Geosyntec consultants

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# Memorandum

**Date:** January 17, 2024

**To:** Billi Jo Huddleston, CHMM, Florida Power & Light Company

**From:** Ben Amos, Ph.D., P.E. and Lane Dorman, P.G., Geosyntec Consultants, Inc.

**Subject:** 2019 Groundwater Velocity Estimate, Gulf Clean Energy Center, Ash Landfill No. 1, Pensacola, FL

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## INTRODUCTION

On behalf of Florida Power & Light Company ("FPL"), Geosyntec Consultants, Inc. ("Geosyntec") prepared this *2019 Groundwater Velocity Estimate Memorandum* ("Memo") for FPL's Gulf Clean Energy Center ("GCEC") Coal Combustion Residuals ("CCR") unit Ash Landfill No. 1 ("LF1"). The purpose of this Memo is to document the calculated horizontal groundwater velocities at LF1 in 2019. This Memo supplements the summary of CCR groundwater monitoring activities conducted in 2019 and reported in the *2019 Annual Groundwater Monitoring Report* (Geosyntec, 2020[1]), in accordance with groundwater sampling and analysis requirements of 40 Code of Federal Regulations ("CFR") Section 257.93(c).

## GROUNDWATER VELOCITY CALCULATIONS

Groundwater flow rates were calculated based on the following:

1. Horizontal hydraulic gradients estimated from groundwater elevations measured during each sampling event in 2019.

2. The geometric mean (geomean) hydraulic conductivity (47 feet per day [ft/day]) for LF1 documented in the *Groundwater Hydraulic Conductivity Evaluation, Ash Landfill Number 1 and Ash Landfill Number 2* (Geosyntec, 2023[2]).

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[1] Geosyntec Consultants, 2020. *2019 Annual Groundwater Monitoring Report*, Gulf Power Company, Plant Crist, Ash Landfill No. 1. January 31, 2020.
[2] Geosyntec Consultants, Inc., 2023. *Groundwater Hydraulic Conductivity Evaluation, Ash Landfill Number 1 and Ash Landfill Number 2*, Florida Power & Light Company, July 2023

3. An estimated effective porosity of 0.25, based on the lithologic materials surrounding the screened interval (Sterrett, 2007[3]).

Input parameters and calculations are summarized in **Table 1**. Groundwater elevation maps from 2019 are included as **Figures 1, 2, and 3**.

Horizontal hydraulic gradients between MW-101 and MW-109, a monitoring well-pair representative of groundwater flow near LF1, were calculated based on groundwater elevation data from 2019 groundwater sampling events. The resulting horizontal gradients were approximately 0.0024 ft/ft, 0.0023 ft/ft, and 0.0017 ft/ft in February, May, and October 2019, respectively.

The geomean hydraulic conductivity for the uppermost aquifer adjacent to LF1 was estimated from pneumatic slug tests performed at six monitoring wells around LF1 (Geosyntec, 2023). The lithology of this aquifer generally consists of fine to coarse sand (SCS, 2017[4]); the geomean hydraulic conductivity (47 ft/day) is within the anticipated hydraulic conductivity range for a fine to coarse sand (Freeze and Cherry, 1979[5]).

The horizontal groundwater flow velocity was calculated using a form of Darcy's Law:

$V = (K*i)/n_e$

Where:

V = groundwater velocity (ft/day);

K = hydraulic conductivity (ft/day);

i = horizontal hydraulic gradient (ft/ft); and

$n_e$ = effective porosity (unitless).

The calculated horizontal groundwater flow velocities at LF1 were 0.45 ft/day (164 ft/year), 0.44 ft/day (160 ft/year), and 0.32 ft/day (117 ft/year) in February, May, and October 2019, respectively.

## CLOSING

In accordance with the groundwater sampling and analysis requirements of 40 CFR Section 257.93(c), the horizontal groundwater velocities calculated for the selected well pair at LF1 (i.e., MW-101 and MW-109) were approximately 0.45 ft/day (164 ft/year), 0.44 ft/day (160 ft/year), and 0.32 ft/day (117

[3] Sterret, R.J., 2007. *Groundwater and Wells*, Third Edition, New Brighton, MN: Johnson Screens, A Weatherford Company.
[4] Southern Company Services, 2017. *Gulf Power Company, Plant Crist, Ash Landfill No. 1, Ash Landfill No. 2, and Gypsum Storage Area Well Design, Installation, Development and Decommissioning Report*, October.
[5] Freeze, R.A. and J.A. Cherry, 1979. *Groundwater*, Englewood Cliffs, NJ: Prentice Hall.

ft/year) in February, May, and October 2019, respectively. The calculated horizontal groundwater velocities for 2019 are similar to those calculated previously (Geosyntec, 2023[6]). This Memo has been prepared under the supervision of a State of Florida licensed Professional Engineer and Professional Geologist with Geosyntec.

