# SIXTH FIVE-YEAR REVIEW REPORT FOR RAMAPO LANDFILL SUPERFUND SITE ROCKLAND COUNTY, TOWN OF RAMAPO, NEW YORK

**Prepared by**

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

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**Pat Evangelista, Director**
**Superfund and Emergency Management Division**

September 30, 2025

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**Date**

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LIST OF ABBREVIATIONS & ACRONYMS

| | |
|---|---|
| AWQS | Ambient Water Quality Standards |
| BMP | Best Management Practices |
| CFR | Code of Federal Regulations |
| DCR&EE | Declaration of Restrictive Covenants and Restrictions and Environmental Easement |
| EC | Emerging Contaminant |
| EPA | United States Environmental Protection Agency |
| FYR | Five-Year Review |
| gpy | Gallons Per Year |
| HA | Health Advisory |
| HHRA | Human Health Risk Assessment |
| HI | Hazard Index |
| ICs | Institutional Controls |
| MCLs | Maximum Contaminant Levels |
| MDL | Method Detection Limit |
| µg/L | micrograms per liter |
| mg/kg | Milligrams per Kilogram |
| NPL | National Priorities List |
| NYSDEC | New York State Department of Environmental Conservation |
| O&MM | Operation and Maintenance Manual |
| OU | Operable Unit |
| PFAS | Per- and Polyfluoroalkyl Substances |
| PFNA | Perfluorononanoic Acid |
| PFOA | Perfluorooctanoic Acid |
| PFOS | Perfluorooctanesulfonic Acid |
| POTW | Publicly-Owned Treatment Works |
| PRP | Potentially Responsible Party |
| RAOs | Remedial Action Objectives |
| RD | Remedial Design |
| RI/FS | Remedial Investigation and Feasibility Study |
| ROD | Record of Decision |
| SMP | Site Management Plan |
| UU/UE | Unlimited Use/Unrestricted Exposure |
| VOC | Volatile Organic Compound |

# I. INTRODUCTION

The purpose of a five-year review (FYR) is to evaluate the implementation and performance of a remedy 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.

This is the sixth FYR for the Ramapo Landfill Superfund site. The triggering action for this statutory review is the completion date of the previous FYR, which was February 21, 2020. The FYR has been prepared because hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure (UU/UE).

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

The site is being addressed as a single operable unit (OU), which is the subject of this FYR.

This FYR was conducted by EPA remedial project managers George Jacob and Tom Mongelli. Participants included Julie McPherson, EPA risk assessor; Rachel Griffiths, EPA hydrogeologist; Shereen Kandil, EPA Community involvement coordinator; and Payson Long of the New York State Department of Environmental Conservation (NYSDEC).

The Potentially Responsible Party (PRP) for the site was notified of the initiation of the FYR. The FYR began on May 31, 2024.

## Site Background

The Ramapo Landfill site is located at 250 Torne Valley Road in the Village of Hillburn, Town of Ramapo, Rockland County, New York. A site location map is provided in Appendix A, Figure 1, attached. A property boundary map is provided in Appendix A, Figure 2.

The landfill, which is situated on a 96-acre tract, occupies approximately 60 acres. The landfill consists of two major lobes (northern and southern) and slopes steeply toward the west with grades ranging from less than one percent to greater than 30 percent. Both landfill lobes contain mixed refuse. Substances reportedly disposed of in the landfill include industrial sludge and other wastes from a pharmaceutical company, sewage sludge, municipal refuse, asbestos, construction and demolition debris, yard debris, paint sludge (presumably from an automotive plant), and liquid wastes from a paper company. Utility corridors lie on three sides of the site, high voltage power transmission lines are located to the east and west, and a high-pressure gas line is situated to the south. A power substation is located just north of the site. The Ramapo Police Department currently uses a portion of the site for a shooting range.

In the 1950s and 1960s, portions of the site were excavated as a source of gravel. In 1971, the Rockland County Department of Health granted a permit to the Town of Ramapo for the operation of a sanitary landfill. At that time, the site was owned by the Ramapo Land Company and the contract-operator was the Torne Mountain Sand and Gravel Co., Inc.

Municipal waste was accepted in the landfill until 1984 and construction and demolition debris was accepted until 1989.

A residential apartment complex of 25 units has a water supply well located approximately 450 feet to the west of the landfill. A smaller apartment complex of two units maintains a well about 1,200 feet to the west of the landfill. These wells are designated as PW-1 and PW-2, respectively. Veolia North America owns and operates public supply wells SVWC-93, 94, 95, and 96, located approximately 1,600 feet to the west of the landfill.

Appendix B, attached, summarizes the documents utilized to prepare this FYR. Appendix C, attached, summarizes the Site's history, geology/hydrogeology and land use. Additional details related to background, physical characteristics, geology/hydrogeology, land/resource use, and history related to the Site can be found at www.epa.gov/superfund/ramapo-landfill.

## FIVE-YEAR REVIEW SUMMARY FORM

| SITE IDENTIFICATION | | |
|---|---|---|
| **Site Name:** Ramapo Landfill Superfund Site | | |
| **EPA ID:** NYD000511493 | | |
| **Region:** 2 | **State:** NY | **City/County:** Town of Ramapo/Rockland County |
| **SITE STATUS** | | |
| **NPL Status:** Final | | |
| **Multiple OUs?** No | **Has the site achieved construction completion?** Yes | |
| **REVIEW STATUS** | | |
| **Lead agency:** State | | |
| **Author name (Federal or State Project Manager):** George Jacob/Tom Mongelli | | |
| **Author affiliation:** EPA | | |
| **Review period:** 5/31/2024 - 7/31/2025 | | |
| **Date of site inspection:** 11/14/2024 | | |
| **Type of review:** Statutory | | |
| **Review number:** 6 | | |
| **Triggering action date:** 2/21/2020 | | |
| **Due date *(five years after triggering action date)*:** 2/21/2025 | | |

## II. RESPONSE ACTION SUMMARY

### Basis for Taking Action

In September 1983, the Ramapo Landfill site was placed on the Superfund National Priorities List.

Between 1980 and 1988, NYSDEC and the Town of Ramapo entered into four Orders on Consent to effect phasing out landfill operations, constructing a surface water and groundwater diversion system and a leachate collection and transport system, conducting a remedial investigation and feasibility study (RI/FS), and designing and constructing the remedy that was to be ultimately selected. The Town also received a Title 3, Environmental Bond Act grant to assist it in performing the remedial activities.

The results of the RI revealed the presence of volatile organic compounds (VOCs) in three locations--downslope of the southern lobe adjacent to a former holding basin situated near Torne Valley Road, on the sideslope of the southern lobe, and in paint sludge located off-property across Torne Valley Road; VOCs were not detected in surface soil samples. Semi-volatile organic compounds, including polycyclic aromatic hydrocarbons, were detected in waste samples and surface soil samples. Antimony, barium, beryllium, cadmium, calcium, chromium, copper, lead, selenium, and zinc were detected in surface soil and waste samples at concentrations exceeding background by an order of magnitude. NYSDEC Class GA Ambient Water Quality Standards (AWQS) and Guidance Values (T.O.G.S. 1.1.1) and/or EPA Maximum Contaminant Levels (MCLs) were exceeded for arsenic, chromium, iron, lead, magnesium, manganese, mercury, sodium, benzene, chlorobenzene, and di-n-octyl phthalate in on-site groundwater monitoring wells. No federal or state drinking water standards were exceeded in groundwater samples collected from the nearby water supply wells during the RI.

The baseline human health risk assessment (HHRA) identified five potential exposure pathways by which the public may be exposed to contaminant releases at the site under current and future land-use conditions. These pathways included ingestion of soil, dermal contact with soil, inhalation of vapors from the landfill, ingestion of groundwater, and inhalation of vapors during showering. Under current land-use conditions, unacceptable non-carcinogenic risks were identified for workers and child trespassers. Under future land-use conditions, unacceptable risks were identified for adult and child residents living on the site and workers. The primary chemical contributors to noncarcinogenic health risks were xylenes (total) and chlorobenzene for inhalation of vapors from the landfill, and manganese and arsenic for ingestion of groundwater.

For known or suspected carcinogens, under current land-use conditions, the risk characterization showed that cancer risks for all receptors evaluated (*i.e.,* adults, children, and workers) were less than or within the acceptable cancer risk range. Under future land-use conditions, cancer risks for children and workers were within the acceptable range. However, the sum of future cancer risks for all exposure pathways assessed for adults were marginally outside the range. Arsenic and benzene were the chemicals responsible for the highest carcinogenic risks from groundwater ingestion and inhalation of vapors, respectively.

Surface water and sediment samples collected from site water features indicated some impacts from site-related contaminants.

An ecological assessment was conducted to evaluate exposure risks to aquatic life. A comparison of the results obtained from sediment samples with NYSDEC sediment cleanup criteria indicated that contaminant concentrations did not exceed the cleanup criteria. Therefore, sediments are not expected to pose a risk to aquatic life. In reviewing the surface water contaminant concentrations, aquatic surface

water standards were exceeded for copper, iron, lead, mercury, sulfide and zinc, however, they did not pose unacceptable risk for ecological receptors. The ecological studies also indicated that there are no federally-listed threatened or endangered species identified at the site. The landfill is in the historical range of a subspecies of the Eastern Woodrat, Neotoma floridana magister, listed by NYSDEC as endangered in New York State. However, because the species' habitat is within rock outcrops or boulder fields, it is unlikely to occur on or in the immediate vicinity of the landfill. No other NYSDEC rare, threatened or endangered species or critical habitats are known to occur within the vicinity of the landfill.

## Response Actions

The Town of Ramapo, under NYSDEC oversight, constructed a leachate collection system along the downgradient edge of the landfill from 1984 to 1985. The collected leachate was conveyed to a wastewater treatment pond at the site's southwest corner. After aeration and settling in the pond, the water was discharged to the Ramapo River. In 1990, the collected leachate was discharged to the Village of Suffern Wastewater Treatment Plant via a 7,900-foot sewer line.

Based upon the results of the RI/FS, the following remedial action objectives (RAOs) were established: 1) prevent inhalation of vapors from the landfill; 2) prevent human and animal contact with contaminated soil from the landfill surface; 3) prevent erosion of contaminated surface soil through surface-water runoff; 4) minimize the infiltration of rainfall or snow melt into the landfill, thus reducing the quantity of water percolating through the landfill materials and leaching out contaminants; and 5) reduce the movement and toxicity of the contaminated landfill leachate into groundwater and the subsequent downgradient migration of contaminants.

In March 1992, EPA signed a Record of Decision (ROD) for the site. The selected remedy included:

- Installation of a cap on the top of the landfill using a multimedia system, including layers of fill material, a gas-venting system and an impermeable membrane. The landfill side slopes would be capped using a multimedia system without an impermeable membrane if confirmatory studies demonstrated that this approach met the RAOs. Should the confirmatory studies indicate that the overall remedy's effectiveness would be significantly reduced by not including an impermeable barrier in the multimedia cap on the side slopes, then an impermeable barrier was to be included in the cap on some or all of the side slopes of the landfill.
- Installation of groundwater extraction wells to supplement the existing leachate collection system.
- Installation of a perimeter drain around the sections of the cap containing the impermeable membrane to collect and divert surface water runoff.
- Collection and diversion of leachate seeps to the existing leachate collection system.
- Conveyance of the collected leachate and contaminated groundwater via the sewer system to a local wastewater treatment facility.
- Imposition of property deed restrictions which would include measures to prevent the installation of drinking water wells at the site, and restrict activities which could affect the integrity of the cap.
- Performance of a maintenance and sampling program upon completion of closure activities. The monitoring program will provide data to evaluate the effectiveness of the remedial effort. Additional monitoring points would be established as needed to detect any future movement of site contaminants toward drinking water sources off-site.

