

## 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:** 2018 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 *2018 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 2018. This Memo supplements the summary of CCR groundwater monitoring activities conducted in 2018 and reported in the *2018 Annual Groundwater Monitoring Report* (Geosyntec, 2019<sup>1</sup>), 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 2018.
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<sup>2</sup>).

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<sup>1</sup> Geosyntec Consultants, 2019. *2018 Annual Groundwater Monitoring Report*, Gulf Power Company, Plant Crist, Ash Landfill No. 1. January 31, 2019.

<sup>2</sup> Geosyntec Consultants, Inc., 2023. *Groundwater Hydraulic Conductivity Evaluation, Ash Landfill Number 1 and FR8309/PR23035*

3. An estimated effective porosity of 0.25, based on the lithologic materials surrounding the screened interval (Sterrett, 2007<sup>3</sup>).

Input parameters and calculations are summarized in **Table 1**. Groundwater elevation maps from 2018 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 2018 groundwater sampling events. The resulting horizontal gradients were approximately 0.0024 ft/ft, 0.0019 ft/ft, and 0.0018 ft/ft in March, June, and October 2018, 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<sup>4</sup>); the geomean hydraulic conductivity (47 ft/day) is within the anticipated hydraulic conductivity range for a fine to coarse sand (Freeze and Cherry, 1979<sup>5</sup>).

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

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*Ash Landfill Number 2*, Florida Power & Light Company, July 2023

<sup>3</sup> Sterret, R.J., 2007. *Groundwater and Wells*, Third Edition, New Brighton, MN: Johnson Screens, A Weatherford Company.

<sup>4</sup> 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.

<sup>5</sup> Freeze, R.A. and J.A. Cherry, 1979. *Groundwater*, Englewood Cliffs, NJ: Prentice Hall.

$n_e$  = effective porosity (unitless).

The calculated horizontal groundwater flow velocities at LF1 were 0.45 ft/day (165 ft/year), 0.35 ft/day (128 ft/year), and 0.34 ft/day (124 ft/year) in March, June, and October 2018, 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 (165 ft/year), 0.35 ft/day (128 ft/year), and 0.34 ft/day (124 ft/year) in March, June, and October 2018, respectively. The calculated horizontal groundwater velocities for 2018 are similar to those calculated previously (Geosyntec, 2023<sup>6</sup>). This Memo has been prepared under the supervision of a State of Florida licensed Professional Engineer and Professional Geologist with Geosyntec.

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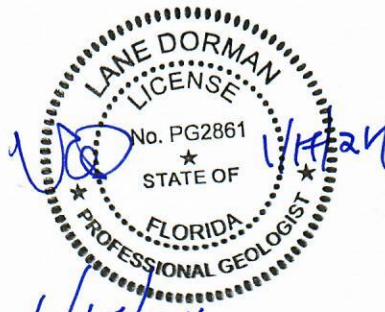
<sup>6</sup> Geosyntec Consultants, Inc., 2023. *2022 Annual Groundwater Monitoring Report*, Florida Power & Light Company, Gulf Clean Energy Center Ash Landfill No.1, January 31, 2023  
FR8309/PR23035

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Florida Professional Engineer No. 82837

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Date



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

  
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Date

# TABLE

**Table 1. 2018 Groundwater Velocity Input Parameters and Calculations  
Gulf Clean Energy Center, Landfill Number 1  
Pensacola, FL**