[6] Geosyntec Consultants, Inc., 2023. *2022 Annual Groundwater Monitoring Report*, Florida Power & Light Company, Gulf Clean Energy Center Ash Landfill No.1, January 31, 2023

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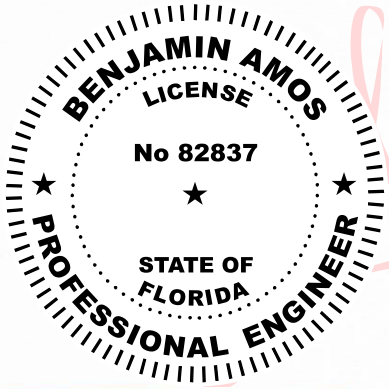


This document has been electronically signed and sealed by Benjamin Amos P.E. on 17 January 2024 using a SHA-1 authentication code. Printed copies of this document are not considered signed and sealed, and the SHA-1 authentication code must be verified on any electronic copies.
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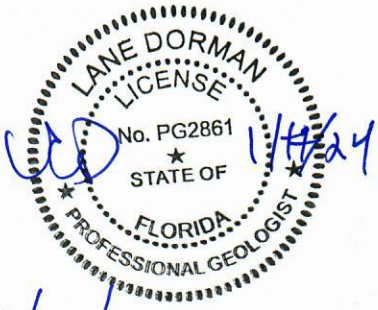
Benjamin K. Amos, Ph.D., P.E.
Florida Professional Engineer No. 82837