- Development of a contingency plan for rapid implementation of additional measures to protect nearby residents and users of groundwater if those measures are determined to be necessary.[1]

Additionally, based upon the results of confirmatory studies, it was concluded that a cap with an impermeable barrier on the landfill's side slopes would be protective and more cost-effective than a cap without an impermeable barrier on the side slopes. An Explanation of Significant Differences was issued on November 26, 1997 to document these findings.

## Status of Implementation

The Town of Ramapo retained URS Consultants, Inc. to conduct the remedial design (RD), solicit and obtain bids for the landfill closure, and provide construction administration and resident engineering.

As was noted above, the ROD stated that an impermeable barrier would be placed on the landfill's side slopes if confirmatory studies indicated that the remedy's overall effectiveness would be significantly enhanced. The confirmatory studies indicated that the exclusion of an impermeable barrier from the landfill cap on the side slopes would result in increased infiltration of rainfall through the cap. This would cause the generation of greater quantities of contaminated groundwater, which would result in greater operational costs to collect and treat a larger volume of contaminated groundwater and leachate. In addition, it was determined that either a thicker soil cover or an impermeable barrier would be needed on the side slopes to provide adequate control of landfill gases. The impermeable barrier was found to be the less costly of the two options. Therefore, based upon the results of the confirmatory studies, it was concluded that a cap with an impermeable barrier on the landfill's side slopes would be protective and more cost-effective than a cap without an impermeable barrier on the side slopes. An Explanation of Significant Differences was issued on November 26, 1997 to document these findings.

The RD was approved by NYSDEC in 1992. The RD not only included the plans and specifications for the construction of the landfill cap, installation of groundwater extraction wells to supplement the existing leachate collection system and installation of a perimeter drain, but also included a preliminary design (contingency plan) for the connection of nearby residents to the Pothat Water Company water line should groundwater monitoring indicate that groundwater standards are being contravened.

A construction contract was awarded to Geo-Con, Inc., in 1993. Construction of the remedy was performed from 1994 to 1997.

## Institutional Controls Summary Table

Table 1, below, summarizes the status of the institutional controls.

[1] The contingency plan would include a preliminary design for an alternate water supply. If drinking water standards are significantly exceeded for site-related parameters in residential wells, or in the same aquifer in the closest monitoring wells to the residential wells, and detected concentrations are confirmed by subsequent sampling, residents would immediately be provided with bottled water and/or an acceptable point-of-use treatment system as an interim measure until an alternate water supply could be constructed.

**Table 1: Summary of Planned and/or Implemented Institutional Controls**

| 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) |
|---|---|---|---|---|---|
| Landfill property & groundwater | Yes | Yes | Landfill property | To prevent the installation of drinking water wells at the site and restrict activities which could affect the integrity of the cap | Declaration of Restrictive Covenants and Restrictions and Environmental Easement (DCR&EE) August and October 2012 |

## Systems Operations/Operation & Maintenance

An Operation and Maintenance Manual (O&MM) covering post-landfill cap construction inspection and maintenance was submitted and approved by NYSDEC as part of the RD. The inspections called for in the O&MM are to document the condition of the landfill cover system, groundwater extraction system, leachate collection system, monitoring wells, gas venting system and access roads. During the first year following the landfill cap construction, the site was inspected quarterly and following major storm events. For the subsequent years, the site has been inspected on an annual basis as follows:

- The site is inspected for debris, litter, waste and vandalism;
- The landfill cap is inspected for vegetation loss due to erosion or poor grass growth. Annual ground inspections notes stressed or undesirable species of vegetation on the landfill surface and side slopes;
- The landfill property is visually inspected for leachate outbreaks (precipitates on the ground surface, intermittent seeps, or soft spots);
- The leachate collection system inspection includes manholes, pipes, the valve control panel and tank level controls;
- The landfill cap is inspected for cracks, settlement, erosion and deposition, ponding, and animal burrows;
- The gas venting pipes are inspected for damage;
- The site access gate and fence are inspected for operational locks and vandalism;
- The culverts, drainage ditches, and settlement gauges are inspected for sediment buildup or erosion;
- The groundwater monitoring wells are inspected for operational locks, damage, and vandalism; and
- The extraction wells, leachate collection system, and leachate seep diversion system are inspected to ensure their integrity.

An annual Periodic Review Report submitted by the Town includes a summary of the findings of the above-noted inspection along with a certification that remedy-related operation and management is being performed.

Contaminated groundwater from the site is currently pumped from seven extraction wells. Trend analyses are used to optimize and update the groundwater capture from the site.

Consistent with NYSDEC requirements associated with effecting a DCR&EE, the Town prepared a Site Management Plan (SMP), which was finalized in 2017. The SMP incorporates an Institutional/Engineering Control Plan, Inspection and Monitoring Plan, and O&MM to provide for the continual post-closure monitoring and maintenance of the landfill.

The monitoring program originally called for the sampling of the groundwater monitoring wells and drinking water wells three times a year. In 2003, due to the relative stability of the sampling results, the groundwater and residential drinking water well monitoring frequency was changed to every five quarters to consider potential seasonal effects. More frequent sampling (*i.e.,* quarterly) is performed for the water supply wells because of past MCL exceedances and given their close proximity to the landfill.

Groundwater sampling at the site occurs every fifth quarter at 23 monitoring locations. The groundwater monitoring includes shallow overburden monitoring wells (UP-OS, 1-OS, 2-OS, 4-OS, 7-OS, 8-OS, 9-OS, and 10-OS), intermediate overburden monitoring wells (UP-I, 3-OS/I, 8-I, 9-I, and 10-I) and bedrock monitoring wells (UP-R, 8-R, 9-R, and 10-R). Water supply wells PW-1, PW-2, SVWC-93, SVWC-94, SVWC-95, and SVWC-96 are also monitored. See Figure 3 for the locations of the above-noted monitoring wells and water supply wells. Groundwater sampling locations are denoted on Appendix A, Figure 3, attached. Groundwater samples are analyzed for VOCs, metals, per- and poly-fluoroalkyl substances (PFAS), 1,4-dioxane, and geochemical leachate parameters.

Because contamination was detected in the "upgradient" monitoring well MW-5 cluster, a new monitoring well cluster (UP-OS/I/R) was installed in October 2016.

In 2017, flow meters were installed on each extraction well and a notification system was installed to provide alerts if any malfunctions occur.

During this FYR period, routine groundwater sampling occurred in October 2020, January 2022, May 2023, August 2024, and March 2025.

The efficacy of the leachate collection and groundwater extraction system has improved significantly since 2011, when the total extracted volume was less than 10 million gallons per year (gpy). Since 2012, the average extracted volume is approximately 14 million gpy; the extracted volume was approximately 18 million gallons in 2024. The increased extraction volume correlates to decreasing contaminant trends.

In response to the recommendations from the 2020 FYR, a capture zone analysis was performed. To support this effort, a limited groundwater sampling event was conducted in October 2023 and samples were analyzed for metals. The capture zone analysis was completed in 2023. The analysis included extraction well inspection and a pumping assessment. During the inspection, the pumps were shut down to allow the water level to equilibrate. Because the static water levels were above the designed "pump on" levels, all the pumps should have started operating when they were switched back on. However, only extraction well W-1 started pumping automatically, which indicated that the pump control sensors in extraction wells W-2 through W-7 were not functioning properly. Additionally, the pump in extraction well W-6 was not operational during the inspection. It is not clear how long the extraction well pumps were not operating properly. The pump in extraction well W-6 was replaced and the pump control settings on the remaining extraction well pumps were updated, allowing them to perform properly.

*Remedy Resilience*

Potential impacts to the site area from severe weather have been assessed, and the performance of the remedy is currently not at risk due to weather-related effects in the region and near the Site. Please see Appendix D, attached, for the full evaluation.

## III. PROGRESS SINCE THE LAST REVIEW

The protectiveness determinations from the last FYR are summarized in Table 2, below.

**Table 2: Protectiveness Determinations/Statements from the 2020 FYR**

| OU | Protectiveness Determination | Protectiveness Statement |
|---|---|---|
| 01 | Short-term Protective | The remedy protects human health and the environment in the short-term because the remedies have interrupted exposure of humans and ecological receptors to landfill wastes and institutional controls to prevent the installation of drinking water wells at the site and to restrict activities which could affect the integrity of the cap are in place. For the remedy to be protective in the long-term, extraction well capture efficacy must be determined. |
| Sitewide | Short-term Protective | The remedy protects human health and the environment in the short-term because the remedies have interrupted exposure of humans and ecological receptors to landfill wastes and institutional controls to prevent the installation of drinking water wells at the site and to restrict activities which could affect the integrity of the cap are in place. For the remedy to be protective in the long-term, extraction well capture efficacy must be determined. |

Tables 3 and 4, below, provide the status of the recommendations and comments/suggestions, respectively, from the 2020 FYR.

**Table 3: Status of Recommendations from the 2020 FYR**

| OU | Issue | Recommendations | Current Status | Current Implementation Status Description | Completion Date (if applicable) |
|---|---|---|---|---|---|
| 01 | Extraction well capture efficacy cannot be determined | A capture zone analysis of the leachate collection system needs to be conducted. | Completed | PRP conducted a capture zone analysis and a report was submitted to USEPA and NYSDEC. The extraction wells are now pumping as designed, which is expected to improve leachate collection. | 02/20/2024 |

**Table 4: Status of Comments/Suggestions from the 2020 FYR**

| Comments/Suggestions | Comments/Suggestions Status |
|---|---|
| Emerging contaminants (EC) sampling for 1,4-dioxane and per- and poly-fluoroalkyl substances (PFAS) was conducted during the review period. Upgradient monitoring wells, downgradient sentinel wells, and two public supply wells were sampled. EPA will continue to work with NYSDEC to determine whether further sampling at this site is necessary. | In July 2019, select groundwater samples were analyzed for 1,4-dioxane and PFAS. Based on the 2019 results, the parameters are now collected as part of routine groundwater sampling events at select monitoring and public supply wells and have been reported in 2020, 2021, 2023, and 2024. The EC sampling was expanded to include additional monitoring wells, water supply wells (PW-1, PW-2, SVWC-93, and SVWC-96), and a leachate sample in 2025. |
| The flow meters for the extraction wells are not functional. The flow meters need to be replaced. | The flow meters were replaced. |
| Deep-rooted plants and trees are growing on the landfill's cover on the drainage swales in various areas at the top of the landfill. Because this vegetation could compromise the integrity of the landfill cover, it should be removed. | The vegetation was removed. It has, however, grown back. It will need to be removed again. |
| Several bedrock monitoring wells were not sampled during the last five years. Chromium has been detected above its criteria in overburden and intermediate monitoring wells and also exceeded its respective criteria in historical bedrock monitoring wells. All monitoring wells should be included in the future sampling events and analyzed for site-related TCL/TAL. | The monitoring includes sampling monitoring wells 1-OS/I, 2-OS, 3-OS/I, 4-OS, 7-OS, 8-OS, 8-I, 8-R, 9-OS, 9-I, 9-R, 10-OS, 10-I, 10-R, UP-OS, UP-I, and UP-R. During the capture zone field work, sampling was performed at monitoring well 3-R and all monitoring points from monitoring well clusters 3, 8, 9, and 10 located immediately downgradient of the active recovery wells. Future events will include all the monitoring wells. Monitoring well cluster 5 is located on the upgradient side of the landfill and was replaced by the "UP" well cluster in response to a recommendation in the fourth five-year review report. Therefore, sampling the "5" cluster wells may not be necessary. |

## 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 Ramapo 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 CIC posted a public notice on the EPA site webpage, www.epa.gov/superfund/ramapo-landfill, and provided the notice to the town, county, and library repositories by email on December 5, 2024, with a request that the notice be posted in municipal offices and on the village/town webpages. This notice indicated that a FYR would be conducted at the Ramapo Landfill Superfund site to ensure that the cleanup at the site continues to be protective of people's health and the environment. Once the FYR is completed, the results will be made available at the following repositories: Finkelstein Public Library, 24 Chestnut Street, Spring Valley, New York; Suffern Free Public Library, Washington and Maple Avenues, Suffern, New York; and the EPA Region 2 Superfund Records Center, 290 Broadway, 18th Floor, New York, New York. In addition, the final report will be posted on

the following website, www.epa.gov/superfund/ramapo-landfill. Efforts will be made to reach out to local public officials to inform them of the results.

