LOWER COST ALTERNATIVE FOR MUNICIPAL SEWER INSPECTION AND MAINTENANCE

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ABSTRACT

The manhole used for inspection and maintenance in a sewer system can be replaced with a lower cost alternative access at two straight run pipe junctions upstream of a sewer system. The lower cost alternative was developed based on employing currently available video inspection and remote controlled sewer cleaning equipment. A pilot model was constructed by the City of Edmonton using polyvinyl chloride pipes and fittings. It was found that the lower cost alternative access was easy to construct and cost effective. By utilizing this alternative, the potential cost saving in a subdivision is approximately $1,150 per hectare.

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EXECUTIVE SUMMARY

The objective of this study is to investigate sewer line access options that would mitigate problems associated with a standard manhole and reduce subdivision servicing costs while maintaining the function of a standard manhole. Canada Mortgage and Housing Corporation recognized this need and funded the study.

The study was divided into two phases. The first phase involved the development of alternate sewer line access options and evaluate the most favourable option including construction details, materials, hydraulic performance, operation and maintenance, and comparison with a standard manhole. During the course of the study, various municipalities, manufacturers, and sewer maintenance companies were contacted and some of their comments were used in the development of alternate sewer line access options.

The second phase consists of the construction of a field model along with monitoring with respect to settlement around the top of the access, debris accumulation, frequency of cleaning required and structural integrity of the facility. The information gathered from the monitoring makes it possible to quantify potential savings in operation and maintenance costs.

Three sewer line access options have been developed. The most favourable option is the one with a single entry and constructed with an oversized standard tee that allows access for cleaning and video inspection equipment.

The preferred sewer line access has the following merits:

- o cost effective
- o ease in construction
- o minimize or eliminate surface runoff and infiltration
- o allows the installation of an access cover at any location by rotating the chimney

The proposed sewer line access is easily accessible by any sewer video inspection and cleaning equipment. Also, sewer ventilation is achieved through the holes drilled in the cap at the top of the chimney. The smaller diameter and fewer construction joints on the chimney together with surface runoff to the access cover being drained into a soakaway will mitigate inflow and infiltration into the sewer system. Since the sewer line access is backfilled with granular material settlement will also be mitigated.

The proposed sewer line access could be constructed utilizing standard PVC, PVC ultra rib and reinforced concrete pipe and fittings. PVC ultra rib and reinforced concrete pipe and fittings are the most economical for sewer pipes 200 mm to 300 mm and 375 mm to 450 mm, respectively. PVC, nevertheless, is a widely accepted material and more readily available and therefore, it is recommended that this material be used for the construction

of the access facility.

On comparison, the proposed PVC sewer line access is more economical than a standard manhole. The saving increases from 29% to 45% when the depth of the structure increase from 3 metres to 6 metres. However, the saving decreases with increased pipe diameter. For a system in a typical land development project, the capital cost saving would be approximately $1,150.00 per hectare and therefore, a significant saving would be realized in a large development. Further savings would be realized if the preferred sewer line access were used in the storm sewer system where catch basin leads could be directly connected into the sewer line.

The proposed sewer line access would not completely replace all standard manholes but could be used at a junction with two straight run pipes in a sanitary sewer system and also in storm systems in which catch basin leads are connected directly into the sewer line. The sewer line access is also suitable only at a junction where flow monitoring will not be carried out and for sewer lines 450 mm or smaller in diameter.

In view of the cost saving and other merits noted above, the proposed sewer line access should be considered as a favourable alternate to a standard manhole. It is recommended that a field model be constructed and subsequent monitoring be carried out to evaluate performance and determine the additional saving in maintenance that the proposed sewer line access could generate.

«Solution de rechange économique pour l'entretien et l'inspection des égouts municipaux»

RÉSUMÉ

Cette étude a pour but d'examiner des dispositifs d'accès aux canalisations d'égout susceptibles, même en conservant les fonctions d'un regard standard, d'atténuer les problèmes associés avec les regards de visite standards et d'abaisser les coûts de viabilisation des lotissements. La Société canadienne d'hypothèques et de logement avait reconnu ce besoin, et c'est pourquoi elle a financé cette étude.

L'étude a été divisée en deux phases. La première a consisté à mettre au point des solutions de rechange aux dispositifs standards donnant accès aux canalisations d'égout, à évaluer la solution la plus avantageuse sur le plan des détails de construction, des matériaux, de la performance hydraulique, de l'utilisation et de l'entretien, puis de procéder à une comparaison avec un regard de visite standard. Les responsables de l'étude ont communiqué avec des municipalités, des fabricants et des entreprises d'entretien de regards de visite et ont utilisé certains des commentaires qu'ils ont recueillis pour concevoir de nouveaux dispositifs d'accès.

La seconde phase a servi à construire un modèle sur le terrain et à le doter d'appareils destinés à mesurer le tassement autour de la partie supérieure du dispositif d'accès, l'accumulation de débris, la fréquence des opérations de nettoyage nécessaires et l'intégrité structurale de l'installation. L'information ainsi obtenue devait permettre de quantifier les économies envisageables au chapitre de l'utilisation et de l'entretien.

Trois dispositifs d'accès aux égouts ont été mis au point. Le dispositif le plus prometteur est constitué d'un seul point d'entrée et comporte un té normalisé de grand format qui permet l'introduction de l'équipement de nettoyage et d'inspection vidéo.

Le dispositif d'accès préconisé possède les avantages suivants :

- économie
- réalisation facile
- réduction ou élimination de l'infiltration et du ruissellement de surface
- possibilité d'aménager un couvercle d'accès à n'importe quel endroit en faisant tourner la cheminée

Le dispositif d'accès aux égouts envisagé permet l'introduction facile de tout équipement d'inspection vidéo et de nettoyage. De plus, la ventilation des égouts est réalisée grâce à des ouvertures percées dans le couvercle coiffant la cheminée. Le faible diamètre du dispositif et le petit nombre de joints sur la cheminée, associés au fait que les eaux de ruissellement qui parviennent au couvercle d'accès sont acheminées vers un regard absorbant, atténuent l'afflux et l'infiltration dans le réseau d'égouts. Comme l'accès à l'égout est remblayé avec des matières granulées, le tassement sera vraisemblablement réduit aussi.

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Le dispositif d'accès proposé pourrait être réalisé avec du PVC standard, du PVC Ultra-Rib et du béton armé pour les canalisations et les raccords. Le PVC Ultra-Rib et le béton armé servant aux canalisations et raccords sont les matériaux les plus économiques pour les égouts de 200 mm à 300 mm et de 375 mm à 450 mm, respectivement. Cela dit, le PVC demeure un matériau largement accepté et plus facilement disponible et on recommande donc l'utilisation de ce matériau pour réaliser le dispositif d'accès.

Après comparaison, le dispositif d'accès aux égouts en PVC que l'on propose est plus économique qu'un regard de visite standard. Les économies passent de 29 % à 45 % lorsque la profondeur de la structure augmente de 3 mètres à 6 mètres. Toutefois, les économies diminuent quand le diamètre du tuyau augmente. Dans le cas d'un réseau destiné à un aménagement foncier standard, les économies possibles en coûts d'immobilisations pourraient être de l'ordre de 1 150,00 $ l'hectare et, par conséquent, les économies pour un vaste aménagement seraient substantielles. Des économies additionnelles seraient possibles si le dispositif d'accès aux égouts préconisé était utilisé dans le réseau d'égouts pluviaux, là où les conduites d'amenée du puisard pourraient être branchées directement à la canalisation d'égout.

Le dispositif d'accès proposé ne remplacerait pas complètement tous les regards standards, mais il pourrait être utilisé au point de rencontre de deux canalisations droites au sein d'un réseau d'égout sanitaire ainsi que dans les égouts pluviaux où les conduites d'amenée du puisard sont directement branchées à la canalisation d'égout. Le dispositif d'accès à l'égout ne convient également qu'à un raccord où l'on ne procédera pas à des contrôles de débit et à des canalisations de 450 mm de diamètre et moins.

Compte tenu des économies et autres avantages susmentionnés, le dispositif d'accès aux égouts proposé devrait être considéré comme une solution de rechange favorable par rapport à un regard de visite standard. On recommande qu'un modèle soit construit sur le terrain et que des contrôles en service soient par la suite effectués afin d'en évaluer la performance et de déterminer quelles économies additionnelles ce dispositif pourrait permettre de réaliser sur le plan de l'entretien.

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1.0 INTRODUCTION

1.1 MANHOLE FUNCTIONS

A manhole is an appurtenance in a sewer system that has the following functions:

A. Provide an entry for maintenance personnel to carry out visual inspections of sewers and to carry out maintenance operations including cleaning and rehabilitation.

B. Provide a junction for multiple pipe connections and at grade changes in sewer lines.

C. Provide an access for flow monitoring and sewage sampling.

D. Ventilate the sewer system.

E. Provide a transition from gravity flow to pressure flow.

1.2 OPERATION AND MAINTENANCE PROBLEMS

The manhole is usually installed either in the carriageway or in the boulevard of a road right-of-way. The replies of a survey received from 12 municipalities in Canada indicated that common operation and maintenance problems associated with manholes are summarized as follows:

A. Differential settlement occurs between the roadway and manhole. This condition imposes a potential hazard to motorists, bicyclists, and pedestrians year round.

B. The differential settlement around manholes in the pavement has a tendency to re-occur. This creates the need for continuous maintenance efforts and manhole repairs.

c. The repair or replacement of manholes in a boulevard can be disruptive and costly due to the presence of underground and/or above ground franchise utilities, sidewalks, trees, etc.

D. Ground water seeps into the sanitary sewer system through cracks and/or joints in the manhole. This additional inflow/infiltration (I/I) flow, which is not always accounted for in the sewer design has the following adverse impact:

- o Increased sewage treatment costs due to increased inflow volume.

  Increased probability of expansion to existing sewage treatment plants being required, if the additional inflow exceeds the plant capacity. Additional cost and effort to adjust the chemical dosage and equipment to cope with fluctuating inflow may also be necessary. Failure to respond to this increased flow results in higher risk of improper effluent treatment which is hazardous to the receiving water body and creates a detrimental effect on the environment.

- o Increased maintenance and operation costs due to additional capacity requirements for the sewage collection system and pumping stations.

- o Contributes to basement flooding.

- o Can cause additional combined sewer overflow into receiving water bodes.

With the advent of remote controlled equipment, it is no longer necessary for man entry manholes to accommodate inspection, cleaning and rehabilitation, and repairs. Changes in the mode of operation not only has the advantage of reducing the size of manhole and hence construction costs but also minimizes the potential risk of exposure to poisonous or explosive gases which can be present in a manhole. In view of the above, the need for a study to develop alternate sewer access may be timely and warranted.

1.3 OBJECTIVE

The prime objective of the study is intended to mitigate the problems associated with the standard manhole and to reduce subdivision servicing costs by introducing an economical, efficient, technically sound, and innovative structure to replace the standard manhole yet maintaining ease in operation and maintenance.

The study involved an extensive investigation and analysis of various configuration options and construction materials and methods, structural stability and hydraulic performance.

1.4 SCOPE

The study was confined to the upper reaches of storm and sanitary sewer systems and sewer pipe sizes not exceeding 450 mm in diameter. The reasons are as follows:

A. In the past, alternate sewer accesses such as cleanouts and lampholes, have been used in small size sewer systems and therefore an initial effort will concentrate on small size sewer systems only. If it is proven that an alternate sewer line access can be developed that is practical and cost efficient for a small size sewer system, a subsequent study should be carried out for large size sewer systems.

B. To limit the scope of work because of the limited funding available.

2.0 APPROACH

The study is an attempt to make use of the latest remote controlled sewer cleaning and inspection equipment to develop alternate sewer line access. Efforts have been made to identify the latest market available equipment and equipment that is currently being used by most municipalities.

The study was carried out in two phases. The first phase involved the development and evaluation of the significance of alternate sewer line accesses and the second phase will involve the construction and monitoring of a field model to verify its viability and merits.

2.1 PHASE 1

The work of this phase involves the development of the most favourable sewer line access option and evaluate its viability in terms of technical feasibility and cost effectiveness. The work included the following tasks:

A. Data Collection

The collection of available relevant information as follows:

- Research reports on current sewer collection system design and maintenance practices published in various engineering journals.

- Communication with a number of municipalities' engineering and maintenance staff to identify user needs, maintenance problems and concerns.

- Collection of information on current sewer cleaning and monitoring equipment as well as rehabilitation methods and materials.

- o Consultation with operations personnel from sewer cleaning, video inspection and flow monitoring organizations to determine the limitations of market available equipment.

- o Discussions with various pipe manufacturers to identify the suitability and pros and cons of available materials.

- o Evaluation and review of all data collected to determine the requirements for potential structures and availability of material for the construction.

B. Investigation of Potential Structure configuration Options

Based on the information obtained in the data collected above, a number of configuration options were developed.

C. Screening of configuration Options

A rating system comprising of four important physical and functional criteria was developed for the evaluation and identification of the configuration options. They are:

- o Structural: degree of structure stability.

- o Hydraulic: suitability of hydraulic performance regarding flow junction and flow transition.

- Operational: suitability for cleaning, video inspection and rehabilitation equipment, flow monitoring as well as ventilation of the sewer system.

- Maintenance: degree of susceptibility to debris accumulation and ease of repairs.

Each configuration option was evaluated and the option which had the highest rating was selected for detailed evaluation.

D. Detailed Evaluation of Selected Option

The detailed evaluation of the selected option involved the following:

- assessment of configuration using various materials available.

- evaluation of construction methods.

- performed hydraulic calculations in respect to flow patterns and friction losses through the structures.

- construction cost estimates for various materials.

- submission of the selected option to municipalities, manufacturers, and sewer inspection and cleaning organizations for comment.

- refinement of the selected option in accordance with feedback from various sources.

E. Preparation of Interim Report

An interim draft report was prepared to document the findings in Phase 1. This report was submitted to CMHC and the City of Edmonton to substantiate the value of advancement to Phase 2 of the project.

2.2 PHASE 2

The work of this phase is to construct a field model and carry out monitoring to determine the potential saving of the proposed sewer line access in operation and maintenance costs.

A. Construction of a Field Model

A field model for the preferred option will be constructed by the City of Edmonton for performance evaluation.

B. Performance Monitoring

The structure will be evaluated and tested in respect to structural integrity, hydraulics, maintenance and operations performance. The results of the tests and evaluation are documented in the final report.

It is planned that two video camera inspections will be carried out at the end of 6 and 12 months after installation.

C. Preparation of Final Report

A final report was prepared which presented the results of all evaluations, calculations, cost estimates, design, construction methods and recommendations.

3.0 DATA COLLECTION AND REVIEW

The data which has been collected and reviewed is summarized as follows:

3.1 COMMENTS FROM MUNICIPALITIES

Thirty-four municipalities in a number of provinces were contacted to provide information on sewer maintenance facilities, practices and major issues as well as to solicit innovative input on sewer line access options. Only twelve municipalities responded. Comments from these municipalities are attached in Appendix "A" and are summarized as follows:

Generally, none of the municipalities who provided us with comments are aware of any alternate sewer pipe access currently being used but they are all interested in developing an innovative structure that would improve the problems associated with manholes such as differential settlement, leakage and frost heaving. Some of the municipalities have attempted to rectify these problems by a range of methods:

3.1.1 Mitigation of Problems

A. Differential Settlement:

- o Flat manhole top instead of cone top.
- o Floating manhole frame and cover.
- o Precast concrete adjustment ring or cast-in-place concrete ring constructed with concrete having a strength of 35 Mpa at 28 days, air entrainment of 5% - 8% and water/cement ratio of 0.40 maximum.
- o "Set 45" epoxy mortar to construct a 20 mm minimum thickness bedding for the manhole frame and cover.

B. Leakage:

- o Rubber gasket joint.
- o Rubber neck.
- o Kent seal.

C. Frost Heaving:

- o Clean gravel backfill around manhole.

3.1.2 Cleaning

For sewer cleaning, all municipalities generally employ a power flusher with a vacuum unit. Occasionally, a rodding and bucket machine will be used.

3.1.3 Inspections

For sewer inspections, both video camera and visual inspections are being used by all municipalities.

3.2 MANUFACTURERS

A. Sewer Inspection Equipment

- o Image Inspection Services Ltd., Calgary, Alberta

B. Sewer Cleaning Equipment

- o Aquatech, Inc., Calgary, Alberta

C. Flow Monitoring Equipment

- o Greyline Instruments Inc., Toronto, Ontario

D. Pipe and Fittings

- CRP Products & Manufacturing Ltd., Edmonton, Alberta - polyethylene pipe
- IPEX Inc., Edmonton, Alberta - PVC pipes
- Big 'O' Inc., Taber, Alberta - corrugated polyethylene pipe
- Hydro Systems Ltd., Edmonton, Alberta - concrete pipe
- Armtec Construction Products, Edmonton, Alberta - corrugated steel pipe

E. Access Frame and Cover

- Norwood Foundry Ltd.

3.3 SEWER OPERATION AND MAINTENANCE ORGANIZATIONS

A. Sewer Inspection

- I.S. Inspection Services Ltd.

B. Flow Monitoring

- Hydro Data Services Inc.

3.4 UNIT PRICES

- IPEX Inc.
- Norwood Foundry Ltd.
- Hydro Systems Ltd.
- Raywalt Construction Co. Ltd.
- Lafarge Construction Materials
- CRP Products & Manufacturing Ltd.

3.5 ENGINEERING PUBLICATIONS

A literature search was carried out to identify various engineering publications containing topics which address alternate sewer line access. It was found that cleanouts and lampholes have been used in sewer systems in the past, as an economy measure. These accesses are described as follows:

A. Cleanout

A cleanout consists of a light cast iron frame and cover and a line of pipe connected to the sewer with bends so that cleaning equipment can pass through it. The various types of cleanouts that have been constructed are shown in Fig. 1.

The City of Dallas installed cleanouts on 150 mm and 200 mm diameter sewers at 75 m to 90 m intervals and at the upper ends of laterals, except at junctions. Also, some municipalities allow a cleanout to be installed at the upper end of a sewer within 45 m to 60 m of a manhole.

B. Lamphole

A lamphole consists of a vertical 200 mm diameter pipe connecting to the sewer with a tee and having a light frame and cover at the street surface. It allows the sewer to be inspected by lowering a light and sighting from the adjacent manholes but does not allow cleaning equipment to enter the sewer. Lampholes are seldom used.

Engineering publications and references that were referred to in carrying out this study are shown in Appendix "B".

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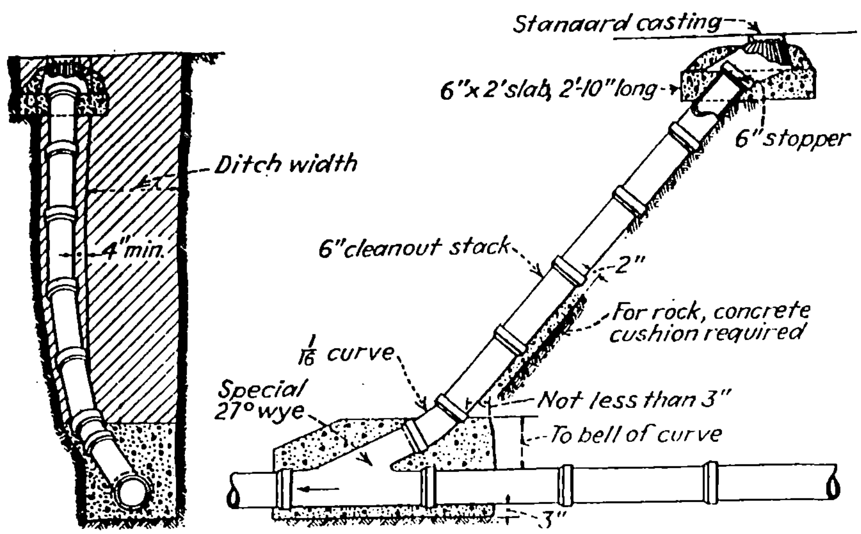
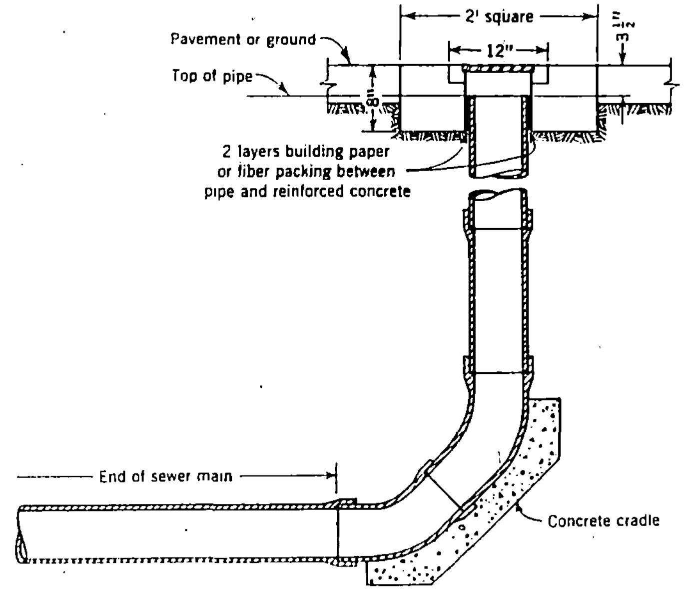


STANDARD CLEANOUT USED BY THE CITY OF DALLAS

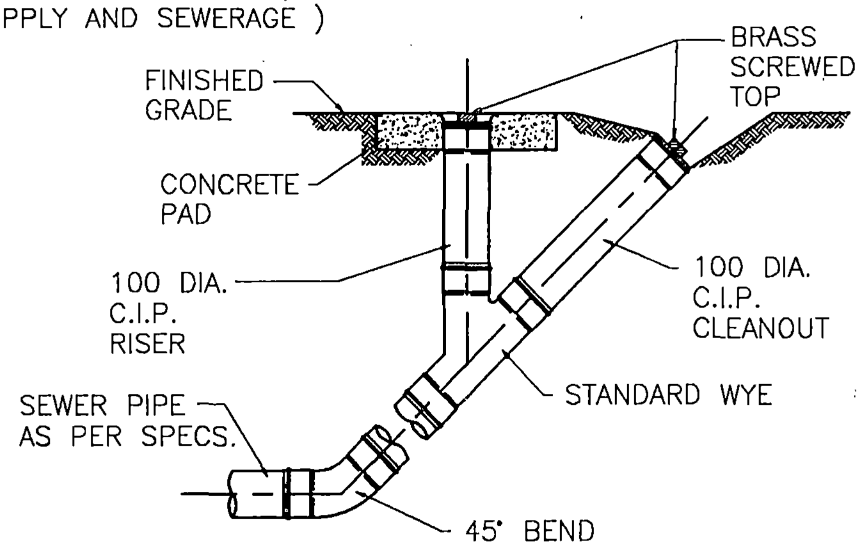
(COURTESY OF STEEL, WATER SUPPLY AND SEWERAGE)



Note:
Cleanout line to be of the same diameter and material as sewer main

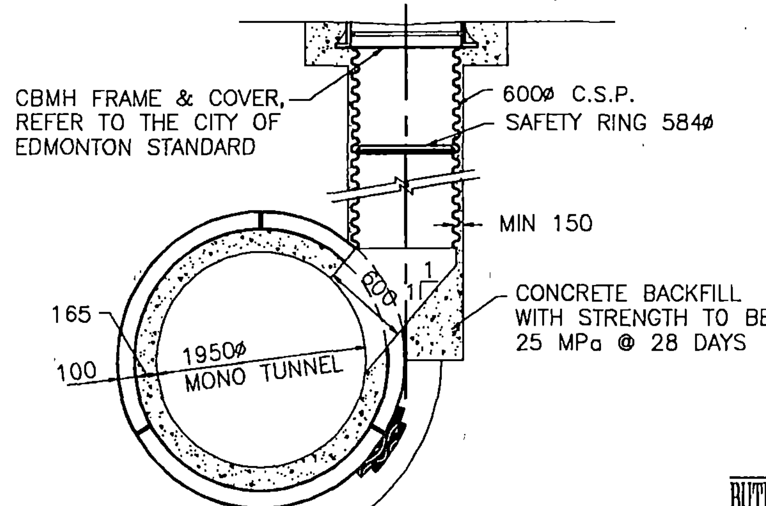
TERMINAL CLEANOUT

(COURTESY OF ASCE DESIGN AND CONSTRUCTION OF SANITARY AND STORM SEWERS)



TYPICAL END OF LINE CLEANOUT

(COURTESY OF ALBERTA RECREATION AND PARKS)



DRILL DROP

(COURTESY OF THE CITY OF EDMONTON)

FIG. 1

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C. Drill Drop

A drill-drop consists of a 600 mm diameter corrugated steel pipe encased in 75 mm thick concrete. The drill drop is used to ventilate tunnels and connect sewers to deep tunnels. The top of a ventilation drill drop would be a standard manhole frame and cover embedded in a concrete slab while a sewer connection drill drop has an entrance at the bottom of a manhole.

4.0 DESIGN CRITERIA

Based on the information obtained from various sources as stated in Section 3, the design criteria for sewer line access was established as follows:

4.1 STRUCTURAL

A. All connections should meet the following minimum leakage requirements:

Polyvinyl Chloride & Polyethylene Pipe & Fittings: 5.0 L/dia./mm/dia./km.
Concrete Pipe & Fittings: 20.0 L/day/mm/dia./km.

B. Configuration should be such that it is simple to assemble and easy to construct.

C. Use market available materials whenever possible and use specially fabricated fittings only when an alternative is not possible or is more cost effective.

d. Use strong and durable material, with high resistance to corrosion and abrasion.

E. Minimize infiltration potential.

F. Minimize settlement potential.

4.2 HYDRAULIC

A. Minimize potential of turbulent flow, ie. promote streamline flow.

4.3 OPERATION

A. The access must be large enough to allow the entry of video inspection, sewer cleaning and rehabilitation equipment. For sewer cleaning the access should have enough space to accommodate a pressure flushing hose and a 200 mm ⌀ solid vacuum hose. The minimum radius for the tee at the bottom of the access is shown in Table 1 below.

TABLE 1

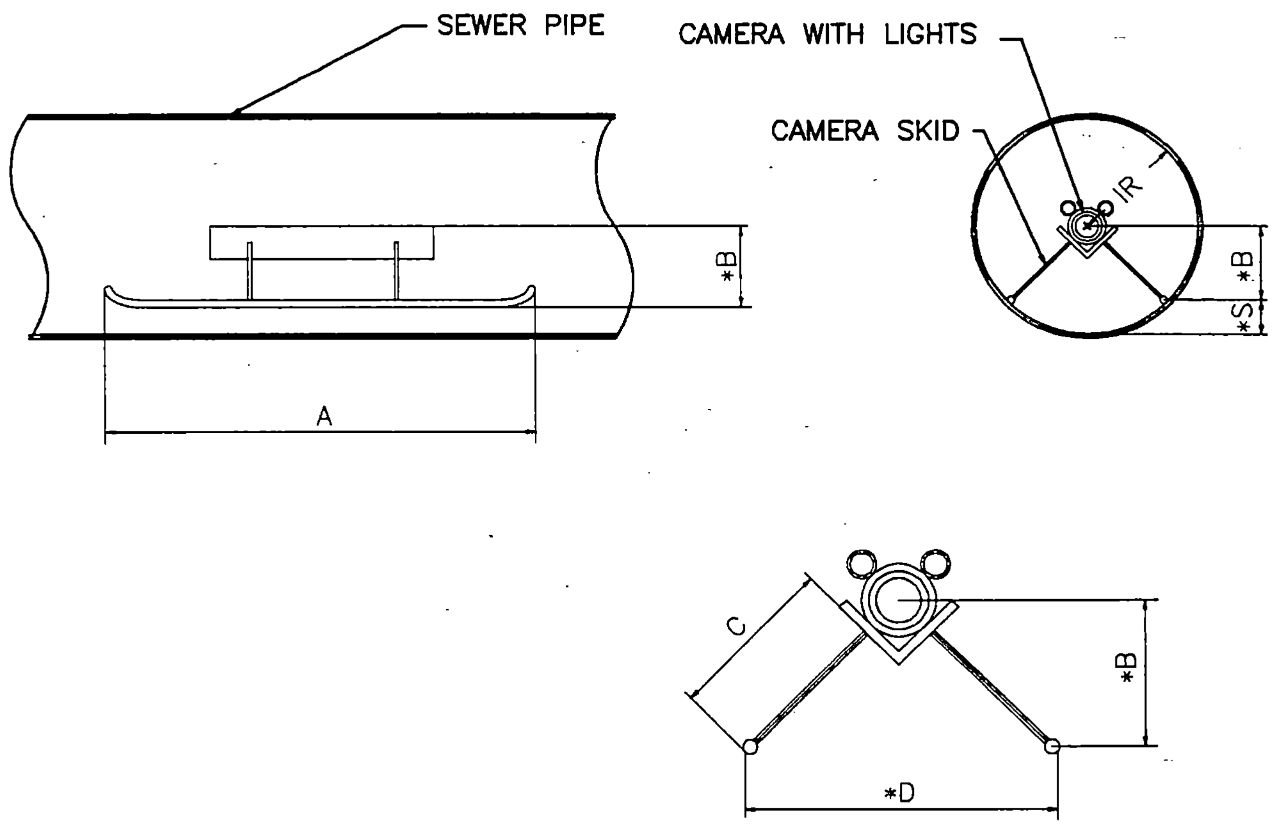
MINIMUM TURNING RADIUS

Pipe Diameter (mm)	Outside Radius (mm)	Radius (mm)
200	300	600
250	300	600
300	300	600
375	375	750
450	450	900
525	525	1050
600	600	1200

The radius as shown in Table 1 was determined on the basis of the size of the skid used for the video inspection equipment shown on Fig. 2 and therefore the access is easily accessible by all video camera inspection and cleaning equipment.