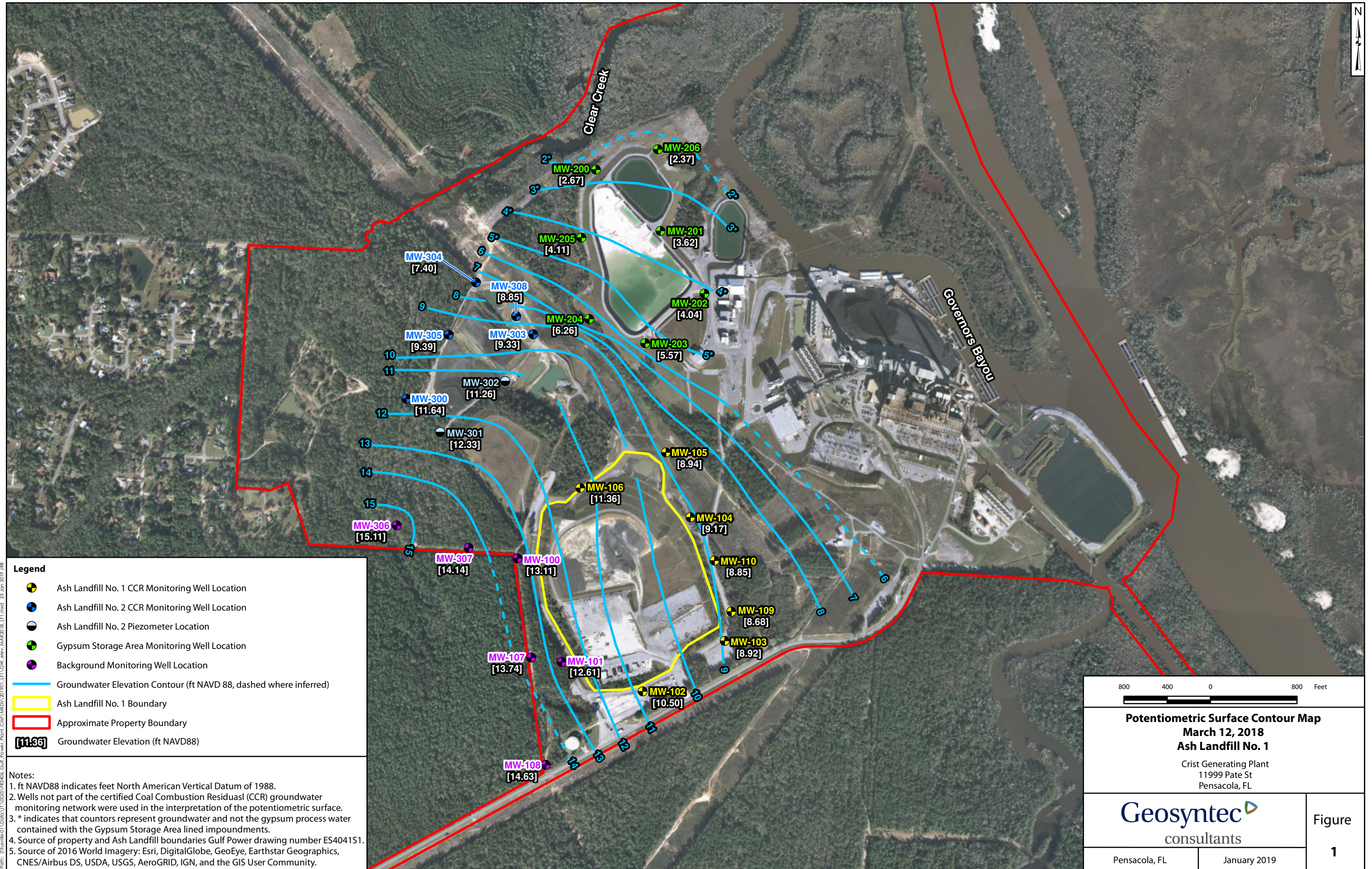
Flow Paths	Groundwater Elevation (ft) <sup>1,2</sup>		Change in Groundwater Elevation ( $\Delta h$ ) <sup>3</sup> (ft)	Distance ( $\Delta l$ ) <sup>3</sup> (ft)	Hydraulic Gradient ( $\Delta h/\Delta l$ ) <sup>3</sup> (ft/ft) <sup>4</sup>	Hydraulic Conductivity <sup>5</sup> , K (ft/day) <sup>6</sup>	Effective Porosity ( $n_e$ )	Linear Groundwater Velocity <sup>7</sup>	
								ft/day	ft/year <sup>8</sup>
MW-101/MW-109	Mar-18	12.61	3.93	1637	0.0024	47	0.25	0.45	164.7
		8.68							
MW-101/MW-109	Jun-18	11.38	3.05						
		8.33							
MW-101/MW-109	Oct-18	10.45	2.96		0.0018			0.34	124.1
		7.49							

