

MMM Group Limited  
Suite 111-93 Lombard Avenue  
Winnipeg, MB R3B 3B1  
t: 204.943.3178 | f: 204.943.4948  
[www.mmm.ca](http://www.mmm.ca)

February 1, 2010

Ref. No. 5509123.000.710

Mr. Terry Holding, C.E.T., Project Coordinator  
City of Winnipeg, Water & Waste Department  
Engineering Division  
110 – 1199 Pacific Avenue  
Winnipeg MB R3E 3S8

Dear Mr. Holding:

**Re: NEWPCC Digester Number 11 – Condition Assessment of Roof**

MMM Group Limited (MMM) is pleased to present this condition assessment report of the cast-in-place two way concrete roof slab of Digester 11 at the North End Water Pollution Control Centre (NEWPCC).

**Background**

MMM met with City personnel on Tuesday, December 1, 2009 to discuss the condition of the roof of Digester Number 11 (originally designated Digester 9 on the as-built drawings). It was reported that early in the morning of Sunday, November 29, 2009 the following observations were made regarding Digester Number 11 by City site personnel:

- The surface of the roof had risen approximately 0.9 m to 1.2 m (3 to 4 feet) near the centre;
- Digester sludge was leaking from various places on its outer shell;
- Significant damage was observed to the roof top piping;
- The Pressure Relief Valve (PRV) at the centre of the structure was venting, meaning that the biogas pressure was at or above high set point;
- Gauges indicated an internal pressure of at least 3.5 kPa; and
- Two hours after the event, the majority of the deformation had dissipated.

Access to the rooftop of the Digester was subsequently restricted by the City for safety reasons.

We were advised that a similar event had occurred approximately 10 years ago at Digester 12 (originally designated Digester 11 on the as-built drawings). Significant damage to the roof was reported, such that it was subsequently overlaid with another concrete slab.

MMM was asked to review the drawings, review the site observation statements and visit the site in order to provide an immediate structural assessment of the situation, given the facts at the time.

MMM visited the site the afternoon of Tuesday, December 1 and had these observations:

- While walking on the pavers in the immediate vicinity of the Digester roof, the sensation of standing on a balloon or bladder was noticed, indicating that the digester sludge was between the roof membrane and the roof;
- The roof piping was damaged in such a way that indicated that the surface piping moved upward relative to the deck;
- The roof deformation appeared to have subsided significantly since the original event, based on damage noticed on the piping; and
- Drawings indicate that the roof of the 33.5 m (110') inside diameter Digester is composed of the following:
  - 50 mm (2") thick unit concrete pavers on bearing pads, measuring 610 mm x 760 mm (24" x 30");
  - Rigid insulation;
  - Roofing membrane;
  - Light weight concrete insulation (containing vermiculite) varying in thickness from 150 mm near the centre to 75 mm near the perimeter of the roof; and
  - 230 mm (9") thick cast-in-place reinforced concrete slab supported by the 610 mm (2') thick exterior walls and 16 – 508 mm (20") diameter concrete columns on a 6.7 m (22') grid, with 1.52 m (5') diameter capitals.

MMM advised that the safety of the roof could not be assured and recommended that access to the roof be restricted to those with full fall arrest measures. It was recommended that the roofing be removed so that direct observation of the roof slab could be made.

MMM surveyed the top of the roof pavers on December 4, 2009 to record the event and also to estimate the maximum deformation of the roof based on piping damage. The results of this survey can be seen on the attached drawing 5509123-C-01.

FWS Group was retained by the City to remove the roofing so that the concrete roof slab could be visually inspected by MMM.

Removal of the roofing started on December 16, 2009 and was completed on January 21, 2010.

MMM inspected the surface of the roof on January 22, 2010 with the following observations made:

- Numerous cracks were observed ranging in width from hairline to 6 mm. These cracks appear to have been created years ago. A drawing indicating the mapped cracks is attached (dwg. 5509123-C-02);
- Several spalls were observed in the surface of the roof; and
- The concrete at the location of the larger cracks is displaced vertically relative to each side of the crack. (i.e. the concrete is dropped on one side of the crack). These measurements are also shown on the attached drawing.