NOMINAL PIPE SIZE ASTM D 3034 DR 35	ACTUAL INSIDE DIA.	A	*B	C	*D	*S
150	150.24	432	41	38	82	12
200	201.17	483	55	57	109	16
250	251.46	533	73	83	145	23
300	299.21	584	95	114	190	34
375	366.42	635	122	152	244	46
450	446.10	686	158	203	316	65

REMARKS : ALL DIMENSIONS ARE IN MILLIMETRES
" * " DENOTES APPROXIMATE DIMENSION
DATA BASED ON INFORMATION SUPPLIED BY ISI



CAMERA SKID WITH EXTENSION

VIDEO INSPECTION EQUIPMENT

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FIG. 2

DRAWN WITH CAD 10/22/94 14:33 D:\-3203C.MHC\AFIG2C 1:10

B. The horizontal part of the access should have adequate cross fall and hence flushing velocity to avoid accumulation of debris at the bottom of the access.

C. The bottom of the access should be visible from the surface, so that the bottom of the access can be seen by video inspection personnel.

4.4 MAINTENANCE

A. Provide ventilation for sewer.

5.0 SEWER PIPE ACCESS CONFIGURATION OPTIONS

Based on the design criteria as stated in Section 4, the following sewer pipe access configuration options were developed.

Generally, to accommodate video inspection equipment, an access should have a size equivalent to the size of the sewer pipe to be inspected. However, to accommodate a power flusher with a 200 mm diameter vacuum hose unit for sewer cleaning, the minimum diameter of an access would have to be 300 mm. Because of the minimum diameter requirement, the connection of the sewer line access to a sewer main with a diameter less than 300 mm will require additional reducers or increasers.

5.1 OPTION 1

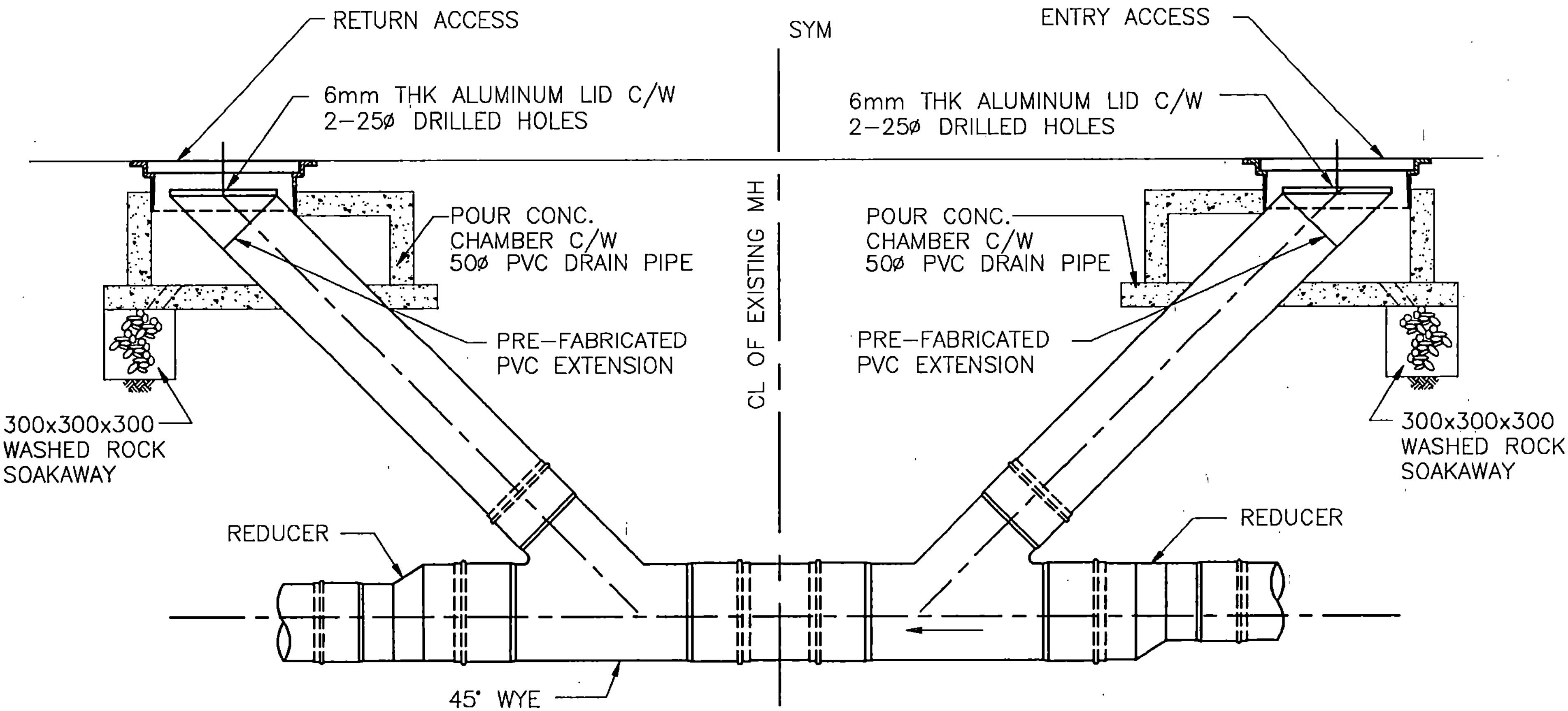
This option requires two accesses; one for the entry of video inspection and cleaning equipment, and the other one for the return of the equipment. The conceptual design of this option is shown in Figures 3 and 4 and the layout for various pipe junctions is shown on Figure 5.

There is no advantage to this option in comparison with the other two options.

The disadvantages of this option are:

- double entry
- inclined access
- longer access
- higher construction cost
- difficult to compact backfill between pipes
- potential settlement

DRAWN WITH CAD 10/22/94 15:28 D:\-3203C.MHC\AFIG3C 1:25



CONCEPTUAL DESIGN OF OPTION '1'

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FIG. 3

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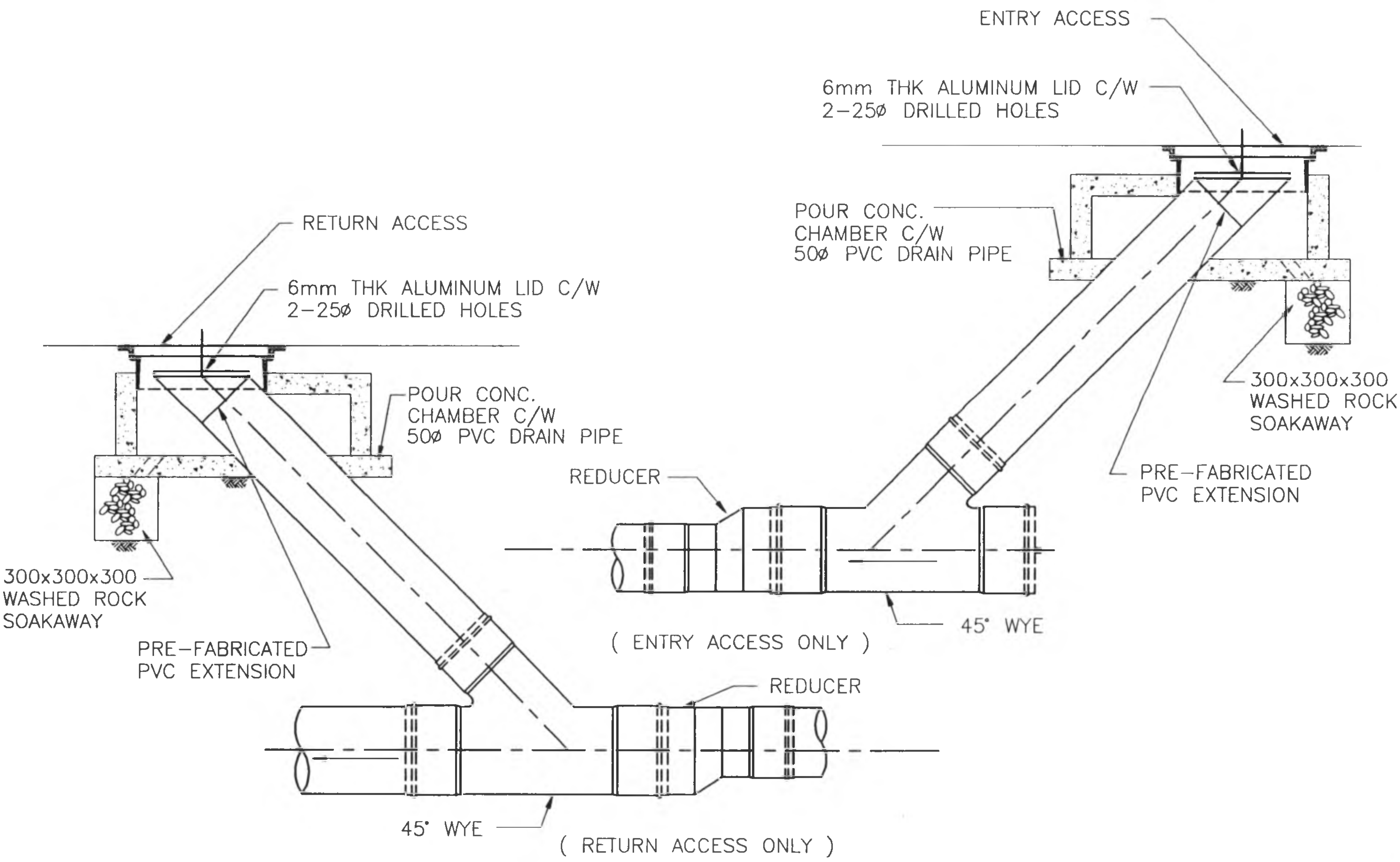

CONCEPTUAL DESIGN OF OPTION '1'

(SEPARATE ENTRY & RETURN ACCESS)

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FIG. 4

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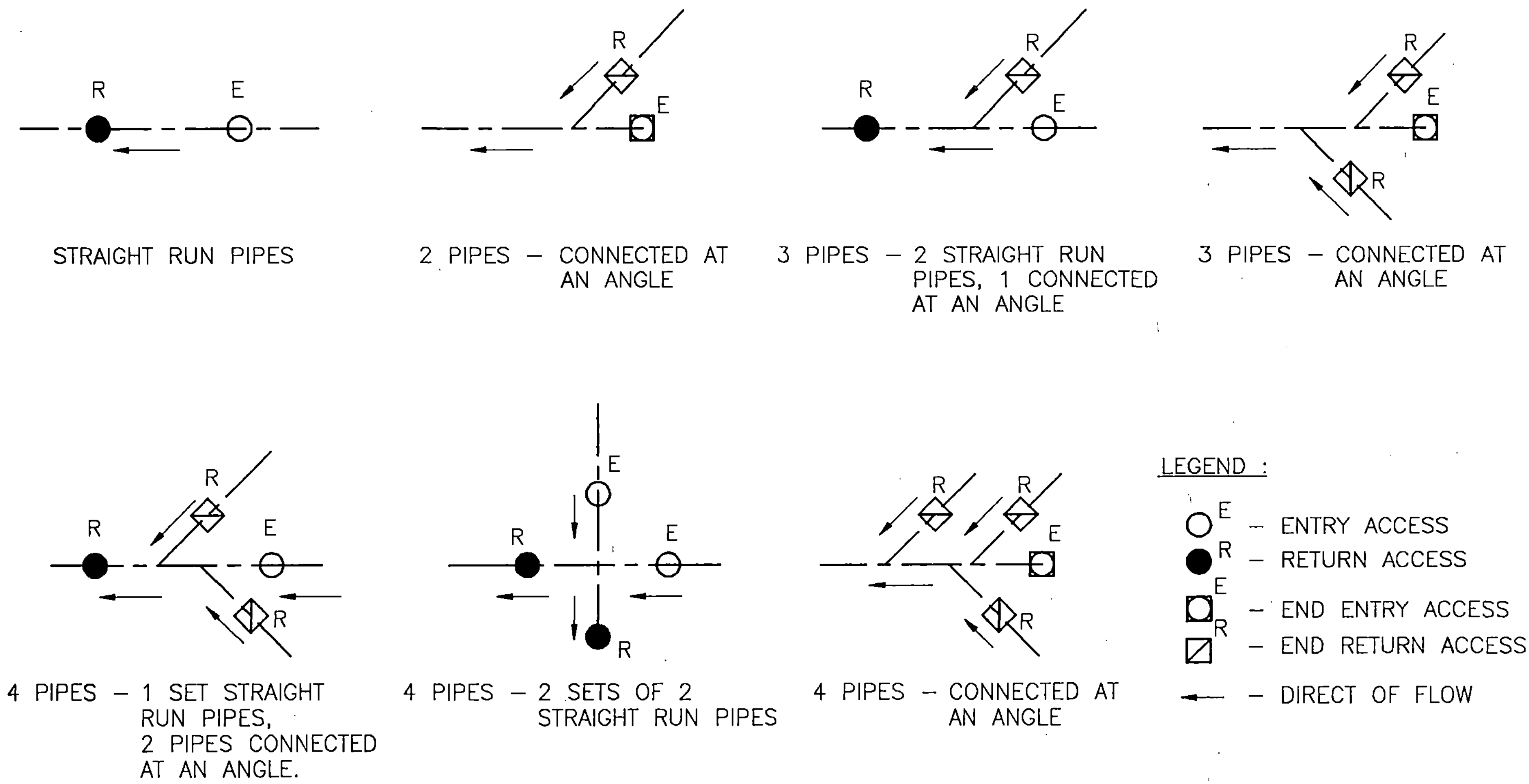

LAYOUT OF OPTION '1' FOR VARIOUS PIPE JUNCTIONS

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FIG. 5

5.2 OPTION 2

This option requires a single entry with a double wye at the upper section of the chimney of the access to provide an entry and return access for the video inspection and cleaning equipment. The conceptual design is shown in Figures 6 and 7 and the layout for various pipe connections for this option is shown in Figure 8.

The advantage of this option is:

- o single entry

The disadvantages of this option are:

- o double wye is a standard fitting only for polyvinyl chloride and ductile iron pipe. For other materials, prefabrication of this fitting would be necessary.
- o poor compaction in the triangular area below the sloping portion.

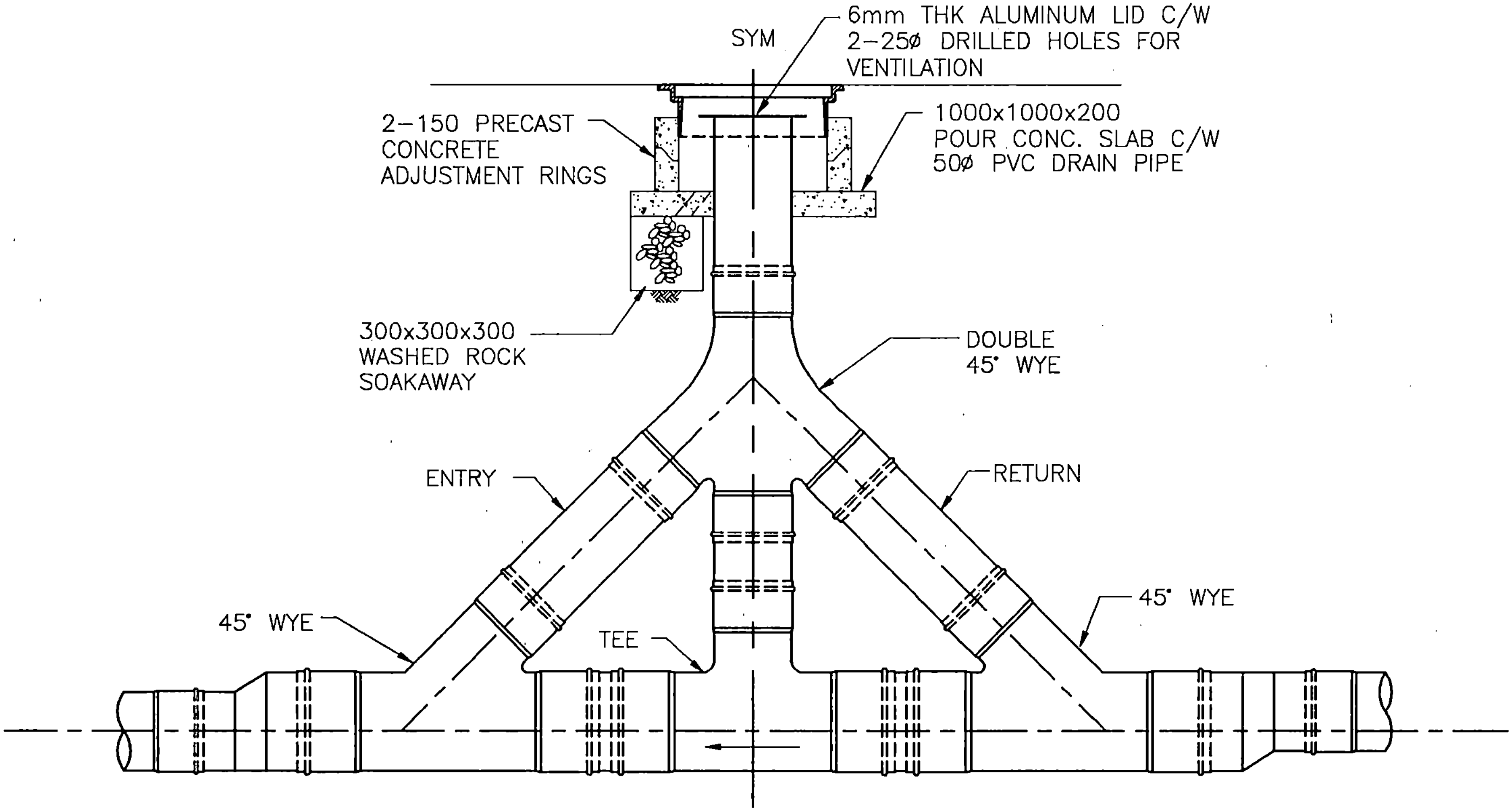
5.3 OPTION 3

The option also has a single entry and utilizes a tee that provides adequate space for the video inspection, cleaning and rehabilitation equipment to enter the sewer system. The conceptual design and layout for various pipe connections is shown on Figures 9 and 10, respectively.

The advantages of this option are:

- o simple to assemble
- o single entry
- o good compaction around access and therefore future settlement will be minimized
- o constructed with standard pipe fittings and manhole frame and cover.

There is no disadvantage of this option in comparison with the other two options.



CONCEPTUAL DESIGN OF OPTION '2'
(ENTRY AND RETURN COMBINED ACCESS)

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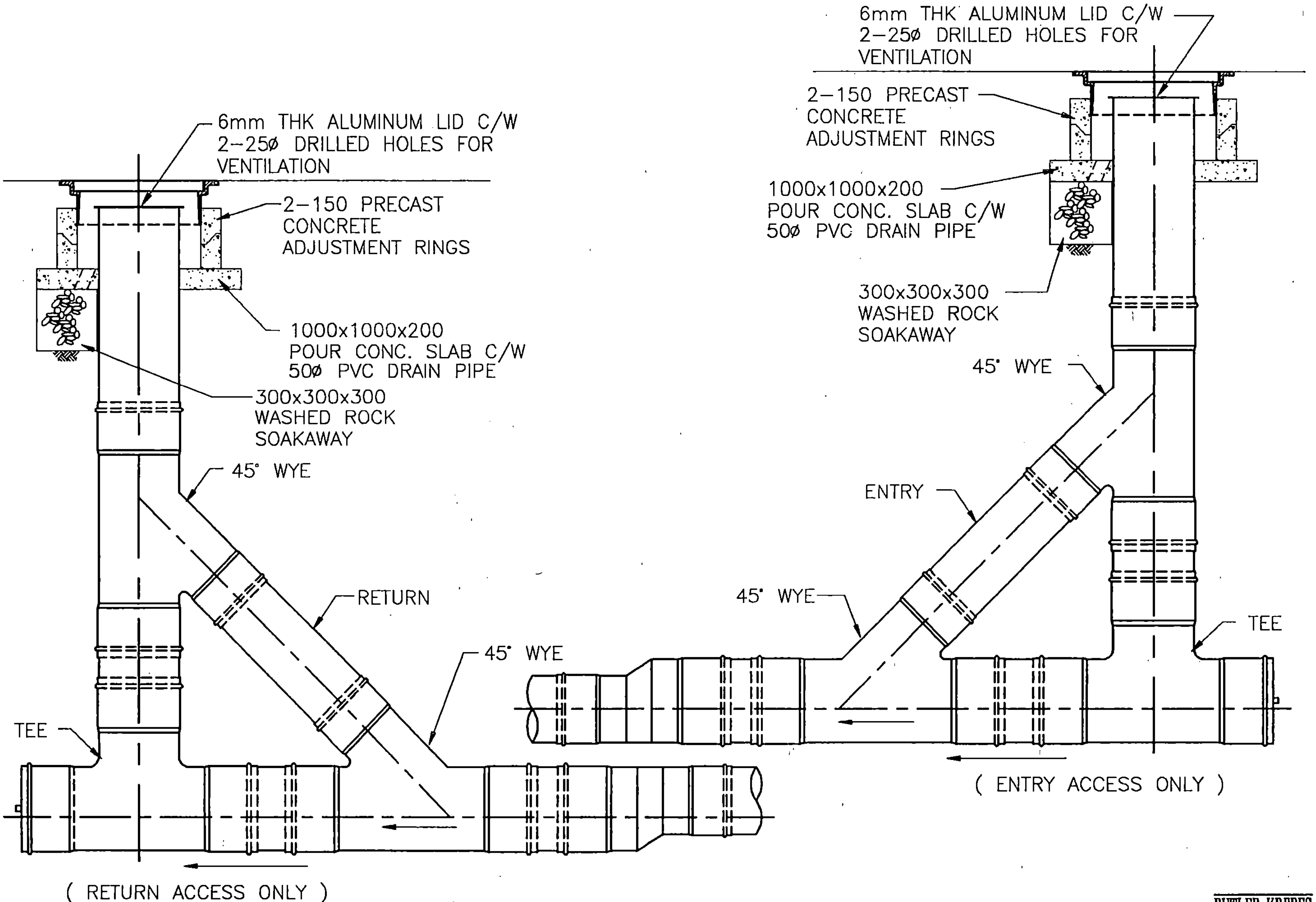
FIG. 6



CONCEPTUAL DESIGN OF OPTION '2'

(SEPARATE ENTRY AND RERTURN ACCESS)

FIG. 7

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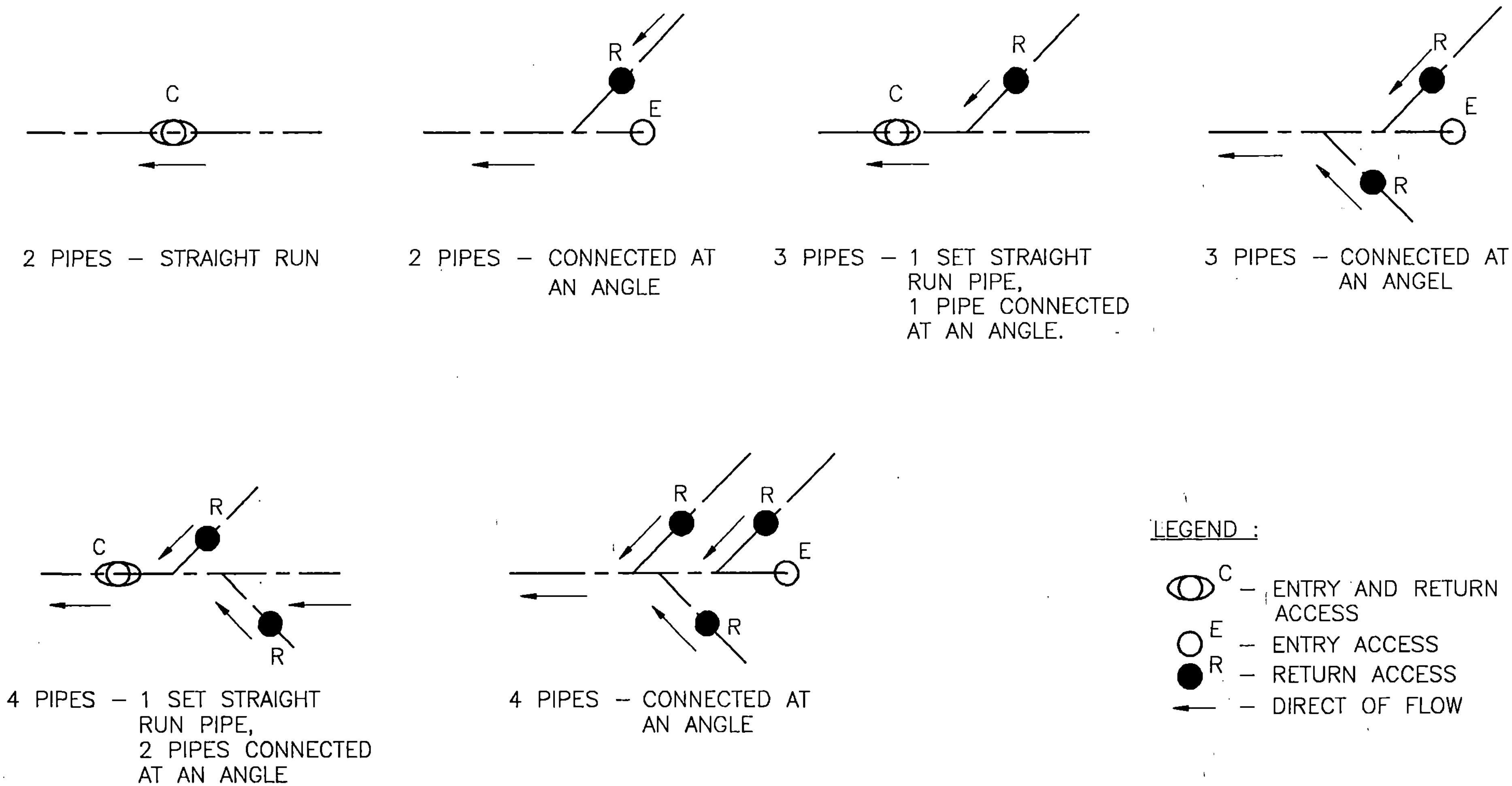

LAYOUT OF OPTIONS '2' FOR VARIOUS PIPE JUNCTIONS

FIG. 8

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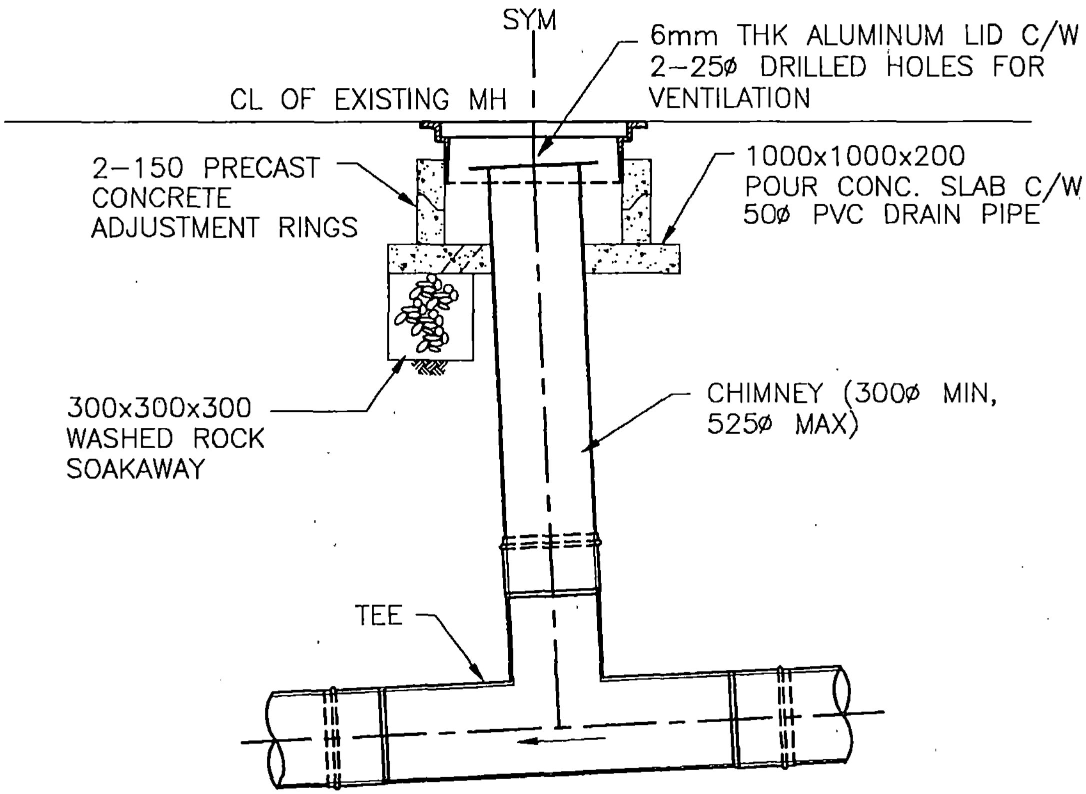

