

Memorandum – Coastal Engineering Review

Summary of Geologic Resources Inventory (GRI) Support Documents: Gateway National Recreation Area (GATE)

February 2026

Review Request Summary

The Geologic Resource Inventory (GRI) is one of 12 baseline natural resource inventory efforts within the National Park Service (NPS) Inventory and Monitoring (I&M) Division. The GRI is a cooperative effort between the NPS, Colorado State University, and the University of Alaska Fairbanks. It strives to advance science-based management of natural resources in the national parks and raise awareness about geology and the role that geologic features and processes play in the environment.

The GRI team, working closely with a variety of partners, provides each of the approximately 270 parks in the I&M networks with a geologic scoping meeting, digital geologic map data and poster, and a park-specific geologic report. These products are designed to enhance stewardship of park resources by providing valuable information about geologic formations, processes, hazards, and links among geology, history, and other natural resources. The National Park Service identified 13 coastal parks that have geologic scoping meeting summaries and at least one digital geologic map, but do not have a traditional GRI report: Biscayne National Park (BISC), Cape Cod National Seashore (CACO), Canaveral National Seashore (CANA), Castillo de San Marcos National Monument (CASA), Cumberland Island National Seashore (CUIS), Fire Island National Seashore (FIIS), Fort Caroline National Memorial (FOCA), Fort Frederica National Monument (FOFR), Fort Matanzas National Monument (FOMA), Fort Pulaski National Monument (FOPU), Fort Sumter and Fort Moultrie National Historical Park (FOSU), Gateway National Recreation Area (GATE), and Timucuan Ecological and Historic Preserve (TIMU). As of spring 2024, the GRI team is transitioning to a proposal-based system, and not all parks will receive a traditional report, including all 13 of the identified coastal parks. Many of these coastal parks were originally scoped in the early 2000s and have map products approaching or now exceeding 20 years old. Therefore, to provide a status update to the coastal parks in lieu of a traditional report, the GRI team requested assistance from EA Engineering, Science, and Technology, Inc., PBC (EA), with the following:

- Prepare park-specific literature reviews focused on geologic resources to provide data resource for future work
- Prepare a literature review of service-wide and regional resources that could be useful to multiple parks
- Evaluate available digital geologic map data for each park and assess its relevance to coastal management needs

Literature Reviews

Introduction

The literature review for each park consists of an Excel spreadsheet listing all identified sources and PDF files for each source. The spreadsheet includes a link that opens the associated PDF file directly. These files for Gateway National Recreation Area can be downloaded from the NPS DataStore at: <https://irma.nps.gov/DataStore/Reference/Profile/2317173>.

Methodology

To ensure consistency across parks, EA followed the steps below when searching for sources:

- Checked EA servers for project files already in EA possession or previously cataloged in literature reviews, annotated bibliographies, memorandum reference lists, and related materials.
- Reviewed the GRI Product Page (NPS 2024a) to identify GRI products previously compiled by the National Park Service for each park unit.
- Conducted an advanced search of NPS DataStore using the following methods:
 - In the Text Fields section, enter:
 - Description contains geolog*
 - OR Title contains geolog*
 - OR Keyword contains geolog*
 - In the Content Units section, enter the four-letter code for the park unit/select it from the list
- Completed a general Google search focused on scholarly articles. When results were excessive, searches were refined by applying a publication date cutoff of 2016 or 2017.
- Reviewed the following resources relevant to multiple parks:
 - Coastal engineering inventories of select parks (NPS 2013)
 - The NPS Paleontology Library, a repository for electronic copies of geology and paleontology publications, reports, and other media, including the following paleontological resource inventory types:
 - Park-specific Paleontological Resource Inventories (NPS 2024b)
 - Service-wide Thematic Paleontological Resource Inventories (NPS 2023a)
 - I&M Network Based Paleontological Resource Inventories (NPS 2023b)
 - Shoreline change project maps for 88 ocean and Great Lake park units (NPS 2022)
- Reviewed reference lists from reports already identified, particularly those that were comprehensive, relevant, and/or recently published.
- Used the following resource topics as a starting point for search terms (this list is not exhaustive, and additional terms were added based on park-specific topics):

