Hornby Island Volunteer Fire Department
3850 Central Road
Hornby Island, B.C.
V0R 1ZO

PRELIMINARY SEISMIC REVIEW EXISTING FIREHALL BUILDING

Prepared by,
Ron McMurtrie, P.Eng.

November 7, 2000

CONSULTING ENGINEERS

RON McMURTRIE

5225 JEROW ROAD, HORNBY ISLAND, B.C. V0R 1Z0 (250) 335-1192 email: jasbreez@island.net

November 7, 2000

Hornby Island Fire Department
3850 Central Road
Hornby Island, BC
V0R 1Z0

ATTENTION: MR. GIFFORD LA ROSE, FIRE CHIEF
RE: SEISMIC ASSESSMENT OF FIREHALL BUILDING

Dear Sir:

Attached is my report on the structural assessment of the firehall building with regards to seismic (earthquake) loading as per the requirements of the 1998 B.C. Building Code.

The first part of the report Sections 1 to 4 outline the findings of my investigation and preliminary seismic analysis and conclude with recommendations for possible courses of action. My basic conclusion is that to attempt to upgrade the existing building to the full requirements of the building code would not be feasible from a practical and economic standpoint. This then leaves the following options: 1. Construct a new building; 2. Demolish and rebuild the building and ; 3. Improve the seismic performance of the existing building. Preliminary costs for options 1 and 2 are included in the report. The development of cost estimates for option 3 however is a more complex issue. This will require a more detailed cost benefit analysis and further investigations.

I would be pleased to meet with the firehall committee and HIRRA executive to go over the findings of my study and discuss the possible options in more detail.

Please call me at your convenience to discuss this further.

Yours truly,

Ron McMurtrie, P.Eng.

CONSULTING ENGINEERS
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1. INTRODUCTION

As part of Provincial Emergency Preparedness program (P.E.P.) the Hornby Island Residents and Ratepayers Association (HIRRA) want to have a seismic evaluation done on the firehall building. Buildings such as fire stations, police stations and hospitals are defined in the 1998 B.C. Building Code as "Post Disaster Buildings". These buildings are considered essential to provide services in the event of a disaster.

This evaluation is considered to be a preliminary review. It assesses the existing structure under earthquake loading as defined in Part 4 of the 1998 B.C. Building Code. The expected performance of the building and upgrade requirements are described in Section 3 of the report. Recommendations regarding options for courses of action are made in Section 4.

The existing firehall building is a structure of mixed construction (concrete masonry block and wood frame) that has been built over a period of several years in what appears to be three phases or sections. Phase I constructed in the early 1970's consists of #1 Bay, #2 Bay and the entrance wing and the second floor consisting of office and meeting/recreation rooms. Phase II consists of #3 Bay and Phase III consists of #4 Bay. The building was constructed using mainly community volunteer labour and some donated materials.

It is understood that the building was not originally built to any earthquake design codes or standards. However some seismic upgrading was applied to the main floor of the Phase I building area. Unfortunately no drawings or records are available which detail this work.

2. BUILDING SURVEY

A visual survey of the building was carried out on October 3, 2000. The purpose of the survey was to identify the lateral load resisting systems of the building and to gather information regarding construction materials and details. It was not possible to inspect many items such as reinforcing of masonry and concrete, fasteners and connection details (due to concealment by wall sheathing and finishes) However much can be deduced or inferred through examples of connection details in visible areas, general construction practices used in the building and the age of the structure. Some measurements were made to verify the dimensions shown on the existing plans and to verify member sizes etc. Masonry walls were "tapped" with a hammer to determine whether they were hollow or grouted solid.

A detailed summary and description of the main structural elements of the building and a list of observations that are pertinent to the seismic assessment of the building is contained in the Appendix (refer to the attached drawings for the locations of the components).

3. STRUCTURAL ASSESSMENT

3.1 SEISMIC EVALUATION

A preliminary seismic analysis was performed on the building. The lateral earthquake forces were calculated in accordance with the 1998 B.C. Building Code and include the addition of a second floor wood frame addition over Bays #3 and #4. The purpose of the analysis was to evaluate existing building elements and to determine upgrading requirements.

The seismic evaluation indicates that most or all of the existing building components are not capable of resisting the seismic loads or are not properly detailed, anchored or interconnected to ensure continuity of load path down to the foundation. The situation is worsened by the fact that an incompatible mixture of rigid and elastic building materials are used in different parts of the building and in different orientations. Hence potentially large displacements accommodated by flexible wood framing systems could lead to brittle failure of rigid unreinforced masonry elements. Or conversely loads that could be resisted by the wood systems may not get transferred to these elements until after failure of the stiff masonry elements has occurred. The National Research Council of Canada (NRC) in its Structural Commentaries of Part 4 of the building code states that "large dissimilarities in the stiffness and ductility characteristics of framing systems in the orthogonal directions should be avoided".

3.2 SUMMARY OF FINDINGS

It is expected that the existing firehall building would perform poorly in a significant seismic event (earthquake). The main reasons for this are: **1.** The use of unreinforced and under reinforced concrete block masonry in much of the main floor walls. Unreinforced masonry is perhaps the worst building material to use in a high seismic zone (it is not permitted in the B.C. Building Code). **2.** The existence of large poorly braced openings in the south-east face of the building and the north-west face in Bays #3 and #4.
3. Deficiencies in the detailing of and anchorage and connections between horizontal force resisting elements (roof and floor diaphragms) and vertical elements (shearwalls) and vertical elements to foundation (including hold-down anchorage against uplift).
4. Inadequate anchorage of vertical load carrying systems (floor and roof joists and trusses) to their supports (bearing walls and beams).

