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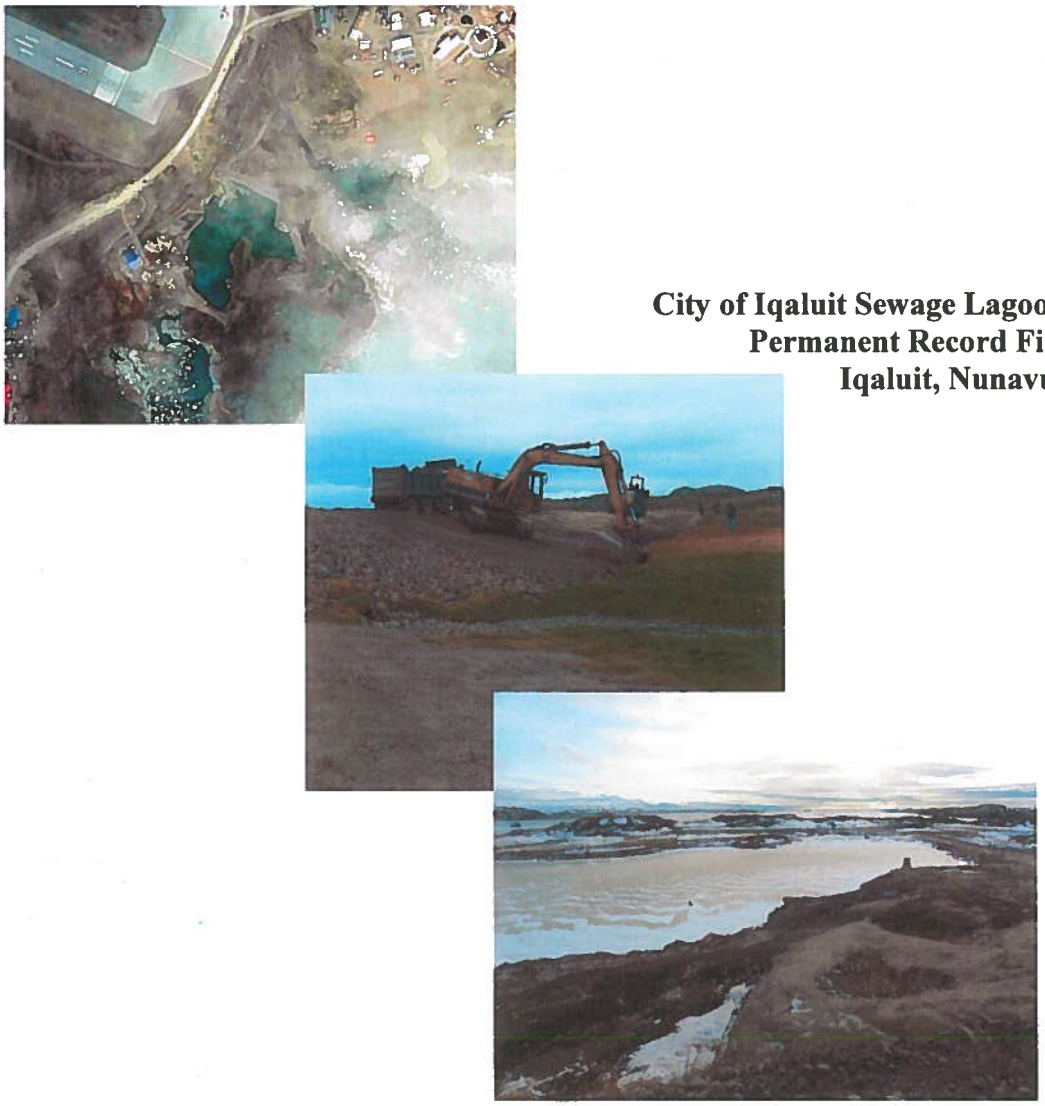

City of Iqaluit Sewage Lagoon
Permanent Record File
Iqaluit, Nunavut

PRODUCED FOR:
City of Iqaluit

PRODUCED BY:
CONCENTRIC ASSOCIATES INTERNATIONAL INCORPORATED

CONCENTRIC REFERENCE NUMBER:
12-4323

DATE:
May, 2012

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Table of Contents

CONCENTRIC

Iqaluit

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Annual Update Pages

CONCENTRIC

Iqaluit
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Instructions

The annual update pages are to be completed on an approximately annual basis. It is recommended that updating occur no later than 13 months after the previous update, and no earlier than 11 months after the previous update.

The update description should contain a brief and concise summary of any additions to the Permanent Record File (PRF) since the last update. Typically this would include a new DSI/DSR, any repairs/maintenance activities, updates to the Permanent Log Book (PLB), new construction, alteration, supplementary historical documents, etc.

The individual that fills in the Name & Signature space in the update pages below will be referred to henceforth in the PRF as the *responsible person*. That person shall be a competent third-party professional retained by the City of Iqaluit, through the Engineering Department.

Please refer to the following example:

Date	Update Notes	Name & Signature
September 30 2004	No additions to PRF	ALLAN MURRAY
September 4 2005	Completion of 2004 DSI in February 2005; a copy has been added to Tab 6. No DSI conducted in 2005.	ALLAN MURRAY
September 22 2006	Completion of 2006 DSI in August 2006; a copy has been added to Tab 6. The sewage lagoon taken off-line on July 21, 2006; all effluent to new treatment plant; see Tab 5.	ALLAN MURRAY

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Iqaluit
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Date	Update Notes	Name & Signature
February 2005	Completion of DSI dated February 16 2005 by Concentric; copy added to Tab 6.	
August 2006	Completion of DSI dated August 31 2006 by Concentric; copy added to Tab 6. Repairs/alterations to west berm completed August 2006, see Tabs 5 & 7. Lagoon taken off line June 2006; all effluent to new sewage treatment plant, lagoon now on back-up status, see Tab 5.	
October 2009	Completion of DSI dated October 29 2009 by Concentric; copy added to Tab 6.	
September 2011	Completion of DSI dated September 21 2011 by Concentric; copy added to Tab 6.	
June 2012	DSR Requirement Investigation dated June 29 2012 by Concentric; copy added to Tab 6	

Iqaluit
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Date	Update Notes	Name & Signature

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Introduction

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Introduction

The Canadian Dam Safety Guidelines (DSG's) requires that all structures exceeding prescribed height and volume minimums be subject to Dam Safety Reviews (DSR's) and Dam Safety Inspections (DSI's) at regular intervals. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The City of Iqaluit sewage lagoon falls under the requirements of the DSG's. The first DSR conducted on the sewage lagoon was undertaken in 2001.

One of the documentation requirements of the DSR is that a Permanent Record File (PRF) be created and maintained for the life of the dam structure/facility. This document constitutes the PRF.

The DSG's stipulate that a Permanent Record File (PRF), suitable for transfer to the regulatory agency, (in this case the Nunavut Water Board), should be maintained as an ongoing historical reference. The file is required to contain the following:

- History and Background (Tab 3)
- Operations, Maintenance & Surveillance (OMS) Manual (Tab 4)
- Permanent Log Book (PLB) (Tab 5)
- Records of all DSR's and DSI's (Tab 6)
- As-Built Drawings (And Design Data) (Tab 7)

This PRF requires updating in accordance with the instructions of Tab 1.

Iqaluit

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History & Background

CONCENTRIC

Iqaluit
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History & Background

The existing lagoon is located to the west of the City, south of the FOL barracks, on the tidal plain at the head of Koojesse Inlet. The lagoon was constructed at this location circa 1978.

The sewage lagoon was formed by the construction of two berms that connected the shoreline to a natural island formation. The man-made structures form the east and west boundaries of the lagoon; the north and south boundaries therefore utilize the natural topography.

The original area and capacity of the lagoon are reported in the literature to be approximately 17,000 square meters and 32,000 cubic meters, respectively.

In 1981, a partial wash out occurred during high tide, which was subsequently repaired. The repair reportedly washed out again that same year. Subsequent upgrades in 1983 increased the capacity of the lagoon to approximately 56,000 cubic meters.

According to the literature, the lagoon was the subject of investigative studies in 1983 and 1984, which proposed various upgrades, including the following:

- Lining of exterior slopes with filter cloth and rip-rap.
- Construction of an overflow (spillway) in the west berm.
- Construction of a positive outlet control.
- Installation of an impermeable liner on the interior slopes.

In June 1991, a breach of the west berm caused a major effluent spill into Koojesse Inlet.

A preliminary engineering report from July 1991 indicated that the spillway and impermeable liner upgrades had not been done, and that as-built drawings for any upgrades could not be located. The 1991 report recommended specific repairs and improvement for the berm reconstruction area. These included erosion protection (filter cloth and rip-rap) on the upstream and downstream sides, section conformity (2H:1V and 3H:1V on the upstream and downstream sides respectively), and construction of a spillway section.

In a December 1991 supplementary report concerns over material suitability prompted the recommendation to further flatten slopes to 3H:1V and 4H:1V on the upstream and downstream sides, respectively, of the west berm.

In December 1997, significant seepage developed on the west berm. Recommendations were made in a February 1998 engineering report to increase monitoring, to develop a spill preparedness plan, and to maintain the lagoon at its lowest possible level.

Iqaluit

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In June 1998, a Spill Contingency Plan was prepared for the Town by an engineering consultant, which included a Sewage Lagoon Preparedness Plan. In that document, it is stated that the potential existed for further uncontrolled sewage releases due to berm failure.

A Dam Safety Review (DSR) for the Lake Geraldine Dam and Sewage Lagoon was prepared in 2001.

A Dam Safety Inspection (DSI) was conducted in October 2002.

The DSI noted no significant changes since the 2001 DSR, but highlighted the seepage concerns of the east berm and the threat of overtopping in the spring.

The DSI reiterated the recommendations of the 2001 DSR, as follows:

- There is inadequate information concerning the as-built conditions of the berms
- The berms are not considered safe in their current condition and are non-compliant with the design and performance standards of the DSG.
- Remedial measures included three (3) options - an impermeable liner; buttressing the berms; and building a new lagoon.

No DSI was conducted in 2003, based on previous documentation searches. However, a geotechnical investigation was conducted in 2003.

The scope of the geotechnical investigation was to undertake a topographic survey of the lagoon and conduct a slope stability analysis of the berms. A separate hydrologic report is referenced, but has not been located. It would appear that the geotechnical investigation was attempting to address some of the as-built issues discussed in the 2002 DSI.

Conclusions from the geotechnical investigation included:

- Adequate (satisfying the Dam Safety Guidelines) factors of safety exist for steady state seepage and rapid drawdown scenarios
- The west berm should remain stable provided it is protected against overtopping and adequate erosion protection is installed on the downstream face

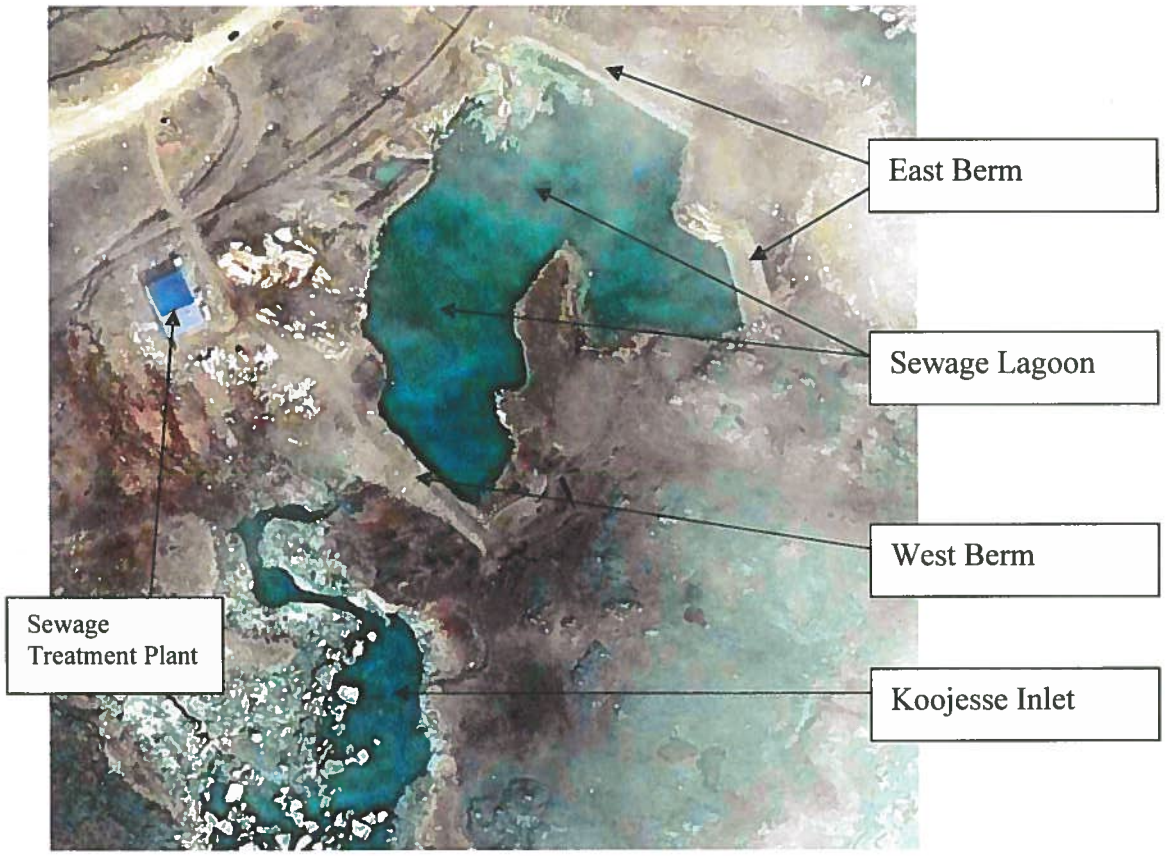
The report indicated that catastrophic failure is unlikely with the above provisos, however, localized failures or seeps were to be expected until such time as the lagoon was lined with an impervious material, or rebuilt.

The recommendations from the 2004 DSI are consolidated as follows:

- Preparation of the Permanent Record File (PRF) remains outstanding.
- Undertake the next DSI prior to October 2005.
- The safety/stability recommendations from the 2003 geotechnical report (discussed above) should be implemented in 2005.

The above recommendations were not acted on in 2005. In August 2006, the west berm was upgraded to effect the recommendations contained in past reports.

In August 2006 a DSI was completed, which took into consideration the upgraded west berm, and acknowledged the preparation of this PRF. The following are representative photographs from 2002 and 2006



Aerial View of Iqaluit Sewage Lagoon Circa 2002

Iqaluit
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West Berm Repairs, August 2006

Completed West Berm Repairs, August 2006; Sewage Treatment Plant in Background

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Operations Maintenance & Surveillance Manual

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Operation Maintenance & Surveillance (OMS) Manual

The DSG's require that a dam Operation, Maintenance, and Surveillance (OMS) Manual be provided for every dam structure to which the DSG's apply.

This manual has been prepared in general compliance with the DSG's, and commensurate with the complexity of the sewage lagoon facility. The sewage lagoon facility has no operable controls, systems and/or components, with the exception of the outlet control valve and structure near the west berm. For this reason the OMS Manual is a fairly brief and rudimentary document.

The following headings are as suggested in the DSG's:

General Description, History, Location, & Access

For a general description, brief history, and photographic record, please refer to Tab 3.

Access to the sewage lagoon is via Akilliq Road. The entrance into the Sewage Treatment Plant off of Akilliq Road leads directly to the west berm of the lagoon.

Chain of Operational Responsibilities

The responsible persons for the sewage lagoon facility are, in ascending order:

- Plant Operator*
- Utilidor Foreman*
- Public Works Operations Superintendent*
- Director of Public Works
- Chief Administrative Officer

*These individuals are responsible for regularly scheduled inspections other than DSR's and DSI's.

Requirements for Staff Training

No specific training is warranted

Responsibility and Mechanism for Review and Update

The OMS Manual should be reviewed at each annual update, see Tab 1.

CONCENTRIC

If significant changes/alterations have occurred during the previous year, the OMS manual should be updated/revised to reflect these changes/alterations as appropriate.

The responsibility for review, updating and revisions to the OMS lies with the responsible person identified in Tab 1.

Requirements for Operation, Maintenance and Surveillance

The sewage lagoon is an older retaining structure built on "leaky dam" technology. There is no liner and no significant operating controls, systems, or components. Effluent is discharged from sewage trucks at the east end of the lagoon. The berms retain the sewage for a time allowing aeration and breakdown. The pervious nature of the berms allows percolation through the berm section. The only operating component is a control valve and structure located near the west berm which may be used to regulate (draw down) the level in the lagoon.

Operation

The word "operation" in the DSG's is associated with the premise that "the operation of a dam shall not violate any important design assumptions that could impair the safety of the dam." Review of Section 3.2 of the DSG indicates that this section applies to more complex dams with operable flow control equipment, ice rakes, trash racks, penstocks, etc. Simply stated, the sewage lagoon is not really "operable".

