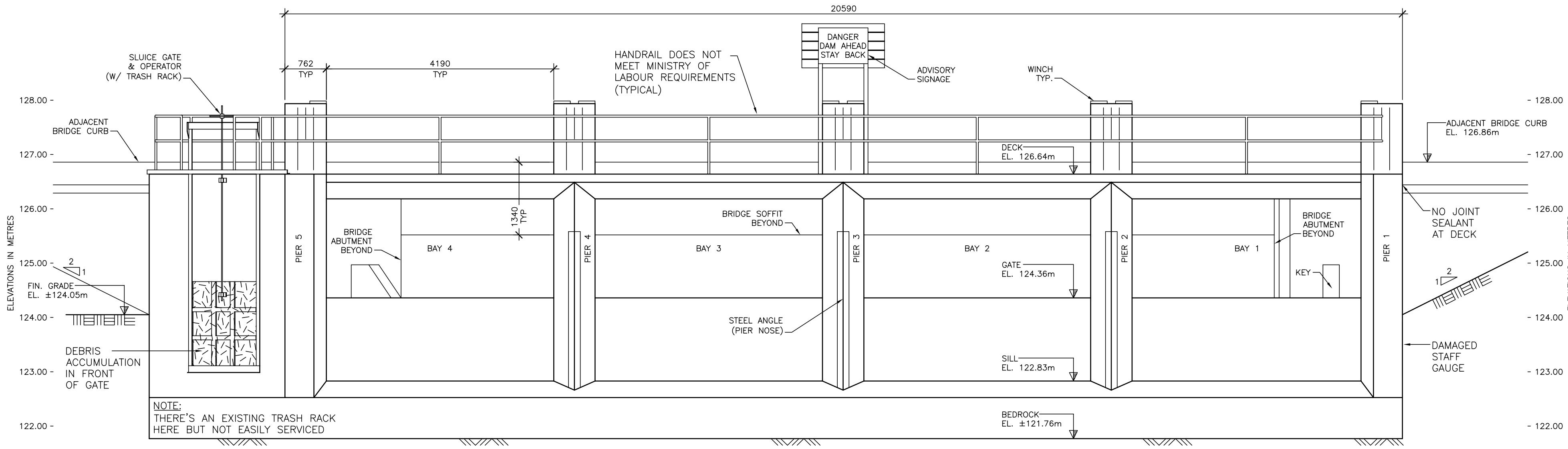
GEOTECHNICAL

Concrete Strength				
Method				
Location	Deck	Overflow Weir	Dam Segment ☐ South ☐ West	Dam Segment ☐ North ☐ East
Strength				

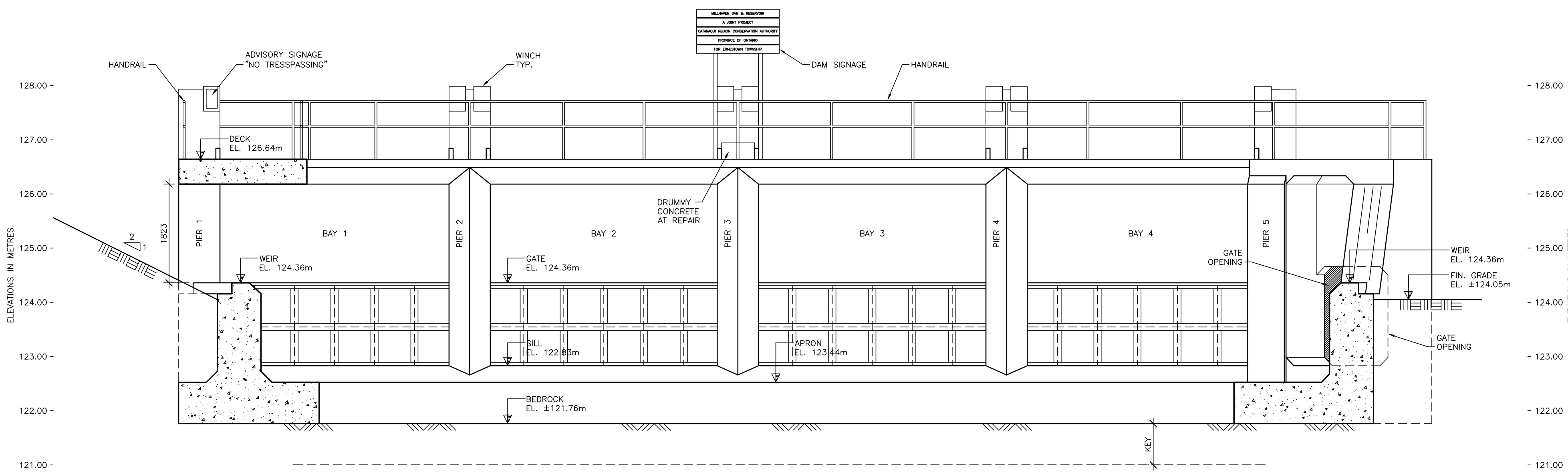
Other Remarks
Generally in good condition

Photograph(s): √ digital ☐ print
See photographs.

