

2020 Town of Duck Topographic and Hydrographic Survey Report

Prepared for:

Town of Duck

Prepared by:

**Aptim Environmental & Infrastructure, LLC
2481 N.W. Boca Raton Blvd.
Boca Raton, FL 33431**

July 2020

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ABSTRACT

Aptim Environmental & Infrastructure, LLC (APTIM) was contracted by Duck, North Carolina to provide a topographic and hydrographic survey. The 2020 topographic and hydrographic survey consisted of thirty-four (34) profile stations spanning across the Town of Duck, NC. APTIM surveyors conducted the beach and hydrographic surveys from June 7, 2020 through June 25, 2020.

The physical monitoring of the Town of Duck included topographic and hydrographic surveys of the beach and offshore areas. The monitoring data is necessary to observe and assess beach conditions for future construction. The scientific monitoring processes provide information necessary to plan, design, and optimize subsequent follow up projects. The information gathered may potentially reduce the need for, and cost of, unnecessary work as well as potentially reducing any environmental impacts that may have occurred or is expected to occur.

SURVEY METHODOLOGIES

The surveys were conducted in accordance with the Minimum Performance Standards for the U.S. Army Corps of Engineers (USACE), Engineering and Design Hydrographic Surveying Manual (EM 1110-2-1003).

This survey is in accordance with Chapter 56.1606 of the North Carolina Administrative Code (NCAC) specifications established by The North Carolina Engineering and Land Surveying Act (GS89C). In addition, all hydrographic surveying was conducted under the direct supervision of an American Congress of Surveying and Mapping (ACSM) Certified Hydrographer (CH). Included in this Topographic and Hydrographic Survey Report are seven (7) maps visualizing profiles, one (1) project location map and six (6) plan view maps. The plan view maps show reduced true position elevation data collected during the survey. The location of all published control, as well as control found and used for survey purposes, is presented in the Monument Information Report provided in **Appendix 1**.

Vertical data was collected in the North American Vertical Datum of 1988 (NAVD88). All Horizontal data is provided in the North Carolina State Plane Coordinate System, North American Datum of 1983(2011) (NAD 83(2011)). Profile data is presented in xyz format relative to The North American Vertical Datum of 1988 (NAVD88) in **Appendix 2** (digital format only). Profile plots are provided in **Appendix 3**. Ground digital photography obtained during the survey is provided in **Appendix 4**. Copies of all field book pages are provided in **Appendix 5** (digital format only).

The field survey and data collection activities encompassed four (4) phases. Brief descriptions of each survey phase, including methodologies and quality control/quality assurance procedures, are described below.

Phase One: Control Reconnaissance/Establishment/Verification

Prior to the start of the survey, reconnaissance of the monuments was conducted to confirm that survey control was in place and undisturbed. Real Time Kinematic Global Positioning System (RTK GPS) was used within a virtual reference station (VRS) network to locate and confirm survey control for this project. The North Carolina Geodetic Survey Continuously Operating Reference Station (CORS) Network stations used for this project included NCDU (Duck 3), NCBI (Bodie Island), NCBX (Buxton), NCEL (Elizabeth), and NCCR (Creswell). The horizontal and vertical accuracy of control data meets the accuracy requirements as set forth in the Engineering and Design Hydrographic Surveying Manual (EM 1110-2-1003). In order to achieve required accuracy, the topographic and hydrographic surveys were controlled using 2nd order monuments, specifically WAY, KITTY, CAFFEY, X254, and

Y254 from the National Geodetic Survey (NGS). Horizontal and vertical positioning checks were conducted at the beginning and end of each day using at least two 2nd order monuments in the project area. The RTK GPS utilizes statistical methods to ensure accuracy of RTK GPS data remains within the 95% confidence interval. The control check shots were acquired using a minimum of five (5) epochs which results in a high accuracy location. Results from 2nd order control checks are displayed showing northing, easting, monument elevation, inverses, horizontal and vertical root mean square error, location description and photographs as indicated in the Monument Information Report (**Appendix 1**).

Phase Two: Beach Profiles

Upon completion of the control reconnaissance survey, beach/upland and nearshore operations were initiated. Cross-sections of the beach in the project area were surveyed using extended rod RTK GPS rovers, and standard RTK GPS rovers. Extended rod RTK GPS rovers were used to augment RTK GPS survey capability into the nearshore. The current systems allow surveyors from APTIM to collect the entire beach profile with RTK GPS technology. Incorporation of RTK GPS into monitoring surveys greatly reduces the potential for human error during data collection and reduction.

Profiles commenced from the onshore control point and extend seaward overlapping the offshore data. Nearshore portions of the profiles were surveyed by two (2) surveyors with an Extended Rod Trimble R8 and R10 RTK GPS rovers who entered the water wearing Personal Floatation Devices (PFD). Trimble TSC3 data collectors are equipped with Bluetooth technology allowing wireless communication with the GPS receiver at a data exchange speed of 2.1 megabits per second. The rover system allows surveyors from APTIM to reach a maximum water depth of eleven (11) feet. The nearshore survey extended seaward to a point overlapping the offshore portion of the profiles by at least fifty (50) feet.

The upland portion of the survey commenced at the waterline and extended 250 feet landward of the dune or until an obstacle was encountered. The upland portions of the profiles were surveyed using an RTK GPS. Elevations were taken at approximately twenty-five (25) foot intervals along each profile line and at all grade breaks. To maintain online accuracy, surveyors utilized the RTK GPS feature *stakeout point*. *Stakeout point* allows surveyors to maintain the profile azimuth without relying on a survey lathe or conventional compass bearings.

Phase Three: Nearshore/Offshore Profiles

The Nearshore/Offshore profiles were conducted at each required profile station. The profiles were obtained 2,500 feet beyond the shoreline or to the -30 NAVD88 contour, whichever is more landward. The landward limits of the nearshore profiles were based on a minimum overlap of fifty (50) feet beyond the seaward extent of beach profiles. Soundings were

collected at 200kHz with an Odom Hydrotrac II single frequency sounder connected to a centrally located, hull-mounted transducer on APTIM's twenty-eight (28) foot Parker survey vessel. These soundings were then reduced to 25' spacing, sufficient to provide an accurate depiction of the seafloor.

Data was digitally stored using HYPACK 2020 Software. A Trimble R8 RTK GPS and a TSS DMS-25 dynamic motion sensor were used onboard the survey vessel to provide instantaneous tide corrections and attitude corrections. Manual tide readings were taken while conducting the onshore portion of the profile to verify onboard tide readings. In order to maintain the vessel navigation along the profile lines, HYPACK 2020 navigation software was used. This software provided horizontal position to the sounding data allowing real-time review of the data in plan view or cross-section format. HYPACK 2020 also provided navigation to the helm to minimize deviation from the online azimuth.

Horizontal and vertical positioning checks were conducted at the beginning and end of each day as described in phase one (1) of the survey. The sounder was calibrated via bar-checks and a sound velocity probe at the beginning and end of the day. The DIGIBAR PRO sound velocity meter offers a fast, additional calibration for sound velocity as compared to the traditional bar-check. Bar-checks were performed from a depth of five (5) feet to a depth of at least twenty-five (25) feet. Analog data showing the results of the bar-check calibration was displayed on the sounder charts at five (5) foot increments during descent of the bar. Offshore data was collected within two (2) weeks of onshore data collection for each line.

Phase Four: Data Reduction/Submittals

Upon completion of the field work, data was edited and reduced with Trimble Business Center, HYPACK 2020, and APTIM's internal software programs. The upland and nearshore portions of the beach profile were viewed and edited in Trimble Business Center and a comma delimited XYZ file was created. The offshore raw digital data was viewed and edited in HYPACK 2020's *Single Beam Editor*. The offshore RTK GPS tide data that was collected was compared to the manually collected RTK GPS nearshore tide data, local observed, and predicted tides for data verification purposes. Tide corrected offshore data was exported and a comma delimited XYZ file was created. All overlapping profile data was compared in cross section to ensure system accuracy. The edited beach profile data and offshore profile data were merged, and a representative cross-section was derived for each profile line. The cross sections were developed using internal APTIM plotting programs.

The final plots were edited and reviewed with comparisons to previous years; discrepancies were noted and resolved. The final approved cross-section data was prepared in the required formats for submittal (**Appendix 3**). Digital data is provided in the State required vertical datum NAVD88.

Map Preparation:

Upon completion of the surveys and data reduction, the survey maps were prepared in ArcGIS 10.7.1. In order to avoid congestion, the survey maps do not show all collected elevations, but enough to give an accurate depiction of the cross sections. The survey maps display profile data and control monument locations plotted against Esri's background aerial imagery from March, 2018.

Ground Digital Photography:

Surveyors from APTIM collected three (3) digital photos at a mid-beach location at each profile location. The three (3) photos included one (1) in each shore-parallel direction and one (1) landward toward the monument. Wherever possible, an additional digital photo was taken of the control identification or stamping on the monument.

2020 TOWN OF DUCK
TOPOGRAPHIC AND HYDROGRAPHIC
SURVEY REPORT



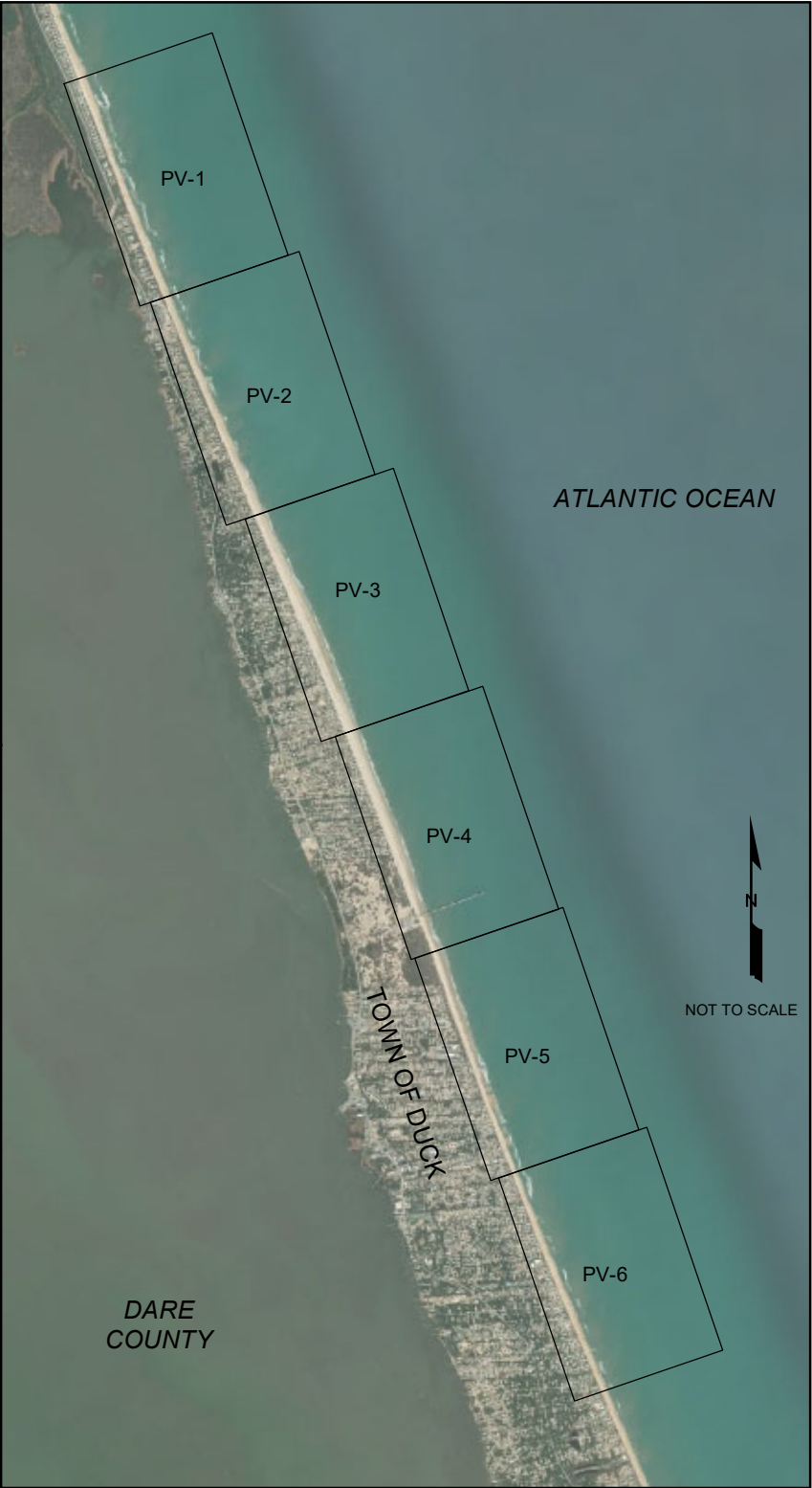
LEGEND	
	PROFILE STATION
	CONTROL MONUMENT
PV	PLAN VIEW
CS	COVER SHEET
NAVD	NORTH AMERICAN VERTICAL DATUM
NAD	NORTH AMERICAN DATUM
NTS	NOT TO SCALE
Rd	ROAD
NC	NORTH CAROLINA
AZ	AZIMUTH
MON	MONUMENT
ID	IDENTIFICATION
MK	MARK
U.S.	UNITED STATES OF AMERICA
LLC	LIMITED LIABILITY COMPANY
Dr	DRIVE
BLVD	BOULEVARD
Ln	LANE

INDEX TO SHEETS

- 1 COVER SHEET AND PROJECT LOCATION MAP
2-7 PROJECT PLAN VIEWS

TOWN OF DUCK STATION INFORMATION JUNE 2020			
DATUMS: NAD83(2011) / NAVD88 (U.S. SURVEY FEET)			
STATION	NORTHING	EASTING	AZIMUTH
D-01	918267.70	2951387.50	70.00
D-02	917384.40	2951733.80	70.00
D-03	916429.40	2952103.00	70.00
D-04	915495.30	2952464.00	70.00
D-05	914598.00	2952849.30	70.00
D-06	913696.90	2953224.40	70.00
D-07	912798.80	2953607.30	70.00
D-08	911897.90	2953983.00	70.00
D-09	910994.82	2954356.65	70.00
D-10	910066.74	2954759.12	70.00
D-11	909133.14	2955158.05	70.00
D-12	908412.53	2955461.41	70.00
D-13	907478.35	2955874.29	70.00
D-14	906578.33	2956252.15	70.00
D-15	905677.78	2956628.57	70.00
D-16	904767.65	2956978.72	70.00
D-17	903863.92	2957333.66	70.00
D-18	902886.47	2957718.79	70.00
D-19	902331.03	2957932.45	70.00
D-20	901760.74	2958139.73	70.00
D-21	900958.70	2958472.10	70.00
D-22	900228.80	2958754.00	70.00
D-23	899515.60	2958992.70	70.00
D-24	898739.80	2959267.20	70.00
D-25	897824.30	2959601.70	70.00
D-26	896902.30	2959928.60	70.00
D-27	895981.90	2960250.60	70.00
D-28	895073.00	2960604.10	70.00
D-29	894166.20	2960963.60	70.00
D-30	893257.60	2961317.70	70.00
D-31	892350.70	2961676.70	70.00
D-32	891379.40	2962078.10	70.00
D-33	890553.20	2962439.40	70.00
D-34	889616.10	2962839.60	70.00

TOWN OF DUCK A-MON CONTROL			
MONUMENT	NORTHING	EASTING	M. ELEV.
CAFFEY	915308.87	2952084.11	1.99
KITTY	859358.84	2977204.86	9.17
WAY	924642.81	2948590.66	4.88
X 254	876428.61	2968761.03	9.93
Y 254	880716.27	2966184.93	12.15



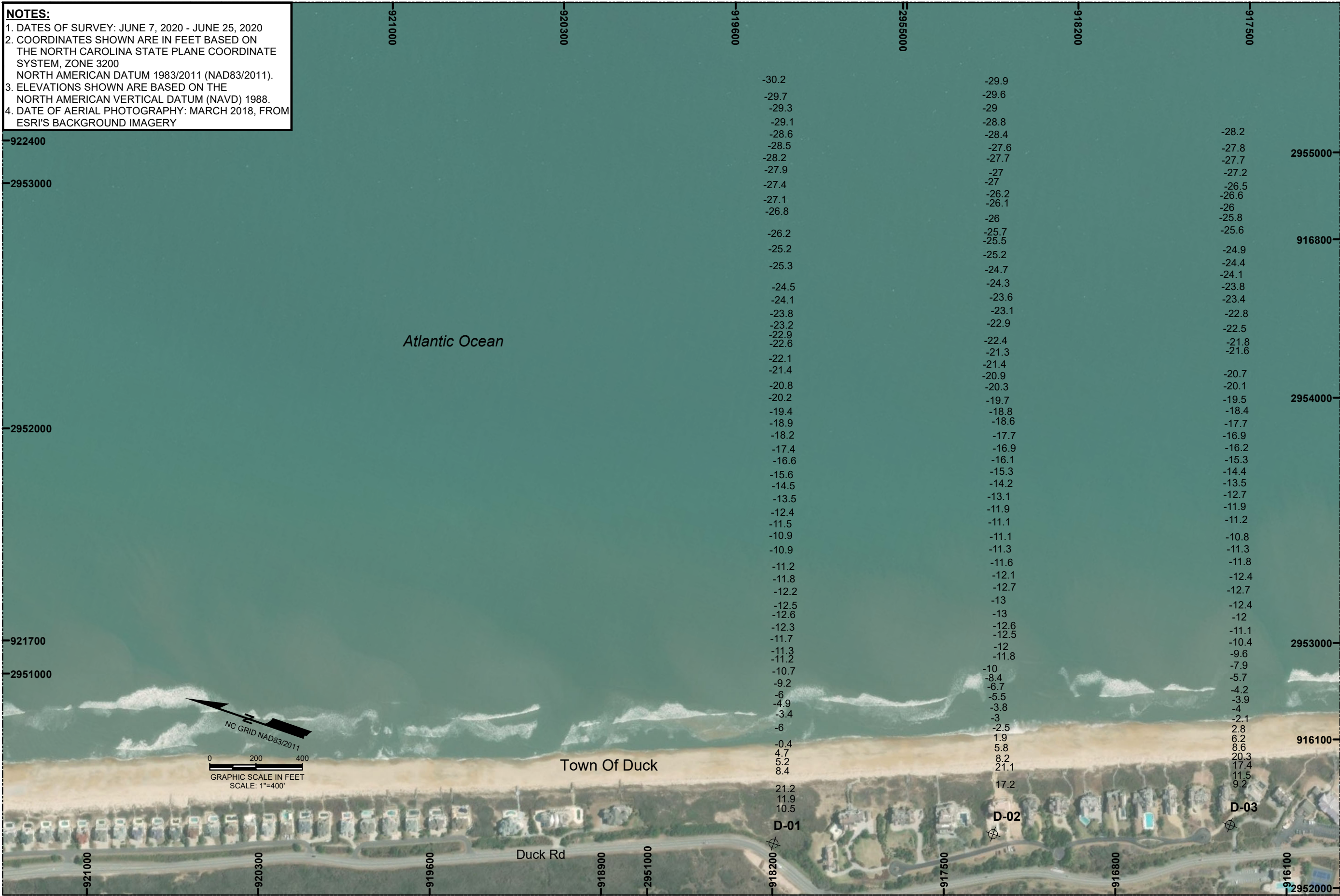
APTIM
ENVIRONMENTAL & INFRASTRUCTURE, LLC

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FAX: (910) 791-4129

Designed by: M. Lowe	Checked by: M. Lowe	Reference Files:	2020 TOWN OF DUCK TOPOGRAPHIC AND HYDROGRAPHIC SURVEY REPORT COVER SHEET
Drawn by: L. Shanon	Reviewed by: R. Hart		
Date: July 2020	Submitted by: M. Lowe		
Plot Scale: AS NOTED	Comm. No.: 631014677		
			Drawing No. CS
			SHEET 1 OF 7

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- NOTES:**
1. DATES OF SURVEY: JUNE 7, 2020 - JUNE 25, 2020
 2. COORDINATES SHOWN ARE IN FEET BASED ON THE NORTH CAROLINA STATE PLANE COORDINATE SYSTEM, ZONE 3200
NORTH AMERICAN DATUM 1983/2011 (NAD83/2011).
 3. ELEVATIONS SHOWN ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM (NAVD) 1988.
 4. DATE OF AERIAL PHOTOGRAPHY: MARCH 2018, FROM ESRI'S BACKGROUND IMAGERY



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Reference Files:		Checked by:		Reviewed by:		Submitted by:		Comm. No.:		Description	
Designed by:	Drawn by:	Checked by:	Reviewed by:	Submitted by:	Comm. No.:	No.	Date				
M. Lowrie	R. Hart	M. Lowrie	R. Hart	M. Lowrie	631014677						
D. Shanon											
Date:	July 2020										
Plot Scale:	AS NOTED										

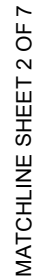
2020 TOWN OF DUCK
TOPOGRAPHIC AND HYDROGRAPHIC
SURVEY REPORT

PLAN VIEW

DRAWING NO.
PV-1

SHEET 2 OF 7

1. DATES OF SURVEY: JUNE 7, 2020 - JUNE 25, 2020
2. COORDINATES SHOWN ARE IN FEET BASED ON THE NORTH CAROLINA STATE PLANE COORDINATE SYSTEM, ZONE 3200
NORTH AMERICAN DATUM 1983/2011 (NAD83/2011).
3. ELEVATIONS SHOWN ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM (NAVD) 1988.
4. DATE OF AERIAL PHOTOGRAPHY: MARCH 2018, FROM ESRI'S BACKGROUND IMAGERY



MATCHLINE SHEET 4 OF 7

APTIM

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TOPOGRAPHIC AND HYDROGRAPHIC SURVEY REPORT

PLAN VIEW

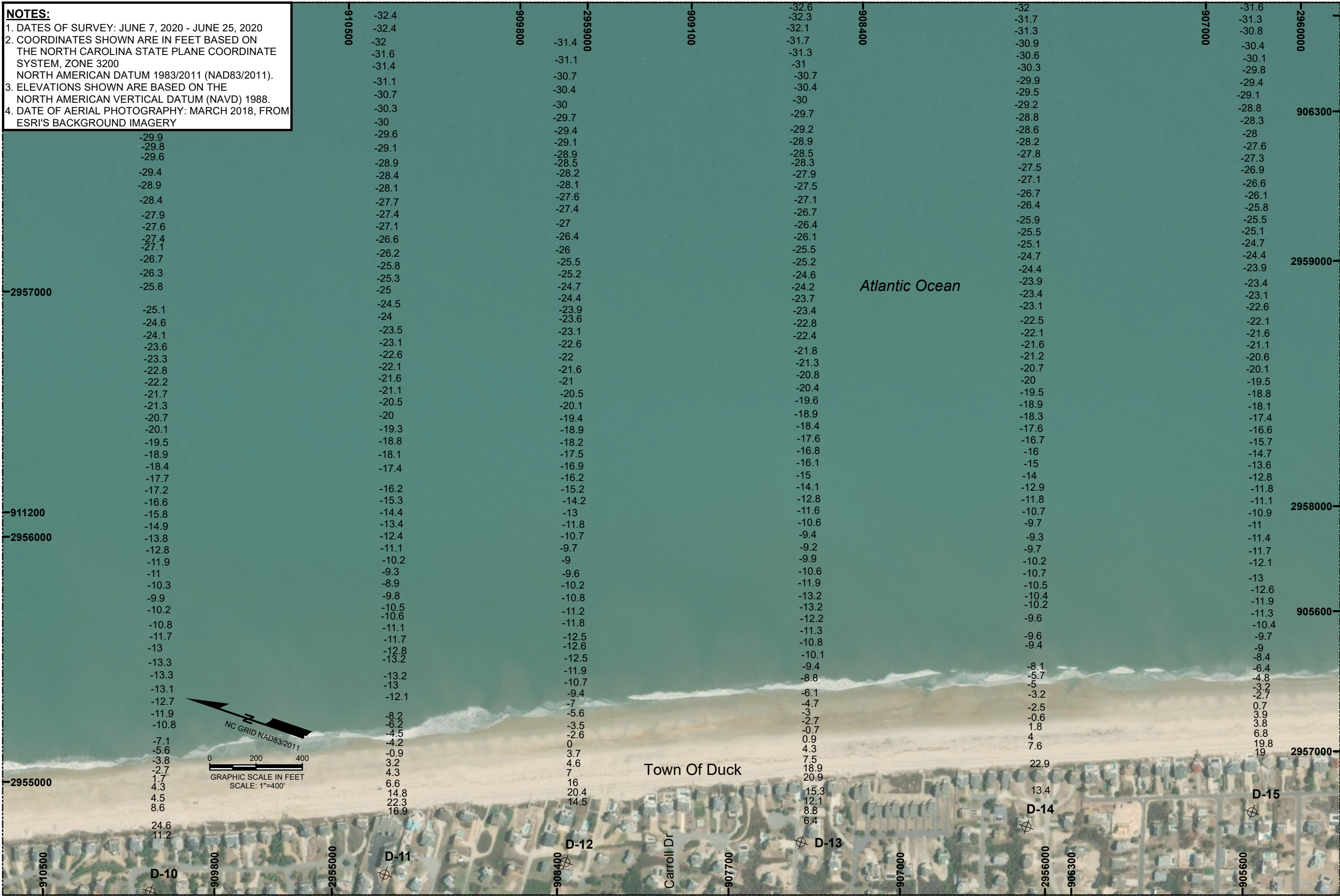
DRAWING NO.

PV-2

SHEET 3 OF 7

NOTES:
1. DATES OF SURVEY: JUNE 7, 2020 - JUNE 25, 2020
2. COORDINATES SHOWN ARE IN FEET BASED ON THE NORTH CAROLINA STATE PLANE COORDINATE SYSTEM, ZONE 3200
NORTH AMERICAN DATUM 1983/2011 (NAD83/2011).
3. ELEVATIONS SHOWN ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM (NAVD) 1988.
4. DATE OF AERIAL PHOTOGRAPHY: MARCH 2018, FROM ESRI'S BACKGROUND IMAGERY

MATCHLINE SHEET 3 OF 7

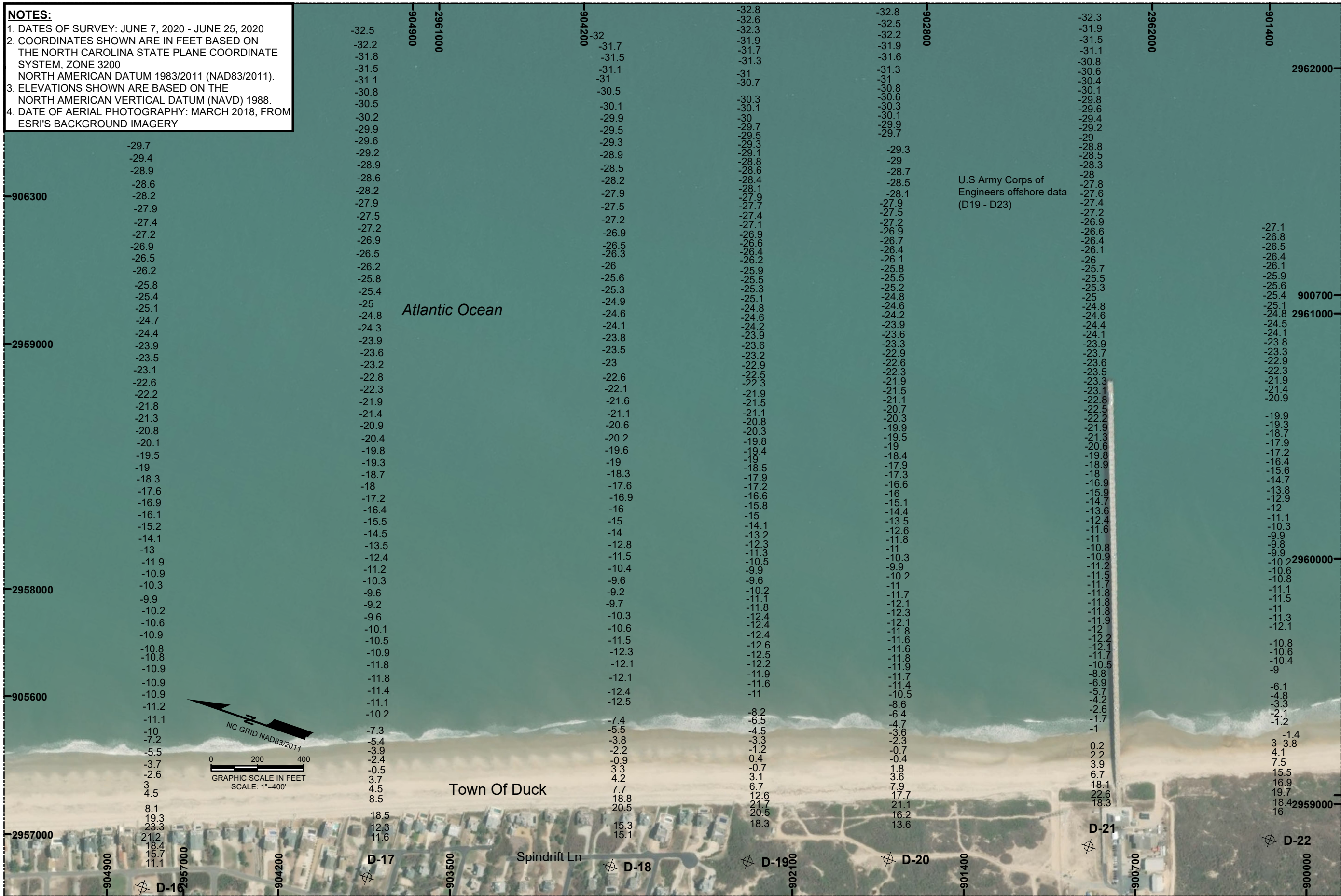


MATCHLINE SHEET 5 OF 7

2020 TOWN OF DUCK TOPOGRAPHIC AND HYDROGRAPHIC SURVEY REPORT		APTIM ENVIRONMENTAL & INFRASTRUCTURE, LLC 2481 N.W. BOCA RATON BOULEVARD, BOCA RATON, FL 33431 PH: (910) 791-9494 FAX: (910) 791-4129	
DRAWING NO. PV-3		PLAN VIEW	
SHEET 4 OF 7			

