

APPENDIX 'C'

PIPELINE LOADING ASSESSMENT

*REPORT OF THE IMPACT OF A PROPOSED PATHWAY OVER THE CITY OF
WINNIPEG EXISTING 600mm PRESTRESSED CONCRETE PIPE
(DAKOTA FEEDERMAIN EXTENSION) AND THE EXISTING 1650mm
PRESTRESSED
CONCRETE PIPE (SECOND BRANCH AQUEDUCT)*

1.0 General

An asphaltic concrete multi-use pathway, 4.1 metre wide is proposed north of Bishop Grandin Boulevard at Shorehill Drive. The pathway extends across the Nairn Road drain. This report reviews the impact on the 600mm Dakota Feedermain Extension and the 1650mm Second Branch Aqueduct, from the construction activity of the proposed works.

The Greater Winnipeg Water District issued a tender in 1958 for the "Supply, Delivery and Installation of 5'-6" Second Branch Aqueduct."

The Metropolitan Corporation of Greater Winnipeg, Waterworks and Waste Disposal Division issued two tenders in 1964 for 1) "Supply and Delivery of Concrete Water Pipe for Feeder mains", and 2)"Installation of Pipe for Dakota Feedermain Extension".

The pipe for both projects was Prestressed Concrete Pressure Pipe.

The KGS Group supplied G. A. Pratt & Associates Inc. with the tenders and drawing for both projects.

A/ 1650mm (5' – 6') Second Branch Aqueduct

Existing 1650mm Second Branch Aqueduct

The pipeline was designed, manufactured and supplied by the Lock Joint Pipe Co. The award of the tender in 1958 was for the prestressed embedded cylinder concrete pressure pipe.

In this tender, the Greater Winnipeg Water District supplied the design requirements for the pipe. Lock Joint Pipe Co., using these pipe design requirements submitted their design calculation sheets and design graphs that met the Greater Winnipeg Water District design requirements and the A.W.W.A. C-301-55T standard.

The Greater Winnipeg Water District design standards are shown on Drawing 12-100-37-01.

Existing Elevations

The invert elevation of the 1650mm (66") Second Branch Aqueduct at the proposed pathway is 227.96. The top of the pipe elevation is at approximately 229.79. The pipe was designed for a cover over the pipe of 2.74 metres (9 feet) for the ground elevation of 232.53. The elevation of the existing ground is elevation 231.80 or about 2 metres (6.6 feet) over the top of the pipe.

Proposed Elevation

Drawing No.: 12-100-37-01 shows the elevation of the proposed asphalt pathway. The asphalt surface elevation over the existing 1650mm Second Branch Aqueduct is 231.70 (760.17) or 1.91 metres (6.27 feet) above the pipe.

The proposed structure of the asphaltic concrete pathway is 75mm of asphalt and 200mm of base material. The subgrade is therefore at elevation 213.43 or 1.64 metres (5.38 feet) above the pipe.

Specifications

The tendered specifications outlined the design conditions that the Contractor would have to design the prestressed embedded cylinder concrete pressure pipe as well as meeting A.W.W.A. C301-55T specifications.

The specifications in 1958 were less stringent than the present day specifications for the same pipe. For instance the following have been upgraded:

1958 Specification

- A.W.W.A. C301-55T
(1955 tentative Standard)
- trench width OD +24"
- soil density -110#/cu.ft.
- $K_u = 0.13$
- live load H-20

Present Day Specification

- A.W.W.A. C301-07 (2007)
- OD + 750mm
- 120#/cu.ft
- $K_u = 0.11$
- HS20 or RTAC axle load of
37,500 pounds

Impact on Second Branch Aqueduct

The Contractor supplied their design notes and three graphs prepared from the design notes. The graphs provided the 3 edge bearing value of the pipe using the specified loading and internal pressure.

The loading condition that will have the greatest impact on the 1650mm Second Branch Aqueduct will be at the elevation of the subbase (231.43) over the top of the pipe which is at elevation 229.79. The amount of cover will be 5.38 feet vs the design cover of 9 feet. Using the original design criteria the soil dead load was recalculated as well as the H-20 live load on the pipe surface. The internal water pressure remains the same as the original pipe design.

The combination loading calculations applied to the design curves for the pipe show the points to be below the appropriate curves.

Applying the present day specifications, the combination loading calculations applied to the design curves for the pipe show the points to be near or above the appropriate curves.