The control valve may be used to draw down the level of the lagoon should restrictions be placed on berm retention.

Maintenance

Maintenance procedures as described in Section 3.3 of the DSG are intended to ensure that the structures are maintained in a safe and serviceable condition. In this section the term "maintenance" is intended to mean significant, and not minor, maintenance.

Ordinarily, major maintenance would be triggered by a DSR or DSI, or a regularly scheduled inspection by the Plant Operator, Utilidor Foreman, or Public Works Operations Superintendent.

In the event that major maintenance is warranted in the interval between DSI's, the proposed maintenance and/or concern should be immediately brought to the attention of the responsible person. A decision would then be made on what action to take. Any major maintenance/repairs should be documented in accordance with Tabs 1,5, and 7.

Iqaluit
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Surveillance & Monitoring

Surveillance and monitoring as described in Section 3.4 of the DSG are intended to ensure that a reasonable degree of inspection and monitoring are undertaken.

Approximately twice per year (recommended times for inspection are early June and mid October) regularly scheduled inspection by the Plant Operator, Utilidor Foreman, or Public Works Operations Superintendent should be conducted and noted in the PLB in Tab 5. The control valve, access, and structure should be inspected for proper operation.

Under the DSG's annual inspections (DSI's) are mandated annually. The DSI's should be conducted by the responsible person, who should also be a professional engineer licensed to practice in Nunavut.

The lagoon should be inspected immediately after any unusual event such as seismic disturbance, impact damage, vandalism, extreme weather, etc.

Emergency Preparedness

Section 4 of the DSG's involves Emergency Preparedness.

Based on our review of the current DSG's, an Emergency Preparedness Plan is not required.

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Permanent Log Book

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Instructions

The DSG's require that a Permanent Log Book (PLB) shall be provided for every dam structure to which the DSG's apply. The logbook should contain notations or records of the following:

- Changes to normal operation
- Unusual events or conditions
- Inspection activity
- Weather conditions and trends
- Unusual maintenance activities
- Tests of any control equipment

The Permanent Log Book (PLB) is to be updated in accordance with these instructions. All updates should be completed either on the same day as the event noted or within 24 hours of the event. The PLB should be updated by the person that undertakes the particular inspection.

The only control equipment is the control valve and access structure, which should be inspected for proper operation during the twice yearly regularly scheduled inspections.

Please refer to the following example:

Date	Reason for Inspection	Action Required	Name & Signature
February 10 2005	DSI Conducted by Concentric	Nothing immediate; report will be added to the PRF in Tab 6	
June 30 2005	Regular Inspection by Plant Foreman	None	
August 6 2005	Unscheduled Inspection by Plant Foreman due to unusual amount of rainfall over the previous 24 hours	No obvious problems. Continue to monitor, another inspection will be done tomorrow.	

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Date	Reason for Inspection	Action Required	Name & Signature

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Dam Safety Reviews & Dam Safety Inspections

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Instructions

This Section contains copies of all Dam Safety Inspections and Dam safety Reviews conducted on the sewage lagoon facility. The documents should remain in chronological order.

Whenever a new document is added it should be noted in the Annual Update Pages, (Tab 1), a notation of the associated site inspection should be noted in the Permanent Log Book, (Tab 5), and added to the register in this Section, below.

REGISTER of DAM SAFETY REVIEWS & INSPECTIONS

Date	Document
February 3 2002	Dam Safety Review by Trow
October 2002	Dam Safety Inspection by Trow.
February 16, 2005	Dam Safety Inspection by Concentric.
August 31, 2006	Dam Safety Inspection by Concentric.
October 29 2009	Dam Safety Inspection by Concentric

Iqaluit
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REGISTER of DAM SAFETY REVIEWS & INSPECTIONS

Date	Document
September 21 2011	Completion of Dam Safety Inspection by Concentric
June 2012	DSR Requirement Investigation dated June 29 2012 by Concentric

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TOWN OF IQALUIT
DAM SAFETY REVIEW FOR
LAKE GERALDINE DAM
&
SEWAGE LAGOON

Trow Consulting Engineers Ltd.

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Building 1080
Iqaluit, Nunavut. XOA OXO
e-mail: trow@trowot.com
Phone: (800) 514-9044
Fax: (613)-225-7337

Executive Summary

The Town Of Iqaluit retained Trow Consulting Engineers Ltd., (Trow), in October 2001, to prepare a Dam Safety Review (DSR) for the Lake Geraldine Dam, and for the sewage lagoon dikes.

The DSR for both retaining structures was conducted in October and November 2001, in accordance with Dam Safety Guidelines, prepared by the Canadian Dam Association.

As a result of the DSR, the following conclusions and recommendations have been made regarding Lake Geraldine Dam:

As a result of the DSR, the following conclusions and recommendations have been made regarding the sewage lagoon dikes:

1. Introduction

The Town Of Iqaluit was mandated to commission an inspection report of the Lake Geraldine Dam, and the sewage lagoon embankment structures (dikes). The report was to be in accordance with the Canadian Dam Association publication, Dam Safety Guidelines, published in January, 1999.

A Dam Safety Review (DSR) is a comprehensive, formal review process, conducted at regular intervals, that involves completion of checklist items in accordance with the Dam Safety Guidelines.

It is expected that in the interval between DSR's, a Dam Safety Inspection (DSI) would be performed on a yearly basis. The DSI is a much less comprehensive review, comprising a visual inspection to identify any changes in condition, or any observed concerns.

The DSR is therefore a benchmark that is established for both new and existing dams which should be updated at specified milestones. Under the current guidelines, a DSR is required for these structures simply because no previous DSR exists.

2. HISTORY & BACKGROUND

In the following chronological summary, record documents have been referenced. After each reference, a number appears in parenthesis. That number corresponds to tabulated record document numbers in Section 4, where details are provided on the document source.

Lake Geraldine Dam:

The town of Iqaluit derives its water supply from Lake Geraldine, which is retained by a structure consisting of two sections; one a cast in place concrete gravity dam incorporating a spillway section, the other a cast in place concrete cut-off wall and embankment. Both concrete structures are founded on rock, and engage rock at their abutments.

Lake Geraldine is a natural body of water in an irregularly shaped basin. It is fed by rainfall and snow/ice melt. The total watershed area is approximately 385 hectares.

In the late 1950's, the demand for a reliable year round source of water resulted in the construction of a cast in place concrete gravity dam, and a section of earth berm with a central cast in place concrete cut off wall. The project was designed and built by the Department Of National Defense. According to the literature, the original construction took place circa 1958.

Since that time, as the Town has grown and water demands have risen, the dam has been raised three times to increase the storage capacity. The first height increase of 0.3m reportedly took place in 1979. The second construction took place in 1985, and increased the height of the spillway structure by 1.15m. The third alteration was done in 1995, and increased the height of the spillway structure by a further 1.5m.

The 1995 alteration included an extensive rock anchoring program for the gravity dam portion.

In the time span of the available historical data, which extends back to 1984, there have been only a few notable events relating to the safety and serviceability of the dam structures.

- In November 1984 joint and patch repairs were made to localized areas on the upstream side of the spillway structure by diving contractors.
- In June 1990 an inspection report (3) of the structure by diving contractors was made following construction blasting. The 1984 repair areas were also assessed.
- In June 1990 a visual inspection report (4) was prepared for the Town by an engineering consultant, as a result of the construction blast. No significant damage was noted.
- In July 1990 a dam inspection and stability report (5,6) was conducted for the Town by an engineering consultant. Recommendations were made regarding repair of leaking joints, and provisions to increase stability should the dam be raised in the future.

- In September 1990, a diving contractor performed crack repairs and prepared an inspection report (7). Repair material used was oakum.

- In October 1997 a visual inspection report (10) was prepared for the Town by an engineering consultant. Leaking cracks were identified, however, these were not viewed as being structurally significant. It was recommended that leaking cracks be chemically grouted.

- In June 1998, a study (11) was prepared for the Department Of Public Works by an engineering consultant to assess the hydrological impact of a dam failure on a proposed downstream hospital site.

Sewage Lagoon:

The existing lagoon is located to the west of the town, south of the FOL barracks, on the tidal plain at the head of Koojesse Inlet. The lagoon was constructed at this location circa 1978.

The sewage lagoon was formed by the construction of two dikes that connected the shoreline to a natural island formation. The man-made structures form the east and west boundaries of the lagoon; the north and south boundaries therefore utilize the natural topography.

The original area and capacity of the lagoon are reported in the literature to be approximately 17,000 square meters and 32,000 cubic meters, respectively.

In 1981, a partial wash out occurred during high tide, which was subsequently repaired. The repair reportedly washed out again that same year. Subsequent upgrades in 1983 increased the capacity of the lagoon to approximately 56,0000 meters.

According to the literature, the lagoon was the subject of investigative studies in 1983 and 1984, which proposed various upgrades, including the following:

- Lining of exterior slopes with filter cloth and rip-rap.
- Construction of an overflow (spillway) in the west dike.
- Construction of a positive outlet control.
- Installation of an impermeable liner on the interior slopes.

In June 1991, a breach of the west dike caused a major effluent spill into Koojesse Inlet.

A preliminary engineering report (12) from July 1991 indicates that the spillway and impermeable liner upgrades had not been done, and that as-built drawings for any upgrades could not be located. The 1991 report recommended specific repairs and improvement for the dike reconstruction area. These included erosion protection (filter cloth and rip-rap) on the upstream and downstream sides, section conformity (2H:1V and 3H:1V on the upstream and downstream sides respectively), and construction of a spillway section.

In a December 1991 supplementary report (13), concerns over material suitability prompted the recommendation to further flatten slopes to 3H:1V and 4H:1V on the upstream and downstream sides, respectively.

In December 1997, significant seepage developed on the west dike. Recommendations were made in a February 1998 engineering report (16) to increase monitoring, to develop a spill preparedness plan, and to maintain the lagoon at its lowest possible level.

The current retention volume is approximately 25,000 m^3.

In June 1998, a Spill Contingency Plan (17) was prepared for the Town by an engineering consultant which included a Sewage Lagoon Preparedness Plan.

In that document, it is stated that the potential exists for further uncontrolled sewage releases due to dike failure.

3. Scope Of Work & Methodology

The level of detail required for a DSR is influenced by several factors as follows:

- Importance of structure
- Complexity of structure
- Consequences of failure
- Completeness, continuity, and availability of record documentation
- Current condition

Reasonably extensive documentation exists for both the Lake Geraldine Dam and the sewage lagoon dikes, however, as this is the first DSR and benchmark document for any subsequent inspection, we have included a complete review of the required tasks.

A summary of our methodology to complete the work is presented below:

1. Acquire and assemble chronological documentation, including but not limited to:

   - Design Documents
   - Repair Specifications
   - Past Condition Assessment Reports
   - Records of Alteration

   The bulk of the record documents were retrieved from the Town records.

2. Review all available record documentation.

3. Perform a site inspection to assess the current condition of the structures. No invasive work was performed; the condition assessment was visual in nature.

4. Interview maintenance and management personnel as required and appropriate.

5. Execute the DSR checklist of items.

6. Prepare the draft DSR report, complete with site surveys, photographs, structural sections, and field notes as required and appropriate. Submit to and discuss with the Town Engineer.

7. Submit the final DSR report.

4. Relevant Record Documents

The following documentation has been utilized in the preparation of this report. Other record documentation was provided but not directly applicable to the DSR.

TABLE I
RELEVANT RECORD DOCUMENTATION
LAKE GERALDINE DAM

No.	Date	Description	Author
1	August 1984	Lake Geraldine Water Supply Study	OMM
2	January 1985	Water Supply Improvements	OMM
3	June 1990	General Diving Report	Arctic Divers
4	June 1990	Dam Inspection for Blast Damage	Hardy BBT
5	July 1990	Dam Inspection & Leakage Repair	Acres
6	July 1990	Dam Stability	Acres
7	Sept. 1990	Diving Report	Arctic Divers
8	Feb. 1995	Lake Geraldine Storage Study	OMM
9	June 1995	Lake Geraldine Storage Design Dwgs. & Specifications	OMM
10	October 1997	Dam Inspection	Trow
11	June 1998	Dam Failure Study	EBA

TABLE II
RELEVANT RECORD DOCUMENTATION
SEWAGE LAGOON

No.	Date	Description	Author
12	July 1991	Preliminary Engineering Report on Repairs to Iqaluit Sewage Lagoon	UMA
13	Dec. 1991	Supplement to Preliminary Engineering Report on Repairs to Iqaluit Sewage Lagoon	UMA
14	Dec. 1992	Performance Evaluation for Sewage Lagoon 1990 to 1992	UMA
15	May 1995	Geotechnical Evaluation Proposed Sewage Lagoon	Agra
16	Feb. 1998	Iqaluit Sewage Lagoon Investigation Final Report	FSC
17	June 1998	Municipality of Iqaluit Spill Contingency Plan	Dillon

5. Commentary On Dam Safety Review Requirements

According to Dam Safety Guidelines, the document applies to those structures that are at least 2.5 meters in height, and which have at least 30,000 cubic meters of storage capacity. Both the Lake Geraldine dam and the sewage lagoon dikes exceed these minimums.

The Dam Safety Guidelines document is far reaching in terms of applicability and requirements for conformance. This is understandable as the type and complexity of structures that fall under the jurisdiction of the document varies considerably, from relatively small and simple embankments or dikes to massive and complex dams associated with hydroelectric generating facilities, irrigation, flood control, etc.

The document requires a systematic checklist review, which includes the following items. For each item, the applicable Section number from the Dam Safety Guidelines is shown in parenthesis.

1. Dam Classification (1)
2. Site Inspection (2)
3. Design & Construction Review: (2)
   - 3.1. Earthquakes (5)
   - 3.2. Floods (6)
   - 3.3. Discharge Facilities (7)
   - 3.4. Geotechnical Considerations (8)
   - 3.5. Concrete Structures (9)
   - 3.6. Reservoir & Environment (10)
   - 3.7. Construction (11)
4. Operation & Testing (2,3)
5. Maintenance (2,3)
6. Surveillance & Monitoring (2,3)
7. Emergency Preparedness (2,4)
8. Compliance With Previous Reviews (2)

6. Lake Geraldine Dam DSR

DAM CLASSIFICATION (DSG SECTION 2.2.1)

Based on our knowledge of the Dam Safety Guidelines, and the dam structure itself, the Lake Geraldine Dam has a consequence category of "High" for both the Life Safety and Socioeconomic, Financial and Environmental categories. Under the guidelines, it is therefore required to have a Dam Safety Review every seven (7) years.

SITE INSPECTION (DSG SECTION 2.2.2)

A visual site inspection of the dam structures was performed in October 2001. The inspection was non-invasive in nature, and did not include an underwater assessment. A photographic and video record of our inspection was made, and appends this report.

A summary of observed conditions is as follows:

- The visible portions of the concrete structures are generally in good condition with no evidence of concrete durability issues. A few localized areas exhibited spalling due to embedded formwork remnants.
- Several actively seeping cracks were observed. These cracks are generally vertical in orientation and hairline in width, as would be expected for shrinkage (non-structural) cracking. The location and extent of shrinkage cracking has not changed significantly since the 1997 inspection.
- There was no evidence of distress or overstressing of any portion of the visible structure.
- The rate of leakage through the control joint south of the spillway section has not changed significantly since the 1997 inspection.
- Minor corrosion of the 1985 spillway extension frame.

Based on our review of the record documentation, it is our understanding that the elevation of the top of the concrete cut-off wall in the embankment portion of the dam is at least equal to the elevation of the top of the concrete gravity dam portion of the dam. We have in part based the Dam Safety Review on this condition.

DESIGN & CONSTRUCTION REVIEW (DSG SECTION 2.2.3)

This section constitutes the bulk of the Dam Safety Review process. We have followed the format in the DSG document for convenience and clarity.

Earthquakes (DSG Section 5)

According to the DSG, dams shall be evaluated to withstand a Maximum Design Earthquake (MDE) without release of the reservoir. For a High Consequence Category, the DSG requires evaluation at 50% - 100% of the Maximum Credible Earthquake (MCE). To paraphrase the DSG, the MCE is defined as the largest reasonably conceivable earthquake that appears possible under the presently known tectonic framework.

Concrete Gravity Dam Portion

For the concrete portions of the dam, two sections were assessed; the spillway section and the gravity dam itself. For each section, the worst case was assessed, which corresponded to the maximum retained height.

Our analysis has based the MCE on statistical seismic data in the National Building Code (NBC) 1997, specifically zonal velocities and accelerations for the Iqaluit area. The calculation involves deriving a resultant force proportional to the mass of the structure, and includes an allowance for the inertial effect of the retained water. We have used 100% of the calculated MCE as our Maximum Design Earthquake. That value is 68 kN per meter width of the gravity dam section, and 73 kN per meter width of the spillway section.

The MDE loads were applied in combination with other loads in accordance with Section 9.4, Load Combinations, Concrete Structures.

