a design proposal for:

Ascension Catholic Parish

and

Mount Calvary Church,
Lutheran Triune Congregation

by

Alan N. Nakatsui

Faculty of Environmental Design
UNIVERSITY OF CALGARY
Calgary, Alberta

November 26, 1985

A Master's Degree Project
submitted in partial fulfillment
of the requirements for the degree,
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The undersigned certify that they have read, and recommend to the Faculty of Environmental Design for acceptance, a Master's Degree Project entitled:

A CHURCH FOR TWO FAITHS

submitted by Alan N. Nakatsui in partial fulfillment of the requirements for the degree of Master of Environmental Design.

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a church for two faiths

ABSTRACT

A Church For Two Faiths

by

Alan N. Nakatsui

November 26, 1985

Supervisory Committee:

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The subject of this document is the work undertaken as a Master's Degree Project (MDP), in partial fulfillment of the requirements for the degree of Master of Environmental Design (Architecture).

This project is the design of a building shared by two Calgary religious groups, the Ascension Catholic Parish, and the Mount Calvary Church of the Lutheran Triune Congregation. The shared or ecumenical facility is not unique, but this will be the first of its type for Calgary. As such it will be a symbol of the common ground for Christian faiths, and a sign of its future direction both locally, and at a wider scale. Thus, it was of particular importance in the design to accommodate this sharing while preserving the individual identities of the two faiths both in terms of functional use of the spaces, and visual expression of these aspects.

The document examines the contextual issues affecting the design, and the client's objectives in developing a new facility. An architectural program developed for the purposes of this MDP is presented. Rationale supporting the design, and technical aspects of the construction are discussed and illustrated with drawings.

ACKNOWLEDGEMENTS

I would like to thank the members of my supervisory committee for their assistance and continued interest throughout the course of this project. Tang Lee was both chairman of the committee, and my faculty advisor during my studies in this faculty. As committee member external to this faculty, Hugo Meynell, from the Department of Religious Studies offered expertise in his field.

I would also like to express my appreciation for the help of Bruce Beamer and Larry Hoffman, who are members of the Lutheran and Catholic congregations involved, and were on the respective building committees. The time they gave acting as my clients was very valuable to me.

The financial assistance of the Faculty of Environmental Design was very much appreciated.

And most importantly, special thanks go to my classmates and friends who assisted me in many ways throughout the course of this project.

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1. INTRODUCTION

This Master's Degree Project (MDP) is based on an actual proposal to develop a facility shared by the Ascension Catholic Parish and the Mount Calvary Church, of the Lutheran Triune Congregation. The two religious groups serve the communities of Huntington Hills, Beddington Heights, MacEwan Glen, and Sandstone Valley in north-west Calgary. When approached in September of 1984, they had already taken some preliminary steps toward the realization of their objective: they had formed their respective building committees, prepared written statements of their objectives, and jointly purchased a site.

At that time two building committee members, Bruce Beamer from the Lutheran congregation, and Larry Hoffman from the Catholic parish agreed to serve as "clients" for the purposes of the MDP, the intent of which was to undertake the project as an architectural design problem. Upon faculty approval of the topic and committee, the following steps were undertaken: program development, site analysis, preliminary design, schematic design, and limited design development. The facilities program developed for this MDP detailing the functional and spatial requirements is based on the statements of objectives written by the two building committees. The context of the project was examined in terms of potential physical, historical, and social influences on the

design. Issues which were considered in the design development included requirements of the Alberta Building Code, structural and mechanical systems, building energy analysis, acoustics, sightlines, and construction cost. However, production of a full set of working drawings was beyond the scope of this project's requirements.

Due to the academic nature of an MDP, some constraints applied: the MDP was independent of the actual project; the legal and logistical aspects of cost-sharing of capital and operational expenses were not considered; and access to the building committee was somewhat limited. However, these were considered not to have a significant negative effect on the overall design process. To mitigate any potential difficulties with this situation, additional sources such as Catholic and Lutheran ministers, and architects familiar with church design were approached. In addition, energy conservation and utilization of solar energy were not considered priorities although briefly examined. In other ways it was to be as realistic as possible, taking into account City of Calgary land use bylaws and the Alberta Building Code.

2. CONTEXT

The contextual issues which were considered in the design of this church may be broken down into three major areas, although these overlap to some extent. The physical and social contexts are of significance mainly at the local level, while the historical context is important in a broader sense.

2.1 Physical Context

Physical characteristics taken into consideration include both man-made and natural phenomena on the site and surrounding area. Man-made phenomena refer to those represented by the suburban fabric of which this facility will be an integral part. Encompassed in the natural phenomena are topographical features and climatic conditions.

In terms of location within the city, the site is in northwest Calgary (Figure 1). It is near the northern limits at the border of the new subdivision of Sandstone Valley and the older community of Beddington Heights (Figure 2). Also to be served by this facility are the communities of Huntington Hills and MacEwan Glen immediately adjacent to the south and west.

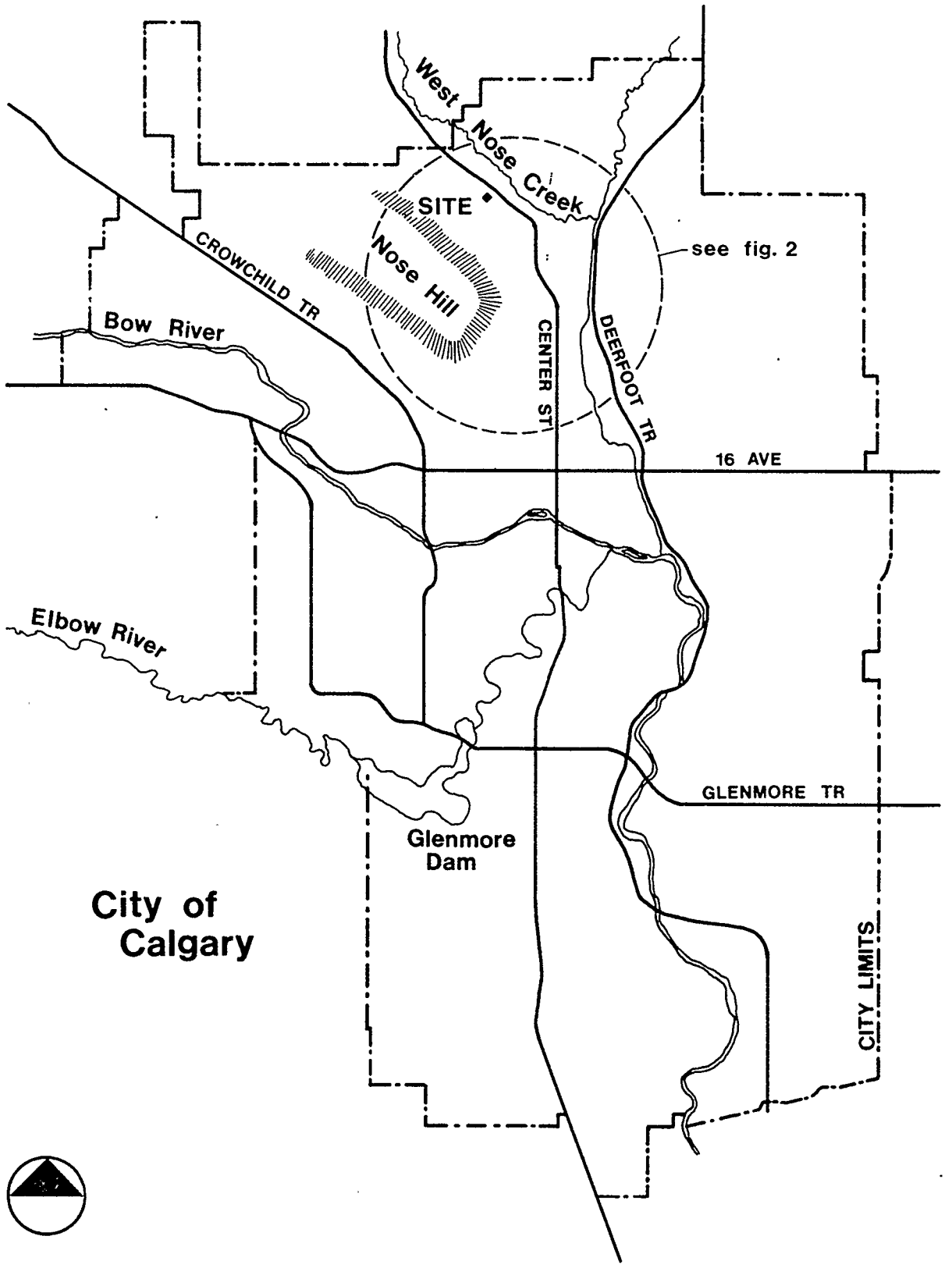


FIG. 1
SITE LOCATION

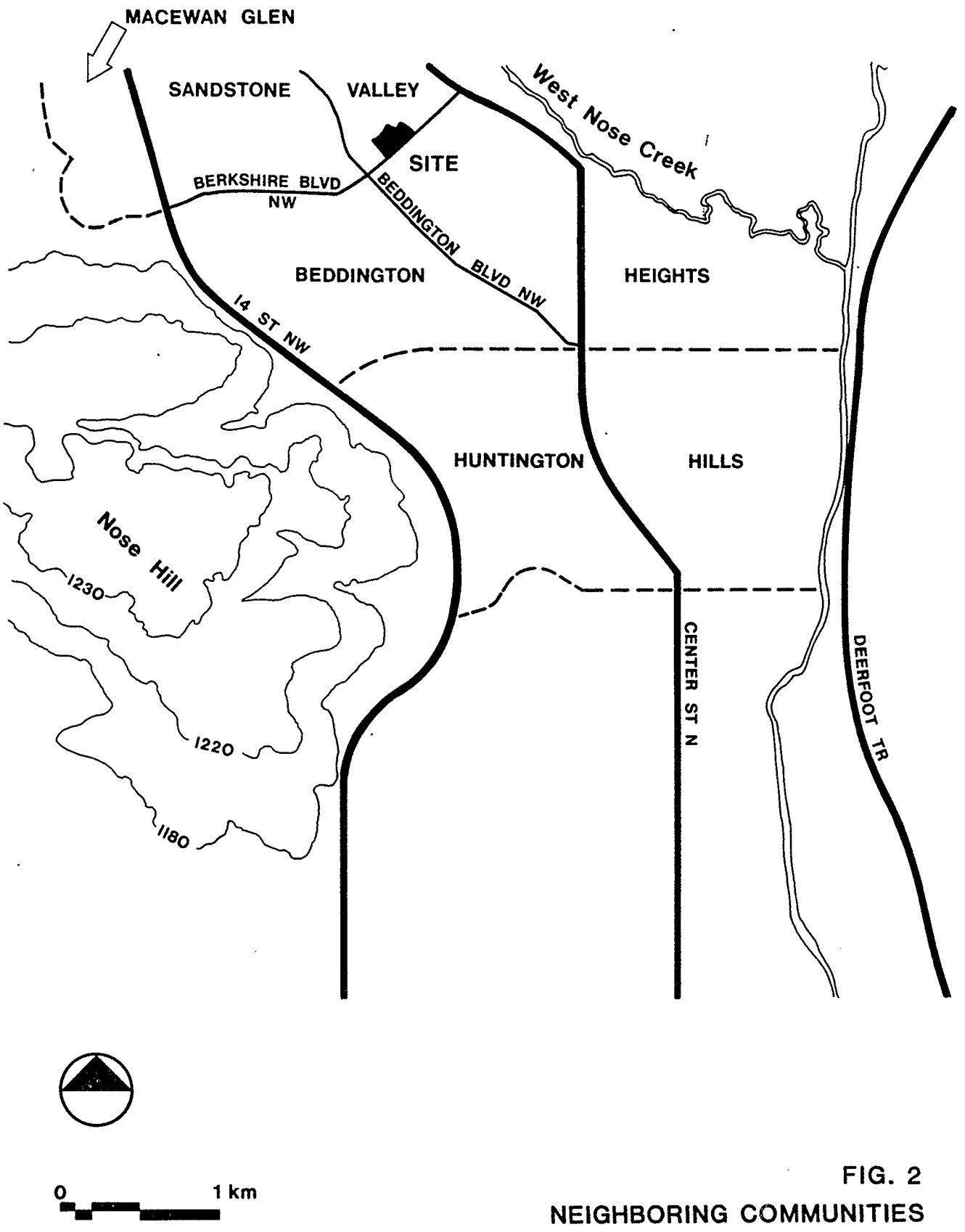


FIG. 2
NEIGHBORING COMMUNITIES

The major streets serving these areas, Berkshire Boulevard and Beddington Boulevard N.W. intersect at this point (refer to Site Plan, Chapter 5). Vehicular access is permitted by the City Transportation Department only via Berkshire Boulevard N.W. near mid-block. Access from Santana Hill N.W. (adjacent street on north-west side of site) is not permitted in order to minimize traffic flow on this residential street.

The site will face single family housing across the two adjacent streets. On the north-east side single family residential lots back onto the site, and a small park is to be developed at the northern corner.

The adjacent lot to the south-west will be developed as a Park-and-Ride facility (where transit riders may park their private vehicles to take public busses downtown). The possibility exists of sharing parking or utilizing this city-owned facility for overflow parking, subject to negotiations with the City. This latter possibility is the one assumed for this project. The former would require negotiations between client and City to establish a cost sharing agreement and time frame for development of the parking area (the City itself would not proceed with construction until a much larger population base was established in the area).

It is assumed that any visual blockage of the proposed building from the major street intersection by intervening development will be limited to some trees, part of the landscaping provided by the City on its bus loop parking lots. There

will be no major structures.

Two topographical features are significant to the design of the building and site. The site is located on the north-east facing slope of a shallow valley created by West Nose Creek. Visible on the east side of the valley, are outcroppings of sandstone, which unfortunately will be obscured from the site by houses in the near future. To the south-west, Nose Hill forms the top of this slope, and is the most significant land form in this area. One of its effects is the shadow cast over the area near sunset: in winter this occurs up to three quarters of an hour in advance of sunset for the rest of the city. A sun path chart for the building site illustrates the effect (Figure 3). The crest of the hill is visible from the site though the foreground is rooftops of houses.

Natural vegetation in the area is dry prairie grasses with low scrub brushes in the gullies where more moisture is present. These would not be suitable for landscaping. Thus, other non-native vegetation suitable to dry areas would be required for landscaping. Trees, ornamental bushes, and lawn grasses are typically used in the surrounding residential area, but require watering and continuous maintenance.

Climatic conditions are assumed to be those of the Calgary area. However, microclimate influences, if any, exerted by Nose Hill have not been previously documented and are not taken into account in the design. The most important influences on microclimate are sun and wind. These must be taken into account in the design of the building and landscaping to create sunny shel-

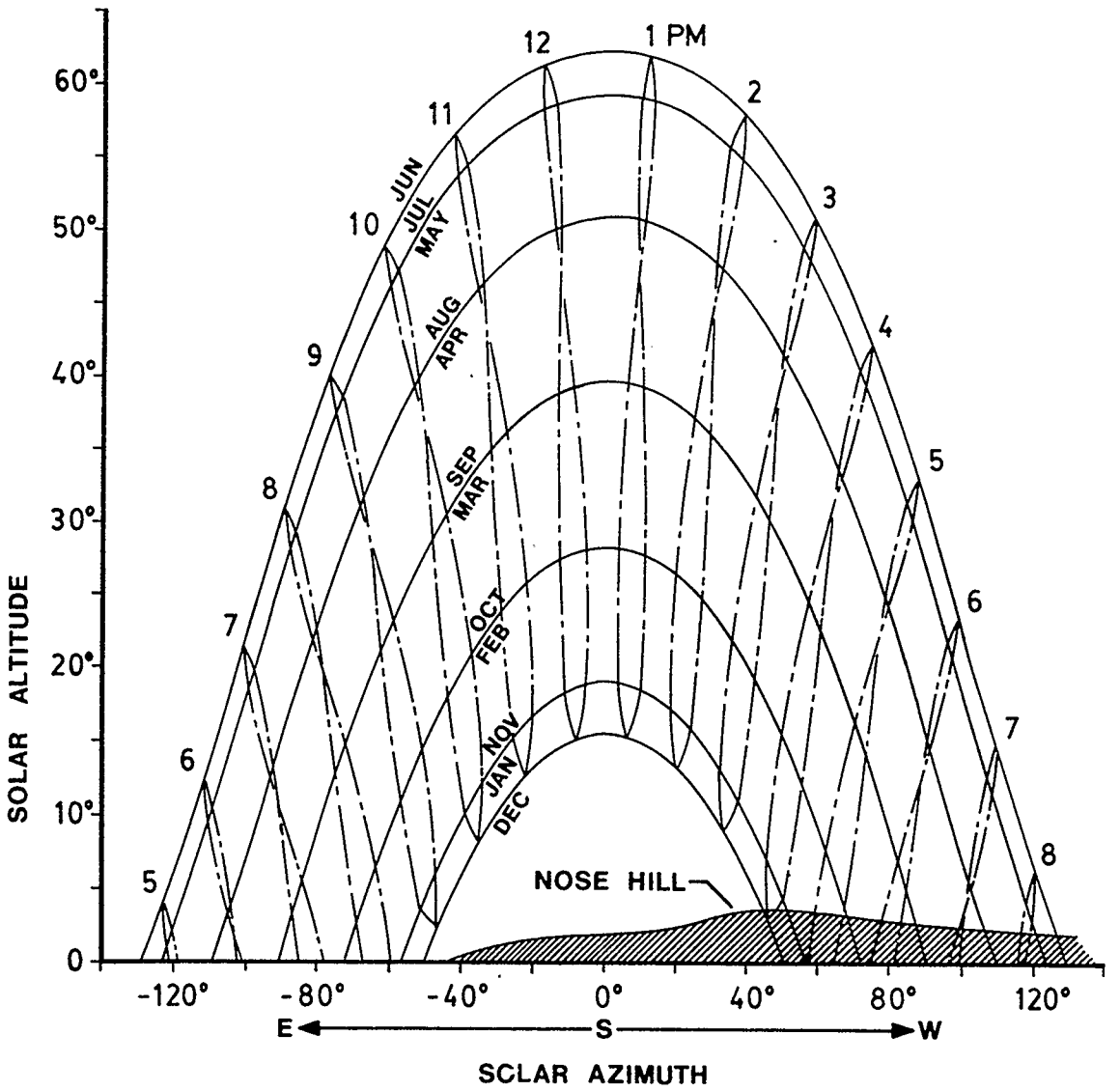


FIG. 3
SUN PATH CHART

Notes:
1. Times are Mountain Standard.
2. Sun paths are shown for the 21st day of each month.
3. Location is Calgary: Latitude 51 North
Longitude 114 West.

tered spaces at entries and in courtyards. Also, trees and bushes may be used to block wind in parking lots. A wind rose for the City of Calgary (Figure 4) shows that winds from the north-west quadrant are the most severe because of the combination of relatively high mean wind speed and frequency. Winds from the west are not as severe because they are generally warmer Chinooks.

2.2 Social Context

In general terms, social context refers to the inter-relationship between man and architecture. Although there are potential effects at a broader scale, the major impact of this project will be felt by those who live in the neighborhood and are members of the churches. The response of the design to the neighborhood must be in terms of architectural form, scale, materials, and complexity. These take into consideration the buildings of the surrounding area, as well as references to the building type. Such historical references are dealt with in the next section.

The social context of churches in general has potentially conflicting aspects. On one hand, the architecture should respond to the neighborhood; on the other, the owners usually want their presence visually expressed by the building. Of course, churches have the advantage of being readily accepted as landmarks in neighborhoods. Historically, they were sited in prominent locations such as on hills, and reached as high as possible with towers and spires.

