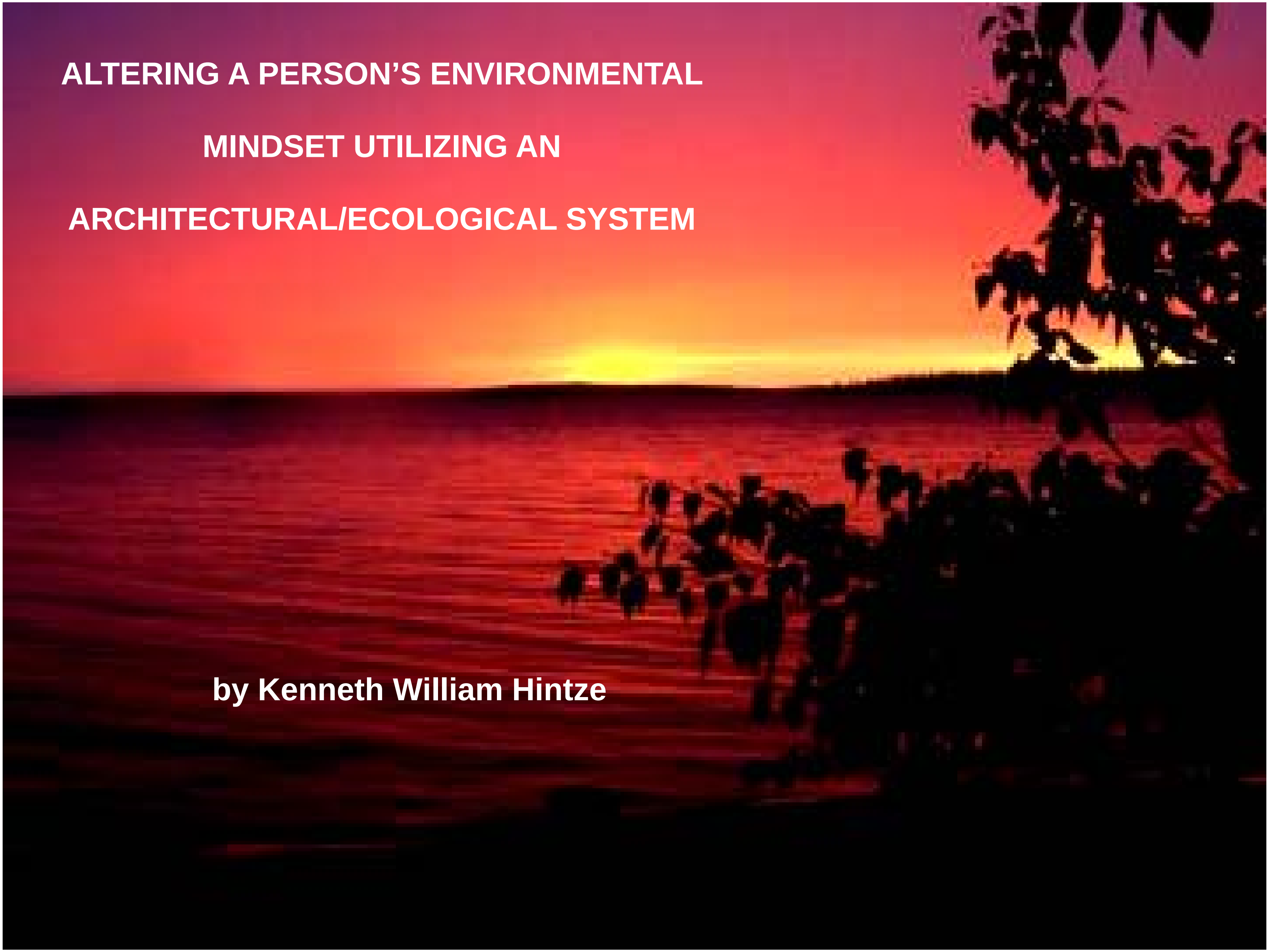
ALTERING A PERSON'S ENVIRONMENTAL
MINDSET UTILIZING AN
ARCHITECTURAL/ECOLOGICAL SYSTEM
by Kenneth William Hintze

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Kenneth William Hintze

A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master of Architecture

MONTANA STATE UNIVERSITY
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April 2007

APPROVAL

of a thesis submitted by

Kenneth William Hintze

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the Division of Graduate Education.

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Kenneth William Hintze

April 2007

TABLE OF CONTENTS

The Camp Grayling Eco-Lodge investigates how an architectural/ecological system can be utilized to alter a person's mindset. A person's mindset towards our natural resources can be influenced if you introduce alterations to their lifestyle. As visitors observe more efficient and less costly methods, they are more likely to implement them into their own lives.

The human race has taken for granted that we must pump oil and gas from the ground; that power plants pollute; that our cars pollute; and that our skied are clouded with smog. Is this simply the price we must pay for the convenience that our current technology offers?

With changes in the way we design buildings, we can move towards buildings that generate more pollution-free power than they use. The balanced marriage between high-technology to generate pollution-free electricity and low-technology to stabilize indoor temperatures is a way to bridge both worlds together while still focusing on detail and design.

The Eco-Lodge Vision for Sustainability:

∞Be responsible stewards of the environments and communities in which we live, work, and play.

∞Strive to improve environmental performance in all of our operations

∞Be a leader in sustainability in our professional organizations and the broader tourism sector.

∞Educate staff, guests, and suppliers about our sustainability goals and initiatives, and encourage personal action.

∞Operate in a manner that is compliant with all government laws and regulations.

∞Support research and education programs to improve our sustainability practices.

"In our hearts we know there is something maniacal about the way we are abusing the planetary environment"[1].

Theodore Roszak

Figure A — Existing Camp Grayling in Northern Saskatchewan, the site for this thesis project.

Figure B — Taliesin West in Arizona, an example of precision design, detailing and craft.

The purpose of this thesis project is to investigate how to alter a person's mindset utilizing an architectural/ecological system. An autonomous fishing camp is one that is designed to function separately from infrastructural support services, such as the electric power grid, municipal water systems, sewage treatment systems, storm drains, and communication services. Historically, the primary reasons for designing a project "off-the-grid" were to be safer in potential times of disaster and terrorism attacks, to be more cost efficient, and to have a less negative impact on the environment. Besides attaining the obvious physical advantages of designing off-the-grid, psychological advantages such as the feeling of doing the right thing for the greater good of society and for the individual can also be achieved.

Architecture forms the built environment, which I believe is characteristic of our identity. How we craft the design, the details, and the form of a project to be built speaks volumes of who are, or how we want to be perceived. As more of our natural resources become consumed each day, we have the opportunity to craft our identity as a global community with either giving back to the environment, or further consuming it. What legacy do we want to leave behind as the generations after us look back to see what was important to us? This all begins with each individual just taking a stance and deciding to make a positive impact on the environment. I want us to leave a legacy of a global community that cared about what state the world was going to be left in for the generations after us.

In 2002, British architects Brenda and Dr. Robert Vale[2] wrote, "*It is quite possible to construct a 'house with no bills', which would be comfortable without heating and cooling, which would make its own electricity, collect its own water and deal with its own waste. These houses can be built now, using off-the-shelf techniques. It is possible to build a house with no bills for the same price as a conventional house, but* *it would be (25%) smaller*"[3].

Designing autonomous projects makes sense for today's design professionals to consider, due to society's frightening dependence on distant and depleting resources. The primary goal of any autonomous or sustainable design should be to harness any on-site resources, such as rain, wind, and sunlight, as a way to provide safe and secure sources of power, heat, and water. Without considering these available on-site resources and finding a way to harness them, they become wasted.

Figure C — A floating house, which is as autonomous as one can achieve.

It is important to distinguish between autonomous designs and sustainable designs, as they do not always have to fall under each category. A project can be designed that has interdependence from infrastructural support services, but still falls short in the positive aspects of oil reserves, greenhouse gas emissions, and the retention of the local watershed. However, the purpose of this thesis is to carefully consider both autonomous and green design aspects and to include them both in this off-the-grid and environmentally-friendly project.

FOOTNOTES

1. Wines, James. (2000). Green Architecture. Taschen Publishing, Pg.31.

2. Brenda Vale and Dr. Robert Vale are professors at the School of Architecture at the University of Auckland; and were the keynote speakers at the 2004 tour “Sustainable Houses: Moving to Mainstream”

3. Vale, Brenda & Vale, Dr. Robert. (2004). Sustainable Development begins at home. Retrieved February 25, 2006, from On Line Opinion website: <*http://www.onlineopinion.com.au/view.asp?article=1906*>

FIGURES CITED

Figure A — My original photo taken of the existing Camp Grayling in 2005.

Figure B — My original photo taken of Taliesin West in Arizona in 2005.

Figure C — *http://www.ianink.com/04_ian/pics/2002_12_20_floathouse.jpg*

Figure A — A graphic of native Buffalo hunting.

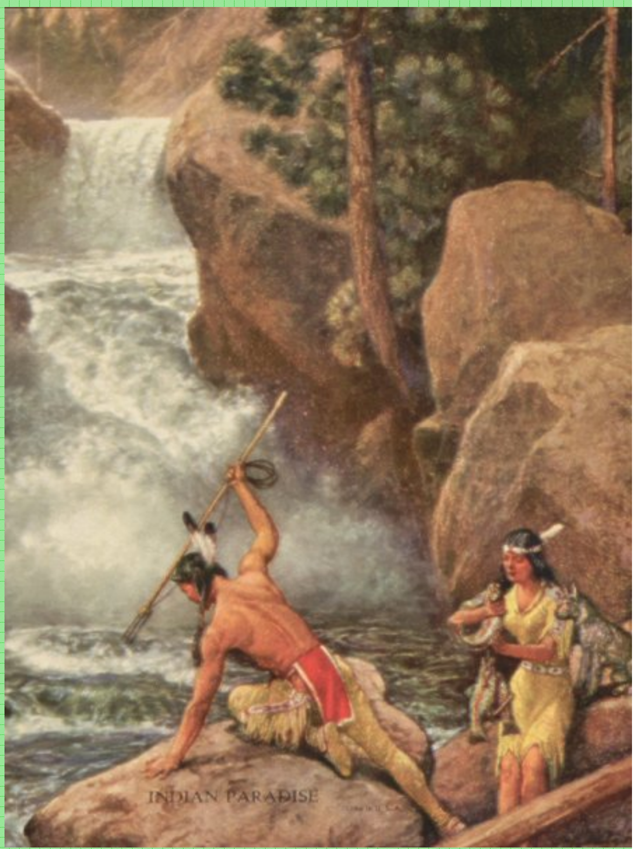

Figure B — A graphic of native fishing.

"Among our major tasks is the creation of ecologically derived human support systems - renewable energy, agriculture aquaculture, housing and landscapes. The strategies we research emphasize a minimal reliance on fossil fuels and operate on a scale accessible to individuals, families and small groups. It is our belief that ecological and social transformations must take place at the lowest functional levels of society if humankind is to direct its course towards a greener, saner world"[1].

the New Alchemists

We live in a society which consumes energy and energy-providing resources at an alarming rate. In North America, every year energy consumption increases by an average of 5%[2]. North America is one of the world's leading energy consumers and it is obvious to everyone that the energy supply is decreasing while the demand is increasing. As eloquently stated by Tommy Zhou, "*Most of our energy comes from oil which, found in the Earth, is quickly disappearing. As the future comes we must find alternate forms of energy to supply our ever increasing demands*"[3].

For generations before us, people with lesser technology thrived in harmony with nature. Native Americans hunted the buffalo and wasted almost no part of them after the hunt. In Northern Saskatchewan, at Black Lake, the natives hunted the caribou in a nomadic fashion, similar to that used by the Native Americans when hunting the buffalo. As Sheila J. Minni wrote in her 1976 paper about the Black Lake community, "*The basic adaptation of the Black Lake people has not been to a single environmental zone but to a single animal species whose range cross-cuts several environments*"[4]. In other words, the Black Lake people have always respected the various environmental zones of their land because it sustained the herds, which in turn sustained the Black Lake people. This historical context of respect for the environment from the people of the Black Lake area serves as a reminder that even though technology has evolved, we still need to respect Mother Nature as the basic provider of everything we use.

The Black Lake people understood what they were doing with their nomadic lifestyle.

Figure C — A graphic of native Caribou hunting.

They followed the caribou herds to sustain their lives. They knew that the herds moved to graze in fresh and unoccupied areas, thus allowing the previous grassland to replenish for future grazing. The Black Lake people also used the resources of the land while they followed the herds. They clearly understood that they would someday return to the area and therefore did not allow themselves to disgrace or abuse the land. "*…the regional band has its social identity as a 'people'. The total territory yields sufficient materials for the necessities of life…so that within its domain the regional band can endure as an identity for generations. Characteristically, the total constituency of the regional band is not physically together. The families that make up the regional band are most apt to come together when operating as a task group exploiting a resource which allows large assembly, as at a fall fishing camp*"[5].

Using the great examples of the Black Lake people from the past serves as a reminder that harmony with nature is not out of our reach. Harmony with nature means utilizing all of the resources available on a site without exhausting them. Having an autonomous project eliminates the need for collecting and transporting resources from off-site, which reduces a portion of the costs and impacts of the support services for the on-the-grid group. Fewer mouths to feed obviously equals less supply for the big utility companies. An autonomous project is usually energy-efficient in its operations, thus making the project more cost-efficient, as it is proven that smaller energy needs can be more easily satisfied off-the-grid[6].

We are not against maintaining the environment, but we generally don't bother to take the time to understand the process of accomplishing it. We know what they like and know what we want. We seem to routinely fail to understand that the end product is equally as important as the process. Understanding the process of design requires competence in all aspects of design and construction. That competence must include the more complex understanding of the difference between how something is built and how something can best be built. Looking to the state of our environment, as mentioned earlier in this section, I feel that a stance on energy efficiency is paramount to leaving the world in a better state for future generations.

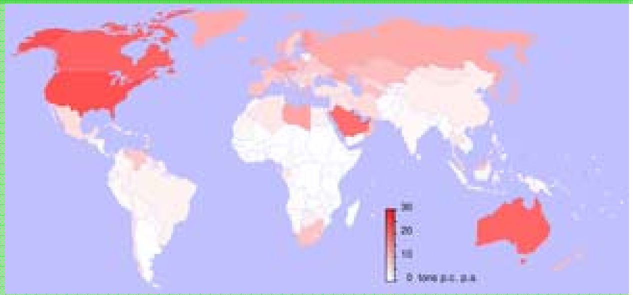

Figure D — A graphic of CO^2 emissions produced by country.

Figure E — A graphic of the Ecological footprint.

I am also taking an approach of investigating the carbon footprint of this thesis project as compared to other existing fishing/hunting camps in Northern Saskatchewan. Carbon footprint is a measure of carbon dioxide (CO_2) emitted through the combustion of fossil fuels[7]. In the case of a business, it's measured as a part of the everyday operations. This approach reveals the amount of natural resources consumed and measures the environmental impact. CO_2 emissions are recognized as a greenhouse gas, of which increasing levels warrant a serious approach to understand how it works and how we can fight the problem. This is important because Canada ranks as the number 10 highest producer of CO_2 emissions per capita in the top 201 countries of the world, with 18.7 metric tons[8]. The United States of America is ranked at number 7 with 20.6 metric tons[8]. This has North America holding 2 of the top 10 spots in CO2 emissions produced.

My goal for this thesis project is to create a year-round and autonomous fishing lodge camp that is independent from the infrastructural support services, while considering environmentally responsible green design. The primary focus will be to design an autonomous project , which includes the use of renewable resources and the production of fewer or equal amounts of greenhouse gases than it consumes by means of understanding the overall carbon impact of this project.

FOOTNOTES

1. The New Alchemists. (2000). The New Alchemy Institute. Retrieved February 28, 2006, from the New Alchemists website: <*http://www.vsb.cape.com/~nature/greencenter/newalchemy.html*>

2. Natural Resources Canada. (2006). The Government of Canada. Retrieved March 04, 2006, from the Natural Resources of Canada website: <*http://oee.nrcan.gc.ca/english/index.cfm*>

3. Hyper Text Book. (2005). The Physics Fact book. Retrieved March 13, 2006, from the Hypertextbook website: <*http://hypertextbook.com/facts/1998/TommyZhou.shtml*>

4. Minni, Sheila J., The Prehistoric Occupations of Black Lake, Northern Saskatchewan. (Mercury Series Paper No.53, Archaeological Survey of Canada, National Museum of Man, Ottawa. 1976) 5

5. Helm, June, The Nature of Dogrib Socioterritorial Groups. (Man the Hunter, R.B. Lee & I. Devore, Ed., Aldine Publishing Co., Chicago. 1969) 119,121

6. Natural Resources Canada. (2006). The Government of Canada. Retrieved March 05, 2006, from the Natural Resources of Canada website: <*http://oee.nrcan.gc.ca/english/index.cfm*>

7. Wikipedia. (2006). Carbon Footprint. Retrieved April 13, 2006, from the Wikipedia website: <*http://en.wikipedia.org/wiki/Carbon_footprint*>

8. Wikipedia. (2006). CO2 Emissions per Capita. Retrieved April 13, 2006, from the Wikipedia website: <*http://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions_per_capita*>

FIGURES CITED

Figure A — *http://images.google.com/imgres?imgurl….3Dindian%2Bhunting%2Bbuffalo%26svnum%3D10%26hl%3Den%26lr%3D*

Figure B — *http://images.google.com/imgres?imgurl….3Dindian%2Bfishing%26svnum%3D10%26hl%3Den%26lr%3D*

Figure C — *http://www.civilization.ca/cmc/archeo/kichisibi/paleo/4gr.jpg*

Figure D — *http://en.wikipedia.org/wiki/Carbon_footprint*

Figure E — *http://carbon.hampshire.edu/~sroof/images/image010.jpg*

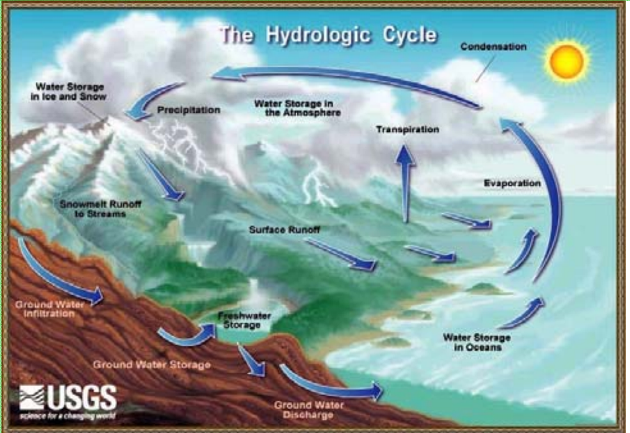

Figure A — A graphic of the hydrologic cycle.