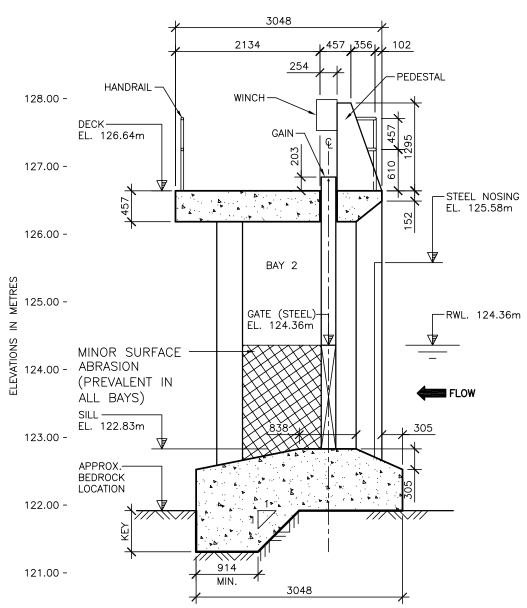
Appendix D
Drawings - Deficiencies



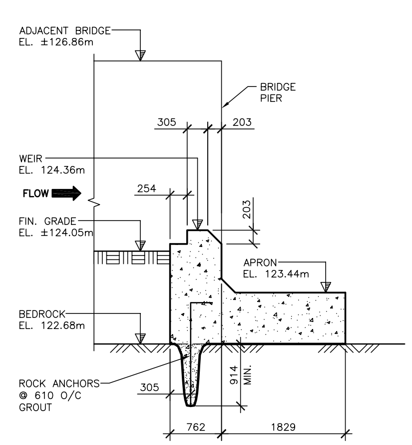
A / 02 ELEVATION
UPSTREAM
SCALE 1:50



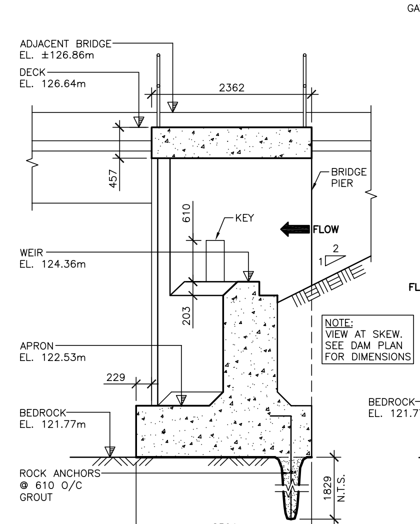
B / 02 ELEVATION
DOWNSTREAM
SCALE 1:50



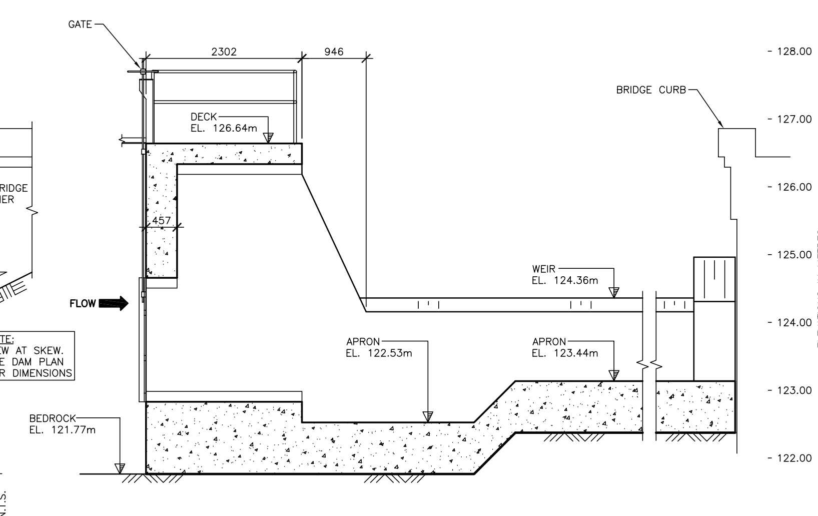
C / 02 SECTION
CONTROL STRUCTURE
SCALE 1:50



D / 02 SECTION
SOUTH WEIR
SCALE 1:50



E / 02 SECTION
NORTH WEIR
SCALE 1:50



F / 02 SECTION
SPILL WAY
SCALE 1:50

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No.	REVISION	DATE	APPD.
A	RELEASED FOR INFORMATION	MARCH 2006	M.M.

SEAL
LICENSED PROFESSIONAL ENGINEER — M.H. NELSON — PROVINCE OF ONTARIO

DESIGNED:
CHECKED:
DATE:

CATARAQUI REGION CONSERVATION AUTHORITY
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Trow Associates Inc.
1595 CLARK BOULEVARD
BRAMPTON, ONTARIO L6T 4V1
FAX: (905) 793-0641 TEL: (905) 793-9800

PROJECT
WILTON ROAD DAM

LOCATION
ODESSA, ONTARIO

TROW PROJECT NO. BRIF00194757A
CLIENT PROJECT NO. ---

DRAWING TITLE
DEFICIENCIES

SCALE 1:50	DATE MARCH 2006
DRAWN BY M.S.A.	REV. NO. A
DESIGNED BY S.F.	DRAWING NO. WIL-03D
CHECKED BY M.H.N.	

