#3388

Flair Homes Project
REPORT NO. 1
Description of Project Homes

Report of the Flair Homes
Enerdemo Canada/CHBA Mark XIV Project

Cat. No. M91-11/2-1-1989E
ISBN 0-662-16642-6

January 1989

Published by the authority of the Minister of Energy, Mines and Resources Canada, Goverment of Canada

For more information on this report or to obtain additional copies write to:

Energy, Mines and Resources Canada
Residential Energy Management Division
Ottawa, Ontario
KIA OE4

This report was prepared by:

G. Proskiw, P.Eng., and
J. Beckman
Unies Limited
1666 Dublin Avenue
Winnipeg, Manitoba
R3H OH1

Printed in Canada

DESCRIPTION OF PROJECT HOUSES

PART OF THE

FLAIR HOMES ENERGY DEMO/CHBA FLAIR MARK XIV PROJECT

BY

G. PROSKIW, P.ENG.
AND J. BECKMAN
UNIES Ltd.

JUNE, 1988

ACKNOWLEDGEMENTS

The author(s) wish to express their appreciation and thanks to the members of the project's National Steering Committee, Technical Advisory Committee and resource individuals, who provided invaluable direction, review and advice in the design of the project and the preparation of this report.

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Mr. R. Slasor of Energy, Mines and Resources Canada
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Mr. D. Verville of Today Homes (East) Ltd.

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SECTION 1
INTRODUCTION

1.1 THE FLAIR HOMES ENERGY DEMO/CHBA FLAIR MARK XIV PROJECT

The Flair Homes Energy Demo/CHBA Flair Mark XIV Project is a demonstration with three objectives:

1. To demonstrate and evaluate the performance of low energy building envelope systems.
2. To demonstrate and evaluate the performance of various types of mechanical systems with an emphasis on ventilation systems.
3. To transfer the knowledge gained in the project to the Canadian home building industry.

In addition, the project is structured to support the R-2000 Home Program funded by Energy, Mines and Resources Canada and administered by the Canadian Home Builders Association. The project acquired the Mark XIV designation when a substantial portion of the research priorities identified by the Technical Research Committee of the CHBA in 1983/84 was incorporated into the project.

Support for the project has been provided by Energy, Mines and Resources Canada under the Energy Demo Program and by Manitoba Energy and Mines under the Manitoba/Canada Conservation and Renewable Energy Demonstration Agreement (CREDA). Project management is the responsibility of Flair Homes (Manitoba) Ltd. of Winnipeg. Monitoring, which will continue until the spring of 1989, is the responsibility of UNIES Ltd.

1.2 REPORT SCOPE AND FORMAT

This report has been prepared as a reference document for use with other reports and publications issued as part of the project. It contains detailed descriptions of the 20 houses constructed as part of the project including:

- sample floor plans and elevations
- building envelope cross-sections
- air/vapour barrier system details
- mechanical system schematics
- descriptions of the operation of the heating and ventilation systems

It does not contain any discussion of monitoring schedules or results since these will be dealt with in separate documents.

The report has been structured to provide both a quick overview and a detailed description of the project houses. Section 2 contains the summary of the houses while Sections 3 and 4 provide further details of the building envelope and mechanical systems.

SECTION 2
HOUSE DESCRIPTION SUMMARY

2.1 CONSTRUCTION HISTORY

The 20 project houses were constructed in north-east Winnipeg in the Genstar Development Co. Lakeside Meadows subdivision. Houses #1 to #10 were completed in the spring of 1985 and occupied shortly thereafter. Houses #11 to #20 were completed in the spring of 1986 and were also occupied soon afterwards. Construction time was approximately five months for each structure. All houses were built by Flair Homes (Manitoba) Ltd.

2.2 SITE PLAN

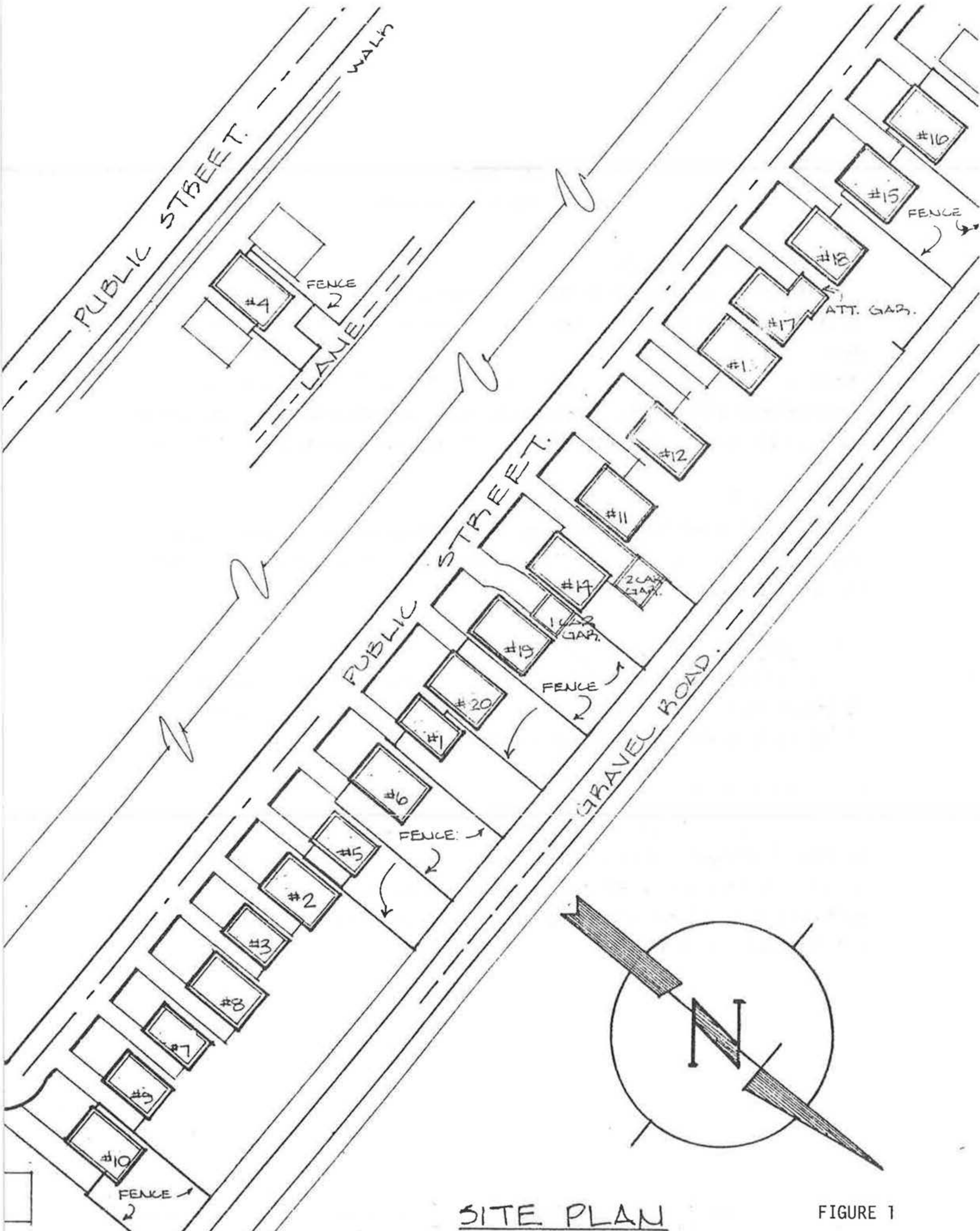
Figure 1 shows the project site plan. Nineteen of the houses are located side by side with the 20th located approximately 1 km away. All the project houses face south.

2.3 FLOOR PLANS AND ELEVATIONS

As shown in Figures 2 and 3, two basic floor plans were used for the 20 houses with various elevations employed on the south side. A sample elevation is shown for House #12 in Figure 4.

2.4 SUMMARY TABLE

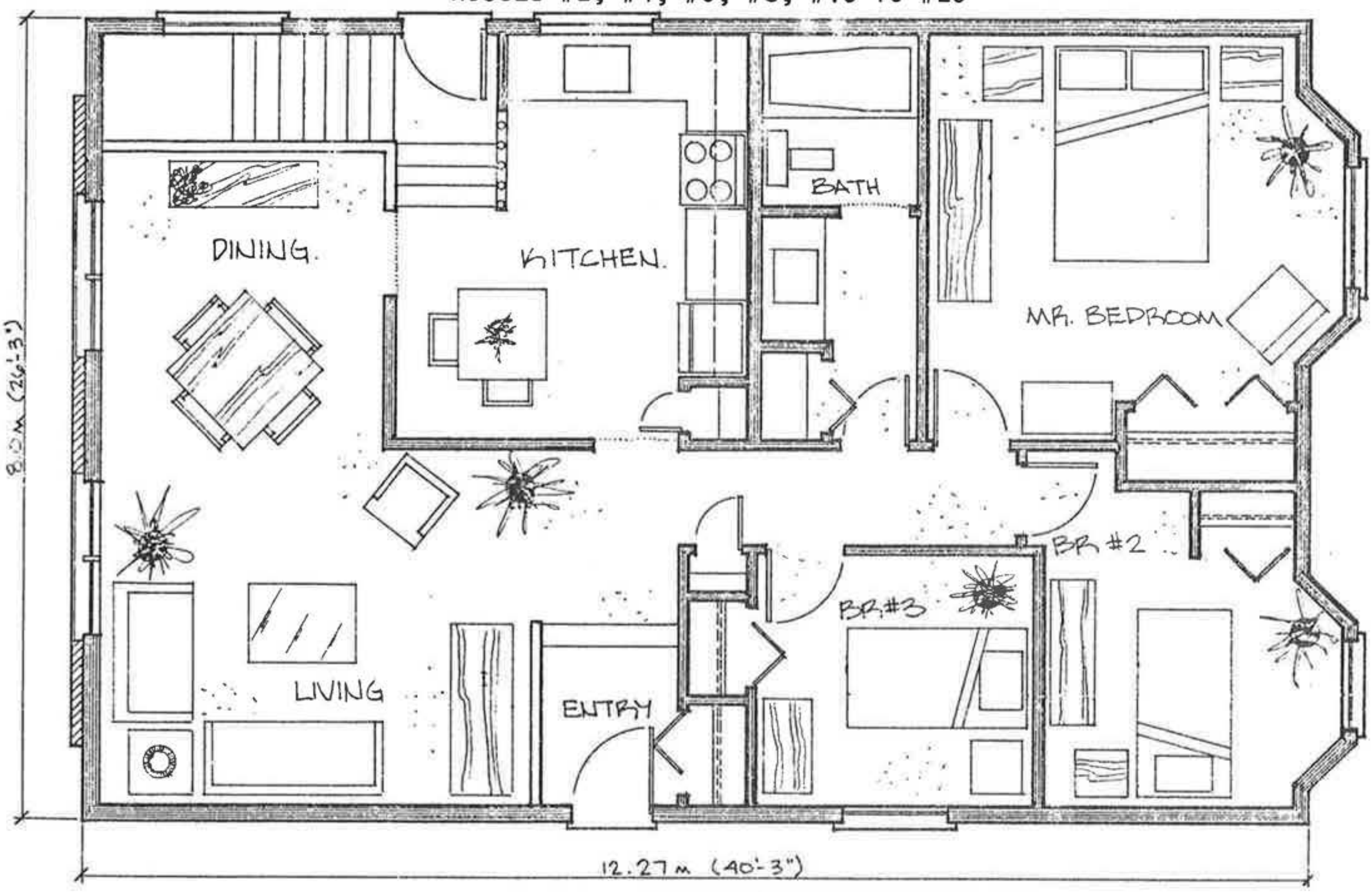
Tables 1 and 2 contain summaries of the building envelopes and mechanical systems. Detailed descriptions of the various components and systems are provided in Sections 3 and 4. Notice that the houses within each pair (e.g. #1 and #2, #9 and #10, etc.) are identical except for minor architectural variations.



SITE PLAN

FIGURE 1

SAMPLE FLOOR PLAN
HOUSES #2, #4, #6, #8, #10 TO #20



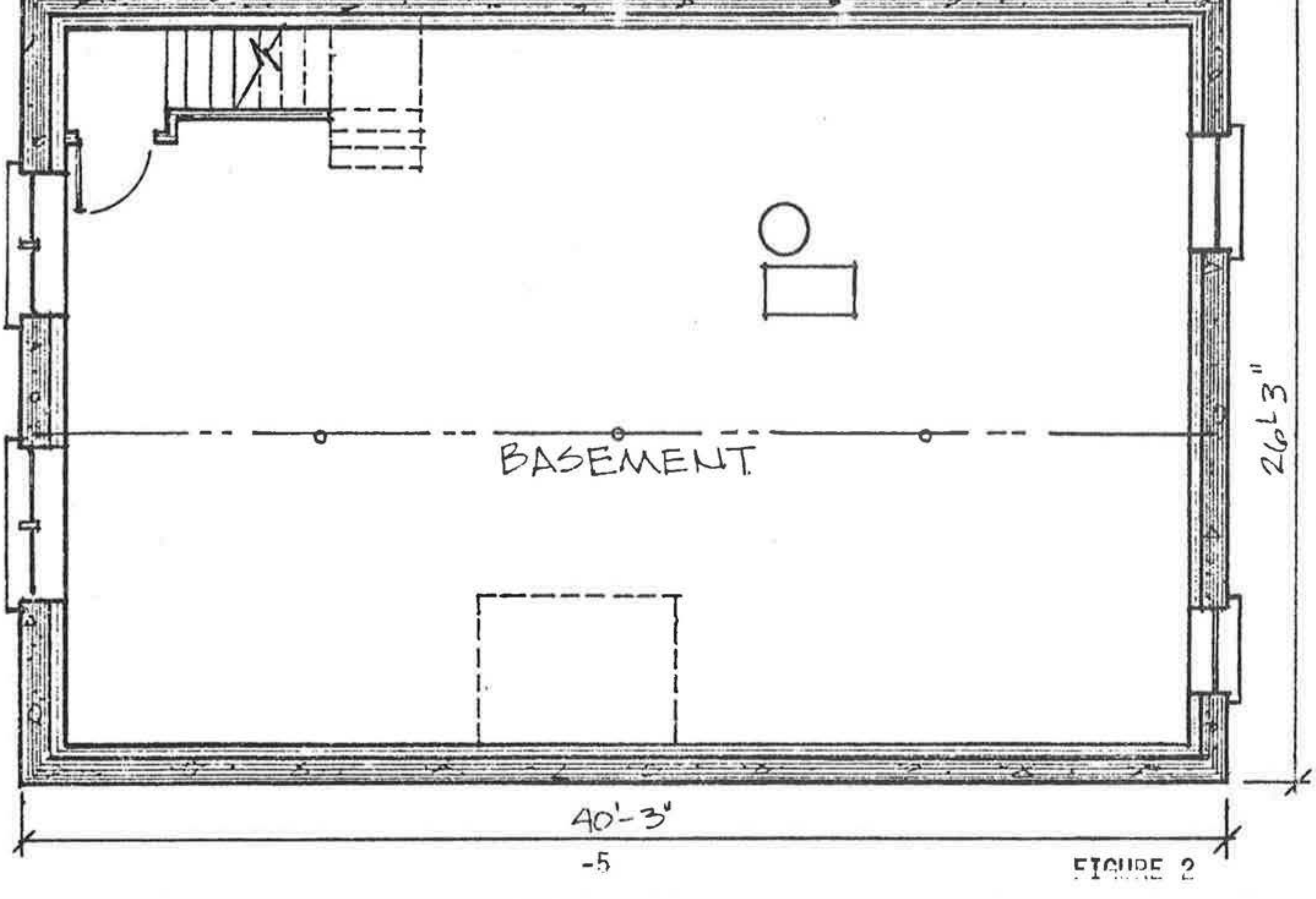
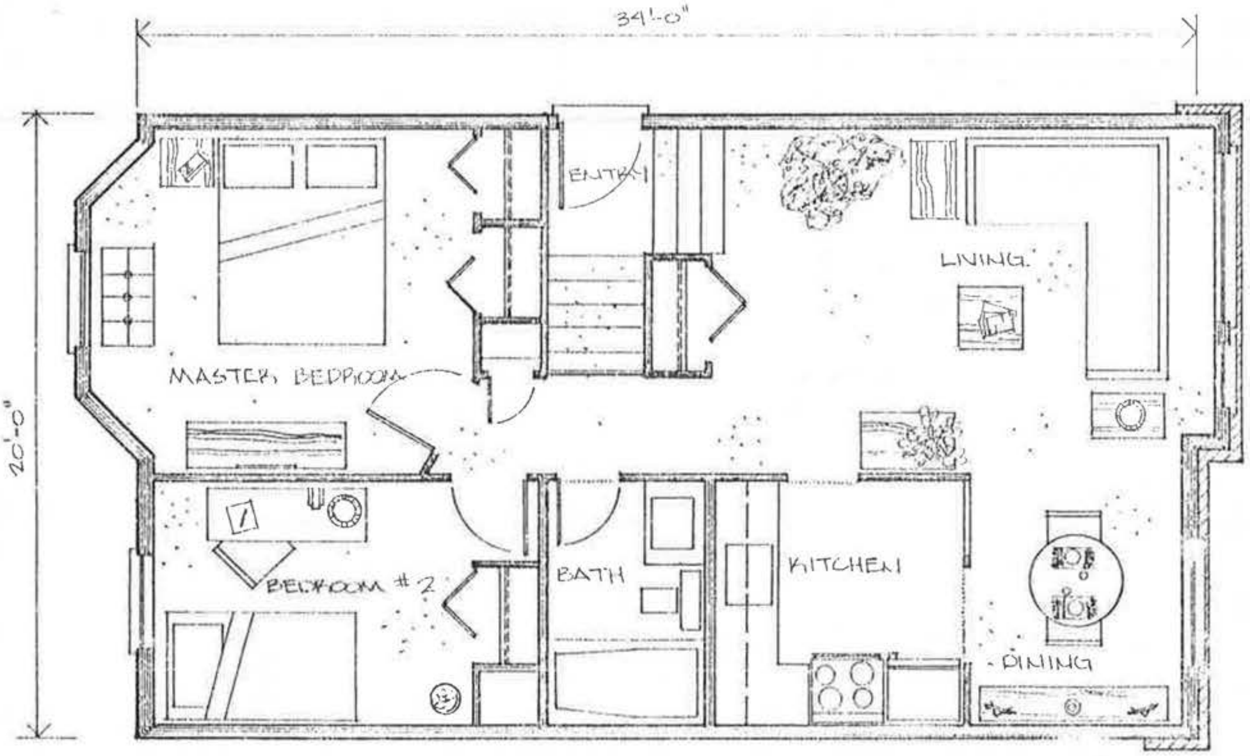
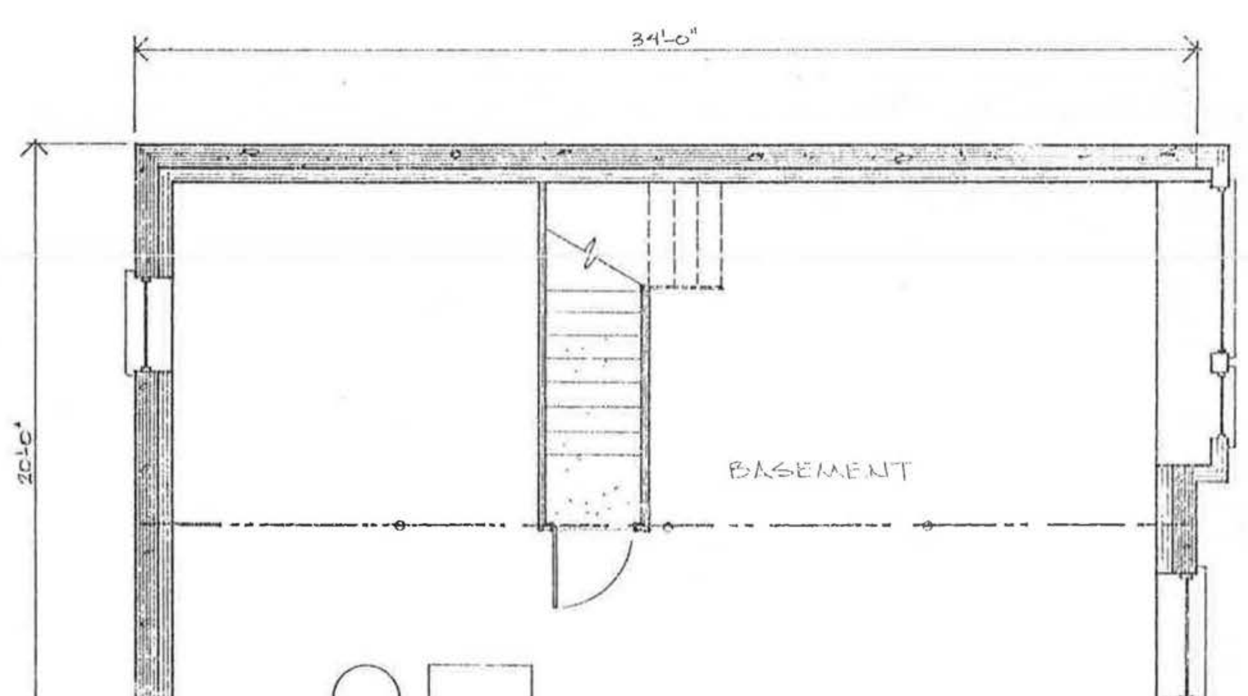


