ESTIMATION OF HIGH GROUND-WATER LEVELS FOR CONSTRUCTION AND LAND USE PLANNING- A CAPE COD MASSACHUSETTS EXAMPLE- UPDATED 1991 REVISED 2006

Cape Cod Commission

Prepared in Cooperation with the
U.S. Geological Survey,
Water Resources Division

CONTENTS

PLATES 1-4

(available at the Cape Cod Commission)

NOTE: Pdf files of the annual ranges for groundwater levels and index well area are now available online, and may be downloaded for each Cape Cod town. These are on a more up-to-date base and may be easier to use then the originally published plates.

Estimation of High Ground-Water Levels for Construction and Land Use Planning, A Cape Cod, Massachusetts, Example – Updated 2006

By Michael H. Frimpter and Gabrielle C. Belfit

ABSTRACT

A technique for estimating the level to which ground water can rise as a consequence of weather and seasonal factors has been developed to assist the home-building industry, which designs and constructs septic systems, and health officials, who regulate septic systems. The report includes four plates that map areas where annual ground-water level ranges of 0-2 feet, 2-3 feet, 3-4 feet, 4-5 feet, and 5-6 feet are expected, and areas where water levels are best indexed to water levels in each of nine long-term observation wells. Information from the maps, nine tables of water-level correction factors, and the concurrent water levels at a test site and at an index observation well are used to estimate the high water level.

The technique assumes temporal and spatial continuity. It assumes that future precipitation, evaporation, and transpiration will be the same as in the past, and it assumes strong correlations between water-level fluctuations at septic-system sites and index wells. Water levels from the nine index-observation wells showed a high degree of correlation with the other 43 wells. Out of a possible 1.0, all of the pairs of wells used to revise the maps in this report had correlation coefficients of 0.8 or better, and more than 50 percent of the pairs of wells had coefficients of 0.9 or better. Statistical tests of the correlation coefficients and the number of pairs of measurements (student's t-test) showed all of the correlations to be significant at the 0.05 level.

This report includes a demonstration of the application of the technique for estimation of high ground-water level, a design parameter needed for septic system regulation on Cape Cod. The technique can also be used at potential building construction sites and other places where estimates of highest ground-water levels for construction and land use planning - - "a Cape Cod example".

INTRODUCTION

High ground-water levels are a major cause of septic-system failures, wet basements, and other problems for suburban and rural residents. For example, unexpectedly high ground-water levels can floor septic systems, causing sewage to back up into the home, and (or) reach the land surface, threatening public health, creating obnoxious odors, and devaluating property (Figure 1.) Persons who come in contact with untreated sewage can be exposed to bacterial and viral diseases, such as hepatitis, dysentery, cholera, and typhoid fever. Conditions leading to these problems can be anticipated during design phases of construction.

This report presents and estimation technique that could be employed, with certain adaptations, almost anywhere in the world that high ground-water levels in soil present problems with regard to construction. Practical applications of the technique are the design and safe use of septic-tank drainage pits, trenches, and fields, and the design of foundations, basements, and landscaping and drainage. The technique can be used in any season, thus eliminating the need to restrict water-level measurements to periods of high water level. It can, as an aid, help relieve builders, construction engineers, and health officials of seasonal restrictions on site testing.

Photograph courtesy of Soil Conservation Service, U.S. Department of Agriculture

Septic test regs disgruntle some Yarmouth builders wait for 'high time'

By Fran Gilpin

Yarmouth is not the strictest town on the Cape when regulating groundwater testing for installation of subsurface septic systems. But the recurrence of dissatisfied pleas heard around the community from building contractors, engineers and real estate agents about the town's amendments to Title V of the state sanitary code would almost make one think otherwise.

"I'm totally unaware of any specific complaints," said Ralph Cipolla, who headed [illegible] selectmen's health boa- [illegible] created last fa" [illegible] 'rumor, a' [illegible] but you [illegible]

building industry was generally favorable to Title V in the beginning since it brought a semblance of uniformity to town government building codes. When each town began going off in six different directions from Sunday, however, the tradesmen lost their enthusiasm for Title V.

"The uniformity was gone," said Johnson, "and that's when I had to object to what the Yarmouth Board of Health was doing. I also thought [illegible] Barnes, the then-health officer) was rushing it. We' [illegible] Title V, stan- [illegible] itself, would [illegible]

"The Register" 5/28/81

Figure 1- Newpaper article.

The maps and tables in this report were updated from an earlier report (Frimpter and Fisher, 1983). Data in this report has been updated on the basis of measurements made from 52 short-term observation wells with 13 years of record, and 8 long-term observation wells having 28 to 36 years of record. The original report was based on 146 short-term observation wells having 1 year of record and 9 long-term wells having 16 to 28 years of record. Although the authors are unaware of any reports of septic system failures caused by the use of estimates made with the original report, the maps and tables in this updated report will allow estimation of high ground-water levels with improved accuracy. Index wells that best represent areas of southern Yarmouth, southern Barnstable, Mashpee, Falmouth, and Bourne differ from those used for the original report, but water-level ranges were not changed. Tables 1-9 have been expanded to include new extremes of water levels that occurred since the original reports were prepared and the need to calculate extensions of the tables is no longer necessary. Maps of annual water level ranges that are town specific have been added online as pdf files to replace Plates 1-4.

To avoid septic-system failure caused by high ground-water levels, the Commonwealth of Massachusetts Department of Environmental Quality Engineering (1995) require that the bottoms of

domestic septic systems be at least 4 feet above the maximum anticipated level of the water table. The aerated zone between the bottom of the leaching facility of the septic system and the water table acts as a safety zone against flooding and also allows physical, chemical, and microbial processes to convert the sewage constituents into less noxious forms. Accurate estimates of high ground-water levels are therefore, necessary for the construction of properly operating septic systems.

This report is the product of a cooperative study by the Cape Cod Commission and the U.S. Geological Survey.

Ground-water Fluctuation with Time and Location

Ground-water levels can fluctuate several feet in response to seasonal weather and conditions and hydrologic factors. A single water-level measurement, although easily obtained, will rarely represent extreme ground-water levels. During the summer months, when evaporation and transpiration rates are high, water levels decline, reaching their lowest levels in late fall (fig. 2). During the winter months, water levels rise and commonly reach their highest levels in March and April. Recognizing this seasonal variation in water levels, some public health agencies have previously required that water levels be measured only during late winter and early spring for septic-system permit applications.

Hydrologic factors, other than seasonal changes in evaporation and transpiration, cause fluctuations in groundwater level. Long periods of below-average or no precipitation (one definition of a drought), such as that in the mid-1960s may cause water levels to decline to several feet below normal. Above-average precipitation, such, as occurred in the early 1970s, may cause water levels to rise higher than normal. Pumping of wells causes water levels to decline.

Hydrologic location also affects water-level range. Generally, the range is smallest near the ocean and near its bays, estuaries, or salt marshes. For example, the water level in observation well SDW 252 in Sandwich, 0.3 miles from Cape Cod Bay, fluctuated only 2.6 feet while the water level in well SDW-253 in Sandwich, 6 miles inland from Cape Cod Bay, fluctuated 9.3 feet over the same 13-year period (figs. 3 and 4). However, tidal fluctuations can affect groundwater levels within about 300 feet of the shore.

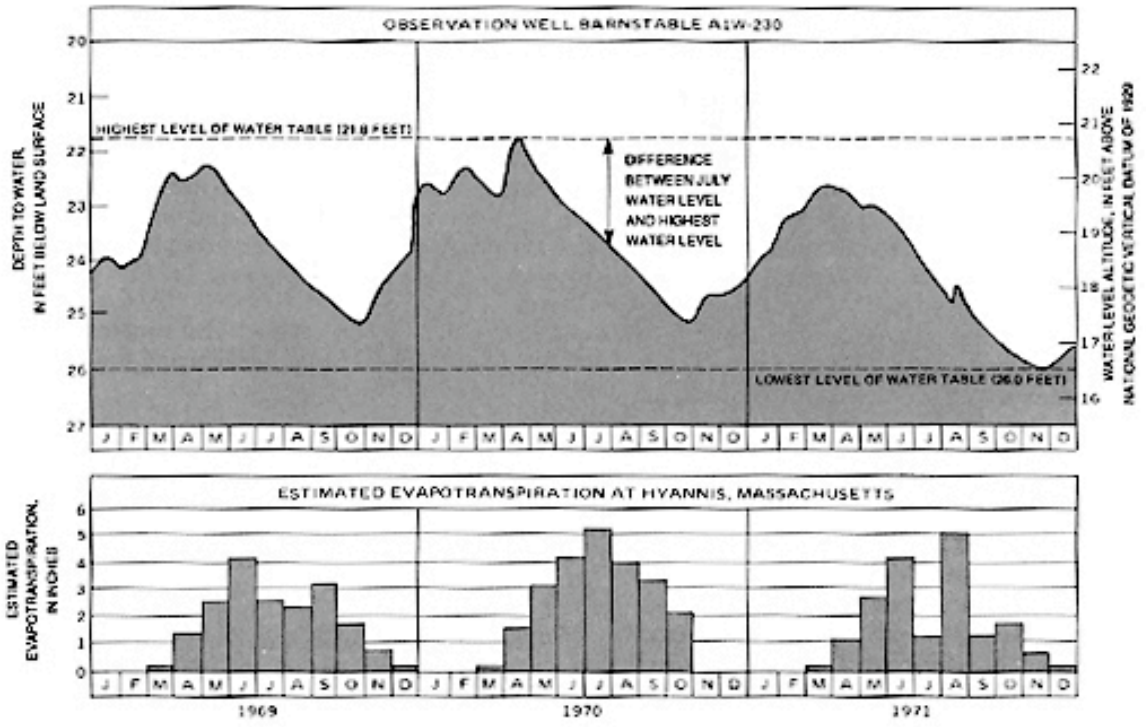

Figure 2.--Monthly water-level fluctuations in response to evapotranspiration.

