APPENDIX B

Pipeline Loading Assessments, Fort Garry/St. Vital Feedermain Bishop Grandin at Pembina Highway

AECOM
99 Commerce Drive
Winnipeg, MB, Canada R3P 0Y7
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204 477 5381 tel
204 284 2040 fax

July 21, 2010

Project No. 60150576 (4.2)

VIA E-MAIL (JacksonWT@mmm.ca)

Wally Jackson, P. Eng.
Project Engineer
MMM Group Limited
111-93 Lombard Avenue
Winnipeg, MB R3B 3B1

Dear Mr. Jackson:

Regarding: Pipeline Loading Assessments, Fort Garry/St. Vital Feedermain – Bishop Grandin at Pembina Highway

As per your request, we have reviewed the impact of the active transportation path near the intersection of Bishop Grandin and Pembina Highway, overtop of the Fort Garry/St. Vital Feedermain. We believe that the proposed construction can be performed safely, subject to the recommendations and construction limitations noted herein.

This report does not address the existing condition of the Fort Garry/St. Vital Feedermain to withstand additional loading. All findings within this report assume the existing Feedermain is in good condition and capable of functioning within the original design intent.

Based on the information provided, we believe that the work can be undertaken with the feedermain in service; however, the work needs to be very carefully implemented to minimize the possibility of initiating a feedermain failure. It is extremely important to delineate the feedermain location in the field accurately, to construct the works to grades noted, and to preclude the temporary storage of materials over the feedermain.

Discussions with the Water Services Division of the Water and Waste Department will be required to get final approval for these recommendations. While we can and will secure approval in concept at this time, some of the risk considerations are dependent on other activities that may be taking place on the Regional Water System and, therefore, the recommendations noted herein will need to be reviewed once the actual timing for construction has been finalized.

As noted above, when construction is carried out it is critical that the controls noted herein be implemented by your staff and the Contractor (and any Subcontractors) and that all personnel at the site be made cognizant of the significance of working in close proximity to the feedermain. A feedermain failure would be catastrophic (prestressed concrete pipe typically fails in a non-ductile mode) with the potential to cause extensive damage to infrastructure in the area and adjacent properties.

Data Collection and Review

In order to complete the analysis, we reviewed the following information:

- Original construction record drawings as provided by the City of Winnipeg WWD (attached in Appendix A):
    - Drawing D-1646 and D-1647
- Original pipe specification sheets from Canron (Hyprescon), as provided by the City of Winnipeg (attached in Appendix B)
- Original Pipe Laying Schedules, as provided by the City of Winnipeg (attached in Appendix B)
- Proposed construction drawings for work overtop the Fort Garry/St. Vital Feedermain, as provided by Mr. Wally Jackson. (attached in Appendix C)
- AWWA Standard C301-84 - Prestressed Concrete Pressure Pipe, Steel-Cylinder Type
- AWWA Standard C301-07 - Prestressed Concrete Pressure Pipe, Steel-Cylinder Type

The affected portion of Fort Garry/St. Vital Feedermain was constructed in 1988 as part of the Bishop Grandin / Pembina Highway interchange project. The pipe is a 750 mm (30") Prestressed Lined Cylinder Pipe manufactured by Canron (Hyprescon). The feedermain pipe was constructed in accordance to AWWA C301-84 and designed utilizing the "Cubic Parabola Design Method". The proposed active transportation path construction along Bishop Grandin will affect the feedermain just to the west of the CN Letellier Subdivision tracks and again near Pembina Highway.

For the purposes of this loading assessment we will designate the feedermain crossings as Crossing 1 and Crossing 2. Crossing 1 will denote the feedermain crossing nearest to Pembina Highway. Crossing 2 will denote the feedermain crossing just to the west of the CN Tracks.

Based on record information the pipe invert at Crossing 1 is 228.500 m. This corresponds to a top of pipe elevation of 229.340 m. The proposed construction drawings indicate an existing ground elevation at this location of approximately 232.900 m. This produces a final cover of 3.560 m (11.68') and a construction cover of 3.285 m (10.78') given a pavement structure of 0.275 m.

Based on record information the pipe invert at Crossing 2 is 228.787 m. This corresponds to a top of pipe elevation of 229.627 m. The proposed construction drawings indicate a pavement elevation of 232.710 m. This produces a final cover of 3.083 m (10.12') and a construction cover of 2.808 m (9.21') given a pavement structure of 0.275 m.

On review of design notes received from the City of Winnipeg, the pipe was designed with the following properties:

- P_o value of 200 psi. P_o is the internal pressure that exactly relieves compression in the pipe concrete core caused by prestressing wire.
- Working pressure P_w of 690 kPa (100 psi)
- Transient pressure allowance P_t of 344 kPa (50 psi)
- Prestressing wire area of A_y = 0.301 in^2/ lin.ft.
- W_o value of 6220 lbs/lin ft, which is nine tenths of the 3 edge bearing strength
- External loading conditions
    - Cover depth of 3.1 m (10')
    - HS20 live loading
    - Trench width 1.92 m (6.3')
    - Soil weight of 1925 kg/m^3 (120 lb/ft^3)
    - Load factor 1.5

Loading Analysis

The original design notes were reviewed and compared to the proposed conditions. The proposed end use and construction conditions appear to be consistent with the original design criteria.

The Fort Garry/St. Vital Feedermain typically operates under sustained pressures less than 80 psi. The current AWWA C304 standard requires a minimum transient allowance of the greater of 40 percent of the working pressure or 40 psi which should be an ample transient allowance in this portion of the feedermain network.

Live and dead loads were computed for the proposed path as well as construction cover conditions. In the original design, dead loads were calculated assuming a trench condition, with trench width equal to pipe outside diameter plus 0.6 m (2'). While this is a commonly used design criterion, experience suggests that control of trench width is difficult to achieve and trenches often exceed these design values, especially with veed out trenches. A more conservative criterion is a positive projection embankment load, using a Heger load distribution vertical arching factor of 1.4, which corresponds to a Type 2 ASCE Standard Installation. Live loads were computed using an AASHTO Alternate Tandem and HS20 design vehicle in passing mode.

Original project specifications, trench sections, and considerable experience in test excavations around local feedermains indicate that compacted sand was used in the embedment zone. Based on long term research of Heger, McGrath and others[1], a conservative bedding factor for this type of installation would be 1.9, consistent with what is commonly referred to as Class B bedding. Dead loading was calculated based on an assumed soil density of 120 lbs/ft^3 which is consistent with current standard design practice.

Analysis of the dead and live loads imparted on the pipe show that long term proposed loads exceed that of short term construction loads. This is due to the depth of cover and reduced influence of live loads at the depth of cover present. Because of this the long term loads were used in our loading assessment of the pipe.

Analysis of the 750 mm PCCP feedermain was done using a stress analysis method and checked with the cubic parabola method (original design method). **Figure 1** shows that the long term transient loading on the pipe for the first pipe crossing. The figure shows that the imparted loading on the pipe is well within its strength envelope. **Figure 3** shows the long term transient loading for the second crossing. The loading is also well within the strength envelope of the pipe.

Figure 3 shows the combined-load vs. depth of cover. On the graph the maximum dead load and combined loads are shown along with the final cover found at each site. The graph indicates that the pipe is sensitive to an increase in dead loading as at depths above 5.8 m (19') the dead load intercepts the pipes strength envelope. It is therefore important to limit additional cover and surcharge loading on the pipe. Loads presented in all figures are actual estimated loads.

Figure 3 also includes loading analysis for several typical types of construction equipment that may be utilized at this site. Due to the depth of cover found at this site the construction equipment does exceed the long term loading conditions. This information is provided as a guideline for potential contractors to assess equipment requirements for construction. Actual equipment used must be verified in terms of the recommendations provided below.

[1] *American Concrete Pipe Association, Concrete Pipe Technology Handbook – A Presentation of Historical and Current State-of-the-art Design and Installation Methodology, March 1993*

Figure 1 - Combined-Load Diagram for Crossing 1 (Long Term Loading)

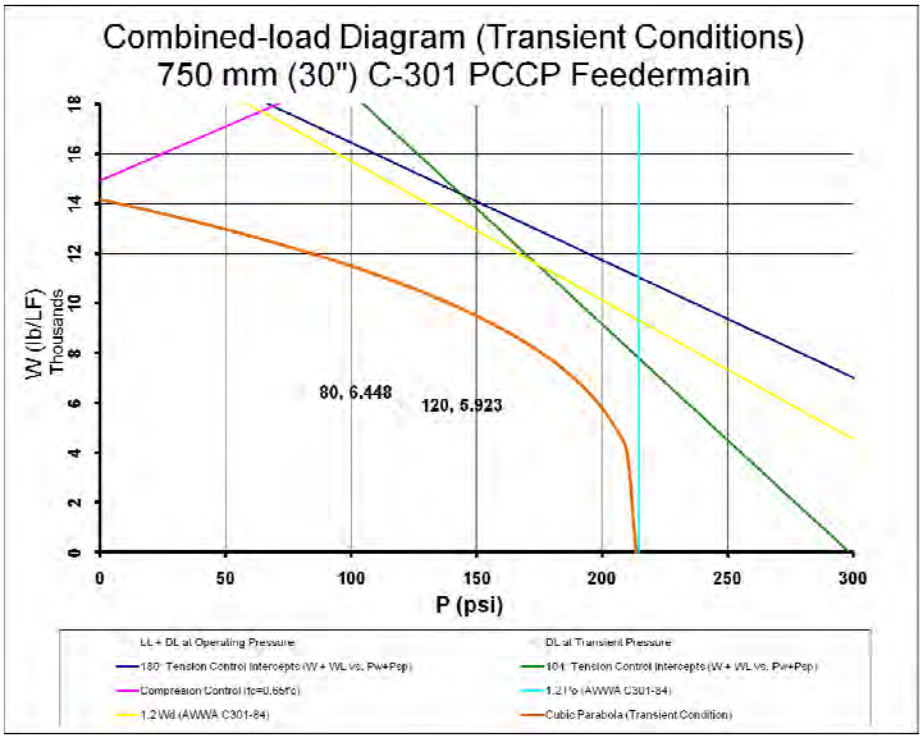


Figure 2 - Combined-Load Diagram for Crossing 2 (Long Term Loading)