FIGURE 2





SAMPLE FLOOR PLAN
HOUSES #1, #3, #5, #7, #9

FIGURE 3

FIGURE 4

SAMPLE ELEVATION

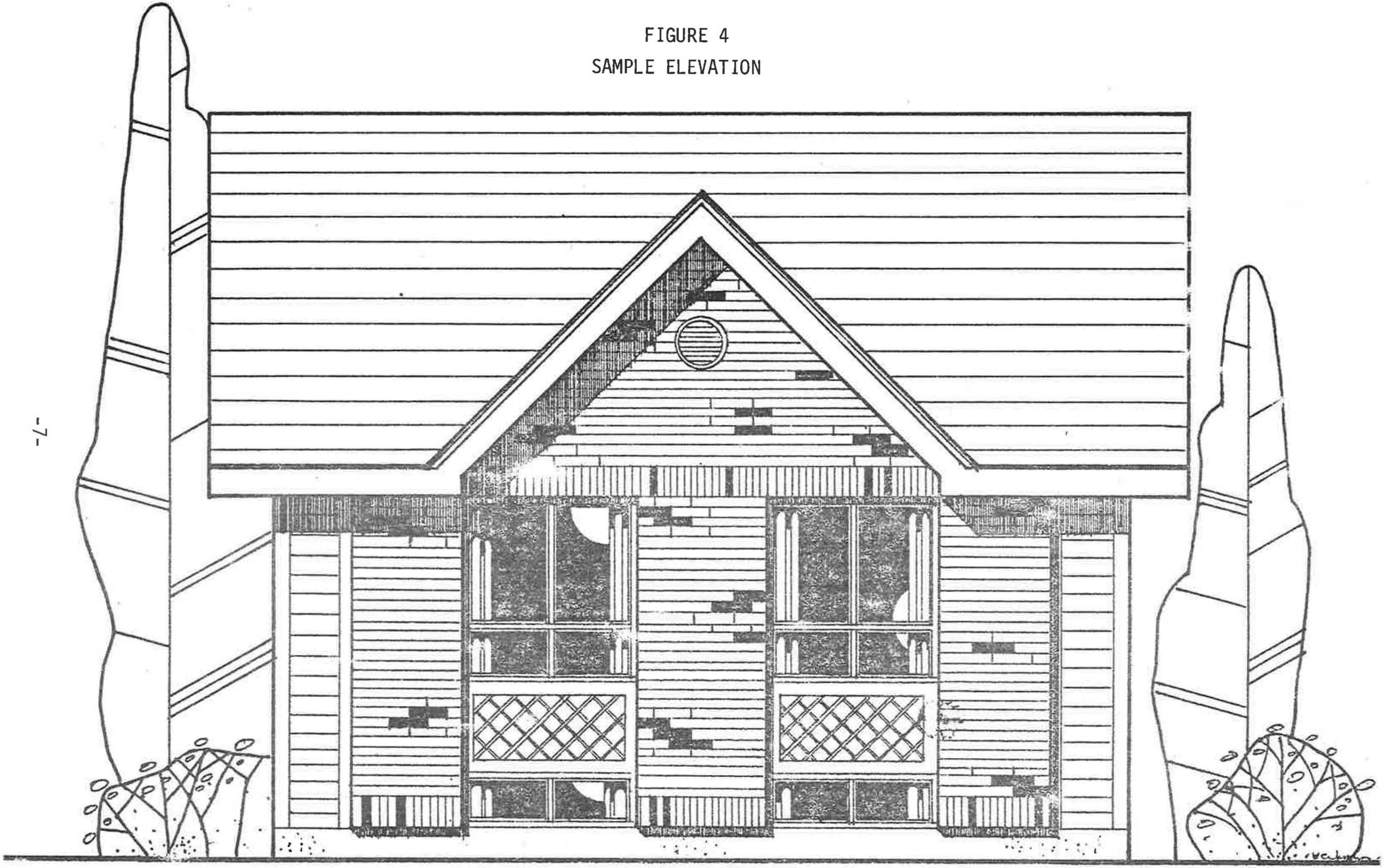


TABLE 1
HOUSE DESCRIPTION SUMMARY, BUILDING ENVELOPES

HOUSE	NOMINAL INSULATION LEVELS (RSI/R)				BUILDING ENVELOPE						
	WALLS	BASEMENT WALLS	FLOOR SLAB	CEILING	WALL CONSTRUCTION	BASEMENT CONSTRUCTION	CEILING CONSTRUCTION	WINDOW TYPE	DOOR TYPE	AIR BARRIER SYSTEM	VAPOUR BARRIER SYSTEM
1,2	4.70 (26.7)	3.52 (20.0)	0 (0)	7.04 (40.0)	38x140(2x6) c/w 38 mm (1½") Glasclad Insulated Sheathing (Reversed)	Interior Glass Fibre Batts, 38x64 (2x3) Framing	Truss Construction c/w Blown-in Cellulose Fibre Insulation and Vaulted Ceiling c/w Glass Fibre Batts	Triple-Glazed	Insulated Steel	ADA	Paint
3,4	4.70 (26.7)	3.52 (20.0)	0 (0)	7.04 (40.0)	38x140(2x6) c/w 38 mm (1½") Glasclad Insulated Sheathing (Reversed)	Interior Glass Fibre Batts, 38x64 (2x3) Framing	Truss Construction c/w Blown-in Cellulose Fibre Insulation and Vaulted Ceiling c/w Glass Fibre Batts	Triple-Glazed	Insulated Steel	ADA	Paint
5,6	4.70 (26.7)	3.52 (20.0)	0 (0)	7.04 (40.0)	38x140(2x6) c/w 38 mm (1½") Glasclad Insulated Sheathing (Reversed)	Interior Glass Fibre Batts, 38x64 (2x3) Framing	Truss Construction c/w Blown-in Cellulose Fibre Insulation and Vaulted Ceiling c/w Glass Fibre Batts	Triple-Glazed	Insulated Steel	ADA	Paint
7,8	3.52 (20.0)	3.52 (20.0)	0 (0)	7.04 (40.0)	38x140 (2x6)	Interior Glass Fibre Batts, 38x64 (2x3) Framing	Truss Construction c/w Blown-in Cellulose Fibre Insulation and Vaulted Ceiling c/w Glass Fibre Batts	Triple-Glazed	Insulated Steel	ADA	Paint
9,10	3.52 (20.0)	3.52 (20.0)	0 (0)	7.04 (40.0)	38x140 (2x6)	Interior Glass Fibre Batts, 38x64 (2x3) Framing	Truss Construction c/w Blown-in Cellulose Fibre Insulation and Vaulted Ceiling c/w Glass Fibre Batts	Triple-Glazed	Insulated Steel	4 mil poly	4 mil poly
11,12	5.07 (28.8)	2.29 (13.0)	1.18 (6.7)	7.04 (40.0)	38x140(2x6) c/w 51 mm (2") Glasclad Insulated Sheathing	76 mm (3") Exterior Baseclad Insulation	Truss Construction c/w Blown-in Glass Fibre Insulation	Triple-Glazed	Insulated Steel	Simplified ADA	Paint
13,14	5.07 (28.8)	2.29 (13.0)	0 (0)	7.04 (40.0)	38x140(2x6) c/w 51 mm (2") Glasclad Insulated Sheathing	Interior Glass Fibre Batts, 38x64 (2x3) Framing	Truss Construction c/w Blown-in Glass Fibre Insulation	Triple-Glazed	Insulated Steel	Simplified ADA	Paint
15,16	7.04 (40.0)	3.52 (20.0)	0 (0)	7.04 (40.0)	Double Wall	Interior Glass Fibre Batts, 38x64 (2x3) Framing	Truss Construction c/w Blown-in Cellulose Fibre Insulation	Triple-Glazed	Insulated Steel	6 mil poly	6 mil poly
17,18	7.04 (40.0)	3.52 (20.0)	0 (0)	7.04 (40.0)	Double Wall	Interior Glass Fibre Batts, 38x64 (2x3) Framing	Truss Construction c/w Blown-in Cellulose Fibre Insulation	Triple-Glazed	Insulated Steel	6 mil poly	6 mil poly
19,20	3.87 (22.0)	3.87 (22.0)	0 (0)	7.04 (40.0)	38x89(2x4) c/w 51 mm SM Insulated Sheathing	Exterior 51 mm SM Insulation and Interior Glass Fibre Batts, 38x64 (2x3) Framing	Truss Construction c/w Blown-in Cellulose Fibre Insulation	Triple-Glazed	Insulated Steel	ADA	Paint

TABLE 2
HOUSE DESCRIPTION SUMMARY, MECHANICAL SYSTEMS

HOUSE	MECHANICAL SYSTEMS SPACE HEATING	DHW HEATING	VENTILATION SYSTEM	VENTILATION DISTRIBUTION SYSTEM	ENERGY STANDARD
1,2	Forced Air Electric Furnace	Electric Tank	Heat Recovery Ventilator	Heating System Ductwork	R-2000
3,4	Forced Air Electric Furnace	Electric Tank	Heat Recovery Ventilator	Heating System Ductwork	R-2000
5,6	Forced Air Electric Furnace	Electric Tank	Heat Recovery Ventilator	Heating System Ductwork	R-2000
7,8	Forced Air Electric Furnace	Electric Tank	Central Exhaust	Fresh Air Intake to Heating System Ductwork	
9,10	Forced Air Gas Furnace	Gas Tank	Bathroom Exhaust Fan	None	
11,12	Integrated Exhaust-Only Heat Pump HRV Which Provides DHW Heating and Supplemental Space Heating. Electric Baseboards and Supplemental Electric DHW Heating.			Envelope Leakage	R-2000
13,14	Forced Air Electric Furnace	Electric Tank	Heat Recovery Ventilator	Heating System Ductwork	R-2000
15,16	Integrated Air-to-Air Heat Pump HRV, Electric Furnace and DHW Heater			Heating System Ductwork	R-2000
17,18	Electric Baseboards	Electric Tank	Heat Pump Heat Recovery Ventilator	Dedicated Ventilation System	R-2000
19,20	Electric Baseboards	Electric Tank	Heat Recovery Ventilator	Dedicated Ventilation System	R-2000

SECTION 3
BUILDING ENVELOPE SYSTEMS

3.1 HOUSES #1 to #6

Houses #1 to #6 are constructed using the Airtight Drywall Approach (ADA) in which the drywall serves as a structural air barrier with gaskets placed between major structural elements to control air leakage at the joints. Paint functions as the vapour barrier. The main walls are constructed using 38x140 (2x6) studs with 38 mm (1½") exterior insulated sheathing ("Glasclad"). An interesting feature of the construction is that the insulated sheathing, which comes complete with a spun-bonded polyolefin air barrier ("Tyvek") on one face, is reversed so that the air barrier faces inwards. As a result, joints between adjacent sheets do not have to be taped since they are secured against framing members which reduce air leakage. Continuous drywall, installed prior to the partition walls, is used on the ceiling with penetrations kept to a minimum. The cast-in-place concrete basements are insulated from the interior. On those houses in which the basements are not finished, a conventional polyethylene vapour barrier is used on the warm side of the basement framing/insulation. All of the houses meet the R-2000 Standard. Details are given in Figures 5 and 6. The gasket and paint schedules are shown below.

GASKET SCHEDULE

Type 1 - Polyethylene sill plate gasket

Electrical Outlets - Poly pan boxes and foam cover gaskets

PAINT SCHEDULE

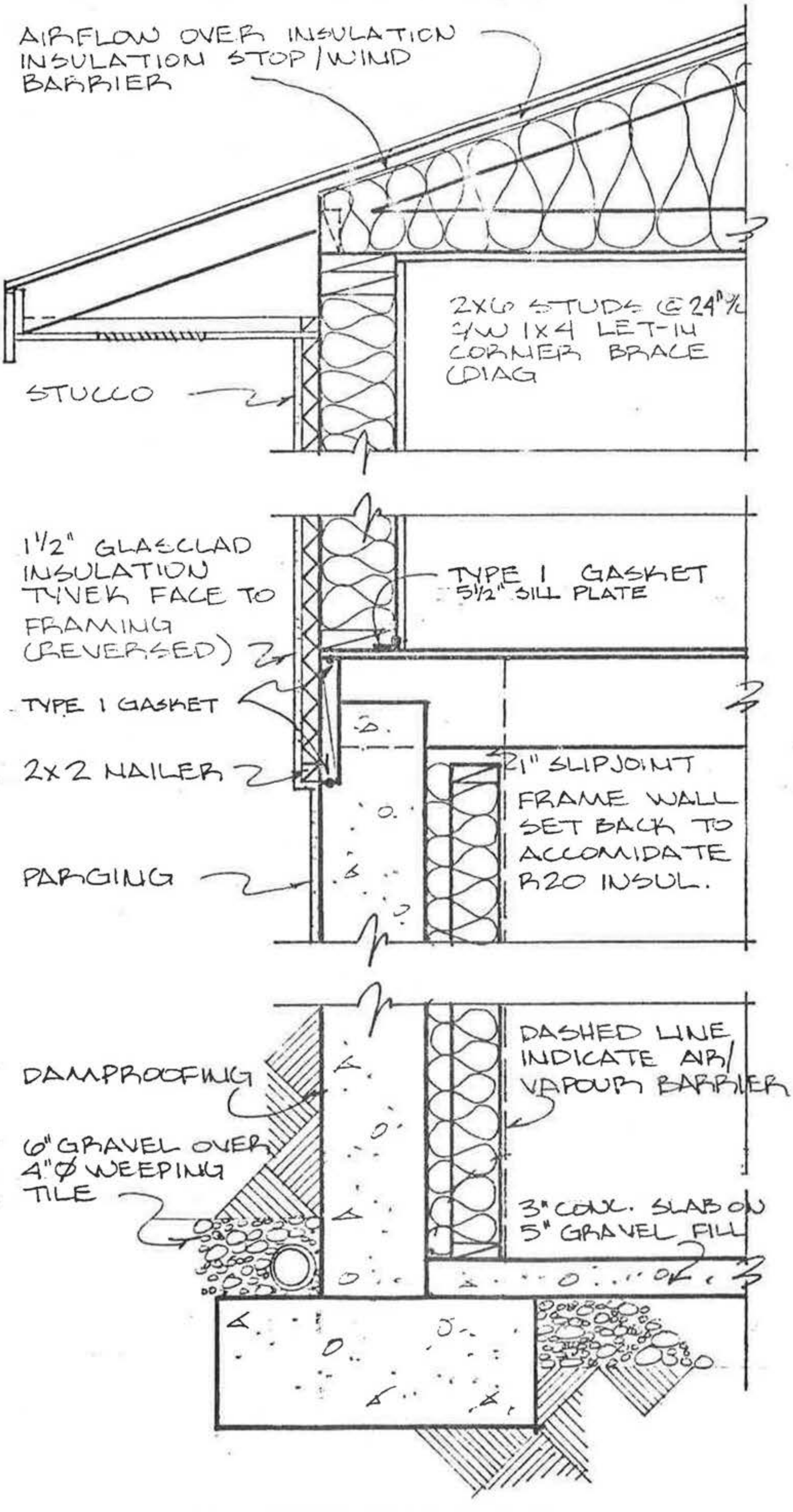
Walls

- o Latex primer
- o Latex finish coat

Ceiling

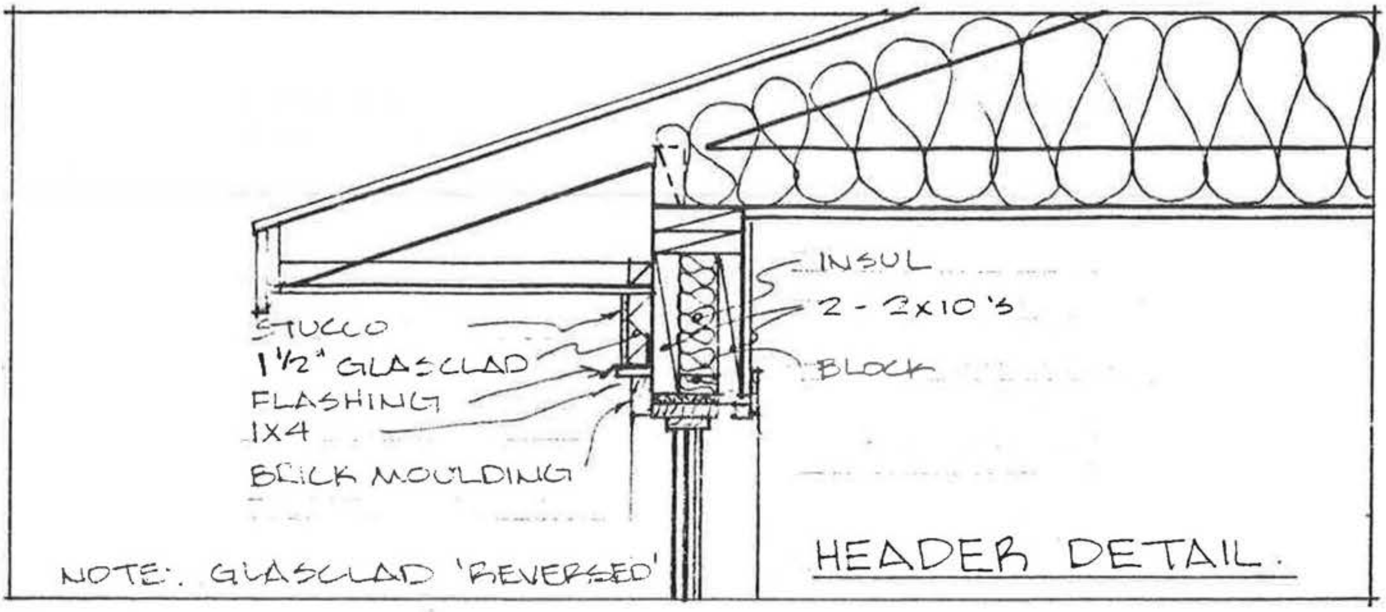
- o Latex primer
- o Texture finish coat

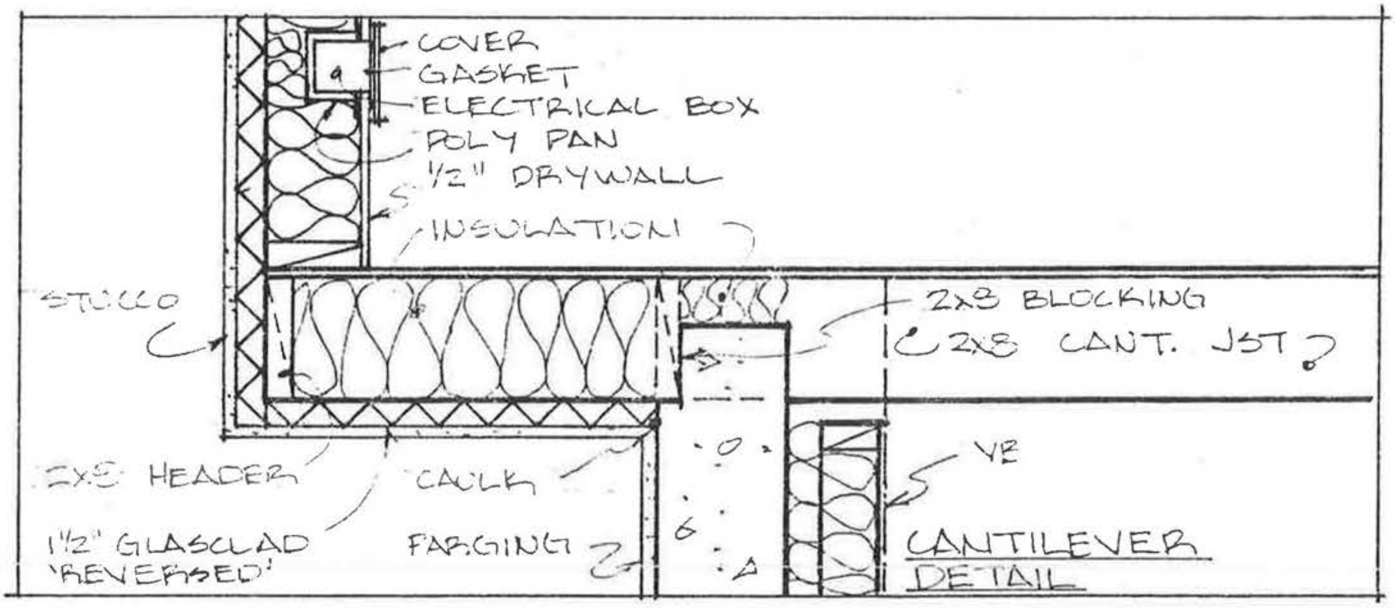
FIGURE 5

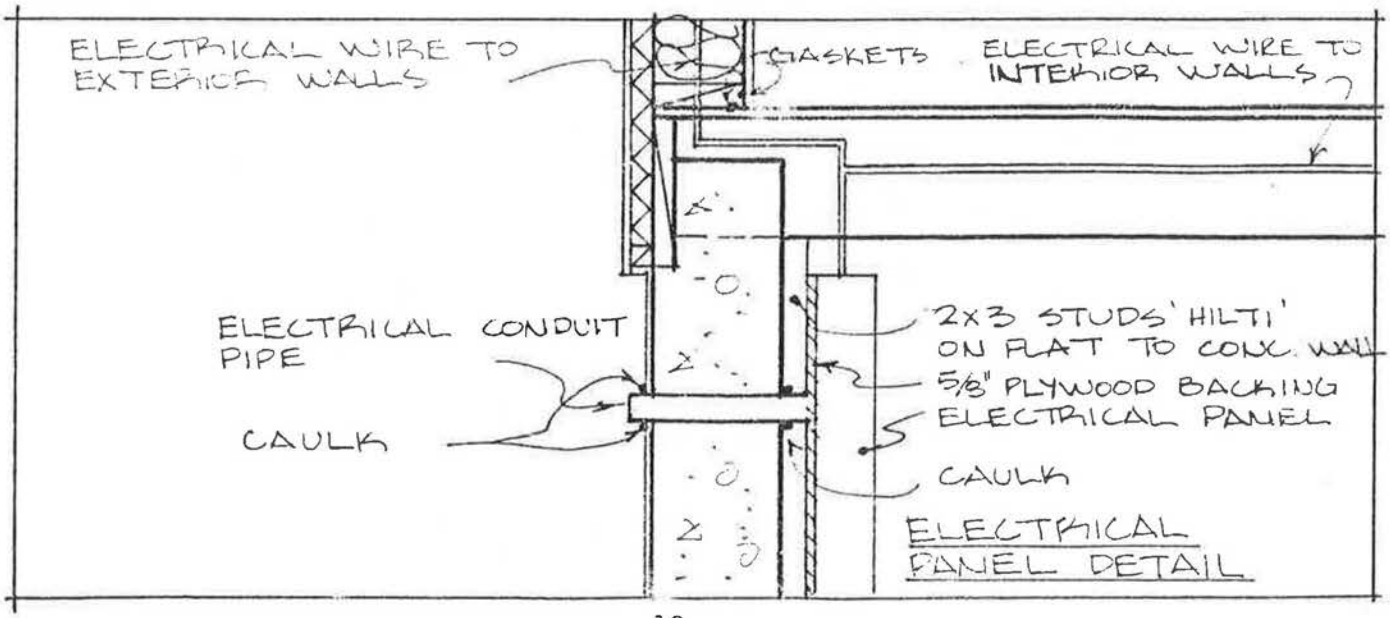


CROSS SECTION HOUSES #1 TO #6

FIGURE 6
CONSTRUCTION DETAILS HOUSES #1 TO #6







3.2 HOUSES #7 and #8

The building envelopes are similar to those used on Houses #1 to #6 except that exterior insulated sheathing is not used. Instead, conventional fibreboard sheathing is employed. The ADA system is used for the main walls and ceiling with the basements having conventional polyethylene vapour barriers. With the exception of the ADA components, these two houses are very similar to conventional construction practices for the Winnipeg area. Details are given in Figures 7 and 8. The gasket and paint schedules are shown below.