CONCEPTUAL DESIGN OF OPTION '3'

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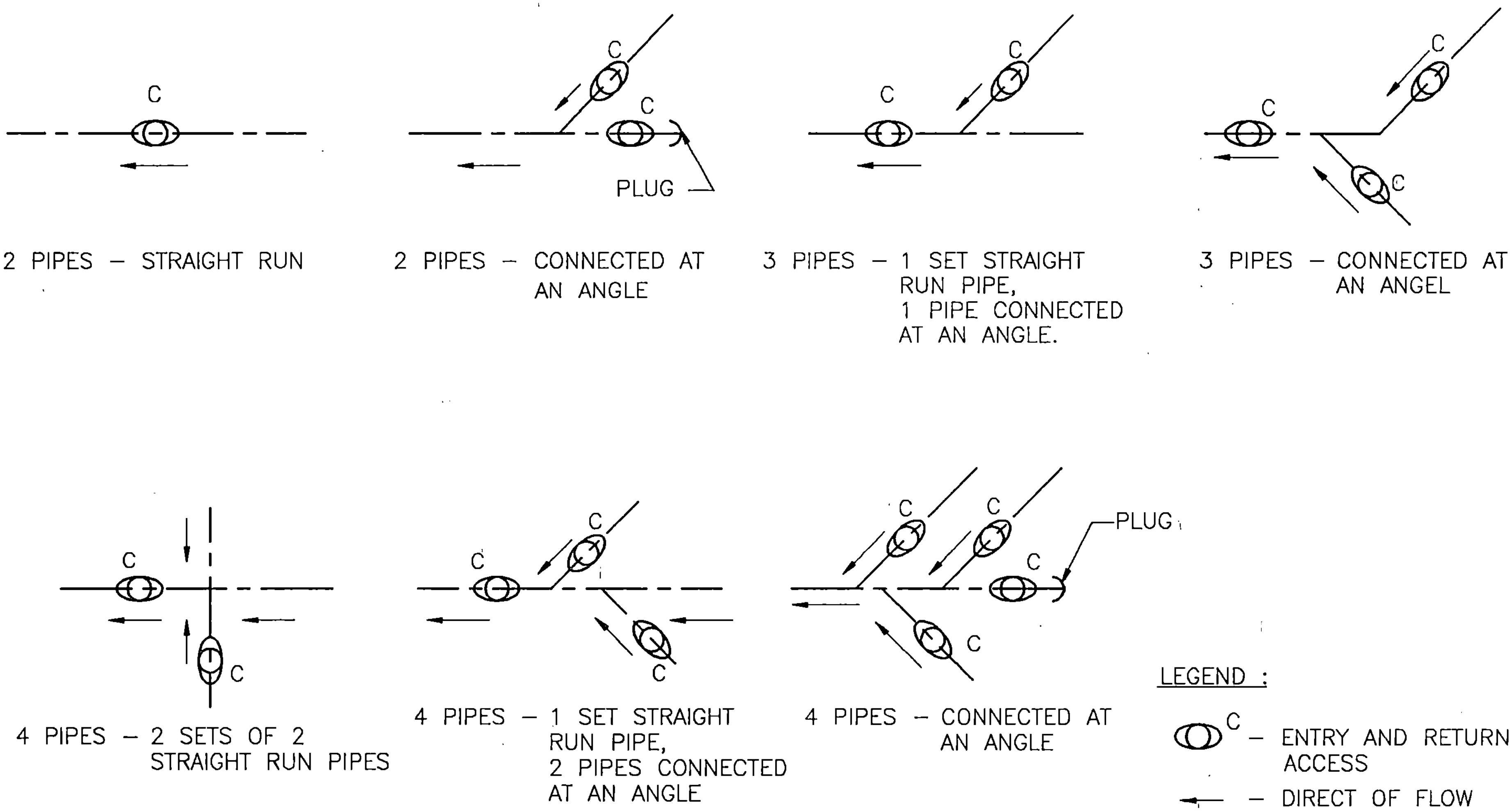
FIG. 9



LAYOUT OF OPTIONS '3' FOR VARIOUS PIPE JUNCTIONS

FIG. 10

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5.4 COMPARISON OF CONFIGURATION OPTIONS

The evaluation and comparison of the options are shown in Table 2 below.

TABLE 2

COMPARISON OF CONFIGURATION OPTIONS

Description	Option 1					Option 2					Option 3				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Structural Stability			x						x						x
Hydraulic Performance			x					x							x
Operation					x				x					x	
Maintenance					x		x								x
Ease in Construction			x					x							x
Requirement of Special Fittings					x			x							x
Construction Cost		x				x									x
TOTAL SCORE	26					20					34				

Note: 1 means lowest in score.

As shown in Table 2, Option 3 ranks the highest and therefore, Option 3 is the preferred configuration.

6.0 PREFERRED SEWER LINE ACCESS

The preferred sewer line access consists of a chimney supported on a tee and complete with a cover.

The chimney of the sewer line access is constructed with a piece of straight pipe and should have a diameter equal to the sewer main or 300 mm minimum to accommodate cleaning and video inspection equipment.

The tee could be a standard fitting or a prefabricated fitting. A prefabricated tee would ideally have a smooth turning radius as stipulated in Table 1 rather than the usual tee configuration with a sharp 90° turn. However, due to difficulties in fabrication, the smooth curve is replaced with a straight section that also provides more maneuvering space for the equipment than a curved section would.

If the sewer line access is constructed using standard fittings, the tee at the bottom of the access would usually be one or two sizes larger than the sewer pipe size. The oversized tee is required to provide adequate space for the video inspection and cleaning equipment to enter the sewer pipe. The connection of the tee to the chimney will require a concentric reducer. Generally, a concentric reducer is more costly than a pipe and therefore, to minimize the construction cost, a larger pipe is used to replace the reducer for the construction of the chimney. As a result of this cost saving measure, the minimum size of the chimney will be 375 mm in diameter.

The concrete chamber is constructed with a 200 mm thick poured concrete base and a 50 mm diameter drain pipe on top of a washed rock soakway. Two 150 mm high precast concrete adjustment rings will then be placed on the base to form a round chamber.

The sewer line access can be accessed easily by any sewer video camera inspection and cleaning equipment.

6.1 CONSTRUCTION DETAILS

6.1.1 Straight Run Pipes

A. Sewer Line Access Constructed with Standard Fittings

As shown on Figure 11, two reducers will be required to connect the sewer line access to a sewer main.

B. Sewer Line Access Constructed with Special Fittings

As shown on Figures 12 and 13 for sewer pipe of 300 mm diameter and smaller, the sewer line access could be connected with two reducers to the sewer main. For sewer pipe larger than 300 mm diameter, the sewer line access could be connected directly to the sewer main.

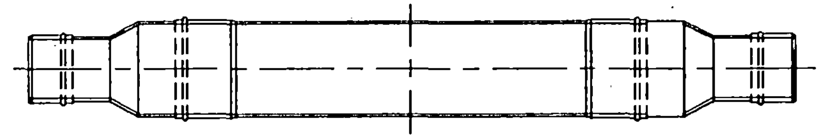
C. Upstream and Downstream Sewer Main of Different Sizes

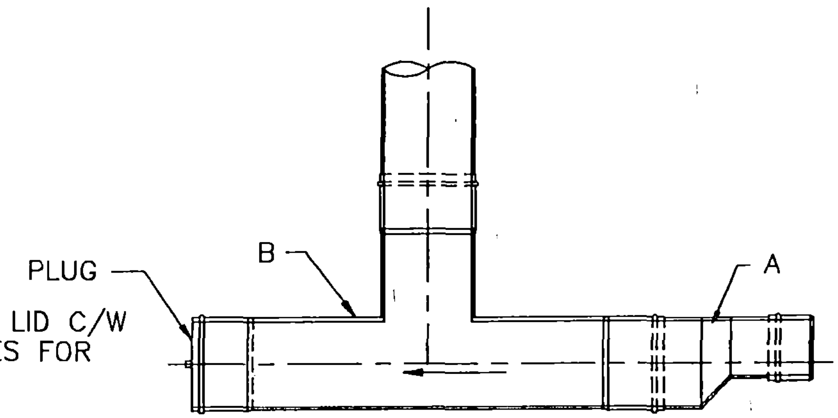
As shown on Figure 14, the size of the tee used on the sewer line access will be the same as the downstream sewer main. In order to keep the downstream sewer water level not higher than the upstream sewer, an eccentric reducer will be required for the connection of the sewer line access to the upstream sewer.

STRAIGHT PIPE ACCESS
MARKET AVAILABLE PVC FITTINGS

PIPE DIAMETER	A ECCENTRIC INCREASER	B TEE	ACCESS COVER **
200	200x375	375	NF-90-FC
250	250x375	375	NF-90-FC
300	300x450	450	NF-90-FC
375	375x450	450	NF-90-FC
450	450x525	525	NF-90-FC

REMARKS : " ** " MANUFACTURED BY NORWOOD FOUNDRY


SECTION X



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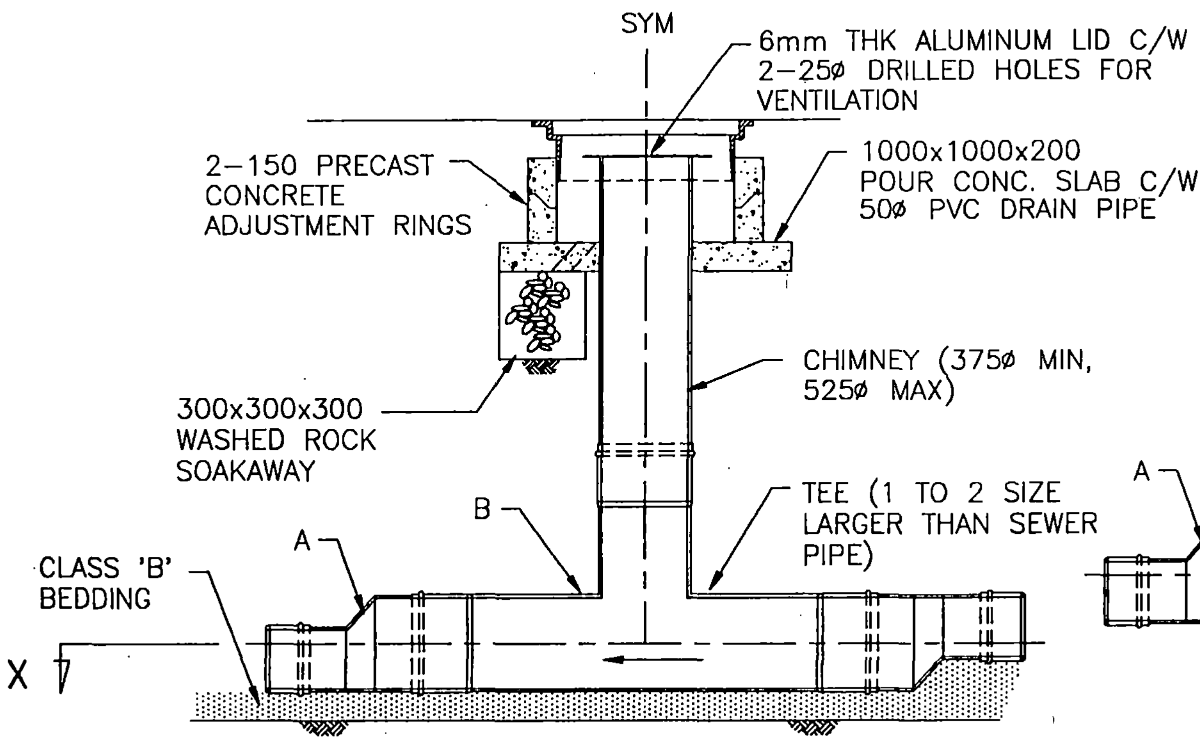

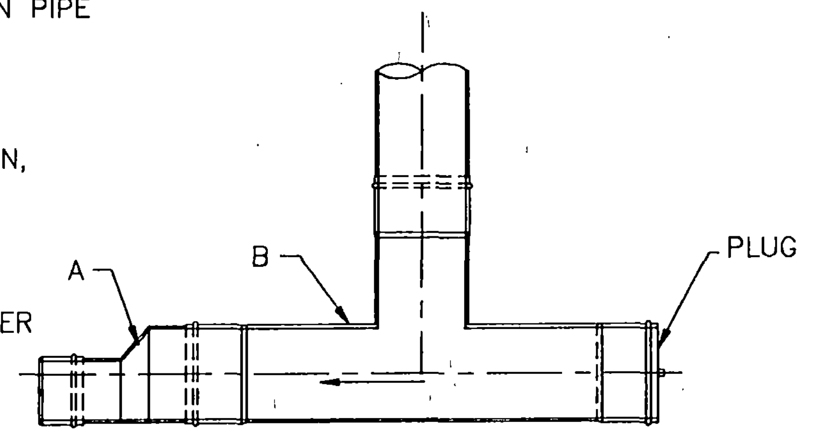

(ENTRY ACCESS ONLY)

OPTION '3' - TWO PIPES CONSTRUCTION WITH MARKET AVAILABLE FITTINGS

FIG. 11

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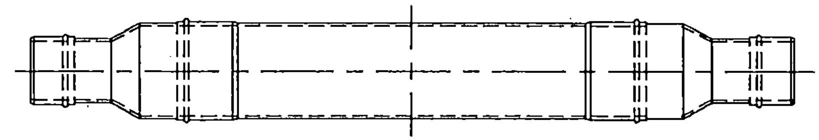
STRAIGHT PIPE ACCESS
PREFABRICATED PVC FITTINGS

PIPE DIAMETER	A ECCENTRIC INCREASER	B TEE	ACCESS COVER**	R
200	200x300	300	NF-90-FC	600
250	250x300	300	NF-90-FC	600

REMARKS : " * " NOT REQUIRED
" ** " MANUFACTURED BY NORWOOD FOUNDRY



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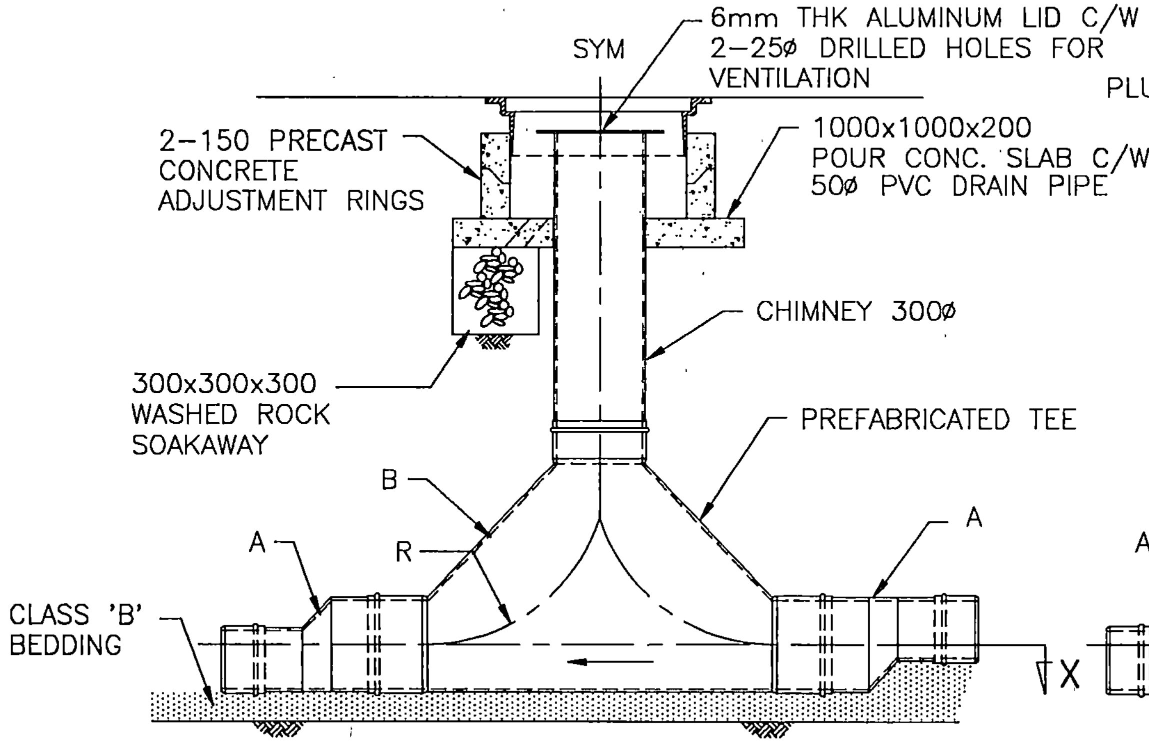

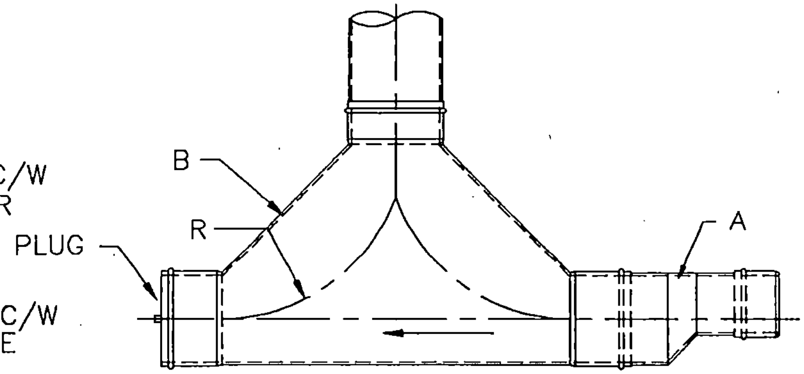

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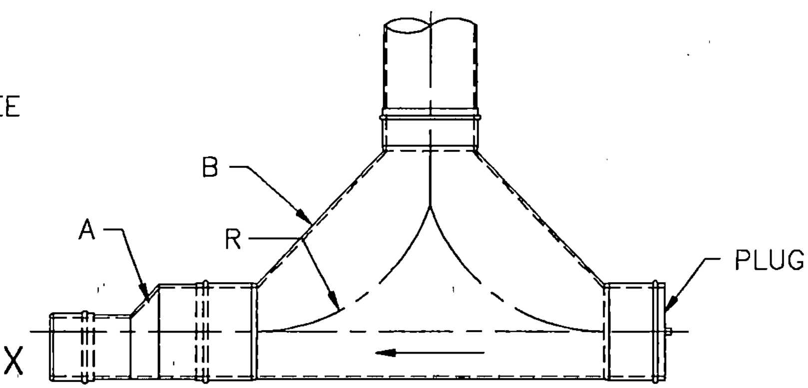

(ENTRY ACCESS ONLY)

OPTION '3' - TWO PIPES CONSTRUCTION WITH PREFABRICATED FITTINGS

(FOR SEWER PIPES DIAMETER LESS THAN 300 mm ø)

FIG. 12

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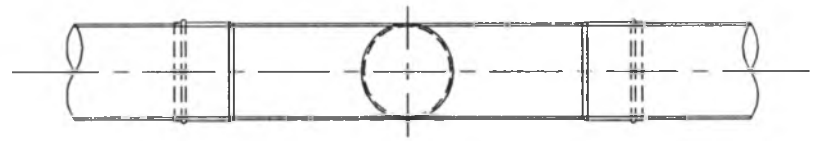
STRAIGHT PIPE ACCESS
PREFABRICATED PVC FITTINGS

PIPE DIAMETER	A ECCENTRIC INCREASER	B TEE	ACCESS COVER**	R
300	300x300	300	NF-90-FC	600
375	*	375	NF-90-FC	750
450	*	450	NF-90-FC	900

REMARKS : " * " NOT REQUIRED
" ** " MANUFACTURED BY NORWOOD FOUNDRY



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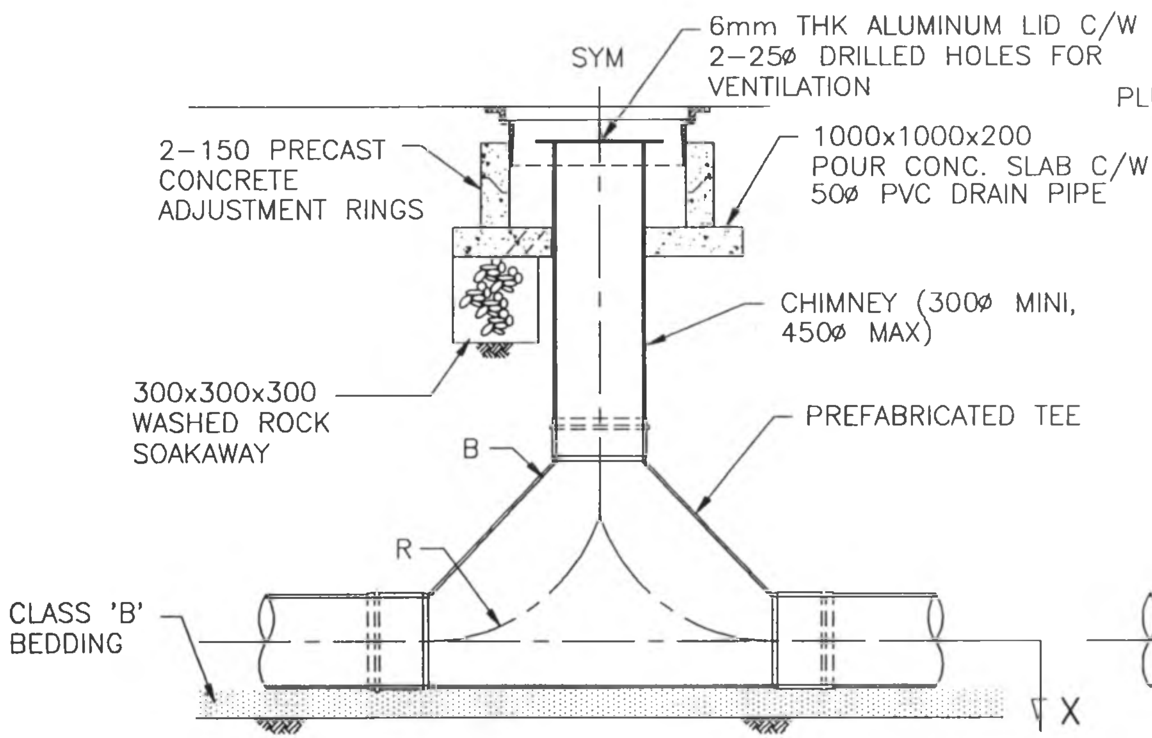

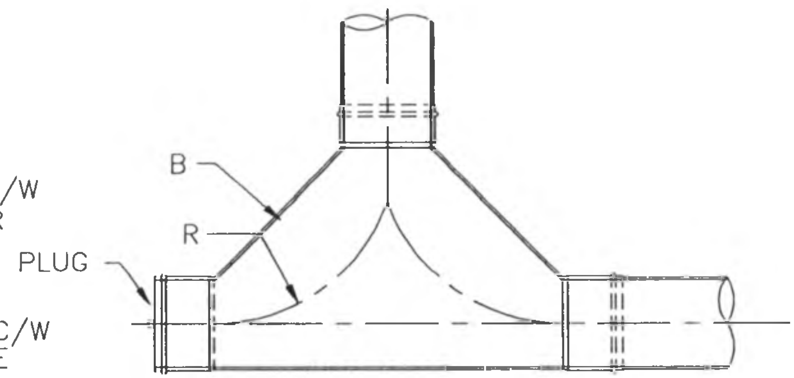

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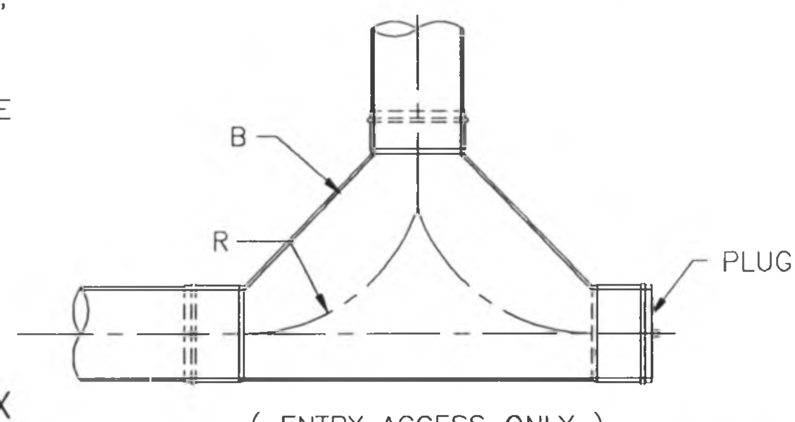

(ENTRY ACCESS ONLY)

OPTION '3' – TWO PIPES CONSTRUCTION WITH PREFABRICATED FITTINGS

(FOR SEWER PIPES DIAMETER OF 300 mm ø AND LARGER)

FIG. 13

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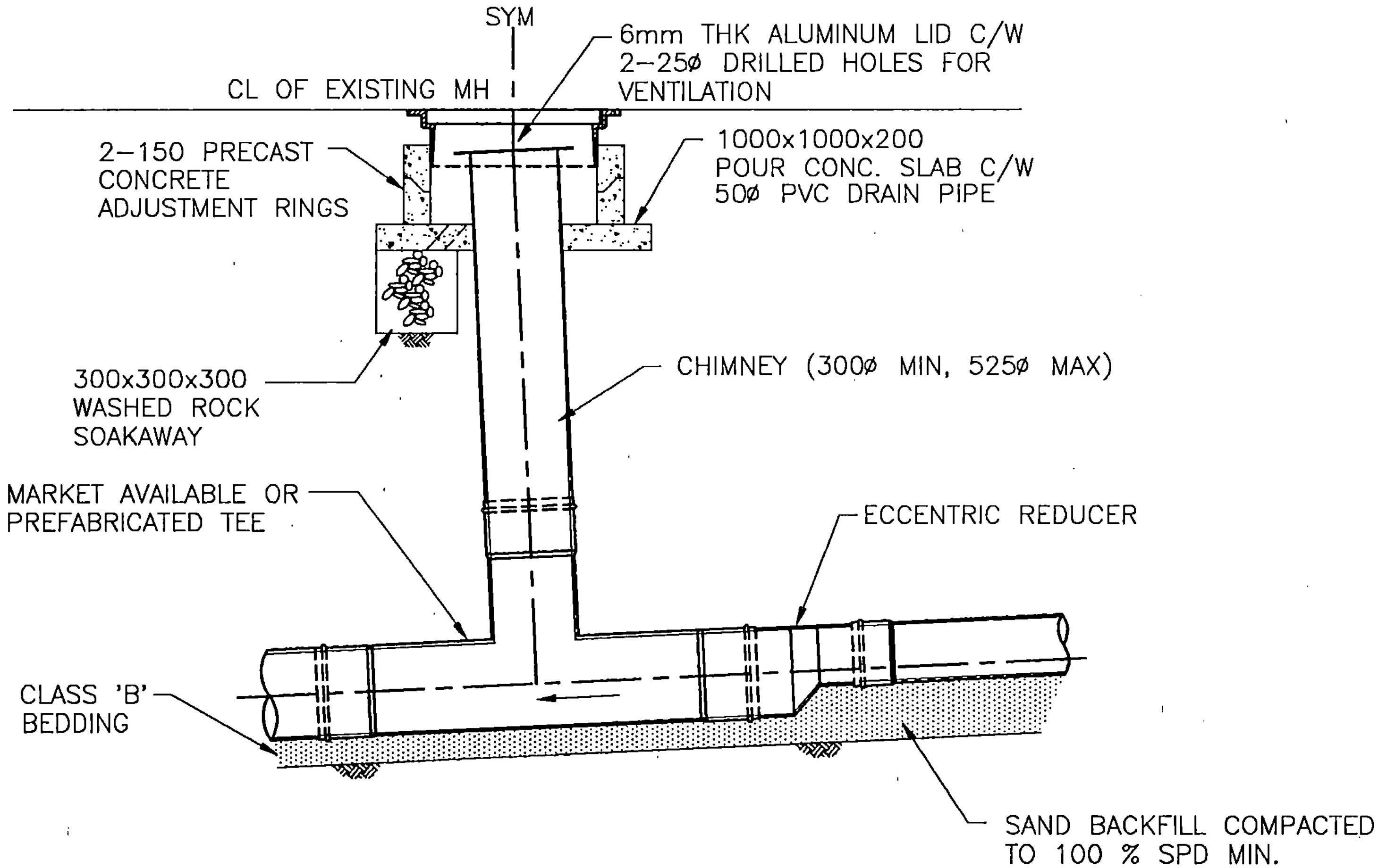

CONNECTING VARIOUS SIZE PIPES

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FIG. 14

D. Upstream and Downstream Sewer Main with Different Slopes

As shown in Figure 15, the tee for the sewer line access will be installed with the same slope as the upstream sewer main. The exception is when the drop is insufficient to streamline the flow through the access section, then the sewer line access will be installed to meet the drop required. The downstream and/or upstream sewer pipe will be connected to the tee with an offset in the joint. This will not exceed the maximum offset recommended by the manufacturer. Generally, the allowable offset is in the range of 2° to 2.5° that is equivalent more or less to a 4% change in slope.

