# ABSTRACT

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| Title of Thesis: | RACE TO NET ZERO: REDESIGNING FORMULA ONE TRACKS FOR THE BETTERMENT OF COMMUNITIES |
| | Nicholas Christopher DiBella, Master of Architecture, 2022 |
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Formula One is one of the most recognizable and accepted forms of racing across the world and has made a declaration to make the sport substantially more sustainable by the year 2030. As of 2022, the sport has not made nearly enough changes across its facilities to reach these goals. This thesis aims to identify a process and design for making one of the Formula One tracks in the US net-zero and for helping visitors learn and involve themselves with the sport's history and future. F1 facilities and racetracks have a high potential to help the sport reach its goals and lower its large carbon footprint. Race tracks are large swaths of predominantly paved land and offer nothing back to the earth from which they take except heat and runoff. Using four key concepts: stormwater management, reduction of the heat island effect, onsite energy generation, and xeriscaping, a formula one race track could perform better for the environment. To create a stronger relationship between the sport, the community, and the environment, community education and involvement programming will build and strengthen ties that will make the sustainability goals even more achievable.

# RACE TO NET ZERO: REDESIGNING FORMULA ONE TRACKS FOR THE BETTERMENT OF COMMUNITIES

by

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## Getting to Know Formula One

### Sport History

Formula One is considered by many to be the pinnacle of racing; undeniably it is the highest tier of open-wheel single-seater auto racing in the world. Formula One can be traced back to the beginnings of motorsport racing itself, back to the end of the 19$^{th}$ Century, where instead of elaborate circuits, races took place on the streets of cities. Formula One has grown since its creation and first season in 1950. The original rules did not specify limitations on how much power the cars could produce nor the size of the cars themselves. This freedom from rules made the sport extremely dangerous, but it also led to many technological advancements within the sport. The sanctioning body of Formula One at the time found that such unsafe conditions were unacceptable and needed to be changed. Specific rules regarding cars' power, weight, and size were implemented, and only cars meeting the specific "Formula" were allowed to compete.

*Figure 2 2016/2017 Formula One Chassis Rule Change Comparison (Source: Giorgio Piola/Formula One)*

Even after the rules were put into place, Formula One cars were still the fastest road course racing cars in the world. They were able to generate such high speeds on road courses through their ability to corner. The cornering ability of the car is largely due to the amount of downforce created by the cars' aerodynamic shapes. In 2017, major rule changes were put into place that amplified the cars' on-track abilities. The changes included wider front and rear wings and wider tires, which increased cornering forces on the cars to almost 8g and brought the top speeds of the cars to around 230 mph. Some of the increase in speed was due to the new hybrid engine introduced in 2017, capable of running at RPMs of 15,000. The rule package for a car in Formula One was changed once again in 2022, but this time it was intended to create closer racing by changing the aerodynamics of the car and creating a more affordable car overall. As of 2022, the cost of operating a mid-tier team is about $120 million.

The sanctioning body of Formula One at the time of the rules being put into place was the Fédération Internationale de l'Automobile, or the FIA, as it is more commonly known. The FIA was founded in 1904 and was created to bring safety and rules to motorsports. The FIA has climbed to its position as the highest authority in international motorsports due to its international fame and acceptance brought forth by Formula One. With the FIA's role as the international governing body of Formula One and other motorsports, the FIA rules regulations were implemented to provide an equal playing field for drivers and teams. They also help protect the driver by setting standards for safety and act as an arbitrator when disputes arise regarding the rulings they have put forward. The FIA does more to regulate the sport than it ever has. Not only does it regulate the cars' and driver's safety inside the cars, but it also regulates the tracks where they race.

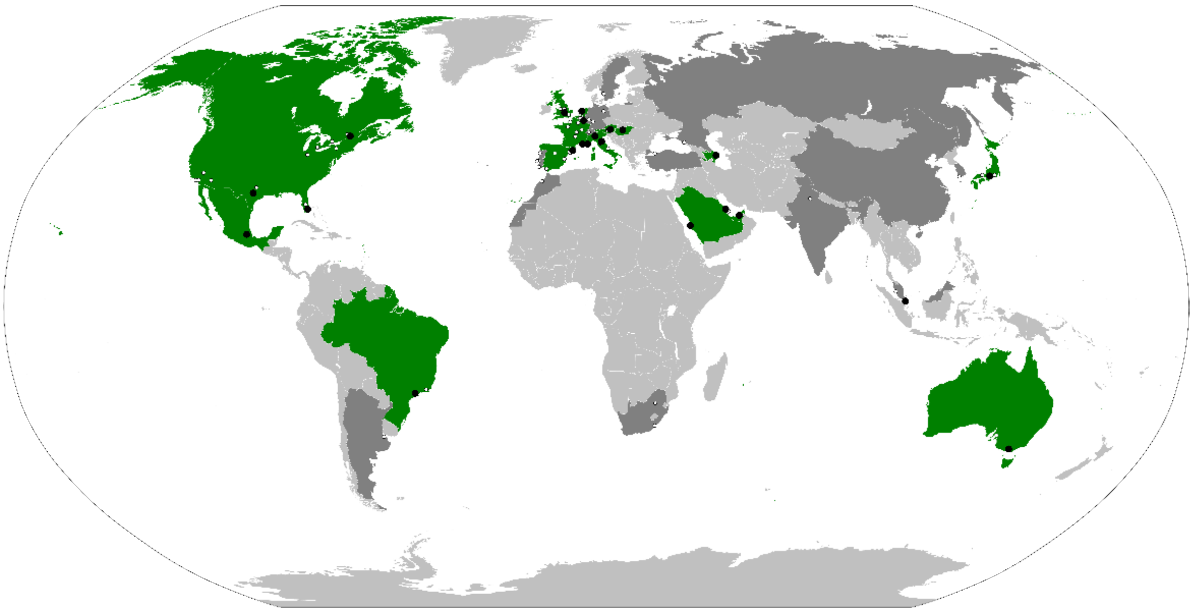

*Figure 3 By Cherkash - Own work, based on the information in List of Formula One circuits and 2022 Formula One season, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=111164776*

The Formula One season is comprised of 22 Grands Prix. A Grand Prix is a race that is part of a championship series. Formula One racing may have a European background, but the championship spans the globe, with half of the races taking place outside of Europe. Some of the European Grands Prix have been around since before the creation of Formula One and have consistently been held every season. The Monaco Grand Prix is one of the longest-running Grand Prix and is considered by many to be the most important and celebrated race on the schedule. Typically, each country that is responsible for holding a Grand Prix event holds only one per season, and the event is named for the country that hosts it, such as the Italian Grand Prix. If a country is a host to multiple Grand Prix events, the second event will be named for the city in which it takes place. For example, the Steiermark or Steryan Grand Prix is named after the Austrian town, but the Austrian Grand Prix takes the name of the

Country. While the name of the race may stay the same from year to year, the location of the race can change because of many different factors. Some factors include track suitability and financial status. The German Grand Prix typically switches between the Hockenheim Circuit and the Nürburgring. The United States has hosted six different Grands Prix, including the Indianapolis 500, with additional events named after the host city.

*Figure 4 Monaco Grand Prix (Source:Planet F1 https://www.planetf1.com/news/monaco-grand-prix-guarantee-continue/)*

Circuits in Formula One racing are relatively similar, given that they are all made up of the same base parts configured in different ways. A typical layout features a long straight paved surface where the starting grid, start/finish line, and pit lane reside. This section of the track is where most of the fan seating is located so that they can experience some of the most important parts of the race. The pit lane on the front stretch of the circuit is where drivers stop during the race for new tires, car adjustments, repairs. Attached to the pit lane is the garage area of the track where major repairs are made to the racecars and where work is done to the cars before the start of races. The next major element of the track is Turn One and subsequently, the remainder of the track turns. The number of turns and corners varies depending on the track, but most tracks have a clockwise direction. The layout of the turns and straights are what make each individual track unique.

Most circuits have been constructed and designed for this high caliber of racing, while some circuits are laid out on public streets. The design of circuits has become more and more sophisticated as driver safety has become more and more important due to increasing car speeds. Most new circuits in Formula One have been designed by Hermann Tilke and have fallen under some scrutiny for having created boring races.

*Figure 5 Diagrammatic Layout of Circuit of the Americas, Austin, Texas (Source: Formula One)*

Growing Sport Culture

Formula One is worth pursuing as a new realm for designers largely due to the quickly growing fanbase in the sport. While there are several lifelong fans or at least fans who have been a part of the sport before the release of *Drive to Survive* on Netflix, many are new. The F1 fanbase is a very accepting group, excited to share their affinity for the sport with anyone who shares it. As is the case in most fan bases, however, change can sometimes be seen as negative and be criticized heavily. Change within the sport can be seen as a good thing, as it keeps the sport from stagnation and will likely help to draw in more viewers, sponsors, and money.

Formula One racing became the "fastest-growing major sports league on the planet in terms of follower growth"[1] in 2021, with 49.1 million total followers. The sport is continuing to grow, with more and more engagement on social media platforms such as Facebook, Instagram, Twitter, Tik Tok, YouTube, Twitch, and even Snapchat as time passes. Views on F1.com and the F1 app have also been growing. This high and fast growth in the digital fanbase is proof that Formula One is not only competitive with other sports with a digital presence, but it is surpassing those other major sports.

[1] Liam Parker, "Formula 1 Announces Audience and Fan Attendance Figures for 2021 | Formula One World Championship Limited," February 17, 2022, https://corp.formula1.com/formula-1-announces-audience-and-fan-attendance-figures-for-2021/.

*Figure 6 Formula One's diagrammatic representation of increased engagements across sports (Source: Formula One)*

The size of Formula One's television audience is showing notable growth as well. Cumulative TV audiences for F1 races in 2021 are growing, having reached 1.55 billion viewers, which is 4 percent higher than in the 2020 season. This growth, particularly compared to 2020, is especially strong in the Netherlands (+81%), the USA (+58%), France (+48%), Italy (+40%), and the UK (+39%)[2]. In terms of TV Unique Viewers, which are specifically the numbers of people who tune in to at least one race in a season, China, Spain, Russia, and the USA all showed notable growth. In an age where more and more people are digital viewers rather than television viewers, the growth in both mediums shows the range of audiences showing interest in the sport.

[2] Parker.

*Figure 7 Formula One's Diagrammatic showing audience increase across different sports (Source: LIVEWIRE SPORTS/Formula One)*

In terms of race attendance, the most recent figures from 2021 reflect the limited capacities of many F1 events. Due to COVID-19, the pre-COVID numbers of 4.16 million attendees is higher than 2021's 2.69 million[3]. Despite being noticeably lower in numbers, the fact that 2.69 million people immediately returned to attending racing as soon as they were allowed to do so is a display of a passionate and committed fanbase. Under the assumption that the COVID-19 pandemic will eventually become negligible, those pre-COVID attendance figures are expected to return and grow even further. Even despite this hit to the overall numbers, there were Grands Prix in 2021 that hosted more attendees than in pre-COVID 2019, such as in the "USA (400,000), Mexico (371,000), and Great Britain (356,000)"[4]. Additionally,

[3] Parker.
[4] Parker.

in 2021, Belgium, the Netherlands, Turkey, Brazil, Abu Dhabi, Saudi Arabia, Austria, and Hungary all hosted F1 events that each drew in over 100,000 people[5].

The most jarring statistic that supports designers' investment in Formula One is analytics company Nielsen Sports' finding that "one billion people will claim an interest in Formula One by April 2022"[6]. Just in the past year, overall interest in F1 grew 73 million, and 77 percent of that growth was by the 16-35 age group, which only made-up 46 percent of the total.[7] According to Nielsen's research, the Netflix docuseries about Formula One, "Drive to Survive", as well as the Virtual Grand Prix series held during the height of COVID-19, were major contributors to the growth in this younger age group[8]. March of 2020 brought this audience's interest levels "from one in four to one in three"[9]. The 16-35 age group also tended to engage more with younger drivers who used the streaming platform Twitch to reach fans around this same time[10]. The reason given for such high growth in interest from this age group was that the "Drive to Survive" docuseries is much more narrative-based, which made it more appealing and accessible to these audiences that may have had little prior knowledge about F1. All this new interest in the sport, especially in the USA, has resulted in a second race to be scheduled in the country. The race in Miami added to the 2022 schedule will be "the first time the US has hosted two races since 1984". [11]

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5 Parker.

6 "Study: F1 on Course to Reach 1bn Fans in 2022 with 16-35 Audience on the Rise," *SportsPro* (blog), March 26, 2021, https://www.sportspromedia.com/news/f1-1bn-fans-2022-audience-formula-one-drive-to-survive-study/.

7 Giles Richards, "Climate Emergency Accelerates F1's Efforts to Clean up Its Image," *The Guardian*, November 26, 2021, sec. Sport, https://www.theguardian.com/sport/2021/nov/26/climate-emergency-accelerates-f1-efforts-to-clean-up-image.

8 "Study."

9 "Study."

10 "Study."

11 Richards, "Climate Emergency Accelerates F1's Efforts to Clean up Its Image."

A major component of the culture within the sport is technological advancements. Considering that the sport is regulated by such a strict set of rules, teams look to develop the cars in ways that the rules do not cover but that could give them a competitive edge over their competition. Advancements have been points of contention between teams, but some have translated into real-world applications. This culture has not changed since the influx of viewers and fans and likely will never change due to the competitive nature of the sport and the need to have an edge over the competition.

Strategic Priorities

One of F1's current strategic priorities is empowerment, having both an engaged and high-performing workforce. One major focus of this priority is trying to reach as wide an audience as possible, seeking talent in populations that do not always have the existing connections or resources to easily enter this workforce. They seek diversity in drivers as well as in the many other careers within the field, and they want to ensure that their working environment feels inclusive to everyone. By seeking talent from a wide pool, F1 believes the best, highest-performing workforce will be found. Another way that F1 aims to empower its workforce is by training employees in a skill-oriented fashion. Identifying employees' existing talent and skills and then helping them develop skills most relevant to the career allows them to be given a place to thrive even if they come in without directly relevant prior knowledge or experience. Protecting workers by creating and maintaining healthy and safe working environments, as well as embracing "diversity of thought" and inclusive values allows workers to feel safe in their work environment[12].

Another strategic priority of F1 is increasing competitiveness on the track. This is achieved through technical innovation, equitably distributed financial benefits to teams, improvements to the "racing spectacle" in ways that appeal to wider audiences, and governance that is more streamlined, "transparent, fair, and timely" [13]. All of these make the sport more competitive for the teams and garner larger fanbases for those teams. Fan engagement is another one of F1's major strategic priorities. To increase engagement with fans, the focus is placed on turning every F1 event into a spectacle enjoyable to people all over the world, expanding their Esports Championship, broadcasting to a wider variety of digital audiences in popular languages, keeping up regular digital content creation, and using marketing campaigns to strengthen fans' connections with the sport.

Another important strategic priority of Formula One is a commitment to sustainability. F1 aims to lower its carbon footprint by working towards net-zero carbon racecars by 2030 and transporting materials in more efficient, lower-emitting ways. Any operations that can be made remote are to be made remote, thus requiring less transportation of materials and a lower carbon footprint. Innovations in 5G technology and cloud-based broadcasting are used to improve these remote abilities. On the office side of the sport, F1 aims to both increase efficiency and eventually use 100% renewable power in office spaces.

[12] "Formula One Corporate Strategy" (Formula One, 2020).
[13] "Formula One Corporate Strategy."

One more inter-woven strategic priority in F1 is collaboration. Acquisition of commercial partnerships that promote sustainability is prioritized, as is increasing "opportunities for local people, causes, and businesses to access and benefit from F1 events"[14], which includes a government-partnered STEM program. Another aspect of collaboration is community building, which aims to build stronger relationships within the teams and between the fans and the teams.

*Figure 8  Formula One's WE RACE AS ONE initiative diagrammatic (Source: Formula One)*

*<u>Environmental Impacts and Initiatives</u>*

Environmental Impacts

To understand the context in which F1 began its sustainability efforts, it is important to understand the default environmental impacts of F1 racing. In 2019, F1's carbon footprint was estimated to be 256, 551 Tons of CO2 equivalent[15]. This figure

[14] "Formula One Corporate Strategy."
[15] Formula One, "F1 Sustainability Strategy" (Formula One, 2020), 1.

is equivalent to over 185,000 passenger vehicles driven per year or almost 103,000 homes' energy use for one year[16]. Of these emissions, 0.7% are from power unit emissions, 7.3% are from event operations (including broadcasting, generator use, & others), and 19.3% are from facilities and factories[17]. A single F1 car burns almost 250 pounds of fuel each race, which adds up to almost 5,000 pounds of fuel in a 20-car race, and over 111,000 pounds of fuel burned during a racing season[18]. While the fuel burned by the cars might be expected by some to be the most prominent environmental issue with F1, transporting the vehicles and equipment across the world affects the F1 carbon footprint much more, with transportation logistics contributing 45% of the footprint and business travel for the people contributing 27.7%[19].

A less-predicted source of environmental impacts by the sport is that of the fans. Fans' willingness to travel long distances by car or plane to follow the races had created a sizable carbon footprint of about 1.64 million metric tons, which puts the actual sport's 256,500 number into a shadow[20]. Incorporation of systems that seek to lower not only the physical sport's carbon footprint but also that of the fans visiting the facilities is vital to new and existing development during this growth of Formula One.

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16 OAR US EPA, "Greenhouse Gas Equivalencies Calculator," Data and Tools, August 28, 2015, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.
17 Formula One, "F1 Sustainability Strategy," 1.
18 Greenorb, "How Bad Is F1 Raceing For The Environment? - Thinking Sustainably," August 20, 2021, https://www.thinkingsustainably.com/f1-raceing-for-the-environment/.
19 Formula One, "F1 Sustainability Strategy" (Formula One, 2020), 9.
20 Formula One, "F1 Sustainability Strategy" (Formula One, 2020), 8.

*Figure 9 Formula One's Graphic breaking down their carbon footprint (Source: Formula One/F1 Sustainability Report)*

Progress and Current Initiatives

Formula One, in recognition of the impacts its current existence has on the environment, has set ambitious goals to minimize its impact. As mentioned in the Sustainability Report, F1 aims to "systematically reduce the CO2 emissions generated by [its] operations, events, logistics, and race cars to Net Zero by 2030"[21]. As proof of progress, The Guardian reported that F1 cars today "have 52% thermal efficiency, a figure believed to be almost unachievable and 20% greater than road cars"[22]. Efficiency is a very sought-after goal in the sport, partially because it can allow the

[21] Formula One, "F1 Sustainability Strategy" (Formula One, 2020), 4.
[22] Richards, "Climate Emergency Accelerates F1's Efforts to Clean up Its Image."

same operations to create a lower carbon footprint. F1 will certainly need to continue these efficiency and other sustainability measures in step with its growth in order to remain on track for the goals.

*Figure 10 Formula One's Pledge for sustainability over the next 8 years (Source: Formula One/F1 Sustainability Report)*

## <u>*Sustainable Design*</u>

### Environmental Impacts of Sports Stadium

Sports stadiums and the systems incorporated in them consume massive portions of resources from the communities in which they are located. The resources consumed in terms of operation of facilities include land, water, energy production, and food[23]. Another major consideration, as mentioned above, is the environmental impact of having so many fans in the stadium, which typically manifests in waste generation and transportation of these large numbers of people[24].

Within the issue of waste generation, food waste is known as a large contributor in the environmental community, and this rings true during events held in sports stadiums. One strategy to minimize food waste in sports stadiums is to include compost bins at each stadium location that prepares or distributes food. Food scraps such as banana peels, eggshells, and animal bones and fats can all be thrown into the bins, thus saving "hundreds of thousands of food from ending up as waste in landfills" and allowing it to be "sent to local farms to serve as compost"[25]. Another kitchen-related waste product is leftover cooking oil. An alternative use for the oil besides simple disposal is the production of biofuel, which annually could be equivalent to "removing over 129,000 pounds of CO2 from the air"[26].

Another area in which waste generation can be sustainably improved is in the materials used for containing food. This includes utensils, drink containers, food packaging, and plates. Since stadiums tend to have multi-million dollar contracts with different suppliers of these products, Aquino et al. argue that sports teams and stadium operations managers have the upper hand, allowing them to either reasonably tell vendors "that they want more sustainable options or go with a more sustainable

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[23] Ileana Aquino et al., "Sustainable Design Strategies for Sport Stadia," *Suburban Sustainability* 3, no. 1 (June 2015), https://doi.org/10.5038/2164-0866.3.1.1020.
[24] Aquino et al.
[25] Aquino et al.
[26] Aquino et al.

vendor"[27]. Once this food and packaging are in the hands of the fans themselves, there is one more strategy towards minimizing wastefulness: recycling and composting with informative labels that prevent confusion as to what can go in which bins. Aquino et al. note that in a full 50,000 seat stadium, about 122,000 pounds of waste is generated when recycling and composting are not in the equation.