Date




1/17/24

Lane Dorman, P.G.
Florida Professional Geologist No. PG2861

1/17/24
Date

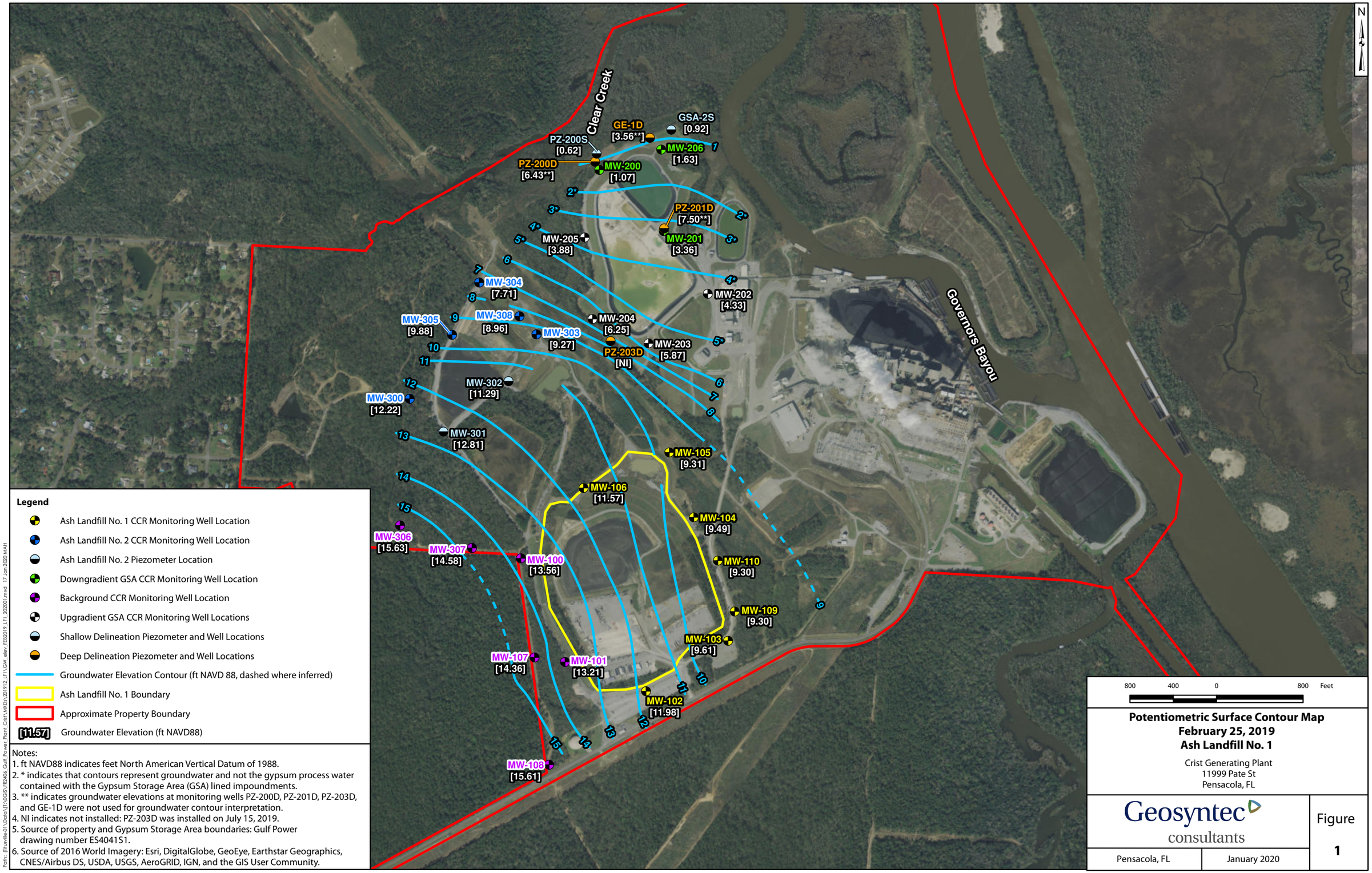
# TABLE

# Table 1. 2019 Groundwater Velocity Input Parameters and Calculations
# Gulf Clean Energy Center, Landfill Number 1
# Pensacola, FL

| Flow Paths | Groundwater Elevation (ft)[1,2] | | Change in Groundwater Elevation ($\Delta h$)[3] (ft) | Distance ($\Delta l$)[3] (ft) | Hydraulic Gradient ($\Delta h/\Delta l$)[3] (ft/ft)[4] | Hydraulic Conductivity[5], K (ft/day)[6] | Effective Porosity ($n_e$) | Linear Groundwater Velocity[7] | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | ft/day | ft/year[8] |
| MW-101/MW-109 | Feb-19 | 13.21 | 3.91 | 1637 | 0.0024 | 47 | 0.25 | 0.45 | 163.9 |
| | | 9.30 | | | | | | | |
| MW-101/MW-109 | May-19 | 13.99 | 3.81 | | 0.0023 | | | 0.44 | 159.7 |
| | | 10.18 | | | | | | | |
| MW-101/MW-109 | Oct-19 | 11.40 | 2.80 | | 0.0017 | | | 0.32 | 117.4 |
| | | 8.60 | | | | | | | |

Notes:
1. Elevations are in feet relative to the North American Vertical Datum of 1988
2. ft = feet
3. $\Delta h$ = Change in groundwater elevation, $\Delta l$= Distance along flow path
4. ft/ft = feet per foot
5. K values were calculated based on 2023 slug tests
6. ft/day = feet per day
7. Groundwater flow velocity equation = $(\Delta h/\Delta l * K)/n_e$
8. ft/year = feet per year

# FIGURES




**Legend**

- Ash Landfill No. 1 CCR Monitoring Well Location
- Ash Landfill No. 2 CCR Monitoring Well Location
- Ash Landfill No. 2 Piezometer Location
- Downgradient GSA CCR Monitoring Well Location
- Background CCR Monitoring Well Location
- Upgradient GSA CCR Monitoring Well Locations
- Shallow Delineation Piezometer and Well Locations
- Deep Delineation Piezometer and Well Locations
- Groundwater Elevation Contour (ft NAVD 88, dashed where inferred)
- Ash Landfill No. 1 Boundary
- Approximate Property Boundary
- [11.57] Groundwater Elevation (ft NAVD88)

Notes:
1. ft NAVD88 indicates feet North American Vertical Datum of 1988.
2. * indicates that contours represent groundwater and not the gypsum process water contained with the Gypsum Storage Area (GSA) lined impoundments.
3. ** indicates groundwater elevations at monitoring wells PZ-200D, PZ-201D, PZ-203D, and GE-1D were not used for groundwater contour interpretation.
4. NI indicates not installed: PZ-203D was installed on July 15, 2019.
5. Source of property and Gypsum Storage Area boundaries: Gulf Power drawing number ES4041S1.
6. Source of 2016 World Imagery: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