**Discussion**

It is apparent that the internal pressure of Digester 11 exceeded the capacity of the containment system resulting in the discharge of the digester sludge through openings in the roof slab onto the surface of the roof slab, beneath the membrane.

The following table demonstrates the pressures needed to raise portions of the roof, assuming that the roof membrane remained intact:

Item	Pressure Needed To Lift It
2' roof pavers	1.2 kPa
2" roof pavers and a 200 lb person on a 24" x 30" paver	3.1 kPa
2" roof pavers, insulation and 9" thick concrete roof (not considering connectivity to the walls and columns, which is unrealistic)	6.7 kPa

As noted earlier, the observed pressure was a minimum of 3.5 kPa.

It is our belief that the roof of the Digester did not lift off of the columns, but rather that the roof membrane was lifted off of the roof, causing the appearance that the roof had lifted.

The extensive hairline cracking appears to have been caused by concrete shrinkage, whereas the larger cracks appear to be as a result of structural failure of the slab (see photos below).





This failure was likely the result of over pressurization of the interior of the digester that caused a stress reversal of the concrete slab so that a negative bending was induced into the middle strip region that was designed only for positive bending.

**Conclusions and Recommendations**

The following recommendations are provided qualified by the fact that only the surface of the roof has been inspected. There have been no material testing performed on the concrete to determine its strength, nor has the condition of the reinforcing steel been determined. We recommend that the underside of the roof be inspected and that material testing be performed in order to obtain a more thorough understanding of the structure.

It is our opinion that the roof slab has failed along a middle strip roughly concentric about the centre of the digester. We recommend that no additional load be applied to the failed area shown on the attached drawing 5509123-C-03. Access to the interior of the digester is allowed only if the indicated area remains unloaded (i.e. no snow loading, water loading, etc.).

It is also recommended that any heavy point loads that must be placed on the roof be located directly over column locations.

If you have any questions or comments, please call me at 943-3178.

Regards.

