



Water Level and Saltwater Encroachment Monitoring, and Data Analysis

TYPES OF DATA

- WATER LEVEL MONITORING
- WATER QUALITY MONITORING
- SURFACE AND BOREHOLE GEOPHYSICAL DATA

WATER LEVEL MONITORING



REAL-TIME WATER LEVEL MONITORING SITE



REAL-TIME WATER LEVEL MONITORING SITE



USGS Photo by Paul Diaz

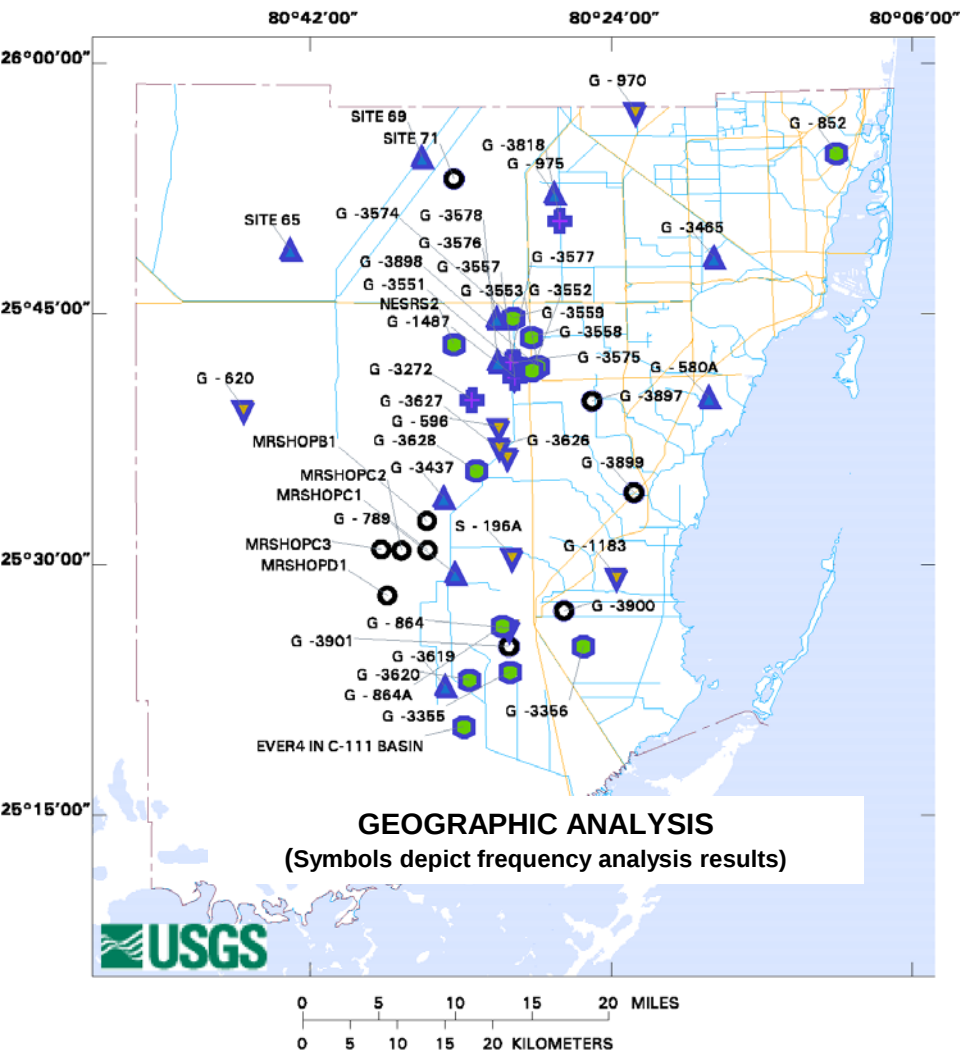
MANUAL WATER LEVEL MEASUREMENT



 **USGS**

WATER-LEVEL ANALYSES

- FREQUENCY ANALYSIS
- TREND ANALYSIS
- GRAPHICAL EXAMINATIONS
- GEOGRAPHIC EVALUATIONS



Water level compared to historical data, after long-term trends are removed:

- Insufficient information available to compute water-level statistics
- ◼ In lowest 10 percent of past water elevations
- ◼ Within lowest 10 to 30 percent of past water elevations
- ◼ Within 20 percent of the median of past water elevations
- ◼ Within highest 10 to 30 percent of past water elevations
- ◼ In highest 10 percent of past water elevations

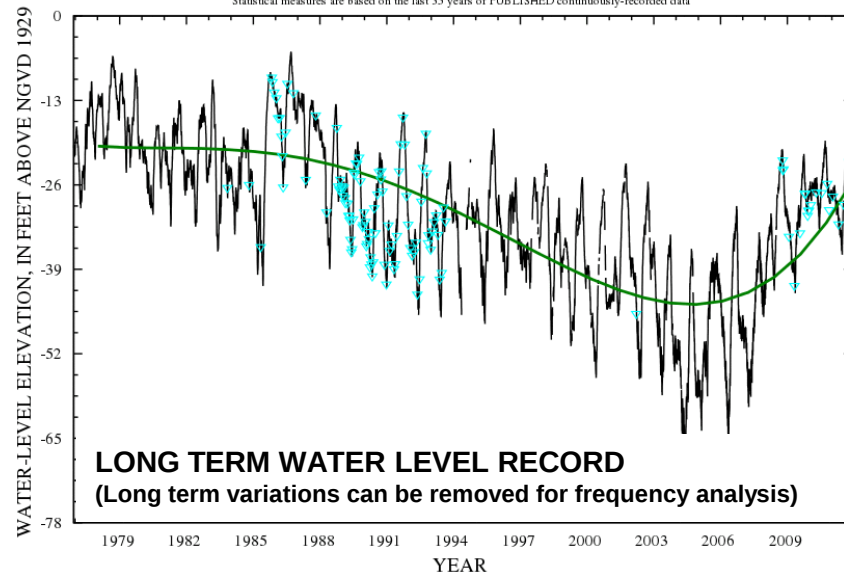
Water levels at selected sites in Miami-Dade County, Florida,

Based on PROVISIONAL DATA, as of December 6, 2011.

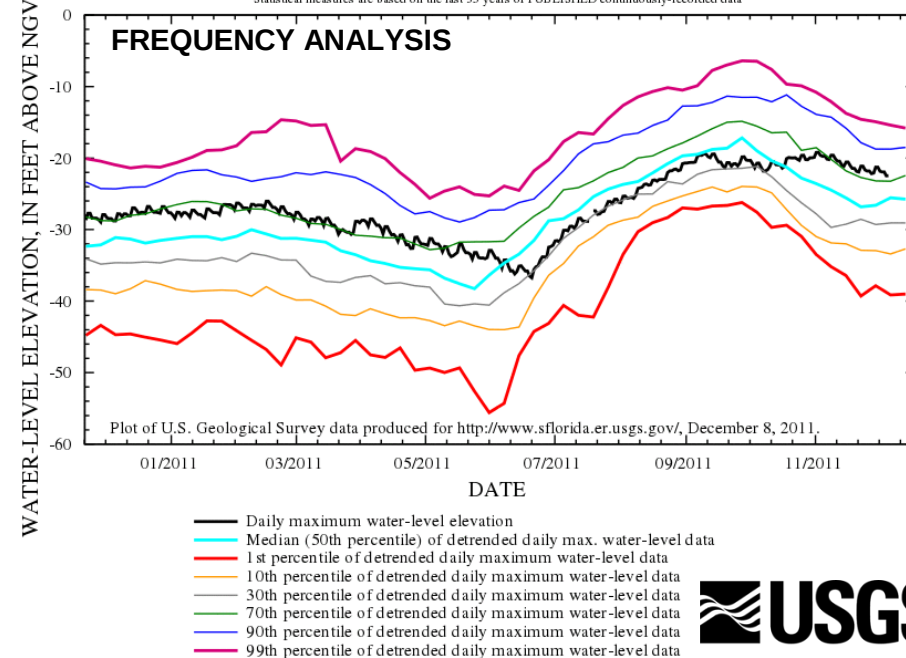
Water-level elevations from the past 35 years at L - 581 (263532081592201)

PROVISIONAL DRAFT -- Subject to Revision.