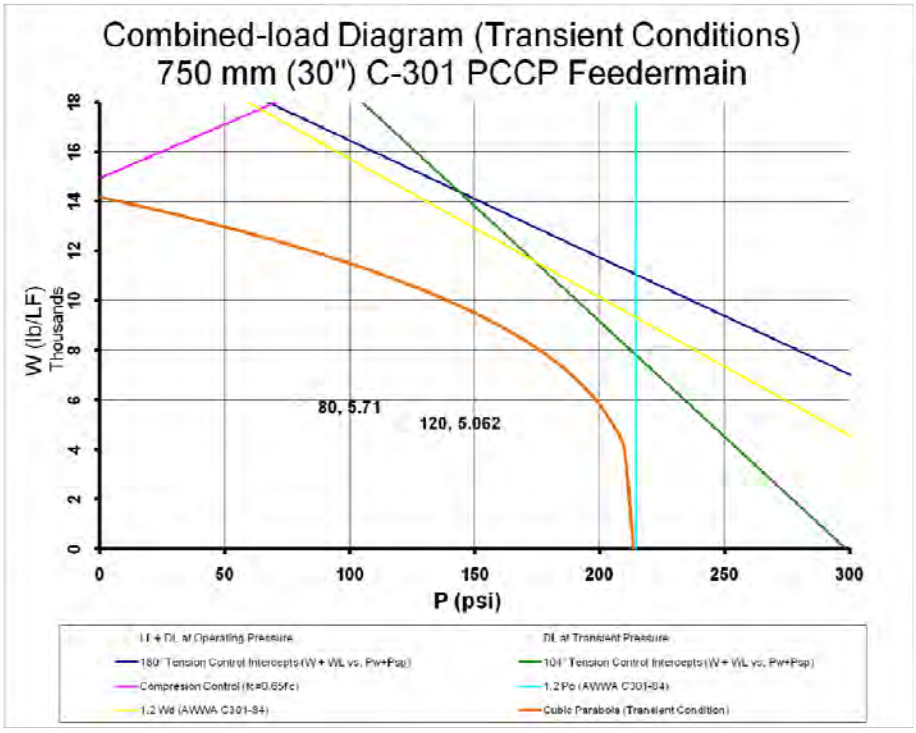
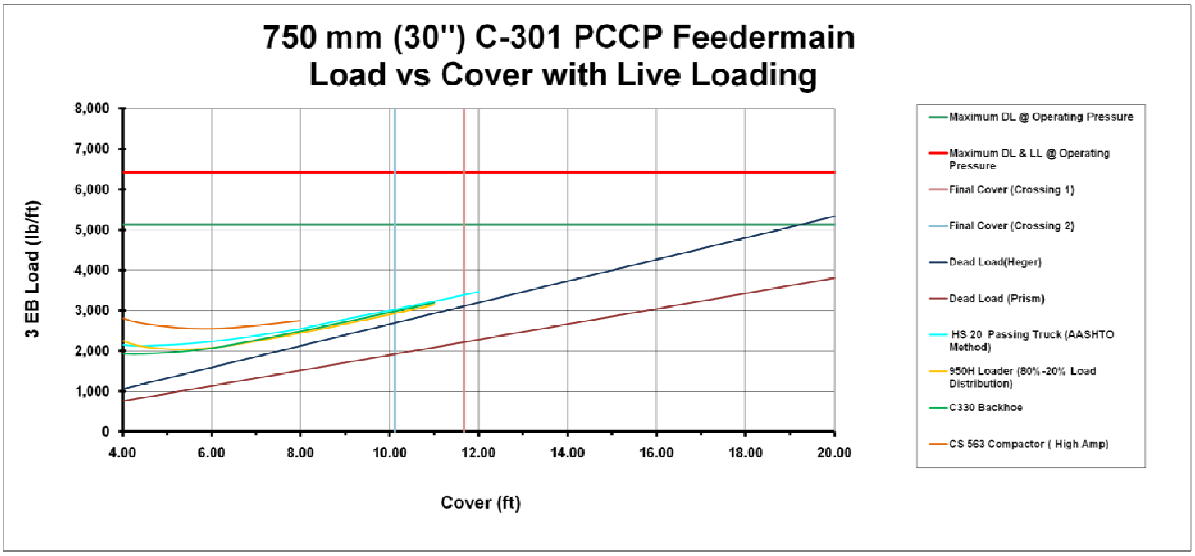


Figure 3 - Combined Load vs. Cover (750 mm C-301 Feedermain)



Thermal Protection and Frost Loading

The proposed construction does not change the pipe cover significantly. While cover over the pipe exceeds Winnipeg design standards, the replacement of soil with pavement and granular road base structure, combined with loss of potential winter snow cover will increase frost penetration at the site. However, due to the depth of cover, additional frost protection is not warranted.

Feedermain Operational Limitations

Due to the depth of cover over the feedermain, and the scope of the work, we do not believe that the feedermain is required to be taken out of service for construction, provided the construction monitoring and controls noted herein are adhered to. The applied loads to the feedermain during construction should be conservatively within the operating limitations for the pipe. Applied loads should be less than the applied loads during normal operations and, therefore, while there is reason to operate with an abundance of caution, there is not a technical reason to remove the feedermain from service to facilitate construction.

Construction Limitations and Recommendations

Based on the analysis completed, the proposed path construction should be able to be safely constructed, based on the live loads and earth covers noted above and subject to the following implementation recommendations:

Contractors carrying out repair work or working in close proximity to the Feedermain shall meet the following conditions and technical requirements:

1) Pre-work, Planning and General Execution

   a. No work shall commence at the site until the Construction Method Statement has been accepted and the Feedermain location has been clearly delineated in the field. The Method Statement is a submission from the contractor intended to describe

construction sequence and procedures, as well as demonstrate knowledge and conformance to these recommendations.

b. Contact the City of Winnipeg WWD Department, Construction Services Coordinator (Andy Vincent) prior to construction.

c. Work shall only be carried out with equipment that has been reviewed and quantified in terms of its loading implications by the Contract Administrator.

d. Vehicular traffic that is compliant to City of Winnipeg load restrictions will be permitted to cross the Feedermain once suitable granular subbase is in place that will adequately support loads without rutting. Feedermain crossings shall be temporarily constructed to the same grade as the proposed pavement.

e. For transverse crossings of the Feedermain in support of pavement construction activities, designate crossing locations and confine equipment crossing the pipe(s) to these locations. Reduce equipment speeds to levels that minimize the impacts of impact loading.

f. For construction work activities either longitudinally or transverse to the alignment of the Feedermain work only with equipment and in the manner stipulated in the accepted Construction Method Statement and the supplemental requirements noted herein.

g. Subgrade, subbase and base construction shall be kept in a rut free condition at all times. Construction equipment is prohibited from crossing pipelines until subbase is constructed and the grade is sufficient to support the equipment without rutting.

h. Granular material, construction material, soil or other material shall not be stockpiled on the pipelines or within 5 metres of the pipe centerline.

i. Where work is in proximity to the Feedermain, utilize construction practices and procedures that do not impart excessive vibration loads on the Feedermain or that would cause settlement of the subgrade below the Feedermain. Only single live loads will be permitted on the Feedermain at any one time until pavements are in place.

2) Excavation

a. Where there is less than 1.6 metres of earth cover over the Feedermain and further excavation is required either adjacent to or over the feedermain, utilize only smooth edged excavation buckets, soft excavation or hand excavation techniques.

b. Where there is less than 2.5 m of earth cover over the feedermain, offset backhoe or excavation equipment from Feedermain, a minimum of 3 m from Feedermain centerline, to carry out excavation.

c. Equipment should not be allowed to operate while positioned directly over the Feedermain.

3) Subgrade Construction

a. Subgrade compaction shall be limited to static compaction methods within 3 metres of the Feedermain and only with equipment that are well within the rated loading capacity of the Feedermain.

b. Stage work activities to minimize the time period that unprotected subgrade is exposed to the environment and protect the subgrade against the impacts of adverse weather if subbase/ base course construction activities are not sequential with excavation.

4) Subbase and Base Course Construction

   a. Subbase or base course materials shall not be dumped directly on pipelines but shall be stockpiled outside limits noted in these recommendations and shall be carefully bladed in-place.
   b. Subbase compaction shall be either carried out by static methods without vibration or with smaller approved equipment such as hand held plate packers or smaller roller equipment.

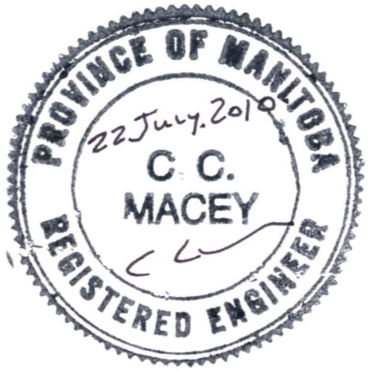
5) The Contractor shall ensure that all work crew members understand and observe these requirements. Prior to commencement of on-site work, the Contractor shall jointly conduct an orientation meeting with the Contractor Administrator with all superintendents, foremen and heavy equipment operators to make all workers on site fully cognizant of the limitations of altered loading on the Feedermain, the ramifications of inadvertent damage to the pipelines, the constraints associated with work in close proximity to the Feedermain and the specific details of the Construction Method Statement in instances where a Construction Method Statement is in effect.

6) Employees of the Contractor or any Subcontractor that fail to comply with the conditions for working in close proximity to the Feedermain shall be promptly removed from the Site.

We trust this information meets your requirements on this matter. Should you have any queries or require further information or clarification, please do not hesitate to contact either the writer or Marv McDonald, C.E.T. of this office.

Sincerely,

AECOM Canada Ltd.



C.C. Macey, P. Eng.
Senior Technical Director - Water Infrastructure Management
chris.macey@aecom.com

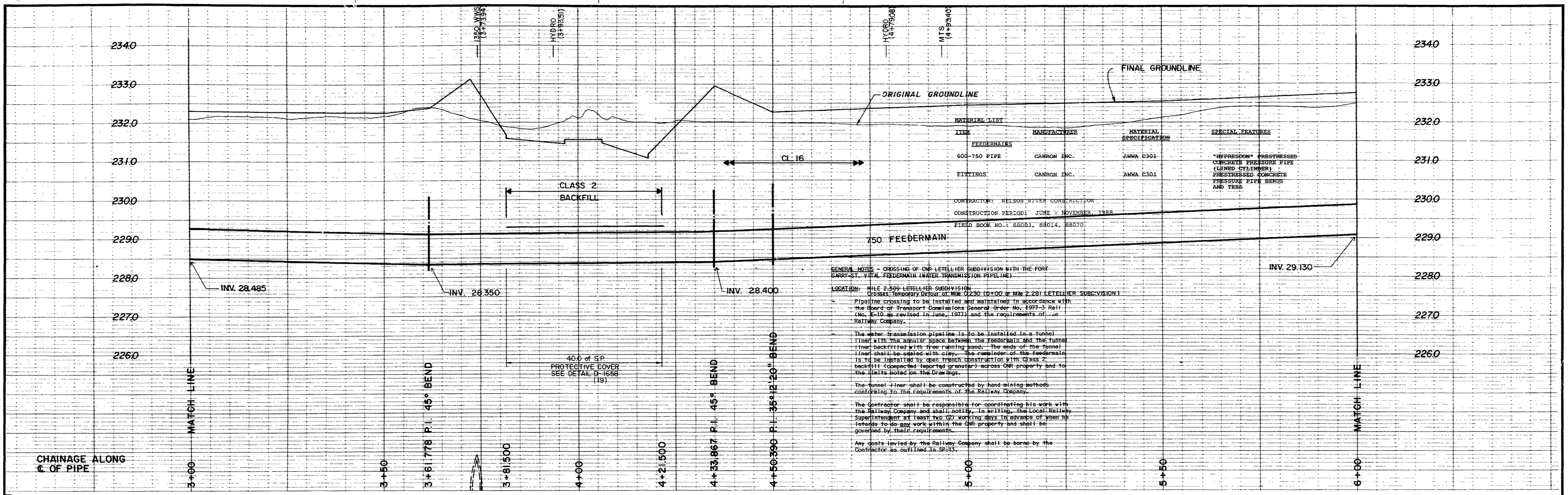
ADB/MGM/CCM.gms
Encl.

cc: R.A. Sorokowski/D. Griffin – WWD
A. Weremy/T. Josephson – WSD
K. Zurek/ A. Vincent– WWD Design & Construction
A. Braun, M.G. McDonald - AECOM

