UNIVERSITY OF NOTRE DAME
College of Engineering
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING AND EARTH SCIENCES

2022 CEEES Junior Class Field Trip

New York City Behind-the-Scenes Infrastructure

Wednesday, September 28 – Sunday, October 2

PURPOSE OF THE CEEES JUNIOR CLASS ANNUAL FIELD TRIP: To expose students to some of the biggest and most innovative infrastructure design and construction efforts going on in the United States; to provide an opportunity to see first-hand that the need to rebuild our often failing infrastructure is huge; to learn about the complexity of the structural, transportation, water resources, and environmental projects that keep our nation productive, efficient and healthy; and to interact one on one with project and design engineers. These trips help students see the wide range of opportunities available to become innovative leaders and also help connect the classroom to the outside world.

photo credit: https://www.nycurbanism.com/blog/2019/10/15/270-park-rendering

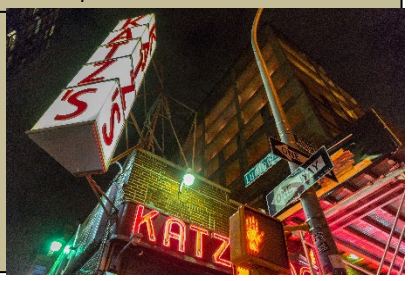
WEDNESDAY, SEPTEMBER 28

5:00am **Bus to NYC, meet at Eck Visitor Center bus stop (by bookstore)**

(*13 hour trip, 11 ½ hours of driving time)*

photo credit Barbara Johnston

7:30pm **Dinner at <u>Katz's Delicatessen</u>**
205 E. Houston Street, New York, NY 10002
Founded in 1888, one of New York's oldest kosher-style delis, each week serves 15,000 pounds of pastrami, 8,000 pounds of corned beef, 2,000 pounds of salami and 4,000 hot dogs.



By Urbankayaker - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=36134844

9:00pm	**Bus to <u>Brooklyn Bridge</u> (*15 minutes*) and walk to midway point of bridge for views of Manhattan and to see this iconic bridge up close, back to bus by 10pm**

https://triptins.com/walking-the-brooklyn-bridge/

BROOKLYN BRIDGE

Considered a brilliant feat of 19th-century engineering, the Brooklyn Bridge was a bridge of many firsts. It was the first suspension bridge to use steel for its cable wire. It was the first bridge to use explosives in a dangerous underwater pressurized containment structure called a caisson. At the time it was built, the 3,460-foot Brooklyn Bridge was also crowned the

longest suspension bridge in the world. But the Brooklyn Bridge was plagued with its share of problems. Before construction even began, the bridge's chief engineer, John A. Roebling, died from tetanus which resulted from a construction site accident. The project was taken over by his son, Washington Roebling. Three years later, Roebling developed a crippling illness called caisson's disease, known today as "the bends," caused by a person going too quickly from the pressurized caisson to the surface. Bedridden but determined to stay in charge, Roebling used a telescope to keep watch over the bridge's progress. He dictated instructions to his wife, Emily, who passed on his orders to the workers. During this time, an unexpected blast damaged one caisson, a fire damaged another, and a cable snapped from its anchorage and crashed into the river. Despite these problems, construction continued at a feverish pace. By 1883, 14 years after it began, Roebling successfully guided the completion of one of the most famous bridges in the world -- without ever leaving his apartment. The bridge opened to the public on May 24, 1883, at 2:00 p.m. A total of 150,300 people crossed the bridge on opening day. Each person was charged one cent to cross. The bridge opened to vehicles on May 24, 1883, at 5:00 p.m. A total of 1,800 vehicles crossed on the first day. Vehicles were charged five cents to cross. www.pbs.org/wgbh/buildingbig/wonder/structure/brooklyn.html According to the New York City Department of Transportation, currently, an average of over 116,000 vehicles, 30,000 pedestrians, and 3,000 cyclists travel over the bridge each day.

10:00pm	**Bus to Hilton Garden Inn New York/Midtown Park Avenue, 45 East 33rd Street**
10:30pm	**Check-in to hotel** **(Bus driver to stay at the Hilton Meadowlands, Two Meadowlands Plaza, East Rutherford, NJ – all items must be taken off of the bus)**

THURSDAY, SEPTEMBER 29

Are you in Group 1, 2 or 3 for morning; and Group One or Two for afternoon split? (see Daily email!)

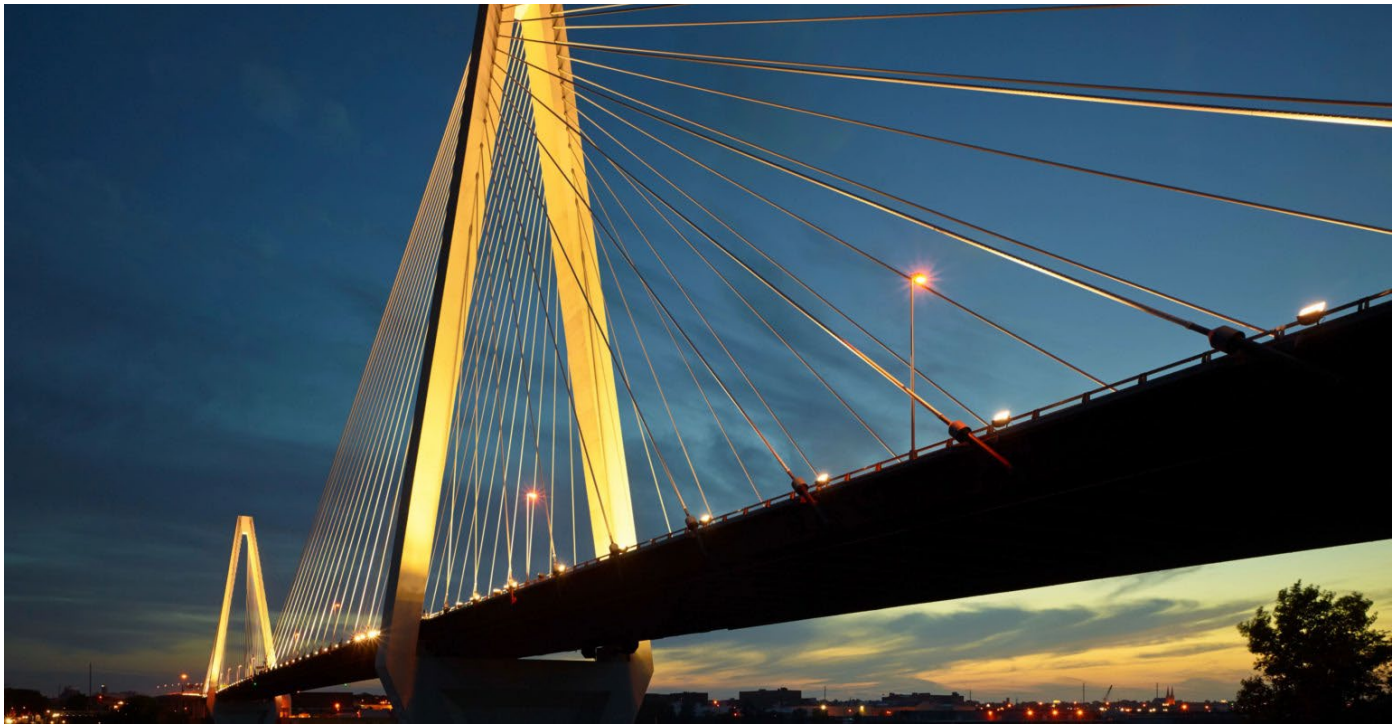
Wear: ***All should wear clothes appropriate for engineering office visit; Afternoon Group Two will walk back to hotel after HNTB visit/lunch at 12:30pm, get PPE and change into construction attire for construction site afternoon visit***