3.3 POTENTIAL FAILURE MODES

During a strong earthquake the following failures could occur: **A.** Extreme damage and/or collapse of masonry walls. Blocks may also become dislodged and sent flying through the air at great risk of injury or even death to persons standing near the walls (especially outside the exterior unreinforced walls). **B.** Excessive sway and/or collapse of walls and framing at the garage doors. **C.** Failure and possible collapse of the masonry/stud wall along Grid A from seismic induced soil load. **D.** Failure and possible collapse of the masonry/stud wall on Grid B due to unreinforced masonry section and poor anchorage of studwall. **E.** Failure of second storey wood frame shearwall piers (between windows). **F.** Floors and roofs could be pulled off of their supports (beams and bearing walls) and collapse onto the floor below. **G.** Failure and potential collapse or buckling of plywood shearwalls (added as seismic upgrade elements) due to out-of-plane loads from the unreinforced block walls impacting the stud walls. This could lead to further collapse of floors and walls above. **H.** Failure of main floor shearwalls as a result of insufficient anchorage to foundation for both lateral loads and uplift from overturning moments. **I.** Excessive damage, failure and possible collapse of walls due to insufficient lateral support and load transfer from floor and roof diaphragms.

3.4 COMMENTARY ON EXISTING SEISMIC UPGRADING

It is understood that the addition of studwalls and sheathing to the main floor in Bays #1 and #2 and in Bay #3 along Grid C was part of a seismic upgrading done a number of years ago (there are no drawings or engineer's reports available that detail or certify this work). The performance of the plywood shearwalls for in-plane seismic loading is dependant on the nailing pattern of the plywood and the anchorage of the walls to the roof/floor diaphragm above and the slab below. If properly nailed and anchored it is likely that these walls could provide good lateral seismic resistance to this part of the building. The performance of these walls will also depend upon the connection of the floor and roof (Bay #3) to the original masonry walls. If this connection is strong, loads will get transferred to the stiffer masonry walls before enough displacement in the wood walls has occurred to absorb the load. This could lead to damage or failure in the masonry walls before loads can get picked up by the wood shearwalls.

Performance in out-of-plane seismic loading is of greater concern. The block wall could buckle outward under lateral load and cause blocks to break free and fall which would be very dangerous. Conversely the relatively heavy block walls could transfer loads to the studwalls. Calculations show that the 12' long 2x4 studs do not have adequate strength to resist this load. This could result in buckling or collapse of the stud walls.
The work done to brace the garage door openings in Bays #1 and #2 does not appear adequate to resist the full seismic loading. The system of exterior 2x4 and plywood reinforcing with steel connecting plates is connected to a shearwall on Grid 4, E-F. Calculations show that a larger shearwall with high anchorage requirements and a collector strut running the full width of Bays #1,#2 and #3 with adequate connection to the horizontal diaphragms above is required.

The anchoring of the timber posts and beams along Grid D will help prevent the beams from being pulled off the posts and the posts from kicking out from under the beams. This work was not analyzed in detail.

3.5 UPGRADING TO 1998 BUILDING CODE

Upgrading the existing building to the full requirements of the 1998 B.C. Building Code for seismic loading would be a huge undertaking. There would be three parts to this work.

Part 1 would be the removal (or demolition) of building elements (for example some of the main floor walls) and subsequent rebuilding or replacement. This could also include additional foundation or anchorage elements that may necessitate removal and replacement of sections of the existing floor slab.

Part 2 would involve "gutting" of large areas of the building (example floors, roofs and walls) and subsequent upgrading of existing components and retrofitting and/or addition of new structural elements, connectors and anchors. This gutting would involve the removal of exterior finishes and sheathing and/or interior finishes in much of the building. Once the upgrading is done the finishes and wall coverings would have to be reapplied or replaced and/or cosmetically repaired and resealed from the weather.

Part 3 of the work would be the addition of new lateral load resisting elements to the existing layout. Examples of this include the addition of anchored wingwalls beyond the perimeter of the existing building to brace the large garage door openings.

The unit costs of renovating and retrofitting building components are often several times the unit cost of new construction. In addition inherent weakness in the layout of the building and in the building materials would make upgrading to the full Code requirements very difficult to achieve. It is the author's opinion that reaching the Code standard would be extremely onerous from a practical standpoint and unrealistic from an economic perspective.

3.6 GENERAL IMPROVEMENTS TO SEISMIC RESISTANCE

It is possible to improve the seismic performance of the firehall building without going to the full extent of satisfying all aspects of the building code. This program could involve: **1.** Replacing, upgrading and/or reinforcing existing structural components; **2.** Adding some new seismic resisting elements to the building and; **3.** Adding and improving anchorages to existing elements and their connections to other elements.

Examples of the most effective components that could be included in the above program include:

1. Main floor walls.
2. Anchored shear resistant wing-walls outside the existing perimeter of the building (including collector struts and anchorage to existing diaphragms).

3. Main floor shearwall anchorage. Connections of diaphragms to shearwalls. Anchorage of floor and roof systems to bearing walls and beams.