## Goals and Objectives

The goal of this thesis is to explore a scheme for the Formula One Miami Grand Prix that will simultaneously help get Formula One to its goal of net-zero energy or even further to net-positive energy, bring in new fans and viewers, and provide education about the sport in terms of both history and advancements towards a greener future. In order to achieve this goal, one objective is to create an additional facility to the existing track that can be woven into the track's fabric and be used as a place to teach people about the sport. This additional facility will be used to also get local youth engaged and involved.

Another objective is to both design and identify ideal locations for on-site energy generation. There will inevitably be irregularly-shaped spaces due to the nature of the site, and those will be taken advantage of when suitable. An additional objective for this thesis is to design the facility to be adaptable for other non-racing uses. This will allow the facility to serve as part of the local community even during weekends that are not hosting races.

[27] Aquino et al.

## Scope and Delimitations

### Justification of Altering a Circuit

As mentioned above, racetracks and sports stadiums can be massive generators of waste and carbon emissions. With Formula One's desire or need to reach net-zero by 2030, there is much that can be done at the level of individual circuits to help this. Architecturally speaking, this is the best place to make changes to the sport, but it can also help to set a precedent for other tracks and stadiums to be net-zero or be used for more purposes outside of race weekends.

# Chapter 2: Site Studies

## *Site Selection*

### Criteria for Potential Site

Site selection for the potential location of this thesis came down to four distinct locations scattered across the United States. While there may have been hundreds of different potential locations to choose from, one of the most important factors in the selection process was the need for the track to be existing or be in the process of being built. Eventually, the search was narrowed to four locations: the Circuit of the Americas in Austin, Texas; the Sonoma Raceway in Sonoma, California; Watkins Glen International in Watkins Glen, New York; and the Miami International Autodrome in Miami Gardens, Florida.

After obtaining the four primary sites, they were all judged based on nine key criteria. The criteria were: connection to Formula One history, track update and facility design/redesign needs, climate and resiliency requirements, distance from major cities, capability to integrate public transit, capability to handle increasing amounts of spectators, capability to integrate commercial or institutional programming, available open space, alternative-use capabilities, and future development plans.

| CRITERIA | CIRCUIT OF THE AMERICAS | SONOMA RACEWAY | MIAMI STREET CIRCUIT | WATKINS GLEN |
|---|---|---|---|---|
| Connection to F1 History | -Current Site of the United State Grand Prix | -No Current Connection To F1 | -The future site of a Formula One street Circuit | -Former Site of the United States Grand Prix |
| Track Update and Facility Design/Redesign Needs | -Track and facilities are new | -The track and its facilities are outdated | -Track and facilities are now in the design phase | -Track and facilities are outdated |
| Climate and Resiliency Requirements | Climate and Resiliency Requirements | Climate and Resiliency Requirements | - Tropical Climate. Coastal resiliency is need with the proximity to the coast. | Climate and Resiliency Requirements |
| Distance from Major City and Capability to integrate public transit | -14 Miles from downtown Austin, Texas | -34 Miles from Downtown San Francisco, California | -17 Miles from downtown Miami, Florida but is within the fabric of the Miami metropolitan area | -84 Miles to Syracuse, New York |
| Capability to Handle increasing amounts of Spectators | - There is ample space now to hold increasing spectators and room to grow. | - There is ample space now to hold increasing spectators and room to grow. | -Once the facilities are built it will be hard to adjust for a growing number of spectators | - There is ample space now to hold increasing spectators and room to grow. |
| Ability to Integrate Commercial or Institutional Programming | The proximity to Austin and the available space make adding commercial or institutional programming easy | There is a good amount of space and a relatively close connection to a city making this viable | The lack of available space make the addition of commercial or institutional space difficult, but could be found elsewhere | Space is available but there may not be a good enough connection to a city to bring people |
| Available Open Space | Available Open Space | Available Open Space | -Not much available due to the fact the track is being built in the parking lot of the HardRock Arena | Available Open Space |
| Alternative Use Capabilities | -Currently has other uses besides racetrack, including amphitheater, soccer stadium, and more | -There are not current other uses besides racing, but there is room for them | -Currently used for the Miami Dolphins and Tennis matches | -There are not current other uses besides racing, but there is room for them |
| Future Development | Currently there is little to no Future development around | N/A | Located in a city with a lot of future development located around it | N/A |

*Figure 11 Site Selection Matrix: Criteria and Information (Source: Nicholas DiBella)*

Circuit of the Americas

The Circuit of the Americas is the current site of the United States Grand Prix, which has been the only Formula One race in the U.S. It is comprised of 1,500 acres outside downtown Austin, Texas, and it hosts both action sports and music events with its racetrack, soccer stadium, amphitheater, and more[28]. The racetrack is 3.41 miles long and includes challenging topography for drivers and thus viewing entertainment for fans[29].

The racetrack and the site's facilities are relatively new, having been constructed only 10 years ago (compared to the sport's roots in the 1920s and 1930s) in 2012. It was designed by Hermann Tilke and HKS[30]. The same year as its opening, Formula One raced the U.S. Grand Prix at the Circuit in a memorable race for fans as the last time Lewis Hamilton won in a McLaren before switching to Mercedes[31].

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[28] "Circuit of The Americas - COTA | Austin, TX," accessed April 21, 2022, https://www.austintexas.org/listings/circuit-of-the-americas-cota/6879/.
[29] "Circuit of The Americas - COTA | Austin, TX."
[30] "United States Grand Prix 2022 - F1 Race," Formula 1® - The Official F1® Website, accessed April 21, 2022, https://www.formula1.com/en/racing/2022/United_States/Circuit.html.
[31] "United States Grand Prix 2022 - F1 Race."

*Figure 12 Aerial View of Circuit of the Americas (Source: Planet Labs, Inc. - https://medium.com/planet-stories/a-grand-prix-world-tour-86b08d45ae46, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=77058455)*

The site's 14-mile distance from Austin and ample available space in the area make it a prime location for growth and increased connectivity. The facilities have enough space to account for fanbase growth in the sport, and the surrounding area would be able to easily accommodate new commercial or institutional programming. There are not currently any plans for future development around this site, so a proposal for future development would likely be a requirement if this site is chosen. There are also very few expectations for meeting climate and resiliency guidelines that some other facilities have in place, so there is plenty of room for improvement in the sustainability rea

Sonoma Raceway

The Sonoma Raceway is 34 miles from downtown San Francisco, California. This site currently has no connection to Formula One, so the selection of this site would boost the F1 connection to the west coast. The track was first built on the 720-acre site in 1968 with a 2.52-mile track[32]. The first event at the track was held that same year, and the USAC IndyCar race was held there two years later in 1970[33].

Sonoma's track and its facilities are outdated now and would require substantial renovations in order to meet the requirements of Formula One. The requirement of making these improvements could be a good opportunity to overhaul some of the systems in place and replace them with more sustainable, efficient, and safe ones. These facilities have little to no climate and resilience requirements on the surface, but their location in California subjects them to both California's stricter sustainability requirements and the potential danger of wildfires.

The facilities are not tight for space and have plenty of room to grow for increased spectator numbers as well as increased development. There are not any other uses directly near this track, but there is room for them, so the development of additional uses could be beneficial. The connection with such a major and vibrant city as San Francisco could help build new cultural ties between the city and the sport.

[32] "Sonoma Raceway," RacingCircuits.info, accessed April 21, 2022, https://www.racingcircuits.info/north-america/usa/sonoma-raceway.html.
[33] "Sonoma Raceway."

*Figure 13 Aerial View of Sonoma Raceway (Source: By JGkatz|Jeffrey G. Katz - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=14589515)*

Miami Grand Prix

The Miami Grand Prix is planned to be the future site of a Formula One street circuit, the Miami International Autodrome. The circuit will be temporary but has been "designed to have a permanent feel" and a "street circuit vibe"[34]. The site is currently used for Miami Dolphins games and tennis matches. The track and its facilities are in the construction phase now (Spring 2022), and the first race at the track is expected to be in the early summer of 2022. This will put a second U.S. race on the F1 season's calendar for the first time, and this location will be the "11th

[34] "Miami Grand Prix 2022 - F1 Race," Formula 1® - The Official F1® Website, accessed April 19, 2022, https://www.formula1.com/en/racing/2022/Miami/Circuit.html.

different American venue to host a round of the Formula One world championship"[35].

The climate at this site 17 miles away from downtown Miami, Florida is tropical, and coastal resiliency would be an important factor to consider with its proximity to the coast.

Once the facilities are built, it will be more difficult to adjust for a growing number of spectators due to its positioning within the urban fabric of the Miami metropolitan area, so it is important for the existing design to account for that potential. The lack of available space directly around the site would make the addition of commercial or institutional space more difficult, but the urban location allows connections with those uses to be more locally available already. The urban context does have future development planned, so it can be assumed that more commercial and institutional uses will be added and/or improved. As an example of how tight the site is for space, the racetrack is being built where some of its parking lots currently exist.

[35] "Miami Grand Prix 2022 - F1 Race."

*Figure 14 Aerial View of The Miami Grand Prix under construction (Source: FormulaOne.com)*

Watkins Glen

Watkins Glen International is the site of a former United States Grand Prix, located 84 miles away from Syracuse, New York. This track and its facilities are outdated, having hosted the Formula One Championship for twenty seasons in a row from 1961 to 1980[36]. Until the completion of the Circuit of the Americas in Austin, this was the most recent purpose-built circuit for the U.S. Grand Prix[37].

One benefit of this site is the amount of available space for future development. It is unknown if there are local plans for development, but there is certainly room for building out and making room for more spectators as the sport

[36] Maurice Hamilton, *Grand Prix Circuits: Maps and Statistics from Every Formula One Track*, Illustrated (HarperCollins Publishers, 2015).
[37] Hamilton.

grows in popularity. This open space could also be used to incorporate additional uses besides racing since racing is currently the only user on the site. While there is plenty of available open space, however, there may not be a strong enough connection to a nearby city to draw in as many people due to distance and a lack of transportation options besides driving.

It is unclear whether this area of New York State has any climate and resiliency requirements. Even if there were new requirements, existing buildings are often exempt from such requirements.

*Figure 15 Aerial View of Watkins Glen International (Source: Nascar.com)*

Selection

The ultimate selection came down to Circuit of the Americas and the Miami Grand Prix. The Miami grand Prix was chosen based on the criteria and rating done in the site selection matrix.

- Future Development needs
- Alternative Use Capabilities
- Ability to integrate commercial or institutional programming
- Capability to handle increasing number of spectators
- Distance from major city and ability to integrate public transport system
- Climate and resiliency requirements

# RACE TO NET ZERO

REDESIGNING FORMULA ONE TRACKS TO BE NET ZERO

## SITE SELECTION MATRIX

| CRITERIA | CIRCUIT OF THE AMERICAS | SONOMA RACEWAY | MIAMI STREET CIRCUIT | WATKINS GLEN |
|---|---|---|---|---|
| Connection to F1 History | 3 | 1 | 2 | 3 |
| Track Update and Facility Design/Redesign Needs | 1 | 3 | 3 | 3 |
| Climate and Resiliency Requirements | 1 | 2 | 3 | 1 |
| Distance from Major City and Capability to integrate public transit | 2 | 2 | 3 | 1 |
| Capability to Handle increasing amounts of Spectators | 3 | 3 | 1 | 2 |
| Ability to Integrate Commercial or Institutional Programming | 2 | 2 | 3 | 2 |
| Available Open Space | 3 | 3 | 1 | 3 |
| Alternative Use Capabilities | 3 | 1 | 3 | 1 |
| Future Development | 3 | 2 | 3 | 2 |
| Total out of 30 | 21 | 19 | 22 | 18 |

*Figure 16 Site Selection Matrix: Criteria and Rating (Source: Nicholas DiBella)*

*Site: Miami Grand Prix (Miami International Autodrome)*

Site History

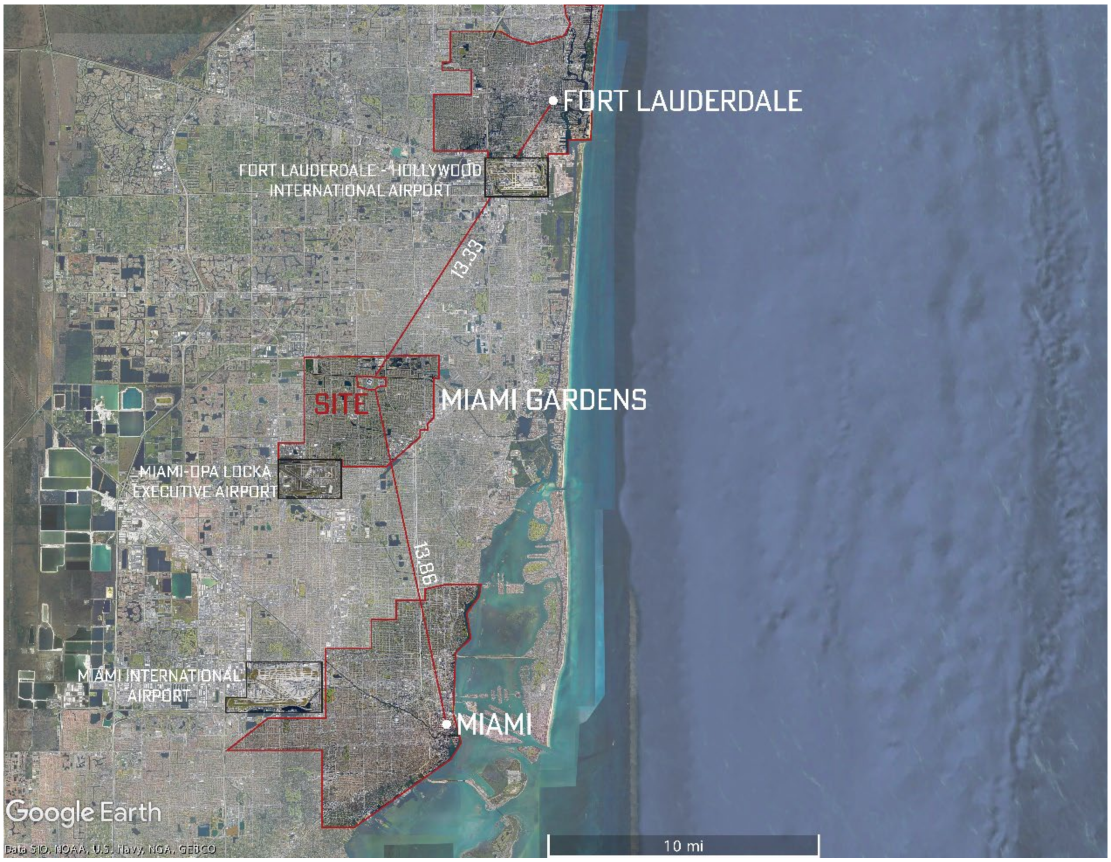


*Figure 17 Map showing Site and Proximity to Surrounding Cities (Source: Google Earth edited by author Nicholas DiBella)*

*Miami Gardens History*

Miami Gardens was first incorporated as a city in Miami-Dade County in 2003. It lies between Fort Lauderdale and Miami and is close to several major highways. Miami Gardens takes up about 20 square miles[38] and had a 2019 population of about 111,363[39]. The city's boundaries are listed as "151st Street to the South; Countyline Road to the North; North Miami Avenue/Northeast 2nd Avenue to the East; Northwest 47th Avenue to the West"[40].

The dominant ethnic group in Miami Gardens is Black or African American, comprising 68.6% of the population (See Fig. 15)[41]. The next largest ethnic group, less than one-third of the dominant one, is White-identifying Hispanic, comprising 21.3% of the population[42]. All other ethnicities fall below 4% of the total population[43]. 87.2% of Miami Gardens residents are U.S. citizens, with the remaining 32.2%, which is about 36,000 people, born outside the U.S. (See Fig. 16)[44]

38 "About the City | Miami Gardens, FL," accessed April 21, 2022, https://www.miamigardens-fl.gov/252/About-the-City.
39 "Miami Gardens, FL | Data USA," accessed April 19, 2022, https://datausa.io/profile/geo/miami-gardens-fl/#about.
40 "About the City | Miami Gardens, FL."
41 "Miami Gardens, FL | Data USA."
42 "Miami Gardens, FL | Data USA."
43 "Miami Gardens, FL | Data USA."
44 "Miami Gardens, FL | Data USA."

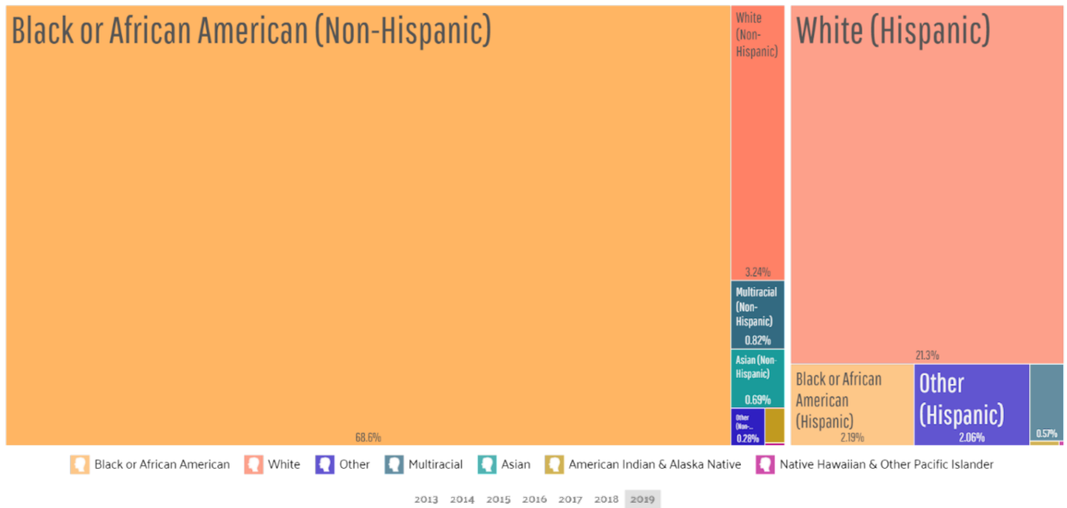


*Figure 18 Graphic showing the racial and ethnic demographics of Miami Gardens (Source: Datausa.io)*

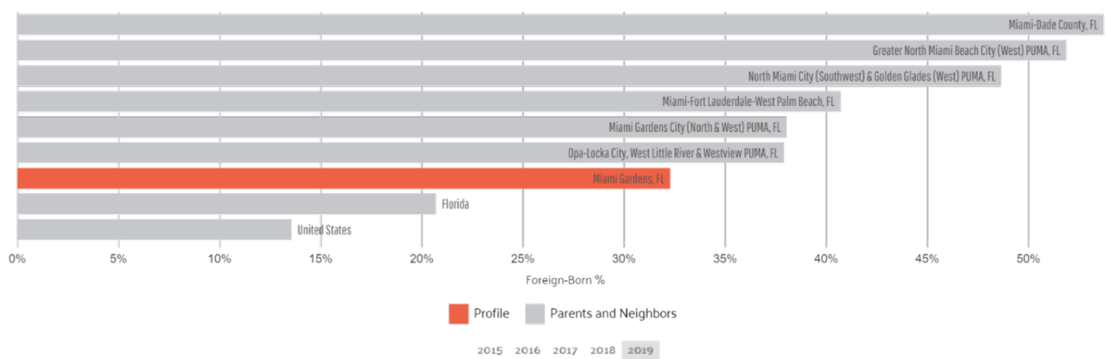


*Figure 19 Graph showing percentage of foreign-born (Source: Datausa.io)*

In 2019, the median household income for residents of Miami Gardens was $44,064 (See Fig. 18), and the median property value was $190,000 with a homeownership rate of 63.5%[45].

[45] "Miami Gardens, FL | Data USA."

The poverty rate of Miami Gardens is 21%, which is much higher than the national average of 12.3%[46]. Women aged 25-34 are the first most common demographic with poverty status, with boys aged 6-11 falling in second and women aged 35-44 in third[47] (datausa.io).

In terms of transportation trends for Miami Gardens, 84.7% of workers drove alone to work, and the city's average commute time is 32.2 minutes[48]. Other modes of transportation are significantly less used due to the car-centric infrastructure of the area, with carpooling as the second most common transportation mode at 5.91%[49]. Rail access options for the city include the Florida East Coast Railway and the South Florida Tri-Rail System.