GASKET SCHEDULE

Type 1 - Polyethylene sill plate gasket

Electrical outlets - Poly pan boxes and foam cover gaskets

PAINT SCHEDULE

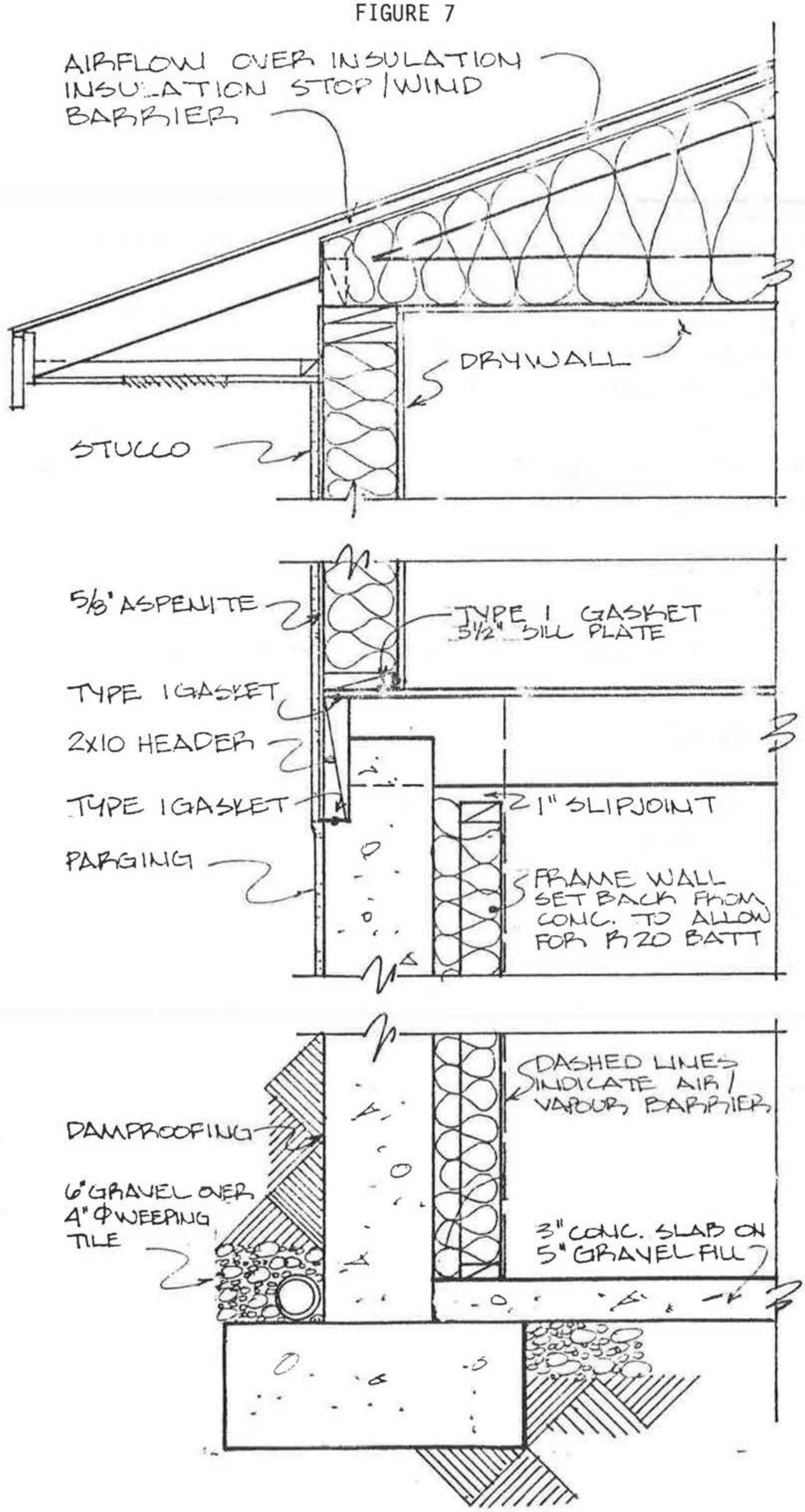
Walls

- Latex primer
- Latex finish coat

Ceiling

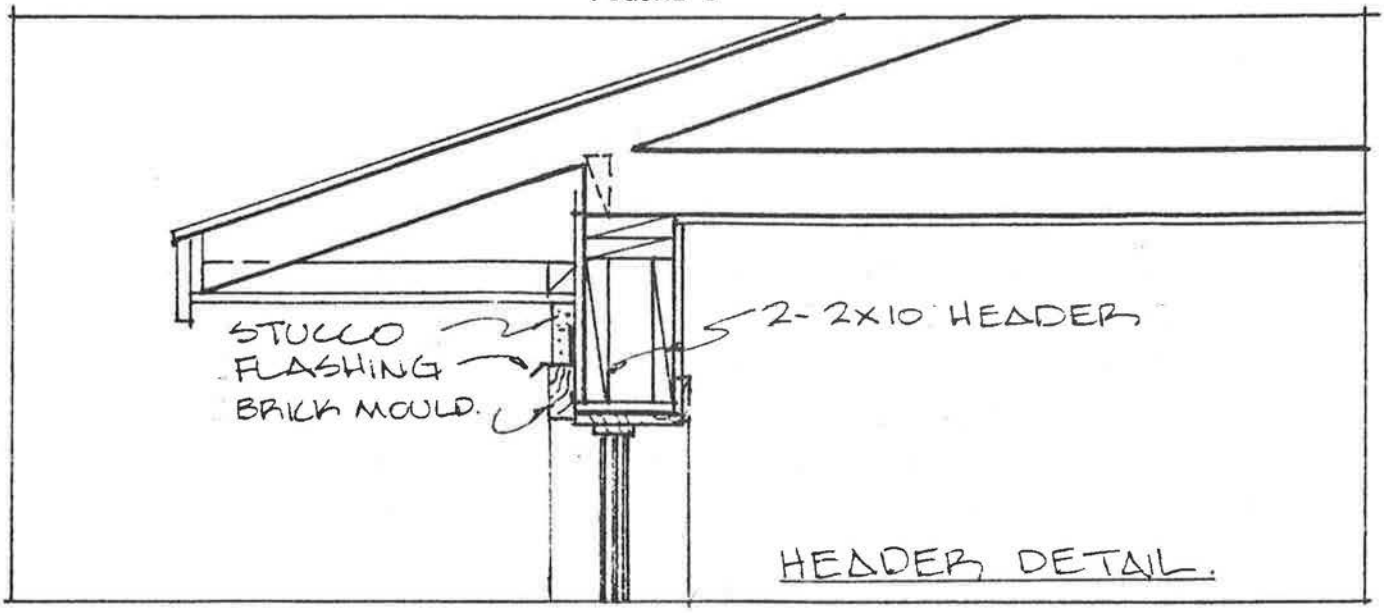
- Latex primer
- Texture finish coat

FIGURE 7

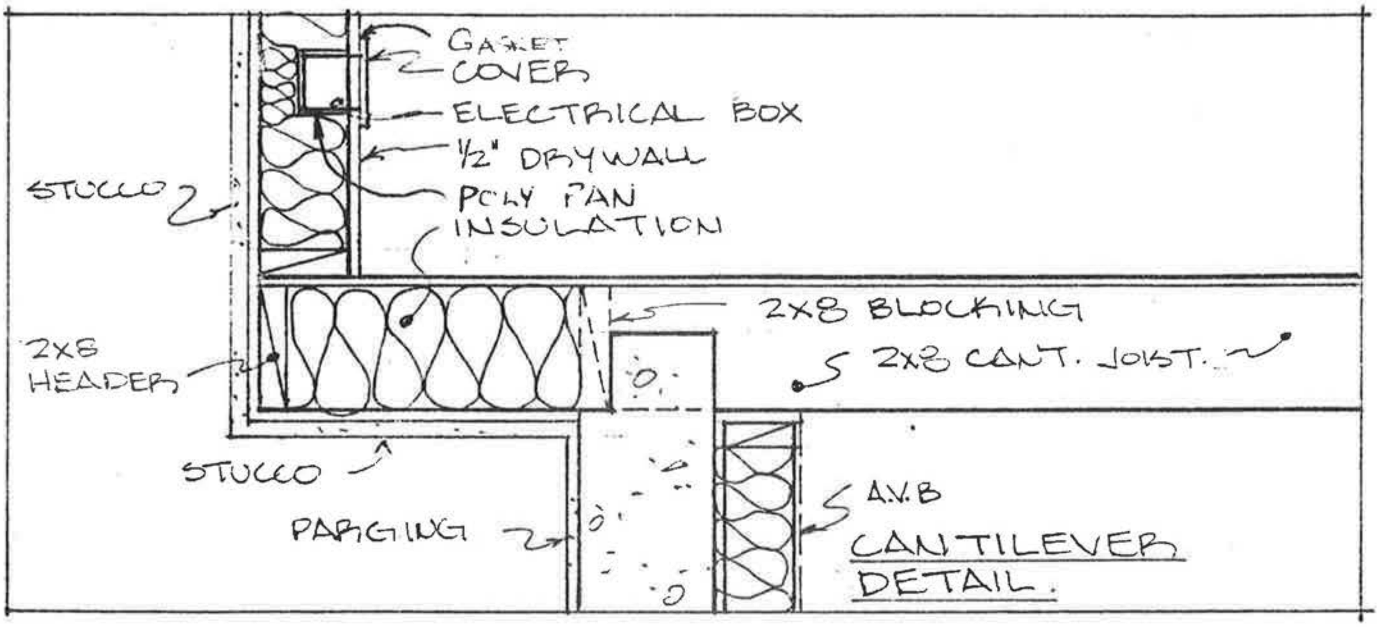


CROSS SECTION HOUSES #7 & #8

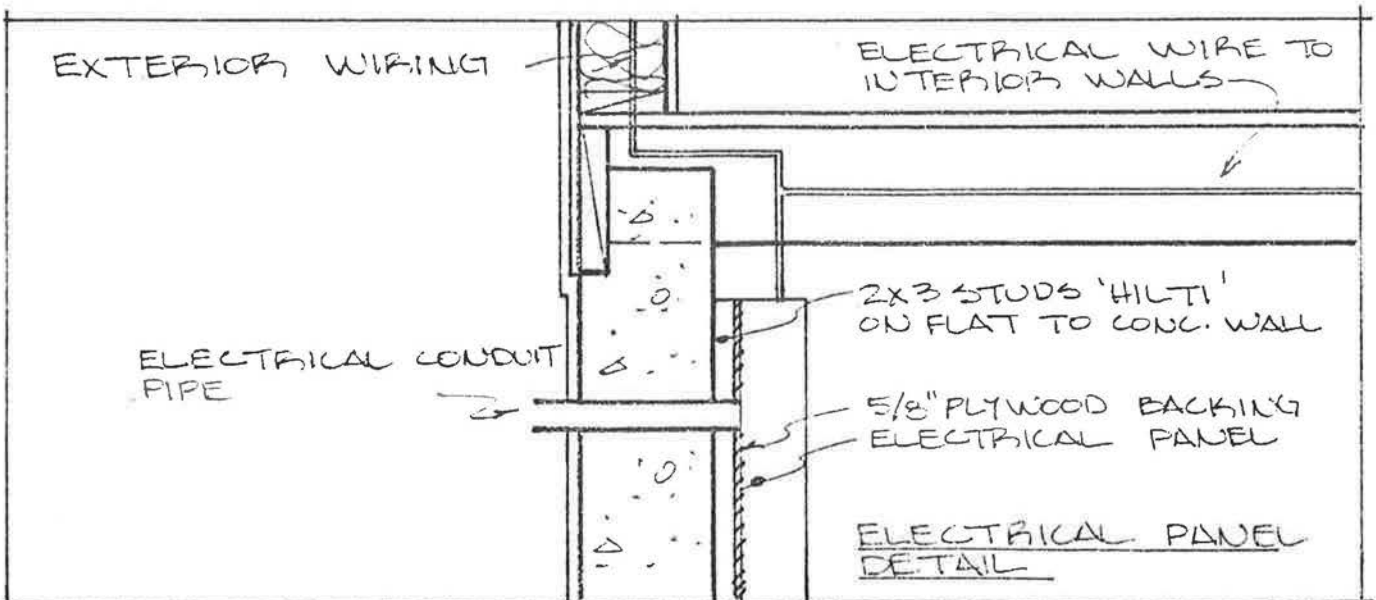
FIGURE 8



STUCCO
FLASHING
BRICK MOULD.
2-2X10 HEADER
HEADER DETAIL.



GASKET
COVER
ELECTRICAL BOX
1/2" DRYWALL
STUCCO
POLY PAN
INSULATION
2X8 BLOCKING
2X8 HEADER
2X8 CANT. JOIST.
STUCCO
A.V.B
PARGING
CANTILEVER DETAIL.

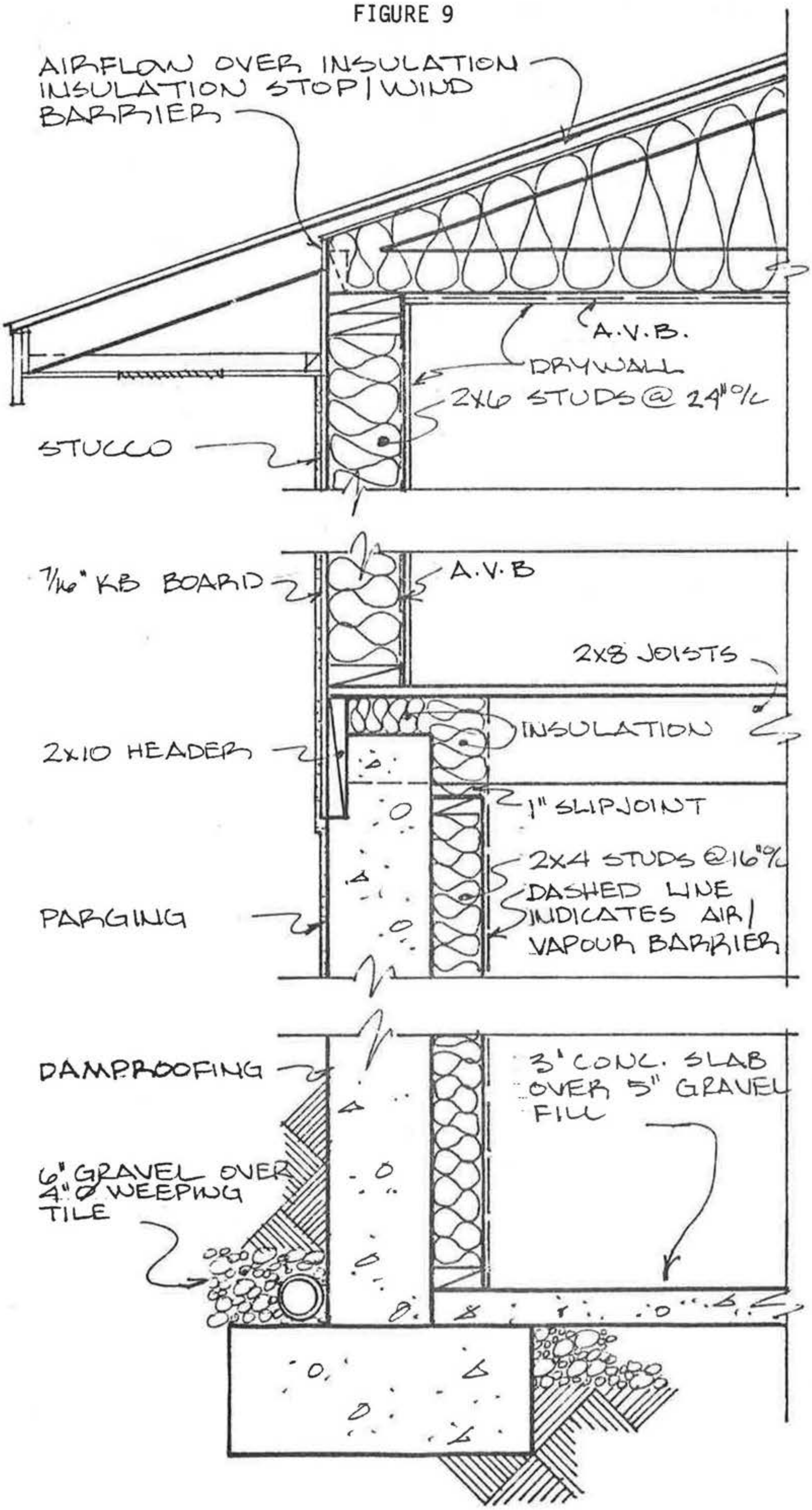


EXTERIOR WIRING
ELECTRICAL WIRE TO INTERIOR WALLS
2X3 STUDS 'HILTI' ON FLAT TO CONC. WALL
ELECTRICAL CONDUIT PIPE
5/8" PLYWOOD BACKING
ELECTRICAL PANEL
ELECTRICAL PANEL DETAIL

3.3 HOUSES #9 and #10

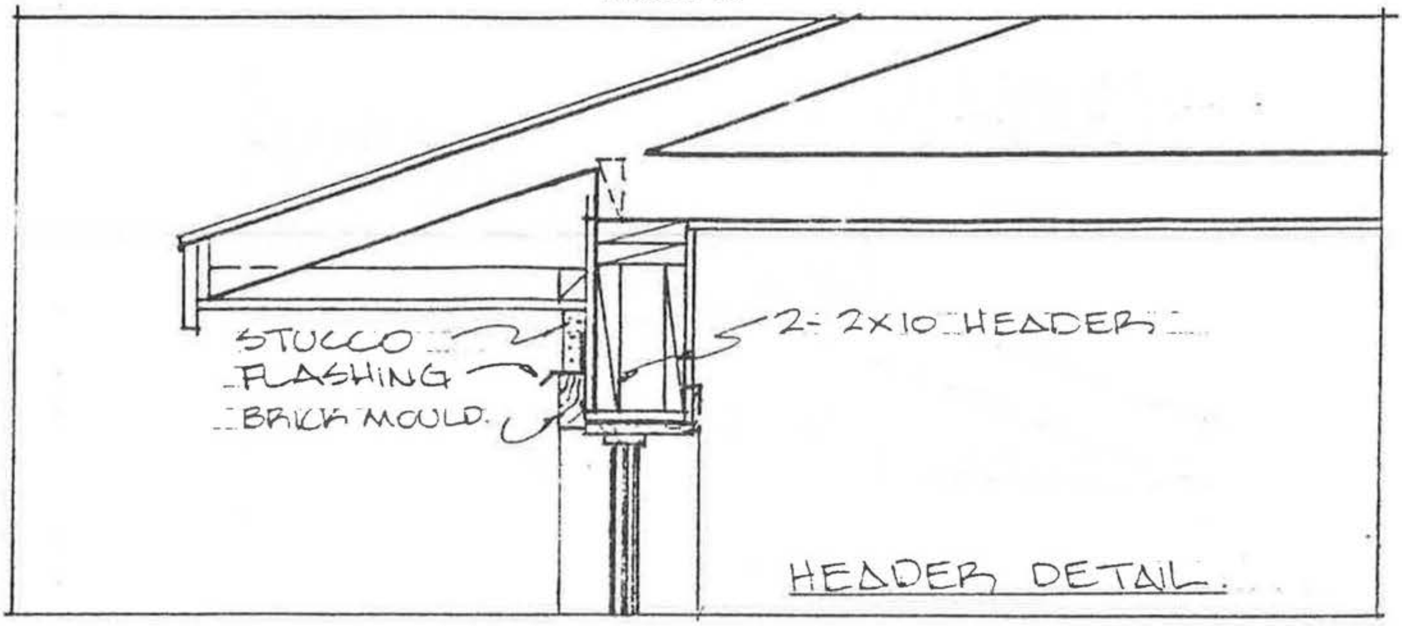
These two houses are typical of conventional construction in the Winnipeg market. Main walls use 38x140 (2x6) framing insulated to RSI 3.52 (R-20.0) with fibreboard sheathing on the exterior. The vapour barrier consists of 4 mil polyethylene stapled in place with no caulking between sheets or at penetrations. The vapour barrier runs down the main walls to the bottom plate where it is stapled in place. No special measures are taken to reduce air leakage around the floor system although the stucco used on three of the four walls tends to function as an exterior air barrier. Penetrations for electrical outlets on exterior walls are "bagged" with polyethylene but not tightly sealed. No gaskets are used in any of the construction. Construction details are shown in Figures 9 and 10.