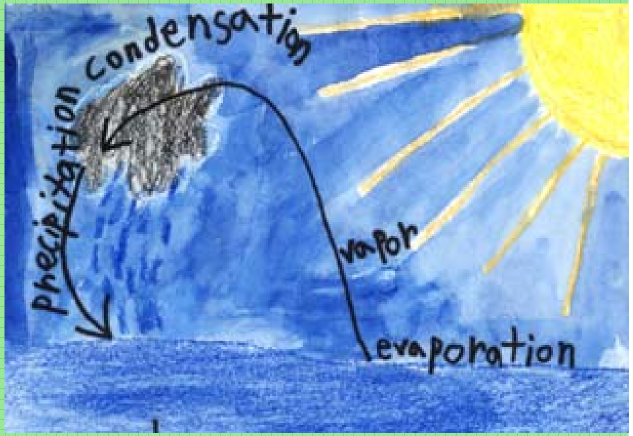

Figure B — A graphic of the water cycle.


Figure C — A graphic of well drilling.

"The building as architecture is born out of the heart of man, permanent consort to the ground, comrade to the trees, true reflection of man in the realm of his own spirit. His building is therefore consecrated space wherein he seeks refuge, recreation and repose for the body but especially for the mind."[1].

Frank Lloyd Wright

Camp Grayling will be Saskatchewan's premiere hunting/fishing camp with the latest energy-efficient strategies when implemented. These strategies will create a fully functional year-round business in the northern Saskatchewan woods that operates entirely off-the-grid and with minimal impact on the natural resources that sustain this operation. The beauty of nature and the continuing renewal of these resources are the heart of the fishing/hunting operations in Northern Saskatchewan. It is therefore logical to focus the layout and design of a fishing/hunting lodge on the aspects of energy efficiency and on creating minimal site impact.

An autonomous and sustainable project must be custom designed to suit the specific climate and location needs and must consider other critical areas, such as: passive solar techniques, alternative toilet and sewage systems, thermal massing designs, electrical production, efficient fenestration, and maintenance systems.

Water Systems

One option for supplying water to a remote and autonomous camp is to drill a well. However drilling can be expensive and is an uncertain activity due to water depths. The rugged Precambrian shield landscape of the Camp Grayling area can be as hard as drilling through granite[2], which means that a rock-eating drill bit would have to be used. Transporting the drilling equipment to the proposed site could also be difficult. Designing a building with captured water systems for future re-use and utilizing the rainwater, with a supplemental system in dry times, makes more sense for a remote project. Reducing water use with waterless urinals and composting toilets are a definite possibility.

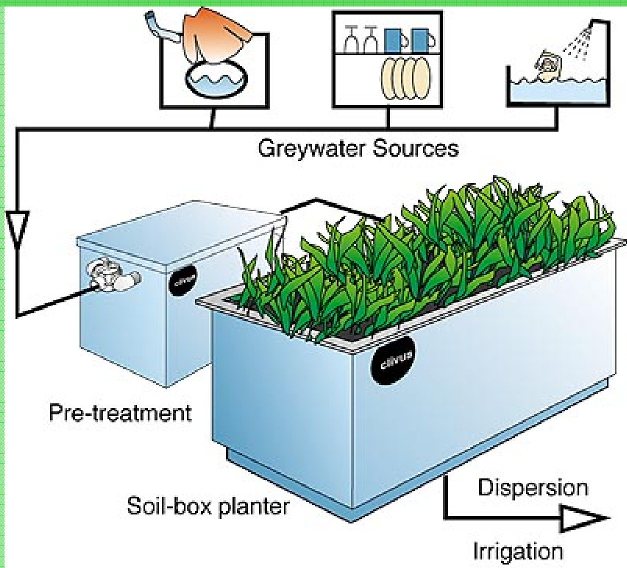

Figure D — A graphic of a grey water system.

Grey water is wastewater generated from activities such as laundry, bathing, and dishwashing. You want to take extra precautions when dealing with gray water, since it can be considered to be a health and pollution hazard if released into the natural environment uncontrolled,[3] which I want to avoid at all costs in this remote and pristine site. Grey water systems have the ability to reuse wash water for plant life support. A grey water system could cut in half the amount of water normally used in a project; but additional equipment such as a sump, grey water pressurization pump, and secondary plumbing would have to be purchased. Taking advantage of newer technologies for water purification only makes sense. You need water purification because water should not be drunk unless it has been purified and because this is a remote and pristine site, one in which you need to take every precaution necessary to ensure it stays in this condition. Reverse Osmosis and Water Processors can produce unlimited amounts of pure water from polluted water, ocean water, and even from air[4].

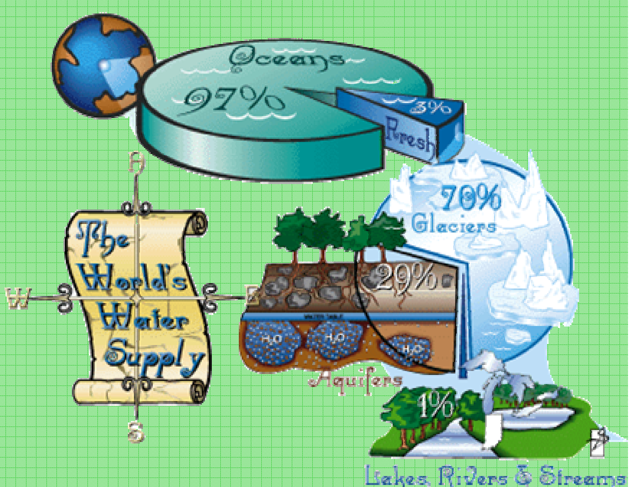

Figure E — A graphic of the world's water supply.

The Organization For Economic Co-operation and Development (OECD) ranks Canada 28 out of 29 OECD countries in terms of per capita water consumption[5]. According to the OECD, "*Canadians use about 1,600 cubic meters of water per person per year. This is more than twice the average as a person from France, about three times as much as the average German, four times as much as the average Swede, and almost eight times as much as the average Dane. Canada's per capita water consumption is 65 per cent above the OECD average. Canada ranks 26 out of 29 for total water consumption among OECD countries, with only the United States, Japan and Mexico using more water than Canada. Even in Canada, which has the largest per capita water supply in the world, shortages are experienced.*"[6] Most Canadians live within 200 kilometers of the American border[7], yet a significant portion of our water is found in northern Canada, where Camp Grayling is located.

To calculate the amount of water required, I will use Environment Canada's calculated average Canadian daily domestic use of 343 liters per person[8]. Since this is a camp that will have the potential to hold 50 clients at capacity and 8 staff members, I will multiply 58 people by 343 liters per person to equal 19,894 liters per day at Camp

Grayling at maximum capacity. The staff will be cleaning the facilities, washing dishes, and doing laundry on a daily basis, but the clients won't need to access laundry unless by request. The clients will still shower, but designing the camp to use systems of water conservation will allow the number of 19,894 liters per day to decrease. In the table below[9], I break down the total daily water used for Camp Grayling to equal 14,124 liters per day. As such, I will declare that a 15,000-liter reserve would equal enough water for maximum capacity.

DAILY USE (Appliance)	TYPE	AVERAGE RATE OF FLOW	AVERAGE TOTAL WATER USED	MAXIMUM #	TOTAL WATER USED FOR CAMP GRAYLING
Shower (average shower is 8 min)	Water Saver	8.5 liters per minute	68 liters per shower	58 people	3944 liters
Toilet	Compost	Waterless	0	116-174	0 liters
Washing Machine	Twin Tub		40 liters per wash	15 loads	600 liters
Dishwasher			20-50 liters per load	6 loads	300 liters
Cooking, Cleaning & Drink-ing		10 liters per minute	150 liters per 24 hour day	58 people	8700 liters
Brushing teeth with running water			5 liters per brush	116 times	580 liters
Total					14124 liters

Figure F — A graphic table of water required.

Camp Grayling Average Monthly Precipitation												
MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Average Monthly Precipitation (cm)	0.2	2.2	1.6	1.9	3.9	4.3	15.5	3.3	3.8	2.1	3.2	1.1

Figure G — A graphic table of site precipitation.

For this thesis project, the primary source of water supply will be capturing precipitation and the use of grey water. In times of extreme dry weather, a supplemental system of pumping river water from the rapids of the Fond du Lac River, which feeds Black Lake, would be appropriate. I will not consider a well as an option due to the difficulty in transporting the necessary materials to and from the site and unknown costs of drilling to uncertain depths.

Sewage Systems

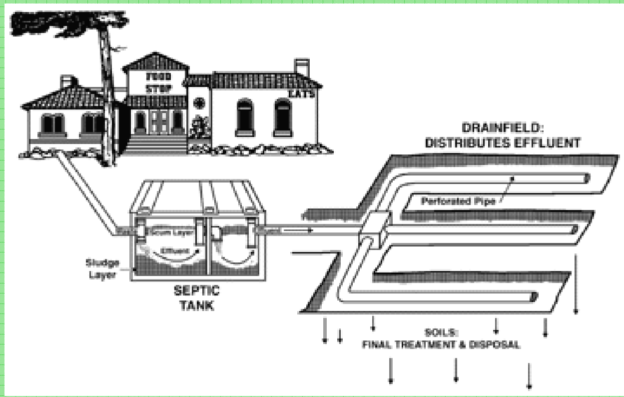

Figure H — A graphic of an on-site sewage system

A campsite designed for use "off-the-grid" must also utilize a private sewage disposal system. In some provincial areas, the health department inspectors will not only specify exactly where on the site the system will be placed but will also simply state the size of all equipment required and the installation method[10]. In addition, many areas limit both the minimum lot size on which a private sewage disposal system might be placed and minimum unit size, if both a sewage disposal system and a well are required. Most of these requirements are established because of the local soil type, and because the potable water supply might be contaminated by a sewage disposal system. These requirements apply to my project because I do not want to contaminate the water supply at this pristine site in any way.

Private sewage disposal systems usually consist of the building sewer, which leads from the building into a septic tank and then the line into a distribution box that feeds the fluid into the disposal, or leach fields. For this fishing/hunting camp, the septic tank may feed into a seepage pit, as opposed to the commercial scale packaged units.

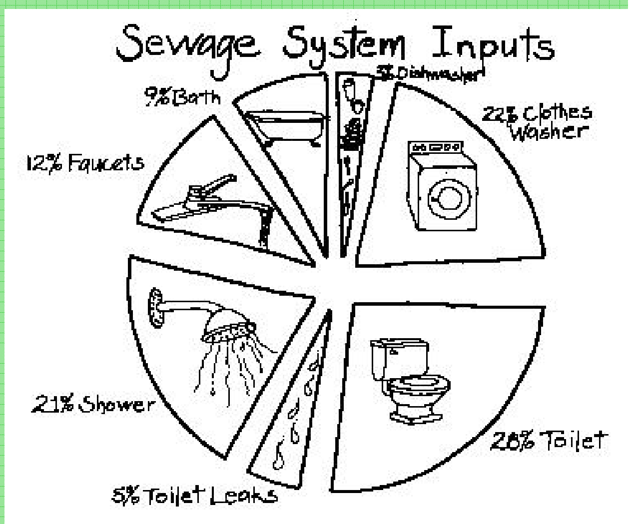

Figure I — A graphic of sewage system inputs.

For septic tanks, a watertight unit is placed underground, where it receives the sewage from the building and holds it for about a day while the suspended solids settle to the bottom and putrefy. The liquids pass out of the tank at the other end into the distribution box. Septic tanks will occasionally have to be pumped to remove the solids, which settled to the bottom. Failing to pump them can cause overflow and contaminated ground water.

Composting toilets can easily allow the sewage to be disposed of in a manner similar to the regular garbage, can reduce water usage considerably, and can eliminate the cost of septic tanks[11]. However, the local landfill must utilize sanitary methods of storing the compost for this to be acceptable. Composting toilets can require significant space in the room below the toilet, as I want this system to finish the

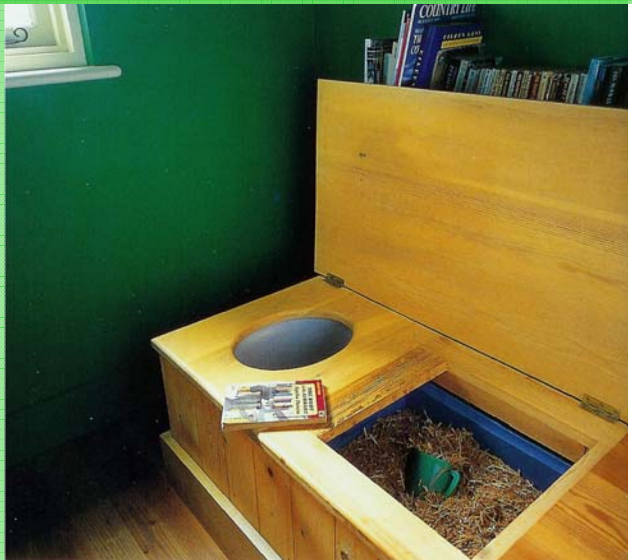

Figure J — A graphic of a composting toilet.

composting on-site. Since these composting toilets will be electricity-free, they will require the maintenance employees to rotate a composting drum to stir the composting humanure. This approach views the human solid waste as a resource instead of waste, as composted human waste can provide valuable nutrients to a garden.

Some technologically advanced houses contain biological treatment systems that eliminate nutrients and bacteria while converting grey water and sewage to clear water[12]. This is usually done using beds of plants and aquaria, producing an odor and color free reclaimed water source. This water is then reused for toilets and outside non-edible plant life. In the northern Saskatchewan climate, a design should place the plants and aquaria inside a greenhouse space, due to freezing, since this will be a year-round camp. The downside of biological treatment systems is that if the space isn't occupied, the system dies due to starvation. The thesis project would require someone to be there year-round to ensure the system thrived.

Any waste that is safe to burn will be burned during campfires, while biodegradable wastes will be left in the dry composting toilets. All cooking materials and cleaning supplies will be allowed to be biodegradable only, so it won't negatively impact the environment when discarded into composting bins. Cooking oils will be drained into large plastic drums for future use of bear baiting. New areas will be used each year to provide the best opportunity for hunters to get a mature bear. Bear baits will be set up in a natural manner, which keep the bears relaxed. Experienced bear baiters swear that used cooking oil is among the most seductive baits that bears love to eat[13].

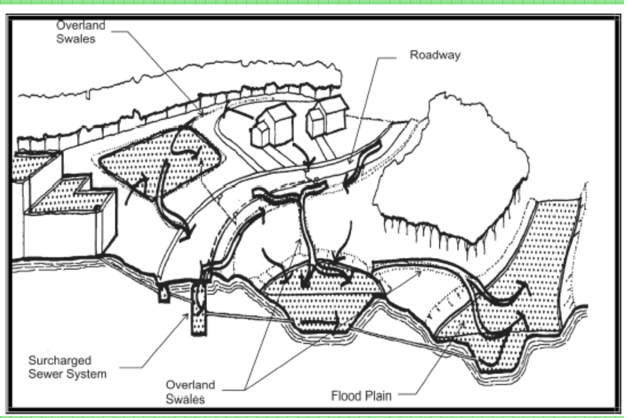

Figure K — A graphic of a drainage system.