Appendix E
Stability Evaluation

EXISTING CONDITIONS

Winter Water:	123.80 m (equal both sides of dam)
Summer Water:	124.36 m
Flood:	124.96 m
Tailwater:	124.70 m (flood conditions only)

We have ignored winter conditions as all lateral loads are equalized (i.e. water at the same level on both sides).

CONTROL STRUCTURE (Section C)

Summer	F	M
D	642.48	840.24
H	141.42	-111.25
U	-182.65	-371.15
Net Down-force	459.83	
Horizontal Force	141.42	

Resistance to Sliding: 0.67 x 466.79 = 312.75

Safety Factor Sliding: 312.75 / 141.42 = 2.21

Net Moment: 357.84

Resultant: `X' = 357.84 / 459.83 = 0.78 m
`e' = (3.05 / 2) – 0.78 = 0.75
Does not meet criteria for resultant being in mid-third of structure.

Quake	F	M
D	642.48	840.24
H	141.42	-111.25
U	-182.65	-371.15
Q_H	62.32	-104.07
Q_V	-31.16	-40.82
Net Down-force	428.67	
Horizontal Force	203.74	

Resistance to Sliding: 0.67 x 428.67 = 287.21

Safety Factor Sliding: 287.74 / 203.74 = 1.41

CONTROL STRUCTURE continued

Net Moment: 212.95

Resultant: `X' = 212.95 / 428.67 = 0.50
`e' = (3.05 / 2) – 0.50 = 1.03
Does not meet criteria for resultant being in mid-third of structure.

Flood	F	M
D	466.49	601.61
H	28.44	-39.83
U	-15.24	-30.97
Net Down-force	451.25	
Horizontal Force	28.44	

Resistance to Sliding: 0.67 x 451.25 = 302.34

Safety Factor Sliding: 302.34 / 28.44 = 10.63

Net Moment: 530.81

Resultant: `X' = 530.81 / 451.25 = 1.18
`e' = (3.05 / 2) – 1.18 = 0.34
Meet criteria for resultant being in mid-third of structure.

Conclusion

One central bay was considered as representative of the entire structure. Under all loading conditions considered, the safety factor for sliding was adequate. Under normal (summer) and quake loads, the result was out of the mid-third. On bedrock, this is not critical. Furthermore, by considering only the one central bay we have ignored the more massive end bays tied into the two weirs. We feel this structure is stable under all conditions.

SOUTH WEIR (Section D)

Summer	F	M
D	63.68	66.97
H	17.06	9.28
U	-21.575	-18.62
Net Down-force	42.11	
Horizontal Force	17.06	

SOUTH WEIR continued

Resistance to Sliding: 0.67 x 42.11 = 28.21

Safety Factor Sliding: 28.21 / 17.06 = 1.65

Net Moment: 57.63

Resultant: `X’ = 57.63 / 42.11 = 1.37 m
`e’ = (2.59 / 2) – 1.37 = -0.07
Meets criteria for resultant being in mid-third of structure.

Quake	F	M
D	63.68	66.97
H	17.06	9.28
U	-21.575	-18.62
Q_H	6.19	-3.65
Q_v	-3.10	-3.26
Net Down-force	39.01	
Horizontal Force	23.25	

Resistance to Sliding: 0.67 x 39.01 = 26.14

Safety Factor Sliding: 26.14 / 23.25 = 1.12

Net Moment: 50.72

Resultant: `X’ = 50.72 / 39.01 = 1.30 m
`e’ = (2.59 / 2) – 1.30 = 0

Meets criteria for resultant being in mid-third of structure.

Flood	F	M
D	37.68	39.62
H	3.04	-1.36
Net Down-force	37.68	
Horizontal Force	3.04	

Resistance to Sliding: 0.67 x 37.68 = 25.25

Safety Factor Sliding: 25.25 / 3.04 = 8.30

SOUTH WEIR continued

Net Moment: 38.26

Resultant: `X' = 38.26 / 37.68 = 1.02 m
`e' = (2.59 / 2) – 1.02 = 0.28

Meets criteria for resultant being in mid-third of structure.

Conclusion

Trow feels that Section D is representative of this structure. It was assumed that the structure is under lateral pressure of water plus active pressure of the submerged soil (where applicable). The structure was found to be safe under all loading conditions considered.

NORTH WEIR (Section E)

Summer	**F**	**M**
D	80.01	119.91
H	43.13	-36.55
U	-32.87	-56.78
Net Down-force	47.14	
Horizontal Force	43.13	

Resistance to Sliding: 0.67 x 47.14 = 31.58

Safety Factor Sliding: 31.58 / 43.13 = 0.73

Net Moment: 26.58

Resultant: `X' = 26.58 / 47.14 = 0.56 m
`e' = (2.591 / 2) – 0.56 = 0.74

Does not meet criteria for resultant being in mid-third of structure.