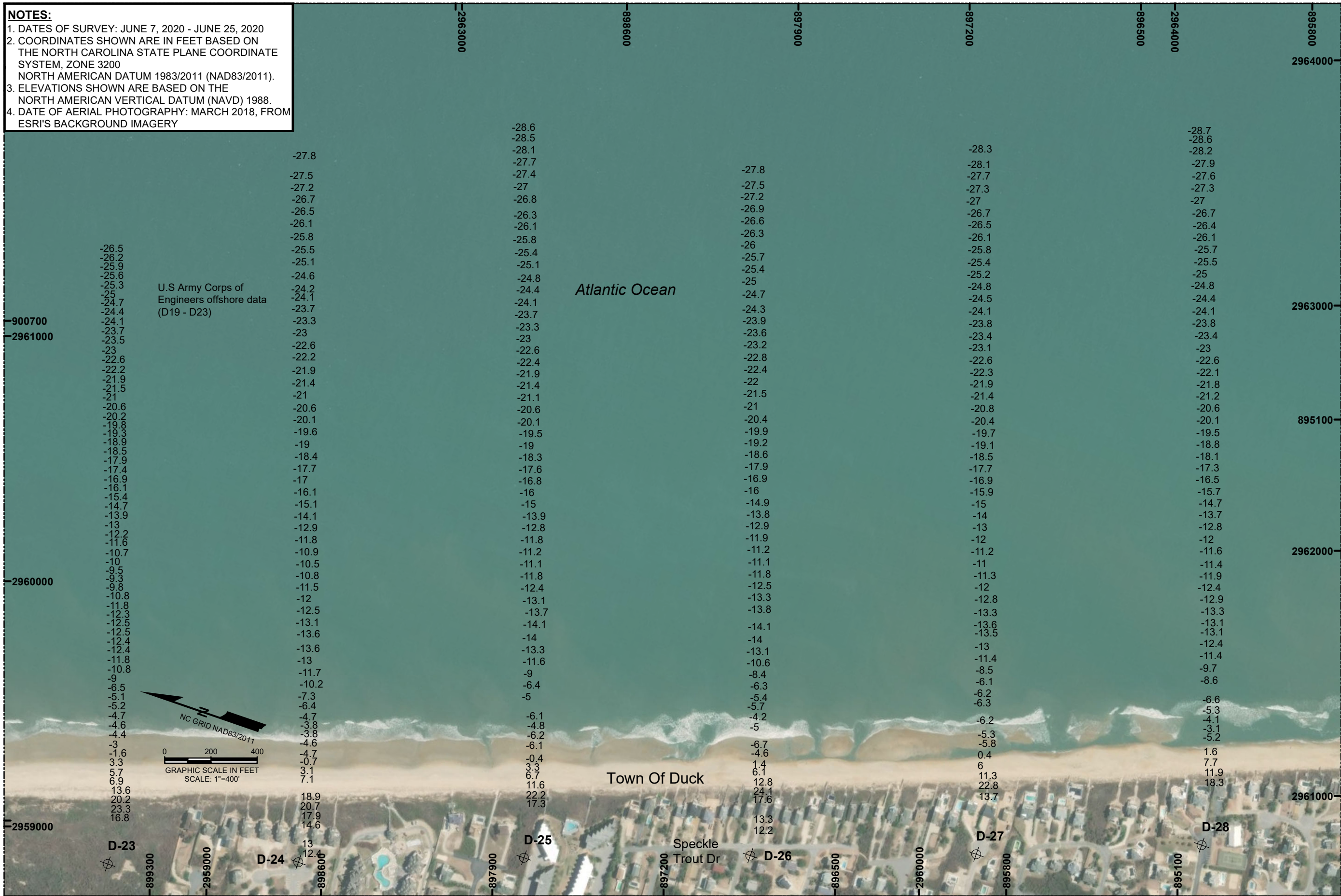
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MATCHLINE SHEET 4 OF 7



MATCHLINE SHEET 6 OF 7

2020 TOWN OF DUCK TOPOGRAPHIC AND HYDROGRAPHIC SURVEY REPORT		APTIM ENVIRONMENTAL & INFRASTRUCTURE, LLC 2481 N.W. BOCA RATON BOULEVARD, BOCA RATON, FL 33431 PH: (910) 791-9494 FAX: (910) 791-4129	
DRAWING NO. PV-4		PLAN VIEW	
SHEET 5 OF 7		Description No. Date	
Reference Files:		Checked by: M. Lowie Reviewed by: R. Hart Submitted by: M. Lowie Comm. No.: 631014677 AS NOTED	
Designed by: M. Lowie Drawn by: T. Shanon Date: July 2020 Plot Scale: AS NOTED			



MATCHLINE SHEET 7 OF 7

2020 TOWN OF DUCK TOPOGRAPHIC AND HYDROGRAPHIC SURVEY REPORT		APTIM ENVIRONMENTAL & INFRASTRUCTURE, LLC 2481 N.W. BOCA RATON BOULEVARD, BOCA RATON, FL 33431 PH: (910) 791-9494 FAX: (910) 791-4129	
DRAWING NO. PV-5		SHEET 6 OF 7	
Reference Files:		Checked by: M. Lowie Reviewed by: R. Hart Submitted by: M. Lowie Comm. No.: 631014677 AS NOTED	
Date: July 2020		No. Date	
Description			

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MATCHLINE SHEET 6 OF 7

- NOTES:**
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 4. DATE OF AERIAL PHOTOGRAPHY: MARCH 2018, FROM ESRI'S BACKGROUND IMAGERY



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Designed by: M. Lowrie	Checked by: M. Lowrie	Reference Files:	No.	Date
Drawn by: J. Shanon	Reviewed by: R. Hart			
Date: July 2020	Submitted by: M. Lowrie			
Plot Scale: AS NOTED	Comm. No.: 631014677			
Description				
2020 TOWN OF DUCK TOPOGRAPHIC AND HYDROGRAPHIC SURVEY REPORT				
DRAWING NO. PV-6				
SHEET 7 OF 7				

PLAN VIEW

Survey Report Notes

Survey Title: 2020 Town of Duck
Topographic and Hydrographic Survey Report

Prepared Date: July 2020

Prepared For: Duck, NC

Prepared By: Aptim Environmental & Infrastructure, LLC

Dates of Survey: June 7, 2020 through June 25, 2020

Survey Location: Town of Duck D-01 through D-34

Notes:

1. The survey is neither valid nor complete without both the survey report and described survey maps. Digital data files encompassing the following have also been provided in the following formats listed.
 - *Monument Information Report (Appendix 1)*
 - *ASCII file (profile xyz data. Digital only) (Appendix 2)*
 - *Profile Plots (Appendix 3)*
 - *Ground Digital Photography (Appendix 4)*
 - *Project field books (Digital Only) (Appendix 5)*
2. The information on this map represents the results of the survey on the dates indicated and can only be considered as indicating the general conditions existing at the time.
3. The coordinates shown are in US survey feet based on the vertical and horizontal data that was collected and presented relative to the North American Vertical Datum of 1988 (NAVD88) and the North Carolina State Plane Coordinate System, North American Datum of 1983(2011) (NAD 83(2011)).
4. Vertical measurements are based on second order monuments KITTY, WAY, CAFFEY, X254, and Y254 per published NGS coordinates.

5. Bearings are based on a bearing of South 24° 10' 46" East between NGS second order monuments KITTY and CAFFEY per published NGS coordinates.
6. Underground and subaqueous improvements and/or utilities were not located as part of this survey and should be field verified prior to any dredging or construction activities.
7. Refer to APTIM field book No. 520 and NC field book No. 252 for swims and the onshore portion, and navigation book No. 57 for the offshore portion.
8. Aids to navigation were not located during this survey.
9. Soundings were collected using an Odom Hydrotrac II, Single Frequency, survey grade sounder. The sounder was calibrated prior to the start of the survey following manufacturers recommended procedures.
10. This survey was conducted for the Town of Duck for use as a topographic and hydrographic survey.

APPENDIX OVERVIEW

1) Monument Information Report

Data collected during the survey is entered in a spreadsheet format and compared to data provided by NGS. This comparison shows differences in northings, eastings and elevation of NGS published control, what was collected in the field, and what was used during profile reduction.

2) Profile XYZ data (digital only)

Offshore survey data was converted into APTIM files. Onshore data was reduced by standard means of reduction, entered in APTIM format, and merged with the offshore data. APTIM format is used for in-house plotting, volume computations and other engineering analyses. The APTIM formatted data was converted into XYZ format. The XYZ data is provided in the datum collected (NAVD88) as per state standards.

3) Profile Plots

Profile plots of this survey data compared with historical profile data.

4) Ground Digital Photography

APTIM surveyors collected three (3) digital photos at a mid-beach location at each profile location. The three (3) photos included one (1) in each shore-parallel direction and one (1) landward toward the monument. In addition, wherever possible a digital photo was taken of the control identification or stamping on the monument.

5) Field Book Pages (digital only)

This appendix includes copies of the field book pages used for the survey. Refer to APTIM field book No. 520 and NC field book No. 252 for the swims and the onshore portion, and navigation field book No. 57 for the offshore survey.

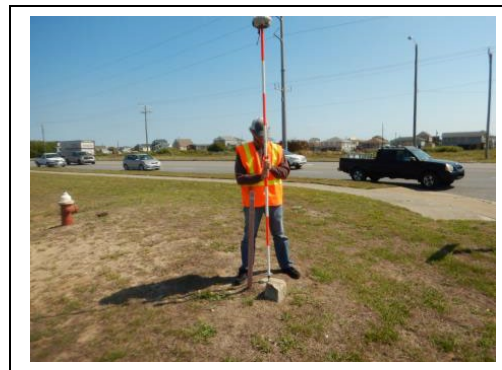
APPENDIX 1

MONUMENT INFORMATION REPORT

CONTROL MONUMENT USED BY APTIM FOR 2020 TOWN OF DUCK TOPOGRAPHIC AND HYDROGRAPHIC SURVEY REPORT JUNE 2020	
DATUMS: NAD83(2011) - NAVD1988 (US SURVEY FEET)	
Designation	KITTY
Stamping	KITTY 1962
Northing	859358.84
Easting	2977204.86
Horizontal Root Mean Square Error	0.11
Elevation	9.17
Vertical Root Mean Square Error	0.23
Description	Station is located about 0.65 miles east of the post office in Kitty Hawk. The station is a standard disk set in a 12x12 inch concrete monument. It is 126 feet east-southeast of the intersection, 17 feet east of a power line pole and 2.7 feet northeast of a metal witness post with sign. The mark is flush with the ground.



Monument: KITTY



Location Verification: KITTY

Mean of Inverse Shots – Published Versus APTIM Found				
Monument	No. of Shots	ΔN	ΔE	ΔZ
KITTY	33	0.00	-0.02	0.15

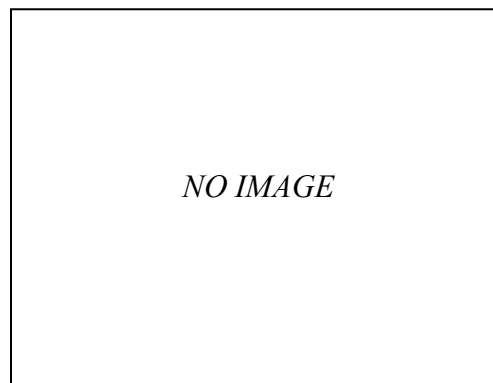
CONTROL MONUMENT USED BY APTIM FOR 2020 TOWN OF DUCK TOPOGRAPHIC AND HYDROGRAPHIC SURVEY REPORT JUNE 2020	
DATUMS: NAD83(2011) - NAVD1988 (US SURVEY FEET)	
Designation	Way
Stamping	Way
Northing	924642.81
Easting	2948590.66
Horizontal Root Mean Square Error	0.11
Elevation	4.88
Vertical Root Mean Square Error	0.05
Description	The mark is 18.9 MI SE of Currituck and 5.6 Mi. NE of Jarvisburg along NC 12 for 1.4 Mi. N from the Currituck/Dare county line on the centerline prolongation of an asphalt runway. Mark is about 3 Ft. lower than NC 12 and recessed 3 In. below the ground. Located 175.5 Ft. W of the centerline of NC 12, 168 Ft. S-SE of the S end of the private runway.

Mean of Inverse Shots – Published Versus APTIM Found				
Monument	No. of Shots	ΔN	ΔE	ΔZ
WAY	6	0.07	0.04	-0.04

CONTROL MONUMENT USED BY APTIM FOR 2020 TOWN OF DUCK TOPOGRAPHIC AND HYDROGRAPHIC SURVEY REPORT JUNE 2020	
DATUMS: NAD83(2011) - NAVD1988 (US SURVEY FEET)	
Designation	CAFFEY
Stamping	CAFFEY 1935
Northing	915308.87
Easting	2952084.11
Horizontal Root Mean Square Error	0.09
Elevation	1.99
Vertical Root Mean Square Error	0.05
Description	Station is about 350 feet W of Caffey Inlet Coast Guard Station, on a small sand neck which extends into the marsh on the E shore of Currituck Sound. This neck is just S of an old can buoy lying in the marsh and is just N of a small gut which the road crosses on a small bridge. The station is about 225 feet W of a flagpole at the fence line W of the coast guard station, a point in line with the S fence, and 179 feet NW of the center of the bridge.



Monument: CAFFEY



Location Verification: CAFFEY

Mean of Inverse Shots – Published Versus APTIM Found				
Monument	No. of Shots	ΔN	ΔE	ΔZ
CAFFEY	31	-0.05	-0.02	0.04

CONTROL MONUMENT USED BY APTIM FOR 2020 TOWN OF DUCK TOPOGRAPHIC AND HYDROGRAPHIC SURVEY REPORT JUNE 2020	
DATUMS: NAD83(2011) - NAVD1988 (US SURVEY FEET)	
Designation	X 254
Stamping	X 254
Northing	876428.61
Easting	2968761.03
Horizontal Root Mean Square Error	0.08
Elevation	9.93
Vertical Root Mean Square Error	0.02
Description	Proceed along NC 12 for 1.1 mi. N from the intersection of US 154 in Kitty Hawk to house number 92. The mark is in the NW corner of the property level with the centerline of NC 12 and flush with the ground. It is located 35.8 Ft. E of the centerline of NC 12, 54.0 Ft. S of the S edge of concrete drive to the house and 1 Ft. W of a witness post.

Mean of Inverse Shots – Published Versus APTIM Found				
Monument	No. of Shots	ΔN	ΔE	ΔZ
X 254	4	-0.01	0.06	0.00

CONTROL MONUMENT USED BY APTIM FOR 2020 TOWN OF DUCK TOPOGRAPHIC AND HYDROGRAPHIC SURVEY REPORT JUNE 2020	
DATUMS: NAD83(2011) - NAVD1988 (US SURVEY FEET)	
Designation	Y 254
Stamping	Y 254
Northing	880716.27
Easting	2966184.93
Horizontal Root Mean Square Error	0.10
Elevation	12.15
Vertical Root Mean Square Error	0.05
Description	Proceed along NC 12 for 2.1 mi. N from the intersection of US 154 in Kitty Hawk to house number 160. Station is level with the centerline of NC 12 and flush with the ground. Located 31.5 Ft. E of the centerline of NC 12, 30 Ft. S-SW of the center of concrete drive to house, 8.4 Ft. S of a water meter, 1.2 SW of a witness sign, and 3.3 Ft. W-SW of a power pole with 2 guy wires and a reference tag.

Mean of Inverse Shots – Published Versus APTIM Found				
Monument	No. of Shots	ΔN	ΔE	ΔZ
Y 254	27	-0.02	-0.03	0.03

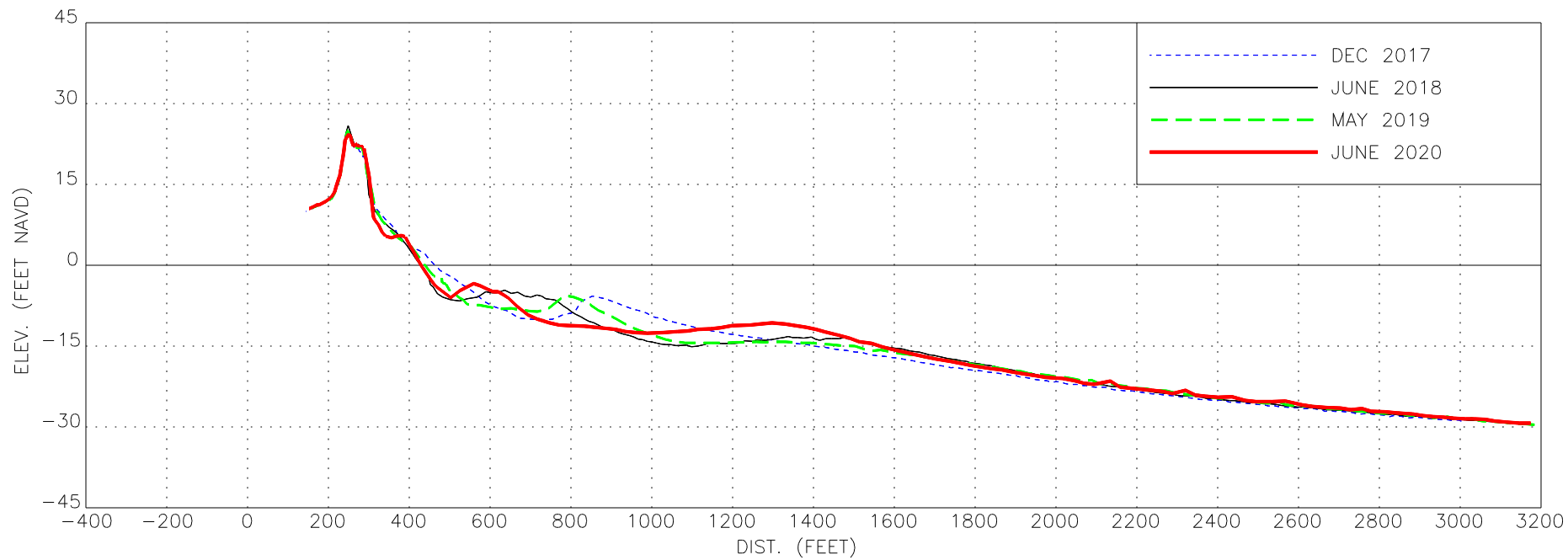
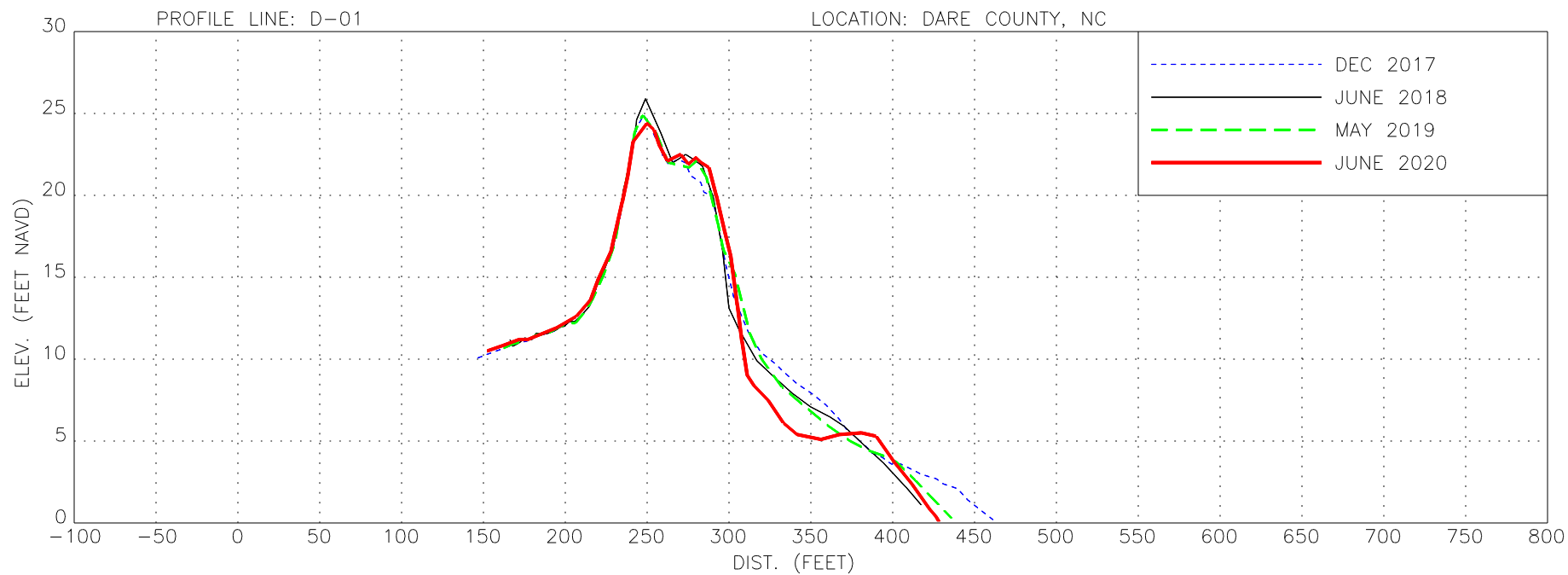
TOWN OF DUCK STATION INFORMATION			
JUNE 2020			
DATUMS: NAD83(2011) / NAVD88 (US SURVEY FEET)			
STATION	NORTHING	EASTING	AZIMUTH
D-01	918267.70	2951387.50	70.00
D-02	917384.40	2951733.80	70.00
D-03	916429.40	2952103.00	70.00
D-04	915495.30	2952464.00	70.00
D-05	914598.00	2952849.30	70.00
D-06	913696.90	2953224.40	70.00
D-07	912798.80	2953607.30	70.00
D-08	911897.90	2953983.00	70.00
D-09	910994.82	2954356.65	70.00
D-10	910066.74	2954759.12	70.00
D-11	909133.14	2955158.05	70.00
D-12	908412.53	2955461.41	70.00
D-13	907478.35	2955874.29	70.00
D-14	906578.33	2956252.15	70.00
D-15	905677.78	2956628.57	70.00
D-16	904767.65	2956978.72	70.00
D-17	903863.92	2957333.66	70.00
D-18	902886.47	2957718.79	70.00
D-19	902331.03	2957932.45	70.00
D-20	901760.74	2958139.73	70.00
D-21	900958.70	2958472.10	70.00
D-22	900228.80	2958754.00	70.00
D-23	899515.60	2958992.70	70.00
D-24	898739.80	2959267.20	70.00
D-25	897824.30	2959601.70	70.00
D-26	896902.30	2959928.60	70.00
D-27	895981.90	2960250.60	70.00
D-28	895073.00	2960604.10	70.00
D-29	894166.20	2960963.60	70.00
D-30	893257.60	2961317.70	70.00
D-31	892350.70	2961676.70	70.00
D-32	891379.40	2962078.10	70.00
D-33	890553.20	2962439.40	70.00
D-34/-197+12	889616.10	2962839.60	70.00

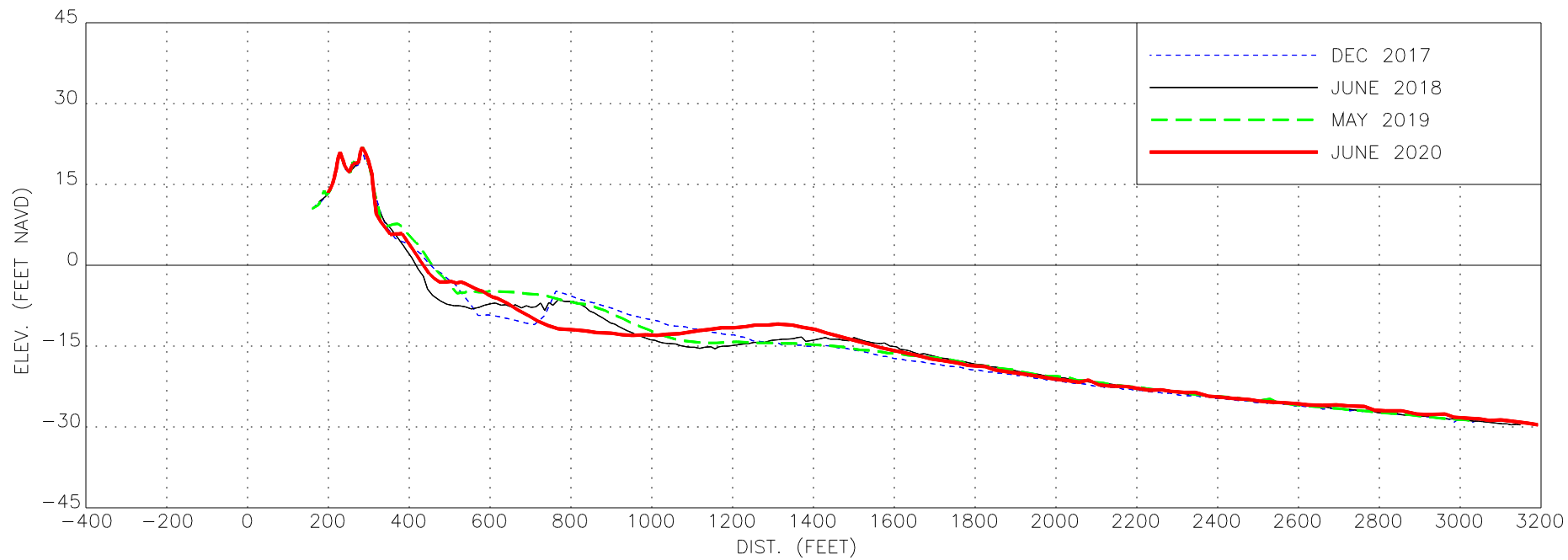
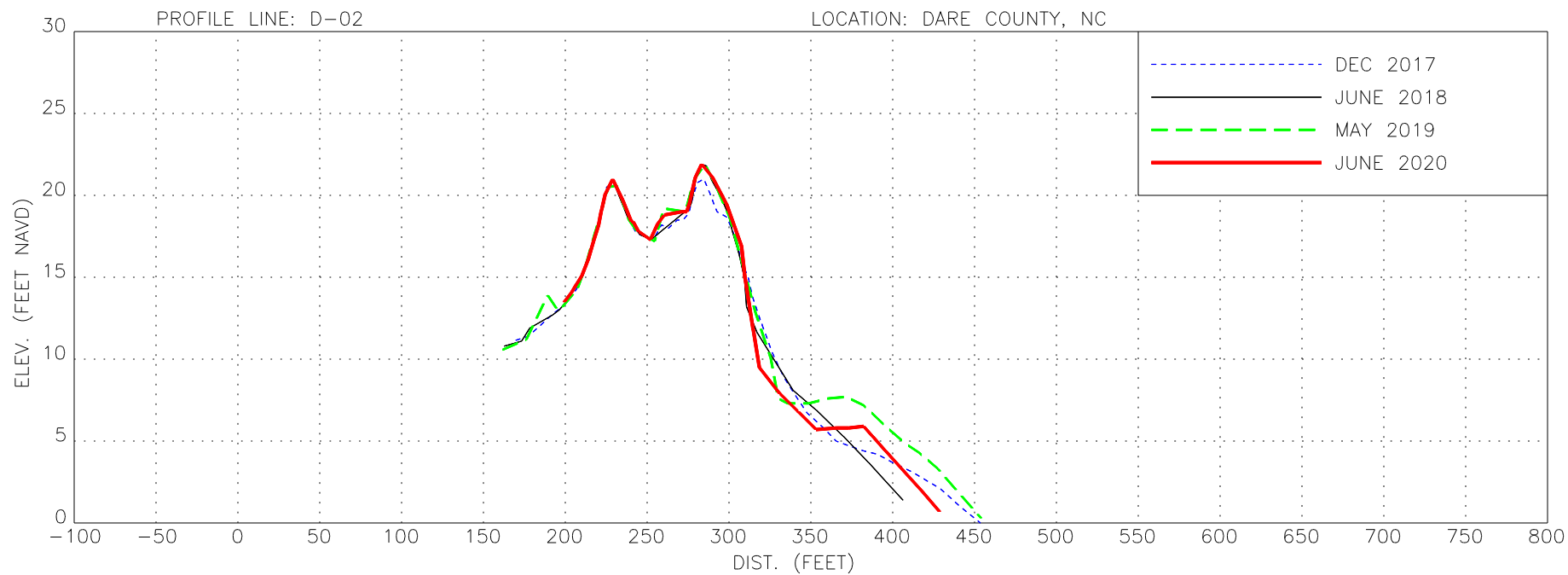
APPENDIX 2: Profile XYZ Data

