INDUSTRY CORNER

STATION POINTE GREENS—
THE JOURNEY TO NET ZERO AFFORDABLE HOUSING

Jennifer Hancock and Brian Scott

INTRODUCTION

Station Pointe Greens, a proposed 219-unit residential and commercial development, promises to be one of the most leading edge Passive House Certified Developments in North America. However, an innovative project such as this requires much time and research, and this project being no exception, it is still in its research and design phase. Its story began in 2008 when the City of Edmonton issued a request for proposals from developers regarding improvement of a brownfield site in Belvedere. This was done as part of the City’s redevelopment initiative for an area which was in dire need of revitalization. The Communitas Group saw a huge opportunity to develop a large-scale multi-family project immediately adjacent to a light rail transit and bus hub. And so the vision of an affordable and sustainable housing project began to take shape.

Communitas had already tested the ‘green’ construction waters on previous projects, most notably Grandin Green, a 15-storey high-rise which was the first Canadian project to qualify for the Federal CBIP grant (25% more energy efficient than required by the Model National Energy Code for Buildings). However, they had never attempted anything as bold and leading edge as Station Pointe Greens. Their goal from the outset was to build one of the greenest multi-family housing cooperative complexes in North America. And like most developers, Communitas wanted to build it with as little ‘green’ premium as possible. This was, after all, to be affordable housing.

In the beginning, the vision was to see how close the project could get to being a net-zero energy, zero carbon emissions project and still remain affordable. It evolved, through the assistance of grant research financing received from the Équilibrium Communities Initiative (Canada Mortgage and Housing Corporation and Natural Resources Canada), to an affordable development seeking Passive House Certification, including an on-site waste water treatment facility. And furthermore, the need to research ‘green financing’ arose. How would Communitas best fund the green premium so that the units could stay affordable? So even though this project is still in the research and design phase, the evolution of the design process, the waste water treatment plant, and the green financing research has yielded some interesting information worth sharing.

KEYWORDS
affordable green housing, passive house, integrated design, energy efficiency, green financing, ecological water treatment, multi-family housing

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PHASE ONE—INITIAL DESIGN

Station Pointe Greens was envisioned as a mixed use development that would incorporate residential units, live/work units, and retail/commercial spaces, all within an ideal urban village setting. The live/work spaces would support light industrial uses, artist studios, and other community services, while the retail spaces would be targeted to local neighbourhood businesses and would include small business/office/artist studio spaces which would allow artists and craftspeople to interact with visitors. The residential component was to incorporate a diverse mix of ages, professions, and income brackets in order to create a strong and dynamic community. The location would provide easy access to downtown Edmonton as well as to major shopping centres and many sports, educational, and recreational facilities in the area. Finally, a community centre was included that will provide meeting and social gathering space for the community as a whole, and includes a day care centre, a kitchen facility, and the capacity to create a dining room function for residents to share meals.

In 2009, Hartwig Architecture, together with input from Communitas, came up with a preliminary design concept for the site. The site’s layout was based on the City’s special zoning by-law and controls for the area. It consisted of three 6-storey buildings with commercial on the main floor and apartments above, a high rise tower, a set of townhouses, and a community centre. At this stage, it was assumed that the sustainability goals would be reached through energy efficient mechanical and envelope design strategies, such as geo-exchange fields and district energy systems. Thus, the very first iteration of the design and site plan simply complied with the zoning controls and showed most of the buildings bordering the near diamond-shaped site, leaving room for a community center in the center courtyard.

In addition to the easy access to the transit hub just across the street, the site was ideally located within a larger planned community, directly across from a central “village square” and adjacent to a landscaped walking and bicycling trail connecting Edmonton North and South.
It was shortly after the initial site layout was completed that Communitas discovered the EQuilibrium™ Communities Initiative Program (EQC), a jointly-sponsored grant program between Natural Resources Canada (NRCan) and Canada Mortgage and Housing Corporation (CMHC). This program was designed to provide financial assistance for neighbourhood development projects which would provide measurable improvements over current approaches in the areas of energy and water consumption, land use planning, sustainable transportation, and other features. It was at this time that Communitas and Hartwig decided to broaden the team.

**PHASE TWO—GRANT APPLICATION SUCCESS**

In order to assemble the best application for the grant money available through the EQC program, Communitas brought in Vital Engineering and Cobalt Engineering to assist with the application and to gain their sustainable design expertise for the project. In 2010, an EQC grant of $481,000 was awarded to the Station Pointe Greens team. Ultimately, this funding enabled the design team to undertake extensive research using an integrated design approach aimed at optimizing the design for an energy efficient, affordable housing development.