## Data Review

*Upgradient Monitoring Well Sampling Results*

The upgradient monitoring well cluster, which includes three nested wells screened in the shallow overburden (monitoring well UP-OS), deep overburden/weathered rock (monitoring well UP-I), and bedrock (monitoring well UP-R), was sampled three times during this FYR period. Sporadic metals exceedances of the lower of federal MCLs or NYSDEC AWQS were observed in the upgradient well cluster during the FYR period. Chromium concentrations of 54 micrograms per liter (µg/L) in monitoring well UP-I in 2023 marginally exceeded the AWQS of 50 µg/L. Concentrations of iron exceeded the MCL of 300 µg/L during the review period, and the highest concentrations were observed in monitoring well UP-OS (1,620 µg/L) and monitoring well UP-I (2,220 µg/L) in 2023. Nickel marginally exceeded its AWQS of 100 µg/L in 2023 at a concentration of 108 µg/L in monitoring well UP-I. VOCs were not detected in upgradient groundwater during the review period.

*Downgradient Monitoring Well Sampling Results*

Data collected during the review period from monitoring wells located downgradient of the landfill indicate relatively consistent detections of iron and manganese above their respective AWQS of 300 µg/L. These constituents are present in the regional aquifer and are likely being mobilized because of the typically reducing and acidic geochemistry of landfills. Less consistent detections include chromium, magnesium, nickel, sodium, and thallium above their respective MCLs or AWQS. As was noted in the "Upgradient Monitoring Well Sampling Results" section above, nickel and sodium are present in upgradient monitoring wells. VOCs were not detected in downgradient monitoring wells during this review period.

Chromium was detected above its AWQS of 50 µg/L at monitoring wells 1-OS, 1-I, 1-R 2-OS, 3-OS/I, 4-OS, 7-OS, 7-I, 7-R, 8-OS, 8-R, 9-I, and 9-R during the review period. The maximum concentration of 3,190 µg/L was observed in monitoring well 3-OS/I in 2020. Chromium concentration trends during the last five years typically exhibit stable or decreasing concentrations, including at monitoring well 3-OS/I, which has decreased to 673 µg/L in March 2025. Chromium speciation was conducted during the October 2023 limited sampling event. Of the three chromium exceedances noted in October 2023, the primary form of chromium in two of the three samples is trivalent chromium; the more toxic hexavalent chromium is only present at lower concentrations. The speciation results from monitoring well 8-R, however, show that hexavalent chromium is the dominant form. This is limited to the vicinity of monitoring well 8-R and is not present in samples collected further downgradient.

Magnesium was detected at 66,800 µg/L (above its AWQS of 35,000 µg/L) in monitoring well 8-R in 2020; in March 2025, the concentration decreased to 38,000 µg/L. With the exception of monitoring well 5-OS on two occasions, this has been the only location with exceedances since 1999 and has been relatively stable with the exception of the 2020 sampling result.

Concentrations of nickel exceeding its AWQS were observed in downgradient monitoring wells 3-OS/I and 3-R during the review period. Nickel was also detected marginally above its AWQS at upgradient monitoring well UP-I. The maximum concentration detected during the review period was 711 µg/L in monitoring well 3-OS/I in 2020. The concentrations of nickel in monitoring well 3-OS/I decreased throughout the review period from its highest concentration of 1,044 µg/L in 2019 to 197 µg/L in 2025. The only nickel exceedance in monitoring well 3-R was observed in March 2025 at 106 µg/L, marginally above the AWQS.

Sodium exceeded its MCL of 20,000 µg/L at the majority of monitoring locations. Concentration trends for sodium show a generally increasing trend since 1999, but most locations show decreasing trends since 2019.

Thallium exceeded its AWQS of 0.5 µg/L in 2020 in monitoring wells 1-OS, 3-OS/I, and 7-OS. The highest detection was 15 µg/L in monitoring well 1-OS. All thallium concentrations have been below their AWQS following the 2020 sampling event.

*Water Supply Well Sampling Results*

Groundwater samples from water supply wells PW-1, PW-2, SVWC-93, SVWC-94, SVWC-95, and SVWC-96 were collected and compared to AWQS and EPA MCLs. During the review period, sodium (naturally-occurring) was detected above its MCL of 20,000 µg/L in all the public supply wells. The levels detected are consistent with the detections from downgradient monitoring wells and may be related to the application of road salt. During the 2024 sampling event, concentrations of lead in water supply well PW-1 were detected at 38 µg/L, which exceeded its EPA MCL of 15 µg/L. This was, however, an isolated detection. No VOCs were detected in any water supply wells.

*Emerging Contaminants (ECs)*

In response to a request from NYSDEC, in July 2019, select groundwater samples were analyzed for ECs 1,4-dioxane and PFAS. Based on the 2019 results, the parameters are now collected as part of routine groundwater sampling events at select monitoring and water supply wells and have been reported in 2020, 2021, 2023, 2024, and 2025. The results are summarized below.

In 2020, NYSDEC established drinking water MCLs for perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) of 10 ng/L and for 1,4-dioxane of 1 µg/L. In 2023, NYSDEC released ambient water quality guidance values of 6.7 ng/L for PFOA, 2.7 ng/L for PFOS, and 0.35 µg/L for 1,4-dioxane. In April 2024, EPA finalized drinking water MCLs for PFOA and PFOS of 4 ng/L. These numbers are used for comparison purposes for the data reported below.

<u>1,4-Dioxane</u>

Groundwater samples were collected and analyzed for 1,4-dioxane from monitoring wells UP-OS, UP-I, UP-R, 9-OS, 9-I, 9-R, 10-OS, 10-I, and 10-R and public supply wells SVWC-94 and SVWC-95 as part of the routine monitoring program. In 2025, sampling was expanded to include a leachate sample, monitoring wells 8-OS, 8-I, and 8-R and water supply wells PW-1, PW-2, SVWC-93, and SVWC-96. Concentrations of 1,4-dioxane exceeded both its NYSDEC MCL and guidance value in monitoring well 9-R in all five sampling events during the review period, with a maximum concentration of 9.83 µg/L in 2025.

Concentrations of 1,4-dioxane exceeded both the NYSDEC MCL and guidance value in monitoring well 8-OS (1.45 µg/L), 8-I (37.4 µg/L), and 8-R (23.5 µg/L) during the 2025 sampling event. Concentrations of 1,4-dioxane were either not detected or were detected below the NYSDEC MCL and guidance value in the remainder of the wells sampled throughout the review period.

In March 2025, the landfill leachate collection system (Manhole A-5, Figure 3) upgradient of the public supply wells was sampled to determine 1,4-dioxane concentrations in leachate. 1,4-Dioxane exceeded the NYSDEC MCL and guidance value in the leachate at a concentration of 2.36 µg/L.

Per- and Poly-Fluoroalkyl Substances

Groundwater samples were collected for PFAS analysis from monitoring wells UP-OS, UP-I, UP-R, 9-OS, 9-I, 9-R, 10-OS, 10-I, and 10-R and public supply wells SVWC-94 and SVWC-95 as part of the routine monitoring program. In 2025, sampling was expanded to include a leachate sample, monitoring wells 8-OS, 8-I, and 8-R and water supply wells PW-1, PW-2, SVWC-93, and SVWC-96.

In 2020, PFAS, including PFOA and PFOS, were detected above federal MCLs[2] in monitoring wells 9-OS, 9-I, and 9-R. Concentrations of PFOA and PFOS did not exceed NYSDEC MCLs, but exceeded the NYSDEC guidance value for PFOS in monitoring well 9-OS at a concentration of 3.56 ng/L. PFOA and PFOS were also detected above federal MCLs, but below NYSDEC MCLs in public water supply wells SVWC-94 and SVWC-95.

In 2022, PFAS exceeded both the federal and state MCLs for PFOA in monitoring wells 9-I and 9-R. Concentrations of PFOS exceeded the NYSDEC guidance value in monitoring wells 9-I and 9-R with a maximum concentration of 7.29 ng/L. Public water supply well SVWC-95 had a detection of PFOS marginally above its federal MCL at 4.68 ng/L.

In 2023, PFAS only exceeded MCLs in monitoring well 9-R. Concentrations of PFOA only exceeded the federal MCL at 9.28 ng/L, but PFOS exceeded the federal MCL and NYSDEC guidance value at a concentration of 6.92 ng/L. Concentrations in the sampled public water supply wells did not exceed MCLs in 2023.

In 2024, PFAS exceeded both the federal or state MCLs and guidance values for PFOA and PFOS in monitoring wells 9-OS, 9-I, and 9-R with a maximum concentration of 21.9 ng/L PFOA in monitoring well 9-R. PFOA and PFOS also exceeded their federal or state MCLs in public water supply wells SVWC-94 and SVWC-95 with a maximum concentration of 11.6 ng/L PFOA in SVWC-94.

In response to an EPA request, emerging contaminants sampling in March 2025 was expanded to include a leachate sample, monitoring wells 8-OS, 8-I, and 8-R and water supply wells PW-1, PW-2, SVWC-93, and SVWC-96 in addition to the routine sampling locations. Concentrations of PFOA exceeded the state and/or federal MCL and guidance value in monitoring wells 8-OS (8.5 ng/L), 8-I (58.3 ng/L), 8-R (53.5 ng/L), 9-OS (5.44 ng/L), 9-I (5.53 ng/L), and 9-R (18.6 ng/L). Concentrations of PFOS exceeded the state and/or federal MCL and guidance value in monitoring wells 8-OS (4.81 ng/L), 8-I (12.4 ng/L), 8-R (17.2 ng/L), and 9-R (5.7) ng/L. PFAS concentrations were detected above state and/or federal MCLs in the

[2] It should be noted that although the federal MCLs were not in effect until April 2024, the historical data was compared to these levels for purposes of evaluating trends over the full FYR period and protectiveness.

public water supply wells PW-1, SVWC-04 and SVWC-95. Concentrations of PFOA exceeded state and federal MCLs in PW-1 (11.5 ng/L), and only exceeded federal MCLs in SVWC-94 (4.72 ng/L) and SVWC-95 (4.14 ng/L). Concentrations of PFOS only slightly exceeded federal MCLs in PW-1 (4.17 ng/L). There were no exceedances noted in monitoring wells UP-OS, UP-I, UP-R, 10-OS, 10-I, 10-R and public supply wells SVWC-93 and SVWC-96.

