Enhanced Groundwater Monitoring and Resource Assessment

prepared by the

U.S. Geological Survey

for the

Louisiana Department of Natural Resources

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BACKGROUND

From “Recommendations for a Statewide Groundwater Management Plan:”

The most significant and fundamental groundwater resource management issue facing Louisiana is the lack of timely and continuous acquisition of comprehensive aquifer-wide groundwater level measurements, water well production data, and groundwater quality data.

Source: Ecology and Environment (2011)

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PROBLEMS/CONCERNS

- Groundwater withdrawals have caused water levels to decline in some Louisiana aquifers.
- In certain areas, these withdrawals are creating conditions favorable for saltwater encroachment.
- Hydraulic fracturing of shales for petroleum and natural gas could adversely affect water supplies and water quality.

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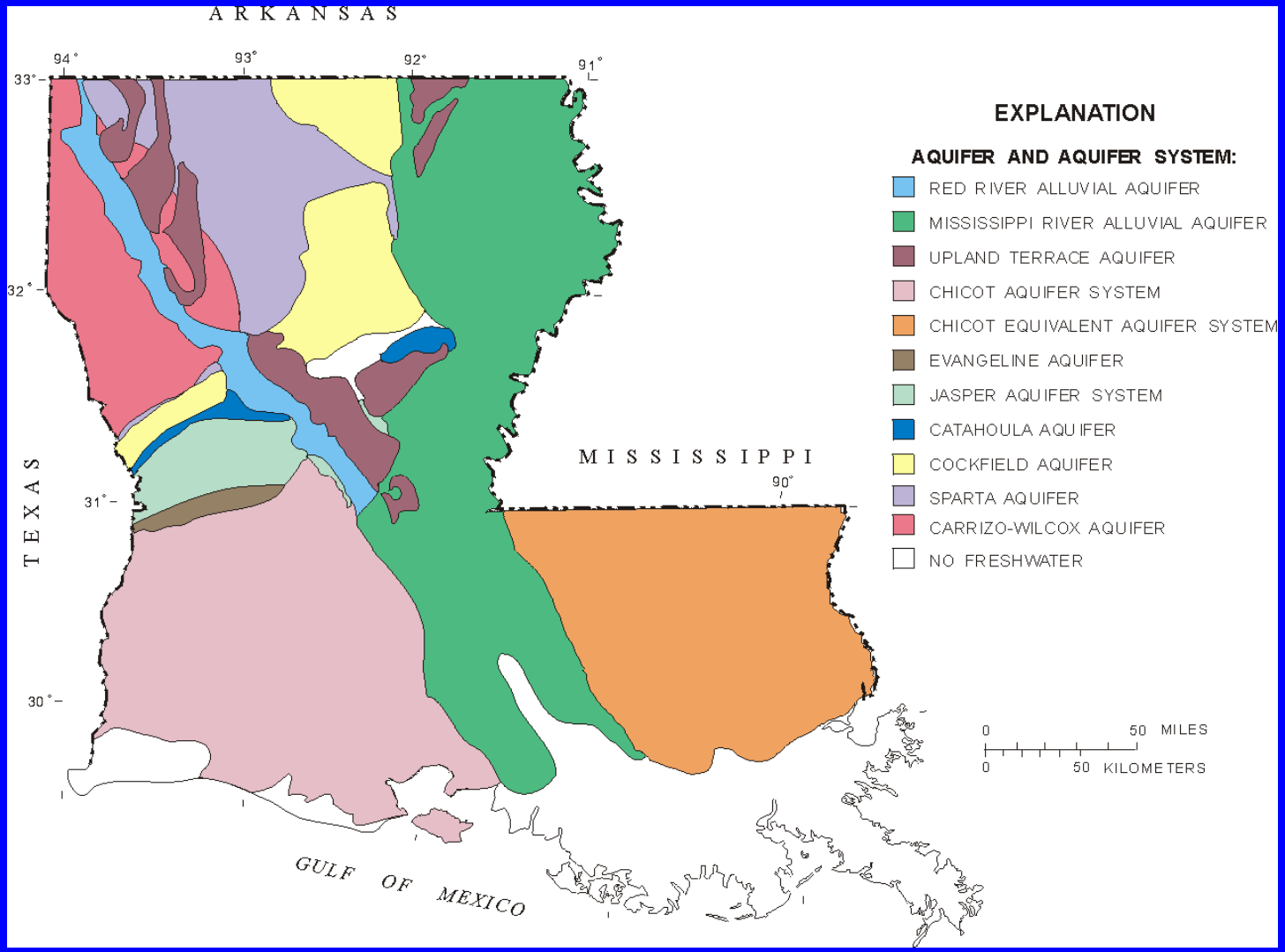
Surface extent of Louisiana's aquifers and aquifer systems



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Major aquifers, aquifer systems, and aquifer subunits in Louisiana

Mississippi River and Atchafalaya alluvial aquifers
Red River alluvial aquifer
Upland Terrace aquifer
Chicot aquifer system
- Undifferentiated sand
- Upper sand
- Lower sand
- 200-foot sand of the Lake Charles area
- 500-foot sand of the Lake Charles area
- 700-foot sand of the Lake Charles area

Chicot Equivalent aquifer system
- 400-foot sand of the Baton Rouge area
- 600-foot sand of the Baton Rouge area
- upland terrace aquifer
- Ponchatoula aquifer upper sand

New Orleans area aquifers
- Gramercy aquifer
- Norco aquifer
- Gonzales-New Orleans aquifer
- 1,200-foot sand of the New Orleans area
- Evangeline aquifer

Evangeline equivalent aquifer system
- 800-foot sand of the Baton Rouge area
- 1,000-foot sand of the Baton Rouge area
- 1,200-foot sand of the Baton Rouge area
- 1,500-foot sand of the Baton Rouge area

Evangeline equivalent aquifer system (continued)
- 1,700-foot sand of the Baton Rouge area
- Ponchatoula aquifer lower sand
- Big Branch aquifer
- Kentwood aquifer
- Abita aquifer
- Covington aquifer
- Slidell aquifer

Jasper aquifer system
- Jasper aquifer
- Williamson Creek aquifer
- Carnahan Bayou aquifer

Jasper equivalent aquifer system
- 2,000-foot sand of the Baton Rouge area
- 2,400-foot sand of the Baton Rouge area
- 2,800-foot sand of the Baton Rouge area
- Tchefuncte aquifer
- Hammond aquifer
- Amite aquifer
- Ramsey aquifer

Catahoula aquifer
Franklinton aquifer
Cockfield aquifer
Sparta aquifer
Carrizo-Wilcox aquifer

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OBJECTIVE

To provide the State of Louisiana with comprehensive information that can be used to assess groundwater conditions and manage these resources.

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5 Element Approach

- Enhanced water-level network
- Updated potentiometric maps
- Enhanced chloride monitoring network
- Water-quality network
- Annual water-use estimates

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Element 1 – Enhanced Water-Level Network

NEED

Knowledge of short-term and long-term water-level changes in all of Louisiana's aquifers is needed to understand the affects of water withdrawals and other influences on groundwater resources.

OBJECTIVE

Improve understanding of short-term and long-term water-level trends in Louisiana's aquifers through increased water-level monitoring.