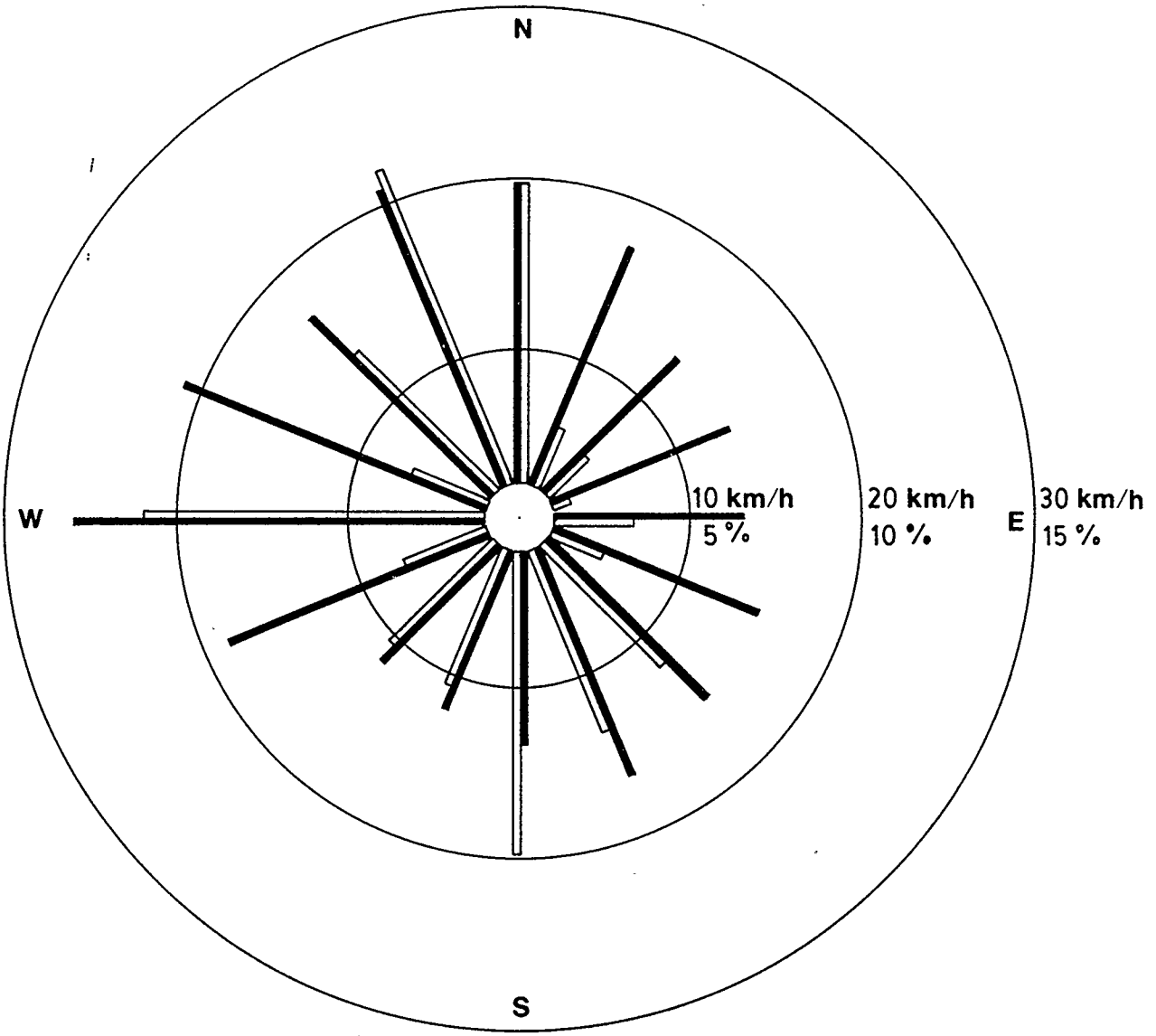


FIG. 4
WIND ROSE

Notes:
1. Based on meteorological summaries, 1955 to 1980.
2. Location, Calgary International Airport.

In terms of building type, the surrounding area is predominantly a suburban mix of residential development interspersed with schools, small scale neighborhood commercial establishments, other churches, and small parks. The residential developments range from single family homes to townhouse style condominiums. The nearest shopping center is Beddington Mall approximately one and one-half kilometres to the south-east.

Accessibility is another important issue. Because the population density of the area is relatively low, it is assumed that most people will arrive by car. Only a small portion may use public transit. Currently, there are three bus routes with bus stops within a block of the site. Access to the building from these points will be via sidewalk along Berkshire Boulevard.

2.3 Historical Context

"Churches were usually designed with a particular form of service or liturgy in mind" (Clowney, 1982, p8). In this light, it may be said that there are two major concerns in Western Christianity today: corporate worship, and ecumenism, which are central to this project. It should also be noted that some churches have reduced the traditional separation of secular and ecclesiastic activities through the use of multi-purpose spaces suitable for both. Sovik (1973) argues for this 'non-church' form as a return to the original concept of church as meeting place, and as a more cost-efficient, practical approach to such facilities. Lynn (1972) puts forward a similar argument for

flexibility in the use of the church building, and for inter-denominational sharing of facilities.

Today's emphasis on the corporate, as opposed to individualistic, aspect of worship suggests a seating plan which is fan-shaped as opposed to the more formal and historical rectangular plan. In fact, it might be argued that this type of seating has historical precedence, since worshipers at one time stood informally around the speaker, naturally assuming a fan shape.

The recent interest in ecumenism is grounded in the Edinburgh Missionary Conference in 1910, and Vatican Council II (1962-65) (O'Connell, Nanaimo Daily Free Press, Feb 3, 1979). One of the many ways this concept of a unified Christianity is given expression is in a shared church facility. This is one of the primary motivating factors for the decision of the Ascension Parish and Triune Congregation to join together in this project. However, it should be noted that although such facilities are referred to as ecumenical churches, they do not generally accomplish a full merger of the denominations involved: their individuality is maintained through the provision of separate services or individual spaces.

This has determined the two basic forms that shared churches have taken. The first has a single major worship space which is shared by scheduling of services for the different congregations involved. Recent examples are the Assiniboia Christian Center in Winnipeg, Manitoba, and the Nanaimo Ecumenical Center in Nanaimo, British Columbia. The first provides separate chapels for Anglican and Catholic worship in addition to their main space. An

example of the latter is the Inter-Faith Center in Columbia, Maryland in the United States (Figure 5). Here, Catholics and Protestants each have a major space for worship, and other spaces are shared.

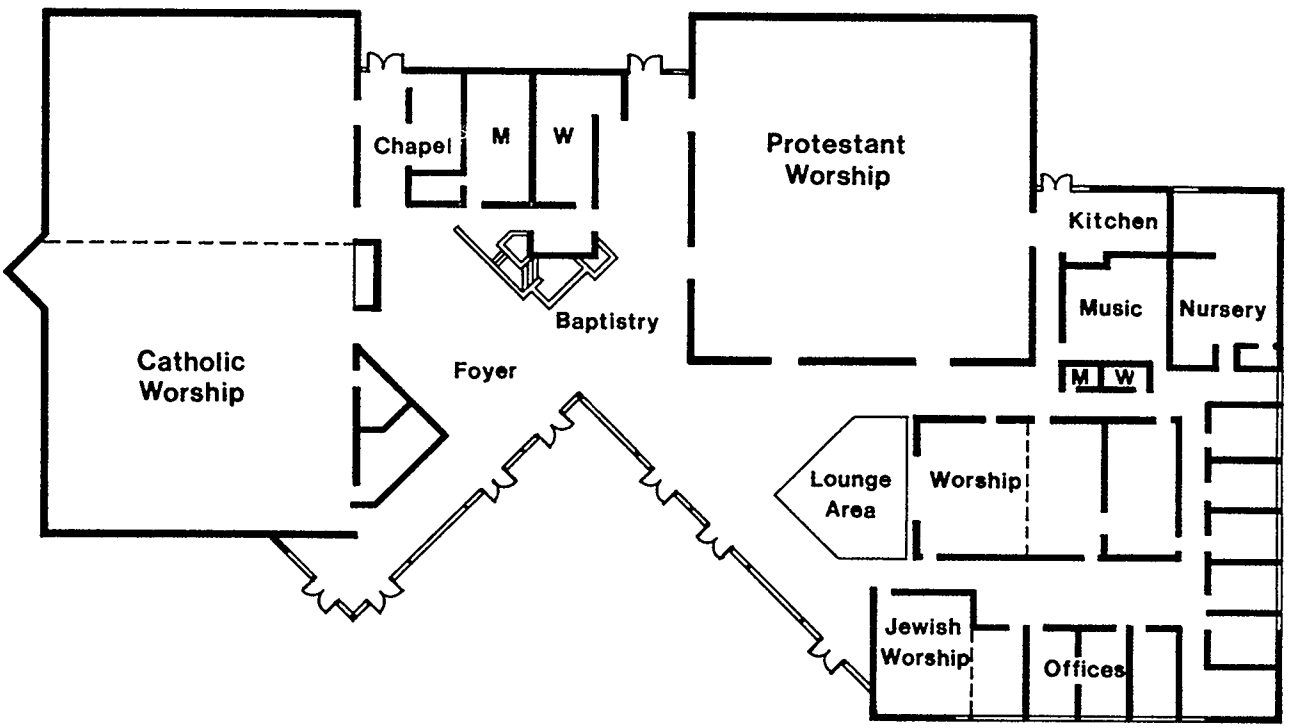


FIG. 5
PLAN, INTERFAITH CENTER

(Source: Lynn, 1972, p268)

"Church building today is characterized by its great variety... there are few 'rules'." (Clowney, 1982, p91) There is no single building form or style which is readily identifiable as a Christian church, although there is a tendency to use steeply pitched roofs. Instead one must rely on various other clues, the cross being the most important and recognizable of them. Others are the use of stained glass windows, bell towers, and steeples.

3. CLIENTS' OBJECTIVES

At the commencement of this MDP, written statements of the objectives and functional requirements of both Catholic and Lutheran groups were made available by the respective building committees. Their general objective of sharing a facility was mutual, but many of the details of how this was to be accomplished had not been worked out. A facilities program integrating the requirements set out in these documents and further defined in consultation with the clients was developed for the purposes of this MDP (Appendix B). Some of the concerns which were taken into consideration are discussed below.

3.1 The Need For This Facility

Although the actual need for this facility was not questioned, the concerns of the congregations that were to be met by this building were examined. The major concerns had to do with the presently inadequate facilities, and with the sharing of a single building.

Both groups perceived their present spaces to be inadequate for their needs. The Catholics were meeting in a school gymnasium: two services for up to three hundred each were being held each Sunday to accommodate the congregation. The Lutherans were renting space seating about sixty-five in a shopping mall: this

was also too small. What they desired was a more formal setting for their worship services, with room to accommodate the whole congregation. They saw a need for approximately seven hundred seats for the Catholic congregation, and three hundred for the Lutherans in a new building. This would meet their present needs, including an immediate increase resulting from a new facility, plus future increases as the new communities of MacEwan Glen and Sandstone Valley develop further.

The possibility of sharing to meet these needs arose for a number of reasons: both groups foresaw the need for a new facility that would provide spaces for worship, recreation, and social activities; the communities to be served by these churches were the same; there were potential savings in capital and operational costs; and it would be a symbolic gesture toward ecumenism that would be viewed as significant not only at the local level, but at a much wider scale, particularly because it would be the first of its type in Calgary (Calgary Herald, July 21, 1985).

3.2 One or Two Worship Spaces?

A requirement specified by both clients was the provision of separate worship spaces. This was questioned as they also indicated that economic considerations motivated their decision to share. The use of a single space would result in significant savings in both capital and operational costs in terms of the building and site. It would also be logical in terms of maximization of use since the worship space is often limited to liturgical functions, which results in its being utilized for only a

few hours each week. Fewer parking spaces could be provided, resulting in a reduction of the site area required. However, the decision to have two spaces was supported by a number of other considerations.

Both groups wished to have the same time slot from 10:00 AM to 12:00 noon on Sundays available for their services. Although scheduling could eliminate this problem, it would be achieved at the loss of some flexibility. For instance, the ability to have services vary in length from one to the next would be reduced. A half hour or more would be necessary between services to allow for people to leave the first service and make room in the parking lot. Thus, in order to have two services, with the second at 10:00 AM, the first would have to be scheduled for 8:00 AM. And, of paramount importance, the stated objective of promoting intermingling of the two congregations would be, to a great extent, lost.

Because the size of the Lutheran congregation was less than half that of the Catholic, there was concern that the ambience of the space would be unsuitable for them in a single large space. In addition, the Lutherans wished to have some flexibility in seating, with a flat floor to accommodate other functions. The Catholics would be better served by a sloping floor because of the relatively larger numbers to be served. In this point the Lutherans come closer to providing the type of facility advocated by Sovik and Lynn (see Historical Context). However, they will have to face the inconvenience of having to shift chairs about to fully realize the flexibility of the space.

A concept which the clients held to be fundamental to their proposal to share was the contact between the two congregations. What was envisioned was the mingling of the two groups, especially prior to Sunday services and after, when refreshments would be served.

Although the Catholic and Lutheran liturgies are becoming more similar, there remain some important differences in the practices and sensibilities of the two faiths. The Catholics require a number of religious elements which must be visible within the nave of the church. These include the fourteen Stations of the Cross which are arranged around the perimeter of the room, holy water vessels that are provided at each entrance, and the altar of repose often situated adjacent to, yet set apart from the altar platform. This latter item may be situated elsewhere, but is thus more inconvenient. None of these elements are of significance to the Lutheran faith and they would rather not have them present.

Accepting the assumption that separate worship spaces were required, what was desired was an architectural solution which symbolized the ecumenical spirit of the venture, and expressed the cooperative nature, while retaining the identities of the denominations involved.

3.3 Shared Spaces

Most of the other spaces could be common. This would allow the sharing of not only the spaces themselves, but related equipment, mechanical services, and staff. In addition, many spaces could be multi-functional (Table 1). Depending on their function these spaces could be used simultaneously by both groups or scheduled. Grouped functionally, the common areas included foyer, administration, nursery, auxiliary rooms and gymnasium.

TABLE 1. SHARING OF MULTI-FUNCTIONAL SPACES

FUNCTION	ROOM	Counseling	Conference	Education	Youth Center	Playschool	Crying Room	Dining	Recreation	Worship
Administration	Reception	●	●							
	Counseling	●	●	●						
	Conference #1	●	●	●						
	Conference #2	●	●	●						
Education	Library		●	●	●					
	Youth Center		●	●	●	●				
	Sunday School		●	●		●				
Worship	Multi-purpose		●	●			●			●
	Crying Room			●			●			●
Social	Parish Hall			●				●	●	●

An obvious space for sharing was the foyer, the design of which could enhance the social interaction of the two congregations particularly before and after Sunday services. In consideration of this objective a refreshment servery convenient to this area was to be provided.

The administration area consisted of the ministers' offices, reception, and counseling room. A single receptionist could serve both congregations or the hours of service extended by using shifts. The counseling room would be shared. A prominent location adjacent to the main entry was desirable for the convenience of new visitors, and for control and security.

The nursery was to be operated as a drop-in day nursery during the week and to serve parents for Sunday services. It could operate with a staff of two. Access to the nursery independent of the other areas was desirable for convenience in dropping off and picking up children, to avoid disturbance of other functions, and for fire exiting requirements.

Auxiliary rooms provided space for classrooms, conference rooms, and a library. Only one classroom was required by the Catholics for Sunday school, while the Lutherans required up to twelve spaces. It was anticipated that some of these could be provided by the use of portable screens in the gymnasium although not as desirable in terms of acoustics; this requirement would decline as the number of children in the congregation decreases over the years. The two conference rooms, library, Sunday school, youth center and counseling room would provide for up to ten spaces using folding partitions in the larger rooms.

The gymnasium was also to be a multi-functional space. As a gymnasium it was to accommodate structured sports such as badminton, volleyball, and basketball on a recreational level. Thus, the clear height and floor area could be sized smaller than that

required for regulation-sized courts. It was also to serve as a parish hall. Therefore, a space which was more than a common gym hall was desired. To accommodate the possibility of rental of the hall, an entry from which the other areas could easily be secured was required.

3.4 Other Spaces

Other spaces that were necessarily single-function were the sacristies, confessionals, and Catholic rectory. Their use and positioning were specific to the churches they served.

The rectory was to be attached to the main building to allow convenient indoor access by the Catholic minister(s). Its purpose, in addition to being the minister's residence, was to accommodate guests and, in future, an assistant minister. As with any residence, a private entry was desirable.

4. TECHNICAL ASPECTS

This chapter presents the technical aspects of building construction which were examined in the development of the design. The subjects include the Alberta Building Code, foundations, structure, mechanical systems, energy use, acoustics, and construction cost. Emphasis was placed on the analysis of building energy performance using computer simulation.

4.1 Building Code

Requirements of the Alberta Building Code were examined to determine their impact on the design. Many of these, such as regulations on construction materials, provision of fire compartments with rated fire separations, and limitations on travel distance to exits from the building relate to fire safety. The main considerations are discussed below (further detail is presented in Appendix B).

The major occupancies served by this facility are:

Group A, Division 2	-auditoria, churches, community halls gymnasia, libraries, schools.
Group B, Division 2	-day care centers.
Group C	-houses.
Group D	-offices.

The general requirements for fire safety in the building as a whole are based on major occupancies, floor area, and whether or not fire sprinklers are provided. In terms of major occupancies and floor area, firewalls could be used to divide the building up into spaces which would be considered to be separate buildings for the purposes of this part of the Code. Thus, a number of alternatives would be possible depending on the way the above elements were combined. The scheme adopted provides fire sprinklers and no firewalls.

Sprinklering was chosen for a number of reasons. It allows combustible construction to be used: thus, a roof system of plywood web joists and plywood sheathing could be used in place of open web steel joists and steel deck at approximately one half the cost. Even greater savings are realized by combining this with fibreglass batt insulation installed between the joists rather than rigid insulation over the decking, due to the lower cost of the material and installation method. The overall saving of approximately $190,000 for structure and roofing more than off-sets the cost of the sprinklering system ($55,000 at $16 per square metre). In addition, there is an associated reduction in fire insurance rates for sprinklered buildings.

Maximum occupant loads for the various spaces must be calculated according to the building code. Thus, maximum loads for the worship spaces total 1042 persons, and for the parish hall, 633 persons. The nursery and program rooms can accommodate an additional 150 persons. These are the figures that must be used

in calculating fire exiting requirements, numbers of parking spaces, and washroom fixtures. However, since the possibility of filling both the parish hall and churches at the same time is extremely remote, the cumulative total for the entire building is not used for parking and washroom requirements. Thus, at any given time the number of parking stalls required is 209 for the worship spaces alone, or 211 for the parish hall. Similarly, nine washroom fixtures for each sex are provided to meet the demand of the parish hall alone; this provides more than the minimum of four fixtures for each sex required for the other spaces. These are situated off the stairwell lobby to allow the hall and other spaces to function independently without elaborate security measures.

4.2 Foundations

Since no soils tests results were available for this particular site, the developer of the subdivision was consulted to determine general conditions, which indicated that spread footings would be suitable. This would have to be confirmed by geotechnical engineers.

Sandstone bedrock occurs generally at a depth of 2.4 to 3.0 metres below grade in the area. Because of the slope of the site, there is some potential for encountering bedrock in excavating for foundations. By stepping the building down with the slope and limiting the basement to the kitchen and washrooms off the parish hall, potential problems are minimized. Other reasons for avoiding below-grade spaces are: the greater cost of

structural floors (over basement areas) as opposed to slabs-on-grade ($98 compared to $24 per square metre), assuming compacted fill is not required below the slab; and the ease of accessibility to spaces located at grade.

4.3 Structure

The structure varies according to function and spans required for the different spaces. In general, however, glued laminated (glu-lam) wood beams and plywood web joists are consistently used for roofs, concrete block is used for bearing walls, and poured-in-place concrete is used for structural floors.

In the worship spaces where a high quality of finish is desirable the main structural members are exposed glu-lam beams. Minor members, insulation, and fire sprinklers are concealed beneath a gypsum board ceiling. Painted a light colour, this will provide a reflective surface to diffuse and direct light down to the congregation. The roof structure is supported by concrete block walls that also serve as shear walls against wind loading, and are exposed as the interior finish.