The Integrated Design Process, by its very nature, brings together stakeholders and designers early on to help identify cost-effective design and systems synergies; the Station Pointe Greens project experience bears this out. More often than not, however, this front-end design research is a luxury that most developers cannot afford. And while not to diminish the respective roles each player had in the final outcome, it must be said that the final design breakthroughs achieved by the team would very likely never have been reached without the EQC grant.
So with the funds in place, Communitas held a full-day charrette in the spring of 2010. Thirty four participants made up of key stakeholders, future owners, the design team, invited experts, and representatives from the City of Edmonton came together to brainstorm possible design ideas. The following six Rs were adopted as overarching principles for this exercise and for the whole project:

- Recognize—Sustainable Design opportunities early (Integrated Design Process)
- Reduce—The use of resources: fuel, energy, water
- Remember—Laws of Physics, return back to basics, passive design
- Recycle—Waste, energy, water, material flows
- Renewable—Harness on-site renewable solar and its derivatives
- Real Costs—Solutions make short and long term economic sense

With these principles guiding all considerations, it made sense then that the design was to take advantage of passive solar as much as possible.

Although this charrette was just the beginning of a long and detailed analysis which sought to optimize the design, three major ideas emerged at the end of the day. One of the major outputs from this meeting was the discovery that the original site layout, as per Phase 1 site plan, was inadequate to contribute to the most efficient passive heating design. Therefore, the site was redesigned so as to maximize solar gain and minimize internal site shading. The buildings were moved so that they bordered the northeast and northwest edges of the site.

The concept of an on-site natural waste water treatment facility materialized as an important item to consider. And last, two distinct design paths emerged from this charrette and it was decided by the group that these two design routes should be explored in more depth.

**PHASE THREE—PASSIVE DESIGN OR ACTIVE DESIGN?**

A Passive Design path and an Active Design path emerged clearly from the charrette. The Passive Design focused on items like a high-performance envelope and high-performance glazing with the goal of downsizing the mechanical system. The Active Design still considered envelope and glazing, albeit to a lesser extent, and focused instead on technologies like ground source heat pumps, underground solar thermal energy storage, and a district energy system to achieve the same energy target.

At this time Passive House (PH) targets were set as a goal. These included:

- Airtight building shell – 0.6 ACH (Air changes per hour) @ 50 Pascal pressure, measured by blower door test
- Annual heating/cooling requirement of 15kWh/m2/year (4.75 kBTU/sf/yr) residential area
- Primary energy of 120 kWh/m2/year (38.1 kBTU/sf/yr)
- Window U-Value 0.8 W/m2/K
- Ventilation system with heat recovery with 75% efficiency with low electric consumption @ 0.45 Wh/m3
- Thermal bridge free construction = 0.01 W/mK

The PH approach, according the Canadian Passive House Institute, ‘aims for an optimal economic investment combined with the highest levels of comfort and indoor air quality.’ It is one of the strictest building standards with regard to energy performance in the world.
As designs were explored, it was assumed that to achieve the most cost-effective outcome, a double-loaded corridor apartment design was a given. However, with a double-loaded corridor design, more than half of the suites were north-facing, and therefore had no direct access to solar gains. Once the buildings were re-located on the site plan to border the northeast and northwest sides of the site, as per Phase Two site layout, something still needed to be done about passive heating on the north sides of the building. Communitas partner Brian Scott, who had led the successful design strategy at Grandin Green, proposed the concept of using a combination of Earth Tubes and Solar Stacks on the south side of the building as a potential solar energy harvesting and savings strategy. The idea was that these solar stacks and earth tubes would both pre-heat or pre-cool the incoming supply air, and furthermore, through capitalizing on solar-induced stack effect, would reduce the need for mechanical ventilation, thus significantly reducing heating, cooling, and mechanical energy. In this plan, the supply and exhaust air would be all connected and would take advantage of stack effect as opposed to stack effect being a disadvantage.

Before any detailed modeling could commence, especially on the Passive fork, Cobalt Engineering submitted concept sketches describing the most feasible way to utilize the solar stacks and earth tubes concept. Once Cobalt modeled the solar stack and earth tube concept, they were able to confirm that this design had the potential capacity to perform as expected. However, just as Cobalt was completing their research, Stuart Fix, a PHI Certified Passive House Designer and certified and trained engineer, joined the Vital team and the project gained new momentum in the Passive House direction.

