City of Richmond

Report to Committee

To:	General Purposes Committee	**Date:**	To General Purposes - Feb 4, 2003 February 24, 2003
From:	Jim Hancock Fire Chief	**File:**	2052-02
Re:	**Community Safety Building Replacement - Fire Hall Construction Program**		

Staff Recommendation

1. That the Fire Hall Replacement Schedule be amended, as detailed in the attached report dated February 19, 2003 from the Fire Chief; and

2. That structural preloading of the two fire hall sites at 22451 Westminster Highway (Hamilton) and 3911 Russ Baker Way (Sea Island), proceed using funds identified in the 2003 Capital Program for the Hamilton Fire Hall following rezoning of the properties; and

3. That the attached conceptual designs for both Hamilton Fire Hall and Sea Island Fire Hall be approved in principle for the rezoning applications and to solicit further community input.

Jim Hancock
Fire Chief

Att. (5)

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ROUTED TO: CONCURRENCE	**CONCURRENCE OF GENERAL MANAGER**
Budgets .... Y ☑ N ☐ Parks Design, Construction & Programs .. Y ☑ N ☐ Policy Planning .... Y ☑ N ☐ Transportation .... Y ☑ N ☐	

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Staff Report

Origin

In view of the additional information available following the results of the geotechnical surveys carried out at the proposed Hamilton and Sea Island fire hall sites, staff are proposing that the construction schedules for these fire halls be re-evaluated with Council.

These projects were also referred by the Community Safety Committee in order for Council and the community to review conceptual plans for the replacement of the fire halls, prior to directing the consultants to proceed with detailed design.

Background

The two sites for the replacement of fire halls in East Richmond (Hamilton) and Sea Island (Burkeville), were approved by Council during 2002, following consultation with the two communities and geotechnical surveys are now complete.

Analysis

Hamilton – Soil conditions in East Richmond are well documented and the soils analysis for the Hamilton site is consistent with earlier assumptions. Examination of the options determined that conventional sand pre–loading and a raft slab foundation offer improved long term benefits with respect to minimal settlement and least cost over the options of pile supported foundations. However, this strategy requires the Hamilton site to be preloaded for a 12-month period to maximize these benefits (Appendix A).

To accommodate the more difficult soil conditions and in keeping with the sustainable building objective, the design process opted to reduce and simplify the building footprint resulting in the proposed three-level fire hall (Appendix B). Staff are satisfied that the internal working relations of the building program meet or exceed the requirements of Fire Rescue operations.

Sea Island – The results of the geotechnical survey conducted at the proposed Russ Baker Way site also recommend a raft slab foundation over conventional piling as the optimum design solution. At this location, only a 6-month pre-load period is recommended (Appendix C).

Since the soil structure at this site is denser than at Hamilton, it is anticipated that the fire hall would remain a two-level facility as originally planned (Appendix D).

In order to accommodate the pre-load periods recommended for both the Hamilton and Sea Island fire halls, staff propose that both sites be pre-loaded in 2003 using funds approved in the 2003 Capital Plan for the Hamilton Fire Hall. This strategy would then permit tendering of both fire halls in September of 2003, for sequential construction in 2004 that would potentially realize cost savings.

Options – The following options have been considered:

1. The current schedule calls for construction to commence on the Hamilton Fire Hall during 2003 and the Sea Island Fire Hall in 2004. This could be accomplished if the Hamilton building was to be pile supported in addition to site densification, at an estimated cost of $430,000 (Not recommended).

2. The Hamilton Fire Hall site could also be excavated and filled with lightweight materials (lava pumice), supporting a raft slab construction, at an additional cost of $152,000, with minimal change to the current schedule. Lightweight fill must be encapsulated and there is some concern over the effectiveness of this strategy for a post disaster facility (Not recommended).

3. Both sites, Hamilton and Sea Island, could be simultaneously prepared and preloaded with conventional sand fill for periods of 12 and 6 months respectively at an estimated cost of $127,000 per site. This results in the least impact on the proposed budgets but results in both fire halls then being constructed during 2004, with Hamilton completed during 2005 (Recommended).

ACTION	Advantages	Disadvantages
Pile Supported Foundation	Fast, meets current schedules for Hamilton and Sea Island. Minimum future building settlement.	High Cost - $430,000 Noisy, disruptive to neighbourhood, potential damage to surrounding buildings. Minor settlement of paved and driveway areas still occurs. Proximity of Hwy 91A embankment at Hamilton adds complications.
Raft Slab on Lightweight Fill	Fast, will meet current schedule for Hamilton and Sea Island. Minimum future building settlement.	Relatively high cost - $152,000. Fill material has to be enclosed. Minor settlement of paved and driveway areas still occurs. Proximity of Hwy 91A embankment at Hamilton complicates.
Raft Slab on Conventional Pre Lading	Less Costly - $127,000. Less overall settlement. No complications from Hwy 91A embankment (Hamilton). Permits tendering of two fire hall projects in 2003 which could result in additional cost savings.	Delay of 6 and 12 months following rezoning before construction commences.

Schedule/Process

Resulting from the recommended revisions to the construction program, the following schedule is now proposed

March 2003	Submit Rezoning applications for Hamilton and Sea Island fire hall sites. Submit a Development Permit (DP) application for Sea Island and initiate an environmental impact assessment and a mitigation/compensation planting plan, and consult with relevant authorities (i.e. Department of Fisheries and Oceans). Community and Public Information meetings for both sites. Preload specification prepared. Project cost estimate refined.
April 2003	Report to Planning Committee and first reading of Council for rezoning of the Hamilton and Sea Island fire hall sites. Additional meeting(s) with the Sea Island community, as required this month and/or beyond, to address DP issues. Preload contract tendered.
May 2003	Public Hearing and final adoption of rezoning for the Hamilton and Sea Island fire hall sites. Preload contract awarded.
June 2003	Site preparation and preload commences at Sea Island and Hamilton fire hall sites
January 2004	Construction commences for Sea Island Fire Hall.
June 2004	Construction commences for Hamilton Fire Hall.

As part of the overall communication strategy for publicizing the Community Safety Buildings program staff are planning to hold community meetings in Hamilton and Sea Island to answer questions and receive input on the fire hall conceptual designs, with the results being reported back to Council. This is in addition to the mandatory public meetings held in connection with the projects' rezoning and Development Permit processes (i.e. Public Hearing).

Financial Impact

The approved 2003 Capital Plan includes a budget of $3,203,929 for the Hamilton Fire Hall. The draft 2004 Capital Plan, proposes $3,000,000 for Sea Island.

The strategy recommended by staff proposes that approximately $250,000 of the $3,203,929 budget approved for the Hamilton Fire Hall be used to initiate rezoning and preloading of both the Hamilton Fire Hall, and Sea Island Fire Hall sites in 2003. Therefore, there is no financial impact anticipated.

The proposed 2004 capital budget would then be amended to reflect proposed construction of both the Hamilton Fire Hall, and Sea Island Fire Hall in 2004 (Appendix E).

Conclusion

Shifting the focus from the proposed sequential individual fire hall replacements to the simultaneous development of the fire hall sites at Hamilton and Sea Island results in a number of financial and environmental advantages. Tendering both Hamilton and Sea Island fire halls would also realize cost benefits reflected in economies of scale and reduced contractor overheads.

While completion of the Hamilton Fire Hall will be delayed by one year, both fire halls would be operational in 2005 as originally intended.

Staff recommend that rezoning and, where required, development permit applications, now be submitted for Hamilton and Sea Island Fire Halls and that the proposed concepts be presented to the public for further input prior to proceeding with detail design and cost estimates.

David Naysmith, P. Eng.
Manager, Facilities Planning & Construction
(3312)

Appendix A – Extract from Levelton Engineering Report - Hamilton
Appendix B – 3-D Drawing, elevations and site plan - Hamilton
Appendix C - Extract from Levelton Engineering Report – Sea Island
Appendix D - 3-D Drawing, elevations and site plan – Sea Island
Appendix E – Revised MS Project schedule

DN:cmm

be severely compromised by liquefaction of the sand deposit. It is recommended that ground densification by stone column installation be carried out for a pile-supported building so that liquefaction of the sand deposit does not occur.

