NORTHERN LIGHTS SOLUTIONS

GOOD SHEPHERD MINISTRIES™

2015 GREEN ENERGY CHALLENGE

PROPOSAL

SUBMISSION DATE: APRIL 20, 2015

CECA/NECA

UNIVERSITY OF TORONTO STUDENT CHAPTER

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1 Executive Summary

Northern Lights Solutions is pleased to present its proposal for an energy retrofit and resiliency upgrade for Good Shepherd Ministries, a three-storey homeless shelter in downtown Toronto, Canada. A fixture on the outskirts of downtown since 1963, Good Shepherd Ministries provides hot meals, clean clothes, and beds to sleep in for anyone who requires them. With the increased number of power outages and storms that have occurred in Toronto over the past few years, it is clear that this facility is in dire need of an improvement in resiliency and an emergency power system, so that in the event of future power outages, Good Shepherd Ministries will not have to turn people away at their door.

After conducting two separate site visits to Good Shepherd Ministries, Northern Lights Solutions identified three key components to the renovation: a retrofit of the critical lighting to LEDs, installation of solar panels on the roof to harvest energy from the sun, and the installation of a generator to provide additional power. Together, the solar panels and the generator will provide energy to power the critical loads of Good Shepherd Ministries in the case of a power outage. Northern Lights Solutions has also developed a resiliency plan that will redefine the ways in which Good Shepherd Ministries operates during a power outage.

The project cost is estimated at $420,864. Northern Lights Solutions has identified $62,209 in grants and incentives, bringing the total cost down to **$358,655**. All currency is in Canadian dollars (CAD). The team also proposes a bank loan structure to help finance the project, which can be paid off in just over 17 years. Starting in early July of 2015, the project is scheduled to be complete in just over five months while remaining sensitive to the facility's operating schedule.

Northern Lights Solutions has created a comprehensive outreach strategy to support the development of this proposal. Through several initiatives, the team has promoted green energy awareness within its community. As well, the team has established an excellent working relationship with CECA, its industry partners, and its client. As a result, the proposal is very thorough and reflects significant industry involvement.

Northern Lights Solutions elects to use the following weighting factors for the technical sections of this proposal: 1.4 for the Lighting Retrofit, and 0.6 for the Energy Audit/Benchmark.

1.1 Mission Statement

Our mission is to provide our clients with innovative solutions that will best address their needs in a cost effective manner. We understand that there is no "one size fits it all" solution, and our team makes every effort to deepen our understanding of our clients' needs in every project.

2 Project Overview

2.1 The Client – Good Shepherd Ministries

In 1963, Good Shepherd Ministries opened its doors in the east end of downtown Toronto, Canada to provide shelter to Toronto's homeless citizens. Despite Good Shepherd's humble beginnings, it has expanded the services it provides, including a Resettlement/Housing Program, the Drug and Alcohol Recovery Enrichment Program (DARE), and a life skills program for veterans, called Veterans Living Better **[1]**.

Figure 1: Exterior View of Good Shepherd Ministries

From the very start, Good Shepherd Ministries has provided hot meals, clothing, and warm beds to anyone who required them. On a typical day, this translates to over 1,200 meals served, more than 100 articles of clothing distributed, 10 medical clinic visits, and all 91 beds filled **[2]**. Brother David Lynch and the wonderful staff at Good Shepherd graciously agreed to partner with Northern Lights Solutions and its industry supporters on this project.

2.2 The Project

Shown in Figure 1, Good Shepherd Ministries operates in a three storey masonry-cladded building located at 412 Queen Street East, Toronto, Canada. The facility is occupied 24/7 year round.

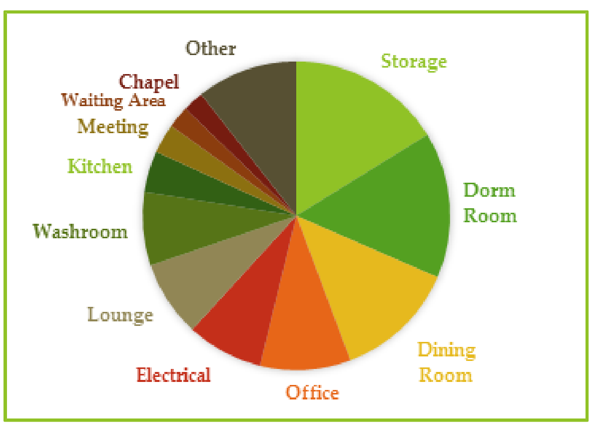


Figure 2: Space Allocation

Figure 2 presents a breakdown of how space is allocated within the Good Shepherd Ministries complex. As shown, most of the space is distributed between the dormitories, storage, and the dining room.

Dormitories are located on the second and third floors of the building. All the dormitory areas have washrooms and meeting rooms to host events with the facility's clients. Figure 3 shows a typical dormitory area on the second floor.

On the main floor, the kitchen and dining room areas occupy most of the space; these areas are where the majority of the activity at Good Shepherd Ministries occurs. As shown in Figure 4, this area is lit by fluorescent lights which have been reported as outdated.

Figure 3: Typical Dorm area

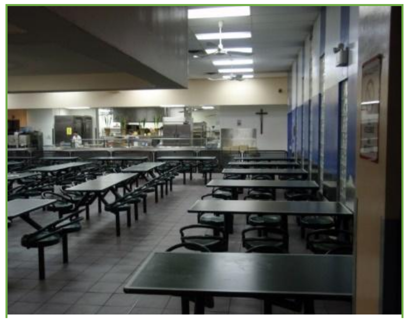


Figure 4: Kitchen/Dining Area

Figure 5: Basement Storage

The basement is one of the most important areas for the building's operations: the storage area (Figure 5). Non-perishable items are stored in boxes and bins; a large walk-in freezer is used to store perishable items. The basement is equipped with a conveyor belt to facilitate loading and unloading of delivered goods.

The building underwent major reconstruction in the early 1990's to integrate many of the areas used today. In 2009, major renovations in the kitchen and dining room areas replaced most of the equipment, modified the layout, and retrofitted some of the lighting system.

Despite having undergone renovations, the building has many deficiencies. There are noticeable drafts in the vestibule and throughout the building, indicating deficiencies in the building's envelope. Most of the lighting systems are outdated and require replacement in the near future to reduce energy consumption and to improve functionality for the staff and occupants.

Finally, none of the past renovations considered adding a back-up power system, which has been identified as an important operational factor by the staff and is a key component of this project. This need was highlighted during the summer of 2014 when a power outage affected the facility during the lunch meal service. Fortunately, the food was already cooked, but it had to be served on paper plates because the dishwashers were not operable. All other operations were stopped. Because there was no formal resiliency plan in place, the facility's clients were directed to other centres for support until the outage was resolved.

Good Shepherd Ministries' operations depend on the reliability and efficiency of its facilities. The building, although partially renovated in 2009, still needs significant upgrades that are critical for reducing energy consumption, addressing lighting needs, and increasing resiliency. Northern Lights Solutions has thoroughly assessed Good Shepherd Ministries' facilities and proposes an integrated solution to accomplish these upgrades, as outlined later in this document. Appendix A contains floor plans of the entire Good Shepherd Ministries facility.

3 Northern Lights Solutions – The Project Team

The Northern Lights Solutions organizational structure is shown in Figure 6. The team consists of 25 students divided into five working groups; each group addressing one aspect of the design. The team leaders, shown in boxes, are responsible for liaising between the project manager and the working groups. The resumes of the team leaders follow.

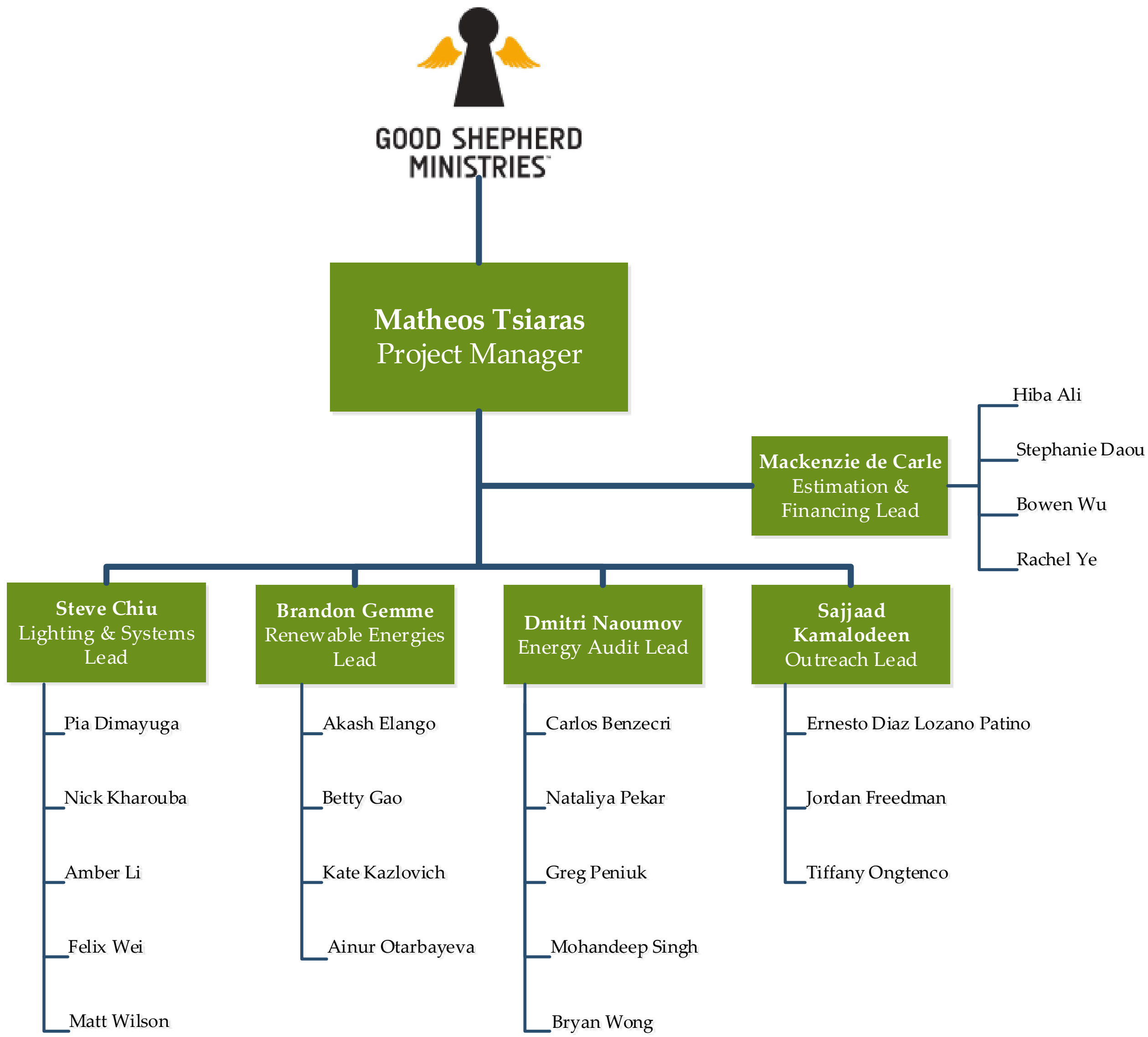


Figure 6 Organizational Chart

3.1 Matheos Tsiaras - Project Manager

Matheos has completed his third year of Civil Engineering studies at the University of Toronto, and is currently completing a 16-month co-op term with IBI Group in their Transportation Systems Group. He previously completed a 4-month work term with Toronto 2015 with their Transportation Functional Area. Matheos brings experience in project management and sustainable design through course work and extra-curricular activities into his role as Project Manager for the Green Energy Challenge.

Education	Skills & Certifications	Memberships
BASc, Civil Engineering Class of 1T5+PEY University of Toronto Toronto ON, Canada	• *Applications:* Microsoft Office (incl. Project and Visio) • *Software:* AutoCAD, VBA, Synchro	• Canadian Society of Civil Engineers, University of Toronto Chapter • Institute of Transportation Engineers, UofT Chapter

Relevant Experience

Transportation Systems Designer, IBI Group **May 2014-Present**

- Pan Am/Parapan Am Games: developing operational plans for the Unified Transportation Control Centre, and Traffic Management Measures for the Games Route Network
- Involved in development, configuration, and testing of various Advanced Traffic Management Systems, including systems in British Columbia and South Africa
- Assisting IBI during the business development process, including RFP release, amendments, and proposal submittals

Transportation Intern, Toronto 2015 The Organizing Committee for the 2015 Pan American/Parapan American Games **May 2013-August 2013**

- Established a method for determining Games-time operational vehicle/parking needs for the company via a spreadsheet template and meetings with each Functional Area
- Illustrated all vehicle trips for all client groups to/from venues using an origin/destination matrix
- Was in charge of daily management of the company fleet, including approvals of fleet usage, scheduling of cleaning/maintenance, and maintaining accurate records of fleet usage

Team Member, Survey Camp **August 2013**

- Created a topographic map of the entire campgrounds using distance, angle, and elevation measurements from over 200 points across the grounds
- Designed a highway curve on the campground, including station locations, elevations, and volumes of cut/fill
- Delivered a presentation on a proposed sustainable building design to be located at the camp

Team Leader, Engineering Strategies & Practice II **January 2012-April 2012**

- Led a team of six students that produced a system for tracking the carbon footprint of campus clubs for a client
- Evaluated design solutions based on implementation requirements, accessibility, and cost
- Produced Project Requirements, and Conceptual and Final Design Specifications documents

Extra-Curricular Activities

- Appointed Executive (Project Manager), CECA/NECA University of Toronto Student Chapter
- PEY Representative, University of Toronto Civil Engineering Club
- Promotions Director, Tenor Sax, Skule (Engineering) Stage Band

3.2 Dmitri Naoumov - Team Lead – Energy Audit

Dmitri is a Civil Engineering student at the University of Toronto who is currently in a 12-month internship at Arup in their structural design group. He has previously completed a 4-month internship at Infrastructure Ontario as part of the major projects group. In prior years, Dmitri worked at PCL Constructors Canada Inc. Due to his course works and personal interests Dmitri is a strong asset to the Green Energy Challenge team.

Education	Skills & Certifications	Memberships
BASc, Civil Engineering Class of 1T5+PEY with Honours University of Toronto LEED Green Associate	• *Applications:* Microsoft Office • *Software:* AutoCAD, Revit, VBA, Bentley Microstation, GSA (SAP equivalent)	• Canadian Society of Civil Engineers, University of Toronto Chapter • Professional Engineers of Ontario

Relevant Experience

Structural Designer, Arup **September 2014-Present**

Projects: Billy Bishop Toronto Airport Pedestrian Tunnel, York University Engineering Building, Eglinton Crosstown Light Rail Transit Project, Tokyo Canadian Embassy.

- Assisting the lead structural engineer with design and review stages. Developing automated spreadsheets for rapid design.
- Conducting drafting and structural modeling using various software.

Summer Associate, Infrastructure Ontario **May 2014-August 2014**

- Maintained and improved on the established RFI procedures for the Milton General Hospital Project.
- Attended and took minutes at weekly executive meetings. Responsible for minutes and material distribution within Infrastructure Ontario.

Team Leader, Survey Camp **August 2014**

- Created a topographic map of the entire campgrounds using distance, angle, and elevation measurements from over 300 points across the grounds
- Designed a highway curve on the campground, including station locations, elevations, and volumes of cut/fill
- Delivered a presentation on a tentative RFP for a building upgrade within the grounds

Sustainable Construction Student, PCL Constructors Canada Inc. **May 2012-August 2012**

- Developed a standard LEED credit implementation procedure for several project teams.
- Initiated, pursued, and implemented business card digitization and a digital file structure redesign.
- Cleaned out, updated, and maintained internal project databases.

Extra-Curricular Activities

- Volunteer at community repairs club as a mentor and handyman
- Avid biker with over 15000 km ridden over the last three years
- Part of Sustainable Engineers Association, University of Toronto

3.3 Steve Chiu - Team Lead – Lighting & Systems

Steve has completed his third year of Civil Engineering studies at the University of Toronto, and is currently completing a 12-month co-op term with the TTC in their Maintenance Engineering Department. He previously completed a 1-month work term with LEA Consulting in their Traffic department. Steve brings his wealth of software and technical skills into his role for the Green Energy Challenge.

Education

BASc, Civil Engineering
Class of 1T5+PEY
University of Toronto
Toronto ON, Canada

Skills & Certifications

- *Applications:* Microsoft Office (incl. Project and Visio)
- *Software:* AutoCAD, Microstation
- *Programming*: C, Java, VBA, HTML, CSS

Memberships

- Canadian Society of Civil Engineers, University of Toronto Chapter
- Institute of Transportation Engineers, UofT Chapter

Relevant Experience

Engineering Student, TTC Maintenance Engineering — **September 2014-Present**

- Preparing and training the Maintenance Engineering Department for inclusion into Ontario's ICall system
- Surveying and creating spill contingency maps for TTC's Corporate Spill Program
- Developing and carrying out a procedure for streetcar special track work geometry analysis
- Assisting in redesigning existing TTC subway station platforms to better accommodate mobility aids

Traffic Surveyor, LEA Consulting — **May 2013-August 2013**

- Performed field traffic surveys for condo developments
- Coordinated reports and logged data to supervisor
- Gained experience in traffic surveying techniques and processes

Team Leader, Survey Camp — **August 2013**

- Created a topographic map of the entire campgrounds using distance, angle, and elevation measurements from over 200 points across the grounds
- Designed a highway curve on the campground, including station locations, elevations, and volumes of cut/fill
- Delivered a presentation on a proposed sustainable building design to be located at the camp

Team Leader, Engineering Strategies & Practice II — **January 2012-April 2012**

- Led a team of six students that produced a system for restructuring a client's fruit collection process
- Evaluated design solutions based on implementation requirements, accessibility, and cost
- Produced Project Requirements, and Conceptual and Final Design Specifications documents

Extra-Curricular Activities

- Common Room Manager, University of Toronto Civil Engineering Club
- Designer, Freelance Mapping Project
- Member, CECA/NECA University of Toronto Student Chapter

3.4 Brandon Gemme - Team Lead – Renewable Energies

Brandon is currently in his third year of Civil Engineering studies at the University of Toronto. He previously completed a 4-month work term with Professor Sheikh's Structural Research Group at the University of Toronto. Brandon brings experience in project management and sustainable design through course work, work experience and extra-curricular activities into his role for the Green Energy Challenge.