- | | |
|---------------------------|--------------------------------------|
| – Surficial features | – Saltwater intrusion |
| – Hydrogeomorphic map | – Sediment transport |
| – Unconsolidated deposits | – Hydrology and hydrogeology |
| – Storm impacts | – Nearshore/seafloor/benthic habitat |
| – Erosion | – Shoreline evolution |
| – Overwash | – Paleontology/fossils |
| – Breaches | – Land disturbance |
| – Inlet formation | – Seismicity |
| – Sea level rise | – Waves, currents, and tides |
| – Marshes | – Wind |

Spreadsheet Details

Column A, File Name: Each row in this column includes a unique filename identifier corresponding to a specific PDF file stored in the park folder. Each filename begins with the park four-letter identifier, followed by GRI, and then a sequential number (for example, FIIS GRI_001).

Column B, First-Level Grouping: One of the following groupings was selected from the list below to best match the document scope:

- General/natural resources
- Geology
- Coastal processes/geomorphology
- Habitat
- Engineering

Column C, Date of Publication: This is provided separately from the citation for ease of review.

Column D, Citation: These use a modified APA-style format. Examples are provided below.

Example of a journal article:

Schwab, W. C., W. E. Baldwin, C. J. Hapke, E. E. Lentz, P. T. Gayes, J. F. Denny, J. H. List, and J. C. Warner. 2013. Geologic Evidence for Onshore Sediment Transport from the Inner Continental Shelf: Fire Island, New York. *Journal of Coastal Research* Volume 29, Issue 3: pp. 526–544.

Example of an agency report:

U.S. Army Corps of Engineers. 2007. *Atlantic Coast of Long Island, Fire Island Inlet to Montauk Point, New York Storm Damage Reduction Reformulation Study, Work Order 28, Inlet Modifications*. US Army Corps of Engineers, New York District, North Atlantic Division. 493 pp.

Column E, Short Title/Access: This includes the document title or a shortened version of the title and is linked directly to the associated PDF file.

Column F, Literature Review Summary: This includes the document abstract (if sufficiently concise) or a brief summary describing the scope and contents of the document, with a focus on relevance to geologic resources.

Column G, Keywords: This includes three to five keywords based on review of the document or keywords identified in NPS DataStore.

Column H, Notes: This is optional and is used to provide additional information, such as whether appendices are included as separate files or entries in the literature review.

GATE Literature Review Summary

GATE encompasses approximately 27,000 acres from Sandy Hook, New Jersey, to Breezy Point in New York City, protecting green space within one of the most urbanized regions in the United States. The literature review for this park includes 25 sources published between 1976 and 2022. EA developed keywords based on the coastal resources addressed in each reviewed source. These keywords are provided in column G of the spreadsheet and are summarized below.

- | | | |
|-------------------------|----------------------------|-------------------------------|
| ▪ Accretion | ▪ Earthquakes | ▪ Morphological change |
| ▪ Adaptation plan | ▪ Ecosystem restoration | ▪ Natural resource conditions |
| ▪ Bathymetric | ▪ Engineering | ▪ Natural resources |
| ▪ Beach morphology | ▪ Environmental assessment | ▪ Nature-based solutions |
| ▪ Beach nourishment | ▪ Erosion | ▪ NRCA |
| ▪ Beach | ▪ Flooding | ▪ Oceanography |
| ▪ Bedrock geology | ▪ Geology | ▪ Orthophotography |
| ▪ Biota | ▪ Geomorphology | ▪ Restoration |
| ▪ Chemical oceanography | ▪ Groundwater | ▪ Salt marsh erosion |
| ▪ Climate change | ▪ Habitat | ▪ Salt marsh restoration |
| ▪ Coastal dynamics | ▪ Hurricane | ▪ Salt marsh |
| ▪ Coastal erosion | ▪ Hydrogeology | ▪ Sea level rise |
| ▪ Coastal processes | ▪ Infrastructure | ▪ Sediment |
| ▪ Coastal profile | ▪ Isotopic stratigraphy | ▪ Sediment morphology |
| ▪ Coastal vulnerability | ▪ LiDAR | ▪ Sediment supply |
| ▪ Coastal | ▪ Marsh | ▪ Sediment transport |
| ▪ Community | ▪ Marsh migration | ▪ Sedimentology |
| ▪ CVI | ▪ Marsh retreat | |
| ▪ Dredge | ▪ Monitoring | |
| ▪ Dune | | |