The parish hall is a multi-purpose space that requires rugged finishes for recreational activities, but must also be suitable for community dinners. Exposed glu-lam wood beams are used for the main structural roof members, supporting plywood web joists. Concrete block bearing walls, exposed to the interior, are used for their durability, ease of maintenance, and low cost.

All other spaces such as the foyer, rectory, nursery, classrooms, and offices have shorter spans, and thus do not require heavy beams. Plywood web joists are used throughout. These are supported on interior walls of concrete block, and exterior walls of wood stud construction. This allows for inexpensive construction materials and techniques. It also accommodates high insulation levels with fibreglass batts between the joists.

4.4 Mechanical System

The mechanical system is a simple heating and ventilating system without air conditioning (Figure 6). Space heating is provided by hydronic baseboard units. Ventilating air is heated by gas-fired furnaces and delivered at a constant volume rate. Natural ventilation is the mode of cooling for the smaller spaces such as the offices, classrooms, and rectory. In the worship spaces, air conditioning is not provided because of the relatively large volumes of the spaces, which help to dissipate body heat; the large thermal mass available in the exposed concrete block walls and ceramic tiled concrete floor slab; the time of day they would normally be used (10:00 to 11:00 AM); and the typically short services (approximately one hour). In addition, it is anticipated that the proportion of time the parish hall will be filled with occupants to an extent that would require air conditioning would not warrant its installation.

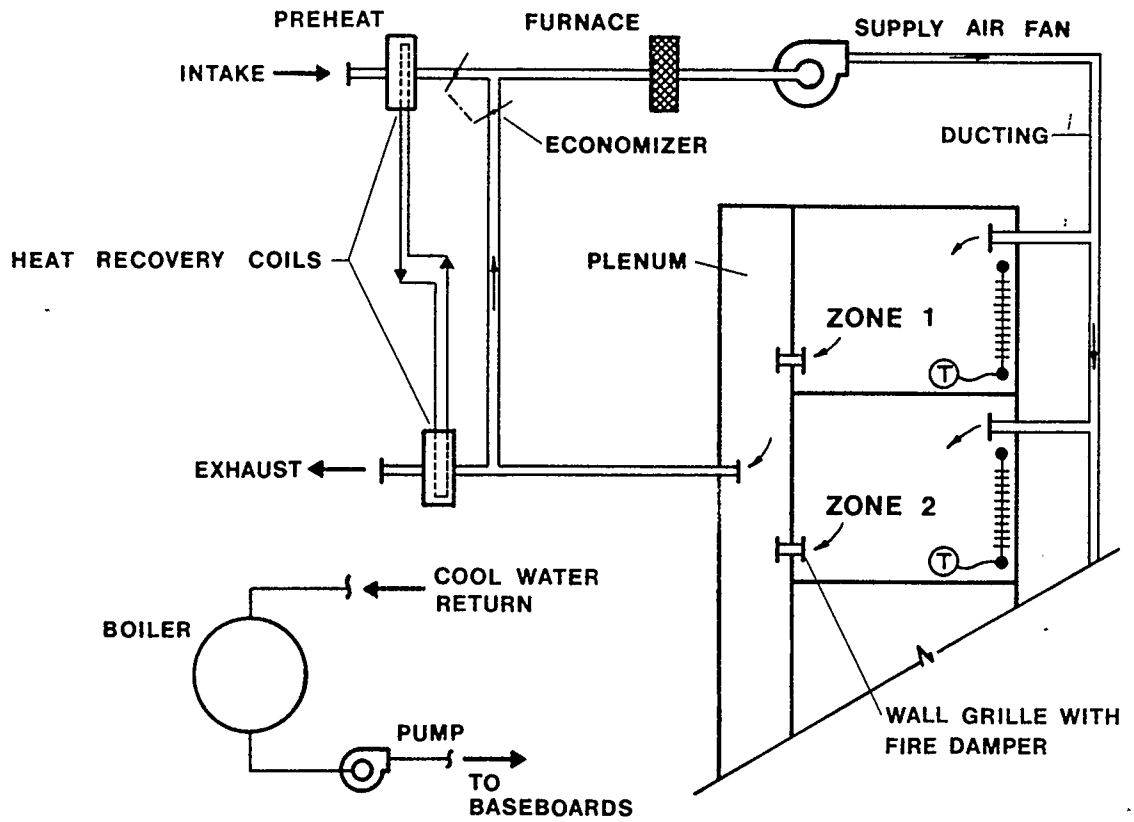


FIG. 6

HEATING AND VENTILATING SYSTEM SCHEMATIC

Notes:
1. Furnace and boiler are natural gas fired.
2. Zone thermostat Ⓣ
3. Baseboard heaters •HHHHHHHHHHHH•

This system was chosen for its simplicity and low cost. It allows each major zone to have its own ventilating unit controlled from the zone. These zones coincide with the major spaces: sanctuaries, parish hall, foyer, nursery, and rectory; the administrative area and classrooms are consolidated into two zones. Each zone would be controlled by a user-set timing device which would automatically switch off the fan.

In contrast, a variable air volume system would allow more control but also would require more complicated and expensive control equipment. Such equipment includes dampers and/or variable speed fans and terminals which control air quantity and temperature to each room. The administrative and educational areas, and nursery could then be a single zone, with individual controls in each room. It would also have an impact on operating cost since temperatures in unused rooms could be set back.

4.5 Energy Consumption

Energy consumption was studied with the use of a computer program, DOE 2.1A, developed for the United States Department of Energy by Lawrence Berkley Laboratory, California, and Los Alamos Scientific Laboratory, New Mexico (Government of the United States, 1980). This is a sophisticated program that accepts a high level of detail in the description of a building and its use to perform an hour-by-hour simulation of the operation of the building for a period of up to one year. It also requires detailed weather data, which in this case was extracted directly from the actual Calgary meteorological reports for the year 1978 (representative weather data for Calgary).

The base building that was encoded for input into the program was insulated to RSI 2.5 in the walls and RSI 3.7-4.0 in the roofs. Further details are presented in Appendix C. Modifications were made to this base building to identify the effects of varying certain components of the building.

Figure 7 shows the results of the elimination parametrics study that was performed to isolate the annual consumption of energy by each of the components specified. Domestic hot water is not accounted for as the quantity of water consumed will be minimal and will not be a major factor in total energy consumption.

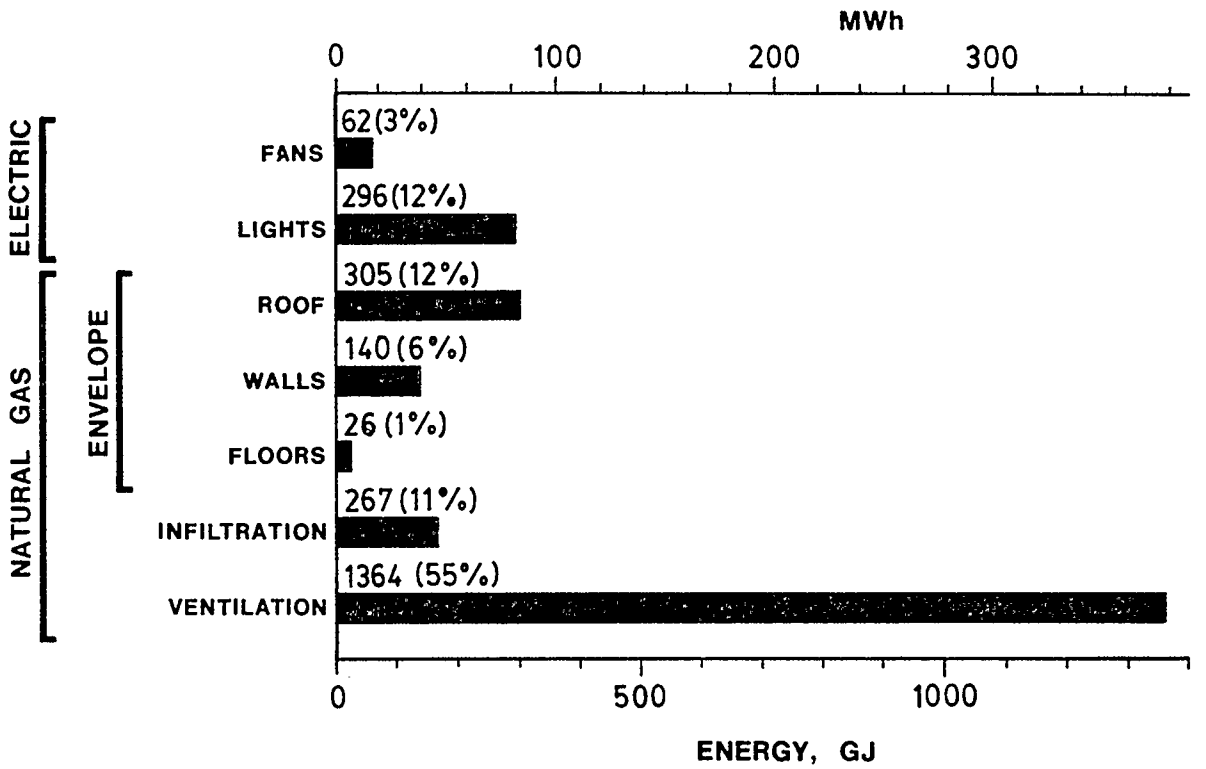


FIG. 7

ESTIMATED ANNUAL ENERGY CONSUMPTION BY COMPONENT

Notes:
1. Based on results of DOE 2.1A computer simulation.
2. Figures are energy in gigajoules (per cent of total).

The annual component energy costs as estimated by the computer program are summarized below:

TABLE 2. ESTIMATED ANNUAL ENERGY COSTS BY COMPONENT

		COST, $	% of TOTAL
Electrical:	Fans	850	9
	Lighting	4 040	38
Natural Gas:	Heating	2 160	20
	Ventilating	3 530	33
TOTAL		$ 10 580	100%

The results indicate the potential areas for energy savings: lighting takes only twelve per cent of the annual energy, but represents thirty-eight per cent ($4,040) of the cost; preheating of the ventilating air (3.3 litres/second per person) requires fifty-five per cent of the total energy consumed, representing thirty-three per cent ($3,530) of the annual cost. The various strategies for reducing the energy costs associated with lighting and ventilating were not modelled in the computer simulations. However, the possibilities are discussed in general terms below.

There are two levels at which electrical lighting costs may be addressed. The first is in the choice of fixtures, which have varying lumen outputs per unit of energy required. The second is the use of natural lighting during daylight hours to reduce the electrical lighting requirements. This may be accomplished through a range ways, from simply turning lights out when not required, to sophisticated electronic devices that sense the lighting levels and vary the electrical lighting to suit.

Because the mechanical system operates only at full capacity whenever any zone is occupied, regardless of the number of occupants, it could often supply more air than required to maintain a comfortable and healthy environment. This is especially true of the parish hall which would often be used by much fewer than the design capacity of four hundred occupants. Thus, significant savings could be realized with further system controls such as control of the air volume delivered to the spaces, intermittent operation of the fans, control of the amount of recirculated air, or recovery of heat from exhausted air.

The first method, control of air volume, is unsuitable because the system terminals which are designed for a constant volume flow rate do not operate properly at lower air speeds. Therefore, the entire system would necessarily have to be designed for variable air volume operation.

The second method, intermittent operation of the fans, is also unsuitable because of the disturbing acoustic and pressure variations. This would be especially disruptive in the worship spaces. In addition, automatic controls for this type of operation, that respond to the number of occupants present, are not available.

The third method, recirculation of air, is currently used in this type of system, and is capable of reducing the cost of heating the ventilating air. Control is not directly responsive to the number of occupants, but rather to the air temperature of the space: the higher the temperature, the greater the fraction of

outside air delivered to the space. A minimum fraction of outside air is set, usually about twenty per cent. This works well with assembly occupancies since "stuffiness" within such spaces is related to, and often accompanied by overheating of the body. As the temperature in the space rises due to the occupants, the amount of fresh air increases. This alternative requires very simple automatic controls, and is also the least costly to install. However, fan energy consumption is not reduced.

The last method, heat recovery from the exhaust air, is also feasible. A recovery rate of up to fifty per cent is possible. However, more maintenance would be required, and there would be no reduction in fan energy consumption. In addition, there would be a penalty in terms of capital cost for the equipment, and increased space required in the mechanical room.

Both these last two methods are viable solutions to reduce energy costs. The one chosen would have to be determined by a comparison of the life cycle costs of each.

Insulation, windows and shading were manipulated to study the effect of these building components on energy usage. Results of these test cases are shown in Figure 8. Doubling the insulation throughout results in annual savings of only twelve per cent in energy consumption and eight per cent ($760) in costs, not enough to justify the cost of the extra insulation. Further runs and a life cycle cost analysis would be required to establish an optimum level. Other modifications save less than five per cent in energy use and three per cent ($320) in annual costs.

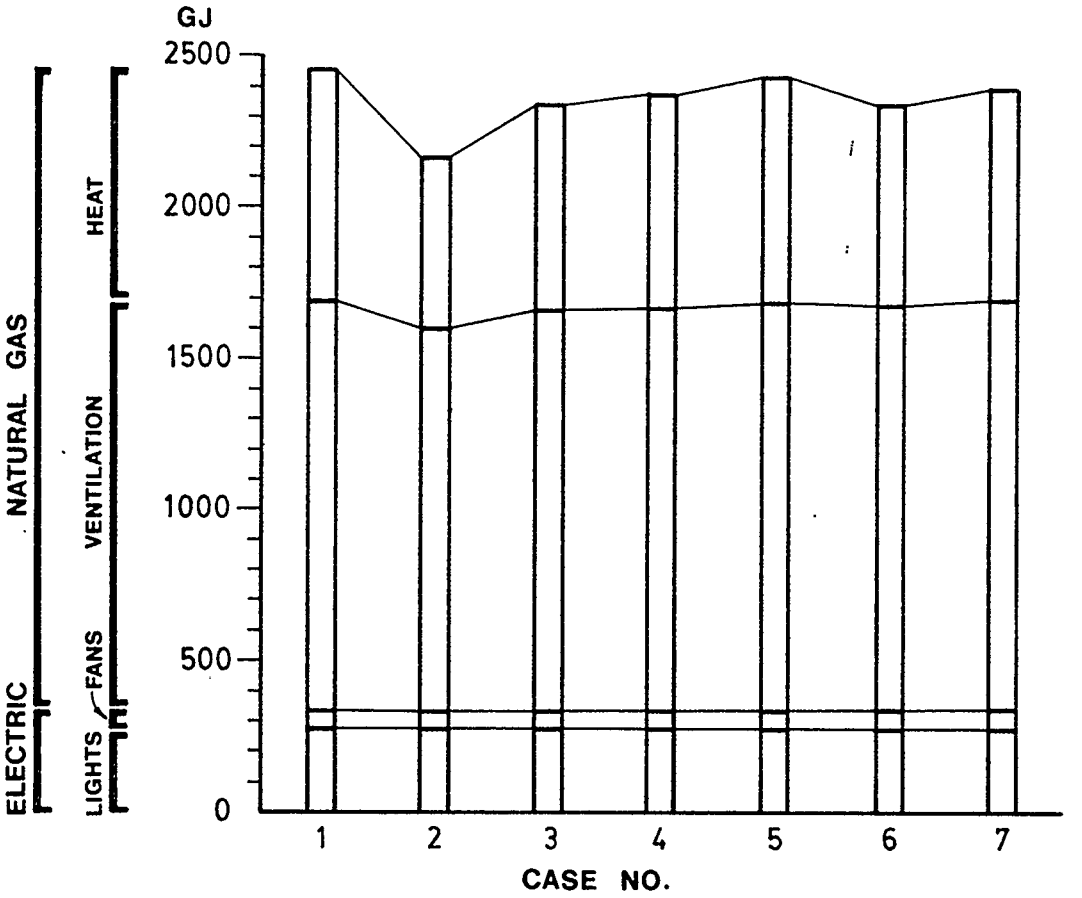


FIG. 8

ANNUAL ENERGY CONSUMPTION PARAMETRIC STUDY

1. BASE BUILDING: walls, RSI 2.5; roof, RSI 4; no windows.
2. INCREASED INSULATION: double values of Case 1.
3. PLAIN WINDOWS: 10% of exterior wall areas.
4. SHADING: applied to Case 3.
5. REFLECTIVE GLAZING: applied to Case 3.
6. PLAIN WINDOWS: 10% of floor areas.
7. SHADING: applied to Case 6.

For the window areas chosen, the modifications to this parameter had little impact on overall energy performance of this building configuration and mechanical system. Shading and reflective glazing had little effect. Greater differences could be expected with larger window surface areas, and the provision

of air conditioning.

Windows do have a significant influence on daily operation, however. It was found that with plain windows, even with shading, some spaces overheated on very hot summer days. Reflective glazing was helpful in reducing the maximum temperatures reached. Although operable windows are provided in the rectory and the smaller rooms for natural ventilation, this could not be simulated by the program.

In terms of overall performance, the energy budget of the base building tested is 767 MJ/sq.m/year, including electrical use for lighting but excluding domestic hot water and office equipment, which is well below the standards set by Alberta Public Works, and Public Works Canada for their buildings (Table 3). It approaches that of the United States General Services Administration, whose figures are for a milder climate. However, the results for this project do not include air conditioning.

TABLE 3. BUILDING ENERGY PERFORMANCE STANDARDS

STANDARD	MAXIMUM ANNUAL ENERGY CONSUMPTION kWh/sq.m	MJ/sq.m
Alberta Public Works	300	1000
Public Works Canada	250	900
U. S. General Services Administration	200	720
Estimate for church (computer simulation)	210	767

Adapted from: Minsos Vaitkunas Jamieson Arch. Ltd., 1978, p V.

Notes: 1. Includes natural gas and electrical consumption.
2. Church estimate does not include domestic hot water and miscellaneous office electrical equipment.

4.6 Acoustics

The two considerations involving acoustics are: the maintenance of an acceptable acoustical separation between various spaces, the important ones being the worship spaces, parish hall, classrooms, nursery, and offices; and performance of the room itself in providing an acceptable environment for the various activities.

In terms of acoustical separation, the major spaces are isolated by intervening corridors. The parish hall is well insulated by concrete block mass walls, and an air lock in the circulation path. It is anticipated that during religious services, adjacent spaces will be used for compatible functions such as Sunday school, which would not be disturbed by the service.

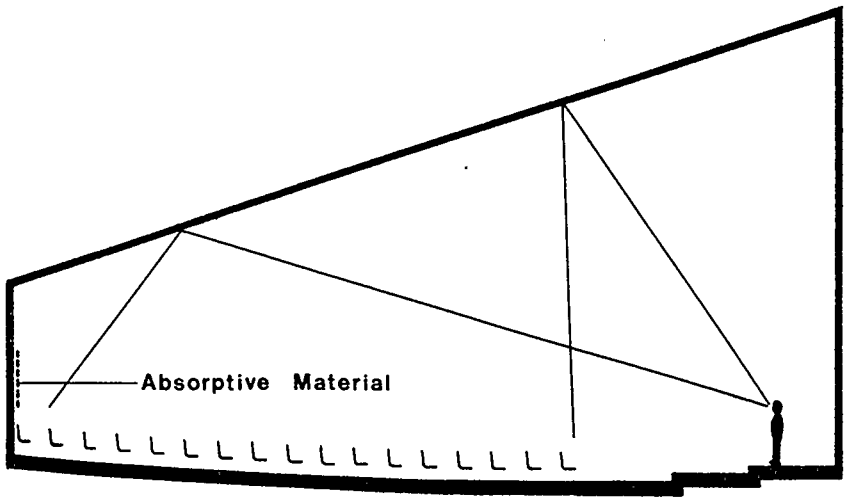
Acoustical performance of the room itself is especially important in the larger spaces such as the worship spaces and parish hall. Thus, calculations of reverberation times were performed for these spaces using various volumes and surface finishes to find a suitable time for the functions they would serve (Appendix D).