Education	Skills & Certifications	Memberships
BASc, Civil Engineering Class of 1T6 with Honours University of Toronto Toronto ON, Canada	• *Applications:* Microsoft Word, Excel, Powerpoint, Project, Publisher, Visio • *Software:* AutoCAD, Google Sketchup	• Canadian Society of Civil Engineers, University of Toronto Chapter

Relevant Experience

Summer Research Assistant, University of Toronto **May 2014-August 2014**

- Coordinated and scheduled skilled trades such as welding and machining. Responsible for other project management related tasks, such as coordinating and assigning tasks to groups of people during specimen casts, and scheduling lab time to complete all given tasks.
- Participated in weekly research meetings during which design and scheduling decisions were made. Daily responsibilities include concrete cylinder testing, specimen preparation and data analysis, the building of formworks, placement of strain gauges, bending and cutting of steel reinforcement, ordering and retrieval of materials and equipment.
- Worked extensively with Google Sketchup and AutoCAD to produce various 2D and 3D models which were used in the lab in order to coordinate several tasks such as specimen testing and the construction of formworks.
- Produced and worked with several documents outlining lab procedures in great detail.

Team Member, Survey Camp **August 2014**

- Created a topographic map of the entire campgrounds using distance, angle, and elevation measurements from over 200 points across the grounds
- Designed a highway curve on the campground, including station locations, elevations, and volumes of cut/fill
- Delivered a presentation on a proposed sustainable building design to be located at the camp

Team Member, Steel & Timber Design Project **December 2014**

- Designed the steel bracing system of a three storey steel building in Toronto as specified by CAN/CSA-S16-09 requirements.
- Produced engineering drawings outlining the design specification using AutoCAD

Extra-Curricular Activities

- Team Leader, Green Energy Challenge - CECA University of Toronto Student Chapter
- Mentor, University of Toronto Civil Engineering Club
- Leader, Engineering Orientation Week (2013, 2014)

3.5 Mackenzie de Carle - Team Lead – Estimation & Finance

Mackenzie is currently in his second year of study at the University of Toronto for Civil Engineering. He previously completed a 4-month work term with MMM in their rail department. Mackenzie brings scheduling and site experience to his role as Estimation & Finance Lead through class and work experience.

Education	Skills & Certifications
BASc, Civil Engineering Class of 1T7 University of Toronto Toronto ON, Canada	• *Applications:* Microsoft Office • *Software:* AutoCAD, Python, C, Google Sketchup

Relevant Experience

Construction Inspector, MMM Group — **May 2014-August 2014**

- Worked on a subway station rehabilitation and upgrade for the TTC
- Work involved reading and interpreting construction drawings to ensure compliance with the design including steel and concrete works
- Ensured compliance with the Occupational Health and Safety Act and Regulations
- Helped report contractor's progress in regards to the schedule and activities completed
- Reported on daily progress of contractor
- Confirmed task completion percentages on a monthly basis

Lifeguard, YMCA of Centre County — **Summer 2010-Summer 2014**

- Enforced rules and policies to the participants
- Demonstrated quality customer service

University Course Projects — **September 2013-Present**

- Reported on the weekly progress of a 40+ storey condominium
- Designed a truss pedestrian bridge
- Designed and built a model train beam bridge
- Wrote a design brief focused on improving clothes hangers
- Wrote a Request for Proposal to improve the checkout process of veterinary clinics

Extra-Curricular Activities

- Estimation & Finance Team Lead, CECA/NECA University of Toronto Student Chapter
- Lab Volunteer, University of Toronto Structures Lab under Prof. Frank Vecchio
- Safety Lead, University of Toronto Concrete Canoe Team

3.6 Sajjaad Kamalodeen - Team Lead – Outreach

Sajjaad has completed his third year of Civil Engineering studies at the University of Toronto, and is currently completing a 12-month co-op term The Regional Municipality of York. He previously completed a 2-month work term with Trinidad Engineering & Research. Sajjaad brings experience in sustainable design through course work and extra-curricular activities into his role as the outreach team lead for the Green Energy Challenge.

Education

BASc, Civil Engineering
Class of 1T5+PEY
University of Toronto
Toronto ON, Canada

Skills & Certifications

- *Applications:* Microsoft Word, Excel, Powerpoint, Project, Publisher
- *Software:* AutoCAD, ArcGIS

Memberships

- Canadian Society of Civil Engineers, University of Toronto Chapter
- Institute of Transportation Engineers, UofT Chapter

Relevant Experience

Engineering Assistant, The Regional Municipality of York **September 2014-Present**

- Assisted in the delivery of major capital roads projects in the Region of York by performing a range of applications, including the following:
- Assisted in the review of detailed design submissions from consultants on various design projects and in the development of Request for Proposals (RFP) documents.
- Calculated and verified the accuracy of quantities for contract tender items in construction projects, and reviewed contract tender documents for accuracy

Engineer Trainee, Trinidad Engineering & Research Ltd. **Summer 2013**

- Performed a variety of applications including geotechnical laboratory testing, engineering surveying and field visits, under the supervision of a senior engineer. Prepared site descriptions at field visits.
- Engineering Land Surveying - Performed a topographical survey of the parcel of land that contained an office building, including site features and then plotted it using AutoCAD
- Geotechnical Laboratory Testing - Performed and calculated various soil and concrete laboratory tests and observed oil drilling operations which included the taking of underground samples

Team Leader, Survey Camp **August 2013**

- Created a topographic map of the entire campgrounds using distance, angle, and elevation measurements from over 200 points across the grounds
- Designed a highway curve on the campground, including station locations, elevations, and volumes of cut/fill
- Delivered a presentation on a proposed sustainable building design to be located at the camp

Student Life - Director of Events, MSA, U of T **June 2013-May 2014**

- Organized and executed events for members of the student club to attend, network and socialize with fellow peers in a relaxing environment.
- Learnt how to plan and coordinate events through an authorization system and within a budget

Extra-Curricular Activities

- Outreach Team Lead, CECA/NECA University of Toronto Student Chapter
- Photographer, MSA University of Toronto

4 Technical Analysis 1: Energy Audit / Benchmark

Northern Lights Solutions performed a comprehensive energy audit to document the energy usage of Good Shepherd Ministries. All the appliances, fixtures and equipment were documented and tallied to analyze what elements of the building consumed the most power. Metered data was also analyzed to validate the results. Furthermore, the team conducted an energy benchmark using the ENERGY STAR benchmarking tool.

4.1 Energy Audit Results

A site visit was conducted in order to perform the energy audit. During the visit, Northern Lights solutions gathered information on appliance models, power consumption and usage (i.e. hours per day). Good Shepherd Ministries utilizes two main sources of energy: electrical energy from the grid and natural gas. Because one of the components of this proposal is to increase the resiliency and develop a lighting retrofit, Northern Lights Solutions' analysis is focused on the electrical energy usage.

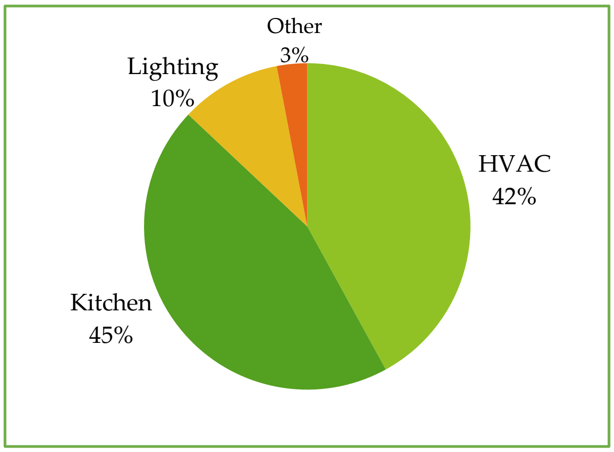


Figure 7: Energy Use Breakdown

As seen in Figure 7, most of the electrical energy used at Good Shepherd Ministries is used to power the HVAC and all the kitchen appliances, which includes walk-in freezers and coolers, ovens, stoves and industrial dishwashers. Lighting is also a relevant portion of the energy consumption, mainly due to the fact that most of the existing fixtures are fluorescent. Other sources of energy usage include computers, medical equipment, miscellaneous plug loads, fire pumps and the elevator motor.

Table 1 and Table 2 outline the HVAC equipment currently in use at Good Shepherd Ministries.

Table 1: Roof HVAC Equipment

Item	Technical Spec	Gas (Btu/hr)	Electrical (kW)
ICE Heater	Input, min	66,000	
	Input, max	200,000	
	Electric Motor, rated		0.75
Large Lennox (HVAC)	Input, min	312,000	
	Input, max	480,000	
	Output	380,000	
	Cooling	270,000	
	Compressors, rated		45
	Evaporator Fans, approx		8.5
Medium Lennox (HVAC)	Input, min	156,000	
	Input, max	240,000	

Item	Technical Spec	Gas (Btu/hr)	Electrical (kW)
	Output)	192,000	
	Cooling	138,000	
	Compressors, rated		22
	Evaporator Fans, approx		5
Small Lennox (HVAC)	Input, min	-	
	Input, max	125,000	
	Cooling, approx	70,000	
	Compressor, rated		11
	Fans, rated		0.75
LG Air Conditioner	Electric, approx		1.5

Table 2: Indoor Air Conditioning Units

Location	Rated Power (HP)	Voltage (V) & Phases	Cooling Capacity (t)	Electrical use(kW)
Waiting Room/Basement	1/3	208V, 1p	3	3.8
Laundry/Basement	1/3	208V, 1p	3	3.8
South Side/First Floor	½	600V, 3p	4	11.3
South Side/Second Floor	1/3	208V, 1p	3	11.3
Third Floor	1/6	208V, 1p	1.5	3.8

Figure 8: Rooftop HVAC Units

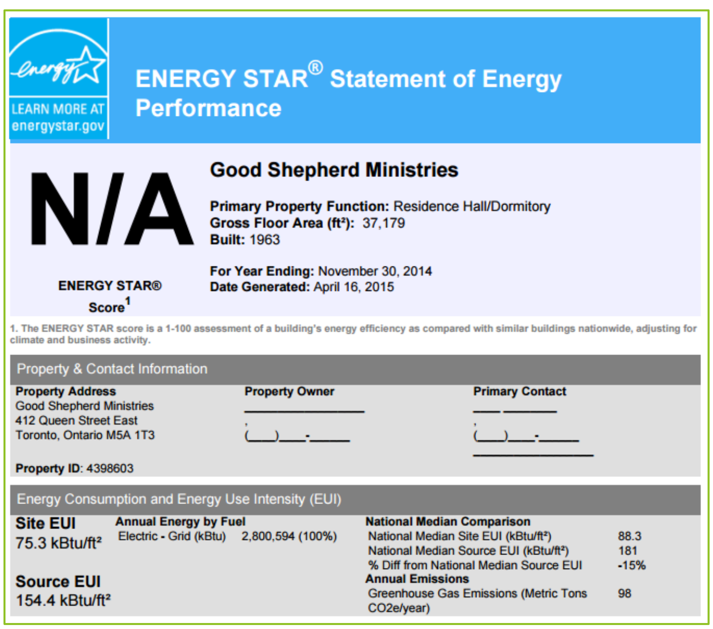
Figure 8 shows the large and medium Lennox units. The remaining units are located out of view. As shown in the image, the roof of the building is flat and has a significant amount of empty space. Moreover, there are no tall structures nearby that can cast shadows on the roof. This creates the potential for the installation of a solar PV system, which will be futher discussed in section 6.

Additionally, Northern Lights Solutions analyzed historical metered data to understand how energy consumption varied throughout the year. As shown in Figure 9, the months with the most extreme temperatures (high and low) had spikes in energy usage, associated with higher loads placed on the HVAC equipment.

Figure 9: Monthly Energy Usage Graph

4.2 Energy Benchmark

Northern Lights Solutions performed a comprehensive benchmark leveraging ENERGY STAR's online tool. All relevant building data (floor area, space distribution, metered energy consumption) was entered into the software. Because the majority of the space at Good Shepherd Ministries is used for dormitory and dining purposes, the online tool was not able to generate an Energy Star Score. However, the software was able to generate the energy consumption and energy use intensity metrics, as shown in Figure 10.



LEARN MORE AT energystar.gov

ENERGY STAR® Statement of Energy Performance

N/A

ENERGY STAR® Score[1]

Good Shepherd Ministries

Primary Property Function: Residence Hall/Dormitory
Gross Floor Area (ft²): 37,179
Built: 1963

For Year Ending: November 30, 2014
Date Generated: April 16, 2015

1. The ENERGY STAR score is a 1-100 assessment of a building's energy efficiency as compared with similar buildings nationwide, adjusting for climate and business activity.

Property & Contact Information

Property Address	Property Owner	Primary Contact
Good Shepherd Ministries 412 Queen Street East Toronto, Ontario M5A 1T3	________ , (___)___-____	___ _____ , (___)___-____ ________

Property ID: 4398603

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
75.3 kBtu/ft²

Annual Energy by Fuel
Electric - Grid (kBtu) 2,800,594 (100%)

Source EUI
154.4 kBtu/ft²

National Median Comparison

National Median Site EUI (kBtu/ft²)	88.3
National Median Source EUI (kBtu/ft²)	181
% Diff from National Median Source EUI	-15%

Annual Emissions

Greenhouse Gas Emissions (Metric Tons CO2e/year)	98

Figure 10: ENERGY STAR Benchmark Results

4.3 Recommendations

Taking into account the results of the analysis, the available budget from government funding and the facility's internal budget, Northern Lights Solutions recommends three components of energy retrofit.

The first component is to reduce facility lighting loads by upgrading the outdated fluorescent lighting in the dining, hallway, and staircase areas to LED. These are the areas of the facility that have the highest traffic, and would continue to be used in the event of a power outage.

The second component is to put a generator on the roof of the building to provide loss of power resiliency to the facility. There is also potential to utilize the roof for a solar PV array, which would be the third component of the retrofit. The roof is currently unused, with the exception of a few HVAC units. The size of the roof and the location of the facility create the potential to mount a solar array.

5 Technical Analysis 2: Lighting Retrofit

Good Shepherd Ministries currently uses several types of lighting lamps and fixtures, including fluorescent, CFL, and halogen. Much of the lighting is out of date, and the client has expressed the need for a lighting retrofit. Northern Lights Solutions conducted a lighting analysis at Good Shepherd Ministries; the current lighting demand has been identified in section 5.1, and section 5.2 outlines the renovations that Northern Lights Solutions plans to implement in order to improve the performance of the lighting at Good Shepherd Ministries. Appendix B contains the Reflected Ceiling Plans for the existing and proposed lighting system, and Appendix C contains the complete lighting schedules for both the existing and proposed systems.

5.1 Existing Lighting System

The existing lighting fixtures consist mostly of T8 40W 4ft fluorescent tubes, used in fixtures that support both single and quad tubes. The basement is lit entirely by T8 75W 6ft single fluorescent tubes. There were several 13/18W CFL bulbs scattered throughout the building, mainly in the dormitory areas, and the lighting in the chapel consisted of 25W halogens in fixtures that supported triple bulbs. All lights are controlled with standard on/off switches, and control mechanisms are limited to an infrared motion sensor in the men's washroom on the first floor.

Table 3 outlines the current lighting conditions at Good Shepherd Ministries. The current total lighting demand is 31.6kW.

Table 3: Existing Lighting Conditions

Light Type	Total Fixtures	Total Lamps	Total Wattage (W)
40W Fluorescent 4 ft tube with diffuser	138	536	21440

Light Type	Total Fixtures	Total Lamps	Total Wattage (W)
40W Fluorescent 4 ft tube	133	133	5320
75W Fluorescent 6 ft tube	19	19	1425
13W CFL Dorm Light	94	94	1222
Emergency Light + Battery	28	56	403
32W Fluorescent U-Tube	12	24	768
13W CFL Spherical Dome	22	22	286
18W CFL Spherical Recessed in Ceiling	11	11	198
25W Halogen	21	21	525
Total			**31,587**

Table 4 outlines the hours of operation of each of the major areas in Good Shepherd Ministries, as well as the light type that is currently in place in each of those areas.

Table 4: Hours of Operation of Lighting

Hours of Operation		Light Type
Storage	6am-6pm	75W Fluorescent 6 ft tube
Dining	6am-6pm	40W Fluorescent 4 ft tube with diffuser
Dorm	6pm-11pm	13W CFL Dorm Light
Dorm Hallway	24 hours	13W CFL Spherical Dome
Offices	9am-5pm	40W Fluorescent 4 ft tube with diffuser
Electrical	9am-5pm	40W Fluorescent 4 ft tube
Lounge	9am-5pm	40W Fluorescent 4 ft tube with diffuser
Hallway	24 hours	40W Fluorescent 4 ft tube with diffuser
Washroom	24 hours	40W Fluorescent 4 ft tube with diffuser
Counsel/Meeting	9am-5pm	40W Fluorescent 4 ft tube with diffuser
Kitchen	6am-6pm	40W Fluorescent 4 ft tube with diffuser
Dishwashing	6am-6pm	40W Fluorescent 4 ft tube with diffuser
Chapel	9am-5pm	25W Halogen
Medical	9am-5pm	40W Fluorescent 4 ft tube with diffuser
Laundry	6am-6pm	75W Fluorescent 6 ft tube
Stairwells	24 hours	40W Fluorescent 4 ft tube with diffuser

Northern Lights Solutions has identified the critical lighting at Good Shepherd Ministries for the purpose of replacing it with more energy efficient lighting, as further explained in section 5.2. The team has determined that the critical areas of Good Shepherd Ministries are the kitchen and dining areas, hallways, stairways, and the emergency lights. These are the areas of the facility that have the highest traffic, and these lights would remain on in the event of a power outage. Table 5 shows the critical lighting demand of the current system at Good Shepherd Ministries, which totals 12.7kW.

Table 5: Critical Lighting of Existing Conditions

Light Type	Total Fixtures	Total Lamps	Total Wattage (W)
40W Fluorescent 4 ft tube with diffuser	76	288	11520
40W Fluorescent 4 ft tube	19	19	760
75W Fluorescent 6 ft tube	-	-	-
13W CFL Dorm Light	-	-	-
Emergency Light + Battery	28	56	403
32W Fluorescent U-Tube	-	-	-
13W CFL Spherical Dome	-	-	-
18W CFL Spherical Recessed in Ceiling	-	-	-
25W Halogen	-	-	-
Total			**12,683**

5.2 Proposed Lighting System

The first improvement to the lighting of Good Shepherd Ministries is the retrofit of the critical areas with LED lights, which will be inserted into the existing T8 fixtures. Northern Lights has selected the Canada LED Lighting T8 LED 18W 4ft tube as the replacement for all the 4ft fluorescent tubes **[3].** As demonstrated by Table 6, the lighting in the critical areas of the building (hallways, kitchen, dining room, stairwells), have been changed to the new lamps, and the difference in the total critical lighting load can be seen when compared to Table 5.