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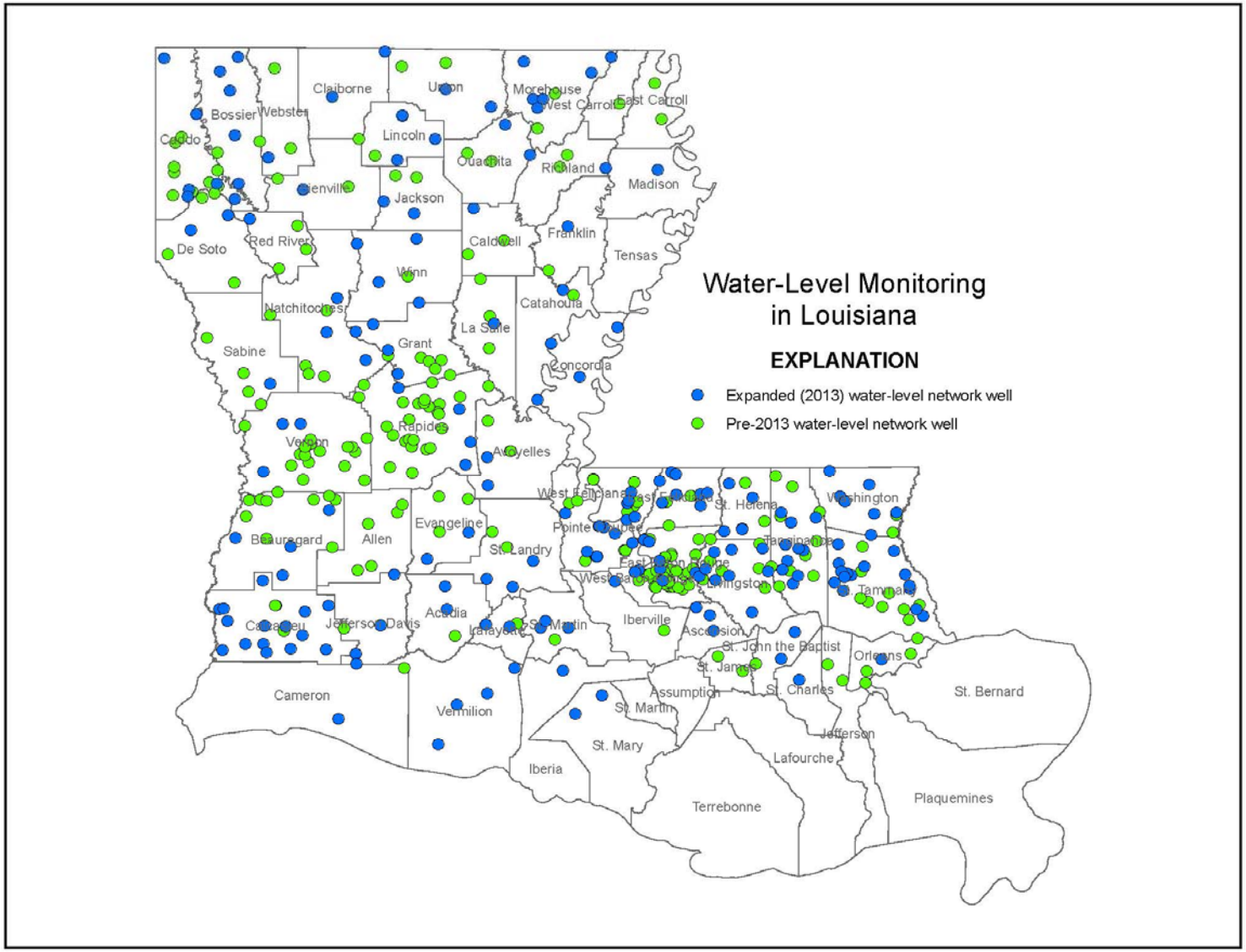
Water-Level Monitoring
in Louisiana
EXPLANATION
Expanded (2013) water-level network well
Pre-2013 water-level network well
Claiborne
Union
Morehouse
West Carroll
East Carroll
Bossier
Webster
Caddo
Lincoln
Ouachita
Richland
Madison
Jackson
Red River
De Soto
Caldwell
Franklin
Tensas
Winn
Natchitoches
Catahoula
La Salle
Grant
Sabine
Concordia
Rapides
Vernon
Avoyelles
West Feliciana
East Feliciana
St. Helena
Washington
Pointe Coupee
Tangipahoa
Evangeline
Beauregard
Allen
St. Landry
East Baton Rouge
West Baton Rouge
Livingston
St. Tammany
Calcasieu
Jefferson Davis
Acadia
Lafayette
St. Martin
Iberville
Ascension
St. John the Baptist
Orleans
St. James
Assumption
St. Charles
St. Bernard
Cameron
Vermilion
St. Martin
Jefferson
St. Mary
Lafourche
Iberia
Terrebonne
Plaquemines

Element 1 – Enhanced Water-Level Network

APPROACH

- The State-wide water level monitoring network was expanded from 279 to 473 wells and cover all major aquifers in Louisiana.
- Water levels are measured quarterly at 439 wells to provide information on seasonal and long-term trends.
- Water levels are measured hourly at 32 wells in 19 aquifers to provide details of seasonal and short-term trends that may not be apparent or detected by quarterly measurements.
- The resulting data are available in tabular and graphical format at USGS web sites (http://waterdata.usgs.gov/la/nwis/gw/ and http://groundwaterwatch.usgs.gov/StateMaps/LA.html).

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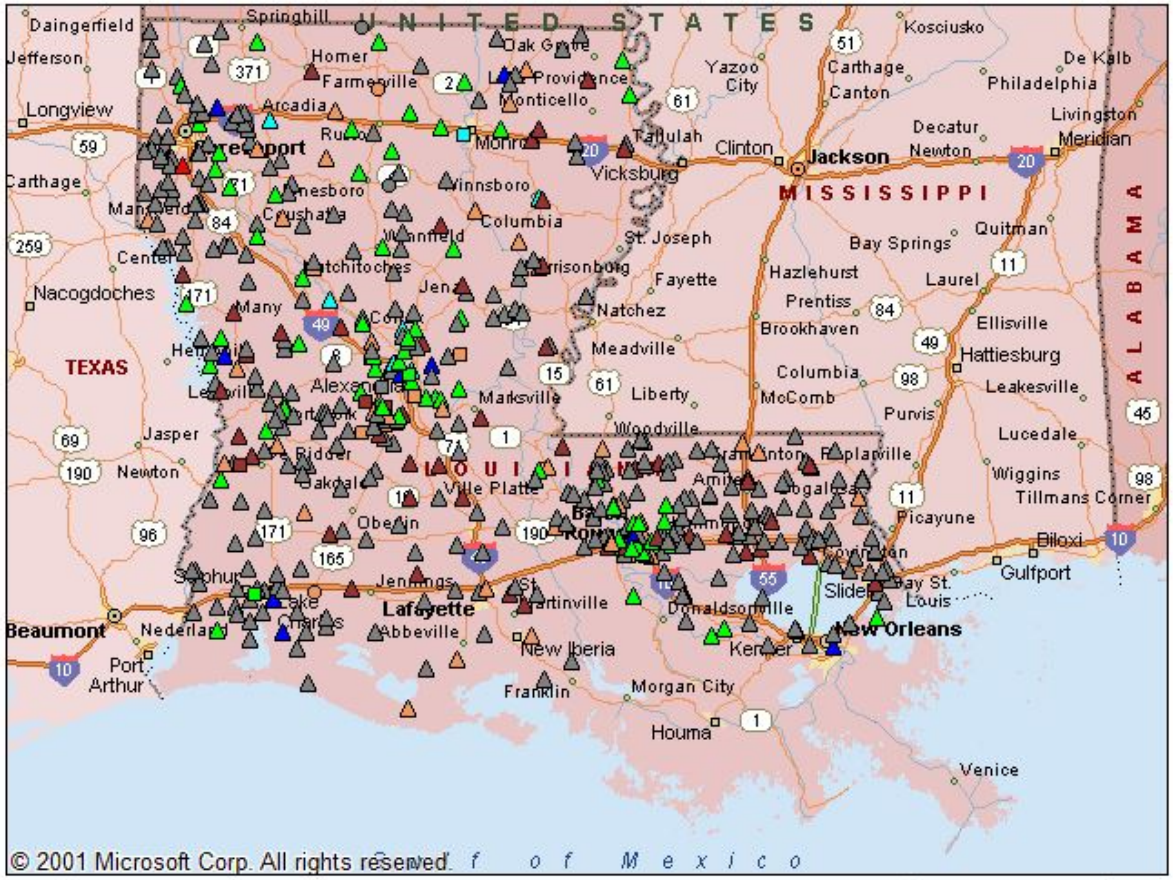
USGS Groundwater Watch network

Louisiana Active Water Level Network

Hover mouse over site for information.
Click site to open page with county information and site selection.



Explanation - Percentile classes (symbol color based on most recent measurement)							
Low	<10 Much Below Normal	10-24 Below Normal	25-75 Normal	76-90 Above Normal	>90 Much Above Normal	High	Not Ranked

Wells	Springs
○ Real-Time	■
□ Continuous	◪
△ Periodic Measurements	◪

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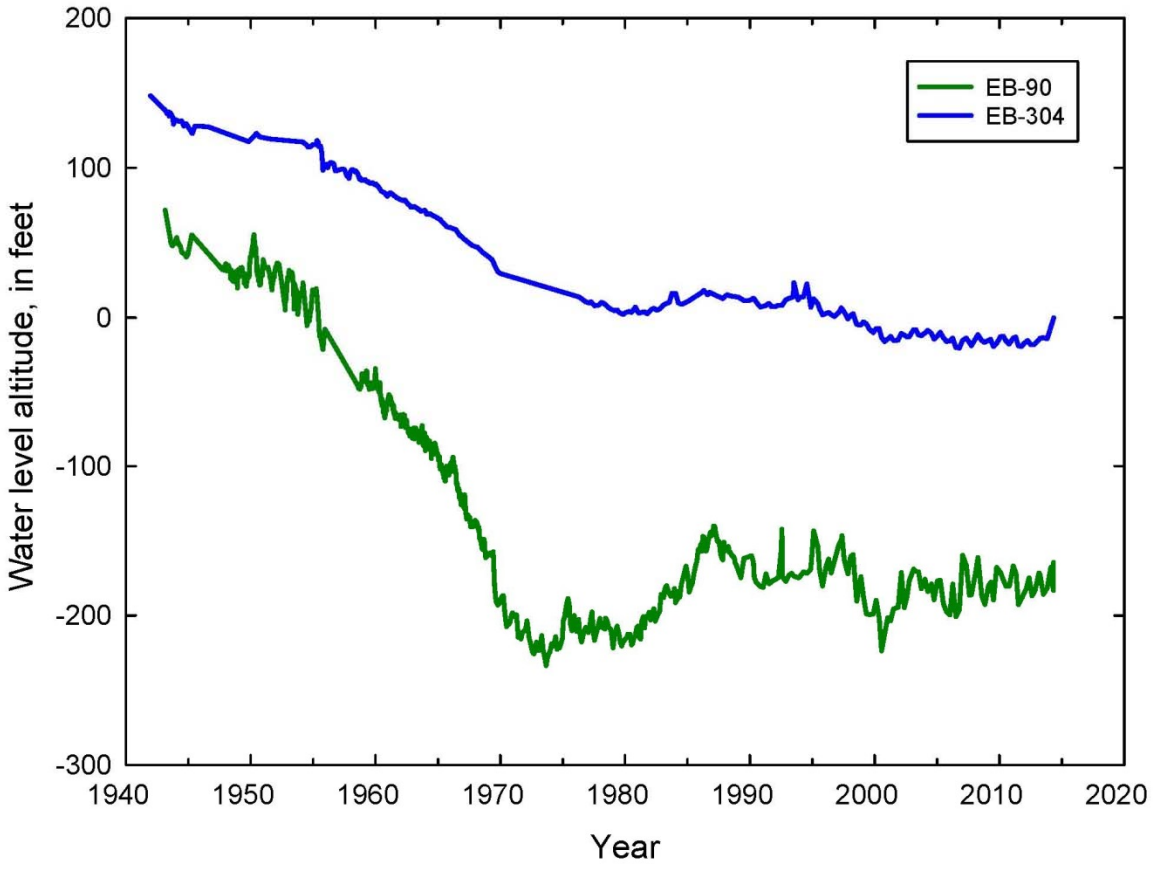
http://groundwaterwatch.usgs.gov/StateMaps/LA.html

Long-term water-level trends in the “2,000-foot” sand of the Baton Rouge area at wells located near the center of pumping (EB-90) and about 10 miles away (EB-304).