Ground settlement and horizontal ground movements are considered likely to occur in Richmond in the event of a major earthquake. It is anticipated that the stability of the road embankment south of the site will generally control ground movements at the subject site. A seismic event will increase the shear forces in the soil that underlie and support the road embankment, decreasing the stability of the embankment. If the embankment becomes unstable, large horizontal ground movements and ground heave could occur at the subject site. Detailed numerical modelling of the embankment movement with a computer would be required to define the magnitude of ground movement at the subject site in the event of an earthquake. Additional subsurface investigation below the embankment and review of as-built records would be required to provide input data for the computer modelling. Assessing the stability of the off-site fill embankment is beyond the scope of this geotechnical assessment. Levelton would be pleased to provide a proposal for a stability assessment of the road embankment

To mitigate the impacts of the potential ground movements at the subject site during an earthquake, the building could be designed to accommodate ground movements and still be functional. This option would likely only be possible if magnitudes of ground movements are relatively low. A superstructure that is light and strong such as steel framing that can accommodate significant rotation would be beneficial.

Alternatively, stabilising the subject site could be done to mitigate the potential for excessive ground movement in the event of an earthquake event. Installing vertical, stiff elements such as gravel columns through the soft peat and silt deposit will increase the effective strength of the sub-soils and decrease potential ground movements. It is likely that stabilising a large area such as the front portion of the site will be required to significantly increase site stability.

4.5 PEAT STRIPPING, STRUCTURAL FILL AND PRELOAD

As discussed above, recommended site preparation for a building founded at-grade on a raft slab includes peat stripping, structural fill placement and preloading.

Stripping of peat soil and placement of structural fill is recommended to limit the potential for post-construction building settlement. Peat stripping will likely be required to about 3m outside of the building outline. Therefore, offsetting buildings from the property lines may be appropriate if permission to excavate beyond the property line can not be obtained.

Structural fill should be placed to restore grade to the under-side of raft slab level. It is recommended that structural fill consist of clean, pit-run sand or rive sand compacted in 300m vertical lifts to at least 100% of Standard Proctor maximum dry density, in accordance with ASTM D-698. Vibrations induced by fill compaction works will be noticeable at off-site areas and may negatively impact neighbouring buildings. Using a small, walk behind drum compactor with 300mm lifts will limit off-site vibrations to levels that generally to raise concerns with neighbours. It is recommended that a sample of proposed structural fill be provided to the Geotechnical Engineer of record to confirm the materials suitability prior to its use.

Preload fill may consist of any granular fill that has relatively high density, including river sand. It is anticipated that placing the top of the preload at about 2.0m above the floor slab level and 1.5m beyond the building outline will be appropriate. A preload duration of 6 to 9 months is estimated to be sufficient. There is a potential that the preload may cause ground heave at adjacent off-site areas. Placement of fill in stages of 1m separated by at least one-month is typically required to safeguard against excessive ground heave at surrounding areas. Therefore, it is recommended that an allowance for a 9 to 12 month period from the initiation of fill placement to the completion of preloading be allowed for. Review of the actual preload settlement by the Geotechnical Engineer is required to confirm suitable preload duration. Preload settlement is measured by surveying preload monitors at regular interval.

Offsetting the toe of the preload about 1.5m to 3m from settlement sensitive structures is estimated to be appropriate to limit the potential for negative impacts. The Geotechnical Engineer will require building loads, locations and site grades to finalize peat stripping and preload design and prepare and Excavation and Preload Drawing.

It is understood that grade will be raised at parking and driveway adjacent to the building. Delaying paving and installation of buried services at parking, driveway, storage and other areas for several months after the placement of fill to raise grade will allow a large amount of the settlement induced by the fill weight to occur, limiting the magnitude of post-construction settlement.

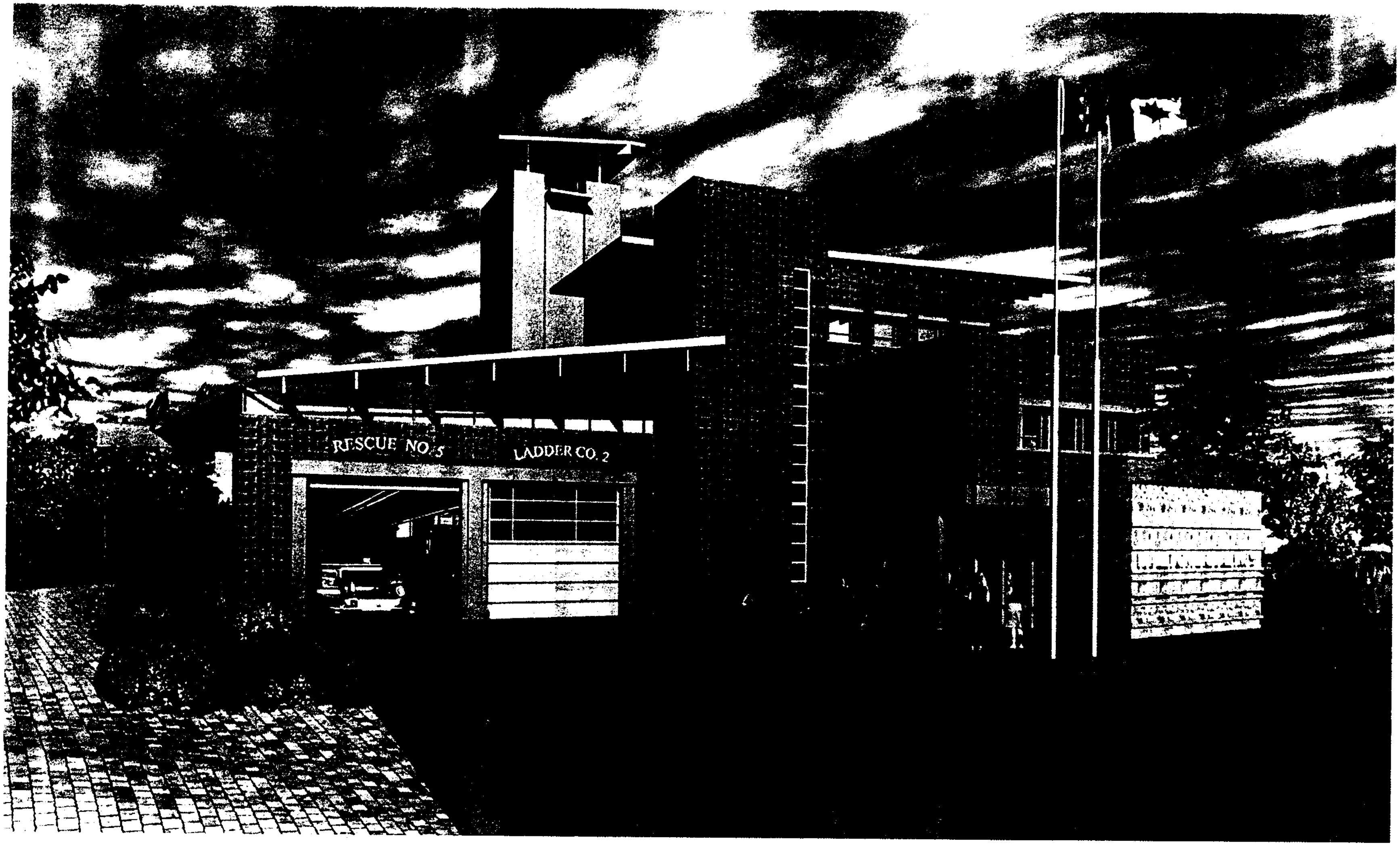
Placement of fill can induce significant settlement at off-site areas, in particular at areas within 5m of fill placement. The Geotechnical Engineer can further assess this risk when grading plans are available.

4.6 Ground Densification Works

The sand deposit is contains layers subject to liquefaction in the event of major earthquake. Ground densification to safeguard against liquefaction of the sand deposit is recommended for a pile-supported building to avoid loss of support for piles founded in the sand deposit. In addition, ground densification may be desirable for a building founded at-grade on a raft slab to limit ground displacements in the event of a major earthquake event.

Ground densification in the Richmond area is generally achieved by compacting the soil through the process of installing gravel columns. The gravel columns may be constructed by several methods including vibro-replacement and rammed stone column methods.

