2009-2011 Status Network Statewide Results

Florida Department of Environmental Protection (FDEP)

Division of Environmental Assessment and Restoration

Bureau of Assessment and Restoration Support, Watershed Monitoring Section

Goal of the Status Monitoring Network

The objective of the Status Monitoring Network is to broadly characterize Florida's water quality with a known statistical confidence. To accomplish this goal, the Network uses a random site monitoring design, in which water sampling locations are chosen in a random and unbiased manner. Because it is fiscally and logistically prohibitive to sample every waterbody in the state, a random site monitoring design is a cost-effective approach to producing statistically valid estimates of statewide water conditions. In 2009, FDEP's Watershed Monitoring Section (WMS) began annually reporting on Florida's water quality (in the past this reporting took place every 5 years). This monitoring program addresses statewide and regional (within Florida) questions; it is not designed to evaluate specific lakes, rivers, streams, or wells.

Monitoring Design

The Status Monitoring Network categorizes Florida's fresh waters into six resource types. Four of these are surface water: small lakes, large lakes, rivers, and streams. The other two resources are ground water: unconfined and confined aquifers. Each year, the resource coverages are updated or created to incorporate documented changes, deletions or additions. Not all randomly selected stations can be sampled for various reasons. Those that can be sampled are termed accessible. Those stations that cannot be sampled are considered either dry or inaccessible. If a selected location does not represent the assigned resource, it is removed from the coverage and added to the proper resource for the following year's selections. The following paragraphs provide further details on the resource types and monitoring design.

Lakes

In this monitoring design, lakes are defined as natural or established reservoirs that are at least 1 meter deep and contain at least 1/4 acre of open water (free of emergent vegetation and trees). Based on this definition, the state of Florida has approximately 4,166 sampleable lakes. FDEP has divided these lakes by size into two categories: small lakes of 10 to 25 acres and large lakes over 25 acres. The small lakes are treated as points and the large lakes are sampled based on area. This division allows a better characterization of the state's lake resources: if all lakes were in one category, the size of large lakes would skew site selection and cause small lakes to be under-represented.

Rivers and Streams

There have been issues using traditional classification, commonly referred to as Strahler order, on the flowing surface waters of the state. In order to better categorize those waters, WMS contacted

several interested parties (e.g., Water Management Districts, other sections of FDEP) to submit suggestions for the river resource. Based on these recommendations, the state has 2,708 miles of rivers. The remaining streams and tributaries are designated as the stream resource. These total about 16,914 miles, although some may be dry during periods of drought. The two resources can have different habitats and uses.

Aquifers

Aquifers are permeable layers of sand, gravel, or rock that contain water. Unconfined aquifers are near the land surface and are easily affected by human activities. Confined aquifers lie below a layer of material, such as fine-grained clay, that limits the downward flow of water. Water in confined aquifers usually filters slowly through sediment and rock layers, and is older and less affected by human activities. Ground water is monitored through wells in unconfined and confined aquifers.

Sampling and Analysis

Sixty samples from each surface water resource type, and 120 samples from each ground water resource type, were collected throughout the state in order to assess the conditions of each resource listed above. In addition to overall statewide assessment, the question arose as to what the water conditions were in each of Florida's 6 zones (i.e., Northwest Florida, Suwannee River District, St. Johns River District, Southwest Florida, and the 2 South Florida zones). After discussion with the U.S. Environmental Protection Agency (EPA), it was determined that several years of data could be combined to increase the number of samples to 30 per zone per resource, thereby increasing the reliability of statistical assessments. The design allows multiple years to be combined, with one extra stipulation: the sample sites must be on the resource coverage of the final year. For example, 2009 data taken at Stream A could only be used if the 2011 "Streams List" included Stream A. This stipulation required mapping out the sample sites for each year and comparing them to the 2011 coverage before any analyses could be performed.

On occasion, less than the maximum number of samples (60 or 120) were collected in a given year. When this occurred, the reasons for the missing samples were documented. If the sample size was reduced to a point that created a margin of error greater than 20%, insufficient data (ISD) was reported.

Summary and Results

As noted above, 60 samples from each surface water resource type, and 120 samples from each ground water resource type, were collected each year to estimate statewide water conditions. Based on these sample sizes, the 95% confidence interval for 2009-2011 data is $\pm$ 12% for surface water and $\pm$ 9% for ground water. Therefore, we have 95% confidence that surface water data are within 12% of the reported value, and similarly ground water data are within 9% of the reported value. For a given resource type, at least 26 samples are needed to obtain a margin of error within $\pm$ 20%.

The tables below show the sampling carried out for each resource type, in terms of number of large and small lakes, miles of rivers and streams, and number of wells tapping confined and unconfined aquifers. Reduced rainfall or periods of drought occur on a cyclical basis in many areas of Florida. This can cause waterbodies to become dry or inaccessible. Prolonged or intense periods of drought can adversely affect water chemistry. The average annual precipitation for 2009-2011 was comparable with the 30-year annual average (51.15 versus 54.88 inches, respectively).

Table 1. Size and Accessibility of Surface Water Resources.

This is a six-column table. Column 1 lists the surface water resource type, Column 2 lists the resource size, Column 3 lists the percent of the resource that is accessible, Column 4 lists the percent that is dry, Column 5 lists the percent that is inaccessible, and Column 6 lists number of samples analyzed from 2009-2011.

