FIFTH FIVE-YEAR REVIEW REPORT FOR BARCELONETA LANDFILL SUPERFUND SITE BARCELONETA, PUERTO RICO

Prepared by

U.S. Environmental Protection Agency
Region 2
New York, New York

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April 30, 2025

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Date

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LIST OF ABBREVIATIONS & ACRONYMS

1,1-DCE	1,1-dichloroethene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIC	Community Involvement Coordinator
CD	Consent Decree
DNER	Department of Natural and Environmental Resources
EPA	United States Environmental Protection Agency
EQB	Environmental Quality Board
FYR	Five-Year Review
ICs	Institutional Controls
MCL	Maximum Contaminant Level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
PFAS	Per- and Polyfluoroalkyl Substances
PRPs	Potentially Responsible Parties
RAOs	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RI/FS	Remedial Investigation and Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
RSL	Regional Screening Levels
SDWS	Secondary Drinking Water Standards
SMARP	Summary of Maintenance Activities Required to be Performed
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
UU/UE	Unlimited Use and Unrestricted Exposure
VOCs	Volatile Organic Compounds

I. INTRODUCTION

The purpose of a five-year review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) is preparing this FYR review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Contingency Plan (NCP)(40 CFR Section 300.430(f)(4)(ii)), and considering EPA policy.

This is the fifth FYR for the Barceloneta Landfill Superfund Site (the site). The triggering action for this statutory review is the completion date of the previous FYR on May 22, 2020. The FYR has been prepared due to the fact that hazardous substances, pollutants or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure (UU/UE).

The Site consists of one operable unit which will be addressed in this FYR.

The Barceloneta Landfill Superfund Site FYR was led by Guillermo Hernandez-Lopez, Remedial Project Manager (RPM). Participants included Julie McPherson, Human Health and Ecological Risk Assessor; and William Yeung, Hydrogeologist. The relevant entities such as the potentially responsible parties (PRPs) were notified of the initiation of the five-year review on December 11, 2024. The review began on 9/5/2024.

Site Background

The Barceloneta Landfill ("the Landfill"), an inactive non-hazardous domestic and industrial waste disposal facility, is located in Barceloneta, Puerto Rico on the north coast of the island, approximately 20 miles due west of San Juan. The Landfill is about 4.5 kilometers south of the Town of Barceloneta in the Florida Afuera Ward. The property which contains the Barceloneta Landfill is approximately 32.6 hectares (80.6 acres) in size and is owned by the Municipality of Barceloneta **(Figure 1)**. The Landfill is surrounded by a tropical forest. The Quebrada Cimarrona, a tributary of the Rio Grande de Manati, is located 0.8 kilometers north of the Landfill. A small residential area of approximately 150 residences in Barrio Bajura Adentro is located approximately one kilometer east of the Landfill. Approximately two kilometers north of the Landfill, in an area with more gentle topographic relief, there are a series of manufacturing facilities. The nearest village is Cruce Magueyes, located approximately two kilometers west north-west of the Landfill. The residences in the area of the Landfill are served by a public water supply system that uses groundwater as a source.

The property contained three surface depressions which were used for waste disposal. These waste disposal areas are known as the Northern, Southern, and Southeastern Disposal Areas. Each disposal area was located in a depression or "sumidero" (sinkhole) that is surrounded by conical limestone hills referred to as "mogotes." The three waste disposal areas cover about 15 acres. The northern disposal area is separated into two sections by an access road. The Southern Disposal Area was also known as the Superfund disposal area or "El Superfondo." The Northern and Southern Disposal Areas were filled and inactive at the time of the 1996 Record of Decision (ROD). All three disposal areas were covered by the National Priorities List (NPL) site listing and are addressed by this report.

The Barceloneta Landfill is located in a belt of rugged karst topography that extends along the north coast from 30 kilometers (19 miles) east of San Juan to the west of the island. In the vicinity of the site, this belt is located from about one kilometer south of the coast to about 20 kilometers (12 miles) inland. North (seaward) of this rugged karst region is a belt of relatively flat coastal plain sediments. South (landward), the rugged karst terrain transitions into the central mountainous core of the island. Features of this karst landscape include numerous

sumideros, steep scarp cliffs on the mogotes and adjoining ridges which surround the sumideros, and a lack of surface streams or drainage features associated with individual sumideros.

There are currently no reuse plans for the landfill property. Groundwater in the area of the Site is used as a source of drinking water; however, no potable wells are located in, or threatened by groundwater contamination from the Site, and residents nearby have access to a public water supply.

The property on which the Barceloneta Landfill is located was purchased by the Municipality of Barceloneta during the early 1970s. Preparation of the Site for landfill use began in April 1972, and the landfill operations commenced in August 1973. Reportedly, the Landfill was initially approved to receive both municipal and industrial waste but was restricted to only municipal waste disposal in 1975. However, disposal of industrial wastes appears to have continued past 1975. Specific dates of active filling in each of the three disposal areas are difficult to determine given the lack of detailed record keeping: The Puerto Rico Environmental Quality Board (EQB) (now the Puerto Rico Department of Natural and Environmental Resources, DNER) has information which indicates that the Landfill (all three disposal areas) was used in the late 1970s for disposal of wastes which contained hazardous substances.

The site was proposed for inclusion on the NPL in December 1982 and was subsequently approved and listed as an NPL site in September 1983. In 1984, a Remedial Action Master Plan (RAMP) was prepared by an EPA contractor for the Site. Based on the RAMP, a Remedial Investigation and Feasibility Study (RI/FS) Work Plan was developed. In September 1990, a Consent Order was signed in which ten settling defendants agreed to perform the RI/FS for the site. Pursuant to the Work Plan, sampling of subsurface soils, ground water and surface water was completed. The first phase of the RI was completed in 1992 and the second phase of the RI field work was completed in January 1994. A final RI report was received by EPA in March 1995 and a streamlined Risk Assessment was completed in May 1995. An abbreviated Final FS was conducted in accordance with EPA's Presumptive Remedy guidance and was received by EPA in September 1995.

FIFTH FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Barceloneta Landfill Site		
EPA ID: PRD980509129		
Region: 2	**State:** PR	**City/County:** Barceloneta
SITE STATUS		
NPL Status: Deleted		
Multiple OUs? No	**Has the site achieved construction completion?** Yes	
REVIEW STATUS		
Lead agency: EPA		
Author name (Federal or State Project Manager): Guillermo Hernandez-Lopez		
Author affiliation: EPA		
Review period: 9/5/2024 - 4/1/2025		
Date of site inspection: 10/11/2024		
Type of review: Statutory		
Review number: 5		
Triggering action date: 5/22/2020		
Due date *(five years after triggering action date)*: 5/22/2025		

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

EPA's Streamlined Risk Assessment evaluated any potential adverse effects to human health from exposure to chemical contamination present in the vicinity of the Site groundwater. The reasonable maximum human exposure was used. The results indicated that the levels of contaminants present in the groundwater pose a relatively low long-term threat to human health. However, if no action is taken with respect to the Landfill, the continued release of contaminants into groundwater could potentially result in a greater risk at some point in the future. Therefore, based on the results of the abbreviated Risk Assessment, EPA has determined that actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in the ROD, may present a current or potential threat to public health, welfare, or the environment. An ecological risk assessment was not conducted as part of the RI/FS (discussed under Question B).

Response Actions

Remedy Selection
On July 5, 1996, EPA issued a ROD for the site. The ROD selected the following remedial action objectives for the site:

- To prevent direct contact with waste material;
- To reduce or eliminate the potential for the Landfill disposal areas to release hazardous substances to groundwater;
- To reduce or eliminate the potential for migration of hazardous substances to groundwater downgradient of the Landfill;
- To prevent the migration of and control Landfill gas; and
- To minimize any potential future impacts of hazardous substances that may migrate into environmental media.

The selected remedy included:

- Installing a low-permeability cover system for the three Landfill cells meeting the requirements of (Resource Conservation and Recovery Act) RCRA Subtitle D and Puerto Rico's Regulations Governing Landfill Closure.
- Conducting long-term groundwater and surface water monitoring to evaluate the effectiveness of the cover system. It is anticipated that monitoring will be conducted on a quarterly basis for the first year, semi-annually for the next four years, and then annually.
- Regrading the site and installing storm water management improvements at the site to reduce infiltration of storm water into the Landfill and reduce leachate generation. Monitoring will include the eight existing monitoring wells. Initially, the wells will be sampled for a broad parameter list. The list has been developed based on constituents detected above maximum contaminant levels (MCLs) in the Remedial Investigation and on the requirements of the RCRA Subtitle D and Puerto Rico's Regulation Governing Landfill Closure. After the first five years, the parameter list would be reviewed and those parameters not detected above standards would be omitted. The exact long-term groundwater monitoring program will be further defined in the remedial design (RD).
- Conducting a landfill gas survey during predesign to determine the necessity of a landfill gas collection system. The appropriate type of system, if necessary, will be determined during RD.
- Implementing a long-term operation and maintenance program for the cover system which will include inspection of the system and provision for repair.
- Recommending, to appropriate authorities that institutional controls be established. Institutional controls are recommended in order to protect the integrity of the landfill cover system and to reduce potential exposure to landfill contents. The institutional controls will include recommending that zoning restrictions be established for the Site to limit future land use and that a deed restriction be established to limit future land and groundwater use.
- Installing a perimeter fence with signs to restrict access.
- Reevaluating site conditions at least once every five years to determine if a modification of the selected remedy is necessary.

Status of Implementation

On September 30, 1997, a Consent Decree (CD) memorialized a settlement whereby ten parties that had been identified as PRPs agreed to implement the remedy selected in the ROD. The PRPs hired M&S Ingenieria y Ciencia Asociados, who prepared remedial design plans and specifications that EPA approved on September 17, 1999. On December 16, 1999, EPA approved the Remedial Action Work Plan and the PRPs proposed M&S Ingenieria y Ciencia Asociados as their remedial action contractor.

EPA approved early Remedial Actions that were initiated prior to the final approval of the Remedial Design Report. These activities included the excavation and stockpiling of clay and the excavation and relocation of waste from a discovered waste area. They were initiated on September 7, 1999. On-site construction of the remedial action started on January 24, 2000, and was completed on August 30, 2000. The groundwater monitoring program started in June 2002.

The site property consists mainly of forested areas which provide a habitat for various plant, insect and animal species. In order to protect the landfill cap, trees will not be allowed to grow on the capped area. However, grasses will be permitted to grow, and it is expected that the Landfill areas will be comparable to the surrounding ecology. On October 3, 2011, the Site was deleted from the NPL.

IC Summary Table

Table 1: Summary of Planned and/or Implemented ICs

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Soil/Groundwater (GW)	Yes	Yes	Landfill Site, 20 acres, located at Florida Afuera Ward	No use and/or excavation of soil; GW shall not be withdrawn or extracted for any use.	Deed restriction for future land use and GW extraction February 22, 2010

Systems Operations/Operation & Maintenance

Post-construction operation and maintenance (O&M) activities are being implemented as described in the Operation and Maintenance and Post-Remediation Monitoring Manual (the "O&M Plan") approved by EPA. The O&M Plan for the site includes sitewide groundwater monitoring, and inspection and maintenance of the cap cover and stormwater management system, access roads, fencing, signage, monitoring wells and the gas venting system.