Table 6: Critical Lighting of Proposed System

Light Type	Total Fixtures	Total Lamps	Total Wattage (W)
18W LED 4 ft tube with diffuser	76	288	5184
18W LED 4 ft tube	19	19	342
75W Fluorescent 6 ft tube	-	-	-
13W CFL Dorm Light	-	-	-
Emergency Light + Battery	28	56	403
32W Fluorescent U-Tube	-	-	-
13W CFL Spherical Dome	-	-	-
18W CFL Spherical Recessed in Ceiling	-	-	-
25W Halogen	-	-	-
Total			**5,929**

Table 7 outlines the complete proposed lighting system for Good Shepherd Ministries, including the existing non-critical lighting lamps, and the new retrofitted critical lighting.

Table 7: Proposed Lighting System Conditions

Light Type	Total Fixtures	Total Lamps	Total Wattage (W)
40W Fluorescent 4 ft tube with diffuser - existing	62	248	9920
18W LED 4 ft tube with diffuser - new	76	288	5184
40W Fluorescent 4 ft tube - existing	114	114	4560
18W LED 4 ft tube – new	19	19	342
75W Fluorescent 6 ft tube	19	19	1425
13W CFL Dorm Light	94	94	1222
Emergency Light + Battery	28	56	403
32W Fluorescent U-Tube	12	24	768
13W CFL Spherical Dome	22	22	286
18W CFL Spherical Recessed in Ceiling	11	11	198
25W Halogen	21	21	525
Total			**24,833**

Table 8 shows the total energy savings achieved from this component lighting retrofit for Good Shepherd Ministries. In total, 6.8kW is saved from the replacement of lamps alone; a savings of 22%. Upon Notice to Proceed, Good Shepherd Ministries and Northern Lights Solutions can work together to determine if a larger-scale replacement of lamps and fixtures would be a worthwhile investment.

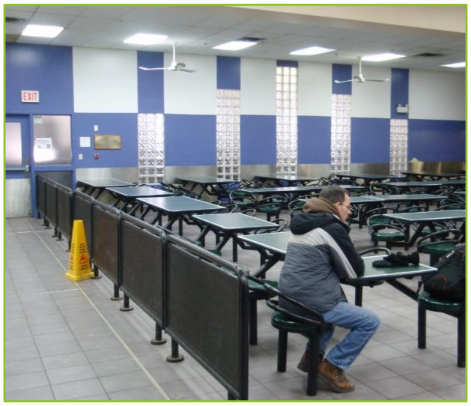
Table 8: Energy Savings from Lighting Retrofit

	Existing System (kW)	Proposed System (kW)	SAVINGS (kW)
Complete	31.6	24.8	**6.8**
Critical	12.7	5.9	

The replacement of lamps and fixtures is not the only component of the lighting retrofit that Northern Lights Solutions proposes. Non-critical areas of the building, including washrooms, offices, storage, the chapel, laundry, meeting rooms, and the lounges can be outfitted with occupancy sensors to reduce operating time and in turn reduce total energy consumed. Northern Lights Solutions estimates that a total of 40 of the Lutron MS-OPS2H-WH-C Occupancy Switches will be required **[4].**

5.3 Day Lighting Impacts

The areas of Good Shepherd Ministries that have many exterior windows, mainly the lounges and some of the offices, receive plenty of natural daylight, which was evidenced by the lux meter used during Northern Lights Solutions' walk-through of the building. Beyond the addition of occupancy sensors, further enhancements were not deemed beneficial for these areas.



However, Northern Lights Solutions does propose one renovation in the dining room that would increase the natural lighting into the area. As shown in Figure 11, along the east wall of the dining room there is a series of translucent windows which let in some natural light from the waiting area and the outside. Replacing these windows with new transparent windows would allow more natural light to come into the dining room. This will be further explored by Northern Lights Solutions upon Notice to Proceed.

Figure 11: Translucent Windows in Dining Area

6 Technical Analysis 3: Critical Load Analysis & Micro-Grid Concept

Good Shepherd Ministries' operations require a constant power supply, and currently they are fully dependent on grid power. Considering the impact Good Shepherd Ministries' operations have in the local community, and how critical their services are for those in need, a resilient power supply is much needed. Northern Lights Solutions has conducted a critical loads analysis, and developed a system solution and a resiliency plan to address Good Shepherd Ministries' needs.

6.1 Critical Load Analysis

Following Technical Analysis 1, Northern Lights Solutions performed a Critical Loads Analysis to identify which components of the building have priority for the back-up power system. To perform the analysis, the definition of critical loads provided by the United States Agency for International Development (USAID) was followed. They define critical loads as "crucial loads required to operate the facility" **[5]** and further classify critical loads in two categories:

- *Contact Critical Loads*: Loads which can withstand fluctuations in voltage and brief loss of power.
- *No Contact Critical Loads*: Loads which cannot withstand fluctuations in voltage and brief loss of power.

The analysis determined that virtually all the loads at Good Shepherd Ministries facility are contact critical loads as they do not have any equipment that will be seriously affected by a few minutes without power.

It was determined that HVAC systems should be considered critical because the average minimum temperature during the winter in Toronto is below -7 °C **[6].** However, air conditioning units were considered non-critical since the average maximum temperature during the summer only is 25 °C **[6]**. Lighting for certain areas (hallways, stairwells, dining room) was considered critical as it is an essential component for security of the facilities. Fire protection equipment was also considered critical because of the high risk a fire could pose to the occupants. Medical clinic equipment was deemed critical due to the relatively high possibility of having to provide medical assistance to an individual during an emergency situation, and because medicine stored in refrigeration need to be kept properly chilled (this need was also highlighted by the client). The kitchen equipment was also considered critical due to the role that Good Shepherd Ministries has in the community. If a power outage was to happen during meal preparations, over a thousand people could be affected. Table 9 outlines the critical loads of Good Shepherd Ministries. A portion of plug loads were also considered critical to power certain systems that may have not been included in the other categories.

Table 9: Good Shepherd Ministries Critical Loads

Item	Electrical (kW)
HVAC	93
Kitchen Equipment	37
Medical Equipment	0.5
Fire Pumps	5
Lighting	5.9
Plug Loads	5

6.2 Preliminary Resiliency Plan

Resilience is defined as the positive ability of a proposed system to adapt to the consequences of a catastrophic failure caused by power outages, extreme weather events, and/or other hazards. Northern Lights Solutions has developed a preliminary Resiliency Plan as part of this proposal. Upon Notice to Proceed, the team will work closely with Good Shepherd Ministries to detail this plan further so that it can be implemented in their practices.

This preliminary resiliency plan describes the design requirements of the proposed system as outlined in section 6.3, the environment in which it operates, and potential hazards. In addition, an emergency plan was identified, which includes operating and response concepts that Good Shepherd Ministries will implement to mitigate the effects of a power outage.

6.2.1 Operating Environment

Good Shepherd Ministries is located in Toronto, Canada, which is considered to have a semi-continental climate with variable temperature and precipitation throughout the year. The average yearly rainfall and snowfall are 714mm and 122cm, respectively, but Toronto has been susceptible to extreme storms in recent years, such as an ice storm in 2013 which resulted in

300,000 people without power for almost three days. During an ice storm such as this, Good Shepherd Ministries provides warmth and shelter to anyone who needs it.

Good Shepherd Ministries is located in an older neighbourhood on the outskirts of downtown, and is the tallest building on its block. Both the proposed solar and generator systems will be located on the roof of the building, which is easily accessible via stairs; as a result, the proposed solar system in particular is unlikely to be blocked by any shade from adjacent buildings.

The operations of Good Shepherd Ministries require a constant power supply for cooking meals and providing a comfortable accommodation for its clients. Considering the importance of Good Shepherd Ministries in the local community, the need for a back-up power system and resiliency plan is evident. As mentioned earlier, a power outage could mean that thousands of people in need would not have access to much needed hot meals, or worse, have no shelter during a freezing winter night.

6.2.2 Hazards

As Good Shepherd Ministries is not considered a high-profile building, it is unlikely that it would be deliberately attacked by an external group. The major hazards to the building, therefore, are either accidental or natural. Some accidental hazards include the overcharging of batteries which reduces the charge life of the batteries and the damage of equipment during regular cleaning or maintenance, both which would have an effect on the resilience of the system. The greater concern is natural hazards, which include natural disasters such as hurricanes or earthquakes and extreme weather events such as ice storms. Toronto is located in a low seismic activity zone, so the likelihood of the system being damaged by an earthquake is minimal. However, it has been witness to major hurricanes and storms which cut power from cities for days at a time, therefore these storms have a high likelihood of damaging the proposed system unless the appropriate precautions are taken. Electrical storms are also a hazard that should be considered; upon Notice to Proceed, Northern Lights Solutions will further explore electrical surge and lighting protection options for Good Shepherd Ministries.

6.2.3 Design Requirements

If a power outage was to occur, the proposed system for Good Shepherd Ministries must be resilient enough to allow continued operation, with particular attention paid to the critical loads identified in Section 6.1. The proposed system must also meet certain resilience requirements such as the recovery time objective, which measures the ability to return Good Shepherd Ministries to full power operation **[7].** As a preliminary estimate, Northern Lights Solutions has determined this objective to be three days, which was roughly the length of time that Toronto was without power during the 2013 ice storm.

The solar photovoltaic panels on the roof of Good Shepherd Ministries will generate electrical power to charge batteries which provide clean energy to the building during a power outage. The generator serves the same purpose as the solar panels; it will provide additional power to the microgrid if/when either the solar panels become ineffective from damage or lack of energy input from the sun, or the batteries begin to lose charge. Having these two components of the proposed system increases the overall system resilience by always ensuring that there will be microgrid power for the building.

The services that Good Shepherd Ministries provides require many staff and volunteer workers who use their time to help those in need. All staff and volunteers will need to be made aware of and trained in the operational changes that will occur in the event of a power outage to ensure the backup system can run as designed, including ensuring that the minimum amount of energy is being used by patrons while Good Shepherd Ministries is being powered by the microgrid. Additionally, the proposed system must be designed with enough simplicity so that staff on site can operate the system and solve trivial problems, typically accomplished through automation and employee training. If an on-site technician is incapable of fixing a problem due to a lack of technical knowledge or materials a Solar PV contractor will need to be hired to repair the system.

6.2.4 Emergency Management

Some general precautions that Good Shepherd Ministries will need to take to improve the overall resilience of the microgrid system and the building as a whole (before a power outage occurs). These include proper solar panel operational training for staff, scheduled cleaning of the panels to maximize solar gain, proper maintenance of the batteries, improvements to the building envelope and the use of more efficient appliances.

Once it becomes apparent that there will be a disruption in power, Good Shepherd Ministries must begin making operational changes to ensure that the critical loads will not lose power, and the schedule of powering the critical loads via the microgrid system, shown in Table 10, needs to be adhered to. This includes turning off computers and non-critical lighting, preparing the microgrid system for use (e.g. making sure the batteries are fully charged), preparing extra food, and using the laundry machine if needed.

Table 10: Schedule of Powering Critical Loads via Microgrid

Critical Load	Electrical (kW)	Minimum Operating Schedule
HVAC	93	3:00am-5:00am; 10:00am-12:00pm; 5pm-10:00pm
Kitchen Equipment	37	6:00am-9:00am; 12:00pm-4:00pm
Medical Equipment	0.5	24 hours
Fire Pumps	5	24 hours
Lighting	5.9	24 hours
Plug Loads	5	24 hours

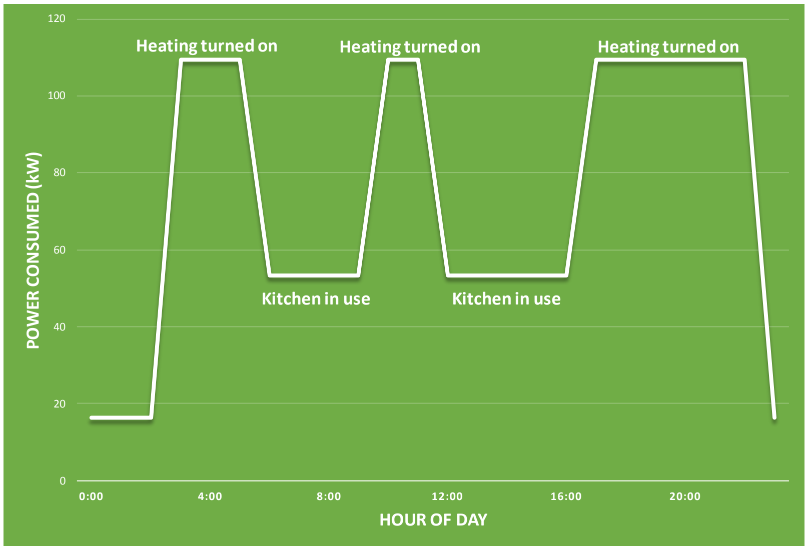


Figure 12: Critical Loads Energy Profile

From Figure 12, the maximum load that must be supported by the back-up power system is in the order of 110 kW, assuming that operation of the systems is done according to the suggested schedule in Table 10. Northern Lights Solutions would like to note that Table 10 is a preliminary estimate of the scheduling of the powering of critical loads. Upon Notice to Proceed, the team will work with Good Shepherd Ministries to refine the minimum operating schedule for each critical load, and further break down the critical loads as needed (e.g. separating cooking and dishwashing under kitchen equipment).

6.3 Proposed System

6.3.1 System Concept

Northern Lights Solutions has designed the conceptual system described in Figure 13. It is comprised of two microgrid elements: a solar PV system and a diesel generator. The system is designed so that the solar PV system can be used in parallel with grid power during normal operating conditions to reduce grid power consumption. However, in case of a power outage, the diesel generator will provide power for the critical loads identified in section 6.1. The solar PV system will still be able to provide power during an outage, however, reducing the load imposed on the generator. Northern Lights Solutions is proposing a system with two separate panel boards due to the differences in frequencies from the power generated by the solar PV and the power coming from the grid.

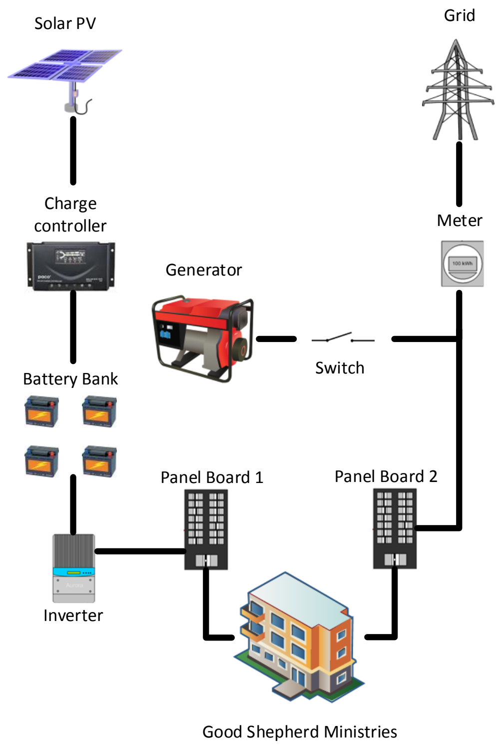


Figure 13: System Concept

6.3.2 Solar Photovoltaic System

The first component of the microgrid system, the solar photovoltaic system, will provide energy to Good Shepherd Ministries by converting solar radiation energy into usable electrical energy using solar panels. Northern Lights Solutions suggests that Good Shepherd Ministries uses the CS6P-260P solar module, sold by Canadian Solar. With regards to the system layout, each module is 982x1638x40mm with a minimum spacing of 500mm between panels **[8].** The proposed system layout is comprised of 145 CS6P-260P modules, each with a nominal maximum power of 260W, giving the entire system a maximum power of 37.7kW. The PV cells will collect energy during the day while the sun is out and use that energy to lower Good Shepherd Ministries' load demands, especially during peak energy hours. These PV cells will be mounted on brackets at 10 degrees to allow for maximal power generation. The PV cells will be fully braced to resist the strong winds of Toronto, especially during storms. Figure 14 shows a Revit model rendering of the building with the proposed solar panel installation.

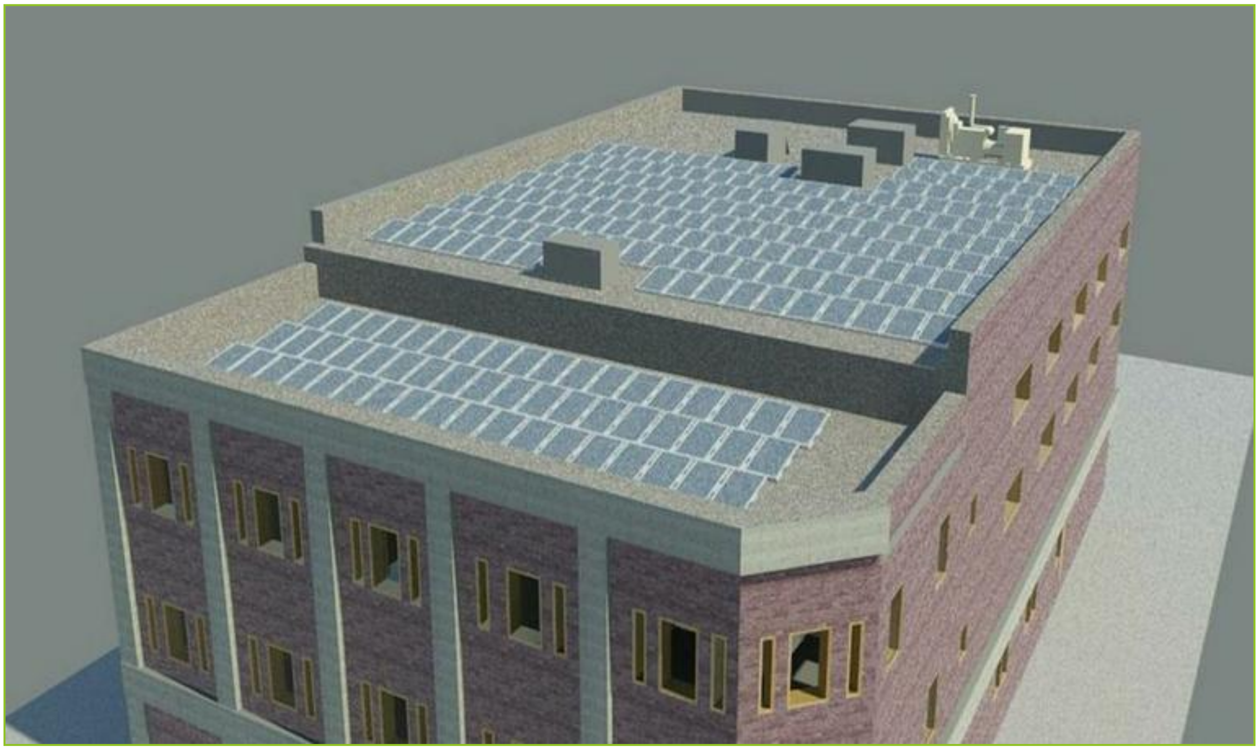


Figure 14: Proposed Solar System Layout (Render)

As energy is generated by the PV modules, it will be stored in the battery pack that will be located in the basement of the building. While the batteries will allow the system to reduce peak load demands, its main function will be to allow this system to continue short term operation in the event of a loss of power. To determine the sizing of the batteries, Good Shepherd Ministries made a design assumption that it will take 30 minutes for the automatic switch to activate the diesel generator (see section 6.3.3) in the event of a power loss, and as such the batteries must support Good Shepherd Ministries' critical loads for this period of time. The critical loads include all those that operate constantly including: medical equipment, lighting, fire pumps and plug loads. Following the specified design procedure in **[9]** and considering these critical loads must last for thirty minutes, the batteries combined should have at least 310AH. Northern Lights Solutions suggests Good Shepherd Ministries use the S-500EX battery sold by Rolls Battery **[10].** Good Shepherd Ministries could also decide to use a much larger battery bank which would allow the building to operate off-grid using solar energy for a larger amount of time; however this design will use a diesel generator to compensate for this lost energy.