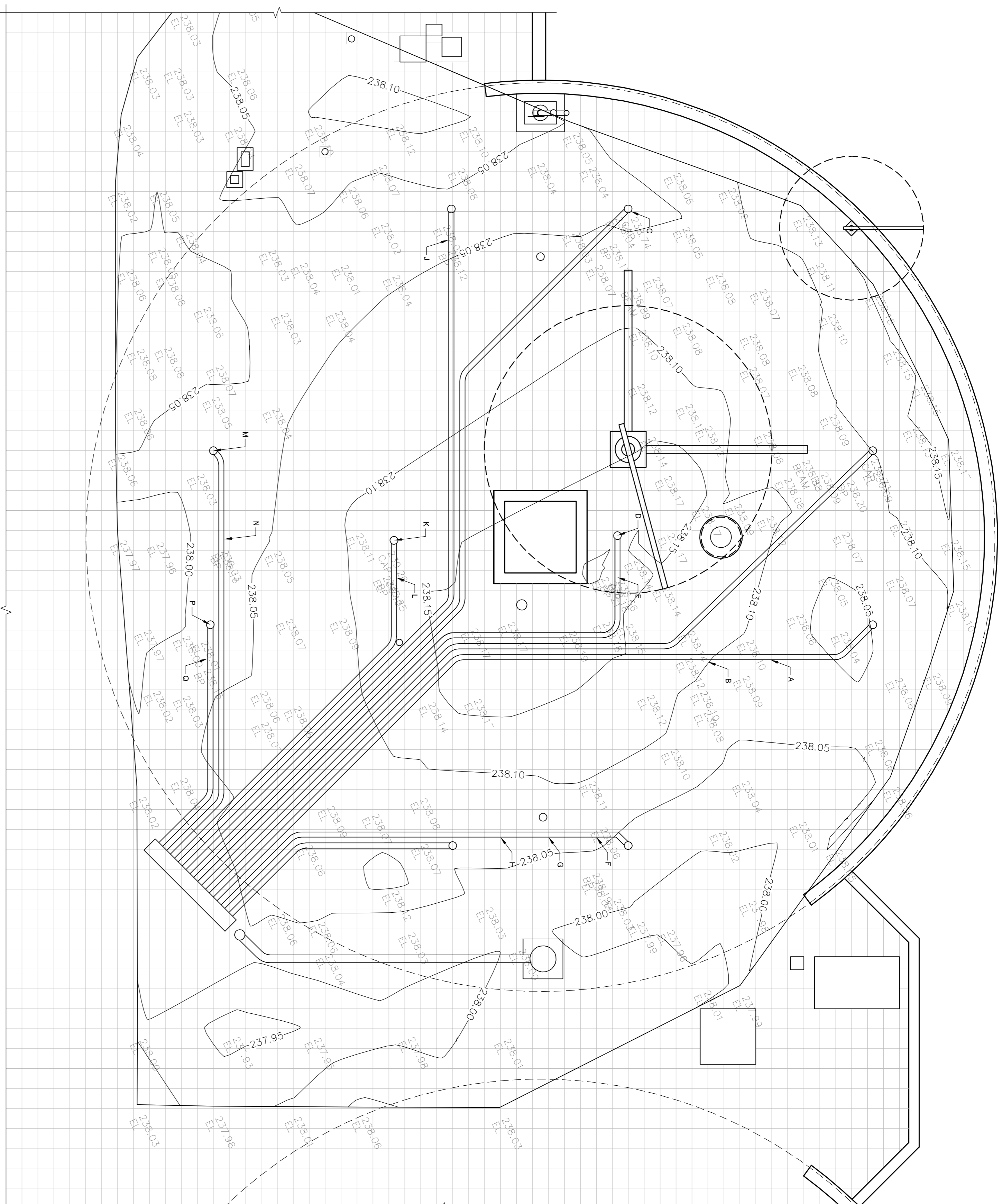
**MMM Group Limited**



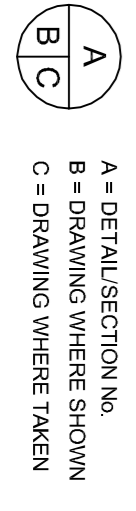
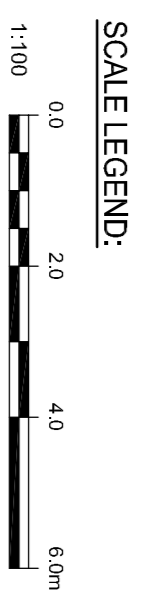
Jim Lukashenko, P. Eng.  
Manager, Bridges and Structures

JL/dt  
5509123 100129 NEWPCC Dig 11 Condition Assessment

NOTE  
 All elevations are provided for the use and by the user, who should verify the design professional has reviewed the elevation and there are no representations of data that made by the design professional in any part with whom the design professional has not reviewed the elevation.



