State Summary for Massachusetts

Information on population density, use of domestic-water supply, land use, and distribution of the 11 selected contaminants (arsenic, atrazine, benzene, deethylatrazine (CIAT), manganese, nitrate (data for nitrate consists of analyses for nitrite plus nitrate, as N, by the laboratory), perchloroethene (PCE), radon, strontium, trichloroethene (TCE), and uranium) for domestic well data for Massachusetts is shown in figures MA1–MA16. The percentage of samples greater than U.S. Environmental Protection Agency (USEPA) human-health benchmarks for National Water-Quality Assessment (NAWQA) Program major-aquifer studies that included Massachusetts is given in table MA1. The areal extent of some NAWQA major-aquifer studies goes beyond the State boundary (fig. MA4). All data associated with a major-aquifer study are provided and are used in contaminant summaries even if the sampled well was located outside the State boundary. The NAWQA aquifer studies extended into several States, but only 16 of the samples were collected in Massachusetts. The "Selected References" section at the end of this summary lists previous Massachusetts studies that are relevant to the 11 contaminants.

In Massachusetts, the largest areas with the highest population density are in the eastern parts of the State (fig. MA1). About 40 percent of the domestic (private) and public drinking-water supply is obtained from ground water. The population (by census-block group for 1990) using a domestic-water supply from ground water was greatest in the western, central, and southeastern parts of the State (fig. MA2). Although Massachusetts is a heavily populated State, it also contains many forested lands. Most of the forested areas are located in the western and central part of the State, where a majority of the domestic-water supply users also are located (fig. MA3).

Three major-aquifer studies in two principal aquifers (New York/New England crystalline-rock and glacial aquifers) included samples that were collected in Massachusetts (fig. MA4). The NewYork/New England crystalline-rock aquifers in Massachusetts consist mostly of metamorphic and igneous rocks predominantly composed of gneiss and schist and are mostly confined aquifers (Olcott, 1995). The regolith and fractures in the bedrock serve as the primary areas of storage, and well yields generally are only a few gallons per minute, although some well yields may exceed 100 to 500 gallons per minute (Olcott, 1995).

Several glacial aquifers occur near the land surface throughout Massachusetts and are contained in unconsolidated sand and gravel deposits of Quaternary age. Most of the individual aquifers that comprise the system are not hydraulically connected, and were formed mostly from sediments deposited by continental glaciers or by meltwater from glaciers, or from alluvium in valleys of major streams (Trapp and Horn, 1997). Most of the productive aquifers contain water under mostly unconfined conditions. Well yields are quite variable in the glacial systems because of variable thicknesses, coarseness of material, and the extent of the deposits.

Water-quality data for 11 selected contaminants (table 2) in samples from domestic-water supplies were compiled and summarized. The concentrations relative to USEPA human-health benchmarks (table 2, fig. MA5) and the number of major-aquifer studies with concentrations greater than human-health benchmarks were both considered in evaluating the

Table MA1. Percentage of samples with concentrations greater than U.S. Environmental Protection Agency human-health benchmarks for National Water-Quality Assessment (NAWQA) Program major-aquifer studies that included Massachusetts.

Study-Unit code for NAWQA major-aquifer study	Principal aquifer	Contaminant	Number of samples	Percentage of samples with concentrations greater than human-health benchmark
necbsus2	New York/New England crystalline-rock aquifers	Radon	28	[1]96/46
connsus1	New York/New England crystalline-rock aquifers	Radon	27	[1]96/37
connsus2	Glacial aquifers	Radon	27	[1]81/3.7
necbsus2	New York/New England crystalline-rock aquifers	Uranium	30	10
connsus2	Glacial aquifers	Manganese	28	7.1
necbsus2	New York/New England crystalline-rock aquifers	Manganese	30	6.7
necbsus2	New York/New England crystalline-rock aquifers	Arsenic	30	6.7
connsus1	New York/New England crystalline-rock aquifers	Arsenic	26	3.8
connsus2	Glacial aquifers	Nitrite plus nitrate	28	3.6

[1]First number is the percentage greater than 300 picocuries per liter (proposed Maximum Contaminant Level), and second number is the percentage greater than 4,000 picocuries per liter (alternate proposed Maximum Contaminant Level).

potential concern to human health. This analysis assumes that current USEPA benchmarks (U.S. Environmental Protection Agency, 2006) are the most relevant and accurate measure of human-health risk. Figures MA6–MA16 indicate an absence of data for the eastern part of Massachusetts where domestic wells are known to have high concentrations of arsenic and nitrate (Leslie DeSimone, U.S. Geological Survey, written commun., 2007).

Radon had the greatest potential human-health concern because it had the largest percentage of samples with concentrations greater than the human-health benchmark of 300 picocuries per liter (pCi/L). Radon concentrations were largest in two major-aquifer studies (connsus1 and necbsus2) in the New York/New England crystalline-rock aquifers, where more than 96 percent of the samples had concentrations greater than 300 pCi/L, which is the proposed Maximum Contaminant Level (MCL) for radon. Radon concentrations in about 46 percent (necbsus2) and 37 percent (connsus1) of the samples had concentrations greater than the alternative proposed MCL of 4,000 pCi/L (table MA1). Median radon concentrations were greater than 2,000 pCi/L for the connsus1 major-aquifer study and about 3,000 pCi/L for the necbsus2 major-aquifer study (fig. MA5). About 81 percent of samples in the connsus2 major-aquifer study in the glacial aquifers had radon concentrations greater than 300 pCi/L, but only about 4 percent (one sample) had a concentration greater than 4,000 pCi/L; median radon concentrations in this study were less than 1,000 pCi/L (fig. MA5, table MA1). Radon-222 is a decay product of radium-226, and radon concentrations greater than the human-health benchmark are widespread and can be attributed to natural sources in the soil and rock material in Massachusetts.

Manganese also had some potential concern to human health. Manganese concentrations were greater than the human-health benchmark (Lifetime Health Advisory (HA) of 300 micrograms per liter (μg/L)) in about 7 percent of the samples from the connsus2 major-aquifer study in the glacial aquifers and from the necbsus2 major-aquifer study in the New York/New England crystalline-rock aquifers (table MA1). Median concentrations for each aquifer study were less than 30 μg/L (fig. MA5). A few samples available in the U.S. Geological Survey (USGS) State data in NWIS had manganese concentrations that were greater than the human-health benchmark (fig. MA10), but these concentrations appear to be distributed randomly and are interspersed with samples that have concentrations less than the human-health benchmark.

NAWQA data did not show arsenic concentrations to be greater than the human-health benchmark in any of the samples collected in the State of Massachusetts; however, USGS State data showed arsenic concentrations to be greater than the human-health benchmark (MCL of 10 μg/L) in several samples (fig. MA6). An area in the south-central part of the State had several samples with concentrations greater than the human-health benchmark, and many people could be using domestic-water supplies in this area (fig. MA2). Additional information in Zuena and Keane (1985) indicates that several wells in the eastern part of the State also have concentrations greater than the human-health benchmark even though that data are not represented in the USGS databases.

NAWQA data did not show nitrate concentrations to be greater than the human-health benchmark in any of the samples collected in the State of Massachusetts; however, a few samples available in the USGS State data in NWIS had nitrate concentrations greater than the human-health benchmark (MCL of 10 milligrams per liter (mg/L) as N) (fig. MA11). Additional data collected for a study described by Persky (1986) that are not in the USGS State database indicated that 2.8 percent of the 3,309 samples analyzed for nitrate were greater than the MCL in the eastern part of the State.

NAWQA data did not show uranium concentrations within the State of Massachusetts to be greater than the human-health benchmark. Three samples (10 percent) from the necbsus2 major-aquifer study had concentrations greater than the human-health benchmark (MCL of 30 μg/L) (fig. MA16), but these samples were collected from wells in Maine.

For the entire Massachusetts data set, atrazine (fig. MA7), benzene (fig. MA8), CIAT (fig. MA9), PCE (fig. MA12), strontium (fig. MA14), and TCE (fig. MA15) did not have concentrations larger than USEPA human-health benchmarks for either NAWQA or USGS State data. CIAT is a degradation product of atrazine and does not have a human-health benchmark; however, for this report, the MCL for atrazine is used as a benchmark for CIAT because their toxicities are considered equivalent.

