Uncertainty Ranges Associated with EPA's Estimates of the Area of Land Close to Sea Level

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1.3. Uncertainty Ranges Associated with EPA's Estimates of the Area of Land Close to Sea Level

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Section 1.3.1. Approach

Author: James G. Titus

Introduction

Digital Elevation Model output allows one to easily generate a point estimate ("best guess") of the amount of land below a particular elevation X by simply tabulating the number of points below X and multiplying by the cell size that each point represents. The accuracy of available elevation data varies, however, so the accuracy of these point estimates of the area estimates will vary as well. For some purposes, it may be sufficient to have a "best guess" estimate. But for other purposes, one needs some sort of uncertainty range. Fortunately, most elevation data come with a precision estimate, which makes it possible to develop an uncertainty range.

Section 1.3 explains how Dave Cacela and this author generated an uncertainty range for the estimates of the amount of land close to sea level within different shore protection categories and different elevations, which form the basis of this report. Section 1.3.1 explains the assumptions and the basic approach for estimating uncertainty; Section 1.3.2 explains how the approach was implemented. Section 1.3.3 provides the results. The final results constitute the three appendices to this section.

Like Section 1.2, by Jones and Wang, the starting point is the elevation data set developed in Section 1.1 by Titus and Wang. The approach for specifying uncertainty is based on the most important sources of error in that analysis. The actual implementation, however, uses the output from Section 1.2, in which Jones and Wang overlay the elevation study by Titus and Wang with the eight state-specific shore protection studies that Titus and Hudgens developed in their unpublished analysis mentioned in Section 1.2. Section 1.1 provided cumulative elevation distributions for dry land and nontidal wetlands; Section 1.2 subdivided the dry land into the various shore protection categories. Our exposition of the approach taken focuses on the elevation distribution of dry land. But not only did we apply the procedure to the totals for dry land, we also applied it to all the other shore protection categories and nontidal wetlands.

We warn the reader at the outset that this section switches between metric (standard international) and English (imperial) units of measurement. The final results are in metric units—but most of the underlying elevation data were based on topographic maps with contour intervals measured in feet. The point of measurements provided in this section is generally to explain the relationship between input data and assumptions, not to inform the reader about the magnitude of any particular effect. Therefore, the reader unfamiliar with one or the other system of measurements need not attempt to make conversions. In the few cases where that actual magnitude may matter, our convention is metric.

Background

Previous assessments of the land vulnerable to sea level rise have provided an uncertainty range; but the uncertainty range did not include uncertainty associated with topographic information. EPA's 1989 *Report to Congress* provided an uncertainty range about the area of land lost for a rise in sea level of 50, 100, or 200 cm. In Appendix B to that *Report to Congress*, Titus and Greene (1989) developed the uncertainty range, based on a study by Park et al. (1989), who used a sample of study area sites, and calculated a point estimate of land loss of each site. The published uncertainty range used a simple sampling error approach, treating the study sites as a random sample from the entire population of USGS quads. Because Park et al. did not report an uncertainty range for their sample sites, Titus and Greene made no attempt to include that uncertainty. In effect, Titus and Greene assumed that Park et al. accurately estimated the amount of land at particular elevations in those areas they assessed. The true uncertainty associated with their estimates included both sampling and measurement error; but the published uncertainty range considered only the sampling error.

This study uses the elevation data from Section 1.1, as formatted by the analysis explained in Section 1.2. That data set estimated the elevations of all land above spring high water. That is, it estimated elevations for dry land and nontidal wetlands, but did not estimate elevations for tidal wetlands. (Knowing that land is tidal wetland tells us that the land elevation is below spring high water and above mean low water, which provides a narrower uncertainty range about the elevation than if we know only that the land is below, for example, the 10-ft contour on a topographic map.) Because they obtained data for the entirety of the study area, there is no sampling error. The source of error stems entirely from the limitations in precision of the Section 1.1 results.

The overall approach is to make an assumption about the potential vertical error of the elevation data and the extent to which that error is random versus systematic. The magnitude of the error varies by data source: because we assume that error is a function of contour interval, which in turn varies by topographic quad, we calculate error separately for each topographic quad. Let us first explain our basis for focusing on vertical error of the elevation data, and then explain how low and high estimates for areas were calculated where the input data were USGS contour maps and other data with relatively coarse contour intervals (1 meter or worse), as well as our procedure for when the data had higher quality (2 feet or better).

Horizontal and Vertical Precision

Figure 1.3.1 depicts the various sources of data used to estimate elevations and the areas of land at particular elevations. In most locations, Titus and Wang relied on USGS 1:24,000 scale maps with various contour intervals. The second most common source of data was LIDAR provided by Maryland or North Carolina, which give elevations at various points in a grid.

USGS maps follow the national mapping standards for vertical and horizontal precision. The vertical standard is that 90 percent of the well-defined points along a contour must be within one-half the contour interval above or below the stated elevation of the contour. The horizontal standard is that 90 percent of the points should be within one fiftieth of an inch (about half a millimeter). On a 1:24,000 scale map, the allowable horizontal accuracy would be 12 meters. The LIDAR data sources generally have vertical precision on the order of 10–30 cm and horizontal error of less than 1 meter.

To keep the analysis reasonably manageable, this study ignores the horizontal error and focuses entirely on the vertical errors. Inspection of the USGS maps and the maps produced by Titus and Wang shows that most lowland is in an area where the contours are hundreds—and often thousands—of meters apart. Random error on the order of 12 meters is very small by comparison and not likely to substantially change an estimated error range. The horizontal error of LIDAR seemed even less likely to matter. In an assessment of the impacts of rising sea level, what matters is that most of the input data had contour intervals of 5 feet (150 cm) or worse, and we are interested in the implications of a 50-cm rise.

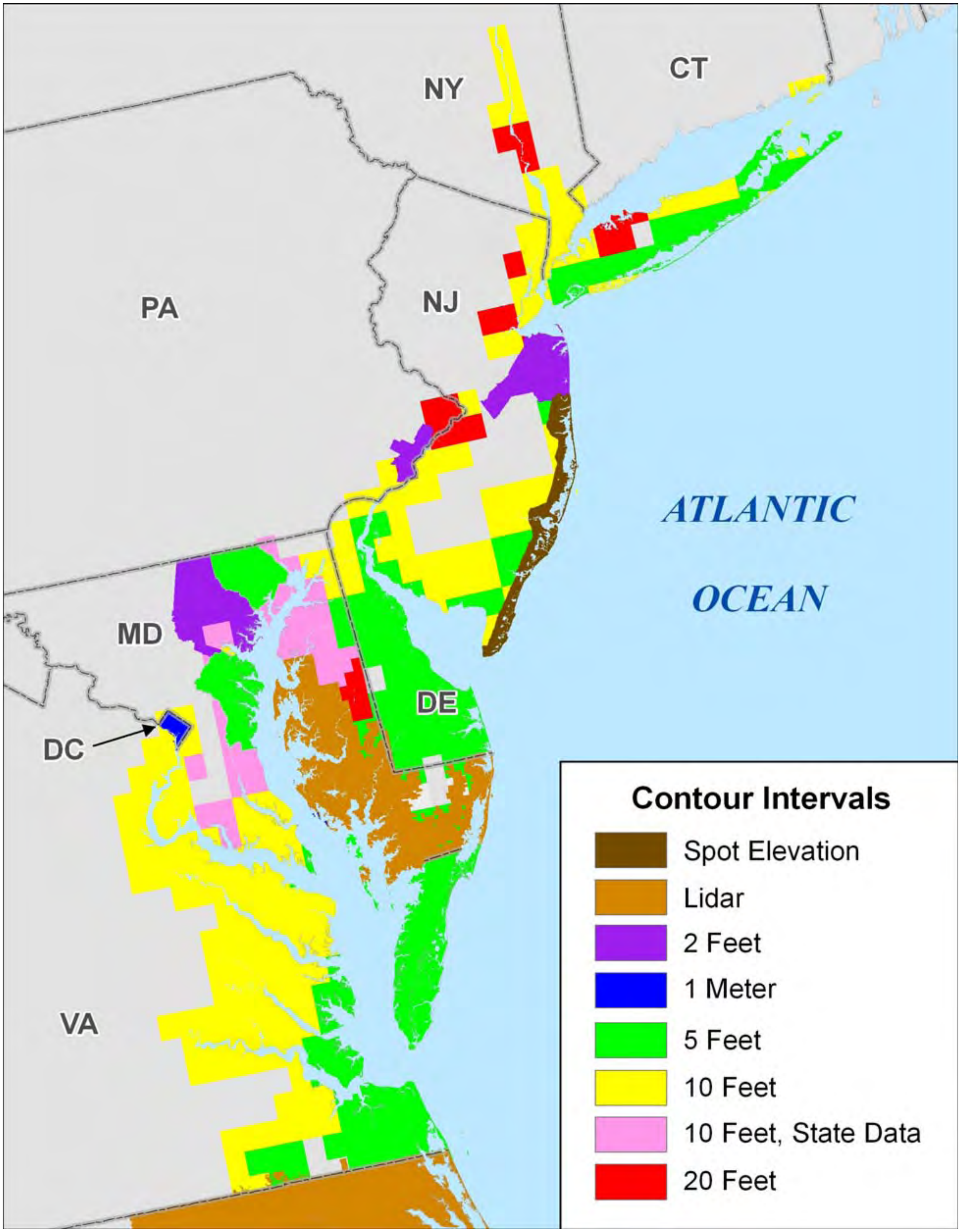

Figure 1.3.1. Input Elevation Data used in Section 1.1 to Estimate Area of Land Close to Sea Level. Quadrangles with a 10-ft contour interval and a 5-ft supplemental contour are shown as 5 feet. The Maryland data included 5-ft contours drawn from spot elevation with RMS error of 5 feet; hence the legend calls the data “10 feet, State Data”; USGS 5-ft contours have an RMS error of 2.5 feet.

Areas with USGS Maps as the Input Data

This analysis assumes that the standard deviation of error within a neighborhood is one-half the contour interval, based on National Map Accuracy standards. For reasons discussed below, the calculations also assume that half the error is random and half is systematic, so that the standard deviation of the uncertainty is one-quarter the contour interval for areas the size of a county or larger. These assumptions are adjusted to address possible error in the estimate of spring high water (SHW).

Our Initial Model of Vertical Error

Based on a comparison of their model results with LIDAR from Maryland and North Carolina (see Section 1.1, Jones 2007, and Jones et al. 2008), Titus and Wang report that the root mean square (RMS) error[1] of their elevation data sets tended to be approximately one-half the contour interval of the input contour. (Strictly speaking, their comparison measured the root mean square of the difference between the DEM and the LIDAR, which overestimates the error of the DEM.[2]) That finding seems roughly consistent with the National Map Accuracy Standard that 90 percent of the well-defined points should be within one-half contour interval of the stated elevation (Bureau of the Budget 1947)—"roughly" because they are not identical: If mean error is zero, a 90 percent confidence limit will almost always be a wider interval than the range defined by an estimate plus or minus the RMS error. In a normal distribution, the 90 percent interval would encompass a range ±1.64 times the RMS error (generally called standard deviation or σ in this case).[3] But one would expect the error across all elevations to be greater than the error at those elevations where we have a contour. For example, if a USGS map says that one contour is 5 feet above the vertical datum and that another contour is 10 feet above the vertical datum, and then one estimates an 8-ft contour through interpolation, we would expect the USGS contours to be somewhat more accurate than the 8-ft contour derived from the two USGS contours. So the assumption that 90 percent of the points along the contour are within one-half the contour interval of the stated elevation would be roughly consistent with the assumption that the standard deviation of error for all elevations is one-half the contour interval.[4] Because Titus and Wang did not know whether their estimates have a mean error or not, the more general term "RMS error" better describes the uncertainty. The contour intervals vary from place to place—but we know the contour interval at all locations. Therefore, this study assumes that RMS error equals one-half the contour interval for all locations where contour maps were the underlying source of the data.

Given that the availability of an estimate of the RMS error, this author's first thought was that the low and high estimates could be derived by simply (a) adding and subtracting the RMS error from the DEM[5] data set developed by Titus and Wang, cell by cell, and then (b) retabulating the data. In effect, this approach would add and

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[1] RMS error is calculated by taking the difference between the estimated and actual values for each point, squaring that difference, taking the sum of squares, dividing that sum by the total number of data points, and taking the square root. If the mean error is zero, RMS error is equal to the standard deviation of the error. If the mean error is not zero, then RMS error is equal to the square root of the sum of (a) the square of the mean error plus (b) the square of the standard deviation of the error.

[2] In general, whenever one has two independent measurements M_1 and M_2, with random error e_1 and e_2,

$$\text{variance}(M_1 - M_2) = \text{variance}(e_1) + \text{variance}(e_2).$$

Thus, the variance of one error is equal to the variance of the difference minus the variance of the other error.

[3] The RMS error band includes about 68 percent of all data points.

[4] In the case of normally distributed error, we are saying, in effect, that 90 percent of the points along the contour are within 0.5 contour interval, while 90 percent of all points are within 0.82 (1.64/2) the contour interval of the stated elevation.

[5] DEM is an abbreviation for digital elevation model. Literally, that means the model used to calculate elevations. People in the business of making elevation maps, however, often use this term when referring to the actual set of elevation data points calculated by their model. The Titus and Wang data set we used has data points on a 30-m grid.

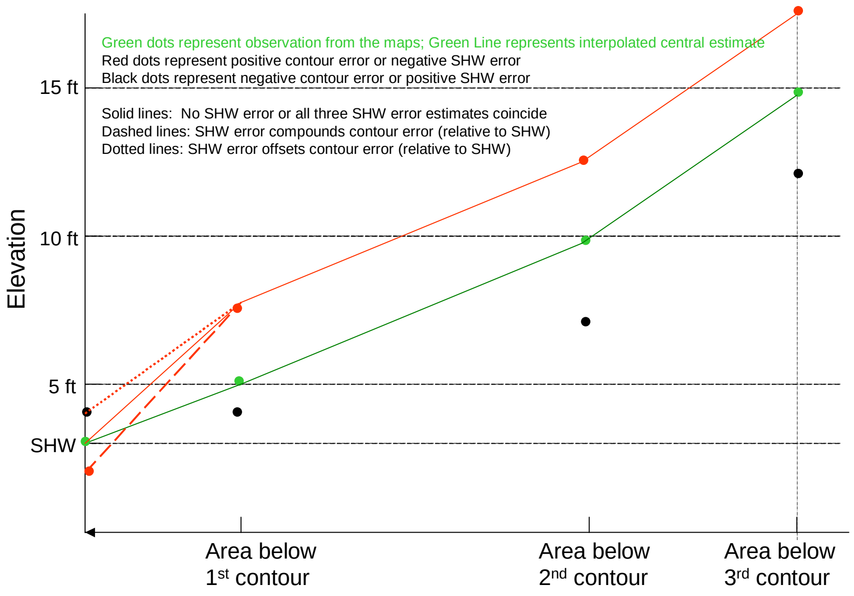

Figure 1.3.2. Interpolated Elevation Estimates Relative to NGVD29. Central estimate and high contour error (with and without SHW error, relative to NGVD, ignoring model error). This case assumes a 5-ft contour interval, a 1-ft error in estimating the elevation of spring high water, and contour error of 2.5 feet. Red dots represent positive contour error and negative SHW error, both of which cause a positive error in our estimates of elevation relative to SHW.

subtract the RMS error from the cumulative distribution of elevations. However, as those authors discuss in Section 1.1, their DEM contained plateaus along the input contours, which were artifacts of the interpolation algorithm, with no physical basis.[6] Therefore, they concluded that a linear interpolation of elevations between the contours would give a better estimate of the area of land below a particular elevation than the cumulative distribution of their cell-by-cell DEM output. Therefore, their elevation density distribution assumed that elevations were uniformly distributed between contours. If the input data said that there are 100 ha of land between the 5- and 10-ft contours, for example, then there are 20 ha between the 5- and 6-ft contours, they assumed. Thus, their cumulative elevation distribution function was a series of line segments connecting a few points that represent actual observations based on the contour interval and the area of land above spring high water land below specific contours.[7] (See the green line in Figure 1.3.2, discussed below.)

This study assumes that the same logic that applies for the "point estimates" would apply to EPA's effort to estimate an uncertainty range. Choosing instead to add or subtract one-half contour interval from the DEM, would (for example) create data sets with plateaus at 2.5, 7.5, 12.5, and 17.5 feet in those areas where the USGS data had a contour interval of 5 feet, just as the Titus and Wang output had plateaus at SHW, 5, 10, 15, and 20 feet.[8]

Let us go back to the source information. For each quad, Titus and Wang provide

- the areas of land that lie below specific elevation contours from the input data set (e.g., the area between the 5- and 10-ft contours in a given quad), and
- their estimate of the elevation of spring high water relative to NGVD29 (derived from NOAA tidal datum).

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[6] See Section 1.1.3 at Step 4, and especially Table 1.1.3 in Section 1.1.4. The large horizontal error but small vertical error in replicating contours is indicative of large plateaus.

[7] In an area with a 5-ft contour interval, those points would be (SHW, 0) , (5, A(5)), (10, A(10)), (15, A(15)), (20, A(20)) … etc., where A(x) is the area of land between spring high water and elevation x.

[8] Their data set also created plateaus just above their spring high water supplemental contour. Thus, if spring high water is 2 feet (NGVD29), then the high-elevation estimate would have a plateau at 4.5 feet; the low-elevation estimate would have a plateau at 2.5 feet below spring high water, that is, –0.5 feet (NGVD29).

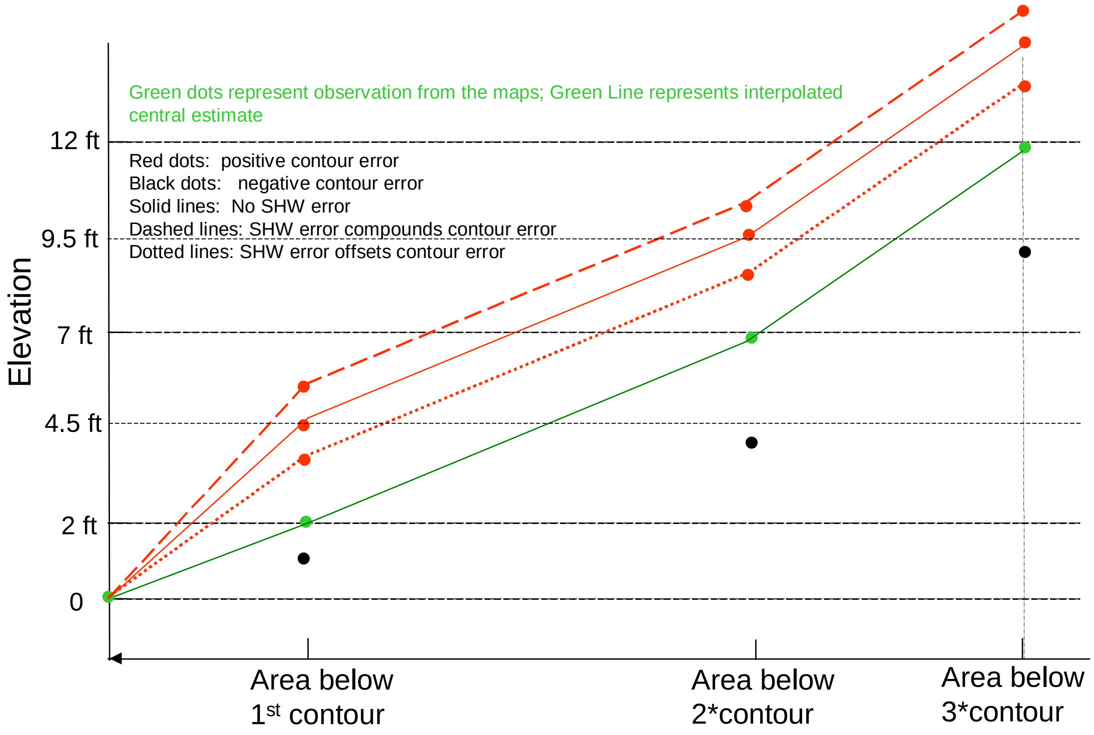

Figure 1.3.3. Interpolated Elevation Estimates Relative to Spring High Water. Central estimate and high contour error (with and without SHW error, relative to SHW, ignoring model error). This case assumes a 5-ft contour interval, a 1-ft error in estimating the elevation of spring high water, and contour error of 2.5 feet.

The estimates of the land below various elevations were based on simple linear interpolation of this information.[9] Figures 1.3.2 through 1.3.4 illustrate a proposed approach to generating high and low elevation estimates, respectively. But before discussing that approach, let us examine a depiction of the Titus and Wang analysis (see Section 1.1) used as input to this study. In Figure 1.3.2 (as well as Figures 1.3.3 and 1.3.4), the four green dots represent the values of the input data. This example quad has a 5-ft contour interval, and spring high water is estimated to be 3 feet above NGVD29. The first green dot shows the estimated elevation of spring high water; this dot appears along the vertical axis because all the dry land and nontidal wetlands are above spring high water (by definition). The other three points show the amount of land (other than tidal wetlands) below the 5-, 10-, and 15-ft contours. The green line is the cumulative elevation distributions that Titus and Wang derived through interpolation—but transposed so that the cumulative elevation is on the horizontal axis and elevation on the vertical axis. The figures are transposed from the traditional way of depicting cumulative distribution functions, because the transposed version gives us the actual profile of a typical transect or cross section of the land.

Now let us consider a possible way to think about high and low error. In Figure 1.3.2, the three red dots with elevations of 7.5, 12.5, and 17.5 feet represent high estimates of the elevation of the contours. That is, given the RMS error of one-half the contour interval (2.5 feet), the 5-ft contour could actually be as high as 7.5 feet. Along the vertical axis, we see three dots.

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[9] In some cases, the 5-ft contour was seaward of the wetland boundary and the Titus and Wang interpolation disregarded the 5-ft contour on the assumption that it was obsolete. In those cases, the interpolation created—in effect—a new 5-ft contour farther inland, which was used in quantifying the land below 5 feet in a given quad.

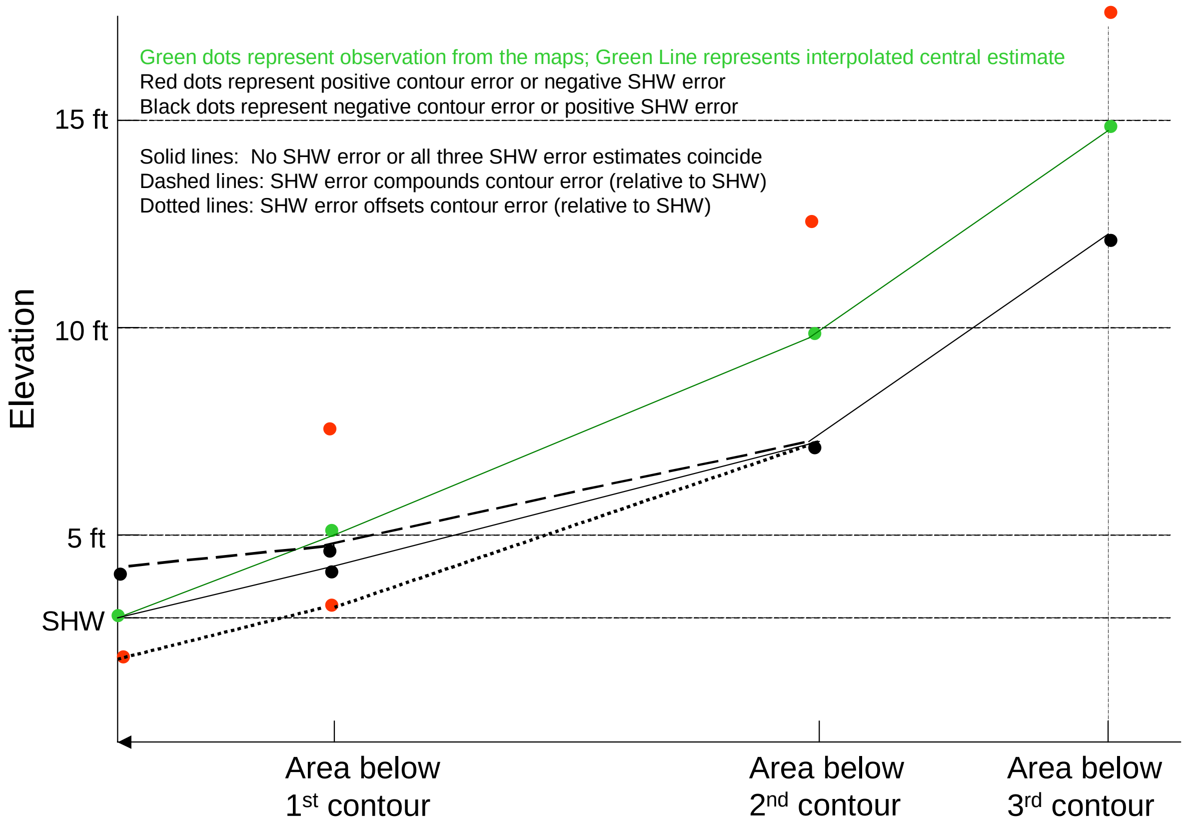

Figure 1.3.4. Interpolated Elevation Estimates Relative to NGVD29. Central estimate and low contour error (with and without SHW error, relative to NGVD, ignoring model error). This case assumes a 5-ft contour interval, a 1-ft error in estimating the elevation of SHW, and contour error of 2.5 feet

As previously mentioned, the green dot is the estimate of spring high water (3 feet). The red and black dots at 2 and 4 feet, respectively, represent the possibility that Titus and Wang over- or underestimated SHW, respectively. The three red lines represent the alternative high-elevation cumulative elevation distributions (and average profile) implied by the three different estimates of the elevation of SHW. In all these cases, the profile is steeper than the profile implied by the input data. The dashed line—where spring high water is less than estimated—provides the steepest profile and hence the greatest error. Put another way, the dashed line assumes that SHW is lower—and the contour is higher—than assumed by Titus and Wang; i.e., the errors compound. Figure 1.3.3 shows the same four cases, but with elevations relative to spring high water instead of NGVD29. Comparing Figures 1.3.2 and 1.3.3 may help one visualize the impact of SHW error on the land profile (cumulative elevation distribution) assumed in the calculations. Each of the four profiles has the same shape in Figure 1.3.3 as it has in Figure 1.3.2. When measured against NGVD (Figure 1.3.2), the three high-contour error profiles start at different elevations (reflecting uncertainty about the elevation of the lowest spot of dry land, SHW) but coincide after the first contour (because SHW error has no impact on the topographic contours). When measured against SHW (Figure 1.3.3), the profiles all start out at zero, because error in estimating SHW has no impact on the definitional assumption that dry land extends down to SHW. But the profiles diverge because errors in SHW have a 1:1 impact on elevations measured relative to SHW. Whatever the true elevation of the 5-ft contour relative to NGVD29, overestimating SHW by 1 foot lowers the estimated elevation relative to SHW by 1 foot.[10]

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[10] The error of elevations relative to spring high water would be 1 foot greater if the red dot (in Figure 1.3.2) was

All the figures show the implications of errors in spring high water and elevation estimates. There is no reason to think that these errors are correlated and every reason to assume that they are independent: two different federal agencies (USGS and NOAA) compiled the underlying data.[11] Therefore, when calculating uncertainty, we should assume that these errors are independent. It follows that the total elevation error is calculated as the square root of the sum of squares. Thus, in areas where the contour error is significant, the error in spring high water makes very little difference. But in areas with precise elevation data, error in spring high water can account for about one-half the total error.

Figure 1.3.4 presents a story similar to Figure 1.3.2 but for the low elevation case. The story is not completely symmetrical because of the first contour. The contour interval of the USGS maps at this location is 5 feet; but it is almost impossible for the USGS contour to have overestimated the actual elevations by 2.5 feet. Substantial dry land ("area below 1st contour") is above SHW (approximately 3 feet NGVD) and below the first contour. If the low elevation estimate were to assume that the lowest contour is at 2.5 feet, there would be an impossible result: the land above SHW (3 feet) cannot also be below 2.5 feet. This analysis avoids such an anomaly by assuming that RMS error is one-half the actual contour interval used. Thus, if SHW is between 2 and 4 feet, the lowest contour interval is 1 to 3 feet; so the low case assumes that the lowest contour is between 3.5 and 4.5 feet above NGVD (depending on the error in estimating SHW) rather than at 2.5 feet.