Appendix A

Feedermain Record Drawings

WO 102-84



MATERIAL LIST

ITEM	MANUFACTURER	MATERIAL SPECIFICATION	SPECIAL FEATURES
FEEDERMAINS			
600-750 PIPE	CANRON INC.	AWWA C301	"HYPRESCON" PRESTRESSED CONCRETE PRESSURE PIPE (LINED CYLINDER)
FITTINGS	CANRON INC.	AWWA C301	PRESTRESSED CONCRETE PRESSURE PIPE BENDS AND TEES

CONTRACTOR: NELSON RIVER CONSTRUCTION

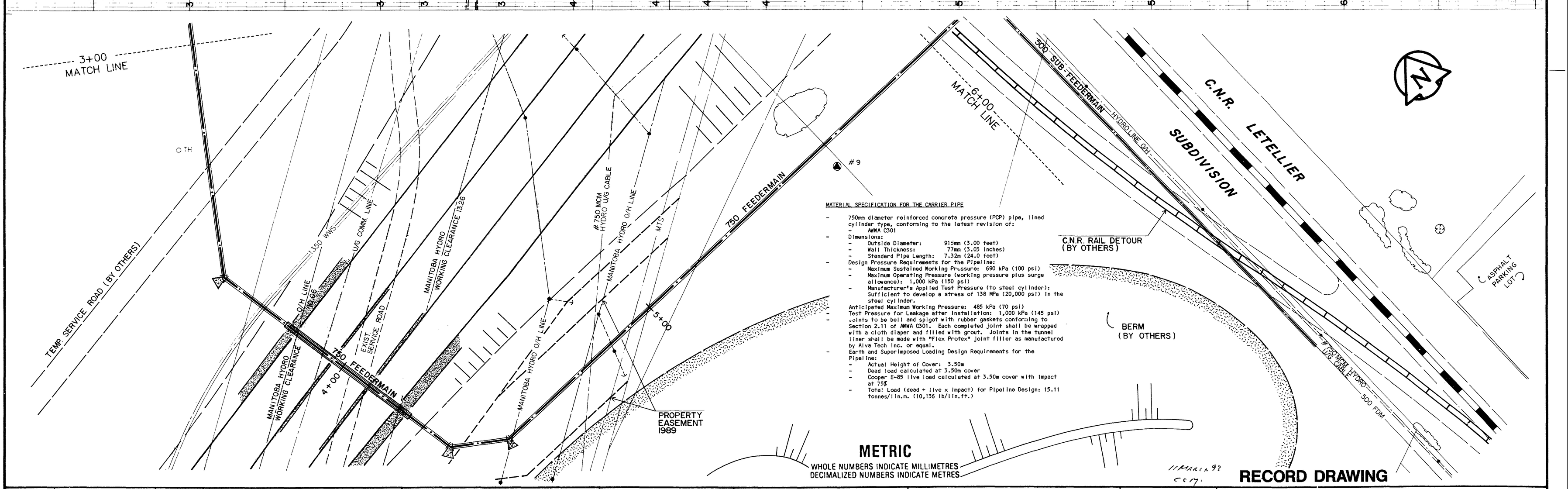
CONSTRUCTION PERIOD: JUNE - NOVEMBER, 1988

FIELD BOOK NO.: 88003, 88014, 88070

GENERAL NOTES - CROSSING OF CNR LETELLIER SUBDIVISION WITH THE FORT GARRY-ST. VITAL FEEDERMAIN (WATER TRANSMISSION PIPELINE)

LOCATION: MILE 2.509 LETELLIER SUBDIVISION
Crosses Temporary Detour at Mile 0.230 (0+00 of Mile 2.281 LETELLIER SUBDIVISION)

- Pipeline crossing to be installed and maintained in accordance with the Board of Transport Commissions General Order No. 1977-5 Rail (No. E-10 as revised in June, 1977) and the requirements of the Railway Company.
- The water transmission pipeline is to be installed in a tunnel liner with the annular space between the feedermain and the tunnel liner backfilled with free running sand. The ends of the tunnel liner shall be sealed with clay. The remainder of the feedermain is to be installed by open trench construction with Class 2 backfill (compacted imported granular) across CNR property and to the limits noted on the Drawings.
- The tunnel liner shall be constructed by hand mining methods conforming to the requirements of the Railway Company.
- The Contractor shall be responsible for coordinating his work with the Railway Company and shall notify, in writing, the Local Railway Superintendent at least two (2) working days in advance of when he intends to do any work within the CNR property and shall be governed by their requirements.
- Any costs levied by the Railway Company shall be borne by the Contractor as outlined in SP-15.



MATERIAL SPECIFICATION FOR THE CARRIER PIPE

- 750mm diameter reinforced concrete pressure (PCP) pipe, lined cylinder type, conforming to the latest revision of:
  - AWWA C301
- Dimensions:
  - Outside Diameter: 915mm (3.00 feet)
  - Wall Thickness: 77mm (3.03 inches)
  - Standard Pipe Length: 7.32m (24.0 feet)
- Design Pressure Requirements for the Pipeline:
  - Maximum Sustained Working Pressure: 690 kPa (100 psi)
  - Maximum Operating Pressure (working pressure plus surge allowance): 1,000 kPa (150 psi)
  - Manufacturer's Applied Test Pressure (to steel cylinder): Sufficient to develop a stress of 138 MPa (20,000 psi) in the steel cylinder.
- Anticipated Maximum Working Pressure: 485 kPa (70 psi)
- Test Pressure for Leakage after Installation: 1,000 kPa (145 psi)
- Joints to be bell and spigot with rubber gaskets conforming to Section 2.11 of AWWA C301. Each completed joint shall be wrapped with a cloth diaper and filled with grout. Joints in the tunnel liner shall be made with "Flex Protex" joint filler as manufactured by Alva Tech Inc. or equal.
- Earth and Superimposed Loading Design Requirements for the Pipeline:
  - Actual Height of Cover: 3.50m
  - Dead load calculated at 3.50m cover
  - Cooper E-85 live load calculated at 3.50m cover with impact at 75%
  - Total Load (dead + live x impact) for Pipeline Design: 15.11 tonnes/lin.m. (10,136 lb/lin.ft.)

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

11 MARCH 98 ccm

RECORD DRAWING

EXISTING	LEGEND-PLAN	PROPOSED	EXISTING	LEGEND-PLAN	PROPOSED	EXISTING	LEGEND-PROFILE	PROPOSED
150 mm W.M.	WATERMAIN	150 mm W.M.		HYDRO		150 mm W.M.	WATERMAIN	
	HYDRANT			M.T.S.			HYDRANT	
	VALVE			CONCRETE			VALVE	
300 mm L.D.S.	LAND DRAINAGE SEWER	300 mm L.D.S.		ASPHALT		300 mm L.D.S.	LAND DRAINAGE SEWER	300 mm L.D.S.
250 mm W.W.S.	WASTE WATER SEWER	250 mm W.W.S.		PROPERTY LINE		250 mm W.W.S.	WASTE WATER SEWER	250 mm W.W.S.
	MANHOLE			SURVEY BAR			℄ PROFILE	
	CATCH BASIN			SURVEY MONUMENT				
	CURB INLET							
	JUNCTIONS							
	CULVERT							
	GAS							

LOCATION APPROVED
UNDERGROUND STRUCTURES
J. MacVicar APR 15/88
SUPV U/G STRUCTURES COMMITTEE DATE

NOTE:
LOCATION OF UNDERGROUND STRUCTURES AS SHOWN ARE BASED ON THE BEST INFORMATION AVAILABLE BUT NO GUARANTEE IS GIVEN THAT ALL EXISTING UTILITIES ARE SHOWN OR THAT THE GIVEN LOCATIONS ARE EXACT. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION.

B.M. MONUMENT #9
ELEV. 232.445

NO	REVISIONS	DATE	BY
C	ADDED CONST'D GROUNDLINE	AUG/1992	bgd
B	REVISED TO RECORD DWG.	JAN6/89	bgd
A	Added General Notes	July 4/88	bgd

UMA Engineering Ltd.
Engineers & Planners
1479 Buffalo Place, Winnipeg, Manitoba, Canada R3T 1L7

DESIGNED BY FMI	CHECKED BY ccm. 15 April 98
DRAWN BY RN, WJd	APPROVED BY
HOR SCALE 1:500	RELEASED FOR CONSTRUCTION
VERTICAL 1:50	
DATE April 15/88	DATE

CONSULTANT DRAWING NO. 41-02-0265-240-02

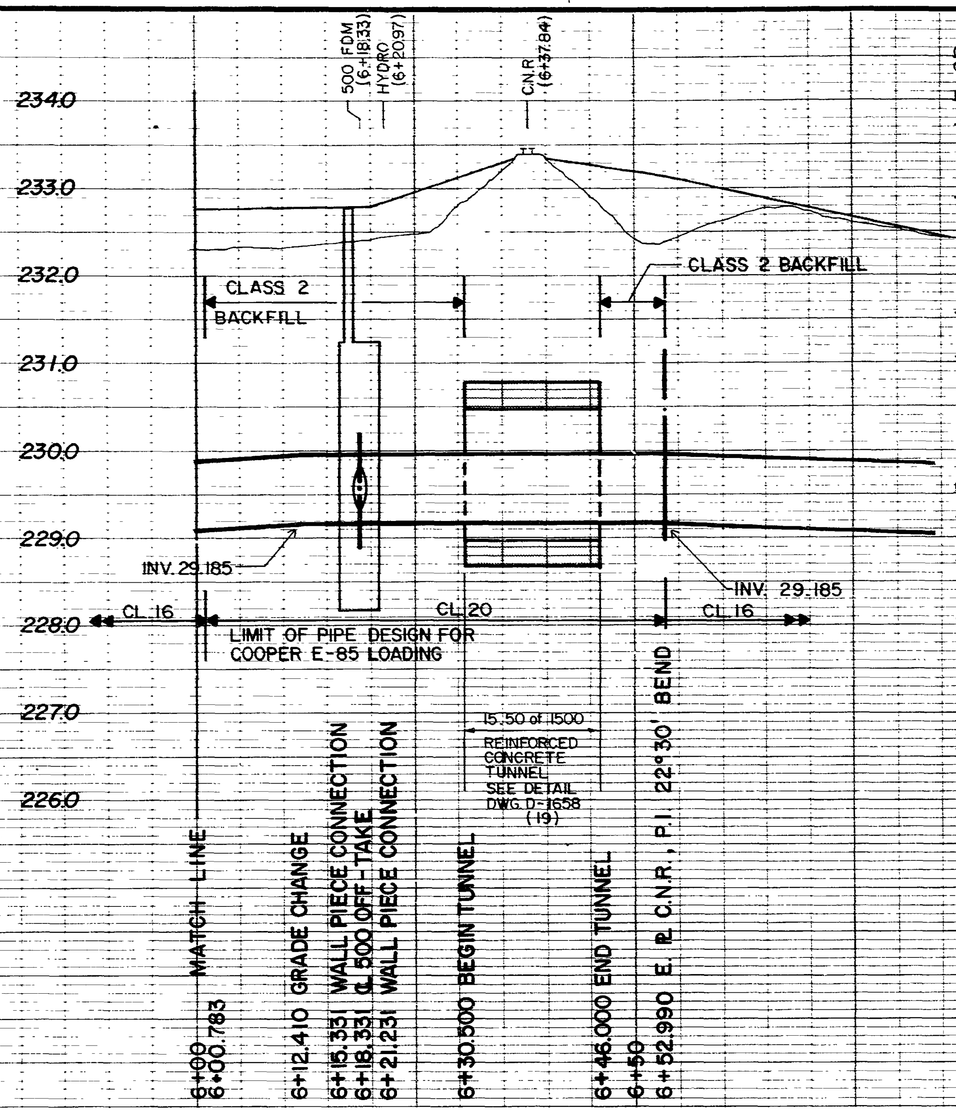
ENGINEER'S SEAL
PROVINCE OF MANITOBA
15 Apr 98
C.C. MACEY
ccm.
REGISTERED ENGINEER

