

## **TIDES AND WATER LEVELS**

NOAA tide station 8534720 Atlantic City, NJ was the source of final verified water level heights for the Mid-Atlantic Corridor, Coast of Delaware surveys. Preliminary and verified water level data for this station were downloaded from the NOAA Center for Operational Oceanographic Products and Services Tides & Currents web site (<http://tidesandcurrents.noaa.gov/>). All water level data in meters were annotated with Coordinated Universal Time (UTC).

Final water level files for each tide zone were created from downloaded verified tide data using the **SABER Create Water Level Files** tool. Water level files contained water level heights that were algebraically subtracted from depths to correct the sounding for tides and water levels. These water level files were applied to the multibeam data using the **SABER Apply Tides** program within the **SABER** software.

When it was necessary to apply updated water level correctors such as verified tides to the GSF files, the program removed the previous water level corrector and applied the new corrector. Each time a routine was run on the GSF multibeam data file, a history record was appended to the end of the GSF file documenting the date and water level files applied. For quality assurance, the **SABER Check Tides** program was run on all GSF files to confirm that the appropriate water level corrector had been applied to the GSF file.

After confirmation that verified water levels were applied to all multibeam data, grids were created and analyzed using various color change intervals. The color intervals provided a means to check for significant, unnatural changes in depth across zone boundaries due to water level correction errors, unusual currents, storm surges, etc.

The primary means for analyzing the adequacy of zoning was observing zone boundary crossings in **MVE**. In addition, cross line analysis using the **SABER Analyze Crossings** software was used to identify possible depth discrepancies resulting from the applied water level corrector. Discrepancies were further analyzed to determine if they were the result of incorrect zoning parameters or weather (wind) conditions between the tide station and the survey area. The NOAA provided preliminary zone boundaries and zoning parameters are presented in Table C-5.

**Table C-5. Preliminary Tide Zone Parameters**

<b>Zone</b>	<b>Time Corrector (minutes)</b>	<b>Range Ratio</b>	<b>Reference Station</b>
DB1	0	1.00	8557380
DB1A	-12	1.00	8557380
SA26	0	0.92	8534720
SA26A	0	0.87	8534720
SA27	+6	0.88	8534720
SA27A	+6	0.92	8534720
SA28	+6	0.97	8534720
SA35	+18	0.97	8534720
SA36	+18	0.93	8534720

<b>Zone</b>	<b>Time Corrector (minutes)</b>	<b>Range Ratio</b>	<b>Reference Station</b>
SA37	+30	0.98	8534720
SA38	-36	1.00	8557380
SA44	-24	1.00	8557380

### **Final Tide Note**

H11648, H11649, and H11650 surveys were entirely within preliminary water level zones for Atlantic City, NJ, 8534720 (SA26, SA26A, SA27, SA27A, and SA36). Analysis of the multibeam data from all three surveys in **MVE** and in depth grids revealed minimal depth jumps across the junction of the zones. A spreadsheet analysis of the correctors for each zone (summarized in Table C-6) also confirmed the adequacy of zoning correctors based on Atlantic City, NJ (8534720). For this analysis, observed verified water levels from 06 July 2007 through 18 November 2007, were entered into the spreadsheet. Correctors were computed at 6 minute intervals for each zone. Differences were computed zone-to-zone. As a result, the NOAA preliminary zone boundaries and zoning parameters for Atlantic City (8534720) were accepted as final and applied to all multibeam data for H11648, H11649, and H11650.

**Table C-6. Comparison of Water Level Correctors with Zoning Parameters for Station 8534720**

<b>Zones</b>	<b>SA36 – SA27A</b>	<b>SA26 – SA27A</b>	<b>SA27 – SA27A</b>	<b>SA26A – SA27A</b>	<b>SA26A – SA27</b>
Maximum	0.182	0.118	0.004	0.072	0.097
Minimum	-0.125	-0.097	-0.075	-0.168	-0.104
Average	0.008	0.000	-0.031	-0.039	-0.008
Standard Deviation	0.045	0.025	0.018	0.033	0.024

H11647 survey used preliminary zones from both Lewes, DE; 8557380 (DB1A SA38, and SA44); and Atlantic City, NJ; 8534720 (SA37, SA35, SA28, SA36, and SA27A). Analysis of the H11647 multibeam data in **MVE** and in depth grids revealed significant jumps across the junction of zones based on Atlantic City, NJ (8534720) and the zones based on Lewes, DE (8557380). A spreadsheet was constructed to compare the two sets of NOAA preliminary zoning parameters. The results are summarized in Table C-7. For this analysis, observed verified water levels from 06 July 2007 through 18 November 2007, for both stations were entered in the spreadsheet. Correctors were computed at 6-minute intervals for each zone. Differences (Table C-7) were computed for each zone on Lewes, DE (8557380) with the adjacent zone on Atlantic City, NJ (8534720).

**Table C-7. Comparison of Water Level Correctors with Zoning Parameters for Station 855738 and 8534720**

<b>Zones</b>	<b>SA38 – SA37</b>	<b>SA44 – SA37</b>
Maximum	0.248	0.307
Minimum	-0.235	-0.327
Average	0.000	0.000
Standard Deviation	0.088	0.128

This verified the observed significant difference in multibeam depths caused by differences in verified water level correctors at the zone boundaries depended on the stage of the tide and environmental factors (wind and rain). As a result of this analysis the water level zoning correctors based entirely on Atlantic City, NJ (8534720) were applied to all multibeam data for H11647. Zone DB1 was not used, and zone DB1A was extended slightly on the west to incorporate the one line of multibeam data extending across the Cape Henlopen area. All other zone boundaries were the preliminary boundaries provided by NOAA.

Zoning parameters for zones DB1A, SA28, SA37, SA38, and SA44 were modified to minimize water level corrector jumps across the zone boundaries using verified observed water level data from the Atlantic City, NJ (8534720) station. All final correctors are shown in Table C-8.

**Table C-8. Final Tide Zone Parameters**

<b>Zone</b>	<b>Time Corrector (minutes)</b>	<b>Range Ratio</b>	<b>Reference Station</b>
DB1A	+18.0	0.96	8534720
SA26	0	0.92	8534720
SA26A	0	0.87	8534720
SA27	+6	0.88	8534720
SA27A	+6	0.92	8534720
SA28	+12	0.92	8534720
SA35	+18	0.97	8534720
SA36	+18	0.93	8534720
SA37	+18	0.98	8534720
SA38	+12	0.99	8534720
SA44	+12	0.98	8534720

A spreadsheet was constructed to compare water level correctors across these zone boundaries for H11647 using the final zone parameters and the results are shown in table C-9. In addition the multibeam data crossing these boundaries were compared in MVE and by observing the crossings in the depth grids.

**Table C-9. Comparison of Water Level Correctors with Zoning Parameters for Station 8534720 for H11647**

<b>Zones</b>	<b>DB1A – SA44</b>	<b>SA38 – SA44</b>	<b>SA37 – SA44</b>	<b>SA37 – SA38</b>	<b>SA37 – SA35</b>	<b>SA28 – SA35</b>	<b>SA36 – SA35</b>	<b>SA36 – SA27A</b>
Maximum	0.091	0.019	0.103	0.096	0.019	0.076	0.004	0.182
Minimum	-0.157	-0.001	-0.126	-0.143	-0.001	-0.173	-0.074	-0.125
Average	-0.016	0.008	0.000	-0.008	0.008	-0.039	-0.031	0.008
Standard Deviation	0.028	0.005	0.027	0.027	0.005	0.034	0.018	0.045