Tyler Buskirk, Kyle Fackler, and Josh McMahon
EGR 343: Semester Research and Design Project
Dr. Wunderlich
November 29, 2016

Abstract:

The plan to hold the Summer Olympics of 2020 in Tokyo, Japan is a major undertaking. For a city that is overpopulated, earthquake prone, and structurally outdated; allocating land to build a facility and host a large amount of athletes involves careful planning and consideration. Selecting a site of location is priority number one. Because of the continuous risk of seismic activity, *Japan Property Central* advises to build west of the inner hub of Tokyo and take advantage of areas that contain "parks and low-density neighborhoods." Also, we plan to triangulate a location near local airports to assist with the demand of public transportation. In order to achieve LEED-Platinum rating, we intend to focus on heat island reduction through use of photovoltaics and pollution reduction through low carbon emissions. In the end, our facility must hold a capacity of approximately 20,000 people and be about 50,000m^2 (~538200 ft^2) in area.

Narrative and Data:

Religion is a very large influence within Japanese architecture and aesthetics. Shinto is a belief that emphasizes the influence of nature. For example, the basic elements of air, wind, and water have been incorporated into modern Japanese architecture. Ancient Japanese buildings have also shown up within more modern designs. Japanese temples have curved roofs because Buddhists believed that they would ward of evil spirits (H. Lombardi, L. Lombardi 2013). These ideas will be incorporated into the design of the Aquatic Center. The main aspects of this design are to show rolling lines and curves to represent the flow of water and the curved roofs of ancient Japanese temples.

The overall design of the Aquatic Center however strays from traditional views of buildings and has brought upon a more modern feeling. Not only, does the Aquatic Center have influences of ancient Japanese culture, but also well-known architects and designs. These influences come from Kenzo Tange's "St. Mary's Cathedral", Tadao Ando's "21_21 Design Sight" (The Guardian, 2012), and Finnish American architect, Ero Sarrinen and his design of the Dulles Airport.

As far as Demographics go, Tokyo is a metropolitan center located in Japan that has a population of 13.491 million and the city itself is 2,191 square kilometers. It has a population density of 6,158 people per square kilometer with about 1.94 people per household. The city's population is classified into three different categories: child, working age, and the aged population. There are 1.477 million classified children, 8.85 million working age people, and 2.642 people classified in the aged population. Out of the ages 15 and older, 6.013 million people were employed and 375,000 are fully unemployed. The surrounding area is mountainous with its coastline being lowlands (Tokyo's History, Geography, and Population). However, central Tokyo is only about 130 feet above sea level and relatively flat. This will make it easier to build an aquatic center in Tokyo (Tokyo). The city has plenty of places for Japan has a building height limit of 200 meters due to flight paths from surrounding airports (Building Regulations in Japan).

With that in mind, the next step in our building design was to select a site of construction. Analyzing factors such as earthquake risk, population density, and infrastructure safety, we emphasized safety first in our decision to minimize those risks. In article published by Japan Property Central, national advocates suggest to build west of Tokyo to avoid major fault lines and flooding risks. In cities such as Hachioji, Chofu, and Tama, that consist more of parks and low density neighborhoods allow for construction. After a glimpse glance at all three cities, we selected a site near Chofu's international airport in local park. We have confidence in the stability of this location because of the presence of nearby Ajinomoto Stadium. We can take advantage of stadium parking and run shuttles to limit the carbon footprint within the city. Sustainable strategies will be of the upmost importance as we rely on alternative energies and natural lighting to provide comfort and efficiency.

Design for a Large LEED-Platinum Facility for the 2020 Olympics in Tokyo

Introduction:

To preface our project proposal, we were tasked with the assignment to design a facility for the 2020 Tokyo Olympics that meets the requirements laid out for a LEED-Platinum facility. In order to obtain credit for architectural design implementations, there are is a set of guidelines under the form of Building, Design and Construction that help lead the way to transforming an idea into a piece of architecture lead by green concepts and technologies. This checklist can be used for New Construction and Renovation or Multifamily Midrise. Since the Olympics is an event that fosters athletic competitions, the checklist for New Construction and Renovation was more applicable. We plan to use the aforementioned checklist that is broken into eight subsections to help lead our design and create a platinum-rated project.