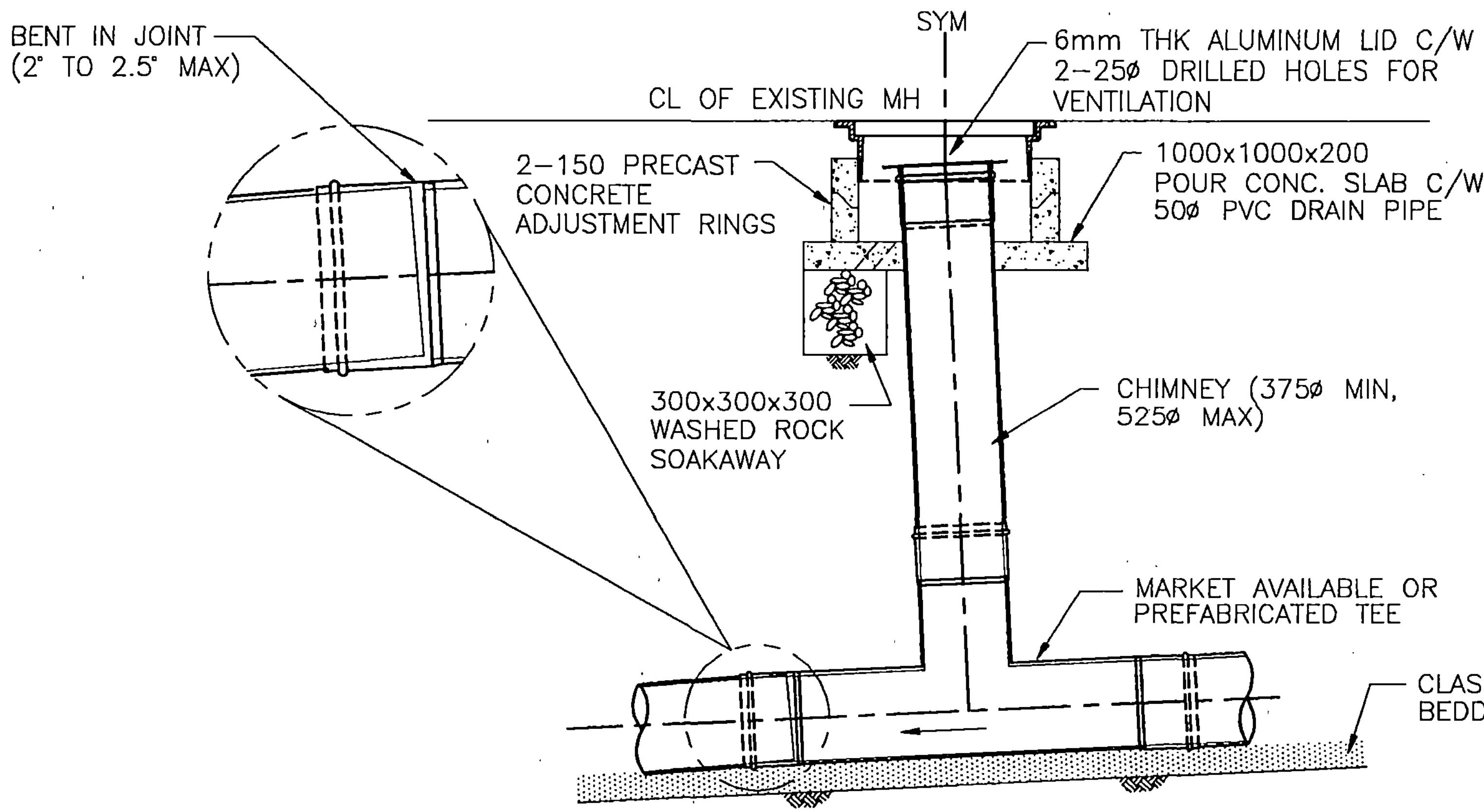
E. Drop Structure

As shown on Figure 16, the drop of the downstream sewer pipe could be achieved by connecting the upstream pipe into a tee in the chimney of the sewer line access. For structural stability, the space between the bottom of the upstream sewer main and the bottom of the access will be required to be backfilled with fillcrete.

This drop structure is not recommended since high abrasion may occur at the wall of the access where the velocity of the sewage stream would be excessive.

6.1.2 Location of Access Cover

As shown on Figure 17, the access cover could be located along the sewer main or at any location by rotating the tee of the sewer line access. Depending on the size of the sewer main, a larger concrete base for the



CONNECTING PIPE WITH DIFFERENT SLOPES

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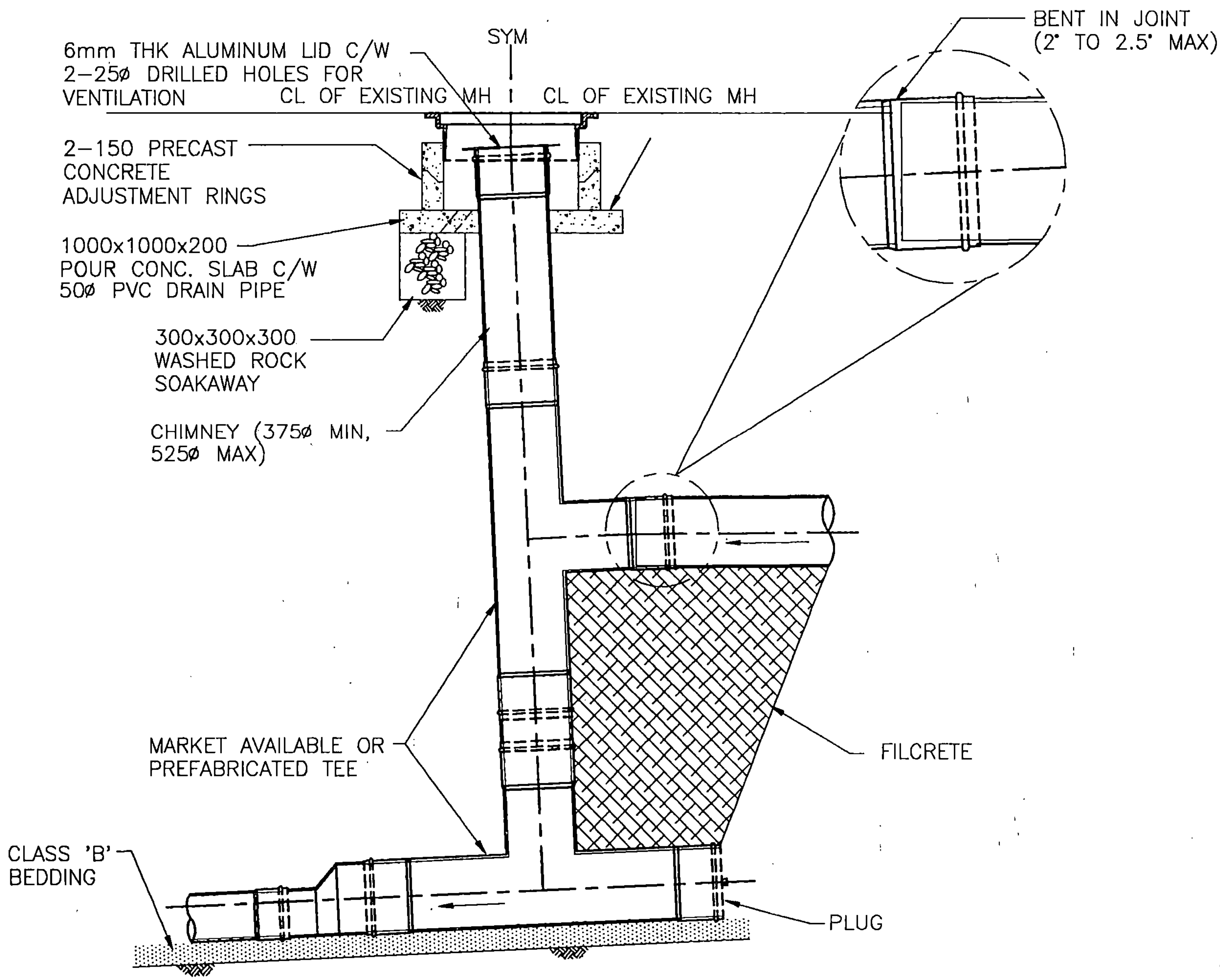
FIG. 15



DROP PIPE

FIG. 16

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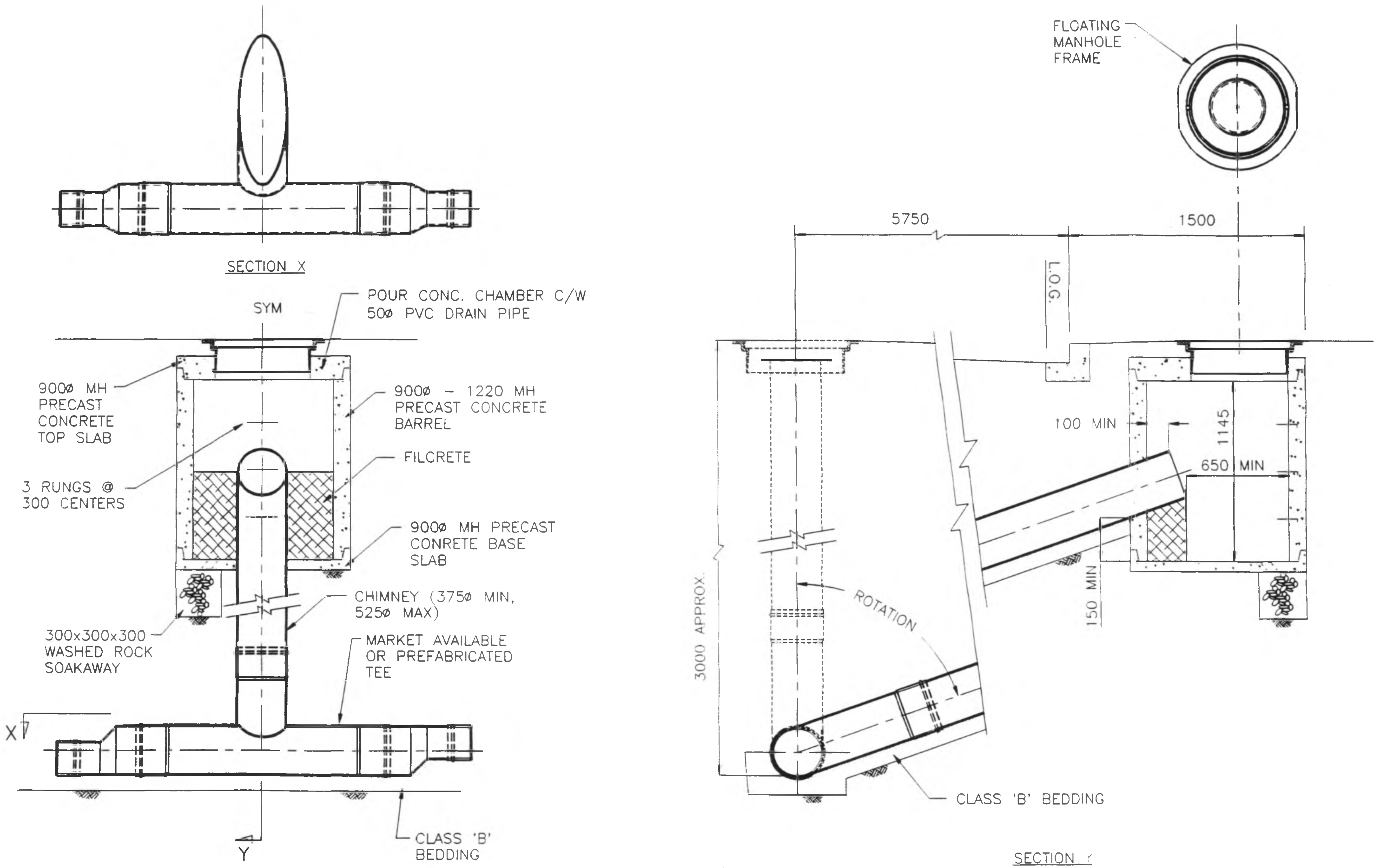


ALTERNATE LOCATION OF ACCESS COVER

FIG. 17

sewer line access cover will be required.

6.1.3 Two Sewer Pipes Connected on an Angle

As shown on Figure 10, when two pipes are to be connected on an angle, two accesses will be required. The angle of the sewers can be overcome by using fittings or an offset in joints whichever is more appropriate.

6.1.4 Multiple Pipe Connections

As shown on Figure 10, for multiple pipe connections, each sewer pipe will require an independent sewer main access. The angle of the sewer pipes can also be overcome by using fittings or an offset in joints whichever is more appropriate.

7.0 HYDRAULIC EVALUATIONS

The sewer line access will produce two flow patterns. For a two pipe junction, the flow pattern would be a normal turbulent pattern since the access is connected to the sewers with gradually enlarged increasers, gradually contracted reducers and rounded edge wyes and tees. However, for a junction with three or more pipes, the flow pattern would be of a large-scale turbulent type due to the impact of the converging stream. Generally, the friction loss caused by the turbulence of the sewer line access is less than a standard manhole where sudden enlargement and contraction occur at the exit and entrance.

The hydraulic performance of the sewer line access could be evaluated by the minor friction losses associated with turbulence caused by enlargement, contractions, change in direction and impact of the converging streams. These minor losses can be calculated as shown in the following sections.

7.1 INCREASER

The frictional loss for an increaser can be calculated on the basis of gradual enlargement as follows:

$$H_i = K_i \left(\frac{V_m^2}{2g} - \frac{V_d^2}{2g} \right)$$

Where	H_i	=	increaser friction loss (m)
	V_m	=	velocity in upstream sewer pipe (mps)
	V_d	=	velocity in downstream sewer pipe (mps)
	K_i	=	friction loss coefficient, as shown in Table 3 which is obtained from 'Handbook of Hydraulics' by King
	g	=	acceleration due to gravity = 9.8 m/sec^2

TABLE 3

VALUES OF K_i FOR GRADUAL ENLARGEMENT

	Total Angles of Cone						
d_1/d_2	4°	10°	15°	20°	30°	50°	60°
1.2	0.02	0.04	0.09	0.16	0.25	0.35	0.37
1.4	.03	.06	.12	.23	.36	.50	.53
1.6	.03	.07	.14	.26	.42	.57	.61
1.8	.04	.07	.15	.28	.44	.61	.65
2.0	.04	.07	.16	.29	.46	.63	.68
2.5	.04	.08	.16	.30	.48	.65	.70
3.0	.04	.08	.16	.31	.48	.66	.71
4.0	.04	.08	.16	.31	.49	.67	.72
5.0	.04	.08	.16	.31	.50	.67	.72

Note: d_1 = downstream pipe diameter
d_2 = upstream pipe diameter

7.2 REDUCER

The friction loss for a reducer can be calculated on the basis of gradual contraction as follows:

$$H_r = K_r\left(\frac{V_d^2}{2g} - \frac{V_n^2}{2g}\right)$$

Where
H_r = reducer friction loss (m)
V_n = velocity in upstream sewer pipe (mps)
V_d = velocity in downstream sewer pipe (mps)
K_r = friction loss coefficient = 0.04 for short contractions
g = acceleration due to gravity = 9.8 m/sec^2

The small friction loss for a reducer is because increase in velocity is associated with small head loss.

7.3 BEND

The friction loss for a small radius bend is caused by separation and the secondary flow and can be calculated as follows:

$$H_B = K_B \frac{V^2}{2g}$$

Where	H_B	=	friction loss (m)
	V	=	velocity (mps)
	g	=	acceleration due to gravity = 9.8 m/sec
	K_B	=	friction loss coefficient which is a function of the angle of the bend (Q) and the ratio of the pipe diameter (d) and bend radius (r). The friction loss coefficient is shown in table 4 and is derived from 'Handbook of Hydraulics' by King.

TABLE 4

VALUE OF K_B FOR BEND

d/r	K		
	22 1/2°	45°	90°
1	0.12	0.17	0.23
2	0.07	0.10	0.13
4 or larger	0.04	0.06	0.08

7.4 JUNCTION

At a junction, there will be two or more flow paths and the main sewer being common to all upstream paths. The hydraulic design of a junction is the design of two or more transitions, one for each flow path. The total friction loss will be the summation of the losses due to curvature and impct of the converging stream. The curvature losses are as calculated in Section 7.3 and the converging stream impact loss is calculated as follows:

$$H_S = \frac{V_T^2}{2g}$$

where H_S = converging stream impact loss (m)

V_T = velocity component of the velocity in the branch sewer (mps). The velocity component is the one which is perpendicular to the flow in the receiving sewer.

g = acceleration due to gravity = 9.8 m/sec^2

7.5 DROP ACROSS AN ACCESS

The sewer line access provides a gradual transition for flow from the upstream and downstream sewers. To streamline the flow through the transition without any backup, a drop across the transition will be required to compensate for friction losses. The drop required for the sewer line access can be calculated as follows:

$$H_A = (H_d - H_u) + H_l$$

where H_A = drop across access (m)

H_d = energy gradeline of downstream sewer (m)

H_u = energy gradeline of upstream sewer (m)

H_l = friction loss (m)

The friction loss (H_l) will be the sum of the friction losses for all fittings and the impact of the converging streams. Generally, when fittings are placed in close proximity the total loss would be less than the numerical sum of the losses for all fittings. Therefore, the drop across an access calculated on the basis of summation of friction losses for all fittings is on the conservative side.

8.0 CONSTRUCTION MATERIALS

8.1 ACCESS CHIMNEY

The available pipe and fitting materials that could be used for the construction of the chimney of the sewer line access for storm and sanitary sewer systems include the following:

- polyvinyl chloride
- polyethylene
- ultra rib polyvinyl chloride
- reinforced concrete
- smooth internal wall corrugated polyethylene (Big 'O' pipe)
- vitrified clay
- asbestos cement
- corrugated steel
- ductile iron

8.1.1 Less Favourable Materials

The following materials are not recommended for the construction of a sewer line access for the following reasons:

- Smooth wall corrugated polyethylene and corrugated steel pipe and fitting. At present a coupling is not available to provide a connection with polyvinyl chloride, and reinforced concrete pipe which are most common for the construction of a sanitary and storm sewer.

- Vitrified clay and asbestos cement pipe and fittings. Both materials are very brittle and therefore require concrete encasement for the full depth of the access and hence, are more costly and time consuming to construct.

- o Ductile iron pipe and fittings. Ductile iron pipe and fittings are expensive and, also require corrosion protection.

8.1.2 Favourable Materials

The favourable materials for the construction of a sewer line access are polyvinyl chloride (PVC), ultra rib polyvinyl chloride and reinforced concrete pipe and fittings. These materials are more favourable for the following reasons:

A. PVC and Ultra Rib PVC Pipe and Fittings

- o fitting less than 375 mm in diameter is more economical
- o light weight and easy to handle with the use of equipment
- o fewer joints
- o compatible with sewer pipe materials

B. Reinforced Concrete Pipe and Fittings

- o fitting larger than 375 mm is more economical
- o compatible with storm sewer pipe material.

The evaluation and comparison of the materials are shown in Table 5.

As shown in Table 5, PVC pipe and fittings ranks the highest and therefore, is the recommended material.

TABLE 5

COMPARISON OF MATERIALS

Description	PVC DR 35					PE (SDR 32.5)					Ultra Rib PE (SDR 32.5)					Concrete (C76-CLV)				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Weight				x					x						x		x			
Requirement of special coupling for connection in new construction				x					x		x								x	
Cost of coupling used in connection to existing sewer pipes			x						x					x					x	
Joint in chimney				x						x					x				x	
Requirement of equipment for placement				x						x					x		x			
Cost of Pipe			x					x							x		x			
Ease in construction				x						x				x				x		
Corrosion resistance				x						x					x				x	
Cost of fitting less than 350 mm ⌀				x						x					x				x	
Cost of fitting larger than 375 mm ⌀		x					x						x							x
TOTAL SCORE	45					42					42					34				

Note: 1 means lowest in score.

8.2 ACCESS COVER

The manhole frame and cover currently in use in a conventional manhole could also be used for the sewer line access. Of the standard manhole covers currently available, the floating type is preferred. This manhole frame and cover is free to float up and down with the pavement and hence minimize cracks, and irregularities developing around the cover. The size of the access cover is shown in Table 6.

TABLE 6

ACCESS COVER SIZE

Sewer Pipe Size (mm)	Access Cover Size (mm)
200 to 375	500
450	600

The size of cover for sewer pipe less than 300 mm in diameter could be reduced if a concentric reducer is used between the chimney and the tee of the access. However, the construction with a concentric reducer in such a case would result in higher cost, yielding little to no net benefit.

8.3 CONNECTIONS

The PVC and concrete sewer line access could be connected to various types of sewer pipe with a flexible rubber coupling manufactured by Power Seal Pipeline Products Corporation or by others. The flexible coupling is constructed of a tough elastomeric PVC barrel and series 300 18-8 stainless steel bands.

9.0 CONSTRUCTION METHODS

9.1 BEDDING

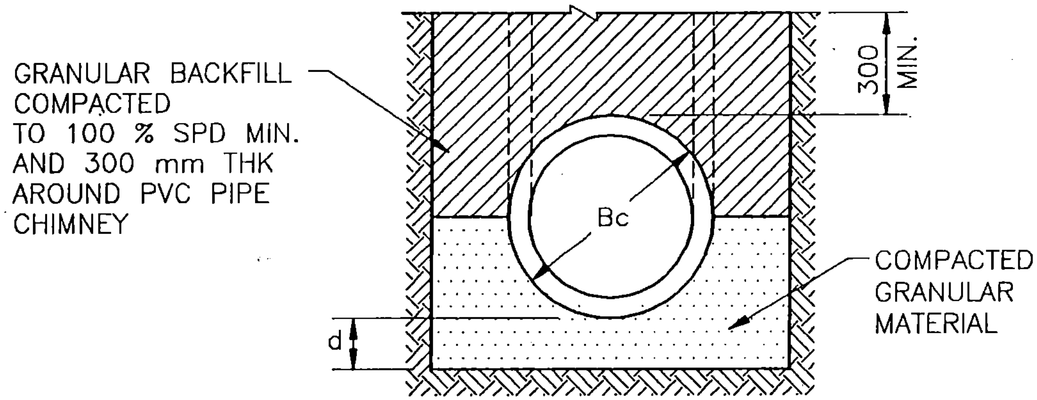
The tee bottom of the preferred access must be installed on a stable and uniform foundation and embedded in a Class 'B' sand bedding as shown in Fig. 18.

9.2 ALIGNMENT AND BACKFILL

The chimney of the preferred sewer line access must be installed straight and smooth without any bending. To keep the chimney sturdy during placement of backfill, wooden braces may be used to hold the top of the chimney firmly in position. Backfill must be placed in a maximum 150 mm layer evenly around the chimney and then compacted to 100% Standard Proctor Density minimum. Screened sand must be used in the area 300 mm around the chimney so that differential settlement and frost heaving is minimized. The remainder of the trench could be backfilled with suitable native material.

9.3 CONNECTION TO EXISTING SEWERS

The sewer line access can be connected to any sewer pipe with a 300 mm long spacer and a flexible rubber coupling as discussed in Section 8.3.



LEGEND:

Bc = OUTSIDE PIPE DIAMETER
d = DEPTH OF BEDDING MATERIAL BELOW PIPE (100 mm MIN., 150 mm IN ROCK)

CLASS 'B' BEDDING N.T.S

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FIG. 18

10.0 COST ESTIMATES

The construction costs for the sewer line access for two straight run pies and a standard manhole are estimated on the basis of the following criteria:

A. 1994 Construction Costs including supply of Material sand Installation

B. Alternate Sewer Line Access Constructed with Various Materials

- o Floating manhole frame and cover, manufactured by Norwood Foundry.
- o 300 mm granular backfill around chimney.
- o PVC pipes DR 35 and standard fittings.
- o Reinforced concrete pipe C76-CL V.
- o Concrete base and precast adjustment rings shall be constructed with 35 MPa sulphate resistant concrete.
- o Additional excavation not required.
- o 50 mm diameter PVC drain pipe.
- o 300 mm x 300 mm x 300 mm washed rock sump.

C. Standard Manhole

- o 1200 mm diameter.
- o Floating manhole frame and cover, manufactured by Norwood Foundry.
- o 300 mm granular backfill around chimney.
- o Precast concrete base slab, pre-benched based, barrels, cone top and adjustment rings.
- o Additional excavation required to enlarge a sewer trench for the installation of the manhole.
- o Aluminum rings.
- o Installed with equipment.

- Rubber gasket joints.
- Precast manhole barrel and cone top include the cost of aluminum manhole steps.

D. Unit Prices

The unit prices for materials are manufacturer's quoted prices and are shown in Appendix "C".

E. 15% Contractor mark-up.

10.1 CONSTRUCTION COST ESTIMATES

The tabulated estimated construction costs are based on manufacturer's quoted prices. Since manufacturers will generally discount the quoted prices for a contractor, therefore the estimated construction prices may be slightly higher than actual contract prices.

The construction cost estimates for an alternate sewer line access for various pipe size and fitting materials and a standard 1200 mm diameter manhole is shown in Table 7.

TABLE 7
CONSTRUCTION COST ESTIMATES

Depth	Size of Sewer Main	Construction Costs				
		PVC Ultra Rib	PVC Standard Fittings	PVC Prefabricated Fittings	Concrete Pipe	Standard Manhole
3	200	1,921	2,108	3,177	2,198	2,965
	250	2,010	2,138	3,257	2,240	2,994
	300	2,446	2,529	2,924	2,402	3,028
	375	3,137	3,673	2,998	3,059	3,051
	450	3,526	3,758	3,379	3,422	3,351
4	200	2,001	2,220	3,271	2,311	3,486
	250	2,101	2,250	3,350	2,352	3,515
	300	2,546	2,667	3,017	2,531	3,549
	375	3,312	3,843	3,110	3,209	3,572
	450	3,702	3,929	3,518	3,573	3,809
5	200	2,082	2,331	3,364	2,423	3,893
	250	2,192	2,361	3,443	2,465	3,922
	300	2,646	2,804	3,111	2,659	3,956
	375	3,488	4,013	3,222	3,359	3,979
	450	3,878	4,100	3,657	3,724	4,191
6	200	2,188	2,467	3,482	2,561	4,474
	250	2,308	2,597	3,561	2,602	4,503
	300	2,771	2,967	3,229	2,812	4,537
	375	3,688	4,209	3,359	3,534	4,560
	450	4,079	4,296	3,821	3,900	4,767

10.2 COMPARISON OF CONSTRUCTION COSTS

Table 7 in Section 10.1 reveals the following results:

A. For Pipe 200 mm and 250 mm in diameter, standard manhole and concrete Pipe access are the two materials that result in the highest construction costs. The construction costs for other materials in descending order are, PVC ultra rib, PVC standard fitting, and concrete Pipe.

B. For 300 mm diameter Pipe, the standard manhole results in the highest construction cost and the construction costs for other materials in descending order are PVC ultra rib, concrete Pipe fitting, PVC standard fitting and PVC fabricated fitting.

C. For pipes of 375 mm and 450 mm in diameter, PVC prefabricated fitting provides for the lowest construction cost and generally concrete Pipe is the second lowest.

The graphs showing the comparison of construction costs are shown in Figs. 19 to 26 attached in appendix "D".

10.3 PREFERRED CONSTRUCTION MATERIALS

The preferred construction materials for the proposed sewer line access of various diameter are discussed as follows:

A. For pipes of 200 mm and 250 mm in diameter, although PVC ultra rib Pipe and fitting results in the least construction cost, PVC is the preferred material. The reason is that PVC Pipe and fitting is widely accepted by municipalities.