THE CITY OF WINNIPEG
WORKS AND OPERATIONS DIVISION
WATERWORKS, WASTE & DISPOSAL DEPARTMENT

BISHOP GRANDIN BLVD. EXTENSION
FORT GARRY - ST. VITAL
FEEDERMAIN RELOCATION
STA. 3+00 TO STA. 6+00

CITY DRAWING NUMBER D-1646
SHEET 7 OF 24
07 C

WO 102-84



GENERAL NOTES - CROSSING OF CNR LETELLIER SUBDIVISION WITH THE FORT GARRY-ST. VITAL FEEDERMAIN (WATER TRANSMISSION PIPELINE)

LOCATION: MILE 2.50m LETELLIER SUBDIVISION
- Crosses Temporary Detour at Mile 0.230 (0+00 at Mile 2.28 LETELLIER SUBDIVISION)

- Pipeline crossing to be installed and maintained in accordance with the Board of Transport Commissions General Order No. 1977-3 Rail (No. E-10 as revised in June, 1977) and the requirements of the Railway Company.

- The water transmission pipeline is to be installed in a tunnel liner with the annular space between the feedermain and the tunnel liner backfilled with free - - sand. The ends of the tunnel liner shall be sealed with clay. The remainder of the feedermain is to be installed by open trench construction with Class 2 backfill (compacted imported granular) across CNR property and to the limits noted on the Drawings.

- The tunnel liner shall be constructed by hand mining methods conforming to the requirements of the Railway Company.

- The Contractor shall be responsible for coordinating his work with the Railway Company and shall notify, in writing, the Local Railway Superintendent at least two (2) working days in advance of when he intends to do any work within the CNR property and shall be governed by their requirements.

Any costs levied by the Railway Company shall be borne by the Contractor as outlined in SP-15.

MATERIAL SPECIFICATION FOR THE CARRIER PIPE

- 750mm diameter reinforced concrete pressure (PCP) pipe, lined cylinder type, conforming to the latest revision of AWWA C301
- Dimensions:
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  - Wall Thickness: 77mm (3.05 inches)
  - Standard Pipe Length: 7.32m (24.0 feet)
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- Anticipated Maximum Working Pressure: 485 kPa (70 psi)
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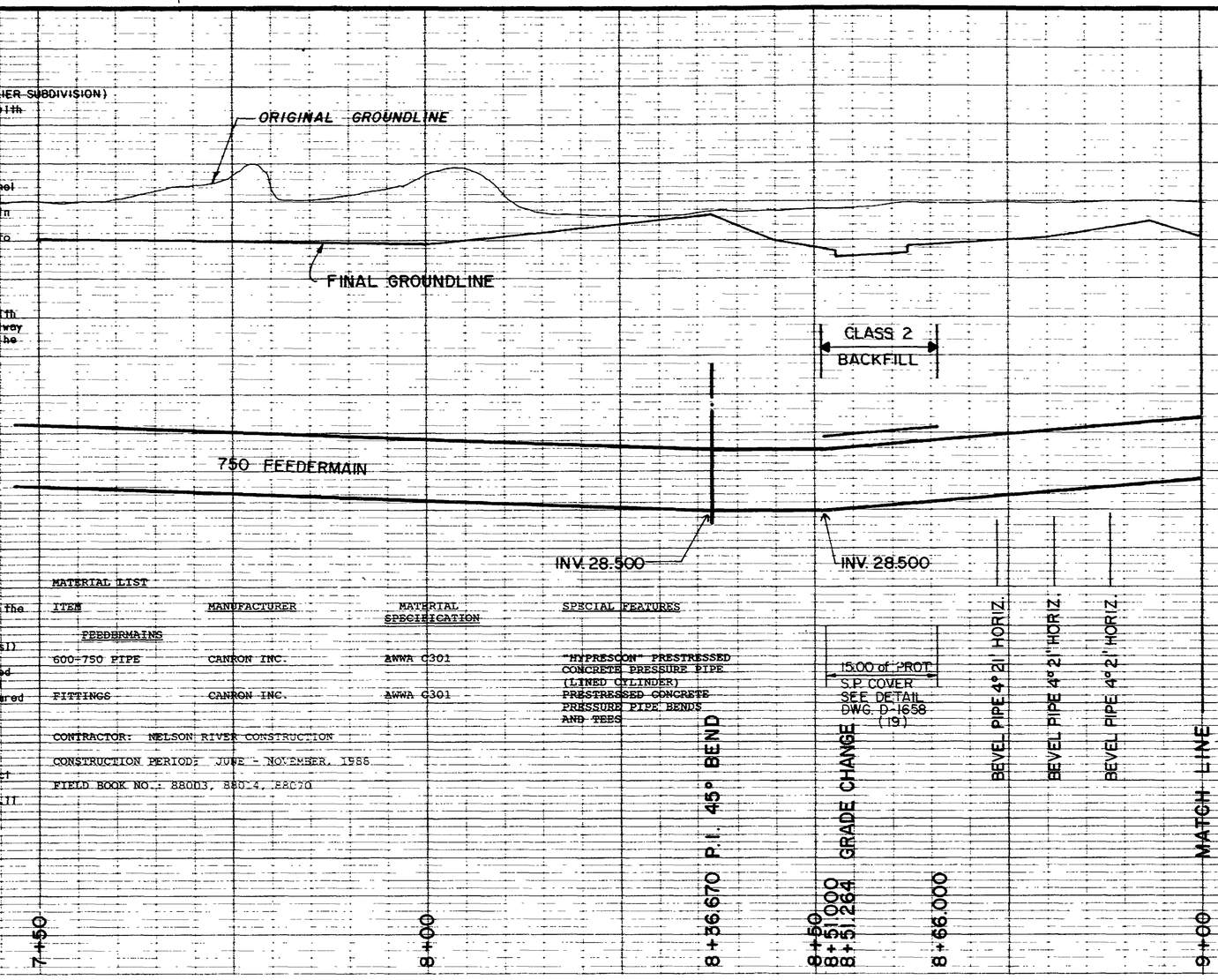

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FITTINGS -	CANNON INC.	AWWA C301 -	PRESTRESSED CONCRETE PRESSURE PIPE BENDS AND TEES

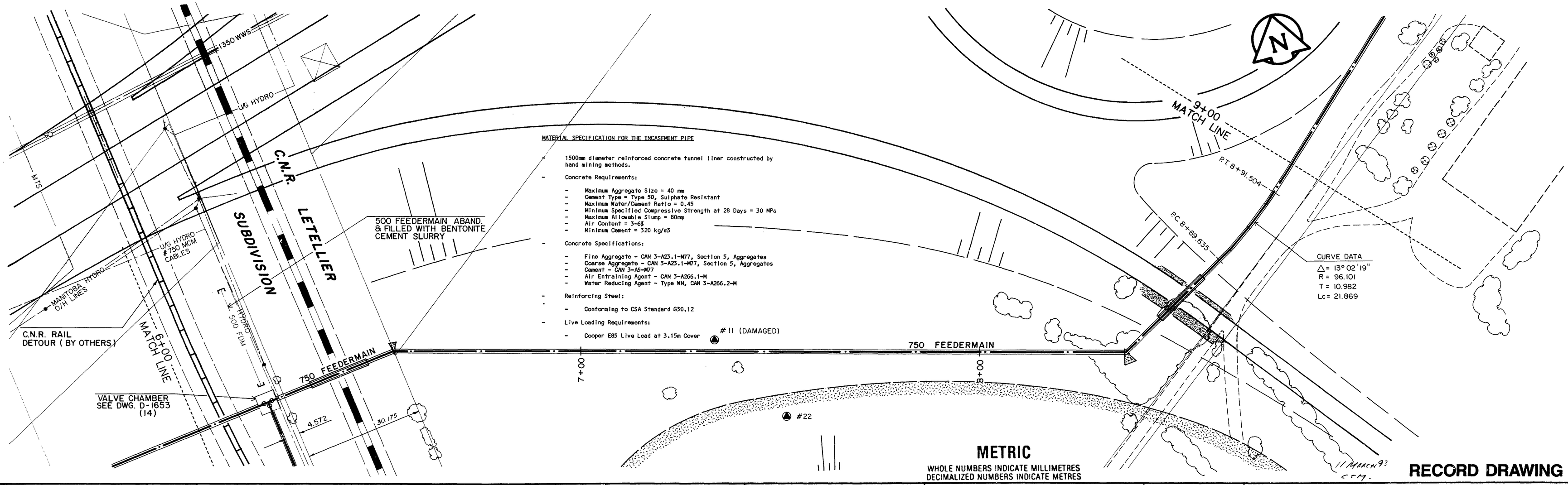
CONTRACTOR: NELSON RIVER CONSTRUCTION

CONSTRUCTION PERIOD: JUNE - NOVEMBER, 1988

FIELD BOOK NO.: BB003, BB014, BB018

MATERIAL SPECIFICATION FOR THE ENCASEMENT PIPE

- 1500mm diameter reinforced concrete tunnel liner constructed by hand mining methods.
- Concrete Requirements:
  - Maximum Aggregate Size = 40 mm
  - Cement Type = Type 50, Sulphate Resistant
  - Maximum Water/Cement Ratio = 0.45
  - Minimum Specified Compressive Strength at 28 Days = 30 MPa
  - Maximum Allowable Slump = 80mm
  - Air Content = 3-6%
  - Minimum Cement = 320 kg/m3
- Concrete Specifications:
  - Fine Aggregate - CAN 3-A23.1-M77, Section 5, Aggregates
  - Coarse Aggregate - CAN 3-A23.1-M77, Section 5, Aggregates
  - Cement - CAN 3-A5-M77
  - Air Entraining Agent - CAN 3-A266.1-M
  - Water Reducing Agent - Type WN, CAN 3-A266.2-M
- Reinforcing Steel:
  - Conforming to CSA Standard G30.12
- Live Loading Requirements:
  - Cooper E85 Live Load at 3.15m Cover



METRIC

WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

RECORD DRAWING

11 MARCH 93 CCM.

150 mm W.M.	WATERMAIN	150 mm W.M.		HYDRO		150 mm W.M.	WATERMAIN	
	HYDRANT			M.T.S.			HYDRANT	
	VALVE			CONCRETE			VALVE	
300 mm L.D.S.	LAND DRAINAGE SEWER	300 mm L.D.S.		ASPHALT		300 mm L.D.S.	LAND DRAINAGE SEWER	300 mm L.D.S.
250 mm W.W.S.	WASTE WATER SEWER	250 mm W.W.S.		PROPERTY LINE		250 mm W.W.S.	WASTE WATER SEWER	250 mm W.W.S.
	MANHOLE			SURVEY BAR			PROFILE	
	CATCH BASIN			SURVEY MONUMENT				
	CURB INLET							
	JUNCTIONS							
	CULVERT							
	GAS							
EXISTING	LEGEND-PLAN	PROPOSED	EXISTING	LEGEND-PLAN	PROPOSED	EXISTING	LEGEND-PROFILE	PROPOSED