Wear for dinner: ***casual clothes, comfortable walking shoes***

6:00am-8:15am	**Continental breakfast available in hotel, let attendant know you are with the Notre Dame engineering group**
8:30am	**All Leaving from lobby for 5 minute walk to the Empire State Building to HNTB's design offices – need QR code for entry – found in email**
9:00am	**Check in and escorted up to HNTB offices**
9:00am – 11:30am	**HNTB design offices presentations (Groups 1, 2, 3)**
11:30am – 12:30pm	**Box lunches in HNTB offices**

HNTB

HNTB Corporation is an architecture, engineering, planning, and civil engineering consulting management firm that was founded in 1914. Their areas of expertise range from architecture, aviation, bridges, construction management, design build, environmental planning, highways, intelligent transportation systems, program management, tolls, rail and transit, tunnels and water. HNTB's bridge practice includes experts in accelerated bridge construction, cable-stayed, truss, girder, movable, suspension, pedestrian, transit, segmental, reconstructed and cantilever bridges



https://www.hntb.com/project-list-bridges/

At completion of HNTB visit/lunch, groups will split as follows:

Group One:

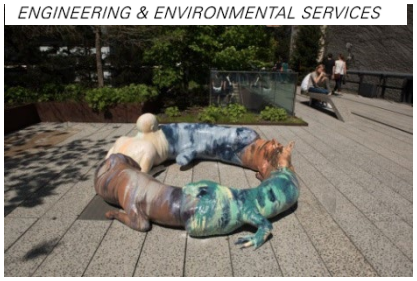
12:30pm	**Depart ESB for 15 minute walk to Langan design offices, 360 W 31st St. 8th fl**
1:00pm – 3:00pm	**Langan office visit and walk part of** High Line
3:00pm – 5:30pm	**Walk back to hotel, free time**

Group Two:

12:30pm	**Depart ESB for 5 minute walk back to hotel to get PPE and change into construction attire.**
1:00pm	**Meet in lobby for 15 minute walk to Severud, 469 Seventh Ave (between W35th & W36th**
1:30pm – 4:00pm	**Severud Associates Consulting Engineers, 469 Seventh Ave for an overview presentation, followed by 25 minute walk to construction site visit of 270 Park**
4:00pm – 5:30pm	**Walk back to hotel, free time**

Langan, an engineering and environmental consulting firm, was founded as a geotechnical specialty firm in 1970. Their projects include airports, brownfield redevelopment, colleges and universities, energy, environmental remediation, environmental compliance, hospitals and healthcare, infrastructure, residential, renewable energy, tall buildings, waterfront and marinas, among others. The company provides services in Site/Civil, Geotechnical, Environmental, Earthquake/Seismic, Demolition, Traffic and Transportation, Surveying and 3D Scanning, Information Management, Landscape Architecture and Planning, Environmental Planning, Natural Resources and Permitting.

LANGAN
ENGINEERING & ENVIRONMENTAL SERVICES

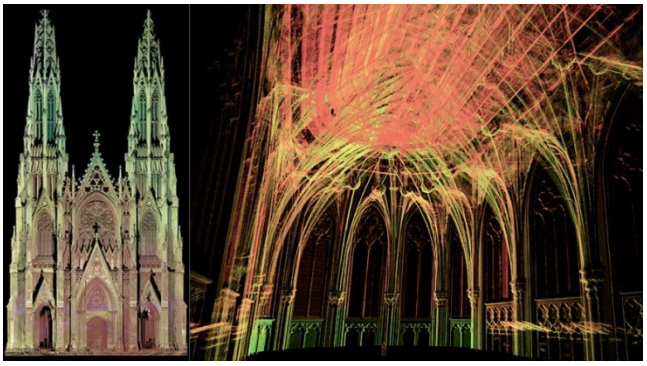


SUSTAINABILITY: Langan is a leader in providing sustainable engineering services on urban infill, brownfield, and landfill development projects. These projects help clients and communities reuse impacted lands and combat urban sprawl by allowing communities to densify from within instead of expanding. The sustainability benefits are many – from reducing traffic, lowering reliance on cars, preserving undeveloped open space, reducing pollution and carbon emissions, and promoting health and quality of life.

Projects include LEED site feasibility analysis, Air quality assessments, Ecological wastewater treatment design, Low impact

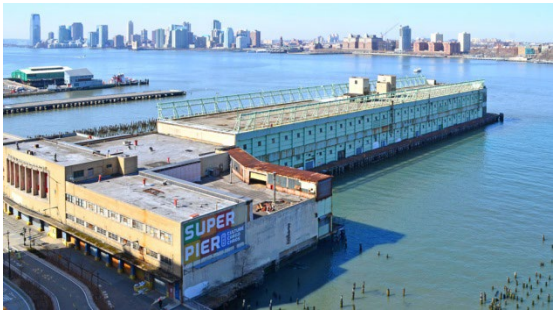
stormwater design and master planning, Brownfield redevelopment, Green roof design, High efficiency site lighting and irrigation design, Wildlife and habitat evaluations, Wetland delineation, design, and mitigation, Geothermal feasibility studies and system design support, Landfill post-closure redevelopment
Carbon footprinting, Green and sustainable remediation, Climate change resiliency.
https://www.langan.com/sustainability-2/

We will learn about some of Langan's ongoing work, but here are a couple of their projects involving places that we will see on this trip.



St. Patrick's Cathedral publicly announced its restoration in 2012 after years of pollution critically deteriorated both the interior and exterior. Langan performed 3D laser scans of the façade, sanctuary, and attic spaces to document the conditions and model the building's unique layout. This highly detailed data saved the project team time and money, and the deliverables were regularly compared to the base survey to maintain accuracy.

An abandoned railroad structure spanning 19 blocks on Manhattan's West Side, the High Line overpass, became the nation's first elevated park. Langan site/civil engineers assisted with the design and permitting of three plazas within the High Line (the Gansevoort Street, 19th Street, and 10th Avenue Square plazas). Working with the developers, Langan obtained DEP drainage plan permits to connect drains for the project areas and at street level for the length of the high line structure. Langan environmental engineers provided remediation design and oversight.



Pier 57, an approximately 560,000-GSF pier, a once abandoned shipping and passenger terminal, is now the site for public green space. rooftop beach, rock-climbing wall, and 200 stores and businesses. Langan's environmental engineers performed extensive due diligence services for this location, including a Phase I Environmental Site Assessment and Phase II Environmental Site Investigation. As a result of flooding associated with Superstorm Sandy, Langan provided an emergency spill response team when six above-ground storage tanks became buoyant and spilled approximately 31,000-gallons of fuel oil into the pier's Head House caisson and elevator pits.