B. For 300 mm diameter Pipe, PVC is the preferred material for the construction of the proposed sewer line access. The reasons are as follows:

- o PVC ultra rib is not widely accepted by the municipalities.
- o The cost of concrete Pipe is approximately 5% less than the cost of PVC, however PVC has a high resistance to hydrogen sulphide and corrosive alkali soils as well as fewer joints to assemble.

C. For pipes of 375 mm and 450 mm in diameter, PVC Pipe and prefabricated fittings result in the lowest construction cost and therefore, it is the preferred material for these sizes.

TABLE 8

POTENTIAL SAVINGS FOR THE PREFERRED MATERIAL

VERSUS A STANDARD 1200 MM DIAMETER MANHOLE

Depth	Size of Sewer Main	PVC Standard Fitting		PVC Prefabricated Fitting		Standard Manhole Cost
		Cost	% Saving	Cost	% Saving	
3	200	2,108	29			2,965
	250	2,138	29			2,994
	300	2,529	16			3,028
	375			2,998	2	3,051
	450			3,379	-1	3,351
4	200	2,220	36			3,486
	250	2,250	36			3,515
	300	2,667	25			3,549
	375			3,110	13	3,572
	450			3,518	8	3,809
5	200	2,331	40			3,893
	250	2,361	40			3,822
	300	2,804	29			3,956
	375			3,222	19	3,979
	450			3,657	13	4,191
6	200	2,467	45			4,474
	250	2,597	42			4,503
	300	2,967	35			4,537
	375			3,359	26	4,560
	450			3,821	20	4,767

10.4 POTENTIAL SAVINGS AS ILLUSTRATED FOR A TYPICAL SMALL SUBDIVISION

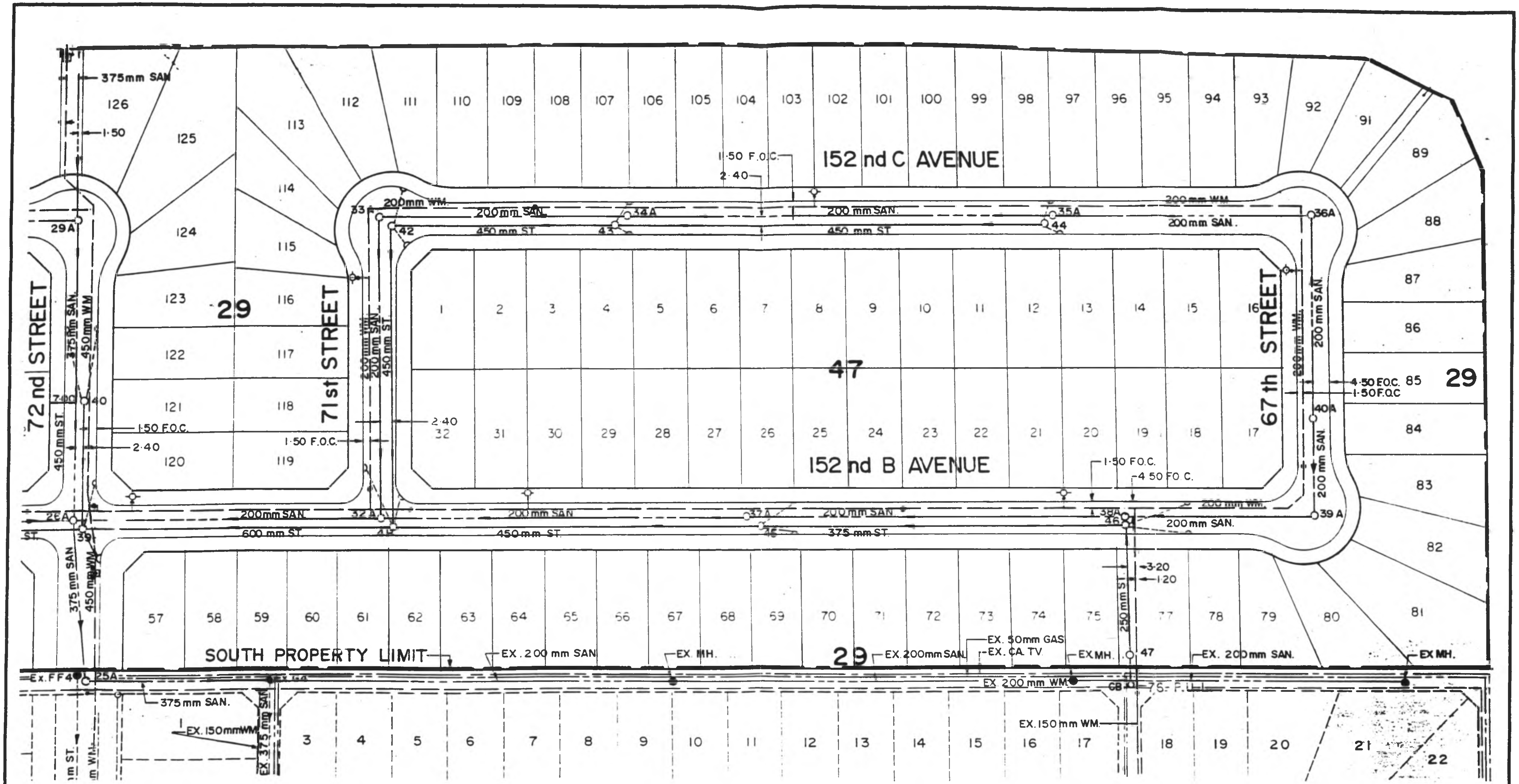
In order to demonstrate the significance of the cost saving for an alternative sewer line access, a typical subdivision development in Edmonton as shown in Fig. 27 was used. The subdivision is approximately 6 hectares, consisting of 88 lots with lot areas of approximately 468 square metres. The sanitary sewer manholes that theoretically would be replaced with the proposed alternative include 34A, 35A, 37A, 38A and 40A. The construction costs of these manholes as a standard manhole and an alternative sewer line access are as follows:

- o standard manhole $ 20,033.00
- o alternative sewer line access:
  - PVC ultra rib Pipe and fitting $ 11,874.00
  - PVC Pipe and fitting $ 13,135.00

The cost saving in using a PVC ultra rib and PVC sewer line access is as follows:

Description	Cost Saving			
	PVC ($)	% Over Standard MH	PVC Ultra Rib ($)	% Over Standard MH
Entire Subdivision	6,898	34	8,159	41
Per Lot	78	34	93	41
Per Hectare	1,150	34	1,360	41

Although the cost savings for a small scale development are not dramatic, cost savings for a larger development would be significant.



SUBDIVISION PLAN

FIG. 27

BUTLER KREBES & Associates Inc.

11.0 COMPARISON OF ALTERNATIVE SEWER PIPE ACCESS WITH CONVENTIONAL MANHOLE

Description	Alternative Sewer Pipe Access	Standard Manhole
1. Advantages	- More compact structure and hence requires less time and effort to construct. Also eliminates the need for equipment to place the chimney. - Tighter joint which eliminates or significantly reduces potential leakage. - Eliminates surface water running into the sewer system. - When the structure is constructed with PVC the structure will not be subject to attack by hydrogen sulphide and corrosive alkali soil. - Reduced backfill settlement. - More cost effective. - Top of access can be located on the boulevard or pavement. - Can be constructed with various types of materials.	- Allows for visual inspection of sewer Pipe. - Allows for setting up flow monitoring equipment and carrying out calibration for hydraulic evaluation of sewer line. - Provides more working space for cleaning video inspection and rehabilitation equipment. - Allows for man-entry.
2. Disadvantages	- Too small to allow maintenance personnel to enter and carry out visual inspection and flow monitoring. - Could measure depth of flow for flow monitoring purposes but could not provide velocity and flow information which requires calibration. - Require the use of a long rod equipped with a bucket at the end to obtain sewage sample from the sewer.	- Generally, settlement occurs which is caused by improper compaction around cone top. - Not cost effective for manholes at the upper end of a sewer system and for a two Pipe junction. - Subject to corrosion in sewer that generates hydrogen sulphide and ground contains corrosive alkali soil. - Require equipment to place the barrels. - Allows surface runoff to penetrate the system.
3. Construction Costs 3 m depth 4 m depth 5 m depth 6 m depth	PVC Pipe and fittings <u>Range</u> <u>Average</u> 2,108-3,379 2,744 2,220-3,518 2,869 2,331-3,657 2,994 2,467-3,821 3,144	Precast Concrete <u>Range</u> <u>Average</u> 2,965-3,351 3,158 3,486-3,809 3,648 3,893-4,191 4,042 4,474-4,767 4,621
4. Limitations	- Not suitable for locations where flow monitoring operation is expected. - Not suitable for drop Pipe construction.	- Not suitable for sewers that generate hydrogen sulphide and soil that contains corrosive alkali soil unless protective measures are provided. - Majority constructed with concrete and sometimes with corrugated steel Pipe together with corrugated steel Pipe storm sewers.

12.0 OPERATION AND MAINTENANCE

It is anticipated that the alternative sewer line access will require routine cleaning by high pressure flushing. The frequency of cleaning, structural and hydraulic performance and other maintenance requirements can be estimated only after an evaluation of a pilot model is conducted.

It is expected that two video camera inspections of the field model will be carried out at the end of the 6 and 12 months after the installation of the model. Monitoring the field model is warranted to gather valuable information to assess its performance and quantify additional cost savings that the proposed access may have in association with maintenance and operation.

Sewer line access monitoring will include the following areas;

A. structural conditions
B. physical conditions
C. settlement

13.0 CONCLUSIONS

1. The study shows that the alternative sewer line access could replace a standard manhole cost effectively at a two straight run pipe junction except for a drop pipe condition. The proposed access is easily accessible by all sewer video inspection and cleaning equipment and provides proper ventilation for the sewer. The chimney has a smaller diameter than a standard manhole and is constructed with a full length of pipe that has fewer joints to allow infiltration. In addition, all surface runoff will drain into a gravel soakaway and not into the sewer system which increases the loading on the sewage treatment plant.

2. A review of the design of a number of subdivisions reveals that two straight run pipe junctions in a sanitary sewer system alone results in the range of 35% to 45% of the total number of junctions for both the sanitary and storm sewer systems. In the subdivision used for illustration purposes, the construction cost for PVC sewer line accesses in a sanitary sewer system produces a cost saving of approximately $1,150 per hectare. Therefore, for a large development, the overall cost saving in using alternative sewer line accesses would be quite significant. The cost saving would increase further for some municipalities in Ontario where catch basin leads are connected directly into a storm sewer, and hence make it feasible to install the proposed sewer line access in a storm sewer system.

3. It is recognized that the proposed sewer pipe access could not be used for flow monitoring. However, flow monitoring would only be carried out in a few manholes at strategic locations in a watershed and, therefore, this drawback would likely not offset the merits of the alternative access.

4. The merits of the alternative access include the following:

- more economical
- easier and quicker to construct
- minimize or eliminate surface runoff infiltration
- cover can be located off the pavement

5. Although PVC ultra rib pipe and fittings is the most economical material for the construction of an alternative access less than 300 mm in diameter, PVC pipe and fittings are recommended until such time that PVC ultra rib pipe and fittings receive greater acceptance by municipalities.

6. In view of the capital cost saving and additional benefits described above, the alterative PVC sewer line access is deemed to be a feasible alternate to the standard manhole.

14.0 RECOMMENDATIONS

It is recommended that the following items be implemented:

1. construct a field model.

2. Monitor the field model to evaluate its performance and assess the potential savings in operation and management costs, which includes:

   - o two video camera inspections at the end of 6 and 12 months after the installation of the field model to determine structural and physical conditions of the sewer line access.
   - o visual inspection of settlement around the access.

CORPORATE AUTHORIZATION

This document entitled "Alternate Sewer Line Access Study" was prepared by Butler Krebes & Associates Inc.

Herman Hung Chee Ng, M.A.Sc., P. Eng.
Chief Engineer

John S. Krebes, P. Eng.
Principal

PERMIT TO PRACTICE
BUTLER KREBES & ASSOCIATES INC.
Signature
Date
PERMIT NUMBER: P 4112
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Permit to Practice

APPENDIX 'A'

CORRESPONDENCE

1. The following municipalities were requested to provide comments:

City of Edmonton
City of Calgary
City of Winnipeg
City of Richmond
City of Red Deer
City of Medicine Hat
City of Yellowknife
City of Ottawa
Greater Vancouver Regional District
City of Moncton
City of St. John's
City of Halifax
City of Camrose
City of Lethbridge
City of Wetaskiwin
City of Burnaby
City of Kamloops
District of Surrey
City of Vancouver
City of Fredericton
City of Saint John
City of Dartmouth
City of Hamilton
Municipality of Metropolitan Toronto
City of Scarborough
City of Thunder Bay
City of Toronto
City of Waterloo
City of Windsor
City of York
City of Moose Jaw
City of Regina
City of Saskatoon
City of Charlottetown

2. The following municipalities have provided comments:

City of Edmonton
City of Calgary
City of Winnipeg
City of Richmond
City of Red Deer
City of Medicine Hat
City of Yellowknife
City of Ottawa
Greater Vancouver Regional District
City of Moncton
City of St. John's
City of Halifax

THE CITY OF Edmonton TRANSPORTATION

13TH FLOOR CENTURY PLACE
9803 102A AVENUE
EDMONTON ALBERTA
T5J 3A3
FAX (403) 428 5798

June 29, 1992

File: 51-929-506-007

Butler Krebes Associates Ltd.
200, 4224 - 93 Street
Edmonton, Alberta
T6E 5P5

RECEIVED JUL - 6 1992

ATTENTION: Mr. Herman Ng, P. Eng.

Dear Sir:

RE: ALTERNATIVE SEWER MAINTENANCE ACCESS STUDY

Thank you for letting us review your draft application to the Alberta Municipal Affairs on the above-mentioned subject. There are certain merits in the proposal and it seems worthwhile to pursue. Our comments are as follows:

I. General

1) Manholes are used for a number of activities besides video inspection and sewer cleaning. These activities must be maintained, at reasonably comparative costs, with any new "cleanout" system.

2) Economic justification should be based on examination of all the activities presently occurring through manholes. The cost of undertaking these activities should be compared for both systems. Typical circumstances initiating the activity should be noted.

3) Manholes are not used all the time at lot service connections to the sewers. And yet, these locations represent typical conditions where manholes are traditionally specified:

   (a) changes in sewer grade;
   (b) changes in flow direction; and
   (c) junctions between pipes.

   The operation, maintenance, and the replacement record of these connections should be reviewed, perhaps on improvement, if required. This type of connection could provide a starting point.

4) Replacement of manholes with "cleanouts" should be confined to the upper reaches of the system. Here, obstructions are relatively small and amenable to removal by power equipment. A whole range of hydraulic considerations need to be addressed including flow junctions, drop manholes and transition from gravity flow to surcharge.

II. Additional "Cost" Savings

1) Traditional manholes have been a source of additional costs when installed in roadways. Differential settlement between the roadway and manhole can cause unsightly, even dangerous, conditions. Lowering the manhole rim or raising the roadway is costly and the repair creates another area where differential settlement can occur. Solution to this problem may be addressed as part of the study.

2) Under boulevard servicing, repair/replacement of manholes can be a destructive and costly operation. "Cleanouts" could be smaller and save both the costs and aesthetics of the system.

3) Manholes have been a source of I/I in sanitary sewers. A smaller "cleanout" would reduce both the rates and volumes of I/I. Cost savings would include:

   (a) Reduced sewage treatment costs (volume of flow);
   (b) More effective treatment - despite higher concentrations of contaminants - caused by longer retention times in treatment facilities;
   (c) Delayed treatment plant increases;
   (d) Delayed/elimination of sewer capacity upgrades;
   (e) Reduced pumping costs;
   (f) Reduced basement flooding;
   (g) Reduced combined sewer overflows.

III. Activities at Manholes

1) Manholes are used as points for flow monitoring. Alternatives for executing this activity may be addressed on the study.

2) Manholes are used to vent the system. Slim buildup, toxic atmospheres, SO_2 buildup - released through manholes in the downstream system - and explosive gas mixtures are potential problems that need to be attended.

3) "Cleanouts" may impede the hydraulic function of the sewer system. As the system makes the transition from flow under atmospheric pressures to surcharge, water hammer can be aggravated by improper venting of air.

   There can also be a drastic drop in capacity caused by trapped air in the sewer.

4) "Cleanouts" are likely not applicable for drop manholes. In addition to the venting problem, formation of the energy dissipation pool and hydraulic jump chamber is difficult. These facilities are also not conducive to cleaning/repair without manual access.

5) Manholes are typical "tie-in" points for CB leads. Cleaning of CB's is a regular maintenance activity due to their susceptibility to clogging. A key question for the study is whether it is more efficient and effective to undertake this regular activity on a system using "cleanouts" or a system with manholes.

6) Manholes are frequently used during rehabilitation or construction of sewers. Typical examples are "in-situ" relining of sewers and the use of micro-tunnelling machines. Cost-effective alternatives or adoptions of the techniques should be identified.

7) CCTV of sewers is frequently performed in response to a drainage complaint. Under these circumstances, the CCTV is typically undertaken between manholes. If a blockage occurs between the manholes, it is necessary to operate the equipment in both the upstream and downstream directions. The "cleanouts" may have to accommodate CCTV operations in both the upstream and downstream directions.

8) At street intersection, manholes are frequently used as the junctions of up to four (4) pipes. The hydraulics of a "cleanout" (or group of "cleanouts") under such conditions should be considered. The access of both the CCTV and cleaning equipment to the correct pipe should also be addressed.

I hope the foregoing provides food for thought concerning this interesting proposal.

Yours truly,

Ken Chua, P. Eng., M. Sc.
Acting Director
Drainage Engineering
Drainage Branch

KC/dh

THE CITY OF CALGARY
ENGINEERING & ENVIRONMENTAL SERVICES DEPT.
SEWER DIVISION - OPERATIONS (#29)

CALGARY 100 1894 • 1994

Fax No. 268-3476

1994 June 27

RECEIVED
JUL 15 1994

BUTLER KREBES
& Associates Inc.
Suite 210, 8616 - 51 Avenue
Edmonton, AB T6E 6E6

Attention: Herman H.C. Ng, M.A.Sc., P. Eng.

RE: ALTERNATIVE SEWER MAINTENANCE ACCESS STUDY

The City of Calgary adheres to the Standards and Guidelines for Municipal Wastewater and Storm Drainage Facilities prepared by Alberta Environment. There are mandatory requirements for manholes, as follows:

3.3.2 Manholes:

Manholes shall be durable structures for the purpose of providing convenient access to sewers for observations, inspections, and maintenance operations, at the same time causing a minimum of interference in the hydraulics of the sewer system.

Where corrosion is anticipated because of either sulphate attack or sulphates, consideration shall be given to the provision of corrosion resistant material or effective protective linings.

3.3.2.1 Location:

Manholes shall be located at all sewer junctions, changes in grade, changes in pipe size, changes in alignment (except for curvilinear sewers), and termination points in the sewer system.

3.3.2.2 Spacing:

The acceptable manhole spacing will vary depending on the availability of cleansing equipment. The following outlines the minimum requirements for manhole spacing, however the limits may be exceeded provided that the applicant can demonstrate the availability of suitable equipment to handle the larger spacings.

3.3.2.2 Spacing - Cont'd:

Sewer Diameter	Maximum Allowable Manhole Section
200 to 375 mm	120 m
450 to 750 mm	150 m
900 mm and larger	Variable, greater than 150 m

3.3.2.3 Sizing:

For sewers up to 1050 mm in size, manholes shall be constructed with a diameter of at least 1200 mm or the sewer diameter plus 600 mm, whichever is greater. For sewers larger than 1200 mm, special type manholes or tee riser manholes may be used. Safety and entry requirements should also be considered when sizing manholes.

The City of Calgary makes application to Alberta Environment, Standard and Approvals for all Municipal wastewater and storm drainage facilities and designs the systems to the standards outlined by the Province.

We have not experienced many problems with differential settlement around manholes in the pavement. Groundwater seepage is minimized by the use of manhole barrel jointing materials. The following materials have been approved:

APPROVED MATERIALS	**SUPPLIER**
Rubber Gasket	Concrete Pipe Plants
Rub'r Neck	National Coupling, Kitchener, Ontario
Kent Seal	Hamilton Kent, Mississauga, Ontario

Currently, we do not have any maintenance problems or concerns with our manhole structures, however, we are receptive to new materials for manhole construction, or new techniques for the rehabilitation of deteriorating manholes.

Manholes provide convenient access for observation, inspection and maintenance operations. Our cleaning activities are based on the following equipment types:

Clean Mains	Power flusher Cable-cleaning machines Powerflushed combination unit

Clean manhole catchbasin & leads	Vactor Vacuum Truck Power flusher combination unit
Clean manhole & catchbasin	Manually by flushing truck and other crews.

We have developed an alternative structure for obtaining sewer discharge samples from service connections to commercial and industrial premises. The manhole is constructed on the service connection and is used primarily for testing the sewage.

If you require further information, please contact Mike MacIsaac, Supervisor of Maintenance at (403) 268-1233.

Yours truly,

Z. Zalusky, P. Eng.
Operations Engineer
Sewer Division - Opr. (#29)

ZZ/al

c. M. MacIsaac, Supervisor Maintenance, Sewer Division - Operations

Encl.

THE CITY OF CALGARY
ENGINEERING & ENVIRONMENTAL SERVICES DEPT.
SEWER DIVISION - OPERATIONS SECTION (#29)

Fax No. 268-3476

1994 June 17

BUTLER KREBES
& Associates Inc.
Suite 210, 8616 - 51 Avenue
Edmonton, AB T6E 6E6

Attention: Mr. Herman H.C. Ng, M.A.Sc., P. Eng.

Dear Sir:

Re: Alternative Sewer Maintenance Access Study

I am attaching our manhole specifications for sewer main sizes up to 600 mm in diameter.

Our comments follow:

(1) Repair cost associated with differential settlement around manholes.

We do not see this as a large problem. We need access into our sewer system to clean and inspect the mains. Manholes have to be available at certain intervals and of certain size to allow equipment and personnel access. Manholes have to be of adequate size to allow workers to perform equipment set ups at the main invert.

In the future access will become more critical to allow the use of trenchless technology methods to repair and/or replace sewer mains.

(2) Eliminate groundwater seepage through joints.

We do not see this as a problem with new manholes, since all joints are sealed.

..../2

What kind of improvements would we like to see in manholes?

We have areas where concrete manholes and sewer mains deteriorate within a relative short time (15 - 20 years) because of the alkali found in the adjacent soils.

Manholes and mains made of alkali resistant materials would be of benefit in these areas.

If you have any questions please call me at 268-4951.

Yours truly,

T. Fedick, P. Eng.
Superintendent Const./Maint.
Sewer Division - Operations (#29)

TF/al

Att/

MANHOLE COVER

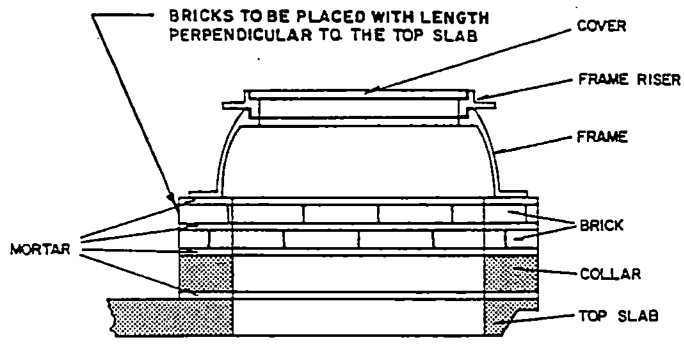
- USE STANDARD MANHOLE COVER AS PER DRAWING SHEET # '1' (452·1001·012).
- USE GRATED MANHOLE COVER AS PER DRAWING SHEET # '2' ONLY IF CONSTRUCTION DRAWINGS INDICATE (452·1001·011).

MANHOLE FRAME RISER

- USE MANHOLE FRAME RISER AS PER DRAWING SHEET # '3' (452·1001·007).
- USE ONLY FOR FINAL ADJUSTMENTS TO GRADE.

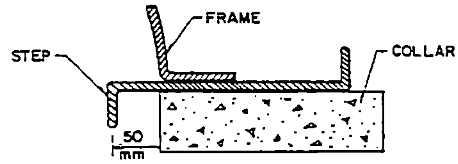
MANHOLE FRAME

- USE STANDARD OR SHALLOW MANHOLE FRAME AS PER DRAWING SHEET # '4' & # '5' RESPECTIVELY. (452·1001·013) (452·1001·014)



COLLAR DETAIL

NOTES: 1 – MANHOLE STEP TO BE INSTALLED ABOVE THE TOP SLAB A DISTANCE OF 400mm ABOVE THE TOP STEP IN THE BARREL ASSEMBLY.



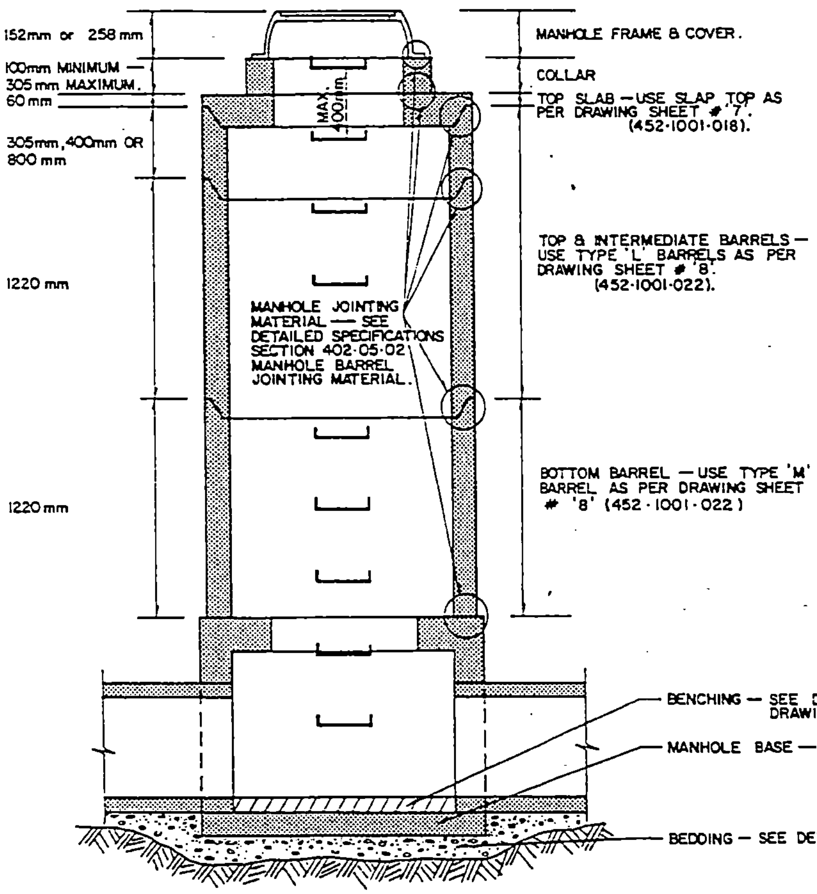
- MANHOLE STEP TO BE INSTALLED BETWEEN FRAME AND COLLAR OR BRICKS.
- NO PARGING TO BE USED ON MANHOLE BRICKS.
- MAXIMUM OF 3 COURSES OF BRICK TO BE USED.
- USE 150mm PRECAST COLLAR PRIOR TO FINAL ADJUSTMENTS.
- USE PRECAST COLLARS FOR FINAL ADJUSTMENTS. COMBINATION OF BRICK & PRECAST. COLLAR ONLY TO BE USED IF PRECAST COLLARS CANNOT ATTAIN DESIRED ELEVATION.

BRICK – ALL BRICKS SHALL CONFORM TO THE LATEST A.S.T.M. SPECIFICATIONS C139.

COLLAR – USE PRECAST CONCRETE COLLAR(S) AS PER DRAWING # '6' (452·1001·006)

STEP – USE MANHOLE STEP AS PER DRAWING # '9' (452·1001·021)

MORTAR – SEE DETAILED SPECIFICATIONS, SECTION 402·03·02 MORTAR.



BENCHING – SEE DETAILED SPECIFICATION 403·09·00 BENCHING & DRAWING SHEET # '39' (452·1003·007)

MANHOLE BASE – USE MANHOLE BASES AS PER DRAWING SHEET # 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 & 20. (CITY STANDARDS)

BEDDING – SEE DETAILED SPECIFICATIONS 403·04·03 MANHOLE BEDDING.

NOTES: FOR TYPE '1' MANHOLES THE EXTENSION FROM THE TOP OF THE MANHOLE BASE TO SURFACE SHALL COMPRISE OF THE COLLAR & MANHOLE FRAME & COVER. ALL OTHER MANHOLES THE EXTENSION FROM THE TOP OF THE MANHOLE BASE TO SURFACE SHALL COMPRISE OF A COMBINATION OF INTERMEDIATE & TOP BARRELS, TOP SLAB, COLLAR, MANHOLE FRAME & COVER. MAXIMUM TWO (2) TOP BARRELS PER MANHOLE, IF REQUIRED.