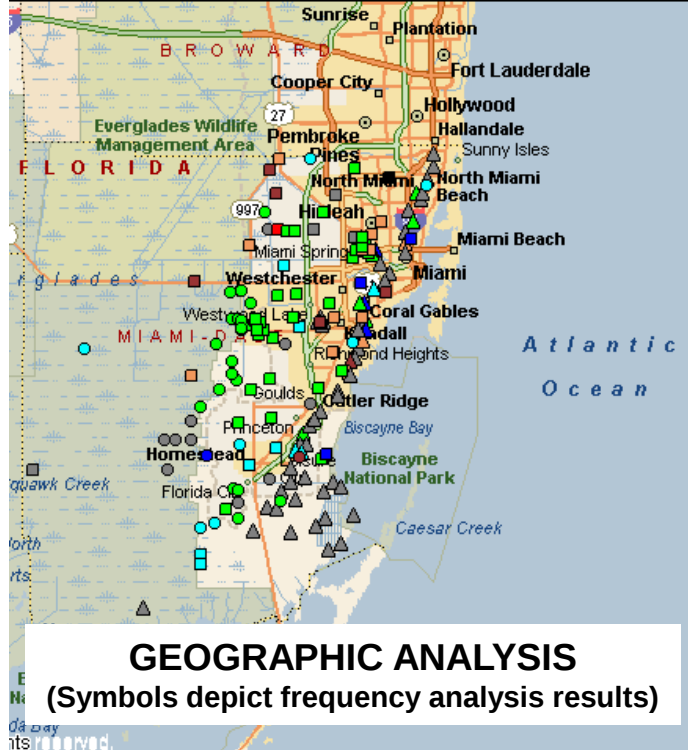
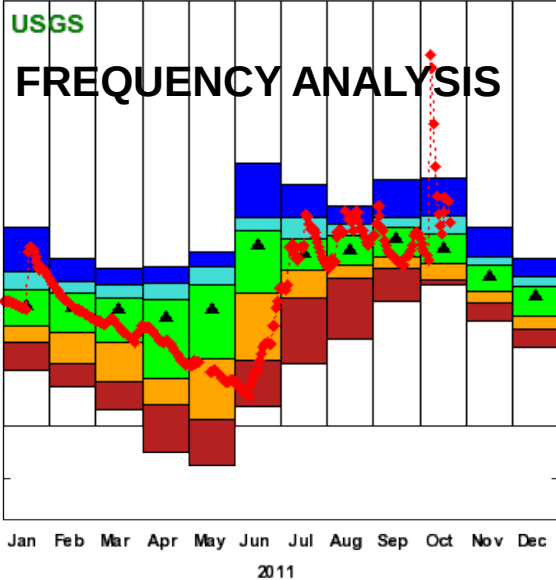
Statistical measures are based on the last 35 years of PUBLISHED continuously-recorded data


Comparison of current water-level elevations to historical data at L - 581 (263532081592201)
PROVISIONAL DRAFT -- Subject to Revision.

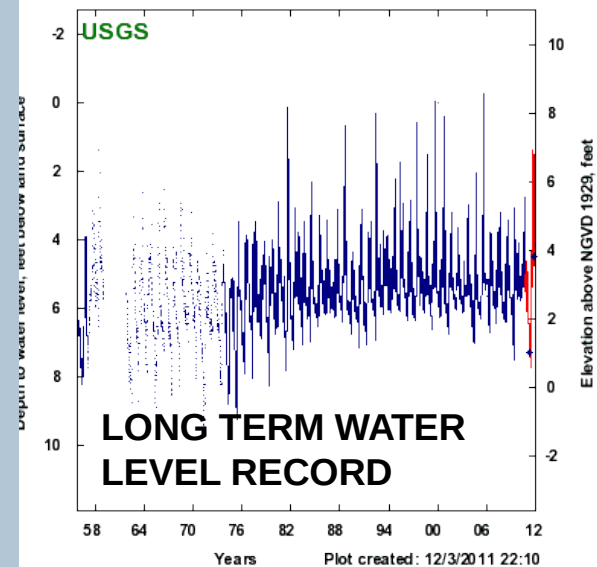
Statistical measures are based on the last 35 years of PUBLISHED continuously-recorded data