In addition to the batteries, the inverter size must match the maximum generation capacity of the PV system. The inverter converts the direct current (DC) into alternating current (AC) electricity which can be used by the building. Northern Lights Solutions suggests using the CSI-12KDT-GW sold by Canadian Solar **[11].** Finally, once all of the components of the system are designed to meet the requirements, a system controller must be chosen to meet Good Shepherd Ministries' energy requirements similar to the Microgrid Control System (MCS) offered by

General Electric **[12],** which automatically creates load forecasts and optimizes energy costs. The system controller will determine when power should be stored or used to lower demand. While the solar PV system will provide Good Shepherd Ministries with clean energy, it cannot supply the energy required to meet all of their critical loads and for this reason a generator must be added for backup power considerations.

6.3.3 Diesel Generator

Following the generator sizing guide provided by Siemens **[13]**, and accounting for the power supplied by the solar system, Northern Lights Solutions has determined that the generator needs to be sized for 200 kW to support the starting loads of the HVAC system. Based on a comprehensive research of available generators, Northern Lights Solutions proposes that a Generac SD200 generator is installed **[14]**. Figure 15 is a picture of the generator.

Northern Lights Solutions is proposing to install the generator on the roof of the building. The generator will be equipped with a weatherproof enclosure to protect it from the elements. Preliminary structural analysis showed that this is a feasible option. Northern Lights Solutions will perform more in-depth calculation upon Notice to Proceed. The advantage of it being on the roof is that it will not take up valuable indoor space, and eliminates the need for a ventilation system. If this alternative is deemed infeasible upon further analysis, Northern Lights Solutions will develop a proposal to install the generator in the basement. That installation would be performed following NFPA 110 and NFPA 37 provisions to ensure operation of the generator is safe for occupants.

Moreover, the generator will be equipped with a 1325 gallon tank that will allow the generator to run for up to 90 hours, which will be more than enough to meet the 3 day recovery time objective outlined in section 6.2. The tank and generator will be incorporated in a single unit.

Lastly, Northern Lights Solutions proposes that a Generac 600 VAC HTS smart switch is installed **[15].** This switch will be used to transfer the power from the grid to the generator during an outage. The switch shall be located beside the existing panelboards in the electrical room.

Figure 15: Generac SD200 generator

7 Schematic Estimate, Schedule, & Finance Plan

7.1 Proposed Project Cost Estimate

With the assistance of Alltrade Industrial and Graybar Canada, Table 11 presents the cost estimate for the entire project for Good Shepherd Ministries, broken down into the different design components, namely the lighting retrofit, the generator, and the solar photovoltaic system. This estimate includes labour and several ancillary costs, including permit acquisition, equipment rental, and travel expenses. Costs for the detailed design of each of the design components were estimated at 2% of the total lighting cost for the lighting design, 18% for the generator, and 8% for the solar. A 6% margin for overhead and profit was also included in the estimate. The total proposed project cost is **$420,864**.

Annual operations and maintenance costs for the three major components of the design have been estimated at $5,000. As well, as seen in the specifications sheets for the design components, they are all expected to last longer than 20 years, therefore the expected replacement costs for this project over that span is zero.

It is worth noting that the estimate is exclusive of any government (or otherwise) grants or incentives. Any funding that will be utilized by Northern Lights Solutions, as well as the impacts that it will have on the total project cost, return on investment, and payback period will be presented in section 7.3.

Table 11: Project Cost Estimate

Category	Description	Quantity	Units	Material Cost ($/units)	Cost (15% markup) ($)	Hours	Labour Cost ($)	Total Cost ($)
Design Costs								
	Design of Lighting							$1,000.00
	Design of Generator							$20,000.00
	Design of Solar							$15,000.00
Lighting								
	18 Watt LED 4ft tube w/ diffuser	76	ea	$96.93	$8,471.68	76	$29,047.00	$42,971.00
	18 Watt LED 4ft tube	19	ea	$71.93	$1,571.67	19		
	Remove 18 Watt LED 4ft tube w/ diffuser	62	ea	-	-	31		
	Remove 18 Watt LED 4ft tube	114	ea	-	-	57		
	Disposal of old fixtures	176	ea	$10.00	$2,024.00	-		
	Occupancy Sensors	40	ea	$20.00	$920.00	20		
Generator								
	200 kW Generac SD200	1	ea	$54,000.00	$62,100.00	16	$14,680.00	$113,188.00
	Install on Roof	1	ea	$8,000.00	$9,200.00	16		
	Transfer Switch	1	ea	$10,000.00	$11,500.00	8		
	2" Rigid Steel Conduit Assembly	0.8	c/feet	$1,138.20	$1,047.14	14.4		
	# 3/0 T-90 / R-90 Wire	80	m	$6.64	$610.88	6.56		
	# 3/0 Wire Termination	6	ea	$2.10	$14.49	3.9		
	Controls Wiring							
	1" Rigid Steel Conduit Assembly	0.8	c/feet	$474.34	$436.39	9.6		
	# 12 T-90 / R-90 Wire	267	m	$0.43	$132.03	5.33		
	# 12 Wire Termination	20	ea	$0.53	$12.19	3		
	Main Breaker							
	200a Breaker to tie in transfer switch	1	ea	$6,000.00	$6,900.00	8		
	1325g Diesel Tank	1	ea	$5,000.00	$5,750.00	8		
	diesel fuel for startup and commissioning	500	L	$1.20	$690.00	-		
	Commissioning	1	Lot	$100.00	$115.00	16		
Solar								
	40kW Solar Panel Install						$44,040.00	$180,334.00
	145 Panels	40000	W	$0.80	$36,800.00	80		
	Racking	40000	W	$0.20	$9,200.00	80		
	balance of system	40000	W	$0.25	$11,500.00	80		
	10kW Invertor	4	ea	$9,000.00	$41,400.00	32		
	1" Rigid Steel Conduit Assembly	0.8	c/feet	$474.34	$436.39	9.6		
	# 6 T-90 / R-90 Wire	80	m	$1.25	$115.00	2.8		
	# 6 Wire Termination	6	ea	$0.79	$5.45	1.8		
	Batteries	6	ea	$5,000.00	$34,500.00	48		
	1" EMT Conduit Assembly	0.1	c/feet	$159.16	$18.30	0.6		
	# 6 T-90 / R-90 Wire	10	m	$1.25	$14.38	0.35		
	# 6 Wire Termination	6	ea	$0.79	$5.45	1.8		
	Main Breaker							
	60a Breaker to tie in transfer switch	1	ea	$2,000.00	$2,300.00	8		
Additional Costs								
	Permits							$5,750.00
	Consumables (5%)							$2,928.00
	Tools and Rentals							
	Equipment rentals							$6,113.40
	Small Tools (3%)							$1,757.20
	Fuel Surcharge (2%)							$1,171.00
	Travel and Site Expenses							$6,829.00
							Subtotal	**$397,041.60**
							Overhead and Profit	$23,822.50
							Project Total	**$420,864.10**

7.2 Proposed Project Schedule

Northern Lights Solutions has developed a preliminary project schedule for this proposal. The schedule incorporates all of the tasks needed to take this project from the proposal stage to installation and commissioning. Northern Lights Solutions has developed this proposal from the perspective of a design-build electrical contractor, which is reflected in the project schedule.

Following the pre-construction tasks, Northern Lights Solutions will begin two parallel streams of work. The first one is the development of the following two ancillary plans:

- **Outreach and Business Development Plan.** Northern Lights Solutions will consult with Good Shepherd Ministries to refine the Outreach and Business Development plan outlined in this proposal, and will identify opportunities to continue the outreach effort throughout the project implementation phases.
- **Resiliency Plan.** Northern Lights Solutions will work with Good Shepherd Ministries' staff to develop a better understanding of their day-to-day operations and their needs during a power outage situation in order to develop a comprehensive resiliency plan that builds upon the preliminary plan outlined in this proposal. This resiliency plan will incorporate detailed information on how to operate during a power outage situation, as well as instructions to test and maintain the system to ensure it is always operational.

The second stream of work will be the completion of the system design. This proposal contains a conceptual design, which still needs detailing and engineering design for certain components, as well as an assessment of the current electrical system to ensure it will be able to handle the upgrades. During the design phase, Northern Lights Solutions will oversee the completion of the technical design as well as the procurement of permits for the project.

Following the design phase, Northern Lights Solutions will oversee the selection of sub-contractors for installation. Although listed as separate subcontractors, Northern Lights Solutions proposes to allow sub-contractors to bid for more than one installation, potentially having only one subcontractor doing the installation for all three system elements.

After the design phase, three main installation phases will occur: one for the lighting retrofit, one for the solar PV system, and one for the generator. The lighting retrofit will be scheduled to be performed at times of the day that do not affect Good Shepherd Ministries' operations. During the night, the kitchen and dining room areas will be installed, and during the day, the dormitories and hallways will be installed. The solar PV and generator installations will be done mostly outside and in the electrical and mechanical rooms, so as to not affect Good Shepherd Ministries' operations.

As shown in Figure 16, the project should be completed in just over five months.

ID	Task Name	Duration	Start	Finish
1	**Pre-construction**	**19 days**	**Mon 7/6/15**	**Thu 7/30/15**
2	Notice to proceed	0 days	Mon 7/6/15	Mon 7/6/15
3	Sign Contract	1 day	Mon 7/6/15	Mon 7/6/15
4	Kick-off meeting	1 day	Thu 7/16/15	Thu 7/16/15
5	Prepare project schedule	10 days	Fri 7/17/15	Thu 7/30/15
6	**Ancillary Plans**	**88 days**	**Fri 7/17/15**	**Tue 11/17/15**
7	Develop outreach strategy	5 days	Fri 7/17/15	Thu 7/23/15
8	Develop resiliency plan	21 days	Fri 7/17/15	Fri 8/14/15
9	Execute outreach strategy	83 days	Fri 7/24/15	Tue 11/17/15
10	**Design Phase**	**55 days**	**Fri 7/31/15**	**Thu 10/15/15**
11	Complete Lighting Design	10 days	Fri 7/31/15	Thu 8/13/15
12	Complete solar design	14 days	Fri 7/31/15	Wed 8/19/15
13	Complete generator system design	28 days	Fri 7/31/15	Tue 9/8/15
14	Prepare shop drawings	12 days	Wed 9/9/15	Thu 9/24/15
15	Review design	5 days	Fri 9/25/15	Thu 10/1/15
16	Final Design approval	0 days	Thu 10/1/15	Thu 10/1/15
17	Obtain Permits	10 days	Fri 10/2/15	Thu 10/15/15
18	**Lighting Retrofit**	**17 days**	**Fri 10/16/15**	**Mon 11/9/15**
19	Contractor selection and award	7 days	Fri 10/16/15	Mon 10/26/15
20	Material procurement	1 day	Tue 10/27/15	Tue 10/27/15
21	Installation - first floor	4 days	Wed 10/28/15	Mon 11/2/15
22	Installation- second floor	2 days	Tue 11/3/15	Wed 11/4/15
23	Installation- third floor	2 days	Thu 11/5/15	Fri 11/6/15
24	Commisioning and testing	1 day	Mon 11/9/15	Mon 11/9/15
25	**Solar PV**	**27 days**	**Fri 10/16/15**	**Mon 11/23/15**
26	Contractor selection and award	7 days	Fri 10/16/15	Mon 10/26/15
27	Material procurement	1 day	Tue 10/27/15	Tue 10/27/15
28	Delivery and hoisting	5 days	Fri 10/30/15	Thu 11/5/15
29	Racking	7 days	Mon 11/2/15	Tue 11/10/15
30	Balancing of system	7 days	Wed 11/11/15	Thu 11/19/15
31	Commisioning and testing	2 days	Fri 11/20/15	Mon 11/23/15
32	**Generator**	**27 days**	**Fri 10/16/15**	**Mon 11/23/15**
33	Contractor selection and award	7 days	Fri 10/16/15	Mon 10/26/15
34	Material procurement	1 day	Tue 10/27/15	Tue 10/27/15
35	Delivery	2 days	Wed 10/28/15	Thu 10/29/15
36	Generator installation	2 days	Fri 10/30/15	Mon 11/2/15
37	Transfer switch installation	3 days	Tue 11/3/15	Thu 11/5/15
38	Controls and wiring installation	2 days	Tue 11/3/15	Wed 11/4/15
39	Main breaker installation	1 day	Tue 11/3/15	Tue 11/3/15
40	Tank installation	10 days	Fri 11/6/15	Thu 11/19/15
41	Commisioning and testing	2 days	Fri 11/20/15	Mon 11/23/15
42	**Closeout**	**4 days**	**Tue 11/24/15**	**Fri 11/27/15**
43	Operator training	2 days	Tue 11/24/15	Wed 11/25/15
44	Final acceptance testing	2 days	Thu 11/26/15	Fri 11/27/15
45	Project completion	0 days	Fri 11/27/15	Fri 11/27/15

Project: GSM Retrofit.mpp
Date: Mon 4/20/15

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

Page 1

Figure 16: Project Schedule

7.3 Proposed Finance & Cash Flow Plan

7.3.1 Grants & Incentives

Northern Lights Solutions explored several options for grants and/or incentives that will reduce the total cost of the project. The team has identified three programs that would in total reduce the total cost by $62,209. Table 12 outlines the details, and a brief explanation of each follows.

Table 12: Grant and Incentive Programs

Description	Quantity	Rate	Savings
Live Green Toronto	1	$25,000	$25,000
Community Energy Partnership Program	1	$30,000	$30,000
Industrial Accelerator – Retrofit (lighting)	7.08 kW (lighting)	$400/kW (lighting)	$2,832
Industrial Accelerator – Retrofit (solar)	43.77 MWh/year (solar)	$0.10/kWh (solar)	$4,377
		Total	**$62,209**

7.3.1.1 Live Green Toronto Grants

The Live Green Toronto Community Grant program provides funding Toronto-based projects that reduce greenhouse gases, improve air and water quality, and/or help adapt to the negative impacts of climate change. The grant can cover up to $25,000 of the cost of the project **[16]**.

7.3.1.2 The Community Energy Partnership Program

The Community Energy Partnerships Program (CEPP) is a grant program to support community power in Ontario. The program provides funding for co-operatives to develop renewable energy generation. The program assists in paying for paying up to $30,000 of the costs associated with developing renewable energy projects **[17]**.

7.3.1.3 IESO Industrial Accelerator – Retrofit

The Industrial Accelerator – Retrofit program by the Independent Electricity System Operator (IESO) provides an incentive for organizations that reduce their electricity demand especially if it is during peak hours. A portion of the initial cost is paid for based on the energy savings that will be made. The amount will be $400 for every kW of demand reduced in lighting savings and $0.10 for every kWh reduced in one year **[18]**.

7.3.2 Finance & Cash Flow Plan

7.3.2.1 Project Financing

Table 13 outlines the total cost, return on investment, and payback period for the entire project. In the calculation of energy savings, the Green Energy Challenge rate of $0.25/kWh was used, and an average of 1161 hours of sunshine per year in Toronto was used for calculating the energy savings of the solar panels **[19]**. The return on investment for the complete project is 5.2%, and the payback period is just over 19 years.

Table 13: Project Return on Investment & Payback

	Lighting	Generator	Solar	Total
Cost	$42,971	$113,188	$180,334	**$420,864**
Incentives				**$62,209**
Energy Savings	$7,781	N/A	$10,942	**$18,723**
Return on Investment	18.11%	N/A	6.07%	**5.22%**
Payback (Years)	5.52	N/A	16.48	**19.16**

Using NECAWORKS, Northern Lights Solutions was able to determine the benefit/cost ratios for the lighting and solar components of the project, as well as the ratio for those two design components combined. As shown in Figure 14, the combined benefit/cost ratio is 1.0.

Table 14: Benefit/Cost Ratios

	Benefit/Cost Ratio
Lighting	1.55
Solar	0.72
Total	**1.0**

7.3.2.2 Project Cash Flow

Assuming that Good Shepherd Ministries does not have sufficient cash on hand to pay for the entire project cost, a total of **$358,655** up front, Northern Lights Solutions suggests the use of a bank loan, as outlined in Table 15. Using the total annual energy savings from the project, as well as a $1,000/month payment, the loan will be paid off in approximately 17 years assuming an interest rate of 5%. Figure 17 is a visualization of the term of the loan.