Although map accuracy standards provide a basis for the contour-error assumption, the literature does not provide a good estimate of uncertainty for SHW. This exposition has looked at the case where the error in SHW is 1 foot, because whole numbers can help simplify numerical illustrations. Our final results, however, assume that uncertainty for spring high water is approximately 15 cm (6 inches). Section 1.1 suggests that error is likely to be less than 6 inches, pointing out that the estimates are based on interpolation of spring tide ranges from more than 750 sites, and that the variation from site to site tends to be about 5 cm (2 to 3 inches), or less. Within a given quad—the unit of analysis for this study—those errors should cancel to some extent, causing the error to be less.

Using an Error Function to Represent Low and High Cumulative Distributions

The previous discussion explains the low and high estimates as alternative possibilities for the average shore profile, given the points along the profile for which observations are available. That is, the discussion compared the "best guess" profile estimated by Titus and Wang, with proposed high and low profiles. Recall, however, that although one usually displays y = f(x), in this case, the argument of the function is shown on the vertical axis. That is, in Section 1.1, Titus and Wang estimated the area as a function of elevation. Similarly, this study needs to estimate the low and high estimates as a function of elevation.

For computational purposes, it may be useful to think of error as a function of the best-guess central estimate. Viewed together, Sections 1.1 and Section 1.2 estimate the area of land within each shore protection category within each quad by 0.1-ft elevation increments. Thus, if one can express low = f(central estimate) and high = g(central estimate), then one need merely assign low and high elevations to each area. That is:

$$A\_low_{ik,low,f(E)} = A_{ik,E}$$

$$A\_high_{ik,high,g(E)} = A_{ik,E}$$

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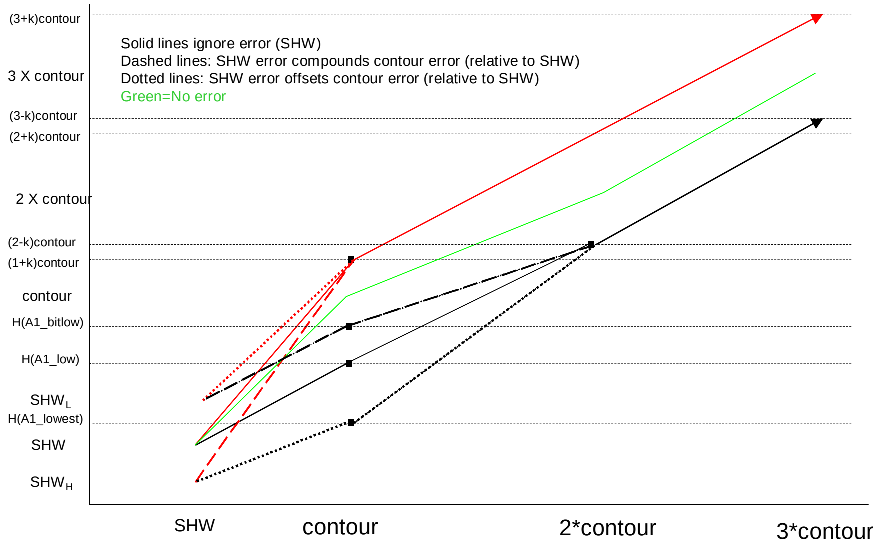
the actual value, and 1 foot less if the black dot was the actual value.

[11] The Section 1.1 estimates of spring high water are based entirely on NOAA tidal observations and NOAA analysis relating mean sea level to the fixed reference elevations used by topographic data (i.e., NAVD88 and NGVD29).



Note: H(A1_low) = contour – k*(contour-SHW), where k represents the ratio of RMS error to contour Interval, typically 1/2

H(A1_lowest) = contour – k*(contour-SHW$_H$)
SHW$_H$=SHW-SHW_error

H(A1_bitlow) = contour – k*(contour-SHW$_L$)
SHW$_L$=SHW+SHW_error

Figure 1.3.5. High and Low Estimates as a Function of the Best Guess. The difference between the red line and the green is the high vertical error; the difference between the black line and the green is the low vertical error. High error is constant beyond the first contour; low error is constant beyond the second contour. The vertical scale of this drawing is exaggerated below one contour to better display the relationships at low elevations.

where $A_{ij,E}$ represents the area of land in the ith shore protection category in the kth USGS quad at elevation E, as estimated in Section 1.2[12]; f and g are the error functions that express low and high elevation estimates as a function of the central estimate of elevation, and A_low and A_high represent the areas of land at elevation E in the low and high elevation cases. Figure 1.3.5 shows the low and high elevations as a function of the central estimate of elevation, i.e., functions f and g.

Refinements

Our initial model has two important flaws: it assumes that precision in modeling a single point is the same as our precision in estimating the total, and it ignores the model error of our linear interpolation. Let us examine each of these issues.

Systematic and random error. Intuitively, one might assume that the precision with which one can reasonably estimate the area of vulnerable land is the same as the precision of the input data. But that is true only if all errors are perfectly correlated. If we think that all elevations are likely to have been over- or underestimated by the same amount, then the ability to estimate the total is no more precise than the ability to estimate the elevation of a particular location. In such a case, there is no random error; all error is systematic. But that should rarely be the case.

Most elevation estimates include both a random and a systematic component. Along the contour, random errors would be expected as a human being attempts to trace a contour while viewing aerial photographs through a stereoplotter; systematic error might occur through biases caused by settings in the instrumentation or by subsiding benchmark elevations. Between the contours, systematic errors are likely because the actual "lay of the land" often departs from what one would expect from a linear interpolation. In developed areas, people have often filled and

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[12] Jones and Wang overlaid the elevation data from Titus and Wang with the shore protection likelihood maps from an unpublished analysis to create cumulative elevation distribution functions for each of the shore protection categories. In effect, they subdivided the cumulative elevation distribution functions estimated by Titus and Wang, into the separate cumulative distribution functions for the different categories of likelihood of shore protection. Thus, all the uncertainties we analyze here result from the Titus and Wang analysis; but the actual input data came from Jones and Wang.

bulkheaded the shore, increasing the amount of land 50–100 cm above the tides at the expense of land 0–50 cm above the tides; in undeveloped areas bluffs occur in some areas, and the land follows a more gentle slope in other areas.

A sophisticated treatment of this question is beyond our time and budget constraints. Therefore, we need a simple parameterization. Figures 1.3.6 compares the cumulative elevation distributions of LIDAR collected by the state of Maryland (see Section 1.1, Jones 2007, and Jones et al. 2008 for additional details) to the interpolated results for the area on the Eastern Shore of Maryland where LIDAR was available (see Figure 1.3.1), subdivided into four subareas with varying data quality. The vertical axes omit magnitudes, which are unimportant for the purposes here.

The four figures all suggest that systematic error is well less than one-half the contour interval. In the areas with a 5-ft contour interval (Figure 1.3.6a), the DEM interpolation is about 1 foot lower (to the left) than the LIDAR below 3 feet; but above 4 feet the interpolation and LIDAR are less than 0.5 feet (15 cm) apart. In the areas with a 1-m contour (Figure 1.3.6b), the DEM interpolation and LIDAR are less than 10 cm (4 inches) apart below 1 meter. Above that point, the DEM interpolation increases to 50 cm greater than the LIDAR, but the difference is generally 25 cm. In the area that used the Maryland DNR data—which have an RMS error of 5 feet—the difference is less than 1 foot (30 cm) below the 10-ft contour (Figure 1.3.6c). It increases to 2.5 feet at the 15-ft contour before declining. In those areas that rely on USGS 20-ft contours (Figure 1.3.6d), the DEM underestimates the elevation by 2 to 3 feet, on average.

These comparisons (as well as the comparison with North Carolina LIDAR reported by Jones [2007] and Section 1.1.) lead to two insights worth applying in this error assessment. First, in areas the size of a county or two, the cumulative elevation distribution is within one-half the nominal RMS error of the data most of the time; and it almost never exceeds the reported RMS error. Therefore, one would expect that when there are many counties (e.g. results for entire states), the cumulative elevation distribution would continue to converge and almost never exceed one-half the nominal RMS error of the data set. That is, *it seems safe to assume that the systematic error over a large area is no more than one-half the reported RMS error of the data*. Therefore, this error assessment assumes that when USGS maps are the input data set, the low and high estimates are one-quarter the contour below and above the central estimates derived by interpolating between those contours in Section 1.2. that the high error may be greater than the low error, as displayed in Figures 1.3.2 and 1.3.4.

Model error from linear interpolation. The potential for linear interpolation to understate elevations appears to be particularly pronounced at very low elevations. The approach described so far assumes, in effect, that below the first contour, error is proportional to elevation (relative to SHW). But there is no reason to assume that precision increases at low elevations; that was simply an artifact of linear interpolation in a scheme designed to prevent assuming the impossible, such as dry land being below spring high water. These assumptions seem more defensible on the low end than on the high end. That is, assuming that the area of land below elevation X is proportional to X below the first contour is more unreasonable for the high-elevation uncertainty than the low-elevation uncertainty:

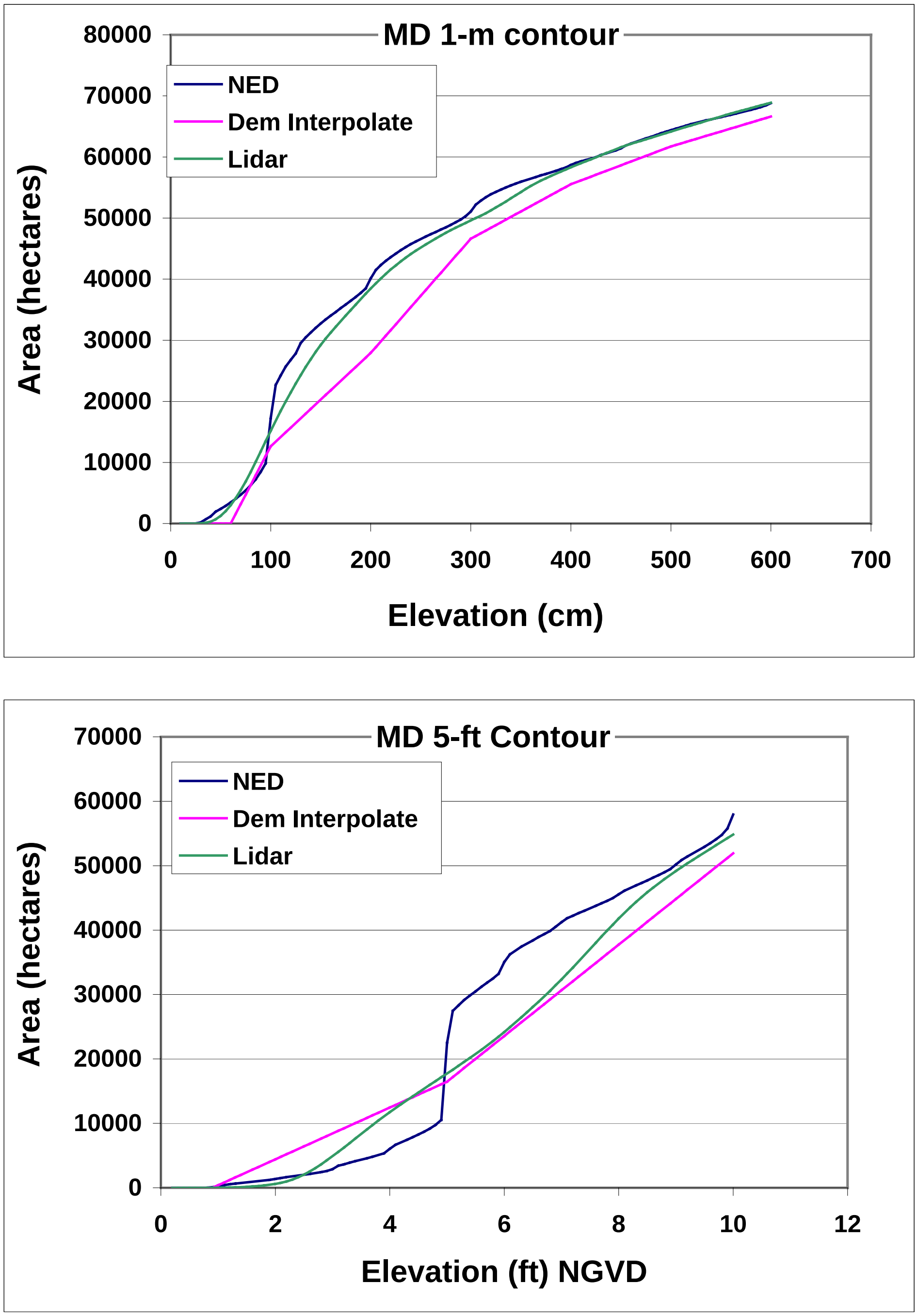

Figure 1.3.6. Cumulative Area of Land Close to Sea Level according to USGS National Elevation Data (NED), interpolation of the Titus and Wang DEM, and State of Maryland's LIDAR in the area where LIDAR was available (see Figure 1.3.1). The data are divided according to the best available data other than LIDAR: (a) USGS maps with 5- ft contours; (b) USGS maps with 1 meter contours, (c) 5-foot contours created from MD-DNR data in areas where USGS maps had 20-ft contours; and (d) USGS 20-ft contours. See Section 1.1 and accompanying metadata for more details.

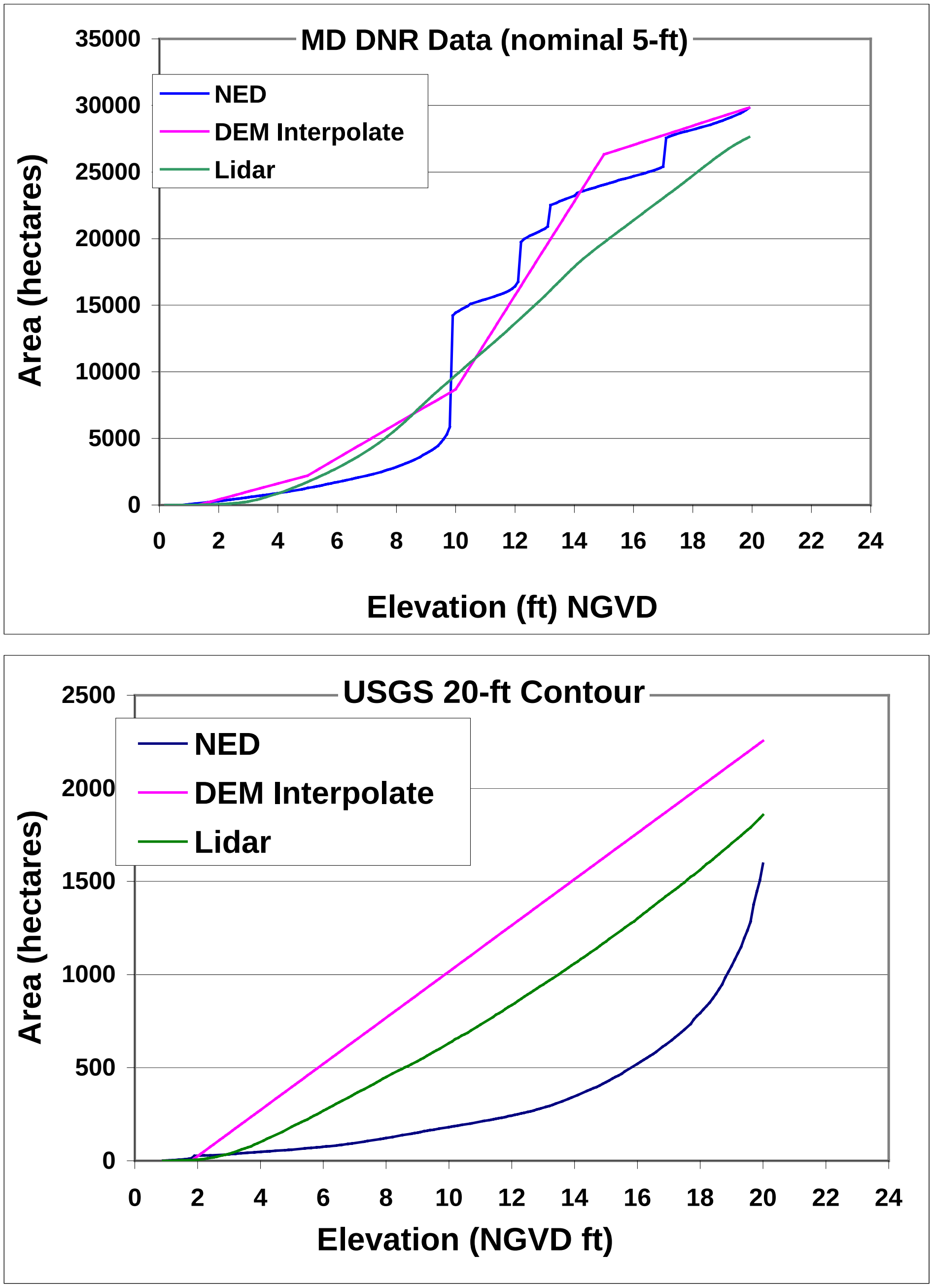

Figure 1.3.6. Cumulative Area of Land Close to Sea Level according to USGS National Elevation Data (NED), interpolation of the Titus and Wang DEM, and State of Maryland's LIDAR in the area where LIDAR was available (see Figure 1.3.1). The data are divided according to the best available data other than LIDAR: (a) USGS maps with 5- ft contours; (b) USGS maps with 1 meter contours, (c) 5-foot contours created from MD-DNR data in areas where USGS maps had 20-ft contours; and (d) USGS 20-ft contours. See Section 1.1 and accompanying metadata for more details.

Second, the tendency for the DEM interpolation to underestimate elevations appears to be somewhat more pronounced than any tendency to overestimate elevations. In Maryland this is clearly the case. (Titus and Wang, and Jones, found that in North Carolina, the interpolation overestimated elevations of very low land; but they concluded that the unique situation of North Carolina was probably to blame in that case. [13]) That tends to reinforce our inclination to assume

- The wetlands boundary is at the kink of the most common concave-up profile. So the use of wetlands data means that interpolation already accounts for cases where the profile is below a linear trend.

- The accuracy assessment shows the Section 1.1 DEM to underestimate elevations close to spring high water (see Figure 1.3.6):

    - In Maryland, they generally found that more than half of the land between spring high water and the first contour was above the midpoint between spring high water and the elevation of the first contour.

    - The error was particularly great when the contour interval was large.

- USGS contour selection also creates a downward bias: Consider an area with a 10-ft contour. If there is much land below the 5-ft contour, USGS is likely to reduce the contour interval to 5 feet or at least collect a 5-ft supplemental contour. This does not always occur, but the tendency is enough for a high-elevation scenario to assume that there is no land below the 2.5-ft contour.

- The mathematics limits downside uncertainty: Because elevations must be above spring high water, they can only be a little bit less than the very low elevations under consideration, while they could be much higher.

Thus, if the point estimate assumes 100 hectares within 0.5 feet above spring high water, it is desirable that the low estimate does not assume 100 hectares to be 2 feet below spring high water. That does not mean, however, that the high estimate ought to rule out the possibility that this land is actually 3 feet above spring high water. Low bluffs really are common along the coast—so a high scenario that assumes a low bluff with an elevation of contour/4 is actually quite realistic. (By contrast, a high scenario that assumes an unmapped dike protecting low land that it contour/4 below spring high water is not realistic.) Put another way, there is good reason to not think that there is a large amount of dry land below high tide—but there is no reason to think that there is a significant amount of land just above spring high water. Therefore, the high scenario should allow for the possibility that there is no significant amount land barely above the tides.

Figure 1.3.6 supports this concern. In Figures 1.3.6a and 1.3.6c, the interpolation understates elevations by about 1 foot below 4 feet in elevation, and then declines. In Figure 1.3.6d, where the underlying USGS maps have a 20-ft contour interval, the interpolation finds as much land below 3 feet as LIDAR finds below 5 feet, and as much land below 17 feet as the LIDAR finds below 20 feet. Thus, at an elevation of one-quarter the contour interval, the error is about two-thirds the error seen at the contour. (In Figure 1.3.6b, the error is fairly minor at all elevations.)

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[13] Much of North Carolinas coastal wetlands are truly are classified as nontidal wetlands, and hence the interpolations in Section 1.1 treated them as uniformly distributed between SHW and the 5-ft contour, which is generally more than 1 meter above SHW. (The final results used LIDAR and hence are not affected directly by this problem.) Much of those wetlands are at sea level, and classified as nontidal because the rivers and sounds along which they are found have an astronomical tide so small that, for most practical purposes, it is nontidal. When considering the impact of sea level rise, it would be more accurate to consider these areas to be “nanotidal wetlands.”

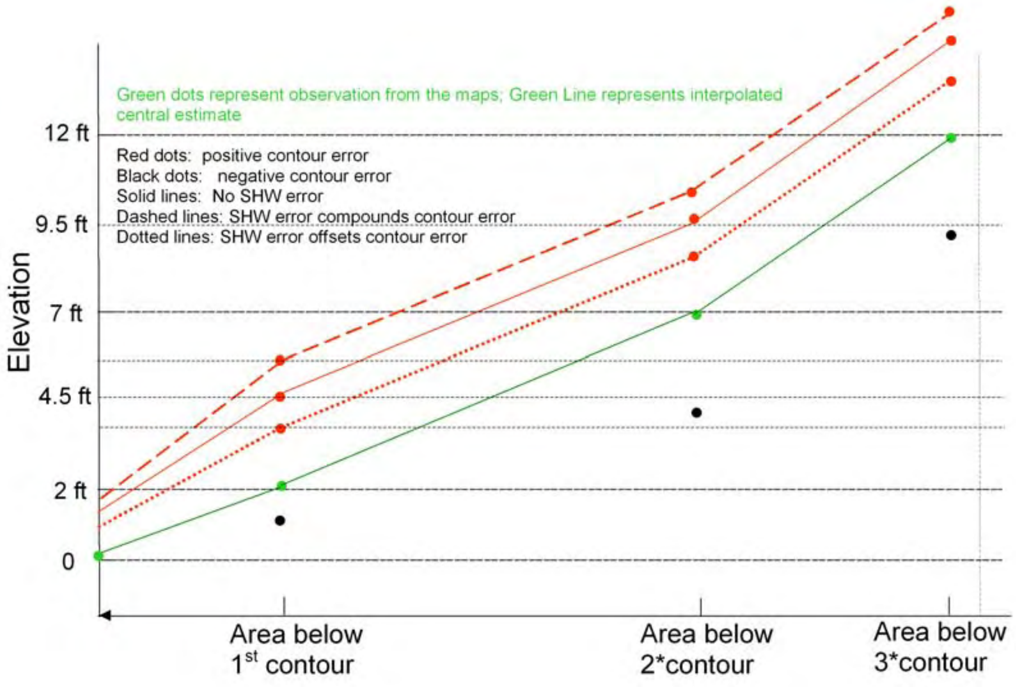

Figure 1.3.7. High Elevation Estimates Relative to Spring High Water, including Possible Model Error (with and without SHW error, relative to NGVD, ignoring model error). This case assumes a 5-ft contour interval, a 1-ft error in estimating the elevation of SHW, a contour error of 2.5 feet, and a high-end error that is always at least one-quarter the contour interval

There is no completely satisfactory way to model this possibility. The simplest approach would have been to simply add and subtract one-quarter the contour interval to the entire distribution, but this analysis employs a more complicated approach in part to avoid impossible results in the low case (e.g., dry land up to one-quarter the contour interval below SHW). But this is not a problem with the high scenario. Therefore, *the high scenario assumes that all land is at least one-quarter times the contour interval above SHW*. In effect, the high estimate assumes that one can not rule out a bluff with an elevation at one-quarter the lowest contour interval. Comparing Figure 1.3.7 to Figure 1.3.3 shows that this assumption has no impact on elevations above the first contour.

Areas with Higher Precision Data

In areas with higher precision data, these considerations are less important. They mostly apply to problems between contours; and EPA does not need elevations in increments finer than 50 cm. What is important is that no matter how precise the elevation data, we will report some uncertainty because LIDAR measures elevations relative to a fixed reference plane, while we report elevations relative to spring high water, which we estimate imprecisely. As mentioned above, this analysis assumes that the estimates of spring high water have an error of 15 cm (6 inches).

In Section 1.1, Titus and Wang used the LIDAR, spot elevation, and actual DEM results where contour intervals were 2 feet (60 cm) or less. Therefore, the interpolation model did not apply and it would be reasonable to simply add or subtract the systematic error. We saved some time, however, by applying the algorithm developed for USGS data to these results as well rather than rewriting a separate algorithm.

Section 1.3.2. Implementing the Approach using Geographically Specific Error Functions Approach

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The objective of elevation uncertainty analyses is to acknowledge uncertainty about the actual elevation of any particular geographic region and to quantify it so that the elevation in a particular region can be expressed as a range of plausible values. Consequently, estimates of flooded areas under any particular scenario of sea level rise can also be expressed as a range of plausible values.

This section reports the actual methods used to calculate ranges of plausible elevation that reflect the reasoning about landscapes, interpretation of map accuracy, and between-contour interpolation methods described in Section 1.3.1. It is intended to describe the essential features of methodology introduced in Section 1.3.1 that were actually applied in the uncertainty analysis in a manner that includes specific mathematical definitions that allow for reproducibility.

The reasoning in Section 1.3.1 about uncertainty is described in terms of two generalized error functions. One of the functions defines the lower limit of plausible elevation and the other defines the upper limit. Considered jointly, the error functions define the amount of uncertainty about elevation (vertical error) associated with any geographic point. To quantify uncertainty in a particular geographic location, the generalized error functions are used with parameters that are specific to that particular location to define plausible ranges of elevation for that location. Plausible ranges of elevation determine in this manner are subsequently translated into plausible ranges of area that may be inundated by various sea level rise scenarios.

Magnitude of Uncertainty in the Data Sources

Uncertainty analyses consider two main sources of uncertainty. The analyses consider both types of uncertainty jointly to generate an estimate of total uncertainty that is specific to each geographic area in the study.

One source of uncertainty derives from imprecision in elevation values in the source data. Each location in the study area is represented by one of several types of source data with differing amounts of inherent precision. As described in Section 1.3.1, the inherent precision of each type of source data is a known value that is expressed as the root mean square error (RMSE) and in the same units of measure as the vertical units provided (Table 1.3.1). Data with greater inherent precision have less uncertainty with regard to the true elevation of a particular geographic point and, conversely, source data with lesser inherent precision have more uncertainty with regard to the true elevation of a particular point. (See Figure 1.3.8 and Table 1.3.1; and Section 1.1 and Section 1.2 for additional details concerning the precision of the source data used in the study area.)

The second source of uncertainty derives from the estimated elevation of SHW relative to the NGVD29 for any particular section of coastline as derived from local tide gage data. The elevation of SHW is relevant because the elevations provided by the source data are expressed relative to the NGVD29 datum, but the estimation of inundation is expressed relative to SHW (see Section 1.1 for a description of how the elevations relative to SHW were derived).

Aggregate Uncertainty

All NGVD29 elevations from the source data are converted to elevations relative to SHW by:

$$E_{jk} = E_{ngvd,jk} - SHW_{k} \quad (1)$$

where:

E_{jk} is the derived nominal elevation of point j in region k relative to SHW
$E_{ngvd,jk}$ is the nominal elevation of point j in region k relative to NGVD29, as provided in the source data
SHW_{k} is the estimated (NGVD29) elevation of SHW for region k.

SHW_{k} is not known with absolute certainty; thus the precision of E_{jk} is a function of two sources of uncertainty: (1) the magnitude of uncertainty inherent in $E_{ngvd,jk}$ and (2) the magnitude of uncertainty in SHW_{k}. In principle, the magnitude of uncertainty in SHW_{k} could vary by region k, but in this study SHW_{k} is defined as a constant value of 0.5 feet. These two sources of uncertainty were assumed to be statistically independent; thus, the magnitude of total uncertainty is estimated with the basic equation:

$$P_{jk} = \sqrt{P_{mshw,k}^{2} + P_{ngvd,jk}^{2}} \quad (2)$$

where:

$P_{mshw,k}$ is the magnitude of uncertainty in SHW_{k} expressed as RMSE, defined as a constant value of 0.5 feet
$P_{ngvd,jk} = kC_{jk}$ or
$P_{ngvd,jk}$ is a specified the magnitude of uncertainty in $E_{ngvd,jk}$ expressed as RMSE (feet)[14]
P_{jk} is the magnitude of total effective uncertainty in E_{jk} (feet)
C_{jk} is the magnitude of contour intervals represented in the relevant source data for point j,k[15]
k is a scalar that varies by source data (e.g., 0.5; see Table 1.3.1).