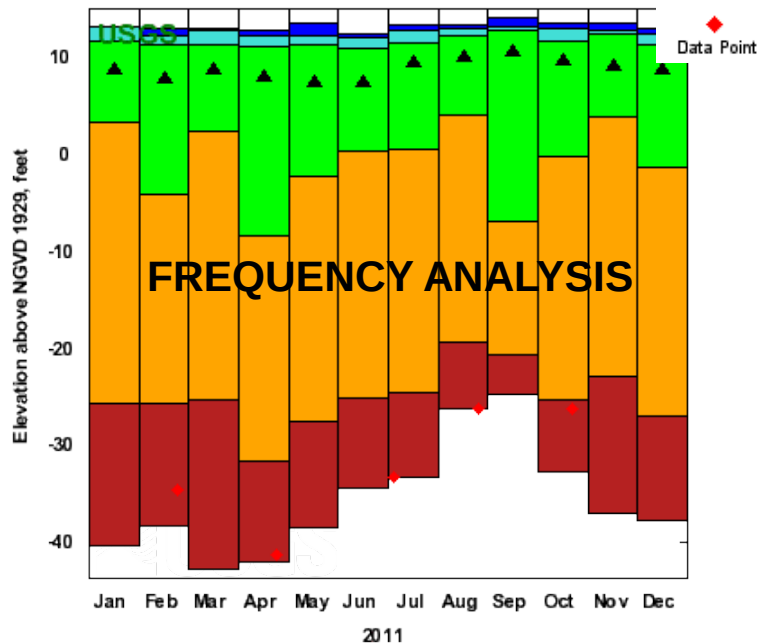
2528290 80285101 - F - 358



2528290 80285101 - F - 358



2640020 82012801 - L -2700

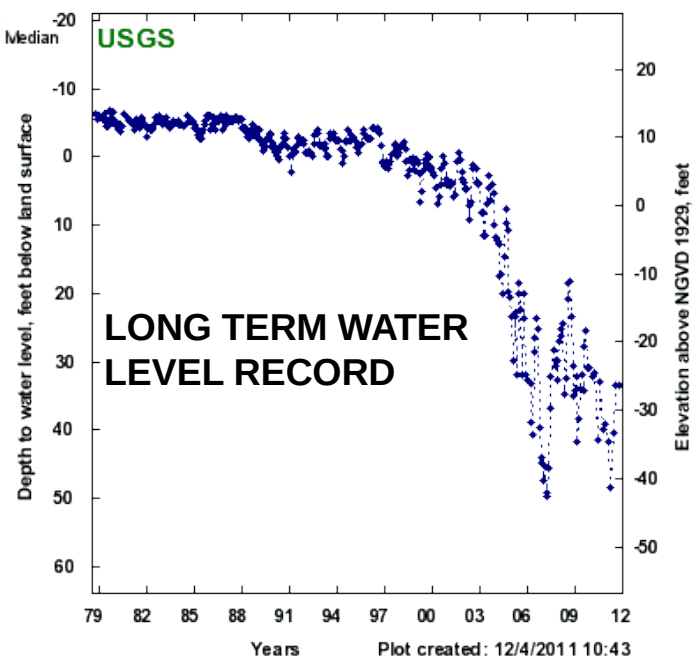


Explanation - Percentile Classes



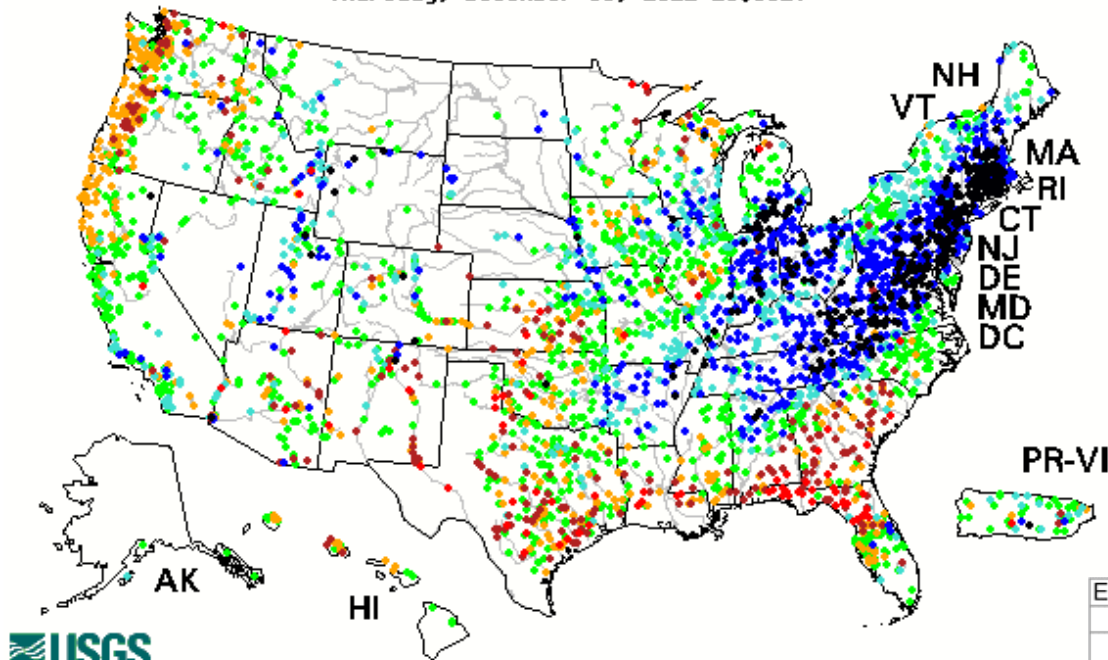
▲ Monthly Median

2640020 82012801 - L -2700



Thursday, December 08, 2011 13:30ET

NATIONAL WATER WATCH WEBSITES



GROUNDWATER WATCH ↓

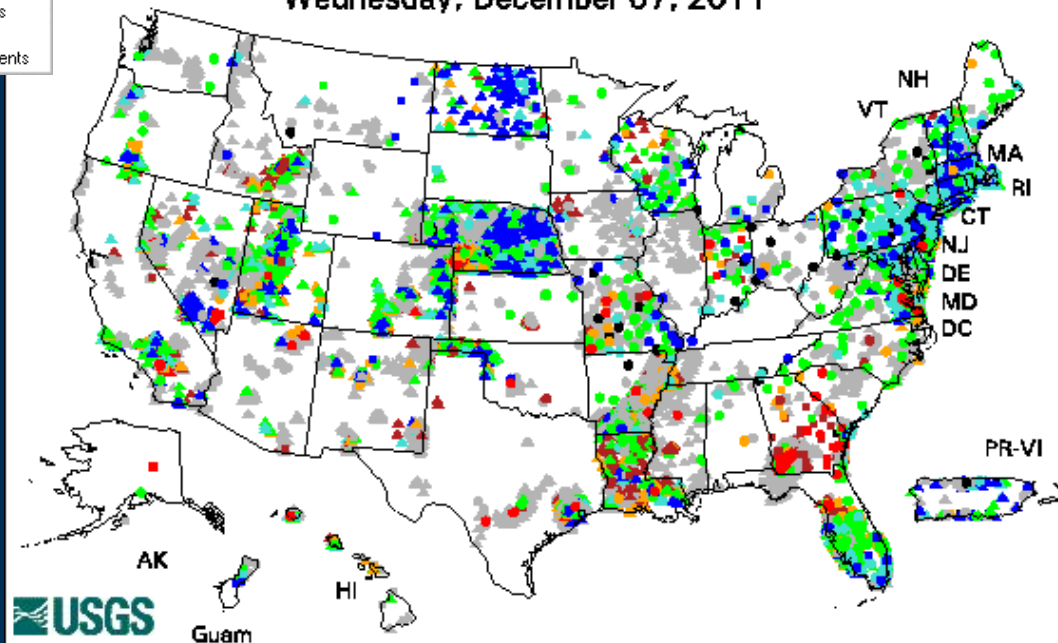
Explanation - Percentile classes (symbol color based on most recent measurement)								○ Real Time
● Low	● <10	● 10-24	● 25-75	● 76-90	● >90	● High	● Not Ranked	□ Continuous
	Much Below Normal	Below Normal	Normal	Above Normal	Much Above Normal			△ Periodic Measurements

Explanation - Percentile classes (symbol color based on most recent measurement)								○ Real Time
● Low	● <10	● 10-24	● 25-75	● 76-90	● >90	● High	● Not Ranked	□ Continuous
	Much Below Normal	Below Normal	Normal	Above Normal	Much Above Normal			△ Periodic Measurements

↑ SURFACE WATER WATCH



Wednesday, December 07, 2011



Guam

WATER QUALITY SAMPLING

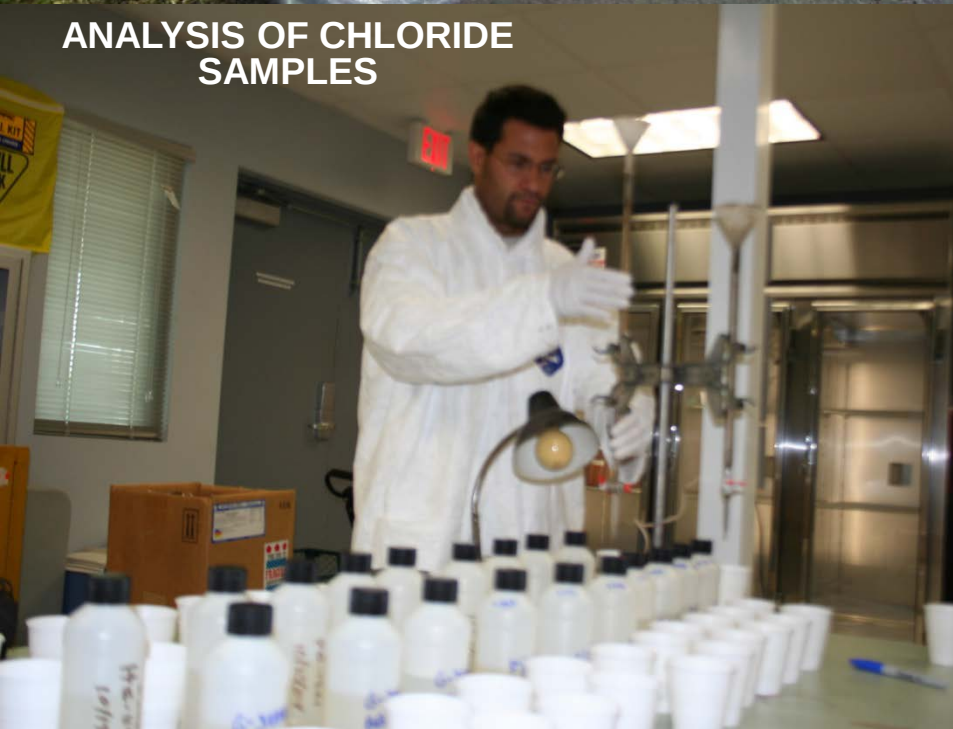
- SALINITY (CHLORIDE, TDS, SALINITY, CONDUCTIVITY)
- REAL-TIME CONTINUOUS CONDUCTIVITY
- MAJOR AND TRACE ION SAMPLING
- STABLE AND UNSTABLE ISOTOPE SAMPLES
- DISSOLVED GASES (SF_6 , CFCs)

