Environmental Impact Issues in the Transformation of Existing Apartments Into "Ecoresidences" at Macdonald Campus of McGill University

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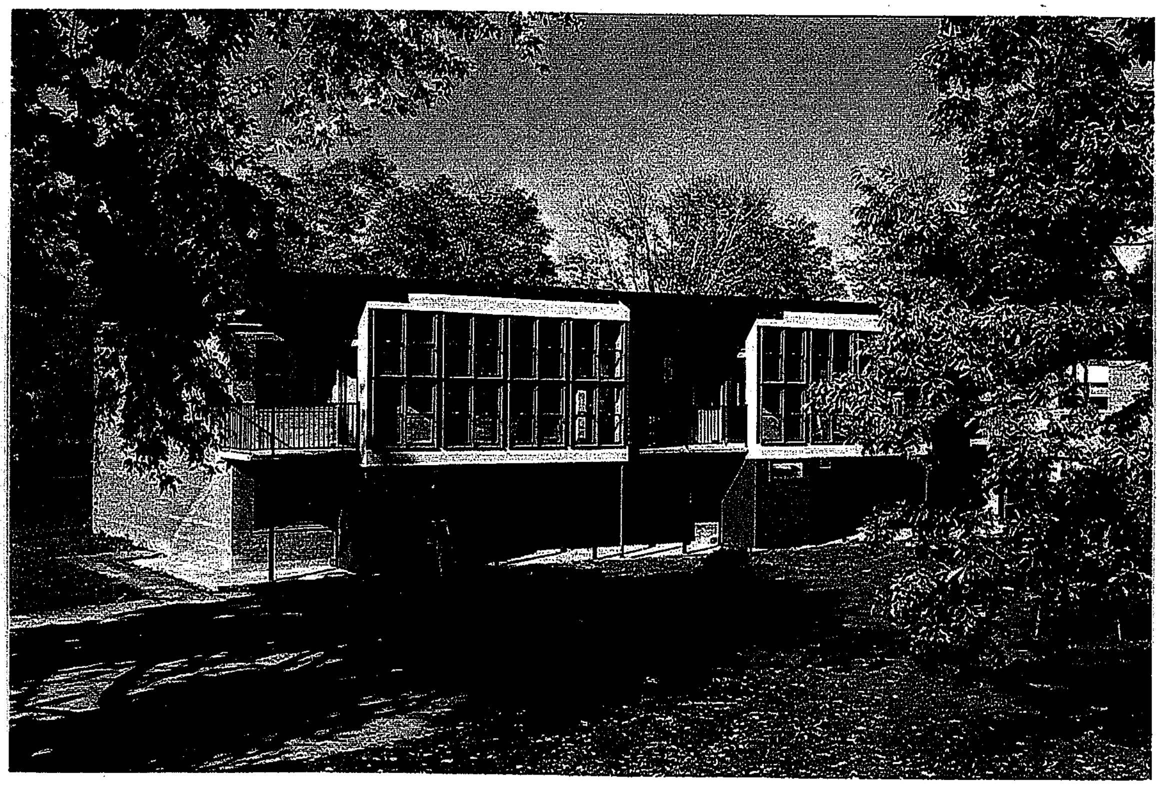

EXECUTIVE SUMMARY

The EcoResidence Project is located on Macdonald Campus of McGill University in Sainte-Anne-de-Bellevue at the western tip of the island of Montreal.
The project consists of a renovation of an existing 60 apartment student residence building (originally called Robertson Terrace) built over 30 years ago. The renovation process places emphasis on environmental performance, through the re-use of existing facilities, the re-use and recycling of materials, the introduction of suitable environmental initiatives (or at least the minimal infrastructure to allow these items to be easily added in the future) and the improvement of energy performance.

The EcoResidence project has been committed to an environmental position, combining a research farm, arboretum and academic campus with housing for staff and students, who were integrally involved in the development, research and monitoring of the project. The construction phases 1 and 2 addressed the programming and transformation requirements of the project, as well as the integration of numerous ecologically sound responses to sustainability without burdening the project with major cost increases or scheduling delays.

The "environmental initiatives" represent innovative and environmentally sensitive approaches, systems or attitudes that are fundamental to creating a project that can be both a model and a laboratory of environmental sustainability. These initiatives, broken down into infrastructure and item cost, were to be integrated throughout the construction period and beyond, as research is completed and funding becomes available.

These "environmental initiatives" include active solar energy heating of hot water, rain water collection and distribution, passive solar heating from greenhouses, reuse and recycling of dismantled components, waste water treatment facility or gray water recuperation, innovative organic gardening and landscaping, replacement of existing electric heat source with alternative renewable heat source(s), specific energy efficiency measures, innovative environmentally-friendly furniture and equipment and creating a PVC-free project.

A couple of ecologically-sensitive components of our project resulted in minimal cost increases and a very modest lengthening of the timetable of the project. These items included insulating the new roof/attic space and separating masonry from other demolition components. Other "environmental initiatives" (such as upgrading existing windows and doors, reusing on site other windows and doors etc...) in fact led to significant cost savings and no increase in the time for construction. In order to meet the concerns of the numerous client representatives it was necessary to simultaneously improve energy performance and transform the overall aesthetic of the buildings.

The reuse of windows and doors was the most ambitious aspect of reuse carried out on the project. The exercise required a considerable amount of additional coordination for us, including detailed inspections of the condition of each door and window in order to specify necessary work and considerable follow-up as the work proceeded. In producing detailed schedules and specifications, we were able to direct the work of the contractor very precisely, controlling both costs and scheduling effectively. Certainly such work is time consuming and labor intensive, but there were no undue delays and the final costs of the work certainly make this approach very attractive.

Although this project has attempted in many ways to incorporate some energy saving and sustainable development measures which rely on newer technologies (if not the complete item, then at least its planning or infrastructure so as to facilitate its eventual inclusion), the majority of these environmental measures taken have in fact been based on "low-tech" common sense principles applied through a careful transformation of the buildings.

To complete a built project that is genuinely founded on environmental principles, numerous conditions and factors must be created and set in place; collectively defining and committing to common project goals and team participant roles from the outset of a project; anticipating the sensitivity of a project to time and financial constraints, scale of economies and collaboration efforts, while addressing client expectations; and having the courage to attempt an innovative process outside of traditional conventions.

When a myriad of diverse goals are initially outlined, their eventual compatibility is heavily dependent on clearly defining team roles and prioritizing project goals. Our case study project included the participation of numerous players; client (Dean of the faculty, student user representatives and management employees), project manager (separate from the client, but acting as an agent for the client), fundraising team, consulting engineers (structural, and mechanical / electrical) and ourselves, architects. Although as architects we often coordinated the group of participants with respect to environmental research, planning and technical solutions, the responsibility for financial decisions (which impacted directly on the order of priorities) was controlled and shared by different participants during different phases. By not creating a unique collaborative unit, working in parallel on all decision-making responsibilities, the environmental depth of the project was dependent on the efforts of individual participants and their capacity to convince their fellow colleagues. More emphasis should be placed on developing a collaborative process from the outset, that allows innovative projects to be built. This may result in increased project start-up costs, risk-taking (but not necessarily from a financial perspective), and increased time commitments, but it could save considerable time and money in the long run.

Reuse of building materials and components in this project dictated a supplementary degree of coordination and collaboration between design professionals, client representatives and the builder. The design process actually extended well into the preparation of contract documents, tendering and some aspects continued into the construction phase as well. With a traditional client (in our case study, a university), financial uncertainty is not acceptable after the completion of final design..

The approach of incorporating numerous sustainable development principles in our base design while planning (and in some cases including) additional environmental initiatives for future phases, is both promising but highly complex and messy.

We believe that, given the right circumstances, there are many latent opportunities out there awaiting motivated clients. Two key elements to promoting the potential of these dormant projects are the following:

The need to assemble and disseminate well documented case studies supporting sustainable development as both a philosophical and financially viable alternative.

The need to encourage both consultants and clients to partake actively in the labor-intensive processes of the project. In order not to simply rely on the good-natured enthusiasm of these consultants and clients, grants, subsidies or tax breaks should be created to compensate and acknowledge the complex roles that these participants must perform. The real costs to society would still nonetheless be reduced.

Incidences sur l'environnement de la transformation d'appartements existants en « écorésidences » sur le campus Macdonald de l'Université McGill

RÉSUMÉ

Le projet d'ÉcoRésidence du campus Macdonald de l'Université McGill est situé à Sainte-Anne-de-Bellevue à l'extrême ouest de l'île de Montréal. Il s'agit de la rénovation d'une résidence existante pour étudiants de 60 appartements (nommée à l'origine Robertson Terrace) construite il y a 30 ans. La rénovation vise avant tout à améliorer le rendement environnemental des bâtiments; seront incorporés au processus la réutilisation d'installations existantes, la réutilisation et le recyclage de matériaux, l'introduction d'options écologiques valables (ou au moins de l'infrastructure de base permettant de les ajouter facilement dans l'avenir) et l'amélioration du rendement énergétique.

En associant une ferme expérimentale, un arboretum et un campus universitaire au logement des membres du personnel et des étudiants qui ont participé à l'élaboration ainsi qu'aux activités de recherche et de suivi, le projet d'ÉcoRésidence a traduit une attitude respectueuse de l'environnement. Les étapes 1 et 2 de la construction ont porté sur la programmation et la rénovation ainsi que sur l'intégration de nombreuses caractéristiques écologiques pour un environnement durable sans pour cela grever le budget de hausses de coûts importantes ou causer des retards dans le calendrier des travaux.

Ces caractéristiques ou « options » écologiques correspondent à des procédés, à des systèmes ou à des attitudes novateurs et écologiques qui sont essentiels pour créer un projet pouvant servir de modèle et devenir un laboratoire de durabilité environnementale. Les options, réparties en coûts d'infrastructure et en coûts d'éléments, devaient être intégrées pendant et après la construction, au fur et à mesure que les recherches se terminaient et que les sommes nécessaires à leur concrétisation étaient débloquées.

Ces options écologiques englobent le chauffage de l'eau chaude à l'énergie solaire active, la collecte et la distribution des eaux de pluie, le chauffage solaire passif au moyen de serres, la réutilisation et le recyclage des matériaux de démolition, la mise en place d'une station d'épuration des eaux usées ou la récupération des eaux grises, le jardinage et l'aménagement paysager organiques novateurs, le remplacement des sources de chaleur électriques existantes par des sources de chaleur renouvelables et l'adoption de mesures précises d'amélioration du rendement énergétique, l'utilisation de mobilier et d'équipement « verts » novateurs et l'élaboration d'un projet sans PVC.

Quelques-uns des éléments écologiques de notre projet n'ont entraîné que des

coûts marginaux minimes et un léger retard par rapport au calendrier prévu, par exemple l'isolation du nouveau comble et la séparation des matériaux de maçonnerie des autres matériaux de démolition. D'autres options écologiques (comme la rénovation des anciennes portes et fenêtres, la réutilisation des autres portes et fenêtres, etc.) ont en réalité permis de faire des économies importantes et n'ont pas causé de retard dans l'exécution des travaux. Pour rassurer les nombreux représentants du client, il a fallu améliorer le rendement énergétique des bâtiments tout en modifiant leur architecture.

La réutilisation des portes et fenêtres était l'aspect le plus ambitieux du volet réutilisation du projet. Cela a exigé beaucoup plus de coordination de notre part, entre autres l'évaluation détaillée de l'état de chaque porte et fenêtre pour déterminer le travail de rénovation à faire et énormément de suivi pendant les travaux. En établissant un calendrier détaillé et en élaborant des directives, nous avons pu guider très précisément le travail de l'entrepreneur maîtrisant par le fait même les coûts et l'ordonnancement des travaux. Il est vrai que ces activités prennent beaucoup de temps et de travail, mais malgré cela, elles n'ont causé aucun retard exagéré et le coût final des travaux rend ce procédé très intéressant.

Bien qu'on ait tenté, au cours du projet, diverses façons d'incorporer des mesures d'économie d'énergie et de développement durable qui s'appuient sur des technologies nouvelles (si ce n'est pas l'élément en soi, du moins sa planification ou son infrastructure pour en faciliter l'incorporation ultérieure), la majeure partie de ces options écologiques se sont appuyées, en réalité, sur des éléments de « technologie rudimentaire », c'est-à-dire qu'on a fait appel au simple bon sens en procédant à une transformation prudente des bâtiments.

Pour mener à terme un projet de construction authentiquement écologique, de nombreuses conditions et de nombreux facteurs sont essentiels : il faut que tous les intervenants participent à la définition du projet, s'engagent à réaliser les objectifs communs et chacun doit connaître son rôle au sein de l'équipe dès le départ; il faut prévoir dans quelle mesure le projet sera sensible aux délais courts et aux contraintes financières; il faut aussi avoir une idée des économies d'échelle à réaliser et des efforts de collaboration nécessaires, et ce tout en répondant aux attentes du client; il faut enfin avoir le courage d'adopter un processus novateur qui s'écarte des sentiers battus.

Lorsqu'on établit au départ une myriade d'objectifs différents, leur compatibilité éventuelle est étroitement liée à la clarté des rôles définis pour chaque membre de l'équipe et à leur degré de priorité. Notre projet-pilote a exigé la participation de nombreux acteurs : le client (doyen de la faculté, représentants des étudiants utilisateurs et employés d'entretien), le gestionnaire du projet (différent du client, mais agissant aussi à titre de représentant du client), l'équipe de levée de fonds, les ingénieurs-conseils (ingénieur des structures et ingénieurs électricien et mécanicien) et nous-mêmes, les architectes. Même si en tant qu'architectes nous avons souvent coordonné les efforts du groupe d'intervenants pour ce qui est de la recherche environnementale, de la planification et de l'élaboration de solutions techniques, les décisions financières (qui influaient directement sur l'ordre de priorités) étaient prises par des participants différents suivant les étapes. La mise en place de plusieurs unités de collaboration et le travail parallèle pour toutes les prises de décisions ont créé une situation où l'ampleur du projet environnemental dépendait des efforts individuels de chaque participant et de sa capacité à convaincre ses collègues. Il faudrait s'efforcer d'instaurer un processus de collaboration dès le début, collaboration qui permettra de mener à bien des projets innovateurs. Les coûts de démarrage, les risques (pas nécessairement du point de vue financier) et le nombre d'heures à investir seraient peut-être plus élevés, mais cela permettrait de réaliser à long terme des économies considérables de temps et d'argent.

Dans ce projet, la réutilisation de matériaux de construction et d'éléments a exigé encore plus d'efforts de coordination et de collaboration entre les concepteurs, les représentants et le constructeur. Le processus de conception a débordé sur les étapes de la préparation des documents contractuels et de l'appel d'offres, certains points n'ayant été réglés que pendant la construction proprement dite. Avec un client traditionnel (dans le cas présent, une université), l'incertitude financière est inacceptable après l'achèvement du plan final.

Le fait d'incorporer de nombreux principes de développement durable dans notre conception de base tout en planifiant (et dans certains cas en incluant) des options écologiques additionnelles pour des étapes ultérieures, est très prometteur mais aussi très complexe et propice à la confusion.

Nous croyons que, en présence de circonstances favorables, il y a beaucoup de possibilités qui n'attendent que des clients motivés à les exploiter. Voici deux éléments clés pour faire valoir le potentiel de ces projets dormants :

> Il faut élaborer des études de cas bien documentées appuyant le développement durable comme solution viable tant d'un point de vue philosophique que financier et les diffuser.
>
> Il faut encourager les consultants et les clients à participer activement aux processus des projets à forte densité de main-d'oeuvre. Pour ne pas compter seulement sur l'enthousiasme de ces experts-conseils et de ces clients, des bourses, des subventions ou des allégements fiscaux devraient être créés pour soutenir et reconnaître le rôle complexe que ces participants doivent jouer; il en coûterait quand même moins cher à la société.

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1. INTRODUCTION

A. Background

Location and Site:

The EcoResidence Project is located on Macdonald Campus of McGill University in Sainte-Anne-de-Bellevue at the western tip of the island of Montreal.
The project consists of a renovation of an existing 60 apartment student residence building (originally called Robertson Terrace) built over 30 years ago. The renovation process places emphasis on environmental performance, through the re-use of existing facilities, the re-use and recycling of materials, the introduction of suitable environmental initiatives (or at least the minimal infrastructure to allow these items to be easily added in the future) and the improvement of energy performance.

The architects, Daniel Pearl and Mark Poddubiuk of L'O.E.U.F. (L'Office de l'Éclectisme Urbain et Fonctionnel), who teach at McGill University School of Architecture and UQAM school of Environmental Design, have attempted to position the project as one that is not only financially viable, but one that is research oriented and inclusive; students from both McGill's School of Architecture and the Faculty of Agricultural and Environmental Sciences have participated in design and analytic exercises as related to the core transformation project as well as parallel suitable environmental initiatives (menu items, which will be described later on).

This project is of considerable relevance to the CETC C-2000 program, because of the relative lack of depth in the program of information relating to the use of re-use of materials, including issues related to logistics, embodied energy, verification of performance of existing materials to new uses, storage, handling and cost issues.

B. Project Mandate

The two T-shaped two storey residential blocks of Robertson Terrace, built in 1965-67 as one & two bedroom apartments, had become significantly dilapidated over the years due to the lack of regular maintenance (see photos 1 & 2 and drawings 3 - 8). Built with load-bearing masonry walls, mostly concrete floor slabs and wood joists supporting the original roofs, these buildings were constructed to surpass a 30 year life span. The total gross area of both buildings is 39 000 square feet.

The architectural mandate was to evaluate the condition of the existing run-down apartment buildings, and to recommend either complete or partial demolition of the two blocks along with new construction if appropriate. No capital funds were available for the project and any proposal had to be self-financing; supported exclusively by future students' rent.

While major repairs were required, the superstructure was sound and the buildings were worth salvaging. The decision was made to group together 40 of the existing one bedroom apartments to create 10 new 6-bedroom, two storey units, as well modestly renovate the 20 existing, 2-bedroom, two storey units (there were not enough funds available to transform these 20 two-bedroom apartments into larger units). The renovation of Robertson Terrace transformed it into an "Eco-Residence" - a project that incorporates the latest in recycling/reuse techniques and many "green" products as well as providing a forum for innovative academic ecological research. It provides the opportunity to create an Ecological Living Group, expressing the common interest of its residents to experiment in ecological living.

