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VANCOUVER ISLAND UNIVERSITY GATHERING PLACE

MECHANICAL SCHEMATIC DESIGN REPORT

Prepared For:

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1.0 INTRODUCTION

The Purpose of this report is to outline the current General Mechanical Design Approach options for the Vancouver Island University Gathering Place. The project consists of a single storey building containing areas dedicated to serve First Nations students and to accommodate associated cultural and educational functions. The project has significant sustainability goals that will be co-ordinated with the entire design team. The project will be designed with LEED® categories considered, however actual certification via CaGbC is not required. A Sustainability Charrette was conducted on October 9, 2008. The purpose of the Charrette was to familiarize the project stakeholders with the project, to generate project sustainability goals, and to brainstorm and prioritize sustainability strategies. A separate report will be issued outlining the results of the Charrette. Select strategies that directly affect the mechanical system design are also discussed within this report.

2.0 DESIGN CRITERIA

We will base our design on the recent concept architectural drawings provided. The mechanical, plumbing and fire protection systems will be designed in accordance with the intent of all applicable codes and standards. The following is a list of some of the applicable codes and standards:

2.1 APPLICABLE CODES AND STANDARDS

- ✓ British Columbia Plumbing Code, current edition.
- ✓ British Columbia Building Code, current edition.
- ✓ ASHRAE 90.1 (Energy Code) as adopted by the BC Building Code.
- ✓ CGAB 194.2 Canadian Gas Association and Provincial Regulations.
- ✓ Provincial Fire Marshall Regulations.
- ✓ Applicable NFPA Regulations.
- ✓ Local Building By-Laws.
- ✓ BC Boiler and Pressure Vessel Act.
- ✓ American Society of Heating, Refrigeration and Air Condition Engineers (ASHRAE).
- ✓ American Society of Plumbing Engineers (ASPE).
- ✓ Sheet Metal Contractors Association of North America (SMACNA).

3.0 EXTERIOR PLUMBING SYSTEMS

General

The building will be fully serviced with connections co-ordinated through the design team's civil consultant. Cost of all service/permits shall be by the contractor unless co-ordinated otherwise through the owner. The preliminary analysis indicates that the following site services are required. Piping connections for the mechanical contractor will occur 36" from the building perimeter.

- ✓ 150mm service sanitary sewer.
- ✓ 200mm service storm sewer.
- ✓ 150 building foundation drainage around structural footings.
- ✓ 150mm combined domestic/fire water supply.
- ✓ 34 Kpa natural gas supply.

In general, pipe and fitting materials used will be listed in the following schedule:

SERVICE:	**MATERIAL:**
Sanitary Drainage and Vent	PVC (buried), type "M" copper or "DWV" copper (exposed within suites), cast iron (concealed within building)
Storm Drainage	PVC (buried), cast iron (concealed within building)
Footing Drainage	PVC SDR 35 perforated to suit depth of bury
Domestic Water	Type K soft copper, PVC ringtite, cement lined ductile iron (buried), Type L hard copper (within building)
Recycled Stormwater	Type L hard copper (within building), all recycled storm water piping will be painted purple and identified clearly as non-potable water per City standards

4.0 INTERIOR PLUMBING SYSTEMS

4.1 DOMESTIC COLD WATER SYSTEMS

The domestic cold water system will consist of:

- ✓ Central pressure reducing valve (if required).
- ✓ Distribution system to building DWH tanks.
- ✓ Irrigation cap-off at water entry room.
- ✓ Domestic cold water piping will distributed to all drinking fountains, lavatories, sinks, and kitchen equipment. A separate recycled rainwater distribution system is being considered. If pursued, the recycled rainwater system will feed water closets (refer to section below).

4.2 DOMESTIC HOT WATER SYSTEMS

The domestic hot water system will consist of:

- ✓ An individual gas fired hot water tank, centrally located. Domestic hot water distribution piping will be connected to all plumbing fixtures requiring hot water. Hot water supply temperature will be approximately 140°F. Water tempering valves will be located in all public lavatories and sinks. Pressure balanced mixing valves will be located in all showers. A hot water recirculation system will be provided for all bathroom groups to reduce the delay of hot water availability. The kitchen will also be served by the central domestic hot water system.