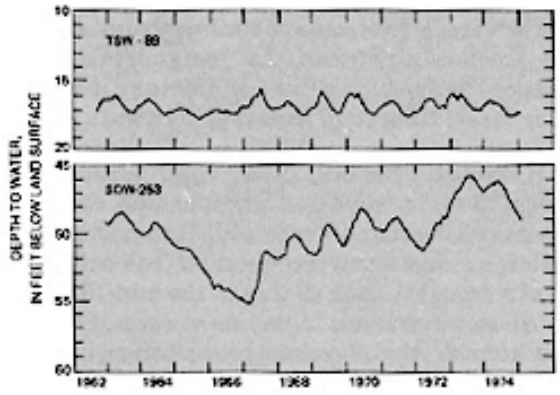

Figure 3.--Dissimilar water-level fluctuations in wells at 0.3 mile (TSW-89) and 6 miles (SDW-253) from Cape Cod Bay.

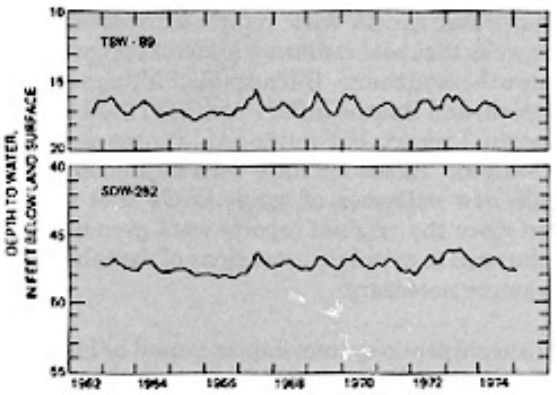

Figure 4.--Similar water-level fluctuations in two wells about 28 miles apart, but close to Cape Cod Bay.

Explanation of the Technique

The technique described in this report depends on several hydrologic characteristics of Cape Cod. First, weather and climate are relatively uniform throughout Cape Cod. Second, future weather and climatic conditions are assumed to be the same as in the past. This assumption is supported by no observable long-term trend in water levels in the observation-well network. Third, most of Cape Cod consists of sandy deposits that have relatively uniform hydrologic properties from site to site. This technique is designed to be used at sites underlain by sandy and gravelly soils, and not in wetlands or at sites where layers of clay, silt, or till are present.

Water-level ranges are generally not shown in wetlands, marshes, and water bodies on the maps (plates 1-4 available at the Cape Cod Commission, or download pdf files) in this report, because use of the technique in these areas would be inappropriate and lead to errors. In addition, the map delineations of the wetlands, marshes, and water bodies are too inaccurate for lot-by-lot assessments and should not be used to determine where the technique mayor may not be applied. Field investigation to determine on-site soil and hydrologic conditions is needed for proper evaluation of the suitability of the site for application of the technique.

The Cape Cod Commission, Water Resources Office, in cooperation with the U.S. Geological Survey (USGS), maintains a network of 65 observation wells across the Cape. The water levels in these wells are measured on a monthly or bi-monthly basis, and the data are maintained by both the Commission and the USGS in computer databases.

Water-level data for a 13-year period for 52 wells were used to determine five ranges (0-2 feet, 2-3 feet, 3-4 feet, 4-5 feet, and 5-6 feet) of annual fluctuations in ground-water levels (plates 1-4 refer to the printed copy of this publication, pdf files indicating the ranges and fluctuations for each town may also be downloaded). Nine of the 52 observation wells were selected as index wells. Areas where water levels best correlate with each of the nine index-observation wells are delineated on the maps as dashed-line boundaries (plates 1-4). Since the initial reports on high water levels on Cape Cod were written in 1980 and 1983, additional data have since been collected and analyzed. Multiple-regression analyses of ground-water levels has resulted in selection of one new index-observation well, MIW-29 in Mashpee, and elimination of index well BHW-198 in Bourne for use with the estimating technique. Also, the areas represented by the index-observation wells have been revised. New water-level correction tables computed from the 1991 water-level records (longer than those in 1980) are included in this report. The tables are matrixes of water-level adjustments to be applied to water-level measurements from test sites. The similarity of water levels in two observation wells almost 30 miles apart on opposite sides of Cape Cod Bay is evidence of a high degree of correlation (fig. 4). Water levels from the nine index-observation wells showed a high degree of correlation with the other 43 wells. Out of a possible 1.0, all of the pairs of wells used to revise the maps in this report had correlation coefficients of 0.8 or better, and more than 50 percent of the pairs of wells had coefficients of 0.9 or better. Statistical tests of the correlation coefficients and the number of pairs of measurements (student's -test) showed all of the correlations to be significant at the 0.05 level.

The water-level adjustment tables 1-4 and 6-9 are calculated from water-level records that span the periods of the highest (1972, 1987) and lowest (1965, 1981) annual precipitation recorded at Hyannis over a 96-year period (1894-1990). Table 5 for the new Mashpee index well is derived from water levels measured over 14 years (1976 and August 1978 through September 1991). A test of the technique using 49 wells showed that, over a 5-year period, water levels exceeded the estimated high-water level at only 8 percent of the wells, and all errors were less than 0.75 foot.

Sites near tidal water bodies present special problems. Within about 300 feet of tidal bodies, tides affect ground-water levels on Cape Cod. Where land elevations are close to sea level and the water table is shallow, tidal effects are superimposed on the seasonal fluctuations for which the technique in this report is designed. At a site affected by tides; estimates of high ground-water level may be made by first measuring the water level fluctuation over 24 hours (12 hours during a full or new moon), and then subtracting one half of that fluctuation from the depth to high water level estimated by the technique.

The response of the ground-water level to tides is delayed for variable lengths of time, according to soil properties and distances between a site and the tidal water body. Because the amount of delay is not known in advance, two ground water-level measurements one made at high tide and the other at low tide, may not measure the full range of ground-water level caused by tides. Also, tidal magnitudes differ according to phase of the moon and season, therefore selection of the measurement date can have an additional effect on the observed range in ground-water levels. For further information, "Tide tables (current year) high and low water predictions, East Coast of North America" can be purchased from National Ocean Service, Distribution, 6501 Lafayette Ave., Riverdale, MD 20840.

ESTIMATION OF HIGH GROUND-WATER LEVELS

Step 1. Measure Depth-to-Water at the Test Site

Measure the depth-to-water below the land surface (fig. 5) and record it on the computation form (fig. 6). Make measurement to the nearest 0.1 foot (fig. 5) and note soil conditions. For example, as recorded on the computation for Step 1 the depth-to-water was 10.8 feet on September 12, 2006. Sites should be inspected for the presence of buried layers of silt, clay, or till prior to attempting to estimate water levels. This technique is valid only in sandy and gravelly soil.

Figure 5- Measuring depth to water.

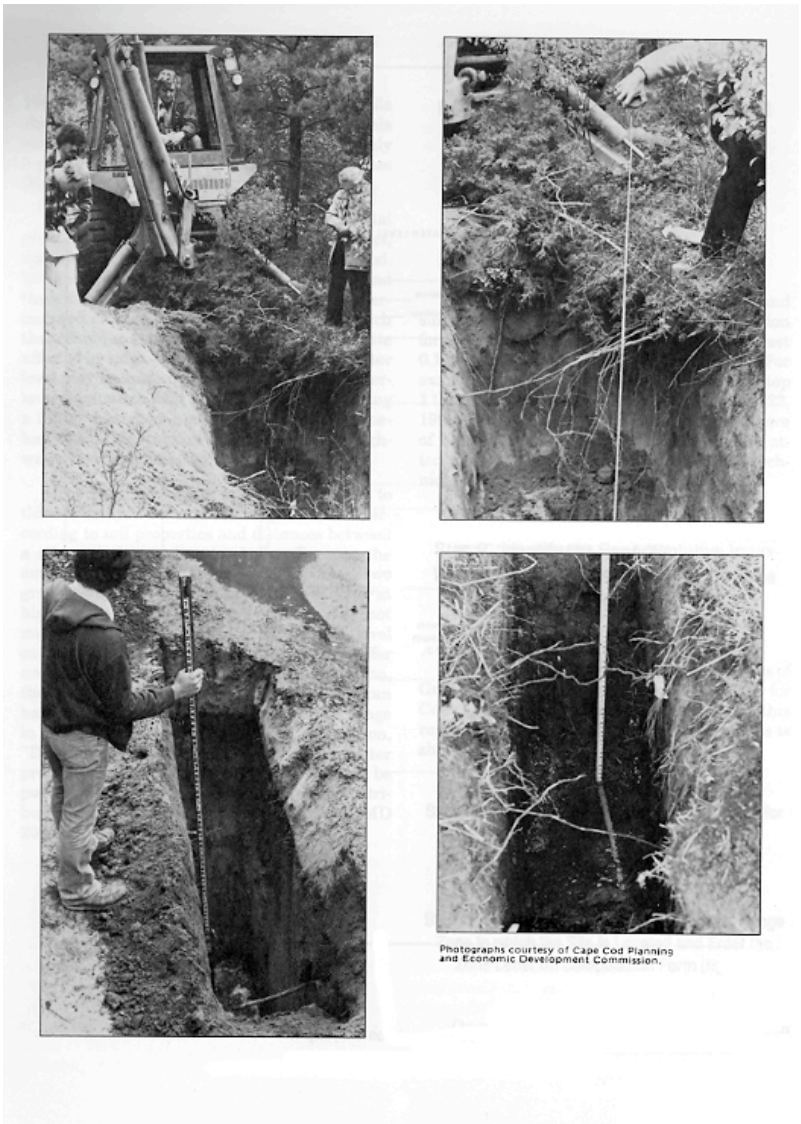

Figure 6- Computation Form Step 1

HIGH GROUND WATER-LEVEL COMPUTATION FORM

Date: _____

Site Location: _____ Permit: _____

_____

Owner: _____ Phone: _____

Contractor: _____ Phone: _____

Notes: _____

_____

STEP 1 Measure depth to water table to nearest 1/10 ft. (depth is in feet below land surface) Date: **9/12/06** mm/dd/yy — **10.8** feet below ls

STEP 2 Using Water-Level Range Zone and Index Well Map locate site and determine:

A) Appropriate index well

B) Water-level range zone

STEP 3 Using monthly "Current Water Resources Conditions" determine current depth to water level for index well.