Upgradient monitoring wells UP-I and UP-R have not had detectable concentrations of PFAS. Low-level detections of PFAS were, however, observed in upgradient monitoring well UP-OS throughout the review period. The maximum concentrations of PFOA (2.73 ng/L in 2020) and PFOS (0.272 ng/L in 2025) in monitoring well UP-OS are below their respective MCLs and guidance values and do not suggest a source on the eastern upgradient side of the landfill. In March 2025, the landfill leachate collection system (Manhole A-5, Figure 3) upgradient of the public supply wells was sampled to determine PFAS concentrations in leachate. Concentrations of PFOA (18.6 ng/L), PFOS (5.7 ng/L), and PFNA (36.4 ng/L) were observed in the leachate sample. This data confirms that the landfill is a source of PFAS. It is EPA's expectation that improvements to the leachate collection system (as described under Sections II and II) will result in decreasing concentrations downgradient of the landfill.

The ROD included a contingency plan for an alternate water supply if drinking water standards are significantly exceeded for site-related parameters in residential wells, or in the same aquifer in the closest monitoring wells to the residential wells, and detected concentrations are confirmed by subsequent sampling. Currently, exceedances of drinking water standards have been limited for site-related parameters. The county samples PW-1 and PW-2 on a quarterly basis to ensure there are not sustained exceedances of drinking water standards. Although Veolia North America has a county-wide action plan with the New York State Department of Health (NYSDOH) for implementing treatment to address ECs detected in water supply wells (SVWC-94 and SVWC-95) and both Veolia North America and NYSDOH are aware of the presence of ECs in the noted public water supply wells, treatment has not been implemented yet.[3] EPA will continue to work with the state and county to ensure data is reviewed in a timely manner to ensure improvements to the leachate collection result in decreased levels of ECs in the public supply wells. Additionally, EPA will continue to coordinate with the state and county to track the progress toward Veolia's compliance with the Safe Drinking Water Act requirements.

**Site Inspection**

The inspection of the site was conducted on November 14, 2024. In attendance were Mr. Jacob (EPA), Mr. Long (NYSDEC), Michael Sadowski from the Town of Ramapo, and Andrew Millspaugh from Sterling Environmental, the consultant to the PRP. The purpose of the inspection was to assess the protectiveness of the remedy.

During the inspection, it was noted that deep-rooted plants and trees are growing along some sections of the landfill's cover on the drainage swales. This vegetation could compromise the integrity of the landfill cover. At the inspection, the Town of Ramapo representative indicated that the vegetation will be removed later in 2025.

[3] As public supply wells, SVWC-94 and 95 are subject to the compliance schedule established by the Safe Drinking Water Act.

## V. TECHNICAL ASSESSMENT

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

The implemented remedy includes the installation of a cap with an impermeable membrane, installation of groundwater extraction wells to supplement the existing leachate collection system, and collection and diversion of leachate to the leachate collection system for off-site treatment. The cap is currently being maintained by the Town as part of the New York State Part 360 closure requirements. NYSDEC inspects and assesses the integrity of the cap annually, as does the Town of Ramapo during periodic mowing of the grass. Currently, leachate and extracted groundwater are treated off-site by the Rockland County Sewer District. As required by the ROD, a DCR&EE was recorded in 2012 to prevent the installation of drinking water wells at the site and to restrict activities that could affect the integrity of the cap.

Iron and manganese both downgradient and upgradient of the landfill continue to exceed their secondary MCLs. The upgradient monitoring well cluster confirms the regional presence of the naturally-occurring inorganic constituents at the site. The presence of other contaminants downgradient of the landfill, including chromium, magnesium, nickel, sodium, and thallium, are less consistent.

A 2023-2024 capture zone analysis determined that most of the extraction well pumps were not properly operating. The pump issues were quickly resolved, and the extraction wells are now operating as intended to induce an inward and upward groundwater flow gradient to intercept landfill leachate. It is unknown how long the pumps were not properly operating prior to the capture zone analysis inspection.

Concentrations of PFAS (PFOA and PFOS) and 1,4-dioxane exceeded their respective NYSDEC and federal MCLs in downgradient monitoring and public water supply wells during the review period. Based on 2025 sampling results, PFAS and 1,4-dioxane are also present in the landfill leachate. Since the extraction well system is now operating as designed, the PFAS levels will likely show decreasing concentrations in response to improved capture. However, because contaminants located outside of the capture zone will not be captured, monitoring is needed to determine the extent of the ECs beyond the capture zone and whether they continue to impact public water supply wells. Therefore, future EC sampling should continue to include the monitoring wells and public supply wells that were part of the 2025 expanded sampling event (SVWC-93, SVWC-96, PW-1, PW-2 and monitoring wells 8-OS, 8-I, and 8-R) in addition to the routinely sampled locations.

Although Veolia has a county-wide action plan with NYSDOH for implementing treatment to address ECs detected in water supply wells, and both Veolia North America and NYSDOH are aware of the presence of ECs in the noted public water supply wells, treatment has not been implemented in water supply wells SVWC-94 and SVWC-95 yet. Veolia North America provides quarterly progress updates available to the public concerning the development of this action plan in coordination with NYSDOH. PFAS exceedances in supply well PW-1 have been limited, although the county has notified the property owners at PW-1 and placed this well (and PW-2) on quarterly sampling to ensure there are not sustained exceedances of drinking water standards. Upgradient monitoring wells UP-I and UP-R have not had detectable concentrations of PFAS; low-level detections of PFAS were, however, observed in upgradient monitoring well UP-OS throughout the review period although the results were below their respective MCLs and guidance values and do not suggest a source on the eastern upgradient side of the landfill. Additional rounds of sampling will aid in determining whether improvements to the leachate collection system are reducing migration of PFAS related to the landfill toward these supply wells and if additional optimization is needed.

***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?***

Although some exposure assumptions have changed and several exposure pathways were not evaluated in the 1991 HHRA, the need to take a remedial action remains valid. The toxicity values for several contaminants of concern have changed since the RI. To account for changes in toxicity values since the RI, the maximum detected concentrations of these contaminants in monitoring wells during the review period were compared to their respective MCLs. Several site-related contaminants were identified as exceeding their respective MCLs or NYSDEC AWQS for groundwater. Institutional controls prevent the installation of drinking water wells on site; however, residents downgradient obtain their drinking water from smaller community supply wells (PW-1 and PW-2) and larger public supply wells (SVWC-93, SVWC-94, SVWC-95 and SVWC-96). Emerging contaminants PFAS and 1,4-dioxane were analyzed in select wells during this review period. In March 2025, Potable water supply wells, PW-1, PW-2, SVWC-93, SVWC-94, SVWC-95 and SVWC-96 analyzed for PFAS constituents. PFAS compounds were detected in several downgradient wells and all potable water supply wells during this review period with some concentrations exceeding NYSDEC MCLs and ambient water quality guidance values, as well as the federal MCLs as described below.

1,4-Dioxane was detected consistently in monitoring well 9-R and public supply well SVWC-95. The concentrations of 1,4-dioxane exceeded NYSDECs guidance value (0.35 µg/L; see https://dec.ny.gov/environmental-protection/water/emerging-contaminants). EPA has recently promulgated MCLs for PFAS. The current EPA groundwater standard for PFAS is 4 ng/L for PFOA and PFOS (https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations). NYSDEC's MCL for both PFOA and PFOS is 10 ng/L. The maximum detected concentrations of PFAS constituents were compared to EPA and NYSDEC MCLs. PFAS was detected in the "9" series monitoring wells and the two public supply wells (SVWC-94 and SVWC-95) above their respective EPA MCLs in 2020, 2022, and 2024, but were below both EPA and NYSDEC MCLs in 2023. In 2025, the following potable wells PW-1, PW-2, SVWC-93 and SVWC-96 were included in the PFAS analysis as well as the 8 cluster wells. PFAS compounds were at or above either the EPA MCL or NYSDEC MCL in the "8" series wells, PW-1, SVWC-94, SVWC-95 and SVWC-96. PFAS did not exceed the EPA or NYSDEC MCL in PW-2 or SVWC-93. As stated under Question A, additional rounds of sampling from the expanded well sampling network (monitoring wells 8-OS, 8-I, and 8-R and supply wells PW-1, PW-2, SVWC-93 and SVWC-96) are needed to evaluate if improved capture associated with the leachate collection system is occurring.

The ROD evaluated potential risks to ecological receptors. The 1991 remedial investigation evaluated potential site impacts to aquatic and terrestrial species. For aquatic endpoints, the RI assessed impacts at Torne Brook, which flows adjacent to the landfill. Surface water ARAR exceedances were identified for inorganic contaminants including iron, lead, copper, mercury, sulfide, and zinc. However, because the leachate holding pond was excavated and treated as part of the site remedy, the potential for future impact from the landfill to the brook was considered low and surface water remediation was not a remedial objective for the site. Sediment in Torne Brook was also evaluated in the RI and not found to pose a risk to aquatic life based on concentrations of site related contaminants detected below NYSDEC sediment cleanup criteria. Overall, the potential ecological effects from the landfill are minor and the remedy is expected to adequately protect ecological receptors since the leachate holding pond was excavated and treated off-site, which eliminated exposure to ecological receptors. Ecological risk is minimal for the site and remedial actions are protective of wildlife.

The RAOs established in the ROD are valid at this time.

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

No additional information has arisen that would call into question the protectiveness of the remedy.

## 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): OU1 | Issue Category: Remedy Performance | | | |
|---|---|---|---|---|
| | **Issue:** Site-related PFAS (PFOA and PFOS) and 1,4-dioxane sporadically exceeded their respective NYSDEC and federal MCLs in downgradient monitoring and public supply wells during the review period and not all monitoring wells are regularly being sampled for these contaminants. | | | |
| | **Recommendation:** Regular sampling for ECs in routine monitoring and supply wells in addition to 8-OS, 8-I, and 8-R, as well as water supply wells PW-1, PW-2, SVWC-93, and SVWC-96, should occur over at least three additional rounds of sampling to evaluate whether improvements to the leachate collection system are reducing migration of PFAS related to the landfill toward these supply wells and if additional optimization is needed. | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Party Responsible** | **Oversight Party** | **Milestone Date** |
| Yes | Yes | PRP | EPA/State | 9/30/2028 |

| OU(s): OU1 | Issue Category: Monitoring | | | |
|---|---|---|---|---|
| | **Issue:** EPA, NYSDEC, and Rockland County need clear lines of communication to share monitoring data to ensure appropriate actions to address drinking water are taken, if necessary. | | | |
| | **Recommendation:** Enhance communication and data sharing between Rockland County and NYSDEC/EPA to ensure all parties have access to the most recent data. | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Party Responsible** | **Oversight Party** | **Milestone Date** |
| No | Yes | PRP | EPA/State | 12/31/2025 |

## OTHER FINDINGS

In addition, the following are suggestions that were identified during the FYR and may improve performance of the remedy as well as management of O&M, but do not affect current and/or future protectiveness:

- Several bedrock monitoring wells were not sampled during the last ten years. Because contaminants have been detected above MCLs in overburden and intermediate monitoring wells and also exceeded their respective criteria in historical bedrock monitoring wells, all monitoring wells should be included in future sampling events and analyzed for site-related Target Compound List/Target Analyte List.