Surface Water Resource	Resource Size (number, length)	% Accessible	% Dry	% Inaccessible	Number of Samples
Large Lakes (≥25 acres)	1,725 lakes	84.1	7.5	8.4	178
Small Lakes (10-25 acres)	2,441 lakes	48.6	24.5	26.9	156
Rivers	2,707.7 miles	75.2	6.4	18.4	162
Streams	16,914.4 miles	25.2	32.8	42.0	140

Table 2. Size and Accessibility of Ground Water Resources.

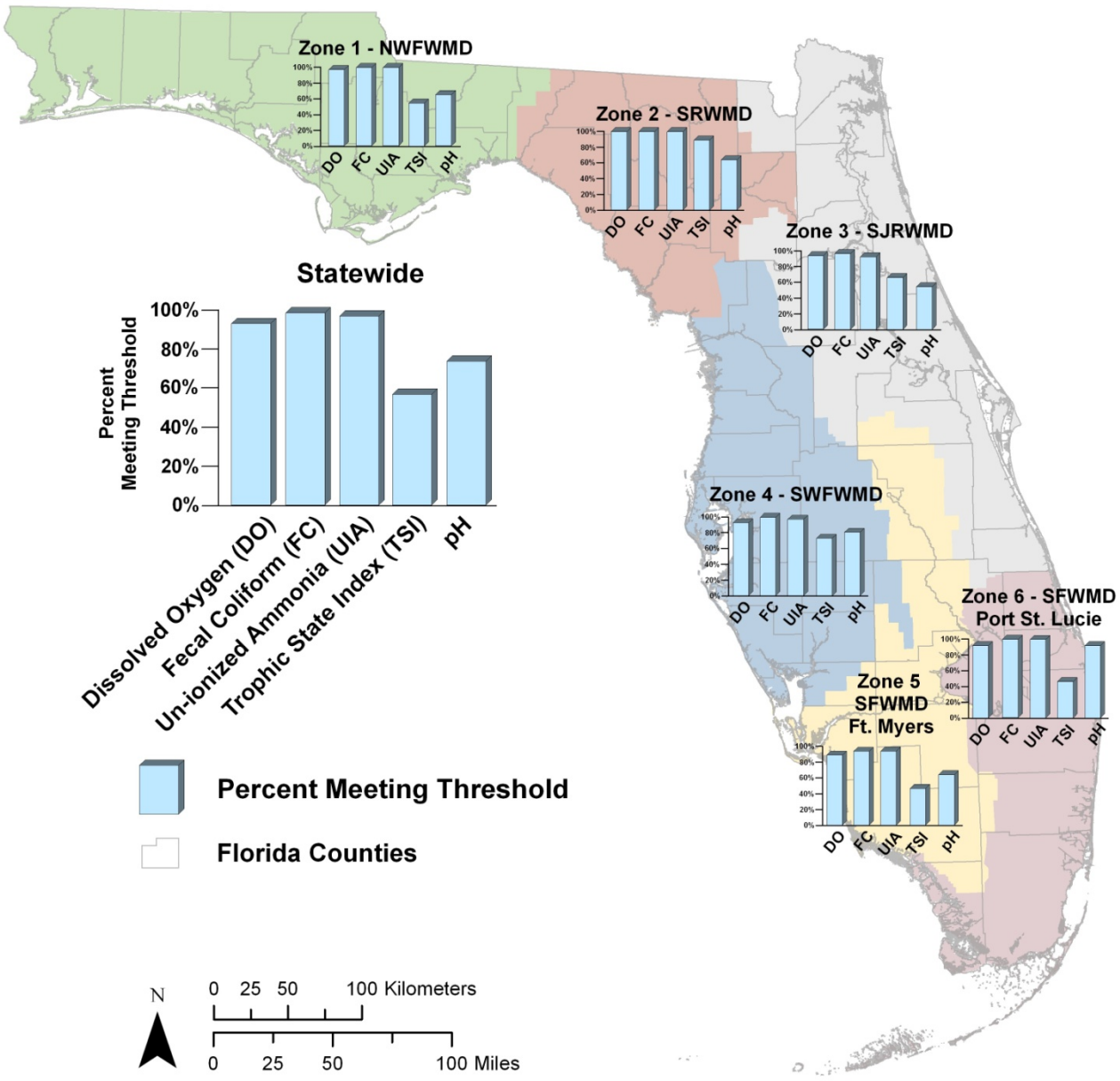
This is a five-column table. Column 1 lists the ground water resource type, Column 2 lists the resource size (number of wells), Column 3 lists the percent of wells that is accessible, Column 4 lists percent that is inaccessible, and Column 5 lists the number of samples analyzed from 2009-2011.

Ground Water Resource	Resource Size (number of wells)	% Accessible	% Inaccessible	Number of Samples
Unconfined Aquifers	757	45.2	54.8	332
Confined Aquifers	590	55.7	44.3	324

Statewide maps showing the percentages of waterbodies attaining water quality standards are provided below. Appendix A lists the definitions and numeric standards for water quality indicators. Tables of results are given in Appendix B. Detailed information on the Status Monitoring Network design can be found at: http://www.dep.state.fl.us/water/monitoring/docs/watershed-monitoring-design-document.pdf.

