JANUARY 26, 2023

MUNICIPALITY OF TOA ALTA DECEMBER 2022 MONTHLY REPORT

CIV. NO. 3:21-01087-DRD

N. AYALA
TERRATEK ENGINEERING GROUP, PSC
P.O. Box 367445 San Juan, PR 00936

Contents

I. DISTRIBUTION LIST

DOJ: david.l.gordon@usdoj.gov
EPA: spielmann.lee@epa.gov
plossl.carl@epa.gov
DNER: nildasanchez@drna.pr.gov
mariavrodriguez@drna.pr.gov

MTA: carlos@cwllegal.com
dbatlle@cstlawpr.com
jramirez@amrclaw.com
cagosto674@gmail.com

II. REPORT ORGANIZATION

As part of the USA-MTA Civ. No. 3:21-01087-DRD Stipulation and Preliminary Injunction Order, MTA shall prepare and submit monthly reports regarding the performance of its obligations under this Order until completion of the requirements of Paragraphs 3 through 10 of this Order. Each report shall cover the period ending on the last day of each month. Each report must be sent to DOJ, EPA, and DNER on or before the 15th day of the month following the reporting period. Each monthly report shall include:

i. description of compliance with each requirement of this Order;

ii. the volume, acreage and location of the Intermediate Cover that was applied;

iii. the volume and disposition of leachate and leachate-contaminated stormwater collected;

iv. results of any sampling analysis performed; and

v. Notification of any noncompliance with this Order, including a statement describing the noncompliance and its underlying causes, and proposed measures and an implementation schedule to correct the noncompliance.

The monthly report is divided into four sections.

Section 1 presents a summary of the order requirements and the compliance status for each requirement. *Please note that Task ID's are not related to the order assigned paragraphs.*

Section 2 will include detail information or supporting documentation regarding the compliance status of each requirement in need of comprehensive description or status details.

Section 3 is a projection of next month activities.

Section 4 includes all the attachments included with the report.

III. Section 1: SUMMARY

Municipality of Toa Alta Civ. No. 3:21-01087-DRD		
Reporting Period:		December 1 to December 31, 2022
Reporting Number:		05
Reporting Official:		Nivia Ayala, PE/TerraTek
Reporting Date:		1/26/2023
	Description of Compliance with each requirement of the Order	
ID	Requirement	Compliance Status
1	Daily Cover	Daily cover was completed prior to April 30, 2022.
2	Cessation of Waste Disposal	In-Compliance
3	Posting of Signs	In Compliance
4	Intermediate Cover	Intermediate cover was scheduled to start by October 1, 2022. However, MTA is still waiting for DNER funds to acquire specified cover material and contract an independent contractor to perform the required task. After DNER approves, or approves with modifications or conditions, any MTA revised permanent closure plan, and if the approved plan includes a schedule for completion of Intermediate Cover, that schedule shall control. Please see Additional comment for ID 4 item.
5	Maintenance of Cover	Monthly Maintenance for applied daily cover is performed for compliance assurance. Please see Attachment 1 for Inspection reports.
6	Slope Stability	Short Term Controls were completed by May 1. 2022. Diversion works to prevent stormwater runoff on the top deck for entering the North Slope Area and erosion controls. Maintenance is performed monthly. Safety Barrier fencing was still pending installation during the reporting period, even though it has an active Purchase Order the supplier was not able to deliver the materials during the reporting period. Please see additional comments for ID 6 Item.
7	Leachate Management	Field work for the Survey of Leachate Seeps was completed on December 19, 2022. A new topographic map was prepared to georeferenced every leachate seepage identified.
8	Stormwater Management	
8a	Short Term Controls	A monthly routine for pest control will be implemented for both North and South Ponds. Catch basins, ditches, swales and channels were inspected weekly, when necessary, cleaned of accumulated debris and eliminate any observed standing/stagnant water. When applicable, catch basins, ditches, swales, and channels were periodically mowed and cleaned. The diesel tank secondary containment is inspected weekly, when necessary, cleaned of accumulated debris and eliminate any observed standing/stagnant water. As a complimentary source reduction a monthly larvicide program will start on February, 2023. The larvicide program will be

		applied at the Sedimentation Ponds and other identified areas with standing water within the Toa Alta Municipal Landfill and its facilities.
8b	Survey of Leachate Seeps	Completed on December 19, 2022
8c	Stormwater Management Plan	The H-H Study was completed on December 15, 2022. Presently we are on the design phase. With the information of the H-H Study a new set of structural controls will be designed to manage the stormwater regulatory requirements applicable to landfill facilities.
8d	Discharges of Stormwater Not from Pond	N/A
8e	Discharge/Disposal of Pond Liquid	N/A
Additional Requirements		
The volume, acreage, and location the Intermediate Cover that was applied.		N/A
The volume and disposition of leachate contaminated stormwater collected.		None
Results Of Any Sampling Analysis Performed		None
Notification Of Noncompliance		Safety Barrier fencing was still pending installation during the reporting period, even though it has an active Purchase Order the supplier was not able to deliver the materials during the reporting period.

IV. SECTION 2: DETAIL INFORMATION OR SUPPORTING DOCUMENTATION OF EACH REQUIREMENT IN NEED OF COMPREHENSIVE DESCRIPTION OR STATUS DETAILS

A. COMPLETED REQUIREMENTS

Access:

Access is granted to the United States and the Commonwealth of Puerto Rico, and their employees, representatives and contractors, to conduct the necessary inspections and studies, including and the applicable records review to evaluate existing conditions, following the agreed terms in the Stipulation.

Daily Cover:

Daily Cover at the facility was completed on April 30, 2022. All areas of exposed waste were covered by Daily Cover.

Cessation of Waste Disposal:

The cessation of waste disposal at the facility was completed by March 30, 2022. However, as agreed in the Stipulation, the temporary storage of construction and demolition (C&D) waste, bulk household waste (durable goods such as mattresses, furniture, and appliances), or yard waste (vegetation waste generated by land maintenance) for final disposal at a different landfill is active and been performed on a daily basis.

Posting of Signs:

A sign with a size of four feet by five feet was installed at the landfill entrance. See the attached picture.

B. ID 4: Intermediate Cover

As has been explained numerous times throughout the process, the Municipality needs the funding to perform several of the required tasks, commencing with the Intermediate Cover Task, as it is one of the more costly initial tasks to be performed. The following is a chronological order of the Municipality performed steps to negotiate and acquire the funds to perform this task:

<u>Rural Development:</u>

1. On May 18, 2020, the Municipality submitted a Notice of Intent to Rural Development requesting the award of funds under the Disaster Mitigation Assistance Grant for the landfill.
2. On September 4, 2020, the Municipality amended its request to include the landfill closure, post-closure activities and expansion.
3. On July 16, 2021, the Municipality received a Rural Development email confirming that all the required documents for the appropriate Disaster Mitigation Assistance Grant for the landfill was completed.
4. On August 22, 2022, the Municipality held a Public Hearing related to the grant funds requested.

5. USDA Rural Grant Program, MTA submitted a final Environmental Assessment to: Quiles, Danna - RD, San Juan, PR <danna.quiles@usda.gov>; Cabrera, Jose - RD, San Juan, PR <Jose.Cabrera@usda.gov>; Davila, Sandimary - RD, San Juan, PR <Sandimary.Davila@usda.gov>; Gonzalez, Melvin - RD, SAN JUAN, PR <Melvin.Gonzalez@usda.gov>. The document was submitted on September 30, 2022.
6. As of today, the Rural Development process is still on-going, but has not yet completed.

Department of Natural and Environmental Resources (DNER)

1. The DNER, during the EPA Public Hearing held on February 23, 2022, stated publicly and during the hearing that they would make available to the Municipality the required funds for the appropriate landfill closure.
2. As a result of DNER public comments, a meeting on March 24, 2022, between the Municipality, DNER and La Fortaleza was held to discuss the details related to the funds availability.
3. On March 31, 2022, the Municipality provided the required information by the DNER, including the schedule and cost estimate for said agency to prepare a Memorandum of Understanding (MOU) that would provide the necessary funds to the Municipality for the landfill's closure activities.
4. After continuous inquiries by the Municipality, the DNER on June 10, 2022, finally provided a draft MOU for the funds access. The Municipality issued its comments to the MOU on July 12, 2022.
5. A meeting was held on November 2, 2022, with Puerto Rico Office of Management and Budget, the DNER and MTA to discuss the extent of the DOJ requirements and DNER Closure Plan request. The purpose of the meeting also includes the addition of a transfer station located at the Landfill existing site.
6. A conference call was held on November 29, 2022 where PROMB required an additional cost spreadsheet including the cost of a transfer station design and construction.
7. As of today, and after significant follow-up efforts with the DNER, they have not responded with the definitive version of the MOU and the availability of funds.
8. An email was sent on December 5, 2022 to Ms. Maria V. Rodriguez, Anais Rodriguez Vega, Elid Ortega Orozco, Claribel Rivera following up regarding the MOU with the agency.
9. An email was sent on December 20, 2022 to Ms. Maria V. Rodriguez, Anais Rodriguez Vega, Elid Ortega Orozco, Claribel Rivera following up regarding the MOU with the agency.

Currently, the Municipality is analyzing the different alternatives at their disposal in order to advance the execution of the required Intermediate Cover tasks.

Additionally, MTA has already started the RFQ process for a Landfill Contractor

Dates	Activities
January 15, 2023	RFQ initial announcement.
February 15, 2023	Deadline for interested contractors to submit and present questions.
March 15, 2023	Due date for SOQs.
April 15-30, 2023	Deadline for Municipality evaluation and determination of SOQ.
May 15, 2023	Perform negotiations with applicable contractors (if necessary).
May 30, 2023	Final Determination of RFQ (if necessary).

A Closure Conceptual Design is ready to be submitted to DNER.

C. ID 6: Safety Barrier Fencing

Presently, MTA is going over the contracting and finance process to contract the installation of the safety barrier. Materials are already on site. The shortage on the chain supply of these kind of construction materials have a delay of three (3) months. As MTA is required to follow purchasing and finances municipal processes,

D. ID7: Leachate Management Plan

A technical discussion with Mr. Carl Plossl from EPA and Dr. Tim Townsend regarding the possibility of reaching at least a 90% reduction in releases of leachate from the unlined portion of the Landfill was held on October 13, 2022. The discussion included the data and assumptions for the US HELP Model, the required process flow for an effective closure plan execution and the execution of an on-site pilot leachate generation rate assessment will be completed by December 9, 2022. However, the weather conditions and extensive rainfall events made it impossible to complete the pilot test. This specific test needs to be performed after January 18, 2023, as the MTA Project Coordinator will not be available after that date. This pilot test will be performed before February 15, 2023.

E. ID8a: Hurricane Fiona Debris Management

Fiona's debris started to be hauled and disposed to the La Vega Landfill at Vega Baja on November 28, 2022. The disposal was completed on December 23, 2022.

From: December 01, 2022 to December 31, 2022

Municipality of Toa Alta	
Department of Transportation and Municipal Publics Works	
Debris Log Toa Alta Municipal Landfill	
DATE	**CUBIC YARDS**
1 de diciembre de 2022	279
2 de diciembre de 2022	303
5 de diciembre de 2022	196
6 de diciembre de 2022	271
7 de diciembre de 2022	254
8 de diciembre de 2022	203
9 de diciembre de 2022	248
12 de diciembre de 2022	232
13 de diciembre de2022	286
14 de diciembre de 2022	200
15 de diciembre de 2022	239
TOTAL	2,711

Photos:

V. SECTION 3: PROJECTION OF NEXT MONTH ACTIVITIES

January 5, 2023

Weekly Inspection

January 13, 2023

Weekly Inspection

January 20, 2023

Weekly Inspection

January 27, 2023

These dates are subject to change.

VI. Section 4: Attachments

Attachment 1: Weekly Inspections

Attachment 2: H-H Preliminary Report

Attachment 3: Leachate Seepage Preliminary Table

ATTACHMENT 1

INSPECTIONS

Friday, December 2, 2022

Approval Status	Approved
Nombre de la persona que hace la inspeccion	Christian Villalta Calderón
Email	cristhianvillalta@gmail.com
Fecha	Friday, December 2, 2022
Hora	03:09 PM
Condicion del Clima	Soleado
Esta la entrada limpia y libre de basura?	Si
Foto Entrada	

Hay Personal en la caseta de seguridad? SI

Cuantos camiones han llegado en el dia? 4

Fecha de la ultima verificacion del sistema de manejo de lixiviados Celda Sur? Friday, December 2, 2022

Horas de operacion de la planta electrica 8

Datos de eventos de lluvia

No hay datos disponibles de lluvia. No se cuenta con un pluviometro.

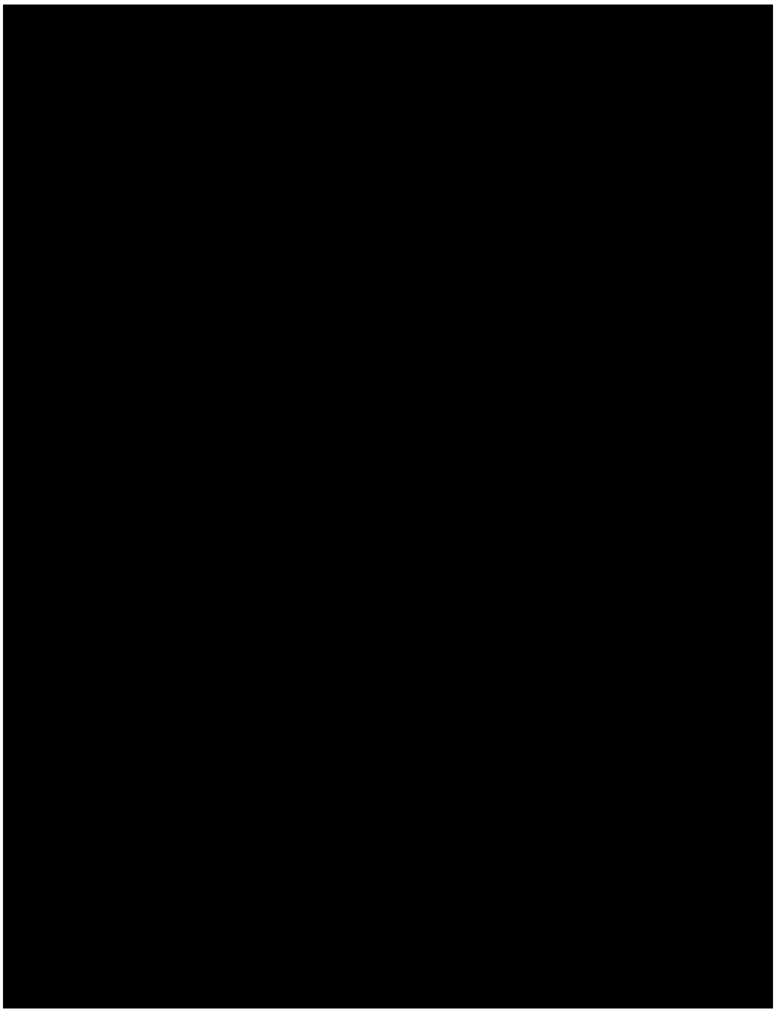
Estan las areas verdes limpias y se ha realizado mantenimiento? SI

Incluir Foto

Estan los diques limpios y sus valvulas cerradas con candado? SI

Condicion de Cubierta Talud Norte Excelentes condiciones

Incluir foto



Condicion Operacion Recibo de Escombros Mucho material acumulado

Tomar foto

Equipos Operando

Una retroexcavadora y un digger.

Condicion de medidas de control de erosion y sedimentacion

Buena

Se pueden notar brotes de lixiviado?

SI

Añadir fotos deal area de brotes visibles

Condicion de los caminos internos Excelentes condiciones

Condicion de areas de desvio de materiales Esta area estaba llena de White Goods! y se limpió.

Tomar Foto de haber condiciones que necesiten mejoras

Signature

Approval Activity History

Actor	Actions	Date
Notification	Email sent. (Your request has been approved.) cristhianvillalta@gmail.com	Friday, December 9, 2022
N Nivia Ayala nayala@terratekpr.com	Approve	Friday, December 9, 2022

TERRATEK
ENGINEERING GROUP, PSC

Friday, December 9, 2022

Approval Status Approved

Nombre de la persona que hace la inspeccion Christian Villalta Calderón

Email cristhianvillalta@gmail.com

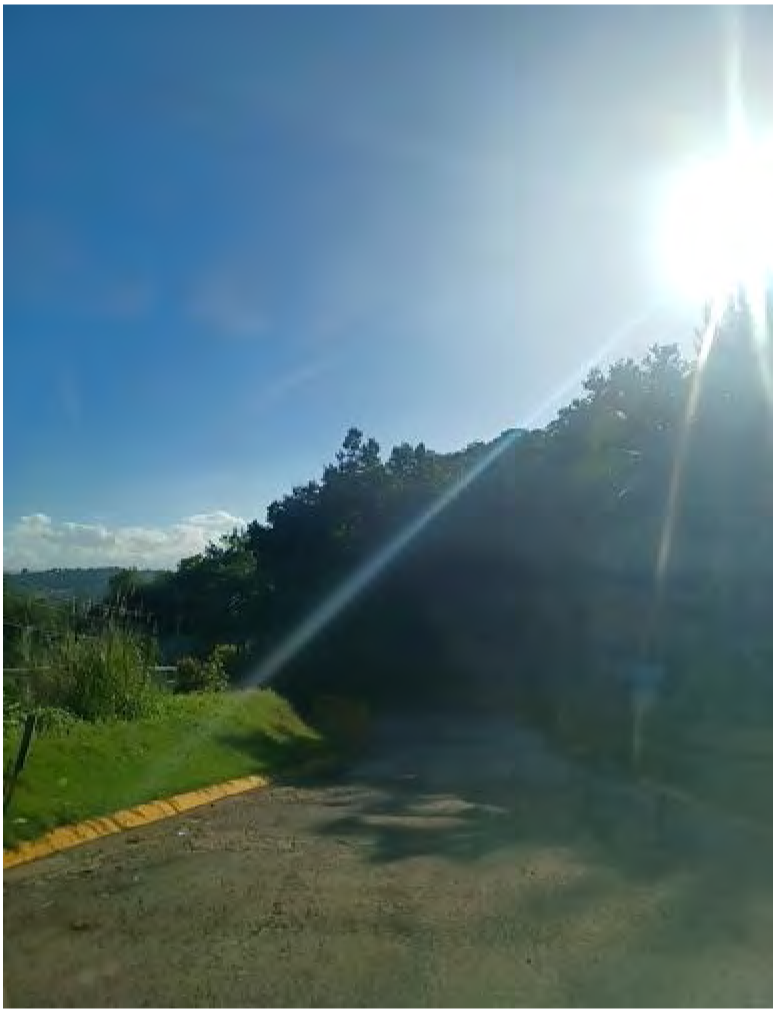
Fecha Friday, December 9, 2022

Hora 03:20 PM

Condicion del Clima Soleado

Esta la entrada limpia y libre de basura? Si

Foto Entrada



Hay Personal en la caseta de seguridad? SI

Cuantos camiones han llegado en el dia? 10

Fecha de la ultima verificacion del sistema de manejo de lixiviados Celda Sur? Friday, December 9, 2022

Horas de operacion de la planta electrica 8

Datos de eventos de lluvia

No hay datos disponibles de lluvia.

Estan las areas verdes limpias y se ha realizado mantenimiento? SI

Incluir Foto

Estan los diques limpios y sus valvulas cerradas con candado?

SI

Condicion de Cubierta Talud Norte

Excelentes condiciones

Incluir foto

Condicion Operacion Recibo de Escombros

Mucho material acumulado

Tomar foto

Equipos Operando

Una retroexcavadora.

Condicion de medidas de control de erosion y sedimentacion	Buena
Se pueden notar brotes de lixiviado?	NO
Condicion de los caminos internos	Excelentes condiciones. Esta semana se limpiaron los caminos internos.
Condicion de areas de desvio de materiales	Esta area estaba llena de White Goods! y se limpió.
Signature	

Approval Activity History

Actor	Actions	Date
Notification	Email sent. (Your request has been approved.) cristhianvillalta@gmail.com	Monday, December 12, 2022
N Nivia Ayala nayala@terratekpr.com	Approve	Monday, December 12, 2022

Wednesday, December 14, 2022

Approval Status Approved

Nombre de la persona que hace la inspeccion Christian Villalta Calderón

Email cristhianvillalta@gmail.com

Fecha Wednesday, December 14, 2022

Hora 01:00 PM

Condicion del Clima Soleado

Esta la entrada limpia y libre de basura? Si

Foto Entrada

Hay Personal en la caseta de seguridad? SI

Cuantos camiones han llegado en el dia? 4 a llevarse los escombros.

Fecha de la ultima verificacion del sistema de manejo de lixiviados Celda Sur? Wednesday, December 14, 2022

Horas de operacion de la planta electrica 8

Datos de eventos de lluvia

No hay datos disponibles.

Estan las areas verdes limpias y se ha realizado mantenimiento? SI

Incluir Foto

Estan los diques limpios y sus valvulas cerradas con candado? SI

Condicion de Cubierta Talud Norte Excelentes condiciones

Incluir foto

Condicion Operacion Recibo de Escombros

Necesita Limpieza

Tomar foto

Equipos Operando

Una retroexcavadora.

Condicion de medidas de control de erosion y sedimentacion

Buena

Se pueden notar brotes de lixiviado?

SI

Añadir fotos deal area de brotes visibles

Condicion de los caminos internos	Excelentes condiciones. Esta semana se limpiaron los caminos internos.
Condicion de areas de desvio de materiales	Esta area estaba llena de White Goods! y se limpió.
Signature	

Approval Activity History

Actor	Actions	Date
N Nivia Ayala nayala@terratekpr.com	Approve	Thursday, December 15, 2022
Notification	Email sent. (Your request has been approved.) cristhianvillalta@gmail.com	Thursday, December 15, 2022

ATTACHMENT 2

H-H “PRELIMINARY” STUDY

FOR DISCUSSION ONLY

December 15, 2022

Nivia I. Ayala, PE
General Manager
TerraTek EG, PSC
P.O. Box 367445
San Juan, PR 00936-7445

Subject: **DRAFT FOR REVIEW PURPOSES ONLY**
PRIVILEGED AND CONFIDENTIAL
Hydrologic/Hydraulic Preliminary Report
Existing Conditions Evaluation
Vertedero Municipal de Toa Alta
Project Location: PR-165, Km. 8.2
Contorno Ward
Toa Alta, Puerto Rico
Project No. 22-0025

Dear Engineer Ayala:

Caribe Environmental Services (CES) respectfully submits a digital copy of the referenced report documenting the Hydrologic/Hydraulic (H/H) existing condition evaluation conducted for the referenced project. This study was conducted to assist with the design of the necessary stormwater controls to be implemented as part of the facility's Storm Water Pollution Prevention Plan (SWPPP).

We appreciate the opportunity to assist the TerraTek EG, PSC with this project. If you have any question regarding this report, please do not hesitate to contact us at your convenience.

Respectfully,

TO BE SIGNED BEFORE FINALIZATION

Luis R. Colón Morales, P.E., M.E.
Senior Hydrologist
Lic. No. 21864

Raúl Colón, P.E., P.H.
Principal
Lic. No. 8119

DRAFT FOR REVIEW PURPOSES ONLY

PRIVILEGED AND CONFIDENTIAL

HYDROLOGIC/HYDRAULIC PRELIMINARY REPORT
EXISTING CONDITIONS EVALUATION
VERTEDERO MUNICIPAL DE TOA ALTA
PROJECT LOCATION: PR-165, KM. 8.2
CONTORNO WARD
TOA ALTA, PUERTO RICO

PREPARED FOR:

TERRATEK EG, PSC
SAN JUAN, PUERTO RICO

PREPARED BY:

CARIBE ENVIRONMENTAL SERVICES
CAGUAS, PUERTO RICO

PROJECT NUMBER 22-0025

DECEMBER 2022

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

TABLE OF CONTENTS

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

TABLE OF CONTENTS (Continued)

TABLES

FIGURES

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

TABLE OF CONTENTS (Continued)

APPENDICES

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

CERTIFICACION

ESTUDIO HIDROLOGICO – HIDRAULICO

Certifico que este estudio hidrológico-hidráulico fue preparado utilizando las prácticas de hidrología e hidráulica normalmente utilizadas por profesionales competentes dentro de este campo, aplicables al proyecto según descritas en el documento propio, y que a mi mejor entender y conocimiento basándome en los estudios y medidas de campo provistas por otras personas, los resultados del estudio son ciertos y correctos.

Certificado en Caguas, Puerto Rico hoy ___ de ____________ de 20___.

TO BE SIGNED BEFORE FINALIZATION

RAUL COLON, P.E., P.H.
LIC. NUM. 8119

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

1.0 INTRODUCTION

According to the information provided by TERRATEK, a Hydrologic/Hydraulic (H/H) Study needs to be conducted for the Toa Alta municipal landfill to assist with the design of the necessary stormwater controls to be implemented, as part of the facility's Storm Water Pollution Prevention Plan (SWPPP). The H/H study included in this report evaluated the existing landfill hydrologic conditions. TERRATEK requested a H/H to be conducted to meet the stormwater regulatory requirements applicable to landfill facilities.

Since the proposed landfill design improvements may change based upon the H/H results and the landfill requirements, this preliminary report includes the H/H study for the existing conditions. The final selection of runoff controls that should be implemented at the landfill is typically an iterative process that will involve the Municipality of Toa Alta, TERRATEK, and its civil design firm. Therefore, a meeting with TERRATEK and the selected civil design firm should be conducted to discuss the type and quantity of runoff control systems needed for the facility. Once an agreement is reached regarding the runoff controls to be evaluated, a H/H for the proposed conditions should be conducted.

In this report we are including preliminary recommendations to assist the design team developing the storm water controls.

1.1 Purpose & Objective

The purpose of this study was to generate hydrologic and hydraulic data to be used as part of the SWPPP requirements.

The objective of the study was to evaluate existing hydrologic and hydraulic conditions at the landfill area. The results obtained in this study are expected to be used by the project designer, to

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

develop runoff control systems to manage the runoff of the landfill area once completely developed.

1.2 Involved Parties & Authorization

TERRATEK was retained by the Municipality of Toa Alta to implement the SWPPP required by the National Pollutant Discharge Elimination System (NPDES) Multi-Sector General Permit (MSGP). TERRATEK retained Caribe Environmental Services (CES) to conduct a H/H evaluation of the landfill facility. This work was conducted in accordance to CES proposal PR21-0083, authorized by TERRATEK on June 22, 2022.

1.3 Study Description

1.3.1 Site Location

The Project Site is located at the PR-165 Road, Km. 8.2, within the Contorno Ward of the Toa Alta Municipality in Puerto Rico. A Site Location Map is provided in ***Figure 1***. A Site Aerial Photograph, showing the Project Site's features, general settings, and surroundings are provided in ***Figure 2***. The approximate coordinates of the Project Site are: 18°22'17.84"N; 66°15'53.17"W.

According to the as-built topographic map prepared for the Project Site by engineer Hector Tirado Rodriguez, P.E., R.P.A, LIC. 12,215, dated September 14, 2022, the Project Site elevation varies from approximately 170 meters PRVD02, at the central portion of the landfill area, to about 110 meters PRVD02, at the ponds located at the northern and southern portion of the Project Site.

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

According to the Topographic Map of the Corozal (1972) and Vega Alta (1969) Quadrangles, sinkhole formations are common at this portion of Puerto Rico and potential sinkhole areas are shown in the topographic maps located in the central and southwestern portions of the Project Site. The closest surface water bodies to the Project Site are an unnamed creek located approximately 60 meters to the northeast, which appears to have been channelized, and eventually discharges into the Rio Grande de la Plata, and the Quebrada Arenas located approximately 100 meters to the west of the project site.

1.3.2 Flooding Problem Description

Storm water runoff from the landfill area is regulated by the EPA NPDES permit for industrial activities. The Toa Alta landfill is included in Sector L of the EPA permit (ie: Landfills, Land Application Sites and Open Dumps). In order to design new storm water structures and control needed as part of the NPDES MSGP SWPPP, a H/H study of the site’s existing conditions is necessary.

1.3.3 Designing Conditions

Based upon the FEMA FIS studies data for Puerto Rico (FEMA Panel 0685H), no detail study or regulatory flood elevations have been computed for the project area. The hydrologic-hydraulic study included in this report was conducted following the 2016 Puerto Rico Planning Board Hydrology-Hydraulic Guidelines.

This evaluation includes the watershed draining from the project site and adjoining offsite watershed draining into the same discharge points, as the onsite drainage areas. The hydrologic evaluation was executed using the HEC-HMS model to evaluate the 100-year storm - 24, 12, 6, and 1-hour durations (1st quartile – percentile 10% and 4th quartile – percentile 90%) storm events for the existing conditions at the project site. The hydraulic evaluation was conducted using the HEC-HMS model to evaluate the ponded areas for the 100-year storm events. We understand that the 100-year storm will be the basis to design the landfill storm water controls.

1.3.4 Scope of Work

The scope of work for this project included the following activities:

- A hydrologic study of the Toa Alta Landfill and surrounding areas, to estimate the 100-year storm, 24, 12, 6, and 1-hour durations flow hydrographs, with the 10% and 90% percentile temporal rain distribution, under existing conditions.
- Hydraulic Evaluation of the existing stormwater ponds located within the landfill for the 100-year storm, 24, 12, 6, and 1-hour durations flow hydrographs, with the 10% and 90% percentile temporal rain distribution.
- Preparation of a report documenting the analyses conducted.

1.3.5 Project Impact

The proposed project consists of implementing storm water runoff controls as part of the SWPPP. Therefore, no negative hydrologic or hydraulic impacts are expected as a result of the proposed project. The proposed project is needed as part of the NPDES MSGP requirements. Eventually, as part of the proposed project, changes in peak flows, velocities and water surface elevations at the project site will need to be evaluated during proposed conditions.

1.3.6 Data Collection

1.3.6.1 Site Visit

A visual reconnaissance of the Project Site and surroundings was performed by engineers Raúl Colón and Luis Raúl Colón Morales of CES on October 25, 2022. The method used to observe the hydrologic hydraulic conditions consisted of walking along the perimeter of the landfill area and within the project site and immediate surroundings. Site settings and conditions were documented with photographs, as appropriate, ***Appendix A***. The approximate location and orientation of the photographs is presented in ***Figure 2***.

1.3.6.2 Previous Historical Studies

No previous hydrologic -hydraulic studies were available for our review during the preparation of this report.

1.3.6.3 Historical Data

No historical data was available for the unnamed and the Arenas creeks.

1.3.6.4 Database

The data used during the course of this study were obtained from the following sources:

- Topographic Survey Map prepared by engineer Hector Tirado Rodriguez, P.E., R.P.A, LIC. 12,215, dated September 14, 2022 (see ***Appendix B)***
- U.S. Geological Survey 7.5 Min. Topographic Map of Corozal, P.R. (USGS 2018)
- U.S. Geological Survey 7.5 Min. Topographic Map of Vega Alta, P.R. (USGS 2018).
- U.S. Geological Survey 7.5 Min. Topographic Map of Corozal, P.R. (USGS 1972, rev 1974)
- U.S. Geological Survey 7.5 Min. Topographic Map of Vega Alta, P.R. (USGS 1969, rev 1983)
- U.S. Geological Survey Hydrologic Unit Maps, https://water.usgs.gov/GIS/huc.html
- NOAA Atlas 14, Volume 3, Version 4 Gridded Precipitation Frequency Estimates for Puerto Rico and the U.S. Virgin Islands, 2006 (Revised 2008), ***Appendix C***

- Soil Survey of the San Juan Area, Puerto Rico, U.S. Department of Agriculture Soil Conservation Survey; Survey Area Data: Version 16, September 12, 2022, ***Appendix D***
- Flood Insurance Rate Map, Panel 0685 of 2160 (Map Number 72000C0685H), by the Federal Emergency Management Agency (FEMA). Effective date April 13, 2018, ***Appendix E***.
- Basin slope rasters for Puerto Rico StreamStats, https://www.sciencebase.gov/catalog/item/5d7146ebe4b0c4f70cfdc8e3
- Roughness Characteristics of Natural Channels by Harry II. Barnes, Jr. U.S. Geological Survey Water-Supply Paper 1849
- Chapter 7 Hydrologic Soil Groups Part 630 Hydrology National Engineering Handbook, United States Department of Agriculture, Natural Resources Conservation Service (210–VI–NEH, May 2010)
- Chapter 8 Land Use and Treatment Classes Part 630 Hydrology National Engineering Handbook, United States Department of Agriculture, Natural Resources Conservation Service (210–VI–NEH, May 2010)
- Chapter 9 Hydrologic Soil-Cover Complexes Part 630 Hydrology National Engineering Handbook, United States Department of Agriculture, Natural Resources Conservation Service (210–VI–NEH, May 2010)
- Chapter 15 Time of Concentration Part 630 Hydrology National Engineering Handbook, United States Department of Agriculture, Natural Resources Conservation Service (210–VI–NEH, May 2010)
- Land use map prepared by the Puerto Rico Planning Board and the University of Puerto Rico, 2006 (http://www.agencias.pr.gov/agencias/gis/descargaGeodatos/ambientales/Pages/Usos-y-cubierta-de-suelos.aspx
- Google Earth Pro, 7.3.4.8642 (64-bit), May 12, 2022 10:55:31 PM UTC
- NOAA Mean Annual Precipitation 1981-2010, http://www.srh.noaa.gov/sju/?n=mean_annual_precipitation2
- 2018 USGS Lidar DEM: Post Hurricane Maria - Puerto Rico, https://www.fisheries.noaa.gov/inport/item/60105
- Digital Elevation Model (DEM), CRIM_Basemap_Project_1996-98
- USGS Caribbean Water Science Center available online database (https://pr.water.usgs.gov/)

1.3.7 Alternative Evaluations

This evaluation does not include the analysis of stormwater control alternatives that can be implemented as part of the SWPPP. Based upon the existing conditions evaluation results, CES

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

can discuss with TERRATEK and the civil design firm potential stormwater control scenarios and its feasibility.

1.3.8 Limitations

This evaluation was conducted by CES Principal, Eng. Raúl Colón. We note that neither CES or Eng. Colón attempted to independently verify the accuracy or completeness of the data provided, but did not detect inconsistencies or omissions of a nature that might question the validity of the information. To the extent that the conclusions in this report are based in whole or in part on such information, they are contingent on its validity. Neither CES or Eng. Colón assumes responsibility for any consequence arising from any information or condition that was concealed, withheld, misrepresented or otherwise not fully disclosed or available to us.

This study has been undertaken and performed in a professional manner, in accordance with generally accepted practices, using the degree of skill and care ordinarily exercised by reputable consultants under similar circumstances. No other warranty, expressed or implied is made.

The hydrologic and hydraulic study was limited to the area covered by the landfill area and immediate surrounding areas, which are the higher elevation terrain in the area. This evaluation did not include a hydrologic/hydraulic evaluation of drainage areas not draining into the landfill area, including any creek or sinkhole area on which the landfill area may discharge.

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

2.0 HYDROLOGIC EVALUATION

2.1 Drainage Areas Delineation

Drainage Areas (DA) were delineated using the USGS Corozal and Vega Alta topographic maps, the project site topographic map prepared by engineer Hector Tirado Rodriguez, P.E., R.P.A, LIC. 12,215, dated September 14, 2022, the 2018 USGS Lidar DEM: Post Hurricane Maria - Puerto Rico, the USGS Hydrologic Unit Maps, and field observations made during the site visit.

The Drainage Areas included as part of the study included: seven areas draining from the project site and six offsite drainage areas which drain into the same drainage point as the onsite drainage areas. For purposes of this study the drainage areas were identified as follows:

- DA-1 Onsite
- DA-1 Offsite
- DA-2 Onsite
- DA-2 Offsite
- DA-3 Onsite
- DA-3 Offsite
- DA-4 Onsite
- DA-4 Offsite
- DA-5 Onsite
- DA-5 Offsite
- DA-6 Onsite
- DA-6 Offsite
- DA-7 Onsite

These drainage areas are presented in ***Figure 3***. The existing drainage area delineations were visually verified in the field by CES personnel. As shown in ***Figure 3:***

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

- DA-1 Onsite; consists mostly of bare ground surface, the north pond, and slight vegetation and shrubs located at the northern portion of the landfill area. This drainage area drains into the North Pond.
- DA-1 Offsite; consists mostly of shrubs vegetation and some impervious areas associated with the local access road and scarce rural residential developments located to the north of the landfill area. This drainage area drains into the North Pond.
- DA-2 Onsite; consists mostly of bare ground surface, the south pond, slight vegetation and shrubs and impervious areas associated with the landfill access road and office structures, located at the southern and eastern portions of the landfill area. This drainage area drains into the South Pond.
- DA-2 Offsite; consists mostly of shrubs vegetation and south pond located to the south of the landfill area. This drainage area drains into the South Pond.
- DA-3 Onsite; consists mostly of bare ground surface, shrubs vegetation, and impervious areas associated with the landfill access road and office structures, located at the eastern portion of the landfill area. This drainage area drains into the unnamed creek located to the northeast of the project site
- DA-3 Offsite; consists mostly of shrubs and heavy vegetation and some impervious areas associated with the road, rural residential developments, and the municipal public works facility located to the east of the landfill area. This drainage area drains into the unnamed creek located to the northeast of the project site.
- DA-4 Onsite; consists mostly of bare ground surface, and medium vegetation and shrubs located at the western portion of the landfill area. This drainage area drains into the Quebrada Arenas located to the west of the project site.
- DA-4 Offsite; consists mostly of shrubs vegetation located to the west of the landfill area. This drainage area drains into the Quebrada Arenas located to the west of the project site.
- DA-5 Onsite; consists mostly of bare ground surface, and slight vegetation and shrubs vegetation located at the southwestern portion of the landfill area. This drainage area drains into the Quebrada Arenas located to the west of the project site.
- DA-5 Offsite; consists mostly of shrubs vegetation and a residential property located to the southwest of the landfill area. This drainage area drains into the Quebrada Arenas located to the west of the project site.
- DA-6 Onsite; consists mostly of bare ground surface, a sinkhole ponding area at the southwest portion, and slight vegetation and shrubs located at the south portion of the landfill area. This drainage area drains into the Southwest Pond.
- DA-6 Offsite; consists mostly of medium and shrubs vegetation and some impervious areas associated with the local access road and scarce rural residential developments located to the south of the landfill area. This drainage area drains into the sinkhole ponding area at the southwest portion.

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

- DA-7 Onsite; consists mostly of impervious areas associated with the landfill access road and shrub vegetation, located at the southeastern portion of the landfill area. This drainage area drains out the landfill main entrance road.

This study only included the evaluation of the existing conditions. When the proposed conditions are evaluated, the offsite areas should remain unchanged from existing conditions. However, due to the impacts of the proposed design project, the onsite areas' condition will change. These changes will need to be evaluated as part of the proposed conditions H/H study.

A summary of the computed watershed area during existing conditions is presented in ***Table 1.*** As shown in this summary table, the offsite drainage areas included in the hydrologic analysis cover an area of approximately 67 acres [0.105 square miles (mi^2)], and the onsite drainage areas included in the hydrologic analysis cover an area of approximately 45 acres (0.070 mi^2).

2.2 Identification of Water Bodies and Sinkhole Formations

As described in *Section 2.3.1*, sinkhole formations were possibly located in the central and southwestern portions of the Project Site. The closest surface water bodies to the Project Site are an unnamed creek located approximately 60 meters to the northeast, which appears to have been channelized, and eventually discharges into the Rio Grande de la Plata, and the Quebrada Arenas located 100 meters to the west of the project site, eventually draining into the Rio Lajas.

During our site inspection, it appeared that the unnamed creek is an intermittent stream, which is a dry creek except during storm events, and the Quebrada Arenas appears to be a perennial stream that has flowing water year-round during a typical year. Tributary creeks were identified in the USGS topographic maps that would contribute to the Quebrada Arenas. However, no tributary creeks were identified that would contribute to the unnamed creek.