As we began brainstorming our design, we decided to focus our attention on the creation of a certain part of the athletic facilities used for the Olympics, specifically the pool. The aquatic center, as it is formally known, has the potential to include all the elements for a LEED certification, as well as the opportunity to be creative in design in both the interior and exterior architecture. Most notably, the aquatic center will showcase a large arena-like atmosphere with indoor seating overlooking the Olympic sized pool and high dive areas. Also, the center will have areas dedicated for the athletes to warm up and cool down, as well as locker rooms for the athletes to safely store their belongings. As for the fans, there will be areas to buy concessions and souvenirs, and obviously plenty of restrooms reasonably located near heavy populated areas. After providing a brief overview of what to expect inside the Aquatic Center, it will be our job to figure out how to design it in a such way that meets the demands of a LEED-Platinum facility, without compromising some of the necessary features briefly described in the layout. This report will show how we intend to blend our creative capacities to design a facility that is right for Tokyo and the surrounding architecture and culture, while receiving deserved and accredited points at the same time.

Location and Transportation:

The first subsection in the project checklist for a LEED v4 for Building, Design and Construction is Location and Transportation. This describes ways in which LEED will provide credit for meeting green standards when taking into account neighboring lands and transportation responsibilities. The most impactful area under this subsection is the area that features a sustainable effort to recognize surrounding density and diverse uses. This area has a lot to do with the specific site location and the influence of surrounding elements. LEED describes it as constructing a building whose main entrance is within a certain proximity of a similarly utilized building. That being said, we plan to build our aquatic center in a small patch of land near Ajinomoto Stadium. This location is relatively close to inner city Tokyo – only about 18 miles, which makes it a probable site. It is far enough away from the hustle and bustle of the urban center, but close enough to take advantage of what the city has to offer. Its proximity to the stadium that is located in the outskirts of Chofu City allows for us to take advantage of the services provided by the athletic arena at Ajinomoto Stadium. Those services, such as public transportation in the form of shuttles and parking, will help earn LEED credits in areas for reduced parking footprint and access to quality transit. Furthermore, this section of land is located very close to Chofu Airport. Although this airport is a commuter lines and not an international mainstay, it seems it may not serve a great purpose. However, it does demonstrate that the area is adequate for the immense influx of athletes and tourists. With the appearance of an airport and stadium, it naturally suggests that there are services for hotel arrangements, eateries, public transportation, etc. Integrating the local amenities will prove vital in attaining LEED credits and proving to the establishment that the surrounding community will provide a major source of land integration. In the end, this section of Location and Transportation in the LEED project checklist has proved beneficial in guiding our search in selecting a site of location. Although there were other factors to consider, it was important that we continue to focus on the LEED credentials first and foremost.

Sustainable Sites:

The next subsection in the project checklist in order to gain accreditation for a LEED-Platinum rated building is “Sustainable Sites.” Under this section is some of the most important contributions to our design to keep in mind. This is where we can gain points for satisfying the requirements in developing the location selected and

making sure that the local community supports it. LEED realizes it is important to keep a steady balance between new construction and old inhabitance. Therefore, when new designs are constructed they must show a similar trend to the architecture that is already present in the community. However, LEED also acknowledges the need for diverse and unique architecture and it provide assurances if, when performing the construction at the site, local habitats and ecosystems are preserved. The idea to preserve the local wildlife goes hand-in-hand with the areas of site assessment and site development, as well as Japan's unique characteristic to love and preserve nature. As expressed in our narrative of data, Japan emphasizes the influence of nature and religion in their architecture. Japanese tradition illustrates the faithful connection and delicacy shared in the world around them and treat both the natural world and faith as one (H. Lombardi, L. Lombardi 2013). Therefore, it is important that when we undergo construction for our design, we keep in mind the surrounding habitat and integrate it into our design. We intend to do this by designing walking trails surrounding the facility to promote tourist interaction with nature, as well as a reduced carbon footprint when promoting travel by foot from place to place.

Other factors leading into gaining credit for this section is finding ways to manage rainwater, reduce heat island affects and reduce light pollution. This is where our design can get very creative. As illustrated in our project proposal presentation, the aquatic center's most unique feature is the way in which the roof will flow and connect to each other to resemble waves crashing into each other. Also, we intend to integrate the traditional Japanese curved eave design into our building. The design of the roof will enable us to control where the rainwater will flow using a thorough down-spout and gutter system. Capturing the rainwater and utilizing its resource we be more intently discussed in the next section which describes water efficiency. That being said, the heat island effect which is a major factor in an incredibly populated urban center such as Japan will be reduced by installing energy efficient appliances, providing shade and planting trees and other vegetation. Each of these factors can play a role in reducing surface and air temperatures, not to mention make it more aesthetically pleasing. Also, we plan to reduce light pollution by maximizing our use of window paneling to take advantage of the natural light from the sun. Here, it is important to note that our design will feature fluorescent ceiling lights and LED's used in competitive sports arenas that minimize glaring effects and, overall, reduces the risks of distraction.