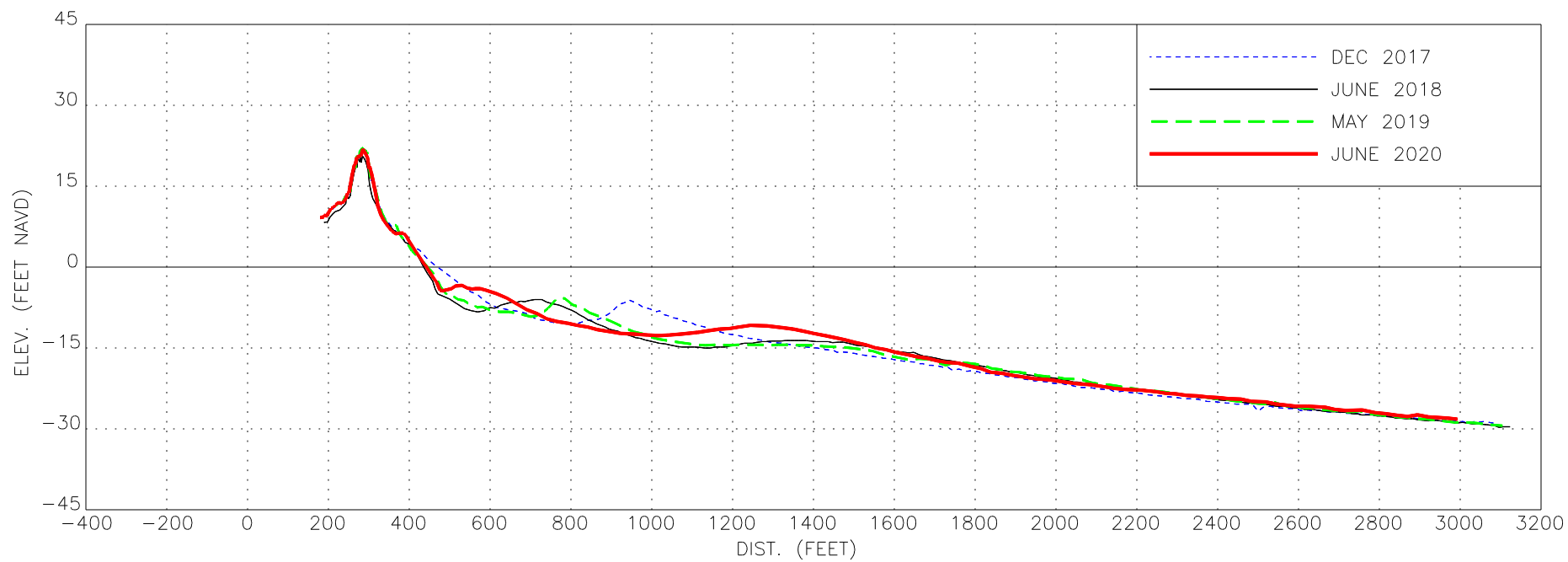
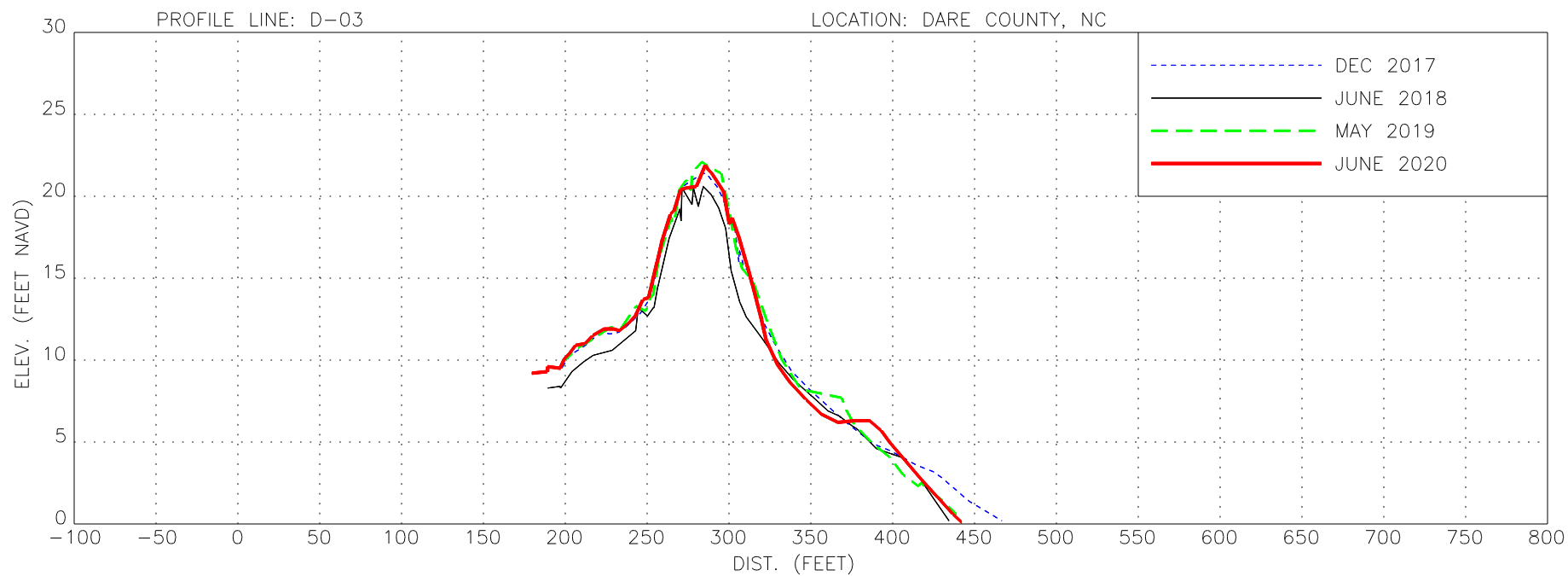
PROFILE XYZ DATA
(Available in digital format only)

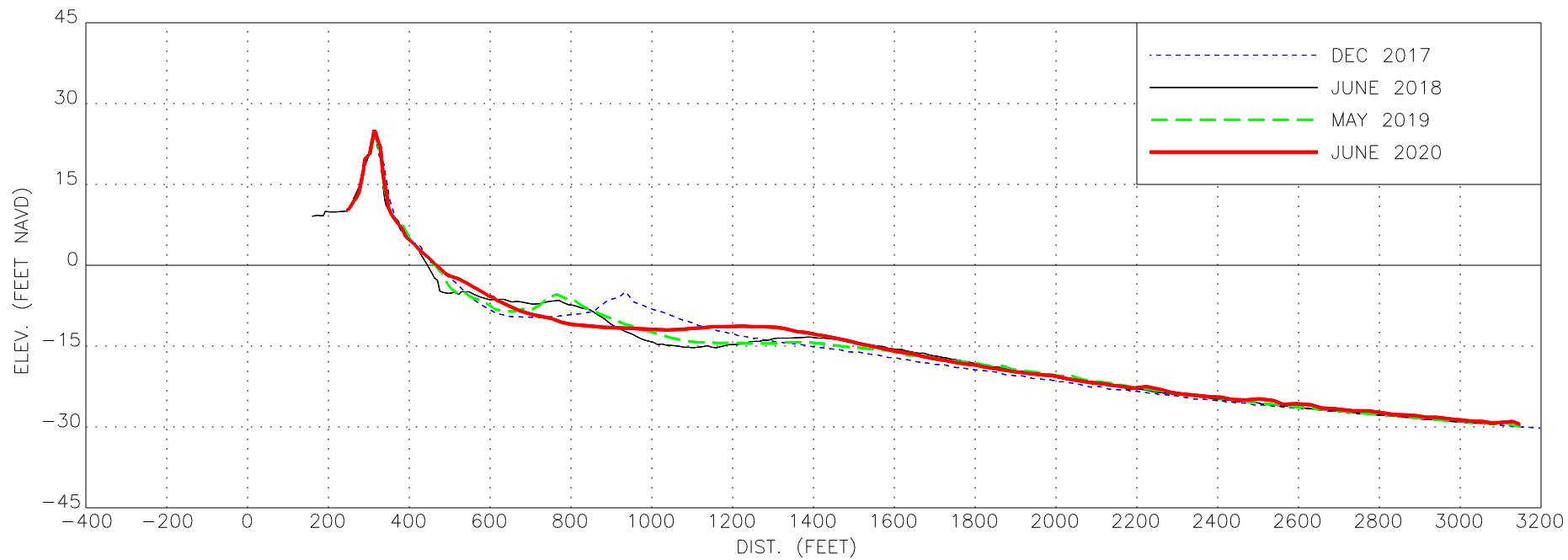
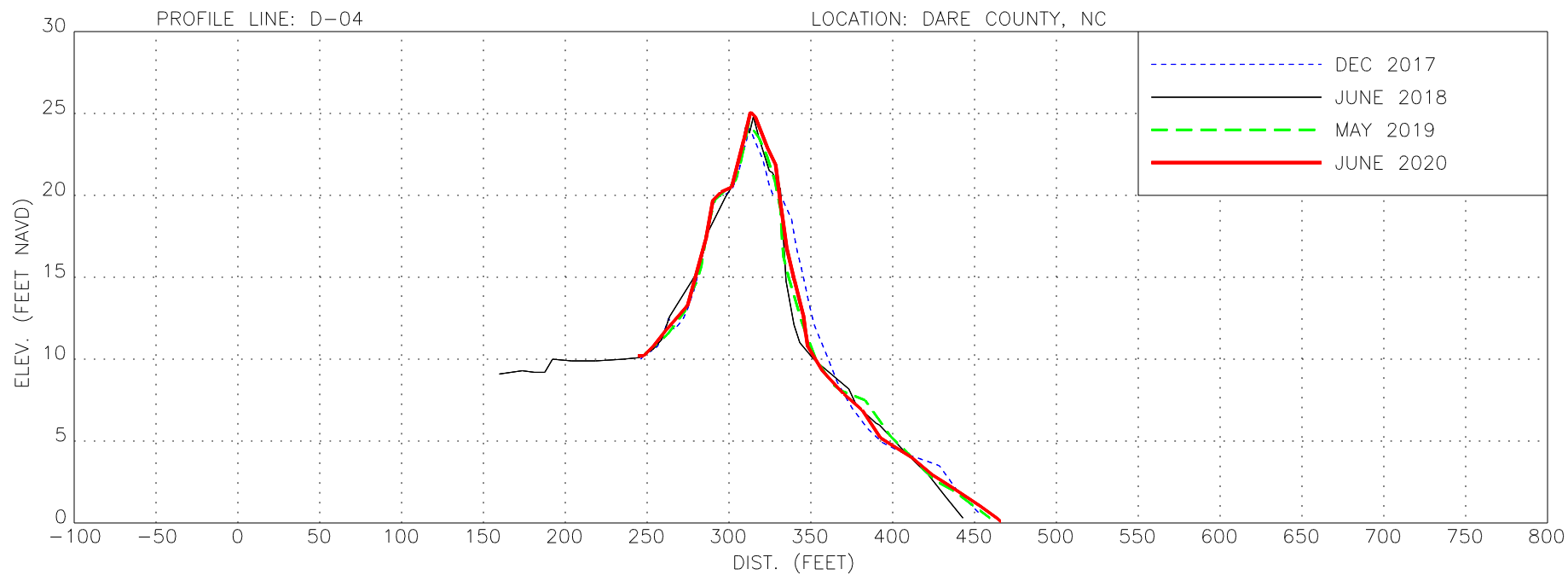
APPENDIX 3

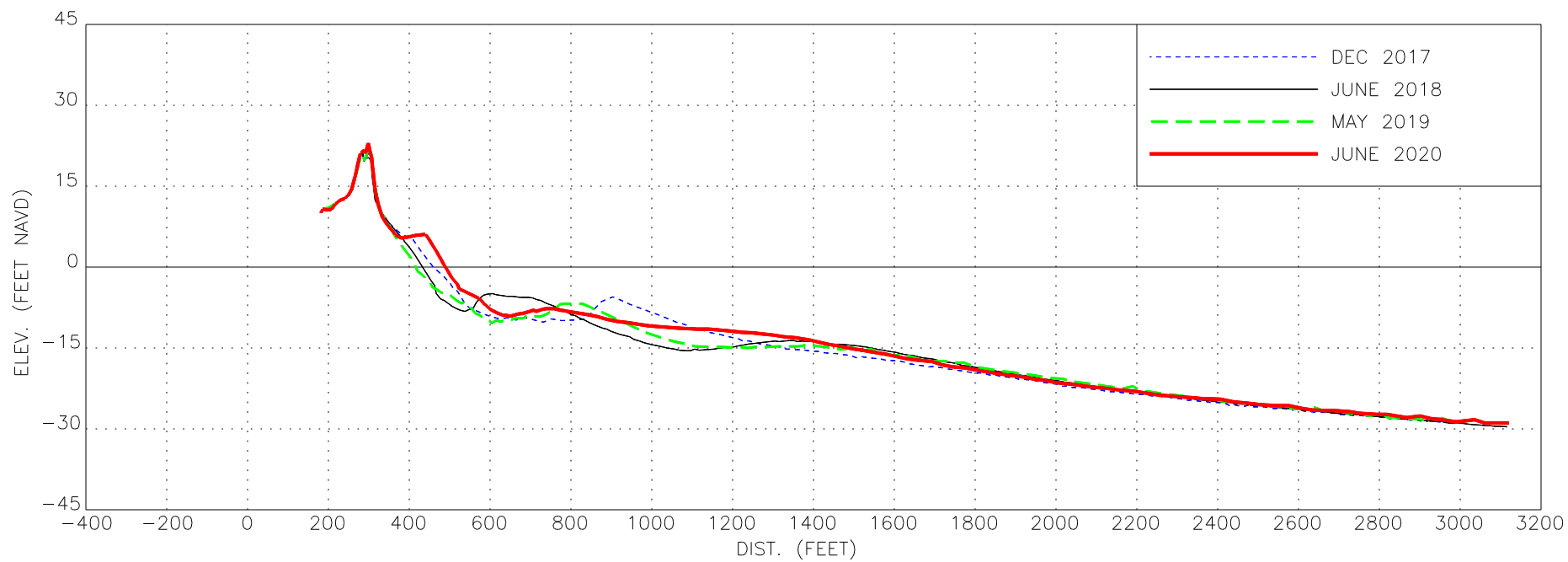
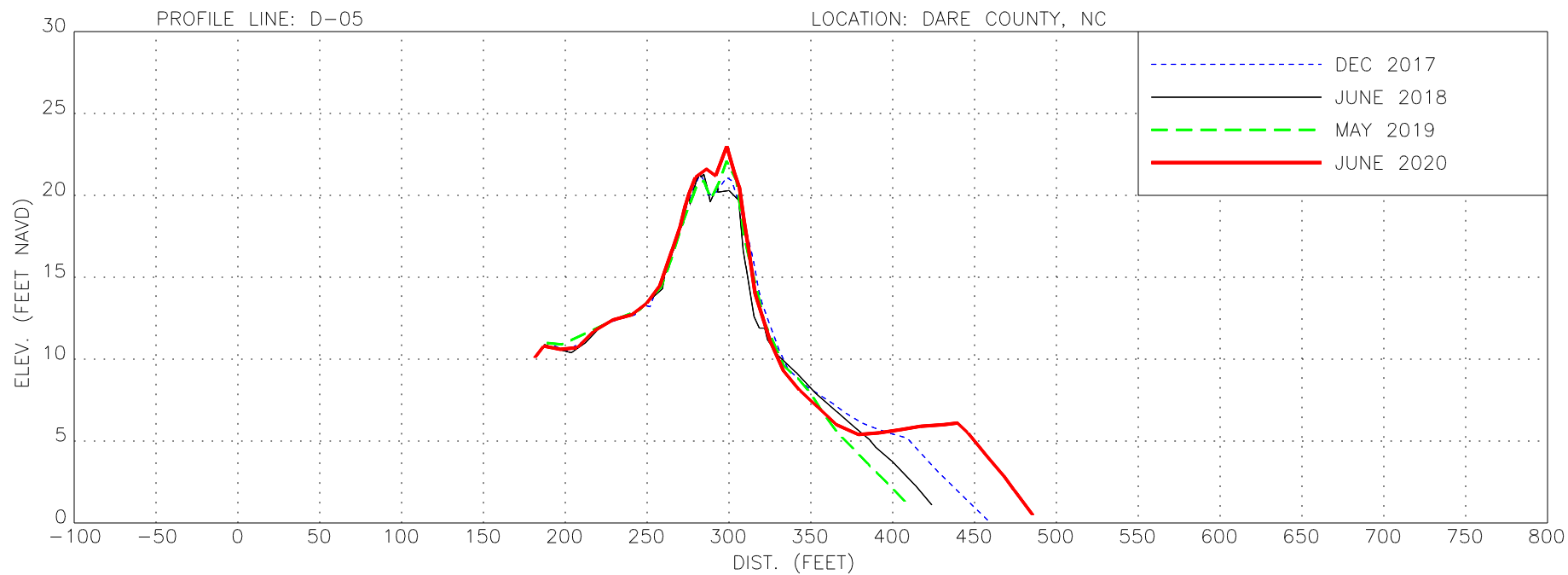
PROFILE PLOTS

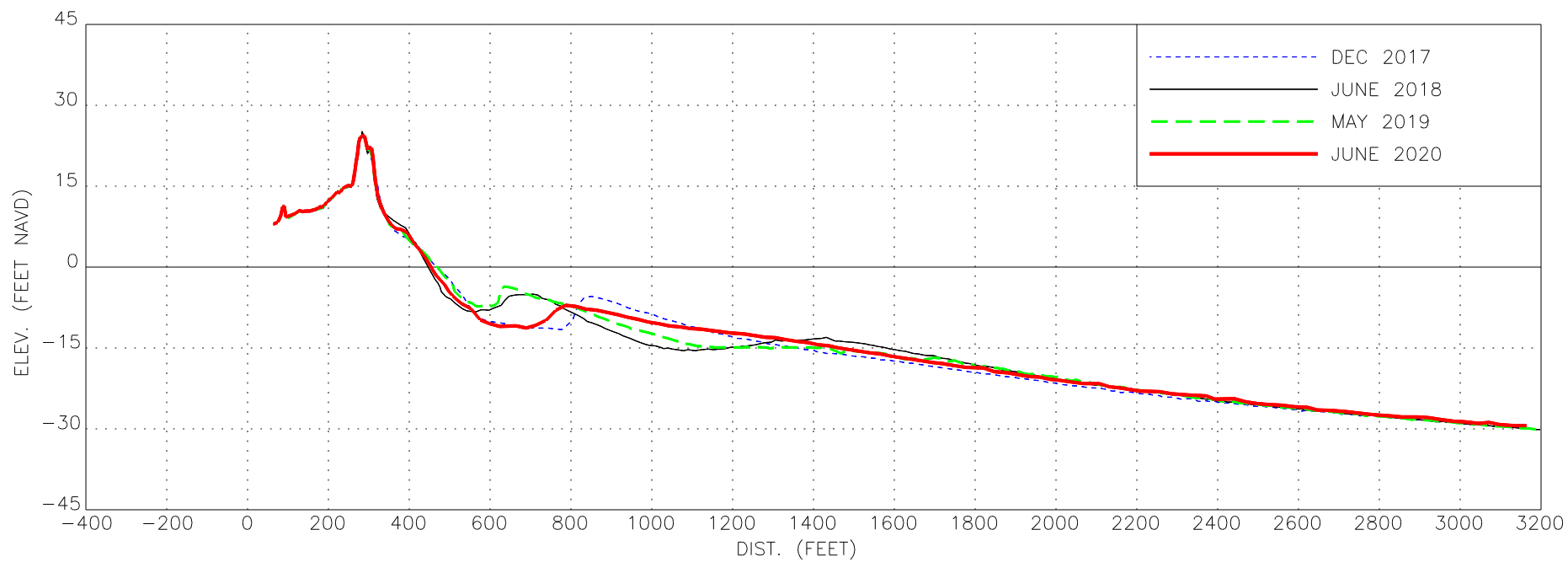
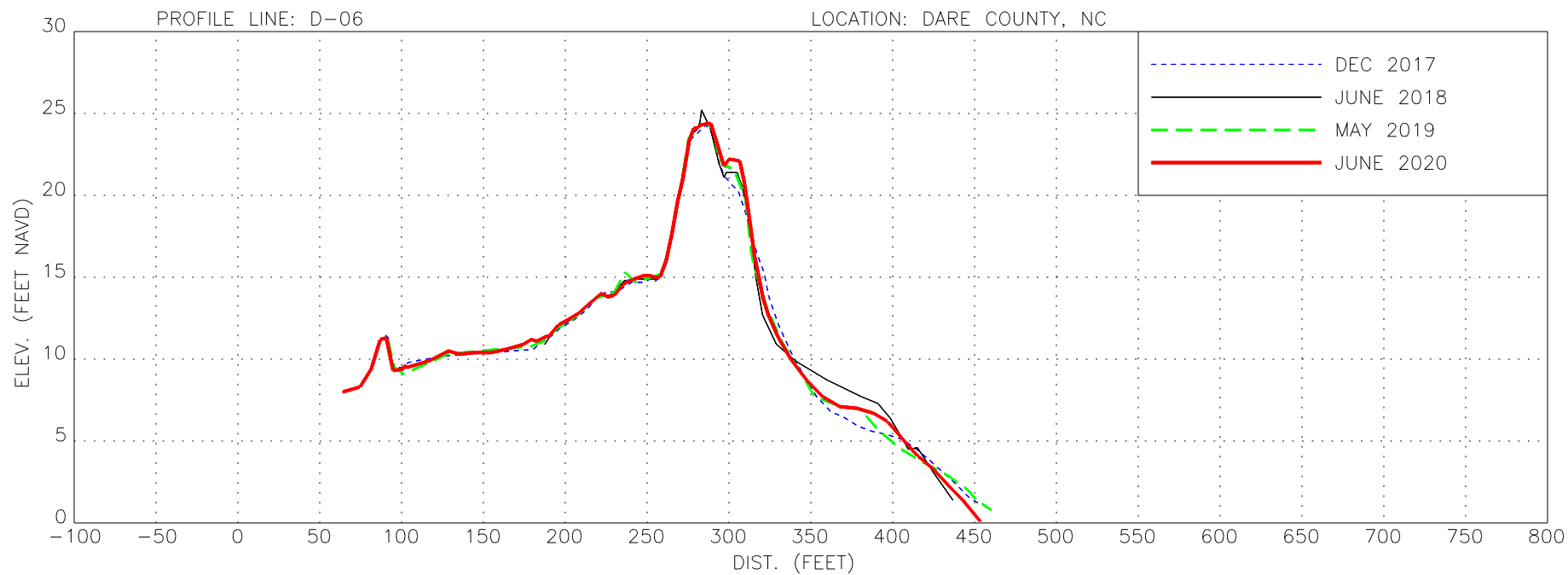


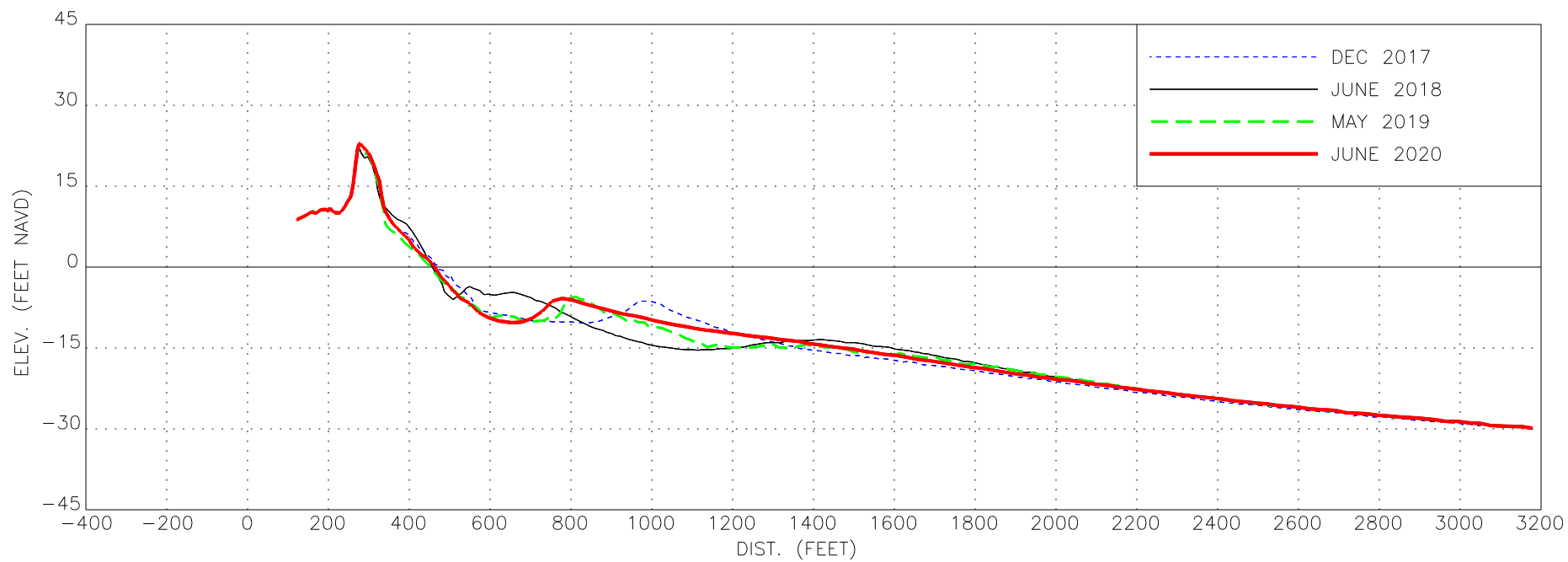
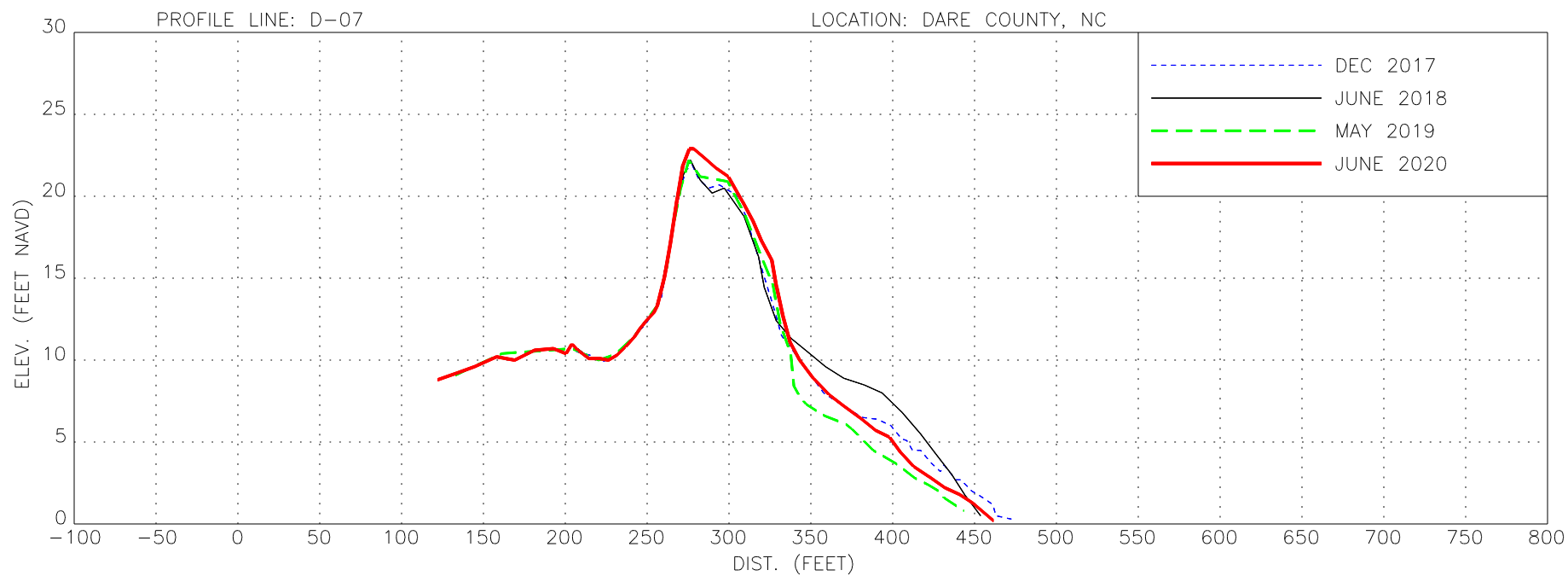