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Element 2 – Updated Potentiometric Maps

NEED

Updated potentiometric maps are needed to spatially visualize water level patterns and the impacts of pumping; delineate cones of depression, water-level gradients, and flow paths; and determine the spatial extent of water-level changes.

OBJECTIVE

To improve understanding of the impacts of pumping, water-level trends, and water-level gradients in each aquifer through increased frequency of potentiometric map production for all aquifers.

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Element 2 – Updated Potentiometric Maps

APPROACH

- Potentiometric maps of each aquifer or aquifer in the state will be updated on a 10-year basis. Each year, water-level data will be collected from 2 to 4 aquifers over a short time period and used to create potentiometric maps.
- Maps of water-level changes also will be created by comparing the new data to previously collected data.
- The maps will be published in the USGS Scientific Investigations Map series.

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Element 2 – Tentative 10-year potentiometric map schedule

YEAR	AQUIFER OR AQUIFER SYSTEM	NO. OF MAPS
2012-13	Carrizo-Wilcox and Catahoula aquifers	2
2013-14	"400-ft" and "600-ft" sands of the Baton Rouge area and the upland terrace and Upper Ponchatoula aquifers	3
2014-15	Cockfield and Upland terrace aquifers (N Louisiana)	2
2015-16	"800-ft," "1000-ft," "1200-ft sand," and "1500-ft" sands of the Baton Rouge area	4
2016-17	Sparta, Lower Ponchatoula, and Evangeline aquifers	3
2017-18	Jasper aquifer system and Mississippi/Atchafalaya River alluvial aquifer	2
2018-19	Gonzales-New Orleans, Gramercy, and Norco aquifers, and the Red River alluvial aquifer	2
2019-20	"1700-ft," "2000-ft," "2400-ft," and "2800-ft" sands of the Baton Rouge area	4
2020-21	Tchefunte, Hammond, Amite, Ramsey, Big Branch, Kentwood, Abita, Convington, Slidell, and Franklinton aquifers	3
2021-22	Upper Chicot, "200-ft," "500-ft," and "700-ft" sands of the Lake Charles area	2

Potentiometric map of the Carrizo-Wilcox aquifer in northwestern Louisiana, 2013.

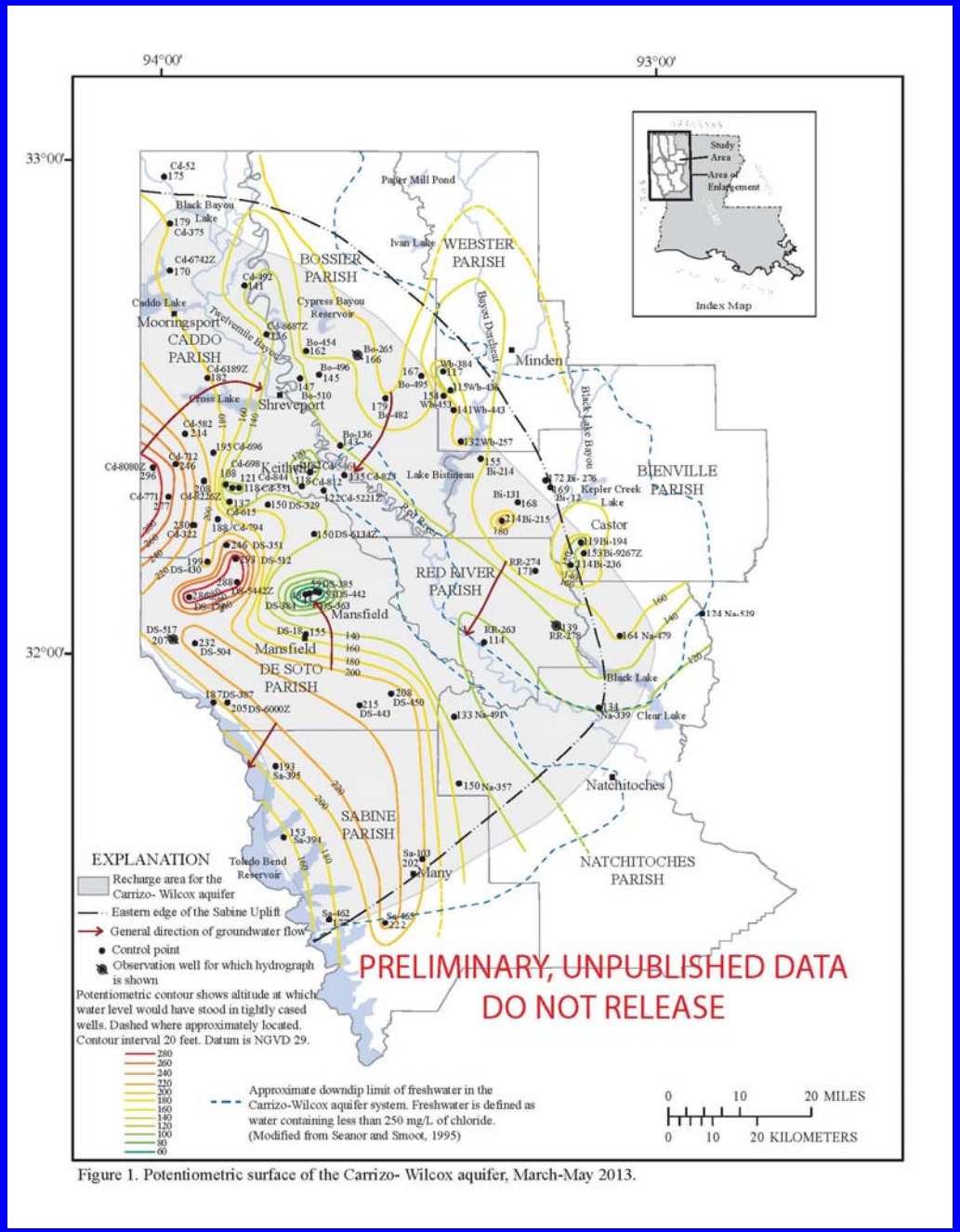

Figure 1. Potentiometric surface of the Carrizo- Wilcox aquifer, March-May 2013.

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Water-level changes, 1991-2013, in the Carrizo-Wilcox aquifer in northwestern Louisiana.