Drainage Systems

To best utilize the rain for water supply, a functional drainage system must be properly coordinated. If not properly designed, water pools and floods along the site surface as it flows to a low point. Proper planning can address this issue, as understanding where to place paved areas, lawns, and turf means more managed filtering through

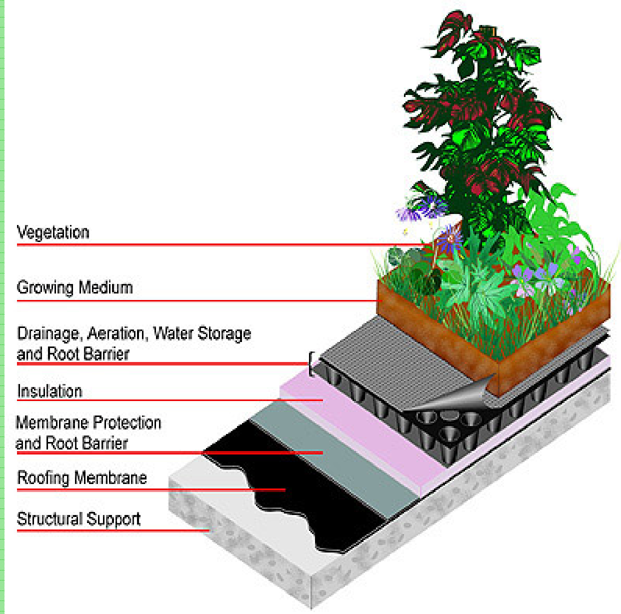

Figure L — A graphic of a green roof.

Figure M — A graphic of Ben Franklin experimenting with electricity.

the ground to recharge aquifers. The landscaping can also be designed to add swales so that the water is collected in a shallow ditch, thus aiding in site drainage. Utilization of a green roof would also be a fantastic option, as it could reduce heating and cooling loads on a building and catch precipitation for a roof garden. The monthly precipitation was previously documented in the Water Systems section. For this thesis project, collecting rainwater into a cistern is the option I will use in the design of Camp Grayling.

Electric Systems

Before I can attempt a cost analysis of alternative energy systems, I must perform a thorough investigation into the maximum energy demands of this camp. This investigation will lead to estimates, which I will then factor in an additional 10% to account for error in my calculations. The following table represents the estimated electrical demand including the type of electrical device being used, the watts per hour of that device, the typical amount of use for this device per week, and the converted typical amount of use per day.

An option for electricity generation I will utilize is harnessing the wind. According to the U.S. Department of Energy, "*When wind is added to a utility system, no new backup is required to maintain system reliability*."[14] At Camp Grayling, the average monthly wind speeds range from 14.2 km/hr (8.8 mph) to 18.9 km/hr (11.7 mph), while the maximum wind speeds range from 24 km/hr (14.9 mph) to 62 km/hr (38.5 mph)[15]. The following table displays the average wind speed per month at my site.

Camp Grayling Average Monthly Wind Speed												
MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Average Monthly Wind Speed (km/hr)	15.0	15.7	16.4	16.7	15.3	15.5	17.5	18.9	17.5	16.3	14.4	14.2

Figure N — A graphic table of monthly wind speed.

TECHNICAL ISSUES

ELECTRICAL DEVICE	DEVICE WATTS per Hour	HOURS OF USE PER DAY	DAYS OF USE PER WEEK	AVERAGE WATT-HOURS PER DAY
Commercial Size Sun Frost Refrigerator/Freezer	48.75	24	7	1170.00
Vacuum Cleaner	630	1	7	630.00
Television (24" Color)	80	1.5	5	85.71
VCR/DVD	30	1	5	21.43
Alarm Clock x 16 required	5	24	7	1920.00
Laptop Computer	55	2	7	110.00
Ink Jet Printer	35	1	1	5.00
Lighting – Hunter Cabin Main Lighting x 16	50	4	7	3200.00
Lighting – Hunter Cabin Task Lighting x 62	15	2	7	1860.00
Lighting – Hunter Cabin Bathroom x 16	25	2	7	800.00
Lighting – Lodge Main Lighting x 4	50	5	7	1000.00
Lighting – Lodge Task Lighting x 10	15	2	7	300.00
Lighting – Lodge Bathroom	25	4	7	100.00
Lighting – Lodge Kitchen	25	4	7	100.00
Kitchen – Microwave	900	0.5	7	450.00
Kitchen – Exhaust Hood over Stove	144	0.5	7	72.00
Large Range Burner	2100	0.5	7	1050.00
Small Range Burner	1250	0.5	7	625.00
Oven	11850	4	7	47400.00
Equator EZ3612 Energy Star Combo WD x 2	143	2	7	2002.00
Door Lighting	50	4	7	200.00
Exterior Path Lighting (Motion Detecting Solar Garden Lights)	0	8	7	0
TOTAL ESTIMATED ELECTRICITY FOR CAMP + 10% error factor				(<u>*63101.14*</u>) **69.41 kWh/day**

Figure O — A graphic table of the electrical load.

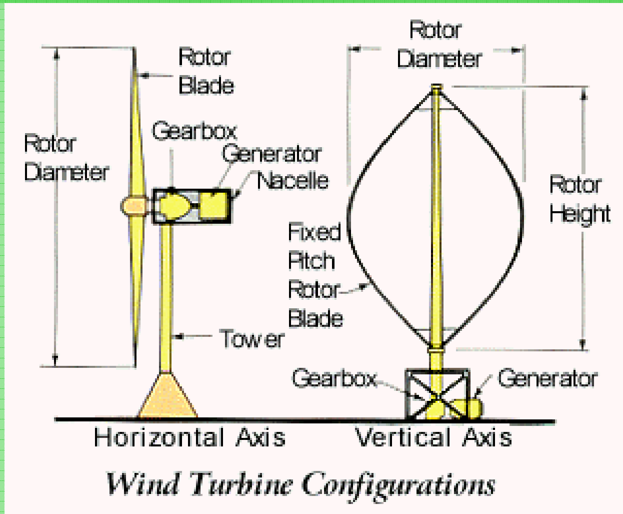

Figure P — A graphic of a wind turbine design.

Figure Q — A graphic of a wooded area turbine.

This wind speed information for the site suggests that the average wind speed is enough to make this a viable option. Wind power turbines have a less expensive cost per-watt as compared to photovoltaic cells. To generate power, an autonomous house of 1,000 square feet needs only a 5m-diameter rotor unit to supply enough energy[16]. This thesis project is substantially larger than 1,000 square feet, with a lodge and 16 cabins. As such, I will increase it to a 10 m diameter rotor unit, which brings a rating of 25KW and an annual 45 MWh[17], thus acting as a great supplementary power source.

Taking the estimated daily-required energy at peak season and multiplying it by the 152 days of the main hunting/fishing season, you get a requirement of 10,209.84 KWh or 10.21 MWh. Even if you were to assume that this maximum rate was multiplied over 365 days, the total requirement comes out to 24,516.69 KWh or 24.52 MWh. The calculated annual rating of 45 MWh of production from wind generation far exceeds this requirement, but you need to consider some factors in wind generation before assuming that the loads are met by wind alone. Since wind does not blow all of the time, it cannot be the only power source without some form of storage system. A wind turbine in the wind speed conditions of my site should run about 65%-90% of the time[18]. However, this does not mean that it is working at full capacity. The truth is that it will actually be running at less than full capacity, which is the capacity factor. If you divide the actual amount of power produced over time against the power that would be produces if the turbine operated at maximum output all of the time, then you have calculated the capacity factor. A typical capacity factor would be between 40% to 80%[19], which means I have to adjust the earlier wind generated electricity calculations to reflect this. Using the low estimates of 65% operating time, the capacity factor calculation becomes 29.25 MWh/year divided by 45 MWh/year, which equals 65%. This falls into the capacity factor range mentioned earlier, which is still higher than the estimated calculated electrical amount of 24.52 MWh per year at full capacity for the operation (which won't be at maximum capacity in the winter). This brings me to a dilemma on what to do with the excess power produced.

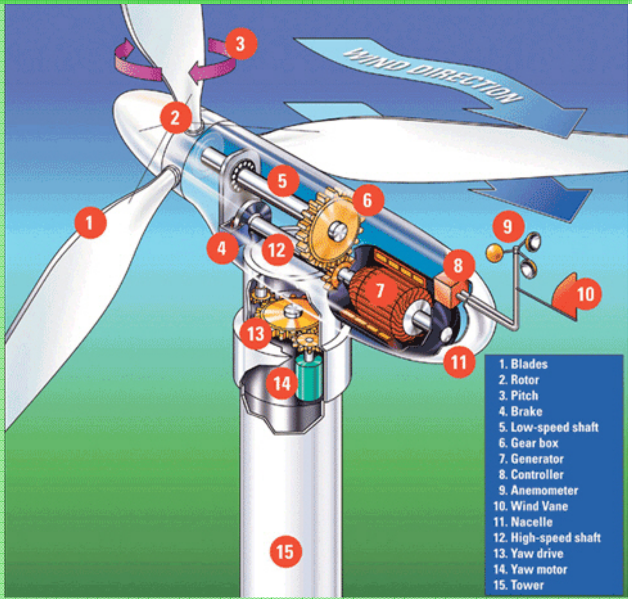

Figure R — A graphic of a wind turbine's inner components

Figure S — A graphic of the wind blowing.

Wind generation combined with the photovoltaic cells will provide opportunities for power generation on either cloudy days or windless days. Electricity can also be stored in batteries on-site for future use, if needed. However the implication of storing and disposing of a toxic product should be avoided if one wants to achieve less damage to the environment. The site already has power lines available from the Saskatchewan utility company, Sask Energy, so attaching the project to the electric power grid for the advantages of net metering is a great option for this project. The decision here becomes is it more important to be strictly off-the-grid, or is it more important to help reduce the energy impact through producing it yourself and making it available to others? I feel that I need to alter my approach at this point to allow a connection to the power grid of Sask Energy and to apply net metering. At the earlier calculated rate of energy production, attaching to the power grid of Sask Energy will still result in Camp Grayling never paying an electric bill.

In times of low wind, long cloudy conditions, and Sask Energy power outages (which do happen in the far north), I feel that a back-up system is necessary for this remote location. To be responsible in this design, I have to assume extended periods of low-power conditions are possible. An auxiliary gas or diesel-run generator only needs to run for about an hour to fully charge the batteries for a full day of operation. With the average wind speed and amount of average daylight for my site, this isn't an immediate concern. However, I still feel that it is responsible to include an auxiliary generator for a back-up power source. Since one of the main historic reasons for developing autonomous projects is the feeling of safety in times of potential disaster, having no back-up source of power certainly goes against that concept. Having access to a generator, but not using it daily, would also serve as a reminder of the lesser negative impact on the environment. People need to be comfortable, both physically and mentally. The generator could also be run off of methane digesters, fueled by human solid waste and kitchen scraps, instead of fossil fuels, if we sacrifice using composting toilets[20].

Another technique I will implement to provide the electrical load is photovoltaic cells. With 2,500 hours of free sunshine on average per year (an average of 6.85 hours of sunlight per day and the most of any province in Canada)[21], utilizing photovoltaic cells is the most obvious place to begin development of the electric system. Incorporating photovoltaic cells into the original camp master planning maximizes the potential of the units and saves the greater expansion and difficulty of adding later. The most modern photovoltaic cells have a lifespan of around 40 years[22], when they would most likely require replacing, which makes them a fine investment for this sunny environment.

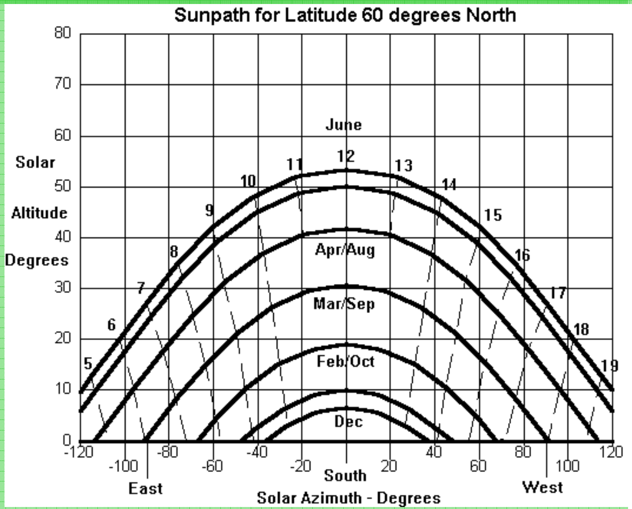

Figure T — A graphic of the sunpath at Camp Grayling (59º 15' N).

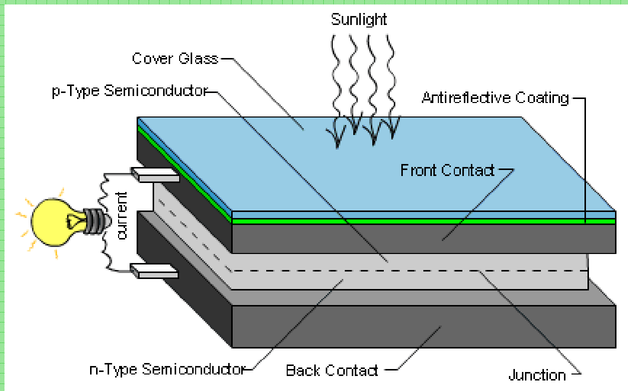

Figure U — A graphic of a photovoltaic cell's inner components


Figure V — A graphic of photovoltaic cells used.

The photovoltaic cells will not need to supply the entire electrical demand, as the wind generators, even in calculating the low end percentages, already give back in net metering. My research for the most economical photovoltaic panel has produced the Photowatt pw750 series panel that costs $275.00[23]. The produced electrical amount of 67.17 KWh/day is my target, as it is estimated electrical demand. The following table is a standard way of sizing a photovoltaic system. I utilized amps in the calculations instead of watts, as used in the earlier electrical demand table.

PHOTOVOLTAIC SIZING TABLE	
Total AC watt-hours per day	67170
System Nominal Voltage	12
Total amp-hours per day	5597.5
Wiring losses and safety factor	1.2
Total daily amp-hour requirement	6717
Estimated Insulation (Sun Hours)	6.85
Total PV array current in amps	980.58
Photowatt pw750 series	$275.00
Amps per unit	4.6
Number of modules required in parallel	213
Cost of the panels:	$58,575.00

Figure W — A graphic table of photovoltaic sizing.

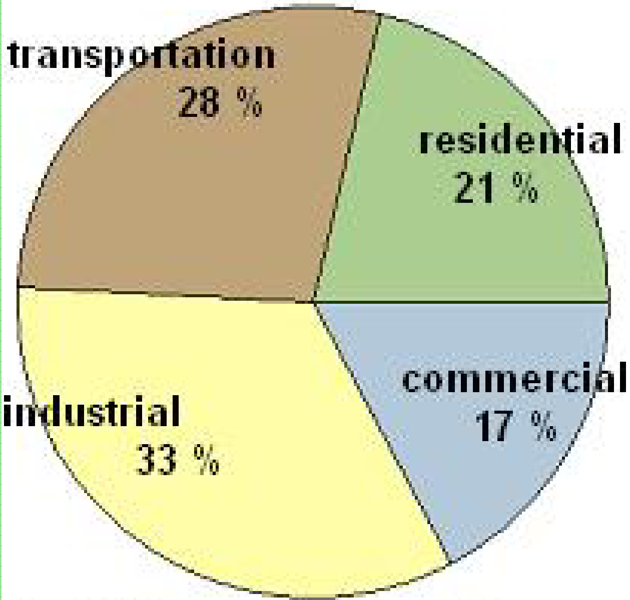

Figure X — A graphic of Canadian energy usage in 2004.


Figure Y — A graphic of energy conservation on a

These photovoltaic panels are 48.7 inches by 21.9 inches in dimension[24]. This camp requires utility sheds and has a nice open clearing in the back of the property, which makes a great location for the wind generator and for these panels to be designed for the roof of these utility sheds from the beginning. The lodge roof is being designed for catching rainwater, so it is not available for photovoltaic cells.

The electrical demands can also be reduced through energy conservation techniques. Energy conservation is increasing the use of energy so one can achieve a higher output for similar consumption. Conserving the electricity you use on a daily basis it is just as important as generating your own electricity. The systems are a great place to start thinking about energy saving, but continuing it with energy-efficient fluorescent lights, appliances, and laptop computers will make a large impact on electricity savings, and therefore money savings. Understanding that space conditioning accounts for approximately 50% of home energy consumption in Canada[25], you can understand how passive heating and cooling strategies can greatly reduce the electrical demand. Lighting comes in at approximately 12% of home energy consumed[26], which makes it a great place to apply energy conservation techniques. Energy Star, a US government-funded program, rates appliances against the federal standard for that particular appliance. Energy Star shows that by using Compact Fluorescent Light Bulbs (or CFL's) as opposed to the standard incandescent bulb, saves approximately 66% electricity[27]. Understanding products like this can greatly reduce your electrical load by conserving energy.

<u>Heating Systems</u>

Using the proper techniques and technology, passive solar heating can effectively heat most structures in temperatures even as cold as those found during a Northern Saskatchewan winter. Utilizing triple glazed insulating windows, usually krypton or argon insulated, permits passive solar heat to naturally heat the building. Site orientation, form design, and thermal massing must also be properly utilized to be effective. Site orientation is important because the windows should face the sun,

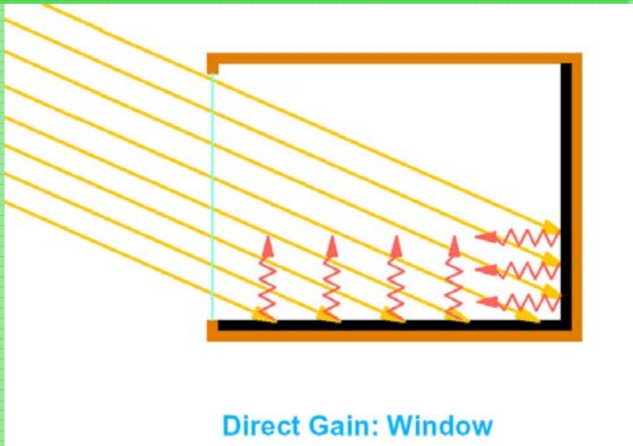

Figure Z — A graphic of passive heating.