Table 15: Cash Flow Data

	Project	Bank Loan
Project Cost	$420,864	
Incentives	$62,209	
Total Bank Loan (P)		$358,655
Annual Savings	$18,723	
Annual Capital Payment		$12,000
Total Annual Payment (A)		$30,723
Interest Rate (i)		5%
A/P		0.08566307
Loan Payback (years)		**17**

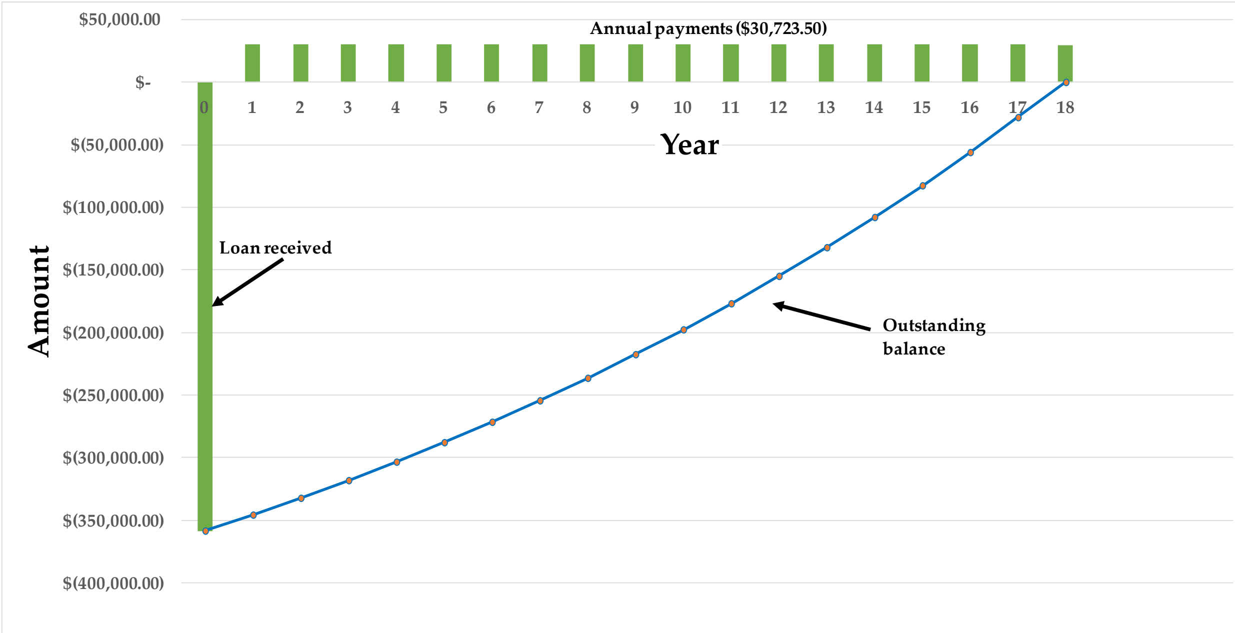


Figure 17: Project Cash Flow Plan

7.3.2.3 IESO Feed-in-tariff (FIT) Program

The FIT system is designed to encourage the construction of small, embedded renewable energy projects. Through the program, the system operator offers long-term contracts to buy clean electricity at above-market rates. A solar project such as the one included in this design would be eligible to receive $0.343/kWh produced for the next 20 years **[20]**. Though this program offers a much greater financial incentive than the IESO Industrial Accelerator, FIT contracts require that the solar PV be grid-tied. This configuration would therefore not be able to supply energy in the case of a power outage, so Good Shepherd Ministries would have to rely completely on the generator, thereby decreasing the overall resiliency of the system. Therefore, Northern Lights Solutions does not propose the use of the FIT program; however, should Good Shepherd Ministries like to pursue this alternative; this can be re-evaluated upon Notice to Proceed.

8 Outreach

8.1 Energy Awareness & Business Development

Northern Lights Solutions has developed a comprehensive business development plan to promote energy awareness through the project solution that is complimentary to and builds upon several existing initiatives in the City of Toronto. The plan leverages a combination of events, online resources and other activities to maximize target audience.

8.1.1 Project Blog

Northern Lights Solutions developed an online blog to share the progress of the project with the community. Two entries have already been published to the blog, and it has received 134 visitors and has 8 email followers.

Figure 18: First blog entry

Northern Lights Solutions proposes that, following Notice to Proceed, the blog will continue to be updated. The online blog can also be integrated with Good Shepherd Ministries' website to increase visitors. Furthermore, this blog can be leveraged to share information on best practices related to energy savings so that readers not only learn about the status of the project but also learn energy-reducing strategies they can implement at home.

Figure 18 is a screenshot from the first blog entry, via www.cecauoft.wordpress.com

Figure 19 is a screenshot from the March CECA online newsletter, which featured a brief article about the blog.

CECA/NECA UNIVERSITY OF TORONTO STUDENT CHAPTER BLOG

Posted in Canadian Electrical Contractors Association (CECA) By **System Admin** On **Mar 25, 2015**

The Student Chapter has started a blog chronicling their current team projects. The Northern Lights Solutions is a new organization which was created in January 2015 as the official team of the Canadian Electrical Contractors Association (CECA)/ National Electrical Contractors Association (NECA) University of Toronto Student Chapter participating in the 2015 Green Energy Challenge, an international competition organized by ELECTRI International. The Group's Project Manager and President worked hard to identify potential clients for the competition, and eventually came across Good Shepherd Ministries. Good Shepherd Ministries is a charity organization that helps anyone in need in the City of Toronto. To read more about their involvement in the competition, follow their blog HERE.

Figure 19: Student Chapter Blog in CECA Newsletter

8.1.2 University of Toronto Sustainability Conference

Figure 20: Northern Lights Solutions at the U of T Sustainability Conference

Northern Lights Solutions attended existing conferences and events focused on sustainability as a key component of its' business development strategy. As the largest and most diverse city in Canada, Toronto hosts dozens of events where the team can advertise the project and increase energy awareness.

On January 31, 2015, Northern Lights Solutions participated in the University of Toronto Sustainability conference, an event organized by the Sustainable Engineers Association (Figure 20). This annual conference attracts thousands of students, academics and members of the university to participate in workshops, lectures, and a tradeshow of clubs that work on sustainability related topics. The team attracted hundreds of visitors to its booth who asked questions about the chapter, its history, and about the project. In the future, Northern Lights Solutions plans to work with Good Shepherd Ministries to identify similar events that can be used to promote this project.

8.1.3 Energy Jeopardy Competition

In addition to promoting the project through online resources and attendance at community events, Northern Lights Solutions organized several social events dedicated to promoting the project. These events were designed as fun, competitive challenges where participants could learn about the project and related topics on energy conservation in an informal setting.

For example, during the month of March, the University of Toronto Students Union organized the U of T ECOFest 2015, a month-long campaign to promote local events that focused on sustainability topics. Northern Lights Solutions organized an event to promote the project during this month to leverage this campus-wide initiative and increase attendance and interest. On March 27, 2015 Northern Lights Solutions hosted an "Energy Jeopardy" competition, where participants competed to test their knowledge on energy conservation topics. Six teams of two members each competed during a night filled with fun and learning about building science, green energy generation, and sustainable transportation, among other topics. Furthermore, Northern Lights Solutions' Project Manager took the opportunity at the start of the event to introduce the project and to promote the work with Good Shepherd Ministries. Figure 21 and Figure 22 contain pictures from the Energy Jeopardy event.

The event was a huge success, and the attendees were very satisfied with the results. Northern Lights Solutions proposes that, following Notice to Proceed, to work with Good Shepherd Ministries to identify further opportunities where similar events can be organized.

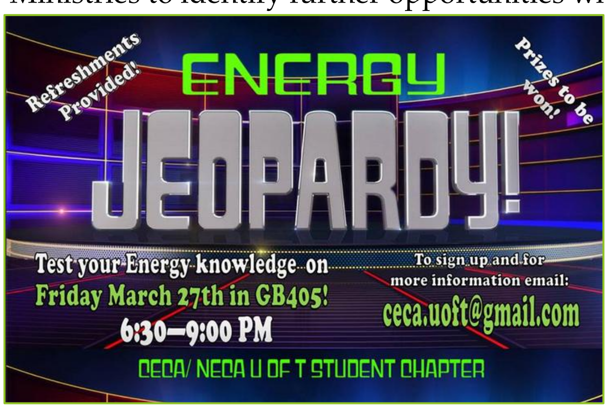


Figure 21: Energy Jeopardy Poster

Figure 22: Energy Jeopardy Winning Team

8.2 Feedback Letters

GOOD SHEPHERD MINISTRIES
WELCOME HOMELESS

April 15, 2015

Mr. Matheos Tsiaras
Project Manager, 2015 Green Energy Challenge
CECA/NECA University of Toronto Student Chapter
Room GB134, Galbraith Building
Department of Civil Engineering
University of Toronto
35 St. George Street
Toronto, ON M5S 1A4

Dear Mr. Tsiaras:

I am writing to thank you for the energy and time you have given to preparing a CECA/NECA submission for Good Shepherd Ministries.

It would be wonderful to have a micro-grid that would enable Good Shepherd to continue providing the essentials of life (food, water, shelter) to vulnerable individuals during a prolonged power outage, and that would help to reduce costs, both financial and environmental.

Your analysis of the Good Shepherd Centre building, including energy use and lighting, and services that need to continue during a power outage, shows a thorough understanding of the operations of the building and of Good Shepherd's numerous services.

Your concept of a solar power system combined with a diesel generator seems practical and detailed, and makes good use of the roof space available at Good Shepherd Centre. With a reduced environmental footprint and reduced energy costs, Good Shepherd will be able to focus more resources on the homeless and most neglected members of our community.

The detailed analysis of the lighting at Good Shepherd will definitely be helpful as we work to modernize this aspect of our facility working toward a more energy efficient and self-sustaining operation.

Thank you for your site visits, for researching the subject so thoroughly, and for providing such a comprehensive report of Good Shepherd Centre's energy needs. Your team has my enthusiastic support in the Green Energy Challenge, and I hope we will have the opportunity to work further on the micro-grid for Good Shepherd Centre.

Sincerely,

for David Lynch OH

Brother David Lynch, OH
Executive Director

CECA
ACEE
CANADIAN ELECTRICAL CONTRACTORS ASSOCIATION
ASSOCIATION CANADIENNE DES ENTREPRENEUR ELECTRICIENS

April 16, 2015

Northern Lights Solutions –
Canadian Electrical Contractors Association (CECA)/ National Electrical Contractors Association (NECA)
University of Toronto Student Chapter

Re: Feedback from CECA on the Green Energy Challenge submission by Northern Lights Solutions.

Attention: Matheos Tsiaras, Project Manager

Congratulations! It hardly seems that a year has passed since this all began but here we are. The amount of work that you have done to establish yourselves as NECA's first international chapter is nothing short of remarkable. The fact that you are producing a viable product for the 2015 Green Energy Challenge speaks to your unrelenting tenacity, drive and teamwork. We are proud to be associated with a group of young people that are certain to be among the future leaders of our industry.

CECA's role for your success as a Student Chapter has been as an industry resource, coordinating our people to help you. As a resource for your Green Energy submission we have contributed in the following ways: (1) Introduced you to the Good Shepherd Ministries, (2) attended and gave valuable insights at all site meetings, (3) provided a mentor, Bob Ritzmann of Alltrade Industrial Contractors Inc., who has been invaluable to this project (he in turn introduced Graybar as an industry partner), (4) contacted other industry partners (Milwaukee Tools) to help in the delivery stage of this project and (5) provided industry information and education, i.e. "Contractor 101" - blended learning version.

What has morphed from this is phenomenal. You have comported yourself with respect and maintained the highest degree of professionalism when dealing with Brother David Lynch, the staff and clientele of the Good Sheppard Ministries at all site meetings. Bob Ritzmann's feedback letter attests you have done the same with him as well. Your attention to detail in reporting progress has impressed all, especially with the formation of the Northern Lights Solutions – 2015 Green Energy Blog.

Suffice to say you have utilized your available resources well, organized your team effectively, put together a workable budget and taken responsibility to meet the strict time constraints of the competition to come up with a viable solution that will be implemented to aid the Good Shepherd Ministry.

On behalf of the CECA we wish Northern Lights Solutions great success in the 2015 Green Energy Challenge. Regardless of the outcome, your efforts to date have made all of you winners.

Yours truly

Tom Vivian, Standard Practices Consultant to the Canadian Electrical Contractors Association

460 – 170 Attwell Drive, Toronto, Ontario, Canada M9W 5Z5 T. 416.675.3226 F. 416.675.7736
ceca@ceca.org www.ceca.org

ALLTRADE
INDUSTRIAL CONTRACTORS INC.

April 15, 2015

University of Toronto – CECA Student Chapter

Attention: Matheos Tsiaras

I was asked by the ECAO office in Toronto a number of months ago to be an industry advisor to your University of Toronto CECA Student Chapter. After our initial meeting, I could sense the passion that your team has. This of course inspired me to be a part of your team.

Alltrade Industrial Contractors has been in business for almost 4 years now. We are a multi-trade contractor with electrical, mechanical, millwright, iron worker, and sheet metal trades, and just recently added our fabrication facility. We focus on the industrial and renewable energy sectors. With the Ontario FIT program currently underway, we have become experts in 10WM solar farm installations, and also roof top solar installations. Currently we have about 300 employees, and 90 service trucks on the road, doing both service and new construction.

So when I learned that your project was linked to the renewable energy sector, this fit right into the line of work our company has done well, and I was eager to help. I did also call several of our suppliers and was able to convince them to be a part of the team to assist your group.

Your team did a fantastic job in picking the Good Shepard Ministries building for this project. This organization provides a great service to the Toronto downtown area, and as a not for profit group is always looking to make their dollars go as far as possible. When your complete group came for the fact finding and audit processes, you were very respectful to the management of the Good Shepard Ministries, you provided them with specific tasks before the meeting, and they were able to deliver you utility bills, drawings, and some of the history of the building. I was impressed with your leadership, and really the whole group's efforts to pull all of the info together.

Of course as exciting as the theoretical part of the project is, I am really hoping we can bring this project to a reality as a step two. I am planning to raise the support from other contractors, and suppliers, and together with our company, to actually do the retrofit, and refurbishment required, so that the Good Shepherd Ministries can benefit from all of your groups work, and see the savings that this project can bring. I know they will put the savings into helping more people.

Regards,

Bob Ritzmann, President

Alltrade Industrial Contractors Inc.

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Feedback Letter - Alltrade.docx
www.alltradeindustrial.com

8.3 Articles in Department / University Newsletter

Not Just for the Average ECE: U of T's CECA

POLLY LIN
SENIOR EDITOR

For some Skule students, CECA is just another acronym, another short name for one of the many professional associations represented at the University of Toronto. However, the presence of CECA at U of T marks a great milestone for both the university and the electrical contracting industry.

CECA stands for the Canadian Electrical Contractors Association, and is the Canadian equivalent of NECA, the National Electrical Contractors Association. CECA represents over 8,000 electrical contractors across Canada who collectively generate over $5 billion in revenues, and directly employs more than 70,000 workers. U of T has had the honour and privilege of creating the 1st Student Chapter in all of Canada (the 30th student chapter of CECA/NECA overall), as well as the only student chapter outside of the United States.

Although generating awareness and encouraging students to pursue careers in the electrical contracting industry is one of CECA's goals, participation in the club is not limited to ECE students. In fact, the entire executive team, and most of the club's 25 members are Civil Engineering students. Contrary to its name, there is more to electrical contracting than electricity, and by the same extension, there is more to being a member of the club than being an ECE student. The CECA team wants to help students of all disciplines gain exposure to a relatively new industry in Canada, develop a passion for sustainable design, and hone various transferable skills such as networking and project management.

Spearheading the first CECA student chapter not only at UofT, but in the country is no small feat, but the executive council's positive attitude and perseverance made the success of the student chapter inevitable. Although its history at U of T is fairly short - only 10 months long since its April 30, 2014 inception - founders of UofT's CECA student chapter, president Ernesto Diaz Lozano Patino (CIV 1T5 +PEY), vice-president Kate Kazlovich (CIV 1T5 +PEY), and treasurer Stephanie Daou (CIV 1T5) are optimistic that this is only the start of a very bright future for CECA student chapters in Canadian universities. Patino says: "I realized this opportunity had a lot of potential to engage students from various disciplines and would add a lot of value to the student life. The success stories from the NECA chapters in the U.S. motivated me to want to initiate something like that in Canada, and make UofT the pioneer of this initiative." The two remaining executive members, Project Manager Matheos Tsiaras (CIV 1T5 +PEY), and Communications Coordinator Tiffany Ongtenco (CIV 1T5) joined the club months after, helping Patino to realize these goals at U of T.

"Our chapter is the only one of its kind in the country, and provides unique opportunities for students to work side by side with industry contractors in real-life design competitions and challenges. Additionally, we have access to a wide variety of educational resources from NECA, CECA and ELECTRI International.", continues Patino. With a number of successfully held events under their belt, the current focus of U of T's CECA club is its participation in The Green Energy Design Competition, an annual design competition open to all CECA/NECA student chapters.

This year, The Green Energy Challenge has the club retrofitting a building for Good Shepherd Ministries, a local charity in Toronto that provides services for the less fortunate. The project consists of developing a back-up power system in order to improve resiliency due to loss of utility power, as well as designing an energy retrofit for the building; the club is working on a design proposal to be submitted in late May. The top 3 teams will be given the opportunity to present their proposal to a panel of judges at the annual NECA convention in San Francisco, and will have the opportunity to win up to $4,000. However, for U of T's CECA Chapter, this is not only a design challenge that deals with the theoretical, the support behind the club is immense, and their proposed design will likely be implemented with the support of industry contractors, suppliers, and CECA members.

CECA may be considered a young club within the Faculty of Applied Science and Engineering at U of T, but its progress and goals are equivalent to those who have been here for years. In fact, Patino's aspirations for CECA at U of T is a great example of why the club has seen so many successes thus far, and will likely see many more: "I want to see student chapters being created in other Canadian universities, developing a network of Canadian chapters that eventually will become as strong as the one in the U.S. I want to see U of T being the quarterback behind this initiative, motivating others to follow our example and add momentum to the initiative."

The club encourages any and all interested students to talk to its current members and learn about the opportunities that they can offer. CECA will be holding a Jeopardy-style social event that is open to all participants on March 27, 2015, and students can contact CECA members at ceca.uoft@gmail.com. Let's all wish U of T's very own CECA Student Chapter the best of luck as they prepare to submit their Green Energy Challenge Proposal!