In the load combination case involving the MDE, the overall contribution of seismic loads is less than 10%, and is not considered significant compared to uplift and hydrostatic forces. This is consistent with previous reviews and design notes, which do not consider seismic forces.

Embankment Dam Portion

Floods (DSG Section 6)

According to the DSG, dams shall be evaluated to safely pass an Inflow Design Flood (IDF), which is based on Consequence Category and the Probable Maximum Flood (PMF). The PMF is an estimate of the most severe "reasonably possible" flood at a particular location and time of year. For a High Consequence Category, the DSG requires an IDF with an annual exceedence probability between 1/1000 and the PMF. For this review, we have used the PMF as a conservative estimate of the IDF. The PMF was based on a regression analysis for the nearby Sylvia Grinnel River.

Based on our analysis, the spillway structure, in its current configuration, can safely pass the estimated Inflow Design Flood.

Discharge Facilities (DSG Section 7)

Section 7 of the DSG has a broad applicability that includes flow control equipment, instrumentation, and emergency backup equipment, which are relevant to more complex structures. In the case of the Lake Geraldine Dam, the applicability really only involves the spillway section.

According to the DSG, discharge facilities shall be capable of passing an Inflow Design Flood (IDF) without adversely affecting the freeboard. Freeboard is defined as the vertical distance between the water surface elevation and the lowest elevation of the top of the containment structure.

The freeboard should satisfy the requirements of section 7.2, Freeboard. That section indicates that sufficient freeboard be provided such that the percentage of overtopping waves during extreme flood or wind conditions is limited to an amount that would not lead to dam failure.

The Lake Geraldine Dam essentially has only one effective discharge facility, that being the spillway section. Normal water levels are at or slightly below the spillway discharge elevation, which yields a freeboard of approximately 0.9m (3 feet).

Based on our analysis, the spillway is capable of passing an Inflow Design Flood. Wave action overtopping the gravity structure is not considered significant given the relatively small fetch of the lake.

Section 7 also requires consideration of the following for discharge facilities:

- Resistance to erosion
- Adequate energy dissipation
- Capability to pass floating debris

At this time, there are no concerns with the above items.

Geotechnical Considerations (DSG Section 8)

Section 8 of the DSG presents Geotechnical considerations for proposed dams, as well as for several configurations of existing dams.

Concrete Gravity Dam Portion

Not applicable.

Embankment Dam Portion

Concrete Structures (DSG Section 9)

Section 9 of the DSG applies to concrete structures founded on strong, competent rock. Based on our review of the record data, and the dam performance over the last 43 years, it is believed that the foundations are indeed competent rock, and that invasive conformation and/or assessment is not warranted at this time.

Our assessment follows the format of Section 9 as follows:

Section 9.2 – Condition Of Structures And Site

The structure was visually inspected on site as described above. At the time of our visit, we did not observe any conditions that would adversely affect the structural adequacy and/or performance.

Observations that are considered minor at this time include:

- Several shrinkage cracks, actively seeping at a low rate.
- One joint leak estimated at 2-4 liters per minute, south of the spillway section.
- A few areas of spalling and delamination, due to embedded formwork.
- Corrosion of the 1985 spillway extension frame.

No general concrete deterioration problems were noted.

Section 9.3 – Loads

Loads used in our assessment of structural stability were in conformance with this sub-section, with the exception that Temperature (T) and backfill/silt deposit loads (S) were not considered applicable. A summary of loads considered is as follows:

- D Dead loads of permanent structures
- H, H_F Maximum normal and flood headwater levels, respectively
- U Internal (uplift) water pressure
- I Thrust created by an ice sheet
- Q Maximum design earthquake

Section 9.4 – Load Combinations

Load combinations used in our assessment of structural stability were in conformance with this sub-section, with the exception that the "Unusual Loading"

case was not considered applicable. A summary of load combinations considered is as follows:

- Usual D+H+I+U
- Flood $D+H_F+U$
- Earthquake $D+H+Q+U_Q$

Section 9.5 – Design And Analysis

A static and seismic analysis was performed on the dam using the above loads and combinations, and considering the following:

- Sliding
- Overturning
- Overstressing

Based on our analysis, and site inspection, the dam structure is deemed adequate to resist the above effects. The minimum factor of safety for overturning and sliding were calculated to be 1.33 and 1.72, respectively.

Typically, we would require minimum factors of safety for overturning and sliding of 1.5 and 2.0, respectively, for an existing structure.

Although the calculated values are slightly below our usual norms of acceptance, it is our opinion that the stability of the dam is adequate and would satisfy minimum factors of safety under more sophisticated analysis, for the following reasons:

1. The calculated factors are for the worst case load combination at the spillway section, which is the weakest link of the structure. The section was analyzed as if it was a stand-alone structure. In reality, the spillway section is relatively narrow in elevation, and directly engages the wing walls of the gravity section at each end. Given these boundary conditions, we believe the factor of safety would be similar to the 1.6 calculated for the gravity section.

2. The sliding calculation does not take into account the resistance offered by the rock anchors, which is significant, and would likely result in a factor of safety against sliding well in excess of 2.0.

Copies of our sliding and overturning calculations append the report.

Section 9.6 – Performance Indicators

The DSG recommends that the assessment of concrete dams include the following performance indicators:

- Position of resultant force
- Normal stresses at the heel and toe
- Sliding factors
- Observed conditions, based on records of permanent monitoring equipment such as joint meters, plumb lines, monument displacement, piezometric pressures, extensometers, and accelograms.

We have determined that the resultant force for the "Usual" load case is within the middle third of the section, as required. Normal stresses are also within acceptable limits.

Expressions to determine sliding factors are not considered applicable due to the rock anchor retrofit program of 1995. To our knowledge, no permanent monitoring instrumentation exists at or remote from the site.

Section 9.7 – Acceptance Criteria

This sub-section presents commonly accepted values for sliding factors. As mentioned above, the expressions for sliding factors are not considered applicable due to the rock anchor retrofit program of 1995. Concrete strength factors are within acceptable limits.

Reservoir & Environment (DSG Section 10)

According to the DSG, the following conditions should be assessed as they relate to the reservoir and environment:

a) The stability of slopes around the reservoir rim.
b) Detrimental affects of groundwater, reservoir water, soil, etc., on dam safety.
c) Silt deposition affecting discharge facilities or dam stability.
d) Hazards to local ecology.
e) Reservoir drawdown capability.
f) Reservoir debris and ice should not present an unacceptable risk to dam safety.

Based on our review and inspection, the only significant items are e) and f). Items a), b), c), and d) are not a concern at this time.

Regarding item e), the reservoir does not have rapid drawdown capability. Section 10.5 of the DSG indicates a requirement for rapid drawdown for those dams subject to severe damage by earthquake, or where a high potential for internal erosion exists. In our opinion, these risk factors do not apply, and rapid drawdown is not required.

Regarding item f), we have allowed for ice thrust in our stability analysis. We note that the ice thrust loads may be reduced by partial drawdown of the reservoir before major ice loads are developed. Debris has historically not been a problem, however, it should be cleared periodically from the upstream face to allow underwater inspections.

Construction (DSG Section 11)

This section applies to new construction and therefore is not applicable.

OPERATION & TESTING (DSG SECTION 2.2.4)

The applicable reference section of the DSG is Section 3: Operation, Maintenance, and Surveillance.

Our interpretation of this section of the DSG requires some clarification on the meaning and intent of the words "operation" and "testing". In this section of the DSG, "testing" generally refers to the testing of equipment required to operate discharge facilities. In the case of the Lake Geraldine Dam, the primary discharge facility is the spillway section, and as such, no equipment exists. Therefore, there is no testing requirement.

The word "operation" in the DSG is associated with the premise that "the operation of a dam shall not violate any important design assumptions that could impair the safety of the dam." From this premise, and our review of Section 3.2 of the DSG, it would appear that this section really applies to more complex dams with operable flow control equipment, ice rakes, trash racks, penstocks, etc. Simply stated, the Lake Geraldine Dam is not really "operable".

Notwithstanding these interpretations, there should be some basic operational procedures for ice management and cleaning of upstream debris that would form part of the OMS Manual (see below).

Other applicable requirements of Section 3 are described below.

In the DSR checklist of required items, the DSG indicate that a Permanent Record File (PRF) suitable for transfer to the regulatory agency be maintained as an ongoing historical reference. The file should contain the following:

- OMS Manual (see below)
- Permanent Log Book (see below)
- History and photographic record
- As-Built Drawings
- Performance reports
- All design data
- Records of all inspections and DSR's

Based on our review and correspondence, a PRF does not exist, however, most of the raw data is readily available.

The DSG indicate that a dam Operation, Maintenance, and Surveillance (OMS) Manual shall be provided for every dam structure. The manual may be quite involved depending on the complexity of the dam. For the Lake Geraldine Dam, an acceptable manual would likely be relatively simple and concise. The manual should contain information and procedures that

include the following:

- General description, history, location, access, etc.
- Chain of operational responsibilities
- Requirements for training of involved staff
- Responsibility and mechanism for review and update, including DSR input
- Requirements for operation, maintenance and surveillance as per Sections 3.2, 3.3, and 3.4 of the DSG (See below)

Based on our review and correspondence, an OMS Manual does not exist.

The DSG indicate that a Permanent Logbook shall be provided for every dam structure. The logbook should contain notations or records of the following:

- Changes to normal operation
- Unusual events or conditions
- Inspection activity
- Weather conditions and trends
- Unusual maintenance activities
- Tests of any control equipment

Based on our review and correspondence, a Permanent Logbook does not exist.

MAINTENANCE (DSG SECTION 2.2.5)

The applicable reference section of the DSG is Section 3: Operation, Maintenance, and Surveillance.

Maintenance Procedures (MPS) as described in Section 3.3 of the DSG are intended to ensure that the structures are maintained in a safe and serviceable condition.

No formal Maintenance Procedures exist. These should form part of the OMS Manual.

SURVEILLANCE & MONITORING (DSG SECTION 2.2.6)

The applicable reference section of the DSG is Section 3: Operation, Maintenance, and Surveillance.

Surveillance Procedures (SPS) as described in Section 3.4 of the DSG are intended to ensure adequate inspection and monitoring. Applicable considerations are as follows:

a) Procedures or requirements for routine visual inspection by staff, including inspection records.
b) Procedures for implementation of any required action as a result of a routine inspection.
c) Procedures or requirements for more detailed regular inspections, such as underwater assessments.

d) Procedures or requirements for special inspections due to extreme events or unusual observations.

No formal Surveillance Procedures exist. These should form part of the OMS Manual.

EMERGENCY PREPAREDNESS (DSG SECTION 2.2.7)

Section 4 of the DSG involves Emergency Preparedness. The primary requirement is that an Emergency Preparedness Plan (EPP) exists. An EPP should describe the actions to be taken by the owner and operator in the event of an emergency. The EPP should include the following:

- Emergency identification and evaluation
- Preventative action
- Notification procedure and flowchart
- Response during darkness, adverse weather, etc.
- Available resources and their allocation
- Inundation maps, based on an Inundation Study

Based on our review and correspondence, no formal Emergency Preparedness Plan exists.

COMPLIANCE WITH PREVIOUS REVIEWS (DSG SECTION 2.2.8)

No previous Dam Safety Review documents exist at this time.

7. Sewage Lagoon DSR

DAM CLASSIFICATION (DSG SECTION 2.2.1)

Based on our knowledge of the Dam Safety Guidelines, and the lagoon embankment structures, the sewage lagoon has a consequence category of "Low" for Life Safety, and "High" for Socioeconomic, Financial and Environmental categories. Under the guidelines, it is therefore required to have a Dam Safety Review every seven (7) to ten (10) years.

SITE INSPECTION (DSG SECTION 2.2.2)

A visual site inspection of the embankment dikes was performed in October 2001. The inspection was non-invasive in nature, and did not include an underwater assessment. A photographic and video record of our inspection was made, and appends this report.

A summary of observed conditions is as follows:

DESIGN & CONSTRUCTION REVIEW (DSG SECTION 2.2.3)

This section constitutes the bulk of the Dam Safety Review process. We have followed the format in the DSG document for convenience and clarity.

Earthquakes (DSG Section 5)

Floods (DSG Section 6)

Discharge Facilities (DSG Section 7)

Section 7 of the DSG has a broad applicability that includes flow control equipment, instrumentation, and emergency backup equipment, which are relevant to more complex structures. In the case of the sewage lagoon, the applicability really only involves the spillway section.

Normal water levels are approximately _____ below the spillway discharge elevation, which yields a freeboard of approximately _____.

Based on our analysis, the spillway is capable of passing an Inflow Design Flood. Wave action overtopping the structure is not considered significant.

Section 7 also requires consideration of the following for discharge facilities:

- Resistance to erosion
- Adequate energy dissipation
- Capability to pass floating debris

At this time, we have the following concerns with the above items.

Geotechnical Considerations (DSG Section 8)

Section 8 of the DSG presents Geotechnical considerations for proposed dams, as well as for several configurations of existing dams.

Concrete Structures (DSG Section 9)

This section is not applicable.

Reservoir & Environment (DSG Section 10)

According to the DSG, the following conditions should be assessed as they relate to the reservoir and environment:

a) The stability of slopes around the reservoir rim.
b) Detrimental affects of groundwater, reservoir water, soil, etc., on dam safety.
c) Silt deposition affecting discharge facilities or dam stability.
d) Hazards to local ecology.
e) Reservoir drawdown capability.
f) Reservoir debris and ice should not present an unacceptable risk to dam safety.

Based on our review and inspection, the only significant items are ____. Items _____ are not considered a concern at this time.

Construction (DSG Section 11)

This section applies to new construction and therefore is not applicable.

OPERATION & TESTING (DSG SECTION 2.2.4)

The applicable reference section of the DSG is Section 3: Operation, Maintenance, and Surveillance.

As per the rationale for the Lake Geraldine Dam, there is no testing requirement for the lagoon. It is also not considered "operable".

The following items are considered a requirement, and were described in detail in Section 7, above.

- Permanent Record File (PRF)
- Dam Operation, Maintenance, and Surveillance (OMS) Manual
- Permanent Logbook

MAINTENANCE (DSG SECTION 2.2.5)

The applicable reference section of the DSG is Section 3: Operation, Maintenance, and Surveillance.

Maintenance Procedures (MPS) as described in Section 3.3 of the DSG are intended to ensure that the structures are maintained in a safe and serviceable condition.

No formal Maintenance Procedures exist. These should form part of the OMS Manual.

SURVEILLANCE & MONITORING (DSG SECTION 2.2.6)

The applicable reference section of the DSG is Section 3: Operation, Maintenance, and Surveillance.

Surveillance Procedures (SPS) as described in Section 3.4 of the DSG are intended to ensure adequate inspection and monitoring. Applicable considerations are as follows:

a) Procedures or requirements for routine visual inspection by staff, including inspection records.
b) Procedures for implementation of any required action as a result of a routine inspection.
c) Procedures or requirements for more detailed regular inspections, such as underwater assessments.
d) Procedures or requirements for special inspections due to extreme events or unusual observations.

No formal Surveillance Procedures exist. These would should part of the OMS Manual.

EMERGENCY PREPAREDNESS (DSG SECTION 2.2.7)

Section 4 of the DSG involves Emergency Preparedness. The primary requirement is that an Emergency Preparedness Plan (EPP) exists. An EPP should describe the actions to be taken by the owner and operator in the event of an emergency. The EPP should include the following:

- Emergency identification and evaluation
- Preventative action
- Notification procedure and flowchart
- Response during darkness, adverse weather, etc.
- Available resources and their allocation
- Inundation maps, based on an Inundation Study

A Sewage Lagoon Preparedness Plan was prepared in 1998. The plan is contained in Appendix B of the Spill Contingency Plan that forms part of the record documentation we reviewed. It is believed that this document, with some modification, would be adequately as an EPP.

COMPLIANCE WITH PREVIOUS REVIEWS (DSG SECTION 2.2.8)

No previous Dam Safety Review documents exist at this time.

8. Summary

Based on our inspection, review, and analyses, we summarize the results of the DSR as follows:

Lake Geraldine Dam

1. In accordance with Section 1 of the DSG, the dam has been classified as having a High Consequence Category.

2. The dam is in a safe and serviceable condition at this time, with no significant changes in visible condition compared to the last (1997) inspection.

3. The dam is in general compliance with the required design and performance standards of the DSG, Sections 5 through 11, where applicable and appropriate for the structure, as discussed above. Safety improvements are therefore not recommended at this time.

4. The dam is in non-compliance with the requirements of Sections 3 and 4 of the DSG. The following documents do not exist at this time:

    - Permanent File
    - OMS Manual
    - Logbook
    - Emergency Preparedness Plan

5. Based on the available record documentation, the submerged portion of the dam has not been assessed since 1990.

Sewage Lagoon

9. Recommendations & Required Action

Lake Geraldine Dam

1. The structures should have a Dam Safety Inspection (DSI) conducted in 2002, preferably by mid-October of that year. This is essentially a yearly non-invasive review comprising a visual inspection to identify any changes in condition, or any observed concerns. The summary written report generated would form a permanent record document to be included in the Permanent Record File.