(1)

The basic definition of P_{jk} was not applied universally to all points in region k. In some subregions within region k, P_{jk} is associated with points j,k, but in other subregions, particularly regions of low elevation, P_{jk} is redefined by an ad hoc function of E_{jk} that is described below.

Estimating Elevation Uncertainty

The magnitude of uncertainty about E_{jk} was defined as P_{jk} at all relatively high elevations. In such regions, upper and lower bounds on E_{jk} were defined simply as:

$$E_{jk,l} = E_{jk} - P_{jk} \quad (3)$$

$$E_{jk,u} = E_{jk} + P_{jk} \quad (4)$$

where:

E_{jk} is the nominal elevation of point j,k [16]
$E_{jk,l}$ and $E_{jk,u}$ represent the lower and upper bounds on E_{jk}, respectively.

(2)

However, the simple formulations in Equations 3 and 4 were considered inadequate for providing realistic bounds for E_{jk} in locations with low elevation, where "low elevations" are defined to be lower than selected reference elevations. For estimating $E_{jk,u}$, a reference elevation was taken to be E'_{jk}, the elevation of "first contour," which is E_{jk} corresponding to $E_{ngvd,jk}$ equal to the lowest nonzero elevation contour in the source data for region k. For estimating $E_{jk,l}$, an additional reference elevation was taken to be E''_{jk}, the elevation of "second contour," which is E_{jk} corresponding to $E_{ngvd,jk}$ equal to the second-lowest nonzero elevation contour in the source data for region k.

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[14] For areas described by some types of source data, e.g., USGS topographic maps, $P_{ngvd,jk}$ is defined as a certain fraction of the contour intervals used in the base maps, but for other types of source elevation data not based on contour intervals, e.g., elevations derived from LIDAR data, $P_{ngvd,jk}$ is a constant (Table 1.3.1). For USGS maps, $P_{ngvd,jk} = kC$.

[15] For source data not based on a contour interval, such as SPOT and LIDAR, contour interval was derived from the RMSE of the source data.

[16] Nominal elevations were determined from the source data using interpolation methods described in Section 1.1.

The general uncertainty modeling procedure can be succinctly described as two complex error functions. One such function describes the error in a positive direction, i.e., the amount by which the “true” elevation, E^*_{jk}, could exceed the nominal elevation E_{jk}. The other such function describes the error in a negative direction, i.e., the amount by which the “true” elevation, E^*_{jk}, could lie below the nominal elevation E_{jk}. The functions are asymmetrical because of the assumption that the magnitude of errors in the negative direction will tend to be relatively dampened if E_{jk} is lower than E'_{jk} or E''_{jk} (defined below; see Section 1.3.1 for the justification of this assumption).

The error function for determining an upper bound on E_{jk} is a set of line segments defined as:

$$E'_{jk} = (C_{jk} - \mathrm{MSWH}_k) \tag{5}$$

$$P_{jk,u} = \begin{cases} gE'_{jk} + E_{jk} \times (P_{jk} - gE'_{jk}) / E'_{jk} & \mathit{If}\ E_{jk} < E'_{jk} \\ P_{jk} & \mathit{If}\ E_{jk} \geq E'_{jk} \end{cases} \tag{6}$$

$$E_{jk,u} = E_{jk} + P_{jk,u} \tag{7}$$

where:

SHW is the elevation of mean spring high water for point j,k

g is a constant (e.g., 0.25)

E'_{jk} is the elevation (relative to SHW) of “first contour”

$P_{jk,u}$ is the magnitude of error in a positive direction

$E_{jk,u}$ is the upper bound on E_{jk}.

The error function for determining a lower bound on E_{jk} is a set of line segments defined by:

$$E''_{jk} = (2C_{jk} - \mathrm{MSWH}_k) \tag{8}$$

$$P'_{jk} = \sqrt{((1-k)P_{mshw})^2 + (kE'_{jk})^2} \tag{9}$$

$$P_{jk,l} = \begin{cases} P'_{jk} E_{jk} / E'_{jk} & \mathit{If}\ E_{jk} > 0\ \mathit{and}\ E_{jk} < E'_{jk} \\ P'_{jk} + ((E_{jk} - E'_{jk})(P_{jk} - P'_{jk})) / (E''_{jk} - E'_{jk}) & \mathit{If}\ E_{jk} \geq E'_{jk}\ \mathit{and}\ E_{jk} < E''_{jk} \\ P_{jk} & \mathit{If}\ E_{jk} \geq E''_{jk} \end{cases} \tag{10}$$

$$E_{jk,l} = \max(0, (E_{jk} - P_{jk,l})) \tag{11}$$

where:

P'_{jk} is a measure of uncertainty analogous to P_{jk}

E''_{jk} is E_{jk} corresponding to $E''_{ngvd,jk}$, the elevation of the second-lowest non-zero elevation contour in the base map for region k

$P_{jk,l}$ is the magnitude of error in a negative direction

$E_{jk,l}$ is the lower bound on E_{jk}.

The typical shape of the error functions defined by Equations 1 through 11 are depicted in Figure 1.3.8.

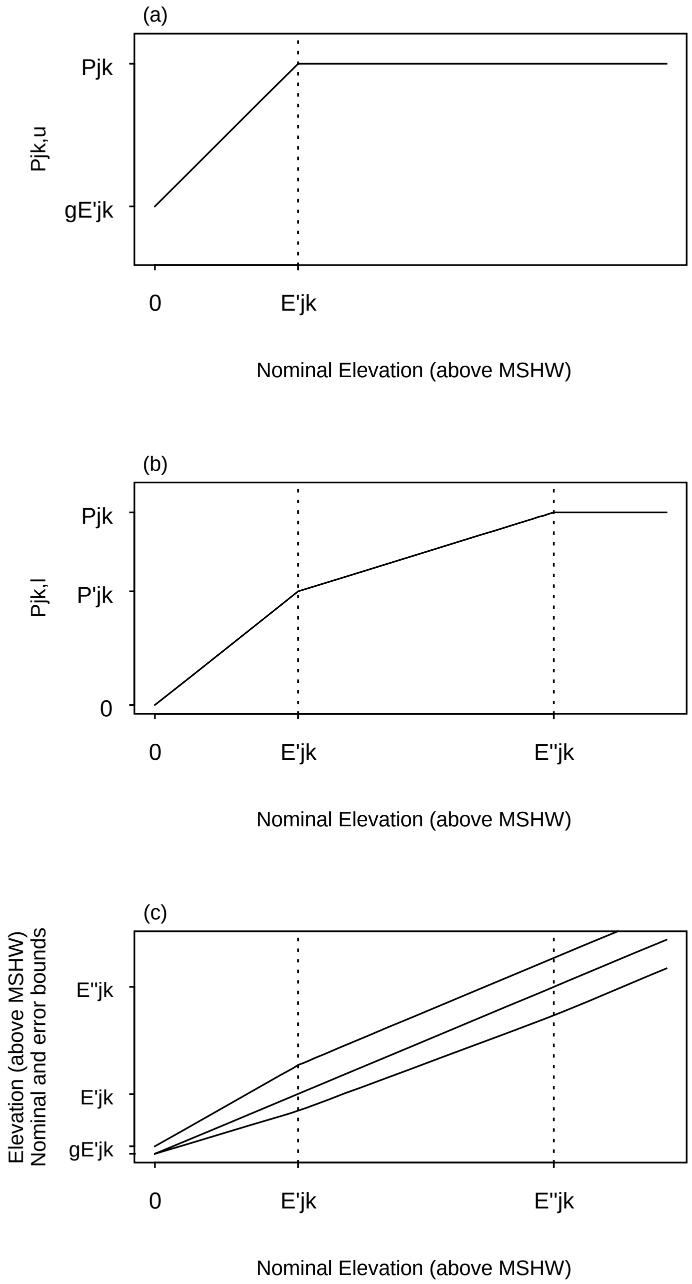

Figure 1.3.8. Generalized Error Functions Used to Estimate Uncertainty Bounds on Elevation. Panel (a) depicts magnitude of uncertainty in a positive direction; panel (b) depicts magnitude of uncertainty in a negative direction; and panel (c) describes the net effect of the functions depicted in panels (a) and (b), expressed as positive and negative uncertainty bounds relative to the nominal elevation.

Estimating Ranges of Plausible Elevation

Before the uncertainty analyses, acreages for a particular region and protection scenario were compiled into bins corresponding to elevations above SHW 0.1-ft increments.[17] For example, for scenarios,

> $A_{k,s,0.1}$ = area between E_{jk} = 0 feet and E_{jk} = 0.1 foot (hectares)
>
> $A_{k,s,0.2}$ = area between E_{jk} = 0.1 feet and E_{jk} = 0.2 foot (hectares), etc.

Thus, collectively the $A_{k,s}$ values can be considered as a density[18] with each element associated with a particular E_{jk}. Considering the meaning of $E_{jk,l}$ and $E_{jk,u}$, each $A_{k,s}$ can be associated with all three values: E_{jk}, $E_{jk,l}$, and $E_{jk,u.}$ By extension, each E_{jk} elevation can be associated with three alternative values of $A_{k,s}$ by aligning with cases where $E_{jk} = E_{jk,l}$ and $E_{jk} = E_{jk,u.}$ In this manner, two additional "densities" are generated such that for each E_{jk} there are three alternative corresponding $A_{k,s.}$ The alternative densities have little implicit meaning, but converting each of the alternative densities to cumulative distributions provides alternative elevation profiles that are meaningful for generating a range of estimates of total flooded area under various amounts of sea level rise.

Procedural Notes

Data processing and calculations related to the elevation uncertainty analyses were conducted with S-Plus software (Professional Developer version 7; Insightful Corporation, Seattle, WA). In addition to quality control procedures used during development of the S-Plus algorithms used to solve for the uncertainty endpoints, quality control procedures were conducted independently from the S-Plus algorithms using MS-Excel spreadsheets for selected test cases.

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[17] The data used as the basis for the uncertainty analyses were expressed with a resolution of 0.1 feet (see footnote 14), and the general processing of those data to develop uncertainty limits were conducted with a resolution of 0.1 feet. Prior to comparisons with elevations of interest (e.g., a selected amount of sea level rise), the basic results with 0.1 foot resolution were further subdivided into 10 bins of equal size to provide a quasi-resolution of 0.01 feet.

[18] Not strictly a probability density because the sum of all H_k,s equal a total area in region k for scenarios, not one.

Table 1.3.1. Features of distinct base map data sources related to estimation of elevation uncertainty

State	Quadrangle	County	Source	Contour interval (ft)	k (base)[a]	g	RMS cm (base)	SHW (ft)[b]
DC	Alexandria	Washington DC	1 m	3.280839	0.5	0.25	50	3.49
DC	Anacostia	Washington DC	1 m	3.280839	0.5	0.25	50	3.51
DC	Washington East	Washington DC	1 m	3.280839	0.5	0.25	50	3.39
DC	Washington West	Washington DC	1 m	3.280839	0.5	0.25	50	3.22
DE	Assawoman Bay	Sussex	5 ft	5	0.5	0.25	76.2	2.71
DE	Bennetts Pier	Kent	5 ft	5	0.5	0.25	76.2	3.89
DE	Bethany	Sussex	5 ft	5	0.5	0.25	76.2	2.76
DE	Bombay Hook	Kent	5 ft	5	0.5	0.25	76.2	4.22
DE	Cape Henlopen	Sussex	5 ft	5	0.5	0.25	76.2	2.89
DE	Clayton	Kent	5 ft	5	0.5	0.25	76.2	4.07
DE	Delaware City	New Castle	5 ft	5	0.5	0.25	76.2	3.89
DE	Dover	Kent	5 ft	5	0.5	0.25	76.2	4.13
DE	Ellendale	Sussex	5 ft	5	0.5	0.25	76.2	3.67
DE	Fairmount	Sussex	5 ft	5	0.5	0.25	76.2	2.88
DE	Frankford	Sussex	5 ft	5	0.5	0.25	76.2	2.78
DE	Frederica	Kent	5 ft	5	0.5	0.25	76.2	3.95
DE	Georgetown	Sussex	5 ft	5	0.5	0.25	76.2	3.2
DE	Greenwood	Kent	5 ft	5	0.5	0.25	76.2	3.79
DE	Greenwood	Sussex	5 ft	5	0.5	0.25	76.2	3.79
DE	Harbeson	Sussex	5 ft	5	0.5	0.25	76.2	3.01
DE	Harrington	Kent	5 ft	5	0.5	0.25	76.2	3.92
DE	Hickman	Kent	5 ft	5	0.5	0.25	76.2	3.82
DE	Kenton	Kent	5 ft	5	0.5	0.25	76.2	4.18
DE	Laurel	Sussex	5 ft	5	0.5	0.25	76.2	2.53
DE	Lewes	Sussex	5 ft	5	0.5	0.25	76.2	3.13
DE	Little Creek	Kent	5 ft	5	0.5	0.25	76.2	4.06
DE	Marydel	Kent	5 ft	5	0.5	0.25	76.2	4.03
DE	Milford	Kent	5 ft	5	0.5	0.25	76.2	3.89
DE	Millsboro	Sussex	5 ft	5	0.5	0.25	76.2	2.8
DE	Milton	Sussex	5 ft	5	0.5	0.25	76.2	3.45
DE	Mispillion	Kent	5 ft	5	0.5	0.25	76.2	3.85
DE	Penns Grove	New Castle	5 ft	5	0.5	0.25	76.2	4.06
DE	Rehoboth	Sussex	5 ft	5	0.5	0.25	76.2	2.83
DE	Seaford East	Sussex	5 ft	5	0.5	0.25	76.2	3.37
DE	Seaford West	Sussex	5 ft	5	0.5	0.25	76.2	2.5
DE	Selbyville	Sussex	5 ft	5	0.5	0.25	76.2	2.75
DE	Sharptown	Sussex	5 ft	5	0.5	0.25	76.2	2.24
DE	Smyrna	Kent	5 ft	5	0.5	0.25	76.2	4.2
DE	Taylorsbridge	New Castle	5 ft	5	0.5	0.25	76.2	4.05
DE	Trap Pond	Kent	5 ft	5	0.5	0.25	76.2	2.79
DE	Trap Pond	Sussex	5 ft	5	0.5	0.25	76.2	2.79
DE	Wilmington S	New Castle	5 ft	5	0.5	0.25	76.2	3.89
DE	Wyoming	Kent	5 ft	5	0.5	0.25	76.2	3.98
DE	Cecilton	New Castle	10 ft	10	0.5	0.25	152.4	3.92
DE	Elkton	New Castle	10 ft	10	0.5	0.25	152.4	3.83
DE	Marcus Hook	New Castle	10 ft	10	0.5	0.25	152.4	4.05
DE	Middletown	New Castle	10 ft	10	0.5	0.25	152.4	3.98
DE	Newark East	New Castle	10 ft	10	0.5	0.25	152.4	3.84
DE	Saint Georges	New Castle	10 ft	10	0.5	0.25	152.4	3.85
DE	Wilmington N	New Castle	10 ft	10	0.5	0.25	152.4	3.99
MD	Aberdeen	Cecil	20 ft DNR	5	1	0.5	152.4	2.36
MD	Anacostia	Prince George S	20 ft DNR	5	1	0.5	152.4	2.5

Table 1.3.1. Features of distinct base map data sources related to estimation of elevation uncertainty

State	Quadrangle	County	Source	Contour interval (ft)	k (base)[a]	g	RMS cm (base)	SHW (ft)[b]
MD	Baltimore East	Baltimore City	20 ft DNR	5	1	0.5	152.4	1.6
MD	Baltimore West	Baltimore City	20 ft DNR	5	1	0.5	152.4	1.6
MD	Benedict	Calvert	20 ft DNR	5	1	0.5	152.4	1.9
MD	Betterton	Kent	20 ft DNR	5	1	0.5	152.4	2
MD	Bowie	Prince George S	20 ft DNR	5	1	0.5	152.4	2.1
MD	Bristol	Calvert	20 ft DNR	5	1	0.5	152.4	2.1
MD	Centreville	Kent	20 ft DNR	5	1	0.5	152.4	1.6
MD	Charlotte Hall	Charles	20 ft DNR	5	1	0.5	152.4	1.7
MD	Chestertown	Kent	20 ft DNR	5	1	0.5	152.4	1.8
MD	Church Hill	Kent	20 ft DNR	5	1	0.5	152.4	2.2
MD	Claiborne	Talbot	20 ft DNR	5	1	0.5	152.4	1.5
MD	Conowingo Dam	Cecil	20 ft DNR	5	1	0.5	152.4	2.4
MD	Earleville	Cecil	20 ft DNR	5	1	0.5	152.4	2.1
MD	Edgewood	Harford	20 ft DNR	5	1	0.5	152.4	1.9
MD	Galena	Cecil	20 ft DNR	5	1	0.5	152.4	2.3
MD	Gunpowder Neck	Harford	20 ft DNR	5	1	0.5	152.4	1.6
MD	Hanesville	Harford	20 ft DNR	5	1	0.5	152.4	1.6
MD	Havre De Grace	Cecil	20 ft DNR	5	1	0.5	152.4	2.2
MD	Langford Creek	Kent	20 ft DNR	5	1	0.5	152.4	1.5
MD	Lower Marlboro	Calvert	20 ft DNR	5	1	0.5	152.4	2.1
MD	North Beach	Calvert	20 ft DNR	5	1	0.5	152.4	1.5
MD	Perryman	Harford	20 ft DNR	5	1	0.5	152.4	1.9
MD	Piscataway	Prince George S	20 ft DNR	5	1	0.5	152.4	2.5
MD	Popes Creek	Charles	20 ft DNR	5	1	0.5	152.4	1.7
MD	Price	Caroline	20 ft DNR	5	1	0.5	152.4	2.4
MD	Prince Frederick	Calvert	20 ft DNR	5	1	0.5	152.4	1.7
MD	Relay	Baltimore City	20 ft DNR	5	1	0.5	152.4	1.5
MD	Ridgely	Caroline	20 ft DNR	5	1	0.5	152.4	2.3
MD	Rock Hall	Kent	20 ft DNR	5	1	0.5	152.4	1.6
MD	Rock Point	Charles	20 ft DNR	5	1	0.5	152.4	1.8
MD	Spesutie	Cecil	20 ft DNR	5	1	0.5	152.4	1.8
MD	Swan Point	Kent	20 ft DNR	5	1	0.5	152.4	1.5
MD	Washington East	Prince George S	20 ft DNR	5	1	0.5	152.4	2.6
MD	Aberdeen	Harford	5 ft	5	0.5	0.25	76.2	2.2
MD	Annapolis	Anne Arundel	5 ft	5	0.5	0.25	76.2	0.5
MD	Bloodsworth Island	Somerset	5 ft	5	0.5	0.25	76.2	1.8
MD	Bowie	Anne Arundel	5 ft	5	0.5	0.25	76.2	1.2
MD	Bristol	Anne Arundel	5 ft	5	0.5	0.25	76.2	1.3
MD	Conowingo Dam	Harford	5 ft	5	0.5	0.25	76.2	2.4
MD	Curtis Bay	Anne Arundel	5 ft	5	0.5	0.25	76.2	0.7
MD	Deale	Anne Arundel	5 ft	5	0.5	0.25	76.2	0.6
MD	Deale Oe E	Anne Arundel	5 ft	5	0.5	0.25	76.2	0.5
MD	Edgewood	Harford	5 ft	5	0.5	0.25	76.2	1.9
MD	Gibson Island	Anne Arundel	5 ft	5	0.5	0.25	76.2	0.6
MD	Havre De Grace	Harford	5 ft	5	0.5	0.25	76.2	2.1
MD	Kedges Straits	Somerset	5 ft	5	0.5	0.25	76.2	1.6
MD	Millington	Cecil	5 ft	5	0.5	0.25	76.2	2.3
MD	North Beach	Anne Arundel	5 ft	5	0.5	0.25	76.2	0.6
MD	Odenton	Anne Arundel	5 ft	5	0.5	0.25	76.2	1
MD	Perryman	Harford	5 ft	5	0.5	0.25	76.2	1.9
MD	Point Lookout	St. Mary S	5 ft	5	0.5	0.25	76.2	1.6
MD	Point No Point	St. Mary S	5 ft	5	0.5	0.25	76.2	1.6

Table 1.3.1. Features of distinct base map data sources related to estimation of elevation uncertainty

State	Quadrangle	County	Source	Contour interval (ft)	k (base)[a]	g	RMS cm (base)	SHW (ft)[b]
MD	Relay	Anne Arundel	5 ft	5	0.5	0.25	76.2	0.7
MD	Round Bay	Anne Arundel	5 ft	5	0.5	0.25	76.2	0.6
MD	Saxis	Somerset	5 ft	5	0.5	0.25	76.2	2
MD	South River	Anne Arundel	5 ft	5	0.5	0.25	76.2	0.6
MD	Sparrows Point	Anne Arundel	5 ft	5	0.5	0.25	76.2	0.6
MD	Spesutie	Harford	5 ft	5	0.5	0.25	76.2	2
MD	Sudlersville	Kent	5 ft	5	0.5	0.25	76.2	2.2
MD	White Marsh	Harford	5 ft	5	0.5	0.25	76.2	1.8
MD	Alexandria	Prince George S	10 ft	5	1	0.25	152.4	2.6
MD	Broomes Island	Calvert	10 ft	5	1	0.25	152.4	1.7
MD	Cecilton	Cecil	10 ft	5	1	0.25	152.4	2.3
MD	Colonial Beach North	Charles	10 ft	5	1	0.25	152.4	1.7
MD	Cove Point	Calvert	10 ft	5	1	0.25	152.4	1.5
MD	Curtis Bay	Baltimore City	10 ft	5	1	0.25	152.4	1.5
MD	Elkton	Cecil	10 ft	5	1	0.25	152.4	2.3
MD	Hollywood	St. Mary S	10 ft	5	1	0.25	152.4	1.7
MD	Indian Head	Charles	10 ft	5	1	0.25	152.4	1.9
MD	King George	Charles	10 ft	5	1	0.25	152.4	1.5
MD	Leonardtown	St. Mary S	10 ft	5	1	0.25	152.4	1.8
MD	Mathias Point	Charles	10 ft	5	1	0.25	152.4	1.7
MD	Mechanicsville	Calvert	10 ft	5	1	0.25	152.4	1.8
MD	Mount Vernon	Charles	10 ft	5	1	0.25	152.4	2.2
MD	Nanjemoy	Charles	10 ft	5	1	0.25	152.4	1.6
MD	North East	Cecil	10 ft	5	1	0.25	152.4	2.2
MD	Piney Point	St. Mary S	10 ft	5	1	0.25	152.4	1.8
MD	Port Tobacco	Charles	10 ft	5	1	0.25	152.4	2
MD	Quantico	Charles	10 ft	5	1	0.25	152.4	1.8
MD	Saint Clements Island	St. Mary S	10 ft	5	1	0.25	152.4	1.8
MD	Saint George Island	St. Mary S	10 ft	5	1	0.25	152.4	1.6
MD	Saint Marys City	St. Mary S	10 ft	5	1	0.25	152.4	1.7
MD	Solomons Island	Calvert	10 ft	5	1	0.25	152.4	1.6
MD	Stratford Hall	St. Mary S	10 ft	5	1	0.25	152.4	1.8
MD	Widewater	Charles	10 ft	5	1	0.25	152.4	1.6
MD	Barren Island	Dorchester	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Blackwater River	Dorchester	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Bloodsworth Island	Dorchester	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Cambridge	Dorchester	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Centreville	Kent	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Chicamacomico River	Dorchester	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Church Creek	Dorchester	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Claiborne	Queen Anne S	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Crisfield	Somerset	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Deal Island	Somerset	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Delmar	Wicomico	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Dividing Creek	Somerset	Lidar	1[c]	0.47	0.25	14.3	0[b]
MD	East New Market	Dorchester	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Easton	Talbot	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Eden	Somerset	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Ewell	Somerset	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Federalsburg	Caroline	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Fowling Creek	Caroline	Lidar	1[b]	0.47	0.25	14.3	0[b]
MD	Golden Hill	Dorchester	Lidar	1[b]	0.47	0.25	14.3	0[b]

Table 1.3.1. Features of distinct base map data sources related to estimation of elevation uncertainty

State	Quadrangle	County	Source	Contour interval (ft)	k (base)[a]	g	RMS cm (base)	SHW (ft)[b]
MD	Hebron	Wicomico	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Honga	Dorchester	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Hudson	Dorchester	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Kedges Straits	Somerset	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Kent Island	Queen Anne S	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Kingston	Somerset	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Langford Creek	Kent	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Love Point	Queen Anne S	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Mardela Springs	Dorchester	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Marion	Somerset	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Monie	Somerset	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Nanticoke	Dorchester	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Ninepin Branch	Wicomico	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Oxford	Dorchester	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Pocomoke City	Somerset	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Preston	Caroline	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Princess Anne	Somerset	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Queenstown	Queen Anne S	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Rhodesdale	Dorchester	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Richland Point	Dorchester	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Ridgely	Caroline	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Saint Michaels	Queen Anne S	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Salisbury	Wicomico	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Saxis	Somerset	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Seaford West	Caroline	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Sharptown	Dorchester	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Taylors Island	Dorchester	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Terrapin Sand Point	Somerset	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Tilghman	Dorchester	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Trappe	Caroline	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Wango	Wicomico	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Wetipquin	Dorchester	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Whaleyville	Wicomico	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Wingate	Dorchester	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Wye Mills	Queen Anne S	Lidar	1 [b]	0.47	0.25	14.3	0 [b]
MD	Assawoman Bay	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Berlin	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Boxiron	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Dividing Creek	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Girdletree	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Hallwood	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Kingston	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Ninepin Branch	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Ocean City	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Pocomoke City	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Public Landing	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Selbyville	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Snow Hill	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Tingles Island	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Wango	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Whaleyville	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]
MD	Whittington Point	Worcester	Lidar	1 [b]	0.98	0.25	30	0 [b]

Table 1.3.1. Features of distinct base map data sources related to estimation of elevation uncertainty