_____ mm/yy

STEP 4 Using Table of Potential Water Level Rise for index well (STEP 2A), current depth to water level for index well (STEP 3), and water-level zone (STEP 2B) determine water-level adjustment.

STEP 5 Estimate depth to high water by subtracting the water-level adjustment (STEP 4) from measured depth to water level at site (STEP 1).

Step 2. Identify the Representative Index Well and Annual Water-Level-Range Zone for the Test Site.

Locate the test site on the "Annual Range of Ground-Water Level and Index-Well Areas for Cape Cod" maps. (plates 1-4) accompanying this report. You can also download a pdf of the town where the site is located to determine the index well and annual range zone. The location of the example test site is shown on plate 2.

Step 2A. Determine the Appropriate Index Well for the Site and Enter the Well Number on Computation Form (fig. 7).

Step 2B. Determine the Annual Water Level Range Zone In which the Site Is Located and Enter the Zone Letter on Computation Form (fig. 7).

On plate 2, the example test site is located in the area indexed to well MIW-29 and in Water Level-Range Zone B.

Figure 7- Computation Form Step 2

HIGH GROUND WATER-LEVEL COMPUTATION FORM

Date: _____

Site Location: _____ Permit: _____

Owner: _____ Phone: _____

Contractor: _____ Phone: _____

Notes: _____

STEP 1 Measure depth to water table to nearest 1/10 ft. (depth is in feet below land surface) Date: **9/12/06** (mm/dd/yy) **10.8** feet below ls

STEP 2 Using Water-Level Range Zone and Index Well Map locate site and determine:

A) Appropriate index well **MIW-29**

B) Water-level range zone **B**

STEP 3 Using monthly "Current Water Resources Conditions" determine current depth to water level for index well. _____ (mm/yy)

STEP 4 Using Table of Potential Water Level Rise for index well (STEP 2A), current depth to water level for index well (STEP 3), and water-level zone (STEP 2B) determine water-level adjustment.

STEP 5 Estimate depth to high water by subtracting the water-level adjustment (STEP 4) from measured depth to water level at site (STEP 1).

Step 3. Determine Current Depth-to-Water Level for Index Well

Determine the depth-to-water for the index well identified in Step 2A using the Cape Cod Commission Web site (fig 8) www.capecodcommission.org/wells.html or the Cape Cod Commission bimonthly newsletter "The Commission Reporter ". Select the level for the end-of-month closest in time to the date of the water-level measurement at the test site. Record that water level and the date at the Step 3 level on the computation form (fig. 9). For example, the index well recorded in Step 2A was Mashpee 29 (MIW-29), and the monthly report for September 2006 shows that the depth to water for Mashpee 29 was 8.06 feet below land surface (8.1 feet when rounded to the nearest tenth of a foot).

"The Commission Reporter" is available from the Cape Cod Commission, 3225 Main Street, Barnstable, MA 02630 or online www.capecodcommission.org/wells.html. Note that the index well uses a 3-character alpha-numeric prefix based on the location of the well. For example, Barnstable 230 is also A1W-230 in Figure 8.

Figure 8 – Index Well Monthly Data

September 2006

Location	Well No.	Water Level*	Record High*	Record Low*	Departure from Average** Monthly	Overall	USGS Site Number**** (links to USGS national water-level database)
Barnstable	A1W 230	23.4	20.5	26.6	0.9	0.2	413956070164301
Barnstable	A1W 247	22.6	20.5	28.6	2.2	1.8	414154070165001
Brewster	BMW 21	8.1	6.9	13.6	2.1	2.0	414518070020301
Chatham	CGW138	23.8	20.9	26.6	0.6	0.0	414100070011101
Mashpee	MIW 29	8.1	5.6	10.0	1.0	0.4	413525070291904
Sandwich	SDW 252	47.0	45.8	48.2	0.5	0.2	414418070241601
Sandwich	SDW 253	47.8	45.8	55.1	2.4	2.3	414124070265901
Truro	TSW 89	12.0	10.2	13.0	0.4	0.0	420206070045901
Wellfleet	WNW 17	10.4	7.3	12.8	0.4	0.1	415353069585401

Figure 9- Computation Form Step 3

HIGH GROUND WATER-LEVEL COMPUTATION FORM

Date: _____

Site Location: _____ Permit: _____

_____

Owner: _____ Phone: _____

Contractor: _____ Phone: _____

Notes: _____

_____

STEP 1 Measure depth to water table to nearest 1/10 ft. (depth is in feet below land surface)

Date: **9/12/06** mm/dd/yy — **10.8** feet below ls

STEP 2 Using Water-Level Range Zone and Index Well Map locate site and determine:

A) Appropriate index well: **MIW-29**

B) Water-level range zone: **B**

STEP 3 Using monthly "Current Water Resources Conditions" determine current depth to water level for index well.

9/6 mm/yy — **8.1**

STEP 4 Using Table of Potential Water Level Rise for index well (STEP 2A), current depth to water level for index well (STEP 3), and water-level zone (STEP 2B) determine water-level adjustment.

STEP 5 Estimate depth to high water by subtracting the water-level adjustment (STEP 4) from measured depth to water level at site (STEP 1).

Step 4. Determine Water-Level Adjustment

Refer to the water-level-adjustment table, "Potential Water-Level Rise, in feet, for Use With Index Well..." (tables 1-9 in the back of this report) for the appropriate index well (recorded in Step 2A). Record the water-level-adjustment value on the computation form (fig. 10) to determine the correct water-level adjustment, locate the current water level for the index well in the left-hand column of the water-level adjustment table. Then read from left to right on the same horizontal row to the column of adjustment values for the zone recorded in Step 2B. Figure 11 shows the water-level adjustment for the example test site is 2.4 feet.

Figure 10- Computation Form Step 4

HIGH GROUND WATER-LEVEL COMPUTATION FORM

Date: _____

Site Location: _____ Permit: _____

Owner: _____ Phone: _____

Contractor: _____ Phone: _____

Notes: _____

STEP 1 Measure depth to water table to nearest 1/10 ft. (depth is in feet below land surface)

Date: **9/12/06** (mm/dd/yy) — **10.8** feet below ls

STEP 2 Using Water-Level Range Zone and Index Well Map locate site and determine:

A) Appropriate index well: **MIW-29**

B) Water-level range zone: **B**

STEP 3 Using monthly "Current Water Resources Conditions" determine current depth to water level for index well.

9/6 (mm/yy) — **8.1**

STEP 4 Using Table of Potential Water Level Rise for index well (STEP 2A), current depth to water level for index well (STEP 3), and water-level zone (STEP 2B) determine water-level adjustment.

2.4

STEP 5 Estimate depth to high water by subtracting the water-level adjustment (STEP 4) from measured depth to water level at site (STEP 1).

Figure 11- Water Level Adjustment Table

Table 5 **Potential water-level rise, in feet, for use with index well Mashpee MIW-29**

WATER LEVEL	ZONE A	ZONE B	ZONE C	ZONE D
5.7	0	0	0	0
5.8	0.1	0.1	0.1	0.2
5.9	0.1	0.2	0.3	0.3
6	0.2	0.3	0.4	0.5
6.1	0.3	0.4	0.5	0.7
6.2	0.3	0.5	0.7	0.8
6.3	0.4	0.6	0.8	1
6.4	0.5	0.7	0.9	1.2
6.5	0.5	0.8	1.1	1.3
6.6	0.6	0.9	1.2	1.5
6.7	0.7	1	1.3	1.7
6.8	0.7	1.1	1.5	1.8
6.9	0.8	1.2	1.6	2
7	0.9	1.3	1.7	2.2
7.1	0.9	1.4	1.9	2.3
7.2	1	1.5	2	2.4
7.3	1.1	1.6	2.1	2.7
7.4	1.1	1.7	2.3	2.8
7.5	1.2	1.8	2.4	3
7.6	1.3	1.9	2.5	3.2
7.7	1.3	2	2.7	3.3
7.8	1.4	2.1	2.8	3.5
7.9	1.5	2.2	2.9	3.7
8	1.5	2.3	3.1	3.8
8.1	1.6	2.4	3.2	4
8.2	1.7	2.5	3.3	4.2
8.3	1.7	2.6	3.5	4.3
8.4	1.8	2.7	3.6	4.5
8.5	1.9	2.8	3.7	4.7
8.6	1.9	2.9	3.9	4.8

Step 5. Estimate Depth-to-High-Water Level at Test Site

Using the computation form (fig. 12), subtract the water-level-adjustment value determined in Step 4 from the measured depth-to-water at the site recorded in Step 1 to obtain the estimate of depth-to-high-water level and record on the computation form (fig. 12). Figure 12 shows that the estimated depth-to high-water level at the example test site is 8.4 feet below the land surface.

Figure 12- Computation Form Step 5

HIGH GROUND WATER-LEVEL COMPUTATION FORM

Date: _____

Site Location: _____ Permit: _____

_____

Owner: _____ Phone: _____

Contractor: _____ Phone: _____

Notes: _____

_____

STEP 1	Measure depth to water table to nearest 1/10 ft. (depth is in feet below land surface)	Date:	**9/12/06** mm/dd/yy	**10.8** feet below ls
STEP 2	Using Water-Level Range Zone and Index Well Map locate site and determine:			
	A) Appropriate index well		**MIW-29**	
	B) Water-level range zone		**B**	
STEP 3	Using monthly "Current Water Resources Conditions" determine current depth to water level for index well.	**9/6** mm/yy	**8.1**	
STEP 4	Using Table of Potential Water Level Rise for index well (STEP 2A), current depth to water level for index well (STEP 3), and water-level zone (STEP 2B) determine water-level adjustment.			**2.4**
STEP 5	Estimate depth to high water by subtracting the water-level adjustment (STEP 4) from measured depth to water level at site (STEP 1).			**8.4**

APPLICATION OF THE TECHNIQUE ON CAPE COD

The estimating technique described in this report has been widely used on Cape Cod for the past decade. According to the State of Massachusetts Sanitary Code (Title 5), and before the development of the technique, ground-water elevations for design and regulation of septic systems had to be measured when ground water was at its maximum elevation. In an attempt to conform to this regulation, some local Boards of Health restricted testing to the months of March, April, and May, the period of seasonal high ground-water levels. However, homebuilders found this restriction to be an impediment to efficient planning and scheduling of construction, while engineers and health officials found it to be inaccurate because springtime high water levels can vary significantly from year to year.