2. An underwater inspection of the submerged structures should be done in 2002. This inspection should be coordinated with, and be under the direction of, the DSI recommended in Item 1, above. Underwater inspections should be carried out with at least the same frequency as Dam Safety Reviews, i.e. every seven years.

3. The dam is in non-compliance with the requirements of Sections 3 and 4 of the DSG. The following documents need to be developed and maintained.

   - Permanent File
   - OMS Manual
   - Logbook
   - Emergency Preparedness Plan

   In terms of time to compliance, we do not believe it is necessary, or realistic, to produce completed documents forthwith, however, it is our opinion that an understanding to proceed be demonstrated as soon as practically possible so as to show intent. We would certainly expect full compliance be achieved well before the next DSR in seven years time. A timeline of two years to full compliance would be reasonable. Regulatory agencies may well impose timelines for compliance upon review of the DSR.

Sewage Lagoon

We would be pleased to discuss this report with you at your convenience.

Yours truly,

Trow Consulting Engineers Ltd.

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APPENDIX 1
SITE PHOTOGRAPHS
LAKE GERALDINE DAM

APPENDIX 2
SITE PHOTOGRAPHS
LAKE GERALDINE DAM
DAMAGE PATH

APPENDIX 3
SUMMARY STABILITY CALCULATIONS
LAKE GERALDINE DAM

APPENDIX 4
GENERAL ARRANGEMENT DRAWINGS
LAKE GERALDINE DAM

APPENDIX 5
SITE PHOTOGRAPHS
SEWAGE LAGOON

APPENDIX 6
GENERAL ARRANGEMENT DRAWINGS
SEWAGE LAGOON

APPENDIX 7
VIDEO RECORD
LAKE GERALDINE DAM
SEWAGE LAGOON

CONCENTRIC

Concentric Associates International

City of Iqaluit Sewage Lagoon
Iqaluit, Nunavut
Dam Safety Inspection

February 16, 2005
REPORT

Produced For:
THE CITY OF IQALUIT, NUNAVUT

Produced By:
CONCENTRIC ASSOCIATES INTERNATIONAL

Concentric Project Reference Number:
04-1166

City of Iqaluit Sewage Lagoon
Iqaluit, Nunavut
Dam Safety Inspection

CONTENTS

1. EXECUTIVE SUMMARY

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the City of Iqaluit sewage lagoon. The scope of work for the assignment has been undertaken in accordance with Concentric's proposal 04-1166, dated November 19, 2004.

The site inspection and reporting were conducted on February 9, 10 and 11, 2005, by Allan Murray, P.Eng., of Concentric. Snow and ice cover did not allow adequate assessment of the structures. It is strongly recommended that the next DSI be conducted prior to October 2005.

OBSERVATIONS:

- No significant changes in condition were observed since the previous DSI
- City of Iqaluit Engineering staff reported no maintenance/repair works since the last DSI was conducted in 2002.

RECOMMENDATIONS:

1. Preparation of the required Operation & Safety Manual, Emergency Preparedness Plan, Logbook, and Permanent File, remains delinquent, despite initial identification for compliance in 2001, and repeated non-compliance in 2002, 2003, and 2004. Steps should be taken to address this issue in 2005, as continued non-compliance negates the purpose, and validity, of the entire process, that began in 2001 with the Dam Safety Review (DSR).

2. Undertake the next DSI prior to October 2005.

3. Based on record documents and discussion with the City of Iqaluit Engineering Department, the lagoon may be in service for perhaps another two (2) or three (3) years. If this is indeed the case, best practices would seem the best approach for ongoing safety and serviceability of the berms. Unfortunately, the safety/stability recommendations from the 2003 geotechnical report (discussed herein) have not been implemented. This work should have been undertaken in 2004. It is strongly recommended that the recommended measures (adequate protection against overtopping, and adequate erosion protection installed on downstream portions of the berms) be implemented in 2005. Design and analysis would be required prior to construction.

4. If the sewage lagoon is to remain in service significantly longer than indicated in item 1, above, it is strongly recommended that the lagoon be either redesigned and rebuilt; or, that an impervious liner be installed with erosion measures applied to downstream faces of berms. Either option will likely require a new DSR.

2. INTRODUCTION

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the City of Iqaluit sewage lagoon located in Iqaluit, Nunavut.

This assignment and the scope of work described herein has been undertaken in accordance with Concentric's proposal 04-1166, dated November 19, 2004.

The site visit and reporting were conducted on February 9, 10 and 11, 2005.

Allan Murray, P.Eng., of Concentric, met with the following personnel at the City of Iqaluit:

- Brad Sokach, Director of Engineering, City of Iqaluit
- Geoff Baker, Project Manager, City of Iqaluit Department of Engineering

This report summarizes our terms of reference for the assignment, observations, conclusions and recommended action.

3. BACKGROUND

The Canadian Dam Safety Guidelines (DSG) requires that all structures exceeding prescribed height and volume minimums be subject to Dam Safety Reviews (DSR's) and Dam Safety Inspections (DSI's) at regular intervals.

A DSR is a comprehensive, formal review process that involves completion of checklist items in accordance with the Dam Safety Guidelines. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The sewage lagoon requires a DSR every ten (10) years. The DSR for the sewage lagoon was conducted in 2001.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection only to identify any changes in condition, or any observed concerns.

A detailed historical perspective may be referenced in the DSR on file with the City of Iqaluit.

4. SCOPE OF SERVICES

Our directive has been to undertake a Dam Safety Inspection (DSI) in accordance with the DSG, for the sewage lagoon. The inspection consisted of an on-site visual assessment, notation of any significant changes in condition since the last available DSI, preparation of a written report in a format compatible with the DSR, and a photographic record.

The following is a summary of the scope of work for this assignment. The DSI report is the primary deliverable, and has been prepared in accordance with the DSG document.

- Review available record documentation, to be provided by the City
- Review, in particular, reports and/or repairs/upgrades conducted since the 2001 DSR
- Interview and/or solicit input from maintenance personnel and City Administration regarding operating performance, concerns, incidents, repairs, and any notable concerns
- Conduct a visual on-site assessment of the sewage lagoon
- Prepare a photographic record documenting general and representative conditions
- Identify, characterize, and risk-assess any actual or potential concerns
- Prepare a written report summarizing our observations, items of concern, and recommendations
- Indicate any recommended repairs
- Prioritize action items
- Submit final documents in electronic format and hard copy

Limitations

At the time of the inspections, visual acuity of the site was difficult due to snow and ice accumulation. Snow and ice cover did not allow adequate assessment of the structure. It is strongly recommended that the next DSI be conducted prior to October 2005.

5. SUMMARY OF PREVIOUS DSI'S

The following is a summary of observations and recommendations made from the previous DSI's:

January 7, 2003 (2002) DSI

A DSI was conducted by Trow Consulting Engineers (Report MA15882A, dated January 7, 2003) in October 2002. The DSI was termed "...an interim step prior to the implementation of remedial measures..." recommended in the 2001 DSR.

The DSI noted no significant changes since the 2001 DSR, but highlighted the seepage concerns of the east berm and the threat of overtopping in the spring.

The DSI reiterated the recommendations of the 2001 DSR, as follows:

- There is inadequate information concerning the as-built conditions of the berms
- The berms are not considered safe in their current condition and are non-compliant with the design and performance standards of the DSG.
- Remedial measures include three (3) options - an impermeable liner; buttressing the berms; and building a new lagoon.

Not stated in the 2002 DSI, but recommended in the 2001 DSR, were the following additional requirements, which are believed to be still outstanding:

- Complete the remaining outstanding non-compliance requirements of Section Nos. 3 and 4 of the DSG, as follows:
  - Permanent file
  - Operation, Maintenance and Surveillance Manual
  - Logbook
  - Emergency Preparedness Plan

2003 DSI

Based on our discussions with the City of Iqaluit Engineering Department, there is no 2003 DSI on file. However, a geotechnical investigation was conducted by Trow Associates Inc. (Report OTGE00016794A, dated October 8, 2003) in 2003.

The scope of the geotechnical investigation was to undertake a topographic survey of the lagoon and conduct a slope stability analysis of the berms. A separate hydrologic report is referenced, but was not provided to us. It would appear that the geotechnical investigation was attempting to address some of the as-built issues discussed in the 2002 DSI.

Salient points from the geotechnical investigation include:

- Adequate (satisfying the Dan Safety Guidelines) factors of safety exist for steady state seepage and rapid drawdown scenarios
- The berm slopes should remain stable provided they are protected against overtopping and adequate erosion protection is installed on downstream faces
- Catastrophic failure is unlikely with the above provisos, however, localized failures or seeps are expected until such time as the lagoon is lined with an impervious material, or rebuilt

The report also notes that it is Trow's understanding that the lagoon will remain operational for perhaps four (4) more years, (2007) until the new sewage treatment plant is complete.

6. COMMENTARY ON DAM SAFETY GUIDELINES

The Canadian Dam Association publication, Dam Safety Guidelines (DSG), governs the nature and frequency of inspection and review activities for structures which fall under its umbrella criteria.

The DSG applies to those structures that are at least 2.5 meters in height, and which have at least 30,000 cubic meters of storage capacity.

The DSG document is far reaching in terms of applicability and requirements for conformance. This is understandable as the type and complexity of structures that fall under the jurisdiction of the document varies considerably, from relatively small and simple embankments or dikes to massive and complex dams associated with hydroelectric generating facilities, irrigation, flood control, etc.

The DSG requires that all structures exceeding the height and volume minimums described above be classified according to their "consequence category", that is, the consequence of dam failure in terms of life safety, and socio-economic impact. The category assigned may range from very low to very high. The consequence category dictates the requirement and frequency of Dam Safety Reviews.

A Dam Safety Review (DSR) is a comprehensive, formal review process, conducted at regular intervals, that involves completion of checklist items in accordance with the Dam Safety Guidelines. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The frequency of DSR's varies depending on consequence category. For structures where significant life safety and/or socio-economic consequence exist, the DSR is usually conducted every five (5) to ten (10) years. The sewage lagoon requires a DSR every ten (10) years. The initial DSR for the sewage lagoon was conducted in 2001; therefore, the sewage lagoon is due for an updated DSR in 2011. If significant alterations to the structure take place before this date, an updated DSR would be required.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection (DSI) would be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection to identify any changes in condition, or any observed concerns. The results of the DSI are incorporated into the DSR documentation. A DSI may trigger repairs, or changes in standard operating procedures.

7. OBSERVATIONS

Sewage Lagoon

The sewage lagoon was accessed on foot. The review was hampered by considerable accumulation of snow and ice. Based on our limited visual assessment we have the following comments:

- Seepage was not observed downstream of the east berm. Seepage was observed in previous inspections by others.
- The majority of the lagoon was frozen, with small areas of open effluent near the inflow.
- Considerable constant flow was observed at the outflow.
- No evidence of repair/maintenance/upgrade work was evident

Overall, the condition of the structure has not changed significantly since the previous DSI.

We note that the safety (berm stability) issues identified in the 2001 DSR and 2002 DSI have had a solution proposed in the 2003 geotechnical report.

Unfortunately, the recommended measures to ensure safety and stability have not been implemented.

8. RECOMMENDATIONS

The following actions are recommended:

1. Preparation of the required Operation & Safety Manual, Emergency Preparedness Plan, Logbook, and Permanent File, remains delinquent, despite initial identification for compliance in 2001, and repeated non-compliance in 2002, 2003, and 2004. Steps should be taken to address this issue in 2005, as continued non-compliance negates the purpose, and validity, of the entire process, that began in 2001 with the Dam Safety Review (DSR).

2. Undertake the next DSI prior to October 2005.

3. Based on record documents and discussion with the City of Iqaluit Engineering Department, the lagoon may be in service for perhaps another two (2) or three (3) years. If this is indeed the case, best practices would seem the best approach for ongoing safety and serviceability of the berms. Unfortunately, the safety/stability recommendations from the 2003 geotechnical report (discussed above) have not been implemented. This work should have been undertaken in 2004. It is strongly recommended that the recommended measures (adequate protection against overtopping, and adequate erosion protection installed on downstream portions of the berms) be implemented in 2005. Design and analysis would be required prior to construction.

4. If the sewage lagoon is to remain in service significantly longer than indicated in item 1, above, it is strongly recommended that the lagoon be either redesigned and rebuilt; or, that an impervious liner be installed with erosion measures applied to downstream faces of berms. Either option will likely require a new DSR.

We would be pleased to discuss this report with you.

Should there be any questions, please contact the undersigned.

Yours truly,

Concentric Associates International Inc.,

Allan D. Murray, P.Eng.,
Project Manager

APPENDIX A
Photographs

CONCENTRIC

Concentric Associates International Incorporated

City of Iqaluit Sewage Lagoon
Iqaluit, Nunavut
Dam Safety Inspection

August 31, 2006
REPORT

Produced For:
THE CITY OF IQALUIT, NUNAVUT

Produced By:
CONCENTRIC ASSOCIATES INTERNATIONAL INCORPORATED

Concentric Project Reference Number:
06-1405

City of Iqaluit Sewage Lagoon
Iqaluit, Nunavut
Dam Safety Inspection

CONTENTS

1. EXECUTIVE SUMMARY

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the City of Iqaluit sewage lagoon. The scope of work for the assignment has been undertaken in accordance with Concentric's proposal 06-1405.

The site inspection and reporting were conducted on August 17 and 24, 2006, by Allan Murray, P.Eng., of Concentric.

It is recommended that the next DSI be conducted prior to October 2007.

OBSERVATIONS:

No significant changes in condition were observed since the previous DSI, with the following exceptions:

- The sewage lagoon is currently inactive, as all sewage is being processed at the sewage treatment plant.
- The sewage lagoon has been drawn down to a near empty level as a result of its inactive status
- As a result of the draw down, considerable sludge accumulation is now visible, which has likely reduced the lagoon capacity
- The west berm repairs recommended in previous DSI's have been completed.

RECOMMENDATIONS:

1. Preparation of the required Operation & Safety Manual, Logbook, and Permanent File, remains incomplete, however, the City has authorized this work to proceed this year.
2. Undertake the next DSI prior to October 2007.
3. The capacity of the sewage lagoon should be confirmed and sludge removal undertaken if required.
4. It is understood that the intent of the City of Iqaluit is to retain the sewage lagoon as a back-up facility only. Given this occasional use the facility in its current configuration (pending the capacity check recommended in Item 3, above) should be adequate for the intended purpose. However, this does not mean preventative maintenance can be overlooked. Localized failures and/or seeps are to be expected. The City of Iqaluit should remain aware that the lagoon operates on old technology – it is essentially a "leaky dam", and its use may be prohibited at any time in the future.

2. INTRODUCTION

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the City of Iqaluit sewage lagoon located in Iqaluit, Nunavut.

This assignment and the scope of work described herein has been undertaken in accordance with Concentric's proposal 06-1405.

The site visit and reporting were conducted on August 17 and 24, 2006.

Allan Murray, P.Eng., of Concentric, met with the following personnel at the City of Iqaluit:

- Geoff Baker, Director of Engineering, City of Iqaluit

This report summarizes our terms of reference for the assignment, observations, conclusions and recommended action.

3. BACKGROUND

The Canadian Dam Safety Guidelines (DSG) requires that all structures exceeding prescribed height and volume minimums be subject to Dam Safety Reviews (DSR's) and Dam Safety Inspections (DSI's) at regular intervals.

A DSR is a comprehensive, formal review process that involves completion of checklist items in accordance with the Dam Safety Guidelines. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The sewage lagoon requires a DSR every ten (10) years. The DSR for the sewage lagoon was conducted in 2001.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection only to identify any changes in condition, or any observed concerns.

A detailed historical perspective may be referenced in the DSR on file with the City of Iqaluit.

4. SCOPE OF SERVICES

Our directive has been to undertake a Dam Safety Inspection (DSI) in accordance with the DSG, for the sewage lagoon. The inspection consisted of an on-site visual assessment, notation of any significant changes in condition since the last available DSI, preparation of a written report in a format compatible with the DSR, and a photographic record.

The following is a summary of the scope of work for this assignment. The DSI report is the primary deliverable, and has been prepared in accordance with the DSG document.

- Review available record documentation, to be provided by the City
- Review, in particular, reports and/or repairs/upgrades conducted since the 2001 DSR
- Interview and/or solicit input from maintenance personnel and City Administration regarding operating performance, concerns, incidents, repairs, and any notable concerns
- Conduct a visual on-site assessment of the sewage lagoon
- Prepare a photographic record documenting general and representative conditions
- Identify, characterize, and risk-assess any actual or potential concerns
- Prepare a written report summarizing our observations, items of concern, and recommendations
- Indicate any recommended repairs
- Prioritize action items
- Submit final documents in electronic format and hard copy

Limitations

The DSI is based on visual assessment; no invasive inspection/assessment was done.