The original residential blocks, although durable, were quite sober, in the minimalist modernist tradition. The absence of color, modulation, extension of the roof plane and hierarchical treatment of the landscape, led to a negative image that the transformation strategy needed to address. *(The faculty had labeled the buildings 'Motel Sarajevo').*

We have attempted to position the project as one that is not only financially viable, but one that is research oriented and inclusive; students from both McGill's School of Architecture and the Faculty of Agricultural and Environmental Sciences, participated in design and analytic exercises as related to the core transformation project as well as parallel suitable environmental initiatives.

Although this project has attempted in many ways to incorporate some energy saving and sustainable development measures which rely on newer technologies (if not the complete item, then at least its planning or infrastructure so as to facilitate its eventual inclusion), the majority of these environmental measures taken have in fact been based on "low-tech" common sense principles applied through a careful tinkering of the buildings. With a minimal initial budget of approximately $36 /square foot, one has no choice but to work within such parameters.

C. Project Description

PROJECT CONSTRUCTION COST:			$1 400 000.00
PROJECT SIZE:		Total gross floor area	38 000 s.f.
PROJECT COST PER SQUARE FOOT:			$35.90 /s.f.
PROJECT SCHEDULE:			
	phase 1	completed	Sept - Dec. 1997
	phase 2	completed	May - October 1998
	phase 3	Scheduled (but funding not confirmed)	May - October 1999

Client: McGill University, Montréal (Québec)
Deborah Buszard, Dean of the Faculty of Agricultural and Environmental Sciences
Gopal Menon, Project Manager, Facilities Development

Project architects: L'O.E.U.F. (L'Office de l'éclectisme urbain et fonctionnel)
Pearl Poddubiuk Hogan architecture et design
project team: Daniel Pearl, Mark Poddubiuk, Jill Hogan, Bernard Olivier, André Miller, Christine Besner.

Consultants: Preliminary design: Pearl Poddubiuk architectes (L'O.E.U.F. enrg.) in collaboration with Dr. Avi Friedman, consultant.
structural: Jan Vrana, structural engineer.
mech/electr.: N. Lapierre, Lamjian International.

General Contractor: Phase 1 – Construction Bramiteck INC.
Phase 2 - Gaston Champoux 1973 Inc.

Photographer: Daniel Pearl

2. IDENTIFICATION OF SUITABLE GROUPINGS OF ADDITIONAL ENVIRONMENTAL INITIATIVES FOR THIS (OR SIMILAR) PROJECT(S);

Gradually, past environmental innovations are being revived, entering mainstream building practice and design. Building systems are being designed mindful of conservation and recycling of energy and water, the use of renewable resources and improved air quality. Research is being focused on waste management - reduction, re-use and recycling non-toxic materials, durability, maintenance, life-cycle costing and manufacturing. Attitude changes in construction have been brought on by renewed consumer and professional awareness, government legislation, and financial and environmental imperatives, as well as individual and institutional enterprise.

The EcoResidence project at Macdonald Campus has been committed to this environmental position, combining a research farm, arboretum and academic campus with housing for staff and students, who were integrally involved in the development, research and monitoring of the project. The construction phases 1 and 2 addressed the programming and transformation requirements of the project, as well as the integration of numerous ecologically sound responses to sustainability without burdening the project with major cost increases or scheduling delays.

The *"environmental initiatives"* represent innovative and environmentally sensitive approaches, systems or attitudes that are fundamental to creating a project that can be both a model and a laboratory of environmental sustainability. These initiatives, broken down into infrastructure and item cost, are to be integrated throughout the construction period and beyond, as research is completed and funding becomes available.

The following table includes two columns labeled *estimated infrastructure costs and estimated total item costs.* The inclusion of these two columns is solely to help understand the magnitude of each of the *"environmental initiatives".*

There were initially ten major groupings of environmental initiatives recommended for this project (subsequently, Item # 7 had been removed by the client):

SUMMARY CHART OF ENVIRONMENTAL INITIATIVES:

	ENVIRONMENTAL INITIATIVES	Estimated infrastructure cost	Estimated total item cost
1	Solar heating of domestic hot water	$2 000 to $12 000	$30 000
2	Rain water collection and redistribution for use in greenhouses and laundry machines, and various measures to reduce overall water consumption	$2 000 to $10 000	$60 000
3	Passive solar heating from greenhouses	$5 000 to $20 000	$40 000 to $60 000
4	Re-use and recycling of dismantled components	$10 000 to $20 000	$50 000
5	Waste water treatment facility (living machine)	$6 000 to $15 000	$500 000 to $1 000 000
6	Innovative organic gardening and landscaping	$2 000 to $5 000	$50 000
7	Replacement of existing electric heat source with alternative renewable heat source(s).	$10 000 to $25 000	$150 000
8	Energy efficiency measures: lighting, kitchen appliances, improved building envelope airtightness (roof/ceiling, energy efficient windows and doors)	$2 000 to $4 000	$40 000 to $80 000
9	Environmentally friendly built-in and movable furniture and equipment	$2 000 to $4 000	$20 000
10	PVC - FREE project; replacing all PVC specifications with equivalent substitutes.	$2 000 to $4 000	$30 000 to $50 000

DESCRIPTION OF STATUS OF EACH ENVIRONMENTAL INITIATIVE:

(and their applicability to other similar projects)

1) ACTIVE SOLAR ENERGY HEATING OF HOT WATER

The heating of domestic hot water represents a significant portion of the energy consumption on most projects. The inclusion of *active solar energy heating of hot water* has already been proven worthy, both in terms of long term cost savings (payback over 10 to 15 years) and sustainability, in previous projects. What is less evident is a sensitive inclusion of this initiative in terms of both a project's aesthetics and user sensitivity.

A) Description of proposed strategy for our case study project:

The original domestic hot water system was heated in a central hot water tank in each building (RT1 and RT2) and then distributed to the individual units, supplying approximately enough hot water for 40 students per building. The initial renovation strategy called for each of the transformed 6-plex units to be provided with its own electric hot water tank, reducing heat loss in hundreds of feet of piping and providing individual control. This strategy would have still benefited from active solar preheating of the water (when the solar exposure was significant enough) by connecting the two large common domestic hot water tanks to active solar roof panels located above the two existing central mechanical cores.

B) Description of actual strategy employed or attempted and its future status:

Given the restrictive budget of the project, the client chose to keep the existing central hot water heating system as is, was decided upon by the client, mostly for cash flow reasons. An evaluation of how to heat these central hot water tanks through active solar panels was to be carried out by the client as well.

The reasons for pre-planning the *active solar energy heating of domestic hot water* from a design and user perspective included the following:

1) to ensure that no future installation of *active solar energy heating* significantly compromised the lifestyle and occupancy of the users (students);

2) to ensure that the installation of *active solar energy heating* could be centrally located over the existing central mechanical cores for maximum efficiency, ease of maintenance, as well as reserving enough room in a somewhat cramped mechanical core, was reserved so as not to force any duplication of work and costs in the future.

These two strategies were incorporated into the retrofitting of the two central mechanical cores. The costs for implementing the *active solar energy heating of domestic hot water* in the future has been minimized, and the decision as to when to undertake this environmental initiative still rests with the client.

2). RAIN WATER COLLECTION AND REDISTRIBUTION

Conservation and redistribution of rain water can contribute significantly to a reduction in consumption of fresh water resources. The reuse, (filtering and redistribution) of rainwater must be selective in order to be cost-efficient; low level uses such as washing machines and toilet bowls.

A) Description of proposed strategy for our case study project:

There is a central location (existing mechanical room) where both the main (rain water leader) RWL and sewage lines pass through before exiting into the main university sewage treatment systems, for each building (RT1 and RT2). These separate lines would make storage of rain water in centralized reservoir relatively straightforward. This water could then be distributed to adjacent laundry machines and possibly greenhouses. This initiative was originally planned to only function during non-winter months.

B) Description of actual strategy employed or attempted and its future status:

The reasons for pre-planning the *rain water collection and redistribution* from a design and user perspective were the following:

1) to ensure that no future installation of *rain water collection and redistribution* significantly compromised the lifestyle and occupancy of the users (students). For this to be respected, the redistribution of water to the greenhouses was eliminated;

2) to ensure that the installation of *rain water collection and redistribution* allowed enough room for both rain water collection and active solar hot water heating to co-exist within the same central mechanical core area.

These two strategies were incorporated into the retrofitting of the two central mechanical cores. The costs for implementing *rain water collection and redistribution* in the future, has been minimized, and the decision as to when to undertake this environmental initiative rests with the client.

C) Additional measures to reduce water consumption employed or attempted:

The phase 2 budget did not include any additional measures to reduce water consumption. Simple devices like special shower heads, low-flush toilets and self regulating faucets can effectively reduce water and energy consumption (they can be added by McGill maintenance staff inexpensively after the completion of phase 2). The client did not want to invest into this environmental initiative at the moment because there are no regulatory requirements or cost-saving incentives to motivate the client at this time, and unionized construction labor rates would have made these relatively inexpensive upgrades more expensive than necessary..

3). PASSIVE SOLAR HEATING FROM GREENHOUSES.

Greenhouses incorporating trombe walls can capture solar energy and store it for later use, then distribute this stored energy to the main living areas of the units by natural conduction and convection or by low-tech mechanical means.

A) Description of proposed strategy for our case study project:

By initially introducing new greenhouses into all of the individual units we were attempting to fuse together numerous ecological and design principles. Some of the environmental principles include the reuse of existing windows removed from the main building (bedrooms), incorporation of a new fresh air supply in conjunction with the creation of a crude *trombe wall*, (also conceived to embrace passive solar design principles). Some of the important design principles include the creation of a renewed architectural image with respect to both the newly formed individual 6-plexes as well as the revitalization of the overall central courtyard and the introduction of an entrance vestibule.

In order to maximize the passive solar energy potential of the greenhouses and render them as the active lungs of the units, a number of improvements were planned. Most greenhouse roofs would benefit from the addition of carefully designed sunlight scoops in order to maximize solar gain and compensate for their various orientations as well as ensure adequate ventilation in summer. Storage of solar energy could also be improved by excavating the lower level of the greenhouse and backfilling it with rubble from demolition.

Automated ventilation systems would optimize heat recovery from the greenhouses and rubble fill as well as distribution within the units, and could be combined with heat recovery ventilators to improve indoor air quality, possibly taking advantage of the capacity of plants to naturally filter air. This component also lends itself to student research and participation.

B) Description of actual strategy employed or attempted and its future status:

The important aspects in designing the *passive solar heating from greenhouses* from a programmatic and user perspective included the following:

1) to ensure that this feature is *not just a technical solution*, the greenhouses must animate both the courtyard as well as the individual 6-plexes from a visual and programmatic perspective;

2) to ensure that the use of the greenhouses by the students is not burdened with daily maintenance requirements.

These two strategies were incorporated into phase 2 of the project. The costs for implementing additional *passive solar heating from greenhouses* in the future, has been minimized (at the moment, it is planned that the greenhouses would only function during non-winter months, although an electrical circuit and outlet - to ensure non-freezing conditions to sustain plant-life, has already been incorporated). The elimination of the proposed light scoops at the top of the greenhouses was not realized because of the lack of funding and the evaluation that the net solar gain did not justify the extra costs even if funding were to be found. Storage of solar energy by excavating the lower level of the greenhouse and backfilling it with rubble from demolition would have proven to be somewhat more cost effective and sustainable, but the lack of funding during the construction phase of the project rendered this option impractical as well. The decision to modify the active use of the greenhouses (to allow for use during winter months) and the inclusion of an automated low-tech ventilation system, is still plausible and the decision rests with the client.

4) REUSE AND RECYCLING OF DISMANTLED COMPONENTS

Construction and demolition waste constitutes one third of all solid waste entering Canadian landfills and as such is a significant impediment to federal initiatives to reduce solid waste by 50% before the year 2000. Waste reduction in new construction is readily practiced on many new projects, and the recycling of construction waste is beginning to be practiced in some jurisdictions. Re-use, the incorporation of construction materials and assemblies intact with little or no modification in new construction and renovation is rarely practiced though it is probably the most environmentally sound alternative in waste management.

In order to best achieve a significant reduction in demolition and construction waste on this particular project, we have established the following objectives by order of priority

1. Reuse waste materials intact, on site for the same or similar applications as originally intended for the material (primary reuse)
2. Reuse waste materials on site by modifying them for a new application (secondary reuse)
3. Recycle waste materials off-site to produce more of the same material (primary recycling)
4. Recycle waste materials off-site to produce other materials or products (secondary recycling)

5. Reduce waste in the use of new materials as much as possible

A) Description of proposed strategy for our case study project:

In order to incorporate re-use as a strategy for waste reduction on this project, a number of tasks were to be undertaken. Materials to be salvaged were to be inventoried and evaluated, potential re-use applications were to be identified, techniques for dismantling materials and assemblies were to be determined, cleaning, preparation and storage requirements were to be defined and specifications for salvaging materials were to be prepared. Modifications of materials and assemblies were to be evaluated and the design and drawings revised to accommodate the specific nature of the used materials to be incorporated. Materials identified for potential re-use can be found in sections two and three.

1) Prior to any demolition work in the basic contract, we were to;

- prepare a list of all materials that would be generated as waste in the demolition,
- evaluate quantities, condition and suitability for reuse applications, the potential reuse applications for these materials within the project, any preparation or modification of materials necessary prior to reuse, how reused materials are to be dismantled and removed, how reused materials are to be stored, alternative methods of disposal of materials not suitable for reuse on this project (such as recycling),
- estimate additional professional (coordination, evaluation, specification) and construction related (dismantling, storage, preparation) costs,
- prepare specifications for the dismantling, storage and preparation of all materials to be reused, for source separation of all waste materials not to be reused so that they may be recycled or otherwise disposed,
- prepare guidelines for waste reduction in the use of new materials as a general condition of the contract (including monitoring quantities of waste materials, centralizing preparation of materials, prefabrication of components etc.)
- obtain necessary approvals from client for reuse, recycling and reduction of demolition and construction waste (including additional costs)
- tender and negotiate additional costs with general contractor.

2) The following tasks were planned to take place during the dismantling and construction stages of the basic contract;

- monitor quantities and condition of materials as they are dismantled,
- verify our original evaluation of the suitability of various materials for reuse applications,
- monitor the storage of materials, the preparation of materials for future reuse, the source separation of materials not suitable for reuse, the waste reduction practices of the general contractor and subcontractors,
- locate alternative methods of disposal of materials not suitable for reuse,
- locate sources of additional used materials that could be incorporated within the project,
- revise the design, working drawings and specifications to incorporate used materials as they are salvaged,
- prepare addenda to the basic contract or issue new contract documents for tendering as required for the incorporation of used materials and recycling of materials not suitable for reuse.

B) Description of actual strategy employed or attempted and its future status:

Waste reduction and full scale monitoring, to the extent that we had planned it, was quite difficult to achieve for numerous reasons although some degree of success with respect to certain items was achieved. With no confirmation of any landscape budget during the first three months of construction, as well as a sensitive time schedule, certain waste reduction and re-use strategies could not be carried out. For a more detailed description see sections 2 and 3.

5). WASTE WATER TREATMENT FACILITY (A LIVING MACHINE).

An ecological sewage treatment facility utilizes living plants, animals and micro-organisms to clean wastewater in a manner similar to the natural purification process that occurs in wetlands and marshes. It is an alternative to conventional high energy and chemically-intensive sewage treatment. Such a system could bring the water to near drinking quality and the effluent could be safely discharged into the immediate environment.

A) Description of proposed strategy for our case study project:
This facility is to be the focus of a great deal of interdisciplinary research throughout the university (Natural Resource Sciences, Agricultural and Bio-systems Engineering, Engineering, Microbiology, Plant Biology, Entomology etc). It is to be highly valuable and unique for teaching and demonstration purposes, and it could provide motivated residents with the opportunity to participate in both the continuous study of the ecological waste water treatment and the daily running of the facility.

B) Description of actual strategy employed or attempted and its future status:
The ecological waste water treatment facility was originally planned to consist of a highly visible and attractive, plant-filled greenhouse structure within the central courtyard. An expandable system for treating the wastewater of 200-1000 people is still being considered for this project. The existing separation of storm and sanitary drains makes the project more feasible, though new sewer, water and electrical lines would have to be added to the eventual location of the ecological waste water treatment facility prior to the completion of any landscaping. The eventual location of the ecological waste water treatment facility is envisioned to be in the southern courtyard away from the central courtyard, so that it can be visited and used without hindering semi-private student activities. This location would also facilitate expansion and layout flexibility which the central courtyard location could not provide.

GRAY WATER RECUPERATION

This option was only to be explored if a "living machine" proved unfeasible. However, gray water recuperation would require a new drainage line and treatment system. This line could be attached to the ceiling of the ground floor 6-plexes, although this was not obvious. Since the living machine" had not been proven to be either feasible or unfeasible, this option was not further explored.

6) INNOVATIVE ORGANIC GARDENING & LANDSCAPING

This project presents an opportunity to develop a sophisticated landscape to serve as a long term laboratory for horticultural research and organic and other ecological approaches to gardening as well as a model case study for community living.

A) Description of proposed strategy for our case study project:

The landscaping of the site is to be a collaborative project to be developed and realized with the participation of the project architects, students and faculty from Macdonald Campus and the School of Architecture as well as the residents of the project. This is planned for phase three (Spring 1999). While this feature clearly affords a direct appropriation of the project process by the eventual users (students), the base price contract did not have any landscaping allowance.

A preliminary landscape plan for the site has been proposed, which includes a raised common central garden surrounded by a common path providing access to individual front gardens for each of the units.

Materials salvaged from the renovation were planned to be used as fill (concrete, brick) or material to build retaining walls, fences, furniture and accessories (concrete block, lumber and steel).

