STREET USE & SERVICING PLANNING:

AN INVESTIGATION OF DESIGN POSSIBILITIES AND FEASIBILITY OF UNDERGROUND PUBLIC UTILITY STRUCTURES IN LOCAL RESIDENTIAL STREETS

by

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B.A., The University of British Columbia, 1957

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We accept this thesis as conforming to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA
April, 1964
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Date May 3, 1964.
ABSTRACT

This thesis was prompted by the belief that local residential streets could be better used and serviced if a common underground structure were provided for all utilities. Such a structure could not only get wiring underground, a desirable aim in itself, but also gather all of the utilities together in a narrow portion of the street. This would free the remainder of the street from the restrictions imposed by the utilities, and allow designers to create more interesting and pleasant environments. It was further believed that such structures might be feasible if the designing and servicing of local streets were considered comprehensively.

These beliefs have been investigated by formulating and testing the general hypotheses that installing utilities in specially designed underground structures in local residential streets would:

a) permit better use and design of such streets than is possible by current servicing practices;

b) be feasible (from functional, physical, social, staging, administrative, political, financial, and economic points of view) if comprehensively designed.

The scope of this investigation has been limited to future local streets in single-family residential districts of Metropolitan Vancouver for these reasons. Future streets would allow maximum flexibility in design and savings in servicing costs by proposed practices. Local streets generally have simpler and smaller-sized facilities which are most widely spread. Single-family residential districts are and will be the largest land use and hence, have the most increase in streets. Metropolitan Vancouver has been studied because of its proximity and familiarity to the investigator and its variety of servicing practices.
Street use is the use made of streets including such ones as playing, not currently facilitated. The 'servicement' is that part of the physical environment created by property service facilities in the streets. Property services are those public services providing service to property as distinct from people. Current practice is the ways of designing and installing facilities followed at the present time. The term 'better' in the first hypothesis is interpreted in terms of elements of the public interest. These include public health, safety, convenience, amenity, welfare, and economy. Criteria of feasibility have been established for the evaluation of the proposed practices. These include functional, physical, social staging, administrative, political, functional, and economic feasibility. They are essentially different ways of looking at a complex problem.

Three general types of public utility structures have been considered in three different conditions. The three types are trough, tunnel, and tube-conduit. A trough is open to the surface and covered by a sidewalk. A tunnel is a single underground space, usually tubular, between manholes. The tube-conduits have several cells or tubes. The three conditions are when the structure contains all utilities, all but the drainage, and only electrical and communicative utilities.

All public services to property involving permanent facilities in streets that are or could conceivably be provided by public or private agencies have been considered. They have been classified into ten classes by functional characteristics of interest in the investigation. The first class is the access services. The next four are the utilities: baric (or pressure), communicative, drainage and electrical. The remainder are called other services and include: furnishing, gardening, 'holding' indicating, and 'keeping' services.
Current practices have been described in terms of 'best', 'normal', and 'worst' practices because of the wide range of practices that exist.

Proposed practices that would be involved or could result from installing utilities in common underground structures have been described in comparison to current practice. These proposed practices have been evaluated in effect by testing specific hypotheses about each practice by application of appropriate feasibility criteria.

The proposed designing practices have been found to be feasible in almost all respects, with a few qualifications as follows:

1) functional layouts involving roads and parking areas close to houses would have to be tested for public acceptance by full-scale development projects.

2) it is functionally unfeasible to install gas pipes in structures because of the potential safety hazard involved.

The feasibility of the proposed practices has been found to be as follows:

a) the all-utility trough and tunnel structures are unfeasible except for those few people willing to pay highly for the benefits that would accrue.

b) The all-utility tubed-conduit appears to be economically feasible. Indeed, it might provide savings that could be passed on to those served or taxpayers generally, or used to provide additional services or a higher quality of service.

c) The other utility structures appear to be generally feasible, or so nearly so economically that people would be willing to pay for the extra benefits.

It is suggested that the design and feasibility possibilities of the all-utility tubed-conduit be investigated by means of a full scale experimental development. This should be done at
the same time as a nearby development following current practices. This would allow careful evaluation of the costs, and public reaction to the proposed practice in comparison to current practices.
ACKNOWLEDGEMENTS

This investigation could not have been carried out without the co-operation of many officials of municipal and other public service agencies including the privately owned utility companies. Several gave up a considerable amount of time to answer numerous questions about their services which could be answered only by persons having a great deal of knowledge and experience on such highly specialized subjects. These officials are listed in the Bibliography. For this cooperation and assistance I am most grateful. I particularly appreciate the information and assistance given by Mr. Douglas Kenyon, City Engineer of Port Moody, without which the economic analysis would have been much more difficult and less satisfactory.

This thesis is unlikely to have been completed without the encouragement of friends and family over the several years that have been spent on it, and the assistance of the latter during the final stages of putting together such a large report. I am particularly indebted to my long-suffering wife for the many weekends and evenings spent typing drafts, instead of following more pleasurable pursuits.

The form of the thesis would have been less satisfactory than at present without the suggestions of the several thesis advisors involved over the years, and for these I offer my thanks.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td><strong>I. DEFINITIONS AND CRITERIA</strong> - Definitions and Classification of Structures and Services Investigated, and Criteria for Evaluating Them</td>
<td>17</td>
</tr>
<tr>
<td>Definitions of Terms Used</td>
<td>17</td>
</tr>
<tr>
<td>Outdoor Room Analogy</td>
<td>24</td>
</tr>
<tr>
<td>Types of Utility Structures Investigated</td>
<td>26</td>
</tr>
<tr>
<td>Classification of Services</td>
<td>29</td>
</tr>
<tr>
<td>Elements of the Public Interest as Criteria for Evaluating Street Use and Servicing Practices</td>
<td>34</td>
</tr>
<tr>
<td>Principles of Street Use and Servicing (integration, payment for benefit, and maximum benefit)</td>
<td>39</td>
</tr>
<tr>
<td>Plan Elements and Feasibility Tests</td>
<td>48</td>
</tr>
<tr>
<td>Summary</td>
<td>56</td>
</tr>
<tr>
<td><strong>II. CURRENT PRACTICES</strong> - A Description of Current Street Use and Servicing Practices in Ten Municipalities of Metropolitan Vancouver</td>
<td>57</td>
</tr>
<tr>
<td>Areal Scope of Current Practices Investigated</td>
<td>63</td>
</tr>
<tr>
<td>Street Uses</td>
<td>65</td>
</tr>
<tr>
<td>Current Process of Designing Street Use and Servicement</td>
<td>67</td>
</tr>
<tr>
<td>Current Process of Installing Property Service Facilities</td>
<td>72</td>
</tr>
<tr>
<td>Composite Best, Normal and Worst Servicing Practices</td>
<td>76</td>
</tr>
<tr>
<td>Summary</td>
<td>85</td>
</tr>
<tr>
<td>CHAPTER</td>
<td>PAGE</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>III. PROPOSED DESIGNING PRACTICES - A Description of the Proposed Process of Designing Property Service Facilities for Local Residential Street Use and Servicement.</td>
<td>86</td>
</tr>
<tr>
<td>Assumptions and Principles of Proposed Practices</td>
<td>87</td>
</tr>
<tr>
<td>Proposed Process of Designing Street Use and Servicement</td>
<td>88</td>
</tr>
<tr>
<td>Designing Street Use and Servicement of Intersections</td>
<td>117</td>
</tr>
<tr>
<td>Designing the Subdivision</td>
<td>131</td>
</tr>
<tr>
<td>Future Services</td>
<td>135</td>
</tr>
<tr>
<td>Summary of Proposed Designing Practices</td>
<td>138</td>
</tr>
<tr>
<td>IV. PROPOSED INSTALLING PRACTICES - A Description of the Proposed Process of Installing Property Services Facilities for Local Street Use and Servicement.</td>
<td>141</td>
</tr>
<tr>
<td>Proposed Process of Installing Subdivision Plats</td>
<td>142</td>
</tr>
<tr>
<td>Proposed Process of Preparing the Street for Servicing</td>
<td>144</td>
</tr>
<tr>
<td>Proposed Process of Installing Utility Structures</td>
<td>147</td>
</tr>
<tr>
<td>Proposed Process of Installing Utilities</td>
<td>147</td>
</tr>
<tr>
<td>Proposed Process of Installing Pavements (and Curb-Gutters)</td>
<td>151</td>
</tr>
<tr>
<td>Proposed Process of Installing Plants</td>
<td>151</td>
</tr>
<tr>
<td>Proposed Process of Installing Other Service Facilities</td>
<td>153</td>
</tr>
<tr>
<td>Summary of Proposed Process of Installing Service Facilities</td>
<td>156</td>
</tr>
<tr>
<td>CHAPTER</td>
<td>PAGE</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>V. EVALUATION OF PROPOSED PRACTICES - Determination of the Feasibility of the Proposed Street Use and Servicing Practices.</td>
<td>158</td>
</tr>
<tr>
<td>Evaluation of Proposed Street Use and Design</td>
<td>159</td>
</tr>
<tr>
<td>Evaluation of Proposed Designing Practices</td>
<td>161</td>
</tr>
<tr>
<td>Evaluation of the Feasibility of the Proposed Practices of Installing Property Service Facilities</td>
<td>168</td>
</tr>
<tr>
<td>Summary and Conclusions</td>
<td>184</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>187</td>
</tr>
<tr>
<td>APPENDIX - Table of Contents for Appendices</td>
<td>192</td>
</tr>
<tr>
<td>A. CURRENT SERVICING PRACTICES - A Detailed Description and Ranking for Ten Selected Metropolitan Municipalities, and Comparison With Practices Elsewhere</td>
<td>193</td>
</tr>
<tr>
<td>B. INSTALLING UTILITY STRUCTURES - A Description of Possible Processes for the Various Types</td>
<td>243</td>
</tr>
<tr>
<td>C. COST DATA</td>
<td>255</td>
</tr>
<tr>
<td>TABLE</td>
<td>PAGE</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>I. Classification of Services</td>
<td>29a</td>
</tr>
<tr>
<td>II. Land Values - Municipality of Richmond</td>
<td>46</td>
</tr>
<tr>
<td>III. An Analysis of Factors Affecting Trees and Supply Lines</td>
<td>71</td>
</tr>
<tr>
<td>IV. Estimated Utility Costs per Foot</td>
<td>174</td>
</tr>
<tr>
<td>V. Underground Wiring Costs for Transformer - Secondary Combination to Serve Back-to-Back Lots</td>
<td>255</td>
</tr>
<tr>
<td>VI. 1963 Estimating Costs for Sewers, City of Port Moody</td>
<td>256</td>
</tr>
</tbody>
</table>
# LIST OF DIAGRAMS

<table>
<thead>
<tr>
<th>DIAGRAM</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Types of Proposed Utility Structures</td>
<td>27</td>
</tr>
<tr>
<td>2. Types of Proposed Utility Structures</td>
<td>96</td>
</tr>
<tr>
<td>3. Effect of Location on Depth of Drains</td>
<td>97</td>
</tr>
<tr>
<td>4. Effect of Street Slope and Manhole Spacing on Depth of Drains</td>
<td>99</td>
</tr>
<tr>
<td>5. Functional Layouts of Electric Power Service Facilities</td>
<td>103</td>
</tr>
<tr>
<td>6. Illustrative Layout of Pavements Near Natural Features</td>
<td>107</td>
</tr>
<tr>
<td>7. Facilities at the Intersection of Two Local Streets</td>
<td>120</td>
</tr>
<tr>
<td>8. Proposed Design of Intersection of Two Local Streets</td>
<td>122</td>
</tr>
<tr>
<td>10. 'Servi-Center' at Intersections of Collector Streets</td>
<td>126</td>
</tr>
<tr>
<td>11. Suggested Designs of 'Servi-Center'</td>
<td>129</td>
</tr>
<tr>
<td>12. Comparison of Cross-Sectional Areas Involved in Grading</td>
<td>146</td>
</tr>
<tr>
<td>13. Suggested Modifications to Lighted Street Name Signs</td>
<td>155</td>
</tr>
<tr>
<td>14. Suggested Pedestrian Signs</td>
<td>155</td>
</tr>
<tr>
<td>15. Suggested All-Utility Tubed-Conduit</td>
<td>181</td>
</tr>
<tr>
<td>16. Modified All-Utility Tubed-Conduit</td>
<td>181</td>
</tr>
<tr>
<td>17. Possible Types of All-Utility Trough Structures</td>
<td>247</td>
</tr>
<tr>
<td>18. Electric Trough-Curb-Gutter</td>
<td>250</td>
</tr>
<tr>
<td>19. Curb-Gutter Electric Tubed-Conduit</td>
<td>252</td>
</tr>
</tbody>
</table>
# LIST OF MAPS

<table>
<thead>
<tr>
<th>MAP</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Large-Scale Developments in Vancouver</td>
<td>59</td>
</tr>
<tr>
<td>2. Metropolitan Vancouver Areas Investigated</td>
<td>64</td>
</tr>
<tr>
<td>2. Metropolitan Vancouver Areas Investigated</td>
<td>194</td>
</tr>
<tr>
<td>3. City of Vancouver Development at 54th &amp; Kerr.</td>
<td>199</td>
</tr>
</tbody>
</table>
INTRODUCTION

Streets have always been, and are likely to remain essential parts of human settlements. When men claim parcels of land for their use and from trespass by others, they must set aside portions for streets to permit access to their land from outside the settlement and movement between parcels without trespass. Even temporary settlements of nomads (including weekend campers) demonstrate this fact.

Animal and insect 'settlements' also usually involve the equivalent of streets, some of which are perhaps more sophisticated than man's most complex creations. This is partly due to the fact that some animals and most insects can move on vertical or under horizontal surfaces, whereas man can not. Generally, he is unable to operate effectively with his limbs above his head. Also, man has not yet been willing to accept the degree of communal living practiced by such 'social' insects as ants and bees.

Man has developed various devices such as stairs, elevators, and escalators for vertical movement within buildings but the buildings must still be linked by streets. Helicopters and similar devices allow movement between separated sites, but the sites generally must be accessible by fuel and repair vehicles requiring streets.

Two current trends in inventions suggest the need for streets for movement may be reduced in the future. One is the development of means of communication that reduce the need for personal contact. The former are unlikely to become practicable for everyone including children and handicapped persons. On the other hand, the more people using them, the greater would be the trespass of space above sites and consequent invasion of privacy.
Means of communication are being conceived that theoretically could eliminate all movement except for changes of residence upon marriage. However, these involve connection of each dwelling by cables and/or electric power wires running in streets.

Streets are also used as rights-of-way for the facilities of services supplying such commodities as water and gas, or removing such wastes as storm water and sewerage. Thus, even if streets were not required for movement, they would be required for utilities unless each dwelling were made completely independent and self-sufficient. Such a possibility is conceivable. Indeed, research for the space program is solving the technological problems of living for extended periods in self-contained environments. However, this is unlikely to be sociologically or politically acceptable, and the historical tendency has been to increase, not reduce, the number of utilities in streets.

Streets required only for utilities need not be so wide as when also used for movement, but they perform other functions requiring width. These include acting as a firebreak between buildings and ensuring that adequate light and air is available to buildings. Also, streets are used as locations for the facilities of other services best supplied communally but required only intermittently, such as mail collection and delivery. Streets provide an open space which gives relief through contrast with adjacent development, especially when the street is planted and the development is intensive. Indeed, facades of buildings as we know them would not exist without streets. Finally, these open spaces provided by streets are public — people can meet, socialize, and play on common ground. Thus streets fulfill many basic human needs.

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Acceptance of the need for streets is universal, but the manner of meeting this need varies considerably between cultures. For example, the difference between the approach in North America and Europe is comparable to the difference in approach to the necessity for eating. The North American attitude seems to be "if we must eat, then let's spend as little time and effort as possible so that we can save it for things we want to do". In contrast, the European attitude seems to be "if we must eat, then let's spend sufficient time and effort to make it as pleasurable as possible".

The choice of which approach one accepts on such matters as time and effort spent on such necessities as eating is essentially an individual one, conditioned of course by one's cultural environment. The choice of which approach is followed in meeting the need for streets is essentially a public one, however, since only public action can protect the public interest in having an efficient and economical street system. This involves the establishment of standards and procedures for setting aside streets to meet the needs of the entire existing and potential future population, instead of just the immediate needs of individuals.

Thus the public can, and does, deliberately bring about changes in the way streets are set aside or used that are deemed to be in the public interest. The question is, are streets being set aside and used as well as they might be, or are there some changes that could be made for the better? In the opinion of this investigator, the answers are no, and yes, respectively—at least for local streets in single-family residential areas. The reasons for this opinion are that streets are considered either to occupy an excessive amount of land for the use that is made of them, or are not well designed or developed for the uses that could be made of them, and to result in excessive costs.
Land is the platform of all human activity and an irreplaceable resource. It behooves man to use it prudently, yet on this continent vast amounts of land are taken out of productive uses for streets apparently without fully compensating benefits. The proportion of land occupied by streets (including lanes) in urban and suburban areas can vary from about one-fifth to one-half, but is generally around thirty percent. A study of central cities in the United States found streets to be a fairly constant proportion averaging 28.1 percent of the developed area. Even assuming the rarely attained one-fifth can be attained in all future local residential streets, the total area involved will be great because of the tremendous growth anticipated in single family residential districts. Streets will continue to be the second largest urban land use. Hence, anything which allows either better use of streets or reduction of the area occupied by them would be to everyone's benefit.

Servicing costs for future local residential streets also will be tremendous in total because of the anticipated spread of development and consequent length of streets involved. The costs will be proportionately greater than past ones because of the higher standards of service being demanded and

2 An area in Steveston, Richmond, having 100 ft. wide streets and small square blocks had streets occupying 47.8 percent.

3 Harland Bartholomew, Land Uses in American Cities, Cambridge, Harvard University Press, 1955, (Harvard City Planning Studies IV), p. 63, which also provides the following data:

<table>
<thead>
<tr>
<th>No. of Cities</th>
<th>Population Group</th>
<th>Streets-Percentage of Total Developed Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>50,000 or less</td>
<td>28.33</td>
</tr>
<tr>
<td>13</td>
<td>50,000 - 100,000</td>
<td>33.27</td>
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<tr>
<td>7</td>
<td>100,000 - 250,000</td>
<td>27.57</td>
</tr>
<tr>
<td>5</td>
<td>250,000 and over</td>
<td>24.75</td>
</tr>
</tbody>
</table>
will be higher on a per lot basis because of the strong
tendency towards wider lots. Any savings in these costs
resulting from innovations could be shared by the community or
used to provide more services or raise the standard of them.

There are three main approaches to these problems of
land use and servicing costs. One is to reduce the total
amount of land used and the consequent servicing costs by
controlling the spread of development. This involves such
land use planning devices as zoning of permitted uses, and
programming of capital expenditures on such public works as
trunk water mains and sewers. The second approach is to reduce
the total amount of land used and costs of servicing by reducing
the area and costs of individual street sections. This involves
reducing the width of streets, the lengths of blocks, and costs
of installing services. Except for the latter, these matters
are also usually of concern in the best land use planning.
The third general approach is to increase the benefit derived
from given street areas and costs of services. This approach
currently seems to be considered outside the province of land
use planning. Indeed, it is apparently outside the specific
jurisdiction of any one profession, which may partly explain
the lack of followers.

This thesis is an attempt to explore this rather
neglected field of what is herein termed 'street use planning'.
Consideration is given where pertinent to the first two
approaches mentioned above, especially the costs of servicing.
The main focus, however, is on the use made of, and environment
created by streets and the service facilities in them.

The purpose of this investigation is to determine the
design possibilities and feasibility of certain proposed
practices of accommodating street uses and providing public
services in future local streets of single family residential districts of Metropolitan Vancouver, in comparison to current practice. The proposed practices of accommodating street uses differ from current practices in that each street section would be custom designed to meet the specific needs of the users of it, particularly the adjacent residents. For example, playing and other forms of recreation would be provided for, while car parking would be accommodated only where, and to the extent needed. Design possibilities for accommodating these uses and creating desirable environs would be considerably greater than in current practice. This is because the services would occupy or affect less of the street and be less rigidly placed than in current practice, thus freeing space and making flexible the placement of street uses. This would be accomplished by installing most or all of the utilities in underground structures specially designed for this purpose, and by placing the structures and pavements in the most advantageous locations in the street. It is primarily for these practices that the feasibility must be determined.

Three basic types of structure with minor variations are considered, called 'trough', 'tunnel', and 'tubed-conduit', respectively. All would form a continuous space or spaces for all or most of the 'utilities'. These are the continuous facilities of those public services providing such commodities as water, gas and electric power; and such services as telephone and other means of communication; drainage and sewerage. The trough would be open to the surface making the utilities accessible throughout their length. It would be covered by the sidewalk. Tunnels and tubed-conduits would be installed at the depth required for the storm drains and sewers. The utilities would be accessible only at intervals via manholes. These structures need not always be under the sidewalk, although there
are advantages to this location. Two other cases are considered for all three structures — when the drainage and sewerage facilities are not included in the structure, and when the structures contain only electrical and communicative utilities.

The concepts behind these structures are certainly not new. They are essentially expressions of the principle of economy through integration. In these cases, the main savings are in the costs of excavation and backfilling of trenches for each utility eliminated when several utilities are installed together. Troughs under precast concrete 'flagstone' sidewalks have been used for many years in England to carry electric wires, telephone cables, and gas pipes. The famous sewers of Paris can be considered tunnels as defined herein because they have several utilities installed in them. Ducts or conduits having multiple 'cells' or spaces can be considered tubed-conduits, although they currently carry only electrical and communicative facilities. Furthermore, either the prevalence or apparent logic of these concepts is evidenced by queries such as "Why are the wires and things not put under the sidewalk (or in ducts, etc.)?"

Such queries most often arise in discussions about underground wiring. They are usually raised as ideas which might yield solutions to one or more of the problems associated with underground wiring. For instance, one problem is the protection of electric wires from damage and people from electrocution by inadvertent contact such as while digging. Several means have been tried to protect wires laid directly in the soil to save the cost of conduits, such as covering them with wooden or concrete planks. Since the planks add to the cost of the underground wiring, means of protecting wires not involving extra costs are sought, and the idea of using the sidewalk arises. However, this presents the problem that wires laid under
sidewalks make detection and repair of faults more difficult or costly.

Much research and experimentation has been and is being undertaken in the United States and Canada to find means of reducing the costs of underground wiring, while maintaining acceptable standards of safety and convenience, so that more wiring will be placed underground. Some efforts have been remarkably successful, and the proportion of wiring being installed underground is increasing steadily. In practically all instances, underground wiring still costs more initially than overhead wiring, but the difference has been reduced to an amount acceptable to either utility companies or developers. Some utility companies accept all or part of the extra costs because underground wiring involves long-term savings due to lower maintenance, repair, and replacement costs. Others accept the extra costs where developers guarantee to install appliances that will consume specified quantities of electric power. Some developers have accepted all or part of the extra costs in order to obtain higher prices or easier sales than competitors not installing wiring underground.

In Metropolitan Vancouver, a few individuals or developers have accepted substantial extra costs for underground wiring in special circumstances, but the utility company has neither encouraged nor contributed substantially to underground wiring installations. With some justification, the former privately-owned utility company argued that people will not bear the extra


5"Underground Wiring Is a Major Sales Feature of New Florida Community," House & Home, vol. XXII, no. 6 (December 1962) p. 65, and Richmond Gardens Development in the Township of Richmond are examples.
costs of underground wiring, and that it would be unfair for those already served by overhead wiring to subsidize those being served by underground wiring. These problems apparently have been resolved satisfactorily in other places mainly by reducing the extra costs of underground wiring. Perhaps the lack of incentive on this score is due to the lack of competition with other suppliers of energy, since the electrical utility company also controls the gas service.

Considerable research and experimentation also has been undertaken to find new or improved materials, designs, and installing techniques for facilities of various services in order to reduce their costs, improve their appearance, or improve some other aspect of the service they provide. Examples of new or improved materials are plastic for gas and water pipes, asbestos cement for water pipes and sewers, plastic insulations for wires, and reflectorized metal for signs. New or improved designs are being developed for joints in pipes and sewers, for the manholes giving access to them, for street lamps and their supports, and for other facilities or parts thereof. Often new or improved techniques of installing facilities either result from changes in materials and design, or make changes in these possible. For example, signs can now be installed easily on metal poles or posts because of new designs for attachment devices, and manholes can be constructed without forms because of precast sections. On the other hand, new techniques of solvent welding for jointing and tapping make it possible and

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6 The B. C. Electric was taken over by the Provincial Government in 1961 and made part of the B. C. Hydro & Power Authority.

7 In a release entitled "Views of the B. C. Electric with Respect to Underground Electric Service," (7 June 1956), and a pamphlet "Should Electric Service Wires be Placed Underground?"
10.

economical to use plastic pipe. In addition, new techniques can reduce costs so that materials or designs formerly too expensive can be more widely used. For example, machines which can extrude concrete or asphalt curbs without forms makes curbing of more streets economically feasible.

Nearly all such research and experimentation pertaining to single-family residential districts has been aimed at improving or reducing the cost of installing facilities of individual or a few related types of services. Probably the most services involved directly in any one project are when underground wiring involves integrated installation of the facilities of the electric power, street lighting, telephone, and cable-television services. The facilities of two services are occasionally installed together such as drains and sewers or curbs and sidewalks. But most improvements or changes occur in only one service at a time. This situation is probably a natural consequence of the tendency to specialization since the scope of interest of specialists tends to become limited.

Considering for the moment only pavements and utilities, there is specialization in responsibility for the designing and installing of facilities, and in manufacturing necessary materials and machines. While municipalities have some responsibility of ensuring adequate standards for all services, in practice the main responsibility falls on the agency providing the services. Designing of the systems and facilities of the services provided by municipalities is usually further divided among sections of engineering departments, or may be contracted out to consultants. Installing of facilities may be done by forces of the agencies responsible, by contractors for them, or by developers. Finally the manufacturers are usually highly specialized as to type of material used, or product or machine produced.

Each separate organization strives to reduce its costs
while either increasing the quality or usage of the service, or increasing its share of the business of providing the service. The aim of the private organizations is the obvious one of increasing profits by reducing costs and by either increasing revenues through serving more customers and improved service for which more can be charged, or by doing more towards provision of the service. The aim of public organizations, where similar comparisons between costs and revenues for specific services cannot be made, is the provision of the most service in terms of quality or extent for the monies available. Whatever research and experimentation that is undertaken by these organizations is geared to their aims. Thus, private telephone and electric power companies seek cheaper installations or expanded services and have the resources to do so. Municipal engineering sections seek less expensive designs for facilities. Contractors seek faster techniques for installing facilities. Both usually have limited resources for research. Developers are interested in the total costs of the services they have to install, but like contractors, can only undertake research when they can spread the costs over many miles of serviced roads, and such research is mainly to find faster techniques for installing the services. Manufacturers often spend much money on research, but this is understandably only on their product or material. In these circumstances, perhaps it is not surprising that little research or experimentation involves more than one or two services.

A praiseworthy exception to the foregoing general situation is 'Project Dapper', the acronym for Distribution Appearance Engineering Research Project. This project is a joint undertaking of the Arizona Public Service and General Electric Company directed primarily at overhead distribution

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lines, poles, and whatever the poles support, but keeping the total system in focus. The approach is especially interesting. Economics are forgotten until the time of practical application in the hope of accelerating industrial progress.\textsuperscript{9} Two principles are involved which:

... call for a shifting of mental gears by utility men: That the public may not agree with the designer's usual assumption that his functional design is attractive; and that economics can be sacrificed somewhat for appearance.\textsuperscript{10}

Streamlining of overhead distribution facilities by eliminating such 'dispensable baggage' as crossarms has so far resulted in the best-looking facilities being the least costly.\textsuperscript{11}

In this investigation, an attempt has been made to take a general but comprehensive and imaginative planning approach to the whole problem of street use and servicing. This was done in the belief that this would yield better results than would the sum of detailed specific engineering and financial investigations of each street use and service. By 'better' is meant either less total cost for the same number and quality of street uses and services, or more street uses and services or higher quality at the same cost. Each of the three proposed practices of providing services has been investigated to determine whether it is better than current practices. Since current practice is far from being homogeneous, it has been found necessary to describe it in terms of several ranks of which the most important are best, normal, and worst. To test each of the three proposed practices against these three ranks potentially could involve nine tests. However, only the three relating to best practice have been tested, and the results used to determine the relationships to the other current practices.

\textsuperscript{9} \textit{Electrical World}, p. 47. \textsuperscript{10} \textit{Loc. cit.} \textsuperscript{11} \textit{Loc. cit.}
The testing of the proposed practices consists of determining their feasibility in relation to current practices. The types of feasibility considered are functional, physical, social, staging, administrative, political, financial, and economic. For all but the last type, determination of whether the proposed practices are feasible or not purely from these points of view has been established in relation to current practices in Metropolitan Vancouver or elsewhere. Where additional costs are involved, they are considered in the examination of economic feasibility. Thus, if otherwise feasible, the important test is that of economic feasibility.

The specific hypotheses to be tested in this investigation are that installing utilities in specially designed underground structures in local residential streets would:

a) permit better use and design of such streets than is possible by current servicing practices;

b) be feasible (from functional, physical, social, staging, administrative, political, financial, and economic points of view) if comprehensively designed.

The scope of this investigation has been limited to future local streets in single-family residential districts of Metropolitan Vancouver for the reasons outlined below. Future streets, that is streets to be serviced in the future whether legally existing now or not, would allow the maximum flexibility in layout of street uses and savings in servicing costs by the proposed practices. Hence, the proposed practices are most likely to be feasible in streets having no services.

Local streets are defined herein as those which carry 'local' non-through traffic and 'local' facilities of all services. The latter are the simpler and generally smaller-sized facilities of the service systems such as those near the beginning of a collection system and end of a distribution
system. These are easiest to deal with because of their simplicity, consistency, and greater number—the larger facilities in systems tending to be more complex, variable, and fewer in number.

Single-family residential districts are those districts designated by municipal zoning by-laws in which only single-family dwellings and ancillary structures such as garages and carports can be constructed. Such districts constitute the largest proportion of the total area of a metropolis and of most municipalities, and will constitute the largest proportion of areas to be developed in the future. They also tend to have more street per unit of land use than other types of land uses. Hence, future single-family residential districts will have the most miles of streets and services.

Metropolitan Vancouver has been chosen partly because of its proximity and familiarity to the investigator, and partly because of its range of topographic, soil, and climatic conditions, and resultant range of servicing practices. Practices outside of this scope are mentioned when they do not occur within it, but the feasibility of the proposed practices in relation to them are only discussed briefly in the concluding chapter.

Within the area thus limited, however, the investigation embraces all public services to property involving permanent facilities in streets that currently are or conceivably could be provided by public or private agencies. It covers not only the ordinary, taken-for-granted services, but also some uncommon or rather exotic ones. Thus, besides roads and sidewalks which facilitate access of vehicles and pedestrians to property, consideration is given to services providing pavements to facilitate access by other modes of travel such as by cycle or
horseback. All utilities or continuous facilities are considered. Drainage and sewerage are of prime concern. Besides pipes providing under pressure such commodities as water and gas, consideration is given to ones providing such commodities as fuel oil. In addition to the familiar telephone service, such less common or well known communicative services as those providing fire, burglary, and attack alarm systems; street lighting and traffic control systems are included. Electric power and street lighting must of course be included as important utilities, but some consideration is also given to such an exotic electric service as heating of pavements.

While the services mentioned thus far are the more obvious and in some respects more important ones, they represent only about one half of those considered. The others provide facilities that are usually separate or discrete (i.e. non-continuous), and often far-between. Examples are boxes for holding letters and parcels for collection; mail and newspapers for distribution; shelters for telephoning from or waiting for transit vehicles; and signs, signals or markings indicating information, regulations, and hazards. Services which occasionally do or might involve facilities such as garbage collection and various services for keeping streets clean and safe (e.g. sweeping, pruning of trees) are also considered. Finally, but at least second most important in terms of area and visual impact, are what are herein termed the 'gardening' services. These include the provision of trees, shrubs, grass and other plants, and their maintenance. Some of the services included might not ordinarily be considered public services, but are considered so here because they are provided for the benefit of the public generally, by or for public or quasi public agencies, and are maintained by them.
The organization of the thesis is as follows: Chapter I more fully defines the problem and the terms and criteria used. Chapter II describes current practice and defines the practices against which the proposed practices are to be evaluated. Proposed designing practices are described and discussed in Chapter III, and proposed installed practices in Chapter IV. These are evaluated in Chapter V.
CHAPTER I
DEFINITIONS AND CRITERIA:
DEFINITIONS AND CLASSIFICATION OF STRUCTURES AND SERVICES
INVESTIGATED, AND CRITERIA FOR EVALUATING THEM

This chapter is devoted to forging the 'tools' necessary for the purposes of this investigation. These include the basic tools of written communication — the words used. These are defined first. Then an 'outdoor room analogy' is introduced for use throughout this report to express some uncommon concepts in terms of common experience. The types of utility structures and the services being investigated are then described, the latter by a functional classification required in view of the number of services involved. Elements of the public interest have been developed as criteria for evaluating street use and servicing practices. Some principles of street use and servicing are stated to avoid repetition of the arguments supporting them. These are followed by a description of 'plan elements' which essentially are various ways of looking at the processes and practices involved. Finally, feasibility criteria relating to each of the plan elements are stated. These are later used for evaluating proposed street use and servicing practices in comparison to current practices of servicing.

I. DEFINITIONS OF TERMS USED

In attempting to discuss various aspects of the many subjects involved in this investigation, it was found that the problem of communication of meaning was complicated by the plethora of meanings or connotations attached to many of the words relating to the subjects. It is suggested that such lack of definition and common acceptance of explicit meaning is evidence of the lack of disciplined thought in this field. There are two possible approaches towards a solution of this
dilemma. One is to invent new words having explicit meanings, but this necessitates learning a new vocabulary before being able to appreciate what is being conveyed. The other approach is to restrict the meanings, or give special meaning to commonly used words for a particular purpose. With a few exceptions noted below, the second approach has been used in this investigation. However, in some instances it has been considered necessary to introduce modified forms of words to express meanings for which there are no simple terms in common usage.

Insofar as possible, without getting too far away from the commonly accepted connotations of the words used, two principles have been followed in establishing the definitions of the terms used in this report. One is that generic terms have been used where convenient to pertain to things of the same kind or class, or when dealing with groups rather than individual items, especially when discussing the characteristics of groups. The application of this principle permits simplification of the general discussion by avoiding the necessity of listing all items in a group. Also, the undesirable omission of items in the interest of brevity or due to the probability of oversight in such a complex discussion is avoided by using generic terms. For example, the term 'access services' covers all services facilitating access to property regardless of mode of travel.

The second principle applied to the definitions is that they should be specific and exclusive. This has led in many instances to the division of a particular aspect of the investigation into a definite number of mutually exclusive possibilities ranging from a simple 'either-or' situation up to one involving perhaps twenty possibilities. In other instances, after specific and exclusive definitions had been assigned to various aspects of a particular field of interest, there has been 'something left over'. In such instances the remaining portion
usually has been referred to as 'other aspects' of the particular field where a specific term has not been assigned. For example, the access services are usually divided into 'pedestrian access', 'vehicular access', and 'other access services', where the latter includes other modes of travel such as cycles, horseback, and vehicles with special requirements.

The most important application of the second principle is the reduction of the meaning of certain forms of words to one specific meaning in an attempt to avoid confusion. The six forms of key words used and their general meaning are illustrated below for the word 'service'.

1. the infinitive, usually transitive, verb form (to _____) expressing an action; e.g. to service a district means to provide a service or services to the district.

2. the adjective form (-able, -ible) expressing the condition in which the action is possible and/or practicable; e.g. this district is too steep and rocky to be serviceable, or this district is un-serviceable.

3. the verb or noun form (-ing) expressing the actual performing of the action; e.g. The City is servicing this area; servicing is required in that district.

4. the noun form (-er, -or) meaning the person who, the agency or that which performs the action; e.g. the City is the servicer for this district.

5. the adjective form (-ed) indicating the completed performance of the action; e.g. That district is now completely serviced.

6. the noun form (-sion, or -ment) expressing the state or condition which exists after the action has been performed; the result of the action; e.g. The servicement of that district is of a low standard.

The term 'servicement' is an example of a word derived or constructed to express concepts, usually of the sixth form, for
which there is no commonly accepted simple term. On the other hand, the sixth form of words in common usage are the ones most often herein stripped of one or more chief meanings. For instance, an attempt has been made to restrict the meaning of words like 'subdivision' and 'development' to the state or condition which exists after the action of 'subdividing' or 'developing' has been performed. Thus the common connotation of the act of performing these actions has been removed and relegated to the third or -ing form exclusively.

In the above illustration, the term service has been used in the general sense covering all public service being considered. In actual application the term is used more often in reference to a particular service. Thus the various forms are apt to appear more often with an adjective, adverb, or clause restricting the meaning to the service or services in question. For example, to service a district electrically and with sewers, the district must be serviceable electrically and with sewers; the electrical and sewerage servicing must be done by the electrical and sewerage servicer, and when the district has been serviced electrically and with sewers, the electrical and sewerage servicement should be inspected and maintained to prolong its useful life.

Two exceptions to the general approach of restricting meanings of commonly used words are the terms 'baric' and 'holding'. Both are generic terms for a number of services having a common functional characteristic distinct from other services, and of interest in this investigation, for which there is no common term at present. These terms were selected partly to avoid restricting the meaning of words required for other purposes and partly to fit into an alphabetical classification of service groups. The 'baric' services are those supplying commodities to site or streets through pipes under pressure. The dictionary
defines baric as meaning "of or pertaining to weight, especially of air; barometric".¹ It is used here for services functioning under (non-electric) pressure such as water and gas. The term 'holding' pertains to services providing 'holders' in streets in which goods or waste materials are temporarily held for later collection or distribution. The term is deliberately unusual to emphasize the concern with the facilities provided in streets rather than the collection or delivery aspects of such public services as postal or newspaper distribution.

The division of the various aspects discussed in this report into discrete parts, and the specific and exclusive definitions employed in many cases may admittedly seem rather arbitrary. This arbitrariness should be of little concern considering the need for consistency and clarity. Undoubtedly, with more study, the divisions and definitions could be refined to improve consistency and clarity, or to permit wider application. These 'tools', it is hoped, have been refined sufficiently for the job at hand; that of communicating the various aspects, concepts, and ideas discussed. Further refining has been left to others at a later date.

Some awkwardness or stiltedness is bound to occur when, as in this report, an attempt is made to introduce consistency in the arrangement of the elements of phrases and in the use of terms or phrases to a language such as English. These departures from normal practice may cause the reader to re-read something that does not 'look right'. Although these stumbling blocks occasionally may be somewhat irritating, it is believed that they serve the useful function of making the reader aware that a more specific and precise interpretation than that of common usage is intended.

Key definitions of terms have been introduced as required throughout the report. The ones introduced in the remainder of this section are those necessary to establish the scope of the investigation. They are based upon and abstracted from dictionary definitions, modified as noted in the footnotes.

**Current Practice versus Proposed Practice**

Throughout this report, the terms 'current practice' and 'proposed practice' shall be interpreted as distinguishing the prevailing or customary manner in which certain things are done from a manner in which they might be done in the future. These terms have been used particularly with certain of the six forms mentioned above of words such as 'subdivide', 'service', 'improve', 'control', and 'land-develop'. They are also used with the various actions involved in each of these broad processes where the proposed manner in which these actions are performed is significantly different from current practice. The interpretation of the distinctions meant by the use of these terms in conjunction with a term such as 'servicing' has been made the subject of later chapters in this report, so that only rather formal definitions are given below in this section.