It is recommended that the site be densified to at least 3m beyond the proposed building outline. It is recommended that the contract for ground densification be based on performance criteria. Electric cone penetration tests (CPT's) are the most effective method to assess the performance of the ground densification works. It is estimated that achieving a cone tip resistance of about 170bar will provide a suitable factor of safety against liquefaction of the sand deposit. The performance criteria should be finalised by the Geotechnical Engineer prior to tendering based on review of site grading and other parameters.



City of Richmond
Firehall No. 5- Hamilton
VIEW FROM WESTMINSTER HIGHWAY
01/27/03

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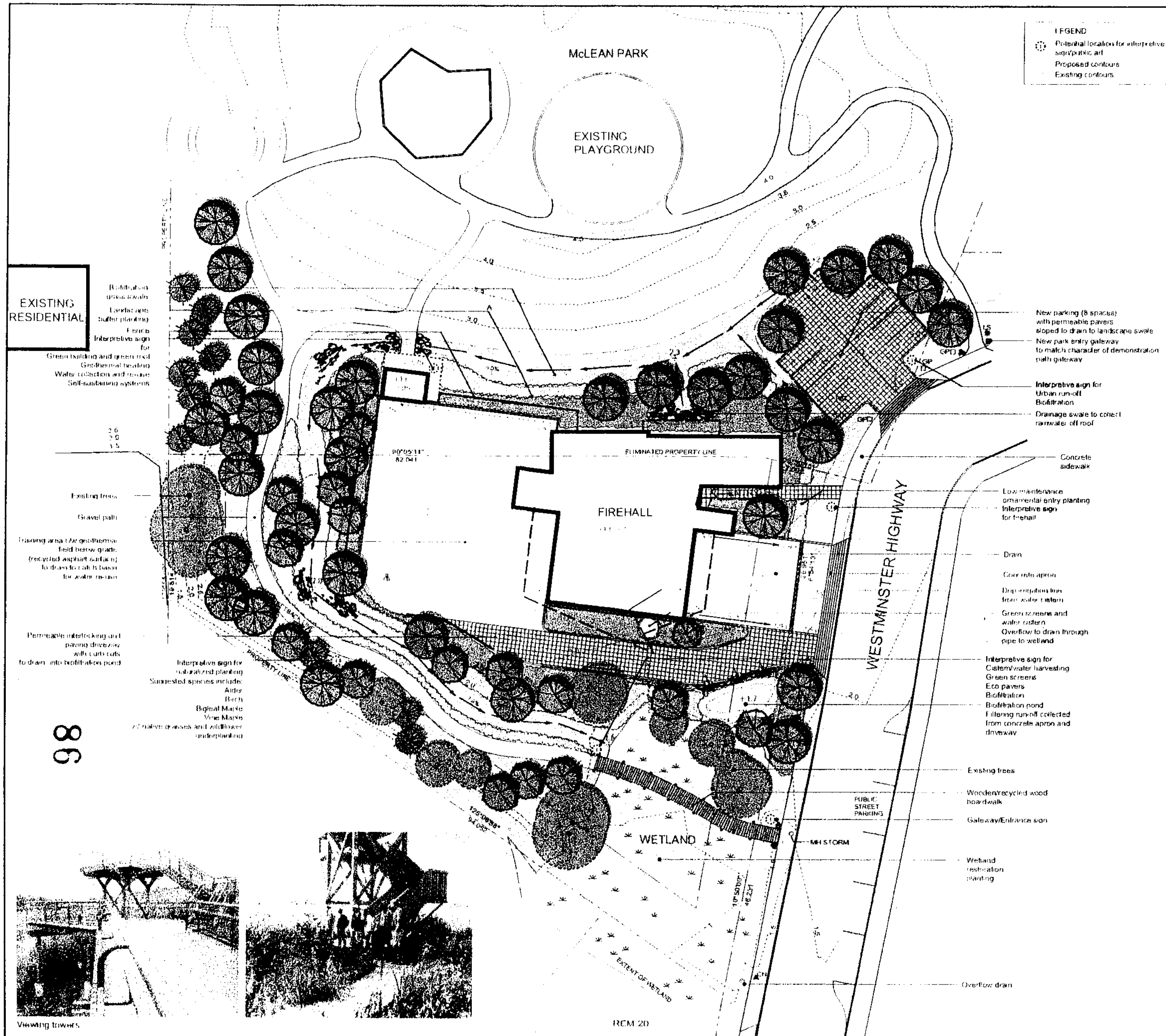
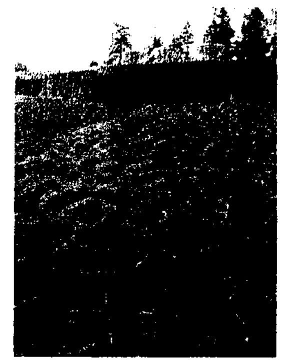
APPENDIX B



Viewing towers

Water Cistern

Roof scuppers draining to retention pond



Green roof

Green screens

PROJECT

HAMILTON FIREHALL No. 5

Richmond, BC

for

City of Richmond

SHARP & DIAMOND

Landscape Architecture & Planning

DRAWING

Conceptual Landscape Plan

DRAWING NUMBER

L-1

02.415

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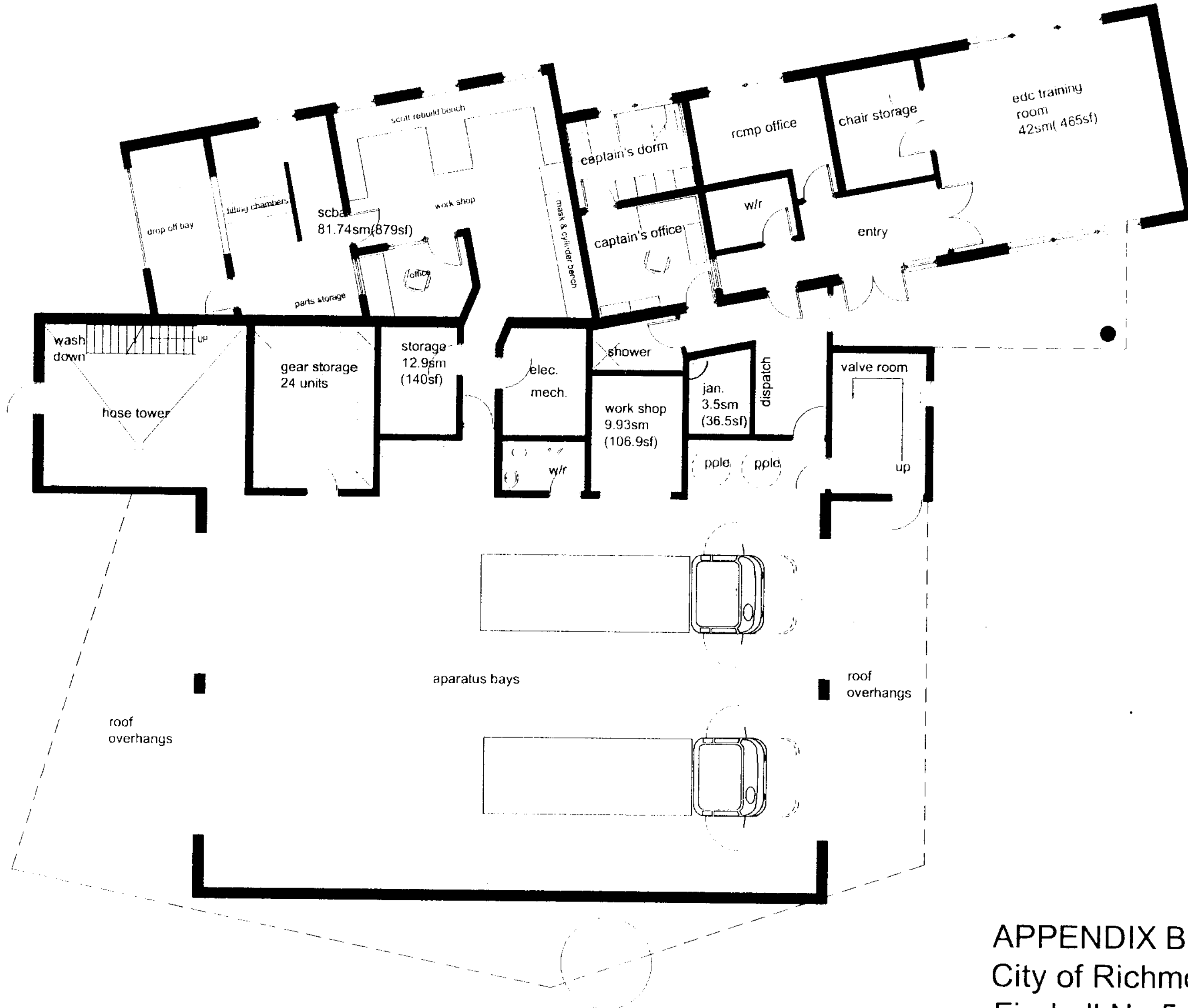