No.	Date	Revision	App'd
6	93-12-29	NOTE ADDED	
5	93-01-11	NOTE ADDED	
4	88-05-26	REVISED MANHOLE BARREL SECTION Nº	
3	86-12-10	REVISED MIN. COLLAR DIMENSION	
2	84-12-13	NOTES REVISED	
1	84-5-15	FILE NUMBERS ADDED	

Drawn: R. KU — Date: 83-11-15

Scale: NOT TO SCALE

Approved by: for City Engineer

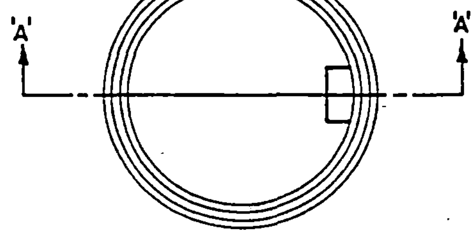
THE CITY OF CALGARY
ENGINEERING DEPARTMENT

MANHOLE ASSEMBLY

Sheet: 38

File Number: 452·1001·023

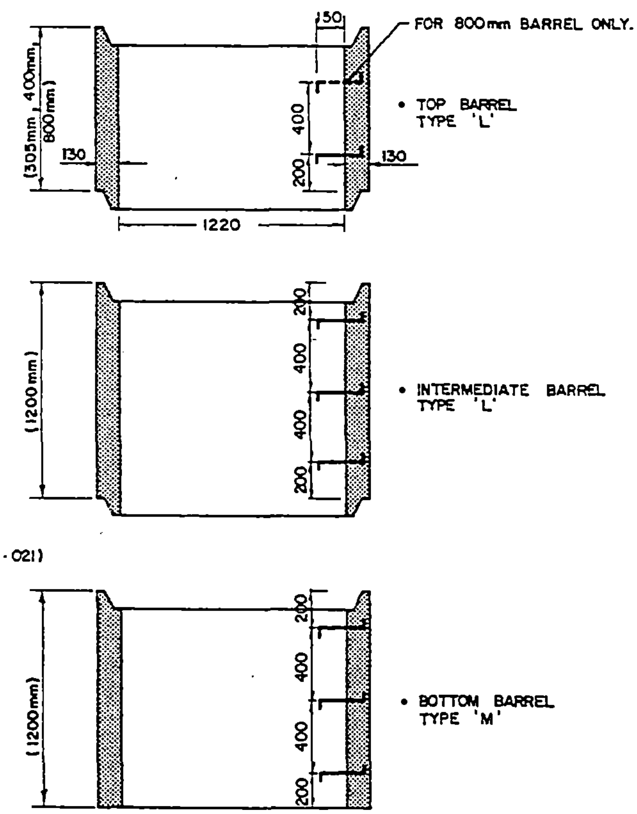
(REDUCED COPY 1-J-23)



PLAN

• COMMON TO ALL BARRELS

NOTE:
1. MAXIMUM TWO (2) TOP BARRELS PER MANHOLE, IF REQUIRED.



SECTION 'A—A'

MATERIAL SPECIFICATIONS

- ALL PRECAST CONCRETE MANHOLE RISERS TO CONFORM TO A.S.T.M. DES. C478 (LATEST EDITION)
- STEPS AS PER STD. DRAWING SHEET #'9' (452·1001·021) SPACED AT 400mm

OTHER APPROVED MANHOLE RISERS

PRE-CON MANUFACTURING LTD.

1) 300mm
2) 400mm
3) 800mm
4) 1200mm
5) 1600mm
6) 2000mm

SEE FILE NUMBER 452·1041·003

DIMENSIONS ARE MILLIMETRES UNLESS OTHERWISE NOTED — METRIC

No.	Date	Revision	App'd
4	93·01·11	NOTE 1. ADDED	
3	881104	NOTES ADDED	
2	86·12·10	ADDED STEP DIMENSION	
1	84·5·15	FILE NUMBER ADDED	

Drawn K.T. Date 83 10 13
Scale 1 : 20
Approved by for City Engineer

THE CITY OF CALGARY
ENGINEERING DEPARTMENT

MANHOLE RISERS (BARRELS)

Sheet 8

File Number 452·1001·022

REDUCED COPY 1-J-22

FILE No.

THE CITY OF RED DEER

P.O. BOX 5008, RED DEER, ALBERTA T4N 3T4

Public Works Department
(403)342-8238 FAX (403) 343-7074

RECEIVED
JUN 21 1994

June 17, 1994

Butler Krebes & Associates Inc.
210, 8616 - 51 Avenue
EDMONTON, Alberta
T6E 6E6

Attention: Herman H.C. Ng, M.A.Sc.,P.Eng.

Dear Sir:

RE: ALTERNATIVE SEWER MAINTENANCE ACCESS STUDY

In response to your request for information on problems with manholes, I have the following comments:

1. We use slab tops on all of our manholes and this eliminates most settlement proglems associated with cone tops.

2. We use rubber nek on all sanitary joints and prebenched bases in most new construction; therefore, infiltration is kept to a minimum.

3. We use the Vactor Model 2100 sewer cleaner and Sewer Jet to clean sewers.

4. C.C.T.V. inspection is also performed on all sani mains.

5. We use visual inspection through manholes to ensure proper flow in mains.

6. We also use manholes as inspection access for possible contaminants in the services to obtain samples of the sewage.

7. Manholes are used for flushing sani sewers with a 2.5" hose.

Yours truly,

Ron Wardner
Water & Wastewater Superintendent

/blm

c Water and Wastewater Labour Foreman II - Sewer Maintenance

Medicine Hat
The Gas City

ENVIRONMENTAL UTILITIES
717 - 16 Street, S.W.

■ TELEPHONE (403) 529-8171
■ FAX (403) 528-4955

Mailing Address:
580 - 1 Street, S.E.
Medicine Hat, AB
T1A 8E6

RECEIVED
JUN 2 0 1994

June 14, 1994

Butler Krebes & Associates Inc.
Suite 210
8616 - 51 Avenue
Edmonton, AB
T6E 6E6

Attention: Herman H.D. Ng, M.A.Sc.,P.Eng.

Dear Mr. Ng:

RE: ALTERNATIVE SEWER MAINTENANCE ACCESS STUDY

In response to your request for information regarding the above, I would submit the following:

Maintenance Problems and Concerns

- Adjustments required when final grading of roads is time consuming
- Manhole frames and lids have a tendency to rock due to traffic
- Adjustments to accommodate slope in roads i.e. hills, infiltration

Potential Improvements

- Improved method for achieving final grades of manholes
- Provisions for adjusting slope on roads
- Infiltration addressed
- Lighter weight to improve handling in the field

Sewer Cleaning

- The city uses flushers and rodding machines for cleaning and removing plugs from lines. On occasion bucket machines are used. The latter are used in lines above 300mm. Size of i.d. required would be 1200mm. Smallest manhole used is 1060mm.

...\2

Alternative Structures

- Corrugated steel culvert
- Square precast concrete structures
- Double T's and Y's (the latter is used for cleaning only)

H.E. Arndt
Environmental Utilities Manager

HEA/llg

City of
Yellowknife

RECEIVED
JUN 21 1994

June 16, 1994

Butler Krebes & Associates Inc.
Suite 210, 8616 - 51 Avenue
Edmonton, Alberta
T6E 6E6

Attention: Herman H.C. Ng, M.A.Sc, P.Eng.

RE: Alternative Sewer Maintenance Access Study

In response to your letter of May 31, 1994 we can provide you with the following information.

The City of Yellowknife uses ⅝" crush rather than salt on the streets, in conjunction with several unpaved roads, gravel obstruction of the storm sewer manholes has been an ongoing maintenance problem. These blockages often trap water and freeze within the storm sewer lines. Manholes are also affected by permafrost which can push them above the grade of the road. Occasionally crews must cut these manholes down by either removing some of the metal rings or removing the concrete ring completely.

In our opinion potential improvements to the storm sewer system would entail a shorter distance between manholes, i.e. 200 feet rather than the present 300 feet and replacement of ribbed metal culverts with a smooth plastic pipe, which we believe is already on the market.

At present our storm sewer maintenance practices consist of flushing out these lines with an IHC Vactor truck and cleaning out the sumps during the summer months. Late in October City crews cover all storm sewer manholes with 6 mil poly to prevent water from entering the system and freezing before it can be eliminated. During spring run-off the plastic is removed when there is a sufficient quantity of water. Crews using the Vactor truck and a truck mounted steam generator with hose and snake thaw any frozen lines.

.../2

P.O. Box 580
Yellowknife, N.W.T.
X1A 2N4
Tel. (403) 920-5600
Fax: (403) 920-5649

Other than the smooth plastic pipe previously mentioned there are no alternative structures we know of.

We hope this information will be useful in your study, if you have any questions please feel free to contact either the undersigned or Steve Conroy at 920-5609.

Sincerely,

Cheri Doucette
Public Works Clerk

cc. Dan Levert - Director Public Works

/cd

THE CITY OF WINNIPEG
REGIONAL SERVICES BRANCH

105-1155 Pacific Avenue
Winnipeg, Manitoba
R3E 3P1

FAX: (204) 774-6751

RECEIVED JUN 30 1994

June 23, 1994

Mr. Herman H.D. Ng, M.A. Sc., P. Eng.
Butler Krebes and Associates Inc.
Suite 210, 8616-51 Avenue
Edmonton, Alberta
T6E 6E6

Dear Sir:

Re: Alternative Sewer Maintenance Access Study

Please find attached information pertaining to your letter dated May 31, 1994.

1. The City of Winnipeg's sewer and appurtenance inventory.

2. Sewer rehabilitation strategy.

3. Sewer maintenance equipment owned by the City of Winnipeg. Most sewer maintenance can be accomplished using the C.B. and sewer cleaner (Vactor). More information on the Vactor can be obtained from Mr. Michael Rodden at 604-430-4274. I've also been informed that manual cleaning might be required in some situations.

4. The six City of Winnipeg Water and Sewer Supervisors and their telephone numbers. If you require information on maintenance problems and other concerns, I would suggest you contact the above.

5. The City of Winnipeg Operations Department Maintenance Management Task Methods for the Sewer Section.

If you have any questions, please contact me at 986-6808.

Yours truly,

Wes Hill

W. Hill
Technologist II
Regional Services Branch

WH/llj
Attach.

TELEPHONE
(902) 421-

15 June 1994

CITY OF HALIFAX

P.O. Box 1749
HALIFAX, NOVA SCOTIA
B3J 3A5

RECEIVED
JUN 2 1 1994

Mr. H. C. Herman, M.A.Sc., P.Eng.
Butler Krebes & Associates Ltd.
Suite 210, 8616-51 Avenue
Edmonton, Alberta
T6E 6E6

Dear Mr. Herman:

Re: Sewer Maintenance Study

The following is in response to your letter of 31 May 1994.

The maintenance problems with the manholes (frames and covers) in the City of Halifax are no different than those experienced by other municipalities, particularly in areas where temperature changes from winter to summer are quite significant. The major problems include differential settlement around manholes, cracking of asphalt, frost heaving and seepage of groundwater.

Every year we repair and adjust a very significant number of manholes. This adds to high maintenance costs, as well as an inconvenience to the public. We have experimented with various methods of repairs and adjustment in the past but have not found any one satisfactory solution.

Last year we engaged a local consultant to study the problem and recommend solutions on a long-term basis. Findings and recommendations of this study are contained in the attached report.

With respect to your question regarding the cleaning of the sewers and the equipment used, we clean our sewer lines and catchbasins on a regular basis, primarily once every 5 years. Some sewer lines get cleaned more often than others, depending on the size and the slope of the line and its location. We use the following equipment:

- Catchbasin Cleaner VAC-ALL E18, manufactured by LEACH (12" suction)
- One Combination Sewer Cleaner AQUATECH Model B-10, and,
- One PEABODY - MYERS VACTOR 2100.

Trusting the above is satisfactory. If you have any further questions or need additional information, please call me at 421-6972, area code 902.

Yours very truly,

N S Tomar

N. S. TOMAR, P.ENG.,
ENVIRONMENTAL HEALTH ENGINEER

NST/klz

City Of St. John's
P.O. Box 908, St. John's, NF, Canada A1C 5M2 (709) 576-8600

JUN 20 1994

June 14, 1994

Mr. Herman H. C. Ng
Butler Krebes & Associates Inc.
Suite 210, 8616-51 Avenue
Edmonton, Alberta
T6E 6E6

Dear Mr. Ng:

ALTERNATIVE SEWER MAINTENANCE ACCESS STUDY

With reference to your letter dated May 31, 1994 regarding the above noted subject, we offer the following comments:

1. We have a serious problem with differential settlement around manhole frames in the winter. We experience numerous freeze-thaw cycles during our winter months which aggravates this problem. Each year we must repair dozens of manhole frames which are either too high or too low due to frost action.

2. We are experimenting with different construction techniques to minimize the differential settlement problem. We are trying a floating-type manhole frame which is designed to move with the asphalt. We are also experimenting with setting the frame in asphalt rather than concrete. We don't have enough experience yet to know if these techniques are working.

3. We use a high pressure water sewer flushing truck (sewer jet) as our primary main sewer cleaning equipment. By using various nozzle sizes on this truck, we are able to clear most blockages. We also use a combination vacuum truck/sewer jet truck for sewer maintenance. This truck is used for vacuuming out gravel and other solids from catch basins and sanitary sewers, but is also used as a sewer jet for clearing blockages. Access to the sewers is by way of manholes.

4. We are not aware of any alternative access structures.

We are very interested in receiving a copy of the results of your survey and any recommendations which you make on this issue.

Yours truly,

Paul Mackey

Paul Mackey, P. Eng.,
Manager, Environmental Services

MONCTON
OFFICE OF THE COMMISSIONER OF ENGINEERING AND PUBLIC WORKS
BUREAU DU COMMISSAIRE D'INGÉNIERIE ET DES TRAVAUX PUBLICS

RECEIVED
AUG - 8 1994

1994 July 29

Butler Krebes & Associates Inc.
Suite 210, 8616-51 Avenue
Edmonton, Alberta
T6E 6E6

ATTENTION: HERMAN H.C. Ng, M.A.Sc., P. Eng.

RE: ATTACHED SURVEY

In reply to your survey dated May 31, 1994, I refer you to the following:

I
1. RING AND COVERS
2. BENCHING
3. ACCESS TO SEWERS BY UNAUTHORIZED INDIVIDUALS
4. ENTRY INTO A GAS ENVIRONMENT BY STAFF

II
1. ONE PIECE MANHOLES PRECAST OF PLASTIC OR A CONCRETE PRODUCT
2. RING AND COVER FIT AND ADJUSTMENTS
3. PRE-INSTALLED LADDERS

III
1. SEWER CLEANERS ARE AN AQUATECH SJ 2000 PRESSURE UNIT WITH AN IME VACUUM TRAILER AND AN AQUATECH SJR 2500 PRESSURE UNIT WITH AN AQUATECH JV 1000 VACUUM TRAILER.
2. WE ALSO HAVE TWO CATCH BASIN CLEANERS AS WELL, A VAC ALL AND A VACTOR MODEL 400 D.

IV - NOTHING THAT I AM AWARE OF.

If you require anything further, please contact me at your convenience.

A L MacPherson

A. L. MacPherson, P. Eng.
DIRECTOR OF UTILITIES
AND EQUIPMENT

ALM/kas

cc: R. H. LeBlanc

City Hall - Hôtel de Ville
774 rue Main Street
Moncton, N. B.
Canada, E1C 1E8
Tel: (506) 853-3525
Fax: (506) 853-3543

City of
RICHMOND

6911 No. 3 ROAD, RICHMOND, B.C. V6Y 2C1
(604) 276-4000 FAX 276-4197

ENGINEERING DEPARTMENT 276-4010

June 10, 1994
File: 59.1

FAXED

Via Fax

Mr. Herman H.C. Ng, M.A.Sc., P. Eng.
Butler Krebes & Associates Inc.
Suite 210 - 8616 51st Avenue
Edmonton, Alberta
T6E 6E6

Dear Mr. Ng:

Re: Alternative Sewer Maintenance Access Study

Thank you for your letter of May 31, 1994. By copy of this letter, I am inviting Ms. Beth Currie, P. Eng., of the Greater Vancouver Regional District (GVRD) to respond.

Beth is coordinating a task force which is studying ways of reducing infiltration and inflow into sanitary sewers. I think that some of the information gathered from surveys as part of that study will be of use to you. Maybe some of your ideas will be valuable in the GVRD study also.

Yours truly,

K McDonald.

Ken McDonald, P. Eng.
Project Engineer

KMD:kdl
pc: Beth Currie, GVRD (Fax No. 436-6714)

Greater Vancouver Regional District

4330 Kingsway, Burnaby, British Columbia, Canada V5H 4G8

Sewerage and Drainage Department
Sewers and Drainage Division

Fax Memo

To:	Name	Herman H.C. Ng, M.A.Sc., P. Eng.
	Company	Butler Krebes & Associates Inc.
	Department	
	Phone	(403) 465-4800
	Fax	(403) 463-3100
From:	Name	Beth Currie, P. Eng.
	Phone	(604) 432-6494
	Fax	(604) 436-6714

Date: June 14, 1994 Time: 03:38 PM

Total number of pages, including cover sheet: 1

Message:

Your letter of May 31, 1994 to the City of Richmond was forward to me by Ken McDonald. I am a Senior Project Engineer with the Greater Vancouver Regional District. The District owns and operate large trunk and interceptor sewers tributary to four wastewater treatment plants in the Greater Vancouver region. I am coordinating a regional I/I reduction program with our eighteen member municipalities, of whom Richmond is one.

With regards to your letter, I am afraid that the majority of our sewers are 900 mm diameter or greater and we do not have any experience specific to problems with manholes on sewers up to 600 mm diameter. However, I would like to point out that we use manholes not only for access to the sewer system, but as installation points for equipment used for monitoring flows and sampling wastewater. You may want to consider such things in your report.

We would be very interested in receiving a copy of your final report. Best of luck with your research.

Beth Currie

Beth Currie, P. Eng.
Senior Project Engineer

If you do not receive all pages, please call as soon as possible to: (604) 432-6450.

City of
Ville d' Ottawa

Department of
Engineering and Works

Service du génie et des
travaux publics

111 Sussex, Ottawa, Ontario K1N 5A1
Fax no. 564-4617

(613) 564-1119

EW-634-4

RECEIVED AUG - ...

1994 August 2

Herman H.C. Ng, P. Eng.
Butler Krebes & Associates Inc.
Suite 210, 8616-51 Avenue
Edmonton, Alberta
T6E 6E6

Dear Mr. Ng:

Re: Alternative Sewer Maintenance Access Study

Thank you for giving us the opportunity to comment on the options set forth in your letter of 1994 May 31.

From a maintenance perspective, it is true that we could reduce costs associated with settlement around manholes. However, we have some grave concerns with these proposals, and these are outlined below.

1. How would we be able to visually examine sewer lines without manholes for the cameras and crews to gain access to the sewer lines?

2. How would we be able to clean the sewers, including vacuuming, without access points?

3. How would we be able to tell if a storm sewer was overtaxed without a manhole where the water could flow (or gush) out?

4. How could debris be trapped before it entered the sewer, necessitating more costly cleaning operations? (Our manholes presently contain sumps to trap the debris.)

The Operations Branch would prefer that manhole structures have a narrow opening at the top (just large enough to permit entry by maintenance staff), but which widen out at the bottom to allow enough space for staff to properly inspect the sewer lines.

We use high velocity sewer cleaning to clear sewer lines, vacuums for manholes, and T.V. cameras to inspect the lines. The sewer cleaning equipment uses standard sized hoses and nozzles. We are not aware of any feasible alternative to manholes which would enable us to carry out all these activities; however, we would be interested in reviewing any suggestion you might offer.

.../2

If you need any further information, please feel free to contact either Ray Yantha, Manager of Parks, Trees and Sewer Operations, or Luc Dugal, Sewer Operations Superintendent. Mr. Yantha can be reached at (613) 564-1119, and Mr. Dugal at (613) 564-8341.

Yours truly,

for A.B. Garnett
Director of Operations

SRS:ss
317792.L

APPENDIX 'B'

REFERENCES

REFERENCES

1. Handbook of Hydraulics, King and Brate
2. Elementary Fluid Mechanics, Vennard.
3. Water Supply and Sewerage, Steel.
4. Design and Construction of Sanitary and Storm Sewers, A.S.C.E.
5. An Introduction to Trenchless Technology, Kramer, McDonald, Thomson.
6. Handbooks of Municipal Administration and Engineering, Foster.
7. Open Channel Hydraulics, Chow.
8. Simplified Monitoring Techniques for Urban Runoff-Binder, Katj and Ripp, WE & M, 1981.
9. Sewer Maintenance and Rehab Options, Andrews and Yonker, WE & M, 1981.
10. Infiltration/Inflow Source Identification by Comprehensive Flow Monitoring, DeCoite, Tsujita and Petroff, WPCF, 1981.
11. Developments in Sewerage 1, Bartlett.
12. Urban Storm Drainage Criteria Manual, Wright-McLaughlin Engineers.
13. Operation and Maintenance of Wastewater Collection Systems, Manual of Practice No. 7, WPCF.
14. Manhole Adjustment Study for the City of Halifax, Jacques, Whiteford and Associates Limited.

APPENDIX 'C'

UNIT PRICES

1. PIPES AND FITTINGS

Description	PVC (SDR 35)	Reinforced Concrete (C76-CL V)
A. Pipe		
300 mm ⌀	30.50/m	36.40
375 mm ⌀	46.20/m	47.10
450 mm ⌀	69.00/m	79.30
B. Fittings		
a. Tees		
300 mm x 300 mm	137.00/each	195.00/each
375 mm x 375 mm	225.00/each	230.00/each
450 mm x 450 mm	375.00/each	290.00/each
b. Reducer		
375 mm x 200 mm	215.00/each	145.00/each
375 mm x 250 mm	225.00/each	145.00/each
375 mm x 300 mm	249.00/each	165.00/each
450 mm x 375 mm	394.00/each	175.00/each

2. STANDARD MANHOLE

A. 1200 mm ⌀ Precast Concrete Base Slab 200.00/each

B. 1200 mm ⌀ Precast Concrete Barrel

410 mm 158.00/each

1200 mm 343.00/each

1630 mm 447.00/each

C. 1200 mm ⌀ Precast Cone Top

	610 mm	260.00/each
D.	Precast Concrete Grade Ring	
	50 mm	32.00/each
	100 mm	32.00/each
	150 mm	38.00/each
E.	Floating Manhole Frame and Cover	300.00/each

3. BACKFILL MATERIALS

o	Washed Rock	16.00/m^3
o	Screened Sand	4.20/m^3

APPENDIX 'D'