Sitewide Groundwater Monitoring

The groundwater monitoring program was developed during the RD phase. The system includes the eight existing monitoring wells. Groundwater sampling was conducted quarterly for the first year, semi-annually for the next four years, and currently is conducted annually. There were no contaminants of concern (COCs) formally identified in the 1996 ROD. Initially, the wells were sampled for a broad parameter list developed based on constituents detected above MCLs in the RI, RCRA Subtitle D requirements, and Puerto Rico's Regulation Governing Landfill Closure. The number of wells and list of parameters was later reduced based on the 2000 O&M Plan criteria.

The groundwater monitoring started in June 2002 and has been performed by PRP consultants. Currently, consistent with the September 2000 O&M Plan, five monitoring wells (MW-1, MW-4, MW-6, MW-7 and MW-8) are being sampled on an annual basis. Groundwater samples are analyzed for the following parameters: TSS; TDS; manganese; mercury; nickel; aluminum; chromium; and iron.

Sampling for emerging contaminants, such as per- and polyfluoroalkyl substances (PFAS) and 1,4-dioxane has not been performed at this site. In April 2024, EPA established MCLs for several PFAS compounds such as perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). The site's historic operations included accepting municipal and industrial waste for landfilling. PFAS and 1,4-dioxane are commonly associated with

landfills due to the variety of wastes disposed in them. Emerging contaminants should be evaluated in the next FYR period.

Cap Cover and Stormwater Management

During the last five years, the O&M activities for the cap cover and stormwater management have been performed at the site in accordance with the O&M Plan. O&M activities include visually inspecting the cap and stormwater management system and identifying areas of interest that could affect the integrity of the cap and the stormwater management system. Thereafter, these areas of interest are documented by the Barceloneta municipality's consultant and addressed by the municipality.

During this FYR period at least one unresolved issue related to an area of interest is outstanding. This area of interest consists of a subsidence/cavity in the Southeastern Disposal Area **(Figure 2)**. Other areas of interest were also identified during this period, including erosion areas, remaining tree stumps and filling of sinkholes along the cap perimeter at the Southeastern Disposal. These areas of interest were identified by the Barceloneta Municipality's consultants during quarterly inspections and were documented in the Quarterly Inspection Reports and summarized in the Summary of Maintenance Activities Required to be Performed (SMARP) for each year and are included in this FYR period. A summary is presented below:

Identified Areas of Interest - Outstanding

- **Subsidence/Cavity #1**: This area of interest was first identified by TrueLand Construction, LLC (former consultant for the municipality of Barceloneta) during June 2022 (2nd Quarter of 2022, April – June 2022). When first identified, the cavity had a length of approximately 20 feet wide and 15 feet deep. During the 2024 2nd Quarter report, the cavity expanded to approximately 132 feet wide along the perimeter of the mogote and a depth of approximately 40 feet deep. This cavity had not been observed during previous FYRs. However, at the end of the cap installation during the Remedial Action in September 2000, a subsidence was observed, and guidelines to address these subsidences in the future were included in the Remedial Action Construction Report, Appendix L – Guidelines for Remediation of Cavities Resulting from Subsidence of Waste Fill. Some of these guidelines are currently being implemented, including limiting access to the area with safety mesh and signage. Also, to limit runoff infiltration a temporary berm had been installed to divert runoff away from this area. A geotechnical engineering firm is being procured by the Barceloneta Municipality to address on-going expansion of the subsidence/cavity.
- Tree stumps were observed within the Southeastern Disposal Area that require further maintenance to prevent growth.
- Trees were observed in the perimeter of the cap within the Southeastern Disposal Area that will need to be cut to prevent damage to the cap.

Other Areas of Interest - Addressed

- **Subsidence/Cavity #2**: This area of interest was first identified by TrueLand Construction, LLC during January 2023 (4th Quarter of 2022, October - December 2022). The cavity was identified and measured approximately 40 feet along the mogote, 6 feet wide, and 5 feet deep. This area was addressed with fill material prior to the site inspection conducted on October 11, 2024.
- **Subsidence/Cavity #3**: This area of interest was first identified by Optimus Consulting & Management in June 2023 (2nd Quarter of 2023, April – June 2023). The subsidence was identified north of Subsidence/Cavity #1, it measured approximately 40 feet along the mogote, 25 feet wide, and 5 feet deep. This area was addressed with fill material and documented in the 2024 2nd Quarter Inspection Report.

- **Erosion Area #1**: This area of interest was first identified by TrueLand Construction, LLC during February 2021 (4th Quarter of 2020). This area was filled/repaired with soil and rock material, but it should be closely monitored to confirm the area stabilizes and not further eroded.
- **Erosion Area #2:** This area of interest was first identified by TrueLand Construction, LLC in February 2021 (4th Quarter of 2020). This area was addressed with fill material by the municipality.

Fencing and Signs, Access Roads, Monitoring Wells and Gas Venting System

The below observations were extracted from the Barceloneta Municipality's consultants during the June 2024 inspection (2nd Quarter of 2024, April – June 2024) quarterly inspections.

- **Fencing and signs:** Vegetation was observed growing close to and within a few small segments of the perimeter fence, which will need to be cleared. But overall, the perimeter fencing and gates, including signs were observed generally in good condition.
- **Access roads:** Erosion was observed in the Superfund Disposal Area access road. Specifically, close to the second gate that leads into the Superfund Disposal Area. All other areas were observed generally in good condition.
- **Monitoring wells:** All monitoring wells, including concrete pads, protective covers and bollards, and locks were observed to be in good condition. The pumps and tubing were documented in working condition during sampling activities by the Barceloneta Municipalities subcontractor.
- **Gas venting system:** Several gas vents were observed with vegetation, including small shrubs. Further maintenance work will be required to remove vegetation and small shrubs.

Remedy Resilience

Potential impacts from severe weather have been assessed, and the site may be impacted by more frequent and severe hurricanes. Increased storms may be contributing to further erosion of the cavities/subsidence observed onsite. EPA is and will continue to work with the PRPs to address these issues. The PRPs have created a temporary berm to limit runoff entering the cavities/subsidence and are working on a permanent solution. The potential also exists for future power outages as the frequency and magnitude of storm events increases. However, there is no active remedy at this site only operation and maintenance of the cap cover and groundwater well monitoring. The cap cover and well system will continue to be monitored at the site. Further details are included in **Appendix D**.

III. PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the 2020 FYR as well as the recommendations from the 2020 FYR.

Table 2: Protectiveness Determinations/Statements from the 2020 FYR

OU #	Protectiveness Determination	Protectiveness Statement
Sitewide	Protective	The remedy at the Barceloneta Landfill currently protects human health and the environment.

No issues were identified as part of the 2020 FYR.

IV. FIVE-YEAR REVIEW PROCESS

Community Notification, Involvement & Site Interviews

On August 7, 2024, EPA Region 2 posted a notice on its website indicating that it would be reviewing site cleanups and remedies at Superfund sites in New York, New Jersey, and Puerto Rico, including the Barceloneta Landfill Superfund site. The announcement can be found at the following web address: https://www.epa.gov/superfund/R2-fiveyearreviews.

In addition to this notification, the EPA Community Involvement Coordinator (CIC) for the site, Brenda Reyes, posted a public notice on the EPA site webpage https://www.epa.gov/superfund/barceloneta-landfill and provided the notice to the Barceloneta Municipality by email on January 27, 2025, with a request that the notice be posted in municipal offices and on the village/town webpages. This notice indicated that a Five-Year Review (FYR) would be conducted at the Barceloneta Landfill site to ensure that the cleanup at the site continues to be protective of human health and the environment. Once the FYR is completed, the results will be made available at the following repository: Barceloneta Municipality Public Library. In addition, the final report will be posted on the following website: https://www.epa.gov/superfund/barceloneta-landfill. Efforts will be made to reach out to local public officials to inform them of the results."

Data Review

Pursuant to the ROD, O&M activities include monitoring of the groundwater to detect changes in contaminant concentrations. Currently, five groundwater monitoring wells are sampled and analyzed on an annual basis for manganese, mercury, nickel, aluminum, chromium, iron, TDS, and TSS. The results are compared to the MCLs, or Secondary Drinking Water Standards (SDWS) identified in the ROD. Nickel does not currently have an MCL. However, all previous FYRs compare nickel to its former MCL of 0.1 mg/L. This FYR will also compare nickel results to its former MCL for consistency. The criteria for the current analytes are as follows:

Analyte	Criteria
Manganese	0.05 mg/L based on SDWS
Mercury	0.002 mg/L based on MCL
Nickel	0.1 mg/L based on former MCL
Aluminum	0.05 to 0.2 mg/L based on SDWS
Iron	0.3 mg/L based on SDWS
Chromium	0.1 mg/L based on MCL
TSS	None
TDS	500 mg/L based on SDWS

Locations of the monitoring wells and results of the latest June 2024 monitoring well groundwater sampling are included in **Figure 3** of **Appendix B**. Historical results for each well, including for the past five years are included in **Appendix C**.

MW-1

Analytical results from MW-1, the upgradient background well, did not show contaminant concentrations above MCLs or SDWSs. The results of this sampling period show a decrease when compared to the results of the previous FYR sampling period; where manganese and iron exceeded their respective SDWS, and nickel and chromium exceeded their MCLs.

MW-4

Overall, analytical results from MW-4 during this review period are consistent with the previous FYR, except for the June 2022 sampling event results. The analytical results from the 2022 sampling event showed approximately

an increase of one-order of magnitude when compared to the 2021 sampling results for all analytes except for TDS. A detailed description is provided below for each analyte:

- TSS concentrations have been consistently above historical concentrations, including the two highest concentrations observed since sampling began in 2002, with 37.4 mg/L in June 2024 and 306 mg/L in June 2022.
- TDS concentrations are consistent with historical results and show a decreasing trend since June 2022. This differs from the previous FYR when TDS concentrations had not shown a decreasing trend.
- Manganese exceeded its SDWS of 0.05 mg/L for three out of the five years during this review period, with results ranging from 0.0225 mg/L to 0.26 mg/L. This shows an increase from the previous FYR manganese concentrations, which ranged from 0.0102 mg/L to 0.0897 mg/L. The June 2022 result of 0.26 mg/L is the highest since the April 2007 sampling event.
- Mercury concentrations were above the MCLs in four of the five years of this reporting period, including an exceedance of one-order of magnitude in June 2022 (0.192 mg/L), which is currently the highest concentration observed since monitoring began.
- Nickel barely exceeded its former MCL for two out of the five years during this reporting period. The MCL exceedances were similar with 0.129 mg/L in June 2022, and 0.124 mg/L in June 2023. Nickel has not exceeded MCLs in MW-4 since September 2006. The June 2024 results were below the MCL.
- Aluminum concentrations have been historically non-detect except for the March 2018 sampling event. However, concentrations were above the SDWS during this reporting period for three (June 2021, June 2022 and June 2024) out of the five sampling events. This includes the two highest concentrations (11.5 mg/L in June 2022, and 2.47 mg/L in June 2024) for this monitoring well since sampling started in 2012.
- Iron concentrations exceeded the SDWS in three (June 2021, June 2022 and June 2024) out of the five sampling events. This includes the two highest concentrations (17.3 mg/L in June 2022, and 4.49 mg/L in June 2024) for this well since sampling started in 2012.
- Chromium concentrations exceeded the MCL (0.1 mg/L) in June 2022 (0.853 mg/L) and June 2024 (0.182 mg/L), however it was non-detect during the July 2023 sampling event.