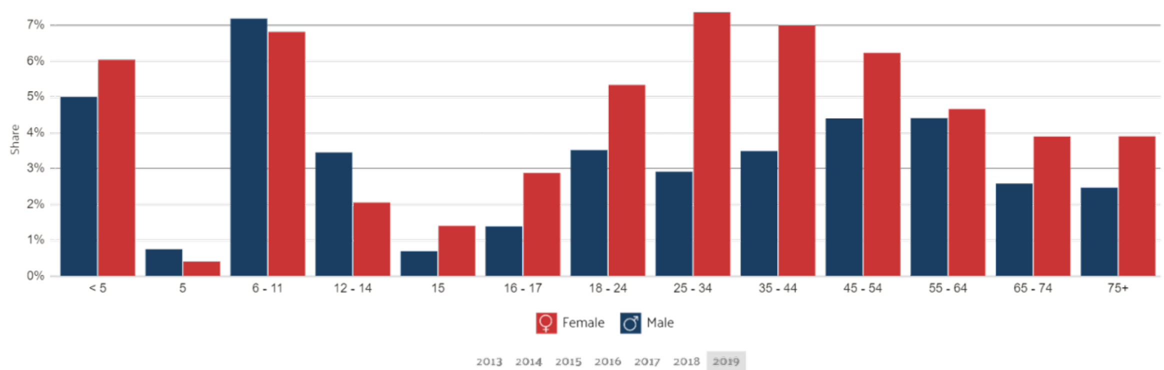


*Figure 20 Graph showing the poverty percentage by age group (Source: Datausa.io)*

[46] "Miami Gardens, FL | Data USA."
[47] "Miami Gardens, FL | Data USA."
[48] "Miami Gardens, FL | Data USA."
[49] "Miami Gardens, FL | Data USA."

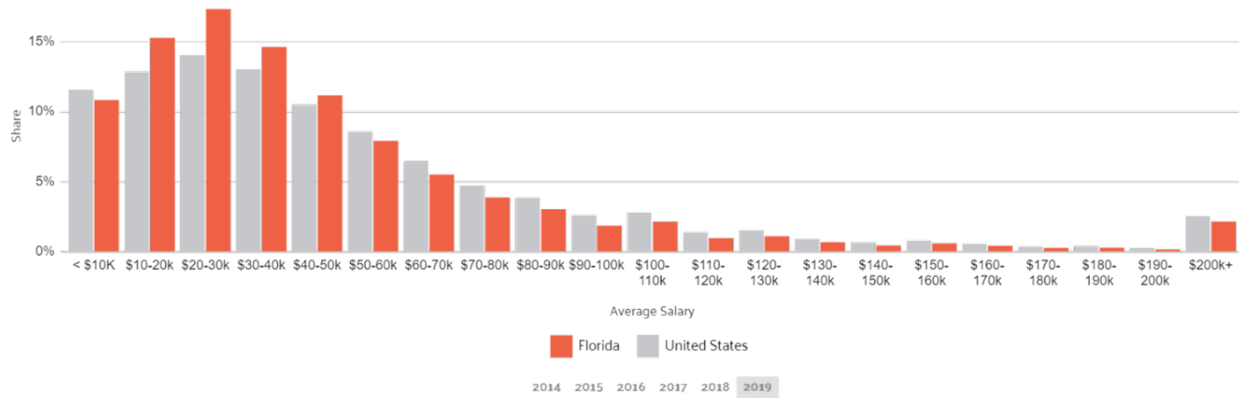


*Figure 21 Graph showing average salary (Source: Datausa.io)*

*Hard rock stadium history*

The Hard Rock Stadium was dedicated in 1987 when the land was still considered unincorporated in Miami-Dade County[50]. The stadium is considered to be the brainchild of Joe Robbie, founder of the Miami Dolphins. The existing Orange Bowl in Miami made NFL officials reluctant to ever allow the Super Bowl to be hosted in Miami again. Eager to bring the attention of the Super Bowl back to Miami, Robbie purchased the 160 acres of land[51] for the proposed stadium. While many local residents protested and even sued over the proposal, Robbie defended himself with

[50] Cooper Rollow, "ROBBIE`S BRAINCHILD NOW STANDS AS HIS MONUMENT," Chicago Tribune, accessed April 21, 2022, https://www.chicagotribune.com/news/ct-xpm-1989-01-22-8902270739-story.html.
[51] "Stadium Facts | Sun Life Stadium," accessed April 21, 2022, https://web.archive.org/web/20150726203828/http:/www.sunlifestadium.com/stadium-facts.

the fact that the land was open and that no housing would be destroyed for this stadium, unlike many other stadia[52].

The total cost for the original stadium project was $115 million[53], and to finance it, Joe Robbie produced a financial plan for the stadium that had never been done before. The plan was for all construction to be privately funded by using "sales of 10-year leases for priority seating as the down payment on loans"[54]. When rent for the land was drastically increased and high-interest rates threatened the project, Robbie used expensive sales for skyboxes and club seats as collateral[55]. The $14.6 million in annual revenue created by these expensive seats was dedicated to construction costs, leading multiple banks to feel more comfortable issuing large bonds for the project[56].

The stadium underwent major renovations in 2007 for $250 million[57] and in 2015-2016 for $550 million[58]. Both renovations contributed to added flexibility for the multiple sports that the stadium can host.

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52 Rollow, "ROBBIE`S BRAINCHILD NOW STANDS AS HIS MONUMENT."
53 "Stadium Facts | Sun Life Stadium."
54 Rollow, "ROBBIE`S BRAINCHILD NOW STANDS AS HIS MONUMENT."
55 Rollow.
56 Rollow.
57 "Stadium Facts | Sun Life Stadium."
58 "Hard Rock Stadium (Dolphins Stadium) – StadiumDB.Com," accessed April 21, 2022, http://stadiumdb.com/stadiums/usa/dolphins_stadium.

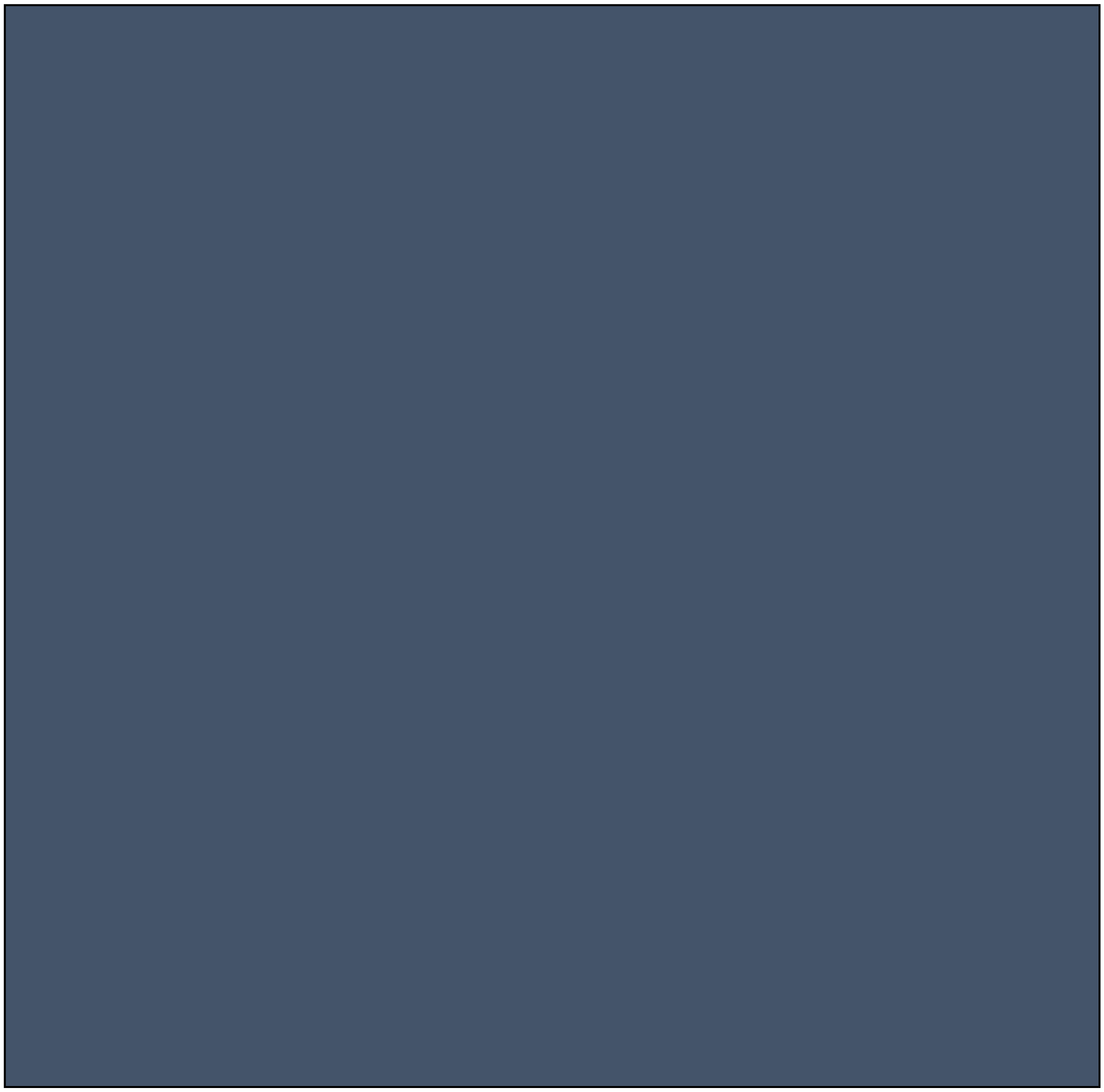


*Figure 22 Graphic showing part of the renovations that took place to the stadium from 2015-2016 (Source: Structure Magazine)*

Site Inventory

The site of the Miami Grand Prix is roughly 241 acres and is boxed in by streets, highways, and a canal. The site is flat with little to no topographic changes. The levelness across the site and the amount of rain and flooding across Florida have led to the creation of stormwater lines put in across the site that dump excess water into the adjacent canal. Above many of the stormwater drains is a permeable parking surface that helps diffuse the water down to the drains. The amount of permeable parking surface across the site is 4,271,566 sq ft. The central element of the site is the Hard Rock Stadium, which takes up approximately 755,743 square feet. Accompanying the football stadium is a tennis stadium that uses a total of 65,536 square feet of site area.


*Figure 23 Satellite image of Hard Rock Stadium Site (Source Google Earth/Nicholas DiBella)*

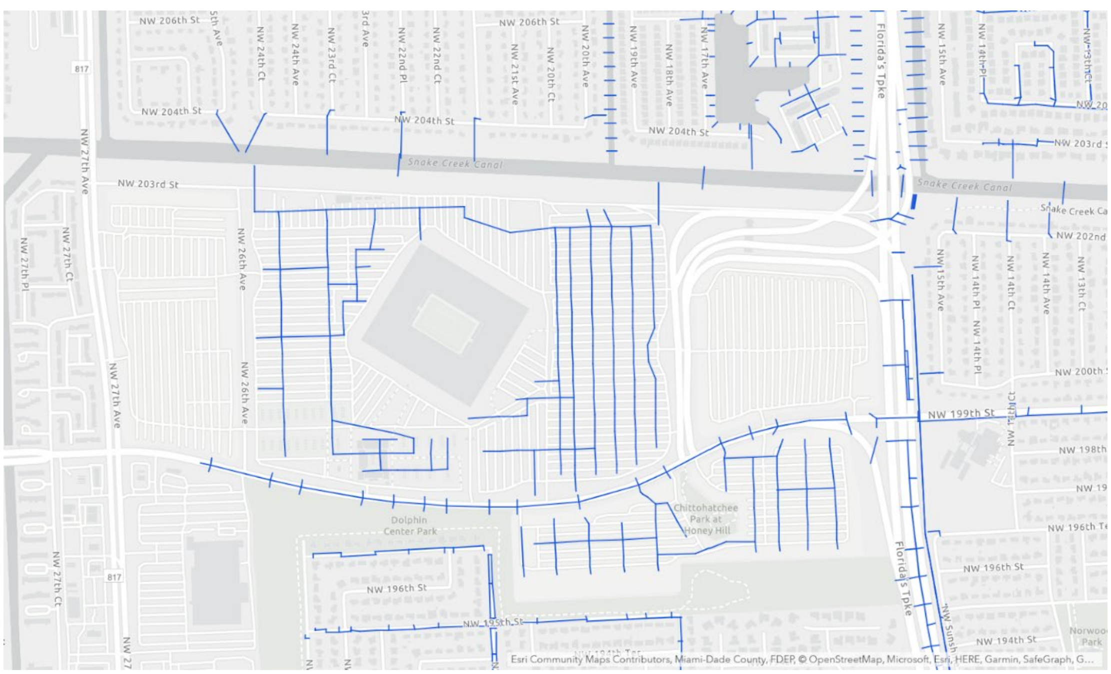



*Figure 24 Map showing existing site drainage locations (Source: ArcGIS)*

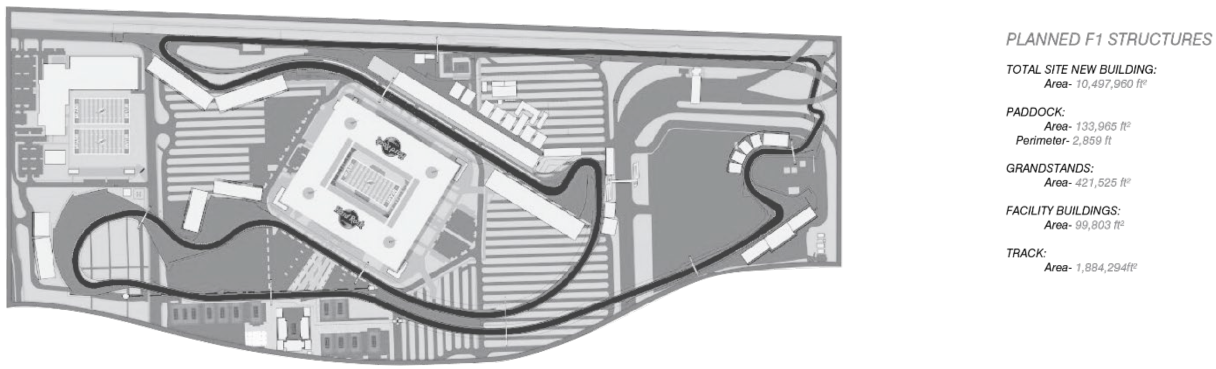



*Figure 25 Potential Site Diagraming the Layout for the 2022 Miami Grand Prix (Source: Formula One/ Edited by author Nicholas DiBella)*

With the introduction of the Grand Prix circuit to the site, there are several new interventions that are being added to the site. The first and most important addition to the site is the new speedway or circuit. The circuit will take up a total of 1,884,294 square feet of available surface area. It will feature three main straightaways and nineteen different turns. The Grand Prix will also bring with it several sets of grandstands spread out around major turns and straightaways of the track, which is ideal for the sport's growing fanbase. There have been plans to create a total of eleven different sets of grandstands totaling 421,525 square feet. To support the event, the Grand Prix will also get other track-related buildings constructed, totaling 99,903 square feet. The most important building to be constructed on the site is the paddock. The paddock has many uses, including the garage area where cars are kept and worked on, the FIA control center, the track maintenance control center, the media and broadcasting center, additional stadium seating, and a lounge area. The total proposed area of the paddock is around 133,966 square feet.

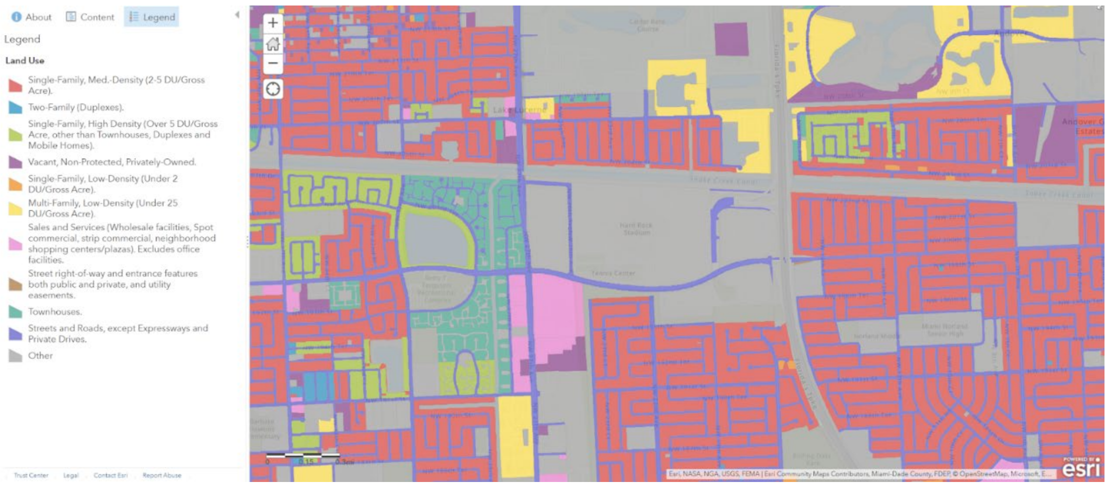
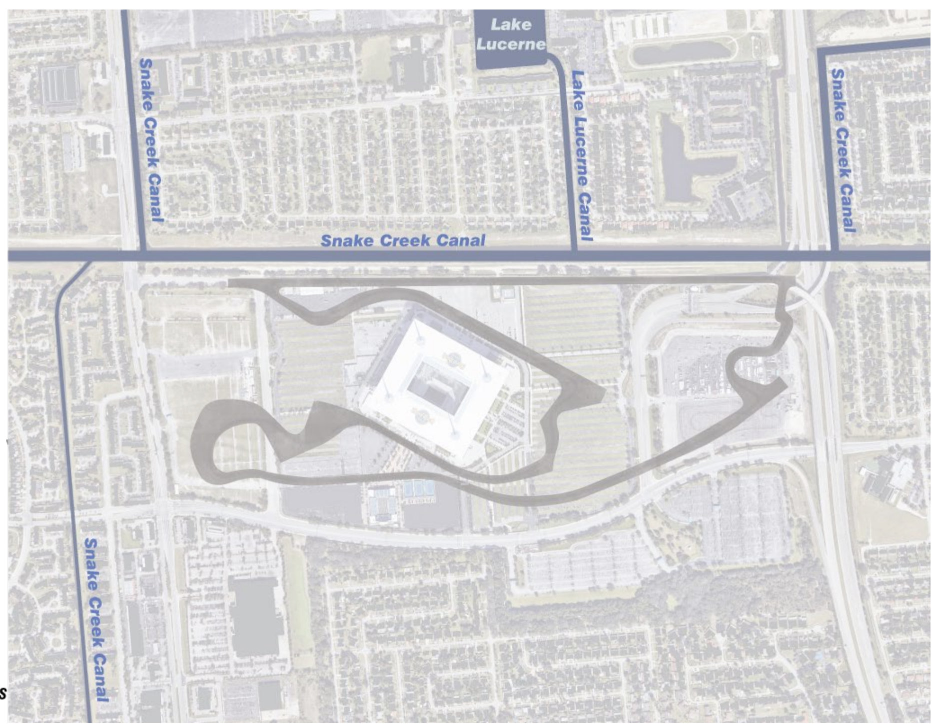



*Figure 26 Graphic showing the Land use around the Miami Grand Prix Site (Source: ArcGIS)*




**Major Waterways**

*Figure 27 Diagram of Major Waterways Surrounding the Site (Source Google Earth edited by Author Nicholas DiBella)*