- Seismicity
- Ship wake
- Shoreline changes
- Shoreline formation
- Shoreline orientation
- Shoreline
- Soil horizons
- Soil survey
- Storm surge
- Structures
- Subsidence
- Topography
- Wetland ecosystem
- Wetlands

In addition to park-specific literature reviews, a review was completed that includes service-wide and regional resources that may benefit multiple parks. These resources include vulnerability assessment protocols, monitoring protocols, climate change inventories/impacts, sea level rise scenarios/evaluations, coastal hazard assessments, and mapping tools that provide data for all parks, among others. Although resources are ideally provided as PDF documents, some are only useful when accessed digitally (e.g., mapping data).

Research and data are continually being published. These literature reviews may not be exhaustive; however, they provide a foundation for understanding the range of geologic resources in each park, as well as relevant internal National Park Service guidance and resources. The methodology described above may be used for future searches to update information, if desired.

Geologic Map Assessment

Introduction

Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps, such as coastal or geologic hazard maps, may be used by the GRI to create digital geographic information systems (GIS) data that meet park needs. These GIS data allow geologic information to be easily viewed and analyzed alongside other resource management information.

The GRI team compiled digital geologic maps for each of the 13 coastal parks: BISC, CACO, CANA, CASA, CUIS, FIIS, FOCA, FOFR, FOMA, FOPU, FOSU, GATE, and TIMU. As part of, and in parallel with, the GRI literature review process, EA assessed the relevance of the GRI GIS data sets (all available on the NPS DataStore; some exceeding 20 years old) to each park's current coastal management needs. This assessment is based in part on EA's perspective as technical experts well versed in NPS management requirements.

Methodology

This work was completed without the use of GIS software and instead relied on review of the GRI Scoping Meeting Summary and the GRI Ancillary Map Information document, both available on NPS DataStore. For each park, EA's assessment focused on answering the following questions about the GRI digital geologic map(s):

1. Are the source maps (i.e., the maps that GRI digitized to create the GIS data sets) comprehensive in terms of features relevant to the coastal park? If not, what gaps are there?
2. Are the source maps recent enough (relative to extreme storms, especially) to accurately represent the park's current configuration?
3. Does an online search yield any maps that are more relevant?

In addition to park-specific literature reviews, a review was completed that includes service-wide and regional resources that may benefit multiple parks. These resources include vulnerability and monitoring protocols, climate change inventories and impacts, sea-level-rise scenarios and evaluations, coastal hazard assessments, and mapping tools that provide data for all parks. Although resources are ideally provided as PDF documents, some are only useful when accessed digitally (for example, mapping data).

Research and data are continually being published. These literature reviews may not be exhaustive; however, they provide a basis for understanding the range of geologic resources in each park, as well as internal NPS guidance documents and resources that may be used. The methodology described above can be followed in future searches to update information, if desired.

GATE Map Assessment

The information summarized below is based on information presented in the *Geologic Resources Inventory Scoping Summary Gateway National Recreation Area* (Thornberry-Ehrlich 2011), the *Gateway National Recreation Area GRI¹ Ancillary Map Information Documents* (NPS 2016a and NPS 2016e), and the NPS DataStore page data for the GATE GRI maps produced by GRD. Information on the seven GATE GRI maps is presented in table 1.

The scoping meeting summary (Thornberry-Ehrlich 2011) identified a wide range of significant geologic resource management issues in GATE (table 2). Table 2 identifies each of the groups in the first column as well as which of the existing GRI map products provide information on them. If an existing map provides incomplete information, this is indicated in the 'data gap' column.