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

Figure 1 shows possible sinkhole formations located within the Project Site. ***Figure 3*** shows the Quebrada Arenas and the unnamed creek with the general flow pattern and the project site with respect to the study drainage areas.

According to "Principal aquifers of Puerto Rico and the U.S. Virgin Islands" by Robert A. Renken, January 11, 1998, U.S. Geological Survey, the Project Site is located overlying Carbonate-rock aquifers part of the North Coast Limestone aquifer system lower aquifer.

2.3 Physiographical Information

2.3.1 Topographic Maps

According to the information obtained from the Topographic Map of the Corozal (2018) and Vega Alta (2018) Quadrangles, the topography of the study area at the onsite areas consists mostly of moderate to steep sloping terrain. The topography of the study area at the offsite areas consists mostly of moderate sloping terrain with some relatively flat areas. According to the as-built topographic map prepared for the Project Site by engineer Hector Tirado Rodriguez, P.E., R.P.A, LIC. 12,215, dated September 14, 2022, the Project Site elevation varies from approximately 170 meters PRVD02, at the central portion of the landfill area, to about 110 PRVD02, at the pond areas located at the northern and southern portion of the Project Site. According to the information obtained from the USGS Topographic Maps, the offsite areas elevations varies from about 175 m MSL along the southeastern portion where hills are located to a lower elevation of about 100 m MSL along the PR-165 road to the northeast of the project site.

2.3.2 USGS Geologic Map

According to the USGS *Geologic Map of the Vega Alta and Corozal Quadrangles,* the shallow geology, of the landfill area prior to landfill operations, consists of Rio Indio Limestone Member (Tcr) and Quebrada Arenas Limestone Member (Tcq). The Tcr geologic unit is characteristically dark yellowish orange in contrast to the pale-orange tints of adjacent limestone units. The member consists of earthy, generally thick-bedded limestone that in this area commonly contains no quartz sand; an exception is near Toa Alta where the upper part is a very fragmental yellowish-orange limestone that contains scattered quartz grains and many pelecypods. At several places, the member includes lenses of soft marly clay rich in large Lepidocyclina. The Rio Indio Limestone Member is about 100 meters thick in the valley of the Rio Cibuco, but in the eastern half of the quadrangle, the member thins rapidly to a total thickness of only 65 meters near Toa Alta.

The Tcq geologic unit, the hard limestone of the member, is in beds ranging from ½ meter to 2 meters in thickness that are separated by soft chalky grayish-orange limestone beds averaging half a meter in thickness. Corals are present locally, but in general, the member is only sparsely fossiliferous. The outcrop area of the member is characterized by sinkholes as deep as 35 meters interspersed with rounded hills that are covered with large angular fragments of limestone. The member is about 60 meters thick in the western part of the quadrangle, but near Toa Alta, where the lower part grades laterally into beds included with the Rio Indio Member it is only about 20 meters thick

During our site reconnaissance, typical limestone rock openings were observed in the outcropping geological formation, which may suggest potential areas for runoff drainage (see ***Photographs 8*** and ***15***).

2.3.3 Land Use and Vegetation Cover

In general, the onsite drainage areas included in this study consist mostly of the existing landfill facility, which includes impervious, bare-ground, and some pastures and shrubs areas. The offsite drainage areas included in this study consist mostly of undeveloped lands covered with, pastures, woods, shrubs, and scarcely developed rural residential properties.

2.3.4 Curve Number (CN)

The CN is an index of the infiltration loss potential of the watershed. A higher CN indicates a higher runoff potential. The CN is a function of the soil type, hydrologic soil group, land use, soil cover, and the antecedent moisture condition. Data used to compute weighted CNs were obtained from the Soil Survey of the San Juan Area, Puerto Rico, U.S. Department of Agriculture Soil Conservation Survey; Survey Area Data: Version 16, September 12, 2022; Aerial Imagery obtained from Google Earth Pro (June 2022), the USGS topographic maps for Corozal and Vega Alta (USGS, 2018); and field observations.

In its simplest form, the hydrologic soil group is determined by the water-transmitting soil layer with the lowest saturated hydraulic conductivity and depth to any layer that is more or less water impermeable or depth to a water table (if present). The least transmissive layer can be any soil horizon that transmits water at a slower rate relative to those horizons above or below it. The four hydrologic soil groups are described as:

- Group A—Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil;
- Group B—Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded;
- Group C—Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted;
- Group D—Soils in this group have high runoff potential when thoroughly wet. Water

movement through the soil is restricted or very restricted.

A custom soil resource report for the study area prepared by the USDA, is included in ***Appendix D***. The USDA report shows the hydrologic soil group rating at the study area. ***Figure 4*** shows the hydrologic soil group rating obtained from the USDA within the drainage areas.

Land use is the watershed cover and includes every kind of vegetation, litter and mulch, fallow, and bare soil as well as nonagricultural uses, such as water surface (lakes, swamps) and impervious surfaces (roads, roofs). During this study, the land use classes were obtained from field observation and observation made from satellite images obtained from Google Earth Pro. ***Figure 3*** shows also the different estimated land cover types within the drainage areas.

The variability in the CN results from rainfall intensity and duration, total rainfall, soil moisture conditions, cover density, stage of growth, and temperature. These factors of variability are collectively called the antecedent moisture condition and are divided into three classes:

- AMC II for average conditions
- AMC I for dry conditions, and
- AMC III for wetter conditions.

The CN values used in the storm event model were representative of average antecedent soil moisture conditions II (AMC II). Computations of average weights CN values for the drainage area are included in ***Appendix F***. Summaries of the computed CN values are presented in ***Table 1***. CN values for existing conditions were estimated to range from 75.3 to 89.2 for onsite drainage areas and from 77.0 to 86.9 for offsite drainage areas

This study only included the evaluation of the existing conditions. When the proposed conditions are evaluated, the offsite areas CN should remain unchanged from existing conditions. However, due to the impacts of the proposed design project the onsite areas' CN condition will change.

These changes will need to be evaluated in the proposed conditions H/H study.

2.3.5 Times of Concentration and Lag Time

The time of concentration (TC) is considered as a measure of how fast the watershed may respond to a rainfall event and is basically a function of the drainage area physical characteristics. The lag time (L), which is the actual value input into the HEC-HMS model, is the delay between the time runoff from a rainfall event over a watershed begins until runoff reaches its maximum peak. Various researchers (Mockus 1957; Simas 1996) found that for average natural watershed conditions and an approximately uniform distribution of runoff, the lag time is equal to 3/5 of the TC.

Time of Concentrations values were computed using the Natural Resources Conservation Service (NRCS) watershed lag method which is one of the accepted methods listed in the 2016 HH DNER guidelines. The NRCS watershed lag method was developed by Mockus in 1961. It spans a broad set of conditions ranging from heavily forested watersheds with steep channels and a high percent of runoff resulting from subsurface flow, to meadows providing a high retardance to surface runoff, to smooth land surfaces and large paved areas (National Engineering Handbook Part 630.1502 Methods for estimating time of concentration). Equation 15-4b obtained from this handbook defines time of concentration as follows;

$$T_c = \frac{\ell^{0.8}(S+1)^{0.7}}{1{,}140Y^{0.5}}$$

Where;
Tc = Time of concentration, hour
ℓ = flow length, feet
Y = Average watershed land slope (%)
S= Maximum potential retention, inches = (1,000/cn') – 10
cn'= retardance factor

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

The flow length is defined as the longest path along which water flows from the watershed divide to the outlet. In developing the regression equation for the lag method, the longest flow path was used to represent the hydraulically most distant point in the watershed. During this study flow lengths were measured using aerial photographs obtained from Google Earth Pro and the USGS Corozal and Vega Alta Topographic maps.

The retardance factor, cn', is a measure of surface conditions relating to the rate at which runoff concentrates at some point of interest. The term "retardance factor" expresses an inverse relationship to "flow retardance." Low retardance factors are associated with rough surfaces having high degrees of flow retardance, or surfaces over which flow will be impeded. High retardance factors are associated with smooth surfaces having low degrees of flow retardance, or surfaces over which flow moves rapidly. The retardance factor is approximately the same as the curve number (CN) as defined in NEH630.09. During this study the computed CN for was used as the cn'.

In order to obtain the average watershed land slope, the Basin slope rasters for Puerto Rico were obtained from the USGS with a maximum spatial resolution of 10 meters were used. Statistical analysis was conducted to obtain the slope mean value at the drainage areas. ***Figure 5***, shows the calculated slope values and calculated mean value.

Computations of TC values for the drainage area are included in ***Appendix G***. Summaries of the computed TC values are presented in ***Table 1***. TC values for existing conditions were estimated to range from 2.1 to 5.5 minutes for onsite drainage areas and 1.6 to 9.7 minutes for offsite drainage areas. It is noted that if the calculated lag time for a particular drainage area is less than the Minimum Lag time permitted by the HEC HMS model, then the minimum lag time allowed by the model was used, for that basin. Minimum Lag time permitted by HEC HMS model is 3.5 minute.

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

This study only included the evaluation of the existing conditions. When proposed conditions are evaluated, the offsite areas TC should remain unchanged from existing conditions. However, due to the impacts of the proposed project the onsite areas' TC condition will change. These changes will need to be evaluated in the proposed conditions H/H study.

2.4 Historical, Flow, Rainfall Data & Temporal Distribution

Estimates of flood flow having given recurrence intervals or probabilities of exceedance are needed for the design of hydraulic structures and floodplain management. As indicated in the 2016 Hydrologic Hydraulic Guidelines prepared by the Puerto Rico Planning Board and the Department of Natural and Environmental Resources (DNER), a flow frequency analysis is the preferred method in order to estimating a peak flow exceedance, if gage data are available and are adequate. In Puerto Rico, the United States Geological Survey (USGS) has been collecting flow data from many rivers and streams for the past 50 years.

A review of the USGS Caribbean Water Science Center available historic online database (https://waterdata.usgs.gov/pr/nwis/current/?type=flow&group_key=basin_cd) was conducted to verify if recorded flow data had been collected along the unnamed creek and the Arenas Creek. However, no flow data was available for the area of study included in this report.

Rainfall depth-duration data for the 100-year storm event was generated using data from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, 2006, Volume 3, Version 4 (Updated 2008). ***Appendix C*** presents the NOAA rainfall depth data at the approximate centroid location of the total drainage area. The rainfall data used in the hydrologic analysis is summarized in ***Table 2***. As show in this table, the 100-year recurrence event ranges from a rainfall depth of 3.34 inches in 1 hour to a rainfall depth of 13.9 inches in 24 hours.

To develop runoff hydrographs for particular storm durations, the rainfall depths presented in ***Table 2*** need to be distributed in time and space. Temporal distributions of heavy precipitation are provided for use with precipitation frequency estimates from NOAA Atlas 14 Volume 3 for 1-, 6-, 12-, 24- and 96-hour durations covering Puerto Rico and the U.S. Virgin Islands. The temporal distributions are expressed in probabilistic terms as cumulative percentages of precipitation and duration at various percentiles. According to the NOAA Atlas 14 the starting time of precipitation accumulation was defined in the same fashion as it was for precipitation frequency estimates for consistency.

According to the 2016 DNER HH guidelines, after an exhaustive analysis of the 180 temporal distributions for the 1, 6, 12, and 24 storm durations, it was concluded that the temporal distribution that generates the highest peak flows, in Puerto Rico, corresponds to the 1st and 4th Quartile and the 10% and 90% percentiles, respectively. Therefore, for this study, these two quartiles and percentiles were used to compute the time distribution of the rainfall. ***Tables 3A*** to ***3H***, present the resulting temporal distributions for the 100-year (24, 12, 6, and 1-hour duration) storm events.

2.5 Observed Hydrographs

No observed or measured hydrographs are available for the project site. Computer model hydrographs generated during this study are included in the following sections of this report.

2.6 Methodology

2.6.1 SCS Methodology

The hydrologic evaluation for this study was conducted using rainfall data in conjunction with the USACE Hydrologic Modeling System (HEC-HMS) computer model (Version 4.10, USACE, JUL 2022) in order to generate simulated peak flows. This hydrologic modeling system is designed to simulate the rainfall-runoff processes in dendritic watershed systems. It is designed to be applicable in a wide range of geographic areas for solving the widest possible range of problems. This includes large river basin water supply and flood hydrology, and small urban or natural watershed runoff.

Hydrographs produced by the program are used directly or in conjunction with other software for studies of water availability, urban drainage, flow forecasting, future urbanization impact, reservoir spillway design, flood damage reduction, floodplain regulation, and systems operation. The HEC-HMS model includes the Soil Conservation Service (SCS) parametric unitary hydrograph model which is capable of using the unit hydrograph generation methodology recommended by the SCS to estimate design hydrographs from selected design storms.

The SCS unitary hydrograph model is based upon averages of unitary hydrograph derived from gaged rainfall and runoff for a large number of small agricultural watersheds throughout the United States. The SCS Technical Report 55 (1986) and the National Engineering Handbook (1971) describe the unitary hydrograph model in detail. Runoff hydrographs for the 100-year storm - 24, 12, 6, and 1-hour durations (1^{st} quartile – percentile 10% and 4^{th} quartile – percentile 90%) were computed at selected locations within the study area, as required by the hydraulic model.

2.6.2 HEC HMS Model Configuration

The principal watershed parameters considered for the development of runoff hydrographs using the SCS method are: Drainage Area (DA), Curve Number (CN), and Time of Concentration (TC) which correlates to the Lag Time. These parameters, in addition to the rainfall data, are input into the HEC-HMS computer model.

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

Control specifications are one of the main components in a project, even though they do not contain much parameter data. Their main purpose is to control when simulations start and stop, and what time interval is used in the simulation. Each control specification sets the time window over which a simulation will be performed. The window is specified using a separate start date, start time, end date, and end time. Each control specification includes the time interval that will be used to perform computations during a simulation.

For this project, the time interval varied from 48 to 6 hours and the computations time interval was set to 1 minute for all events. ***Appendix H*** shows the drainage area configuration and parameters used in the HEC-HMS model for existing conditions.

2.6.3 Hydrological Model Calibration and Validation

As required by the 2016 DNER guidelines a calibration of the hydrologic model is needed in order to obtain the hydrological parameters values that would result in accurate results. The calibration of a model is a systematic process of comparing the model generated results with the observed data and adjusting the hydrological parameters so the generated result would similar to those observed. In the precipitation-runoff models, this function measures the degree of variation between computed and observed hydrographs. In addition, the guidelines indicated that to properly calibrate the model a hydrological run needs to be conducted with the adjusted parameters and compared with another set of observed data. The guidelines also clarify that it may not be feasible to calibrate the hydrological model due to the lack of adequate observed or measured data.

As described in *Section 3.1.4*, no historical flow data was available for the area of study. Therefore, it is our opinion that there is not sufficient adequate data to calibrate the hydrological model, as required by the DNER guidelines.

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

2.6.4 Evaluated Alternative and Result Verification

The HEC-HMS model was executed to evaluate the 100-year storm - 24, 12, 6, and 1-hour durations (1st quartile – percentile 10% and 4th quartile – percentile 90%) storm events for the existing conditions at the area of study. The results of the existing hydrologic evaluation are summarized in ***Tables 4A*** and ***4B.***

As shown in ***Table 4A***, the maximum computed peak flow occur during the 100-year - 1-hour (4th quartile) duration storm event. The generated onsite peak flows vary from ***8.0 cfs*** to ***124.7 cfs***. The generated offsite peak flows vary from ***8.3 cfs*** to ***316.1 cfs***. The maximum peak inflows at the North Pond, South Pond, and sinkhole ponding area at the southwest portion, occur during the 100-year - 1-hour (4th quartile) duration storm event, with peak flows of ***151.7, 111.3, and 67.9 cfs***, respectively.

As shown in ***Table 4B***, the maximum generated volume occurs during the 100-year - 24-hour (1st and 4th quartile) duration storm event. The generated onsite volumes vary from 1.1 acre-feet to 16.1 acre-feet. The generated offsite volumes vary from 1.2 acre-feet to 48.1 acre-feet. The peak volume stored at North Pond, South Pond, and sinkhole ponding area at the southwest portion, are 19.8, 14.7, and 9.1 acre-feet respectively.

The HEC-HMS model computer printouts for the hydrologic evaluations under existing conditions are included in ***Appendix I***. Since no observed or measured data was available for the study area that could be used to compare the hydrologic results obtained, the computed flood discharge values at the project site were compared with the results from regression equations for estimating peak discharges for streams in Puerto Rico developed by López and other 1979). This

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

comparison was only made to have an idea of the reasonability of the estimated peak flows. The purpose of this comparison was not to validate the computed results.

According to this USGS report, the regression equation for 100-years recurrence interval is:

Q_{100} = $Q=268\ CDA^{0.832} \times MAR^{0.531}$, where;

Q = is estimated discharge, in cubic feet per second, for the indicated recurrence interval in years
MAR= is mean annual rainfall, in inches = **70 inches** (obtained from NOAA, ***Appendix J***)
CDA= is contributing drainage area, in square miles

DA-1 Offsite 0.00625 mi²
DA-1 Onsite 0.02469 mi²
DA-2 Offsite 0.00367 mi²
DA-2 Onsite 0.01953 mi²
DA-3 Offsite 0.07859 mi²
DA-3 Onsite 0.00769 mi²
DA-4 Offsite 0.00211 mi²
DA-4 Onsite 0.00606 mi²
DA-5 Offsite 0.00286 mi²
DA-5 Onsite 0.00720 mi²
DA-6 Offsite 0.01153 mi²
DA-6 Onsite 0.00303 mi²
DA-7 Onsite 0.00172 mi²

The following table presents the flow comparison:

Flood Event – 100 years

Drainage Areas	USGS Regression Equation	Computed Peak Flow (cfs)	% of Difference
DA-1 Offsite	37.5	25.1	40
DA-1 Onsite	117.6	124.7	6
DA-2 Offsite	24.1	16.8	36
DA-2 Onsite	99.8	94.6	2
DA-3 Offsite	308.2	316.1	3

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

Drainage Areas	USGS Regression Equation	Computed Peak Flow (cfs)	% of Difference
DA-3 Onsite	44.6	34.2	26
DA-4 Offsite	15.2	8.3	59
DA-4 Onsite	36.6	26.7	31
DA-5 Offsite	19.6	14.7	28
DA-5 Onsite	42.2	26.9	44
DA-6 Offsite	62.4	51.6	19
DA-6 Onsite	20.5	16.3	23
DA-7 Onsite	12.8	8.0	46

As shown in the above tale in general the computed values using the USGS regression equations are in the same order as those computed by the HEC-HMS computer model. Given the inherent technical differences between both methodologies and the fact that no recorded data are available for calibration of the computed values we understand that the HEC-HMS computer model results can be considered representatives of expected flow conditions at the study area. In general, detailed computer modeling, as provided by the HEC-HMS model, produce more realistic results, as those provided by the USGS equations, since the computer model takes into consideration the specific site factors that impact the runoff generation in a watershed. Typically, the values obtained from the USGS Regression Equation are used as a reference frame regarding the order of magnitude of the peak flow. It is our professional opinion that the HEC-HMS computed flows for the study area are representative and reasonable for site hydrologic conditions.

2.6.5 Sensitivity Analysis

Sensitivity analysis is a method to determine which parameters of the model have the greatest impact on the model results. It ranks model parameters based on their contribution to overall error in model predictions. Sensitivity analysis can be local and global (Haan, 2002). In the local sensitivity analysis, the effect of each input parameter is determined separately by keeping other model parameters constant. The result is a set of sensitivity functions, one for each model parameter. In the global sensitivity analysis, all model inputs are allowed to vary over their ranges at the same time. Global sensitivity is based on the use of probabilistic characteristics of the input random variable. In this study, a local sensitivity analysis was adopted for evaluating the event model.

The method of factor perturbation is commonly used method in hydrologic analysis (McCuen, 2002). The partial derivates of the following equation can be approximated by numerical derivates as (Haan, 2002):

$$\frac{\partial y}{\partial x} \cong \frac{O_2 - O_1}{P_2 - P_1} \cong \frac{O_{P+\Delta P} - O_{P-\Delta P}}{2\Delta P}$$

ΔP = is the perturbation value (10%)

P = input parameter (CN, Precipitation, Lag Time)

O = Model result (Flow)

The set of the parameters of the run model in *Section 3.2.4*, was deemed as baseline parameter set. Then, the highest peak event 100 year - 1-hour (4th quartile) model was run repeatedly with the starting baseline value for each parameter multiplied, in turn, by 0.9 and 1.1, while keeping all other parameters constant at their nominal starting values. The hydrographs resulting from the scenarios of adjusted model parameters compared with the baseline model hydrograph are shown in ***Figures 6A*** to ***6C***. Only the hydrographs from the Discharge Point-3 in the HEC-HMS model was used, since this is the elements that generates the largest peak flows for all scenarios. In addition, the parameter variation behavior at other locations is similar.

Figure 6A shows the streamflow hydrographs generated at the Discharge Point-3 from scenarios where the precipitation was increased/decreased by 10%. The hydrographs don't differ that much from the baseline hydrograph at the start of the flood event. However, as the hydrograph moves forward in time the flow difference with a 10% increase in precipitation resulted in an increase of

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

47.9 cfs (13.9%) and the flow difference with a 10% decrease in precipitation resulted in a decrease of 56.2 cfs (16.3%) at the time of the peak flow. The later part of the hydrograph does not change significantly.

Figure 6B shows the streamflow hydrographs generated at the project site from scenarios where the CN was increased/decreased by 10%. The hydrographs do differ from the baseline hydrograph at the start of the flood event. As the hydrograph moves forward in time the flow difference with a 10% increase in CN resulted in an increase of 81.5 cfs (23.7%) and the flow difference with a 10% decrease in CN resulted in a decrease of 84.9 cfs (24.7%) at the time of the peak flow. The later part of the hydrograph does not change significantly.

Figure 6C shows the streamflow hydrographs generated at the project site from scenarios where the lag time was increased/decreased by 10%. The hydrographs don't differ that much from the baseline hydrograph at the start of the flood event. However, as the hydrograph moves forward in time the flow difference with a 10% increase in lag time resulted in an decrease of 11.0 cfs (3.2%) and the flow difference with a 10% decrease in lag time resulted in an increase of 8.9 cfs (2.6%) at the time of the peak flow. The later part of the hydrograph does not change significantly.

Based upon the sensitivity results obtained, the resulting HEC-HMS model is most sensitive to the CN and precipitation parameters. A small change in this parameter can generate significant variation in peak hydrographs. Also, the lag time parameter exercises an important role in the modeling of peak hydrographs, but when compared to CN and precipitation, the sensitivity is of less significance.

It is noted that the results were obtained by a local sensitivity analysis. These results reflect the given combination of model parameters. However, different parameter combination may generate different values of the performance measures used in the sensitivity analysis, although a

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

significant change in the pattern of the sensitivity results is not expected. Even though, this evaluation assists in the determination of which are the most sensitive parameters for the analysis, no calibration of these parameters was possible because no observed hydrologic data is available. Therefore, the results of the hydrologic model under the existing and proposed conditions, remain as computed by the model.

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

3.0 HYDRAULIC EVALUATION

3.1 Known and Historic Flood Events

No historical or regulatory flood data was available for the area of study.

3.2 Description and Evaluation of the Hydraulic System

Three ponding areas exist at the project site, as described below:

- North Pond, which receives runoffs from Drainage areas DA-1 onsite and DA-1 offsite
- South Pond, which receives runoffs from Drainage areas DA-2 onsite and DA-2 offsite
- Sinkhole ponding area at the southwest portion, which receives runoffs from Drainage areas DA-6 onsite and DA-6 offsite.

The other drainage areas eventually drain into the offsite creeks. This hydraulic study only included the on-site ponding areas. No evaluation of any off-site creek or conveyance structure was included.

The existing ponding areas were analyzed to estimate the volume storage capacity and resulting flood elevation in the ponds. The objective of the evaluation was to determine if the existing pond capacity can manage the 100-year flood event or if an overflow to off-site areas may be possible.

3.3 Methodology

Hydraulic computations for the existing ponds were conducted using the HEC-HMS computer model. In addition to its hydrologic capabilities, HEC-HMS is capable of simulating the routing of a flood wave through reservoirs or detention ponds. The storage routing is used to simulate the flood wave movement through river reaches or reservoirs and to define outflow hydrographs at the exit point of the reservoir and the expected flood elevations at the reservoir area. For this study, the reservoir routing method available in the HEC-HMS model was used. The existing ponds were evaluated using the Outflow Structures Routing Method, designed to model reservoirs with a number of uncontrolled outlet structures.

The Elevation-Storage alternative was used during the modeling process. An elevation-storage relationship was developed based upon the available topographic data for each pond by using the Conic Formula, ***Appendix K***. After the routing process is complete, the HEC-HMS program results included computed the elevation and flow storage for each time interval.

3.4 Hydraulic Model Boundary Conditions

An Initial Condition sets the amount of storage in the reservoir at the beginning of a simulation. For this study, it was assumed that the ponds had their storage capacity available prior to the beginning of a simulation. For the North and South Ponds the water level measured by the surveyor at the time of the field survey was assume to be the initial pond elevation. Also, it was assumed that the reservoir tailwater had no effect on the reservoir outflow and that the only outflow was through spillway overflow at the pond top surface.

3.5 Existing Conditions

The HEC-HMS computer model was modified to simulate the routing of storm events through the ponds. To route the flood hydrograph throughout the ponds it is necessary to develop stage–storage relationships for the pond areas and stage-discharge relationships for the outlet structures (spillway weir). The stage-discharge curve for the outlet structure system was computed using the HEC-HMS computer model. This model uses the standard equations for computing weir flows for both submerged and not submerged conditions. Both, the stage-storage and stage-discharge curves developed for the detention system are presented in ***Appendix L***. The coefficients of discharge used in the weir equation was 2.5.

3.6 Hydraulic Model Calibration

Since no water surface elevation for historic storm events or flood maps were available for the study area, no hydraulic calibration could be conducted during this study.

3.7 Analysis of Hydraulic Results

Table 5 presents the peak elevation at each pond resulting from the evaluated storm event. As expected, the peak elevation and storage occurs during the 100 year – 24 hour storm event. ***Table 6*** present the hydraulic capacity results and available storage for each of the ponds. The HEC-HMS model computer printout including the ponds' existing condition simulations is included in ***Appendix I***.

The data included in ***Table 6*** indicated that none of the pond's storage capacity is exceeded and all of the ponding areas have the capacity to manage the expected 100-year storm runoff volumes. In addition, as described in *Section 3.1.3.2*, sinkhole and limestone formations are expected to be present in the areas where the pond areas are located. As informed to us by landfill personnel, the water level at the ponds remains approximately the same all year long including when significant rainfall events occur. This suggest that the limestone formations surrounding the pond's areas may be acting as runoff drainage features during storm events. This is consistent with the regional geology in which stormwater is expected to be infiltrated at a high capacity through the rock openings and sinkhole formations.

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

As expected, in the proposed conditions the drainage area configuration will likely be modified. Therefore, any modification needs to be modeled to evaluate the ponds' capacity. As part of the proposed conditions evaluation runoff management can be evaluated using the ponds areas to determine if the ponds have the capacity to manage the flow increase without overtopping.

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

Based upon the results obtained during this study, the following is concluded:

- A hydrologic study was conducted to estimate the existing conditions 100-year recurrence peak flow that would occur at the project site.
- The Drainage Areas included as part of the study included seven areas draining from the project site and six offsite drainage areas which drain into the same drainage point as the onsite drainage areas.
- The offsite drainage areas cover an area of approximately 67 acres (0.105 square miles mi²). The onsite drainage areas included in the hydrologic analysis cover an area of approximately 44.8 acres (0.070 mi²).
- CN values for existing conditions were estimated to range from 75.3 to 89.2 for onsite drainage areas and from 77.0 to 86.9 for offsite drainage areas.
- TC values for existing conditions were estimated to range from 2.1 to 5.5 minutes for onsite drainage areas and 1.6 to 9.7 minutes for offsite drainage areas.
- Rainfall depth-duration data for the 100-year storm event was generated using data from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, 2006, Volume 3, Version 4 (Updated 2008). The 100-year recurrence event ranges from a rainfall depth of 3.34 inches in 1 hour to a rainfall depth of 13.9 inches in 24 hours.
- The HEC-HMS model was executed to evaluate the 100-year storm - 24, 12, 6, and 1-hour durations (1st quartile – percentile 10% and 4th quartile – percentile 90%) storm events for the existing conditions.
- The maximum computed peak flow occurs during the 100-year - 1-hour (4th quartile) duration storm event. The generated onsite peak flows vary from 8.0 cfs to 124.7 cfs. The generated offsite peak flows vary from 8.3 cfs to 316.1 cfs.
- The maximum peak inflows at the North Pond, South Pond, and sinkhole ponding area at the southwest portion occur during the 100-year - 1-hour (4th quartile) duration storm event, with peak flows of 151.7, 111.3, and 67.9 cfs, respectively.
- The maximum generated volume occurs during the 100-year - 24-hour (1st and 4th quartile) duration storm event. The generated onsite volumes vary from 1.1 acre-feet to 16.1 acre-feet. The generated offsite volumes vary from 1.2 acre-feet to 48.1 acre-feet.

- Three ponding areas exist at the project site; the North Pond which receives runoffs from Drainage areas DA-1 onsite and DA-1 offsite; the South Pond which receives runoffs from Drainage areas DA-2 onsite and DA-2 offsite; and the sinkhole ponding area at the southwest portion which receives runoffs from Drainage areas DA-6 onsite and DA-6 offsite.
- The peak volume stored at North Pond, South Pond, and sinkhole ponding area at the southwest portion are 19.8, 14.7, and 9.1 acre-feet respectively.
- The hydraulic results indicate that, under existing conditions, none of the three pond areas evaluated produce an overflow of runoff. The existing storage capacity of these pond areas is sufficient to manage the 100 -years storm event. This analysis assumes that prior to the occurrence of the 100 year storm event the pond areas will have available their maximum capacity.
- As informed to us by landfill personnel, the water level at the ponds remains approximately the same all year long including when significant rainfall events occur. This suggest that the limestone formations surrounding the pond's areas may be acting as runoff drainage features during storm events. This is consistent with the regional geology in which stormwater is expected to be infiltrated at a high capacity through the rock openings and sinkhole formations.
- Based upon the sensitivity results obtained, the resulting HEC-HMS model is most sensitive to the CN and precipitation. A small change in this parameter can generate significant variation in peak hydrographs. Also, the lag time parameter exercises an important role in the modeling of peak hydrographs, but when compared to CN and precipitation, the sensitivity is of less significance. Even though, this evaluation assists in the determination of which are the most sensitive parameters for the analysis, no calibration of these parameters was possible because no observed hydrologic data was available. Therefore, the results of the hydrologic model under the existing and proposed conditions, should remain as computed by the model.

4.2 Recommendations

Based upon the results of this investigation the following is recommended:

- Our scope of work included the evaluation of existing hydrologic and hydraulic conditions at the landfill area. The results obtained should be used to develop runoff control systems to manage the runoff of the landfill area once completely developed.

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

- Evaluate the landfill proposed conditions. As part of the proposed conditions evaluation runoff management can be evaluated using the ponds areas to determine if the ponds have the capacity to manage the flow increase without overtopping.

- As part of the proposed conditions, we recommend considering the installation of a berm and grate at the entrance of the landfill near the guardhouse to intersect runoffs flowing through the access road and redirect them toward the nearest pond area.

- As part of the proposed conditions, it should be considered to relocate all equipment and storage areas associated with the landfill in which runoffs generated at these areas may drain outside the landfill.

- If as part of the project runoff management design, it is determined that the pond areas have the capacity to manage the 100-year storm event without overtopping, then it is possible to justify that the landfill runoff would not drain into waters of the United States. Under this scenario the need for compliance with the EPA National Pollutant Discharge Elimination System (NPDES) Multi-Sector General Permit may not be necessary. If this scenario is possible, it should be discussed with the EPA.

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

5.0 REFERENCES

Topographic Survey Map prepared by engineer Hector Tirado Rodriguez, P.E., R.P.A, LIC. 12,215, dated September 14, 2022

U.S. Geological Survey 7.5 Min. Topographic Map of Corozal, P.R. (USGS 2018)

U.S. Geological Survey 7.5 Min. Topographic Map of Vega Alta, P.R. (USGS 2018)

U.S. Geological Survey 7.5 Min. Topographic Map of Corozal, P.R. (USGS 1972, rev 1974)

U.S. Geological Survey 7.5 Min. Topographic Map of Vega Alta, P.R. (USGS 1969, rev 1983)

U.S. Geological Survey Hydrologic Unit Maps, https://water.usgs.gov/GIS/huc.html

NOAA Atlas 14, Volume 3, Version 4 Gridded Precipitation Frequency Estimates for Puerto Rico and the U.S. Virgin Islands, 2006 (Revised 2008)

Soil Survey of the San Juan Area, Puerto Rico, U.S. Department of Agriculture Soil Conservation Survey; Survey Area Data: Version 16, September 12, 2022

Flood Insurance Rate Map, Panel 0685 of 2160 (Map Number 72000C0685H), by the Federal Emergency Management Agency (FEMA). Effective date April 13, 2018

Basin slope rasters for Puerto Rico StreamStats, https://www.sciencebase.gov/catalog/item/5d7146ebe4b0c4f70cfdc8e3

Roughness Characteristics of Natural Channels by Harry II. Barnes, Jr. U.S. Geological Survey Water-Supply Paper 1849

Chapter 7 Hydrologic Soil Groups Part 630 Hydrology National Engineering Handbook, United States Department of Agriculture, Natural Resources Conservation Service (210–VI–NEH, May 2010)

Chapter 8 Land Use and Treatment Classes Part 630 Hydrology National Engineering Handbook, United States Department of Agriculture, Natural Resources Conservation Service (210–VI–NEH, May 2010)

Chapter 9 Hydrologic Soil-Cover Complexes Part 630 Hydrology National Engineering Handbook, United States Department of Agriculture, Natural Resources Conservation Service (210–VI–NEH, May 2010)

PRIVILEGED AND CONFIDENTIAL
DRAFT FOR REVIEW PURPOSES ONLY

Chapter 15 Time of Concentration Part 630 Hydrology National Engineering Handbook, United States Department of Agriculture, Natural Resources Conservation Service (210–VI–NEH, May 2010)

Google Earth Pro, 7.3.4.8642 (64-bit), May 12, 2022 10:55:31 PM UTC

NOAA Mean Annual Precipitation 1981-2010, http://www.srh.noaa.gov/sju/?n=mean_annual_precipitation2

2018 USGS Lidar DEM: Post Hurricane Maria - Puerto Rico, https://www.fisheries.noaa.gov/inport/item/60105

Digital Elevation Model (DEM), CRIM_Basemap_Project_1996-98

USGS Caribbean Water Science Center available online database (https://pr.water.usgs.gov/)

NOAA Mean Annual Precipitation 1981-2010,

http://www.srh.noaa.gov/sju/?n=mean_annual_precipitation2

Soil Conservation Service (SCS), "Hydrologic Guide for Use in Watershed Planning", National Engineering Handbook, Section 4, Hydrology 1964

U.S. Army Corps of Engineers (USACE), "HEC-HMS",V.4.2.1 March 2017, Hydrologic Engineering Center, Davis, California.

U.S. Army Corps of Engineers (USACE), "HEC-RAS River Analysis System" User's Manual. Version 4.2. August 2016, Hydrologic Engineering Center, Davis, California.

U.S. Army Corps of Engineers (USACE), "HEC-RAS River Analysis System" Hydraulic Reference Manual. Version 5.0. February 2016, Hydrologic Engineering Center, Davis, California

Storm water Conveyance Modeling and Design, 1st Edition, Haestad-Durrans, 2003

NOAA Atlas 14, Volume 3, Version 4 Gridded Precipitation Frequency Estimates for Puerto Rico and the U.S. Virgin Islands, March 2008 (Updated version of U.S. Department of Commerce

PRIVILEGED AND CONFIDENTIAL

Hydrology & Hydraulic Systems, 2nd Edition, Ram S. Gupta, 2001

Calibration, verification, and sensitivity analysis of the HEC-HMS hydrologic model CFCAS project: Assessment of Water Resources Risk and Vulnerability to Changing Climatic Conditions Project Report IV.

PRIVILEGED AND CONFIDENTIAL

TABLES

PRIVILEGED AND CONFIDENTIAL

Table 1
Summary of Drainage Areas Characteristics

Drainage Area Identification	Area (acres)	Area (mi²)	CN (AMC II)	CN (AMC I)	CN (AMC III)	TC (min)	T_{lag} (min)
DA-1 Offsite	4.00	0.00625	77.7	60	89.5	5.3	3.2*
DA-1 Onsite	15.80	0.02469	87.0	74	95	2.0	1.2*
DA-2 Offsite	2.35	0.00367	82.3	64	92	1.6	1.0*
DA-2 Onsite	12.50	0.01953	84.5	70	94	5.5	3.3*
DA-3 Offsite	50.30	0.07859	81.3	63	91	9.7	5.8
DA-3 Onsite	4.92	0.00769	81.3	63	91	2.6	1.6*
DA-4 Offsite	1.35	0.00211	77.0	60	89.5	2.0	1.2*
DA-4 Onsite	3.88	0.00606	80.9	63	91	2.9	1.7*
DA-5 Offsite	1.83	0.00286	86.9	74	95	1.6	1.0*
DA-5 Onsite	4.61	0.0072	75.3	57	88	4.3	2.6*
DA-6 Offsite	7.38	0.01153	81.5	63	91	4.1	2.5*
DA-6 Onsite	1.94	0.00303	89.2	78	96	2.7	1.6*
DA-7 Onsite	1.10	0.00172	83.7	65	93	2.1	1.2*
Total Onsite DA **Total Offsite DA**	**44.75** **67.21**	**0.06992** **0.10501**					

CN = Curve Number
TC = Time of Concentration
T_{lag} = Lag Time = 0.6 TC;
* If calculated lag times is less than the Minimum Lag time permitted by HEC HMS model, then the minimum lag time will be used. Minimum Lag time permitted by HEC HMS model = computational interval time / 0.29 = 1 minute / 0.29 = 3.44 minutes; then T_{lag} = 3.5 minute.