Hudson Yards, the largest private development in the US opened in 2019, and was constructed on 28-acres over a working rail yard with 300 caissons supporting the platform and buildings. Langan supported this redevelopment since 2002.

https://www.hudsonyardsnewyork.com/discover/edge

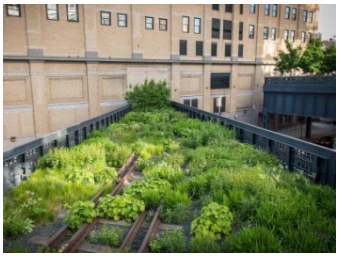
The highest sky deck in the Western Hemispher e is located at 30 Hudson Yards. The Edge looks down 100 stories from a glass floor

High Line: Out of Use Railroad Trestle to Public Landscape *(from thehighline.org)*

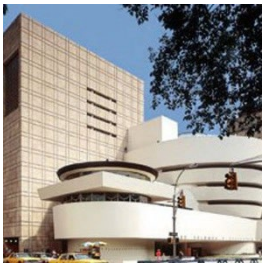
The High Line is a public park built on a historic freight rail line elevated above the streets on Manhattan's West Side. The High Line is now one continuous 1.45 mile long greenway that features 500+ species of plants and trees. High Line Art commissions and produces 30+ public art projects each year, including site-specific commissions, exhibitions, performances, and video programs.

1934 As part of the West Side Improvement Project, the High Line opens to trains. It runs from 34th Street to St John's Park Terminal, at Spring Street. It is designed to go through the center of blocks, rather than over the avenue, carrying goods to and from Manhattan's largest industrial district.

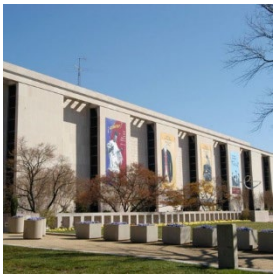
1980s Following decades-long growth in the interstate trucking industry, the last train runs on the High Line in 1980, pulling three carloads of frozen turkeys. A group of property owners lobbies for demolition while Peter Obletz, a Chelsea resident, activist, and railroad enthusiast, challenges demolition efforts in court.

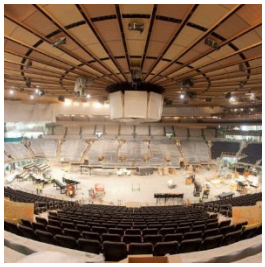


1999-2014 From conception by two residents of the High Line neighborhood, Joshua David and Robert Hammond, to planning studies, to ideas competition, to design selection, to ownership transfer to the City, to groundbreaking, and finally development in four stages/sections, the dream becomes a reality.**SUSTAINABLE PRACTICES:** Self-seeded grass, trees and other plants grew on the out-of-use elevated rail track during the 25 years after the trains stopped running. These grasses and trees inspired the planting designer Piet Oudolf to "keep it wild." Nearly half of the plant species and cultivars planted on the High Line are native to the United States. **HOW ARE THE PLANTS WATERED?** The High Line's green roof system is designed to allow the plants to retain as much water as possible. In addition, there is an irrigation system installed with options for both automatic and manual watering. **HOW IS THE HIGH LINE SUSTAINABLE?** The High Line is inherently a green structure. It re-purposes a piece of industrial infrastructure as a public green space. The High Line landscape functions essentially like a green roof; porous pathways contain open joints, so water can drain between planks and water adjacent planting beds, cutting down on the amount of storm-water that runs off the site into the sewer system. The High Line has on-site **COMPOSTING FACILITIES**, an **INTEGRATED PEST MANAGEMENT PROGRAM**, uses **GREEN SEAL CERTIFIED CLEANING SOLUTIONS** and **POST-CONSUMER PAPER PRODUCTS.**


SEVERUD ASSOCIATES Consulting Engineers P.C. Started in 1928 by Fred N. Severud, an engineer known for his skill at devising structural solutions for damaged masonry on the masonry and brick facades of buildings around NYC. Later the firm became known for its bold and ingenious designs, developing a reputation for engineering innovative structural designs for complex and unusual buildings. Renowned architects such as Eero Saarinen, Mies van der Rohe, Charles Luckman, and Philip Johnson became faithful clients. Together, these architectural innovators and the firm's talented engineers designed many iconic structures, including the Gateway Arch in St. Louis, the Seagram Building and Madison Square Garden in NYC, and the Crystal Cathedral in Garden Grove, California. Severud Associates has also designed more buildings on the National Mall in Washington, DC than any other structural engineering firm. Recent notable projects include 20 Times Square, the Bank of America Tower at One Bryant Park, and the Transformation of Madison Square Garden, all in New York City; the Novartis East Hanover Campus and redevelopment of Terminal A at Newark Liberty International Airport, both in New Jersey; and the Los Angeles Forum renovations in California.





270 Park Avenue is set to be the new state-of-the-art global headquarters for JPMorgan Chase. The 1,388-foot (423 meter), 60-story skyscraper will be New York City's largest all-electric tower with net zero operational emissions and exceptional indoor air quality that exceeds the highest standards in sustainability, health and wellness. It will help define the modern workplace with 21st century infrastructure, smart technology and 2.5 million square feet of flexible and collaborative space that can easily adapt to the future of work. The new building will house up to 14,000 employees – replacing an outdated facility designed in the late 1950s for about 3,500 employees. It will offer 2.5 times more outdoor space on the ground level of Park and Madison Avenues,

270 Park Avenue. Rendering © DBOX for Foster + Partners

featuring wider sidewalks and a large public plaza on Madison Avenue with natural green space and other amenities geared toward the residents, workers and visitors who frequent the neighborhood on a daily basis. The concept for the new design was to create a timeless addition to Park Avenue, which celebrates the city's iconic architectural history and serves as a powerful new symbol for the next generation of office towers in New York. Using a state-of-the-art structural system to negotiate the site constraints below and at ground level, the innovative fan-column structure and triangular bracing allow the building to touch the ground lightly across the entire block. By lifting the building about 80 feet (24 meters) off the ground, it extends the viewpoint from the Park Avenue entrance through to Madison Avenue. **270 Park Avenue will be 100 per cent powered by renewable energy** sourced from a New York State hydroelectric plant. In addition to operating on net zero carbon emissions, the building will use state-of-the-art building technology and systems to ensure it operates as efficiently as possible, including intelligent building technology that uses sensors, AI and machine learning systems to predict, respond and adapt to energy needs; advanced water storage and reuse systems to reduce water usage by more than 40 per cent; triple pane glazing on the façade and automatic solar shades connected to HVAC systems for greater energy efficiency; and outdoor terraces featuring natural green space and plantings. **The project also recycled, reused or upcycled 97% of the building materials from the demolition** – far exceeding the 75% requirement of the leading green building standard.