Worship spaces present a difficult problem as they must provide for both speech and liturgical music, which represent extremes in optimum reverberation times. McGuiness, Stein, and Reynolds (1980, p 1188) recommend a compromise of 1.4 seconds and up for churches, and over 2.0 seconds for liturgical services and music. An organ consultant suggested a compromise of 3.0 seconds, which would favour the pipe organ to the extent that speech would be difficult to understand. Calculations show that

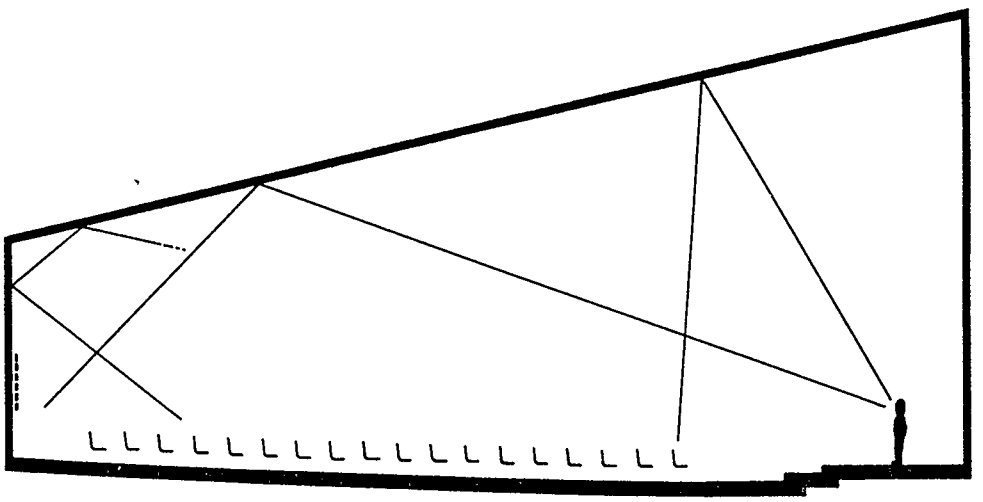
room volume controls the upper limit of reverberation times. Excessively large room volumes would be required to achieve times of 2.0 seconds or greater. Therefore, the lower requirement of 1.4 seconds was chosen as the benchmark for the worship spaces when fully occupied. Padded seats help to limit the increase in reverberation times when fewer occupants are present.

Figure 9 shows acoustic ray diagrams for the Catholic worship space. These show that the configuration of the room is suitable for speech: a large portion of the ceiling is useful in reflecting the sound down to the congregation. Another consideration is the possibility of sound reflections being heard as echoes. This occurs when the difference between the length of travel of the sound going directly to the listener and that reflecting from a surface before reaching the listener exceeds twenty-one metres. The rear wall and the ceiling are the critical surfaces in this respect: in this case only the rear wall has the potential to cause echoes. Possible solutions are to provide acoustically absorbent panels continuously along the back wall as shown, or to install angled panels that disperse the sound.

The Lutheran space is not shown as it would be very similar, and is not as critical since it is much smaller. Another difference in this space is the need to accommodate a pipe organ in terms of space, location, and reverberation time. As noted earlier, reverberation time is made as high as practicable. Organ specialists were consulted as to space and location requirements. The room needed for an organ is dependent on its physical size, and this in turn is dependent on the size of the room. For this



Section – Side Rows



Section – Central Aisle

FIG. 9

ACOUSTIC RAY DIAGRAMS

Catholic Worship Space

case a 1000 pipe, 14 rank organ is indicated. Location within the room must consider a number of factors. These include physical relationship with the minister, choir, and congregation, sound distribution, and visual impact. Any position carries with it certain advantages and disadvantages which are discussed in the Architects' Journal Information Library, Church Buildings. It was decided to place the organ at the rear as it is in Our Saviour Lutheran Church in Calgary, which is very similar in both shape and size to this design. Both the minister of this church and a pipe organ specialist indicated satisfaction with this layout. Although it results in a physical separation of choir and director from the minister, the small size of the room minimizes this negative aspect. One other effect that must be tolerated is that the congregation cannot easily see the choir.

4.7 Sight Lines

One of the requirements of assembly spaces is good sight lines. Provision for this ensures good direct sound distribution as well. Appendix E presents the calculations performed to find appropriate floor slopes and platform heights.

For the Lutheran space which has a flat floor, a platform height of about 800 mm is needed. There are two negative aspects to this layout that must be endured by the congregation. The sightlines to the altar, which ideally allows a view of the top surface, is far from ideal. In addition, parts of the service not conducted from the top level of the platform will not be as visible from the back rows.

In the Catholic space the much larger size requires a sloped floor. In order to limit the overall rise an iscidomal slope (curved slope which provides equal sight lines for each row) is necessary. For a platform height of 400 mm a constant rise slope would have an overall rise of 3.0 m compared to 700 mm for the iscidomal.

4.8 Site Utilization

Table 4 below shows that the site area is more than adequate for the proposed building and parking. Additional area beyond that required for screening the parking is placed in two blocks, one adjacent to the rectory, and a larger block next to the City park to the north. With landscaping the rectory then has a semi-private yard, and the park is effectively enlarged to provide space for the nursery as well as neighborhood children. The option exists to expand the building on the north-west and north-east sides of the parish hall. Linkages to the expansion would be from one or both arms of the corridors leading to the foyer.

TABLE 4. SITE UTILIZATION

ITEM	AREA, sq.m	PER CENT OF SITE
Building Footprint	3288	15.7
Hard Surfacing	6974	33.4
Landscaping	10628	50.9
Total Site Area	20890	100.0

4.9 Construction Cost

Net building construction cost is estimated to be $1.91 million dollars ($558.93 per square metre), excluding furnishings and equipment, design fees and contingencies. These figures are based on 1985 Yardsticks For Costing (Murray, 1985) composite unit rates and other sources. A more detailed account is presented in Appendix F.

5. DESIGN

The building design derives from a synthesis of the programmatic and contextual issues, subject to the technical constraints of environmental control and building safety presented in the previous chapters. The resolution of these various concerns, including response to context, expression of function and symbol in terms of exterior and interior forms, and internal functional relationships are discussed below. This is to be read with reference to the drawings in Section 5.5.

5.1 Response to Context

As discussed earlier, the character of the surrounding area is primarily single family and low-rise condominium residential, with support facilities such as schools, small scale strip commercial, and green space reserves. To respond to this social context and yet provide a visual presence, a number of devices are required.

A low profile is achieved by keeping the ancillary functions to a single storey surrounding the main church spaces, emphasizing the horizontal line. The parish hall, which requires a high ceiling for recreational activities, is depressed a full storey height below the rest of the building and two meters below the

surrounding grade. This allows the flat roofs covering these spaces to form a continuous plane, above which only the peaks of the church forms and cross rise. The forms rise with low slopes toward the center, presenting a visual flow from horizontal to vertical lines, and minimizing the portion of building mass that exceeds one storey in height.

As noted in the site analysis, the general lie of the land is a gentle slope to the north. Therefore, the site lies below the level of the major street intersection, de-emphasising any presence the building might have from this important viewpoint. Fortunately, the lot between the intersection and this site will not have any large structures blocking the view. To maximize the visual impact from the street intersection the building is situated as close as is practicable to the south corner of the lot. Room is provided for vehicular access and to allow a portion of the parking to be in close proximity to the south building entry.

At-grade parking facilities are potential eyesores to communities, and do not provide an ideal setting for buildings. Therefore, the parking spaces are divided into two blocks, each oriented to a major entry to the building. Screening is provided by recessing the parking area into the slope where possible and by planting of shrubbery and trees. Use of the bus loop parking lot for overflow parking is also anticipated by the scheme.

The slope is utilised by depressing the parish hall one storey height, and providing a partial basement under the main level to house ancillary functions such as the kitchen, wash-

rooms, storage, and mechanical room. The floor levels of the churches are at an equal height to avoid any sense that one is above or better than the other. All areas are accessible through at-grade entrances except the parish hall which requires a short ramp.

Since most visitors will arrive by car, the entry roadway is placed directly on the major diagonal axis of the building. The cross is seen framed by the Catholic and Lutheran worship spaces, and the courtyard and main entry is visible past the vertex of the library walls.

5.2 Exterior Expression

A major consideration in the development of the exterior form was the provision of a visible symbol of two Christian faiths joining in a single building. Thus, the forms housing the worship spaces deliberately contrast with and rise above that of the ancillary spaces. Their forms sweep up toward each other and fall away at the center, where they frame a cross. An expression of the relationship formed by the two congregations may be visualized: the forms are reflections of each other, yet retain their identity; they face each other, aspiring to a common center, a single cross symbolizing as well, their earliest beginnings.

Spaces serving ancillary functions are visually subordinated to the worship spaces by their low profile and common roof plane. However, variety is maintained with undulating planes and curves of the walls articulating or emphasizing the different requirements within. Partially enclosed courtyards are used to create a

variety of semi-public and private spaces to enhance entrances, to provide wind buffers, and to accommodate the changing grade levels.

5.3 Interior Expression

Inside, as well, the center of the building is emphasized and exploited as a symbolic focus. Though not the exact centroid of the building, this is the intersection of a number of important axes. The axis of the central aisles in the worship spaces, the vertical axis of the cross, and the orthogonal axes defined by the major circulation corridors coincide here.

Such a space should serve a function commensurate in importance. Thus, a religious element of great importance to both Lutherans and Catholics, the baptismal font, is placed here. The font is often a striking sculptural piece, providing a visual focus. Immediately surrounding the font the floor is sunken slightly to impart a symbolic effect of stepping down into a body of water. This further emphasizes the significance of the center and allows members of the congregation to gather around to witness baptisms.

A skylight directly above, and windows opening to the courtyard would flood the area with natural light, creating a very open ambience in close contact with the outdoors. Through the skylight the cross and the peaks of the worship spaces would be visible, reinforcing the sense of place.

Inside the church spaces the altar platform is placed below the peak of the space at the place of greatest prominence. This high backdrop serves as an ideal location for the traditional cross. Recessed into this face, and made the full height and width, it would become a part of the fabric of the structure itself, its very size commanding attention. Seating is fan-shaped around the altar, emphasizing the corporate aspect of worship, and reducing distances to back rows.

5.4 Internal Relationships

These relationships are dealt with in detail in the program provided in Appendix A. Therefore, only an overview is provided here. The relationships of the major spaces, in terms of circulation, are summarised in Figure 10.

The layout of the major circulation paths is the main organizing element for the spatial relationships. This would also serve to orient the user with its simple clarity. As noted earlier, the intersection near the center of the building becomes a very important place because of its location and use. People would be encouraged to use the space because of its openness and close contact with the outdoors. Mingling of the congregations before and after services would be invited since doors enter directly into the Lutheran and Catholic spaces from this center. Because these doors are at the fronts of the sanctuaries they required special consideration of their use: it would be disturbing for people to enter here once services began. Thus, the

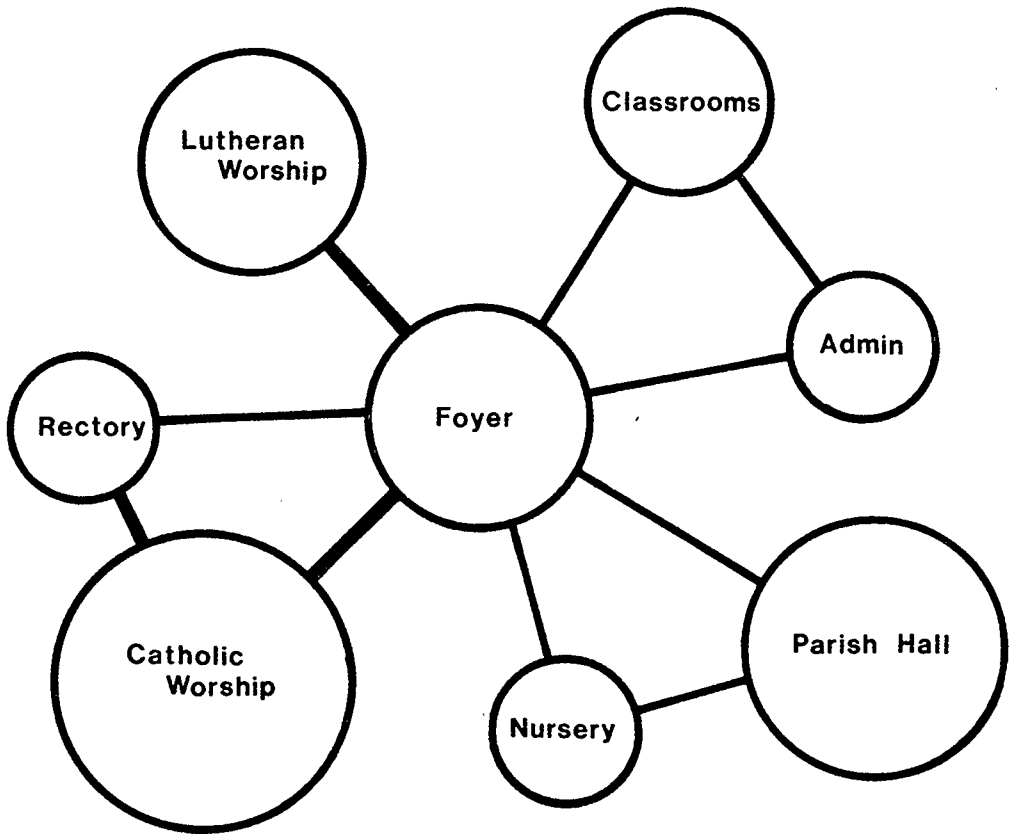


FIG. 10

FUNCTIONAL RELATIONSHIPS

doors could be left open until services started, then closed to signal this situation, and late-comers would use the rear doors.

In general, the plan consists of the two major worship spaces opposite each other on a central axis, surrounded by all the other supporting and ancillary functions. These are arranged in groups such that the administration area is adjacent to the main entry, and related facilities such as library and conference rooms are nearby. Due to the use of these spaces for multiple functions the Sunday school room and youth center are grouped

with these. The nursery and parish hall are placed near each other, and immediately off the second major entry. This places the kitchen in close proximity to both. Because the rectory is a relatively private space, it is located away from the main stream of traffic next to the Catholic Church to which it is functionally attached. A further benefit of the placement is that it is remote from the major traffic artery, Berkshire Boulevard, and access is from the residential street, Santana Hill.

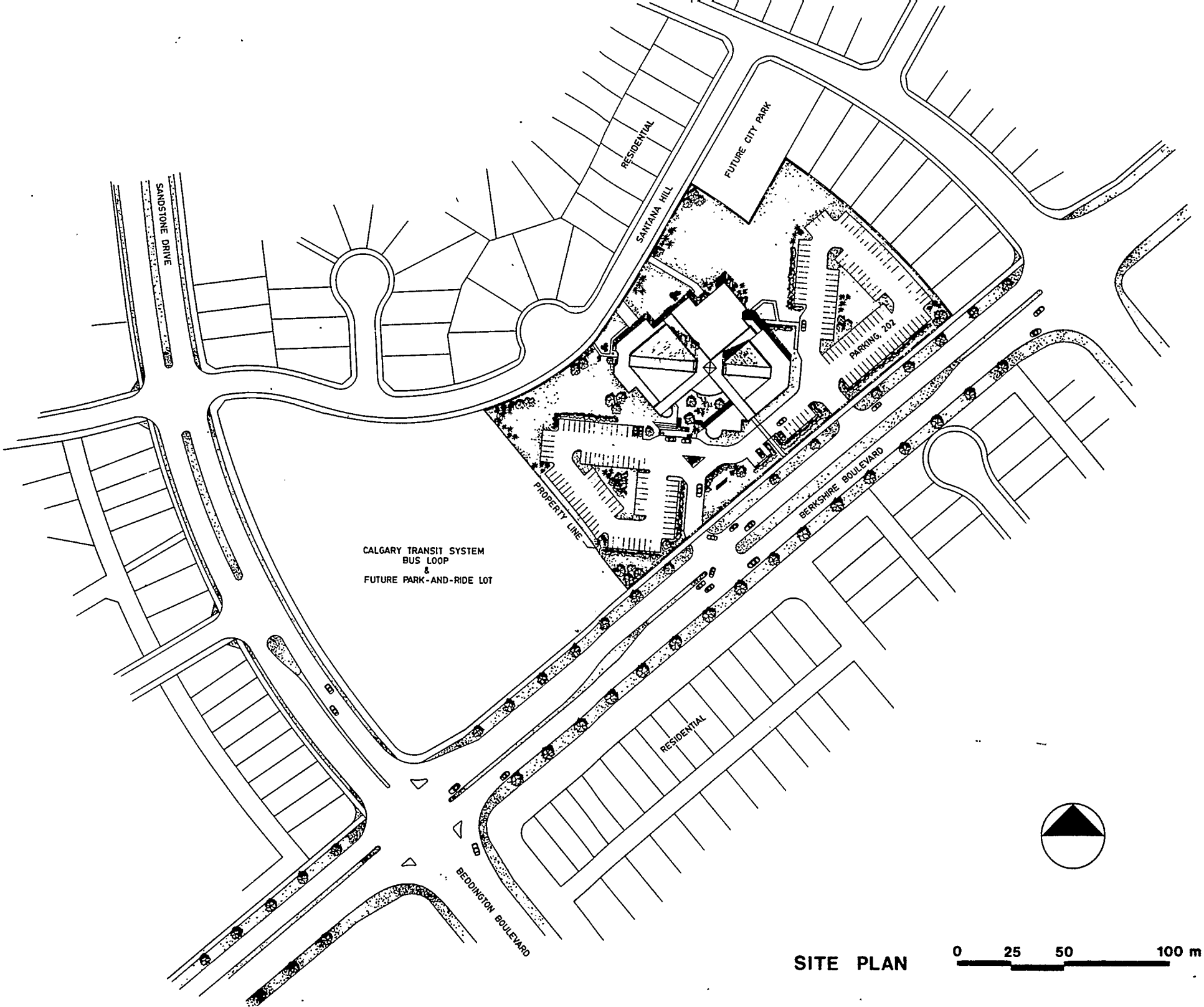
5.5 Drawings

As noted earlier, the drawings in this section serve to illustrate the concepts put forward in the previous sections of this chapter: the response to the physical, social, and historical contexts; external and internal expression of functional and symbolic aspects; and organization of the various functions.

Exterior wall finishes are white dash trowelled stucco with reddish-brown brick panels at strategic locations to emphasize certain areas and provide contrast to the white. Brick is thus used at the entries to the building, and as the cladding for the round forms of the library and chapel. Cedar shakes are used for the sloping roofs of the worship spaces.

The building sections show the use of split-face ribbed concrete block in a pattern bordered by vertically scored ground face block (200 x 200 pattern). The warm grey tone, and texture of the material will give a rugged character that will contrast with, and complement wood elements such as the glu-lam beams and furniture. In the parish hall ribbed block is used only on the

upper portion of the wall and scored block on the lower portion. This reduces the vertical scale of the wall and provides a smoother surface for areas with which the occupants could come into contact.



