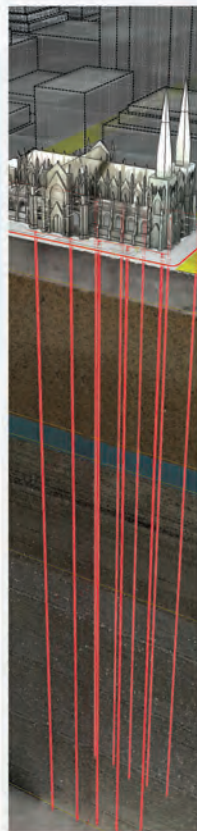
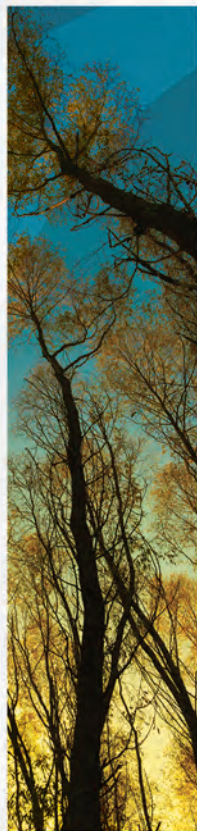


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## GEOTHERMAL HEAT PUMP SYSTEMS QUALIFICATIONS

**CONTACT: Paul K. Boyce, PE, PG, President/CEO**  
630 Johnson Avenue, Suite 7 • Bohemia, NY 11716  
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# FIRM PROFILE



# PWGC: SOLUTIONS FOR A CHANGING WORLD

## MEET PWGC

PWGC was founded more than 29 years ago by Paul Grosser, PhD, PE, PG, a thought leader who recognized the need for a multi-disciplined engineering and environmental consulting firm that offered a diverse range of services to meet market demand regionally and nationally. Based in Bohemia, NY, PWGC has offices in New York City, Albany, Syracuse, Connecticut and Washington.

PWGC serves the New York Metropolitan region and has established a strong reputation for innovative problem solving and providing quality services to municipal, educational, private, public and federal clients. The firm is dedicated to providing cost-effective and timely services that result in practical solutions for its clients.

PWGC has a multi-disciplined staff of more than 70 professionals, which includes recognized experts in the application of wastewater and water supply technologies. Its strength lies with these licensed professional engineers, geologists and hydrogeologists, LEED accredited professionals and environmental compliance specialists, which gives PWGC a wealth of experience key to helping bring your project from idea to reality.

## CHOOSE PWGC

Whether your objectives are planning, design and/or redevelopment, PWGC's solutions are innovative and economical. PWGC is committed to client goals and our dynamic team of professionals provide innovation and flexibility to deliver customized solutions to projects regardless of size, complexity or duration.

## THE PWGC DIFFERENCE

What sets us apart is our customized approach to each project, rapport with regulatory agencies and exceptional project management. This approach has cemented PWGC's industry reputation as a leader in engineering. PWGC's assets that translate into additional value for you:

- Strong working relationships with key regulatory sector players
- Specialists in regulatory requirements to facilitate quicker approvals
- Highly responsive to budget & time constraints to get your project on line faster
- Project and quality control monitoring to exceed your project needs
- More than 70 dedicated professionals to provide a wide array of services
- Strict adherence to environmental compliance standards

**Make PWGC quality environmental consulting and engineering solutions work for you.**

## PWGC QUICK FACTS

### Corporate

- Founded & Incorporated: 1990
- SAM/SBA Registered
- Small Business
- DUNS # 798730966
- Federal ID: 11-3612196

### Offices

- Bohemia, NY
- New York, NY
- Saratoga Springs, NY
- Syracuse, NY
- Seattle, WA
- Shelton, CT

### Qualifications

- LICENSES - Engineer, Geologist, LSP, NC, NY, NJ, PA, MD, IN, NH, MA, FL, WA
- LEED-AP
- Envision

### Service Codes

#### NAICS

- 562910 Environmental Remediation
- 541330 Engineering
- 541620 Environmental Consulting
- 562998 Waste Management Services
- 541370 GIS Base Mapping
- 237130 Green Services

#### SIC

- 8999 Environmental Services
- 8711 Engineering Services



# COMPREHENSIVE SUMMARY LIST OF SERVICES

## Environmental Services

- Contract Administration
- Petroleum & Chemical Spill Investigation & Remediation
- Remedial Alternative Assessment & Design
- Remedial Construction Management
- Property Transaction Services
  - Due Diligence, RI/FS, PCR
  - Brownfields Redevelopment—Investigation, Remediation, Program Management
  - Phase I, Phase II Environmental Site Assessments
  - NYC E-Designated Sites
  - NYC OER Program Management—Investigations, Remediation, Grant Application
  - Cost Estimating—Property Investigation & Remediation
- Environmental Audits—Assess Environmental Liability
- Environmental Assessment & Contaminant Source Evaluation
- Groundwater Investigation & Remediation
- Aquifer/Pumping Testing
- Risk-Based Approach Solutions
- Site Closure Reports
- UST/AST Management
- Air, Water, Soil & Soil Vapor Sampling/Monitoring Community Air Monitoring
- Environmental & Health Risk Assessment
- Radiological Investigation & Remediation Services
- Hazardous Waste Management
- Soil Management, Certified Clean Fill
- Storm Water Management
- Water Table Evaluation & Flood Mitigation
- Dewatering Design, Permitting & Compliance Sampling

## Environmental Compliance/Management

- Air Quality—Title V Permitting, Air Emission Inventories, Tier II & TRI Reporting
- Articles XI & 12 Hazardous Materials Storage Compliance for Nassau & Suffolk Counties, NY
- Chemical/Petroleum Bulk Storage Tanks—Permitting, Audits, Regulatory/Environmental Compliance Management
- Facilities Contingency Plan Development/Management, including SPCC, SWPPP, FRP
- Compliance Review
- Regulatory Compliance Reporting
- FAR 139.321 Fire Safety Inspections
- Fuel Storage Facilities & Mobile Fuel Equipment

## Wastewater/Water Supply

- Water Supply/Wastewater—Systems, Planning, Design
- Groundwater Modeling
- Site/System/Feasibility Evaluation, Planning & Technical Assistance
- Water Conservation Plan Development

## Expert Counseling/Client Representation

- Expert Testimony, Support & Counsel

## Natural Resource Studies

- Wetlands Delineation, Permitting & Mitigation Design
- Threatened & Endangered Species Surveys
- Migratory Studies
- Ecological Studies
- Ecological Risk Assessments
- National Environmental Policy Act (NEPA) Studies
- Planning
- Watershed Analysis

## Energy/Sustainability Solutions

- Geothermal System Feasibility Analysis, Design, Permitting & Construction Management
- Renewable Energy Design for Solar & Wind
- Carbon Footprint Analysis, Profile & Management
- Alternative Fueling Station Planning & Design, Equipment Specification, Construction Observation, Permitting, Compliance & Facility Commissioning for Compressed Natural Gas, Hydrogen, Biodiesel & Ethanol-85
- Building Due Diligence & Energy Studies
- LEED Administration & Sustainable Design Practices
- High Performance Sustainable Buildings
- Energy Conservation & Energy Recovery Alternatives
- MEP/High Efficiency Equipment Solutions
- Power Generation, Cogeneration & Fuel Cells
- Energy Modeling, Utility Rebate Programs & Tax Incentives
- Green Legislation & ARRA Stimulus Grants
- GIS Based Modeling for Wind, Solar & Carbon Footprint Analysis

## Civil/General Engineering

- “Best Economic Alternatives” Evaluation
- Comprehensive Feasibility Studies
- Conservation Plan Development
- Construction Planning, Management, QA/QC
- Drainage Planning, Grading & Design
- Evaluation, Planning & Technical Assistance
- Facility Design & Condition Assessment
- Planning & Design
- Property Condition Report

## Geographical Information Systems/ Global Position Systems

- Data Collection & Conversion
- Infrastructure & Asset Management
- Wetlands & Endangered Species Delineation
- Digital Elevation Model Analysis
- Customized GIS Applications, GIS/CAD Integration
- Database Development, Conversions, Manual Digitizing
- Website development
- GPS Field Data Collection & Post-Processing
- Remote Sensing & Image Processing





# GEOTHERMAL DESIGN & CONSULTING SERVICES

## Subsurface Conditions Due Diligence

- Published US Geological Survey geologic/hydrogeologic data review
- Site-specific data review, e.g., environmental and geotechnical investigations
- PWGC in-house records review, nearby prior projects
- Consult with local drilling firms
- Proximity to water tunnels, major utilities/easements, rail/subway tunnels, etc.