Fix began in-depth research of the design to date, and pushed the project in a couple of ways. First, he felt that even with the PH standards as targets, it was important to actually seek Passive House certification and not just use the PH targets. His rationale was that the team would probably not actually achieve the targets without shooting for certification and that it was a missed opportunity to not apply for certification. Teams that submit for a third-party review often end up with more stringent design and construction practices as opposed to...
to shadowing a standard or a rating system. It is this third party review that can keep teams a little more conscientious throughout the process. Therefore, without actually pursing PH certification, the chances of achieving the targets were significantly diminished in Fix's opinion.

Fix also suggested the use of the Passive House Planning Package for modeling to compliment the Integrated Environment Solutions (IES) modeling that had already been done. So with the double-loaded corridor solar stack design in hand, Fix attended a PH conference where it was reviewed and commented on by experts in the field. The feedback from the conference was clear; the solar stack and earth tube design was not favored. Research and analysis, primarily done in Europe, concluded that notwithstanding their potential for energy savings, the initial capital costs and complexity of these combined strategies at this scale made them an economically non-viable option.

Therefore, in order to achieve a Passive House compliant building, the entire floor plan and site plan required a rethink and redesign. Thus, in spite of the significant time and financial investment in what was already an advanced design concept, Scott gathered the design team together to explore the viability of a single-loaded corridor design. In spite of initial reservations as to its economic feasibility, the team persisted and by the end of the day, concluded that a single-loaded corridor could be an economically viable option, even though the building would have to be separated into four towers in order to maximize the floor plate.
FIGURE 6. Version 3 of Site Layout with solar exposure and single-loaded corridor design.

FIGURE 7. Single-loaded corridor floor plan.
efficiency and provide each suite with direct solar exposure. It was decided that the additional cost of creating four separate towers would be offset by reducing the building heights (eliminating the solar stack distribution system which required ventilation duct head room on each floor), among other factors. It should be reiterated that although the solar stack and earth tube concept was not explored further for this project, it was deemed to have potential merit and could be a strategy for a smaller-scaled project.

PHASE FOUR—COST ANALYSIS AND DEFINING THE DESIGN

In the spring of 2011, Chandos Construction Ltd. (Chandos) undertook the task of conceptual estimating for the project. The design had reached a point where two feasible options existed: the Passive and the Active models. The site plan and floor plans had been tweaked and it was now time to start honing in on a final design. By performing a conceptual estimate and examining the full life cycle cost (capital cost, maintenance cost, and replacement cost), the team could identify the most cost-effective design strategy. This breakdown would give a truer picture of the costs and allow Communitas the best information with which to make a final design decision.

Without detailed design drawings, Chandos, along with the developer and design team, assessed the deltas between the Active and Passive models. Five major construction components were isolated as being different: the exterior wall and EIF system; the roof and foundation slab insulation; mechanical systems; electrical systems; and windows. It was also deemed important to examine these Active and Passive models in relation to conventional construction techniques. Therefore, a reference design model titled “Code Plus” was added to the mix to provide a baseline cost against which the Passive and Active model costs would be compared. Since there is no set definition of conventional design, the team decided to use the Alberta Building Code for the reference design standard for all but the ventilation air system, which instead was to comply with a full suite compartmentalization approach. This ventilation design strategy was first introduced at Grandin Green and subsequently was adopted by the Province as a best practice ventilation air design in multi-family residential high rise buildings (sealed suite entry doors, separate HRV/ERV in each suite, and a roof top unit for corridor air supply and conditioning).

Exterior Wall and EIFS

Using an exterior insulation finish system (EIFS) was discussed as probably one of the most cost-effective finishes for this project. With this in mind, the group set out to identify the most cost-effective way to achieve the targeted R-Value. After examining multiple exterior and interior insulation combinations, a local company was discovered, Polycore Canada. Polycore wall systems are comprised of EPS Styrofoam panels with an imbedded steel stud and can be designed and manufactured to multiple sizes and thicknesses.

The main benefits of the Polycore wall system were the flexibility of the finish that could be applied to the panel, the lack of thermal bridging issues because the steel stud is imbedded in the Styrofoam panel at the interior face, the small incremental cost to increase the R-Value (just the cost to add a few extra inches of Styrofoam), and the fact that it was a local manufacturer.

The downsides to this product were significant for this project. It was lacking proper fire-rating for the height of Station Pointe Greens and had never been installed on anything higher than three stories. Moreover, it was uncertain that it could pass/achieve the desired fire-rating
for the thickness of panel we would ultimately require for our Passive model design. Even with these significant downsides, this product was kept as a hopeful for the Station Pointe Greens project. The small incremental increase in cost to achieve the needed R60 insulation value was one of its biggest draws, along with the lack of thermal bridging and flexibility of finish. Therefore, the team decided to continue to pursue this option realizing that a product like this could possibly be a ‘game changer.’ This product, and others like it, could make high R-value envelope design and construction a lot more affordable for many projects. Note that before the Polycore Wall system is incorporated into the design, the architect, structural engineer, and a building science expert will need to thoroughly analyze and then agree that this product is appropriate for the project.