B) Description of actual strategy employed or attempted and its future status:

Although materials were salvaged from the renovation (separated into large piles in the central courtyard), no funding was found in time to actually carry out any landscaping during the phase 2 construction. Thus the masonry piles (concrete, brick) had to be disposed of (since it could not be stored in the central courtyard for months due to security and aesthetic reasons). This feature suffered more from time pressure than anything else.

7) REPLACEMENT OF EXISTING ELECTRIC HEAT SOURCE WITH ALTERNATIVE RENEWABLE HEAT SOURCE(S).

Electricity is the principal source of energy for the project. Reducing energy consumption reduces the impact upon natural resources, reduces the demand upon public utilities and provides direct financial benefits for the user. Masonry heaters and other similar high efficiency alternative heat sources' main distinction is the ability to store a large amount of heat. This means that you can cleanly burn a large load of material without overheating your residence. The heat is stored in the masonry (or cast iron) thermal mass, and then it can slowly radiate into your house for the next 12 to 24 hours.

A) Description of proposed strategy for our case study project:

The client requested that the existing electric baseboards be retained as the primary source of heating in the initial renovation of the buildings. Electrical consumption would be greatly reduced with the incorporation of secondary high efficiency alternative heat sources using inexpensive and readily available renewable resources or waste products as fuel (cereal burning stoves, wood pellet stoves or even more conventional wood burning stoves). Properly located and planned, these alternative heat sources could substitute for electric heating in common spaces most of the year, resulting in up to 70 percent electrical savings. Framing for openings in floors and roofs would be provided as well as any necessary flues. Additional mechanical distribution of the heat generated (by use of low tech fans) as well as automated controls of these stoves could also maximize energy savings.

B) Description of actual strategy employed or attempted and its future status:

The client stated that they were concerned with the potential liability problems that could arise from allowing students to manage alternative heat sources (burning renewable resources or waste products as fuel). The university is also currently connected to a special hydro station that is equipped with emergency power backup system in case of a disaster (example ice storm). Since there are no special incentives in place for multi residential projects, it is difficult to invest limited capital funds on such a tight budget without seriously compromising other technical ameliorations. Bio-mass or burning renewable resources or waste products may still be a long term option, given the farming nature of the neighboring properties.

8). ENERGY EFFICIENCY MEASURES

Most energy efficiency measures are discussed in detail in section 6;

LIGHTING.

Using energy efficient fixtures and bulbs could increase the initial capital cost but the pay-back period is generally quite short. Automated controls that would gradually shut down non-essential lights and bring them back on line as the user habits require would reduce demand and reduce energy costs.

A) Description of proposed strategy for our case study project:

It was planned that all new light fixtures would be energy efficient models and that all existing re-used light fixtures would be retrofitted (where possible) with compact fluorescent light bulbs.

B) Description of actual strategy employed or attempted and its future status:

The base contract did not allow us to include more expensive energy efficient fixtures or control / monitoring systems, but about half of the new fixtures were energy efficient models and energy efficient bulbs could be added after the completion of phase 2

9) INNOVATIVE ENVIRONMENTALLY-FRIENDLY FURNITURE AND EQUIPMENT

Conventional fittings, furniture and equipment are often made and assembled with products that release toxic and harmful gases into the indoor environment, a particular problem in increasingly air tight, sealed buildings. Alternatives to these materials and methods of assembly exist (such as water based glues and low formaldehyde wood panels) but often at additional costs to more conventional items.

A) Description of proposed strategy for our case study project:

In order to eliminate toxic products from the project, substitutions of more environmentally friendly furniture and equipment was to be made and a disciplined approach to product research, specification and approval as well as construction supervision was to be undertaken. Better quality, better suited and more durable furniture was to be selected; recycled or reused furniture should have been considered and student participation in the design and fabrication of furniture was to be pursued.

B) Description of actual strategy employed or attempted and its future status:

The client stated that the budget for the initial phases of the project could not allow for any innovative approach, and there were no design fees whatsoever to pursue recycled or reused furniture. For the most part, durable wood furniture was purchased and installed. Student participation in the design and fabrication of furniture was to take place but there was not enough time to organize this concerted effort, and it could not easily take place on site due to legal liability problems and coordination problems with the General contractor.

10) CREATING A PVC - FREE PROJECT .

As a result of accidental fires of buildings containing PVC's, large levels of hydrogen chloride gas are created, dioxins and furans are produced and heavy metals are released. The production, use and disposal of PVC also results in the creation and release of large amounts of toxic chemicals. These substances end up in the environment, adding to the level of persistent toxic chemicals which are building up in the air, soil and water, in the food chain and in our bodies. The chemicals used to make PVC are toxic and carcinogenic and PVC is the source of two chemicals - dioxin and phthalates - that are considered to be hormone disruptors.

PVC is present in many common building products - piping and tubing, electrical wire sheathing, flooring, windows and doors, cladding, profiles and trim, waterproofing membranes, plumbing and electrical fixtures as well as furniture and appliances. Many alternatives exist, though sometimes at greater cost. In order to eliminate PVC from the project, substitutions of PVC-free products should be made and a disciplined approach to product research, specification and approval as well as construction supervision should be undertaken.

A) Description of proposed strategy for our case study project:

By exploring PVC free alternative components for our base contract relatively early on (before completing the design and specifications) we were able to evaluate both cost and durability of non-toxic substitutes. We also attempted to make the removal of any new PVC component as seamless as possible (so that if monies were to be made available, an upgrade could occur quite easily and quickly.

B) Description of actual strategy employed or attempted and its future status:

PVC-free substitution components for our base contract included the following (although this list is not complete);

Fiberglass windows, rubber gaskets, exterior aluminum moldings, fiberglass door frames and extensions, metal hardware.

The vinyl flooring that we included (since no other solution was acceptable for budgetary or aesthetic reasons by the client) does contain approximately 10 per cent PVC, but this was the only new product or component with a PVC content. The installation will allow it to be easily replaced at some time in the future. The hardest aspect of eliminating PVC in any components (including accessories) was in our review of shop drawings that often attempted to incorporate some standard PVC accessories. We found that after the supplier was forced to substitute their standard PVC accessories with innovative alternatives, that in fact their product improved (and in the case of the Fiberglas window manufacturer, they thanked us for requiring them to be innovative).

3. TRACKING OF MAJOR EVENTS IN THIS CASE STUDY PROJECT IMPLEMENTATION;

Major events related to individual items are included in previous sections. This section outlines overall project events affecting the design and implementation of the environmental impact issues.

A) DESIGN TIMELINE FROM INITIAL FEASIBILITY STUDY IN MAY 1997 TO DECEMBER 1997.

July 1997: presentation of feasibility study findings, supporting transformation/retrofit strategy versus demolition and new construction, to client;

October 1997: commencement of first phase construction with the negotiations of how to dismantle and store materials on site;

December 1997: completion of first phase construction and documentation of recuperated materials to be re-used during the following construction phases.

B) REDESIGN TIMELINE FROM INITIAL BIDS IN JANUARY 1998 TO MAY 1998.

April 1998: how the redesign process encouraged more re-use in some areas while other items were cancelled or postponed.

C) CONSTRUCTION TIMELINE FROM MAY 1998 TO OCTOBER 1998, WITH PARALLEL TIMELINE OF ENVIRONMENTAL INITIATIVES AND THEIR FUND-RAISING EFFORTS.

June 1998: commencement of second phase construction with the negotiations of how to dismantle and store materials on site, while attempting to postpone as long as possible certain decisions (to allow the fundraising to take place).

August 1998: freezing the timeline with respect to fundraising opportunities and resolving all incomplete efforts to date;
freezing the scope of work for the second phase construction, where all further fundraising proceeds would be applied to a future third phase construction.

4 IDENTIFICATION OF MAJOR MATERIAL FLOWS RELATED TO RE-USE, RECYCLING AND DEMOLITION OF MATERIALS, AND THE IDENTIFICATION OF ISSUES AFFECTING THE COST AND TIME TABLE OF THE PROJECT;

The accompanying chart on the two following pages summarizes both major material flows related to conservation, re-use, recycling and demolition of major materials and an estimate of the cost / value of certain items after the completion of the transformation project.

Section	Material description	Type	Quantity	Quantity	Status after Retrofit	Cost/Value after Retrofit	
	(major material flows)		(number)	(l.ft., sq.ft., cu.ft.)	(reuse, recycling, demolition)	quantitative before/after	qualitative improvement description
03	**Concrete**						
	interior concrete floor slab	4" reinforced		400 sq.ft. - 133 cu.ft.	disposed		
	interior concrete floor slab	4" reinforced		14 000 sq.ft.- 4 667 cu.ft.	conserved & restored		
	exterior concrete walkway	4" reinforced		540 sq.ft. - 180 cu.ft.	disposed		
	exterior concrete walkway	4" reinforced		2 100 sq.ft. - 700 cu.ft.	conserved & restored		
04	**Concrete block and Brick**						
	Int. concrete block	6" hollow block		909 sq.ft. - 455 cu.ft.	diposed		
		6" hollow block		1390 sq.ft.- 665 cu.ft.	conserved & restored		
		8" hollow block		2000 sq.ft. - 1333 cu.ft	diposed		
		8" hollow block		6960 sq.ft.- 4 640 cu.ft.	conserved & restored		
	exterior brick demolition			1292 sq.ft.	diposed		
	exterior brick repair (reuse)	New firewalls		600 sq.ft.	Reused on-site		
		Reused in place		50 sq.ft.	conserved & restored		
	exterior brick replacement			1600 sq.ft.	diposed		
05	**Metals**						
	exterior steel staircase	Main central	2	15 treds (10 l.ft.) each	conserved & modified		
		Emergency	4	15 treds (10 l.ft.) each	recycled		
	exterior steel railing	upper walkways	2	400 l.ft.	recycled		
		Ind. unit balconies	20	140 l.ft.	conserved & restored		
	exterior steel columns	HSS 3"x3"	39	312 l.f.	recycled		
	exterior steel columns	HSS 3"x3"	5	40 l.f.	reused on-site		
	aluminum flashing			1650 l.f.	recycled		
	aluminum window sills		40	225 l.ft.	conserved & restored		
06	**Lumber**						
	exterior solid 2"x3" milldeck	roof struct. above balconies		2500 sq.ft.	diposed		
	exterior solid 2"x3" milldeck	roof struct. above balconies		130 sq.ft.	reused on-site		
	exterior (roof) 2"x10" parapet			1710 l.ft.	diposed		
	exterior (roofing) plywood			18800 sq.ft.	conserved & restored		
	interior wood flooring	5/8" solid birch		5260 sq.ft.	conserved & restored		
	interior wood window sills		40	225 l.ft.	conserved & restored		
	Interior partitions	Wood studs		427 l.ft.	diposed		
	Interior partitions	Wood studs		1240 l.ft.	conserved & restored		
	Interior partitions	Metal studs		1320 l.ft.	New		
	Drywall			6832 sq.ft.	diposed		
	Drywall			19840 sq.ft.	conserved & restored		
	Drywall			21120 sq.ft.	New		

Section	Material description (major material flows)	Type	Quantity (number)	Quantity (l.ft., sq.ft., cu.ft.)	Status after Retrofit (reuse, recycling, demolition)	Cost/Value after Retrofit: quantitative before/after	Cost/Value after Retrofit: qualitative improvement description
08	**Doors**						
	interior	A1 bedroom	63		New		
		A2 cupboard	56		conserved & restored		
		A3 cupboard	58		conserved & restored		
		A4 cupboard	30		conserved & restored		
		A5 cupboard	24		reused on-site		
		A6 cupboard	24		reused on-site		
		A7 cupboard	16		reused on-site		
	exterior	E1 ground floor	41		conserved & modified	$500	improved en. eff.+ increased daylight
		E1	6		conserved & restored		
		E2	21		conserved & modified	$500	improved en. eff.+ increased daylight
		E3	10		conserved & restored		
		E4	4		conserved & restored		
		E4	6		conserved & modified	$500	improved en. eff.+ increased daylight
08	**Windows**						
	exterior	A1 Common areas	1		conserved & restored		
		A1 Common areas	3		Resused on-site		
		A2 Common areas	2		conserved & restored		
		A2 Common areas	2		Resused on-site		
		B1 Bathroom	16		diposed		
		B2 Bathroom	24		diposed		
		C1 Kitchens	16		conserved & restored		
		C2 Kitchens	24		conserved & restored		
		F1 bedrooms	38		conserved & restored		
		F1 Bedrooms	17		Resused on-site		
		F2 Bedrooms	33		conserved & restored		
		F2 Bedrooms	24		Resused on-site		
		D1 Living rooms	16		Resused on-site		
		D1 Living rooms	24		conserved & restored & modified		
		E1 Living rooms	12		conserved & restored		
		F1 greenhouse	17		Resused on-site	$500	improved en. eff.+ increased daylight
		F2 greenhouse	24		Resused on-site	$500	improved en. eff.+ increased daylight
	Kitchen cabinets						
	countertops		60	345 l.ft.	disposed		
	interior steel framing	upper cabinets	60	660 l.ft.	disposed		
		lower cabinets	60	345 l.ft.	disposed		
	cabinet hardware				disposed		
15	**Plumbing**						
	Kitchen sinks and fixtures		40		conserved & restored		
	Bathroom fixtures		60 sets		conserved & restored		
	plumbing infrastructure						
16	**Electrical**						
	Electrical fixtures						
	electrical infrastructure						

DIVISION 03
CONCRETE
Including

-interior concrete floor slab	4" reinforced
-exterior concrete gallery	5"-6" reinforced

A) General comments:

A modest quantity of existing exterior and interior concrete slabs were cut and removed in the renovation of the 6-plex dwelling units (900 square feet removed versus approximately 16 000 square feet conserved). Generally, concrete can be sawn and removed intact though it is very costly to transport if not broken up on site.

B) Description of strategy employed or attempted:

The general contractor carefully cut the concrete slabs so that he did not have to significantly repair the remaining edges or surfaces left intact. Three options were evaluated for recycling:

1) storing sections of concrete slab as fill below the greenhouses to serve as thermal mass for storage of passive solar energy;
2) crushing concrete slab to then be used on site as a paving material or as fill for exterior hard landscaping;
3) removal and crushing concrete slabs off site by specialized demolition contractors for reuse as fill.

All three strategies were rejected by the client for monetary and scheduling reasons. Funds were just not raised in time to allow any of the three options to be realized. An effort to make use of crushing equipment operating on a nearby highway reconstruction project was attempted,, but there was not enough time available to organize this task, and no funds were available at the time for any landscaping.

C) Resultant effect on the cost and timetable of the project:

Since fundraising was occurring simultaneously with construction, it was decided that concrete sections were to be separated out (with other forms of masonry) from regular construction waste (see photos in appendix A) so that crushing or thermal mass storage could occur if funds were available. In fact, most concrete was cut only after client had decided to dispose of all rubble material and the general contractor disposed of the concrete directly at no extra charge. There was no delay to the project, though the contractor did have to plan out the location of the separated rubble so as not to impede other exterior work on the buildings.

DIVISION 04
MASONRY
Including
- concrete block (6" and 8" hollow)
- clay brick

A) General comments:

A significant quantity of existing interior concrete block partitions were removed in the renovation of the 6-plex dwelling units in order to connected 4 units into one 6-plex unit. Additional concrete block was removed in the demolition of the parapets and for new window openings in RT1-A and RT2-A. Generally, concrete block can be removed intact and is often easier to handle in that condition (see photos in appendix A) . Concrete blocks can be salvaged intact and then reused, but this is too labor intensive (thus costly due to union wages) to be justified for this or similar projects in Quebec.

Existing clay brick was removed from a number of areas due to spalling, particularly on north elevations and replaced with a near match of new brick. Additional clay brick was also removed in the demolition of the parapets, for new window openings in RT1-A and RT2-A as well as the demolition of free standing walls protecting the exterior fire escape stairs and around garbage rooms. Generally, brick can removed intact but removing mortar is very difficult. Most of the clay brick removed in the restoration of the building envelope was spalling or otherwise in very poor condition. There is considerable debate about reuse of brick intact as it is difficult to ascertain its durability.

B) Description of strategy employed or attempted:

The general contractor did in fact remove the masonry with care and piled them up outside in the central courtyard. Six options were considered for reuse and recycling of masonry:

1) reusing concrete block and brick for repairs to existing;
2) reusing concrete block and brick intact as an exterior paving material or to build dry laid retaining walls;
3) storing some concrete block and brick as fill below the greenhouses to serve as thermal mass for storage of passive solar energy;
4) storing some concrete block and brick on site as fill within the courtyard, creating a raised bed for planting;
5) crushing some concrete block and brick to then be used on site as a paving material or as fill for exterior hard landscaping;
6) removal and crushing concrete block and brick off site by specialized demolition contractors for reuse as fill.

Only a very limited quantity of concrete block and brick was reused for repairs due to the poor condition of the brick and the cost of removing mortar. The other five strategies were eventually rejected by the client for budget and scheduling reasons. Funds were not raised in time to allow any of the options related to landscaping or greenhouses to be realized. The client was also concerned about the maintenance of crushed brick and block as a paving material and the schedule did not allow for sufficient research. Reusing the rubble as fill was rejected for fear that the partially crushed concrete blocks could impede drainage and plant growth This research was not further explored, but we are not convinced that the client's reservations are in fact well-founded.

An effort to make use of crushing equipment operating on a nearby highway reconstruction project was attempted, but there was not enough time available to organize this task, and no funds were available for any landscaping. A final attempt was made to convince two local demolition contractors to take the rubble for crushing, storage and reuse as fill, but the market for such material in Quebec is not yet established and the costs were too high. Finally, all the rubble in the courtyard was loaded into containers and disposed at a landfill site.

C) Resultant effect on the cost and timetable of the project:

Since fundraising for the greenhouses and landscaping was occurring simultaneously with construction, the contractor agreed to separate the concrete block and brick rubble from other construction waste and store it within the central courtyard for possible reuse in lieu of disposing of all construction waste as originally required by his contract (see photo #   ). There was no additional cost or delay due to separating the material, though the contractor did have to plan out the location of the separated masonry rubble so as not to impede other exterior work on the buildings.
The general contractor did charge an extra to eventually load the separated concrete block and brick into demolition containers and dispose of it once all other strategies for reuse had been rejected by the client. There was no delay to the project.