**Current practice**, actual performance, or application of knowledge (as distinct from theory), including repeated or habitual action, that is commonly acknowledged or accepted, or is a matter of general use.\(^2\)

**Proposed practice**, actual performance, or application of knowledge (as distinct from theory), including repeated or habitual action, that has been propounded or offered (in this report) for consideration or adoption.\(^3\)


\(^3\)Ibid., words in parentheses added.
Public Services = Personal Services + Property Services

The interpretation of the term 'public service' shall be:

The business of supplying some commodity to any or all members of a community or of providing some service where exercise of the calling involves some legal privilege or a natural or virtual monopoly. 4

This term shall be considered the generic term for all services of which there are two basic types - services to persons and services to property.

Personal services. Personal services, or as they are known more commonly, social services, involve the health, welfare, and social assistance types of services. The fire and police protection services are also involved insofar as they pertain to the protection of persons. To avoid the difficulty of establishing this proportion when it is not crucial to this investigation, these services have been assumed to apply solely to property. The facilities involved in the provision of the personal services include structures such as hospitals, libraries, and art galleries. These personal services are outside the scope of this investigation.

Property services. A property service shall be interpreted as:

The business of supplying some commodity (as gas, electricity, power, water) to any or all properties of a community or of providing some service (as transportation, as by railroad or bus or by pipeline; communication, as by telegraph or telephone....) where exercise of the calling involves some legal privilege or a natural or virtual monopoly. 5

The property services together with street uses are the subject of this investigation. Because of their different

4Webster, op. cit. 5Ibid.
natures and the consequent need for separate treatment herein, the property services have been segregated into three groups. These are access services, utility services (or 'utilities'), and other services. The access services are those providing pavements to facilitate access to and movement between property. The utility services shall be interpreted as:

those property services requiring permanent continuous facilities (commonly called 'utilities') installed in a public right-of-way (or easement) in order to make a commodity (as gas, water, electricity, power), or some service (as communication, as by telephone; or waste collection as by sewers), other than access services, available to any or all properties in a community.$^6$

The third group of 'other services' is comprised of the remaining services - that is, those that are neither access nor utility services - considered in this investigation. Some of these may not ordinarily be considered as public services, or may not ordinarily be provided in local residential streets in Metropolitan Vancouver. However, they have all been provided somewhere at sometime in more important streets, other use districts, or other urban areas and could be provided in local residential streets with modifications where necessary.

Before proceeding to a further classification of the services being considered, an analogy useful for this and other purposes in this report is interjected below.

II. 'OUTDOOR ROOM ANALOGY'

Analogies to familiar phenomena are often effective means of expressing views or communicating ideas about less familiar phenomena. It has been deemed helpful for the purposes of this report to supplement explanations or discussions about street use

$^6$Derived from above definitions modified by restricting location and excluding access services.
and servicing practices by rephrasing them in terms of the more common knowledge or experience relating to rooms or houses. The street is considered as an outdoor room whose floor is the pavement or other horizontal surfaces, whose walls are the facades of adjoining buildings, and whose ceiling is the sky or overhead wiring, and whose furnishings are the various facilities installed in them.

This concept and the related one of 'street furniture' are not new. They were used by Peter Oberlander in an eloquent plea for better design of the visual aspects of streets based on a case study of streets in Vancouver. The concept has merely been broadened, refined, and changed in emphasis somewhat for the purposes of this investigation. It has been broadened to give more consideration to what is under the floor. Thus, the wires and pipes of the various property services can be thought of in terms of their counterparts in buildings. The 'street furnishings' concept has been refined to segregate several types of street furnishings of which furniture is but one. Finally, the emphasis has been changed from an essentially static descriptive analogy to one also considering functional relationships and processes involved in producing the furnished street. For example, processes of installing services in streets are described in terms of house building operations. Also, the principles and problems of the various property services can be expressed in terms of the familiarity people have with building services. For example, the problem of locating discharges from water mains or buried cables can be likened to that of finding a leak in the water system or a short circuit in the electrical system of a house.

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The 'outdoor room' analogy is used throughout the remainder of this report where it is deemed helpful in expressing concepts, processes, and relationships. This continuity and consistency is considered preferable to separate analogies that might be more appropriate in specific instances, because the parts can more easily be fitted into the whole picture and be seen in their proper perspective.

III. TYPES OF UTILITY STRUCTURES INVESTIGATED

Three basic types of underground structures for utilities have been investigated for three different degrees of integration—a total of nine possible types of utility structures. The three basic types are troughs, tunnels, and tubed-conduits. The three degrees of integration are: complete which is termed 'all-utility'; complete except for drainage facilities termed 'non-drainage'; and having only electrical and communicative service facilities termed 'electrical' for the sake of brevity. These nine possible types of structures are illustrated on Diagram 1. It should be noted that variations in shape are possible. For example, tunnels could be square or rectangular in cross-section instead of round. However, the types illustrated are typical and considered to represent the range of possibilities. They are not to be considered mutually exclusive in the sense that only one type would be used in a system. For example, an all-utility trough might run along the street, a non-drainage tubed-conduit across the street, and an electrical tunnel to houses.

The distinguishing characteristics of troughs are that they are open to the surface and covered by a walk, thus making utilities accessible throughout their length without manholes. In effect, they are lined trenches; the lining being of concrete either cast in place or precast. The covering walk would be
# Types of Utility Structures

<table>
<thead>
<tr>
<th>TYPES OF STRUCTURES</th>
<th>ALL-UTILITY</th>
<th>NON-DRAINAGE (no drains)</th>
<th>ELECTRICAL (elec. + commun)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TROUGHS</strong></td>
<td><img src="image1.png" alt="Diagram" /></td>
<td><img src="image2.png" alt="Diagram" /></td>
<td><img src="image3.png" alt="Diagram" /></td>
</tr>
<tr>
<td>(&quot;lined trenches&quot;)</td>
<td>Open to surface</td>
<td>Utilities completely accessible</td>
<td>Electrical utilities covered by sidewalk, precast concrete</td>
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<td></td>
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<tr>
<td><strong>TUNNELS</strong></td>
<td><img src="image4.png" alt="Diagram" /></td>
<td><img src="image5.png" alt="Diagram" /></td>
<td><img src="image6.png" alt="Diagram" /></td>
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<tr>
<td>- underground</td>
<td>Between manholes</td>
<td>Utilities accessible only at manholes</td>
<td>Electrical conduit forms sidewalk, precast concrete</td>
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<tr>
<td><strong>TUBED-CONDUITS</strong></td>
<td><img src="image7.png" alt="Diagram" /></td>
<td><img src="image8.png" alt="Diagram" /></td>
<td><img src="image9.png" alt="Diagram" /></td>
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<tr>
<td>- underground</td>
<td>Between manholes except electrical conduit</td>
<td>Utilities accessible only at manholes</td>
<td>Electrical conduit forms sidewalk, precast concrete</td>
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*NOTE: could also be square or rectangular in cross-section, i.e., duct instead of tube*

*DIAGRAM 1. TYPES OF PROPOSED UTILITY STRUCTURES*
precast in sections. Tunnels are completely underground structures forming one continuous open space between manholes, so the utilities are accessible only at manholes. They could be cast in place, or more likely precast. Tubed-conduits are similar to tunnels in that they require manholes to provide access to the utilities, but have several separate spaces or 'tubes'. Also, the electrical tubed-conduit need not be underground. It could serve as a sidewalk, or looking at it the other way, the sidewalk could contain tubes for wires and cables. Such a structure and all trough covers must be strong enough to carry vehicles at driveway crossings or be specially strengthened there.

The depth of the bottoms of structures depends upon the utilities contained. Indeed, the degrees of integration could be thought of as resulting in structures that are deep, intermediate, and shallow, respectively. The all-utility types are deepest because of the drainage utilities which must be below inlets in buildings and on sites to receive waste fluids from them by gravity flow. The depth of non-drainage structures is dependent upon two considerations; namely the protection of the structure from damage and baric utilities from freezing. Damage is only likely under roads. It is probably only a problem in the case of the tunnel because the tubed-conduit would be quite strong and the trough would have to be specially strengthened whenever crossing a road. The serious problem of baric utilities freezing in underground spaces is dealt with under discussion of functional feasibility.

Connections would require some form of lined space beneath the electrical tubed-conduit, although it may not be a manhole in the sense that a man could get into it.

This assumes the ordinary condition where sump pumps or force drains (i.e. under pressure) are not involved.

See page 161.
For present purposes, it has been assumed that the depth of baric utilities could be the same as when installed in the ground if the manholes are completely covered (i.e., no holes). The depth of electrical tunnels (and tubed-conduits if installed underground) is dependent only upon consideration of potential damage.

IV. CLASSIFICATION OF SERVICES

The number and variety of property services that can be installed in streets to-day is quite surprising. One's first impression is that there are relatively few, but 'ticking them off' on the fingers may yield a dozen or so. Closer scrutiny of what is actually in streets yields many more. The exact number is unimportant and depends upon what one is willing to accept as a separate service. Almost forty 'services' are considered herein, but some of these actually represent groups of what might be considered separate services, so the total could be perhaps twice that many. Such numbers and variety are unmanageable without classification.

The services have been classified by relevant functional characteristics into ten groups to which have been assigned generic terms expressing the purpose or functional characteristic of the group of services. Except for the last group which is somewhat different from the others, the principal facilities of these services have also been assigned generic terms. These service groups, the services in them, and their principal facilities are summarized in Table I on the following page and discussed more fully below. They are roughly in descending order of importance. The space devoted to each is not proportionate to importance because, as is often the case, the unusual and unfamiliar require the most explanation.
<table>
<thead>
<tr>
<th>ACCESS SERVICES:</th>
<th>Pavements:</th>
<th>OTHER SERVICES:</th>
<th><strong>FURNISHING SERVICES:</strong></th>
<th><strong>FURNISHINGS:</strong></th>
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<tbody>
<tr>
<td>Vehicular</td>
<td>roads</td>
<td>Furniture</td>
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<td>walks</td>
<td>Finishes</td>
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<td>paths:</td>
<td>Finishes</td>
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<td>cabinets.</td>
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<td>bridle</td>
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<td>floor &amp; wall surfaces</td>
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<td>Other furnishing:</td>
<td>Decorations</td>
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<td>Ornaments</td>
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<td>Pipes:</td>
<td>Telephone</td>
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<td>Water</td>
<td>*</td>
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<td>Gas</td>
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<td>Cable television T.V.cable &amp; radio</td>
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<tr>
<td>Other baric:</td>
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<td>Fire alarm</td>
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<tr>
<td>Fuel oil</td>
<td>*</td>
<td>Burglary alarm</td>
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<td>Steam</td>
<td>*</td>
<td>Traffic control</td>
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<td></td>
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<td>Telegraph</td>
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<td>Storm drainage</td>
<td>*</td>
<td>Collection</td>
<td>letter,</td>
</tr>
<tr>
<td>Sanitary drainage</td>
<td>*</td>
<td>holding</td>
<td>parcel boxes</td>
</tr>
<tr>
<td>(or sewerage) (or sewer)</td>
<td></td>
<td>Distribution</td>
<td>mail,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>holding</td>
<td>newspaper</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ELECTRICAL SERVICES:</th>
<th>Wires:</th>
<th><strong>INDICATING SERVICES:</strong></th>
<th><strong>Indicators:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>*</td>
<td>Informative</td>
<td>signs</td>
</tr>
<tr>
<td>Street lighting</td>
<td>*</td>
<td>Regulatory</td>
<td>signs,</td>
</tr>
<tr>
<td>Other electrical:</td>
<td></td>
<td>Demarcative</td>
<td>signals</td>
</tr>
<tr>
<td>Trolley bus</td>
<td>*</td>
<td>Advertising</td>
<td>markings</td>
</tr>
<tr>
<td>Heating</td>
<td>*</td>
<td></td>
<td>signs</td>
</tr>
</tbody>
</table>

**KEEPING SERVICES:**

- Services keeping facilities: such as:
  - in sound condition roads
  - functioning roads
  - clean and tidy roads, pipes
- Other keeping services roads, drains

* Same term as for service, e.g. water pipes
The first class of services is the **access** one whose services facilitate access to property abutting a street by providing pavements upon which people and vehicles or other modes of travel can move easily to and into each property from others, or wait to do so. They include vehicular, pedestrian, and other access services for modes of travel such as cycle, horseback, transit and emergency vehicles. These provide respectively roads, walks, and paths such as cycle, bridle, and special paths for transit or emergency vehicles. These are analogous to driveways and walks or hallways giving access to a room.

The next four classes of services are the utility services or utilities which have continuous facilities installed in streets to provide commodities or services to property or remove waste products from it. They are the baric, communicative, drainage, and electrical services.

The **baric** or pressure services are those which supply commodities to property or streets through pipes under pressure. They include the services supplying water, gas, and other commodities such as fuel oil or steam. Their pipes and other fittings are analogous to those in buildings. For example, a fire hydrant can be thought of as a street hose bibb or tap.

The **communicative** services are those which make possible several types of communication by installing cables and related facilities in streets. The most important of these is the telephone service, but the cable-television and cable radio services are becoming important in areas having poor reception. The other communicative services are the alarm, control, and telegraph services. The alarm services communicate alarms about fire, burglary, attack by enemy action, radiation, or toxic gas.

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11 See page 20. for explanation and definition of the term 'baric'.

The control services communicate impulses to control remotely such conditions as illumination, temperature, moisture, and traffic flow. These are analogous to such household services as those providing 'intercom', closed-circuit television, and fire or burglary alarm systems between rooms or parts of a building.

The drainage services are those which collect and remove storm water and sewage by gravity flow through drains and consist only of the storm drainage and sanitary drainage (or sewerage) services. The facilities of these services are analogous to similar household services. For example, the curb-gutter, grating, and lateral to the street storm drain are like the eavestrough or roof gutter, screen, and downspout on houses. The road is formed with crests and valleys just like a roof, only the slopes are less obvious. The sanitary drain or sewer is like that in buildings except that there are few 'stacks' or vertical sewers and no vents since manholes serve the functions performed by these facilities.

The electrical services are those supplying electricity through wires as a source of power for private purposes, light for streets, and light, heat, and electric charge for certain other public purposes. They are analogous to the house wiring and (built-in) lighting systems.

The remaining five classes of services are collectively termed 'other services' as distinct from the access class and utilities group. They have little in common except that when facilities are involved, they are generally small and discrete (i.e. not continuous like utilities). The classes of services included are furnishing, gardening, holding, indicating, and keeping services.

The furnishing services are those which enhance the environment of which the street forms an important part, and
make the street more livable by providing furnishings. Street furniture, finishes, and such other furnishings as decorations, ornaments, and decorative lighting, which are described in terms of analogous household furnishings, are considered. For example, street furniture includes benches, fences, and cabinets which are analogous to couches, playpens, and built-in cabinets in the house. Similarly, finishes on the 'floor' and 'walls' of the streets, decorations, and ornaments, can be related to those in houses.

The **gardening** services are those concerned with installing and caring for plants in streets. Trees and grass are the most important plants because of their prominence and the coverage of the latter, which is second only to pavements. The planting services install trees, grass, shrubs, flowers, and such ground covers as ivy and moss. The plant care services maintain plants by pruning, mowing, watering and such operations as fertilizing, spraying, and weeding. These services are comparable to the planting of and caring for plants indoors except for grass and ground covers. The latter two are analogous in terms of function to the portions of a floor not covered by carpet since the pavement, like the carpet, is ordinarily used for movement. Unfortunately, some confusion may arise because of the common metaphor likening grass to a carpet on the basis of textures which are reversed for facilities analogous functionally.

The **holding** services are those providing holders for the temporary storage of goods or waste materials for later collection or distribution and use. The services have been arbitrarily split into two groups - those holding for collection and those for distribution. The concern here is with the facility installed in the street and not the collection and distribution or delivery aspects of the services involved. Analogous facilities in houses are bags or containers in kitchens
holding garbage, later 'collected' and taken to a can in the lane; and boxes holding milk or mail later 'distributed' to refrigerator and recipient.

The indicating services are those providing indicators such as signs, signals, and markings to indicate information, regulations, demarcations, and advertisements of various types by words, symbols, and other means. The information includes names and numbers of streets, blocks, buildings, and routes; directions to specific places, and other facts. Regulations include those governing vehicular and pedestrian movement. Demarcations indicate boundaries of movement ways or hazards. Advertisements indicate names of the installer or manufacturer of facilities, property for sale, events, and products for sale. There are few analogous facilities in houses because there is not the same need for them. Room name and direction signs are not required because residents know them and guests can ask. They are required in buildings such as hospitals, which also exhibit most other types of indicative facilities. Certain facilities within houses and from house to house are somewhat better standardized than comparable street facilities. For example, one of the rare instances of an informative service in a household is the 'H' indicating the hot water tap. Positioning this to the left of the cold tap is so well standardized in North America that reversed positioning usually requires special warning signs. On the other hand, it could be argued that many poorly designed houses should be better served with indicators of hazards, including embarrassment for those unfamiliar with room layout or faulty locks. Some houses during such social gatherings as cocktail parties seemingly would benefit from traffic signals!

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12 This is not the case in Europe where an English speaking person has the additional difficulty in France of remembering that 'C' means hot (sometimes).
The keeping services are those which have no facilities in streets, but keep facilities of other services in states of sound physical condition, proper functional condition, and cleanliness and tidyness. They involve some highly specialized equipment whose requirements and limitations should be taken into account in the design of the facilities of other services. The operations involved have their counterpart in the house. Sweeping and flushing roads are obvious examples. Patching holes in pavement is like replacing damaged floor tiles. Repairing leaks in pipes or wires involves similar operations. An exception is meter-reading, one of the other keeping services.

The whole range of services in each of these ten functional classes and their respective facilities are more fully discussed in the following chapter.

V. ELEMENTS OF THE PUBLIC INTEREST AS CRITERIA FOR EVALUATING STREET USE AND SERVICING PRACTICES

The public interest is a determinant of street use and servicing practices in the same sense that Chapin shows it to be a determinant of land use. As he points out, the public interest "connotes the notion of control ... not only in the conventional action sense of imposing regulatory measures, passing on street and utility locations, ... but also in the preaction sense which is involved in the city planning process itself".

By treating elements of the public interest as abstractions, they can be used as criteria in evaluating street use and servicing practices in terms of the control exercised over them.

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14Ibid., p. 41
by the public. Consequently, Chapin's 'elements of the public interest' have been used as a basis for such criteria with appropriate modifications for the purposes of this investigation.

As with Chapin, the concern here is with the public interest in land development, particularly that public action seeking to assure soundness and livability using soundness in the financial sense, and livability to refer broadly to those qualities in the physical environment ... which tend to induce in citizens a feeling of mental, physical and social well-being according to the extent to which their fundamental day-to-day living needs and wants are satisfied.15

Elements of the Public Interest

In a restricted sense, a barometer of what is generally held to be the limits of the public interest is provided by the courts. According to Chapin,

The public interest is frequently used in law to refer to what the courts will sanction as a public purpose, whether under the police power, the power of eminent domain, or the power of taxation. For example, health welfare, morals, and safety have become generally recognized tests of the public interest in American jurisprudence. Convenience, comfort, and prosperity are sometimes cited, but are less frequently allowed by the courts and usually only in combination with the other four tests.16

Chapin points out that the public interest concept in a legal sense, as indicated by the history of court actions, is an evolving one. It tends

... to broaden in time as new elements become more generally sanctioned in a cultural context, but also tending to lag behind their social acceptance.17

15 Ibid., p. 41  
16 Ibid., p. 42  
17 Ibid.
He then states that for planning purposes,

... a more advanced concept of the public interest is warranted, one which builds on the legal tests but which seeks forward-looking guideposts taken directly from the social currents of the times. In land use planning, the purposes usually identified with the public interest are five: health, safety, convenience, economy, and amenity.\(^{18}\)

He emphasizes that "in the context of land use planning each of the five public purposes has broader meaning than that ascribed to it by the courts alone".\(^{19}\)

Chapin's interpretation of the elements of the public interest has been accepted generally but modified for the purposes of this investigation. Much of his interpretation applies to land use, and is either ignored here or transposed to street use or servicing. The major modification is the addition of a sixth element, welfare. This includes the welfare, and to a lesser extent the morals aspects included in court tests of public interest which Chapin partially covers in his broadened elements. These aspects are considered more important for street use than land use and warrant separate consideration. Also, Chapin's interpretation is too general for present purposes, so specific definitions are stated below.

Each criterion can be expressed positively as a state or condition, or negatively as a 'freedom from' an undesirable state or occurrence. Stated positively, the states or conditions are abstractions that can be neither defined precisely nor subjected to evaluation. On the other hand, the states or occurrences it is desirable to be free from can be stated fairly easily in a manner that leaves little room for misinterpretation. Also, statistical data and other information pertaining to these criteria are inherently of the negative form of recording when persons have not been free from certain

\(^{18}\)Chapin, op. cit., p. 42

\(^{19}\)Ibid.
undesirable conditions or occurrences. For example, health is measured in terms of the absolute number of sicknesses or deaths or the number in relation to a unit of population (usually 1000). Similarly, safety is considered in terms of accident rates. Convenience and amenity as interpreted herein can be measured in terms of the number of complaints. In view of these considerations, the negative type of interpretation follows the positive type based on dictionary definitions. Several of the definitions are further amplified by statements of the criteria considered tests of an adequate environment by the Housing Committee of the American Public Health Association. Each definition is followed by a reference of the criterion's relative importance for the various services.

Public Health:
1. The health of a community.
2. Freedom from disease, infection, etc.
3. Protection against contagion and provisions for maintenance of cleanliness.

This criterion is important for the water, sewerage, and storm drainage services particularly, and to a lesser extent for gas, gardening and keeping services, but is relatively unimportant for the others.

Public Safety:
1. State or condition of being safe or of giving confidence.
2. Freedom from danger, harm, loss, and anxiety or fear.
3. Protection against accident hazards.

The public safety criterion applies to all services, but the importance varies considerably. It is most important for the access and electrical services.

Committee on the Hygiene of Housing, American Public Health Association, Planning the Neighbourhood, Public Administration Service, 1948, p. vii; cited by Chapin, op. cit., p. 43.
Public Convenience:
1. State or quality of being convenient, as of place, time, etc.
2. Freedom from discomfort or trouble as would be caused by an interruption in the provision of a service, or obstruction to its use.

This criterion applies to all services; its importance depending upon the frequency, duration, and intensity of the discomfort or trouble resulting from the interruption or obstruction.

Public Economy:
1. Quality or state of being efficient in terms of municipal expenditures and cost to the user of the services.
2. Freedom from excessive municipal expenditure and freedom from excessive cost to the user of the services.

This criterion, in effect, has been treated as the measure of various means of obtaining a given attainment of the other criteria and is discussed more fully later.

Public Amenity:
1. Quality or state of being pleasant or agreeable.
2. Freedom from ugliness.
3. Provision of possibilities for reasonable aesthetic satisfaction.

This criterion is involved in all visible facilities of the property services.

Public Welfare:
1. The condition of faring well; well-being.
2. Freedom from pain or discomfort; prosperity.

This criterion covers discomfort or trouble caused indirectly or by partial failure of a service, and long-run health considerations
such as effects of continued conditions of inadequate sunshine and ventilation or excessive noise and atmospheric pollution. It is also a 'catch-all' for relatively minor aspects not fitting neatly into any of the other categories. For example, when pedestrians are splashed by vehicles, their health, convenience, and economy may be adversely affected through the danger of wearing wet clothes and the bother and cost of cleaning same.

VI. PRINCIPLES OF STREET USE AND SERVICING

Certain other measures or criteria have been used in this investigation to evaluate street use and servicing practices that are based upon what are herein referred to as principles of such practices. These are statements of conclusions about certain relevant matters which are essentially judgements — perhaps value judgements in some cases — on the part of the investigator. They ought to be acceptable if the premises or assumptions they are based upon are granted. The principles, premises and the measures or criteria are discussed below with examples where considered helpful. They are presented here for convenience of reference and to avoid repetition of the reasoning involved.

Principle of Integration

The principle of integration is that sharing of common facilities or operations by two or more services is better in terms of cost and appearance than installing them independently. Certain types of ancillary facilities such as supports and conduits, and certain operations such as excavating and backfilling are required for several services and can sometimes be shared by two or more of them. When a facility installed or an operation carried out for one service has been shared by others, the need for additional independent facilities or operations for these other services has been eliminated. Thus, the total costs
are reduced. The saving can be shared by all of the services involved through those services sharing another's facility or operation rebating part of their saving.

When support facilities have been eliminated by integration the resultant appearance is also usually better than would be the case with independent supports. For example, poles supporting trolley wires also support street lights; traffic signals and their control boxes; fire alarm, police and transit supervisor's call boxes; some of the wiring and cabling necessary for all of the foregoing including electrical supply wires for the trolley wires; street name, traffic and parking regulation signs; letter and newspaper boxes, and street decorations. While some of these facilities such as street decorations would probably not be installed if partial support were not already available, most have been and often still are installed on independent supports. Although many of our major streets are visually cluttered with trolley and other overhead wiring, the overall appearance of them if all of the above-mentioned facilities were on independent supports would be far worse.

Unplanned integration however, can produce results that are unattractive and a disservice in that individual facilities become ineffective. This situation occurs at many intersections of major streets where, as Mr. Oberlander points out, the traffic signals piled on top of one another create "... a veritable Christmas tree with glittering toys hanging on it all year round and the multiplicity of signs cause confusion and diminish each other's value".21

The degree of integration involved in the various servicing practices being investigated will be evaluated in relation

to what is considered feasible. Feasibility of integration, whenever possible, has been based upon acceptance in practice in areas of Metropolitan Vancouver, in other places, or in comparable circumstances.

**Principle of Payment for Benefit**

The principle of payment for benefit is simply that those, and only those who benefit from use of local streets and services, should pay for them in proportion to their benefit. This principle should be acceptable on the basis of such principles as equity, fairness, and justice, and may seem to not need stating. However, the principle is not followed in some instances and must be defined to enable evaluation of departures from it.

The principle can not be rigorously applied to all benefits because of the twin difficulties of placing values on some intangible, infrequent, and highly subjective benefits, and of finding means of collecting payment for them. Some can be transposed to benefits of those for whom methods of payment are available. For example, a tourist (i.e. a non-resident) benefits from street name signs, pavements and other facilities in finding his way, driving to, and parking in front of the dwelling he is visiting. It would be difficult to assess and collect for these benefits from the tourist. Such benefits could be transposed into benefits that the owner of the dwelling derives from the visitor's presence, and for which he is willing to pay a share of the cost of the facilities through property taxes, albeit a small one.

The benefit that commercial, industrial, and other activities derive from the consumers or employees on local streets is reflected in the value of the land upon which the activities are located. Indeed, the land value could be thought of as being proportional to the length of local streets within
the activity's zone of influence. Thus a portion of the cost of the facilities on the street which assist in getting to or otherwise dealing with the activities (e.g. telephone and postal service), could be charged to the land value of the site of the activity. A similar argument could be made when the activity actually uses the street such as for delivery of merchandise, although licences and fuel taxes are the more common source of payment for such benefits.

All such indirect benefits are outside the scope of this investigation. The concern here is with the more important and direct benefits that are, or can be derived when services are provided in or through a street. These are the benefits to users of abutting sites, which in this investigation are the dwellers in single family residences. The benefit is almost nil when no services are available since the land cannot be used without them. Some benefit can be derived when vehicular access service is provided because the site can be used for recreational purposes such as picnics, for exercise from clearing operations, or for supplying firewood or other natural products. Benefit from being able to live on the site usually can be derived only when water service is available, and often only when drainage, electrical, and perhaps sewerage services are available. Benefit increases as other services are made available. The full benefit of services such as planting trees may not be derived for some years.

Potential benefits are reflected in land value which is practically nil without services, tends to jump significantly when vehicular access and water services are provided, and continues to rise as other services are provided. Land values also seem to be higher or to be held longer than in otherwise comparable areas where there are ample full-grown trees. However, this is difficult to prove because of other factors
tending to affect land values such as quality and condition of housing, social prestige value, and changes in use (e.g. conversion from single-family to multi-dwellings). In general then, land values are a good indicator of potential benefit to be derived from services and a just means of apportioning at least their costs of installation.

Potential and/or actual benefit is often paid for on a local improvement basis. This consists either of an equal tax on each site, or more usually a tax related to the length of site frontage on the street, with special provisions for corner and odd-shaped sites. Such taxes follow the payment for benefit principle for the part paid directly, but usually a portion is paid by the municipality out of general revenue.\(^{22}\) Thus, for example, people in areas without adequate street lighting are contributing to the expense of adequate lighting in other areas. These are usually the less and more wealthy respectively because of their relative willingness to pay extra taxes. Since only so much is budgeted each year for services such as street lighting, improved lighting tends to be installed mainly in wealthy areas where people are willing to pay for it. This contributes to the feeling of people in the low income areas that they are getting less and paying more since they see services deteriorate while property taxes rise.

A policy based upon need would probably concentrate street lighting expenditures in the areas in which various social problems such as juvenile delinquency are concentrated, possibly

\(^{22}\)Assuming this is paid out of Property Tax revenue (i.e. that other revenues are used for other purposes) about half of this comes from other people's improvements. This is because while land is taxed at 100 percent of assessed value and improvements at only 50 percent (by most municipalities), improvements are worth about twice as much in total.
at the expense of other works programs such as roads. Such improvements in service might not be reflected in land value increases. However, they could be justified on the grounds that taxes on the relatively high land values (on a front footage basis) in these areas had been paid for many years since the original facilities had been paid for.

Actual benefits accruing to the user of a service should be paid for by the user in proportion to either the costs he entails or the proportion he uses. Thus, charges for service connections from the street facility to the dwelling, and service charges on amount of commodities such as water, gas, electricity, consumed, can be justified on the basis of the payment for benefit principle. Flat rate charges for use of such services as water and telephone can be justified on this principle only to the extent that there are different rates for different classes of users based on average usages. Since the difference from the average of values within a group can be more than those between group averages, high users can in effect be subsidized by low users. Also, high users tend to be wealthy people who own swimming pools, automatic washing machines and multiple or private phones, whereas the low users tend to be those not able to afford such luxuries. However, complete rectification of these inequities would necessitate metering all service usage at a cost liable to result in increased service charges to everyone, including the low users. Hence, the best that can be done is to keep charges reasonably representative by having many segregated groups with frequent checks of average usage, and by installing meters on exceptionally heavy users such as those with swimming pools.

Taxes on 'improvements' to sites such as houses, garages, and paved driveways are not considered by this investigator to be equitable sources of payment for the benefit from the
services. They bear no relation to the cost of the facilities installed in streets as do taxes on land values because services must go by a site whether improved or not. They provide a poor basis of financing services because the number and value of improvements to be constructed in a given area is uncertain. If sites remain unimproved for some time, an unfair burden is placed on owners of other land or improvements. Improvements also do not necessarily reflect use as well as do service charges, although owners of the more valuable houses tend to also own luxuries resulting in higher usage of some services. However, there are significant exceptions to this general tendency such as in blighted areas where the assessed improvement values are depreciated the maximum amount while usage of services has increased because more people are crowded into the area.23

The most serious departure from the payment for benefits principle, in the opinion of this investigator, occurs when those subdividing land into sites for houses do not pay for the services required for the area. While subdividers as such do not benefit from the use of any services, (other than perhaps vehicular access), they benefit in the price they receive for lots sold from the portion of the value attributable to the services that have been or that are expected to be installed.24 When the subdivider has paid for installation of the services, he receives from the purchaser of the lot payment for the benefits

23 It should be noted that taxes on improvements would not accord with the 'ability to pay' criteria (considered only indirectly herein) in such cases either, since slum landlords are wealthy in proportion to the extent to which they let their properties depreciate and to which they crowd in people. But land values in such areas tend to be relatively high.

24 If they are also builders, they may benefit from use of services during construction and in display houses, but pay service connection and other service charges and property taxes prior to selling property.
that the purchaser will derive. When he has not paid for them, he receives an unearned increment in that he did nothing to add this portion of the value. This increment is theoretically equal to the reduction in price that buyers would demand to prevent in effect paying for the services a second time through taxes. Except for any local improvement taxes however, the buyer is unaware of increased taxes due to the municipality having installed the services he will benefit from, because it has been spread over all taxpayers and is small for each one. The burden of all such taxes accumulated over the time required to pay for the installation of the service, falls mainly on the majority who do not benefit from the service. This surely is a gross injustice when the subdivider may have received the equivalent of full benefit without paying anything. It should be noted that when required to pay for services, subdividers cannot necessarily raise prices to cover the added costs, because of market resistance. They may have to reduce their profit margin, what they pay for raw land, or both. The effect of increased service costs on raw land values can be seen in Table II.

**TABLE II.**

<table>
<thead>
<tr>
<th>Sewers not required</th>
<th>Where sewers required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1954</td>
<td>$1,000 per acre</td>
</tr>
<tr>
<td>1958</td>
<td>$2,200 to $5,000 per acre</td>
</tr>
<tr>
<td>1959</td>
<td>$2,200 to $5,000 per acre</td>
</tr>
</tbody>
</table>

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Principle of Maximum Benefit

The principle of maximum benefit is that the public interest is best served when all facilities to be installed in streets are installed immediately prior to occupation of all of the dwellings being served. Facilities installed for some periods prior to occupation of all dwellings that could be served, means that some potential benefit from the services has not been realized. Similarly, facilities installed some time after occupation of dwellings being served means that some benefit has not been derived from these services. Neither are in the public interest. The former loss of benefit constitutes a waste of resources including the land in unused sites, the land in streets, and the facilities not required to serve the occupied dwellings if they were in a compact development. Looking at it another way, the people who could have occupied these unused sites require equivalent resources of land and services elsewhere.

Where the facilities have been installed by the subdivider and any maintenance costs are paid for out of taxes on land, the waste is at the expense of the landowner. Other servicing and taxation policies tend to shift the expense to others who cannot benefit from the services and thus reduce the pressure on the landowner to utilize the site. Therefore, it may remain unused for many years in some cases.

The other loss of benefit is contrary to the public interest in that delaying installation results in reduction in convenience at least, in amenity and safety frequently, in health and welfare occasionally, and in economy practically always. The latter is due partly to the waste of expenditure on temporary facilities (e.g. septic tanks), partly to the extra costs of installing services after roads have been paved and lawns planted, and partly because of rising costs.

Benefit from such facilities as trees may be insignificant
immediately after being installed and only partial for some time thereafter if saplings are planted.

The loss in benefit of either type could be expressed in terms of 'service years'. A means of weighting and summing the loss of various services would provide an objective measure for comparing servicing practices, but this has not been considered necessary for the purposes of this investigation.

VII. PLAN ELEMENTS AND FEASIBILITY TESTS

The plans of street uses and facilities being investigated in this report are considered to have eight aspects which are interdependent and overlapping, but must be looked at separately. These are functional, physical, social, staging, administrative, financial, economic, and political. Each aspect could be considered as a special type of plan (e.g. physical plan, etc.), and if they were separate and distinct elements, a simple putting together of them would yield the overall plan. Since this is not the case and the term 'plan' has so many meanings, separate terms have been used for each element and the term 'plan' has been reserved for the whole complex. Essentially these aspects represent the different ways of looking at a particular problem that are considered necessary for a complete understanding of its complicated nature.

In order to determine the feasibility of a plan, the feasibility of each element of it must be checked, and in some cases must be checked for several phases of the lifetime of the projected represented by the plan. The principal phases are: installation (initial and secondary), operation and maintenance (during construction and the useful life of project), and replacement.

These elements and their feasibility tests are outlined below to introduce the terms and concepts involved. As an aid to interpretation of their meaning and relationships to one
another, the terms are accompanied by examples from a situation analogous to the one being considered here and more readily comprehended. This is that of a man considering purchasing or renting new accommodation for himself and his parents. Further clarification of the interpretation of these concepts has been left to their application later in the report.

**Plan Elements**

The elements of a street use and facility plan, their field of concern, and the house-buying analogy are as follows:

**Functional layout** is that part of the plan dealing with the organization of activity and sensory zones and operation of service systems, including dynamic and time considerations. House 'plans' do not often show activity zones, though they should form the basis of the plan view design. Exceptions are indications of activity zones smaller than a room such as a 'conversation' area in a living room or various zones of well-designed kitchens. Activity zones often are indicated on plot plans, however. Sensory zones relating to temperature, light, noise, and smell are occasionally indicated and often implied on drawings. They normally coincide with activity zones or groups of them. The 'mechanical services' part of the set of drawings for a house includes diagrams of the heating, plumbing, and wiring systems which show symbolically the organization of the parts of the systems and note pertinent characteristics of their operation (pressure, voltage, etc.).

**Physical design** is that part of the plan dealing with the deployment of material objects in three-dimensional space and their physical attributes; that is, the adaptation of physical means to the ends being considered. This is analogous to the 'blue prints' for a house including elevations, plan views, sections, details of construction materials and techniques, and specifications of materials and finishes. These show respectively
appearance, spatial relationships, structural system, special designs for particular construction problems, and the quality of material and workmanship that must be provided.

**Social provision** is that part of the plan dealing with special provision of facilities, or deployment of them, with the intention of serving social needs as distinct from such physical needs as food and shelter or such personal needs as privacy. Analogous social provisions in houses are formal living rooms or parlors as distinct from family rooms, or such special facilities as liquor cabinets or cocktail bars in recreation rooms.

**Staging schedule** is that part of the plan dealing with the order or sequence in which parts of the physical design are put together and in which functioning systems are put into operation, including tests of the systems and their operational characteristics. It is analogous to the schedule that wise builders prepare to avoid delays caused by poor receiving and handling of materials, by tradesmen getting in each other's way or waiting for others to finish their job, and by waits for inspections. Such matters are the builder's concern and increase in importance with the number of units being built. They do not enter the prospective homeowner's deliberations unless he builds the house himself, but other staging considerations do. These are ones dealing with the scale and scope of construction undertaken initially. For example, certain parts of the eventual building (e.g. extra bedroom, recreation room, carport) or construction operation (e.g. interior painting) might be left to a later secondary phase. Both types of staging considerations are important in public projects because of their effects on other parts of the plan as discussed later in this report.

**Administrative arrangement** is that part of the plan dealing with the management of the project during the
construction, operation, and replacement phases, including matters of jurisdiction and responsibility. In house building, only the financial arrangements are important to the prospective owner (unless he is also the builder). The builder normally, (or architect occasionally) handles other administrative arrangements such as obtaining permits; hiring and paying subcontractors, carpenters and labourers; ordering and paying for materials; arranging for inspections; and supervising the whole construction process.

Financial budget is that part of the plan dealing with the 'financing' of the project. This includes consideration of the sources of revenue, the costs of borrowing at various rates for various periods, the sharing of costs, and the means of repayment. Continuing the analogy, such a budget would involve not only consideration of mortgage costs, but also such matters as whether the parents would pay rent, help pay off the mortgage, or make a cash settlement.

Economic scheme is that part of the plan dealing with the worth of the project in relation to its costs considering primary and secondary benefits and costs, regardless of to whom they accrue. In house buying, such considerations generally are made on a highly subjective basis. However, in the situation being used for purposes of illustration, the man might make a careful analysis of the relative advantages and costs of such possibilities as: building or renting two houses, a duplex, a house with an 'in-law' suite; building a house and renting an apartment, or renting two apartment suites.

Political program is that part of the plan dealing with the promotion and propagandization of the merits of the plan compared with existing or other proposed plans. This could embrace the dissemination of information to, and soliciting of support from, the public and private agencies directly
involved (including municipal councils, utility companies, and labour unions), special interest groups (such as Community Planning Association of Canada, Community Arts Council, Good Roads Association, Traffic Safety Council), and the public generally in order to gain support for the plan. An analogous situation would be that of an individual wanting to build a house of unusual appearance or unorthodox construction who seeks support from owners of adjacent property, a group of architects, a labour union, and anyone else he thinks might help influence responsible authorities to relax or amend regulations prohibiting such a house.