270 Park Avenue, Photo by Michael Young

https://www.fosterandpartners.com/projects/270-park-avenue/ This building's supertall status comes from 700,000 square feet of unusued development rights purchased from nearby landmarked properties, as the 2017 Midtown East Rezoning plan allows. JP Morgan acquired 680,000 square feet of air rights from Grand Central and another 50,000 square feet from St. Bartholomew's Episcopal Church. Proceeds from the air rights will then be used to finance the city's public space improvements in Midtown. https://www.6sqft.com/jpmorgan-chase-unveils-new-nyc-headquarters-at-270-park-avenue/

Both Groups:

5:30pm	**Meet in lobby of hotel for 25 minute walk to ND Club of NYC Networking Event – Happy Hour, The Pub@Rosie O'Grady's, 800 7th Avenue (at 52nd St)**
6:00pm-7:45pm	**ND Club of NYC Networking Event**
7:45pm	**5 minute walk to John's Time Square, 260 W 44th Street for dinner**
8:00pm – 9:30pm	**Dinner at John's of Times Square, 260 W 44th Street (we all have to arrive as a group in order to be seated)** ***All you can eat NY pizza and calzones***

FRIDAY, SEPTEMBER 30

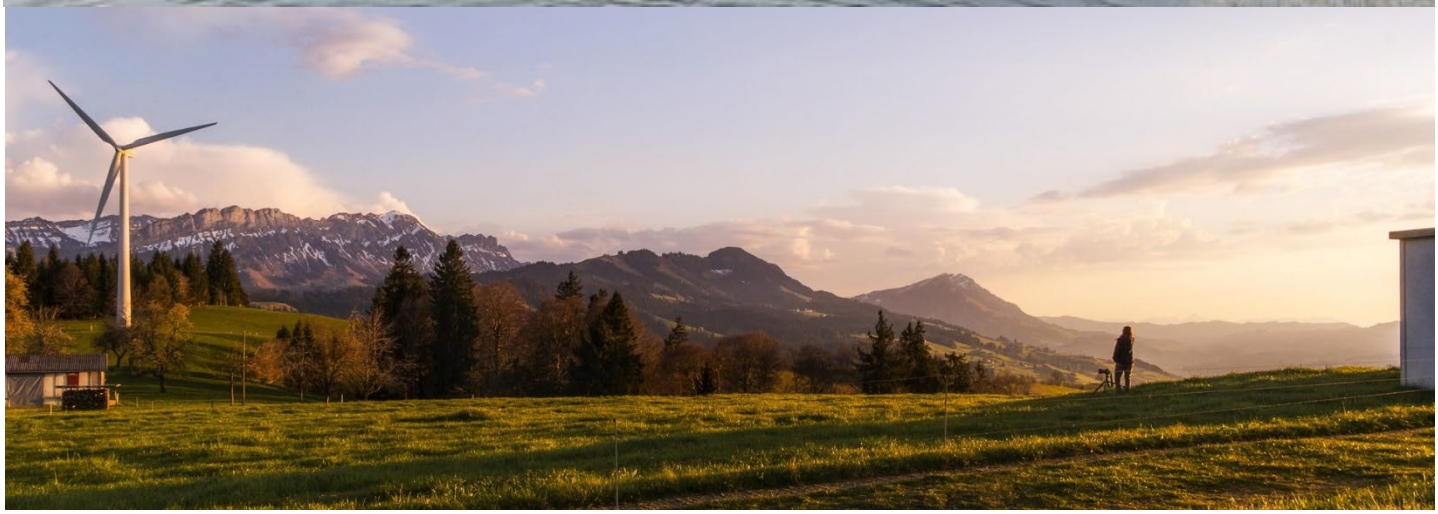
Are you in Afternoon Group One Two? The groups will split for the afternoon.

Wear: *Group One* will need PPE and construction attire – bring on bus to be prepared for afternoon

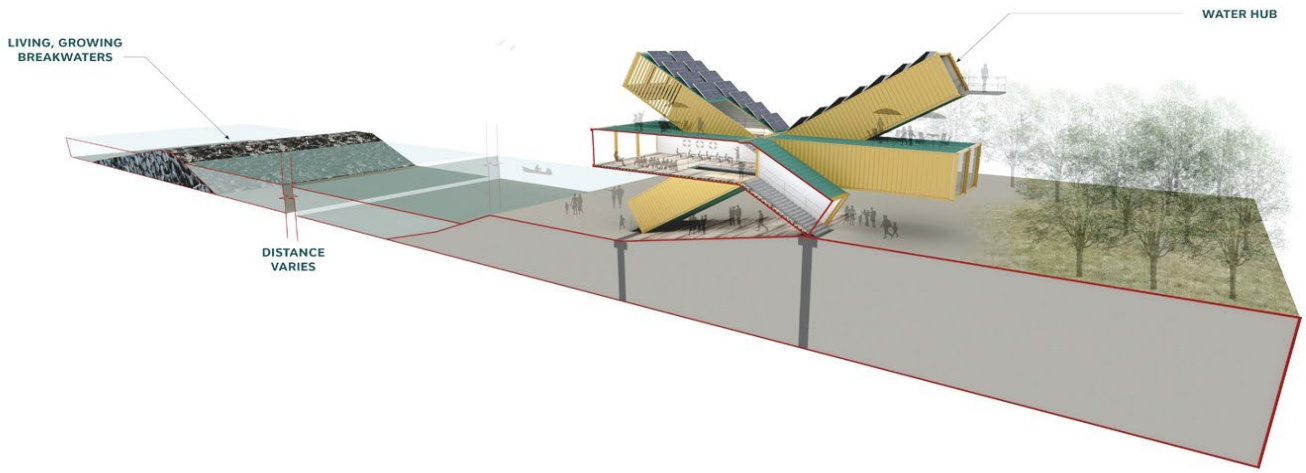
***Group Two* should wear clothes appropriate for engineering office visit**

6:00am-8:15am	**Continental breakfast available in hotel, let attendant know you are with the Notre Dame engineering group**
8:30am	**Both Groups Depart by bus for Living Breakwaters, Staten Island, arrive by 10am**
10:00am-noon	**Overview and construction tour with WSP, Governor's Office of Storm Recovery, and SCAPE Studio**

WSP USA, former WSP/Parsons Brinckerhoff and Parsons Brinkerhoff is one of the leading engineering professional service firms, with 37,000 talented people, based in more than 500 offices across 40 countries. The firm operates in the fields of strategic consulting, planning, engineering, construction management, energy, infrastructure and community planning.



Living Breakwaters Coastal Resilience: An innovative living infrastructure solution, incorporating a necklace of offshore breakwaters, aims to reduce coastal erosion, revive ecologies, and connect the community to the Staten Island shoreline. https://www.wsp.com/en-us/projects/living-breakwaters-coastal-resilience