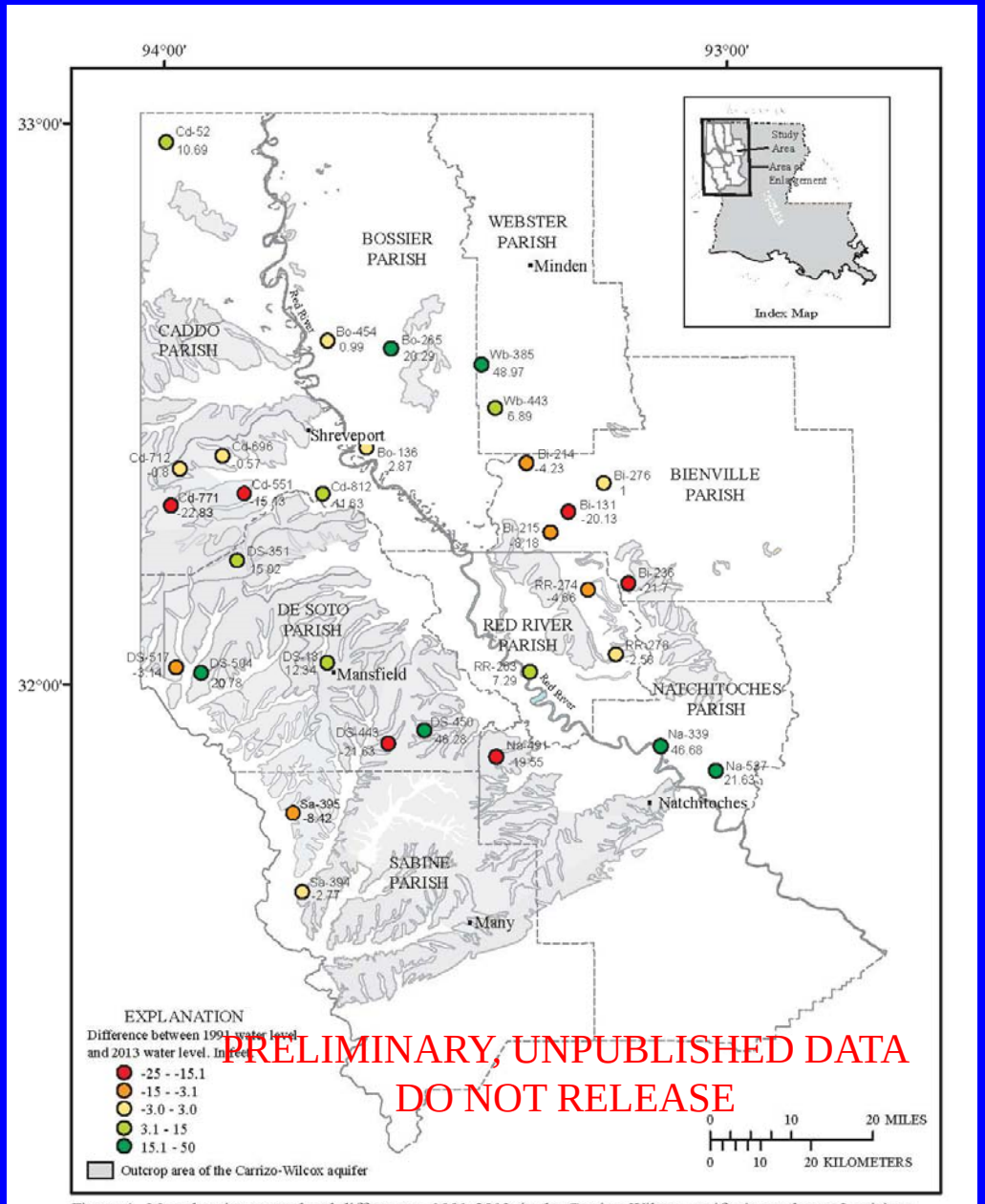

Figure 4. Map showing water-level differences, 1991-2013, in the Carrizo-Wilcox aquifer in northwest Louisiana.

PRELIMINARY, UNPUBLISHED DATA
DO NOT RELEASE

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Potentiometric map of the Catahoula aquifer in central Louisiana, 2013

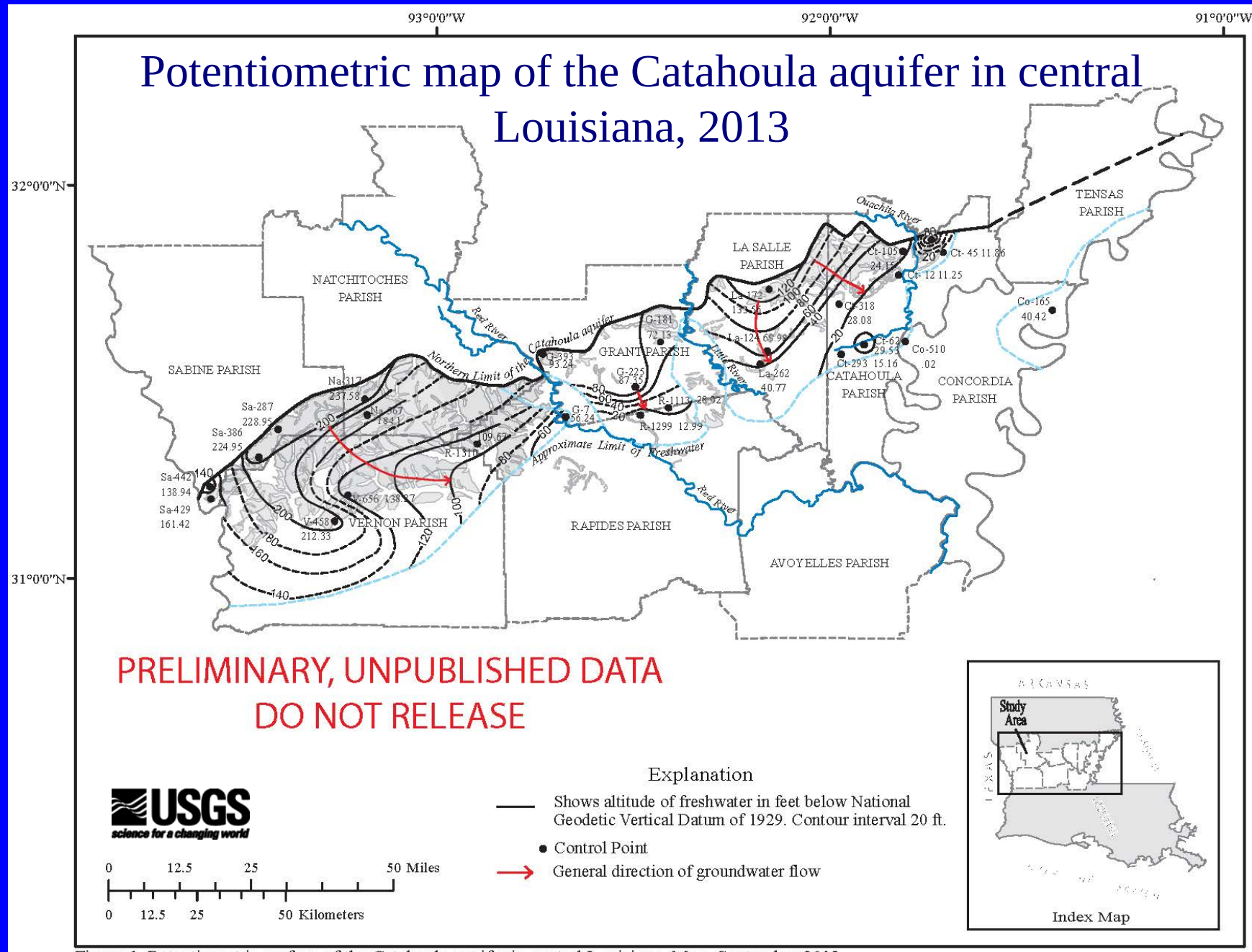

Figure 1. Potentiometric surface of the Catahoula aquifer in central Louisiana, May- September 2013.

Potentiometric map of the “2,000-foot” sand of the Baton Rouge area, 2002.

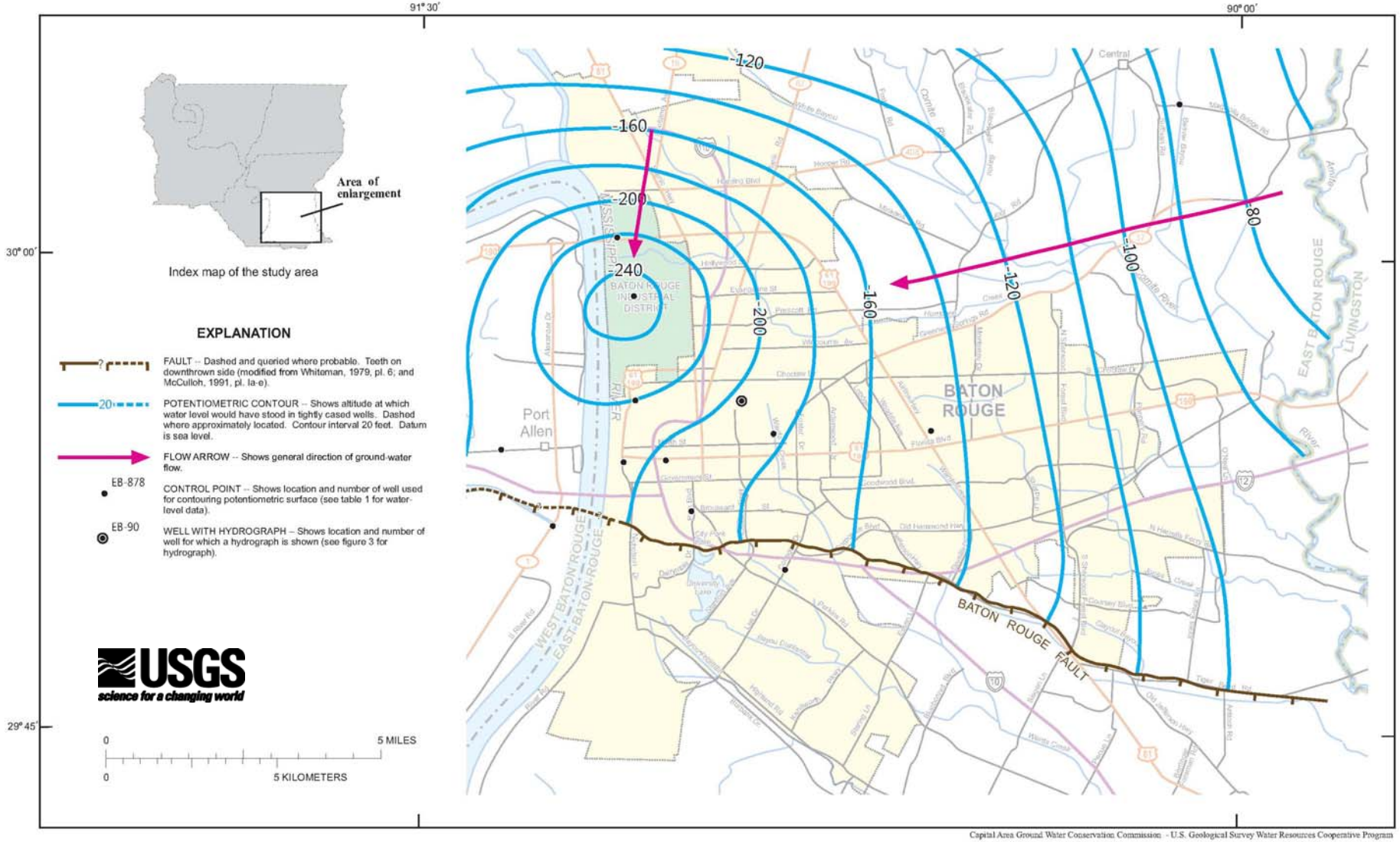

Figure 5. Potentiometric surface of the “2,000-foot” sand in parts of East and West Baton Rouge Parishes, southeastern Louisiana, May 2002.