## Feasibility Study

- Evaluate ground coupling options – open loop wells, closed loops, standing column wells, ponds, energy piles and foundations, ATES and BTES
- Evaluate configurations – individual buildings, campus/district heating and cooling, integration with other renewables (PV, solar thermal, ice, CHP, etc.)
- Conceptual well and/or loop field layouts
- Potential site constraints and limitations, constructability
- Typical operation and maintenance
- Applicable permits, filings, and notifications
- Project logistics and scheduling
- Construction costs, economic and financial analysis
- Utility rebates and tax credits
- Field testing recommendations

## Design

- Well/loop-side system design, coordination with project architect, MEP and other consultants
- Prepare coordinated construction documents
- Cost estimating support

## Field-Testing Programs

- Arrange and implement field-testing programs
- “Piggyback” geothermal testing with geotechnical and environmental drilling programs
- Open loop test wells and pumping tests
- Groundwater sampling and testing
- Groundwater modeling
- Closed system test loop installation and ground thermal testing
- Data analysis and report preparation

## Environmental Due Diligence

- Existing Phase I/II environmental reports review
- Order/review updated environmental database search report and Sanborn maps
- Potential for encountering contaminated groundwater
- Potential for contaminated drill spoils, i.e., disposal cost premiums

## Filings and Notifications

- USEPA “Authorization by Rule”
- NYSDEC Division of Mineral Resources drilling permit
- NYSDEC Division of Water Long Island Well permit
- NYCDEP sewer discharge permit
- NYCDEP approval to drill near public water supply facilities (e.g., water tunnels)
- MTA, PANYNJ, LIRR, etc. approvals to drill in proximity to rail/subway lines
- NYCDOT Revocable Consent for sidewalk wells/loops
- NYCDOT sidewalk/street closing permits support

## Construction Administration

- Identify qualified drilling contractors
- Coordinate pre-bid inspection
- Review/comment on bids, recommend contractor selection
- Review/comment on shop drawings
- Review/respond to RFI’s
- Review/prepare as-built drawings

## Field Inspection during Construction

- Drilling/well and loop field construction inspection
- Document geologic/hydrogeologic conditions
- Monitor compliance with permit conditions
- Coordinate required field data reporting to agencies
- Coordinate/collect baseline groundwater samples and pump test (hydraulic) data
- Coordinate between mechanical engineer and drilling contractor
- Inspect borehole “drift” monitoring by specialty subcontractor
- Oversee/coordinate vibration and noise monitoring, if required
- Oversee/coordinate noise monitoring, if required
- System Installation/Final Engineering report

## System Start-Up and Commissioning

- System charging, disinfection, start-up and balancing support
- Coordinate hydraulic and thermal capacity testing
- Well-side system commissioning
- Operation and Maintenance manual preparation and training

## Operation and Maintenance

- Monitor system performance
- Troubleshoot operating systems
- Diagnose well problems and performance
- Develop system corrective actions and well rehabilitation programs



## GEOTHERMAL CONSULTING PROJECT MATRIX (JUNE 2019)

FACILITY	LOCATION	USE	NO. YEARS OPERATING (APPROX.)	PWGC DESIGN ++	LEED PROJECT	SYSTEM CAPACITY (FLOW FOR OPEN LOOP)	FEASIBILITY/ PLANNING				DESIGN/FIELD TESTING						CONSTRUCTION						OPERATION & MAINTENANCE																		
							Feasibility Study	Subsurface Due Diligence	Hydrogeological Analysis	Groundwater Investigation	Design	Design Consult	Design Peer Review	Cost Estimating	Test Loop & Thermal Testing	Test Well Coordination	Groundwater Sampling	Pump Test	Groundwater Modeling	Permit/Filing Support	Regulatory Agency Liaison	Bidding Support	Contractor Negotiation	Construction Consultation	Construction Administration	Construction Oversight	Groundwater Testing	Start-Up and Balancing	O&M Support	Existing System Assessment	Troubleshooting	Develop Corrective Actions	Video Logging	Well Rehabilitation							
OPEN LOOP																																									
New York Institute of Technology	Old Westbury, NY	7 New Bldgs (dorms and Student Center)	--	✓		1800 gpm	✓	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓																				
Amneal Pharmaceuticals **	Brookhaven, NY	Manufacturing	5	✓	✓	3600 gpm	✓	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓																
NSLIJ - Glen Cove Hospital **	Glen Cove, NY	Hospital - 10 Buildings	50+	✓		650 gpm & 180 gpm	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Pratt Institute	Brooklyn, NY	Administrative Offices			✓	200 gpm	✓	✓	✓	✓																															
C.W. Post College **	Brookville, NY	Administrative Buildings	10+	✓		320 gpm	✓	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓																
Hofstra University ##	Uniondale, NY	Dormitories, Student Center				250 gpm																				✓	✓	✓													
Brooklyn Children's Museum (NYCDDC) **##	Brooklyn, NY	Museum	10		✓	420 gpm			✓	✓			✓			✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Queens Botanical Garden (NYCDDC) **##	Queens, NY	Administrative Offices, Events	10		✓	150 gpm			✓	✓	✓		✓					✓					✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Brooklyn Navy Yard - Bldg 92 **	Brooklyn, NY	Offices	7	✓	✓	140 gpm	✓	✓	✓	✓	✓				✓	✓	✓		✓	✓	✓	✓	✓	✓																	
Ford Motors Corp.	Dearborn, MI	Auto Manufacturing	--			--			✓																																
Ross School **	East Hampton, NY	Field House	12+	✓	✓	54 gpm					✓	✓																													
Ross School - Buildings 2 & 5 **	East Hampton, NY	Offices, Classrooms	8+	✓	✓	500 gpm & 250 gpm	✓	✓	✓		✓		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓																
Clark Art Institute - New Visitor, Exhibition and Conference Center **##	Williamstown, MA	Museum	5+		✓	550 gpm			✓	✓	✓		✓			✓	✓	✓				✓			✓	✓													✓		
Clark Art Institute - Stone Hill Conservation Cntr **##	Williamstown, MA	Environmental Education, Offices	7		✓	340 gpm			✓	✓			✓													✓	✓														
Macy's Bay Shore Mall **##	Bay Shore, NY	Retail	10+			1,100 gpm																				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Macy's Broadway Mall **##	Hickville, NY	Retail	10+			1,100 gpm			✓		✓		✓			✓										✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
40 Meadow Lane **	Southampton, NY	Private Residence	3+	✓		45 gpm	✓	✓	✓	✓	✓				✓	✓			✓	✓		✓	✓																		
151 Ocean Road	Bridgehampton, NY	Private Residence	--	✓		40 gpm	✓	✓	✓	✓																															
Suffolk County Community College	Brentwood, NY	Library	--		✓	200 gpm	✓	✓	✓	✓																															
Eastport/South Manor School District **	Eastport, NY	New K-12 School	--	✓	✓	400 gpm	✓	✓	✓	✓	✓		✓	✓		✓	✓			✓	✓		✓	✓																	
62 Further Lane **	East Hampton, NY	Private Residence	2+	✓		100 gpm	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓																			
628 Lumber Lane	Bridgehampton, NY	Private Residence	In Construction	✓		60 gpm	✓	✓	✓	✓	✓		✓							✓	✓		✓	✓	✓	✓															
Standard Microsystems **##	Hauppauge, NY	Manufacturing	10+			600 gpm			✓		✓		✓							✓	✓		✓	✓	✓	✓	✓														
New Lane Elementary School **##	Coram, NY	School Building	10+			600 gpm																				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Citibank **##	Melville, NY	Commercial	10+			325 gpm																				✓															
All Systems **	Deer Park	Manufacturing	10+			2,650 gpm	✓		✓																																
Loeb Residence	East Hampton, NY	Private Residence	--			90 gpm	✓		✓	✓	✓		✓			✓							✓																		
St. Joseph's Church	Brooklyn, NY	Worship	--			550 gpm	✓	✓	✓																																
Private Residence **	Ovid, NY	Private Residence	8+			50 gpm																				✓	✓	✓													
Kensington Public Library (NYCDDC)	Brooklyn, NY	Library	--		✓	200 gpm			✓		✓															✓															
Underwriters Laboratories, Inc. ##	Melville, NY	Offices, Laboratory	--			300 gpm	✓		✓		✓		✓													✓															
St. Stanislaus Church	Brooklyn, NY	Worship	--			100 gpm	✓		✓																																