The objective of this type of program would be to improve the seismic performance of the building as much as possible within budgetary constraints. Obviously there would come a point (or points) where continued spending would not result in significant improvement to the seismic resistance of the building. The critical consideration is reducing the probability or likelihood of a collapse in the building during an earthquake. It is considered beyond the scope of work of this assignment to perform this kind of detailed cost/benefit and probability analysis.

3.7 CONCLUSIONS

It is concluded that it is not likely feasible from a practical and economic standpoint to upgrade the existing firehall building to the seismic requirements of the 1998 B.C. Building Code. It is however possible to make some improvements to the seismic performance of the building. The costs and details of an upgrading program including the expected benefits versus money spent will require a more detailed economic and structural analysis and a more detailed investigation of the existing building construction.

There are also other options to be considered. These include the construction of a new firehall building and the demolition and reconstruction of the existing building to the requirements of the 1998 B.C. Building Code. The three options are considered in the following section.

4. RECOMMENDATIONS

4.1 CONSTRUCT NEW BUILDING

To meet the guidelines of the P.E.P. a new "post disaster" firehall building constructed to the seismic requirements of the 1998 B.C. Building code would provide a building capable of providing essential services in the event of an earthquake. The existing firehall building could be used for other purposes such as workshops, manufacturing or processing of automotive repair etc. Revenue could be generated through the sale or lease of this facility.

The cost of a new building based on concrete slab and foundation with wood-frame construction is estimated at approximately $100/sq.ft. for main floor truck bays (12' ceilings) and $125 per square foot for second floor offices, meeting rooms and recreation areas (8' ceilings).

The existing building main floor area (Bays #1, #2, #3 and #4) is 2600 sq.ft. (this does not include the small entrance wing). This would result in a new cost of about $260,000. The existing second floor area is 1400 sq.ft. New cost would be $175,000. Total cost to replace the existing building is estimated at $435,000. Expanding the second floor to

2600 sq.ft. (match main floor area) would result in a total estimated building cost of $585,000. Land acquisition, site preparation and servicing costs would need to be added to this total.

4.2 DEMOLISH AND REBUILD

The existing building could be taken down and a new "post-disaster" building constructed in its place. Cost of new construction would be as in section 4.1 above. Land acquisition, site preparation and servicing costs would not be required. An allowance would be required for the demolition of the building. This could be offset by the salvage of building materials for sale or reuse.

4.3 IMPROVE EXISTING BUILDING

The option of upgrading the existing building has been discussed in sections 3.6 and 3.7 above. Further engineering and economic study would be required to assess the merits of this option. One consideration would be to rebuild Bays #3 and #4 complete with a second floor to the seismic standards of the building code. Ideally this would be constructed independently from Bays #1 and #2 and could form the "post disaster" section of the overall facility. Essential services and equipment could be housed in this section.

Costs for rebuilding Bays #3 and #4 complete with full second floor would be as described in section 4.1. For main and second floor areas of 1500 sq.ft. each the total estimated cost is $337,500. An allowance for the demolition of the existing bays and an additional sum for excavation and earthwork would also be required.

APPENDIX

I. Firehall Survey Notes and Observations
II. Firehall Drawings

I. SURVEY NOTES AND OBSERVATIONS

A. MAIN FLOOR

Item	Location	Description & Comments
1A.	Grid A, 1-5	Exterior bearing wall. 13'4" tall (6'8" bottom half 8" concrete block/6'8" top half 2x6 stud (unknown spacing) with 3/8" plywood) x 48'long. Supports #4 Bay roof. (A block = A stud = 320 sq.ft. A total = 640 sq.ft.)

- Wall not continuous from floor to ceiling (hinge at ½ height at block/stud joint). No lateral support provided at hinge.
- Details of block reinforcing unknown (solid vertical grout cores at 48" o/c). Photographs show vertical bars and slab dowels. Top course is solid grouted. Block, grout and mortar strength and specifications unknown.
- Wall founded on slab (edges thickened).
- Soil pressure from backfill against block wall. Block wall is not built as a retaining wall (i.e. cantilevered footing and special reinforcement or buttressing) or a basement wall (i.e. special reinforcement and lateral support at top of wall). Soil backfill approx. 2' to 4'wide between cut slope (conglomerate rock) and wall. Soil pressure considerably less than if cut made in granular soil slope. No evidence of excessive displacement, rotation or bulging of block wall. Some effervescence noted in mortar joints.
- Nailing pattern of plywood (size and spacing) unknown. At base of stud wall evidence that plywood does not extend down to bottom plate. Perimeter nailing appears to be to studs only. Anchorage of stud wall to block wall unknown.

Item	Location	Description & Comments
2A.	Grid B, 2-4	Interior bearing wall. 12' tall from Bay #3 slab to ceiling (4' bottom section 8"concrete block/8' top section 2x6 at 24" o/c stud with 5/8" plywood) x 40' long. Supports Bay #3 roof and Bay #4 roof via short pony stud wall built on top of Bay #3 roof. (A block = 160 sq.ft. A stud = 320 sq.ft. A total = 480 sq.ft.)

- Wall not continuous from floor to ceiling. Hinge at 4' height at block/stud joint.
- Block wall exposed at a doorway cut between #3 and #4 Bays. Hollow unreinforced masonry block except solid grout top course and wire "ladder" reinforcement every second course in mortar joints. No vertical reinforcement.

Block, grout and mortar strength and specifications unknown. Wall appears to be founded on slab. Anchorage to slab is unknown.