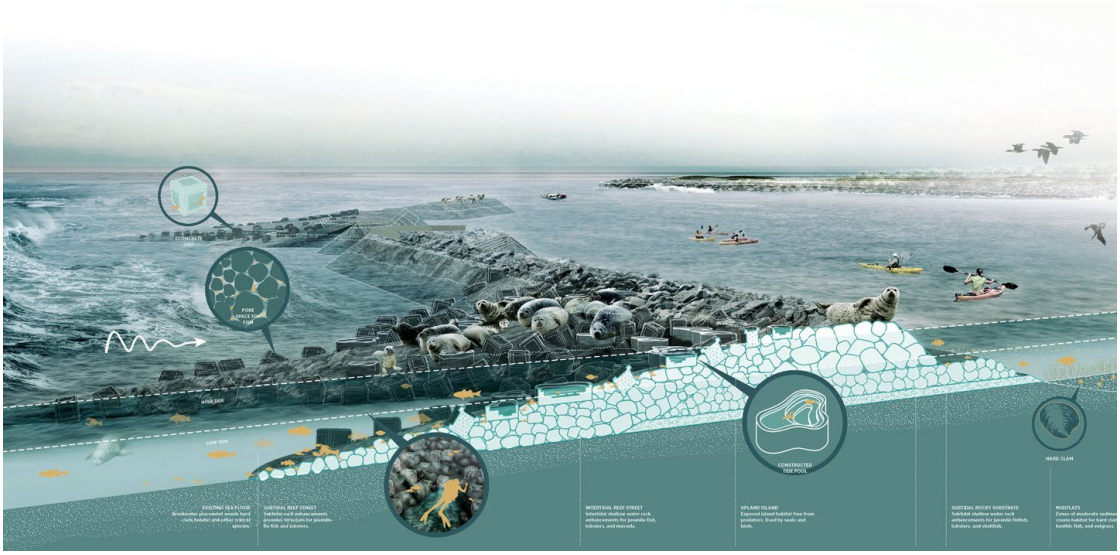


The Scape Team Living Breakwaters HUD Rebuild By Design

Need for Enhanced Erosion Protection

The southeastern shoreline of Staten Island, New York has experienced continued erosion over decades due to increasingly intense waves. Additionally, wave activity, siltation, dredging and pollution have significantly deteriorated the marine ecology of Raritan Bay, including the once abundant oyster population and the rich biodiversity it supported.

The need for enhanced erosion protection came into stark relief during recent storm events, including Superstorm Sandy, when the community of Tottenville experienced severe damage from storm surge. Following Sandy, the U.S. Department of Housing and Urban Development and the Presidential Hurricane Sandy Rebuilding Task Force launched "Rebuild by Design" to seek community and policy-based solutions to protect U.S. cities most vulnerable to intense weather events. WSP was part of the interdisciplinary team led by SCAPE Architecture that proposed the selected "Living Breakwaters" concept.



The Scape Team Living Breakwaters HUD Rebuild By Design

Creating Habitat Breakwaters

The project is designed to reduce the risk of storm damage to Staten Island by creating habitat breakwaters to attenuate waves and reduce shoreline erosion. The living infrastructure will also

provide habitat to the bay's rich ecosystem of marine life, rebuild local oyster populations and create educational, recreational and commercial opportunities for residents. Additionally, a land-based "Water Hub" facility will be constructed to provide educational, monitoring, stewardship and social engagement programs designed to bring residents to the water to re-engage with their ecology.

WSP USA is conducting all in-water geotechnical analysis for the design of the living breakwaters and is supporting the community engagement effort, especially as it relates to the siting and design for the Water Hub, an on-land space for visiting groups, recreational activities, and educational programs.

Resilience Initiatives

Living Breakwaters is designed to work in concert with other ongoing resilience initiatives in the area, including the New York Rising Community Reconstruction Tottenville Dune and Coastal Dune Plantings project. The vegetated dune system will be strengthened by the breakwaters, to provide a layered system of protection. The project is now a project of the State of New York and will be further developed and implemented by the Governor's Office of Storm Recovery in the coming years. https://www.wsp.com/en-us/projects/living-breakwaters-coastal-resilience

GOVERNOR'S OFFICE OF STORM RECOVERY (GOSR)

Living Breakwaters Project Background and Design

12:00 – 1:45pm	**Bus back to Manhattan** **Box lunch on bus** **Drop off in Manhattan around 7th or 8th near Penn Station between 30th and 34th**

Group One:

1:45pm	**Walk to Severud, 469 Seventh Ave (between W35th & W36th)**
2:00pm – 4:00pm	**Severud Associates Consulting Engineers, 469 Seventh Ave for an overview presentation, followed by 20 minute walk to construction site visit of 270 Park**

Group Two:

1:45pm	**Walk to Langan design offices, 360 W 31st St. 8th fl**
2:00pm – 4:00pm	**Langan office visit and walk part of High Line**

Open time the rest of the afternoon and evening.
Homework time, relaxation or city exploring.
Some suggestions of things to do on page 19
Keep safety in mind! Don't go out alone, go out only with others, be extra careful with traffic and all crossings, and keep in touch with your hotel mates about your whereabouts!

SATURDAY, OCTOBER 1
Wear: ***clothes appropriate for engineering office visit***

6:00am-8:00am	**Continental breakfast available in hotel, let attendant know you are with the Notre Dame engineering group**
8:15am	**Depart by bus for AECOM, 125 Broad Street, NYC**
9:00am- 10:30am	**AECOM overview, 2nd Ave Subway Program, Lower Manhattan Resiliency and studio**
10:30am	**Depart by bus to WTC Transportation Hub**
11:00am – 11:30am	**Brief tour of WTC Transportation Hub**

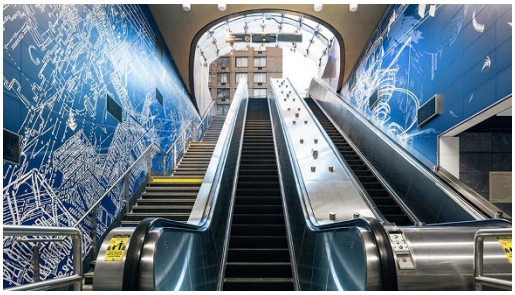
AECOM launched when a handful of employees from design and engineering companies shared a dream of creating an industry-leading firm dedicated to delivering a better world. With the merging of five entities, the official founding was in 1990, although many of the predecessor firms had distinguished histories dating back more than 120 years. Since then, more than 50 companies have joined AECOM. The company consists of planners, designers, engineers, consultants and program and construction managers, delivering professional services spanning cities, transportation, buildings, water, new energy and environment.

Some highlighted projects include One World Trade Center, Port of Los Angeles Waterfront, Mercedes-Benz Stadium, Golden 1 Center, Warner Bros. World Abu Dhabi

SAS – Second Avenue Subway

Commuters living on Manhattan's East Side lacked a direct subway line, resulting in a surplus of riders on the Lexington Avenue Subway's 4, 5 and 6 trains, which in turn caused delays and safety risks in bottlenecked stations. In an effort to relieve excessive crowding and stress on the entire system's infrastructure, MTA commissioned AECOM-Arup Joint Venture as the prime engineering and design consultant for the new Second Avenue Subway, which resulted in the first major expansion of the New York City Transit subway system in over 50 years with its 1.8 mile expansion between 63rd and 96th Street. Among the innovative solutions:

Tunneling: A tunnel boring machine (TBM) weighing 485 tons and measuring 450 feet long was used to excavate 12,800 feet of twin-track tunnels measuring just over 22 feet in diameter. The three new stations rank among the largest underground excavations in North America, at nearly 64 feet wide, 100 feet deep and 1,600 feet long. The tunnel's concrete liners were the first in New York City not to use steel-reinforcing bars, instead using steel fibers for flexural reinforcing and crack control, and polypropylene fibers for prevention of explosive spalling in the event of a tunnel fire.