¹ Note that the GRI program was briefly named the Geologic Resource Evaluation (GRE) program. The abbreviations GRI and GRE refer to the same program although products of different vintages may display either of the abbreviations.

Table 1. Summary of GRI map products for GATE

GRI Map Product	Citation	Data Layers	Sources
Digital Bedrock Geologic-GIS Map (Large-scale)	NPS 2016a	– SHBRGLGA (Geologic Contacts) – SHBRGLG (Geologic Units) – SHBRFLT (Faults) – SHBRSURA (Surficial Contacts) – SHBRSUR (Surficial Units) – SHBRSEC (Geologic Cross Section Lines) – SHBRGOL (Geologic Observation Localities) – SHBRMIN (Mine Point Features) – SHBRCVR (Bedrock Cover) – SHBRCVRA (Bedrock Cover Boundaries) – SHBRSYM (Map Symbolology)	<i>Geologic units and their related contacts were produced from:</i> Minard, J.P., 1969, Geology of the Sandy Hook Quadrangle in Monmouth County, New Jersey: U.S. Geological Survey, Bulletin 1276, scale 1:24,000. (GRI Source Map ID 2583) Stanford, S.D. and Sugarman, P.J., 2010, Bedrock Geology of the Long Branch Quadrangle, Monmouth County, New Jersey: New Jersey Geological Survey, Open-file Map OFM 78, scale 1:24,000. (GRI Source Map ID 75557)
Digital Bedrock Geologic-GIS Map (Small scale)	NPS 2016b	GWBRFLT (Faults), GWBRGLG (Geologic Units), GWBRGLGA (Geologic Contacts) and GWBRSEC (Geologic Cross Section Lines).	<i>Geologic units and their related contacts were produced from:</i> Pristas, R. P., 2004, Bedrock Geology of New Jersey: New Jersey Geological Survey, Digital Geodata Series DGS 04-6, scale 1:100,000. (GRI Source Map ID 7285) Rickard, L.V., Isachsen, Y.W., and Fisher, D.W., 1970, Geologic Map of New York: Lower Hudson Sheet: New York State Museum, Map and Chart Series 15, scale 1:250,000. (GRI Source Map ID 7288)

GRI Map Product	Citation	Data Layers	Sources
Digital Surficial Geologic-GIS Map (Large scale)	NPS 2016c	– SHSFGGLGA (Geologic Contacts) – SHSFGGLG (Geologic Units) – SHSFSURA (Surficial Contacts) – SHSFSUR (Surficial Units) – SHSFCN1 (Bedrock Surface Elevation Contours) – SHSFHZAA (Hazard Area Feature Boundaries) – SHSFHZA (Hazard Area Features) – SHSFSEC (Geologic Cross Section Lines) – SHSFATD (Geologic Attitude Observation Localities) – SHSFGML (Geologic Measurement Localities) – SHSFGOL (Geologic Observation Localities) – SHSFMIN (Mine Point Features) – SHSFBSN (Topographic Basins) – SHSFBSNA (Topographic Basin Boundaries)	Geologic units and their related contacts were produced from: Stanford, Scott D., 2002, Surficial Geology of the Elizabeth Quadrangle, Essex, Hudson, and Union Counties, New Jersey: New Jersey Geological Survey, Open-file Map OFM 42, scale 1:24,000. (GRI Source Map ID 55336) Stanford, Scott D, 2000, Surficial Geology of the Sandy Hook Quadrangle, Monmouth County, New Jersey: New Jersey Geological Survey, Open-file Map OFM 39, scale 1:24,000. (GRI Source Map ID 2584) Stanford, Scott D., 2000, Surficial Geology of the Long Branch Quadrangle, Monmouth County, New Jersey: New Jersey Geological Survey, Open-file Map OFM 38, scale 1:24,000. (GRI Source Map ID 47707) Stanford, Scott D, 1999, Surficial Geology of the Perth Amboy and Arthur Kill Quadrangles, Middlesex and Union Counties, New Jersey: New Jersey Geological Survey, Open-file Map OFM 28, scale 1:24,000. (GRI Source Map ID 47711) Stanford, Scott D., 1995, Surficial Geology of the Jersey City Quadrangle, Hudson and Essex Counties, New Jersey: New Jersey Geological Survey, Open-file Map OFM 20, scale 1:24,000. (GRI Source Map ID 2585)