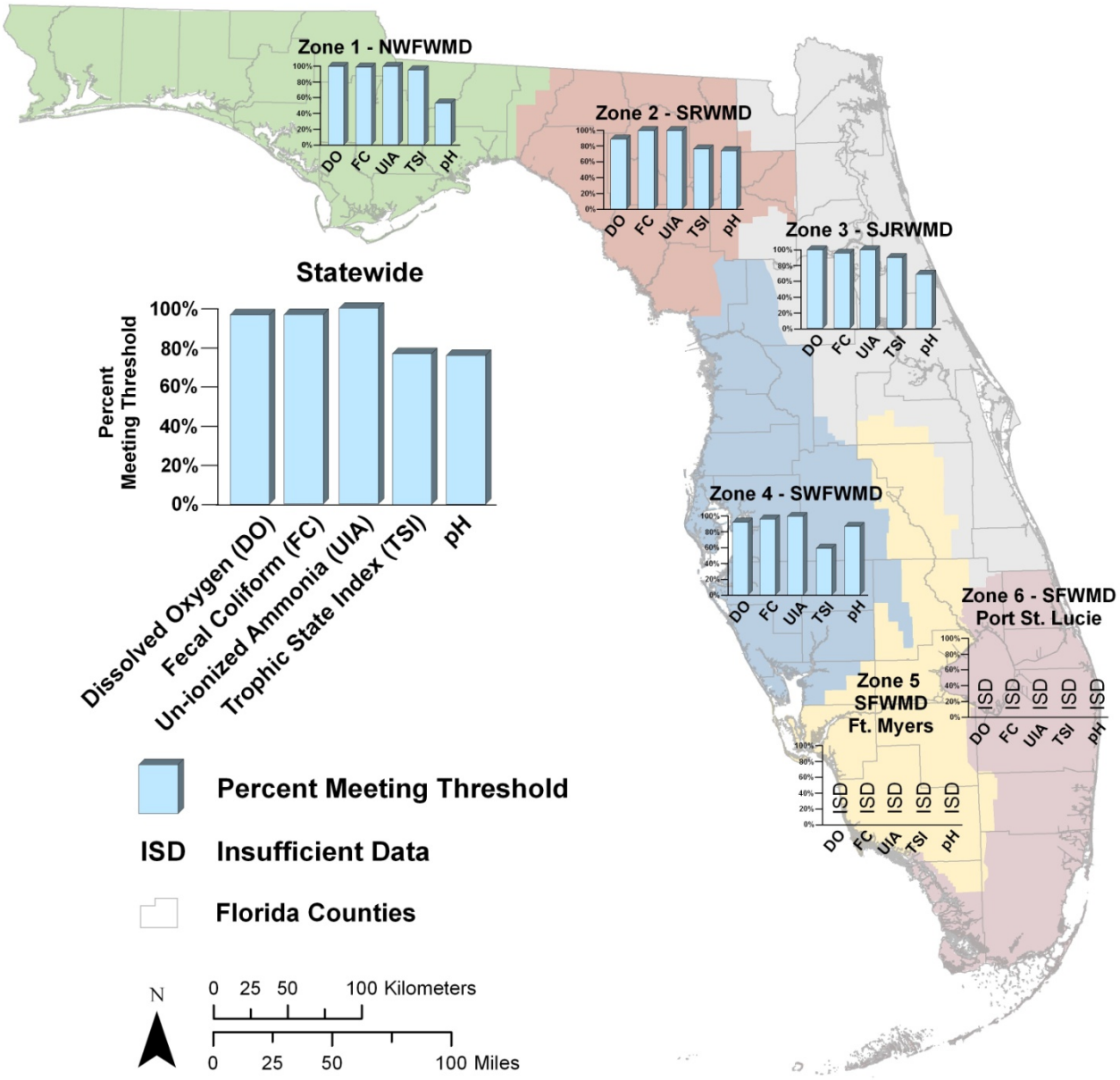
For more information, contact:
Florida Department of Environmental Protection, Watershed Monitoring Section, MS 3525
2600 Blair Stone Road, Tallahassee, FL 32399
(850) 245–8433; http://www.dep.state.fl.us/water/monitoring/

Large Lakes Resource
2009 - 2011



Created July 5, 2012 by Florida Department of Environmental Protection staff in the Division of Environmental Assessment and Restoration, Watershed Monitoring Section. This map is a representation of ground conditions and is not intended for further analysis. For more information contact Stephanie.Sunderman@dep.state.fl.us or (850)-245-8433.