- 14" +/- step in slab elevation occurs on either side of wall from #4 to #3 Bays.
- Nailing pattern of plywood (size and spacing) unknown (drywall covering). Anchorage of stud wall to block wall and to roof over unknown.

3A. Grid C, 2-4 Interior bearing wall. 12' tall x 40' long. 8" concrete block sandwiched between two 2x4 at 16"o/c studwalls each with 3/8" plywood sheathing. Supports #3 Bay roof, 2nd floor loads and 2nd floor roof loads via the 2nd floor stud-bearing wall over. (A total sandwich wall = 480 sq.ft.)

- Block wall reinforcement unknown (but likely hollow and unreinforced as evidenced in wall on Grid 2, C-E and Grid E, 2-4. Top course likely solid grouted). Anchorage of block to floor/roof over and to concrete floor slab unknown. Block, grout and mortar strength and specifications unknown.
- Nailing pattern of plywood (size and spacing) unknown (drywall covering). Anchorage of stud wall to roof/floor above and concrete floor slab unknown.
- Anchorage of shearwall elements against uplift unknown.

4A. Grid D, 2-4 Post and beam row. 12' high ceiling x 40'+/- long. Built-up lumber beam on timber posts. Supports 2nd floor Loads.

- Posts anchored to floor slab with steel angle plates and bolts.
- Posts attached to beams with nailed-on plywood gussets and/or bolts and steel plates.
- Anchorage of 2nd floor to beams unknown.
- Anchorage of beam to block wall (Grid 2 @ D) unknown.

5A. Grid E, 2-4 Bearing wall. 12' tall x 40' long. 8" concrete block with one interior 2x4 studwall at 16" o/c sheathed with 3/8" plywood. Supports 2nd floor loads above #1 Bay and 2nd floor roof loads via the 2nd floor stud bearing wall over and 2nd floor office loads via a lumber ledger bolted to the block wall at an 8' height (from Grid 3 to 4). (A = 480 sq.ft.)

- Block wall hollow/unreinforced. Top course solid grouted. Anchorage of block to floor over and to concrete floor slab unknown. Block, grout and mortar strength and specifications unknown.
- Nailing pattern of plywood (size and spacing) unknown (drywall covering). Anchorage of stud wall to floor above and concrete floor slab unknown.
- Anchorage of shearwall elements against uplift unknown.

6A. Grid F, 3-4 Exterior bearing wall. 8' tall x 20'6" long. 8" concrete block with exterior siding. Supports 2nd floor office floor roof loads over via exterior studwall (A = 164 sq.ft.)

- Block wall hollow/unreinforced. Top course grouted solid. Lintel beam over window grouted solid (reinforcement unknown). Anchorage of block to floor over and to concrete floor slab unknown. Block, grout and mortar strength and specifications unknown.

7A.	Grid 1, A-B Grid 5, A-B	Garage door end piers (non-bearing). 13'4" tall (6'8" bottom half 8" concrete block/6'8" top half 2x6 stud with 3/8" plywood) x 1'4" wide one side and 2'8"wide other side of garage door opening.

- Piers not continuous from floor to ceiling (hinge at ½ height at block/stud joint).
- Details of block reinforcing unknown. Photographs show vertical bars and slab dowels. Vertical cores solid grouted. Top course solid grouted. Block, grout and mortar strength and specifications unknown.
- Nailing pattern of plywood (size and spacing) unknown. At base of stud wall evidence that plywood does not extend down to bottom plate. Perimeter nailing appears to be to studs only. Anchorage of stud wall to block wall and roof over unknown.

8A.	Grid 2, B-C Grid 4, B-C	Garage door end piers (non-bearing) 12' tall (4' bottom section 8" concrete block/8' top section 2x6 studwall with plywood sheathing) x 1'8" wide one side and 2'8" wide other side of garage door opening.

- Piers not continuous from floor to ceiling (hinge at 4' height at block/stud joint).
- Block portion hollow/unreinforced. Top course grouted solid. Block, grout and mortar strength and specifications unknown.
- Nailing pattern of plywood (size and spacing) unknown. Anchorage of stud wall to block wall and roof over unknown.

9A.	Grid 2, C-E	Exterior wall (non-bearing except for beam point loads and gable end loads from wood frame second second floor) 12' tall x 27'long. 8" concrete block with interior 2x4 studwall at 16" o/c and plywood sheathing. (A = 324 sq.ft.)

- Block wall hollow/unreinforced. Top course grouted solid. Anchorage of block to floor over and to concrete floor slab unknown. Block, grout and mortar strength and specifications unknown.
- Lateral support of top of wall by floor diaphragm unknown.
- Nailing pattern of plywood (size and spacing) unknown (drywall covering). Anchorage of stud wall to floor above and concrete floor slab unknown.
- Anchorage of shearwall elements against uplift unknown.

10A.	Grid 4, C-E	Garage door posts/framing. 12' tall timber and/or built-up

lumber vertical members with applied exterior reinforcing of 2x4 stud and plywood sheathing connected with bolted steel gusset plates at top of columns and steel angles anchored to slab at column bases. Outside posts at Grids C and E are non-load bearing (framing for overhead doors). Central post at Grid D is load bearing (supports timber beam Grid D).