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**Potentiometric Surface Contour Map**
**February 25, 2019**
**Ash Landfill No. 1**

Crist Generating Plant
11999 Pate St
Pensacola, FL

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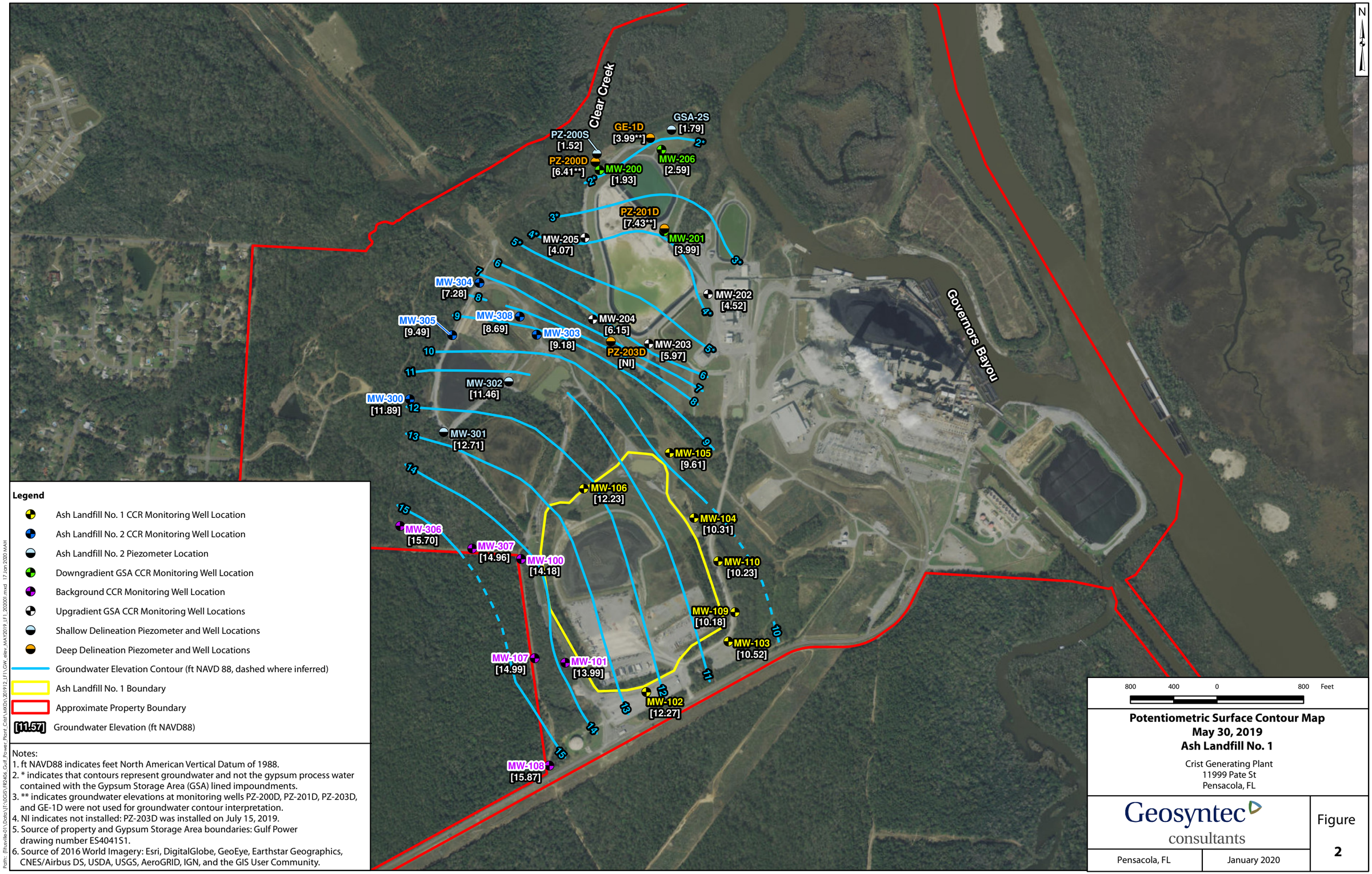
Figure **1**




**Legend**

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**Potentiometric Surface Contour Map**
**May 30, 2019**
**Ash Landfill No. 1**

