Team 689 Executive Summary

The group aims to design a net-zero and water wise building for the Evolve Community Library utilizing energy and water simulation tools such as, RETScreen, Ecotect Weather Tool, Vasari for Autodesk, and Rainwater Harvesting Design and Costing Tool.

I. Preliminary Design Decisions
Ecotect Weather Tool was used in determining the optimum building orientation and passive system adaptations. Based on a compromise between over-heating and under-heating due to solar radiation, the team took into consideration that 142.5 degrees to the true north was determined to be the best orientation. As a result of mapping out potential passive systems on the psychometric chart to determine whether the adaptation will benefit the comfort level of a community library, it is determined that three systems can be efficiently adapted in Toronto’s climate: passive solar heating, thermal mass, and natural ventilation.

II. Achieving Net-Zero Energy
The two strategies are to first minimize the net-energy consumption and maximize net-energy production.

a) Minimizing net-energy consumption
Energy Analytical Models of a base case model and four scenarios were generated using Vasari to provide approximate net-energy consumption for each case. Each scenario had adjusted parameters from the scenario before in an attempt to reduce the consumption. The aim was to reach a simulation result that is close to the top quarter percentile energy benchmark from City of Toronto’s Energy and Conservation Demand Plan 2014-2019. A few conclusions can be made from analyzing the results of these scenarios.

To decrease the annual net-energy consumption:
1. Using passive measures such as a central courtyard for natural day lighting, passive heating, and using stack effect to promote natural ventilation, the southern façade utilizes a double skin and the courtyard greenhouse preheat air during the winter (11% net consumption reduction)
2. Increase building thermal mass and insulation: the use of thermal mass walls and concrete construction helps to retain heat (25% net consumption reduction)
3. Reducing operating volume for heating and cooling: The lower the occupied volume of space in the house, the less overall energy is required for space heating and electricity usage (2% reduction)

b) Maximizing net energy production
The group considered wind, ground source, and solar energy as the three potential energy generating sources on-site. Wind energy option was abandoned through wind studies which indicate that wind energy is not viable source energy, unless the wind plant height was increased to heights inappropriate for the community. Energy production of GSHP (Ground Source Heat Pump) and PV (Photovoltaic) were evaluated using RETscreen to design and size the systems to maximize capacity.

On-site energy production through a ground source heat pump and PV panels, which will produce a combined 976,901 kwh/yr. All of this produced an approximate net energy gain of 63%.

III. Achieving Water-Wise Design
The three strategies are to minimize the water consumption, maximize rain water collection, and on-site recovery of wastewater. Rainwater Harvesting Design and Costing Tool were used to optimize net water consumption. As a result, the team succeeded in reducing 70% of the net demand by switching to water efficient fixtures (toilet, faucets, and urinals). To maximize rain water collection, the entire roof surface is designed to harvest water. As a result, rain water collected off sets the net water demand by 29%. The team opted for a living machine system for non-potable water treatment on-site. The living machine is in theory self-sufficient and is able to recover a great percentage of waste water. This system decreases the demand for rain-water collection during the winter months.

Out of the calculated 1550 m³/yr of water of the optimized net demand, 50% was from the recovered water in the living machines, 29% was from collected rainwater, 14% was to be from municipal sources, and 9% from other losses. In the end, 77% of the water will be recoverable.
THE WELL LIBRARY

ASPECTS of SUSTAINABILITY

1. Minimizes wind and shadowing impact on the surrounding neighbourhood
2. Finds a balance between aesthetic roof surfaces for PV panels and aesthetics
3. Controls roof surface to form a continuous system for harvesting rainwater
4. Maximizes the south façade and creating light wells for natural day-lighting and passive solar heating while minimizing heat loss of the north façade (combined part elevations
5. Diverting the large amount of solar heat gain with sun-shading devices
6. Creates additional high-performance living machines that filter water
7. Uses a high-performance and economical, appropriate building envelope with optimal insulation and materials
8. Optimizes indoor air quality using a green wall, being machine, and natural ventilation methods
9. Extends access spaces like a green source heat pump and PV (solar) panels in a closed-loop system
10. Incorporates rainwater to be used in the building's systems, allowing for universal access in the building, further enhancing community participation in the building

COMMUNITY

Adaptation with Time
Share of Ideas, Interactions between Distinct Demographic Group
Community Fabric

ENVIRONMENTAL

Energy Conversation
Fossil Fuels
Life Cycle Analysis
High Performed Building Envelope
Water | Conserve and Reuse

PERSONAL

Accessibility
Occupant Comfort, Experience, and Needs
Spatial Layout, Exciting Spaces
Identity

MAIN SPATIAL CONCEPT

A central ‘life-giving’ space, or heart is enveloped within the encasing building forms. A sense of shelter and an inward focus is achieved here. Circulation then occurs around this central space. This becomes the entrance into the building, shielded from the noise and activity from the main street.

"THE HEART" OF THE BUILDING

Central green space within the central heart, we imagine it to be a multi-use, complex, and allow portion of the building. Here, related elements can be sent to the other portions of the building. This space can provide connections between the exterior, daylight, solar heat, ventilation, water collection and purification, and view, etc.