- The capture zone analysis performed during the review period determined that most of the extraction well pumps were not properly operating. The pump issues were resolved, and the extraction wells are now operating as intended. It is unknown how long the pumps were not properly operating prior to the capture zone analysis inspection. The O&M plan needs to be updated to ensure the system is to be periodically monitored to determine if it is operating properly, and that repairs or adjustment are completed in a timely manner if needed.

- Deep-rooted plants and trees are growing along some sections of the landfill's cover on the drainage swales. Because this vegetation could compromise the integrity of the landfill cover, it should be removed.[4]

- Veolia is in the process of designing and implementing a granular activated carbon treatment system which will address emerging contaminants in public supply wells downgradient of the landfill (SVWC-93, 94, 95, and 96), as well as additional supply wells. Rockland County estimates this will take three to four years to implement. Progress on the effort should be monitored.

[4] At the FYR inspection, the Town of Ramapo representative indicated that the vegetation will be removed in 2025.

## VII. PROTECTIVENESS STATEMENT

| Protectiveness Statement(s) | | |
|---|---|---|
| *Operable Unit:*<br>OU1 | *Protectiveness Determination:*<br>Protectiveness Deferred | *Planned Addendum Completion Date:*<br>12/31/2028 |
| *Protectiveness Statement:* A protectiveness determination for the remedy cannot be made until further information is obtained. Further information will be obtained by performing at least three additional rounds of sampling for emerging contaminants at the routine and expanded site monitoring well and public supply well locations to determine if concentrations are decreasing following improvements to the leachate collection system and whether additional optimization is necessary. It is expected that these actions will take approximately three years to complete, at which time a protectiveness determination will be made. Additionally, communication and data sharing between Rockland County and NYSDEC/EPA needs to be enhanced to ensure all parties have access to the most recent data. | | |

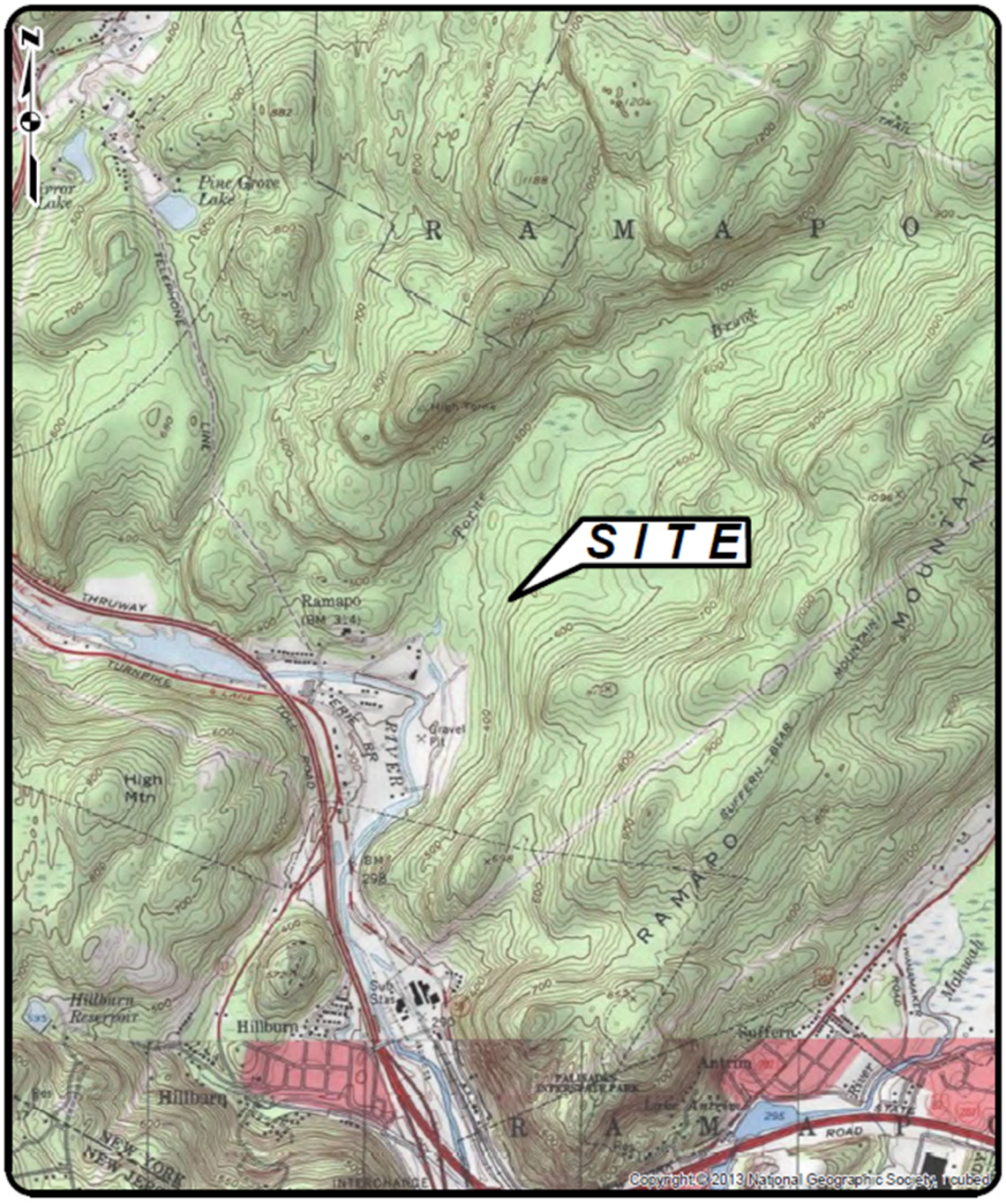
| Sitewide Protectiveness Statement |
|---|
| *Protectiveness Determination:*<br>Protectiveness Deferred |
| *Protectiveness Statement:* A protectiveness determination for the remedy cannot be made until further information is obtained. Further information will be obtained by performing at least three additional rounds of sampling for emerging contaminants at the routine and expanded site monitoring well and public supply well locations to determine if concentrations are decreasing following improvements to the leachate collection system and whether additional optimization is necessary. It is expected that these actions will take approximately three years to complete, at which time a protectiveness determination will be made. Additionally, communication and data sharing between Rockland County and NYSDEC/EPA needs to be enhanced to ensure all parties have access to the most recent data. |

## VIII. NEXT REVIEW

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

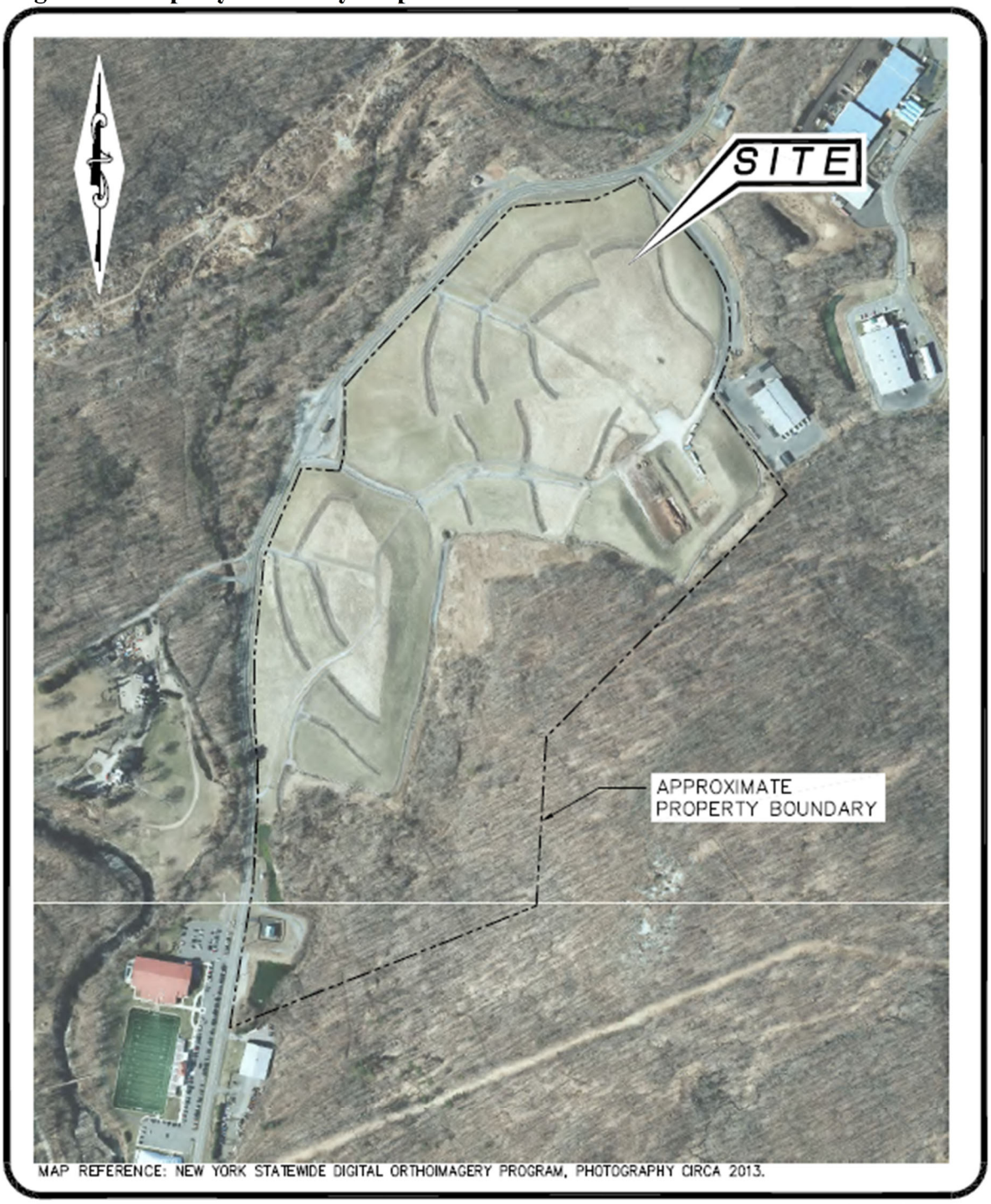
# APPENDIX A – FIGURES

**Figure 1: Site Location Map**




| | | | | |
|---|---|---|---|---|
| STERLING<br>Sterling Environmental Engineering, P.C.<br>24 Wade Road • Latham, New York 12110 | SITE LOCATION MAP<br>TOWN OF RAMAPO LANDFILL<br>TOWN OF RAMAPO ROCKLAND CO., NY | | | |
| PROJ.NO. 20010 | DATE: 10/14/2020 | SCALE: 1 " = 2,000 ' | DWG.NO. 20010001G | FIGURE 1 |