Active: In order to achieve an effective R-30 wall, we priced out a 6” Polycore wall system, as described above. This system would provide the required R-30 wall needed for this design and significantly reduce thermal transfer.

Passive: In order to achieve an effective R-60 wall, we priced out a 14” Polycore wall system, which would give the required R-60 needed for this design. As mentioned above, this thickness of panel has not yet received the proper fire rating required for buildings over 3 stories high but our team is hopeful that this rating will be achieved.

Code Plus: A conventional steel stud exterior wall with 3” of rigid insulation and exterior EIFS system would provide an R-15 to R-20.

**Roofing and Foundation Slab**

The roofing design and construction would utilize a SBS (styrene-butadiene-styrene) membrane along with sloped insulation. The foundation slab would use rigid insulation to attain appropriate R values.

A green roof had always been on the wish list for this project. However, the cost of a green roof is often prohibitive for many owners. Chandos separately priced out a green roof for both the Active and the Passive models for the developers’ knowledge.

Active: R-40 would be needed for this design. Utilizing SBS membrane with 10” thick sloped insulation was considered and costed. If installing a green roof, then 8” to 10” of sloped insulation would be needed along with the green roof modules which would give an R-40 value. The slab would need to achieve R-20 using a rigid insulation.

Passive: R-70 would be needed for this design by using SBS membrane with 14” thick sloped insulation. A green roof would still require 14” of sloped insulation and would achieve an R-70. The slab would need to achieve R-50 using rigid insulation.

Code Plus: R-20 would be achievable with the use of SBS membrane and 6” thick sloped insulation. Conventional construction often does not call for insulation of the slab so it was not included for.

**FIGURE 8.** Polycore wall system being installed for an industrial shop.
**Mechanical System**

With the help of local mechanical and sheet metal sub-contractors, a potential mechanical design was fleshed out in more detail. In both the Passive and Active models, the domestic hot water was priced for an electric boiler with solar pre-heat.

*Active:* The Active model assumed the use of Ground Source Heat Pumps for heating and cooling, combined with a heat pump, boiler, and solar pre-heat for the water. The in-suite heating would utilize a Daikin (Variable Refrigerant Volume) Fan coil unit plus an individual Energy Recovery Ventilator (ERV) in each suite for ventilation. Hallway ventilation would run off a Heat Recovery Ventilator (HRV) and heat pump.

*Passive:* The Passive model assumed that the envelope with its higher R-Value needed less mechanical system for heating and cooling. Each of the suites would be heated with electric baseboard with mini-split air conditioning units for cooling. In-suite ventilation would be supplied by an ERV, the hallway would also have an HRV plus electric coils.

*Code Plus:* Conventional construction (by Communitas’ standards) would include a mid-efficient boiler, cooling tower/chiller, mid-efficient gas hot water tanks, fan coils to distribute heating, HRVs in each suite for ventilation, and the hallways would utilize a natural gas fired Roof Top Unit (RTU) for ventilation.

An interesting note about the mechanical design for both the Active and Passive design paths is the treatment of the units and corridors as separate compartments, a design successfully used at Grandin Green since 2000. Each unit would have a sealed door and would be ventilated using an in-suite ERV. The hallways and common areas have a separate ventilation system which uses an air side economizer roof top unit to maintain comfort and fresh air supply (varying the fresh air supply from 10% to 100%). From an energy standpoint, this saves having to pressurize the corridor, thus pushing fresh air into the suites (which is how suite ventilation is often handled), provides 90% reduction in central air supply system sizing, and the elimination of 24/7 full ventilation of the building with one third air changes per hour, to name but a few of the advantages. Finally, from a comfort standpoint, this design dramatically reduces noise transfer between suites, effectively eliminates air (and smell) transfer between suites, and dramatically reduces stack effect phenomena and its attendant smell and comfort issues.

**Electrical Systems**

As was to be expected, the electrical systems varied only slightly between the designs. The electrical cost differences stem from the variance in wiring requirements for the different HVAC equipment. We assumed that other than the HVAC system wiring, the rest of the electrical system would remain similar between the different design paths.

*Active:* The geothermal and VRV system required the electrical design to be augmented relative to a conventional design, reflecting the increase in the number of heat pumps and fancoils in the VRV system and geothermal system.