SITE PLAN

0 25 50 100 m

1 FOYER

a. BAPTISMAL FONT
b. COFFEE SERVERY
c. COAT STORAGE

2 CATHOLIC WORSHIP

a. ALTAR
b. LECTERN
c. BAPTISMAL FONT
d. ALTAR OF REPOSE
e OFFICIANTS' SEATS
f. CHOIR
g SACRISTY / VESTRY
h. CONFESSIONAL
j. CRYING ROOM / CHAPEL

3 LUTHERAN WORSHIP

a. ALTAR
b. LECTERN
c OFFICIANTS' SEATS
d. CHOIR
e. PIPE ORGAN
f CRYING ROOM
g. SACRISTY / VESTRY

4. ADMINISTRATION

a. RECEPTION
b. MINISTER'S OFFICE
c COUNSELING ROOM
d. LIBRARY

5. PROGRAM ROOMS

a. CONFERENCE ROOM
b. YOUTH CENTER
c. SUNDAY SCHOOL

6. NURSERY

a. STAFF
b. SLEEPING ROOM
c. WASHROOM

7. PARISH HALL

a. PORTABLE STAGE

8. RECTORY

a. LIVING ROOM
b. DINING ROOM
c. KITCHEN
d. BEDROOM
e. WASHROOM
f. HOUSEKEEPER'S SUITE
g. GARAGE
h. UTILITY ROOM

9. KITCHEN

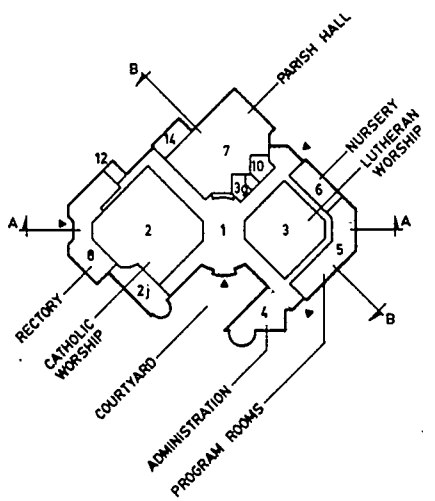
10. WASHROOM

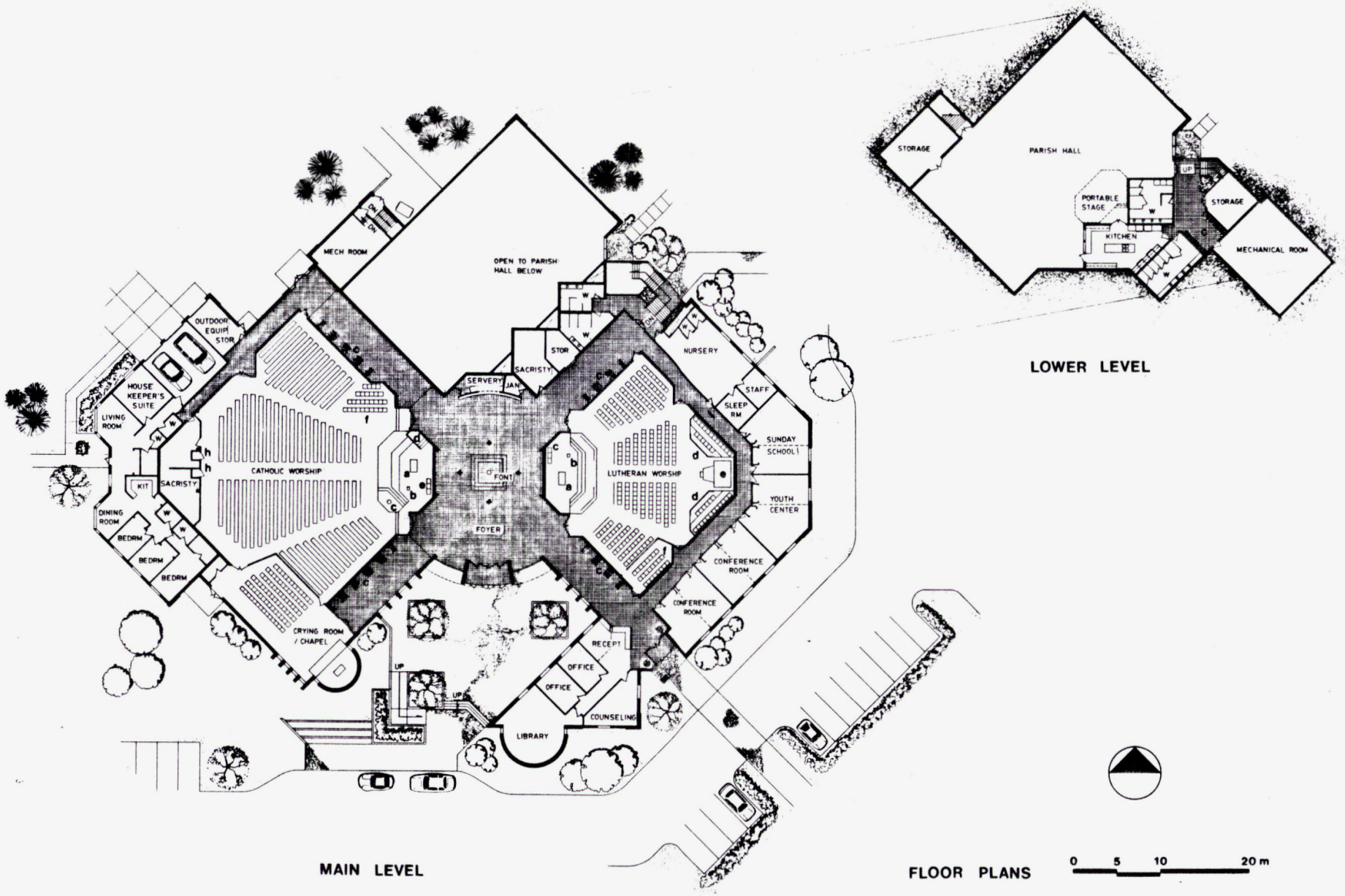
11. STORAGE

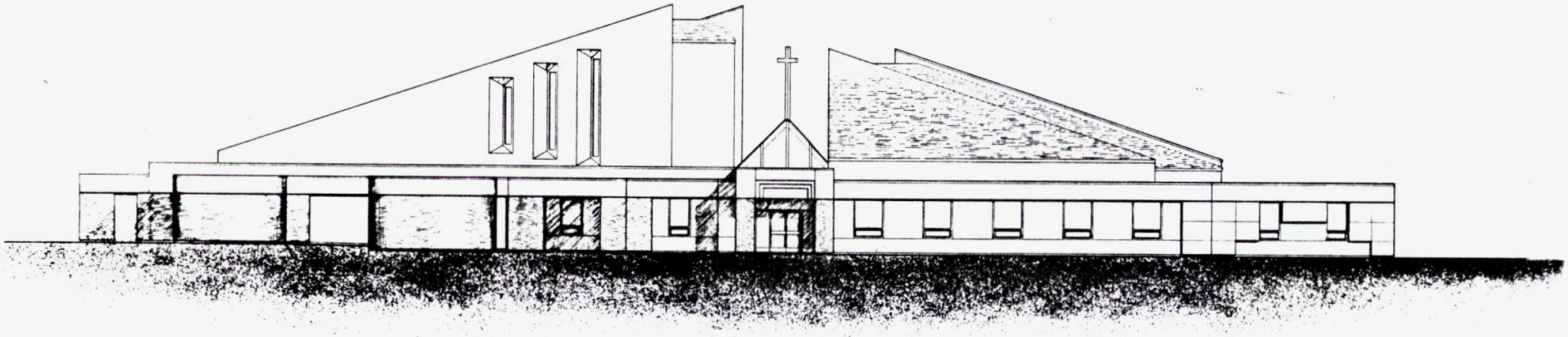
12. OUTDOOR EQUIPMENT STORAGE

13. JANITOR'S CLOSET

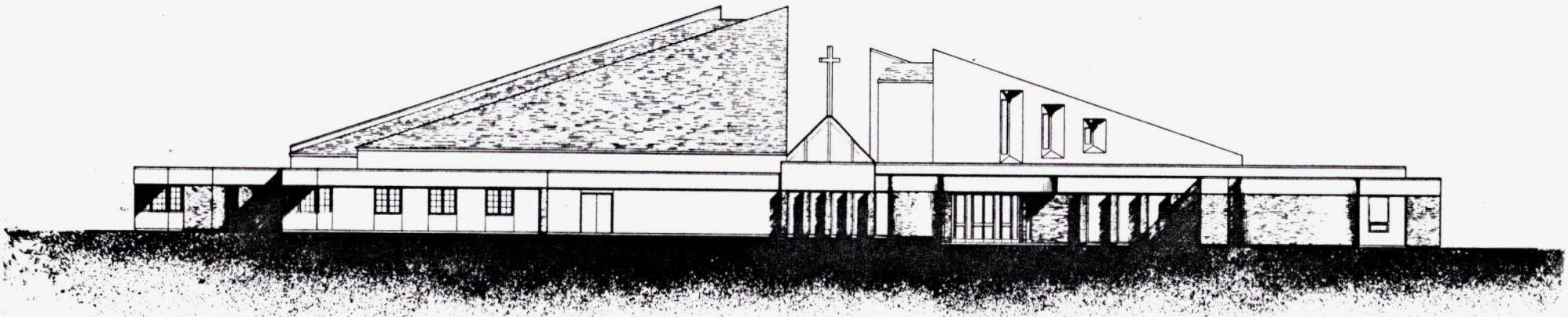
14. MECHANICAL ROOM




STORAGE
PARISH HALL
UP
PORTABLE STAGE
W
STORAGE
KITCHEN
MECHANICAL ROOM
W
LOWER LEVEL
MECH ROOM
OPEN TO PARISH HALL BELOW
OUTDOOR EQUIP STOR
HOUSE KEEPER'S SUITE
LIVING ROOM
KIT
SACRISTY
DINING ROOM
BEDRM
BEDRM
BEDRM
CATHOLIC WORSHIP
CRYING ROOM / CHAPEL
STOR
SACRISTY
SERVERY
JAN
FONT
FOYER
NURSERY
STAFF
SLEEP RM
SUNDAY SCHOOL
LUTHERAN WORSHIP
YOUTH CENTER
CONFERENCE ROOM
CONFERENCE ROOM
RECEPT
OFFICE
OFFICE
COUNSELING
LIBRARY
UP
UP
MAIN LEVEL
FLOOR PLANS
0 5 10 20 m

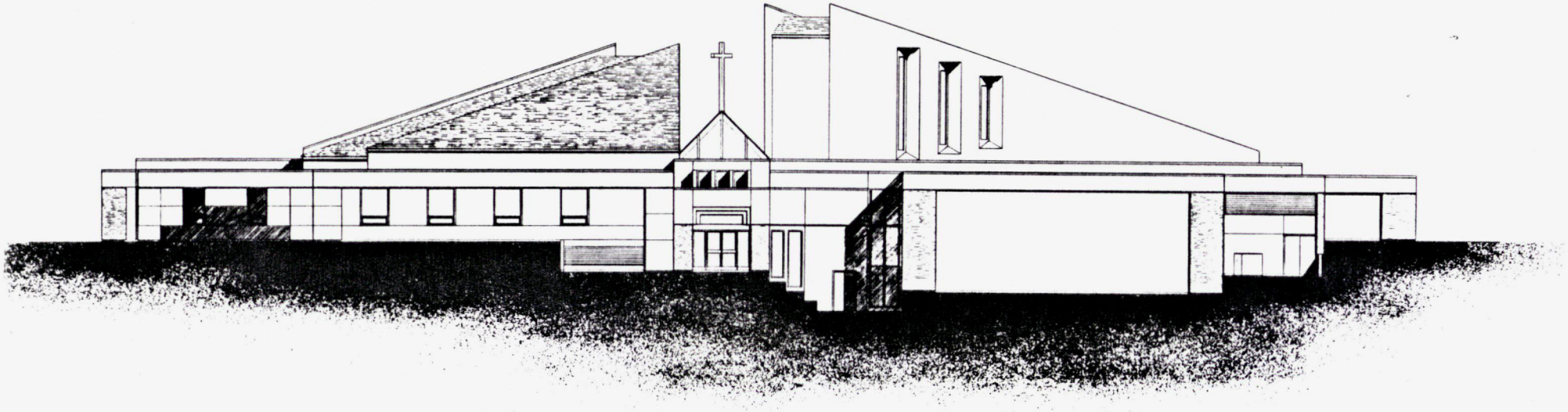


SE ELEVATION

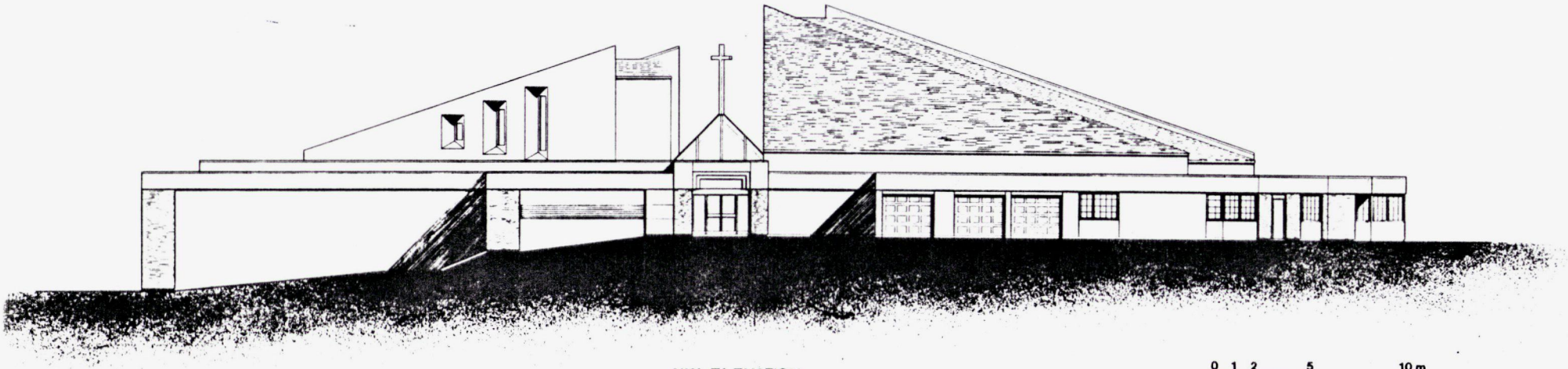


SW ELEVATION

0 1 2 5 10 m

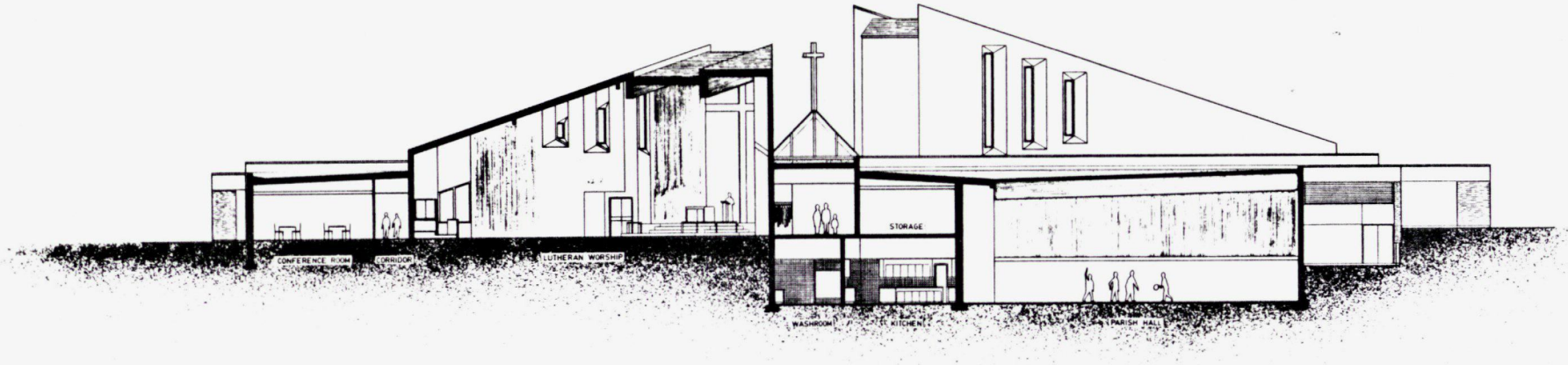


NE ELEVATION

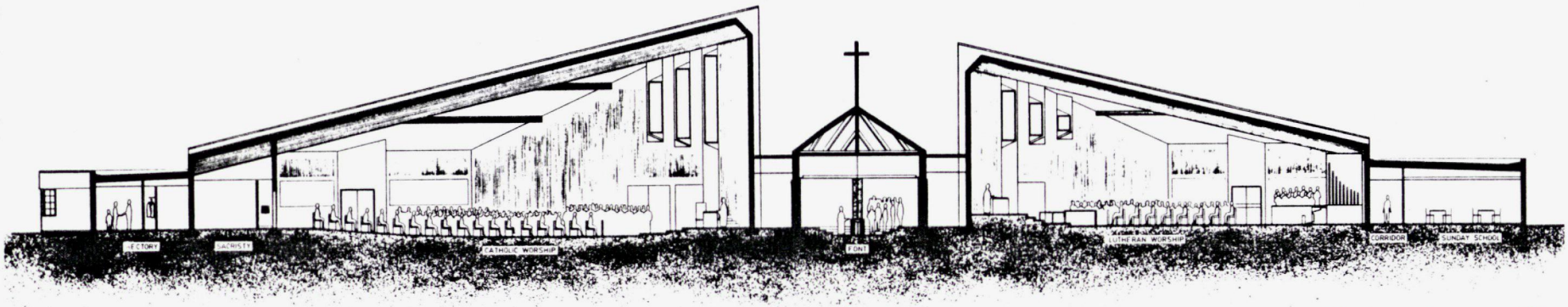


NW ELEVATION

0 1 2 5 10 m



SECTION B-B



SECTION A-A

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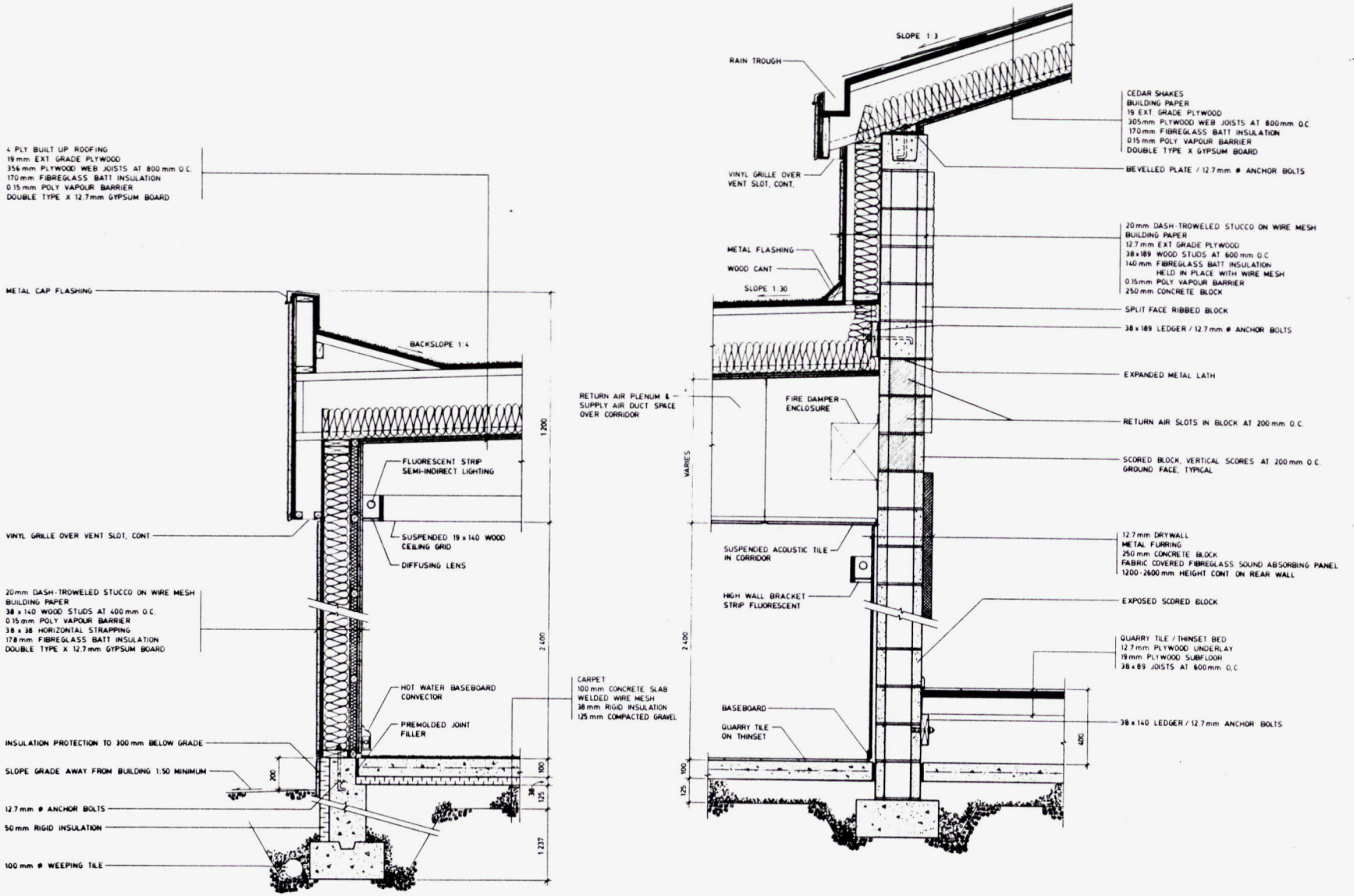


EXTERIOR **INTERIOR**

WALL SECTIONS

appendix

A. Facilities Program

PROPOSED SITE UTILIZATION

FUNCTION	AREA, sq.m
Parking: @ 30 sq.m per stall	5610
Loading/Garbage Pick-up	35
Passenger Drop-off	50
Site Coverage for Single Storey Building	3000
Landscaping	12195
Total Site Area	20890

PARKING CALCULATIONS (based on City of Calgary bylaws):

Church @ 1 stall per 5 persons
No. of stalls = 1042 / 5 = 209

Hall @ 1 stall per 3 persons
No. of stalls = 633 / 3 = 211

SPACE REQUIREMENTS

SPACE	NO. OF PEOPLE	UNIT AREA, sq.m/person	* AREA, sq.m
ENTRY:			
Foyer	1000	0.25-0.35	250 - 350
Coatroom	1000	0.01	100
Washrooms			30 - 40
Storage			50
			430 - 540
CATHOLIC WORSHIP:			
Seating	650	0.63-1.0	410 - 650
Choir	30-40	1.0	30 - 40
Sanctuary		0.21-0.33	137 - 217
Sacristy/Vestry			30 - 35
Multi-purpose	40-80	1.0	40 - 80
Confessionals	2		10
			657 -1032
LUTHERAN WORSHIP:			
Seating	250	0.63-1.0	160 - 250
Choir	35	0.63-1.0	23 - 35
Sanctuary		0.21-0.33	60 - 95
Pipe Organ			15
Sacristy/Vestry			25
Crying Room	15	1.0	15
			298 - 435
ADMINISTRATION:			
Reception/Secretary			35
Catholic Minister			22
Lutheran Minister			22
Counseling			22
Conference Room #1			38 - 50
Conference Room #2			38 - 50
Photocopy/Filing			16
			193 - 217
Sub-Total			1588 -2224

SPACE REQUIREMENTS (continued)

SPACE	NO. OF PEOPLE	UNIT AREA, sq.m/person	* AREA, sq.m
PARISH HALL:			
Hall	400	1.0 -1.3	400 - 520
Kitchen			50
Storage			50
Washrooms			40 - 50
			540 - 670
EDUCATION:			
Library			45
Youth Center	50	0.9 -1.1	45 - 55
Nursery	15-20		65 - 93
Sunday School	50	0.63-1.0	32 - 50
			187 - 243
ANCILLARY:			
Janitor			6
Mechanical/Electrical (6%)			127
Outdoor Equipment Storage			50
			183
RECTORY:			
Residence, Housekeeping Suite			200
Sub-Total			1110 -1296
Previous Sub-Total			1588 -2224
Total			2698 -3520

* NOTE: Net areas not including major circulation.