Main Floor Plan

APPENDIX B
City of Richmond
Firehall No 5 - Hamilton

Schematic Floor Plans
03 / 02/ 05

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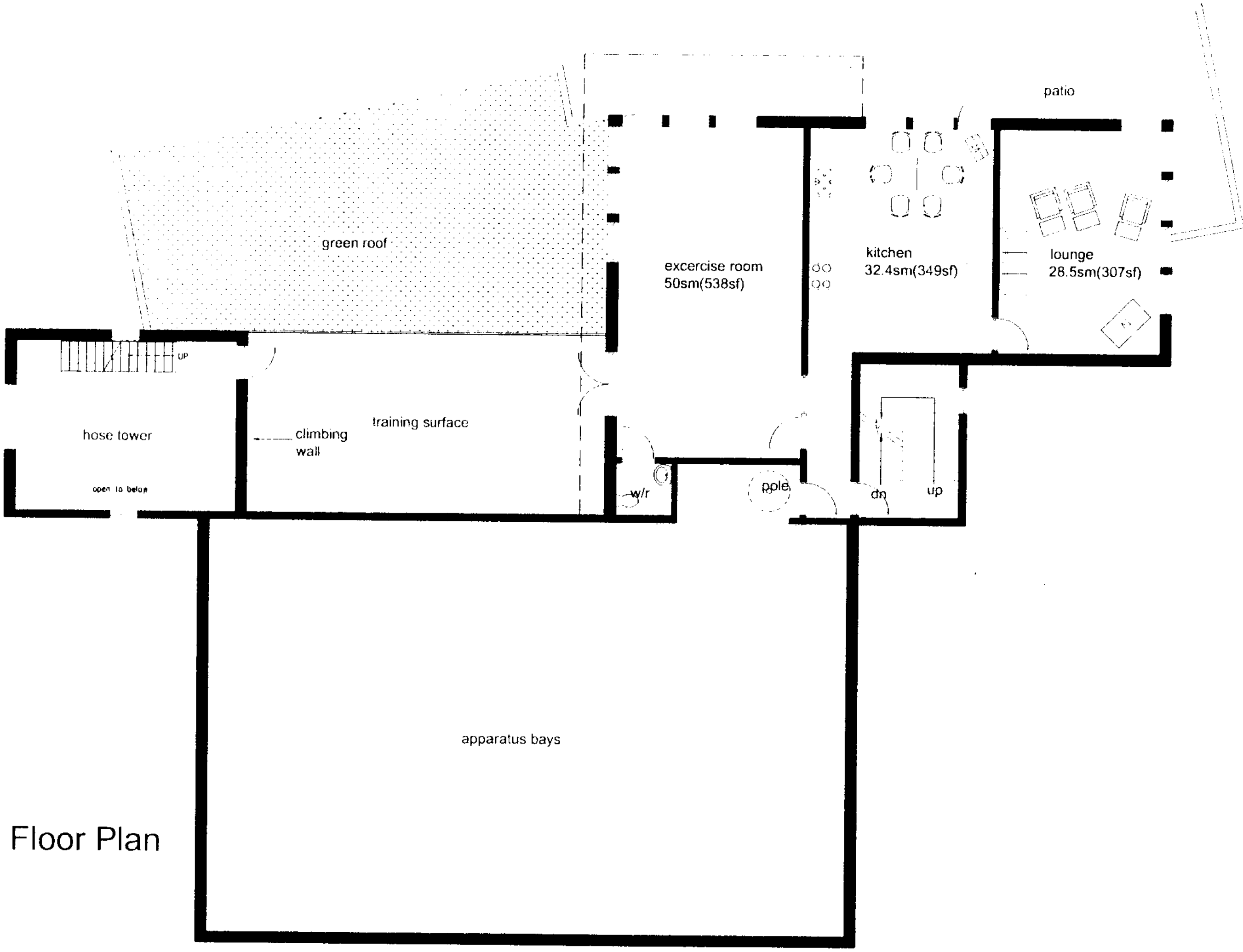

Second Floor Plan

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Firehall No 5 - Hamilton

Schematic Floor Plans
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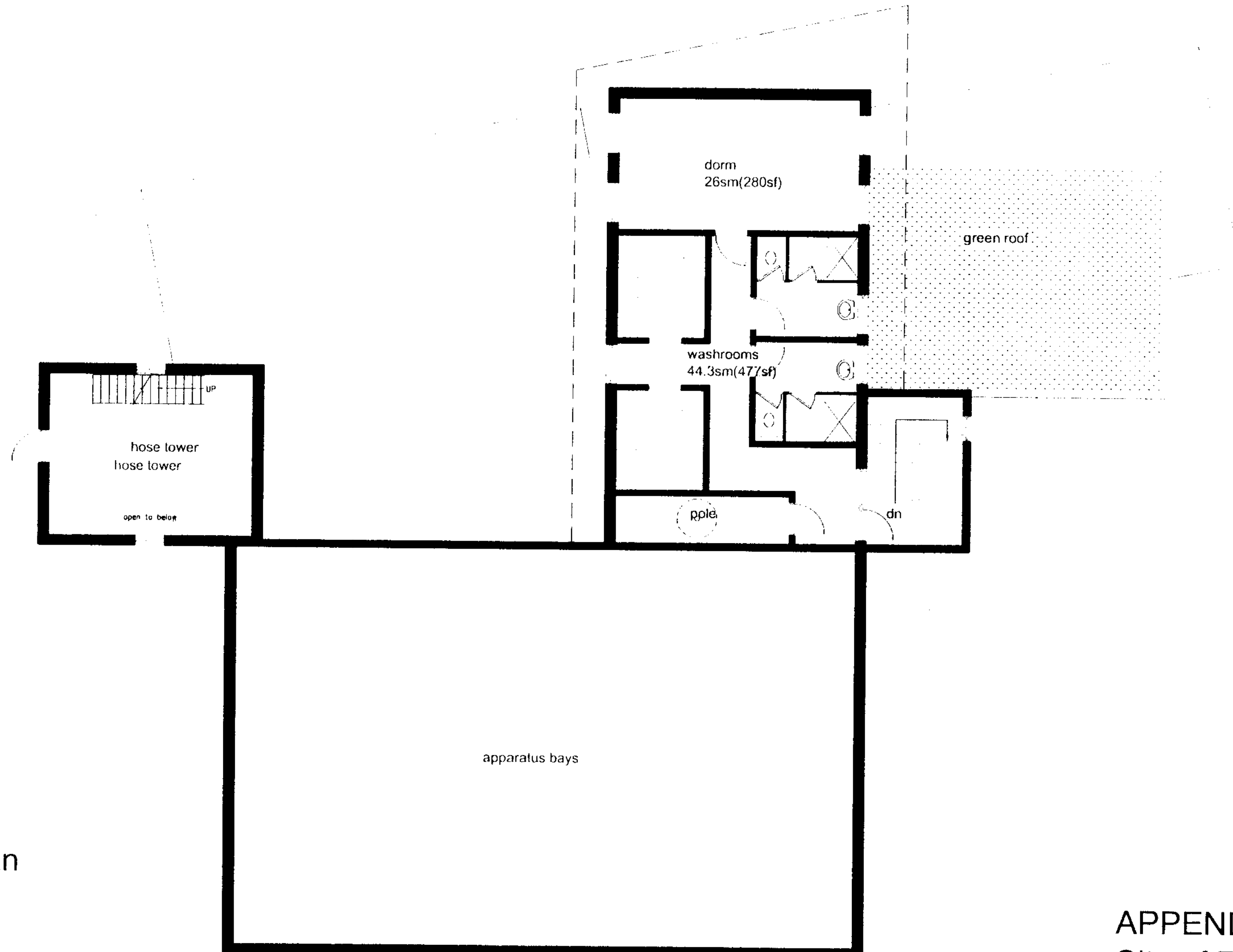