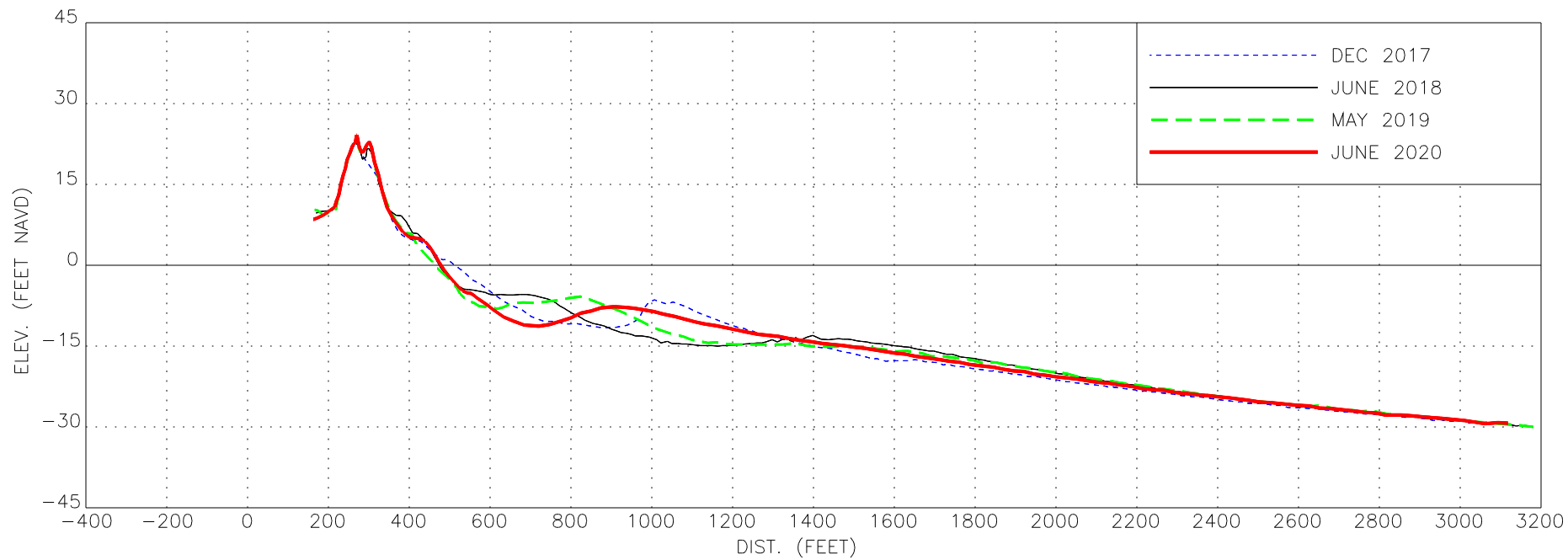
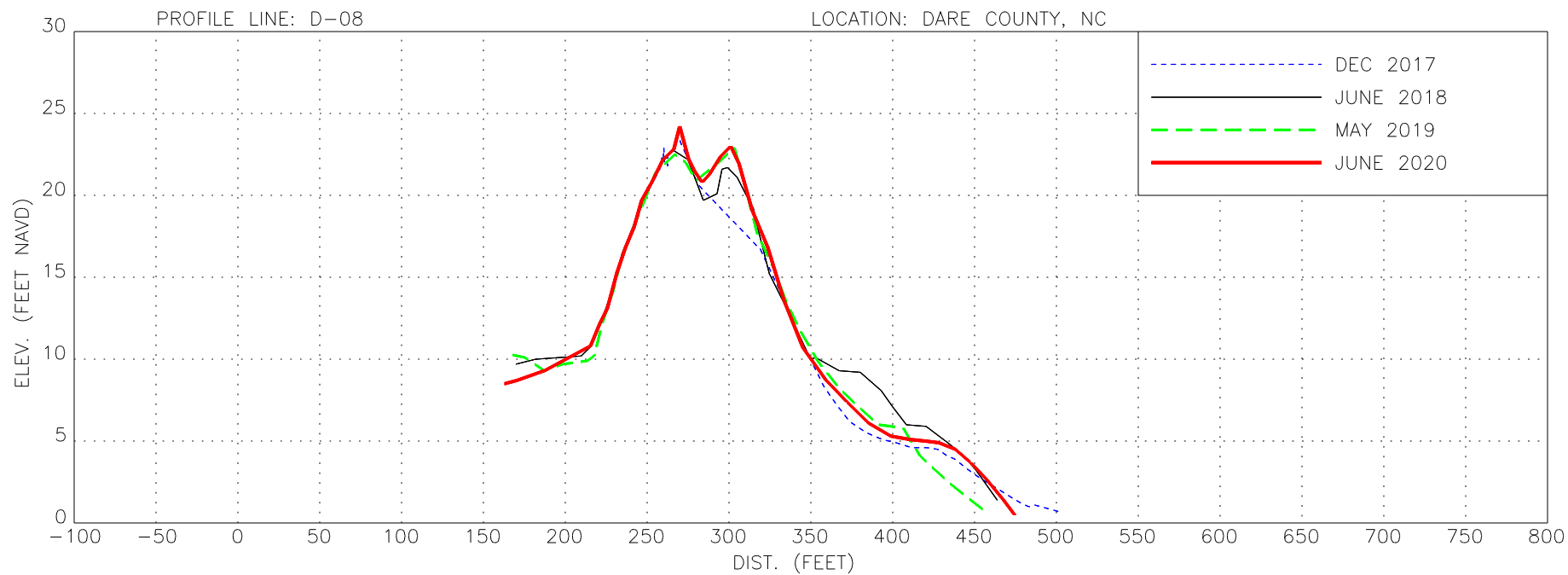


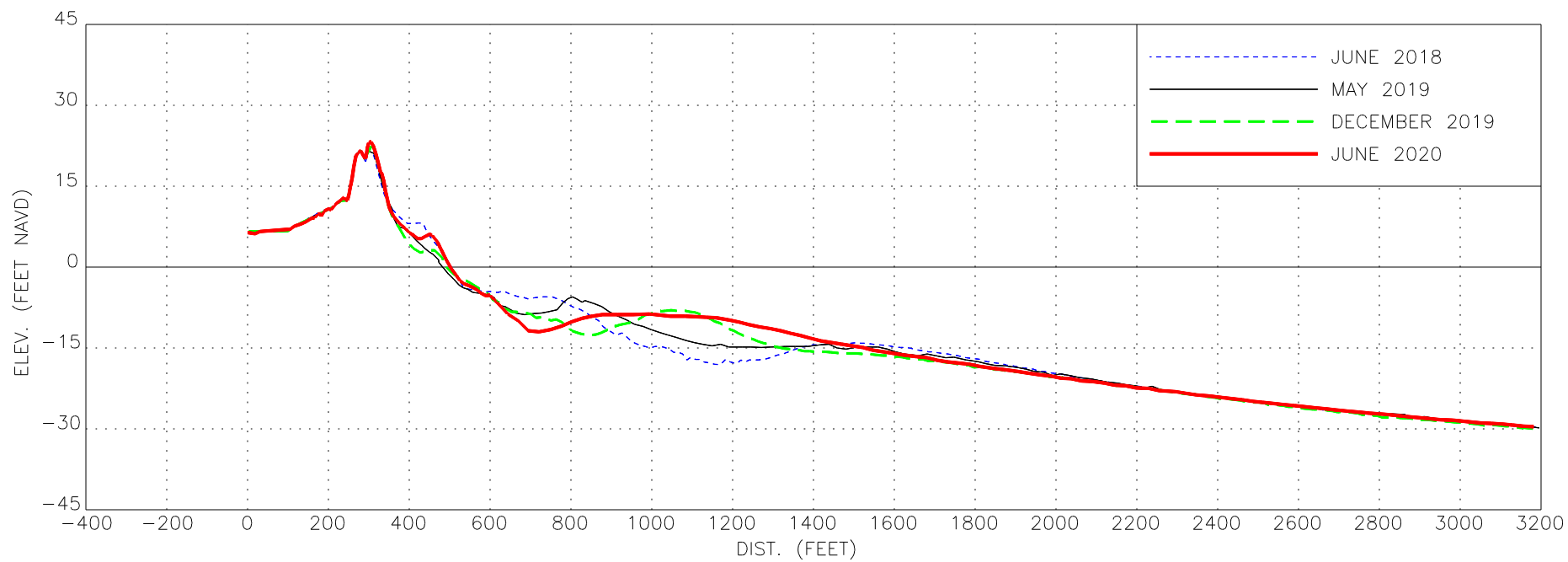
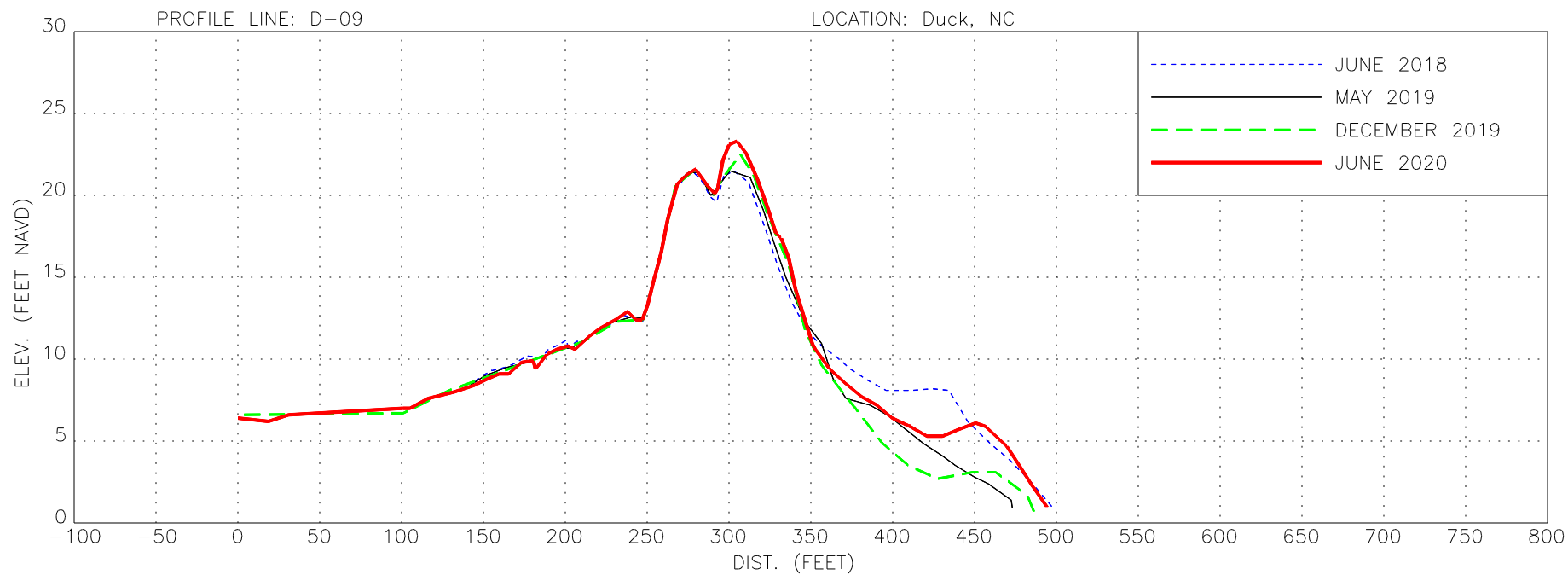


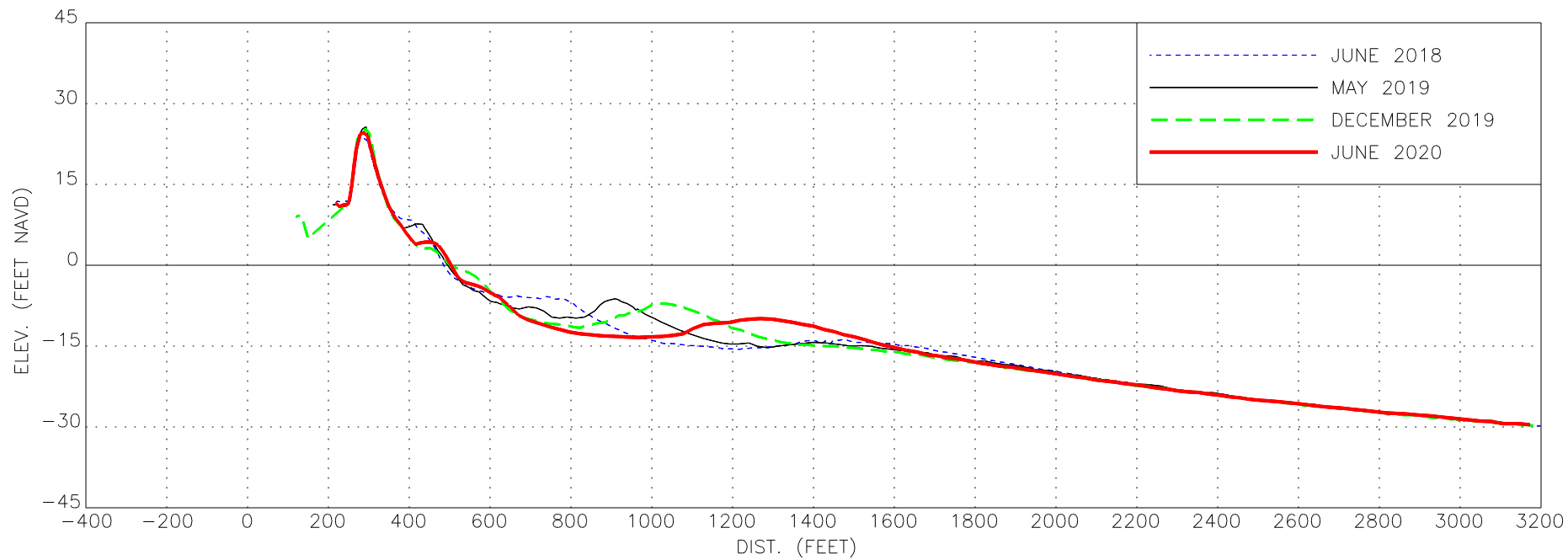
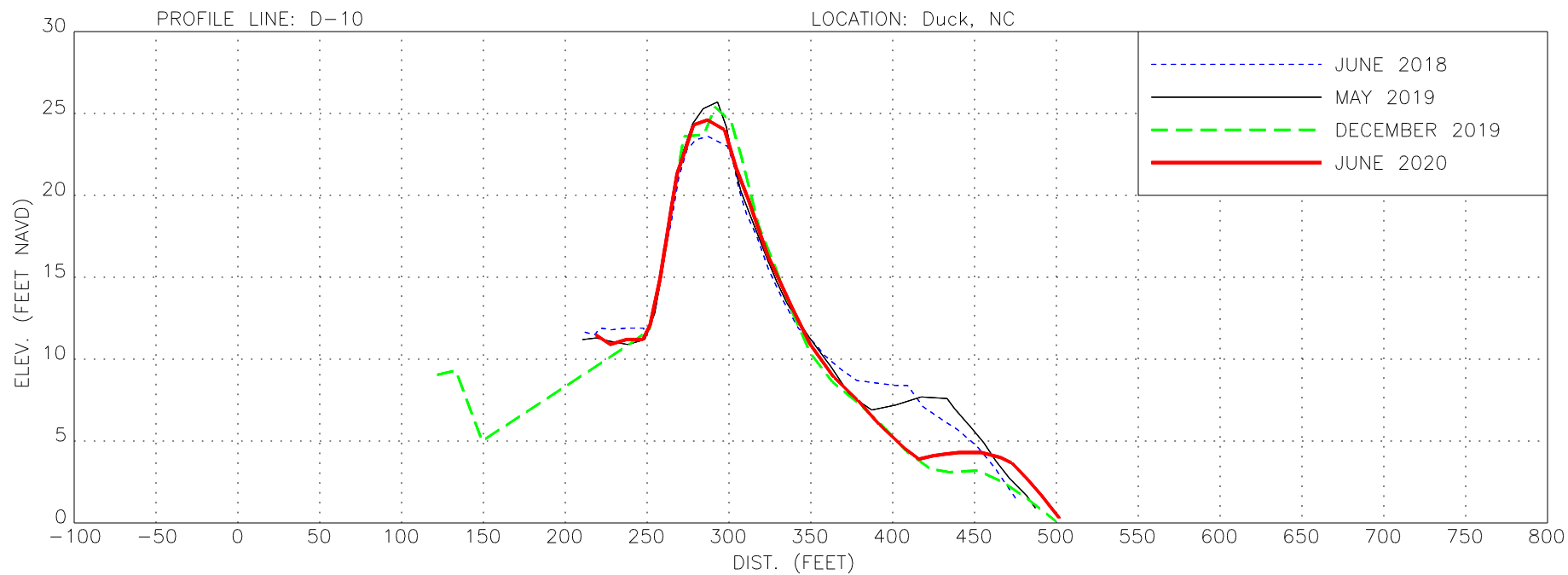


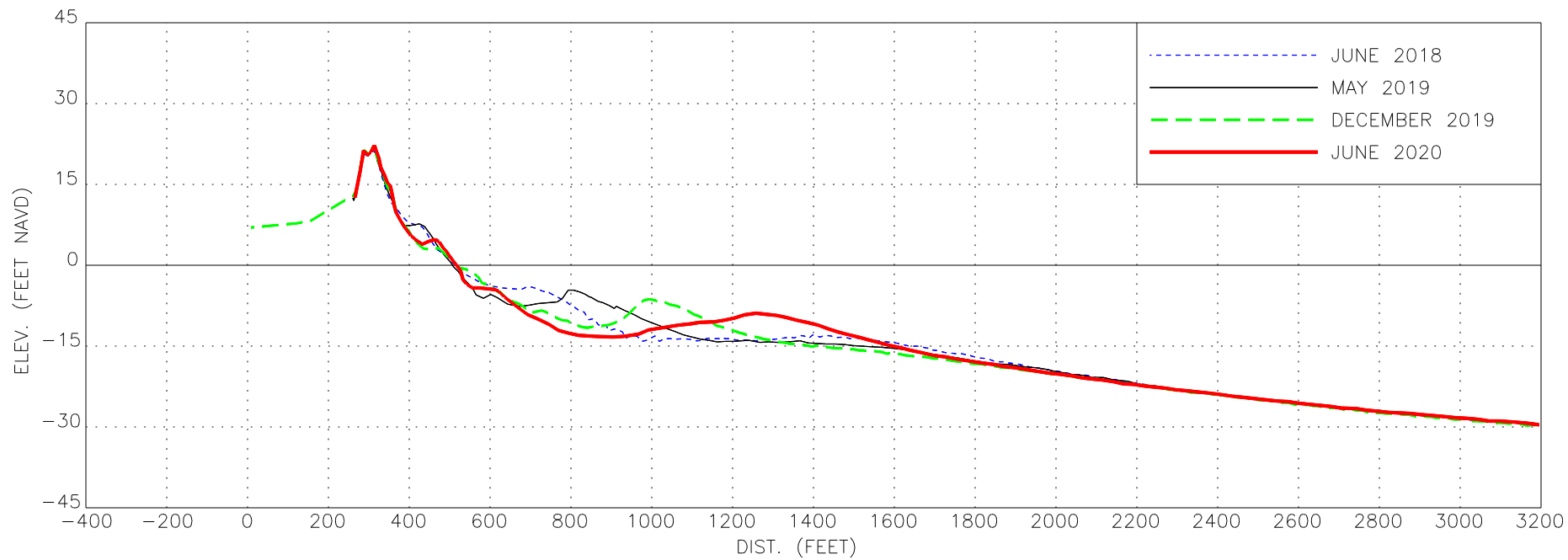
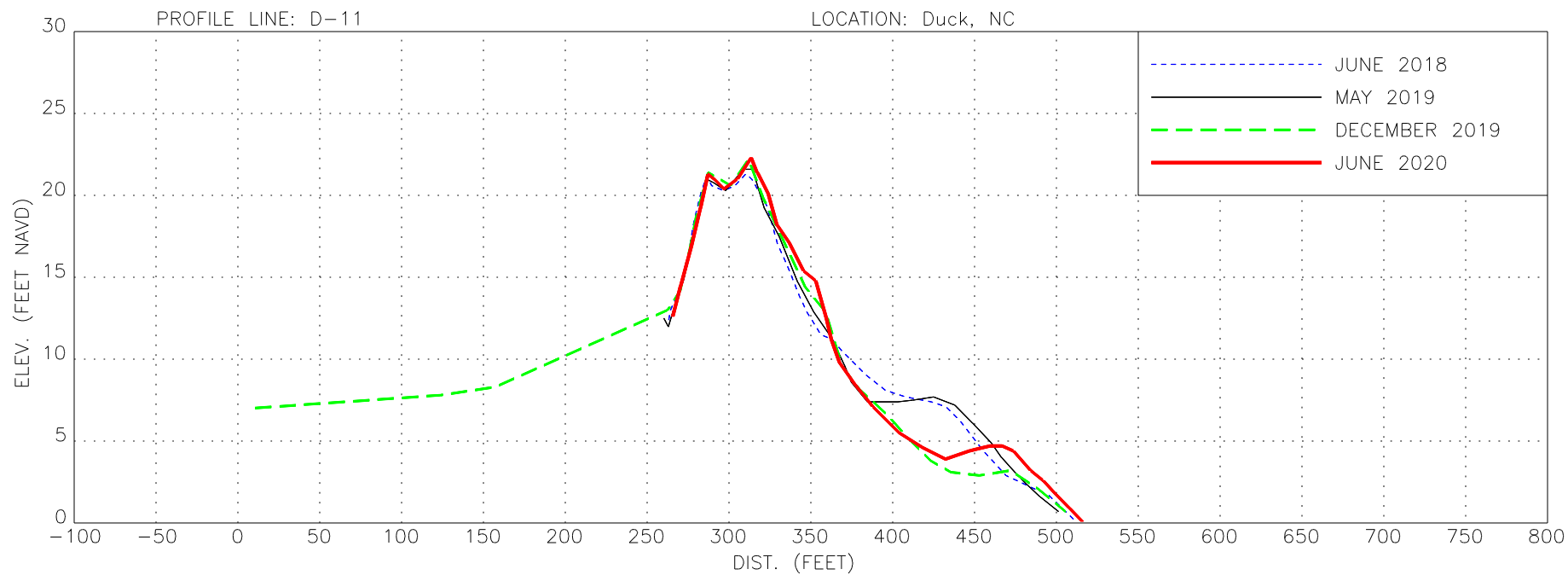


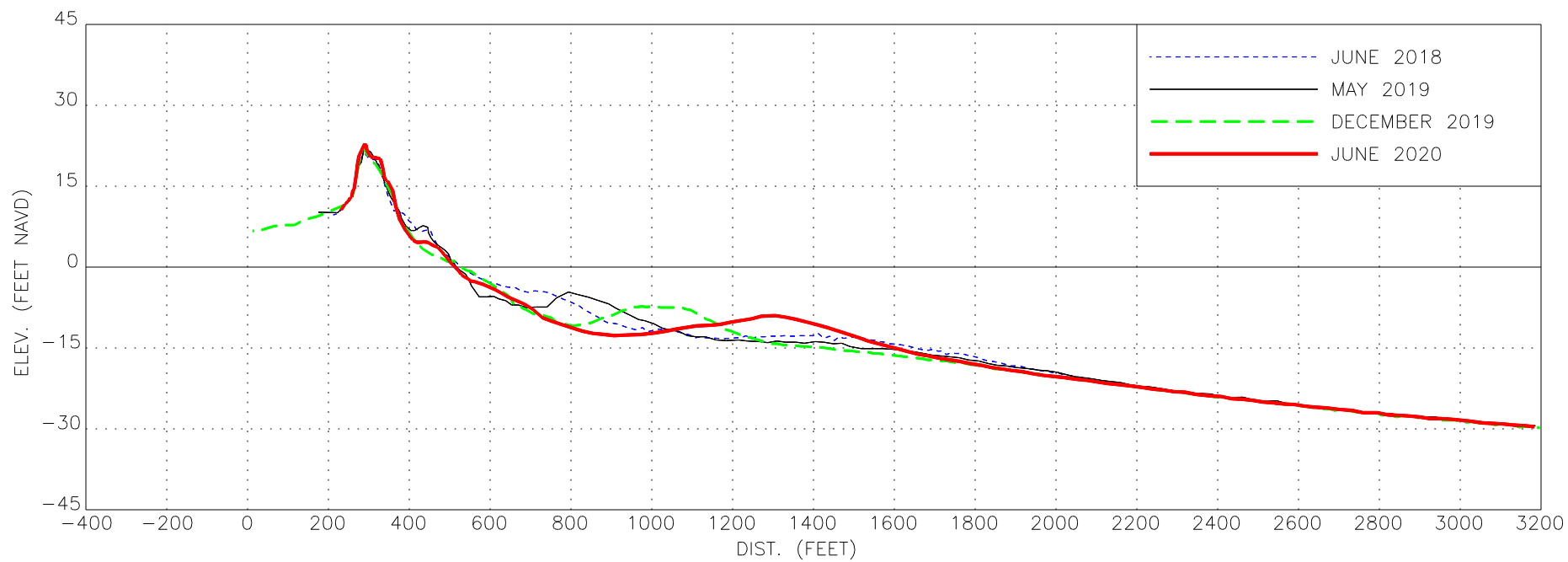
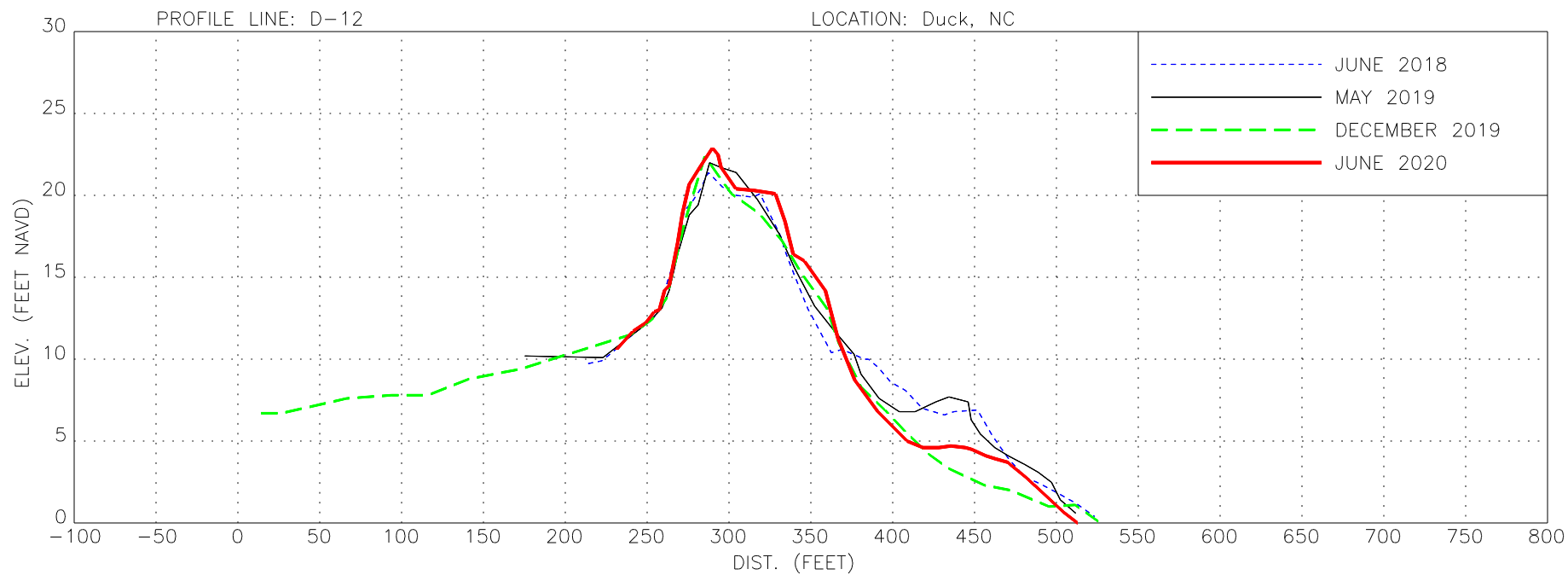


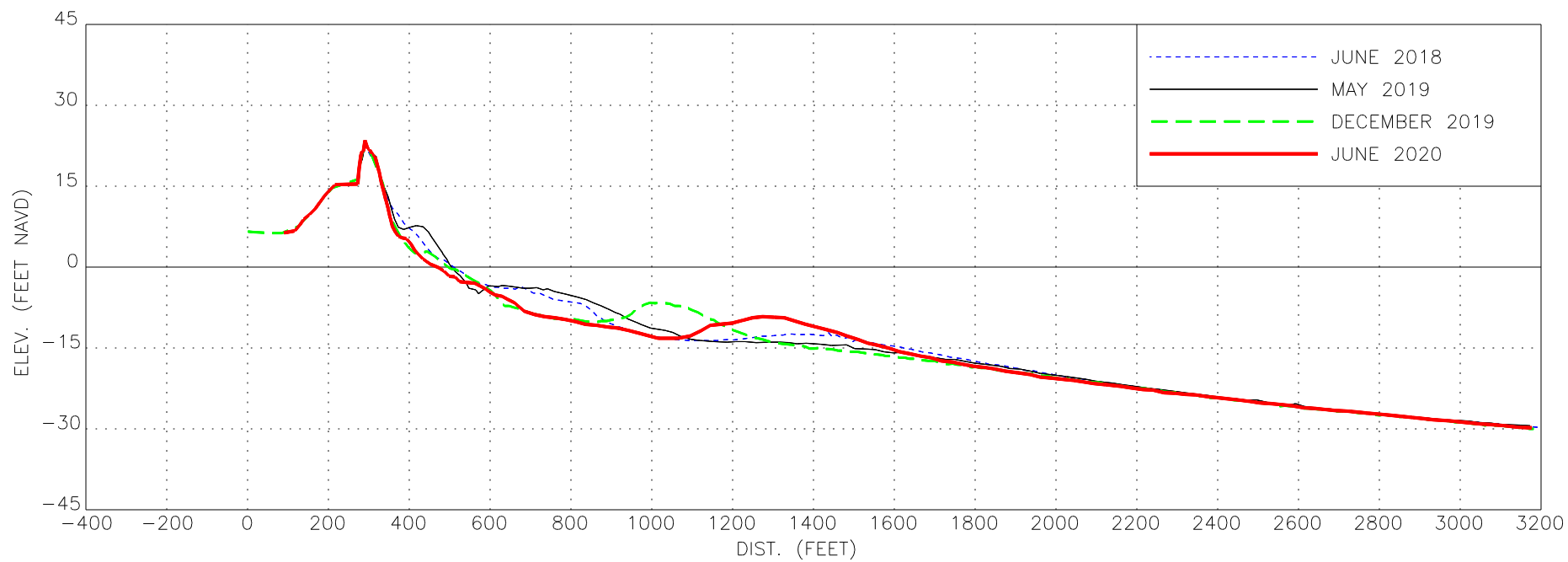
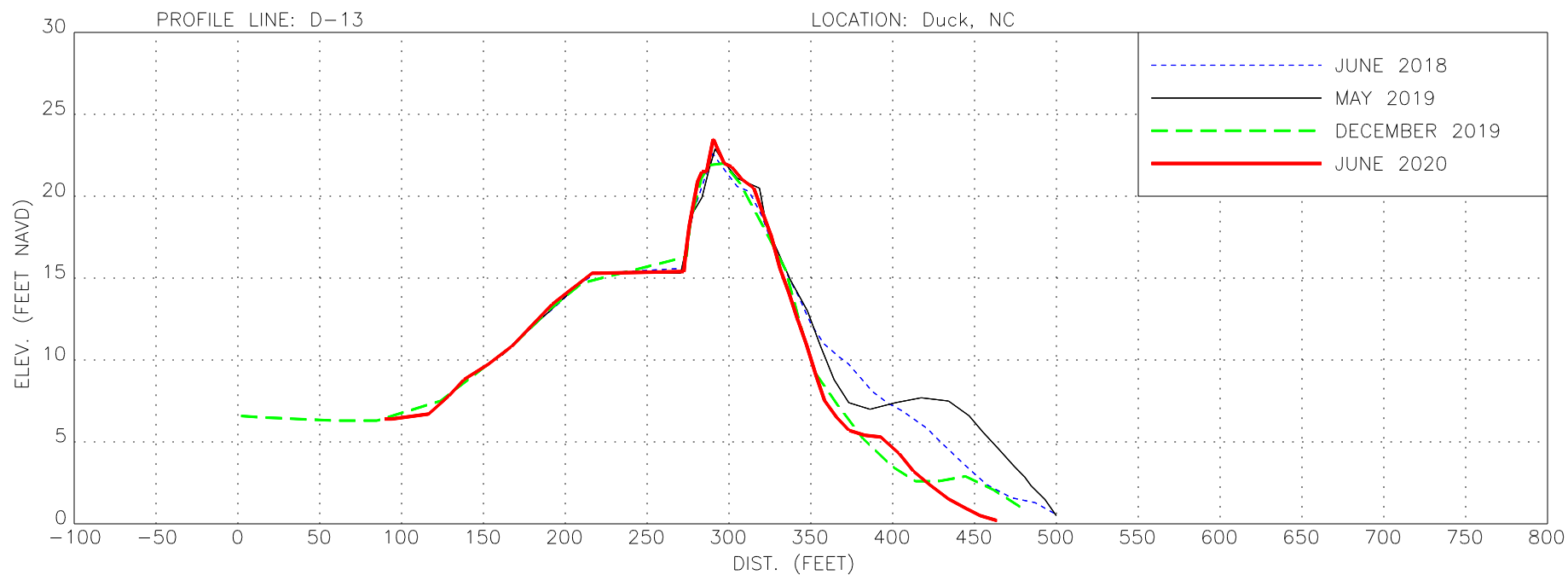