GRI Map Product	Citation	Data Layers	Sources
Digital Surficial Geologic- GIS Map (Small scale)	NPS 2016d	– GWSFSTK (Surficial Thickness) – GWSFSTKA (Surficial Thickness Boundaries) – GWSFGLG (Geologic Units) – GWSFGLGA (Geologic Contacts) – GWSFCN1 (Elevation of Top of Bedrock or Coastal Plain Formations) – GWSFOCR (Outcrops) – GWSFOCRA (Outcrop Boundaries) – GWSFSEC (Geologic Cross Section Lines)	<i>Geologic units and their related contacts were produced from:</i> Cadwell, D.H., Connally, G.G., Dineen, R.J., Fleisher, P.J., Fuller, M.L., Sirkin, Les, and Wiles, G.C., 1991, Surficial Geologic Map of New York: Lower Hudson Sheet: New York State Museum, Map and Chart Series 40, scale 1:250,000. (GRI Source Map ID 1574) Pristas, R. P., 2007, Surficial Geology of New Jersey: New Jersey Geological Survey, Digital Geodata Series DGS 07-2, scale 1:100,000. (GRI Source Map ID 74858)

GRI Map Product	Citation	Data Layers	Sources
Digital Pre-Hurricane Sandy Geomorphological-GIS Map	NPS 2016e NPS 2016e	– GATEMRPHA_PRE_SANDY (Geomorphologic Unit Boundaries (pre-Hurricane Sandy)) – GATEMRPH_PRE_SANDY (Geomorphologic Units (pre-Hurricane Sandy))	<i>Geologic units and their related contacts were produced from:</i> Psuty, N.P., McLoughlin, S.M., Schmelz, W., and Spahn, A., 2014, Geomorphological Map of Gateway National Recreation Area (Pre-Hurricane Sandy), New York and New Jersey: Rutgers University, Institute of Marine and Coastal Sciences, unpublished digital data and map, scale 1:6,000. (GRI Source Map ID 75949) (pre-Hurricane Sandy Geomorphologic Maps of Gateway National Recreation Area, New York and New Jersey). <i>The following 3 maps are extracts from the above source map.</i> 2016. Unpublished Digital Pre-Hurricane Sandy Geomorphological-GIS Map of the Jamaica Bay Unit, Gateway National Recreation Area, New York (NPS, GRD, GRI, GATE, JABA digital map) adapted from a Rutgers University Institute of Marine and Coastal Sciences unpublished digital data by Psuty, N.P., McLoughlin, S.M., Schmelz, W. and Spahn, A. (2014). NPS Geologic Resources Inventory Program 2016. Unpublished Digital Pre-Hurricane Sandy Geomorphological-GIS Map of the Staten Island Unit, Gateway National Recreation Area, New York (NPS, GRD, GRI, GATE, STIS digital map) adapted from a Rutgers University Institute of Marine and Coastal Sciences unpublished digital data by Psuty, N.P., McLoughlin, S.M., Schmelz, W. and Spahn, A. (2014). NPS Geologic Resources Inventory Program 2016. Unpublished Digital Pre-Hurricane Sandy Geomorphological-GIS Map of the Sandy Hook Unit, Gateway National Recreation Area, New Jersey (NPS, GRD, GRI, GATE, SAHO digital map) adapted from a Rutgers University Institute of Marine and Coastal Sciences unpublished digital data by Psuty, N.P., McLoughlin, S.M., Schmelz, W. and Spahn, A. (2014). NPS Geologic Resources Inventory Program