**Figure 2: Property Boundary Map**

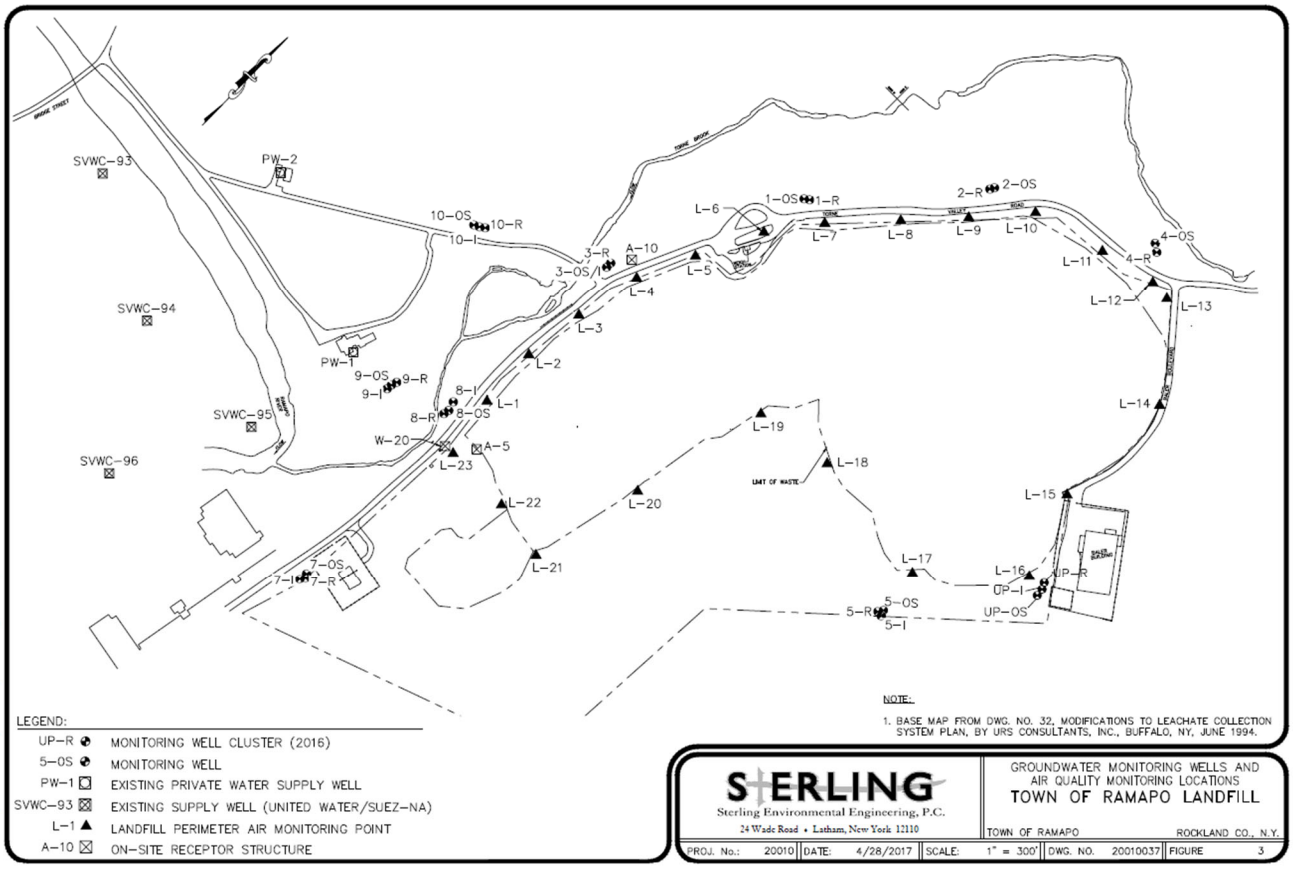



STERLING
Sterling Environmental Engineering, P.C.
24 Wade Road • Latham, New York 12110

PROPERTY FEATURES
TOWN OF RAMAPO
LANDFILL
TOWN OF RAMAPO ROCKLAND CO., N.Y.

| PROJ. No.: | 20010 | DATE: | 6/24/14 | SCALE: | 1" = 500' | DWG. NO. | 20010036 | FIGURE | 2 |
|---|---|---|---|---|---|---|---|---|---|

**Figure 3: Sampling Locations**



# APPENDIX B – REFERENCES

| Documents, Data, and Information Reviewed in Completing Five-Year- Review | |
|---|---|
| Remedial Investigation and Feasibility Study Report, URS Consultants, Inc. | 1991 |
| Record of Decision, EPA | 1992 |
| Final Design Analysis Report, URS Greener, Inc. | 1994 |
| Explanation of Significant Differences, EPA | 1997 |
| Preliminary Close-Out Report, EPA | 1997 |
| Operation and Maintenance Monitoring Manual, URS Greener, Inc. | 1998 |
| Construction Monitoring Report Ramapo Landfill Remediation, URS Greiner, Inc. | 1998 |
| Five Year Review Report, EPA | 1999 |
| Second Five-Year Review Report, EPA | 2004 |
| Addendum to the Second Five-Year Review report. | 2005 |
| Third Five-Year Review Report, EPA | 2009 |
| DCR & EE | 2012 |
| Revised Draft SMP, Sterling Environmental Engineering | 2014 |
| Plan for Best Management Practices & Preliminary Roof Design for shooting range, Town of Ramapo | 2014 |
| Work Plan, Installation report and sampling results for the new downgradient sentinel well cluster | 2014 |
| Fourth Five-Year Review Report, EPA | 2015 |
| Work Plan, Installation report and sampling results for the new upgradient monitoring well cluster | 2017 |
| Fifth Five-Year Review Report, EPA | 2020 |
| Periodic Review Reports, Sterling Environmental Engineering | 2019-2024 |
| Capture Zone Analysis Report | 2024 |

# APPENDIX C--SITE TOPOGRAPHY, GEOLOGY, AND HYDROGEOLOGY

## Site Geology/Hydrogeology

The main surface waters in the vicinity of the site are the Ramapo River, Torne Brook and Candle Brook. The Ramapo River, located approximately 300 feet from the southwest corner of the site, is a New York State Department of Environmental Conservation (NYSDEC) Class "A" water, which may be used as a source of water supply for drinking, culinary, or food-processing purposes. Torne Brook, which flows near the western boundary of the site, and Candle Brook, a tributary of Torne Brook, are NYSDEC Class "B" waters, suitable for primary contact recreation and any other use, except as a source of water supply for drinking, culinary, or food-processing purposes. The United States Geological Survey has identified an area of less than ten acres near the headwaters of Candle Brook as a wetland.

The site is underlain by a sequence of glacially derived unconsolidated sediments that overlie bedrock, which is comprised of granitic and biotite gneiss. The bedrock geology is structurally complex with numerous fault systems in the area. A fracture trace analysis identified a number of lineaments in the vicinity of the site, the most obvious one being the Ramapo fault (approximately 1.25 miles southeast of the site), which strikes northeast and dips steeply southeast. Two other lineaments observed within the immediate area of the landfill include one that lies adjacent to the west side of the landfill and trends northeast. This lineament may represent faulting or other subsurface structures controlling deflections in Torne Brook. The second lineament trends east-west and appears to cross the central portion of the landfill. The shallow aquifer is comprised of permeable sediments consisting of a grey to brown, very loose to loose sand or sandy gravel with some silt with a hydraulic conductivity on the order of $1 \times 10^{-4}$ centimeters per second (cm/sec) and a medium-dense to very dense silty sand or gravelly sand with abundant boulders and cobbles with hydraulic conductivity values ranging from $5.1 \times 10^{-5}$ to $1.4 \times 10^{-4}$ cm/sec. Below these sand units is a thin weathered rock zone ranging in thickness from a few inches to nearly five feet with hydraulic conductivity values ranging from $4 \times 10^{-5}$ to $1.5 \times 10^{-3}$ cm/sec. Underlying the weathered rock zone is a granitic and biotite gneiss bedrock aquifer. In some locations, highly fractured zones were found within the bedrock suggesting faulting. Hydraulic conductivity values for the bedrock aquifer ranged from $8.9 \times 10^{-5}$ to $1 \times 10^{-2}$ cm/sec.

Past investigations found that shallow (water-table aquifer) groundwater generally flows toward Torne Brook and the Ramapo River with Torne Brook acting as the discharge area for the water-table aquifer, and that groundwater in the bedrock aquifer likely flows beneath Torne Brook. Vertical flow measurements indicate that groundwater generally flows downward.

## Land and Resource Use

The Town subdivided the property north of the limit of waste and sold it to the Rockland County Solid Waste Management Authority in 1998. The Rockland County Solid Waste Management Authority currently operates a garbage transfer facility at this location. A pistol range utilized by the Town of Ramapo Police Department is located in the northeastern area of the site. Immediately adjacent to it (south of the pistol range), the Rockland County Solid Waste Management Authority constructed a leaf composting facility in 2007.

Ten water supply wells, serving a population of over 200,000, are located along the Ramapo River both upstream and downstream of the site. Four of these wells are located within 1,600 feet of the landfill, the nearest being 750 feet from the landfill. The closest water supply well is located approximately 450 feet west of the site on the west bank of the Ramapo River at a residential apartment complex of 25 units. A two-unit apartment building maintains a well about 1,200 feet from the landfill.

# APPENDIX D – REMEDY RESILIENCE EVALUATION

In accordance with Region 2 practice, three tools were utilized to assess the Ramapo Landfill site. Screenshots from each of the tools used are included below.

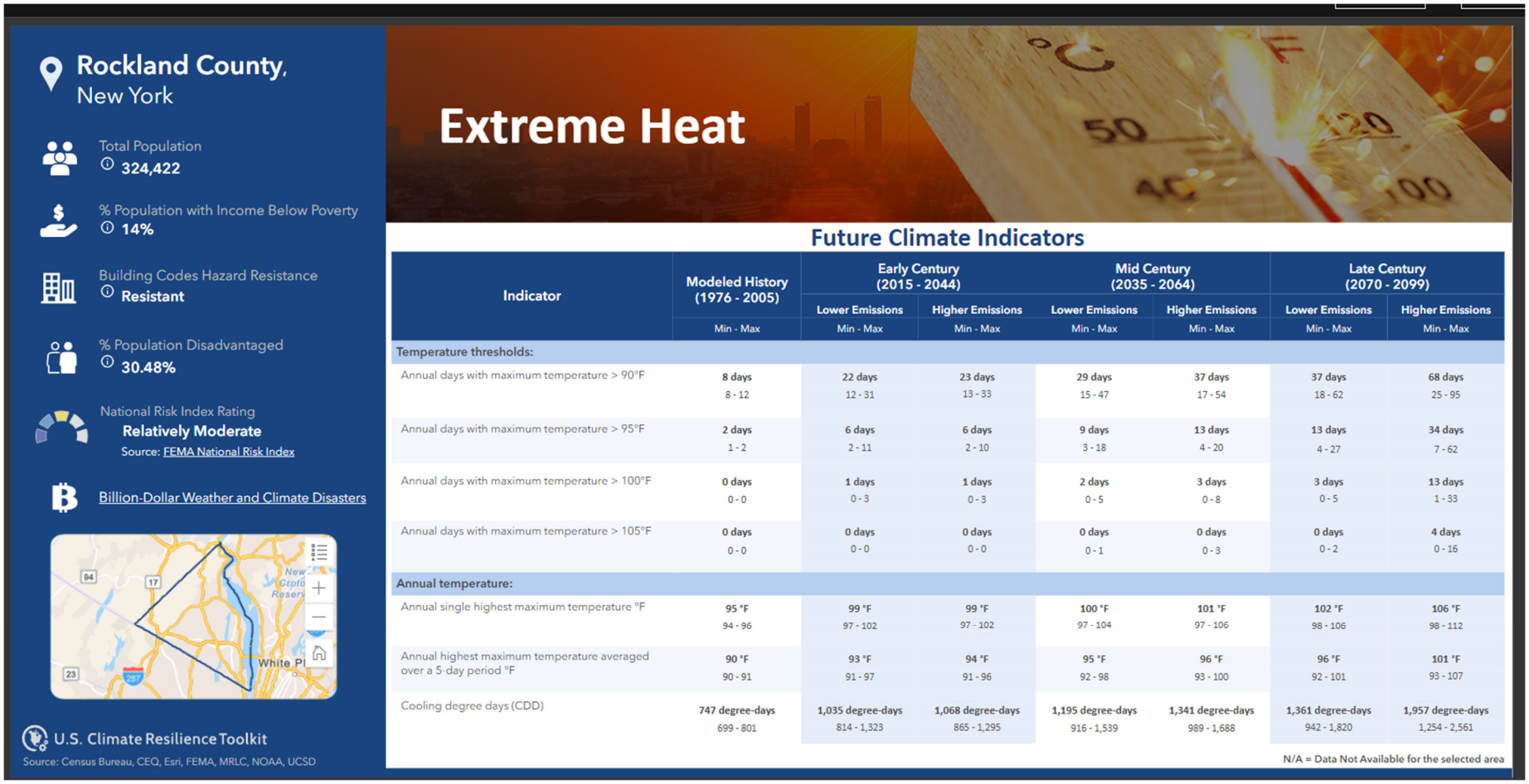
The first tool, the CMRA Tool (see CMRA) examined five hazards (extreme heat, drought, wildfire, flooding, and costal inundation) for Rockland County, the county in which the site is located. According to the CMRA tool, the National Risk Index Rating for extreme heat, drought, and wildfire are "Relatively Moderate," "Very Low," and "Very Low," respectively (see Figures D-1 through D-3). The CMRA tool reported the risks for flooding and costal inundation are "Relatively Low" and "Relatively Moderate," respectively, as shown in Figures D-4 and D-5.