Feasibility Tests

The feasibility of a plan for a project is the measure of its practicability, that is, what can be dealt with successfully. It depends upon many factors of varying importance and is neither obvious nor simple in such a complicated problem. Indeed, it may not be as obvious and simple as some people would have it in other problems, if all factors were considered. For instance, the most feasible plan may have neither the best possible physical design and functional layout, nor the least cost of those possibilities being considered, but some compromise of all factors. Because of the complexity of the problem in question, the feasibility of each element of the plan is treated separately before attempts are made to evaluate the overall feasibility of a plan.

An investigation of feasibility is essentially a critical examination of proposals in relation to the objectives of the proposals, to accepted standards, and to possible alternative proposals. The form of test for feasibility used in this report is that of questioning aspects of the plan. Obviously, the more and better the questions, the more rigorous will be the test. Outlined below are the main questions pertaining to the plan
elements to show the nature and scope of interpretation placed upon 'feasibility' in this report. The house-building analogy is introduced whenever it might aid interpretation.

**Functional feasibility** is an evaluation of the degree to which functional layouts serve the public interest in terms of all public interest criteria except amenity, of services in operation under all conditions; their standards; and alternative means of providing the same services. Questions on this would be of the type, "Will this system function safely under all conditions?" This should be done for each system and criteria applied first generally, and then successively to every separable part and function. The questions also should be applied in each relevant case under various critical conditions such as abnormal weather, interruption of service, or long-term situation. Although prospective homeowners seldom question such matters, there are some functional aspects of household systems which should be given due consideration. For instance, one might question how well heating and plumbing systems would work in severe cold spells; how much inconvenience would be suffered if electric power, domestic gas, or other service were interrupted; and what are long-term prospects for plumbing systems having two types of metal that could corrode through electrolytic action.

**Physical feasibility** is an evaluation of the degree to which physical designs serve the public interest under normal conditions in terms of all public interest criteria, their standards, and alternative means of providing the same services. Appropriate questions would range from the general one, "How well is the public interest served by this particular combination of services?" to "How well comparatively would the public interest be served by this particular alternative means or material for this service?" These are analogous to the prospective homeowner asking "Does this design best serve my interest?"
Are the rooms large enough? Can I arrange my furniture in them? Should there be more fixed electrical outlets or baseboard wiring channels with moveable outlets?"

Social feasibility is an evaluation of the degree to which special provisions for social purposes provide the possibility or potential for meeting social needs, without forcing undesirable or unwanted socializing. This condition is included to avoid creation of situations in which social contact and relationships are unavoidable and impinge on the ability to achieve privacy, such as when two or more households share bathroom facilities.

Staging feasibility is an evaluation of the degree to which a project can be separated into discrete parts, functions, or construction procedures that can be carried out independent of, and hence, at a different stage than other ones. The effect on public interest of such separation must be checked for each criterion in terms of all the other criteria since a given separate stage might be feasible in terms of several criteria, but not the remaining ones. The objective is to find the most feasible separations considering scale and sequence. Questions toward this objective range from "Is it feasible to install this service separately from all others?" to "Is it feasible to perform this particular construction procedure separately from the others?" The first type are primarily to establish the scale of the initial major construction stage, which is governed by considerations of financial and economic feasibility. The second type deals with the effect of sequence on efficiency and economy, and consequently, on economic feasibility. Analogous questions would be "Could I leave the garage, extra bedroom, finishing of basement, interior painting and other items out of the contract or provide them later when I could better afford them?" Also, "Should I do the interior painting before the contractor finishes the floors, installs lighting fixtures and wood trim to avoid
expense and bother of cleaning paint from them?"

**Administrative feasibility** is an evaluation of the degree to which the public interest is served by the management of installation and operation of services in terms of convenience, efficiency and economy. Pertinent questions are: "Who should be responsible for doing or supervising what, and how?", and "How will disputes and unforeseen problems be handled?"

**Financial feasibility** is an evaluation of the degree to which the various stages of the project can be afforded by those paying for them. The following series of questions must be asked: "Who benefits from this stage of the project and by how much? Can they all afford to pay for it in proportion to the benefit they receive? Who should pay for it and how? How should the stages be financed - over what period and at what rate of interest?" Financial feasibility may be the over-riding consideration in house buying and place severe limitations on desirable physical, functional, and economic aspects. Indeed, it seems that as a general rule when financial limitations are most stringent, the extent to which advantage can be taken of the more economically feasible schemes is least. To change the analogy for a moment, a Rolls-Royce might be the most economical car to own in the long run, but few could afford to realize the potential savings.

**Economic feasibility** is an evaluation of the degree to which benefits of a project (or stage thereof) exceed costs. The most economically feasible project is that having the maximum net benefit; that is, the maximum excess of benefits over cost. This is determined by adjusting the scale and scope of projects selected on the basis of maximum benefit-cost ratio. This adjusting process involves asking "Would the excess of benefits over costs be greater or less if this part or function were added or deleted?"
Political feasibility is an evaluation of the degree to which the project (or stage thereof) could be made acceptable to the public or interested or affected groups such as trade unions, the representatives elected by these groups, and the officials appointed by these representatives. The question is "Will this project (or stage thereof) be acceptable to this group if presented in this particular manner?"

VIII. SUMMARY

The 'tools' used in this investigation have now been forged - the principal definitions have been stated; the types of structures and services being investigated have been described and classified; and criteria have been developed for evaluating street use and servicing practice. These criteria include elements of the public interest, principle of street use and servicing, and feasibility criteria related to several ways of looking at the overall plan.
CHAPTER II

CURRENT PRACTICES

A DESCRIPTION OF CURRENT STREET USE AND SERVICING PRACTICES
IN TEN MUNICIPALITIES OF METROPOLITAN VANCOUVER

In order to compare properly any proposal with an existing situation, one should know both well. The better each is described or defined, the better should be the quality of the comparison between them in terms of certainty and accuracy. For the purposes of this investigation, current street use and servicing practices are described and defined in this chapter in terms of the services and criteria mentioned in the preceding chapter. The description is confined to local streets in single-family residential areas except where mention of practices outside these confines serves to clarify or place in a proper perspective the practices of principal concern herein.

The description of current street use practice is reasonably straightforward and simple since the uses made of streets are universal, and the ones specially accommodated or facilitated in local single-family residential streets are practically always the same. The description of current servicing practices including the facilitating of such uses, however, is far from simple. Looking carefully at the result of servicing practices - what is herein terms 'servicement' - one finds little complete homogeneity, even in relatively small areas. Exceptions are areas that have been serviced by one developer in a short time, especially recently. Even in areas once serviced in the same manner, differences arise between streets because of the continuing process of adding services, and upgrading and/or replacing their facilities. But few areas, especially large

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1see page 19. for definition of this term
ones, are serviced at one time in Metropolitan Vancouver, and there are differences between them in the manner in which they have been serviced. These differences are due largely to differences in the minimum standards required by municipalities and to changes that have been made in them over the years. However, some differences arise when large-scale developers install services at a standard above the minimum required at the time of development by the municipality in which the development occurs.

The most significant instances of such large-scale developments are introduced together here because repeated reference is made to them throughout this chapter and related Appendix A. All but one of these are shown on Map 1 on the following page. The earliest sample is what is now called the 'Old Shaughnessy' area of Vancouver that was developed by the Canadian Pacific Railway Company in the 1910's. This was done to a high standard, especially of planting, and is still a desirable 'prestige' area. The C. P. R. has subdivided the former Quilchena Golf Course and the Oakridge area since World War II, but both have been serviced by the City in the usual (low standard) manner.² The Shaughnessy Golf Course is to be subdivided soon and serviced to a standard comparable to Old Shaughnessy. The fate of Langara Golf Course, the remainder of a 6000 acre grant to the C. P. R., is uncertain at present. The Provincial Government developed for leasehold a portion of the University Endowment Lands (U.E.L.) during the late 1920's to a high standard including partial underground wiring.

²These areas also were designed for the C. P. R. by the City Planning Department to include a mixture of uses such as various types of apartment, commercial, and institutional buildings. It is anticipated that future developments of C. P. R. land will be designed by the Planning Department as well.
MAP 1. SELECTED LARGE-SCALE DEVELOPMENTS IN VANCOUVER
Various schemes to develop the remainder have resulted only in clearing of the northerly portion of the area, but this has since become overgrown. Central Mortgage and Housing Corporation has developed Renfrew Heights and Fraserview as low rental housing districts for Second World War veterans. They have a high standard of utilities and pavements, particularly for this low income part of the City, but lack adequate tree growth. The City is currently developing an area it owns south of 54th Avenue, east of Kerr Street (and the Fraserview development), and north of the Fraserview Gold Course, which the City owns and will retain. This development will have a very high standard of service including complete underground wiring and special planting areas. It is hoped to develop the remaining City owned land to the east in a similar manner.

The other large-scale development considered is the 'Richmond Gardens' development in the Township of Richmond (see Map 2, page 64.). This is being developed by Consolidated Building Corporation, the first large-scale builder to move into what has been essentially a small-scale builders preserve. Richmond Gardens will have complete underground wiring and landscaping in addition to the high standard of servicement now required in Richmond.

While these large-scale developments are significant in many respects, they occupy only a small portion of the metropolitan area and required special circumstances that are becoming constantly less prevalent, at least for inlying areas. These consist of corporate control of large unsubdivided tracts of land plus adequate financial resources and 'know how'. Except for the outlying municipalities, there are few large unsubdivided tracts of land remaining that are suitable for residential development. Most should be preserved for agricultural or recreational purposes. There are considerable areas of
partially subdivided land which are not being developed for various reasons. These include municipal ownership coupled with inability or unwillingness to cope with further development for financial reasons, or multiple ownership and complex subdivision. The latter circumstances cannot be dealt with economically by private corporations who lack the necessary powers, or by municipalities who have the powers but lack the financial resources, and sometimes the 'know how'. Thus, for the reasons outlined above and assuming no dramatic changes, most future development will continue to take place on a relatively small scale.

A significant proportion of future single family residential development will occur on land that is already subdivided. Some of this will occur as infilling of previously 'by-passed' or 'side garden' lots which are of no concern here. Much development, however, will occur on land subdivided in speculative sprees as far back as the turn of the century. The servicement of such land ranges from non-existent to as good as adjacent developed areas, but is rarely of a high standard. The opportunity has been lost to require an adequate servicement as a condition of subdivision in these areas. However, since services would have to be added, upgraded, and often replaced in these areas to bring them to today's standards, such areas are of concern herein.

The main concern in this investigation, of course, is with future development in new subdivisions, because it would be in these that the benefits-to-cost relationship of the proposed

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3 The District of North Vancouver is a notable exception in this regard, but is also withholding from development much of its land that ought to be developed for the good of the whole metropolitan area.

4 The 'British Properties' area of West Vancouver has paved roads with curbs, and watermains through considerable undeveloped areas. This can be considered an expensive high-class 'sprawl' area that will eventually be infilled.
practices of designing and installing services in new subdivisions are given prime consideration. Completion of the servicement of existing subdivisions with poor servicement is of secondary concern, and the reservicing of existing developments is of tertiary concern.

In order to describe and define current street use and servicing practices as simply as possible for the purposes of this investigation without losing too much of the variety and complexity, the following approach has been employed. The survey of current servicing practices has been restricted to the ten municipalities in Metropolitan Vancouver which have had the most servicing activity recently and have the greatest potential for further activity. Then the street use practices and designing and installing processes which apply generally have been analyzed. The problems of describing and defining servicing practices where some services are not provided, some are provided considerably later than others, and nearly all are provided at different standards of quality in different municipalities or parts of them, has been resolved as outlined below.

A detailed description of the servicing practices for each type of property service has been made in terms of five ranks - best, better, normal, worse, and worst. The 'normal' rank has been assigned to the most common or prevalent practice for each particular service, and the other practices have been ranked in relation to it. 'Best' and 'worst' ranks have been assigned respectively to the best and worst practices found in the municipalities surveyed. The 'better' and 'worse' ranks have been assigned respectively to practices different from the normal practice, but neither so good nor so bad as the best and worst practices. This detailed description is contained in Appendix A (see page 193.), along with descriptions of actual practice in terms of the distribution or prevalence of the
ranked practices in the ten municipalities surveyed, and descriptions of significantly different practices elsewhere.

This detailed description of current servicing practice has been summarized into 'composite' best, normal, and worst practices as defined generalizations suitable to the purposes of this investigation. These follow in this chapter the further description and definition of the areal scope, the street uses, and the designing and installing processes investigated.

I. AREAL SCOPE OF THE CURRENT PRACTICES INVESTIGATED

Ten municipalities in Metropolitan Vancouver have been selected for investigation of current servicing practices on the basis of recent activity and future potential in the subdividing and servicing of land. They are the City of Vancouver, the surrounding Districts of West Vancouver, North Vancouver, Burnaby, and the Township of Richmond; and the outlying municipalities of the City of Port Moody, the Districts of Port Coquitlam, Coquitlam, Surrey, and Delta. These are shown on Map 2. on the following page.

With the exception of occasional mention of certain practices peculiar to the University Endowment Lands, the other municipalities and unorganized areas in Metropolitan Vancouver have not been included because there has been little recent activity, there is little potential for expansion, or there is some special circumstance. These include the Cities of North Vancouver, New Westminster, and White Rock; Fraser Mills; and the unorganized areas of District Lot 172 (D.L. 172), and the University Endowment Lands (U.E.L.).

The specific reasons are as follows. North Vancouver City owns practically all of the undeveloped land within its boundaries and either services it before sale or sells it on the condition that it be serviced to the City's satisfaction. A
MAP 2. METROPOLITAN VANCOUVER - AREAS INVESTIGATED

Certain delta, agricultural and mountainous lands excluded
recent sale for a comprehensive development of commercial and multiple residential uses was conditional upon provision of high standards of servicing including asphalt roads with concrete curbs, and underground wiring. New Westminster and White Rock are practically completely subdivided except in the Queensborough area of New Westminster where subdividing for 'small holdings' occasionally occurs. Fraser Mills is an industrial enclave and 'company town'. District Lot 172 is an anomaly that should be part of either New Westminster or Burnaby. It is almost completely developed, and is administered by New Westminster as far as most services are concerned. The U.E.L. is only partly developed on a leasehold basis that was supposed to help support the University of British Columbia. The developed area has been serviced to a high standard including concrete curbs and partial underground wiring, and is now one of the best residential areas in Metropolitan Vancouver.\(^5\)

II. STREET USES

Streets can be and have been used for practically all kinds of human activity from, and on occasion including, birth to death. Of concern here are those uses made of local streets in single family residential districts of Metropolitan Vancouver which involve public facilities - that is, facilities for which the public is normally responsible, though it may not provide them. Thus, while streets are 'used' to maintain space between buildings to ensure that adequate light and air reaches them and fire does not spread to them, such uses are of concern only when hindered by facilities. For instance, trees may shut out light (though rarely to an undesirable extent) and bridge

\(^5\)The combination of expensive servicing and relatively low Provincial property taxes suggest that the residents, instead of the University, have been endowed.
the firebreak normally formed by the street. The prime use of streets is for the movement of pedestrians and vehicles, and the waiting or parking of them, which is facilitated by pavements. The second most important use of streets is as right-of-ways for utilities. A third major use is as a space for planting trees and grass, especially in the type of street being considered. A fourth major use is as a location for the facilities of other services, for example, mail boxes and telephone booths.

Local residential streets are used for other purposes of course, but rarely are permanent facilities of public responsibility involved. Perhaps the greatest such use is by children for playing. If any facilities are involved, they are provided by the children or their parents. Local streets also are occasionally used by children for selling lemonade or odds and ends, but the facilities involved are neither public nor very permanent.

The only use involving significant variations in the manner in which it is facilitated is that of vehicular parking. The normal practice is to accommodate this use on both sides of the vehicular access roadway by allowing parallel parking adjacent to the roadway throughout its length, except in and near intersections, and driveways. Municipalities generally have accepted not only the responsibility to allow and provide for vehicular parking, but also the principle that everyone should be able to park in front of his dwelling. This principle is waived when parking is permitted on only one side of dead-end streets such as culs-de-sac, but the loss of convenience is often negligible because there is either adequate parking on the one side or people use their driveways. A more serious departure from this principle occurs when parking is prohibited on one side of a street in order to ease the flow of traffic,
and is completely abandoned when parking is prohibited on both sides of a street for this reason. These are considered worse and worst practices respectively.

The parking use is accommodated or facilitated by installing a pavement on the surface of the parking area, which sometimes has a curb along the edge of it, and the pavement on the roadway which gives access to and allows maneuvering into the parking area. These facilities are discussed with pavements for the vehicular access service.

III. CURRENT PROCESS OF DESIGNING STREET USE AND SERVICEMENT

The current practice of designing the street use and servicement of particular local residential streets is hardly a 'design process' in the sense of there being much opportunity for a designer to create a really exciting and distinctive streetscape. This is because most of the important design decisions have been made in establishing the standard locations for facilities. These are often so complete that decisions are required on only relatively minor matters, at least with regard to the visual result. Furthermore, there is rarely one person or a tightly-knit team responsible for all design decisions not incorporated into standards. Usually particular streets are 'designed' by completing or modifying appropriate standard designs to meet the specific requirements of individual services, often with no more design co-ordination than that provided by such design standards as typical cross-sections and intersection plan views. Thus, one must analyse these design standards to understand the whole process.

Fortunately these departures rarely occur in single family districts (they cannot occur on local streets by definition). Unfortunately they often occur in districts having houses converted to more intensive residential use where the need for parking is greater.
These design standards usually take all ordinary property service facilities into consideration, regardless of whether they are required to be installed upon subdivision, or are likely to be installed at all. This is for the very good reason that it is difficult to add facilities for which no consideration has been given, as evidenced by the problems of installing gas pipes in some areas, for example. There is ordinarily a design standard for the ubiquitous 66 foot wide, with a modified design for either hillsides (e.g. Districts of Burnaby and Delta) or reduced widths (e.g. for 56 feet in Richmond). An exception is the District of North Vancouver which has standards for flat to moderate and steep cross slopes (up to a maximum limit for subdividing of 20 percent), for 66 and 50 foot wide roads, and in 'open ditch' and storm drain designs - a total of six combinations.

The design decisions involved in these standards have been analyzed and are discussed below by what are considered to be the major elements. They are the street uses, pavements, utilities, planting, and other facilities.

**Designing of Street Uses**

In current practice, designing of street uses *per se* really involves only the decisions relating to parking on narrow streets. Decisions must be made as to whether or not parking should be accommodated or not on narrow streets, and if so, on which side. All other uses currently accommodated are accepted by tradition, and little thought seems to be given to possible additional ones.

**Designing of Pavements**

Designing of the vehicular pavement or road is mainly

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7 District of North Vancouver, Standard Plans/Specifications - Subdivision Services, available to subdividers on loan with revision service.
limited to a decision on its width, since it is always laid out symmetrically on the centerline of the street. It has parallel parking strips seven or eight feet wide down both sides except for narrow streets lacking one or both strips. The vehicular access or movement portion of the road varies from the equivalent of one wide moving lane to two full lanes; that is, from about 11 to 24 feet. Thus the total width of pavement can be from 25 to 40 feet in width, but is usually in the 30 to 36 foot range for a 66 foot street. A decision must also be made on the width of permanent type pavement (i.e. asphalt or concrete) which is ordinarily applied only to the movement portion, except in Richmond.

There are two decisions to be made with respect to sidewalks. One is whether to locate them on one or both sides, or not at all as in the case of culs-de-sac. The other decision involves the relationship of the sidewalk to the road. There are two schools of thought on this. One holds that the sidewalk should be near the road to save costs by excavating for it at the same time as the road, and by constructing it integrally with the curb; and to avoid splitting the space available for planting trees. The other school holds that the sidewalk should be away from the road so that pedestrians do not get splashed, so that the sidewalk can have a different configuration than the road, and so that the road can be widened without moving the sidewalk.

Designing of Utilities

Designing of standard locations for utilities involves a trial and test process to achieve an acceptable compromise. Usually it is a matter of modifying previous standards to meet changing needs or adapting standards of other municipalities to local conditions. Perhaps none of the utilities end up in an ideal location, but all must be able to function properly. For example, the ideal location for sewers and storm drains is on the
center line where streets have no cross slope, and the low side otherwise. Thus, unless they are installed together as 'twin' drains as in Vancouver, at least one must be moved away from the ideal location. Both may be far removed from the ideal location if they are not installed under roads as in Richmond. The other underground facilities are so located as to achieve adequate vertical and horizontal separation between sewers and water pipes, and between all drains, pipes, and conduits and tree roots. The latter is an important consideration because utilities other than drains are seldom located under pavements, and hence must be below the only area available for tree planting. A similar conflict arises above this non paved area between tree branches and overhead wiring. It is no wonder some utility men consider trees the bane of their lives. As an illustration of the range of factors that ought to be considered in such designs, a table prepared for a street tree and electric utility conference has been reproduced as Table III on the following page.

Once design standards have been established, designing of installations for most utilities is mainly a matter of locating connections to individual dwellings. The exceptions are drains, which must be designed in relation to the topography of the street considering certain functional limitations such as gradient and manhole spacing.

Designing of Planting

Current design standards establish the line upon which trees are to be placed and the area in which grass can be planted. Where not noted explicitly otherwise, the tree lines are midway between the edges of road and sidewalk on both sides of the street. Grass can be planted on all areas not paved. A list of acceptable species of trees with required spacing may also be incorporated in design standards. Thus, designing of planting
### TABLE III

<table>
<thead>
<tr>
<th>KIND OF SERVICE</th>
<th>COMPONENT FACTORS</th>
<th>QUALITY OF SERVICE</th>
<th>TYPE OF FACILITY INSTALLED</th>
<th>MANNER OF INSTALLATION</th>
<th>INVESTMENT IN FACILITIES</th>
<th>COST TO THE RESIDENT</th>
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<tbody>
<tr>
<td>Electric</td>
<td>Continuity of service and Capacity of facilities</td>
<td>Basic supply pattern and Mechanical strength</td>
<td>Clearance from trees and traffic</td>
<td>Tends to increase with greater clearances</td>
<td>Charge for service</td>
<td></td>
</tr>
<tr>
<td>Street Light</td>
<td>Continuity of service and Intensity of Illumination</td>
<td>Basic supply pattern and Mechanical strength</td>
<td>Clearance from trees and traffic</td>
<td>Tends to increase with greater clearances</td>
<td>Taxes levied</td>
<td></td>
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<tr>
<td>Shade</td>
<td>Amount of shade (Beauty)</td>
<td>Size and shape and Location</td>
<td>Clearance from lines and traffic</td>
<td>Tends to decrease with lesser height</td>
<td>Investment made</td>
<td></td>
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</table>

<table>
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<tr>
<th>Number of Homes</th>
<th>Diversified Demand KW Initial</th>
<th>Transformer Size</th>
<th>Transformer and Secondary Costs per House</th>
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<td>4</td>
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<td>6</td>
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<td>157</td>
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</table>

for a particular street may involve only the selection of the variety of tree to be planted. Vancouver now usually plants two alternating varieties of trees, one flowering, which are located with consideration of street lamps, but the various combinations involved could be covered in design standards.

**Designing of Other Facilities**

The facilities of other property services installed in streets are not covered by municipal design standards, although the responsible agencies have established criteria for their location. For example, mail box location depends upon the number of households served, maximum walking distances, and convenient routes for mail collection. Each such facility is designed independently of others, except that some are located on the supports of other services when in a suitable location.

In summary, the process of designing the street use and servicement of local residential streets is largely carried out by establishing design standards which for the most part require relatively minor modification for adaptation for particular streets.

**IV. CURRENT PROCESS OF INSTALLING PROPERTY SERVICE FACILITIES**

The overall process of installing property service facilities in current practice is to prepare the whole street for servicing, and then to install the service facilities independently in roughly this order: utilities, pavements, and planting. The process of installing each facility is the same in terms of the general types of operations involved. These operations are excavating, preparing a 'bed', installing the facility, backfilling, and cleaning up. The specific operations involved in

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8 Street uses have been omitted because they are not installed themselves, but are facilitated by one or more of the facilities which are installed.
these processes and the exceptions to the preceding generalizations are outlined below.

Preparing the Street for Servicing

The current practice of preparing a street for servicing is to 'clear and grade' the full width of the street. This is required upon subdivision by all of the subdivision control by-laws or related specifications for the municipalities studied. Although the intent is the same, the general terms 'clear' and 'grade' are less descriptive than the terms used in certain by-laws or specifications which are employed herein. One municipality specifies clearing of all trees and brush by complete removal or burning; grubbing out of all main root clusters entirely and roots of various sizes to prescribed depths; and stripping of all topsoil and vegetable matter before grading commences. Another municipality (Burnaby) describes the latter operation as "excavation of organic topsoil materials".

The term 'grading' embraces all operations involved in shaping the ground in and near the street to prescribed designs. Cutting consists of all operations involved in excavating material above desired grade (or shape). These include bull-dozing, shovelling, scraping, and blasting of rock where required. Filling consists of those operations which bring the natural (but stripped) topography up to the required grade. These include bull-dozing, shovelling, and scraping where native material is suitable; and hauling and dumping otherwise. Compacting consists of those operations which consolidate the filled material to

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9 See list of these in Bibliography.

10 District of North Vancouver, Standard Plans & Specifications, a manual loaned to subdividers and kept revised.

acceptable standards by tamping or rolling. **Fine-grading** (or shaping or forming) consists of those operations which bring the street to the desired shape. They include all of the above grading operations except blasting, but are carried out in a more controlled manner involving finer or closer tolerances.

If properly carried out, the process described above prepares the street for installing of the road, and sometimes the sidewalk, without special excavation for these facilities. A road 'bed' or partial pavement such as a gravel sub-base is ordinarily installed at this stage to facilitate movement of vehicles involved in the processes of installing facilities of other services or constructing of dwellings.

**Installing Utilities**

Utilities are installed following preparation of the street and installation of a road bed, but before pavements in the best current practice to avoid damage to pavements. The ideal order would be from the bottom (or deepest) up, but to some extent it does not matter so long as the various operations are staged to avoid conflicts. Thus, the order might be sewers, storm drains, water pipes, gas pipes, and then underground or overhead wiring and cabling.

The process of installing all underground utilities involves the same general types of operations. These general operations are excavating a trench, shaping the trench bottom or preparing a bed for the facility, laying the facility itself, testing the facility, covering the facility, backfilling the trench, and cleaning up. Excavating involves digging by power shovels, backhoes, or trenchers; and shoring when the trench is deep or the sides are unstable. Shaping the trench bottom to fit facilities usually involves hand work with shovels, and with trowels when there are hubs on drains. Beds are laid by placing and shaping sand, gravel, or concrete in the trench bottom.
Laying of facilities usually involves placing sections of drain, pipe, or conduit in the trench and joining them together. Facilities are tested to ensure that they will function properly. Facilities are covered with one of the bedding materials; usually the same one used in the bed. This is done with special care to prevent damage to the facility. Backfilling involves placing suitable material, usually the excavated spoil, in the remainder of the trench in layers, each of which is carefully compacted by tamping. The cleaning up operation consists of removing all unwanted materials including surplus excavated material.

The process of installing overhead utilities differs in the following respects. Instead of trenches, holes are excavated by drilling or shovelling. Supports are erected in the holes instead of laying beds, and the holes are backfilled before, rather than after the wires and cables are installed. These are installed by stringing from support to support, instead of being pulled through conduits from manhole to manhole.

**Installing Pavements**

The process of installing pedestrian access pavements, or sidewalks, is similar to that for utilities. A shallow trench is excavated and shaped, a bed of sand or gravel may be laid, and then the facility itself is installed. When the sidewalk is of concrete, this is done by constructing forms, casting concrete, finishing the surface, and later removing the form. Asphalt sidewalks are cast hot or cold without forms, and rolled. "Screenings" sidewalks are made of finely crushed rock cast without forms and rolled. Backfilling is required only at the sides of concrete sidewalks.

The process of installing vehicular access pavements, or roads, also follows the general pattern, but has several
complications. Excavation is ordinarily required only for connections to driveways and for curb-gutters, since the grading operations shape the ground for the road. Also, the road bed is usually partially installed prior to utilities, but disturbed during the process of installing them. Thus, gravel must be added to form a temporary pavement, or bed for a permanent one. Sand or gravel is placed as a bed for the curb-gutter. When this is of concrete, it is either cast in forms or extruded from a 'curbing' machine. Asphalt curbs are extruded either by similar machines or by attachments on the 'paving' machine. The latter extrudes the asphalt pavement between the curbs, which is then rolled. Backfilling is required only behind the curbs.

Installing Plants
The manner of installing plants is familiar to everyone. In the terms employed here, trees and shrubs are installed by excavating a hole, laying a bed of humus or fertilizer, installing the plant, and backfilling.

Installing Other Facilities
Where they are not installed on lamp supports, the facilities of other property services are installed by excavating a hole, installing a support, backfilling, and then attaching the facility to the support. Thus, the process is similar to that of installing overhead utilities.

V. COMPOSITE BEST, NORMAL, AND WORST SERVICING PRACTICES
The detailed description of current servicing practices contained in Appendix A has been generalized into three 'composite' practices for the purposes of this investigation. These are composite best, normal, and worst practices, against which proposed practices have been tested. As generalizations must, they leave out much of the variation in current practice, but this simplifies the comparison with the proposed practices. They also do not represent the practice in any one municipality
or area thereof, because any one area may be serviced by a mixture of practices from best to worst. The municipality or area closest to each of the composite practices established herein is mentioned with comments on the differences.

The ranking of current servicing practices forming the basis of these composite practices involved the application of the public interest criteria and/or principles presented in the preceding chapter. For instance, servicing practices significantly superior (or inferior) to others in terms of public health, safety, convenience, welfare, amenity or economy have been up-graded (or down-graded). Practices in which subdividers install services have been ranked above others in accordance with the principle of payment for benefit. Similarly practices where facilities are installed prior to first occupancy of dwellings have been ranked above others according to the principle of maximum benefit. Lowest ranks have been assigned to those where services are provided the longest time after first occupancy because the number of years the service was available would be minimized.

Ranks apply only to practices where services are provided, the absence of services being noted in the detailed descriptions in Appendix A. In the discussions of actual practice, the areas with more services are rated higher than others, since it is generally better to have a service than not. Exceptions to this generality might occur where such poor facilities have been installed that they are seldom used and are counter to some elements of the public interest. An example might be a 'screenings' walk that is seldom used because of its dampness, has a poor appearance, and is expensive to maintain.

The composite practices derived from the detailed ranking of current practices are defined below by the major functional classifications of services.
Composite Best Practice

The composite best practice is simply a compilation of the best and better practices for all of the services currently provided. For this purpose, the normal practice has been taken as the best practice where none better than normal exists for a particular service. Thus, the best practice of street use is the normal one of accommodating parking on both sides of the vehicular access roadway on a parallel parking strip adjacent to the roadway throughout its length except at intersections.

The best practices of providing the various services are summarized below by listing for each group of services the facilities that are installed by the subdivider, except where noted, prior to first occupancy of the dwellings in the area being served. These are:

**Access Services**: an asphalt pavement between concrete curb-gutters on a gravel or sand base to specifications established by municipal engineers, and concrete sidewalks on both sides of the street.

**Baric Services**: a cast iron water pipe of minimum six inches diameter, and a plastic coated welded steel gas pipe installed by the B. C. Hydro & Power Authority.

**Communicative Services**: a conduit for telephone cable installed by B. C. Telephone Co. and, if required, cable for cable T.V., alarm, and control services installed by their respective utility companies.

**Drainage Services**: twin storm and sanitary drains plus concrete curb-gutters.

**Electrical Services**: conduits for electric power wires installed by the B. C. Hydro & Power Authority and street lighting wires installed by the subdivider who installs the lamps and their supports.
Furnishing Services: transformer kiosks.

Gardening Services: boulevard trees and grass to be pruned by municipality or parks board, but otherwise cared for by adjacent residents.

Holding Services: no holders, since facilities for the postal service are assumed to be located on collector or more important streets, and garbage cans to be provided by residents.

Indicating Services: street name signs installed by the municipality on the lamp posts. 12

The keeping services are not the concern of the subdivider since the municipality takes over ownership and responsibility for the facilities either upon subdivision or one year later. The keeping service practice however, would tend to be better than normal because of the existence of curbs and good pavements and the elimination of costs to control growth of wild grass and noxious weeds.

Comparison with actual practice. The composite best practice of street use and servicing practices in Metropolitan Vancouver is most closely matched by the Richmond Gardens development in Richmond. Departures from the composite best practice are that this development will have only one sidewalk, asbestos cement instead of cast iron water pipes, and separate instead of twin drains. The loss of potential savings on drains is at the expense of the subdivider, and the other departures will not reduce benefit derived from services significantly. Therefore, for most purposes this development can be considered to represent best practice.

12 See Appendix A, p. 230 from which this has been derived.
The next closest actual practice is Vancouver's subdivision of its own land at 54th Avenue and Kerr Street. The best composite practice will be followed exactly insofar as the facilities are concerned, but the pavements, curbs, and street lighting are to be paid for on a local improvement basis. This practice can be considered better than normal.

The University Endowment Lands can also be considered to have followed a better practice since the departures from composite best practice are the partial overhead wiring and lower standard of lighting. Neither is as serious as they would be in most areas. The pole lines are fairly well hidden by trees, and on most streets, the wide open lawns and yard lighting tend to offset the poorer street lighting provided by upright lamps than by the modern hanging types.

As a standard required of subdividers by municipalities, the composite best practice is most closely matched by Richmond in those areas where sewers are required. The departures are the same as those mentioned for Richmond Gardens, plus not requiring any landscaping. It is better than the proposed requirement for essential urban residential services recommended by the Lower Mainland Regional Planning Board in several respects. There are two parking strips and sidewalks instead of one. Curbs, gutters, and storm drains are included in all circumstances. Wiring and cabling is underground, and boulevard trees and grass are planted.¹³

Composite Normal Practice

Composite normal practice of street use and servicing is similarly derived from the practices described in Appendix A. Normal street use practice is to accommodate only parking by providing pavement for parallel parking on both sides of the

¹³Lower Mainland Regional Planning Board, Land for Living, New Westminster, B. C., June 1963, p. 16.
road throughout its length except at intersections. The normal practices of servicing are listed below:

**Access Services**: subdivider installs only a gravel road; municipality installs asphalt road and concrete sidewalk later on local improvement basis.

**Baric Services**: subdivider installs asbestos cement water pipe; B. C. Hydro & Power Authority installs plastic coated steel gas pipe prior to pavements being installed.

**Communicative Services**: B. C. Telephone Co. and any other utility companies install cables overhead on power poles using integrated cable and support wire to minimize unattractiveness.

**Drainage Services**: subdivider installs ditches with culverts under driveway and front walk connections; municipality later replaces these by storm drains and occasionally curb-gutters on local improvement basis.

**Electrical Services**: B. C. Hydro & Power Authority installs wires overhead on poles placed in lanes or rear easements and street lights at intersections; municipality later installs lamps on painted steel poles with underground wiring on a local improvement basis.

**Furnishing Services**: no furnishings are installed other than those related to other services.

**Gardening Services**: municipality or parks board installs trees only; planting of grass left to residents.

**Holding Services**: no holding services are installed on local streets, postal facilities being assumed to be on collector or more important streets.
Indicating Services: municipality installs reflective sheet metal signs on separate metal posts.

Keeping Services: Keeping services for facilities installed initially in normal practice would be mainly grading of gravel road and cleaning ditches.

Comparison with actual practice. As might be expected, the composite normal practice is exactly matched nowhere, but when slight or partial departures are allowed for, it represents the majority of practices. It is thus a fairly reasonable representation of the normal or typical practices. Specifically, municipalities were considered as conforming to the normal practice when the only serious negative departure from composite best practice was not requiring sewers. The reason is that sewers are required in many, if not all areas of these municipalities by mortgage institutions. Several of the municipalities have compensating, higher standards for other facilities, particularly roads.

The six municipalities thus considered to match most closely the composite normal practice and their departures from it are discussed below in what is considered to be diminishing rank.

Delta requires a 20 foot wide, two inch thick asphalt road instead of the normal gravel one, but otherwise conforms to composite normal practice. West Vancouver requires a similar asphalt pavement and 'sewer accommodation'.

The next four municipalities do not require sewers, and hence are below the composite normal practice in this respect. Port Moody is placed next even though not yet officially requiring higher standards in other facilities, is in fact

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14 In effect this means only reservicing easements for sewers in subdivisions contiguous to sewered areas. Statement by Mr. D. Walton, Municipal Planning Officer, West Vancouver, B.C.
achieving much better, if not best practice. Recently subdividers have installed asphalt roads, concrete curb-gutters, street lighting and underground wiring.\textsuperscript{15}

The District of North Vancouver requires a 26 foot asphalt road, whereas Burnaby and Surrey require only the normal gravel road. However, these municipalities often have power poles on streets because there are no lanes in some areas.

\textbf{Composite Worst Practice}

The composite worst practice of street use and servicing is an amalgam of the worse and worst practices. The worst street use practice is restricting parking on one or both sides of streets except in short culs-de-sac with ample private driveways. The worst servicing practices are listed below:

\textbf{Access Services}: subdivider installs only a gravel or soil cement road, and the municipality installs later nothing better than flush coating on the road and asphalt or screenings walks on a local improvement basis.

\textbf{Baric Services}: subdivider installs undersized water pipes or municipality installs water pipes out of general revenue; B. C. Hydro & Power Authority installs gas pipes after pavements and planting.

\textbf{Communicative Services}: B. C. Telephone Co. and any alarm or control utility companies installs cables on separate telephone poles in streets.

\textbf{Drainage Services}: subdivider installs ditches and culverts which are either left or replaced by municipality to intercept flows on other streets; sewers are not installed.

\textsuperscript{15}Telephone conversation with Mr. Hiebert, Municipal Clerk, Port Moody.
Electrical Services: B. C. Hydro & Power Authority installs wires on separate power poles in streets with single lamps at intersections only.

Furnishing Services: no furnishings are installed.

Gardening Services: no plants are installed, but wild growth and noxious weeds are cut down or sprayed with herbicide.

Holding Services: no holders are installed.

Indicating Services: municipality installs wooden posts with vertical non-reflecting street name signs.

Keeping Services: Keeping services are mainly grading of gravel roads and cleaning ditches.

Comparison with actual practice. None of the municipalities ordinarily follow the worst practice with regard to street use, although parking is either prohibited or is impractical on some streets in delta areas having deep and wide ditches as in parts of Richmond and Delta. However, the remaining municipalities follow several of the worst servicing practices. Port Coquitlam and Coquitlam seem to be the worst overall. Vancouver is included because it requires subdividers to install only the bare minimum required by any municipality and installs some other facilities out of general revenue. The fact that it follows the best practices in installing water and drainage facilities (i.e. cast iron pipe and twin drains) is probably not appreciated so much by those served, as the fact that an asphalt road is not provided as in most of the surrounding municipalities. Furthermore, the roads have tended to remain uncurbed and unpaved for long periods or be flush coated instead of paved with asphalt. It is rather ironic that this situation results largely from the high standards formerly insisted upon for permanent facilities and that one of the better practices
in the Metropolitan area is being followed in a part of Vancouver.

VI. SUMMARY

Current practices of street use and servicing have been described in this chapter for ten municipalities of Metropolitan Vancouver, selected on the basis of recent and future potential servicing activity. The processes of designing and installing applying generally to all services have been described. Then 'composite' best, normal, and worst practices derived from the detailed description and ranking of servicing practices contained in Appendix A have been defined for comparison with the proposed practices described in the next chapter.

16 The standards for curbing and paving in single-family residential areas are currently being examined by the City with a view to establishing less expensive ones that are more likely to be installed, thus raising the actual standard of development.
CHAPTER III
PROPOSED DESIGNING PRACTICES

A DESCRIPTION OF THE PROPOSED PROCESS OF DESIGNING PROPERTY SERVICE FACILITIES FOR LOCAL RESIDENTIAL STREET USE AND SERVICEMENT

The proposed street use and servicing designing practices for future local streets of single-family residential districts are defined and described in this chapter for later evaluation in relation to the current practices described in the preceding chapter. The proposed process of designing the property service facilities is described in comparison to the best current practices where pertinent to point up the differences evaluated in the next chapter.