Small Lakes Resource
2009 - 2011



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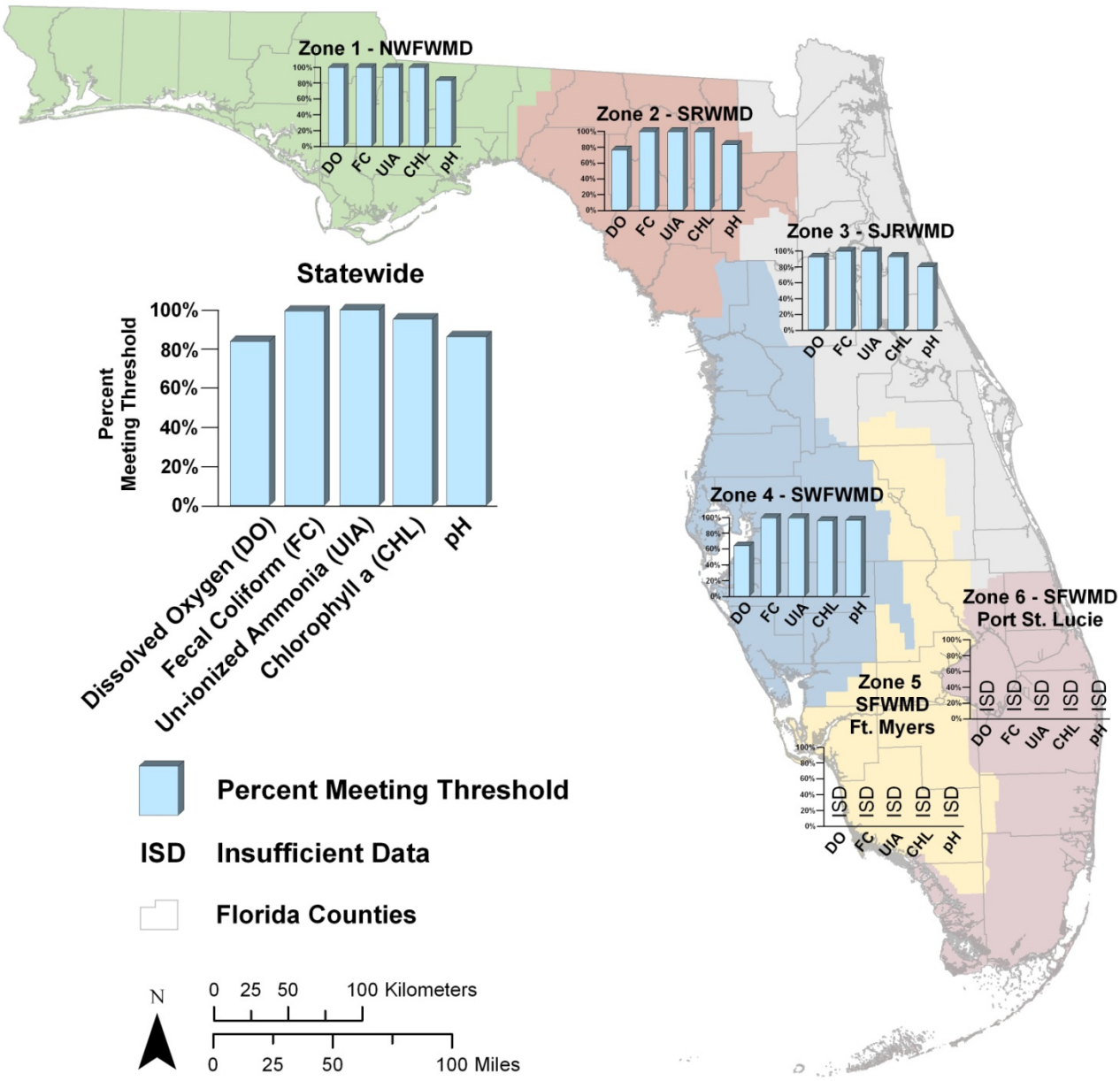
Rivers Resource
2009 - 2011



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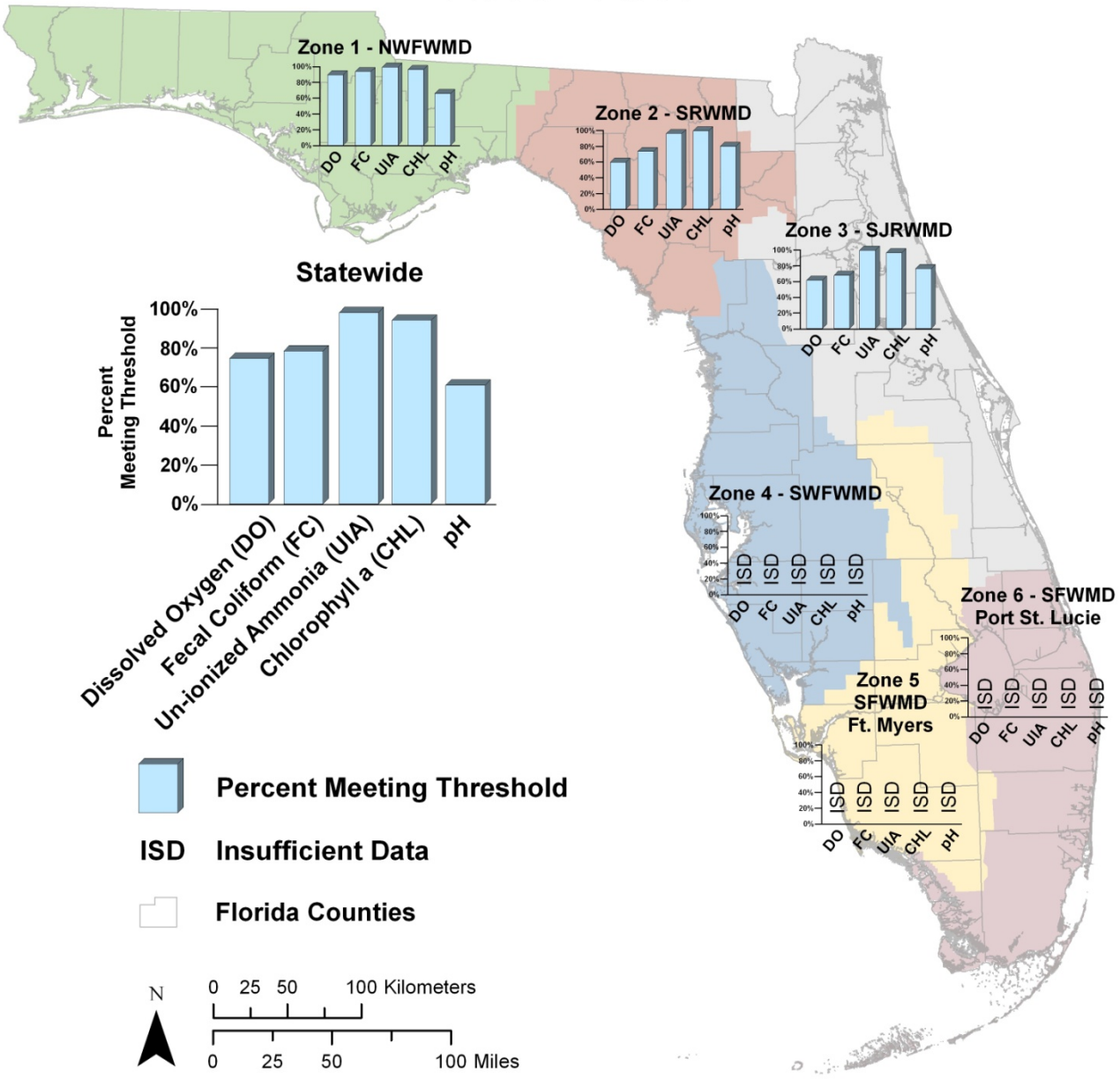
Streams Resource
2009 - 2011