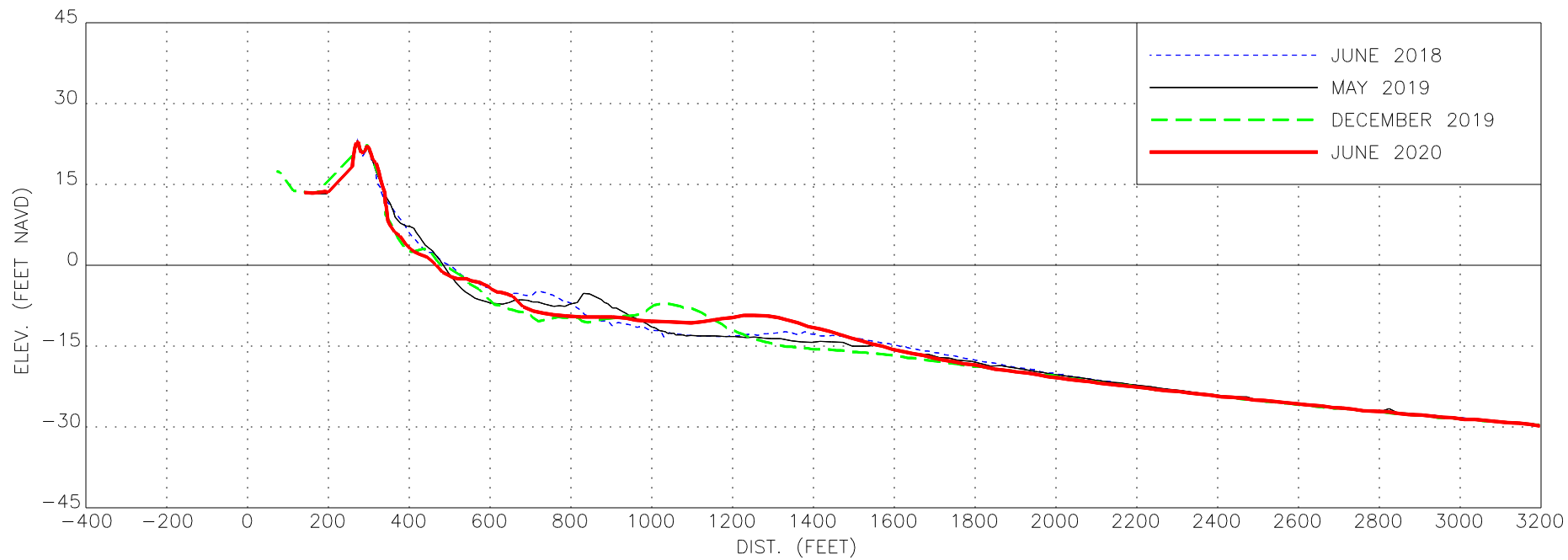
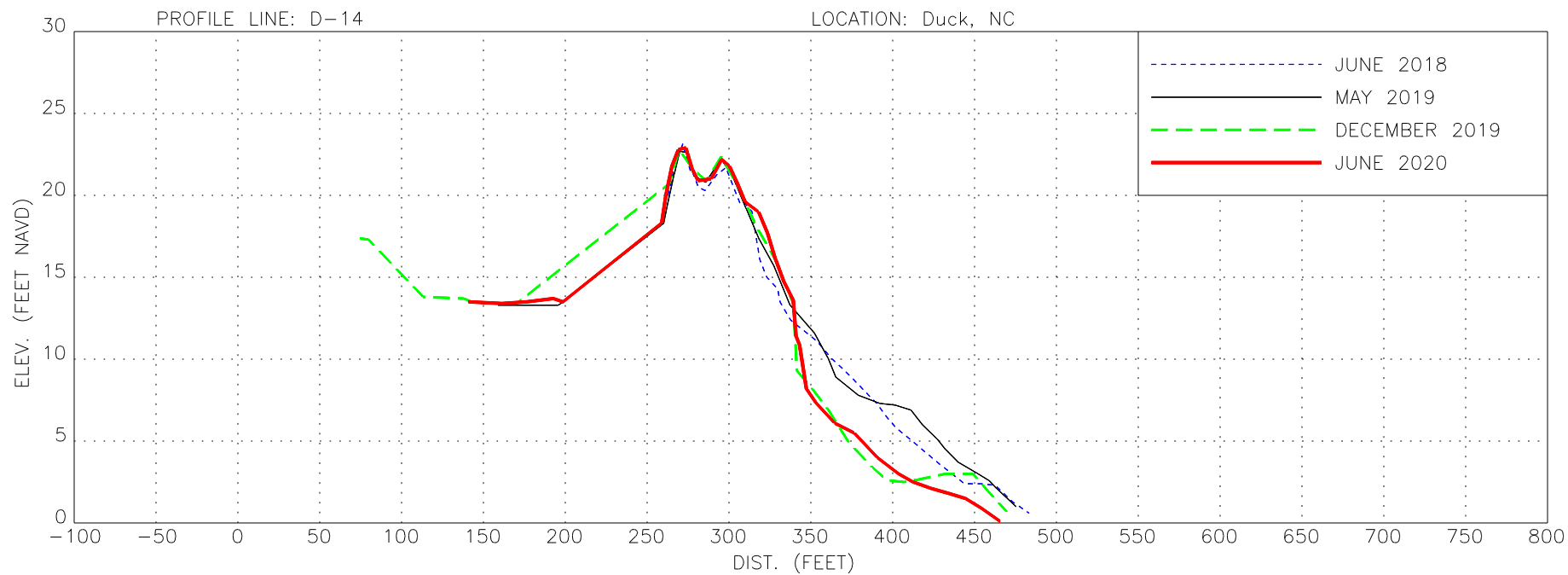


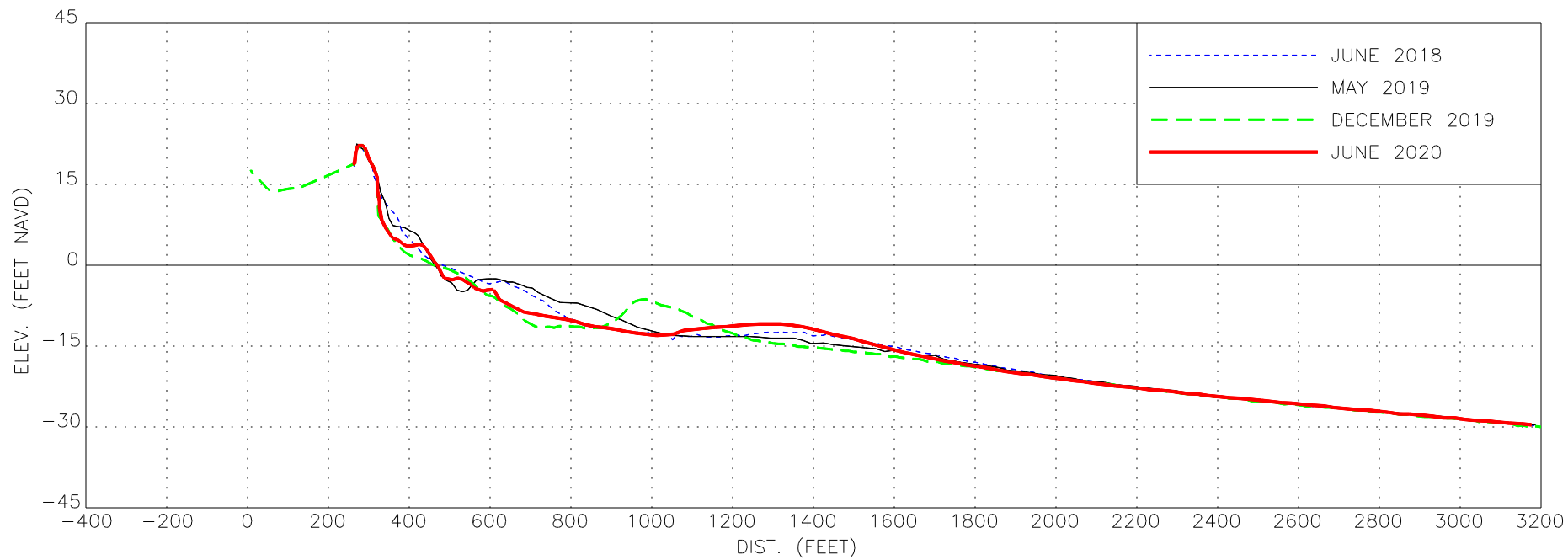
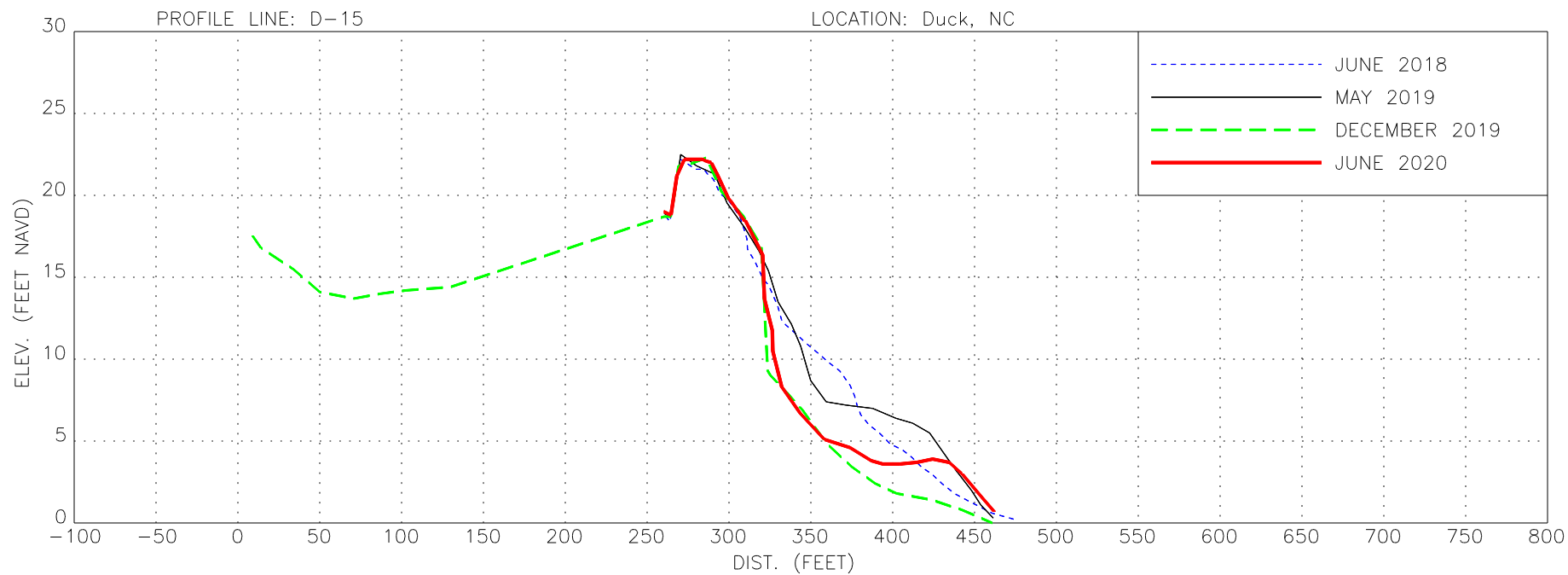


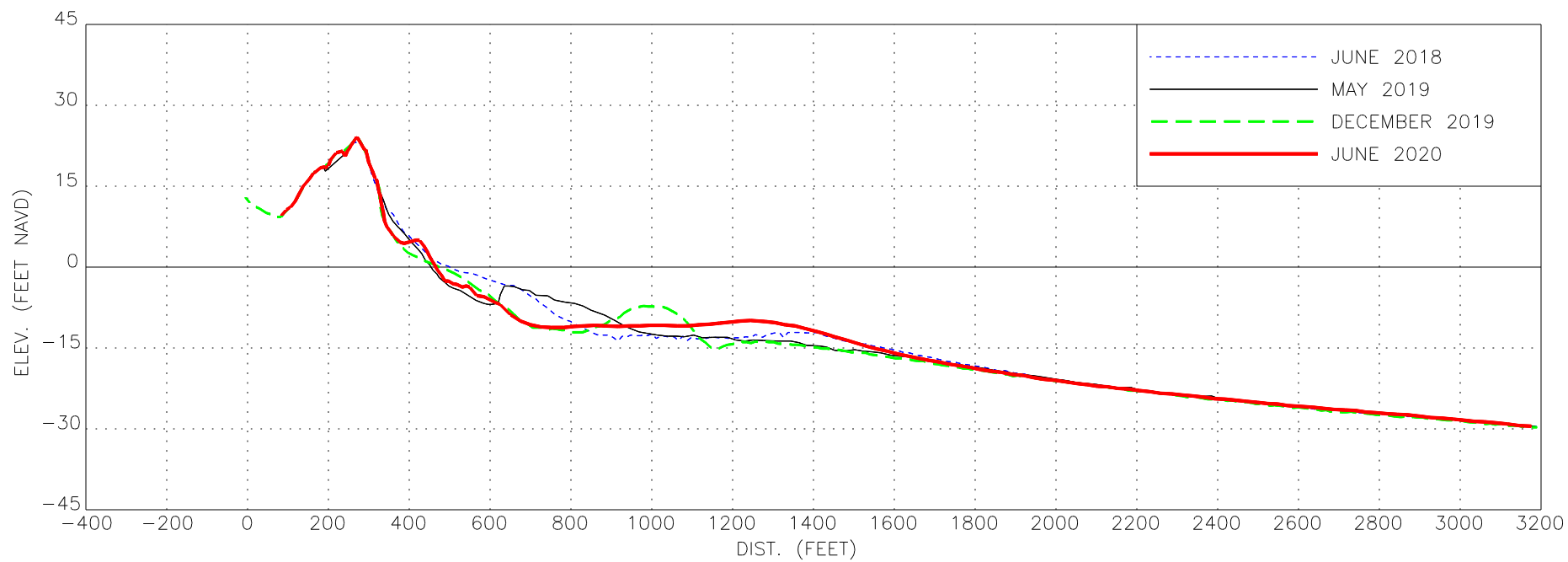
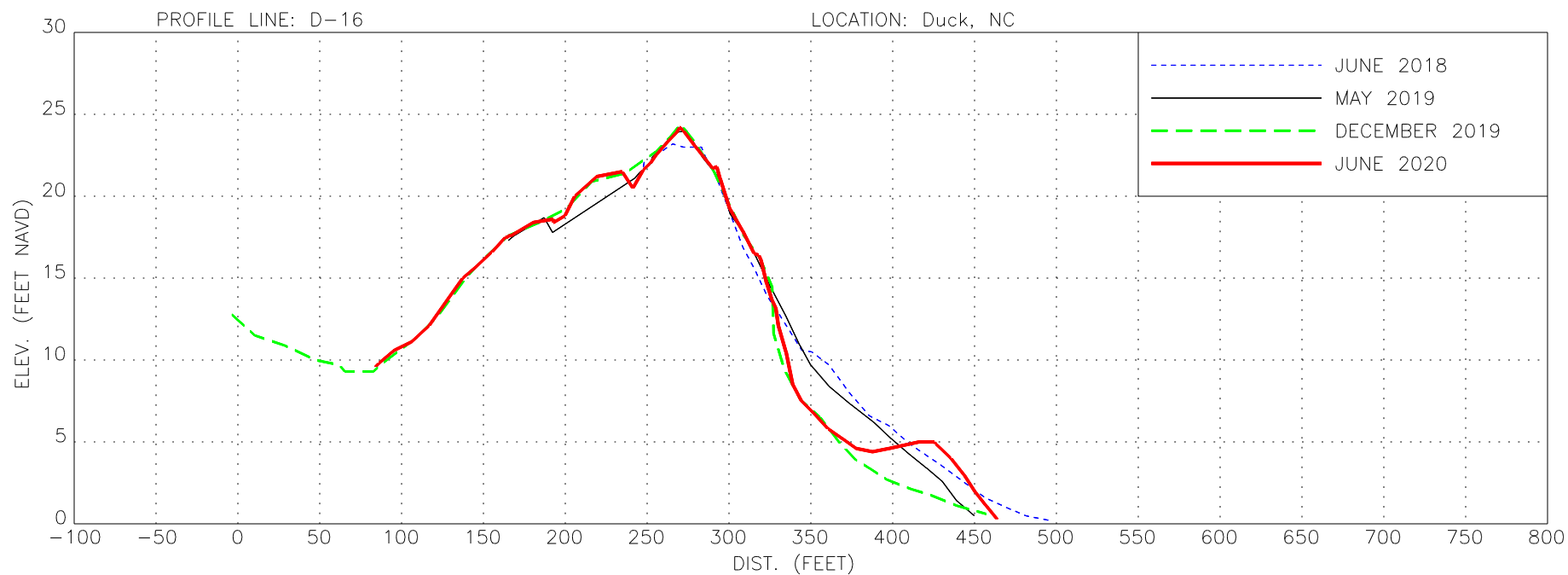


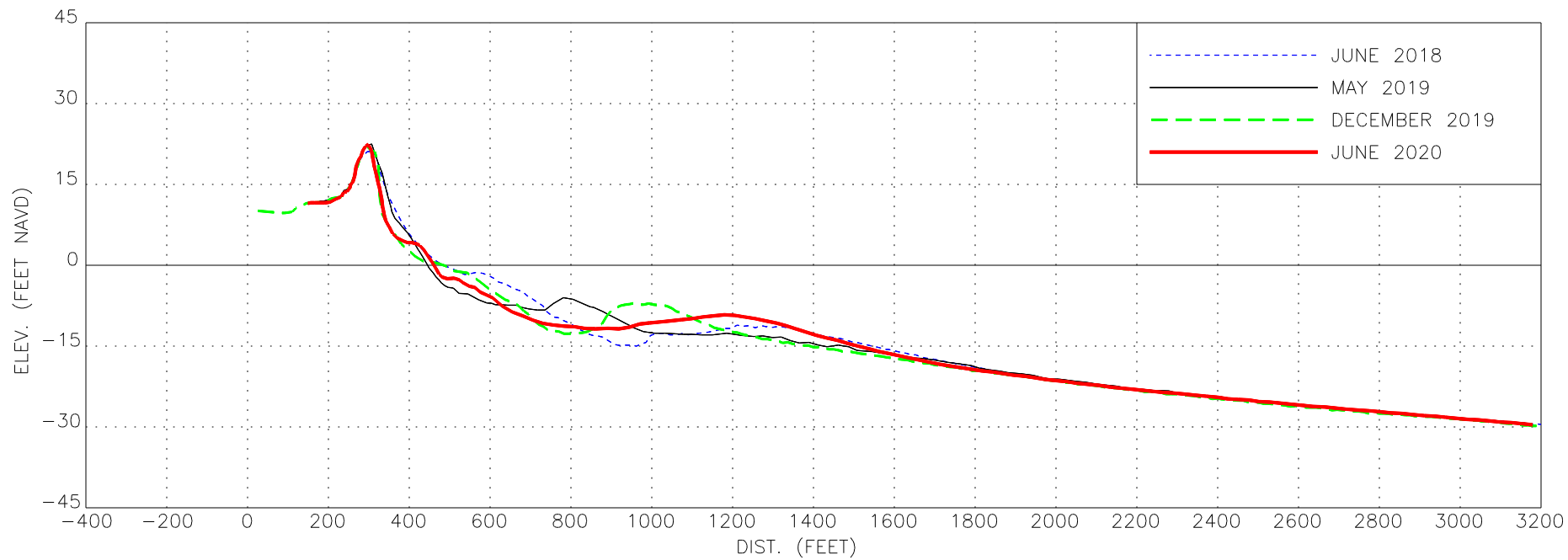
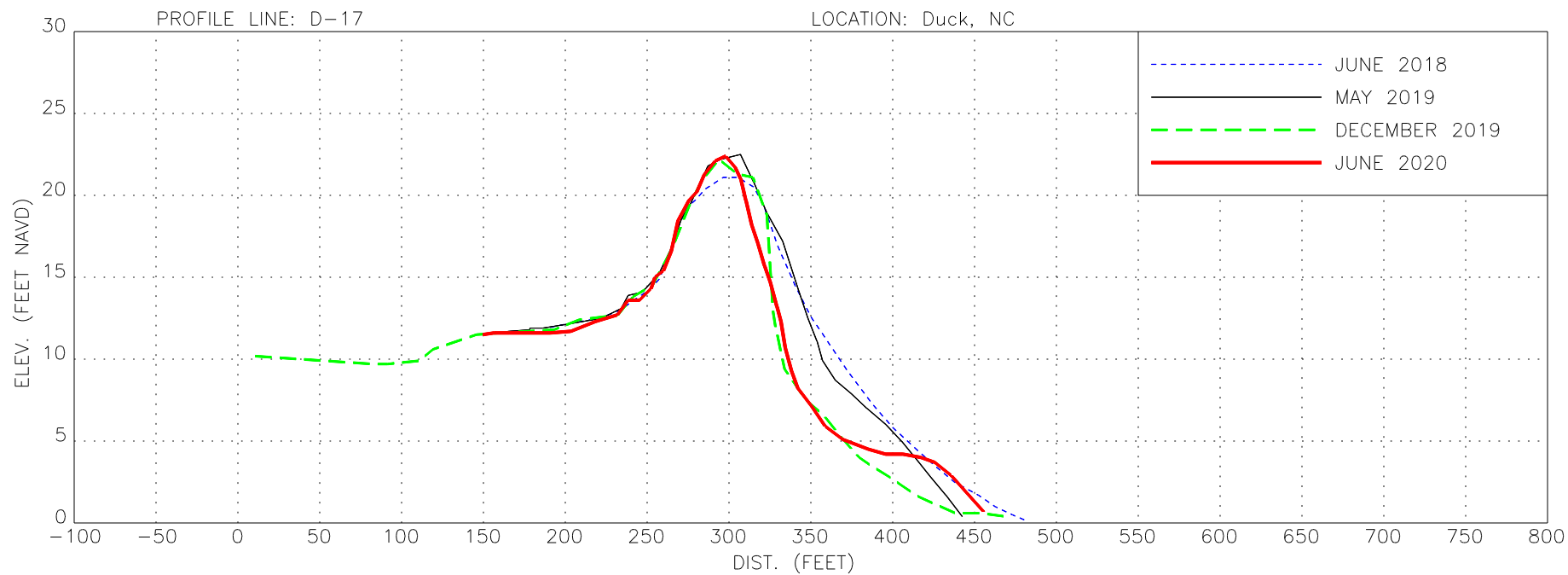


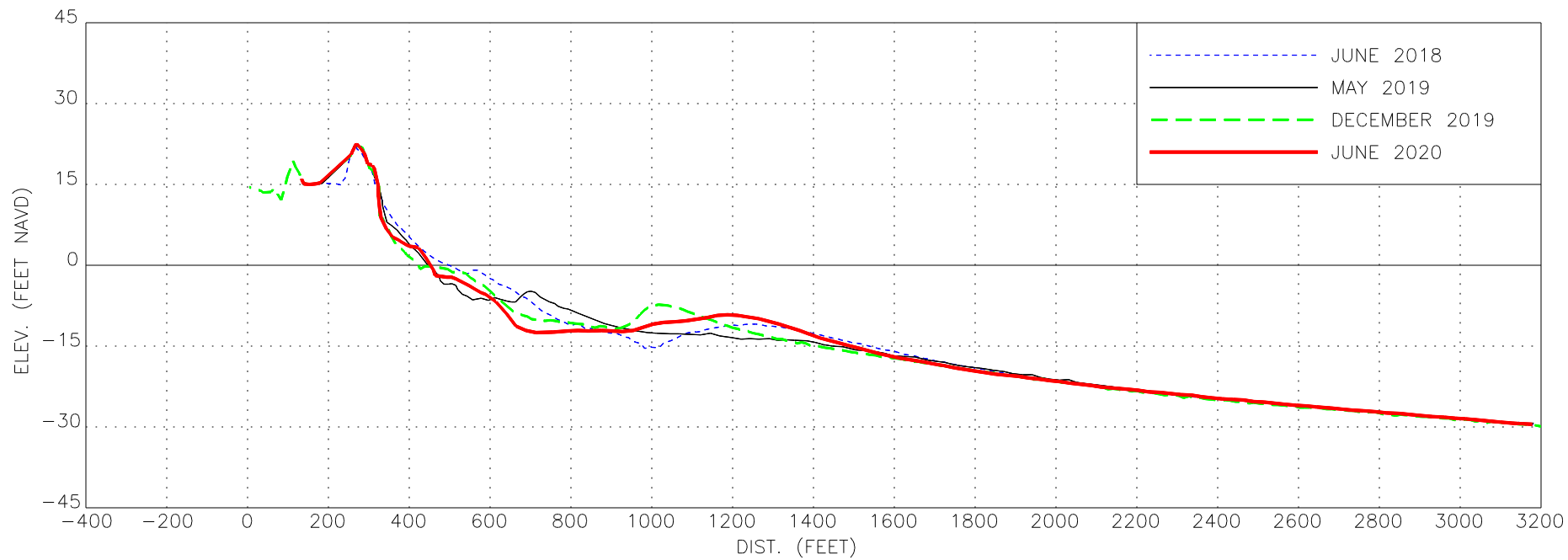
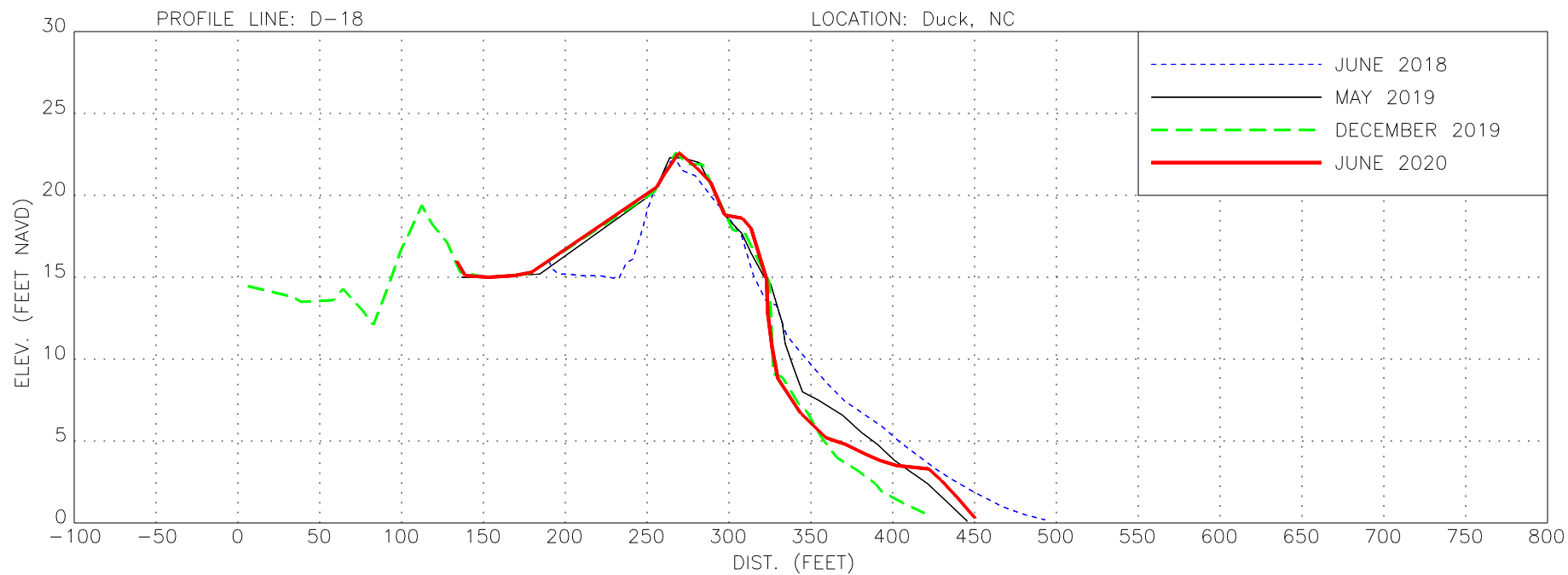