**SUCTION PUMP
AND DECON SET UP**



**SUBMERSIBLE PUMP
AND SAMPLE CHAMBER**

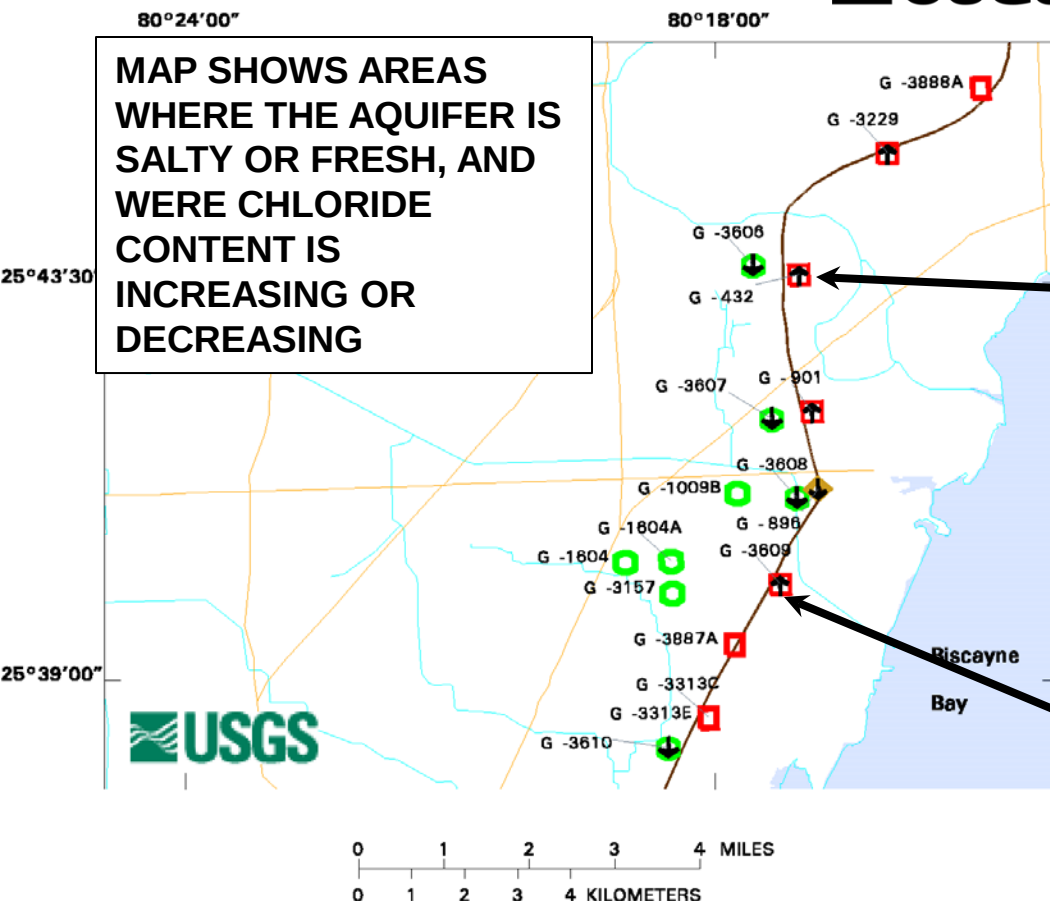
**ANALYSIS OF CHLORIDE
SAMPLES**



**ANALYSIS OF STABLE
ISOTOPE RATIO**

WATER QUALITY ANALYSIS

- GEOGRAPHIC ANALYSIS OF SALINITY RESULTS
- TREND ANALYSES
- ION RATIOS AND MIXING
- AGE DATING



EXPLANATION

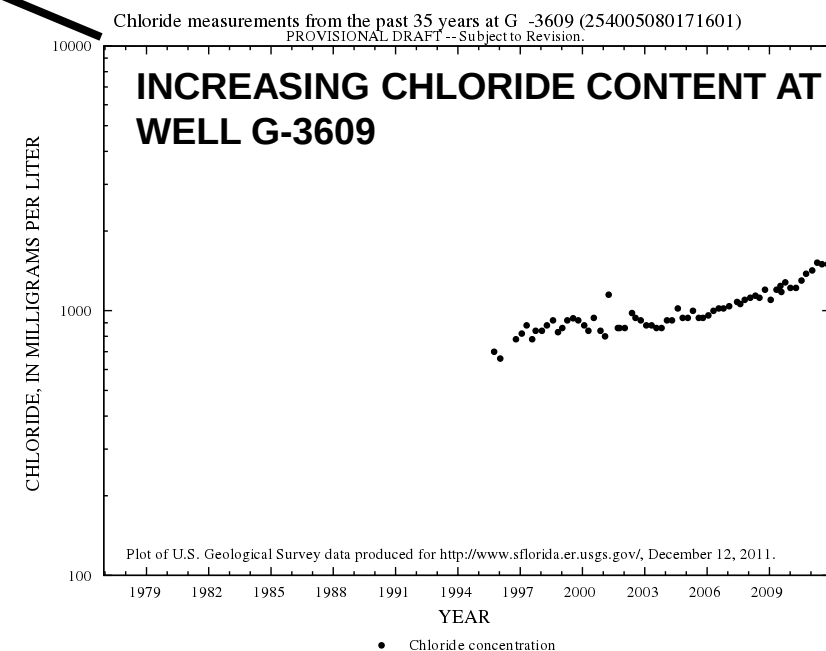
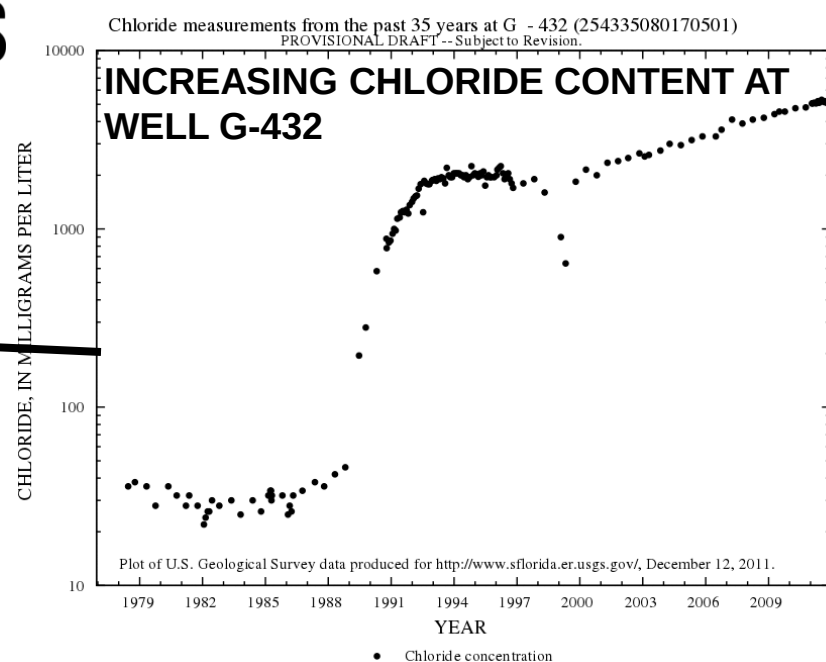
Geographic features:

- Rivers and canals
- Roads and highways
- County boundaries
- Salinity intrusion limit (2008)
- Estimated limit

Chloride concentration compared to last 5 years of record
(Up-arrow: increasing chloride values
Down-arrow: decreasing chloride values
No arrow: stable chloride values)

- Insufficient information available to compute statistics
- Less than 250 mg/l, as chloride
- 250 to 1,000 mg/l, as chloride
- Greater than 1,000 mg/l, as chloride

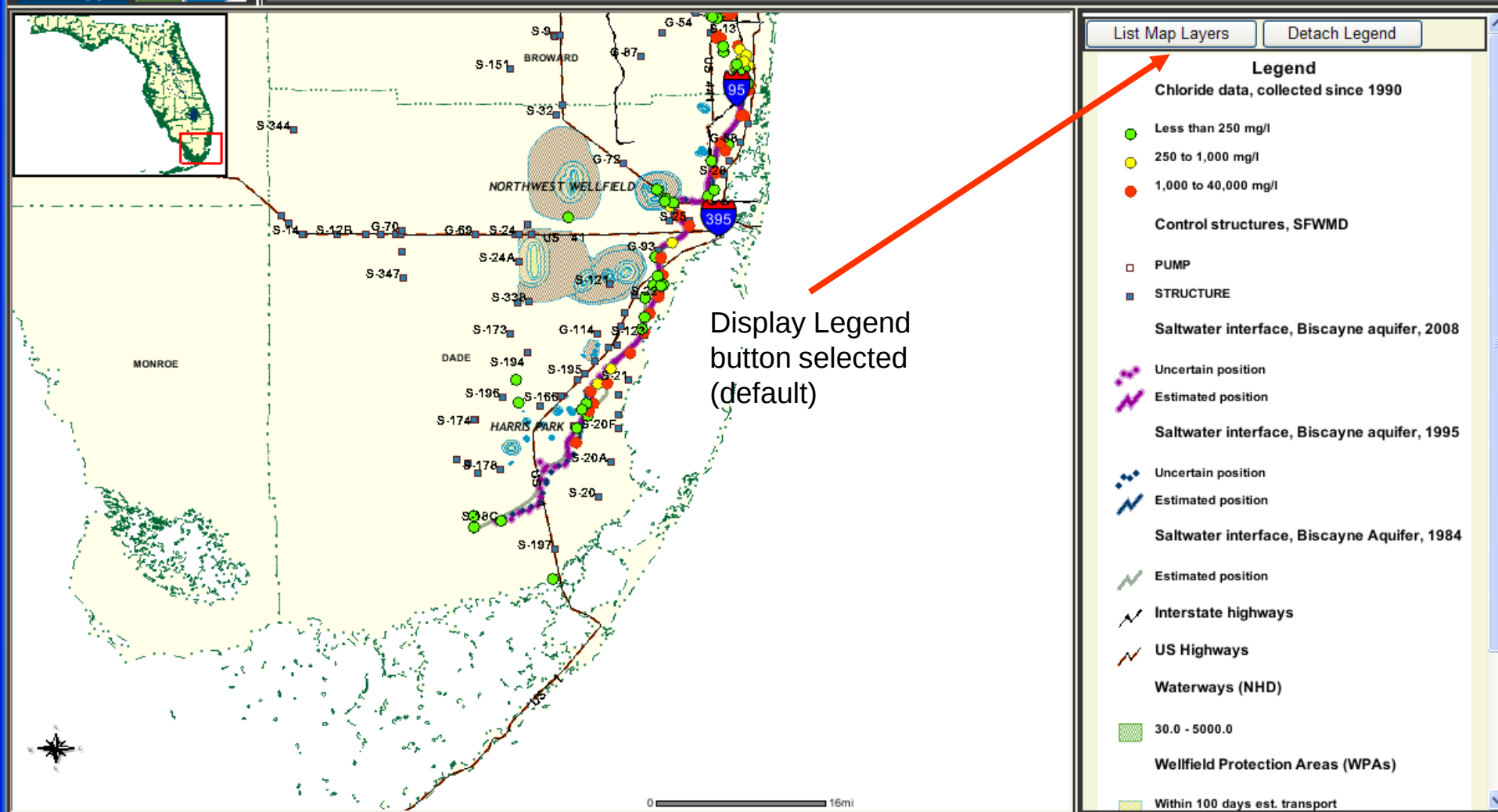
Chloride data from selected sites near South Miami, Miami-Dade County, Florida,
Based on PROVISIONAL DATA, as of October 31, 2011.





USA.gov

☒ text frame, ☐ new window.



Display Legend
button selected
(default)

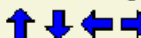
Presentation includes provisional information, subject to change

Map Mode: Zoom In

Print identify information in:

☒ text frame, ☐ new window.