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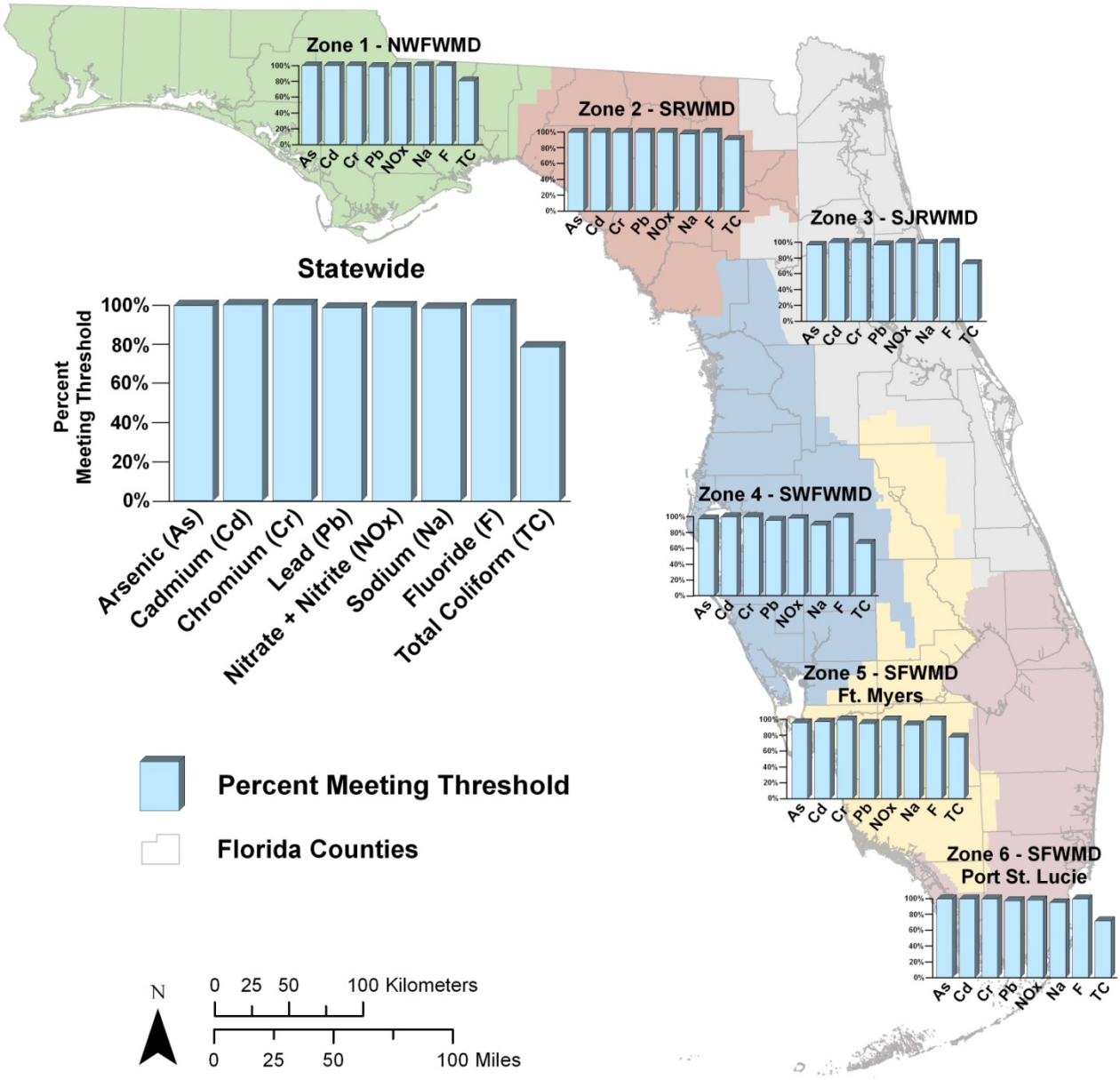
Unconfined Aquifers Resource
2009 - 2011