The practices discussed herein actually constitute a proposed approach to servicing that could result in better street use and servicement, and thus better total development and environment. This approach would be more comprehensive, yet more flexible, than that of current practice, thus allowing greater freedom for imaginative designers to create streets that are more useful and interesting parts of our environments. The approach is described in terms of various possible practices of designing property services. Before proceeding with this description, the assumptions and principles underlying the proposed practices are outlined below.

I. ASSUMPTIONS AND PRINCIPLES OF PROPOSED PRACTICES

The basic assumption of the proposed practices is that the provision in local residential streets of an underground structure in which utilities could be installed would allow

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1The term servicement means the condition or state existing when services have been installed. See page 19 for definition.
better use and servicement of these streets than does current practices. By better use is meant more use of streets - through both greater intensity of present uses and new uses - because of special provisions for such uses. Better servicement means a better physical environment due to the greater degree to which the facilities of the property meet the needs and desires of the people served. The reason for this is that the current practices of installing utilities place such severe limitations on the design of other facilities that there is little flexibility in their placement.

It is further assumed that people would prefer what is herein considered to be better street use and servicement. This is undoubtedly presumptive and 'begging the question' but is necessary at this point because it is not known whether people would accept some of the proposals, having no experience with them. It can be safely assumed that, cost considerations aside, people would prefer the whole range of property services, and at as high a standard as possible. For example, they would prefer concrete curb-gutters to anything less, underground to overhead wiring, and 'lots of nice trees' to a few spindly ones. However, whether they would be prepared to walk a few extra steps from parking areas in exchange for some benefits of a perhaps intangible nature is not known. Psychological studies in depth might provide the answers, but it is more likely to require actual experimental installations. Neither is within the competences of this investigator. Therefore, value judgements are made where necessary on the basis of observed behaviour of people in comparable circumstances.

Specifically, the assumptions made regarding proposed practice, with the principles upon which they are based are:\(^2\)

1) All utilities (i.e. including wiring and cabling) should be installed underground with as many as

\(^2\)See pages 39 - 48 for discussion of these principles.
feasible in utility structures.

2) Utilities, pavements, planting, and other facilities should be comprehensively designed for each section considering needs and desires of resident users of streets.

3) Facilities should be installed:
   - by the subdivider (in accordance with principle of payment for benefit).
   - prior to occupancy of dwellings (principle of maximum benefit).
   - in integrated installations (principle of integration).
   - by logical stages (e.g. utilities before pavements; pavements before planting) (principle of maximum benefit).

II. PROPOSED PROCESS OF DESIGNING STREET USE AND SERVICEMENT

The proposed process of designing street use and servicement would differ from the current practice in two main ways. It would be more comprehensive in terms of the number of factors considered in each design decision, and it would be more intimately related to the problems and possibilities of individual street sections. The process would be more comprehensive partly because of the aim of making greater use of streets which necessitates consideration of some social and additional functional factors. Partly it would be due to changed and variable relationships between facilities of different services. The more intimate design relationship of facilities with individual street sections would make it possible to avoid or minimize topographic and drainage problems and thus reduce costs. On the other hand, it would allow advantage to be taken of special features of the terrain such as rock outcroppings or groups of attractive trees, and to enhance the street environment and the benefit derived from it.

The first step in the process of designing a particular
section of a local residential street would be to establish the probable needs and wants of the people likely to live on the street section. This would depend upon the number of sites abutting the section, their size and shape, and the anticipated income of the residents. The number of sites, coupled with estimates of various average characteristics related to income, would provide estimates of the number of people of various age groups, the number of cars and other pertinent factors. The size and shape of lots would give an indication of the extent to which various needs can be met on the site. For example, large sites tend to have ample space for recreational purposes, and wide sites ample space for driveways on which cars can be parked. Thus the need to accommodate some types of recreation and parking on the street is less in such districts than in others. Unfortunately, the need for street uses is generally greatest where there is least street space available to accommodate them, and vice versa.

The second step in the proposed design process is the examination of problems and possibilities of the particular street section. The terms 'problems' and 'possibilities' are relative in that a problem for one service may well present possibilities for another. For example, rock outcroppings present problems for the access and utility services, but present opportunities for the gardening service in that they could be incorporated into a landscaping design. Hence, the need for comprehensive consideration.

The third step in the proposed design process would be the creative one of preparing a comprehensive design for the particular street section. This is essentially a matter of compromising between the fulfillment of needs and desires, solution of problems and realization of possibilities to achieve an optimum design. The design of particular street sections
would also be related to that of adjoining sections and the street system of the surrounding district. Thus, while each street section could have a character of its own, it should form part of a larger unit of several blocks in extent. Trees are probably the best design element to provide unity throughout such an area because of their visual prominence (when of a fair size) and variety of species or combinations of them. Other plants, especially shrubs, might also be used for this purpose in combination with trees, but only to a limited extent because plants are also probably the best means of achieving variety of design within the street section. Other facilities are unsuitable for achieving unity over relatively small 'neighbourhoods' distinct from other areas because either they cannot be changed significantly visually or to do so would destroy desirable standardization. Thus, such facilities should provide unity over much larger areas, if not the whole metropolitan area. However, the layout and shape of some of them can be manipulated to provide variety and interest within street sections.

Although all factors would be considered comprehensively in the proposed design process, there are six main aspects which can be discussed separately for the sake of simplicity. These are street uses, utility structures, utilities, pavements, planting, and other facilities. They are discussed below in comparison with current practice for two conditions. In the first, it is assumed that an area is subdivided but not serviced. In the second, it is assumed an area is neither subdivided nor serviced, so that the proposed practice of subdividing can be discussed in relation to the preceding discussion of servicing practices. In both cases it is further assumed that the street section being dealt with is a local street in a single-family residential district, and will remain so throughout the lifetime of the houses.
The first condition exists in many parts of the metropolitan area because of excessive subdividing activity for speculative purposes during past land booms. It can be considered to exist at that stage in the subdividing process after staking-out of sites and streets, but prior to registration and commencement of the servicing process. It would also exist in the developed or partially developed areas having so few or such poor property service facilities that they could be ignored in redesigning the street. The typical chain wide (66 feet) street is assumed.

**Proposed Designing of Street Uses**

The proposed practice of designing street uses involves both more uses and more designing than current practice. The latter facilitates the parking use by providing paved parking strips beside the movement portion of the road. Designing involves only the decisions of whether to allow parking on one or both sides and the width of pavement required. Ordinarily both decisions have been incorporated into pavement design standards, so for a particular local street the only decision is the selection of the appropriate standard for the street - typical or cul-de-sac.

The street uses that would be considered in designing new streets (or redesigning existing ones in developed areas) are parking or storing cars, and playing or other forms of recreational activity. The extent to which, and manner in which these would be accommodated in a particular street would be based upon the particular needs or desires of the people to be served. The amount of parking would be based upon an estimate of the need or demand for it including parking for visitors to

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6 The parenthetical comments in this section are included because of the possibility of redesigning existing streets in developed or partially developed areas along similar lines.
the future residents of the area. Since this is the most critical use in terms of the space it consumes, the estimate of the amount of parking required is discussed separately below, followed by discussion of the need for playing space.

Parking. Whether storage of cars in such shelter facilities as carports and garages would be accommodated on streets and the extent of such accommodation would depend on the need or desire for this. The need would be related to such factors as the total need for storage, the amount that could be provided on sites, and the climate. Except for the latter, these factors are similar to those for parking which is discussed below. The desires for on-street storage of cars involve the balance of people's preferences and prejudices regarding convenience of getting to their vehicles, use of their lot site, use of public streets, and ownership of such storage facilities.

The estimate of the amount of parking required would be based upon consideration of such factors as the presence of lanes and driveways, the frontage widths of lots; and the probable car ownership, income, and behaviour of the future residents. These factors are either interrelated or tend to appear in certain combinations and the relationships are often not simple ones. For example, where lanes exist and provide access to garages, it could be argued there is no need for parking on the street except for visitors. However, there seems to be a tendency for more parking to occur on the street during the day in those areas with lanes than those without. On the one hand, people cannot be bothered to use the lanes during the day if they can park in front of their house on the street. On the other hand, areas without lanes usually have driveways which are convenient to use during the day. In either case, as lot sizes and incomes increase the number of cars on the street tends to decrease, except when
someone has many visitors at one time. This occurs even though car ownership also usually increases with income because driveways tend to be built that can accommodate the cars of the resident and one or two visitors.

The behavioural factors include all those factors of a sociological nature which influence the ways in which people use their cars. For example, in socio-economic groups where car ownership or ownership of more than the normal number or quality of cars is rare, there is a tendency to park the rare cars in the most prominent place possible, which is usually on the street in front of the house. At the other end of the scale, where cars may or may not be status symbols, there seems to be a tendency for cars to be parked discreetly out of sight for fear of appearing excessively ostentatious. Most such behavioural factors can be correlated with income and the income of future residents of an area being developed can usually be forecast fairly accurately.

Recreation. The amount and type of playing or other recreational activities accommodated would similarly be based on consideration of needs and desires. In most areas this probably would involve accommodating the needs of children of various ages. For small children, sand boxes and similar suitable facilities might be provided in on-street 'tot lots'. These should be safe if fenced or otherwise protected and supervised by adults for whom benches should be provided. Such facilities seem popular with both mothers and children in the new towns of Sweden. While communal facilities like this are practically unknown here, they might provide an alternative to the much criticized suburban 'coffee klatches' and the opportunity for mothers to be out-of-doors with their children.

\footnote{The Swedish new towns of Vallingby and Farsta were visited by the investigator.}
Probably the greatest need for playing space is for those too old or big to play on single-family residential sites, but not old or big enough to travel to neighbourhood parks which tend to be monopolized by older children. The children in this group like to try playing the group games that older children play, such as baseball and football, for which backyards are too small. They are either not permitted by their parents to go to the parks, or not permitted by older children to play with them on the same park because of their size or inexperience at these games. Consequently, they play on the streets. This is dangerous for them because of vehicular traffic and the presence of parked cars and also subjects the cars to possible damage. For these children, a turfed area of reasonable size would be provided away from intersections and off the road, but clearly visible by approaching drivers.

The needs or desires of other ages and natures of people might also be fulfilled by installing facilities in the street not currently provided. For example, seating areas might be installed for elderly people to get together to chat with their cronies or to watch children playing. The latter would fulfill both their desire to see activity and the children's desire to be seen. While it is granted that people in the Vancouver area generally do not sit out in local streets in single-family residential areas, it may be that this is because no facilities are provided and the environment is inhospitable for such uses. In some areas, special facilities might be installed for certain

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8 One can observe how well used are some benches on streets at transit stops or near parks and where citizens have erected their own crude benches so that they can 'watch the world go by'. Unfortunately, many benches are poorly placed or oriented, and are either not used or require people to turn around to watch the more interesting activities behind the benches. Since some people prefer sitting backwards so they can put their arms on the backs of benches, perhaps the benches should be redesigned or placed in pairs facing opposite directions.
national groups when they would be better provided communally on the street than in back yards. An example is the Italian game of bocce which when played by Italians tends to be somewhat noisy and hence undesirable close to houses whose occupants might not enjoy such noise.9

These needs and desires, and the facilities to fulfill them, would be expressed in terms of the area and any minimum dimensions required for them for the street being designed. These could be considered as goals or standards for the street which it would be desirable to achieve where feasible.

Designing Utility Structures

The designing of utility structures, of course, is a unique aspect of the proposed designing process. The proposed designing practices vary somewhat for the different types of structure because of the differences in factors involved. These types of structures are illustrated and briefly described on the following page. They are discussed below in descending order of difficulty.

The most difficult structure to design is the most highly integrated one - the all-utility trough. This is because the location and depth of its bottom are governed by drainage considerations while its top is governed by pedestrian access consideration, as its cover forms the sidewalk. Since these factors can be in conflict, it would sometimes be necessary to compromise between ideal locations for the drainage and pedestrian access facilities. Such compromises would probably have to favour the drainage facilities in view of the costs involved.

The drainage considerations which apply to the three types of all-utility structures and drains in current practice, are

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9A protest to this effect received considerable publicity in Vancouver newspapers.
<table>
<thead>
<tr>
<th>TYPES OF STRUCTURES</th>
<th>ALL-UTILITY</th>
<th>NON-DRAINAGE</th>
<th>ELECTRICAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>TROUGHS (&quot;lined trenches&quot;)</td>
<td><img src="image1" alt="Diagram" /></td>
<td><img src="image2" alt="Diagram" /></td>
<td><img src="image3" alt="Diagram" /></td>
</tr>
</tbody>
</table>
- open to surface
- utilities completely accessible
- covered by sidewalk
- precast concrete

| TUNNELS | ![Diagram](image4) | ![Diagram](image5) | ![Diagram](image6) |
- underground between manholes
- utilities accessible only at manholes
- precast concrete
NOTE: could also be square or rectangular in cross-section, i.e., duct instead of tube

| TUBED-CONDUITS | ![Diagram](image7) | ![Diagram](image8) | ![Diagram](image9) |
- underground between manholes except electrical tubed-conduit
- utilities accessible only at manholes
- electrical tubed-conduit forms sidewalk, others may also or be under sidewalk
- precast concrete

**Diagram 1. Types of Proposed Utility Structures**
Diagram 3. **Effect of Location on Depth of Drains**

those affecting the depth and consequent costs for various locations within the street. As can be seen from Diagram 3, the shallowest location is on the center line when the property on both sides of the street is at the same elevation, and on the low side when one side is higher than the other. In areas having basementless housing, the depth would be less, providing sufficient cover were maintained above the drains. All-utility structures might be placed on or near the centerline where there is no cross slope, but would be placed towards the low side where there was a cross slope. The trough all-utility structure would be placed as close to these least cost locations as the dictates of the pedestrian access service would allow.

The other all-utility structures - tunnel and tubed conduit - could be placed on them without such restrictions.

A second factor affecting depth of drainage facilities is the relationship of their slope to that of the ground along the street. This involves the complex relationship between the slope of drains and their size, and the flow and velocity of

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10 In current practice, such least cost locations can be used by only one of the two drainage services except for the best practice of installing 'twin' drains. The centerline location is not used for either in municipalities such as Delta and Richmond where street drains are not installed under pavements.
flow in them. Of interest here is that for a given size and
flow, there is a minimum slope to provide sufficient velocity to
keep the drain clear, and a maximum slope that avoids excessive
scouring of the drain. Three general cases, which are illustrated
on Diagram 4 on the following page, are considered. Where the
ground slope is gentle, taken here as between the minimum and
maximum slope for drains, the drain can parallel the ground
slope (see Diagram 4-b). Hence, the drain can be at the minimum
depth for adequate cover or to receive site drains. Where the
ground slope is level or less than the minimum drain slope, the
depth of the drain increases from the minimum depth for adequate
cover or to receive house drains at the upper end (Diagram 4-a).
For these two cases, there is no difference between proposed
and current practice.

There is a difference however, in the third case where the
ground slope exceeds the maximum drain slope. In this case,
depth increases from a minimum at the lower end at a manhole or
intercepting drain towards the upper end. The drain can be
stepped up to the minimum depth at ramp or drop manholes, but
manholes are expensive. Theoretically, on a long straight run,
the spacing of manholes would be reduced from the maximum
(usually 300 feet) to a distance such that savings resulting from
reduced depth of the drain balanced the cost of extra manholes.
In practice however, runs are relatively short between manholes
required at junctions or changes in direction. Hence, it is
often a matter of having one or two manholes between those at
intersecting streets. The extra one is installed only when the
depth otherwise would involve much greater costs, or rock
excavation could be avoided.

In the proposed practice, the utility structure would be
stepped more frequently than drains in current practice because
(a) Level Street

Note: * indicates minimum drain slope
* indicates minimum cover

(b) Gently sloped Street

(c-1) Maximum manhole spacing

(c-2) Manhole added at midpoint

(c-3) Two manholes at third points

(c) Steeply Sloped Street
(i.e. above max. drain slope)

Diagram 4 - Effect of street slope and manhole spacing on depth of drains
manholes or their equivalent would be installed at relatively short intervals for other reasons discussed below. The effect on depth below minimum cover, and hence cost, ignoring that of manholes, is inversely proportionate to the total number of steps. For example, adding one manhole midway between two others to make two steps reduces the maximum depth, the average depth, and the longitudinal sectional area below minimum cover to one half the former values. Similarly, two equidistant additional manholes (three steps) would reduce the values to one-third. These effects on drain depths of additional manholes are illustrated in Diagrams 4-a, -b, and -c.

**Designing Utilities**

The process of designing the facilities of the utility services is the aspect most comparable to the best current practice, allowing for differences due to the existence of the utility structure and in pavement and planting layouts. In the best current practice, a copy of a tentative or preliminary subdivision plat is sent by the municipal planning department to each utility service agency for comments and cost estimates. The functional layouts and physical designs for each service are designed for the subdivision plat mainly by modifying standard layouts and designs to suit the plat. Each agency suggests modifications to the plat, particularly the addition of easements, to meet their requirements. The planning department incorporates these modifications as requirements for final approval of the plat. Problems relating to location of facilities are resolved by a committee of technical representatives of all utility agencies.

In the proposed practice, a tentative or preliminary layout of the utility structure prepared by the municipal planning departments would be sent to the utility agencies. They would design the functional layouts for their services and submit their requirements and suggestions for modifications to the planning
department. After incorporating any modifications considered desirable, the planning department would prepare the physical design of the utility structure on the basis of the requirements. Copies of the design would then be sent to the agencies so that they could prepare detailed designs for their facilities. The technical committees that currently review subdivision plats and settle differences in servicing problems would perform similar functions for the proposed practices.

The functional layouts of the baric facilities would require little designing because they would simply follow the branching pattern of the utility structures. The all-utility structures would have been designed to meet the requirements of the drainage services. Therefore, designing of drainage facilities would be required only for the other types of structures. Thus, special designing of layout would be required mainly for the communicative and electrical services.

The communicative and electric power layouts would be composed mainly of repetitive standard units of several lots with extensions or modifications to fit the situation at hand. These units would be related to those of the utility structure, and based upon careful analysis of the whole range of possible layouts so that they would be practicable and economic as possible. For example, the Virginia Electric and Power Company used computers to determine economic underground wiring layouts for a development having 7,200 living units of which 3,400 are detached residences. A cable-conduit combination was used to simplify replacement of primary and secondary cables, if necessary. The most economic arrangement was found to be a unit

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of 16 lots back to back employing an 'extended services concept'. The latter involved the substitution of individual service cables for a portion of the secondary circuit and associated materials and accessories. This is illustrated on Diagrams 5a and 5b on the following page. Diagrams 5c and 5e show how this sixteen lot unit could be related symmetrically to the four and eight lot utility structure units respectively. Asymmetric layouts are shown in Diagrams 5d and 5f which reduce the length and number of connections of the secondary circuits (by one-quarter and one-half respectively) compared with the symmetric layout.

Designing street lighting however, would be quite different from current practice. It would be done in conjunction with decorative lighting. Therefore, the functional layout would involve a variety of levels and types of illumination to suit the needs of different areas and uses along the street, and provide interest through variety. The wiring layout would involve links from each lamp or group of similar lamps to the nearest transformer via plastic conduit and the utility structure. The wiring outside the structure would be minimized where economic by connecting lamps through the nearest manhole.

The conversion of the functional layouts for the utilities into physical designs should be almost as simple and straightforward as it is in current practice. This is because there would be standard designs for the various parts of the utility structure. Thus, the physical design for a particular street section would be mainly composed of standardized parts, and only

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12 Danforth, op. cit., p. 25; see Table V in Appendix C for results for back-to-back lots., (p. 255).

13 Loc. cit.
Diagram 5: Functional layouts of electric power service facilities

- Transformer
- Primary circuit
- Service
- Utility str.
- Connect. boxes
- Second circuit
- Connection
- Manhole

(a) Virginia Electric 16-lot layout
(b) Virginia Electric Extended Services Layout (*Ext. serv.)
(c) Symmetric 4-lot Layout (left half)
(d) Asymmetrical 4-lot Layout
(e) Symmetrical 8-lot Layout (left half)
(f) Asymmetrical 8-lot Layout
modifications need be shown in special detail. Each utility would have a standard assigned location in the various parts of the utility structures for their main and all related facilities. All of the joints and facilities where connections to site services were made also would be standardized. Facilities such as transformers and large valves which occur periodically would either be alternated so that only one occurred at each connection point, or grouped together in a specially designed part of the utility structure. For example where manholes are involved, many could be essentially large connection boxes, while others were enlarged to accommodate all such periodic facilities. In any case, such facilities as transformers and meters would be designed to take up a minimum of space, yet function efficiently in the utility structures.

Designing Pavements

Designing of pavements for particular sections of a local residential street is straightforward and simple in current practice. Indeed, in the sense employed here, little designing is involved. The alignment, location within the street, width, and details at intersections are all established by design standards. The only decisions involved in completing the plan-view are the location of catch basins, and they are placed according to standards relating to topography. Driveway connections are added where requested by adjacent property owners, except for minor modifications to maintain standards of clearance from facilities such as poles and hydrants. The profile or vertical configuration of the pavements is largely determined by the subdivision. Except for rare instances of substantial regrading to improve road gradients, the designing mainly involves establishing the proper profile at intersections on the basis of standards.
In contrast, the proposed practice would involve custom designing the pavements for each street section in relation to topography and desired street uses. Since the utilities would be confined to a small portion of the street, the road and sidewalk could 'wander' almost from side to side. The wandering should not be aimless, of course, but deliberately planned to meet certain objectives. These include the practical ones of avoiding excessive costs, taking advantage of natural features, and accommodating various street uses efficiently. They also include aesthetic objectives such as creating a varied and interesting environment that is pleasant to be in and move through.

Although all pavements would be considered in designing new streets (or redesigning existing ones), the most important are those for pedestrians and vehicles moving along the street, the connections from these to private walks and drives and to the parking areas, and the parking areas themselves. The pedestrian facility running along or through the street will continue to be referred to as a 'sidewalk' for the sake of simplicity, although it would not always be at the side of the street. The walks from the sidewalk to the private 'front' walks ordinarily are not provided publicly in current practice. They would be provided publicly in the proposed practice because the sidewalk would be a varying distance from the front property line. The connection could form part of the utility structure (e.g. cover of trough) carrying the facilities to the dwellings.

Theoretically, the vehicular access pavement should be custom-designed to accommodate anticipated traffic volumes. In practical application to local streets in a well-designed system of roads, the volumes are usually such that they could be carried

\[14\] The distance varies between municipalities depending upon the standard sidewalk location, but is ordinarily the same within a municipality.
on one lane. If people were prepared to accept a one-way street system in single-family residential districts and the subdivision and street pattern were properly designed for it, only one moving lane would be needed on each street. This would reduce the cost of paving and either free almost fourteen percent of the street for street uses and planting, or make it possible to reduce the width of streets.\textsuperscript{15} However, to maintain comparability with current practice, one moving lane in each direction is assumed to be required ordinarily. The connections to driveways and parking areas would be only one lane or about ten feet wide.

Instead of the current parallel and usually symmetric placement of pavements about the centre line of the street, the functional layout and resultant physical design would be as follows. Where trees, rock, or other natural features worth retaining occurred within the street, only one sidewalk and a road of width adequate for one moving lane in each direction would be installed. The placement would be such as to minimize the damage to the natural attributes of the street. For example, the sidewalk might pass on one side of the feature to be retained and the road on the other. Where a particularly interesting rock formation or tree grouping was to be preserved, the street could not be widened, and traffic was especially light, the road might even be made a single-width two-way lane for a short distance. In other places, one lane of the road might be placed on either side of the feature. The pavements could be placed similarly to one side of the street, or the road on one side and the sidewalk on the other to leave adequate space for playing or other street uses. These ideas are illustrated on Diagram 6 on the following page.

\textsuperscript{15} Based on a two-way road twenty feet wide and one-way eleven feet wide in sixty-six foot wide street.
a) Road and Sidewalk Split Around Feature and Use Area

b) Single Lane Road Section Opposite Feature

c) Road Split Around Feature

d) Sidewalk Only Shifted Around Feature

Diagram 6 - Illustrative Layout of Pavements Near Natural Features
In all of the above-mentioned cases, the vehicular pavement was only for moving vehicles. There would be no provision along these stretches of the allowance for parking of vehicles. Assuming municipalities have the responsibility for providing parking on streets in new single-family residential areas (a debatable point), the proposed practice would differ from the current practice of providing parallel parking along one side, or more usually both sides of the street. The amount of parking would be based on an estimate of the need or demand for it including parking for visitors to the future residents of the area.

Decisions on the functional layout and physical design of parking areas also would involve consideration of several factors. These include the estimated number of spaces required for residents and their visitors, the distances which residents and visitors will walk between parking spaces and dwellings, the direction of approach, whether spaces will be reserved or not, whether parking areas should be screened from view or not, the location of natural features to be retained, desirable locations of other street uses such as playing areas, and costs. The number of parking spaces provided could conceivably range from that requiring all of the space in the street not used for moving vehicles and pedestrians, to a few per block which would allow a high degree of flexibility in their placement. Walking distances would be important if there were a small number of spaces provided at infrequent intervals along the allowance or when parking spaces were reserved for individual residents or their visitors. This would be mainly a problem of arriving at a reasonably equitable balance of walking distance between the parking spaces and individual dwellings.

Reservation or assigning of specific parking spaces to individual residents or their visitors is probably undesirable
because of the problems it would create. Besides probably requiring that more spaces be provided, reservation might be administratively or politically unfeasible because of the difficulty of policing such an arrangement. However, it may be desirable in some places to try to restrict on-street parking to visitors.

The direction of approach might be considered in the detailed functional layout and physical design of the parking areas in the interests of convenience and safety for both habitual users and strangers. For example, where strangers are likely to approach from one direction, the parking areas for their destination might be located past their destination so that they could easily turn into it after location their destination.

The question of screening relatively unattractive parking areas from view is complicated by the desirability of having such parking areas under surveillance for security reasons. An imaginative designer should be able to achieve a compromise in which a parking area can be under surveillance of several houses even though the area is partly screened, but having main views from all houses towards more attractive things such as the natural features that have been retained, or playing areas.

Designing of the other access services is unlikely to involve separate facilities on local streets, but may involve modification of the design of facilities of other services. Equestrian pavements are unlikely to be provided on local streets in single-family residential areas except in peculiar areas such as the Southlands area of Vancouver. Although small non-scheduled buses might be running on local streets to pick up passengers upon call for delivery to the stops of scheduled transit vehicles, these would require no special facilities. Separate pavements would seldom be provided for cycles, but
special ramps might be provided from the sidewalk to the road where the curb had been eliminated. Thus, bicycles and wheel chairs could cross the road from one sidewalk to the other without going over curbs. Similarly, separate pavements are unlikely to be required for emergency vehicles, but provision might have to be made for them to get to otherwise inaccessible portions of the street during emergencies.

**Designing Planting**

Designing of planting is currently limited to decisions on the type or types of boulevard tree to be installed and their spacing along the line established by design standards considering relationship to utilities. In the best current practice the spacing is considered in relation to street lighting and driveway requirements.

The proposed practice would be similar to current practice only in that practically all of the street not covered with pavements would be planted. However, the area would be greater by whatever the amount occupied by the parking use was reduced. More important from a designer's point-of-view is that the areas available for planting would be of varied sizes and shapes. Instead of the current long, narrow strips there would be some fair-sized, roughly rectangular or elliptical open areas for playing, and many triangular or odd-shaped areas around parking or other street use areas.

The planting would be radically different from current practice in several ways. Natural features such as small creeks, rock outcroppings, and individual or groups of trees that

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16 This assumes that the riding of bicycles would be permitted on sidewalks which seems reasonable in present day living conditions where sidewalks are used less than roads, and accidents involving bicycles are rare on sidewalks but more frequent on roads.
could be retained, would be available for incorporation in the design. There would be few restrictions on the type or size of plants that could be installed because the utilities would be safely out of the way. There would be no worry about the branches of trees becoming entangled in overhead wiring, nor about roots getting into sewers, drains, and conduits. Thus some types of trees not fitting the narrow confines of the strip boulevard or not having tidy root systems might be planted. Shrubs would be introduced for screening, defining use areas, and tying the natural features in with the design. Flowering plants could also be introduced to provide a variety of colour and texture. Finally, instead of ubiquitous grass that probably contributes to the current monotonous conformity, there could be a variety of ground covers such as ivy, clover, moss, or other low maintenance types.

All of these factors constitute an opportunity for creative and imaginative landscape design. There would also be a few challenges. The incorporation of natural features into the design is one. Another is the screening of parking areas while permitting surveillance of them. Perhaps the greatest challenge is to create a design that provides interest throughout the year and over the years with a minimum of maintenance. Besides installing mostly plants requiring little maintenance, planting layout should be designed for easy maintenance, provided other considerations are not unduly compromised. For example, grassed areas could be shaped for easy mowing and connected by grass strips requiring an odd number of passes by the mower to avoid back-tracking. Similarly, the detailed physical design should permit easy maintenance. For instance, grass areas might be edged with bricks so that mowers could run on them and leave a neat looking edge without trimming. The matter of maintenance is important because the pride, sense of duty, or social
compulsion which now causes each resident to maintain the boulevard in front of his dwelling would be lacking when there were no obvious area that 'belonged' to each resident. However, the feeling of pride in local environment might be fostered and put to good use by encouraging individuals, groups, or clubs to maintain features such as flower beds and rockeries.

The aim of the designer would be to create a streetscape that was attractive and interesting from the beginning, during the year, and over the years. There should be sensations for senses other than sight such as scented flowers or shrubs, an abundance of textures, and the song of birds. This alone might justify setting aside relatively wild or natural areas. However, there should be some formal areas if only for contrast, and regularly spaced trees on either side of the road would have their place, perhaps a most frequent one in the overall design. For example, 'tunnels' formed of overhanging branches would be most effective when leading to wide open spaces.

**Designing Other Local Residential Street Facilities**

Designing of the facilities of the other services in the proposed practice involves services not provided or considered comprehensively in current practice. The designing of planting has been discussed separately above including consideration of plant care operations, so the gardening services have been covered. This leaves the furnishing, holding, indicative, and keeping services. The designing of facilities for particular local residential streets is discussed first, followed by a discussion of facilities related to the needs of local street residents, but not installed in local streets.

**Furnishing services.** Designing of furnishings for particular local residential streets would relate mainly to furniture and decorative lighting. The furniture would depend
on the type of people living in the area. Where there would be many young children, outdoor 'playpens' or 'tot lots' would be laid out in areas safe from traffic and having interesting views or nearby activities. These 'playpens' would consist of a small area surrounded by a fence containing a sand box and other suitable furniture for the children, and a bench for adults. In districts having an ethnic group that enjoys social recreations requiring special facilities, these could be provided on the street. For example, in districts having Italian residents, bocce courts might be installed in streets instead of backyards where the noise of exuberant players can bother neighbors. Where there would be elderly people, quiet conversation areas could be designed with benches and possibly checker-chess tables.

Furniture and facilities related to the needs of residents on local streets but not usually installed in them would be designed comprehensively on a somewhat larger scale. Instead of the current practice of almost completely independent designing of the functional layout of such facilities, they would be gathered together, integrated in design, and laid out as units serving coincident areas. Such units are herein termed 'servi-centers'. They would be laid out in relation to the functional street system, probably where either long or otherwise important local streets meet collector streets, or where minor collector streets meet a more important one.

There would be little other furniture to design. Most of the cabinets currently necessary for valves, meters, transformers, and such ancilliary facilities would be eliminated because these facilities would be in the utility structures. Thus, the only lids or doors showing would be manhole covers, and they would not require any designing. The few other pieces of furniture

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17 See footnote 9, page 95.
not placed on more important streets such as fire alarm boxes would be laid out at street intersections at fairly regularly spaced intervals. The exception to these generalities would be the fire hydrant.

Designing of finishes, in particular in local streets, would be limited to those of small retaining walls or special pavements in such special use areas as playpens and conversation areas, since most finishes would have been established by standards or other design considerations. A possible exception is the finish of sidewalks formed of trough covers or electrical tubed-conduits. Since these would be precast in manufacturing plants, the opportunity would exist to provide varied patterns or textures involving exposed aggregates, for instance. The pattern or texture could be different for each neighbourhood or local 'cell', so that pedestrians had their own indication of change. Perhaps Junior could be told to "stay on the pink sidewalks!".

The designing of other furnishings would be mainly that for decorative lighting, which would be done in conjunction with the street lighting. There would probably be no decorations and only rare ornaments such as pools, statues, or an occasional 'play sculpture'. Some of the lamps for decorative lighting might be considered as ornaments in designing special use areas, an example being the mushroom-shaped type.

Holding services. Holders would be even more restricted to collector or more important streets than in current practice. However, some letter boxes may be required to maintain convenient walking distances. They would be located at street intersections and laid out in a simple pattern; for instance, every second or third block in both directions.

Holders for garbage might be provided publicly instead of by residents as in current practice. This could be done in two
ways. Enclosures for individual garbage cans could be laid out in lanes or parking areas to serve two or four lot groups. They would prevent dogs from getting at and scattering garbage, and be less disorderly than otherwise. These holders could be similar to the attractive 'trashmaster' with easy-to-open roll-up doors recently introduced. Another way of providing garbage holders publicly would be by setting removable plastic or fiberglass containers into the all-utility structures. These would be laid out for the convenience of residents, possibly in two or four lot groups. The garbage would be deposited in plastic bags supplied publicly in the interest of sanitation and quietness. In the case of the tunnel and tubed-conduit structures, the manholes would provide little space for such purposes, so this idea would only be practicable where houses had incinerators to dispose of everything except tin cans and other incombustible materials.

Indicating services. The proposed practice would aim at having more informative and demarcative, less regulatory, and the same or less advertising indicators in local residential streets than in current practice. Street name and house number signs would be the only informative signs ordinarily provided. The former would be in standard locations at intersections. The latter would be provided on the curb in front of houses and parking spaces if reserved, and on meters and garbage holders. Thus, little designing is involved, assuming the assigning of parking spaces has been dealt with in designing the parking areas. A few other informative signs may be required such as those indicating non-through (i.e. dead-end) streets, sections of one-way road, or playing areas ahead. Preferably these would involve symbols rather than words when required. However, an attempt would be made to obviate their need by careful design of the

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street system, road, and planting to make such situations obvious.

Regulatory signs would similarly be avoided as much as possible, or have informative or demarcative indicators in their place. The fact that parking would not be permitted on the road should be made obvious by its design and that of the parking areas. A 'yield' sign might be required on one side of a one-way road section.

The only demarcative indicators in local streets would be center line and parking space markings, and warning markings or signals where the road divides around a natural feature. The only advertising permitted, other than facility manufacturer's names, would be those for the sale of property.

**Keeping services.** Requirements and limitations of equipment of the keeping service would have been considered in the designing of the facilities of the other services, particularly roads and parking spaces. The roads could be efficiently swept and plowed because of the presence of curbs, absence of parked cars, and a minimum number of curb openings. The latter would not be filled by snow plows because a controllable gate designed by the National Research Council would be fitted to the discharge end of the blade.19 Cars parked in the parking areas would be neither partially buried by plows, nor sprayed with sand or salt. They would also be partially protected from storms by the surrounding screen of trees and shrubs. Streets could be kept clean and tidy by a machine such as the heavy duty 'Litter-Vac' that picks up:

III. DESIGNING STREET USE AND SERVICEMENT OF INTERSECTIONS

Designing the street use and servicement of intersections is discussed separately here because it would be essentially different from that of local streets between intersections. Instead of striving for variety and individuality, the aim would be to achieve consistency and uniformity for intersections of the same type. This would be done by having standard designs for each type to which only minor modifications would be required to meet all conditions. Thus, designing intersections for a particular district would be simply a matter of deciding upon the type, and hence, standard of each intersection.

Intersections are designed by application of standard designs in current practice, but the proposed practice differs in several important respects. The proposed standards would embody a greater area, number of types of intersections, distinction between types, and range of services involved. Intersection standards currently usually involve only the area of intersection or 'overlap' of streets defined by projecting property lines. The proposed standards would include the portion of street 'legs' whose design is affected by the intersection. Instead of a 'typical' standard for a local, major, and (sometimes) collector street intersections, there would be a standard for each possible combination. Of concern here are those involving local streets which intersect with other local, collector, and arterial streets. Each can either have three or four 'legs' - that is, be a 'T' or cross intersection. There would also be standard designs for such special situations as culs-de-sac, bends, and for cross intersections being converted

to two bends to modify a grid to create a functional street system.

Distinction between types of intersections would be greater than in current practice primarily because of deliberate differentiation between local, collector, and major streets. The aim would be to remove any doubt about which street had priority over the other, or whether they were equal in terms of users of them having the right-of-way. All visible facilities would be considered in an attempt to create sufficient differentiation between such dominant elements as pavements, planting, and lighting, that regulatory signs would be unnecessary. To keep the focus on local streets, it has been assumed that there is sufficient differentiation between local and arterial streets since the latter are usually wider and have more traffic lanes, brighter lighting from different types of lamps, and different planting. Unfortunately, the latter often means lack of planting. It is further assumed that three-legged intersections are not a problem in that the priority is obviously with the bar rather than the stem of the 'T', and that designs for them would be essentially modifications of comparable four-legged or cross intersections. Thus the main problem is one of differentiating between local and collector streets, while maintaining sufficient differentiation between the latter and arterial streets. However, some differentiation between two crossing similar streets might be desirable since intersections with no priority differences are accident prone.

Collector streets could be differentiated from local ones in several ways. Their pavements should be wider for fairly rapid movement compared to that desired on local streets. The center line markings could be solid in contrast to dashed ones on local streets. The collector street might have trees evenly spaced for some distance back from the intersection, while the local street has no trees near the intersection. Lighting on
the collector might be brighter, and involve taller, regularly spaced lamps near the intersection, whereas those on the local street were kept back. Thus, the lighting and prominent planting at the intersection would be that of the priority street, making it obvious on approach. Finally, all other visible facilities would be comprehensively designed to reinforce the distinction.

The other visible facilities ordinarily are installed at intersections in current practice, but are not usually designed in relationship to one another. They tend to congregate on collector street intersections, especially around transit stops, but in a haphazard fashion. In the proposed practice, intersections of two local streets would have only those facilities required at all or almost all intersections. These include fire hydrants, street name signs, and street lights. Other facilities would be gathered together at intersections with collector streets to reinforce the appearance of priority, while providing a common and known location for all of them. These facilities would have a highly integrated design in terms of the facilities themselves, and their relationship with others in the street. Possible designs for intersections of local streets with other local and collector streets are discussed separately below.

Intersections of two local streets would have a fire hydrant on one corner and street name signs and lamps on diagonally opposite corners. These locations would be standardized as much as possible (see Diagram 7 on the following page). They may occasionally have a fire alarm box. The road would be only two moving lanes wide even where parallel parking was provided further back on a street, so that turning movements must be made slowly and carefully and pedestrians cross a minimum width of road. However, the curb returns or the curb from one street to the other around the corner would be related to the path of a turning vehicle instead of a simple quarter circle.
PROPOSED PRACTICE

Diagram 7 - Facilities at the intersection of two local streets
The sidewalk would have a ramp down to the road for baby carriages, cycles, and wheelchairs. Although the sidewalk itself could be ramped down, it is probably better to have a separate ramp. Pedestrians might not like ramps because of their slope and slipperyness when wet or icy. Also, children on bicycles would be tempted to dash straight across. The offset ramp might be so arranged that the inside wheels of fire department ladder trucks and large moving vans could 'cut the corner' over them.