Element 3 – Enhanced Chloride Monitoring Network

NEED

Heavy withdrawals from some aquifers have created conditions favorable for saltwater encroachment into freshwater aquifers. Monitoring at additional wells is needed to enhance existing chloride-monitoring networks and close gaps.

OBJECTIVE

To improve understanding of where saltwater encroachment is occurring and rates of encroachment through increased monitoring of Louisiana's aquifers.

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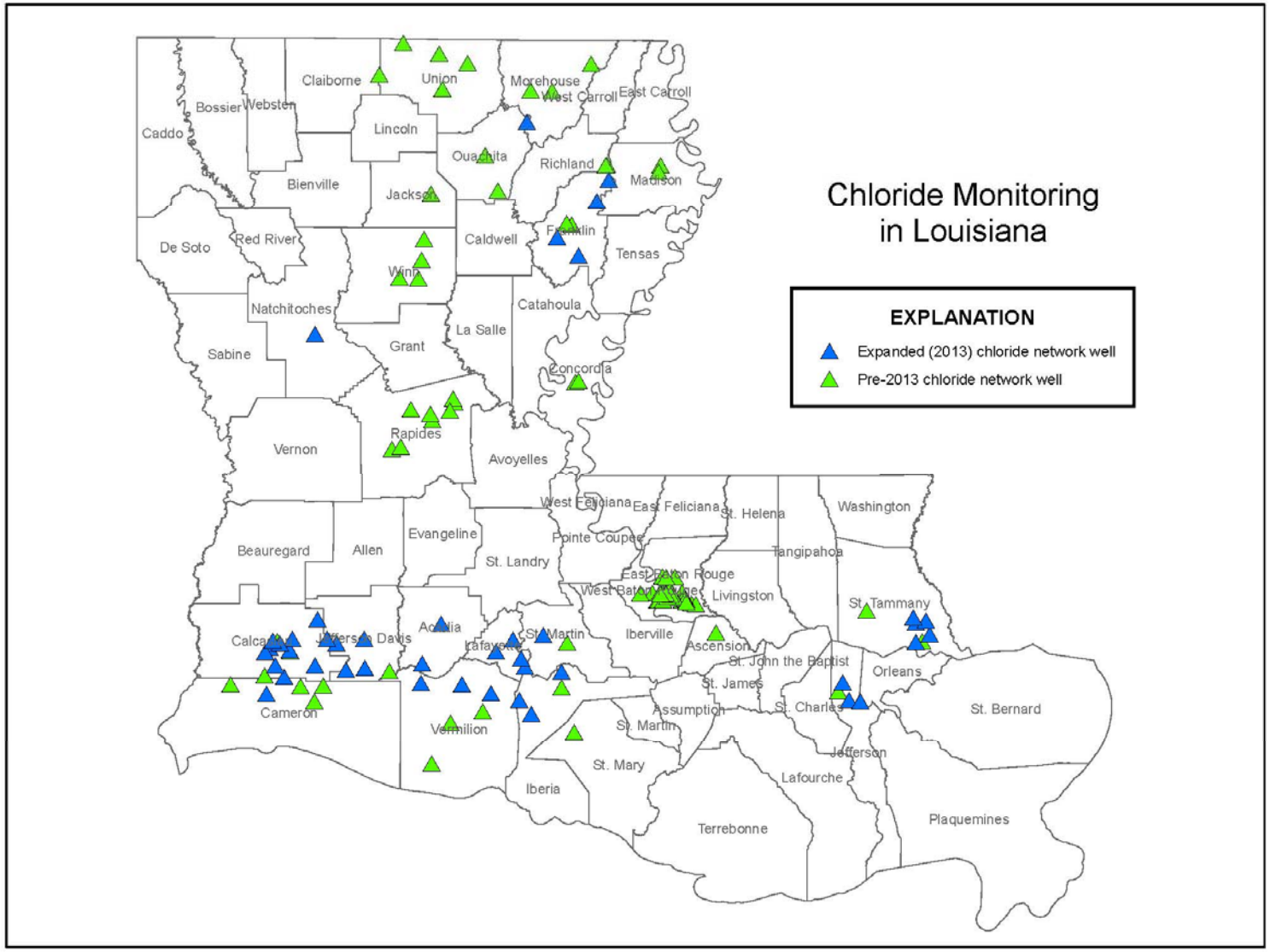
Chloride Monitoring
in Louisiana
EXPLANATION
Expanded (2013) chloride network well
Pre-2013 chloride network well
Claiborne
Union
Morehouse
West Carroll
East Carroll
Bossier
Webster
Caddo
Lincoln
Ouachita
Richland
Madison
Bienville
Jackson
Franklin
Tensas
De Soto
Red River
Caldwell
Winn
Catahoula
Natchitoches
La Salle
Grant
Sabine
Concordia
Rapides
Vernon
Avoyelles
West Feliciana
East Feliciana
St. Helena
Washington
Beauregard
Allen
Evangeline
Pointe Coupee
Tangipahoa
St. Landry
East Baton Rouge
West Baton Rouge
Livingston
St. Tammany
Jefferson Davis
Acadia
St. Martin
Iberville
Ascension
St. John the Baptist
Orleans
St. James
Assumption
St. Charles
St. Bernard
Cameron
Vermilion
St. Martin
Jefferson
St. Mary
Lafourche
Iberia
Terrebonne
Plaquemines

Element 3 – Enhanced Chloride Monitoring Network

APPROACH

- The State-wide chloride-monitoring network was expanded from 96 wells to 146 wells.
- The selected wells improve monitoring in 11 aquifers where saltwater encroachment has occurred or is suspected.
- Water samples are collected semiannually and analyzed for specific conductance and chloride concentration.
- Resulting data are available in tabular format at a USGS web site (http://nwis.waterdata.usgs.gov/la/nwis/qwdata).

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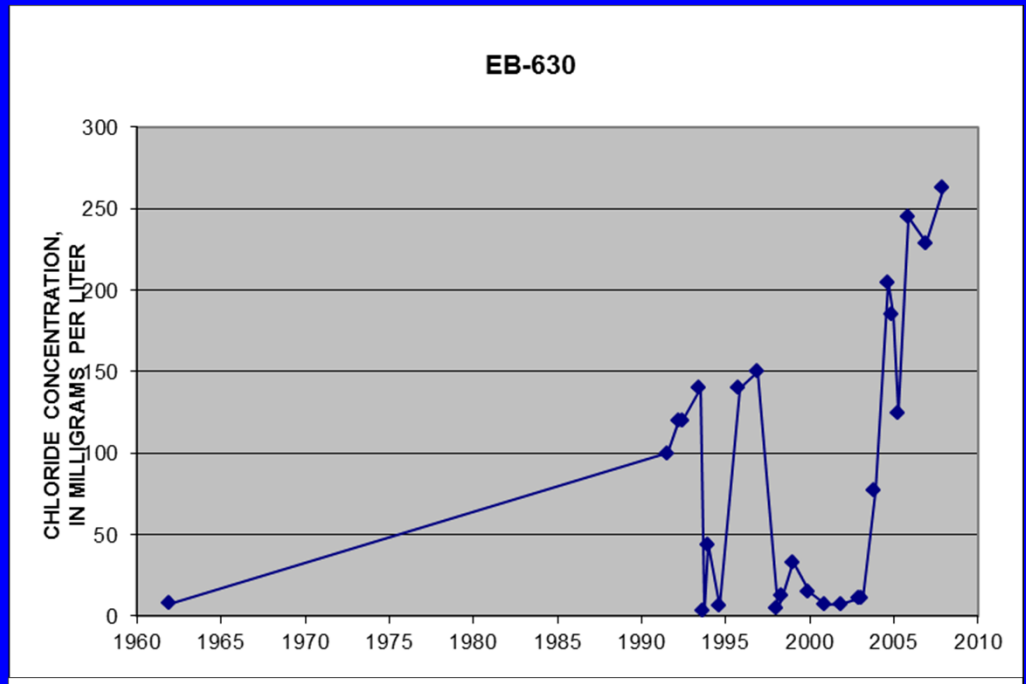
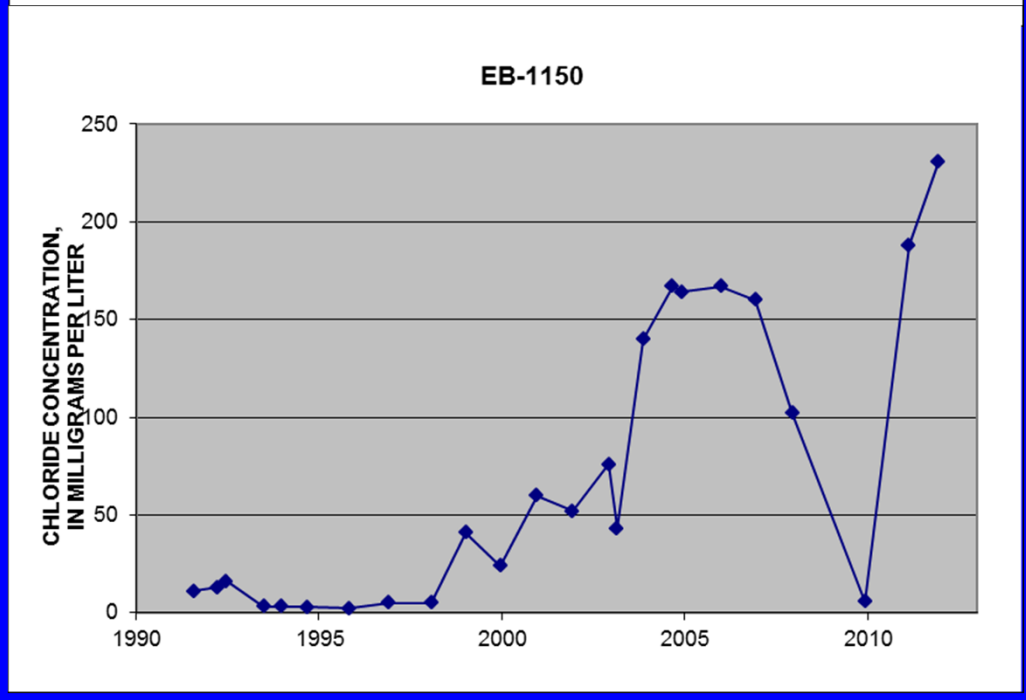
Graphs of chloride concentrations in downtown Baton Rouge public supply wells screened in the "2,000-foot" sand