Water Efficiency:

In the next subsection for the project checklist, we are maneuvering our attention to control water use both inside the building and outside in the form of rain fall. This section is a bit more difficult to earn credits because of our facility's main purpose functioning as a swimming pool. An Olympic sized swimming pool averages around 658,000 gallons to fill and that is based on a pool being 50 meters long, 25 meters wide and at least 2 meters deep (USA Swimming). That statistic gives us a brief prediction in to what kind of expenses and water use to prepare for. Pool water is not often recycled to have alternate forms of use because it usually has a strong concentration of chlorine with a certain pH level that makes it difficult to reuse. The only ways to limit the water usage for the pool is by implementing a reverse osmosis filter that reuses the same pool water but purifies it by removing contaminants and pollutants. As for the outdoor water use reduction, we can rely on yearly rainfall to water vegetation gardens and provide nutrients to the surrounding nature because Japan's annual precipitation is nearly double that of the rest of the world (Tokyo's History, Geography, and Population). Overall, capturing rainwater and reusing it in other areas may play a pivotal role in scoring credit for water efficiency in this section.

Energy and Atmosphere:

The next section that LEED looks into when deciding to give credit is implementing energy saving and reducing instruments. Also, maintaining a stable relationship with the surrounding environment and atmosphere by recognizing the greenhouse emissions entering the air and finding ways to reduce it. This section is the most important area to earn credits as it is worth a third of the overall amount of possible points that can be awarded. Therefore, our design is dedicated to meeting the needs in this area and finding ways to not only save energy, but also reuse it. We plan to optimize energy performance by utilizing solar panels to acquire energy from the sun in order to heat the swimming pools. One of the main leading issues in solar panel usage is finding a way to store the energy brought in by the sun during peak hours. Because of the time difference between Japan and the rest of the world, events can take place during peak sun hours (during the day) and be seen at a reasonable evening time on the east coast (if the event is live). Furthermore, we plan to use energy star appliances in the facility, as previously stated above. They could be utilized in concessional areas or the equipment rooms, where athletic apparel needs to be washed and dried for the athletes.

Materials and Resources:

The next section in the LEED project checklist that will be used to guide our design is materials and resources. This area shows the importance of reusing materials or finding alternate uses for our building. In order to gain credit in this area, we are relying on providing an alternative use for our facility. Since the summer Olympics only comes around every four years, it does not make a whole lot of sense to build a structure only for that event and it not serve any other purpose. That being said, we are designing this facility with the sole purpose that it can become multi-dimensional. Our design will not be a one-and-done creation. Following the summer Olympics of 2020, we would grant permission to the local and outer community to use the building for training purposes and workout grounds, as a way to give back to the community. This opportunity would be part of the upfront negotiations to take place in order to be granted permission from the Japanese government to build in this location. The foundation of our building is laid with reinforced concrete. The exterior of the rest of the building will be made out of glass and a partition of concrete extended from the foundation. These materials will serve an extending purpose as the composition of the materials are very durable and longstanding.

Indoor Environmental Quality:

In what makes up most of the last section in the project checklist for LEED Platinum-rated accreditation is the response to inside air quality. This mostly pertains to the patrons inside the building and the comfort they feel while they are watching the event. Because of the timing of the summer Olympics, it is obvious to realize that heat will not be an issue, but what we can foresee is that air conditioning and air quality may be. Since the aquatic center is designed to hold approximately 20,000 people, we predict if the building is full to capacity, there could be issues with air movement. Without going into too much detail, there will be industrial cooling and ventilation ducts located around the tops of the facility to provide air circulation. Because of the size of the facility, it will be difficult to provide a central thermal temperature inside. So we will rely on proper shading on the exterior of the building to reduce natural heating from the sun and keep the inside air cooling system running at full tilt. Those sitting lowest and closest to the swimming pool will most likely be more comfortable than those sitting up high and above away from the pool. That being said, each location will still provide a quality view of the competition because of the angle of the bleacher seating as the rows go up.