- Construction details of timber/built up lumber posts unknown (not visible).
- Details of plywood/2x4 reinforcing unknown (i.e. nailing pattern of plywood).
- Steel gusset plates connect post reinforcing to horizontal reinforcing member (2x4 with plywood sheathing) at top of doorways. The gusset at Grid E appears to be connected to an exterior applied plywood sheathed wall on Grid 4 from E to F (see Item 11 below).
- Base of posts/reinforcing connected to slab with steel plates and bolts.
- Connection of horizontal reinforcing member to floor above unknown.

11A. Grid 4, E-F — Exterior wall (non-bearing except for gable end loads from wood frame wall above). 8' tall x 14' long. 8" concrete block with exterior plywood sheeted 2x4 studwall (unknown spacing). (A = 112 sq.ft.)

- Block wall hollow/unreinforced. Top course grouted solid. Lintel beam over door grouted solid (reinforcement unknown). Anchorage of block to floor over and to concrete slab unknown. Block, grout and mortar strength and specifications unknown.
- Lateral support of top of wall by floor diaphragm unknown.
- Nailing pattern of plywood (size and spacing) unknown (siding covering). Anchorage of stud wall to floor above and concrete slab unknown.
- Anchorage of shearwall elements against uplift unknown.

12A. Grid 3, E-F — Exterior wall (non-bearing except for gable end loads from wood frame wall above). 8' tall x 14' long. 8" concrete block with exterior cedar siding. (A = 112 sq.ft.)

- Block wall hollow/unreinforced. Top course grouted solid. Anchorage of block to floor over and to concrete slab unknown. Block, grout and mortar strength and specifications unknown.
- Lateral support of top of wall by floor diaphragm unknown.

B. MAIN FLOOR ROOF AND SECOND FLOOR SYSTEMS

Item	Location	Description & Comments
1B.	#4 Bay	Roof framing and diaphragm. Flat roof 19'wide x 50'long. Plywood sheathing on 1" strapping on 2x10 joists @ 12" o/c. Drywall ceiling. (A = 950 sq.ft.)

- Plywood diaphragm thickness and nailing pattern (size and spacing) unknown.
- Plywood panel edges unblocked.
- Diaphragm chord details unknown.
- Connection of diaphragm to shearwalls unknown.
- Anchorage of roof framing to bearing walls unknown.

2B.	#3 Bay	Roof framing and diaphragm. Flat roof 16'wide x 42'long. 5/8" plywood sheathing on 2x8 joists @ 16"o/c. Drywall ceiling. (A = 670 sq.ft.)

- Plywood diaphragm nailing pattern (size and spacing) unknown.
- Plywood panel edge blocking unknown.
- Diaphragm chord details unknown.
- Connection of diaphragm to shearwalls unknown.
- Anchorage of roof framing to bearing walls unknown.

3B.	#1/#2 Bay	Floor framing and diaphragm. 28' wide x 40' long. Plywood (assumed) on lumber joists (size and spacing unknown). Drywall ceiling. (A = 1120 sq.ft.)

- Plywood diaphragm thickness and nailing pattern (size and spacing) unknown.
- Plywood panel edge blocking unknown.
- Diaphragm chord details unknown.
- Connection of diaphragm to shearwalls unknown.
- Anchorage of floor framing to bearing walls and beams unknown.
- Opening in floor diaphragm for hose tower.

4B.	Office wing	Floor framing and diaphragm. 14' wide x 20' long. Plywood on 2x10 @ 16"o/c. Drywall ceiling. (A = 280 sq.ft.)

- Plywood diaphragm thickness and nailing pattern (size and spacing) unknown.
- Plywood panel edge blocking unknown.
- Diaphragm chord details unknown.
- Connection of diaphragm to shearwalls unknown.
- Anchorage of floor framing to bearing walls unknown.
- Opening in floor diaphragm for stairway.

C. SECOND FLOOR

Item	Location	Description & Comments
1C.	Grid C, 2-4 Grid E, 2-4	Exterior bearing walls. 10' tall x 40' long. Cedar siding on 3/8" plywood on 2x6 studs (unknown spacing) with interior drywall. Support roof trusses spanning from Grid C to E and part of roof over office wing (Grid E, 3-4 only).

(A = 800 sq.ft. (2 walls at 400 sq.ft. each)).

- Nailing pattern (size and spacing) of plywood unknown.
- Plywood panel edge blocking unknown.
- Connection to roof above and floor below unknown.
- Anchorage of shearwall elements against uplift unknown.
- Anchorage of lintel beams to supports unknown.

2C. Grid 2, C-E Grid 4, C-E Exterior non-bearing walls. 10' tall x 28' long. Cedar siding on 3/8" plywood on 2x6 studs (unknown spacing) with interior drywall. (A = 560 sq.ft. (2 walls at 280 sq.ft. each)).

- Nailing pattern (size and spacing) of plywood unknown.
- Plywood panel edge blocking unknown.
- Connection to roof above and floor below unknown.
- Anchorage of shearwall elements against uplift unknown.
- Lateral support of top of wall by roof system unknown.

3C. Grid F, 3-4 Exterior bearing wall 8' tall x 20' long. Cedar siding on plywood on 2x6 studs (unknown spacing) with drywall interior. Supports office roof loads. (A = 160 sq.ft.)

- Nailing pattern (size and spacing) of plywood unknown.
- Plywood panel edge blocking unknown.
- Connection to roof above and floor below unknown.
- Anchorage of shearwall elements against uplift unknown.
- Anchorage of lintel beams to supports unknown.

4C. Grid 3, E-F Grid 4, E-F Exterior non-bearing walls. 8' tall x 14' long. Cedar siding on plywood on 2x6 studs (unknown spacing) with interior drywall. (A = 220 sq.ft. (2 walls at 110 sq.ft. each)).