Another method of determining high ground-water levels is from soil color changes (mottling) that can be observed at the depth of the high water table in excavations in some soil types. Soil mottling, however, is not easily detected in many coarse-grained sediments, such as commonly occur on Cape Cod.

In 1995, The State Environmental Code was revised and the Department of Environmental Protection approved the use of this high groundwater estimating technique incorporating it into the language of the regulation 15.103:(3).

Most of the 15 towns of Cape Cod have incorporated the use of the technique in local regulations for septic system installations. The regulations are made under the authority of Section 31 of Chapter Ill, of the General Laws of the Commonwealth of Massachusetts. Virtually every practicing engineer on Cape Cod incorporates the technique when preparing plans for septic-system installation regardless of town regulation. Specific towns that include the USGS high ground-water technique as a Board of Health regulation and the dates of its enactment by the towns are: Yarmouth, 1980; Barnstable. 1981; Mashpee. 1981; Brewster 1986; Bourne, 1988; Dennis, 1989; Eastham, 1989; Harwich, 1989; Sandwich, 1991; and Chatham, 1992, Wellfleet, 1994 and Orleans, 2002. In enforcing the regulations, if there is a disagreement with the application of the method, or its results, it is up to the project proponent's engineer to substantiate a different high water-level estimate.

The USGS publishes the index-well data for on its web site http://waterdata.usgs.gov/nwis/gw. The USGS also publishes annual summaries and graphs of these data in "Water Resources Data, Massachusetts and Rhode Island, " Water Year (current year)". These reports include surface and ground-water levels for selected sites and provide some summary statistics on the observed data. The Cape Cod Commission also publishes the index-well data in their bimonthly newsletter "The Commission Reporter", which is available by subscription and on the Commission website www.capecodcommission.org/wells.html.

SUMMARY

High ground-water levels can be estimated for sand and gravel soils of Cape Cod by using the technique outlined in this report. An estimate can be made on the basis of one water-level measurement made during any season. This technique only applies to sand and gravel deposits and, should not be applied to wetlands or in areas underlain by silt, clay, or till layers. Information and assistance needed to apply the technique are available from both the USGS and the Cape Cod Commission.

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HIGH GROUND-WATER LEVEL COMPUTATION

Date: _____

Site Location: _____ Permit: _____

_____

Owner: _____ Phone: _____

Contractor: _____ Phone: _____

Notes: _____

_____

STEP 1 Measure depth to water table to nearest 1/10 ft. (depth is in feet below land surface)

Date: _____ mm/dd/yy [0] feet below ls

STEP 2 Using Water-Level Range Zone and Index Well Map locate site and determine:

A) Appropriate index well [ ]

B) Water-level range zone [ ]

STEP 3 Using monthly "Current Water Resources Conditions" determine current depth to water level for index well.

_____ mm/yy [ ]

STEP 4 Using Table of Potential Water Level Rise for index well (STEP 2A), current depth to water level for index well (STEP 3), and water-level zone (STEP 2B) determine water-level adjustment.

[0]

STEP 5

Estimate depth to high water by subtracting the water-level adjustment (STEP 4) from measured depth to water level at site (STEP 1).

[0]

NOTE* **Tables 1-9 "Potential Water-Level Rise" are attached as worksheets to this file.**

monthly index well data: www.capecodcommission.org/wells.html

Potential Water-Level Rise (feet) for Index Well-Reference Tables

The below tables are applicable for all Index Well Depth to Water measurements starting in January 2022. These tables were considered and approved by the Cape Cod Commission in February 2022.

Due to changes in the well network, new tables with appropriate adjustments were required. Measurements collected prior to January 2022 should utilize the archived adjustment tables, which can be accessed at the High Groundwater web page: https://capecodcommission.org/our-work/estimating-high-groundwater-level

Or using the following direct link: https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/Website_Resources/waterresources/Archive Groundwater Adjustment Tables.pdf

Potential Water-Level Rise (feet) for Index Well- Reference Table

Following Technical Bulletin 92-001, estimations of high groundwater levels are needed for construction and land use planning on Cape Cod. Using the appropriate index well and water-level range zone, water-level adjustment is provided, defined as Step 4 in the High Ground Water-Level Computation Form.

Index Well: **AIW231**

Index Well Depth to Water (feet below land surface)	Water-Level Range Zone Adjustments (ft)				
	Zone A	Zone B	Zone C	Zone D	Zone E
24.1	0	0	0	0	0
24.2	0.1	0.1	0.1	0.1	0.2
24.3	0.1	0.1	0.2	0.3	0.3
24.4	0.2	0.2	0.3	0.4	0.5
24.5	0.2	0.3	0.4	0.5	0.6
24.6	0.3	0.3	0.5	0.7	0.8
24.7	0.3	0.4	0.6	0.8	0.9
24.8	0.4	0.5	0.7	0.9	1.1
24.9	0.4	0.5	0.8	1.1	1.2
25.0	0.5	0.6	0.9	1.2	1.4
25.1	0.5	0.7	1	1.3	1.5
25.2	0.6	0.7	1.1	1.5	1.7
25.3	0.6	0.8	1.2	1.6	1.8
25.4	0.7	0.9	1.3	1.7	2
25.5	0.7	0.9	1.4	1.9	2.1
25.6	0.8	1	1.5	2	2.3
25.7	0.8	1.1	1.6	2.1	2.4
25.8	0.9	1.1	1.7	2.3	2.6
25.9	0.9	1.2	1.8	2.4	2.7
26.0	1	1.3	1.9	2.5	2.9
26.1	1	1.3	2	2.7	3
26.2	1.1	1.4	2.1	2.8	3.2
26.3	1.1	1.5	2.2	2.9	3.3
26.4	1.2	1.5	2.3	3.1	3.5
26.5	1.2	1.6	2.4	3.2	3.6
26.6	1.3	1.7	2.5	3.3	3.8
26.7	1.3	1.7	2.6	3.5	3.9
26.8	1.4	1.8	2.7	3.6	4.1
26.9	1.4	1.9	2.8	3.7	4.2
27.0	1.5	1.9	2.9	3.9	4.4
27.1	1.5	2	3	4	4.5
27.2	1.6	2.1	3.1	4.1	4.7
27.3	1.6	2.1	3.2	4.3	4.8
27.4	1.7	2.2	3.3	4.4	5
27.5	1.7	2.3	3.4	4.5	5.1
27.6	1.8	2.3	3.5	4.7	5.3
27.7	1.8	2.4	3.6	4.8	5.4
27.8	1.9	2.5	3.7	4.9	5.6
27.9	1.9	2.5	3.8	5.1	5.7

Index Well: **AIW231**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B	Zone C	Zone D	Zone E
28.0	2	2.6	3.9	5.2	5.9
28.1	2	2.7	4	5.3	6
28.2	2.1	2.7	4.1	5.5	6.2
28.3	2.1	2.8	4.2	5.6	6.3
28.4	2.2	2.9	4.3	5.7	6.5
28.5	2.2	2.9	4.4	5.9	6.6
28.6	2.3	3	4.5	6	6.8
28.7	2.3	3.1	4.6	6.1	6.9
28.8	2.4	3.1	4.7	6.3	7.1
28.9	2.4	3.2	4.8	6.4	7.2
29.0	2.5	3.3	4.9	6.5	7.4
29.1	2.5	3.3	5	6.7	7.5
29.2	2.6	3.4	5.1	6.8	7.7
29.3	2.6	3.5	5.2	6.9	7.8
29.4	2.7	3.5	5.3	7.1	8
29.5	2.7	3.6	5.4	7.2	8.1
29.6	2.8	3.7	5.5	7.3	8.3
29.7	2.8	3.7	5.6	7.5	8.4
29.8	2.9	3.8	5.7	7.6	8.6
29.9	2.9	3.9	5.8	7.7	8.7
30.0	3	3.9	5.9	7.9	8.9
30.1	3	4	6	8	9
30.2	3.1	4.1	6.1	8.1	9.2
30.3	3.1	4.1	6.2	8.3	9.3
30.4	3.2	4.2	6.3	8.4	9.5
30.5	3.2	4.3	6.4	8.5	9.6
30.6	3.3	4.3	6.5	8.7	9.8
30.7	3.3	4.4	6.6	8.8	9.9
30.8	3.4	4.5	6.7	8.9	10.1
30.9	3.4	4.5	6.8	9.1	10.2
31.0	3.5	4.6	6.9	9.2	10.4
31.1	3.5	4.7	7	9.3	10.5
31.2	3.6	4.7	7.1	9.5	10.7
31.3	3.6	4.8	7.2	9.6	10.8
31.4	3.7	4.9	7.3	9.7	11
31.5	3.7	4.9	7.4	9.9	11.1
31.6	3.8	5	7.5	10	11.3
31.7	3.8	5.1	7.6	10.1	11.4
31.8	3.9	5.1	7.7	10.3	11.6
31.9	3.9	5.2	7.8	10.4	11.7
32.0	4	5.3	7.9	10.5	11.9
32.1	4	5.3	8	10.7	12
32.2	4.1	5.4	8.1	10.8	12.2