Hydrologic/Hydraulic Preliminary Report
Existing Conditions Evaluation
Vertedero Municipal de Toa Alta
Project Location: PR-165, Km. 8.2
Contorno Ward
Toa Alta, Puerto Rico
CES Project No. 22-0025

PRIVILEGED AND CONFIDENTIAL

Table 2
Rainfall Depth
Precipitation Frequency Estimates

Storm Duration	Rainfall Depth (inches)
	100 YR Frequency
24 hr	13.9
12 hr	10.7
6 hr	7.83
1 hr	3.34

****Source:** NOAA Atlas 14, 2006, Volume 3, Version 4 Gridded Precipitation Frequency Estimates for Puerto Rico and the U.S. Virgin Islands, Updated March 21, 2008

Hydrologic/Hydraulic Preliminary Report
Existing Conditions Evaluation
Vertedero Municipal de Toa Alta
Project Location: PR-165, Km. 8.2
Contorno Ward
Toa Alta, Puerto Rico
CES Project No. 22-0025

PRIVILEGED AND CONFIDENTIAL

Table 3A
100 YEAR – 24 HOUR RAINFALL DISTRIBUTION 4th Quartile – 90% Percentile

Minutes*	% of Total Precipitation**	Accumulated Precipitation
0	0.00	0.00
30	0.45	0.06
60	0.90	0.13
90	1.36	0.19
120	1.80	0.25
150	2.03	0.28
180	2.25	0.31
210	2.47	0.34
240	2.70	0.37
270	2.95	0.41
300	3.20	0.44
330	3.45	0.48
360	3.70	0.51
390	4.05	0.56
420	4.40	0.61
450	4.75	0.66
480	5.11	0.71
510	5.48	0.76
540	5.85	0.81
570	6.22	0.86
600	6.59	0.92
630	6.87	0.96
660	7.15	0.99
690	7.42	1.03
720	7.70	1.07
750	8.33	1.16
780	8.96	1.24
810	9.58	1.33
840	10.22	1.42
870	11.38	1.58
900	12.55	1.74
930	13.72	1.91
960	14.88	2.07
990	16.55	2.30
1020	18.24	2.53
1050	19.92	2.77
1080	21.60	3.00
1110	24.66	3.43
1140	27.72	3.85
1170	30.79	4.28
1200	33.89	4.71
1230	39.67	5.51
1260	45.45	6.32
1290	51.23	7.12
1320	57.01	7.92
1350	67.70	9.41
1380	78.46	10.91
1410	89.23	12.40
1440	100.00	13.90

* Time interval are spaced as indicated in the Table 4.1 of the 2016 HH DNER Guideline requirements
** % Distribution was interpolated from the Appendix I of the 2016 HH DNER Guideline

Hydrologic/Hydraulic Preliminary Report
Existing Conditions Evaluation
Vertedero Municipal de Toa Alta
Project Location: PR-165, Km. 8.2
Contorno Ward
Toa Alta, Puerto Rico
CES Project No. 22-0025

PRIVILEGED AND CONFIDENTIAL

Table 3B
100 YEAR – 24 HOUR RAINFALL DISTRIBUTION
1st Quartile – 10% Percentile

Minutes*	% of Total Precipitation**	Accumulated Precipitation
0	0.00	0.00
30	14.01	1.95
60	28.01	3.89
90	42.02	5.84
120	55.93	7.77
150	64.19	8.92
180	72.45	10.07
210	80.71	11.22
240	88.97	12.37
270	91.10	12.66
300	93.13	12.95
330	95.17	13.23
360	97.20	13.51
390	97.80	13.59
420	98.40	13.68
450	99.01	13.76
480	99.60	13.84
510	99.70	13.86
540	99.80	13.87
570	99.90	13.89
600	100.00	13.90
630	100.00	13.90
660	100.00	13.90
690	100.00	13.90
720	100.00	13.90
750	100.00	13.90
780	100.00	13.90
810	100.00	13.90
840	100.00	13.90
870	100.00	13.90
900	100.00	13.90
930	100.00	13.90
960	100.00	13.90
990	100.00	13.90
1020	100.00	13.90
1050	100.00	13.90
1080	100.00	13.90
1110	100.00	13.90
1140	100.00	13.90
1170	100.00	13.90
1200	100.00	13.90
1230	100.00	13.90
1260	100.00	13.90
1290	100.00	13.90
1320	100.00	13.90
1350	100.00	13.90
1380	100.00	13.90
1410	100.00	13.90
1440	100.00	13.90

* Time interval are spaced as indicated in the Table 4.1 of the 2016 HH DNER Guideline requirements
** % Distribution was interpolated from the Appendix I of the 2016 HH DNER Guideline

Hydrologic/Hydraulic Preliminary Report
Existing Conditions Evaluation
Vertedero Municipal de Toa Alta
Project Location: PR-165, Km. 8.2
Contorno Ward
Toa Alta, Puerto Rico
CES Project No. 22-0025

PRIVILEGED AND CONFIDENTIAL

Table 3C
100 YEAR – 12 HOUR RAINFALL DISTRIBUTION
4th Quartile – 90% Percentile

Minutes*	% of Total Precipitation**	Accumulated Precipitation
0	0.00	0.00
15	0.40	0.04
30	0.80	0.09
45	1.20	0.13
60	1.60	0.17
75	1.88	0.20
90	2.15	0.23
105	2.42	0.26
120	2.70	0.29
135	3.00	0.32
150	3.30	0.35
165	3.60	0.39
180	3.90	0.42
195	4.48	0.48
210	5.05	0.54
225	5.63	0.60
240	6.22	0.67
255	7.28	0.78
270	8.35	0.89
285	9.42	1.01
300	10.48	1.12
315	11.66	1.25
330	12.84	1.37
345	14.02	1.50
360	15.20	1.63
375	16.40	1.76
390	17.61	1.88
405	18.81	2.01
420	20.03	2.14
435	21.64	2.32
450	23.25	2.49
465	24.86	2.66
480	26.47	2.83
495	28.85	3.09
510	31.23	3.34
525	33.62	3.60
540	36.00	3.85
555	39.44	4.22
570	42.88	4.59
585	46.32	4.96
600	49.78	5.33
615	55.09	5.89
630	60.40	6.46
645	65.71	7.03
660	71.02	7.60
675	78.24	8.37
690	85.49	9.15
705	92.75	9.92
720	100.00	10.70

* Time interval are spaced as indicated in the Table 4.1 of the 2016 HH DNER Guideline requirements
** % Distribution was interpolated from the Appendix I of the 2016 HH DNER Guideline

Hydrologic/Hydraulic Preliminary Report
Existing Conditions Evaluation
Vertedero Municipal de Toa Alta
Project Location: PR-165, Km. 8.2
Contorno Ward
Toa Alta, Puerto Rico
CES Project No. 22-0025

PRIVILEGED AND CONFIDENTIAL

Table 3D
100 YEAR – 12 HOUR RAINFALL DISTRIBUTION
1st Quartile – 10% Percentile

Minutes*	% of Total Precipitation**	Accumulated Precipitation
0	0.00	0.00
15	11.37	1.22
30	22.74	2.43
45	34.11	3.65
60	45.44	4.86
75	53.99	5.78
90	62.55	6.69
105	71.11	7.61
120	79.66	8.52
135	83.75	8.96
150	87.77	9.39
165	91.78	9.82
180	95.80	10.25
195	96.73	10.35
210	97.66	10.45
225	98.59	10.55
240	99.50	10.65
255	99.63	10.66
270	99.75	10.67
285	99.87	10.69
300	100.00	10.70
315	100.00	10.70
330	100.00	10.70
345	100.00	10.70
360	100.00	10.70
375	100.00	10.70
390	100.00	10.70
405	100.00	10.70
420	100.00	10.70
435	100.00	10.70
450	100.00	10.70
465	100.00	10.70
480	100.00	10.70
495	100.00	10.70
510	100.00	10.70
525	100.00	10.70
540	100.00	10.70
555	100.00	10.70
570	100.00	10.70
585	100.00	10.70
600	100.00	10.70
615	100.00	10.70
630	100.00	10.70
645	100.00	10.70
660	100.00	10.70
675	100.00	10.70
690	100.00	10.70
705	100.00	10.70
720	100.00	10.70

* Time interval are spaced as indicated in the Table 4.1 of the 2016 HH DNER Guideline requirements
** % Distribution was interpolated from the Appendix I of the 2016 HH DNER Guideline

PRIVILEGED AND CONFIDENTIAL

Table 3E
100 YEAR – 6 HOUR RAINFALL DISTRIBUTION
4th Quartile – 90% Percentile

Minutes*	% of Total Precipitation**	Accumulated Precipitation
0	0.00	0.00
10	0.70	0.06
20	1.41	0.11
30	2.11	0.17
40	2.90	0.23
50	3.70	0.29
60	4.49	0.35
70	5.06	0.40
80	5.63	0.44
90	6.20	0.49
100	7.27	0.57
110	8.34	0.65
120	9.42	0.74
130	10.84	0.85
140	12.26	0.96
150	13.68	1.07
160	15.22	1.19
170	16.76	1.31
180	18.30	1.43
190	20.31	1.59
200	22.32	1.75
210	24.34	1.91
220	27.28	2.14
230	30.22	2.37
240	33.16	2.60
250	37.20	2.91
260	41.25	3.23
270	45.30	3.55
280	50.49	3.95
290	55.67	4.36
300	60.87	4.77
310	67.06	5.25
320	73.24	5.73
330	79.43	6.22
340	86.28	6.76
350	93.14	7.29
360	100.00	7.83

* Time interval are spaced as indicated in the Table 4.1 of the 2016 HH DNER Guideline requirements
** % Distribution was interpolated from the Appendix I of the 2016 HH DNER Guideline

PRIVILEGED AND CONFIDENTIAL

Table 3F
100 YEAR – 6 HOUR RAINFALL DISTRIBUTION
1st Quartile – 10% Percentile

Minutes*	% of Total Precipitation**	Accumulated Precipitation
0	0.00	0.00
10	11.81	0.93
20	23.63	1.85
30	35.42	2.77
40	45.57	3.57
50	55.73	4.36
60	65.88	5.16
70	72.94	5.71
80	79.97	6.26
90	87.00	6.81
100	90.41	7.08
110	93.83	7.35
120	97.21	7.61
130	97.90	7.67
140	98.60	7.72
150	99.29	7.77
160	99.53	7.79
170	99.77	7.81
180	100.00	7.83
190	100.00	7.83
200	100.00	7.83
210	100.00	7.83
220	100.00	7.83
230	100.00	7.83
240	100.00	7.83
250	100.00	7.83
260	100.00	7.83
270	100.00	7.83
280	100.00	7.83
290	100.00	7.83
300	100.00	7.83
310	100.00	7.83
320	100.00	7.83
330	100.00	7.83
340	100.00	7.83
350	100.00	7.83
360	100.00	7.83

* Time interval are spaced as indicated in the Table 4.1 of the 2016 HH DNER Guideline requirements
** % Distribution was interpolated from the Appendix I of the 2016 HH DNER Guideline

Hydrologic/Hydraulic Preliminary Report
Existing Conditions Evaluation
Vertedero Municipal de Toa Alta
Project Location: PR-165, Km. 8.2
Contorno Ward
Toa Alta, Puerto Rico
CES Project No. 22-0025

PRIVILEGED AND CONFIDENTIAL

Table 3G
100 YEAR – 1 HOUR RAINFALL DISTRIBUTION
4th Quartile – 90% Percentile

Minutes*	% of Total Precipitation**	Accumulated Precipitation
0	0.00	0.00
2	0.28	0.01
4	0.56	0.02
6	0.82	0.03
8	1.06	0.04
10	1.30	0.04
12	1.78	0.06
14	2.26	0.08
16	2.82	0.09
18	3.46	0.12
20	4.11	0.14
22	5.06	0.17
24	6.01	0.20
26	7.42	0.25
28	9.31	0.31
30	11.20	0.37
32	13.73	0.46
34	16.26	0.54
36	19.04	0.64
38	22.05	0.74
40	25.07	0.84
42	29.39	0.98
44	33.73	1.13
46	39.31	1.31
48	46.14	1.54
50	52.99	1.77
52	62.32	2.08
54	71.64	2.39
56	81.04	2.71
58	90.52	3.02
60	100.00	3.34

* Time interval are spaced as indicated in the Table 4.1 of the 2016 HH DNER Guideline requirements
** % Distribution was interpolated from the Appendix I of the 2016 HH DNER Guideline

PRIVILEGED AND CONFIDENTIAL

Table 3H
100 YEAR – 1 HOUR RAINFALL DISTRIBUTION
1st Quartile – 10% Percentile

Minutes*	% of Total Precipitation**	Accumulated Precipitation
0	0.00	0.00
2	7.75	0.26
4	15.50	0.52
6	23.13	0.77
8	30.63	1.02
10	38.13	1.27
12	44.36	1.48
14	50.59	1.69
16	55.73	1.86
18	59.78	2.00
20	63.83	2.13
22	66.37	2.22
24	68.90	2.30
26	71.38	2.38
28	73.79	2.46
30	76.20	2.55
32	78.65	2.63
34	81.10	2.71
36	83.51	2.79
38	85.90	2.87
40	88.28	2.95
42	90.17	3.01
44	92.06	3.07
46	93.68	3.13
48	95.05	3.17
50	96.41	3.22
52	97.16	3.25
54	97.92	3.27
56	98.63	3.29
58	99.32	3.32
60	100.00	3.34

* Time interval are spaced as indicated in the Table 4.1 of the 2016 HH DNER Guideline requirements
** % Distribution was interpolated from the Appendix I of the 2016 HH DNER Guideline

Hydrologic/Hydraulic Preliminary Report
Existing Conditions Evaluation
Vertedero Municipal de Toa Alta
Project Location: PR-165, Km. 8.2
Contorno Ward
Toa Alta, Puerto Rico
CES Project No. 22-0025

PRIVILEGED AND CONFIDENTIAL

Table 4A
Summary of Hydrologic Results Peak Flows (cfs)
100 Year Recurrence Period - Existing Conditions

Drainage Area Identification	100YR Peak Flows (cfs)							
	24HR 4th Qt-90%	24HR 1st Qt-10%	12HR 4th Qt-90%	12HR 1st Qt-10%	6HR 4th Qt-90%	6HR 1st Qt-10%	1HR 4th Qt-90%	1HR 1st Qt-10%
DA-1 Offsite	11.7	14.2	11.9	16.0	12.0	16.2	**24.7**	10.1
DA-1 Onsite	47.3	59.7	48.9	71.8	50.1	72.5	**124.7**	65.9
DA-2 Offsite	7.0	8.6	7.2	10.1	7.3	10.1	**16.5**	7.7
DA-2 Onsite	37.3	46.6	38.4	55.2	39.1	55.2	**92.9**	45.9
DA-3 Offsite	148.7	183.3	152.4	210.6	153.6	211.4	**310.7**	143.1
DA-3 Onsite	14.6	18.0	14.9	20.8	15.1	20.9	**33.6**	15.3
DA-4 Offsite	3.9	4.8	4.0	5.3	4.0	5.4	**8.1**	3.3
DA-4 Onsite	11.5	14.1	11.8	16.3	11.9	16.4	**26.2**	11.8
DA-5 Offsite	5.5	6.9	5.7	8.3	5.8	8.4	**14.4**	7.6
DA-5 Onsite	13.4	16.0	13.6	17.7	13.5	17.9	**26.3**	10.1
DA-6 Offsite	21.8	27.0	22.4	31.3	22.7	31.5	**50.7**	23.2
DA-6 Onsite	5.8	7.4	6.0	9.0	6.2	9.4	**16.0**	9.0
DA-7 Onsite	3.3	4.1	3.4	4.8	3.4	4.8	**8.0**	3.9
North Pond Peak Inflow	59.0	73.9	60.8	87.8	62.0	87.8	**149.2**	75.7
North Pond Peak Discharge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South Pond Peak Inflow	44.2	55.2	45.5	65.3	46.4	65.4	**109.4**	53.6
South Pond Peak Discharge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sinkhole SW Peak Inflow	27.7	34.4	28.5	40.3	28.9	40.4	**66.7**	32.0
Sinkhole SW Peak Discharge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Bold Red Font = Peak Discharge
Onsite Drainage Area

Hydrologic/Hydraulic Preliminary Report
Existing Conditions Evaluation
Vertedero Municipal de Toa Alta
Project Location: PR-165, Km. 8.2
Contorno Ward
Toa Alta, Puerto Rico
CES Project No. 22-0025

PRIVILEGED AND CONFIDENTIAL

Table 4B
Summary of Hydrologic Results Volume (ACRE-FT)
100 Year Recurrence Period - Existing Conditions

Drainage Area Identification	100YR Volume (acre-ft)							
	24HR 4th Qt-90%	24HR 1st Qt-10%	12HR 4th Qt-90%	12HR 1st Qt-10%	6HR 4th Qt-90%	6HR 1st Qt-10%	1HR 4th Qt-90%	1HR 1st Qt-10%
DA-1 Offsite	**3.7**	**3.7**	2.6	2.6	1.7	1.7	0.5	0.5
DA-1 Onsite	**16.1**	**16.1**	12.0	12.0	8.3	8.3	2.7	2.7
DA-2 Offsite	**2.3**	**2.3**	1.7	1.7	1.1	1.1	0.3	0.3
DA-2 Onsite	**12.4**	**12.4**	9.1	9.1	6.2	6.2	1.9	1.9
DA-3 Offsite	**48.1**	**48.1**	35.0	35.0	23.5	23.5	6.7	6.7
DA-3 Onsite	**4.7**	**4.7**	3.4	3.4	2.3	2.3	0.7	0.7
DA-4 Offsite	**1.2**	**1.2**	0.9	0.9	0.6	0.6	0.1	0.1
DA-4 Onsite	**3.7**	**3.7**	2.7	2.7	1.8	1.8	0.5	0.5
DA-5 Offsite	**1.9**	**1.9**	1.4	1.4	1.0	1.0	0.3	0.3
DA-5 Onsite	**4.1**	**4.1**	2.9	2.9	1.9	1.9	0.5	0.5
DA-6 Offsite	**7.1**	**7.1**	5.2	5.2	3.5	3.5	1.0	1.0
DA-6 Onsite	**2.0**	**2.0**	1.5	1.5	1.1	1.1	0.4	0.4
DA-7 Onsite	**1.1**	**1.1**	0.8	0.8	0.5	0.5	0.2	0.2
North Pond Peak Storage	**19.8**	**19.8**	14.6	14.6	10.0	10.0	3.1	3.1
South Pond Peak Storage	**14.7**	**14.7**	10.8	10.8	7.4	7.4	2.2	2.2
Sinkhole SW Peak Storage	**9.1**	**9.1**	6.7	6.7	4.5	4.5	1.4	1.4

Bold Red Font = Peak Volume
Onsite Drainage Area

Hydrologic/Hydraulic Preliminary Report
Existing Conditions Evaluation
Vertedero Municipal de Toa Alta
Project Location: PR-165, Km. 8.2
Contorno Ward
Toa Alta, Puerto Rico
CES Project No. 22-0025

PRIVILEGED AND CONFIDENTIAL

Table 5
Summary of Hydrologic Results Peak Elevation (Feet- PRVD02)
100 Year Recurrence Period - Existing Conditions

Pond Identification	100YR Peak Elevation (Feet- PRVD02)							
	24HR 4th Qt-90%	24HR 1st Qt-10%	12HR 4th Qt-90%	12HR 1st Qt-10%	6HR 4th Qt-90%	6HR 1st Qt-10%	1HR 4th Qt-90%	1HR 1st Qt-10%
North Pond Peak Elevation	**367.6**	**367.6**	365.0	365.0	362.5	362.5	356.8	356.8
South Pond Peak Elevation	**394.1**	**394.1**	389.2	389.2	383.8	383.8	372.7	372.7
Sinkhole SW Peak Elevation	**390.5**	**390.5**	388.5	388.5	386.5	386.5	381.2	381.2

Bold Red Font = Peak Elevation

PRIVILEGED AND CONFIDENTIAL

Table 6
Existing Conditions
Ponds - Hydraulic Capacity Results
100 Year - 24 Hr Event

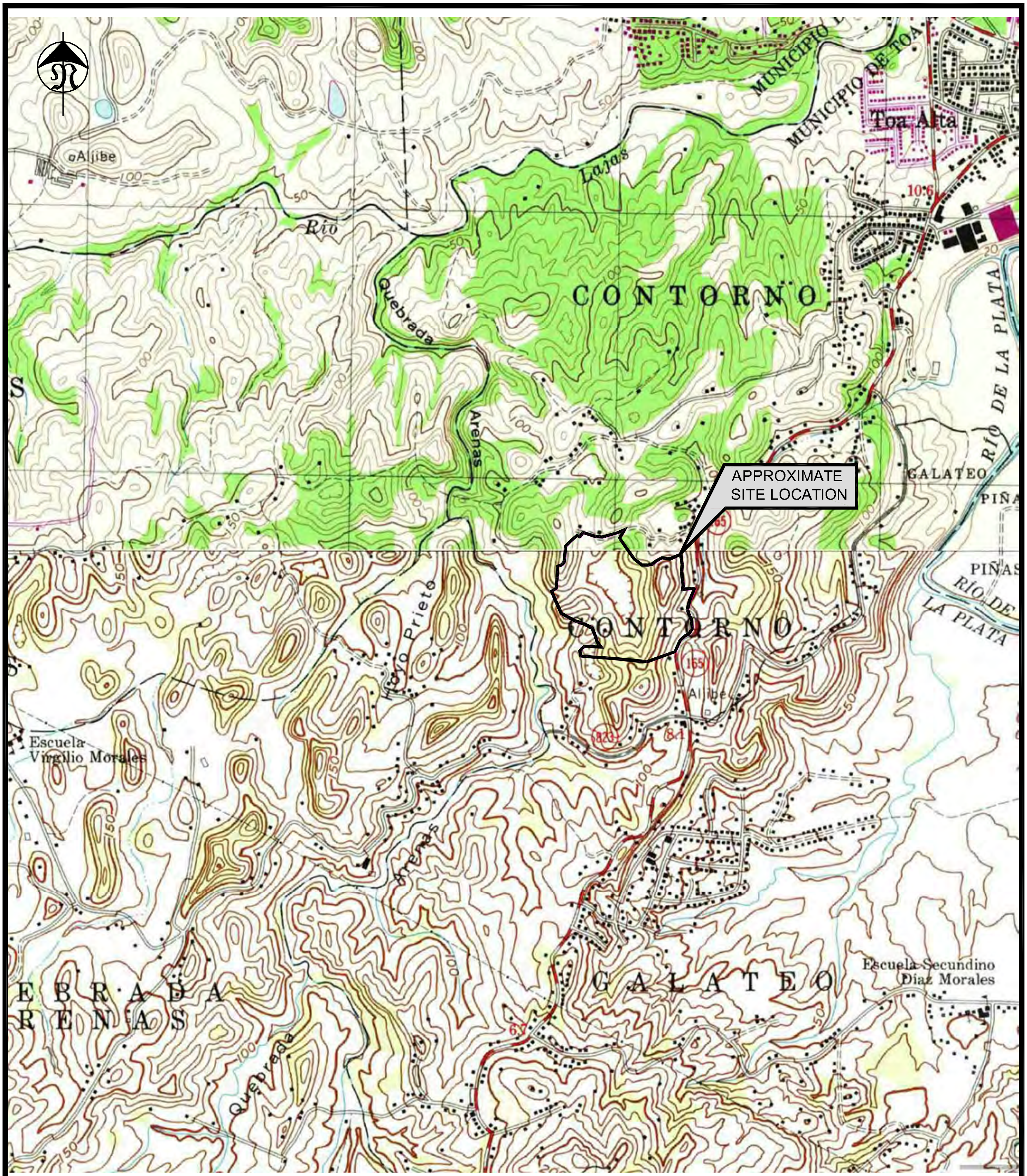
Approximate Pond Maximum Storage Capacity*	Approximate Pond Peak Storage During Simulated Event*	Pond Bottom Elevation	Pond Top Elevation	Peak Water Elevation at Pond
	North Pond			
50.9 Ac-Ft	19.8 Ac-Ft	101 m (331.4 ft)	116 m (380.6 ft)	112 m (367.6 ft)
	South Pond			
118.1 Ac-Ft	14.7 Ac-Ft	110 m (360.9 ft)	130 m (426.5 ft)	120 m (394.1 ft)
	Sinkhole SW			
11.7 Ac-Ft	9.1 Ac-Ft	114 m (374.0 ft)	119.50 m (392 ft)	119 m (390.5 ft)

* Assuming no sedimentation in pond.
** = Generated Runoff Volume Greater Than Available Pond Storage
Ac-Ft = Acres – Feet
Vertical Datum = PRVD02

Hydrologic/Hydraulic Preliminary Report
Existing Conditions Evaluation
Vertedero Municipal de Toa Alta
Project Location: PR-165, Km. 8.2
Contorno Ward
Toa Alta, Puerto Rico
CES Project No. 22-0025

PRIVILEGED AND CONFIDENTIAL

FIGURES



SOURCE: USGS 7.5 MIN TOPOGRAPHIC MAP OF THE COROZAL (1972, REV 1974) AND VEGA ALTA (1969, REV 1983) QUADRANGLES

SCALE: 1:20,000

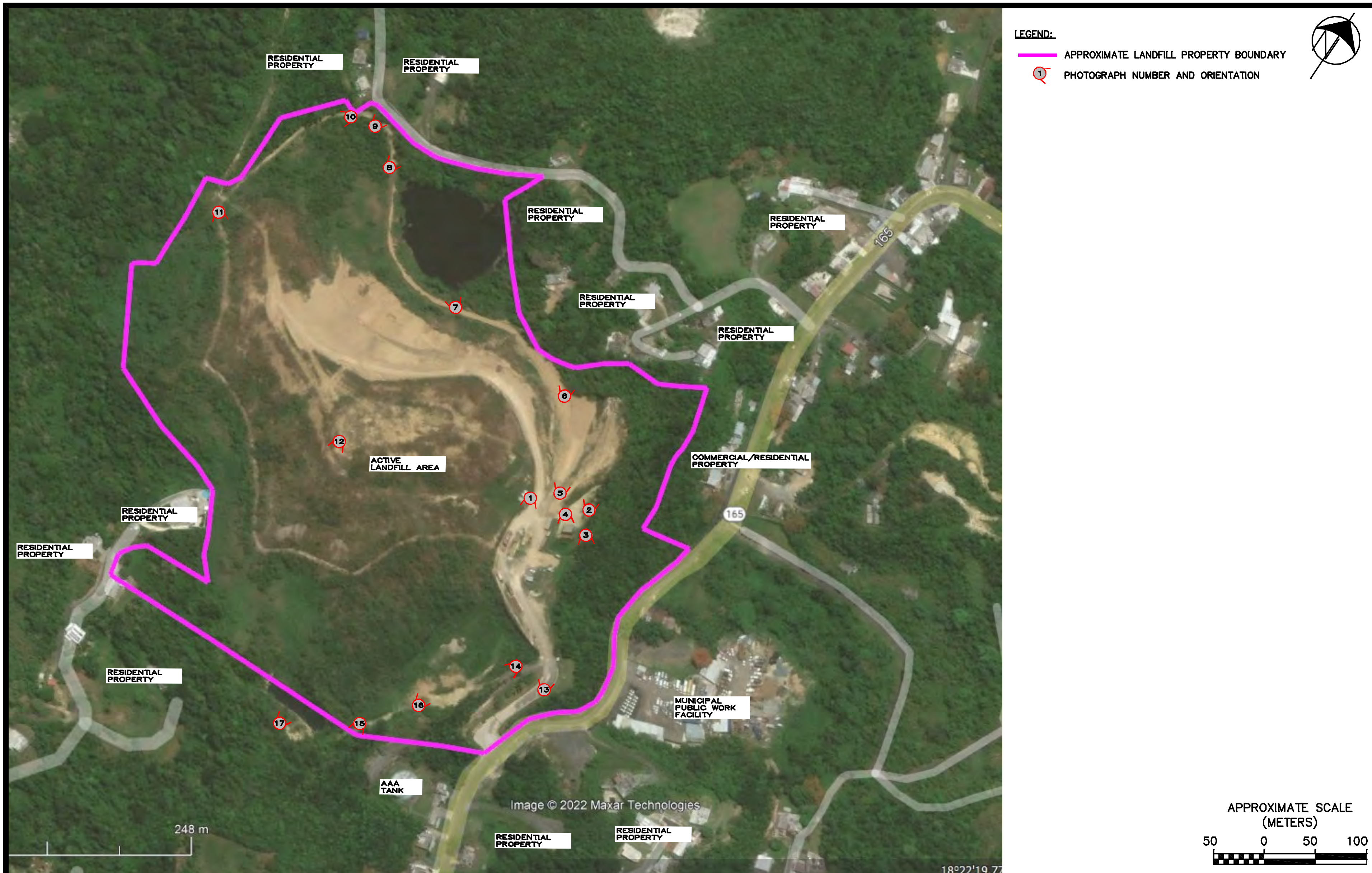
Caribe Environmental Services

HYDROLOGIC/HYDRAULIC PRELIMINARY REPORT
EXISTING CONDITIONS EVALUATION
VERTEDERO MUNICIPAL DE TOA ALTA
PROJECT LOCATION: PR-165, KM. 8.2
CONTORNO WARD
TOA ALTA, PUERTO RICO

SITE VICINITY MAP

PROJECT NO. 22-0025

FIGURE 1



SOURCE: GOOGLE EARTH PRO, AERIAL PHOTOGRAPH DATED JUNE 2022. as-built topographic map prepared for the Project Site by engineer Hector Tirado Rodriguez, P.E., R.P.A, LIC. 12,215, dated September 14, 2022

ALL LOCATIONS ARE APPROXIMATE AND ARE ACCOMMODATED TO FIT THIS FIGURE

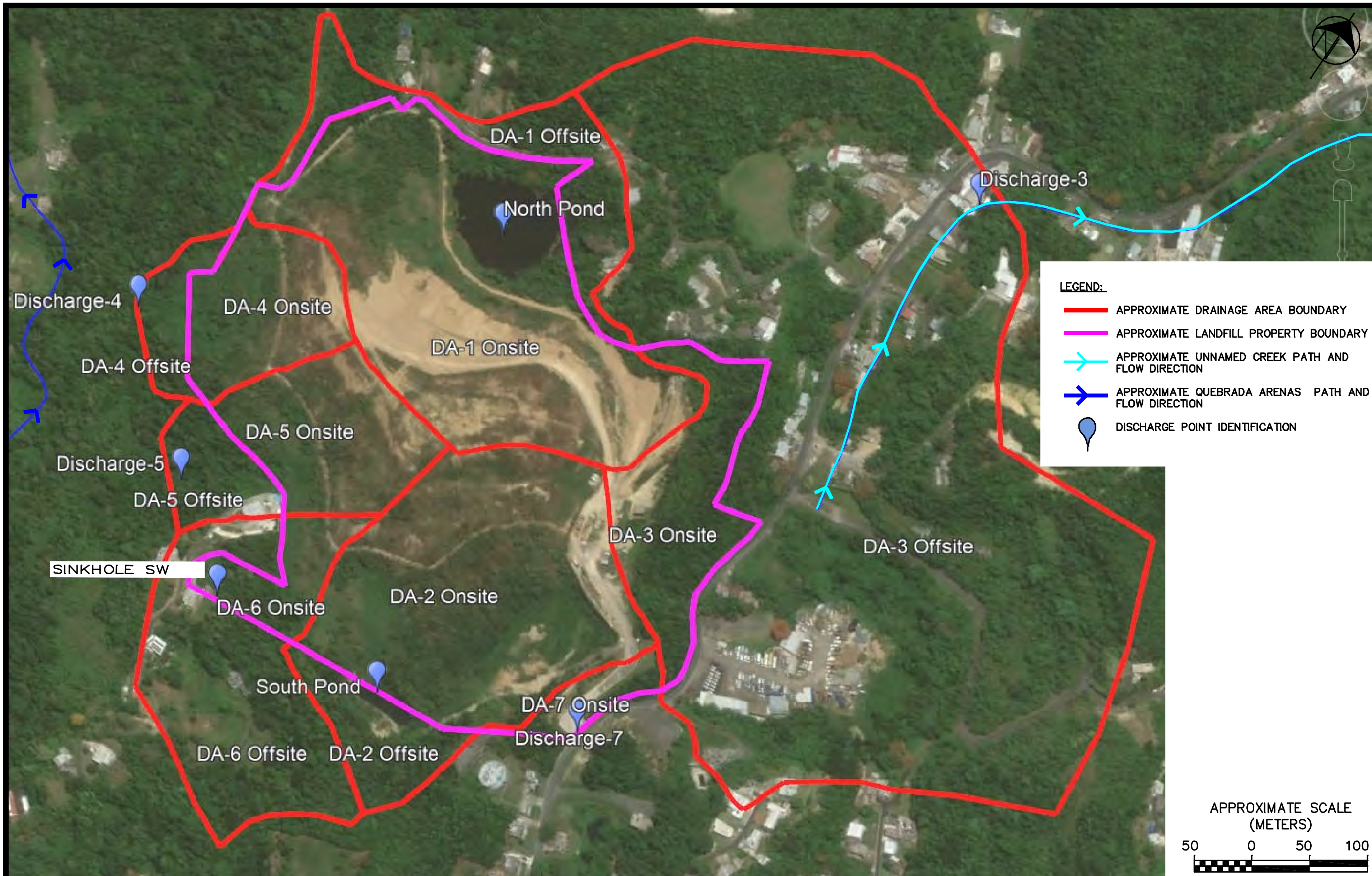
Caribe Environmental Services

HYDROLOGIC/HYDRAULIC PRELIMINARY REPORT
EXISTING CONDITIONS EVALUATION
VERTEDERO MUNICIPAL DE TOA ALTA
PROJECT LOCATION: PR-165, KM. 8.2
CONTORNO WARD
TOA ALTA, PUERTO RICO

SITE AERIAL PHOTOGRAPH
PROJECT SITE'S FEATURES, GENERAL SETTINGS, AND SURROUNDINGS

PROJECT NO. 22-0025

FIGURE 2



SOURCE: GOOGLE EARTH PRO, AERIAL PHOTOGRAPH DATED JUNE 2022. As-built topographic map prepared for the Project Site by engineer Hector Tirado Rodriguez, P.E., R.P.A, LIC. 12,215, dated September 14, 2022

ALL LOCATIONS ARE APPROXIMATE AND ARE ACCOMMODATED TO FIT THIS FIGURE

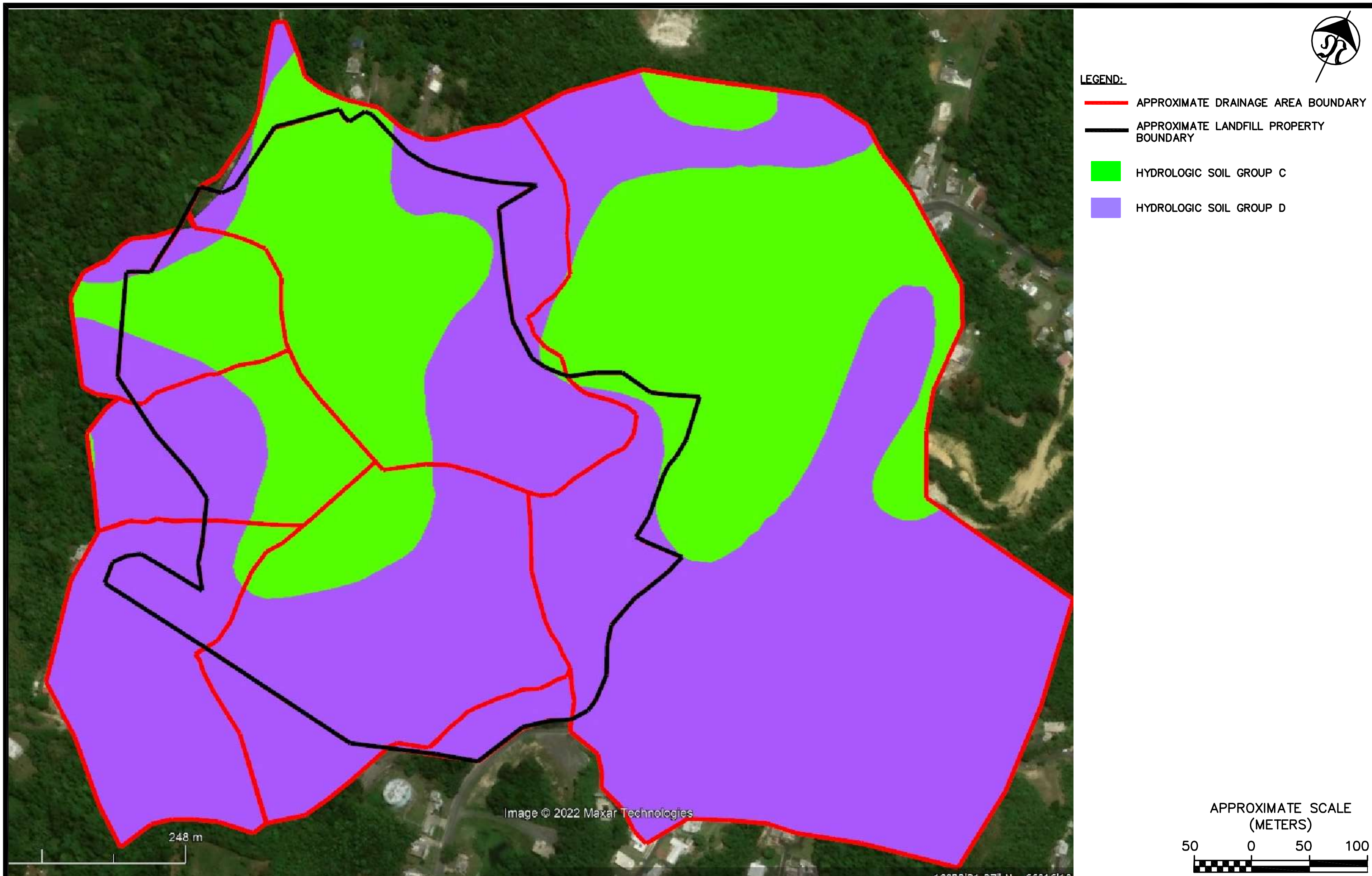
Caribe Environmental Services

HYDROLOGIC/HYDRAULIC PRELIMINARY REPORT
EXISTING CONDITIONS EVALUATION
VERTEDERO MUNICIPAL DE TOA ALTA
PROJECT LOCATION: PR-165, KM. 8.2
CONTORNO WARD
TOA ALTA, PUERTO RICO

ONSITE AND OFFSITE DRAINAGE AREAS DELIMITATION AND LAND USES

PROJECT NO. 22-0025

FIGURE 3



SOURCE: SOIL SURVEY OF THE SAN JUAN AREA, PUERTO RICO, U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SURVEY; SURVEY AREA DATA: VERSION 16, SEPTEMBER 12, 2022.

ALL LOCATIONS ARE APPROXIMATE AND ARE ACCOMMODATED TO FIT THIS FIGURE

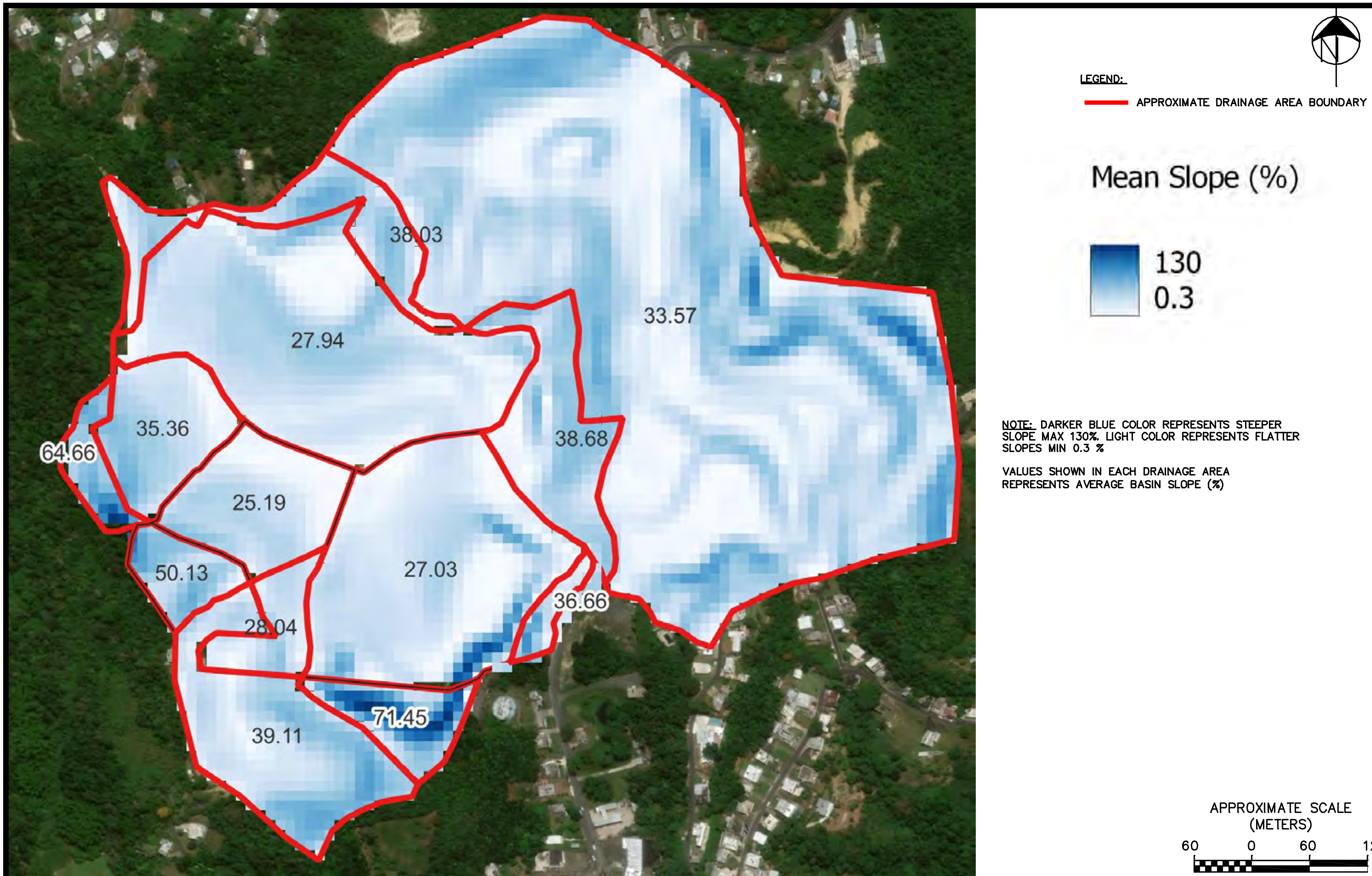
CES Caribe Environmental Services

HYDROLOGIC/HYDRAULIC PRELIMINARY REPORT
EXISTING CONDITIONS EVALUATION
VERTEDERO MUNICIPAL DE TOA ALTA
PROJECT LOCATION: PR-165, KM. 8.2
CONTORNO WARD
TOA ALTA, PUERTO RICO

HYDROLOGIC SOIL GROUP RATING

PROJECT NO. 22-0025

FIGURE 4



SOURCE: SOIL SURVEY OF THE SAN JUAN AREA, PUERTO RICO, U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SURVEY; SURVEY AREA DATA: VERSION 16, SEPTEMBER 12, 2022.