- Nailing pattern (size and spacing) of plywood unknown.
- Plywood panel edge blocking unknown.
- Connection to roof above and floor below unknown.
- Anchorage of shearwall elements against uplift unknown.
- Lateral support of top of wall by roof system unknown.

D. SECOND FLOOR ROOF SYSTEM AND HOSE TOWER

Item	Location	Description & Comments
1D.	Main area	Roof framing and diaphragm. 5:12 sloped peaked roof. 32' wide x 44' long. Metal roofing on existing shingles on strapping on plywood on home-made roof trusses at 24"o/c. Drywall ceiling. (A = 1400 sq.ft.)

- Plywood diaphragm nailing pattern (size and spacing) unknown.
- Plywood panel edge blocking unknown.
- Diaphragm chord details unknown.
- Connection of diaphragm to shearwalls unknown.
- Anchorage of roof framing to bearing walls unknown.

2D. Office area — Roof framing and diaphragm. 5:12 slope. 16' x 24'. Metal roofing on shingles on strapping (assumed) on plywood on lumber joists. Drywall ceiling. (A = 380 sq.ft.)

- Plywood diaphragm nailing pattern (size and spacing) unknown.
- Plywood panel edge blocking unknown.
- Diaphragm chord details unknown.
- Connection of diaphragm to shearwalls unknown.
- Anchorage of roof framing to bearing walls unknown.

3D. Hose tower — 8' x 6' x 32' tall. From main floor to above roof. Plywood sheathing on stud frame construction.

- Laterally supported by floor and roof diaphragms.
- Details of framing and connections at floor and roof unknown.
- Anchorage to floor slab unknown.
- Nail spacing on plywood sheeting 6" to 8" on average (nail size unknown). Panel edges unblocked.

E. MAIN FLOOR AND FOUNDATION

Item	Location	Description & Comments
1E.	Main floor	Concrete floor slab throughout. 6" thick observed at two test excavations outside of #1 Bay on Grids 2 and E. (A total = 2900 sq.ft.)

- Thickness throughout building unknown.
- Reinforcing unknown.
- No evidence of excessive cracking or differential settlement.

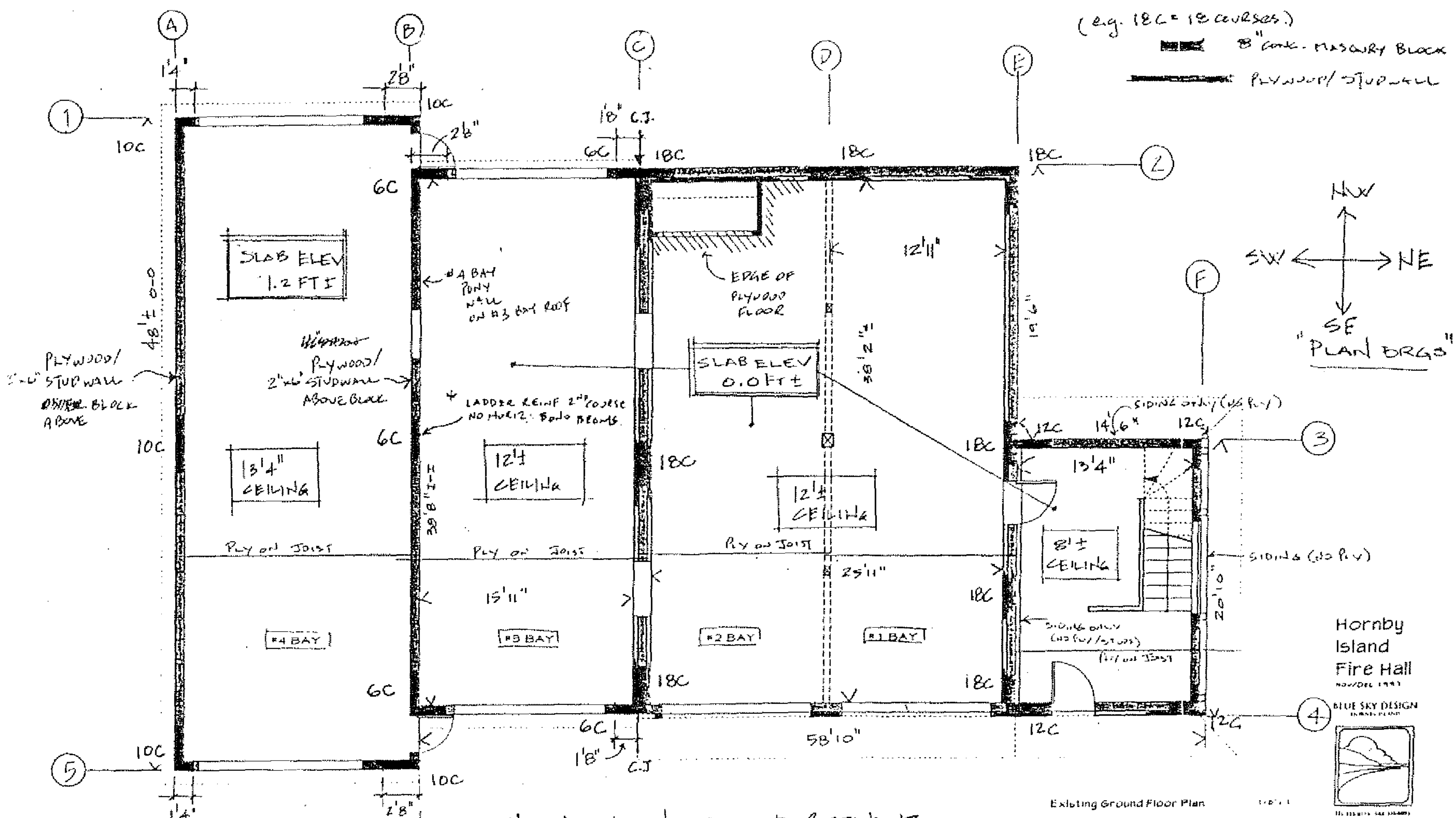
2E. Foundation — Thickened concrete slab footings. 8" to 10" thick observed at two test excavations outside of #1 Bay on Grids 2 and E. Founded on compacted sandy gravel material on conglomerate bedrock (same test excavations).