Quake	**F**	**M**
D	80.01	119.91
H	43.13	-36.55
U	-32.87	-56.78
Q_H	7.76	-7.06
Q_V	-3.88	-5.82

Net Down-force 43.26

NORTH WEIR continued

Horizontal Force 50.89

Resistance to Sliding: 0.67 x 43.26 = 28.98

Safety Factor Sliding: 28.98 / 50.89 = 0.57

Net Moment: 13.70

Resultant: \`X' = 13.70 / 43.26 = 0.32 m
\`e' = (2.591 / 2) – 0.32 = 0.98
Does not meet criteria for resultant being in mid-third of structure.

Flood	F	M
D	47.34	70.95
H	43.13	-8.19
Net Down-force	47.34	
Horizontal Force	43.13	

Resistance to Sliding: 0.67 x 47.34 = 31.72

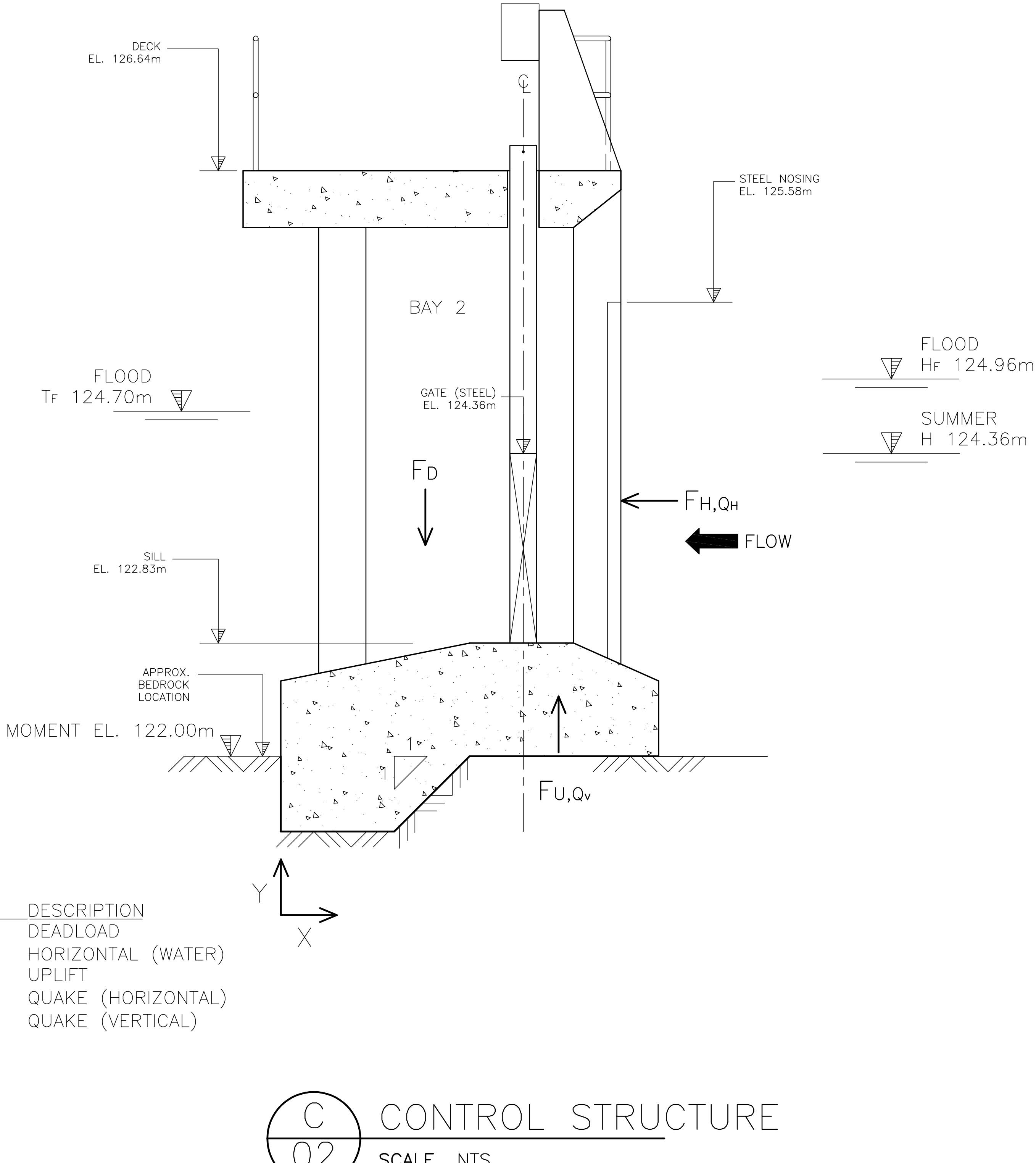
Safety Factor Sliding: 31.72 / 43.13 = 0.74

Net Moment: 62.76

Resultant: \`X' = 62.76 / 47.34 = 1.33 m
\`e' = (2.591 / 2) – 1.33 = -0.03
Meets criteria for resultant being in mid-third of structure.