COST COMPARISON GRAPHS

FIG. 19 COST COMPARISON OF VARIOUS SEWER LINE MATERIAL AT 3.0M DEPTH

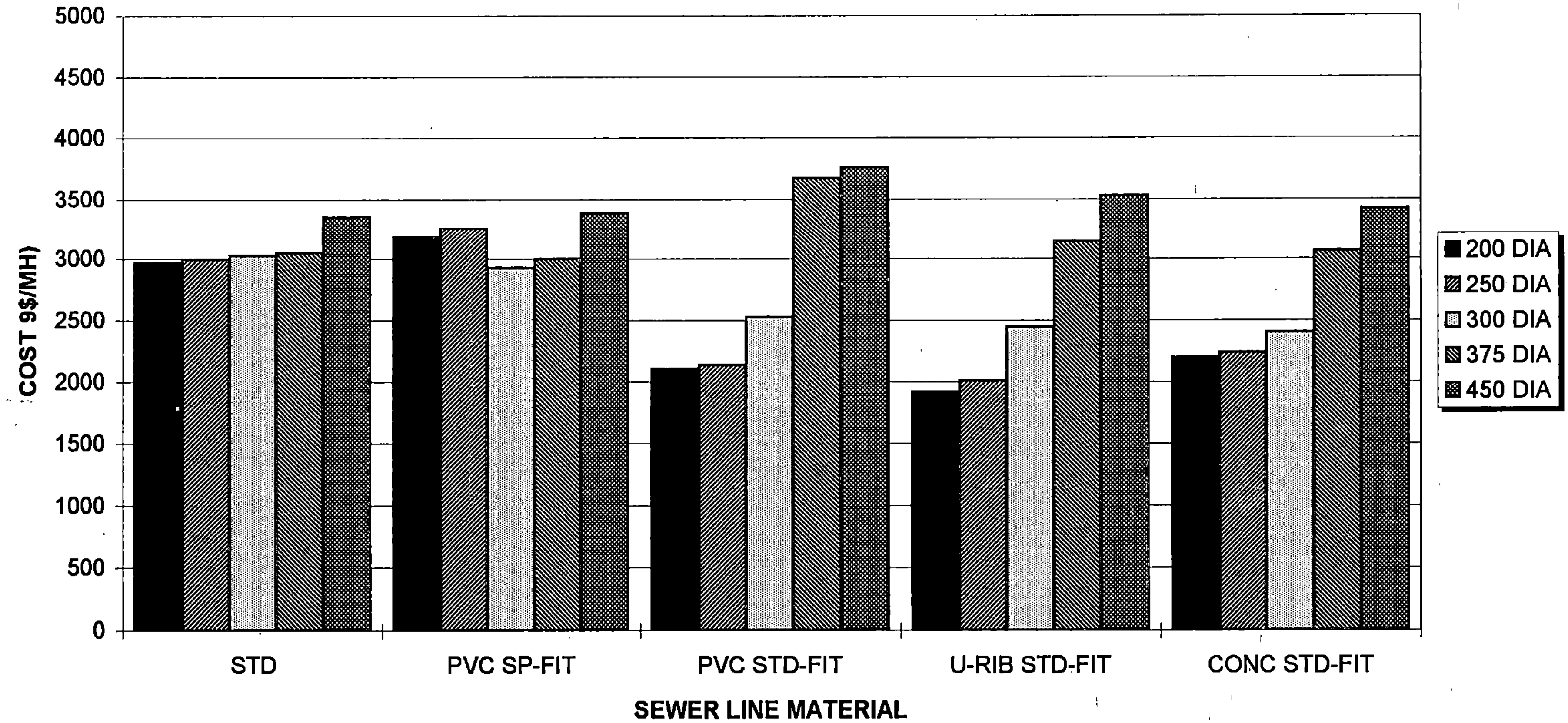


FIG. 20 COST COMPARISON OF VARIOUS SEWER LINE MATERIAL AT 4.0M DEPTH

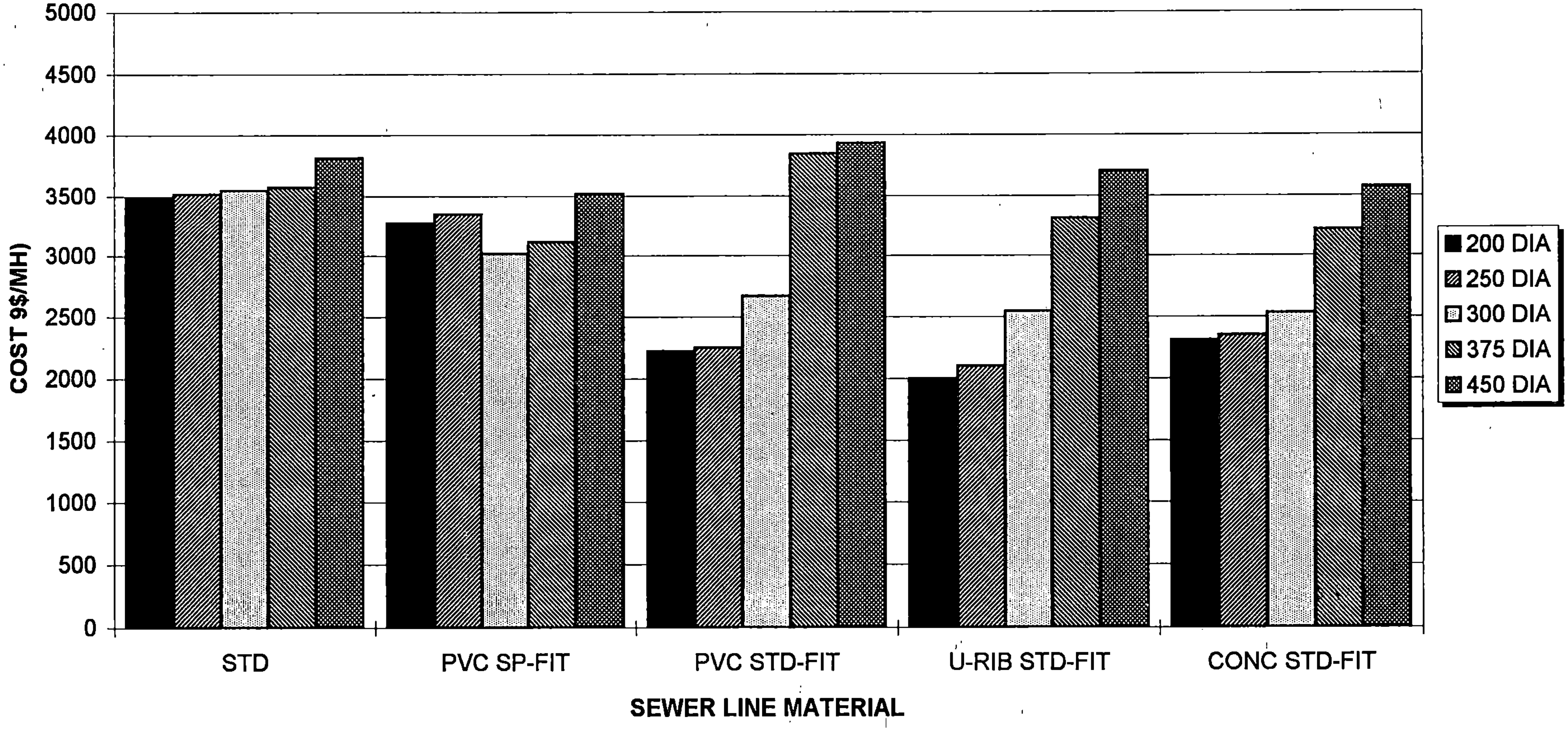


FIG. 21 COST COMPARISON OF VARIOUS SEWER LINE MATERIAL AT 5.0M DEPTH

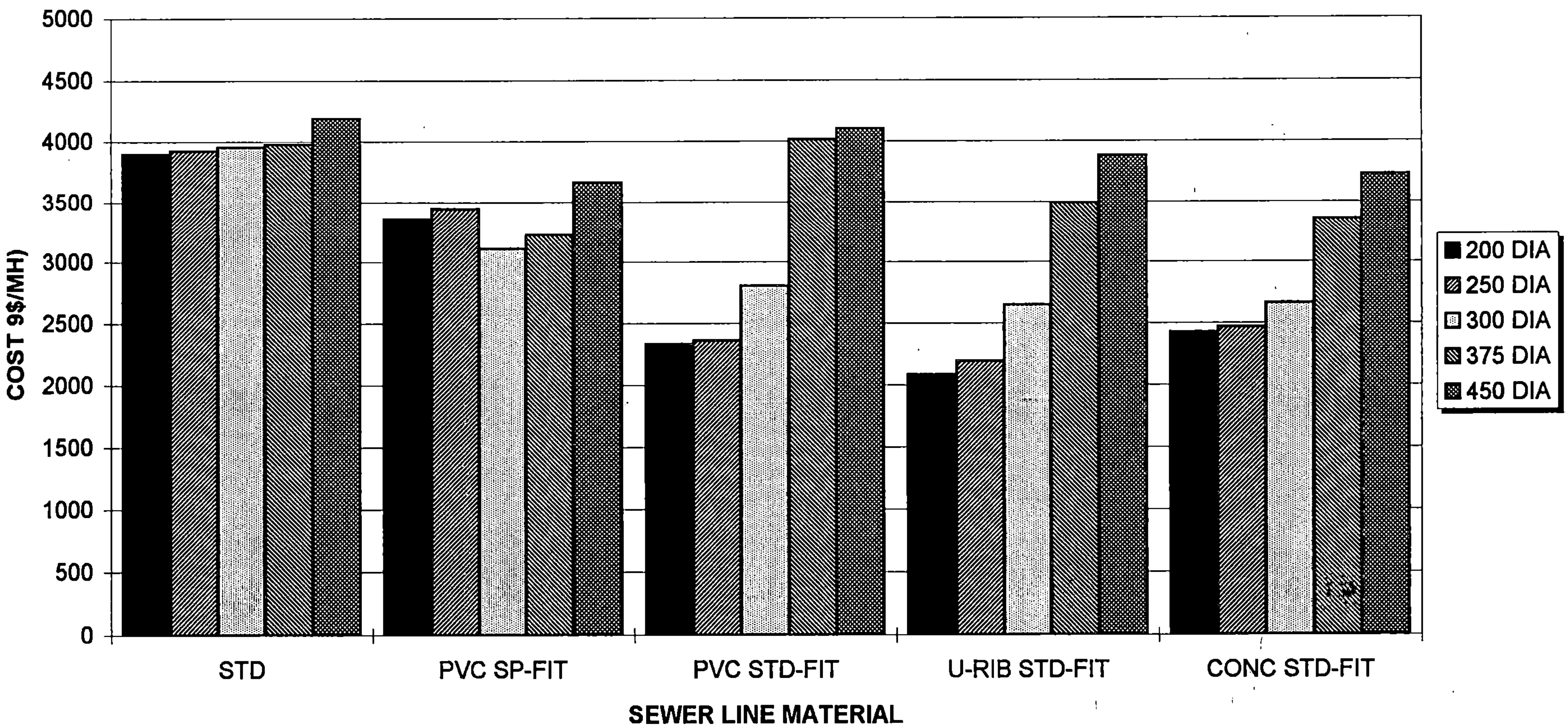
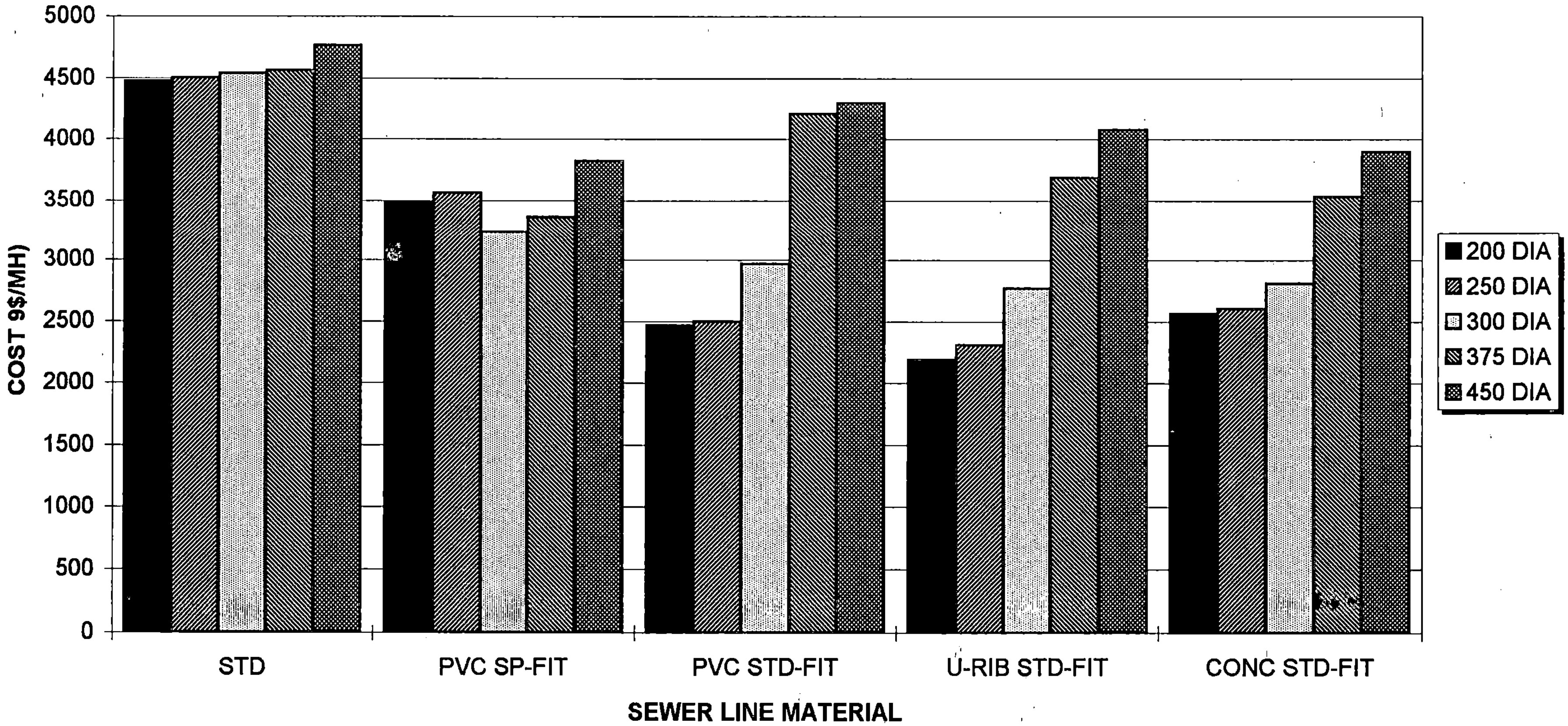


FIG. 22 COST COMPARISON OF VARIOUS SEWER LINE MATERIAL AT 6.0M DEPTH



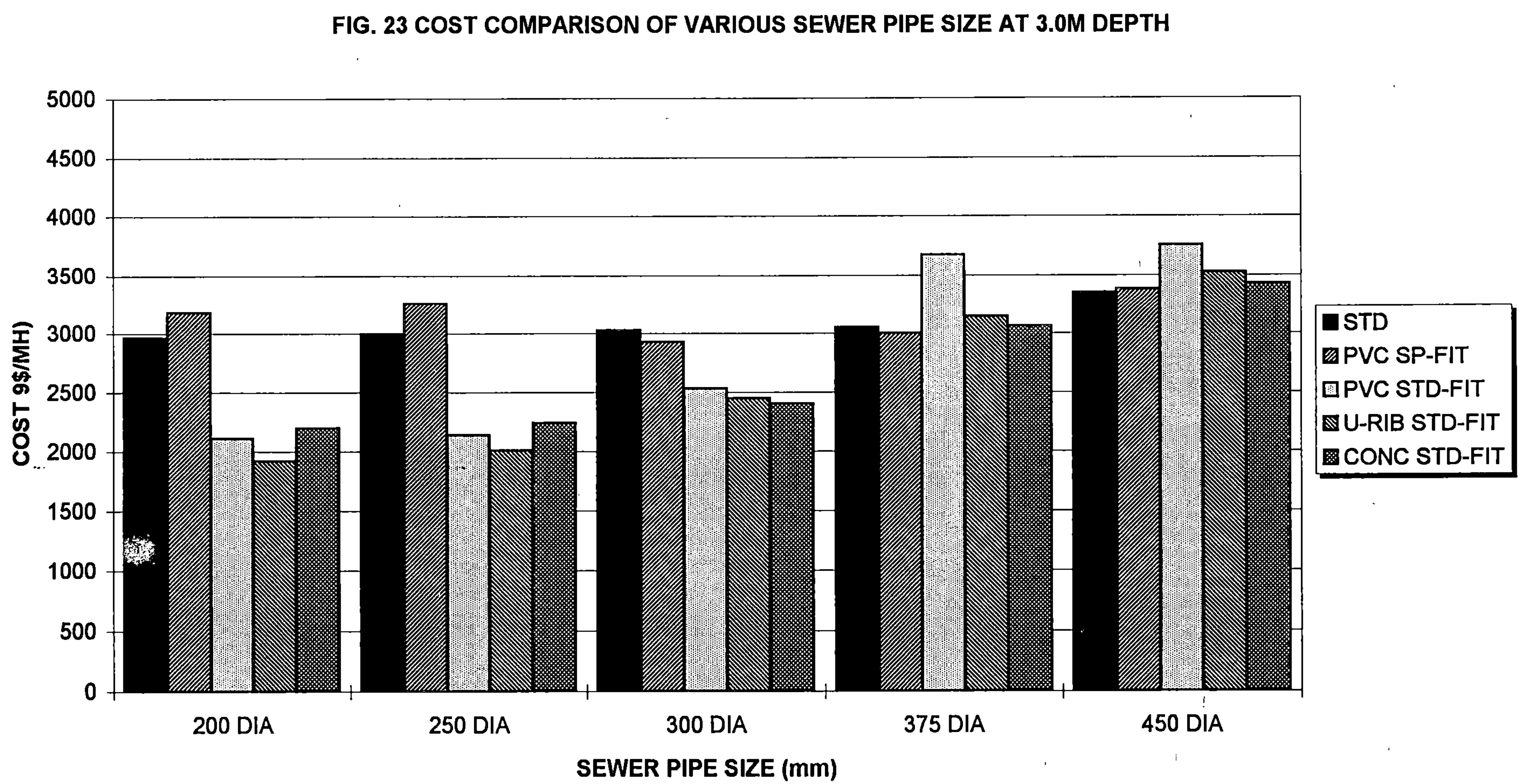


FIG. 23 COST COMPARISON OF VARIOUS SEWER PIPE SIZE AT 3.0M DEPTH
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
COST 9$/MH)
200 DIA
250 DIA
300 DIA
375 DIA
450 DIA
SEWER PIPE SIZE (mm)
STD
PVC SP-FIT
PVC STD-FIT
U-RIB STD-FIT
CONC STD-FIT

FIG. 24 COST COMPARISON OF VARIOUS SEWER PIPE SIZE AT 4.0M DEPTH

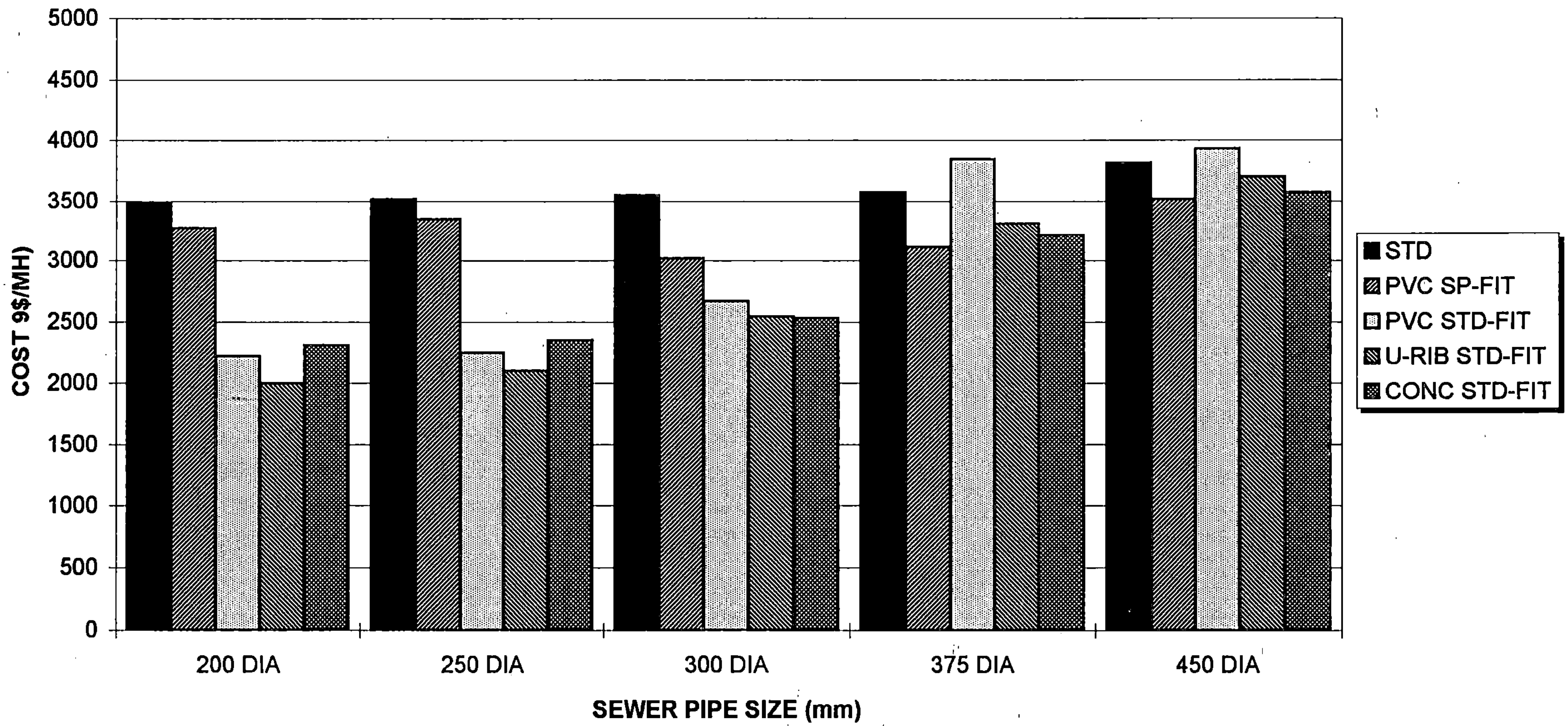


FIG. 25 COST COMPARISON OF VARIOUS SEWER PIPE SIZE AT 5.0M DEPTH

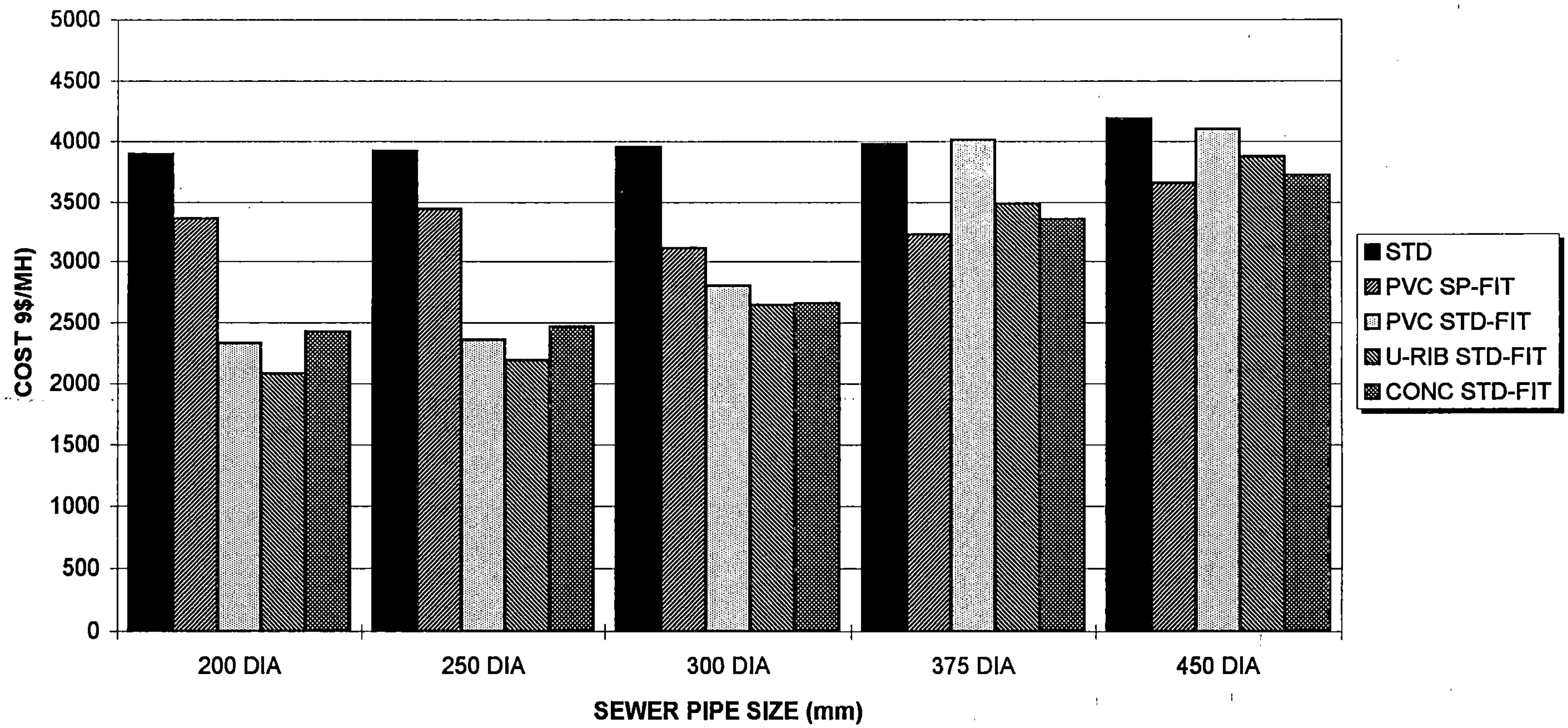
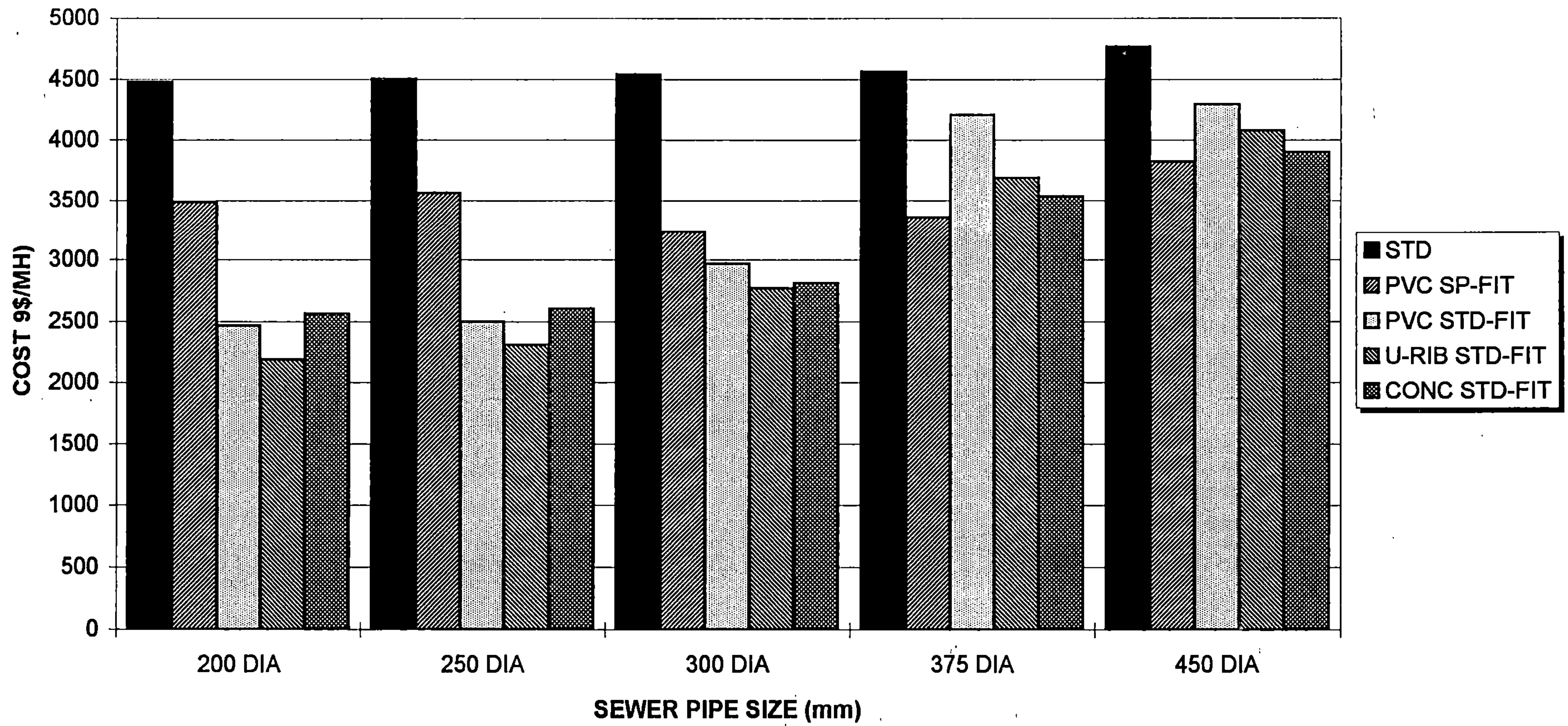


FIG. 26 COST COMPARISON OF VARIOUS SEWER PIPE SIZE AT 6.0M DEPTH



ABBREVIATIONS

Std	Standard 1200 mm ⌀ manhole with two holes.
PVC SP Fit	PVC Pipe and special fittings.
PVC Std Fit	PVC Pipe and standard fittings.
U-Rib Std Fit	Ultra rib PVC Pipe and standard fittings.
Conc. Std Fit	Reinforced concrete Pipe and standard fittings.

APPENDIX “E”

FIELD EVALUATION OF PILOT MODEL

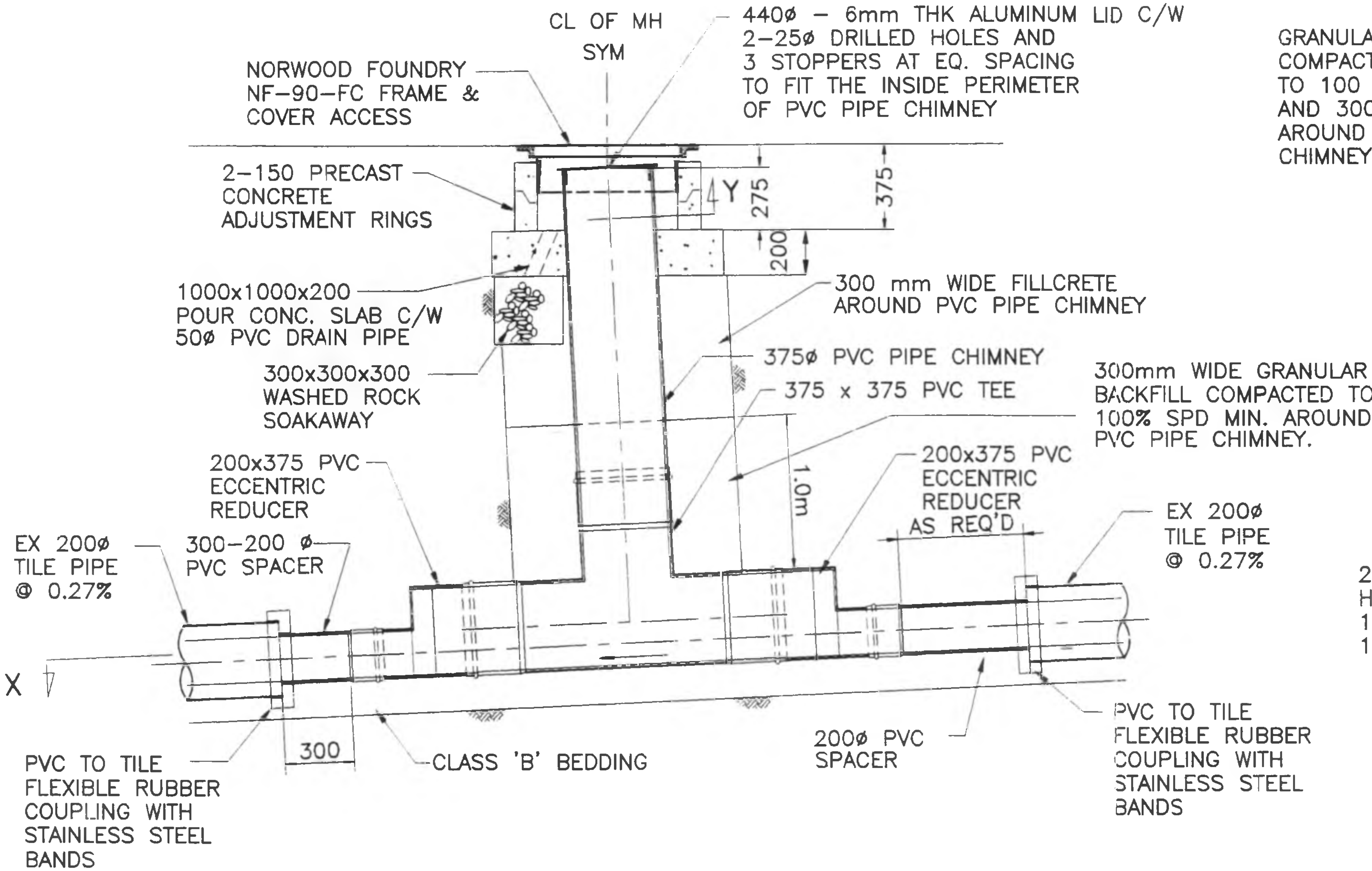
1. INTRODUCTION

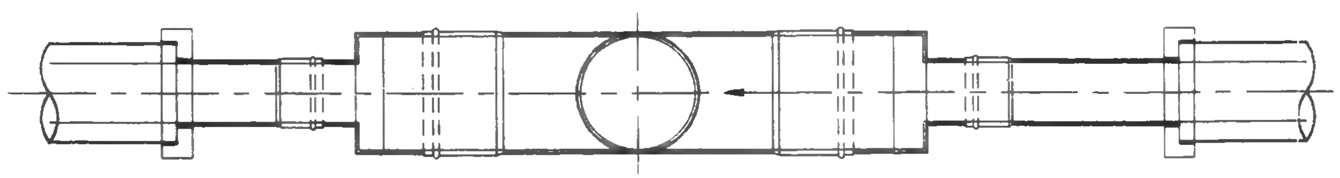
Subsequent to the completion of the detailed design of the alternate sewer access as shown on Fig. A, the City of Edmonton Public Works Department installed a pilot model on an existing 200 mm ⌀ sanitary sewer on June 7, 1995. The pilot model is located on 150 Street approximately 20 metres north of 109 Avenue as shown on Fig. B. The pilot model was installed to evaluate the performance of the proposed alternate sewer access in respect to structural integrity, hydraulic performance, maintenance requirements and operation constraints.