State	Quadrangle	County	Source	Contour interval (ft)	k (base)[a]	g	RMS cm (base)	SHW (ft)[b]
MD	Baltimore East	Baltimore	2 ft	1[b]	1	0.5	30.5	0[b]
MD	Curtis Bay	Baltimore	2 ft	1[b]	1	0.5	30.5	0[b]
MD	Edgewood	Baltimore	2 ft	1[b]	1	0.5	30.5	0[b]
MD	Gunpowder Neck	Baltimore	2 ft	1[b]	1	0.5	30.5	0[b]
MD	Middle River	Baltimore	2 ft	1[b]	1	0.5	30.5	0[b]
MD	Relay	Baltimore	2 ft	1[b]	1	0.5	30.5	0[b]
MD	Sparrows Point	Baltimore	2 ft	1[b]	1	0.5	30.5	0[b]
MD	White Marsh	Baltimore	2 ft	1[b]	1	0.5	30.5	0[b]
MD	Barren Island	Dorchester	MTR	3.28084	0.5	0.25	50	1.6
MD	Honga	Dorchester	MTR	3.28084	0.5	0.25	50	1.4
MD	Hudson	Dorchester	MTR	3.28084	0.5	0.25	50	1.5
MD	Taylors Island	Dorchester	MTR	3.28084	0.5	0.25	50	1.5
MD	Burrsville	Caroline	20 ft USGS	20	0.5	0.25	304.8	2.4
MD	Denton	Caroline	20 ft USGS	20	0.5	0.25	304.8	2.3
MD	Federalsburg	Caroline	20 ft USGS	20	0.5	0.25	304.8	2.3
MD	Fowling Creek	Caroline	20 ft USGS	20	0.5	0.25	304.8	2.1
MD	Goldsboro	Caroline	20 ft USGS	20	0.5	0.25	304.8	2.4
MD	Hickman	Caroline	20 ft USGS	20	0.5	0.25	304.8	2.37
MD	Hobbs	Caroline	20 ft USGS	20	0.5	0.25	304.8	2.2
MD	Marydel	Caroline	20 ft USGS	20	0.5	0.25	304.8	2.3
MD	Preston	Caroline	20 ft USGS	20	0.5	0.25	304.8	2.1
MD	Ridgely	Caroline	20 ft USGS	20	0.5	0.25	304.8	2.3
MD	Seaford West	Caroline	20 ft USGS	20	0.5	0.25	304.8	2.3
NC	Fictitious Nocar	Chowan	Lidar	1[b]	0.36	0.089	10.9	0[b]
NC	Fictitious Nocar	Carteret	Lidar	1[b]	0.37	0.092	11.2	0[b]
NC	Fictitious Nocar	Bertie	Lidar	1[b]	0.37	0.093	11.3	0[b]
NC	Fictitious Nocar	Pitt	Lidar	1[b]	0.38	0.096	11.7	0[b]
NC	Fictitious Nocar	Currituck	Lidar	1[b]	0.4	0.099	12.1	0[b]
NC	Fictitious Nocar	Washington	Lidar	1[b]	0.4	0.101	12.3	0[b]
NC	Fictitious Nocar	Brunswick	Lidar	1[b]	0.41	0.102	12.4	0[b]
NC	Fictitious Nocar	Columbus	Lidar	1[b]	0.41	0.103	12.5	0[b]
NC	Fictitious Nocar	Pasquotank	Lidar	1[b]	0.42	0.105	12.8	0[b]
NC	Fictitious Nocar	Perquimans	Lidar	1[b]	0.42	0.106	12.9	0[b]
NC	Fictitious Nocar	Pamlico	Lidar	1[b]	0.45	0.112	13.7	0[b]
NC	Fictitious Nocar	Martin	Lidar	1[b]	0.47	0.118	14.4	0[b]
NC	Fictitious Nocar	Hyde	Lidar	1[b]	0.48	0.119	14.5	0[b]
NC	Fictitious Nocar	Camden	Lidar	1[b]	0.48	0.12	14.6	0[b]
NC	Fictitious Nocar	Duplin	Lidar	1[b]	0.48	0.121	14.7	0[b]
NC	Fictitious Nocar	Craven	Lidar	1[b]	0.49	0.121	14.8	0[b]
NC	Fictitious Nocar	Bladen	Lidar	1[b]	0.49	0.122	14.9	0[b]
NC	Fictitious Nocar	Dare	Lidar	1[b]	0.52	0.131	16	0[b]
NC	Fictitious Nocar	Onslow	Lidar	1[b]	0.54	0.135	16.4	0[b]
NC	Fictitious Nocar	Lenoir	Lidar	1[b]	0.57	0.144	17.5	0[b]
NC	Fictitious Nocar	New Han	Lidar	1[b]	0.59	0.147	17.9	0[b]
NC	Fictitious Nocar	Pender	Lidar	1[b]	0.61	0.152	18.5	0[b]
NC	Fictitious Nocar	Beaufort	Lidar	1[b]	0.66	0.164	20	0[b]
NC	Fictitious Nocar	Halifax	Lidar	1[b]	0.66	0.165	20.12	0[b]
NC	Fictitious Nocar	Northampton	Lidar	1[b]	0.87	0.217	26.5	0[b]
NC	Fictitious Nocar	Gates	Lidar	1[b]	1.06	0.265	32.3	0[b]
NC	Fictitious Nocar	Hertford	Lidar	1[b]	1.11	0.276	33.7	0[b]
NJ	Alloway	Salem	10 ft	10	0.5	0.25	152.4	3.7
NJ	Arthur Kill	Middlesex	10 ft	10	0.5	0.25	152.4	4.09

Table 1.3.1. Features of distinct base map data sources related to estimation of elevation uncertainty

State	Quadrangle	County	Source	Contour interval (ft)	k (base)[a]	g	RMS cm (base)	SHW (ft)[b]
NJ	Atsion	Atlantic	10 ft	10	0.5	0.25	152.4	2.93
NJ	Bridgeport	Gloucester	10 ft	10	0.5	0.25	152.4	3.77
NJ	Bridgeton	Cumberland	10 ft	10	0.5	0.25	152.4	4.48
NJ	Cape May	Cape May	10 ft	10	0.5	0.25	152.4	3.79
NJ	Cedarville	Cumberland	10 ft	10	0.5	0.25	152.4	3.72
NJ	Central Park	Bergen	10 ft	10	0.5	0.25	152.4	3.34
NJ	Dividing Creek	Cumberland	10 ft	10	0.5	0.25	152.4	3.75
NJ	Dorothy	Atlantic	10 ft	10	0.5	0.25	152.4	5
NJ	Egg Harbor City	Atlantic	10 ft	10	0.5	0.25	152.4	3.19
NJ	Elizabeth	Essex	10 ft	10	0.5	0.25	152.4	4.15
NJ	Five Points	Cumberland	10 ft	10	0.5	0.25	152.4	4.23
NJ	Forked River	Ocean	10 ft	10	0.5	0.25	152.4	1.67
NJ	Frankford	Burlington	10 ft	10	0.5	0.25	152.4	4.74
NJ	Green Bank	Atlantic	10 ft	10	0.5	0.25	152.4	3.15
NJ	Hackensack	Bergen	10 ft	10	0.5	0.25	152.4	4.24
NJ	Jenkins	Atlantic	10 ft	10	0.5	0.25	152.4	3.04
NJ	Jersey City	Essex	10 ft	10	0.5	0.25	152.4	4.16
NJ	Marcus Hook	Gloucester	10 ft	10	0.5	0.25	152.4	3.78
NJ	Millville	Cumberland	10 ft	10	0.5	0.25	152.4	4.37
NJ	New Brunswick	Middlesex	10 ft	10	0.5	0.25	152.4	4.54
NJ	New Gretna	Atlantic	10 ft	10	0.5	0.25	152.4	3.24
NJ	Nyack	Bergen	10 ft	10	0.5	0.25	152.4	3.59
NJ	Oswego Lake	Burlington	10 ft	10	0.5	0.25	152.4	3.01
NJ	Park Ridge	Bergen	10 ft	10	0.5	0.25	152.4	4.24
NJ	Port Elizabeth	Cape May	10 ft	10	0.5	0.25	152.4	3.83
NJ	Rio Grande	Cape May	10 ft	10	0.5	0.25	152.4	3.93
NJ	Runnemede	Camden	10 ft	10	0.5	0.25	152.4	3.66
NJ	Salem	Salem	10 ft	10	0.5	0.25	152.4	3.68
NJ	Sea Isle City	Cape May	10 ft	10	0.5	0.25	152.4	3.4
NJ	Shiloh	Cumberland	10 ft	10	0.5	0.25	152.4	4.06
NJ	Ship Bottom	Ocean	10 ft	10	0.5	0.25	152.4	2.03
NJ	South Amboy	Middlesex	10 ft	10	0.5	0.25	152.4	4.25
NJ	Stone Harbor	Cape May	10 ft	10	0.5	0.25	152.4	3.53
NJ	Toms River	Ocean	10 ft	10	0.5	0.25	152.4	1.68
NJ	Tuckahoe	Atlantic	10 ft	10	0.5	0.25	152.4	3.39
NJ	Tuckerton	Ocean	10 ft	10	0.5	0.25	152.4	2.94
NJ	Weehawken	Bergen	10 ft	10	0.5	0.25	152.4	4.2
NJ	West Creek	Ocean	10 ft	10	0.5	0.25	152.4	2.43
NJ	Wildwood	Cape May	10 ft	10	0.5	0.25	152.4	3.65
NJ	Woodbury	Gloucester	10 ft	10	0.5	0.25	152.4	3.83
NJ	Woodstown	Gloucester	10 ft	10	0.5	0.25	152.4	3.33
NJ	Yonkers	Bergen	10 ft	10	0.5	0.25	152.4	3.59
NJ	Asbury Park	Monmouth	5 ft	5	0.5	0.25	76.2	3.56
NJ	Atlantic City	Atlantic	5 ft	5	0.5	0.25	76.2	3.58
NJ	Ben Davis Point	Cumberland	5 ft	5	0.5	0.25	76.2	4.16
NJ	Bombay Hook Island	Cumberland	5 ft	5	0.5	0.25	76.2	4.24
NJ	Brigantine Inlet	Atlantic	5 ft	5	0.5	0.25	76.2	3.32
NJ	Canton	Cumberland	5 ft	5	0.5	0.25	76.2	3.81
NJ	Delaware City	Salem	5 ft	5	0.5	0.25	76.2	3.92
NJ	Heislerville	Cape May	5 ft	5	0.5	0.25	76.2	3.99
NJ	Lakewood	Monmouth	5 ft	5	0.5	0.25	76.2	1.68
NJ	Marmora	Atlantic	5 ft	5	0.5	0.25	76.2	3.39

Table 1.3.1. Features of distinct base map data sources related to estimation of elevation uncertainty

State	Quadrangle	County	Source	Contour interval (ft)	k (base)[a]	g	RMS cm (base)	SHW (ft)[b]
NJ	Mays Landing	Atlantic	5 ft	5	0.5	0.25	76.2	3.69
NJ	Ocean City	Atlantic	5 ft	5	0.5	0.25	76.2	3.5
NJ	Oceanville	Atlantic	5 ft	5	0.5	0.25	76.2	3.46
NJ	Penns Grove	Gloucester	5 ft	5	0.5	0.25	76.2	3.42
NJ	Pleasantville	Atlantic	5 ft	5	0.5	0.25	76.2	3.62
NJ	Point Pleasant	Ocean	5 ft	5	0.5	0.25	76.2	2.01
NJ	Port Norris	Cumberland	5 ft	5	0.5	0.25	76.2	4.32
NJ	Taylors Bridge	Salem	5 ft	5	0.5	0.25	76.2	4.05
NJ	Wilmington South	Salem	5 ft	5	0.5	0.25	76.2	3.82
NJ	Woodbine	Cape May	5 ft	5	0.5	0.25	76.2	3.58
NJ	Asbury Park	Monmouth	MMTH	1 [b]	1	0.5	30.48	0 [b]
NJ	Asbury Park Oe E	Monmouth	MMTH	1 [b]	1	0.5	30.48	0 [b]
NJ	Farmingdale	Monmouth	MMTH	1 [b]	1	0.5	30.48	0 [b]
NJ	Keyport	Monmouth	MMTH	1 [b]	1	0.5	30.48	0 [b]
NJ	Lakewood	Monmouth	MMTH	1 [b]	1	0.5	30.48	0 [b]
NJ	Long Branch East	Monmouth	MMTH	1 [b]	1	0.5	30.48	0 [b]
NJ	Long Branch West	Monmouth	MMTH	1 [b]	1	0.5	30.48	0 [b]
NJ	Point Pleasant	Monmouth	MMTH	1 [b]	1	0.5	30.48	0 [b]
NJ	Sandy Hook East	Monmouth	MMTH	1 [b]	1	0.5	30.48	0 [b]
NJ	Sandy Hook West	Monmouth	MMTH	1 [b]	1	0.5	30.48	0 [b]
NJ	Atlantic City	Atlantic	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Avalon	Cape May	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Barnegat Light	Ocean	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Beach Haven	Ocean	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Brigantine Inlet	Atlantic	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Cape May	Cape May	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Forked River	Ocean	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Lakewood	Ocean	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Long Beach NE	Ocean	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Marmora	Cape May	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	New Gretna	Atlantic	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Ocean City	Atlantic	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Oceanville	Atlantic	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Pleasantville	Atlantic	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Point Pleasant	Ocean	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Rio Grande	Cape May	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Sea Isle City	Cape May	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Sea Isle City Oe E	Cape May	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Seaside Park	Ocean	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Ship Bottom	Ocean	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Stone Harbor	Cape May	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Toms River	Ocean	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Tuckerton	Ocean	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	West Creek	Ocean	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Wildwood	Cape May	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Woodbine	Cape May	SPOT	1 [b]	1	0.5	30.48	0 [b]
NJ	Beverly	Burlington	20 ft	20	0.5	0.25	304.8	4.9
NJ	Bristol	Burlington	20 ft	20	0.5	0.25	304.8	5.3
NJ	Camden	Burlington	20 ft	20	0.5	0.25	304.8	4.05
NJ	Keyport	Middlesex	20 ft	20	0.5	0.25	304.8	3.94
NJ	Orange	Bergen	20 ft	20	0.5	0.25	304.8	4.28
NJ	Perth Amboy	Middlesex	20 ft	20	0.5	0.25	304.8	4.07

Table 1.3.1. Features of distinct base map data sources related to estimation of elevation uncertainty

State	Quadrangle	County	Source	Contour interval (ft)	k (base)[a]	g	RMS cm (base)	SHW (ft)[b]
NJ	Plainfield	Middlesex	20 ft	20	0.5	0.25	304.8	4.27
NJ	Roselle	Union	20 ft	20	0.5	0.25	304.8	4.09
NJ	Trenton West	Burlington	20 ft	20	0.5	0.25	304.8	5.63
NY	Amityville	Nassau	5 ft	5	0.5	0.25	76.2	1.88
NY	Bay Shore East	Suffolk	5 ft	5	0.5	0.25	76.2	1.51
NY	Bay Shore East Oe S	Suffolk	5 ft	5	0.5	0.25	76.2	3.28
NY	Bay Shore West	Suffolk	5 ft	5	0.5	0.25	76.2	1.44
NY	Bay Shore West Oe S	Suffolk	5 ft	5	0.5	0.25	76.2	3.06
NY	Bellport	Suffolk	5 ft	5	0.5	0.25	76.2	1.39
NY	Brooklyn	Kings	5 ft	5	0.5	0.25	76.2	3.69
NY	Coney Island	Kings	5 ft	5	0.5	0.25	76.2	3.88
NY	East Hampton	Suffolk	5 ft	5	0.5	0.25	76.2	2.24
NY	Eastport	Suffolk	5 ft	5	0.5	0.25	76.2	1.69
NY	Far Rockaway	Kings	5 ft	5	0.5	0.25	76.2	3.98
NY	Freeport	Nassau	5 ft	5	0.5	0.25	76.2	2.52
NY	Gardiners Island East	Suffolk	5 ft	5	0.5	0.25	76.2	2.12
NY	Greenport	Suffolk	5 ft	5	0.5	0.25	76.2	2.46
NY	Howells Point	Suffolk	5 ft	5	0.5	0.25	76.2	2.19
NY	Jamaica	Kings	5 ft	5	0.5	0.25	76.2	4.08
NY	Lynbrook	Nassau	5 ft	5	0.5	0.25	76.2	3.5
NY	Mattituck	Suffolk	5 ft	5	0.5	0.25	76.2	2.66
NY	Mattituck Hills	Suffolk	5 ft	5	0.5	0.25	76.2	3.53
NY	Montauk Point	Suffolk	5 ft	5	0.5	0.25	76.2	2.05
NY	Montauk Point Oe E	Suffolk	5 ft	5	0.5	0.25	76.2	2.25
NY	Moriches	Suffolk	5 ft	5	0.5	0.25	76.2	1.62
NY	Napeague Beach	Suffolk	5 ft	5	0.5	0.25	76.2	2.12
NY	Orient	Suffolk	5 ft	5	0.5	0.25	76.2	2.55
NY	Patchogue	Suffolk	5 ft	5	0.5	0.25	76.2	1.96
NY	Pattersquash Island	Suffolk	5 ft	5	0.5	0.25	76.2	2.48
NY	Quogue	Suffolk	5 ft	5	0.5	0.25	76.2	2.18
NY	Sag Harbor	Suffolk	5 ft	5	0.5	0.25	76.2	2.29
NY	Sayville	Suffolk	5 ft	5	0.5	0.25	76.2	1.83
NY	Southampton	Suffolk	5 ft	5	0.5	0.25	76.2	2.35
NY	Southold	Suffolk	5 ft	5	0.5	0.25	76.2	2.77
NY	Arthur Kill	Richmond	10 ft	10	0.5	0.25	152.4	3.93
NY	Brooklyn	New York	10 ft	10	0.5	0.25	152.4	3.42
NY	Central Islip	Suffolk	10 ft	10	0.5	0.25	152.4	3.07
NY	Central Park	Bronx	10 ft	10	0.5	0.25	152.4	4.21
NY	Elizabeth	Richmond	10 ft	10	0.5	0.25	152.4	3.97
NY	Flushing	Bronx	10 ft	10	0.5	0.25	152.4	5.09
NY	Gardiners Island West	Suffolk	10 ft	10	0.5	0.25	152.4	2.34
NY	Glenville	Westchester	10 ft	10	0.5	0.25	152.4	4.34
NY	Haverstraw	Rockland	10 ft	10	0.5	0.25	152.4	2.82
NY	Jersey City	Ellis	10 ft	10	0.5	0.25	152.4	3.61
NY	Jones Inlet	Nassau	10 ft	10	0.5	0.25	152.4	2.72
NY	Keyport	Richmond	10 ft	10	0.5	0.25	152.4	3.83
NY	Lawrence	Nassau	10 ft	10	0.5	0.25	152.4	3.37
NY	Mamaroneck	Nassau	10 ft	10	0.5	0.25	152.4	5.2
NY	Middle Island	Suffolk	10 ft	10	0.5	0.25	152.4	4.12
NY	Mount Vernon	Bronx	10 ft	10	0.5	0.25	152.4	4.64
NY	Mystic	Suffolk	10 ft	10	0.5	0.25	152.4	2.23
NY	New London	Suffolk	10 ft	10	0.5	0.25	152.4	2.15

Table 1.3.1. Features of distinct base map data sources related to estimation of elevation uncertainty

State	Quadrangle	County	Source	Contour interval (ft)	k (base)[a]	g	RMS cm (base)	SHW (ft)[b]
NY	Nyack	Rockland	10 ft	10	0.5	0.25	152.4	3.02
NY	Ossining	Westchester	10 ft	10	0.5	0.25	152.4	2.87
NY	Perth Amboy	Richmond	10 ft	10	0.5	0.25	152.4	4.04
NY	Plum Island	Suffolk	10 ft	10	0.5	0.25	152.4	2.27
NY	Plum Island Oe E	Suffolk	10 ft	10	0.5	0.25	152.4	2.09
NY	Port Jefferson	Suffolk	10 ft	10	0.5	0.25	152.4	4.6
NY	Riverhead	Suffolk	10 ft	10	0.5	0.25	152.4	3.06
NY	Saint James	Suffolk	10 ft	10	0.5	0.25	152.4	4.65
NY	Sea Cliff	Nassau	10 ft	10	0.5	0.25	152.4	5.15
NY	Shinnecock Inlet	Suffolk	10 ft	10	0.5	0.25	152.4	2.42
NY	South Amboy	Richmond	10 ft	10	0.5	0.25	152.4	4
NY	The Narrows	Kings	10 ft	10	0.5	0.25	152.4	3.72
NY	Wading River	Suffolk	10 ft	10	0.5	0.25	152.4	3.47
NY	Weehawken	New York	10 ft	10	0.5	0.25	152.4	3.45
NY	West Gilgo Beach	Nassau	10 ft	10	0.5	0.25	152.4	2.15
NY	White Plains	Westchester	10 ft	10	0.5	0.25	152.4	3.04
NY	Yonkers	Bronx	10 ft	10	0.5	0.25	152.4	3.33
PA	Beverly	Bucks	20 ft	20	0.5	0.25	304.8	5.25
PA	Bristol	Bucks	20 ft	20	0.5	0.25	304.8	5.42
PA	Langhorne	Bucks	20 ft	20	0.5	0.25	304.8	5.4
PA	Trenton West	Bucks	20 ft	20	0.5	0.25	304.8	5.59
PA	Beverly	Philadelphia	2 ft	2[c]	0.5	0.25	30.48	0[c]
PA	Camden	Philadelphia	2 ft	2[c]	0.5	0.25	30.48	0[c]
PA	Frankford	Philadelphia	2 ft	2[c]	0.5	0.25	30.48	0[c]
PA	Langhorne	Philadelphia	2 ft	2[c]	0.5	0.25	30.48	0[c]
PA	Lansdowne	Philadelphia	2 ft	2[c]	0.5	0.25	30.48	0[c]
PA	Philadelphia	Philadelphia	2 ft	2[c]	0.5	0.25	30.48	0[c]
PA	Woodbury	Philadelphia	2 ft	2[c]	0.5	0.25	30.48	0[c]
PA	Bridgeport	Delaware	10 ft	10	0.5	0.25	152.4	4.02
PA	Lansdowne	Delaware	10 ft	10	0.5	0.25	152.4	4.12
PA	Marcus Hook	Delaware	10 ft	10	0.5	0.25	152.4	3.99
PA	Philadelphia	Delaware	10 ft	10	0.5	0.25	152.4	4.2
PA	Trenton East	Bucks	10 ft	10	0.5	0.25	152.4	5.65
PA	Woodbury	Delaware	10 ft	10	0.5	0.25	152.4	4.08
PA	Ficticious	Philadelphia	2 ft	2[c]	0.5	0.25	30.48	0[c]
VA	Accomac	Accomack	5 ft	5	0.5	0.25	76.2	2.2
VA	Achilles	Gloucester	5 ft	5	0.5	0.25	76.2	2.2
VA	Bethel Beach	Mathews	5 ft	5	0.5	0.25	76.2	1.51
VA	Bloxom	Accomack	5 ft	5	0.5	0.25	76.2	2.37
VA	Bowers Hill	Chesapeake	5 ft	5	0.5	0.25	76.2	2.47
VA	Boxiron	Accomack	5 ft	5	0.5	0.25	76.2	1.22
VA	Cape Charles	Northampton	5 ft	5	0.5	0.25	76.2	1.79
VA	Cape Henry	Virginia Beach	5 ft	5	0.5	0.25	76.2	1.78
VA	Cheriton	Northampton	5 ft	5	0.5	0.25	76.2	2.29
VA	Chesapeake Channel	Virginia Beach	5 ft	5	0.5	0.25	76.2	2.08
VA	Chesconessex	Accomack	5 ft	5	0.5	0.25	76.2	1.75
VA	Chincoteague East	Accomack	5 ft	5	0.5	0.25	76.2	2.09
VA	Chincoteague East Oe S	Accomack	5 ft	5	0.5	0.25	76.2	2.81
VA	Chincoteague West	Accomack	5 ft	5	0.5	0.25	76.2	1.71
VA	Cobb Island	Northampton	5 ft	5	0.5	0.25	76.2	2.84
VA	Courtland	Southampton	5 ft	5	0.5	0.25	76.2	1.7

Table 1.3.1. Features of distinct base map data sources related to estimation of elevation uncertainty

State	Quadrangle	County	Source	Contour interval (ft)	k (base)[a]	g	RMS cm (base)	SHW (ft)[b]
VA	Creeds	Chesapeake	5 ft	5	0.5	0.25	76.2	0.88
VA	Crisfield	Accomack	5 ft	5	0.5	0.25	76.2	1.82
VA	Deep Creek	Chesapeake	5 ft	5	0.5	0.25	76.2	2.16
VA	Deltaville	Lancaster	5 ft	5	0.5	0.25	76.2	1.38
VA	Elliotts Creek	Northampton	5 ft	5	0.5	0.25	76.2	1.93
VA	Ewell	Accomack	5 ft	5	0.5	0.25	76.2	1.56
VA	Exmore	Accomack	5 ft	5	0.5	0.25	76.2	2.02
VA	Fentress	Chesapeake	5 ft	5	0.5	0.25	76.2	1.15
VA	Fishermans Island	Northampton	5 ft	5	0.5	0.25	76.2	2.37
VA	Franklin	Franklin City	5 ft	5	0.5	0.25	76.2	1.7
VA	Franktown	Northampton	5 ft	5	0.5	0.25	76.2	1.73
VA	Gates	Suffolk City	5 ft	5	0.5	0.25	76.2	1.7
VA	Girdletree	Accomack	5 ft	5	0.5	0.25	76.2	1.31
VA	Great Machipongo Inlet	Northampton	5 ft	5	0.5	0.25	76.2	2.85
VA	Hallwood	Accomack	5 ft	5	0.5	0.25	76.2	2.12
VA	Hampton	Hampton City	5 ft	5	0.5	0.25	76.2	2.17
VA	Holland	Isle of Wight	5 ft	5	0.5	0.25	76.2	15
VA	Jamesville	Accomack	5 ft	5	0.5	0.25	76.2	1.55
VA	Kempsville	Chesapeake	5 ft	5	0.5	0.25	76.2	2.21
VA	Knotts Island	Virginia Beach	5 ft	5	0.5	0.25	76.2	0.94
VA	Knotts Island Oe E	Virginia Beach	5 ft	5	0.5	0.25	76.2	2.58
VA	Lake Drummond SE	Chesapeake	5 ft	5	0.5	0.25	76.2	1.04
VA	Little Creek	Norfolk City	5 ft	5	0.5	0.25	76.2	2.13
VA	Mathews	Mathews	5 ft	5	0.5	0.25	76.2	1.83
VA	Metompkin Inlet	Accomack	5 ft	5	0.5	0.25	76.2	2.72
VA	Moyock	Chesapeake	5 ft	5	0.5	0.25	76.2	0.9
VA	Mulberry Island	Isle of Wight	5 ft	5	0.5	0.25	76.2	2.37
VA	Nandua Creek	Accomack	5 ft	5	0.5	0.25	76.2	1.57
VA	Nassawadox	Accomack	5 ft	5	0.5	0.25	76.2	3.1
VA	New Point Comfort	Mathews	5 ft	5	0.5	0.25	76.2	2.08
VA	Newport News North	Hampton City	5 ft	5	0.5	0.25	76.2	2.29
VA	Newport News South	Hampton City	5 ft	5	0.5	0.25	76.2	2.27
VA	Norfolk North	Hampton City	5 ft	5	0.5	0.25	76.2	2.22
VA	Norfolk South	Chesapeake	5 ft	5	0.5	0.25	76.2	2.39
VA	North Bay	Virginia Beach	5 ft	5	0.5	0.25	76.2	1.54
VA	North Virginia Beach	Virginia Beach	5 ft	5	0.5	0.25	76.2	2.24
VA	Parksley	Accomack	5 ft	5	0.5	0.25	76.2	2.01
VA	Pleasant Ridge	Chesapeake	5 ft	5	0.5	0.25	76.2	0.88
VA	Pocomoke City	Accomack	5 ft	5	0.5	0.25	76.2	5
VA	Poquoson East	Poquoson City	5 ft	5	0.5	0.25	76.2	2.13
VA	Poquoson West	Gloucester	5 ft	5	0.5	0.25	76.2	2.14
VA	Princess Anne	Virginia Beach	5 ft	5	0.5	0.25	76.2	1.31
VA	Pungoteague	Accomack	5 ft	5	0.5	0.25	76.2	1.63
VA	Quinby Inlet	Accomack	5 ft	5	0.5	0.25	76.2	2.91
VA	Riverdale	Southampton	5 ft	5	0.5	0.25	76.2	1.7
VA	Saxis	Accomack	5 ft	5	0.5	0.25	76.2	2.05
VA	Ship Shoal Inlet	Northampton	5 ft	5	0.5	0.25	76.2	2.74
VA	Tangier Island	Accomack	5 ft	5	0.5	0.25	76.2	1.62
VA	Townsend	Northampton	5 ft	5	0.5	0.25	76.2	2.42
VA	Virginia Beach	Virginia Beach	5 ft	5	0.5	0.25	76.2	2.07
VA	Wachapreague	Accomack	5 ft	5	0.5	0.25	76.2	2.79
VA	Wachapreague Oe E	Accomack	5 ft	5	0.5	0.25	76.2	2.83

Table 1.3.1. Features of distinct base map data sources related to estimation of elevation uncertainty