5. SUMMARY OF PREVIOUS DSI'S

The following is a summary of observations and recommendations made from the previous DSI's:

January 7, 2003 (2002) DSI

A DSI was conducted by Trow Consulting Engineers (Report MA15882A, dated January 7, 2003) in October 2002. The DSI was termed "...an interim step prior to the implementation of remedial measures..." recommended in the 2001 DSR.

The DSI noted no significant changes since the 2001 DSR, but highlighted the seepage concerns of the east berm and the threat of overtopping in the spring.

The DSI reiterated the recommendations of the 2001 DSR, as follows:

- There is inadequate information concerning the as-built conditions of the berms
- The berms are not considered safe in their current condition and are non-compliant with the design and performance standards of the DSG.
- Remedial measures include three (3) options - an impermeable liner; buttressing the berms; and building a new lagoon.

Not stated in the 2002 DSI, but recommended in the 2001 DSR, were the following additional requirements, which are believed to be still outstanding:

- Complete the remaining outstanding non-compliance requirements of Section Nos. 3 and 4 of the DSG, as follows:
  - Permanent file
  - Operation, Maintenance and Surveillance Manual
  - Logbook
  - Emergency Preparedness Plan

2003 DSI

Based on our discussions with the City of Iqaluit Engineering Department, there is no 2003 DSI on file. However, a geotechnical investigation was conducted by Trow Associates Inc. (Report OTGE00016794A, dated October 8, 2003) in 2003.

The scope of the geotechnical investigation was to undertake a topographic survey of the lagoon and conduct a slope stability analysis of the berms. A separate hydrologic report is referenced, but was not provided to us. It would appear that the geotechnical investigation was attempting to address some of the as-built issues discussed in the 2002 DSI.

Salient points from the geotechnical investigation include:

- Adequate (satisfying the Dan Safety Guidelines) factors of safety exist for steady state seepage and rapid drawdown scenarios
- The berm slopes should remain stable provided they are protected against overtopping and adequate erosion protection is installed on downstream faces
- Catastrophic failure is unlikely with the above provisos, however, localized failures or seeps are expected until such time as the lagoon is lined with an impervious material, or rebuilt

2004 DSI

A 2004 DSI was commissioned, however, it was not authorized by the City of Iqaluit until February 2005. The DSI was conducted by Concentric.

Much of the site was snow covered at the time of the 2004 DSI so the report was limited in nature and basically reiterated previous concerns and items that remained outstanding.

2005 DSI

A 2005 DSI was not conducted.

6. COMMENTARY ON DAM SAFETY GUIDELINES

The Canadian Dam Association publication, Dam Safety Guidelines (DSG), governs the nature and frequency of inspection and review activities for structures which fall under its umbrella criteria.

The DSG applies to those structures that are at least 2.5 meters in height, and which have at least 30,000 cubic meters of storage capacity.

The DSG document is far reaching in terms of applicability and requirements for conformance. This is understandable as the type and complexity of structures that fall under the jurisdiction of the document varies considerably, from relatively small and simple embankments or dikes to massive and complex dams associated with hydroelectric generating facilities, irrigation, flood control, etc.

The DSG requires that all structures exceeding the height and volume minimums described above be classified according to their "consequence category", that is, the consequence of dam failure in terms of life safety, and socio-economic impact. The category assigned may range from very low to very high. The consequence category dictates the requirement and frequency of Dam Safety Reviews.

A Dam Safety Review (DSR) is a comprehensive, formal review process, conducted at regular intervals, that involves completion of checklist items in accordance with the Dam Safety Guidelines. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The frequency of DSR's varies depending on consequence category. For structures where significant life safety and/or socio-economic consequence exist, the DSR is usually conducted every five (5) to ten (10) years. The sewage lagoon requires a DSR every ten (10) years. The initial DSR for the sewage lagoon was conducted in 2001; therefore, the sewage lagoon is due for an updated DSR in 2011. If significant alterations (not including repairs that do not change the height or volume of the structure) to the structure take place before this date, an updated DSR would be required.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection (DSI) would be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection to identify any changes in condition, or any observed concerns. The results of the DSI are incorporated into the DSR documentation. A DSI may trigger repairs, or changes in standard operating procedures.

7. OBSERVATIONS

The sewage lagoon was accessed on foot. Based on our visual assessment we have the following comments:

- The lagoon is currently not in use. All sewage is being processed at the sewage treatment plant. The City of Iqaluit intends to use the lagoon as a back up facility only.
- As a result of inactivity, (loss of inflow) the lagoon has been gradually drawn down by the outflow to a near empty state.
- The repairs to the west berm that were recommended in previous DSI's and other reports have been completed.
- Seepage was not observed downstream of any berms.
- Minimal flow was observed at the outflow.
- Considerable sludge build up was noted now that the lagoon has been drawn down

Overall, the condition of the structure has not changed significantly since the previous DSI, with the above noted exceptions

8. RECOMMENDATIONS

The following actions are recommended:

1. Preparation of the required Operation & Safety Manual, Logbook, and Permanent File, remains incomplete, however, the City has authorized this work to proceed this year.

2. Undertake the next DSI prior to October 2007.

3. The capacity of the sewage lagoon should be confirmed and sludge removal undertaken if required.

4. It is understood that the intent of the City of Iqaluit is to retain the sewage lagoon as a back-up facility only. Given this occasional use the facility in its current configuration (pending the capacity check recommended in Item 3, above) should be adequate for the intended purpose. However, this does not mean preventative maintenance can be overlooked. Localized failures and/or seeps are to be expected. The City of Iqaluit should remain aware that the lagoon operates on old technology – it is essentially a "leaky dam", and its use may be prohibited at any time in the future.

We would be pleased to discuss this report with you.

Should there be any questions, please contact the undersigned.

Yours truly,

Concentric Associates International Incorporated

Allan D. Murray, P.Eng.,
Project Manager

APPENDIX A
Photographs

Photograph 1
Overview, East Berm; note sludge buildup visible now that lagoon is inactive.

Photograph 2
Overview, West Berm; looking south during 2006 repairs

Photograph 3
Overview, West Berm, completed 2006 repairs, looking north

Concentric Associates International Incorporated

City of Iqaluit Sewage Lagoon
Iqaluit, Nunavut
Dam Safety Inspection

October 29, 2009
REPORT

Produced For:
THE CITY OF IQALUIT

Produced By:
CONCENTRIC ASSOCIATES INTERNATIONAL INCORPORATED

Concentric Project Reference Number:
09-2930

City of Iqaluit Sewage Lagoon
Iqaluit, Nunavut
Dam Safety Inspection

CONTENTS

1. EXECUTIVE SUMMARY

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the City of Iqaluit sewage lagoon. The scope of work for the assignment has been undertaken in accordance with Concentric's proposal 09-2930 dated October 15 2009.

The site inspection was conducted on October 22, 2009, by Allan Murray, P.Eng., of Concentric. It is recommended that the next DSI be conducted prior to October 2010.

OBSERVATIONS:

No significant changes in condition of the lagoon and retention berms were observed since the previous DSI which was conducted in 2006.

Representative existing conditions have been documented by photographs in Appendix A.

The required documentation (discussed further below) under the Canadian Dam Safety Guidelines is not up to date, and remains incomplete.

RECOMMENDATIONS:

1. Preparation of the required Operation & Safety Manual, Logbook, and Permanent File was completed in 2007; however, the documents require updating.

2. The Emergency Preparedness Plan has not been completed; it is suggested that the relevance of this document be assessed and a decision made regarding its requirement to exist.

3. The capacity of the sewage lagoon should be confirmed.

4. It is understood that the intent of the City of Iqaluit is to retain the sewage lagoon as a back-up facility only. Given this occasional use the facility in its current configuration (pending the capacity check recommended in Item 3, above) should be adequate for the intended purpose. However, this does not mean preventative maintenance can be overlooked. Localized failures and/or seeps are to be expected. The City of Iqaluit should remain aware that the lagoon operates on old technology – it is essentially a "leaky dam", and its use may be prohibited at any time in the future.

5. Complete the next DSI prior to October 2010.

2. INTRODUCTION

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the City of Iqaluit sewage lagoon located in Iqaluit, Nunavut.

This assignment and the scope of work described herein has been undertaken in accordance with Concentric's proposal 09-2930 submitted on October 15, 2009.

The site visit was conducted on October 22, 2009.

Allan Murray, P.Eng., of Concentric, met with the following personnel at the City of Iqaluit:

- Paul Clow, Director of Engineering, City of Iqaluit

This report summarizes our terms of reference for the assignment, observations, conclusions and recommended action.

3. BACKGROUND

The Canadian Dam Safety Guidelines (DSG) requires that all structures exceeding prescribed height and volume minimums be subject to Dam Safety Reviews (DSR's) and Dam Safety Inspections (DSI's) at regular intervals.

A DSR is a comprehensive, formal review process that involves completion of checklist items in accordance with the Dam Safety Guidelines. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The sewage lagoon requires a DSR every ten (10) years. The current DSR for the sewage lagoon was conducted in 2001.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection only to identify any changes in condition, or any observed concerns.

A detailed historical perspective may be referenced in the DSR on file with the City of Iqaluit.

4. SCOPE OF SERVICES

Our directive has been to undertake a Dam Safety Inspection (DSI) in accordance with the DSG, for the sewage lagoon. The inspection consisted of an on-site visual assessment, notation of any significant changes in condition since the last available DSI, preparation of a written report in a format compatible with the DSR, and a photographic record.

The following is a summary of the scope of work for this assignment. The DSI report is the primary deliverable, and has been prepared in accordance with the DSG document.

- Review available record documentation.
- Conduct a visual on-site assessment of the sewage lagoon
- Prepare a photographic record documenting general and representative conditions
- Identify, characterize, and risk-assess any actual or potential concerns
- Prepare a written report summarizing our observations, items of concern, and recommendations
- Indicate any recommended repairs
- Prioritize action items
- Submit final documents in electronic format and hard copy

Limitations

The DSI is based on visual assessment; no invasive inspection/assessment was done.

This report has been prepared for the sole use of The City of Iqaluit.

5. SUMMARY OF PREVIOUS DSI'S

The following is a summary of observations and recommendations made from past DSI's conducted since the 2001 DSR:

January 7, 2003 (2002) DSI

A DSI was conducted by Trow Consulting Engineers (Report MA15882A, dated January 7, 2003) in October 2002. The DSI was termed "…an interim step prior to the implementation of remedial measures…" recommended in the 2001 DSR.

The DSI noted no significant changes since the 2001 DSR, but highlighted the seepage concerns of the east berm and the threat of overtopping in the spring.

The DSI reiterated the recommendations of the 2001 DSR, as follows:

- There is inadequate information concerning the as-built conditions of the berms
- The berms may not be safe in their current condition and may be non-compliant with the design and performance standards of the DSG.
- Remedial measures include three (3) options - an impermeable liner; buttressing the berms; and building a new lagoon.

Not stated in the 2002 DSI, but recommended in the 2001 DSR, were the following additional requirements:

- Complete the remaining outstanding non-compliance requirements of Section Nos. 3 and 4 of the DSG, as follows:
  - Permanent file
  - Operation, Maintenance and Surveillance Manual
  - Logbook
  - Emergency Preparedness Plan

2003 DSI

Based on our discussions with the City of Iqaluit Engineering Department, there is no 2003 DSI on file. However, a geotechnical investigation was conducted by Trow Associates Inc. (Report OTGE00016794A, dated October 8, 2003) in 2003.

The scope of the geotechnical investigation was to undertake a topographic survey of the lagoon and conduct a slope stability analysis of the berms. A separate hydrologic report is referenced, but was not provided to us. It would appear that the geotechnical investigation was attempting to address some of the as-built issues discussed in the 2002 DSI.

Salient points from the geotechnical investigation include:

- Adequate (satisfying the Dan Safety Guidelines) factors of safety exist for steady state seepage and rapid drawdown scenarios
- The berm slopes should remain stable provided they are protected against overtopping and adequate erosion protection is installed on downstream faces
- Catastrophic failure is unlikely with the above provisos, however, localized failures or seeps are expected until such time as the lagoon is lined with an impervious material, or rebuilt

2004 DSI

A 2004 DSI was commissioned, however, it was not authorized by the City of Iqaluit until February 2005. The DSI was conducted by Concentric.

Much of the site was snow covered at the time of the 2004 DSI so the report was limited in nature and basically reiterated previous concerns and items that remained outstanding.

2005 DSI

A 2005 DSI was not conducted.

2006 DSI

The following is a summary of observations and recommendations from the 2006 DSI prepared by Concentric:

- The lagoon is not in use and sewage is being processed at the sewage treatment plant.
- The lagoon has been drawn down by the outflow with some sludge accumulation.
- The recommended repairs to the west berm have been completed.
- Seepage was not observed downstream of any berms.
- Minimal flow was observed at the outflow.

- Preparation of the required Operation & Safety Manual, Logbook, Permanent File, and Emergency Preparedness Plan remains incomplete.
- The capacity of the sewage lagoon should be confirmed.
- It is understood that the intent of the City of Iqaluit is to retain the sewage lagoon as a back-up facility only. Localized failures and/or seeps are to be expected. The City of Iqaluit should remain aware that the lagoon operates on old technology – it is essentially a "leaky dam", and its use may be prohibited at any time in the future.

Overall, the condition of the structure did not changed significantly since the previous DSI.

6. COMMENTARY ON DAM SAFETY GUIDELINES

The Canadian Dam Association publication, Dam Safety Guidelines (DSG), governs the nature and frequency of inspection and review activities for structures which fall under its umbrella criteria.

The DSG applies to those structures that are at least 2.5 meters in height, and which have at least 30,000 cubic meters of storage capacity.

The DSG document is far reaching in terms of applicability and requirements for conformance. This is understandable as the type and complexity of structures that fall under the jurisdiction of the document varies considerably, from relatively small and simple embankments or dikes to massive and complex dams associated with hydroelectric generating facilities, irrigation, flood control, etc.

The DSG requires that all structures exceeding the height and volume minimums described above be classified according to their "consequence category", that is, the consequence of dam failure in terms of life safety, and socio-economic impact. The category assigned may range from very low to very high. The consequence category dictates the requirement and frequency of Dam Safety Reviews.

A Dam Safety Review (DSR) is a comprehensive, formal review process, conducted at regular intervals, that involves completion of checklist items in accordance with the Dam Safety Guidelines.

The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The frequency of DSR's varies depending on consequence category. For structures where significant life safety and/or socio-economic consequence exist, the DSR is usually conducted every five (5) to ten (10) years. The sewage lagoon requires a DSR every ten (10) years. The initial DSR for the sewage lagoon was conducted in 2001; therefore, the sewage lagoon is due for an updated DSR in 2011. If significant alterations (not including repairs that do not change the height or volume of the structure) to the structure take place before this date, an updated DSR would be required.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection (DSI) would be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection to identify any changes in condition, or any observed concerns. The results of the DSI are incorporated into the DSR documentation. A DSI may trigger repairs, or changes in standard operating procedures.

7. OBSERVATIONS

The sewage lagoon was accessed on foot. Based on our visual assessment we have the following comments:

- There were no significant changes in the lagoon or berm structures since the previous DSI, which was conducted in 2006.
- Seepage was not observed downstream of any berms.
- Minimal flow was observed at the outflow.
- To our knowledge, the sewage lagoon capacity has not been confirmed; this should be done as inactivity and sludge/sediment accumulation may have reduced the effective capacity significantly.
- To our knowledge, the required documentation (discussed previously) under the Canadian Dam Safety Guidelines is not up to date, and remains incomplete.

8. RECOMMENDATIONS

The following actions are recommended:

1. Preparation of the required Operation & Safety Manual, Logbook, and Permanent File was completed in 2007; however, the documents require updating.

2. The Emergency Preparedness Plan has not been completed; it is suggested that the relevance of this document be assessed and a decision made regarding its requirement to exist.

3. The capacity of the sewage lagoon should be confirmed.

4. It is understood that the intent of the City of Iqaluit is to retain the sewage lagoon as a back-up facility only. Given this occasional use the facility in its current configuration should be adequate for the intended purpose. However, this does not mean preventative maintenance can be overlooked. Localized failures and/or seeps are to be expected. The City of Iqaluit should remain aware that the lagoon operates on old technology – it is essentially a "leaky dam", and its use may be prohibited at any time in the future.

5. Complete the next DSI prior to October 2010.

We would be pleased to discuss this report with you.

Should there be any questions, please contact the undersigned.