Topography

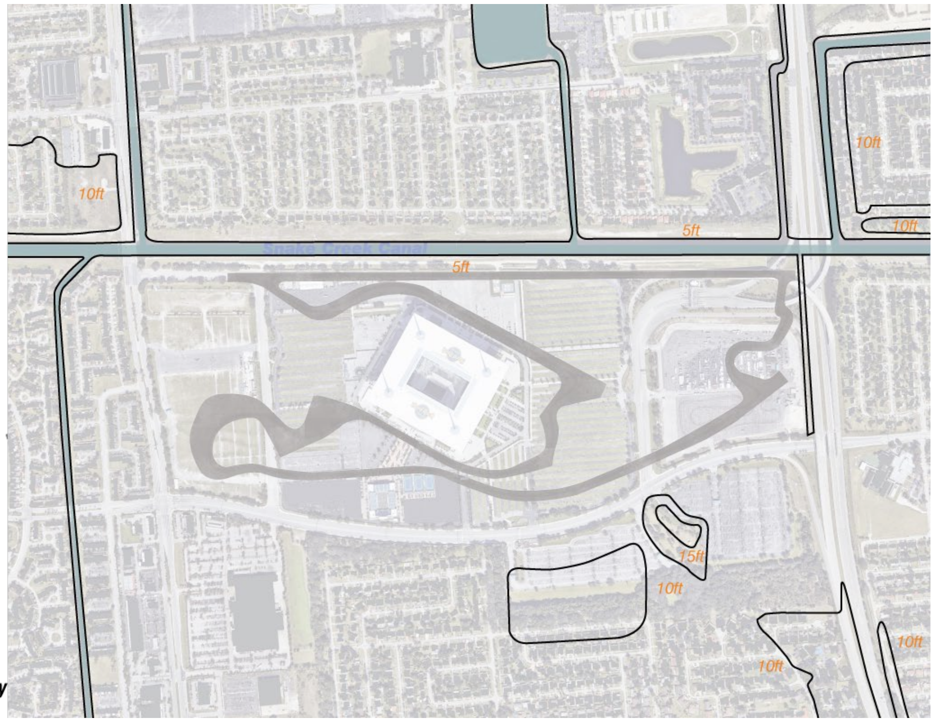



*Figure 28 Diagram of the Site Topography (Source: Google Earth edited by Author Nicholas DiBella)*

Major Roadways

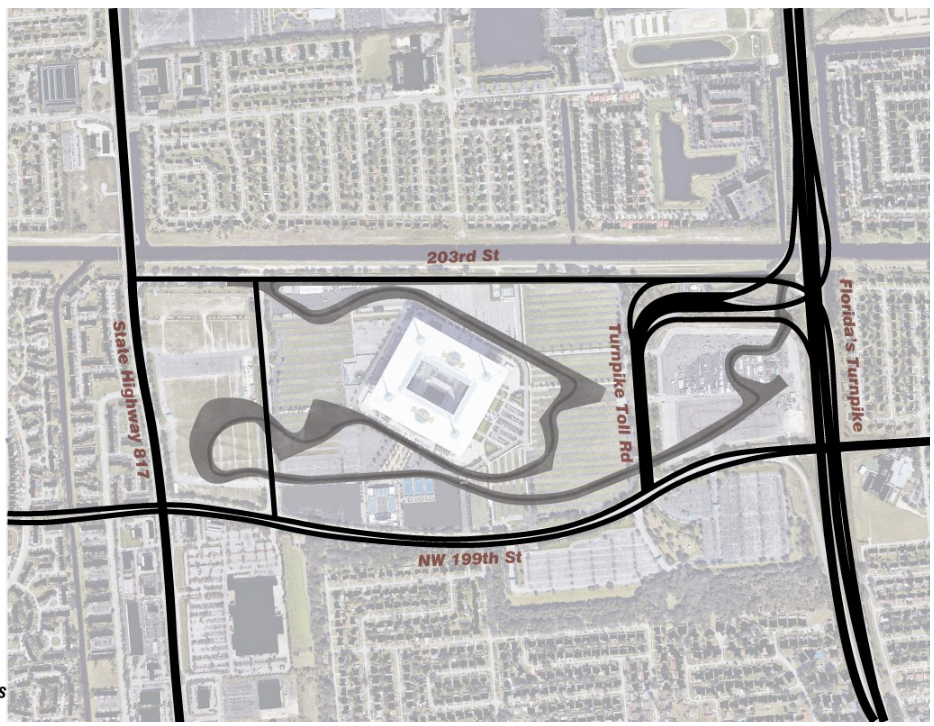



*Figure 29 Diagram of Surrounding Roadways (Source: Google Earth Edited by Author Nicholas DiBella)*

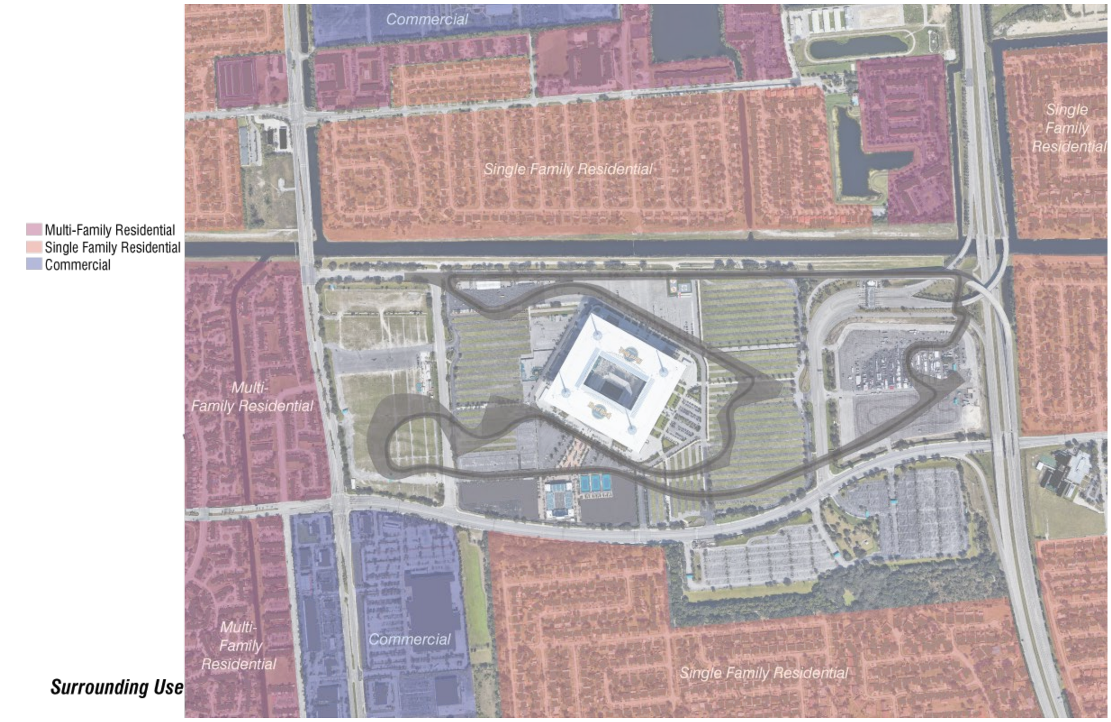


*Figure 30 Diagram of Surrounding Use (Source: Google Earth Edited by Author Nicholas DiBella)*

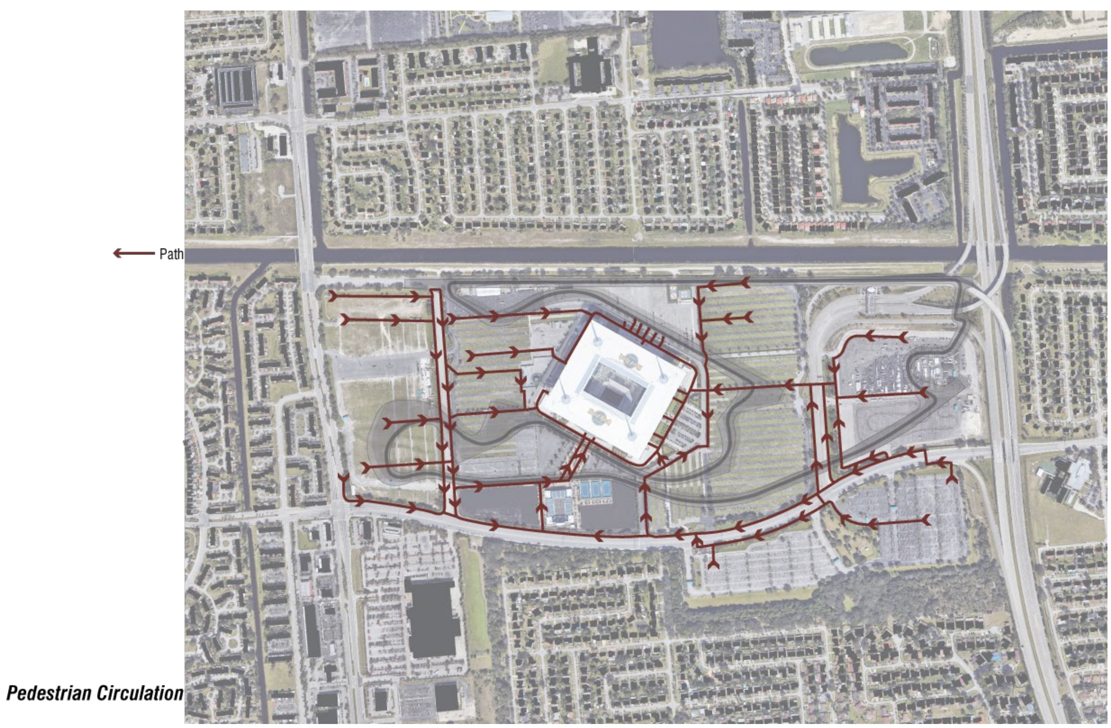


*Figure 31 Diagram of Pedestrian Circulation (Source: Google Earth Edited by Author Nicholas DiBella)*

Service Circulation

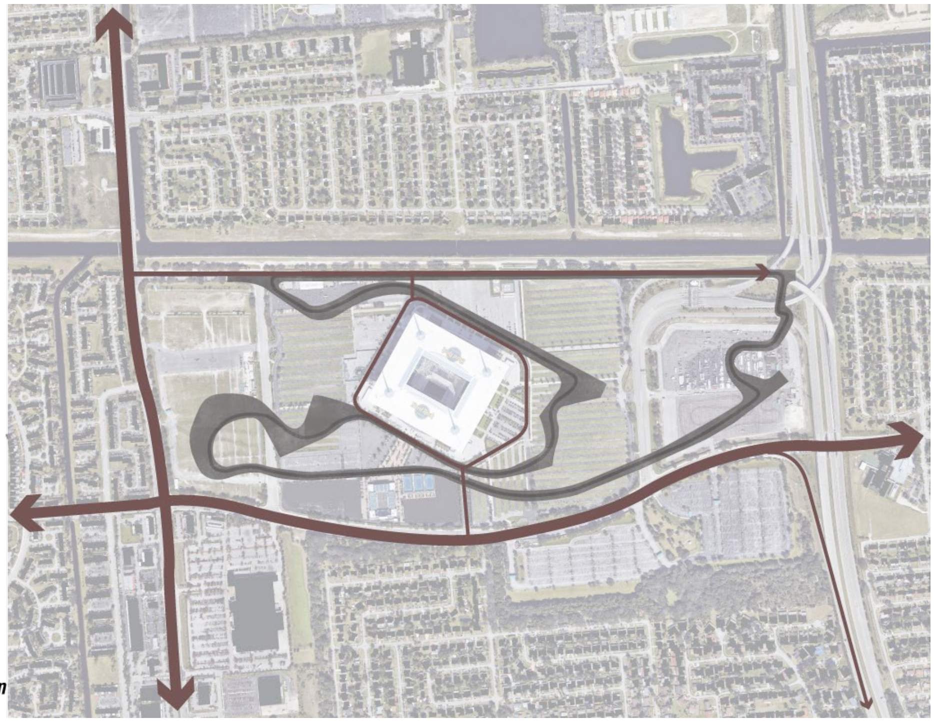


Figure 32 Diagram of Service Circulation (Source: Google Earth Edited by Author Nicholas DiBella)

Vehicular Circulation

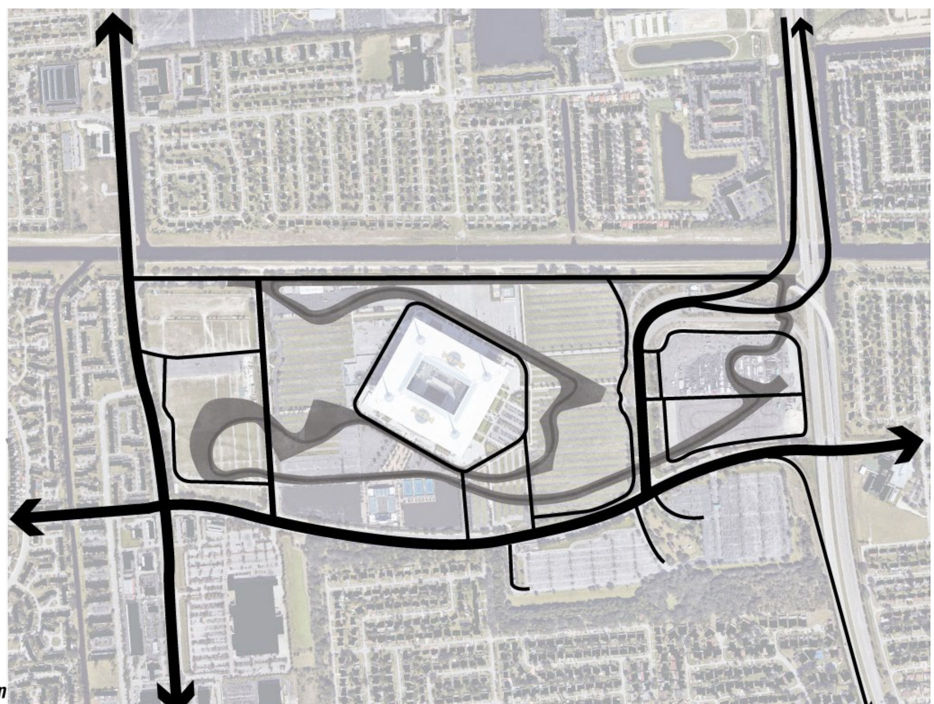


Figure 33 Diagram of Vehicular Circulation (Source: Google Earth Edited by Author Nicholas DiBella)

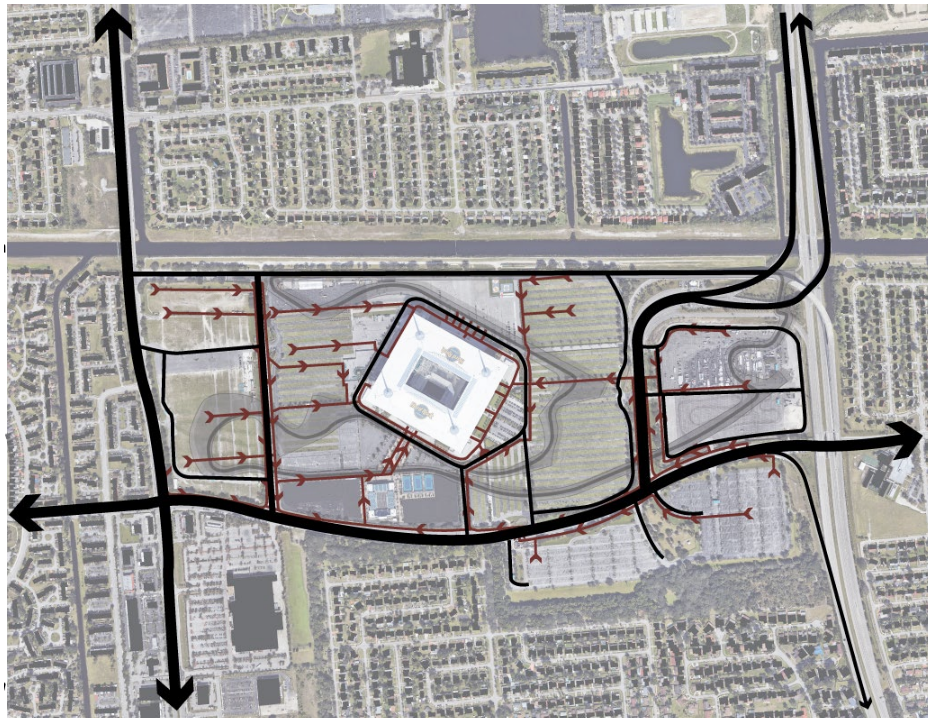


*Figure 34 Circulation Synthesis Diagram (Source: Google Earth Edited by Author Nicholas DiBella)*

Site Environmental Impacts

The Hard Rock Stadium currently has 140 acres of parking[59]. One major environmental impact of this amount of surface parking area is the heat island effect, where dark-colored, low-reflectivity surfaces such as paving, absorb heat from the sun and cause an increase in local ambient temperatures. A direct connection to the heat island effect is the absorption of heat into tens of thousands of parked cars and what that means for energy use. When cars are unshaded, especially during the summer (typical racing season) when there are more hours and stronger levels of sunlight, drivers returning to their cars typically turn on their air conditioning to very high levels for longer periods to increase comfort levels inside the hot cars. This

[59] "Stadium Facts | Sun Life Stadium."

increased use of air conditioning multiplied by the number of drivers produces high levels of emissions.

Another major environmental impact of surface parking is the issue of stormwater runoff. Impervious paved surfaces do not allow rainwater to absorb into the ground below, causing water to run at increasing speeds into drains or nearby natural areas. This can lead to erosion and diminished soil quality. In the case of parking at the Hard Rock Stadium, about half of the parking is impervious surface parking, and the other half is permeable. As previously stated, driving alone is the most common form of transportation in Florida, so it is expected that large amounts of parking are needed at such a site. Luckily, there are many ways of mitigating the negative effects of large numbers of existing surface parking. Other materials in the project relating to stormwater are that the playing field surface is made of Prescription Athletic Turf (PAT)[60]. PAT uses a combination of natural grass and moisture management systems to prevent issues that usually arise when the grass has too much or not enough water available to its roots. The drainage system for the playing fields is arranged so that the playing surface can be firm "within 30 minutes of a 3" per hour rain"[61]. It is important to note that the site is in a flood zone, so preparations must be in place to handle large amounts of water on the site (See Fig.

[60] "Stadium Facts | Sun Life Stadium."
[61] "Stadium Facts | Sun Life Stadium."

24).

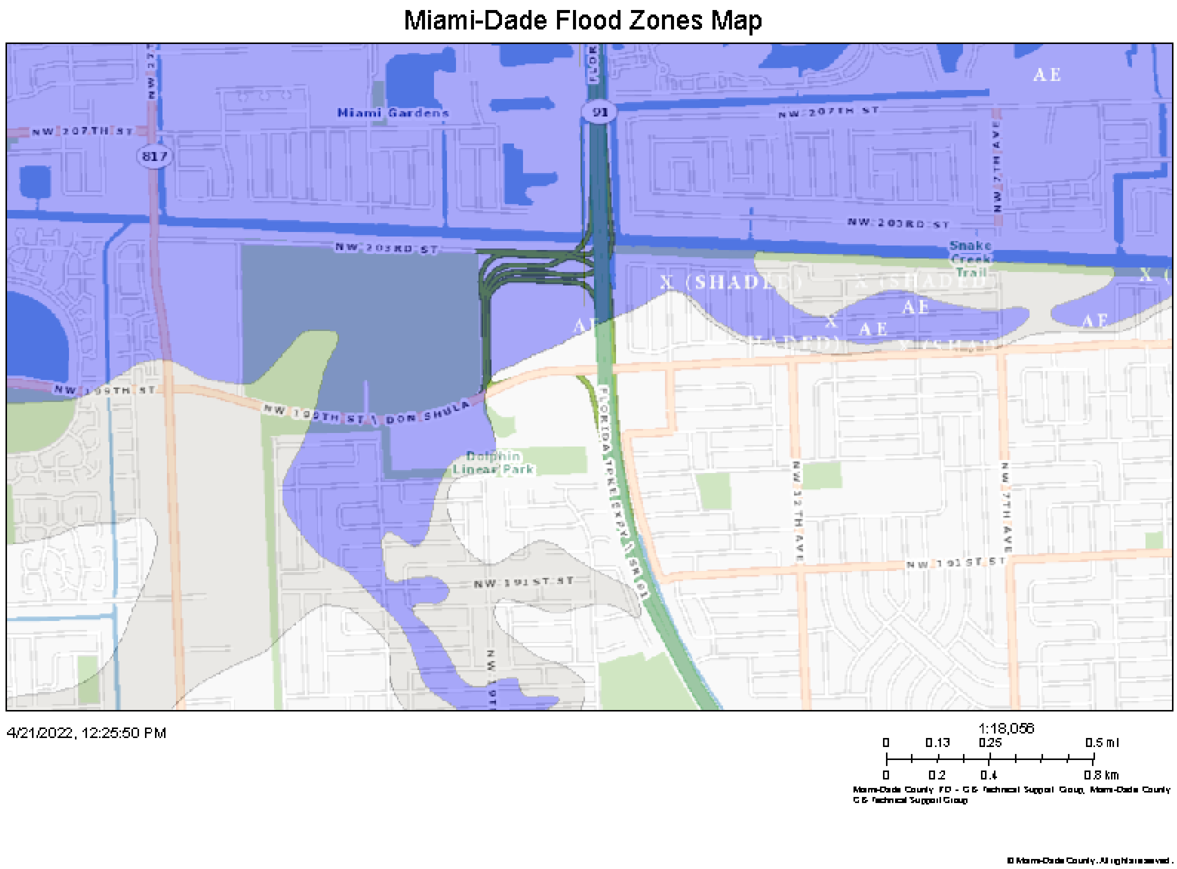



*Figure 35 Miami-Dade Flood Zone Map Looking at the selected Site (Source: ArchGis)*


*Figure 36 Map of the Selected Site showing the proximity of Well Field Protection Area (Source ArcGIS)*

Another environmental impact of the stadium to consider is its embodied energy. Embodied energy is a strategy of measuring the sustainability of a project that is becoming more popularly used, and it is the total amount of energy expended in the entire life cycle of every material in the project. This includes energy expended for the extraction, production, transportation, construction, and even demolition and disposal of the materials. Concrete and steel are two materials with extremely high embodied energy due to the amount of energy required to extract and produce the materials before they are even used in construction. The Hard Rock Stadium project used 55,000 cubic yards of poured concrete, 3,300 pieces of precast concrete, and

6,000 tons of reinforcing steel[62], so those materials likely contributed greatly to the project's overall embodied energy. Other materials that contribute to the embodied energy of the project are the 3 acres of sod, 5 miles of drainpipe, 500,000 yards of excavated material from the site, 140 miles of electrical wire, and 25,000 square yards of carpet[63].