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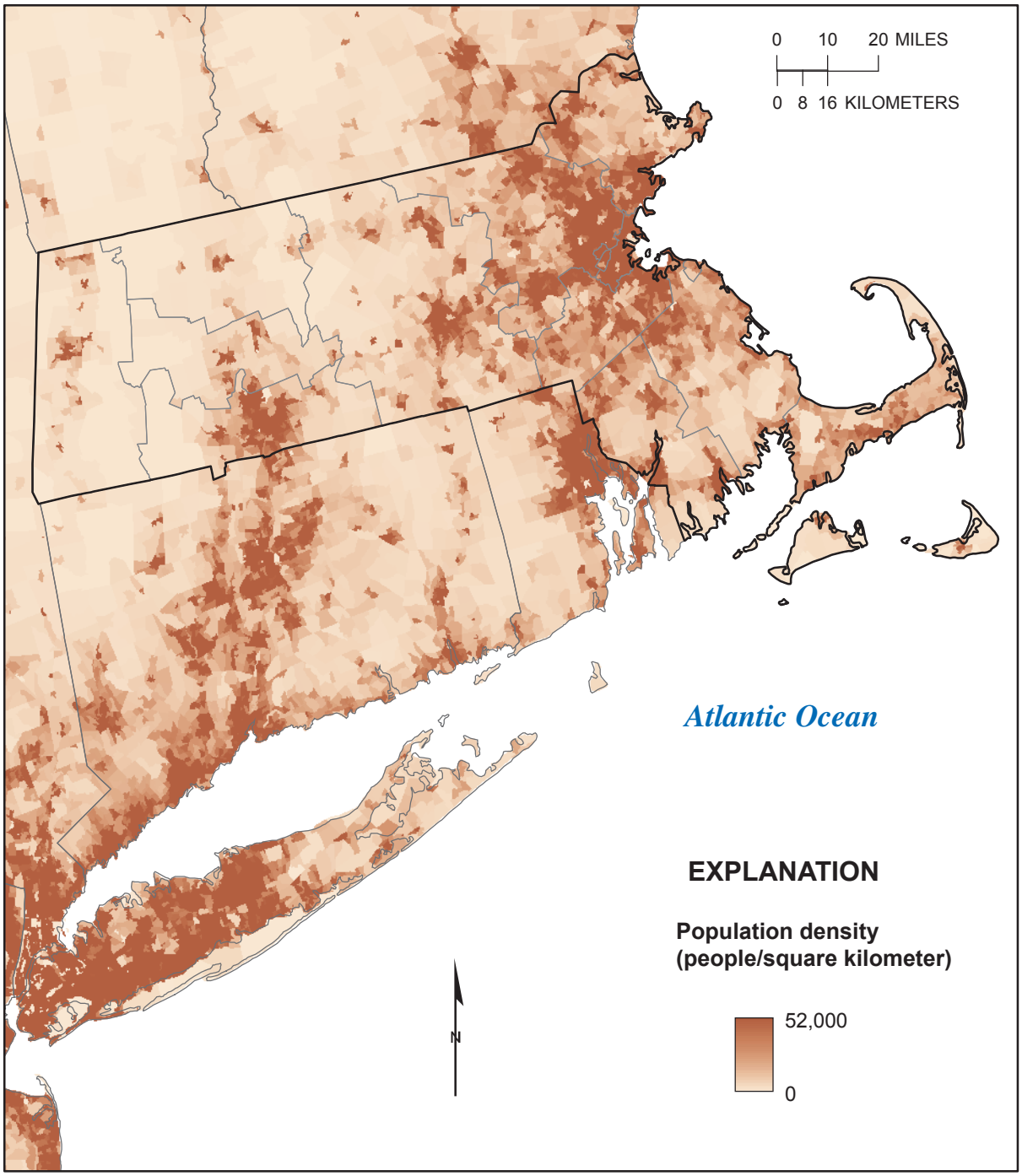
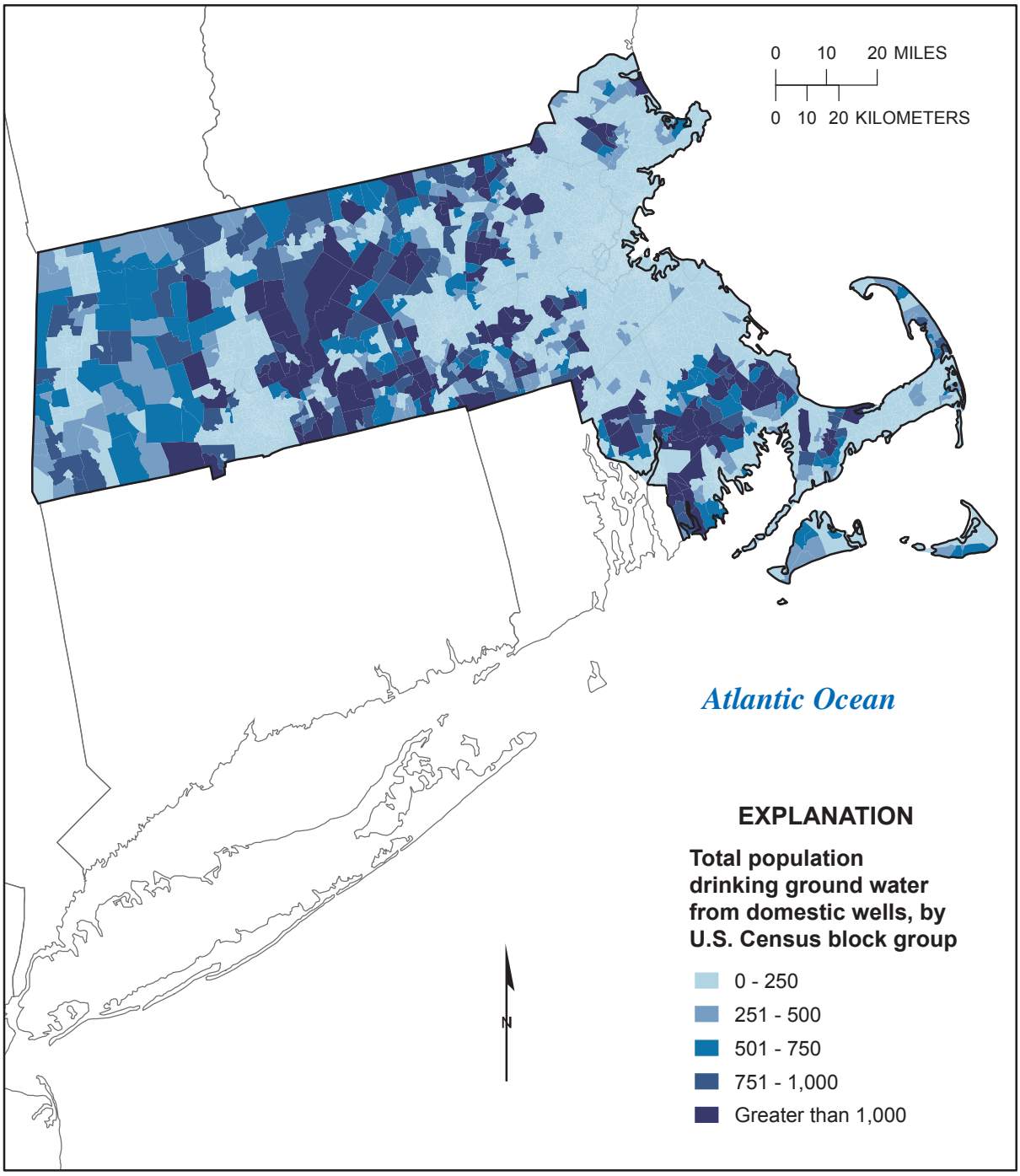


Base information from U.S. Geological Survey digital data, 1:2,000,000
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Figure MA1. Population density for Massachusetts and nearby States. (Data from Hitt, 2003.)



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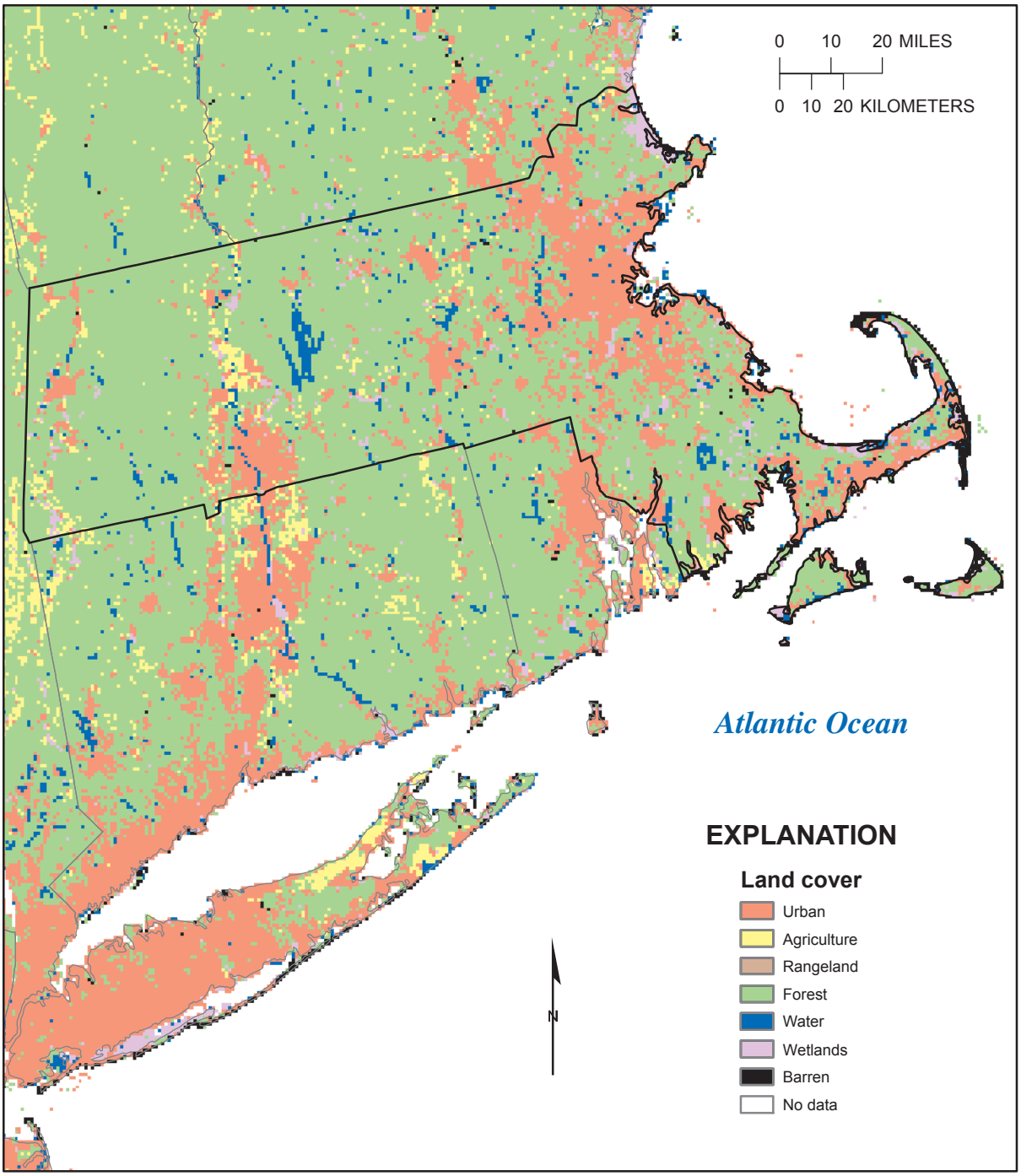
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Figure MA2. Population using domestic-water supply (from ground water) for Massachusetts. (Data from 1990 U.S. Census block group, Kerie Hitt, U.S. Geological Survey, written commun., 1997).