FUNCTIONAL REQUIREMENTS — ENTRY

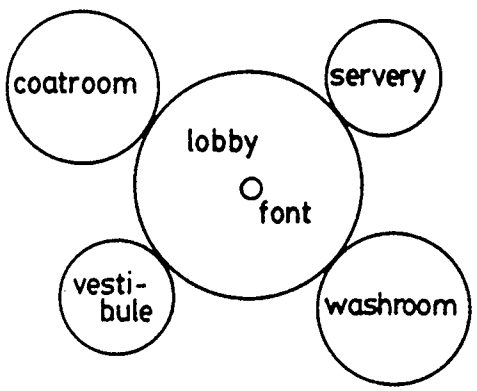
FUNCTIONS:

1. Vestibule(s) for air lock.
2. Foyer to receive guests for worship and activities; provide for social space for up to 1000 after events; provide for circulation to all major spaces; act as an inviting focal point for other spaces; accommodate baptisms.
3. Coatroom for up to 1000 coats -- may be dispersed.
4. Serving of coffee, tea, or juice after services.

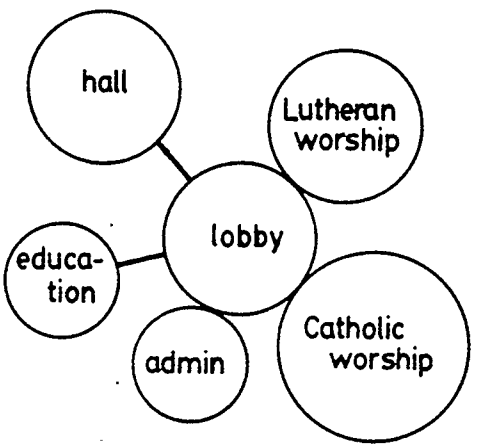
EQUIPMENT:

1. Some seating, but mostly standing and circulation space in foyer.
2. Servery -- space for coffee urn, hot water dispenser, and juice containers. Sink and cupboard storage for cups and related material.

INTERNAL ORGANIZATION:



EXTERNAL RELATIONSHIPS:



SPECIAL REQUIREMENTS:

1. Permanently located font.

FUNCTIONAL REQUIREMENTS ADMINISTRATION

FUNCTIONS:

1. Administration of building and grounds, maintenance, and scheduling of room use.

2. Reception and waiting area, suitable for secretarial services.

3. Catholic and Lutheran ministers' offices -- work area and counseling of individuals.

4. Counseling room for families and small groups; classroom on Sundays.

5. Two conference rooms for up to 25 persons; classrooms on Sundays.

6. Photocopying, filing and stationery storage.

EQUIPMENT:

1. Reception/waiting area -- coffee table, sofa, easy chairs, secretary's desk, work table, extra desk for building administration tasks, space for computer terminal.

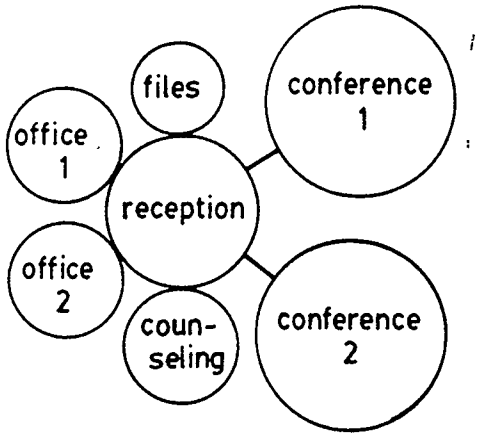
2. Ministers' offices -- desk, table, chair, coffee table, easy chairs, bookshelves.

3. Counseling room -- coffee table, sofa, easy chairs, room for additional stacking chairs for Sunday school seating a total of 10 persons.

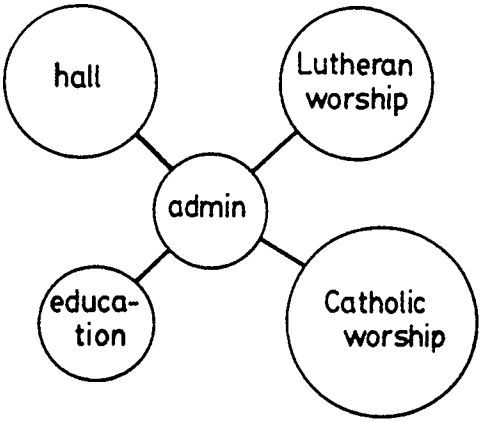
4. Conference rooms -- movable tables and chairs to seat up to 25 persons in conference and for Sunday school.

5. Photocopy/filing room -- photocopy machine, mimeograph, 6 five-drawer legal size filing cabinets, layout table.

INTERNAL ORGANIZATION:



EXTERNAL RELATIONSHIPS:



SPECIAL REQUIREMENTS:

1. Storage of Sunday school materials in multi-use rooms -- possibly in portable units.

2. Built-in white-boards in multi-use Rooms.

FUNCTIONAL REQUIREMENTS LUTHERAN WORSHIP

FUNCTIONS:

1. Sunday worship services 10:00-12:00 AM.
2. Baptisms.
3. Funerals.
4. Weddings.
5. General meetings of congregation.
6. Special services -Epiphany
   -Ascension
   -Lent
   -Christmas and Easter (midnight).

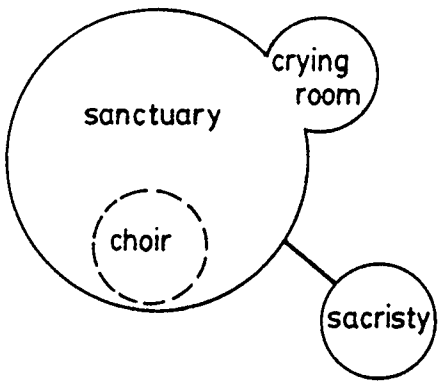
ANCILLARY SPACES:

1. Sacristy/Vestry -- storage and cleaning of communion ware; storage and donning of vestments for clergy and acolytes; storage, construction and sewing of paraments and banners.
2. Crying room -- soundproof room with view of sanctuary to accommodate up to 15 persons; Sunday school classroom for up to 15 persons.

EQUIPMENT:

1. Seating for congregation, 250; choir, 35.
2. Altar, pulpit, lectern, and baptismal font.
3. Electronic sound equipment to transmit to loudspeakers, headphone plug-ins for hearing impaired, and crying room.
4. Screen for overhead projection.
5. Sacristy -- storage for sacred elements, vestments; counter with sink.
6. Crying room -- loudspeakers for sound from sanctuary; chairs, tables.

INTERNAL ORGANIZATION:



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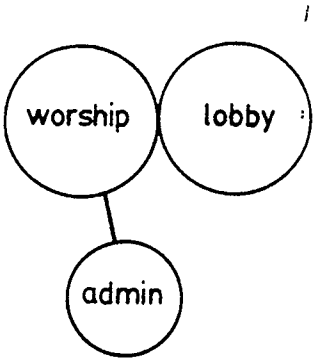


SPECIAL REQUIREMENTS:

1. Space for future pipe organ.
2. Space for other musical instruments/groups.
3. Flexible seating.
4. Use of crying room for Sunday school -- space for portable chalk-board, screen, and audio-visual equipment.
5. Direct access from sacristy to altar desired.

FUNCTIONAL REQUIREMENTS CATHOLIC WORSHIP

FUNCTIONS:

1. Sunday worship 10:00-12:00 AM.
2. Confessions
3. Weddings.
4. Funerals.
5. Special services -Stations of the Cross
   -Benediction
   -Lent
   -Christmas and Easter (midnight).

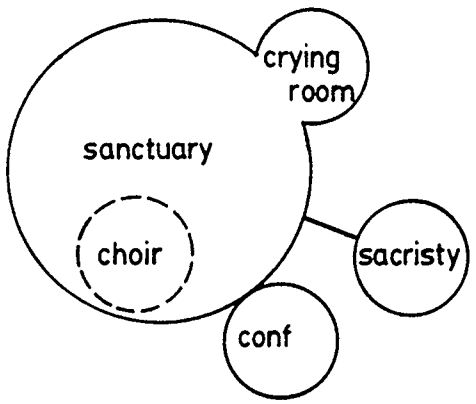
ANCILLARY SPACES:

1. Sacristy/Vestry -- storage of sacred elements, and vestments; donning of vestments by minister and altar boys.
2. Multi-purpose room -- crying or quiet room; small services for up to 80 persons; baptisms; Sunday school for up to 50 persons; meetings; space for time out program for women during week.
3. Confessionals -- 2 screened rooms with adjoining counseling room.

EQUIPMENT:

1. Seating for congregation with kneelers, 650; choir, 30 to 40; clergy, usually 1.
2. Altar, pulpit, and lectern.
3. Screen for overhead projection.
4. Sacristy -- vestment storage, sink, counter.
5. Multi-purpose room -- tables and chairs; altar and portable font; curtain or folding door to screen altar; speakers and headphone plug-ins for sound from sanctuary; storage for Sunday school materials, extra chairs and tables.
5. Audio plug-ins for hearing impaired.

INTERNAL ORGANIZATION:



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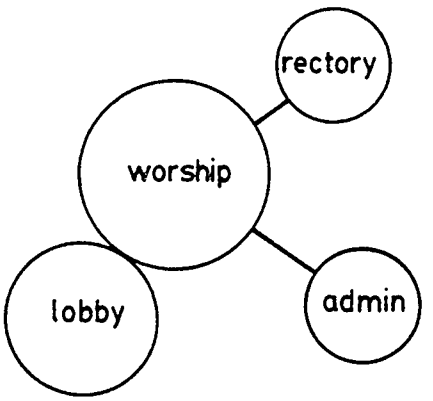


SPECIAL REQUIREMENTS:

1. Preferred location of sacristy: at back of worship space.

2. Multi-purpose room -- must be near diaper changing facilities; provide space for portable chalk-board, screen, and audio-visual equipment.

FUNCTIONAL REQUIREMENTS PARISH HALL

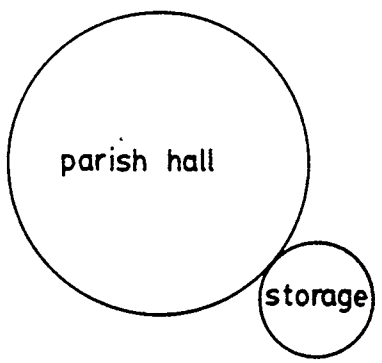
FUNCTIONS:

1. Dinner/dance evenings.
2. Recreation -- table tennis, badminton, volleyball, basketball (if possible).
3. Performances.
4. Education -- up to 15 persons per class; up to 6 classes using screens.

EQUIPMENT:

1. Stacking chairs and tables to seat 400.
2. Portable stage.
3. Storage for chairs, tables, stage, recreational equipment, and Sunday school materials.

INTERNAL ORGANIZATION:



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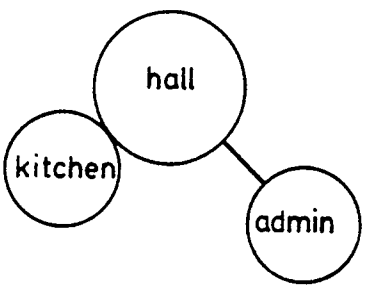


SPECIAL REQUIREMENTS:

1. Room height and surfaces to accommodate sports at recreational level.
2. Stage to be portable.
3. Wet bar.

FUNCTIONAL REQUIREMENTS KITCHEN

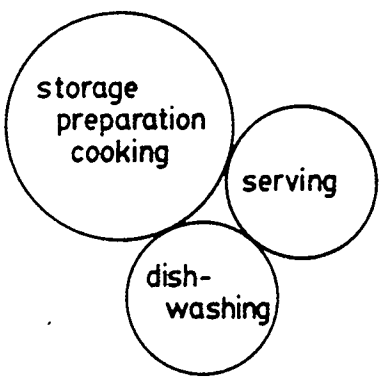
FUNCTIONS:

1. Prepare dinners for up to 400 guests.
2. Prepare lunches/snacks for nursery and play-school.

EQUIPMENT:

1. Storage -- minimal since most food will arrive on day of event; large refrigerator.
2. Preparation -- minimal since most foods will be prepared at home; meat slicer; 2 double sinks.
3. Cooking -- 1 conventional oven (possibly commercial); 2 sets of counter-top elements; 2 microwave ovens.
4. Serving -- dish storage; carts.
5. Cleaning -- counter for stacking dirty dishes; large sink; garbage disposal; commercial dishwasher?

INTERNAL ORGANIZATION:



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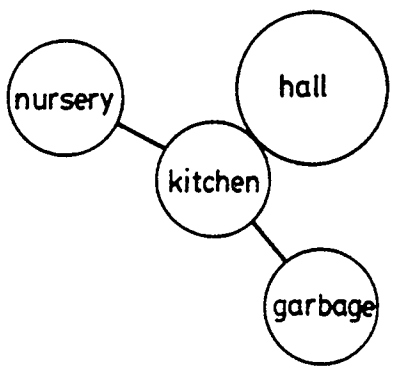


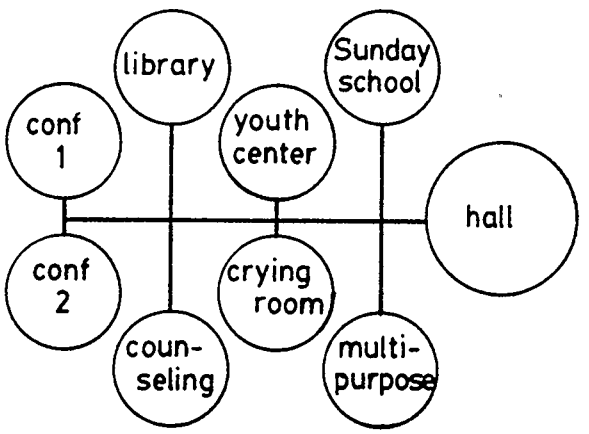
FUNCTIONS

1. Catholic -- single space for up to 50 persons on Sundays.
2. Lutheran -- individual spaces for 12 grades plus youth and adult study areas, up to 15 persons per space on Sundays.

EQUIPMENT:

1. Tables and chairs scaled to appropriate size.
2. Portable white-boards, and audio-visual equipment.
3. Storage for equipment and school materials.

INTERNAL ORGANIZATION:



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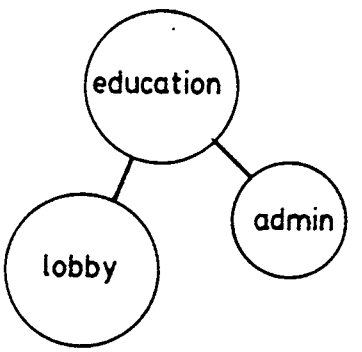


SPECIAL REQUIREMENTS:

1. Other spaces to be used for classrooms -- 2 conference rooms, counseling room, library, youth center, crying room, multi-purpose room Catholic Sunday school room.
2. Provide 7 spaces in community hall with dividing screens.
3. Future playschool -- share Catholic Sunday school room.

FUNCTIONAL REQUIREMENTS NURSERY

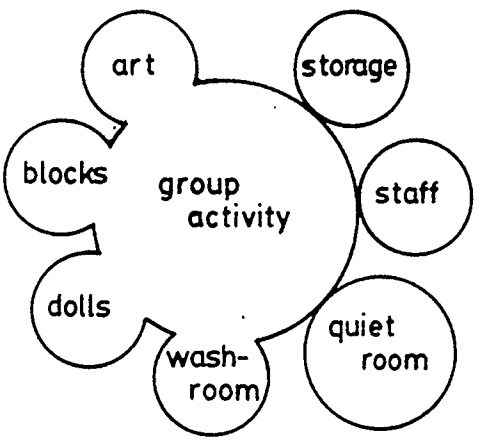
FUNCTIONS:

1. Provide for 15-20 children -- playschool during weekdays, pre-school and nursery on Sundays.
2. To allow parents time for shopping or other activities during weekdays.
3. To care for children during Sunday services.

EQUIPMENT:

1. Tables and chairs to appropriate scale.
2. Portable cots for naps.
3. Children's washroom adjacent.
4. Facilities for arts and crafts.
5. Facilities for 2 attendants.
6. Outdoor playground equipment.