FACILITY	LOCATION	USE	NO. YEARS OPERATING (APPROX.)	PWGC DESIGN ++	LEED PROJECT	SYSTEM CAPACITY (FLOW FOR OPEN LOOP)	FEASIBILITY/PLANNING				DESIGN/FIELD TESTING						CONSTRUCTION						OPERATION & MAINTENANCE						
							Feasibility Study	Subsurface Due Diligence	Hydrogeological Analysis	Groundwater Investigation	Design	Design Consult	Design Peer Review	Cost Estimating	Test Loop & Thermal Testing	Test Well Coordination	Groundwater Sampling	Pump Test	Groundwater Modeling	Permit/Filing Support	Regulatory Agency Liaison	Bidding Support	Contractor Negotiation	Construction Consultation	Construction Administration	Construction Oversight	Groundwater Testing	Start-Up and Balancing	O&M Support
<b>CLOSED LOOP</b>																													
Cornell NYC Tech Campus **	Roosevelt Island, NY	New Academic Building	2	✓	net zero	400 tons	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓		✓	✓						
Staten Island Museum (NYCDDC) **	Staten Island, NY	Museum	6	✓	✓	225 tons	✓	✓			✓		✓						✓		✓	✓							
Weeksville Heritage Center (NYCDDC) **	Brooklyn, NY	Educational Center/Museum	7	✓	✓	90 tons	✓	✓			✓		✓						✓	✓	✓	✓							
FDNY Fire & Rescue Facility (NYCDDC)	Brooklyn, NY	Fire Department	In Construction	✓	✓	225 tons	✓	✓			✓		✓								✓	✓							
Arlington Library (NYCDDC)	Brooklyn, NY	Public Library	--		✓	35 tons	✓	✓																					
Suffolk County Community College STEM Center	Brentwood, NY	School Building	Design Complete	✓	✓	225 tons	✓	✓			✓										✓	✓							
Bridgehampton School	Bridgehampton, NY	K-12 School	In Construction	✓	✓	225 tons	✓	✓			✓		✓	✓							✓	✓							
Suffolk County Dept. of Public Works - Board of Elections Building	Yaphank, NY	Offices	--	✓		80 tons	✓	✓			✓		✓	✓					✓	✓									
Brooklyn Botanic Gardens **	Brooklyn, NY	New Visitor's Center	9+		✓	60 tons				✓																			
Lamont Hall Geological Observatory	Palisades, NY	Special Venues	--			65 tons	✓	✓	✓																				
Con Edison Sherman Creek Workout Center	Manhattan, NY	Maintenance Facility	--			110 tons	✓	✓					✓																
Adelphi University **##	Garden City, NY	Performing Arts/Sports Complex	10+			700 tons																		✓	✓	✓			
Hewlett High School **##	Hewlett, NY	Public School	15+			35 tons																		✓	✓	✓			
Beach Green Dunes Phase II	Far Rockaway, NY	Multifamily Affordable Housing	In Construction		✓	150 tons							✓																
1240 Meadow Lane **	Southampton, NY	Private Residence	3+	✓		30 tons	✓	✓			✓										✓	✓							
1100 Flying Point Road **	Southampton, NY	Private Residence	3+	✓		21 tons	✓	✓			✓																		
1616 Whitestone Expressway	Queens, NY	New Union Headquarter's	--	✓	✓	100 tons	✓	✓			✓		✓																
Cow Neck Farm **	Southampton, NY	Private Residence	8+	✓		40 tons	✓	✓	✓		✓		✓						✓		✓	✓							
Bear Mountain ##	Upstate, NY	Ski Lodge, Cabins	10+			Coils	✓			✓																			
<b>STANDING COLUMN WELL SYSTEMS</b>																													
St. Patrick's Cathedral **	Manhattan, NY	Worship, Offices	2+	✓		10 wells	✓	✓			✓		✓						✓	✓	✓								
City of Cambridge Dept. of Public Works - City Hall Annex **##	Cambridge, MA	City Offices	8+			3 wells	✓	✓	✓	✓	✓		✓						✓	✓		✓	✓	✓					
Columbia University Bowtie Bldg Manhattanville Campus	Manhattan, NY	Offices, Events	--			10 wells	✓	✓																					
General Theological Seminary **##	Manhattan, NY	Dormitories, Hotel, Offices	10+			7 wells							✓						✓	✓		✓	✓						
Columbia University Knox Hall **	Manhattan, NY	Offices, Classrooms	8+		✓	4 wells													✓		✓								
745 Fox Street **##	Bronx, NY	Condominium Building	6+			5 wells																		✓	✓	✓			
Garito Manor **##	New Rochelle, NY	Assisted Living Facility	15+			5 wells																		✓	✓	✓			
Bowdoin College Walker Art Museum ##	Brunswick, ME	Museum	--		✓	4 wells																		✓					
University of Baltimore Law School	Baltimore, MD	Offices, Classrooms	--		✓	1 well	✓	✓		✓									✓		✓								
Fort Ticonderoga Mars Education Center **##	Ticonderoga, NY	Museum	12+		✓	3 wells																	✓						
Google Building	Manhattan, NY	Commercial	--			10 wells	✓	✓																					
Battery Park City Parks Conservancy (in "Visionaire" residential tower)	Manhattan, NY	Institutional, Offices	--		✓	2 wells																	✓	✓					
471 Washington Street	Manhattan, NY	Condominiums	--			3 wells													✓		✓	✓							
250 Bowery	Manhattan, NY	Hotel	--			5 wells													✓	✓	✓								
Bronx Zoo Lion House (NYCDDC) ##	Brooklyn, NY	Exhibit Space	--		✓	5 wells																		✓	✓				
Front Street ##	Manhattan, NY	Residential, Commercial	--			10 wells	✓																✓	✓	✓				
Yonkers Housing Authority Flynn Manor	Yonkers, NY	Apartments	--			7 wells		✓																					
Staten Island Mental Health Society **	Staten Island, NY	Offices	8+		✓	2 wells							✓												✓	✓			