4.3 NATURAL GAS SYSTEM

The natural gas service will consist of distribution piping from a utility supplied meter to:

- ✓ Gas fired hydronic boilers (to supplement the ground coupled heat pump).
- ✓ Indoor fire places (if required).
- ✓ Commercial kitchen equipment (if required).
- ✓ Gas fired domestic hot water tanks.

4.4 STORM DRAINAGE SYSTEM, STORM WATER RECYCLING

The storm drainage system will collect roof gutters and balcony drains and drop down with concealed piping to grade. The number and arrangement of roof drains will be designed to suit the building configuration and be in accordance with the B.C. Plumbing Code. Area drains will pick up grade level drainage. There is no parking area expected to be part of this project.

A Rainwater Recycling System was discussed during the Sustainability Charrette. The suitability of a rainwater capture / storage / treatment, and distribution system will be investigated. If pursued, the rainwater drainage system will feed into a storage tank. Initial sizing is approximately 30,000 gallons. It is proposed that a 72" dia buried culvert be used for storage, approximately 15' long. A separate booster pump package (with hydropneumatic tank), make-up water system, water treatment system (sand filter with UV disinfection light), and distribution piping system is required to distribute greywater to the suites for toilet flushing and site irrigation. The pump package and disinfection system will be located within a vault or basement mechanical room adjacent to the storage tank.

4.5 SANITARY WASTE AND VENT SYSTEMS

All bathroom groups will be connected to the sanitary waste and vent system per code requirements. Kitchen equipment waste will be routed through a grease interceptor if grease cooking is expected.

4.6 GENERAL INTERIOR PLUMBING REQUIREMENTS

- ✓ All internal domestic water, and metallic storm piping shall be insulated with 25 mm thick insulation, complete with vapour sealing on cold water lines.
- ✓ All domestic water systems shall be chemically cleaned.
- ✓ All plumbing systems shall be pressure tested.
- ✓ Non-freeze hose bibbs will be installed outside parkade mechanical rooms. Exterior hose bibbs will be fed from the irrigation system.
- ✓ All piping systems shall be designed to incorporate earthquake restraints as required by the British Columbia Building Code.
- ✓ Hose bibbs in equipment rooms will be provided c/w back flow preventers.
- ✓ Floor drains will be provided in new mechanical rooms.

- ✓ Refer to section 4.4 for recycled rainwater system for toilet flushing.
- ✓ Plumbing fixtures will be selected by the architect, reviewed by AME for water conservation performance. Either waterless or ultra low water consumption urinals will be used for this project.

5.0 FIRE PROTECTION SYSTEMS

The building will be fully sprinklered with a wet system, with the exceptions listed in the following section, and will be complete with supervisory and tamper switches on all main isolation valves, backflow prevention, flow switches, and sprinkler flow control valve assemblies at each floor.

Building will be zoned as follows:

- ✓ Dry sprinklers (or dry heads served from a wet system) for exterior overhangs or areas subject to freezing – designed to NFPA-13: Ordinary Hazard Group 1.
- ✓ Wet sprinklers for all conditioned spaces – designed to NFPA-13: Light and Ordinary Hazard.

Fire extinguisher cabinets complete with 4.5-Kg fire extinguisher will be provided at locations approved by the authority having jurisdiction.

There will be 65 mm ϕ fire hose valves at building entrance lobby.

In general, pipe and fitting materials used will be as listed in the following schedule:

SERVICE:	MATERIAL:
Fire Protection entry to building	Steel Sch. 40 black, to NFPA requirements.
Sprinkler	Steel at appropriate schedule or Type L copper.

All areas will be sprinklered unless otherwise directed by authorities having jurisdiction.

Test flow connections for sprinkler system will be incorporated at the water entry station.

Sprinkler heads will be chrome plated, pendant type in finished areas, and bronze upright type in unfinished areas.

An exterior siamese connection for the fire department and a test connection will be provided adjacent to the main entrance of the building.