INTERNAL ORGANIZATION:



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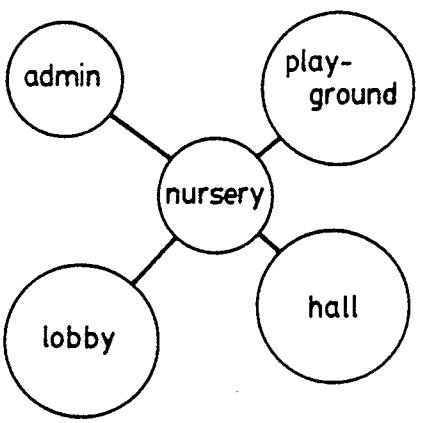


FUNCTIONAL REQUIREMENTS — RECTORY

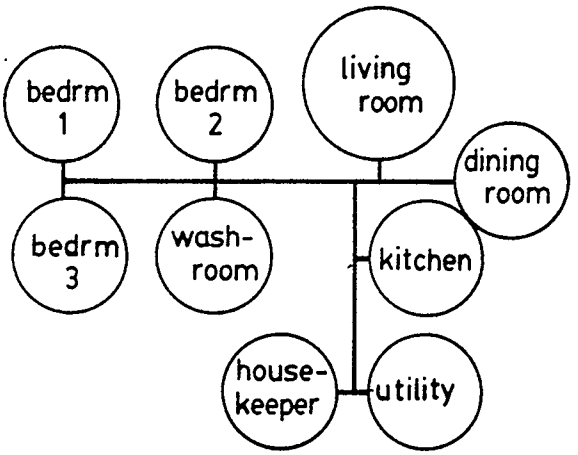
FUNCTIONS:

1. Accommodation for Catholic priest.
2. Entertaining guests.
4. Parish laundry.
5. Garage.

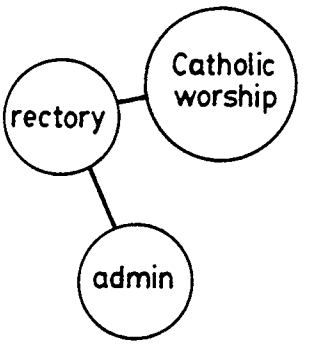
EQUIPMENT:

1. Equip as for normal residence.

INTERNAL ORGANIZATION:



EXTERNAL RELATIONSHIPS:



SPECIAL REQUIREMENTS:

1. Laundry facility to serve church and rectory.
2. Separate facilities for guestrooms.
3. Separate housekeeper's suite.
4. Indoor link to main building.

B. Alberta Building Code

The Alberta Building Code was considered to a preliminary level appropriate to the level of design. Some of the applicable parts are delineated below. The numbers given in brackets refer to the appropriate sections of the building code.

USE AND OCCUPANCY (3.1.2.1)

Group A, Division 2 -auditoria, churches, community halls gymnasia, libraries, schools.
Group B, Division 2 -day care centers.
Group C -houses.
Group D -offices.

OCCUPANT LOADS (3.1.14)

Minimum occupant loads to be used for the purposes of determining fire exiting and washroom requirements for various spaces are governed by this section of the code.

OCCUPANT LOADS FOR MAJOR SPACES

SPACE	SEATING TYPE	AREA/SEAT, sq.m	AREA, sq.m	NO. OF PEOPLE
Catholic Worship	Fixed	N/A	N/A	700
Lutheran Worship	Nonfixed	0.75	220	295
Parish Hall	Nonfixed (with stage)	0.75	475	633
	Nonfixed, with tables	0.95	500	526

SIZE AND OCCUPANCY REQUIREMENTS FOR FIRE SAFETY (3.2)

This section sets out the general requirements for fire safety within the building as a whole. Because the rectory and nursery comprise less than ten per cent of the total building area they do not govern. Of the assembly and office occupancies, requirements for Group A, Division 2 (churches) are the most restrictive and must be applied. Since firewalls may be used to divide the building into fire compartments that are considered separate buildings for the purposes of this part of the Code, numerous ways may be found to accommodate the fire safety requirements. Use of this device effectively reduces the floor areas within the fire compartments, thereby reducing stringency

of the applicable regulations. If firewalls are not used, two alternatives are possible depending on whether or not fire sprinklers are used:

Alternate 1: unsprinklered, up to 5 storeys, any area (3.2.2.15)

- -noncombustible or heavy timber construction.
- -floor assembly above basement -- 2 h fire separation.
- -roof assemblies -- 1 h fire resistance rating.
- -load bearing walls and columns -- 1 h fire resistance rating.

Alternate 2: sprinklered, one storey, facing 3 streets (3.2.2.14)

- -combustible or noncombustible construction.
- -floor assembly above basements -- 3/4 h fire separation.
- -roof assemblies -- 3/4 h fire resistance rating if of combustible construction.

TRAVEL DISTANCES (3.4.2)

For floor areas, travel distance to an exit is measured from either any point in that area, or from the egress door of a room if that room is separated from the rest of the area by a fire separation having a fire resistance rating of at least 3/4 hour. The maximum permitted distances are given below:

Group A -- 30 m.
Group D -- 40 m.

SAFETY REQUIREMENTS WITHIN FLOOR AREAS (3.3.2)

Some of the requirements for assembly occupancies are:

- -aisle widths -- 900 mm minimum serving seats on one side only, or 1100 mm minimum serving seats on both sides, plus 25 mm per metre length of aisle.
- -cross aisle widths -- required width of widest aisle plus 50% of the total required width of other aisles served.
- -length of travel to exit door -- 45 m.
- -corridors -- 1 h fire separation from other spaces.
  -- no rating required if sprinklered.

PLUMBING FACILITIES (3.6.4)

The number of plumbing fixtures required is dependent on the use of the various spaces, and the maximum number of occupants of each of these spaces. Whether the total provided for the entire building is cumulative or not depends on the anticipated occupant load at any given time.

REQUIRED NUMBER OF PLUMBING FIXTURES

SPACE	NO. OF OCCUPANTS	* NO. OF WATER CLOSETS MALE	FEMALE
Parish Hall	400 at tables, design	6	6
	526 at tables, Code maximum	7	7
	633 seated in rows, Code maximum	9	9
Churches	1192 (1042 seated + 150 in nursery and religious education	4	4
Day Care	50	2	2

* Based on the following:
- -community halls -- 3 + 1 per 50 additional persons above 50 for each sex.
- -churches -- 1 per 150 persons of each sex.
- -day care -- 2 each for 11-25 children of each sex.

C. Building Energy Simulation

The DOE (Department of Energy, United States) 2.1A computer program was used to study the energy performance of the designed building. This program simulates the operation of the encoded building hour-by-hour for the user-requested time period (up to one year). Selected building components were varied in parametric runs to study their effect on the overall energy use of the building. Following are the criteria which were defined for input into the program.

WEATHER:

The representative weather data for the Calgary region, selected by a process outlined in the DOE Manuals, is that for 1978.

CONSTRUCTION:

Materials used in the roofs and walls, and their thermal resistance to heat conduction are given in the following table. The materials are listed in order from outside surface to inside surface.

ROOF AND WALL CONSTRUCTION

SURFACE	COMPONENT	RSI
Roof (churches)	-wood shakes	0.17
	-building paper	0.01
	-air layer, 25 mm	0.15
	-fibre-glass insulation	3.60
	-poly vapour barrier	0.00
	-drywall, 12.7 mm	0.08
	TOTAL	4.01
Roof (parish hall)	-gravel	0.01
	-asphalt built-up roof	0.06
	-rigid fibre-glass insulation, 125 mm	3.67
	-exposed steel deck on steel joists	0.00
	TOTAL	3.74

ROOF AND WALL CONSTRUCTION (continued)

SURFACE	COMPONENT		RSI
Roof (other areas)	-gravel		0.01
	-asphalt built-up roof		0.06
	-plywood, 10 mm		0.08
	-air layer, 50 mm		0.15
	-fibre-glass insulation, 170 mm		3.60
	-poly vapour barrier		0.00
	-drywall, 12.7 mm		0.08
		TOTAL	3.98
Wall (parish hall)	-stucco		0.04
	-building paper		0.01
	-plywood, 12.7 mm		0.08
	-fibre-glass insulation, 90 mm		2.09
	-poly vapour barrier		0.00
	-exposed concrete block		0.30
		TOTAL	2.52
Wall (other areas)	-brick		0.14
	-air layer		0.16
	-building paper		0.01
	-plywood, 12.7 mm		0.08
	-fibre-glass insulation, 90 mm		2.09
	-poly vapour barrier		0.00
	-drywall, 12.7 mm		0.08
		TOTAL	2.56
Underground-walls *			1.20

* Underground surfaces are specified by "U" values (unit area heat conductance rates) and losses are calculated based on monthly ground temperatures and exposed surface areas. The areas were calculated as the perimeter length in feet (exterior edges only) of at-grade floors, or the perimeter length described by folding out walls below grade.

OCCUPANCY SCHEDULES:

The following schedules were input to simulate the use of the various spaces: these are used to calculate the sensible and latent heat contributed by occupants.

OCCUPANCY SCHEDULES

DAY OF WEEK	HOURS	MULTIPLIER *
1. Church (Lutheran, 300; Catholic, 700; chapel,65)		
Saturdays	14:00-16:00	0.30
Sundays	09:00-10:00	0.30
	10:00-11:00	0.80
	11:00-12:00	0.30
2. Administration (4)		
Weekdays	09:00-12:00	1.00
	12:00-13:00	0.20
	13:00-17:00	1.00
Weekends	09:00-17:00	0.20
3. Conference/classrooms (150)		
Weekdays	09:00-17:00	0.25
	17:00-21:00	0.50
Saturday	09:00-21:00	0.10
Sunday	09:00-12:00	0.80
	12:00-21:00	0.25
4. Parish Hall (400)		
Weekday	16:00-18:00	0.04
	18:00-21:00	0.06
Saturday	10:00-12:00	0.04
	12:00-17:00	0.08
	17:00-24:00	0.75
Sunday	10:00-12:00	0.12
	12:00-17:00	0.04
Holidays	8:00-24:00	1.00
5. Nursery (20)		
Weekdays	09:00-12:00	1.00
	2:00-13:00	0.20
	13:00-17:00	1.00
6. Foyer (500)		
Weekdays	09:00-17:00	0.01
Sundays	09:00-10:00	0.06
	10:00-11:00	0.01
	11:00-12:00	1.00
7. Rectory (2)		
All days	00:00-09:00	1.00
	09:00-17:00	0.50
	7:00-24:00	1.00

* Factors by which maximum loads (in brackets) are multiplied to obtain number of occupants in space for specified times.

LIGHTING SCHEDULES:

Lighting affects building energy use in two ways. The first is a direct contribution to electrical energy use. The second is an indirect effect due to heat output by the fixtures, specified by the following:

Churches and chapel -incandescent, 43.2 w/sq.m

Rectory -incandescent, 21.6 w/sq.m

Other areas -suspended fluorescent, 21.6 w/sq.m

LIGHTING SCHEDULES *

DAY OF WEEK	HOURS	MULTIPLIER **
1. Rectory		
All days	07:00-09:00	0.70
	18:00-22:00	0.70
	22:00-24:00	0.20
2. Foyer		
All days	00:00-09:00	0.05
	09:00-17:00	0.50
	17:00-22:00	1.00
	22:00-24:00	0.05

* The lighting schedules essentially mirror those for occupancy, except for the rectory and foyer. The multiplier is set to either 1 or 0 (on or off) except as noted.

** Factors by which maximum lighting energy use are multiplied to obtain energy usage for space at specified time periods.

INFILTRATION AND FAN SCHEDULES:

These schedules were set as negatives of each other. In other words infiltration was assumed to be zero when the fans were activated. Infiltration was specified as 0.2 air changes per hour at all other times. Since the fans provided all ventilation (no open windows are allowed by the program), the fan schedules mirrored the occupancy and lighting schedules.

ZONE TEMPERATURE SET-POINTS:

All zone temperatures were controlled by thermostats measuring zone temperatures, and connected to baseboard heaters. The temperatures were set to 20 degrees Celsius during occupied hours. Set-backs to 13 degrees Celsius were simulated, with an intermediate step to 17 degrees Celsius an hour prior to anticipated occupancy of the zone.

MECHANICAL SYSTEM:

The heating and ventilating system that was simulated utilized hydronic baseboard units for heating and natural gas-fired furnaces for preheating outside air for ventilation. Each zone was served by a separate ventilating system.

ENERGY COSTS:

Current monthly costs for energy (as of July,1985):

Natural gas	-fixed charge per month	$9.50
	-total commodity charge	2.48/GJ
	-franchise charge	11.11%
	-provincial discount	4.00%
Electricity	-first 2,500 kWh	$0.0920/kWh
	-next 100 kWh	0.0814
	-next 100 kWh	0.0436
	-next 100,000 kWh	0.0295
	-additional	0.0228

PARAMETRIC RUNS:

Modifications were made to the base building described above to study performance characteristics of particular components. Elimination parametrics were conducted, eliminating in sequence infiltration, wall, and floor loads in order to identify the proportions of their contributions to total annual energy consumption. Windows, glass type, and shading were manipulated as follows to identify their influence:

1. Base building: no windows were input.

2. Insulation in the base building was doubled.

3. Double-glazed windows comprising approximately 10% of the exterior wall areas were inserted; window height was 1500 mm. Glazing characteristics were as follows:

Transmittance	71%
Reflectance	2%
Thermal Resistance	RSI 0.35

4. Shading for the south facing windows of Case 1 were input; overhang was 750 mm.

5. Reflective glazing was used for the windows in Case 1.

6. Double-glazed windows comprising approximately 10% of the floor areas were inserted; overhang was 750 mm. Glazing characteristics were as follows:

Transmittance	19%
Reflectance	45%
Thermal Resistance	RSI 0.62

7. Shading for the south facing windows of Case 4 were input.

SUMMARY OF PARAMETRIC RUNS

CASE NUMBER	1	2	3	4	5	6	7
NATURAL GAS, GJ							
HEATING	795	565	680	704	745	664	696
VENTILATING	1301	1249	1304	1314	1331	1314	1332
SUBTOTAL	2096	1814	1984	2018	2076	1978	2028
ELECTRIC, MWh							
FANS	17.2	16.1	16.7	16.9	17.2	19.4	19.7
LIGHTING	82.2	82.2	82.2	82.2	82.2	82.2	82.2
SUBTOTAL, MWh	99.4	98.3	98.9	99.1	99.4	101.6	101.9
(GJ)	(358)	(354)	(356)	(357)	(358)	(366)	(367)
OVERALL							
TOTAL, GJ	2454	2168	2340	2375	2434	2344	2395
MJ/sq.m	767	678	731	742	761	732	748
COSTS, $1000							
GAS	5.69	4.94	5.39	5.48	5.64	5.38	5.51
ELECTRIC	4.89	4.85	4.87	4.88	4.89	4.95	4.96
TOTAL	10.58	9.79	10.26	10.36	10.53	10.33	10.47

D. Reverberation Calculations

Calculations were performed for the three major spaces: the Lutheran and Catholic worship spaces, and the parish hall. Both volumes and surface treatments were varied to study their effects. For the worship spaces the smallest volume used was with the lowest part of the ceiling at a height of 3500 mm. These were increased by raising the overall height by 1000 mm and 3000 mm. For each of these volumes three combinations of surface finishes were studied.

The coefficients of absorption for the materials tested are given in the following table.

SOUND ABSORPTION COEFFICIENTS

SURFACE MATERIAL	FREQUENCY IN Hz, 125	500	2000
1. TILE: glazed tile	0.01	0.01	0.02
2. BRICK: plain or painted	0.05	0.02	0.05
3. CONCRETE BLOCK: clinker concrete unplastered, unpainted	0.20	0.60	0.50
4. PLASTER: gypsum - on lath or plasterboard over shallow air space	0.25	0.10	0.04
5. PLASTER: 12 mm acoustic spray on 12 mm plasterboard over 75 mm air space	0.30	0.55	0.80
6. GLASS: 6 mm	0.10	0.04	0.02
7. WOOD: boards on joists or battens	0.15	0.10	0.05
8. WOOD: wood-strip floor on battens	0.10	0.10	0.07
9. WOOD: rough, eg. tongue and groove cedar	0.24	0.14	0.13
10. SEATS: padded wood seats	0.10	0.15	0.20
11. "TECTUM" SOUND BLOCKS	0.32	1.43	1.32
12. PEOPLE	0.15	0.40	0.45
13. AIR: per cubic metre	0.00	0.00	.007

Below are selected reports of reverberation times calculated by a computer program based on the following formula:

$$TR = K \times V / \text{sum}(S \times a)$$

where:
TR = reverberation time in seconds
K = 0.16, constant
V = volume of space in cubic metres
S = surface area in square metres
a = coefficient of absorption

A. LUTHERAN CHURCH

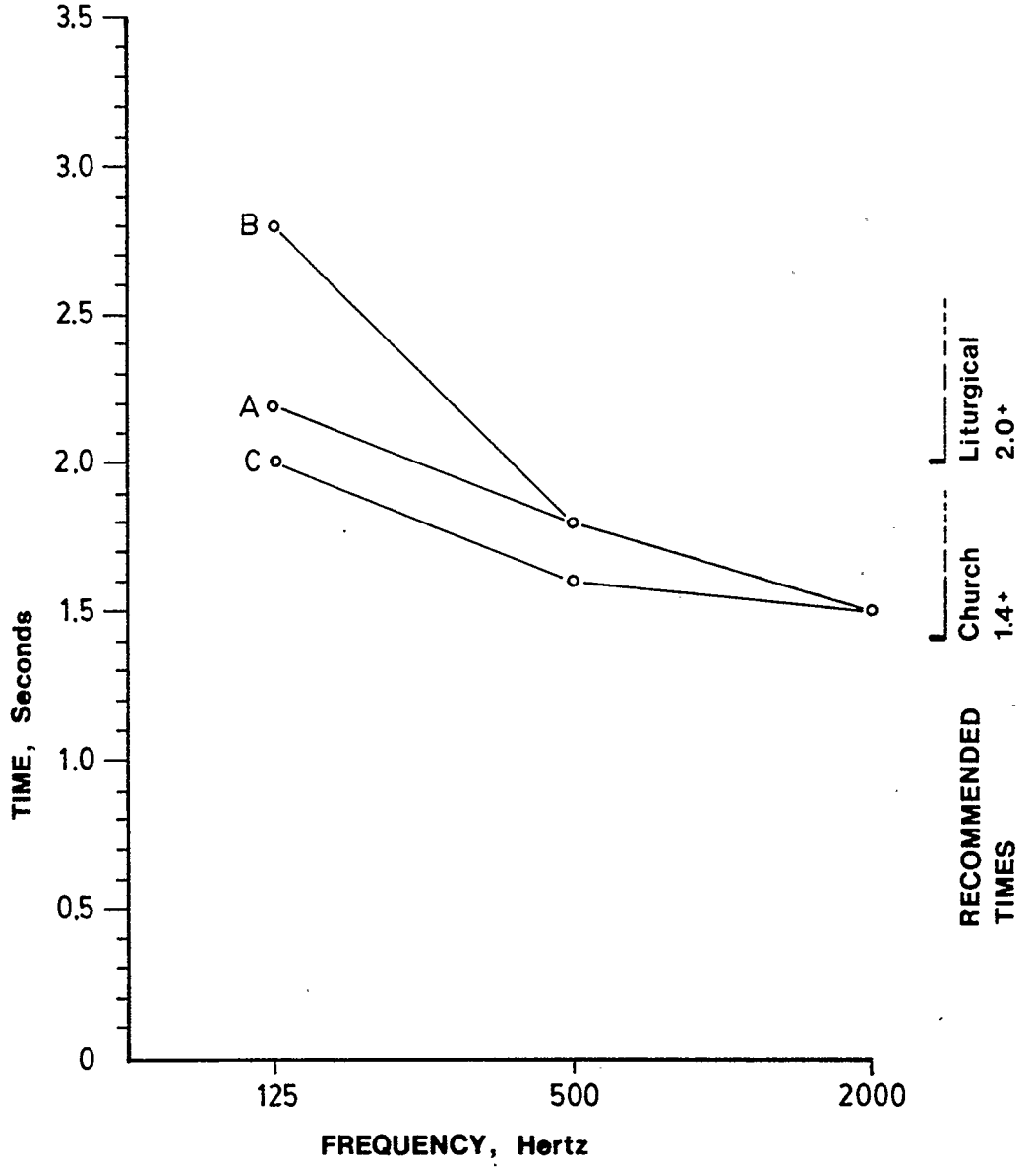
ITEM DESCRIPTION		AREA, sq.m	FREQUENCY IN HZ, 125	500	2000
Absorption in Sabins for:					
Floor	-tile (1)	330	3	3	7
Walls	-brick (2)	330	16	7	16
	-acoustic spray (5)	50	15	27	40
	-glass (6)	35	3	1	1
Ceiling	-drywall (4)	340	85	34	14
Air	-2122 cubic metres (13)		0	0	15
Seats	-285 (10)		28	43	57
Occupants	-285 (12)		43	114	128
Totals	-unoccupied		151	106	149
	-fully occupied		166	187	220
Reverberation times in seconds for:					
all seats unoccupied			2.2	2.9	2.3
2/3 seats occupied			2.1	2.1	1.7
all seats occupied			2.0	1.8	1.5

B. LUTHERAN CHURCH

ITEM DESCRIPTION		AREA, sq.m	FREQUENCY IN HZ, 125	500	2000
Absorption in Sabins for:					
Floor	-tile (1)	330	3	3	7
Walls	-brick (2)	330	16	7	16
	-acoustic plaster (5)	50	15	27	40
	-glass (6)	35	3	1	1
Ceiling	-wood (7)	340	51	34	17
Air	-2122 cubic metres (13)		0	0	15
Seats	-285 (10)		28	43	57
Occupants	-285 (12)		43	114	128
Totals	-unoccupied		117	116	153
	-fully occupied		132	187	224
Reverberation times in seconds for:					
all seats unoccupied			2.9	2.9	2.2
2/3 seats occupied			2.7	2.1	1.7
all seats occupied			2.6	1.8	1.5

C. LUTHERAN CHURCH

ITEM DESCRIPTION		AREA, sq.m	FREQUENCY IN HZ, 125	500	2000
Absorption in Sabins for:					
Floor	-tile (1)	330	3	3	7
Wall	-drywall (4)	330	83	33	13
	-acoustic plaster (5)	50	15	27	40
	-glass (6)	35	3	1	1
Ceiling	-wood (7)	340	51	34	17
Air	-2122 cubic metres (13)		0	0	15
Seats	-285 (10)		28	43	57
Occupants	-285 (12)		43	114	128
			---	---	---
Totals	-unoccupied		183	142	149
	-fully occupied		198	213	220
Reverberation times in seconds for:					
all seats unoccupied			1.8	2.4	2.3
2/3 seats occupied			1.8	1.8	1.7
all seats occupied			1.7	1.6	1.5



REVERBERATION TIMES
Lutheran Worship Space

Notes:
1. Values shown are results of previous tables.
2. Fully occupied condition.
3. Recommended ranges are from McGuiness, Stein, and Reynolds (1980, p1188).