On the assumption that non-signalized intersections should always have streets of non-equal priorities, the following modifications might be made to this standard (see Diagram 8). The centerline of the priority street could be carried through the intersection while that on the other street is cut off by a line at the sidewalk. The lamps could be set back slightly along the priority street and tie in visually with a few others. The trees could be similarly designed.

Before discussing the other types of intersections, it may be well to put them in a frame work to show their relationships. Diagram 9 on page 123 shows a section of a typical grid subdivision which is to be serviced or 'reserviced' by redesigning and upgrading its facilities. The above assumption of non-equal priorities is made instead of the more drastic one that streets must be cut off by various means to make them non-continuous. The bounding streets are assumed to be part of a system at quarter-mile spacing as is often the case. In such a situation, the east-west streets on which the lots front would have priority everywhere except at the 'major' collectors' A and D. These would be given priority to compensate for the otherwise more difficult travel in the north-south directions. Thus, there are three remaining types of intersection: local streets with minor and major collectors, and minor with major collectors.
PROPOSED PRACTICE

DIAGRAM 8 - PROPOSED DESIGN OF INTERSECTIONS OF TWO LOCAL STREETS
DIAGRAM 9 - COMPARISON OF PAVEMENT DESIGNS OF CURRENT AND PROPOSED PRACTICES IN TYPICAL GRID SUBDIVISION
The local collector intersections may not require any more differentiation between the streets than that already discussed. Where other measures are deemed necessary the following could be tried: a line or coloured section of pavement on the local street at the collector. If it proves to be necessary, 'yield' signs could be placed on the local streets at minor collectors, and 'stop' signs at the major collectors. One of the major collectors would be a transit route and require pullouts for buses, a 'bus stop' sign, and a box for the morning newspaper at inbound stops (those for evening papers being downtown). The alternate street 'far side' layout preferred by the transit company for bus pullouts is shown for 'D' street on Diagram 9. For a given resident on an east-west street, either the inbound or outbound stop is on his street, and the other is only one street away along the major collector. The far-side stop past an intersection is safer for pedestrians because they must cross behind the bus where they can see and be seen by approaching motorists.

Although the main concern in this investigation is with local streets, the intersection of two collectors is considered briefly here to suggest possible ways of dealing with the facilities that would not be provided in local streets in the proposed practice, but are required to serve residential districts. In current practice, the only facility that is ordinarily located at intersections of collectors is a letter box, due to the post office's dual concern with convenience to those served and for collection. For similar reasons, parcel and mail boxes are located at intersections of collectors, but less frequently. For the proposed practice, it is suggested that all intersections of collectors have letter, newspaper, and litter holders, and a fire alarm. They may also have some provision for advertising local events. At every other intersection, there would also be a parcel holder and telephone and possibly vending machines for
cigarettes and similar 'convenience' items. Mail boxes might be located at these intersections or the alternative 'minor' ones lacking the bulky parcel holder. In either case the postal facilities would be together for the convenience of mail truck drivers and letter carriers. For example, the latter often have to readdress and remail letters, and could do this upon picking up a bundle from the mail holder, or at the end of a route ending at a collector intersection. The intersections with the telephone, parcel box, and vending machines would be at a half-mile spacing in each direction, and on diagonally opposite corners such as A-5 and D-1 on Diagram 9.

Diagram 10 shows a suggested layout for these intersections of collectors based upon the assumption that the facilities should be designed primarily for the convenience of motorists. One reason for this assumption is that the increase in use of cars to mail letters and pick up a package of cigarettes seems to have paralleled the growth of automobile ownership. This suggests that people will use cars for such purposes if they have them, and that this use will increase with anticipated increases in automobile ownership. The other reason for the assumption is that designing facilities for convenient use by motorists could make the streets more convenient and safe for other street users. For instance, mail trucks and cars parked beside postal facilities force following cars to wait or swing out into the oncoming lane and block the view of pedestrians crossing in front of them. The motorists stopping to mail letters or buy newspapers often endanger their own safety by opening their car door and stepping out without looking. The safety and convenience of pedestrians is not ignored, however. Indeed the suggested layout should be considerably better for them in these respects. They would only have to cross one vehicular traffic lane at a time in crossing the intersection or going to the service
Ramps for wheelchairs and cycles

Yield signs: Pedestrian Vehicular

Note: Minor collector offset above; Major collector aligned at left

Bus stop pull-out bay

Parallel parking Strip

DIAGRAM 10 - 'SERVI-CENTER' AT INTERSECTION OF COLLECTOR STREETS
facilities, all of which would be partially sheltered on the island 'servi-center'.

The suggested layout would probably only be applicable to intersections of two lane collectors in 66 foot wide streets, or intersections of a two lane with a four lane collector when the latter was in a wider street at the intersection. In any case, widening either or both streets near the intersection would allow more generous curvatures and space between pavements for planting. Providing the streets are truly collectors and not carrying long distance through trips that ought to be on arterial streets or freeways, the vehicular traffic flow should be such as to cause little inconvenience in terms of delay. On the major collector, the through and right turn movements would have priority over other movements including pedestrians. Those making left turns would wait for opposing traffic if necessary, without blocking following traffic by turning into the median space. Traffic on the minor collector would only have to stop to yield to the priority of traffic on the major collector when there was any. The through and left turns could be made with less delay than currently on some collectors because openings or breaks are required in the flows on the major collector in only one direction at a time instead of both, by crossing into the median.

21 The term 'servi-center' refers to the integrated installation of such service facilities as letter, parcel and newspaper boxes and telephones in the center of collector street intersections.

22 The total distance would be equal for pedestrians arriving from all eight directions (each side of the four street legs) and equivalent to crossing one street. At present, to reach a facility installed on a corner, pedestrians from two directions cross no streets, those from four cross one, and those from two directions cross two streets. Thus, it would be 'averaged out' for everyone.
One situation that could block a street would arise when either both spaces beside the 'servi-center' were occupied and another driver was waiting to enter, or when one was occupied and a driver of a waiting car felt he could not make a U-turn into the other space because of his car's maneuverability or traffic conditions. Such a situation would likely be infrequent and short-lived, and would probably be remedied by the waiting driver going to another servi-center. Vehicles such as fire trucks and long moving vans might make left turns through the right turn lane short of the servi-center.

Designs for the servi-center are shown on Diagram 11 merely to suggest the possibilities that would exist. The actual design could be made the subject of a competition amongst architects and industrial designers. The facilities should be so designed that they can be easily used from cars including low-slung sports models. For instance, the telephone probably should be the type with the dialing mechanism in the handpiece which is on an extension cord.

Probably the most difficult problem in this respect is designing devices to collect money for services rendered. Ideally, there would be a single device that made change, collected for all services, recorded each transaction separately and warned of tampering. Change making devices are becoming common in vending machines, and ones that can make change for (American) dollar bills were a feature of the Seattle World's Fair. These devices could remove one problem people have in using public services. Indeed, money changing might become a public service in itself. For instances, people might go to servi-centers to get change for bus fares or parking meters. The latter would be especially important in downtown areas where the servi-center could be located on the left side of one-way streets. The changers should at least partially recirculate money received by
DIAGRAM 11 - SUGGESTED DESIGN OF 'SERVI-CENTER'

- coin slots
- change maker
- glass or plastic window
- Telephone and/or fire alarm
- Advertising
- Access door
- curb
giving it out in change to reduce the total held in them, thus reducing the frequency of collection and temptation to pilfer from them. For example, soft drink vending machines give out nickels received, as change for quarters.

Ordinary vending machines do not record transactions because the consumption of a given commodity or brand is obvious by what is left. Machines have been recently introduced in parts of the United States as automated local post offices and grocery stores that accept money, debit the price of items selected, and return the remaining credit as change. Similar operations could be performed by a relatively simple mechanism in each of the major servi-centers controlled by a centrally located computer linked by telephone cable.

The pilferage problem could be lessened by designing stronger money holders than currently installed by the telephone and newspaper companies. When tampered with, the changing mechanism might trigger alarms or cameras, or both. Since the 'get-away setup' would be favourable for theft, alarms are probably of little avail. Cameras could record the appearance of the person or car involved. For recording licence plate numbers, a camera might be mounted in the median island facing the front of one car and the back of another. They would have to be theft-proof themselves, and remain unobstructed. This might require an electric eye that sounded an alarm whenever blocked for more than a few seconds. Alarm systems might also be installed to be triggered by interruptions in power or telephone services. Such measures are expensive, and it would probably be better to have strong money holders with little in them.

To be practicable, the money changing and recording

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Statement by Mr. Dale Johnson, Dale Distributors (B.C.) Ltd., in telephone interview.
devices should cater to as many services and replace as many facilities as possible. It could replace the coin acceptance devices and holders of the telephone, newspaper and postage stamp services; the latter a new service in residential districts. It could also replace the coin mechanisms in a vending machine for cigarettes, matches, and possibly other 'convenience' items. The vending machine could be installed publicly and leased to private firms to supply and service it, or such firms could install the vending machine and coin mechanism at less or no rent. Either way, the public would be better served than currently.

IV. DESIGNING THE SUBDIVISION

The preceding description and discussion of the proposed process of designing local residential street use and servicement was based on the assumption that the subdivision existed. However full benefit from the proposed street use and servicing practices could only be derived when the designing of the subdivision was an integral part of the process. The proposed process of designing a subdivision will be described by first summarizing the best current practice, and then describing differences in the proposed practice.

The process of designing a subdivision for a fairly large area in the best current practice involves surveying the general topography by aerial photography, reconnoitering by the designers to get the 'feel' of the site, designing preliminary plats, checking the same on the ground, revising on the basis of this check incorporation of easement for utilities, and preparation of the final plat. The checking and revising steps may be repeated several times when difficult terrain or meticulous designers are involved. The factors taken into consideration include:
1. Natural features such as ravines, steep slopes and rock formations that are worth preserving for their aesthetic or recreational value, or because of the costs or loss of safety that might be involved due to the drainage and soil stability problems created by their removal.

2. Relatively level areas suitable for economic and safe (i.e. stable) construction of playing fields.

3. Areas having desirable views of either the panoramic type, of which the best are from the top of steep banks, or those with close views of ravines or park areas for prime dwelling sites.

4. Areas or features such as rock outcroppings likely to cause excessive servicing costs.

5. Areas which appear to require special investigation of soil drainage, or other conditions such as marshy areas.

6. Slopes of possible road alignments within acceptable ranges (including minimums) for the various classifications of roads involved.

7. The need for lanes, right-of-ways, or easements for utilities and the alignment of them.

8. Design standards for the subdivision plat (size and shape of lots; width of road and lane allowances; width of right-of-ways and easements) and for the roads and lanes (grades, angle of intersection, type of intersections) established by the Provincial Government or municipality.

9. The quality of development that is wanted in the area. This influences the size of lots required and need for lanes since they can be eliminated in some instances when lots are wide enough to have driveways.

10. Desirable attributes of a functional street system including a systematic hierarchy of street types, minimum number of intersections avoidance of cross intersection of local streets and minimum lengths of straight runs on local streets. These influence layout and size of streets.
No attempt need be made here to describe the processes by which designers consider these factors. They are somewhat subjective, and at best highly creative.

The proposed process of designing subdivisions would give greater attention to certain of the above listed considerations, and would add some sociological and behavioural ones. Much more consideration would be given to natural features in and near potential streets. Besides the minor topographic features and rock formations, interesting individual and groups of trees would be considered for possible incorporation in the design of the street. Since the boundaries of the street would not be fixed at this stage, the possibilities of avoiding problems and taking advantage of opportunities would be greater than if the subdivision existed. For example, the alignments of the road and utility structures could deviate even more from the center line of the tentative street to avoid rock formations or improve grades. Attractive trees would be avoided to save them for incorporation in the planting design. Only when a satisfactory compromise between alignments for the pavements and utility structures, preservation of natural features, and reservation of space for street uses had been achieved, would the street boundaries be established.

The street boundaries would differ radically from the current practice - they would no longer always be parallel. Where there were natural features or areas wanted for special uses the street would be wide - where there were not, it might be narrow. It would also be widened or 'flared out' at intersections of two collector streets to allow for more generous curvatures and spaces around servi-centers. These variations in street width would affect the depth of abutting sites, of course, if their rear property line paralleled the centerline of the street. However, the streets on either side could be
either shifted slightly or narrowed and the rear property line 'averaged' to maintain reasonably comparable depths. Assuming the practice of establishing building setbacks were maintained, this variation in street width would tend to produce naturally the variation in setbacks of houses that architects and planners desire but seldom achieve.

The sociological considerations are the relationships between the physical environment and social phenomena. Little is known about these relationships, or about the effects of changes the environment has on these phenomena. There is a great need to increase our knowledge in this sphere. In the meantime, what knowledge is available should be put to use. For example, one study found that in a lower income working class area where friendships with neighbours seemed important, the pattern and number of friendships formed were adversely affected by several aspects of the subdivision design. These are unusual horizontal or vertical separation between facing houses, absence of a lane along the rear of the lots, and presence of a lane at the side of lots.24

Behavioural characteristics that ought to be considered in subdivision design are similarly lacking in fundamental research. There are some, however, either well known or easily obtainable from observation and experience. One example is the tendency of people to park on the side of the street nearest their home or other destination. Since vehicles must park on the right hand side of two-way streets in British Columbia, people often make somewhat indirect approaches to their destination. Failure to consider this tendency could result in people considering inconvenient a street system that has a perfect 'branching' pattern.

V. FUTURE SERVICES

The proposed practices would take into consideration the possibility that new services would be provided to property, or that existing services might become utilities. This has been the historical tendency in the process of evolution of services to to-day's situation, and there is no reason to assume that it will not continue. It is difficult to predict what will happen, but worthwhile speculating on the possibilities, and perhaps making some provision for the more promising ones.

Changes occur in services when it becomes more efficient or economical to do something communally, or this becomes necessary in the interests of health and safety. These considerations are related to density of development in that the need for communal services increases with density, while becoming more efficient and economic. For instance, rural areas may be served only by roads, or also by drainage ditches, electricity, and telephone. They can be considered to become suburban when served by water pipes in place of wells and usually septic tanks instead of outhouses or toilets connected to rock pits. Urban areas require sewerage service in place of septic tanks. Other services may become necessary or economically feasible as either density increases further or the extent of a given density spreads. As far as local residential streets are concerned, these would be mainly communicative services such as cable-TV and fire alarm systems.

Changes in services to property also occur as a result of technological innovations or sociological and economic revolutions, especially in those involving delivery or collection. For example, ice delivery service was eliminated by refrigerators. Coal, wood, and sawdust fuel delivery services have almost been replaced by fuel oil and natural gas. Milk, bread, fruit and vegetable delivery services may soon disappear since they seem
to be caught in a vicious spiral of having to reduce the quality of service, especially in frequency, which causes loss of customers and a further need for quality reductions. The postal service is relatively immune to such forces.

The question for the future is whether such communal services will be merely abandoned or replaced by a utility service as the natural gas utility replaced other fuel delivery services. Somewhat facetious suggestions have been made to this investigator that it would be nice to have beer 'on tap' by having it 'piped in'. There are two main problems that make beer or milk pipe systems unlikely. One is that of ensuring purity and freshness. This might be possible to overcome but only at tremendous expense. The other problem is that of providing a selection of brands or grades. Also, such systems would only supply single commodities, unlike the variety provided by the 'milkman'.

A more promising possibility is a utility service that could deliver and collect capsules containing almost anything that would fit into them. Such a service could deliver not only dairy products, bread, beer and mail; but also drugs and perhaps groceries. It could collect not only empty capsules and mail, but also unburnable refuse such as tin cans if everyone had incinerators, or possibly all types of household garbage not handled by sink disposal units. The capsules for certain commodities, particularly the liquids such as milk and beer, might be specially designed and used as the containers and be re-usable. Other capsules could be general purpose ones.

The facility carrying the capsules might be some type of enclosed conveyor system, but a baric or pressure system seems more promising. This might be a pneumatic system similar to those in some office buildings or department stores. However, there would be serious switching problems with the number of destinations or 'stations' involved. The capsules might also
be transported through pipes carrying liquids as is being considered on a larger scale for bulk cargoes of coal and wheat.\footnote{Frank Dolphin, "Pipeline'Trains' No Longer Dream", \textit{Financial Post}, 30 March 1963, p. 3.}

An interesting possibility is that of modifying normal baric services for a dual purpose. The gas service is considered unsuitable because it would be outside the proposed utility structures, subject commodities to possible contamination, and present operating difficulties. The latter would arise not only in switching, but also in that pressure differentials adequate to move capsules would be incompatible with the requirements of gas service. On the other hand, the water service seems promising, provided that the capsules were automatically sterilized at inlets and the pipe system could be redesigned to carry them. Although it may be possible to devise a one pipe system, a two pipe system would probably be simpler. This might be an advantage in areas where potable water is expensive because one pipe could carry potable water for drinking and cooking while the other carried slightly brackish or saline water suitable for flushing toilets, watering lawns, and filling swimming pools when treated with chlorine. Another possibility would be to distill necessary potable water in each dwelling, perhaps in the same unit as the capsule sterilizer.

The designing of a system to deliver and collect capsules to single-family residences is beyond the scope of this investigation. There are many problems to be solved, particularly in switching given capsules to given destinations instead of merely carrying a few staples that are constantly circulating until removed by pushing a selector button. However, switching and detecting devices are constantly being improved. For example, railway boxcar numbers can now be detected from patterns of radioactive buttons while the car is moving. It must be
assumed that technological progress will continue, and that
what one man conceives, another will someday do.

Looking further into the future, Marvin Camras, the
inventor of the magnetic recorder, foresees more startling
possibilities. He suggests that

... goods consumed daily such as foods, drugs, and
fuel will be piped into each home in elementary form
of fluid or suspension. Memory packs will control
complex electro-chemical-mechanical processing
equipment that will convert or separate the piped
materials into the desired products.26

The memory packs would hold information on products in the
market, entertainment, education, telephone numbers, receipts,
income tax and other personal data constantly being updated via
the telephone, and viewable on a viewing console.27

The point of interest here is that future utility systems
would be more feasible to install in utility structures than
otherwise, and that consideration should be given to reserving
space for them.

VI. SUMMARY OF PROPOSED DESIGNING PRACTICES

The proposed process of designing the street use and
servicement of local residential streets has been described and
discussed above in relation to current practice. It differs
from current practice in two main ways. It would be more compre-
hensive in terms of the number of factors considered in each
design, especially sociological and behavioural ones. Secondly,
it would be more intimately related to the needs, problems, and

27 Loc. cit.
possibilities of each particular street section, especially relating to such natural features as rock outcroppings and attractive trees.

On the assumption that the subdivision plat existed, six main aspects of the proposed designing process were examined with these results. Designing of street uses would involve uses other than parking such as playing and other recreation, and relating all of them to the needs and desires of various age groups. Designing of utility structures would be unique. It would vary for different types of structures, being most complicated for the all-utility trough because of its high degree of integration and need to compromise between drainage and pedestrian requirements. Designing of utilities would be most comparable to current practice, allowing for differences due to the utility structure. It would be mainly a matter of modifying standard designs to fit particular situations. Pavements and planting would be custom designed to accommodate special use areas and take advantage of natural features; in the former's case by passing to one or both sides of them. Designing of other property service facilities would be limited to the few that would be installed in local residential streets; most would be located at intersections. Designing of intersections was considered separately to show how these facilities would be dealt with, including description of 'servi-centers' for intersections of collector streets.

The assumption was then made that the subdivision plat did not exist to describe how the designing of subdivision plats would be made an integral part of the whole process. This would involve greater attention to natural features and sociological and behavioural considerations.

Finally, the possibilities of future service that could be installed in utility structures has been considered.
The next chapter discusses the process of installing property service facilities in local residential streets.
CHAPTER IV

PROPOSED INSTALLING PRACTICES

A DESCRIPTION OF THE PROPOSED PROCESS OF INSTALLING PROPERTY SERVICE FACILITIES FOR LOCAL RESIDENTIAL STREET USE AND SERVICEMENT

The proposed practices of installing property service facilities for local street use and servicement are described and discussed in this chapter in a fashion similar to that for the proposed designing process in the preceding chapter. That is, the process is briefly described generally and then in more detail by major aspects. As before, these aspects are the utility structures, utilities, pavements, planting, and other facilities. This time, however, the proposed practice of installing a subdivision plat will be discussed first. This is its logical position in the complete process of developing an area, and it is unnecessary here to distinguish between existing and proposed subdivision plats. This is because it is assumed that existing subdivisions would often have to be newly established on the ground. The reason for this is that even where subdivision had been completely established on the ground, many of the survey posts have shifted or disappeared. Furthermore, the proposed practices apply almost as well to ordinary subdivision plats as to the proposed designs. An aspect not requiring designing - preparation of the street for servicing - is introduced after the discussion of the process of installing subdivision plats.

The proposed process of installing subdivision and property service facilities is similar to the best current practice in general terms of staging and operations involved. Utilities would be installed before pavements, pavements before

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1The term 'servicement' means the condition or state existing when services have been installed. See page 19. for definition.
planting and planting before other facilities so that damage to installed facilities while installing others would be minimized. Operations such as excavating and backfilling would be carried out in a similar fashion, though not for the same facilities. Operations for laying facilities would be basically similar, but may be simplified or complicated somewhat by different circumstances. The different circumstances arise mainly because of the presence of the utility structures. Their installation, of course, is the most fundamental difference between the proposed and current practice. The differences from current practice are described and discussed more fully in the following sections.

I. PROPOSED PROCESS OF INSTALLING SUBDIVISION PLATS

The proposed process of installing new subdivision plats, or re-installing old ones, would differ substantially from the best current practice only in the way surveying operations were carried out. Administrative processing and registering of the plat would be the same, or would not be involved in the case of old subdivisions. The basic difference would be the care taken in performing the surveying operations to preserve natural features worth retaining, especially trees. Currently no such care is taken nor need be, because streets are later cleared completely, as are often the sites as well. Sight lines are cleared of all growth wherever convenient for efficient surveying. Rock outcroppings are scaled and marked to establish reference points of varying degrees of permanency. Many disappear when the rock is later removed, just as the cuts through the trees for sight lines disappear when more trees are cleared, so they are currently of little concern.

When it is desired to preserve natural features however, these practices become a matter of concern. Unfortunately, it
is as easy to cut down attractive trees as others, and size matters little with to-day's power saws. The most prominent parts of rock outcroppings are often the most attractive and also most suitable for survey marks. The damage occurs during two surveying operations. The first is that undertaken to determine the detailed topography along potential street alignments. A sight line is cleared along the centerline of the potential street and measurements are taken at regular intervals and changes in slopes to determine the profile of the centerline. Measurements are also taken on lines perpendicular to the centerline to determine the cross-section of the street. Features such as creeks and rock likely to affect the design of the street or road are accurately located. It is during this operation that rock outcroppings are marked with relatively permanent and easily locatable reference points for other surveying work later. The other surveying operation of concern is that of 'staking out' the subdivision plat. This is the operation that actually 'installs' the plat on the ground. It involves more clearing to get sight lines to the corners of every lot. The most efficient way might be down the property lines bounding the street.

In the proposed practice, such damage would be minimized by either training the survey crews to do so, or supervising them to ensure it. Clearing for the survey of detailed topography would follow the tentative road alignment, but would not include trees worth preserving or growth on previously unknown rock formations. These would be carefully surveyed to establish their location and size so that the road could be diverted around them and they could be incorporated in the planting design. Even when the road could not be diverted to preserve especially attractive trees, they should be preserved for moving to other locations. Techniques would be worked out for establishing
reference points on rock outcroppings without defacing them. For example, bench marks might be set on top or back from the face with temporary indicators above them for surveying purposes. Probably the best way of preserving natural features would be for a design-oriented person to accompany the clearing crew to mark features for preservation and make on-site adjustments in the survey reference line.

The proposed practice of staking out the subdivision plat would involve a minimum of clearing and avoidance of trees worth preserving. This could be done by working from the previously established reference line to which trees marked for preservation and the plat design would have been related. Trees on property lines would be preserved by surveying around them instead of 'over their dead bodies'. Rear property markers could be established from a clearing for the lane. Otherwise, the side property lines would be projected back from the front corners. Where there were good trees, a marker might be set short of the rear corner which would be referenced from set marker. Thus, a screen of trees along the rear of lots could be left intact.

II. PROPOSED PROCESS OF PREPARING STREETS FOR SERVICING

The first few general stages of the proposed servicing practices - those preparing the street for servicing - are similar to current practice in terms of the operations involved. These stages are clearing, culverting, rough and fine grading, and installing a road bed. The same operations and machines would be involved for the same purposes, but the extent and resultant costs of these operations would differ considerably. The whole street would not be cleared and graded as is usually required in current practice. Instead it would be cleared and graded only to the extent required for pavements and such street uses as fair sized playing areas.
The clearing process would be confined to the area assigned for pavements and open playing areas except for the removal of specially marked trees that are unwanted and would be dangerous or difficult to remove later. The remainder of the street would be improved later by selective removal of trees and underbrush as part of the process of installing the gardening service. In the areas being cleared, all growth would be removed including roots. Soil suitable for planting purposes would be stock-piled on areas not requiring grading for later use in areas to be planted, instead of being sold as is often the case currently. Unsuitable organic or other material would be removed as at present.

Culverts would be installed prior to or during the rough grading operation on water courses crossing the road as in current practice, but would be large enough for at least boys to crawl through safely. Where the drainage utilities would permit, culverts large enough for adults might be installed, especially where the watercourse was made a park strip with a walk through it. The culvert could have stepping stones or ledges for dry passage in all but heavy storm conditions.

The rough grading operations would be confined to the same areas, but would concentrate on cutting and filling to establish the designed road grade. The fine-grading operations would finish this job and the grading of playing areas, and then tie them into the natural grades according to the design. In relatively rugged terrain, connections to driveways would also be graded to designed alignments and gradients. Installing the roadbed would consist as currently of rolling or tamping the road grade to form a firm foundation for the road, and placing sand or gravel where necessary to permit use of the roadbed by equipment involved in servicing or constructing dwellings.
The proposed process of preparing streets for servicing thus differs from current practice mainly in terms of the areas involved. This affects costs directly, and also indirectly in that smaller volumes would be involved in the grading operations. Diagram 12. shows how the cross-sectional area decreases for a narrower graded area.

Current Practice

Proposed Practice

Diagram 12. Comparison of Cross-sectional Areas Involved in Grading

The total area of cut and fill in the longitudinal section would also be reduced because the road could be more closely fitted to the topography. These two factors would combine to produce substantial reductions in volume of earth moved. There would also be savings due to the decreased width and area of the road-bed for such items as culverts and sand or gravel. On the other hand, there may be somewhat higher unit costs for some operations because of difficulty of maneuvering equipment in small areas. Substantial saving could be realized in rock areas because the design would minimize the amount to be removed. The proposed practices could yield substantial benefits for property owners where there was a steep cross-slope. Driveway gradients could be lowered because of the greater distance to the road when perpendicular (as illustrated by the dotted line on Diagram 12.) or slanting across the site and part of the street. Furthermore, the need for and the cost of retaining walls would be largely eliminated if regrading were kept 'within the street.'
III. PROPOSED PROCESS OF INSTALLING UTILITY STRUCTURES

The proposed practice differs considerably from current practice in that utility structures would be installed, but the processes of installing most of them are generally comparable to current processes of installing certain facilities, particularly those of the drainage services. As for the latter, the three main operations in installing the structures are excavating, installing the structure, and backfilling. Excavating and backfilling techniques for all utility structures could be the same as for installing drains or multi-tubed conduits of comparable size, which may be larger than those ordinarily found in local residential streets. The techniques of installing the tunnel and tubed-conduits could also be the same as for drains and multi-tubed conduits of comparable size. Thus the main differences are in the techniques of installing troughs, especially the all-utility type. However, there are certain other techniques for the tunnel and tubed-conduit structures not currently employed in Metropolitan Vancouver that would be employed where found to be feasible. For instance, several methods involving precasting or extrusion have been considered. Also there is the possibility of installing non-drainage and electrical structures over drains. These different techniques are described and discussed below in Appendix B (see page 243.).

IV. PROPOSED PROCESS OF INSTALLING UTILITIES

The proposed process of installing the facilities of the utility services would differ from current practices mainly in that there would be no excavation or backfilling required for any facilities installed in utility structures. The laying and joining techniques would be generally the same in some cases,

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2See Diagram 1., page 27, for summary of types of utility structures.
but quite different in others. Street lamps and their supports, though not the wiring to them, would be installed as in current practice regardless of the type of utility structure. Other similarities and differences are described below, first for the various types of structures, and then for manholes.

**All-utility trough.** Utilities could be installed in the all-utility trough in almost any order or weather conditions; the latter because the trough could be covered easily and would be deep enough to work in. A transparent or translucent cover would make lighting less necessary. Where the bottom of the trough were not shaped to form drainage channels, drains would be simply laid on the bottom and held against the wall by wedges. Pipes might be laid between them, possibly raised on special concrete blocks, but probably should be installed part way up the wall. Where there were no diaphrags with special cutouts, this could be done by means of attachments to brackets cast in the wall during its construction (perhaps those installed for form work) or attached by 'shooting' in fastening devices. Brackets for wires and cables would be similarly installed or hung from the top of the trough wall. Wires and cables would then by simply strung from bracket to bracket in a similar fashion to overhead wiring. Since the manholes would be fairly closely spaced, brackets might be required only at manholes.

**All-utility tunnel.** Utilities would have to be installed in the all-utility tunnel in a definite order. The storm drain would be first because of its large size, and the sewer next because both should be at the bottom. Dividers would then be inserted, if they had not been placed during construction of the utility structure. These would be thin, flat or slightly curved sheets of a material such as asbestos cement, but preferably something cheaper so long as it were non-perishable.
They would support the other utilities, though not necessarily continuously. Pipes would be installed next against the wall. The drains and pipes would be installed by inserting sections into the tunnel at a manhole, joining a section to it, and pushing them into the tunnel. This procedure would be repeated until the first section reached the next manhole. It is currently employed in rare instances such as installing new gas pipes under roads through old, larger pipes. Finally, wires and cables would be pulled through. To avoid difficulties in getting a pulling string or wire through the structure, especially where the divider was not continuous, a string or wire could be attached to one of the pipes and pulled through by it.

**All-utility tubed-conduit.** Drains and pipes would be installed in all-utility tubed-conduits in the same way as in the all-utility tunnel where they had not been prefabricated into it, except that no divider would be needed. For both kinds of construction the pulling of wires and cables would be the same as in current multi-tubed conduits.

**Non-drainage utility structures.** For all three types of non-drainage utility structures, the drains would have been installed prior to the structure. They would be installed as twin drains according to the best current practice, but backfilling and construction of manholes would stop short of the structure location. Pipes, wires, and cables would be simply laid in the trough. In the other two types, they would be installed in the same manner as for the comparable type of all-utility structure.

**Electrical utility structure.** Both the drainage and baric utilities would have been installed according to the best current practice prior to installation of the electrical utility structures. Wires and cables would be simply laid in the trough.
They would be pulled through the tunnel and tubed-conduits in the same way as for single and multi-tubed conduits in current practice.

**Installing utilities in manholes.** The proposed practices of installing all ancilliary facilities of the utility services in manholes and of making all connections to site services in manholes, presents problems of space allocation. However, it also presents the possibility for prefabrication of large numbers of highly integrated facilities and consequent savings compared with current practices. For instance, a manhole section or insert unit could be fabricated with all of the meter mounts, switches, valves, and related wiring and piping for the four or eight lots that would be served from the manhole. Special possibly larger units would have transformers installed in them. These units would contain as much of the service systems as possible, other than the facilities running between manholes, so that there would be a minimum number of connections to make in the field. Prefabricated underground sewage pumping stations are an example of the degree of integration possible, some having automatic monitoring controls and lighting and ventilating systems which turn on when the cover hatch is opened.

The manhole facility units would be designed to reduce costs both through integration of facilities and rationalization of techniques for installing services upon the basis of research. For example, the number of fittings and size of pipes would be reduced in much the same way as domestic plumbing systems are being made more economical. The number of trips made by service men of each utility agency would be reduced. For example, underground electrical service connections currently can involve three trips; one to install a meter and temporary connection for the house builder, a second to install the connection to a riser outlet near the house under construction, and a third to connect
completed house wiring to the meter through site utility structure.

V. PROPOSED PROCESS OF INSTALLING PAVEMENTS (AND CURB-GUTTERS)

The proposed process of installing curb-gutters and roads would probably be the same as in the best current practice, although the layout would be different. The process of installing the sidewalk would be completely different. Curb-gutters would be extruded in place, except where they served as electrical tubed-conduits. In this case, they would more likely be factory cast or extruded. The road would be paved by slip form pavers laying concrete or asphalt. The sidewalk might also be installed by a slip form paver where independent of utility structures, and provided a machine were developed to pattern the surface. Otherwise, the sidewalk would be precast. The precast units would be installed simply by being placed on the trough structure or in a prepared excavation. They would be linked by dowels to maintain the position except for special sections of trough covers providing access to manholes.

VI. PROPOSED PROCESS OF INSTALLING PLANTS

The proposed process of installing plants would be almost completely different from current practices, which at best only involve planting saplings and seeding boulevards on local residential streets. The difference would begin with the clearing operation and carry through a process involving different plants and techniques for installing all plants.

In the first place, some areas might not be cleared at all, but instead would be left in a natural state. What clearing was done would be by chain saws, axes and bush hooks, instead of by bulldozers, in order to save selected trees. Although such hand clearing would take more time, time could be saved by using the following technique instead of burning or hauling away
Small trees (up to 5" in diameter) and underbrush are fed into the macerating machine which grinds them up and spews out shavings and small chips that settle into the ground as a mulch. The next stage would involve tying the natural features into the overall design by installing plants. As many suitable trees and bushes as possible would be transplanted from the areas that had to be cleared for pavements or special use areas. These would not only be free of capital cost, but would be less expensive to move and more likely to survive than plants brought in. The appearance of rock outcroppings would be enhanced, particularly where cut for pavements by adding rocks and earth into which shrubs and rockery plants would be installed. Finally, all other areas not to be in grass would be planted with ground covers such as moss and ivy.

Grass would be installed in three different ways for different situations. Playing areas would be turfed with a tough and resilient type of grass. Level and open areas would have blankets containing grass seed and fertilizer spread on them. These would be laid by spiked rollers which press the blanket into the ground to prevent it blowing in the wind. Steep or odd-shaped areas would have grass installed by spraying them hydraulically with an emulsion of seed, fertilizer, water and a cellulose fiber mulch.

VII. PROPOSED PROCESS OF INSTALLING OTHER SERVICE FACILITIES

The proposed process of installing other property service facilities would be the same as current practice in a few instances, straightforward for some not currently installed, and quite different for others, especially for those installed in servi-centers. Those installed the same way as in current practice are fire hydrants, painted centerlines on roads, letter and fire alarm boxes, and reflective metal stop and yield signs standards.

The facilities not currently installed in Metropolitan Vancouver that could be installed in a straightforward manner are mainly the various furnishings. For instance, the manner of installing the proposed 'outdoor playpen', benches, pools, and other furniture and ornaments is fairly obvious.

The only other facilities that would be different in local streets would be garbage containers and meters. The former would be installed simply by dropping them into holes in troughs or manholes for which they were designed to fit. Meter mounts would have been installed as part of prefabricated units. The gas and electric meters would be mounted so they could be read by residents through a transparent panel cast into the special sidewalk manhole cover section. The meters would be read remotely for billing purposes as follows:

... a customer's telephone would (without his knowing it) contact his meter periodically, get the meter reading electronically and transmit the information to a billing machine. The billing machine would print the customer's bill and mail it to him. No human eyes would see the meter.6

There would be several differences at intersections, however. Lighted acrylic street name signs would be adapted to fit on street light poles instead on the top of separate posts as in Brampton, Ontario. They might be further adapted by means of a clear or open slot in the bottom and a reflector at the end to light facilities such as letter and fire alarm boxes or other signs (see Diagram 13.). Stop signs could be lighted in this fashion, but might be better left to reflect car headlights, or be lit internally in the same manner as the street name signs. In any case, stop signs would be installed lower than is becoming the practice, because there would be no parked cars to block the view of them. Pedestrian yield signs would be painted onto or cast integrally with precast sidewalks at collector and major streets. They would also be painted on the facing curb as shown on Diagram 14. The curbs around the servi-center and at the ends of the nearby safety islands would be made of special permanent-white reflector concrete to eliminate painting while providing a brighter appearance. Coloured pavements would be installed in the same manner as ordinary pavements in small areas, that is spreading by shovel and rolling. Rumble strips on the approaches to stop signs or divided roads might be formed simply by placing corrugated metal forms on hot asphalt and running over them with rollers. Finally, the facilities in the servi-center would be installed as a unit by mounting it on bolts set in the concrete island, or onto a central lamp or shelter support, depending upon the design of the unit.

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DIAGRAM 13 - SUGGESTED MODIFICATIONS TO LIGHTED STREET NAME SIGNS

DIAGRAM 14 - SUGGESTED PEDESTRIAN SIGNS
VIII. SUMMARY OF PROPOSED PROCESS OF INSTALLING SERVICE FACILITIES

The proposed practices of installing property service facilities in local residential streets are similar to the best current practice in general terms of staging and operations involved. The differences have been described for several major aspects of the process. The proposed process of installing (or re-installing) subdivision plats would differ substantially from the best current practice only in the way surveying operations were carried out. These differences result from the desire to preserve natural features, especially trees, both in the street and on sites. The proposed process of preparing the street for servicing is similar to the best current practice in terms of the operations involved, but they are performed on a reduced area.

The proposed utility structures would be an innovation for local streets, but their installation would be generally similar to that of facilities such as the drains. An exception is the all-utility trough for which several special techniques are mentioned. The tunnels and tube-conduits would be installed in the same way as drains, except for electrical tubed-conduits; these would be installed as curbs or sidewalks, or as they would be if precast.

The proposed process of installing utilities would differ from current practice mainly in that excavation and backfilling would be eliminated for utilities installed in utility structures. Otherwise they are installed in a similar manner to current practice, although a certain order must be followed for tunnels. In some cases pipes and drains could be prefabricated with the structures. Facilities in manholes would be installed by placing prefabricated manhole sections or insert units.

Pavements would be installed in the same manner as in the best current practice, allowing for the layout being different.
However, the process of installing plants would be considerably different. It begins with hand clearing of natural features and involves use of existing trees as much as possible. Several new techniques of planting grass would be used. Facilities of other property services would be the same in a few instances, straightforward for some not currently installed, and different for others, especially those in servi-centers.
CHAPTER V
EVALUATION OF PROPOSED PRACTICES

DETERMINATION OF THE FEASIBILITY OF THE PROPOSED STREET USE AND SERVICING PRACTICES

The two preceding chapters described and discussed proposed processes of designing and installing property service facilities for local residential street use and servicement in comparison with current practices in Metropolitan Vancouver. The practices involved in the proposed processes are evaluated in this chapter in terms of the criteria and principles stated in Chapter I to test the hypotheses of this investigation.

The general hypotheses to be tested are that installing utilities in specially designed underground structures in local residential streets would:

a) permit better use and design of such streets than is possible by current servicing practices.

b) be feasible (from functional, physical, social, staging, administrative, political, financial, and economic points-of-view) if comprehensively designed.

The first hypothesis may be accepted as proven by the range of possibilities for designing street use and servicement described in Chapter III from which anyone could select what he considered to be better. This assumes only that everyone could find something he considered better than current practice. Acceptance of all of the proposed designing practice, particularly the more radically different ones, is unnecessary because only those which prove to be acceptable need be followed. However, the proposed practices would hardly be worth following, even if feasible, unless accepted to a substantial degree. Consequently, acceptance of the proposed designing practices are discussed more fully in this chapter.
Any acceptance of the first hypothesis, of course is conditional upon acceptance of the second - that is, that the proposed practices are feasible. The feasibility of the proposed practices is not always obvious from the definition and description, and therefore must be tested and evaluated. The general hypothesis about feasibility must be tested by a series of specific hypotheses about separable practices. This has been done by determining the feasibility of the various aspects described in the two previous chapters for each kind of feasibility where applicable. Practices are considered to be feasible, and the specific hypotheses acceptable, when they can be shown to be followed in other urban areas or in comparable situations.