MW-6

Analytical results from the downgradient well, MW-6, are mostly consistent with the previous FYR. A detailed description is provided below for each analyte:

- TSS and TDS were consistent during this reporting period when compared to the previous FYR.
- Manganese concentrations have been consistently exceeding the SDWS (0.05 mg/L), similar to the previous FYR with the exception of a noticeable increase during the July 2023 sampling event (1.74 mg/L).
- Mercury was not detected in MW-6, similar to historical results.
- Nickel concentrations have been consistently exceeding its former MCL, and during the last three sampling events showed a slight increase in concentrations when compared to the previous FYR.
- Aluminum concentrations are similar to the previous FYR, where concentrations range from non-detect to slightly above the SDWS.
- Iron concentrations have been consistently above its SDWS, and results are consistent with the previous FYR.

MW-7

Analytical results from the downgradient well, MW-7, are mostly consistent with the previous FYR. A detailed description is provided below for each analyte:

- TSS and TDS were consistent during this reporting period when compared to the previous FYR, including TDS exceedances of its SDWS.
- Manganese concentrations decreased and were non-detect during this reporting period.
- During the June 2024 sampling event, mercury was detected (0.00033 mg/L) at MW-7 above its MCL. Prior sampling events have not detected mercury at MW-7.
- Nickel and aluminum concentrations were non-detect during this reporting period, similar to concentrations during the previous FYR.
- Iron concentrations continued to be reported above its SDWS and showed a slight increase in the last two annual sampling events after its lowest result in June 2020. These results are within the range of concentrations of the previous FYR.
- Chromium concentrations continue to be detected below its MCL, similar to concentrations reported in the previous FYR.

MW-8

Analytical results from the downgradient well, MW-8, are mostly consistent with the previous FYR. A detailed description is provided below for each analyte:

- TSS and TDS were below their SDWS and results are consistent when compared to the previous FYR.
- Except for the July 2023 annual sampling event results, which showed a detection of 0.0298 mg/L, manganese concentration were non-detect during this reporting period.
- Mercury, nickel, and aluminum concentrations were non-detect during this reporting period, similar to historical concentration trends and the previous FYR.
- With the exception of the July 2023 annual sampling event, which showed an exceedance of the SDWS, iron concentrations have been below the SDWS and consistent with the previous FYR.
- With the exception of the July 2023 annual sampling event, which showed an exceedance of the MCL, chromium concentrations have been below the MCL and consistent with the previous FYR.

Overall, the groundwater data showed stable and consistent concentrations when compared to the previous FYR. The only noticeable results were from the June 2022 event in MW-4 where elevated concentrations were observed for manganese, mercury, nickel, aluminum, iron and chromium when compared to historical concentrations. These results, however, largely decreased to historical concentrations during the following sampling event performed in July 2023 although results remained elevated for select compounds and wells compared to historical trends in 2024, particularly within MW-4. The direction of groundwater flow continues to the north. Wells MW-7 and MW-8, further downgradient from MW-4, either showed no impacts in 2024 (MW-8) or iron and TDS results slightly above their respective criteria (MW-7). Residents in the vicinity receive drinking water from a municipal water supply, which is located upgradient of the landfill.

Site Inspection

The inspection of the site was conducted on October 11, 2024. In attendance were Guillermo Hernandez-Lopez, RPM, and Adalberto Bosque, RPM and Supervisor. Ms. Eris Galan, from the Barceloneta municipality, greeted EPA and then left. The municipality was represented by their consultants, Naret Treviño and Teran Treviño from Optimus Consulting & Management.

During the site inspection, as noted in the Annual Reports for this FYR from the Barceloneta Municipality, EPA observed several areas with subsidence, cavities, and erosion within the south-southeastern portion of the Southeastern Disposal Area between the cap limits and the mogotes. Except for subsidence/cavity #1, the rest of the areas have been addressed and are being monitored. EPA also noted tree stumps within the limits of the cap

along the east to southeastern, and south portion of the Southeastern Disposal Area. Several trees were observed along the east to southeastern portion of the Southeastern Disposal Area.

The access controls and restrictions were implemented in the form of fences, locked gate and signs around the site and were generally in good condition. The signs indicating that the landfill is a Superfund site were presented in both Spanish and English. This action prevents entry to the site. Minor access road repair was required near the Superfund Disposal Area, but the rest of the access roads were generally in good condition. Several gas vents required additional maintenance, including vegetation clearing. The monitoring wells, including the concrete pads, protective covers, bollards and locks appeared to be working as intended. Therefore, although repairs for the subsidence/cavity and erosion area are still pending in the Southeastern Disposal Area, the Northern Disposal Area and the Superfund Disposal Area generally appear to be maintained in accordance with the O&M Plan.

V. TECHNICAL ASSESSMENT

QUESTION A: Is the remedy functioning as intended by the decision documents?

The remedy selected in the 1996 ROD included: (1) installing a low-permeability cover system for the three landfill cells meeting the requirements of the RCRA Subtitle D and Puerto Rico's Regulations Governing Landfill Closure; (2) regarding the site and installing storm water management improvements at the site to reduce infiltration of storm water into the landfill and reduce leachate generation; (3) conducting long-term groundwater and surface water monitoring to evaluate the effectiveness of the cover system; (4) conducting a landfill gas survey during predesign to determine the necessity of a landfill gas collection system; (5) implementing an O&M program to inspect the cover system and repair, if necessary; and, (6) implementing institutional controls to protect the integrity of the landfill and install fence to restrict access.

The landfill cap and gas venting system have been constructed on the site. Both engineered remedies are maintained and monitored by the PRPs' contractor and results reviewed by EPA. In addition, the surface water monitoring requirement in the ROD is no longer being implemented. This is because the surface water conditions have changed in the area and there are no longer permanent surface water features on site.

A review of the groundwater monitoring data indicated some variable results during this FYR period. The majority of groundwater results were consistent with the trends reported in the previous FYR, however, the data from on-site well MW-4 were considerably elevated in 2022. Although the concentrations decreased by the latest sampling event in 2024, the results for select analytes such as TSS, aluminum and iron remained elevated compared to previous results. Since the concentrations observed in the downgradient wells remained stable and consistent with historic results, it appears the remedy remains effective in reducing the migration of contamination to groundwater. Nevertheless, inspections have shown three cavities, and two areas impacted by erosion at the southeastern disposal area. Two of the cavities and the erosional areas have been addressed but will need to be monitored. The remaining cavity, however, is considerably larger (132 feet wide) and deeper (approximately 40 feet). This area exposes material underneath the cap and could potentially lead to greater rates of infiltration into the groundwater. The PRPs have created a temporary berm to limit runoff entering the cavities/subsidence and are working on permanent solution. MW-4 is located just downgradient of these areas. Groundwater monitoring will continue to further evaluate whether these cavities may be contributing to elevated concentrations similar to those observed in 2022. While the downgradient wells appear to remain unaffected, the cavities and erosional areas should be addressed to prevent potential infiltration in the future. It is important to note, however, that the remaining cavity extends across a longer portion of the mogote compared to the others, which has created access and equipment stabilization obstacles for complete characterization due to the steep grade. Thus, efforts to further characterize the subsurface extent of the cavity and to remedy the subsidence are likely to encounter significant engineering issues which will need to be further assessed in the next FYR period.

The Municipality of Barceloneta has implemented the institutional controls at the site. The institutional controls include a Deed Restriction on soil and groundwater use in the future. The necessary zoning restrictions and deed restrictions are in place. These controls were placed on the Barceloneta Landfill Deed on October 3, 2011.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

At this time, the remedial action objectives continue to be valid. The objectives have been met and verified by the installation of a low-permeability cover system, long-term groundwater monitoring, and the establishment of institutional controls. However, there are erosion and subsidence issues impacting the landfill cap within southeastern disposal area over the past five years. Exposure via direct contact to the waste material is incomplete and concentrations of contaminants in downgradient groundwater are below MCLs or EPAs Regional Screening Levels (RSLs). In addition, because ingestion of drinking water is not occurring, nor is it expected to occur in the next five years, this pathway is currently incomplete. Comparing the groundwater results to the MCLs or RSLs remains valid.

Vapor intrusion was previously evaluated in the 2005 FYR, which determined that the pathway was not a concern, this pathway is still considered incomplete and not expected to be a concern at this time.

Sampling for emerging contaminants, such as PFAS and 1,4-dioxane has not been performed at this site. While operating, the landfill accepted waste from a variety of municipal and industrial entities which may be associated with these contaminants. PFAS specifically has been linked to a variety of potential sources including construction materials, cleaning agents, electronic products, food packaging, cosmetics, personal care products among many others which may also be associated with the wastes accepted by the landfill while in operation[1]. Emerging contaminants should be evaluated in the next FYR period. There are no drinking water wells immediately downgradient of the landfill. Residents in the immediate vicinity (less than 0.25 mile) receive their drinking water from the public water supply, which are sampled to comply with drinking water standards. In addition, the supply wells are located upgradient to the landfill.

No ecological risk assessment was completed as part of the RI/FS in support of the 1996 ROD. However, the remedy has eliminated surface soil exposure to ecological receptors by the installation of a low permeability cover system. Sampling conducted at the Ojo de Guillo Spring (over 3,100 feet from the site) during the RI indicated that only iron was elevated. Based on the data from the long-term groundwater monitoring, low level metals were detected in the downgradient wells. The Rio Grande de Manati (river) and the Caño Tiburones (wetlands) are beyond this area at approximately 1.7 miles from the site. Therefore, it is unlikely that the low-level detections in groundwater would impact these surface water bodies. In addition, after the 2010 FYR, a site visit indicated that there was no surface water within the site that was in contact with the landfill or hydraulically connect to the groundwater emanating from the landfill. Therefore, although an ecological risk assessment was not performed during the RI, the remedy has effectively eliminated all routes of exposure to site contamination to ecological receptors.

QUESTION C: Has any **other** information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

[1] L. Gaines. “Historical and current usage of per- and polyfluoroalkyl substances (PFAS): A literature review”, American Journal of Industrial Medicine.

VI. ISSUES/RECOMMENDATIONS

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
None
Issues and Recommendations Identified in the Five-Year Review:

OU(s): 1	**Issue Category: Changed Site Conditions**			
	Issue: Erosion and areas of subsidence (e.g., sinkholes/cavities) have been identified in the southeastern disposal area. If Subsidence/Cavity #1 is not addressed it could potentially lead to stormwater contacting waste material underneath the cap, thus impacting groundwater. This occurrence could also impact the integrity of the cap in the adjacent area of the subsidence/cavity. This cavity extends across a large portion of the mogote, creating access and equipment stabilization issues. Efforts to further characterize and remedy the subsidence are likely to encounter significant engineering issues.			
	Recommendation: Perform an evaluation to determine the extent of the subsidence cavity and evaluate and implement a solution to address the on-going expansion of the subsidence areas.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	4/1/2030

OU(s):	**Issue Category: Monitoring**			
	Issue: Based on the site's historic use as a landfill accepting waste from various municipal and industrial entities, emerging contaminants such as PFAS and 1,4-dioxane may be present.			
	Recommendation: Groundwater at the site should be sampled for emerging contaminants, including PFAS and 1,4-dioxane.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	9/30/2027

OTHER FINDINGS

During the site inspection, tree stumps and trees were observed within the limits of the cap cover but do not appear to be impacting the cap integrity. However, if left unattended it could affect the cover integrity in the future. Therefore, it is suggested that these tree stumps and trees are removed/cut in the near term. EPA will work with the PRPs to ensure this maintenance continues to prevent vegetative growth from potentially impacting the cap in the future.