ALL LOCATIONS ARE APPROXIMATE AND ARE ACCOMMODATED TO FIT THIS FIGURE

Caribe Environmental Services

HYDROLOGIC/HYDRAULIC PRELIMINARY REPORT
EXISTING CONDITIONS EVALUATION
VERTEDERO MUNICIPAL DE TOA ALTA
PROJECT LOCATION: PR-165, KM. 8.2
CONTORNO WARD
TOA ALTA, PUERTO RICO

CALCULATED SLOPE VALUES AND CALCULATED MEAN VALUE

PROJECT NO. 22-0025

FIGURE 5

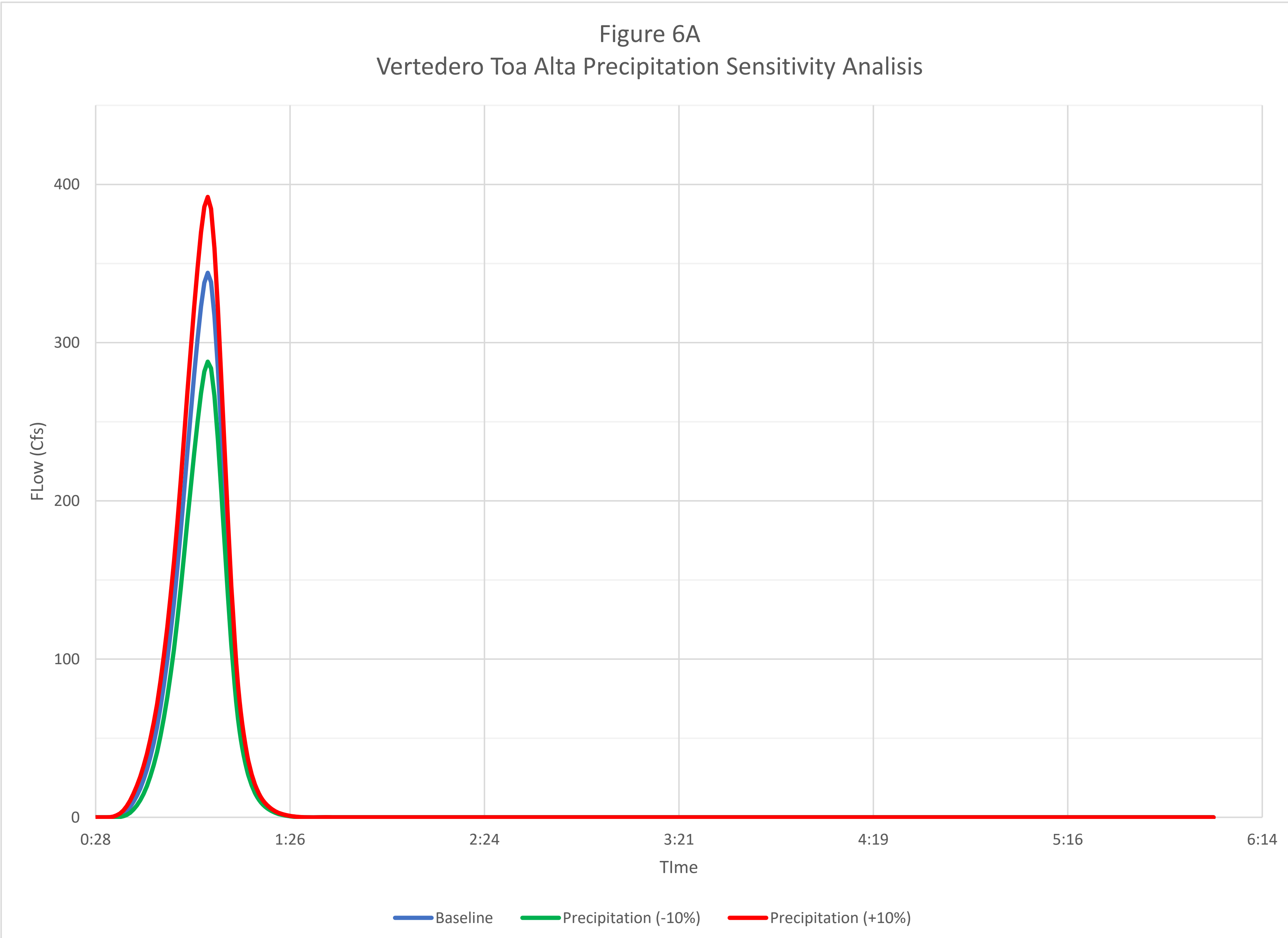


Figure 6A
Vertedero Toa Alta Precipitation Sensitivity Analisis
400
300
200
100
0
FLow (Cfs)
0:28
1:26
2:24
3:21
4:19
5:16
6:14
TIme
Baseline
Precipitation (-10%)
Precipitation (+10%)

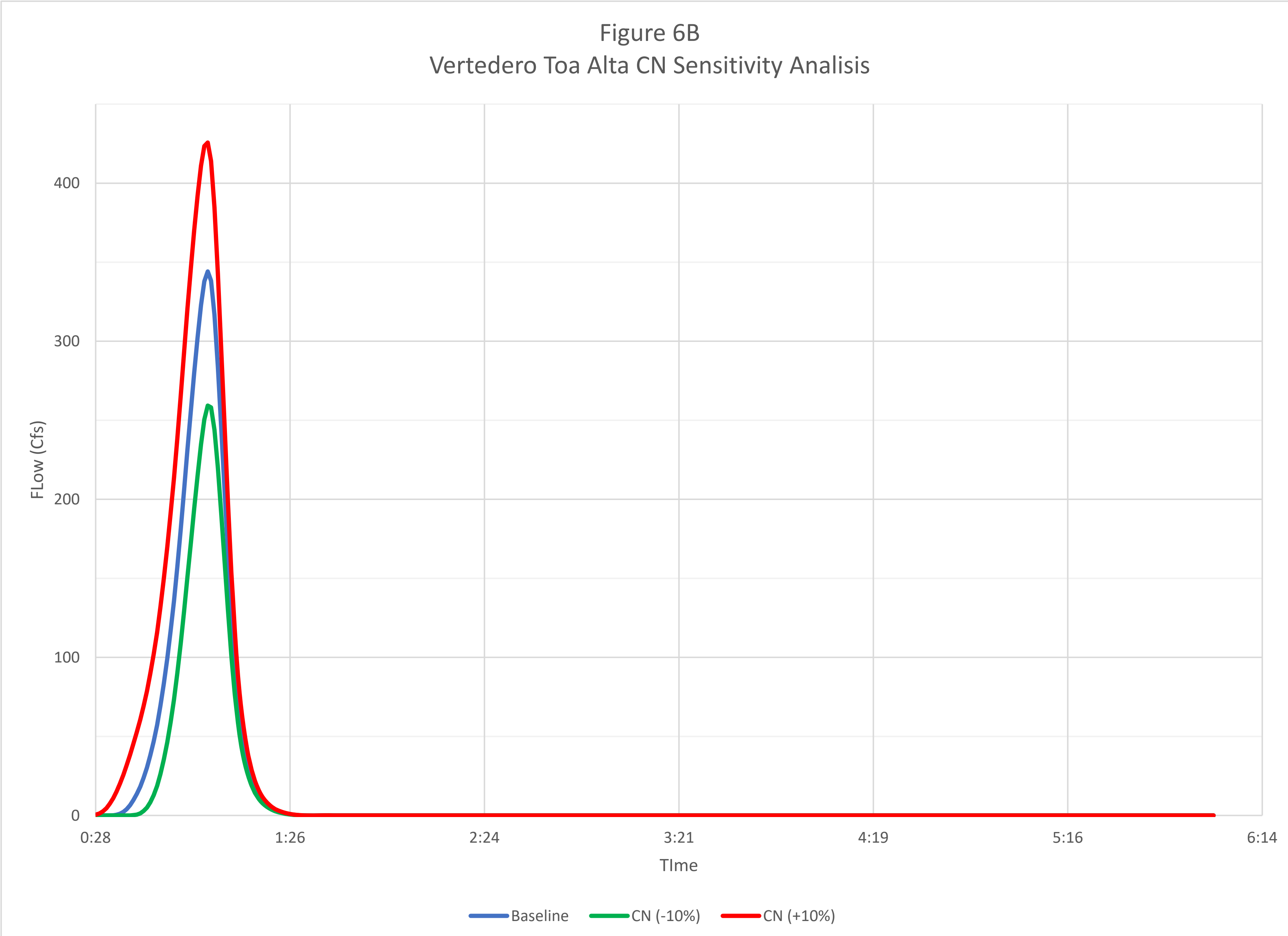
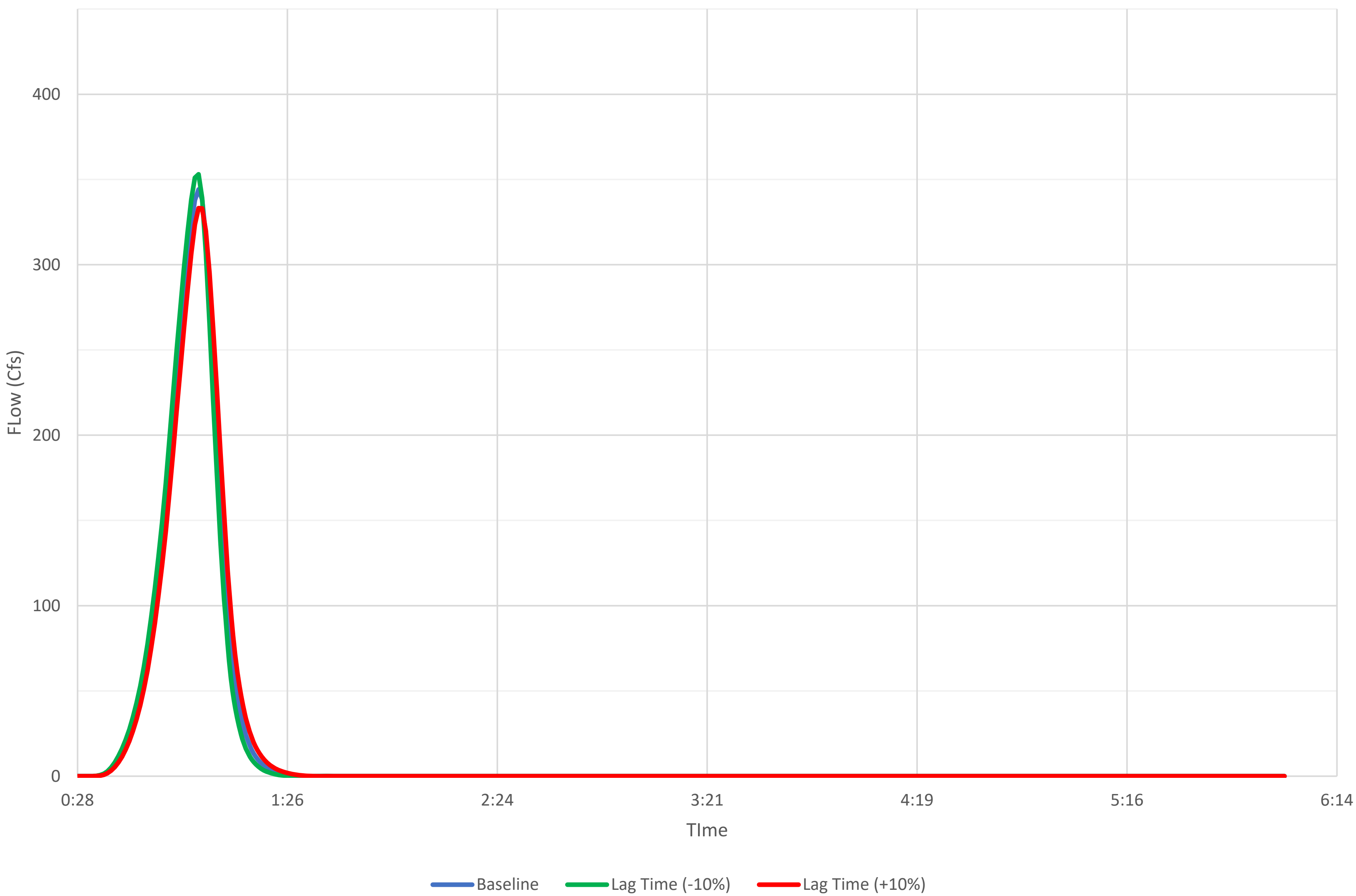


Figure 6B
Vertedero Toa Alta CN Sensitivity Analisis
FLow (Cfs)
0
100
200
300
400
0:28
1:26
2:24
3:21
4:19
5:16
6:14
TIme
Baseline
CN (-10%)
CN (+10%)

Figure 6C
Vertedero Toa Alta Lag Time Sensitivity Analisis



PRIVILEGED AND CONFIDENTIAL

APPENDICES

PRIVILEGED AND CONFIDENTIAL

APPENDIX A

PHOTOGRAPHS

PRIVILEGED AND CONFIDENTIAL

Photograph 1: Partial view of the landfill receiving area at the eastern portion of the landfill facility.

Photograph 2: Partial view of the staging area at the eastern portion of the landfill facility.

Hydrologic/Hydraulic Preliminary Report
Existing Conditions Evaluation
Vertedero Municipal de Toa Alta
Project Location: PR-165, Km. 8.2
Contorno Ward
Toa Alta, Puerto Rico
CES Project No. 22-0025

PRIVILEGED AND CONFIDENTIAL

Photograph 3: Partial view of the staging area at the eastern portion of the landfill facility.

Photograph 4: Partial view of the staging area at the eastern portion of the landfill facility.

PRIVILEGED AND CONFIDENTIAL

Photograph 5: Partial view of the landfill road at the northeastern portion of the landfill facility.

Photograph 6: Partial view of the deteriorated perimeter control along the northern portion of the landfill facility.

PRIVILEGED AND CONFIDENTIAL

Photograph 7: Partial view of the north pond at the northern portion of the landfill facility.

Photograph 8: Limestone formation outcrop and possible runoff drainage feature observed near north pond at the northern portion of the landfill facility.

PRIVILEGED AND CONFIDENTIAL

Photograph 9: Partial view of adjoining low lying area at local road to the north of the landfill facility.

Photograph 10: Partial view of landfill inner road along the northwestern northern portion of the landfill facility.

PRIVILEGED AND CONFIDENTIAL

Photograph 11: Partial view of landfill inner road covered with thick vegetation along the southwestern northern portion of the landfill facility.

Photograph 12: Partial view of the top of landfill at the central portion of the landfill facility.

Hydrologic/Hydraulic Preliminary Report
Existing Conditions Evaluation
Vertedero Municipal de Toa Alta
Project Location: PR-165, Km. 8.2
Contorno Ward
Toa Alta, Puerto Rico
CES Project No. 22-0025

PRIVILEGED AND CONFIDENTIAL

Photograph 13: Partial view of the landfill entrance at the southern portion of the landfill facility, where a berm and inlet grate is recommended to be constructed to redirect runoffs to the south pond.

Photograph 14: Partial view of the landfill southern portion.

PRIVILEGED AND CONFIDENTIAL

Photograph 15: Limestone and rock opening formation observed near the south pond.

Photograph 16: Limestone outcrop formation observed near the south pond.

PRIVILEGED AND CONFIDENTIAL

Photograph 17: Partial view of the south pond.

PRIVILEGED AND CONFIDENTIAL

APPENDIX B

TOPOGRAPHIC PLAN

D A T O S   D E   M E N S U R A

VERTEDERO DESPERDICIOS SOLIDOS MUNICIPIO DE TOA ALTA

PUNTO	LINEA	(Y) NORTE	(X) ESTE	DISTANCIA	RUMBO	DESCRIPCION
1	---	259726.2789	218079.6541	---	---	COLINDANCIA
2	1-2	259687.7616	218086.7881	39.17	S 10°29'35" E	COLINDANCIA
3	2-3	259670.8802	218086.0793	16.90	S 02°24'15" W	COLINDANCIA
4	3-4	259661.5671	218083.8208	9.58	S 13°37'55" W	COLINDANCIA
5	4-5	259652.2931	218083.9954	9.28	S 01°04'44" E	COLINDANCIA
6	5-6	259615.5525	218089.9163	37.21	S 09°09'17" E	COLINDANCIA
7	6-7	259594.3873	218088.4936	21.21	S 03°50'45" W	COLINDANCIA
8	7-8	259594.6962	218097.4753	8.99	N 88°01'50" E	VARILLA
9	8-9	259597.7841	218131.5910	34.26	N 84°49'41" E	COLINDANCIA
10	9-10	259581.2558	218127.2176	17.10	S 14°49'15" W	COLINDANCIA
11	10-11	259558.1484	218117.5352	25.05	S 22°44'04" W	COLINDANCIA
12	11-12	259547.5446	218112.5432	11.72	S 25°12'34" W	COLINDANCIA
13	12-13	259517.8393	218105.8658	30.45	S 12°40'08" W	COLINDANCIA
14	13-14	259501.5428	218110.5782	16.96	S 16°07'41" E	COLINDANCIA
15	14-15	259478.5519	218122.3957	25.85	S 27°12'12" E	COLINDANCIA
16	15-16	259455.0535	218124.6136	23.60	S 05°23'31" E	COLINDANCIA
17	16-17	259444.0522	218123.0219	11.12	S 08°13'56" W	COLINDANCIA
18	17-18	259430.0451	218113.6326	16.86	S 33°50'06" W	COLINDANCIA
19	18-19	259420.1325	218097.1402	19.24	S 58°59'33" W	COLINDANCIA
20	19-20	259404.5192	218079.6520	23.44	S 48°14'30" W	COLINDANCIA
21	20-21	259360.5043	218059.6856	48.33	S 24°24'01" W	COLINDANCIA
22	21-22	259349.0176	218024.6513	36.87	S 71°50'50" W	COLINDANCIA
23	22-23	259322.4930	217955.5215	74.04	S 69°00'31" W	COLINDANCIA
24	23-24	259326.3556	217911.3618	44.33	N 85°00'04" W	COLINDANCIA
25	24-25	259332.9047	217838.0991	73.55	N 84°53'30" W	COLINDANCIA
26	25-26	259336.1021	217801.9631	36.28	N 84°56'37" W	COLINDANCIA
27	26-27	259343.6171	217703.4083	98.84	N 85°38'22" W	COLINDANCIA
28	27-28	259362.7892	217700.9448	19.33	N 07°19'20" W	COLINDANCIA
29	28-29	259373.3445	217709.2277	13.42	N 38°07'19" E	COLINDANCIA
30	29-30	259380.4452	217719.2703	12.30	N 54°44'16" E	COLINDANCIA
31	30-31	259377.5011	217780.6320	61.43	S 87°15'11" E	COLINDANCIA
32	31-32	259396.6639	217766.1750	24.00	N 37°01'56" W	COLINDANCIA
33	32-33	259413.3952	217761.3099	17.42	N 16°12'47" W	COLINDANCIA
34	33-34	259449.1060	217746.5366	38.65	N 22°28'28" W	COLINDANCIA
35	34-35	259460.9965	217724.4821	25.06	N 61°40'08" W	COLINDANCIA
36	35-36	259476.4546	217681.3119	45.85	N 70°17'56" W	COLINDANCIA
37	36-37	259504.5894	217628.9416	59.45	N 61°45'14" W	COLINDANCIA
38	37-38	259587.2266	217592.7368	90.22	N 23°39'33" W	COLINDANCIA
39	38-39	259591.3284	217599.6446	8.03	N 59°17'55" E	COLINDANCIA
40	39-40	259596.8650	217611.2785	12.88	N 64°33'00" E	COLINDANCIA
41	40-41	259617.2167	217612.1590	20.37	N 02°28'38" E	COLINDANCIA
42	41-42	259641.0843	217614.2619	23.96	N 05°02'06" E	COLINDANCIA
43	42-43	259681.4593	217614.1751	40.38	N 00°07'23" W	COLINDANCIA
44	43-44	259685.6587	217633.1109	19.40	N 77°29'45" E	COLINDANCIA
45	44-45	259695.8974	217640.6772	12.73	N 36°27'49" E	COLINDANCIA
46	45-46	259756.9027	217646.2187	61.26	N 05°11'25" E	COLINDANCIA
47	46-47	259796.7139	217688.5884	58.14	N 46°46'59" E	COLINDANCIA
48	47-48	259792.9563	217694.3733	6.90	S 56°59'38" E	COLINDANCIA
49	48-49	259791.2313	217700.8576	6.71	S 75°06'08" E	COLINDANCIA
50	49-50	259805.2372	217708.6469	16.03	N 29°04'50" E	COLINDANCIA
51	50-51	259805.7423	217715.3466	6.72	N 85°41'19" E	COLINDANCIA
52	51-52	259791.7743	217757.3572	44.27	S 71°36'31" E	COLINDANCIA
53	52-53	259790.2918	217780.3583	23.05	S 86°18'44" E	COLINDANCIA
54	53-54	259792.5006	217791.8567	11.71	N 79°07'35" E	COLINDANCIA
55	54-55	259798.3189	217815.9522	24.79	N 76°25'29" E	COLINDANCIA
56	55-56	259806.3372	217839.9461	25.30	N 71°31'17" E	COLINDANCIA
57	56-57	259815.8538	217861.7389	23.78	N 66°24'35" E	COLINDANCIA
58	57-58	259819.3595	217869.3362	8.37	N 65°13'45" E	COLINDANCIA
59	58-59	259806.1468	217861.8473	15.19	S 29°32'40" W	COLINDANCIA
60	59-60	259793.0485	217853.5223	15.52	S 32°26'21" W	COLINDANCIA
61	60-61	259786.1886	217849.7225	7.84	S 28°58'57" W	COLINDANCIA
62	61-62	259739.7250	217881.1160	56.08	S 34°02'43" E	COLINDANCIA
63	62-63	259706.8126	217906.4342	41.52	S 37°34'11" E	COLINDANCIA
64	63-64	259686.7473	217936.0597	35.78	S 55°53'25" E	COLINDANCIA
65	64-65	259685.3825	217949.9273	13.93	S 84°22'45" E	COLINDANCIA
66	65-66	259686.6929	217963.5630	13.70	N 84°30'37" E	COLINDANCIA
67	66-67	259688.1615	217971.7424	8.31	N 79°49'16" E	COLINDANCIA
68	67-68	259702.6635	217991.5238	24.53	N 53°45'16" E	COLINDANCIA
69	68-69	259712.8893	218010.9320	21.94	N 62°12'58" E	COLINDANCIA
70	69-70	259711.1514	218025.7418	14.91	S 83°18'25" E	COLINDANCIA
71	70-71	259709.2843	218040.3506	14.73	S 82°43'00" E	COLINDANCIA
72	71-72	259710.8741	218044.8779	4.80	N 70°39'05" E	COLINDANCIA
73	72-73	259716.4100	218058.2577	14.48	N 67°31'21" E	COLINDANCIA
1	73-1	259726.2789	218079.6541	23.56	N 65°14'21" E	COLINDANCIA

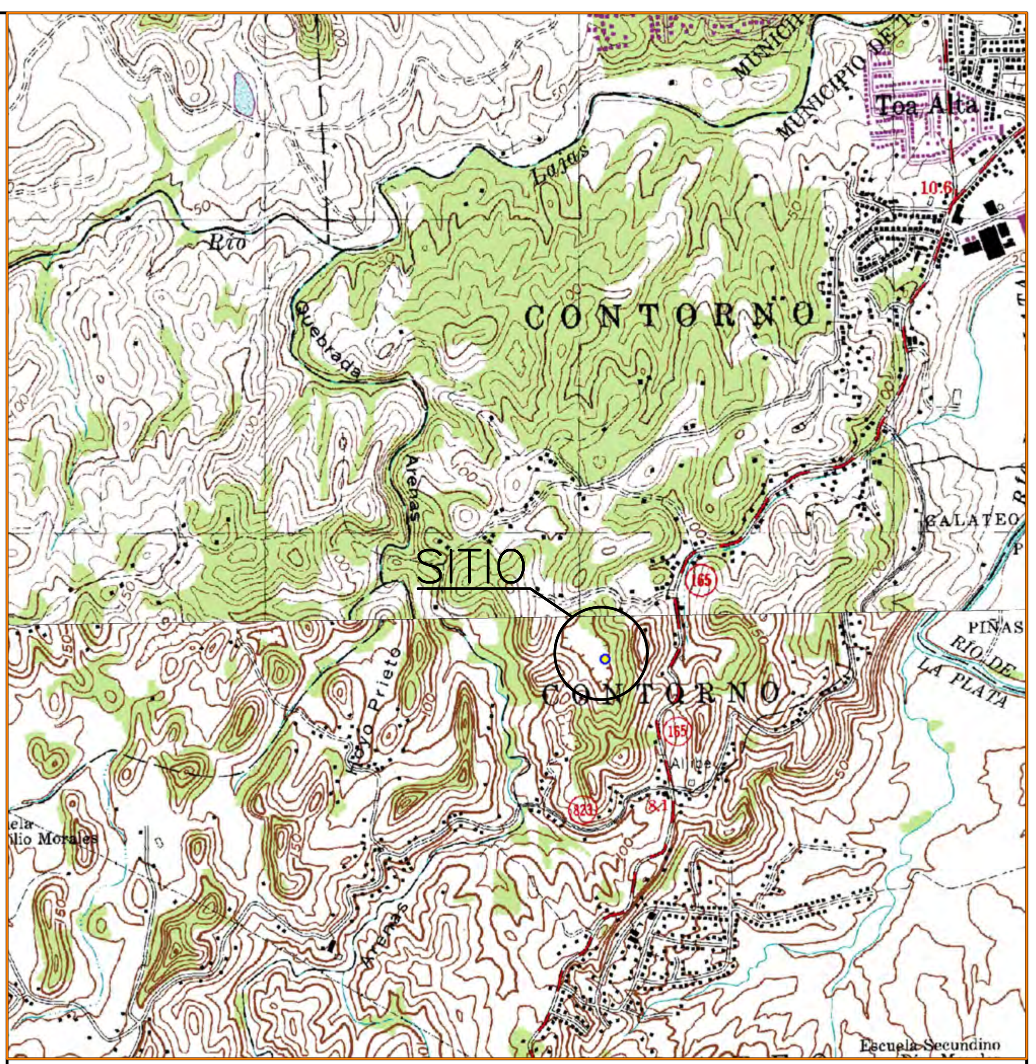
ÁREA = 180402.9815 m^2 =□= 45.8994 cdas.

LEYENDA:

- ESTACION DE CONTROL HORIZONTAL
- PUNTO COLINDANCIA
- LINEA DE COLINDANCIA
- TORRE ELÉCTRICA EXISTENTE
- CONTORNO INTERVALOS DE UN (1.00) METRO
- CONTORNO INTERVALOS DE CINCO (5.00) METROS
- CAMINO EN TIERRA
- ESTRUCTURAS EN HORMIGÓN EXISTENTE (RESIDENCIAS)

NOTAS GENERALES:

1. TODAS LAS DISTANCIAS EXCEPTO LAS INDICADAS SE HAN EXPRESADO EN EL SISTEMA MÉTRICO.
2. LA LOCALIZACIÓN DE LOS PUNTOS SE HA HECHO CON UN MEDIDOR DE DISTANCIA ELECTRÓNICO TOTAL STATION "TOPCON" GTS 230 & COLECTOR DE DATOS NOMAD TRIMBLE.
3. LA MENSURA SE REALIZO POR LOS PUNTOS DE COLINDANCIA EXISTENTES SUJETOS A CONFORMIDAD DE COLINDANTES Y POSIBLE RECTIFICACIÓN.
4. CONTORNOS A INTERALOS DE UN (1.00) METRO.
5. ESTA MENSURA Y TOPOGRAFIA SE LLEVA A CABO A PETICIÓN DE TERRATEK ENGINEERING GROUP, PSC.
6. EL SISTEMA HORIZONTAL ESTA REFERENCIADO A NAD-83 DE PUERTO RICO.
7. SE UTILIZO EQUIPO DE POSICIONAMIENTO GPS GLOBAL ESTACION VIRTUAL (VRS). DATUM: NAD-83 (2011) EP GEOID:G18PR.
8. ESTE TRABAJO CUENTA CON EL APOYO DE FOTOGRAMETRÍA A TRAVÉS DEL EL USO DE "DRONE".
9. PARA LA PREPARACIÓN DE ESTE PLANO SE UTILIZO DATA DEL PLANO CONFECCIONADO POR EL AGRIMENSOR JOSÉ M. COUVERTIER Y CERTIFICADO POR EL ING. EMILIO GUTIÉRREZ DEL ARROYO, LIC. #16,789. DEL MISMO SE UTILIZA DATOS TABLA DE MENSURA.



MAPA DE LOCALIZACION 1:20,000

COORD. LAMBERT NAD-83 X= 217,876.00 Y= 259,575.00

0.000 30.000 60.000 90.000

ESCALA GRAFICA (METROS)

SALMO 137-1 SI JEHOVA NO EDIFICA LA CASA, EN VANO TRABAJAN QUE LA EDIFICAN

HECTOR TIRADO CEL. 502-3278

PLANO TOPOGRÁFICO "ASBUILT" CONDICIONES EXISTENTES

FINCA PROPIEDAD DEL MUNICIPIO DE TOA ALTA

VERTEDERO RESIDUOS SÓLIDOS

SITA: EN CARRETERA PR-165, KM. 9.0, Bo. MAMEY

TOA ALTA, PUERTO RICO

CERTIFICO CORRECTO:

HECTOR TIRADO RODRIGUEZ, P.E., R.P.A.
INGENIERO CIVIL No. 12215

FECHA: SEPTIEMBRE 14, 2022

DIBUJADO POR: D. PASTRANA (3949)

ESCALA: 1: 1,000

PRIVILEGED AND CONFIDENTIAL

APPENDIX C

NOAA ATLAS 14

NOAA Atlas 14, Volume 3, Version 4
Location name: Contorno, Puerto Rico, PRI*
Latitude: 18.3714°, Longitude: -66.2642°
Elevation: 325.95 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

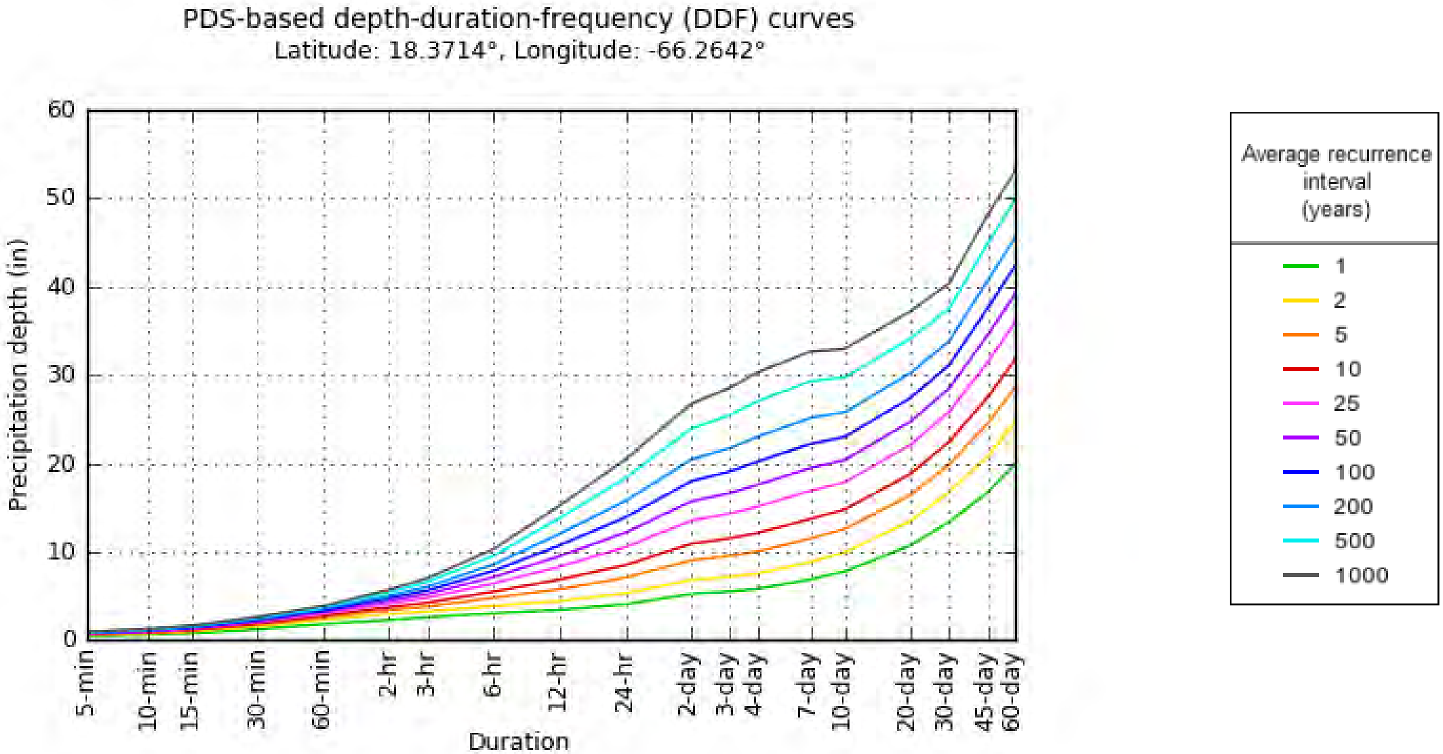
PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