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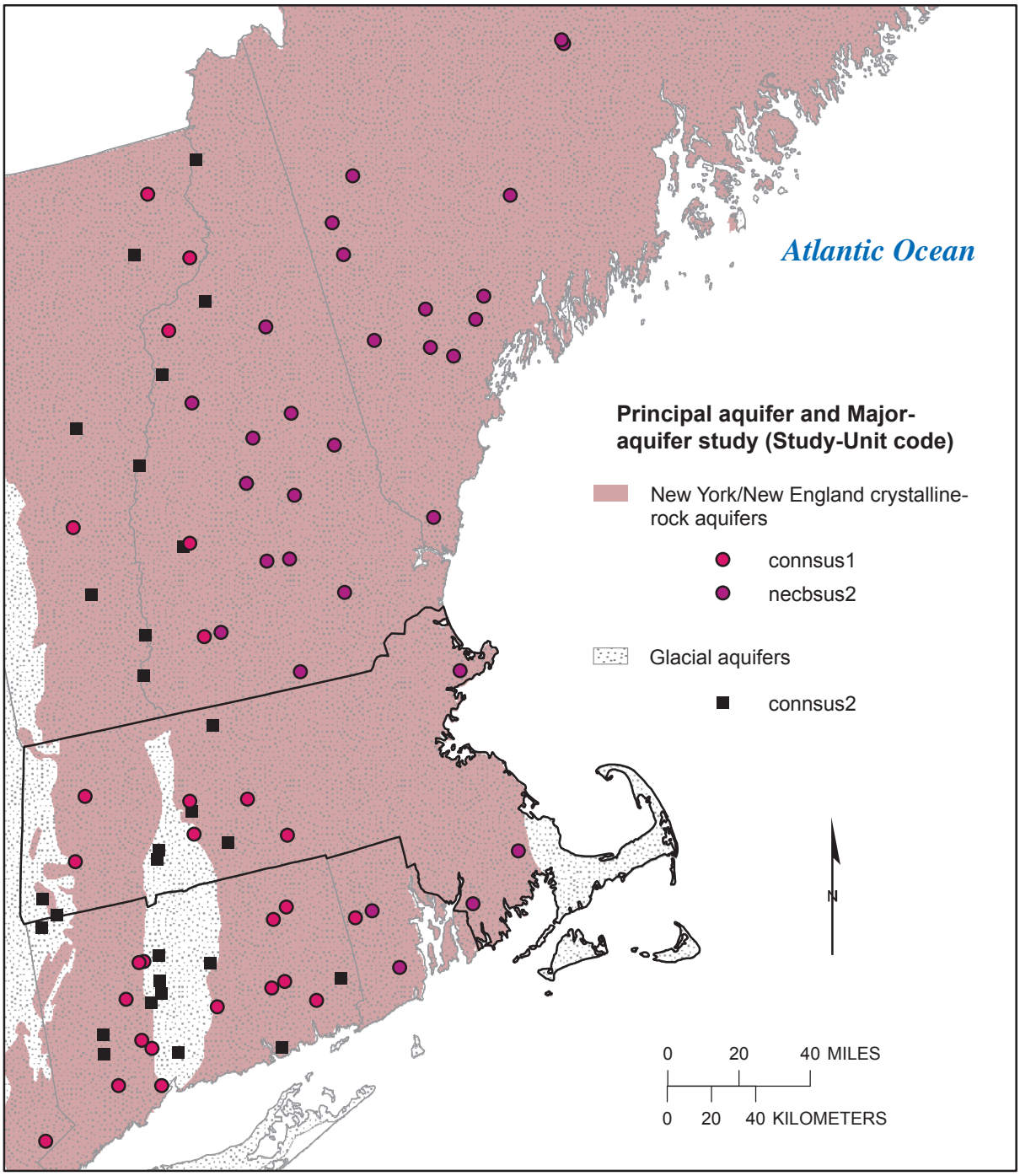
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Figure MA3. Land use/land cover for Massachusetts and nearby States. (Data from Naomi Nakagaki, U.S. Geological Survey, written commun., 2005.)



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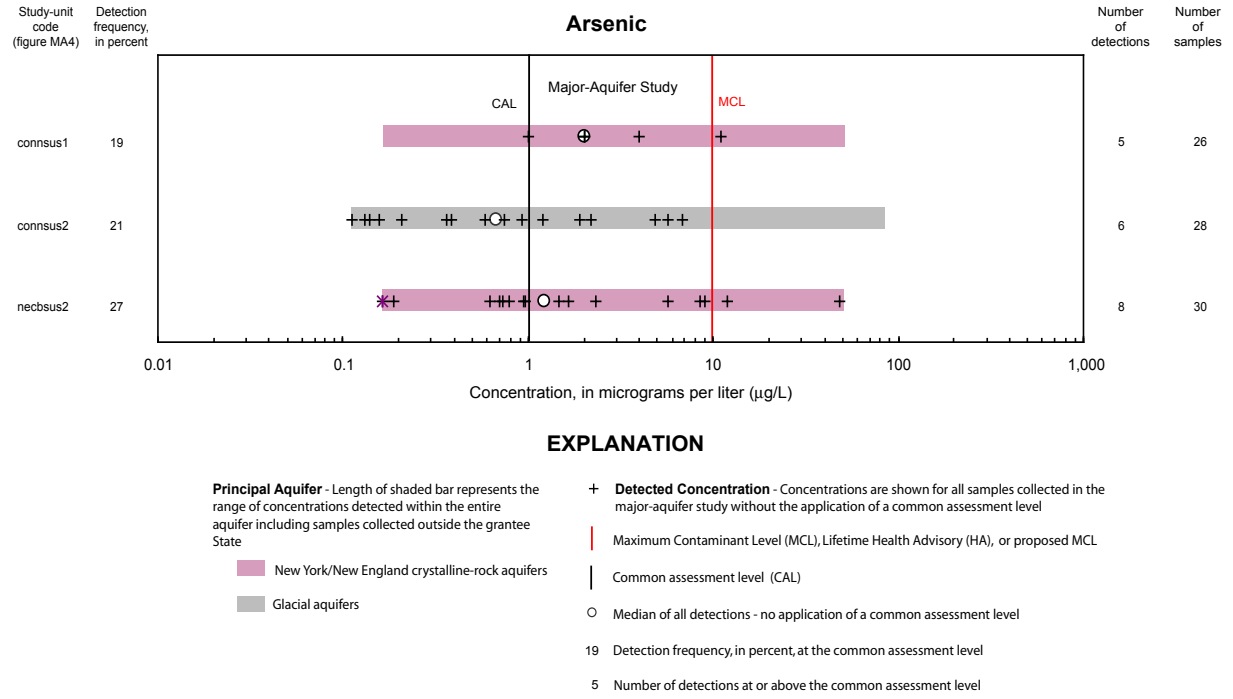
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MA4. Location of domestic wells sampled for National Water-Quality Assessment (NAWQA) major-aquifer studies that included Massachusetts.



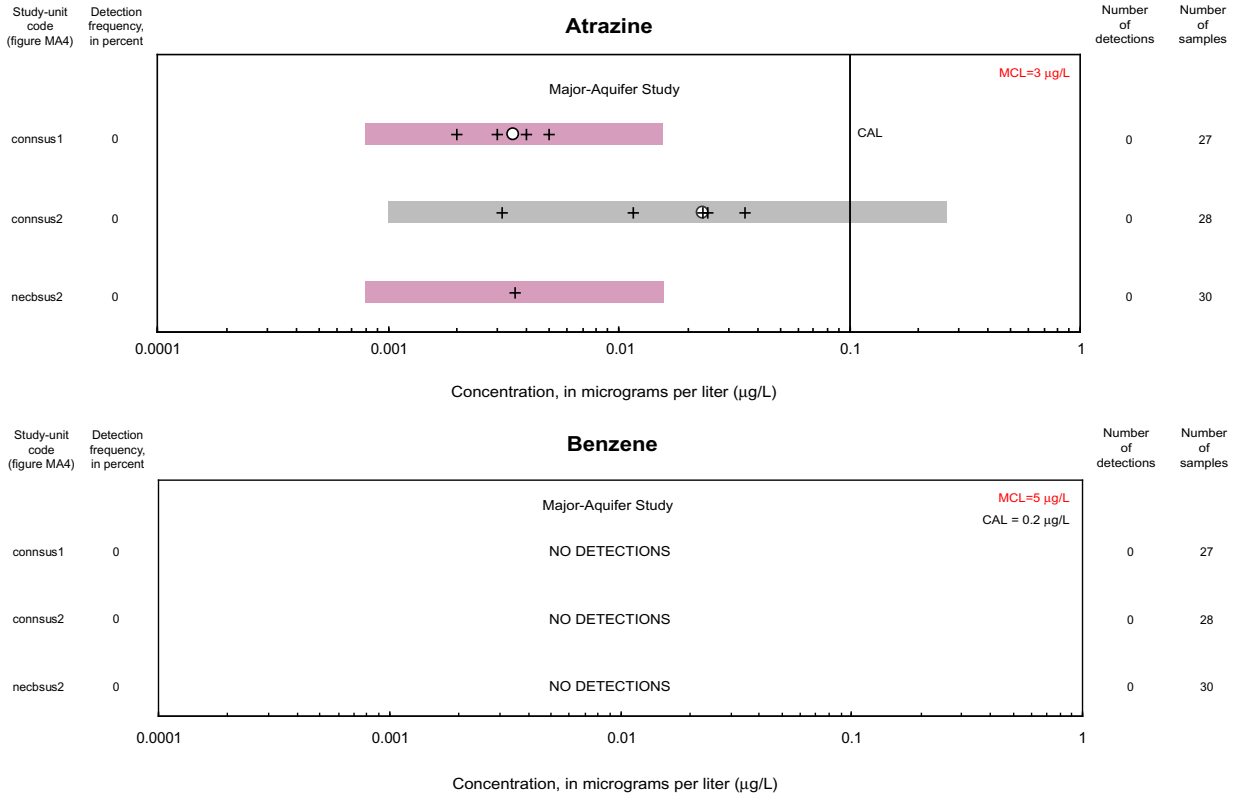


Figure MA5. Statistical summary for 11 selected contaminants by major-aquifer study using domestic-well data from National Water-Quality Assessment (NAWQA) studies for Massachusetts (includes studies for which at least 10 analyses were available).