Figure AA — A graphic of a solar water heater.

which is south in the northern hemisphere, and because the wind can carry away heat from a structure. Form design is important because rounded or aerodynamic forms will tend to let less heat escape. Supplementary heaters will also be utilized in November through March, when the coldest weather appears, since the intention is a year-round operation in the thesis project. Since we will be providing the electricity required from photovoltaic and wind sources, electric heaters and stoves will be utilized, since they are pollution-free sources of heat. This is not a good use of electricity, but both the photovoltaic panels and the wind generator can each supply the necessary energy for this camp, so using some of the excess electricity for pollution-free heat makes sense in the context of this project.

Water Heating Systems

Combining a solar water heater with an electrically powered flow-through heater keeps the water temperature consistent, works effectively in this thesis design. The solar water heater is a well-insulated holding tank, which is filled with hot and available water on sunny days without electric heating. The advantage of using the two systems is that if either system fails, the other can handle the water-heating load until the weather conditions or repairs are corrected.

Cooling

Using the proper techniques and technology, such as a passive solar system, can effectively reduce the cooling load required for a structure. With the recorded high temperature over the past 20 years only being 35.1° C[28] (95.2°F), and temperatures above 32° C typically lasting for only around 2 weeks in the late June/early July months[29] and with the cooling prevailing winds coming off the river, there isn't a great need for cooling systems. Passive strategies will easily handle the cooling requirements. Shaded windows in the summer months and eave overhangs for shading are tested and true methods of passively cooling a structure. The site planning is also a major consideration in this project, as the utilization of tree shade

Figure BB — A graphic of fishing at Camp Grayling.

Figure CC — A graphic of communication.

will cool the buildings and patio areas and the previously mentioned average wind speed will provide plenty of cool breezes. These passive strategies will be more deeply investigated once the design of the structures has taken form.

Food

Intensive gardening can support an adult on as little as 15 square meters of land[30]. So with the large site, enough garden space can be designed to grow fresh vegetables and fruit to sustain the camp's workers and visitors. Indoor gardens can supply the fruit and vegetables in the wintertime, when the amount of people staying at this camp is decreased. Also, this thesis project is a commercial hunting/fishing operation where the plentiful fish and big game (legal amounts of game during the hunting/fishing seasons can easily be frozen for later) could easily be used as a main food source. Any specialty food item would need to be ordered in advance from a grocery store in either Black Lake or Stony Rapids and picked up in one of the camp's vehicles on the one road that accesses the camp.

Communication

The site has existing Sasktel phone lines already run into the campsite, as this is a business and communications are essential for any business. The use of satellite internet, with laptops for less energy consumption, can provide high speed connectivity to remote locations. The internet could provide live sports events, such as the playoffs, for those who insist on routing for their team. There is service in this location, as the community of Black Lake is within 8 kilometers of Camp Grayling; and the community of Stony Rapids is within 20 kilometers. Each of these communities have full access to infrastructural support services. These systems would be available for clients to use if necessary, but they are more for management purposes. There is a level of security when you know you could access the outside world, even though you came here to escape it, since emergencies do happen.

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Figure D — *http://www.greywater.com/soilb.jpg*

Figure E — *http://www.lawater.lsu.edu/images/supply/supply.gif*

Figure F — My original table.

Figure G — My original table.

Figure H — *http://cru.cahe.wsu.edu/CEPublications/eb1807/sewage1.gif*

Figure I — *http://www.clallam.net/EnvHealth/assets/images/inputs1.jpg*

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Figure N — My original table.

Figure O — My original table.

Figure P — *http://www.awea.org/faq/tutorial/wwt_basics.html*

Figure Q — *http://www.otherpower.com/bigmills/mymill2.jpg*

Figure R — *http://www.powerhousekids.com/stellent2/groups/public/documents/pub/phk_ee_re_001502-3.jpg*

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Figure T — *http://www.scolar.org.uk/html/school-info/advanced/advanced-09.html*

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Figure W — My original table.

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Figure AA — *http://www.aranyagardens.co.uk/Pictures/Photos/Slideshows/Solar%20hot%20water%20heating%20panel.jpg*

Figure BB — *http://www.campgrayling.ca/*

Figure CC — *http://www.wmbp.org/assets/userfiles/000274.jpg*

Figure A — A graphic of Angler Rapids location.


Figure B — A graphic of Angler Rapids Lodge.


Figure C — A graphic of Angler Rapids Lodge.

ANGLER RAPIDS WILDERNESS LODGE[1]
Northern Saskatchewan

Angler Rapids Wilderness lodge offers Northern Pike and Walleye fishing reserves off the Churchill River System. They offer “modernized” cabins with electricity and hot water. The energy is supplied by a diesel generator on site.

The water waste is pumped to a leach field, which is an efficient and natural system utilized by lodges throughout northern Saskatchewan. The water used in the camp is pumped directly from the lakes, which are clean partly because there are no major cities or industries along the entire water system to pollute it.

The owners of Angler Rapids haven’t taken enough precautions towards environmentally friendly design. I think this is an excellent example of what the “standard” may be for this typology, which provides a good starting point for this thesis discussion. This applies to my thesis because I now understand more of the mindset behind camp owners and what is really important to them. It’s time to show that being autonomous and sustainable in Saskatchewan can be easily achieved.

In relation to my thesis topic, the following are key potential advantages of the Angler Rapids design:
- This lodge is autonomous in its resources.
- There aren’t any other good advantages that I wish to utilize in this design, as this is a typical fishing lodge in Northern Saskatchewan that does nothing to distinguish itself from the other lodges.

In relation to my thesis topic, the following are key potential disadvantages of the Angler Rapids design:
- The diesel generator as the only source of power emits toxins into the atmosphere and reduces the carbon footprint of this site.

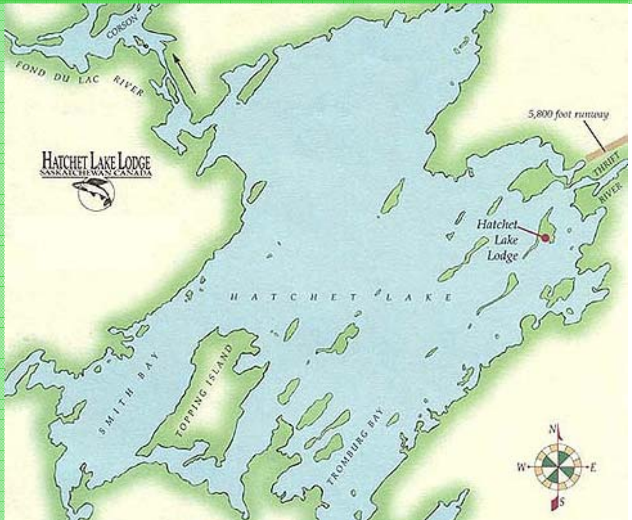

Figure D — A graphic of Hatchet Lake Lodge location.

Figure E — A graphic of Hatchet Lake Lodge.

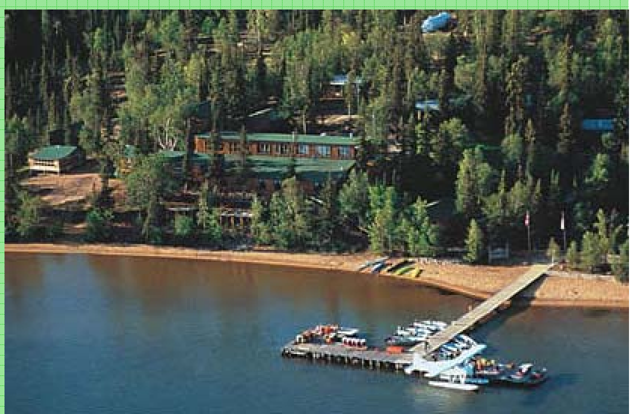

Figure F — A graphic of Hatchet Lake Lodge.

HATCHET LAKE LODGE[2]
Northern Saskatchewan

Hatchet Lake Lodge offers Northern Pike, Arctic Grayling, Walleye, and Lake Trout fishing reserves available on Hatchet Lake. They offer “modernized” cabins with electricity, propane stoves and hot water. A diesel generator on-site supplies the energy. The cabins are all constructed of hand-peeled logs harvested in the local area. The logs were then transported to the campsite and a group of local Cree and Dene Indians, who specialize in log structures, built the cabins using only hand tools.

The owners have installed high efficiency wood burning stoves, which can heat an entire cabin all night on one filling of wood. They use flush toilets, which seems out of place in such a remote design. When I asked George Fleming, the owner, about any active or passive strategies implemented within this camp he said that they make enough money to cover the costs of whatever comes up. Mr. Fleming feels that it is more important to spend money on luxury than to think of anything else. This seems out of place, since George Fleming is a well-respected outdoorsman in Canada and has been featured on multiple outdoorsman TV programs. I appreciate the effort in using locally harvested logs and only hand tools, but this camp misses the point completely in sustainable thinking.

In relation to my thesis topic, the following are key potential advantages of the Hatchet Lake Lodge design:
- This lodge is autonomous in its resources.
- The lodge was constructed of locally harvested hand-peeled logs.
- The lodge was built with only hand tools.
- High efficiency wood burning stoves for cooking and heating.

In relation to my thesis topic, the following are key potential disadvantages of the Hatchet Lake Lodge design:

- The diesel generator as the only source of power emits toxins into the atmosphere and reduces the carbon footprint of this site.
- The attitude that money can cover anything that comes up. This way of thinking is dangerous and doesn't show me a view of the overall picture of the environment. Instead of thinking environment first, he thinks comfort and ease first.

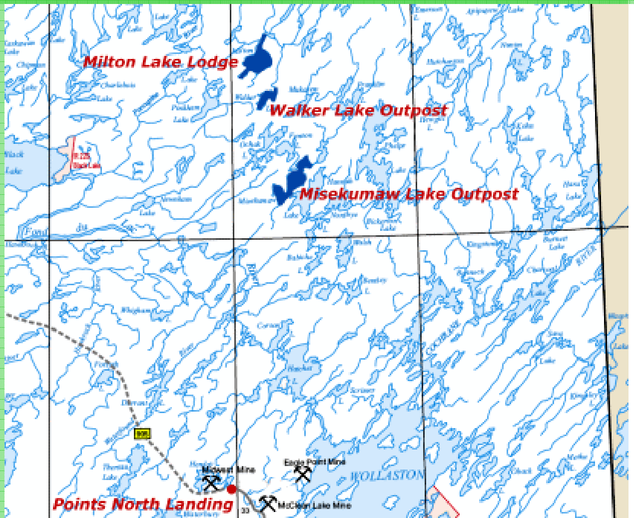

Figure G — A graphic of Milton Lake Lodge location.

Figure H — A graphic of Milton Lake Lodge.

Figure I — A graphic of Milton Lake Lodge.

MILTON LAKE LODGE[3]
Northern Saskatchewan

Milton Lake Lodge offers Northern Pike, Arctic Grayling, and Lake Trout fishing reserves available on Milton Lake. They offer a true remote experience, as no roads exist to this site. The owner chose to fly in 250 twin otter loads of lumber to prevent cutting down trees from the site. He also transported in fishing boats, a hot tub, and some other items for personal comfort via helicopter. Only 8 trees were cut down to make way for the main lodge, which was sited based on impacting the natural growth, the least.

The main lodge was designed to allow trees to be incorporated into the deck, to further connect nature to the man-made environment. The owner installed compost toilets to use an environmentally friendly method of handling sewage. They have marked all paths to the lodge to alleviate people walking on moss, lichen, and other natural growth.

They use a diesel-powered generator, but shut it off for a few hours during the day and all night every night. Battery operated motion detecting lights allow people to see during the nighttime. The owner also personally pays to fly out all recyclables from the site and then have them trucked south to a recycle depot, as opposed to burning them. The camp has a strict policy of catch and release on all trophy fish.

This Lodge provides a Jekyll and Hyde example of an environmentally conscious remote fishing lodge in the same climate as my site. Although I feel that better energy-efficient strategies can be implemented than complete reliance on a diesel generator, the owners of Milton Lake Lodge definitely respect the environment of their site. I believe that this lodge sets the bar in Saskatchewan for fishing/hunting camps with a stressed focus on being friendly to the environment.

In relation to my thesis topic, the following are key potential advantages of the Milton Lake Lodge design:
- The strong belief in impacting the site in the least way possible, although cutting down no trees would be better.
- The use of energy-efficient lighting.
- The turning off of the generator at night to conserve resources.
- The consideration of recyclable material and the effort put in to remove them to a recycle depot.

In relation to my thesis topic, the following are key potential disadvantages of the Milton Lake Lodge design:
- The pride in flying in 250 twin otter loads of lumber to build this lodge and to fly recyclables out. The carbon budget wasted to accomplish this is obscene. He could have tried floating the lumber down the river to the site or considered alternative construction methods. This is a good example of deciding what materials and methods were going to be used without careful consideration as to environmental impact. The owner doesn't seem to understand the negative impact on the environment that this fuel usage is doing.

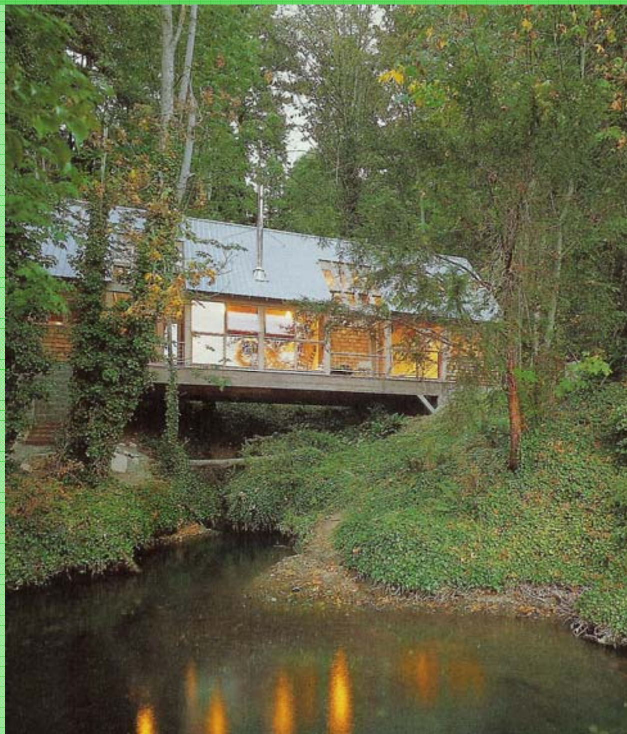

Figure J — A graphic of Cutler's Bridge House.

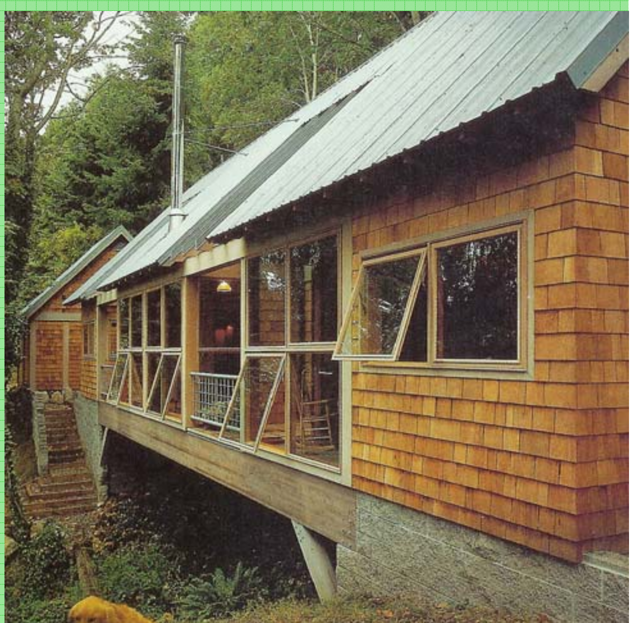

Figure K — A graphic of Cutler's Bridge House.

BRIDGE HOUSE[4]
Bainbridge Island, Washington, USA
James Cutler Architects

A 2200-square foot structure built in 1987, the designer dealt with the problems of a difficult site, which was bisected by a ravine and mountain stream. The solution preserved all of the existing trees and ground cover by spanning over the stream and using hand-excavated foundations to avoid excessive damage. The living areas have outstanding views on a constricted site. As special environmental features, the designer included a solar-responsive south elevation overlooking a small bay on Puget Sound. The structure was built out of non-toxic materials, including solid pine and cedar shingles. Cutler feels very strongly that all buildings must fully protect and respect nature, which this building achieves. He was strict on only disturbing the minimum amount of site possible around the area of the house, so that the outdoors is always showcased as the focus. This focus creates a feeling of the indoors and outdoors combining in harmony.

James Cutler "*prides himself more as a dedicated proponent of making a social change with architecture as it fits into the environment.*"[5] This example clearly displays his philosophy of nature coming first when building on a site. Cutler views the typical architect as a destroyer, where construction and design both work within a process of destroying a natural site and building something foreign to the environment that wouldn't be there otherwise.