6.0 HEATING AND VENTILATION

6.1 DESIGN GUILDLINES

The heating system shall be designed based upon the BC Building Code 2006 - 1% design temperature of -9°C db for Nanaimo, BC.
Our design will incorporate heating season indoor temperatures of 20°C.
Mechanical cooling (air conditioning) will be not be provided for spaces unless deemed absolutely essential by the client group. The elimination of air conditioning and providing passive cooling through natural ventilation was discussed at the Sustainability Charrette and met with support by the client group. In-slab cooling will be considered to provide supplemental cooling to the occupied spaces. The systems involved will be discussed in the following sections of this report.

6.2 VENTILATION RATES

Ventilation, pressurization and air change rates will be provided in accordance with ASHRAE standard 62-1999 (Ventilation for Acceptable Indoor Air Quality) as well as the BC Building Code.

6.3 HEATING AND VENILATION SYSTEM

Ground Coupled Heat Pump Loop:

The basic source of heat for the building will be a central ground coupled heat pump loop. One of two concepts can be utilized including an open-loop that uses groundwater production and injection wells, or a closed loop system that does not require extraction or injection of water. At this time it is unclear which approach is suited for this particular project. The two approaches are described below:

Open Loop: Groundwater is extracted from below-grade via a pair of production wells. Each well draws water from a subsurface aquifer and pumps the water into the building within a piping system. A water-to-water heat pump and heat exchanger is used to transfer building heat to the groundwater (or from the groundwater) to meet the building heating or cooling demand. Heat exchangers are used to protect the heat pump from any contaminants located within the groundwater. The groundwater temperature is changed in this process, and it then is injected back into the ground via a pair of injection wells. Wells are used in pairs to allow for maintenance and repair while the system remains operational. Both the location and depth of the production and injection wells are important. Concerns of "short circuiting" the groundwater temperature and groundwater level govern the location and depth. Further study is required to determine these factors and flow capacity availability in the area.

Closed Loop: An array of vertical boreholes will be placed approximately 20' apart throughout the building footprint and site. The boreholes will be approximately 300' deep with polyethylene tubing embedded in grout within the borehole (5" diameter boreholes, one tube down the length of the borehole, u-bend at the bottom, and one tube back up the borehole). This is the method for absorbing or rejecting building heat to the ground beneath the building. A closed loop piping system is then connected to each of the boreholes and water is pumped through central water-to-water heat pump modules.

The heat pumps will have the capability of both providing space heating, and space cooling via an in-slab hydronic heating system. Each heat pump will respond to the building heating or cooling demand and produce either hot or cold water. This is done by either absorbing or rejecting heat to the ground coupled water loop. The heat pumps will be sized based on the heating load, and it is expected that only partial cooling capacity will be available. PEX type polyethylene tubing is embedded within the concrete floor slab, and heating water is pumped through the tubing to heat the slab on a zone-by-zone basis. If the building requires cooling, the heat pump will produce chilled water to be circulated through the in-slab tubing to provide supplemental cooling. Separate tubing circuits will be provided within the slab to allow simultaneous heating and cooling within the building.

It is expected that the seasonal heating versus cooling load will be significantly unbalanced (i.e. more heating is required throughout the year versus cooling). Also, only a limited capacity is expected to be available from the ground coupled heat pump loop. Economically, the most advantageous approach is to provide a ground coupled loop that has capacity to meet the heating demand for the majority of the year, with a supplemental gas fired boiler to meet the peak demand during the coldest winter weather. This typically results in a ground loop sized for 70% of the design capacity, with a small gas fired boiler to provide for the remaining 30% of the required peak capacity.

A test borehole will be required to verify the ground conditions to accurately determine the ground coupled loop capacity for absorbing and rejecting heat. It is recommended that this be done as soon as feasible, and that a borehole be positioned such that it is useable for the actual project construction as well. The depth of the borehole should be approximately 300 feet. At this time (without the use of actual site test data), we have assumed a nominal capacity of 1.5 tons of heat absorption per 300 foot borehole.