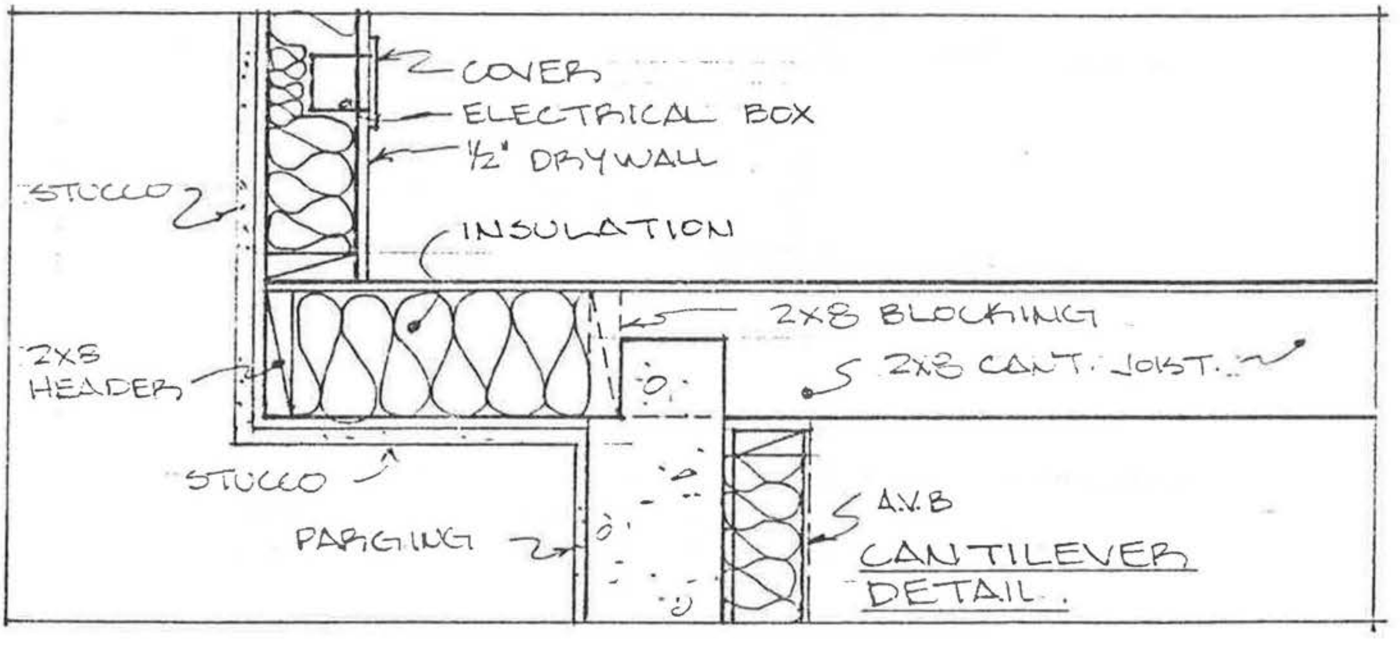
FIGURE 9

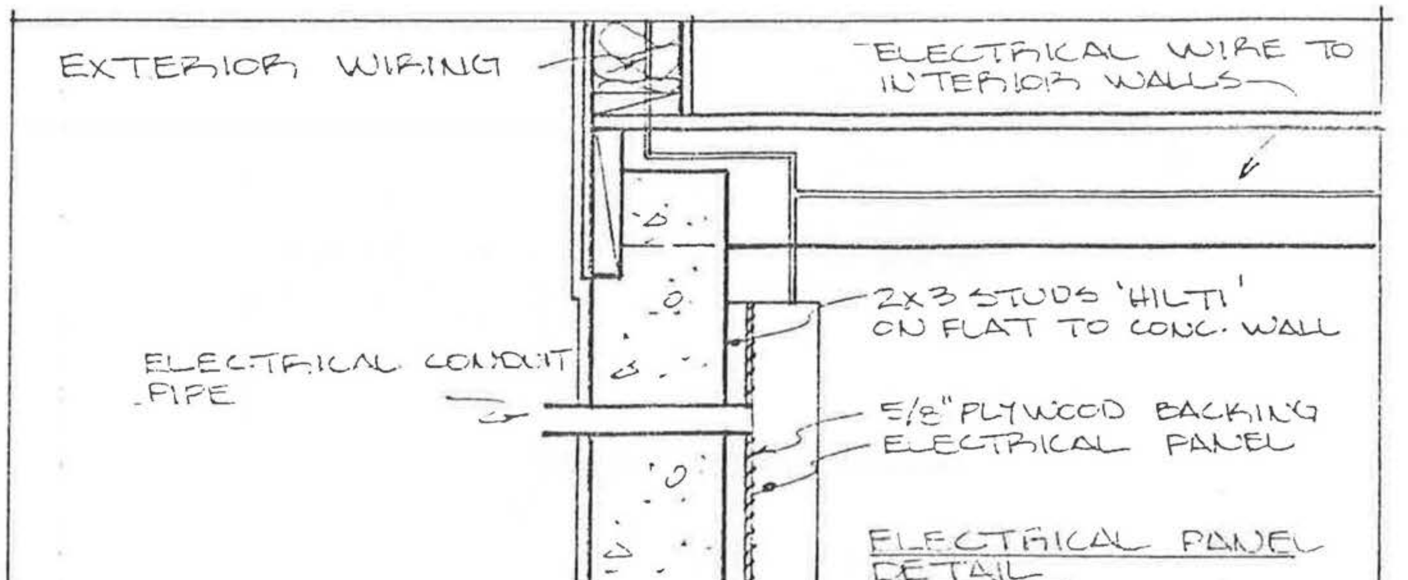


CROSS SECTION HOUSES #9 & #10

FIGURE 10


STUCCO
FLASHING
BRICK MOULD
2-2X10 HEADER
HEADER DETAIL.


COVER
ELECTRICAL BOX
½" DRYWALL
STUCCO
INSULATION
2X8 BLOCKING
2X8 HEADER
2X8 CANT. JOIST.
STUCCO
A.V.B
PARGING
CANTILEVER DETAIL.


EXTERIOR WIRING
ELECTRICAL WIRE TO INTERIOR WALLS
2X3 STUDS 'HILTI' ON FLAT TO CONC. WALL
ELECTRICAL CONDUIT PIPE
5/8" PLYWOOD BACKING
ELECTRICAL PANEL
ELECTRICAL PANEL DETAIL

3.4 HOUSES #11 and #12

These houses are constructed using the Fibreglas Canada Inc. Low Energy House System (FCI LEHS). This is basically a simplified ADA system in which gaskets are only used for electrical outlets on exterior walls and for sealing doors and windows into their rough openings. No polyethylene is used. The FCI LEHS is designed for use with an exhaust-only heat pump HRV which provides ventilation through envelope leakage. As a result, the envelope can be left slightly "leaky".

Main wall construction uses 38x140 (2x6) framing with 51 mm (2") of exterior insulated sheathing complete with an exterior Tyvek air barrier (taped). The basement insulation system uses 76 mm (3") of exterior rigid glass fibre ("Baseclad") with no interior finishing. The floor slab is cast over 38 mm (1½") of Glasclad insulation (with the Tyvek removed to accelerate concrete curing). The houses are built to the R-2000 Standard. Construction details are shown in Figures 11 and 12. The gasket and paint schedules are given below.

GASKET SCHEDULE

Type 2 - Ethafoam rods of appropriate diameter

Electrical Outlets - Poly pan boxes and foam cover gaskets

PAINT SCHEDULE

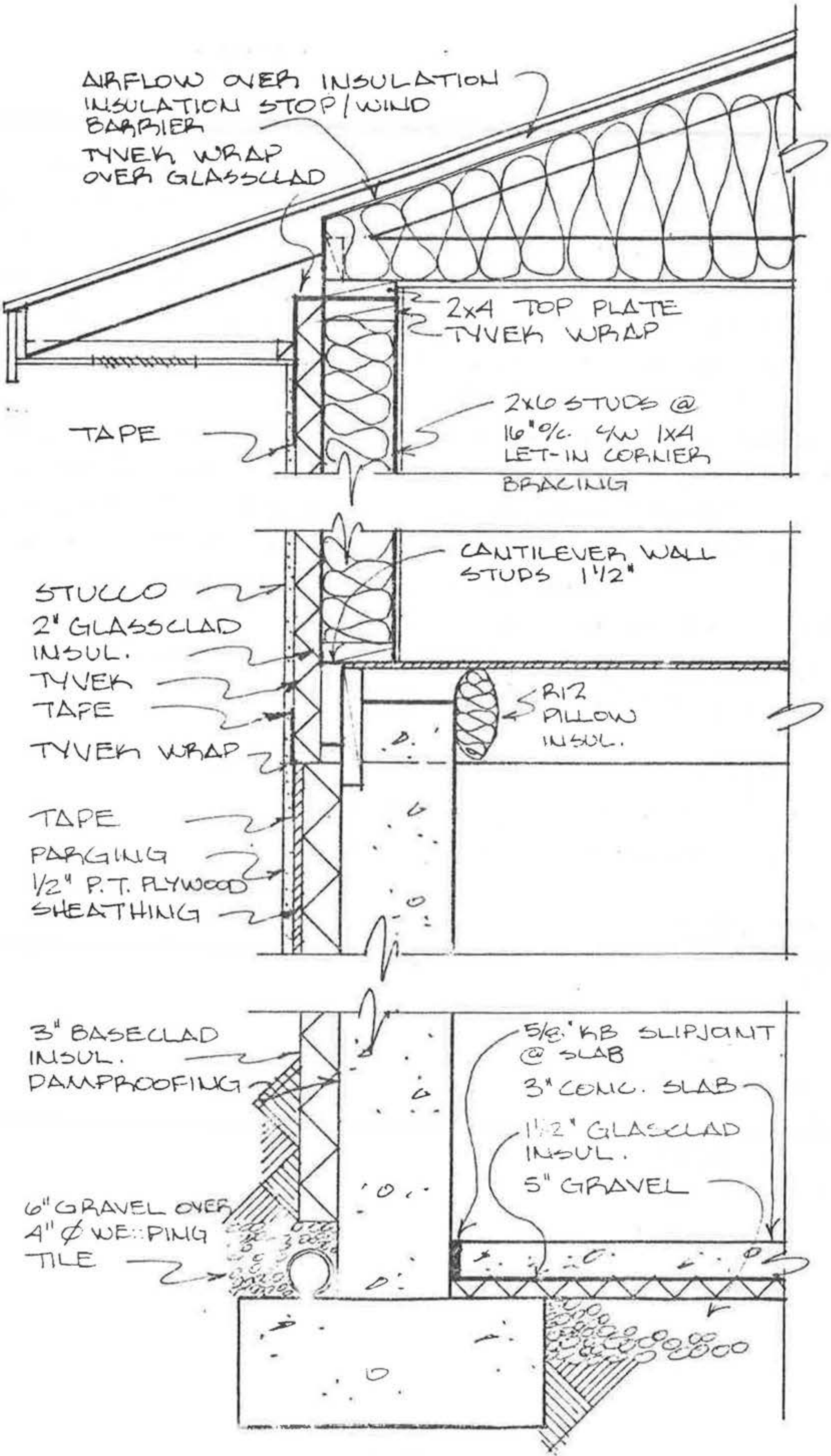
Walls

o Latex primer
o Oil base primer
o Latex finish coat

Ceiling

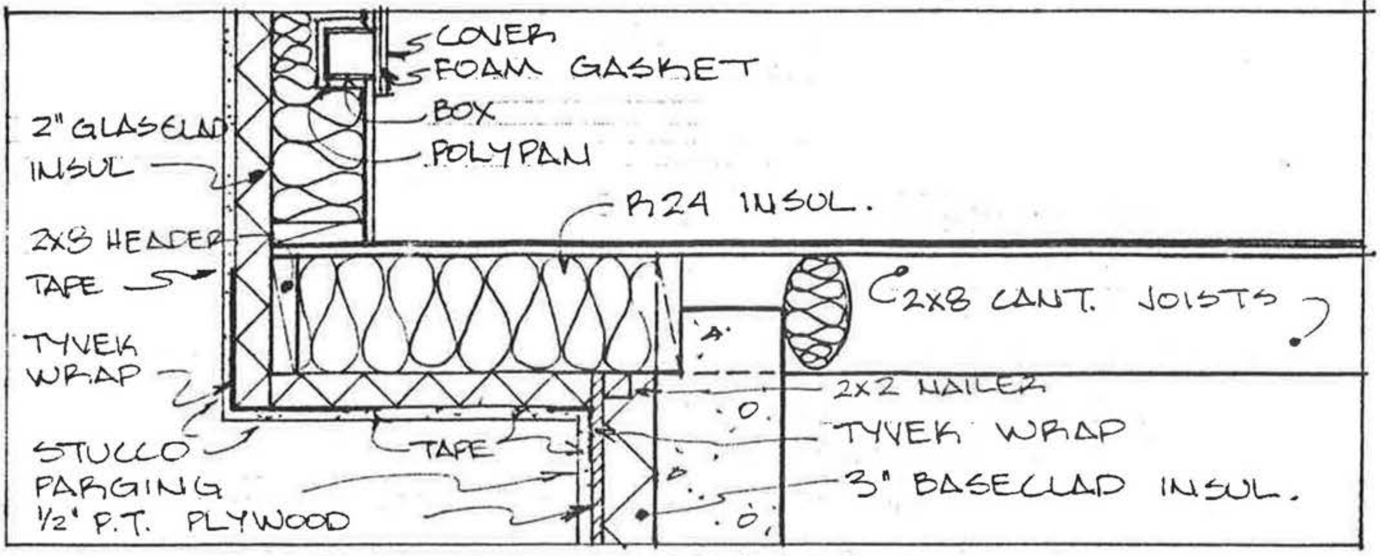
o Latex primer
o Oil base primer
o Texture finish

FIGURE 11

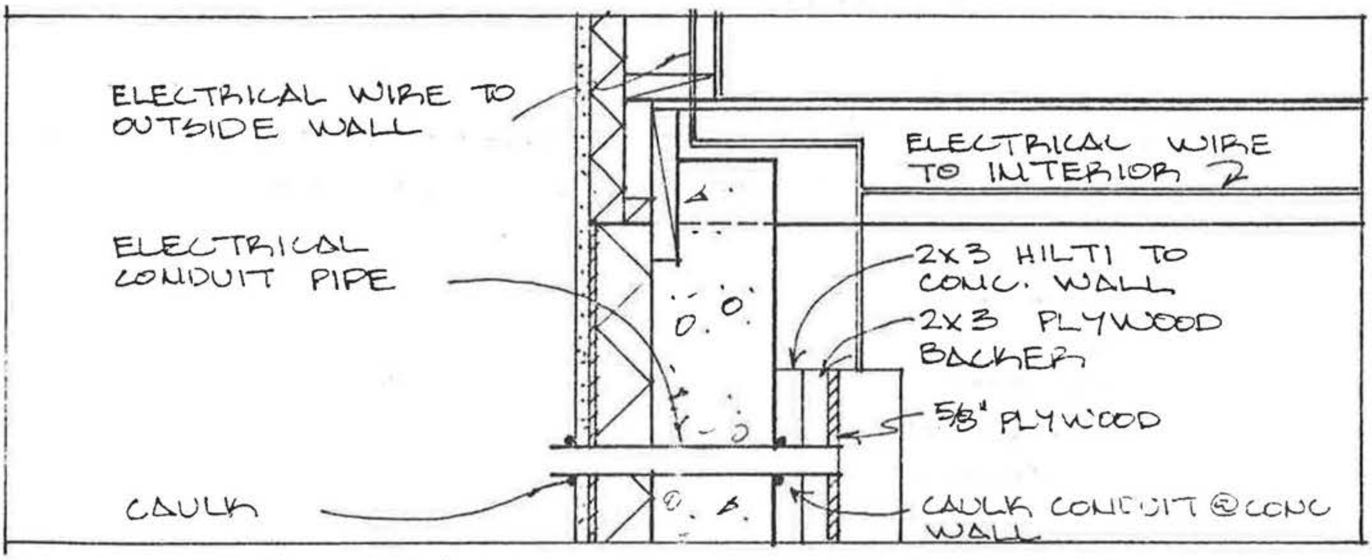


CROSS SECTION HOUSES #11 & #12

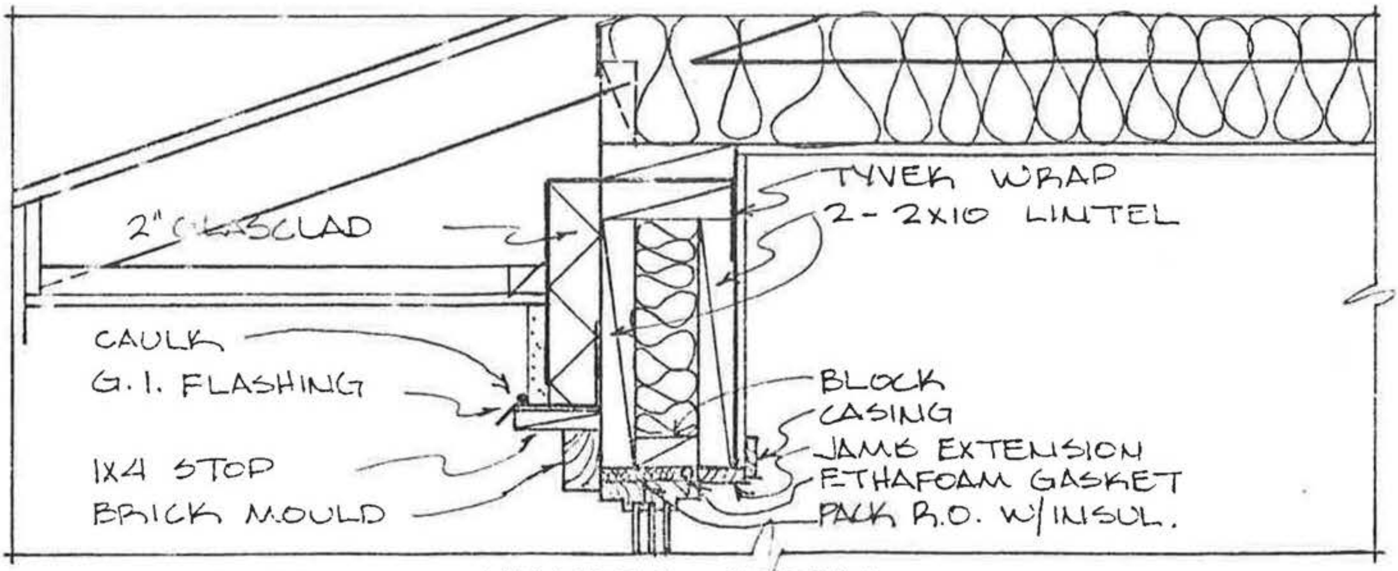
FIGURE 12



CANTILEVER DETAIL



ELECTRICAL PANEL DETAIL



HEADER DETAIL

CONSTRUCTION DETAILS HOUSES #11 & #12

3.5 HOUSES #13 and #14

These two houses are similar to #11 and #12 since they also use the FCI LEH System. Main wall construction consists of 38x140 (2x6) framing with 51 mm (2") of taped Glasclad insulated sheathing. Gaskets are used only around door and window penetrations and at electrical outlets on exterior walls. The basement is more similar to conventional practice and uses interior batts and framing and a polyethylene vapour barrier. No sub-slab insulation is used. The houses are constructed to the R-2000 Standard. Construction details are shown in Figures 13 and 14. The gasket and paint schedules are given below.

GASKET SCHEDULE

Type 2 - Ethafoam rods of appropriate diameter

Electrical Outlets - Poly pan boxes and foam cover gaskets

PAINT SCHEDULE

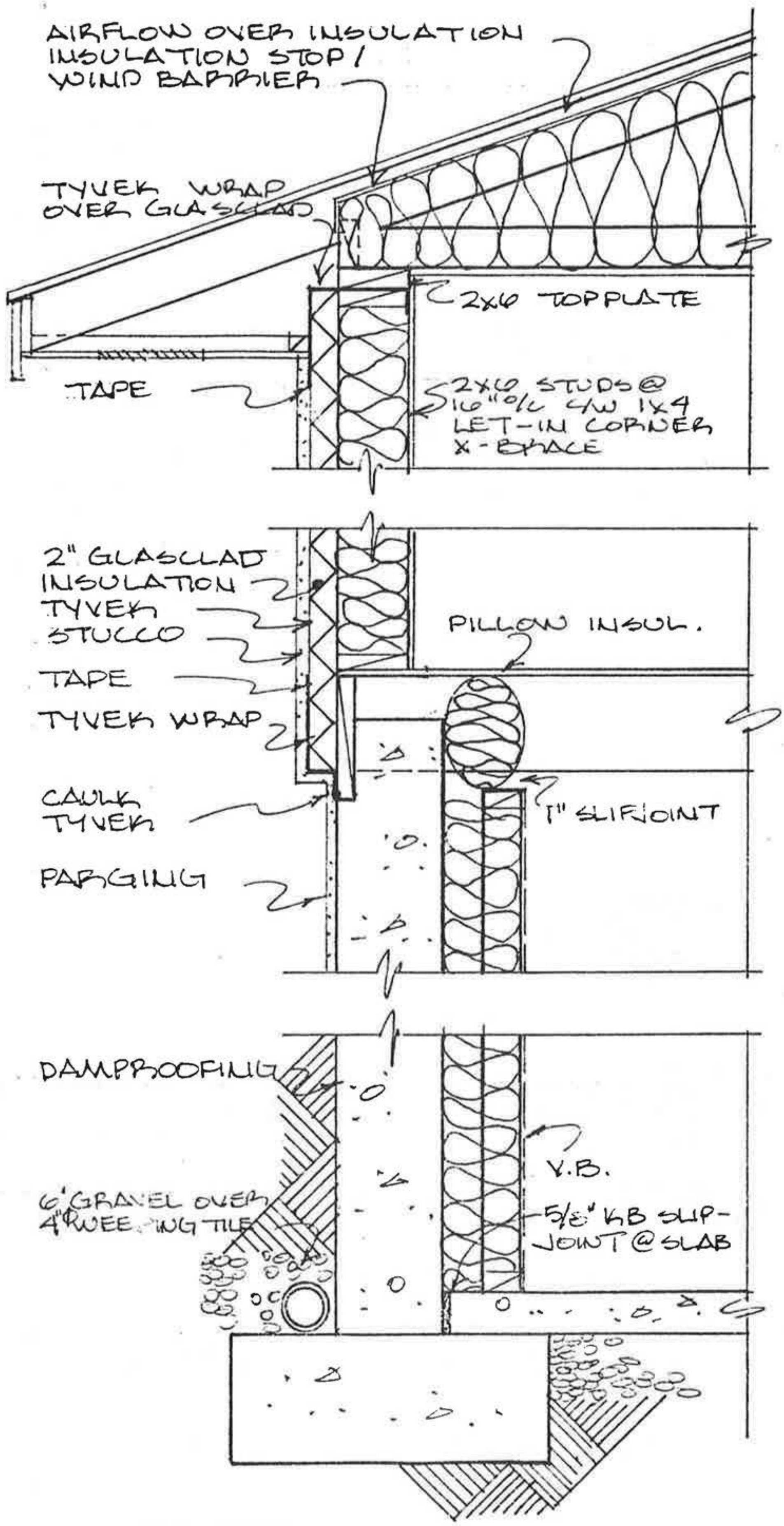
Walls

- o Latex primer
- o Oil base primer
- o Latex finish coat

Ceiling

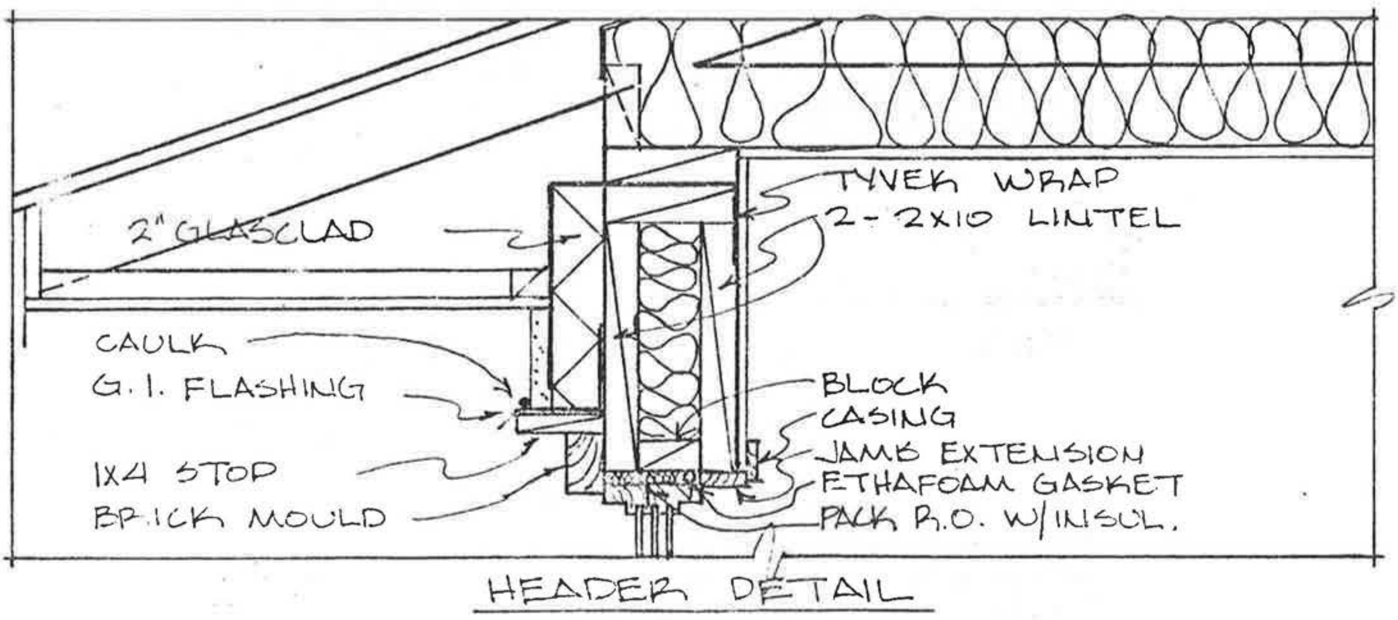
- o Latex primer
- o Oil base primer
- o Texture finish