DIVISION 05
METALS
Including
- exterior steel stairs with concrete filled steel pan treads
- exterior steel stairs with steel grate treads
- exterior railings
- exterior balconies with railings
- exterior steel columns
- metal flashing
- cast aluminum window sills

A) General comments:

A significant quantity of miscellaneous metalwork was removed in the renovation of these buildings. Four steel stairs with steel grate treads were removed from the ends of the upper concrete galleries. Two steel stairs with concrete filled steel pan treads were retained but required considerable repair. Railings of the upper galleries were intended to be mostly retained and repaired. Balconies and railings on the back elevations of RT1-A and RT2-A were also retained. Steel columns supporting the original wood deck over the upper galleries were to be cut to railing height after construction of the cantilevered roof overhangs. All original metal flashing to parapets were removed. Cast aluminum window sills were retained (see photos in appendix A) .

B) Description of strategy employed or attempted:

A number of strategies for reuse of some of the steel members were considered:

1) reusing existing steel stairs with steel grate treads as rough framing of new interior stairs;
2) repairing existing steel stairs with concrete filled steel pan treads;
3) reusing railings of the upper galleries that were to be partially removed at the locations of the new greenhouses around interior floor openings;
4) repairing remaining exterior railings of the galleries including trimming and capping the connected steel columns at railing height;
5) reusing surplus railing sections as grilles to hang plants in the greenhouses;
6) repairing exterior balconies and railings on the rear elevations of RT1-A and RT2-A;

7) reusing surplus steel columns to support greenhouses;
8) retaining existing cast aluminum window sills.

Though the steel stairs were precisely the right dimension to be reused as rough framing for interior stairs, they were badly bent in the demolition and could not be reused. The concrete was removed from the pans of the other remaining exterior stairs and rusted steel members repaired or replaced before pouring new concrete.

The majority of the railings were replaced by new railings by the general contractor in lieu of repairing the existing for no extra charge. The existing railings had not been painted regularly and rust had penetrated into joints and between members making repair prohibitively expensive. They were too badly damaged even to be reused as interior railings or plant hangers. The existing balconies and railings on the rear elevations of RT1-A and RT2-A were generally in good condition, and given that they are rarely used, it was acceptable to clean and repaint them. Only one of twenty balconies had to be replaced. Some steel columns were reused to support the greenhouses.

The cast aluminum window sills were in excellent condition and easily retained in cases where existing windows were conserved in place and repaired.. Installation details of the new fiberglass windows were conceived to incorporate the existing aluminum sills.

All surplus metal was separated from other demolition debris and accumulated in a separate pile in the central courtyard. At the end of the construction, a local scrap metal dealer came to the site to take all of the material.

C) Resultant effect on the cost and timetable of the project:

Much more metal could have been reused on the project had it been regularly painted and maintained. Once badly rusted, repairs are very labor intensive and costly. It is not very useful as anything but scrap metal. In the case of this project, it was generally less costly to replace the metalwork than to repair it.

Separating metal from other construction debris was easily achieved with no additional costs or delays as this practice is already familiar to most contractors. All surplus metal was separated from other demolition debris and accumulated in a separate pile in the central courtyard. At the end of the construction, a local scrap metal dealer came to the site to take all of the material. Though there was not sufficient good quality material for the dealer to pay anything, we saved some money on disposal and the dealer also agreed to take all of the metal kitchen cabinets, having his own crew remove the particle board doors at no charge (see below).

DIVISION 06
WOOD AND PLASTICS
Including
- dimensional lumber
    - 2" x 3" mill deck
    - 2" x 4" framing to interior partitions
    - 2" x 10" parapet framing
- 1" x 4" softwood plank locker partitions
- miscellaneous plank shelving

- 3/4" plywood roof decking
- 5/8" solid hardwood strip flooring
- interior window sills

A) General comments:

A significant quantity of wood was removed in the renovation of these buildings, though the majority of the wood framing was kept intact. The existing roof framing and plywood roof decking was retained as well as the upper floor framing of RT1-B and RT2-B. Wood framed partitions were selectively demolished only in RT1-A and RT2-A. Wood flooring as well as the wood stairs were retained in RT1-B and RT2-B, despite the client's initial reservations about their condition.

The largest quantity of wood removed was the soffit over the galleries of RT1-A and RT2-A built of 2" x3" mill decking with asphalt roofing on the top surface and painted below. Some 2" x 10" framing was removed in the demolition of the parapets. Interior partitions were framed in 2" x 4" and demolished as required for the new layouts of the RT1-A and RT2-A units. Some 1" x 4" softwood planking (spruce?) was removed from the original locker rooms and much miscellaneous shelving was also removed.

Reuse of wood is costly because the material is inevitably 'contaminated' - with nails, gypsum board lath, asphalt roofing paper and paint. Wood also needs to be stored indoors if at all possible or stacked carefully ensuring adequate ventilation of all members. There is at present no mainstream market in Quebec for demolition wood chipping and recycling.

B) Description of strategy employed or attempted:

Despite the difficulties with reusing wood, a number of strategies were considered:

1) reusing 2" x 3" mill decking as floors of new greenhouse vestibules;
2) reusing dimensional lumber for framing of greenhouses;
3) reusing wood shelving for closets;
4) reusing softwood planking as interior finish to the greenhouse vestibules;
4) retaining plywood roof decking;
5) repairing and refinishing interior trim, hardwood flooring and hardwood stairs;
6) identifying other projects where dimensional lumber and planking could be reused;
7) identifying companies that were interested in acquiring used lumber for reuse or recycling.

A small portion of the existing 2" x 3" mill decking was reused by the contractor to construct the vestibule floors. It could also have been reused in other ways or for other projects, except that the joints had come apart in demolition and that it was covered on one side with asphalt roofing. The contractor was not willing to spend the time removing nails from the 2" x 10" parapet framing, much of which was also partially rotted. The 2" x 4" framing of interior partitions was also not cost effective to salvage, given the time it would take to remove nails, drywall screws and pieces of gypsum board lath. All of this lumber, much of which had been stored on site during the construction, was eventually disposed. We tried to find other possible destinations for the wood, either for other projects or for chipping and recycling, but the wood was generally considered to be of too poor quality or too costly to 'decontaminate' (i.e. denail, remove gypsum board, remove asphalt roofing etc.).

Softwood 1" x 4" planking from the demolition of the lockers was originally intended to be reused as a wall finish inside of the greenhouse vestibules. Once again, the contractor felt that for the additional time that it would take to denail, he preferred to install new plywood. This planking was in excellent condition: dry, straight and free of knots. Our structural engineer took a number of loads of it home to build a backyard clubhouse for his children.

We were able to reuse shelving as well as hanger rods in the bedroom closets of RT1-B & RT2-B units. This required us to make an inspection of all existing closets and some coordination (tabulating the required work for each closet) for the contractor. Despite the generally poor appearance of the hardwood floors and stairs (RT1-B & RT2-B units), we were able to conserve the floor, make minor repairs, sand and refinish - producing excellent results. By adapting standard window installation details, we were able to conserve and simply repaint the interior window trim even in the case of new windows.

All of the original plywood roof decking was kept in place after stripping the asphalt roofing and the new trussed roof structure was built over it. The plywood served to enclose the top of the cavity between the original joists, ready for installation of densepack cellulose insulation.

C) Resultant effect on the cost and timetable of the project:

Separating wood from other construction debris was easily achieved at no extra cost though, inevitably, the wood is contaminated with other materials that have been fastened to it. It is particularly important to be able to store the used lumber indoors, as we were able on this project, because it quickly absorbs moisture and can begin rotting. A much larger problem is the lack of any motivation to reuse or recycle softwood in Quebec given the low costs of construction waste disposal, an abundant and inexpensive supply of new lumber and the high cost of cleaning and denailing. There are a number of small companies emerging in Quebec specialized in acquiring hardwood (particularly supplying cabinetmakers) but there is no market for softwood. Having exhausted all of our alternatives, the softwood - mostly dimensional lumber - was disposed at an additional cost of when the renovation of the space in which it was stored began.

DIVISION 07
THERMAL & MOISTURE PROTECTION
Including
- tar and gravel roofing
- Fiberglas insulation
- rigid insulation

A) General comments:

All of the existing tar and gravel roof, as well as metal flashings and a portion of the masonry parapet, was removed in the fall of 1997 as part of the contract for the new roof. Plywood decking was left in place. Some badly water damaged fiberglass batts and expanded polystyrene insulation were removed from the joist spaces , particularly in RT2-

A, during the main renovation contract. All of the original extruded polystyrene insulation glued to the inside face of the exterior masonry walls was left intact under the existing gypsum board lath.

B) Description of strategy employed or attempted:

We did pursue some research into recycling of these materials, particularly the tar and gravel roofing. Though there is an emerging market for recycling asphalt shingles, there is no market at present for tar and gravel roofing. It is simply not cost effective to separate the commingled asphalt, paper and gravel. Quantities of insulation were insufficient to make any recycling possible. All of these materials were discarded.

C) Resultant effect on the cost and timetable of the project:

Not relevant.

DIVISION08
DOORS AND WINDOWS
Including
- solid core, plywood veneer faced flush exterior doors
- aluminum screen doors
- hollow core interior doors with steel frames
- single- and double-glazed, double-hung wood windows
- aluminum storm windows

A) General comments:

Given both the budget constraints and environmental objectives of the project, it was decided to conserve or reuse doors and windows as much as possible. Despite the skepticism of many contractors bidding on the job and the complex task of coordinating repairs and of reusing doors and windows, the final results are very encouraging. Ninety-five percent of interior doors and one hundred percent of exterior doors were conserved in place or reused. Eighty four percent of the existing wood windows were conserved in place and restored or reused in the construction of the greenhouses (see photos in appendix A) .

B) Description of strategy employed or attempted:

After evaluating many different alternatives, the preparation of complex specifications and schedules and lengthy negotiations with the general contractor, the following strategy for conserving and reusing doors and windows was adopted:

1) conserve in place all existing exterior entrance doors and frames with new round glazed openings, new hardware and new weatherstripping (68 no.);
2) conserve in place half of the existing exterior balcony doors with new hardware and new weatherstripping (10 no.);
3) replace and reuse half of the existing exterior balcony doors in the greenhouses with new glazing, new hardware and new weatherstripping (10 no.);
4) conserve in place existing aluminum screen doors and frames (80 no.);
5) conserve in place 66% (144 no.) of the existing interior doors and frames;

6) reuse 29% (64 no.) of the existing interior doors and frames in new locations;
7) conserve in place existing wood windows of RT1-B (48 no.), RT2-B (16 no.), the east elevation of RT1-A (34 no.) and the west elevation RT2-A (48 no.);
8) replace and reuse half of the existing windows the west elevation of RT1-A (18 no.) and the west elevation RT2-A (27 no.);
9) conserve in place existing aluminum screen windows on RT2-B (32 no.) and some windows of RT2-A (12 no.).

The existing solid core exterior doors were generally in good condition and required only minor repairs and considerable painting. Some doors were relocated in order to reverse the door swing. New 22" diameter round windows were cut into the solid core and a round sealed double glazed unit was snapped-in with a black rubber gasket that we bought in bulk from Kawneer. Hardware was generally in poor condition and replaced in order to provide new keying. Openings for the original mortise locks were blocked up with wood. Much of the original aluminum weatherstripping and door sills were also reused, simply replacing worn out gaskets. Spring hinges were added to all of the principal entrances of the units.

In fine tuning the interior layout of the units, we were able to conserve many of the hollow core interior doors in place to serve as closet doors. With the cooperation of the general contractor, we were also able to reuse and relocate most other existing hollow core interior doors also as closet doors. The steel frames were cut out of the wood framing and we developed a detail for installing the frames in the thinner new partitions. Given that most of these doors were reused as closet doors, we were able to also conserve the hardware. Once they were all relocated, we inspected all doors and prepared a tabulation of adjustments and repairs required, door by door, negotiating a fair price for this work with the contractor. The only doors that could not be salvaged for reuse were those located in concrete block partitions slated for demolition.

We attempted to restore all of the original aluminum screen doors, but the costs turned out to be prohibitive and the client chose to do without them. The scrap metal dealer was happy to take a load of eighty aluminum screen doors off our hands.

As for windows, we decided to only replace about one-third of the existing windows: only bedroom and bathroom windows located on the west elevation of RT1-A and the east elevation of RT2-A. The bedroom windows were entirely reused and restored for the construction of the greenhouses, which we would not have otherwise been able to afford to build. Given that the greenhouses did not need to be absolutely air-tight, we repaired rotten portions of the frames and simply fixed shut all sashes prior to installation. Reusing these windows did force us to revise the greenhouse drawings a number of times as we could not be certain of dimensions or quantities until all the existing windows were removed.

We also found that many of the remaining existing windows were fitted with double glazing and decided to restore them. There are a number of contractors specializing in the restoration of windows and we were able to replace sash balances, weatherstripping and tracks. Broken glazing units and aluminum screens were replaced. In some cases, the operable portions of the windows were replaced with new double glazed wood casements. There was some rotting of the existing wood frames at certain locations, particularly because of a lack of regular maintenance, and we were able to develop a detail with the contractor to cap these portions of the windows (particularly wood sills) with painted sheet metal. The rotting of some of these frames seemed to occur mostly where there were aluminum storm windows which trapped moisture on the sills. Additional drainage holes were drilled into the bottom of these windows.

C) Resultant effect on the cost and timetable of the project:

The reuse of windows and doors was the most ambitious aspect of reuse carried out on the project. The exercise required a considerable amount of additional coordination for us, including detailed inspections of the condition of each door and window in order to specify necessary work and considerable follow-up as the work proceeded. In producing detailed schedules and specifications, we were able to direct the work of the contractor very precisely, controlling both costs and scheduling effectively. Certainly such work is time consuming and labor intensive, but there were no undue delays and the final costs of the work certainly make this approach very attractive.

The exterior doors were restored and provided with new round windows for a cost of about $475.00 per door (not including new locks or knobs). New exterior doors pre hung in frames including installation would have cost about $1000.00 each. Interior flush hollow core doors in steel frames were repaired and about one-third of them were relocated at an average cost of $61.00 per door, as compared to an average cost of about $150.00 for an equivalent new door. Wood windows were restored at an average cost of about $215.00, as compared to an average cost of about $500.00 for equivalent new windows. In all, reusing and restoring doors and windows instead of replacing them saved the project over $100 000.00 not including the additional cost of disposal of these windows and doors.

On the other hand, it is very difficult to evaluate the additional costs over time of reusing these items - additional maintenance and energy costs as the reused doors and windows will not likely be as durable and energy efficient as new products. We based our strategy upon giving the buildings a 25 year life, sufficient to pay off the costs of the renovation, but it may be necessary to replace or overhaul some items sooner, particularly some of the windows. It should also be mentioned that such an exercise requires a considerable expenditure of professional time, which is not reflected in standard architectural contracts or fees.

DIVISION 09
INTERIOR FINISHES
Including
- gypsum board lath
- ceramic tile
- vinyl tile and sheet flooring
- vinyl baseboards

A) General comments:

The existing gypsum board lath was removed in the selective demolition of certain partitions, particularly in the RT1-A and RT2-A units. Existing bathrooms were generally retained and ceramic tile replaced in only about fifteen of sixty cases. All existing vinyl flooring and baseboards were removed and replaced.

B) Description of strategy employed or attempted:

Generally, our strategy with respect to interior finishes was to retain the existing layout of partitions and bathrooms as much as possible all the while in keeping with the new communal concept of the residence. The design was revised a number of times in order to retain as many existing partitions as possible and it was decided early in the process to retain all existing bathrooms. We attempted the following strategies with respect to waste reduction:

1) retain as many existing partitions as possible;
2) conserve and restore existing ceramic tile;
3) restore and clean existing vinyl flooring and baseboards;
4) separate gypsum board lath from other construction waste for appropriate disposal;
5) separate ceramic tile from other construction waste for appropriate disposal;
6) separate vinyl tile and baseboards from other construction waste for appropriate disposal.

The most effective strategy was simply retaining as much of the existing partitions as possible as well as the existing bathrooms. In practice, we were nonetheless obliged to demolish more than originally intended, particularly because of electrical and plumbing requirements. The gypsum board lath was mechanically fastened to wood framing and could not be effectively separated.

The existing vinyl flooring could not be retained as it was badly discolored, stained and dirty. It was entirely removed, replaced and, despite our best efforts, disposed with other construction waste. We attempted to convince the client to simply clean and paint the existing concrete slab as we did not have sufficient funds for any other new floor finish than vinyl tile, but it was felt that the new tile would be more appropriate in appearance and for maintenance. Ceramic tile was retained in the majority of cases but, in hindsight, we probably should have replaced more of it, or at the very least insisted upon cleaning out and regrouting all joints. The cleaning of the tile as specified was not really sufficient. The relatively small quantities of ceramic tile removed were disposed with other construction waste.

C) Resultant effect on the cost and timetable of the project:

Inevitably, retaining existing partitions and marrying them to new partitions and finishes led to many debates on site with the contractor about repairs and alignments with the existing finishes. In such a contract it is very difficult to foresee all possible conditions that will emerge but we were generally able to maintain a visually acceptable appearance with minimal extras. Selective demolition also requires a great deal of patience and cooperation on everyone's part. It is simply not possible to complete all the demolition at the beginning of the work and instead it proceeds piecemeal, as required by each of the trades. There were, in fact, few delays and only minimal extra costs due to unforeseen site conditions. One problem that we did have though in preparing the contract occurred because most of the site survey of existing conditions had been done in the fall of 1997. By the time the work commenced in the summer of 1998, there had been considerable additional deterioration of the building.

DIVISION 10
SPECIALTIES
Including
- kitchen cabinets (light gauge steel angle frames with sheet metal shelves/gables and veneered particle board doors)
- medicine cabinets and other bathroom accessories
- hanger rods

A) General comments:

The new layout of kitchens for the RT1-A and RT2-A units required complete replacement of these cabinets. The cabinets did not have to be replaced in the RT1-B and RT2-B units as the existing layout was not changed. Bathroom accessories were mostly existing (but in generally poor condition) as were closet hanger rods.