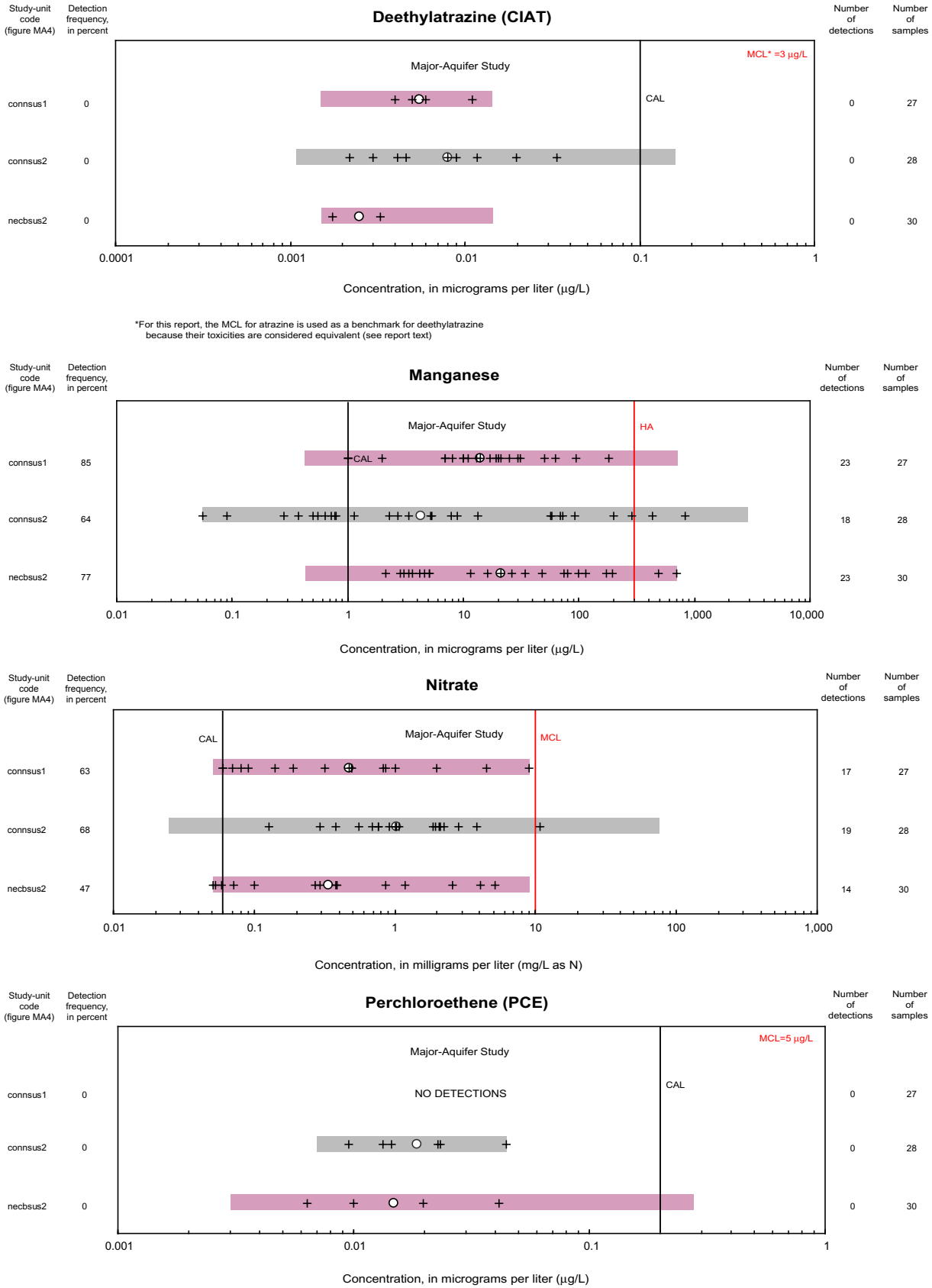


Figure MA5. Statistical summary for 11 selected contaminants by major-aquifer study using domestic-well data from National Water-Quality Assessment (NAWQA) studies for Massachusetts (includes studies for which at least 10 analyses were available).—Continued

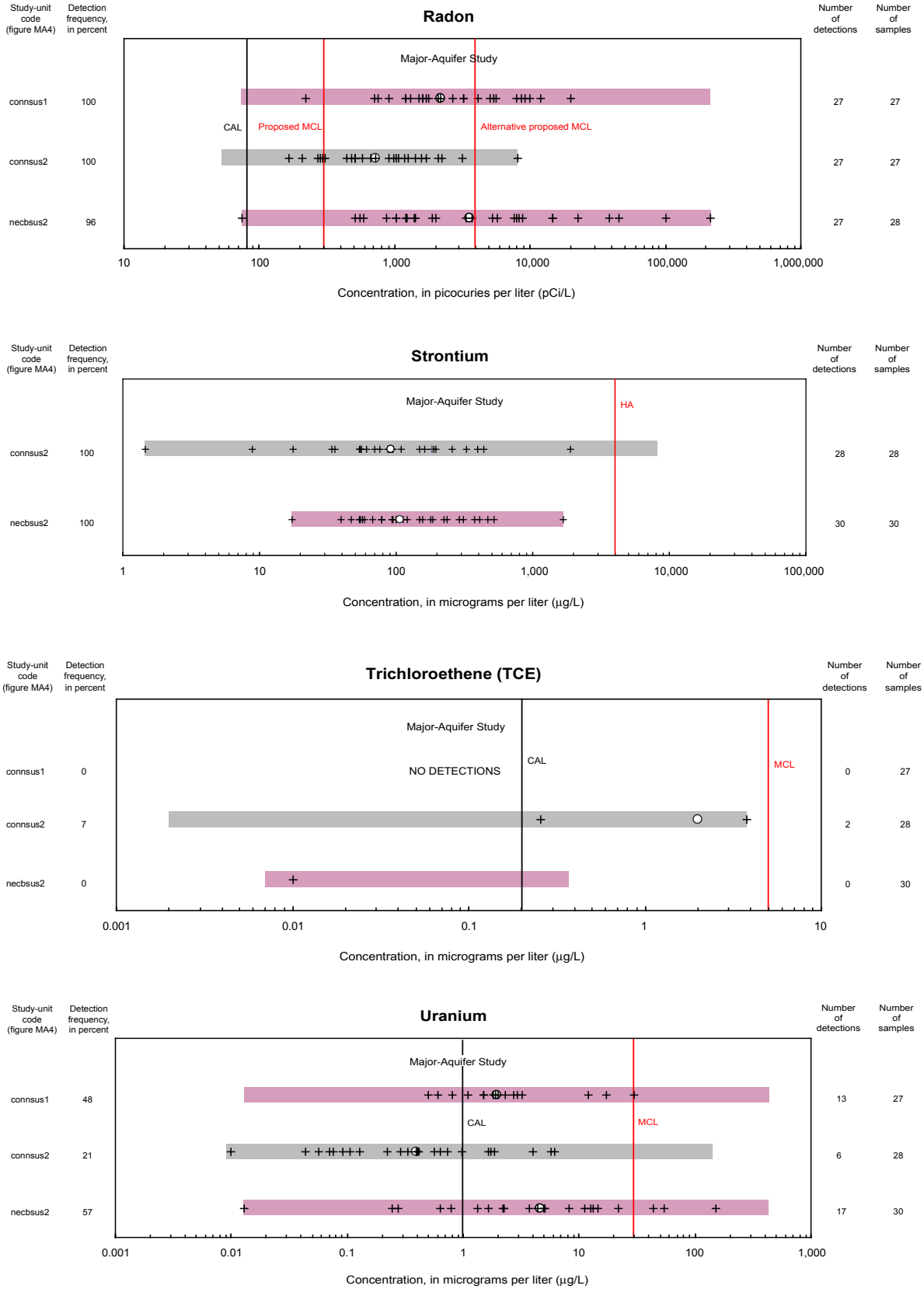
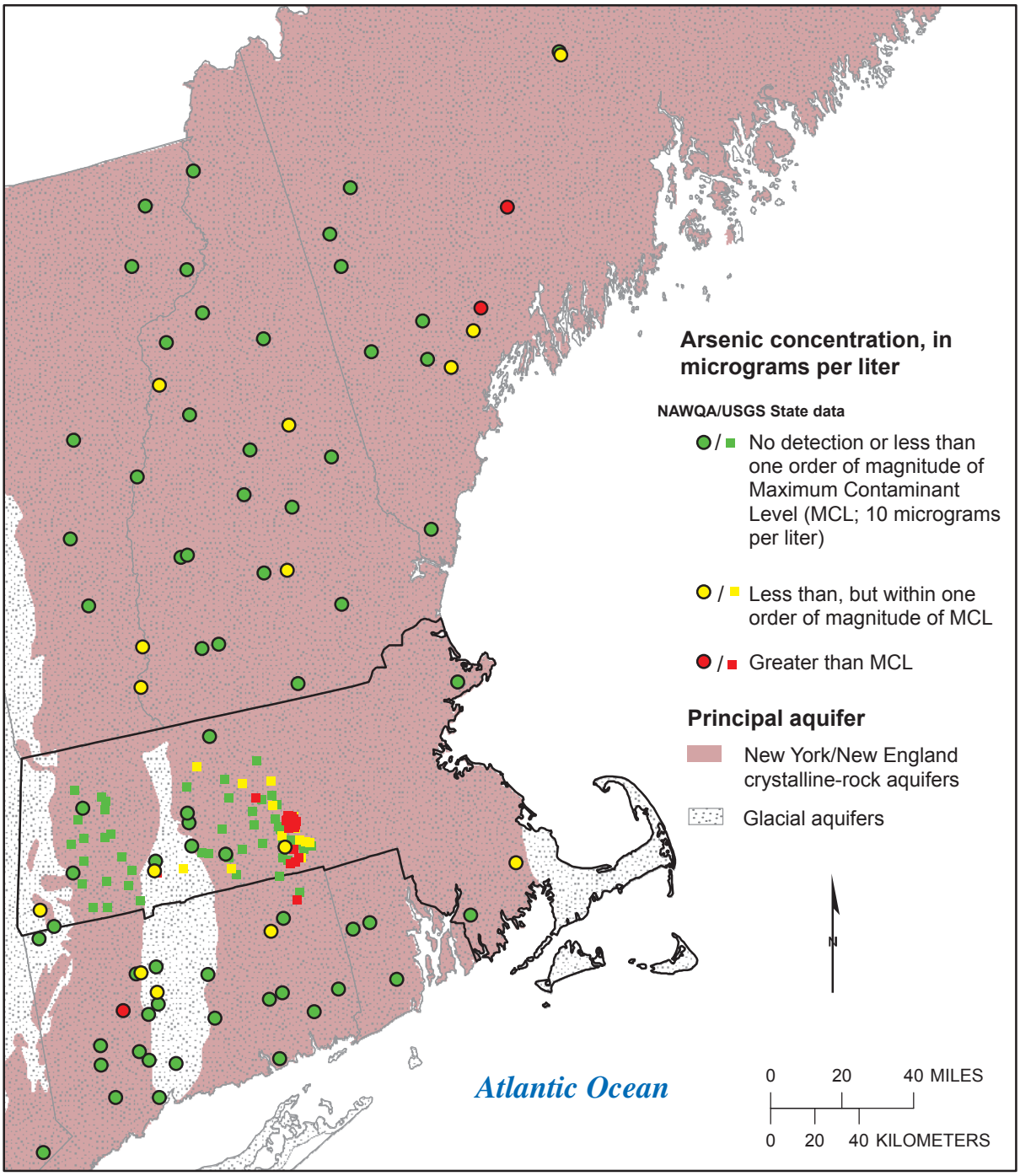