B/ 600mm Dakota Feedermain Extension

Existing 600mm Dakota Feedermain Extension

The pipeline was designed, manufactured and supplied by Canada Iron Foundaries Ltd. pipe division. The trade name of the pipe is "Hyperscon" prestressed concrete cylinder pipe. The Metropolitan Corporation of Greater Winnipeg, Waterworks and Waste Disposal Division prepared a tender in 1964 for "Supply and Delivery of Concrete Water Pipe for Feedermain: Sections 1 and 2 - 24" and 30" Prestressed Concrete Pressure Pipe."

In this tender (specification) the Metropolitan Corporation of Greater Winnipeg supplied the design requirements for the pipe. Canada Iron Foundaries Ltd. pipe division, using these pipe design requirements and using "A.W.W.A. Standard for Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids ANS/AWWA C301-58," submitted three pages of calculations and graphs for the 24" (600mm) diameter pipe to the Corporation. Two pages of calculations from the Waterworks and Waste Disposal Division were attached which were "Check Calculations - Prestressed Concrete Pipe - Dakota Extension."

The Metropolitan Corporation of Greater Winnipeg design standards are shown on Drawing No.: 12-100-37-01.

The Metropolitan Corporation of Greater Winnipeg also tendered for the "Specification for Installation of Pipe for Dakota Feedermain Extension."

Existing Elevations

The invert elevation of the 600mm (24") Dakota Feedermain Extension at the proposed pathway is 228.84. The top of the pipe elevation is at approximately 229.51. The Metropolitan Corporation of Greater Winnipeg specified the pipe was to be designed for 7 feet of cover. The Contractor calculations are for 9 feet of cover. The Metropolitan Corporation of Greater Winnipeg "Check Calculation" sheets also stated the design was for 9 feet of cover. The design ground elevation is 232.26. The elevation of the existing ground is approximately 231.65 or about 1.86 metres (6.1 feet) over the top of the pipe.

Proposed Elevation

Drawing No.: 12-100-37-01 shows the elevation of the proposed asphalt pathway. The asphalt surface elevation over the existing 600mm Dakota Feedermain Extension is 231.80 or 2.29 metres (7.51 feet) above the pipe.

The proposed structure of the asphaltic concrete pathway is 75mm of asphalt and 200mm of base material. The subgrade is therefore at elevation 231.53 or 2.02 metres (6.63 feet) above the pipe.

Specifications

The tendered specifications outlined the design conditions that the Contractor would have to design the 600mm prestressed concrete pressure pipe as well as meeting A.W.W.A. C301-58 specifications.

The specifications in 1964 were less stringent than the present day specifications for the same pipe. For instance the following has been upgraded:

1964 Specification

- A.W.W.A. C301-58 (1958)
- trench width OD +24"
- soil density -110#/cu.ft.
- $K_u = 0.13$
- Live load H-20

Present Day Specification

- A.W.W.A. C301-07 (2007)
- OD + 750mm
- 120#/cu.ft
- $K_u = 0.11$
- HS20 or RTAC axle load of 37,500 pounds

Impact on Dakota Feedermain Extension

The Contractor supplied their design notes and a graph prepared from the design notes. The graph provided the 3 edge bearing value of the pipe using the specified loading and internal pressure.

The loading conditions that will have the greatest impact on the 600mm Dakota Feedermain Extension will be at the elevation of the subbase (231.53) over the top of the pipe which is at elevation 229.51. The amount of cover will be 6.63 feet vs the design cover of 9 feet. Using the original design criteria, the soil dead load was recalculated as well as the H-20 live load on the pipe surface. The internal water pressure remains the same as the original pipe design.

The combination loading calculations applied to the design curves for the pipe show the points to be below the appropriate curves.

Applying the present day specifications the combination loading calculations applied to the design curves for the pipe show them to be on or below the appropriate curves.

Recommendations:

Construction Loading

The construction of the proposed multi-use pathway will create the highest combined loading on the pipe unless limitations are put on the equipment to be used. There are four stages of concern:

- i) excavation of overburden to the subgrade elevation
- ii) compaction of the subgrade
- iii) installation of the 200mm base material and its compaction
- iv) installation of the asphalt surface

It is important that no vibrating compactors be used during the compaction of the subgrade or base course. This will eliminate vibrations that would penetrate below the top of the pipe. If the vibration mechanism is left on during the compaction operation, the vibration may create movement at the pipe joints, which would be a concern.