In relation to my thesis topic, the following are key potential advantages of the Bridge House design:
- The strong belief in nature fist and architecture second, disturbing the absolute minimum amount of site.
- The focus on non-toxic materials.
- The amount of study on site and materiality for the typology. Truly understand your

site before placing buildings where you feel at will.
- The combination of indoors to outdoors in harmony.

In relation to my thesis topic, the following are key potential disadvantages of the Bridge House design:
- The high cost of this construction could prove too much.

THE ARK[6]

Prince Edward Island, Canada

Figure L — A graphic of the Ark.

Designed and constructed by Solsearch Architects in 1976, this bioshelter was created for the colder and far northern climates. Bioshelters are solar greenhouses, which include fishponds, food crops, soil life and insect communities. Ponds of water within the structure passively heat and cool the indoor environment while fostering edible fish to grow. Predatory insects and pest insects are kept from living among the plants, which keeps the number of pests within the structure low.

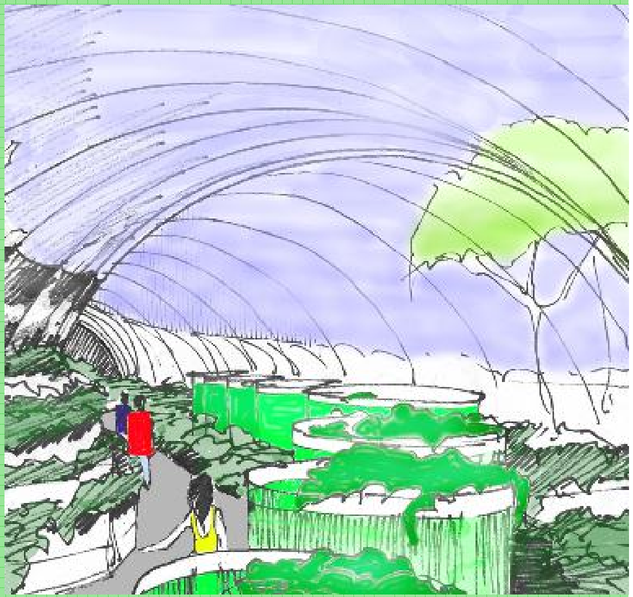

Figure M — A graphic concept sketch of the Ark Bioshelter.

The New Alchemists published the plans for their many designed bioshelter projects, complete with detailed design calculations and blueprints. The Ark, one of these projects, uses multiple systems of solar storage – passive fish ponds, active hot water panels and hot water tanks, active hot air transfer to a rock matrix, and a back-up wood stove. The Ark uses wind based water pumping for electricity production, and was self-contained in food production. It has living quarters for people, fish tanks raising tilapia for protein, a greenhouse watered with fish water, and a closed loop sewage reclamation system that recycled human waste into sanitized fertilizer for the fish tanks[7].

In relation to my thesis topic, the following are key potential advantages of the Ark design:

- The use of passive water strategies to heat and cool the interior.
- The self-containment of food production.
- The recycling of human waste into sanitized fertilizer.
- The fact that the design is for colder Canadian climates, which is suited for my site.

In relation to my thesis topic, the following are key potential disadvantages of the Ark design:

- The inclusion of insect communities might turn off some clients.
- This typology might not fit with my project, but the passive ideas are great to utilize in some regards.

EARTHSHIP[8]
Ridgeway, Colorado, USA


Figure N — A graphic of the Earthship.


Figure O — A graphic of the Earthship.


Figure P — A graphic of the Earthship.


Figure Q — A graphic of the Earthship.

The Earthship in Ridgeway, CO is a self-sustainable and off-the-grid project. There are no electric lines, water mains, or sewer lines. There are no furnaces, air conditioners, or dehumidifiers. The concept of this project is to operate in harmony with the earth. This home is cool in the summer and warm in the winter, while successfully seizing water from the sky.

All electricity comes from photovoltaic solar panels, wind, and geothermal methods. All electricity is stored in deep cycle batteries. The exterior walls are constructed of adobe (mud, water, and straw, as earth has an estimated r-value of 1 per foot), while the interior walls are a honeycomb pattern of recycled cans separated by plaster. The roof is heavily insulated.

Construction of this earthship was rather straightforward and economical (approximately $50.00/sq.ft in 1991). The owners pounded rammed earth into used steel belted radial tires, which were obtained for free from local landfills. Multiple tires stuffed with rammed earth were piled upward, creating a foundation. No furnace was needed because the rammed earth tires act as a thermal mass in the winter, absorbing heat from the sun during the day and re-radiating it into the home at night.

The Earthship was constructed with battered walls and glass cladding oriented in the direction of the southern sky perpendicular to the angle of the winter sun. This simple concept permits light to penetrate at a low angle in the wintertime and prevents light from penetrating at a high angle in the summertime, which means no solar gain in the summertime. The Earthship is cooled in the summertime by operable ceiling vents permitting flow-through ventilation.

The Earthship, having no doors or windows on the northern face, is fronted with earth, shielding it from heat loss to the north. The Earthship also reuses water 4 times throughout the design, as all water is collected off the roof from rain or snowmelt, then filtered, and then kept in cisterns. The first usage is the rain/melted snow, which is clean enough to be used for cooking, cleaning, bathing, and drinking since it has been filtered. After washing clothes, brushing teeth, etc., sinks and bathtubs drain the gray water into planters that grow indoor food and flowers. The gray water moves through the planters and gets recycled by a pump into the toilets. Finally the toilet water is used and sent out to a solar septic tank. This device will distill out the water from the waste, recapture it, and move it to an outside planter to water the non-edible landscape.

In relation to my thesis topic, the following are key potential advantages of an Earthship design[9]:
· Having an earth-bermed home with windows facing south is a good idea in any northern hemisphere climate needing heating.
· Collecting rainwater that falls on the roof reduces the runoff effect of the building and may reduce water and even sewer service.
· Having a combination of photovoltaic cells and wind generation is a sensible way to provide electricity in many conditions.
· Using curved units as horizontal arches to withstand earth loads is a sound structural design idea.
· On site processing of rainwater, grey water and black water using plant beds may lessen the environmental impact of the building on the site.
· Rubber tires make a wind resilient wall.
· Used rubber tires are usually free and it may be possible to be paid to take them from a landfill.

In relation to my thesis topic, the following are key potential disadvantages of an Earthship design[10]:
· The sloped glazing may be difficult to keep water tight and may permit unwarranted solar gain in the summertime. Newer design ideas call for vertical windows in combination with an overhang.

· Rubber tires, in the amount required, would have to be hauled in to the proposed site. This would be a large waste of energy and resources, as the local landfills do not have this many tires available, as opposed to plentiful natural trees that could be harvested for the structures, with the appropriate permit which can be obtained in this region.

· Uninsulated ground coupled thermal mass may offer a large possibility for heat loss, especially in colder climates like northern Saskatchewan. This will vary, to a degree, with soil type and moisture content.

· Rubber tire walls tend to lack structural stiffness and may require perpendicular stiffening members.

· Ground contact of this style could increase the potential hazard due to Radon and other soil gasses.

· Packing or ramming dirt into the inside of a tire could appear to be a very labor-intensive process.

FOOTNOTES

1. All information on Angler Rapids Wilderness Lodge was provided by e-mail correspondence with the owner, Mac Haskins, on March 20, 24 and the Angler Rapids Wilderness Lodge website accessed on March 19, 2006: <*http://www.anglerrapids.com/index.shtml*>

2. All information on Hatchet Lake Lodge was provided by e-mail correspondence with the owner, George Fleming, on March 20, 21 and the Hatchet Lake Lodge website accessed on March 18, 2006: <*http://www.hatchetlake.com*>

3. All information on Milton Lake Lodge was provided by e-mail correspondence with the owner, Ted Cawkwell, on March 21, 22, 23 and the Milton Lake Lodge website accessed on March 19, 2006: <*http://www.miltonlakelodge.com/index.html*>

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Figure B — *http://www.anglerrapids.com/gallery/index.shtml*

Figure C — *http://www.anglerrapids.com/gallery/index.shtml*

Figure D — *http://www.hatchetlake.com*

Figure E — *http://www.hatchetlake.com*

Figure F — *http://www.hatchetlake.com*

Figure G — *http://www.miltonlakelodge.com/index.html*

Figure H — *http://www.miltonlakelodge.com/index.html*

Figure I — *http://www.miltonlakelodge.com/index.html*

Figure J — *http://www.architetturastudiobernardini.com/images/bridge1.jpg*

Figure K — *http://www.architetturastudiobernardini.com/images/bridge2.jpg*

Figure L — *http://www.vsb.cape.com/~nature/greencenter/newalchemy.html*

Figure M — *http://www.vsb.cape.com/~nature/greencenter/newalchemy.html*

Figure N — *http://homepages.moeller.org/dshannon/Earthship/Earthship%20Overview.htm*

Figure O — *http://homepages.moeller.org/dshannon/Earthship/Earthship%20Overview.htm*

Figure P — *http://homepages.moeller.org/dshannon/Earthship/Earthship%20Overview.htm*

Figure Q — *http://homepages.moeller.org/dshannon/Earthship/Earthship%20Overview.htm*

Figure A — A graphic of Camp Grayling's location.

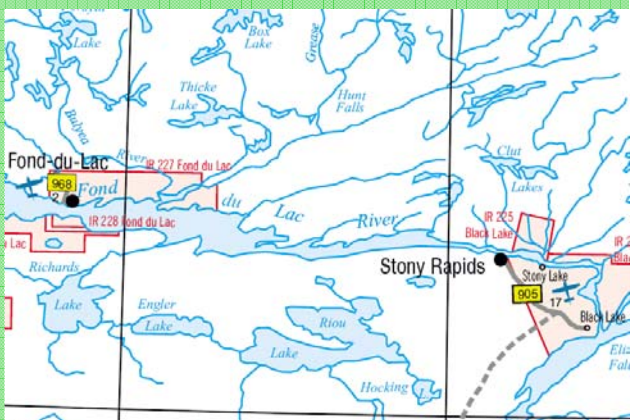

Figure B — A graphic of Camp Grayling's location.

Figure C — A graphic of Camp Grayling's location.

SITE ANALYSIS

The site for Camp Grayling is located within 8 kilometers of the community of Black Lake, Saskatchewan, and within 20 kilometers of the community of Stony Rapids, Saskatchewan, Canada, which are remote fly-in communities. The northern region of Saskatchewan lies on the Canadian Shield geologic formation, which stretches across much of Canada. The site of Camp Grayling is situated 500 miles north of Saskatoon and 60 miles south of the Northwest Territories[1].

SITE INFORMATION	
Latitude	59° 15' N
Longitude	105° 49' W
Elevation	245.40 m

Figure D — A graphic of Site Information.

The site straddles a unique area. To the north is the rugged Pre-Cambrian Shield; while to the south is the Athabasca Sandstone[2]. There are existing phone lines and electricity lines already available to my proposed site. The community of Black Lake is nestled on the shores of the lake from whence it borrows the same name. Black Lake is a beautiful source of freshwater where excellent fish and game resources abound, making it the perfect site to design this thesis project.

The whole province of Saskatchewan enjoys a hot, dry summer. The province's average annual hours of sunshine range from 2,000 to 2,500, which is the most of any province in Canada[3]. In Black Lake, the normal daily temperature ranges from –23.5° C (-10.3° F) in January to 15.5°C (59.9°F) in July[4]. Over the past 40 years, the recorded high temperature in Black Lake was 35.1°C (95.2°F), set in July 1989; the record low, -55.1°C (-67.2°F), was set in January 1994[5]. More specific information is provided on the climate data tables[6] starting on page 46.

Figure E — A graphic of Camp Grayling's location.

Figure F — A graphic of Camp Grayling's location.

Figure G — A graphic of Camp Grayling's North-East shore.

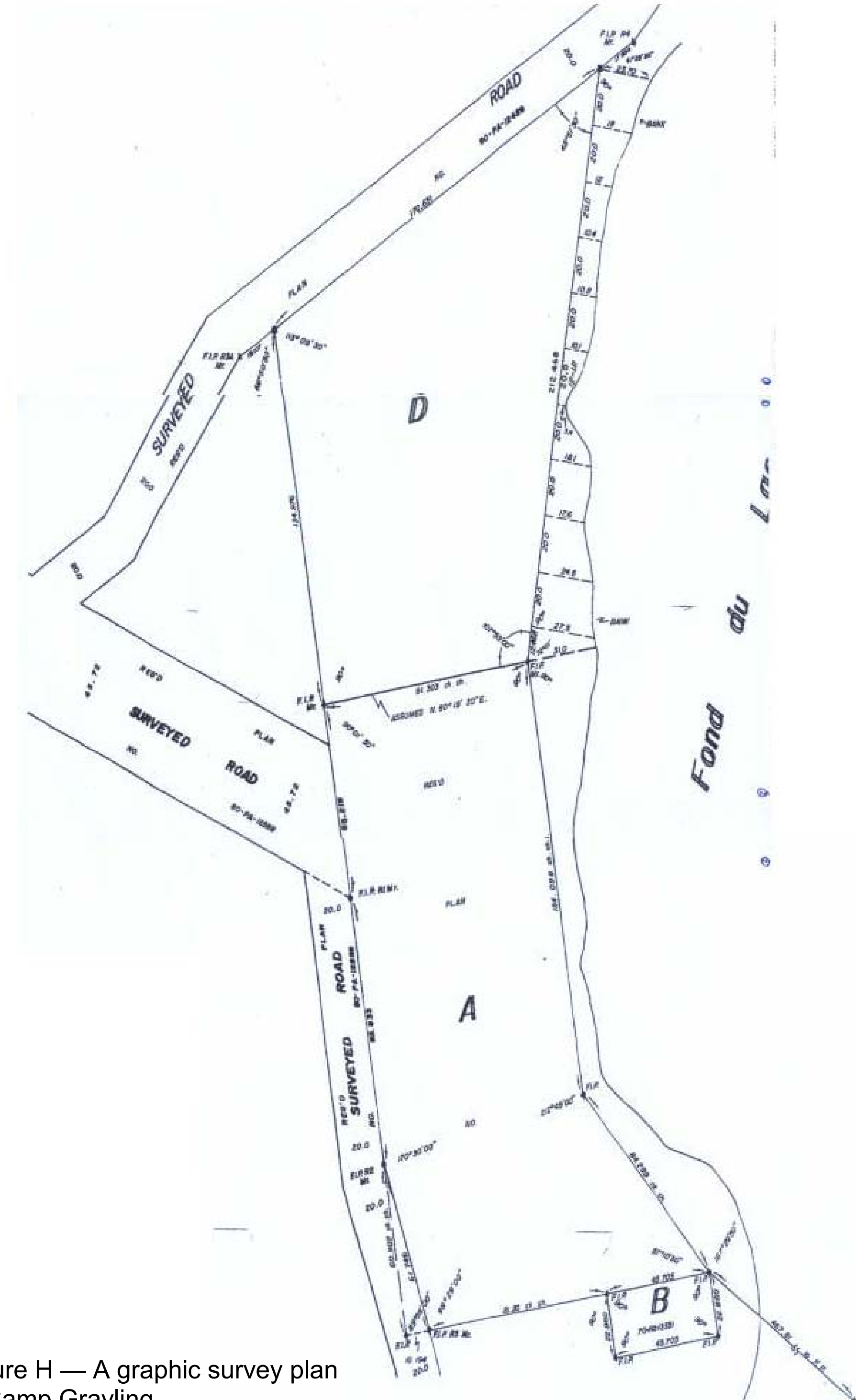

Figure H — A graphic survey plan of Camp Grayling.

Figure I — Camp Grayling looking north.

Figure J — Camp Grayling looking west.

Figure K — Camp Grayling looking southwest.

Figure L — Camp Grayling looking northeast.

Figure M — Camp Grayling's float plane dock.

Figure N — Camp Grayling's float plane dock.

Figure O — Camp Grayling's float plane dock.

Figure P — Camp Grayling's float plane dock.

Figure Q — Camp Grayling's float plane dock.


Figure R — Camp Grayling's existing lodge.


Figure S — Camp Grayling's northeast shore.


Figure T — Camp Grayling's northeast shore.


Figure U — Camp Grayling's existing entrance.


Figure V — Camp Grayling's existing entrance.


Figure W — Camp Grayling's existing entrance.


Figure X — Camp Grayling's existing lodge, south.


Figure Y — Camp Grayling south end of site.


Figure Z — Camp Grayling south end of site.


Figure AA — A Camp Grayling existing typical cabin.


Figure BB — Camp Grayling existing building.


Figure CC — Camp Grayling looking northwest.


Figure DD — Camp Grayling existing cabin.


Figure EE — Camp Grayling looking east.


Figure FF — Camp Grayling facing northeast.


Figure GG — Camp Grayling existing cabin.


Figure HH — Camp Grayling facing south.


Figure II — Camp Grayling facing north.

Figure JJ — A view from the existing lodge.

Figure KK — View from dock, facing west.

Figure LL — In front of existing lodge, facing south east.

Figure MM — Camp Grayling facing east.

Figure NN — Camp Grayling facing south.