*Passive:* The simplicity of this design was exemplified by the fact that besides the mini-split A/C units, the only additional wiring was for the electric baseboards in each suite.

*Code Plus:* The electrical design reflected the fact that each suite contained a conventional fan coil system tied into the hot water and A/C recirc loops to the boiler and rooftop A/C compressor.
Windows
After researching pricing and efficiency of windows in the Edmonton market, Chandos utilized a local window manufacturer for its pricing exercise.

Active: Dual glazed Solarban 60 with Argon fill with a U-Value of .22 in the winter.

Passive: Triple Glazed Solarban 60 with 2x Argon fill providing a U-Value of .13 in the winter.

Code Plus: Dual glazed Solarban 60 with Argon fill with a U-Value of .22 in the winter

Long after the analysis was completed for the Code Plus, Active, and Passive design comparison, a rough analysis was done to compare how a 100% built-to-code building would measure up to the other three design paths. This number was meant to represent the worst-case scenario for a most basic building compared to Station Pointe Greens. This analysis was done to provide a clearer picture of the green premium for this project when compared not only to a basic “best practice design” but also to a rock bottom built-to-code (BrC) building.

While the conceptual estimating process was occurring, it was the expectation of some of the team that the Passive model, with its heavily insulated walls, roof, and slab would be the most expensive. Then the Active model with its ground source heat pumps, would be in the middle and the conventional would, of course, be the least expensive. It also seemed to be the expectation that the premium for this leading edge building would be high, perhaps in the 8–10% range. But the team was surprised when the numbers were finalized. Compared to a built-to-code building, not only was the premium for the Passive House design under 3.5%, but when compared to a Code Plus building was less than 1%. A 1% green premium over Code Plus is all the more significant when bearing in mind that in Europe, where the basic code requirements are higher than even our Code Plus model, multi-family Passive House developments are projected to cost between 3% to 5% more than code.

<table>
<thead>
<tr>
<th></th>
<th>Cost</th>
<th>Cost per sq ft (including parkade and commercial space)</th>
<th>Premium %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building to Code</td>
<td>$59,900,000.00</td>
<td>$222.95</td>
<td>0%</td>
</tr>
<tr>
<td>Code Plus</td>
<td>$61,423,958.00</td>
<td>$228.62</td>
<td>2.54%</td>
</tr>
<tr>
<td>Active</td>
<td>$62,767,441.00</td>
<td>$233.62</td>
<td>4.79%</td>
</tr>
<tr>
<td>Passive</td>
<td>$61,970,929.00</td>
<td>$230.65</td>
<td>3.45%</td>
</tr>
</tbody>
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Along with the conceptual estimate of the project, life cycle and maintenance costs were estimated for the mechanical equipment for both the Active and Passive designs. Interestingly, the Passive design came out with slightly higher costs; again, an unexpected result.

<table>
<thead>
<tr>
<th>Lifecycle and Maintenance Taken Over 25 Years</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>$1,295,319</td>
</tr>
<tr>
<td>Passive</td>
<td>$1,504,730</td>
</tr>
<tr>
<td></td>
<td>$209,412.00 in favor of Active</td>
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</tbody>
</table>
One of the main reasons for the cost premium on the Passive side is that 42 condensing units would need to be installed under the current design assumptions (for the mini split air conditioning units located on each floor). These condensing units would need yearly maintenance and cleaning since they would be located outside on a mechanical balcony. Also, it was assumed that a replacement for each condensing unit would be needed after 25 years, even though it was suspected these units would last much longer. Edmonton's shorter summers and lower summer temperatures combined with the energy efficient design should mean that these units are not overused and may therefore last longer than 25 years.

With the conceptual estimate complete, the team favored the simplicity and overall cost effectiveness of the Passive design over the Active design. One of the interesting outcomes of pursuing this design direction was that by reducing the energy footprint to the PH standard, natural gas service was eliminated from the site, which was not only an economically logical option from both a capital and operational cost perspective, it also resulted in non-energy monthly billing savings (administration and other fixed and variable rate fees) of an estimated $75,000 per year. This savings is often overlooked when focusing only on a cost per BTU/GJ when comparing electricity and natural gas as energy sources.

To put Station Pointe’s passive design in perspective, a comparison to an average Alberta apartment shows the tremendous energy savings predicted for this project.