Panning



Zooming



Map Layout



Map Information



Search



Select Features



Print map



Accessibility

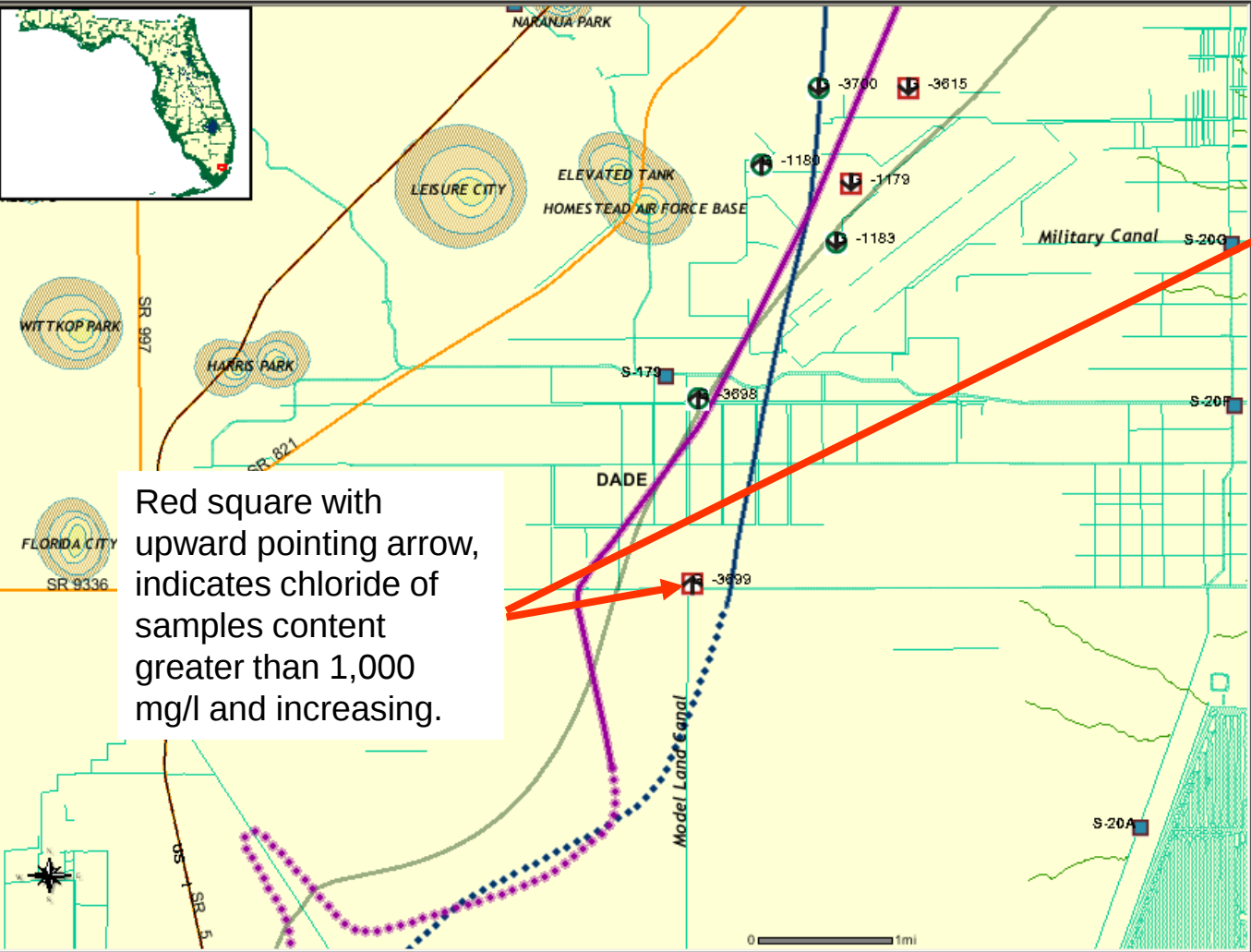
FOIA

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List Map Layers Detach Legend

Legend

Chloride data, collected since 1990

- Less than 250 mg/l, increasing chloride values
- 250 to 1,000 mg/l, increasing chloride values
- Greater than 1,000 mg/l, increasing chloride values
- Less than 250 mg/l, stable chloride values
- 250 to 1,000 mg/l, stable chloride values
- Greater than 1,000 mg/l, stable chloride values
- Less than 250 mg/l, decreasing chloride values
- 250 to 1,000 mg/l, decreasing chloride values
- Greater than 1,000 mg/l, decreasing chloride values
- Limited CL data

Control structures, SFWMD

- PUMP
- STRUCTURE

Saltwater interface, Biscayne aquifer, 2008

- Uncertain position
- Estimated position

Saltwater interface, Biscayne aquifer, 1995

- Uncertain position
- Estimated position

Saltwater interface, Biscayne Aquifer, 1984

- Estimated position

Red square with upward pointing arrow, indicates chloride of samples content greater than 1,000 mg/l and increasing.

Presentation includes provisional information, subject to change

Zoom Tool was used.

Map Mode: Pan

Print identify information in:

- text frame, new window

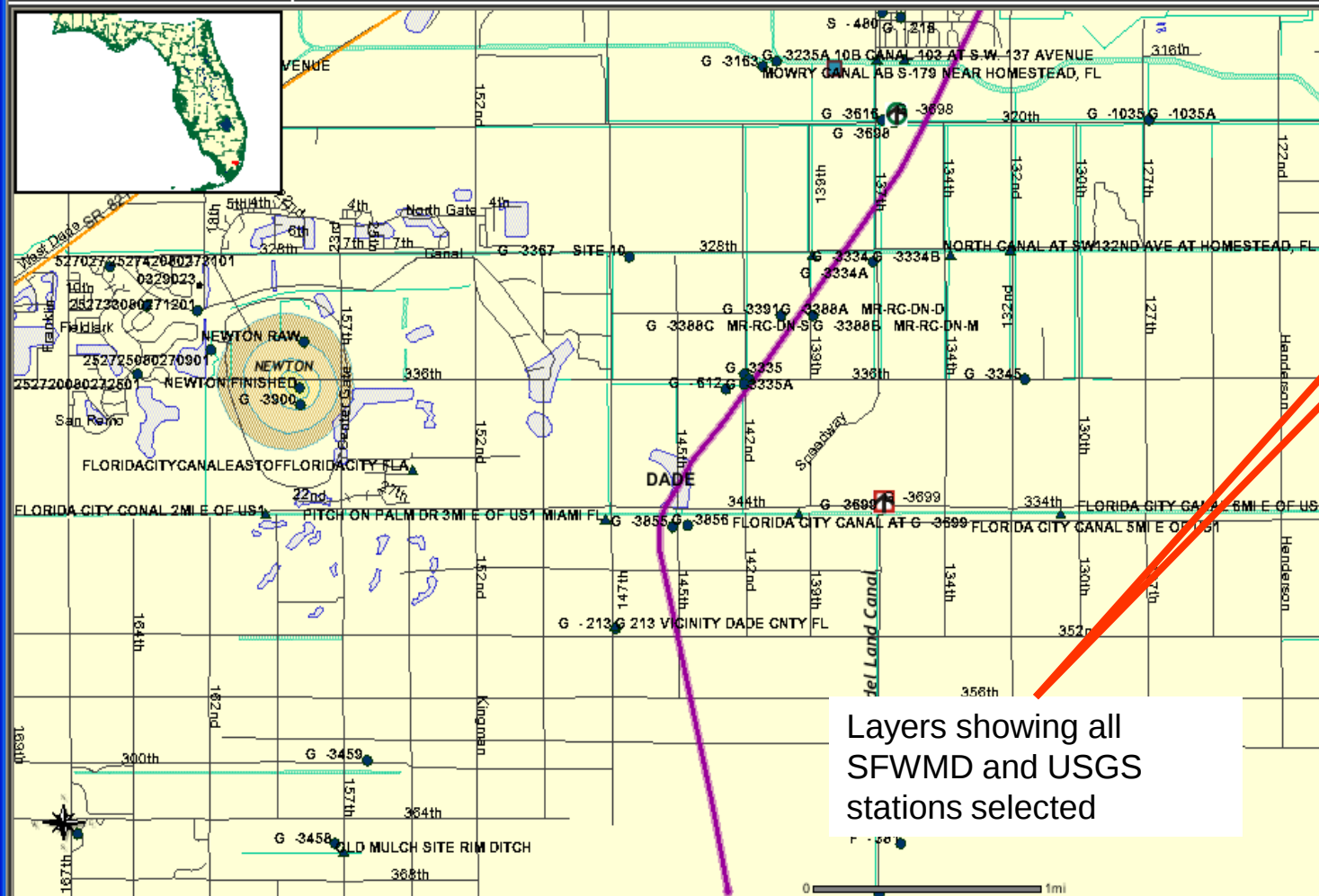
Panning Zooming Map Layout Map Information Search Select Features Print map