B) Description of strategy employed or attempted:

Despite both the client's and the contractor's reservations, we attempted the following strategies:

1) restore existing cabinets in the RT1-B and RT2-B units;
2) restore existing bathroom accessories (particularly medicine cabinets and shower rods);
3) reuse hanger rods;
4) reuse kitchen cabinets in laundry rooms, janitor' apartment and for additional storage in bedrooms.

Our original specifications called for the restoration of the existing kitchen cabinets in the RT1-B and RT2-B units. We intended to replace the cabinet doors and countertops as well as clean and repaint the steel frames and cabinet interiors. At a certain point in the progress of the work, the contractor had removed the existing countertops and cabinet doors, but was unable to find a cabinetmaker willing to undertake the replacement of the doors and countertops. There were two significant problems. First of all, the contractor had removed and disposed of the hinges with the cabinet doors and there was no readily available replacement, given the unusual detail of the steel framed cabinets. Also, the cabinets were out of square which would have required tedious fitting of the new doors. Various alternatives were considered, including adding a new face to the existing cabinets complete with doors, but finally, the contractor agreed to replace the cabinets completely with new for the same price. Given the condition of the existing cabinets, the client gladly accepted this proposal.

We had also requested that the contractor remove the existing cabinet modules from the RT1-A and RT2-A units intact and store them on site for later reuse. The lower cabinets were not in very good condition after removal, particularly as they were badly rusted around sinks and had been largely held together by the countertops. On the other hand, the upper units were easily removed and in good condition. We proposed a number of alternatives for reusing them, particularly to provide additional storage in the bedrooms or for use in laundry rooms, but the client felt that they were unacceptable in appearance and there were no funds available at any point to even install them, nevermind repair or paint them. At a certain point they were dismantled by the scrap metal dealer who took all of the steel frames and the doors and countertops were discarded (see photos in appendix A) .

We made an initial inspection of all bathroom accessories, particularly medicine cabinets and shower rods which we had felt could be reused. They were all partially rusted and, though they could have been cleaned and replated, it was much less expensive to discard and replace them. Hanger rods were reused in the RT1-B and RT2-B units, as the original closets were not altered.

C) Resultant effect on the cost and timetable of the project:

There were no additional costs or delays due to our strategies to reuse the kitchen cabinets, particularly because the scrap metal dealer agreed to dismantle and remove all the cabinets for free at the end of the job. But on the other hand, we were completely unsuccessful in reusing any of these items. The lesson that we learnt is that it is necessary to find trades willing to reuse materials or assemblies and solutions to technical problems prior to bidding. This process requires considerable more detailed study of various components than would normally be required of the architect on this kind of project. There might be some argument to be made, in order to achieve effective reuse of some components, to establish a preliminary stage of dismantling prior to the main contract, in order to work directly with specialized trades.

DIVISION 11
FURNITURE & EQUIPMENT
Including
- stoves
- refrigerators

A) General comments:

There were existing appliances in the majority of the existing units. Most of the stoves and about half of the refrigerators were about thirty years old, dating from the original construction of the buildings. There were much newer refrigerators in about 20 existing units.

B) Description of strategy employed or attempted:

Given that the majority of the housing stock in Montreal is rented rather than owned by its' occupants and often rented without appliances, there is a ready market for used stoves and refrigerators, with retailers and repair shops in every neighborhood. With a few phone calls, the client was able to easily find someone willing to take the older stoves and refrigerators off our hands at no cost. The newer refrigerators were stored on campus for use in other student residences.

C) Resultant effect on the cost and timetable of the project:

There was no cost in having a used appliance dealer come and pick up the existing stoves and refrigerators. In fact, we saved the cost of moving the appliances out of the units and disposing of them - not inconsiderable given the sheer volume of 60 stoves and 60 refrigerators.

DIVISION 15
MECHANICAL
Including
- copper piping
- cast iron drains
- porcelain plumbing fixtures (toilets, sinks and bathtubs)
- kitchen sinks
- plumbing brass (faucets)

A) General comments:

All existing plumbing fixtures in bathrooms were left in place. All existing stainless steel kitchen sinks were removed and reused with new faucets in the new kitchens (see photo in appendix A) . Some sanitary and storm stacks had to be relocated in a few units given the location of new stair openings. The two central hot water tanks were deemed to be in good condition and retained. Initially, we had intended to provide individual hot water tanks for each unit and reuse the central tanks only for active solar pre-heating of the hot water supply to each unit.

B) Description of strategy employed or attempted:

In general we tried to work with the existing plumbing system as much as possible, including the following strategies:

1) conserve in place all existing bathroom plumbing fixtures;
2) reuse stainless steel kitchen sinks and faucets;
3) conserve in place existing storm and sanitary drain systems;
4) conserve in place existing domestic hot and cold water supply;
5) reuse existing central hot water tanks for active solar preheating of domestic hot water.

Most of the bathroom plumbing fixtures were in serviceable condition. At the end of the construction, all plumbing fixtures were inspected by McGill's own plumbing staff and they required only minor repair and maintenance. Very few fixtures required replacement. Stainless steel kitchen sinks were removed intact (including clamps), cleaned and reinstalled in the new kitchen cabinets. Existing kitchen faucets, of which there were dozens of different models in varying condition, were replaced with a standard model to facilitate future maintenance.

The existing sanitary and storm drainage systems were largely untouched, though there were, unfortunately, some unforeseen site conditions requiring relocating some drains. Domestic hot and cold water supply mains were left intact, with some valves added but connections to some fixtures, particularly in kitchens, had to be relocated. There was little or no demolition plumbing waste - the few lengths of copper pipe replaced were generally taken away by the plumber for his own use.

We had originally intended to provide individual hot water tanks for each unit and reuse the central hot water tanks for active solar preheating of the domestic hot water supply, with solar panels on the roof above the existing tanks. This was intended to save energy costs for the client, as the central tanks require maintaining the same temperature and volume of water at all times, regardless of whether all units are occupied. In the final contract, there were not sufficient funds to add the new tanks as well as associated costs (electrical connections, floor drains and some modifications of the existing supply system) and it was decided to retain the existing central tanks and instead consider another approach to active solar hot water heating.

C) Resultant effect on the cost and timetable of the project:

Reusing existing plumbing systems and fixtures as much as possible likely saved time in construction, though there were the inevitable site conditions to be dealt with each week. Unexpected problems or unforeseen locations of plumbing as the demolition proceeded often held up the progress of the work until a solution and extra costs had been accepted by all parties. Though a headache, it is an inevitable part of any renovation work.

In general, it is clear from our experience that most plumbing fixtures will last much longer than the typical twenty-five year cycle of building renovation. Various parts and connections can wear out but are generally easily repaired or replaced. Finding parts for repairs is not always easy, but they are mostly interchangeable from one manufacturer's product to another. Kitchen sinks were easily reused, requiring only a little more patience in removal and a strategy for storing them and associated parts.

There were a few important lessons that can be drawn from this experience. Reusing the fixtures requires a very effective and clear specification for cleaning. It would be helpful if there existed a cost effective and reliable technique to refinish enameled steel bathtubs. There should also be an allowance for both professional time to inspect and specify any repairs during the construction as well as a contingency budget to carry out these repairs. This inspection was carried out too late in the process on this project and there was both some damage to other building components when the water was turned back on as well as some unnecessary delays. Finally, it would be useful to ensure that there are available accessories (such as drain baskets and drain plugs) for all reused fixtures as these inevitably get lost on the construction site.

DIVISION 16
ELECTRICAL
Including
- electrical wiring, conduit and accessories (switches and plugs)
- electrical panels
- electrical baseboard heating
- light fixtures
- thermostats

A) General comments:

None of the existing electrical wiring was replaced in the RT1-B and RT2-B units, as the existing layout was not changed. In the RT1-A and RT2-A units, existing panels were conserved in place and wiring changed only as required by new layout of partitions. The existing electrical baseboard heating was also conserved and replaced only as required for the new layouts or if significantly damaged. Light fixtures, switches and plugs were also replaced only as required, though we were also obliged to upgrade the electrical in order to meet current codes for the RT1-A and RT2-A units.

B) Description of strategy employed or attempted:

As with plumbing, we attempted to work around the existing electrical system as much as possible, including the following strategies:

1) conserve existing electrical panels;
2) conserve as much existing wiring as possible;
3) conserve existing electrical baseboard heating including thermostats;
4) conserve existing lighting;
5) reuse lighting fixtures and other electrical equipment.

We were able to retain most of the existing electrical panels and wiring in the layout of the units, by keeping existing partitions wherever possible and adjusting door locations so as to not have to reroute wiring. Inevitably, there were conditions that arose on site that caused us to revise the layouts a number of times. In cutting the slabs for the new stair openings of the upper floor of the RT2-A units, we discovered that we had cut the conduits for the majority of the upper floor circuits and ended up having to rewire the majority of these areas.

The existing baseboard heating was generally in good condition and we only had to replace units in about half of the bathrooms and all of the original kitchens of RT1-A and RT2-A. Though not the most energy efficient form of heating, the heating load was significantly reduced by densepacking cellulose insulation in the roof of all units and replacement or repair of windows. Many light fixtures were retained, particularly in the RT1-B and RT2-B units, and the electrician was able to find replacement parts for many of these fixtures.

C) Resultant effect on the cost and timetable of the project:

Retaining existing electrical was made somewhat difficult by a lack of any precise layout of existing wiring and we were obliged to modify the layouts somewhat as the demolition proceeded. As a result there were some extras for both additional electrical work and additional demolition that likely cannot be avoided on such renovation work. On the other hand, the cost of reusing as much of the original wiring as possible saved the project considerable costs.

5. DESCRIPTION OF IMPROVED ENERGY PERFORMANCE AND THE EFFECTS AS RELATED TO COST, ORGANIZATION AND SCHEDULING.

SUMMARY CHART OF IMPROVED ENERGY INITIATIVES:

	IMPROVED ENERGY INITIATIVES	SCHEDULING (phasing and sub-phasing)	COST
1	Roof / ceiling Upgrade: The addition of roof trusses on top of the original roof joists and the cellulose dense-packing of the lower roof joist cavity.	The scheduling of this work was difficult mostly because it was an environmental initiative that was not part of the base contract.	$30 000
2	New Windows and Doors: The replacement of windows and doors.	The scheduling of the work was not complicated, but the demands on the architectural team were exhaustive.	$45 000
	Envelope air tightness Upgrade: The amelioration of the air tightness of the windows and doors	The scheduling of the work was not complicated.	$20 000 to $ 25 000
3	Greenhouse Addition: The addition of greenhouses and the resultant creation of trombe walls.	The scheduling of the work was not complicated, but the demands on the architectural team were exhaustive.	$65 000
	Vestibule Addition: The addition of vestibules / air locks	The scheduling of the work was not complicated.	$5 000

1. Roof / ceiling Upgrade:

The addition of roof trusses on top of the original roof joists and the cellulose dense-packing of the lower roof joist cavity was both a technical amelioration and a mechanism to drastically improve the energy efficiency of the ceiling/roof plane. The original roof section contained only one cavity (2"x8" roof joists) with no air space. Approximately fifty percent of the original roof spaces were retrofitted with fiberglass insulation in the 1980's without adding any air ventilation solution. This led to the deterioration of the ceiling plaster boards. The new roof section strategy included work from both the outside and inside (see the detailed section in appendix E) :

a) remove the original roofing membrane and replacing the original plywood where necessary (10 percent);

b) install new roof trusses and roof membrane to create minimal slopes to drains, to create an air ventilation cavity, to create six feet overhangs for east, south and west elevations in order to reduce solar gain during the summer months while still allowing solar gain during the winter months, and to create two feet overhangs on north elevations to protect the exterior brick facades from water infiltration.

c) strip the lower cavity of it's damaged fiberglass insulation and interior ceiling - after allowing the roof joists to dry out, a new plastic vapor barrier and furring were installed below the original 2"x8" roof joists and the lowest cavity was dense-packed with cellulose insulation and a new gypsum board ceiling was installed.

This improved energy performance strategy was also a vital component in transforming the overall aesthetic of the buildings by clearly redefining the wall / roof plane relationship.

2. Windows and Doors:

The mixed strategy of replacement, refurbishment and re-use of windows and doors is the synthesis of numerous factors. The project has promoted re-use where plausible but not to the detriment of the users. The new windows are located in six-plex bathrooms and bedrooms, where the improved energy performance was directly linked to comfort and acoustical privacy. The amelioration of the air tightness of the existing windows and doors is in fact becoming a more accepted practice. There are in fact numerous sub-contractors who specialize specifically in upgrading of the air tightness of the existing windows and doors. This task is labor intensive, and thus it can only be financially viable when the quality of the original windows and doors is above a certain threshold. Most of the windows and all of the doors were repairable without the use of scaffolding. The main goal of eliminating air leakage was met, without changing the original double glazing.

3. Addition of New Greenhouses and Vestibules:

The addition of greenhouses and vestibules and the resultant creation of trombe walls, was both a technical and architectural amelioration. With respect to the greenhouses providing improved energy efficiency please see section 4.3 for a more comprehensive explanation. The entrance vestibules were added to drastically cut down the surge of cold air during the winter months.

6. GENERAL CONCLUSIONS AND RECOMMENDATIONS

The process of planning and then transforming an existing residential project into "ECORESIDENCES", where much emphasis was placed on incorporating innovative environmental strategies within a restricted financial budget, has been both a rewarding and exhausting experience.

To complete a built project that is genuinely founded on environmental principles, numerous conditions and factors must be created and set in place; collectively defining and committing to common project goals and team participant roles from the outset of a project; anticipating the sensitivity of a project to time and financial constraints, scale of economies and collaboration efforts, while addressing client expectations; and having the courage to attempt an innovative process outside of traditional conventions.

When a myriad of diverse goals are initially outlined, their eventual compatibility is heavily dependent on clearly defining team roles and prioritizing project goals. Our case study project included the participation of numerous players; client (Dean of the faculty, student user representatives and management employees), project manager (separate from the client, but acting as an agent for the client), fundraising team, consulting engineers (structural, and mechanical / electrical) and ourselves, architects. Not all participants were hired at the very beginning of the project (the fundraising team and consulting engineers were hired after the completion of the preliminary design), nor was there an adopted environmental approach by all parties involved. The problems that arose with the delays in hiring did not stop the viability of the project, but innovative propositions require more coördination than conventional proposals.

Although as architects we often coordinated the group of participants with respect to environmental research, planning and technical solutions, the responsibility for financial decisions (which impacted directly on the order of priorities) was controlled and shared by different participants during different phases. By not creating a unique collaborative unit, working in parallel on all decision-making responsibilities, the environmental depth of the project was dependent on the efforts of individual participants and their capacity to convince their fellow colleagues. More emphasis should be placed on developing a collaborative process from the outset, that allows innovative projects to be built. This may result in increased project start-up costs, risk-taking (although not necessarily from a financial perspective), and increased time commitments, but it could save considerable time and money in the long run.

Reuse of building materials and components in this project dictated a supplementary degree of coordination and collaboration between design professionals, client representatives and the builder. The design process actually extended well into the preparation of contract documents, tendering and some aspects continued into the construction phase as well. With a traditional client (in our case study, a university), financial uncertainty is not acceptable after the completion of final design..

The following three examples from our case study illustrate how numerous conditions and factors must be created and set in place for environmental principles to be realized.

> Time sensitivity, scale of economies and the lack of immediate landscaping funds, played important roles in impeding the reuse or recycling of concrete and masonry. The scale of the project will often determine the financial viability of crushing concrete and masonry on site (for immediate reuse). The minimum viable scale required will vary for different cities across Canada, since mobile crushers are not yet available or affordable in all regions of the country. Still, in

our opinion, an equally decisive factor in not being able to reuse or recycle concrete and masonry, was the lack of conviction of certain team participants.

Client and industry prejudices played important roles in impeding the reuse of kitchen cabinets. Our original specifications called for the restoration of the existing kitchen cabinets in the RT1-B and RT2-B units. We intended to replace the cabinet doors and countertops as well as clean and repaint the steel frames and cabinet interiors. Certain client representatives (who got involved only during the construction phase) were not convinced that kitchen cabinets were re-usable no matter what specifications for cleaning and repairing were included. At a certain point in the progress of the work, the general contractor had removed the existing countertops and cabinet doors, but was unable to easily find a cabinetmaker willing to undertake the replacement of the doors and countertops. Thus, when the contractor proposed to replace the cabinets completely with new ones for the same price, certain client representatives were quite content. The new cabinets will probably not last as long as the original steel frame ones that were replaced, and they contain more toxic materials as well. It is difficult to persuade people that *new is not always better*.