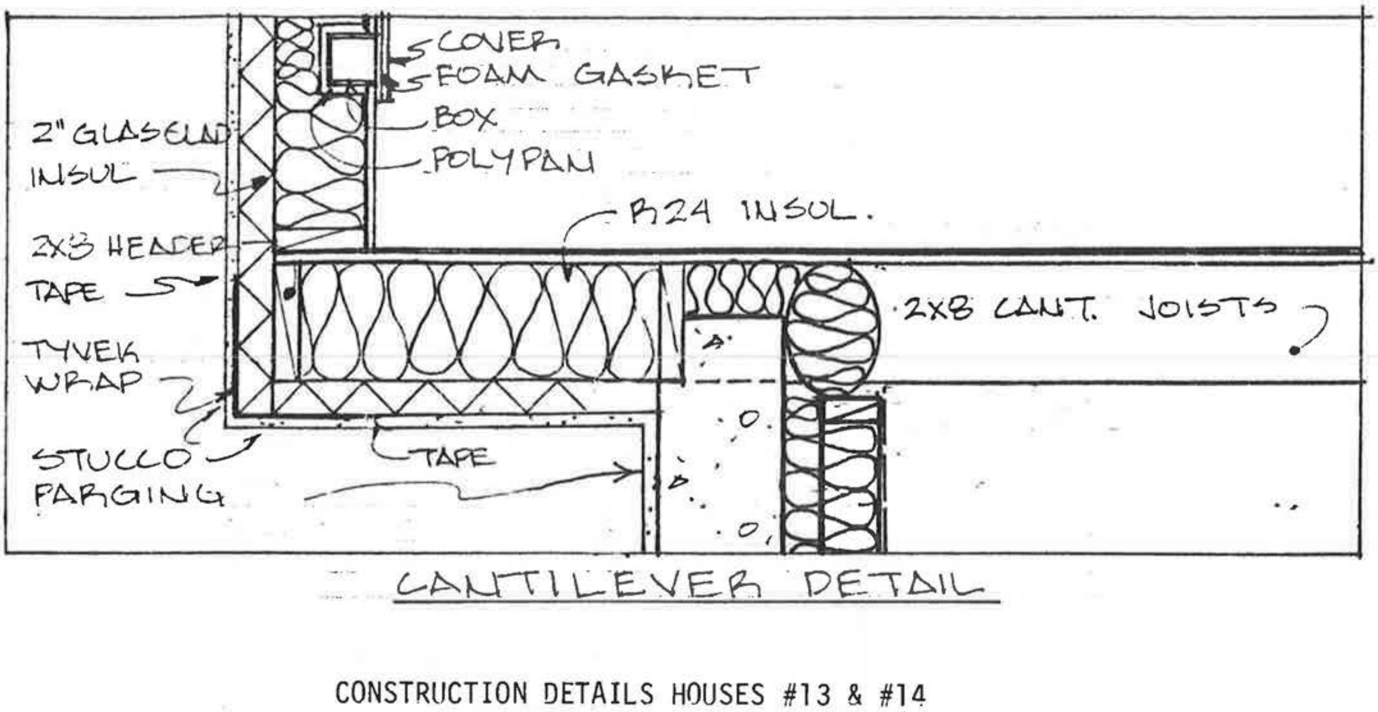
FIGURE 13



CROSS SECTION HOUSES #13 & #14

FIGURE 14



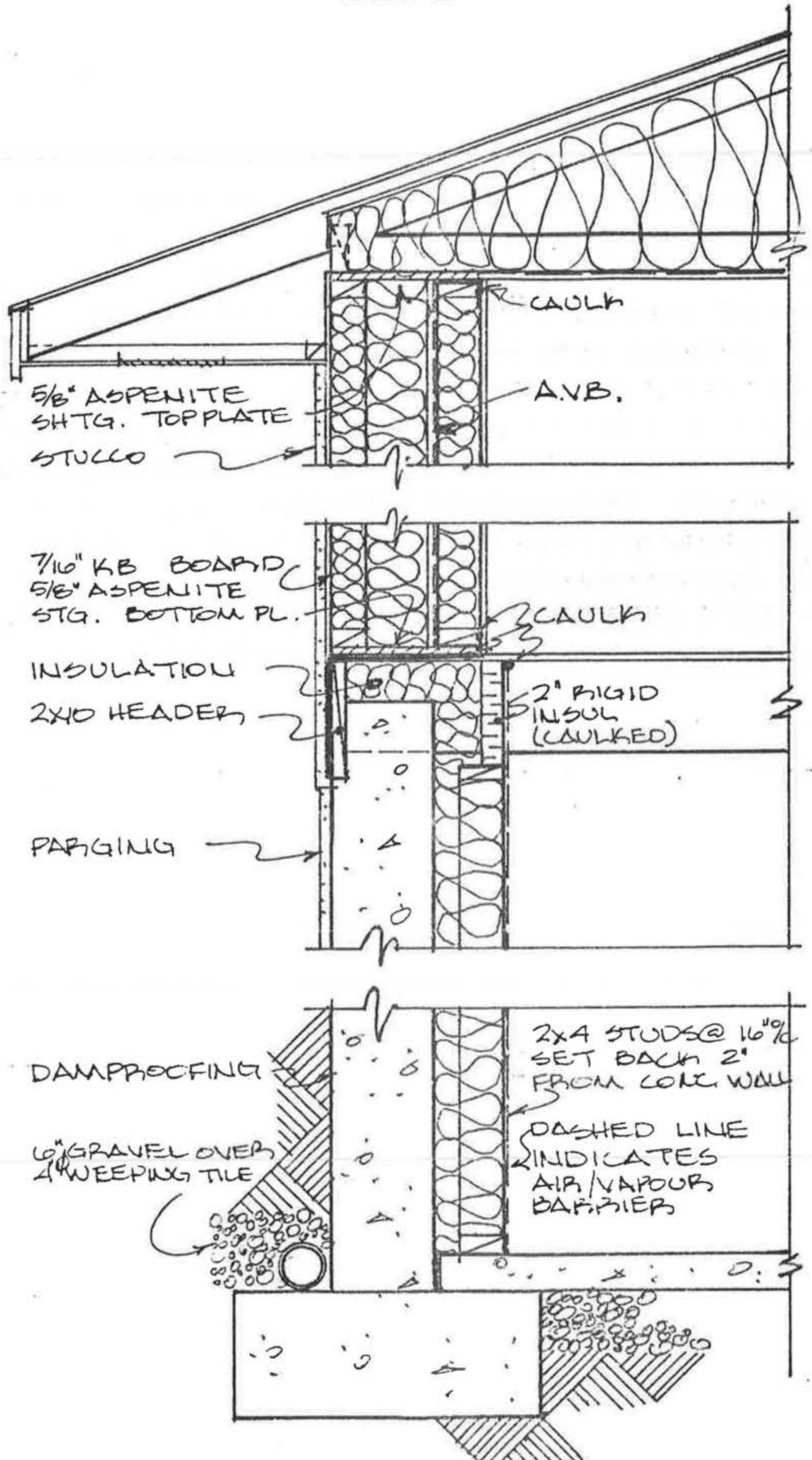


CONSTRUCTION DETAILS HOUSES #13 & #14

3.6 HOUSES #15 to #18

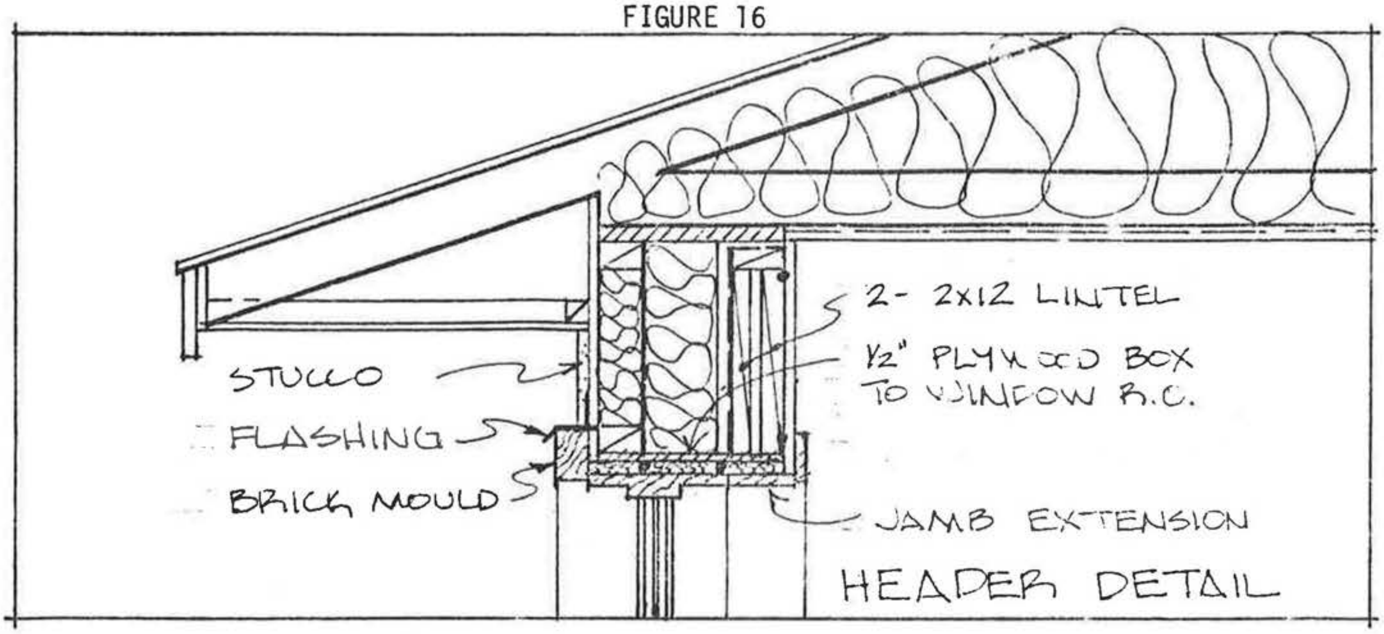
These four houses are built using the double wall system to achieve maximum levels of insulation and envelope tightness for the main walls. The air/vapour barrier is 6 mil polyethylene routed on the exterior of the inner frame wall to protect it against damage during construction. All joints and penetrations in the polyethylene are caulked with acoustical sealant and stapled. Doors and windows are sealed using the "poly wrap" approach to provide a near-airtight seal. A sealed polyethylene air/vapour barrier is used for the ceiling with the drywall being installed prior to the partition walls. The basement uses a conventional insulation/framing system with extruded polystyrene sections sealed into the header spaces to form a continuous air/vapour barrier. A conventional 6 mil polyethylene vapour barrier is used on the basement walls. The houses meet the R-2000 Standard. Construction details are shown in Figures 15 and 16.

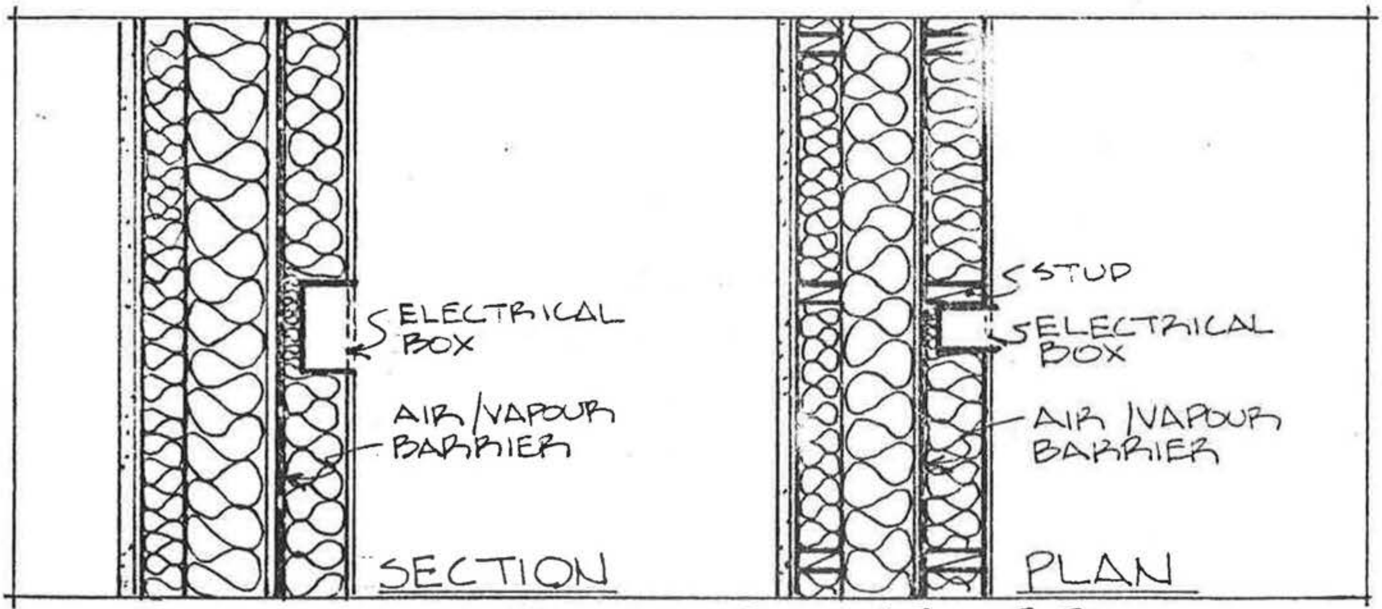
FIGURE 15



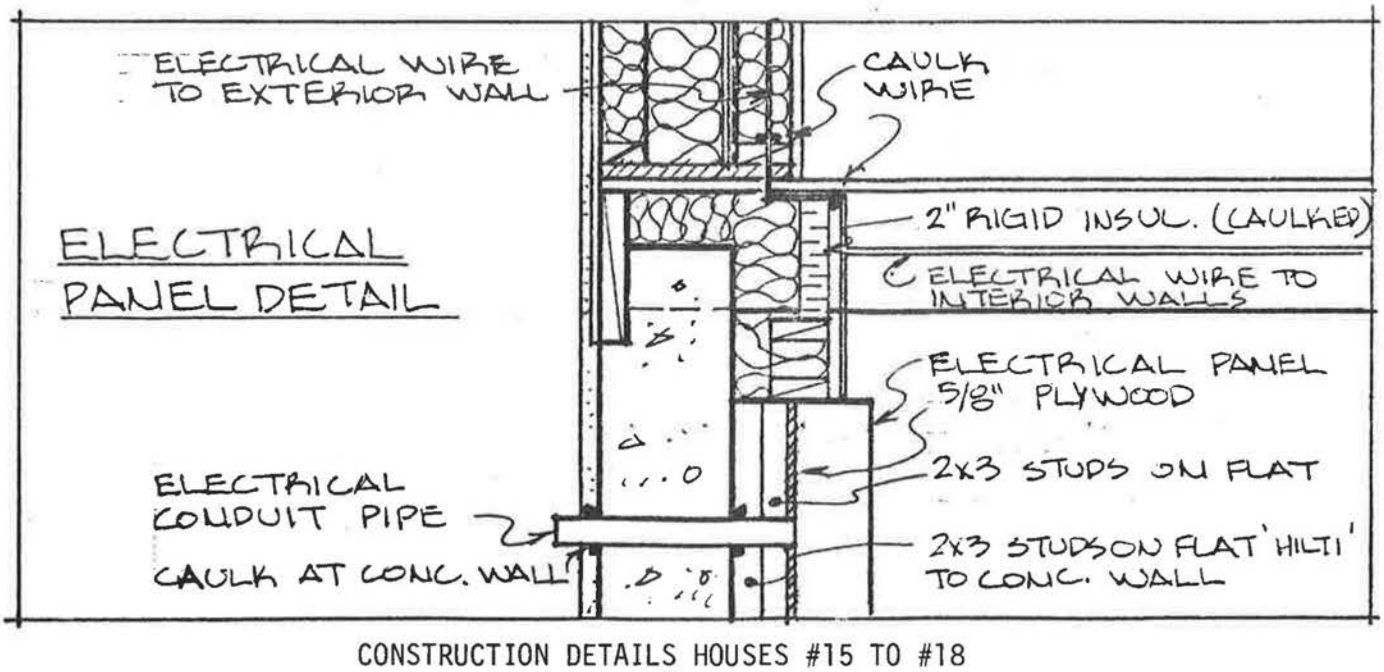
CROSS SECTION HOUSES #15 TO #18

FIGURE 16





ELECTRICAL WALL FIXTURE DETAIL



3.7 HOUSES #19 and #20

These houses are also constructed using the ADA system but with different gasket schedules than the other houses. Main wall construction consists of 38x89 (2x4) framing with 51 mm (2") of extruded polystyrene ("SM") used as an insulated sheathing. Basement wall construction uses both interior and exterior insulation schemes. On the exterior, 51 mm (2") of SM is used to form a continuous line with the main wall sheathing. On the interior, framing and RSI 2.11 (R-12.0) batts are used with a conventional polyethylene vapour barrier. The houses are built to the R-2000 Standard. Construction details are shown in Figures 17 and 18. The gasket and paint schedules are given below.

GASKET SCHEDULE

Type 1 - Polyethylene sill plate gasket
Type 2 - Ethafoam rod of appropriate diameter
Type 3 - Neoprene gasket with adhesive backing
Electrical Outlets - Poly pan boxes and foam cover gaskets