State	Quadrangle	County	Source	Contour interval (ft)	k (base)[a]	g	RMS cm (base)	SHW (ft)[b]
VA	Wallops Island	Accomack	5 ft	5	0.5	0.25	76.2	2.78
VA	Ware Neck	Gloucester	5 ft	5	0.5	0.25	76.2	2.18
VA	Whittington Point	Accomack	5 ft	5	0.5	0.25	76.2	2.79
VA	Yorktown	Gloucester	5 ft	5	0.5	0.25	76.2	2.2
VA	Alexandria	Alexandria	10 ft	10	0.5	0.25	152.4	2.63
VA	Aylett	King and Queen	10 ft	10	0.5	0.25	152.4	3.32
VA	Bacons Castle	Isle of Wight	10 ft	10	0.5	0.25	152.4	2.25
VA	Benns Church	Isle of Wight	10 ft	10	0.5	0.25	152.4	2.47
VA	Boykins	Southampton	10 ft	10	0.5	0.25	152.4	1.7
VA	Brandon	Charles City	10 ft	10	0.5	0.25	152.4	2.12
VA	Buckhorn	Suffolk City	10 ft	10	0.5	0.25	152.4	20
VA	Burgess	Northumberland	10 ft	10	0.5	0.25	152.4	1.39
VA	Capron	Southampton	10 ft	10	0.5	0.25	152.4	1.7
VA	Champlain	Essex	10 ft	10	0.5	0.25	152.4	1.84
VA	Charles City	Charles City	10 ft	10	0.5	0.25	152.4	2.38
VA	Chuckatuck	Isle of Wight	10 ft	10	0.5	0.25	152.4	10
VA	Church View	King and Queen	10 ft	10	0.5	0.25	152.4	20
VA	Claremont	Charles City	10 ft	10	0.5	0.25	152.4	1.98
VA	Clay Bank	Gloucester	10 ft	10	0.5	0.25	152.4	2.34
VA	Colonial Beach North	Westmoreland	10 ft	10	0.5	0.25	152.4	1.89
VA	Colonial Beach South	Westmoreland	10 ft	10	0.5	0.25	152.4	1.87
VA	Corapeake	Suffolk City	10 ft	10	0.5	0.25	152.4	20
VA	Dahlgren	King George	10 ft	10	0.5	0.25	152.4	1.78
VA	Disputanta North	Prince George	10 ft	10	0.5	0.25	152.4	2.48
VA	Drewrys Bluff	Chesterfield	10 ft	10	0.5	0.25	152.4	10
VA	Dunnsville	Essex	10 ft	10	0.5	0.25	152.4	1.84
VA	Dutch Gap	Charles City	10 ft	10	0.5	0.25	152.4	2.87
VA	East of Reedville	Northumberland	10 ft	10	0.5	0.25	152.4	1.33
VA	Fleets Bay	Lancaster	10 ft	10	0.5	0.25	152.4	1.4
VA	Fort Belvoir	Fairfax	10 ft	10	0.5	0.25	152.4	2.25
VA	Fredericksburg	Fredericksburg	10 ft	10	0.5	0.25	152.4	2.84
VA	Gloucester	Gloucester	10 ft	10	0.5	0.25	152.4	2.38
VA	Gressitt	Gloucester	10 ft	10	0.5	0.25	152.4	2.46
VA	Guinea	Spotsylvania	10 ft	10	0.5	0.25	152.4	2.73
VA	Haynesville	Richmond	10 ft	10	0.5	0.25	152.4	1.82
VA	Heathsville	Northumberland	10 ft	10	0.5	0.25	152.4	1.45
VA	Hog Island	Isle of Wight	10 ft	10	0.5	0.25	152.4	2.19
VA	Hopewell	Charles City	10 ft	10	0.5	0.25	152.4	2.72
VA	Indian Head	Fairfax	10 ft	10	0.5	0.25	152.4	1.91
VA	Irvington	Lancaster	10 ft	10	0.5	0.25	152.4	1.5
VA	King and Queen Court House	King and Queen	10 ft	10	0.5	0.25	152.4	2.98
VA	King George	King George	10 ft	10	0.5	0.25	152.4	1.74
VA	King William	Hanover	10 ft	10	0.5	0.25	152.4	10
VA	Kinsale	Northumberland	10 ft	10	0.5	0.25	152.4	1.5
VA	Lake Drummond	Chesapeake	10 ft	10	0.5	0.25	152.4	10
VA	Lake Drummond NW	Chesapeake	10 ft	10	0.5	0.25	152.4	10
VA	Lancaster	Lancaster	10 ft	10	0.5	0.25	152.4	1.59
VA	Lively	Lancaster	10 ft	10	0.5	0.25	152.4	1.65
VA	Loretto	Caroline	10 ft	10	0.5	0.25	152.4	1.97
VA	Lottsburg	Northumberland	10 ft	10	0.5	0.25	152.4	1.49
VA	Machodoc	Westmoreland	10 ft	10	0.5	0.25	152.4	1.61

Table 1.3.1. Features of distinct base map data sources related to estimation of elevation uncertainty

State	Quadrangle	County	Source	Contour interval (ft)	k (base)[a]	g	RMS cm (base)	SHW (ft)[b]
VA	Mathias Point	King George	10 ft	10	0.5	0.25	152.4	1.7
VA	Millers Tavern	Essex	10 ft	10	0.5	0.25	152.4	1.9
VA	Montross	Richmond	10 ft	10	0.5	0.25	152.4	1.79
VA	Morattico	Essex	10 ft	10	0.5	0.25	152.4	1.77
VA	Mount Landing	Essex	10 ft	10	0.5	0.25	152.4	1.83
VA	Mount Vernon	Fairfax	10 ft	10	0.5	0.25	152.4	2.42
VA	New Kent	King William	10 ft	10	0.5	0.25	152.4	2.55
VA	Norge	James City	10 ft	10	0.5	0.25	152.4	2.04
VA	Occoquan	Fairfax	10 ft	10	0.5	0.25	152.4	2.34
VA	Passapatanzy	Caroline	10 ft	10	0.5	0.25	152.4	2.6
VA	Piney Point	Westmoreland	10 ft	10	0.5	0.25	152.4	1.76
VA	Port Royal	Caroline	10 ft	10	0.5	0.25	152.4	2.23
VA	Prince George	Petersburg	10 ft	10	0.5	0.25	152.4	10
VA	Providence Forge	Charles City	10 ft	10	0.5	0.25	152.4	2.56
VA	Quantico	Prince William	10 ft	10	0.5	0.25	152.4	1.87
VA	Rappahannock Academy	Caroline	10 ft	10	0.5	0.25	152.4	2.56
VA	Raynor	Isle of Wight	10 ft	10	0.5	0.25	152.4	10
VA	Reedville	Northumberland	10 ft	10	0.5	0.25	152.4	1.33
VA	Rollins Fork	Caroline	10 ft	10	0.5	0.25	152.4	2.1
VA	Roxbury	Charles City	10 ft	10	0.5	0.25	152.4	2.68
VA	Runnymede	Surry	10 ft	10	0.5	0.25	152.4	20
VA	Saint Clements Island	Westmoreland	10 ft	10	0.5	0.25	152.4	1.81
VA	Saint George Island	Northumberland	10 ft	10	0.5	0.25	152.4	1.52
VA	Saluda	Gloucester	10 ft	10	0.5	0.25	152.4	1.7
VA	Savedge	Prince George	10 ft	10	0.5	0.25	152.4	2.23
VA	Sebrell	Southampton	10 ft	10	0.5	0.25	152.4	1.7
VA	Sedley	Isle of Wight	10 ft	10	0.5	0.25	152.4	1.7
VA	Shacklefords	Gloucester	10 ft	10	0.5	0.25	152.4	2.14
VA	Smith Point	Northumberland	10 ft	10	0.5	0.25	152.4	1.34
VA	Smithfield	Isle of Wight	10 ft	10	0.5	0.25	152.4	2.52
VA	Stafford	Stafford	10 ft	10	0.5	0.25	152.4	1.93
VA	Stratford Hall	Westmoreland	10 ft	10	0.5	0.25	152.4	1.84
VA	Suffolk	Suffolk City	10 ft	10	0.5	0.25	152.4	2.99
VA	Sunbeam	Southampton	10 ft	10	0.5	0.25	152.4	1.7
VA	Supply	Caroline	10 ft	10	0.5	0.25	152.4	10
VA	Surry	James City	10 ft	10	0.5	0.25	152.4	1.9
VA	Tappahannock	Essex	10 ft	10	0.5	0.25	152.4	1.82
VA	Toano	James City	10 ft	10	0.5	0.25	152.4	2.42
VA	Truhart	King and Queen	10 ft	10	0.5	0.25	152.4	2.31
VA	Tunstall	King William	10 ft	10	0.5	0.25	152.4	2.76
VA	Urbanna	Lancaster	10 ft	10	0.5	0.25	152.4	1.55
VA	Vicksville	Southampton	10 ft	10	0.5	0.25	152.4	10
VA	Walkers	Charles City	10 ft	10	0.5	0.25	152.4	2.43
VA	Washington West	Arlington	10 ft	10	0.5	0.25	152.4	2.64
VA	West Point	King and Queen	10 ft	10	0.5	0.25	152.4	2.57
VA	Westover	Charles City	10 ft	10	0.5	0.25	152.4	2.59
VA	Whaleyville	Suffolk City	10 ft	10	0.5	0.25	152.4	20
VA	Widewater	Stafford	10 ft	10	0.5	0.25	152.4	1.79
VA	Williamsburg	Gloucester	10 ft	10	0.5	0.25	152.4	2.46
VA	Wilton	Gloucester	10 ft	10	0.5	0.25	152.4	1.48
VA	Windsor	Isle of Wight	10 ft	10	0.5	0.25	152.4	20

Table 1.3.1. Features of distinct base map data sources related to estimation of elevation uncertainty

State	Quadrangle	County	Source	Contour interval (ft)	k (base)[a]	g	RMS cm (base)	SHW (ft)[b]
VA	Zuni	Isle of Wight	10 ft	10	0.5	0.25	152.4	1.76

a. The values of k listed here are the "base" value of k that relates contour interval to RMS as RMS = k(base) H contour interval. The procedures for conducting uncertainty analyses allow for universal rescaling of k. These values were scaled by a factor of 0.5 in the analysis; i.e., we assume that error = 0.25 times the contour interval in most quads.

b. For these locations, the values of 1 for contour interval and 0 for SHW were provided to trick the algorithm into calculating "contour error" as RMSE/2. This was necessary because of the format in which Jones and Wang had saved the central estimate results for those areas with high precision data. The value of g doe not matter because g had no effect above the contour interval, which is less than the 50 cm increment with which our results are reported.

c. For these locations, the values of 2 for contour interval and 0 for SHW were provided to trick the algorithm into calculating "contour error" as RMSE/2. This was necessary because of the format in which Jones and Wang had saved the central estimate results for those areas with high precision data.

Section 1.3.3. Results

Author: ***James G. Titus***

The results from this section are displayed in Appendices A, B, and C (along with regional summaries). *What we call "low" and "high"(elevation) as we explain our approach in this section are reversed in the tables, because the high elevation means less vulnerability and a lower area close to sea level, and vice versa.*

We encourage the reader to examine these tables and think about both the ratio of the high to the low estimate and the vertical error implied by a given line in the table. If the high estimate at 50 cm is greater than the low estimate for 100 cm, then the vertical error is greater than 25 cm. If the high estimate at 50 cm is greater than the low estimate for 150 cm, then the vertical error is greater than 50 cm.

If the ratio of high to low at 50 cm is great, that may mean that the uncertainty is great; but it may also mean that there is an inflection point nearby. For example, if the data (e.g., LIDAR) show several times as much land between 50 and 65 cm as between 0 and 50 cm, then even if the error is only 15 cm, the ratio of high to low could be very large.[19] This happens in some areas with LIDAR. As a result, if one considers only the ratio of high to low, one might be surprised that the areas with LIDAR do not always seem much more precise than the areas that relied on USGS 5-ft contours. (A second reason that the LIDAR does not always appear more precise than areas with 5-ft contours is that the first contour interval is only 2–3 feet in areas where spring high water is 2–3 feet above NGVD29. Although the subsequent contour intervals are greater, the ratios of high to low get closer to 1 as elevations increase.) Nevertheless, variations in precision are palpable when one looks at areas with a 10- or 20-ft contour interval. See the Pennsylvania tables in Appendix A, where Bucks County has mostly 20-ft contours but Philadelphia has 2-ft contours.

Overall, we estimate between 8,792 and 10,882 square kilometers of land within 50 cm above the tides, and 11,032 to 12,985 square kilometers within 1 meter above the tides in the middle Atlantic (see Appendix C). Our input data and assumptions are based on RMS error; but at the state and regionwide level, much of the errors should cancel. The true amount of land close to sea level is very likely to fall within the ranges we have estimated.

One final warning: The available output provided by Jones and Wang (explained in Section 1.2), which this effort used as input, extended only to an elevation of 20 feet above SHW. Therefore, we cannot literally apply our formula for the high-elevation (low-area) case for elevations above 20 feet minus "error." In cases with a 20-ft contour interval, error is 5 feet; so we cannot apply the low-area formula above 15 feet. The algorithm explained in Section 1.3.2 treats no data as zero, assuming in effect that there is no land above 20-ft SHW. We considered suppressing all calculations above 4.5 meters in such cases, but opted instead to provide the results with an asterisk. That approach seems more reasonable: In these cases, assuming that there is no land above 20-ft SHW is clearly an extreme lower bound. But we doubt that it seriously distorts the statewide results. Typically, a state has only a few quads with a 20-ft contour interval—generally in areas that have very little low land. So even if we had been able to correctly apply our formula (i.e., if Jones and Wang in Section 1.2 had interpolated above 20-ft SHW) the calculated area would not be much

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[19] For example, if the LIDAR shows 10 ha between 0 and 50, and 100 ha between 50 and 65, if error is 15 cm, the high estimate would be 110 ha, and the low estimate would be less than 10. The ratio of high to low would this be more than 11.

greater than zero when considered at the statewide level. Thus, instead of suppressing our "low area" estimate, we provide an estimate that is slightly lower than a rigorous application of our approach.

References

Bureau of the Budget. 1947. National Map Accuracy Standards. Government Printing Office, Washington D.C. Available from: http://rockyweb.cr.usgs.gov/nmpstds/nmas.html. Accessed October 1, 2006.

Environmental Protection Agency. 1989. *The Potential Effects of Global Climate Change on the United States*. *Report to Congress*. EPA-230-05-89-050. U.S. EPA, Washington, D.C.

Jones, R. 2007. Accuracy Assessment of EPA Digital Elevation Model Results. Memorandum and attached spreadsheets prepared for the U.S. EPA under Work Assignment 409 of EPA Contract #68-W-02-027. Distributed with the elevation data.

Jones, R., J. Titus, and J. Wang. 2008. *Metadata for Elevations of Lands Close to Sea Level in the Middle Atlantic Region of the United States.* Metadata accompanying Digital Elevation Model data set. Distributed with the elevation data.

Park, R.A., M.S. Treehan, P.W. Mausel, and R.C. Howe. 1989. The effects of sea level rise on U.S. coastal wetlands. In *The Potential Effects of Global Climate Change on the United States.* EPA-230-05-89-050. U.S. EPA, Washington, DC.

Titus, J.G., AND M.S. Greene. 1989. An overview of the nationwide impacts of sea level rise. In *The Potential Effects of Global Climate Change on the United States*. *Report to Congress. Appendix B: Sea Level Rise*. EPA-230-05-89-052.U.S. EPA, Washington, DC.

References (continued)

Titus, J.G. and J. Wang. 2008. Maps of Lands Close to Sea Level along the Middle Atlantic Coast of the United States: An Elevation Data Set to Use While Waiting for LIDAR, Chapter 1 in J.G. Titus and E.M. Strange (eds.), *Background Documents Supporting Climate Change Science Program Synthesis and Assessment Product 4.1: Coastal Elevations and Sensitivity to Sea Level Ris*e, EPA 430R07004, Washington, DC: U.S. EPA.

Titus, J.G. and D. Hudgens (in press). *The Likelihood of Shore Protection along the Atlantic Coast of the United States. Volume 1: Mid-Atlantic.* U.S. Environmental Protection Agency. Washington, D.C.

Jones, R., J.G. Titus, and J. Wang. 2008. *Metadata for Elevations of Lands Close to Sea Level in the Middle Atlantic Region of the United States.* Metadata accompanying Digital Elevation Model data set. Distributed with the elevation data. U.S. Environmental Protection Agency.

Jones, R. and J. Wang. 2008 Interpolating Elevations: Proposed Method for Conducting Overlay Analysis of GIS Data on Coastal Elevations, Shore Protection, and Wetland Accretion. In J.G. Titus and E.M. Strange (eds.). *Background Documents Supporting Climate Change Science Program Synthesis and Assessment Product 4.1: Coastal Elevations and Sensitivity to Sea Level Ris*e, EPA 430R07004, Washington, DC: U.S. EPA.

Appendix A

Low and High Estimates of the Area of Land Close to Sea Level, by State[a] (square kilometers)

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[a] Low and high are an uncertainty range based on the contour interval and/or stated root mean square error (RMSE) of the input elevation data. Calculations assume that half of the RMSE is random error and half is systematic error. For a discussion of these calculations, see Section 1.3 of this report.

Table A.1 Low and High Estimates of the Area of Land Close to Sea Level in New York

		Meters above Spring High Water																			
		low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
County		**0.5**		**1.0**		**1.5**		**2.0**		**2.5**		**3.0**		**3.5**		**4.0**		**4.5**		**5.0**	
		----------------Cumulative (total) amount of Dry Land below a given elevation---------------																			
Bronx		0.4	3.2	2.2	6.3	4.1	9.4	5.9	13	8.1	16	11	19	14	22	17	25	19	26	22	27
Brooklyn		3.1	10	8.5	17	14	24	20	34	28	43	37	52	46	57	53	63	59	68	64	69
Manhattan		0.03	2.2	1.4	4.3	2.8	6.4	4.2	8.3	5.5	10	7.2	12	8.9	14	11	16	12	17	14	17
Nassau		2.2	19	13	44	31	70	51	85	71	95	85	104	94	113	103	121	111	128*	119	132*
Queens		6.2	17	15	28	23	39	32	49	41	58	51	67	60	72	66	77	71	80	77	81
Staten Island		0.3	7.8	5.1	15	10	22	15	25	20	28	23	31	26	34	29	37	31	38	34	39
Suffolk[2]		14	51	43	97	78	140	115	181	152	217	189	251	222	286	256	316	289	345*	319	371*
Westchester		0.2	2.9	1.7	5.7	3.4	8.4	5.2	11	7.1	13	9.2	15	11	17	13	19	15	20*	16	21*
Ellis & Liberty Islands		<0.01	0.05	0.03	0.1	0.06	0.14	0.09	0.14	0.13	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Statewide		**26**	**114**	**90**	**218**	**166**	**320**	**248**	**405**	**333**	**479**	**412**	**551**	**482**	**615**	**548**	**672**	**608**	**722***	**665**	**757***
Wetlands	Tidal	---------Cumulative (total) amount of Nontidal Wetlands below a given elevation---------																			
Bronx	1.2	0.00	0.01	0.01	0.02	0.01	0.03	0.02	0.06	0.03	0.09	0.04	0.11	0.07	0.14	0.1	0.2	0.1	0.2	0.1	0.2
Brooklyn	10	0.03	0.08	0.07	0.11	0.09	0.14	0.12	0.15	0.14	0.16	0.15	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Nassau	44	0.1	0.4	0.3	0.7	0.5	1.2	0.8	1.5	1.1	1.8	1.4	2.1	1.7	2.3	2.0	2.6	2.2	2.9*	2.6	3.2*
Putnam	1.3	0	<0.01	0.00	<0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.02*	0.01	0.02*
Queens	12	0.0	0.2	0.1	0.3	0.2	0.4	0.4	0.5	0.4	0.6	0.5	0.6	0.6	0.7	0.6	0.7	0.6	0.7	0.67	0.69
Rockland	2.3	0.0	0.02	0.01	0.04	0.02	0.06	0.03	0.07	0.05	0.08	0.06	0.09	0.07	0.09	0.07	0.10	0.08	0.11*	0.1	0.2*
Staten Island	4.0	0.01	0.5	0.3	0.9	0.6	1.3	0.9	1.4	1.2	1.5	1.3	1.6	1.4	1.7	1.5	1.8	1.6	1.9	1.7	1.9
Suffolk	72	1.5	5.7	4.9	9.8	8.5	13	11	15	13	17	15	18	17	20	18	21	19	23*	21	24*
Westchester	1.7	<0.01	0.04	0.03	0.08	0.05	0.12	0.08	0.13	0.10	0.14	0.1	0.2	0.1	0.2	0.1	0.2	0.15	0.21*	0.16	0.23*
Statewide	**149**	**1.7**	**6.9**	**5.7**	**12**	**10**	**16**	**13**	**19**	**16**	**21**	**19**	**23**	**21**	**25**	**23**	**27**	**25**	**29***	**26**	**30***
		Cumulative (total) amount of land below a given elevation[3]																			
Dry Land		26	114	90	218	166	320	248	405	333	479	412	551	482	615	548	672	608	722*	665	757*
Nontidal Wetlands		2	7	6	12	10	16	13	19	16	21	19	23	21	25	23	27	25	29*	26	30*
All Land	**149**	**176**	**269**	**244**	**379**	**325**	**485**	**410**	**573**	**498**	**649**	**579**	**722**	**652**	**788**	**719**	**848**	**781**	**899***	**840**	**936***

*This value is probably too low because of a data limitation. See Section 1.3 of this report.

Note: A peer reviewer noticed that the draft maps showed Gardiners Island as "likely" even though the text said that it had been changed to "unlikely". The effect of that error was to overstate the area of land below one meter where shore protection is likely, and understate the area where shore protection is unlikely, by 0.7, 0.9, and 1.1 square miles for the land within 50, 100, and 200 cm above spring high water. We corrected the maps, but not the quantitative results in this report.

Table A.2 Low and High Estimates of the Area of Land Close to Sea Level in New Jersey

	Meters above Spring High Water																			
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
	0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		5.0	
County	**----------------Cumulative (total) amount of dry land below a given elevation---------------**																			
Atlantic	4	13	14	29	29	42	41	54	50	63	57	71	65	79	73	88	81	96	88	106
Bergen	0.9	16	10	31	20	42	29	44	39	47	43	49	45	51	47	54	49	56*	51	58*
Burlington	0.1	6.3	1.7	12	5.1	18	9.3	25	13	33	18	40	24	47	29	55	35	63*	41	69*
Camden	<0.01	3.8	0.1	7.3	1.7	11	4.3	15	6.9	19	9.5	22	12	26	15	29	18	32*	20	35*
Cape May	8	25	26	50	48	69	65	93	80	117	99	139	120	161	141	182	161	199	180	212
Cumberland	3	16	12	29	21	41	30	53	39	65	50	77	61	88	71	98	81	107	91	114
Essex	0.4	6.1	3.9	12	7.6	17	11	20	15	23	18	25	20	28	23	31	25	32*	28	32*
Gloucester	0.2	9.2	6.1	18	12	27	18	33	23	40	30	47	36	53	42	60	48	65	54	69
Hudson	0.6	16	10	32	21	45	31	49	41	53	46	57	50	61	53	65	57	66*	60	67*
Mercer	0	0.1	0	0.1	0.03	0.19	0.1	0.2	0.1	0.3	0.2	0.4	0.2	0.4	0.2	0.4	0.3	0.4*	0.3	0.4*
Middlesex	0.4	8.8	4.3	17	9.2	25	15	31	20	37	25	44	30	50	36	55	41	59*	46	62*
Monmouth	4.1	10	11	20	21	30	31	39	40	47	49	57	58	65	66	73	74	80	82	87
Ocean	4.6	19	22	44	47	66	67	81	81	94	93	107	105	119	117	129	127	139	137	149
Passaic	0	0.2	0.1	0.3	0.2	0.5	0.3	0.7	0.4	0.9	0.6	1.1	0.7	1.3	0.9	1.5	1.1	1.7*	1.3	1.9*
Salem	5.9	27	21	49	38	70	54	84	69	99	84	114	98	127	111	139	123	151	135	160
Somerset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1*	0	0.2*
Union	0.4	6.9	4.2	14	8.4	19	13	23	17	26	20	29	23	33	26	36	29	39*	32	41*
Statewide	**32**	**184**	**148**	**365**	**289**	**522**	**418**	**645**	**536**	**764**	**642**	**878**	**748**	**989**	**850**	**1096**	**949**	**1185***	**1046**	**1265***

*This value is probably too low because of a data limitation. See Section 1.3 of this report.

Table A.2 Low and High Estimates of the Area of Land Close to Sea Level in New Jersey (continued)

		low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
		0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		5.0	
Wetlands	Tidal	---------Cumulative (total) amount of Nontidal Wetlands below a given elevation---------																			
Atlantic	204	4.8	18	15	29	23	41	32	50	40	59	48	68	57	77	65	86	74	94	82	103
Bergen	15	0.04	0.6	0.4	1.2	0.8	1.5	1.1	1.5	1.48	1.54	1.52	1.55	1.5	1.6	1.5	1.6	1.5	1.8*	1.6	2.1*
Burlington	43	0.2	10	6.2	20	13	30	19	35	26	40	32	45	36	50	40	54	45	59*	49	63*
Camden	2	<0.01	0.3	0.1	0.7	0.3	1	0.5	1.3	0.7	1.6	0.9	1.9	1.2	2.2	1.4	2.4	1.6	2.5*	1.8	2.7*
Cape May	201	7.2	27	22	45	37	63	50	73	63	84	74	94	83	102	92	109	99	115	106	119
Cumberland	213	4.7	24	18	42	31	58	44	65	55	73	63	81	71	87	77	94	84	99	90	103
Essex	0	<0.01	0.03	0.02	0.05	0.04	0.07	0.05	0.07	0.07	0.07	0.07	0.08	0.07	0.08	0.07	0.08	<0.08	0.08*	<0.08	0.08*
Gloucester	18	0.2	8.8	5.9	17	11	24	17	26	22	27	25	29	26	30	28	32	29	33	30	34
Hudson	12	0.01	0.2	0.1	0.3	0.19	0.42	0.3	0.4	0.38	0.45	0.4	0.5	0.4	0.5	0.4	0.5	0.46	0.49*	0.47	0.49*
Mercer	2	0	<0.01	0	0.01	<0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.03	0.01	0.03	0.02	0.03	0.02	0.03*	0.02	0.03*
Middlesex	22	0.1	1.2	0.7	2.3	1.4	3.3	2.1	3.9	2.9	4.6	3.5	5.3	4	5.9	4.6	6.5	5.1	7.2*	5.7	7.8*
Monmouth	12	0.6	1.3	1.4	2	2.1	2.6	2.7	3.3	3.4	3.9	4	4.5	4.5	5	5.1	5.7	5.8	6.3	6.4	6.9
Ocean	125	2.3	12	10	22	19	31	26	38	33	44	39	49	44	54	48	58	53	63	56	66
Passaic	0	<0.01	0.02	0.01	0.03	0.02	0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05*	0.04	0.05*
Salem	110	9.6	25	22	36	30	46	38	49	45	52	49	55	52	58	55	61	58	64	60	68
Somerset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0.03*	0	0.04*
Union	2	0.01	0.2	0.1	0.3	0.2	0.4	0.3	0.5	0.4	0.6	0.4	0.6	0.5	0.7	0.5	0.7	0.6	0.8*	0.6	0.8*
Statewide	**980**	**30**	**128**	**102**	**219**	**169**	**301**	**233**	**348**	**293**	**393**	**341**	**436**	**381**	**474**	**420**	**513**	**455**	**546***	**491**	**576***
		Cumulative (total) amount of land below a given elevation																			
Dry Land		32	184	148	365	289	522	418	645	536	764	642	878	748	989	850	1096	949	1185*	1046	1265*
Nontidal Wetlands		30	128	102	219	169	301	233	348	293	393	341	436	381	474	420	513	455	546*	491	576*
All Land	980	1043	1292	1231	1564	1438	1803	1632	1974	1810	2137	1964	2294	2109	2443	2250	2589	2385	2712*	2517	2822*

*This value is probably too low because of a data limitation. See Section 1.3 of this report.