FACILITY	LOCATION	USE	NO. YEARS OPERATING (APPROX.)	PWGC DESIGN ++	LEED PROJECT	SYSTEM CAPACITY (FLOW FOR OPEN LOOP)	FEASIBILITY/ PLANNING				DESIGN/FIELD TESTING						CONSTRUCTION					OPERATION & MAINTENANCE									
							Feasibility Study	Subsurface Due Diligence	Hydrogeological Analysis	Groundwater Investigation	Design	Design Consult	Design Peer Review	Cost Estimating	Test Loop & Thermal Testing	Test Well Coordination	Groundwater Sampling	Pump Test	Groundwater Modeling	Permit/Filings Support	Regulatory Agency Liaison	Bidding Support	Contractor Negotiation	Construction Consultation	Construction Administration	Construction Oversight	Groundwater Testing	Start-Up and Balancing	O&M Support	Existing System Assessment	Troubleshooting
<b>SPECIALTY GEOTHERMAL PROJECTS</b>																															
New York City Geothermal Heat Pump Manual Update, for NYC Department of Design and Construction	Co-authored "go to" resource for evaluating, designing, and constructing geothermal systems in New York City and other urban locations. Published 2013. <a href="http://www1.nyc.gov/assets/ddc/downloads/Sustainable/GeothermalHeatPumpManual.pdf">http://www1.nyc.gov/assets/ddc/downloads/Sustainable/GeothermalHeatPumpManual.pdf</a>						✓	✓																							
New York City Geothermal Screening Tool , for NYC Mayor's Office and Department of Design and Construction	Member of consultant that developed a web-based screening tool required by NYC Local Law 6 of 2016. PWGC developed geologic maps with geothermal capacity in GIS for various site conditions that was integrated into the tool. <a href="http://www1.nyc.gov/assets/ddc/geothermal/index.html">http://www1.nyc.gov/assets/ddc/geothermal/index.html</a>						✓	✓	✓																						
Contributor to Renewable Heating and Cooling Framework Document, for NYSERDA	Researched geothermal market and barriers, and developed baseline construction and operating costs for closed loop geothermal systems throughout New York State. Recommended certain incentives and actions for NYS to accelerate the geothermal market.																	✓													
Geothermal Feasibility Studies for 4 Recreation Facilities, for Town of Brookhaven, Long Island, NY	Developed schematic layouts and cost-benefit analysis for conversion of 4 existing recreational buildings to geothermal.						✓	✓																							
Campus Geothermal Conversion Due Diligence and Feasibility Analysis, for Fordham University and MEP Assoc., Inc.	Assessed subsurface conditions and feasibility of a full campus conversion to open type geothermal systems, aka, standing column wells and open loop systems.						✓	✓	✓																						
Geologic Mapping for Geothermal Feasibility, for Google(X)	Researched and integrated into GIS state and U.S. Geological Survey surficial geologic mapping for 10 states in the U.S. Compiled regulatory agency website links to publicly-available, on-line geologic and well data records.						✓	✓																							
Geologic Mapping for Aquifer Thermal Energy Storage (ATES) System Feasibility and Screening Tool, for Dutch Consulate of New York	Performed geologic mapping of aquifers suitable for ATEs systems throughout New York State and the Maryland-Washington,D.C.-Northern Virginia metropolitan area. Developed system to rank suitability based on aquifer properties and mapped the ranking in GIS for integration into a web-based screening tool by the client.						✓	✓	✓																						
Technical Support for ATEs Feasibility Studies, for Dutch Consulate of New York	Performed subsurface conditions due diligence and feasibility analysis of using geothermal ATEs systems for two large development projects, one on Long Island (Wyandanch Rising-new YMCA/Health Center) and one along the Brooklyn waterfront (confidential client).						✓	✓	✓		✓											✓									
Energy Piles Feasibility Study, for Con Edison	Performed feasibility analysis of using energy piles, i.e., installation of closed loop piping in structural building piles in place of drilling geothermal boreholes, to provide heating and cooling for a new Con Edison Service Center in Manhattan, NYC.						✓	✓																							
NYPA Geothermal Energy Challenge Applications, for NYCHA tenant organizations	Applied successfully on behalf of tenant organizations for three NYCHA public housing developments in Harlem, NYC, to enter into the NYPA Geothermal Energy Challenge; all three facilities were accepted and completed Stage 1.						✓																								
Wyandanch Rising Feasibility Study, for Town of Babylon	Performed feasibility analysis of several geothermal system options (open loop, closed loop, and ATEs) for a large mixed-use, transit-oriented development on Long Island.						✓	✓	✓		✓																				

Notes:  
**\*\* Operating systems**  
 ++ Ground Heat Exchanger designed by PWGC (in conjunction with mechanical engineering consultant)  
 ## PWGC role included review of original design (BY OTHERS), forensics analysis, identification of issues and recommendation of corrective measures, and/or re-designed portions of system to address issues.



An aerial photograph of a construction site in an urban area. The site is surrounded by existing buildings and a street with parked cars. In the center, there is a large excavation pit with a yellow concrete mixer truck and other construction equipment. A blue graphic overlay with concentric circular patterns is at the bottom of the image.

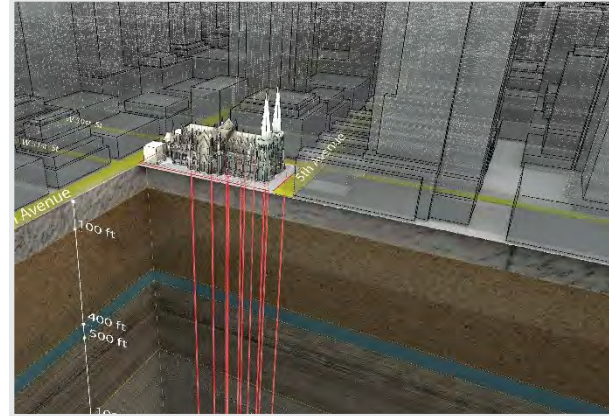
# GEOHERMAL SYSTEMS SUSTAINABLE TECHNOLOGY



## INTRODUCTION TO GEOTHERMAL SYSTEMS

For more than 29 years, PWGC, an experienced environmental engineering firm, has specialized in the application of geothermal technology in the commercial, institutional, educational and high-end residential market segments. Founded by thought leader Paul W. Grosser, PhD., PE, PG, and Executive Chairman, PWGC has developed a well-honed approach to assessing and designing geothermal solutions for properties that benefit both the client and the environment.

Given the growing focus on environmental responsibility, geothermal technology is coming to the fore and represents one of PWGC's most important market segments. As a result, the firm's geothermal practice is led by some of the firm's senior and most experienced members, including President/CEO Paul Boyce, PE, PG, and John Rhyner, PG, LEED AP, Vice President of Geothermal Services, whose real world experience applying geothermal technologies gives PWGC the required perspective to deliver designs that can meet the most stringent development requirements. PWGC has designed and developed a wide variety of geothermal systems ranging in size from



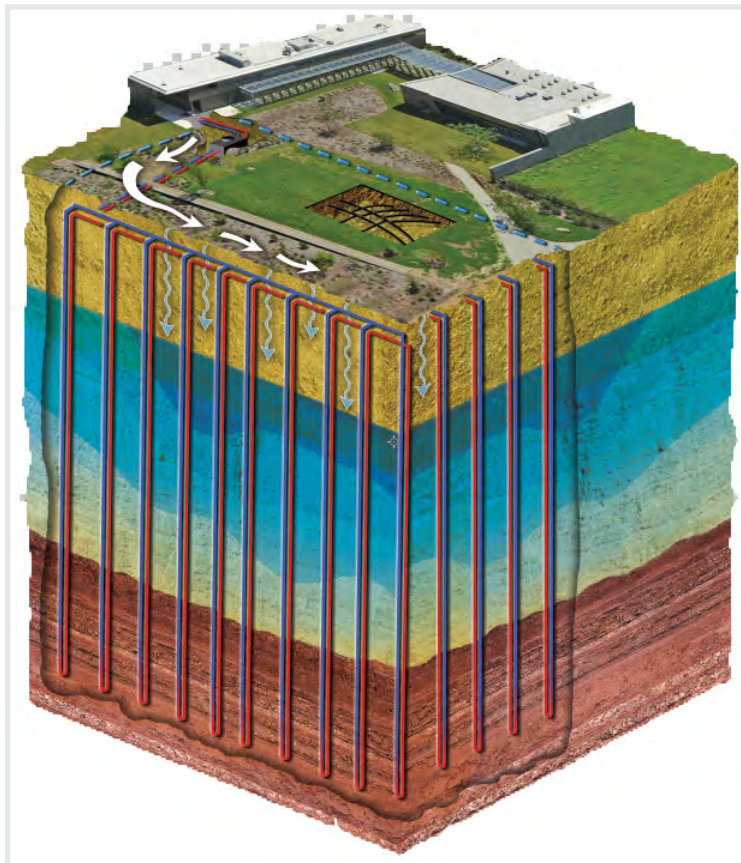
small commercial sites to campus-scale projects for the public and private sector.

### What is a Geothermal Heat Pump (“GHP”) System?

A GHP taps into the massive reservoir of thermal energy stored in the earth beneath us, derived predominantly from the sun, to efficiently heat and cool a building interior. A GHP consists of one or more geothermal (technically “ground source”) heat pumps used in conjunction with a buried ground heat exchanger (loops or wells). This single mechanical system replaces the boilers and central air conditioning units of a conventional HVAC system.