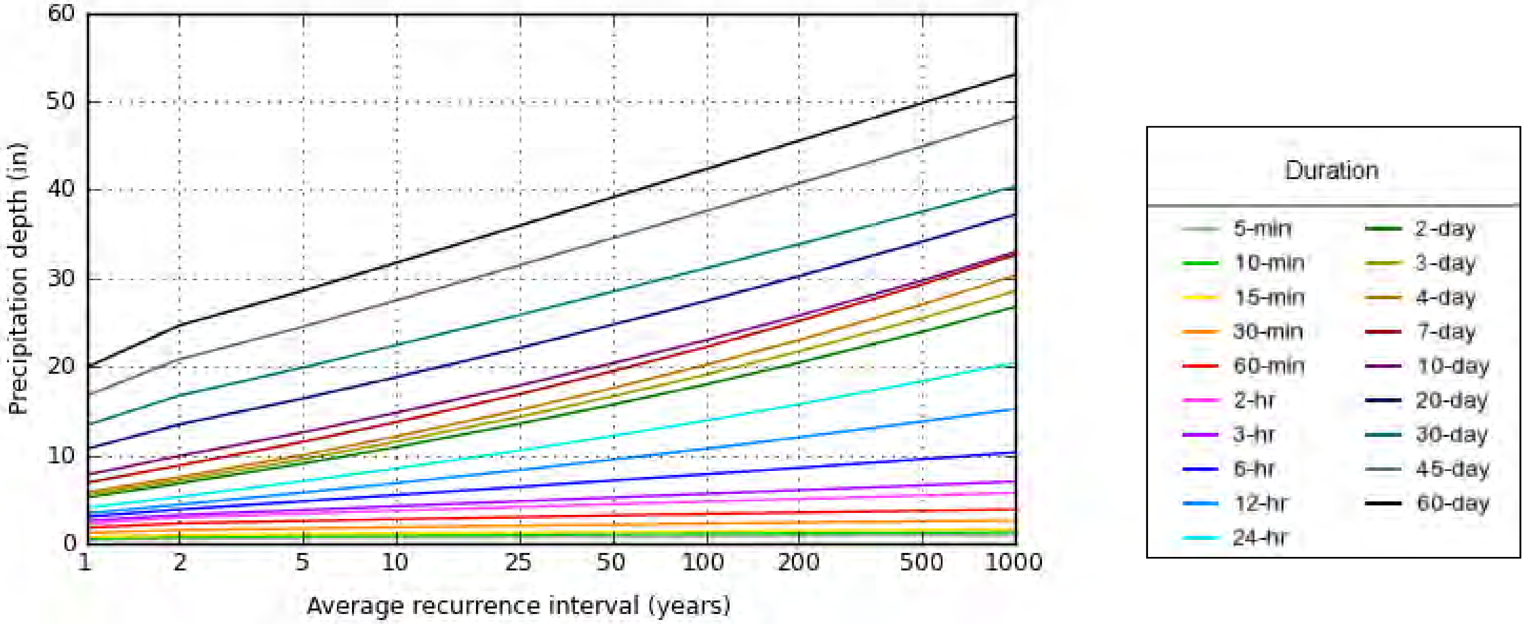
Duration	Average recurrence interval (years)									
	1	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1000**
5-min	**0.431** (0.421-0.467)	**0.546** (0.520-0.577)	**0.611** (0.581-0.645)	**0.660** (0.626-0.698)	**0.719** (0.679-0.762)	**0.762** (0.717-0.809)	**0.801** (0.752-0.856)	**0.840** (0.785-0.904)	**0.890** (0.825-0.963)	**0.925** (0.855-1.01)
10-min	**0.589** (0.575-0.639)	**0.747** (0.710-0.789)	**0.835** (0.794-0.881)	**0.902** (0.855-0.954)	**0.982** (0.929-1.04)	**1.04** (0.980-1.11)	**1.10** (1.03-1.17)	**1.15** (1.07-1.24)	**1.22** (1.13-1.32)	**1.26** (1.17-1.38)
15-min	**0.757** (0.738-0.820)	**0.959** (0.911-1.01)	**1.07** (1.02-1.13)	**1.16** (1.10-1.23)	**1.26** (1.19-1.34)	**1.34** (1.26-1.42)	**1.41** (1.32-1.50)	**1.47** (1.38-1.59)	**1.56** (1.45-1.69)	**1.62** (1.50-1.77)
30-min	**1.21** (1.18-1.31)	**1.54** (1.46-1.62)	**1.72** (1.63-1.81)	**1.85** (1.76-1.96)	**2.02** (1.91-2.14)	**2.14** (2.02-2.27)	**2.25** (2.11-2.40)	**2.36** (2.20-2.54)	**2.50** (2.32-2.70)	**2.60** (2.40-2.83)
60-min	**1.80** (1.75-1.95)	**2.28** (2.17-2.40)	**2.55** (2.42-2.69)	**2.75** (2.61-2.91)	**3.00** (2.83-3.17)	**3.17** (2.99-3.37)	**3.34** (3.13-3.57)	**3.50** (3.27-3.77)	**3.71** (3.44-4.01)	**3.86** (3.56-4.20)
2-hr	**2.26** (2.22-2.49)	**2.93** (2.76-3.11)	**3.38** (3.19-3.59)	**3.72** (3.49-3.96)	**4.14** (3.87-4.42)	**4.45** (4.13-4.78)	**4.75** (4.38-5.13)	**5.04** (4.63-5.50)	**5.42** (4.93-5.97)	**5.71** (5.15-6.33)
3-hr	**2.58** (2.41-2.76)	**3.22** (3.03-3.46)	**3.79** (3.55-4.08)	**4.23** (3.94-4.56)	**4.78** (4.42-5.17)	**5.21** (4.78-5.66)	**5.62** (5.12-6.15)	**6.03** (5.46-6.66)	**6.58** (5.88-7.34)	**7.00** (6.20-7.86)
6-hr	**3.02** (2.77-3.32)	**3.85** (3.54-4.23)	**4.78** (4.38-5.26)	**5.48** (4.98-6.03)	**6.41** (5.77-7.07)	**7.12** (6.37-7.91)	**7.83** (6.92-8.76)	**8.56** (7.49-9.68)	**9.54** (8.23-10.9)	**10.3** (8.79-11.9)
12-hr	**3.41** (3.07-3.83)	**4.41** (3.97-4.97)	**5.75** (5.16-6.49)	**6.83** (6.06-7.70)	**8.31** (7.27-9.41)	**9.49** (8.20-10.8)	**10.7** (9.14-12.3)	**12.0** (10.1-14.0)	**13.8** (11.4-16.3)	**15.2** (12.4-18.1)
24-hr	**4.05** (3.64-4.53)	**5.28** (4.74-5.91)	**7.04** (6.30-7.87)	**8.48** (7.55-9.48)	**10.5** (9.27-11.8)	**12.2** (10.7-13.6)	**13.9** (12.1-15.6)	**15.7** (13.6-17.7)	**18.3** (15.7-20.8)	**20.5** (17.3-23.3)
2-day	**5.22** (4.63-5.93)	**6.80** (6.03-7.73)	**9.04** (7.97-10.3)	**10.9** (9.56-12.4)	**13.5** (11.7-15.4)	**15.7** (13.5-18.0)	**18.0** (15.3-20.7)	**20.4** (17.2-23.6)	**23.9** (19.8-27.8)	**26.8** (21.9-31.3)
3-day	**5.50** (4.89-6.23)	**7.15** (6.37-8.11)	**9.52** (8.43-10.8)	**11.5** (10.1-13.0)	**14.3** (12.5-16.3)	**16.6** (14.4-19.0)	**19.1** (16.3-21.8)	**21.7** (18.4-25.0)	**25.5** (21.2-29.5)	**28.5** (23.5-33.2)
4-day	**5.78** (5.16-6.52)	**7.51** (6.71-8.48)	**10.0** (8.89-11.3)	**12.1** (10.7-13.7)	**15.1** (13.2-17.1)	**17.6** (15.2-19.9)	**20.2** (17.3-23.0)	**23.0** (19.6-26.3)	**27.0** (22.7-31.1)	**30.3** (25.1-35.1)
7-day	**6.86** (6.19-7.65)	**8.84** (7.98-9.85)	**11.5** (10.3-12.8)	**13.7** (12.3-15.3)	**16.9** (14.9-18.9)	**19.5** (17.1-21.9)	**22.2** (19.3-25.1)	**25.1** (21.7-28.5)	**29.3** (25.0-33.4)	**32.7** (27.6-37.5)
10-day	**7.76** (7.08-8.57)	**9.91** (9.05-10.9)	**12.6** (11.4-13.9)	**14.8** (13.4-16.3)	**17.9** (16.0-19.8)	**20.4** (18.1-22.7)	**23.0** (20.3-25.7)	**25.8** (22.6-28.9)	**29.7** (25.8-33.6)	**33.0** (28.3-37.8)
20-day	**10.7** (9.89-11.6)	**13.5** (12.5-14.7)	**16.4** (15.1-17.9)	**18.8** (17.3-20.5)	**22.1** (20.2-24.2)	**24.7** (22.5-27.1)	**27.4** (24.7-30.2)	**30.2** (27.1-33.4)	**34.1** (30.3-38.0)	**37.2** (32.7-41.6)
30-day	**13.4** (12.5-14.4)	**16.7** (15.6-18.1)	**19.9** (18.5-21.5)	**22.4** (20.8-24.3)	**25.8** (23.8-28.0)	**28.5** (26.2-31.0)	**31.1** (28.4-33.9)	**33.8** (30.7-37.0)	**37.5** (33.8-41.3)	**40.4** (36.2-44.7)
45-day	**16.7** (15.6-18.0)	**20.8** (19.4-22.5)	**24.5** (22.8-26.4)	**27.5** (25.5-29.7)	**31.5** (29.1-34.0)	**34.5** (31.8-37.4)	**37.6** (34.4-40.9)	**40.7** (37.1-44.4)	**44.9** (40.5-49.3)	**48.1** (43.2-53.1)
60-day	**19.9** (18.6-21.4)	**24.7** (23.1-26.5)	**28.6** (26.7-30.7)	**31.7** (29.6-34.1)	**35.9** (33.4-38.7)	**39.2** (36.2-42.2)	**42.3** (39.0-45.8)	**45.5** (41.8-49.4)	**49.8** (45.4-54.3)	**53.1** (48.1-58.1)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



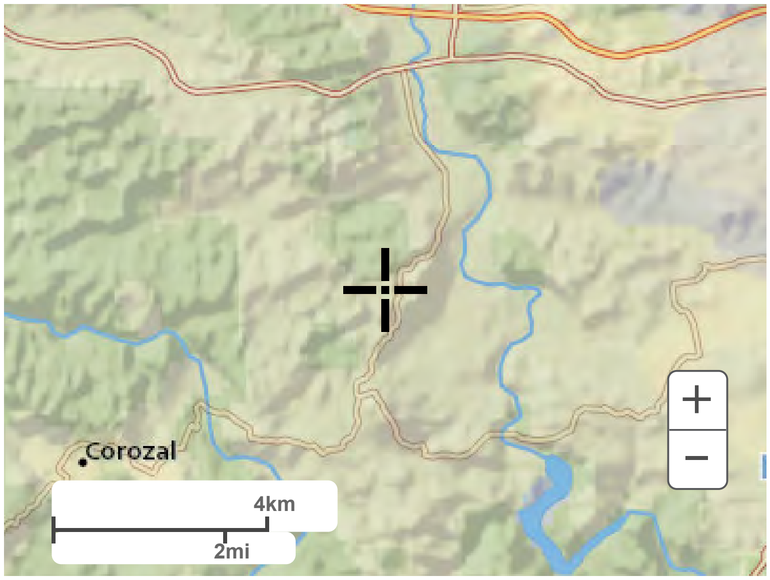


NOAA Atlas 14, Volume 3, Version 4 Created (GMT): Wed Oct 5 11:00:19 2022

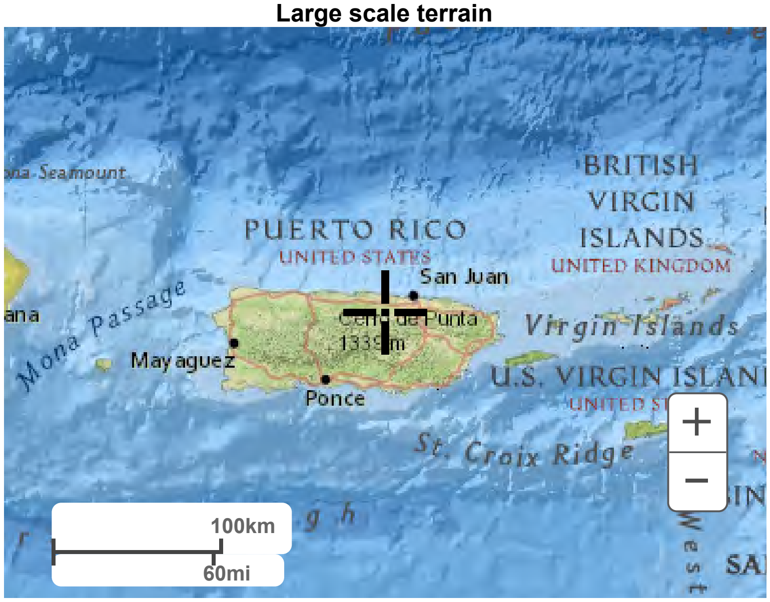
Back to Top

Maps & aerials

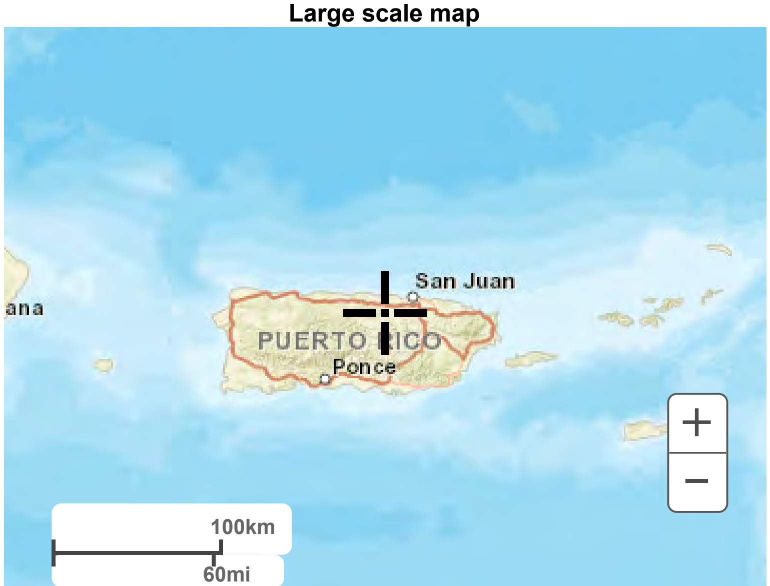
Small scale terrain



Large scale terrain



Large scale map



Large scale aerial

Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Hydrologic/Hydraulic Preliminary Report
Existing Conditions Evaluation
Vertedero Municipal de Toa Alta
Project Location: PR-165, Km. 8.2
Contorno Ward
Toa Alta, Puerto Rico
CES Project No. 22-0025

PRIVILEGED AND CONFIDENTIAL

APPENDIX D

SOIL SURVEY

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

San Juan Area, Puerto Rico

October 4, 2022

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

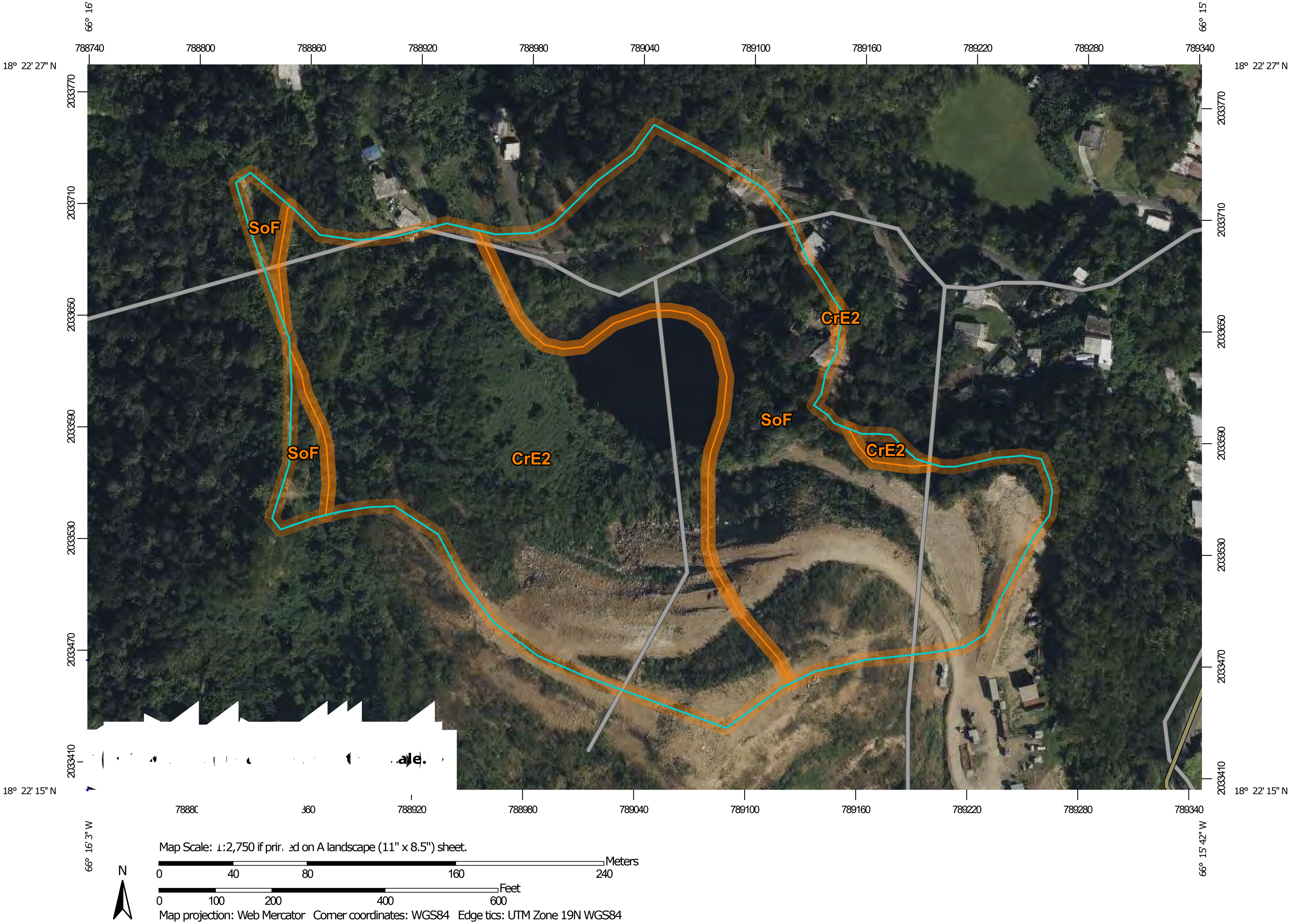
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Juan Area, Puerto Rico
Survey Area Data: Version 16, Sep 12, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 23, 2022—Mar 1, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CrE2	Colinas clay loam, 20 to 40 percent slopes	10.4	53.1%
SoF	Soller clay loam, 40 to 60 percent slopes	9.2	46.9%
Totals for Area of Interest		**19.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however,

onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

San Juan Area, Puerto Rico

CrE2—Colinas clay loam, 20 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2wx40
Elevation: 200 to 600 feet
Mean annual precipitation: 34 to 106 inches
Mean annual air temperature: 69 to 86 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Colinas and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Colinas

Setting

Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Parent material: Coarse-loamy or fine-loamy residuum weathered from limestone

Typical profile

Ap - 0 to 6 inches: clay loam
Bw - 6 to 16 inches: clay loam
BC - 16 to 20 inches: clay loam
Cr - 20 to 60 inches: bedrock

Properties and qualities

Slope: 20 to 40 percent
Depth to restrictive feature: 20 to 48 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 1.42 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Naranjo

Percent of map unit: 5 percent

Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Hydric soil rating: No

Limestone outcrop

Percent of map unit: 5 percent
Landform: Mogotes
Hydric soil rating: No

Tanama

Percent of map unit: 5 percent
Landform: Mogotes
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Soller

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Hydric soil rating: No

SoF—Soller clay loam, 40 to 60 percent slopes

Map Unit Setting

National map unit symbol: byz4
Elevation: 500 to 1,000 feet
Mean annual precipitation: 80 to 90 inches
Mean annual air temperature: 75 to 79 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Soller and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Soller

Setting

Landform: Mogotes
Landform position (two-dimensional): Summit, shoulder, backslope

Landform position (three-dimensional): Head slope, side slope, crest
Down-slope shape: Concave, linear
Across-slope shape: Linear
Parent material: Weathered material

Typical profile

H1 - 0 to 5 inches: clay loam
H2 - 5 to 12 inches: clay
H3 - 12 to 24 inches: weathered bedrock
H4 - 24 to 28 inches: unweathered bedrock

Properties and qualities

Slope: 40 to 60 percent
Depth to restrictive feature: 20 to 34 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low (0.01 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Hydric soil rating: No

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group (DA-1)

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

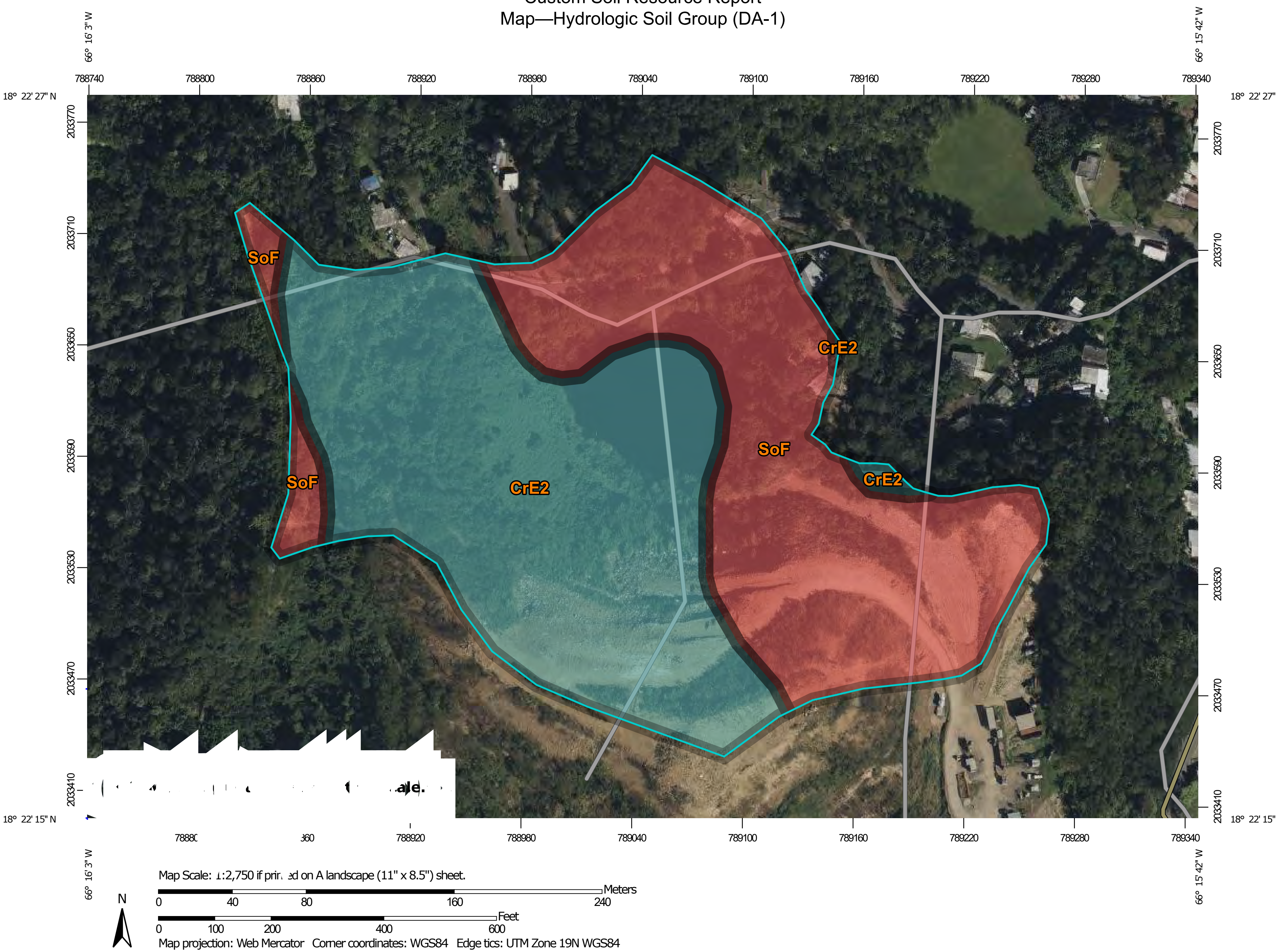
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Custom Soil Resource Report
Map—Hydrologic Soil Group (DA-1)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Juan Area, Puerto Rico
Survey Area Data: Version 16, Sep 12, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 23, 2022—Mar 1, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group (DA-1)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CrE2	Colinas clay loam, 20 to 40 percent slopes	C	10.4	53.1%
SoF	Soller clay loam, 40 to 60 percent slopes	D	9.2	46.9%
Totals for Area of Interest			**19.6**	**100.0%**

Rating Options—Hydrologic Soil Group (DA-1)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Water Features

This folder contains tabular reports that present soil hydrology information. The reports (tables) include all selected map units and components for each map unit. Water Features include ponding frequency, flooding frequency, and depth to water table.

Hydrologic Soil Group and Surface Runoff (DA-1)

This table gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

Surface runoff refers to the loss of water from an area by flow over the land surface. Surface runoff classes are based on slope, climate, and vegetative cover. The concept indicates relative runoff for very specific conditions. It is assumed that the surface of the soil is bare and that the retention of surface water resulting from irregularities in the ground surface is minimal. The classes are negligible, very low, low, medium, high, and very high.

Report—Hydrologic Soil Group and Surface Runoff (DA-1)

Absence of an entry indicates that the data were not estimated. The dash indicates no documented presence.

Hydrologic Soil Group and Surface Runoff–San Juan Area, Puerto Rico			
Map symbol and soil name	**Pct. of map unit**	**Surface Runoff**	**Hydrologic Soil Group**
CrE2—Colinas clay loam, 20 to 40 percent slopes			
Colinas	80	—	C
SoF—Soller clay loam, 40 to 60 percent slopes			
Soller	100	—	D

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

San Juan Area, Puerto Rico

October 4, 2022

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

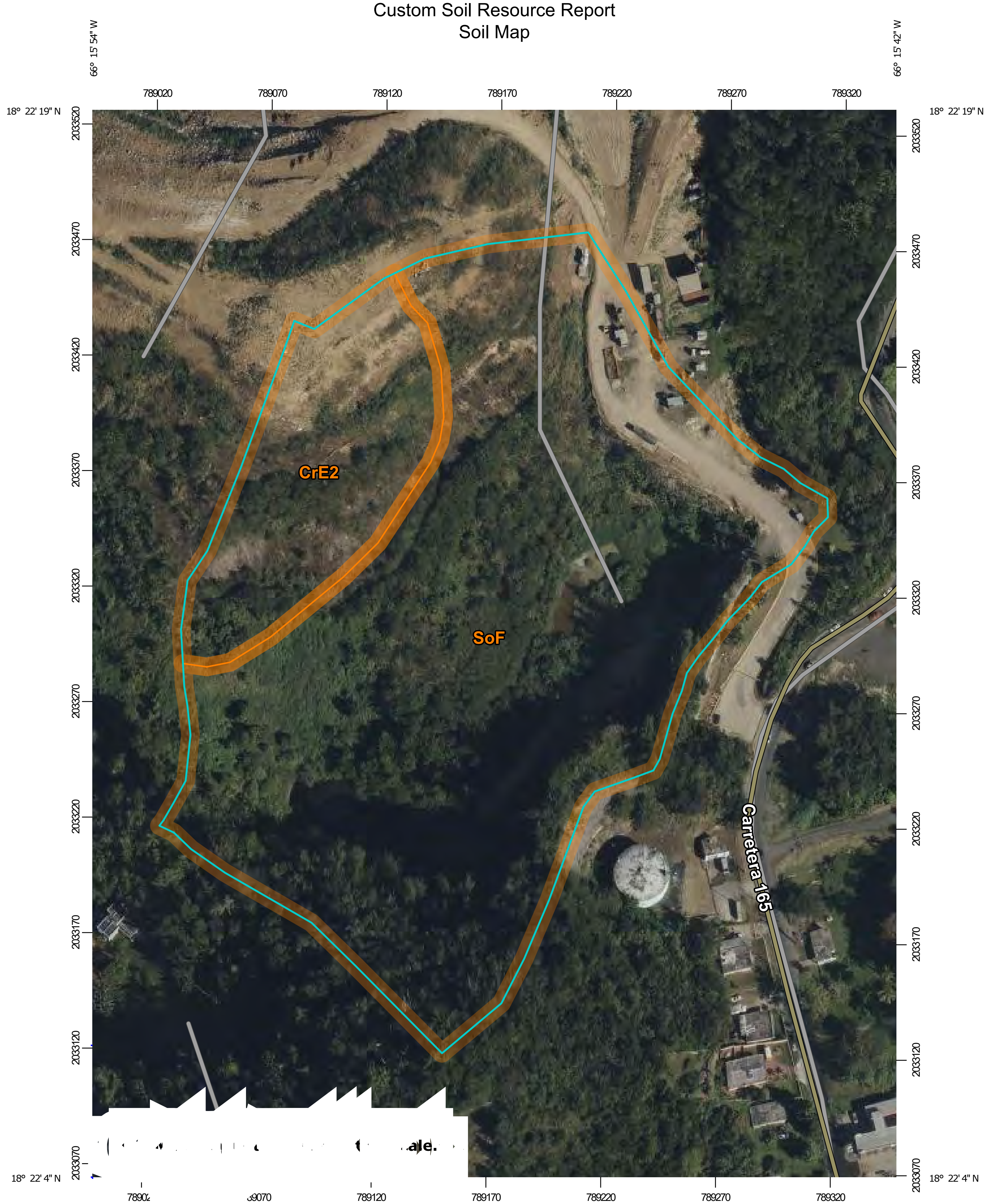
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

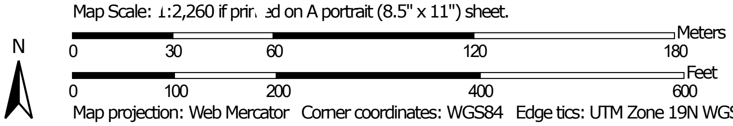
Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:2,260 if printed on A portrait (8.5" x 11") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Juan Area, Puerto Rico
Survey Area Data: Version 16, Sep 12, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 23, 2022—Mar 1, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CrE2	Colinas clay loam, 20 to 40 percent slopes	2.6	17.4%
SoF	Soller clay loam, 40 to 60 percent slopes	12.2	82.6%
Totals for Area of Interest		**14.8**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however,

onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

San Juan Area, Puerto Rico

CrE2—Colinas clay loam, 20 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2wx40
Elevation: 200 to 600 feet
Mean annual precipitation: 34 to 106 inches
Mean annual air temperature: 69 to 86 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Colinas and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Colinas

Setting

Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Parent material: Coarse-loamy or fine-loamy residuum weathered from limestone

Typical profile

Ap - 0 to 6 inches: clay loam
Bw - 6 to 16 inches: clay loam
BC - 16 to 20 inches: clay loam
Cr - 20 to 60 inches: bedrock

Properties and qualities

Slope: 20 to 40 percent
Depth to restrictive feature: 20 to 48 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 1.42 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Naranjo

Percent of map unit: 5 percent

Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Hydric soil rating: No

Limestone outcrop

Percent of map unit: 5 percent
Landform: Mogotes
Hydric soil rating: No

Tanama

Percent of map unit: 5 percent
Landform: Mogotes
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Soller

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Hydric soil rating: No

SoF—Soller clay loam, 40 to 60 percent slopes

Map Unit Setting

National map unit symbol: byz4
Elevation: 500 to 1,000 feet
Mean annual precipitation: 80 to 90 inches
Mean annual air temperature: 75 to 79 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Soller and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Soller

Setting

Landform: Mogotes
Landform position (two-dimensional): Summit, shoulder, backslope

Landform position (three-dimensional): Head slope, side slope, crest
Down-slope shape: Concave, linear
Across-slope shape: Linear
Parent material: Weathered material

Typical profile

H1 - 0 to 5 inches: clay loam
H2 - 5 to 12 inches: clay
H3 - 12 to 24 inches: weathered bedrock
H4 - 24 to 28 inches: unweathered bedrock

Properties and qualities

Slope: 40 to 60 percent
Depth to restrictive feature: 20 to 34 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low (0.01 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Hydric soil rating: No

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group (DA-2)

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

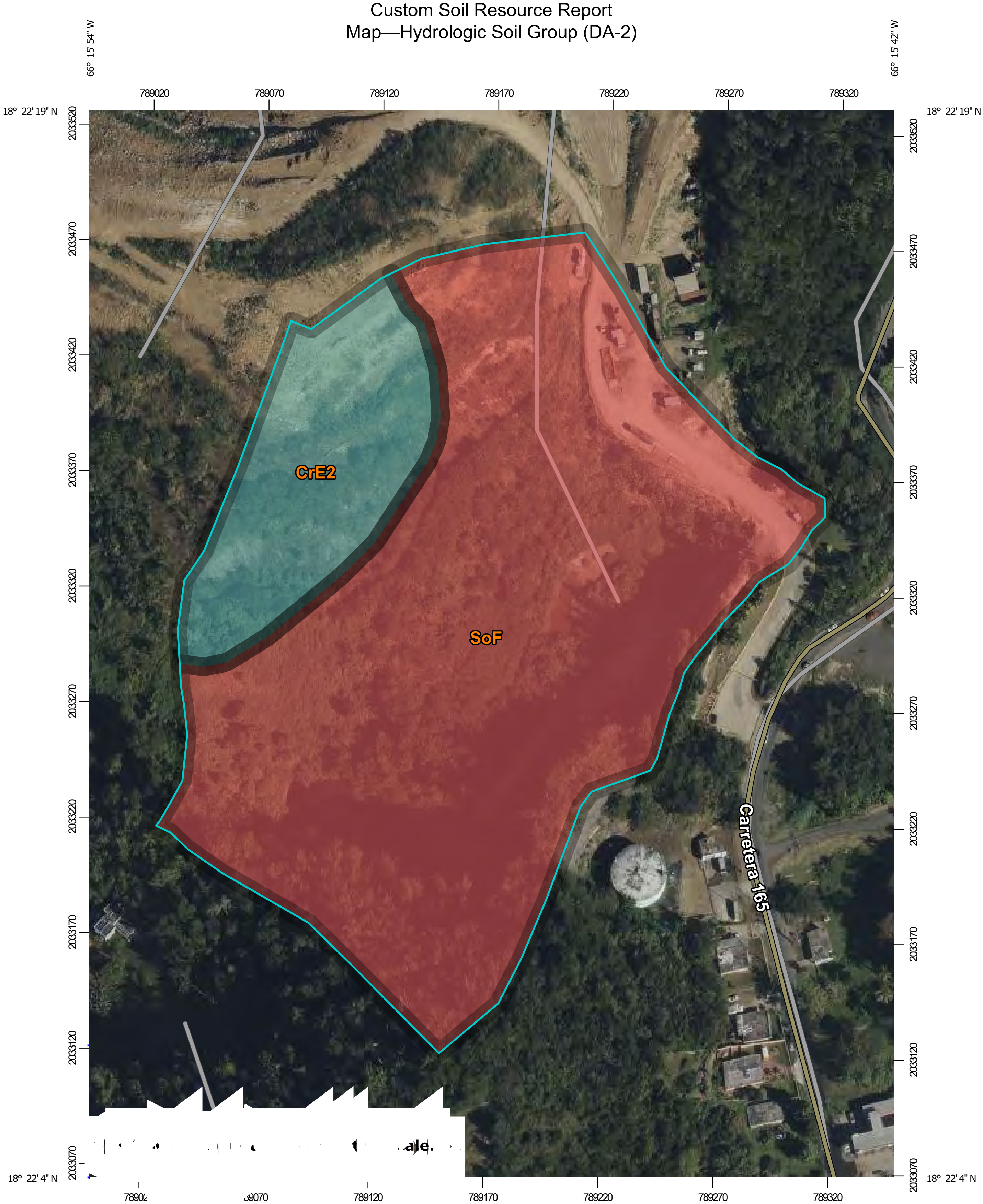
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Custom Soil Resource Report
Map—Hydrologic Soil Group (DA-2)



Map Scale: 1:2,260 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 30, 60, 120, 180

N

Feet: 0, 100, 200, 400, 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Juan Area, Puerto Rico
Survey Area Data: Version 16, Sep 12, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 23, 2022—Mar 1, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group (DA-2)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CrE2	Colinas clay loam, 20 to 40 percent slopes	C	2.6	17.4%
SoF	Soller clay loam, 40 to 60 percent slopes	D	12.2	82.6%
Totals for Area of Interest			**14.8**	**100.0%**

Rating Options—Hydrologic Soil Group (DA-2)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

United States Department of Agriculture

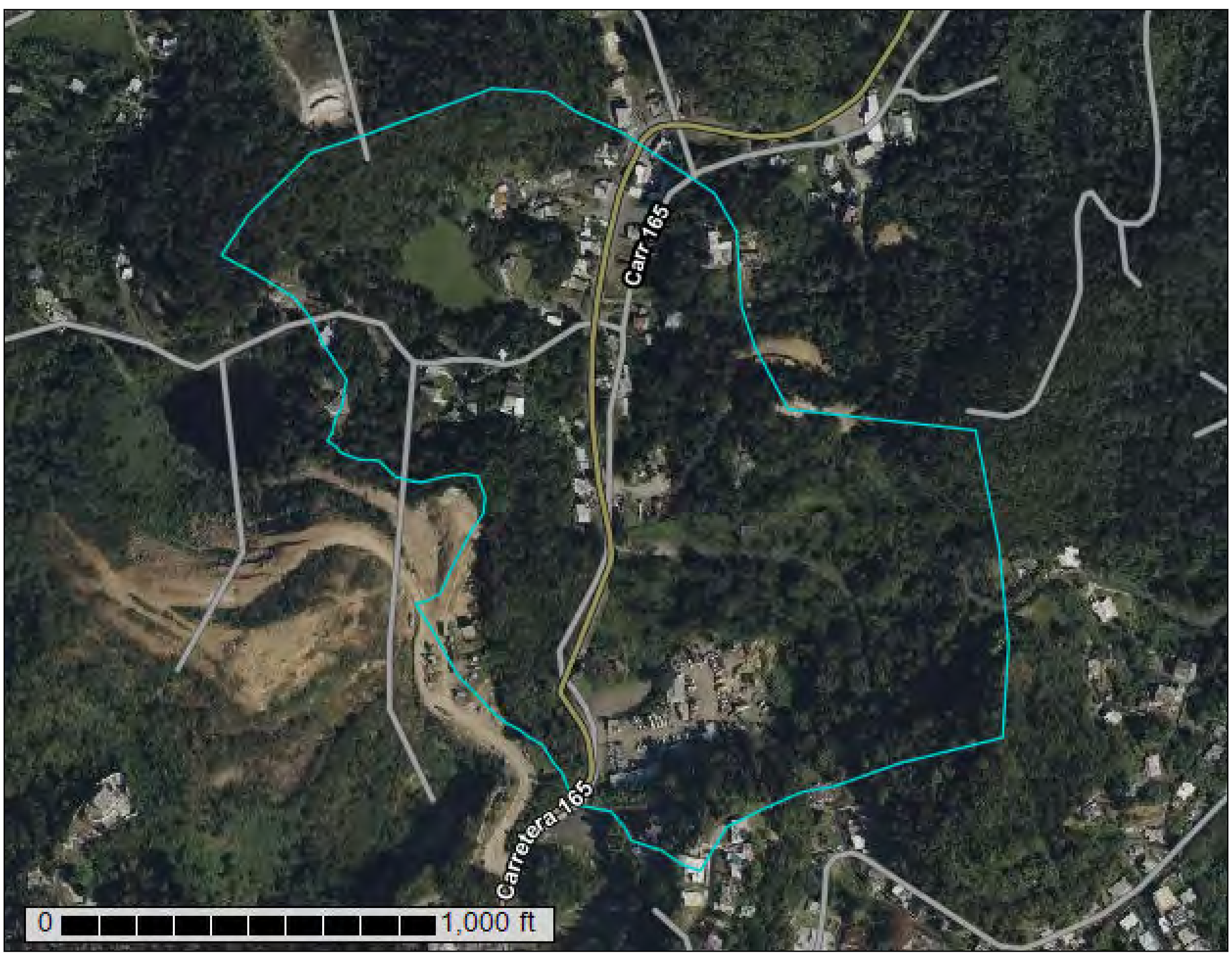
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

San Juan Area, Puerto Rico



October 7, 2022

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:5,390 if printed on A landscape (11" x 8.5") sheet.