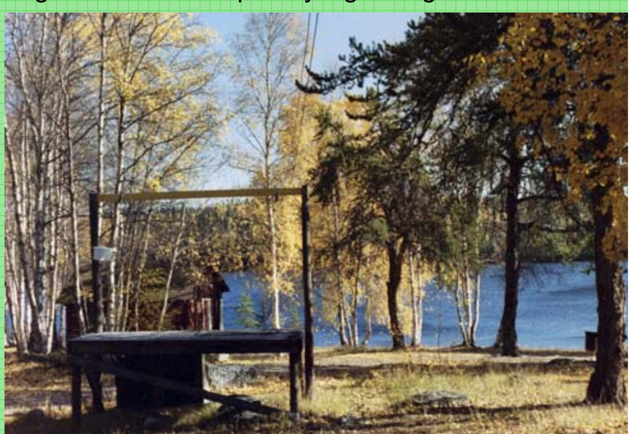

Figure OO — Existing boat fuel station, facing east.


Figure PP — Winter shot looking east.


Figure QQ — Winter shot looking west.


Figure RR — Winter shot looking southeast.


Figure SS — Winter shot looking north.


Figure TT — Winter shot looking east.

Camp Grayling Site Analysis Information												
MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Average Monthly Temperature (°C)	-23.5	-19.3	-20.3	-6.0	1.3	13.7	15.5	13.1	7.4	-3.8	-12.4	-15.2
Average Monthly High Temperature (°C)	-1.6	1.1	3.0	16.0	30.4	28.4	29.3	26.9	22.7	15.4	5.1	-4.6
Average Monthly Low Temperature (°C)	-49.0	-44.0	-35.6	-11.9	-16.1	-1.1	2.4	1.4	-4.6	-8.6	-29.5	-31.2
Average Monthly Precipitation (cm)	0.2	2.2	1.6	1.9	3.9	4.3	15.5	3.3	3.8	2.1	3.2	1.1
Average Monthly Wind Speed (km/hr)	15.0	15.7	16.4	16.7	15.3	15.5	17.5	18.9	17.5	16.3	14.4	14.2
Average Monthly Wind Direction	E	E	E	E	SE	E	E	E	E	E	E	E
Average Monthly Total Rain (mm)	0	0.2	0.2	5.5	30.4	63.4	101.7	72.9	53.9	13.3	1.5	0.1
Average Monthly Total Snowfall (cm)	32.6	25.2	35.6	33.8	15.7	5.8	0	0.8	9.6	40.9	45	33.9
Average Monthly Precipitation (mm)	23.9	17.4	25.8	31.6	42.3	68.7	101.7	73.7	63	46.3	33.2	24.2
Average Monthly Snow Depth (cm)	45	52	53	40	6	0	0	0	1	5	19	33
Average Median Snow Depth (cm)	44	53	53	41	4	0	0	0	0	3	19	33
Average Snow Depth at Month-end (cm)	50	52	54	20	0	0	0	0	2	10	25	38
Extreme Daily Rainfall (mm)	0	0.8	1	14.9	39.4	37	44.8	54.1	29.6	12.8	10.2	0.8
Date (yy/dd)	73/01	76/09	90/29	84/09	84/17	81/26	80/23	76/26	86/03	79/15	83/04	87/07
Extreme Daily Snowfall (cm)	18.8	12.5	31.1	36.4	28.8	34	0	6.9	27.9	57.4	24.2	23.4
Date (yy/dd)	90/20	84/10	85/21	85/20	86/15	82/06	73/01	76/27	72/20	76/03	84/14	88/19
Extreme Daily Precipitation (mm)	14	9.4	12.3	28.8	39.4	37	44.8	54.1	37.4	54.9	22.4	14.8
Date (yy/dd)	84/02	84/10	85/21	85/20	84/17	81/26	80/23	76/26	85/05	76/03	84/14	88/19
Extreme Snow Depth (cm)	84	90	88	97	88	22	0	0	46	76	66	66
Date (yy/dd)	84/30	83/19	83/16	89/24	89/01	82/07	73/01	73/01	72/23	76/05	88/15	89/03
Extreme Wind Chill	-60.5	-57.5	-49.8	-40.9	-24.1	-10.2	-2.7	-7.4	-13.5	-33.3	-47.7	-57.9
Date (yy/dd)	89/31	85/02	74/22	79/02	79/02	83/02	78/06	82/25	83/29	84/31	76/26	84/23
Average Relative Humidity (%)	77.8	80.1	81	80.7	80.2	80	82.1	85.8	88.5	89.5	85.8	79.3

Figure UU — A graphic table of Camp Grayling's Climate Normals.

The communities in this area live and thrive following a traditional way of life that has ancient historic roots. These communities do not have an industrial base, so the people have sustained their equilibrium and relative prosperity by following a traditional lifestyle of fishing, hunting, and trapping. Archeologists have proven that the natives have lived and thrived here in harmony with nature for over six thousand years, which was before the time that the ancient pyramids of Egypt were built[7]. The people in Black Lake and Stony Rapids live with a deep respect for all that nature supplies in the way of resources and for the lifestyle restrictions caused by a severe climate with prominent seasonal variations.

While the site of Camp Grayling is ideal for an autonomous design and while the local people clearly understand the importance of respecting the environment, it's disappointing to discover that Saskatchewan's annual carbon dioxide emissions are the second highest in Canada, considering that Saskatchewan only has the 6th largest population of any province in Canada[8]. Saskatchewan only has 3.4 percent of the national population, which is easily the lowest population density among the four western provinces[9]. Setting a responsible and sustainable example in Saskatchewan is vital if we are to extend the lifespan of our natural resources for generations to come.

The project site is situated at Black Lake, Parcels A & B, Plan 70PA13351. Adjacent site Parcel D, Plan 80PA18158 is part of the base camp on Commercial Land Lease Property No. 300056(R) referred to as westerly bank of the Fond Du Lac River (Black Lake)[10]. There is an access road that enters the site from the west direction. This road can access a person to Black Lake, Stony Rapids, or the local landfill for disposal. The adjacent areas are all heavily dense wooded landscape with no civilization within 8 kilometers of this site. Only one road accesses the site, but you can access it either by boat or by floatplane.

FOOTNOTES

1. Tourism Saskatchewan. (2006). The Province of Saskatchewan. Retrieved March 01, 2006, from the Tourism Saskatchewan website: <*http://cms.westport.k12.ct.us/cmslmc/foreignlanguages/canada/saskat.htm*>

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3. Tourism Saskatchewan. (2006). The Province of Saskatchewan. Retrieved March 01, 2006, from the Tourism Saskatchewan website: <*http://cms.westport.k12.ct.us/cmslmc/foreignlanguages/canada/saskat.htm*>

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9. Tourism Saskatchewan. (2006). The Province of Saskatchewan. Retrieved March 01, 2006, from the Tourism Saskatchewan website: <*http://cms.westport.k12.ct.us/cmslmc/foreignlanguages/canada/saskat.htm*>

10. Camp Grayling land location information provided by Allen Frederickson on March 15, 2006.

FIGURES CITED

Figure A — *http://www.campgrayling.ca/*

Figure B — *http://www.mapquest.ca/campgrayling/saskatchewan*

Figure C — Google Earth image.

Figure D — My original table.

Figure E — *http://www.mapquest.ca/campgrayling/saskatchewan*

Figure F — Google Earth image.

Figure G — *http://www.campgrayling.ca/*

Figure H — Survey Plan supplied by Allen Frederickson.

Figure I through Figure TT — *http://www.campgrayling.ca/*

Figure UU — *http://www.climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html*

PROGRAM

Camp Grayling is an existing fishing/hunting lodge in such severe disrepair that I propose to redesign with an emphasis on self-sustaining techniques in this thesis project. I will base this new site planning design to include sixteen separate cabins for the hunters and staff, two separate maintenance sheds, one separate aviation fuel shed, one separate caretaker/laundry cabin, and one separate main lodge which holds the lounge, kitchen, supply rooms, an office, and management housing. Camp Grayling is located on Black Lake, Saskatchewan, and has been in operation since 1956[1]. This is the only camp on this lake, and is situated on titled land. It has a licensed capacity of 88 guests[2]; even though this design is being limited to 58 people total, so future expansion will be planned in the camp layout. The camp also has outposts on Riou Lake (twelve guests), Selwyn Lake (twelve guests), and Dodge Lake (six guests). In addition, Camp Grayling has a total of twenty-six different lakes on its lease, ten of which have boats with motors[3]. These lakes are used for “day” fly out fishing. The main camp and lodge consists of ten cabins, all with full washrooms that include showers, and a central restaurant and lodge.

Camp Grayling serves the U.S. tourist market, as the guests stay under the American Plan, which is an inclusive vacation. The guest is charged a daily fee, which includes accommodation, meals, ground transportation to and from the airport, use of boat and motor, and guide. Fly outs will be available for either the day or overnight for an additional fee. The camp employs fourteen to twenty local Dene Indians as guides, in addition to four people for kitchen help and house keeping. The camp offers licensed fishing in the species of Lake Trout, Northern Pike, Walleye, Arctic Grayling, and Whitefish. The camp offers licensed big game outfitting in the species of bear, deer, caribou, and moose.

Camp Grayling is a business that should be making over a million dollars a year in net revenue, but neglect over the past twenty years has created an environment unsuitable for a twelve day stay at the cost of $5,000.00 us funds. A new persona, a new identity, and a new camp layout based on self-sustainable techniques would not only improve the business model, but also become part of the energy crisis solution, not the problem.

<ins>Hunter/Employee Cabins</ins>:

The cabins will be basically a place to store your belongings and sleep, as the vast majority of your time will be spent fishing, hunting, or discussing these very topics with the other clients. These cabins will contain four bedrooms, a living room, and a bathroom. The bedroom will contain a double size bed, dresser, closet, nightstand, and desk lamp.

1 living room in cabin @ 20.90 m^2
1 bathroom in cabin @ 7.43 m^2
4 bedrooms in cabin @ 37.16 m^2
1 complete cabin @ 65.49 m^2

16 total cabins @ 1047.84 m^2

<ins>Maintenance Sheds</ins>:

The maintenance sheds will be for storage of tools, extra boat motors, and camp maintenance equipment. One shed will have large bay doors at both ends for vehicles to drive through for service. Both sheds will contain benches the full length of the long sides (14.4 meters) with doors at the shorter ends (8.4 meters). Racks on the walls will offer hanging opportunities for tools to keep items in an organized manner.

2 maintenance sheds @ 124.86 m^2

Total = 249.72 m^2

Aviation Fuel Shed:

The aviation fuel shed will be the storage facility for the aviation fuel, which means it has to be specially designed for containment of potential spills an have appropriate areas for aviation fuel tanks. This is an open plan shed design.

1 aviation fuel shed @ 62.43 m^2

Total = 62.43 m^2

1 caretaker/laundry cabin:

The caretaker/laundry cabin will contain the 2 laundry machines for daily linen cleaning, a small kitchenette for the caretaker, a storage room, a bathroom, a bedroom, and linen storage.

1 laundry space @ 9.29 m^2
1 kitchenette @ 5.57 m^2
1 storage room @ 9.29 m^2
1 bathroom @ 7.43 m^2
1 bedroom @ 9.29 m^2
1 linen storage @ 4.65 m^2

Total = 45.52 m^2

1 main lodge:

The main lodge will contain a lounge/eating area for the clients, a complete kitchen, two supply/storage rooms, an office for management, and housing upstairs for management. The lounge/eating area will contain enough non-fixed table space for 58 people and have a side space of comfortable seating and end tables around a fireplace for twenty people. There will be a fully stocked bar accessible to both of these areas, in addition to a commercial-style kitchen also accessible to these seating areas. The office will have two desks for management to use, accessible to the lounge areas through a private doorway. The upstairs will be open to below by a guardrail, with bedrooms available for management and potential overflow clients.

1 lounge/eating area @ 111.48 m^2
1 bar @ 7.43 m^2
1 commercial-style kitchen @ 32.52 m^2
1 office @ 18.58 m^2
2 storage areas @ 41.81 m^2
8 bedrooms @ 148.64 m^2
4 bathrooms @ 37.16 m^2

Total = 397.62 m^2

FOOTNOTES

1. Information on Camp Grayling operations provided by Allen Frederickson on March 15, 2006.

2. Information on Camp Grayling land location information provided by Allen Frederickson on March 15, 2006.

3. Information on Camp Grayling land location information provided by Allen Frederickson on March 15, 2006.

Camp Grayling Building Code Analysis – National Building Code of Canada (NBC)		
CODE REQUIREMENTS		**CODE REF #**
1. Classification of Buildings		
1.1	Classification – Lodging Houses – Group C – Residential Occupancies	3.1.2.1(1)
	Classification – Repair Garage/Aircraft Hangar – Group F, Div.2 – Medium Hazard Industrial Occupancies	3.1.2.1(1)
1.2	Classification of Multiple Major Occupancies – The Lodge has a Restaurant – Group A, Div.2 – Assembly Multiple Major Occupancy.	9.10.2.4(1)
2. Building Size		
2.1	Building Area Lodge = 397.62 sq.m.	
	Building Area Cabins (typical cabin, 16 units) = 65.49 sq.m. x 16 units = 1047.84 sq.m. total	
	Building Area Maintenance Shed = 249.72 sq.m.	
	Building Area Aviation Fuel Shed = 62.43 sq.m.	
	Building Area Caretaker/Laundry Cabin = 45.52 sq.m.	
2.2	Building Height Lodge = two storeys (no basement)	
	Building Height Cabins (typical cabin, 16 units) = one storey (no basement)	
	Building Height Maintenance Shed = one storey (no basement)	
	Building Height Aviation Fuel Shed = one storey (no basement)	
	Building Height Caretaker/Laundry Cabin = one storey (no basement)	
3. Access Routes		
3.1	All windows located in these buildings will have a similar floor to sill height of 1000mm.	3.2.2.10
3.2	Unobstructed Path of Travel – Since the building is not provided with a fire department connection, the length of the unobstructed path of travel is 90 meters minimum.	3.2.5.5(2) 3.2.5.5(3)
3.3	Width must be 6 meters clear, unless it is proven that less will be satisfactory.	3.2.5.6(1)-a
	The centerline radius must be no less than 12 meters.	3.2.5.6(1)-b
	The overhead clearance will be no less than 5 meters.	3.2.5.6(1)-c
	The gradient change will be no more than 12.5 meters over a minimum of 5 meters.	3.2.5.6(1)-d
	Access routes will have turnaround facilities for any dead-end portion of the access route more than 90 meters long.	3.2.5.6(1)-f

CODE REQUIREMENTS		CODE REF #
4. Fire Resistance Rating & Fire Stopping		
4.1	Fire Separation between Occupancies - Multiple Major Occupancies – Group C & Group A2 in Lodge	3.1.2.1(1)
	Building Restrictions – The NBC states that multiple major occupancies can either be separated with a Fire Separation (which in effect creates 2 separate buildings) OR you use the most restrictive of the two options throughout. They are identical in restrictions, except the Group A2 has a 45 minute Fire Resistance Rating on the roof, where as the Group C has no roof restriction. I don't want to construct a Fire Separation between the residential rooms and the Assembly areas, so I will use the Group A2 classification throughout the lodge. (combustible or noncombustible used singly or in combination)	3.2.2.25
	Building Restrictions – The Cabins will be constructed according to Group C (combustible or noncombustible used singly or in combination)	3.2.2.47
	Building Restrictions – The sheds will be constructed according to Group F2 (combustible or noncombustible used singly or in combination)	3.2.2.71
4.2	Fire Separation of Floor Assemblies – Lodge – Floors shall be fire separations and if of combustible construction, will require a 45 minute Fire Resistance Rating. Mezzanines will require a FRR not less than 45 minutes if constructed of combustible construction.	3.2.2.25.2ab
	Fire Separation of Floor Assemblies – Cabins - Floors shall be fire separations and if of combustible construction, will require a 45 minute Fire Resistance Rating. Mezzanines will require a FRR not less than 45 minutes if constructed of combustible construction.	3.2.2.47.2ab
	Fire Separation of Floor Assemblies – Sheds - Floors shall be fire separations and if of combustible construction, will require a 45 minute Fire Resistance Rating.	3.2.2.71a
4.3	Fire Separation of Roof Assemblies – Lodge – Roofs shall have a 45 minute Fire Resistance Rating if constructed of combustible construction. If Fire-retardant treated wood is used, then the FRR is permitted to be waived.	3.2.2.25.2c
	Fire Separation of Roof Assemblies – Cabins – No restrictions on roofs for his assembly.	3.2.2.47
	Fire Separation of Roof Assemblies – Sheds - No restrictions on roofs for his assembly.	3.2.2.71
4.4	Fire Separation of Structural Members – Lodge – Loadbearing walls, columns, and arches supporting an assembly required to have a FRR rating will also have a FRR rating of not less than 45 minutes or be constructed of noncombustible construction.	3.2.2.25.2d
	Fire Separation of Structural Members – Cabins - Loadbearing walls, columns, and arches supporting an assembly required to have a FRR rating will at least match that FRR rating or be constructed of noncombustible construction.	3.2.2.47.2c
	Fire Separation of Structural Members – Sheds - Loadbearing walls, columns, and arches supporting an assembly required to have a FRR rating will also have a FRR rating of not less than 45 minutes or be constructed of noncombustible construction.	3.2.2.71.2b