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- Staff & Faculty
- Research
- Alumni

Milestone: U of T Engineering Forms First CECA Student Chapter

by Polly Lin Indy1T6

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CECA may be considered a young club within the Faculty of Applied Science and Engineering at UofT, but its progress and goals are equivalent to those who have been here for years. In fact, Patino's aspirations for CECA at UofT is a great example of why the club has seen so many successes thus far, and will likely see many more: *"I want to see student chapters being created in other Canadian universities, developing a network of Canadian chapters that eventually will become as strong as the one in the U.S. I want to see UofT being the quarterback behind this initiative, motivating others to follow our example and add momentum to the initiative."*

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8.4 Local CECA Chapter Interaction

Throughout the project, Northern Lights Solutions enjoyed immense support from and interaction with several industry connections, including CECA, the Electrical Contractors Association of Ontario (ECAO), Alltrade Industrial, and Graybar Canada.

On September 19, 2014, several industry professionals attended the student chapter's first networking event, Fishbowl Conversations. This event gave students their first opportunity to learn about the electrical contracting industry in an informal question-and-answer environment, and allowed the student chapter to begin preparations and have initial conversations with the professionals about the Green Energy Challenge. Throughout the fall of 2014, the student chapter executives held several meetings with Tom Vivian of CECA, Eryl Roberts of ECAO, and Bob Ritzmann of Alltrade Industrial to discuss the general progress of the student chapter and the Green Energy Challenge as well. In fact, the inspiration for the selection of Good Shepherd Ministries as the client for the Green Energy Challenge came from Eryl Roberts, as he is a benefactor to the facility.

Throughout the challenge itself, Northern Lights Solutions was in constant communication with its industry sponsors. Several sponsors attended both visits to Good Shepherd Ministries and provided invaluable guidance and insight to the team as they documented their observations and conducted their analyses. Graybar Canada was of great assistance for the energy analysis and benchmarking, as were Alltrade Industrial and Graybar for price quotations and scheduling information of the design components.

Northern Lights Solutions further welcomed Tom Vivian of CECA, who delivered two interactive seminars called 'Contractor 101'. In these seminars, a case study was presented of a company that was dealing with personnel turnover, as well as determining whether or not to pursue a large project. Exercises with the seminar participants included creating the company organizational chart and performing a SWOT analysis for the new project it was considering pursuing.

Acknowledgments

Northern Lights Solutions would like to thank the following individuals for their support and assistance throughout the project:

University of Toronto

Brenda McCabe, Professor, Civil Engineering, Faculty Advisor to Student Chapter
Jeffrey Siegel, Professor, Civil Engineering
Alec Hay, Director, The Centre for Resilience of Critical Infrastructure

CECA/ECAO & Industry Sponsors

Tom Vivian, Standard Practices Consultant, CECA
David Mason, Vice President, CECA
Eryl Roberts, Executive VP & Labour Relations ECAO
Lucy Roberts, Public Relations & Finance, ECAO
Bob Ritzmann, President, Alltrade Industrial
Glen Hicks, Industrial Manager, Alltrade Industrial
James Neeb, Estimator/Coordinator, Alltrade Industrial
Gary Curran, Lighting Specialist Graybar Canada
Rob Horst, National Market Manager, Renewable Energy, Graybar Canada
Robert Foss, Regional Lighting Manager, Graybar Canada
Garry Fitzpatrick, retired electrical contractor

Good Shepherd Ministries

Brother David Lynch, OH, Executive Director
Wondy Ghessesse, Maintenance Operator
Aklilu Wendaferew, Assistant Executive Director
Eileen Wong, Executive Assistant
Adrienne Urquhart, Director, Fundraising & Public Relations

Technical References

[1] Good Shepherd Ministries (2015). *About Good Shepherd*. Retrieved from http://www.goodshepherd.ca/about/#overview

[2] Good Shepherd Ministries (2015). *Programs & Services.* Retrieved from: http://www.goodshepherd.ca/programs-services/good-shepherd-centre

[3] Canada LED Lighting (2015). *T8 LED Tube 18W.* Retrieved from: http://www.canadaledlighting.com/t8-led-tube-18w-p-7206.html

[4] The Home Depot (2015) *Lutrom Maestro Small Sensing Switch.* Retrieved from: http://www.homedepot.ca/product/maestro-small-room-occupancy-sensing-switch/991493

[5] USAID. (2015). *Load Analysis and Example Calculations*. Retrieved from: http://www.poweringhealth.org/index.php/topics/management/load-analysis-and-example-calculations

[6] ClimaTemps. (2005). *Average Temperatures in Toronto*. Retrieved from: http://www.toronto.climatemps.com/temperatures.php

[7] Hay, A. (2015). *Operational Survival – Putting Resilience at the Core of Infrastructure Planning*. London: Explora Research Limited.

[8] Canadian Solar. (2015) *CS6- 255 260P.* Retrieved from: http://www.canadiansolar.com/fileadmin/user_upload/downloads/datasheets/Datasheet_CS6P-P_en.pdf

[9] Instructables. (2015) *How to Size Your Off-Grid Batteries.* Retrieved from: http://www.instructables.com/id/How-to-Size-Your-Off-Grid-Solar-Batteries-1/

[10] Rolls Battery Engineering. (2015) *S-500EX*. Retrieved from: http://rollsbattery.com/public/specsheets/S-500EX.pdf

[11] Canadian Solar. (2015). *CSI-12KDT-GW Inverter*. Retrieved from: http://www.canadiansolar.com/ca/product_pro_detail.aspx?id=41&s=inverter

[12] General Electric Digital Energy. (2015) *Grid IQ Microgrid Control System.* Retrieved from: https://www.gedigitalenergy.com/multilin/catalog/mcs.htm#mcs3

[13] Siemens. (2011) *Generator Sizing Guide.* Retrieved from: www.siemens.com/download?BTLV_40972

[14] Generac Industrial Power. (2011) *SD200 Datasheet*. Retrieved from: http://www.generac.com/generaccorporate/media/library/content/all-products/generators/industrial-generators/diesel/0185760sby-c-sd200-8-7l.pdf?ext=.pdf

[15] Generac Industrial Power. (2011) *HTS Transfer Switch Datasheet*. Retrieved from: http://gens.lccdn.com/GeneracCorporate/media/Library/content/all-products/transfer-switches/business-transfer-switches/0172720SBY-A-HTS-600-1000-transfer-switch.pdf

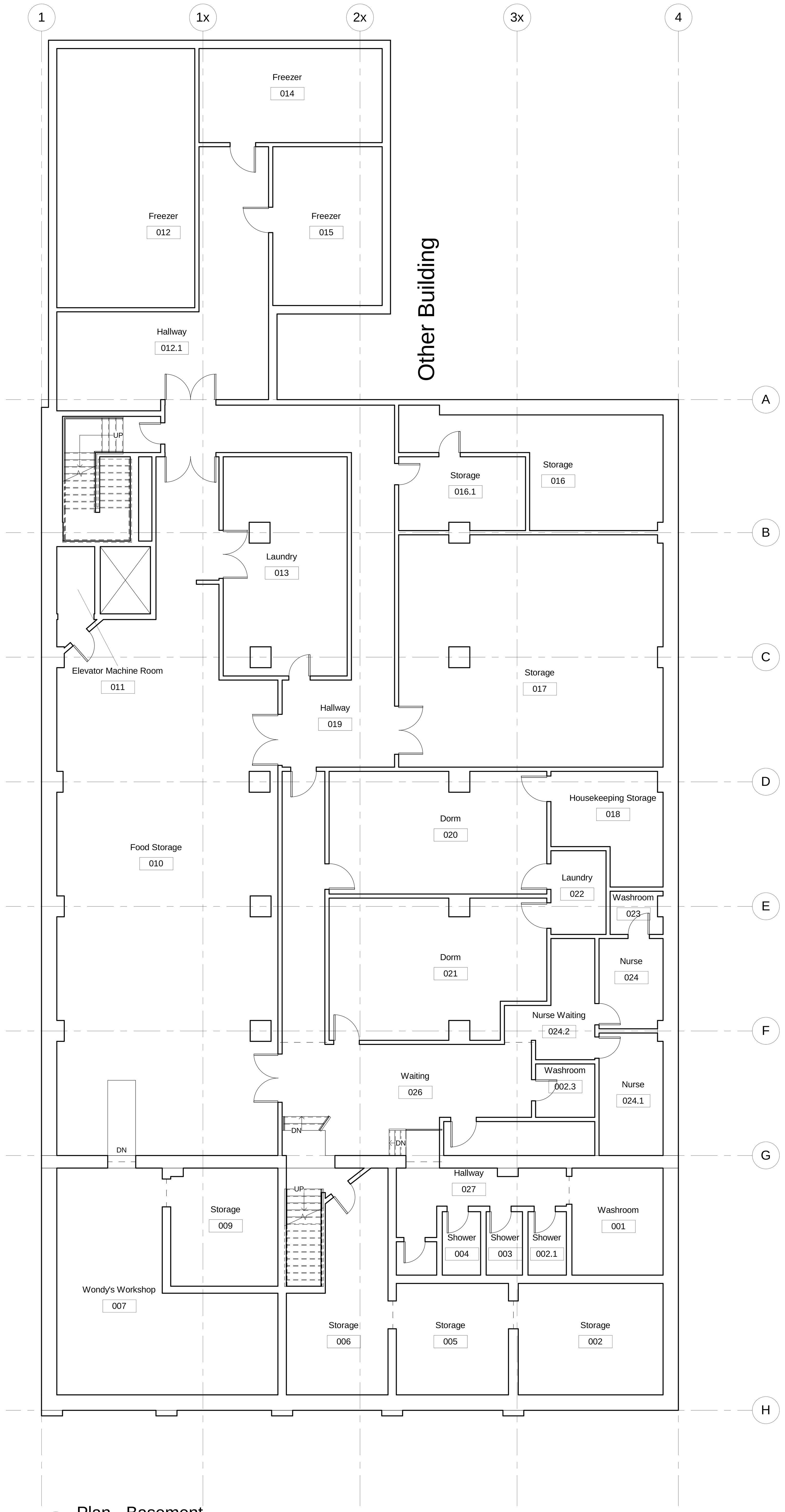
[16] City of Toronto. (2015) *Live Green Toronto Grants.* Retrieved from: http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=393847232bee7410VgnVCM10000071d60f89RCRD

[17] Community Energy Partnerships Program. (2014) *CEPP transition to the consolidated program.* Retrieved from: http://www.communityenergyprogram.ca/Project_Grants/Project_Grants_OverviewPage.aspx

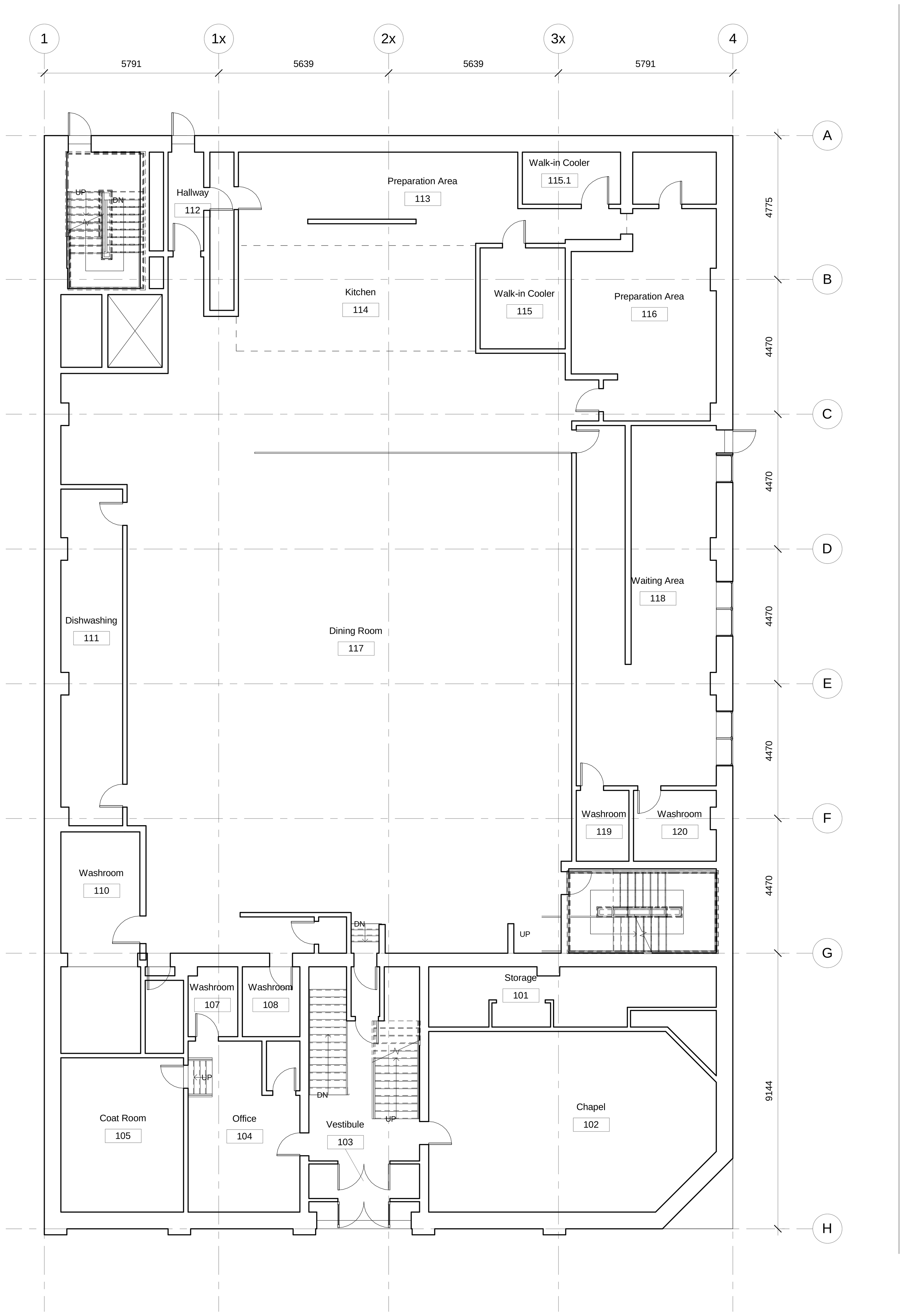
[18] Independent Electricity System Operator. (2015) *Industrial Accelerator.* Retrieved from: http://www.industrialaccelerator.ca/retrofit/overview

[19] Natural Resources Canada. (2014) *Photovoltaic potential and solar resource maps of Canada.* Retrieved from: http://pv.nrcan.gc.ca/index.php?m=r

[20] Independent Electricity System Operator. (2015) *FIT Price Schedule.* Retrieved from: http://fit.powerauthority.on.ca/fit-program/fit-program-pricing/fit-price-schedule