Meters: 0 50 100 200 300

Feet: 0 250 500 1000 1500

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Juan Area, Puerto Rico
Survey Area Data: Version 16, Sep 12, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 23, 2022—Mar 1, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CrE2	Colinas clay loam, 20 to 40 percent slopes	20.0	36.3%
SoF	Soller clay loam, 40 to 60 percent slopes	35.1	63.7%
Totals for Area of Interest		**55.0**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however,

onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

San Juan Area, Puerto Rico

CrE2—Colinas clay loam, 20 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2wx40
Elevation: 200 to 600 feet
Mean annual precipitation: 34 to 106 inches
Mean annual air temperature: 69 to 86 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Colinas and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Colinas

Setting

Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Parent material: Coarse-loamy or fine-loamy residuum weathered from limestone

Typical profile

Ap - 0 to 6 inches: clay loam
Bw - 6 to 16 inches: clay loam
BC - 16 to 20 inches: clay loam
Cr - 20 to 60 inches: bedrock

Properties and qualities

Slope: 20 to 40 percent
Depth to restrictive feature: 20 to 48 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 1.42 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Naranjo

Percent of map unit: 5 percent

Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Hydric soil rating: No

Limestone outcrop

Percent of map unit: 5 percent
Landform: Mogotes
Hydric soil rating: No

Tanama

Percent of map unit: 5 percent
Landform: Mogotes
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Soller

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Hydric soil rating: No

SoF—Soller clay loam, 40 to 60 percent slopes

Map Unit Setting

National map unit symbol: byz4
Elevation: 500 to 1,000 feet
Mean annual precipitation: 80 to 90 inches
Mean annual air temperature: 75 to 79 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Soller and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Soller

Setting

Landform: Mogotes
Landform position (two-dimensional): Summit, shoulder, backslope

Landform position (three-dimensional): Head slope, side slope, crest
Down-slope shape: Concave, linear
Across-slope shape: Linear
Parent material: Weathered material

Typical profile

H1 - 0 to 5 inches: clay loam
H2 - 5 to 12 inches: clay
H3 - 12 to 24 inches: weathered bedrock
H4 - 24 to 28 inches: unweathered bedrock

Properties and qualities

Slope: 40 to 60 percent
Depth to restrictive feature: 20 to 34 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low (0.01 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Hydric soil rating: No

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group (DA-3)

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

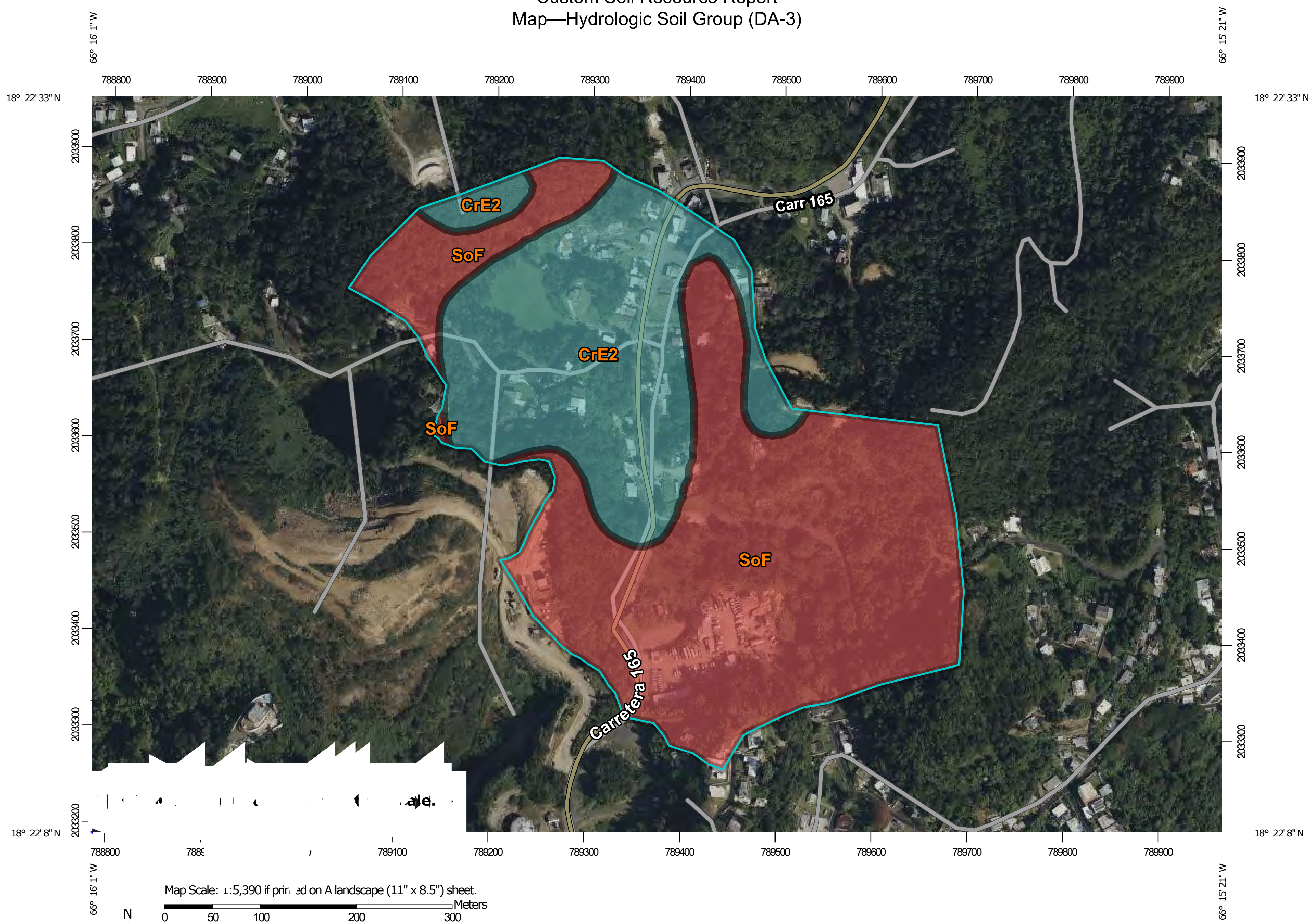
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Custom Soil Resource Report
Map—Hydrologic Soil Group (DA-3)



Map Scale: 1:5,390 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 250 500 1000 1500

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Juan Area, Puerto Rico
Survey Area Data: Version 16, Sep 12, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 23, 2022—Mar 1, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group (DA-3)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CrE2	Colinas clay loam, 20 to 40 percent slopes	C	20.0	36.3%
SoF	Soller clay loam, 40 to 60 percent slopes	D	35.1	63.7%
Totals for Area of Interest			**55.0**	**100.0%**

Rating Options—Hydrologic Soil Group (DA-3)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

United States Department of Agriculture

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

San Juan Area, Puerto Rico

October 4, 2022

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Juan Area, Puerto Rico
Survey Area Data: Version 16, Sep 12, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 23, 2022—Mar 1, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CrE2	Colinas clay loam, 20 to 40 percent slopes	3.3	63.3%
SoF	Soller clay loam, 40 to 60 percent slopes	1.9	36.7%
Totals for Area of Interest		**5.2**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however,

onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

San Juan Area, Puerto Rico

CrE2—Colinas clay loam, 20 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2wx40
Elevation: 200 to 600 feet
Mean annual precipitation: 34 to 106 inches
Mean annual air temperature: 69 to 86 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Colinas and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Colinas

Setting

Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Parent material: Coarse-loamy or fine-loamy residuum weathered from limestone

Typical profile

Ap - 0 to 6 inches: clay loam
Bw - 6 to 16 inches: clay loam
BC - 16 to 20 inches: clay loam
Cr - 20 to 60 inches: bedrock

Properties and qualities

Slope: 20 to 40 percent
Depth to restrictive feature: 20 to 48 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 1.42 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Naranjo

Percent of map unit: 5 percent

Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Hydric soil rating: No

Limestone outcrop

Percent of map unit: 5 percent
Landform: Mogotes
Hydric soil rating: No

Tanama

Percent of map unit: 5 percent
Landform: Mogotes
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Soller

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Hydric soil rating: No

SoF—Soller clay loam, 40 to 60 percent slopes

Map Unit Setting

National map unit symbol: byz4
Elevation: 500 to 1,000 feet
Mean annual precipitation: 80 to 90 inches
Mean annual air temperature: 75 to 79 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Soller and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Soller

Setting

Landform: Mogotes
Landform position (two-dimensional): Summit, shoulder, backslope

Landform position (three-dimensional): Head slope, side slope, crest
Down-slope shape: Concave, linear
Across-slope shape: Linear
Parent material: Weathered material

Typical profile

H1 - 0 to 5 inches: clay loam
H2 - 5 to 12 inches: clay
H3 - 12 to 24 inches: weathered bedrock
H4 - 24 to 28 inches: unweathered bedrock

Properties and qualities

Slope: 40 to 60 percent
Depth to restrictive feature: 20 to 34 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low (0.01 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Hydric soil rating: No

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group (Da-4)

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

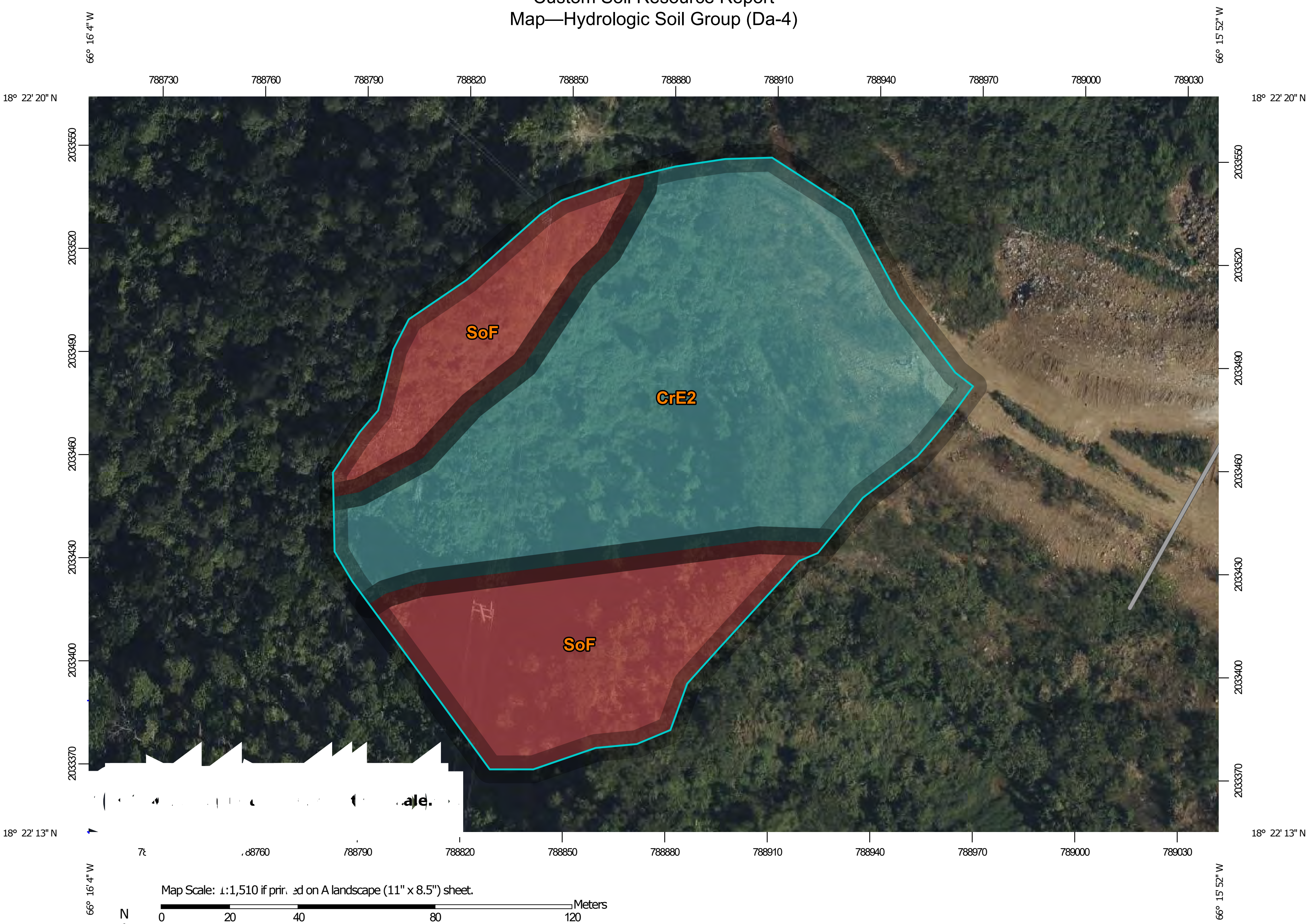
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Custom Soil Resource Report
Map—Hydrologic Soil Group (Da-4)



Map Scale: 1:1,510 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 20, 40, 80, 120

Feet: 0, 50, 100, 200, 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Juan Area, Puerto Rico
Survey Area Data: Version 16, Sep 12, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 23, 2022—Mar 1, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group (Da-4)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CrE2	Colinas clay loam, 20 to 40 percent slopes	C	3.3	63.3%
SoF	Soller clay loam, 40 to 60 percent slopes	D	1.9	36.7%
Totals for Area of Interest			**5.2**	**100.0%**

Rating Options—Hydrologic Soil Group (Da-4)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

San Juan Area, Puerto Rico

October 4, 2022

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

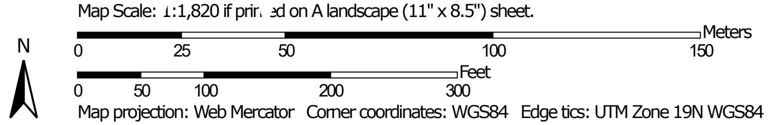
identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:1,820 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Juan Area, Puerto Rico
Survey Area Data: Version 16, Sep 12, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 23, 2022—Mar 1, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CrE2	Colinas clay loam, 20 to 40 percent slopes	2.4	38.0%
SoF	Soller clay loam, 40 to 60 percent slopes	4.0	62.0%
Totals for Area of Interest		**6.4**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however,

onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

San Juan Area, Puerto Rico

CrE2—Colinas clay loam, 20 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2wx40
Elevation: 200 to 600 feet
Mean annual precipitation: 34 to 106 inches
Mean annual air temperature: 69 to 86 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Colinas and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Colinas

Setting

Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Parent material: Coarse-loamy or fine-loamy residuum weathered from limestone

Typical profile

Ap - 0 to 6 inches: clay loam
Bw - 6 to 16 inches: clay loam
BC - 16 to 20 inches: clay loam
Cr - 20 to 60 inches: bedrock

Properties and qualities

Slope: 20 to 40 percent
Depth to restrictive feature: 20 to 48 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 1.42 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Naranjo

Percent of map unit: 5 percent

Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Hydric soil rating: No

Limestone outcrop

Percent of map unit: 5 percent
Landform: Mogotes
Hydric soil rating: No

Tanama

Percent of map unit: 5 percent
Landform: Mogotes
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Soller

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Hydric soil rating: No

SoF—Soller clay loam, 40 to 60 percent slopes

Map Unit Setting

National map unit symbol: byz4
Elevation: 500 to 1,000 feet
Mean annual precipitation: 80 to 90 inches
Mean annual air temperature: 75 to 79 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Soller and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Soller

Setting

Landform: Mogotes
Landform position (two-dimensional): Summit, shoulder, backslope

Landform position (three-dimensional): Head slope, side slope, crest
Down-slope shape: Concave, linear
Across-slope shape: Linear
Parent material: Weathered material

Typical profile

H1 - 0 to 5 inches: clay loam
H2 - 5 to 12 inches: clay
H3 - 12 to 24 inches: weathered bedrock
H4 - 24 to 28 inches: unweathered bedrock

Properties and qualities

Slope: 40 to 60 percent
Depth to restrictive feature: 20 to 34 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low (0.01 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Hydric soil rating: No

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group (DA-5)

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Custom Soil Resource Report
Map—Hydrologic Soil Group (DA-5)

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Juan Area, Puerto Rico
Survey Area Data: Version 16, Sep 12, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 23, 2022—Mar 1, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group (DA-5)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CrE2	Colinas clay loam, 20 to 40 percent slopes	C	2.4	38.0%
SoF	Soller clay loam, 40 to 60 percent slopes	D	4.0	62.0%
Totals for Area of Interest			**6.4**	**100.0%**

Rating Options—Hydrologic Soil Group (DA-5)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

San Juan Area, Puerto Rico

October 6, 2022

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:1,910 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 25, 50, 100, 150

Feet: 0, 50, 100, 200, 300

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Juan Area, Puerto Rico
Survey Area Data: Version 16, Sep 12, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 23, 2022—Mar 1, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CrE2	Colinas clay loam, 20 to 40 percent slopes	0.3	3.6%
SoF	Soller clay loam, 40 to 60 percent slopes	8.9	96.4%
Totals for Area of Interest		**9.3**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however,

onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

San Juan Area, Puerto Rico

CrE2—Colinas clay loam, 20 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2wx40
Elevation: 200 to 600 feet
Mean annual precipitation: 34 to 106 inches
Mean annual air temperature: 69 to 86 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Colinas and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Colinas

Setting

Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Parent material: Coarse-loamy or fine-loamy residuum weathered from limestone

Typical profile

Ap - 0 to 6 inches: clay loam
Bw - 6 to 16 inches: clay loam
BC - 16 to 20 inches: clay loam
Cr - 20 to 60 inches: bedrock

Properties and qualities

Slope: 20 to 40 percent
Depth to restrictive feature: 20 to 48 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 1.42 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Naranjo

Percent of map unit: 5 percent

Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Hydric soil rating: No

Limestone outcrop

Percent of map unit: 5 percent
Landform: Mogotes
Hydric soil rating: No

Tanama

Percent of map unit: 5 percent
Landform: Mogotes
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Soller

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Interfluve, head slope, nose slope, side slope
Down-slope shape: Concave, convex
Across-slope shape: Concave, convex, linear
Hydric soil rating: No

SoF—Soller clay loam, 40 to 60 percent slopes

Map Unit Setting

National map unit symbol: byz4
Elevation: 500 to 1,000 feet
Mean annual precipitation: 80 to 90 inches
Mean annual air temperature: 75 to 79 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Soller and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Soller

Setting

Landform: Mogotes
Landform position (two-dimensional): Summit, shoulder, backslope

Landform position (three-dimensional): Head slope, side slope, crest
Down-slope shape: Concave, linear
Across-slope shape: Linear
Parent material: Weathered material

Typical profile

H1 - 0 to 5 inches: clay loam
H2 - 5 to 12 inches: clay
H3 - 12 to 24 inches: weathered bedrock
H4 - 24 to 28 inches: unweathered bedrock

Properties and qualities

Slope: 40 to 60 percent
Depth to restrictive feature: 20 to 34 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low (0.01 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Hydric soil rating: No

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group (DA-6)

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

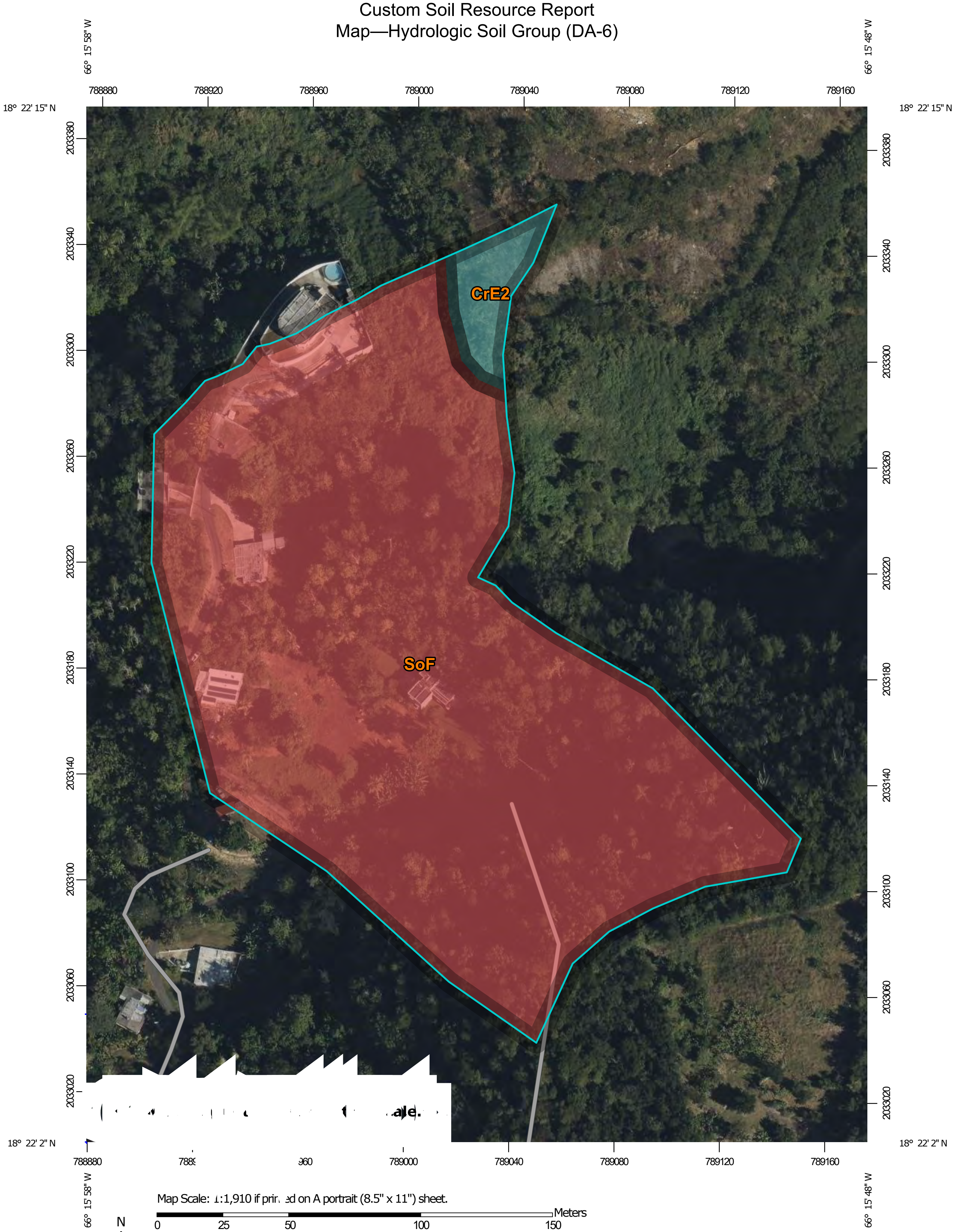
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Custom Soil Resource Report
Map—Hydrologic Soil Group (DA-6)



Map Scale: 1:1,910 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 25, 50, 100, 150

Feet: 0, 50, 100, 200, 300

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Juan Area, Puerto Rico
Survey Area Data: Version 16, Sep 12, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 23, 2022—Mar 1, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group (DA-6)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CrE2	Colinas clay loam, 20 to 40 percent slopes	C	0.3	3.6%
SoF	Soller clay loam, 40 to 60 percent slopes	D	8.9	96.4%
Totals for Area of Interest			**9.3**	**100.0%**

Rating Options—Hydrologic Soil Group (DA-6)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

San Juan Area, Puerto Rico

October 7, 2022

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:1,000 if printed on A portrait (8.5" x 11") sheet.
N
0 10 20 40 60 Meters
0 45 90 180 270 Feet
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Juan Area, Puerto Rico
Survey Area Data: Version 16, Sep 12, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 23, 2022—Mar 1, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
SoF	Soller clay loam, 40 to 60 percent slopes	1.1	100.0%
Totals for Area of Interest		**1.1**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

San Juan Area, Puerto Rico

SoF—Soller clay loam, 40 to 60 percent slopes

Map Unit Setting

National map unit symbol: byz4
Elevation: 500 to 1,000 feet
Mean annual precipitation: 80 to 90 inches
Mean annual air temperature: 75 to 79 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Soller and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Soller

Setting

Landform: Mogotes
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Head slope, side slope, crest
Down-slope shape: Concave, linear
Across-slope shape: Linear
Parent material: Weathered material

Typical profile

H1 - 0 to 5 inches: clay loam
H2 - 5 to 12 inches: clay
H3 - 12 to 24 inches: weathered bedrock
H4 - 24 to 28 inches: unweathered bedrock

Properties and qualities

Slope: 40 to 60 percent
Depth to restrictive feature: 20 to 34 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low (0.01 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Hydric soil rating: No

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group (DA-7)

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Custom Soil Resource Report
Map—Hydrologic Soil Group (DA-7)

Map Scale: 1:1,000 if printed on A portrait (8.5" x 11") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Juan Area, Puerto Rico
Survey Area Data: Version 16, Sep 12, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 23, 2022—Mar 1, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group (DA-7)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
SoF	Soller clay loam, 40 to 60 percent slopes	D	1.1	100.0%
Totals for Area of Interest			**1.1**	**100.0%**

Rating Options—Hydrologic Soil Group (DA-7)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

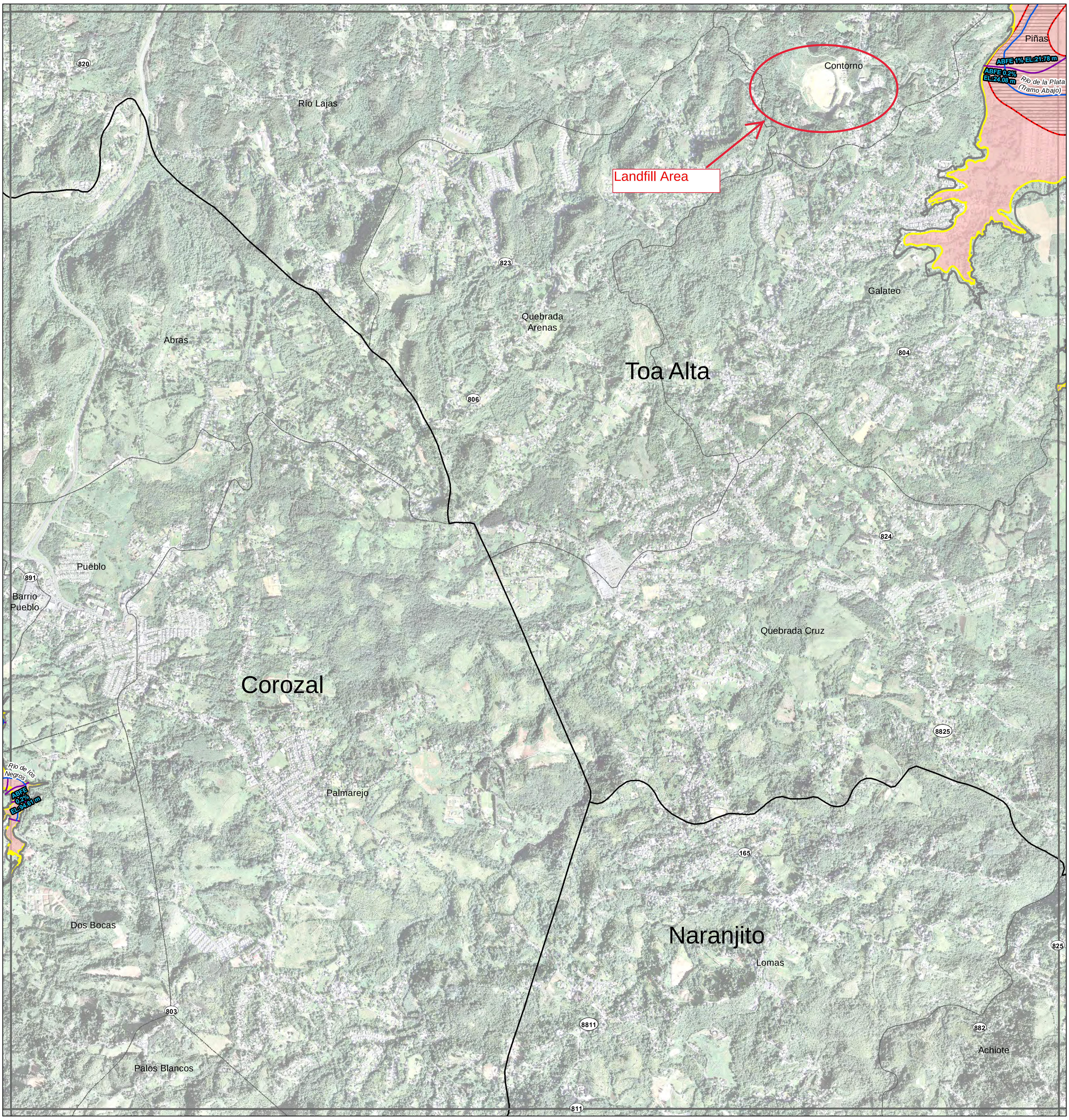
United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

PRIVILEGED AND CONFIDENTIAL

APPENDIX E

PANEL_ 72000C0685H



MAPAS DE NIVELES DE INUNDACIÓN BASE RECOMENDADOS

Estos mapas de niveles de inundación base recomendados (Advisory Maps) desarrollados por FEMA para Puerto Rico identifican que áreas se encuentran en nuevas zonas inundables recomendadas del 1% y 0.2% de probabilidad, así como niveles de inundación base recomendados (ABFE, por sus siglas en inglés) que pueden afectar las prácticas de construcción.

Como parte del esfuerzo de recuperación de la Isla, estos mapas son una herramienta para las agencias, los desarrolladores, diseñadores, técnicos de permisos de construcción, oficiales federales, estatales y municipales y dueños de propiedad, para tomar decisiones informadas de manera que se mitigue por eventos de inundación, se proteja la vida y propiedad, así como la inversión pública y privada.

El propósito de estos mapas es asesorar sobre como las nuevas construcciones, reconstrucciones y mejoras sustanciales deben ser elevadas o diseñadas para minimizar los daños por inundaciones futuras, en base a la mejor información disponible. Además, busca orientar a la ciudadanía sobre el riesgo a inundación al que pudiera estar expuesto.

Para información sobre cómo estos mapas fueron desarrollados y sus limitaciones, puede acceder al documento "Puerto Rico Advisory Data and Products" disponible en la página web de la Junta de Planificación.

Recuerde que antes de una construcción, usted debe consultar con los funcionarios de las oficinas municipales de permiso, las oficinas regionales de permisos (OGPe) o con la Junta de Planificación para determinar las elevaciones obligatorias para su hogar, negocio u otra propiedad.

UTILIZACIÓN

Las elevaciones mostradas en estos mapas son consideradas la mejor información disponible hasta que se desarrollen Mapas de Tasas del Seguro de Inundación (FIRM, por sus siglas en inglés) actualizados.

Estos mapas NO han sido desarrollados para tomar determinaciones respecto al seguro de inundación del Programa Nacional del Seguro de Inundación (NFIP, por sus siglas en inglés). Para propósitos del seguro de inundación, se debe hacer referencia a los FIRMs vigentes para Puerto Rico y disponibles en http://msc.fema.gov o en la herramienta MiPR de la Junta de Planificación (http://gis.pr.gov/mipr/)

LEYENDA

- Hidrografía
- Nivel de Inundación Base Recomendado
- Límite de Acción Moderada de la Ola (LiMWA)
- 1% Probabilidad Anual de Inundación
- 0.2% Probabilidad Anual de Inundación
- Límite ABFE

Zona Inundable

- 0.2% Probabilidad Anual de Inundacion
- A
- AE
- AO
- A Costera
- VE
- Cauce Mayor
- Panel
- Límite Municipal
- Límite de Barrio

NOTAS

1. Elevaciones medidas en metros relativos al Puerto Rico Vertical Datum de 2002 (PRVD02)
2. Zonas idientificadas como A costera o áreas afectadas por acción moderada de las olas (MoWA, por sus siglas en inglés) muestran las áreas donde la altura de la ola fluctúa entre 1.5 a 3 pies, Nueva construcción o mejora sustancial en estas zonas debe utilizar los parámetros establecidos para las zonas VE en el Reglamento de Planificación Núm, 13, vigente, Reglamento sobre áreas Especiales de Riesgo a Inundación. Puede accederlo en el siguiente enlace http://jp.pr.gov/Reglamentos/Relamentos-Planificacioón.

Panel: 72000C0685H Fecha de efectividad: 13/abril/2018

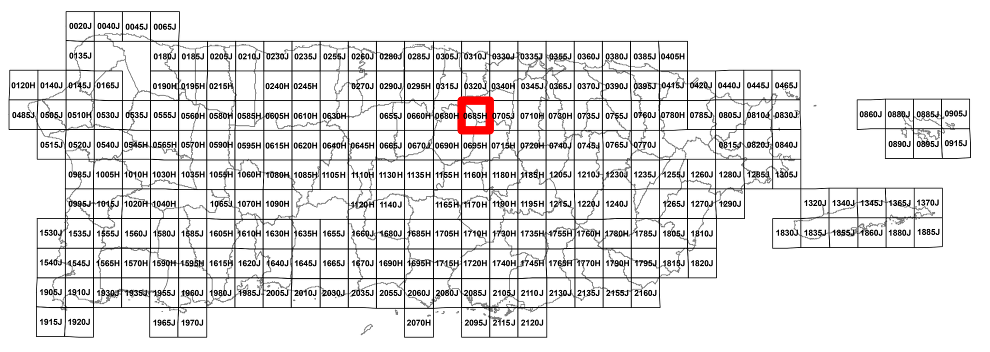
Fecha de revisión del geodato 12/mayo/2018

FEMA

N

0 20 40 80 120 160 Kilómetros

MAPA DE REFERENCIA



Fecha de mapa (pdf): 25/mayo/2018

PRIVILEGED AND CONFIDENTIAL

APPENDIX F

CN COMPUTATIONS

Existing Conditions

Drainage Area (DA-1 Onsite)				
Land Use Cover+	**Hydrologic Soil Group**	**Area (acres)**	**CN (AMC (II)**	**Area x CN**
Woods-Grass combination	C	1.88	72	135
Water or Impervious		1.10	99	109
Bare Soil		3.80	91	346
Woods-Grass combination	D	4.32	79	341
Water or Impervious		0.40	99	40
Bare Soil		4.30	94	404
Total Drainage Area (acres) =	15.80			
Total Drainage Area (mi²) =	0.02469			
Weighted CN =	87.0			
* Assume very similar to WWoods-Grass combination				
+ Good hydrologic conditons.				

Drainage Area (DA-1 Offsite)				
Land Use Cover+	**Hydrologic Soil Group**	**Area (acres)**	**CN (AMC (II)**	**Area x CN**
Woods-Grass combination	C	0.76	72	55
Water or Impervious		0.00	99	0
Bare Soil		0.00	91	0
Woods-Grass combination	D	3.24	79	256
Water or Impervious		0.00	99	0
Bare Soil		0.00	94	0
Total Drainage Area (acres) =	4.00			
Total Drainage Area (mi²) =	0.00625			
Weighted CN =	77.7			
* Assume very similar to WWoods-Grass combination				
+ Good hydrologic conditons.				

Drainage Area (DA-2 Onsite)				
Land Use Cover+	**Hydrologic Soil Group**	**Area (acres)**	**CN (AMC (II)**	**Area x CN**
Woods-Grass combination	C	0.00	72	0.0
Water or Impervious		0.00	99	0.0
Bare Soil		2.60	91	236.6
Woods-Grass combination	D	7.70	79	608.3
Water or Impervious		1.00	99	99.0
Bare Soil		1.20	94	112.8
Total Drainage Area (acres) =	12.50			
Total Drainage Area (mi²) =	0.01953			
Weighted CN =	84.5			
* Assume very similar to WWoods-Grass combination				
+ Good hydrologic conditons.				

Drainage Area (DA-2 Offsite)				
Land Use Cover+	**Hydrologic Soil Group**	**Area (acres)**	**CN (AMC (II)**	**Area x CN**
Woods-Grass combination	C	0.00	72	0.0
Water or Impervious		0.00	99	0.0
Bare Soil		0.00	91	0.0
Woods-Grass combination	D	1.93	79	152.5
Water or Impervious		0.30	99	29.7
Bare Soil		0.12	94	11.3
Total Drainage Area (acres) =	2.35			
Total Drainage Area (mi²) =	0.00367			
Weighted CN =	82.3			
* Assume very similar to WWoods-Grass combination				
+ Good hydrologic conditons.				

Drainage Area (DA-3 Onsite)				
Land Use Cover+	**Hydrologic Soil Group**	**Area (acres)**	**CN (AMC (II)**	**Area x CN**
Woods-Grass combination	C	0.64	72	46.1
Water or Impervious		0.00	99	0.0
Bare Soil		0.00	91	0.0
Woods-Grass combination	D	3.50	79	276.5
Water or Impervious		0.78	99	77.2
Bare Soil		0.00	94	0.0
Total Drainage Area (acres) =	4.92			
Total Drainage Area (mi²) =	0.00769			
Weighted CN =	81.3			
* Assume very similar to WWoods-Grass combination				
+ Good hydrologic conditons.				

Table 9–1 Runoff curve numbers for agricultural lands 1/

Cover description: cover type	treatment 2/	hydrologic condition 3/	CN for hydrologic soil group: A	B	C	D
Fallow	Bare Soil	---	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C & T)	Poor	66	74	80	82
		Good	62	71	78	81
	C & T + CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C & T	Poor	61	72	79	82
		Good	59	70	78	81
	C & T + CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C & T	Poor	63	73	80	83
		Good	51	67	76	80

See footnotes at end of table.

9–2 (210-VI-NEH, July 2004)

Chapter 9 Hydrologic Soil-Cover Complexes Part 630 National Engineering Handbook

Table 9–1 Runoff curve numbers for agricultural lands 1/ — Continued

Cover description: cover type	treatment 2/	hydrologic condition 3/	CN for hydrologic soil group: A	B	C	D
Pasture, grassland, or range-continuous forage for grazing 4/		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
Meadow-continuous grass, protected from grazing and generally mowed for hay		Good	30	58	71	78
Brush-brush-forbs-grass mixture with brush the major element 5/		Poor	48	67	77	83
		Fair	35	56	70	77
		Good	30 6/	48	65	73
Woods-grass combination (orchard or tree farm) 7/		Poor	57	73	82	86
		Fair	43	65	76	82
		Good	32	58	72	79
Woods 8/		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	30	55	70	77
Farmstead-buildings, lanes, driveways, and surrounding lots		---	59	74	82	86
Roads (including right-of-way):						
Dirt		---	72	82	87	89
Gravel		---	76	85	89	91

1/ Average runoff condition, and $I_a = 0.2s$.

2/ Crop residue cover applies only if residue is on at least 5 percent of the surface throughout the year.

3/ Hydrologic condition is based on combinations of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥20%), and (e) degree of surface toughness.
Poor: Factors impair infiltration and tend to increase runoff.
Good: Factors encourage average and better then average infiltration and tend to decrease runoff.
For conservation tillage poor hydrologic condition, 5 to 20 percent of the surface is covered with residue (less than 750 pounds per acre for row crops or 300 pounds per acre for small grain).
For conservation tillage good hydrologic condition, more than 20 percent of the surface is covered with residue (greater than 750 pounds per acre for row crops or 300 pounds per acre for small grain).

4/ Poor: < 50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

5/ Poor: < 50% ground cover.
Fair: 50 to 75% ground cover.
Good: > 75% ground cover.

6/ If actual curve number is less than 30, use CN = 30 for runoff computation.

7/ CNs shown were computed for areas with 50 percent woods and 50 percent grass (pasture) cover. Other combinations of conditions may be computed from the CNs for woods and pasture.

8/ Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed, but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

(210-VI-NEH, July 2004) 9–3

Drainage Area (DA-3 Offsite)				
Land Use Cover+	Hydrologic Soil Group	Area (acres)	CN (AMC (II)	Area x CN
Woods-Grass combination		14.53	72	1046.2
Water or Impervious	C	5.33	99	527.7
Bare Soil		0.00	91	0.0
Woods-Grass combination		24.94	79	1970.3
Water or Impervious	D	5.50	99	544.5
Bare Soil		0.00	94	0.0
Total Drainage Area (acres) =	50.30			
Total Drainage Area (mi²) =	0.07859			
Weighted CN =	81.3			
* Assume very similar to WWoods-Grass combination				
+ Good hydrologic conditons.				

Drainage Area (DA-4 Onsite)				
Land Use Cover+	Hydrologic Soil Group	Area (acres)	CN (AMC (II)	Area x CN
Woods-Grass combination		1.31	72	94.3
Water or Impervious	C	0.00	99	0.0
Bare Soil		1.38	91	125.6
Woods-Grass combination		1.19	79	94.0
Water or Impervious	D	0.00	99	0.0
Bare Soil		0.00	94	0.0
Total Drainage Area (acres) =	3.88			
Total Drainage Area (mi²) =	0.00606			
Weighted CN =	80.9			
* Assume very similar to WWoods-Grass combination				
+ Good hydrologic conditons.				

Drainage Area (DA-4 Offsite)				
Land Use Cover+	Hydrologic Soil Group	Area (acres)	CN (AMC (II)	Area x CN
Woods-Grass combination		0.38	72	27.4
Water or Impervious	C	0.00	99	0.0
Bare Soil		0.00	91	0.0
Woods-Grass combination		0.97	79	76.6
Water or Impervious	D	0.00	99	0.0
Bare Soil		0.00	94	0.0
Total Drainage Area (acres) =	1.35			
Total Drainage Area (mi²) =	0.00211			
Weighted CN =	77.0			
* Assume very similar to WWoods-Grass combination				
+ Good hydrologic conditons.				

Drainage Area (DA-5 Onsite)				
Land Use Cover+	Hydrologic Soil Group	Area (acres)	CN (AMC (II)	Area x CN
Woods-Grass combination		2.42	72	174.2
Water or Impervious	C	0.00	99	0.0
Bare Soil		0.00	91	0.0
Woods-Grass combination		2.19	79	173.0
Water or Impervious	D	0.00	99	0.0
Bare Soil		0.00	94	0.0
Total Drainage Area (acres) =	4.61			
Total Drainage Area (mi²) =	0.00720			
Weighted CN =	75.3			
* Assume very similar to WWoods-Grass combination				
+ Good hydrologic conditons.				

Drainage Area (DA-5 Offsite)				
Land Use Cover+	Hydrologic Soil Group	Area (acres)	CN (AMC (II)	Area x CN
Woods-Grass combination		0.00	72	0.0
Water or Impervious	C	0.00	99	0.0
Bare Soil		0.00	91	0.0
Woods-Grass combination		0.93	79	73.5
Water or Impervious	D	0.20	99	19.8
Bare Soil		0.70	94	65.8
Total Drainage Area (acres) =	1.83			
Total Drainage Area (mi²) =	0.00286			
Weighted CN =	86.9			
* Assume very similar to WWoods-Grass combination				
+ Good hydrologic conditons.				

Chapter 9 | Hydrologic Soil-Cover Complexes | Part 630 National Engineering Handbook

Table 9–5 Runoff curve numbers for urban areas 1/

Cover description cover type and hydrologic condition	Average percent impervious area 2/	CN for hydrologic soil group A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) 3/					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) 4/		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)		77	86	91	94

1/ Average runoff condition, and $I_a = 0.2S$.