<table>
<thead>
<tr>
<th>Energy Requirements</th>
<th>Station Pointe Greens</th>
<th>Average Alberta Apartment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per year to heat and cool</td>
<td>9.7 kWh/m²*</td>
<td>135 kWh/m²</td>
</tr>
<tr>
<td>Per year total primary source of energy</td>
<td>148 kWh/m²*</td>
<td>705 kWh/m²</td>
</tr>
</tbody>
</table>

*These are the projected values using the more conservative IES modeling tool. The building achieving Passive House Standard energy targets will attain 120 kWh/m².
With this well researched design, the building once constructed should not only achieve significantly reduced energy usage, but also a more comfortable indoor environment quality for the residents.

**WASTE WATER TREATMENT—ECOLOGICAL WATER RECLAMATION**

In sticking with the leading edge green development concept, an on-site waste water treatment process was hoped for right from the first charrette. Patrick Meyer was brought on board to guide this process. Considering that Alberta still has stringent laws with regard to water treatment, water processing, and the reuse of processed grey and or black water, this has always been a challenging item to pursue. Currently, Alberta allows for rainwater reclamation, but no other grey or black water is allowed to be reclaimed on site and then re-used.

The Station Pointe team is proposing to use an ecological system to treat waste water on site to tertiary levels and then reuse it for the community’s toilet flushing and sub-surface landscape irrigation. Since the ecological water reclamation (EWR) system is like an indoor wetland and is housed in a greenhouse, it was conceived that this EWR building could be incorporated into the building being used to house the community’s bicycle storage facility and café. Because the EWR produces no odour and looks like an indoor garden, it becomes a pleasant amenity for the community rather than the liability a standard treatment system would become for the nearby residents. Separated by glass partitions, patrons could enjoy a coffee and the view of plants. And in a winter city like Edmonton, it is a huge bonus to be able to get a dose of green in the winter.

**FIGURE 10.** Rendering of the waste water treatment, bike storage, and café facility.
So, how does this EWR system work? Very simply put, the waste water flows by gravity into holding tanks under the parkade. Air is added to the waste water as it arrives to aerate it and the sludge is mixed up. Once fully aerated, the sludge mixture is pumped to tanks in the solarium that are filled with plants, snails and bacteria that will break down the solids in the waste water. The water flows by gravity from tank to tank and gets ‘cleaner’ each time it moves over. Next the water will flow through a wet-land which not only continues the clarification process but additionally reduces the nutrient load. Finally the water is passed through a sand filter and then is treated with a UV filter to neutralize the remaining pathogens. The above ground tanks are open-top HDPE plastic and the entire water surface is covered in plants. This process generates no smell and is esthetically pleasing to the eye. Station Pointe Greens residents will have their own solarium that not only looks nice, but cleans all their sewage.

The design of the building will follow the same Passive House targets as the aggregate of the community, thereby reducing the energy needs to maintain temperatures above 10°C for the biology to thrive and complete their job. The system has also been designed to operate as much on gravity as possible to reduce the needs of pumping and excessive electricity use. Any waste heat will be recovered for the use of the complex.
It has been considered that using parkade air for this system could be an advantage. On the coldest days of winter, the parkade air would be considerably warmer than outside air and would therefore require considerably less pre-heating. Moreover, the plants would feed off the carbon monoxide and ultimately would end up scrubbing the air before it is released into the atmosphere.

While rainwater capture and reuse is often incorporated into sustainable designs, the EWR process will produce all the water needed for toilet flushing and sub-surface irrigation; therefore, rainwater capture and reuse is minimal on this project. Captured rainwater will provide a small source of irrigation water for residents with roof top gardens. It has been discussed as a worthwhile venture to include plumbing, during the design and construction phase, so that rainwater harvesting can more easily be incorporated into the system at a future date. In the near future, we will likely be able to make good use of this source of additional water. Moreover, the site is not expecting to generate large quantities of storm water discharge thanks to incorporating strategies like green roofs, permeable pavers, and bio-retention cells.

The vegetation used in the tanks can come from a variety of plant types; yellow water lily, water lettuce, marsh marigold and umbrella palm to name a few. Another interesting outcome of using plants as part of the waste processing system is their potential as a supplemental source of revenue. Because of the rich source of ‘food’ for the plants, they tend to grow at a considerably faster pace than under normal conditions. If the plants grow too large and multiply, they begin to crowd each other out and can inhibit operations. Therefore, the plants will constantly need to be culled and harvested. These surplus plants can either be composted or, better yet, they can be sold wholesale or at retail prices through the café and thus provide another source of income for the community. Wholesale revenues have been projected to be as high as $50,000 per year once fully operational.