Structural and geotechnical: Tying a brand new subway line into an existing, 100-year-old system is a Herculean endeavor, especially since this line sits below some of the world's most congested infrastructure and ground conditions can vary from the hard rock of Manhattan schist to the soft soils of old river beds and swamps. One challenge involved an area of fractured, weathered rock at the start of the east tunnel that was not discovered despite numerous borings. Ground freezing was determined as the best approach to allow hard-rock TBMs to safely pass through, a decision that necessitated adjustments in tunnel sequencing but still kept the project on track.

Acoustics: Working with recordings taken at existing subway stations, acousticians used Sound Lab technology to create digital models and assess the best ways to reduce subway noises. Solutions included joint-free running rails with concrete ties encased in rubber, ceilings lined with perforated metal panels backed with sound-absorbing fiberglass, and public-address speakers placed strategically to optimize intelligibility.

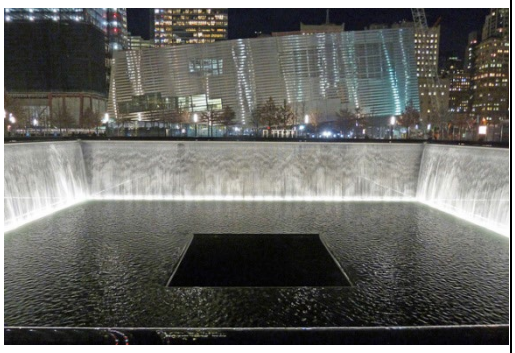
Social: SAS sets a new standard for the city's subway system. Stations are safe and welcoming, with high ceilings, column-free public spaces, Wi-Fi access and added security measures. Each station now has street entrances with escalators and ADA-accessible elevators — features much appreciated by riders who long endured stairway-only access. Energy-efficient lighting and graphical signage aid passenger orientation and reinforce station identity, which is further established through one-of-a-kind art installations anchoring each station. These monumental works of art, commissioned specifically for this project, collectively make SAS the largest permanent public art display in the state.

Opened to passengers on January 1, 2017, this US$4.45-billion project was completed on time and within the targeted budget, a major accomplishment given the scope and size. An intricate balance of infrastructure, buildings and transit, SAS is delivering on its promise to provide significant benefits across the entire transportation network by increasing accessibility with a one-seat ride to destinations throughout Manhattan, while reducing congestion on the nearby Lexington Avenue line by some 40-percent during peak morning hours. Average weekday ridership on SAS reached 190,000 passengers in its first year of operation, proving this project is more than better transit — it's better living.

WORLD TRADE CENTER
HISTORY OF THE TWIN TOWERS

1939 - At the World's Fair in Flushing, NY the "World trade center" pavilion is dedicated to "world peace through trade."
1964 - The Port Authority unveils an architectural plan for the WTC featuring the world's tallest buildings.
1966 - Construction begins at the WTC site with the demolition of 78 Dey Street. Excavation work begins for the WTC. First use of "slurry wall" method in the United States.
1970 - The North Tower of the WTC exceeds the height of Empire State Building at 1,368 feet, making it the tallest building in the world.
1971 - The South Tower of the WTC is topped off at 1,362 feet.
1973 - The World Trade Center is dedicated.
1974 - Tightrope artist Philippe Petit performs an unauthorized walk between the Twin Towers.
1975 - Top of the World Observation Deck opens, South Tower.
1976 - Windows of the World Restaurant opens, North Tower.
1993 - Terrorists detonate 1,500 pounds of explosives in a van parked in the underground public parking lot of the WTC, two levels below the southern wall of the North Tower. The attack kills six people, injures more than 1,000 people and creates a five-story crater beneath the towers, resulting in hundreds of millions of dollars of damage. The Port Authority implements a $250 million upgrade plan focusing on life safety and security.
1994 - The WTC is designated one of the "Seven Wonders of the Modern World" by the American Society of Civil Engineers. The WTC is visited by every U.S. president between the time of its opening and the time of its destruction at least once, as well as by many dignitaries and heads of state.
1995 - A memorial fountain is dedicated in the WTC plaza to the victims of the 1993 bombing.
1998 - The Port Authority announces plans to seek a 99-year net lease of the complex.
2000 - The WTC reaches its highest occupancy rate.
July 2001 - The WTC is net-leased to private developer Silverstein Properties, Inc. for approximately $3.2 billion. A three-to-six month transition period commences.
September 2001 – On September 11, two planes hijacked by terrorists crash into the Twin Towers, destroying the complex. One World Trade Center is struck at 8:46 a.m.; Two World Trade Center at 9:03 a.m. A timeline of events of that day.
2002 - Six-month anniversary of the September 11 attacks is marked with beams of light. On May 30, the WTC recovery ends with a public Last Column Ceremony.
2002 - The 9-11 Commission is created to study the events leading up to the September 11 attacks and to provide recommendations on emergency preparedness and response. The 9-11 Commission issues its report on July 22, 2004.
2003 - On November 23, a temporary World Trade Center PATH station opens to replace the one destroyed on September 11.
2006 - The newly constructed 7 World Trade Center opens on May 23, the first building to be rebuilt in Lower Manhattan after the September 11 attacks.
http://www.panynj.gov/wtcprogress/history-twin-towers.html

The 9/11 Memorial



The Reflecting Pools – These pools and cascading waterfalls are set in the exact footprints of the North and South World Trade Center Towers which were destroyed on September 11, 2001. The pools are the largest man-made waterfalls in the North America. The pools are one of the most moving memorials in the world. It is nearly impossible to view the pools without experiencing overwhelming emotions.

The Memorial honors those who died on 9/11, including those who perished at the World Trade Center, the Pentagon in Washington D.C. and the victims of hi-jacked Flight 93 that crashed in Pennsylvania. Also included are the oft-forgotten six victims of the 1993 World Trade Center bombing.

The victims' names are inscribed around the bronze edges of the pools. Instead of being arranged alphabetically, the names are organized by "meaningful adjacencies." Names are grouped together based on their relationships with other victims, such as co-workers, family members, friends, and even those who commuted together.

The 9/11 Memorial & Museum

Through interactive technology, archives, narratives and a collection of artifacts, the Museum recounts the events of 9/11. Unlike the Memorial, you must purchase tickets to enter. Information about visiting: https://www.911memorial.org/visit

One World Trade Center

Nick-named the "Freedom Tower," One World Trade Center is the tallest of the WTC complex. It's no coincidence that its height is 1,776 feet. The Observatory on the 100th and 101st floors is open and is quite an amazing experience. For information on visiting click on this link: One World Observatory ("Freedom Tower"). Floors 1-19 are the base of the building with a 65-foot-high (20 meter) public lobby. Rented office space begins on the 20th Floor and continues to the 64th Floor. On Floor 65 is a sky lobby and then office floors resume on Floor 65 to Floor 90. Floors 91–99 and 103–104 are mechanical floors. Opened 2014.

The World Trade Center Transportation Hub – the Oculus

The Oculus is home to 12 subway lines, the World Trade Center PATH station, and dozens of retailers, serving over a million people every week. The Oculus and the Transportation Hub are owned and operated by the Port Authority of New York and New Jersey.