Third Floor Plan

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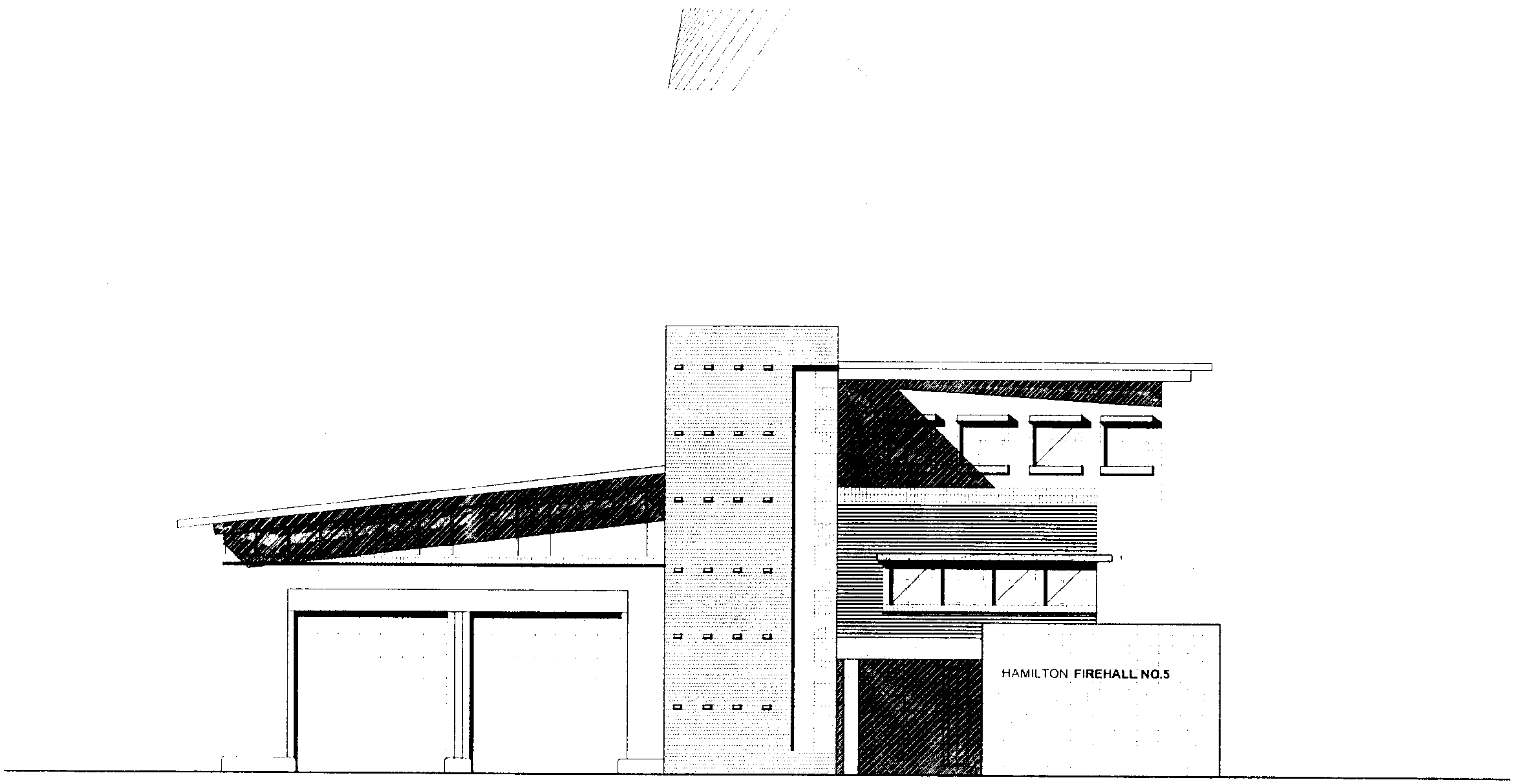

East Elevation

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Elevations
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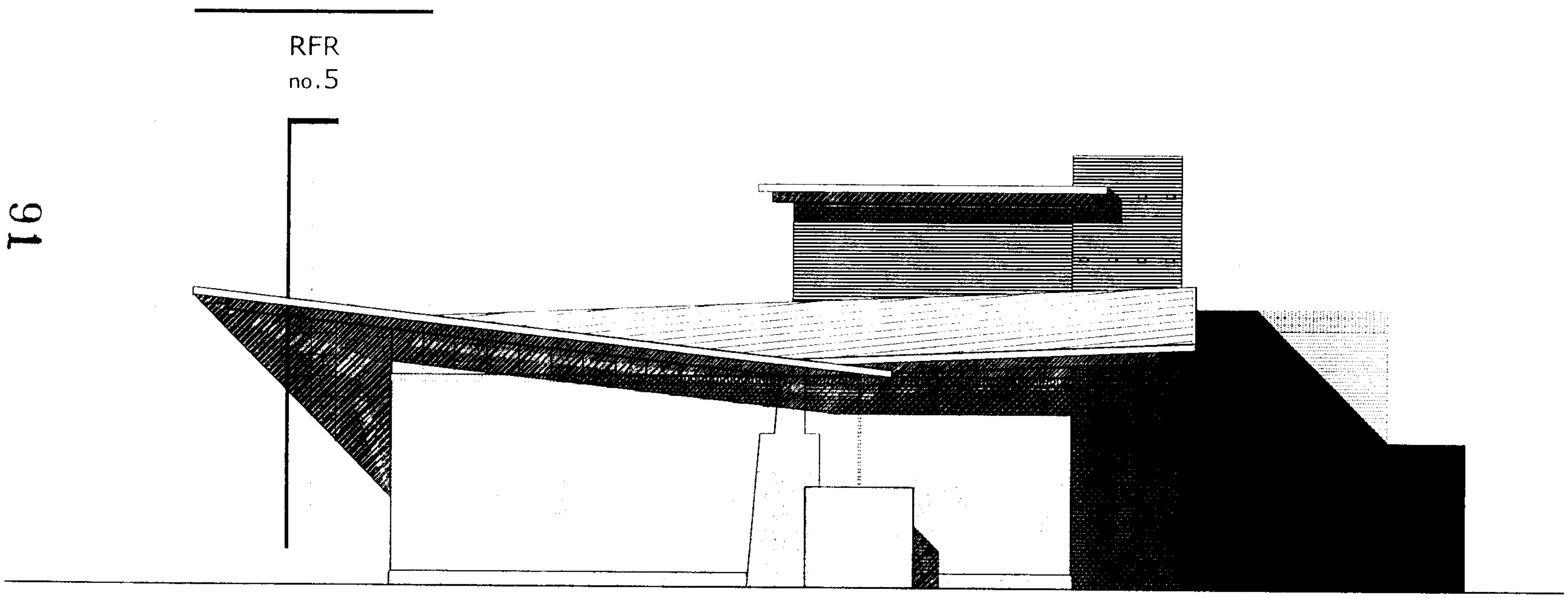

South Elevation

APPENDIX B
City of Richmond
Firehall No 5 - Hamilton

Elevations
03 / 02/ 05

It is recommended that ground densification by stone column installation be carried out for the proposed firehall building with either an at-grade foundation or a piled foundation so that liquefaction of the sand deposit does not occur. Installation of stone columns by the vibro-replacement method is anticipated to be most the suitable ground improvement method for the subject site. Carrying out ground improvement at the building site and to about 6m beyond the building site is anticipated to be sufficient.

After ground improvement, it is estimated that in the event of a major earthquake the potential for horizontal ground movement at the building will be in the order of 100mm. Ground settlement induced by a major earthquake event is estimated to be limited to 30mm if suitable ground densification is carried out. Horizontal ground movement and settlement of this magnitude is considered to be tolerable for the proposed structure on a raft slab provided the structure is designed to accommodate some differential ground movement.

4.5 Peat Stripping, Structural Fill and Preload

As discussed above, recommended site preparation for a building founded at-grade on a raft slab includes stripping of existing fill and organic-rich soil followed by structural fill placement and preloading.