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
- Gypsum Storage Area Monitoring Well Location
- Background Monitoring Well Location
- Groundwater Elevation Contour (ft NAVD 88, dashed where inferred)
- Ash Landfill No. 1 Boundary
- Approximate Property Boundary
- Groundwater Elevation (ft NAVD88)

**Notes:**

1. ft NAVD88 indicates feet North American Vertical Datum of 1988.
2. Wells not part of the certified Coal Combustion Residuals (CCR) groundwater monitoring network were used in the interpretation of the potentiometric surface.
3. \* indicates that contours represent groundwater and not the gypsum process water contained with the Gypsum Storage Area lined impoundments.
4. Source of property and Ash Landfill boundaries Gulf Power drawing number ES4041S1.
5. Source of 2016 World Imagery: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

800 400 0 800 Feet

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**Potentiometric Surface Contour Map**  
**March 12, 2018**  
**Ash Landfill No. 1**  
 Crist Generating Plant  
 11999 Pate St  
 Pensacola, FL

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**Geosyntec**  
 consultants

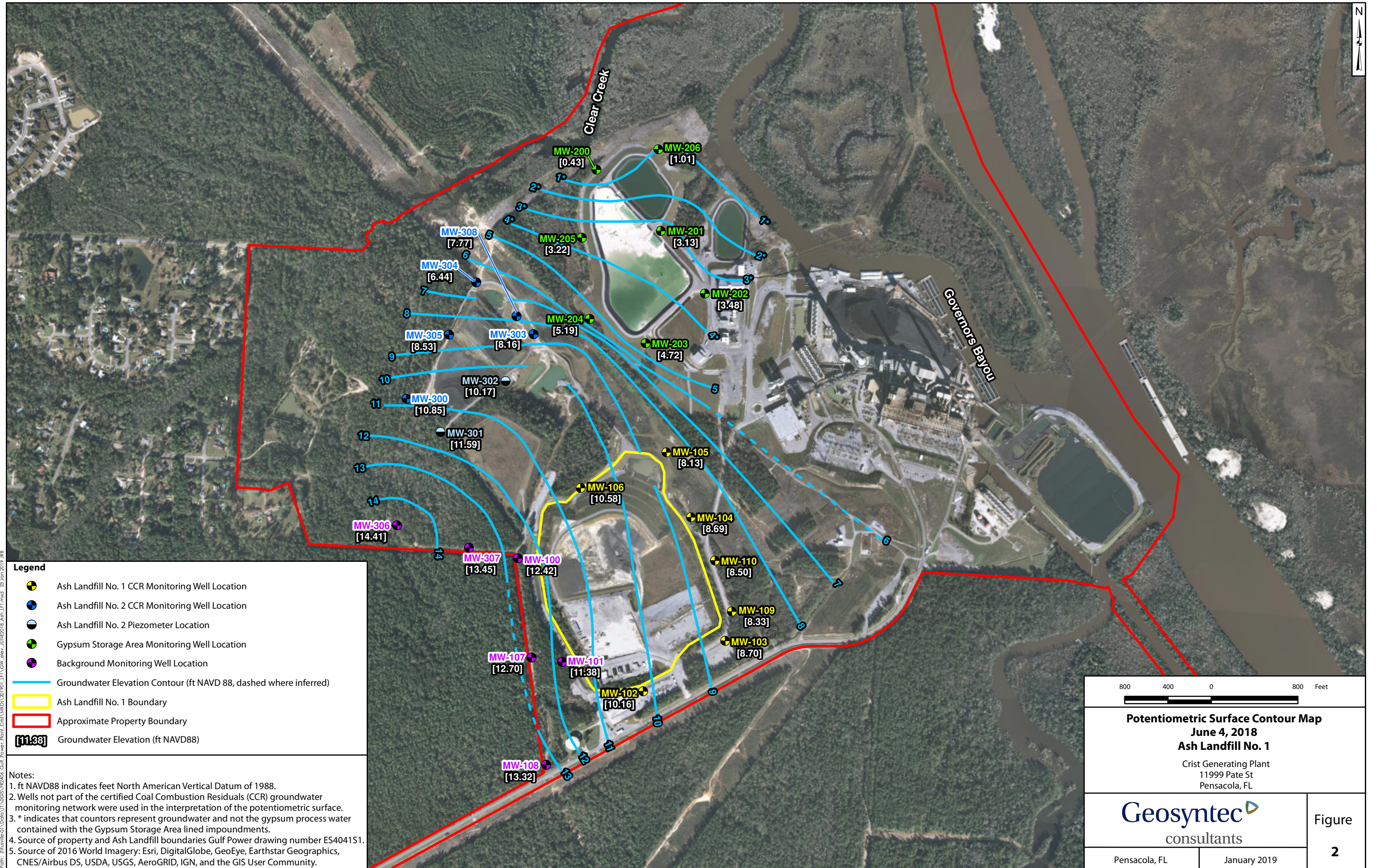
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Pensacola, FL      January 2019