Yours truly,

Concentric Associates International Incorporated

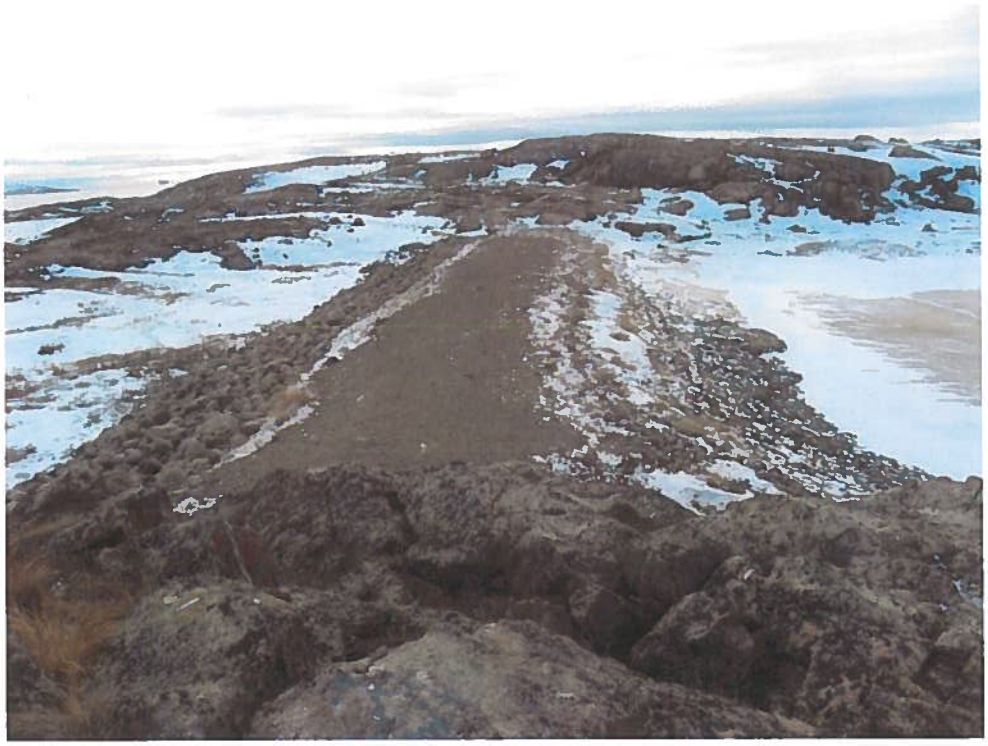
Allan Murray, P.Eng.,
Project Manager

APPENDIX A
Photographs

Photograph 1
Overview looking East.

Photograph 2
Overview looking West

Photograph 3
East Berm, North segment; no change since 2006



Photograph 4
East Berm, South segment; no change since 2006

Photograph 5
West Berm, no change since 2006

Photograph 6
Discharge from Sewage Treatment Plant

CONCENTRIC

Concentric Associates International Incorporated

City of Iqaluit Sewage Lagoon
Iqaluit, Nunavut
Dam Safety Inspection

September 21, 2011

REPORT

Produced For:
THE CITY OF IQALUIT

Produced By:
CONCENTRIC ASSOCIATES INTERNATIONAL INCORPORATED

Concentric Project Reference Number:
11-3999

City of Iqaluit Sewage Lagoon
Iqaluit, Nunavut
Dam Safety Inspection

CONTENTS

1. EXECUTIVE SUMMARY

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the City of Iqaluit sewage lagoon. The scope of work for the assignment has been undertaken in accordance with Concentric's proposal to the City.

The site inspection was conducted on September 14, 2011, by Allan Murray, P.Eng., of Concentric. It is recommended that the next DSI be conducted prior to October 2012.

OBSERVATIONS:

No significant changes in condition of the lagoon and retention berms were observed since the previous DSI which was conducted in 2009.

Representative existing conditions have been documented by photographs in Appendix A.

The required documentation (discussed further below) under the Canadian Dam Safety Guidelines is not up to date, and remains incomplete.

RECOMMENDATIONS:

1. Preparation of the required Operation & Safety Manual, Logbook, and Permanent File was completed in 2007; however, the documents require updating.

2. The Emergency Preparedness Plan has not been completed; it is suggested that the relevance of this document be assessed and a decision made regarding its requirement to exist. We can assist with this exercise.

3. The capacity of the sewage lagoon should be confirmed.

4. It is understood that the intent of the City of Iqaluit is to retain the sewage lagoon as a back-up facility only. Given this occasional use the facility in its current configuration (pending the capacity check recommended in Item 3, above) should be adequate for the intended purpose. However, this does not mean preventative maintenance can be overlooked. Localized failures and/or seeps are to be expected. The City of Iqaluit should remain aware that the lagoon operates on old technology – it is essentially a "leaky dam", and its use may be prohibited at any time in the future.

5. A Dam Safety Review (DSR) is required prior to October 2012.

2. INTRODUCTION

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the City of Iqaluit sewage lagoon located in Iqaluit, Nunavut.

This assignment and the scope of work described herein has been undertaken in accordance with Concentric's proposal to the City.

The site visit was conducted on September 14, 2011.

This report summarizes our terms of reference for the assignment, observations, conclusions and recommended action.

3. BACKGROUND

The Canadian Dam Safety Guidelines (DSG) requires that all structures exceeding prescribed height and volume minimums be subject to Dam Safety Reviews (DSR's) and Dam Safety Inspections (DSI's) at regular intervals.

A DSR is a comprehensive, formal review process that involves completion of checklist items in accordance with the Dam Safety Guidelines. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The sewage lagoon requires a DSR every ten (10) years. The current DSR for the sewage lagoon was conducted in 2001/2002.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection only to identify any changes in condition, or any observed concerns.

A detailed historical perspective may be referenced in the DSR on file with the City of Iqaluit.

4. SCOPE OF SERVICES

Our directive has been to undertake a Dam Safety Inspection (DSI) in accordance with the DSG, for the sewage lagoon. The inspection consisted of an on-site visual assessment, notation of any significant changes in condition since the last available DSI, preparation of a written report in a format compatible with the DSR, and a photographic record.

The following is a summary of the scope of work for this assignment. The DSI report is the primary deliverable, and has been prepared in accordance with the DSG document.

- Review available record documentation.
- Conduct a visual on-site assessment of the sewage lagoon
- Prepare a photographic record documenting general and representative conditions
- Identify, characterize, and risk-assess any actual or potential concerns
- Prepare a written report summarizing our observations, items of concern, and recommendations
- Indicate any recommended repairs
- Prioritize action items
- Submit final documents in electronic format and hard copy

Limitations

The DSI is based on visual assessment; no invasive inspection/assessment was done.

This report has been prepared for the sole use of The City of Iqaluit.

5. SUMMARY OF PREVIOUS DSI'S

The following is a summary of observations and recommendations made from past DSI's conducted since the 2001 DSR:

January 7, 2003 (2002) DSI

A DSI was conducted by Trow Consulting Engineers (Report MA15882A, dated January 7, 2003) in October 2002. The DSI was termed "...an interim step prior to the implementation of remedial measures..." recommended in the 2001 DSR.

The DSI noted no significant changes since the 2001 DSR, but highlighted the seepage concerns of the east berm and the threat of overtopping in the spring.

The DSI reiterated the recommendations of the 2001 DSR, as follows:

- There is inadequate information concerning the as-built conditions of the berms
- The berms may not be safe in their current condition and may be non-compliant with the design and performance standards of the DSG.
- Remedial measures include three (3) options - an impermeable liner; buttressing the berms; and building a new lagoon.

Not stated in the 2002 DSI, but recommended in the 2001 DSR, were the following additional requirements:

- Complete the remaining outstanding non-compliance requirements of Section Nos. 3 and 4 of the DSG, as follows:
  - Permanent file
  - Operation, Maintenance and Surveillance Manual
  - Logbook
  - Emergency Preparedness Plan

2003 DSI

Based on our discussions with the City of Iqaluit Engineering Department, there is no 2003 DSI on file. However, a geotechnical investigation was conducted by Trow Associates Inc. (Report OTGE00016794A, dated October 8, 2003) in 2003.

The scope of the geotechnical investigation was to undertake a topographic survey of the lagoon and conduct a slope stability analysis of the berms. A separate hydrologic report is referenced, but was not provided to us. It would appear that the geotechnical investigation was attempting to address some of the as-built issues discussed in the 2002 DSI.

Salient points from the geotechnical investigation include:

- Adequate (satisfying the Dan Safety Guidelines) factors of safety exist for steady state seepage and rapid drawdown scenarios
- The berm slopes should remain stable provided they are protected against overtopping and adequate erosion protection is installed on downstream faces
- Catastrophic failure is unlikely with the above provisos, however, localized failures or seeps are expected until such time as the lagoon is lined with an impervious material, or rebuilt

2004 DSI

A 2004 DSI was commissioned, however, it was not authorized by the City of Iqaluit until February 2005. The DSI was conducted by Concentric.

Much of the site was snow covered at the time of the 2004 DSI so the report was limited in nature and basically reiterated previous concerns and items that remained outstanding.

2005 DSI

A 2005 DSI was not conducted.

2006 DSI

The following is a summary of observations and recommendations from the 2006 DSI prepared by Concentric:

- The lagoon is not in use and sewage is being processed at the sewage treatment plant.
- The lagoon has been drawn down by the outflow with some sludge accumulation.
- The recommended repairs to the west berm have been completed.
- Seepage was not observed downstream of any berms.
- Minimal flow was observed at the outflow.

- Preparation of the required Operation & Safety Manual, Logbook, Permanent File, and Emergency Preparedness Plan remains incomplete.
- The capacity of the sewage lagoon should be confirmed.
- It is understood that the intent of the City of Iqaluit is to retain the sewage lagoon as a back-up facility only. Localized failures and/or seeps are to be expected. The City of Iqaluit should remain aware that the lagoon operates on old technology – it is essentially a "leaky dam", and its use may be prohibited at any time in the future.

2009 DSI

The following is a summary of observations and recommendations from the 2009 DSI prepared by Concentric:

- There were no significant changes in use, or the lagoon/berm structures since the previous DSI.
- Seepage was not observed downstream of any berms.
- Minimal flow was observed at the outflow.
- To our knowledge, the sewage lagoon capacity has not been confirmed; this should be done as inactivity and sludge/sediment accumulation may have reduced the effective capacity significantly.
- To our knowledge, the required documentation (discussed previously) under the Canadian Dam Safety Guidelines is not up to date, and remains incomplete.
- Update the Operation & Safety Manual, Logbook, and Permanent File.
- The Emergency Preparedness Plan has not been completed; it is suggested that the relevance of this document be assessed and a decision made regarding its requirement to exist.
- It is understood that the intent of the City is to retain the sewage lagoon as a back-up facility only. Localized failures and/or seeps are to be expected. The lagoon operates on old technology; it is essentially a "leaky dam", and its use may be prohibited at any time in the future.
- Complete the next DSI prior to October 2010.

6. COMMENTARY ON DAM SAFETY GUIDELINES

The Canadian Dam Association publication, Dam Safety Guidelines (DSG), governs the nature and frequency of inspection and review activities for structures which fall under its umbrella criteria.

The DSG applies to those structures that are at least 2.5 meters in height, and which have at least 30,000 cubic meters of storage capacity.

The DSG document is far reaching in terms of applicability and requirements for conformance. This is understandable as the type and complexity of structures that fall under the jurisdiction of the document varies considerably, from relatively small and simple embankments or dikes to massive and complex dams associated with hydroelectric generating facilities, irrigation, flood control, etc.

The DSG requires that all structures exceeding the height and volume minimums described above be classified according to their "consequence category", that is, the consequence of dam failure in terms of life safety, and socio-economic impact. The category assigned may range from very low to very high. The consequence category dictates the requirement and frequency of Dam Safety Reviews.

A Dam Safety Review (DSR) is a comprehensive, formal review process, conducted at regular intervals, that involves completion of checklist items in accordance with the Dam Safety Guidelines.

The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The frequency of DSR's varies depending on consequence category. For structures where significant life safety and/or socio-economic consequence exist, the DSR is usually conducted every five (5) to ten (10) years. The sewage lagoon requires a DSR every ten (10) years. The initial DSR for the sewage lagoon was conducted in 2001/2002; therefore, the sewage lagoon is due for an updated DSR by the end of 2012. If significant alterations (not including repairs that do not change the height or volume of the structure) to the structure take place before this date, an updated DSR would be required.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection (DSI) would be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection to identify any changes in condition, or any observed concerns. The results of the DSI are incorporated into the DSR documentation. A DSI may trigger repairs, or changes in standard operating procedures.

7. OBSERVATIONS

The sewage lagoon was accessed on foot. Based on our visual assessment we have the following comments:

- There were no significant changes in the lagoon or berm structures since the previous DSI, which was conducted in 2009.
- Seepage was not observed downstream of any berms.
- Minimal flow was observed at the outflow.
- To our knowledge, the sewage lagoon capacity has not been confirmed; this should be done as inactivity and sludge/sediment accumulation may have reduced the effective capacity significantly.
- To our knowledge, the required documentation (discussed previously) under the Canadian Dam Safety Guidelines is not up to date, and remains incomplete.

8. RECOMMENDATIONS

The following actions are recommended:

1. Preparation of the required Operation & Safety Manual, Logbook, and Permanent File was completed in 2007; however, the documents require updating.

2. The Emergency Preparedness Plan has not been completed; it is suggested that the relevance of this document be assessed and a decision made regarding its requirement to exist.

3. The capacity of the sewage lagoon should be confirmed.

4. It is understood that the intent of the City of Iqaluit is to retain the sewage lagoon as a back-up facility only. Given this occasional use the facility in its current configuration should be adequate for the intended purpose. However, this does not mean preventative maintenance can be overlooked. Localized failures and/or seeps are to be expected. The City of Iqaluit should remain aware that the lagoon operates on old technology – it is essentially a "leaky dam", and its use may be prohibited at any time in the future.

5. A Dam safety Review (DSR) is required prior to October 2012.

We would be pleased to discuss this report with you.

Should there be any questions, please contact the undersigned.

Yours truly,

Concentric Associates International Incorporated

Allan Murray, P.Eng.,
Project Manager

APPENDIX A
Photographs

Photograph 1
Overview of West berm.

Photograph 2
Overview looking East; note lagoon level and sludge accumulation.

Photograph 3
Overview, Northeast berm.

Photograph 4
Overview, Southeast berm.

CONCENTRIC

Our file # 12-4487

June 29, 2012

City of Iqaluit
Department of Engineering
P.O. Box 460 via email
Iqaluit, Nunavut
X0A 0H0

Attention: **Mr. Paul Clow, Project Officer**

Re: **Iqaluit Sewage Lagoon**
DSR Requirement Investigation

Dear Paul:

Concentric Associates International Incorporated (Concentric) was retained to determine if and how often Dam Safety Reviews (DRS's) are required for the Sewage Lagoon in Iqaluit, Nunavut.

Background and Description

The Iqaluit Sewage Lagoon was constructed south of the FOL barracks, on the tidal plain at the head of Koojesse Inlet circa 1978. The lagoon is formed by 2 man-made berms (east and west) and the natural topography to the north and south.

The sewage lagoon has not been in use for several years, the water treatment plant constructed circa 2006 removes the need for the lagoon. However the lagoon is required as an emergency back-up in the event of a failure at the water treatment plant.

Observations

The Canadian Dam Safety Guidelines (DSG) were originally published in 1999. That document formed the basis for the Dam Safety Review (DSR) conducted by Trow (now exp) in 2001/2002. The Trow (now exp) DSR recommended a new DSR every ten (10) years.

The DSG's have since undergone significant revisions, with a new issue published in 2007.

Concentric suggested that, prior to a new DSR being conducted, a review of the classification criteria, and thus the DSR requirements of the 2007 DSG be conducted.

SASKATOON
220 3rd Avenue South,
Suite 413,
Saskatoon, Saskatchewan
S7K 1M1
T: 306.343.5500
TF: 1.866.919.8899
F: 306.343.3601

REGINA
369 Park Street,
Regina, Saskatchewan
S4N 5B2
T: 306.522.6100
TF: 1.866.919.1861
F: 306.522.6101

WINNIPEG
300 - 1600 Ness Avenue,
Madison Square
Winnipeg, Manitoba
R3J 3W7
T: 204.783.1276
TF: 1.866.919.4531
F: 204.478.4940

LONDON
700 Richmond Street,
Suite 307,
London, Ontario
N6A 5C7
T: 519.452.7700
TF: 1.866.919.4531
F: 519.452.1712

OTTAWA
5310 Canotek Road,
Unit 30,
Ottawa, Ontario
K1J 9N5
T: 613.824.8900
TF: 1.866.919.4530
F: 613.824.8901

IQALUIT
P.O. Box 957,
Iqaluit, Nunavut
X0A 0H0
T: 867.979.3300
TF: 1.866.919.4533
F: 867.979.3302

According to the 2007 Dam Safety Guidelines, the suggested frequency for DSR's to be performed varies, based on the Dam Classification. For example, with a Significant Class Dam a DSR is required every 10 years.

Section 2.5 of the safety guidelines outlines the consequences to be evaluated for the various classifications.

Consequences for the determination of Dam Classification are as follows:

- Population at Risk (PAR), defined as the number of people who would be exposed to the hazard of a dam failure.
- Loss of Life, defined as the number of people would be exposed to flood waters and would experience consequences that could range from inconvenience and economic losses to loss of life.
- Environmental and Cultural Values: defined as significant environmental losses as assessed in terms of whether restoration of environment is feasible and how long it would take. Cultural losses include damage to irreplaceable historical and cultural features.
- Infrastructure and Economics, defined as economic losses including direct damage to third-party property, facilities, other utilities and infrastructure.