Construction Procedure

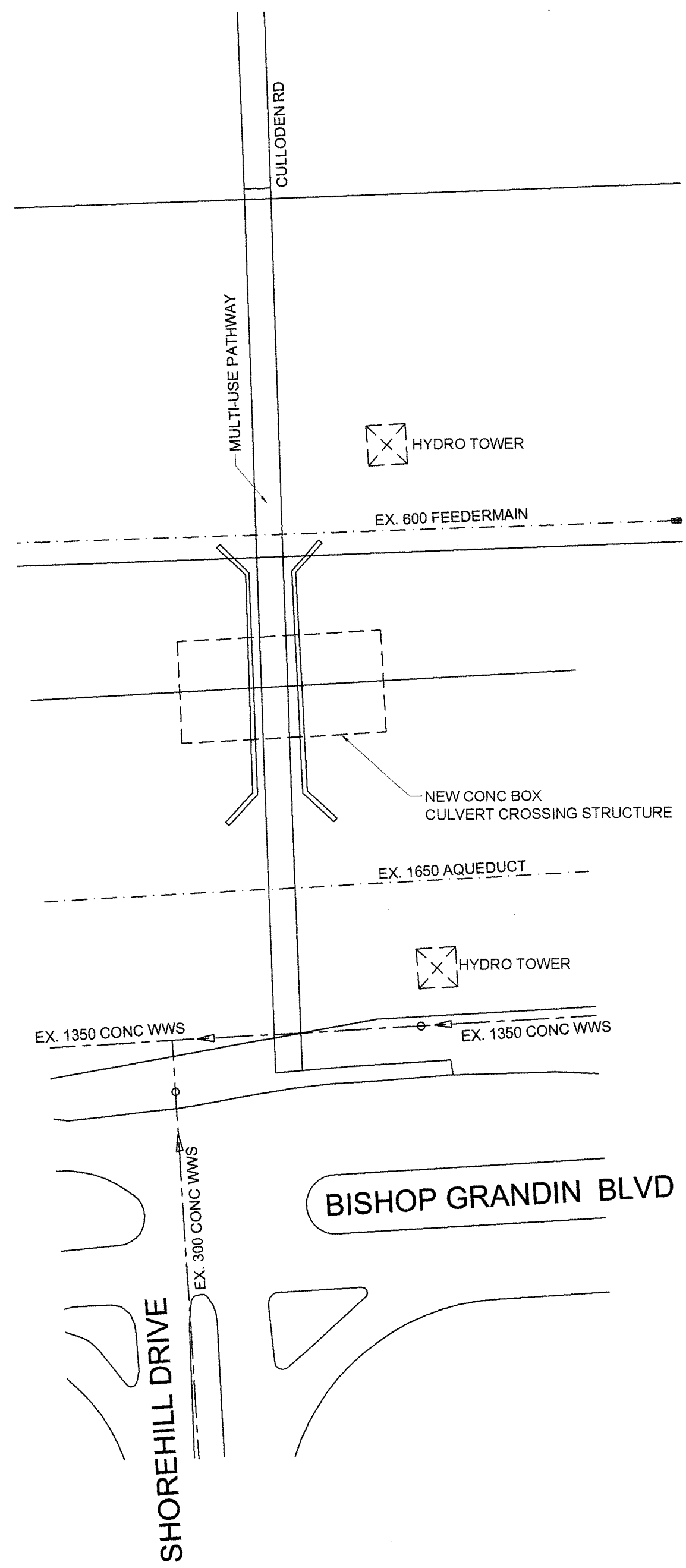
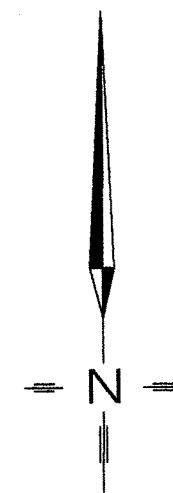
There are numerous stages of construction that could effect the structural integrity of the pipe in the combination loading (dead load plus live load) under the "T" transient curve. Therefore, the following construction procedures should apply.