PAINT SCHEDULE

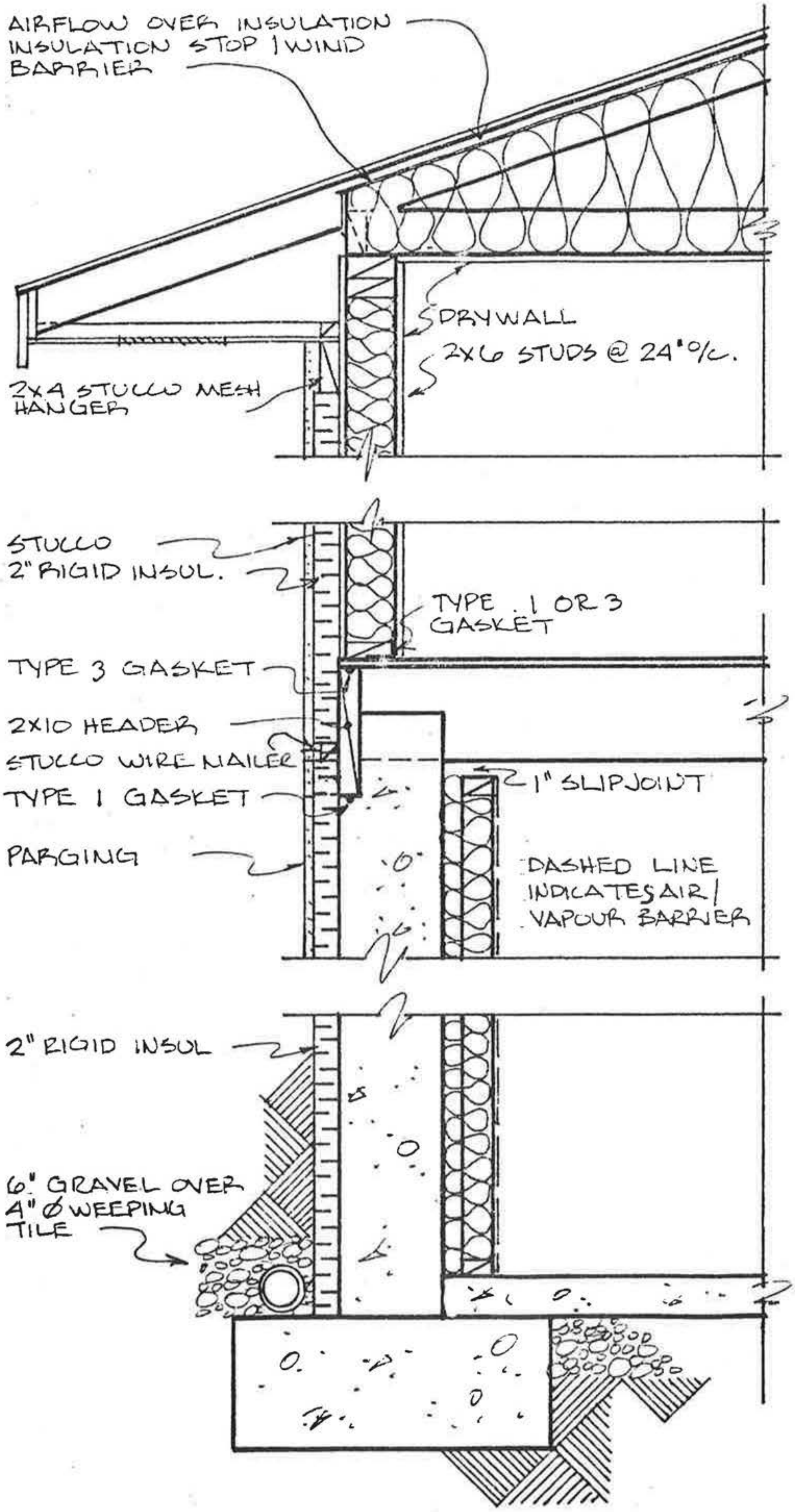
Walls

- Latex primer
- Oil base primer
- Latex finish coat

Ceiling

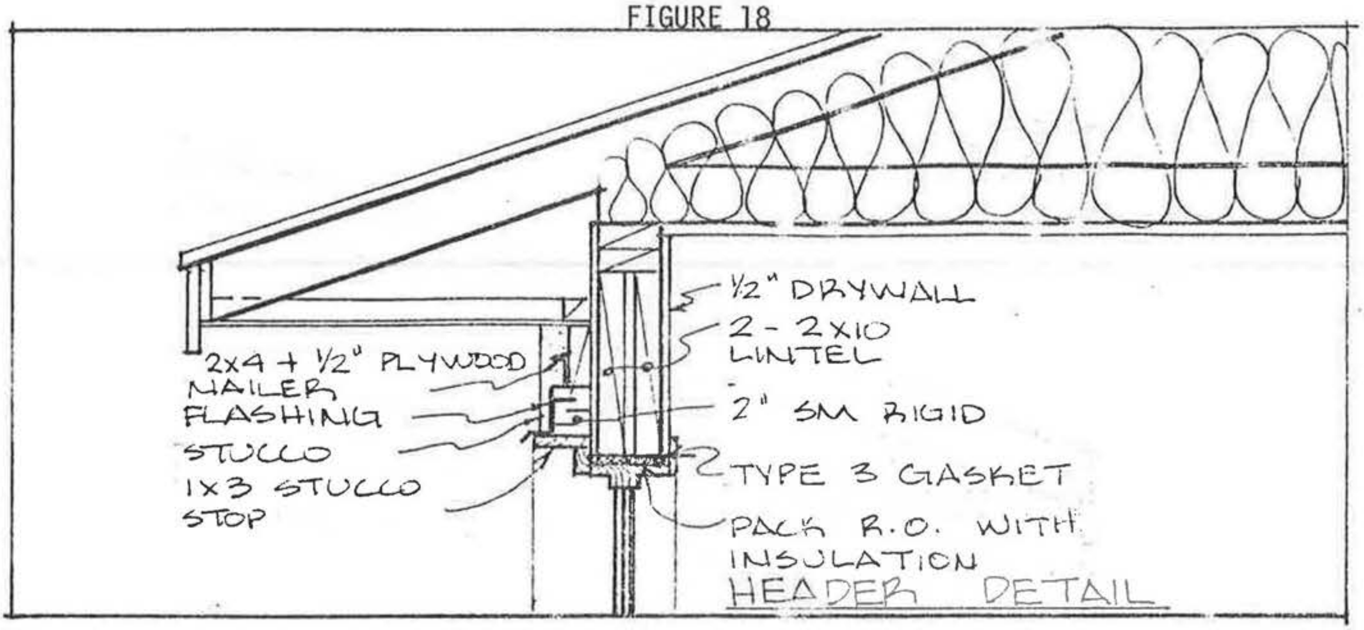
- Latex primer
- Oil base primer
- Texture finish coat

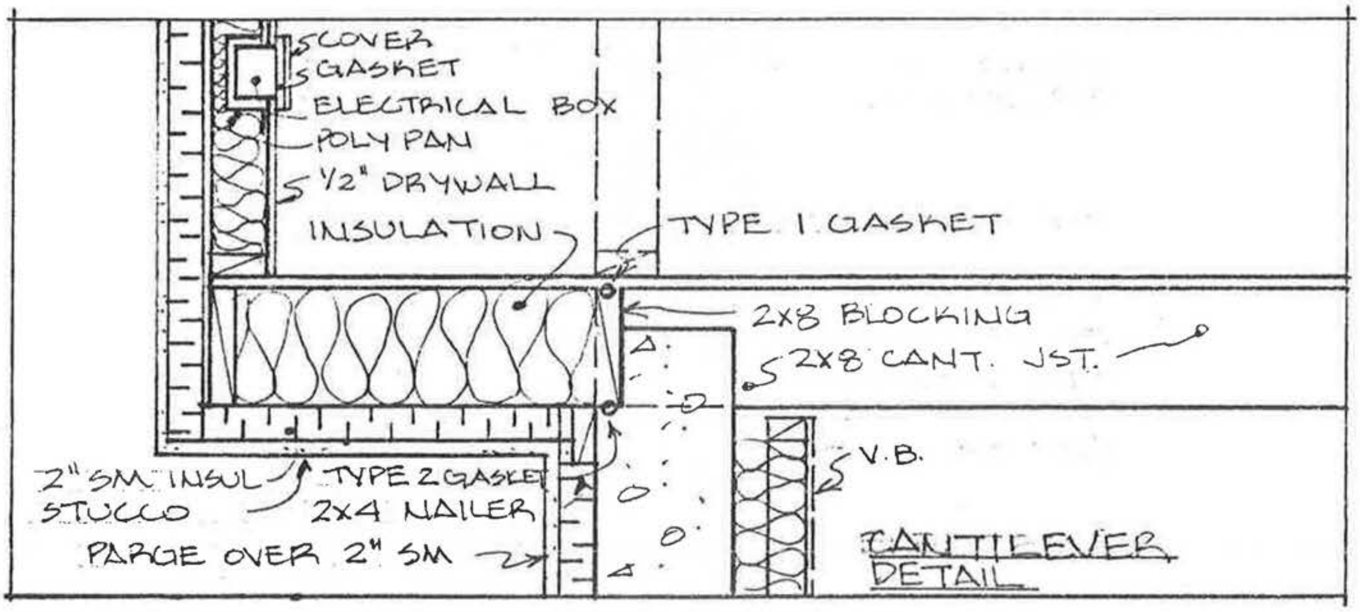
FIGURE 17

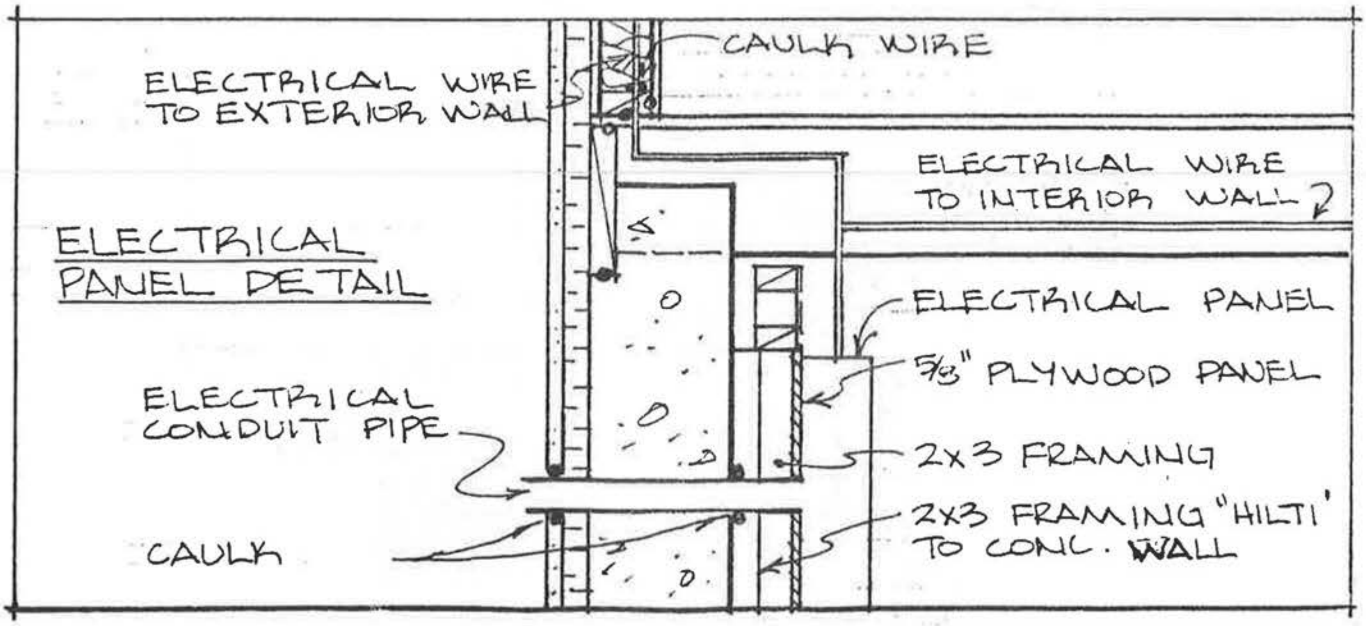


CROSS SECTION HOUSES #19 AND #20

FIGURE 18





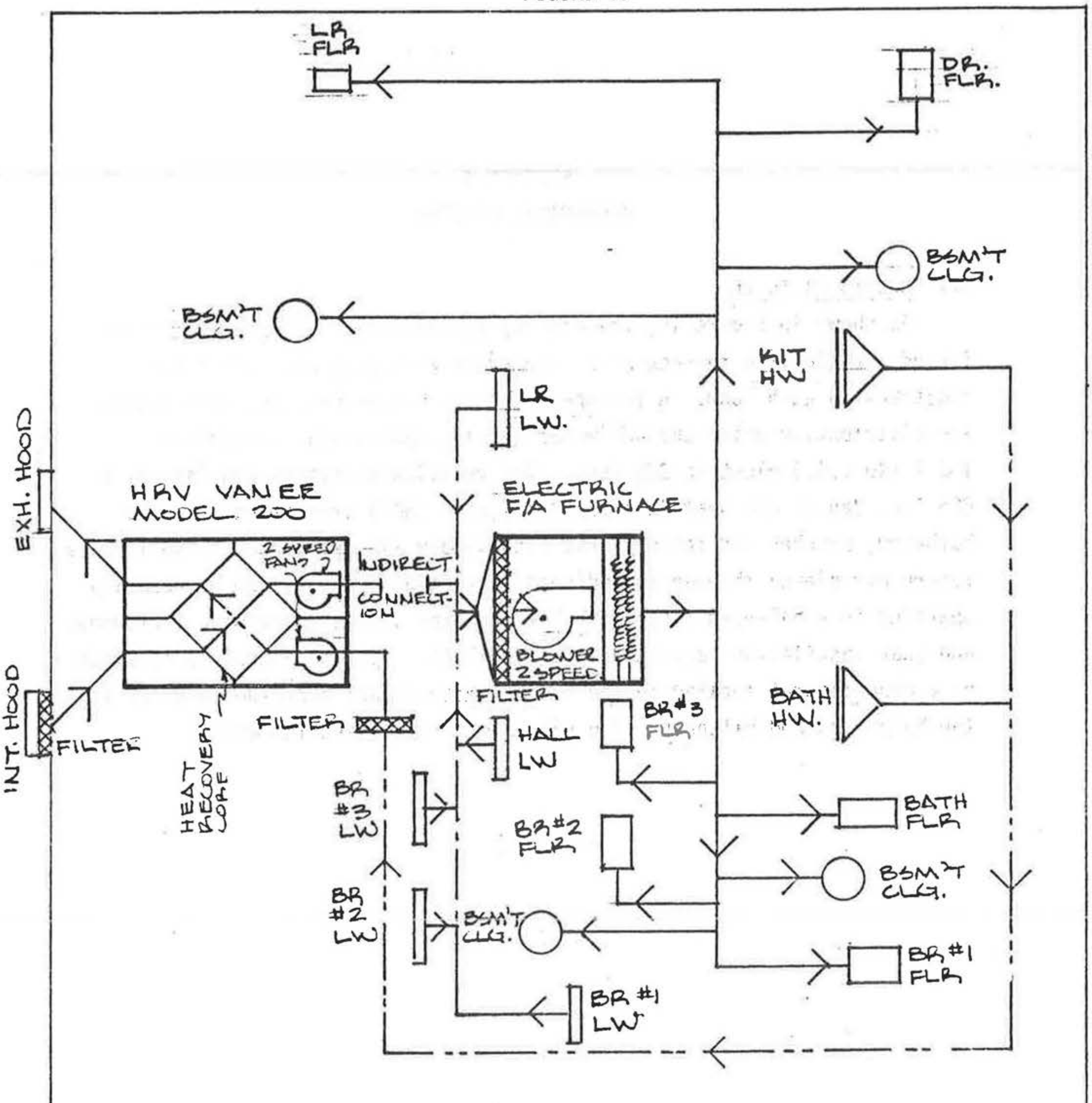


CONSTRUCTION DETAILS HOUSES #19 AND #20

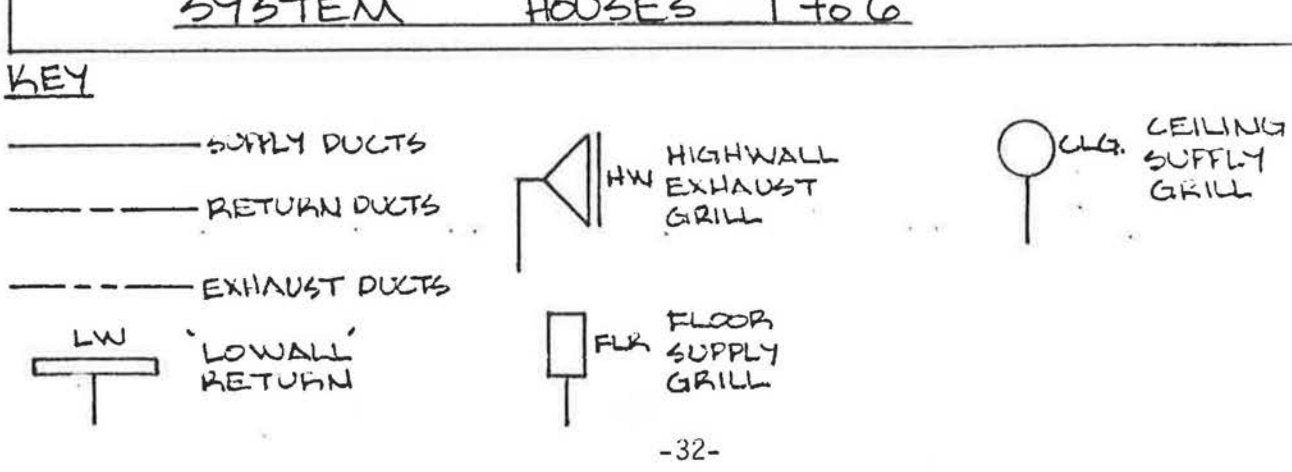
SECTION 4
MECHANICAL SYSTEMS

4.1 HOUSES #1 to #6

As shown in Figure 19, the heating system uses a conventional 10 kW forced air electric furnace with floor-mounted supply and return air registers in each room. A two-speed furnace blower provides ventilation air distribution while the hot water heating system uses a standard 182 l (40 I.G.) electric DHW tank. The ventilation system consists of a CES Inc. Van EE 200 Heat Recovery Ventilator (HRV) exhausting from the bathroom, kitchen and laundry area with supply air delivered to the furnace return air plenum through an indirect connection. The system is normally operated in a balanced state with low and high speeds to provide continuous and peak ventilation respectively. Ventilation system control is provided by a dehumidistat located in the hallway with manual override switches in the bathrooms and kitchens. The HRV is a first-generation unit.



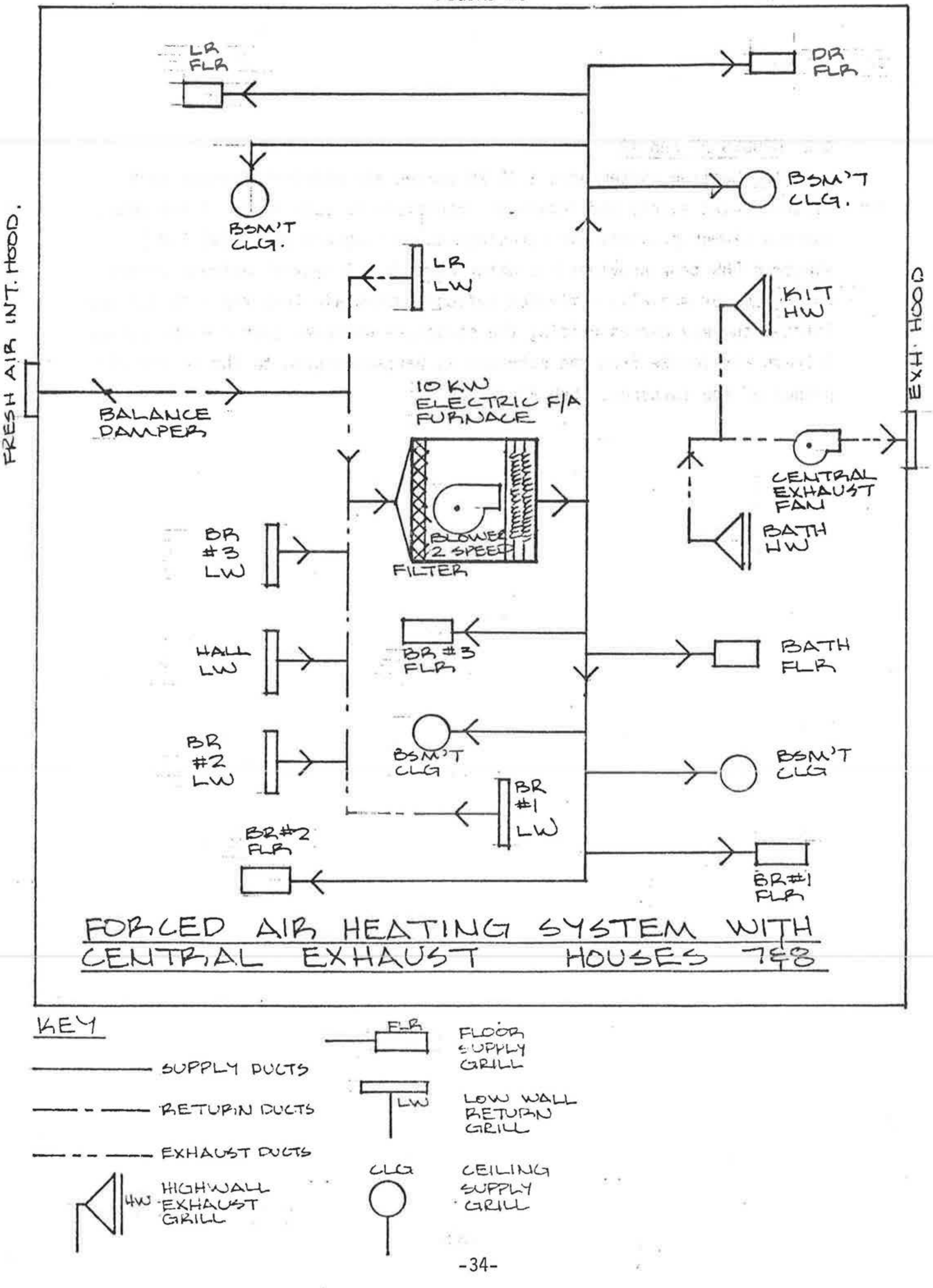
COMBINED HRV/FORCED AIR HEATING SYSTEM HOUSES 1 to 6



4.2 HOUSES #7 and #8

The heating system uses a 10 kW forced air electric furnace with floor-mounted supply and return air registers in each room. A two-speed furnace blower provides air circulation. A standard 182 l (40 I.G.) electric DHW tank provides hot water heating. A central exhaust system controlled by manually activated switches draws air from the bathroom and kitchen thereby depressurizing the structure whenever they are operating. A fresh air intake from the outdoors is hard-connected to the return air plenum of the furnaces. See Figure 20.