The Oculus was positioned as part of the WTC masterplan by Daniel Libeskind and designed by Santiago Calatrava. The structure's white metal-clad steel ribs reach up and out in a monumental move symbolic of a hand releasing a dove. The structure's orientation serves as a lasting reminder of the attacks of September 11, 2001. It is in alignment with the sun's solar angles on each September 11, from 8:46am, when the first plane struck, until 10:28am, when the second tower collapsed. Its central skylight fits this alignment and washes the Oculus floor with a beam of light.

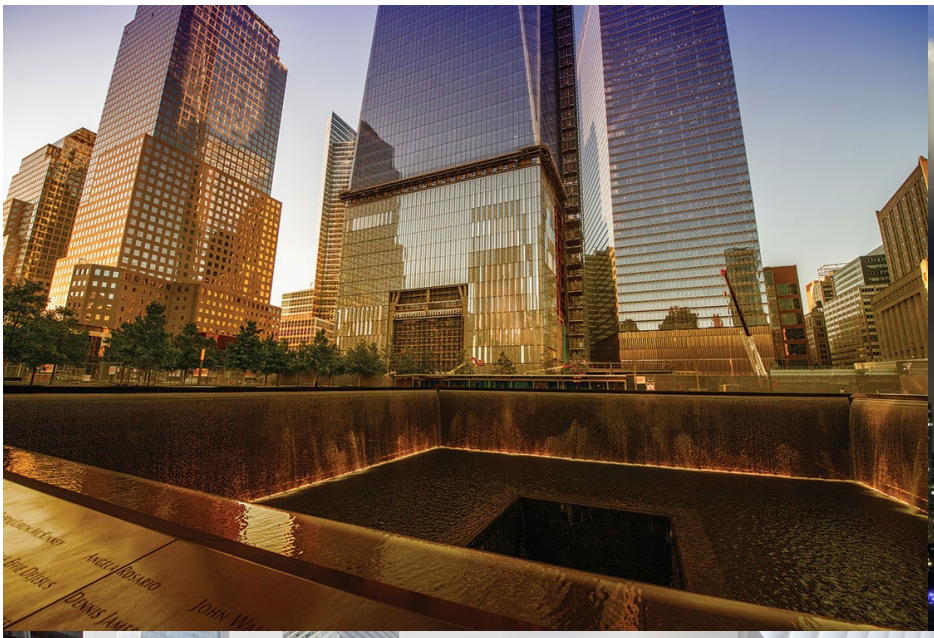
https://www.officialworldtradecenter.com/en/local/learn-about-wtc/oculus-transportation-hub.html

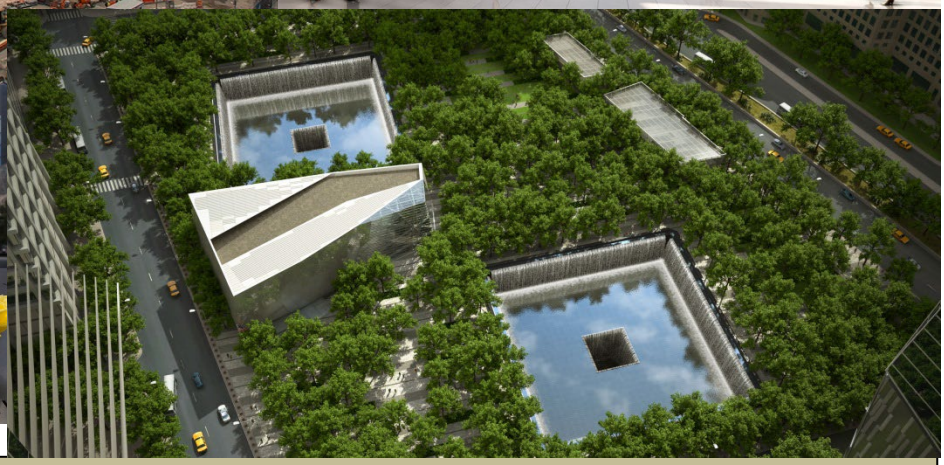
2 World Trade Center is not complete due to many delays in design. Although the foundation has been in place since 2013, investors are still being sought for the tower.

3 World Trade Center opened in 2018 and is 1,079 feet tall and has one of the largest terraces in NYC at 5,000 sq ft.

4 World Trade Center faces directly onto the World Trade Center Memorial Plaza. Rising 977 feet, designed by Maki and Associates, the 72-story tower is intended to assume a quiet but dignified presence at the site

7 World Trade Center was completed in 2006 and was the first tower rebuilt after the attacks. Standing 741 feet and 52-stories tall it sits on the same site as the original 7 World Trade Center.





From the ashes of Ground Zero in New York City, a new and vibrant World Trade Center (WTC) emerged, with AECOM at the center of it all. Along with the World Trade Center's new towers One, Three and Four and the Vehicular Security Center, AECOM served, in a joint venture, as construction manager for the 800,000-square-foot WTC Transportation Hub. We also participated in the design of the Hub as part of a joint venture led by world-renowned architect Santiago Calatrava. The Hub is the third largest transportation center in New York City.

https://infrastructure.aecom.com/2019/newyork/world-trade-center-transportation-hub

Open time from noon on through evening.
Homework time, relaxation or city exploring.
Keep safety in mind! Don't go out alone, go out only with others, be extra careful with traffic and all crossings, and keep in touch with your hotel mates about your whereabouts!

A Few Places You Might Consider Visiting

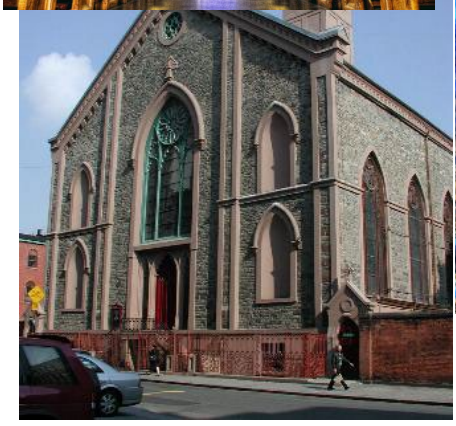
Staten Island Ferry **free views city, bridges,** Statue of Liberty 	Ellis Island **and** Guastavino Tile Arches in the Registry Room  Guastavino tiles can be found at over 250 locations in NYC!	One World Trade Center **(amazing observation deck)** 	Summit One Vanderbilt  1200 feet above the sidewalk	National September 11 Memorial and Museum 
Metropolitan Museum of Art  or Museum of Modern Art 	**Walk through** Central Park 	Skinny high rise buildings  	Top of the Rock **– spectacular views – 3 levels – you can see St. Patrick's Cathedral, Yankee Stadium, WTC, Brooklyn Bridge, Central Park – civil engineering in every direction!**  	The Newtown Creek Digester Eggs and nature walk, Greenpoint, Brooklyn  
Moynihan Train Hall  Expansion of Penn Station, city's former main post office	American Museum of Natural History 	**New York's Catholic Heritage:** St. Peter's Roman Catholic Church, St. Elizabeth Ann Seton Shrine, Tammany Hall, Lower East Side Tenement Museum 	Grand Central Terminal  Great video On GCT!	Catacombs Tour of Old St. Patrick's Cathedral 