GRI Map Product	Citation	Data Layers	Sources
Digital Post-Hurricane Sandy Geomorphological-GIS Map	NPS 2016f	– GATEMRPHA_POST_SANDY (Geomorphologic Unit Boundaries (post-Hurricane Sandy)) – GATEMRPH_POST_SANDY (Geomorphologic Units (post-Hurricane Sandy))	<i>Geologic units and their related contacts were produced from:</i> Psuty, N.P., Schmelz, W., Greenberg, J., and Spahn, A., 2015, Geomorphological Map for Gateway National Recreation Area (Post-Hurricane Sandy): Rutgers University, Institute of Marine and Coastal Sciences, unpublished digital data and map, scale 1:6,000. (GRI Source Map ID 76053) (post-Hurricane Sandy Geomorphologic Maps of Gateway National Recreation Area, New York and New Jersey). <i>The following 3 maps are extracts from the above source map:</i> 2016. Unpublished Digital Post-Hurricane Sandy (2015) Geomorphological-GIS Map of the Jamaica Bay Unit, Gateway National Recreation Area, New York (NPS, GRD, GRI, GATE, JABA digital map) adapted from a Rutgers University Institute of Marine and Coastal Sciences unpublished digital data by Psuty, N.P., Schmelz, W., Greenberg, J. and Spahn A. (2015). NPS Geologic Resources Inventory Program 2016. Unpublished Digital Post-Hurricane Sandy (2015) Geomorphological-GIS Map of the Staten Island Unit, Gateway National Recreation Area, New York (NPS, GRD, GRI, GATE, STIS digital map) adapted from a Rutgers University Institute of Marine and Coastal Sciences unpublished digital data by Psuty, N.P., Schmelz, W., Greenberg, J. and Spahn A. (2015). NPS Geologic Resources Inventory Program 2016. Unpublished Digital Post-Hurricane Sandy (2015) Geomorphological-GIS Map of the Sandy Hook Unit, Gateway National Recreation Area, New Jersey (NPS, GRD, GRI, GATE, SAHO digital map) adapted from a Rutgers University Institute of Marine and Coastal Sciences unpublished digital data by Psuty, N.P., Schmelz, W., Greenberg, J. and Spahn A. (2015). NPS Geologic Resources Inventory Program

GRI Map Product	Citation	Data Layers	Sources
Digital Geomorphological- GIS Map	NPS 2016g	– NYISMRPHA (Geomorphologic Unit Boundaries) and NYISMRPH (Geomorphologic Units)	<i>Geologic units and their related contacts were produced from:</i> Per communication with source map authors, no significant change in the geomorphology of the New York Harbor Islands from Hurricane Sandy was recorded. Pre- and post-Hurricane Sandy versions were not required. Psuty, N.P., Hudacek, W., Schmelz, W., and Spahn, A., 2015, Geomorphological Map for Governors Island, Ellis Island, and Liberty Island Upper New York Bay: Rutgers University, Institute of Marine and Coastal Sciences, unpublished digital data and map, scale 1:12,000. (GRI Source Map ID 76080) (Geomorphologic Map of New York Harbor Islands, New York).

Table 2. Geologic resource management issues addressed in existing GRI map products

Geologic Resource Management Issues	Digital Bedrock Geologic – GIS Map (Large and Small Scale)	Digital Surficial Geologic – GIS Map (Large and Small scale)	Digital Pre-Hurricane Sandy Geomorphological – GIS Map	Digital Post-Hurricane Sandy Geomorphological – GIS Map	Digital Geomorphological – GIS Map	Data Gap
Coastal Development/ evolution and management				X	X	
Coastal erosion				X	X	
Fluvial and lacustrine features and processes (including wetlands)		X				
Seismicity	X					
Disturbed lands				X		
Submerged features		X	X	X		
Climate Change impacts						X

Geologic Resource Management issues are provided in scoping meeting summary (Thornberry-Ehrlich 2011)

Are the source maps (i.e., the maps that GRI digitized to create the GIS data sets) reasonably comprehensive in terms of features relevant to the coastal park? If not, what gaps are there?