Crist Generating Plant
11999 Pate St
Pensacola, FL

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Figure 2

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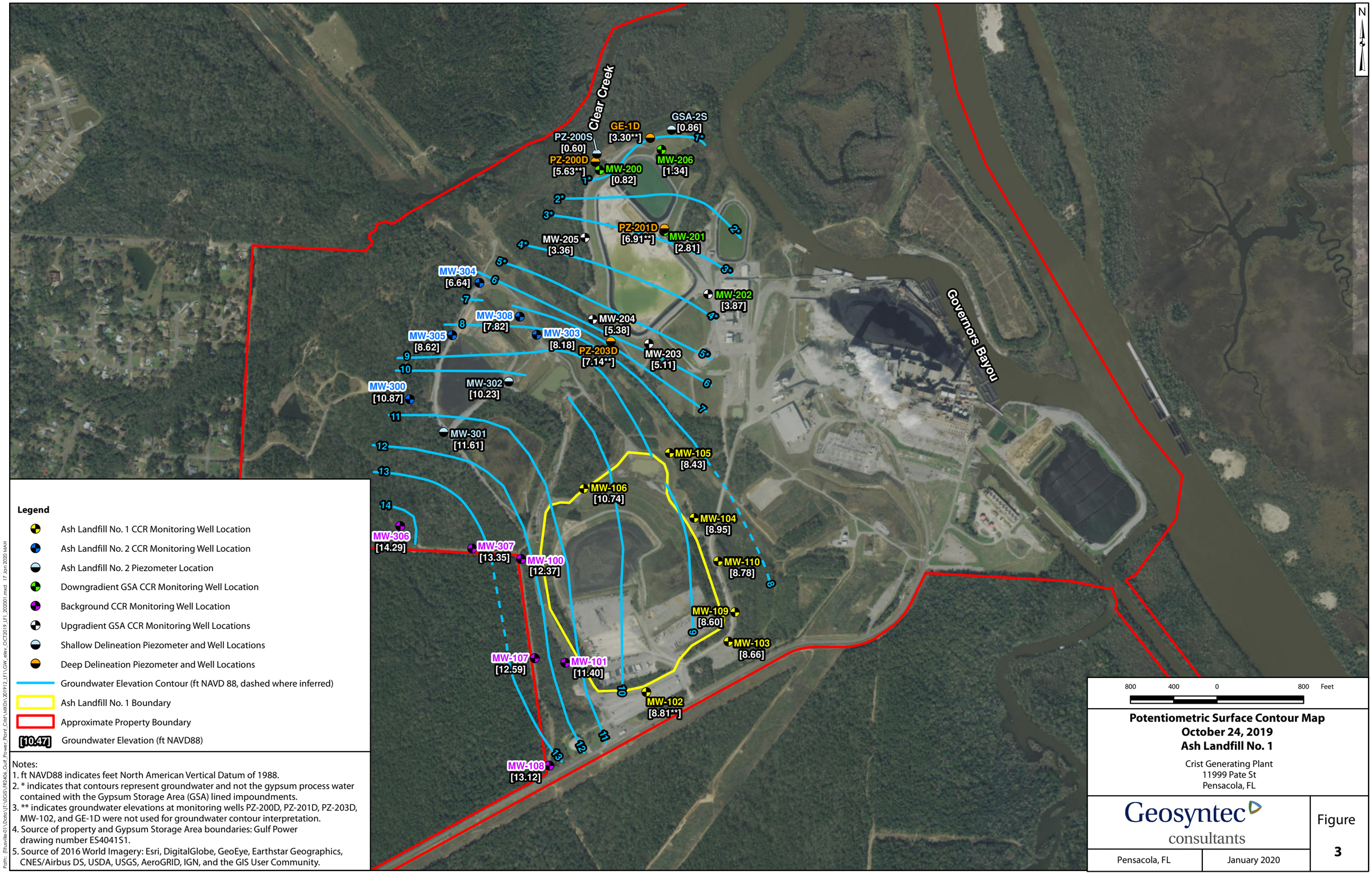


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- Deep Delineation Piezometer and Well Locations
- Groundwater Elevation Contour (ft NAVD 88, dashed where inferred)
- Ash Landfill No. 1 Boundary
- Approximate Property Boundary
- [10.47] Groundwater Elevation (ft NAVD88)

Notes:
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4. Source of property and Gypsum Storage Area boundaries: Gulf Power drawing number ES4041S1.
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**Potentiometric Surface Contour Map**
**October 24, 2019**
**Ash Landfill No. 1**

Crist Generating Plant
11999 Pate St
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Figure **3**