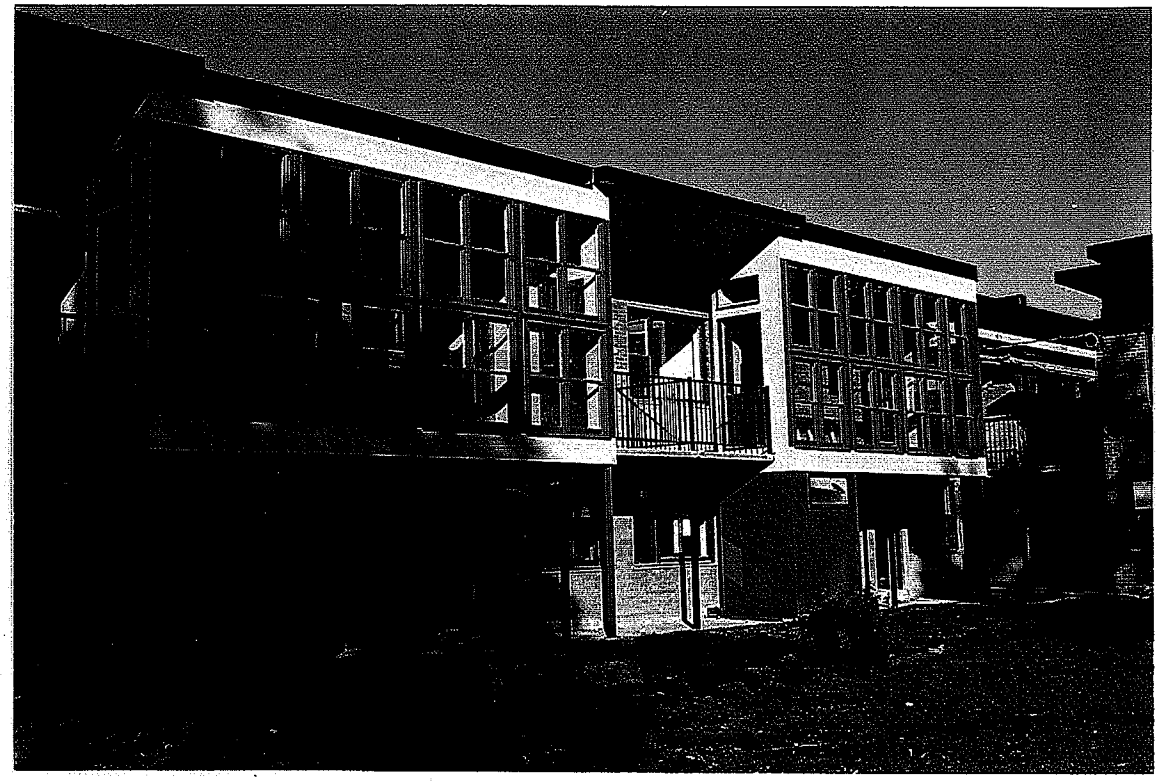
Innovation and flexibility in the design process played a significant role in the capacity of the project to successfully conserve and restore or reuse on site, all of the original doors and windows. Here the client's encouragement and enthusiasm to support the inclusion of new greenhouses attached to the six-plex units (built with the windows removed from the original apartment bedrooms), proved to be decisive. Our experience has shown that incorporating environmental design principles and user sensitivity into the design development process, is the most pro-active way to promote sustainable development.

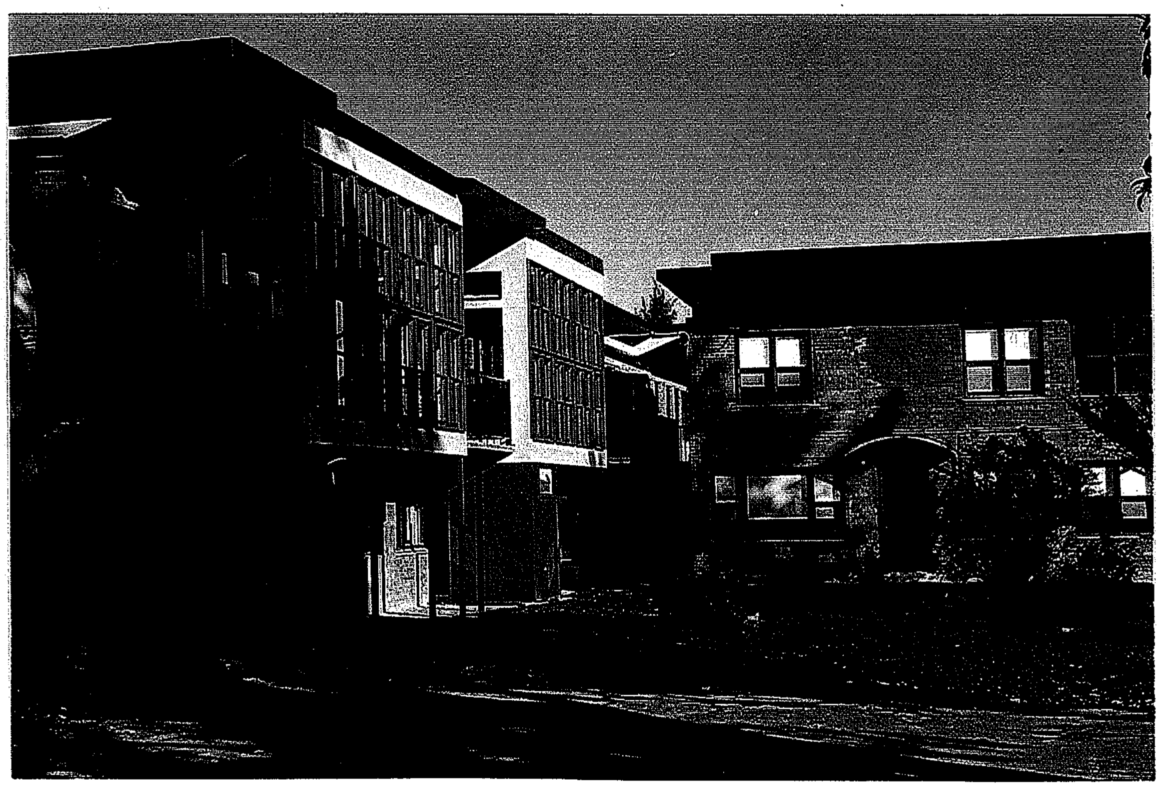
The approach of incorporating numerous sustainable development principles in our base design while planning (and in some cases including) additional environmental initiatives for future phases, is both promising but highly complex and messy.

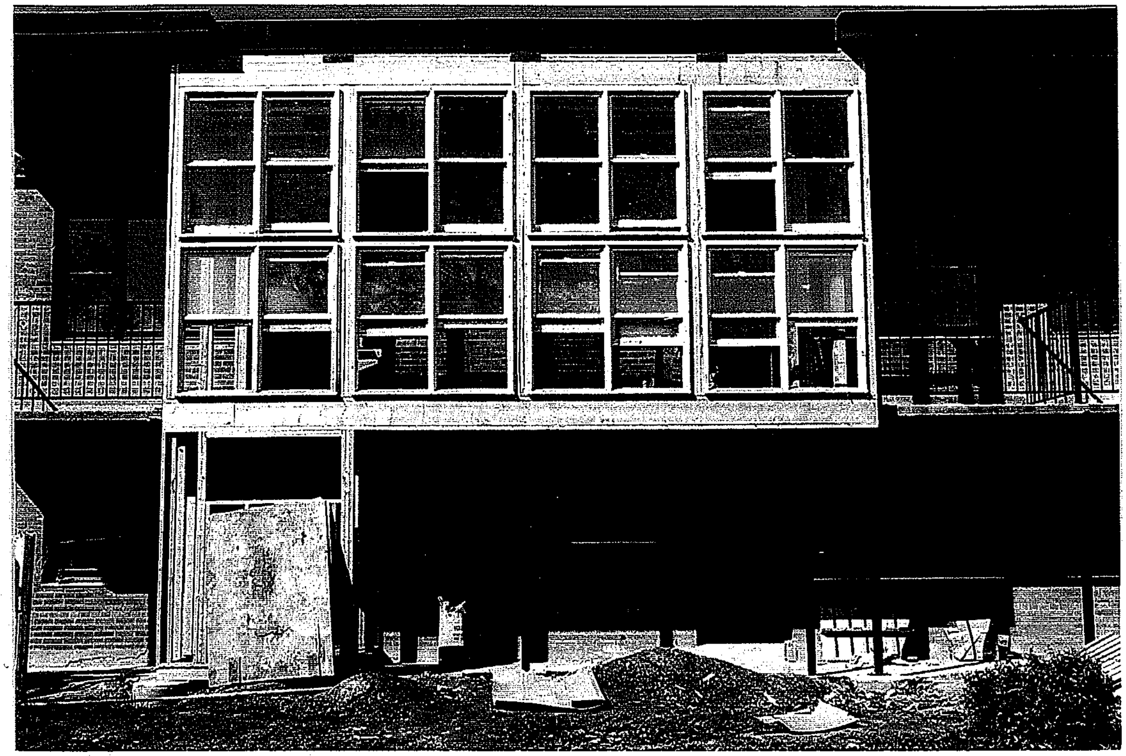
We believe that, given the right circumstances, there are many latent opportunities out there awaiting motivated clients. Two key elements to promoting the potential of these dormant projects are the following:

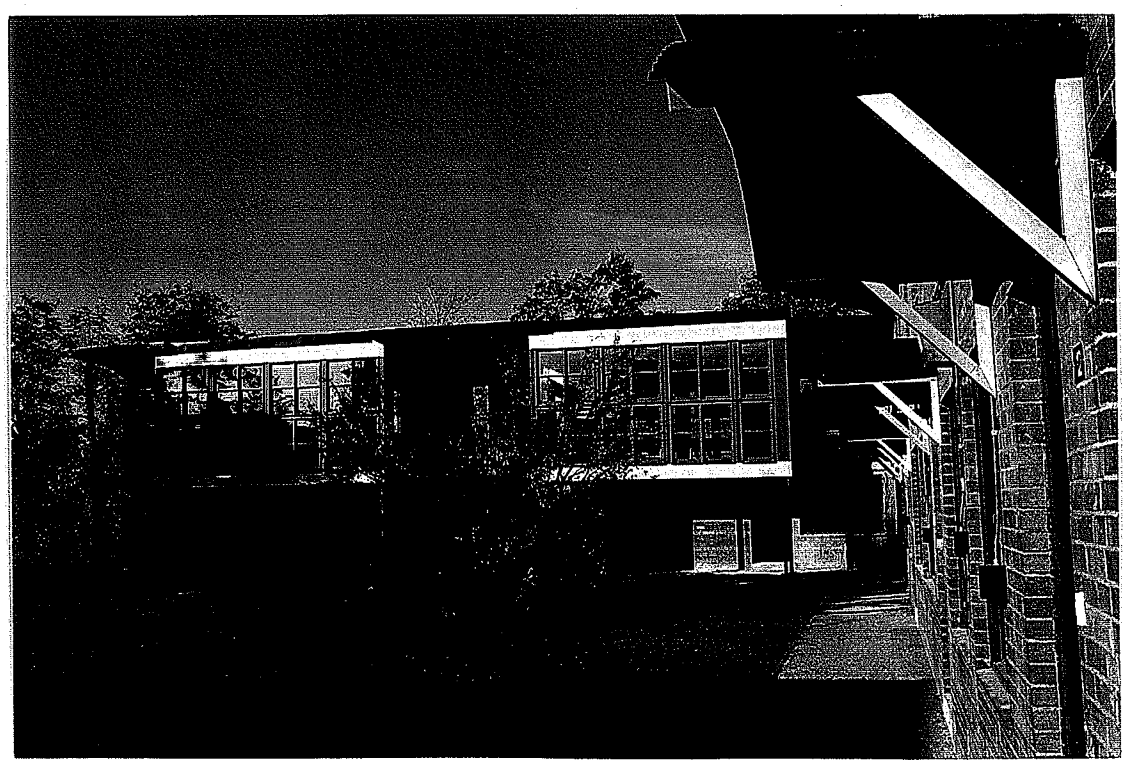
The need to assemble and disseminate well documented case studies supporting sustainable development as both a philosophical and financially viable alternative.

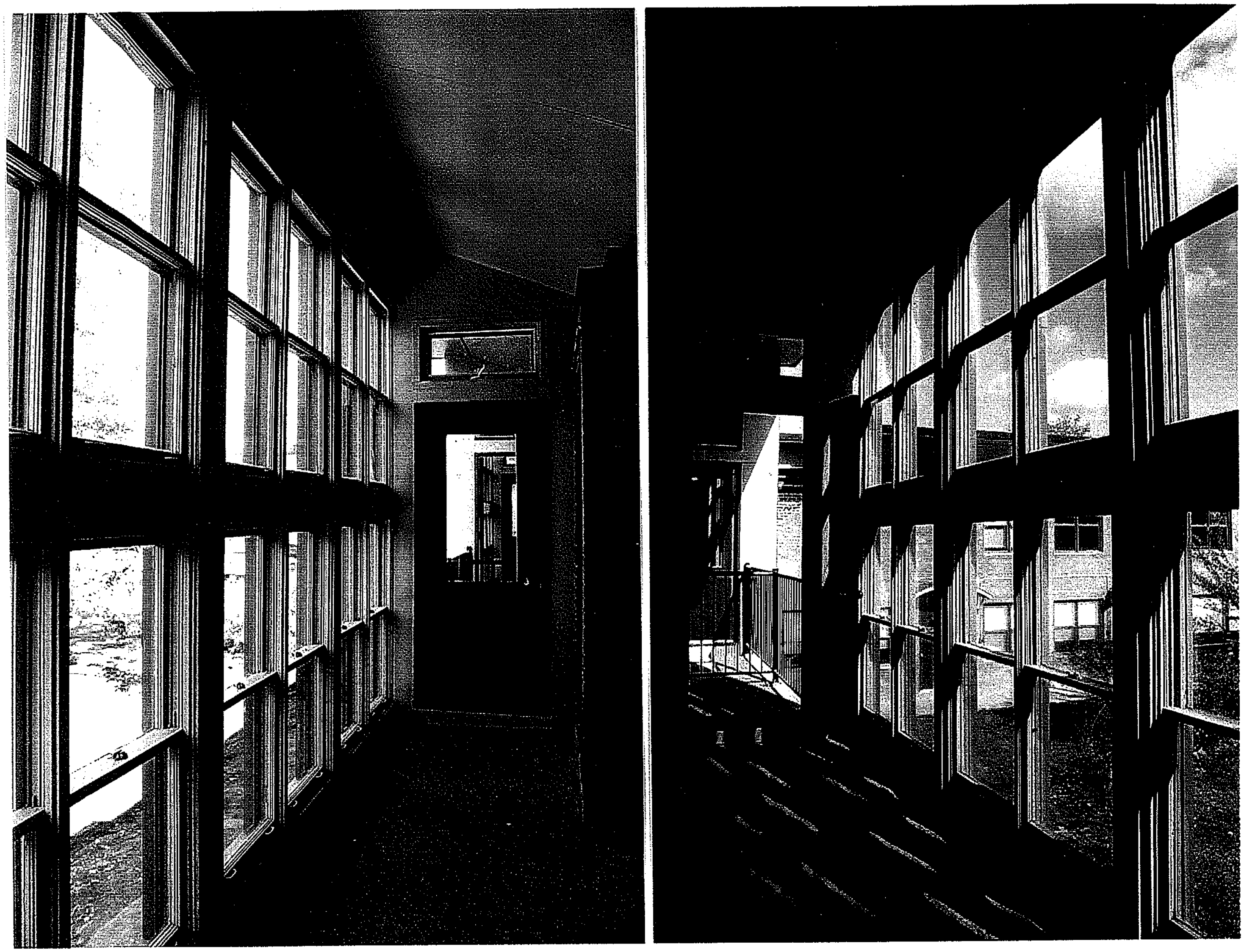
The need to encourage both consultants and clients to partake actively in the labor-intensive processes of the project. In order not to simply rely on the good-natured enthusiasm of these consultants and clients, grants, subsidies or tax breaks should be created to compensate and acknowledge the complex roles that these participants must perform. The real costs to society would still nonetheless be reduced.