2/ The average percent impervious area shown was used to develop the composite CNs. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition.

3/ CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space type.

4/ Composite CNs for natural desert landscaping should be computed using figures 9–3 or 9–4 based on the impervious area percentage (CN=98) and the pervious area CN. The pervious area CNs are assumed equivalent to desert shrub in poor hydrologic condition.

Drainage Area (DA-6 Onsite)				
Land Use Cover+	Hydrologic Soil Group	Area (acres)	CN (AMC (II)	Area x CN
Woods-Grass combination	C	0.12	72	8.6
Water or Impervious		0.00	99	0.0
Bare Soil		0.19	91	17.3
Woods-Grass combination	D	0.71	79	56.1
Water or Impervious		0.92	99	91.1
Bare Soil		0.00	94	0.0
Total Drainage Area (acres) =	1.94			
Total Drainage Area (mi²) =	0.00303			
Weighted CN =	89.2			
* Assume very similar to WWoods-Grass combination				
+ Good hydrologic conditons.				

Drainage Area (DA-6 Offsite)				
Land Use Cover+	Hydrologic Soil Group	Area (acres)	CN (AMC (II)	Area x CN
Woods-Grass combination	C	0.00	72	0.0
Water or Impervious		0.00	99	0.0
Bare Soil		0.00	91	0.0
Woods-Grass combination	D	6.46	79	510.3
Water or Impervious		0.92	99	91.1
Bare Soil		0.00	94	0.0
Total Drainage Area (acres) =	7.38			
Total Drainage Area (mi²) =	0.01153			
Weighted CN =	81.5			
* Assume very similar to WWoods-Grass combination				
+ Good hydrologic conditons.				

Drainage Area (DA-7 Onsite)				
Land Use Cover+	Hydrologic Soil Group	Area (acres)	CN (AMC (II)	Area x CN
Woods-Grass combination	D	0.84	79	66.4
Water or Impervious		0.26	99	25.7
Bare Soil		0.00	94	0.0
Total Drainage Area (acres) =	1.10			
Total Drainage Area (mi²) =	0.00172			
Weighted CN =	83.7			
* Assume very similar to WWoods-Grass combination				
+ Good hydrologic conditons.				

PRIVILEGED AND CONFIDENTIAL

APPENDIX G

COMPUTATIONS OF TC

CN AMC-II

Drainage Area	Flow Lentgh (feet)	CN	S (inches)	Y (%)	Tc (hour)	TC (min)	Lag (min)
DA-1 Offsite	950	77.7	2.87	38.03	0.09	5.3	3.2
DA-1 Onsite	350	87.0	1.49	27.94	0.03	2.0	1.2
DA-2 Offsite	380	82.3	2.15	71.45	0.03	1.6	1.0
DA-2 Onsite	1050	84.5	1.83	27.03	0.09	5.5	3.3
DA-3 Offsite	2150	81.3	2.30	33.57	0.16	9.7	5.8
DA-3 Onsite	450	81.3	2.30	38.68	0.04	2.6	1.6
DA-4 Offsite	375	77.0	2.99	64.66	0.03	2.0	1.2
DA-4 Onsite	475	80.9	2.36	35.36	0.05	2.9	1.7
DA-5 Offsite	375	86.9	1.51	50.13	0.03	1.6	1.0
DA-5 Onsite	510	75.3	3.28	25.19	0.07	4.3	2.6
DA-6 Offsite	810	81.5	2.27	39.11	0.07	4.1	2.5
DA-6 Onsite	560	89.2	1.21	28.04	0.05	2.7	1.6
DA-7 Onsite	360	83.7	1.95	36.66	0.03	2.1	1.2

$$L = \frac{\ell^{0.8}(S+1)^{0.7}}{1{,}900Y^{0.5}} \quad \text{(eq. 15–4a)}$$

Applying equation 15–3, $L=0.6T_c$, yields:

$$T_c = \frac{\ell^{0.8}(S+1)^{0.7}}{1{,}140Y^{0.5}} \quad \text{(eq. 15–4b)}$$

where:
- L = lag, h
- T_c = time of concentration, h
- ℓ = flow length, ft
- Y = average watershed land slope, %
- S = maximum potential retention, in

$$= \frac{1{,}000}{cn'} - 10$$

where:
- cn' = the retardance factor

PRIVILEGED AND CONFIDENTIAL

APPENDIX H

HMS CONFIGURATION

HEC-HMS 4.10 [C:\Users\rcolo\My Drive\CES Projects\Municipio de Toa Alta Vertedero HH\HH\HEC-HMS\Vertedero_Toa_Alta\Vertedero_Toa_Alta.hms]

File Edit View Components GIS Parameters Compute Results Tools Help

--None Selected-- --None Selected-- --None Selected--

- Vertedero Toa Alta
  - Basin Models
    - Existing Conditions
      - DA-1 Onsite
      - DA-3 Onsite
      - DA-3 Offsite
      - Reach-3
      - Discharge Point-3
      - North Pond
      - DA-2 Onsite
      - South Pond
      - DA-2 Offsite
      - DA-6 Offsite
      - DA-6 Onsite
      - Sinkhole SW
      - DA-5 Onsite
      - Reach-5
      - DA-5 Offsite
      - Discharge Point-5
      - DA-4 Onsite
      - Reach-4
      - DA-4 Offsite

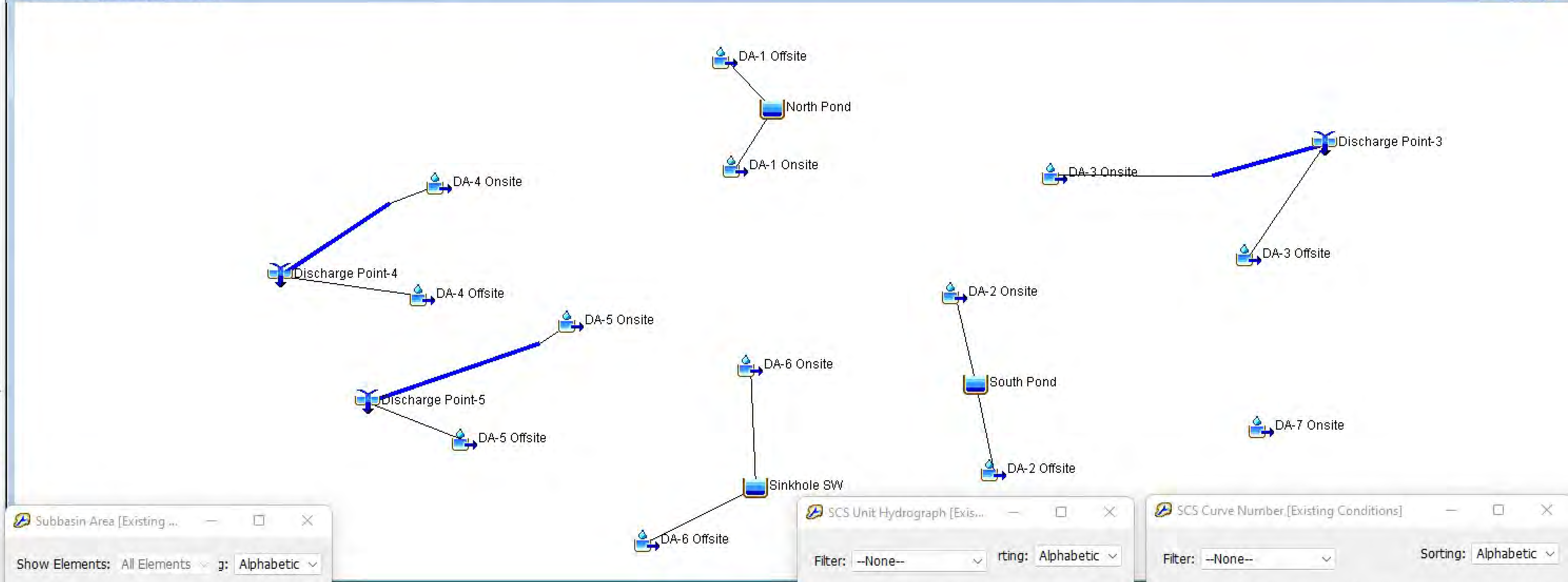
Components Compute Results

Basin Model

Name: Existing Conditions

Description:	
Unit System:	U.S. Customary
Sediment:	No
Replace Missing:	No
Local Flow:	No
Unregulated Outputs:	No
Flow Ratios:	No
Terrain Data:	--None--

Basin Model [Existing Conditions]



Subbasin Area [Existing ...

Show Elements: All Elements Sorting: Alphabetic

Subbasin	Area (MI2)
DA-1 Offsite	0.00625
DA-1 Onsite	0.02469
DA-2 Offsite	0.00367
DA-2 Onsite	0.01953
DA-3 Offsite	0.07859
DA-3 Onsite	0.00769
DA-4 Offsite	0.00211
DA-4 Onsite	0.00606
DA-5 Offsite	0.00286
DA-5 Onsite	0.00720
DA-6 Offsite	0.01153
DA-6 Onsite	0.00303
DA-7 Onsite	0.00172

Compute: All Elements Print Apply Close

SCS Unit Hydrograph [Exis...

Filter: --None-- Sorting: Alphabetic

Subbasin	Graph Type	Lag Time (MIN)
DA-1 Offsite	Standard (PRF 484)	3.5
DA-1 Onsite	Standard (PRF 484)	3.5
DA-2 Offsite	Standard (PRF 484)	3.5
DA-2 Onsite	Standard (PRF 484)	3.5
DA-3 Offsite	Standard (PRF 484)	5.8
DA-3 Onsite	Standard (PRF 484)	3.5
DA-4 Offsite	Standard (PRF 484)	3.5
DA-4 Onsite	Standard (PRF 484)	3.5
DA-5 Offsite	Standard (PRF 484)	3.5
DA-5 Onsite	Standard (PRF 484)	3.5
DA-6 Offsite	Standard (PRF 484)	3.5
DA-6 Onsite	Standard (PRF 484)	3.5
DA-7 Onsite	Standard (PRF 484)	3.5

Compute: All Elements Calculator...

SCS Curve Number [Existing Conditions]

Filter: --None-- Sorting: Alphabetic

Subbasin	Initial Abstraction (IN)	Curve Number	Impervious (%)
DA-1 Offsite		77.7	0.0
DA-1 Onsite		87.0	0.0
DA-2 Offsite		82.3	0.0
DA-2 Onsite		84.5	0.0
DA-3 Offsite		81.3	0.0
DA-3 Onsite		81.3	0.0
DA-4 Offsite		77.0	0.0
DA-4 Onsite		80.9	0.0
DA-5 Offsite		86.9	0.0
DA-5 Onsite		75.3	0.0
DA-6 Offsite		81.5	0.0
DA-6 Onsite		89.2	0.0
DA-7 Onsite		83.7	0.0

Compute: All Elements Calculator... Close

PRIVILEGED AND CONFIDENTIAL

APPENDIX I

HMS OUTPUT

Project: Vertedero Toa Alta Simulation Run: Existing 1HR-10%

Start of Run: 13Jun2019, 00:00 Basin Model: Existing Conditions
End of Run: 13Jun2019, 06:00 Meteorologic Model: 100YR-1 HR 10%
Compute Time: 12Dec2022, 13:47:40 Control Specifications: 6 Hours

Show Elements: All Elements Volume Units: IN ACRE-FT Sorting: Alphabetic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
DA-1 Offsite	0.00625	10.1	13Jun2019, 00:18	0.5
DA-1 Onsite	0.02469	65.9	13Jun2019, 00:16	2.7
DA-2 Offsite	0.00367	7.7	13Jun2019, 00:17	0.3
DA-2 Onsite	0.01953	45.9	13Jun2019, 00:17	1.9
DA-3 Offsite	0.07859	143.1	13Jun2019, 00:20	6.7
DA-3 Onsite	0.00769	15.3	13Jun2019, 00:17	0.7
DA-4 Offsite	0.00211	3.3	13Jun2019, 00:18	0.1
DA-4 Onsite	0.00606	11.8	13Jun2019, 00:17	0.5
DA-5 Offsite	0.00286	7.6	13Jun2019, 00:16	0.3
DA-5 Onsite	0.00720	10.1	13Jun2019, 00:18	0.5
DA-6 Offsite	0.01153	23.2	13Jun2019, 00:17	1.0
DA-6 Onsite	0.00303	9.0	13Jun2019, 00:16	0.4
DA-7 Onsite	0.00172	3.9	13Jun2019, 00:17	0.2
Discharge Point-3	0.08628	157.1	13Jun2019, 00:21	7.4
Discharge Point-4	0.00817	15.1	13Jun2019, 00:18	0.7
Discharge Point-5	0.01006	17.3	13Jun2019, 00:18	0.8
North Pond	0.03094	0.0	13Jun2019, 00:00	0.0
Reach-3	0.00769	15.3	13Jun2019, 00:23	0.7
Reach-4	0.00606	11.8	13Jun2019, 00:18	0.5
Reach-5	0.00720	10.1	13Jun2019, 00:19	0.5
Sinkhole SW	0.01456	0.0	13Jun2019, 00:00	0.0
South Pond	0.02320	0.0	13Jun2019, 00:00	0.0

Summary Results for Reservoir "South Pond"

Project: Vertedero Toa Alta   Simulation Run: Existing 1HR-10%
Reservoir: South Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	13Jun2019, 06:00	Meteorologic Model:	100YR-1 HR 10%
Compute Time:	12Dec2022, 13:47:40	Control Specifications:	6 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	53.6 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 00:17
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	2.2 (ACRE-FT)	Peak Storage:	2.2 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	372.7 (FT)

Summary Results for Reservoir "Sinkhole SW"

Project: Vertedero Toa Alta   Simulation Run: Existing 1HR-10%
Reservoir: Sinkhole SW

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	13Jun2019, 06:00	Meteorologic Model:	100YR-1 HR 10%
Compute Time:	12Dec2022, 13:47:40	Control Specifications:	6 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	32.0 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 00:17
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	1.4 (ACRE-FT)	Peak Storage:	1.4 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	381.2 (FT)

Summary Results for Reservoir "North Pond"

Project: Vertedero Toa Alta   Simulation Run: Existing 1HR-10%
Reservoir: North Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	13Jun2019, 06:00	Meteorologic Model:	100YR-1 HR 10%
Compute Time:	12Dec2022, 13:47:40	Control Specifications:	6 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	75.7 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 00:16
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	3.1 (ACRE-FT)	Peak Storage:	3.1 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	356.8 (FT)

Global Summary Results for Run "Existing 1HR-90%"

Project: Vertedero Toa Alta Simulation Run: Existing 1HR-90%

Start of Run: 13Jun2019, 00:00
End of Run: 13Jun2019, 06:00
Compute Time: 12Dec2022, 13:47:41

Basin Model: Existing Conditions
Meteorologic Model: 100YR-1 HR 90%
Control Specifications: 6 Hours

Show Elements: All Elements Volume Units: IN ACRE-FT Sorting: Alphabetic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
DA-1 Offsite	0.00625	24.7	13Jun2019, 01:01	0.5
DA-1 Onsite	0.02469	124.7	13Jun2019, 01:00	2.7
DA-2 Offsite	0.00367	16.5	13Jun2019, 01:00	0.3
DA-2 Onsite	0.01953	92.9	13Jun2019, 01:00	1.9
DA-3 Offsite	0.07859	310.7	13Jun2019, 01:02	6.7
DA-3 Onsite	0.00769	33.6	13Jun2019, 01:01	0.7
DA-4 Offsite	0.00211	8.1	13Jun2019, 01:01	0.1
DA-4 Onsite	0.00606	26.2	13Jun2019, 01:01	0.5
DA-5 Offsite	0.00286	14.4	13Jun2019, 01:00	0.3
DA-5 Onsite	0.00720	26.3	13Jun2019, 01:01	0.5
DA-6 Offsite	0.01153	50.7	13Jun2019, 01:01	1.0
DA-6 Onsite	0.00303	16.0	13Jun2019, 01:00	0.4
DA-7 Onsite	0.00172	8.0	13Jun2019, 01:00	0.2
Discharge Point-3	0.08628	338.3	13Jun2019, 01:02	7.4
Discharge Point-4	0.00817	34.3	13Jun2019, 01:01	0.7
Discharge Point-5	0.01006	40.3	13Jun2019, 01:01	0.8
North Pond	0.03094	0.0	13Jun2019, 00:00	0.0
Reach-3	0.00769	33.6	13Jun2019, 01:07	0.7
Reach-4	0.00606	26.2	13Jun2019, 01:02	0.5
Reach-5	0.00720	26.3	13Jun2019, 01:02	0.5
Sinkhole SW	0.01456	0.0	13Jun2019, 00:00	0.0
South Pond	0.02320	0.0	13Jun2019, 00:00	0.0

Summary Results for Reservoir "South Pond"

Project: Vertedero Toa Alta Simulation Run: Existing 1HR-90%
Reservoir: South Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	13Jun2019, 06:00	Meteorologic Model:	100YR-1 HR 90%
Compute Time:	12Dec2022, 13:47:41	Control Specifications:	6 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	109.4 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 01:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	2.2 (ACRE-FT)	Peak Storage:	2.2 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	372.7 (FT)

Summary Results for Reservoir "Sinkhole SW"

Project: Vertedero Toa Alta Simulation Run: Existing 1HR-90%
Reservoir: Sinkhole SW

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	13Jun2019, 06:00	Meteorologic Model:	100YR-1 HR 90%
Compute Time:	12Dec2022, 13:47:41	Control Specifications:	6 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	66.7 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 01:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	1.4 (ACRE-FT)	Peak Storage:	1.4 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	381.2 (FT)

Summary Results for Reservoir "North Pond"

Project: Vertedero Toa Alta Simulation Run: Existing 1HR-90%
Reservoir: North Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	13Jun2019, 06:00	Meteorologic Model:	100YR-1 HR 90%
Compute Time:	12Dec2022, 13:47:41	Control Specifications:	6 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	149.2 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 01:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	3.1 (ACRE-FT)	Peak Storage:	3.1 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	356.8 (FT)

Global Summary Results for Run "Existing 6HR-10%"

Project: Vertedero Toa Alta Simulation Run: Existing 6HR-10%

Start of Run: 13Jun2019, 00:00
End of Run: 13Jun2019, 12:00
Compute Time: DATA CHANGED, RECOMPUTE

Basin Model: Existing Conditions
Meteorologic Model: 100YR-6 HR 10%
Control Specifications: 12 Hours

Show Elements: All Elements Volume Units: IN ACRE-FT Sorting: Alphabetic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
DA-1 Offsite	0.00625	16.2	13Jun2019, 01:00	1.7
DA-1 Onsite	0.02469	72.5	13Jun2019, 00:31	8.3
DA-2 Offsite	0.00367	10.1	13Jun2019, 01:00	1.1
DA-2 Onsite	0.01953	55.2	13Jun2019, 01:00	6.2
DA-3 Offsite	0.07859	211.4	13Jun2019, 01:01	23.5
DA-3 Onsite	0.00769	20.9	13Jun2019, 01:00	2.3
DA-4 Offsite	0.00211	5.4	13Jun2019, 01:00	0.6
DA-4 Onsite	0.00606	16.4	13Jun2019, 01:00	1.8
DA-5 Offsite	0.00286	8.4	13Jun2019, 00:31	1.0
DA-5 Onsite	0.00720	17.9	13Jun2019, 01:00	1.9
DA-6 Offsite	0.01153	31.5	13Jun2019, 01:00	3.5
DA-6 Onsite	0.00303	9.4	13Jun2019, 00:31	1.1
DA-7 Onsite	0.00172	4.8	13Jun2019, 01:00	0.5
Discharge Point-3	0.08628	231.9	13Jun2019, 01:01	25.8
Discharge Point-4	0.00817	21.8	13Jun2019, 01:01	2.4
Discharge Point-5	0.01006	26.2	13Jun2019, 01:01	2.8
North Pond	0.03094	0.0	13Jun2019, 00:00	0.0
Reach-3	0.00769	20.9	13Jun2019, 01:06	2.3
Reach-4	0.00606	16.4	13Jun2019, 01:01	1.8
Reach-5	0.00720	17.9	13Jun2019, 01:01	1.9
Sinkhole SW	0.01456	0.0	13Jun2019, 00:00	0.0
South Pond	0.02320	0.0	13Jun2019, 00:00	0.0

Summary Results for Reservoir "South Pond"

Project: Vertedero Toa Alta   Simulation Run: Existing 6HR-10%
Reservoir: South Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	13Jun2019, 12:00	Meteorologic Model:	100YR-6 HR 10%
Compute Time:	12Dec2022, 13:47:44	Control Specifications:	12 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	65.4 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 01:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	7.4 (ACRE-FT)	Peak Storage:	7.4 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	383.8 (FT)

Summary Results for Reservoir "Sinkhole SW"

Project: Vertedero Toa Alta   Simulation Run: Existing 6HR-10%
Reservoir: Sinkhole SW

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	13Jun2019, 12:00	Meteorologic Model:	100YR-6 HR 10%
Compute Time:	12Dec2022, 13:47:44	Control Specifications:	12 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	40.4 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 01:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	4.5 (ACRE-FT)	Peak Storage:	4.5 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	386.5 (FT)

Summary Results for Reservoir "North Pond"

Project: Vertedero Toa Alta   Simulation Run: Existing 6HR-10%
Reservoir: North Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	13Jun2019, 12:00	Meteorologic Model:	100YR-6 HR 10%
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	12 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	87.8 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 01:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	10.0 (ACRE-FT)	Peak Storage:	10.0 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	362.5 (FT)

Global Summary Results for Run "Existing 6HR-90%"

Project: Vertedero Toa Alta Simulation Run: Existing 6HR-90%

Start of Run: 13Jun2019, 00:00
End of Run: 13Jun2019, 12:00
Compute Time: DATA CHANGED, RECOMPUTE

Basin Model: Existing Conditions
Meteorologic Model: 100YR-6 HR 90%
Control Specifications: 12 Hours

Show Elements: All Elements Volume Units: IN ACRE-FT Sorting: Alphabetic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
DA-1 Offsite	0.00625	12.0	13Jun2019, 06:00	1.7
DA-1 Onsite	0.02469	50.1	13Jun2019, 06:00	8.3
DA-2 Offsite	0.00367	7.3	13Jun2019, 06:00	1.1
DA-2 Onsite	0.01953	39.1	13Jun2019, 06:00	6.2
DA-3 Offsite	0.07859	153.6	13Jun2019, 06:00	23.5
DA-3 Onsite	0.00769	15.1	13Jun2019, 06:00	2.3
DA-4 Offsite	0.00211	4.0	13Jun2019, 06:00	0.6
DA-4 Onsite	0.00606	11.9	13Jun2019, 06:00	1.8
DA-5 Offsite	0.00286	5.8	13Jun2019, 06:00	1.0
DA-5 Onsite	0.00720	13.5	13Jun2019, 06:00	1.9
DA-6 Offsite	0.01153	22.7	13Jun2019, 06:00	3.5
DA-6 Onsite	0.00303	6.2	13Jun2019, 06:00	1.1
DA-7 Onsite	0.00172	3.4	13Jun2019, 06:00	0.5
Discharge Point-3	0.08628	168.5	13Jun2019, 06:00	25.8
Discharge Point-4	0.00817	15.9	13Jun2019, 06:00	2.4
Discharge Point-5	0.01006	19.3	13Jun2019, 06:00	2.8
North Pond	0.03094	0.0	13Jun2019, 00:00	0.0
Reach-3	0.00769	15.1	13Jun2019, 06:06	2.3
Reach-4	0.00606	11.9	13Jun2019, 06:01	1.8
Reach-5	0.00720	13.5	13Jun2019, 06:01	1.9
Sinkhole SW	0.01456	0.0	13Jun2019, 00:00	0.0
South Pond	0.02320	0.0	13Jun2019, 00:00	0.0

Summary Results for Reservoir "South Pond"

Project: Vertedero Toa Alta Simulation Run: Existing 6HR-90%
Reservoir: South Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	13Jun2019, 12:00	Meteorologic Model:	100YR-6 HR 90%
Compute Time:	12Dec2022, 13:47:45	Control Specifications:	12 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	46.4 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 06:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	7.4 (ACRE-FT)	Peak Storage:	7.4 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	383.8 (FT)

Summary Results for Reservoir "Sinkhole SW"

Project: Vertedero Toa Alta Simulation Run: Existing 6HR-90%
Reservoir: Sinkhole SW

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	13Jun2019, 12:00	Meteorologic Model:	100YR-6 HR 90%
Compute Time:	12Dec2022, 13:47:45	Control Specifications:	12 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	28.9 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 06:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	4.5 (ACRE-FT)	Peak Storage:	4.5 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	386.5 (FT)

Summary Results for Reservoir "North Pond"

Project: Vertedero Toa Alta Simulation Run: Existing 6HR-90%
Reservoir: North Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	13Jun2019, 12:00	Meteorologic Model:	100YR-6 HR 90%
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	12 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	62.0 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 06:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	10.0 (ACRE-FT)	Peak Storage:	10.0 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	362.5 (FT)

Global Summary Results for Run "Existing 12HR-10%"

Project: Vertedero Toa Alta Simulation Run: Existing 12HR-10%

Start of Run: 13Jun2019, 00:00 Basin Model: Existing Conditions
End of Run: 14Jun2019, 00:00 Meteorologic Model: 100YR-12 HR 10%
Compute Time: 12Dec2022, 13:47:42 Control Specifications: 24 Hours

Show Elements: All Elements Volume Units: IN ACRE-FT Sorting: Alphabetic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
DA-1 Offsite	0.00625	16.0	13Jun2019, 01:00	2.6
DA-1 Onsite	0.02469	71.8	13Jun2019, 01:00	12.0
DA-2 Offsite	0.00367	10.1	13Jun2019, 01:00	1.7
DA-2 Onsite	0.01953	55.2	13Jun2019, 01:00	9.1
DA-3 Offsite	0.07859	210.6	13Jun2019, 01:01	35.0
DA-3 Onsite	0.00769	20.8	13Jun2019, 01:00	3.4
DA-4 Offsite	0.00211	5.3	13Jun2019, 01:00	0.9
DA-4 Onsite	0.00606	16.3	13Jun2019, 01:00	2.7
DA-5 Offsite	0.00286	8.3	13Jun2019, 01:00	1.4
DA-5 Onsite	0.00720	17.7	13Jun2019, 01:00	2.9
DA-6 Offsite	0.01153	31.3	13Jun2019, 01:00	5.2
DA-6 Onsite	0.00303	9.0	13Jun2019, 01:00	1.5
DA-7 Onsite	0.00172	4.8	13Jun2019, 01:00	0.8
Discharge Point-3	0.08628	231.0	13Jun2019, 01:01	38.5
Discharge Point-4	0.00817	21.7	13Jun2019, 01:01	3.6
Discharge Point-5	0.01006	26.0	13Jun2019, 01:01	4.3
North Pond	0.03094	0.0	13Jun2019, 00:00	0.0
Reach-3	0.00769	20.8	13Jun2019, 01:06	3.4
Reach-4	0.00606	16.3	13Jun2019, 01:01	2.7
Reach-5	0.00720	17.7	13Jun2019, 01:01	2.9
Sinkhole SW	0.01456	0.0	13Jun2019, 00:00	0.0
South Pond	0.02320	0.0	13Jun2019, 00:00	0.0

Summary Results for Reservoir "South Pond"

Project: Vertedero Toa Alta Simulation Run: Existing 12HR-10%
Reservoir: South Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	14Jun2019, 00:00	Meteorologic Model:	100YR-12 HR 10%
Compute Time:	12Dec2022, 13:47:42	Control Specifications:	24 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	65.3 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 01:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	10.8 (ACRE-FT)	Peak Storage:	10.8 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	389.2 (FT)

Summary Results for Reservoir "Sinkhole SW"

Project: Vertedero Toa Alta Simulation Run: Existing 12HR-10%
Reservoir: Sinkhole SW

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	14Jun2019, 00:00	Meteorologic Model:	100YR-12 HR 10%
Compute Time:	12Dec2022, 13:47:42	Control Specifications:	24 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	40.3 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 01:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	6.7 (ACRE-FT)	Peak Storage:	6.7 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	388.5 (FT)

Summary Results for Reservoir "North Pond"

Project: Vertedero Toa Alta Simulation Run: Existing 12HR-10%
Reservoir: North Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	14Jun2019, 00:00	Meteorologic Model:	100YR-12 HR 10%
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	24 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	87.8 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 01:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	14.6 (ACRE-FT)	Peak Storage:	14.6 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	365.0 (FT)

Global Summary Results for Run "Existing 12HR-90%"

Project: Vertedero Toa Alta   Simulation Run: Existing 12HR-90%

Start of Run: 13Jun2019, 00:00
End of Run: 14Jun2019, 00:00
Compute Time: DATA CHANGED, RECOMPUTE

Basin Model: Existing Conditions
Meteorologic Model: 100YR-12 HR 90%
Control Specifications: 24 Hours

Show Elements: All Elements   Volume Units: IN ACRE-FT   Sorting: Alphabetic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
DA-1 Offsite	0.00625	11.9	13Jun2019, 12:00	2.6
DA-1 Onsite	0.02469	48.9	13Jun2019, 12:00	12.0
DA-2 Offsite	0.00367	7.2	13Jun2019, 12:00	1.7
DA-2 Onsite	0.01953	38.4	13Jun2019, 12:00	9.1
DA-3 Offsite	0.07859	152.4	13Jun2019, 12:00	35.0
DA-3 Onsite	0.00769	14.9	13Jun2019, 12:00	3.4
DA-4 Offsite	0.00211	4.0	13Jun2019, 12:00	0.9
DA-4 Onsite	0.00606	11.8	13Jun2019, 12:00	2.7
DA-5 Offsite	0.00286	5.7	13Jun2019, 12:00	1.4
DA-5 Onsite	0.00720	13.6	13Jun2019, 12:00	2.9
DA-6 Offsite	0.01153	22.4	13Jun2019, 12:00	5.2
DA-6 Onsite	0.00303	6.0	13Jun2019, 12:00	1.5
DA-7 Onsite	0.00172	3.4	13Jun2019, 12:00	0.8
Discharge Point-3	0.08628	167.3	13Jun2019, 12:00	38.5
Discharge Point-4	0.00817	15.8	13Jun2019, 12:00	3.6
Discharge Point-5	0.01006	19.2	13Jun2019, 12:00	4.3
North Pond	0.03094	0.0	13Jun2019, 00:00	0.0
Reach-3	0.00769	14.9	13Jun2019, 12:06	3.4
Reach-4	0.00606	11.8	13Jun2019, 12:01	2.7
Reach-5	0.00720	13.6	13Jun2019, 12:01	2.9
Sinkhole SW	0.01456	0.0	13Jun2019, 00:00	0.0
South Pond	0.02320	0.0	13Jun2019, 00:00	0.0

Summary Results for Reservoir "South Pond"

Project: Vertedero Toa Alta   Simulation Run: Existing 12HR-90%
Reservoir: South Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	14Jun2019, 00:00	Meteorologic Model:	100YR-12 HR 90%
Compute Time:	12Dec2022, 13:47:42	Control Specifications:	24 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	45.5 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 12:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	10.8 (ACRE-FT)	Peak Storage:	10.8 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	389.2 (FT)

Summary Results for Reservoir "Sinkhole SW"

Project: Vertedero Toa Alta   Simulation Run: Existing 12HR-90%
Reservoir: Sinkhole SW

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	14Jun2019, 00:00	Meteorologic Model:	100YR-12 HR 90%
Compute Time:	12Dec2022, 13:47:42	Control Specifications:	24 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	28.5 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 12:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	6.7 (ACRE-FT)	Peak Storage:	6.7 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	388.5 (FT)

Summary Results for Reservoir "North Pond"

Project: Vertedero Toa Alta   Simulation Run: Existing 12HR-90%
Reservoir: North Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	14Jun2019, 00:00	Meteorologic Model:	100YR-12 HR 90%
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	24 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	60.8 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 12:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	14.6 (ACRE-FT)	Peak Storage:	14.6 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	365.0 (FT)

Project: Vertedero Toa Alta   Simulation Run: Existing 24HR-10%

Start of Run: 13Jun2019, 00:00   Basin Model: Existing Conditions
End of Run: 15Jun2019, 00:00   Meteorologic Model: 100YR-24 HR 10%
Compute Time: DATA CHANGED, RECOMPUTE   Control Specifications: 48 Hours

Show Elements: All Elements   Volume Units: IN ACRE-FT   Sorting: Alphabetic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
DA-1 Offsite	0.00625	14.2	13Jun2019, 02:00	3.7
DA-1 Onsite	0.02469	59.7	13Jun2019, 02:00	16.1
DA-2 Offsite	0.00367	8.6	13Jun2019, 02:00	2.3
DA-2 Onsite	0.01953	46.6	13Jun2019, 02:00	12.4
DA-3 Offsite	0.07859	183.3	13Jun2019, 02:00	48.1
DA-3 Onsite	0.00769	18.0	13Jun2019, 02:00	4.7
DA-4 Offsite	0.00211	4.8	13Jun2019, 02:00	1.2
DA-4 Onsite	0.00606	14.1	13Jun2019, 02:00	3.7
DA-5 Offsite	0.00286	6.9	13Jun2019, 02:00	1.9
DA-5 Onsite	0.00720	16.0	13Jun2019, 02:00	4.1
DA-6 Offsite	0.01153	27.0	13Jun2019, 02:00	7.1
DA-6 Onsite	0.00303	7.4	13Jun2019, 02:00	2.0
DA-7 Onsite	0.00172	4.1	13Jun2019, 02:00	1.1
Discharge Point-3	0.08628	201.2	13Jun2019, 02:00	52.8
Discharge Point-4	0.00817	18.9	13Jun2019, 02:00	4.9
Discharge Point-5	0.01006	22.9	13Jun2019, 02:00	5.9
North Pond	0.03094	0.0	13Jun2019, 00:00	0.0
Reach-3	0.00769	18.0	13Jun2019, 02:06	4.7
Reach-4	0.00606	14.1	13Jun2019, 02:01	3.7
Reach-5	0.00720	16.0	13Jun2019, 02:01	4.1
Sinkhole SW	0.01456	0.0	13Jun2019, 00:00	0.0
South Pond	0.02320	0.0	13Jun2019, 00:00	0.0

Summary Results for Reservoir "South Pond"

Project: Vertedero Toa Alta   Simulation Run: Existing 24HR-10%
Reservoir: South Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	15Jun2019, 00:00	Meteorologic Model:	100YR-24 HR 10%
Compute Time:	12Dec2022, 13:47:43	Control Specifications:	48 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	55.2 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 02:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	14.7 (ACRE-FT)	Peak Storage:	14.7 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	394.1 (FT)

Summary Results for Reservoir "Sinkhole SW"

Project: Vertedero Toa Alta   Simulation Run: Existing 24HR-10%
Reservoir: Sinkhole SW

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	15Jun2019, 00:00	Meteorologic Model:	100YR-24 HR 10%
Compute Time:	12Dec2022, 13:47:43	Control Specifications:	48 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	34.4 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 02:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	9.1 (ACRE-FT)	Peak Storage:	9.1 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	390.5 (FT)

Summary Results for Reservoir "North Pond"

Project: Vertedero Toa Alta   Simulation Run: Existing 24HR-10%
Reservoir: North Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	15Jun2019, 00:00	Meteorologic Model:	100YR-24 HR 10%
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	48 Hours

Volume Units: IN ACRE-FT

Computed Results

Peak Inflow:	73.9 (CFS)	Date/Time of Peak Inflow:	13Jun2019, 02:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	19.8 (ACRE-FT)	Peak Storage:	19.8 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	367.6 (FT)

Global Summary Results for Run "Existing 24HR-90%"

Project: Vertedero Toa Alta Simulation Run: Existing 24HR-90%

Start of Run: 13Jun2019, 00:00
End of Run: 15Jun2019, 00:00
Compute Time: DATA CHANGED, RECOMPUTE

Basin Model: Existing Conditions
Meteorologic Model: 100YR-24 HR 90%
Control Specifications: 48 Hours

Show Elements: All Elements Volume Units: IN ACRE-FT Sorting: Alphabetic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
DA-1 Offsite	0.00625	11.7	14Jun2019, 00:00	3.7
DA-1 Onsite	0.02469	47.3	14Jun2019, 00:00	16.1
DA-2 Offsite	0.00367	7.0	14Jun2019, 00:00	2.3
DA-2 Onsite	0.01953	37.3	14Jun2019, 00:00	12.4
DA-3 Offsite	0.07859	148.7	14Jun2019, 00:00	48.1
DA-3 Onsite	0.00769	14.6	14Jun2019, 00:00	4.7
DA-4 Offsite	0.00211	3.9	14Jun2019, 00:00	1.2
DA-4 Onsite	0.00606	11.5	14Jun2019, 00:00	3.7
DA-5 Offsite	0.00286	5.5	14Jun2019, 00:00	1.9
DA-5 Onsite	0.00720	13.4	14Jun2019, 00:00	4.1
DA-6 Offsite	0.01153	21.8	14Jun2019, 00:00	7.1
DA-6 Onsite	0.00303	5.8	14Jun2019, 00:00	2.0
DA-7 Onsite	0.00172	3.3	14Jun2019, 00:00	1.1
Discharge Point-3	0.08628	163.3	14Jun2019, 00:00	52.8
Discharge Point-4	0.00817	15.4	14Jun2019, 00:00	4.9
Discharge Point-5	0.01006	18.9	14Jun2019, 00:00	5.9
North Pond	0.03094	0.0	13Jun2019, 00:00	0.0
Reach-3	0.00769	14.6	14Jun2019, 00:06	4.7
Reach-4	0.00606	11.5	14Jun2019, 00:01	3.7
Reach-5	0.00720	13.4	14Jun2019, 00:01	4.1
Sinkhole SW	0.01456	0.0	13Jun2019, 00:00	0.0
South Pond	0.02320	0.0	13Jun2019, 00:00	0.0

Summary Results for Reservoir "South Pond"

Project: Vertedero Toa Alta   Simulation Run: Existing 24HR-90%
Reservoir: South Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	15Jun2019, 00:00	Meteorologic Model:	100YR-24 HR 90%
Compute Time:	12Dec2022, 13:47:44	Control Specifications:	48 Hours

Volume Units: ○ IN ● ACRE-FT

Computed Results

Peak Inflow:	44.2 (CFS)	Date/Time of Peak Inflow:	14Jun2019, 00:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	14.7 (ACRE-FT)	Peak Storage:	14.7 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	394.1 (FT)

Summary Results for Reservoir "Sinkhole SW"

Project: Vertedero Toa Alta   Simulation Run: Existing 24HR-90%
Reservoir: Sinkhole SW

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	15Jun2019, 00:00	Meteorologic Model:	100YR-24 HR 90%
Compute Time:	12Dec2022, 13:47:44	Control Specifications:	48 Hours

Volume Units: ○ IN ● ACRE-FT

Computed Results

Peak Inflow:	27.7 (CFS)	Date/Time of Peak Inflow:	14Jun2019, 00:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	9.1 (ACRE-FT)	Peak Storage:	9.1 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	390.5 (FT)

Summary Results for Reservoir "North Pond"

Project: Vertedero Toa Alta   Simulation Run: Existing 24HR-90%
Reservoir: North Pond

Start of Run:	13Jun2019, 00:00	Basin Model:	Existing Conditions
End of Run:	15Jun2019, 00:00	Meteorologic Model:	100YR-24 HR 90%
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	48 Hours