LOCATION APPROVED
UNDERGROUND STRUCTURES
SUPV U/G STRUCTURES COMMITTEE — DATE

NOTE:
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B.M. MONUMENT #22
ELEV. 233.036

NO	REVISIONS	DATE	BY
C	ADDED CONST'D GROUNDLINE	AUG.8/92	bgd
B	REVISED TO RECORD DWG.	JAN.6/89	bgd
A	ADDED GENERAL NOTES	Jul 4/88	bgd

UMA Engineering Ltd.
Engineers & Planners
1479 Buffalo Place, Winnipeg, Manitoba, Canada R3T 1L7

DESIGNED BY FMI	CHECKED 15 April 88 BY C.C.M.
DRAWN BY RN	APPROVED BY
HOR SCALE 1:500 VERTICAL 1:50	RELEASED FOR CONSTRUCTION
DATE April 15/88	DATE

ENGINEER'S SEAL
PROVINCE OF MANITOBA
15 April 88
C.C. MACEY
C.C.M.
REGISTERED ENGINEER

CONSULTANT DRAWING NO.
41-02-0265-240-02

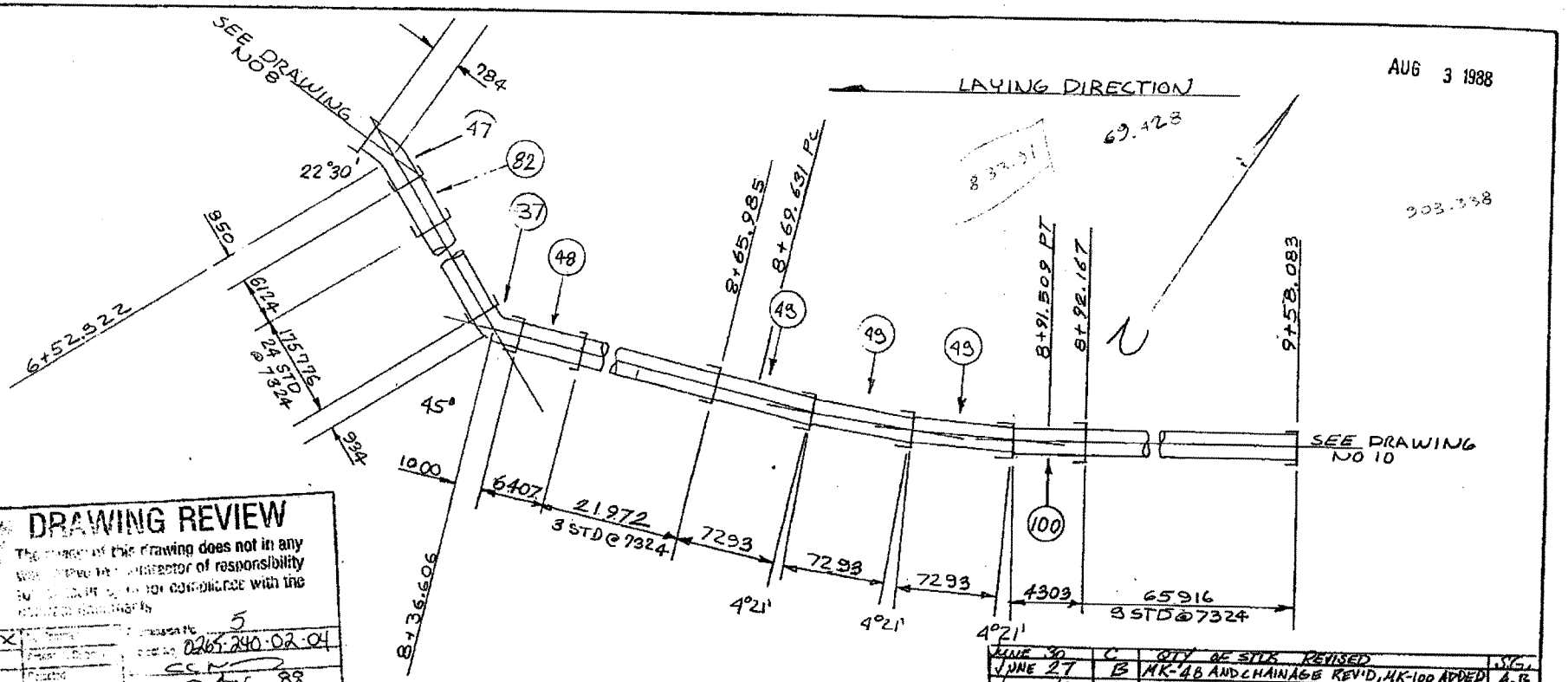
THE CITY OF WINNIPEG
WORKS AND OPERATIONS DIVISION
WATERWORKS, WASTE & DISPOSAL DEPARTMENT

BISHOP GRANDIN BLVD. EXTENSION
FORT GARRY-ST. VITAL
FEEDERMAIN RELOCATION
STA. 6+00 TO STA. 9+00

CITY DRAWING NUMBER D-1647
SHEET 8 OF 24
08 c

Appendix B

Pipe Design Notes



AUG 3 1988

DRAWING REVIEW

The [illegible] of this drawing does not in any [illegible] relieve the Contractor of responsibility [illegible] for compliance with the [illegible] requirements.

X	[illegible]	5
	[illegible]	0265-240-02-04
	Checked	CC M
	See Remarks	08 MAY 88

UMA ENGINEERING LTD.
1475 Buffalo Place, Winnipeg, Manitoba R3T 1L7

DATE	NO	REVISION	BY
JUNE 30	C	QTY OF STDS REVISED	SG
JUNE 27	B	MK-48 AND CHAINAGE REV'D, MK-100 ADDED	A.B
JUNE 14	A	GENERAL	

CANRON hyprescon®

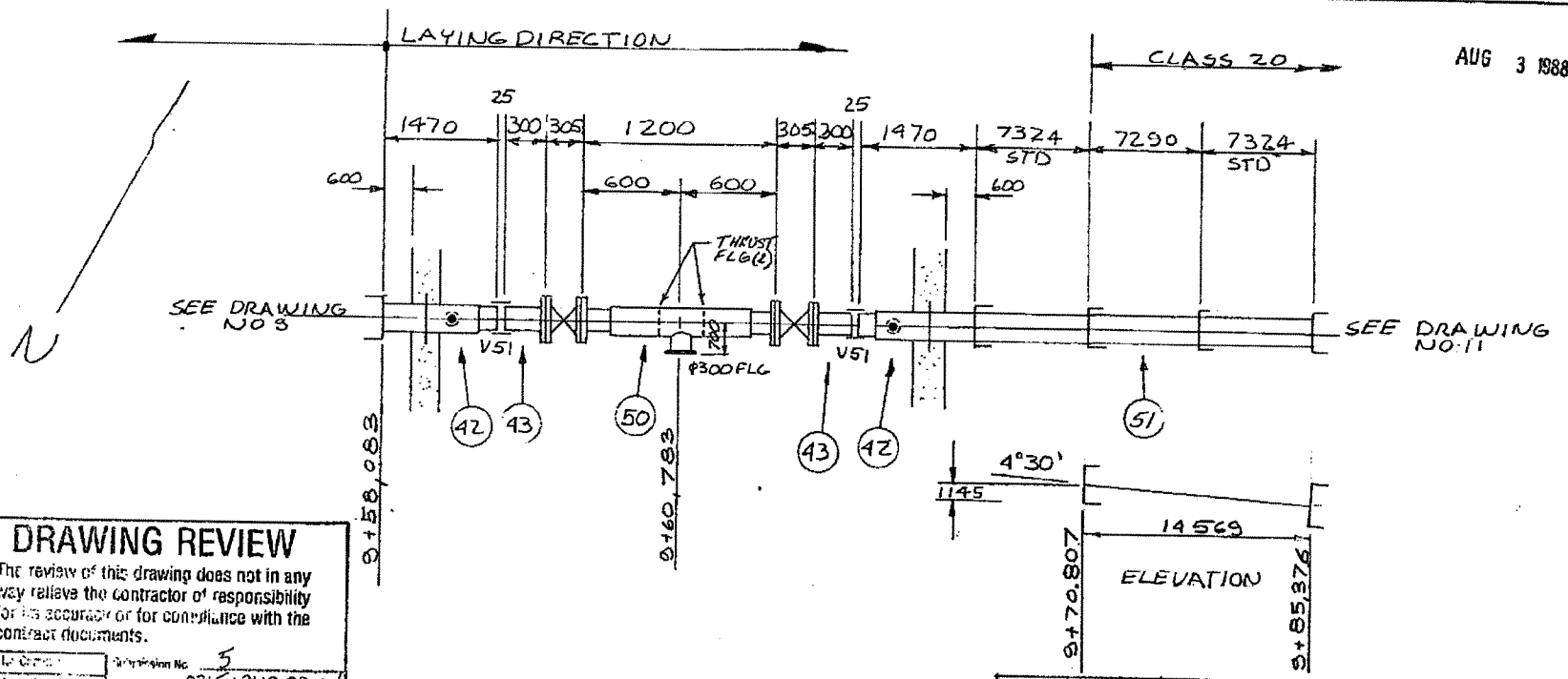
THE CITY OF WINNIPEG (88-86)

+750 FEEDER MAIN

SCALE: —— DATE: MAY 20 88

DRAWN	CHECKED	APPROVED	PROJECT	DWG.	REV.
[illegible]	[illegible]	[illegible]	46-3002	9	C

QTY.	MKno.	DIA.	DESCRIPTION	LENGTH	ENDS	REFERENCE
1	100	750	SHORT C-301(L) CL.16	4294	S&B	
1	82	750	SHORT C-301 (L) CL.16	6115	S&B	
3	49	750	BEVEL PIPE 4°21' AT SPIGOT	7282	S&B	C-30
1	48	750	SHORT C-301 (L) CL.16	*6398	S&B	
1	37	750	ELBOW 45°	1000x925	S&B	C-54
1	47	750	ELBOW 22°30'	850X775	S&B	C-29
36	STD	750	STD PIPE C-301 (L) CL.16	7315	S&B	46-3002-C



DRAWING REVIEW

The review of this drawing does not in any way relieve the contractor of responsibility for its accuracy or for compliance with the contract documents.

X	In Order	Submission No. 5
	Amend as Noted	Project No. 0265.240.02.04
	Rejected	By CL
	See Remarks	Date 08 Dec. 88.

UMA ENGINEERING LTD.

1479 Buffalo Place, Winnipeg, Manitoba

DATE	NO	REVISION	BY
JUNE 27	C	CHAINAGE AND MK-50 REV'D	A.E.
JUNE 14	B	GENERAL	S.G.
JUNE 3RD 88	A	CHANGE DRAWING NUMBER OF MK-51	A.E.