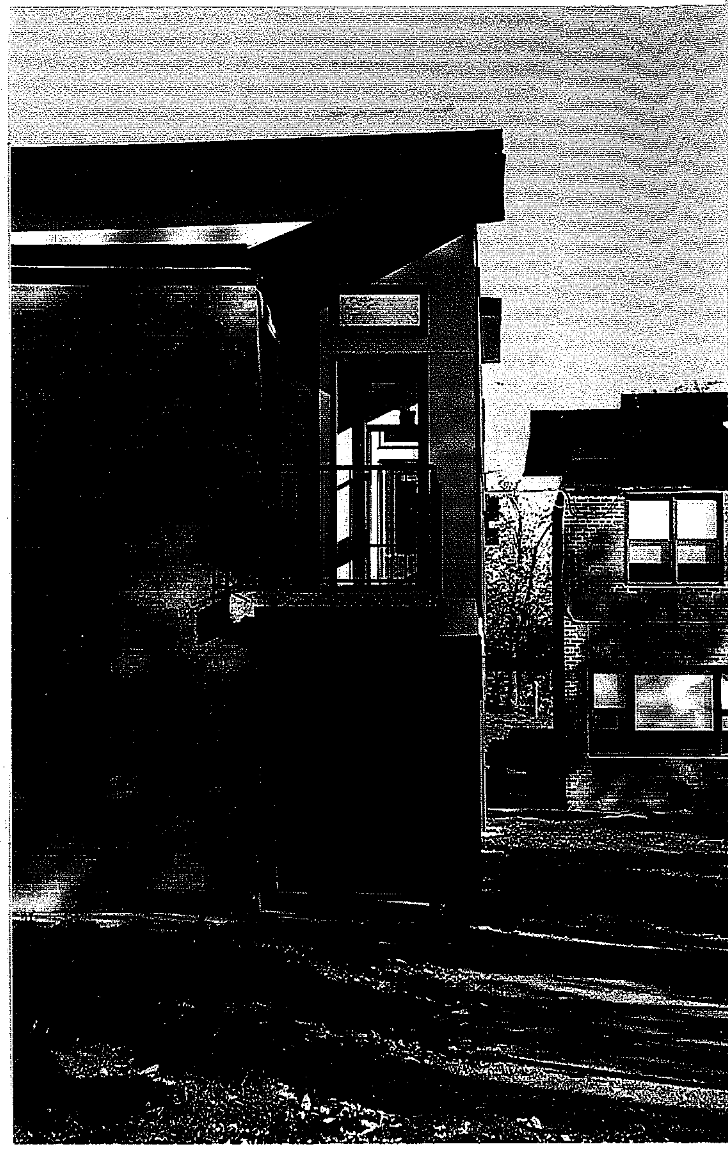


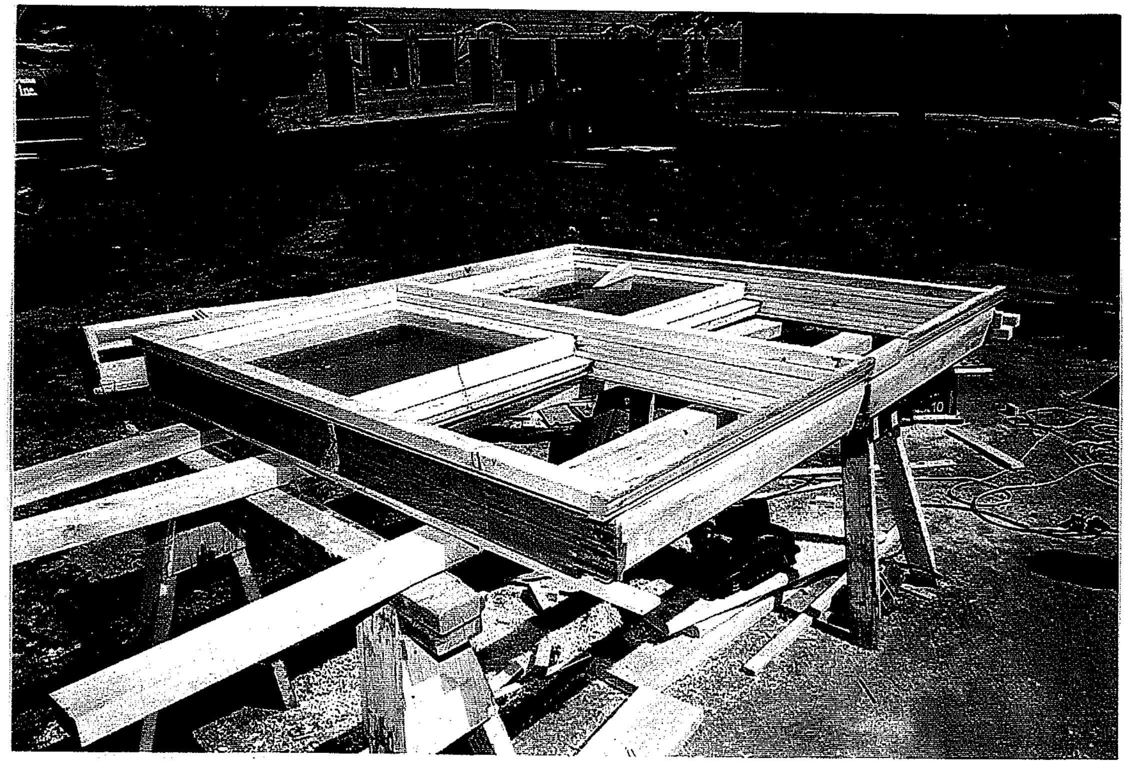


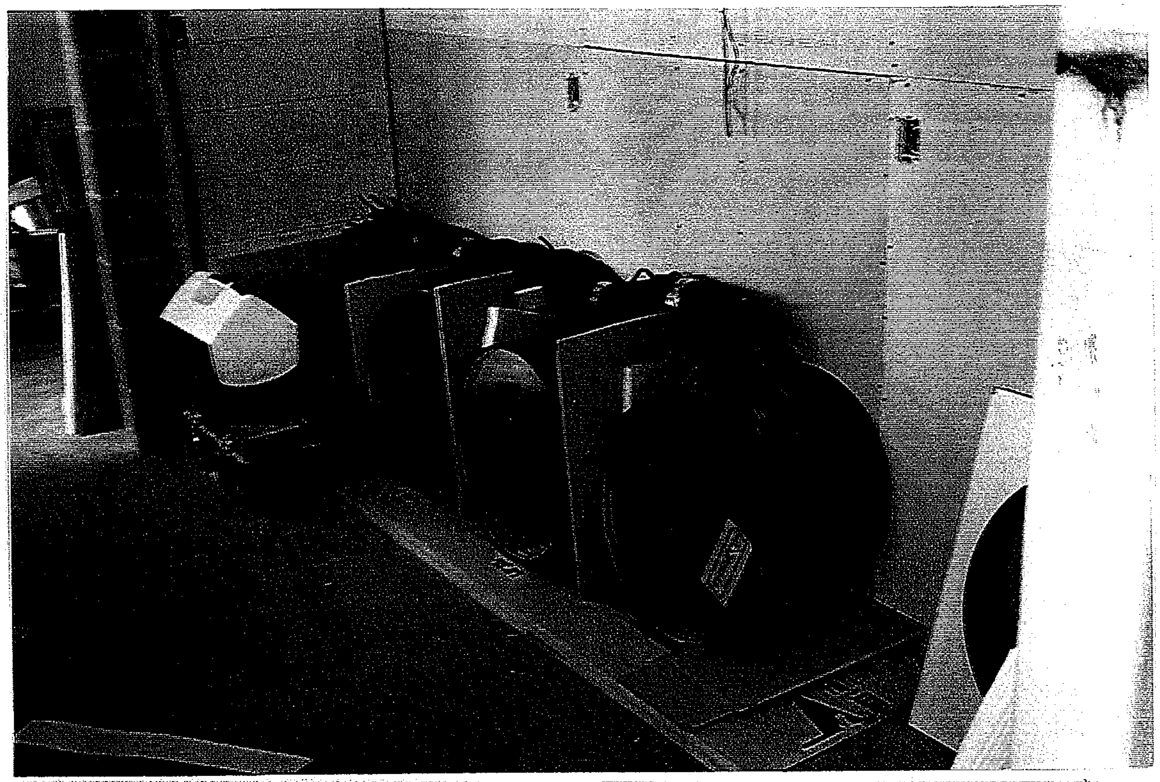










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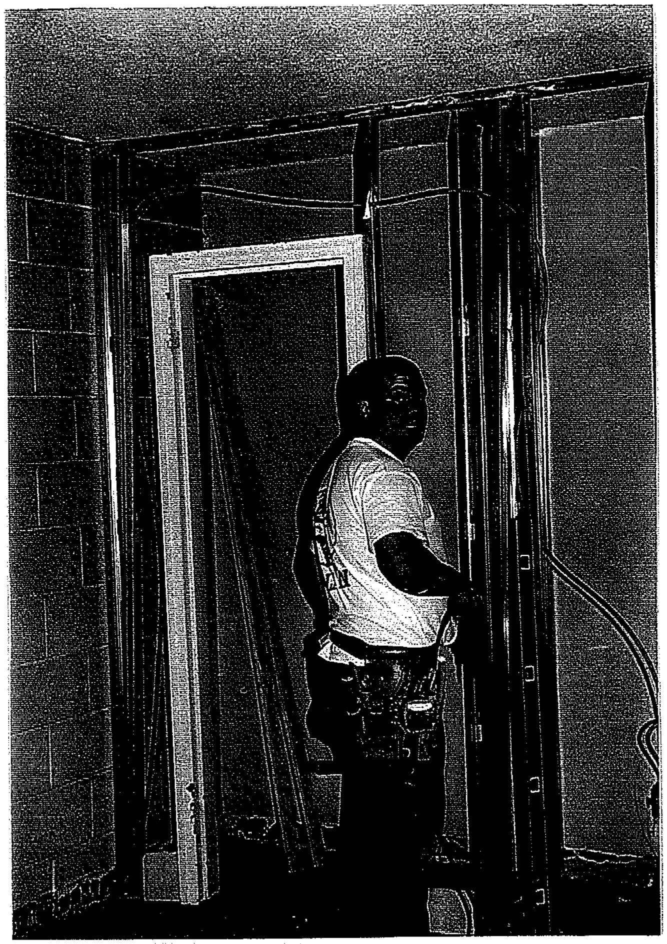
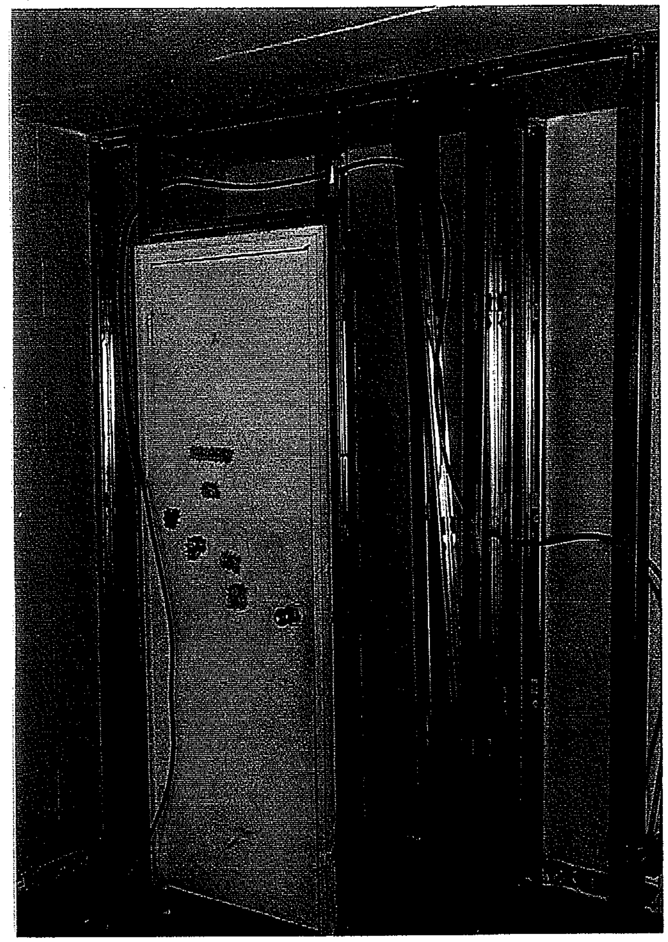
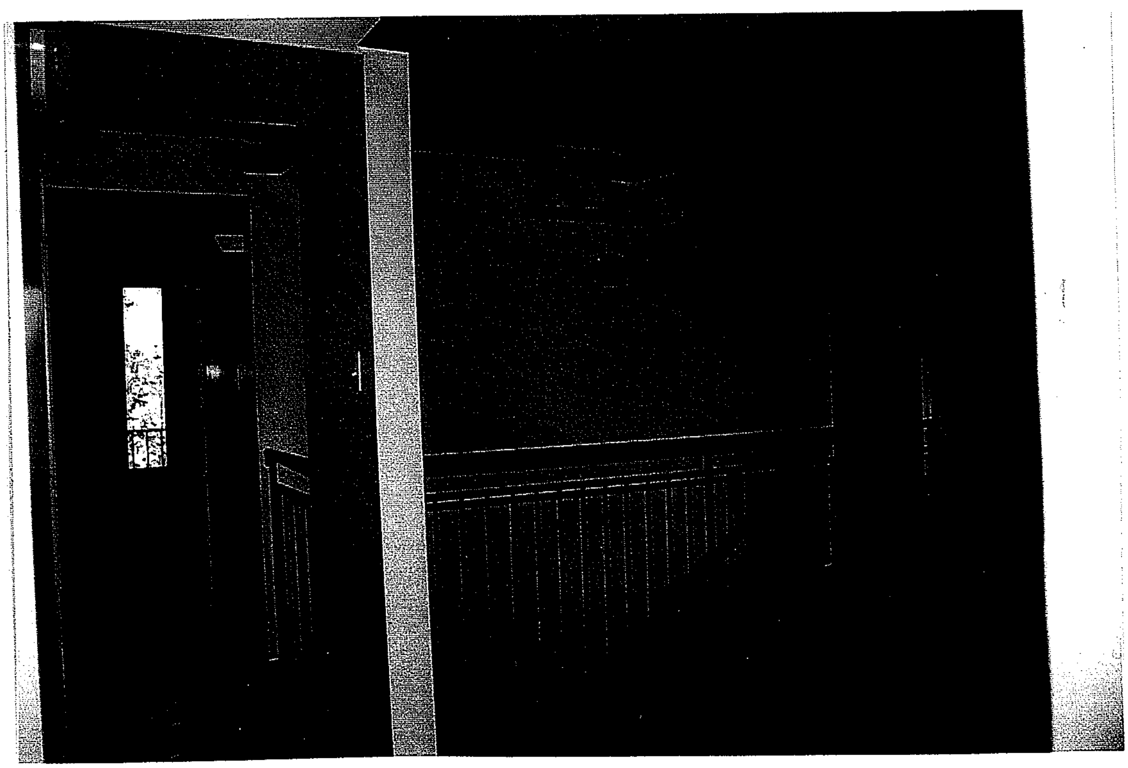
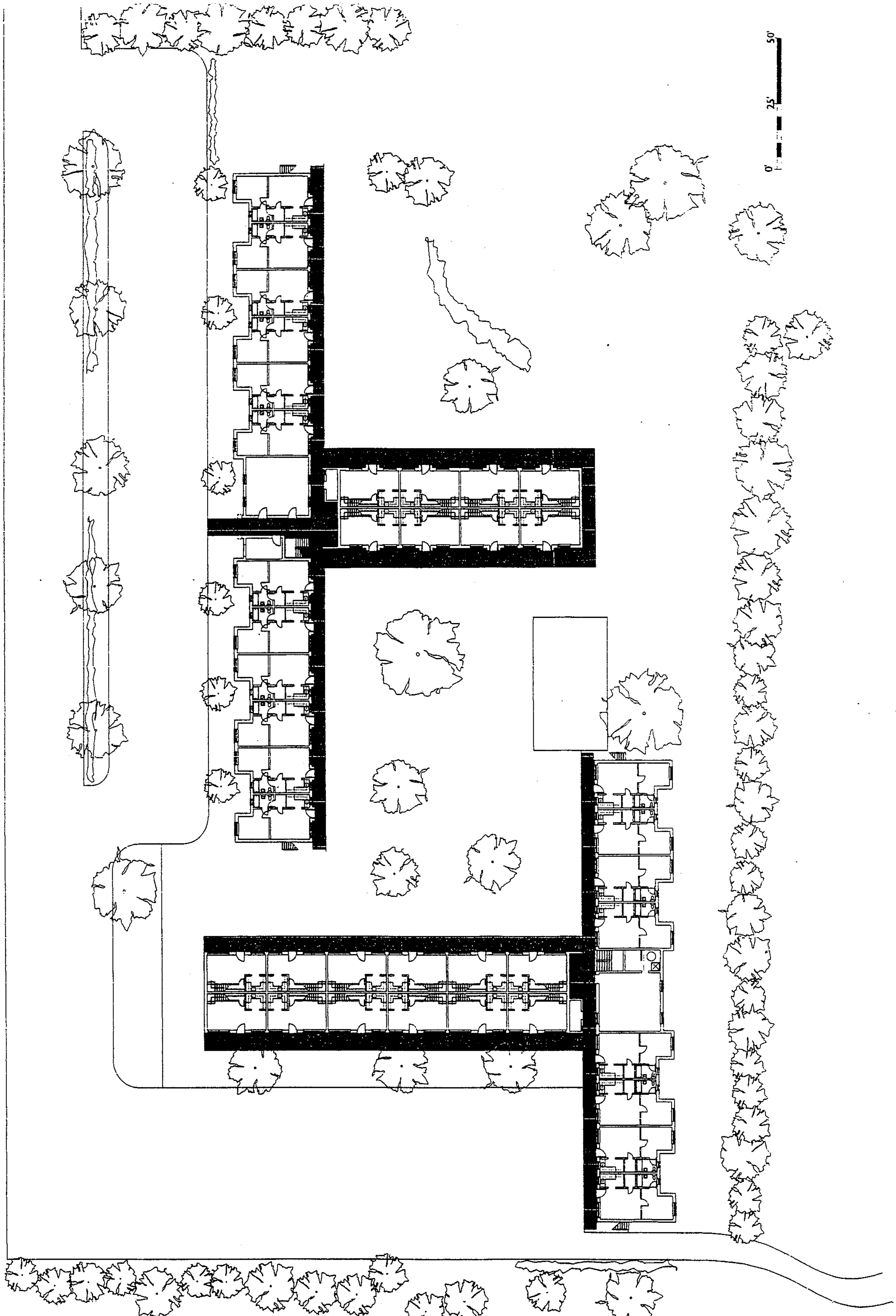
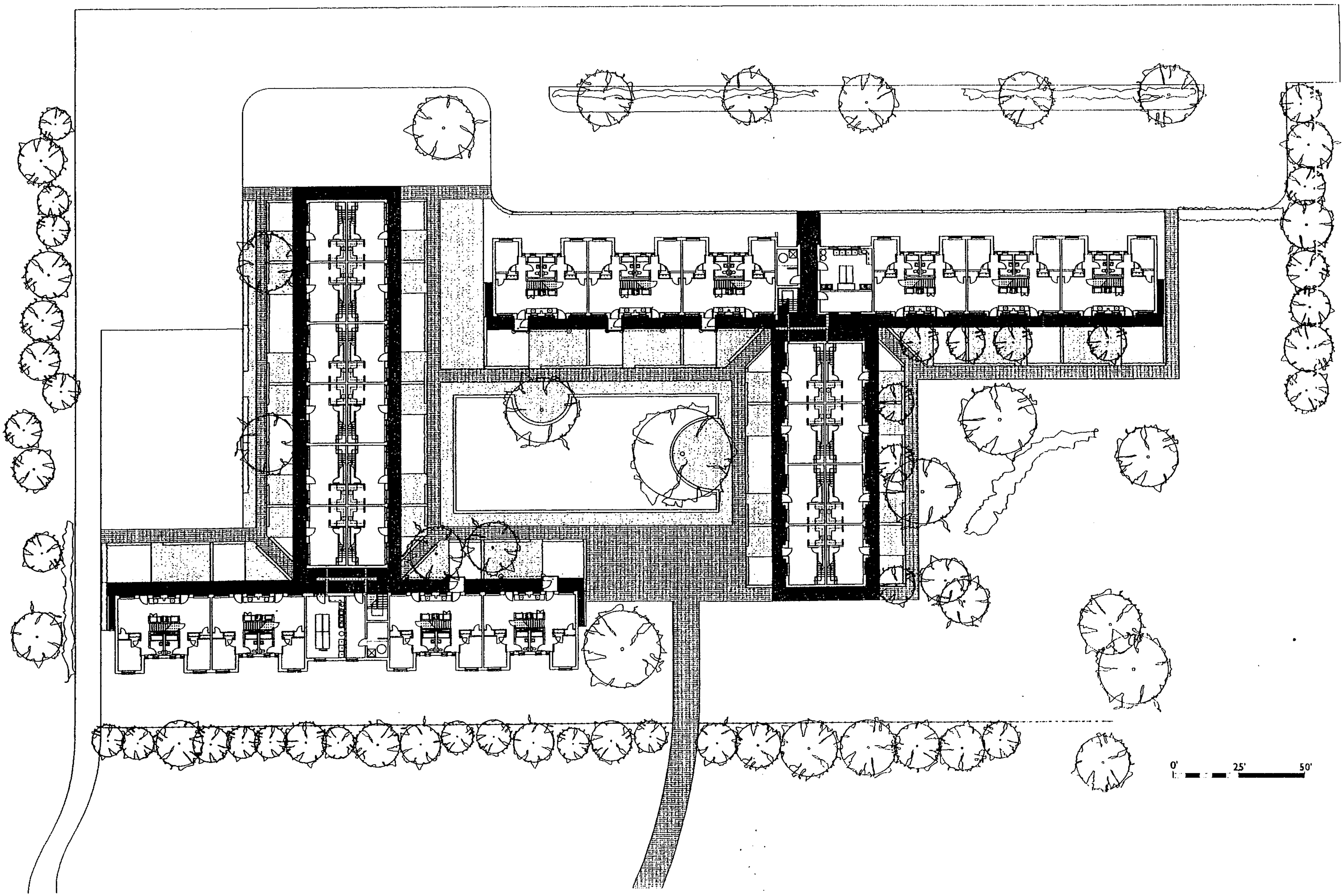