Accessibility FOIA Privacy Policies and Notices Take Pride in America USA.gov



Presentation includes provisional information, subject to change





- Sites**
- ☒ Active since 1990
 - ☐ No samples since 1990
 - ☐ Induction logs
 - ☐ Water-level
- Monitoring Sites**
- ☒ General monitoring inventories
 - ☒ USGS - all stations
 - ☒ SFWMD - wells
 - ☒ Saltwater Intrusion, Biscayne Aquifer
 - ☒ Estimated intrusion extents
 - ☒ Saltwater interface, 2008
 - ☒ Saltwater interface, 1995
 - ☒ Saltwater interface, 1984
 - ☒ Chloride contours, Hialeah/Miami Springs
 - ☒ Infrastructure
 - ☒ Hydrography
 - ☒ Major waterways
 - ☒ Canal control structures
 - ☒ Canals, streams, coastline
 - ☒ Lakes, ponds
 - ☒ Wellfield protection areas

Florida Cities, c. 2000 is now the Active Layer

Presentation includes provisional information, subject to change



Map Mode: Zoom In

Print identify information in:

☒ text frame, ☐ new window

Panning

Zooming

Map Layout

Map Information

Search

Select Features

Print map



Accessibility

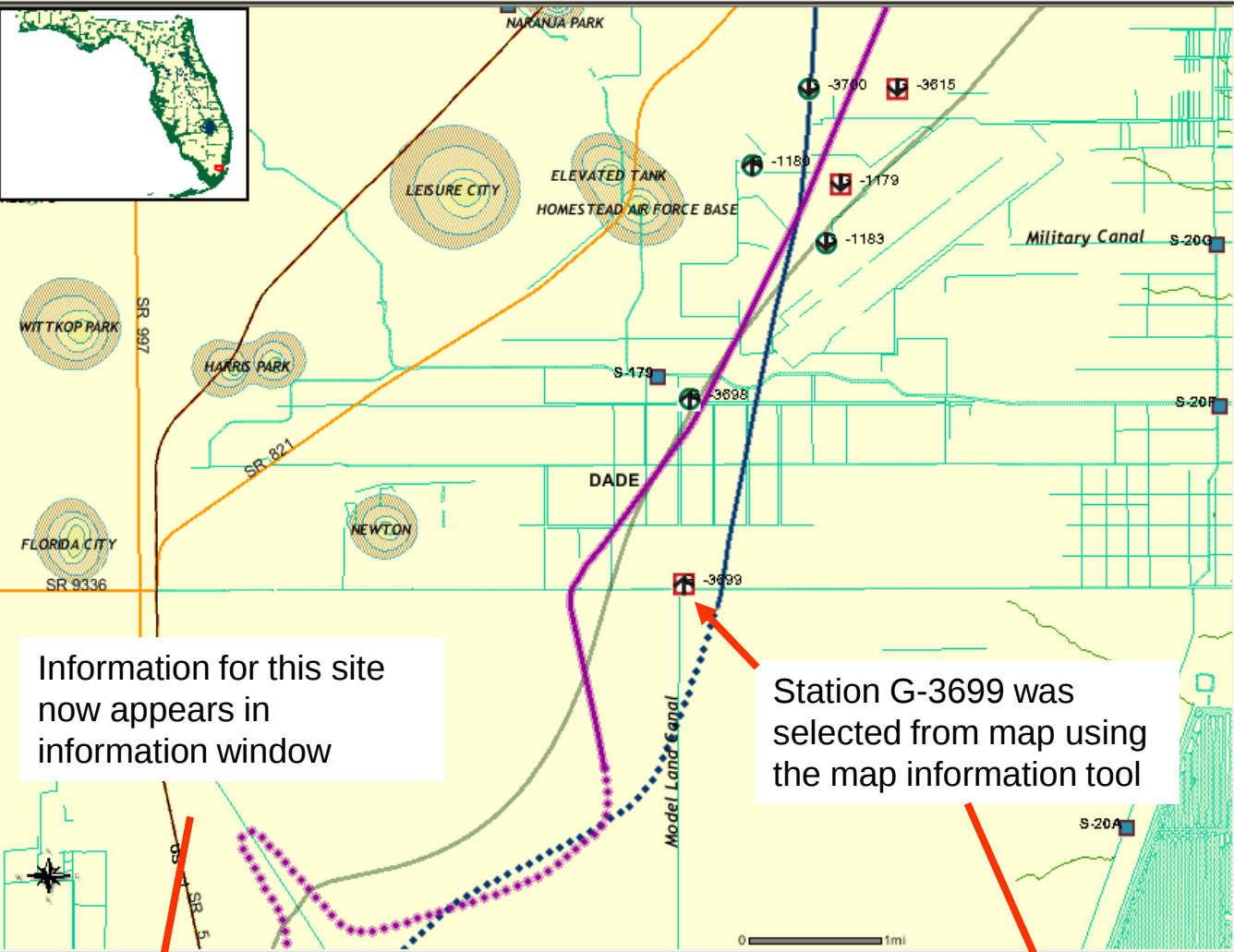
FOIA

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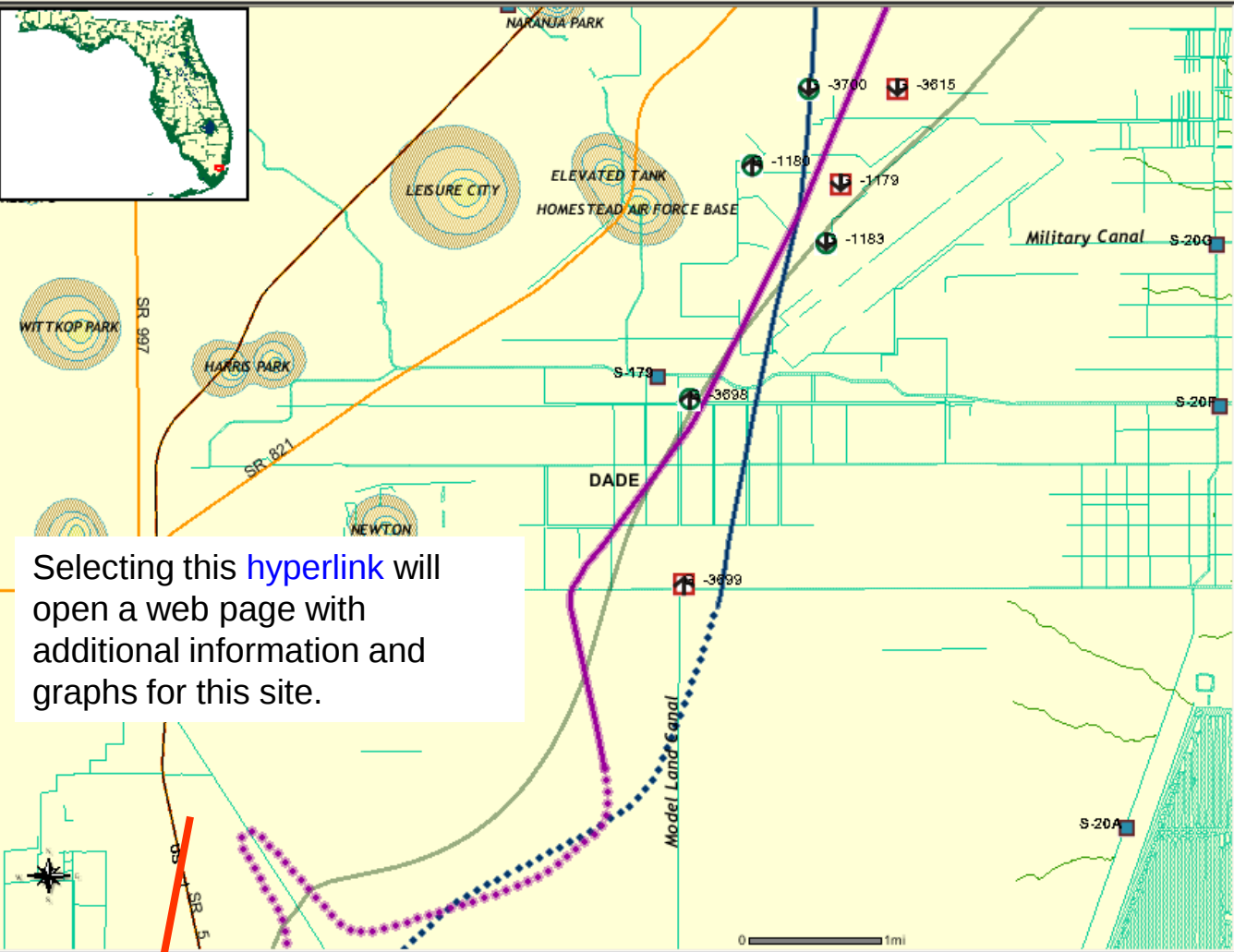
Chloride data, collected since 1990

Rec	USGS Station ID	Longitude	Latitude (NAVD 1983)	Station name	Latest CI concentration mg/l	Last date measured	Date lowest chloride	Date highest chloride	Date monitoring starts
1	USGS 252652080244301: local data page	-80.411582	25.448612	G -3699	8700	2009-OCT-07 09:45	2002-OCT-23 09:10	2009-APR-14 16:44	2002-OCT-23 09:10

Map Mode: ID Visible Features

Print identify information in:

- text frame, new window



List Map Layers Detach Legend

Legend

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Selecting this [hyperlink](#) will open a web page with additional information and graphs for this site.