I. EVALUATION OF PROPOSED STREET USE AND DESIGN

Complete testing of the first general hypothesis could involve the formulation and testing of a specific hypothesis for each of the proposed practices by application of the appropriate criteria or principle. This is considered unnecessary for the following reasons. In the first place, the principles formed the basis of the assumptions about the proposed practices and the public interest criteria. While it would be desirable to make such tests, it can hardly be done by the person who has made the judgements involved. In the second place, the proposed practice involves accommodating more street uses and providing more services whose facilities would be installed at the same or better standard than in the best current practice. It is only necessary to assume that people would consider these conditions 'better' to accept the hypothesis. In effect, the hypothesis must be accepted by definition, if this assumption is accepted.

Validity of the assumption that people would consider the proposed practice better than current practices would require actual servicing of a street by these practices since even a
psychological study in depth is unlikely to reveal how people would react to such unfamiliar situations. Features of the proposed practices which might bother some people are the closeness of the road to houses in some sections, the presence of playing areas or natural features in front of houses, and the lack of uniformity of treatment for every house. The latter point covers possible reactions that the proposed practices would be 'unfair', 'inequitable', and somehow 'undemocratic'.

In an attempt to allay such potential criticisms, the following points are noted. The proposed practice of street use and servicement which affects the physical environment have been deliberately made somewhat extreme to show the range of possibilities that would exist when some of the limitations of current practice were removed. Any specific proposal such as having the road close to one side of the street that proved to be unacceptable would be experimented with to find acceptable solutions. For example, either the road could be placed less close to the houses, or more intensive planting could be placed between the houses and the road. However, it should be noted that unlike such situations in current practice, there would be compensating advantages to these situations. These situations could be of limited extent and only where especially large playing areas or natural features were to be avoided; the major part of street length could be reasonably symmetrical.

With regard to the matters of fairness and equity, it is assumed that significant differences would be reflected in market prices and taxes. While it may be democratic to level social distinctions, in this investigator's opinion it should not mean reducing the physical environment to the 'least common denominator'. This usually means eliminating the best along with the worst to produce mediocrity. Instead, the investigator believes there should be the opportunity for an optimum of choice of the
environment in which one could live. Those who wished to live in the sections of streets having uniform servicement should be able to do so - but there also should be provision for others. For example, those who so wished could 'hide' behind the preserved natural features. They are more likely than most suburbanites to attain the goal of enjoying urban services in a natural or rustic environment. Others might prefer being exposed to activity such as would be likely to occur in the areas designed for playing, or even being close to the road - for as the saying goes, "one man's meat is another man's poison."

The result of such a variety of choice of physical environment within single family residential areas could well be a variety of types of people. In the opinion of many planners and sociologists, this would make for better communities than the extreme homogeneity of many such areas to-day in terms of human relationships and even possibly mental health.

II. EVALUATION OF PROPOSED DESIGNING PRACTICES

The feasibility of the proposed designing practices is evaluated in this section for each of the plan elements.

Functional Layouts and Their Feasibility

The feasibility of the proposed functional layouts of the various main aspects of the designing process are discussed below.

Street uses. The functional layout of street uses would be related to the layouts of pavements and planting in two opposite ways - by exclusion and inclusion - depending upon the use in question. The open space laid out for playing must exclude pavements and include planting (turf). On the other hand, areas laid out for parking include pavements, but exclude planting. Special use areas for conversation or recreation, preferably in or near natural features, may exclude both pavements and planting because they could be accommodated by furniture and
'floor' finishes.

The layouts of open playing and special use areas would be feasible if pavements could be laid out so as to provide the necessary width and avoid natural features.

Structure. The functional layout of public utility structures would be related to the drainage services in most cases, and the pedestrian access service in the case of troughs. They are related in current practice (all parallel), so what is new is that they would not be straight and in the same location relative to the street boundary. Thus, they may be considered feasible if the 'wandering' of the pedestrian pavement is feasible.

Utilities. The utilities would all be related to the utility structure according to their respective 'branching' patterns, so their functional layout is feasible with the same qualification as above.

Pavements. Sidewalks are currently laid out both beside and as far as possible from roads and parking areas. The only functional reason for not wandering between these extremes seems to be probable increases in length. However, the increases would be slight compared to benefits of a more pleasant passage. Hence, the proposed layouts can be considered feasible.

Roads would be laid out to avoid natural features, open playing areas, and parking areas, while providing a reasonably free-flowing vehicular route. Both the road and parking areas would be much closer to houses in places along the street than at present where every house is ordinarily set back the same minimum distance. However, they would not be closer than roads at the ends of blocks currently are to houses, on corner lots which often face such a 'side' or 'flanking' street. Undoubtedly many
people would consider it undesirable to have a road close to their house. However, besides having little traffic this road would have no parking, and thus no noise from car doors slamming and party-leavers talking loudly. There would usually be a compensating feature across the road such as an open area, a natural feature, or landscaping, including that around parking areas. The latter would have only a narrow opening in the planted screen and it would not be opposite houses. The road itself might be partially screened by a low hedge. In view of these considerations, roads close to houses might be acceptable. Indeed, some people who like to watch activity might consider such a situation desirable. If not, either the houses could be moved back, or the road placed further away with perhaps more landscaping between.

It should be noted that the layouts illustrating the proposed practice were somewhat extreme examples to show the range of possibilities. When actually put into practice, less extreme layouts might be used, or such extreme ones might be used infrequently. The limits and frequency of layouts having roads close to houses would be based upon people's reaction to them. Since this requires a full-scale experiment, the feasibility of proposed practices is at present indeterminate for the extreme cases, at least.

Planting. The proposed functional layout of planting is similar to that of some parks where natural features are either worked into the overall design, or the design is adapted to the feature. There seems no functional reason for not doing the same in local streets; therefore, it is considered feasible.

Other facilities. In general, the proposed functional layout of the facilities of other property services is mainly a rationalization of existing layouts and the tendency to congregate at certain intersections, so functionally feasible. The
'servi-center' functional layout might prove to be unfeasible in streets of ordinary width having more traffic than assumed, but should be feasible when streets can be widened and traffic is light.

**Physical Designs and Their Feasibility**

Designing of the detailed physical design of particular street sections should be feasible, provided the functional layout is feasible. It would mainly involve putting together or modifying standard designs, most of which are found in current practice though not necessarily in local streets. For example, the proposed designs for roads and parking areas and related planting are similar to those in some of the better designed parks.

**Social Provisions and Their Feasibility**

The social provisions are the accommodations made for certain street uses by functional layout and installation of facilities, particularly furniture and finishes including plants. The proposed designing should be socially feasible because it is aimed at providing the opportunity for greater social use of streets without forcing undesired social contact. For instance, children will probably always play in streets, but given the opportunity to play in a variety of areas, they would tend to stay off the road. They would have the choice of playing on turfed open areas, paved parking areas, and the natural areas. The latter might have partial forts and tunnels (of large drains, for example) for team games, or areas for individual exploration.

Similarly, the provision for younger children and adults of various age groups would provide the opportunity of using the street for social purposes. The proposed outdoor 'playpens' would provide the opportunity for mothers of young children to get together for a chat out-of-doors with their children, or with several children whose mothers had things to do which were
best done without the children present. Such facilities appeared to be well used in the Swedish new town of Farsta. Social contact might be forced to some extent on people sharing small parking areas, especially if parking spaces were reserved. With this possible exception, the proposed designing practices are considered to be socially feasible.

**Staging Schedules and Their Feasibility**

The proposed designing programme would have four main stages. The first would involve preparing a tentative functional layout for street use areas, pavements, planting, the utility structure, and the subdivision. The second would involve mutual adjustment of the first three, and designing of the functional layout of the utilities. The third stage would involve a compromise design for all the aspects mentioned, the utility structure layout being modified if necessary for the requirements of the utilities. Finally, detailed designs would be prepared for all aspects including any other facilities required.

The process is similar to the best practice now followed in Richmond insofar as the utilities and subdivision are concerned. The other aspects require more factors to be considered, but would not change the basic process significantly, so should be feasible for staging.

**Administrative Arrangements and Their Feasibility**

The administrative arrangement for the designing process would be related to the stages mentioned above. The first stage would be done by either the municipal planning department or planning consultants for the subdivider.\(^1\) In the latter case, for those outlying municipalities not having planning departments, this function could be performed for them by the Lower Mainland Regional Planning Board or planning consultants.
the plans would be reviewed by the planning department. In either case, the planning department might hire consultants for assistance or advice on large subdivisions. Either the planning consultants or the planning department should have a landscape architect or designer and possibly other specialists on their design team as staff member or consultant. The important thing is the creativity, imagination, and ability to handle such complex matters comprehensively of the team or individual doing the designing. Perhaps a new profession of street architects or designers might evolve!

The second stage of designing functional layouts of utilities would be done by the respective utility agencies. The third and fourth stages would be handled by the same agency as the first - the planning department - for all plan elements except the final design of utilities. A committee of technical representatives of the various utility agencies and the planning department would resolve any problems that arose.

These arrangements would be similar to those in the best current practice of administering the subdivision process, such as in Richmond. Although the matters dealt with would be more complex, the arrangements could be basically the same and hence administratively feasible.

Financial Budgets and Their Feasibility

The financing of the major costs of designing would be done by the subdivider by paying fees to either consultants or to the municipality. The latter would ensure equity between those hiring consultants or not and be in accordance with the principle of payment for benefit. Some utility agencies whose design costs attributable to particular areas are relatively slight (e.g. telephone) might continue to pay their costs out of general revenue such as from service charges. In all instances, a portion of design costs would be paid for out of general
revenue because of the general benefit that would result. Residents of areas benefitting from the proposed practices would pay slightly more than a proportionate share of this, assuming their land values were higher.

The practice of charging fees for designing is followed in the best current practice in Richmond, and is therefore feasible.2

Economic Feasibility of Proposed Designing Practices

All of the major aspects of the proposed process of designing street use and servicing would be more expensive than current practice, with the possible exception of that for utilities. However, the extra care in designing would result in savings in costs of installing roads and utilities, especially where rock was involved, and in extra benefits. The latter would accrue from the accommodation of more uses (e.g. playing), from having planting that was complete and effective from the start, and from a more interesting and distinctive environment.

These potential savings and benefits are difficult to evaluate; the former because they would depend upon detailed investigation of conditions in a particular street section; the latter because there is no experience with the proposed practices. If they were significant, they would be reflected in either higher profits for subdivider-servicers, or increased land values relative to areas serviced by other practices. Assuming these economic benefits exceeded the designing costs, the proposed designing practices would be economically feasible. Criteria might be established to ensure that, on balance, this would be the case.

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2 Richmond, Notes for the Information and Guidance of Land Owners, Subdividers and Land Developers Relevant to the Subdivision of Residential Land Within the Municipality of Richmond, Planning Department, Richmond, September, 1961, p. 8.
**Political Program and Its Feasibility**

Public acceptance of the proposed street use and servicing practices would require a demonstration project to show in terms most people could understand (i.e. a complete physical environment) what streets could be like. Such a project could be carried out by a private developer or municipality in an area having one ownership. It might be simpler for the municipality to do it because the municipality is involved in any case, and could relax its by-laws (e.g. for clearing the whole street) for itself with less political problems than for private developers. Thus, a municipal council would have to be persuaded to undertake such a project by its planning department, or civic-minded organizations such as the Community Planning Association of Canada, and the Community Arts Council.

Such an experiment could be conducted in a similar manner to Vancouver's 'experimental' servicing of its subdivision at 54th Avenue and Kerr Street with underground wiring.

**Summary of Evaluation of Proposed Designing Practices**

The proposed designing process for street use and servicing in local residential streets appears to be feasible from all points of view with the following qualifications. The public acceptance of roads close to houses and 'communal' parking areas and the assumption regarding the relationship between benefits and costs could only be determined by full-scale experiment. This should be done at the same time as an adjacent area served by current practices so that comparisons can be easily made.

**II. EVALUATION OF THE FEASIBILITY OF THE PROPOSED PRACTICES OF INSTALLING PROPERTY SERVICE FACILITIES**

The proposed practices of installing the facilities of property services are evaluated in this section for most of the feasibility points of view. Social and political feasibility have been discussed in relation to designing and need not be repeated.
Functional feasibility was also covered above for all aspects in terms of functional relationships. It is discussed below only in terms of operation of the utilities over time. Thus, all aspects are considered only for physical, staging, administrative, financial, and economic feasibility.

Functional Feasibility of Proposed Practices of Installing Facilities

There are several operational problems presented by the proposed practice of installing utilities in underground structures. Among the potentially serious ones, in increasing order of importance, are rodents in the structures, reduced efficiency of transformers, freezing of pipes and drains, and gas leaks. Rodents might enter structures via drains and damage wires and cables, although some of the new materials may be less subject to such damage. This possibility would be best countered by preventive measures such as careful design of openings to the structures and screening of drain outfalls.

Tests of transformers and capacitors installed in underground enclosures indicate that considerable derating is necessary, except where ventilation is adequate. This is because the heat-conducting capabilities of soil drops off rapidly as it loses moisture. This suggests that the structures, at least those with transformers, should be well ventilated in the summer.

In cold climates, the ventilation of structures should be reduced in the winter to retain the heat given off by transformers and wires. This would reduce the possibility of pipes freezing or the need for insulation. Knowledge of temperature conditions

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4 Ibid.
underground is rather meagre for ordinary situations, let alone for the complex ones involved in underground structures with different utilities. Some investigations have been made of the problems of installing utilities in permafrost, but they serve mainly to show how little is really known. Recent investigations about thermal conditions for underground wiring have produced results contrary to expectations, and suggest that much more research is needed in this field as well. However, for the climate of Metropolitan Vancouver, the problem of freezing should not be such that normal precautions would not be adequate.

The problem of gas leaks is extremely serious because gas could spread over extensive areas in the utility structures. This would increase the difficulty of detecting leaks, the probability of an explosion, and the extent of damage resulting from an explosion. The cost of gas-tight bulkheads and detection devices would probably exceed the benefits from having gas pipes in underground structures. Therefore, it is considered uneconomic to install gas pipes in utility structures.


7 Dapper Project, *loc. cit.*
However, to avoid having to trench across and repair roads to install gas pipes, the following practices are proposed. Main gas pipes crossing roads would either be installed before the roads, or a conduit would be installed through which the gas pipe would later be pushed. Road crossings for house connections would be restricted for example, to every two or four lots. They would be installed in either a sealed utility structure or a separate conduit installed with the structure.

**Physical Designs and Their Feasibility**

The proposed physical designs have been designed, insofar as possible at this stage, to be practicable. There would be certain problems such as ensuring that the utility structures were watertight, and in fitting all necessary facilities into relatively small manholes. Also, the design of the facilities in 'servi-centers' would have to be more carefully worked out than has been done for this investigation. This ought to be made the subject of a design competition amongst architects and industrial designers.

Other than these problems the physical design is considered feasible. Much of it is similar to current practices, although not necessarily in local streets. The structures are similar to large drains except for the troughs. The pavement and planting designs are similar to those in well designed parks.

**Staging Schedules and Their Feasibility**

The general schedule for the proposed practice would be as follows. The subdivision plat would be installed first followed by preparation of the street for servicing. Then the utility structure would be installed. The utilities would be installed next, and then the pavements and planting. Finally, the facilities of other property services would be installed. The street uses would have been facilitated by certain pavement, planting, and other facilities installations.
Each of the major stages may have schedules for the operations involved, or the order may not matter. Such is the case for installing utilities in a structure, except for all-utility tunnels which must have facilities installed in a definite order. With this exception and a few modifications because of the presence of the structure, the proposed staging schedules would be similar to those of comparable current practices. They might be 'tighter' or involve less total time because many operations would be eliminated or performed in factories beforehand.

**Administrative Arrangements and Their Feasibility**

The proposed administrative arrangements for installing facilities are similar to current practice. Installing of facilities for street uses would be the responsibility of those installing the various facilities. Municipal engineers would be responsible for the installing of the utility structures, pavements, and municipally provided utilities or other services. Utility companies and public service agencies such as the Post Office would be responsible for their own facilities. Planting would be the responsibility of parks boards where they existed; otherwise that of engineering departments. Conflicts of responsibility or other problems would be resolved by a committee of technical representatives of the various service agencies. This could be the same committee which would deal with designing problems.

Since these arrangements are similar to existing ones, they are considered administratively feasible.

**Economic Schemes and Their Feasibility**

The proposed process of installing property service facilities involves the considerable extra expense of the utility structure. It saves expenses by eliminating facilities or operations, particularly those of excavating and backfilling. These savings are estimated below to determine what can be offset against the cost of the structure.
In order to estimate the savings of the proposed practices, it is necessary to know the costs of the materials or operations eliminated. These costs are difficult to determine for two reasons. One is that they may not be known in the detail or breakdown required here because this is not required in current practice. For instance, sufficiently accurate estimates for many purposes can be made by applying unit costs for the whole process or major parts of it that have been derived from past experience. In such cases, it is unnecessary to know the costs by breakdowns of interest here. The other problem is that many organizations are reluctant to disclose their costs to competitors, including municipalities versus contractors. In the face of these problems, it has been necessary to make do with what information was obtainable, and make assumptions about what is not. Unfortunately, satisfactory information on costs of underground wiring for this area was not obtained. Consequently, the electrical and communicative are omitted from the estimates below, but discussed thereafter. The gas service has been omitted because it is considered functionally unfeasible to install gas pipes in the proposed utility structures. Thus, the only utilities to consider are drains and water pipes. Sidewalks are also of interest, but roads are not because they have no direct involvement with the utility structure.

The costs for drains are the most important because of their magnitude, and also because certain operations are most comparable to those of the proposed practice. Fortunately, an excellent breakdown of costs of installing drains separately was made available by the City Engineer of Port Moody. These costs are reproduced as Table V in Appendix C and used as the basis for the estimates summarized in Table IV on the following page. They are based on an average depth of 8 feet in conditions involving no rock excavation and minimal shoring. Unfortunately,
### TABLE IV
ESTIMATED UTILITY COSTS PER FOOT OF STREET

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNIT COSTS $/ft.</th>
<th>Actuals/ft.</th>
<th>Relative to Best Practice</th>
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<td></td>
<td></td>
<td>EXISTING PRACTICES</td>
<td>PROPOSED PRACTICES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Normal</td>
<td>Best</td>
</tr>
<tr>
<td>DRAINS:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excavation for</td>
<td>1.55</td>
<td>3.10</td>
<td>1.55*</td>
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<tr>
<td>Bedding sand in place</td>
<td>.40</td>
<td>.80</td>
<td>.60</td>
</tr>
<tr>
<td>8&quot; with gasket 12&quot; plain</td>
<td>.90</td>
<td>2.05</td>
<td>2.05</td>
</tr>
<tr>
<td>Laying of</td>
<td>.59</td>
<td>1.18</td>
<td>1.18</td>
</tr>
<tr>
<td>Manholes</td>
<td>1.03</td>
<td>2.06</td>
<td>2.06*</td>
</tr>
<tr>
<td>Backfilling</td>
<td>1.48</td>
<td>2.96</td>
<td>1.48*</td>
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<tr>
<td>Clean-up</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supervision</td>
<td>.74</td>
<td>1.68</td>
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<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub Total</td>
<td>13.63</td>
<td>9.66*</td>
<td>-2.06*</td>
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<tr>
<td>Eng. Contingencies 15%</td>
<td>-</td>
<td>2.04</td>
<td>1.45</td>
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<tr>
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<td>15.67</td>
<td>11.11*</td>
<td>-2.37*</td>
</tr>
<tr>
<td>WATER PIPE:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.75*</td>
<td>1.68</td>
<td>-1.68</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>=or-</td>
</tr>
<tr>
<td>Laying of</td>
<td>Incl.</td>
<td>70</td>
<td>=or-</td>
</tr>
<tr>
<td>6&quot; pipe, hydrants etc.</td>
<td>2.00</td>
<td>2.62</td>
<td>.62</td>
</tr>
<tr>
<td>Total</td>
<td>3.75*</td>
<td>5.00</td>
<td>-2.30*</td>
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<tr>
<td>SIDEWALK: 4' wide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3.18</td>
<td>3.18*</td>
<td>6.36*</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>22.60*</td>
<td>22.47</td>
<td>-7.85*</td>
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</tbody>
</table>
cost breakdowns for the 'twin' sewers presently being installed in Port Moody have not been prepared yet. Also, this information is not available from Vancouver, the only other municipality following this best practice. Consequently, it has been necessary to make a number of assumptions to get a breakdown for twin sewers against which the proposed practices can be compared.

As shown in Table IV, only the cost of the drains and the laying of them has been assumed to be the same for twin drains as in the normal practice of installing them separately. Excavation, backfilling, and clean-up costs have been assumed to be the same as for an individual drain. These costs could be somewhat greater because the trench may have to be wider, but there should be a saving as a result of installing manholes for the two drainage services in a common excavation. The supervision and overhead costs also have been assumed to be the same as an individual drain, since the same Port Moody crew that installs drains separately is now installing twin drains. Manholes costs have been assumed to be the same as for two drains installed separately. The costs could be slightly higher because the common concrete base must be somewhat larger than separate ones, or lower because the formwork and labour costs may be reduced for a base common to two manholes. The costs of bedding sand in place has been assumed to be half way between that for an individual drain and that for two installed separately. These assumptions are considered reasonable by the City Engineer for Port Moody on the basis of his limited experience with twin sewers. He suggests that laying or overhead costs may be reduced with more experience. This is supported by the two relationships supplied by the Vancouver Sewer Engineer as follows:

8 Interview with Mr. Douglas Kenyon, City Engineer, Port Moody, B. C.
In general, an 8" and 12" twin sewer costs about 25% more than a 12" sewer if built under the same conditions. Similarly, the cost of the 'twin' sewer is about two-thirds the cost of similar separate sewers.\(^9\)

Applying these relationships, the total cost would be approximately $10.00 and $10.45 respectively, so the estimates can be considered to be somewhat high.

The costs for installing water pipe in the best practice involving cast iron pipe were also supplied by Port Moody. The normal practice costs for asbestos cement pipe are from Richmond. The excavation costs are unusually low because of favourable soil conditions and should be considered a minimum. For instance, subtracting the material cost of $2.00 from the $4.25 total unit cost employed by Delta gives an excavating cost of $2.25 which is close to the $2.38 amount for Port Moody.

The sidewalk costs are for a four foot wide sidewalk in Richmond, which again is low compared with other municipalities, some of whom install sidewalks five feet wide. The difference between best and normal practices is simply that the former installs sidewalks on both sides, the latter on only one. It is interesting to note the closeness of the total costs for the two practices. In effect, the possible gain by switching from normal to the best practice is one sidewalk and cast iron instead of asbestos cement water pipes.

The estimated savings of the proposed practices have been related to the best practice costs for all-utility structures and shown by differences. As indicated on Table IV, the excavation and backfilling costs for all three types of structures have been assumed to be the same as twin drains - that is, there

\(^9\)Letter to investigator from Mr. Arthur Gordon, Sewer Engineer, City of Vancouver.
would be no saving. In fact, as suggested by the 'or' the backfilling costs might be greater because more excavated material would have to be removed. The necessity for this could be reduced by considering this material as 'cut' in the 'cut and fill' design of the street. The costs for placing bedding sand have been assumed to be equal to the best practice, except that they would be eliminated (for a $0.60 saving) where bedding sand was not required for troughs cast in place. Drain costs would be the same for troughs and tunnels, but have been omitted at this point for the tube-conduit since the drains might be incorporated into the structure. The cost of laying has similarly been omitted for the tubed-conduit. Laying costs for the other structures have been assumed to be the same as for twin sewers. However, the costs should be less for troughs because of more favourable conditions, and might be more for tunnels because drains would have to be pushed through them. Manholes have been assumed to cost the same for tunnels and tubed-conduits as for twin drains. They are unnecessary with all-utility troughs, so yield a saving. Finally, the supervision and overhead costs have been assumed to be the same or less than for twin sewers.

The non-material non-laying costs of installing water pipes in utility structures (i.e. excavation, backfilling etc.) have been assumed to be completely eliminated for a saving of $1.68 compared with best current practice. There would be an additional saving of $0.62 if asbestos cement pipes were substituted for cast iron. This seems reasonable when the superior strength and other characteristics of cast iron are not required when water pipes are enclosed in structures. In the case of the tubed-conduit, the pipe costs have been omitted, but not those for hydrants and valves.
The cost of installing one sidewalk has been assumed to be completely eliminated for a saving of at least $3.18. It should be more because the costs are ordinarily higher than this in current practice, and sidewalk sections would be precast to eliminate the need for formwork and all but a minimum of field labour.

The total savings in the costs of installing these few utilities in all-utility structures is thus estimated to be in the order of $7.85 for the trough, $5.48 for the tunnel, and $10.68 for the tubed-conduit. These can be considered minimum in that in addition there should be substantial savings in the costs of installing the communicative and electrical services underground. The excavating and backfilling costs would be completely eliminated, but may be offset to an unknown extent by costs not otherwise incurred. Furthermore, no consideration has been given to potential savings in operating costs during the lifetime of the facilities or upon their partial or complete replacement. In the latter case, compared to current practice there would be a saving in all costs except the relatively minor ones of removing the old and laying a new facility, including repair costs for damage done to other facilities such as pavements necessarily involved at present. Nor do they include possible savings in the costs of roads. These comments should be kept in mind during the following discussion of the cost of the utility structures and the test of their feasibility.

All-utility trough. The cost of the all-utility trough, can be estimated roughly from unit estimating costs for retaining walls of $60 per cubic yard of concrete in place (i.e. cast in forms). Only $15 per cubic yard is for the concrete itself. A trough 8 feet deep, 4 feet wide, with 6" walls and base has a cross-sectional area of 9.5 square feet. The volume of this section is $9.5 \times 1 \times 27 = 0.35$ cubic yards which would cost
$21.12. This exceeds the estimated saving of $7.85 by $13.27 so this structure must be considered unfeasible when constructed by casting in forms.

The total unit cost used above is for one-of-a-kind projects and may be too high for what might become standard procedures. Also, techniques involving casting without forms or installing precast sections might be employed as discussed in Appendix A. The estimated saving of $7.85 covers the cost of concrete for this section at $5.28 per lineal foot, but leaves little for costs of placing the concrete. Thus, either an extremely efficient technique or more savings must be found before the all-utility trough could become feasible compared to best current practice.

**All-utility tunnel.** It has been assumed that the most practical means of constructing the all-utility tunnel is by installing spun reinforced concrete drains. To enclose a 12 inch storm drain, an 8 inch sewer, and a 6 inch water main, requires a 30 inch tunnel costing $7.77 (including tax). To estimate the cost of laying this, the City Engineer of Port Moody suggested working back from the total unit cost used by the Greater Vancouver Water and Sewerage District Board, although he considers it too high at $17. Since excavation, bedding sand, manholes, backfilling and supervision and overhead costs have been allowed for in the estimate of costs of installing the tunnel, $5.20 can be accounted for ($1.55 + 0.40 + 1.03 + 1.48 + .74). Subtracting this $5.20 and the $7.77 drain cost from $17.00 leaves $4.03 for the costs of laying the tunnel plus extra costs in above items, which seems excessive. Adding this to the tunnel cost of $7.77 gives a total of $11.80 which exceeds the estimated saving of $5.48 by $6.42.

The more common size storm drain for local streets of 10 inches would reduce the required size of tunnel to 24 inches.
This would reduce the cost of the tunnel considerably and the estimate of savings only slightly (the difference in cost between a 12 inch and 10 inch drain).

**All-utility tubed-conduit.** The estimate of costs for the all-utility tubed-conduit are based on costs of hollow core concrete slabs supplied by Superior Concrete Ltd. of North Vancouver. It has been assumed that the proposed tubed-conduits could have comparable costs to these hollow core slabs if they were produced in sufficient volume to warrant construction of a special extrusion machine. Costs of the slabs are quoted in square feet of deck area. Two types are two feet wide and six and eight inches deep costing $1.00 and $1.20 per square foot. Since they are two feet wide, a lineal foot costs $2.00 and $2.40 respectively. Dividing by their net cross-sectional areas yields costs per square inch of cross-section of $0.22 and $0.24.

A suggested 'economy' design for the all-utility is shown in Diagram 15, which meets or exceeds the design requirements for the extrusion process. The cross-sectional area is 185.63 square inches. Applying the average unit cost of $0.23, the cost of this section would be $4.46. Since the estimated saving is $10.68, there is a surplus $6.22 which would more than cover laying costs. Thus, this structure appears to be economically feasible.

This 'economy' structure could be made to function effectively if the extruded material were dense and water-tight, and the joints were perfect. The water tube might be lined with plastic. However, the potential danger to public health of contamination of the water supply would always exist. A better design would be that shown in Diagram 16 which has an enlarged tube for inserting an independent water pipe. Adding the cost of asbestos cement pipe of $2.12 and laying of $0.70 back in, the surplus would be $3.40 which is still ample for covering the
costs of laying the structure. If plastic pipe were used, the
cost of the pipe itself would probably be higher, but joints
would be fewer and laying faster. Also, the size of the void
and consequent amount of material in the structure could be
reduced slightly.

Thus, the all-utility structure appears to be economically
feasible. Indeed, it may provide a surplus, especially when
possible savings on underground wiring and cabling costs are
considered. This surplus could either be passed on as savings
to lot purchasers and taxpayers, or be used to provide additional
or higher quality services.

Other types of structures. The other types of structures
have not been investigated in detail, since it is necessary only
to find one feasible type to make the proposed street uses
possible. However, some of these other types may be otherwise
more feasible than all-utility structures in certain circumstances.
For example, where topography dictates unusual locations for
drains, the non-drainage types could be used. Generally speaking, they should be economically feasible because their costs would be substantially reduced when the relatively large drains were not involved, while the savings would not be reduced so much. Most of the estimated savings arise from reductions in costs of installing water pipes and a sidewalk and these would remain for the non-drainage types. Excavation and backfilling costs would be nil where these structures were installed above and in the trench excavated for drains. Finally, a utility structure such as the electrical tubed-conduit might well be provided at less cost than an ordinary sidewalk while also serving as a sidewalk because of the economy of reduced cross-sectional area and prefabrication.

**Per lot costs.** The above estimates are all on a lineal foot basis. Perhaps the relationships in terms of costs per lot are more significant. Assuming lots 66 x 120 feet, which seems to be becoming a standard except in Vancouver, about 40 feet of utilities are required per lot when side streets are included.¹⁰

Taking the differences between estimated savings and costs before consideration of factors likely to narrow them, the all-utility trough and tunnel costs exceed savings by an estimated $13.27 and $6.42 respectively. The all-utility structure could yield a saving of say, for the sake of illustration, $0.50. This means extra costs of $531.00 and $257.00 or a saving of $20.00 This is just for the street facility. The differences for connections to dwellings must be considered. The average length of them would be slightly more than half the street width plus the minimum setback or front yard. For a 66

foot road and 30 foot setback, this would be 63 feet. Assuming the differences to be about one-third that for the street facility because of the smaller utility sizes involved, these differences per foot would be $4.42, $2.14 and $0.166 respectively. The amounts would be $278, $135, and $10.50 for total extra costs of $809 for the trough, $391 for the tunnel and saving of $30.50 for the tubed-conduits. In each case the amounts are higher than would normally result if lots were narrower, streets were narrower, or the setback were less.

How significant are these costs? Costs in excess of $809 have been paid merely to have wires and cables installed underground, although by few people. The number who have paid more than $392 is substantial, especially in the United States. Since these people have considered the benefits that will accrue to them worth such extra costs, in this sense underground wiring is economically feasible. In the same sense, a proportion of people would accept the extra costs of the proposed practices as being economically feasible. For a given cost the proportion should be higher than for underground wiring because the benefits should be greater. The proportion of people willing to pay such extra costs increases as the costs decrease, of course. On the other hand, the ability to decrease costs depends partly on the proportion willing to accept such costs in that some costs can be reduced when dealing with large numbers or volumes.

**Summary of economic feasibility.** The proposed all-utility trough and tunnel structures have been found to be unfeasible compared to current practice, for the assumptions made concerning their costs. They might be accepted as being feasible by those people placing a high value on the benefits that would accrue from them; the proportion of people of this opinion would tend to increase as the cost differential compared to current practice decreased. This differential would tend to decrease with increased use of such structures.
However, the all-utility tubed-conduit has been found to be economically feasible provided all of the necessary assumptions are valid. Indeed, it might well produce a net saving that could be passed on to those served or taxpayers generally.

The other types of utility structures appear to be economically feasible, or so nearly so that the extra costs would probably be accepted in exchange for the benefits that would accrue.

Summary of Evaluation of Proposed Practices of Installing Facilities

Since the evaluation of economic feasibility has been summarized immediately above, only the other aspects have been included here. Generally speaking, the proposed practices of installing facilities are considered to be feasible, primarily because they are similar to those in current practice. There are certain functional problems, most of which can be dealt with relatively easily. An exception is that it is considered unfeasible to install gas pipes in the proposed utility structures. The proposed physical designs are considered to be feasible in that they are based upon existing ones. Staging in the proposed practice would involve 'tighter' schedules, but is otherwise comparable to the best current practice. The administrative arrangements proposed are basically modifications of the best existing practices, and are therefore considered feasible.

IV. SUMMARY AND CONCLUSIONS

The proposed street use and design defined and described in Chapter III are considered to be better than the best current practice, on the assumption that there would be sufficient choice for people to find what they considered better. Subject to this assumption, the first hypothesis can be accepted. The assumption
could only be checked by actual experimentation with the proposed practices.

The proposed designing process for street use and servicing in local residential streets appears to be feasible from all points of view with the following qualifications. Public acceptance of roads close to houses and 'communal' parking areas and the assumption regarding the relationship between benefits and costs could only be determined by full-scale experiment.

The proposed practices of installing property service facilities appear to be feasible with minor qualifications from all points of view except economically. The all-utility trough and tunnel structures are economically feasible on the basis of the assumptions made, although they might be accepted by some people who value the resultant benefits highly. The all-utility tubed-conduit, however, appears to be not only economically feasible, but possibly able to yield savings compared to the best current practice. These could be either shared by those served and taxpayers, or used to provide additional services or a higher quality of services. The other types of structures appear to be economically feasible or so nearly so that the extra costs would be accepted in exchange for the added benefits that would accrue.

It is suggested that the design possibilities possible with utility structures and the apparent feasibility of all-utility tubed-conduits are worth investigating further.

An actual full-scale experiment on the basis of the proposed practices should be undertaken. This should be accompanied by development of a nearby area at the same time so that detailed cost and public reaction can by analyzed and evaluated on comparable bases.
Certain aspects, such as the design of the proposed 'servi-center' or typical 'problem' streets might be made the subject of competitions for architects and landscape designers. Eventually, a new profession of street architects or designers might evolve who would concern themselves with this important part of our environment.
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G. INTERVIEWS

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Ferman, Ben., and Gary Barclay. Design Engineers, Superior Concrete Products Ltd., 551 Seymour Blvd., North Vancouver.

Hickley, D. i/c Civic Design Section, Planning Dept., City of Vancouver.

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Johnson, Dale. President, Dale Distributors (B.C.) Ltd.

Kenyon, Douglas. City Engineer, City of Port Moody.

Libbey, Hugh. Manager, Gas Distribution, B. C. Hydro & Power Authority.

MacLellan, Len., Utilities Engineer, Engineering Dept., City of Vancouver.

Taylor, J. B. Superintendent of Service Requirements, Central Post Office, Vancouver, B. C.

Walton, Dennis. Municipal Planning Officer, District of West Vancouver.

Welsh, Douglas. Engineer, District of North Vancouver.
# TABLE OF CONTENTS

## APPENDIX

### A. CURRENT SERVICING PRACTICES - A Detailed Description and Ranking for Ten Selected Metropolitan Municipalities, and Comparison with Practices Elsewhere

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Services (vehicular, pedestrian, other)</td>
<td>197</td>
</tr>
<tr>
<td>Baric Services (water, gas, other)</td>
<td>202</td>
</tr>
<tr>
<td>Communicative Services (telephone, cable TV and radio, other)</td>
<td>206</td>
</tr>
<tr>
<td>Drainage Services (storm, sanitary)</td>
<td>211</td>
</tr>
<tr>
<td>Electrical Services (power, street lighting, other)</td>
<td>214</td>
</tr>
<tr>
<td>Furnishing Services (furniture, finishes, other)</td>
<td>217</td>
</tr>
<tr>
<td>Gardening Services (planting, plant care)</td>
<td>221</td>
</tr>
<tr>
<td>Holding Services (for collection, distribution)</td>
<td>224</td>
</tr>
<tr>
<td>Indicating Services (informative, regulatory, demarcative, advertising)</td>
<td>229</td>
</tr>
<tr>
<td>Keeping Services (keeping facilities in sound condition, functioning, clean and tidy, other)</td>
<td>235</td>
</tr>
</tbody>
</table>

### B. INSTALLING UTILITY STRUCTURES - A Description of Possible Processes for the Various Types

- Trough Structures | 243
- Tunnel Structures | 249
- Installing Non-drainage and Electrical Structures Over Drains | 253

### C. COST DATA

<table>
<thead>
<tr>
<th>Table Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table V. - Underground Wiring Costs for Transformer-Secondary Combination to Serve Back-to-Back Lots</td>
<td>255</td>
</tr>
<tr>
<td>Table VI. - Sewer Costs, City of Port Moody</td>
<td>256</td>
</tr>
</tbody>
</table>
APPENDIX A

CURRENT SERVICING PRACTICES:
A DETAILED DESCRIPTION AND RANKING FOR TEN SELECTED METROPOLITAN MUNICIPALITIES, AND COMPARISON WITH PRACTICES ELSEWHERE.

This appendix presents the detailed description and evaluation of current servicing practices in local residential streets in metropolitan Vancouver from which the composite best, normal, and worst practices described in Chapter II were derived for the purposes of this investigation.

Ten municipalities have been selected for this detailed examination on the basis of recent subdivision and servicing activity and future potential. They are the City of Vancouver; the surrounding Districts of West Vancouver, North Vancouver, Burnaby, and the Township of Richmond; and the outlying municipalities of the City of Port Moody, Districts of Port Coquitlam, Coquitlam, Surrey, and Delta. These are shown on Map.2 on the following page. The reasons for not including the other municipalities in metropolitan Vancouver are outlined in Chapter II (see page 63).

The servicing practices have been evaluated qualitatively and are described below in terms of five ranks - best, better, normal, worse and worst. The normal rank is assigned to the most common or widespread practice for a given service, and the other ranks are related to it. Best and worst ranks are assigned to practices that are superior and inferior respectively to the normal practice in some significant aspect. The better and worse ranks are introduced whenever there are practices significantly distinct from the others. Thus, 'better' refers to a practice significantly superior to the normal practice, but inferior to the best practice for that particular service.

The evaluation of current servicing practices involved
Vancouver Surrounding Municipalities

Certain delta, agricultural and mountainous lands excluded

MAP 2. METROPOLITAN VANCOUVER - AREAS INVESTIGATED
the application of the public interest criteria and/or the principles presented in Chapter I. For instance, a servicing practice that was significantly superior (or inferior) to others in terms of public health, safety, convenience, welfare, amenity, or economy has been up-(or down-) graded. Also, practices in which subdividers install facilities which have been ranked above others on the basis of the principle of payment for benefit. Similarly, practices where facilities are installed prior to first occupancy have been ranked above others according to the principle of maximum benefit. It should be noted that these ranks apply only to practices where services are provided.