1 Plan - Basement
1 : 75



2 Plan - 1st Floor
1 : 75

Nothern Light Solutions

No.	Description	Date

2015 Green Energy Challenge
Good Shepherd Ministries

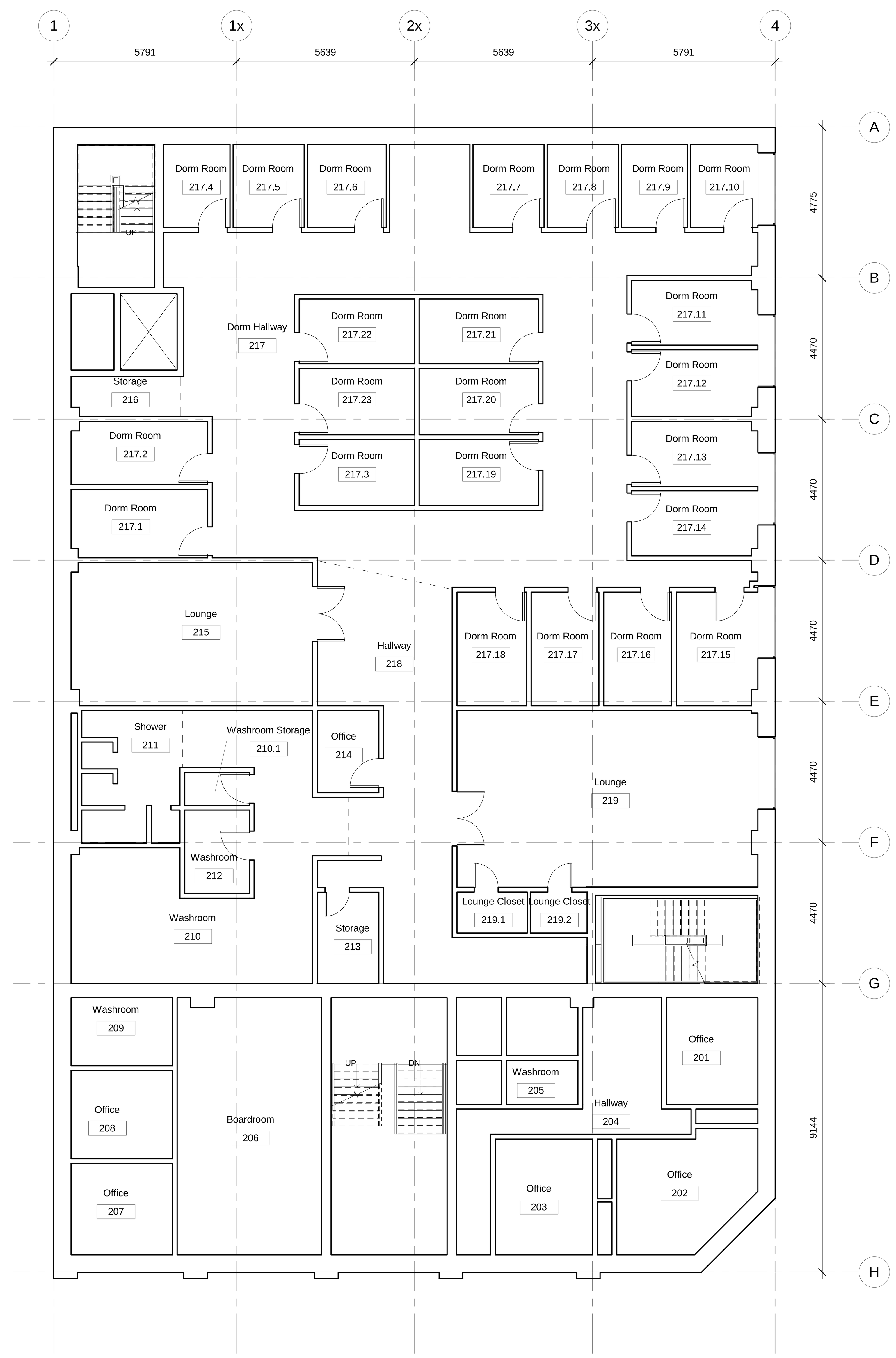
Plan - Basement, 1st Floor

Project number	0001
Date	March 9, 2015
Drawn by	DN
Checked by	MT

A100

Scale	1 : 75

20-Apr-15 9:54:20 AM



1 Plan - 2nd Floor
1 : 75

2 Plan - 3rd Floor
1 : 75

Nothern Light Solutions

No.	Description	Date

2015 Green Energy Challenge
Good Shepherd Ministries

Plan - 2nd Floor, 3rd Floor

Project number	0001
Date	March 9, 2015
Drawn by	DN
Checked by	MT

A101

Scale 1 : 75

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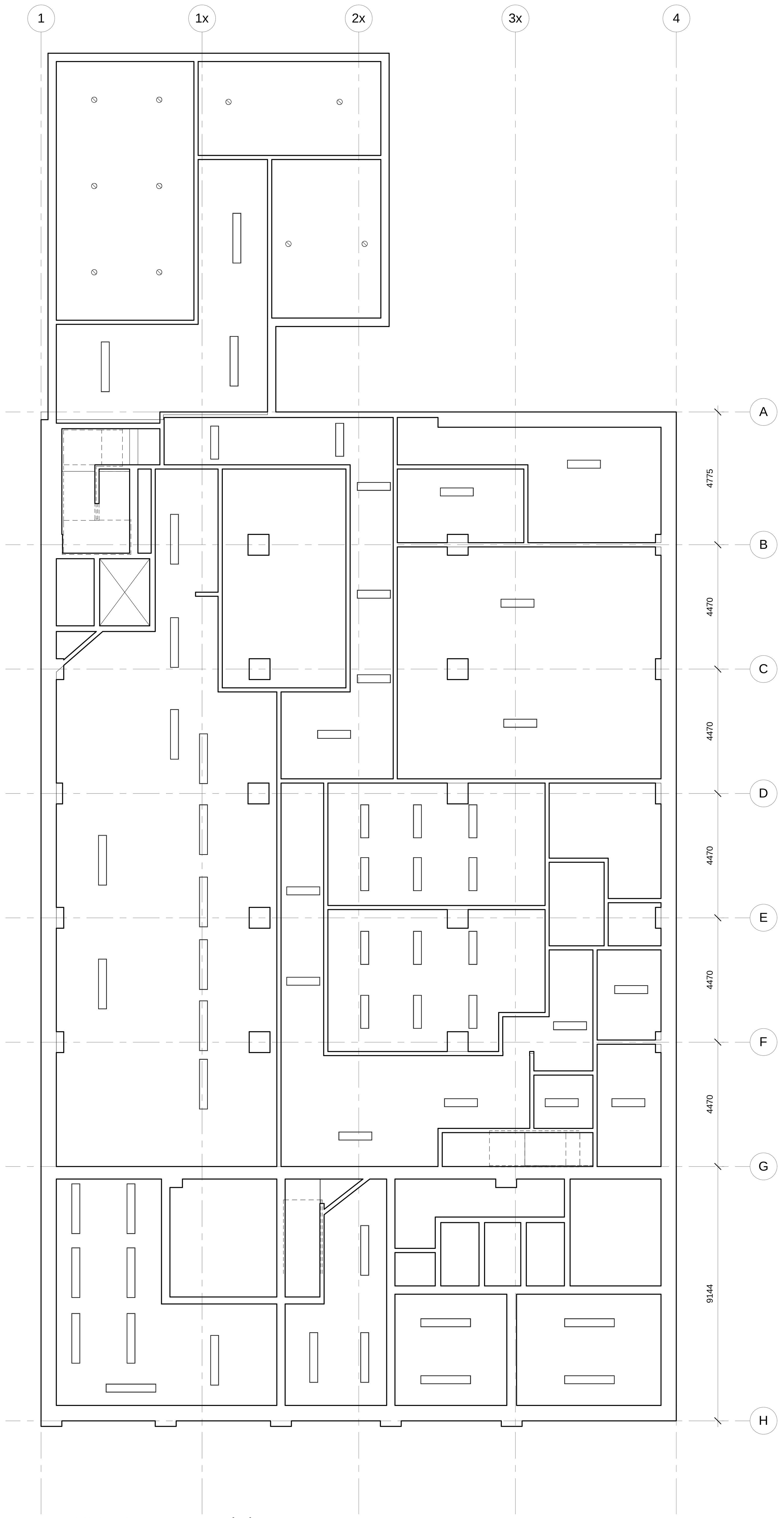
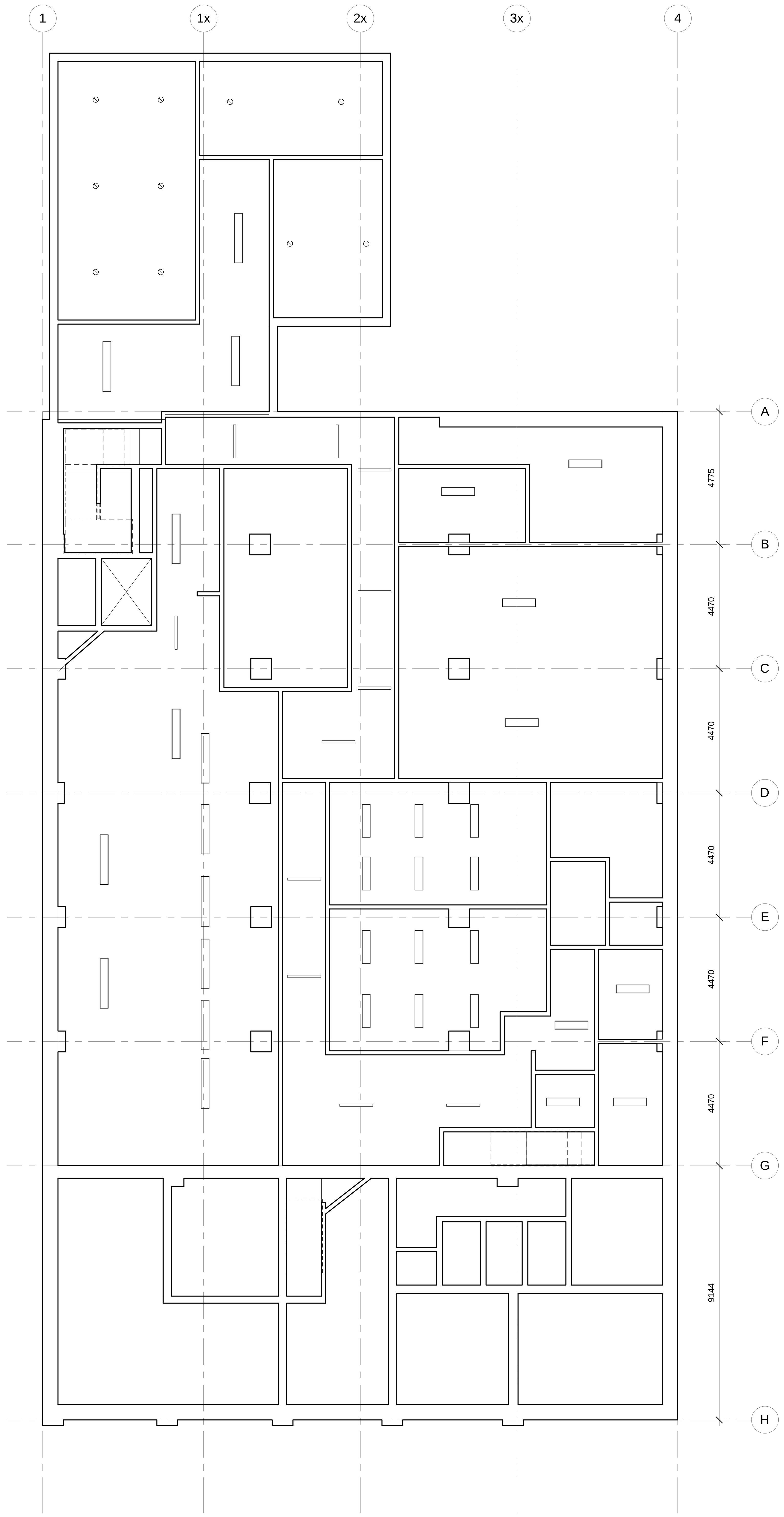


1 RCP - Basement - Existing
1 : 75



2 RCP - Basement - Proposed
1 : 75

Fixture Symbol	Fixture Type
	13W CFL Ceiling Pot Light
	32W Fluorescent U light
	75W 6 foot Fluorescent Light
	40W 4 foot Fluorescent Light
	75W Halogen Flood Light
	18W LED Tube Light

Nothern Light Solutions

No.	Description	Date

2015 Green Energy Challenge
Good Shepherd Ministries

RCP - Basement

Project number	0001
Date	March 9, 2015
Drawn by	DN
Checked by	MT

A102

Scale 1 : 75

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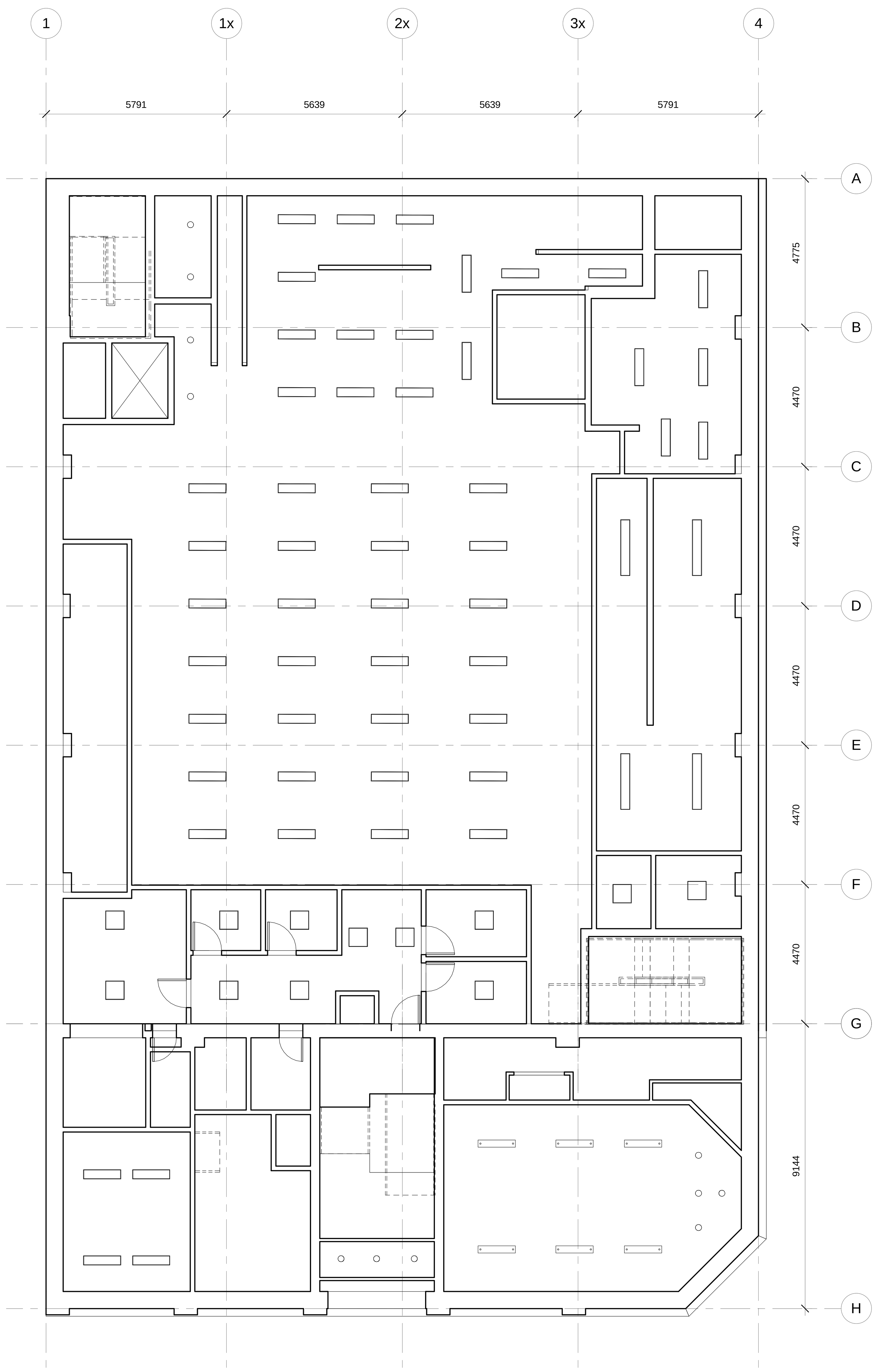
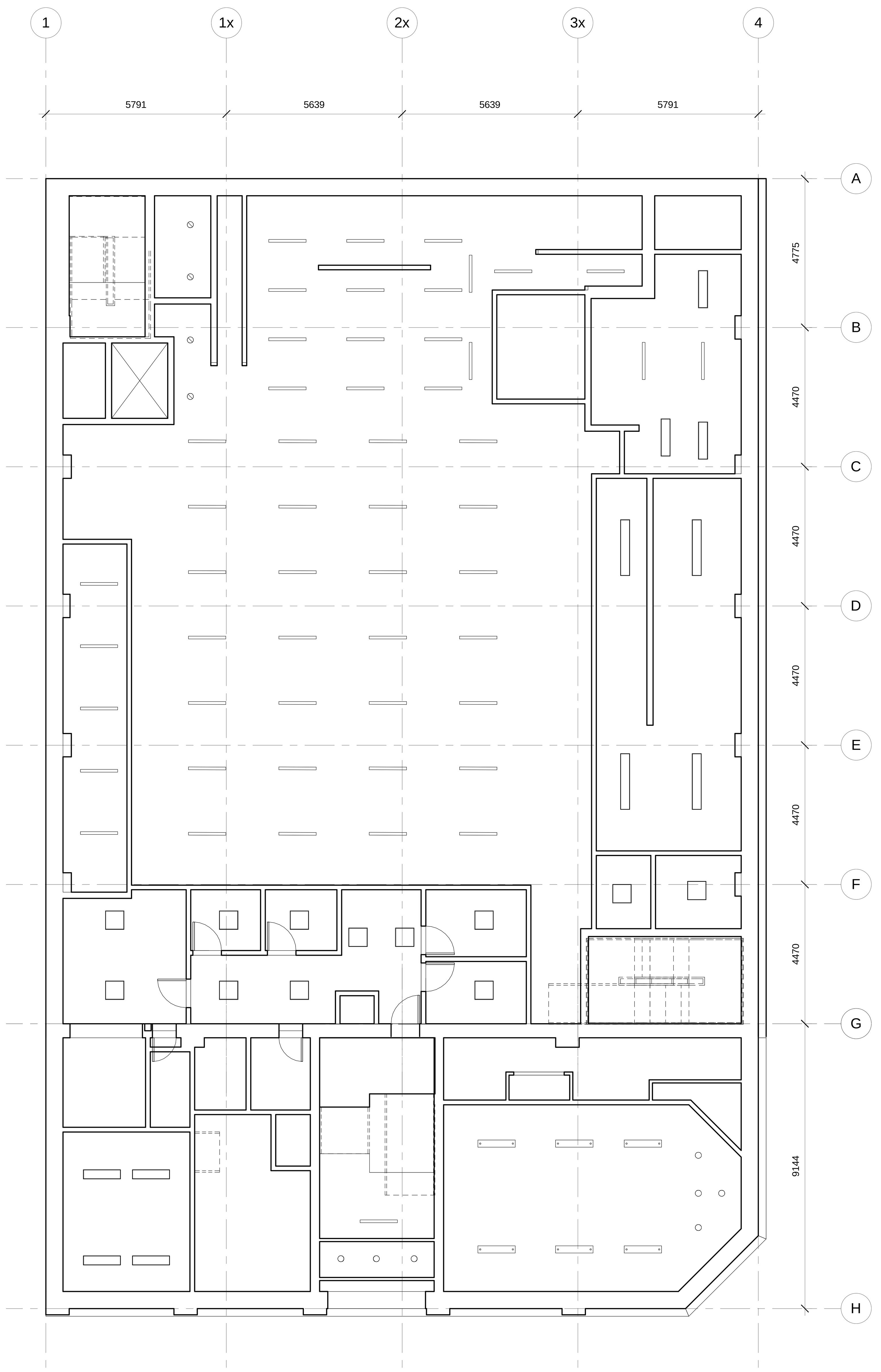


1 RCP - 1st Floor - Existing
1 : 75



2 RCP - 1st Floor - Proposed
1 : 75

Fixture Symbol	Fixture Type
	13W CFL Ceiling Pot Light
	32W Fluorescent U light
	75W 6 foot Fluorescent Light
	40W 4 foot Fluorescent Light
	75W Halogen Flood Light
	18W LED Tube Light