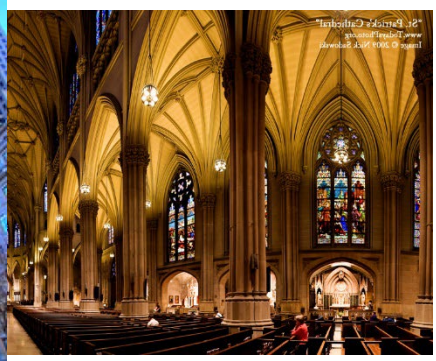
SUNDAY, OCTOBER 2
Wear: ***Clothes for Mass***
Bring: ***All luggage, everything from your room, we'll be checking out of hotel before we head to Mass. We will be stopping when we are on our way back to campus, and you can change clothes then if you would like.***

6:00am – 8:15am	**Continental breakfast available in hotel, let attendant know you are with the Notre Dame engineering group**
8:30am	**Meet in lobby for departure! *with all luggage – checking out of hotel* to board bus for 15 minute drive to St. Patrick's Cathedral**
9:00am	**Mass at <u>St. Patrick's Cathedral</u>**

New York City has two Saint Patrick's Cathedrals

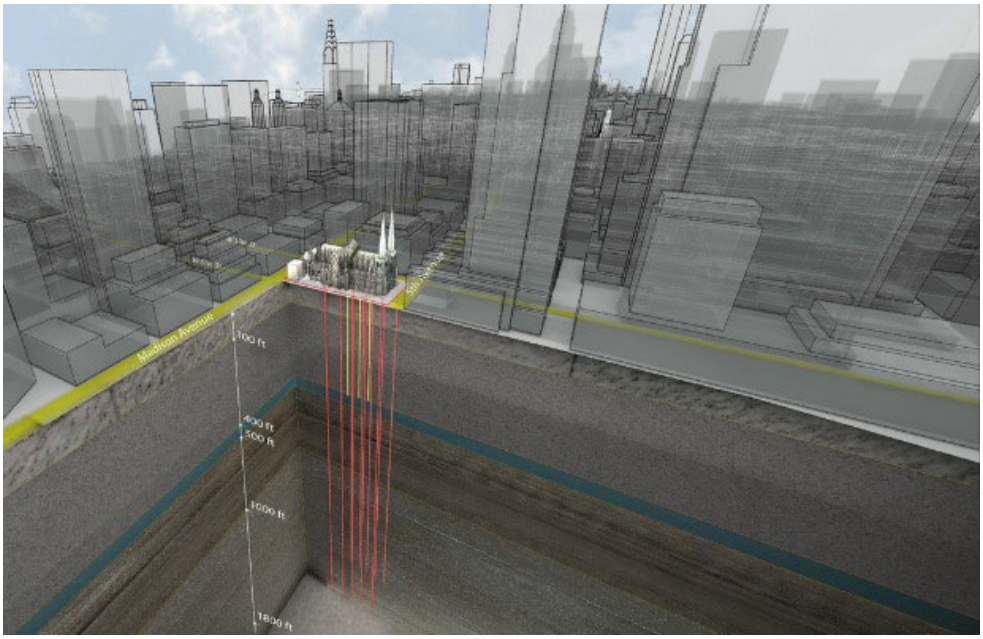
The Basilica of St. Patrick's Old Cathedral, located in lower Manhattan, is the original Cathedral of the Archdiocese of New York and was built in 1840 to replace the original wood frame building of St. Peter's Church, the first Catholic house of worship in the city. St. Peter's was built in 1785 at a time when there were only two hundred Catholics and one priest in the city. In 1805, Mrs. Elizabeth Bayley Seton, founder of the Sisters of Charity in this country, was converted to Catholicism and made her profession of faith, received her first communion, and was confirmed in the old Saint Peter's Church. In the early 1800s, the Diocese of New York was created, which inspired the increasing Catholic population. In 1842, Bishop John Hughes became Bishop of New York. At that time, his cathedral was the largest church structure in New York City. When New York became an archdiocese in 1850, Bishop Hughes became the first archbishop.





In 1853, when Archbishop John Hughes announced his ambition to build a new **St. Patrick's Cathedral**, the idea was ridiculed as "Hughes' Folly," as the proposed, near-wilderness site was considered too far outside of the city. Archbishop Hughes, nonetheless, persisted in his vision to build the most beautiful Gothic Cathedral in the New World in what he believed would one day be "the heart of the city." Construction started in 1858, but was stalled for five years because of the Civil War and the need for additional funding. The workers needed to go fight in the war, and the war put a financial strain on the entire country. Money was so tight that the archdiocese had to settle for a plaster ceiling for the cathedral rather than continuing to use marble. The Cathedral was formally opened in 1879.

St. Patrick Cathedral facts: More than five million visitors each year step inside; The cathedral seats 2,400 people and conducts seven masses on weekdays on eight on Sundays; There are 9,000 organ pipes, more than 20 altars, 3,700 stained-glass panels, 19 bells, and the 9,000 pound bronze doors at the main entrance were designed to be opened using only one hand. **Going Green:** From "The New, Green Pride of St. Patrick's Cathedral Is Underground," Sharon Otterman, NYTimes, March 4, 2018: "One year ago, as part of its almost $200 million dollar renovation, St. Patrick's Cathedral launched a state-of-the-art geothermal heating and cooling system to replace its system of steam radiators and 1960s-era air conditioning. Around the cathedral's perimeter are now 10 wells as deep as 2,200 feet into the Manhattan bedrock, collecting groundwater that helps the church efficiently heat and cool. The cathedral now reaches six times deeper than its Gothic spires soar high…At the heart of St. Patrick's new system is its geothermal plant, a tightly packed former boiler room under the church's campus that is loaded with pumps, compressors and other equipment that makes the system work. A computer system automatically determines whether to cool or heat based on thermostats set around the 76,000-square-foot cathedral campus. It can switch various wells on and off, and it can heat some areas while cooling others…Four separate loops of water propel heat and cooling through the system. The first loop brings the groundwater, measuring about 55 degrees year round, from the wells into the geothermal plant. The second loop leads to a machine that cools the water down to about 45 degrees in summer, or heats it up to 130 degrees in winter. That water is then piped through the campus and into fan coils scattered around the buildings.



With a system this complex, its designers weren't sure if it was going to work all the time. What about a heat wave? Or in a cold snap? So they also installed a traditional cooling tower and a natural gas boiler system as backup. But the backup has not yet been necessary. Since the geothermal launched in February 2017, it has provided all of the cathedral's heating and cooling, to the delight of its engineers. The project, designed by the Landmark Facilities Group and P.W. Grosser Consulting, won a 2018 honor from the New York Chapter of the American Council of Engineering Companies...[T]he engineers estimate that the new system will reduce energy use over a traditional system by about 30 percent annually. For St. Patrick's, that totals roughly 94,000 kilograms in the carbon dioxide emissions, or about as much created when burning 218 barrels of oil. According to the mayor's office, approximately 20 geothermal systems have been installed in New York City in the past five years, but St. Patrick's is believed to be the largest."

10:00am	**Drive back to Notre Dame** (*11 ½ hour drive without stops, but we will be stopping*)

Phone numbers: ***Trip Coordinators: Diane Westerink, 574-286-9696; Joannes Westerink, 574-532-3160***