Only one major gap and several minor data gaps exist in the GRI GIS datasets relative to the park geologic resource management concerns identified above. The primary data gap is the lack of information addressing climate change impacts at GATE, which are discussed in several sources included in the literature review. Minor data gaps are documented in two reports describing the development of the GATE geomorphological map: *Development of the Geomorphological Map for Gateway National Recreation Area Principal Characteristics and Components* (Psuty et al. 2018), and the methods for updating the map following Hurricane Sandy, *Development of the Geomorphological Map for Gateway National Recreation Area (Post-Hurricane Sandy) (1) Principal Characteristics and Components and (2) Metrics of Change* (Psuty et al. 2017). Although these reports quantify and document geomorphic changes following Hurricane Sandy, erosion has not been reassessed since their publication.

The bedrock geologic units identified in the GRI Digital Bedrock Geologic GIS Maps of Gate National Recreation Area are listed below, generally from youngest to oldest:

- Qtm – tidal-marsh deposits, Pleistocene and Recent
- Qga – glacial and alluvial deposits, Quaternary
- Qal – alluvium, Pleistocene and Recent
- Qbs – Beach sand, Pleistocene and Recent
- Qfc – Foraminiferal clay, Pleistocene and Recent
- Qgs – Glauconitic sand, Pleistocene and Recent
- Tch – Cohansey Formation
- Tkw – Kirkwood Formation
- Tkl – Kirkwood Formation, lower Member
- Tsr – Shark River Formation
- Tmq – Manasquan Formation
- Tvt – Vincetown Formation
- Tht – Hornerstown Formation
- Kbr – Cretaceous bedrock
- Km – Monmouth group, Matawan Group and Magothy Formation, undivided
- Kt – Tinton Formation)

Red Bank Sand

- Krs – Red Bank Formation, Shrewsbury Member
- Krsh – Red Bank Formation, Sandy Hook Member
- Kns – Navesink Formation
- Kml – Mount Lauren Formation
- Kw – Wenonah Formation
- Kmt – Marshalltown Formation
- Ket – Englishtown Formation
- Kwb – Woodbury Formation
- Kmv – Merchantville Formation
- Kcq – Cheesequake Formation
- Kmg – Magothy Formation
- Kr – Raritan Formation, undivided
- Krw – Raritan Formation, Woodbridge Clay Member
- Krf – Raritan Formation, Farrington Sand Member
- Kp – Potomac Formation
- Jd – Jurassic Diabase

- JTRp – Passaic Formation, undivided
- JTRpms – Passaic Formation, mudstone facies
- JTRps – Passaic Formation, sandstone and siltstone facies
- TRpg – Passaic Formation, gray bed
- TRb – Brunswick Formation
- TRp – Palisade Diabase
- TRl – Lockatong Formation
- TRla – Lockatong Formation
- TRs – Stockton Formation
- Ohr – Harrison Gneiss
- OCi – Inwood Marble
- OZs – Serpentine
- OZm – Manhattan Schist

The map also includes six geologic cross sections and a columnar profile.

The surficial geologic units present in the GRI Digital surficial Geologic-GIS Maps of Gate National Recreation Area are listed below, generally from youngest to oldest:

- Qaf – Artificial fill
- Qaft – Trash fill
- Qb – Beach and nearshore marine sand
- Qbi – Barrier island
- Qm – Estuarine and salt marsh deposits
- Qal – Alluvium
- Qs – Swamp and marsh deposits
- Qcal – Colluvium and alluvium
- Qe – Eolian deposits
- Qhkl – Glacial lake Hackensack, lake-bottom deposits
- Qbn – Glacial Lake Bayonne deposits, sand and gravel, deltaic deposits
- Qbnl – Glacial Lake Bayonne deposits, silt, clay and fine sand, lake bottom deposits
- Qls – Lacustrine sand
- Qrw – Rahway outwash
- Qrt – Raritan terrace deposits
- Qld – Lacustrine delta
- Qk – Kame deposits
- Qt – Rahway Till
- Qtt – Rahway till, discontinuous
- Qty – Rahway Till, yellow phase
- Qpt – Lower Passaic terrace
- Qwf – Late Wisconsinan glaciofluvial plain deposits
- Qwlb – Late Wisconsinan glacial lake-bottom deposits
- Qez – Elizabeth River deposits
- Ql – Uncorrelated glacial-lake deposits
- Qsp – Pre-advance stratified sediment
- Qic – Ice-contact deposits
- Qwb – Glacial Lake Woodbridge deposits
- Qab – Glacial lake Ashbrook despoits, sand, pebbly sand and minor pebble to cobble gravel
- Qabl – Glacial lake Ashbrook despoits, silt, clay, and fine sand
- Qsu – Uncorrelated sand and gravel deposits
- Qpf – Plainfield outwash
- Qmt – Metuchen outwash
- Qpa – Perth Amboy outwash
- Qtm – Till of the terminal moraine
- Qsw – Weathered shale
- Qtl – Lower stream terrace deposits
- Qc – Lower colluvium
- Qcm2 – Cape May Formation, unit 2
- Qcm1 – Cape May Formation, unit 1

- Qtu – Upper stream terrace deposits
- Qcu – Upper colluvium
- QTgl – Upland gravel, lower phase
- QTg – upland gravel
- QTgl – Upland gravel, lower phase
- QTuc – Upland colluvium
- Tp – Pensauken Formation
- Tpg – Pensauken Formation, glauconitic phase
- Tbh – Beacon Hill gravel
- Tbh – Beacon Hill gravel
- TKr – Weathered bedrock

The geomorphological geologic units present in the GRI Pre-Sandy Digital geomorphological Geologic-GIS Maps of Gate National Recreation Area are:

- Rps – Artificial planar surface
- Rsr – Elevated surface/ridge
- Rbu – Bulkhead
- Rpd – Pier/dock/boardwalk
- Rjg – Jetty/groin
- Rs – Seawall
- Rp – Pond
- Hbe – Beach
- Hfd – Active foredune
- Hsf – Sand flat
- Hwl – Wetland
- Hfda – Major abandoned foredune
- Hfdi – Minor abandoned foredune
- His – Inter-ridge swale
- Hbd – Back dune slope
- Hcb – Cliff/bluff/scarp
- PEtm – Terminal moraine
- PEop – Outwash plain

The geomorphological geologic units present in the GRI Post-Sandy Digital geomorphological Geologic-GIS Maps of Gate National Recreation Area are:

- Rpsarti – Ficial planar surface
- Rsr – Elevated surface/ridge
- Rbu – Bulkhead
- Rpd – Pier/dock/boardwalk
- Rjg – Jetty/groin
- Rs – Seawall
- Rp – Pond
- Hbe – Beach
- Hfd – Active foredune
- Hsf – Sand flat
- Hwl – Wetland
- Hwo – Washover
- Hfda – Major abandoned foredune
- Hfdi – Minor abandoned foredune
- His – Abandoned inter-ridge swale
- Hbd – Abandoned back dune slope
- PEtm – Terminal moraine
- PEop – Outwash plain

Are the source maps recent enough (relative to extreme storms, especially) to accurately represent the park's current configuration?

The source maps are dated 2016. There have not been notable physical storm impacts to this park since Hurricane Sandy (NPS 2024c), however, the maps may not accurately represent the park's configuration due to shoreline changes that occur in the dynamic coastal system.

Does an online search yield any maps that that are more relevant?

Additional sources below have been identified to supplement the existing maps and data:

- NOAA Digital Coast: Data Access Viewer (NOAA OCM 2024a) – Includes imagery, land cover, and elevation data.
- NOAA Sea Level Rise Viewer (NOAA OCM 2024b) – Allows users to view various sea level rise scenarios, marsh migration, community and infrastructure vulnerability, and high tide flooding scenarios.
- NOAA Coastal Flood Exposure Mapper (NOAA OCM 2024c) – The mapping tool includes ecosystem exposure, infrastructure exposure, societal exposure, and hazard layers.

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