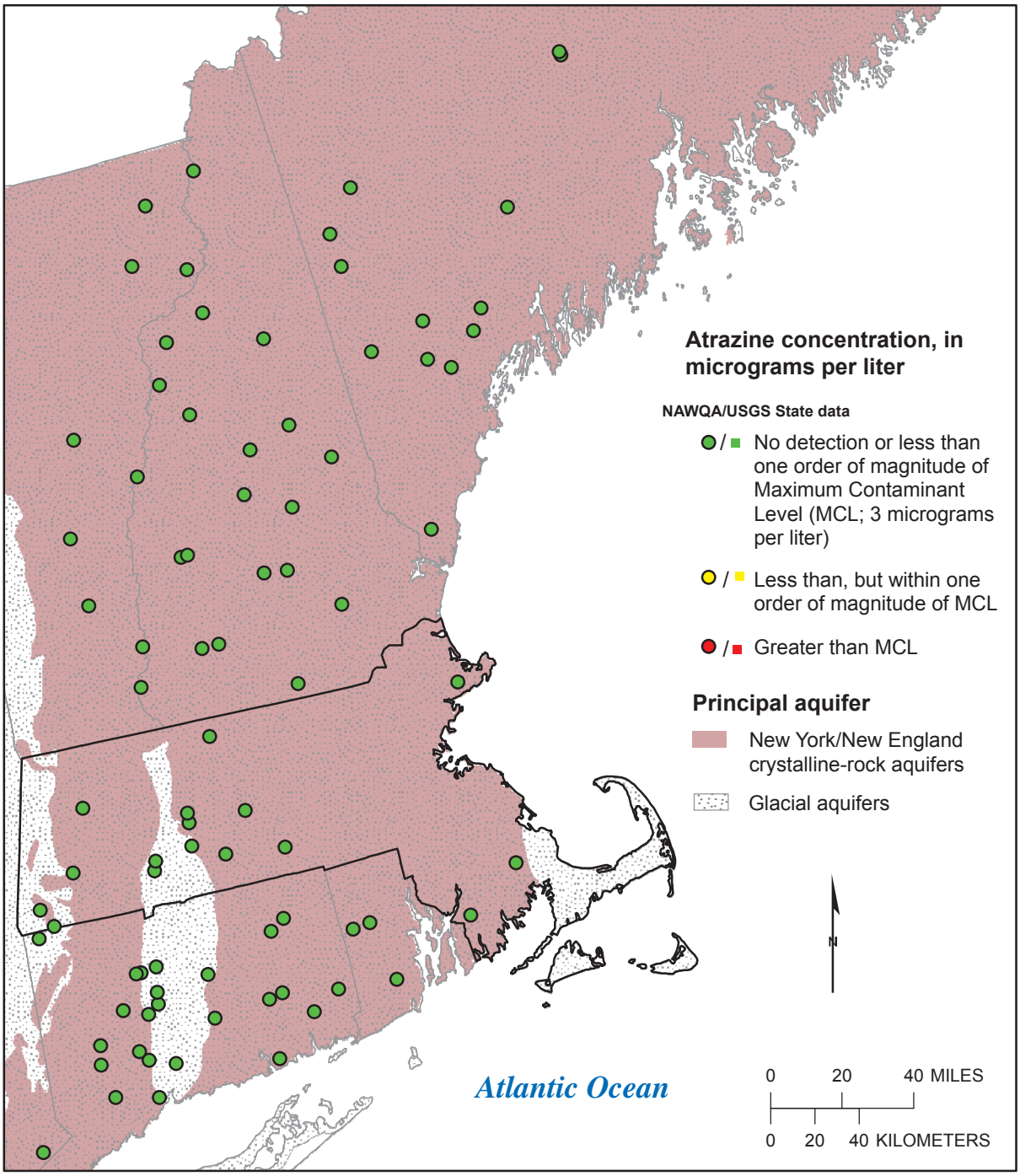
Figure MA5. Statistical summary for 11 selected contaminants by major-aquifer study using domestic-well data from National Water-Quality Assessment (NAWQA) studies for Massachusetts (includes studies for which at least 10 analyses were available).—Continued



Base information from U.S. Geological Survey digital data, 1:2,000,000
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MA6. Concentration of arsenic in samples from domestic wells in Massachusetts and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



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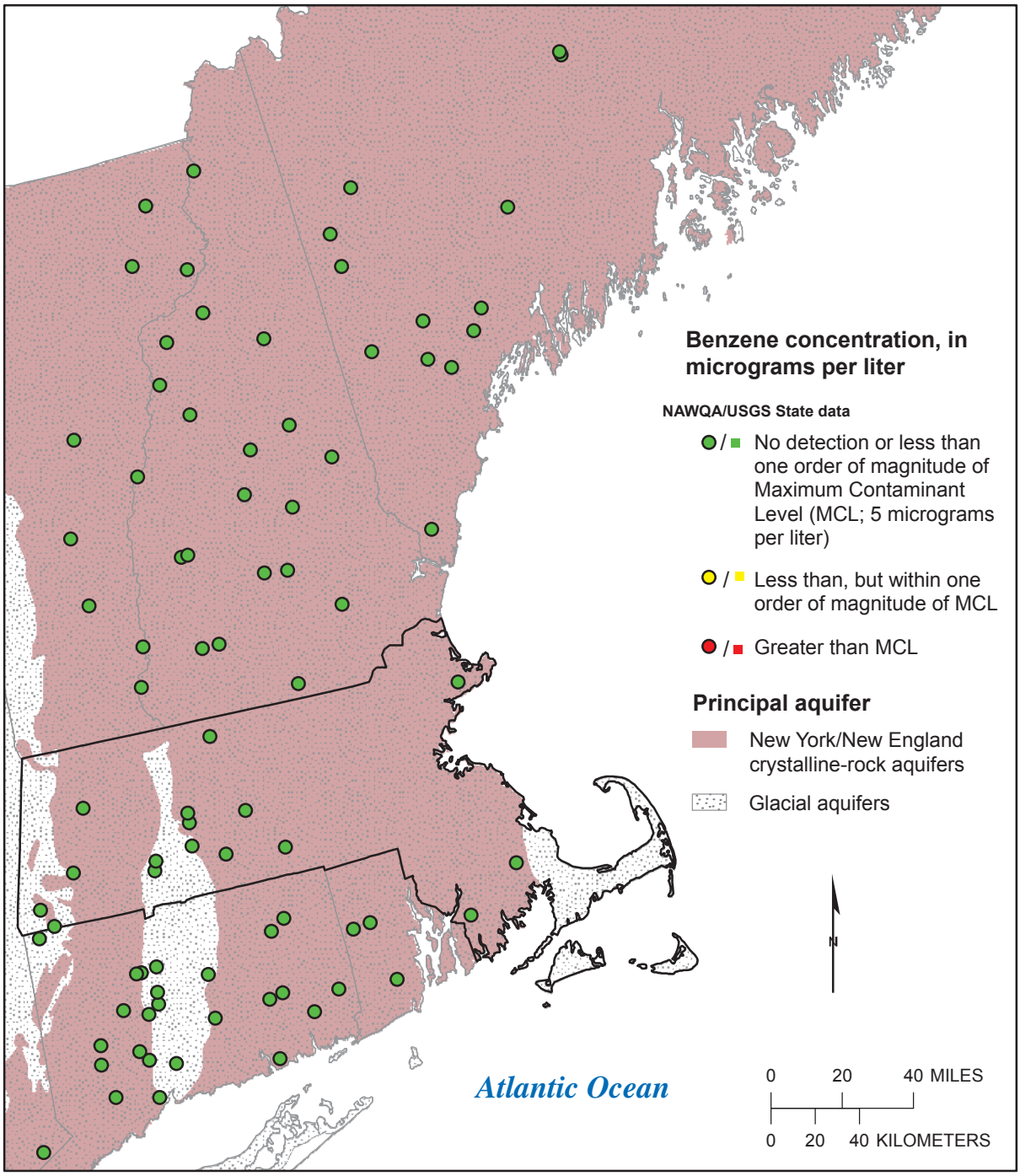
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