In addition, minor access road repair is required near the Superfund Disposal Area and several gas vents required additional maintenance, including vegetation clearing.

VII. PROTECTIVENESS STATEMENT

Protectiveness Statement(s)	
Operable Unit: 1	*Protectiveness Determination:* Short-term Protective
Protectiveness Statement: The remedy for the Barceloneta Landfill is protective of human health and the environment in the short term, as there are no complete exposure pathways. For the remedy to be protective in the long term, the subsidence expansion needs to be controlled and repaired, and the presence of emerging contaminants needs to be evaluated.	

Sitewide Protectiveness Statement
Protectiveness Determination: Short-term Protective
Protectiveness Statement: The remedy for the Barceloneta Landfill is protective of human health and the environment in the short term as there are no complete exposure pathways. For the remedy to be protective in the long term, the subsidence expansion needs to be controlled and repaired, and the presence of emerging contaminants needs to be evaluated.

VIII. NEXT REVIEW

The next FYR report for the Barceloneta Landfill Superfund Site is required five years from the completion date of this review.

APPENDIX A – REFERENCE LIST

Document Name	Document Date
Record of Decision, Barceloneta Landfill Site	July 1996
Operation and Maintenance and Post Remediation Monitoring Manual	March 2000
Remedial Action Construction Report	November 2000
First Five-Year Review Report	August 11, 2005
Second Five-Year Review Report	August 30, 2010
Third Five-Year Review Report	September 17, 2015
Fourth Five-Year Review Report	May 22, 2020
Ground Water Monitoring Report, Year Seventeenth (17th) – June 2020, by TrueLand Construction, LLC	August 20, 2020
Annual Report, Year 2020, by TrueLand Construction, LLC	March 24, 2021
Ground Water Monitoring Report, Year Eighteenth (18th) – June 2021, by TrueLand Construction, LLC	September 18, 2021
Annual Report, Year 2021, by TrueLand Construction, LLC	February 28, 2022
Ground Water Monitoring Report, Year Eighteenth (19th) – June 2022, by TrueLand Construction, LLC	September 30, 2022
Annual Report, Year 2022, by Optimus Consulting & Management, PSC	February 28, 2023
Ground Water Monitoring Report, Twentieth Year (20th) – July 2023, by Optimus Consulting & Management, PSC	September 18, 2023
Annual Report, Year 2023, by Optimus Consulting & Management	February 26, 2024
Ground Water Monitoring Report, Twenty-First Year (21st) – June 2024, by Optimus Consulting & Management, PSC	September 23, 2024
Quarterly Inspection Report, 2024, First (1st) Quarter (January – March)	May 15, 2024
Quarterly Inspection Report, 2024, Second (2nd) Quarter (April – June)	June 30, 2024

APPENDIX B – FIGURES

Figure 1: Site Location Map

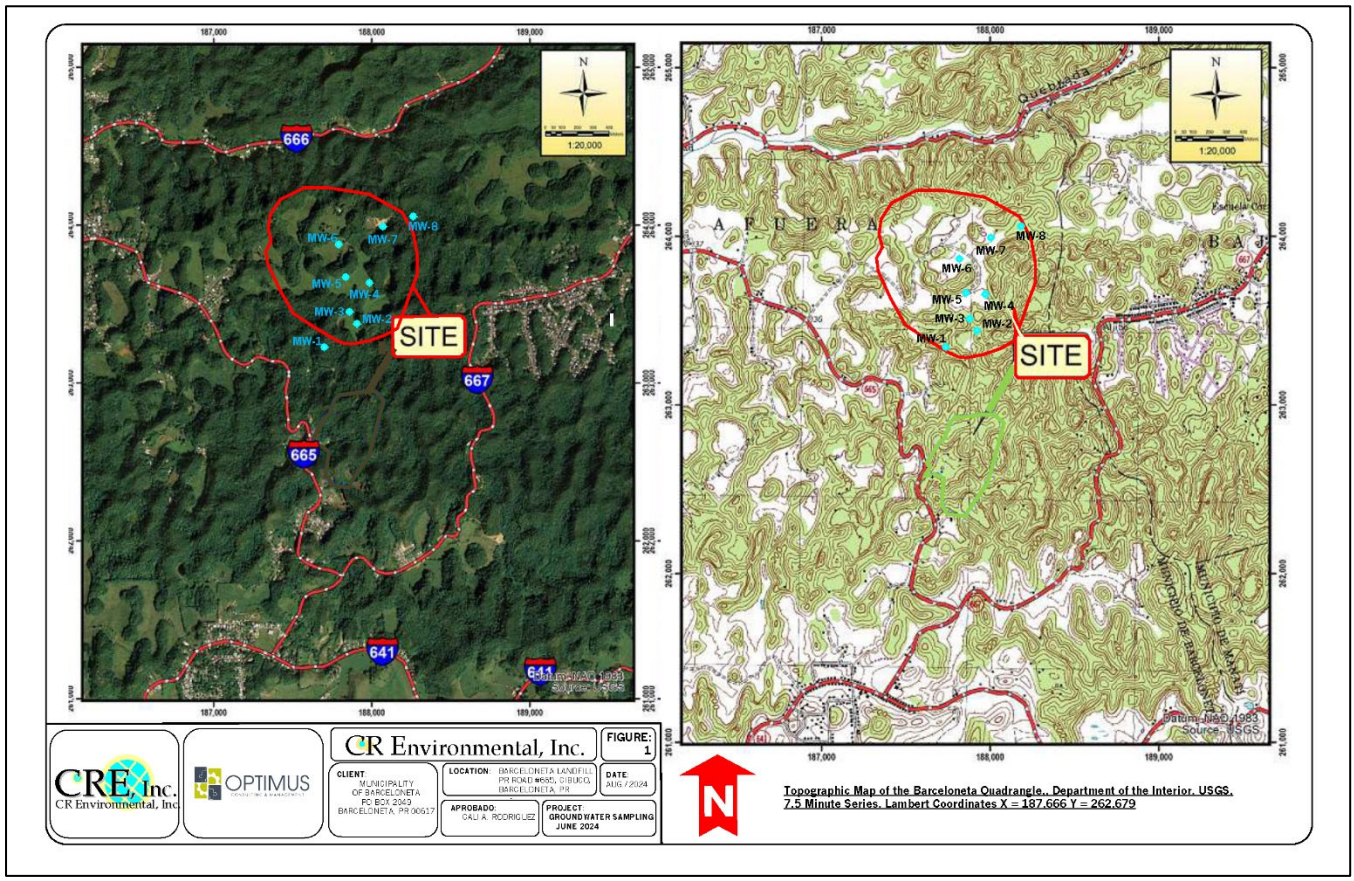


Figure 2: Subsidence/Cavities and Areas of Erosion Site Location Map

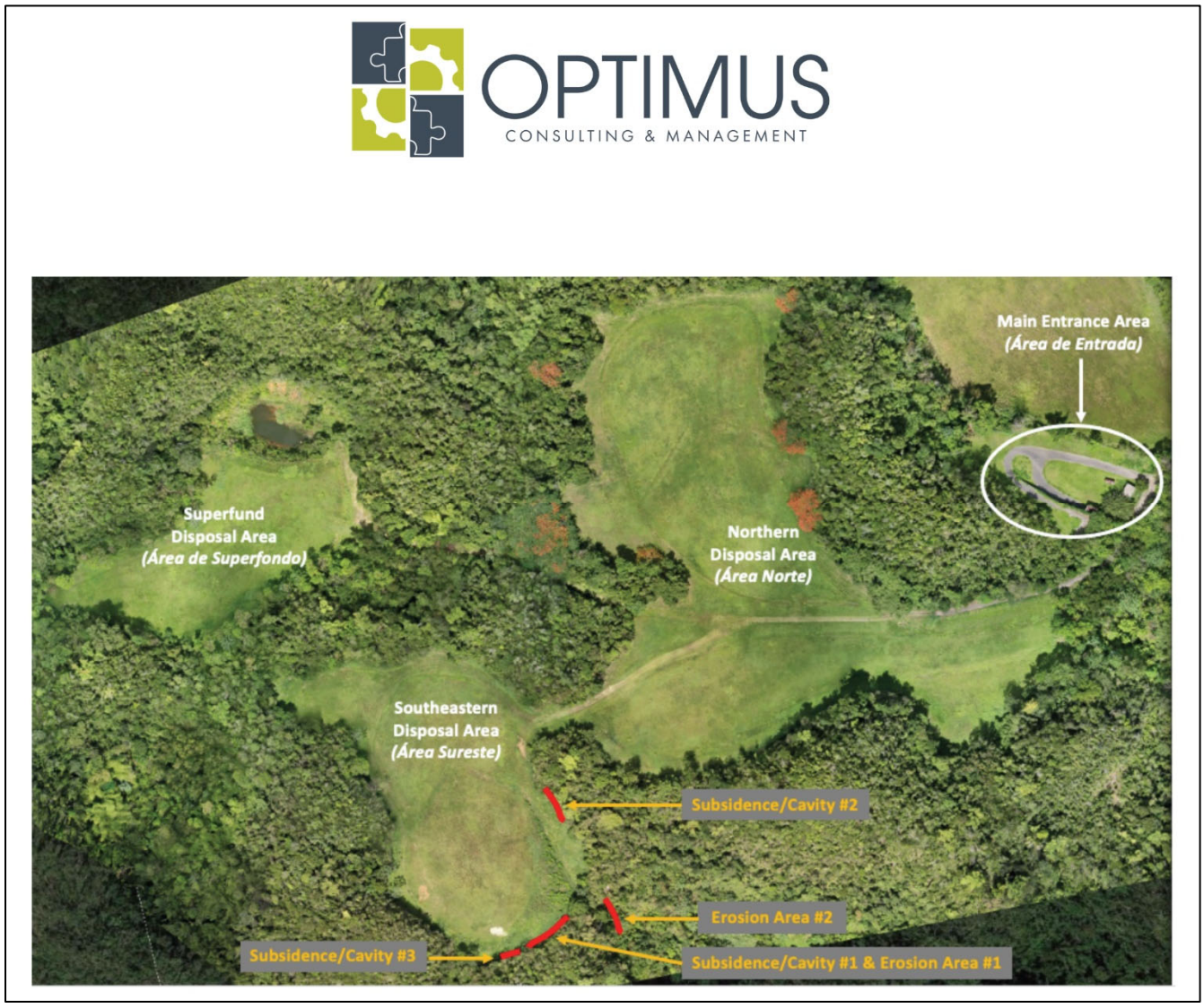
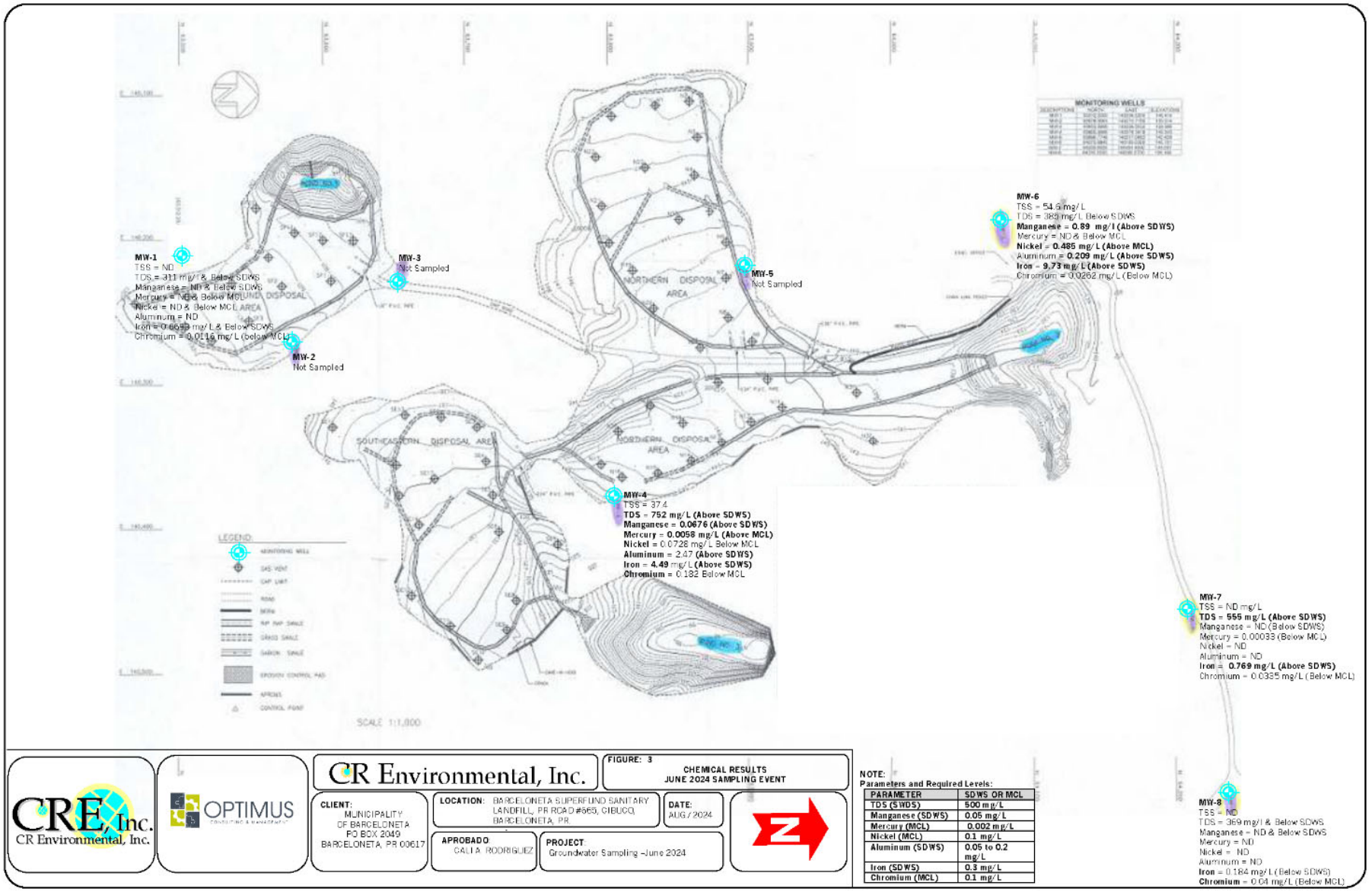