It should be noted that the EWR process has not yet been finally approved by the City of Edmonton or the Province of Alberta, but both have confirmed approval in principle subject to confirmation of public safety measures and permit confirmations. In large part, having both parties involved in the discussions and planning right from the beginning yielded not only valuable input and buy-in, but also significantly contributed to their support. The team has designed this system to connect with the Edmonton sewer system, thus ensuring a fail-safe discharge option has been provided; at any time, the system could be switched over to convey sewage into the City of Edmonton system as per normal.

The inclusion of on-site waste water treatment would be extremely leading edge. It is anticipated that after a few years of data

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**FIGURE 13.** Plants from the Solar Aquatics System™ in the Centre for Interactive Research on Sustainability building, UBC. Photo taken by Patrick Meyer.
collection, and if deemed safe by authorities, the processed water would not only be used for toilet flushing and irrigation, but also for processes like clothes washing and ultimately, could be brought to potable water standard and used on site for all potable water applications. Even with the current design with limited re-use applications, the economics of eliminating the use of potable water for toilet flushing and the entire by-passing of the sanitary system, given the discharge of the surplus processed water into the storm system, means that the EWR will save the project an estimated $47,000 per year (potable water reduction savings and elimination of sanitary fees). This savings is enough to completely finance the capital cost premium of the facility if this savings is leveraged into a 25-year green loan. A further bonus of this system would be extraction of the heat from the discharge stream for use in the pre-heating the domestic hot water (DHW) needs. Indeed, it has been suggested that new waste water heat extraction technology currently in use in Vancouver, British Columbia, may result in the EWR generating as much as 100% of both space heating and DHW needs; this recent development remains to be further explored.

GREEN FINANCING
Green developments historically have been shown to cost up to 10% more than non-green developments; however, until the majority of the market is prepared to pay this premium or the premium for sustainable green housing is somehow removed altogether, green housing has very little chance of catching on with the masses. And with most people generally unwilling to pay a higher price for green, there is little incentive for a developer to build more expensive green housing and risk either not selling the units or potentially being unable to recoup the green cost premium. However, without eliminating the green premium, creative green financing options can level the playing field between green and non-green developments and make them more standard practice.
According to Lynn Hanley of the Communitas Group, there are two options for covering the cost of the green premium on the Station Pointe Greens units. Either the developer could increase the cost per unit, which would place them at a slightly higher cost than other non-green units on the market, or the developer could cover the green premium with a loan. A green fee would then be charged to each unit on a monthly basis which would be offset by the savings achieved through the greening of the building, thus resulting in a net-zero financial impact.

The latter choice seems obvious in keeping the units within market price while paying the green premium back over time with the savings. The green savings are generated from a combination of lower utility costs, reduced maintenance requirements (due to smaller or less equipment, and more durable or lower maintenance finishes), and lower building replacement reserve allocations (due to reduced equipment replacement costs). In other words, even with a green loan payment as part of the monthly fees, a household living in an equivalent sized and featured building without any green features would be paying the same monthly fees as a green building which has leveraged its savings into a green loan payment stream.

<table>
<thead>
<tr>
<th>Annual Budget</th>
<th>Conventional*</th>
<th>Station Pointe</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance and Cleaning</td>
<td>$58,500</td>
<td>$45,000</td>
<td>$13,500</td>
</tr>
<tr>
<td>Garbage</td>
<td>$11,653</td>
<td>$11,653</td>
<td>$0</td>
</tr>
<tr>
<td>Replacement Reserve</td>
<td>$24,930</td>
<td>$20,160</td>
<td>$4,770</td>
</tr>
<tr>
<td>Administration</td>
<td>$14,000</td>
<td>$14,000</td>
<td>$0</td>
</tr>
<tr>
<td>Insurance</td>
<td>$18,000</td>
<td>$18,000</td>
<td>$0</td>
</tr>
<tr>
<td>Gas (heat and domestic hot water)</td>
<td>$51,667</td>
<td>$0</td>
<td>$51,667</td>
</tr>
<tr>
<td>Water</td>
<td>$15,227</td>
<td>$9,476</td>
<td>$5,667</td>
</tr>
<tr>
<td>Power (domestic hot water)</td>
<td>$0</td>
<td>$10,833</td>
<td>$10,833</td>
</tr>
<tr>
<td>Power</td>
<td>$65,100</td>
<td>$28,229</td>
<td>$36,871</td>
</tr>
<tr>
<td>Total Annual Unit Costs</td>
<td>$258,077</td>
<td>$159,460</td>
<td>$101,726</td>
</tr>
<tr>
<td>Per Unit per Month</td>
<td>$480</td>
<td>$292</td>
<td>$188</td>
</tr>
</tbody>
</table>

*Note that the conventional building used for the purposes of this study was a building built to code with no upgrades.