Conclusion

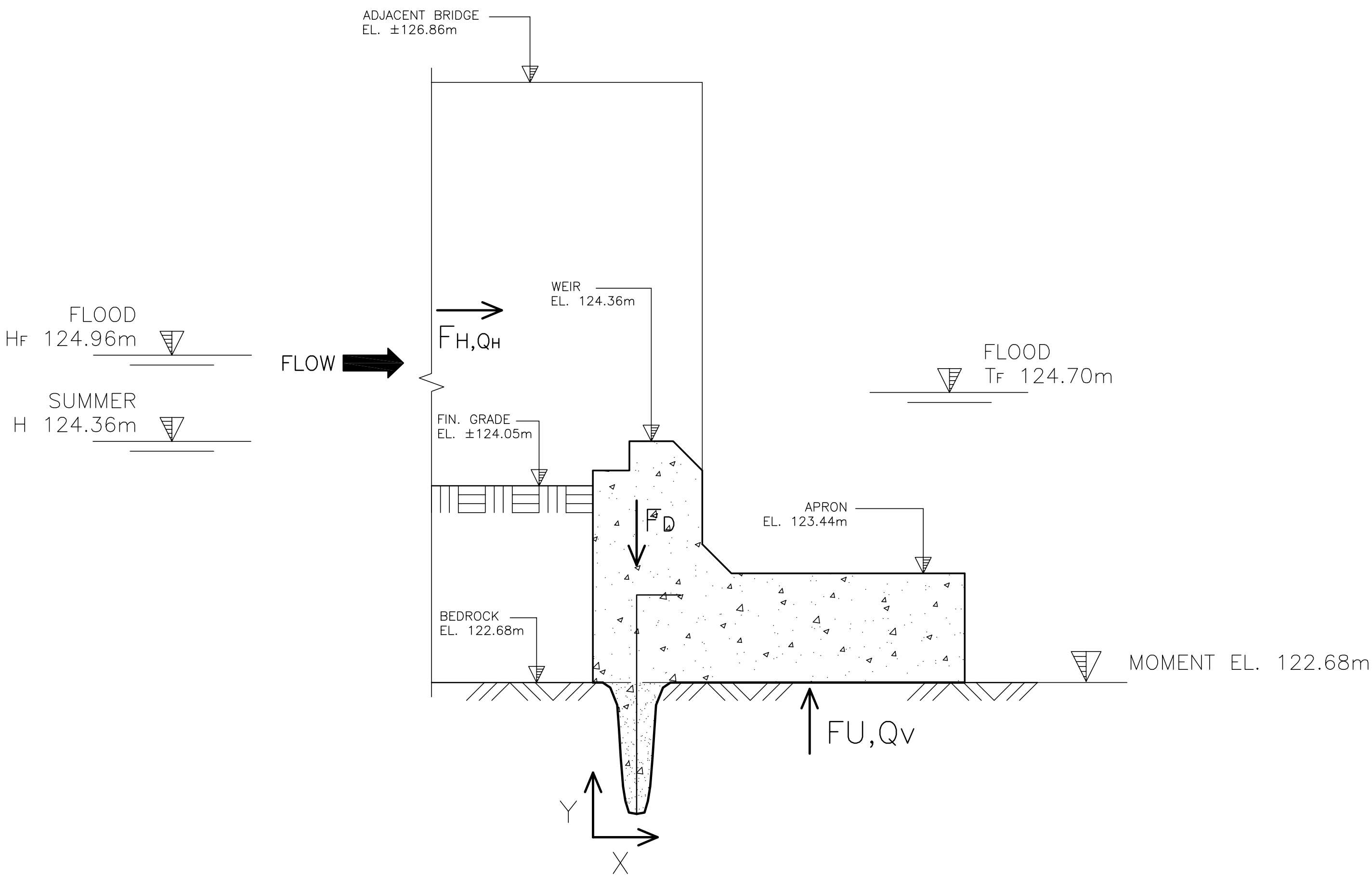
The safety factor for sliding was found inadequate under all conditions. The resultant is also out of the mid-third under normal conditions. Note: we have ignored the anchor bolts shown on the drawing. However, considering the structure as a whole, the weir is short, anchored to the bridge and control structure piers so it is considered to be safe.



SYMBOL	DESCRIPTION
F_D	DEADLOAD
F_H	HORIZONTAL (WATER)
F_U	UPLIFT
F_{QH}	QUAKE (HORIZONTAL)
F_{QV}	QUAKE (VERTICAL)