- Thickness of footings throughout building unknown.
- Interior bearing wall footings unknown.
- Post footings (Grid D) unknown.
- Width of thickened slab footings unknown.
- Founding soil/rock throughout building unknown.

- Reinforcing unknown.
- No evidence of excessive cracking or differential settlement (verified by absence of cracking in unreinforced masonry walls).

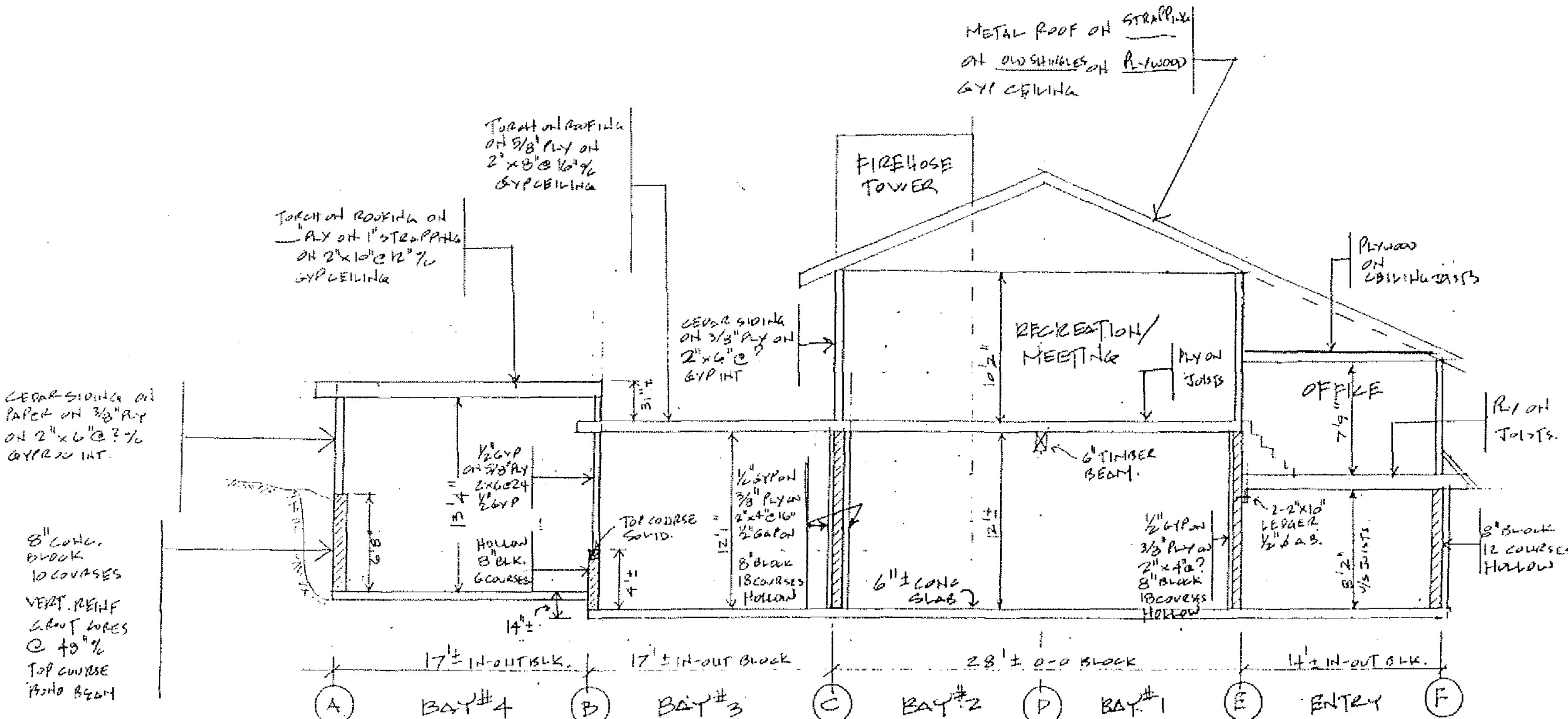
F. GENERAL OBSERVATIONS

- Appears to have been constructed in 3 Stages.
- Stage I: Bays #1 and #2; Entry/office wing and; Second floor area.
- Stage II: Bay #3.
- Stage III: Bay #4.
- Seismic upgrading (plywood studwalls) applied to Bays #1 and #2 and to Bay #3 on Grid C.
- Bay #3 not constructed integrally with Bay #2 (vertical construction joint along Grid C). Bay #3 roof shares bearing wall with Bay #2 (Grid C).
- Bay #4 not constructed integrally with Bay #3. Bay #4 roof is supported on top of Bay #3 roof by short pony wall (Grid B).
- Bay #4 roof not in same horizontal plane as rest of building (30" higher)
- Bay #4 floor slab not in same horizontal plane as rest of building (14" higher)