A. CATHOLIC CHURCH

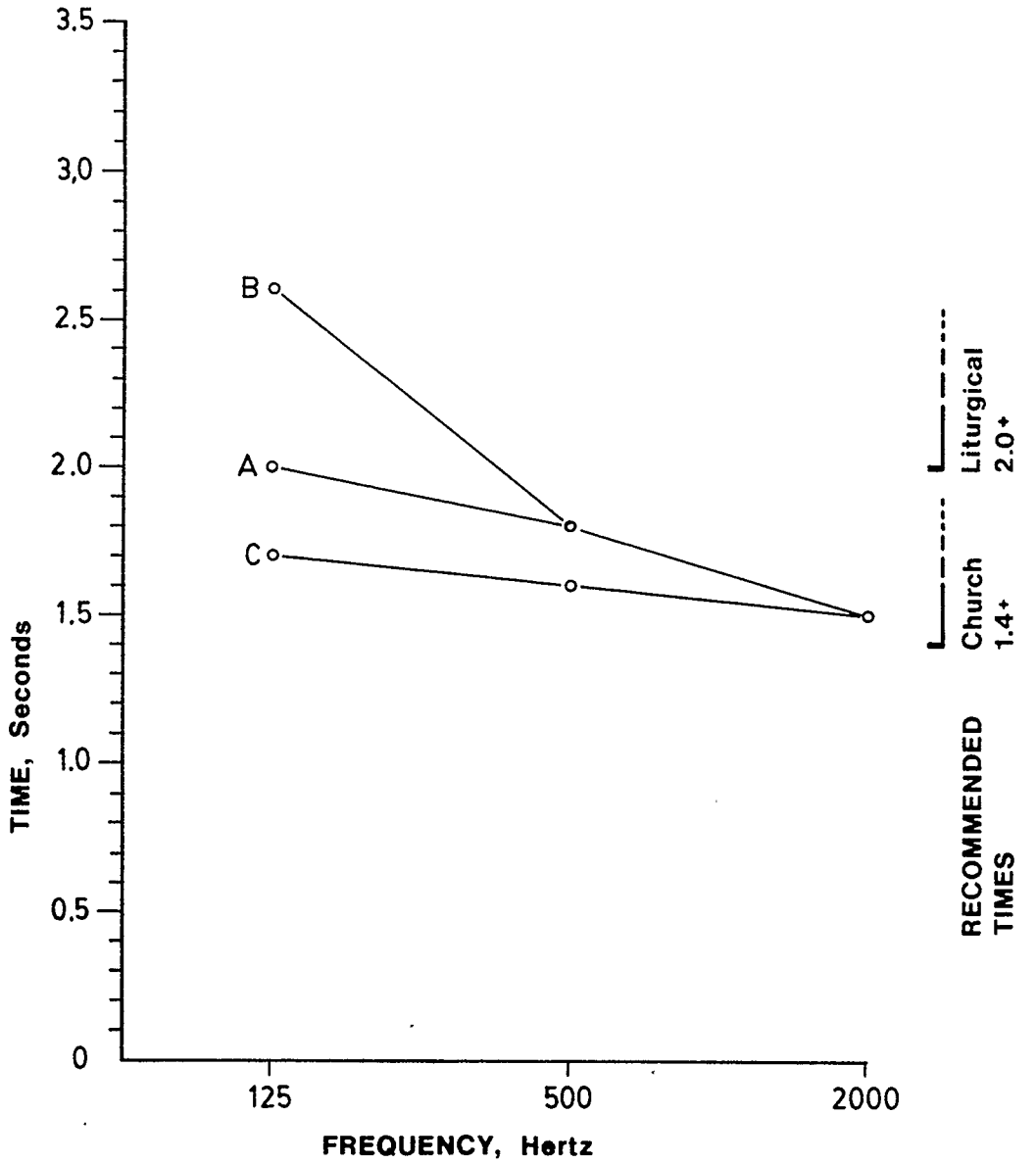
ITEM DESCRIPTION		AREA, sq.m	FREQUENCY IN HZ, 125	500	2000
Absorption in Sabins for:					
Floor	-tile (1)	581	6	6	20
Walls	-brick (2)	502	25	10	25
	-acoustic plaster (5)	65	20	36	52
	-glass (6)	40	4	2	1
Ceiling	-drywall (4)	600	150	60	24
Air	-4311 cubic metres (13)		0	0	30
Seats	-700 (10)		70	105	140
Occupants	-700 (12)		105	280	315
			---	---	---
Totals	-unoccupied		274	218	284
	-fully occupied		309	393	459
Reverberation times in seconds for:					
all seats unoccupied			2.5	3.2	2.4
2/3 seats occupied			2.3	2.1	1.7
all seats occupied			2.2	1.8	1.5

B. CATHOLIC CHURCH

ITEM DESCRIPTION		AREA, sq.m	FREQUENCY IN HZ, 125	500	2000
Absorption in Sabins for:					
Floor	-tile (1)	581	6	6	12
Walls	-brick (2)	502	25	10	25
	-acoustic plaster (5)	65	20	36	52
	-glass (6)	40	4	2	1
Ceiling	-wood (7)	600	90	60	30
Air	4311 cubic metres (13)		0	0	30
Seats	-700 (10)		70	105	140
Occupants	-700 (12)		105	280	315
			---	---	---
Totals	-unoccupied		214	218	290
	-fully occupied		249	393	465
Reverberation times in seconds for:					
all seats unoccupied			3.2	3.2	2.4
2/3 seats occupied			2.9	2.1	1.7
all seats occupied			2.8	1.8	1.5

C. CATHOLIC CHURCH

ITEM DESCRIPTION		AREA, sq.m	FREQUENCY IN HZ, 125	500	2000
Absorption in Sabins for:					
Floor	-tile (1)	581	6	6	12
Walls	-drywall (4)	502	126	50	20
	-acoustic plaster (5)	65	20	36	52
	-glass (6)	40	4	2	1
Ceiling	-wood (7)	600	90	60	30
Air	-4311 cubic metres (13)		0	0	30
Seats	-700 (10)		70	105	140
Occupants	-700 (12)		105	280	315
Totals	-unoccupied		315	258	285
	-fully occupied		350	433	460
Reverberation times in seconds for:					
all seats unoccupied			2.2	2.7	2.4
2/3 seats occupied			2.0	1.8	1.7
all seats occupied			2.0	1.6	1.5



REVERBERATION TIMES
Catholic Worship Space

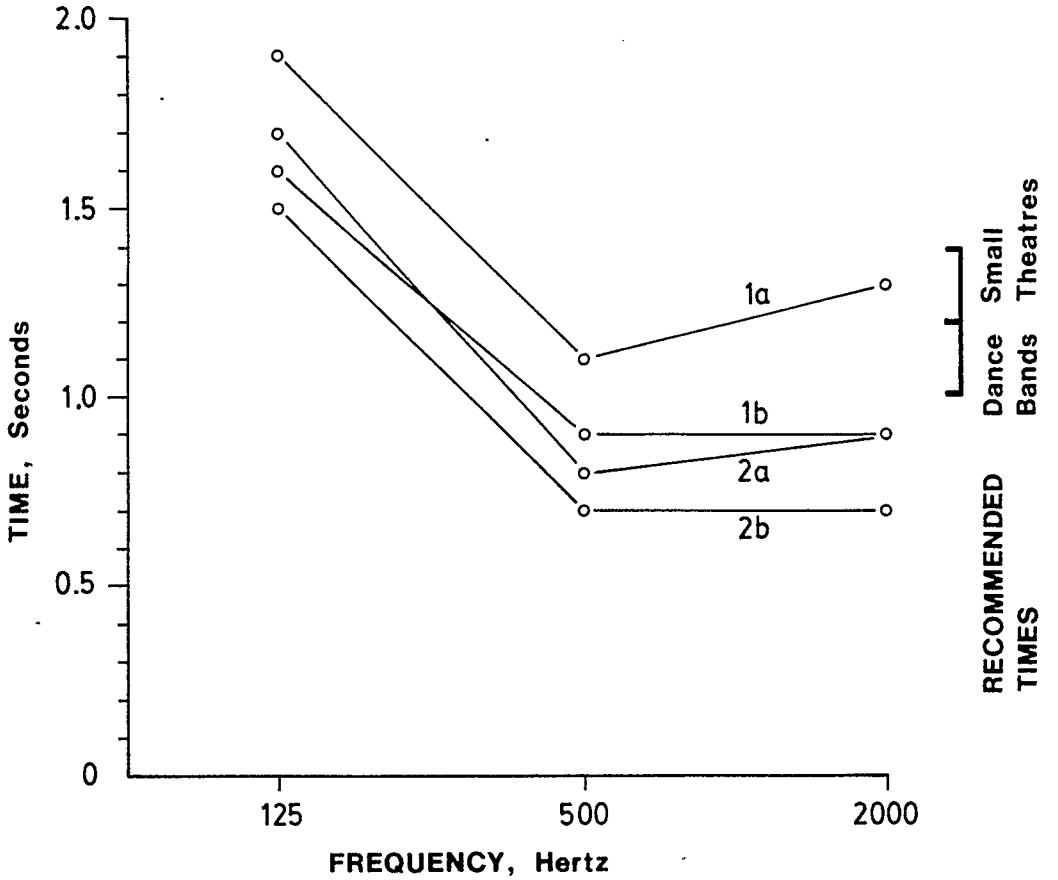
Notes:
1. Values shown are results of previous tables.
2. Fully occupied condition.
3. Recommended ranges are from McGuiness, Stein, and Reynolds (1980, p1188).

1. PARISH HALL

ITEM DESCRIPTION		AREA, sq.m	FREQUENCY IN HZ, 125	500	2000
Absorption in Sabins for:					
Floor	-wood (8)	497	50	50	35
Walls	-concrete block (3)	700	140	420	350
	-glass (6)	79	8	3	2
Ceiling	-wood (9)	497	119	70	65
Air	-3787 cubic metres (13)		0	0	27
Seats	-400, plastic		0	0	0
Occupants	-400 (12)		60	160	180
Totals	-unoccupied		317	542	477
	-fully occupied		377	702	657
Reverberation times in seconds for:					
unoccupied			1.9	1.1	1.3
fully occupied			1.6	0.9	0.9

2. PARISH HALL

ITEM DESCRIPTION		AREA, sq.m	FREQUENCY IN HZ, 125	500	2000
Absorption in Sabins for:					
Floor	-wood (8)	497	50	50	35
Walls	-concrete block (3)	450	140	420	350
	-Tectum (11)	250	80	358	330
	-glass (6)	79	8	3	2
Ceiling	-wood (9)	497	119	70	65
Air	-3787 cubic metres (13)		0	0	27
Occupants	-400 (12)		60	160	180
Totals	-unoccupied		347	750	682
	-fully occupied		407	518	862
Reverberation times in seconds for:					
unoccupied			1.7	0.8	0.9
fully occupied			1.5	0.7	0.7



REVERBERATION TIMES
Parish Hall

Notes:
1. Values shown are from previous tables for two different room finishes.
2. Unoccupied condition (a) and fully occupied condition (b).
3. Recommended ranges are from McGuiness, Stein, and Reynolds (1980, p1188).

E. Sight Lines in Worship Spaces

Sight lines for the church assembly spaces were calculated according to the following formulas developed by Peter H. Frink (Packard, 1981, p22):

Constant slope floor, vertical focal plane,

$$P = 100/L(H_E - H_{aps} + (N - 1)C) + 100C/T$$

$$H_{aps} = H_E - PL/100 + LC/T + (N - 1)C$$

Flat floor, vertical focal plane,

$$H_{aps} = H_E + LC/T + (N - 1)C$$

Iscidomal floor, vertical focal plane,

$$E_n = D_n(E_1/D_1 + C(1/D_1 + 1/D_1 + 1/D_1 + 1/D_1 + \ldots 1/D_{n-1}))$$

where,

APS = arrival point of sight
N = number of rows of seats
n = row number for which computations are being made
D_n = horizontal distance from APS to eye position at row n
L = horizontal distance from first row eye position to a vertical focal plane
E_n = elevation of eye level at row n above APS
H_E = eye height of seated person (1120 mm typical)
H_{aps} = height of APS above first row floor level
C = sightline head clearance, 64 mm to see over two rows in front
T = row to row spacing
P = percent slope

For the results below the following assumptions have been made:

1. Arrival point of sight is for a vertical focal plane, the height being approximately chest level, 1200 mm.
2. Horizontal distance to first row eye position is 5000 mm.
3. Eye height is set at 1120 mm.
4. Staggered seating is used so that sight lines are between

the heads of the next row and above the heads of the second row in front: sightline head clearance is 64 mm for this condition.

5. Row to row spacing is 900 mm.

FLOOR RISE FOR ACCEPTABLE SIGHT LINES

SPACE	FLOOR TYPE	PLATFORM HEIGHT	NUMBER OF ROWS	FLOOR SLOPE, %	OVERALL RISE, mm
Catholic	constant slope	400	18	19.3	2950
		700	18	13.3	2035
		1000	18	7.3	1110
	iscidomal	400	18	-	655
Lutheran	flat	850	10	0	0

F. Cost Estimate

The following cost estimate is based on the composite unit rates for construction from 1985 Yardsticks For Costing for Calgary as at January, 1985. These were modified according to other sources such as Lansdowne's Construction Cost Handbook, and local businesses. A factor for escalation would have to be applied in order to update these figures to current values or to construction start date. Furnishings and equipment, design fees, and contingencies are not included. Site development costs do not include trees, shrubs or other plantings.

SUMMARY: CONSTRUCTION COST ESTIMATE

		QUANTITY	UNIT RATE	TOTAL $	COST $/sq.m
1. SUBSTRUCTURE					
1.1	Basement Excavation	2316 sq.m	8.50	19 686	5.76
1.2	Trench Excavation	232 m	29.25	6 786	1.99
1.3	Strip Footing	646 m	27.15	17 537	5.14
1.4	Column Footings	12	174.75	2 097	0.61
1.5	Foundation Walls	398 sq.m	130.89	52 130	15.26
				98 236	28.77
2. STRUCTURE					
2.1	Slab on Grade	3130 sq.m	23.85	74 650	21.86
2.2	Upper Floor	361 sq.m	97.74	35 284	10.33
2.3	Roof	3130 sq.m	30.00	93 900	27.50
				203 834	59.69
3. EXTERIOR CLADDING					
3.1	Roof Finish	3130 sq.m	33.95	106 249	31.11
3.2	Exterior Walls	1715 sq.m	100.48	172 320	50.46
3.3	Windows	188 sq.m	225.00	42 300	12.39
3.4	Screens with Doors	50 sq.m	417.96	20 898	6.12
3.5	Overhead Doors	18 sq.m	103.33	1 860	0.54
3.6	Skylight	29 sq.m	250.00	7 250	2.12
				350 877	102.75

SUMMARY: CONSTRUCTION COST ESTIMATE (continued)

4. INTERIOR PARTITION AND DOORS					
4.1	Permanent Partitions	2112 sq.m	38.60	81 513	23.87
4.2	Movable Partitions	82 sq.m	172.22	14 122	4.14
4.3	Doors	83	589.77	48 951	14.33
				144 586	42.34
5. VERTICAL MOVEMENT					
5.1	Stairs	-	-	10 000	2.93
6. INTERIOR FINISHES					
6.1	Exterior Walls	782 sq.m	22.60	17 673	5.18
6.2	Interior Partitions	1794 sq.m	4.09	7 337	2.15
6.3	Floors	3059 sq.m	70.71	216 314	63.34
6.4	Ceilings	3059 sq.m	40.00	122 360	35.83
				363 684	106.50
7. ELECTRICAL		3415 sq.m	57.40	196 021	57.40
8. MECHANICAL					
8.1	Plumbing	3415 sq.m	29.27	99 947	29.27
8.2	HVAC and controls	3415 sq.m	59.66	203 740	59.66
8.3	Fire Sprinklers	3415 sq.m	18.83	64 304	18.83
				367 991	107.76
9. OVERHEAD AND PROFIT @ 10%				173 523	50.81
NET BUILDING COST				$ 1 908 752	558.93
10. SITE DEVELOPMENT					
10.1	Parking and Roadways	6624 sq.m	16.80	111 295	-
10.2	Walkways	75 m	43.00	3 225	-
10.3	Brick Paving	350 sq.m	33.05	11 567	-
10.4	Lawn (Seeded)	10628 sq.m	3.70	39 323	-
				165 410	
TOTAL COST, BUILDING AND SITE				$ 2 074 162	

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B. Personal Communications

1. Pastor John Anderson, Lutheran Church of Our Saviour, 8831 Fairmont Drive S.E. Calgary.

2. Father William Trienekens, Corpus Christi Catholic Church, 404 Northmount Place N.W. Calgary.

3. John L. M. Bolton, Organ Consultant, Design Organs, 228 Parkland Way S.E. Calgary.

4. Stephen Chan, Inspection Engineer, Building Regulations, City of Calgary.

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7. Phillip Ho, Special Projects Engineer, Building Regulations, City of Calgary.

8. Robert Kirby, Faculty of Environmental Design, University of Calgary.

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11. Jim Love, Associate Professor, Faculty of Environmental Design, University of Calgary.

12. Dave Parker, Architect, Woods Parker Architects, 126a 16 Avenue N.E. Calgary.

13. John Wiebe, Mechanical Engineer, Wiebe Forest Group Ltd. 604 24a Street N.W. Calgary.

C. Churches Visited

1. Canadian Martyrs, 835 Northmount Drive N.W.
2. Cathedral of St. Mary's, 219 18 Avenue S.W.
3. Church of Our Saviour, 8831 Fairmont Drive S.E.
4. Corpus Christi, 404 Northmount Place N.W.
5. Highwood Lutheran, 419 Northmount Drive N.W.
6. St. Anthony's Church, 5340 4 Street S. W.
7. St. Bernard's Church, 711 37 Street N.W.
8. St. Lukes, 1566 Northmount Drive N.W.
9. St. Pius X, 2424 24 Avenue N.W.