A. During the removal of soil to obtain the level of the subgrade, the Contractor shall use track-type loaders for excavation and tandems to haul out the excess material. The equipment should operate so it crosses the existing pipe perpendicular to and not parallel to, or straddling the pipe. No equipment weight should exceed an axial load of 20 000 pounds.

B. Compaction of the subgrade should be carried out by "non-vibratory" compaction equipment with a working weight not exceeding 20 000 pounds.

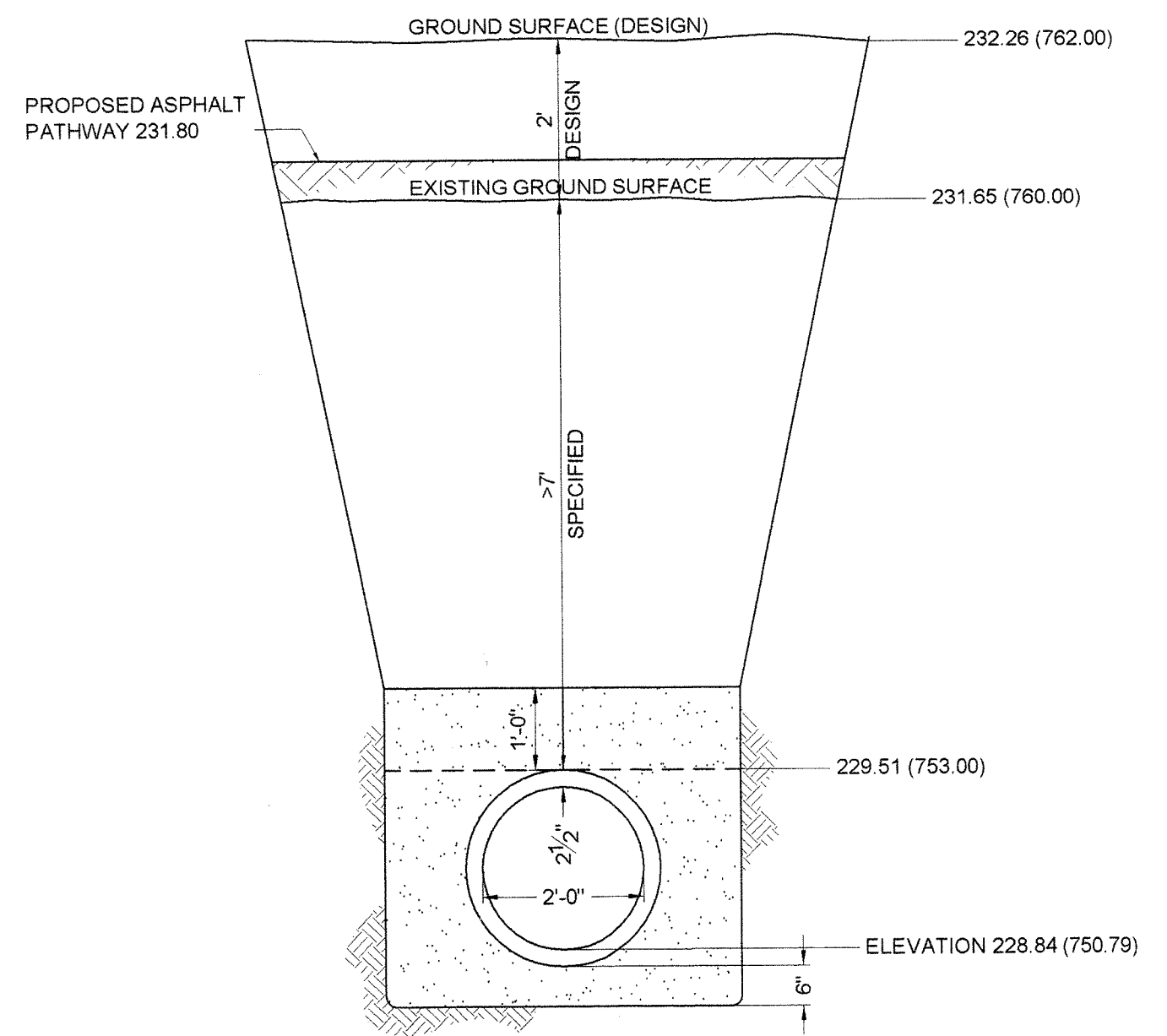
C. The hauling of limestone subbase, base and asphaltic concrete material shall be with tandems or, if tractor trailers are to be used, a fill area over the pipe must be built to transport the material to both sides of the pipe. Any load over 20 000 pounds axial load must not cross the pipe except on the "bridge" fill area, which must be at least three metres above the top of the pipe and three metres on each side of the center line of the pipe.