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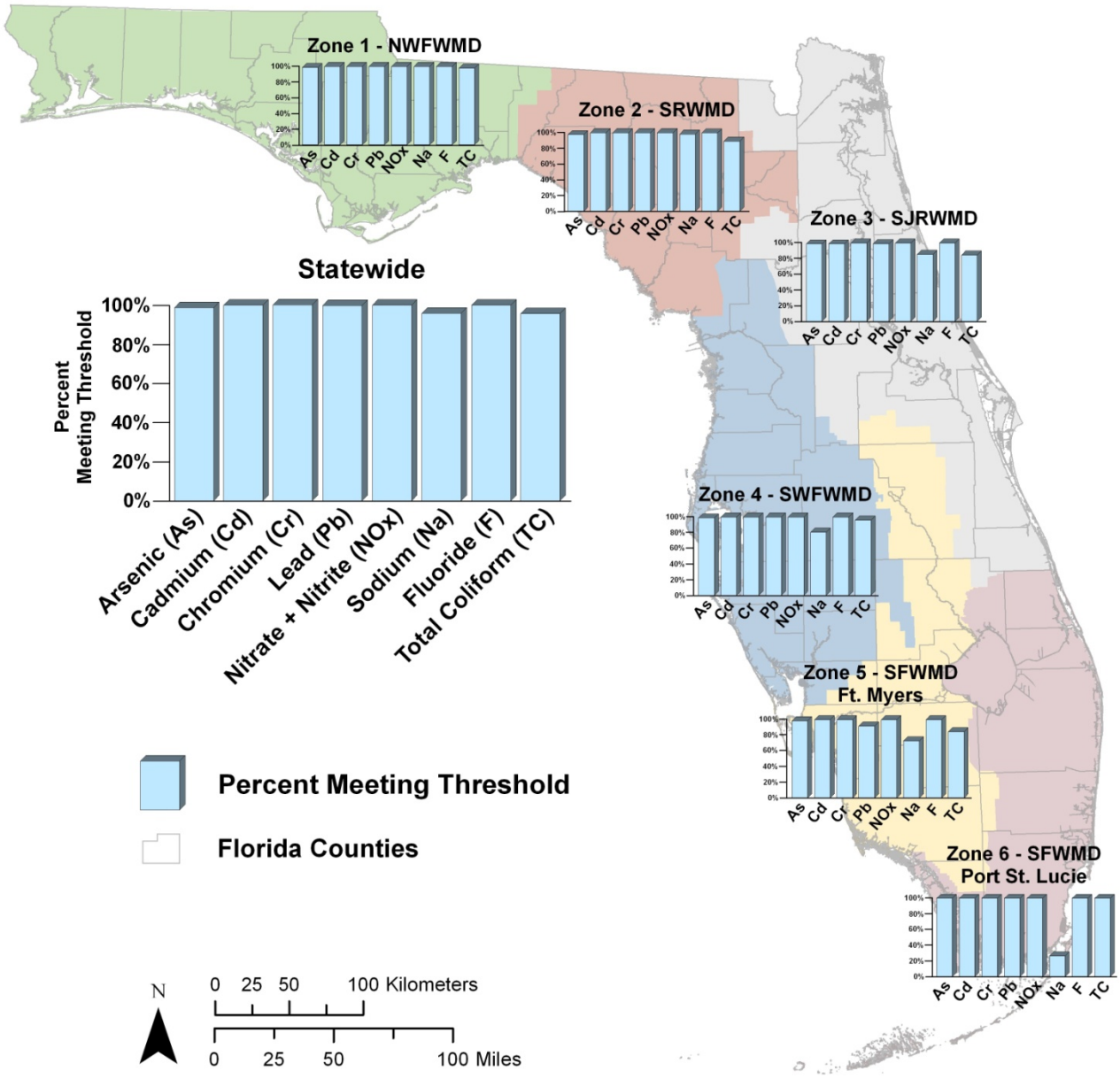
Confined Aquifers Resource
2009 - 2011



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Appendix A. Water Quality Indicators and Associated Criteria

Surface Water

Each indicator listed below was chosen because it has an applicable state criterion, found in *Criteria for Surface Water Quality Classifications, Rules 62-302 and 62-303, Florida Administrative Code.*

Table A1. Indicators Used to Assess Surface Water Resources.

This is a three-column table. Column 1 lists the indicator, Column 2 lists the criterion or threshold, and Column 3 lists the designated use.

mL – milliliters; mg/L – milligrams per liter; SU – standard units; µg/L – micrograms per liter; PCUs – platinum cobalt units

Indicators	Criterion or Threshold	Designated Use
Fecal Coliform Bacteria	< 400 counts/100mL	Recreation
Dissolved Oxygen	≥ 5 mg/L	Aquatic Life
pH	≥ 6 and ≤ 8.5 SU	Aquatic Life
Un-ionized Ammonia	≤ 0.02 mg/L	Aquatic Life
Chlorophyll *a*	≤ 20 µg/L	Aquatic Life
Trophic State Index	If color ≤ 40 PCUs, then TSI ≤ 40 If color > 40 PCUs, then TSI ≤ 60	Aquatic Life

Fecal coliform bacteria: The single-sample threshold for fecal coliform is 400 counts per 100 milliliters of water. These bacteria can enter water through the discharge of waste from mammals and birds, agricultural and stormwater runoff, and untreated human sewage. The presence of fecal coliform bacteria may indicate that the water is contaminated by other disease-causing organisms.

Dissolved oxygen (DO): The state criterion for DO is a minimum of 5 milligrams per liter to maintain healthy conditions for aquatic life. Lower levels do not affect human recreation. Algae and plants produce oxygen through photosynthesis. Oxygen is also dissolved in water by wind and wave action. Respiration by aquatic animals, decomposition, wastewater, stormwater runoff from urban streets or farmland, and failing septic tanks consume oxygen. Natural conditions—such as ground water from springs, water from swamps/wetlands, higher water temperatures, and calm and cloudy weather—can also decrease DO levels in waterbodies.

pH: The surface water criterion for pH is between 6 and 8.5 standard units. The pH scale, which ranges from 0 to 14, is a measure of the degree of acidity or alkalinity of a solution. Numbers below 7.0 indicate acidity; numbers above 7.0 indicate alkalinity. The midpoint of 7.0 on the pH scale represents neutrality, meaning the solution is neither acidic nor alkaline. A waterbody's pH can affect many chemical and biological processes, and aquatic organisms are adapted to a certain range. When pH levels are outside this range, it stresses these organisms' physiological systems and can reduce reproduction. Atmospheric deposition (acid rain), geology, vegetation, and pollution can cause changes in pH.