CODE REQUIREMENTS		CODE REF #
5. Occupant Load		
5.1	Determine the Occupant Load for each space in the building Lodge – Group A2 Occupancy Total Net Area = 248.98 sq.m. Use of Floor Area = Space with non-fixed seating (0.75 sq.m./person) 248.98/0.75 = **331 people**	3.1.16.1
	Lodge – Group C Occupancy Total Net Area = 148.64 sq.m. Use of Floor Area = Dwelling Units (4.60 sq.m./person) 148.64/4.60 = **32 people**	3.1.16.1
	Typical Cabin – Group C Occupancy Total Net Area = 65.49 sq.m. Use of Floor Area = Dwelling Units (4.60 sq.m./person) 65.49/4.60 = **14 people**	3.1.16.1
	Aviation Shed – Group F2 Occupancy Total Net Area = 62.43 sq.m. Use of Floor Area = Storage space warehouse (28.00 sq.m./person) 62.43/28.00 = **2 people**	3.1.16.1
	Maintenance Shed – Group F2 Occupancy Total Net Area = 124.86 sq.m. Use of Floor Area = Storage garage (46.00 sq.m./person) 124.86/46.00 = **2 people**	3.1.16.1
	Caretaker/Laundry Cabin – Group C Occupancy Total Net Area = 45.52 sq.m. Use of Floor Area = Dwelling Units (4.60 sq.m./person) 45.52/4.60 = **9 people**	3.1.16.1

CODE REQUIREMENTS		CODE REF #
6. Means of Egress		
6.1	Means of Egress Corridor Width – The minimum public corridor width shall be 1,100mm. Doors Opening onto a Corridor – If the occupant load exceeds 60 people, then the doors must swing in the direction of travel to the exit. Egress Doorway & Travel Distance Required – will be calculated after the form design takes shape.	3.3.1.5 3.3.1.9 3.3.1.10
6.2	Exit Requirements Travel Distances & Distances Between Exits – 45 meters in a floor area that contains an occupancy other than a high hazard industrial occupancy, provided it is sprinklered throughout. Width & Height of Exits – The required width for exits shall not be less than 1,100mm for the corridors and passageways, 900mm for stairways, and 790mm for doors. Exit Capacity Based on Occupant Load & Exit Capacity Calculations - will be calculated after the form design takes shape, since it is dependent upon the Egress Doorway & Travel Distance Requirement calculations. Exit Stairway Widths & Number of Exit Stairs Required - will be calculated after the form design takes shape, since it is dependent upon the Egress Doorway & Travel Distance Requirement calculations. Height of Exits – Exit doorways will have a height of 2050mm. Headroom Clearance – Each exit shall have a headroom clearance of 2,100mm minimum. - The headroom clearance for stairways measured vertically above any landing or the nosing of any stair tread shall be no less than 2,050mm. - The headroom clearance for doorways shall not be less than 2,030mm. - No doorway closer or other device shall reduce the headroom clearance to less than 1980mm. Exit Enclosure – All exits will have a 45-minute fire separation.	3.4.2.4 3.4.2.5 3.4.3.4 3.4.3.6
7. Washroom Requirements		
7.1	Occupant Load is split evenly between the sexes Lodge – the Lodge occupant load was calculated to be 363 people, but Camp Grayling isn't licensed to hold more than 88 clients. As such, I feel a solid argument could be made with the Building Code officials that using 363 people as the basis for calculations would not make any sense. Even though I am designing for 58 people, I will use the number of 88 in my calculations so future expansion would still accommodate the fully licensed capacity. 88 people/2 = 44 of each sex represented * one uni-sex washroom is required for barrier-free accessibility.	3.7.4.2(1)
	Typical Cabin – 14 people, 14/2 = 7 of each sex represented.	3.7.4.2(1)
	Aviation Shed – 2 people, 2/2 = 1 of each sex represented.	3.7.4.2(1)
	Maintenance Shed – 2 people, 2/2 = 1 of each sex represented.	3.7.4.2(1)
	Caretaker/Laundry Cabin – 9 people, 9/2 = 4.5, = 5 of each sex represented.	3.7.4.2(1)

CODE REQUIREMENTS		CODE REF #
7.2	Water Closets Required Lodge – 44 males = 1 water closet - 44 females = 2 water closets	3.7.4.2a
	Typical Cabin = 1 water closet per dwelling unit	3.7.4.2.9
	Aviation Shed – 1 males = 1 water closet - 1 females = 1 water closet	3.7.4.2a
	Maintenance Shed – 1 males = 1 water closet - 1 females = 1 water closet	3.7.4.2a
	Caretaker/Laundry Cabin – 1 water closet per dwelling unit	3.7.4.2.9
7.3	Lavatories Required - one lavatory is required for every 2 water closets located in a room. All washrooms must meet or exceed this requirement.	3.7.4.3(1)
7.4	Floor Drains Required All washrooms will be equipped with a floor drain in the event of a water closet overflowing.	3.7.4.7(1)
7.5	Barrier-Free Design of Washroom - one barrier-free washroom will be provided on the main floor for public use. - there shall be a 1500mm clear turning radius in the washroom to allow for maneuverability of a wheelchair. - grab bars will be inserted with proper backing for support. - allow proper clearance at doorways for the user to operate the door.	3.8.3.12
8. Barrier-Free Design		
8.1	Entrances - No less than 50% of pedestrian entrances of a building shall be barrier-free and shall lead to the outdoors at sidewalk level or to a ramp that is suitable to requirements as per the building code. - All exterior entrances will lead to the outdoors at sidewalk level. - Ramps may be incorporated into the design - The minimum number of barrier-free entrances required is one, since this is an A2 occupancy.	3.8 3.8.1.2
8.2	Barrier-Free Path of Travel - The unobstructed width for the passage of wheelchairs in a barrier-free path of travel is required to be 920mm	3.8.1.3
8.3	Occupancy Requirements - A barrier-free path of travel is required from the barrier-free entrances throughout the entrance storey and within all other normally occupied floor areas served by a passenger elevator or other platform equipped passenger-elevating device. - A barrier-free path of travel is not required for the following rooms: service spaces and janitor rooms	3.8.2.1(2)

CODE REQUIREMENTS		CODE REF #
8.4	Access to Parking Areas - Access to a barrier-free path of travel is provided from a barrier-free entrance to the exterior parking area.	3.8.2.2
8.5	Washrooms Required to be Barrier-Free - A barrier-free uni-sex washroom is required, located on the entrance storey by the other washrooms, with the male and female washrooms also equipped with barrier-free facilities.	3.8.2.3
8.6	<u>Design Standards</u> Accessibility Signs - In order to indicate the location of barrier-free entrances within the building, signs with the international symbol of accessibility will be installed. - Barrier-Free washrooms located on the first storey will be identified by this same sign.	3.8.3.1
	Exterior Walks - Exterior walks will be designed as barrier-free, which overrules Code requirements. - All exterior walks will be slip-resistant, continuous, and even surfaced. - All exterior walks will be a minimum of 1200mm wide, which exceeds the required minimum of 1100mm - All exterior walks will have a level area adjacent to a doorway no less than 1500mm x 1500mm. - All exterior walks more than 30 meters long will have a minimum width of 1500mm.	3.8.3.2
	Doorways & Doors - A minimum of 800mm for clear width in a barrier-free path of travel when the door is in he open position is required. - proper design of door operating devices will be incorporated, preventing the need for tight grasping and twisting of the wrist. - door thresholds will be less than 13mm higher than finished floor surface, and will be beveled to allow for the passage of wheelchairs. - Doors which provide a barrier-free path of travel at an entrance will be equipped with a power door operator. - Every door equipped with a closer in a barrier-free path of travel shall have a clear space of 600mm where the door swings towards the approach side, and 300mm where the door swings away from the approach side. - A vestibule at a barrier-free entrance will provide a distance between 2 doors in series of not less than 1200mm, plus the width of any door that swings into the space in the path of travel from one door to another. - Only the active leaf in a multiple leaf door in a barrier-free path of travel need conform to these requirements.	3.8.3.3
	Ramps - Ramps will have a minimum width of 870mm between handrails. - Ramps will have a slope not more than 1 in 12 - Ramps will have a level area no less than 1500mm x 1500mm at the top and bottom. - Ramps will have a level area no less than 1200mm long and at least the same width as the ramp at intervals no more than 9 meters along its length and where the ramp changes direction.	3.8.3.4

	CODE REQUIREMENTS	CODE REF #
	Spaces in Seating Area - Wheelchair designated spaces will be designed to be clear and level. - Wheelchair designated spaces will be designated to be 900mm wide and 1220mm long since wheelchairs will approach from the rear of the space. - Wheelchair designated spaces will be designed so that at least two designated spaces are side by side. - Wheelchair designated spaces will be designed so that they are located next to a barrier-free path of travel without infringing on egress.	3.8.3.6
	Water Closet Stalls - Water closet stalls required shall be 1500mm x 1500mm and be equipped with a door which is lockable from the inside, and provides a clear opening of 760mm wide with the door in the open position. - The door on the stall shall swing outward and have a door pull no less than 140mm long, located at the mid-point. - Clearance between the wall and the water closet shall be not less than 285mm and no more than 305mm. - Be equipped with grab bars which will be mounted horizontally on the side wall closest to the water closet - Grab bars should also be mounted on the wall behind the water closet, extending the full width of the toilet bowl since the water closet does not have a water tank wall mounted type. - Be mounted at a height between 840mm and 920mm above the floor, resisting a load of 1.3 kN (minimum), and be no less than 30mm and no more than 40mm in diameter, and be clear from the wall 35mm to 45mm. - Stalls should also be equipped with a coat hook mount no more than 1400mm above the floor, located on a side wall.	3.8.3.8
	Water Closets - The uni-sex & barrier free washroom's water closet shall be equipped with a seat located no less than 400mm and no more than 460mm above the floor. - The uni-sex & barrier free washroom's water closet shall be equipped with hand operating flushing controls that are easily accessible to a wheelchair user, or they are to be automatically operable. - The uni-sex & barrier free washroom's water closet shall be equipped with a seat lid or other back support, and not have a spring-actuated seat.	3.8.3.9

CODE REQUIREMENTS		CODE REF #
	Lavatories - The uni-sex & barrier free washroom's lavatories shall be located so that the distance between the centerline of the lavatory and the sidewall is not less than 460mm. - The uni-sex & barrier free washroom's lavatories shall have a rim height not more than 865mm above the floor. - The uni-sex & barrier free washroom's lavatories shall have a clearance beneath the lavatory not less than 760mm wide, with 735mm high at the front. - The uni-sex & barrier free washroom's lavatories shall have automatic faucets installed, meeting code requirements. - The uni-sex & barrier free washroom's lavatories shall have soap dispensers that will not be located more than 1200mm above the floor and be in an area that is accessible to persons in wheelchairs, meeting code requirements. - The uni-sex & barrier free washroom's lavatories shall have mirrors installed with the bottom edge not more than 1000mm above the floor level, meeting code requirements.	3.8.3.11
	Special Washrooms - The uni-sex & barrier-free washroom will have its door lockable from the inside, but releasable from the outside in the event of an emergency. - The uni-sex & barrier-free washroom will have the lock/handle located between 900mm and 1000mm above the floor, and it must be graspable. - The uni-sex & barrier-free washroom will have the door swing inward. - The uni-sex & barrier-free washroom will have no dimension less than 1700mm. - The uni-sex & barrier-free washroom will have a shelf located not more than 1200mm above the floor. - The uni-sex & barrier-free washroom will have a turning radius of 1500mm minimum clear.	3.8.3.12

FOOTNOTES

Code Review section referenced from:

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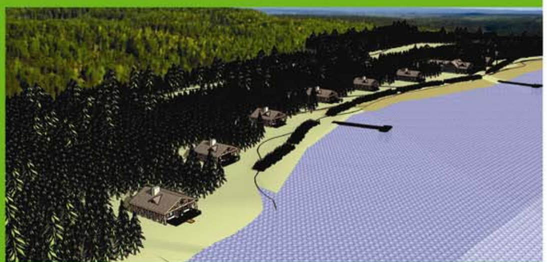
THE GOAL IS TO ALTER A PERSON'S MINDSET ABOUT THE ENVIRONMENT

UTILIZE A SYSTEM OF UNDERSTANDING THE SITE FEATURES AVAILABLE AND USE IN A SUSTAINABLE WAY

IMPLEMENT FEATURES SUSTAINABLY WITHIN THE ARCHITECTURAL DESIGN AND SITE LAYOUT

SHOWCASE THE SUCCESSFUL IMPLEMENTATION FOR THE PUBLIC TO APPRECIATE AND LEARN FROM

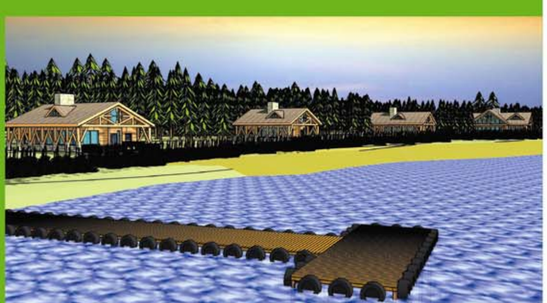
INFORMED PUBLIC CAN "PAY IT FORWARD" AND PASS ALONG THE EXPERIENCE TO OTHERS, CREATING A CYCLE OF INFORMATION



Overall Site Perspective over Fon Du Lac River from South East

Perspective of entry road to Eco-Lodge

Perspective of PV Cell Structure from South



Perspective from Fon Du Lac River

Perspective from East shore

What is this project about?

The Camp Grayling Eco-Lodge investigates how an architectural/ecological system can be utilized to alter a person's mindset. A person's mindset towards our natural resources can be influenced if you introduce alterations to their lifestyle. As visitors observe more efficient and less costly methods, they are more likely to implement them into their own lives.

The Camp Grayling Eco-Lodge operates in one of the most beautiful ecosystems in the world. This project is passionate about maintaining these magical places and taking great pride in creating enthusiasm within those who venture there.

The Camp Grayling Eco-Lodge's Vision for Sustainability:

- Be responsible stewards of the environments and communities in which we live, work, and play
- Strive to improve environmental performance in all operations
- Be a leader in sustainability in professional organizations and the broader tourism sector
- Educate staff, guests, and suppliers about our sustainability goals and initiatives, and encourage personal action
- Operate in a manner that is compliant with all government laws and regulations
- Support research and education programs to improve our sustainability practices
- Contribute to the economic and social well-being of our local communities
- Deliver strong financial results to ensure a sustainable future for our company

Project Justification

When it comes to designing our buildings we take for granted that our structures need mechanical heating and cooling systems. The entire earth is powered every day by solar energy, yet we fail to actively take advantage of this free source of power. We fail to think sustainably.

With changes in the way we design buildings, we can move towards buildings that generate more pollution-free power than used. The best approach to augmenting the impact of the human presence is through the utilization of combined technologies. This can be done by utilizing both conventional and progressive building techniques. This balanced marriage can still bridge the two worlds together without losing sight of detail and design.

Eco-Lodge Roadways

I discussed a deal with Eric Cline, the Saskatchewan Minister of Industry & Resources, to guarantee winter accomodations for the mine workers in exchange for donated road gravel. A potash mine 60 miles away supplies the nearby First Nations Reservation of Black Lake with gravel crushed on site from the top layer of mined rock. This rock is free of Radon dust and already being used to maintain existing roadways in the area.

Image of Organic Barley crop

Organic Barley Grown on Site

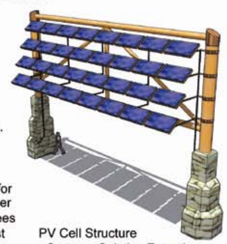
A portion of the site will be cleared for building the Eco-Lodge structures, so I am choosing to seed a renewable crop in Organic Barley here. The nearby First Nations Reservation of Black Lake contains an Organic Micro-Brewery. By dedicating 5.39 acres of the site to seeding Organic Barley we can help produce 1,260.6 gallons (or 13,638 bottles) of Organic Beer. The estimated amount needed for the Eco-Lodge guests is 12,600 bottles per season. Organic beer offers the benefits of not introducing a host of harmful substances into the environent (herbicides, insecticides, fungicides) and reduces the fossil fuel required to transport beer around the world. A European study also suggests that seeding barley reduces the loss of Carbon Dioxide from soil up to 70%. The plant roots uptake the carbon and incorporate it into the cell wall materials.

Electrical Production

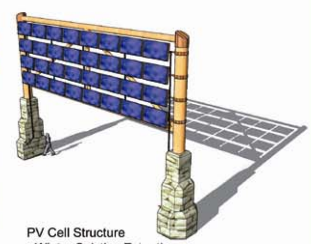
Two sources of generating emission-free electricity being utilized here are Solar Powered Photovoltaics and Wind Turbines. The calculated monthly electrical demand is 2,287 KWh.

PV Units:

The PV Units of choice are the JIL-3000, where a single 62.5"x32.5"x3.5" panel is rated at 240 Wattage. 61 of these panels will produce just under the entire monthly electrical demand, yet I have designed for 64 panels. The Panel structure manually tilts each month to a specific sun angle for maximum electrical generation. Summer Solstice is the highest point at 54 degrees and Winter Solstice would be the lowest point at 8 degrees. The PV units alone cover the monthly electrical demand.