Figure  
**1**

Path: (file:///C:/Users/ADMIN/OneDrive/Desktop/Projects/CCR/011901/GW\_elev\_MAR2018\_LFI.mxd; 23-Jan-2019; JRB)





Path: (file:///C:/Users/101010/Desktop/OGS/PP2406\_Gulf\_Power\_Plant\_Crist/MXD/201901\_LFW\_elev\_JUNE2018\_Ash\_L1.mxd 23 Jan 2019 10:08 AM)

**Legend**

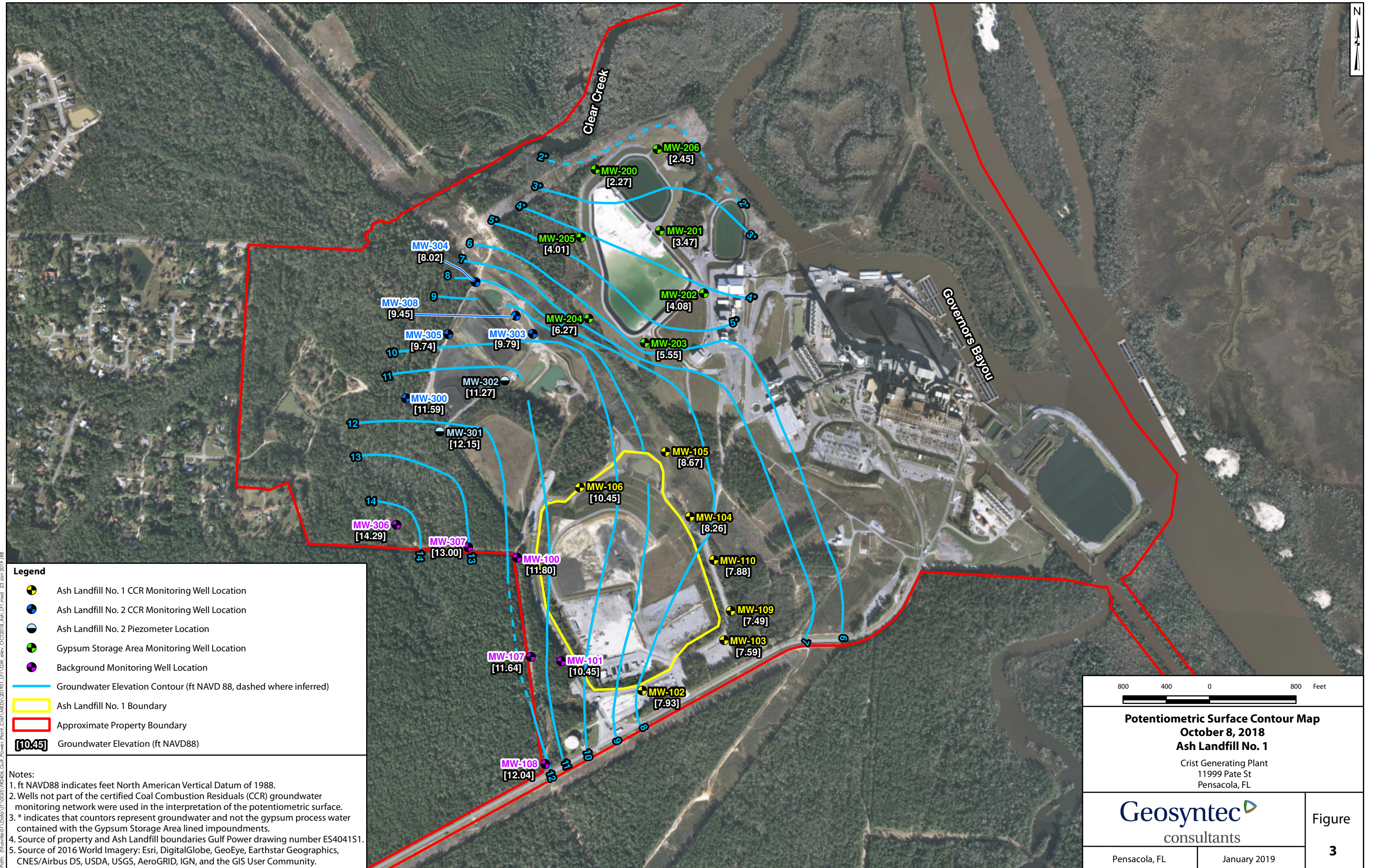
- Ash Landfill No. 1 CCR Monitoring Well Location
- Ash Landfill No. 2 CCR Monitoring Well Location
- Ash Landfill No. 2 Piezometer Location
- Gypsum Storage Area Monitoring Well Location
- Background Monitoring Well Location
- Groundwater Elevation Contour (ft NAVD 88, dashed where inferred)
- Ash Landfill No. 1 Boundary
- Approximate Property Boundary
- [11.38] Groundwater Elevation (ft NAVD88)