FIGURE 20

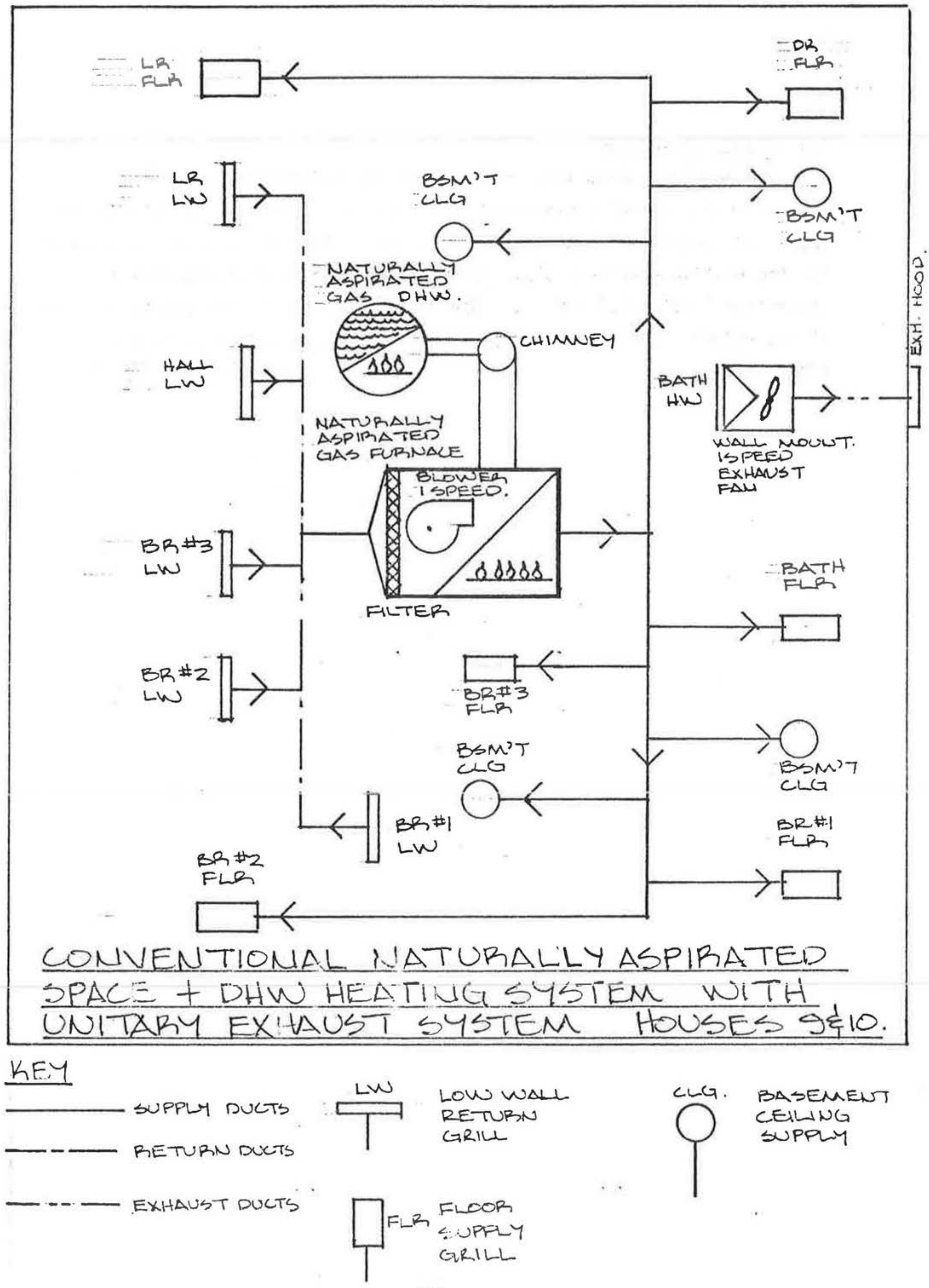


LR FLR
DR FLR
BSM'T CLG.
BSM'T CLG.
LR LW
KIT HW
FRESH AIR INT. HOOD.
EXH. HOOD
10 KW ELECTRIC F/A FURNACE
BALANCE DAMPER
CENTRAL EXHAUST FAN
BLOWER 2 SPEED
FILTER
BR #3 LW
BATH HW
HALL LW
BR #3 FLR
BATH FLR
BR #2 LW
BSM'T CLG
BSM'T CLG
BR #1 LW
BR#2 FLR
BR#1 FLR
FORCED AIR HEATING SYSTEM WITH CENTRAL EXHAUST HOUSES 7&8
KEY
SUPPLY DUCTS
RETURN DUCTS
EXHAUST DUCTS
FLR
FLOOR SUPPLY GRILL
LW
LOW WALL RETURN GRILL
CLG
CEILING SUPPLY GRILL
HW
HIGHWALL EXHAUST GRILL

4.3 HOUSES #9 and #10

The heating system used in Houses #9 and #10 consists of a conventional, naturally aspirated forced air gas furnace with floor-mounted supply and return air registers in each room. Nominal seasonal efficiency for the heating system is 60%. Hot water heating is provided with a conventional 114 l (25 I.G.) gas DHW tank. The ventilation system consists of individual bathroom exhaust fans; no fresh air intake is provided. See Figure 21.

FIGURE 21


LR FLR
DR FLR
LR LW
BSM'T CLG
BSM'T CLG
NATURALLY ASPIRATED GAS DHW.
CHIMNEY
EXH. HOOD
HALL LW
BATH HW
NATURALLY ASPIRATED GAS FURNACE
WALL MOUNT. 1 SPEED EXHAUST FAN
BLOWER 1 SPEED.
BR#3 LW
BATH FLR
FILTER
BR#2 LW
BR#3 FLR
BSM'T CLG
BSM'T CLG
BR#1 LW
BR#1 FLR
BR#2 FLR
CONVENTIONAL NATURALLY ASPIRATED
SPACE + DHW HEATING SYSTEM WITH
UNITARY EXHAUST SYSTEM HOUSES 9&10.
KEY
SUPPLY DUCTS
RETURN DUCTS
EXHAUST DUCTS
LW
LOW WALL RETURN GRILL
CLG.
BASEMENT CEILING SUPPLY
FLR
FLOOR SUPPLY GRILL

4.4 HOUSES #11 and #12

Houses #11 and #12 use the "Habitair" system manufactured by Fiberglas Canada Inc. which is part of the FCI Low Energy House System. As shown in Figure 22, the Habitair is an integrated HRV system which provides unbalanced, exhaust-only ventilation, supplementary space heating, DHW heating and a degree of air conditioning. Ventilation air is provided by air leakage through the envelope. Space heating is provided by conventional electric baseboards sized to meet the full design load.

4.4.1 System Description

The Habitair system consists of a Heat Recovery Module (HRM) containing a heat pump, a DHW tank and an exhaust fan, and an Air Distribution Module (ADM) containing a hot water coil, a recirculation fan, and a ductwork crossover mechanism. The Habitair ductwork is used for recirculation and exhaust air. The exhaust fan has four, manually adjusted speed settings and continuously draws air from the bathroom and kitchen. A booster fan in the bathroom, controlled by a wall switch, increases the exhaust rate when necessary.

4.4.2 System Operation - Winter or Heating Mode

A manual changeover lever on the ADM converts the system from cooling to heating mode. The exhaust fan in the HRM continuously draws stale air from the bathroom and kitchen, and passes it over the heat pump evaporator before exhausting it. The heat pump extracts heat from the exhaust air stream and dumps this heat into the bottom of an integral DHW tank via the heat pump condensor. The recirculation fan draws air from the living room and the bedrooms, passes the air over the hot water coil and returns it to the front entrance of the house. If there is a demand for space heating, as sensed by the first stage of the living room two-stage heating thermostat, and the DHW is above a pre-set temperature, water is circulated from the DHW tank to the hot water coil in the ADM. If there is no heat available, or if the heat available from the DHW is insufficient to meet the heating load, the zone temperature will fall below the second stage set point and baseboard heaters in the living room will be activated to satisfy

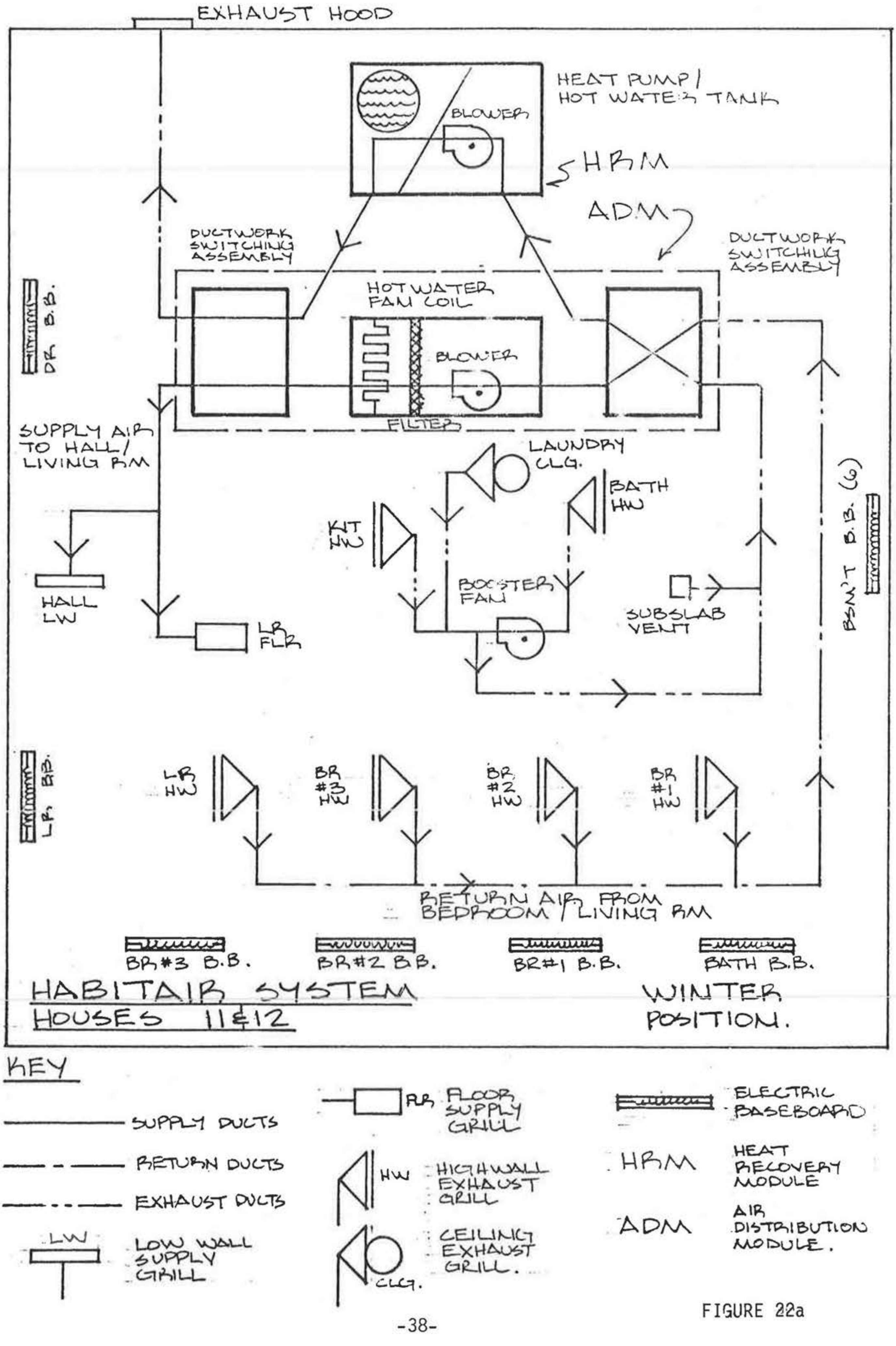

EXHAUST HOOD
HEAT PUMP/
HOT WATER TANK
BLOWER
HRM
ADM
DUCTWORK
SWITCHING
ASSEMBLY
DUCTWORK
SWITCHING
ASSEMBLY
HOT WATER
FAN COIL
BLOWER
FILTERS
DR. B.B.
SUPPLY AIR
TO HALL/
LIVING RM
LAUNDRY
CLG.
BATH
HW
KIT
HW
BOOSTER
FAN
SUBSLAB
VENT
BSM'T B.B. (6)
HALL
LW
LR
FLR
LR, B.B.
LR
HW
BR
#3
HW
BR
#2
HW
BR
#1
HW
RETURN AIR FROM
BEDROOM/LIVING RM
BR#3 B.B.
BR#2 B.B.
BR#1 B.B.
BATH B.B.
HABITAIR SYSTEM
HOUSES 11&12
WINTER
POSITION.
KEY
SUPPLY DUCTS
RETURN DUCTS
EXHAUST DUCTS
LW
LOW WALL
SUPPLY
GRILL
FLR
FLOOR
SUPPLY
GRILL
HW
HIGHWALL
EXHAUST
GRILL
CLG.
CEILING
EXHAUST
GRILL.
ELECTRIC
BASEBOARD
HRM
HEAT
RECOVERY
MODULE
ADM
AIR
DISTRIBUTION
MODULE.

FIGURE 22a

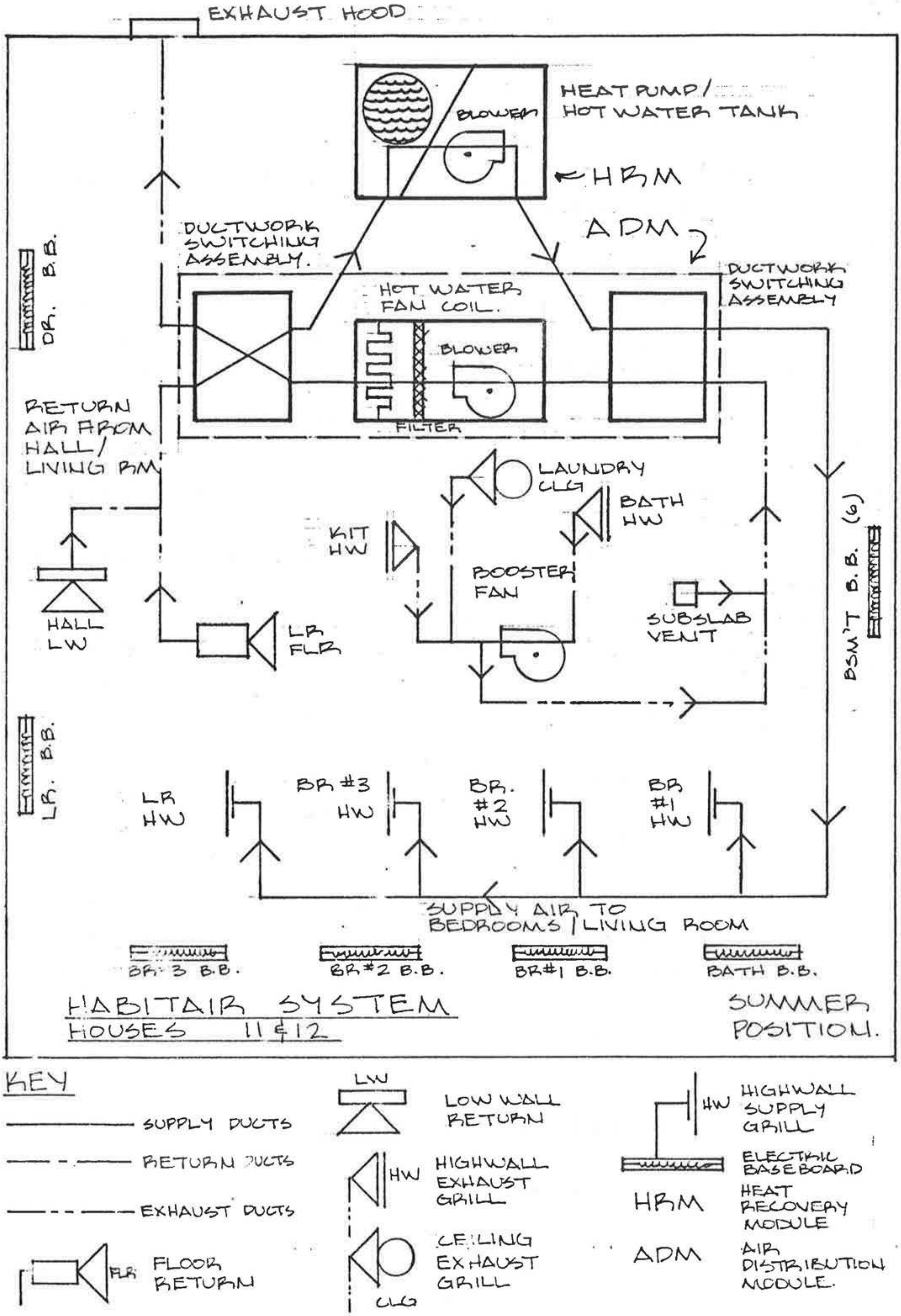

EXHAUST HOOD
HEAT PUMP / HOT WATER TANK
BLOWER
HRM
ADM
DUCTWORK SWITCHING ASSEMBLY.
DUCTWORK SWITCHING ASSEMBLY
HOT WATER FAN COIL.
BLOWER
FILTER
DR. B.B.
RETURN AIR FROM HALL / LIVING RM
LAUNDRY CLG
BATH HW
KIT HW
BOOSTER FAN
SUBSLAB VENT
BSM'T B.B. (6)
HALL LW
LR FLR
LR. B.B.
LR HW
BR #3 HW
BR. #2 HW
BR #1 HW
SUPPLY AIR TO BEDROOMS / LIVING ROOM
BR. 3 B.B.
BR#2 B.B.
BR#1 B.B.
BATH B.B.
HABITAIR SYSTEM
HOUSES 11 & 12
SUMMER POSITION.
KEY
SUPPLY DUCTS
RETURN DUCTS
EXHAUST DUCTS
FLR FLOOR RETURN
LW LOW WALL RETURN
HW HIGHWALL EXHAUST GRILL
CLG CEILING EXHAUST GRILL
HW HIGHWALL SUPPLY GRILL
ELECTRIC BASEBOARD
HRM HEAT RECOVERY MODULE
ADM AIR DISTRIBUTION MODULE

FIGURE 22b

the heating demands. If there is a demand for cooling, the Habitair will operate in the heating mode during winter operation.

4.4.3 Summer Operation - Summer or Cooling Mode

In the summer, air flow paths are altered by the manual changeover mechanism on the ADM. The exhaust air is routed over the hot water coil in the ADM and recirculation air passes through the HRM. The direction of recirculation air in the ductwork is reversed with conditioned air being supplied to each room and return air being taken from the grille located in the front door well. Again both fans run continuously.

The heat pump is operated by a demand for DHW or by a demand for space cooling as sensed by the cooling stage of the living room thermostat. If there is a demand for cooling, and the temperature of the DHW rises above the DHW "high" limit temperature, the DHW circulation pump is activated and excess heat in the DHW tank is dumped to the exhaust air stream by circulating DHW through the fan coil. If there is a demand for DHW heating, house air is cooled, even though there is no demand for cooling. This may cause the baseboard heating to be activated.

4.4.4 Domestic Hot Water

Domestic water heating is routinely provided by the heat pump condensor coil located in the bottom of the DHW tank in the HRM. In the heating season, the heat pump will operate whenever there is a demand for DHW. Should the demand for DHW heating exceed the heat supply from the heat pump, and the temperature in the DHW tank falls below the set point of a second thermostat, the second thermostat activates two 750 watt electric heaters in the tank. In the summer, the heat pump is activated by either a demand for DHW heating or a demand for space cooling. Excess heat in the DHW tank is dumped via the hot water coil in the ADM to the exhaust air stream before it leaves the house. Auxiliary DHW heating is provided, as required, by the in-tank electric heaters. (A conventional, 114 l (25 I.G.) electric DHW tank is also used in the project houses to enable the energy performance of the system to be more accurately monitored.)

4.5 HOUSES #13 and #14

Space heating in houses #13 and #14 is provided by a 10 kW forced air electric furnace. The ventilation system uses a CES Van EE 2000 HRV which draws exhaust air from the bathroom, kitchen and laundry area and provides supply air to the return air plenum of the furnace through an indirect connection. Hot water heating is provided with conventional 182 l (40 I.G.) electric DHW tank. The ventilation system is normally operated in a balanced state with low and high speeds to provide continuous and peak ventilation respectively. Distribution of the ventilation air is provided through continuous operation of the furnace blower. Supply and return air registers are located in each zone of the house. With the exception of a single floor-mounted register in the living room (under the windows), only high-sidewall supply air registers are used. Ventilation system control is provided by a dehumidistat and manually activated override switches. The HRV is a second generation unit. See Figure 23.

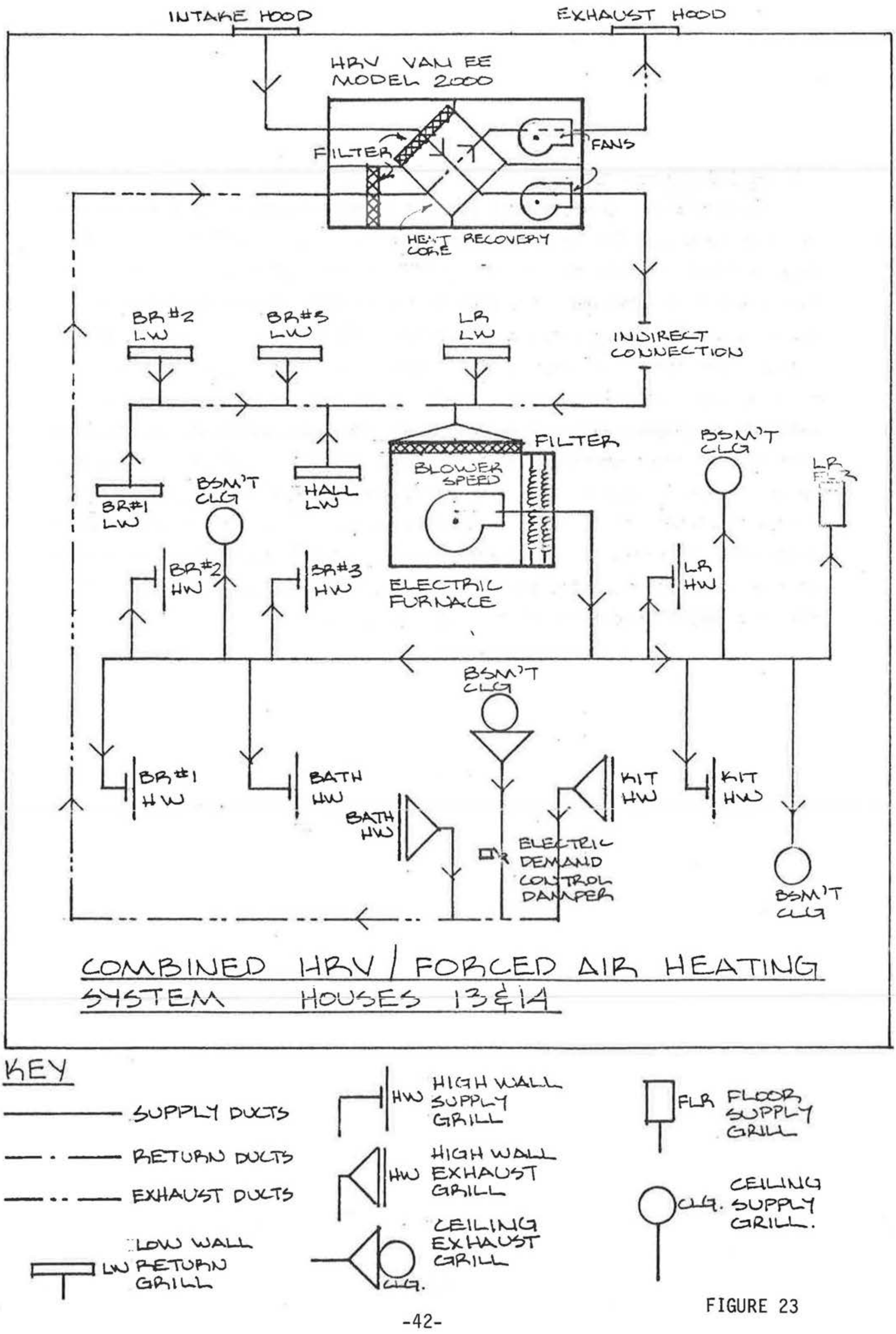

INTAKE HOOD
EXHAUST HOOD
HRV VAN EE
MODEL 2000
FILTER
FANS
HEAT RECOVERY CORE
BR#2 LW
BR#3 LW
LR LW
INDIRECT CONNECTION
FILTER
BLOWER SPEED
BSM'T CLG
LR FLR
BR#1 LW
BSM'T CLG
HALL LW
BR#2 HW
BR#3 HW
ELECTRIC FURNACE
LR HW
BSM'T CLG
BR#1 HW
BATH HW
BATH HW
KIT HW
KIT HW
ELECTRIC DEMAND CONTROL DAMPER
BSM'T CLG
COMBINED HRV / FORCED AIR HEATING SYSTEM HOUSES 13&14
KEY
SUPPLY DUCTS
RETURN DUCTS
EXHAUST DUCTS
LW LOW WALL RETURN GRILL
HW HIGH WALL SUPPLY GRILL
HW HIGH WALL EXHAUST GRILL
CLG. CEILING EXHAUST GRILL
FLR FLOOR SUPPLY GRILL
CLG. CEILING SUPPLY GRILL.