Figure 3: Monitoring Well Groundwater Results



APPENDIX C – TABLES

Table 1: Chronology of Site Events	
Event	**Date (s)**
Final NPL listing	9/1/1983
ROD signature	7/5/1996
Enforcement documents (CD, AOC, Unilateral Administrative Order)	9/28/1990
Consent Decree Civil Action No. 98-1013 JAF	9/30/1997
Remedial design complete	9/30/1997
On-site remedial action (RA) construction start	1/24/2000
Remedial Action Complete	11/8/2001
Final Close-out Report	8/8/2011
Deletion from NPL	10/3/2011
First Five-Year Review	8/11/2005
Second Five-Year Review	8/30/2010
Third Five-Year Review	9/17/2015
Fourth Five-Year Review	5/22/2020
Current Fifth Five-Year Review	4/30/2025

TABLE 2
CHEMICAL ANALYSIS OF GROUNDWATER SAMPLES (HISTORICAL RESULTS)
BARCELONETA SUPERFUND SITE

Location	Sample Date	TSS (mg/L)	TDS (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Aluminum (mg/L)	Iron (mg/L)	Chromium (mg/L)
MW-1	Jun-02	NT	NT	NT	NT	NT	-	-	-
	Oct-02	NT	NT	NT	NT	NT	-	-	-
	Dec-02	NT	NT	NT	NT	NT	-	-	-
	Mar-03	NT	NT	NT	NT	NT	-	-	-
	Oct-03	1	330	ND	ND	0.051	-	-	-
	Dec-03	ND	290	ND	ND	0.026	-	-	-
	Mar-04	ND	340	0.012	ND	0.077	-	-	-
	Jun-04	2	430	0.027	ND	0.041	-	-	-
	Sep-04	ND	320	0.038	ND	0.065	-	-	-
	Mar-05	3	360	**0.16**	ND	**0.16**	-	-	-
	Sep-05	3	344	**0.187**	ND	**0.136**	-	-	-
	Apr-06	3	326	**0.037**	ND	**0.146**	-	-	-
	Sept-06	3	356	**0.0595**	ND	**0.0787**	-	-	-
	Apr-07	ND	324	**0.0616**	ND	**0.095**	-	-	-
	Apr-08	-	-	-	-	-	-	-	-
	Oct-09	25.5	325	**0.0557**	ND	**0.281**	-	-	-
	Mar-10	ND	310	ND	ND	ND	-	-	-
	Mar-11	ND	325	0.015	ND	0.04	-	-	-
	Oct-12	ND	364	ND	ND	0.0051	ND	0.131	0.0289
	Oct-13	ND	338	ND	ND	ND	ND	ND	ND
	Nov-14	ND	410	ND	ND	**0.0542**	ND	0.156	ND
	Nov-15	ND	325	ND	ND	ND	ND	0.0564	ND
	Nov-16	4.0	350	0.0318	ND	0.0495	ND	**2.34**	**0.506**
	Mar-18	15.0	320	**0.101**	ND	**0.155**	ND	**5.96**	**1.58**
	April-19	6.0	285	0.0235	ND	ND	ND	**0.816**	0.0725
	June-20	ND	225	ND	ND	ND	ND	0.23	0.0374
	June-21	ND	315	ND	ND	ND	ND	0.0673	0.0109
	June-22	ND	465	ND	ND	ND	ND	0.176	0.0238
	July-23	ND	310	ND	ND	ND	ND	0.0542	0.0119
	Jun-24	ND	311	ND	ND	ND	ND	0.0693	0.0116
RL		**4**	**10**	**0.01**	**0.0002**	**0.04**	**0.200**	**0.050**	**0.010**
MCL		**NONE**	**-**	**-**	**0.002**	**0.1**	**NA**	**NA**	**0.1**
SDWS		**NONE**	**500**	**0.05**	**-**	**NONE**	**0.05 TO 0.2**	**0.3**	**NA**

TABLE 2 (CONTINUED)
CHEMICAL ANALYSIS OF GROUNDWATER SAMPLES (HISTORICAL RESULTS)
BARCELONETA SUPERFUND SITE

		TSS	TDS	Manganese	Mercury	Nickel	Aluminum	Iron	Chromium
Location	Sample Date	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
MW-4	Jun-02	2.0	**750**	ND	**0.0080**	0.042	-	-	-
	Oct-02	7.0	**760**	ND	**0.0088**	0.056	-	-	-
	Dec-02	6.0	**830**	ND	**0.0076**	0.063	-	-	-
	Mar-03	ND	**780**	0.011	**0.0078**	0.069	-	-	-
	Oct-03	3.0	**780**	0.012	**0.0054**	0.062	-	-	-
	Dec-03	NT	NT	NT	NT	NT	-	-	-
	Mar-04	6	**870**	ND	**0.0059**	0.031	-	-	-
	Jun-04	NT	NT	NT	NT	NT	-	-	-
	Sep-04	6	300	ND	0.014	0.027	-	-	-
	Mar-05	5	**960**	ND	**0.0072**	ND	-	-	-
	Sep-05	ND	**772**	0.0212	**0.00777**	0.0107	-	-	-
	Apr-06	1	**890**	0.124	**0.0024**	**0.125**	-	-	-
	Sept-06	ND	**956**	**0.557**	0.00104	**0.217**	-	-	-
	Apr-07	ND	**902**	**0.517**	**0.0086**	0.0603	-	-	-
	Apr-08	-	**-**	-	**-**	-	-	-	-
	Oct-09	ND	**978**	0.0297	**0.00465**	0.0703	-	-	-
	Mar-10	ND	**1020**	ND	**0.00615**	ND	-	-	-
	Mar-11	ND	**712**	0.0233	**0.00132**	ND	-	-	-
	Oct-12	0.95	**550**	0.0159	**0.0045**	0.0203	ND	**0.303**	**0.12**
	Oct-13	12.5	**695**	0.0134	0.00190	ND	ND	ND	ND
	Nov-14	ND	**945**	0.0125	**0.0058**	0.066	ND	0.0568	0.0125
	Nov-15	7.0	**1090**	0.0451	**0.0063**	0.0813	ND	0.223	0.0288
	Nov-16	ND	**1200**	0.0102	**0.0064**	ND	ND	ND	ND
	Mar-18	21	**740**	**0.0897**	0.00085	ND	**1.32**	**2.17**	0.0688
	April-19	4.0	**770**	**0.0517**	0.00086	0.0542	ND	0.190	ND
	June-20	7.0	405	**0.0961**	0.001	0.0507	ND	0.154	ND
	June-21	15	**835**	0.0225	**0.0034**	ND	**0.411**	**0.518**	0.0281
	June-22	306	**1040**	**0.26**	**0.0192**	**0.129**	**11.5**	**17.3**	**0.853**
	July-23	ND	**885**	0.0275	**0.0031**	**0.124**	ND	0.16	ND
	Jun-24	37.4	**752**	**0.0676**	**0.0058**	0.0728	**2.47**	**4.49**	0.182
RL		**4**	**10**	**0.01**	**0.0002**	**0.04**	**0.200**	**0.050**	**0.010**
MCL		**NONE**	**-**	**-**	**0.002**	**0.1**	**NA**	**NA**	**0.1**
SDWS		**NONE**	**500**	**0.05**	**-**	**NONE**	**0.05 TO 0.2**	**0.3**	**NA**