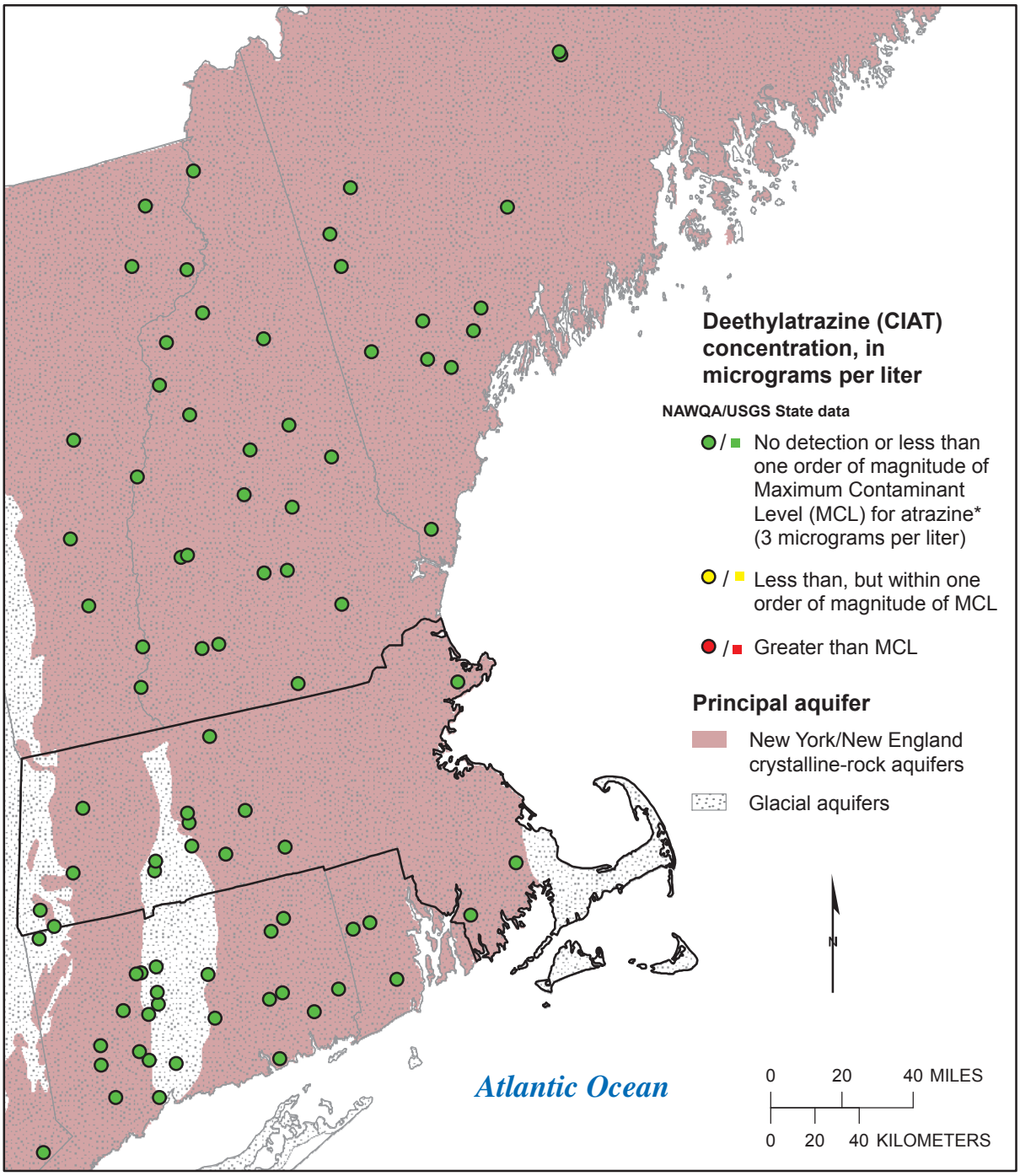
Figure MA7. Concentration of atrazine in samples from domestic wells in Massachusetts and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



Base information from U.S. Geological Survey digital data, 1:2,000,000
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MA8. Concentration of benzene in samples from domestic wells in Massachusetts and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



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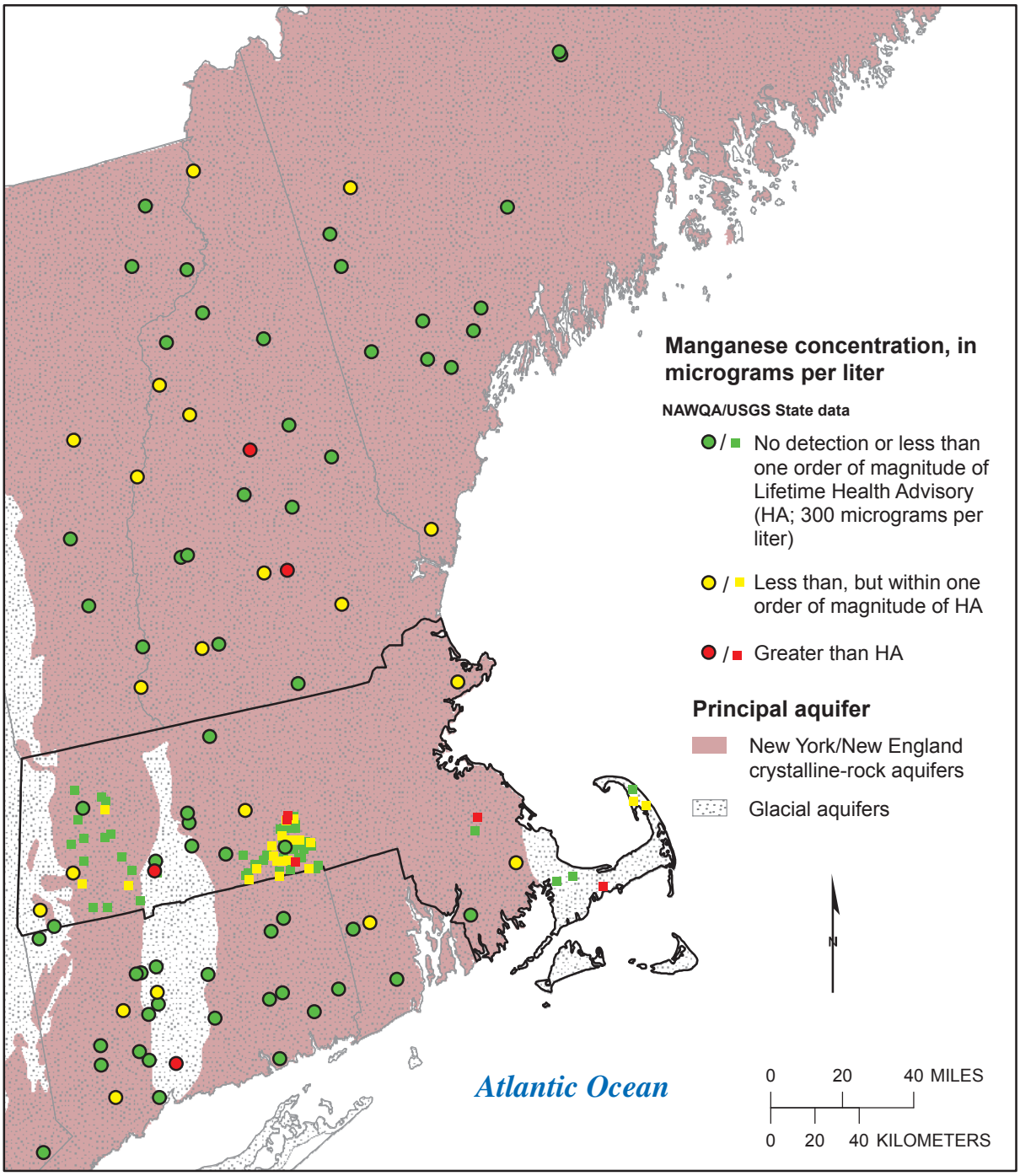
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

* For this report, the MCL for atrazine is used as benchmark for deethylatrazine because their toxicities are considered equivalent (see report text).

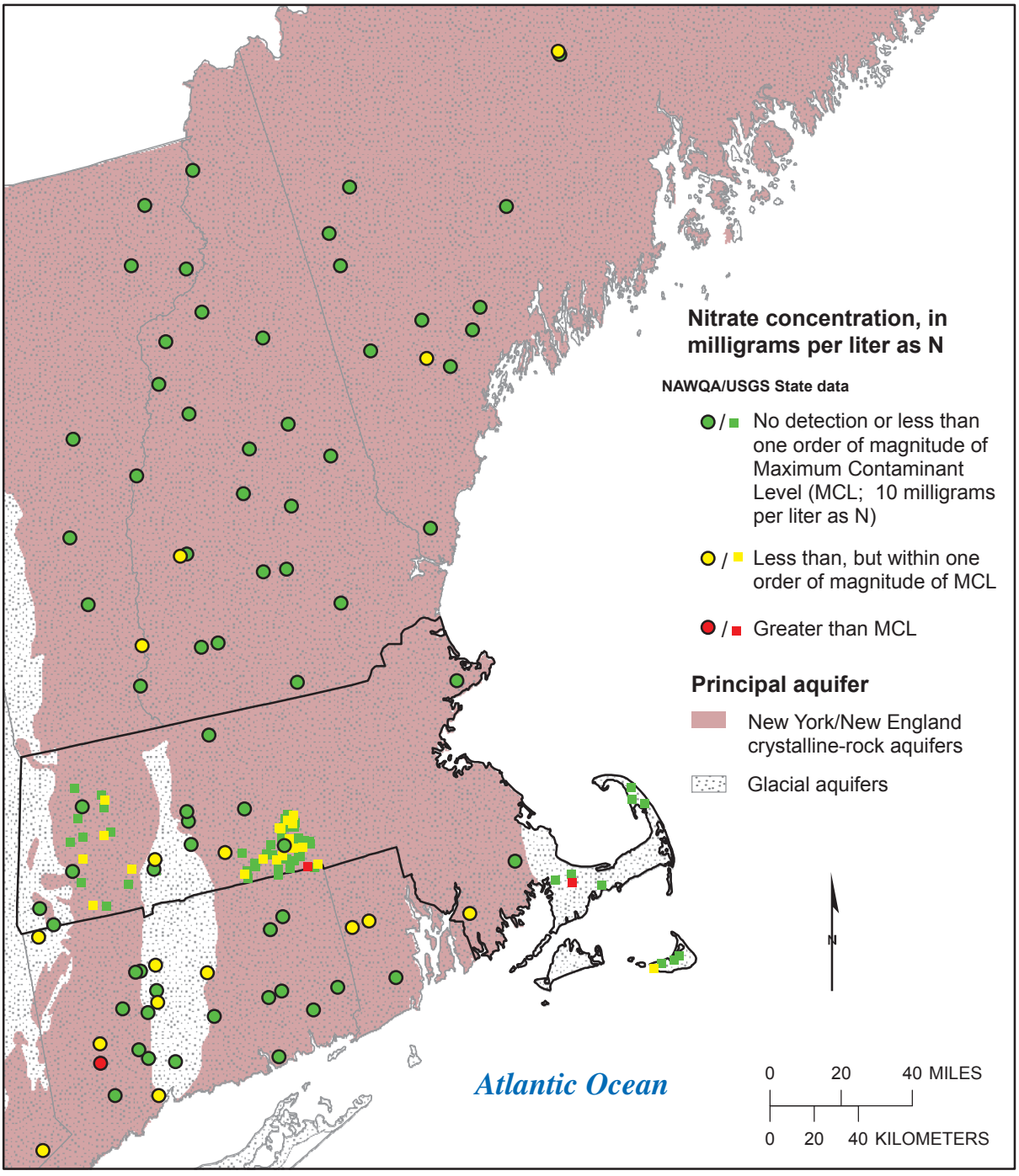
Figure MA9. Concentration of deethylatrazine (CIAT) in samples from domestic wells in Massachusetts and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