The second tool is called the NOAA Sea Level Rise Viewer (SLRV) (see https://cost.noaa.gov/slr/). This tool assessed the potential for impacts to the site vicinity from sea level rise and coastal flooding. The site is located approximately 12 miles from the coast. Therefore, coastal flooding is unlikely. This is evidenced in Figure D-6 which shows the site will not be impacted by a "worse scenario" 10-foot sea level rise.

The final tool is called the USGS U.S. Landslide Inventory (see https://www.usgs.gov/tools/us-landslide-inventory-and-susceptibility-map). As shown by Figure D-7, there is a low to moderate vulnerability of a landslide at the site although there has not been evidence of landslides on or near the site in the past.

Based on this information, potential site impacts from severe weather have been assessed, and the performance of the remedy is currently not at risk due to the expected weather-related effects in the region and near the site.

# FIGURE D-1




## 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 |
| **Temperature thresholds:** | | | | | | | |
| Annual days with maximum temperature > 90°F | 8 days<br>8 - 12 | 22 days<br>12 - 31 | 23 days<br>13 - 33 | 29 days<br>15 - 47 | 37 days<br>17 - 54 | 37 days<br>18 - 62 | 68 days<br>25 - 95 |
| Annual days with maximum temperature > 95°F | 2 days<br>1 - 2 | 6 days<br>2 - 11 | 6 days<br>2 - 10 | 9 days<br>3 - 18 | 13 days<br>4 - 20 | 13 days<br>4 - 27 | 34 days<br>7 - 62 |
| Annual days with maximum temperature > 100°F | 0 days<br>0 - 0 | 1 days<br>0 - 3 | 1 days<br>0 - 3 | 2 days<br>0 - 5 | 3 days<br>0 - 8 | 3 days<br>0 - 5 | 13 days<br>1 - 33 |
| Annual days with maximum temperature > 105°F | 0 days<br>0 - 0 | 0 days<br>0 - 0 | 0 days<br>0 - 0 | 0 days<br>0 - 1 | 0 days<br>0 - 3 | 0 days<br>0 - 2 | 4 days<br>0 - 16 |
| **Annual temperature:** | | | | | | | |
| Annual single highest maximum temperature °F | 95 °F<br>94 - 96 | 99 °F<br>97 - 102 | 99 °F<br>97 - 102 | 100 °F<br>97 - 104 | 101 °F<br>97 - 106 | 102 °F<br>98 - 106 | 106 °F<br>98 - 112 |
| Annual highest maximum temperature averaged over a 5-day period °F | 90 °F<br>90 - 91 | 93 °F<br>91 - 97 | 94 °F<br>91 - 96 | 95 °F<br>92 - 98 | 96 °F<br>93 - 100 | 96 °F<br>92 - 101 | 101 °F<br>93 - 107 |
| Cooling degree days (CDD) | 747 degree-days<br>699 - 801 | 1,035 degree-days<br>814 - 1,323 | 1,068 degree-days<br>865 - 1,295 | 1,195 degree-days<br>916 - 1,539 | 1,341 degree-days<br>989 - 1,688 | 1,361 degree-days<br>942 - 1,820 | 1,957 degree-days<br>1,254 - 2,561 |

N/A = Data Not Available for the selected area

# FIGURE D-2

## Rockland County, New York

Total Population
324,422

% Population with Income Below Poverty
14%

Building Codes Hazard Resistance
Resistant

% Population Disadvantaged
30.48%

National Risk Index Rating
Very Low
Source: FEMA National Risk Index

Billion-Dollar Weather and Climate Disasters


U.S. Climate Resilience Toolkit
Source: Census Bureau, CEQ, Esri, FEMA, MRLC, NOAA, UCSD


### 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:** | | | | | | | |
| Average annual total precipitation | **49"**<br>47 - 51 | **51"**<br>47 - 57 | **51"**<br>46 - 56 | **51"**<br>47 - 58 | **52"**<br>48 - 56 | **53"**<br>48 - 58 | **55"**<br>49 - 61 |
| Days per year with precipitation (wet days) | **187 days**<br>183 - 192 | **186 days**<br>177 - 198 | **186 days**<br>173 - 198 | **185 days**<br>175 - 197 | **184 days**<br>171 - 198 | **185 days**<br>174 - 198 | **182 days**<br>157 - 201 |
| Days per year with no precipitation (dry days) | **179 days**<br>173 - 182 | **179 days**<br>167 - 188 | **179 days**<br>167 - 192 | **180 days**<br>168 - 190 | **181 days**<br>167 - 195 | **180 days**<br>167 - 192 | **183 days**<br>164 - 208 |
| Maximum number of consecutive dry days | **11 days**<br>11 - 13 | **12 days**<br>10 - 13 | **12 days**<br>11 - 14 | **12 days**<br>10 - 15 | **12 days**<br>11 - 15 | **12 days**<br>10 - 15 | **13 days**<br>11 - 15 |
| **Temperature thresholds:** | | | | | | | |
| Annual days with maximum temperature > 90 °F | **8 days**<br>8 - 12 | **22 days**<br>12 - 31 | **23 days**<br>13 - 33 | **29 days**<br>15 - 47 | **37 days**<br>17 - 54 | **37 days**<br>18 - 62 | **68 days**<br>25 - 95 |
| Annual days with maximum temperature > 100 °F | **0 days**<br>0 - 0 | **1 days**<br>0 - 3 | **1 days**<br>0 - 3 | **2 days**<br>0 - 5 | **3 days**<br>0 - 8 | **3 days**<br>0 - 5 | **13 days**<br>1 - 33 |

N/A = Data Not Available for the selected area

# FIGURE D-3

## Rockland County, New York

Total Population
324,422

% Population with Income Below Poverty
14%

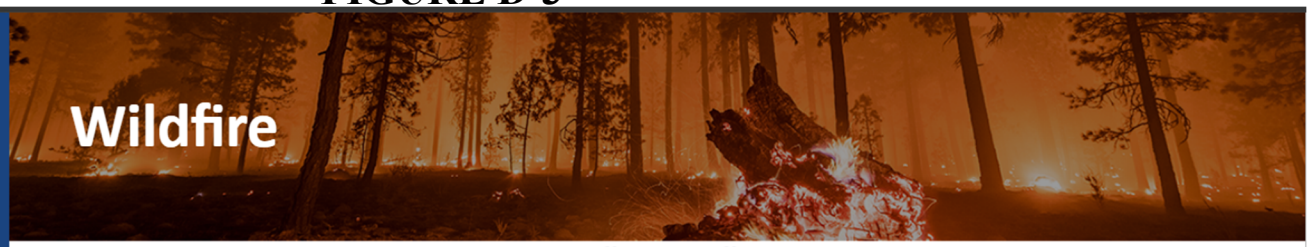
Building Codes Hazard Resistance
Resistant

% Population Disadvantaged
30.48%

National Risk Index Rating
Very Low
Source: FEMA National Risk Index

Billion-Dollar Weather and Climate Disasters


U.S. Climate Resilience Toolkit




## 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:** | | | | | | | |
| Days per year with no precipitation (dry days) | **179 days**<br>173 - 182 | **179 days**<br>167 - 188 | **179 days**<br>167 - 192 | **180 days**<br>168 - 190 | **181 days**<br>167 - 195 | **180 days**<br>167 - 192 | **183 days**<br>164 - 208 |
| Maximum number of consecutive dry days | **11 days**<br>11 - 13 | **12 days**<br>10 - 13 | **12 days**<br>11 - 14 | **12 days**<br>10 - 15 | **12 days**<br>11 - 15 | **12 days**<br>10 - 15 | **13 days**<br>11 - 15 |
| Days per year with precipitation (wet days) | **187 days**<br>183 - 192 | **186 days**<br>177 - 198 | **186 days**<br>173 - 198 | **185 days**<br>175 - 197 | **184 days**<br>171 - 198 | **185 days**<br>174 - 198 | **182 days**<br>157 - 201 |
| **Temperature thresholds:** | | | | | | | |
| Annual days with maximum temperature > 90°F | **8 days**<br>8 - 12 | **22 days**<br>12 - 31 | **23 days**<br>13 - 33 | **29 days**<br>15 - 47 | **37 days**<br>17 - 54 | **37 days**<br>18 - 62 | **68 days**<br>25 - 95 |
| Annual days with maximum temperature > 100°F | **0 days**<br>0 - 0 | **1 days**<br>0 - 3 | **1 days**<br>0 - 3 | **2 days**<br>0 - 5 | **3 days**<br>0 - 8 | **3 days**<br>0 - 5 | **13 days**<br>1 - 33 |

# FIGURE D-4

## Rockland County, New York

Total Population
324,422

% Population with Income Below Poverty
14%

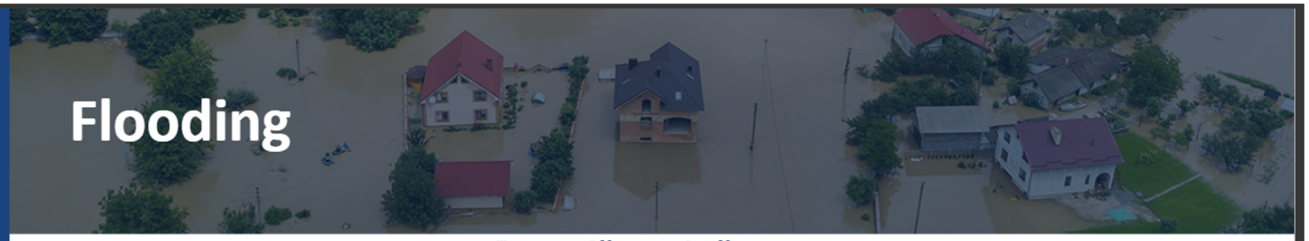
Building Codes Hazard Resistance
Resistant

% Population Disadvantaged
30.48%

National Risk Index Rating
Relatively Low
Source: FEMA National Risk Index

Billion-Dollar Weather and Climate Disasters


U.S. Climate Resilience Toolkit
Source: Census Bureau, CEQ, Esri, FEMA, MRLC, NOAA, UCSD