Index Well: **AIW231**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B	Zone C	Zone D	Zone E
32.3	4.1	5.5	8.2	10.9	12.3
32.4	4.2	5.5	8.3	11.1	12.5
32.5	4.2	5.6	8.4	11.2	12.6
32.6	4.3	5.7	8.5	11.3	12.8
32.7	4.3	5.7	8.6	11.5	12.9
32.8	4.4	5.8	8.7	11.6	13.1
32.9	4.4	5.9	8.8	11.7	13.2
33.0	4.5	5.9	8.9	11.9	13.4
33.1	4.5	6	9	12	13.5
33.2	4.6	6.1	9.1	12.1	13.7
33.3	4.6	6.1	9.2	12.3	13.8
33.4	4.7	6.2	9.3	12.4	14
33.5	4.7	6.3	9.4	12.5	14.1
33.6	4.8	6.3	9.5	12.7	14.3
33.7	4.8	6.4	9.6	12.8	14.4
33.8	4.9	6.5	9.7	12.9	14.6
33.9	4.9	6.5	9.8	13.1	14.7
34.0	5	6.6	9.9	13.2	14.9
34.1	5	6.7	10	13.3	15
34.2	5.1	6.7	10.1	13.5	15.2
34.3	5.1	6.8	10.2	13.6	15.3
34.4	5.2	6.9	10.3	13.7	15.5
34.5	5.2	6.9	10.4	13.9	15.6
34.6	5.3	7	10.5	14	15.8
34.7	5.3	7.1	10.6	14.1	15.9
34.8	5.4	7.1	10.7	14.3	16.1
34.9	5.4	7.2	10.8	14.4	16.2
35.0	5.5	7.3	10.9	14.5	16.4

Potential Water-Level Rise (feet) for Index Well- Reference Table

Following Technical Bulletin 92-001, estimations of high groundwater levels are needed for construction and land use planning on Cape Cod. Using the appropriate index well and water-level range zone, water-level adjustment is provided, defined as Step 4 in the High Ground Water-Level Computation Form.

Index Well: **AIW247R**

Index Well Depth to Water (feet below land surface)	Water-Level Range Zone Adjustments (ft)			
	Zone A	Zone B	Zone C	Zone D
21.9	0	0	0	0
22	0.1	0.1	0.1	0.2
22.1	0.1	0.2	0.3	0.3
22.2	0.2	0.3	0.4	0.5
22.3	0.3	0.4	0.5	0.7
22.4	0.3	0.5	0.7	0.8
22.5	0.4	0.6	0.8	1
22.6	0.5	0.7	0.9	1.2
22.7	0.5	0.8	1.1	1.3
22.8	0.6	0.9	1.2	1.5
22.9	0.7	1	1.3	1.7
23	0.7	1.1	1.5	1.8
23.1	0.8	1.2	1.6	2
23.2	0.9	1.3	1.7	2.2
23.3	0.9	1.4	1.9	2.3
23.4	1	1.5	2	2.4
23.5	1.1	1.6	2.1	2.7
23.6	1.1	1.7	2.3	2.8
23.7	1.2	1.8	2.4	3
23.8	1.3	1.9	2.5	3.2
23.9	1.3	2	2.7	3.3
24	1.4	2.1	2.8	3.5
24.1	1.5	2.2	2.9	3.7
24.2	1.5	2.3	3.1	3.8
24.3	1.6	2.4	3.2	4
24.4	1.7	2.5	3.3	4.2
24.5	1.7	2.6	3.5	4.3
24.6	1.8	2.7	3.6	4.5
24.7	1.9	2.8	3.7	4.7
24.8	1.9	2.9	3.9	4.8
24.9	2	3	4	5
25	2.1	3.1	4.1	5.2
25.1	2.1	3.2	4.3	5.3
25.2	2.2	3.3	4.4	5.5
25.3	2.3	3.4	4.5	5.7
25.4	2.3	3.5	4.7	5.8
25.5	2.4	3.6	4.8	6
25.6	2.5	3.7	4.9	6.2
25.7	2.5	3.8	5.1	6.3
25.8	2.6	3.9	5.2	6.5
25.9	2.7	4	5.3	6.7
26	2.7	4.1	5.5	6.8

Index Well: **AIW247R**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B	Zone C	Zone D
26.1	2.8	4.2	5.6	7
26.2	2.9	4.3	5.7	7.2
26.3	2.9	4.4	5.9	7.3
26.4	3	4.5	6	7.5
26.5	3.1	4.6	6.1	7.7
26.6	3.1	4.7	6.3	7.8
26.7	3.2	4.8	6.4	8
26.8	3.3	4.9	6.5	8.2
26.9	3.3	5	6.7	8.3
27	3.4	5.1	6.8	8.5
27.1	3.5	5.2	6.9	8.7
27.2	3.5	5.3	7.1	8.8
27.3	3.6	5.4	7.2	9
27.4	3.7	5.5	7.3	9.2
27.5	3.7	5.6	7.5	9.3
27.6	3.8	5.7	7.6	9.5
27.7	3.9	5.8	7.7	9.7
27.8	3.9	5.9	7.9	9.8
27.9	4	6	8	10
28	4.1	6.1	8.1	10.2
28.1	4.1	6.2	8.3	10.3
28.2	4.2	6.3	8.4	10.5
28.3	4.3	6.4	8.5	10.7
28.4	4.3	6.5	8.7	10.8
28.5	4.4	6.6	8.8	11
28.6	4.5	6.7	8.9	11.2
28.7	4.5	6.8	9.1	11.3
28.8	4.6	6.9	9.2	11.5
28.9	4.7	7	9.3	11.7
29	4.7	7.1	9.5	11.8
29.1	4.8	7.2	9.6	12
29.2	4.9	7.3	9.7	12.2
29.3	4.9	7.4	9.9	12.3
29.4	5	7.5	10	12.5
29.5	5.1	7.6	10.1	12.7
29.6	5.1	7.7	10.3	12.8
29.7	5.2	7.8	10.4	13
29.8	5.3	7.9	10.5	13.2
29.9	5.3	8	10.7	13.3
30	5.4	8.1	10.8	13.5
30.1	5.5	8.2	10.9	13.7
30.2	5.5	8.3	11.1	13.8
30.3	5.6	8.4	11.2	14
30.4	5.7	8.5	11.3	14.2
30.5	5.7	8.6	11.5	14.3
30.6	5.8	8.7	11.6	14.5
30.7	5.9	8.8	11.7	14.7

Index Well: **AIW247R**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B	Zone C	Zone D
30.8	5.9	8.9	11.9	14.8
30.9	6	9	12	15
31	6.1	9.1	12.1	15.2
31.1	6.1	9.2	12.3	15.3
31.2	6.2	9.3	12.4	15.5
31.3	6.3	9.4	12.5	15.7
31.4	6.3	9.5	12.7	15.8
31.5	6.4	9.6	12.8	16
31.6	6.5	9.7	12.9	16.2
31.7	6.5	9.8	13.1	16.3
31.8	6.6	9.9	13.2	16.5
31.9	6.7	10	13.3	16.7
32	6.7	10.1	13.5	16.8
32.1	6.8	10.2	13.6	17
32.2	6.9	10.3	13.7	17.2
32.3	6.9	10.4	13.9	17.3
32.4	7	10.5	14	17.5
32.5	7.1	10.6	14.1	17.7
32.6	7.1	10.7	14.3	17.8
32.7	7.2	10.8	14.4	18
32.8	7.3	10.9	14.5	18.2
32.9	7.3	11	14.7	18.3
33	7.4	11.1	14.8	18.5
33.1	7.5	11.2	14.9	18.7
33.2	7.5	11.3	15.1	18.8
33.3	7.6	11.4	15.2	19
33.4	7.7	11.5	15.3	19.2
33.5	7.7	11.6	15.5	19.3
33.6	7.8	11.7	15.6	19.5
33.7	7.9	11.8	15.7	19.7
33.8	7.9	11.9	15.9	19.8
33.9	8	12	16	20
34	8.1	12.1	16.1	20.2
34.1	8.1	12.2	16.3	20.3
34.2	8.2	12.3	16.4	20.5
34.3	8.3	12.4	16.5	20.7
34.4	8.3	12.5	16.7	20.8
34.5	8.4	12.6	16.8	21
34.6	8.5	12.7	16.9	21.2
34.7	8.5	12.8	17.1	21.3
34.8	8.6	12.9	17.2	21.5

Potential Water-Level Rise (feet) for Index Well- Reference Table

Following Technical Bulletin 92-001, estimations of high groundwater levels are needed for construction and land use planning on Cape Cod. Using the appropriate index well and water-level range zone, water-level adjustment is provided, defined as Step 4 in the High Ground Water-Level Computation Form.