Chloride data, collected since 1990

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Print identify information in:

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USGS

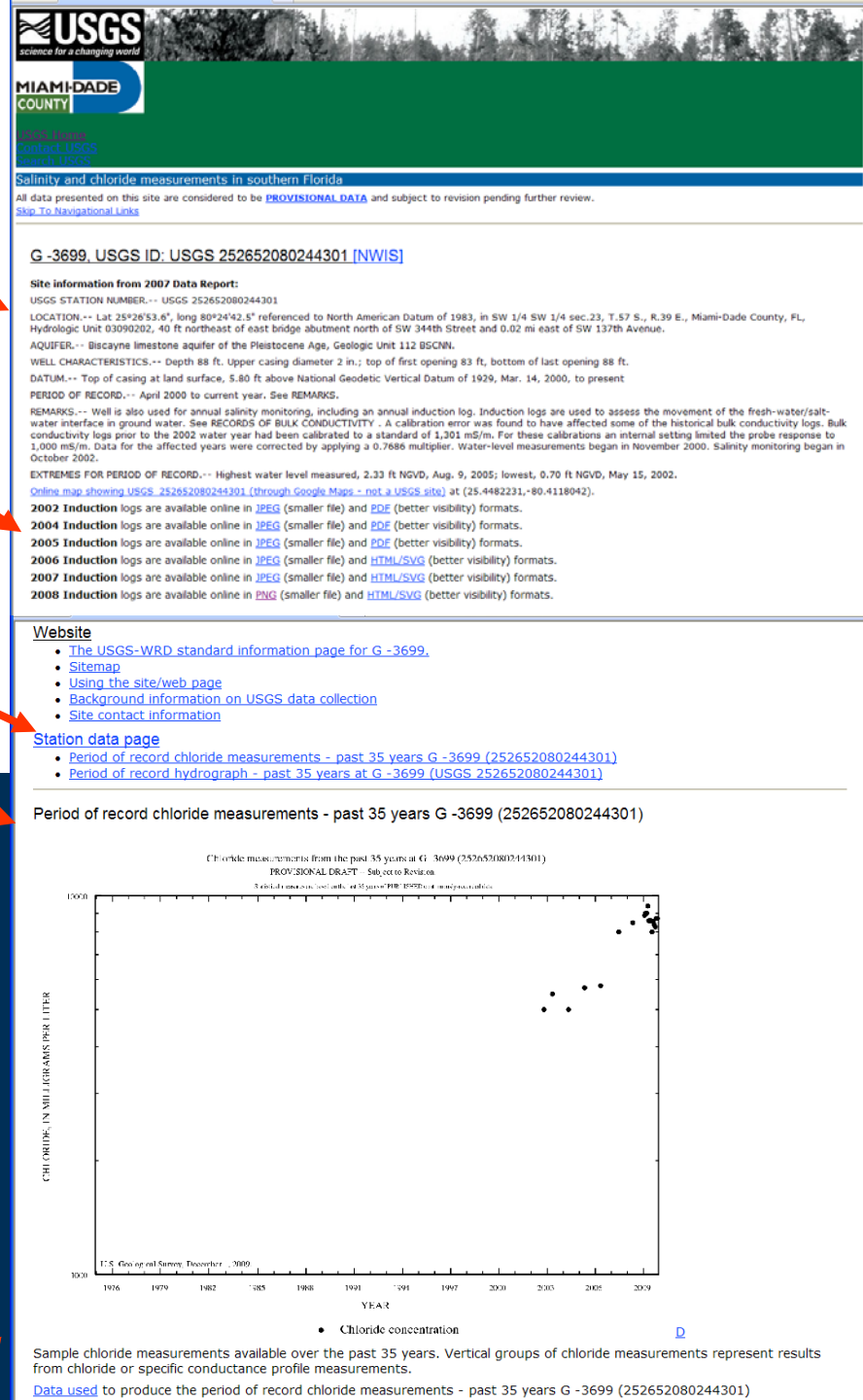
Web page for site includes:

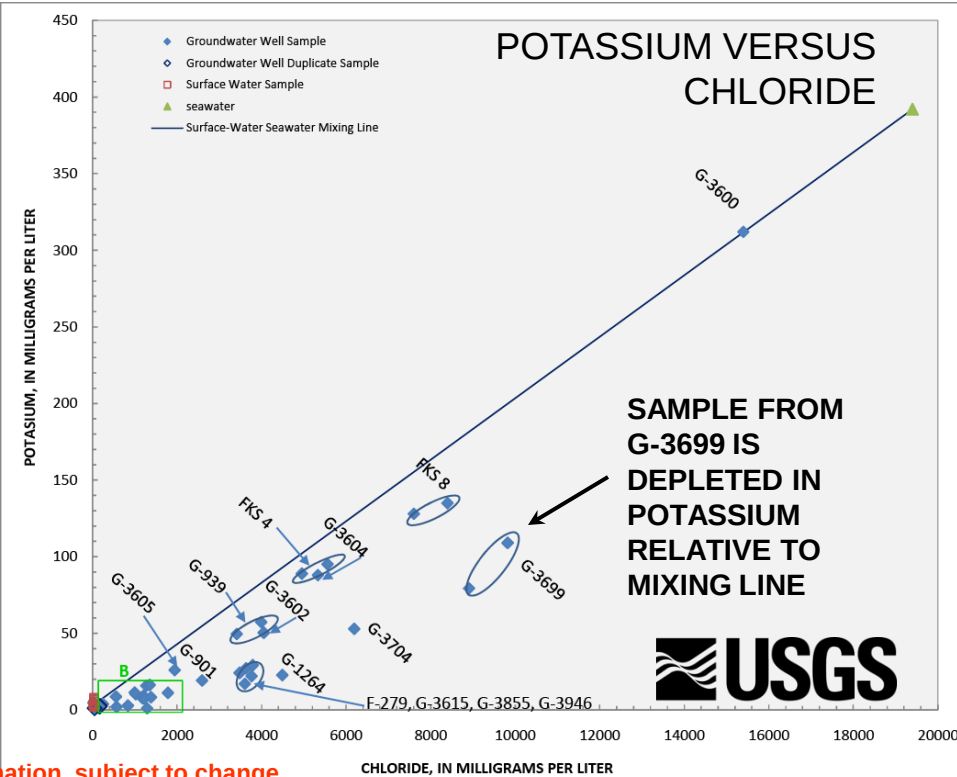
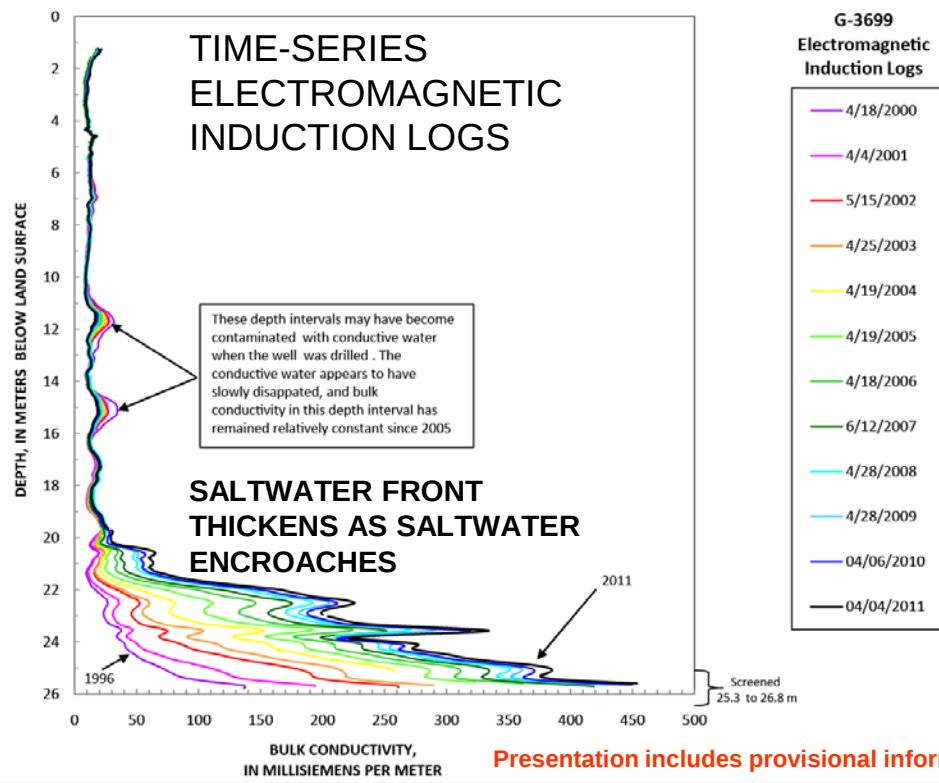
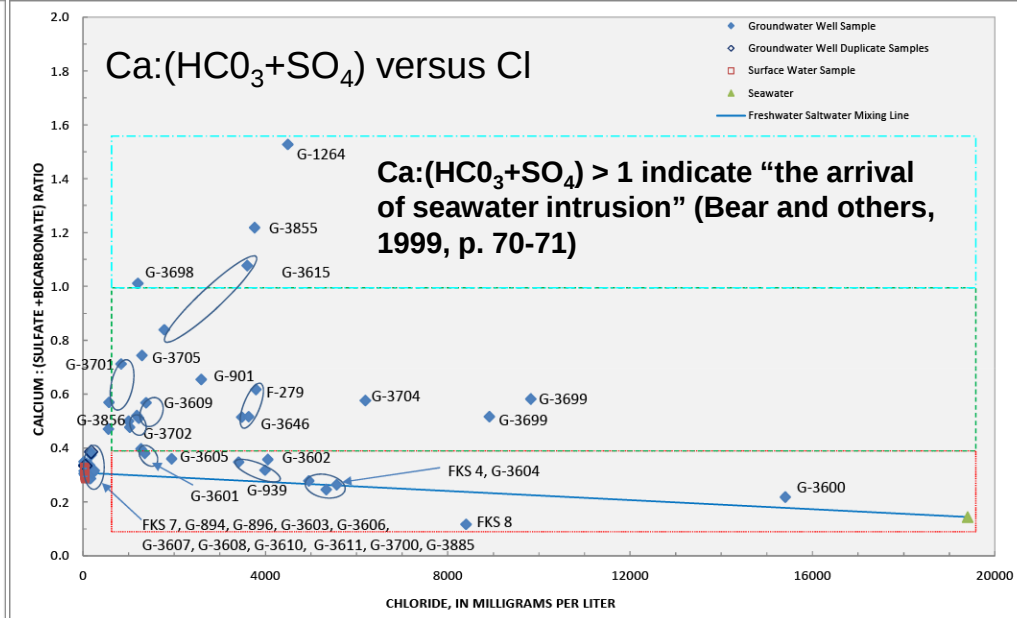
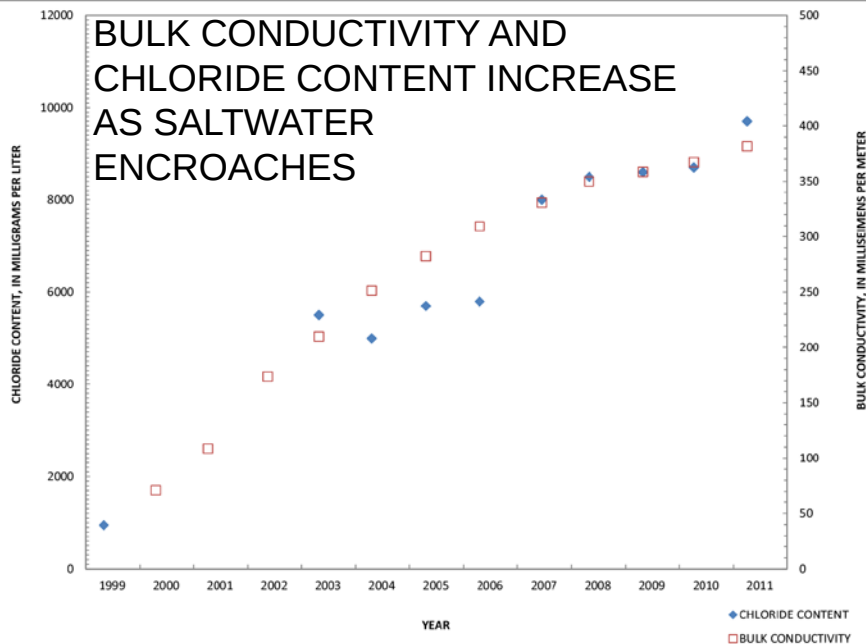
Well construction and location information.