DIGESTER #11 - PAVES SURVEY PLAN  
 1:100

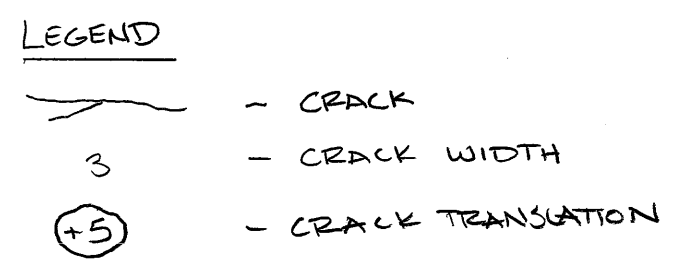
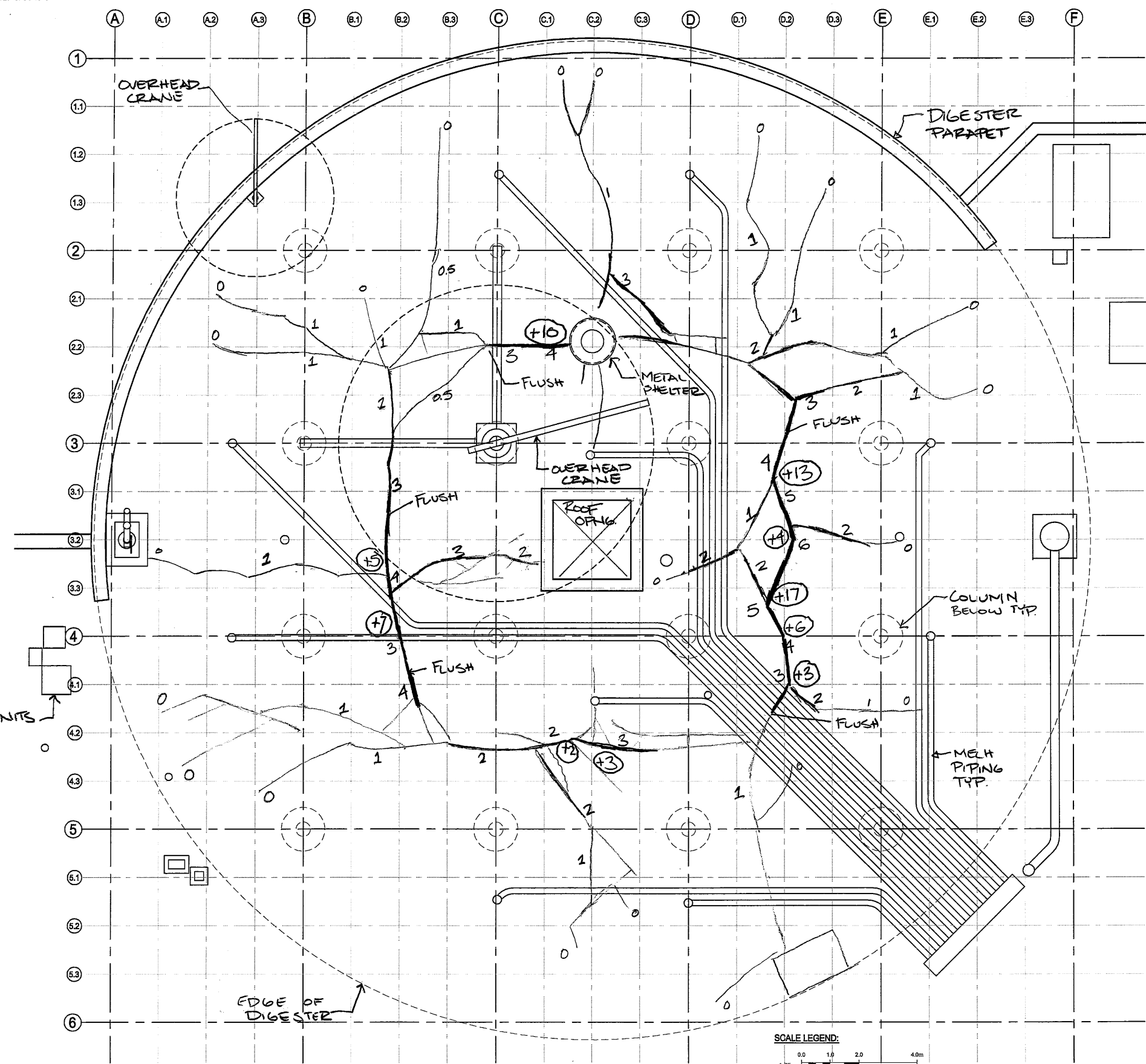


METRIC  
 WHOLE NUMBERS INDICATE MILLIMETRES  
 DECIMALIZED NUMBERS INDICATE METRES

LOCATION	'A'
A	75mm
B	75mm
C	100mm
D	500mm
E	480mm
F	125mm
G	100mm
H	75mm
J	60mm
K	50mm
L	125mm
M	100mm
N	75mm
P	75mm
Q	75mm

'A' equals the measured girth of mechanical piping base on field observation of damage, measured on December 4, 2009.