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For centuries, Libraries have stood as symbols of enlightenment, learning, and civility in a society. It is a place of the mind; a sanctuary from which the chaos of the world outside can be filtered. The Library is a place of learning, knowledge, and growth. It is a place where people can come together to share ideas, collaborate, and learn from each other. The Library is a place of comfort and peace, a place where people can retreat from the outside world and immerse themselves in the written word. The Library is a symbol of culture, education, and intellectual curiosity. It is a place of wonder and discovery, a place where people can explore new ideas and concepts and expand their horizons. The Library is a place of community, where people can come together to discuss and learn from each other. It is a place of diversity, where people from all walks of life can come together and share their knowledge and experiences. The Library is a place of inspiration, where people can be inspired by the stories and ideas of others and be motivated to achieve their own goals and dreams. The Library is a place of tradition, where people can learn about the past and the values and beliefs of those who came before them. The Library is a place of innovation, where people can explore new ideas and concepts and push the boundaries of what is possible. The Library is a place of beauty, where people can be inspired by the architecture and design of the building. It is a place of reflection, where people can take a moment to think and to be. The Library is a place of hope, where people can be inspired by the power of the human spirit and the ability to overcome challenges and achieve great things. The Library is a place of wonder, where people can be inspired by the beauty of the written word and the infinite possibilities that it holds. The Library is a place of imagination, where people can explore new ideas and concepts and create new worlds in their minds. The Library is a place of connection, where people can come together and share ideas and experiences. It is a place of community, where people can learn from each other and grow together. It is a place of inspiration, where people can be motivated to achieve their goals and dreams. The Library is a place of transformation, where people can learn and grow and change. It is a place of possibility, where anything is possible. The Library is a place of hope, where people can be inspired by the power of the human spirit and the ability to overcome challenges and achieve great things. The Library is a place of beauty, where people can be inspired by the architecture and design of the building. It is a place of reflection, where people can take a moment to think and to be. The Library is a place of wonder, where people can be inspired by the beauty of the written word and the infinite possibilities that it holds. The Library is a place of imagination, where people can explore new ideas and concepts and create new worlds in their minds. The Library is a place of connection, where people can come together and share ideas and experiences. It is a place of community, where people can learn from each other and grow together. It is a place of inspiration, where people can be motivated to achieve their goals and dreams. The Library is a place of transformation, where people can learn and grow and change. It is a place of possibility, where anything is possible. The Library is a place of hope, where people can be inspired by the power of the human spirit and the ability to overcome challenges and achieve great things.
MAIN BUILDING COMPONENTS

- Photo-Voltaic Panels
- Vertical circulation - stairs and library ramps
- Rainwater Collection System
- Central courtyard with living machines
- Structure - Concrete columns and rigid cores
- Ground source heat pump

INTEGRATED SUSTAINABLE SYSTEMS PATH

- Municipal Supply
  - Washing Hands
- Rain Water
  - Primary Filter
  - Rain Water Storage Tank
- Trash Tank
- Primary Tanks
- Disinfection
- Filtration
- Setting
- Flow Equilization
- Reuse Storage Tank
- Winter Garden
- Recovered Water
- Waste Water
- Space Heating
  - Ground Source Heat Pump
  - Radiant Floor Heating
  - Supplementary Heating (40 Units)
- Air Handling Unit
  - Return Air
- Winter: Preheating Air
  - Boiler
- Summer: Ventilation
- Conditioned Space
- Supply Air
- Natural Gas
- Electricity
- Solar Energy

LEGENDS
- Pump
- Valve
- Boiler
- Chiller
- Water Top Up

SPACE HEATING

INTEGRATED SUSTAINABLE SYSTEMS PATH

LIVING MACHINE SYSTEM

- Fiction
- Quiet
- Loud
- Personal Study
- Carrels
- Reading Chairs
- Casual Group Seating
- Children's Craft and Work Space
- Magazines, CDs, DVDs, MP3s, Audiobooks, Monthly Picks
- Non-Fiction, Periodicals, Reference
- Children's Collections & Play-space

BASEMENT, CHILDREN'S PLAY AREA
WATER WISE IS TO BE ACHIEVED IN THREE STEPS:

1. **Reduce Net Water Demand**
   - 70% Net Demand Reduction
   - a) optimized water fixtures: toilet, faucet, shower
   - b) appropriate plant selection to reduce irrigation (ex. living machine doubles as a planter, living wall)

2. **Rain Water Harvesting**
   - 29% of Net Demand
   - a) maximize roof surface area for rain collection
   - b) per-filtration of rain water before storing to reduce water loss

3. **On-Site Non-Potable Water Treatment**
   - 50% - 91% of Net Demand
   - a) living machine system provides emergent indoor/_score on-site water treatment system
     - Technology for treating sewage and potable water by using living components of nature’s own purification processes
     - Advantages:
       - 1. Aesthetic biological systems of fish, and plants
       - 2. Treatment of indoor air (-breaking down VOCs)
       - 3. Completely self-sustaining in theory

Water Sources to Meet Net Water Demand*

- Harvested Rain Water: 444 m³/yr
- Living Machine (Recovered Water): 750 m³/yr
- Other Losses: 133 m³/yr
- Municipal (Potable Water): 222 m³/yr

NET WATER RECOVERABLE of 77%