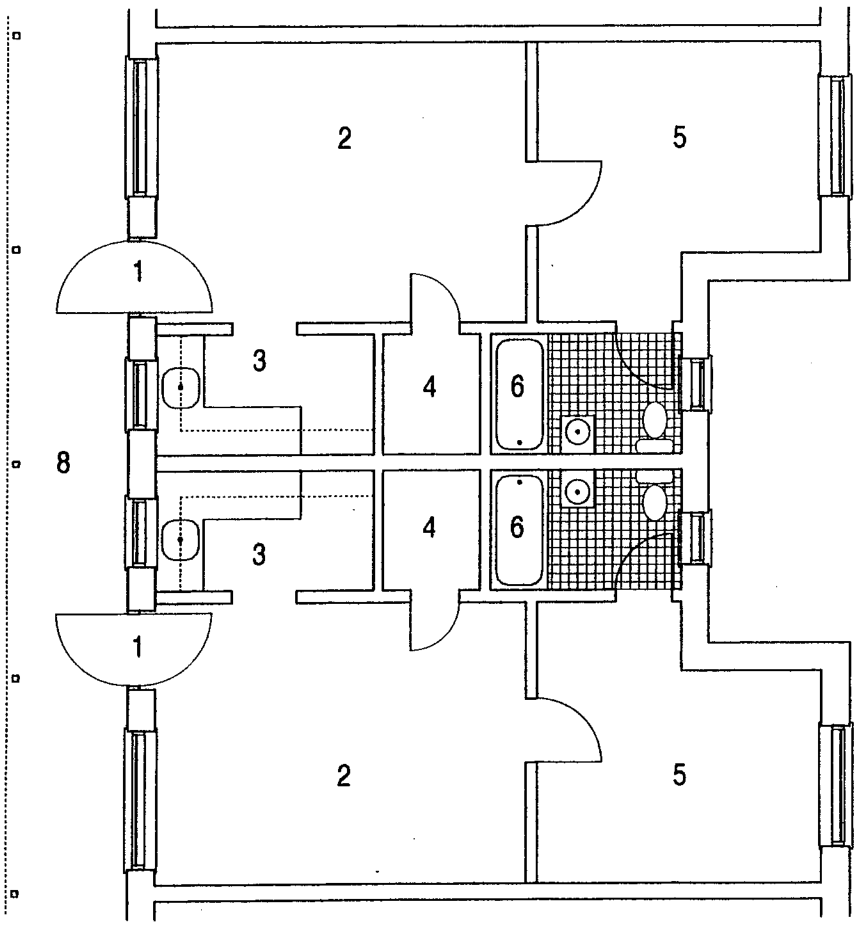




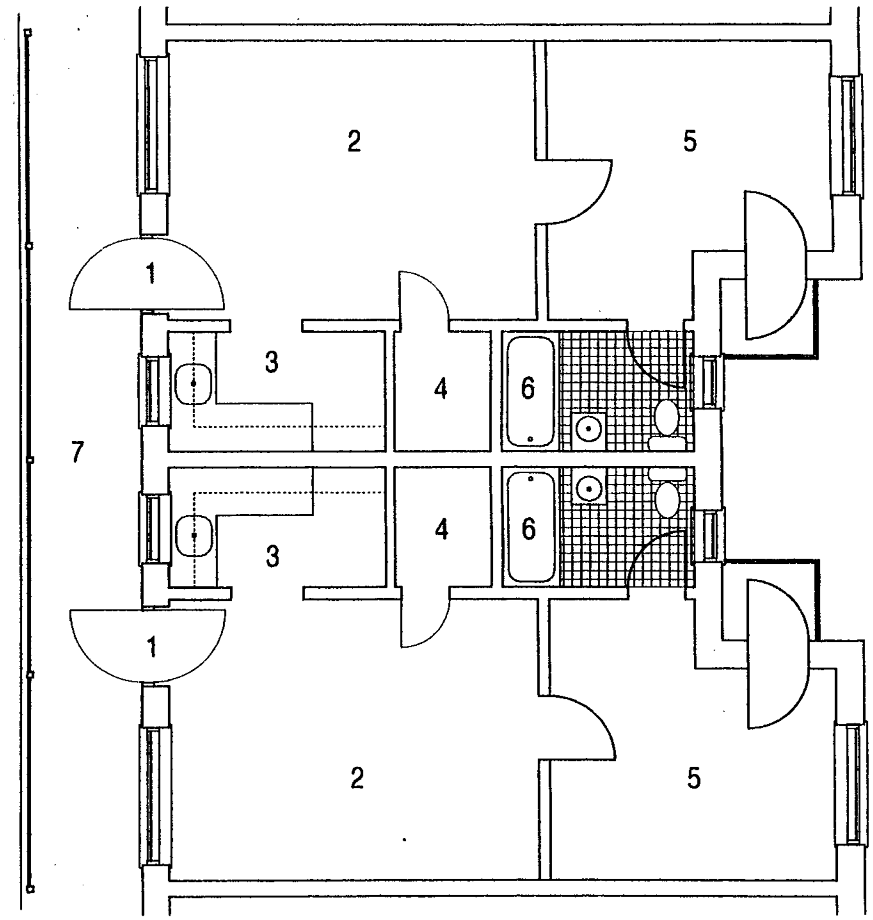


Existing Site Plan

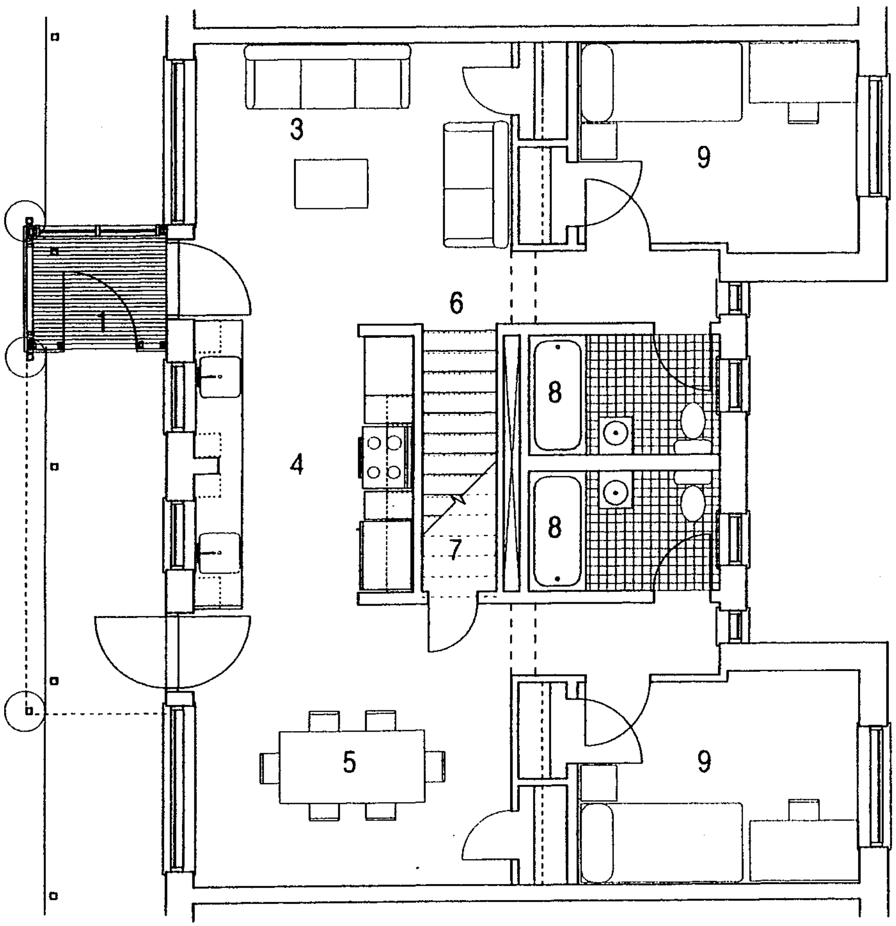

0'
25'
50'



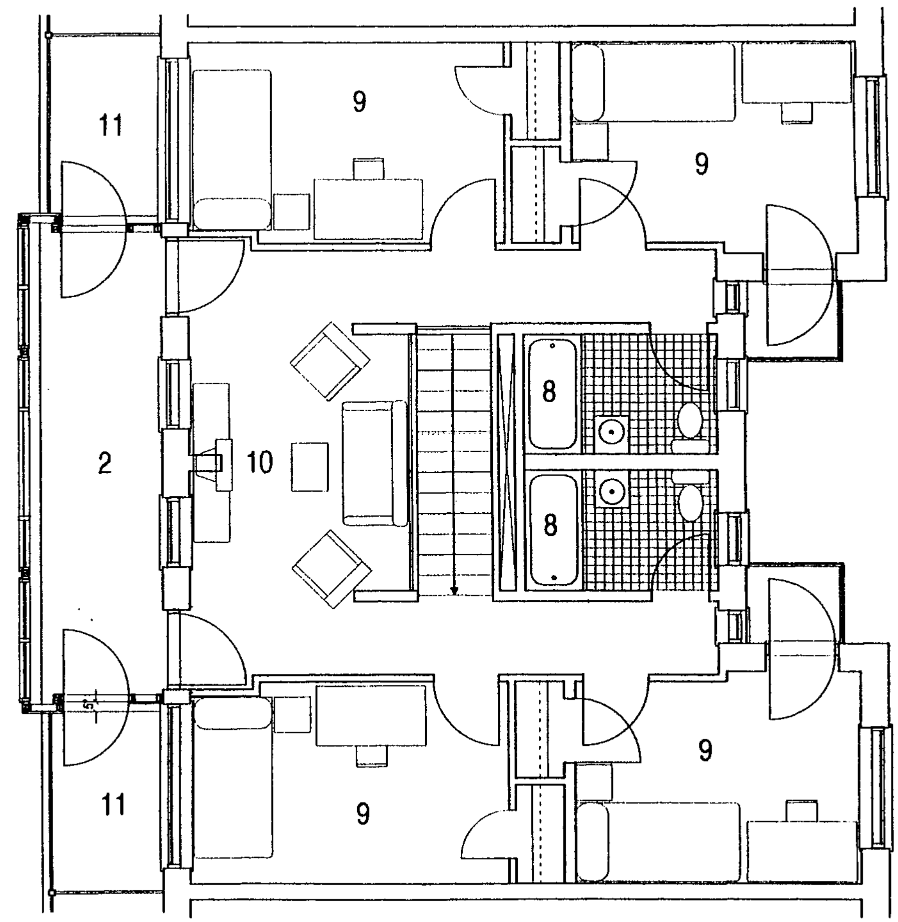
Existing Ground Floor Plan



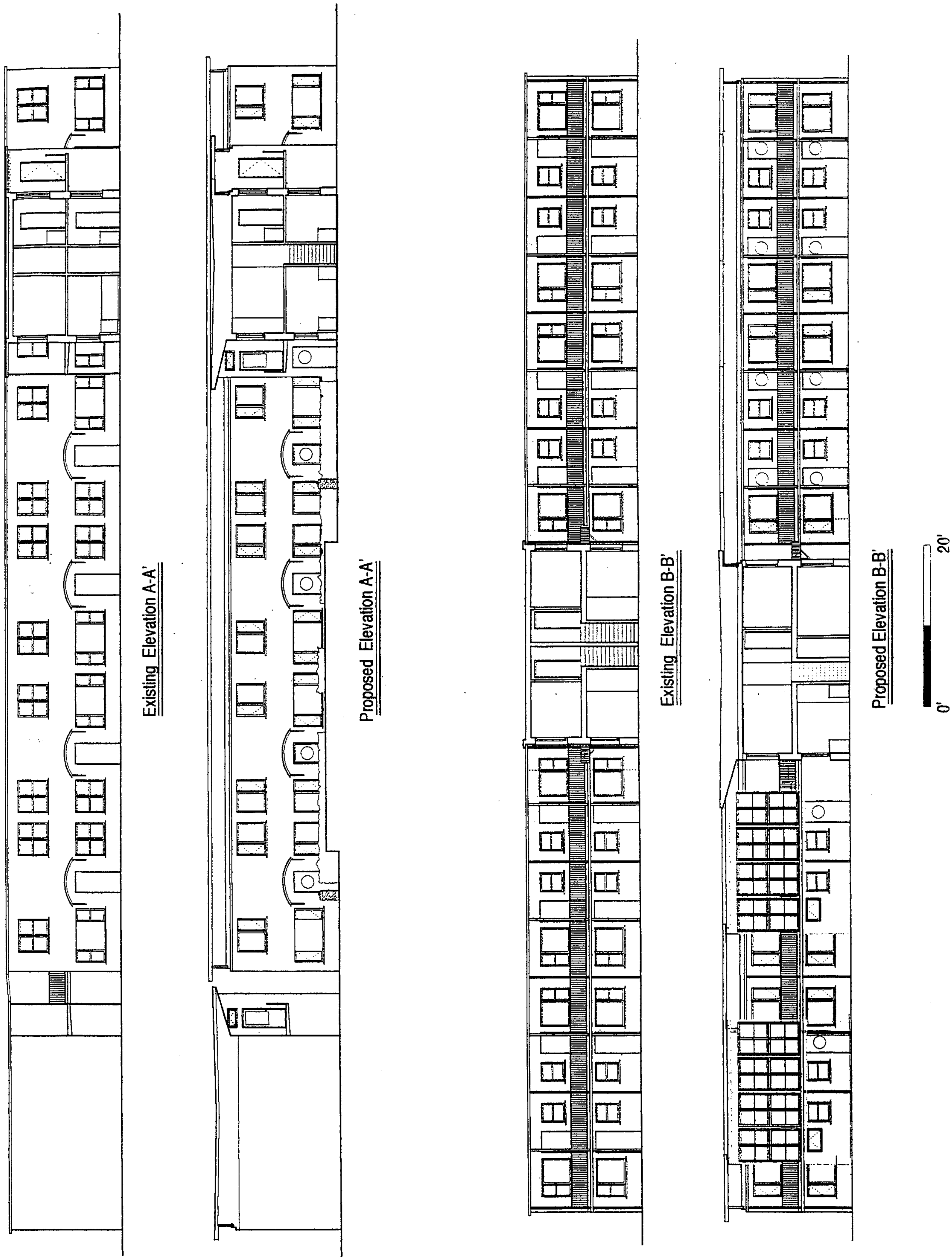
Existing Second Floor Plan

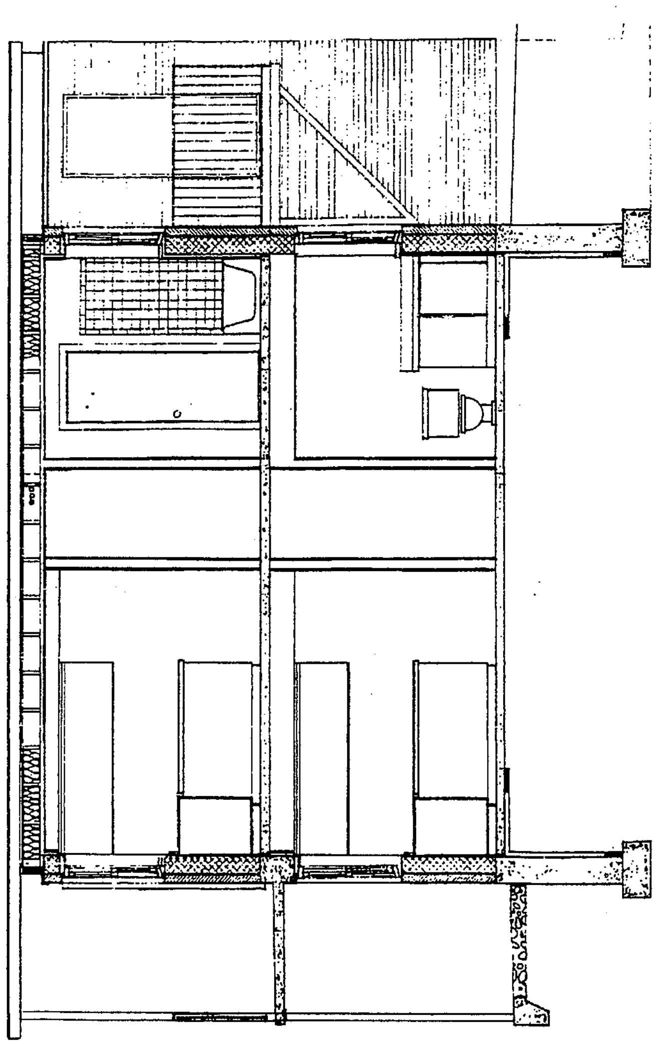


Proposed Ground Floor Plan



Proposed Second Floor Plan


Existing Elevation A-A'
Proposed Elevation A-A'
Existing Elevation B-B'
Proposed Elevation B-B'
0'
20'



Existing Section