### Benefits of GHP Systems

Ground-source heat pump technology is an established, although often overlooked, HVAC option towards achieving greater energy efficiency and reducing our dependence on foreign oil. Buildings account for over 40 percent of the total energy used throughout the world, and the greatest portion of energy use in buildings is for heating and cooling. The United States Environmental Protection Agency and Department of Energy have concluded that a GHP is the most energy efficient, environmentally-clean, and easy to maintain heating and cooling system on the market today. Multiple studies have shown they have the lowest life-cycle cost of all other HVAC systems. With demonstrated high efficiencies come lower utility bills, on the order of 30 percent to more than 50 percent reduction over a conventional HVAC system, and elimination of on-site fossil fuel use and carbon emissions. Other benefits include elimination of noisy chillers, cooling towers and furnaces; reduced mechanical room size; supreme climate and dehumidification control; no visible outdoor equipment and contribution towards achieving points towards LEED certification.



## THE PWGC APPROACH AND LEADING INDUSTRY EXPERTISE

### The PWGC Approach

PWGC recognizes that every development project has its own identity and each geothermal application is unique, depending on client objectives, site conditions and regulatory environments. Our approach to each assessment is based on extensive discourse with the client to ensure that each geothermal design will meet their heating and cooling objectives. A GHP may not be a good fit at every site and there are many things to consider. That is where PWGC comes in. Our services include timely upfront due diligence and feasibility analysis that allows our clients to make an informed decision whether or not to pursue a GHP system and, if so, what type of ground heat exchanger to use. PWGC's services include filings and planning, cost analysis, field-testing programs, modeling, design, construction management, system start-up, and developing maintenance programs.

### PWGC an Industry Leader

PWGC's know-how has enabled us to be selected to work on a host of influential geothermal projects in the New York Metropolitan Region including St. Patrick's Cathedral HVAC retrofit to geothermal, the planned President Barack Obama Library and Museum in Chicago, Cornell University's flagship building, the Bloomberg Center, at its NYC Tech Campus on Roosevelt Island, and the NYC Department of Design and Construction Geothermal Heat Pump Manual.

PWGC believes that greater deployment of geothermal technology is necessary to help achieve the very aggressive goals for increased energy efficiency and reduced greenhouse gas emissions set by New York City, New York State and other states. To that end, PWGC has played a significant advocacy role at all levels of government. Some of the firm's activities and accomplishments include:

- Founding member, Long Island Geothermal Energy Organization (LI-GEO) established in 2012
- Charter member of the New York State Geothermal Energy Organization (NY-GEO) established in 2014
- Advisor to NYC City Council on drafting language for two geothermal bills to advance and facilitate use of geothermal technology in the city: Int. 694-A (registered as Local Law 32 of 2013) and Int. 609-A (Local Law 6 of 2016)
- Member, advisory committee to NYSERDA's Renewable Heating and Cooling department
- IGSPHA geothermal designer trainer (open loop systems)
- NYSERDA certified GSHP rebate contractor
- Contributor, NYSERDA Renewable Heating and Cooling Framework Document
- Co-author, NYC Geothermal Heat Pump System
- Co-consultant, NYC web-based Geothermal Feasibility Screening Tool
- Former committee member, joint ANSI/CSA C448 Series 16 North American GSHP Design and Installation Standards
- Member, Urban Green Advancing Electrification Advisory Committee (U.S. Green Building Council NYC Chapter)
- Author, uniform geothermal code promulgated by the Suffolk County Planning Commission.
- Advisor to various NYC agencies, including the Mayor's Office, Office of Sustainability and the NYC Economic Development Corporation, regarding the viability of greater deployment of geothermal technologies within the five boroughs.
- Author, the geothermal chapter for the Long Island Groundwater Resources Management Plan for Long Island's bi-County (Nassau and Suffolk Counties) Commission on Aquifer Protection (LICAP).

Our exceptional personnel and experience give PWGC's clients the foresight to make well-informed decisions to allow their projects to move from the realm of ideas to reality. PWGC is at the cutting edge of the growing geothermal industry, and can lead you through each step towards evaluating, choosing and implementing the technology at your project site.



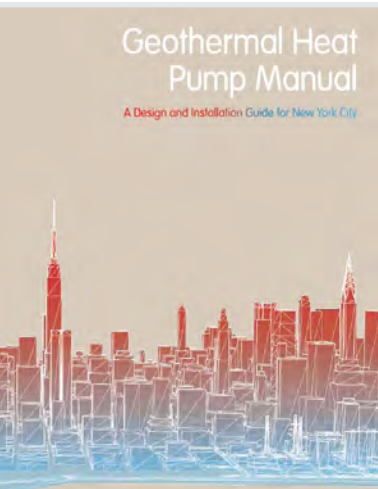


## PWGC GEOTHERMAL HEAT PUMP SYSTEM PROJECT EXPERIENCE

### Standing Column Well Geothermal System - St. Patrick's Cathedral, Manhattan, NY

In 2015, the Archdiocese of New York City completed major restoration of St. Patrick's Cathedral, Manhattan, NYC, and replacement of the facility's heating and cooling plant with a geothermal system. Since 2009 PWGC has served as geothermal consultant to the Archdiocese, participating in feasibility analysis and screening of the geothermal options. The Archdiocese selected a geothermal system due to many significant benefits over a conventional HVAC system including eliminating use of steam heating and energy-intensive chillers, more favorable life-cycle costs, and more in line with the church's goal of increased environmental stewardship.

PWGC served as the design engineer for the "well side" of the HVAC system, which included a 10-well standing column well system that supplies the entire base load of the cathedral and adjoining buildings. PWGC also provided construction administration during the drilling phase and construction support during installation and testing of the horizontal supply and return piping, and interior equipment including the well manifolds, filters, and controls. PWGC negotiated on behalf of the Archdiocese with the New York State Department of Environmental Conservation (NYSDEC) Division of Mineral Resources for a reduction in the frequency of disruptive borehole drift monitoring required by the agency to ensure drilling does not pass beneath adjoining properties. The system has operated since the summer of 2016 to the full satisfaction of the Archdiocese.



### New York City Geothermal Heat Pump Manual

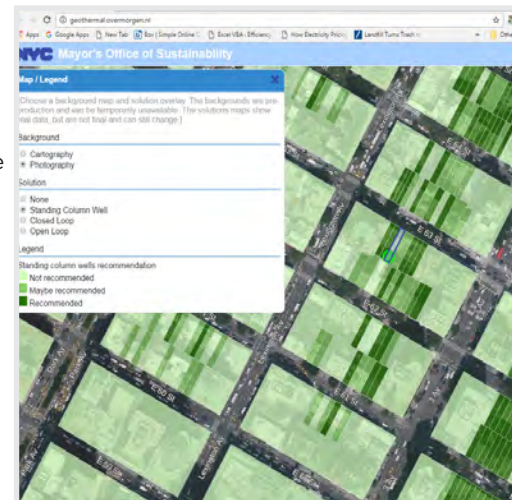
The New York City Department of Design and Construction (NYCDDC) has been the pioneer in evaluating and developing geothermal projects in the five (5) boroughs for nearly 15 years, and PWGC staff have assisted them over this entire time span. Besides designing new systems for NYCDDC and troubleshooting existing systems designed by others, NYCDDC selected PWGC in 2011 to re-write its Geothermal Heat Pump Manual, originally published in 2002. The Manual is a "how to" document that quickly became, and remains today, a well-referenced standard for the industry, both locally and nationally. The updated manual was published in 2013 and is available online at:

<http://www1.nyc.gov/assets/ddc/downloads/Sustainable/GeothermalHeatPumpManual.pdf>

### Web-Based Geothermal Feasibility Screening Tool, New York City

PWGC served on a consultant team working for the NYC Mayor's Office of Sustainability (MOS) and NYCDDC to develop a publicly available, web-based geothermal feasibility screening tool for the five (5) boroughs. The tool was required by Local Law 6 of 2016 as part of the city's "80 by 50" initiative to improve energy efficiency of its building stock and reduce greenhouse gas emissions. PWGC's role was to develop geologic maps in GIS format to integrate into the tool and to map areas in the city where geothermal systems are geologically and technically suitable. The tool can be accessed at:

<http://www1.nyc.gov/assets/ddc/geothermal/index.html>



## PWGC GEOTHERMAL HEAT PUMP SYSTEM PROJECT EXPERIENCE

### **Innovative Geothermal System - First Academic Building (FAB), Cornell University (Cornell NYTech)**

PWGC was selected by Cornell University to develop a unique geothermal well system to serve the first building constructed for Cornell's Technology-Focused Campus ("Cornell NYTech") on Roosevelt Island, New York, NY. The Bloomberg Center is a science education and research facility of approximately 150,000 square feet with a peak (dominant) cooling load of approximately 300 tons and a goal of Net Zero Energy usage.