CANRON hyprescon®

THE CITY OF WINNIPEG (88-86)

750 FEEDERMAIN

QTY.	MK no.	DIA.	DESCRIPTION	LENGTH	ENDS	REFERENCE
1	STD	750	STD PIPE C301 (L) CL-20	7315	SEB	46-3002-D
1	51	750	BEVEL PIPE 4°30' AT SPIGOT CL-20	7281	SEB	C-66
1	50	750	TEE 750x750x300 FLG F/W 120° THRUST FLG (2)	1200	FLGEFLG	C-31
2	43	750	ADAPTOR	605	FLGEV51	C-57
2	42	750	SHORT C/W 750 IPT BOTTOM 150 IPT TOP / WALL FLG	1461	V51EB	C-26
1	STD	750	STD PIPE C-301 (L) CL. 16	7315	SEB	46-3002-C

SCALE: DATE:

DRAWN	CHECKED	APPROVED	PROJECT	DWG.	REV.
			46-3002	10	C

June 8th, 1988

CANRON INC.

AWWA C-301 APPENDIX "A" DESIGN

City of Winnipeg
Tender 88-86

750mm DIAMETER C-301 (E) PIPE

Datas:

Pw = Working Pressure = 690 kPa
Pwh= Transient Pressure = 344 kPa
Pt = Test Pressure = 1000 kPa

Pd = Design Pressure = Larger of $\frac{Pw + Pwh}{1.4}$ or $\frac{Pt}{1.25}$
= 800 kPa
= 116 P.S.I.

Bd = Trench width = O.D. + 1000mm = 1.92m = 6.3 feet

w = unit weight of soil material = 1925 kg/m3 = 120 lbs/ft3

Ku' = .110

Lf = Load factor = 1.5

A - Condition 1

H = Depth of fill = 3.1 meter = 10 feet

Live Load = HS20 LOADING

- Calculation of external load

Wd = External load for trench installation
= 4551 x 1.2 = 5462 lbs./lin.ft.

"Concrete Pipe Design Manual"
Table 22 (D)

June 8th, 1988

WITH

Ku' = .11
w = 120 lbs/ft.3
Bd = 6.3 feet

Live Load

Wl = 280 lbs./lin.ft. from "Concrete Pipe Design Manual". table 45

Combined analysis (see graph 3)

For a class 16 pipe

Po = 200 P.S.I.
Wo = 6220 lbs./lin.ft.

SO

For working conditions

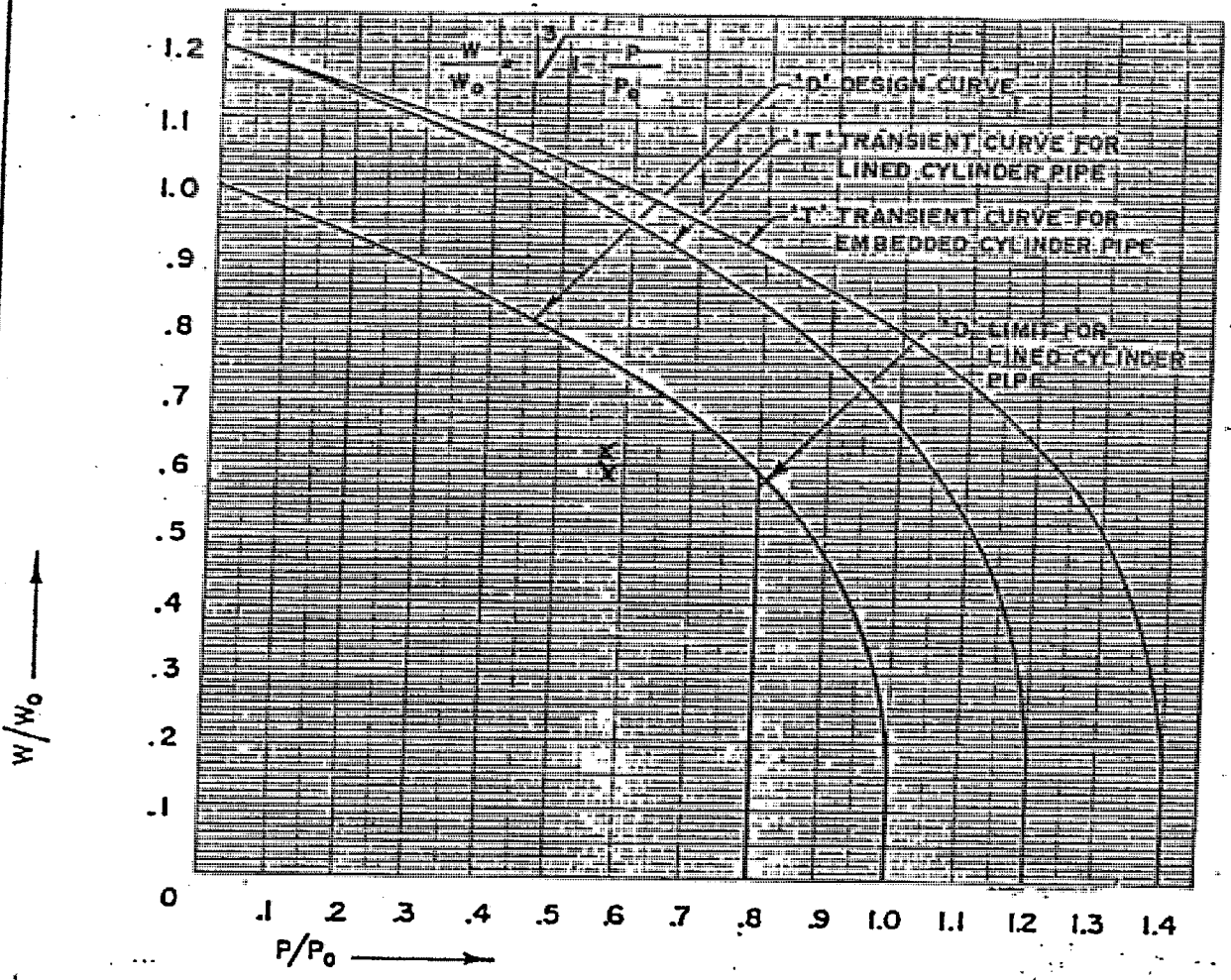
$Pw/Po = .58$ $\quad \frac{Wd/Lf}{Wo} = .59$

For Live Load

$Pw/Po = .58$ $\quad \frac{Wd/Lf + Wl/1.5}{Wo} = .62$

.: CLASS 16 PIPE IS ADEQUATE

PRESTRESSED CONCRETE CYLINDER PIPE
COMBINED INTERNAL-EXTERNAL LOADING ANALYSIS



DATA		
WIRE AREA $in.^2/ft.$		
P_o	p.s.i.	200
W_o	lbs/ft.	6220
P_w	p.s.i.	116
P_{wh}	p.s.i.	---
W_d	lbs/ft.	5462
W_1	lbs/ft.	280
L.F.		1.5

COMBINATION LOADING		
UNDER 'D' CURVE	$\frac{P_w}{P_o} = .58$	$\frac{W_d/L.F.}{W_o} = .59$
UNDER 'T' CURVE	$\frac{P_w + P_{wh}}{P_o} = ---$	$\frac{W_d/L.F.}{W_o} = ----$
UNDER 'T' CURVE	$\frac{P_w}{P_o} = .58$	$\frac{W_d/L.F. + W_1/1.5}{W_o} = .62$

NOM. PIPE DIAMETER – 30 inches
CLASS – 16

JOB ORDER NO. – 46-3002
REVISION –

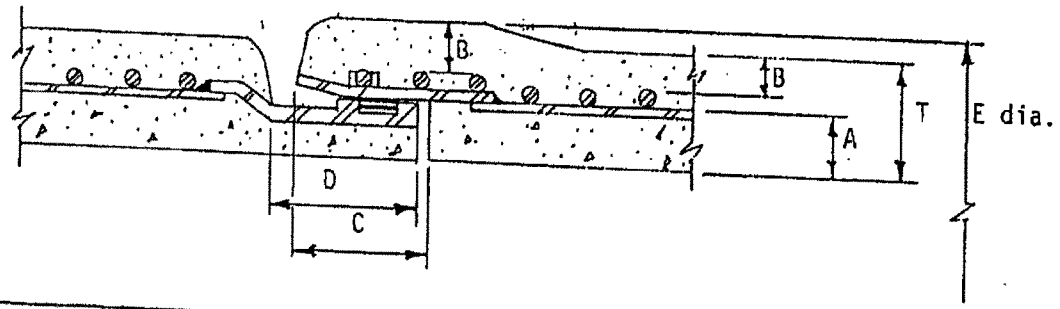
CANRON LIMITED
PIPE DIVISION

SPECIFICATION: A.W.W.A. C-301 · APPENDIX 'A'

PREP. BY G.B. | DATE: | DWG. NO. 3

APPROVED BY

750 mm (30") DIA. PRESTRESSED CYLINDER PIPE



Rev.	Date	By	Description

Actual I.D.	762.0 mm	Conc. Lining 'A'	47.6 mm	Std. Pipe Length	7.32m
Cylinder O.D.	857.3 mm	Mortar Coating (min.) 'B'	25.4 mm	Nom. Pipe Wall 'T'	78.3 mm
Joint Dia.	870.0 mm	Bell Depth 'C'	82.6 mm	Pipe O.D. at Bell 'E'	942.6mm
Cylinder Gauge	1.5 mm	Spigot Depth 'D'	95.3 mm	Joint Ring Dwg. M-A-101, M-A-151	
				Gasket Dwg. M-A-201	

Class	Working Pressure kPa	Select	A648 Class III Wire					Concrete Strength at Wrapping MPa	Calculated Weights				
			Area mm^2/m	No. 6	Dia. mm	Spacing mm	No. per 3m		Cylinder kg/m	Wire kg/m	Lining kg/m	Coating kg/m	Pipe Weight kg/m
16		C	637	6	4.9	29.3	102	24.3	32	13.5	282	192	520
20		D	809	6	4.9	23.1	130	30.3	32	17.1	282	191	522

CANRON hyprescon®

SPECIFICATION: AWWA C301(L)

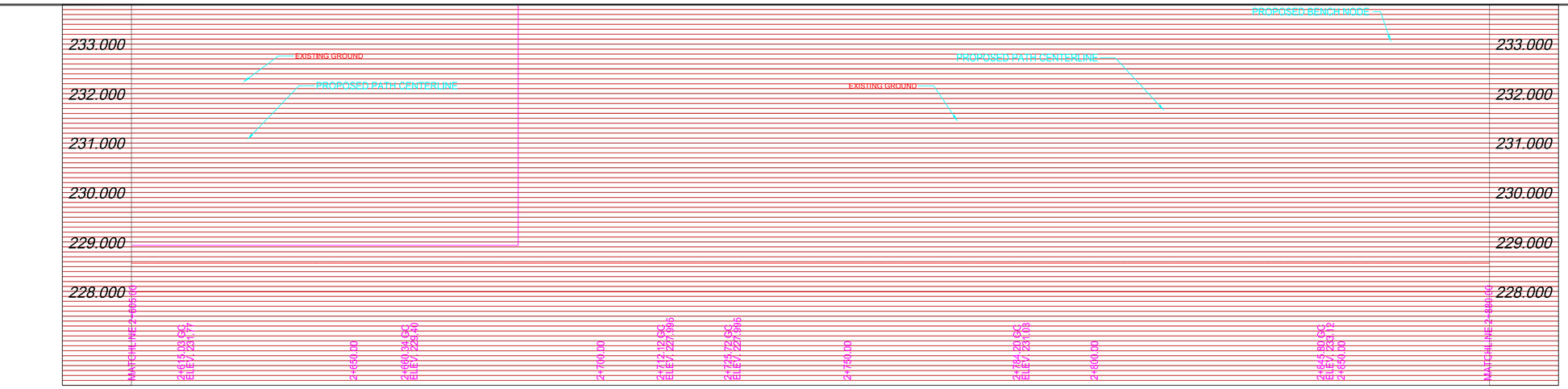
PREP. BY: S.G.