The format of this appendix is as follows. The various practices of a given service are described by their ranks. The actual practice in Metropolitan Vancouver is then described by noting which municipalities or parts of them follow the various practices. This description is based upon the investigator's knowledge of the area and an examination of municipal subdivision control by-laws. Finally, practice elsewhere than in the ten selected municipalities is mentioned when pertinent. In some cases, this involves areas in Metropolitan Vancouver not otherwise considered, particularly the University Endowment Lands (U.E.L.). Most of such comments, however, pertain to practices elsewhere in North America and in Europe. Those for North America are based upon a perusal over the past five years of newspapers and magazines, particularly the Financial Post and House & Home. The comments about Europe are based mainly upon observations made by the investigator on a tour from June to November in 1961.

The order in which the services are discussed follows the classification of services outlined in Chapter I, beginning with the access services. For the convenience of the reader, Table I showing a summary of the classification of services is reproduced on the following page.
### TABLE I.
**CLASSIFICATION OF SERVICES AND THEIR FACILITIES**

**OTHER SERVICES:**

<table>
<thead>
<tr>
<th>ACCESS SERVICES: Pavements:</th>
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<tbody>
<tr>
<td>Vehicular roads</td>
<td>Baric services: Pipes:</td>
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<tr>
<td>Pedestrian walks</td>
<td>Water *</td>
</tr>
<tr>
<td>Other access: paths:</td>
<td>Gas *</td>
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<tr>
<td>Cycle cycle</td>
<td>Other baric:</td>
</tr>
<tr>
<td>Equestrian bridle emerg.</td>
<td>Fuel oil *</td>
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<td>Emergency veh. transit</td>
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**COMMUNICATIVE SERVICES:**

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<th>Cables:</th>
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<tr>
<td>Telephone *</td>
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<td>Cable television T.V.cable &amp; radio</td>
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<td>Other communicative:</td>
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<td>Fire alarm *</td>
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<tr>
<td>Burglary alarm *</td>
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<td>Traffic control *</td>
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**DRAINAGE SERVICES:**

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<td>Sanitary drainage * (or sewerage) (or sewer)</td>
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**ELECTRICAL SERVICES:**

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**FURNISHING SERVICES:**

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<td>Finishes</td>
</tr>
<tr>
<td>Decorations</td>
</tr>
<tr>
<td>Ornaments</td>
</tr>
<tr>
<td>Decorative</td>
</tr>
<tr>
<td>Lighting</td>
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**GARDENING SERVICES:**

<table>
<thead>
<tr>
<th>Plants:</th>
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<tbody>
<tr>
<td>Planting services</td>
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<tr>
<td>Trees, shrubs, flowers, grass, ground covers.</td>
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**HOLDING SERVICES:**

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<tbody>
<tr>
<td>Collection</td>
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<tr>
<td>Distribution</td>
</tr>
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<td>Letter, parcel boxes</td>
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<td>Mail, newspaper</td>
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**INDICATING SERVICES:**

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<td>Informative</td>
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<td>Regulatory</td>
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<td>Demarcative</td>
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<tr>
<td>Advertising</td>
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<td>Signs</td>
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<td>Signs</td>
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<td>Signals</td>
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<td>Markings</td>
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**KEEPING SERVICES:**

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<td>Facilities:</td>
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<td>In sound condition roads</td>
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<tr>
<td>Functioning roads</td>
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<tr>
<td>Clean and tidy roads, pipes</td>
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<tr>
<td>Other keeping services</td>
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<tr>
<td>Such as:</td>
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<tr>
<td>Roads</td>
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<tr>
<td>Pipes</td>
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* Same term as for service, e.g. water pipes
II. ACCESS SERVICES

The services herein classified as access services are those facilitating access to the property abutting a street by providing pavements upon which people and vehicles or other modes of travel can move easily to and into each property from others, or wait to do so. The current practice of providing vehicular, pedestrian, and other access service facilities are discussed separately below.

**Vehicular Access**

The vehicular access service provides roads and connections to driveways on abutting property upon which vehicles of most types can drive, wait, and park. In current practice, the road is always centered in the street, and is usually symmetrical in functional layout and physical design. The central portion used for the movement of vehicles along the street ordinarily has a strip on either side for parking vehicles parallel to the street. Exceptions are unusually narrow streets and short culs-de-sac which may have parking on only one side or none at all. These parking strips are seven or eight feet wide and may be paved with a different material than the movement portion. Currently, the latter usually accommodates two full movement lanes (one for each direction) in preference to earlier practices involving a compromise width roughly equivalent to a lane and a half. Since the lanes can be anything from eight to twelve feet wide, local roads with parking strips on both sides range from thirty to forty feet in width. The variations in current practice of providing vehicular pavements are outlined below.

**All practices.** The best practice of facilitating the vehicular access service is for the subdivider to install an asphalt pavement between concrete curb-gutters on gravel or sand sub-bases to specifications established by municipal engineers. Better than normal practices are installing an asphalt pavement with an asphalt curb or no curb. The normal practice is for the
subdivider to install a gravel pavement only and the municipality to install an asphalt pavement later, on a local improvement basis. A worse practice is installing flush coats instead of asphalt on the same basis. The worst practice is the provision by the subdivider of a gravel or soil cement pavement with no later addition of a more durable surface.

**Actual practice.** The best practice is followed fully only in Richmond. Asphalt pavements with concrete curbs have been or are being installed in other areas in special circumstances, such as institutional or municipal land ownership. The University Endowment Lands and Central Mortgage and Housing Corporation developments such as Fraserview and Renfrew Heights have these facilities. A city-owned area being developed in Vancouver will have them.\(^1\) Some large-scale developments have asphalt pavement and concrete curbs installed for competitive reasons rather than as a municipal requirement, but these are exceptions.

The better than normal practices are followed in Delta, West Vancouver, and North Vancouver, the latter requiring an asphalt curb in addition to the asphalt pavement. The other municipalities follow the other practices except in the special circumstances mentioned. Whether the practice is a particular area will follow the normal, worse, or worst practices depends on the willingness of both the municipality and residents to pay for the pavements. Generally speaking, the tendency to install asphalt or flush coat pavements is greater near Vancouver and near streets already paved, although flush coating is more common than asphalt in Vancouver itself. It is somewhat ironic that the actual standard of paving in many areas of Vancouver has been lower than in areas of other municipalities because the standards set for permanent type pavements were higher. One such standard was for cast concrete pavements and curbs which were

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\(^1\)At 54th. Avenue and Kerr Street; (see diagram on following page).
installed in only those few blocks where the residents were willing to pay for them. The majority of streets have a less permanent type requiring more maintenance. The City is currently embarking on a 'low-cost paving program' to raise the actual standard of pavements and reduce maintenance costs.

**Practice elsewhere.** Some recent developments in the United States have concrete roads installed by paving machines.²

**Pedestrian Access**

The pedestrian access service provides a pavement whose primary purpose is to facilitate movement of pedestrians along the street. The pedestrian pavement is commonly called a sidewalk because it is at the side of the street. It may be located anywhere between the edge of the road and the boundary of the street. It is usually offset at least one foot from the boundary to allow work to be done on it or to take up differences in grade between sidewalk and private property. There are two schools of thought on location of the sidewalk in the street. One holds that sidewalks should be near the road so that clearing and excavating for them can be carried out with these operations for the road so that the sidewalk can be built integrally with the curb to save costs, and so that the space available for planting trees is not split. The other holds that the sidewalk should be away from the road so that people walking on it will not get splashed, so that the sidewalk can have a different configuration than the road, and so that the road can be widened without moving the sidewalk. The latter point should not apply to local streets, but unfortunately does in some cases. Sidewalks are usually four or five feet wide.

**All practices.** The best practice of providing pedestrian pavements is for the subdivider to install concrete sidewalks on both sides of the street prior to occupancy of dwellings in the area. A better than normal practice is for the subdivider to

²According to several advertisements in magazines such as *House & Home*. 
install one sidewalk. The normal practice is for municipalities to install sidewalks on one or both sides some time after first occupancy on a local improvement basis. A worse practice is installing asphalt pavements because they require more maintenance and more frequent replacement than concrete ones, and thus can cost more in the long run, though being cheaper initially. Installing screenings walks by the municipality out of general revenue is the worst practice because the fine-screen crushed rock particles settle unevenly and become scattered, resulting in damp spots, puddles, and an untidy appearance.

**Actual practice.** The best practice has only been followed in Vancouver's recent subdivision and the University Endowment Lands where the servicers happened to be the owners. Richmond requires subdividers to follow the better practice of providing one concrete sidewalk, and also requires an asphalt pavement where walkways are provided at the rear of lots. All other municipalities including Vancouver ordinarily follow the other practices with the normal practice of adding concrete walks on a local improvement basis being more common in Vancouver and the surrounding municipalities. Screenings pavements are installed by municipalities in older developments, especially along the flanking street of a block where a concrete sidewalk cannot be paid for on a local improvement basis.

**Other Access Services**

The other access services are those providing pavements for modes of travel other than by ordinary motor vehicles and walking including cycle, wheelchair, equestrian, emergency vehicles, and transit. Transit and equestrian can be excluded from local streets by definition, and the other modes ordinarily require only special consideration in the layout of streets and provision of ramps to avoid the curb.

**Actual practice.** Special consideration or provision for these other modes is practically non-existent on local streets.
in Metropolitan Vancouver, and rare on other streets. Motor cycles use the road. Bicycles, tricycles, and wheelchairs usually travel on the sidewalk, even though bicycles are often prohibited on sidewalks by municipal by-law. There is a special two foot wide asphalt cycle path on a one block section of Chancellor Boulevard in the Endowment Lands for children going to University Hill School. There are wheelchair ramps at Twelfth Avenue and Heather Street for the Vancouver General Hospital. The hospital also has a special sidewalk crossing for emergency vehicles on Twelfth Avenue at Willow Street. Bridle paths on streets are confined to Southwest Marine Drive and the 'Southlands' area of Vancouver, which is a small holdings or limited agricultural district.

III. BARIC SERVICES

The baric or pressure services are those which supply commodities to property or streets through pipes under pressure. Water and 'domestic' gas are the only commodities ordinarily supplied to residential districts. However, such commodities as fuel oil and steam have been supplied through pipes installed in streets elsewhere and conceivably could be supplied in residential districts. Consequently, they have been included in the baric services considered below.

Water

Water is supplied for such private purposes as drinking and cooking for which it must be potable; washing, bathing, and swimming for which it must be clean; sprinkling of gardens and flushing of pavements for which it must have adequate pressure; and cooling for which it must be cool. The important public purposes requiring water under adequate pressure and available through hydrants in the streets are fire-fighting and flushing of streets and sewers. Water also may be provided for such public
purposes as supplying fountains for drinking, cooling, or their amenity value; and for sprinkling of lawns and plants, but rarely on local residential streets.

**Best, normal, worse, and worst practices.** The installing of cast iron water pipes has been taken as the best practice when the normal practice is to use asbestos cement pipes. In either case, they are supplied by the subdivider, or by the municipality at the subdivider’s expense, and are a minimum of six inches in diameter to ensure adequate pressure for fire-fighting purposes. A worse practice, regardless of material or size, is considered to be that of the municipality supplying the water service at its own expense. There are two main reasons for this. One is that the municipality may be unable to control the spread of development into areas which are uneconomic to service because of the political pressure to provide water service. The other is that it is believed to be inequitable because on the one hand the land owner receives the market value of serviced land when he did not pay for the services. On the other hand the land buyer pays the market price which includes the cost of servicing and then has to help pay through taxes, for the cost of the municipality providing these services. This is contrary to the principle of payment for benefit. The worst practice is installing undersized pipes - that is, pipes whose diameter is too small to either provide adequate pressure for fire-fighting purposes or to meet the needs of the ultimate development in the area served. This is a matter of financial feasibility, because it is done where there is a provincial government limitation on the amount of costs that can be charged to the people being served, and a limitation on the financial resources of the municipality to supply services in areas having a low density of development.

**Actual practice.** The larger-sized water transmission pipelines are of precast concrete or welded steel installed by the Greater Vancouver Water District Board. Distribution pipes
are of cast iron in Vancouver and normally of asbestos cement in the other municipalities, except for the larger sizes where cast iron is used. Vancouver is the only municipality not requiring the subdivider to install the water service. The problem of under-sized water pipes has been mainly confined to parts of Surrey.

Gas

Natural gas is supplied in Metropolitan Vancouver by the B. C. Hydro & Power Authority for such domestic purposes as home and water heating, cooking, and outdoor lighting.

Normal, worst, and actual practice. The actual practice of installing the facilities of the gas distribution service is homogeneous throughout the area studied because only one agency is involved and its own forces do the work. The distinction is made herein between what is now the normal practice of installing facilities prior to pavements and planting in developments and what is considered to be the worst practice of installing them afterwards. The former privately owned B. C. Electric Company tried to maintain favourable public relations when installing facilities in developed areas by striving "to restore everything as near as possible and practical to the original condition." This policy included careful replacement of sod, reseeding where necessary, requesting inspection by householder of work done on rockeries and flower beds, and restitution for plants killed. Cuts in driveways were to be kept small, were temporarily "cold patched", and then permanently repaired with hot asphalt mix after settlement. The present publicly owned company seems to be following this policy reasonably well on private property but does not repair cuts in streets as well as it might.

4Loc. cit.
Gas pipe has been mainly steel coated with asphalt and wrapped with paper, but the competition from plastic pipes has forced steel pipe companies to produce a polyvinylchloride (P.V.C.) coated pipe that is becoming the standard for this area. The new portions of the distribution system are under high pressure and require only one-half inch diameter house connections and two or three inch street facilities. The former are usually installed a minimum twelve inches deep or below normal digging, but deeper where regrading is expected. Street facilities are installed eighteen inches deep and quite close to trees because roots usually do them no harm. They must be deeper under roads.5

**Practice elsewhere.** The gas utility company serving Metropolitan Vancouver also serves parts of the Fraser Valley and has a fair sized plastic pipe test installation at Abbotsford. While the pipe itself is cheaper than steel pipe, several problems and expenses were encountered, which, together with reservations about the long-term durability of the pipe make the company reluctant to install much more at present. One problem is that present plastic valves are considered unsuitable so metal ones are used, but it is uneconomic to provide cathodic protection to these when separated electrically by plastic pipe.6

**Other Baric Services**

There are no other baric services currently installed in local residential streets in Metropolitan Vancouver. There are a few in downtown Vancouver such as steam pipes leading to the building served by the steam plant in the Hotel Vancouver. The University of British Columbia has an extensive steam heating system that is partly underground, occasionally in structure

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5The information in this paragraph was derived from an interview with Mr. Hugh Libbey, Manager of Gas Distribution, B. C. Hydro & Power Authority.

6Ibid.
containing facilities of other services. However, the system is not related to the street system - indeed, it seems to avoid streets to minimize crossings.

**Practice elsewhere.** Fuel oil distribution systems have been installed in the streets of a few residential developments in New York State by a developer who found them to be less expensive than installing either a gas system or fuel oil tanks for each house. Those served by this system get these advantages:

- no fuel-oil tanks to replace or repair;
- no worry about running out of oil when roads are blocked by snow;
- no oil trucks running over lawns;
- year-round monthly filling;
- no short-term price increases during oil shortages.

### IV. COMMUNICATIVE SERVICES

The communicative services are those which make possible several types of communication by installing cables and other facilities in streets. The telephone service is by far the most important, but the alarm and control ones are often necessary and cable-television is gaining in popularity and importance.

**Telephone**

The telephone service is provided primarily for communicating by voice. It can be used for communicating by various types of signals such as high-speed transmission of data for computers and other machines. The main private use of the telephone is for conversation between two persons, but there is a growing use of telephone answering devices which either record the message of the person calling or give out such information.

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8 Loc. cit.
as the time, a standard musical tone, weather forecasts, and current entertainment events. Such devices are provided by private companies on rental basis or by charges for advertisements given out with other information. Public 'pay' phones serve the same purposes. These and certain other facilities are considered separately because their requirements and the services they provide are different. These include public 'taxi' phones, and police and transit supervisor call boxes, all having direct lines to the respective office or headquarters. All telephone facilities are provided by the B. C. Telephone Company.

Best, normal, and worst practices. The best practice of providing the telephone service is installing telephone cables underground in conduits laid in a common trench with those of the electric power and lighting services. The normal practice is to install cables overhead on power poles using an integrated cable and having support wire to minimize the unattractiveness of the facility. The worst practice is installing cables on separate telephone poles using hangers to suspend the cable from an independent support wire.

Actual practice. Telephone cables have been installed underground only in small areas in Vancouver, North Vancouver, Port Moody, and Richmond. Vancouver is currently placing cables underground in a City-owned subdivision that it is servicing. These are exceptions to the general rule of overhead installation.

9 Few public pay phones (called 'pay stations' by the telephone company) actually are installed on streets in Metropolitan Vancouver, unlike most other parts of North America. An official of the telephone company states that the company is unable to provide as many public pay phones as it thinks are required for adequate service, especially in downtown Vancouver, because the City will not permit them on the streets and there are few places where they can be placed on private property. Some of the existing locations may be lost when the site upon which they are located is more intensively developed. The reason given for the City policy was that the phone booths block the view of motorists and are therefore unsafe.
Practice elsewhere. There is a trend in other parts of North America towards installing telephone cables underground. The Bell Telephone System, which controls 81 percent of the telephones in the United States, asked its 22 operating companies to bury their cables whenever possible. It is expected that virtually all new service will be installed underground by 1970. Many of the more recent underground installations have been by the direct burial method. In this method, special underground cables are laid directly in the earth rather than being pulled through conduits. They are sometimes placed in a common trench with electric power wires with a separation of only a few inches. A new 'random' laying technique is being used by Illinois Bell and Commonwealth Edison that has reduced their trenching costs by 25 percent. Phone cables and power wires are laid at the same time in a 30 inch trench that requires only one backfill. Separation trenching recommended by the National Safety Code calls for a 36 inch trench and one foot vertical separation requiring two laying and backfilling operations. One of the most interesting techniques is the direct burial of telephone cables by ploughing. This is done by pulling a cable into the space opened up in the earth by a point attached to the bottom of a blade pulled through the earth by a tractor. This technique obviates the need for excavating and backfilling a trench, but is suitable only in certain soil conditions.

Cable-television and Cable-radio

Services supplying television and radio signals (video and audio) via coaxial cable from a master antenna are herein termed cable-television (or cable TV) and cable-radio. The two are normally supplied together, but the radio may be frequency.


11 Ibid., p. 128.
modulated (FM) only. These services are becoming popular in areas where either normal reception is poor or where expensive and unsightly individual antennas would be required to receive distant stations properly.

Normal and actual practice. The normal practice is to install cables on telephone poles or on power poles with telephone cables. Amplifiers are required at the master antenna and at intervals along the cable to maintain signal strength.

Other Communicative Services - Alarm, Control, Telegraph

The alarm and control services are discussed together here because they are similar in most respects. Their purpose is to communicate alarms or control impulses from detecting or reporting stations to stations at which action occurs as a result of the alarm or control impulse. The detecting and reporting can be done either manually or automatically and the resultant action can also be automatic or manual.

The alarm service is concerned with communicating alarms about fire, burglary, and attack by enemy action, radiation, or toxic gas. Facilities for fire alarms are the most common and the only ones ordinarily installed in local residential streets. They consist of a simple reporting device - the common 'fire alarm box' or station - cable to the nearest fire hall, and devices there for ringing a bell and indicating the location of the reporting device. Automatic fire detecting devices are usually only installed on commercial or industrial property where they ring a local fire bell as well as sending an alarm to the fire hall. Public fire alarm systems are provided by the municipality.  

Burglary detection devices are also normally confined to commercial and industrial property and are usually automatic. They also usually ring a bell on the premises as well as sending

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12 Vancouver has a City-owned fire alarm company. Sarnia, Kingston, and some suburbs of Montreal have systems provided by privately owned telephone companies.
an alarm to the police station. The exceptions are banks which
during the day use a manually operated reporting device that does
not ring a bell on the premises, but may start a movie camera.
Burglary alarm systems are provided by separate companies or the
telephone company. The attack alarm service operates in the
reverse fashion in that the alarm is sounded by devices such as
sirens located around the areas served, usually on public buildings
such as firehalls. The alarm is communicated from a central
manually operated reporting device. Automatic radiation detecting
devices are currently being installed in the United States by the
federal government.

The control service is comprised of those facilities
dealing with the control of such conditions as illumination,
temperature, moisture, and traffic flow. The level of illumina-
tion is the only condition ordinarily controlled on local
residential streets. This involves switching street lights on
and off when the level of natural illumination is below or above
the minimum desired level. This can be done either by control
impulses sent from centrally located manual or automatic reporting
devices, or from automatic detecting devices attached to each
lamp or one of those on a common circuit. Control of temperature
and moisture conditions is currently confined to buildings except
perhaps, for heated pavements which are practically unknown in
this area. Control of traffic conditions is required where
traffic volumes are high such as on major and downtown streets.
Traffic signals are normally controlled by timing devices located
in boxes attached to poles at one of the corners of the
intersection. Vancouver has one installation in which a series
of traffic signals are controlled by an analog computer on the
basis of the traffic volumes entering a system as counted by
infra-red detectors installed over the traffic lanes. Control
service facilities are installed by the municipality.

Telegraph cables are similar to and installed with
telephone cables both overhead and underground, and since they
rarely occur in residential areas are of no further concern here.

**Best and normal practice.** The best practice of installing the alarm and control cables is in conduits provided by the subdivider along with electric power and lighting ones. The normal practice is to string the cables on power or telephone poles.

**Actual practice.** All fire alarm main cables are underground in Vancouver, usually in space in large conduits rented from the telephone company that was set aside at the City's request. Leads from fire alarm boxes to main cable are underground whenever other wires and cables are underground but are usually on telephone poles.\(^{13}\)

V. DRAINAGE SERVICES

The drainage services are those which collect and remove storm water and sewage by gravity flow through drains and consist of only the storm drainage and sanitary drainage or sewerage services.

**Storm Drainage**

The storm drainage service collects and removes excess storm and ground water from property and streets by providing facilities to collect or intercept flowing water and concentrate and channel the flow away from the area. On property, storm water (rain, melted snow, etc.) is collected and intercepted by the valleys and gutters of roofs and flows through downspouts to the site drain. Ground water is intercepted by drains of tile or perforated pipe usually placed around buildings which also connect to the site drain. The site drain carries the flows from these sources and any others such as gutters or gratings in driveways to the street storm drain. The storm drains on sites or streets may be 'open' (i.e. uncovered) drains consisting of

\(^{13}\)Interview with Mr. Len MacLellan, Utilities Engineer, Engineering Dept., City of Vancouver.
trenches lined with concrete, corrugated metal, or wood; or ditches simply cut into the earth. Storm water on streets is intercepted by open drains, particularly gutters, collected by catch-basins, and carried by laterals to the street storm drains. Ground water under pavements is sometimes collected by tile or perforated pipes in gravel beds either under or alongside the pavements and carried by laterals to the street storm drain.  

**All practices.** The best practice is considered to be installing storm drains integrally with sanitary drains as 'twin' drains, and concrete curb-gutters by the subdivider. A better practice than normal is installing concrete curb-gutters and separate storm drains by the subdivider. The normal practice is for the subdivider to install ditches with culverts under driveway and front walk connections that are often later replaced by storm drains and less often supplemented by curb-gutters. installed on a local improvement basis. A worse practice is installing ditches with culverts and later adding storm drains and catch basins out of general revenues on some streets to intercept the flow in the ditches on other streets. The worst practice is installing ditches and culverts only.  

**Actual practice.** The best practice has been followed only in the City-owned land that Vancouver is currently subdividing and servicing. Vancouver ordinarily installs twin drains in new subdivisions at its own expense and installs curb-gutters later on a local improvement basis when requested, but this is relatively uncommon.  

The better practice is required only in Richmond but has been followed in several of the better recent developments in other municipalities and the University Endowment Lands. The other practices are followed in the other municipalities considered, and judging by recent practice the adding of storm drains is the exception rather than the rule. 

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14 The term 'storm sewer' has been avoided so that the term sewer can be restricted to the sanitary drainage (i.e., sewerage) services.
Sanitary Drainage or Sewerage

The sanitary drainage or sewerage service collects and removes sewage and waste fluids from plumbing facilities of buildings through plumbing stacks and a sewer connection to the sanitary drain or sewer in the street.

All practices. The best practice is for the subdivider to install sanitary drains with storm drains as twins. A better than normal practice is for the subdivider to install sewers separately. The normal practice is for the municipality to allow the installation of septic tanks by developer or homeowner, and to install sanitary drains later on a local improvement basis. The practice of the municipality installing sewers at the time of subdivision is considered worse than the normal one in terms of the principle of payment for benefit, although it is better than one involving septic tanks from the standpoint of health. The worse practice is to allow installation of septic tanks and not provide sewers later.

Actual practice. The best practice has been followed only in Vancouver's recent subdivision of its own land (at 54th. Ave. and Kerr Street). The better practice is required in some areas of Richmond and Delta, and is followed in some other areas where required by mortgage institutions. The normal practice is followed in areas not covered by the other practices. The worse practice is followed by Vancouver which is considered best practice when its own land is involved. The worst practice is followed in the least dense portions of the outlying municipalities.

Practice elsewhere. Some developments in the United States beyond economic extension of trunk sewers are being served by sewers and small sewage treatment plants. The sewers are designed to tie in with the trunk when extended, and the treatment plant can be moved to other locations. This allows development at urban densities without the problems of septic tanks in poorly drained soils, and eliminates the extra costs of the tanks and
sewer installation (repairing pavements, etc.)

VI. ELECTRICAL SERVICES

Electrical services are those supplying electricity through wires as a source of power for private purposes, light for streets, and light, heat and electrical charge for certain other public purposes discussed below.

Electric Power

The private uses to which electric power is put are many and varied, and ever increasing. The major types are lighting, heating - including water heating, cooking, clothes drying, and ironing - and powering motors of the host of appliances available today. The B. C. Hydro & Power Authority installs electric power facilities in all of the areas being considered.

All practices. The best practice of installing the electric power service is for the Authority to lay wires in conduits provided by the subdivider in a common bed with conduits of other services. A better practice than normal is installing wirings underground across streets and confining overhead wires to easements along rear property lines. The normal practice is wiring overhead from poles placed in lanes or easements along the rear property line which also carry telephone service facilities. A worse practice is having the overhead wiring and telephone cabling on poles installed in the streets. The worst practice is having separate poles for the electric power and telephone services installed on streets.

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16 New Westminster buys electric power in bulk and retails it through its own distribution system.
Actual practice. Underground wiring has been installed only in a few small areas of Vancouver, North Vancouver, Richmond, New Westminster, and Port Moody. The combination of underground and overhead wiring has been used only in the University Endowment Lands. The majority of areas are served by overhead wiring by either the normal practice where there are lanes or the worse practice where there are not, since the electric power company has discouraged using rear easements. Separate poles for electric power and telephone services have seldom been installed in recent years but vast areas remain served by this worst practice.

Practice elsewhere. Prior to about 1960, electric power installations in residential districts involving only underground wirings were severely limited in number and extent in North America and the prospects were none too encouraging. In Canada there were only a few in Ontario. Most such installations were considered as tests or experiments to determine the practicality of underground wiring and had widely varying success in achieving the aim of reducing costs to that of overhead wiring. A survey in 1956 found that underground wiring had been installed in small developments in Peterborough at no extra charge because of expected savings, and in Toronto at less cost than overhead in favourable soil conditions and in co-operation with the telephone company.\footnote{Ruth Martin Thompson, "To Bury or Not to Bury", Ontario Planning Supplement, Toronto, Community Planning Branch of Department of Planning and Development, vol. 3, no. 5 (May-June 1956).} Most electrical utility companies, however, either refused to consider underground wiring or charged so much extra that it could be afforded by very few.

A more recent survey in the United States has found a marked change of attitude which is attributed to a policy change.
by the Bell Telephone System in favour of underground wiring. Where telephone cables are installed underground, the electric utility companies not only lose potential rental for use of their poles, but also are put in a sensitive position. An electric company executive is quoted as saying:

> With all the other utility lines out of sight, we're the only ones left messing up the landscape, and we're really beginning to feel the public pressure. It's good public relations for us to go underground as fast as we can.

**Street Lighting**

The street lighting service provides illumination for streets by installing lamps on supports and wires to supply them with electricity.

**Best, better, normal, and worst practices.** The best practice of installing the street lighting service is considered to be that of the subdivider installing lamps on 'ornamental' aluminum poles with underground wiring. Installing aluminum poles is considered better than the normal practice of installing painted steel poles because maintenance costs are lower and they are more attractive. Both are on a local improvement basis and have underground wiring in conduits with other wires or in separate conduits installed alongside the curb or sidewalk. By far the worst practice is for the electric utility company to hang a single lamp at intersections from wooden power poles.

**Actual practice.** The best practice is required only in Richmond. However, underground wiring by the better and normal practices is becoming more common in recent installations and is replacing the worst practice in older areas.

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19 *Loc. cit.*
Practice elsewhere. Streets in a few recent developments in the U. S. have been lit by lamps installed in the front yards of private property by the owners as a condition for being served by underground wiring. In Europe, particularly on narrow streets in England and Germany, both incandescent and fluorescent lamps are installed on brackets attached to buildings with wiring running along ledges of the building. Lamps are also installed in Germany by hanging them from support wires suspended between rings attached to buildings.

Other Electrical Services

The other electrical services considered are those providing electricity through wires as a source of light, heat and electrical charge for the following public purposes. The light is for shelters, special use areas (e.g. conversation, playing) and decorative lighting - the lamps themselves being considered furnishings. Heat would be supplied for such purposes as melting snow and ice from pavements, protecting pipes from freezing, and possibly heating soil for plants. The latter is a rather exotic service likely to be installed only in planting boxes in civic squares. An electric charge is applied to metal pipes and fittings installed in the soil to prevent electrolytic action.

Actual practice. Light is provided only in telephone shelters. Heating is not considered to be required in the climate of this area. Anti-cathodic protection is generally only provided for gas pipes in adverse soil conditions.

VII. FURNISHING SERVICES

The furnishing services are those which enhance the environment of which the street forms an important part and make the street more livable by providing furnishings. These furnishings are either facilities or properties of facilities not essential to the provision of other services, but which
increases the convenience, amenity, and welfare of those using streets, usually at the expense of economy. They are analogous to the furnishings of rooms which makes them more comfortable and pleasant. The concept is a broadening and refining of the 'street furniture' one, often used by those expressing the need for better design of visible facilities in streets. The term furniture has been restricted herein to facilities analogous to things usually thought of as furniture in houses as distinct from other furnishings. Besides discussing some of these other furnishings, more fully than is customary, the concept of finishes on visible surfaces is more fully developed.\(^{20}\)

**Furniture Services**

The furniture services are those providing such facilities as benches, fences, guardrails, shelters, cabinets, and toilets. Benches, which are analogous to couches, are for sitting while waiting for transit vehicles, supervising children at play, conversing with neighbours, or simply 'watching the world go by'. Fences would form 'outdoor cribs' to enclose play areas for small children containing a sand box and perhaps other furniture for playing. Guardrails are analogous to handrails or bannisters. Shelters might be provided for people waiting for transit vehicles, making telephone calls or using toilets, and for cycles or vehicles temporarily stored in the street. Cabinets enclose such facilities as power transformers installed at or near ground level, and various valves and other devices that must be accessible from the surface. Toilets are toilets wherever they are.

**Actual practice.** The only furniture besides cabinets for valves and other devices currently installed in local residential

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\(^{20}\) The whole concept of furnishings is developed still further in Chapter III.
streets are transformer 'kiosks' where there is underground wiring. These are usually in easements adjacent to lanes. Telephone shelters or 'booths' are located on more important streets, usually in commercial districts. Shelters for people waiting for transit vehicles are quite rare. Besides sizeable ones at the termini of several transit routes and small ones on a few rural routes, provided by the transit companies, there are transit shelters only at such places as the University, Oakridge Shopping Centre, and on Broadway near Arbutus Street in Vancouver. These were installed respectively by the University, the Shopping centre, and a bakery outside its head office. Toilets are not installed because of the problems of keeping them clean, tidy, and functioning, and the fear of children being molested.

Practice elsewhere. In the Swedish new town of Farsta, small fenced areas with sand boxes for small children and benches for their mothers appeared to be well used and appreciated by both, even though only about fifteen feet from the road. The design of street furniture in Europe is generally of a higher standard than that in North America.

Finishes Services

The finishes services are those providing surface finishes to facilitate certain uses or to improve the appearance of facilities. Considering the street as an outdoor room having pavements as carpets on a grass floor (analogy by function instead of texture), areas of special paving for such street uses as conversing or waiting for transit vehicles can be considered as 'scatter rugs' and 'welcome mats'. Like such furnishings in the home, they should have appealing textures or colours to provide variety and interest as well as distinguishing them from more utilitarian pavements. Unlike streets in other districts which can have interesting 'walls', the walls of local residential streets have the neutral character of window walls in living rooms which expose and serve as a frame for the view beyond.
Solid, opaque walls are thus confined to such vertical surfaces as retaining walls which are rare on residential streets since differences in elevation are usually taken up on the property off the street.

**Actual practice.** No examples of floor or wall finishes in the sense used herein were found by the investigator in the local residential districts studied. This is perhaps fortunate because in his opinion, many of the examples in other districts are rather appalling. Waiting areas at bus stops are often paved with screenings or poor quality asphalt. Even where there was a desire and opportunity to create a 'pedestrian island' for the block containing the Queen Elizabeth Theatre by special finishes on the sidewalks surrounding the block, the result was a rather dismal failure. The alternating brushed and dimpled sections are barely distinguishable from ordinary sidewalks and certainly less effective than alternative designs involving extension of the bold line pattern of the plaza at a smaller scale which had been prepared. Retaining walls installed by municipalities to allow for road widening are undoubtedly well-designed structurally, but seem to lack other design considerations. Usually no attempt is made to give the concrete surfaces texture or pattern. Some sections of retaining walls have been built of granite paving blocks (from beside former street car tracks) that are excellent in themselves, but look out of place between adjoining concrete walls, usually of different heights. On the other hand, to show what can be done, the Parks Board improved the appearance of the obsolete bath house terrace at English Bay by constructing a stone retaining wall to form a planting box.

**Practice elsewhere.** In Europe finishes are also much more carefully considered than in North America, not only for special

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21 Interview with Mr. D. Hickley, Civic Design Section, Planning Dept., City of Vancouver.
use areas, but often in the utilitarian pavements as well.  

Other Furnishing Services

The other furnishing services are those providing such furnishings as decorations, ornaments and decorative lighting. As in the home decorations are mainly for special occasions when gaily coloured strings of lights, pictures, and other things such as greenery, are hung about. Banners are perhaps more analogous to curtains or drapes that frame the view. Ornaments are more permanent furnishings such as statues and pools which are like figurines and aquariums. Decorative lighting includes any lighting primarily for such aesthetic purposes as highlighting the special features such as ornaments or planted areas. In the latter case, the lamp itself may constitute a furnishing when attractively designed.

Actual practice. Such other furnishings are practically unknown in local residential streets, but ornamental pools and decorative lighting are becoming common at entrances of developments for which an attempt is being made to create a favourable 'image'. Otherwise, ornaments and decorative lighting in streets is rare though it occurs in parks. Decorations however, are common on major streets in commercial districts, especially for the Christmas season, and Vancouver is becoming justly famous for the banners and pavement paintings on its Georgia and Burrard 'amenity streets'. These streets have permanent brackets for banners and a few sections of other streets plus the bridges crossing False Creek have permanent sockets for flags attached to lamp supports.

VIII. GARDENING SERVICES

The gardening services are those concerned with installing and caring for plants in streets. The more important plants are

trees because of their prominence and grass because the area covered is second only to pavements. The other types of plants that can be installed in streets are shrubs, flowers and ground covers such as ivy, moss, and rockery plants.

**Planting Services**

The planting services are those concerned with installing trees, shrubs, flowers, grass, and other ground covers.

*Best, normal, and worst practices.* The best practice for the planting services is for the subdivider to install boulevard trees and grass by seeding. A more normal practice is for the municipality to install the trees and leave planting of grass to adjacent property owners. The worst practice is also leaving the tree planting to the property owners who may choose unsuitable types such as those which drip sticky substances on cars parked beneath them or berries on sidewalks.

*Actual practice.* The best practice is being followed in The Richmond Gardens development but has been followed otherwise on no other local streets recently, and on only parts of certain major streets with median strips such as King Edward Avenue and Cambie Street in Vancouver. The planting of these streets is being done in stages with several years elapsing between installation of pavements and plants, during which time the area to be planted grows wild. The planting on these streets is not finished yet. When the normal practice is followed, the trees are usually installed a considerable time after most other services have been installed. Planting of grass on the boulevard by adjacent property owners usually does not take place until they have completed the landscaping of their own property, which may take a year or two. In many areas, especially those in the outlying municipalities having low densities of development, the boulevard is allowed to grow wild. The worst practice is less common than formerly because municipalities or their parks boards are better able to supply appropriate types of trees for
boulevards.

Vancouver has been removing large old trees and replacing them with new ones, generally of smaller flowering varieties. Unfortunately this has been done usually by removing all of the old trees at one time and then planting the new ones. This exposes houses of styles and conditions better left partly screened from view and creates a bare look that lasts for several years. Formerly well-treed areas such as the West End have had their character largely spoiled by replacement carried out in this manner in a short time.

**Practice elsewhere.** Several of the more progressive developers in the U.S. are planting trees and grass as sales attractions, and a few install fair-sized trees to make the development look complete and mature. However, such finishing is still less common than in Europe where trees are planted after the utilities are installed and grass is planted as soon as the pavements are installed.

Another practice observed in Europe and considered desirable is that of progressive replacement of trees. Such famous treed streets as the Champs Elysees give the impression of having trees of uniform size and spacing. Closer inspection reveals a wide range of ages and spacing. The appearance of uniformity is partly the result of careful pruning, but also due to the replacement program. Fair sized trees (trunks about four inches in diameter) are planted beside aging or diseased trees and given a chance to establish themselves before removal of the unwanted tree. Consequently there are never any noticeable gaps. The process can be carried out rather unobtrusively (except that chain saws are now used) because there is no need to jackhammer holes in concrete and patch up old holes. Instead, the granite blocks in the planting strip and the cast iron grille around the trees are simply rearranged.
Plant Care Services

The plant care services are those which maintain plants in a safe and attractive condition. Trees are kept safe by pruning of branches that have broken or grown in the way of pedestrians and vehicles or overhead wiring. Pruning may be done by the municipality, parks board, electric power or telephone utility companies, or adjacent property owners. Grass is cared for by mowing, watering, and fertilizing and other planted areas by weeding, watering, fertilizing, and spraying. These operations are performed by the municipality, parks board, or the adjacent property owners.

Actual practice. Except for pruning of trees, care of plants on local residential streets is left in the hands of the adjacent property owners. They generally take reasonably good care of 'their' boulevard because normally they have planted the grass and consider it an extension of the lawn on their property. Some property owners also take care of the trees on the boulevard to some extent, including pruning occasionally. Pruning is usually done by the parks board, however, except where there is overhead wiring. In this case it is often done by the electric power or telephone utility company. Their interest is to keep their wires and cables free of branches and they succeed in this respect, but not in enhancing the appearance of the trees. On streets with planted medians such as Cambie and King Edward, the plants in the median are completely and generally well cared for by the parks board. Some such as Cambie are treated, in effect, as extensions of a park.

IX. HOLDING SERVICES

The holding services are those providing holders in streets for the temporary storage of goods or waste materials for later collection or distribution and use.
Collection Holding Services

The collection holding services are those providing facilities in which are held for later collection such goods as letters and parcels and such waste materials as litter and garbage.