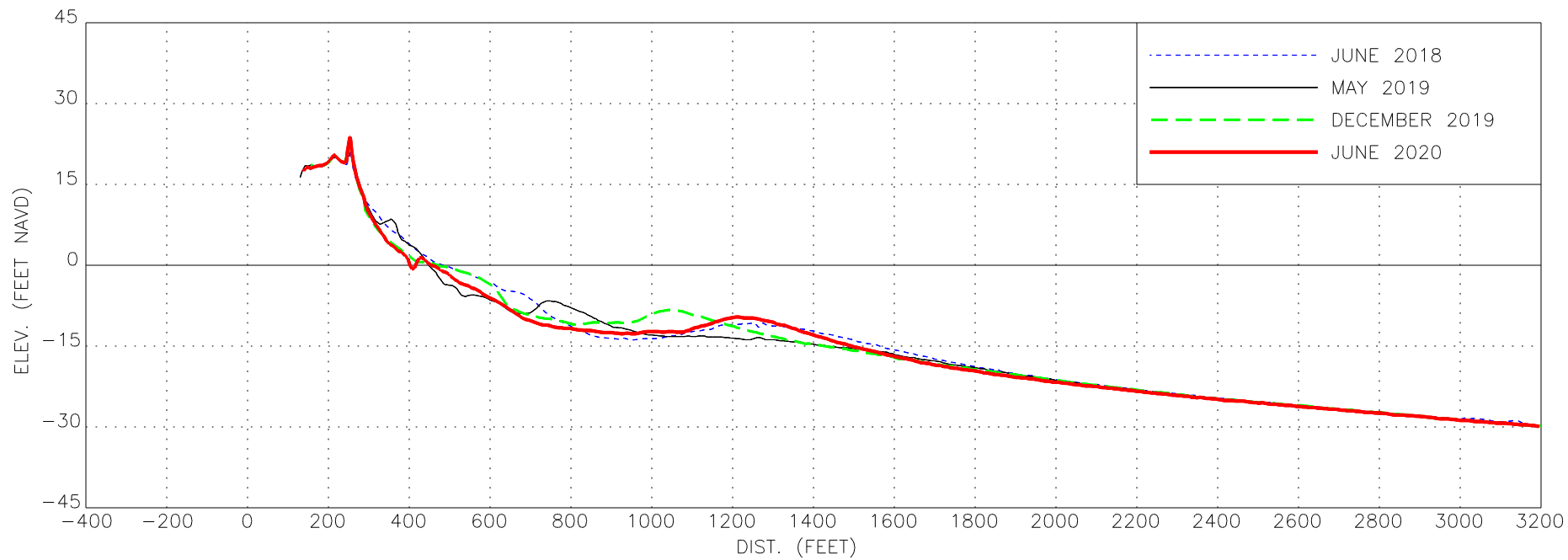
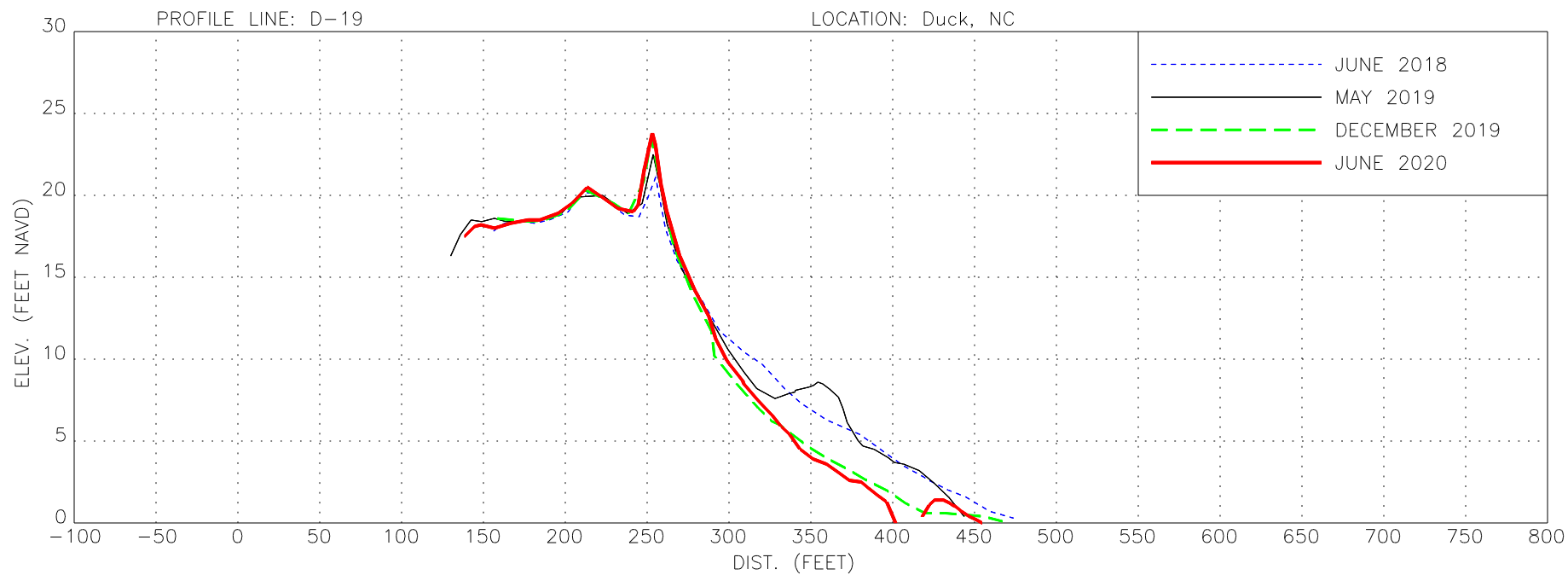


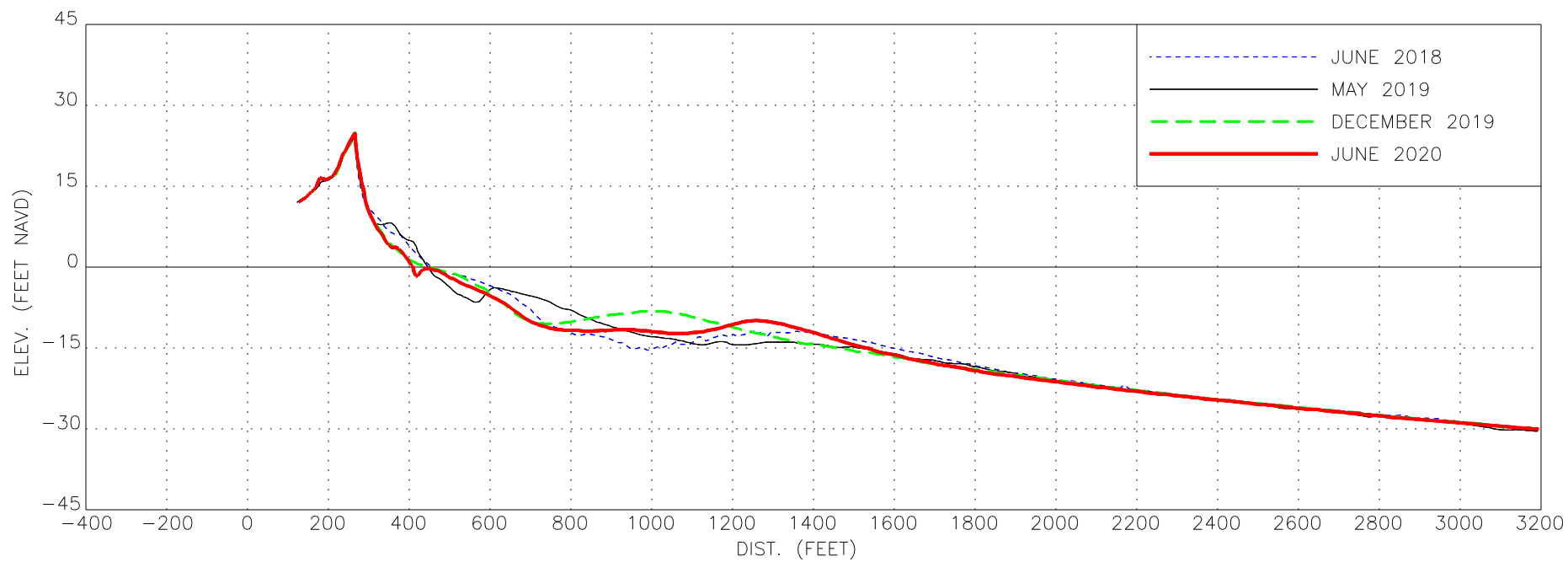
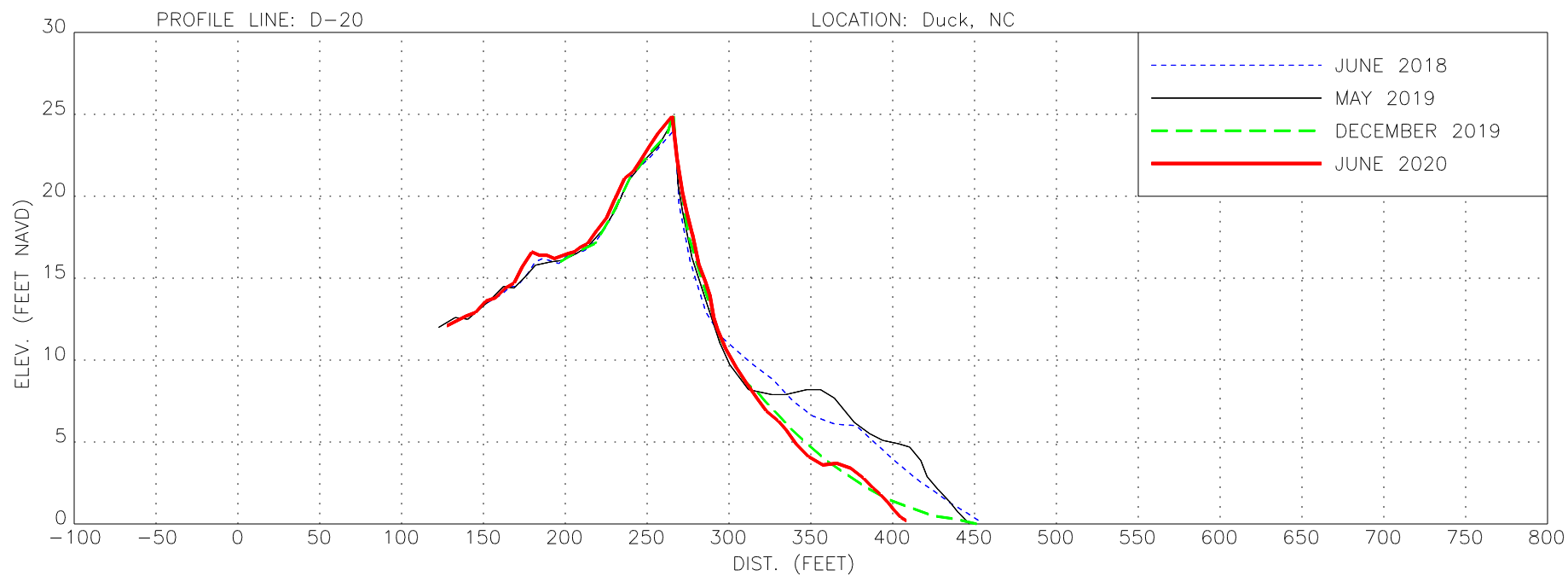


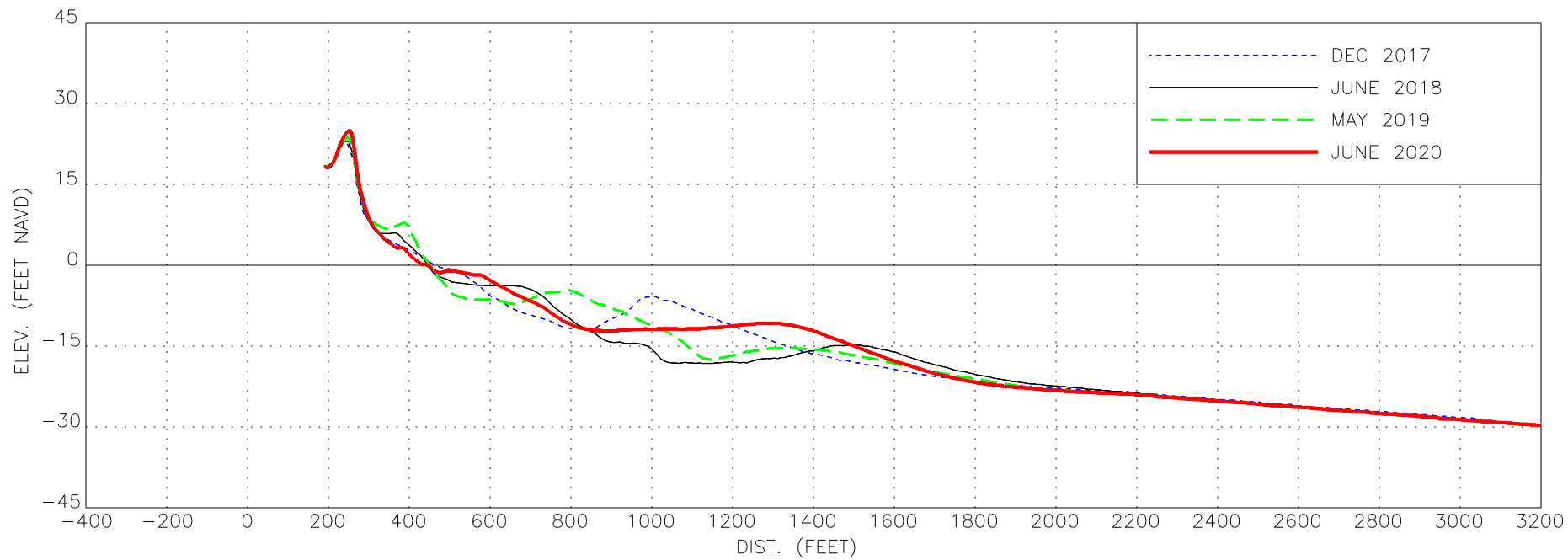
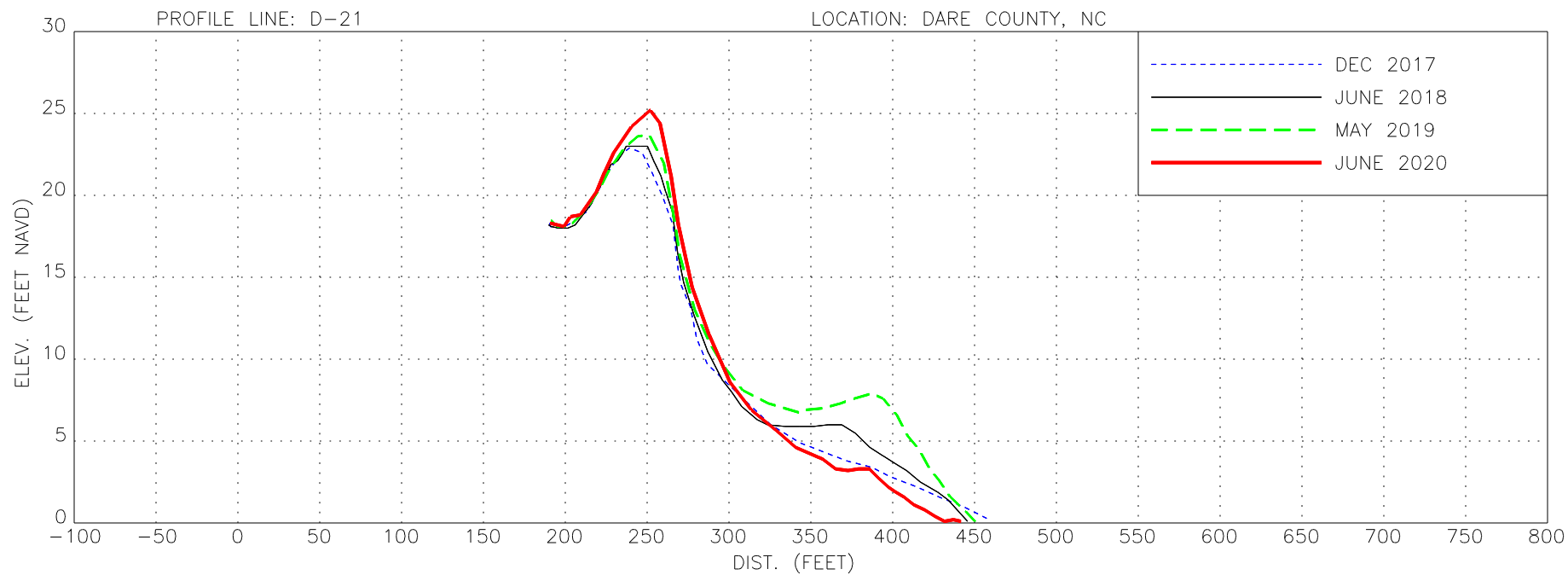


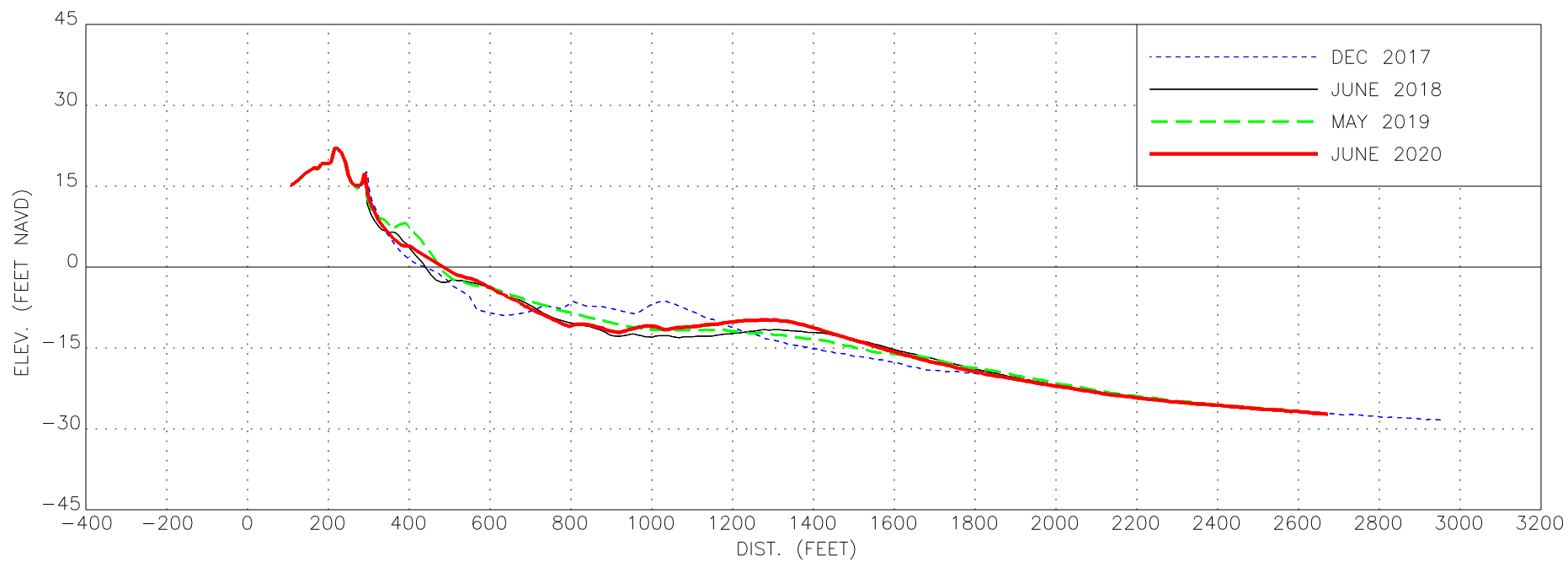
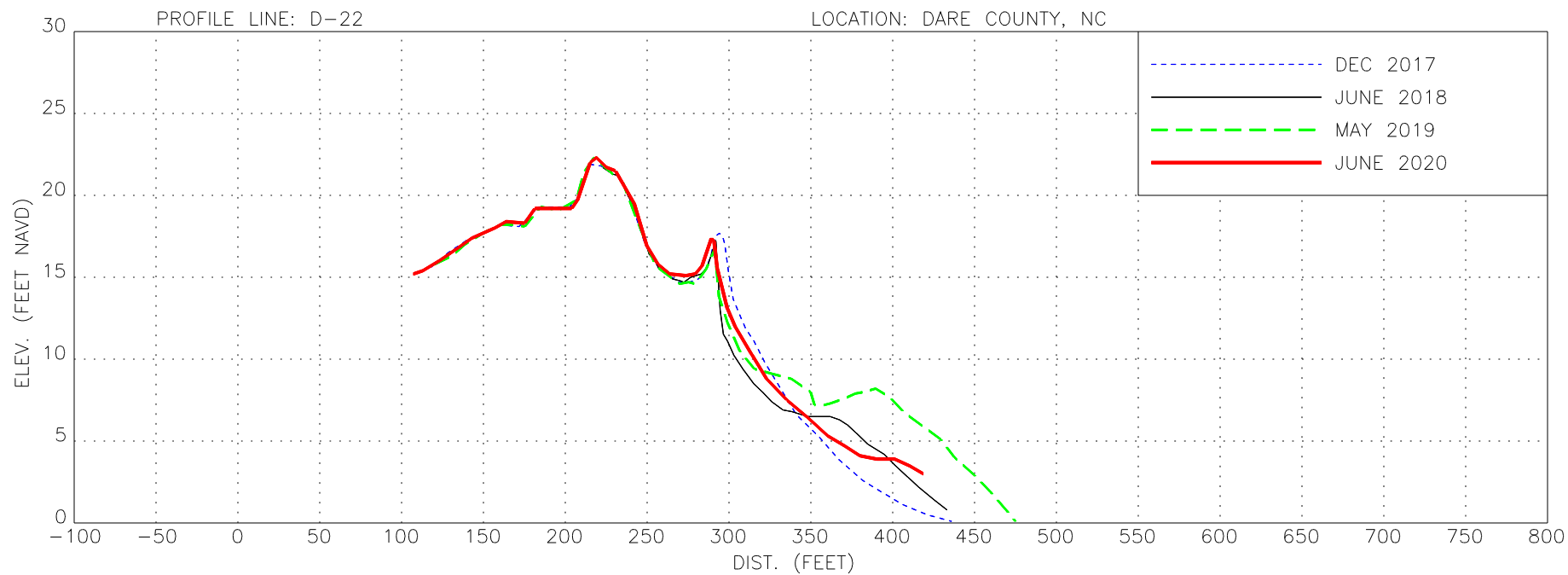


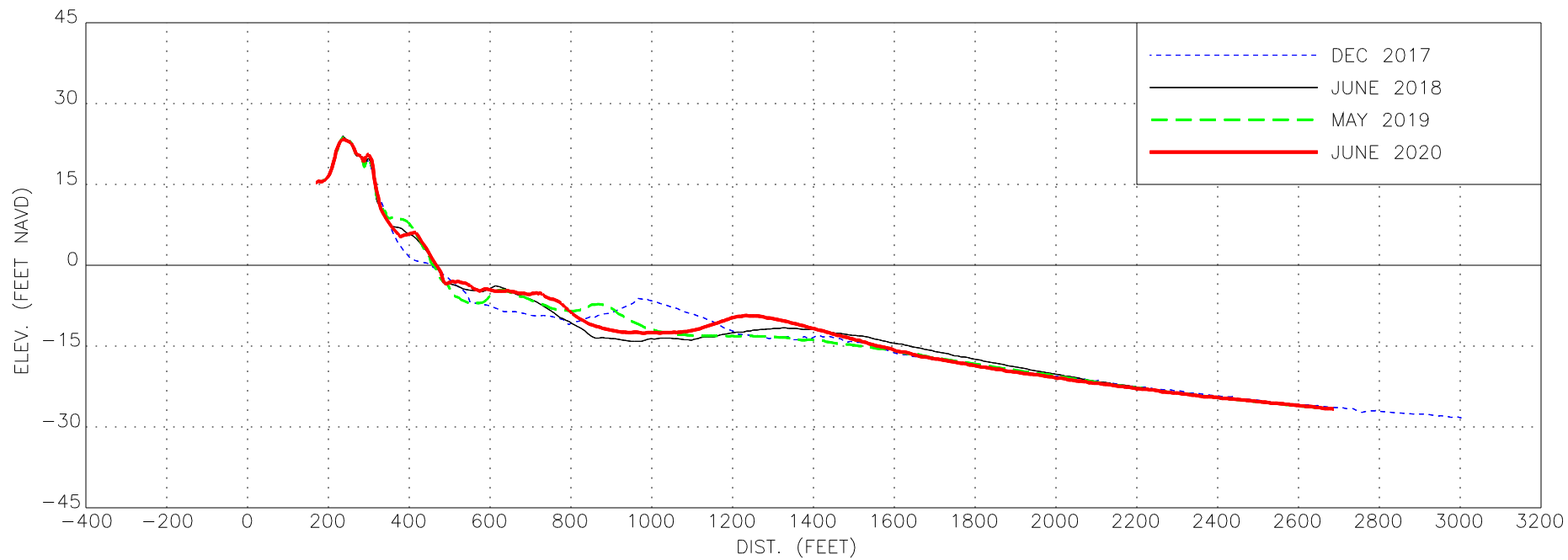
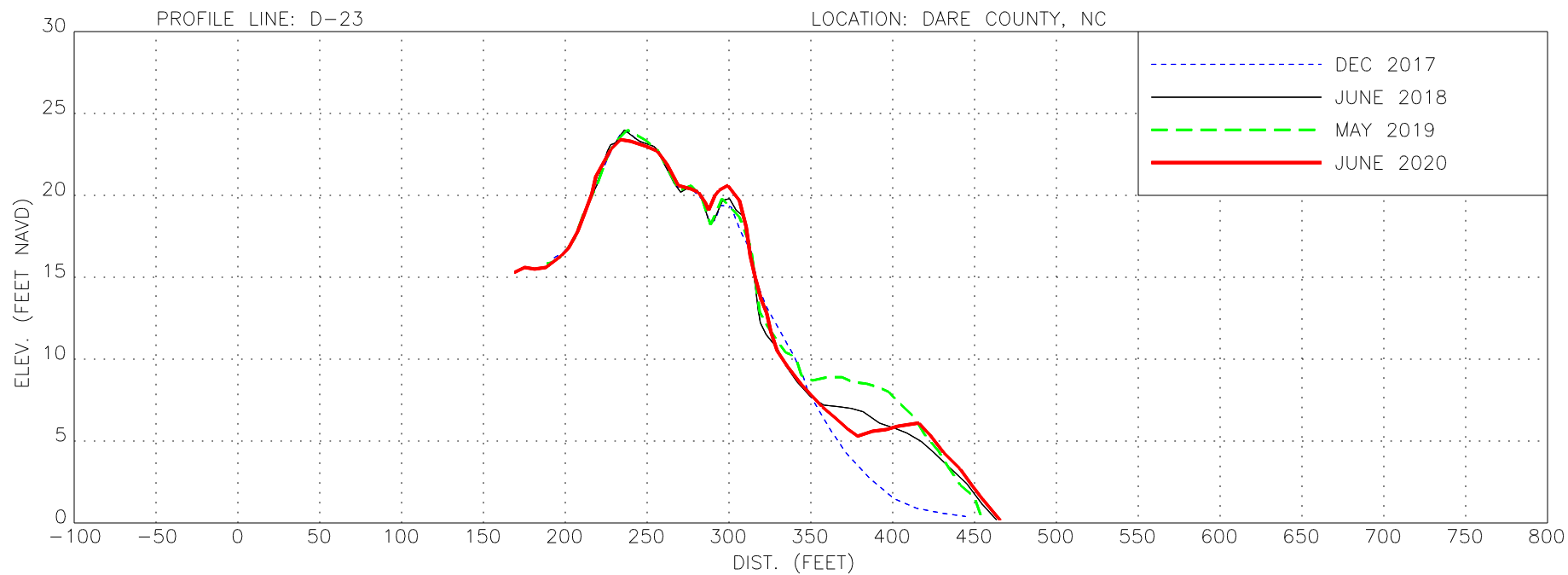


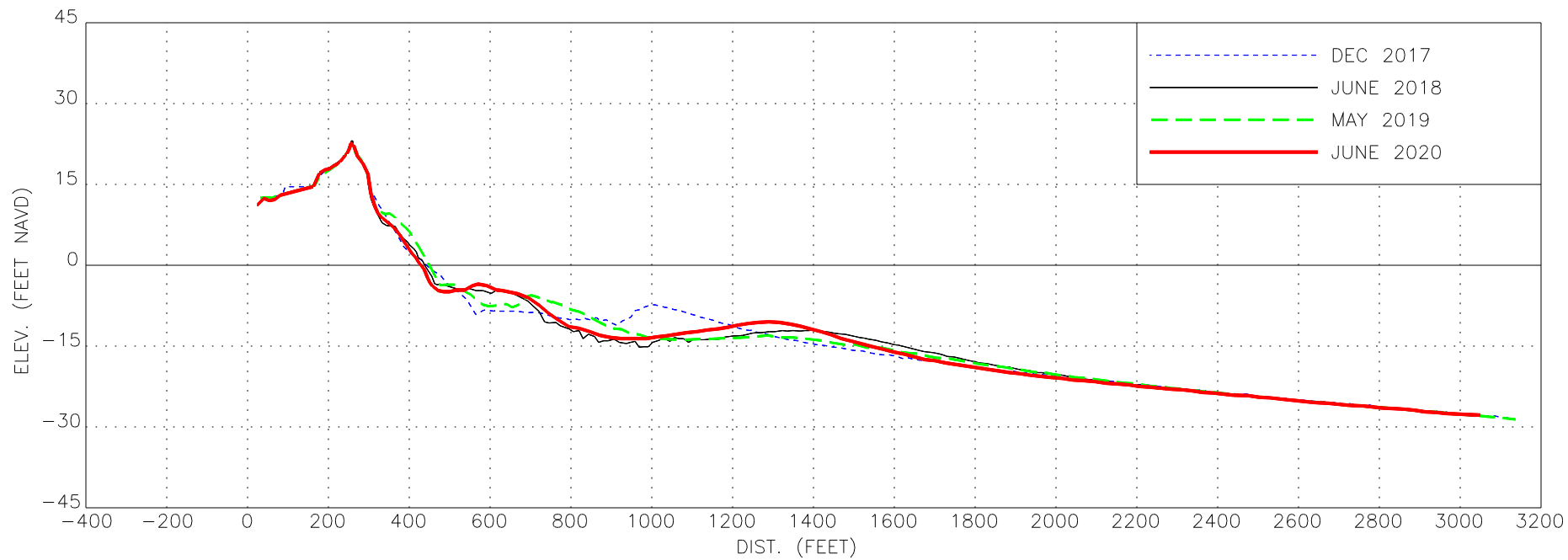
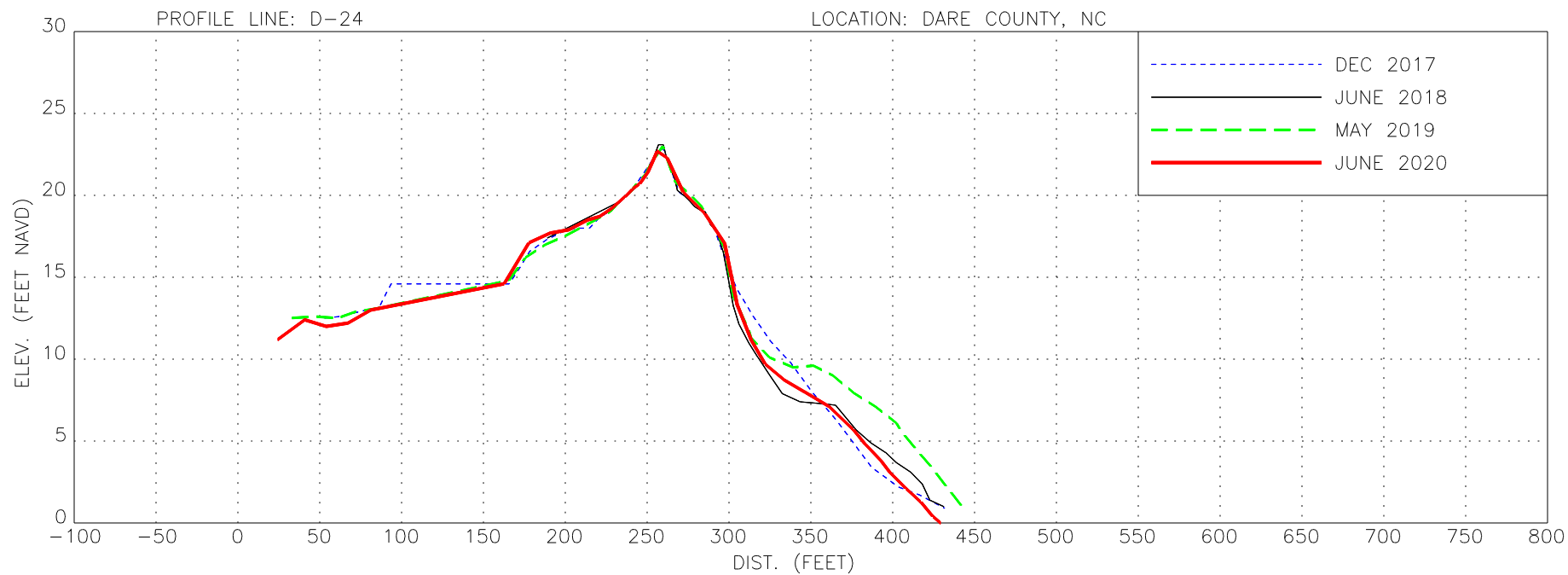