				ENGINEER'S SEAL	
1111 - 93 Lombard Ave Winnipeg, MB R2B 3B1 1.204.943.3178   204.943.4848 www.mmm.ca		DESIGNED BY: - DRAWN BY: C.J.L. CHECKED BY: - APPROVED BY: J.P.L.		RELEASED FOR CONSTRUCTION: - ORIGINAL SIGNED BY: - BIO OPPORTUNITY: - PLOT DATE: -	
NO. 0 REVISIONS		ISSUED FOR INFORMATION: 09.12.16 DATE: 09.12.16 BY: J.P.L.		AS NOTED AS NOTED DATE: 09.12.16	
CONSULTANT DRAWING NO.: 5509123-C-01		SHEET 1 OF 1		CITY DRAWING NO.: -	
THE CITY OF WINNIPEG WASTE AND WATER DEPARTMENT		NORTH END POLLUTION CONTROL CENTRE DIGESTER #11 ROOF REPAIR		PAVES SURVEY PLAN - DECEMBER 4, 2009	

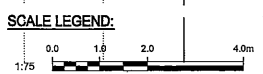


**FOR INFORMATION PURPOSES ONLY**  
JANUARY 25, 2010

**DIGESTER #11 - ROOF SURFACE CRACK MAP**  
OBSERVED ON JANUARY 22/2010  
BY CARLIN LETKEMAN (MMM GROUP) A/C

A = DETAIL SECTION No.  
B = DRAWING WHERE SHOWN  
C = DRAWING WHERE TAKEN

**METRIC**  
WHOLE NUMBERS INDICATE MILLIMETRES  
DECIMALIZED NUMBERS INDICATE METRES

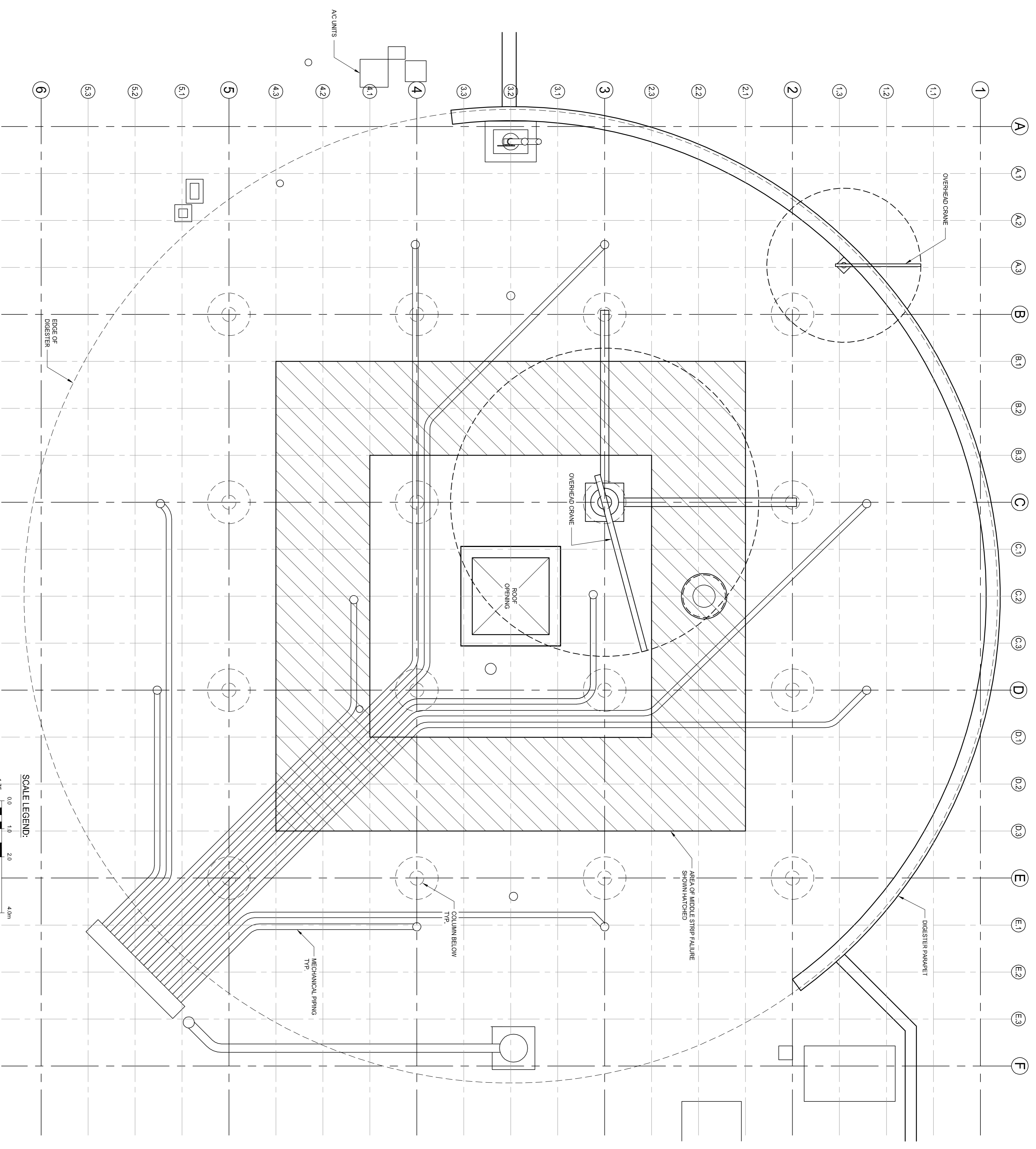


<b>MMM GROUP</b>		MMM Group Limited Suite 111 - 93 Lombard Ave. Winnipeg, MB R3B 3S1 T. 204.943.3176   F. 204.943.4868 www.mmm.ca	
DESIGNED BY	-	CHECKED BY	-
DRAWN BY	C.J.L.	APPROVED BY	J.P.L.
HOR. SCALE	AS NOTED	RELEASED FOR CONSTRUCTION	ORIGINAL SIGNED BY
VERT. SCALE	AS NOTED		
No.	REVISIONS	DATE	BY
		10.01.20	
		10.01.20	

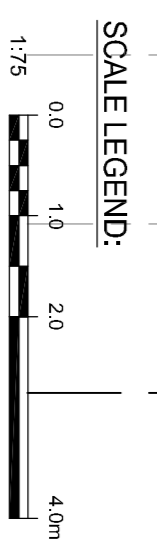
 <b>THE CITY OF WINNIPEG</b> WASTE AND WATER DEPARTMENT	<b>NORTH END POLLUTION CONTROL CENTRE</b> <b>DIGESTER #11</b> <b>ROOF REPAIR</b> ROOF PLAN - JANUARY 25, 2010