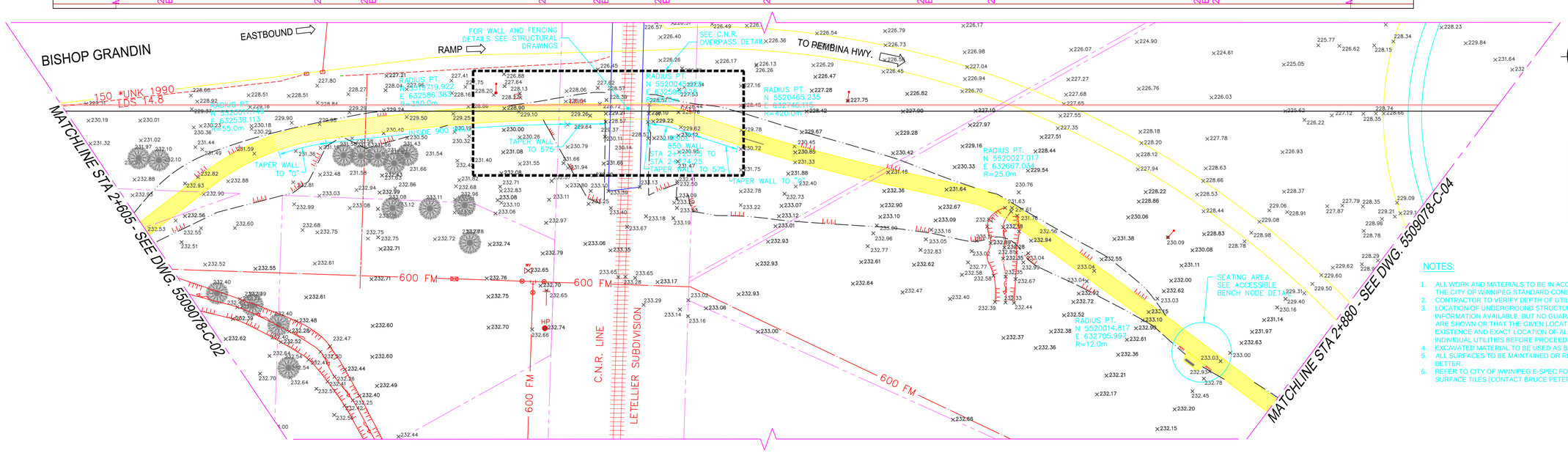
DATE: MAY 30, 1988

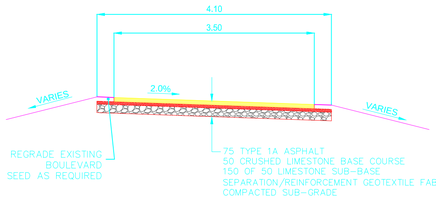
APPROVED BY

DWG. NO. 46-3002

FORM #03

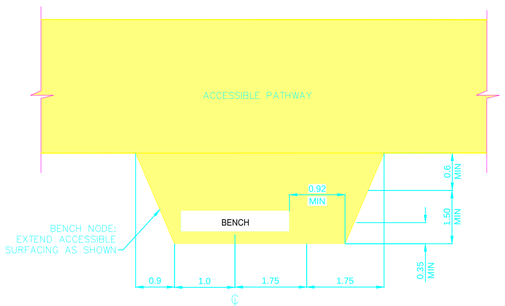






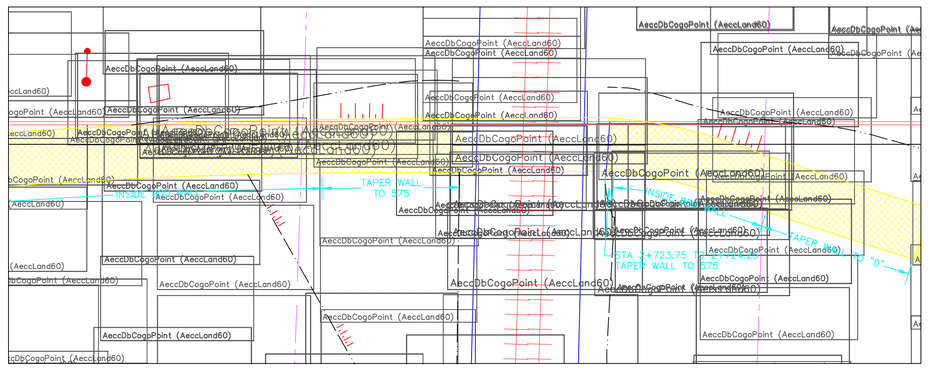
TYPICAL ASPHALT PATH SECTION

SCALE: NTS



ACCESSIBLE BENCH NODE DETAIL

SCALE: NTS



C.N.R. OVERPASS DETAIL

SCALE: 1:200

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APEGM
Certificate of Authorization
MMM Group Limited
No. 4531 Date: APR 30 2010

METRIC
WHOLE NUMBERS INDICATE MILLIMETERS
DECIMALIZED NUMBERS INDICATE METERS

	ASPHALT PATHWAY			EXISTING DITCH FLOW			EXISTING GROUND	
	PROPOSED CONCRETE PATH			CMP CULVERT			PROPOSED CENTERLINE	
	PATHWAY CENTRELINE			MANHOLE				
	PROPERTY LINE			CATCH BASIN				
31.99	WALKWAY ELEVATION	32.50	HP	HYDRO POLE				
	WATER VALVE			HYDRO POLE WITH LIGHT				
	SWALE			CUT AREA EXTENTS				
	MTS CABLE			FILL AREA EXTENTS				
	SEWER							
	CONC. WWS							
	WATER							
EXISTING	LEGEND-PLAN	PROPOSED	EXISTING	LEGEND-PLAN	PROPOSED	EXISTING	LEGEND-PROFILE	PROPOSED

LOCATIONS APPROVED
UNDERGROUND STRUCTURES
SIGNED BY:

SUPV U/G STRUCTURES DATE

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G.B.M. ELEV. 232.335 — CITY OF WINNIPEG MAPPING AND SURVEYS CAP IN CONCRETE PILE, S/E CORNER OF BISHOP GRANDIN BLVD AND WAVERLY AVE.

NO.	REVISIONS	DATE	BY
4	-	-	-
3	-	-	-
2	-	-	-
1	ISSUED FOR REVIEW	20.08.09	RMB

MMM GROUP

MMM Group Limited
Suite 111 - 93 Lombard Ave.
Winnipeg, MB R3B 3B1
t. 204.943.3178
f. 204.943.4948
www.mmm.ca

DESIGNED BY	CWS/MR	CHECKED BY	-
DRAWN BY	CWS/MR	APPROVED BY	RMB
HOR. SCALE	1:500	RELEASED FOR CONSTRUCTION	-
VERTICAL	1:50		
DATE:	01.04.10	DATE	-

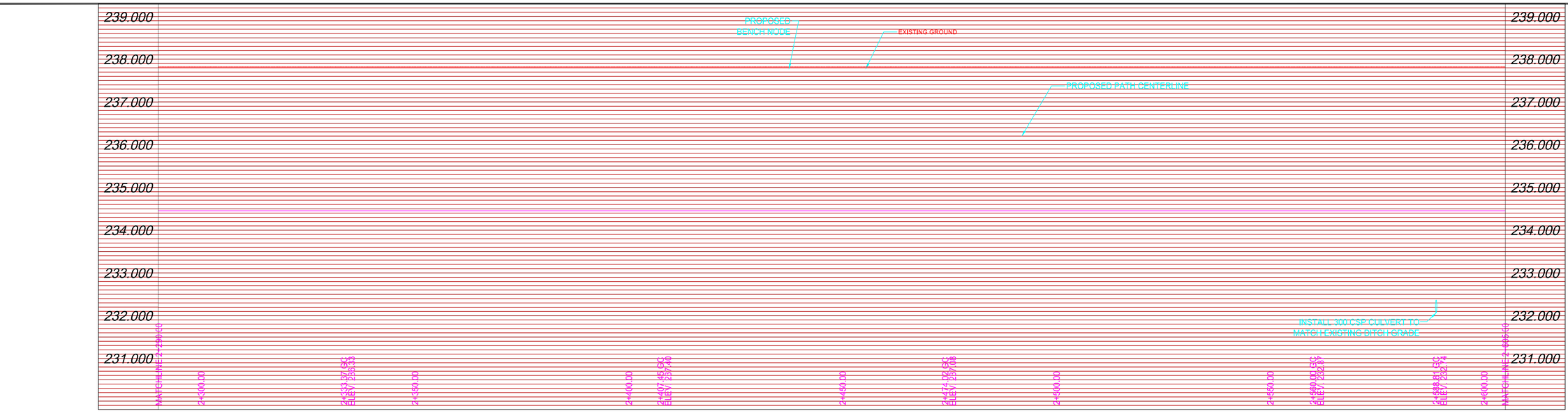
ENGINEER'S SEAL
PROVINCE OF MANITOBA
R.M. BORODY
REGISTERED PROFESSIONAL ENGINEER

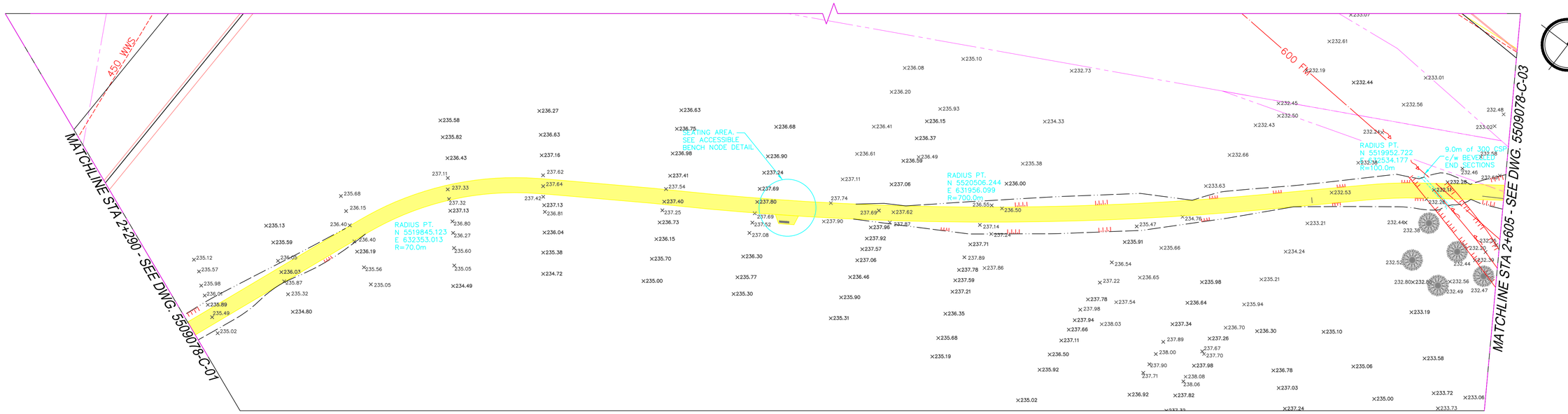
CONSULTANT ACAD DWG. NO.
5509078-C-003

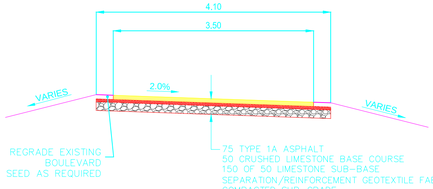
Winnipeg
CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