Stripping of existing fill and organic-rich soil and placement of structural fill is recommended to limit the potential for post-construction building settlement. Stripping will likely be required to about 3m beyond the building outline. Therefore, offsetting buildings from the property lines may be appropriate if permission to excavate beyond the property line can not be obtained.

Structural fill should be placed to restore grade to the under-side of raft slab level. It is recommended that structural fill consist of clean, pit-run sand or river sand compacted in 300mm vertical lifts to at least 100% of Standard Proctor maximum dry density, in accordance with ASTM D-698. Vibrations induced by fill compaction works will be noticeable at off-site areas and may negatively impact neighbouring buildings. Using a small, walk behind drum compactor with 300mm lifts will limit off-site vibrations to levels that generally do not raise concerns with neighbours. It is recommended that a sample of proposed structural fill be provided to the Geotechnical Engineer of record to confirm the materials suitability prior to its use.

Preload fill may consist of any granular fill that has relatively high density, including river sand. It is anticipated that placing the top of the preload at 1.5m above the floor slab level and 1.5m beyond the building outline will be appropriate. A preload duration of 3 to 6 months is estimated to be sufficient. If a shorter preload duration is desired, a higher preload could be utilised. Review of the actual preload settlement by the Geotechnical Engineer is required to confirm suitable preload duration. Preload settlement is measured by surveying preload monitors at regular interval.

It is understood that grade will be raised at parking areas and driveways adjacent to the building. Delaying paving and installation of buried services at parking, driveway, storage and other areas for three months or longer after the placement of fill to raise grade will allow the majority of the settlement induced by the fill weight to occur, limiting the magnitude of post-construction settlement. Placing the grade fill at parking and driveway areas at the same time as the building preload could be considered to minimise post-construction settlement and construction delays. However, higher costs will be incurred relative to utilising the building preload fill for grade fill at parking and driveway areas.

Placement of preload fill and fill to raise grade can induce significant settlement at off-site areas, in particular at areas within 5m of fill placement. The Geotechnical Engineer can further assess this risk when grading plans are available. It is recommended that the Geotechnical Engineer prepare an Excavation and Preload Drawing once building locations and grades are available.

4.6 GROUND DENSIFICATION WORKS

The sand deposit contains layers subject to liquefaction in the event of major earthquake. Ground densification to reduce or eliminate liquefaction of the sand deposit is recommended to limit the potential for ground movement at the building site to tolerable levels in the event of a major earthquake event. Ground densification in the Richmond area is generally achieved by compacting the soil through the process of installing gravel column by the vibro-replacement methods. It is recommended that the site be densified to at least 6m beyond the proposed building outline.

The depth to which densification works are required varies from 12m to 16m across the site based on the two CPT's. It is recommended that several additional CPT's be advanced at the building area to finalise the depth to which densification works are required once the building location is finalised and access for drilling equipment to the building area is available (i.e. vegetation cleared and ditches filled as required). For preliminary costing, it is suggested an average depth of 15m for densification be assumed.

It is recommended that the contract for ground densification be based on performance criteria as the densification results are significantly influenced by the Contractor's methodology. Electric cone penetration tests (CPT's) are the most effective method to assess the performance of the ground densification works. The performance criteria should be finalised by the Geotechnical Engineer prior to tendering based on review of site grading, the additional CPT testing and other parameters. Performing densification at a small test section is recommended to assess the effectiveness of the Contractor's methodology.

4.7 POTENTIAL OFF-SITE IMPACTS OF PILE DRIVING AND GROUND DENSIFICATION

Pile driving and ground densification works can cause significant vibrations, which may impact nearby structures. It is recommended that vibration monitoring be carried out at adjacent buildings to assess if excessive building vibrations are being induced.

Pile installation or ground densification works can cause movements in nearby structures due to displacement of soil as the pile or stone column is installed, in particular within 10m of the work. It is recommended that settlement/heave monitoring programs be conducted during the driving to assess whether neighbouring buildings, roads and services are experiencing excessive movement.

There is some potential that vibration from pile driving or ground densification may cause minor cracking to building finishes at near-by buildings, in particular within about 30m of the work. It is recommended that a pre-construction building condition survey of these buildings be carried out to document building conditions prior to piling work or ground densification works. This information will be useful to assess the validity of any damage claims that may arise.

Levelton possesses the experience and expertise to conduct the pre-construction condition survey and vibration monitoring and would be pleased to provide such services upon your request.

City of Richmond
Firehall No. 4- Sea Island
VIEW FROM SOUTH EAST
03/03/03

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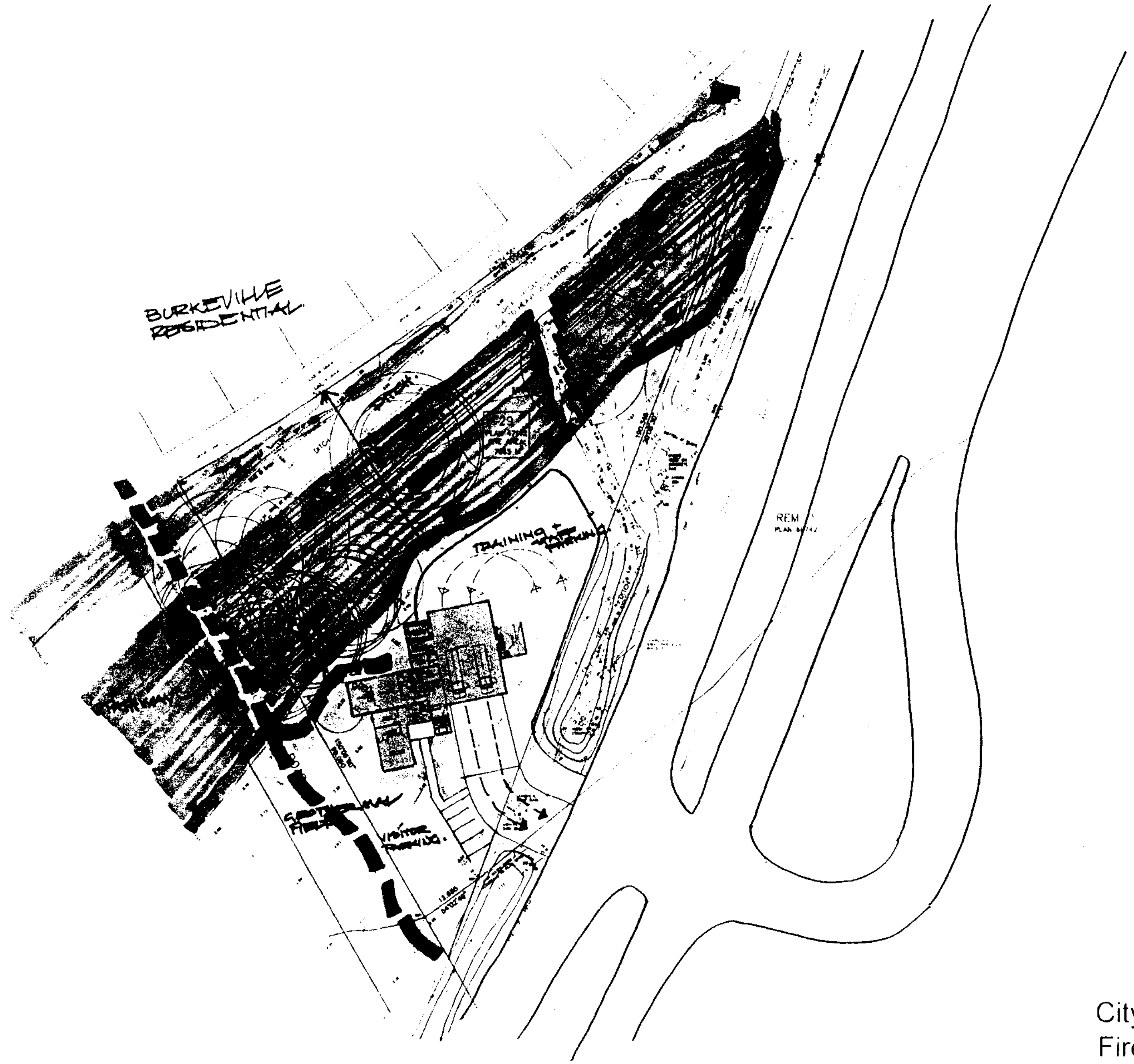