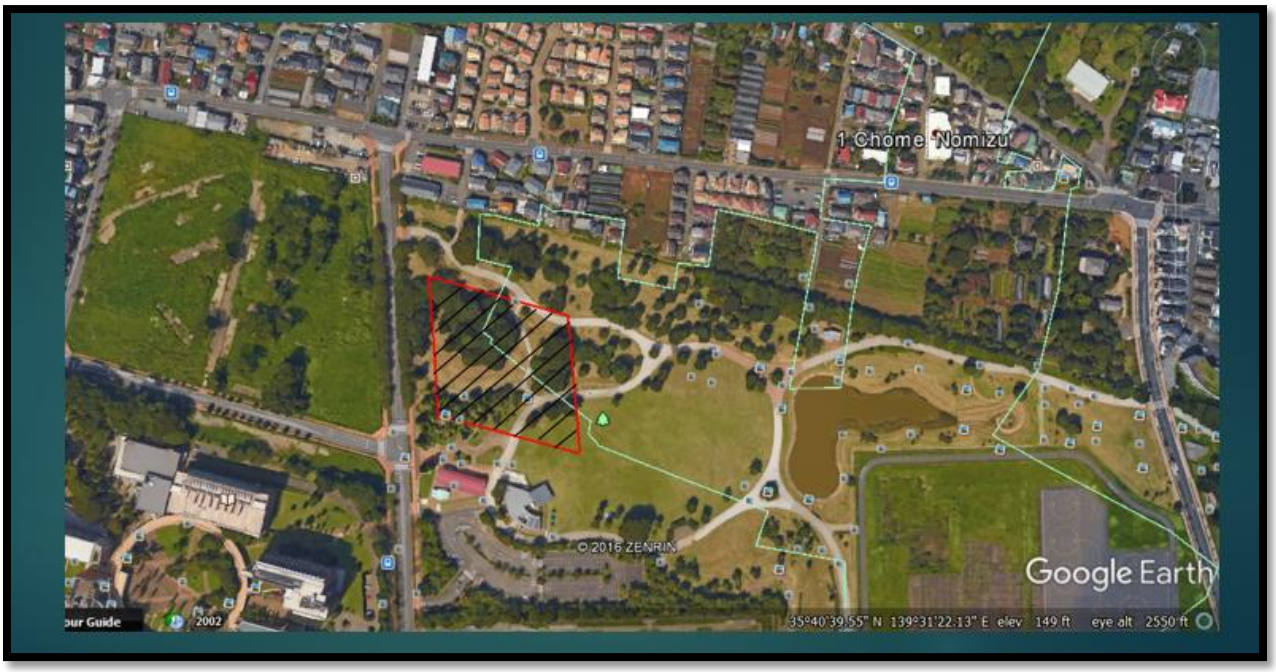
Design and Conclusion:

The size of our Aquatic Center is vaguely based off the size and structure of a well-known sports venue here in the United States, Madison Square Garden. That venue is used for a variety of sports and entertainment events, therefore, it needs to be large enough to satisfy the capacity requirements (76,000 m^2). Thus, we decided a field size of 50,000 m^2 would be suitable for our needs and still comfortably seat 20,000 people.

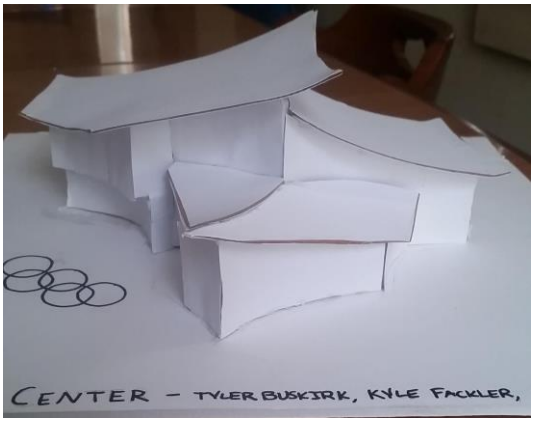
Original Creative Work:

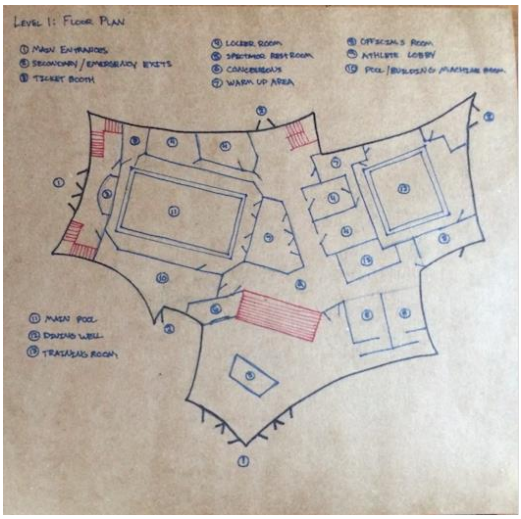
We broke the design work into three parts:

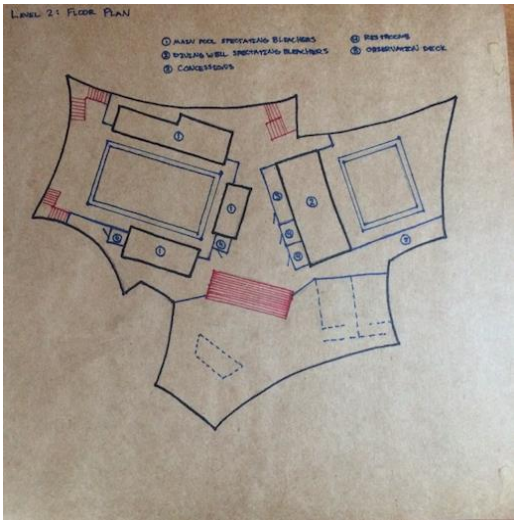
1. Site Selection and Sizing (Tyler Buskirk)
2. Model/Floor Plan (Kyle Fackler)
3. Revit/Floor Plan (Josh McMahon



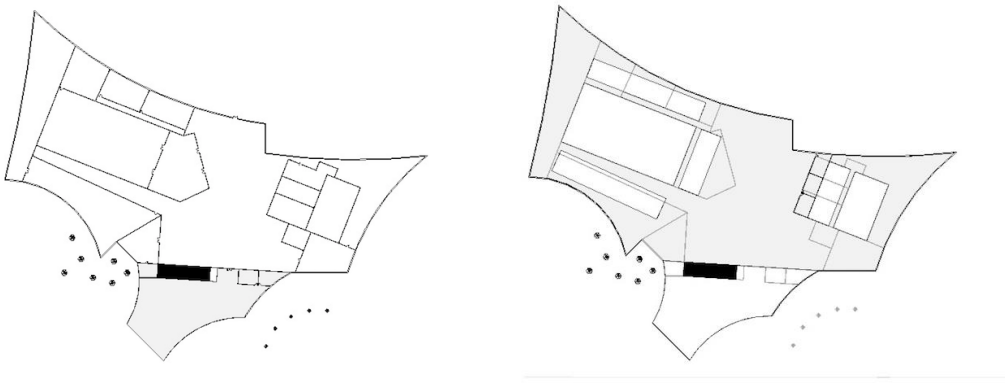
Above: The three images above detail the location of the Aquatic Center. The first image shows where Chofu City is in proximity to inner city Tokyo. The next image gives in an idea using the "star" what the area provides. The site is located in the same area as Ajinomoto Stadium and Chofu airport. The final picture shows the exact location where we plan to construct – coordinates (35°40'39.55" N, 139°31'22.13" E). ***Tyler Buskirk***