Table A.3 Low and High Estimates of the Area of Land Close to Sea Level in Pennsylvania

		Meters above Spring High Water																			
		low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
County		0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		5.0	
		----------------Cumulative (total) amount of Dry Land below a given elevation---------------																			
Bucks		0.04	4.4	0.2	8.5	2.5	13	5.3	18	9	23	12	27	15	32	19	36	22	39*	25	42*
Delaware		0.4	6.1	4	12	7.9	17	12	18	15	19	17	21	18	22	20	24	21	25	22	26
Philadelphia		3.6	6.1	6.8	12	13	19	20	25	26	31	32	37	37	42	42	46	47	51	51	55
Statewide		**4**	**17**	**11**	**33**	**24**	**49**	**37**	**61**	**50**	**73**	**61**	**85**	**71**	**96**	**81**	**106**	**90**	**115***	**99**	**123***
Wetlands	Tidal	---------Cumulative (total) amount of Nontidal Wetlands below a given elevation---------																			
Bucks	1.9	0.04	0.9	0.1	1.9	0.6	3	1.2	4.1	2	5.2	2.9	6.3	3.7	7.2	4.5	7.6	5.4	7.9*	6.2	8.2*
Delaware	3.6	0.1	0.8	0.6	1.7	1.1	2.2	1.6	2.2	2.1	2.2	2.2	2.3	2.2	2.3	2.2	2.3	2.25	2.27	2.26	2.28
Philadelphia	0.6	0.5	0.6	0.6	0.9	0.9	1.2	1.2	1.4	1.5	1.61	1.62	1.69	1.71	1.78	1.79	1.84	1.85	1.89	1.89	1.93
Statewide	**6.1**	**0.6**	**2.4**	**1.3**	**4.5**	**2.7**	**6.4**	**4.1**	**7.7**	**5.6**	**9.1**	**6.7**	**10**	**7.7**	**11**	**8.6**	**12**	**9.5**	**12***	**10**	**12***
		Cumulative (total) amount of land below a given elevation																			
Dry Land		4	17	11	33	24	49	37	61	50	73	61	85	71	96	81	106	90	115*	99	123*
Nontidal Wetlands		1	2	1	4	3	6	4	8	6	9	7	10	8	11	9	12	9	12*	10	12*
All Land	6	11	25	18	44	32	61	47	75	62	88	74	101	85	113	95	124	106	133*	115	141*

*This value is probably too low because of a data limitation. See Section 1.3 of this report

Table A.4 Low and High Estimates of the Area of Land Close to Sea Level in Delaware

		Meters above Spring High Water																			
		low	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**
County		**0.5**		**1.0**		**1.5**		**2.0**		**2.5**		**3.0**		**3.5**		**4.0**		**4.5**		**5.0**	
		----------------Cumulative (total) amount of Dry Land below a given elevation---------------																			
Kent		8.8	25	22	41	35	57	48	78	66	98	86	119	107	144	129	168	154	191	178	210
New Castle		7.1	19	17	30	26	41	34	52	44	64	54	75	65	87	77	98	88	110	99	119
Sussex: Chesapeake Bay		0.5	1.6	1.4	3.3	2.7	5.2	4.3	7.1	6	11	8.5	14	12	18	15	24	20	29	26	36
Sussex: Delaware Bay		6.4	18	16	31	27	43	37	55	48	67	60	79	72	89	83	99	93	109	103	120
Sussex: Atlantic Coast		11	32	28	54	46	74	65	95	83	117	104	140	126	163	149	187	173	211	197	234
Statewide		**34**	**96**	**84**	**158**	**136**	**221**	**188**	**287**	**246**	**356**	**313**	**426**	**382**	**499**	**453**	**575**	**527**	**647**	**603**	**719**
Wetlands	Tidal	---------Cumulative (total) amount of Nontidal Wetlands below a given elevation---------																			
Kent	169	4.9	11	10	17	15	22	19	25	23	28	26	31	29	34	32	37	36	41	39	44
New Castle	74	1.8	3.8	3.5	4.8	4.3	5.8	5.1	6.7	5.8	7.6	6.7	8.4	7.5	9.2	8.3	9.9	9	11	9.7	11
Sussex: Chesapeake Bay	6.7	0.6	1.8	1.6	2.7	2.4	3.5	3.1	4.4	3.8	5.4	4.8	6.4	5.8	7.7	6.9	9.4	8.4	11	10	13
Sussex: Delaware Bay	67	2.1	4.8	4.6	6.2	5.7	7.5	6.8	8.6	8	9.6	9	11	10	11	11	12	12	13	12	13
Sussex: Atlantic Coast	41	1.7	4.9	4.2	7.5	6.6	10	8.8	12	11	14	13	16	15	17	16	18	18	20	19	21
Statewide	**357**	**11**	**27**	**24**	**38**	**34**	**48**	**43**	**56**	**52**	**64**	**59**	**72**	**67**	**80**	**75**	**87**	**82**	**95**	**90**	**102**
		Cumulative (total) amount of land below a given elevation																			
Dry Land		34	96	84	158	136	221	188	287	246	356	313	426	382	499	453	575	527	650	603	719
Nontidal Wetlands		11	27	24	38	34	48	43	56	51	64	59	72	67	80	75	87	82	95	90	102
All Land	357	402	480	465	553	527	626	588	701	655	778	730	855	806	936	885	1019	967	1102	1050	1178

Table A.5 Low and High Estimates of the Area of Land Close to Sea Level in Maryland

	Meters above Spring High Water																			
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
County	0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		5.0	
	----------------Cumulative (total) amount of Dry Land below a given elevation---------------																			
Anne Arundel	1.7	7.2	6.7	15	12	26	20	39	32	50	44	59	54	68	63	77	72	86	81	94
Baltimore County	2.3	6.6	7.3	13	14	20	21	27	28	36	37	46	47	56	57	65	66	73	75	81
Baltimore City	0.2	2.1	0.9	3.9	1.7	5.7	2.7	7.5	4.2	9.7	5.7	12	7.4	14	9.6	17	12	19	14	21
Calvert	0.4	3.9	1.7	5.8	3.1	7.6	4.6	10	6.1	14	7.6	17	10.0	21	14	26	17	31	21	36
Caroline	0.7	3.2	2.2	6.1	4.1	9.2	6.9	13	9.9	16	13	20	16	23	19	27	23	30*	26	33*
Cecil	0.2	2.5	1.0	5.2	1.8	7.9	3.7	12	5.7	16	7.8	20	11	25	16	29	20	34	24	38
Charles	0.7	12	4.8	21	9.0	30	15	40	22	53	30	67	40	77	53	85	66	93	77	99
Dorchester	30	120	150	215	231	269	282	313	322	348	358	386	396	416	423	439	445	457	462	474
Harford	0.7	17	7.6	25	15	33	22	40	28	49	34	57	42	64	50	69	59	74	65	78
Howard	0	0.01	0.01	0.03	0.01	0.05	0.02	0.07	0.04	0.1	0.05	0.14	0.07	0.2	0.1	0.2	0.1	0.3	0.2	0.3
Kent	0.2	8.4	4.8	16	10	23	16	33	23	45	29	56	37	68	48	80	59	93	71	105
Prince George's	0.2	2.2	0.9	3.9	1.6	5.6	2.9	7.2	4.3	8.9	5.6	11	7.1	13	8.9	16	11	19	13	21
Queen Anne's	0.6	4.1	5.3	12	14	22	24	35	37	50	52	68	69	88	89	107	107	126	125	143
Somerset	17	58	70	101	113	153	168	193	198	210	215	233	240	260	268	289	297	318	327	345
St. Mary's	2.4	16	8.0	28	14	41	24	58	35	79	46	101	62	118	83	129	104	139	120	148
Talbot	2.2	7.8	11	24	30	54	64	99	110	139	149	175	184	210	218	239	245	260	266	279
Wicomico	5.0	15	18	29	32	43	47	58	62	72	76	86	90	101	105	115	119	129	133	142
Worcester	4.4	21	25	48	53	83	88	119	124	153	158	183	187	209	213	235	239	261	265	288
Statewide	**69**	**307**	**326**	**570**	**560**	**832**	**812**	**1104**	**1053**	**1350**	**1267**	**1596**	**1500**	**1833**	**1737**	**2045**	**1960**	**2243***	**2165**	**2425***

*This value is probably too low because of a data limitation. See Section 1.3 of this report

Table A.5 Low and High Estimates of the Area of Land Close to Sea Level in Maryland (continued)

		low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
County		**0.5**		**1.0**		**1.5**		**2.0**		**2.5**		**3.0**		**3.5**		**4.0**		**4.5**		**5.0**	
Wetlands	Tidal	---------Cumulative (total) amount of Nontidal Wetlands below a given elevation---------																			
Anne Arundel	12	0.2	0.7	0.6	1.6	1.1	4.8	3.1	8.1	6.3	11	9.5	12	12	14	13	15	14	16	15	17
Baltimore County	10	0.1	0.3	0.3	0.7	0.7	1.0	1.0	1.3	1.3	1.5	1.5	1.7	1.7	1.8	1.8	2.0	2.0	2.2	2.2	2.3
Baltimore City	0.2	<0.01	0.03	0.01	0.04	0.02	0.05	0.03	0.1	0.04	0.1	0.05	0.1	0.06	0.1	0.06	0.1	0.07	0.1	0.08	0.1
Calvert	15	0.1	0.9	0.4	1.3	0.7	1.7	1.1	2.2	1.4	3.0	1.7	3.8	2.2	4.7	3.0	5.7	3.8	6.6	4.7	7.5
Caroline	14	0.3	1.4	0.7	2.6	1.3	4.0	2.5	5.3	3.5	6.4	4.4	7.5	5.3	8.6	6.2	9.8	7.1	11*	8.0	12*
Cecil	13	0.01	0.2	0.04	0.7	0.1	1.2	0.4	1.7	0.8	2.3	1.2	2.8	1.7	3.5	2.2	4.2	2.8	4.9	3.5	5.5
Charles	24	0.1	3.8	1.5	6.5	2.9	9.2	4.8	12	7.0	14	9.3	16	12	18	14	20	16	21	18	23
Dorchester	425	15	46	53	70	76	90	94	104	107	112	114	121	124	129	131	136	137	139	140	143
Harford	29	0.2	2.5	1.2	3.8	2.3	5.0	3.3	6.2	4.3	7.6	5.2	9.0	6.4	10	7.8	11	9.1	11	10	12
Howard	0	0	0.03	0.01	0.04	0.02	0.04	0.03	0.05	0.04	0.06	0.04	0.06	0.05	0.07	0.06	0.08	0.06	0.09	0.07	0.10
Kent	18	0.1	1.1	0.9	2.6	2.0	4.1	3.3	5.4	4.3	6.8	5.2	7.9	6.1	9.3	7.2	11	8.3	13	9.7	14
Prince George's	14	0.1	0.8	0.3	1.4	0.6	2.0	1.0	2.5	1.5	3.2	2.0	3.8	2.5	4.7	3.2	5.6	3.8	6.5	4.6	7.2
Queen Anne's	21	0.2	1.1	1.5	3.0	3.2	4.8	4.9	6.5	6.5	8.1	7.9	9.6	9.5	12	11	14	13	16	15	18
Somerset	265	6.6	16	17	21	23	31	35	40	41	43	45	52	54	60	62	69	71	78	81	90
St. Mary's	19	0.5	2.8	1.7	5.3	2.8	7.8	4.6	11	6.7	15	8.8	19	12	22	16	25	20	28	23	31
Talbot	26	0.1	0.3	0.5	1.0	1.3	2.1	2.5	4.2	4.8	6.2	6.8	8.5	9.1	12	13	15	16	17	18	20
Wicomico	67	5.4	9.9	11	13	16	22	24	29	30	35	37	44	47	54	56	60	62	66	67	70
Worcester	142	0.7	5.2	6.0	10	11	16	17	22	23	29	30	36	37	42	43	48	49	54	54	58
Statewide	**1116**	**29**	**93**	**97**	**146**	**145**	**207**	**203**	**261**	**249**	**304**	**289**	**355**	**341**	**406**	**390**	**451**	**435**	**490***	**474**	**531***
		Cumulative (total) amount of land below a given elevation																			
Dry Land		69	307	326	570	560	832	812	1104	1053	1350	1267	1596	1500	1833	1737	2045	1960	2243*	2165	2425*
Nontidal Wetlands		29	93	97	146	145	207	203	261	249	304	289	355	341	406	390	451	435	490*	474	531*
All Land	1116	1214	1516	1539	1832	1820	2155	2130	2481	2418	2769	2672	3067	2957	3354	3243	3612	3510	3849*	3754	4071*

*This value is probably too low because of a data limitation. See Section 1.3 of this report

Table A.6 Low and High Estimates of the Area of Land Close to Sea Level in **Washington, D.C.**

		Meters above Spring High Water																			
		low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
		0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		5.0	
		----------------Cumulative (total) amount of Dry Land below a given elevation---------------																			
Washington, D.C.		1.6	3.0	2.8	4.4	4.1	5.8	5.5	7.4	7.0	9.3	8.9	11	11	13	13	15	14	16	16	18
Wetlands	Tidal	---------Cumulative (total) amount of Nontidal Wetlands below a given elevation---------																			
Washington, D.C.	0.5	0.03	0.05	0.05	0.07	0.07	0.1	0.09	0.12	0.12	0.14	0.13	0.16	0.15	0.19	0.18	0.24	0.2	0.3	0.28	0.32
		Cumulative (total) amount of land below a given elevation																			
Dry Land		2	3	3	4	4	6	5	7	7	9	9	11	11	13	13	15	14	16	16	18
Nontidal Wetlands		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All Land	0.5	2	3	3	5	5	6	6	8	8	10	9	12	11	14	13	15	15	17	17	19

Table A.7 Low and High Estimates of the Area of Land Close to Sea Level in Virginia

Jurisdiction	Meters above Spring High Water																			
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
	0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		5.0	
	----------------Cumulative (total) amount of Dry Land below a given elevation---------------																			
Eastern Shore	**21**	**63**	**56**	**111**	**93**	**159**	**137**	**204**	**180**	**243**	**221**	**279**	**258**	**315**	**294**	**349**	**329**	**382**	**362**	**416**
Accomack	13	41	37	78	65	115	98	149	131	172	160	192	180	211	200	227	218	242	233	257
Northampton	7.4	22	20	33	29	44	39	55	49	71	61	87	78	104	94	122	111	140	129	159
Northern Virginia	**0**	**5.1**	**2.8**	**10**	**6.3**	**15**	**9.7**	**20**	**13**	**25**	**17**	**29**	**21**	**34**	**25**	**39**	**30**	**44**	**35**	**49**
Arlington	0	0.2	0.1	0.5	0.3	0.7	0.5	1.3	0.6	1.9	0.8	2.6	1.4	3.3	2.1	4	2.7	4.7	3.4	5
Alexandria	0	0.4	0.3	0.9	0.6	1.3	0.9	1.7	1.2	2.1	1.5	2.5	1.8	2.9	2.2	3.2	2.5	3.6	2.9	4
Fairfax	0	2	1.1	3.9	2.5	5.9	3.8	7.6	5.2	9.2	6.6	11	8	12	9.5	14	11	15	12	18
Prince William	0	1	0.5	2	1.2	3	1.9	3.9	2.6	4.7	3.3	5.5	4	6.3	4.8	7.2	5.6	8	6.4	8.8
Rappahannock Area	**0**	**3.3**	**1.8**	**6.5**	**4.1**	**9.9**	**6.4**	**14**	**8.7**	**20**	**11**	**26**	**15**	**31**	**20**	**37**	**26**	**43**	**32**	**49**
Stafford	0	1.4	0.8	2.7	1.7	4.2	2.7	5.4	3.6	6.8	4.6	8.1	5.7	9.4	6.9	11	8.2	12	9.5	14
Fredericksburg	0	0.1	0.04	0.1	0.1	0.2	0.1	0.2	0.2	0.3	0.2	0.3	0.3	0.4	0.3	0.4	0.3	0.5	0.4	0.5
King George	0	2.7	1.5	5.4	3.3	8.1	5.2	11	7.1	16.7	9	22	12	27	17	32	22	37	27	43
Spotsylvania	0	0.09	0.05	0.2	0.1	0.3	0.2	0.3	0.2	0.4	0.3	0.5	0.3	0.5	0.4	0.6	0.5	0.7	0.5	0.8
Caroline	0	0.4	0.3	0.9	0.6	1.3	0.9	1.8	1.2	2.3	1.5	2.8	1.9	3.3	2.4	3.8	2.9	4.4	3.4	5.2
Northern Neck	**0.1**	**22**	**11**	**43**	**27**	**66**	**42**	**92**	**58**	**141**	**74**	**190**	**100**	**239**	**147**	**287**	**193**	**336**	**240**	**378**
Westmoreland	0	4.7	2.4	9.3	5.7	14	9	21	12	37	16	53	24	69	39	84	54	100	69	112
Richmond	0	4.6	2.4	8.9	5.5	13	8.7	18	12	25	15	32	20	38	26	44	32	51	38	57
Northumberland	0	5.9	2.8	11	6.9	17	11	24	15	44	19	64	27	84	46	104	65	124	85	141
Lancaster	0.1	7	3.6	14	8.5	21	14	28	19	35	24	42	29	48	36	55	42	61	48	68
Middle Peninsula	**9.1**	**42**	**33**	**89**	**66**	**139**	**108**	**190**	**149**	**230**	**186**	**268**	**220**	**307**	**258**	**336**	**292**	**364**	**319**	**392**
Essex	0	3.8	2	7.3	4.6	11	7.1	15	9.7	22	12	28	17	34	22	40	28	46	34	53
King and Queen	0	2.9	1.7	5.7	3.7	8.6	5.5	12	7.5	15	9.6	19	13	22	16	26	19	30	23	33
King William	0	1.6	0.9	3.2	2	4.8	3.1	8.4	4.2	13	5.4	18	9.6	22	14	27	18	32	23	36
Middlesex	0.2	3.4	2	6.8	4.4	11	7	14	10	19	13	23	16	27	20	31	24	35	28	39
Gloucester	4.1	16	13	33	26	50	41	67	55	76	67	84	75	93	84	99	91	104	96	111

Table A.7 Low and High Estimates of the Area of Land Close to Sea Level in Virginia (continued)

	low	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**
	0.5		**1.0**		**1.5**		**2.0**		**2.5**		**3.0**		**3.5**		**4.0**		**4.5**		**5.0**	
Mathews	4.7	15	13	33	26	54	44	73	62	85	79	97	90	108	101	113	111	117	115	121
Hampton Roads	**24**	**91**	**78**	**200**	**154**	**333**	**264**	**469**	**381**	**650**	**519**	**848**	**711**	**1045**	**907**	**1192**	**1089**	**1307**	**1215**	**1424**
James City	0.1	3.8	2	7.2	4.7	11	7	14	9.4	18	12	22	15	26	19	30	23	34	27	39
York	1.4	6	5	13	9.9	21	16	28	23	33	28	37	33	42	38	45	42	48	44	51
Newport News	2.2	6.9	6	11	9.7	15	13	18	16	21	19	25	23	28	26	33	30	38	35	42
Poquoson	1.4	4.5	4	8.8	7.4	13	11	16	15	16	16	17	17	17	17	17	17	17	17	17
Hampton	1.9	5.9	5	18	13	32	25	45	38	60	51	74	65	88	80	93	90	98	95	102
Surry	0	1.4	1	2.7	1.7	4.1	2.7	5.3	3.6	6.2	4.6	7.1	5.5	8	6.4	9	7.2	9.9	8.1	11
Isle of Wight	0.2	3.4	2	6.2	4.2	9.1	6	12.8	8	17	10	22	14	26	18	31	22	35	27	42
Norfolk	1.9	5.8	5	17	13	30	24	42	35	67	52	91	77	115	101	120	118	124	122	128
Virginia Beach	9.3	33	30	69	55	117	94	163	138	219	185	273	241	327	295	368	347	393	378	418
Suffolk	0.7	4.3	3.1	7.1	5.4	10	7.5	15	10	23	13	31	21	39	28	50	37	60	47	73
Portsmouth	1.2	3.9	3.5	9.6	7.6	15	13	22	18	33	27	45	38	56	50	61	58	65	63	70
Chesapeake	3.5	12	11	31	22	57	45	87	69	137	100	205	162	272	229	337	298	385	353	430
Other Jurisdictions	**0**	**9.9**	**5.7**	**19**	**12**	**29**	**19**	**40**	**26**	**54**	**32**	**67**	**44**	**80**	**56**	**93**	**68**	**106**	**81**	**122**
Charles City	0	3.2	1.8	6.3	4	9.6	6.2	13	8.4	18	11	23	15	28	19	32	23	37	28	43
Chesterfield	0	1.3	0.8	2.6	1.7	3.9	2.5	4.8	3.4	5.5	4.3	6.2	5	7	5.7	7.7	6.3	8.4	7	8.9
Colonial Heights	0	0.04	0.02	0.1	0.05	0.1	0.07	0.12	0.09	0.14	0.12	0.15	0.1	0.2	0.1	0.2	0.15	0.19	0.16	0.24
Hanover	0	0.02	0.02	0.05	0.03	0.1	0.05	0.2	0.1	0.3	0.1	0.4	0.2	0.5	0.3	0.6	0.4	0.7	0.5	0.7
Henrico	0	0.8	0.5	1.5	1	2.3	1.5	2.8	2	3.2	2.5	3.7	2.9	4.1	3.3	4.6	3.8	5.1	4.2	6.3
Hopewell	0	0.4	0.2	0.8	0.5	1.1	0.7	1.3	1	1.4	1.2	1.6	1.4	1.7	1.5	1.8	1.6	1.9	1.7	2.2
New Kent	0	2.1	1.2	4.1	2.6	6.2	4	9.4	5.4	13	6.9	17	10	21	14	25	18	29	22	34
Petersburg	0	0	0	0	0	0	0	<0.01	0	0.01	<0.01	0.01	<0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.03
Prince George	0	1.9	1.1	3.8	2.4	5.7	3.7	8.1	5	11	6.3	14	8.8	17	12	20	15	23	17	26
Williamsburg	0	0.05	0.03	0.1	0.06	0.1	0.1	0.2	0.1	0.3	0.2	0.3	0.2	0.4	0.3	0.4	0.3	0.5	0.4	0.6
Statewide	**54**	**236**	**189**	**479**	**362**	**751**	**585**	**1029**	**816**	**1362**	**1060**	**1707**	**1368**	**2051**	**1708**	**2332**	**2028**	**2582**	**2283**	**2830**

Table A.7 Low and High Estimates of the Area of Land Close to Sea Level in Virginia (continued)

Jurisdiction		Meters above Spring High Water																			
		low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
		0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		5.0	
	Tidal	---------Cumulative (total) amount of Nontidal Wetlands below a given elevation---------																			
Eastern Shore	**946**	**7**	**22**	**20**	**48**	**39**	**76**	**63**	**101**	**87**	**114**	**107**	**126**	**119**	**137**	**131**	**146**	**141**	**153**	**149**	**161**
Accomack	484	7	21	19	45	36	70	58	92	80	104	98	114	108	124	119	132	128	138	134	145
Northampton	462	0.4	1.2	1	3.4	2.5	5.9	4.7	8.1	7	9.7	8.8	11	10	13	12	14	14	15	15	16
Northern Virginia	**17**	**0**	**1**	**0**	**2**	**1**	**3**	**2**	**3**	**2**	**4**	**3**	**4**	**3**	**5**	**4**	**5**	**4**	**6**	**5**	**6**
Stafford	6.8	0	0.5	0.3	1	0.6	1.5	1	1.9	1.3	2.3	1.7	2.6	2	2.9	2.3	3.3	2.6	3.6	3	3.9
Alexandria	0.2	0	0.03	0.02	0.07	0.04	0.1	0.06	0.11	0.09	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.12
Fairfax	4.9	0	0.2	0.1	0.4	0.2	0.6	0.4	0.7	0.5	0.8	0.6	0.9	0.7	1.1	0.9	1.2	1	1.3	1.1	1.4
Prince William	5.1	0	0.2	0.1	0.3	0.2	0.5	0.3	0.6	0.4	0.6	0.5	0.7	0.6	0.8	0.7	0.8	0.7	0.9	0.8	0.9
Rappahannock Area	**20**	**0**	**0.6**	**0.3**	**1.2**	**0.7**	**1.7**	**1.1**	**2.4**	**1.5**	**3**	**1.9**	**3.6**	**2.5**	**4.2**	**3.1**	**4.9**	**3.7**	**5.5**	**4.3**	**6.2**
Fredericksburg	0	0	<0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
King George	13	0	0.5	0.3	1	0.6	1.5	1	2	1.3	2.4	1.7	2.8	2.1	3.3	2.5	3.7	2.9	4.1	3.3	4.6
Spotsylvania	0.1	0	0.02	0.01	0.03	0.02	0.05	0.03	0.06	0.04	0.06	0.05	0.07	0.06	0.08	0.06	0.08	0.07	0.09	0.08	0.12
Caroline	6.3	0	0.1	0.03	0.1	0.1	0.2	0.1	0.3	0.2	0.5	0.2	0.7	0.3	0.9	0.5	1.1	0.7	1.3	0.9	1.5
Northern Neck	**57**	**0**	**2.5**	**1.2**	**4.8**	**2.9**	**7.3**	**4.7**	**9.8**	**6.4**	**14**	**8.1**	**18**	**10**	**22**	**14**	**26**	**18**	**30**	**22**	**34**
Westmoreland	14	0	0.5	0.3	1	0.6	1.5	1	2.2	1.3	3.9	1.7	5.6	2.5	7.2	4.1	8.9	5.7	10.6	7.3	12
Richmond	22	0	0.9	0.4	1.7	1	2.5	1.6	3.3	2.2	3.9	2.8	4.5	3.4	5.1	4	5.7	4.5	6.3	5.1	6.9
Northumberland	11	0	0.5	0.3	1.1	0.6	1.6	1	2.2	1.4	3.7	1.8	5.1	2.4	6.6	3.8	8	5.2	9.6	6.6	11
Lancaster	9.8	<0.01	0.5	0.3	1.1	0.7	1.6	1.1	2.1	1.4	2.5	1.8	2.8	2.2	3.2	2.5	3.5	2.8	3.8	3.2	4.2
Middle Peninsula	**165**	**2.6**	**12**	**9.5**	**26**	**19**	**40**	**31**	**54**	**44**	**66**	**55**	**78**	**67**	**90**	**79**	**98**	**90**	**106**	**98**	**113**
Essex	28	0	0.8	0.4	1.5	0.9	2.3	1.5	2.9	2	3.4	2.5	3.9	3	4.4	3.5	4.8	3.9	5.3	4.4	5.9
King and Queen	22	0	0.9	0.5	1.7	1.1	2.5	1.6	3.1	2.2	3.5	2.8	4	3.2	4.4	3.6	4.8	4	5.3	4.4	5.8
King William	36	0	0.4	0.2	0.7	0.5	1.1	0.7	1.4	0.9	1.7	1.2	2	1.5	2.3	1.8	2.6	2	2.9	2.3	3.3
Middlesex	9.7	<0.01	0.7	0.4	1.4	0.8	2.1	1.4	2.8	1.9	3.1	2.4	3.5	2.8	3.8	3.2	4.1	3.5	4.5	3.8	4.8
Gloucester	44	1.4	5.5	4.5	12	9.1	19	15	25	20	28	25	31	27	34	30	36	33	37	34	38

Table A.7 Low and High Estimates of the Area of Land Close to Sea Level in Virginia (continued)