City of Richmond
Firehall No 4 - Sea Island

Site Plan
1:400

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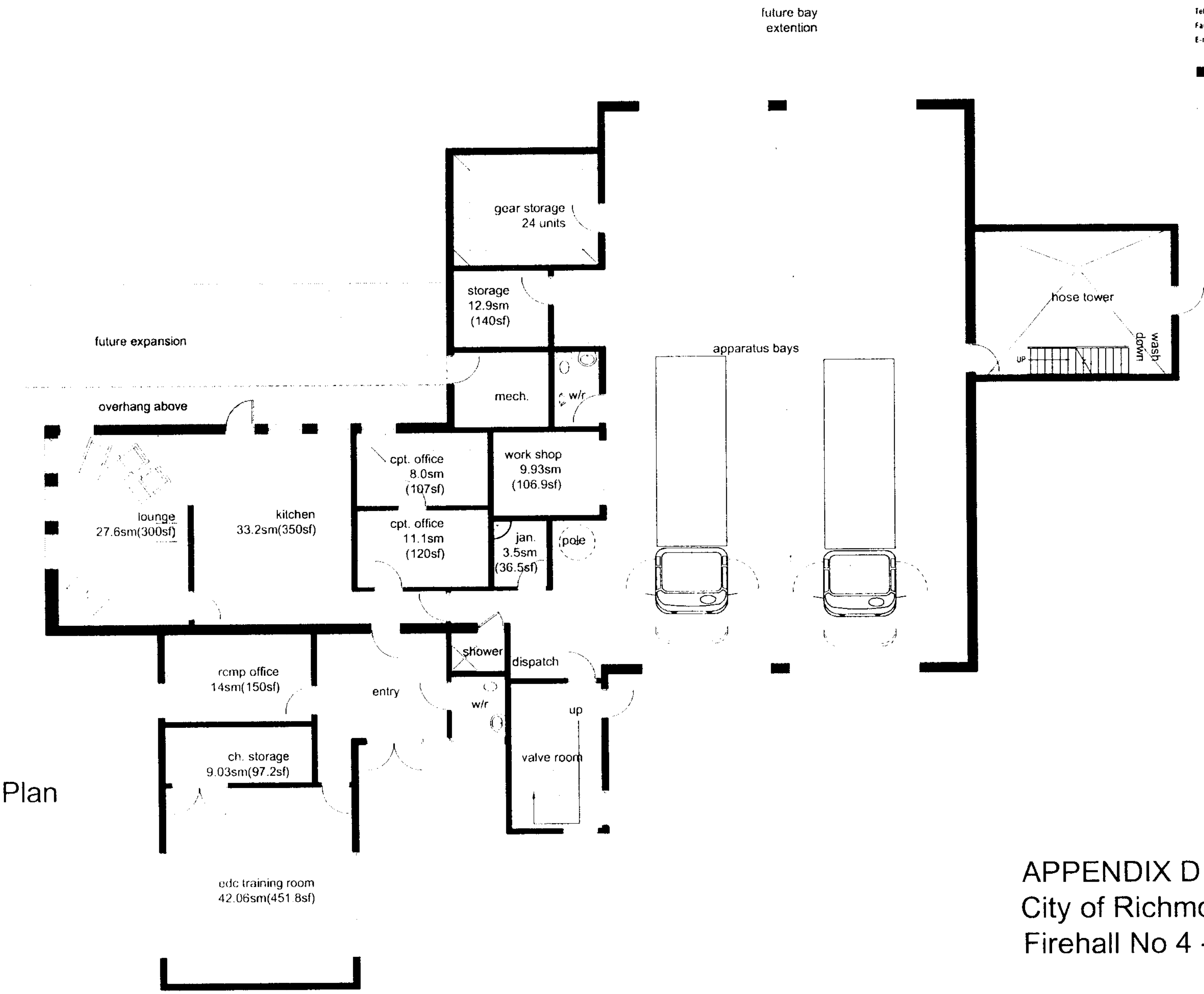

Main Floor Plan

APPENDIX D
City of Richmond
Firehall No 4 - Sea Island

Schematic Floor Plans
03 / 02/ 05

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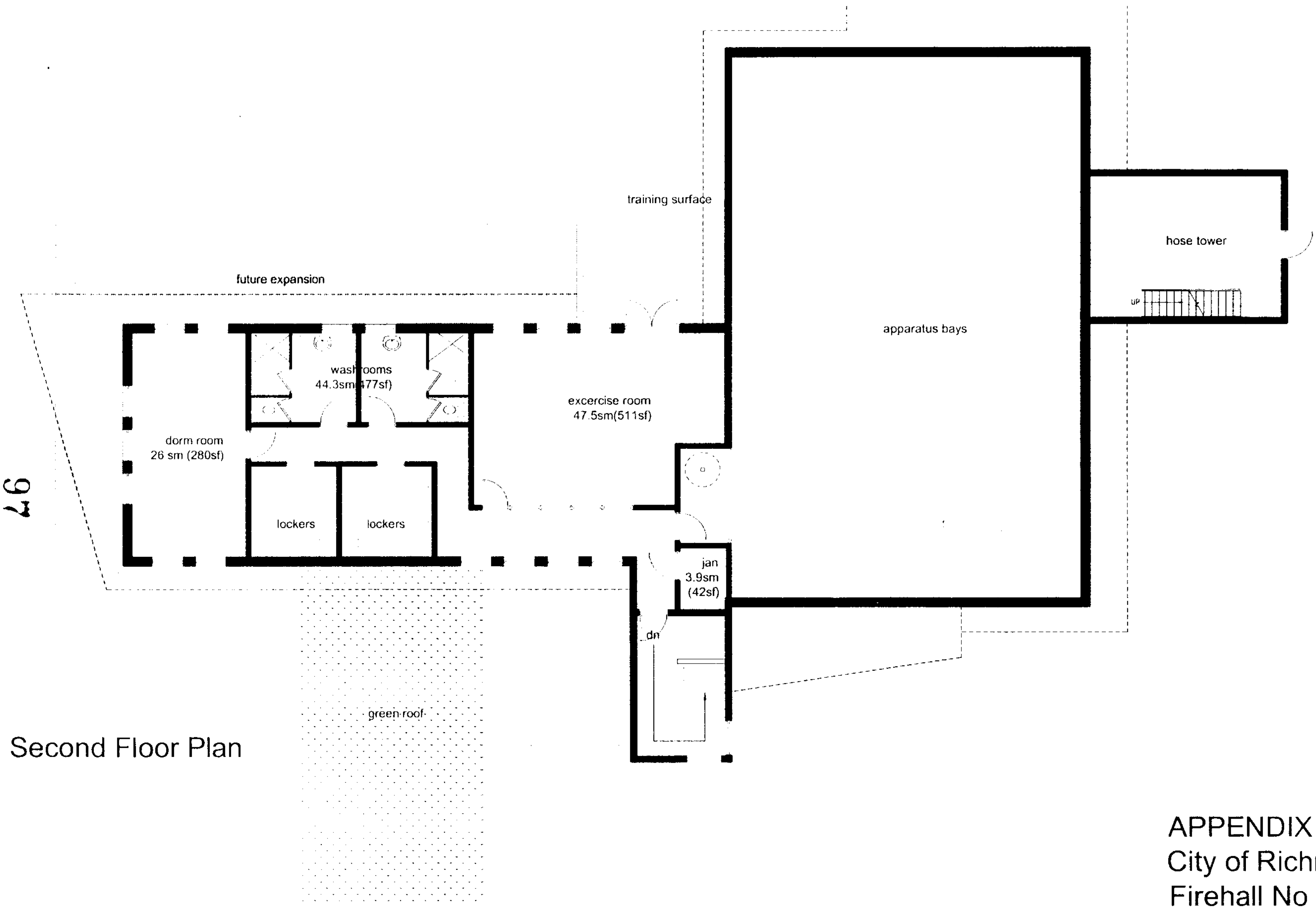