Index Well: **BMW21R**

Index Well Depth to Water (feet below land surface)	Water-Level Range Zone Adjustments (ft)	
	Zone A	Zone B
7.4	0	0
7.5	0.1	0.1
7.6	0.1	0.2
7.7	0.2	0.3
7.8	0.3	0.4
7.9	0.3	0.5
8	0.4	0.6
8.1	0.5	0.7
8.2	0.5	0.8
8.3	0.6	0.9
8.4	0.7	1
8.5	0.7	1.1
8.6	0.8	1.2
8.7	0.9	1.3
8.8	0.9	1.4
8.9	1	1.5
9	1.1	1.6
9.1	1.1	1.7
9.2	1.2	1.8
9.3	1.3	1.9
9.4	1.3	2
9.5	1.4	2.1
9.6	1.5	2.2
9.7	1.5	2.3
9.8	1.6	2.4
9.9	1.7	2.5
10	1.7	2.6
10.1	1.8	2.7
10.2	1.9	2.8
10.3	1.9	2.9
10.4	2	3
10.5	2.1	3.1
10.6	2.1	3.2
10.7	2.2	3.3
10.8	2.3	3.4
10.9	2.3	3.5
11	2.4	3.6
11.1	2.5	3.7

Index Well: **BMW21R**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B
11.2	2.5	3.8
11.3	2.6	3.9
11.4	2.7	4
11.5	2.7	4.1
11.6	2.8	4.2
11.7	2.9	4.3
11.8	2.9	4.4
11.9	3	4.5
12	3.1	4.6
12.1	3.1	4.7
12.2	3.2	4.8
12.3	3.3	4.9
12.4	3.3	5
12.5	3.4	5.1
12.6	3.5	5.2
12.7	3.5	5.3
12.8	3.6	5.4
12.9	3.7	5.5
13	3.7	5.6
13.1	3.8	5.7
13.2	3.9	5.8
13.3	3.9	5.9
13.4	4	6
13.5	4.1	6.1
13.6	4.1	6.2
13.7	4.2	6.3
13.8	4.3	6.4
13.9	4.3	6.5
14	4.4	6.6
14.1	4.5	6.7
14.2	4.5	6.8
14.3	4.6	6.9
14.4	4.7	7
14.5	4.7	7.1
14.6	4.8	7.2
14.7	4.9	7.3
14.8	4.9	7.4
14.9	5	7.5
15	5.1	7.6
15.1	5.1	7.7
15.2	5.2	7.8
15.3	5.3	7.9
15.4	5.3	8

Index Well: **BMW21R**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B
15.5	5.4	8.1
15.6	5.5	8.2
15.7	5.5	8.3
15.8	5.6	8.4
15.9	5.7	8.5
16	5.7	8.6
16.1	5.8	8.7
16.2	5.9	8.8
16.3	5.9	8.9
16.4	6	9
16.5	6.1	9.1
16.6	6.1	9.2
16.7	6.2	9.3
16.8	6.3	9.4
16.9	6.3	9.5
17	6.4	9.6
17.1	6.5	9.7
17.2	6.5	9.8
17.3	6.6	9.9
17.4	6.7	10
17.5	6.7	10.1
17.6	6.8	10.2
17.7	6.9	10.3
17.8	6.9	10.4
17.9	7	10.5
18	7.1	10.6
18.1	7.1	10.7
18.2	7.2	10.8
18.3	7.3	10.9
18.4	7.3	11

Potential Water-Level Rise (feet) for Index Well- Reference Table

Following Technical Bulletin 92-001, estimations of high groundwater levels are needed for construction and land use planning on Cape Cod. Using the appropriate index well and water-level range zone, water-level adjustment is provided, defined as Step 4 in the High Ground Water-Level Computation Form.

Index Well: **CGW138R**

Index Well Depth to Water (feet below land surface)	Water-Level Range Zone Adjustments (ft)			
	Zone A	Zone B	Zone C	Zone D
24.1	0	0	0	0
24.2	0.1	0.1	0.1	0.2
24.3	0.1	0.2	0.3	0.3
24.4	0.2	0.3	0.4	0.5
24.5	0.3	0.4	0.5	0.7
24.6	0.3	0.5	0.7	0.8
24.7	0.4	0.6	0.8	1
24.8	0.5	0.7	0.9	1.2
24.9	0.5	0.8	1.1	1.3
25.0	0.6	0.9	1.2	1.5
25.1	0.7	1	1.3	1.7
25.2	0.7	1.1	1.5	1.8
25.3	0.8	1.2	1.6	2
25.4	0.9	1.3	1.7	2.2
25.5	0.9	1.4	1.9	2.3
25.6	1	1.5	2	2.4
25.7	1.1	1.6	2.1	2.7
25.8	1.1	1.7	2.3	2.8
25.9	1.2	1.8	2.4	3
26.0	1.3	1.9	2.5	3.2
26.1	1.3	2	2.7	3.3
26.2	1.4	2.1	2.8	3.5
26.3	1.5	2.2	2.9	3.7
26.4	1.5	2.3	3.1	3.8
26.5	1.6	2.4	3.2	4
26.6	1.7	2.5	3.3	4.2
26.7	1.7	2.6	3.5	4.3
26.8	1.8	2.7	3.6	4.5
26.9	1.9	2.8	3.7	4.7
27.0	1.9	2.9	3.9	4.8
27.1	2	3	4	5
27.2	2.1	3.1	4.1	5.2
27.3	2.1	3.2	4.3	5.3
27.4	2.2	3.3	4.4	5.5
27.5	2.3	3.4	4.5	5.7
27.6	2.3	3.5	4.7	5.8
27.7	2.4	3.6	4.8	6
27.8	2.5	3.7	4.9	6.2
27.9	2.5	3.8	5.1	6.3

Index Well: **CGW138R**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B	Zone C	Zone D
28.0	2.6	3.9	5.2	6.5
28.1	2.7	4	5.3	6.7
28.2	2.7	4.1	5.5	6.8
28.3	2.8	4.2	5.6	7
28.4	2.9	4.3	5.7	7.2
28.5	2.9	4.4	5.9	7.3
28.6	3	4.5	6	7.5
28.7	3.1	4.6	6.1	7.7
28.8	3.1	4.7	6.3	7.8
28.9	3.2	4.8	6.4	8
29.0	3.3	4.9	6.5	8.2
29.1	3.3	5	6.7	8.3
29.2	3.4	5.1	6.8	8.5
29.3	3.5	5.2	6.9	8.7
29.4	3.5	5.3	7.1	8.8
29.5	3.6	5.4	7.2	9
29.6	3.7	5.5	7.3	9.2
29.7	3.7	5.6	7.5	9.3
29.8	3.8	5.7	7.6	9.5
29.9	3.9	5.8	7.7	9.7
30.0	3.9	5.9	7.9	9.8
30.1	4	6	8	10
30.2	4.1	6.1	8.1	10.2
30.3	4.1	6.2	8.3	10.3
30.4	4.2	6.3	8.4	10.5
30.5	4.3	6.4	8.5	10.7
30.6	4.3	6.5	8.7	10.8
30.7	4.4	6.6	8.8	11
30.8	4.5	6.7	8.9	11.2
30.9	4.5	6.8	9.1	11.3
31.0	4.6	6.9	9.2	11.5
31.1	4.7	7	9.3	11.7
31.2	4.7	7.1	9.5	11.8
31.3	4.8	7.2	9.6	12
31.4	4.9	7.3	9.7	12.2
31.5	4.9	7.4	9.9	12.3
31.6	5	7.5	10	12.5
31.7	5.1	7.6	10.1	12.7
31.8	5.1	7.7	10.3	12.8
31.9	5.2	7.8	10.4	13
32.0	5.3	7.9	10.5	13.2
32.1	5.3	8	10.7	13.3
32.2	5.4	8.1	10.8	13.5

Index Well: **CGW138R**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B	Zone C	Zone D
32.3	5.5	8.2	10.9	13.7
32.4	5.5	8.3	11.1	13.8
32.5	5.6	8.4	11.2	14
32.6	5.7	8.5	11.3	14.2
32.7	5.7	8.6	11.5	14.3
32.8	5.8	8.7	11.6	14.5
32.9	5.9	8.8	11.7	14.7
33.0	5.9	8.9	11.9	14.8
33.1	6	9	12	15
33.2	6.6	9.1	12.1	15.2
33.3	6.1	9.2	12.3	15.3

Potential Water-Level Rise (feet) for Index Well- Reference Table

Following Technical Bulletin 92-001, estimations of high groundwater levels are needed for construction and land use planning on Cape Cod. Using the appropriate index well and water-level range zone, water-level adjustment is provided, defined as Step 4 in the High Ground Water-Level Computation Form.

Index Well: **MIW29**

Index Well Depth to Water (feet below land surface)	Water-Level Range Zone Adjustments (ft)			
	Zone A	Zone B	Zone C	Zone D
5.7	0	0	0	0
5.8	0.1	0.1	0.1	0.2
5.9	0.1	0.2	0.3	0.3
6	0.2	0.3	0.4	0.5
6.1	0.3	0.4	0.5	0.7
6.2	0.3	0.5	0.7	0.8
6.3	0.4	0.6	0.8	1
6.4	0.5	0.7	0.9	1.2
6.5	0.5	0.8	1.1	1.3
6.6	0.6	0.9	1.2	1.5
6.7	0.7	1	1.3	1.7
6.8	0.7	1.1	1.5	1.8
6.9	0.8	1.2	1.6	2
7	0.9	1.3	1.7	2.2
7.1	0.9	1.4	1.9	2.3
7.2	1	1.5	2	2.4
7.3	1.1	1.6	2.1	2.7
7.4	1.1	1.7	2.3	2.8
7.5	1.2	1.8	2.4	3
7.6	1.3	1.9	2.5	3.2
7.7	1.3	2	2.7	3.3
7.8	1.4	2.1	2.8	3.5
7.9	1.5	2.2	2.9	3.7
8	1.5	2.3	3.1	3.8
8.1	1.6	2.4	3.2	4
8.2	1.7	2.5	3.3	4.2
8.3	1.7	2.6	3.5	4.3
8.4	1.8	2.7	3.6	4.5
8.5	1.9	2.8	3.7	4.7
8.6	1.9	2.9	3.9	4.8
8.7	2	3	4	5
8.8	2.1	3.1	4.1	5.2
8.9	2.1	3.2	4.3	5.3
9	2.2	3.3	4.4	5.5
9.1	2.3	3.4	4.5	5.7
9.2	2.3	3.5	4.7	5.8
9.3	2.4	3.6	4.8	6
9.4	2.5	3.7	4.9	6.2
9.5	2.5	3.8	5.1	6.3