PWGC designed an 80-loop borefield using highly-efficient un-grouted ("groundwater filled") boreholes connected to modular reversible chillers in the building's mechanical plant, and with the ability to pump groundwater from the boreholes during peak heating and cooling periods. This "annulus pumping" moderates entering water temperatures to the chillers thus provide higher overall HVAC system efficiencies, and reduced run time by the more energy intensive supplemental cooling tower. This is believed to be the first use of this technique globally.

For Cornell, PWGC completed the original site investigation to test the concept including installation and hydraulic and thermal testing of three boreholes. The PWGC team was subsequently selected by Cornell to prepare final design. Construction was completed in 2015 and the system has operated to the Client's complete satisfaction since startup.



### **Geologic Mapping for Geothermal Feasibility, Google(X)**

"X", the research arm of Google, identified geothermal systems as a potentially transformative technology worth vetting for mass adoption. One of X's main objectives was to evaluate methods to install ground heat exchangers (GHXs) much quicker than the industry standard. Reduced on-site drilling time and loop installation should naturally translate to lower costs and greater uptake of technology. X engaged PWGC to research surficial geologic conditions for 10 states in the U.S., including all New England, New York, New Jersey, Delaware, Minnesota, and Iowa. PWGC compiled state and U.S. Geological Survey surficial geologic maps in GIS, culled the data relative to the Client's objectives, and developed GIS layers of the various mapped geologic formations matched to the relative ease of installation of GHXs. PWGC also compiled regulatory agency website links and publicly available, online geologic and well data records.

### **Geologic Mapping and Feasibility Analysis for Aquifer Thermal Energy Storage (ATES) Systems and Long Island Development Sites, Dutch Consulate of New York City**

As part of its business-to-business program with the United States, the Dutch government is promoting the use of an innovative geothermal technology that Dutch geologists and engineers have developed in the Netherlands. Specifically, Aquifer Thermal Energy Storage (ATES) is a seasonally-reversible open loop-type GSHP with extremely high demonstrated efficiencies. The technology is being marketed by a group of Dutch firms operating collectively as the Dutch ATES Consortium. PWGC has been working with the Consortium for more than 10 years in their efforts locally.

Under contract to the Dutch Consulate of New York City, PWGC performed geologic mapping of aquifers suitable for ATES systems throughout New York State and the Maryland-Washington, D.C.-Northern Virginia metropolitan area. PWGC developed a system to rank ATES suitability based on aquifer properties and mapped the ranking in GIS for integration into a web-based screening tool by the client. Separately, PWGC is providing technical support for ATES feasibility studies at two (2) large development projects, one on Long Island (Wyandanch Rising-new assisted living facility/YMCA/Health Center) and one along the Brooklyn waterfront (confidential client). For both sites, PWGC performed subsurface conditions due diligence relative to the use of ATES systems.

### **Amneal Pharmaceuticals Plant Expansion - Bellport, NY**

The 265,000-square-foot Amneal Pharmaceuticals Plant Expansion in Bellport, New York, was designated a "Transformative Project" by the LI Regional Economic Development Council, which would foster regional sustainability and was projected to create 400 new local jobs, retain 752 jobs, and spur local economic growth. PWGC was engaged by Amneal to design, coordinate filings for well permits and oversee construction of an open loop geothermal well field for interior space cooling and process cooling for the existing building and expansion. PWGC initially performed field testing of groundwater quality to verify suitability for an open loop ground coupling, and subsequently designed a 12-well, 3,600-gallons-per-minute capacity well system.

Groundwater hydraulic and thermal modeling was performed to demonstrate that operating the well field would not present significant negative environmental impact on two nearby Suffolk County Water Authority well fields, to the satisfaction of the SCWA and NYSDEC. PWGC prepared engineering design and construction documents and provided full range of construction administration and field inspection services throughout construction.



## PWGC GEOTHERMAL HEAT PUMP SYSTEM PROJECT EXPERIENCE

### Campus Geothermal Systems - The Ross School

The Ross School is a private school, grades 5-12, located in East Hampton, New York. Ross School has progressively expanded their campus over the past several years to include multiple academic and administrative facilities. Since 1998, PWGC has provided master planning and comprehensive project management services as site/civil engineer for all these improvements.

PWGC initially analyzed use of a campus-wide open loop geothermal system to serve the entire Ross School campus with centralized heating and cooling. PWGC subsequently designed open loop geothermal well systems to serve the heating and cooling demand for three buildings, utilizing the site's unique geologic conditions to maximize its geothermal potential. PWGC managed all project aspects from initial planning to completion and start up, including regulatory permitting, two-dimensional groundwater modeling to assess anticipated effects on the local water table, design of the well field and controls, and construction administration and field oversight. PWGC prepared the O&M manuals for the project and continues to provide guidance on system operation and periodic maintenance activities.

All three (3) systems have been operating to the client's full satisfaction.

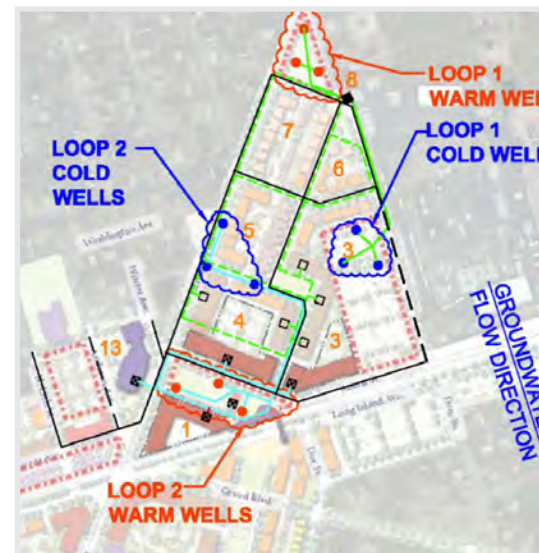
### Geothermal Feasibility Studies for Four (4) Recreation Facilities, Town of Brookhaven, Long Island, New York

The Town of Brookhaven is at the forefront of municipalities on Long Island that are dedicated to improving energy efficiency and reducing GHG emissions at their facilities. In 2018, the Town engaged PWGC to perform a study on the feasibility of implementing geothermal heat pump systems at four (4) Town recreation centers. The study included feasibility analysis with respect to numerous considerations, from suitability of hydrogeologic conditions, proximity to public drinking water supply wells, age of existing conventional equipment, and amount of available outdoor land for drilling, through performing 20-year life-cycle cost benefit analysis for converting to geothermal versus maintaining the existing systems. PWGC developed schematic layouts for two (2) type of geothermal systems: open loop wells and vertical closed loop boreholes. Geothermal O&M cost savings and CO<sub>2</sub> emissions reductions that could be averted after 20 years were calculated and presented.

### District Geothermal System & Microgrid Feasibility & Schematic Design - Wyandanch Rising Development, Wyandanch, NY

Several innovative sustainability initiatives implemented by the Town of Babylon, located on Long Island, New York, have been recognized nationally. For the Town of Babylon, PWGC explored the use of a combination of MicroGrid-scale alternative and renewable energies to serve the Wyandanch Rising redevelopment located in the town. The Project consists of 462,000 square feet of transit-oriented, mixed-use development on 61 acres of brownfields and underutilized land in an economically distressed urban/suburban locale.