Un-ionized ammonia: The threshold for un-ionized ammonia is less than or equal to 0.02 milligrams per liter. This is calculated from total ammonia and is adjusted for temperature, salinity, and pH. Ammonia occurs in different forms; water temperature and pH affect which form predominates at a given time in an aquatic system. Un-ionized ammonia can be toxic to fish and invertebrates.

Chlorophyll *a:** The threshold for chlorophyll *a* is less than or equal to 20 micrograms per liter. Chlorophyll is the pigment that allows algae and plants to convert sunlight into organic compounds during the process of photosynthesis. Excess nutrients, such as nitrogen and phosphorus, can stimulate algal blooms. Excess algae sink to the bottom and decay, using up the oxygen that other

plants and organisms require to survive. High concentrations of chlorophyll reduce water clarity and limit the light available to shallow-water ecosystems.

Trophic State Index (TSI)*: TSI and chlorophyll *a* are the primary measures used to assess nutrient impairment (pollution) in a waterbody. There are two thresholds for TSI, based on the color of a lake. Dark-water lakes with a mean color greater than 40 platinum cobalt units (PCUs) are impaired when their annual mean TSI exceeds 60. Clear and low-color lakes with a mean color less than or equal to 40 PCUs are impaired when their annual mean TSI exceeds 40. TSI is measured using chlorophyll *a*, nitrogen, and phosphorus concentrations. A 10-unit increase or decrease in the index represents a doubling or halving, respectively, of the number of algal cells present.

***** Both TSI and chlorophyll *a* are not standards, but thresholds used to estimate the impairment of state waters. These thresholds are used in the analysis of Status Monitoring Network data, based on single samples collected from a basin at a predetermined time of year. The analysis and representation of these data are not intended to infer the verification of impairment, as defined in Rule 62-303, Florida Administrative Code.

Ground Water

The table below shows the thresholds for eight indicators regulated under potable (drinking) water standards.

Table A2. Indicators Used to Assess Ground Water Resources.

This is a three-column table. Column 1 lists the indicator, Column 2 lists the criterion or threshold, and Column 3 lists the designated use.

µg/L – micrograms per liter; mg/L – milligrams per liter; mL – milliliters

Indicators	Criterion or Threshold	Designated Use
Arsenic	≤ 10 µg/L	Potable Water
Cadmium	≤ 5 µg/L	Potable Water
Chromium	≤ 100 µg/L	Potable Water
Lead	≤ 15 µg/L	Potable Water
Nitrate–Nitrite	≤ 10 mg/L	Potable Water
Sodium	≤ 160 mg/L	Potable Water
Fluoride	≤ 4 mg/L	Potable Water
Total Coliform Bacteria	≤ 4 counts/100 mL	Potable Water

Arsenic, cadmium, chromium, and lead are all naturally occurring metals in the earth's crust. These and other metals are used in manufacturing and can be found in pesticides, preservatives, and industrial operations. They may enter water as a pollutant. Florida has primary standards (criteria) for these metals to protect human health. Excess levels in drinking water can cause adverse health effects.

Nitrate–nitrite is used in fertilizer and is found in human and animal waste. Florida's drinking water standard is 10 milligrams per liter (mg/L) for nitrate and 1 mg/L for nitrite. In addition, to allow for the fact that the toxicity of nitrate and nitrite is additive, the standard for the sum of nitrate and nitrite is 10 mg/L. In the long term, nitrates and nitrites have the potential to cause serious adverse effects in humans.

Sodium (salt) has a drinking water standard to protect individuals who are susceptible to sodium-sensitive hypertension or diseases that cause difficulty in regulating body fluid volume. Sodium is monitored so that individuals on sodium-restricted diets may take the sodium in their water into account. Drinking water contributes only a small fraction (less than 10%) of an individual's overall sodium intake.

Fluoride, a natural element, is added to drinking water systems to reduce dental cavities. Prolonged exposure to levels above 4 milligrams per liter may result in crippling skeletal fluorosis, a serious bone disorder. Lower levels may cause dental fluorosis when children are developing teeth. In its moderate and severe forms, dental fluorosis is a brown staining and/or pitting of the permanent teeth.

Total coliform bacteria are common in the environment and are generally not harmful. The presence of these bacteria in drinking water, however, is an indicator that disease-causing organisms may be present. To reduce the risk of adverse health effects, the U.S. EPA and the State of Florida have set a single-sample maximum of 4 coliform counts per 100 milliliters of fluid. Drinking water that meets this standard is usually not associated with a health risk from disease-causing bacteria and is considered safe.

This survey does not represent a comprehensive analysis of any individual waterbody. FDEP also analyzes for other indicators that do not have threshold values. For a list of all analytes see the 2009-11 Design Document.

Appendix B. Tables of Results from 2009-2011

Table B1. Percent Compliance in Large Lakes.

This is a seven-column table. Column 1 lists the zone; Columns 2-6 list the percent of large lakes that attains target levels of dissolved oxygen, fecal coliform, pH, un-ionized ammonia, and trophic state index, respectively; Column 7 lists the number of large lake samples analyzed from 2009-2011.

Zone	Dissolved Oxygen	Fecal Coliform	pH	Un-ionized Ammonia	Trophic State Index	Number of Samples
1	97.3	100.0	65.5	100.0	54.7	29
2	100.0	100.0	64.0	100.0	89.3	30
3	93.7	96.8	54.3	92.6	66.2	30
4	92.9	100.0	80.9	97.5	73.6	29
5	89.2	94.2	64.4	94.2	46.8	30
6	92.3	100.0	92.3	100.0	46.2	30
Statewide Average	92.7	98.1	73.5	96.6	56.6	178

Table B2. Percent Compliance in Small Lakes.