2010 ACTIVE TRANSPORTATION PROGRAM
BISHOP GRANDIN GREENWAY
PHASE II SOUTH SIDE PATHWAY EXTENSION
PEMBINA HIGHWAY TO 866m WEST OF PEMBINA HIGHWAY
STA. 2+605 TO 2+880

SHEET 3 OF 4







TYPICAL ASPHALT PATH SECTION

SCALE: NTS

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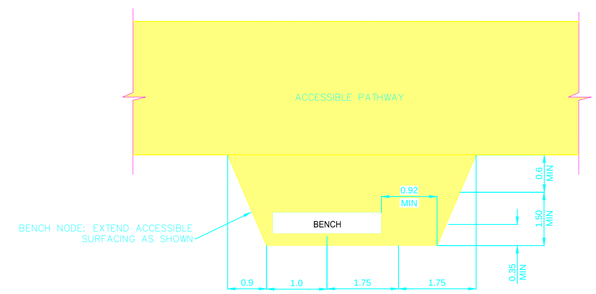

ACCESSIBLE BENCH NODE DETAIL

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APEGM
Certificate of Authorization
MMM Group Limited
No. 4531 Date: APR 30 2010

METRIC
WHOLE NUMBERS INDICATE MILLIMETERS
DECIMALIZED NUMBERS INDICATE METERS

	ASPHALT PATHWAY			CMP CULVERT			EXISTING GROUND	
	PATHWAY CENTRELINE		○	MANHOLE			PROPOSED CENTERLINE	
	PROPERTY LINE		□	CATCH BASIN				
31.99	WALKWAY ELEVATION	32.50	HP	HYDRO POLE				
	WATER VALVE			HYDRO POLE WITH LIGHT				
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	SEWER							
	CONC. WWS							
	WATER							
	EXISTING DITCH FLOW							
EXISTING	LEGEND-PLAN	PROPOSED	EXISTING	LEGEND-PLAN	PROPOSED	EXISTING	LEGEND-PROFILE	PROPOSED

LOCATIONS APPROVED
UNDERGROUND STRUCTURES
SIGNED BY:
SUPV U/G STRUCTURES DATE

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G.B.M. ELEV. 232.335
CITY OF WINNIPEG MAPPING AND SURVEYS CAP IN CONCRETE PILE, S/E CORNER OF BISHOP GRANDIN BLVD AND WAVERLY AVE.

NO.	REVISIONS	DATE	BY
4	-	-	-
3	-	-	-
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1	ISSUED FOR REVIEW	20.08.09	RMB

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DESIGNED BY	CWS	CHECKED BY	-
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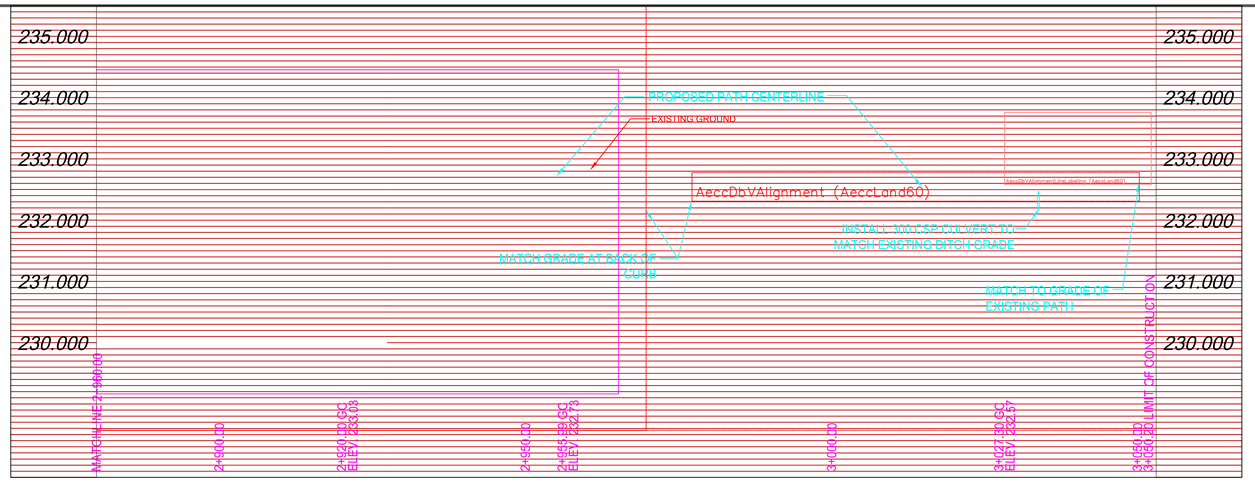
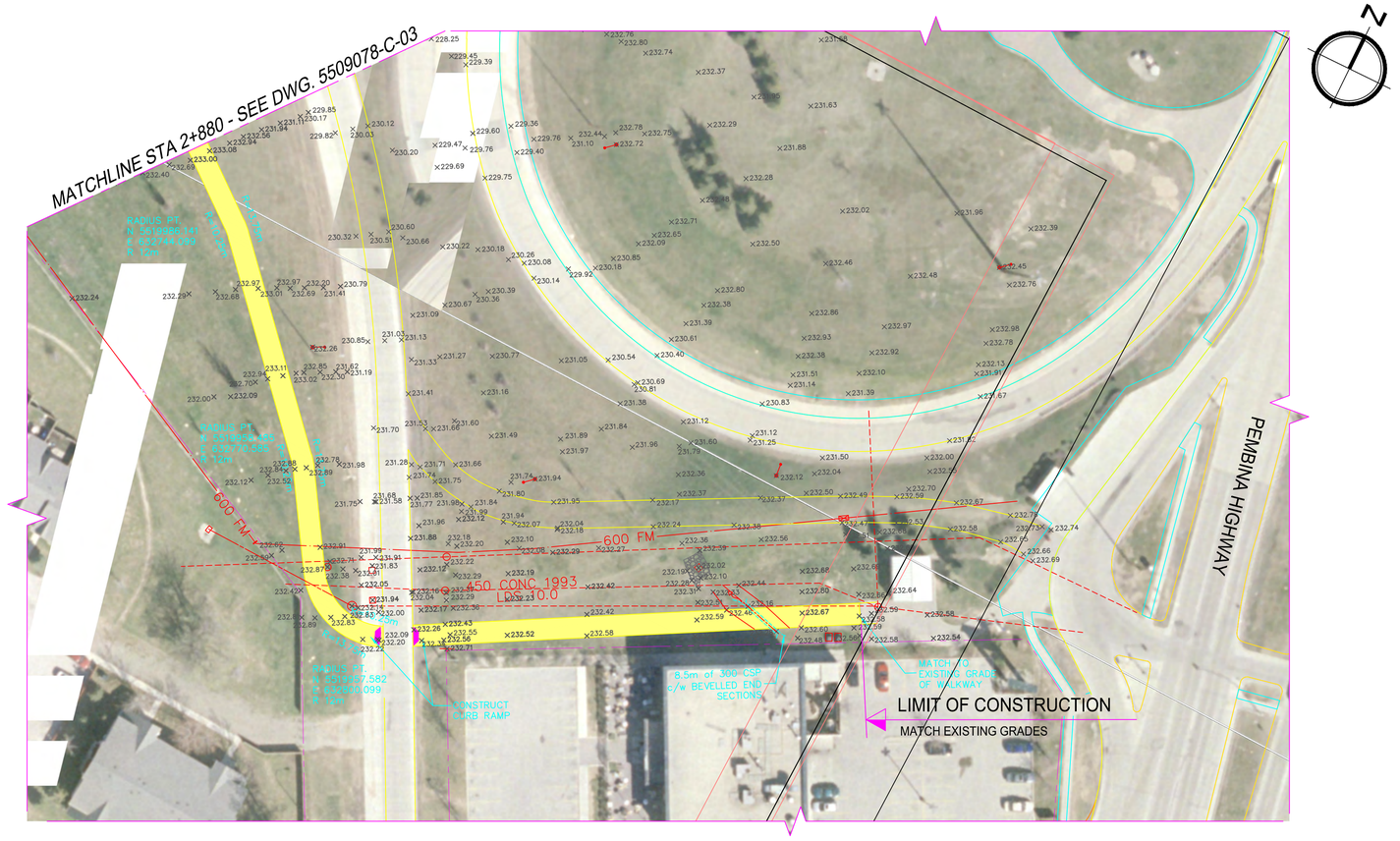
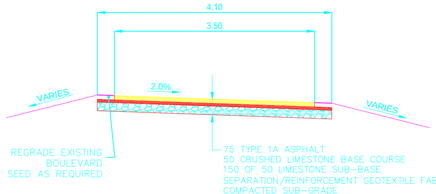
SHEET 2 OF 4







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APEGM
Certificate of Authorization
MMM Group Limited
No. 4531 Date: APR 30 2010

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	PROPERTY LINE		□	CATCH BASIN				
31.99	WALKWAY ELEVATION	32.50	HP	HYDRO POLE				
W	WATER VALVE			HYDRO POLE WITH LIGHT				
	SWALE							
	MTS CABLE							
	SEWER							
	CONC. WWS							
	WATER							
	EXISTING DITCH FLOW							
EXISTING	LEGEND-PLAN	PROPOSED	EXISTING	LEGEND-PLAN	PROPOSED	EXISTING	LEGEND-PROFILE	PROPOSED

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G.B.M. ELEV. 232.335
CITY OF WINNIPEG MAPPING AND SURVEYS CAP IN CONCRETE PILE, S/E CORNER OF BISHOP GRANDIN BLVD AND WAVERLY AVE.

NO.	REVISIONS	DATE	BY
4	-	-	-
3	-	-	-
2	-	-	-
1	ISSUED FOR REVIEW	20.08.09	RMB

MMM GROUP
MMM Group Limited
Suite 111 - 93 Lombard Ave.
Winnipeg, MB R3B 3B1
t. 204.943.3178
f. 204.943.4948
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DESIGNED BY	CWS/MR	CHECKED BY	-
DRAWN BY	CWS/MR	APPROVED BY	RMB
HOR. SCALE	1:500	RELEASED FOR CONSTRUCTION	-
VERTICAL	1:50		
DATE:	15.01.10	DATE	-

ENGINEER'S SEAL
PROVINCE OF MANITOBA
R.M. BORODY
REGISTERED PROFESSIONAL ENGINEER

CONSULTANT ACAD DWG. NO.
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Winnipeg
CITY OF WINNIPEG
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

2010 ACTIVE TRANSPORTATION PROGRAM
BISHOP GRANDIN GREENWAY
PHASE II

SOUTH SIDE PATHWAY EXTENSION
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SHEET 4 OF 4