Index Well: **MIW29**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B	Zone C	Zone D
9.6	2.6	3.9	5.2	6.5
9.7	2.7	4	5.3	6.7
9.8	2.7	4.1	5.5	6.8
9.9	2.8	4.2	5.6	7
10	2.9	4.3	5.7	7.2
10.1	2.9	4.4	5.9	7.3
10.2	3	4.5	6	7.5
10.3	3.1	4.6	6.1	7.7
10.4	3.1	4.7	6.3	7.8
10.5	3.2	4.8	6.4	8
10.6	3.3	4.9	6.5	8.2
10.7	3.3	5	6.7	8.3
10.8	3.4	5.1	6.8	8.5
10.9	3.5	5.2	6.9	8.7
11	3.5	5.3	7.1	8.8
11.1	3.6	5.4	7.2	9
11.2	3.7	5.5	7.3	9.2
11.3	3.7	5.6	7.5	9.3
11.4	3.8	5.7	7.6	9.5
11.5	3.9	5.8	7.7	9.7
11.6	3.9	5.9	7.9	9.8
11.7	4	6	8	10
11.8	4.1	6.1	8.1	10.2
11.9	4.1	6.2	8.3	10.3
12	4.2	6.3	8.4	10.5
12.1	4.3	6.4	8.5	10.7
12.2	4.3	6.5	8.7	10.8
12.3	4.4	6.6	8.8	11
12.4	4.5	6.7	8.9	11.2
12.5	4.5	6.8	9.1	11.3
12.6	4.6	6.9	9.2	11.5
12.7	4.7	7	9.3	11.7
12.8	4.7	7.1	9.5	11.8
12.9	4.8	7.2	9.6	12
13	4.9	7.3	9.7	12.2
13.1	4.9	7.4	9.9	12.3
13.2	5	7.5	10	12.5
13.3	5.1	7.6	10.1	12.7
13.4	5.1	7.7	10.3	12.8
13.5	5.2	7.8	10.4	13
13.6	5.3	7.9	10.5	13.2
13.7	5.3	8	10.7	13.3
13.8	5.4	8.1	10.8	13.5

Index Well: **MIW29**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B	Zone C	Zone D
13.9	5.5	8.2	10.9	13.7
14	5.5	8.3	11.1	13.8
14.1	5.6	8.4	11.2	14
14.2	5.7	8.5	11.3	14.2
14.3	5.7	8.6	11.5	14.3
14.4	5.8	8.7	11.6	14.5
14.5	5.9	8.8	11.7	14.7
14.6	5.9	8.9	11.9	14.8
14.7	6	9	12	15
14.8	6.1	9.1	12.1	15.2
14.9	6.1	9.2	12.3	15.3
15	6.2	9.3	12.4	15.5
15.1	6.3	9.4	12.5	15.7

Potential Water-Level Rise (feet) for Index Well- Reference Table

Following Technical Bulletin 92-001, estimations of high groundwater levels are needed for construction and land use planning on Cape Cod. Using the appropriate index well and water-level range zone, water-level adjustment is provided, defined as Step 4 in the High Ground Water-Level Computation Form.

Index Well: **SDW252R**

Index Well Depth to Water (feet below land surface)	Water-Level Range Zone Adjustments (ft)			
	Zone A	Zone B	Zone C	Zone D
34.3	0	0	0	0
34.4	0.1	0.2	0.2	0.3
34.5	0.2	0.3	0.4	0.5
34.6	0.3	0.5	0.6	0.8
34.7	0.4	0.6	0.8	1
34.8	0.5	0.8	1	1.3
34.9	0.6	0.9	1.2	1.5
35	0.7	1.1	1.4	1.8
35.1	0.8	1.2	1.6	2
35.2	0.9	1.4	1.8	2.3
35.3	1	1.5	2	2.5
35.4	1.1	1.7	2.2	2.8
35.5	1.2	1.8	2.4	3
35.6	1.3	2	2.6	3.3
35.7	1.4	2.1	2.8	3.5
35.8	1.5	2.3	3	3.8
35.9	1.6	2.4	3.2	4
36	1.7	2.6	3.4	4.3
36.1	1.8	2.7	3.6	4.5
36.2	1.9	2.9	3.8	4.8
36.3	2	3	4	5
36.4	2.1	3.2	4.2	5.3
36.5	2.2	3.3	4.4	5.5
36.6	2.3	3.5	4.6	5.8
36.7	2.4	3.6	4.8	6
36.8	2.5	3.8	5	6.3
36.9	2.6	3.9	5.2	6.5
37	2.7	4.1	5.4	6.8
37.1	2.8	4.2	5.6	7
37.2	2.9	4.4	5.8	7.3
37.3	3	4.5	6	7.5
37.4	3.1	4.7	6.2	7.8
37.5	3.2	4.8	6.4	8
37.6	3.3	5	6.6	8.3
37.7	3.4	5.1	6.8	8.5
37.8	3.5	5.3	7	8.8
37.9	3.6	5.4	7.2	9
38	3.7	5.6	7.4	9.3
38.1	3.8	5.7	7.6	9.5

Index Well: **SDW252R**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B	Zone C	Zone D
38.2	3.9	5.9	7.8	9.8
38.3	4	6	8	10
38.4	4.1	6.2	8.2	10.3
38.5	4.2	6.3	8.4	10.5
38.6	4.3	6.5	8.6	10.8
38.7	4.4	6.6	8.8	11
38.8	4.5	6.8	9	11.3
38.9	4.6	6.9	9.2	11.5
39	4.7	7.1	9.4	11.8
39.1	4.8	7.2	9.6	12
39.2	4.9	7.4	9.8	12.3
39.3	5	7.5	10	12.5
39.4	5.1	7.7	10.2	12.8
39.5	5.2	7.8	10.4	13
39.6	5.3	8	10.6	13.3
39.7	5.4	8.1	10.8	13.5
39.8	5.5	8.3	11	13.8
39.9	5.6	8.4	11.2	14
40	5.7	8.6	11.4	14.3
40.1	5.8	8.7	11.6	14.5
40.2	5.9	8.9	11.8	14.8
40.3	6	9	12	15
40.4	6.1	9.2	12.2	15.3
40.5	6.2	9.3	12.4	15.5
40.6	6.3	9.5	12.6	15.8
40.7	6.4	9.6	12.8	16
40.8	6.5	9.8	13	16.3
40.9	6.6	9.9	13.2	16.5
41	6.7	10.1	13.4	16.8
41.1	6.8	10.2	13.6	17
41.2	6.9	10.4	13.8	17.3
41.3	7	10.5	14	17.5
41.4	7.1	10.7	14.2	17.8
41.5	7.2	10.8	14.4	18
41.6	7.3	11	14.6	18.3

Potential Water-Level Rise (feet) for Index Well- Reference Table

Following Technical Bulletin 92-001, estimations of high groundwater levels are needed for construction and land use planning on Cape Cod. Using the appropriate index well and water-level range zone, water-level adjustment is provided, defined as Step 4 in the High Ground Water-Level Computation Form.

Index Well: **SDW253R**

Index Well Depth to Water (feet below land surface)	Water-Level Range Zone Adjustments (ft)		
	Zone A	Zone B	Zone C
43.7	0	0	0
43.8	0.1	0.1	0.1
43.9	0.1	0.2	0.3
44	0.2	0.3	0.4
44.1	0.3	0.4	0.5
44.2	0.3	0.5	0.7
44.3	0.4	0.6	0.8
44.4	0.5	0.7	0.9
44.5	0.5	0.8	1.1
44.6	0.6	0.9	1.2
44.7	0.7	1	1.3
44.8	0.7	1.1	1.5
44.9	0.8	1.2	1.6
45	0.9	1.3	1.7
45.1	0.9	1.4	1.9
45.2	1	1.5	2
45.3	1.1	1.6	2.1
45.4	1.1	1.7	2.3
45.5	1.2	1.8	2.4
45.6	1.3	1.9	2.5
45.7	1.3	2	2.7
45.8	1.4	2.1	2.8
45.9	1.5	2.2	2.9
46	1.5	2.3	3.1
46.1	1.6	2.4	3.2
46.2	1.7	2.5	3.3
46.3	1.7	2.6	3.5
46.4	1.8	2.7	3.6
46.5	1.9	2.8	3.7
46.6	1.9	2.9	3.9
46.7	2	3	4
46.8	2.1	3.1	4.1
46.9	2.1	3.2	4.3
47	2.2	3.3	4.4
47.1	2.3	3.4	4.5
47.2	2.3	3.5	4.7
47.3	2.4	3.6	4.8
47.4	2.5	3.7	4.9
47.5	2.5	3.8	5.1

Index Well: **SDW253R**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B	Zone C
47.6	2.6	3.9	5.2
47.7	2.7	4	5.3
47.8	2.7	4.1	5.5
47.9	2.8	4.2	5.6
48	2.9	4.3	5.7
48.1	2.9	4.4	5.9
48.2	3	4.5	6
48.3	3.1	4.6	6.1
48.4	3.1	4.7	6.3
48.5	3.2	4.8	6.4
48.6	3.3	4.9	6.5
48.7	3.3	5	6.7
48.8	3.4	5.1	6.8
48.9	3.5	5.2	6.9
49	3.5	5.3	7.1
49.1	3.6	5.4	7.2
49.2	3.7	5.5	7.3
49.3	3.7	5.6	7.5
49.4	3.8	5.7	7.6
49.5	3.9	5.8	7.7
49.6	3.9	5.9	7.9
49.7	4	6	8
49.8	4.1	6.1	8.1
49.9	4.1	6.2	8.3
50	4.2	6.3	8.4
50.1	4.3	6.4	8.5
50.2	4.3	6.5	8.7
50.3	4.4	6.6	8.8
50.4	4.5	6.7	8.9
50.5	4.5	6.8	9.1
50.6	4.6	6.9	9.2
50.7	4.7	7	9.3
50.8	4.7	7.1	9.5
50.9	4.8	7.2	9.6
51	4.9	7.3	9.7
51.1	4.9	7.4	9.9
51.2	5	7.5	10
51.3	5.1	7.6	10.1
51.4	5.1	7.7	10.3
51.5	5.2	7.8	10.4
51.6	5.3	7.9	10.5
51.7	5.3	8	10.7
51.8	5.4	8.1	10.8