PWGC evaluated the feasibility to use a utility-scale geothermal system for heating and cooling of the entire development to provide lower energy costs, contribute to greater affordability, and relieve the local utility energy demand. PWGC screened vertical closed loop and open loop systems, each operating in a conventional manner and also utilizing innovative seasonal thermal energy storage in the ground including, respectively, Borehole Thermal Energy Storage (BTES) and ATES. The PWGC Team performed a life-cycle cost analysis for each geothermal option versus a high-efficiency HVAC option baseline. PWGC also evaluated integrating the geothermal system with solar PV and cogeneration, and independent electric utility (MicroGrid) opportunities, public/private partnership arrangements, and import of electric generation and waste heat (steam) from the Town's nearby energy-from-waste incineration plant.





## PWGC GEOTHERMAL HEAT PUMP SYSTEM PROJECT EXPERIENCE

### **Campus-scale Geothermal System - New York Institute of Technology, Old Westbury, NY**

New York Institute of Technology (NYIT) engaged PWGC to perform feasibility analysis of open and closed loop GSHP systems to provide indoor heating and cooling to a major campus expansion, including four (4) new dormitory buildings, a student commons/dining hall, executive offices building, and an academic building on its campus in Old Westbury, Long Island, New York. The development totals about 160,000 square feet, with a peak cooling load of approximately 600 tons. NYIT selected an open loop system and PWGC subsequently coordinated installation of a 300-foot deep test well, groundwater sampling, and a pumping test to verify groundwater quality was suitable and to develop data for the well field design.

PWGC then designed the well field, which included three supply wells and eight return wells. Besides providing heated and chilled water via the heat pumps, the geothermal return water will additionally be available for campus irrigation purposes when needed, to reduce overall campus energy and water usage.

### **Vertical Closed Loop Geothermal System - Weeksville Heritage Center, Brooklyn, NY**

The Weeksville New Education Building site in Bedford Stuyvesant, Brooklyn, New York, is home to a cluster of original, civil war era domestic structures - the historic Hunterfly Road Houses dating from 1840-1880s ("safe houses") - that were part of the African American community of Weeksville. The new building houses a new venue for Weeksville's educational events.

For the New York City Department of Design and Construction (NYCDDC), PWGC designed a closed loop geothermal system for the building, constructed in 2013, that is supplying the full heating and cooling needs of the building. The closed loop borefield consists of 48 loops each drilled to a depth of 470 feet.

PWGC implemented a test closed loop and thermal conductivity test, designed the borefield, including a buried exterior manifold vault due to interior space limitations. PWGC provided construction administration and full-time inspection services during construction, including witnessing start up testing procedures and performance tests. The project has earned LEED Gold certification from the U.S. Green Building Council and a Platinum Engineering Excellence Award to PWGC by the American Council of Engineering Companies.



### **Open Loop Geothermal System - Eastport/South Manor School District, Eastport, NY**

PWGC provided geothermal consulting and design services for a new K-2 grade primary school constructed in 2014 for the Eastport South Manor School District. PWGC initially conducted a feasibility study and field testing program for design of an open loop geothermal system to serve the new school. PWGC assessed the local aquifer conditions and groundwater quality for suitability for an open loop system and optimum location and depths of the wells. PWGC also evaluated the hydraulic effects of system operation on a regulated surface water body adjacent to the site. PWGC subsequently designed the supply and return well field, piping system, manifold, and associated controls, and provided construction administration and field observation services during construction.

The project received LEED Gold certification from the U.S. Green Building Council. In support of the LEED rating, a portion of the geothermal return water can be diverted for irrigation of new playing fields, rather than utilizing treated city water.



## PWGC GEOTHERMAL HEAT PUMP SYSTEM PROJECT EXPERIENCE



### **Vertical Closed Loop Geothermal System - Staten Island Institute of Arts and Sciences**

For the NYCDDC, PWGC designed and provided construction administration and field oversight for installation of a vertical closed loop system for the new Staten Island Museum. The museum is an existing, historic Greek revival architecture building that has undergone full interior renovation. The geothermal system supplies all of the heating and cooling needs for the building, with an estimated peak cooling demand of 114 tons. The borefield consists of 32 loops, each to a depth of 500 feet. Coordination with NYC Parks Department was required to ensure protection of old specimen trees bordering the field allocated for installation of the borefield.

PWGC initially evaluated a closed loop option versus standing column wells and, upon selection of a closed loop system by NYCDDC, coordinated installation of two test closed loops with thermal conductivity testing. Thereafter, PWGC was responsible for design of the borefield, supply and return piping and headers, and buried exterior manifold vault. PWGC also provided construction administration and inspection services, including witnessing drilling and loop installation, horizontal piping installation, and pressure testing, and purging and flushing procedures. The project earned LEED certification from the U.S. Green Building Council.

### **Open Loop Geothermal System Design - Building 92, Brooklyn Navy Yard Development, Brooklyn, NY**

Building 92 is an existing 9,200-square-foot historic structure, and the oldest building, on the grounds of the Brooklyn Navy Yard. The building was renovated and expanded in 2011 with 16,000 additional square feet of space. Indoor heating and cooling is being served by an open loop geothermal system.

PWGC provided full-service geothermal due diligence, field testing, design, and construction administration and observation services to the design team. PWGC initially designed and coordinated installation of two test wells, a 48 hour pumping test, and groundwater quality testing to evaluate the suitability of the site aquifer for an open loop system. PWGC subsequently designed the supply and return well field, piping system, manifold, and associated controls. Two supply wells and two diffusion wells were installed to convey the required flow of 140-gallons-per-minute through the geothermal heat pumps for producing heated and chilled water to fan coil units located throughout the building.

The project received LEED Platinum certification from the U.S. Green Building Council.



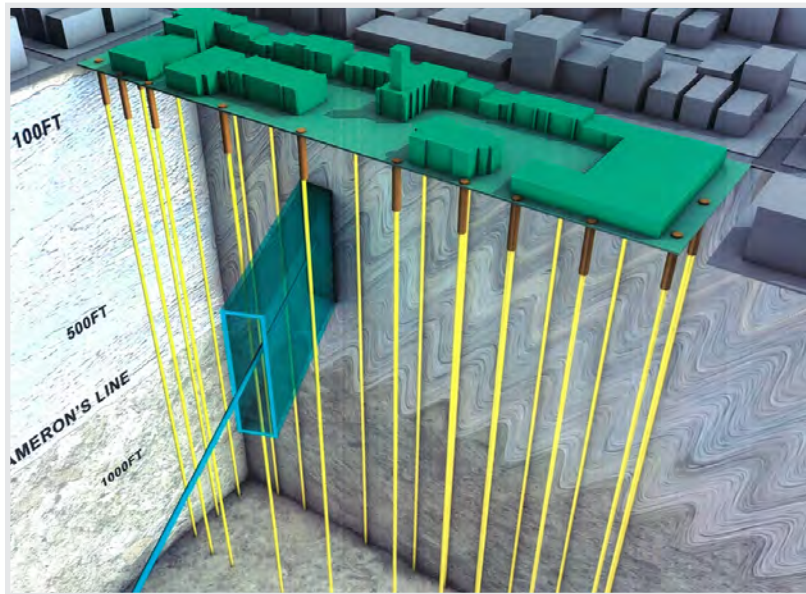
## PWGC GEOTHERMAL HEAT PUMP SYSTEM PROJECT EXPERIENCE

### Standing Column Well Geothermal System Consulting - General Theological Seminary of the Episcopal Church, Manhattan, NY

The General Theological Seminary of the Episcopal Church (GTS), founded in 1817, began a campus-wide renovation project in 2005 that included converting a portion of the campus buildings to an energy-efficient geothermal heat pump HVAC system. The GTS campus covers an entire city block in the Chelsea district of Manhattan, and consists of 16 landmark Gothic Revival buildings.

Seven (7) deep standing column wells (deepest 1,800 feet) were installed through the sidewalks surrounding the campus to tap into the underlying bedrock. The wells were connected to three mechanical rooms, each housing 30-ton capacity water-to-water heat-pumps. Chilled and heated water is then conveyed to fan coil units in the spaces to be conditioned. The system went on line in 2008.