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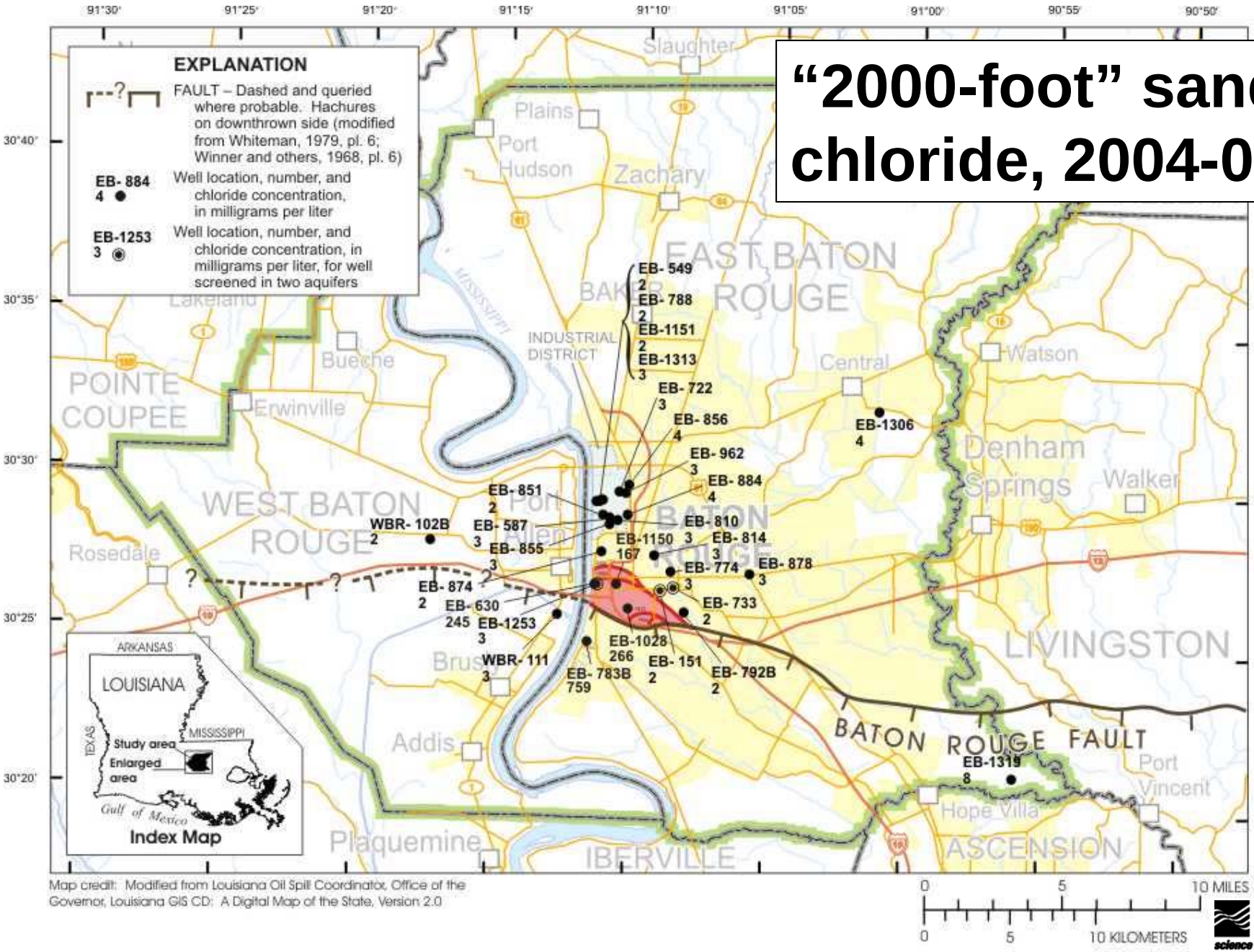
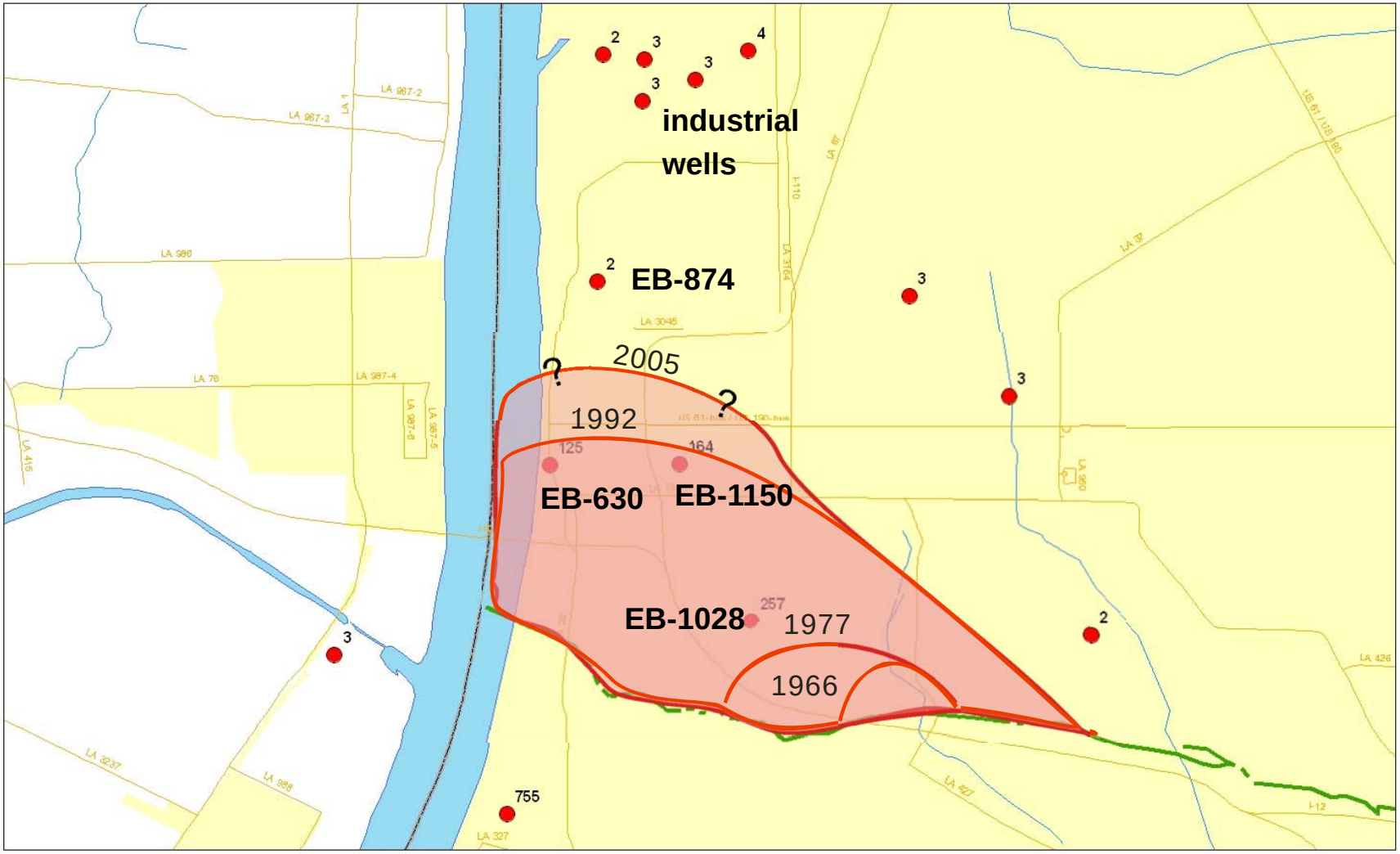


Figure 4. Chloride concentrations in water from wells screened in the “2,000-foot” sand of the Baton Rouge area in East and West Baton Rouge Parishes, Louisiana, 2004-05.