Volume Units: ○ IN ● ACRE-FT

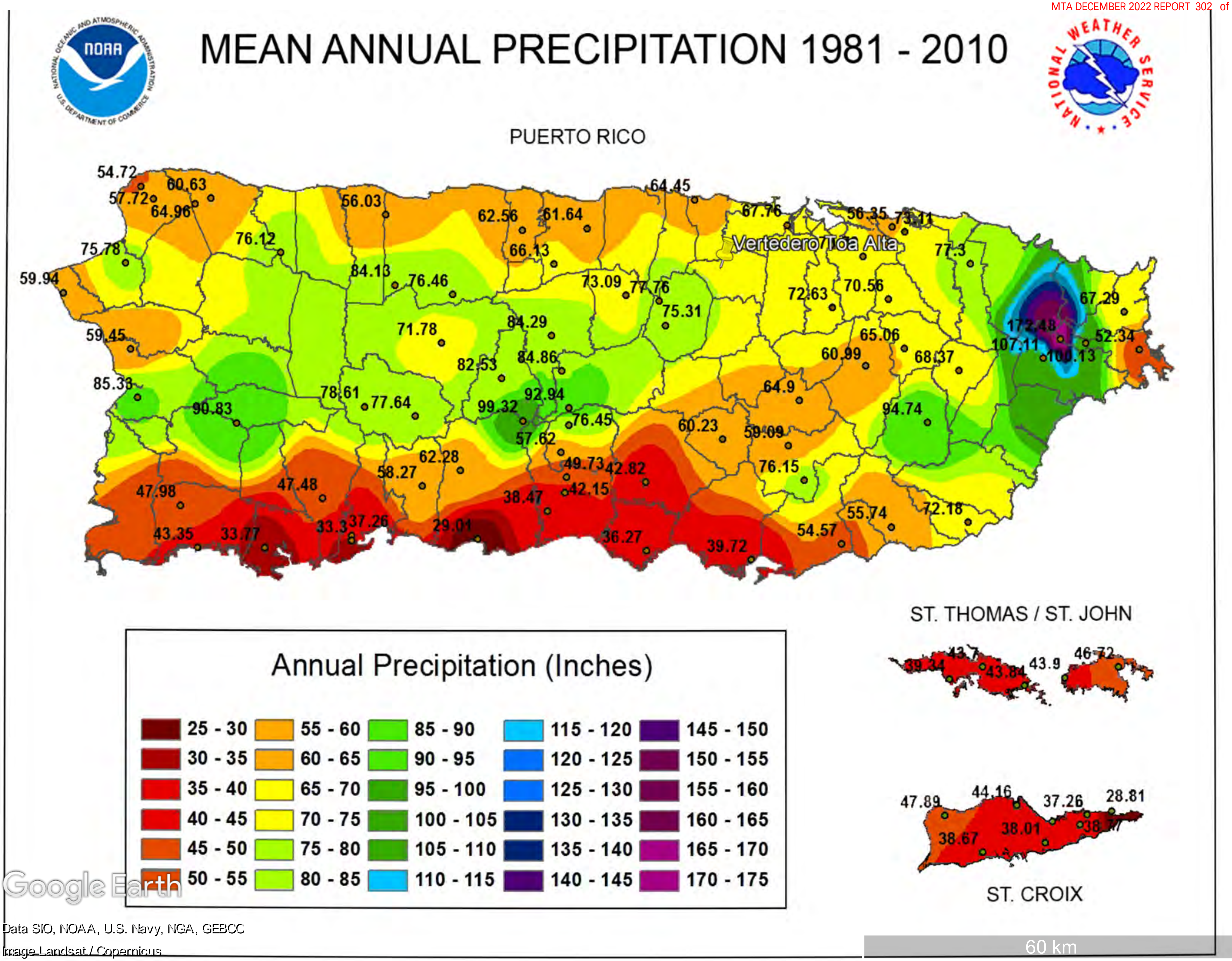
Computed Results

Peak Inflow:	59.0 (CFS)	Date/Time of Peak Inflow:	14Jun2019, 00:00
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	13Jun2019, 00:00
Inflow Volume:	19.8 (ACRE-FT)	Peak Storage:	19.8 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	367.6 (FT)

PRIVILEGED AND CONFIDENTIAL

APPENDIX J

NOAA MEAN ANNUAL RAINFALL


MEAN ANNUAL PRECIPITATION 1981 - 2010
PUERTO RICO
54.72
60.63
57.72
64.96
75.78
76.12
56.03
62.56
61.64
64.45
67.76
56.35
73.11
59.94
66.13
84.13
76.46
73.09
77.76
Vertedero Toa Alta
77.3
75.31
72.63
70.56
67.29
71.78
84.29
65.06
172.48
52.34
59.45
107.11
100.13
82.53
84.86
60.99
68.37
85.33
64.9
78.61
77.64
92.94
90.83
99.32
94.74
76.45
60.23
59.09
57.62
62.28
49.73
42.82
58.27
76.15
47.98
47.48
42.15
38.47
72.18
55.74
43.35
33.77
33.3
37.26
29.01
36.27
54.57
39.72
ST. THOMAS / ST. JOHN
39.34
43.7
43.84
43.9
46.72
ST. CROIX
47.89
44.16
37.26
28.81
38.67
38.01
38.77
Annual Precipitation (Inches)
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
140 - 145
145 - 150
150 - 155
155 - 160
160 - 165
165 - 170
170 - 175
Google Earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
60 km

PRIVILEGED AND CONFIDENTIAL

APPENDIX K

ELEVATION STORAGE

North Pond

Elevation (m)	Area (m²)	Elevation (ft)	Area (acres)	Volume (Conic Formula) AC-Ft	Total Volume (Ac-Ft)
101	45.82	331.4	0.01132237		0
102	73.34	334.7	0.01812271	0.047869354	0.047869354
103	134.15	337.9	0.03314919	0.082880423	0.130749777
104	198.6	341.2	0.04907513	0.134037526	0.264787303
106	455	347.8	0.11243295	0.51574923	0.780536533
107	692	351.1	0.17099692	0.461622049	1.242158581
108	1189	354.3	0.2938083	0.753480273	1.995638855
109	2587	357.6	0.63926163	1.494443444	3.490082299
110	6868	360.9	1.69711977	3.694371468	7.184453767
111	7635	364.2	1.8866496	5.876431163	13.06088493
112	8344	367.5	2.06184731	6.475382692	19.53626762
113	8968	370.8	2.21604107	7.016355807	26.55262343
114	9624	374.0	2.3781422	7.535193353	34.08781678
115	10339	377.3	2.55482255	8.090797941	42.17861472
116	11269	380.6	2.78463056	8.756667254	50.93528198
117	12048	383.9	2.97712565	9.450402208	60.38568418
118	12775	387.2	3.15677127	10.06121905	70.44690323
119	13532	390.4	3.34383004	10.66276441	81.10966764

$$V = d\left(\frac{A_1 + \sqrt{A_1 A_2} + A_2}{3}\right)$$

Where:
V = storage
d = change in elevation between points 1 and 2
A1 = surface area at elevation 1
A2 = surface area at elevation 2

South Pond

Elevation (m)	Area (m²)	Elevation (ft)	Area (acres)	Volume (Conic Formula) AC-Ft	Total Volume (Ac-Ft)
110	21	360.9	0.00518921		0
111	212	364.2	0.05238634	0.0810005	0.0810005
112	1101	367.5	0.27206303	0.485405059	0.566405559
113	1341	370.8	0.33136832	0.988331637	1.554737197
114	1560	374.0	0.3854844	1.174878298	2.729615495
115	1796	377.3	0.44380127	1.359320476	4.088935971
116	2051	380.6	0.50681314	1.558339681	5.647275651
117	2318	383.9	0.57279028	1.769985954	7.417261605
118	2613	387.2	0.64568637	1.997717479	9.414979085
119	2960	390.4	0.73143193	2.257701406	11.67268049
120	3369	393.7	0.83249803	2.563839502	14.23651999
121	5219	397.0	1.28964299	3.45412735	17.69064734
122	8930	400.3	2.20665107	5.668738593	23.35938594
123	10728	403.6	2.65094655	7.957754705	31.31714064
124	12208	406.8	3.01666251	9.291253658	40.6083943
125	13501	410.1	3.33616977	10.417425	51.0258193
126	14661	413.4	3.62281202	11.41298006	62.43879936
127	15808	416.7	3.90624189	12.34849464	74.787294
128	17038	420.0	4.21018151	13.31187954	88.09917354
129	18454	423.2	4.56008273	14.38380014	102.4829737
130	20000	426.5	4.94210766	15.58414226	118.0671159
131	21391	429.8	5.28583124	16.77577456	134.8428905

Sinkhole Ponding Area at Southwest

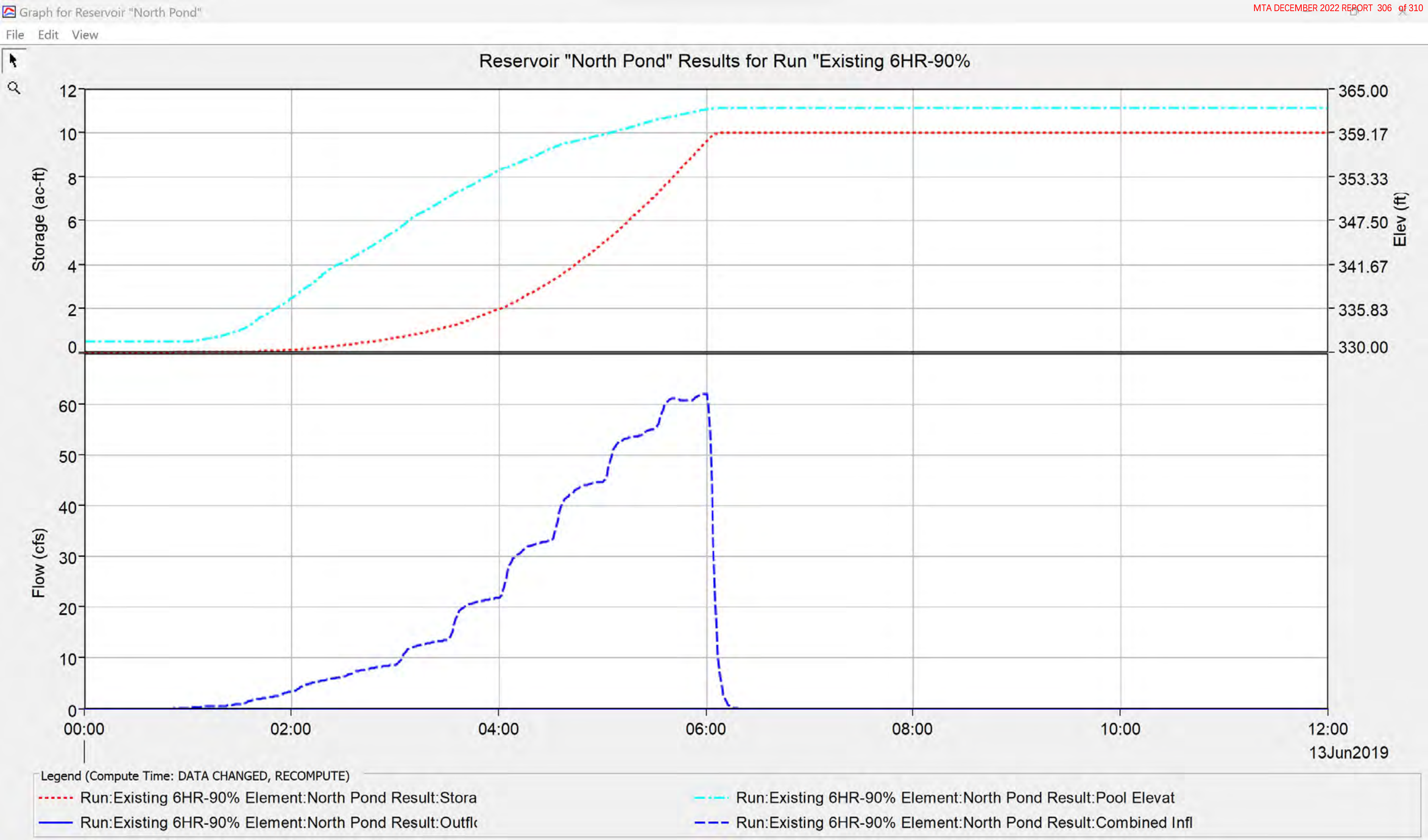
Elevation (m)	Area (m²)	Elevation (ft)	Area (acres)		
114	126	374.0	0.03113528		0
115	617	377.3	0.15246402	0.276148478	0.276148478
116	1431	380.6	0.3536078	0.807412988	1.083561465
117	2248	383.9	0.5554929	1.478966677	2.562528142
118	4097	387.2	1.01239075	2.534901585	5.097429726
119	5614	390.4	1.38724962	3.920500293	9.017930019
120	7687	393.7	1.89949908	5.369948669	14.38787869

Hydrologic/Hydraulic Preliminary Report
Existing Conditions Evaluation
Vertedero Municipal de Toa Alta
Project Location: PR-165, Km. 8.2
Contorno Ward
Toa Alta, Puerto Rico
CES Project No. 22-0025

PRIVILEGED AND CONFIDENTIAL

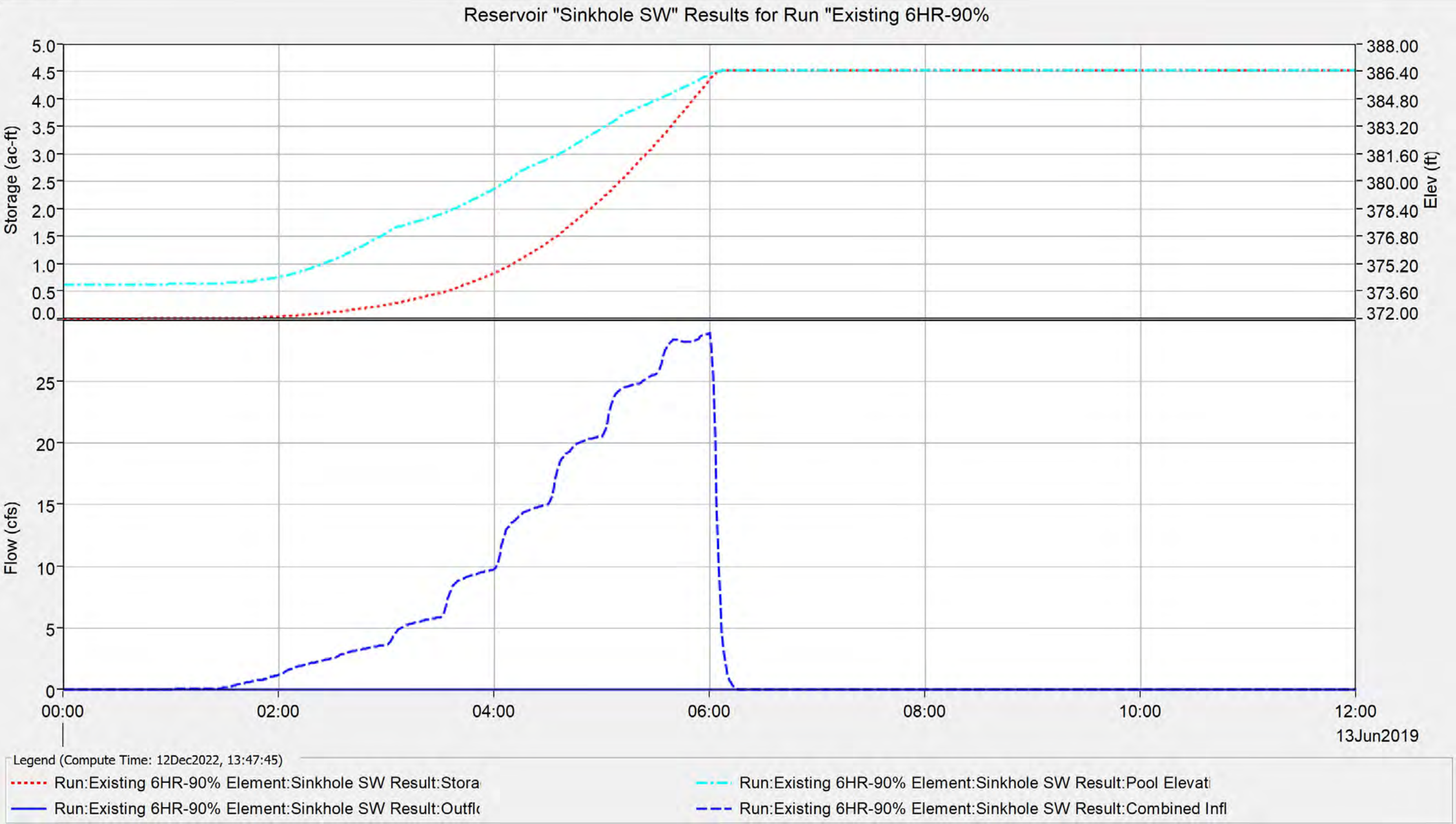
APPENDIX L

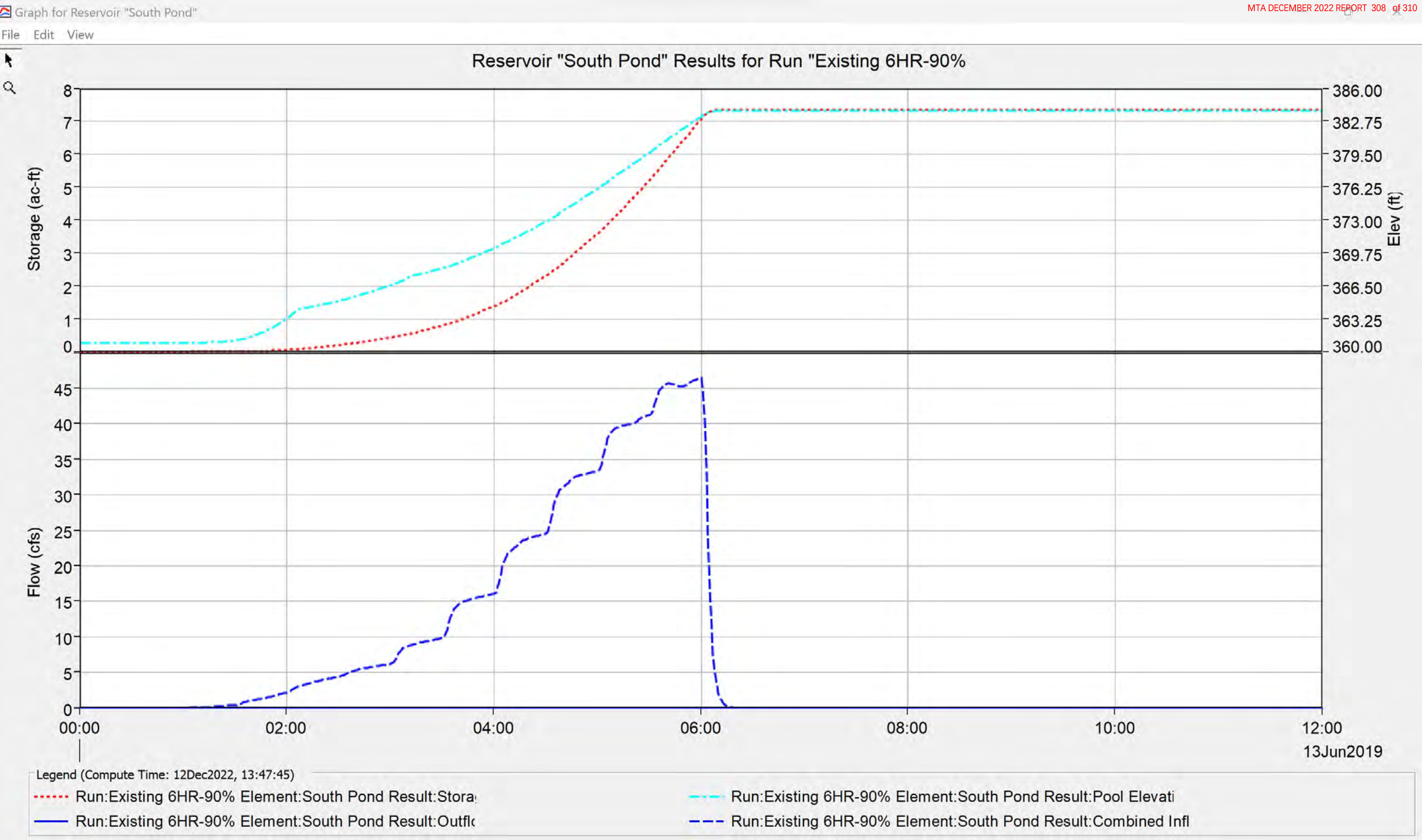
STAGE-STORAGE-DISCHARGE


Graph for Reservoir "North Pond"
File Edit View
Reservoir "North Pond" Results for Run "Existing 6HR-90%
Storage (ac-ft)
12
10
8
6
4
2
0
Elev (ft)
365.00
359.17
353.33
347.50
341.67
335.83
330.00
Flow (cfs)
60
50
40
30
20
10
0
00:00
02:00
04:00
06:00
08:00
10:00
12:00
13Jun2019
Legend (Compute Time: DATA CHANGED, RECOMPUTE)
Run:Existing 6HR-90% Element:North Pond Result:Stora
Run:Existing 6HR-90% Element:North Pond Result:Pool Elevat
Run:Existing 6HR-90% Element:North Pond Result:Outfl
Run:Existing 6HR-90% Element:North Pond Result:Combined Infl

Graph for Reservoir "Sinkhole SW"

File Edit View




Graph for Reservoir "South Pond"
File Edit View
Reservoir "South Pond" Results for Run "Existing 6HR-90%
Storage (ac-ft)
Elev (ft)
386.00
382.75
379.50
376.25
373.00
369.75
366.50
363.25
360.00
Flow (cfs)
00:00
02:00
04:00
06:00
08:00
10:00
12:00
13Jun2019
Legend (Compute Time: 12Dec2022, 13:47:45)
Run:Existing 6HR-90% Element:South Pond Result:Stora
Run:Existing 6HR-90% Element:South Pond Result:Pool Elevati
Run:Existing 6HR-90% Element:South Pond Result:Outflc
Run:Existing 6HR-90% Element:South Pond Result:Combined Infl

ATTACHMENT 3

PRELIMINARY

SURVEY PLAN LECHATE SEEPAGES

FOR DISCUSSION ONLY

T.A. LAND FILL - LIXIVIADOS LOCATIONS				
Point	Northing	Easting	Elevation	Description
101	259607.683	217992.552	141.17	F101
102	259614.017	217989.048	141.43	F102
103	259615.326	217986.952	142.19	F103
104	259617.073	217985.610	142.33	F104
105	259619.382	217985.014	141.77	F105
106	259631.861	217979.142	142.38	F106
107	259664.996	217954.490	138.76	F107
108	259671.549	217943.288	136.58	F108
109	259676.734	217929.300	135.78	F109
110	259683.463	217919.168	132.82	F110
111	259684.808	217906.588	130.44	F111
112	259681.958	217897.972	128.89	F112
113	259680.667	217893.661	127.95	F113
114	259680.163	217888.097	126.70	F114
115	259678.414	217877.594	124.60	F116
116	259677.160	217872.095	123.57	F116
117	259676.107	217867.871	123.24	F117
118	259675.336	217858.363	121.93	F118
119	259674.404	217853.496	121.58	F119
120	259674.295	217851.557	121.34	F220
121	259674.184	217848.096	120.63	F221
122	259673.874	217845.769	120.49	F222
123	259674.612	217835.045	119.21	F223
124	259674.931	217832.621	119.16	F224
125	259675.595	217831.471	118.88	F225
126	259676.092	217827.867	119.13	F226
127	259677.980	217823.134	117.88	F227
128	259678.936	217819.417	118.17	F228
129	259680.756	217815.410	117.68	F229
130	259681.828	217812.338	117.48	F230
131	259684.069	217808.338	117.45	F231
132	259685.796	217805.250	117.28	F232
133	259686.561	217804.016	117.30	F233
134	259688.862	217799.849	117.09	F234
135	259689.534	217798.191	116.91	F235
136	259690.908	217795.443	117.23	F236
137	259692.987	217794.116	116.86	F237
138	259694.189	217792.485	116.75	F238
139	259697.470	217789.885	116.41	F239
140	259700.240	217786.607	116.48	F240
141	259702.889	217784.170	116.27	F241
142	259705.598	217782.678	116.21	F242
143	259707.834	217780.843	115.93	F243
144	259711.683	217778.576	115.91	F244
145	259714.352	217776.826	115.77	F245
146	259725.359	217771.288	115.18	F246
147	259726.483	217770.863	115.08	F247
148	259744.587	217761.943	113.24	F248
149	259750.421	217759.211	112.81	F249
150	259753.327	217757.891	112.54	F250
151	259759.603	217754.889	112.49	F251
200	259628.484	217947.300	149.44	F200
201	259628.204	217945.427	149.85	F201
202	259630.089	217940.301	149.86	F202
203	259630.898	217934.746	150.08	F203
204	259631.761	217932.767	149.95	F204
205	259631.404	217929.871	150.25	F205
206	259632.496	217929.085	149.80	F206
207	259631.337	217923.538	150.41	F207
208	259629.005	217916.946	150.58	F208
209	259629.009	217915.237	150.18	F209
210	259624.284	217907.562	150.44	F210
211	259622.735	217906.475	150.93	F211
212	259613.499	217894.388	151.85	F212
213	259611.412	217890.562	151.97	F213
214	259609.855	217890.204	152.59	F214
215	259608.053	217888.450	152.86	F215
216	259605.672	217884.825	152.77	F216
217	259602.636	217881.763	153.21	F217
218	259599.526	217877.193	153.92	F218
219	259598.583	217876.300	154.07	F219
220	259597.579	217874.561	154.48	F220
221	259597.597	217873.745	154.23	F221
222	259595.116	217870.556	155.15	F222
223	259591.368	217865.150	155.77	F223
224	259587.133	217858.131	156.60	F224
225	259583.006	217850.490	157.27	F225
226	259579.595	217842.550	158.03	F226
227	259579.381	217839.598	158.11	F227
228	259580.676	217803.682	161.11	F228
300	259770.334	217752.529	112.53	F300
301	259768.958	217751.147	112.45	F301
302	259772.363	217748.562	112.82	F302
303	259664.813	217643.127	144.70	F303
304	259430.337	217839.223	142.19	F304
DICIEMBRE 17, 2022				

LEYENDA:

- ESTACION DE CONTROL HORIZONTAL
- PUNTO COLINDACIA
- LINEA DE COLINDANCIA
- TORRE ELÉCTRICA EXISTENTE
- CONTORNO INTERVALOS DE UN (1.00) METRO
- CONTORNO INTERVALOS DE CINCO (5.00) METROS
- CAMINO EN TIERRA
- ESTRUCTURAS EN HORMIGÓN EXISTENTE (RESIDENCIAS)
- SUMIDERO LIXIVIADOS IDENTIFICADOS POR PERSONAL TERRATEK

NOTAS GENERALES:

1. TODAS LAS DISTANCIAS EXCEPTO LAS INDICADAS SE HAN EXPRESADO EN EL SISTEMA MÉTRICO.
2. LA LOCALIZACIÓN DE LOS PUNTOS SE HA HECHO CON UN MEDIDOR DE DISTANCIA ELECTRÓNICO TOTAL STATION "TOPCON" GTS 230 & COLECTOR DE DATOS NOMAD TRIMBLE.
3. LA MENSURA SE REALIZO POR LOS PUNTOS DE COLINDANCIA EXISTENTES SUJETOS A CONFORMIDAD DE COLINDANTES Y POSIBLE RECTIFICACIÓN.
4. CONTORNOS A INTERALOS DE UN (1.00) METRO.
5. ESTA MENSURA Y TOPOGRAFIA SE LLEVA A CABO A PETICIÓN DE TERRATEK ENGINEERING GROUP, PSC.
6. EL SISTEMA HORIZONTAL ESTA REFERENCIADO A NAD–83 DE PUERTO RICO.
7. SE UTILIZO EQUIPO DE POSICIONAMIENTO GPS GLOBAL ESTACION VIRTUAL (VRS). DATUM: NAD–83 (2011) EP GEOID:G18PR.
8. ESTE TRABAJO CUENTA CON EL APOYO DE FOTOGRAMETRÍA A TRAVÉS DEL EL USO DE "DRONE".
9. PARA LA PREPARACIÓN DE ESTE PLANO SE UTILIZO DATA DEL PLANO CONFECCIONADO POR EL AGRIMENSOR JOSÉ M. COUVERTIER Y CERTIFICADO POR EL ING. EMILIO GUTIÉRREZ DEL ARROYO, LIC. #16,789. DEL MISMO SE UTILIZA DATOS TABLA DE MENSURA.

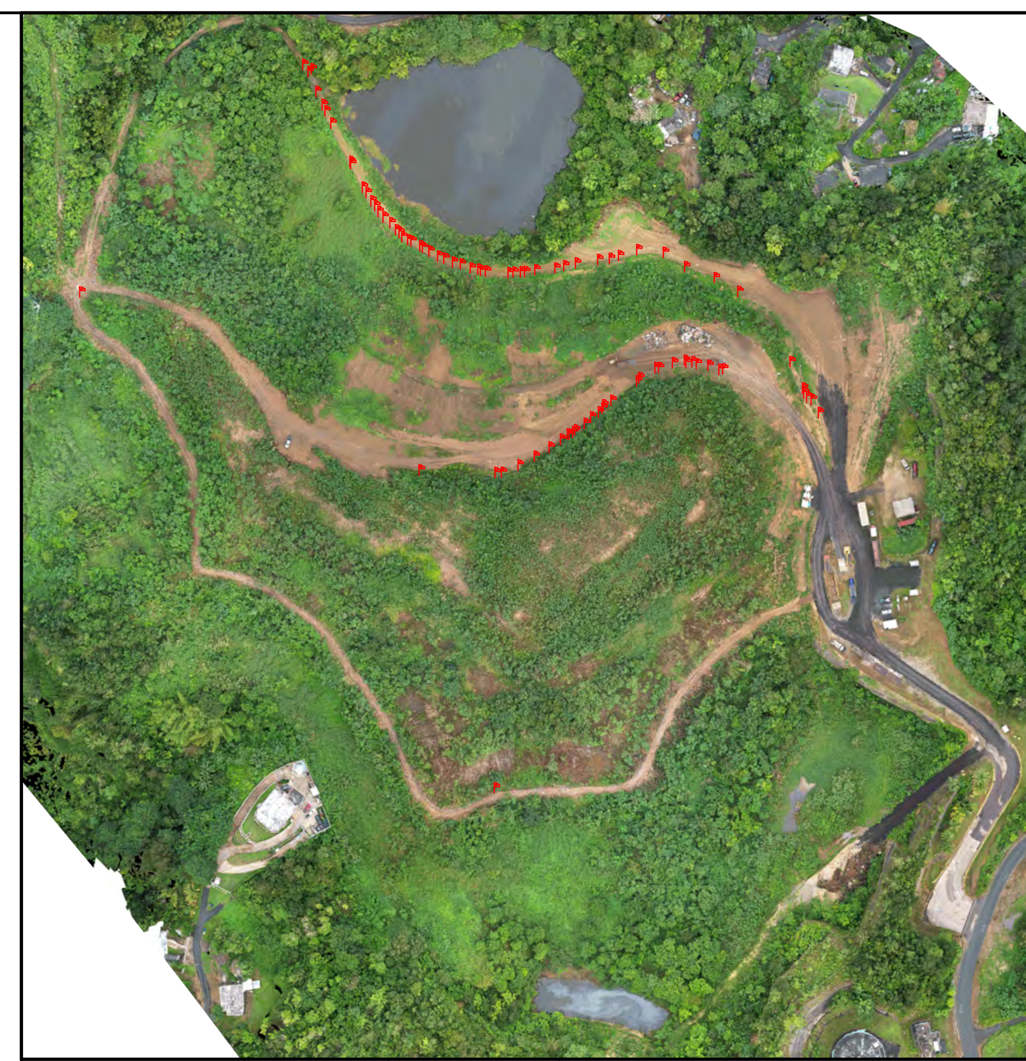
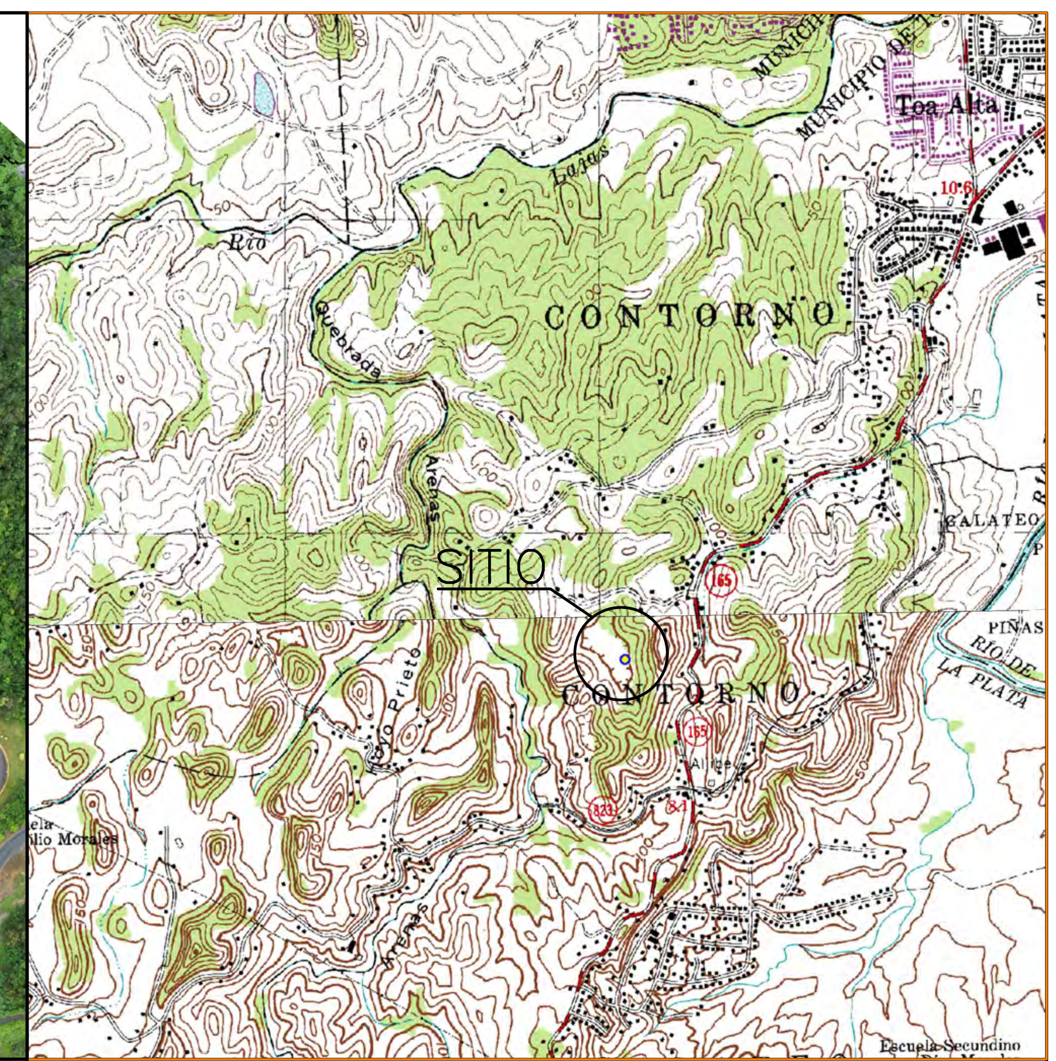
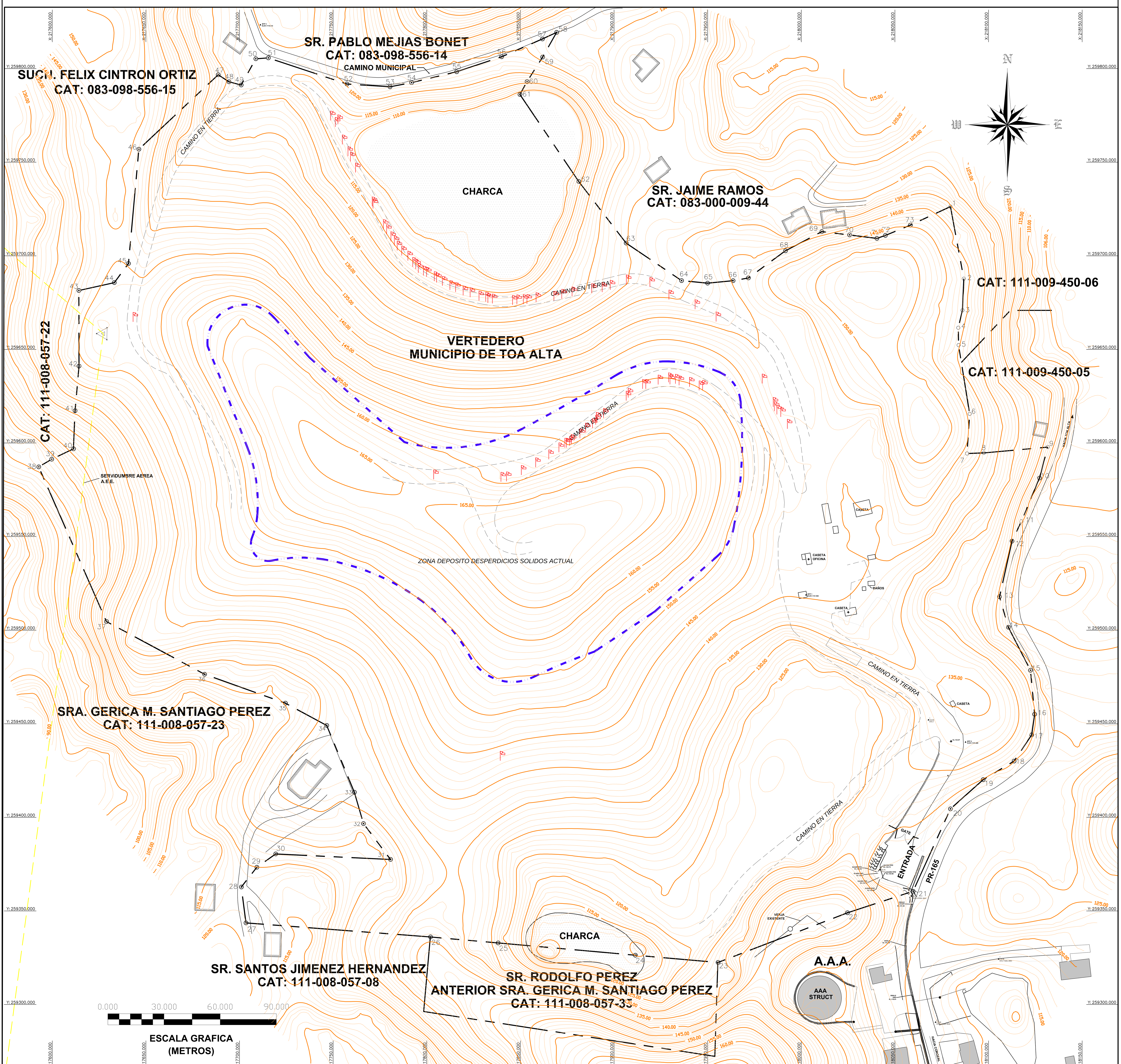


FOTO AÉREA (DRONE) N.T.S.
CONDICIONES EXISTENTES PARA DICIEMBRE 17, 2022



MAPA DE LOCALIZACION 1:20,000
COORD. LAMBERT NAD–83 X= 217,876.00 Y= 259,575.00



PLANO TOPOGRÁFICO "ASBUILT" CONDICIONES EXISTENTES
IDENTIFICACIÓN SUMIDEROS LIXIVIADOS EXISTENTES

FINCA PROPIEDAD DEL MUNICIPIO DE TOA ALTA
VERTEDERO RESIDUOS SÓLIDOS
SITA: EN CARRETERA PR-165, KM. 9.0, Bo. MAMEY
TOA ALTA, PUERTO RICO

HECTOR TIRADO
CEL. 502-3278

CERTIFICO CORRECTO:

HECTOR TIRADO RODRIGUEZ, P.E., R.P.A.
INGENIERO CIVIL No. 12215

FECHA: DICIEMBRE 19, 2022
DIBUJADO POR: D. PASTRANA (3949)
ESCALA: 1: 1,000