**Notes:**

1. ft NAVD88 indicates feet North American Vertical Datum of 1988.
2. Wells not part of the certified Coal Combustion Residuals (CCR) groundwater monitoring network were used in the interpretation of the potentiometric surface.
3. \* indicates that counters represent groundwater and not the gypsum process water contained with the Gypsum Storage Area lined impoundments.
4. Source of property and Ash Landfill boundaries Gulf Power drawing number ES4041S1.
5. Source of 2016 World Imagery: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

<p>800 400 0 800 Feet</p>	
<p><b>Potentiometric Surface Contour Map</b>  <b>June 4, 2018</b>  <b>Ash Landfill No. 1</b>          Crist Generating Plant          11999 Pate St          Pensacola, FL</p>	
<p><b>Geosyntec</b>          consultants</p>	
<p>Pensacola, FL</p>	<p>January 2019</p>
<p>Figure <b>2</b></p>	





Path: (file:///C:/Users/101010/Desktop/Projects/2018/2018\_Ash\_LFI/GW\_elev/OCT2018\_Ash\_LFI.mxd, 23 Jan 2019 10:18 AM)

**Legend**

- Ash Landfill No. 1 CCR Monitoring Well Location
- Ash Landfill No. 2 CCR Monitoring Well Location
- Ash Landfill No. 2 Piezometer Location
- Gypsum Storage Area Monitoring Well Location
- Background Monitoring Well Location
- Groundwater Elevation Contour (ft NAVD 88, dashed where inferred)
- Ash Landfill No. 1 Boundary
- Approximate Property Boundary
- [10.45] Groundwater Elevation (ft NAVD88)

**Notes:**

1. ft NAVD88 indicates feet North American Vertical Datum of 1988.
2. Wells not part of the certified Coal Combustion Residuals (CCR) groundwater monitoring network were used in the interpretation of the potentiometric surface.
3. \* indicates that contours represent groundwater and not the gypsum process water contained with the Gypsum Storage Area lined impoundments.
4. Source of property and Ash Landfill boundaries Gulf Power drawing number ES4041S1.
5. Source of 2016 World Imagery: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

800 400 0 800 Feet

**Potentiometric Surface Contour Map**  
**October 8, 2018**  
**Ash Landfill No. 1**  
 Crist Generating Plant  
 11999 Pate St  
 Pensacola, FL

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Pensacola, FL      January 2019

Figure  
**3**