Ventilation

Ventilation air is provided by a completely independent central air based system. A heat recovery unit, (located in a mechanical room), will provide a minimum quantity of fresh air supply to all regularly occupied spaces. Outdoor air is heated within the heat recovery unit via a heat pump coil connected to the ground coupled water loop. Exhaust will also be drawn from the occupied spaces and the room temperature air will draw through a heat recovery system using either an enthalpy type wheel or heat pipe arrangement. The exhaust air heat will be transferred to the outdoor air intake, reducing the unbalanced, (heating dominated), load on the ground coupled loop.

This ventilation configuration provides the following benefits:

- ✓ Improved indoor air quality (rather than relying on operable windows in winter).
- ✓ Energy savings through efficient central fan system.
- ✓ Energy savings through heat recovered via washroom exhaust airstream.

Operable windows at the occupied level as well as openings at high level in major occupied spaces will provide passive cooling through natural ventilation. The local climate at the University allows the building to take advantage of the cool ocean air to passively cool the building to comfortable temperatures without the use of air conditioning. High level relief air openings have been planned for within the architecture of the longhouse ceremonial hall as well as the student lounge. The high ceiling and structure within these areas allow for significant heat stratification, inducing a convection type airflow current in the large spaces that allows additional outside air to be drawn in through the occupant level windows.

6.4 EXHAUST SYSTEMS

Exhaust of bathrooms will be provided by a central washroom exhaust system. As previously mentioned, occupied rooms will have ducted exhaust air that is fed through the heat recovery unit to preheat outside air intake. This strategy reduces the heating load on the ground coupled loop. Kitchen hood exhaust will be individually ducted to the exterior of the building via a rooftop exhaust fan.

Electrical rooms, elevator machine rooms, and mechanical rooms will all be served by exhaust systems to limit heat gain.

7.0 CONTROL SYSTEMS

- ✓ All equipment will be controlled by either individual type electric controls or Direct Digital Controls (DDC) as follows:
  - The central heat pumps will be controlled by the DDC system and will respond to the building heating or cooling demand.
  - The ground coupled water loop will be controlled by the DDC system.
  - Wall mounted room temperature sensors will be installed for zone temperature control and be connected to the DDC system. Zone level control valves will open/close to allow the radiant in-slab piping to operate for zone heating or cooling.
  - Electrical room, elevator machine room, and mechanical room exhaust fans will be controlled by reverse acting thermostats.
  - The central heat recovery unit will be controlled by the DDC system and will run continuously when the building is occupied.
  - The central washroom exhaust system will be controlled by the DDC system and will run continuously when the building is occupied.
  - The gas fired boiler and associated circulation pumps will be controlled by the DDC system
  - The gas fired domestic hot water tank will be controlled by integral packaged controls. The hot water re-circulating pump will operate on an aqua stat and respond to temperature.

- Relief louvers will be activated by the DDC system to allow high level relief air to exit the building when in cooling mode. The louvers will open based on room temperature sensors.
- The recycled water booster pump package will be operated by a factory packaged controls panel. The pump will automatically maintain pressure in the system for toilet flushing. The UV disinfection system will operate on a flow switch.

8.0 SUSTAINABILITY STRATEGIES

The following energy saving and conservation features are included in the systems outlined within this report:

- ✓ Ground Coupled Water Loop: offers efficient heating and cooling of building due to heat exchange with the ground. Expected Coefficient of Performance (COP) is between 3.5 and 4.0. In other words, for every 1 unit of energy input, 3.5 to 4.0 units of energy are transferred from the ground to the water loop. The use of an electrically driven heat pump reduces the dependency on GHG producing fuels.
- ✓ Partial cooling capacity will be provided for the building. High performance envelope construction is encouraged with shading devices and low-e window coatings. Partial cooling capacity increases thermal comfort, (in lieu of no cooling), and is done so in an efficient manner. The cooling load in the building also aids in providing a balanced load on the ground coupled water loop, reducing the tendency of the ground to cool year after year due to unbalanced heat extraction.
- ✓ Washroom Exhaust System:
  - Heat exchange (energy recovery) from washroom exhaust to ground coupled water loop system.
  - Improved indoor air quality due to continuous ventilation air supply.
- ✓ Ventilation air system:
  - Heat recovery (via heat pipe or enthalpy wheel) allows for efficient heating of air.
  - Improved indoor air quality by direct ventilation air delivered to occupied space.
- ✓ Thermostatically controlled exhaust fans for heat removal in mechanical room, electrical rooms, and elevator machine room.