TABLE 2 (CONTINUED)
CHEMICAL ANALYSIS OF GROUNDWATER SAMPLES (HISTORICAL RESULTS)
BARCELONETA SUPERFUND SITE

		TSS	TDS	Manganese	Mercury	Nickel	Aluminum	Iron	Chromium
Location	Sample Date	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
MW-6	Jun-02	NT	NT	NT	NT	NT	-	-	-
	Oct-02	57	430	**0.84**	ND	**0.84**	-	-	-
	Dec-02	33	390	**0.3**	ND	**0.60**	-	-	-
	Mar-03	5.0	**590**	**0.21**	ND	**0.36**	-	-	-
	Oct-03	12.0	430	**0.13**	ND	**0.28**	-	-	-
	Dec-03	NT	NT	NT	NT	NT	-	-	-
	Mar-04	24	420	**0.24**	ND	**0.52**	-	-	-
	Jun-04	NT	NT	NT	NT	NT	-	-	-
	Sep-04	4	370	**0.16**	ND	**0.29**	-	-	-
	Mar-05	19	410	**0.58**	ND	**0.46**	-	-	-
	Sep-05	ND	364	**1.27**	ND	**0.485**	-	-	-
	Apr-06	21	330	**1.04**	ND	**0.41**	-	-	-
	Sept-06	4	362	**1.06**	ND	**0.341**	-	-	-
	Apr-07	9	334	**0.535**	ND	**0.226**	-	-	-
	Apr-08	-	-	**-**	-	**-**	-	-	-
	Oct-09	33.5	335	**2.18**	ND	**0.768**	-	-	-
	Mar-10	7.50	325	**0.365**	ND	**0.254**	-	-	-
	Mar-11	6.50	340	**0.434**	ND	**0.192**	-	-	-
	Oct-12	8.4	303	**0.135**	ND	0.0971	**0.141**	**1.19**	0.0064
	Oct-13	ND	358	**0.290**	ND	**0.222**	ND	**2.920**	ND
	Nov-14	4.0	410	**0.668**	ND	**0.373**	ND	**5.44**	ND
	Nov-15	13.0	390	**0.418**	ND	**0.255**	**0.413**	**3.20**	0.0162
	Nov-16	24.0	370	**0.203**	ND	**0.314**	**0.338**	**6.48**	0.0341
	Mar.-18	5.0	300	**0.442**	ND	**0.255**	**0.204**	**3.30**	0.0199
	April-19	5.0	330	**0.214**	ND	**0.114**	ND	**0.63**	ND
	June-20	10	390	**0.501**	ND	**0.195**	**0.416**	**2.82**	0.0174
	June-21	6	370	**0.147**	ND	**0.105**	<0.20	**1.01**	ND
	June-22	5.0	380	**0.605**	ND	**0.210**	ND	**2.240**	0.0109
	July-23	19	340	**1.74**	ND	**0.609**	ND	**7.36**	0.023
	Jun-24	54.6	385	**0.89**	ND	**0.485**	**0.209**	**9.73**	0.0262
RL		**4**	**10**	**0.01**	**0.0002**	**0.04**	**0.200**	**0.050**	**0.010**
MCL		**NONE**	**-**	**-**	**0.002**	**0.1**	**NA**	**NA**	**0.1**
SDWS		**NONE**	**500**	**0.05**	**-**	**NONE**	**0.05 TO 0.2**	**0.3**	**NA**

TABLE 2 (CONTINUED)
CHEMICAL ANALYSIS OF GROUNDWATER SAMPLES (HISTORICAL RESULTS)
BARCELONETA SUPERFUND SITE

Location	Sample Date	TSS (mg/L)	TDS (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Aluminum (mg/L)	Iron (mg/L)	Chromium (mg/L)
MW-7	Jun-02	2.0	**620**	ND	ND	ND	-	-	-
	Oct-02	NT	NT	NT	NT	NT	-	-	-
	Dec-02	NT	NT	NT	NT	NT	-	-	-
	Mar-03	5.0	370	ND	ND	0.043	-	-	-
	Oct-03	3.0	**620**	0.01	ND	0.031	-	-	-
	Dec-03	NT	NT	NT	NT	NT	-	-	-
	Mar-04	3	**590**	ND	ND	0.039	-	-	-
	Jun-04	NT	NT	NT	NT	NT	-	-	-
	Sep-04	ND	**520**	0.021	ND	0.099	-	-	-
	Mar-05	4	**520**	0.034	ND	0.064	-	-	-
	Sep-05	ND	**514**	0.0138	ND	0.0558	-	-	-
	Apr-06	2	**558**	ND	ND	0.0351	-	-	-
	Sept-06	4	**574**	0.0413	ND	0.0854	-	-	-
	Apr-07	ND	**534**	0.0147	ND	0.0359	-	-	-
	Apr-08	-	**-**	-	-	-	-	-	-
	Oct-09	ND	**510**	ND	ND	ND	-	-	-
	Mar-10	ND	460	0.0154	ND	0.0611	-	-	-
	Mar-11	ND	445	0.0191	ND	0.0469	-	-	-
	Oct-12	2.8	484	0.0147	ND	0.0554	ND	**0.574**	0.0234
	Oct-13	ND	**522**	0.0519	ND	0.0631	ND	**2.260**	0.0549
	Nov-14	ND	**600**	ND	ND	ND	ND	0.275	ND
	Nov-15	9.0	**710**	0.0153	ND	0.0544	ND	**0.374**	0.0229
	Nov-16	ND	**670**	ND	ND	ND	ND	ND	ND
	Mar.-18	ND	**630**	0.0203	ND	ND	ND	**0.855**	0.0601
	April-19	5.0	**555**	0.0168	ND	ND	ND	**1.52**	0.0441
	June-20	ND	**545**	ND	ND	ND	ND	0.152	ND
	June-21	6.0	**665**	ND	ND	ND	ND	**0.384**	0.0112
	June-22	6.0	**665**	ND	ND	ND	ND	**0.307**	0.0104
	July-23	6	**575**	ND	ND	ND	ND	**0.426**	0.0308
	Jun-24	ND	**555**	ND	0.00033	ND	ND	**0.769**	0.0335
RL		4	10	0.01	0.0002	0.04	0.200	0.050	0.010
MCL		NONE	-	-	0.002	0.1	NA	NA	0.1
SDWS		NONE	500	0.05	-	NONE	0.05 TO 0.2	0.3	NA

TABLE 2 (CONTINUED)
CHEMICAL ANALYSIS OF GROUNDWATER SAMPLES (HISTORICAL RESULTS)
BARCELONETA SUPERFUND SITE

Location	Sample Date	TSS (mg/L)	TDS (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Aluminum (mg/L)	Iron (mg/L)	Chromium (mg/L)
MW-8	Jun-02	NT	NT	NT	NT	NT	-	-	-
	Oct-02	NT	NT	NT	NT	NT	-	-	-
	Dec-02	NT	NT	NT	NT	NT	-	-	-
	Mar-03	NT	NT	NT	NT	NT	-	-	-
	Oct-03	2	480	ND	ND	ND	-	-	-
	Dec-03	ND	240	ND	ND	0.074	-	-	-
	Mar-04	5	450	0.028	ND	0.029	-	-	-
	Jun-04	3	470	ND	ND	0.089	-	-	-
	Sep-04	ND	360	0.016	ND	0.056	-	-	-
	March-05	5	330	0.022	ND	0.055	-	-	-
	Sep-05	ND	324	0.0345	ND	0.0538	-	-	-
	Apr-06	2	358	0.0268	ND	0.0582	-	-	-
	Sept-06	3	364	0.0202	ND	0.0405	-	-	-
	Apr-07	20	336	**0.214**	ND	**0.243**	-	-	-
	Apr-07 Confirmado	ND	332	ND	ND	0.018	-	-	-
	Apr-08	-	-	-	-	-	-	-	-
	Oct-09	ND	340	ND	ND	ND	-	-	-
	Mar-10	ND	348	ND	ND	ND	-	-	-
	Mar-11	ND	295	0.0185	ND	0.0665	-	-	-
	Oct-12	21.2	314	**0.074**	ND	0.097	ND	**2.43**	**0.763**
	Oct-13	ND	345	ND	ND	ND	ND	0.278	0.0379
	Nov-14	ND	445	ND	ND	ND	ND	ND	ND
	Nov-15	ND	465	ND	ND	ND	ND	0.116	0.0226
	Nov-16	ND	500	0.0105	ND	ND	ND	**0.487**	**0.160**
	Mar.-18	ND	290	ND	ND	ND	ND	0.229	0.082
	April-19	16	380	**0.0626**	ND	ND	ND	**1.24**	**0.117**
	June-20	ND	375	ND	ND	ND	ND	ND	0.0101
	June-21	4.0	415	ND	ND	ND	ND	0.0972	0.027
	June-22	17.0	435	ND	ND	ND	ND	0.196	0.049
	July-23	6	405	0.0298	ND	ND	ND	**0.849**	**0.291**
	Jun-24	ND	369	ND	ND	ND	ND	0.184	0.04
RL		**4**	**10**	**0.01**	**0.0002**	**0.04**	**0.200**	**0.050**	**0.010**
MCL		**NONE**	**-**	**-**	**0.002**	**0.1**	**NA**	**NA**	**0.1**
SDWS		**NONE**	**500**	**0.05**	**-**	**NONE**	**0.05 TO 0.2**	**0.3**	**NA**

Notes:

Bold - Values above MCL or SDWS
NT - Sample not Collected
ND - Non-Detected / Below Reporting Limit
mg/L - milligrams per liters
MCL - Maximum Contamination Level
SDWS - Secondary Drinking Water Standard
PQL - Practical Quantitation Limit
RL - Reporting Limit

APPENDIX D – REMEDY RESILIENCE ASSESSMENT

Three tools were utilized to assess the Barceloneta Landfill Superfund site. Screenshots from each of the tools assessed are included here.