Base information from U.S. Geological Survey digital data, 1:2,000,000
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MA10. Concentration of manganese in samples from domestic wells in Massachusetts and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



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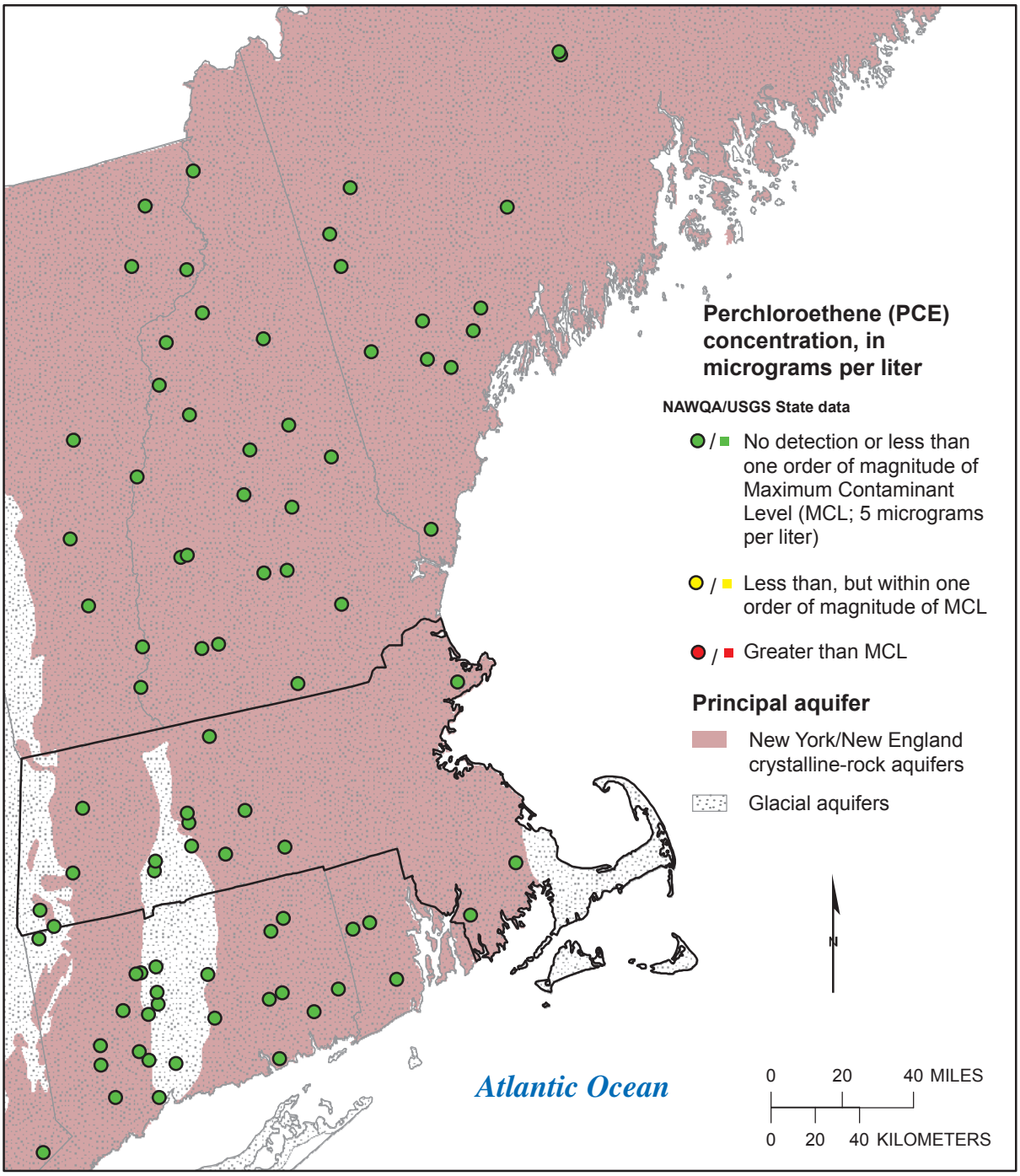
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MA11. Concentration of nitrate in samples from domestic wells in Massachusetts and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



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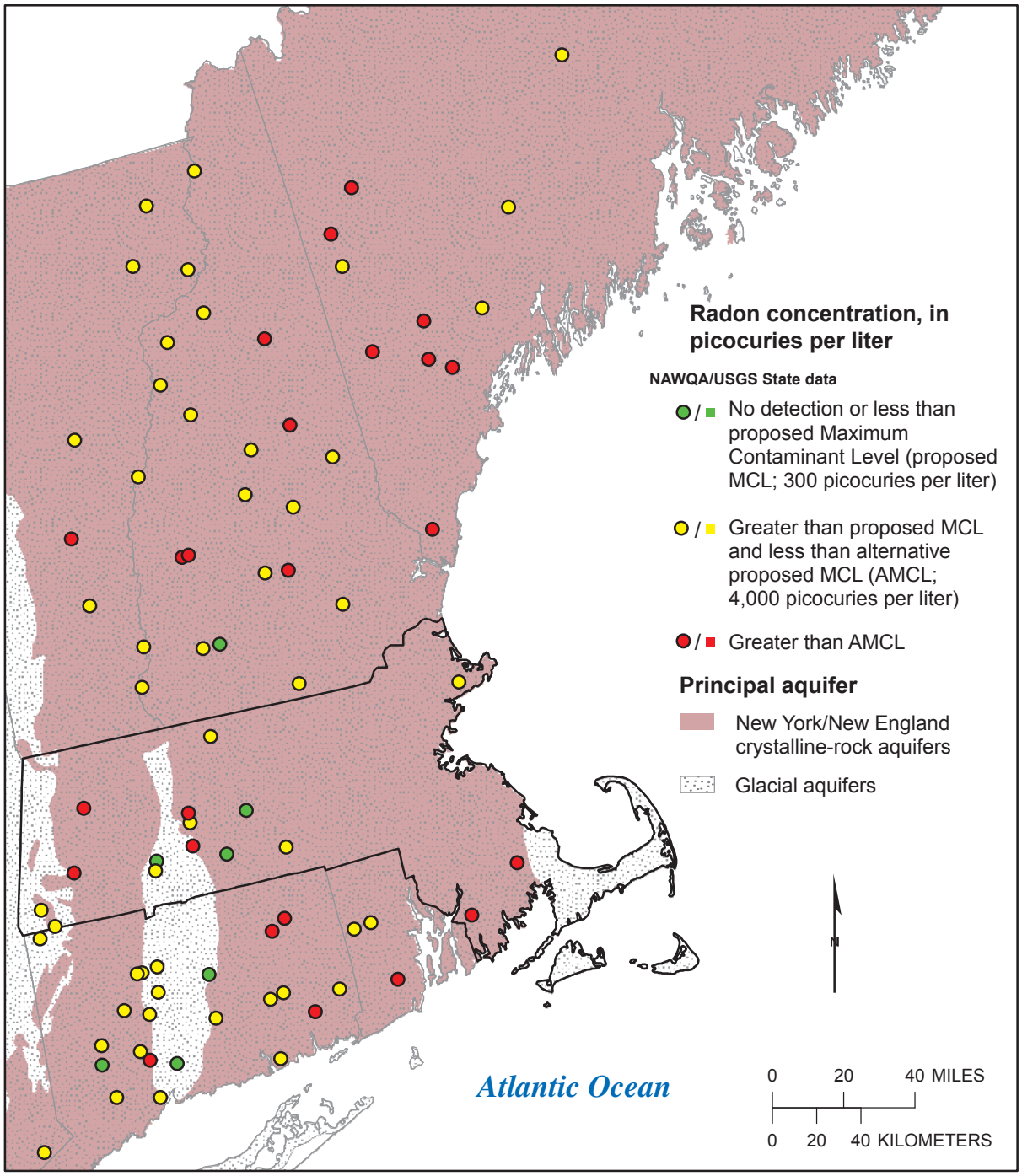
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MA12. Concentration of perchloroethene (PCE) in samples in Massachusetts and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