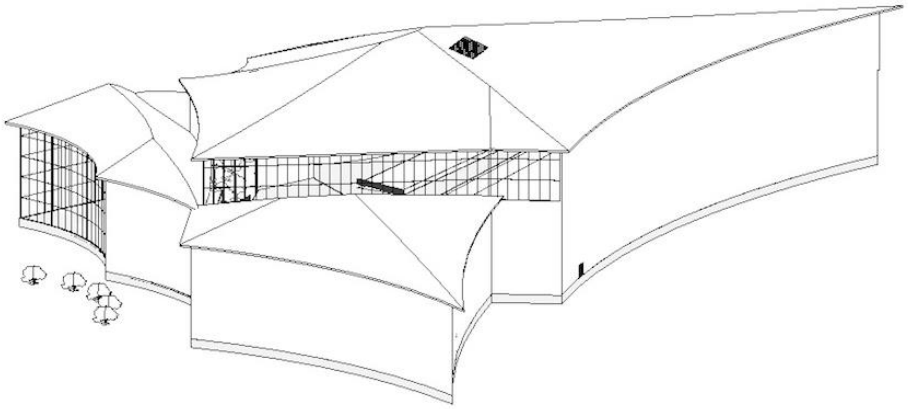


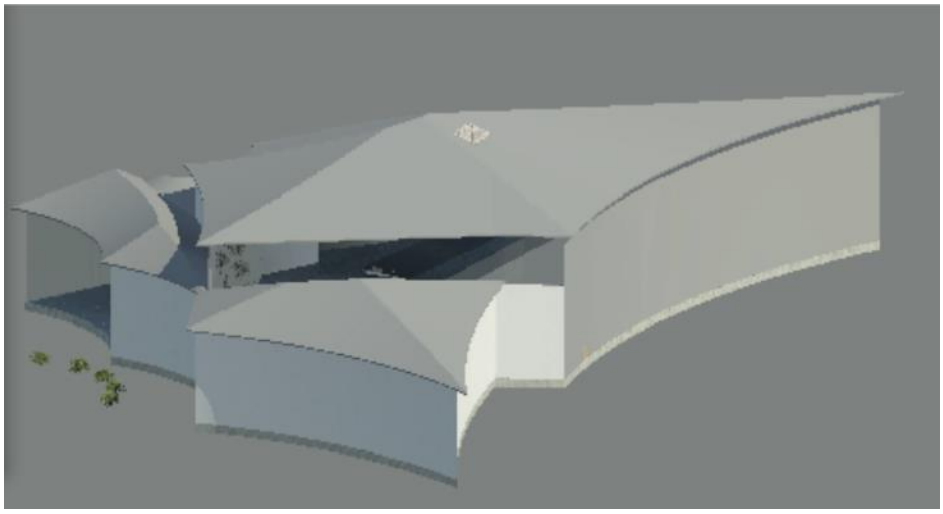




Above: These three pictures shown depict the structure and floor plan of the aquatic center. The model shows the long sweeping lines to represent waves and a curved roof to mimic Japanese Temples. The picture on the left shows the floor plan of the first level for the athletes, and the picture on the right shows the second level floor plan for the spectators. ***Kyle Fackler***







Above: These picture above show the overall design complete in Revit. The first two pictures show the first and second level floor plan, and the last two pictures show a 3D view of the center. ***Josh McMahon***

Annotated Bibliography:

1. Lombardi, Hashi, and Linda Lombardi. "Japanese Architecture: What Makes It Different?" *Tofugu*. N.p., 28 Mar. 2013. Web. 20 Oct. 2016.

Hashi and Linda Lombardi describe the initial upcoming of Japanese architecture and the influences behind each idea. They show how ancient beliefs, religion, and "Zen" were the sources of construction. They also show the implementation of these ideas in modern types of architecture. This source will help in the design process of the Aquatic Center to help withhold Japanese traditions.

2. "10 of Tokyo's Best Works of Architecture." *The Guardian*. Guardian News and Media, 01 Feb. 2012. Web. 20 Oct. 2016

This source gives examples of some of Tokyo's most modern and interesting types of architecture. It also depicts the architects including: Kenzo Tange, Kisho Kurokawa, and Tadao Ando. These designs and architects will help influences the design of the Aquatic Center.

3. "Building Regulations in Japan." n.d. *Japan Property Central.* 19 October 2016.

"Building Regulations in Japan" offers accurate information in regards to the limits and regulations when building in the country of Japan. This document includes how high a building can be when near airports and also regulations for areas around sacred spaces. This will help when designing the aquatic center so that it will be able to fall within the regulations of Japan's building codes.

4. "Tokyo." n.d. *topographic-map.* 20 October 2016.

This document is simply a topographical map to show the elevations of the land. This map helps to show how the aquatic center would have to be built in order to lay on the land.

5. "Tokyo's History, Geography, and Population." n.d. *Tokyo Metropolitan Government.* 19 October 2016.

"Tokyo' History, Geography, and Population" helps us to see the differences in ages of Japan and how many people would be around the area during the Olympics. This document also helps us to understand the surrounding geography of the area in order to incorporate our aquatic center in to it.

6. "What Are the Earthquake Damage Risk Ratings for Tokyo ..." *Japan Property Central*. Japan Property Central K.K., n.d. Web. 20 Oct. 2016.

This article produced by Japan Property Central gives ample information regarding the effects of earthquakes in Tokyo along with what they advise people to do. They give the safest areas to build in Tokyo along with some demographical data.

7. "25 Yard Compared to 50 Meter –." *USA Swimming*. 2010 USA Swimming, n.d. Web. 29 Nov. 2016. <http://www.usaswimming.org/ViewMiscArticle.aspx?TabId=1755&mid=7716&ItemId=3570>.

This article provides detailed information on the expenses and material costs that goes into constructing an Olympic sized pool.