PWGC provided comprehensive technical support to GTS during the filings, bidding, and construction phases of the project and through startup. PWGC negotiated on behalf of GTS with the NYSDEC and NYC Department of Environmental Protection regarding borehole drift monitoring requirements relative to the presence of a new leg of the city's public water supply tunnel system (Tunnel #3) directly beneath the site. In addition, PWGC worked with the drilling contractor to develop measures to stabilize the borehole walls through fractured bedrock zones found at three of the seven well boreholes, designed and coordinated groundwater pumping/drawdown tests to establish well yields and maximum sustainable bleed rates, and coordinated borehole geophysical and video logging of selected boreholes.



### Open Loop Geothermal System - Winnick House, C.W. Post Campus, Brookville, NY

For the renovation of the Winnick House, which houses the administrative offices for C.W. Post staff, the client selected an open loop geothermal system for air-conditioning during the summer season. PWGC performed due diligence of the local aquifer conditions and a feasibility study, well permitting with the NYSDEC, designed the well field system and interior manifold, and managed construction of the system.

The system consists of one supply well and two diffusion (return) wells. PWGC developed and ran a three-dimensional groundwater model to support the spacing between the supply and return wells to avoid thermal breakthrough and ensure optimal efficiency of the system within site constraints. PWGC situated the wells to minimize disruption to campus operations during construction and to facilitate future well maintenance/rehabilitation access.

The system went into operation in 2006 and has operated to the client's full satisfaction. For PWGC's role on the project, the American Council of Engineering Companies awarded PWGC a Platinum Engineering Excellence Award.



## PWGC GEOTHERMAL HEAT PUMP SYSTEM PROJECT EXPERIENCE

### Upgrades to District Geothermal System - Glen Cove Hospital, Northwell Health, Glen Cove, NY

Indoor space and process cooling is supplied to all of the 11 buildings on the 10.3-acre Glen Cove Hospital campus in Glen Cove, Nassau County, New York, by two 50-year-old open loop geothermal well systems. PWGC designed and coordinated upgrades to this campus-scale system which included abandonment of portions of the existing systems, rehabilitation of several wells, and construction of five new wells, horizontal piping, controls and appurtenances. The design and planning of the upgrades were complicated by a nearby plume from a New York State Superfund site. In addition, some of the existing wells and some of the new wells were installed in the protected Lloyd aquifer, which involved petitioning and approval from the NYSDEC to permit the replacement system under “grandfather” provision.

As required by the NYSDEC, PWGC developed a regional 3-dimensional numerical groundwater model to depict hydraulic effects on the aquifers and the potential to induce contaminant flow from the Superfund site or saltwater intrusion from the nearby marine waters (Long Island Sound). PWGC was responsible for all regulatory permitting, developing well rehabilitation and abandonment procedures, design of the new well system, construction administration and resident construction oversight services. PWGC is presently providing guidance on system operation and periodic maintenance.

PWGC met the client’s stringent schedule to maintain critical-care operations at the hospital through close coordination with facility managers during the upgrade work.

## PWGC GEOTHERMAL SYSTEM DESIGN AND CONSULTING AWARDS

- St. Patrick’s Cathedral - 2018 AIA COTE (Committee on The Environment) Award
- St. Patrick’s Cathedral - 2018 ACEC National Engineering Excellence Award - Honor Award
- St. Patrick’s Cathedral - 2018 ACEC-NY Chapter Engineering Excellence Award - Diamond Award
- NYC Geothermal Screening Tool - 2018 ACEC-NY Chapter Engineering Excellence Award - Gold Award
- Weeksville Heritage Center - 2015 ACEC-NY Chapter Engineering Excellence Award - Platinum Award
- C.W. Post Winnick House - 2009 ACEC-NY Chapter Engineering Excellence Award - Platinum Award

## PWGC CLIENT REFERENCES

<b>Long Island University, C.W. Post Campus</b> Mr. Frank Casale - 516-299-3970 720 Northern Boulevard, Brookville, NY 11545	<b>Ross School</b> Mr. Thomas Szajkowski - 631-907-5249 18 Goodfriend Drive East Hampton, NY 11937
<b>Northwell Health - Glen Cove Hospital</b> Mr. Joseph Palumbi - 516-674-7657 101 St. Andrews Lane Glen Cove, NY 11542	<b>New York City Department of Design &amp; Construction</b> Mr. Alex Posner - 718-391-1771 30-30 Thompson Avenue Long Island City, NY 11101
<b>Amneal Pharmaceuticals</b> Mr. Radu Oancea - 631-952-0214 ext. 134 75 Adams Avenue Hauppauge, NY 11788	<b>City of Cambridge Department of Public Works</b> Mr. Tim Boughner - 617-349-4823 147 Hampshire Street Cambridge, MA 02139



## PWGC CLIENTS

### Schools, Colleges and Universities

- Cornell University
- N.Y. Institute of Technology
- Bridgehampton, NY, Public School District
- Hewlett Public School District
- Adelphi University
- Hofstra University
- Fordham University
- Ross School
- Eastport/South Manor Public School District
- C.W. Post College
- Nassau County Community College
- Suffolk County Community College
- Pratt Institute
- Columbia University
- City University of New York
- University of Baltimore Law School

### Institutions

- JAG Architects
- Tod Williams Billie Tsien Architects
- St. Patrick's Cathedral
- Brooklyn Children's Museum
- Queens Botanical Garden
- Brooklyn Botanic Gardens
- Staten Island Museum
- Staten Island Mental Health Society
- Weeksville Heritage Center
- The Bronx Zoo
- General Theological Seminary
- St. Joseph's Church, Brooklyn, NY
- St. Stanislaus Church, Brooklyn, NY
- Brooklyn Navy Yard Development Corp.
- Sterling and Francine Clark Art Institute
- Battery Park City Parks Conservancy
- Fort Ticonderoga

### Architects

- Wiedersum Associates Architects
- Beyer Blinder Belle Architects & Planners
- Murphy Burnham & Buttrick Architects
- Stelle Architects
- Gluckman Mayner Architects
- Helpert Architects
- Robert A.M. Stern Architects
- SBLM Architects
- Morris Adjmi Architects
- Leroy Street Studio Architecture, P.C.
- COOKFOX Architects, LLP

### Engineers and Contractors

- MEP Associates, Inc.
- AECOM
- Buro Hannold Engineers
- VHB Engineering, P.C.
- Bladykas Engineering, PC
- ads Engineers
- JB&B
- Burton Behrendt Smith
- WSP Flack & Kurtz
- Joseph R. Loring & Associates, Inc.
- Lizardos Mechanical & Electrical Engineering
- AKF Group LLC
- Altieri Sebor Wieber, LLC
- Horizon Engineering Associates LLP
- Kallen and Lemelson Consulting Engineers
- Metropolitan Building Consulting Group, PC
- Laszlo Bodack Engineer, P.C.
- Integrated HVAC Systems & Services Inc.
- The Louis Berger Group, Inc.
- Langan Engineering & Environmental Services, P.C.
- Mueller Associates, Inc.
- Greenman-Pedersen Inc.
- ZBF Geothermal, LLC

### Developers/ CM's/Owners Reps

- L+M Developers
- Kulka Construction
- Hill International, Inc.
- Zubatkin Owner Representation, LLC
- Albanese Organization, Inc.
- Peter Moore Associates
- Belvedere Property Management
- HFZ Capital Group
- Two Trees Management
- The J Companies LLC

### Commercial/Industrial

- Amneal Pharmaceuticals
- Google
- Ford Motor Company
- Consolidated Edison on NY
- Northwell Health
- Macy's
- Bridgewater Associates
- Glen Cove Hospital
- Standard Microsystems
- Citibank
- AIL Systems
- Underwriters Laboratories, Inc.
- Yonkers Housing Authority

### Government/Municipalities

- NYC Mayor's Office of Sustainability
- NYS Environmental Research & Development Agency
- Dutch Consulate of New York City
- Town of Brookhaven Parks Department, NY
- Suffolk County Department of Public Works
- Fire Department of New York City
- City of Cambridge, MA, Department of Public Works
- Town of Babylon, NY
- NYC Department of Design & Construction
- NYC Economic Development Corporation