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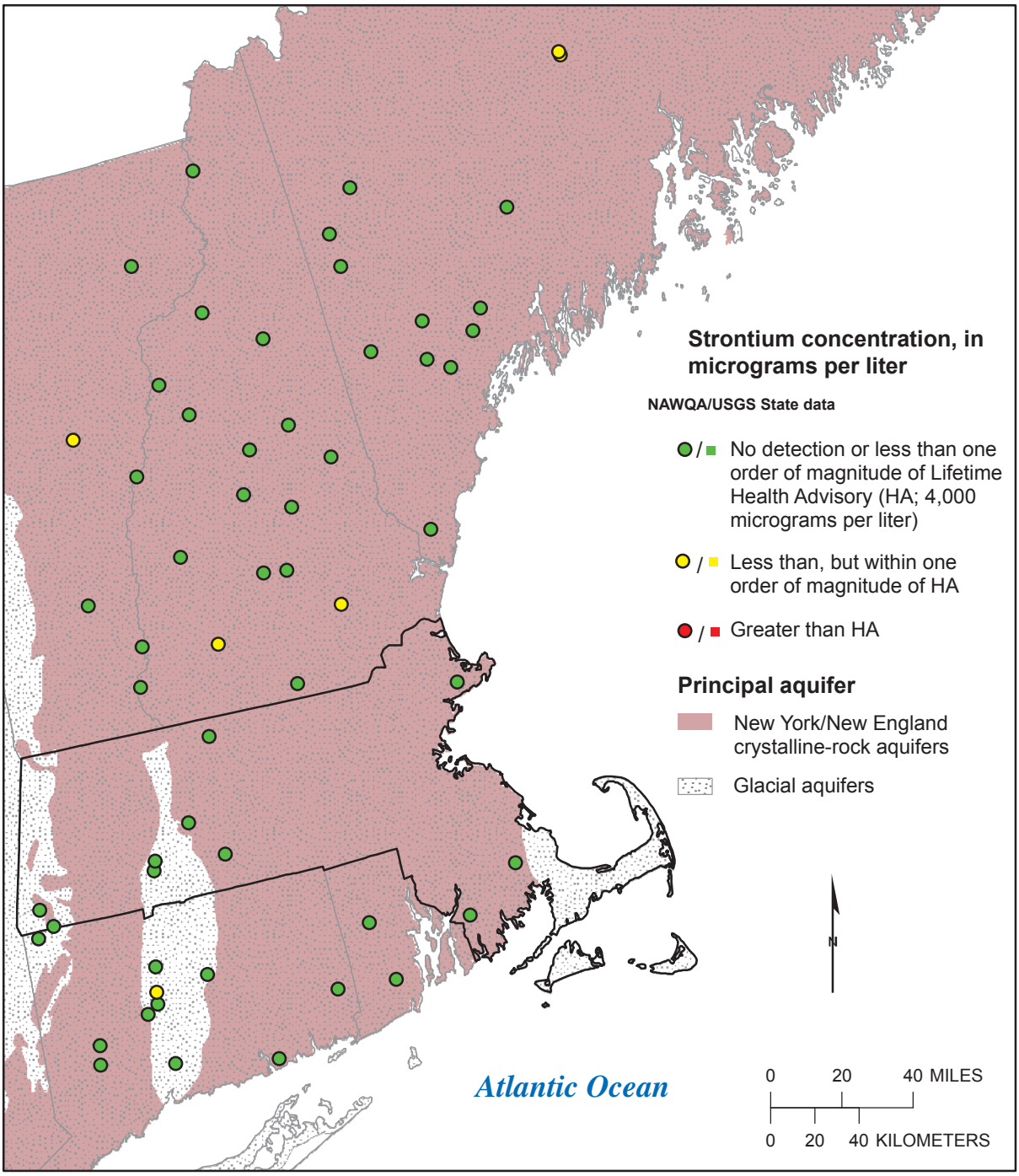
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MA13. Concentration of radon in samples from domestic wells in Massachusetts and nearby States (from National Water-Quality Assessment (NAWQA) studies. No additional data were available from U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



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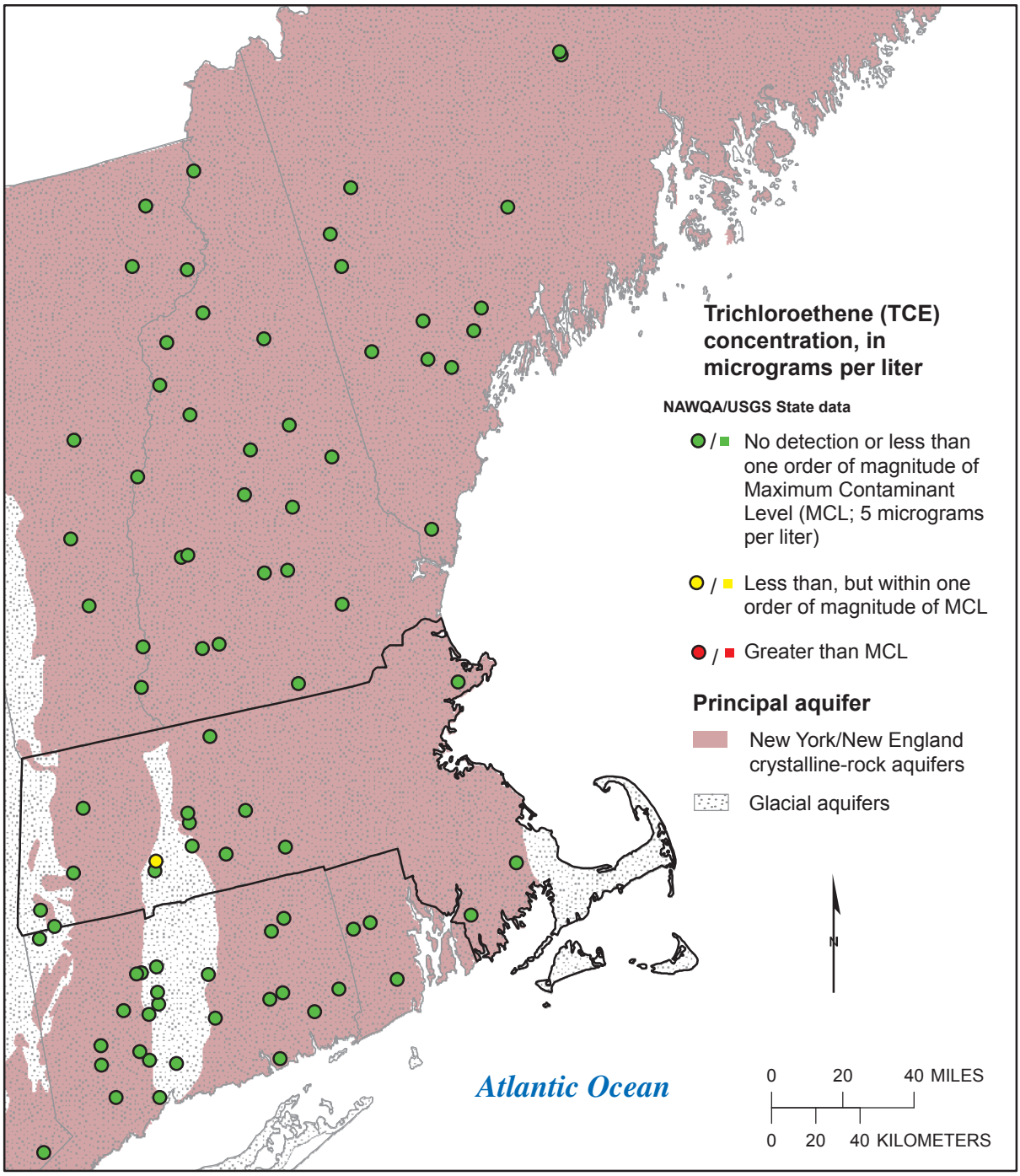
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MA14. Concentration of strontium in samples from domestic wells in Massachusetts and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



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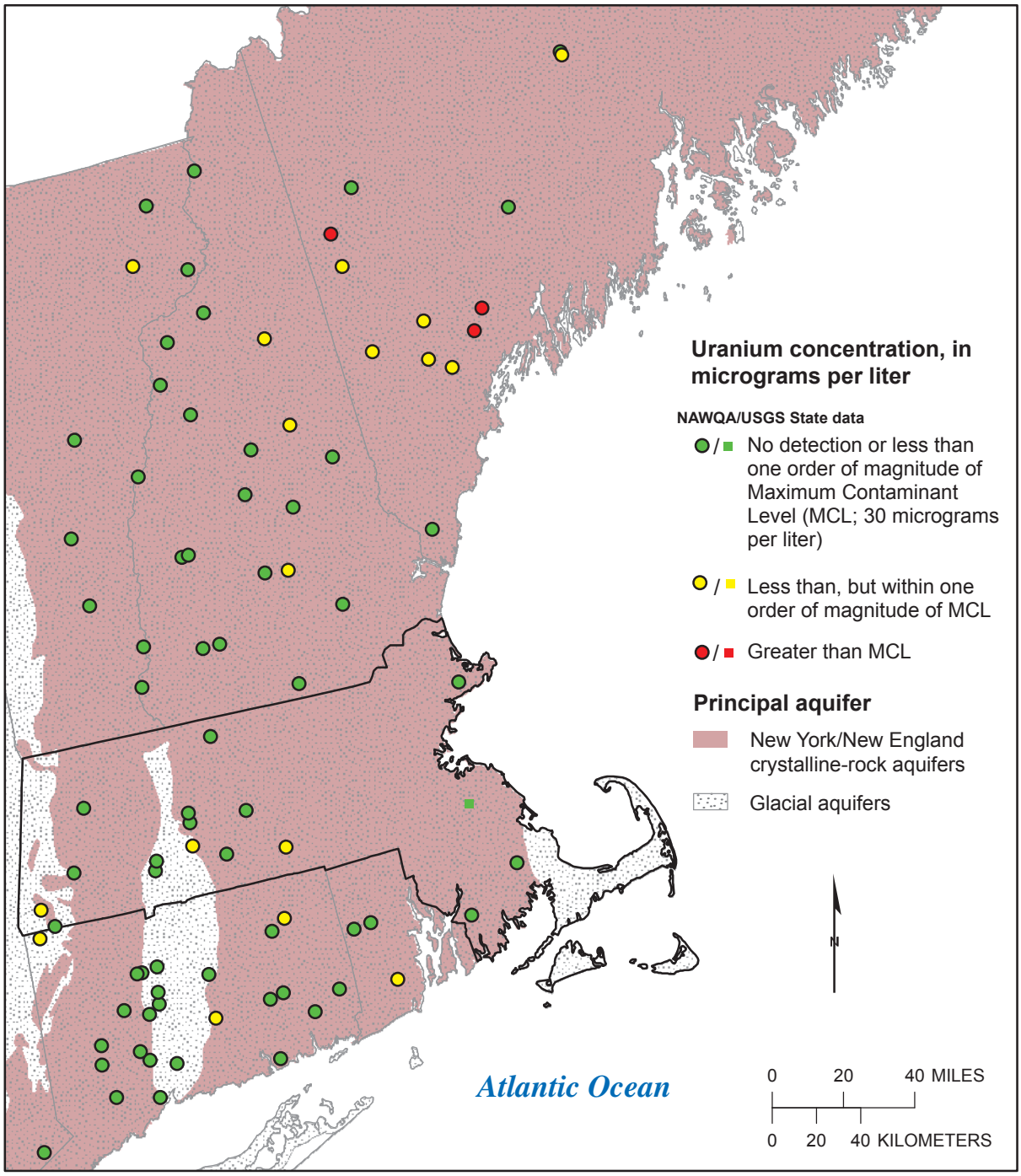
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MA15. Concentration of trichloroethene (TCE) in samples from domestic wells in Massachusetts and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



Base information from U.S. Geological Survey digital data, 1:2,000,000
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MA16. Concentration of uranium in samples from domestic wells in Massachusetts and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).