Location of saltwater and chloride concentrations at sampled wells and in the “2,000-foot” sand. (Note: The location of the saltwater interface in 2005 is unpublished and subject to revision.)

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Element 4 – Water-Quality Network

NEED

Extensive development of shale formations for petroleum and natural gas and oil using hydraulic fracturing techniques could adversely impact water quality in aquifers used for public and domestic supplies.

OBJECTIVE

To initiate water-quality monitoring in areas of existing or planned hydraulic fracturing activity.

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Element 4 – Water-Quality Network

APPROACH

- One hundred wells in areas of current or planned hydraulic fracturing activity were selected for monitoring.
- Samples are collected annually and analyzed at a USGS laboratory for pH, specific conductance, major inorganic ions, dissolved organic carbon, gas oxygenates, and BTEX.
- Analytical results are compared to previous results to determine whether changes have occurred.
- Well owners are notified when potential problems are detected and additional investigation and sampling may result.

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Areas of existing or planned hydraulic fracturing in Louisiana

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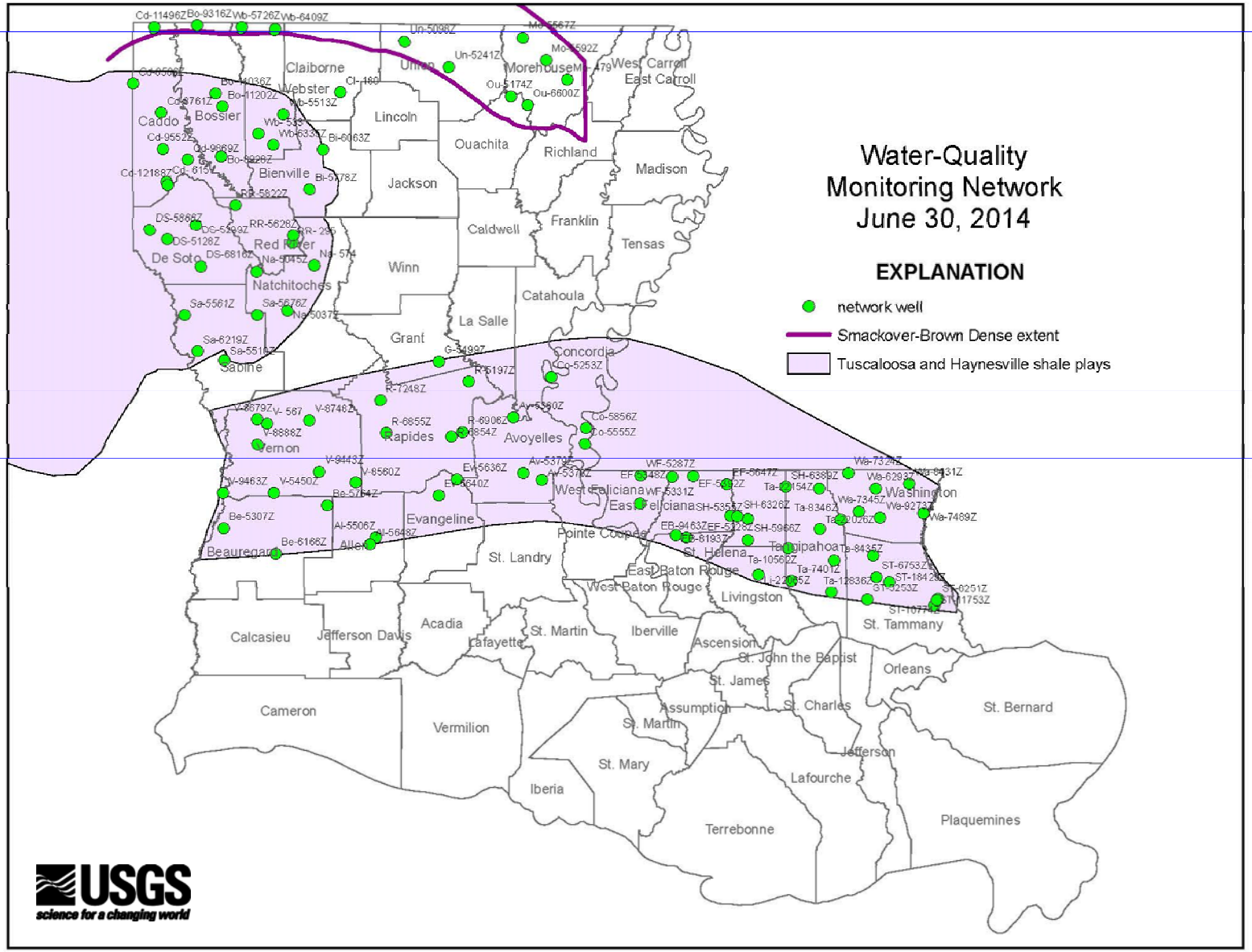
Water-Quality
Monitoring Network
June 30, 2014
EXPLANATION
network well
Smackover-Brown Dense extent
Tuscaloosa and Haynesville shale plays
Claiborne
Webster
Bossier
Caddo
Lincoln
Union
Morehouse
West Carroll
East Carroll
Ouachita
Richland
Madison
Jackson
Bienville
Caldwell
Franklin
Tensas
Winn
Red River
De Soto
Natchitoches
Catahoula
La Salle
Grant
Sabine
Concordia
Rapides
Avoyelles
Vernon
Evangeline
West Feliciana
East Feliciana
Pointe Coupee
St. Landry
Beauregard
Allen
Washington
St. Helena
East Baton Rouge
West Baton Rouge
Livingston
St. Tammany
Calcasieu
Jefferson Davis
Acadia
Lafayette
St. Martin
Iberville
Ascension
St. John the Baptist
St. James
Orleans
St. Bernard
Cameron
Vermilion
Assumption
St. Charles
St. Mary
Iberia
Jefferson
Lafourche
Terrebonne
Plaquemines
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Element 5 – Annual Water Use Estimates

NEED

An annual estimate of water withdrawals for various uses is needed to better understand the impacts of withdrawals on water resources and identify water-use trends

OBJECTIVE

To improve understanding of groundwater and surface water uses, withdrawal rates, and trends.

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Element 5 – Annual Water Use Estimates

APPROACH

- Groundwater and surface-water withdrawals for various uses including public supply, industrial, power generation, irrigation, rural domestic, livestock, and aquaculture are being compiled or estimated annually.
- The withdrawals are tabulated by use, source, parish, aquifer, and surface-water basin.
- Estimated groundwater and surface-water withdrawals in 2012 are available on the Louisiana Water Science Center water-use web page: http://la.water.usgs.gov/WaterUse/default.asp

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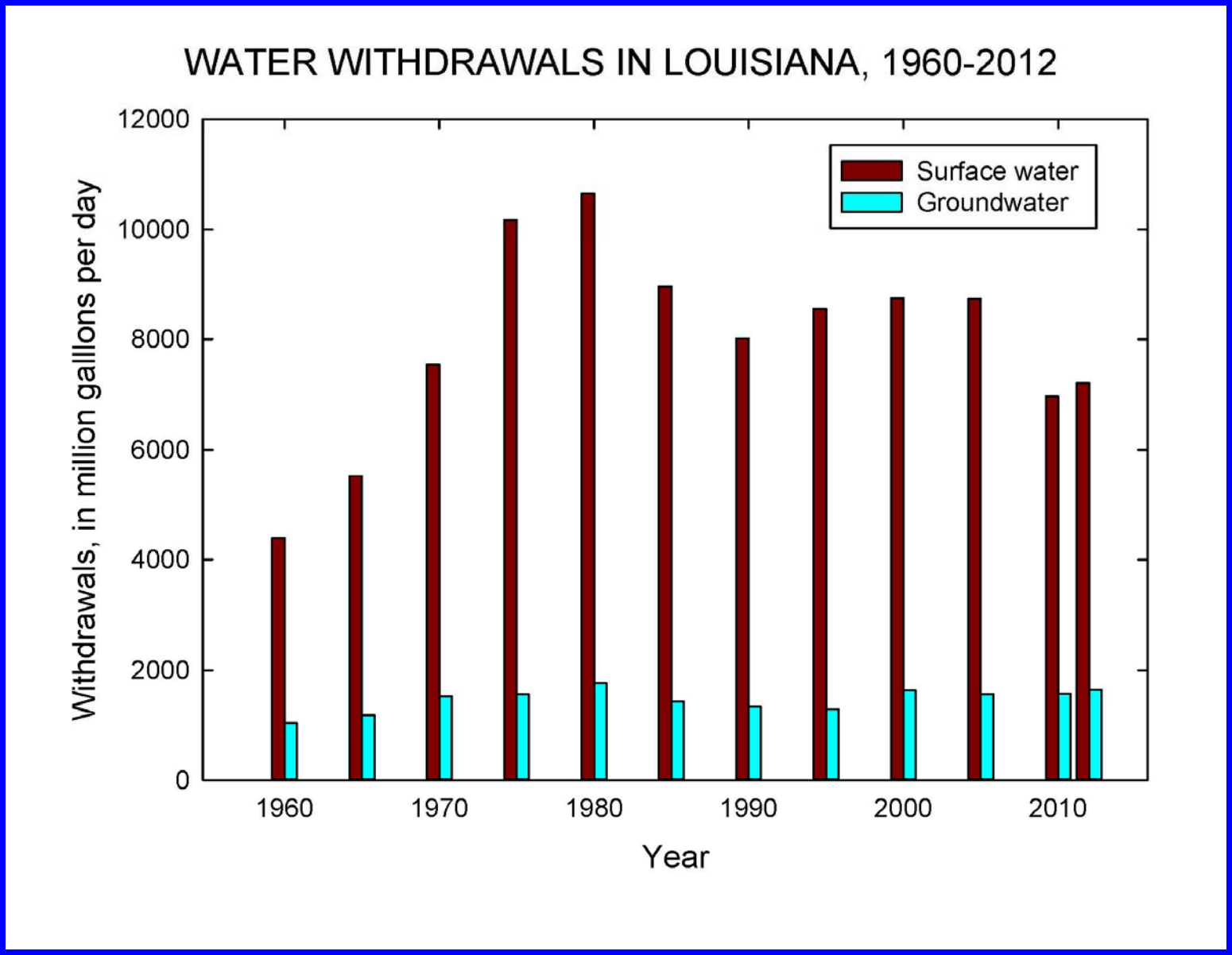