# Chapter 3: Terms of Reference

## *Case Studies Local*

### Club Motorsports Track, Tamworth, New Hampshire

The Club Motorsports Track in Tamworth, New Hampshire is a notable case study for this thesis because of its attention to detail in incorporating stormwater management and erosion control methods that maintain a more natural, aesthetically pleasing appearance. Racetracks are typically large swaths of paved surface with little to no stormwater controls, usually resulting in erosion and poor soil quality. Some specific methods used for erosion control were Rolled Erosion Control Blankets (RECB) for sloped surfaces,  Hydraulic Erosion Control Mulches (HECP) for flat surfaces, and a bonded fiber matrix (BFM) and flexible growth medium (FGM) for particularly steep areas. In terms of stormwater control, the project utilized a turf reinforcement mat (TRM), which is helpful for areas with high volumes of water, and

[62] "Stadium Facts | Sun Life Stadium."
[63] "Stadium Facts | Sun Life Stadium."

additional FGM incorporated. This project was also able to address other racetrack-specific issues such as the need for compacted soil in the shoulders while establishing vegetation.[64] This racetrack is relevant specifically to this thesis because it is in the US, so it is subject to similar building regulations, and it also deals with site conditions that lead to large amounts of water to be dealt with. In this project, the slope of the site makes water management an important aspect to address, and in the Miami site for this thesis, the site naturally has large amounts of water to contend with.

[64] I.Am.Georgia.Harris, "Private Racetrack Nestled in the White Mountains," *Ecological Landscape Alliance* (blog), March 15, 2021, https://www.ecolandscaping.org/03/managing-water-in-the-landscape/private-racetrack-nestled-in-the-white-mountains/.

*Figure 37 Aeriel View of Clun Motorsports Track (Source: Club Motorsports Track/Photo by JASON BRACKETT)*

## *Case Studies International*

### Canadian Grand Prix Paddock, Montreal, Canada

The Canadian F1 Grand Prix Paddock by FABG Architects is a great example of comprehensive design when it comes to Formula One and tracks with proximity to a city. The program of the Canadian Grand Prix Paddock is not much different from any other paddock in the sport. The paddock has 13 stables or garage stalls, each with enough room to fit the maximum two cars allowed to run and owned by each F1 team. The garage space is modular and able to be rearranged depending on what is needed from each team. This is accomplished using temporary partitions so that as the sport evolves so may the facilities. Something that differentiates this facility from others is that "the lounge areas have no exterior walls and are not air-conditioned"[65], and interior finishes were left to represent the material used. The decision to simplify the construction was multifaceted; it first was done for sustainability reasons but also because the project was built using public funds, so the architecture needed to reflect the values of the people. The design of the paddock is sustainable in a few ways, the first being it uses passive ventilation to cool the interior spaces. The other way was allowing the construction material to also be the finishing material meant that fewer resources needed to be used from the earth. Another great design feature of the building was it was constructed using prefabricated materials, concrete panels, steel beams and columns, CLT wooden beams and panels, curtain walls, and removable partitions. This allows the building to be disassembled and recycled at the end of its life or when the Canadian Grand Prix is no longer being held there.[66]

*Figure 38 Photograph of Canadian F1 Grand Prix Paddock(Source: ARCHDaily, Photo by Steve Montpetit)*

[65] "Canada F1 Grand Prix New Paddock / FABG," ArchDaily, March 15, 2021, https://www.archdaily.com/958600/canada-f1-grand-prix-new-paddock-fabg.
[66] "Canada F1 Grand Prix New Paddock / FABG."

### Olympic Radical Park, Rio, Brazil

The Olympic Radical Park in Rio, Brazil, while not a racetrack, is a useful case study because it exemplifies that certain aspects of sports facilities can be adapted to other uses. There was an understanding in the original design of the park that after the 2016 Rio Olympics, it would need to be used for something else. With this understanding, parts of the facility were specifically designed for both Olympic and future park use. The post-Olympic state of the park is referred to as "legacy mode", indicating that it is meant to last for a long time. The stadium seating installed for the Olympics was intentionally designed to "follow the natural slope of the land", and this same slope was meant to provide seating for the park in legacy mode as well[67]. The primary use for the park in legacy mode is recreation space. The lake at the facility was fitted with "security structures and floating decks" to protect the public from more dangerous areas of the park[68]. Buildings that housed Slalom and BMX administration during the Olympics now house "environmental education activities, community events in addition to an administration office for the park"[69]. This park, while not specifically catering to racing, does offer creative solutions to reusing sports facilities when the sports are not actively using the space.

[67] "Olympic Radical Park Rio 2016 / Vigliecca & Associados," ArchDaily, August 2, 2016, https://www.archdaily.com/792521/radical-park-rio-2016-vigliecca-and-associados.
[68] "Olympic Radical Park Rio 2016 / Vigliecca & Associados."
[69] "Olympic Radical Park Rio 2016 / Vigliecca & Associados."


*Figure 39 Olympic Radical Park Brazil (Source: ARCHDaily, Photo by Gabriel Heusi)*

## Mugello Circuit, Scaperia e San Piero, Tuscany, Italy

The Mugello Circuit in Scarperia e San Piero, Tuscany, Italy is a useful case study for this thesis because it demonstrates a full commitment to both social and environmental sustainability. It is not a Formula One track, although Formula One races have taken place there during the COVID-19 pandemic when F1 needed a track to use. The circuit's sustainability program "KISS Mugello", which stands for "Keep it Shiny and Sustainable", first aimed to tackle waste. Waste sorting programming as well as educational resources for all of the fans who spend race weekends camping helps to minimize the waste generated by race weekends. Recycling kits and spaces, waste sorting guides, free cooking oil collection, and free water fountains all help fans lower their environmental footprint of their stay at the races[70]. Other efforts towards waste reduction include coffee waste collection, portable ashtrays to prevent

[70] Jessica Crawford, "Environmental and Social Sustainability at Mugello Circuit," *Green Sports Alliance* (blog), May 29, 2019, https://greensportsalliance.org/environmental-and-social-sustainability-at-mugello-circuit/.

cigarette butt waste, glass recycling education, and a special waste compactor. Spaces promoting recycling include a "green area" with "benches made by recycled plastic and steel…to demonstrate concretely the potential of circular economy"[71]. Fan engagement efforts promoting recycling include a contest for aluminum can recycling as well as recycled aluminum prizes for fans who bring cans to a fan info desk[72]. From the policy side, KISS Mugello also includes cooperation with the FSC to ensure sustainable sourcing for all paper printed materials in the facilities[73].

KISS Mugello also includes efforts toward social sustainability, which supports ensuring the local community organizations and social groups benefit generously from the facilities. One regular event held at race events is the "Pit Walk dedicated to boys and girls with disabilities", allowing these kids "the chance to walk along the pit lane and visit the box of racing Teams"[74]. Local nonprofits partner with Mugello to run a mutually-beneficial food surplus collection in order to prevent food waste[75].

[71] Crawford.
[72] Crawford.
[73] Crawford.
[74] Crawford.
[75] Crawford.

*Figure 40 Aerial View of Mugello Circuit (Source: Formula One Website)*

# Chapter 4: Environmental Systems

## *Large Scale Facility Sustainable Practices*

### Soil compaction and erosion issues

Due to the site's environmental conditions with flat land and being in a flood zone, soil quality is a major consideration associated with stormwater management that could be addressed. In places where compacted soil is used as a walking path, such as in outdoor sections of sports facilities, there is a higher chance for erosion issues, which negatively impacts local water quality and biodiversity. For sites such as racing facilities that have ample outdoor space within the site boundaries, outdoor areas outside the track could be designed in ways that work with and benefit from nature. This could include more native plantings instead of mowed grass, as fields of mowed grass are often less helpful for soil quality and erosion than native plantings. Solutions could also include more defined walking paths made of more permeable material to avoid visitors "paving" their own paths over natural elements and compacting soil. An additional solution that works with the greater site is ensuring that stormwater infrastructure is carefully designed and prepared for different types of weather conditions

### Racetrack water management

Another environmental aspect of the site that could be addressed is the stormwater management specifically relating to the racetrack. Racetracks designed to be used for Formula One are not permeable, so any precipitation that falls on the track must already be integrated into a water management system already. One solution that could re-route the water from being immediately dumped into the neighboring canal is re-distributing it to non-occupiable areas of the site to irrigate plantings. Another solution could be installing a wastewater treatment system that cleans and recycles the wastewater from the track (and potentially from the buildings as well). Finding solutions to responsibly manage water on this site could improve the human experience by incorporating creative landscaping, and it could serve an educational purpose with inclusion of plaques or signs explaining the systems at work throughout the site.

*Energy Efficiency*

Solar panels

The roofs of built structures on the site could have solar panels installed on top. The most obvious benefit to solar panels is on-site energy generation, which could be the exclusive source of energy for lighting on the site. Another less-direct benefit to adding solar panels to roofs is their shade and anti-reflectivity. If solar panels are installed as shading structures on occupiable roofs and parking structures, they can lower the embodied energy of the site by shading cars and buildings, thus lowering their temperatures and requiring less energy to offset the heat. The anti-reflectivity of solar panels (assuming they are treated with anti-reflectivity measures) helps with the heat island effect by preventing as much heat energy as possible from transferring to the structures below. Building roof surfaces not shaded by solar panels can be treated with solar reflective paint, which reflects solar rays away from the building and functions as an anti-fungal solution in humid environments such as Miami.

It is also possible that more irregularly shaped, in-between areas of the site could play dual environmental functions. Solar panels could be mounted at optimal angles with enough distance off the ground that native plantings not requiring as much sunlight would thrive beneath the panels.

*Figure 41Image of Solar Panels (Source: By GbbIT - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=15775198)*

Wind Turbines

Consideration could be given towards whether or not some of the aforementioned in-between spaces could accommodate wind power generation, as "wind energy will, very likely, become increasingly important over the next two decades"[76]. Calculations likely need to be done in order to determine whether wind power is feasible here. One way of beginning the estimation of this feasibility is by researching the average wind speed in the area, as that is a major factor in the site's capacity for wind energy. If the site is deemed an optimal location for wind power, it could lead to major cost savings, as wind generators in the right places can be "the lowest cost electricity generation technologies available," while also lowering the carbon footprint of the site[77]. The higher the site's capacity is to generate wind energy, the lower the overall cost of acquiring the energy.

Wind energy generation would be a useful counterbalance to the solar panels, as "it is often windy when not sunny, and vise versa," so energy could be almost constantly generated [78]. Continual innovation in the field of renewable energy has led to more effective generators, which both automatically increases a given site's wind energy capacity and decreases the cost. The cost of wind energy will continue decreasing long into the future, and even right now, "wind electricity is not fully competitive with fossil and nuclear electricity in many places throughout the world," so it would be wise to join the trend now[79].

Even if the site is optimal for wind generation, there would not likely be enough consistent open space on the site, given its urban conditions, for it to be considered a

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[76] W. E. Leithead, "Wind Energy," *Philosophical Transactions: Mathematical, Physical and Engineering Sciences* 365, no. 1853 (2007): 957–70.

[77] Andrew Blakers et al., "Sustainable Energy Options," in *Learning from Fukushima*, ed. PETER VAN NESS and MEL GURTOV, Nuclear Power in East Asia (ANU Press, 2017), 319–48, http://www.jstor.org/stable/j.ctt1ws7wjm.19.

[78] Blakers et al.

[79] Blakers et al.

wind farm. Another option for using wind energy could be the proposal of or researching for a wind farm "in shallow offshore waters," as wind speeds pick up above water. This idea tends to be controversial in coastal areas, however, as residents and visitors in beach towns/cities are more likely to oppose adding wind turbine farms to their view of the water[80].

*Figure 42 Image of Wind Turbines (Source: By Lesbardd - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=107077637)*

## Passive Design

Passive design can contribute greatly to this project's energy efficiency, thus requiring less energy to be spent throughout the lifecycle of the structures.

[80] Blakers et al.

One major passive design is through tight building envelopes. Careful design consideration must be taken for enclosed structures to maintain air barrier continuity at transitions, thus minimizing thermal bridging and spending less energy on typical building operations. Designing walls, floors, and roofs with high insulation values, as well as installing double- or triple-glazed windows can be helpful for building envelopes in particular.

Another passive design strategy that could be used for both enclosed and semi-enclosed structures is daylighting. Daylighting, which is using natural light to achieve optimal lighting and thermal conditions, would be an ideal strategy to use for this site due to Miami's typical sunny weather[81]. To account for extremely hot and sunny days, overhangs would likely be needed to ensure that buildings and spaces do not overheat. Incorporating overhangs could also be worked into an architectural language that both shades spaces and keeps people comfortable.

[81] "Energy 101: Daylighting," Energy.gov, accessed April 22, 2022, https://www.energy.gov/articles/energy-101-daylighting.

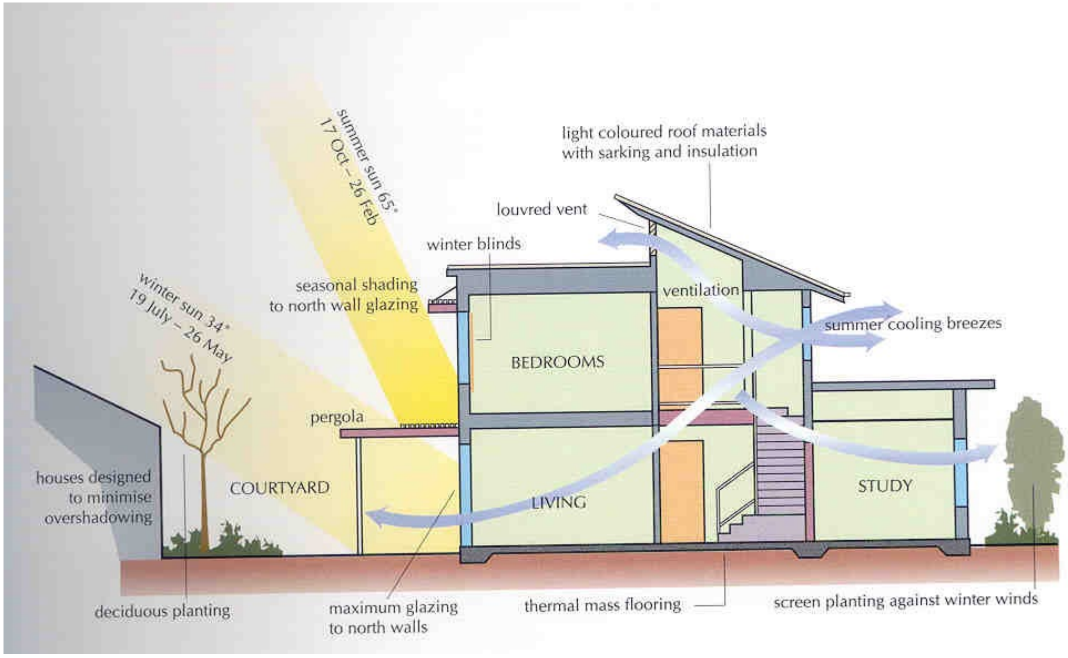


*Figure 43 Diagram of Passive Systems (Source: https://greenhome.osu.edu/passive-design)*

Lighting/ Light Pollution

Light pollution must be a concern throughout the design of the site, as it "can affect human health and the wellbeing of plants and animals, it has an aesthetic dimension, and it is symptomatic of unnecessary resource consumption," plus it can have negative impacts on astronomy work[82]. This issue is not exclusive to the urban nature of this site, but rather one found all over the world.

One side-effect of light pollution and the structures that cause it is that it can increase the perceived length of the days to insects, nocturnal mammals, and birds[83]. Nocturnal flying animals, such as moths and fireflies, that are inactive during times of high lighting levels stay inactive longer than they should when they perceive light from buildings to be an extension of the day's sunlight, which can affect their mating,

[82] John Gelder, "LIGHT POLLUTION," *Environment Design Guide*, 2004, 1–8.
[83] Gelder.

and individual lights can confuse their sense of direction[84]. Nocturnal mammals are less likely to forage in areas with high lighting levels, which can threaten entire species.

The natural cycles of bird reproduction are also negatively affected by the perception of longer sunlight. The reproductive cycles are "photoperiodically controlled," meaning they take indication from lighting levels, since that is usually an indication of when the temperature starts to rise after the winter[85]. When birds' reproductive systems perceive the days as longer and thus spring as beginning, they can cause birds to begin breeding prematurely, with lower survival rates for their offspring[86]. Migratory birds are strongly affected by disorientation caused by the lighting of buildings and cities. Since they tend to fly lower in the sky, once these birds get into seemingly a maze of glass and lights, they get extremely disoriented, leading some to "collide with the buildings while others drop from exhaustion"[87].

The lights at racing facilities need to be very powerful in order to maintain particular lighting qualities on the track at night. LEED rating systems have guidance on outdoor lighting to minimize light pollution, which could easily be an issue across such a large site. Addressing the issue of light pollution, compared with addressing other types of pollution, is not particularly difficult but rather something that needs to be part of the conscious design intentions from the beginning. The method of approaching light pollution at the racetrack and facilities, as everywhere else, is to

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[84] Gelder.
[85] Gelder.
[86] Gelder.
[87] Gelder.

determine exactly how much lighting is needed in each area, and not over-providing. LEED has guidance specifically on shielding luminaires to ensure downlighting and prevent upward-directed light. Since this site could involve a lot of signage for the sake of wayfinding, top-lighting for the signage will help minimize that upward-facing sky-glow. In any areas possible on the existing areas of the site, replacement of existing lighting systems with "low light spill alternatives" would be effective[88].

Vertical Farming

Innovation in vertical farming techniques has reached a point where there are systems such as hydroponics that can limit water "to the precise amount needed for growth" for each plant, leading to extra efficient farming in a potentially dense urban environment[89]. Hydroponics labs are becoming more widely researched, and there are ways to "monitor the pH, amount of nutrients, dissolved oxygen, air temperature, humidity, light intensity and CO2 from a distance" all with an internet connection and computer software[90]. One potentially useful application for vertical farming on the site for this project could be at the vertical parking structures. It could provide a unique, interesting, and educational introduction to the site for anyone parking in the structures.

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[88] Gelder.

[89] Mateusz Piechowiak, "Vertical Farming Technology: How Does It Work?," Vertical Farming Planet, accessed May 22, 2022, https://verticalfarmingplanet.com/vertical-farming-technology-how-does-it-work/.

[90] Piechowiak.

*Structural Systems*

Mass Timber

Mass timber construction is a sustainable building method that has been popular in northern European countries for a while, but has just recently begun picking up steam in the United States. The 2021 revision of the IBC includes additional provisions for cross-laminated timber (CLT) construction. Use of CLT structural systems could allow the project to achieve the environmental benefits of residential density while having 32% less embodied energy than a project primarily constructed of concrete and steel. Additional benefits of CLT are that it is a better insulator and moisture barrier than concrete, so it can contribute to the passive strategy of reducing thermal bridging for energy efficiency.

# Chapter 5: Social Systems

## *Community*

### Community Design

One of the goals of this thesis is to not only design, but to help with community-building. Miami, like many cities, is large and complicated. It is important to keep the residents in mind for large projects such as this, since they are the ones who essentially live with this project, unlike the visitors who travel from city to city to watch races. It will be important to provide to the local community and make this a welcoming place for a variety of people.