- Bay #4 end bay walls not in same vertical plane as rest of building (extends 4' beyond on each end).
- Bays #1 and #2 and entry wing constructed of heavy/rigid/brittle unreinforced masonry walls (on main floor).
- Bays #3 and #4 constructed mainly of light/flexible/elastic wood frame walls.
- Bays #1 and #2 have very large openings in 1 wall (Grid 4) and small openings elsewhere.
- Bays #3 and #4 have very large openings in both end walls and small openings in side walls.
- Center of rigidity of building as a whole is not close to center of gravity.



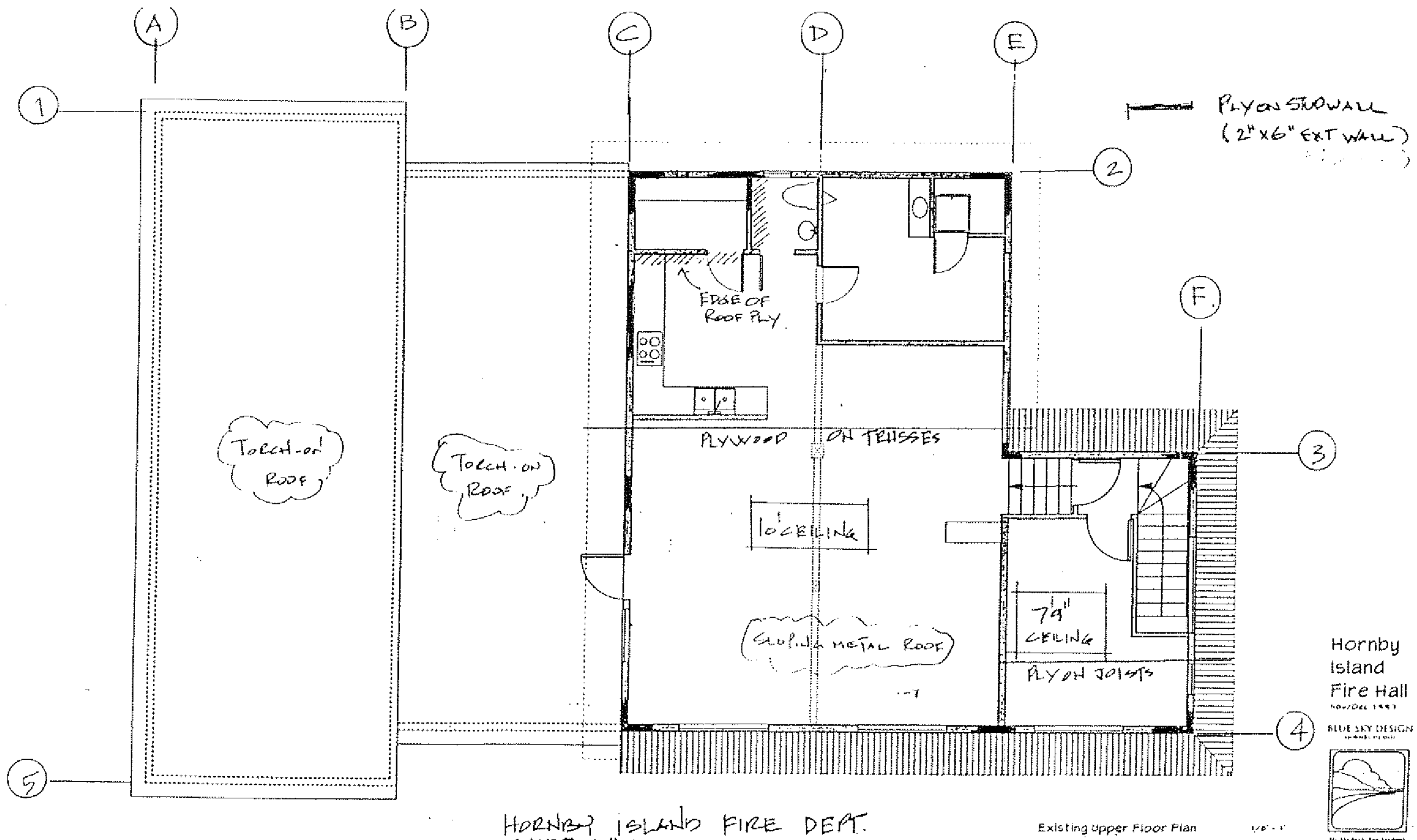
HORNBY ISLAND FIRE DEPARTMENT
SKETCH #2
BY: RM OCT. 19, 2000

RON McMURTRIE & ASSOCIATES
CONSULTING ENGINEERS
PROJECT NO. 2000-03



OCT 5, 2000 HORNBY ISLAND FIRE DEPT. (NOT TO SCALE).
SKETCH #1, BY: RM

RON McMURTRIE & ASSOCIATES
CONSULTING ENGINEERS
PROJ. NO. 2000-03



HORNBY ISLAND FIRE DEPT.
SKETCH #3
BY: RM OCT 19, 2000

Existing Upper Floor Plan

RON McMURTRIE & ASSOCIATES
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