D. Compaction of the subbase, base course and asphalt must be with "non-vibratory" compaction equipment not exceeding 20 000.



SITE PLAN

SCALE: 1/64" = 1'-0"



**24" PRESTRESSED CONCRETE
PRESSURE PIPE
DAKOTA FEEDERMAIN EXTENSION**

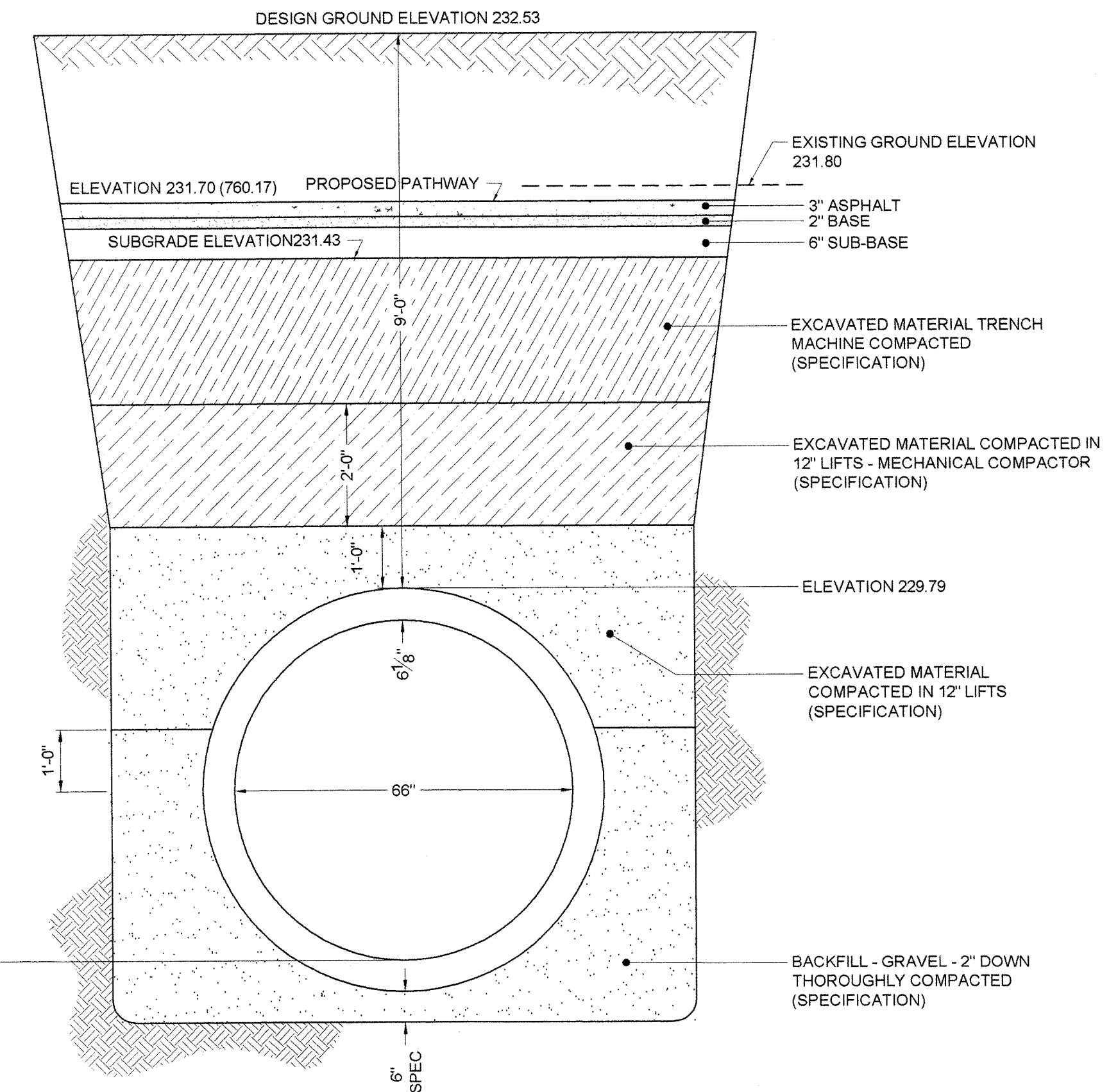
SCALE: 1/2" = 1'-0"