Index Well: **SDW253R**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B	Zone C
51.9	5.5	8.2	10.9
52	5.5	8.3	11.1
52.1	5.6	8.4	11.2
52.2	5.7	8.5	11.3
52.3	5.7	8.6	11.5
52.4	5.8	8.7	11.6
52.5	5.9	8.8	11.7
52.6	5.9	8.9	11.9
52.7	6	9	12
52.8	6.1	9.1	12.1
52.9	6.1	9.2	12.3
53	6.2	9.3	12.4
53.1	6.3	9.4	12.5
53.2	6.3	9.5	12.7
53.3	6.4	9.6	12.8
53.4	6.5	9.7	12.9
53.5	6.5	9.8	13.1
53.6	6.6	9.9	13.2
53.7	6.7	10	13.3
53.8	6.7	10.1	13.5
53.9	6.8	10.2	13.6
54	6.9	10.3	13.7
54.1	6.9	10.4	13.9
54.2	7	10.5	14
54.3	7.1	10.6	14.1
54.4	7.1	10.7	14.3
54.5	7.2	10.8	14.4
54.6	7.3	10.9	14.5
54.7	7.3	11	14.7
54.8	7.4	11.1	14.8
54.9	7.5	11.2	14.9
55	7.5	11.3	15.1
55.1	7.6	11.4	15.2
55.2	7.7	11.5	15.3
55.3	7.7	11.6	15.5
55.4	7.8	11.7	15.6
55.5	7.9	11.8	15.7
55.6	7.9	11.9	15.9
55.7	8	12	16
55.8	8.1	12.1	16.1
55.9	8.1	12.2	16.3
56	8.2	12.3	16.4
56.1	8.3	12.4	16.5

Index Well: **SDW253R**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B	Zone C
56.2	8.3	12.5	16.7
56.3	8.4	12.6	16.8
56.4	8.5	12.7	16.9
56.5	8.5	12.8	17.1
56.6	8.6	12.9	17.2
56.7	8.7	13	17.3
56.8	8.7	13.1	17.5
56.9	8.8	13.2	17.6
57	8.9	13.3	17.7
57.1	8.9	13.4	17.9
57.2	9	13.5	18
57.3	9.1	13.6	18.1
57.4	9.1	13.7	18.3
57.5	9.2	13.8	18.4
57.6	9.3	13.9	18.5

Potential Water-Level Rise (feet) for Index Well- Reference Table

Following Technical Bulletin 92-001, estimations of high groundwater levels are needed for construction and land use planning on Cape Cod. Using the appropriate index well and water-level range zone, water-level adjustment is provided, defined as Step 4 in the High Ground Water-Level Computation Form.

Index Well: **TSW89**

Index Well Depth to Water (feet below land surface)	Water-Level Range Zone Adjustments (ft)		
	Zone A	Zone B	Zone C
10.2	0	0	0
10.3	0.1	0.2	0.2
10.4	0.2	0.3	0.4
10.5	0.3	0.5	0.6
10.6	0.4	0.6	0.8
10.7	0.5	0.8	1
10.8	0.6	0.9	1.2
10.9	0.7	1.1	1.4
11	0.8	1.2	1.6
11.1	0.9	1.4	1.8
11.2	1	1.5	2
11.3	1.1	1.7	2.2
11.4	1.2	1.8	2.4
11.5	1.3	2	2.6
11.6	1.4	2.1	2.8
11.7	1.5	2.3	3
11.8	1.6	2.4	3.2
11.9	1.7	2.6	3.4
12	1.8	2.7	3.6
12.1	1.9	2.9	3.8
12.2	2	3	4
12.3	2.1	3.2	4.2
12.4	2.2	3.3	4.4
12.5	2.3	3.5	4.6
12.6	2.4	3.6	4.8
12.7	2.5	3.8	5
12.8	2.6	3.9	5.2
12.9	2.7	4.1	5.4
13	2.8	4.2	5.6
13.1	2.9	4.4	5.8
13.2	3	4.5	6
13.3	3.1	4.7	6.2
13.4	3.2	4.8	6.4
13.5	3.3	5	6.6
13.6	3.4	5.1	6.8
13.7	3.5	5.3	7
13.8	3.6	5.4	7.2
13.9	3.7	5.6	7.4
14	3.8	5.7	7.6

Index Well: **TSW89**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B	Zone C
14.1	3.9	5.9	7.8
14.2	4	6	8
14.3	4.1	6.2	8.2
14.4	4.2	6.3	8.4
14.5	4.3	6.5	8.6
14.6	4.4	6.6	8.8
14.7	4.5	6.8	9
14.8	4.6	6.9	9.2
14.9	4.7	7.1	9.4
15	4.8	7.2	9.6
15.1	4.9	7.4	9.8
15.2	5	7.5	10
15.3	5.1	7.7	10.2
15.4	5.2	7.8	10.4
15.5	5.3	8	10.6
15.6	5.4	8.1	10.8
15.7	5.5	8.3	11
15.8	5.6	8.4	11.2
15.9	5.7	8.6	11.4
16	5.8	8.7	11.6
16.1	5.9	8.9	11.8
16.2	6	9	12
16.3	6.1	9.2	12.2
16.4	6.2	9.3	12.4
16.5	6.3	9.5	12.6
16.6	6.4	9.6	12.8
16.7	6.5	9.8	13
16.8	6.6	9.9	13.2
16.9	6.7	10.1	13.4
17	6.8	10.2	13.6
17.1	6.9	10.4	13.8
17.2	7	10.5	14
17.3	7.1	10.7	14.2
17.4	7.2	10.8	14.4
17.5	7.3	11	14.6
17.6	7.4	11.1	14.8
17.7	7.5	11.3	15
17.8	7.6	11.4	15.2
17.9	7.7	11.6	15.4
18	7.8	11.7	15.6
18.1	7.9	11.9	15.8

Potential Water-Level Rise (feet) for Index Well- Reference Table

Following Technical Bulletin 92-001, estimations of high groundwater levels are needed for construction and land use planning on Cape Cod. Using the appropriate index well and water-level range zone, water-level adjustment is provided, defined as Step 4 in the High Ground Water-Level Computation Form.

Index Well: **WNW17R**

Index Well Depth to Water (feet below land surface)	Water-Level Range Zone Adjustments (ft)		
	Zone A	Zone B	Zone C
8	0	0	0
8.1	0.1	0.1	0.1
8.2	0.1	0.1	0.2
8.3	0.2	0.2	0.3
8.4	0.2	0.3	0.4
8.5	0.3	0.3	0.5
8.6	0.3	0.4	0.6
8.7	0.4	0.5	0.7
8.8	0.4	0.5	0.8
8.9	0.5	0.6	0.9
9	0.5	0.7	1
9.1	0.6	0.7	1.1
9.2	0.6	0.8	1.2
9.3	0.7	0.9	1.3
9.4	0.7	0.9	1.4
9.5	0.8	1	1.5
9.6	0.8	1.1	1.6
9.7	0.9	1.1	1.7
9.8	0.9	1.2	1.8
9.9	1	1.3	1.9
10	1	1.3	2
10.1	1.1	1.4	2.1
10.2	1.1	1.5	2.2
10.3	1.2	1.5	2.3
10.4	1.2	1.6	2.4
10.5	1.3	1.7	2.5
10.6	1.3	1.7	2.6
10.7	1.4	1.8	2.7
10.8	1.4	1.9	2.8
10.9	1.5	1.9	2.9
11	1.5	2	3
11.1	1.6	2.1	3.1
11.2	1.6	2.1	3.2
11.3	1.7	2.2	3.3
11.4	1.7	22.3	3.4
11.5	1.8	2.3	3.5
11.6	1.8	2.4	3.6
11.7	1.9	2.5	3.7
11.8	1.9	2.5	3.8

Index Well: **WNW17R**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B	Zone C
11.9	2	2.6	3.9
12	2	2.7	4
12.1	2.1	2.7	4.1
12.2	2.1	2.8	4.2
12.3	2.2	2.9	4.3
12.4	2.2	2.9	4.4
12.5	2.3	3	4.5
12.6	2.3	3.1	4.6
12.7	2.4	3.1	4.7
12.8	2.4	3.2	4.8
12.9	2.5	3.3	4.9
13	2.5	3.3	5
13.1	2.6	3.4	5.1
13.2	2.6	3.5	5.2
13.3	2.7	3.5	5.3
13.4	2.7	3.6	5.4
13.5	2.8	3.7	5.5
13.6	2.8	3.7	5.6
13.7	2.9	3.8	5.7
13.8	2.9	3.9	5.8
13.9	3	3.9	5.9
14	3	4	6
14.1	3.1	4.1	6.1
14.2	3.1	4.1	6.2
14.3	3.2	4.2	6.3
14.4	3.2	4.3	6.4
14.5	3.3	4.3	6.5
14.6	3.3	4.4	6.6
14.7	3.4	4.5	6.7
14.8	3.4	4.5	6.8
14.9	3.5	4.6	6.9
15	3.5	4.7	7
15.1	3.6	4.7	7.1
15.2	3.6	4.8	7.2
15.3	3.7	4.9	7.3
15.4	3.7	4.9	7.4
15.5	3.8	5	7.5
15.6	3.8	5.1	7.6
15.7	3.9	5.1	7.7
15.8	3.9	5.2	7.8
15.9	4	5.3	7.9
16	4	5.3	8
16.1	4.1	5.4	8.1

Index Well: **WNW17R**

Index Well Depth to Water (feet below land surface)	Zone A	Zone B	Zone C
16.2	4.1	5.5	8.2
16.3	4.2	5.5	8.3
16.4	4.2	5.6	8.4
16.5	4.3	5.7	8.5
16.6	4.3	5.7	8.6
16.7	4.4	5.8	8.7
16.8	4.4	5.9	8.8
16.9	4.5	5.9	8.9
17	4.5	6	9
17.1	4.6	6.1	9.1
17.2	4.6	6.1	9.2
17.3	4.7	6.2	9.3
17.4	4.7	6.3	9.4
17.5	4.8	6.3	9.5
17.6	4.8	6.4	9.6
17.7	4.9	6.5	9.7
17.8	4.9	6.5	9.8
17.9	5	6.6	9.9
18	5	6.7	10
18.1	5.1	6.7	10.1
18.2	5.1	6.8	10.2
18.3	5.2	6.9	10.3
18.4	5.2	6.9	10.4