PV Cell Structure
- Summer Solstice Extention



PV Cell Structure
- Winter Solstice Extention

Wind Turbine:

Using a 10 meter diameter rotor unit will bring a monthly electrical generation of 3,750 kWh (45 MWh/year). Designing for a low capacity factor of the turbines only operating 60% of the time will bring an adjusted monthly electrical generation of 2,250 KWh/month, just short of the monthly requirement by the turbines alone. Combined, these two sources of clean energy will produce double the monthly required electrical demand.

Wind Turbine Image

The site provides the following materials:
1.) half log exterior siding
2.) lumber
3.) roofing planks
4.) foundation and fireplace stones
5.) reclaimed oak boards from neighboring First Nations reservation

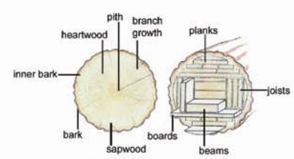
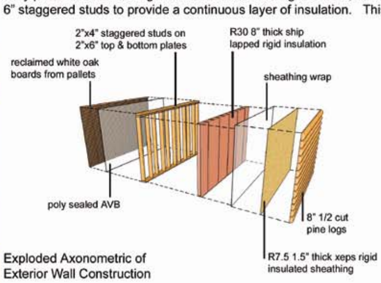


Diagram of lumber cuts from logs

Heating & Cooling

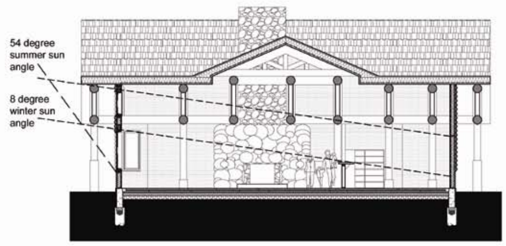
Only passive solar heating and radiant floor heating are used, no furnace is used. All of the exterior walls are constructed of 8" top and bottom plates with 6" staggered studs to provide a continuous layer of insulation. This avoids thermal breaks in the stud wall.



Exploded Axonometric of Exterior Wall Construction

In addition to passive solar heating, a backup heating system is required by code. Tubes of hot water to heat at your feet are quiet and do not dry out the air or stir up dust.

Radiant Floor System



Sun Angle Section

Summer Sun Angle Perspective

Winter Sun Angle Perspective

Eco-Lodge Design Cycles

Riverwater Cooling Cycle

Cooler & Denser riverwater at a constant 4 degrees celsius (39.2 F) settles to the bottom of the Fon Du Lac River

This cooler water is pumped through a screened intake up to the lodge

The water is run through a heat exchange system where heat energy is absorbed from the food and beverage cooler

Water exits the heat exchange system at 13 degrees celsius (55.4 F) and is diverted by gravity to either the 15,000 liter cistern or retaining pond south of lodge

Retaining pond water seeps through soil back into the water system to complete the cycle

Organic Barley Cycle

Cleared western portion of site seeded with organic barley and partially fertilized by composted humanure used as a resource instead of as waste. Organic barley is renewable and the vast amount of trees in this area make it a good choice

Environment Canada recommends a growing season precipitation average of 50.35mm per month, this site averages 67.5mm per month. Irrigation is not needed

Organic barley is harvested and transported to a micro-brewery in Stony Rapids, 20 km away. This micro-brewery has enough storage for production of up to 300 bushels of organic barley. Our average production will be around 134.8 bushels

The organic barley is processed into organic beer and transported 20km back to the Eco-Lodge in reusable kegs. The average production of 134.5 bushels will provide more organic beer than the anticipated demand

The organic barley is reseeded each spring to complete the cycle

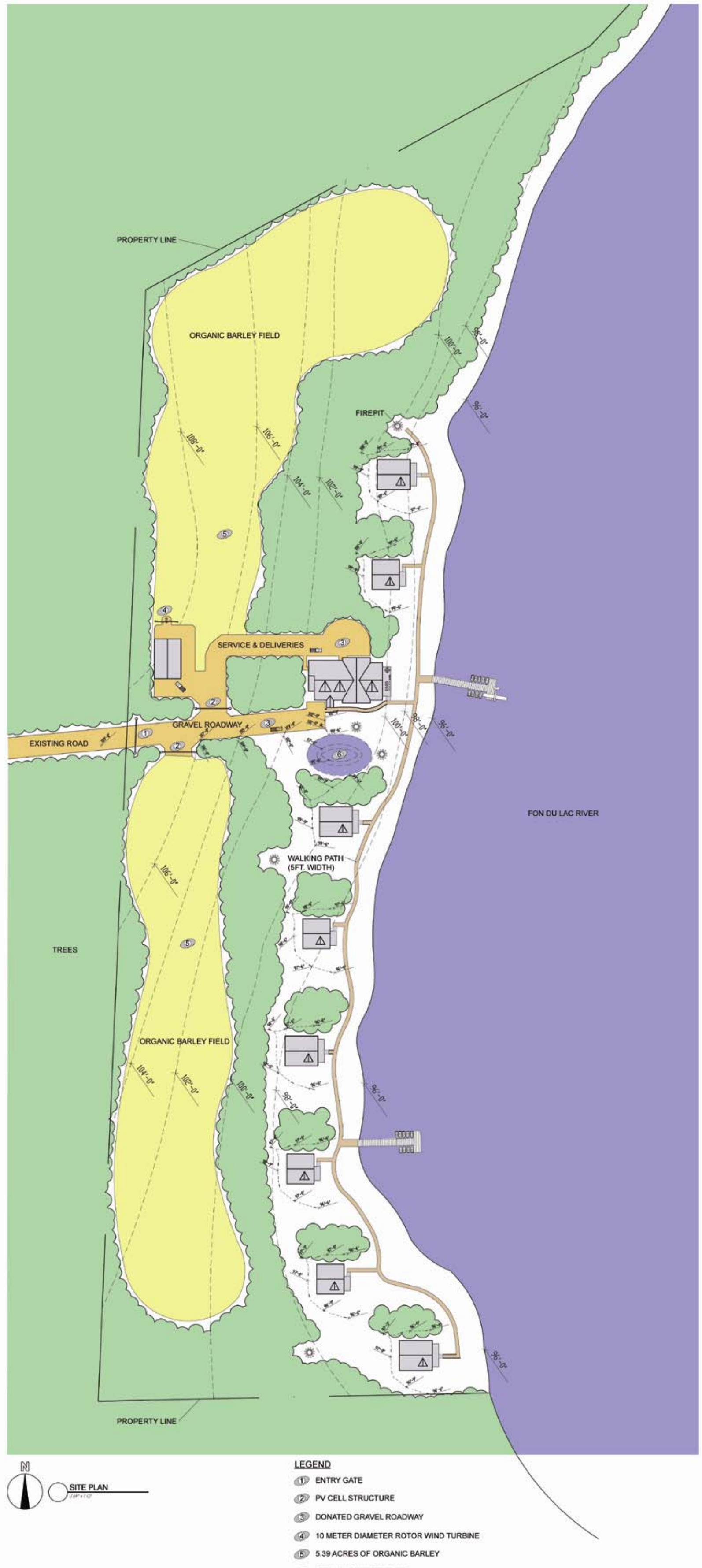
Green Electrical Production Cycle

Green electricity is generated by the PV Cells & Wind Turbine, producing double estimated required amount for use. The excess is net metered back to SaskEnergy

Producing this green electricity creates a cost savings to the Eco-Lodge operations when utility costs increase

Cost savings over the years get reinvested back into new and improved green energy technology. Old technology gets donated to organizations like "Habitat for Humanity" for a tax deduction. This improves the environmental advantages of the camp and creates a social-commuity advantage

New green energy technology bought from savings is installed at Eco-Lodge



PROJECT DOCUMENTATION

Lodge Perspective from Dock

Lodge Perspective of Fireplace

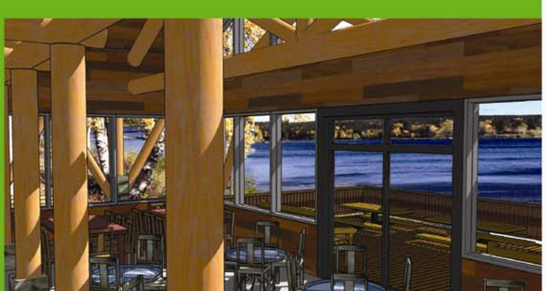
Lodge South Elevation

Lodge East Elevation

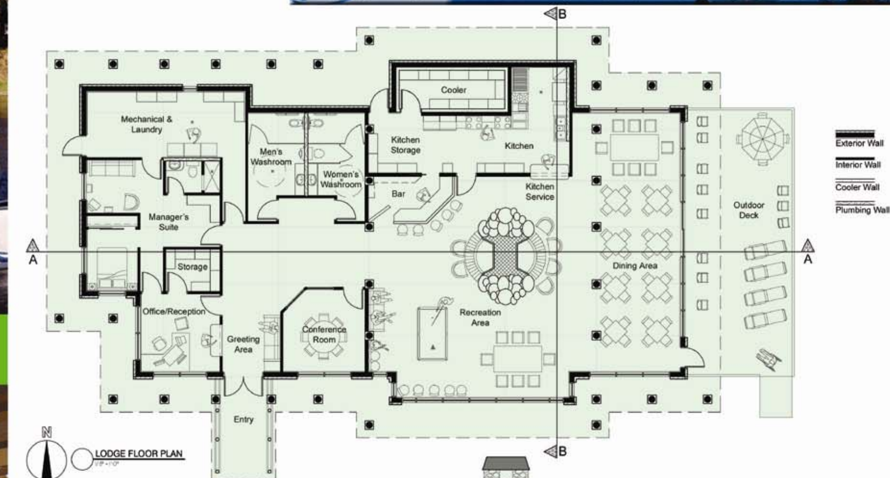
Lodge North Elevation

Lodge West Elevation

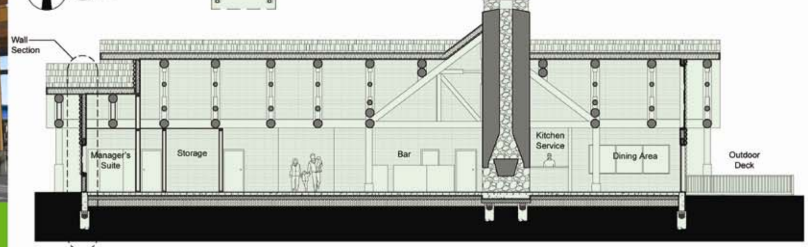
Lodge Perspective of Deck and Fon Du Lac River



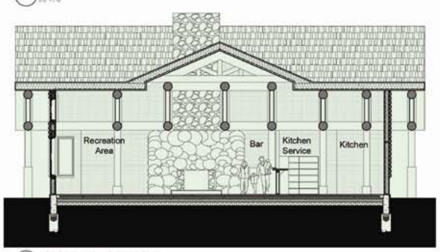
Lodge Perspective of Northern Fon Du Lac River



LODGE FLOOR PLAN



A LODGE BUILDING SECTION A

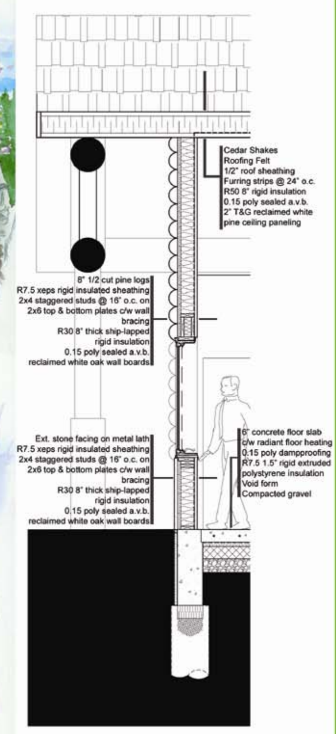


B LODGE BUILDING SECTION B

Interior Concept Perspective

Summer Perspective

Winter Perspective



TYPICAL WALL SECTION


Perspective of Athabasca cabin view


Athabasca Cabin South Elevation


Athabasca Cabin East Elevation


Athabasca Cabin North Elevation


Athabasca Cabin West Elevation


Cabin Bedroom

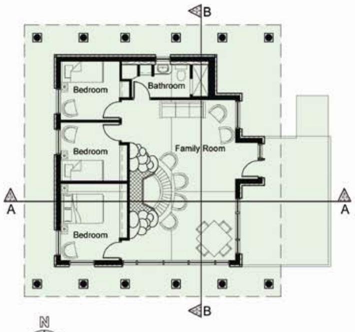

Besnard Cabin South Elevation


Besnard Cabin East Elevation

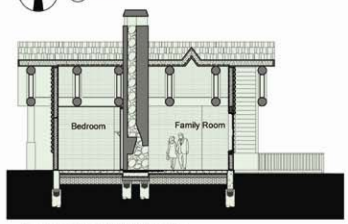

Besnard Cabin North Elevation


Besnard Cabin West Elevation

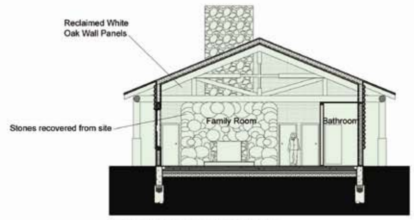

Cabin Perspective from Fon Du Lac River



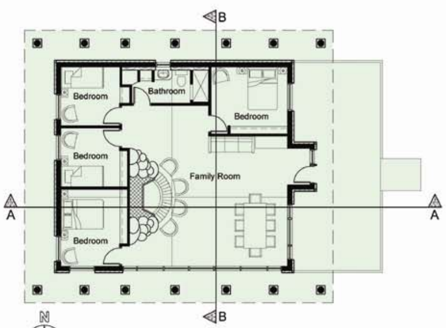
ATHABASCA FLOOR PLAN



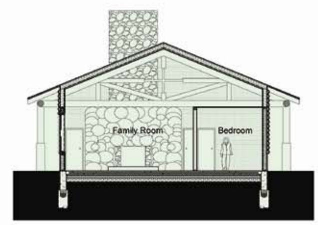
A ATHABASCA BUILDING SECTION A



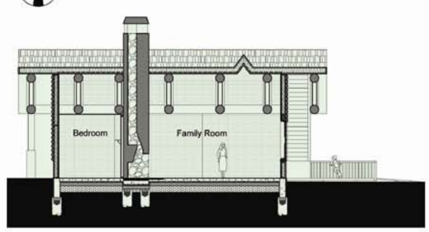
B ATHABASCA BUILDING SECTION B



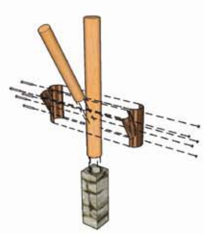
BESNARD FLOOR PLAN

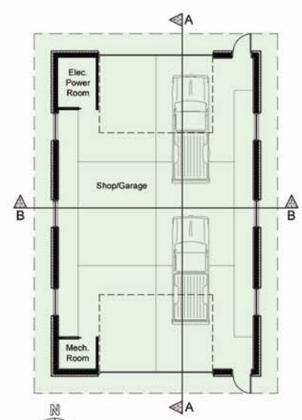


B BESNARD BUILDING SECTION B

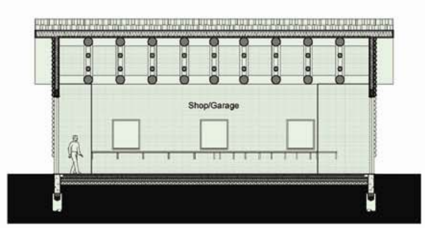


A BESNARD BUILDING SECTION A

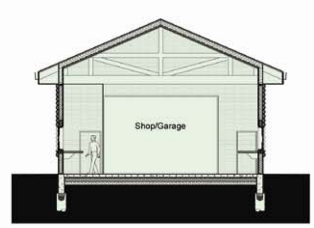

Exploded Axonometric of Typical Column Bracing



SHOP FLOOR PLAN



A SHOP BUILDING SECTION A



B SHOP BUILDING SECTION B

Reflecting back upon this thesis book has finally allowed me to view the work in a more complete context. The end product of this thesis project is much different than what I expected it to become. In the beginning I envisioned a project that was completely off-the-grid and had no connection to the infrastructural support services such as SaskEnergy and SaskTel, but as this project developed I began to see that it made more sense for me to utilize the existing infrastructure so I could become part of the solution, not just avoid the problem.

There was a major change in the middle of this project, where the idea of net-metering came to the foreground and I altered course in my goals for this project. At first, the idea of powering up a battery bank made sense, but then I received the feedback from Tom McNab about how I wasn't really thinking sustainable if I thought disposing of toxic batteries was okay. This opened my eyes to realize that I was fighting the actual site advantages for no reason, which went against my outlined goals. Instead of just powering my own design, I am now proposing to send wind and solar generated power back to SaskEnergy to help in the energy crisis. I feel that my willingness to alter my plans midway through this book is a true indication of my desire to learn and my ability to adapt in the process.

The feedback I have received has been invaluable to the progress of this book, as both Tom Wood and Tom McNab have forced me to think about this topic in ways I never would have thought before. I want to take this opportunity to thank both Tom Wood and Tom McNab for lending their time and energy to assist me with this capstone project. Both of them took a chance on a student that neither of them had previously taught in any class, and I am extremely grateful for everything they have done to assist this project this semester.

I have grown from this experience and I believe it has made me a better architect. I will always treasure this time at Montana State University and within the school of Architecture. Thank you.

Kenneth Hintze