		Meters above Spring High Water																			
Jurisdiction		low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
		0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		5.0	
Mathews	27	1.2	3.8	3.5	8.6	6.7	14	11	19	16	26	22	34	29	41	37	46	44	51	48	55
Hampton Roads	**329**	**12**	**42**	**38**	**74**	**64**	**96**	**84**	**127**	**104**	**167**	**127**	**205**	**164**	**245**	**202**	**285**	**242**	**326**	**279**	**391**
James City	33	<0.01	0.8	0.4	1.5	0.9	2.2	1.4	2.8	1.9	3.3	2.5	3.7	2.9	4.2	3.3	4.6	3.8	5.1	4.2	5.6
York	17	0.19	0.9	0.7	2.7	1.9	4.9	3.7	6.7	5.6	7.4	6.9	8	7.6	8.7	8.2	9.1	8.8	9.5	9.2	9.9
Newport News	15	0.1	0.3	0.3	0.7	0.5	1	0.9	1.3	1.2	1.4	1.35	1.42	1.4	1.5	1.4	1.5	1.5	1.6	1.6	1.7
Poquoson	24	0.02	0.1	0.1	0.4	0.3	0.8	0.6	1.1	0.9	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Hampton	14	0.06	0.2	0.2	0.4	0.3	0.6	0.5	0.9	0.7	1.5	1.1	2.2	1.8	2.9	2.5	4	3.3	5.1	4.4	6.2
Surry	11	0	0.6	0.3	1.3	0.8	1.9	1.2	2.4	1.7	2.5	2.1	2.7	2.4	2.9	2.6	3	2.7	3.2	2.9	3.4
Isle of Wight	29	<0.01	0.3	0.2	0.6	0.4	0.9	0.6	1.4	0.8	2.2	1	3.1	1.5	4	2.4	4.8	3.2	5.7	4	7.3
Norfolk	4.7	0.1	0.3	0.2	0.5	0.4	0.8	0.7	1.1	0.9	1.3	1.1	1.5	1.3	1.7	1.5	1.7	1.7	1.7	1.7	1.7
Virginia Beach	112	4.2	14	13	25	22	33	29	41	37	46	43	50	48	53	51	56	54	57	56	59
Suffolk	26	0.03	0.2	0.1	0.3	0.2	0.4	0.3	0.8	0.4	1.3	0.5	1.8	1	2.3	1.4	3.1	2.1	6.8	2.9	33
Portsmouth	3.7	2.4	7.7	6.8	8.9	8.9	9.2	9.1	9.5	9.3	9.9	9.6	10	10	11	10	11	10.7	11	10.9	11
Chesapeake	40	4.5	17	15	32	28	40	36	58	44	89	56	120	86	152	116	186	149	217	180	251
Other Jurisdictions	**85**	**0**	**5.5**	**3.2**	**11**	**6.9**	**16**	**10**	**20**	**14**	**22**	**18**	**24**	**20**	**26**	**22**	**28**	**24**	**30**	**26**	**33**
Charles City	22	0	1.9	1.1	3.7	2.4	5.6	3.6	6.8	4.9	7.4	6.2	8	6.9	8.6	7.5	9.2	8.1	9.8	8.6	11
Chesterfield	11	0	0.4	0.2	0.7	0.4	1.1	0.7	1.2	0.9	1.2	1.1	1.2	1.17	1.24	1.2	1.3	1.2	1.3	1.2	1.3
Henrico	4.2	0	0.04	0.02	0.08	0.05	0.12	0.1	0.2	0.1	0.2	0.1	0.2	0.2	0.3	0.2	0.3	0.2	0.4	0.3	0.4
Hopewell	0.7	0	0.1	0.1	0.2	0.1	0.3	0.2	0.3	0.3	0.4	0.3	0.4	0.3	0.4	0.36	0.4	0.37	0.41	0.38	0.42
New Kent	34	0	2.3	1.3	4.5	2.9	6.8	4.4	8.1	6	8.7	7.6	9.3	8.2	9.8	8.8	10.4	9.3	11	9.9	12
Prince George	11	0	0.8	0.5	1.5	1	2.3	1.5	3.1	2	3.9	2.6	4.7	3.3	5.5	4	6.3	4.8	7.1	5.5	7.5
Williamsburg	0.4	0	0.02	0.01	0.03	0.02	0.05	0.03	0.06	0.04	0.07	0.05	0.08	0.06	0.1	0.07	0.11	0.09	0.12	0.1	0.14
Statewide	**1619**	**21**	**86**	**72**	**167**	**134**	**240**	**197**	**317**	**260**	**389**	**320**	**459**	**387**	**529**	**455**	**594**	**523**	**657**	**583**	**745**
	Cumulative (total) amount of land below a given elevation																				
Dry Land		54	236	189	479	362	751	585	1029	816	1362	1060	1707	1368	2051	1708	2332	2028	2582	2283	2830
Nontidal Wetlands		21	86	72	167	134	240	197	317	260	389	320	459	387	529	455	594	523	657	583	745
All Land	1619	1694	1941	1881	2265	2115	2611	2401	2965	2694	3370	2999	3785	3374	4199	3782	4545	4170	4858	4486	5193

Table A.8 Low and High Estimates of the Area of Land Close to Sea Level in North Carolina

County	Meters above Spring High Water																			
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
	0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		5.0	
	---------------Cumulative (total) amount of dry land below a given elevation--------------																			
Beaufort	46	90	107	153	174	232	254	314	338	398	419	479	502	573	597	652	669	708	719	741
Bertie	1.8	3.4	4.7	6.8	8.2	10	12	15	17	20	22	26	28	32	35	40	44	51	56	65
Bladen	0	0	0	<0.01	<0.01	0.01	0.02	0.06	0.1	0.2	0.2	0.4	0.5	1.1	1.5	3	4	8.2	10	16
Brunswick	13	18	22	28	33	40	45	52	57	65	70	79	85	95	102	112	119	130	136	145
Camden	10	21	25	45	59	100	115	147	157	188	201	231	240	256	261	281	290	313	321	336
Carteret	52	89	120	172	212	279	318	371	393	412	419	428	434	444	451	462	468	477	481	487
Chowan	2.9	5.0	6.5	9.2	11	15	17	22	27	35	42	55	65	85	100	122	137	159	173	188
Columbus	<0.01	0.01	0.02	0.04	0.05	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.1	1.2	1.5	1.6	1.9
Craven	7.5	15	19	30	36	52	59	77	84	102	109	130	138	164	174	199	208	233	241	265
Currituck	20	34	46	67	83	115	140	174	197	231	248	269	282	297	303	309	312	316	318	322
Dare	43	60	66	80	84	96	100	111	115	124	127	134	136	140	141	144	145	147	147	148
Duplin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.02	0.03	0.07	0.1	0.2	0.2	0.3	0.4	0.8	0.9	1.5
Edgecombe	0	0	0	0	0	0	0	0	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01	0.02	0.03
Gates	5.3	11	11	16	17	22	22	27	28	35	36	50	52	69	72	85	87	103	107	130
Greene	0	0	0	0	0	0	0	0	0	0	0	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01	0.01	0.02
Halifax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<0.01	<0.01	0.06
Hertford	3.7	6.9	7.4	11	12	17	17	21	22	26	26	31	31	36	37	42	43	49	50	55
Hyde	276	405	428	476	490	528	543	581	594	627	635	654	661	676	680	690	692	696	698	702
Jones	1.8	2.7	3.0	4.0	4.4	5.6	6.1	7.7	8.4	11	11	14	15	19	20	25	27	32	35	41
Lenoir	0	0	0	0	0	0	0	0.01	0.02	0.05	0.06	0.1	0.2	0.3	0.4	0.7	0.9	1.5	1.7	2.8
Martin	0.5	1.8	2.6	5.6	7.0	11	13	18	19	23	24	27	28	30	30	33	33	35	36	38
New Hanover	7.1	12	13	19	21	26	28	33	35	41	43	50	52	59	62	69	72	79	81	87
Northampton	0.05	0.1	0.2	0.3	0.3	0.4	0.4	0.8	0.9	1.5	1.6	2.6	2.8	3.8	4.0	5.1	5.3	6.5	6.7	8.0
Onslow	24	31	33	41	44	52	55	65	68	78	82	93	97	108	112	125	130	144	149	162
Pamlico	24	44	60	90	112	145	165	189	204	225	238	258	269	284	291	302	307	314	317	320
Pasquotank	11	26	40	65	83	112	131	161	178	202	221	259	290	350	382	418	432	449	457	460
Pender	5	9	11	16	18	24	27	35	39	50	54	68	73	88	93	109	115	130	135	147
Perquimans	5.0	8.8	12	18	24	39	52	79	97	124	145	189	227	296	335	381	402	420	427	432
Pitt	1.1	1.8	2.4	3.7	4.7	6.5	7.8	10	12	15	17	21	24	30	34	40	45	52	57	65
Sampson	0	0	0	0	0	0	0	0	0	0.02	0.03	0.06	0.07	0.1	0.15	0.2	0.3	0.5	0.6	0.9
Tyrrell	130	235	269	321	331	351	358	369	371	374	375	378	378	379	380	380	380	380	380	380
Washington	5.6	14	22	38	49	68	81	106	128	165	192	238	272	340	387	452	484	519	535	556
Statewide	**697**	**1144**	**1330**	**1717**	**1916**	**2346**	**2566**	**2986**	**3188**	**3571**	**3759**	**4164**	**4385**	**4854**	**5086**	**5484**	**5654**	**5956**	**6079**	**6304**

Table A.8 Low and High Estimates of the Area of Land Close to Sea Level in North Carolina (continued)

County		Meters above Spring High Water																			
		low	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**	**low**	**high**
		0.5		**1.0**		**1.5**		**2.0**		**2.5**		**3.0**		**3.5**		**4.0**		**4.5**		**5.0**	
Wetlands	Tidal	---------Cumulative (total) amount of Nontidal Wetlands below a given elevation---------																			
Beaufort	35	65	95	105	131	139	162	171	202	215	244	252	272	278	290	294	306	310	320	323	330
Bertie	0.3	110	123	127	132	136	142	147	153	159	167	171	177	181	186	191	200	207	219	225	234
Bladen	0	<0.01	0.1	0.2	0.6	0.9	1.8	2.1	3.3	4.1	6.3	7.3	10	11	15	16	21	23	29	31	36
Brunswick	109	38	44	47	52	55	58	61	65	67	71	73	77	79	82	85	88	90	93	95	98
Camden	7.1	137	146	149	155	157	165	168	175	177	184	187	194	197	201	203	210	214	233	243	258
Carteret	334	34	67	87	117	136	164	180	202	216	231	237	243	247	254	258	267	273	281	286	293
Chowan	0	29	32	34	37	38	40	42	44	46	49	51	56	59	64	70	79	84	91	96	104
Columbus	0	0.2	0.5	0.8	1.3	1.9	2.7	3.2	3.9	4.4	5.1	5.5	6.1	6.4	6.7	7	7.3	7.5	8.0	8.9	11
Craven	12	59	74	80	94	100	115	121	137	142	154	159	170	173	184	188	198	202	213	217	227
Currituck	125	129	144	150	159	164	172	178	184	188	194	196	199	201	203	204	206	209	215	219	221
Dare	168	376	525	553	604	619	651	659	664	664	665	666	666	666	666	666	666	666	666	666	666
Duplin	0	0	0	0	0	0	0	0	0.01	0.03	0.1	0.2	0.5	0.7	1.4	1.8	2.9	3.4	4.7	5.3	6.7
Edgecombe	0	0	0	0	0	0	0	0	0	0	0	0	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.03	0.05	0.09
Gates	0	78	89	89	93	94	98	99	102	103	107	108	114	115	121	122	126	126	129	129	132

Table A.8 Low and High Estimates of the Area of Land Close to Sea Level in North Carolina (continued)

County	Meters above Spring High Water																				
		low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
		0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		5.0	
Greene	0	0	0	0	0	0	0	0	0	0	0	0	<0.01	<0.01	0.01	0.01	0.02	0.03	0.1	0.1	0.2
Halifax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<0.01	0.03	0.3	0.5	1.6
Hertford	0	45	53	54	58	58	61	62	65	66	69	69	71	71	74	74	77	78	79	80	81
Hyde	199	325	461	488	538	549	571	578	592	598	614	619	634	638	653	660	672	675	682	685	689
Jones	3.5	7.8	10	11	13	14	16	16	18	19	21	21	23	24	26	26	28	29	31	31	33
Lenoir	0	0	0	0	0.07	0.13	0.38	0.5	1.1	1.5	2.8	3.3	4.9	5.6	7.6	8.4	11	12	14	15	17
Martin	0	58	67	73	88	93	103	106	114	117	124	126	130	132	136	137	140	142	145	147	150
New Hanover	56	28	35	36	39	40	42	43	45	46	48	49	51	52	53	54	56	57	58	59	60
Northampton	0	0.9	1.9	2.0	2.6	2.7	3.5	3.7	5.9	6.0	7.3	7.6	9.6	9.9	11	11	12	12	13	13	14
Onslow	69	25	30	31	35	36	40	41	45	46	49	51	54	55	59	60	64	65	68	69	72
Pamlico	112	52	67	73	81	86	97	106	123	131	142	148	161	171	186	192	201	206	215	221	232
Pasquotank	0.3	50	58	62	68	71	75	79	84	88	93	96	102	106	113	116	119	121	122	124	124
Pender	38	83	107	113	128	132	145	150	161	165	175	179	189	192	202	206	216	219	229	232	239
Perquimans	0.04	38	44	47	52	55	61	66	74	79	86	90	98	103	113	124	137	144	158	167	180
Pitt	0	21	25	27	30	32	35	36	39	41	44	46	49	51	54	57	60	62	65	67	70
Sampson	0	0	0	0	0	0	0	0	<0.01	0.02	0.4	0.6	1.4	1.6	2.3	2.6	3.6	4.0	5.2	5.7	6.8
Tyrrell	3.8	422	502	523	554	559	569	571	579	582	591	593	601	606	614	616	620	621	622	622	623
Washington	0.3	70	78	86	92	96	101	106	112	118	128	134	145	152	162	168	175	180	188	192	197
Statewide	**1272**	**2280**	**2879**	**3048**	**3354**	**3465**	**3694**	**3794**	**3992**	**4087**	**4269**	**4347**	**4509**	**4583**	**4741**	**4818**	**4969**	**5041**	**5198**	**5273**	**5405**
		Cumulative (total) amount of land below a given elevation																			
Dry Land		697	1144	1330	1717	1916	2346	2566	2986	3188	3571	3759	4164	4385	4854	5086	5484	5654	5956	6079	6304
Nontidal Wetlands		2280	2879	3048	3354	3465	3694	3794	3992	4087	4269	4347	4509	4583	4741	4818	4969	5041	5198	5273	5405
All Land	1272	4249	5296	5650	6343	6653	7312	7633	8250	8547	9112	9378	9945	10240	10867	11176	11725	11967	12426	12624	12981

Appendix B

Low and High Estimates for the Area of Dry and Wet Land Close to Sea Level, by Subregion[a] (square kilometers)

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[a] The low and high estimates are based on the on the contour interval and/or stated root mean square error (RMSE) of the data used to calculate elevations and an assumed standard error of 30 cm in the estimation of spring high water. For details, see main text of this Section 1.3.

Table B.1 Low and High Estimates for the Area of Dry and Wet Land Close to Sea Level – Long Island Sound, New York

Locality		Elevations above spring high water									
		50 cm		1 meter		2 meters		3 meters		5 meters	
		Low	High	Low	High	Low	High	Low	High	Low	High
	Cumulative (total) amount of dry land below a given elevation										
Westchester		0.2	1.5	1.1	3.0	2.8	5.8	5.1	8.6	10.0	12.4
Bronx		0.4	2.6	1.8	5.1	4.8	9.8	8.7	14.6	16.9	19.6
Queens		6.2	17.0	14.6	28.1	31.7	48.6	50.7	66.6	76.5	80.8
Brooklyn		3.1	9.1	8.0	15.6	18.8	30.5	34.0	47.4	58.9	62.8
Nassau		2.2	19.2	12.9	44.5	50.9	85.4	85.4	104.1	119.3	132.1
Suffolk		13.7	51.5	43.1	96.8	114.9	181.3	188.6	251.3	318.8	371.4
Total		**25.8**	**100.9**	**81.4**	**193.1**	**223.9**	**361.4**	**372.4**	**492.6**	**600.4**	**679.1**
	Tidal	**Cumulative (total) amount of wetlands below a given elevation**									
Westchester	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Bronx	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Queens	11.9	0.0	0.2	0.1	0.3	0.4	0.5	0.5	0.6	0.7	0.7
Brooklyn	10.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Nassau	43.7	0.1	0.4	0.3	0.7	0.8	1.5	1.4	2.1	2.6	3.2
Suffolk	72.1	1.5	5.7	4.9	9.8	10.8	15.2	15.1	18.3	20.8	23.8
Total	**140.0**	**1.7**	**6.4**	**5.4**	**11.0**	**12.1**	**17.4**	**17.2**	**21.3**	**24.3**	**28.1**
Dry and nontidal wetland		27	107	87	204	236	379	390	514	625	707
All land	140	167	247	227	344	376	519	530	654	765	847

Table B.2 Low and High Estimates for the Area of Dry and Wet Land Close to Sea Level in New York Harbor

			Elevations above spring high water									
			50 cm		1 meter		2 meters		3 meters		5 meters	
			Low	High	Low	High	Low	High	Low	High	Low	High
Locality	**State**	**Cumulative (total) amount of dry land below a given elevation**										
Monmouth	NJ		2.0	5.4	5.9	10.5	15.8	18.7	22.4	24.7	31.2	32.5
Middlesex	NJ		0.4	8.8	4.3	17.4	14.7	31.2	25.4	43.5	45.6	62.0
Somerset	NJ		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Union	NJ		0.4	6.9	4.2	13.7	12.6	22.7	20.2	29.3	31.7	40.9
Hudson	NJ		0.6	16.2	10.4	32.2	30.6	49.0	46.4	56.9	60.4	67.5
Essex	NJ		0.4	6.1	3.9	12.0	11.3	19.6	17.8	25.3	27.8	32.2
Bergen	NJ		0.9	15.6	10.2	31.0	29.4	44.2	42.5	49.0	51.1	58.2
Passaic	NJ		0.0	0.2	0.1	0.3	0.3	0.7	0.6	1.1	1.3	1.9
Ellis Island	NJ		0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Staten Island	NY		0.3	7.8	5.1	15.5	14.9	24.9	23.3	30.8	33.9	39.0
Brooklyn	NY		0.0	0.8	0.5	1.6	1.6	3.1	2.7	4.5	5.3	6.4
Manhattan	NY		0.0	2.2	1.4	4.3	4.2	8.3	7.2	12.1	14.1	17.5
Bronx	NY		0.0	0.6	0.4	1.2	1.2	2.7	2.2	4.4	5.3	6.9
Westchester	NY		0.0	1.3	0.7	2.6	2.3	4.7	4.1	6.1	6.4	8.3
Total			**5.1**	**71.9**	**47.1**	**142.6**	**138.9**	**230.0**	**214.9**	**288.0**	**314.1**	**373.7**
		Tidal	**Cumulative (total) amount of wetlands below a given elevation**									
Monmouth	NJ	7.7	0.1	0.3	0.4	0.6	0.8	0.9	1.1	1.2	1.7	1.8
Middlesex	NJ	21.7	0.1	1.2	0.7	2.3	2.1	3.9	3.5	5.3	5.7	7.8
Union	NJ	2.3	0.0	0.2	0.1	0.3	0.3	0.5	0.4	0.6	0.6	0.8
Hudson	NJ	12.0	0.0	0.2	0.1	0.3	0.3	0.4	0.4	0.5	0.5	0.5
Essex	NJ	0.3	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Bergen	NJ	15.0	0.0	0.6	0.4	1.2	1.1	1.5	1.5	1.5	1.6	2.1
Passaic	NJ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Staten Island	NY	4.0	0.0	0.5	0.3	0.9	0.9	1.4	1.3	1.6	1.7	1.9
Bronx	NY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
Westchester	NY	0.7	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Rockland	NY	2.3	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2
Orange	NY	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Putnam	NY	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dutchess	NY	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total		**67.6**	**0.2**	**3.0**	**2.0**	**5.8**	**5.6**	**9.0**	**8.6**	**11.1**	**12.2**	**15.5**
Dry and nontidal wetland			5	75	49	148	145	239	223	299	326	389
All land		68	73	142	117	216	212	307	291	367	394	457

Table B.3 Low and High Estimates for the Area of Dry and Wet Land Close to Sea Level in New Jersey Shore

County		Elevations above spring high water:									
		50 cm		1 meter		2 meters		3 meters		5 meters	
		Low	High	Low	High	Low	High	Low	High	Low	High
		Cumulative (total) amount of Dry Land below a given elevation									
Cape May		7.6	21.8	23.8	42.0	56.1	73.5	78.4	102.2	124.2	144.1
Atlantic		4.0	13.5	14.0	29.0	40.8	53.9	57.3	71.0	88.5	105.8
Burlington		0.0	2.1	1.3	4.1	4.0	8.9	7.0	15.1	18.4	27.1
Ocean		4.6	18.7	21.8	44.0	67.3	80.6	93.2	106.8	136.6	149.1
Monmouth		2.1	4.9	5.5	9.4	15.3	19.9	26.4	31.8	50.4	54.9
Total		**18.3**	**61.1**	**66.5**	**128.5**	**183.5**	**236.9**	**262.3**	**326.9**	**418.1**	**481.0**
	Tidal	**Cumulative (total) amount of wetlands below a given elevation**									
Cape May	153.2	2.9	12.0	10.2	20.4	22.2	33.1	32.2	42.7	47.6	55.2
Atlantic	204.0	4.8	17.9	14.7	29.2	31.9	50.1	48.3	68.2	82.0	102.9
Burlington	37.3	0.2	9.7	6.2	19.1	18.7	32.7	30.0	41.3	45.8	57.2
Ocean	124.8	2.3	11.6	10.0	21.7	25.8	38.3	39.0	49.4	56.5	65.8
Monmouth	4.4	0.5	0.9	1.0	1.4	1.9	2.3	2.9	3.2	4.8	5.1
Total	**523.6**	**10.7**	**52.1**	**42.1**	**91.9**	**100.5**	**156.5**	**152.4**	**204.9**	**236.5**	**286.3**
Dry and nontidal wetland		29	113	109	220	284	393	415	532	655	767
All land	524	553	637	632	744	808	917	938	1055	1178	1291

Table B.4 Low and High Estimates for the Area of Dry and Wet Land Close to Sea Level in Delaware Estuary

			Elevations above spring high water:									
			50 cm		1 meter		2 meters		3 meters		5 meters	
			Low	High	Low	High	Low	High	Low	High	Low	High
Locality	**State**		Cumulative (total) amount of dry land below a given elevation									
Sussex	DE		6.4	18.2	15.8	30.8	37.3	55.2	60.0	78.6	103.3	119.7
Kent	DE		8.8	24.8	21.9	40.6	47.9	77.6	86.1	119.2	177.8	209.9
New Castle	DE		7.1	19.0	16.8	29.9	34.4	52.2	54.2	75.0	99.0	119.0
Delaware	PA		0.4	6.1	4.0	12.1	11.5	18.0	17.2	20.7	22.2	25.9
Philadelphia[a]	PA		3.6	6.1	6.8	12.4	20.0	24.8	31.6	36.8	51.5	54.8
Bucks	PA		0.0	4.4	0.2	8.5	5.3	18.0	11.9	27.4	25.3	42.1
Mercer	NJ		0.0	0.1	0.0	0.1	0.1	0.2	0.2	0.4	0.3	0.4
Burlington	NJ		0.1	4.3	0.4	8.4	5.3	16.4	11.0	24.5	22.5	42.2
Camden	NJ		0.0	3.8	0.1	7.3	4.3	14.8	9.5	22.4	20.4	34.5
Gloucester	NJ		0.2	9.2	6.1	18.4	17.7	33.3	29.6	46.5	53.5	69.3
Salem	NJ		5.9	26.9	21.3	48.7	53.8	84.4	83.9	114.0	135.5	160.3
Cumberland	NJ		3.0	15.8	12.1	28.9	30.3	53.2	49.5	76.9	90.8	114.3
Cape May	NJ		0.4	3.5	2.5	7.5	8.6	19.9	20.9	36.9	55.5	68.0
Total			**35.9**	**142.0**	**108.0**	**253.7**	**276.5**	**468.0**	**465.7**	**679.2**	**857.7**	**1060.4**
		Tidal	**Cumulative (total) amount of wetlands below a given elevation**									
Sussex	DE	67.4	2.1	4.8	4.6	6.2	6.8	8.6	9.0	10.6	12.3	13.3
Kent	DE	168.7	4.9	11.4	10.4	16.6	19.0	24.6	25.9	30.9	38.8	43.5
New Castle	DE	73.5	1.8	3.8	3.5	4.8	5.1	6.7	6.7	8.4	9.7	11.1
Delaware	PA	3.6	0.1	0.8	0.6	1.7	1.6	2.2	2.2	2.3	2.3	2.3
Philadelphia	PA	0.6	0.5	0.6	0.6	0.9	1.2	1.4	1.6	1.7	1.9	1.9
Bucks	PA	1.9	0.0	0.9	0.1	1.9	1.2	4.1	2.9	6.3	6.2	8.2
Mercer	NJ	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burlington	NJ	5.4	0.0	0.6	0.0	1.2	0.7	2.3	1.5	3.4	3.1	5.8
Camden	NJ	1.5	0.0	0.3	0.1	0.7	0.5	1.3	0.9	1.9	1.8	2.7
Gloucester	NJ	18.0	0.2	8.8	5.9	17.4	16.8	25.9	25.0	28.8	30.4	33.5
Salem	NJ	110.1	9.6	25.1	22.3	35.8	38.2	49.0	48.9	55.4	60.3	67.6
Cumberland	NJ	212.6	4.7	23.6	18.1	42.1	43.6	65.5	63.5	80.6	89.8	103.2
Cape May	NJ	48.3	4.3	14.7	12.2	25.1	28.2	40.3	41.5	51.2	58.6	63.7
Total		**713.5**	**28.3**	**95.5**	**78.5**	**154.2**	**163.0**	**231.8**	**229.7**	**281.6**	**315.1**	**356.8**
Dry and nontidal wetland			64	237	187	408	440	700	695	961	1173	1417
All land		713	778	951	900	1121	1153	1413	1409	1674	1886	2131

[a] This number includes Philadelphia's 2.4 square kilometers of dry land below spring high water, of which 0.87, 0.26, 0.054, and 0.005 are at least 0.5, 1, 2, and 3 meters below spring high water, respectively. Most of this land is near Philadelphia International Airport.

Table B.5 Low and High Estimates for the Area of Dry and Wet Land Close to Sea Level in DelMarVa Atlantic Coast

			Elevations above spring high water:									
			50 cm		1 meter		2 meters		3 meters		5 meters	
			Low	High	Low	High	Low	High	Low	High	Low	High
Locality	State	Cumulative (total) amount of Dry Land below a given elevation										
Northampton	VA		5.1	14.5	13.0	16.8	17.9	20.6	21.4	24.6	30.5	35.0
Accomack	VA		7.5	22.6	20.1	37.7	44.5	61.7	65.8	81.2	103.7	118.9
Worcester	MD		3.7	18.6	21.7	42.4	77.5	102.8	134.0	154.6	219.1	234.6
Sussex	DE		11.1	32.4	27.6	53.5	64.5	94.9	104.2	139.5	196.5	234.2
Total			**27.4**	**88.1**	**82.5**	**150.3**	**204.4**	**280.0**	**325.4**	**399.9**	**549.9**	**622.7**
		Tidal	**Cumulative (total) amount of wetlands below a given elevation**									
Northampton	VA	436.4	0.3	0.8	0.7	2.1	2.8	4.4	4.6	5.2	5.8	6.1
Accomack	VA	327.3	1.3	4.1	3.5	10.4	13.5	20.7	21.9	26.2	31.2	33.7
Worcester	MD	118.5	0.4	4.3	5.0	8.8	14.1	18.1	23.4	27.0	36.0	37.6
Sussex	DE	41.0	1.7	4.9	4.2	7.5	8.8	12.2	12.9	15.7	18.9	20.7
Total		**923.3**[a]	**3.7**	**14.1**	**13.4**	**28.7**	**39.2**	**55.4**	**62.7**	**74.1**	**91.9**	**98.1**
Dry and Nontidal wetland			31	102	96	179	244	335	388	474	642	721
All Land		923	954	1025	1019	1102	1167	1259	1311	1397	1565	1644

[a] Includes 375 square kilometers of tidal mudflats in Northampton and Accomack counties.