As noted by Hanley’s Annual Budget and Total Green Loan charts, the monthly savings are significant and the monthly fees assessed to each unit are very much in line with condo fees in Edmonton.
In the book *Natural Capitalism*, the authors discuss the concept of ‘Tunneling Through the Cost Barrier’ as a way to generate a better product for less. This is achieved by examining the whole building and integrating all of the design features. For example, although adding extra insulation and installing better windows is more expensive, if pushed beyond the typical cost savings benefit cut-off point and taken to the optimum level with whole building design considered, the mechanical system can be significantly downsized or downgraded and ultimately save substantial money over what the original design would have cost. It is strongly suggested by the authors that only optimizing parts without considering the whole design can in fact be more expensive and less efficient. It is in the linking of all the components and pushing beyond the initial cost benefit drop-off barrier that the greatest savings and efficiency will occur. This concept has proven itself true with Station Pointe Greens where the whole system, including operating, life cycle, and maintenance costs were factored into the design analysis, ultimately achieving a very low capital cost green premium. According to Scott, were the entire green savings applied to a green loan, the sale price of the units could be dropped by an order of $30,000 per unit below the sale prices required for a conventionally ‘built to code’ building.

**LESSONS LEARNED SO FAR**

Throughout the process of design and research for this project, there has been much learned along the way. Aside from making the results of the studies widely available through Natural Resources Canada, sharing the process, outcomes, and lessons learned will hopefully help other teams. Ultimately it is hoped that this project can be replicated on smaller or larger scales and thereby increase the uptake of leading edge green building practices.

Preconceived biases closed doors early in the process. For example, the assumption that a double-loaded corridor was the most efficient layout and was the best for achieving the number of units/density for the project ruled out a single-loaded corridor design immediately; it wasn’t even considered. However, the single-loaded corridor turned out to be the best and most cost effective way to achieve the PH target.

Even a dedicated and keen integrated design team can return to their respective traditional design corners. In fact, we continue to battle this silo effect and realize that practice and discipline are the only way we will get better at integration. Interestingly, the mechanical engineer, who was our Passive House expert, ended up steering the design to a single-loaded corridor. The team had to park their traditional roles at the door and be prepared to accept design advice from disciplines that would not usually get to weigh in on site layout or building design.

Traditionally, the entire project development continuum (municipal, architectural, mechanical, marketing approach) is geared to design first and performance second. It was only after setting the goal of PH Certification that the pattern was reversed. However, the team will still face many regulatory challenges in attempting to build this project since the concepts and technology are so cutting edge.

Being prepared to shift gears mid-way through design was a key to success. Once PH Certification became an important target, it was clear that the design needed some serious re-work (for the second time). Many teams would have stayed the course due to the large amount of time already invested in the project. However, this team’s willingness to shift gears is commendable. We recognize the grant money played a role in assisting with this willingness in that the team was being paid for this research time.
THE TEAM
The Station Pointe Greens development owes its successful design outcome to a team which brought years of expertise to the table together with a keen interest in participating in a creative “out-of-the-box” approach to design development. In no particular order, the team players were: The Communitas Group, a consulting firm with over 35 years of expertise in cooperative housing development, community development, and research and planning; Hartwig Architecture, a local architectural firm, with a long and multifaceted design history, including a variety of multi-residential condo and co-op developments and commercial projects; Vital Engineering, a local engineering firm, who offer both mechanical and civil engineering services and specializes in sustainable design; Cobalt Engineering, an engineering firm who specialize in energy modeling and sustainable design; Chandos Construction, a full service general contractor who specialize in construction management and sustainable construction practices; and finally, Patrick Meyer Consulting, who specialize in the design of biological treatment systems for waste water.

CONCLUSION
Station Pointe Greens, once constructed, will be one of the ‘greenest’ and most community-centered developments in North America. The design and research process has yielded many lessons, which will hopefully help other teams follow a similar path. For its innovative design and layout, on-site waste water treatment and financing options, Station Pointe Greens will be one of the most exciting projects being built in the coming years.

ACKNOWLEDGEMENTS
We would to thank NRCan and CMHC for their generous grant to the Station Pointe Greens team. This money made the extensive research possible to bring the design to its current state. Terry Hartwig, Hartwig Architecture, has been heavily involved from the beginning in all the charrette’s and design meetings. His support and input is greatly valued. Thanks also go out to Petrin Mechanical, Comfort Heating, Kehoe Equipment, and Tempo Electric for their assistance in providing the conceptual estimate.

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