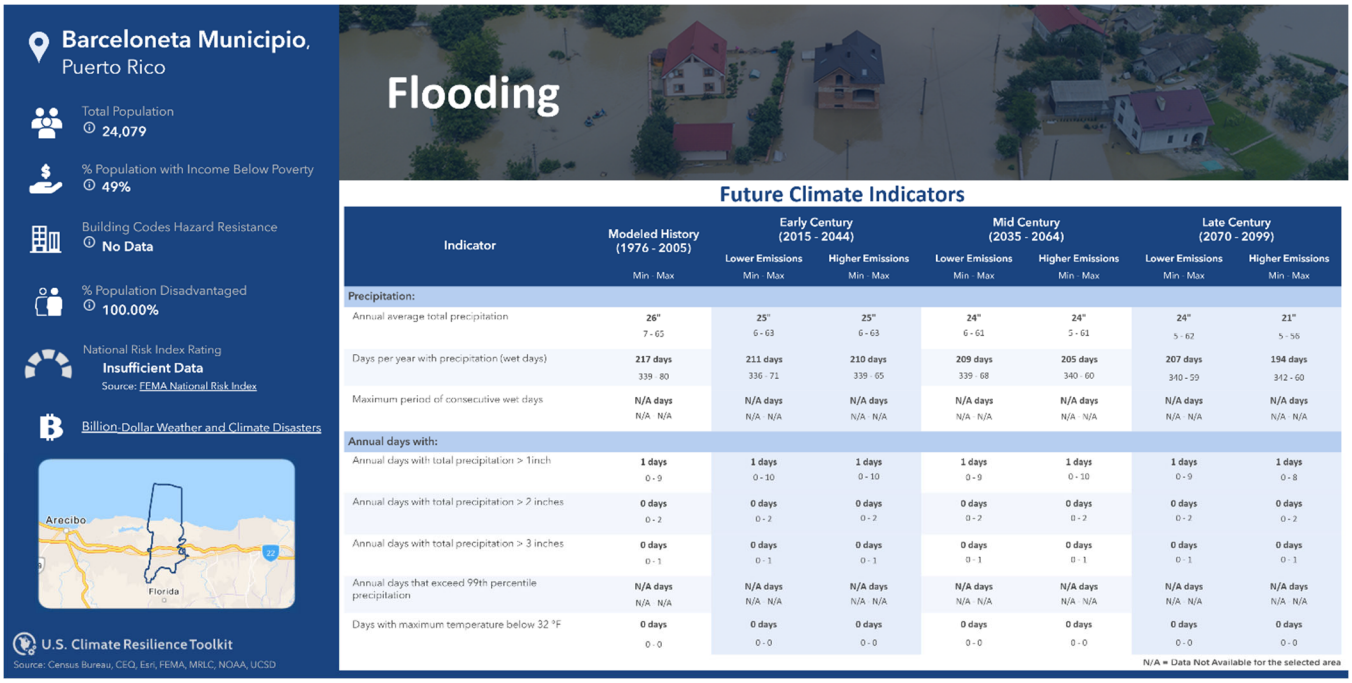
The first tool used to assess the site was the *CMRA Assessment Tool*. The tool examined five hazards for the county the site falls within. As shown by Figures D-1 (Flooding) and D-2 (Drought), the annual average total precipitation over the next 75 years is expected to fluctuate between 21 and 25 inches, while the annual days with total precipitation > 1 inch are expected to stay within the 1-day timeframe. Figure D-1 and D-2 also show that there will be a decrease in precipitation of at least 1-inch, but up to 4 inches in the next 75 years, and an increase in dry days when compared to current levels. The other three hazards examined were wildfire, extreme heat, and coastal inundation. As shown in Figures D-3 and D-4, the CMRA Assessment Tool did not have sufficient data to assign a National Risk Index Rating for wildfire and extreme heat. As shown in Figure D-5, the percent of the county impacted by global sea level rise is anticipated to be 0%. This is likely because the site is located in a mountainous region of the island inland from the coast.

The second tool utilized was the *NOAA Sea Level Rise Viewer*. Figure D-6 shows the site locality under current conditions. Figure D-7 shows the same area under a worst-case scenario assuming a 10-foot rise in sea level. As indicated by these figures, the in-land portion of Barceloneta where the site is located is not expected to be impacted by this rise in sea level.

The third tool utilized was the *USGS U.S. Landslide Inventory*. Figure D-8 shows that there are no recorded landslides within and in the vicinity of the site. However, there is high susceptibility of landslides within and in the vicinity of the former landfill, but less susceptible within the disposal areas.

These tools do not indicate the performance of the remedy is currently at risk due to flooding and sea level rise, or other severe weather risks. Although the site may be impacted by more frequent and severe hurricanes, the site does not have active remedies, only O&M of the cap cover and groundwater well monitoring. Increased storms maybe contributing to further erosion of the cavities/subsidence observed onsite. EPA is and will continue to work with the PRPs to address these issues. The PRPs have created a temporary berm to limit runoff entering the cavities/subsidence and are working on permanent solution. The greatest risk for the cap cover would be from flooding, associated with increased precipitation; however, the CMRA shows that precipitation is likely to decrease in the next 75 years when compared to current levels. The greatest risk to the monitoring well network is likely from falling trees or flying debris from storms and hurricanes. However, the cap cover and monitoring well network are monitored after storm events to assess any damages.

Figure D-1 – CMRA, Flooding in the Vicinity of Barceloneta, PR



Future Climate Indicators

Indicator	Modeled History (1976 - 2005)	Early Century (2015 - 2044)		Mid Century (2035 - 2064)		Late Century (2070 - 2099)	
		Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions
	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max
Precipitation:							
Annual average total precipitation	26" 7 - 65	25" 6 - 63	25" 6 - 63	24" 6 - 61	24" 5 - 61	24" 5 - 62	21" 5 - 56
Days per year with precipitation (wet days)	217 days 339 - 80	211 days 336 - 71	210 days 339 - 65	209 days 339 - 68	205 days 340 - 60	207 days 340 - 59	194 days 342 - 60
Maximum period of consecutive wet days	N/A days N/A - N/A	N/A days N/A - N/A	N/A days N/A - N/A	N/A days N/A - N/A	N/A days N/A - N/A	N/A days N/A - N/A	N/A days N/A - N/A
Annual days with:							
Annual days with total precipitation > 1inch	1 days 0 - 9	1 days 0 - 10	1 days 0 - 10	1 days 0 - 9	1 days 0 - 10	1 days 0 - 9	1 days 0 - 8
Annual days with total precipitation > 2 inches	0 days 0 - 2	0 days 0 - 2	0 days 0 - 2	0 days 0 - 2	0 days 0 - 2	0 days 0 - 2	0 days 0 - 2
Annual days with total precipitation > 3 inches	0 days 0 - 1	0 days 0 - 1	0 days 0 - 1	0 days 0 - 1	0 days 0 - 1	0 days 0 - 1	0 days 0 - 1
Annual days that exceed 99th percentile precipitation	N/A days N/A - N/A	N/A days N/A - N/A	N/A days N/A - N/A	N/A days N/A - N/A	N/A days N/A - N/A	N/A days N/A - N/A	N/A days N/A - N/A
Days with maximum temperature below 32 °F	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0

N/A = Data Not Available for the selected area

Figure D-2 – CMRA, Drought in the Vicinity of Barceloneta, PR

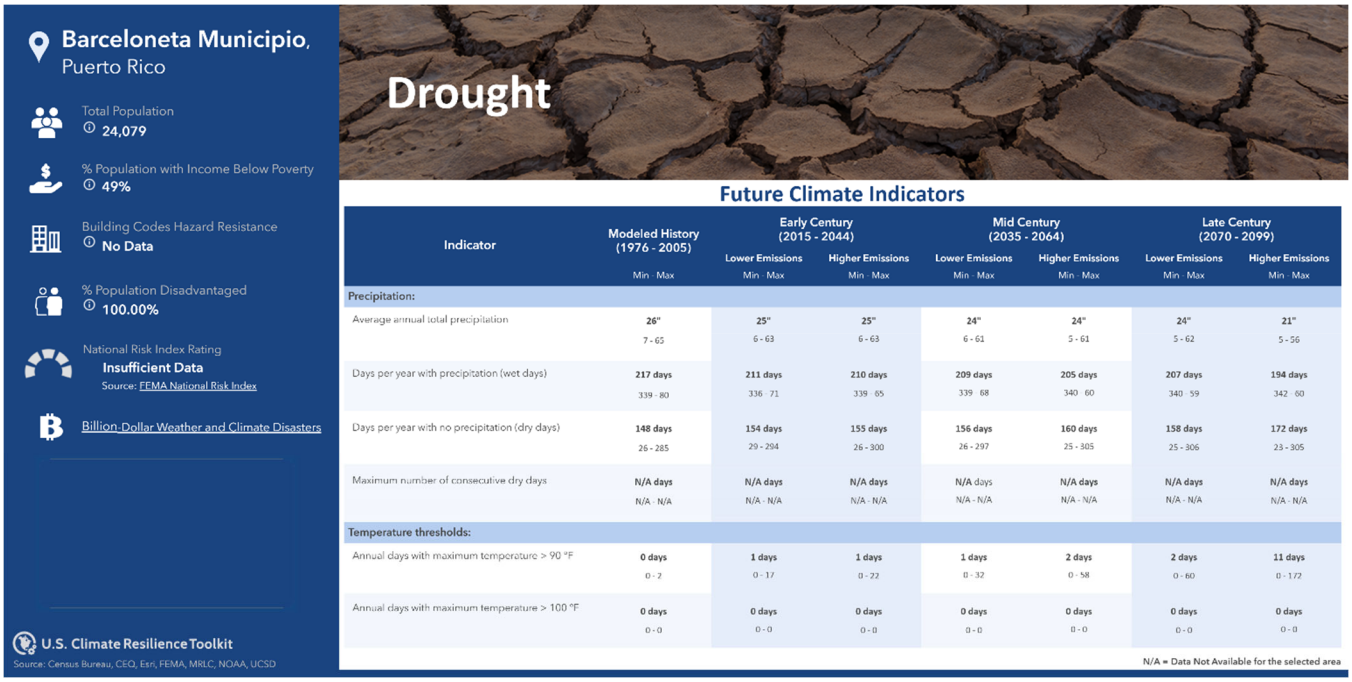
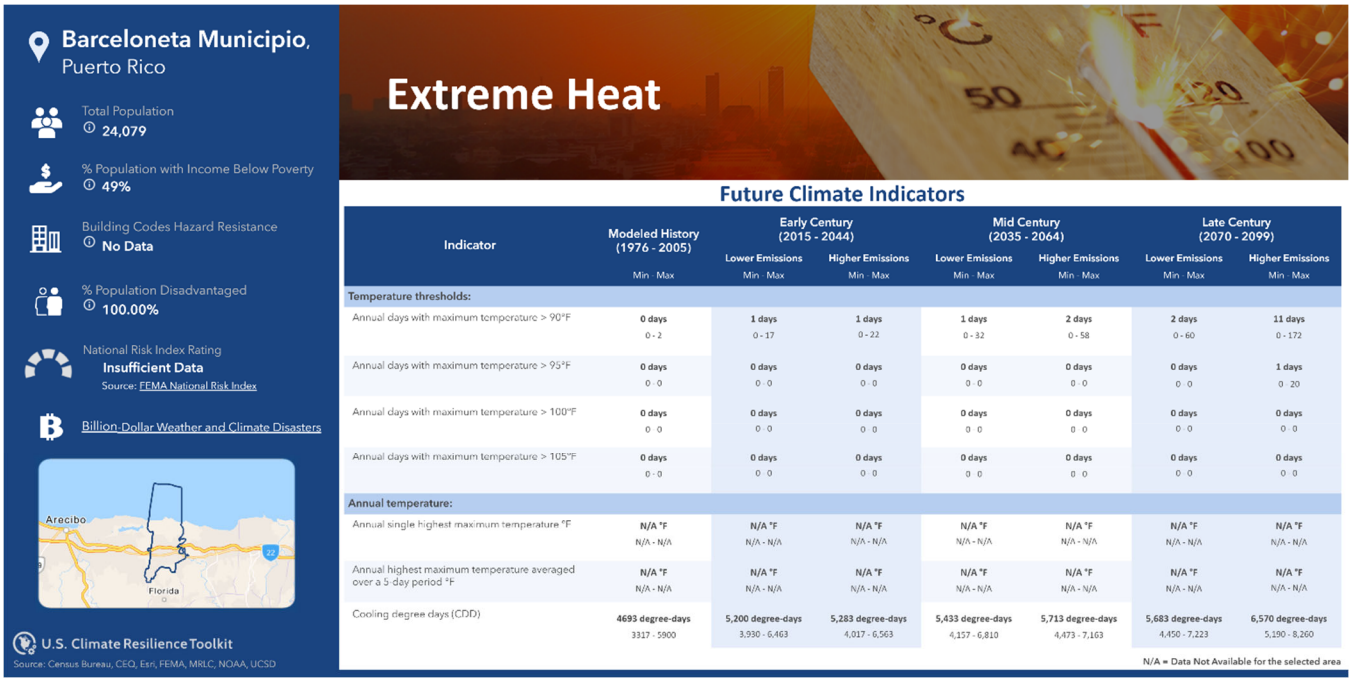