This is a seven-column table. Column 1 lists the zone; Columns 2-6 list the percent of small lakes that attains target levels of dissolved oxygen, fecal coliform, pH, un-ionized ammonia, and trophic state index, respectively; Column 7 lists the number of small lake samples analyzed from 2009-2011.

Zone	Dissolved Oxygen	Fecal Coliform	pH	Un-ionized Ammonia	Trophic State Index	Number of Samples
1	100.0	99.0	53.1	100.0	95.2	30
2	89.1*	100.0	74.3*	100.0	76.7	26
3	100.0	95.7	69.1	100.0	90.1	30
4	92.5	96.8	87.4	100.0	59.3	30
5	ISD	ISD	ISD	ISD	ISD	25
6	ISD	ISD	ISD	ISD	ISD	12
Statewide Average	96.7	96.7	76.0	100.0**	77.0**	156

* Based on 29 samples
** Based on 153 samples
ISD – Insufficient Data

Table B3. Percent Compliance in Rivers.

This is a seven-column table. Column 1 lists the zone; Columns 2-6 list the percent of rivers that attains target levels of dissolved oxygen, fecal coliform, pH, un-ionized ammonia, and chlorophyll a, respectively; Column 7 lists the number of river samples analyzed from 2009-2011.

Zone	Dissolved Oxygen	Fecal Coliform	pH	Un-ionized Ammonia	Chlorophyll *a*	Number of Samples
1	100.0	100.0	83.3	100.0	100.0	30
2	76.5	100.0	83.3	100.0	100.0	30
3	92.6	100.0	80.2	100.0	93.4	29
4	64.2	100.0	96.8	100.0	96.4	30
5	ISD	ISD	ISD	ISD	ISD	22
6	ISD	ISD	ISD	ISD	ISD	21
Statewide Average	83.8	99.2	86.1	99.8	95.1	162

ISD – Insufficient Data

Table B4. Percent Compliance in Streams.

This is a seven-column table. Column 1 lists the zone; Columns 2-6 list the percent of streams that attains target levels of dissolved oxygen, fecal coliform, pH, un-ionized ammonia, and chlorophyll a, respectively; Column 7 lists the number of stream samples analyzed from 2009-2011.

Zone	Dissolved Oxygen	Fecal Coliform	pH	Un-ionized Ammonia	Chlorophyll *a*	Number of Samples
1	90.0	94.1	65.9	100.0	96.5	30
2	59.8	73.6	80.0	96.6	100.0	30
3	61.4*	68.0	76.5	100.0	96.5	30
4	ISD	ISD	ISD	ISD	ISD	9
5	ISD	ISD	ISD	ISD	ISD	25
6	ISD	ISD	ISD	ISD	ISD	16
Statewide Average	74.3**	78.1	60.7	97.8	93.9	140

* Based on 29 samples
** Based on 139 samples
ISD – Insufficient Data

Table B5. Percent Compliance in Unconfined Aquifers.

This is a ten-column table. Column 1 lists the zone; Columns 2-9 list the percent of unconfined aquifer wells that attains target levels of arsenic, cadmium, chromium, lead, nitrate-nitrite, sodium, fluoride, and total coliform, respectively; Column 10 lists the number of unconfined aquifer samples analyzed from 2009-2011.

Zone	Arsenic	Cadmium	Chromium	Lead	Nitrate-Nitrite	Sodium	Fluoride	Total Coliform	Number of Samples
1	100.0	100.0	100.0	98.9	98.9	100.0	100.0	80.7	57
2	100.0	100.0	100.0	100.0	100.0	97.6	100.0	90.4	56
3	96.7	100.0	100.0	96.8	100.0	98.8	100.0	73.0	55
4	97.5	100.0	100.0	95.7	98.1*	89.8	100.0	66.3	54
5	96.7	97.6	100.0	95.7	100.0	93.9	100.0	77.9	53
6	100.0	100.0	100.0	97.8	98.8	95.4	100.0	72.0	57
Statewide Average	99.4	99.9	100.0	98.3	99.0**	98.2	100.0	78.4	332

* Based on 53 samples
** Based on 331 samples

Table B6. Percent Compliance in Confined Aquifers.

This is a ten-column table. Column 1 lists the zone; Columns 2-9 list the percent of confined aquifer wells that attains target levels of arsenic, cadmium, chromium, lead, nitrate-nitrite, sodium, fluoride, and total coliform, respectively; Column 10 lists the number of confined aquifer samples analyzed from 2009-2011.

Zone	Arsenic	Cadmium	Chromium	Lead	Nitrate-Nitrite	Sodium	Fluoride	Total Coliform	Number of Samples
1	98.6	100.0	100.0	100.0	100.0	100.0	100.0	97.8*	59
2	97.7	100.0	100.0	100.0	100.0	98.2	100.0	89.2**	60
3	98.8	98.8	100.0	98.8	100.0	85.6	100.0	84.6	57
4	98.8	100.0	100.0	100.0	100.0	80.6	100.0	96.0*	59
5	98.6	100.0	100.0	91.9	100.0	73.0	100.0	84.6*	59
6	100.0	100.0	100.0	100.0	100.0	26.5	100.0	100.0	30
Statewide Average	98.6	99.9	100.0	99.7	100.0	95.8	100.0	95.6***	324

* Based on 57 samples
** Based on 59 samples
*** Based on 317 samples