One method of designing for communities has been through citizen empowerment and involvement in design decisions, as they are more likely to understand their needs than the hired designer. The more influential position that citizens have in the design of spaces for the community, the more responsive the design is likely to be to potential users. Since many community design scenarios are enabled by "a grassroots or bottom-up process," it is important to work with existing community organizations who already have connections, influence, and experience with local residents[91]. One way the project can do this is by embedding into the project ways to "develop economic alternatives for the owning and managing of a

[91] Mark Francis, "Community Design," *JAE* 37, no. 1 (1983): 14–19, https://doi.org/10.2307/1424592.

neighborhood's residential stock and services"[92]. Due to higher levels of community involvement in this aspect of the project, "the end product is not clearly defined from the outset," but rather it forms through a complex back-and-forth design process in which the designer is more of a mediator between the citizens and the technical requirements for completing work[93].

There is no one-size-fits-all solution to meet every need in a given community, which makes direct involvement with the future users of a space particularly important. While there used to be more designers who claimed to design broadly for "the needs of poor and disenfranchised urban groups," the more successful designers today act more like "advocates for specific populations in targeted neighborhoods," allowing their work to be more thoughtful and applicable for the exact citizens using the space[94]. A notable concept coined by Donald Schon is becoming more widely understood in the design world is "problem setting", which is putting in work with the community to define each "problem" before beginning to contemplate solutions. Leonie Sandercock explains Schon's concept through the example, "Deciding what road to build, where is so much harder than deciding how best to build it"[95]. Achievement of all these aspects of good community design may not be easily done within the scope of this project, but local grassroots organizations could be listed as potential partners for this aspect.

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[92] Francis.
[93] Francis.
[94] Francis.
[95] Leonie Sandercock and Peter Lyssiotis, *Cosmopolis II : Mongrel Cities in the 21st Century* (London ; New York: Continuum, 2003).

Community Gardens

One way of making the site more pleasant for everyone while creating a community resource is through community gardens. There are different arrangements that community gardens can have with a locality, from allowing residents to purchase plots, to providing a certain amount of free space, to hosting gardening classes, to installing automatic irrigation systems and hiring maintenance staff so that community members might only need to harvest. Community gardens can play multiple community roles of "reclamation of public space, community building, and the facilitation of social and cultural expression," making them important cultural resources[96]. In addition to their cultural importance, community gardens can be "an educational resource providing a valuable platform for learning about multiple dimensions of sustainability," thus allowing them to meet goals of this project relating to both community and sustainability[97]. Another major benefit that community gardens can play in communities is the contribution to quality of life of citizens when they have close access to fresh produce.

One consideration to keep in mind about the ideas of incorporating a community garden into this project is the complex relationship between public uses on private property. The documentary *The Garden (2008)* includes an example of private land that the owner allowed citizens to use as a thriving public community garden, only for the owner to end up selling the land to a housing developer, leading to the destruction of many families' plots that they relied on for food. This type of

[96] Linda Corkery, "Community Gardens as a Platform for Education for Sustainability," *Australian Journal of Environmental Education* 20, no. 1 (2004): 69–75.
[97] Corkery.

situation could be extremely damaging if it occurred in Miami Gardens, so many options for providing this use must be explored.

*Figure 44 Example of Community Garden in High Point West Seattle (Source: Wikimedia Commons)*

Community Centers

Community centers can be a useful resource for communities by providing a central location for community meetings of various sizes as well as for other types of events such as wedding receptions or birthday parties. The usefulness of incorporating a community center really comes down to the flexibility that it provides to anyone nearby.

There are recent studies that suggest that community center designs be focused on both equity and entrepreneurship so that the programs developed for the community center are able to last long after their conception. The entrepreneurial approach that is encouraged involves "providing a broad range of services to a broad range of clients, no longer limited to low-income communities," thus balancing out the give-and-take of the center's finances[98]. A community center that is equitable and just does not have to be unsustainable financially despite the reluctance of many social programs to label themselves as businesses. Just because the program makes money in order to keep itself going does not mean that is not giving back to the community enough.

Complete Streets and Pedestrian Forward Design

The concept of complete streets is to design and operate streets "to enable safe use and support mobility for all users," making the entire street-level experience more equitable[99]. Complete streets must be designed for the entire range of ages and abilities that could be using the street, no matter what form of transportation they use. Designing complete streets is meant to make streets safer for everyone while still ensuring that they get where they are going efficiently. Pedestrian safety, driver safety, and bicyclist safety are all increased with a better-integrated transportation system. When safer options for walking and bicycling are available, "one study found that 43% of people reporting a place to walk were significantly more likely to meet

[98] Donovan Finn and Jason Brody, "THE STATE OF COMMUNITY DESIGN: AN ANALYSIS OF COMMUNITY DESIGN CENTER SERVICES," *Journal of Architectural and Planning Research* 31, no. 3 (2014): 181–200.
[99] Lawrence D. Frank et al., "Complete Streets," *Journal of the American Planning Association* 72, no. 1 (March 31, 2006): 75–87, https://doi.org/10.1080/01944360608976725.

current recommendations for regular physical activity than were those reporting no place to walk," so people have more safe access to these healthier transportation alternatives[100].

For this project, complete street guidelines set at the state, regional, and local levels will all be important to follow for the street design proposals on and off of the site. Different areas of the site will likely have different needs for different design elements to be worked into the complete street design, but the range might include "sidewalks, bicycle lanes, bus lanes, public transportation stops, crossing opportunities, median islands, accessible pedestrian signals, curb extensions, modified vehicle travel lanes, streetscape, and landscape treatments"[101].

Accessibility and Universal Design

Accessibility should always be a priority for any new development anywhere. There is an extremely wide range of what can be considered a disability, "including people who are blind, are deaf or hard of hearing, are on the autism spectrum, and have mobility impairments, attention deficits, learning disabilities, and health impairments"[102]. Universal design aims to find solutions that account for this wide range while maintaining the same quality of the spatial experience for all. Universal design for physical spaces is "the design of physical spaces to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized

[100] Frank et al.
[101] Frank et al.
[102] "Universal Design: Process, Principles, and Applications | DO-IT," accessed April 22, 2022, https://www.washington.edu/doit/universal-design-process-principles-and-applications.

design"[103] A notable example of strides taken in the world of universal design is the introduction of curb cuts in the 1970s, which have become ubiquitous because they provided a better sidewalk experience for everyone as a whole (not just for people with physical disabilities), including people pushing objects with wheels such as strollers or vending carts.

In this project, the seven principles of universal design in physical spaces should be closely examined and followed where possible. This might require careful consideration of the scope of where changes are to be made, especially since inconsistencies in accessibility across the site could render the universal design elements to be less effective.

# Chapter 6: Program Analysis

## *Program Precedent*

Canadian Grand Prix Paddock and Circuit Gilles-Villeneuve

[103] Ellen Sweet, "Introduction," in *ACS Symposium Series*, ed. Ellen Sweet, Wendy Strobel Gower, and Carl E. Heltzel, vol. 1272 (Washington, DC: American Chemical Society, 2018), 1–7, https://doi.org/10.1021/bk-2018-1272.ch001.

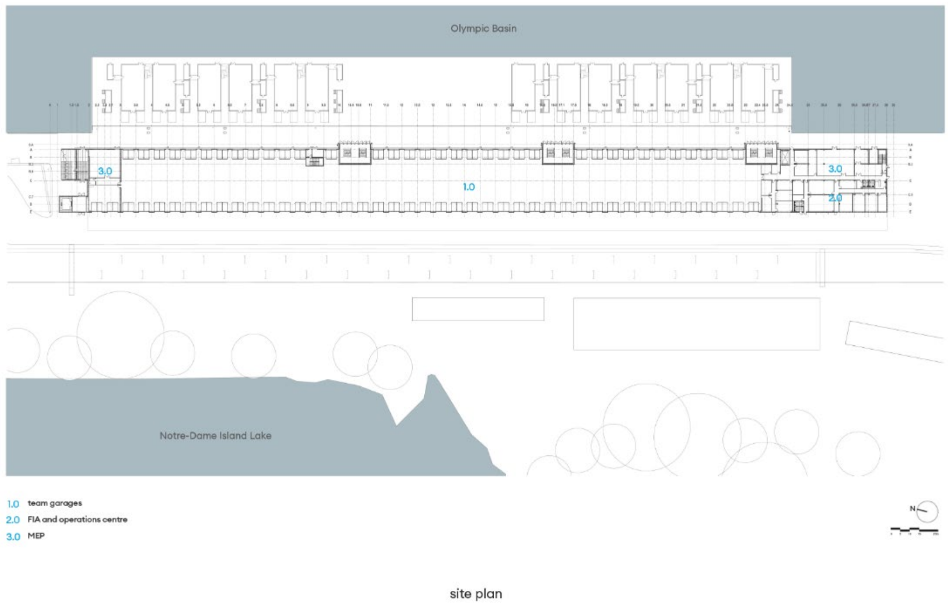


*Figure 45 Ground Floor Plan of Canadian Grand Prix Paddock (Source: FABG Architectes)*

The Canadian F1 Grand Prix Paddock by FABG Architectes not only was also a great influence on the programming of the thesis. The paddock is located in the Circuit Gilles-Villeneuve located on Île Notre-Dame in the middle of the Saint Lawrence River. The Saint Lawrence River bisects the city of Montreal in Canada making the track a usable part of the metropolitan area. The paddock of the Canadian Grand Prix track can be broken down into six different programmatic sections, Track Operations, FIA Operations, Broadcasting, Garage Space, Public Space, and Mechanical. These six different program parts are what can be typically found in a Formula One paddock making it a great example of what should be first thought of for a building program.

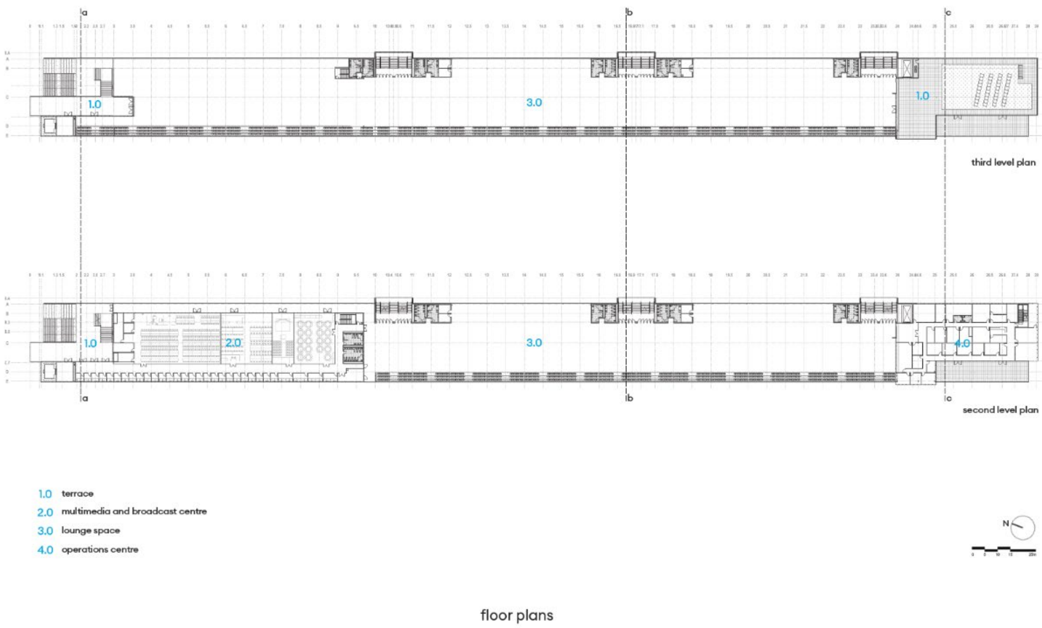


*Figure 46 Second and Third Floor Plan of Canadian Grand Prix Paddock (Source: FABG Architectes)*

The Canadian Grand Prix Paddock program is split across three floors of the building. The bottom floor is dedicated primarily to the garage area. It is important that the garage area be located on ground level so that the cars can be serviced during race times. The Track and FIA operations are split between the first and second floors of the building. Due to the technology available now the track and the race can be monitored more remotely during races and there is no need to create a vertical tower to look out over the entirety of the track. The second floor of the paddock is also home to the Media Center. The media space here is integrated into the building to provide quality space and services to journalists. In most previous track designs media is relegated to a temporary structure that lacks the amenities of a permanent one.

*Figure 47 Canadian Grand Prix Paddock Render Showing Track Operations Portion(Source FABG Architectes http://arch-fabg.com/project/f1)*

The public spaces of the paddock building consist of open terraces, stadium seating, and lounge areas. The three types of areas are spread from the second floor to the third, with the third being a completely public space. Across the building, there are 5,000 seats for viewing the race. The lounge areas are open to the air like the stadium seating; however, they are covered by a roof, but open on the sides, giving way to a breathtaking view of the circuit and the park.

Outside of the internal program the Canadian F1 Grand Prix Paddock and the Circuit Gilles-Villeneuve is a great example of integrating Formula One track into a city. The remaining part of the island that the track is on is park space. When the track is not being used for racing parts of it are turned over to the park. The park uses parts of the track as surfaces to walk or bike on. They have also introduced a beach into the small lake that is in the middle of the track so that there are more uses. On top of the other uses, the city has implemented an art program that places local artworks across the site to help draw people into the area when there is no racing. The track's integration into the city also shows that there can be a balance between paved track surface and green space.

*Figure 48 Lounge Area of Canadian Grand Prix Paddock (Source FABG Architectes http://arch-fabg.com/project/f1)*

*Figure 49 Adjacent Park and Lake of Canadian Grand Prix Paddock (Source FABG Architectes http://arch-fabg.com/project/f1)*

## *Program Space Requirements*

### Program Break Down

Thesis Program

| | Quantity | Size | Total |
|---|---|---|---|
| **Site Engagement** | | | |
| Parking and Verticle Farming | | 975000 | 975000 |
| Community Gardens | | 50000 | 50000 |
| STEM Learning Center | | 50000 | 50000 |
| Bio Fuel Production and Learning | | 30000 | 30000 |
| | | | **1105000** |
| **Sport Engagement** | | | |
| Driving School | 1 | 5000 | 5000 |
| Auto Museum | 1 | 5000 | 5000 |
| Kids Learning/Stem Center | 1 | 3000 | 3000 |
| Garage Viewing | 1 | 3000 | 3000 |
| FIA/Track OperationViewing | 1 | 1800 | 1800 |
| Simulators | 1 | 1245 | 1245 |
| Totals | | | **19045** |
| **Operations Center** | | | |
| Reception | 1 | 135 | 135 |
| Office A | 7 | 205 | 1435 |
| Office B | 3 | 185 | 555 |
| Office C | 2 | 355 | 710 |
| Office D | 1 | 365 | 365 |
| Common/Kitchen | 1 | 530 | 530 |
| Meeting Space | 2 | 435 | 870 |
| Bathrooms | 2 | 75 | 150 |
| Sto. | 1 | 135 | 135 |
| Totals | | | **4885** |
| **FIA Track Operations** | | | |
| Meeting Space A | 1 | 600 | 600 |
| Meeting Space B | 1 | 515 | 515 |
| Office | 10 | 260 | 2600 |
| Reception | 1 | 150 | 150 |
| Bathrooms | 2 | 60 | 120 |
| Sto. A | 1 | 70 | 70 |
| Sto. B | 1 | 210 | 210 |
| Totals | | | **4265** |
| **Multimedia & Broadcast Center** | | | |
| Main Broadcast Booth | 1 | 320 | 320 |
| Booth (Large) | 4 | 130 | 520 |
| Booth (Small) | 27 | 65 | 1755 |
| Conference (Large) | 1 | 5040 | 5040 |
| Conference (Small) | 1 | 2975 | 2975 |
| Media Room | 1 | 1245 | 1245 |
| Multi-Function | 1 | 2395 | 2395 |
| Bathrooms | 2 | 315 | 630 |
| Sto. A | 2 | 205 | 410 |
| Sto. B | 2 | 105 | 210 |
| Sto. C | 1 | 275 | 275 |
| Sto. D | 1 | 75 | 75 |
| Totals | | | **15850** |
| **Garage** | | | |
| Garage Stall | 41 | 1415 | 58015 |
| Totals | | | **58015** |
| **Public Space** | | | |
| Stadium Seating | 1 | 14435 | 14435 |
| Lounge | 1 | 94425 | 94425 |
| Terrace | 1 | 12255 | 12255 |
| Restrooms | 9 | 460 | 4140 |
| Totals | | | **125255** |
| **Back-of-House** | | | |
| Mech. | 1 | 12437 | 12437 |
| Sto. | 1 | 1358 | 1358 |
| Elevator | 2 | 320 | 640 |
| Elevator Mech. | 1 | 445 | 445 |
| Totals | | | **14880** |
| Building Net Square Footage | | | **242195** |
| Building Gross Square Footage | | | **260655** |
| Building Grossing Factor | | | **1.07622** |

*Figure 50 Project Area Tabulations*
*(Source:Created By Author Nicholas DiBella)*

The programmatic uses that will require the most square footage are those that engage the site and the community. A large portion of the parking space will include plantings and vertical farming space. 50,000 square feet will be dedicated to community gardens. The last 30,000 will be used for on-site energy production.

The public gathering and seating for this project will require a total of about 125,255 square feet. The majority of this is needed for the large lounge/exposition area, which requires 94,425 square feet. The stadium seating will need 14,435 square feet, and terrace space would require 12,255 square feet. Nine restrooms would take up the remaining 4,140 square feet.

The garage stalls for the racecars will need to be on the ground level, and each stall requires 1,415 square feet. There will need to be about 41 garage stalls total, so the overall square footage required for this program category is about 58,015 square feet.

The program category for sport engagement will include spaces for both current and potential fans to be more involved with the sport. The total square footage requirement for everything in this category is 19,045 square feet. 5,000 square feet will be dedicated each to the driving school and to the auto museum. 3,000 square feet will go toward each the kids learning/STEM center and the garage viewing area. The last 1,800 and 1,245 will go to FIA/track operation viewing and simulators, respectively.

The next program category in this project will be the multimedia and broadcast center, which totals at 15,850 square feet. This use requires several large spaces such as conference rooms, a multifunctional room, and the main media room. The large conference room requires just over 5,000 square feet, and the smaller one requires almost 3,000 square feet. The multifunctional room requires almost 2,400 square feet, and the media room requires 1,245 square feet. The remaining uses in this category are restrooms, storage, and small booths, all of which total up to 3,885 square feet

The next programmatic use for this project is back of house/mechanical uses, totaling 14,880 square feet. 12,437 square feet will be dedicated to mechanical space, and the remaining square footage will be used for storage, mechanical, and elevator mechanical.

The two smallest programmatic uses for this project are track operations and FIA-specific track operations. These each require reception space, office space, meeting rooms, and storage. The typical track operations program includes a 530 square-foot common area that also functions as a kitchen. The typical track operations program totals at 4,885 square feet, and the FIA-specific track operations totals at 4,265 square feet.