FIGURE 23

4.6 HOUSES #15 and #16

These houses use an integrated system in which all the functions of each house's mechanical system are combined into one unit. The heart of the system is the Peach multi-source heat pump HRV which is a first generation, integrated HRV.

4.6.1 Peach PPHC12/45 Description

As shown in Figure 24, the Peach has an outdoor air loop, an indoor recirculation air loop, and a domestic hot water circulation loop. In addition to the one ton heat pump, the Peach has an integrated 16 kw electric forced air furnace (8 kw have been disconnected in the project houses). Fresh air is admitted from an outdoor air loop through an internal damper into the recirculation air loop. A second internal damper exhausts some of the indoor recirculation air into the outdoor air loop. The manufacturer states that by opening the inlet and exhaust dampers equally, air flows are balanced, and each inch the dampers are opened serves to increase the exhaust/supply air flow by 10% of the total air flow in the unit. Damper adjustment is done manually at the time of commissioning. The recirculation fan operates continuously. Recirculation air is supplied to each zone in the house through high-sidewall grilles and is returned from each room in the house through baseboard return air grilles.

4.6.2 Exhaust System

To provide peak exhaust capacity, a separate exhaust system is required. This is provided by manually switched fans which draw from the bathroom and laundry room. A dehumidistat in the main floor hallway beside the thermostat runs this exhaust fan whenever humidity levels exceed the set point.

Kitchen exhaust is provided by a kitchen range hood exhaust fan. This is ducted down and out through the basement wall. This fan is controlled by a manual switch on the range hood.

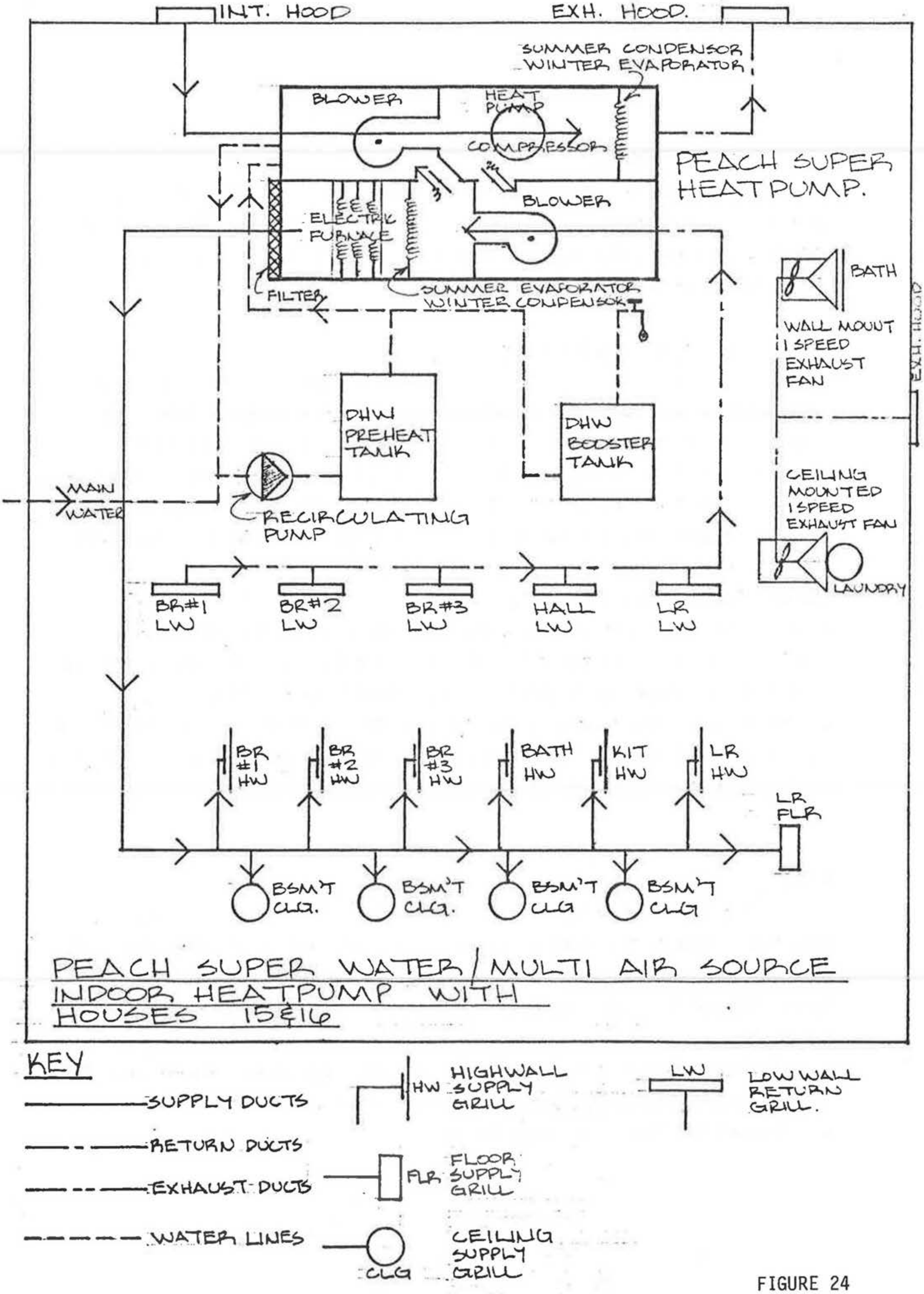

INT. HOOD
EXH. HOOD.
SUMMER CONDENSOR
WINTER EVAPORATOR
BLOWER
HEAT PUMP
COMPRESSOR
PEACH SUPER HEATPUMP.
BLOWER
ELECTRIC FURNACE
FILTER
SUMMER EVAPORATOR
WINTER CONDENSOR
BATH
WALL MOUNT 1 SPEED EXHAUST FAN
EXH. HOOD
DHW PREHEAT TANK
DHW BOOSTER TANK
MAIN WATER
RECIRCULATING PUMP
CEILING MOUNTED 1 SPEED EXHAUST FAN
LAUNDRY
BR#1 LW
BR#2 LW
BR#3 LW
HALL LW
LR LW
BR #1 HW
BR #2 HW
BR #3 HW
BATH HW
KIT HW
LR HW
LR FLR
BSM'T CLG.
BSM'T CLG.
BSM'T CLG
BSM'T CLG
PEACH SUPER WATER/MULTI AIR SOURCE
INDOOR HEATPUMP WITH
HOUSES 15&16
KEY
SUPPLY DUCTS
RETURN DUCTS
EXHAUST DUCTS
WATER LINES
HW
HIGHWALL SUPPLY GRILL
LW
LOW WALL RETURN GRILL.
FLR
FLOOR SUPPLY GRILL
CLG
CEILING SUPPLY GRILL

FIGURE 24

4.6.3 System Operation - Heating Mode

The heat pump extracts heat from the outdoor air stream and adds it to the indoor recirculation air stream. The electric furnace reheats the recirculation air, as required, to meet the space heating load. A Honeywell T 6031 controller which senses outdoor air temperatures interrupts the compressor power supply at outdoor air temperatures below -12°C (10°F).

When the first stage of the thermostat calls for heating, the two blowers in the Peach are switched to high speed until the heating demand has been satisfied. Then the recirculation blower reverts to low speed and the heat pump compressor and outdoor air loop blower turn off. If there is a demand for DHW heating, the heat pump will operate to satisfy this demand. (At low outdoor air temperatures, the heat pump power supply is interrupted, but the outdoor air loop blower still runs on a demand for heat).

If the heat pump is unable to meet the heating requirements, and room temperature falls 1°C below the first stage set point, the second stage of thermostat activates the electric furnace until the room temperature returns to the second stage thermostat set point.

4.6.4 System Operation - Cooling Mode

The heat pump is automatically reversed when cooling is demanded. The heat pump extracts heat from the air flowing in the indoor recirculation air loop and dumps it into the DHW and the outdoor air loop airstream. Cooling is supplied on a demand from the thermostat located on the main floor. When there is a call for cooling, the two blowers are switched to high speed and the compressor starts in the cooling mode. When the demand for cooling is satisfied, the recirculation blower returns to low speed and the compressor and outdoor air loop blower are turned off.

4.6.5 DHW Heating

A two tank DHW system is used in conjunction with the Peach, a 182 l (40 I.G.) gallon preheating tank and a 114 l (25 I.G.) booster tank. Water from the top of the preheating tank is circulated to the Peach, where it is heated by the heat pump condenser, and is then returned to the bottom of the preheat tank. A thermostatic control in bottom of the preheat tank, set at 50°C (122°F), closes a switch to start the circulation pump when the preheat tank temperature falls below the set point. This switch also activates the heat pump, if it is not already operating. A second thermostatic control located in the top of the DHW tank, set at 35°C (95°F) will activate electric heating elements should the tank temperature fall below this temperature. When there is a demand for DHW, preheated water is taken from the top of the preheat tank and supplied to the booster tank. Makeup mains water enters the bottom of the preheat tank.

4.6.6 Control Functions

The laundry exhaust fan is started by the humidistat on the main floor or the wall switch in the laundry room. The range hood is manually switched at the hood. The bathroom exhaust fan is manually controlled by a wall switch in the bathroom.

A Honeywell T 6031 outdoor air sensor (in the outdoor air loop) cuts power to the heat pump when the outdoor air temperature falls below 10°F (-12°C). The deadband on this control is 5°C (9°F).

A two stage thermostat on the main floor calls for the heat pump to satisfy heating demand when the first stage closes. The second stage activates the integral electric furnace. The thermostat also has a cooling stat which reverses heat pump operation and starts it as an air conditioning unit.

4.7 HOUSES #17 and #18

A conventional electric baseboard heating system with individual room thermostats is used for Houses #17 and #18. The ventilation system consists of a Nilan heat pump HRV with a dedicated ductwork system to provide distribution of the ventilation air to each zone of the house. Air is exhausted from the kitchen and bathroom. Ventilation air is provided to the living areas through high-sidewall grilles. The range hood is a recirculating type. See Figure 25.

The Nilan functions similar to a conventional air-to-air HRV, except that a heat pump is used to transfer heat instead of a heat exchanger core. Therefore, it can heat the supply air above the exhaust air temperature. The unit's two blowers normally run on low speed. On demand for increased ventilation (manual switch or dehumidistat) both fans are switched to high speed. The Nilan heat pump operates in heating mode only, that is to say it is not reversible for air conditioning. This unit is designed for European power, but will function satisfactorily on 240 VAC 60 cycle single phase power.

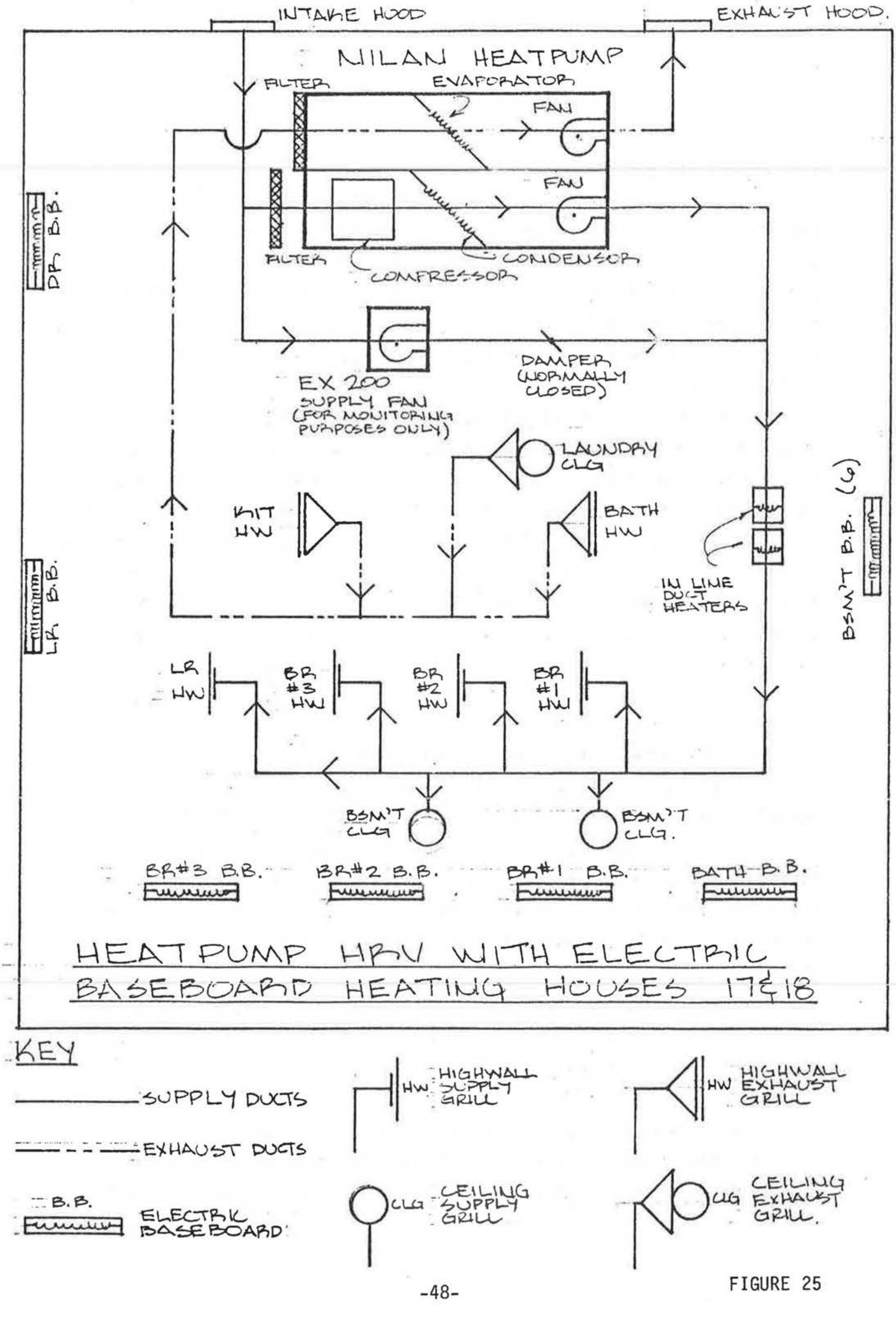
4.7.1 System Operation - Heating Mode

The Nilan compressor is controlled by the first stage of a two stage heating thermostat. The ventilation blowers are controlled by the dehumidistat. On demand for heating, a relay operated by the first stage of the thermostat starts the heat pump. If the heat pump is unable to satisfy the heating demand, and the room temperature falls below the second stage set point of the thermostat, the second stage relay supplies power to the baseboard heaters. Duct heaters downstream of the Nilan ensure that cold air (below 5°C) is not supplied to the living space.

The control system shuts down both the supply and exhaust fans when the heat pump is in the defrost mode. Defrosting uses hot gas and is reported to be complete in 1 to 3 minutes.

4.7.2 System Operation - Cooling Mode

The thermostat is set back so the heat pump compressor will not operate in the summer mode (high temperatures could cause an overpressure



INTAKE HOOD
EXHAUST HOOD.
NILAN HEATPUMP
FILTER
EVAPORATOR
FAN
FAN
FILTER
CONDENSOR
COMPRESSOR
DR. B.B.
EX 200
SUPPLY FAN
(FOR MONITORING PURPOSES ONLY)
DAMPER (NORMALLY CLOSED)
LAUNDRY CLG
KIT HW
BATH HW
IN LINE DUCT HEATERS
BSM'T B.B. (6)
LR. B.B.
LR HW
BR #3 HW
BR #2 HW
BR #1 HW
BSM'T CLG
BSM'T CLG.
BR#3 B.B.
BR#2 B.B.
BR#1 B.B.
BATH B.B.
HEATPUMP HRV WITH ELECTRIC BASEBOARD HEATING HOUSES 17&18
KEY
SUPPLY DUCTS
EXHAUST DUCTS
B.B.
ELECTRIC BASEBOARD
HW HIGHWALL SUPPLY GRILL
HW HIGHWALL EXHAUST GRILL
CLG CEILING SUPPLY GRILL
CLG CEILING EXHAUST GRILL.

FIGURE 25

condition in the heat pump causing it to cut out and cycle). The blowers operate as normal supply and exhaust ventilation fans, switched to high on demand by the humidistat or manual switches.

4.7.3 <u>Control Functions</u>

Dehumidistat or manual switches in the kitchen, laundry or bathroom change blower speed from low to high as additional air movement is desired or required. A two-stage thermostat is used - the first stage starts the Nilan heat pump while the second stage supplies power to the room thermostats for the baseboard heaters on the main floor.

4.8 HOUSES #19 and #20

A conventional electric baseboard heating system with individual room thermostats is used in Houses #19 and #20. The ventilation system consists of a CES Van EE 2000 HRV with a dedicated ductwork system to provide distribution of the ventilation air to each zone of the house. Exhaust air is taken from the bathroom, kitchen and laundry area by the HRV. The system is operated in a balanced mode with low and high speeds to provide continuous and peak ventilation respectively. The HRV is a second generation unit. The supply air ductwork is sized to meet the ventilation load and is therefore dimensionally smaller than that for forced air heating systems. High-sidewall registers are used for the ventilation air. System control is provided by a dehumidistat and manually activated override switches. Hot water heating is provided by conventional 182 l (40 I.G.) electric DHW tank. See Figure 26.

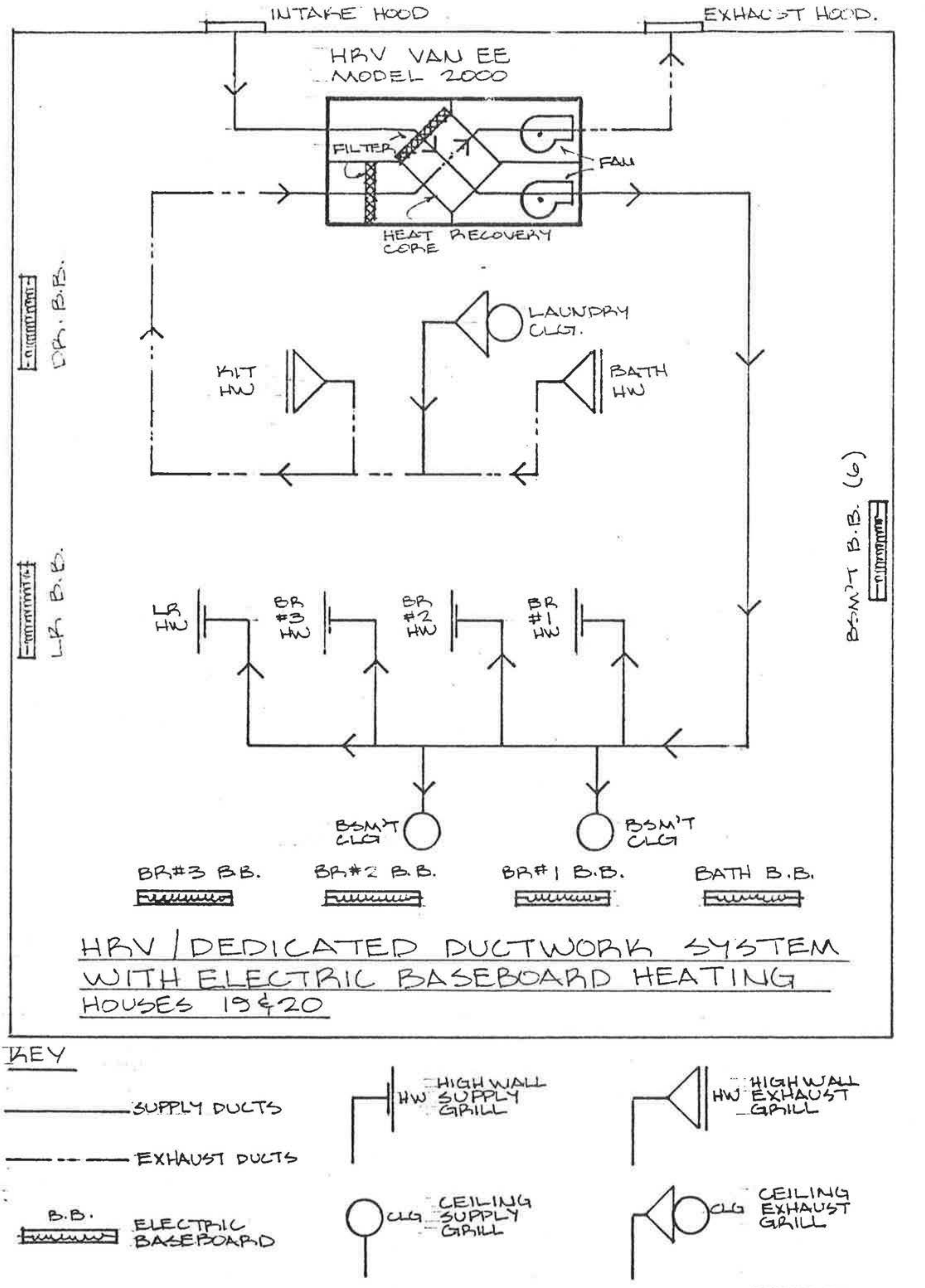

INTAKE HOOD
EXHAUST HOOD.
HRV VAN EE
MODEL 2000
FILTER
FAN
HEAT RECOVERY
CORE
DR. B.B.
LAUNDRY
CLG.
KIT
HW
BATH
HW
BSM'T B.B. (6)
LR. B.B.
LR
HW
BR
#3
HW
BR
#2
HW
BR
#1
HW
BSM'T
CLG
BSM'T
CLG
BR#3 B.B.
BR#2 B.B.
BR#1 B.B.
BATH B.B.
HRV / DEDICATED DUCTWORK SYSTEM
WITH ELECTRIC BASEBOARD HEATING
HOUSES 19 & 20
KEY
SUPPLY DUCTS
EXHAUST DUCTS
B.B.
ELECTRIC
BASEBOARD
HW
HIGH WALL
SUPPLY
GRILL
HW
HIGH WALL
EXHAUST
GRILL
CLG
CEILING
SUPPLY
GRILL
CLG
CEILING
EXHAUST
GRILL

FIGURE 26