## 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 | **49"**<br>47 - 51 | **51"**<br>47 - 57 | **51"**<br>46 - 56 | **51"**<br>47 - 58 | **52"**<br>48 - 56 | **53"**<br>48 - 58 | **55"**<br>49 - 61 |
| Days per year with precipitation (wet days) | **187 days**<br>183 - 192 | **186 days**<br>177 - 198 | **186 days**<br>173 - 198 | **185 days**<br>175 - 197 | **184 days**<br>171 - 198 | **185 days**<br>174 - 198 | **182 days**<br>157 - 201 |
| Maximum period of consecutive wet days | **11 days**<br>10 - 12 | **12 days**<br>10 - 13 | **12 days**<br>10 - 14 | **12 days**<br>9 - 14 | **12 days**<br>9 - 14 | **12 days**<br>10 - 13 | **12 days**<br>9 - 15 |
| **Annual days with:** | | | | | | | |
| Annual days with total precipitation > 1inch | **8 days**<br>7 - 9 | **9 days**<br>7 - 11 | **9 days**<br>7 - 11 | **9 days**<br>8 - 11 | **10 days**<br>8 - 12 | **10 days**<br>8 - 11 | **11 days**<br>8 - 13 |
| Annual days with total precipitation > 2 inches | **1 days**<br>1 - 1 | **1 days**<br>1 - 2 | **1 days**<br>1 - 2 | **1 days**<br>1 - 2 | **1 days**<br>1 - 2 | **1 days**<br>1 - 2 | **2 days**<br>1 - 2 |
| Annual days with total precipitation > 3 inches | **0 days**<br>0 - 0 | **0 days**<br>0 - 0 | **0 days**<br>0 - 0 | **0 days**<br>0 - 1 | **0 days**<br>0 - 1 | **0 days**<br>0 - 1 | **0 days**<br>0 - 1 |
| Annual days that exceed 99th percentile precipitation | **7 days**<br>6 - 8 | **8 days**<br>7 - 9 | **8 days**<br>7 - 9 | **8 days**<br>7 - 10 | **9 days**<br>8 - 11 | **9 days**<br>8 - 11 | **11 days**<br>10 - 13 |
| Days with maximum temperature below 32 °F | **23 days**<br>21 - 26 | **16 days**<br>5 - 21 | **15 days**<br>7 - 21 | **12 days**<br>3 - 18 | **10 days**<br>5 - 17 | **10 days**<br>2 - 16 | **4 days**<br>0 - 10 |

N/A = Data Not Available for the selected area

# FIGURE D-5

**Rockland County, New York**

Total Population
**324,422**

% Population with Income Below Poverty
**14%**

Building Codes Hazard Resistance
**Resistant**

% Population Disadvantaged
**30.48%**

National Risk Index Rating
**Relatively Moderate**
Source: FEMA National Risk Index

Billion-Dollar Weather and Climate Disasters


U.S. Climate Resilience Toolkit
Source: Census Bureau, CEQ, Esri, FEMA, MRLC, NOAA, UCSD

# Coastal Inundation

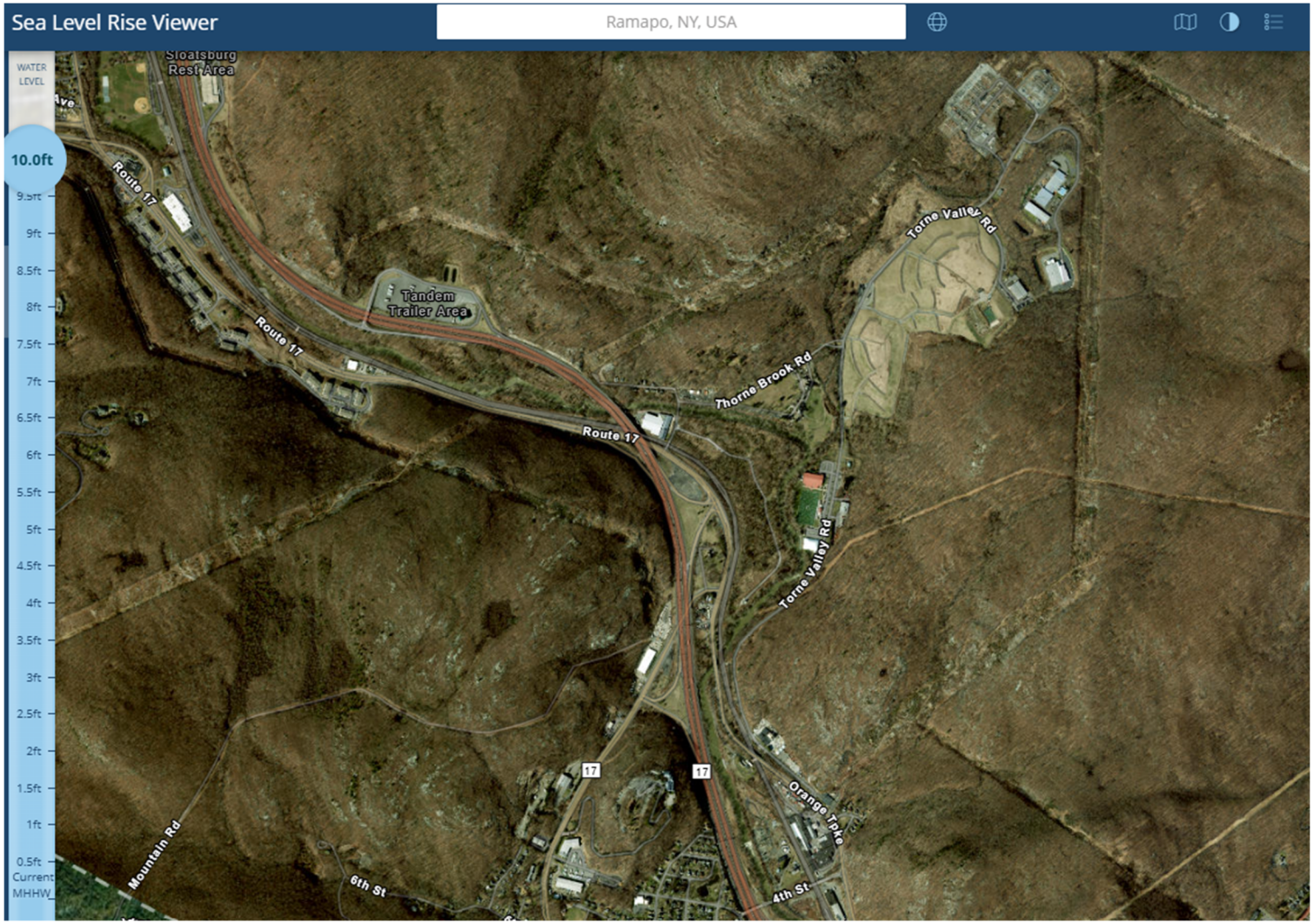
## Future Climate Indicators

| 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 |
| **Sea level rise:** | | | | | | | |
| Percent of selected county impacted by global sea level rise | N/A | 0% | 0% | 0% | 0% | 0% | 1% |

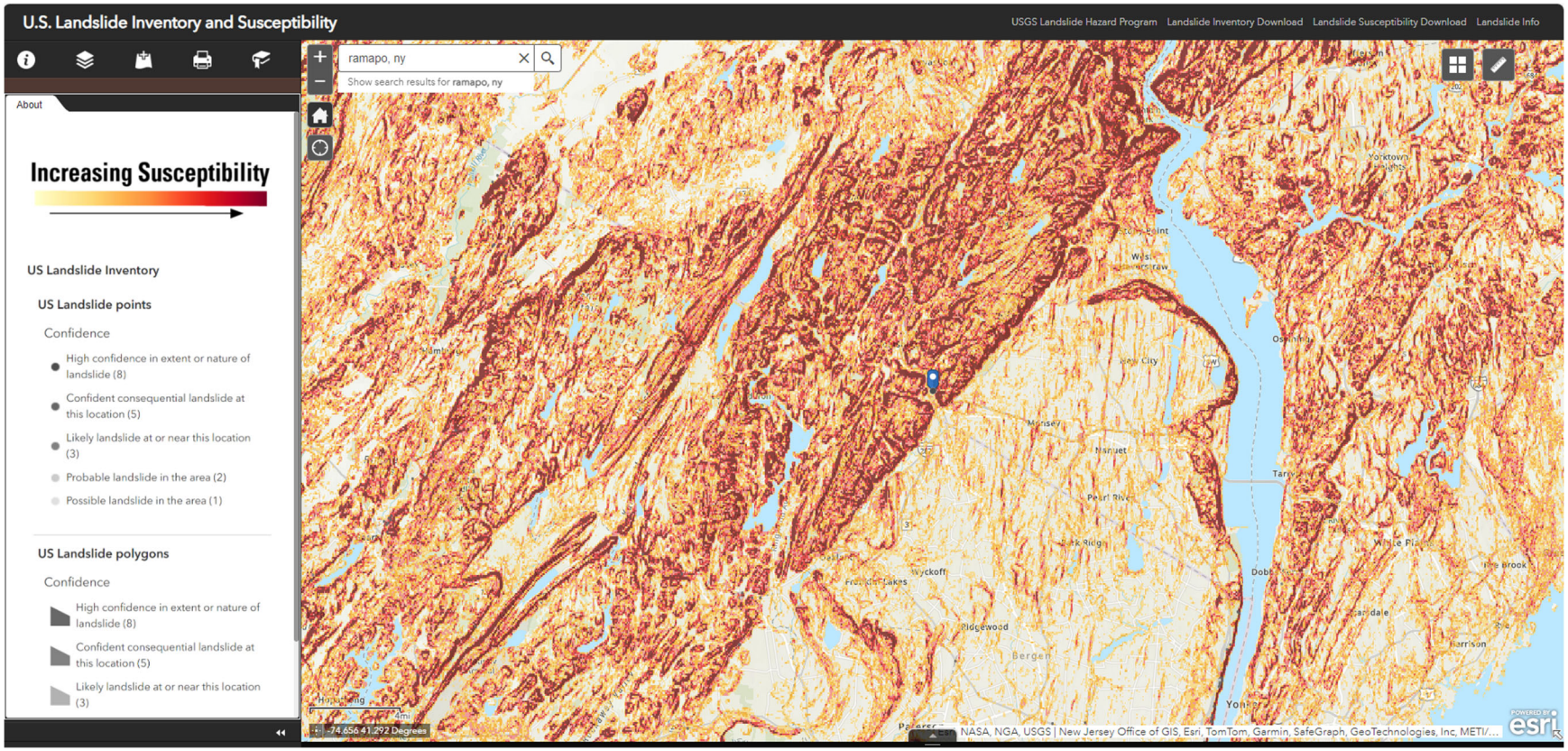
For more information on sea level changes, see the Interagency Sea Level Rise Scenario Tool

N/A = Data Not Available for the selected area

# FIGURE D-6


Sea Level Rise Viewer
Ramapo, NY, USA
WATER LEVEL
10.0ft
9ft
8.5ft
8ft
7.5ft
7ft
6.5ft
6ft
5.5ft
5ft
4.5ft
4ft
3.5ft
3ft
2.5ft
2ft
1.5ft
1ft
0.5ft
Current MHHW
Sloatsburg Rest Area
Route 17
Tandem Trailer Area
Route 17
Route 17
Thorne Brook Rd
Torne Valley Rd
Torne Valley Rd
Orange Tpke
Mountain Rd
6th St
4th St
17
17

# FIGURE D-7




*The site location is denoted by the blue tag.