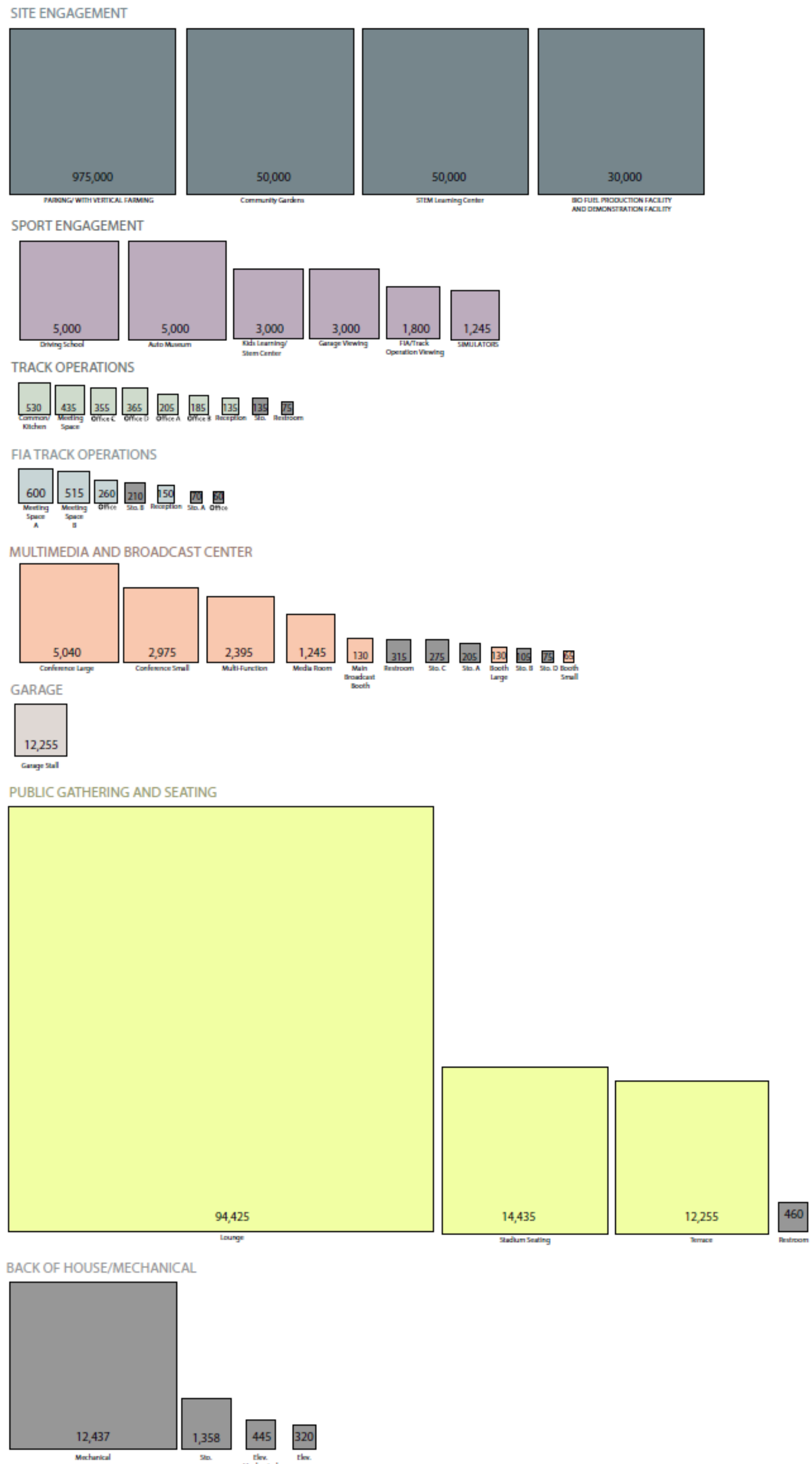


*Figure 51 Blocking of Program (Source: Created By Author Nicholas DiBella)*

## Unique Program

The program uses in this project that was not part of the Canadian Grand Prix Paddock are the site engagement uses and the sport engagement uses. The site engagement uses, such as vertical farming, community gardens, and energy production, have been added to create additional connections with the community and with the environment. These uses allow the site to be less of a barrier and more of a useful component within the community and the environment. The sport engagement program uses, such as the STEM learning center, the industrial design center, the auto museum, the garage viewing area, and the simulators are all unique to this racetrack site. These uses, while also involving community members, also brings in new fans/members of this sport community, which is better for the sport as well.

# Chapter 7: Design

## *Master Plan*

### Site Use

This thesis proposed a massive redesign of the site. Just over half of the existing site will be transformed into a new park for the daily use of the surrounding neighborhoods. The center section of the site will be transformed into a commercial area that will help draw more users to the site on regular days. The eastern portion of the site was redesigned for commercial use but with the addition of a hotel to house athletes, teams, and visiting spectators so that travel distance to and from the site is limited. Parking moved to the existing overflow lot to the south and the massive Walmart lot. And the other overflow lot will be re-forested.


*Figure 52 Proposed Site Use Diagram (Source: Created By Author Nicholas DiBella)*

This design proposes a people mover system to help circulate people and connect the residential community in the north with the one in the south via pedestrian bridges. This system is also an automated guideway transit system, like the systems found at most major airports. It has seven stops and connects users with the significant areas around the site, including the parking structures to the south and all proposed additions. The system will have 2 to 3 trains that run every few minutes to get users around the site efficiently.

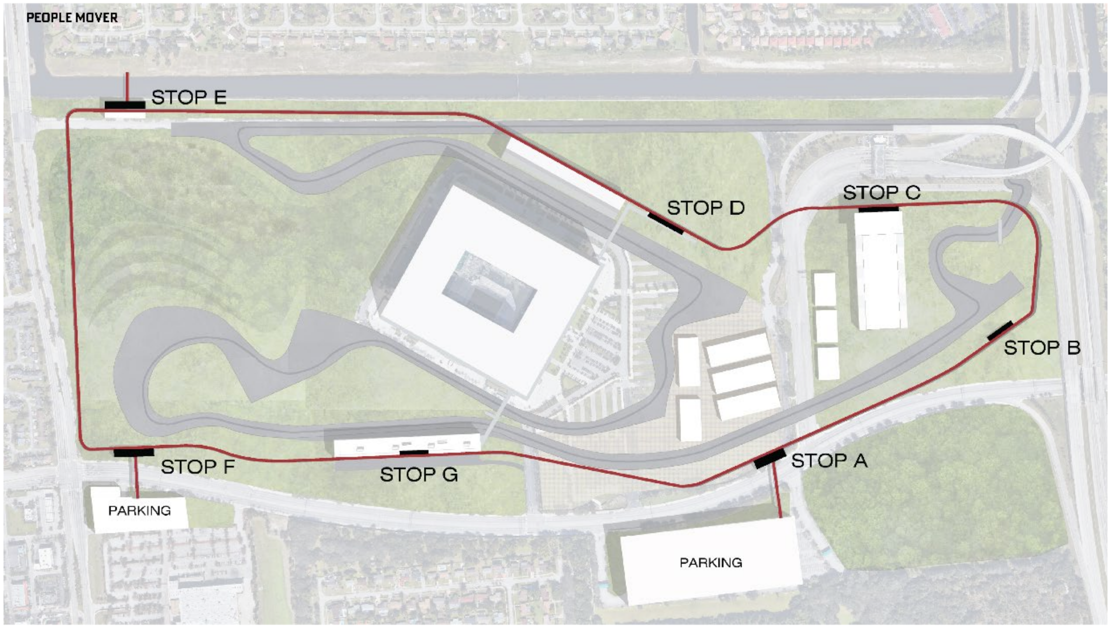


*Figure 53 People Mover Diagram (Source: Created By Author Nicholas DiBella)*

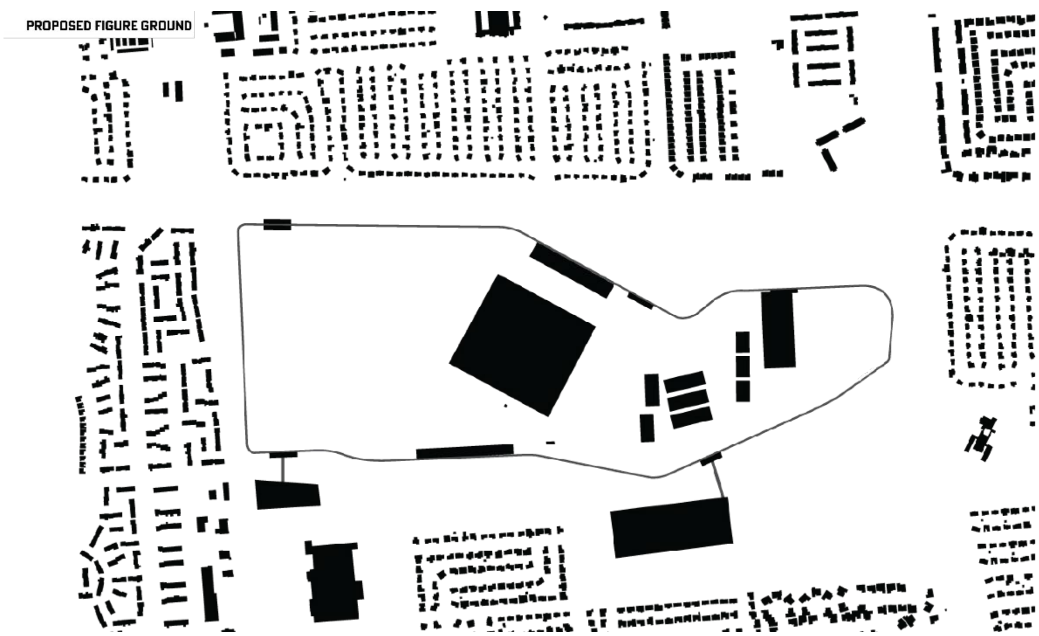


*Figure 54 Figure Ground (Source: Create By Author Nicholas DiBella)*

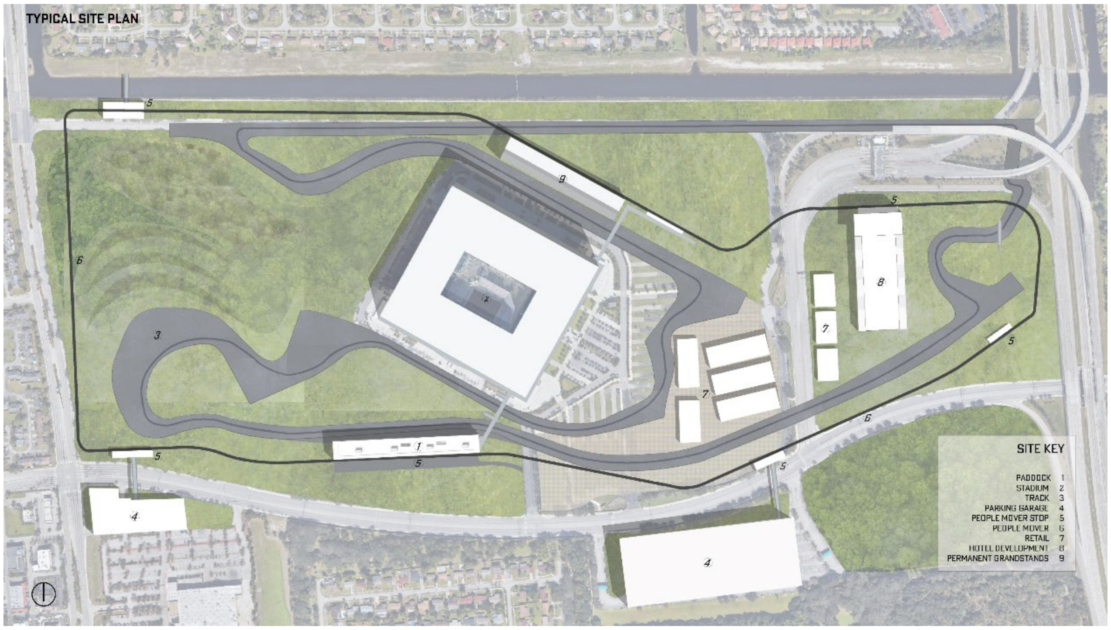


*Figure 55 Typical Day Site Plan (Source: Created By Author Nicholas DiBella)*

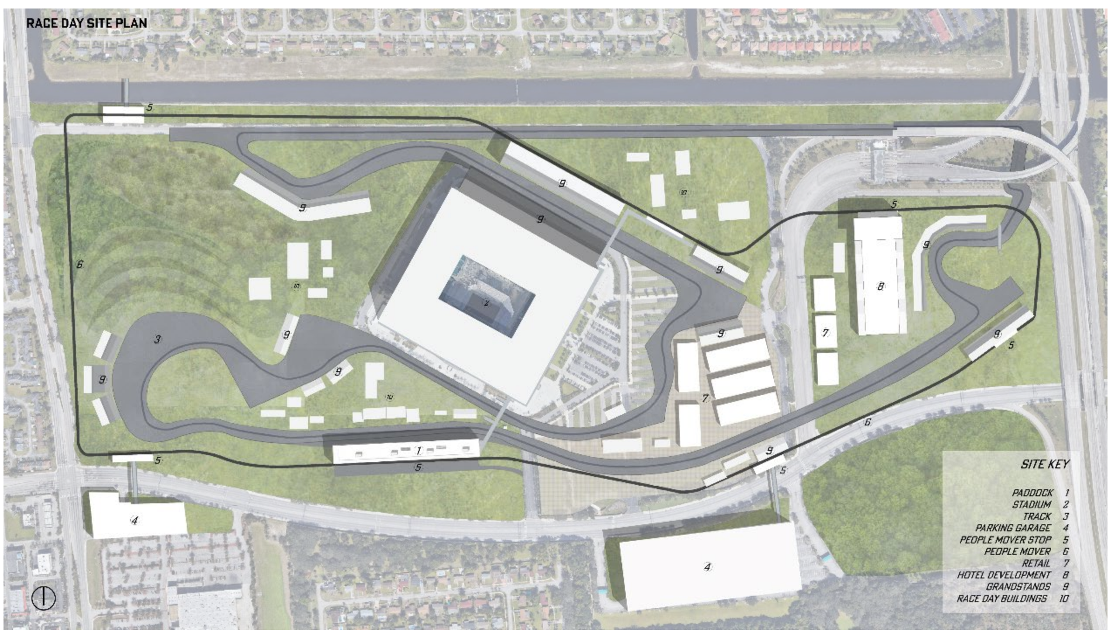


*Figure 56 Race Day Site Plan (Source: Created By Author Nicholas DiBella)*

*Paddock Design*

Design Strategies

The Miami Grand Prix STEM and Design Paddock sits south of the stadium, one of the track's main straightaways, and just north of 199th street. The building stands out against the upward-reaching stadium by reaching out and seemingly moving along the tracks of the site's automated people mover.

*Figure 57 Aerial Rendering From the South (Source: Created by Author Nicholas)*

*Figure 58 Rendering From The pedestrian Bridge Looking back at the stadium (Source: Created by Author Nicholas DiBella)*

The view from the pedestrian bridge linking the paddock and the stadium shows how a user might re-approach the building after an event at the stadium. The building has a sizeable elevated plaza that acts as a gathering space for crowds coming in and out. The elevated plaza also functions as a viewing space during race days and an alternate entrance to the building when people do not use the automated train. The overhang creates drama that adds to the aesthetic of the building. The overhangs also relate to the roof of the adjacent stadium. The overhangs shield users from the elements when standing on the elevated plaza or exiting the people mover.

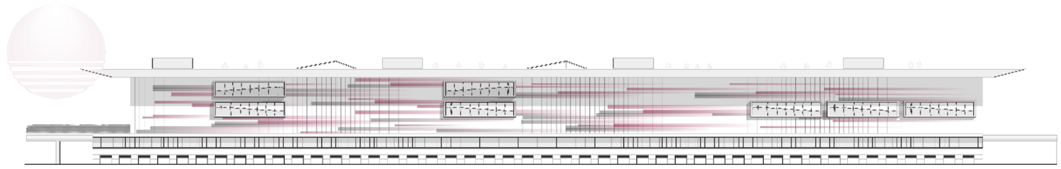

*Figure 59 North Elevation (Source: Created by Author Nicholas DiBella*

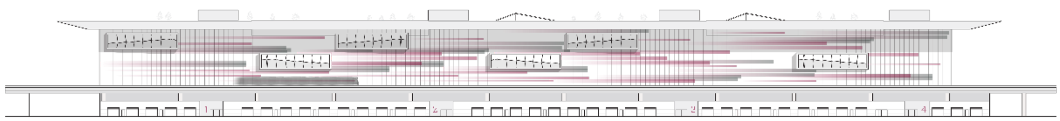

*Figure 60 South Elevation (Source: Created By Author Nicholas DiBella)*

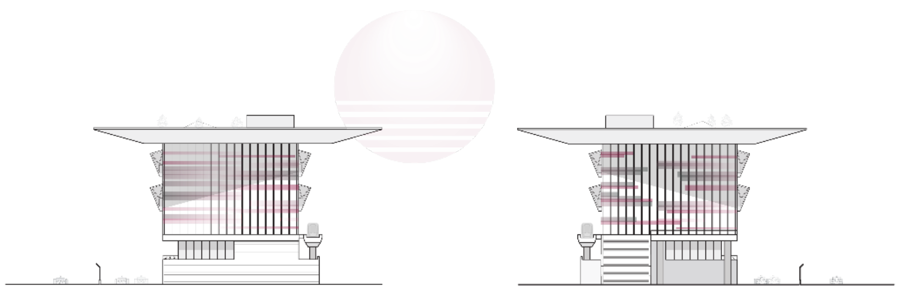

*Figure 61 East and West Facade (Source: Created By Author Nicholas DiBella)*

The people mover system integrates into the southern façade, where it makes a stop to allow passengers to exit. It passes underneath parts of the program that push and punch out, allowing for views of the surrounding community and the track. The punched-out program changes direction based on what level it's on. On the north side of the façade, the 4th level punch outs face west while the 5th level faces east. The central portion of the façade is glass with a translucent red frit that helps to block out some of the light while giving movement to the façade. On the east and west elevation glass, you see the origin point of the glass frit and the meeting point at the other end, mimicking the start and end of a Grand Prix. In the facades, one notices some of the programs that start to push out of the upper floors, lending to views of the racing and creating a more dynamic façade.

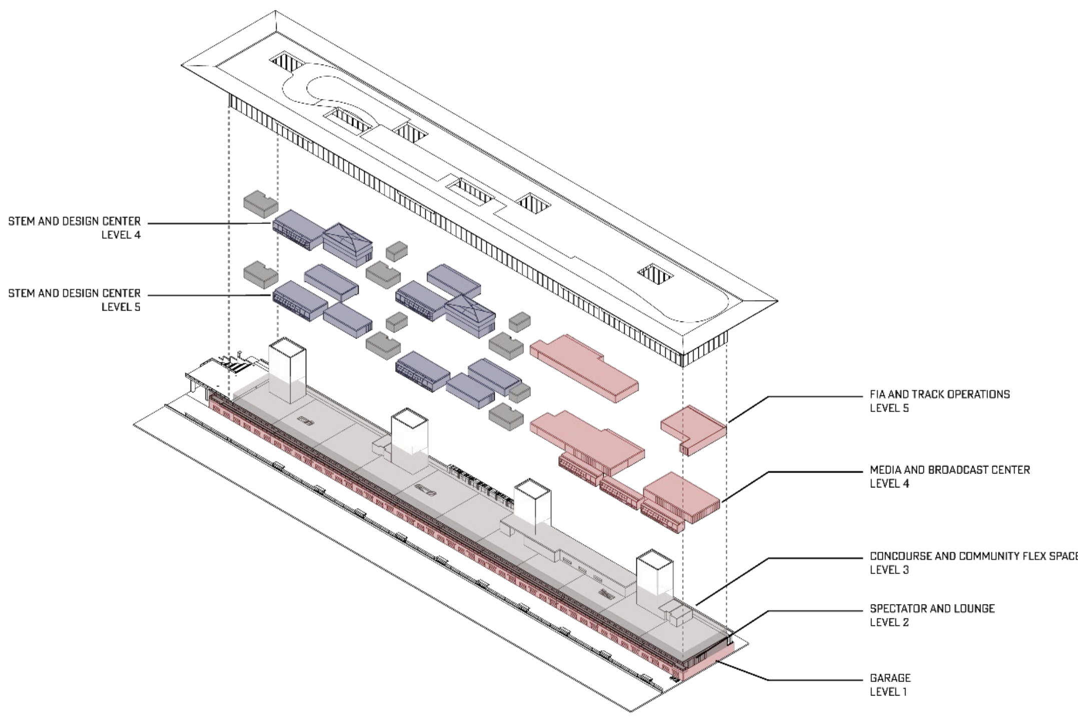


*Figure 62 Program Axon (Source: Created By Author Nicholas DiBella)*

The building program is made up of three main parts. The first, "The Plinth," houses the building's garages, spectator spaces, and mechanical systems. At the top of the plinth is the concourse where users exit the people mover system; above that is the STEM and Design Center and some formula one functions, including a media and broadcast center and FIA and Track operations. The program above the plinth is the "floating program" slotted into the structure like parts on a car. The last part consists of the roof and the "glass skin" set over this floating program like a valve cover on a cylinder head.