- ✓ Water conserving plumbing fixtures and plumbing trim to be used where applicable to conserve water and reduce the waste load on the municipal sewer systems. These fixtures will be:
  - Dual flush toilets.
  - Low flow shower heads.
  - Low flow sink faucets.
  - Waterless or ultra-low flow urinals.
- ✓ OPTION: Grey water storage system for toilet flushing or irrigation – treatment will be provided through sand filtration and UV disinfection. This option will be investigated to determine viability for this project. A further reduction in potable water consumption and a reduction in storm water runoff will result if this option is implemented.
- ✓ Envelope performance recommendations:
  - A maximum glazing to gross wall ratio of 40% is recommended. The heating dominated nature of this building will require exceptional insulation performance if aggressive energy efficiency targets are to be met. For non-residential occupancy, the current ASHRAE 90.1 requirements for 40% glazing are as follows:
  - Code wall performance: U=0.084 (imperial units). Steel stud construction would require R13 cavity insulation plus R3.8 continuous insulation to accomplish this.
  - Code glazing performance: U = 0.570 (imperial units) for fixed glazing and U=0.67 for operable glazing. This is an overall assembly rating including the frame.
  - We recommend significantly improving on the performance requirements in order to contribute to energy savings over time. As such, we recommend exceeding wall performance by approximately 50%. We also recommend glazing with the following performance: U=0.0.38 for fixed and operable units, and a Solar Heat Gain Coefficient of 0.4.

Appendix A

Preliminary Mechanical Equipment List

VIU GATHERING PLACE - PRELIMINARY MECHANICAL EQUIPMENT			
Tag	**Equipment Description**	**Capacity**	**Features**
HRU-1	Admin Area Heat Recovery Unit	450 cfm	Supply & Exhaust, Enthalpy Wheel
HRU-2	Ceremonial Hall Heat Recovery Unit	2000 cfm	Supply & Exhaust, Enthalpy Wheel
HRU-3	Lounge Heat Recovery Unit	500 cfm	Supply & Exhaust, Enthalpy Wheel
EF-1	Kitchen Exhaust	200 cfm	Vapour Removal
EF-2	Electrical Room Exhaust	150 cfm	Heat Removal
EF-3	Mechancial Room Exhaust	150 cfm	Heat Removal
DHWT-1	Gas Fired Domestic Hot Water Tank	100 gal, 100 MBH	Kitchen and Building Use
P-1, P-2	Groundloop Circulating Pumps	5 hp ea.	
P-3, P-4	Heating Water Circulating Pumps	2 hp ea.	
P-5	Radiant Floor Injection Pump	1/4 hp	
P-6, P-7	Radiant Floor Circulating Pumps	2 hp ea.	
P-8	DHW Recirc Pump	1/4 hp	
P-9, P-10	Recycled Water Booster Pumps	5 hp ea.	Booster pump package with vfd's, PRV, and pressure tank
P-11	Recycled Water Treatment Pump	3 hp	
B-1	Gas Fired Boiler	100 MBH	Condensing wall mounted boiler
HP-1, HP-2	Central Heat Pump	10 tons ea.	Groundsource Heat Pump (two modules)
ET-1	Groundloop Expansion Tank	20 gal.	
ET-2	Heating Water Expansion Tank	20 gal.	
ET-3	Domestic Hot Water Expansion Tank	5 gal.	
T-1	Rainwater Storage Tank	2,500 gal.	Underground tank, concrete culvert, 6' dia x 12' long
F-1	Sand Filter for Recycled Water	36" dia	Sand filter for recycled water treatment
UV-1	Ultraviolet lamp for water treatment	60 gpm	Disinfection for recycled water system