Concentric has determined that there is no PAR in the event of a dam failure. Localized seepage is to be expected with un-lined ("leaky") lagoon technology. In the event of a berm failure or wash out as the immediate surrounding area of the lagoon is unpopulated; no risk to human life is expected.

Loss of Life is determined to be zero for the same reasons stated above.

Environmental and Cultural Values: long term loss is not anticipated; there are no historical sites in the vicinity. The lagoon will continue to have localized seepage, and in the unlikely event of a berm failure or washout, the environmental impact will be minimal and temporary in nature.

Regarding Infrastructure and Economics, the immediate area contains limited infrastructure and services. The drainage path is towards Koojesse Inlet, with no threat to the airport and surrounding infrastructure.

Recommendations

Based on our observations, we believe that the Iqaluit Sewage Lagoon has a Low Risk Dam Classification; therefore, a Dam Safety Review is not required. However, the consequences of failure should be reviewed periodically, and the DSG's reviewed for any amendments or revisions.

Should there be any questions, please contact the undersigned.

Yours sincerely,

Concentric Associates International Incorporated

Lisa Koehler A.Sc.T.
Project Manager

Allan Murray P.Eng.
Partner

Iqaluit

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As Built Drawings

CONCENTRIC

Iqaluit
ᐃᖃᓗᐃᑦ

Instructions

This Section contains copies of all As Built drawings available for the sewage lagoon facility. The documents should remain in chronological order.

Whenever a new drawing is added it should be noted in the Annual Update Pages, (Tab 1), a notation of the associated site inspection should be noted in the Permanent Log Book, (Tab 5), and added to the register in this Section, below.

REGISTER of AS BUILT DRAWINGS

Date	Document
December 19 1991	Lagoon Reconstruction and Drainage Improvements Record Drawings –
September 30 2006	West Berm Repairs – August 2006

TOWN OF IQALUIT

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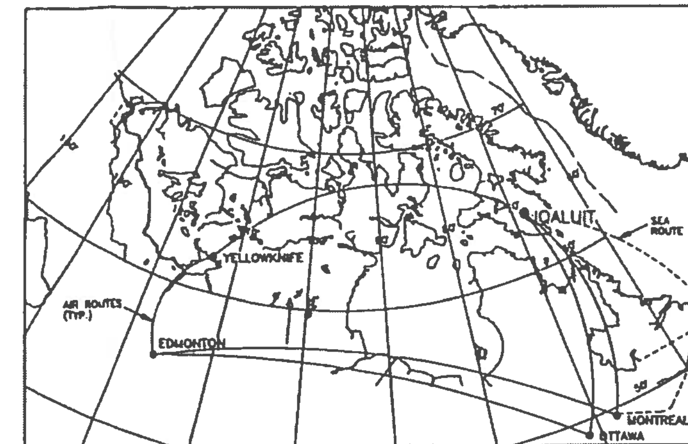


LOCATION PLAN
N.T.S.
IQALUIT - N.W.T. - CANADA

LAGOON RECONSTRUCTION AND DRAINAGE IMPROVEMENTS

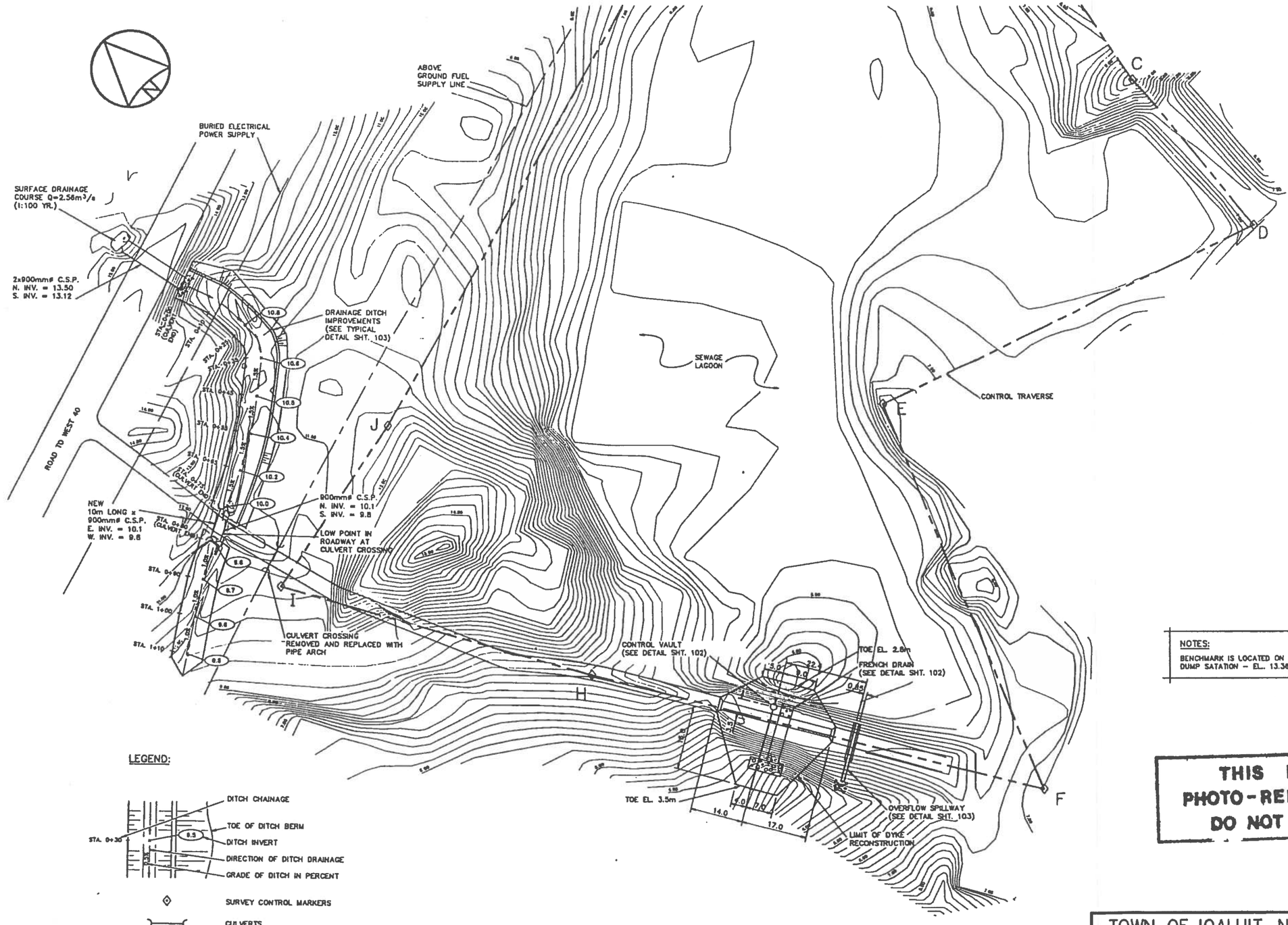
RECORD DRAWINGS

CONTRACT No.

THIS IS A PHOTO-REDUCTION DO NOT SCALE

UMA Engineering Ltd.
Engineers, Planners & Surveyors

Kenneth R. Johnson
M.A.Sc., MCIP, P.Eng.
Planner & Engineer
www.cryofront.com



LEGEND:

- DITCH CHAINAGE
- TOE OF DITCH BERM
- DITCH INVERT
- DIRECTION OF DITCH DRAINAGE
- GRADE OF DITCH IN PERCENT
- SURVEY CONTROL MARKERS
- CULVERTS

NOTES:

BENCHMARK IS LOCATED ON CONCRETE SLAB OF SEWAGE DUMP SATATION – EL. 13.366m.

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PLAN SCALE 0 10 20 30m (10 5 1 : 000)

PERMIT

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER P 007
UMA ENGINEERING LTD

REV	Y	M	D	REVISION DESCRIPTION	DRN	SUPV	DES	CHK	ENG
2	91	12	19	RECORD DRAWING	ME	KRJ		KRJ	KRJ
1	91	08	08	FOR CONSTRUCTION	ME	KRJ	JVA	BCS	KRJ
0	91	07	24	FOR REVIEW	ME	KRJ	JVA	KRJ	KRJ

UMA Engineering Ltd.
Engineers, Planners & Surveyors
British Columbia Alberta Saskatchewan Manitoba Ontario Yukon Territory Northwest Territories

ENGINEER

REGISTERED PROFESSIONAL ENGINEER N.W.T.

TOWN OF IQALUIT, N.W.T.

LAGOON RECONSTRUCTION AND DRAINAGE IMPROVEMENTS

OVERALL SITE PLAN AND GRADING

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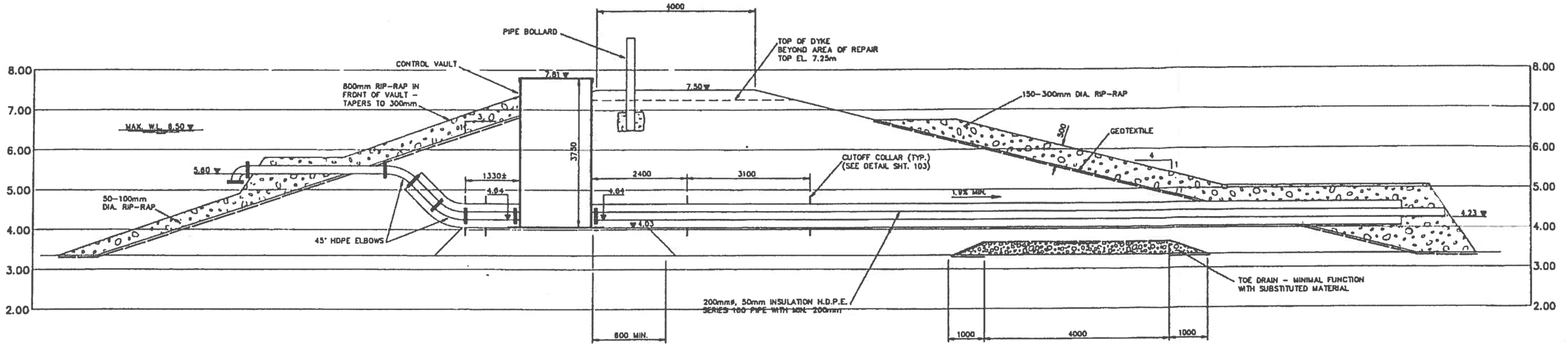
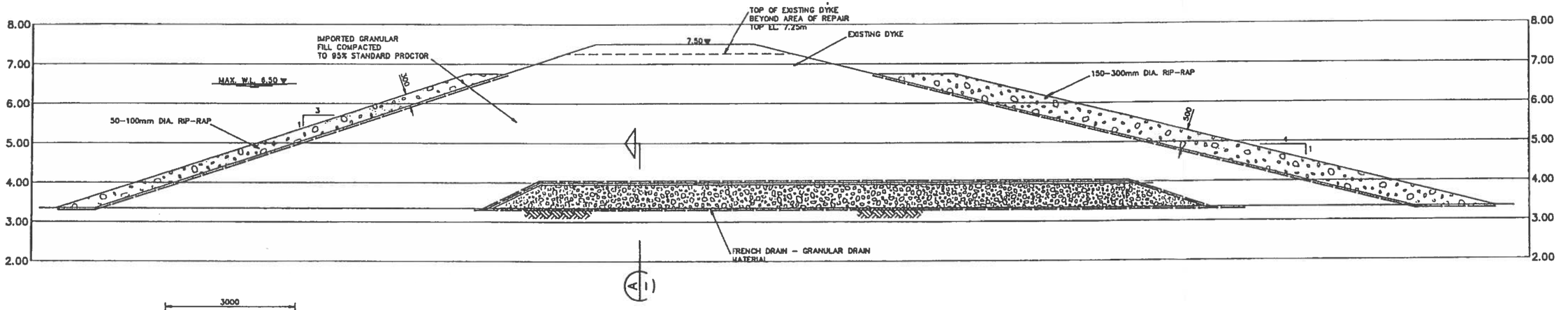
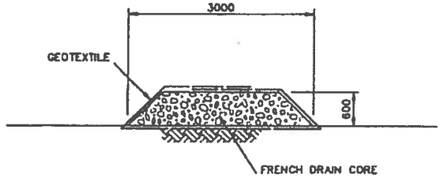
		CD-00-47-A1	101	2



DYKE RECONSTRUCTION

SCALE 1:50





SECTION A

SCALE 1:50

FRENCH DRAIN (MINIMAL FUNCTION WITH SUBSTITUTED MATERIAL)

SCALE 1:50

NOTE: IMPORTED GRANULAR FILL CLASS D2 NOT UTILIZED ABOVE ELEVATION OF FRENCH DRAIN. MATERIAL WITH LARGER FINES COMPONENT SUBSTITUTED BY TOWN OF IQALUIT. DESIGN SLOPES OF 4:1 (EXTERIOR) AND 3:1 (INTERIOR) ACCOMMODATE THIS MATERIAL.

THIS IS A
PHOTO-REDUCTION
DO NOT SCALE

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS AND GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER
P 007
UMA ENGINEERING LTD

2	91	12	10	RECORD DRAWING	ME	KRJ		KRJ	KRJ	
1	91	08	08	FOR CONSTRUCTION	ME	KRJ	JVA	BCG	KRJ	

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Manitoba Ontario Yukon Territory
Northwest Territories

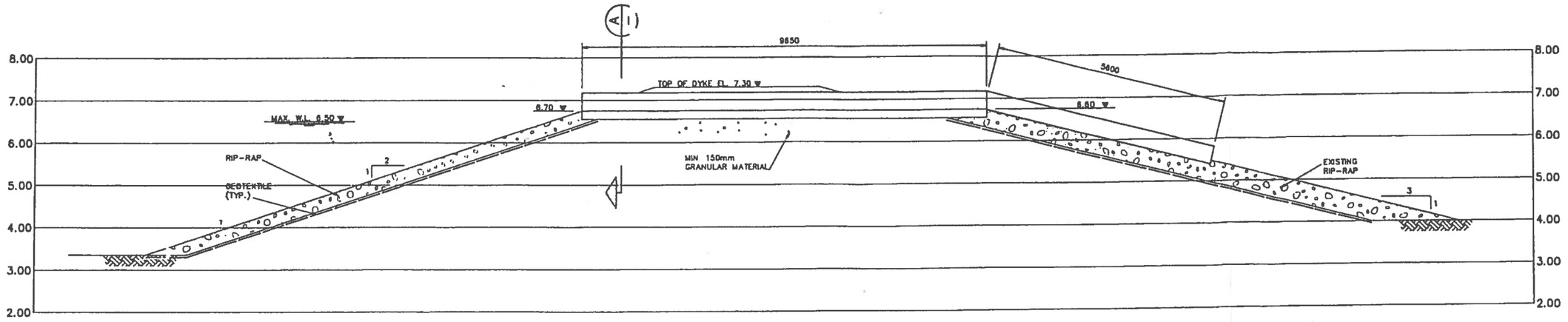
REGISTERED PROFESSIONAL ENGINEER NWT

TOWN OF IQALUIT, N.W.T.

LAGOON RECONSTRUCTION
AND DRAINAGE IMPROVEMENTS

SECTIONS & DETAILS

CODE	DRAWING	REV
	100	2



SECTION THROUGH OVERFLOW SPILLWAY

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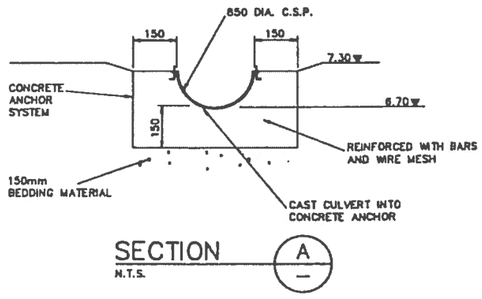
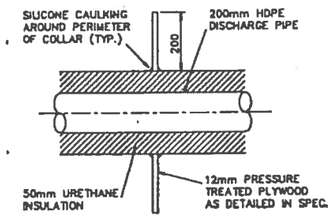
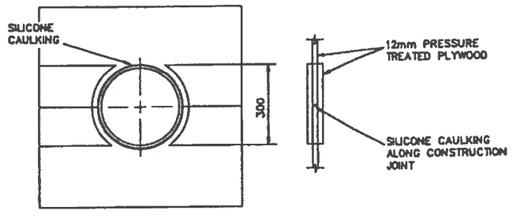


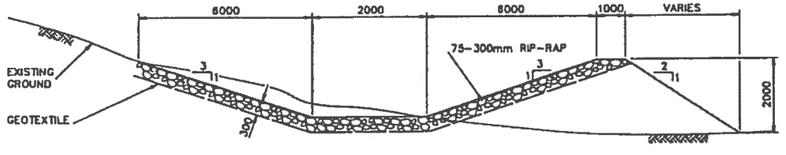
SECTION A — A
N.T.S.