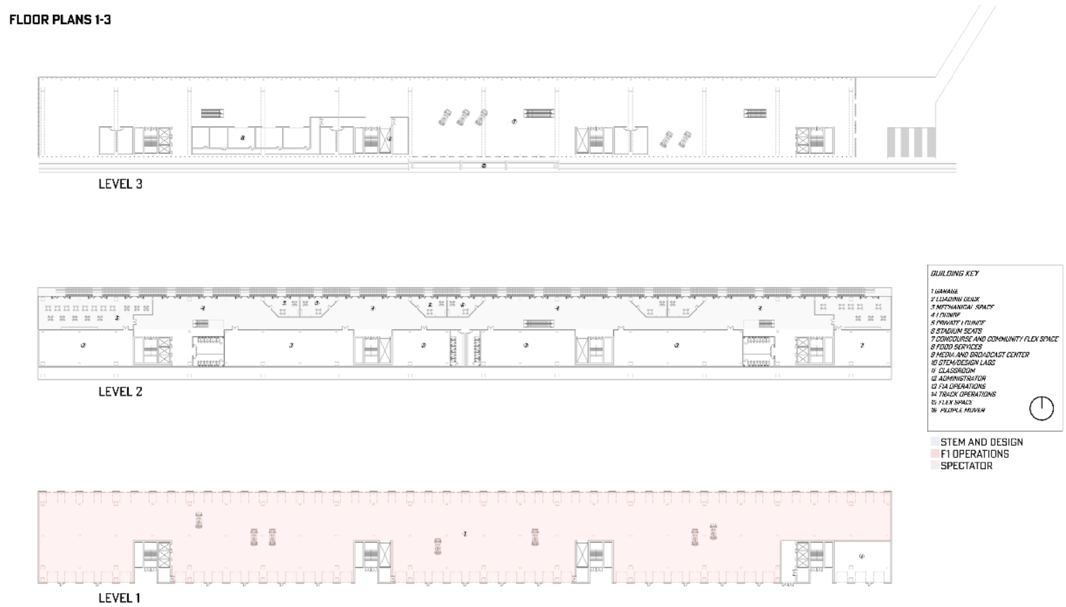


*Figure 63 Floor pLans of Levels 1,2,and 3 (Source: Created by Author Nicholas DiBella)*

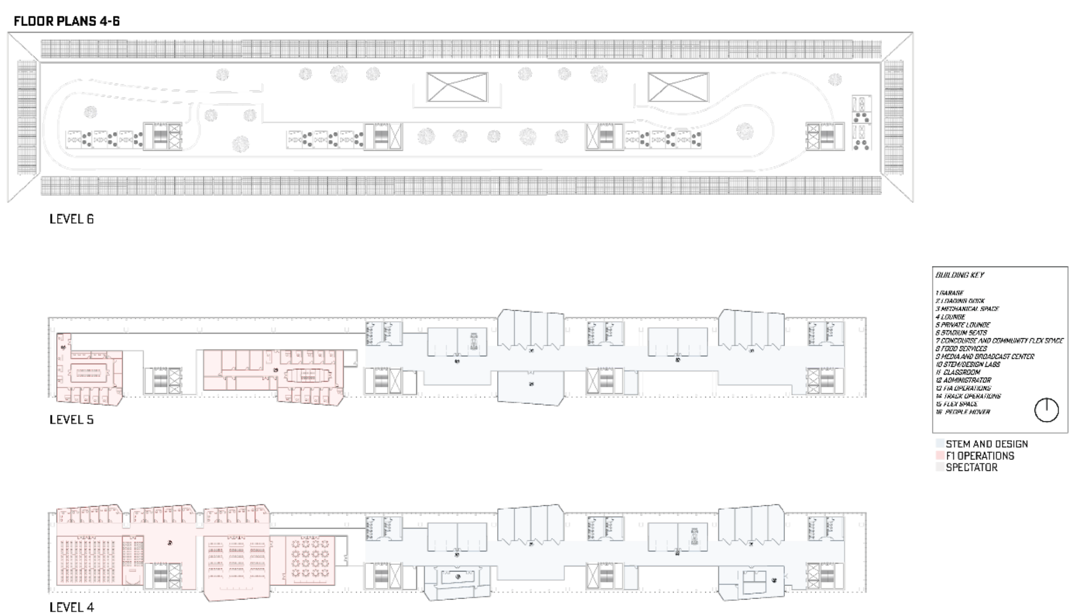


*Figure 64 Floor Plans of Levels 4,5,and 6 (Source: Created by Author Nicholas DiBella)*

Level one through three makes up the plinth. The plinth can be thought of as the bottom end of a motor, meaning it is the more significant moving pieces: rods, engine block, and crankshaft. This is where the power comes from in an engine. The first level comprises garages with a loading bay to supply the rest of the building. Moving up to the second level is the stadium seating and lounges for spectators allowing them to be as close to the action as possible. That level is also where most of the mechanical systems for the building reside. The third level consists of the concourse, which can double as a community gathering space, market, etcetera, and a food service area. The last three levels of the building make up the rest of the Formula One program, the STEM and Design center, and the green roof. The remaining levels above the plinth resemble the top end of a motor. The valve train, fuel injection, and intake are the parts that make the bottom end work efficiently. The remainder of the formula one program includes the races' media and broadcast center, interviews with the drivers, FIA, and track operations. The FIA is the sanctioning body of Formula One, and its job is to make judgment calls and uphold rulings during a race weekend. On the last level, the green roof, there is a small track for people to use.

*Figure 65 Rendering of the Concourse (Source: Created by Author Nicholas DiBella)*

Users get off the people mover at the concourse and make their way through the building to the lounges, STEM, or the stadium. All while passing different displays of Formula one cars and memorabilia. On this level, users can also get glimpses beyond the ceiling at the STEM and F1 areas above them.

*Figure 66 Rendering of Pit Lane (Source: Created by Author Nicholas DiBella)*

The private lounges or the public lounges access the stadium seats above the garage. Both lounges have foldable glass wall systems that allow sounds and fresh air to filter into the building. While the typical spectator spaces may be for the privileged few, this paddock offers a more public seating option that will be offered first to those in the surrounding community before being sold to the general fans.

*Figure 67 Rendering of STEM Lab (Source: Created by Author Nicholas DiBella)*

The STEM and Design center is not just for children to learn but for anyone. The center aims to get people interested in the sport and the science, technology, and design that goes into a Formula One car. The Labs were designed with a garage door so that a full-size F1 car could be brought up one of the freight elevators and rolled into the room. The larger elevators allow people to get a hands-on, up-close look at the inner workings of one of the cars.


*Figure 68 Rendering of Classrooms (Source: Created by Author Nicholas DiBella)*

The glass skin allows visitors to see the action around the building from almost any point. Wayfinding signage also allows for more straightforward navigation through the building. Each building core is marked with a number indicating the sections of the buildings.

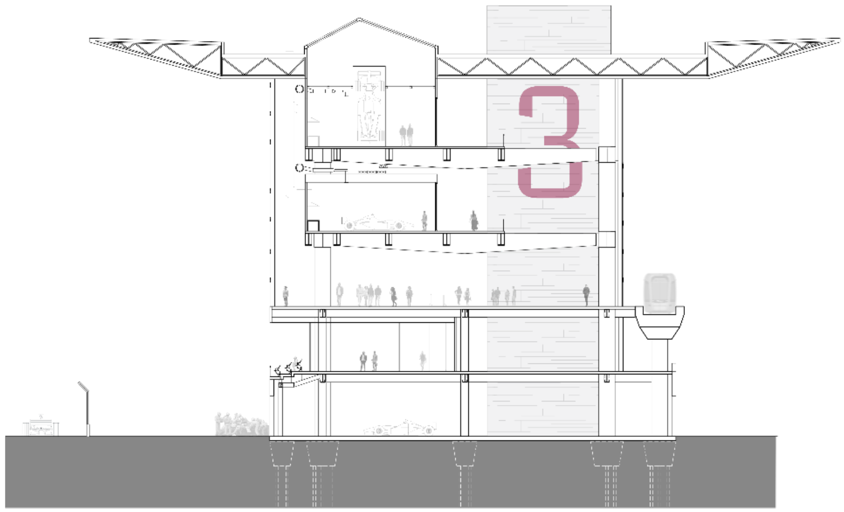


*Figure 69 Building Section 1 (Source: Created By Author Nicholas DiBella)*

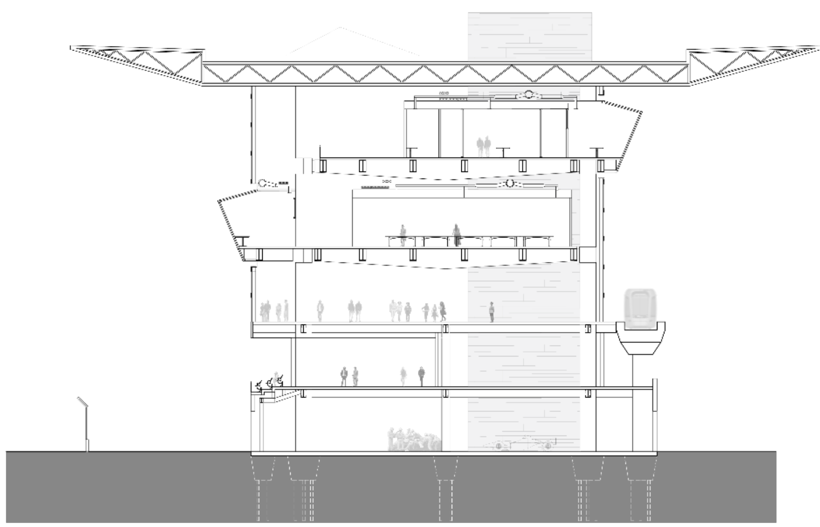

*Figure 70 Building Section 2 (Source: Created By Author Nicholas DiBella)*

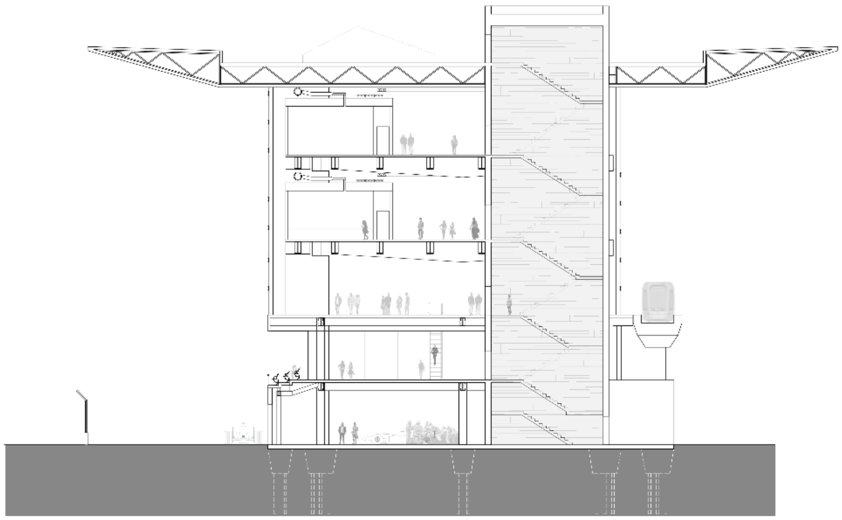

*Figure 71 Building Section 3 (Source: Created By Author Nicholas DiBella)*

The STEM and design labs stack so they may utilize the same venting for the exhaust hoods and other systems. The 5th story STEM LABS are almost triple height with a glass framed roof, allowing large items to be placed in them or different orientations of the cars. The primary building structure is exposed throughout the building, showing the user just how the building works.

*Figure 72 Rendering of The View From the West Approach (Source: Created By Author Nicholas DiBella)*

Structure

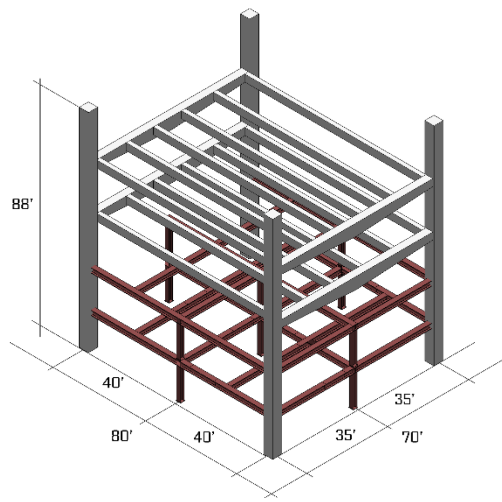


*Figure 73 Structural Bay (Source: Created By Author Nicholas DiBella)*

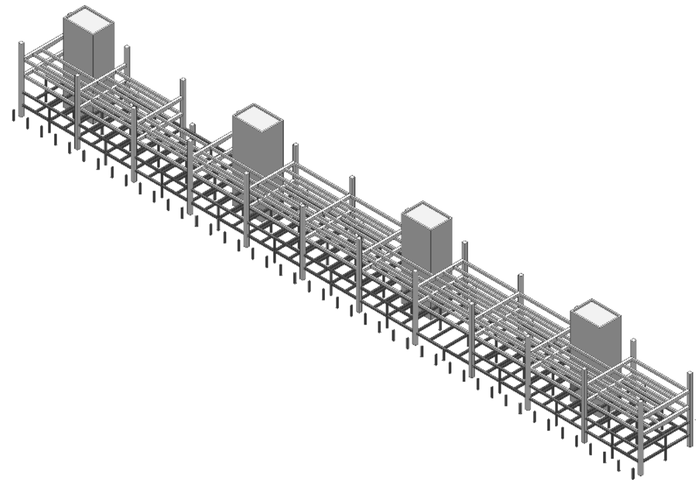

*Figure 74 Building Structural System (Source: Created By Author Nicholas DiBella)*

The building consists of a two-story reinforced steel plinth with 4'x4' columns that span from the bottom level up to the roof. The tall spanning columns connect with similarly sized girders wrapped in a material to give them a tapered look. These columns and girders support the upper two floors and the roof. The elevated programs sit on top of these spans. In the structural bay, you can see the regularity in the structure that guided much of the placement of the upper program. The four tall solid structures are the circulation cores made from 18" thick reinforced concrete work to help anchor the long-span structure.

Like the structure, most mechanical systems are not hidden. They run up the mechanical shafts in the building cores from the second level and out to each level. The program that leans out of the structure gives users a unique experience to see what is under them. In the STEM and Design section of the building, users can not only apply what they are learning but imagine what their ideas and designs might be like on the track below.

Sustainability

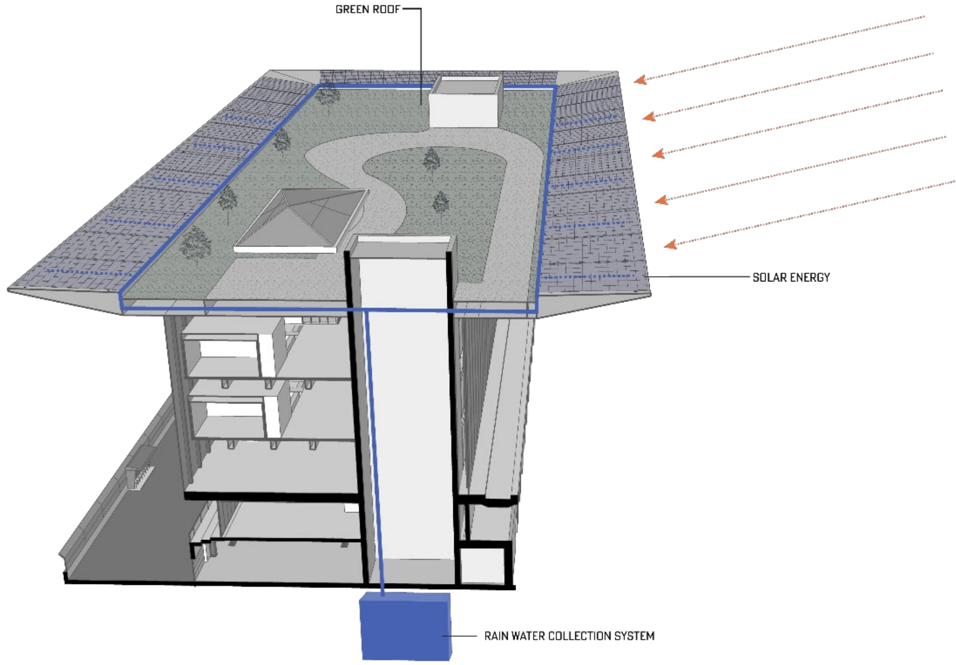


*Figure 75 Sustainability Diagram (Source: Created By Author Nicholas DiBella)*

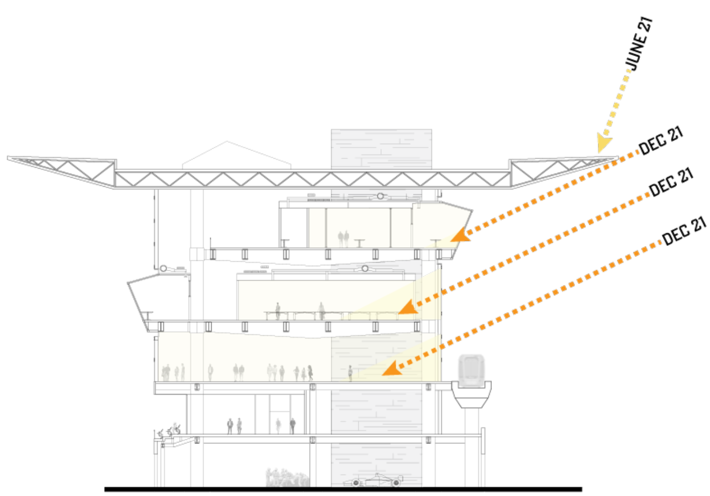


*Figure 76 Sunshade Diagram (Source: Created By Author Nicholas DiBella)*

The building's large overhangs are designed with photovoltaic arrays so that they may capture energy. The site could run off the power it created if the stadium adopted the same energy capture method. Along with the vegetated green roof, there is also a rainwater capture system that utilizes the overhangs. The overhangs slope ever so slightly down that water may run to a gutter system that flows down one of the mechanical shafts to a cistern below. While a large portion of the façade faces south, the overhang blocks the harsh summer sun and allows the building to remain cooler. During the winter, it lets more direct light into the building.

*Conclusion*

While the building may remain stationary, the movement of the track on the north, the people mover on the south, and the users that make their way through the building combine to create an experience that resembles that of Formula One dynamic and engaging.

The design could not capture all of the ideas that the research suggested. This design solution is merely a snapshot of where this thesis progressed in the given time. However, the point of the thesis, that this site and community could benefit and be activated by the creation of a Formula STEM and Design Center, was achieved.

After presenting this thesis and the feedback received, the next iteration would see that the building could manage to have the significant sporting event feel mixed with smaller, more personal moments for those coming to use the stem. The design currently has a large of a scale and user experience, making it seem far too large for the minor use, the STEM and design center. During the presentation, the vastness of the building was equated to the empty eerie feeling of being in an airport alone at two o'clock in the morning. The next iteration of this design would directly address that issue. Also, the design brought up a rich conversation about media and how sports are portrayed. In the following design, the idea of how the media portrays the sport of F1 will become an integral part of the design.

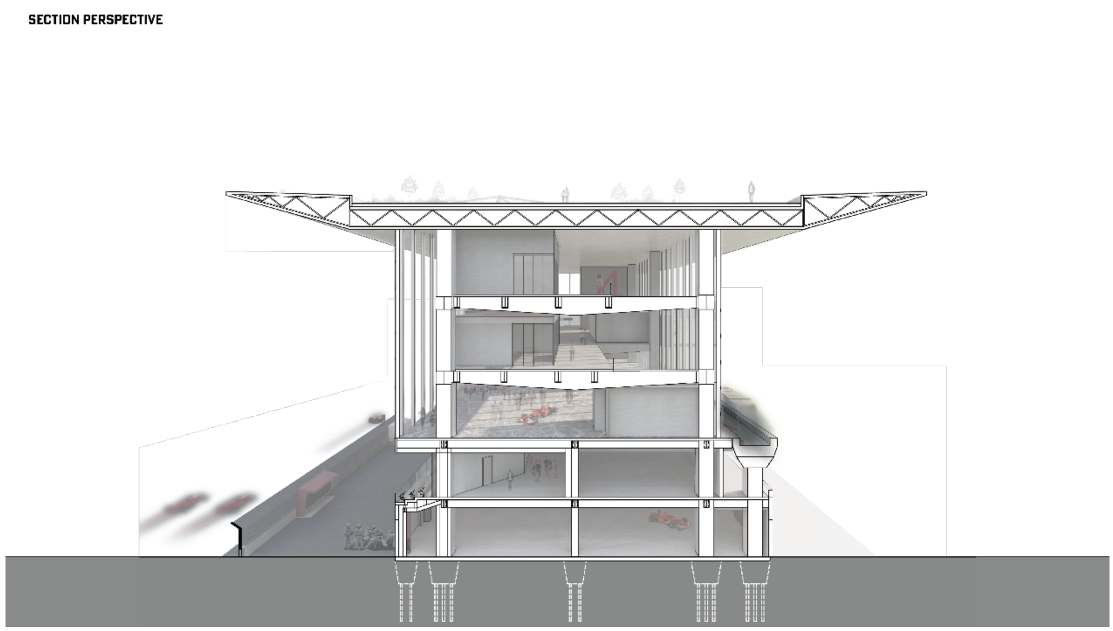


*Figure 77 Section Perspective (Source: Created By Author Nicholas DiBella)*

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