Second Floor Plan

APPENDIX D
City of Richmond
Firehall No 4 - Sea Island

Schematic Floor Plans
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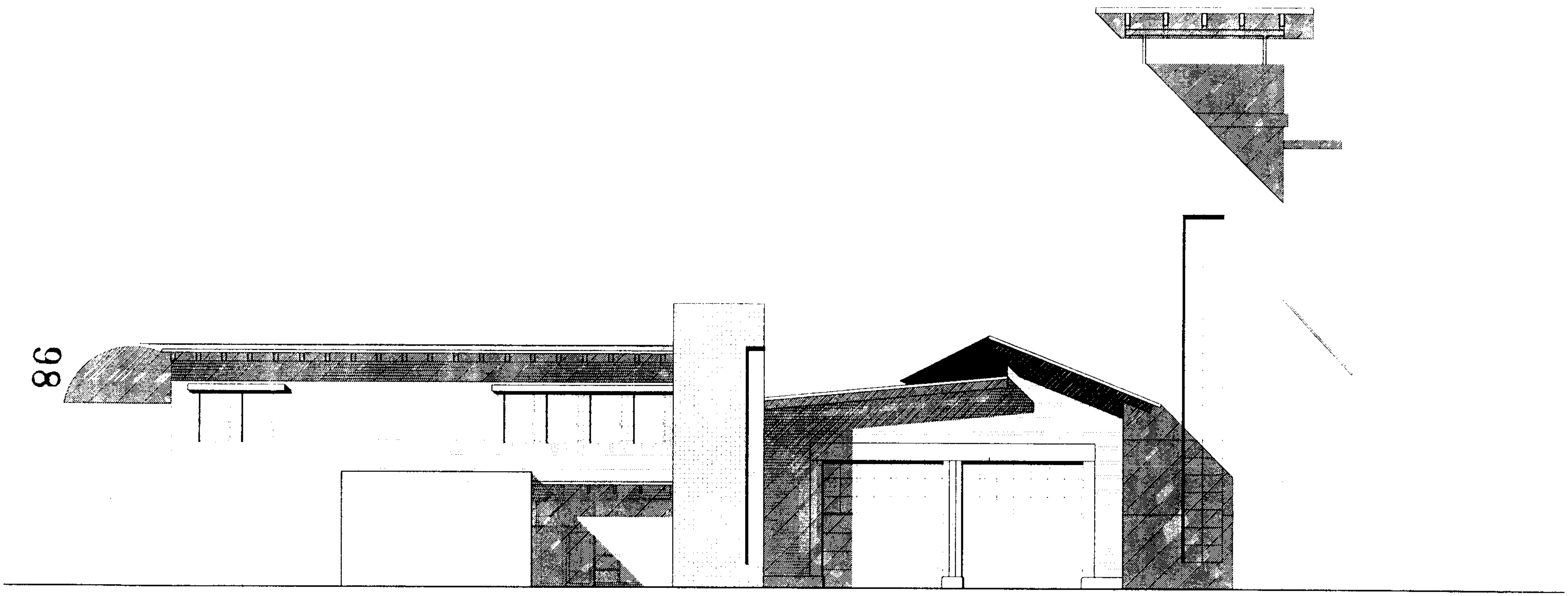

south elevation

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City of Richmond
Firehall No 4 - Sea Island

Schematic Floor Plans
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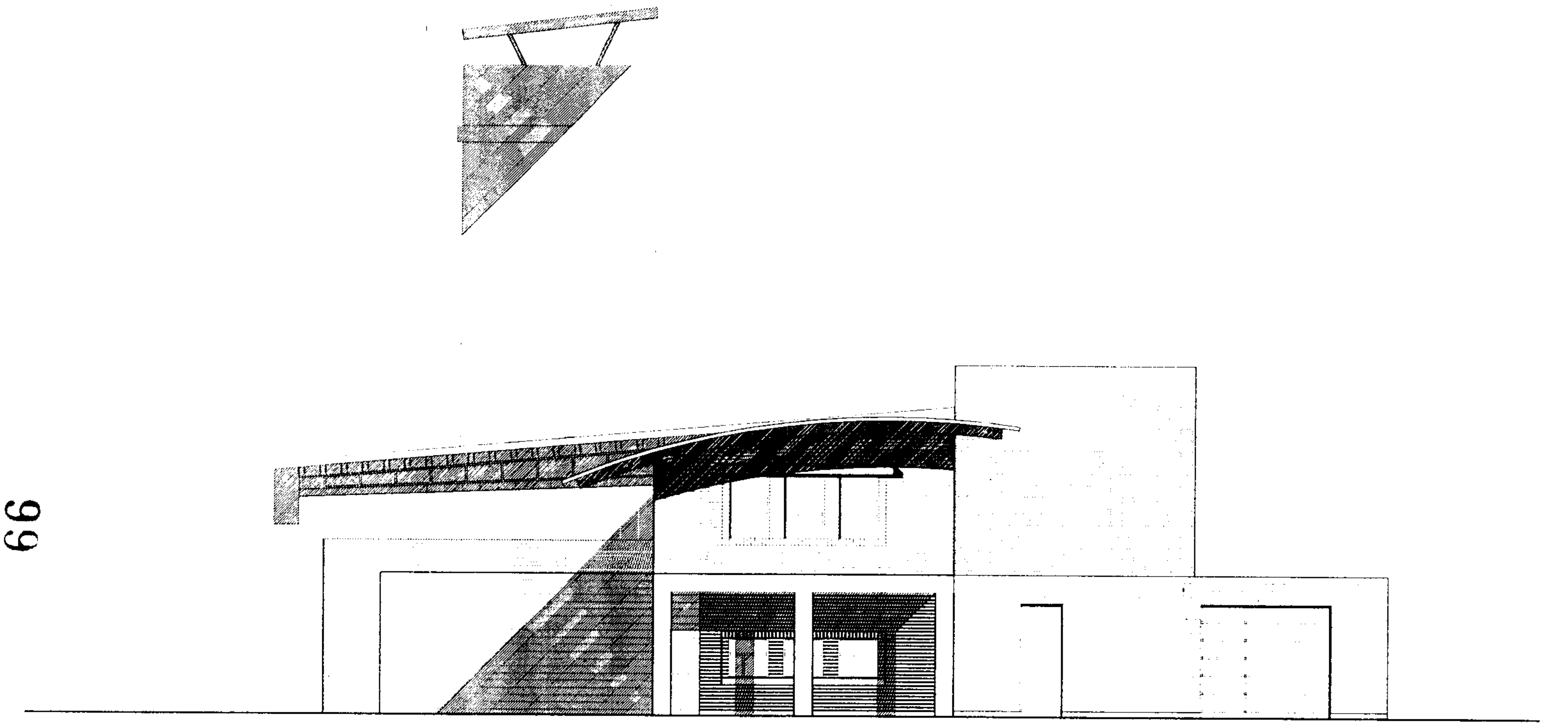

west elevation

APPENDIX D
City of Richmond
Firehall No 4 - Sea Island

Schematic Floor Plans
03 / 02/ 05

Facility	2002 Civic Election year	2003	2004	2005 Civic Election year	2006	2007	2008 Civic Election Year	Project Totals
CSB HQ Replacement (RCMP, RFR, EOC, Traffic) 108,000sf								$ 31,345,500
CSB HQ Bylaw Enforcement – 3,500sf								$ 1,017,000
Fire Hall No. 2 Steveston - Seismic Upgrade								$ 1,039,000
Fire Hall No. 3 Bridgeport - Replacement				[illegible]				$ 2,613,200
Fire Hall No. 3 Bridgeport - Temporary Facility				$ 260,850				$ 260,850
Fire Hall No. 4 Sea Island Replacement		Preload $ 200,000	Const $ 2,270,000					$ 2,595,225
Fire Hall No. 5 Hamilton Replacement		Preload $ 300,000	Const $ 2,170,000					$ 2,595,000
Fire Hall No. 5 Land Acquisition		Land $ 697,600						$ 697,600
Fire Hall No. 6 Seismic Upgrade								$ 824,350
Fire Hall No. 7 Renovations							[illegible]	$ 246,600
Public Art Funding at 1% of Actual Construction Cost			F4 and F5 $ 36,200	F3 $ 18,100		Tennis Club Relocation $ 783,000	CSBHQ $ 225,000	$ - $ 1,062,300
PROJECTED CASH FLOW	**$250,225**	**$1,222,600**	**$4,601,200**	**$2,914,650**	**$4,278,000**	**$16,062,950**	**$14,967,000**	$ 44,296,625