Figure D-3 – CMRA, Wildfires in the Vicinity of Barceloneta, PR

Figure D-4 – CMRA, Extreme Heat in the Vicinity of Barceloneta, PR



Indicator	Modeled History (1976 - 2005)	Early Century (2015 - 2044)		Mid Century (2035 - 2064)		Late Century (2070 - 2099)	
		Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions
	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max
Temperature thresholds:							
Annual days with maximum temperature > 90°F	0 days 0 - 2	1 days 0 - 17	1 days 0 - 22	1 days 0 - 32	2 days 0 - 58	2 days 0 - 60	11 days 0 - 172
Annual days with maximum temperature > 95°F	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	1 days 0 - 20
Annual days with maximum temperature > 100°F	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0
Annual days with maximum temperature > 105°F	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0
Annual temperature:							
Annual single highest maximum temperature °F	N/A °F N/A - N/A	N/A °F N/A - N/A	N/A °F N/A - N/A	N/A °F N/A - N/A	N/A °F N/A - N/A	N/A °F N/A - N/A	N/A °F N/A - N/A
Annual highest maximum temperature averaged over a 5-day period °F	N/A °F N/A - N/A	N/A °F N/A - N/A	N/A °F N/A - N/A	N/A °F N/A - N/A	N/A °F N/A - N/A	N/A °F N/A - N/A	N/A °F N/A - N/A
Cooling degree days (CDD)	4693 degree-days 3317 - 5900	5,200 degree-days 3,930 - 6,463	5,283 degree-days 4,017 - 6,563	5,433 degree-days 4,157 - 6,810	5,713 degree-days 4,473 - 7,163	5,683 degree-days 4,450 - 7,223	6,570 degree-days 5,190 - 8,260

N/A = Data Not Available for the selected area

Figure D-5 – CMRA, Coastal Inundation in the Vicinity of Barceloneta, PR

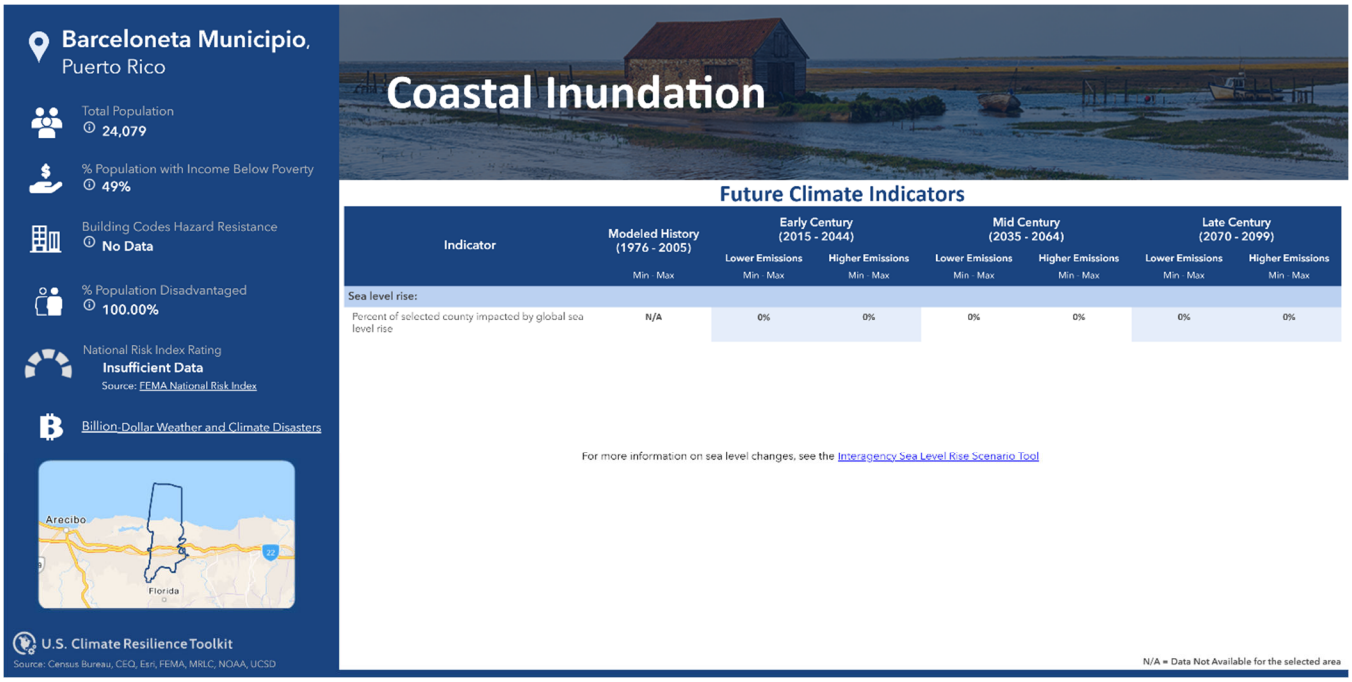


Figure D-6 – NOAA Sea Level Rise Viewer: Current Conditions

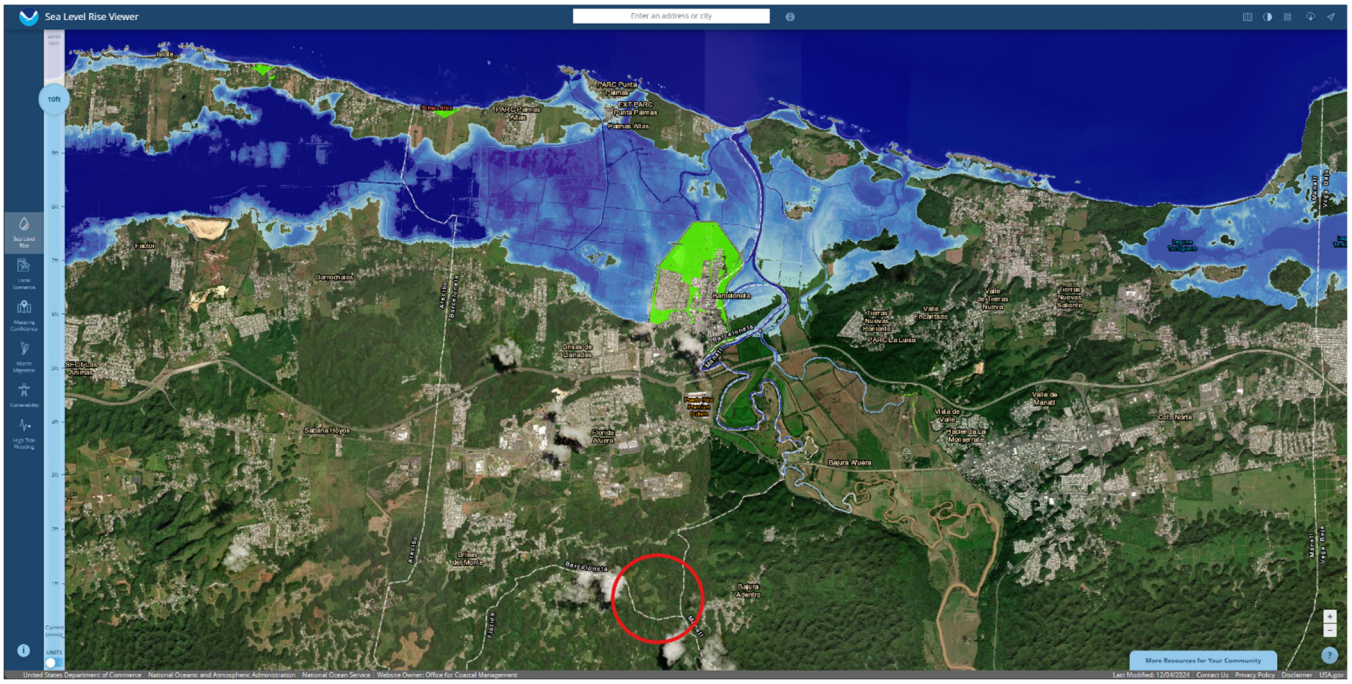


Figure D-7 – NOAA Sea Level Rise Viewer: 10 Foot Rise

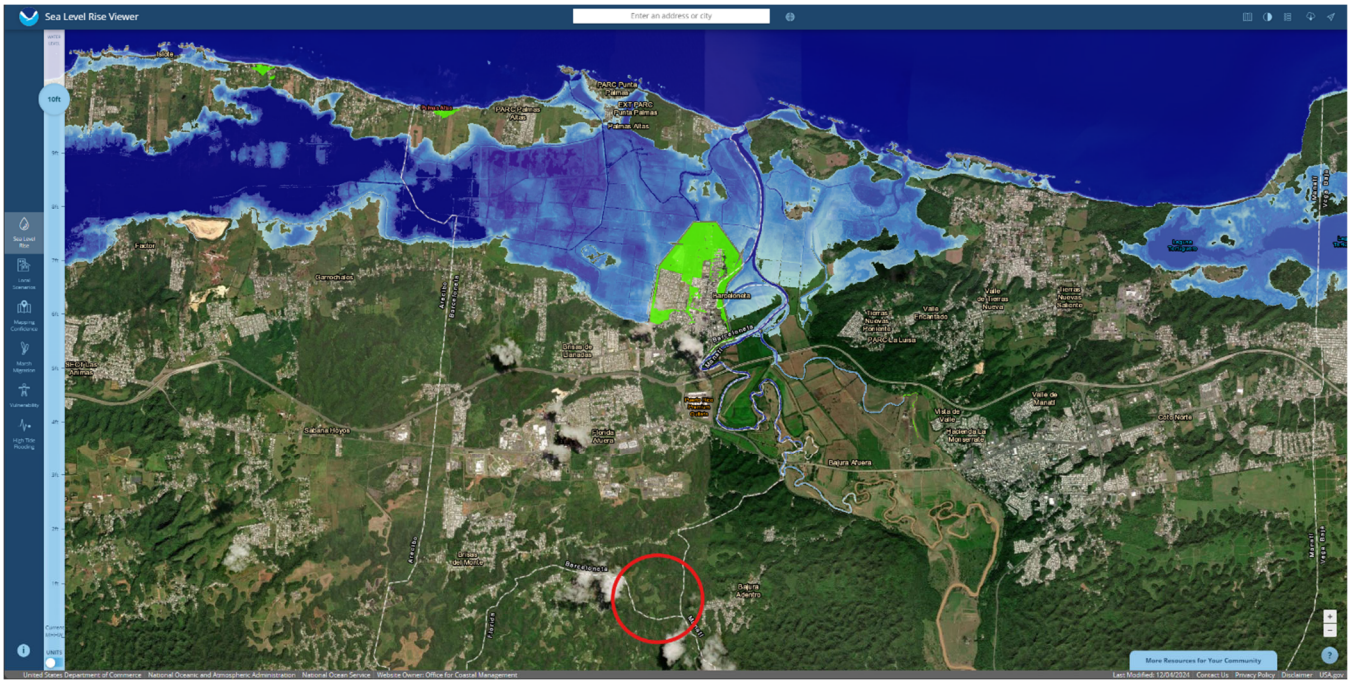


Figure D-8 – USGS U.S. Landslide and Susceptibility Inventory