All practices. For holding letters and parcels deposited by people for later collection by mail trucks, the best practices are installing either ordinary boxes or 'snorkel' boxes placed for use by motorists from their car. The latter are ordinary parcel boxes with a 'snorkel' attachment protruding upwards and backwards through which motorists can deposit letters or parcels without leaving their car. A better than normal practice is installing either letter boxes on the support for another service such as street lighting, or letter and parcel boxes on a common post. The normal practice is to install letter boxes on separate posts and parcel boxes on four-legged stands, often attached to a concrete slab base. A worse practice is installing the temporary olive drab coloured 'suburban' or group type box, because they must be replaced later by the above types of boxes. The worst practice is considered to be installing the rural type box in non-rural areas because of the resultant appearance, costs, and lack of security, although providing more convenient deposit of mail than any of the above types. The normal and worst practices of installing holders for garbage collection respectively are installing garbage cans in lanes, and carrying them out to streets on collection day.

Actual practices. There is only one example of each of the two best practices of installing mail boxes - an ordinary box on a gasoline service station site at Lougheed and Bainbridge in Burnaby and a snorkel box at No. 3 Road and Cook, in Richmond. The latter is the only result of a survey reported underway in 1959. The problem has been that the post office prefers

23 Picture and comment in Vancouver Sun, February 18, 1959, p. 15.
locations on heavily travelled roads and usable from the driver's side of cars for convenient service, but municipalities will not accept stoppages of a lane of traffic on heavily travelled roads by persons using the boxes. Locations on one-way streets or in medians would be suitable, especially if provided with pull-out bays. However, such locations are rare or present other problems such as for pedestrians, and municipalities have been unwilling to provide the pull-out bays.24

The better than normal practice of installing boxes on other supports is followed when possible, but boxes have been removed from wooden power poles at the request of the utility company because of the danger to linemen. Even steel stop sign supports have been considered, but only one was found to be in a suitable location. The better and normal practices are followed wherever letter-carrier delivery service is extended. This is done when the yardage a carrier would have to walk to serve an area divided by the number of calls (i.e. households) does not exceed 40 yards. When this condition is not met, the worse practice of installing 'suburban' boxes is followed, except where rural route delivery exists, because the Post Office is loath to force people in these areas to walk to group boxes.

All of the boxes discussed above are of metal and are painted except for rural boxes which are aluminum galvanized steel. Fiberglass letter boxes have been installed on an experimental basis, and the main post office has two stainless steel 'curbside' boxes. The latter were specially designed in conjunction with the post office and are connected to it by underground conveyor belts.

All post office holders except rural boxes are usually installed at corners of intersections of relatively heavily

24 This and other information on post office practices from interview and telephone conversations with Mr. J. B. Taylor, Superintendent of Service Requirements, Central Post Office, Vancouver.
travelled streets for the convenience of street users. However, their precise placement is often related to the convenience of post office truck drivers without due consideration to other factors in the opinion of the investigator. The large and bulky parcel and mail holders often block the view of motorists. This is especially noticeable in Vancouver's West End where mail holders are placed as close as possible to the corner apparently because mail truck drivers usually have to park beside the stop sign in front of solid rows of parked cars. In this position, the mail trucks present a further hazard.

For garbage collection, the normal practice is followed wherever there is a lane and the worst practice otherwise. In either case, the cans are supplied by the residents. Substantial areas of the outlying municipalities require residents to take their garbage to a municipal dump, and hence, involve no service in streets. Holders for litter collection are confined to downtown, commercial and park areas, and a few locations on major streets.

Practice elsewhere. A private company took over garbage collection in Kingston, Ontario, and supplied residents with green plastic bags for their garbage. These are simply thrown quietly into a truck so there is no need to return cans. The colour makes them unobtrusive on boulevards, hides the garbage and keeps out sunlight.

Saskatoon attempted to reduce garbage collection costs by encouraging the installation of gas-fired incinerators in new subdivisions. These burn all garbage except items such as tin cans which were collected monthly. A five year experiment was ended nine months early because residents complained that the system was "unsanitary, unhealthy, and a nuisance because of the large amount of noncombustible refuse piled up each month."\(^\text{25}\)

**Distribution Holdings Services**

The distribution holding services are those providing holders in which are held for distribution such goods as mail (including letters, parcels, magazines, etc.), newspapers and other commodities for sale and sand for improving traction on icy hills.

**Normal, worse and worst practices.** For holding mail deposited by mail trucks, the normal practice is installing the olive-drab coloured boxes on four-legged stands and concrete slab bases. The worse and worst practices respectively are installing 'suburban' and rural type boxes. For holding newspapers deposited by trucks for sale to customers, the normal and worse practices are installing open-fronted boxes on other supports and separate supports respectively. The worst practice is installing open-ended sheet metal boxes with integral stands, because these blow over easily and generally look 'scattered about'. For holding sand, the normal practice is installing a wooden box with a slide covered opening at the base near the bottom of hills.

**Actual practice.** The normal practice of installing mail holders is followed wherever densities warrant letter-carrier service. Otherwise the suburban boxes are installed, except on rural routes. The suburban or group boxes have individual locked boxes assigned to the dwelling served.

Newspaper boxes are not ordinarily installed in local streets because of home delivery service by 'carrier-salesmen', but are installed on major streets, particularly at transit stops and in denser residential districts such as the West End of Vancouver. The normal practice has been followed where other supports were available; otherwise the worst practice. The worst practice of installing sheet metal boxes is becoming more common in the denser areas at least. In downtown Vancouver there are a few manned newspaper stands, some having shelters for their operators.
There are no other holders installed permanently on streets in Metropolitan Vancouver for other commodities for sale, although there are some outdoors just off the street. These include vending machines for ice and holders for pressed chip fireplace logs on gasoline service station sites. A popcorn cart seems almost permanently established at English Bay Beach in the summer and at Crystal Pool (2 blocks away) in the winter. Nothing else is sold legally in streets that involves holders. A few things are sold that do not require holders such as flowers in downtown Vancouver.26 Sand boxes are installed ordinarily only on major streets.

Practice elsewhere. Some newspapers in the United States, for example, those in Seattle, install cylindrical holders for rolled newspapers on the posts supporting rural mail boxes.

Streets in many European towns and cities have holders from which are sold flowers, art, and tidbits such as chestnuts, leaving aside markets where practically everything is sold from carts or stands. Some holders are relatively permanent while others are carried or wheeled into place daily.

X. INDICATING SERVICES

The indicating services are those providing indicators such as signs, signals, and markings to indicate information, regulations, demarcations, and advertisements of various types by words, symbols, and other means.

Informative

The informative indicating services are those concerned with providing information such as names and numbers of streets, blocks, buildings, and routes; directions to specific places; road and weather conditions; facts of interest to tourists;

26 At Pender and Granville Sts. using the deep window sills of a bank as a shelf.
instructions for use of services; and various information for service management purposes (e.g. numbers on street lamp supports). In current practice, street name or number signs, sometimes with the block number, are the only information facility ordinarily installed publicly in local streets. Building numbers are assigned by the municipality but signs showing them are installed by their owners on the building and occasionally painted on the curb.

All practices. The best practice is installing reflective street name signs on the supports of another service such as lamp posts. A better than normal practice is installing non-reflective, but easily readable signs in the same manner. The normal practice is installing reflective signs on separate metal posts. The worse and worst practices are to install separate wooden posts having lettering on arms and vertically down the post respectively.

Actual practice. The best practice is followed in new developments (except in Vancouver) where supports exist, especially those for so-called ornamental lighting, but more often the normal practice is followed. Vancouver follows the better practice by installing cast metal signs with raised letters painted black on a white non-reflective background. The surrounding municipalities use aluminum sheet signs with reflecting lettering or backgrounds to make them legible at night. The worse practice was followed in Vancouver previously, but now most wooden posts have been replaced. The outlying municipalities such as Surrey follow the worst practice.

Signs indicating route numbers and names, including Civil Defense survival routes, are generally of metal and installed on

27 The street name is often set in the concrete sidewalk near intersections with the year of construction, but these cannot be seen from cars, and are probably seldom used as a source of information.
other supports - the best practice. An exception is the types of sign installed by boards of trade, tourist bureaus, or automobile clubs. These are generally of painted wood and until recently on a wood post. They are currently being installed by nailing them to a block strapped to other supports, and somehow do not look quite right.

In Vancouver the word 'Fire' is being emblazoned in reflective paint directly onto the supports of other services above fire alarm stations.

Regulatory

The regulatory indicating services are those indicating regulations regarding vehicular and pedestrian movements and standing and parking. Although these are prevalent on major and downtown streets, they do not occur on local residential streets except for 'Stop' or 'Yield' signs at intersections with more important streets. The former often also state 'no parking within 20 feet'.

All practices. The best practice of installing regulatory facilities is reflective metal signs on the supports of other services, since this obviates the need for excavations which often involve breaking through concrete walks. A better than normal practice involves reflective metal signs on separate metal supports since these are more durable than wooden ones. The normal practice is to install reflective metal signs on wooden posts. The worse and worst practices respectively involve non-reflective metal and painted wood signs on separate wood posts.

Actual practice. All of the practices have been followed in the past so all types of signs can be seen in Metropolitan Vancouver. The trend is towards reflective metal signs installed (usually, but not always) by the best practice when other supports are available, and otherwise by the better than normal practice. Vancouver has replaced most of its wooden signs and sign posts. Most 'Stop' signs have been converted to the national
standard red colour and are reflective. The practice recently has been to install new signs at a height visible above parked cars, which in some instances makes them difficult to see from some cars and because they are not illuminated by car head-lights on the low beam.

**Practice elsewhere.** Some cities in the U. S. have solved the above-mentioned problem by installing two 'Stop' signs on the same post, one at a level that can be seen above parked cars from a distance, and another at eye level that can be seen when past the parked cars.

**Demarcative**

The demarcative services are those indicating boundaries of movement ways by markings, and hazards by markings or other devices. Boundary markings include centerline, lane and shoulder lines along roads and stop lines and pedestrian crossings at intersections. Permanent hazards can be marked by hatch marks and blinker lights. Temporary hazards are usually marked by barricades with lamps or blinker lights.

**Best, normal, worst practice.** The best practice of installing boundary and hatch markings is with white reflecting paint, 'cat's eyes' on centerlines, and yellow paint for shoulders and 'no passing' zones. Normal practice uses white reflecting paint only, and in the worst practice it is non-reflecting. Other markings are fairly well standardized.

**Actual practice.** In actual practice, boundary markings are rarely installed on local residential streets partly because the pavements are often such that they cannot be so marked. However, the boundary between the shoulder or parking area and roadway is often marked by a change in material as from gravel or concrete to asphalt. Stop lines and a few feet of centerlines are painted at intersections with more important streets in some but not in all parts of Vancouver.
Practice elsewhere. In Europe different uses of pavements such as for parking and moving vehicles are frequently marked by changes in material instead of painting a line. Occasionally the boundary is marked by a different material along it, such as a row of granite blocks set in asphalt.

Advertising

The advertising services are those providing signs (or symbols) in streets to indicate such things as: the agency providing a service, manufacturers of facilities; property for sale or open for inspection; events; candidates for elective offices; and products or non-public services for sale.

Actual practice. Services provided by public agencies generally do not need advertising in the commercial sense since they are essentially monopolies. They tend also to be unique, so need no special identification. Their names, or more usually initials, appear on such facilities as manhole covers as raised cast letters. The coat of arms of Canada is transferred onto postal facilities. The names of other agencies providing public services such as newspapers are usually fairly prominently displayed on facilities they installed. In other instances, such as when service clubs or private firms install benches, they are permitted only a 'courtesy of......' sign of prescribed size. The names of manufacturers of facilities are indicated on them in various ways depending on the nature or material of the facility. The letters are usually raised in cast metal facilities such as manhole covers, valve cabinet lids, catch-basin grilles, fire hydrants, and valves. They are stamped or stencilled on most other materials.

Signs indicating property for sale are usually of the

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28 Such indicators could be classified as information identifying for workmen the ownership of manholes, but are included here because of their similarity with other forms of advertising.
stakes in the grass type, although some rather permanent ones can be seen attached to some properties. Signs indicating coming events and candidates for elective office are temporary in nature, though sometimes stay up longer than they should. They are often installed on supports or shelters for services, particularly wooden ones. Signs advertising products or services other than ones projecting from commercial buildings are rarely installed in streets. The exceptions are advertisements on litter cans and benches that are permitted in exchange for the advertisers providing these facilities. Advertising on litter cans is permitted only in New Westminster. Bench advertisements are permitted in Vancouver, but not in residential areas because of a vigorous campaign by such civic organizations as the Community Planning Association of Canada and the Community Arts Council.

**Practice elsewhere.** Special facilities are provided in European streets for advertising of all sorts. They impose a control on size and location of this advertising and may be partly responsible for the high standard of graphic arts by forcing each poster to compete with the surrounding ones. The justly famous advertising kiosks of Paris are covered by colorful and changing montages. Lucerne, Switzerland, has telephone booths whose height has been increased by half to provide four surfaces for signs above the booth. A new residential section of Bremen, Germany, as a well designed group of facilities including a telephone and litter basket whose major element is a sort of neighbourhood notice board. Besides these special facilities, a practice of installing posters advertising candidates for office in the recent German federal election impressed this investigator. This was to place about twenty to fifty posters bearing the candidates picture side by side along fences facing railways near stations, and facing ramps leading from the autobahns. The effect upon one moving by them was somewhat hypnotic, though not dangerously so. It was so much like a movie
that one half expected the expression to change. Perhaps someone will try that someday!

XI. KEEPING SERVICES

The keeping services are those which keep streets in acceptable states for the health, welfare, safety, convenience, and amenity of those using or dwelling beside them. These states include sound physical condition, proper functional condition, cleanliness and tidiness of facilities. The service which keep these acceptable states require no facilities installed in streets, but may involve the operation of equipment on streets, some of which is highly specialized. The operational problems and characteristics of this equipment should be considered in the functional layout and physical design of affected facilities. The various keeping services are discussed below in four groups. These are services keeping facilities in sound condition, functioning properly, clean and tidy, and other keeping services.

Services Keeping Facilities in Sound Condition

The services keeping facilities in a sound condition or state of repair include the repair of damage, repair of wear and weathering, and replacement of lamps and meters. Damage is distinguished from wear and weathering in that it occurs relatively quickly, often as a result of some accident or 'act of God'.\footnote{Calling the effects of natural phenomenon on man's constructions 'acts of God' seems somewhat sacrilegious when man has usually shown lack of respect for nature (e.g. building in former stream beds, removing natural cover, installing overhead wiring, etc.).} Damage is taken to include that done to one facility when installing another, such as to a pavement when installing a utility under it. The nature of the repair depends of course on the nature and extent of the damage. It may range from
replacement of substantial portions of service systems to mere reconnection of parted facilities. When the damage is substantial as during a storm, temporary repairs may be made in order to restore service quickly. Permanent repairs are made later when there is more time and the weather conditions are more favourable. Temporary repairs are also often made when soil settlement is expected as in repairs to pavements where utilities have been installed.

Repair of wear, weathering and shifting, or in anticipation of them depends upon the material involved. Wood and metal surfaces are painted either when wear and weathering begins to show or periodically on the basis of anticipated deterioration. Repainting of markings on asphalt and concrete is considered to be replacement of an indicative facility. Holes and ruts worn in gravel pavements are repaired by grading, while those in other materials are repaired by filling them with the same material. Leaks in pipes, drains, and wires are repaired by remaking joints or replacing faulty sections of the facility. Shifting of facilities from their proper alignment is caused by uneven settlement, and root or ice action. It is mainly confined to concrete sidewalks but can affect pipes. Repair usually involves removing part of the facility and whatever is causing the shifting and then backfilling and replacing the facility carefully.

Replacements of lamps and meters, other than damaged ones, are somewhat special cases and their classification here or elsewhere must be rather arbitrary. Lamps are replaced either when they have burned out or on a regular program based on their expected life. In the former instance, their replacement could be considered replacement (i.e. re-installing) of the service. Meters are replaced periodically so that they can be tested for accuracy.

Best, normal, and worst practices. The best practice of keeping facilities in a sound condition is considered to be
that involving programming of work upon a priority basis. Damage involving interruptions to services of course has highest priority and the program must be sufficiently flexible to allow rapid adjustment to changes in priority as a result of substantial damage. The normal practice is a sort of 'hit and miss' mixture partly based upon priority, but influenced by complaints. The worst practice is to repair or replace only following complaints.

**Actual practice.** Current practice of keeping facilities sound has not been fully examined herein because it is not completely germane to the purposes of this investigation. However, two practices are worth mentioning. The Vancouver City Engineering Department recently conducted a survey of the condition of all pavements to determine what repairs were necessary. The information was transferred to data processing cards and sorted by priority ratings to form the basis of a repair program. The B. C. Hydro & Power Authority has a gas and electric trouble center to receive complaints about service by telephone and dispatch repair crews by two-way radio. The center handles up to 300 calls on quiet days, but 16,858 between Friday and Tuesday as a result of 'Typhoon Frieda' in October 1962.

**Services Keeping Facilities Functioning**

The services keeping facilities functioning are those which keep pavements, pipes, and drains in service, that is, 'passable' or 'open'. They are required during repair of facilities or during storms or their aftermath to keep the services safe and reasonably convenient. During repairs, pavements are

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31 Dennis Orchard, "City Cleans Up After Typhoon Frieda", *Civic Administration*, (November 1962), vol. 14, No. 11, p. 42.
kept at least partially open to traffic by installing temporary bridging across excavations, and pipes and drains are kept in service by installing temporary diversions or supply or collection tanks.

During storms and their aftermath, pavements are kept in service by removing snow, ice, and accumulated water; by spreading sand to improve traction; and by spreading salt to melt ice or prevent its formation. Snow and ice are removed from pavements by plowing, scraping, or shovelling. Where snowfall is heavy or long-lasting, street systems should be laid out to minimize back-tracking or dead runs by equipment by avoiding dead ends and culs-de-sac. Pavements and curbs should be designed for easy manoeuvering. Accumulated water is removed by pumping or by unblocking the drainage system. Sand and salt are spread by shovel or special spreaders on trucks, often together.

Pipes and drains go out of service as a result of freezing temperatures rather than storms as such, except when blockages occur in drains during storms. Frozen pipes can be thawed by electric conduction heaters if they are metal; otherwise by externally applied heat. Frozen drains can be thawed by electric immersion heaters or steam jets. Pipes and drains can be kept from freezing by applying heat in these manners, or by maintaining flows through them. For example, water may be 'wasted' into drains, thereby maintaining flows in both the water pipes and drains. Natural gas service can be cut off when water vapor droplets in the gas freeze and cause a blockage in the meter. In one cold spell, 900 complaints of dead furnaces were received in one day. 32

The need for services to keep facilities functioning should be avoided or minimized in the layout, design, and installation of the facilities. For instance, areas having heavy

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snowfalls should be avoided or have carefully laid out street systems. Pipes and drains should be placed below frost penetration or otherwise insulated. Facilities susceptible to blockage such as gas meters should be designed or installed so as to avoid this (e.g. by insulation or heating). The following practices are based on the assumption that this has not or could not have been done for some reason such as economic infeasibility.

Best, normal, and worst practices. The best practice of keeping facilities functioning is to take precautionary or preventive measures before interruptions to service occur. For example, spreading salt on wet pavements before ice has formed, wasting water down drains or insulating gas meters before blockages have occurred. The normal practice is to return facilities to service quickly after notification that they are out of service. This implies having the equipment available to render such service quickly. The worst practice is to close off facilities during cold weather or let residents on local streets fend for themselves while keeping only major facilities in service.

Actual practice. The upper levels of development on the North Shore mountains are the only areas ordinarily subjected to heavy and long-lasting snowfalls and low temperatures. The Districts of North and West Vancouver generally have sufficient snow removal and pipe thawing equipment to follow the normal practice of restoring service reasonably quickly. Other municipalities lack sufficient equipment to hand severe infrequent snowfalls or cold spells. This forces them to follow the worst practice, at least for a while. Facilities such as roads with steep grades are closed off and residents of local streets are left to fend for themselves while major facilities are kept open. The latter might even include such best practices as salting before freezing. Generally, the resultant inconvenience is short lived because the storms are short lived and either the snow is removed by melting, rain, and traffic, or the equipment is able
to clear local streets after completing the major ones. However, residents in the meantime may have to thaw their own pipes or call a plumber.

Services Keeping Facilities Clean and Tidy

The services keeping facilities clean and tidy, or cleaning services, are those which remove accumulated dirt and litter in the interest of health, safety, convenience, and amenity. They consist of cleaning pavements, drains, and other facilities, and tidying up the street. Cleaning of pavements is done by flushing with tank trucks or sweeping by mechanical sweepers or brooms. Cleaning of drains is done by flushing with hoses connected to fire hydrants and by scouring with brushes or scrapers pulled through them. These operations are made easier when manholes are near hydrants, and drains are straight or nearly so between manholes. Ditches are cleaned by shovelling or otherwise removing accumulated debris, and regrading. Catch-basins are cleaned by suction pumps on special trucks or by long-handled scoops. Some municipalities such as the District of North Vancouver are avoiding this operation and the possibility of mosquitoes breeding in the catch-basin by eliminating the catch-basin. Storm water is led directly from a grating in the gutter to the street drain via a lateral drain. Cleaning of other facilities such as lamps, glass in shelters, and toilets is done by wiping or washing. Tidying of streets is done by raking leaves and sweeping, shovelling, spearing, or otherwise picking up litter.

As for the services keeping facilities functioning, the practices for cleaning services listed are based upon the assumption that facilities have not or could not have been designed so as to avoid the need for them.

Best, normal, and worst practices. The best practices of the cleaning services are considered to be those involving

33 Interview with Mr. Douglas Welsh, Design Engineer, District of North Vancouver.
mechanical equipment because of its efficiency. Normal practice
is taken to be a combination of mechanical equipment and manual
labor where the worst practice involves only the latter.

**Actual practice.** Flushing and sweeping of pavements is
rather impractical where there are no curbs and since curbs are
relatively rare in local residential streets, so are these
operations. Drains are cleaned everywhere, but at varying fre­
quencies. Vancouver is well equipped with suction pump trucks
for cleaning catch-basins, but the other municipalities still
clean them by scoop. Tidying up is generally confined to com­
mercial and park areas or major streets, and left to residents
in local streets.

**Other Keeping Services**

The other keeping services are those concerned with
'keeping track' of the condition of facilities by inspecting and
testing them, and of the consumption of commodities by reading
meters. Facilities are inspected and tested ordinarily by agents
of the provider of the service, but there are exceptions. After
settling a claim for damages for a collision blamed on a stop
sign being hidden by branches, the Vancouver City Council
decided to ask the police force to ensure that signs are kept
free from such obstruction. This was because the police force
patrols the streets more often and has more vehicles than the
engineering department. Gas and electric meters are read
monthly by employees of the B. C. Hydro & Power Authority; Water
meters are read quarterly or monthly depending upon size by
employees of the municipal engineering departments.

**Best, normal and worst practices.** The best practice of
inspecting services is on a regular basis and more than one at
a time, which is the normal practice. The worst practice is

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34 "Stop Sign Hidden, City Pays $2,879", *Vancouver Sun*,
non-regular, unsystematic inspection. The practices of installing meters is discussed here because of the effect on meter-reading practices. The best practice is considered to be installing meters in streets because this obviates trespass on private property by meter-readers, and leaks in site facilities would be at the expense of the responsible property owner. The normal and worst practices are installing them on and in buildings since this involves trespass onto sites and into buildings respectively.

**Actual practice.** The survey or inspection of pavement conditions in Vancouver covered both the pedestrian and vehicular pavements. Ordinarily the normal practice of inspecting one at a time is followed, but obvious faults in the facilities of a service are usually reported by inspectors of other services. Water meters are installed in streets, but gas and electric meters are normally installed on buildings. The worst practice of installing gas meters inside is followed less often than formerly. They are installed usually on the side of buildings within three feet of the front so they do not spoil the appearance of the front. They are kept away from driveways and carports so that cars do not damage them accidentally. Electric meters are at the back of houses when wires are in the lane, and at the side when wires are in the street.

**Practice elsewhere.** In the U. S. one developer installs electricity meters in the transformer kiosk, and a house-builder installs glass blocks so that water meters inside the house can be read from outside. This protects the meter from frozen droplet blockage, and the house from invasion of privacy.

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APPENDIX B

INSTALLING UTILITY STRUCTURES:
A DESCRIPTION OF POSSIBLE PROCESSES FOR THE VARIOUS TYPES

The proposed processes of installing most types of utility structures are comparable to current processes of installing certain facilities, particularly those of the drainage services. The excavating and backfilling techniques for all utility structures could be the same as for drains or multi-tubed conduits of comparable size, which may be larger than those ordinarily found in local residential streets. Thus, the main differences are in the techniques of installing troughs, especially the all-utility type, several of which involve pre-casting or extruding of the concrete structures. Certain techniques not currently employed in Metropolitan Vancouver have been considered for the other types of structures and for the possibility of installing them over drains. These different techniques are described and discussed below by types of structure.

I. TROUGH STRUCTURES

All-utility Troughs

The all-utility trough is the type of utility structure most different from current practice. It is essentially a lined trench covered by a sidewalk that would be deeper than the other troughs, and hence could require different techniques for installing it. Two basic techniques and a number of variations of one of them have been considered. One involves three special methods of casting concrete in place using trench walls as forms. The other involves the use of various precast concrete units with the possibility of installing them with and without shoring in each case.

Casting in place. One method of casting in place would involve excavating and shaping a trench in the usual manner,
suspension internal forms, inserting reinforcement bars or grids where necessary, and casting concrete between the forms and walls of the trench. The forms would be re-usable metal ones shaped to produce the desired bottom of the trough and internal buttresses where required.

A second method would be to extrude at least the bottom of the trough by adapting machines that can extrude sewers by winching themselves along a shaped trench. One adaptation is to eliminate or block off the ingenious part that shapes the top of an extruded sewer. Another adaptation would be to extend the interior form upwards so that the walls could be cast higher. Where walls could not be thus cast high enough, reinforcing bars and brackets could be inserted into the wet concrete. When set, flat forms could be mounted on the bracket and braced apart to allow casting of the remainder of the wall.

'Milan method'. Casting in place could also be done by an adaptation of the so-called Milan method of constructing subways for rapid transit service. As proposed here, it would involve the following operations. A narrow trench (of four to eight inches width depending on depth) would be excavated to the depth required for the drainage facilities. As the trench was being dug, the Milan Method of filling it would be followed:

... with a special slurry composed of water, Bentonite and a special catalyst. The Bentonite forms a suspension of more or less gelatinous characteristics, forming an impermeable film on the walls of the excavation; hydrostatic pressure

1"New Pipe Machine Casts 55' of Sewer per Hour, Can Cut Costs 30%," House & Home vol. XVIII, no. 3 (September 1960) p. 169.

within the trench prevents caving of the trench walls.\(^3\)

Prefabricated steel reinforcing mats would then be set in the trench and concrete poured through tubes suspended below the level of previous pours to prevent films of Bentonite forming between successive pours. This would create one wall of the trough. When the concrete has set sufficiently the process would be repeated for the other wall of the trough. The earth between the two walls would then be excavated to the required depth. Whatever support was required for the walls during excavating would be later replaced by permanent support such as by precast concrete diaphragms that were wedged and possibly grouted into place. The bottom of the trough would be completed by excavating under the cast walls, shaping the bottom of the trench, and then casting and shaping concrete to form the bottom of the trough.

These techniques obviously would not be suitable for all soil conditions, particularly highly unstable ones in which such a trench would be impossible to dig and maintain during the casting operation. However, with care and ingenuity they might be used in much less than ideal conditions. For example, unstable soil at the upper portion of the trench might be removed so that forms could be constructed to make it possible to cast the complete wall of the trough. In the case of the Milan method, large boulders in the way of the trench might be simply left and the wall cast down to, and if possible around them. When the earth between the walls was being excavated, these could be removed if they were more in the trough than out, or simply sealed into the wall to prevent water entering the structure. While both of these methods could be used in suitable soils at any of the depths likely to be encountered, they would probably

\(^3\)D. W. Beadle, \textit{op. cit.}, p. 32.
be less economic than methods involving precast units at shallower depths, say those less than that at which shoring would be required.

**Precast methods.** The type of precast unit and method of installing them to form the trough would depend upon the depth of the structure and the surrounding soil conditions. The differences are in the walls and the means of supporting them, since the bottom and top units would be the same, the latter being a sidewalk unit. The 'buttress' type is probably best suited for shallower depths and better soil conditions where either shoring is not necessary, or is relatively straightforward and inexpensive. This type of wall is supported by a buttress protruding approximately one-third of the way into the trough, and is formed out of the short leg of an 'L' shaped precast wall unit. The upper sections of the buttress would be shaped or pierced to form supports for the non-drainage facilities. Where the buttress alone provided inadequate strength, the buttress itself could be strengthened by joining the units together vertically or by bridging the gap between opposite buttresses. The latter possibility either impedes the ability to travel along the trough and install facilities easily, or would involve rather 'tricky' means of bridging to maintain these advantages of the trough.

At greater depths and in worse soil conditions, it would probably be better to use the other type of precast wall supported by diaphragms. These would be precast and preferably prestressed concrete units designed to hold apart walls formed of flat precast pannels. Except for a special U-shaped unit at the top, the diaphragms would be rectangles with a truncated diamond shaped opening in the middle (see Diagram 17). Like the buttress the upper portion of the web of the U-shaped diaphragm would be shaped so as to form supports for the non-drainage facilities.
Diagram 17 - Possible Types of All-Utility Trough Structures
There are several conceivable ways of installing the diaphragms and panels in various soil conditions, with or without shoring, whose relative practicability could really only be established by actual full scale trials. Only the more interesting possibilities are mentioned here. One is that the diaphragms could be used to support the shoring during excavation and until the bottom of the structure was installed. The shoring would be removed as the wall panels were fitted into the diaphragms and the trench behind them was backfilled. Another possibility for unstable soil conditions that would not involve shoring, might be called a 'caison' method. In this, several sections of wall would be assembled on top of the desired location. With the bottom edges of the lower panels protected and the ends covered and protected, the trench for the trough would be excavated from within the caisson thus formed. A variation of this method for somewhat more stable soils could be called a 'coffer' method. The coffers would be formed by first lowering the diaphragms into excavations across the line of the tunnel, and lowering the wall panels in the slots of the diaphragms as the earth between and under them was excavated. The problem in this case would be to keep clean those surfaces which must ultimately form water-tight joints.

**Trough cover.** Regardless of the technique involved in installing the trough, its upper edge would be shaped to fit into the cover. The cover would be precast concrete sections with a patterned or textured upper surface and as long as could be conveniently handled. Specially designed and strengthened units would be laid where vehicles would cross to driveways. The sidewalk units might not be laid until most utilities had been installed.

**Non-drainage and electric troughs.** The shallower non-drainage and electric troughs would probably be completely pre-
cast U-shaped concrete units that would be installed by simply lowering them into a prepared trench. The units would be pulled or pushed together and onto the correct alignment to seal their joints. The joints would have a neoprene or similar material gasket to make the trough watertight. There would be relatively few joints because the units would be as long as practicable to handle, probably the forty foot limit for trucks without special permits. The laying of the troughs should be fairly easy in spite of the weight of the units because the work would be done practically at ground level. The portion of the trench not occupied by troughs would then be backfilled with suitable material to within a few inches of the top of the trough. These materials might be sand, gravel, crushed rock, or the excavated material depending upon the anticipated drainage conditions. The trough would be completed when precast concrete sidewalk units were laid on top of the U-shaped trough units, as in the case of the all-utility trough.

It is possible however, that the troughs might be extruded by a machine running on temporary rails similar to that which installs curb-gutters. Electrical troughs might actually be extruded with the curb as shown in Diagram 18, a location well suited for street lighting wires. The same section could be precast as would be the precast cover.

II. TUNNEL STRUCTURES

The tunnel utility structures are essentially tubular conduits between manholes and could be installed in the same way as large conduits or drains and their manholes are currently installed. This involves excavating a trench, shaping the bottom or casting a bed of concrete, laying precast cylindrical sections, and backfilling in a prescribed manner.
Diagram 18 Electrical trough-curb-gutter

An alternative way of installing the tube in places where it must be deep or in soil conditions making trenching expensive would be pushing the tube from one manhole to the next. This pushing technique is used in Britain in soft ground as well as the safe, stable soils to which the Americans confine it, and is carried out as follows:

Usual procedure is to push pipe forward several feet; "muck out" soil and mud accumulated in forward end; check alignment; make steerage adjustments for accuracy; then reset buffers and space blocks for another thrust.  

The proposed practice would use this technique wherever the cost of pushing were less than by ordinary techniques; that is, when extra costs were more than offset by savings in cost of excavating, shoring and backfilling a trench, and laying and bedding the tube. This technique would also be used to carry the tube under substantial watercourses, railway embankments, heavily-travelled streets, and similar obstacles.

The tunnel might also be extruded by a machine that winches itself along a shaped trench of the type being used to

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install sewers in the United States. To be practicable with the more frequent manholes in the proposed practice, the machine would have to run through the manholes. By appropriate shaping of the excavation for the manholes and cutting off the flow of concrete to the upper portion of the tunnel, the manhole could be cast by the machine up to the level of the top of the tunnel. When it had passed the manhole, reinforcing could be inserted and the top of the cast portion shaped to the design. After the concrete had set sufficiently, a precast cover with a hole in it would be placed to carry standard precast concrete manhole sections.

III. TUBED-CONDUIT STRUCTURES

Tubed-conduits could be installed in the same manner as multi-tubed telephone or electric conduits are at present. This is to excavate a trench, lay and join asbestos cement or fiber tubes with spacers between them, and cast concrete around them. The only differences in the proposed practice would be the size and possibly type of tubes involved, and the possible need for testing some of them before the concrete was poured. For example, the water pipe and drains probably should be tested first. However, there are other perhaps better ways to install a tubed-conduit.

One possible way of installing tubed-conduits that would speed up the installation process, would be to cast the conduit in a factory. In effect, this would amount to manufacturing hollow core sections using tested pipes and drains instead of fiber cores. Some fiber cores would be used to form tubes for wires and cables. An alternative would be to extrude concrete sections with appropriately sized circular openings in the

same way in which hollow core slabs are manufactured. Pipes and drains would be inserted in their assigned tube, either at the factory or where being installed. In either case the manufactured sections would be as long as can be handled. The combination of long sections and closely spaced manholes could mean that there would be only two or three joints between manholes. These joints would be designed for easy connection in the field. Steel dowels would be used to ensure proper alignment, and the conduit would be sealed by neoprene gaskets or epoxy cement. The tubes and drains would have their own ordinary joints.

The electrical tubed-conduit presents some interesting possibilities. The sidewalk version could be factory cast with fiber cores and various integral patterns or textured surface, or could be extruded and have patterns or textures added. A curb-gutter version as shown in Diagram 19 could be factory hollow cast or extruded, or be extruded in place by adapting present curbing machines.
IV. INSTALLING NON-DRAINAGE AND ELECTRICAL STRUCTURES OVER DRAINS

The utility structures not containing drains, the non-drainage and electrical ones, could be installed over the twin drains. This would be done ordinarily in the proposed practice because of the possible savings, but would be departed from wherever it was more practicable to do so. The savings would result from sharing common trenches and manholes, thus reducing excavation and manhole costs.

The utility structures could be installed above the drains in three ways: centered, offset, or benched. The centered location would be to make connection with manholes simple and straightforward, but would make it difficult to get at the drains later. This would not be as serious a fault as at present because there would rarely be a need to get at the drains since service connections would be made in the manholes. The offset locations at one side of the trench excavated for the drains would probably only be practical for the smaller electrical utility structure. It could remain offset at manholes, or be curved into them when short sections with flexible joints were used. The benched location would involve excavating a wider trench to the depth required for the utility structure than necessary for the drains. It would thus probably be more expensive than a trench for drains alone, but less expensive than separate trenches.

The savings in manhole costs would arise mainly from sharing them and thereby reducing the number required. Additional savings should be realized by installing prefabricated manhole sections designed for simple installation of the utility structure to or through the manhole. The troughs would further
reduce the costs of manholes by reducing their height and obviating the need for expensive covers. Special short trough sections with a hole in the bottom would be fitted on top of the precast manhole sections. The sidewalk unit covering this section of trough would provide the means of access to the manhole.
<table>
<thead>
<tr>
<th>Number of Homes</th>
<th>Diversified Demand KW Initial</th>
<th>Transformer Size</th>
<th>Transformer and Secondary Costs per House</th>
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<tr>
<td>4</td>
<td>24</td>
<td>25</td>
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<tr>
<td>6</td>
<td>30</td>
<td>37.5</td>
<td>168</td>
</tr>
<tr>
<td>8</td>
<td>36</td>
<td>37.5</td>
<td>148</td>
</tr>
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<td>10</td>
<td>40</td>
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<tr>
<td>24</td>
<td>74</td>
<td>75</td>
<td>157</td>
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TABLE VI
1963 Estimating Costs for Sewers
City of Port Moody

<table>
<thead>
<tr>
<th>Excavation</th>
<th>Cost/Hr</th>
<th>Cost/Day @90$/day</th>
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<tbody>
<tr>
<td>1. 3/4 yd. Shovel &amp; Operator</td>
<td>16.50</td>
<td>132.00</td>
</tr>
<tr>
<td>2. 1 Labourer (shoring)</td>
<td>2.05</td>
<td>16.40</td>
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<table>
<thead>
<tr>
<th>Pipelaying</th>
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<tbody>
<tr>
<td>1. 2 Pipe Layers</td>
<td>(2.26 x 2)</td>
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<tr>
<td>2. Labourer</td>
<td>2.05</td>
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<table>
<thead>
<tr>
<th>Backfilling &amp; Cleanup</th>
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</thead>
<tbody>
<tr>
<td>1. Loader &amp; Operator</td>
<td>7.50</td>
</tr>
<tr>
<td>2. Truck &amp; Driver</td>
<td>5.00</td>
</tr>
<tr>
<td>3. 2 Labourers</td>
<td>(2.05 x 2)</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Supervision &amp; Overhead</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>1. Lead Hand</td>
<td>2.48</td>
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<tr>
<td>2. Overhead -Benefits -20% on Labour (1/5 x22.39)</td>
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<tr>
<td>3. 1/4 Survey Crew</td>
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$49.97 $399.76 $4.36

<table>
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<th>Materials</th>
<th>Cost/foot</th>
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<td>Pipe:</td>
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<tr>
<td>8&quot; sanitary - with gasket</td>
<td>.90</td>
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<td>12&quot; storm - plain</td>
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<tr>
<td>Bedding sand</td>
<td>.40</td>
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<table>
<thead>
<tr>
<th>Manholes: - 7' - 8' deep</th>
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<tr>
<td>42&quot; Manhole Sections</td>
<td>$92.75</td>
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<tr>
<td>42&quot; Con. lid</td>
<td>19.00</td>
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<tr>
<td>C.I. Frame and Cover</td>
<td>35.00</td>
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<tr>
<td>Conc. Base and Bricks</td>
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<tr>
<td>Labour</td>
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$206.74 1.03*

* At 200 foot average spacing
TABLE VI (cont.)

Total costs per foot:

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<th>8&quot; Sewers</th>
<th>12&quot; Storm Drains (catch basins extra)</th>
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<tr>
<td>Excavation, etc.</td>
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<td>4.36</td>
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<tr>
<td>Pipe</td>
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<td>1.15</td>
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<tr>
<td>Bedding sand</td>
<td>.40</td>
<td>.40</td>
</tr>
<tr>
<td>Manholes</td>
<td>1.03</td>
<td>1.03</td>
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<td></td>
<td>6.69</td>
<td>6.94</td>
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<td>+ 15% Engineering</td>
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<td>Contingencies</td>
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<tr>
<td>TOTAL</td>
<td>7.69</td>
<td>7.98</td>
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Source: Mr. Douglas Kenyon, City Engineer, City of Port Moody, letter to writer.