Nothern Light Solutions

No.	Description	Date

2015 Green Energy Challenge
Good Shepherd Ministries

RCP - 1st Floor

Project number	0001
Date	March 9, 2015
Drawn by	DN
Checked by	MT

A103

Scale 1 : 75

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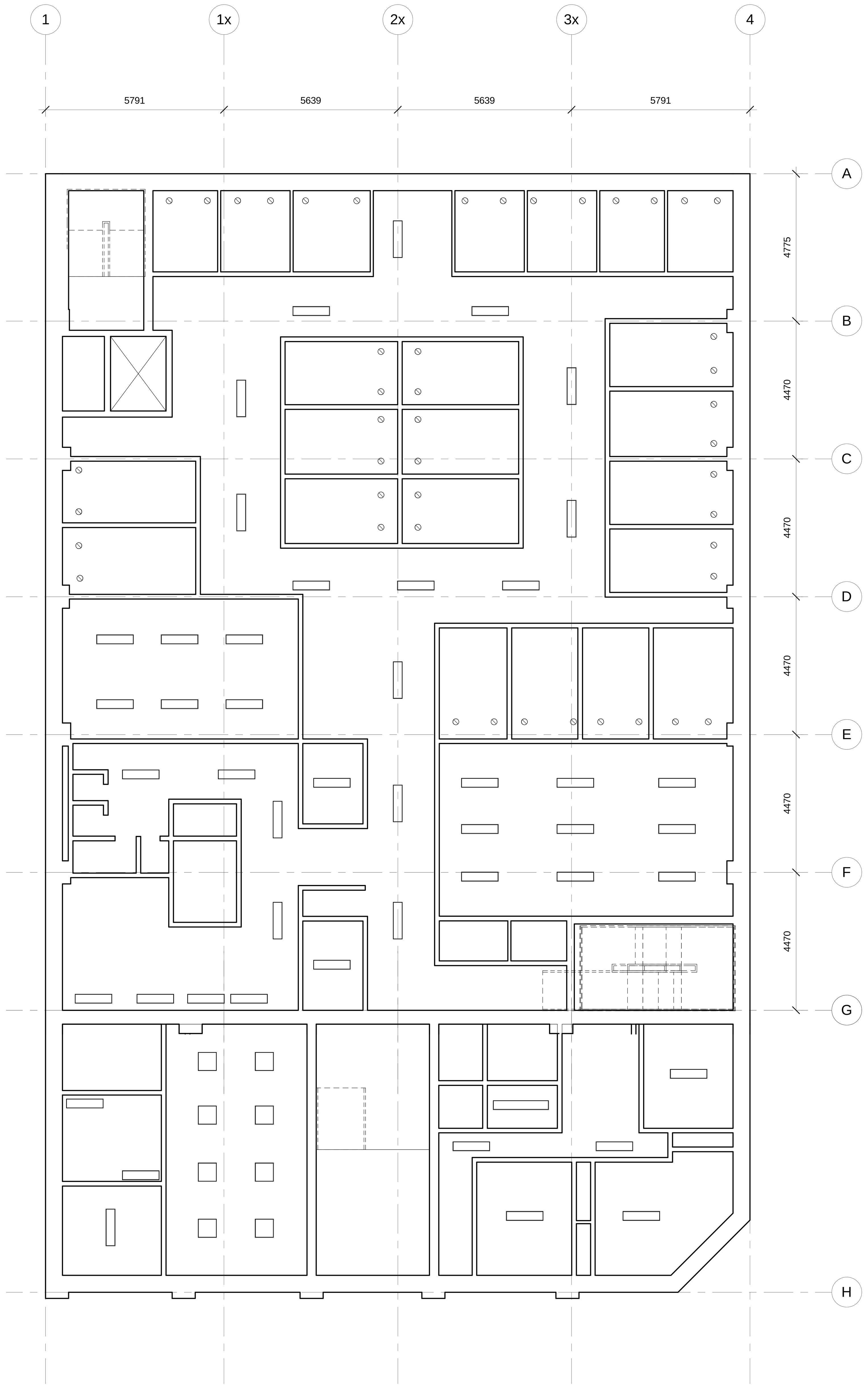
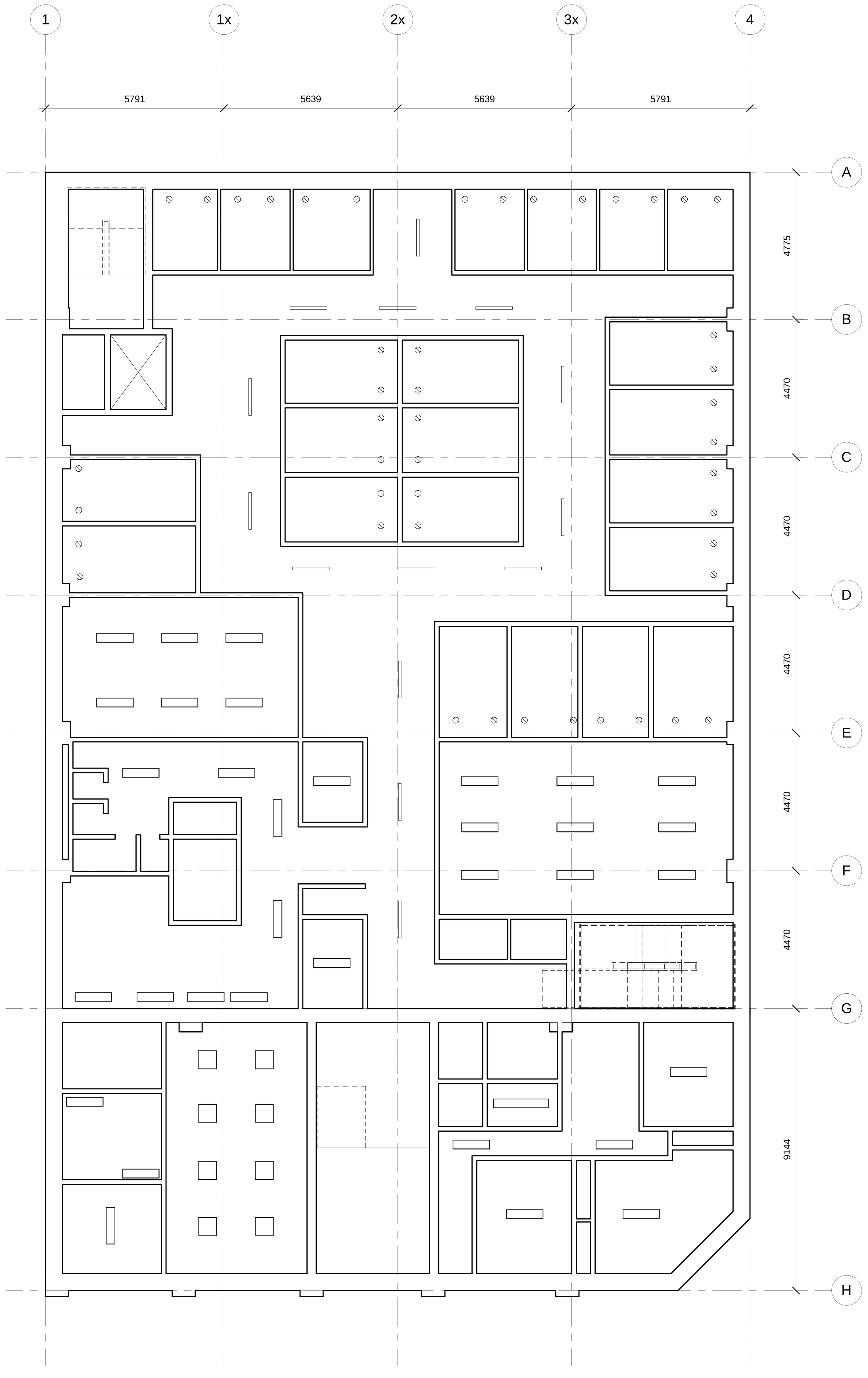


1 RCP - 2nd Floor - Existing
1 : 75



2 RCP - 2nd Floor - Proposed
1 : 75

Fixture Symbol	Fixture Type
	13W CFL Ceiling Pot Light
	32W Fluorescent U light
	75W 6 foot Fluorescent Light
	40W 4 foot Fluorescent Light
	75W Halogen Flood Light
	18W LED Tube Light

Nothern Light Solutions

No.	Description	Date

2015 Green Energy Challenge
Good Shepherd Ministries

RCP - 2nd Floor

Project number	0001
Date	March 9, 2015
Drawn by	DN
Checked by	MT

A104

Scale 1 : 75

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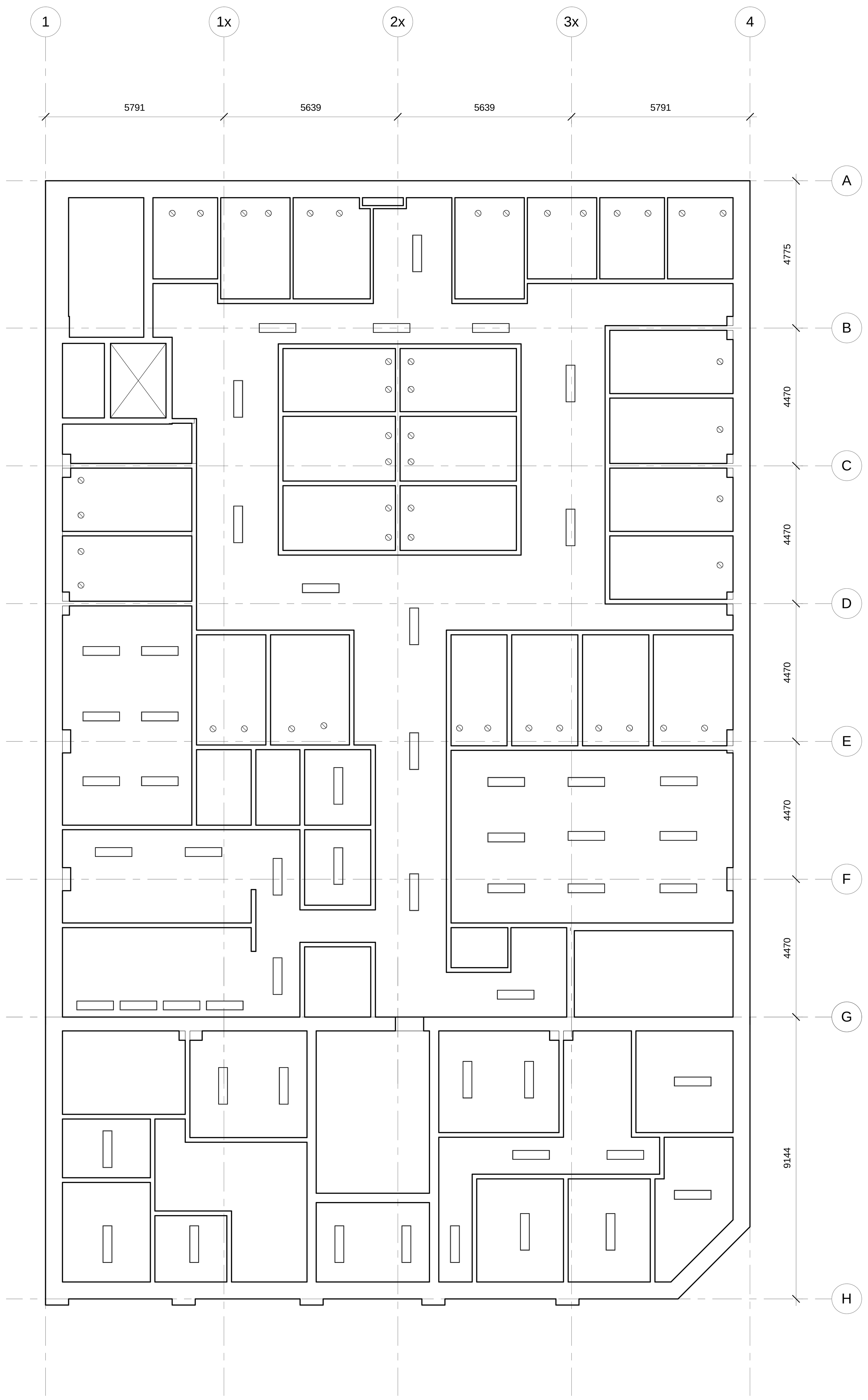
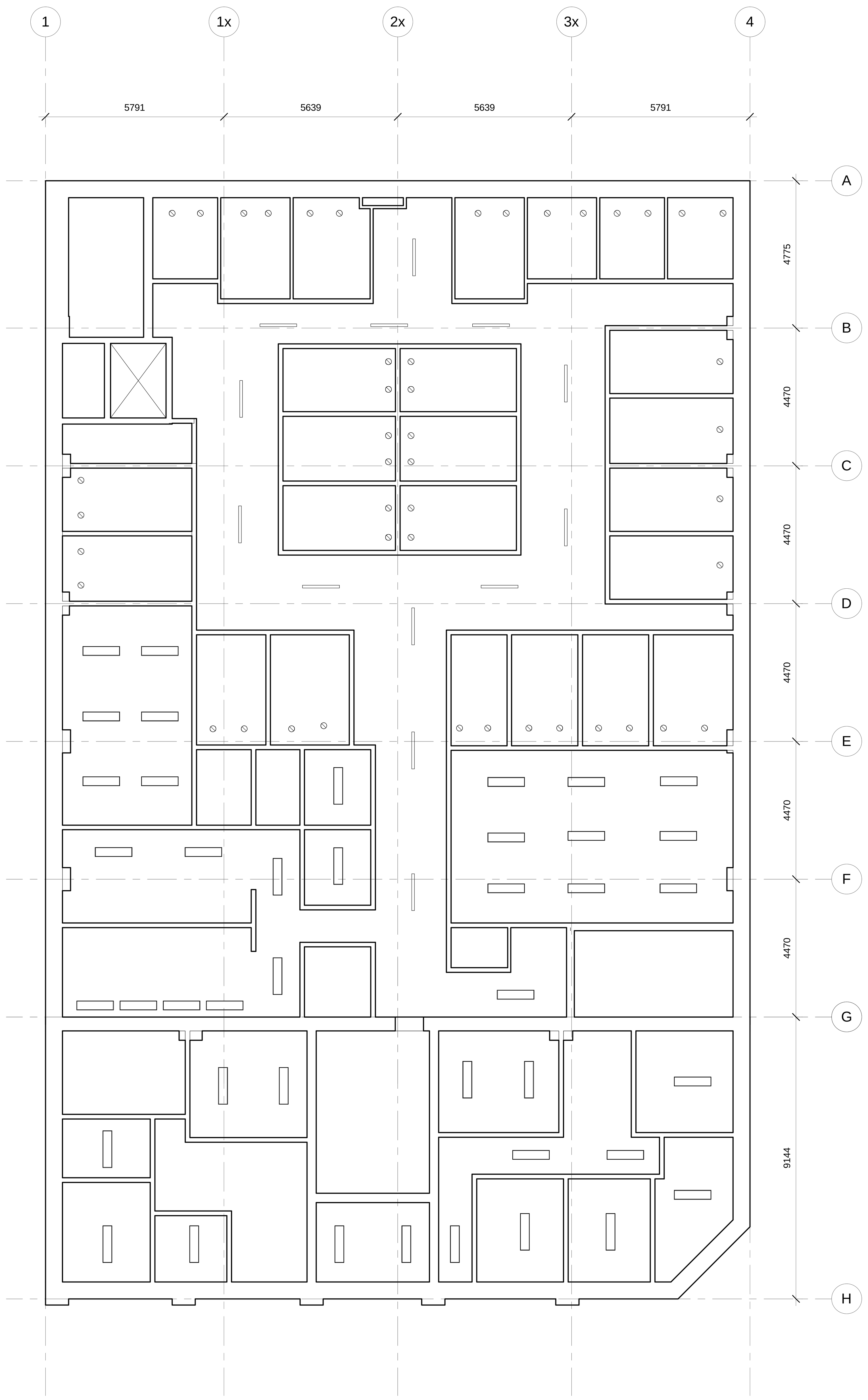


2 RCP - 3rd Floor - Existing
1 : 75



4 RCP - 3rd Floor - Proposed
1 : 75

Fixture Symbol	Fixture Type
	13W CFL Ceiling Pot Light
	32W Fluorescent U light
	75W 6 foot Fluorescent Light
	40W 4 foot Fluorescent Light
	75W Halogen Flood Light
	18W LED Tube Light

Nothern Light Solutions

No.	Description	Date

2015 Green Energy Challenge
Good Shepherd Ministries

RCP - 3rd Floor

Project number	0001
Date	March 9, 2015
Drawn by	DN
Checked by	MT

A105

Scale 1 : 75

20-Apr-15 9:54:30 AM

Complete Existing Lighting Conditions

Light Type	# of Lamps per Fixture	Wattage (W)	Number of Fixtures	Total Lamps	Total Wattage (W)
Third Floor					
4 ft tube with diffuser	4	40	18	72	2880
4 ft tube	1	40	51	51	2040
Dorm Light - CFL	1	13	47	47	611
Spherical Dome - CFL	1	13	1	1	13
Emergency Light + Battery	2	7.2	4	8	57.6
Second Floor					
U-Tube	2	32	8	16	512
4 ft tube with diffuser	4	40	21	84	3360
4 ft tube	1	40	54	54	2160
Dorm Light - CFL	1	13	47	47	611
Spherical Dome - CFL	1	13	1	1	13
Emergency Light + Battery	2	7.2	9	18	129.6
Mezzanine					
U-Tube	2	32	4	8	256
4 ft tube with diffuser	4	40	9	36	1440
First Floor					
4 ft tube with diffuser	4	40	59	236	9440
4 ft tube	1	40	8	8	320
Spherical Dome - CFL	1	13	11	11	143
Spherical Recessed in Ceiling - CFL	1	18	11	11	198
Halogen	1	25	21	21	525
Emergency Light + Battery	2	7.2	8	16	115.2
Basement					
4 ft tube with diffuser	4	40	23	92	3680
6 ft tube	1	75	19	19	1425
4 ft tube	1	40	20	20	800
Spherical Dome - CFL	1	13	9	9	117
Emergency Light + Battery	2	7.2	7	14	100.8
Stairwells					
4 ft tube with diffuser	2	40	8	16	640

Complete Proposed Lighting Conditions

Light Type	# of Lamps per Fixture	Wattage (W)	Number of Fixtures	Total Lamps	Total Wattage (W)
Third Floor					
4 ft tube with diffuser - existing	4	40	15	60	2400
4 ft tube with diffuser - new LED	4	18	3	12	216
4 ft tube - existing	1	40	43	43	1720
4 ft tube - new LED	1	18	8	8	144
Dorm Light - CFL	1	13	47	47	611
Spherical Dome - CFL	1	13	1	1	13
Emergency Light + Battery	2	7.2	4	8	57.6
Second Floor					
U-Tube	2	32	8	16	512
4 ft tube with diffuser - existing	4	40	19	76	3040
4 ft tube with diffuser - new LED	4	18	2	8	144
4 ft tube - existing	1	40	46	46	1840
4 ft tube - new LED	1	18	8	8	144
Dorm Light - CFL	1	13	47	47	611
Spherical Dome - CFL	1	13	1	1	13
Emergency Light + Battery	2	7.2	9	18	129.6
Mezzanine					
U-Tube	2	32	4	8	256
4 ft tube with diffuser - existing	4	40	9	36	1440
First Floor					
4 ft tube with diffuser - existing	4	40	5	20	800
4 ft tube with diffuser - new LED	4	18	54	216	3888
4 ft tube - existing	1	40	6	6	240
4 ft tube - new LED	1	18	2	2	36
Spherical Dome - CFL	1	13	11	11	143
Spherical Recessed in Ceiling - CFL	1	18	11	11	198
Halogen	1	25	21	21	525
Emergency Light + Battery	2	7.2	8	16	115.2
Basement					
4 ft tube with diffuser - existing	4	40	14	56	2240
4 ft tube with diffuser - new LED	4	18	9	36	648
6 ft tube	1	75	19	19	1425
4 ft tube - existing	1	40	19	19	760
4 ft tube - new LED	1	18	1	1	18
Spherical Dome - CFL	1	13	9	9	117
Emergency Light + Battery	2	7.2	7	14	100.8
Stairwells					
4 ft tube with diffuser - new LED	2	18	8	16	288

Proposed LED lamp replacement: Canada LED Lighting T8 LED 18W 4ft tube

Proposed Occupancy Switch: Lutron MS-OPS2H-WH-C