C / 02 CONTROL STRUCTURE

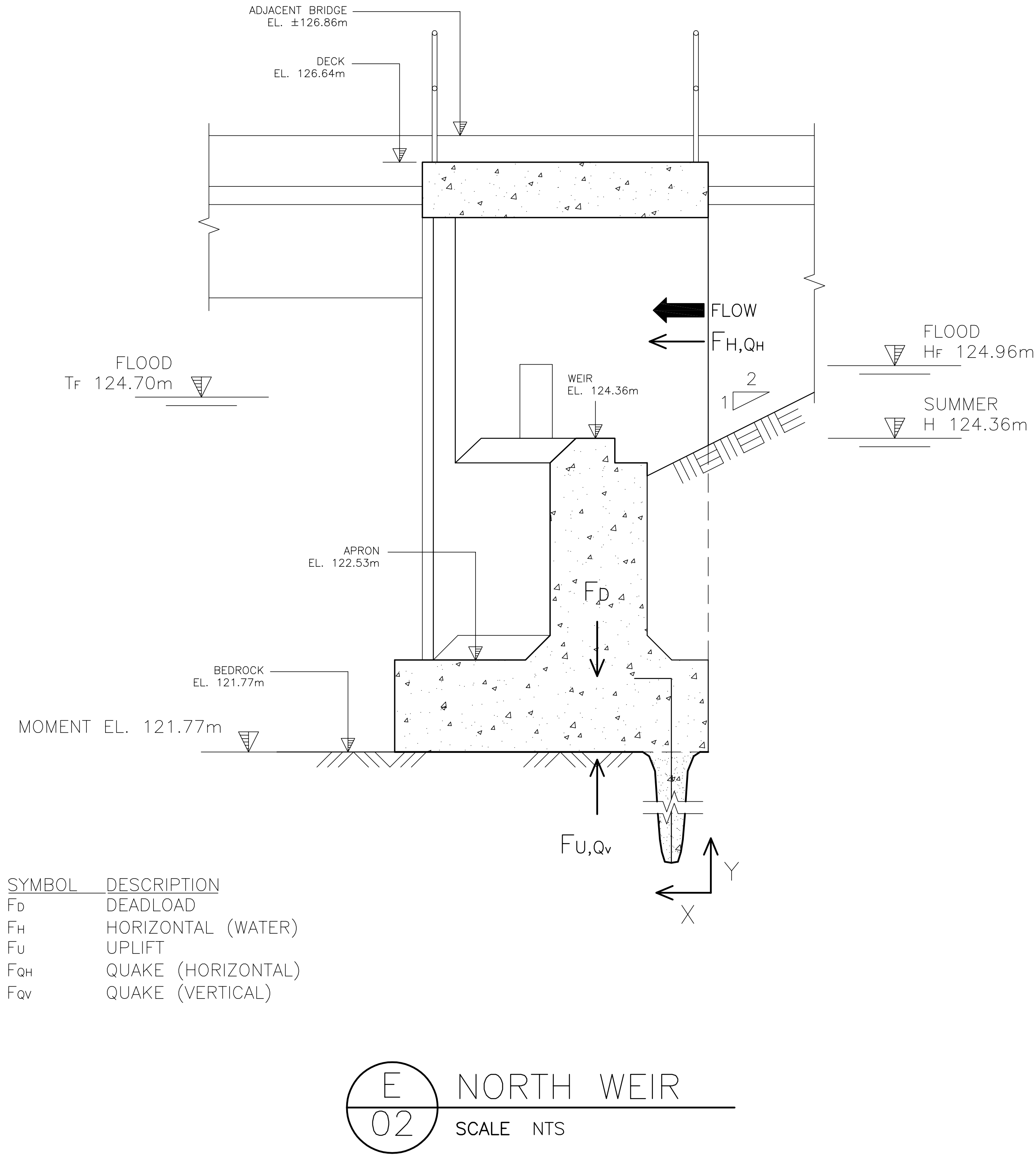
SCALE NTS



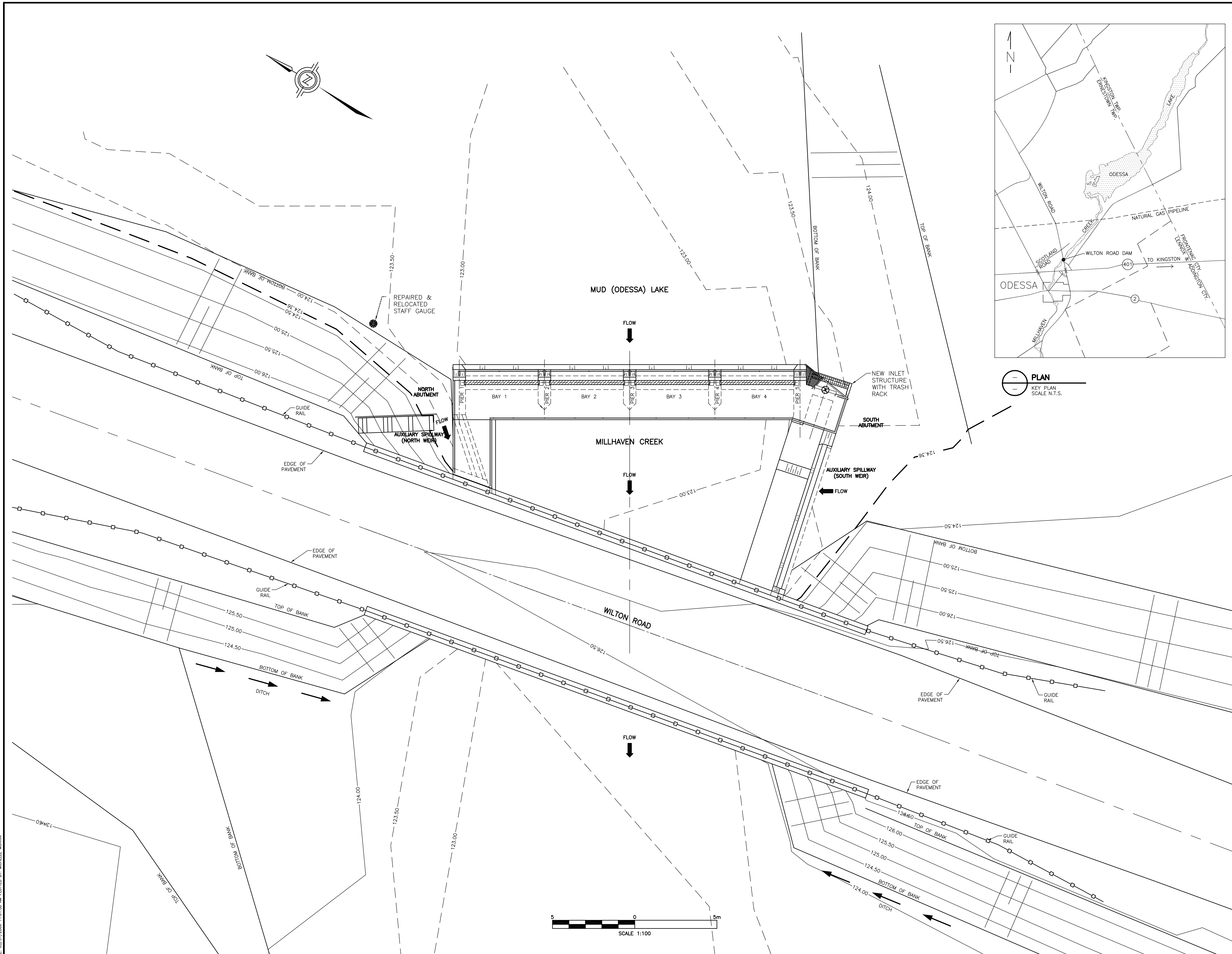
SYMBOL	DESCRIPTION
F_D	DEADLOAD
F_H	HORIZONTAL (WATER)
F_U	UPLIFT
F_{QH}	QUAKE (HORIZONTAL)
F_{QV}	QUAKE (VERTICAL)

D / 02 SOUTH WEIR

SCALE NTS


ADJACENT BRIDGE
EL. ±126.86m
DECK
EL. 126.64m
FLOW
FH,QH
FLOOD
HF 124.96m
FLOOD
TF 124.70m
WEIR
EL. 124.36m
2
1
SUMMER
H 124.36m
APRON
EL. 122.53m
FD
BEDROCK
EL. 121.77m
MOMENT EL. 121.77m
FU,QV
Y
X
SYMBOL DESCRIPTION
FD DEADLOAD
FH HORIZONTAL (WATER)
FU UPLIFT
FQH QUAKE (HORIZONTAL)
FQV QUAKE (VERTICAL)
E
02
NORTH WEIR
SCALE NTS

Appendix F
Drawings - Rehabilitation



GENERAL NOTES:

1. PLANS, ELEVATIONS & SECTIONS ARE BASED ON DRAWINGS PREPARED BY TOTTEN SIMS HUBICKI ASSOCIATES LIMITED PROJECT No. 1781. DATED: MARCH 1974.
2. CONTOURS & ELEVATIONS BASED ON SURVEY CONDUCTED BY TROW ASSOCIATES INC. DATED: NOV. 24 2005.

No.	REVISION	DATE	APPD.
A	RELEASED FOR INFORMATION	MARCH 2006	M.M.