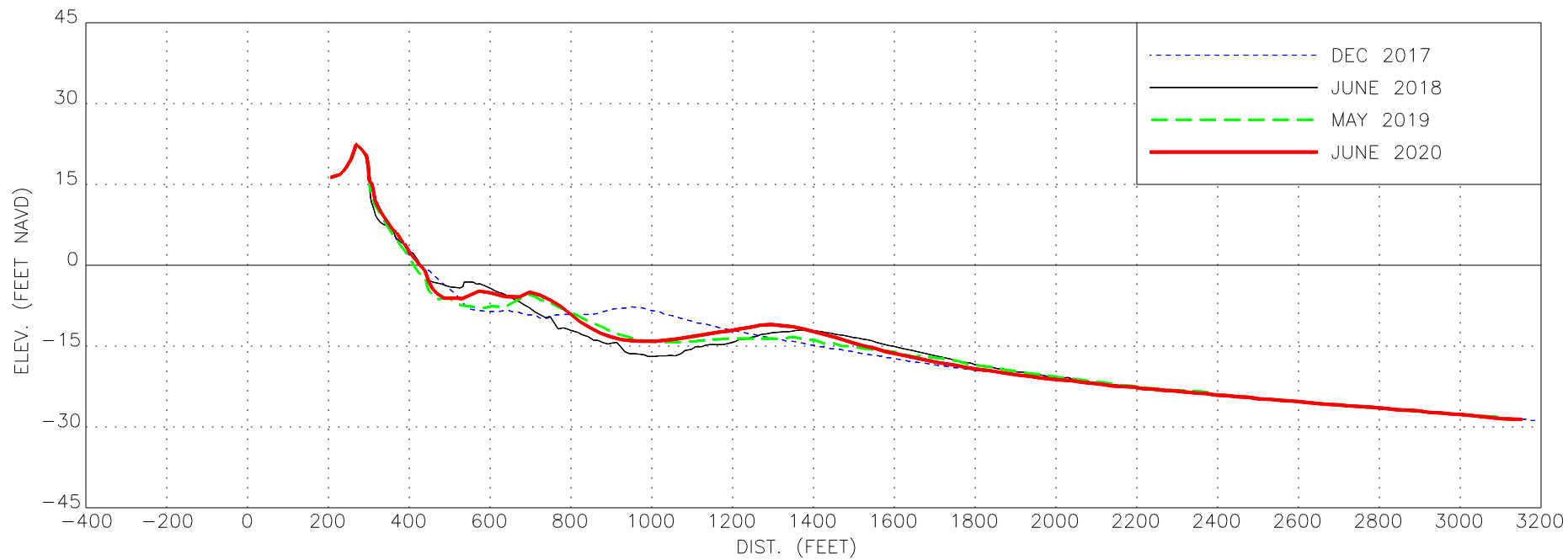
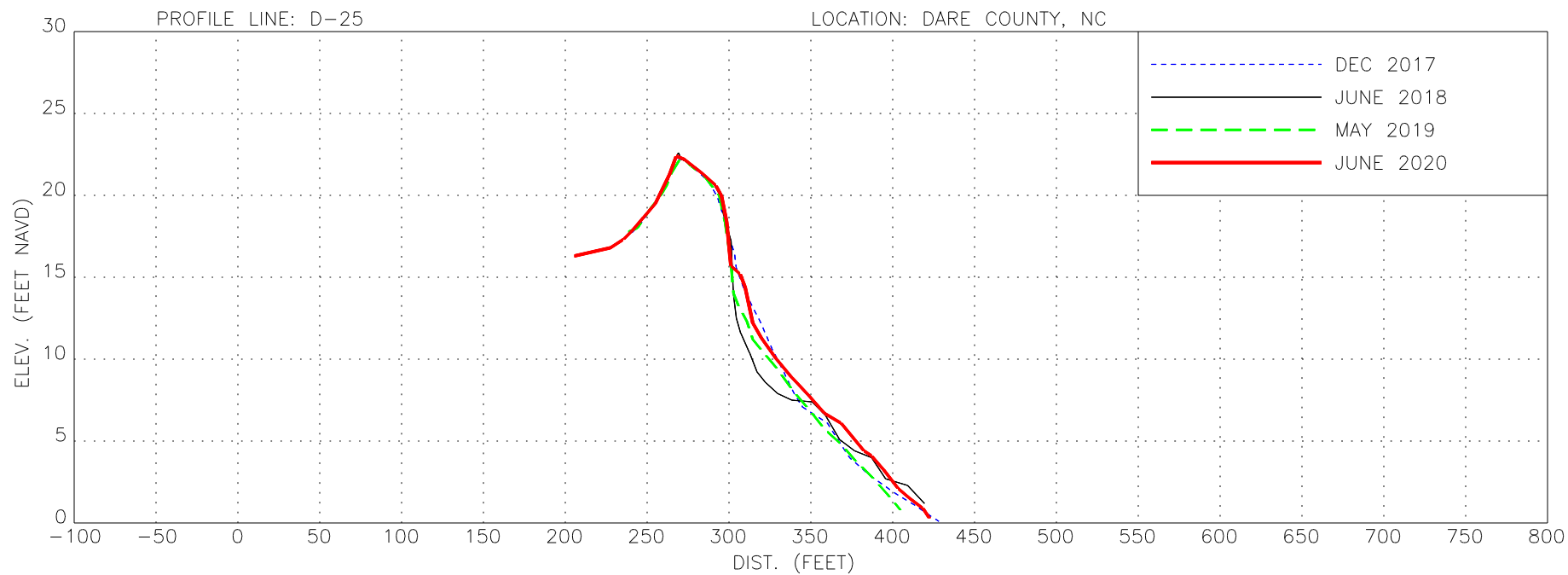


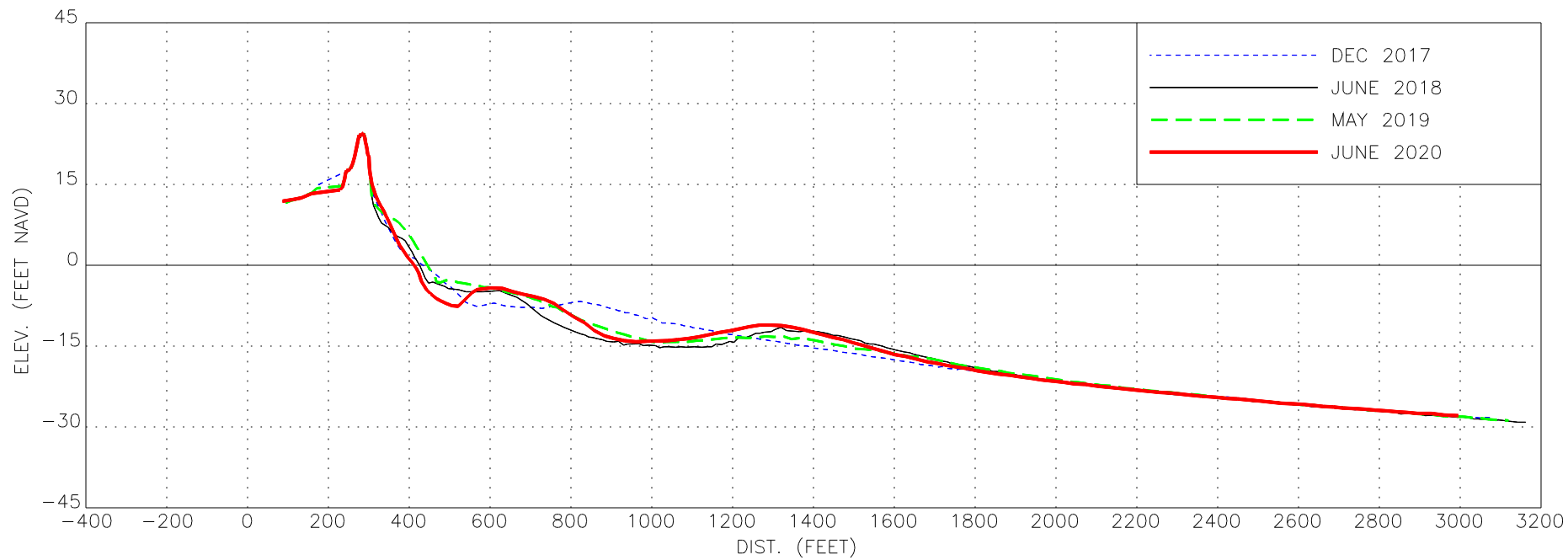
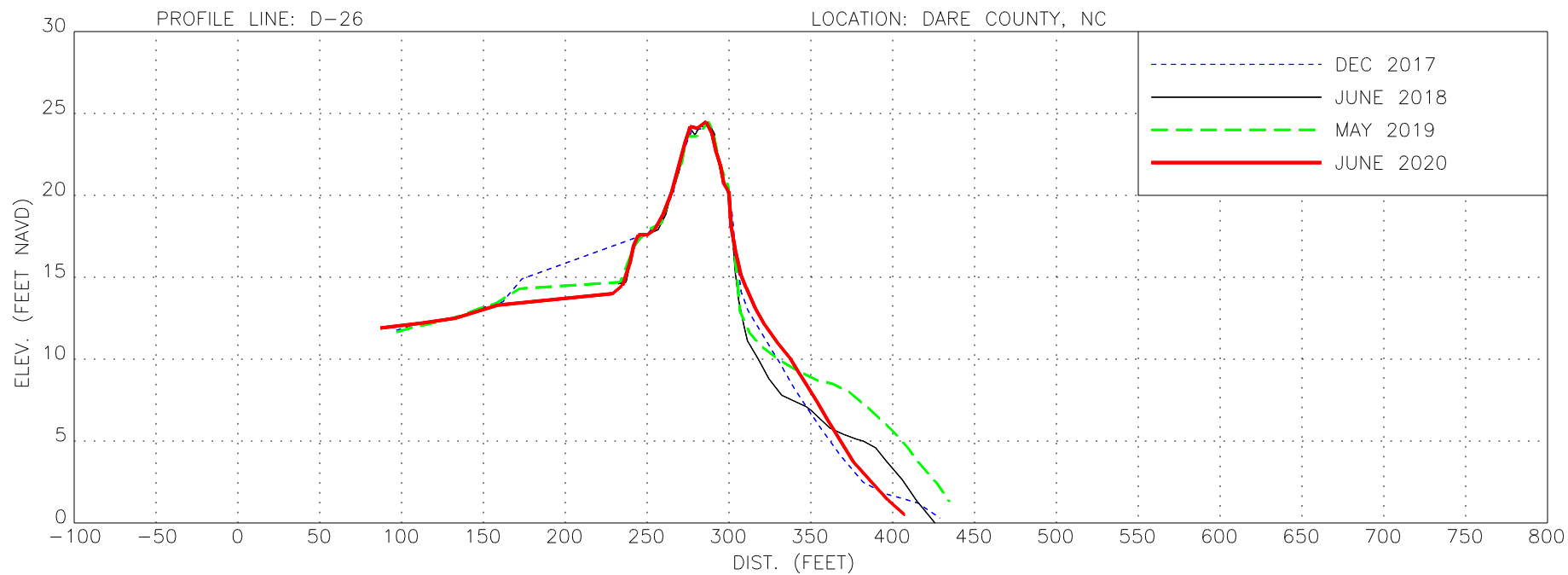


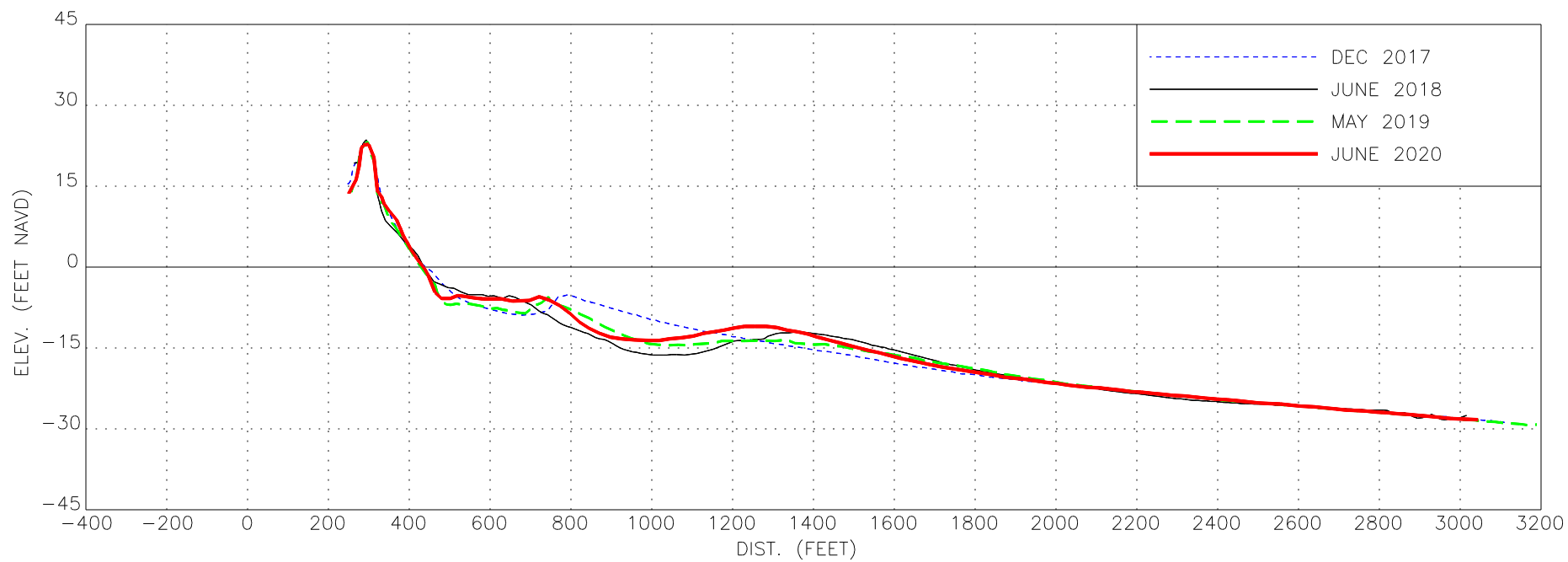
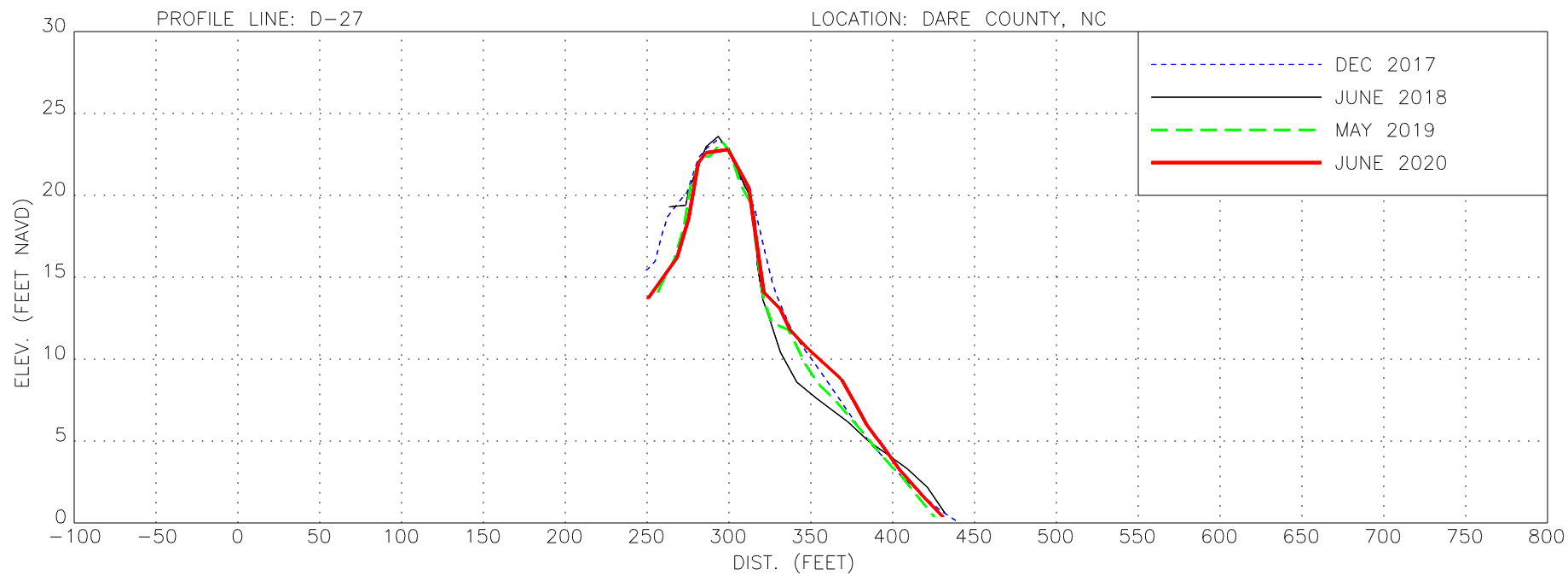


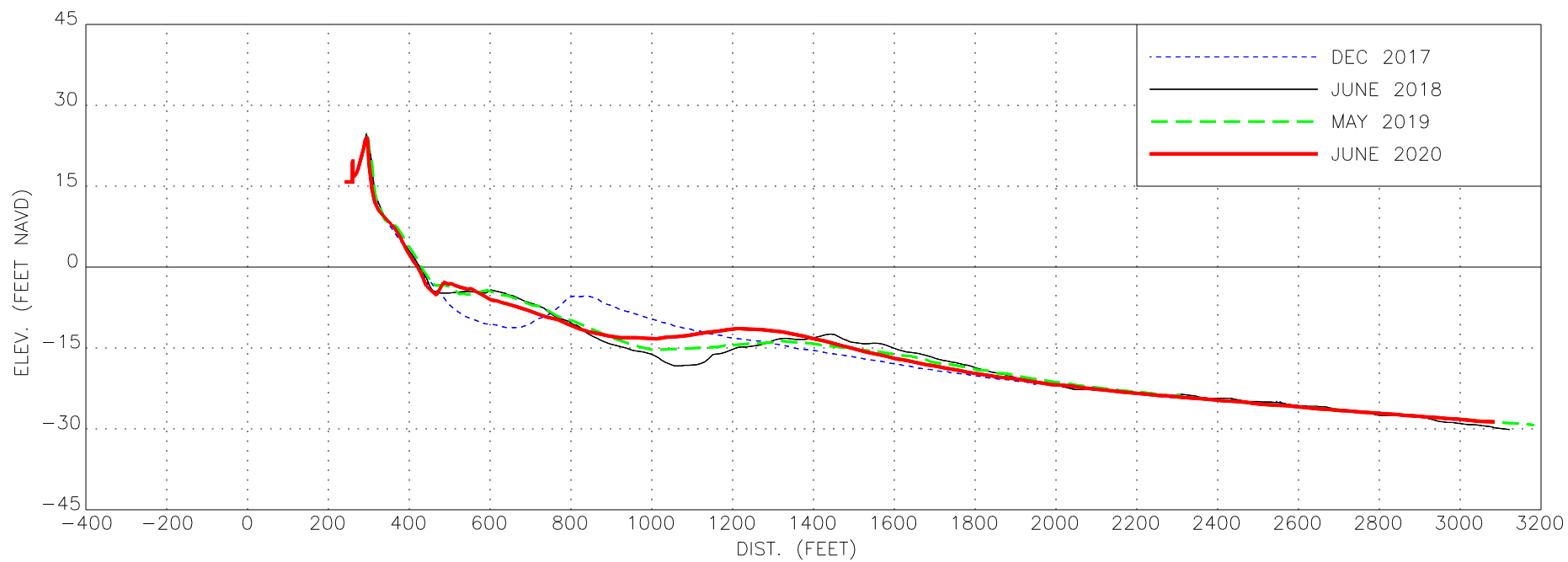
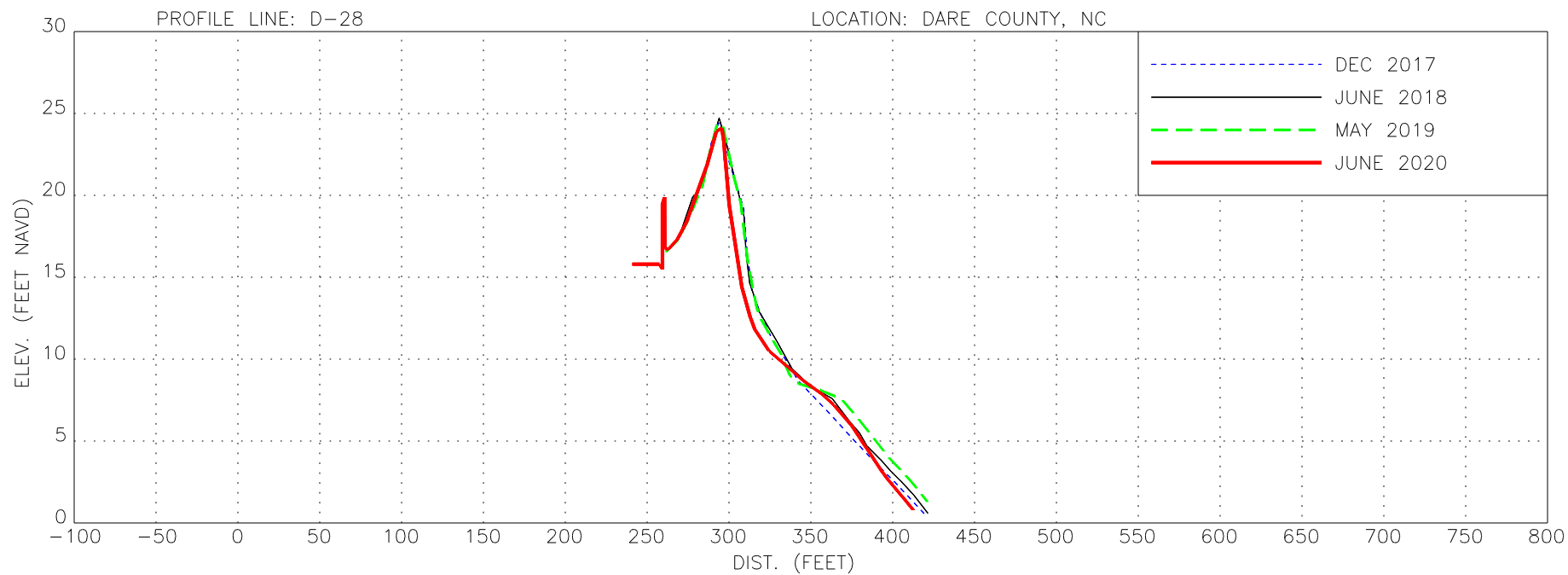


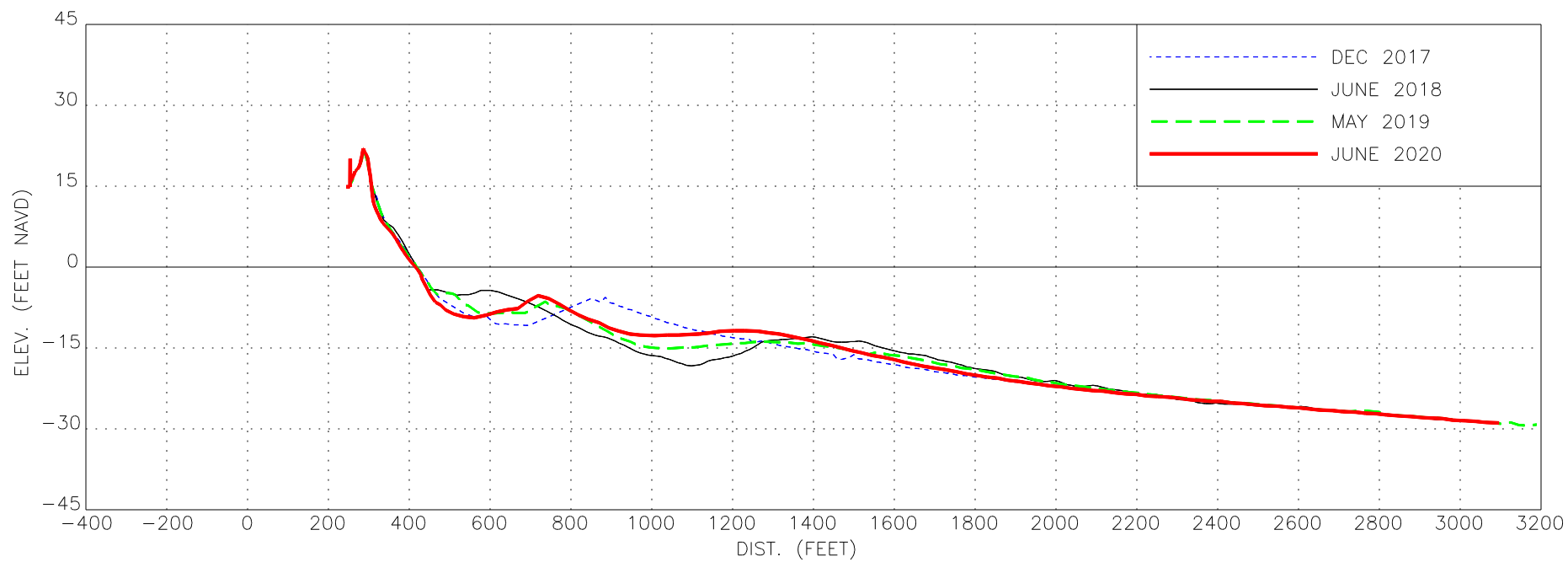
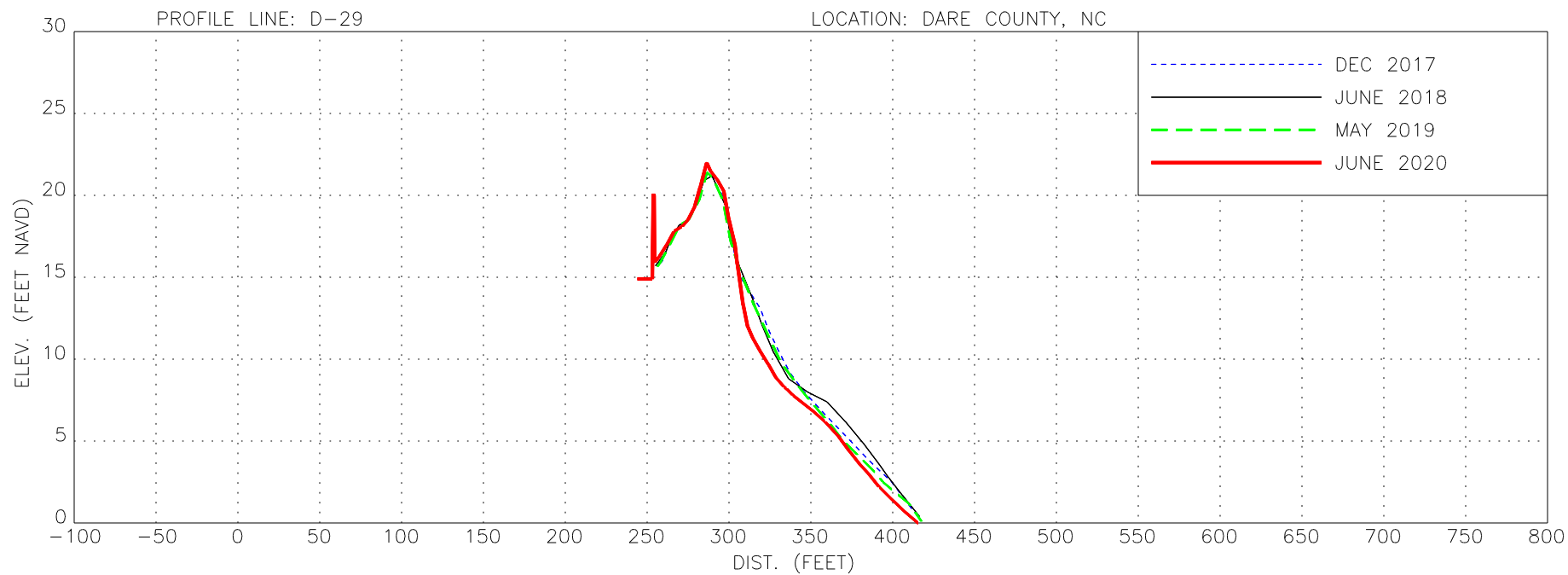