ENGINEER'S SEAL BID OPPORTUNITY: - PLOT DATE: -	CONSULTANT DRAWING No.: 5509123-C-01 SHEET 1 OF 1 CITY DRAWING No.:

Last saved January 26, 2010 - 10:38 AM by LETKEMAN  
 P:\5509123\5509123-000 REV\FCC Digester #11 Roof Plan\_100119.dwg

NOTE:  
 These design documents are prepared solely for the use by the party with whom the design professional has entered into a contract and there are no representations of any kind made by the design professional to any party with whom the design professional has not entered into a contract.



**DIGESTER #11 - ROOF PLAN**  
 1/75



NOTE  
 All dimensions are provided unless otherwise noted. The design professional has reviewed this drawing and there are no representations of data made by the design professional in any part with which the design professional has not reviewed or created.

A - DETAIL SECTION NO.  
 B - DRAWING WHERE SHOWN  
 C - DRAWING WHERE TAKEN

METRIC  
 WHOLE NUMBERS INDICATE MILLIMETRES  
 DECIMALIZED NUMBERS INDICATE METRES

NO.	REVISIONS	DATE	BY	DATE	VERT. SCALE	AS NOTED	RELEASED FOR CONSTRUCTION	ORIGINAL SIGNED BY	BIO OPPORTUNITY	PLAT DATE
-	-	-	-	-	10.02.01	AS NOTED			-	-

**MMM GROUP**  
 Suite 111 - 83 Lombard Ave.  
 Winnipeg, MB R3B 3B1  
 1.204.943.3178 | 204.943.4848  
 www.mmm.ca

ENGINEER'S SEAL

**THE CITY OF WINNIPEG**  
 WASTE AND WATER DEPARTMENT

NORTH END POLLUTION CONTROL CENTRE  
**DIGESTER #11**  
**ROOF REPAIR**  
 MIDDLE STRIP FAILURE PLAN - FEB 1, 2010

**FOR INFORMATION PURPOSES ONLY**  
**FEBRUARY 1, 2010**

CONSULTANT DRAWING NO.: 5509123-C-03  
 SHEET 3 OF 3  
 CITY DRAWING NO.: SK-3