SEAL

LICENSED PROFESSIONAL ENGINEER
M.H. NELSON
PROVINCE OF ONTARIO

DESIGNED: ______
CHECKED: ______
DATE: ______

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PROJECT
WILTON ROAD DAM

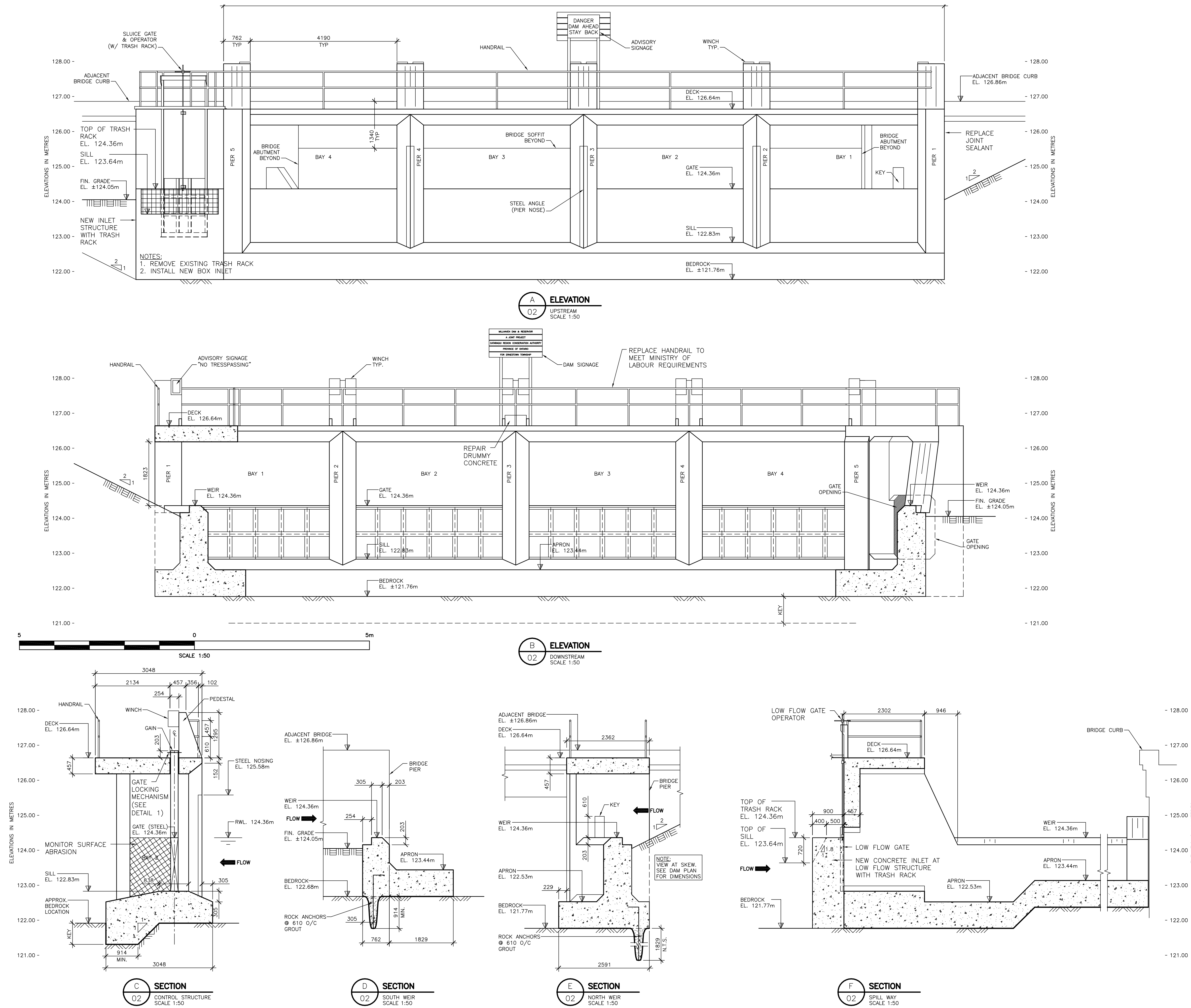
LOCATION
ODESSA, ONTARIO

TROW PROJECT NO.: BRIF00194757A
CLIENT PROJECT NO.: ---

DRAWING TITLE
REHABILITATION SITE PLAN

SCALE: 1:100	DATE: MARCH 2006
DRAWN BY: M.S.A.	REV. NO.: A
DESIGNED BY: S.F.	DRAWING NO.: WIL-01R
CHECKED BY: M.H.N.	

DATE: 03/31/2006 11:01:36 AM PLOTTED BY: MICHELLE MURRIN



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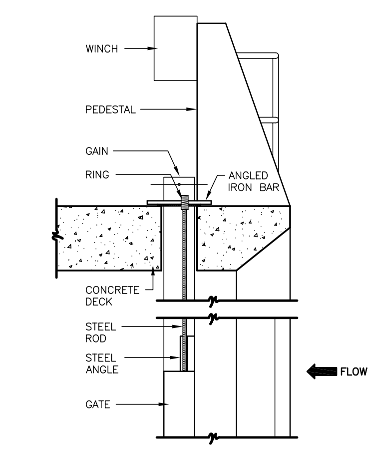
2. CONTOURS & ELEVATIONS BASED ON SURVEY CONDUCTED BY TROW ASSOCIATES INC. DATED: NOV. 24 2005.



1 GATE LOCKING MECHANISM
CONTROL STRUCTURE
SCALE 1:25

No.	REVISION	DATE	APPD.
A	RELEASED FOR INFORMATION	MARCH 2006	M.M.

SEAL: LICENSED PROFESSIONAL ENGINEER M.H. NELSON PROVINCE OF ONTARIO

DESIGNED:
CHECKED:
DATE:

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PROJECT: WILTON ROAD DAM

LOCATION: ODESSA, ONTARIO

TROW PROJECT NO.: BRIF00194757A

CLIENT PROJECT NO.: ---

DRAWING TITLE: REHABILITATION & DETAILS

SCALE: 1:50	DATE: MARCH 2006
DRAWN BY: M.S.A.	REV. NO.: A
DESIGNED BY: S.F.	DRAWING NO.: WIL-03R
CHECKED BY: M.H.N.	

DATE: 03/31/2006 10:31:19 AM PLOTTED BY: MICHELLE MURRIN

Appendix G
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