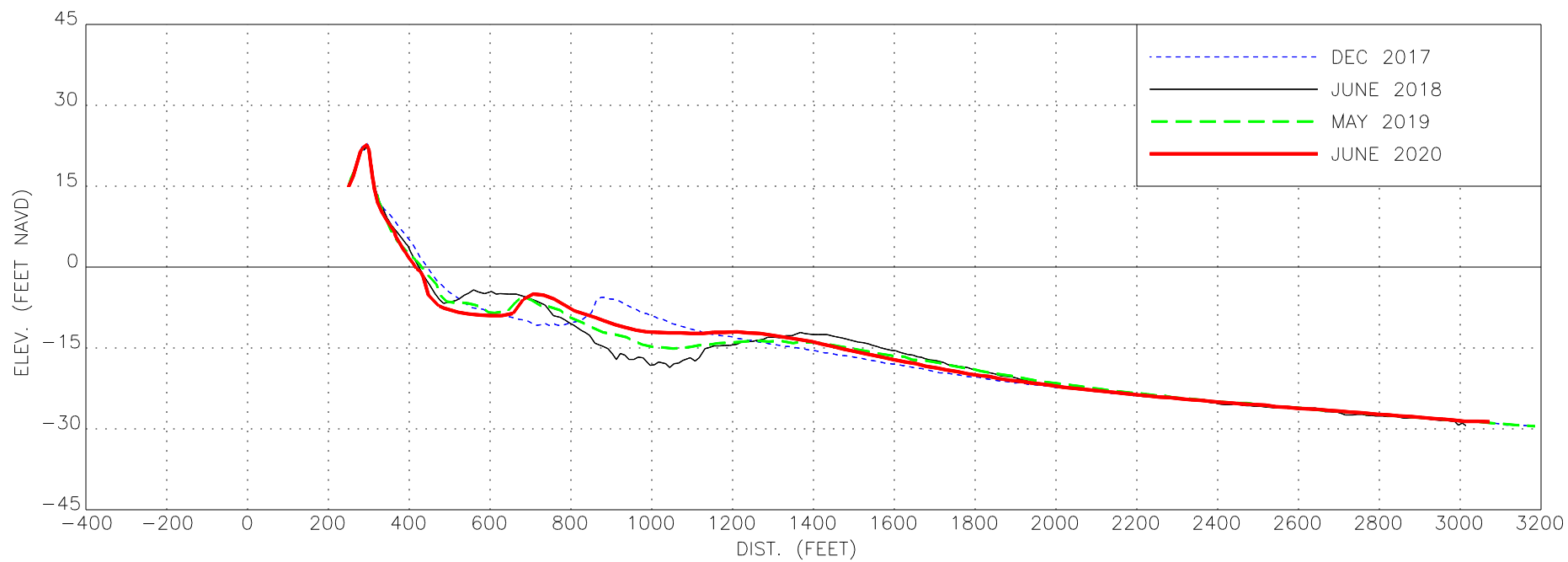
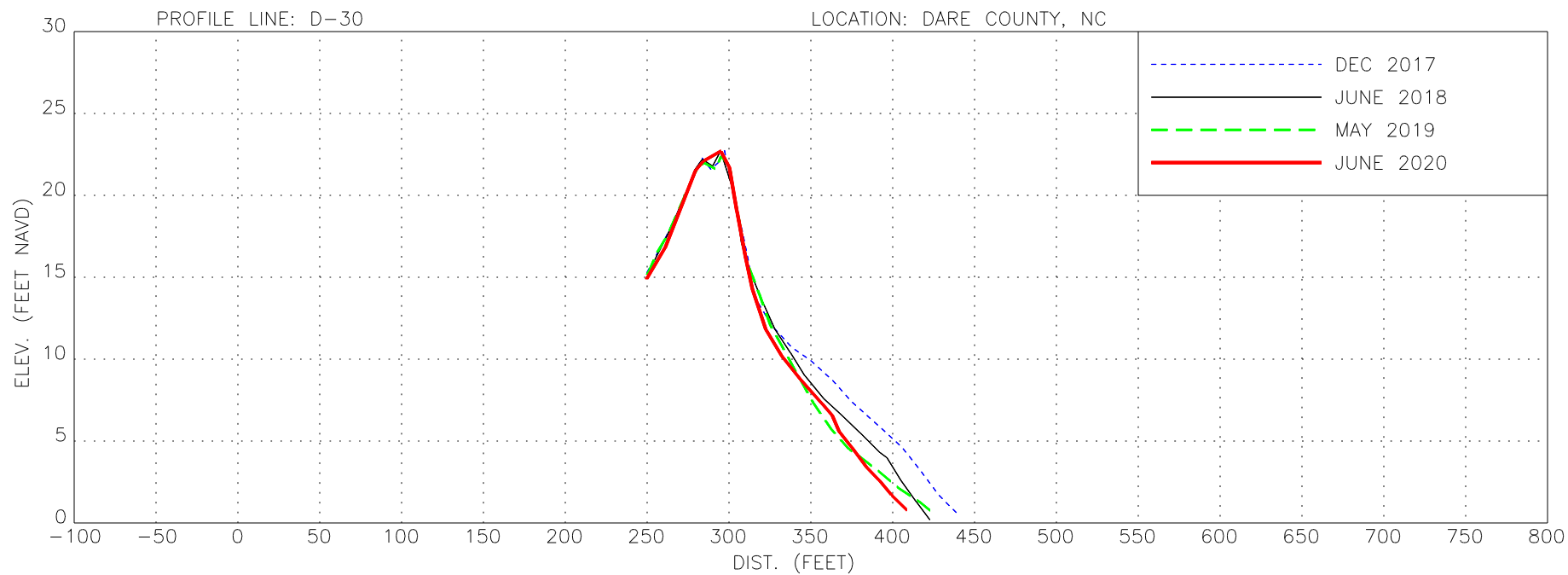


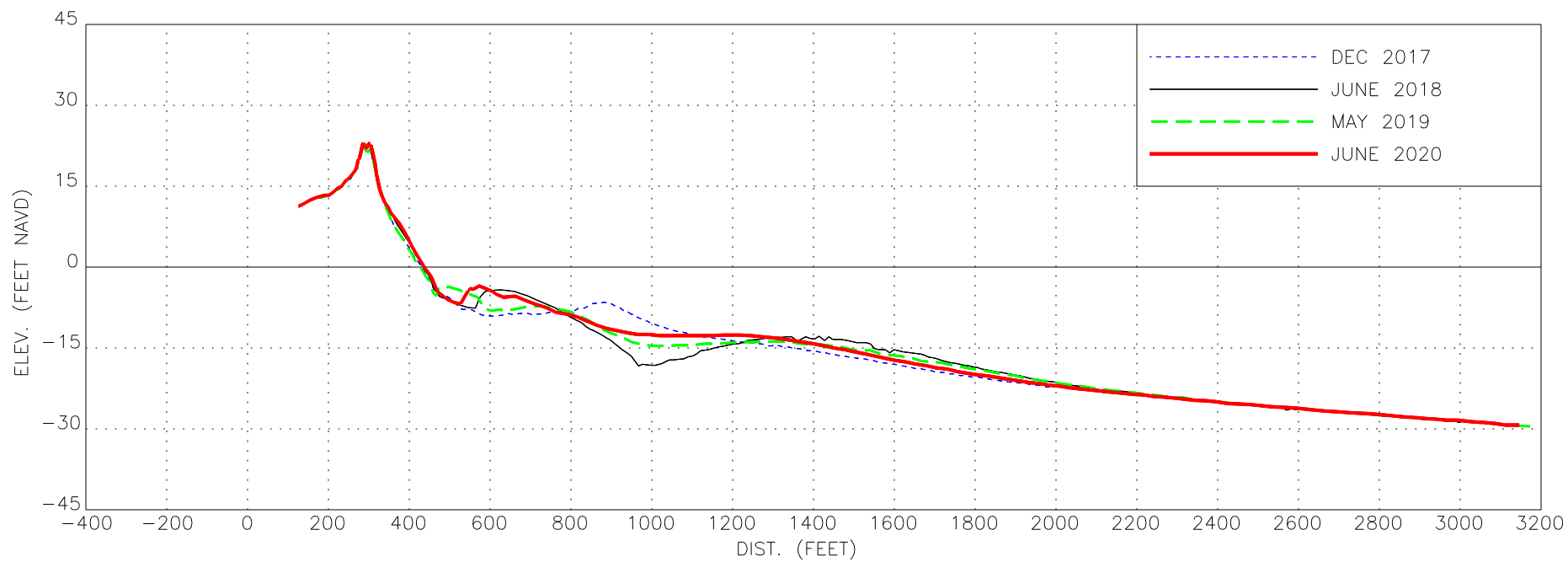
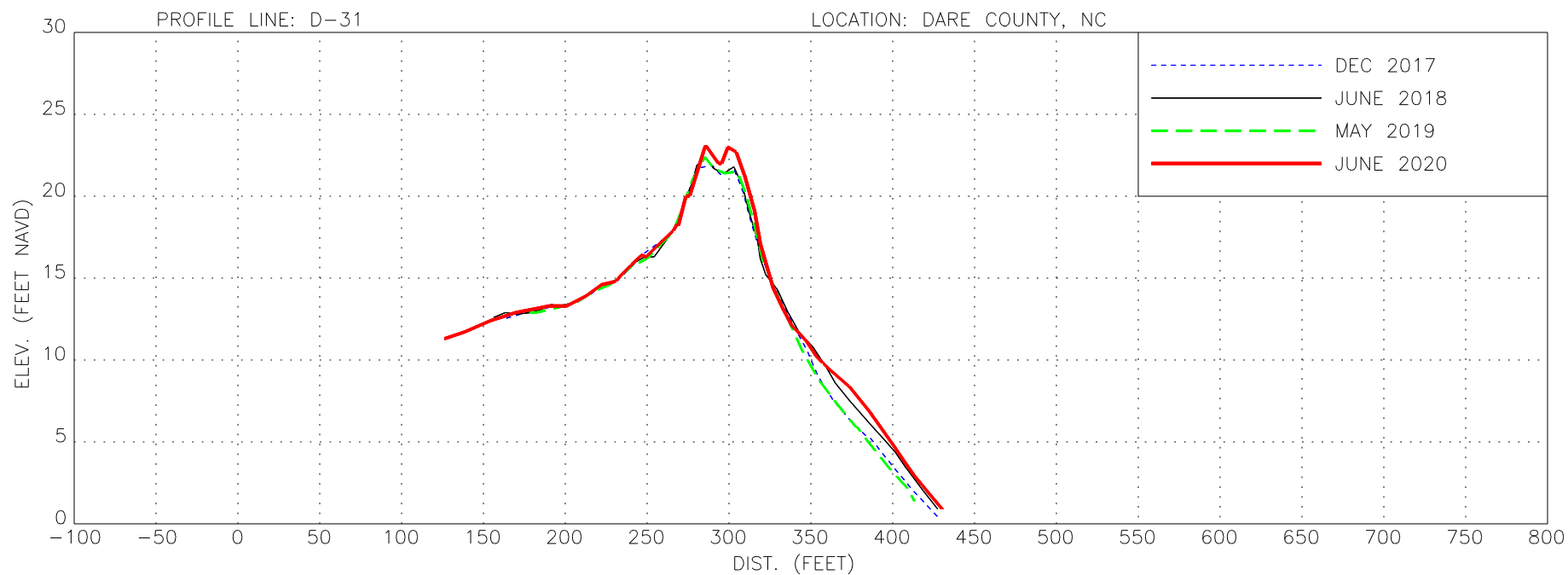


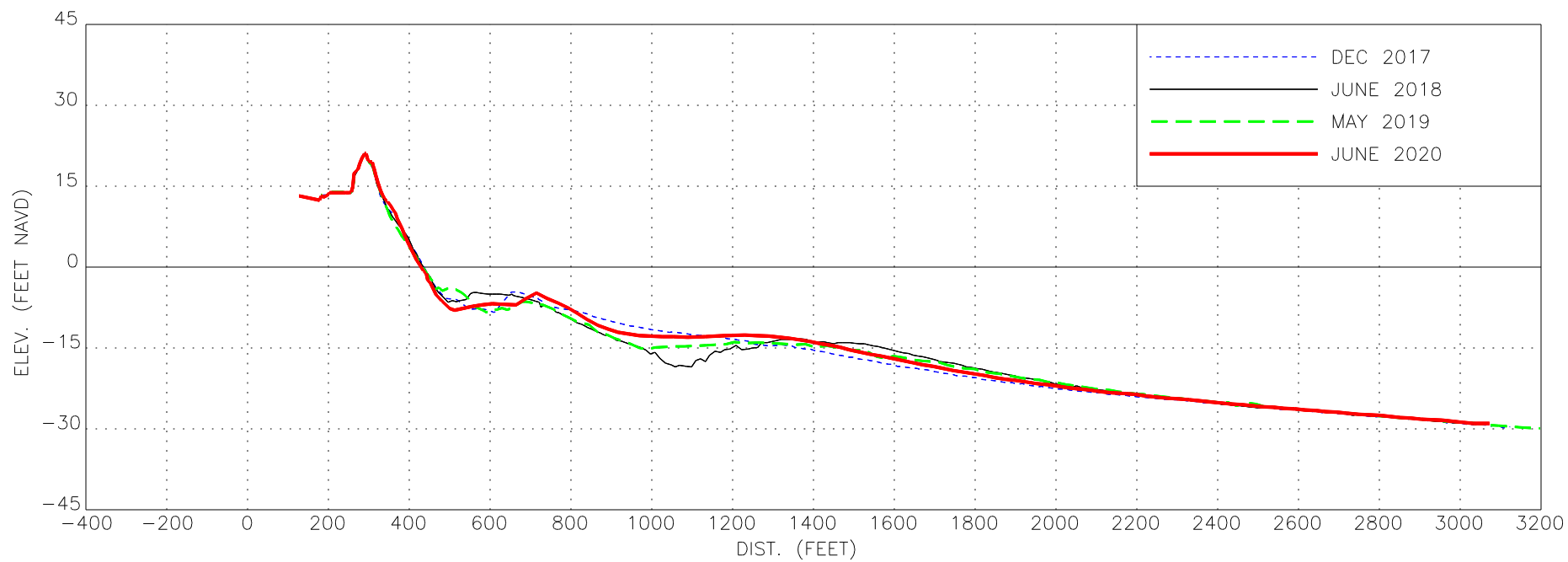
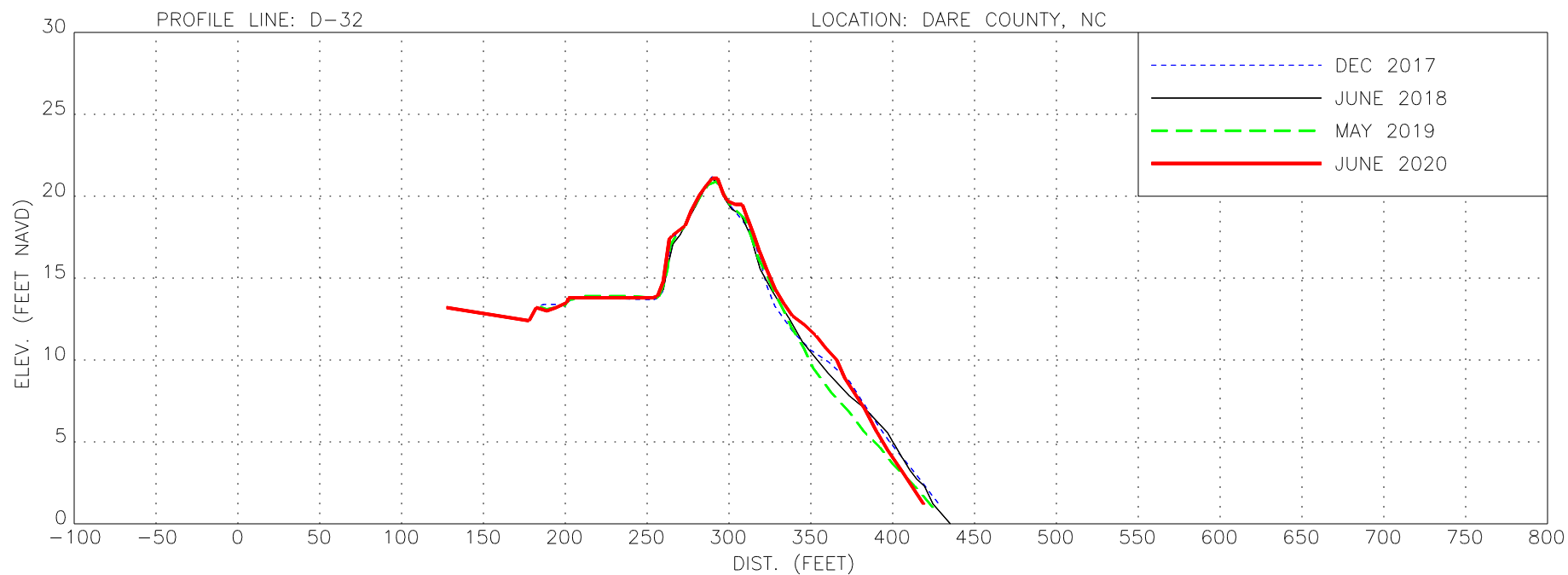


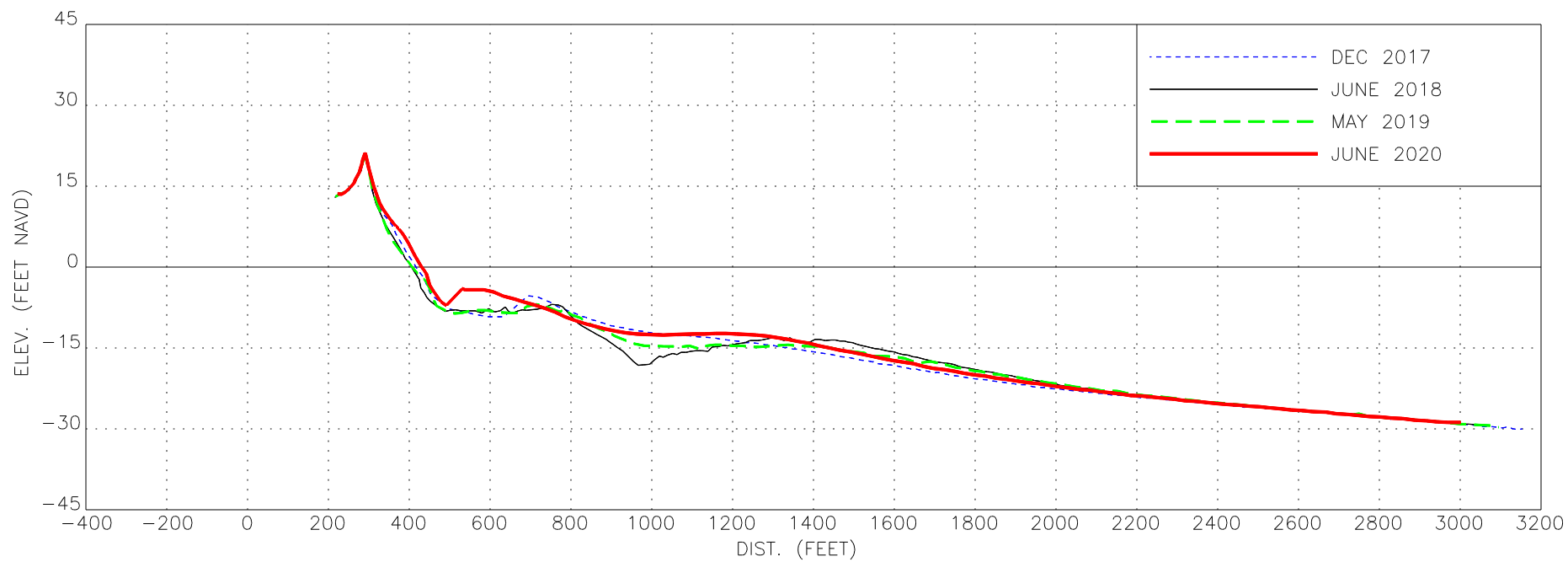
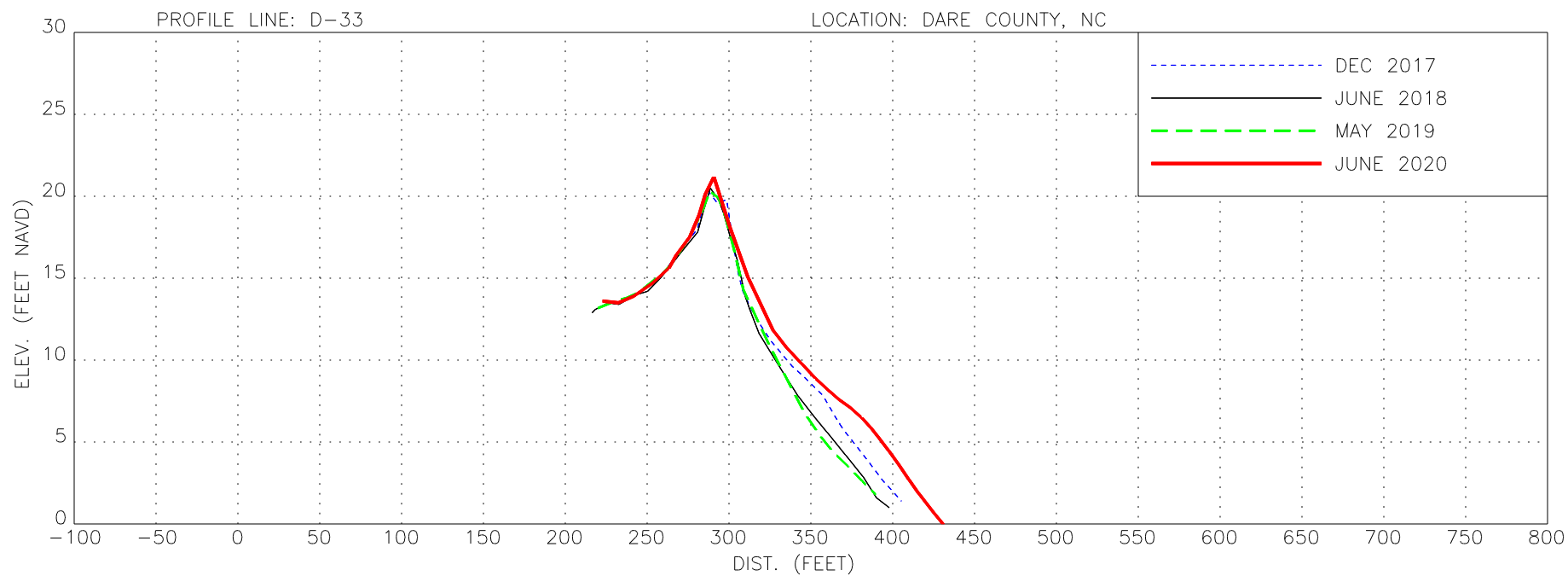


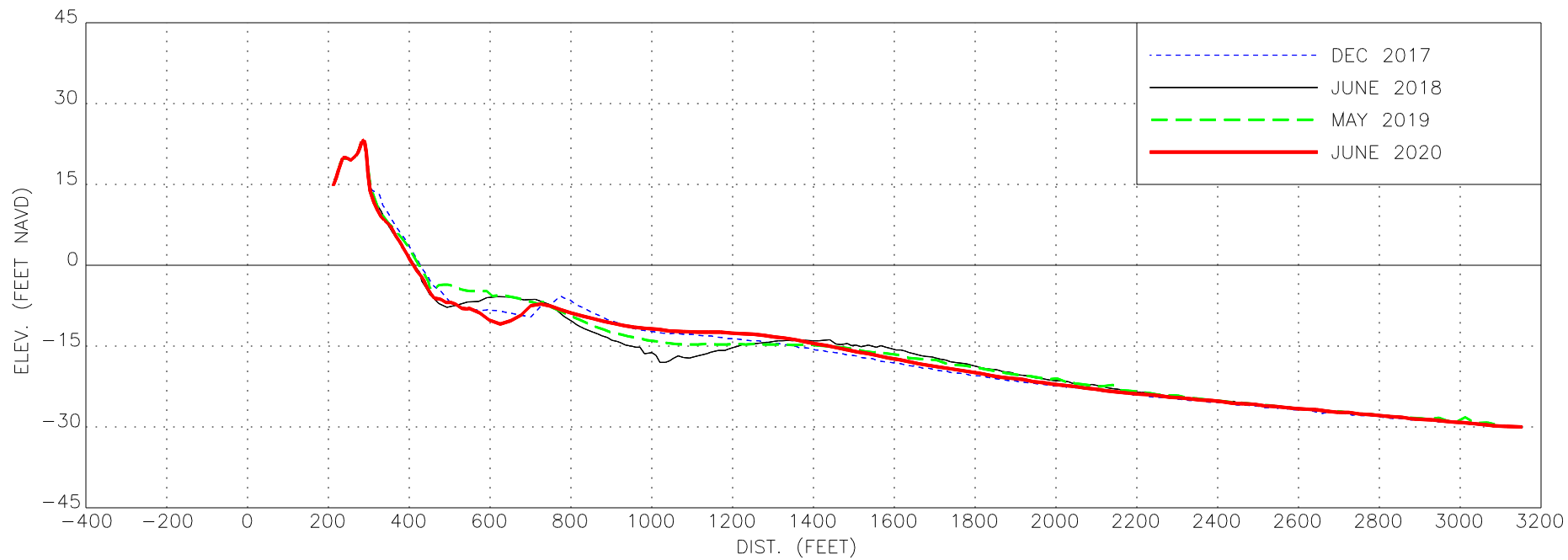
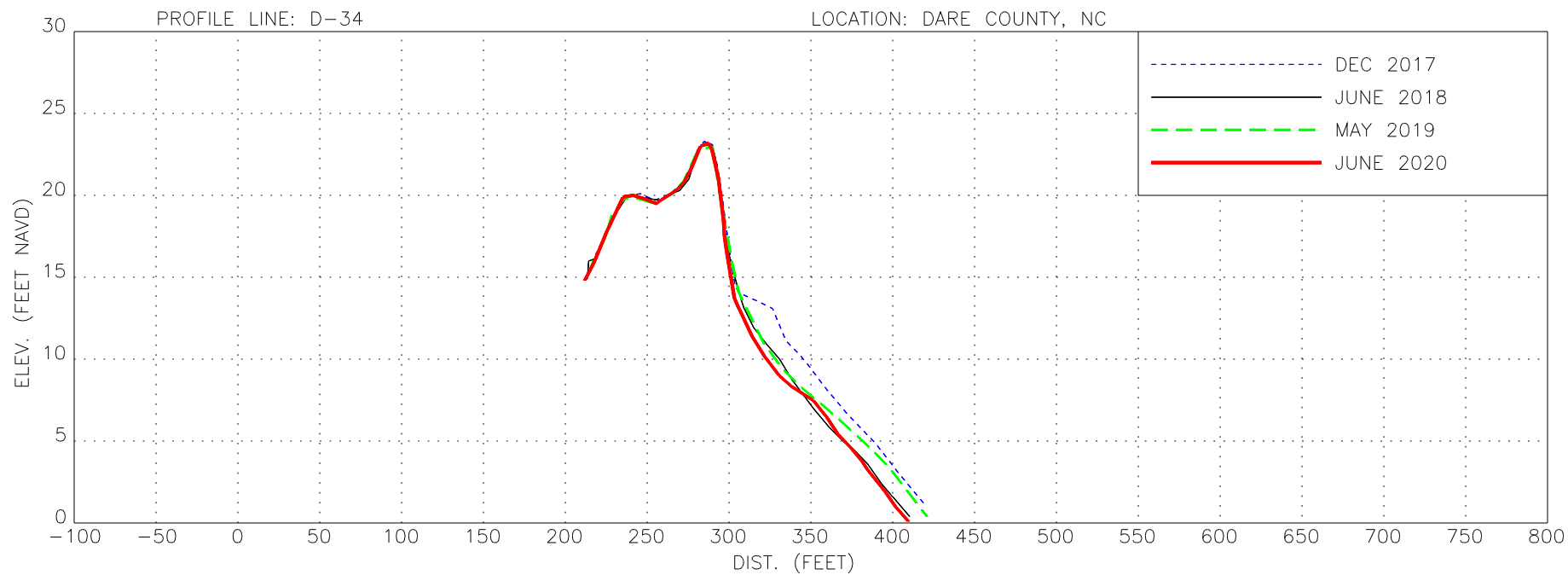












APPENDIX 4

GROUND DIGITAL PHOTOGRAPHY

**Ground Digital Photography
Monument**

D-01



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-02



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-03



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-04



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-05



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-06



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-07



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-08



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-09



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-10



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-11



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-12



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-13



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-14



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-15



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-16



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-17



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-18



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-19



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-20



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-21



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-22



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-23



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-24



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-25



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-26



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-27



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-28



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-29



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-30



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-31



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-32



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-33



North View



South View



Landward View

**Ground Digital Photography
Monument**

D-34/-197+12



North View



South View



Landward View

APPENDIX 5

FIELD BOOK PAGES

(Available in digital format only)