Table B.6 Low and High Estimates for the Area of Dry and Wet Land Close to Sea Level in Hampton Roads, Virginia

Locality		**Elevations above spring high water**									
		50 cm		**1 meter**		**2 meters**		**3 meters**		**5 meters**	
		Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
	Cumulative (total) amount of Dry Land below a given elevation										
Virginia Beach		9.3	33.0	30.3	68.7	93.6	163.2	184.7	272.9	378.1	418.2
Chesapeake		3.5	11.9	10.8	30.6	44.6	86.6	100.4	204.5	353.0	429.7
Norfolk		1.9	5.8	5.2	17.1	24.0	42.4	52.4	91.2	121.7	128.2
Portsmouth		1.2	3.9	3.5	9.6	12.8	22.0	26.7	45.0	62.6	69.9
Suffolk		0.7	4.3	3.1	7.1	7.5	15.2	13.0	31.0	47.3	73.3
Isle of Wight		0.2	3.4	2.1	6.2	6.0	12.8	10.1	21.6	26.8	42.0
Surry		0.0	1.4	0.7	2.7	2.7	5.3	4.6	7.1	8.1	11.2
James City		0.1	3.8	2.2	7.2	7.0	14.2	11.8	22.1	26.7	38.7
York		1.4	6.0	4.8	13.1	16.3	27.7	28.3	37.3	44.3	51.3
Newport News		2.2	6.9	6.1	11.0	12.9	17.9	19.3	24.8	34.9	42.3
Poquoson		1.4	4.5	4.1	8.8	10.9	16.3	16.4	16.6	16.7	16.7
Hampton		1.9	5.9	5.3	18.1	25.4	45.3	51.2	73.8	94.7	102.4
Total		**23.8**	**90.8**	**78.2**	**200.2**	**263.6**	**468.9**	**519.0**	**847.9**	**1214.9**	**1423.8**
	Tidal	**Cumulative (total) amount of wetlands below a given elevation**									
Virginia Beach	111.9	4.2	14.5	13.3	24.9	29.1	40.9	43.5	49.6	56.5	59.3
Chesapeake	39.7	4.5	16.6	15.4	32.1	36.4	58.3	55.7	120.2	180.3	250.8
Norfolk	4.7	0.1	0.3	0.2	0.5	0.7	1.1	1.1	1.5	1.7	1.7
Portsmouth	3.7	2.4	7.7	6.8	8.9	9.1	9.5	9.6	10.3	10.9	11.2
Suffolk	26.4	0.0	0.2	0.1	0.3	0.3	0.8	0.5	1.8	2.9	33.1
Isle of Wight	28.6	0.0	0.3	0.2	0.6	0.6	1.4	1.0	3.1	4.0	7.3
Surry	11.5	0.0	0.6	0.3	1.3	1.2	2.4	2.1	2.7	2.9	3.4
James City	32.8	0.0	0.8	0.4	1.5	1.4	2.8	2.5	3.7	4.2	5.6
York	17.0	0.2	0.9	0.7	2.7	3.7	6.7	6.9	8.0	9.2	9.9
Newport News	15.1	0.1	0.3	0.3	0.7	0.9	1.3	1.4	1.4	1.6	1.7
Poquoson	23.7	0.0	0.1	0.1	0.4	0.6	1.1	1.1	1.1	1.1	1.1
Hampton	14.3	0.1	0.2	0.2	0.4	0.5	0.9	1.1	2.2	4.4	6.2
Total	**329.4**	**11.7**	**42.4**	**38.0**	**74.2**	**84.5**	**127.1**	**126.5**	**205.4**	**279.5**	**391.1**
Dry and Nontidal wetland		35	133	116	274	348	596	645	1053	1494	1815
All Land	329	365	463	446	604	677	925	975	1383	1824	2144

Table B.7 Low and High Estimates for the Area of Dry and Wet Land Close to Sea Level in Middle Peninsula and Northern Neck Areas, Virginia

Locality		**Elevations above spring high water**									
		50 cm		**1 meter**		**2 meters**		**3 meters**		**5 meters**	
		Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
		Cumulative (total) amount of Dry Land below a given elevation									
Gloucester		4.1	16.0	13.2	32.9	40.5	66.9	66.9	84.2	96.4	110.8
Mathews		4.7	14.8	13.4	33.1	43.9	73.1	78.6	96.8	114.7	120.7
Middlesex		0.2	3.4	2.0	6.8	7.3	14.4	13.1	22.8	28.1	38.9
King William		0.0	1.6	0.9	3.2	3.1	8.4	5.4	17.7	22.7	36.1
King and Queen		0.0	2.9	1.7	5.7	5.5	11.9	9.6	19.0	22.7	32.9
Essex		0.0	3.8	2.0	7.3	7.1	15.5	12.3	27.9	34.2	52.8
Lancaster		0.1	7.0	3.6	13.8	13.8	28.0	24.0	41.5	48.4	67.9
Northumberland		0.0	5.9	2.8	11.5	11.0	24.1	19.2	63.8	84.5	140.9
Richmond		0.0	4.6	2.4	8.9	8.7	18.5	15.0	31.6	38.2	56.5
Caroline		0.0	0.4	0.3	0.9	0.9	1.8	1.5	2.8	3.4	5.2
Spotsylvania		0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.5	0.8
Fredericksburg		0.0	0.1	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5
Total		**9.2**	**60.5**	**42.4**	**124.2**	**142.1**	**263.2**	**246.0**	**409.0**	**494.2**	**664.0**
	Tidal	**Cumulative (total) amount of wetlands below a given elevation**									
Gloucester	43.5	1.4	5.5	4.5	11.9	14.7	24.8	24.6	30.8	34.4	38.5
Mathews	27.0	1.2	3.8	3.5	8.6	11.4	19.0	21.6	33.6	48.1	55.1
Middlesex	9.7	0.0	0.7	0.4	1.4	1.4	2.8	2.4	3.5	3.8	4.8
King William	35.6	0.0	0.4	0.2	0.7	0.7	1.4	1.2	2.0	2.3	3.3
King and Queen	21.6	0.0	0.9	0.5	1.7	1.6	3.1	2.8	4.0	4.4	5.8
Essex	27.5	0.0	0.8	0.4	1.5	1.5	2.9	2.5	3.9	4.4	5.9
Lancaster	9.8	0.0	0.5	0.3	1.1	1.1	2.1	1.8	2.8	3.2	4.2
Northumberland	11.4	0.0	0.5	0.3	1.1	1.0	2.2	1.8	5.1	6.6	10.8
Richmond	21.7	0.0	0.9	0.4	1.7	1.6	3.3	2.8	4.5	5.1	6.9
Caroline	6.3	0.0	0.1	0.0	0.1	0.1	0.3	0.2	0.7	0.9	1.5
Spotsylvania	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
Fredericksburg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**214.3**	**2.6**	**14.1**	**10.5**	**29.7**	**35.1**	**62.0**	**61.7**	**90.9**	**113.5**	**136.9**
Dry and Nontidal wetland		12	75	53	154	177	325	308	500	608	801
All Land	214	226	289	267	368	392	539	522	714	822	1015

Table B.8 Low and High Estimates for the Area of Dry and Wet Land Close to Sea Level in Potomac River

			Elevations above spring high water									
			50 cm		1 meter		2 meters		3 meters		5 meters	
			Low	High	Low	High	Low	High	Low	High	Low	High
Locality	**State**		Cumulative (total) amount of Dry Land below a given elevation									
Westmoreland	VA		0.0	4.7	2.4	9.3	9.0	21.2	15.5	53.0	69.2	112.3
King George	VA		0.0	2.7	1.5	5.4	5.2	11.4	9.0	21.9	27.3	42.8
Stafford	VA		0.0	1.4	0.8	2.7	2.7	5.4	4.6	8.1	9.5	13.5
Prince William	VA		0.0	1.0	0.5	2.0	1.9	3.9	3.3	5.5	6.4	8.8
Fairfax	VA		0.0	2.0	1.1	3.9	3.8	7.6	6.6	10.7	12.4	18.1
Alexandria	VA		0.0	0.4	0.3	0.9	0.9	1.7	1.5	2.5	2.9	4.0
Arlington	VA		0.0	0.2	0.1	0.5	0.5	1.3	0.8	2.6	3.4	5.0
DC			1.6	3.0	2.8	4.4	5.5	7.4	8.9	11.1	15.9	17.7
Prince George’s	MD		0.1	1.1	0.5	2.2	1.6	4.0	3.2	5.4	6.6	9.9
Charles	MD		0.7	10.9	4.6	19.4	14.1	38.4	28.3	64.0	74.2	96.0
St. Mary’s	MD		1.6	12.0	5.6	19.8	14.9	39.2	27.9	70.1	81.2	99.8
Total			**4.1**	**39.5**	**20.1**	**70.4**	**60.0**	**141.5**	**109.5**	**255.1**	**308.9**	**428.1**
		Tidal	**Cumulative (total) amount of wetlands below a given elevation**									
Westmoreland	VA	14.4	0.0	0.5	0.3	1.0	1.0	2.2	1.7	5.6	7.3	12.0
King George	VA	13.5	0.0	0.5	0.3	1.0	1.0	2.0	1.7	2.8	3.3	4.6
Stafford	VA	6.8	0.0	0.5	0.3	1.0	1.0	1.9	1.7	2.6	3.0	3.9
Prince William	VA	5.1	0.0	0.2	0.1	0.3	0.3	0.6	0.5	0.7	0.8	0.9
Fairfax	VA	4.9	0.0	0.2	0.1	0.4	0.4	0.7	0.6	0.9	1.1	1.4
Alexandria	VA	0.2	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Arlington	VA	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC		0.5	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.3	0.3
Prince George’s	MD	1.6	0.0	0.3	0.1	0.5	0.4	0.8	0.7	0.9	1.2	2.1
Charles	MD	22.9	0.1	3.6	1.4	6.2	4.6	11.3	9.0	15.9	17.8	22.2
St. Mary’s	MD	11.7	0.3	1.8	0.8	3.3	2.4	7.1	4.9	12.9	15.4	22.5
Total		**81.5**	**0.5**	**7.6**	**3.5**	**13.9**	**11.1**	**26.8**	**21.0**	**42.7**	**50.1**	**70.1**
Dry and Nontidal wetland			5	47	24	84	71	168	130	298	359	498
All Land		82	86	129	105	166	153	250	212	379	441	580

Table B.9 Low and High Estimates for the Area of Dry and Wet Land Close to Sea Level – Maryland Western Shore

		Elevations above spring high water									
		50 cm		1 meter		2 meters		3 meters		5 meters	
		Low	High	Low	High	Low	High	Low	High	Low	High
Locality		Cumulative (total) amount of Dry Land below a given elevation									
Prince George's		0.0	1.1	0.4	1.7	1.3	3.2	2.3	5.3	6.5	10.8
Charles		0.0	0.7	0.3	1.2	0.9	2.0	1.7	2.5	2.7	3.3
St. Mary's		0.8	3.8	2.5	8.0	8.8	18.8	18.2	30.6	38.5	48.4
Calvert		0.4	3.9	1.7	5.8	4.6	10.1	7.6	17.3	21.2	35.7
Anne Arundel		1.7	7.2	6.7	14.6	20.2	38.7	43.5	59.1	80.5	94.3
Howard		0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.3
Baltimore City		0.2	2.1	0.9	3.9	2.7	7.5	5.7	11.9	14.1	21.0
Baltimore		2.3	6.6	7.3	13.0	20.8	27.0	37.0	45.8	74.5	80.7
Harford		0.7	17.3	7.6	25.1	21.7	40.3	34.2	57.1	65.5	78.2
Total		**6.1**	**42.7**	**27.5**	**73.4**	**81.1**	**147.8**	**150.3**	**229.7**	**303.7**	**372.7**
	Tidal	**Cumulative (total) amount of wetlands below a given elevation**									
Prince George's	12.3	0.0	0.5	0.2	0.9	0.7	1.8	1.3	2.9	3.5	5.1
Charles	1.3	0.0	0.2	0.1	0.2	0.2	0.4	0.3	0.4	0.5	0.6
St. Mary's	7.0	0.3	1.0	0.8	2.0	2.2	3.9	3.9	5.9	7.5	8.8
Calvert	14.6	0.1	0.9	0.4	1.3	1.1	2.2	1.7	3.8	4.7	7.5
Anne Arundel	12.1	0.2	0.7	0.6	1.6	3.1	8.1	9.5	12.4	15.3	17.1
Howard	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1
Baltimore City	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1
Baltimore	10.5	0.1	0.3	0.3	0.7	1.0	1.3	1.5	1.7	2.2	2.3
Harford	29.4	0.2	2.5	1.2	3.8	3.3	6.2	5.2	9.0	10.2	12.0
Total	**87.3**	**0.8**	**6.2**	**3.7**	**10.5**	**11.6**	**24.0**	**23.5**	**36.4**	**43.9**	**53.6**
Dry and Nontidal wetland		7	49	31	84	93	172	174	266	348	426
All Land	87	94	136	119	171	180	259	261	353	435	514

Table B.10 Low and High Estimates for the Area of Dry and Wet Land Close to Sea Level – Chesapeake Bay Eastern Shore

			Elevations above spring high water									
			50 cm		1 meter		2 meters		3 meters		5 meters	
			Low	High	Low	High	Low	High	Low	High	Low	High
Locality	**State**	Cumulative (total) amount of Dry Land below a given elevation										
Cecil	MD		0.2	2.5	1.0	5.2	3.7	11.6	7.8	20.0	24.3	37.9
Kent	MD		0.2	8.4	4.8	15.9	16.3	32.9	28.8	56.1	71.4	105.2
Queen Anne's	MD		0.6	4.1	5.3	11.9	24.2	35.0	51.6	68.2	125.2	142.6
Caroline	MD		0.7	3.2	2.2	6.1	6.9	12.5	13.2	19.7	25.9	32.9
Talbot	MD		2.2	7.8	11.1	23.7	64.0	98.7	148.7	175.1	265.6	279.4
Sussex	DE		0.5	1.6	1.4	3.3	4.3	7.1	8.5	13.8	26.0	36.3
Dorchester	MD		30.1	120.0	150.4	214.9	281.9	312.9	358.4	386.2	461.6	474.0
Wicomico	MD		5.0	14.9	18.3	28.6	47.1	58.5	76.0	86.2	133.2	141.6
Somerset	MD		17.1	58.4	70.5	100.7	167.8	193.4	215.1	232.5	326.5	344.6
Worcester	MD		0.7	2.7	3.1	5.8	10.6	16.5	23.6	28.4	46.1	53.4
Accomack	VA		5.8	18.4	16.8	40.4	53.3	87.5	94.2	110.4	129.5	138.1
Northampton	VA		2.3	7.2	6.5	15.8	20.8	34.5	39.9	62.8	98.7	123.7
Total			**65.3**	**249.1**	**291.4**	**472.4**	**701.0**	**901.2**	**1065.8**	**1259.5**	**1734.0**	**1909.7**
		Tidal	**Cumulative (total) amount of wetlands below a given elevation**									
Cecil	MD	12.6	0.0	0.2	0.0	0.7	0.4	1.7	1.2	2.8	3.5	5.5
Kent	MD	18.3	0.1	1.1	0.9	2.6	3.3	5.4	5.2	7.9	9.7	14.4
Queen Anne's	MD	21.4	0.2	1.1	1.5	3.0	4.9	6.5	7.9	9.6	14.6	17.9
Caroline	MD	14.4	0.3	1.4	0.7	2.6	2.5	5.3	4.4	7.5	8.0	11.7
Talbot	MD	26.1	0.1	0.3	0.5	1.0	2.5	4.2	6.8	8.5	17.9	19.6
Sussex	DE	6.7	0.6	1.8	1.6	2.7	3.1	4.4	4.8	6.4	10.1	13.1
Dorchester	MD	424.8	14.9	45.8	53.4	70.1	94.4	104.0	113.8	120.6	140.1	142.5
Wicomico	MD	67.0	5.4	9.9	10.7	13.5	24.2	29.2	37.0	44.4	67.0	70.2
Somerset	MD	265.4	6.6	15.7	17.3	21.3	34.8	39.8	45.1	51.5	80.6	90.1
Worcester	MD	23.7	0.3	0.9	1.0	1.6	2.7	4.0	6.3	8.8	18.2	20.8
Accomack	VA	156.4	5.3	16.7	15.3	34.6	44.8	71.8	76.5	88.2	103.2	111.1
Northampton	VA	25.5	0.1	0.4	0.4	1.2	1.9	3.7	4.2	6.2	8.8	10.1
Total		**1062.4**	**33.8**	**95.3**	**103.3**	**155.0**	**219.5**	**279.9**	**313.0**	**362.4**	**481.7**	**526.9**
Dry and Nontidal wetland			99	344	395	627	921	1181	1379	1622	2216	2437
All Land		1062	1162	1407	1457	1690	1983	2244	2441	2684	3278	3499

Appendix C

Low and High Estimates of the Area of Land Close to Sea Level, by Region: Mid-Atlantic[a] (square kilometers)

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[a] The low and high estimates are based on the on the contour interval and/or stated root mean square error (RMSE) of the data used to calculate elevations and an assumed standard error of 30 cm in the estimation of spring high water. For details, see main text of this Section 1.3.

Table C.1 Low and High Estimates of the Area of Land Close to Sea Level by Region

Jurisdiction		Meters above Spring High Water																			
		low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
		0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		5.0	
		---------------Cumulative (total) amount of Dry Land below a given elevation--------------																			
L.I. Sound and Peconic		**6**	**31**	**22**	**59**	**42**	**86**	**63**	**111**	**85**	**135**	**106**	**158**	**127**	**181**	**149**	**200**	**170**	**216**	**190**	**229**
South Shore Long Island		**19**	**70**	**59**	**134**	**108**	**198**	**161**	**250**	**216**	**293**	**266**	**335**	**309**	**369**	**347**	**400**	**380**	**429**	**410**	**450**
NY Harbor/ Raritan Bay Total		**5**	**72**	**47**	**143**	**93**	**200**	**139**	**230**	**185**	**260**	**215**	**288**	**240**	**316**	**265**	**343**	**290**	**360**	**314**	**374**
New York		0	13	8	25	16	37	24	44	32	51	40	58	46	65	52	72	59	76	65	78
New Jersey		5	59	39	117	77	163	115	186	153	209	175	230	194	251	213	271	231	284	249	295
New Jersey Shore		**18**	**61**	**66**	**129**	**131**	**186**	**184**	**237**	**223**	**283**	**262**	**327**	**304**	**369**	**344**	**409**	**382**	**445**	**418**	**481**
Delaware Bay Total		**19**	**62**	**52**	**108**	**88**	**154**	**124**	**206**	**166**	**259**	**217**	**312**	**268**	**366**	**321**	**421**	**374**	**470**	**427**	**512**
New Jersey		3	19	15	36	27	53	39	73	52	94	70	114	90	134	109	154	127	170	146	182
Delaware		15	43	38	71	61	101	85	133	114	165	146	198	178	232	212	267	247	300	281	330
Delaware River Total		**17**	**80**	**56**	**146**	**103**	**210**	**152**	**262**	**201**	**315**	**249**	**368**	**296**	**417**	**342**	**467**	**386**	**512**	**430**	**549**
Delaware: fresh		2	6	5	10	8	14	11	19	15	24	19	28	24	32	28	36	32	39	35	42
Delaware: saline		5	13	12	20	17	27	23	33	29	40	35	47	41	54	49	62	56	70	64	77
New Jersey: fresh		0	18	7	35	17	52	28	67	39	83	52	98	65	114	77	130	90	144	102	154
New Jersey: saline		6	27	21	48	37	68	53	82	68	96	82	109	95	121	108	133	119	143	130	152
Pennsylvania		4	17	11	33	24	49	37	61	50	73	61	85	71	96	81	106	90	115	99	123
Atlantic Coast of Del-Mar-Va Total		**27**	**87**	**81**	**148**	**140**	**212**	**200**	**275**	**259**	**334**	**318**	**390**	**373**	**443**	**425**	**495**	**477**	**548**	**529**	**599**
Delaware		11	32	28	53	46	74	64	95	82	117	104	139	126	163	149	187	172	210	196	234
Maryland		3	17	20	40	44	69	74	97	101	123	126	145	148	163	165	180	182	196	199	211
Virginia		13	37	33	55	49	69	62	82	75	94	87	106	99	117	111	129	122	141	134	154
Chesapeake Bay Total		**102**	**466**	**441**	**906**	**791**	**1357**	**1193**	**1827**	**1587**	**2334**	**1973**	**2859**	**2448**	**3378**	**2962**	**3818**	**3446**	**4234**	**3865**	**4633**
Delaware		1	2	1	3	3	5	4	7	6	10	9	14	12	18	15	24	20	29	26	36
Maryland		66	290	306	530	515	763	738	1007	952	1227	1141	1451	1352	1670	1572	1865	1778	2047	1966	2213
fresh		9	35	33	70	63	115	106	167	152	212	192	263	243	325	307	394	377	466	449	533
vulnerable		49	187	234	344	379	477	515	605	633	704	731	804	830	892	911	958	974	1011	1024	1058
saline		8	68	39	117	74	171	118	235	167	311	218	385	280	454	354	513	427	570	492	623

Table C.1 Low and High Estimates of the Area of Land Close to Sea Level by Region (continued)

Jurisdiction		Meters above Spring High Water																			
		low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
		0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		5.0	
District of Columbia		2	3	3	4	4	6	5	7	7	9	9	11	11	13	13	15	14	16	16	18
Virginia		34	172	131	369	268	583	445	805	622	1088	815	1383	1073	1677	1362	1915	1634	2141	1857	2366
fresh		1	26	15	50	33	75	50	106	67	152	89	198	125	244	169	292	214	340	260	394
vulnerable		3	8	7	17	14	26	22	35	30	40	37	44	42	48	46	51	50	53	52	55
saline		30	138	108	302	222	482	373	665	525	896	689	1140	906	1385	1147	1573	1370	1748	1545	1916
Virginia Beach Atlantic Coast		**7**	**27**	**25**	**56**	**45**	**99**	**78**	**142**	**118**	**180**	**158**	**219**	**196**	**257**	**235**	**288**	**272**	**299**	**293**	**310**
Pamlico Albemarle Sounds		**602**	**1004**	**1160**	**1492**	**1657**	**2024**	**2211**	**2573**	**2746**	**3080**	**3246**	**3601**	**3798**	**4215**	**4421**	**4760**	**4903**	**5144**	**5241**	**5412**
Atlantic Coast of NC		**94**	**140**	**170**	**225**	**259**	**322**	**355**	**413**	**442**	**491**	**514**	**563**	**586**	**639**	**666**	**724**	**751**	**812**	**838**	**892**
Total NY to NC		**918**	**2101**	**2181**	**3545**	**3457**	**5047**	**4860**	**6526**	**6228**	**7964**	**7523**	**9418**	**8946**	**10949**	**10475**	**12325**	**11831**	**13470**	**12956**	**14441**
Wetlands	Tidal	---------Cumulative (total) amount of Nontidal Wetlands below a given elevation---------																			
L.I. Sound and Peconic	**36**	**1**	**2**	**2**	**4**	**3**	**6**	**4**	**7**	**6**	**8**	**7**	**9**	**8**	**10**	**9**	**11**	**10**	**12**	**11**	**13**
South Shore Long Island	**104**	**1**	**4**	**4**	**7**	**6**	**9**	**8**	**10**	**9**	**11**	**11**	**12**	**11**	**13**	**12**	**13**	**13**	**14**	**14**	**15**
NY Harbor/ Raritan Bay Total	**68**	**0**	**3**	**2**	**6**	**4**	**8**	**6**	**9**	**7**	**10**	**9**	**11**	**9**	**12**	**10**	**13**	**11**	**14**	**12**	**16**
New York	9	0	1	0	1	1	1	1	2	1	2	2	2	2	2	2	2	2	2	2	2
New Jersey	59	0	2	2	5	3	7	5	7	6	8	7	9	8	10	9	11	9	12	10	13
New Jersey Shore	**524**	**11**	**52**	**42**	**92**	**72**	**129**	**101**	**157**	**128**	**181**	**152**	**205**	**174**	**227**	**196**	**249**	**216**	**269**	**237**	**286**
Delaware Bay Total	**497**	**16**	**54**	**45**	**90**	**72**	**121**	**98**	**139**	**121**	**156**	**140**	**173**	**157**	**188**	**172**	**202**	**186**	**214**	**199**	**224**
New Jersey	261	9	38	30	67	51	92	72	106	91	119	105	132	118	142	129	153	139	161	148	167
Delaware	236	7	16	15	23	20	29	26	33	31	37	35	41	39	46	43	49	47	53	51	57
Delaware River Total	**216**	**12**	**41**	**33**	**64**	**49**	**85**	**65**	**93**	**80**	**101**	**90**	**108**	**97**	**115**	**103**	**122**	**109**	**127**	**116**	**133**
Delaware: fresh	5	0	1	1	1	1	2	2	2	2	2	2	3	2	3	3	3	3	3	3	3
Delaware: saline	69	1	3	3	3	3	4	4	5	4	5	5	6	5	6	6	7	6	7	7	8
New Jersey: fresh	29	0	10	6	20	12	29	19	31	25	34	29	37	32	40	34	43	37	46	39	48
New Jersey: saline	108	10	25	22	35	30	44	37	47	44	50	47	52	50	55	52	57	54	59	56	62
Pennsylvania	6	1	2	1	4	3	6	4	8	6	9	7	10	8	11	9	12	9	12	10	12
Atlantic Coast of Del-Mar-Va Total	**757**	**3**	**13**	**13**	**26**	**24**	**38**	**36**	**49**	**47**	**57**	**55**	**64**	**62**	**70**	**68**	**74**	**73**	**78**	**77**	**82**

Table C.1 Low and High Estimates of the Area of Land Close to Sea Level by Region (continued)

Jurisdiction	Meters above Spring High Water																				
		low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
		0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		5.0	
Delaware	41	2	5	4	7	7	10	9	12	11	14	13	16	15	17	16	18	18	20	19	21
Maryland	105	0	4	5	8	9	13	14	17	18	22	22	26	26	28	29	31	31	33	33	34
Virginia	611	1	5	4	10	9	16	13	19	18	21	20	23	22	24	23	25	24	26	25	27
Chesapeake Bay Total	**1903**	**44**	**151**	**143**	**259**	**231**	**375**	**334**	**489**	**425**	**590**	**510**	**699**	**618**	**809**	**724**	**911**	**827**	**1008**	**920**	**1132**
Delaware	7	1	2	2	3	2	4	3	4	4	5	5	6	6	8	7	9	8	11	10	13
Maryland	1011	29	88	92	137	136	194	189	244	231	282	267	329	315	377	361	420	404	458	441	497
fresh	161	2	9	7	18	14	28	23	38	32	48	42	62	57	79	74	99	94	119	114	142
vulnerable	741	26	69	79	101	110	137	147	166	170	182	188	206	213	228	232	242	245	251	253	259
saline	109	1	10	6	18	12	29	19	40	28	51	36	61	45	70	55	79	64	87	73	95
District of Columbia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Virginia	884	14	60	49	119	92	178	141	240	190	302	239	363	296	424	356	481	415	539	469	622
fresh	168	1	12	8	21	14	30	21	37	27	44	34	52	40	59	47	70	56	83	66	118
vulnerable	88	2	5	4	11	9	18	15	25	21	28	26	31	30	35	33	38	36	41	39	45
saline	628	12	43	37	87	69	129	106	178	142	230	179	280	227	330	276	373	324	415	364	458
Virginia Beach Atlantic Coast	**124**	**6**	**21**	**20**	**37**	**33**	**47**	**42**	**57**	**52**	**66**	**61**	**73**	**69**	**81**	**76**	**88**	**84**	**92**	**89**	**96**
Pamlico Albemarle Sounds	**829**	**2083**	**2625**	**2772**	**3039**	**3130**	**3320**	**3401**	**3562**	**3640**	**3789**	**3852**	**3984**	**4045**	**4173**	**4235**	**4352**	**4409**	**4532**	**4592**	**4695**
Atlantic Coast of North Carolina	**443**	**197**	**255**	**275**	**315**	**335**	**374**	**393**	**429**	**448**	**481**	**495**	**525**	**538**	**568**	**583**	**616**	**632**	**666**	**680**	**710**
Total NY to NC	**5500**	**2374**	**3221**	**3351**	**3940**	**3959**	**4512**	**4487**	**5001**	**4963**	**5449**	**5381**	**5864**	**5788**	**6266**	**6189**	**6652**	**6571**	**7026**	**6948**	**7401**
		Cumulative (total) amount of land below a given elevation																			
Dry Land		918	2101	2181	3545	3457	5047	4860	6526	6228	7964	7523	9418	8946	10949	10475	12325	11831	13470	12956	14441
Nontidal Wetlands		2374	3221	3351	3940	3959	4512	4487	5001	4963	5449	5381	5864	5788	6266	6189	6652	6571	7026	6948	7401
All Land	5500	8792	10822	11032	12985	12915	15059	14847	17027	16690	18913	18404	20782	20234	22715	22163	24476	23902	25996	25403	27342