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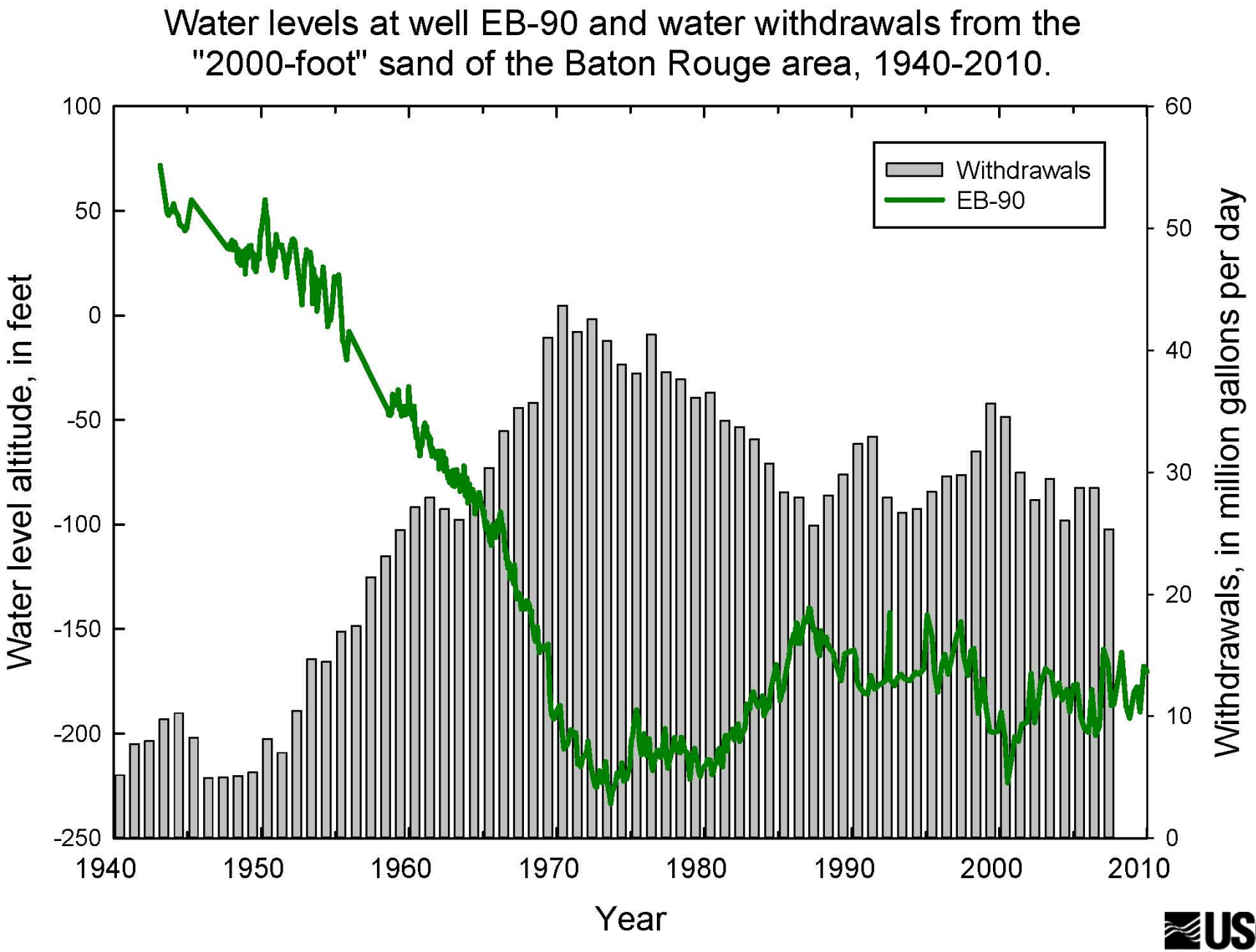
Water levels at well EB-90 and water withdrawals from the "2000-foot" sand of the Baton Rouge area, 1940-2010.
Withdrawals
EB-90
Water level altitude, in feet
Withdrawals, in million gallons per day
Year
100
50
0
-50
-100
-150
-200
-250
60
50
40
30
20
10
0
1940
1950
1960
1970
1980
1990
2000
2010
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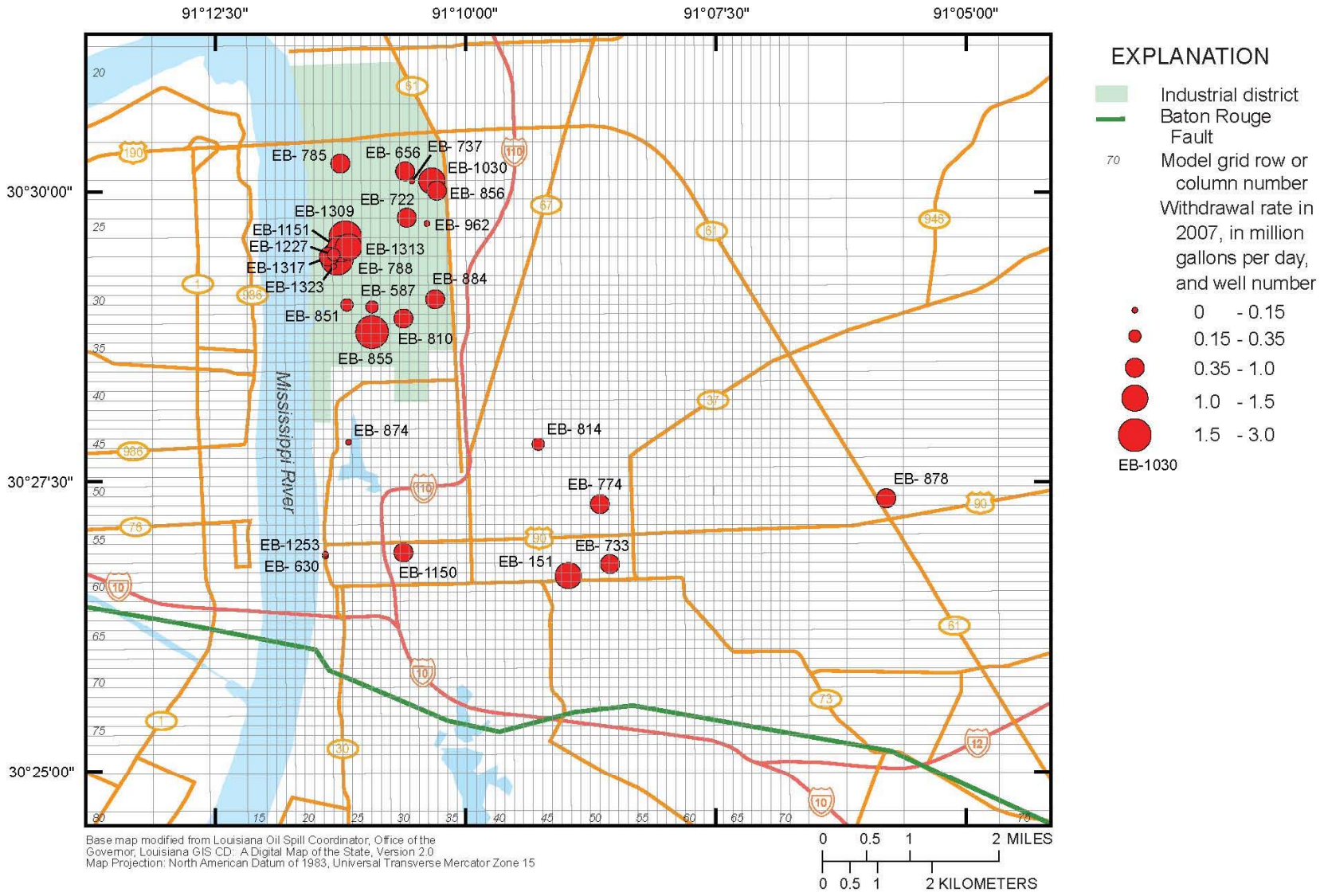

Magnitude and location of withdrawals from wells screened in the “2,000-foot” sand of the Baton Rouge area in 2007.

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Uses of long-term data for groundwater management

- Assessment of impacts of past development.
- Planning for future development.
- Problem detection and delineation.
- Development of tools such as groundwater models.
  - Investigation of management alternatives.
  - Assessment of potential solutions.
  - Prediction of future conditions.
- Assessment of effectiveness of management actions.

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