METROPOLITAN CORPORATION OF GREATER WINNIPEG
DESIGN INFORMATION FOR 600mm PRESTRESSED
CONCRETE PRESSURE PIPE - DAKOTA FEEDERMAIN (1964)

- DESIGNED AND MANUFACTURED IN ACCORDANCE WITH AWWA SPECIFICATION C-301-58.
- DESIGNED AND CONSTRUCTED TO WITHSTAND A 100 PSI WORKING PRESSURE PLUS AN ALLOWANCE FOR WATER HAMMER OF AT LEAST 50 PSI AS WELL AS EXTERNAL PRESSURES CAUSED BY OVERBURDEN, TRAFFIC OR OTHER LOADS.
- TRENCH LOADING BASED ON:
 - PIPE TRENCH - TRENCH WIDTH EQUAL TO O.D. OF THE PIPE PLUS 2 FEET.
 - SOIL WEIGHT - 110#/CU. FT.
 - TRENCH BEDDING FACTOR OF 1.5
 - MINIMUM EARTH COVER OF 8 FEET.
 - $K_u = 0.130$ IN MARSTON'S FORMULA.
 - LIVE LOAD - H - 20 HIGHWAY LOADING

INSTALLATION

- WIDTH OF TRENCH 12" ABOVE TOP OF PIPE - NOT LESS THAN 12" NOR MORE THAN 24"
- NOT LESS THAN 7 FEET COVER OVER THE TOP OF THE PIPE



**66" PRESTRESSED EMBEDDED
CYLINDER CONCRETE PRESSURE PIPE
SECOND BRANCH AQUEDUCT**

SCALE: 1/2" = 1'-0"

GREATER WINNIPEG WATER DISTRICT
DESIGN INFORMATION FOR 1650mm PRESTRESSED EMBEDDED CYLINDER
CONCRETE PRESSURE PIPE (1958)

THE FOLLOWING TABLE GIVES THE REQUIRED MINIMUM THREE EDGE BEARING STRENGTH THAT THE PIPE MUST SUPPORT SIMULTANEOUSLY WITH THE DESIGN INTERNAL PRESSURE

Depth of Cover Feet	Required Earth	3-edge Bearing Strength lbs./lin. ft. Earth plus Live plus Impact
7	4620	+ 960 = 5580
8	5200	+ 750 = 5950
9	5940	+ 590 = 6530
10	6520	+ 545 = 7065
11	7200	+ 480 = 7680
15	9180	+ 270 = 9450
20	11,320	+ 160 = 11510
25	13,600	13,600 + 110 = 13710

BEDDING FACTOR 1.5
SOIL WEIGHT - 110#/CU. FT.
MAX. HEIGHT OF BACKFILL ABOVE TOP OF PIPE 9'

PIPE SUPPLIED AND INSTALLED BY
- LOCK JOINT PIPE COMPANY
- CLASS B PIPE

PIPE TRENCH - NOT LESS THAN 12" NOR MORE THAN 24" GREATER THAN THE OD OF PIPE

PRESSURE - 100' STATIC HEAD (43.35 PSI) AND 50 PSI WATER HAMMER TO MEET AWWA C301 - 55T

APEGM
Certificate of Authorization
G.A. Pratt & Associates Inc.
No. 758 Expiry: April 30, 2013

No.	Revisions	Date	By	Date	Reference
				SEPTEMBER 2012	

G.A. PRATT & ASSOCIATES INC.
ENGINEERING CONSULTANTS

DESIGNED BY: G.A.P.
CHECKED BY: G.A.P.
DRAWN BY: AM
APPROVED BY: G.A.P.
SCALE: AS SHOWN
RELEASED FOR CONSTRUCTION

ENGINEER'S SEAL
PROVINCE OF MANITOBA
G.A. PRATT
AUGUST 2012
REGISTERED ENGINEER

CONSULTANT DRAWING NO.
12-100-37-01

**THE CITY OF WINNIPEG
MULTI-USE PATHWAY - BISHOP GRANDIN BLVD.**

NORTH TO CULLODEN ROAD
CROSSING THE EXISTING 1650MM
AQUEDUCT AND 600MM FEEDMAIN