2. MATERIALS

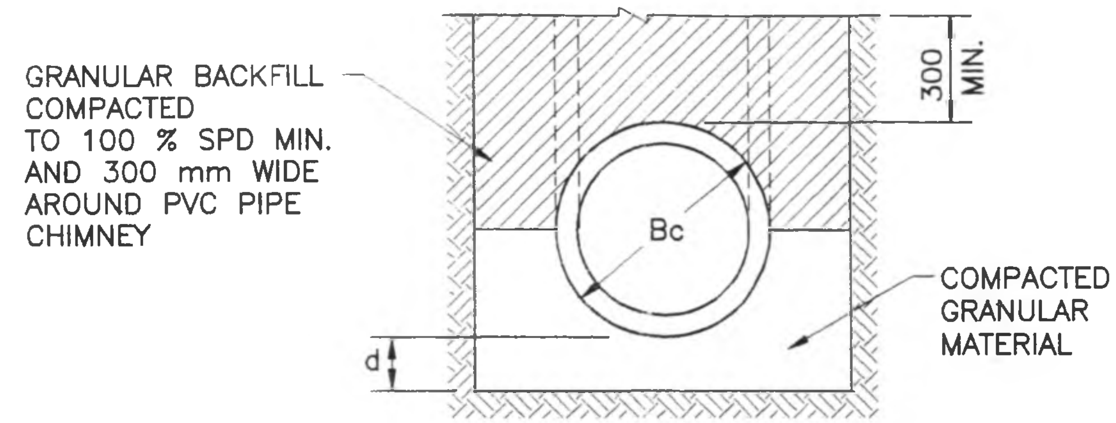
The materials required for the construction of the pilot model are listed as follows:

- 375 mm ⌀ PVC SDR 35 chimney.
- 1 - 375 mm x 375 mm PVC SDR 35 tee.
- 2 - 375 mm x 200 mm PVC SDR 35 reducers.
- 1 - 6 mm thick - 440 mm ⌀ aluminum lid Grade 6061-T6 c/w two 25 ⌀ drilled holes and three stoppers at equal spacing to fit the inside perimeter of PVC pipe chimney.
- 1 - Norwood Foundry NF-90-FC frame and cover.
- 300 mm x 300 mm washed rock soakaway.
- 1000 mm x 1000 mm x 200 mm poured concrete pad (sulphate resistance concrete with a compressive strength of 30 Mpa at 28 days).
- 2 - 150 mm high standard precast concrete manhole adjustment rings.





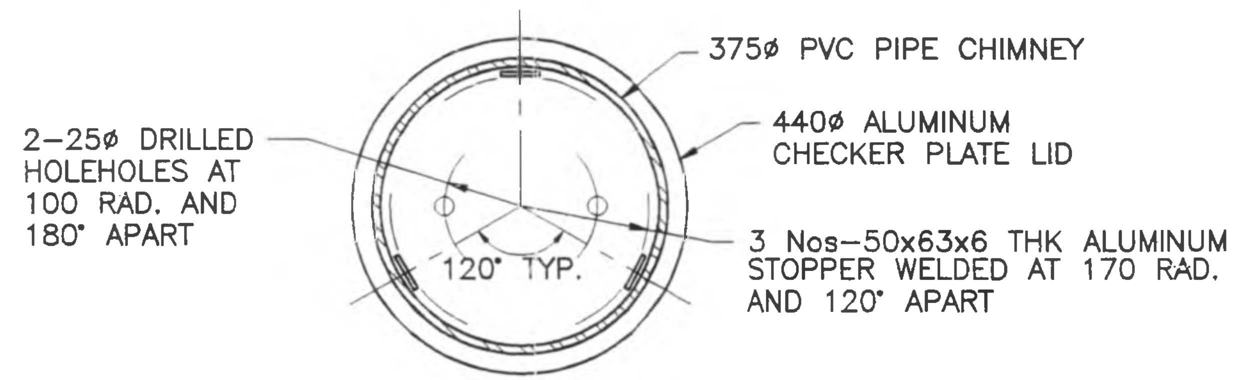
SECTION X



LEGEND:

Bc = OUTSIDE PIPE DIAMETER
d = DEPTH OF BEDDING MATERIAL BELOW PIPE (100 mm MIN., 150 mm IN ROCK)

CLASS 'B' BEDDING N.T.S



SECTION Y 1:10

NOTES AND SPECIFICATIONS:

1. ALL MATERIALS AND CONSTRUCTIONS SHALL CONFORM TO THE LATEST CITY OF EDMONTON STANDARDS AND SPECIFICATIONS.
2. ALL PVC PIPES AND FITTINGS SHALL BE DR35 WITH 'RING–TITE' JOINTS UNLESS OTHERWISE NOTED.
3. CONCRETE SHALL BE SULPHATE RESISTANCE CONCRETE WITH A COMPRESSIVE STRENGTH OF 30 MPa AT 28 DAYS.
4. FLEXIBLE RUBBER COUPLING SHALL BE MANUFACTURED BY POWER SEAL PIPELINE PRODUCTS CORPORATION OR EQUAL.
5. ALUMINUM SHALL BE GRADE 6061–T6.
6. ALL DIMENSIONS ARE IN MILLIMETER UNLESS OTHERWISE NOTED.
7. THE SEWER LINE ACCESS IS LOCATED ON 150 ST. NORTH OF 109 AVENUE.

NOTES:

PERMIT

PERMIT TO PRACTICE
BUTLER KREBES & ASSOCIATES INC.
Signature
Date Oct 19/95
PERMIT NUMBER: P 4112
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

ENGINEER
PROFESSIONAL ENGINEER ALBERTA
HUNG CHEE NG
Oct 19/95

THE CITY OF Edmonton

SEWER LINE ACCESS

DETAILS

EDMONTON ALBERTA

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CKD. BY: HN	SCALE: 1:25 OR A.S.	DRAWING No:	DATE: 10–19–95
DRAWN BY: T.L./D.C.D	FIELD BOOK No:	FIG. A	REV.: 0

DRAWN WITH CAD 02/17/97 08:47 C:\WINDOWS\TEMP\BWC\FIG-A

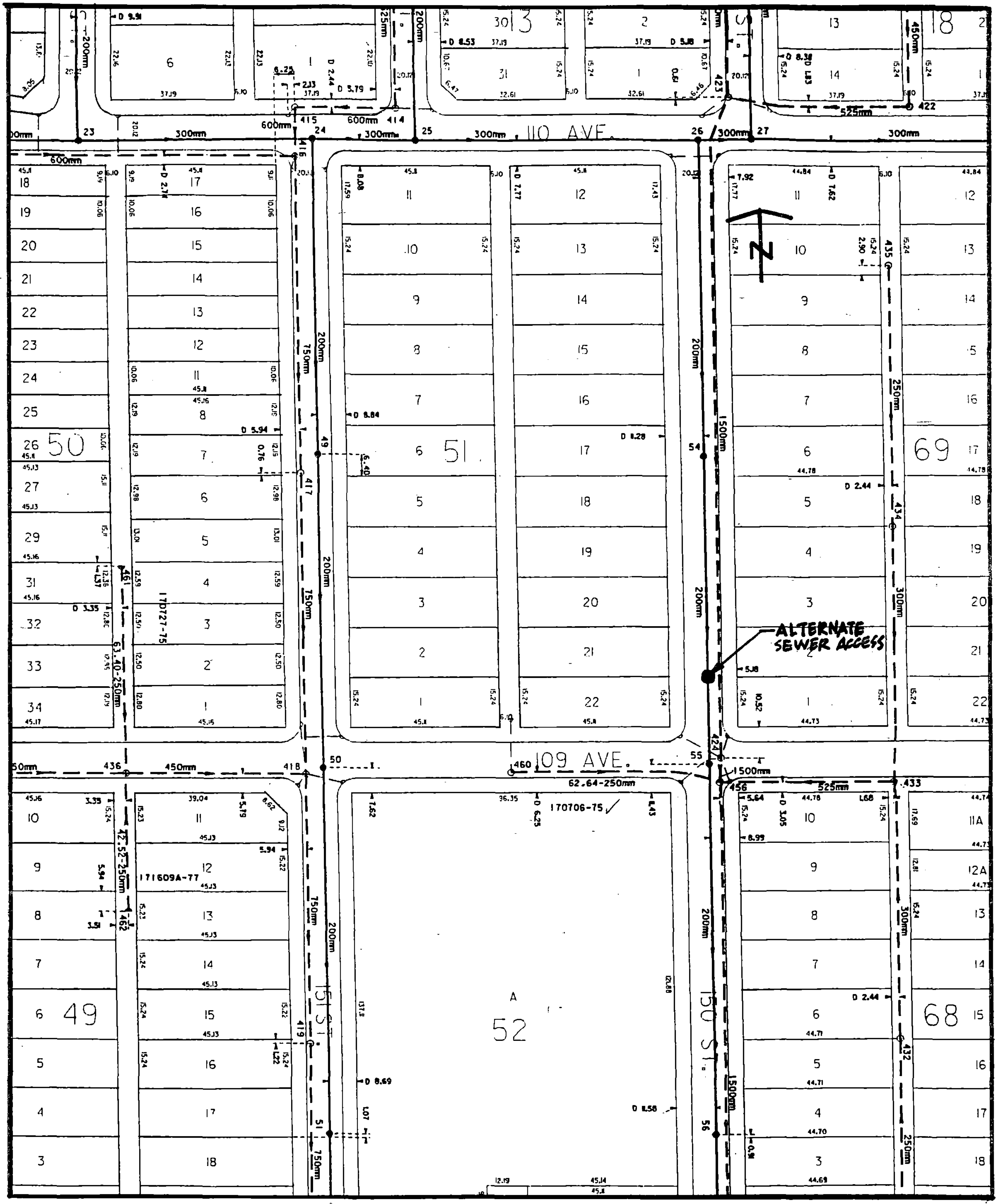

Fig. B. Location of Alternate Sewer Access

- 2 - PVC to tile pipe flexible couplings.

- 50 mm ⌀ PVC drain pipe.

- Sand backfill.

The following variations in construction materials have been used for the construction of the pilot models.

- The reducer is approximately 320 mm long and does not have a smooth conical section as shown on Fig. A. The reducer is fabricated with a short section of 375 mm and 200 mm PVC pipes. The 375 mm ⌀ pipe has a spigot end to allow for connection to the bell end of the 375 mm ⌀ tee and a blind end constructed with a flange fused onto the inside of the pipe. The blind end has an opening to allow for the fusion of the 200 mm ⌀ pipe. The 200 mm ⌀ pipe has a bell end to make a connection to the existing sewer. The reasons for using this fitting instead of the proposed reducer with a smooth conic section are as follows:

    - ▹ 375 mm x 200 mm ⌀ PVC reducer is not readily available and requires custom fabrication.
    - ▹ This fitting is easy to fabricate.
    - ▹ The fitting is lower in cost by approximately $50.

- Washed rock was used in place of sand to provide a bedding for the lower tee. This was required because the trench was saturated and washed rock tended to stabilize the base soil.

- Fillcrete was placed above 1.2 m of sand backfill. Fillcrete was used to overcome the wet and sloughing conditions of the trench.

3. INSTALLATION

The pilot model was installed by the City of Edmonton Public Works Department as part of the rehabilitation of the existing 200 mm ⌀ sanitary sewer. The existing sewer was constructed with vitrified clay tile and has a slope of 0.27%. The alternate sewer access is approximately 3.1 m deep.

3.1 Procedure

The installation procedure for the pilot model is described as follows:

- Excavate trench bottom to design grade.
- Compact bottom of trench to 95% Standard Proctor Density minimum.
- Place washed rock bedding material and compact.
- Install reducer at both ends of the 375 mm ⌀ tee on ground surface.
- Place the 375 mm ⌀ tee on the washed rock bedding to the design grade and alignment.
- Place washed rock to slightly above the springline of the tee to hold the tee in place.
- Connect the reducer at both ends of the tee to existing sewers with flexible couplings.
- Install the 375 mm ⌀ PVC pipe chimney.
- Place additional washed rock to approximately 150 mm above the tee and reducers.

- Place sand backfill approximately 1.2 m above washed rock bedding and compact to 100% Standard Proctor Density.

- Place fillcrete to bottom of washed rock soak-away.

- Construct washed rock soak-away.

- Place fillcrete to bottom elevation of concrete pad.

- Construct poured concrete pad and precast concrete pit with 150 mm standard precast manhole adjustment rings.

- Place aluminum cover and floating manhole frame and cover.

The installation of the alternate sewer access is simple and does not require a crane or backhoe to lower the pipe or fitting into the trench. The installation time excluding backfill and concrete pit is approximately one half hour.

Figs. C to E show the various components of the alternate sewer access during and after installation.

3.2 Comments From City of Edmonton Public Works Department

The comments from the City of Edmonton Public Works Department are shown in Appendix "F".

The comments from the City of Edmonton Public Works Department Construction Foreman, Mr. Les Locskai, are summarized as follows:

- The alternate sewer access can be installed easily and quickly.

- The alternate sewer access is well suited for the replacement of deteriorated manholes on an existing sewer system.

- The alternate sewer access works well on the sanitary sewer system. On a storm sewer system, it can be used only at locations where a catch basin lead is not connected to the manhole.

- The City of Edmonton should consider using the alternate sewer access wherever possible.

4. PERFORMANCE EVALUATION

Closed circuit television (CCTV) camera inspections were conducted on April 29 and June 24, 1996, approximately 10 months after the installation by the City of Edmonton Transportation Department Drainage Operation Branch. The purpose of the inspection was to assess the performance of the alternate sewer pilot model. The results of the inspections are described as follows.

4.1 Structural Integrity

The inspection to evaluate the structural integrity of the alternate sewer access were conducted as follows:

- A CCTV camera was used to inspect the bottom fittings and connection to the existing sewers.

- Visual inspections of the surface and upper chimney area.

The results of the inspections are as follows:

- No structural defects including cracks, offset or open joints for both chimney and bottom fittings.

- Minor offset joint at the north connection of the structure and the existing tile sewer pipe; however, this will not jeopardize the structural stability of the alternate sewer access. As described by the City of Edmonton Construction Foreman, the formation of the minor offset is due to the following factors:

  - the existing sewer and the alternate sewer access are made from different materials.
  - it is difficult to perfectly line up pipes of different materials, especially between new and existing pipes.
  - the coupling may not fit perfectly.

- No buckling was noticed on the structure. The structure is sound and is capable of withstanding traffic loading.

- No surface settlement was evident around the manhole cover.

4.2 Hydraulic Performance

The hydraulic performance of the alternate sewer access was evaluated by visual inspection of the flow through the access bottom. During the inspection, the depth of flow was approximately 50 mm which is approximately 1/4 of the pipe diameter. Sewage flow through the structure bottom was without significant turbulence or back-up.

4.3 Maintenance Requirements

The maintenance requirements for the alternate sewer access was also evaluated based on visual and CCTV camera inspection as follows:

- A visual inspection of the service conditions was conducted from the top of the access in its original state prior to using a nozzle to flush the string downstream to hook up the CCTV camera. The access bottom was clean and did not have any debris built-up. It was noted that light debris did build up in the standard concrete manhole immediately upstream of the alternate sewer access.

- A CCTV camera inspection was conducted to assess service conditions at the hidden areas of the tee, reducers and the junctions of the sewers. It was found that the entire bottom and junctions of sewers were clean and without any debris.

4.4 Operation Constraints

The operation constraints of the alternate sewer access in respect to sewer pipe cleaning and inspection are listed as follows.

4.4.1 Sewer Pipe Cleaning

The pipes in a sewer system constructed using the alternate sewer access can be cleaned only by using high pressure water cleaning equipment. Because of the type of equipment currently available, it can be expected that the majority of debris in a sewer system could be loosened and removed through the alternate sewer access. Only where larger debris that cannot be loosened and broken up by high pressure water jets, would the pipe have to be excavated to remove the material. However, the likelihood of the accumulation of larger debris is minimal if a regular cleaning program is implemented as well as precautions taken during construction.

The adequacy of the alternate sewer access to accommodate high pressure cleaning equipment is evaluated based on measurement of the components of the sewer cleaning facilities. The cleaning equipment used by the City of Edmonton as shown on Figs. G and H, consists of a nozzle and metal suction pipes. The nozzle is connected to a high pressure jet pump through a 20 mm ⌀ rubber hose. The nozzle produces a high pressure jet to clean the sewer and bring the debris to the alternate sewer access. The metal suction pipe is then used to remove the debris from the system through the alternate sewer access. The 200 mm ⌀ metal suction pipes are connected by clamps. The outside diameter of the clamp including the protruding bolts is 320 mm. Most of the time the flushing nozzle and suction pipe are used independently. For sewer pipes with heavy debris, both the flushing nozzle and suction pipe must be used concurrently. The maximum space requirement for high pressure cleaning equipment is therefore 340 mm. Since the smallest size of the chimney of the alternate sewer access is 375 mm ⌀, high pressure sewer cleaning equipment can be used in the alternate sewer access. For larger pipes, the size of the chimney increases with the size of the sewer pipe and therefore the mobility of the suction pipe inside the chimney also increases.

4.4.2 Sewer Pipe Inspection

The development of the alternate sewer access was inspired by the advancement in CCTV cameras currently available for sewer inspection. The CCTV camera inspection not only provides more accurate information but also eliminates the exposure of inspectors operating in a hazardous environment in a conventional manhole.

The City of Edmonton, Drainage Operations Branch conducted a field investigation of the pilot model in respect to the ability of conducting CCTV camera inspections. The following equipment was used for the trial and are shown on Figs. I and J.

- CUES CCTV camera mounted on a 700 mm skid.
- A 900 mm long Crawler.

It was possible to insert and retrieve the CCTV camera from the alternate sewer access without any difficulty. However, the 900 mm long crawler cannot be inserted into the 200 mm sewer line through a 375 mm diameter chimney. To accommodate the City of Edmonton crawler, a chimney of 450 mm diameter would be required.

The proposed alternate sewer access can accommodate crawler with length less than 750 mm and the following crawlers are available:

- Hydraulic jet crawler
  This crawler is 450 mm long and is available from Image Synthesization Inspection Services Ltd.

- Two segment electronic crawler.
  This crawler consists of two 375 mm long segments and is available from Cam-Trac Inspection Services.

4.4.3 <u>Comments From City of Edmonton Drainage Operations Branch</u>

Comments from the City of Edmonton Public Works Department is shown in Appendix "F". The comments are summarized as follows:

- The alternate sewer access is structurally sound.

- The hydraulic performance of the structure appears to be satisfactory.

- CCTV camera inspections can be conducted through the structure with a camera mounted on a skid which has a length less than 750 mm.

- CCTV camera inspections cannot be conducted through the structure with a crawler of 900 mm long. A chimney of 450 mm in diameter will be required for a crawler with this length.

- High pressure cleaning equipment can be used for sewer cleaning through the structure.

- The structure cannot be used for bucket rodding equipment to remove large debris.

5. CONCLUSIONS

The following conclusions are based on our field evaluations.

A. The installation cost of the alternate sewer access is considerably less than a conventional precast concrete manhole.

B. The installation of the alternate sewer access is simple and straight forward. Heavy equipment is not required and it takes only approximately one half hour to install.

C. The alternate sewer access is structurally sound without any cracks.

D. Sewage flows through the bottom of the alternate sewer access smoothly.

E. After approximately 10 months of installation there was no debris built up in the alternate sewer access and therefore maintenance requirements could be less than for a conventional manhole.

F. CCTV camera inspections can be readily conducted through the alternate sewer access with a skid mounted camera.

G. A 450 mm diameter chimney will be required for a crawler of 900 mm length to conduct a CCTV camera inspection in sewers. However, the proposed 375 mm diameter chimney can accommodate a hydraulic jet crawler or any crawler with a length less than 750 mm.

H. High pressure cleaning equipment can be used for sewer cleaning from the top of the alternate sewer access.

I. Larger debris in sewer systems may take one of the following forms:

- pieces of pipe resulting from structural failure.
- debris left in the sewer pipe during construction.
- debris built up over a number of years.
- debris from acts of vandalism.

Large debris must be removed by bucket rodding equipment. However, a sewer system constructed with the alternate sewer access may not require bucket rodding equipment for sewer cleaning for the following reasons:

- Because of the quality and availability of plastic pipes there is a tendency to use plastic for the construction of both small sanitary and storm sewers. Pieces of plastic pipe could normally be removed using a high pressure flusher.

- Debris entering the manhole through acts of vandalism is reduced since the cover can be opened only by using special equipment.

The need for bucket rodding equipment can also be eliminated if the following precautions are taken:

  - ▹ Institute a good inspection program to ensure that large debris does not enter the sewer system during construction.
  - ▹ Institute a sewer cleaning program to clean sewers at regular intervals, especially in industrial areas so that the formation of large debris through build-up and consolidation can be avoided.

J. At present, none of the available trenchless sewer rehabilitation methods can be used to repair structural defects in sewer pipes through the alternate sewer access. Any structural defects in a sewer system constructed with the alternate sewer access have to be repaired using open cut methods.

This condition may change in the near future. In accordance with the information we obtained from Pacific Lining Systems in U.S.A., the company has a joint venture with Sika Robotics Inc. to develop a structural repair method using a robot to spray a seamless layer of resin on the defective pipe wall. The progress of the development is very promising and the equipment could be available in the near future. It is possible that this equipment could be used for pipe repair through the alternate sewer access.

We believe a trenchless rehabilitation method that can be used for the alternate sewer access to repair sewer pipes can be developed if there is a need. It is inappropriate that the lack of trenchless rehabilitation methods at present should prevent the use of the alternate sewer access.

K. In high groundwater table areas, it may be necessary to anchor the alternate sewer access to a concrete pad to counter-act buoyancy.

6. RECOMMENDATIONS

The recommendations based on the field evaluation of the pilot model are as follows:

A. Adopt and install the proposed alternate sewer access in a sewer system where the sewer pipe size is less than 450 mm ⌀ and at the following locations:

- straight run sewers.
- storm sewers where catch basin lead connections are not required.
- upstream of a sewer system
- local roads.

- arterial and collector roads only after trenchless rehabilitation methods that can repair structural defects in a sewer pipe from the ground surface is available.

- corrosive soils.

B. For a sewer system constructed with the proposed alternate sewer access the following preventive measures should be taken:

- Ensure that no large objects are left in the sewer system during construction.

- Institute a program to clean the sewers at regular intervals to avoid the formation of large debris from build-up and consolidation.

APPENDIX “F”

CITY OF EDMONTON COMMENTS

THE CITY OF Edmonton PUBLIC WORKS

CONSTRUCTION BRANCH
14323 - 115 AVENUE
EDMONTON, ALBERTA
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February 23, 1997

File No.: 6.7

Butler Krebes Associates Ltd.
200, 4224 - 93 Street
Edmonton Alberta T6E 5P5

For the attention of Mr. Herman Ng, P. Eng.

Dear Sir:

Re: Alternative Sewer Maintenance Access Study

In 1995 the Construction Branch of the City of Edmonton's Asset Management and Public Works Department installed an alternative sewer access on an existing 200 mm sanitary sewer line during rehabilitation in order to evaluate its constructability and the suitability of the access for sewer maintenance and inspection.

The effort expended in installing the alternative access was considerably less than that needed to construct a full sized manhole. The foreman in charge noted that installation was straightforward and that no unexpected problems occurred. The difficult of connecting two disparate materials led to minor offset on one connection, but this is nothing abnormal and should not affect the performance of the structure.

In my opinion the proposed new sewer access is a viable alternative under certain circumstances, in both new and existing sewer systems. The standard configuration, shown in Figure 11 of the report and used in the trial installation, provides a sound guide for the design and specification of this type of access. It is evident that it will lead to a reduction in the cost of installing accesses to storm and sanitary sewers without seriously compromising the ability to maintain these sewers using modern equipment. Its use as an alternative to standard manholes should be given serious consideration by all owners and operators of municipal sewer systems.

Sincerely,

Mike Brooks

Mike Brooks, P. Eng., M. Sc.
Technical General Supervisor
Construction Branch

MB/mb

THE CITY OF Edmonton TRANSPORTATION

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November 1, 1996

RECEIVED
DEC 13 1996

Butler Krebes & Associates Inc.
Suite 210, 8616 51 Avenue
Edmonton, Alberta
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Attention Mr. John Krebes, P. Eng

Dear Sir,

Subject: Alternative Sewer Line Access Study - CMHC

Further to my letter dated April 16, 1996, I am prepared to clarify some comments on the Alternative Sewer Line Access Study, because of the additional information provided.

Tests conducted by our closed circuit television inspection crew have determined that it was possible to insert skids of various sizes through the access. Additional information indicating that the chimney diameter may vary to suit the size of the sewer line, addresses our main concern of inserting camera skids for the larger pipe diameters.

In item #4 of the conclusions (Page 43) it was mentioned that the "cover can be located off the pavement". There may be limitations in locating the alternative access away from paved areas. Our sewer cleaning combination units are heavy pieces of equipment (approximately 25 tones), therefore, damage to boulevards or other unpaved areas may occur during cleaning of manholes located off the pavement.

Some savings in capital cost could be realized by using this alternative access on the upstream end of typical drainage basins and as access for retrieving wastewater samples from private businesses.

Yours Truly

Andy Bowen, P.Eng.
Director Drainage Operations

cc Ken Chua

Fig. D: Alternate Sewer Access Connection to Existing Sewer

Fig. C: Alternate Sewer Access Base Fittings

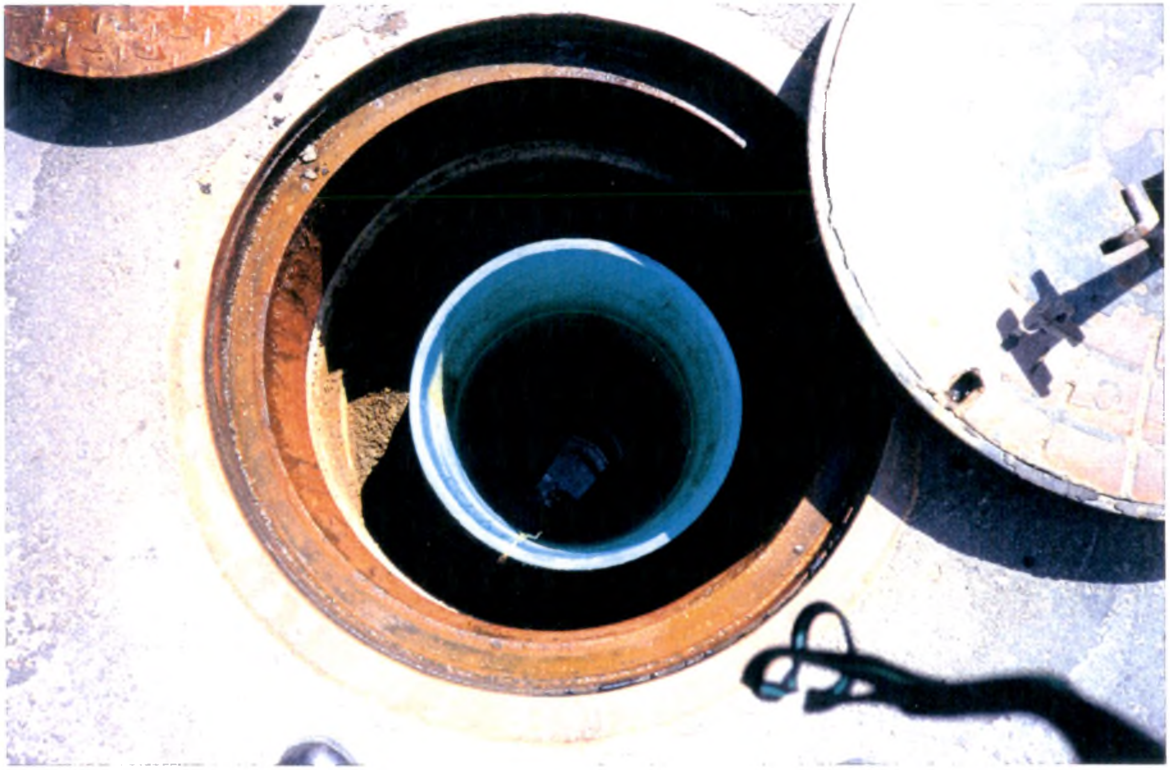

Fig. E: Precast Concrete Pit

Fig. F: Cover of Alternate Sewer Access Chimney and Precast Concrete Pit

Fig. H. Metal Suction Pipes

Fig. G: Vacuum Truck

Fig. I. CUES CCTV Camera

Fig. J: Crawler