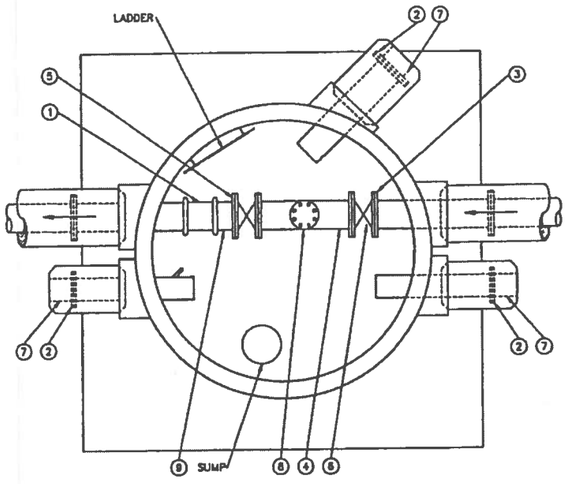
CUTOFF COLLAR DETAIL

N.T.S.



DITCH X-SECTION DETAIL

N.T.S.



REFERANCE

1. VICTAULIC SPOOL PIECE
2. BLIND FLANGE – GALVANIZED
3. VICTAULIC STYLE #741 FLANGE – GALVANIZED
4. FLANGE SPOOL PIECE – GALVANIZED
5. PINCH VALVE
6. 200 KNIFE GATE VALVE (200 CWP CRANE)
7. MASTIC COATED P.U. INSUL. PLUG
8. TEE WITH BLIND FLANGE
9. FLANGE BY VICTAULIC SPOOL PIECE

CONTROL VAULT

N.T.S.

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THE ASSOCIATION OF PROFESSIONAL ENGINEERS GEOLOGISTS AND GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER P 007
UMA ENGINEERING LTD.

2	01	12	10	RECORD DRAWING	ME	KRJ		KRJ	KRJ	
1	01	08	08	FOR CONSTRUCTION	ME	KRJ	JVA	BCG	KRJ	

UMA Engineering Ltd.
Engineers, Planners & Surveyors
British Columbia Alberta Saskatchewan Manitoba Ontario Yukon Territory Northwest Territories

REGISTERED PROFESSIONAL ENGINEER

TOWN OF IQALUIT, N.W.T.

LAGOON RECONSTRUCTION AND DRAINAGE IMPROVEMENTS

SECTIONS AND DETAILS

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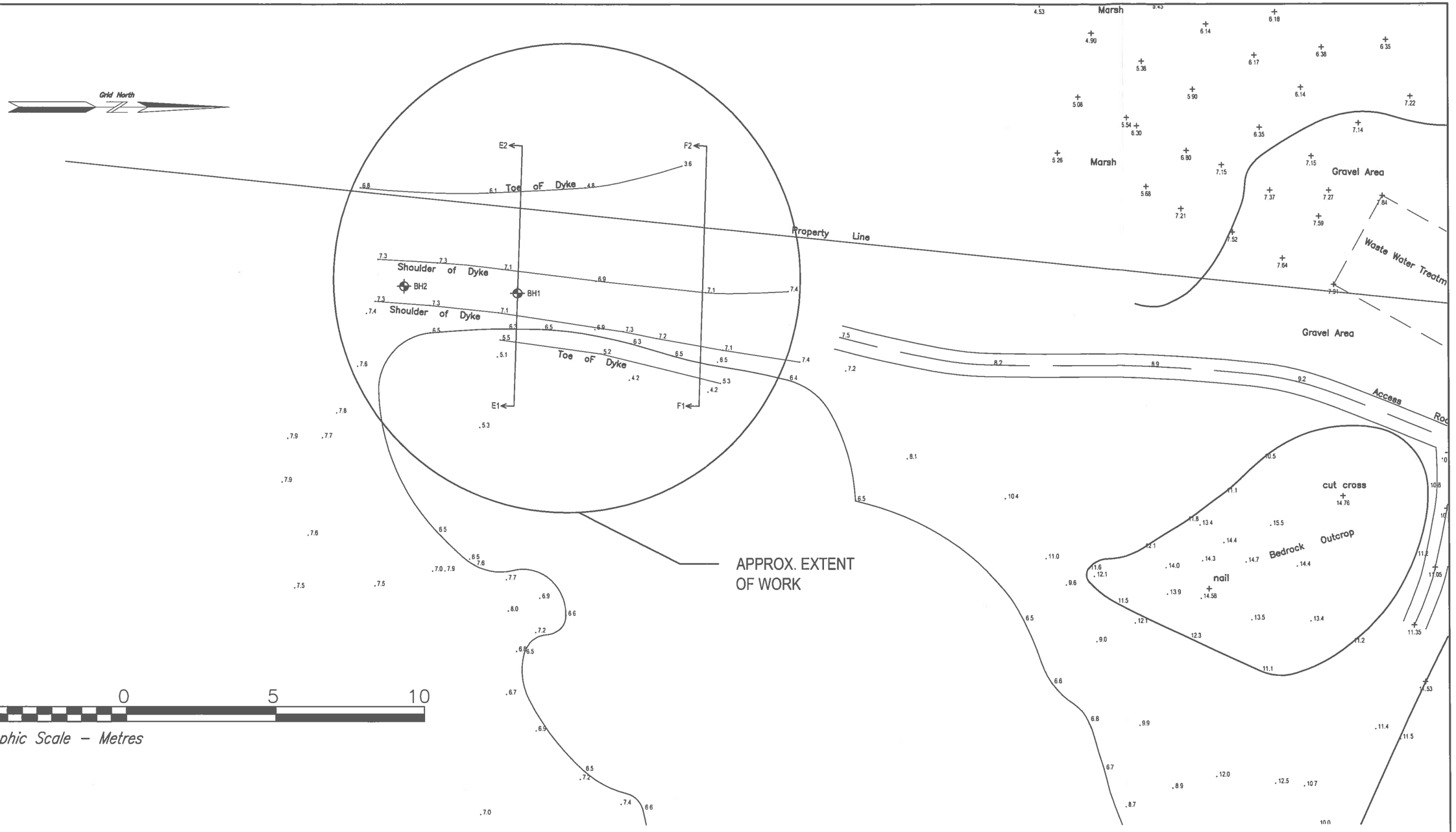


LOCATION OF WORK- LAND SURVEY

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

NO.	REVISION / ISSUED TO	DATE
3	ISSUED FOR TENDER	JUNE. 22/06
2	ISSUED FOR TENDER	JUNE. 15/06
1	ISSUED FOR CLIENT REVIEW	JUNE. 2/06

CONCENTRIC ASSOCIATES INTERNATIONAL INC.
700 Richmond St., Suite 104, London, ON. N6A 5C7. Tel. 519 452.7700 Fax 519 452.1712
1420 Blair Place, Suite 104, Ottawa, ON. K1J 9L8. Tel. 613 824.8900 Fax 613 824.8901

CLIENT NAME: CITY OF IQALUIT

PROJECT ADDRESS: CITY OF IQALUIT NUNAVUT

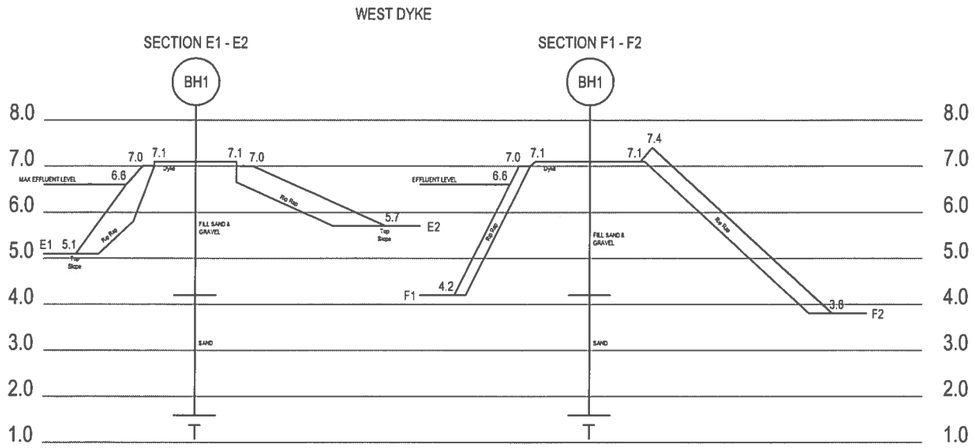
DRAWING TITLE: LOCATION OF WORK PROPOSED

PROJECT NAME: SEWAGE LAGOON WEST DYKE UPGRADES

DESIGN	R.A.H.
DRAWN	C.Y.
APPROV	A.D.M.
SCALE	AS NOTED
DATE	OCT/2005
PROJECT NO	05-1292

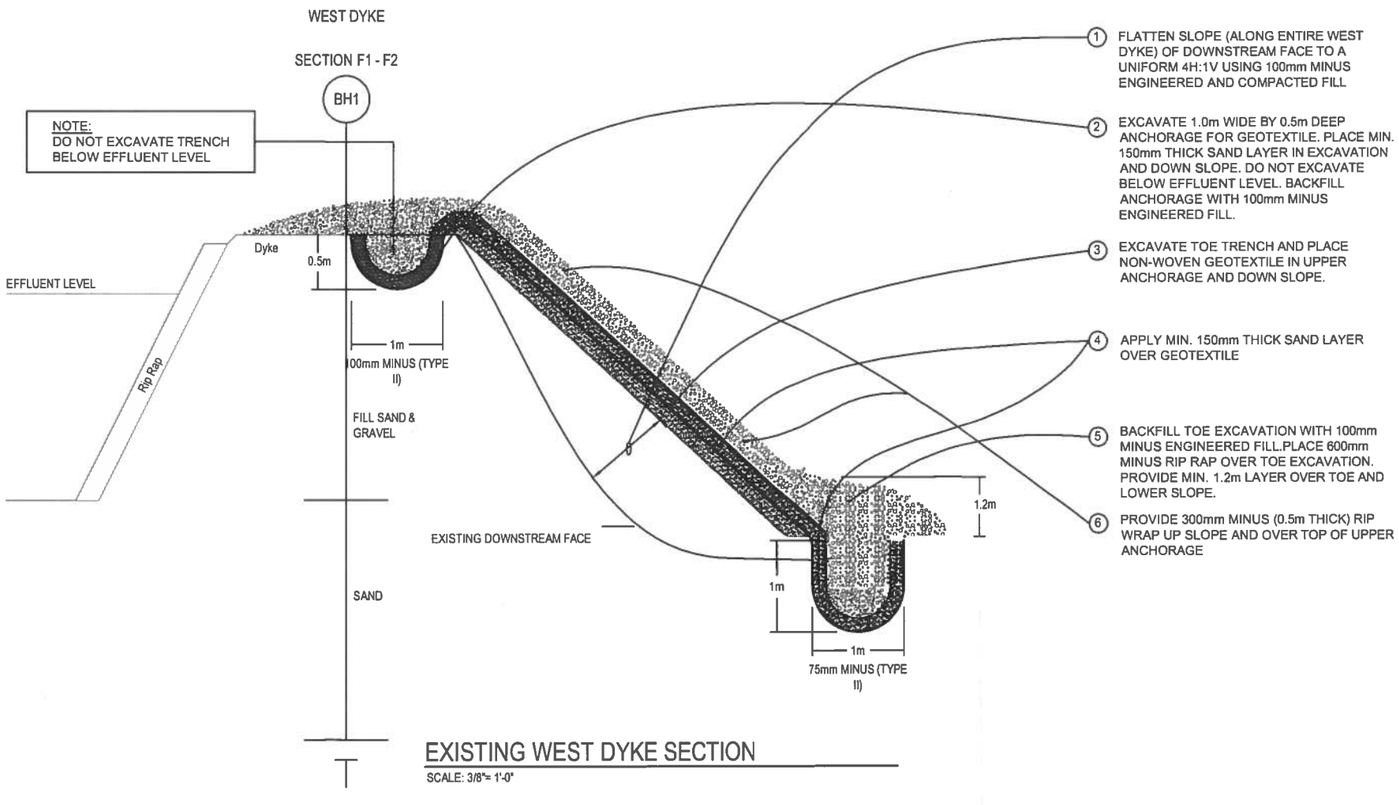
DWG. NO. SK1

1 OF 1



WEST DYKE ELEVATION

SCALE: 3/8"= 1'-0"
*AS PER TROW'S GEOTECHNICAL REPORT (OTGEOOD16794A) DATED OCT 8/2003



EXISTING WEST DYKE SECTION

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

GENERAL NOTES:

1. BIDDERS/CONTRACTORS SHALL CAREFULLY EXAMINE AND STUDY THE DRAWING AND THE SITE OF THE WORK IN ORDER TO SATISFY THEMSELVES BY EXAMINATION AS TO ALL CONDITIONS AFFECTING THE CONTRACT, THE DETAILED REQUIREMENTS OF THE CONSTRUCTION AND EXTENT OF WORK INVOLVED.
2. ALL BIDDERS/CONTRACTORS SHALL CONFIRM OVERALL DIMENSIONS AND QUANTITY OF WORK AND NOTIFY CONSULTANT OF ANY DISCREPANCIES NOTED. NO CONSIDERATION SHALL BE GIVEN FOR CLAIMS FOR EXTRA COMPENSATIONS BEYOND THAT SHOWN ON THE DRAWINGS.
3. NO CLAIM SHALL BE MADE AT ANY TIME AFTER SUBMISSION OF A QUOTATION THAT THERE WAS ANY MISUNDERSTANDING OF THE TERMS AND CONDITIONS OF THE CONTRACT RELATING TO THE SITE CONDITIONS.
4. OBSERVE AND ENFORCE ALL CONSTRUCTION SAFETY MEASURES REQUIRED BY THE OCCUPATIONAL HEALTH AND SAFETY ACT, WCB, MUNICIPAL REGULATIONS, AND OTHER REGULATIONS GOVERNING CONSTRUCTION WORK. THE MOST STRINGENT REQUIREMENTS WILL APPLY.
5. ANY DAMAGES TO EXISTING SERVICES INCURRED BY THE CONTRACTOR DURING THE WORK SHALL BE REPAIRED AND/OR REPLACED TO THE ENTIRE SATISFACTION OF THE PARTIES CONCERNED AT THE CONTRACTORS EXPENSE.
6. BACKFILL SHALL NOT BE PLACED UNLESS SUBGRADE IS COMPLETELY FREE OF FROST.
7. DO NOT USE ANY MATERIAL WITHOUT APPROVAL FROM THE CONSULTANT.
8. MATERIALS SHALL BE PLACED IN LIFTS BY APPROVED EQUIPMENT, FOR FULL WIDTH OF THE EXCAVATION AS SHOWN ON THE DRAWINGS, AND COMPACTED TO 98% STANDARD PROCTOR DRY DENSITY.
9. MATERIAL SHALL BE MOISTENED OR DRIED AS REQUIRED FOR MAXIMUM DENSITY AND THOROUGHLY COMPACTED BY MECHANICAL VIBRATORS CAPABLE OF PRODUCING REQUIRED COMPACTION.

TECHNICAL NOTES:

1. THE DESIGN DETAILS PRESENTED ARE INTENDED TO PROVIDE ENHANCED EROSION PROTECTION FOR THE DOWNSTREAM FACE OF THE WEST DYKE, AS PER RECOMMENDATIONS MADE IN THE TROW GEOTECHNICAL
   REPORT (OTGE00D16794A) DATED OCT 8/2003.
2. THE EROSION CONTROL MEASURES ARE CONSIDERED TEMPORARY. LAGOON TO BE INSPECTED ANNUALLY.
3. PREVENTION OF OVERTOPPING OF THE LAGOON IS REQUIRED TO ENSURE CONTINUED SLOPE STABILITY.
   CONTINUIING TO OPERATE THE LAGOON AT MINIMAL LEVELS AND CONTROLLING THE AMOUNT OF DISCHARGE USING THE CONTROL STRUCTURE CAN PREVENT OVERTOPPING.

NO	REVISION / ISSUED TO	DATE
3	ISSUED FOR TENDER	JUNE. 22/06
2	ISSUED FOR TENDER	JUNE. 15/06
1	ISSUED FOR CLIENT REVIEW	JUNE. 2/06

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CLIENT NAME: CITY OF IQALUIT
PROJECT ADDRESS: CITY OF IQALUIT NUNAVUT
DRAWING TITLE: EXISTING WEST DYKE ELEVATION
PROJECT NAME: SEWAGE LAGOON WEST DYKE UPGRADES

DESIGN	R.A.H.
DRAWN	C.Y
APPROV.	A.D.M.
SCALE	AS NOTED
DATE	OCT/2005
PROJECT NO.	05-1292

DWG. NO. SK2
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Emergency Preparedness Plan

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Emergency Preparedness Plan

Currently an Emergency Preparedness Plan (EPP) does not exist and is not required in Concentric's professional opinion.

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Reserved

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