Links to Electromagnetic induction logs.

Links to the numerical data.

Graphs of water level and chloride content.





TYPES OF GEOPHYSICAL DATA

- TIME-DOMAIN ELECTROMAGNETIC (TEM) SOUNDINGS
- HELICOPTER ELECTROMAGNETIC (HEM) SURVEYS
- CONTINUOUS RESISTIVITY PROFILING (CRP)
- DC RESISTIVITY
- SUB BOTTOM PROFILING / SEISMIC SURVEYS
- INDUCTION LOGGING
- DISTRIBUTED TEMPERATURE SENSING (DTS)
- CAPACITIVELY COUPLED RESISTIVITY (CCR) SURVEYS



GEOPHYSICAL MEASUREMENTS



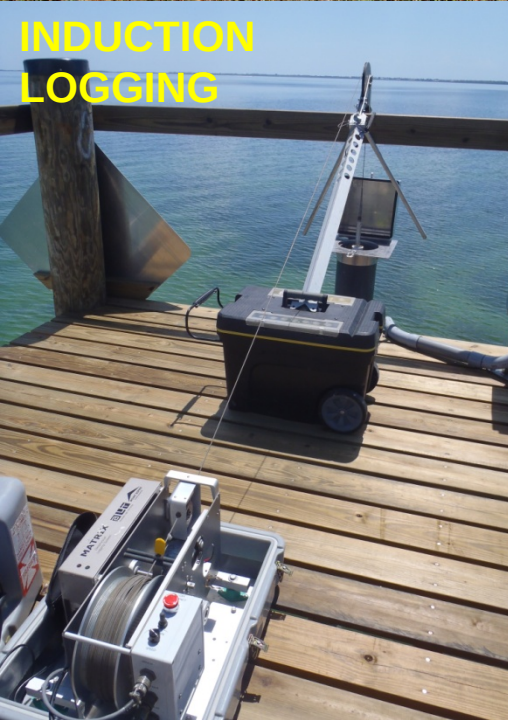
TEM SOUNDING



INDUCTION LOGGING



TEM SOUNDING



INDUCTION LOGGING



CRP SURVEY



CRP SURVEY



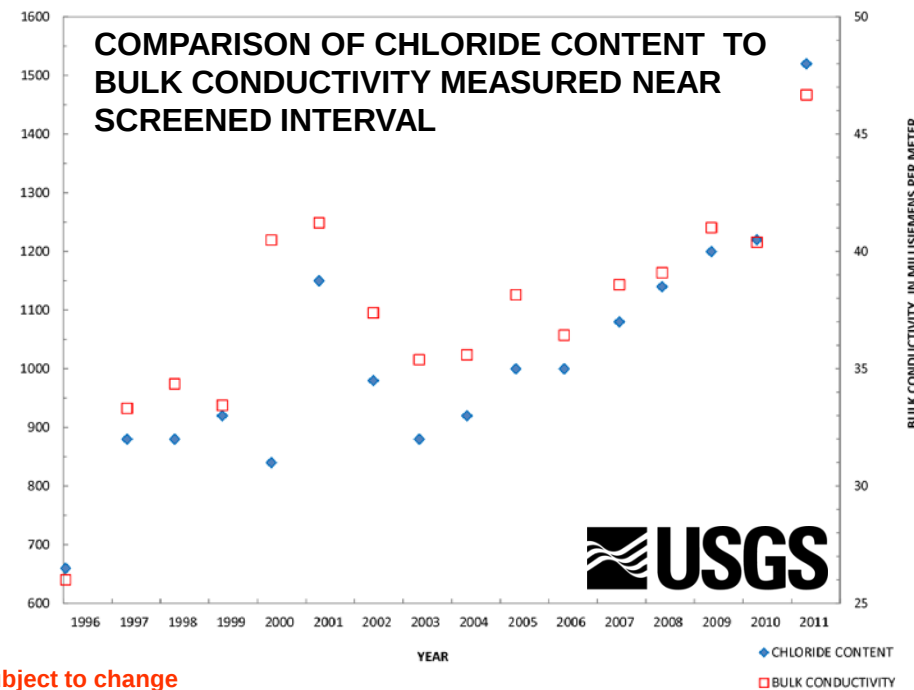
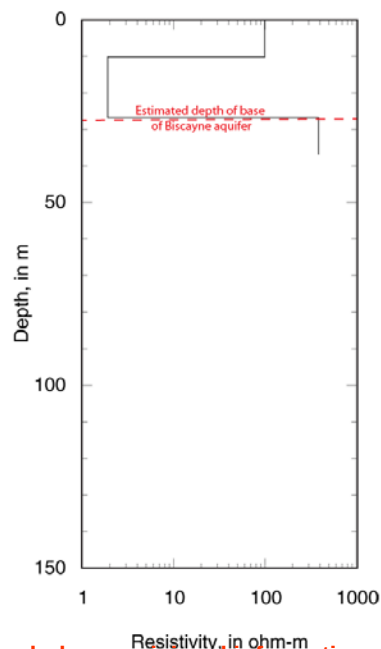
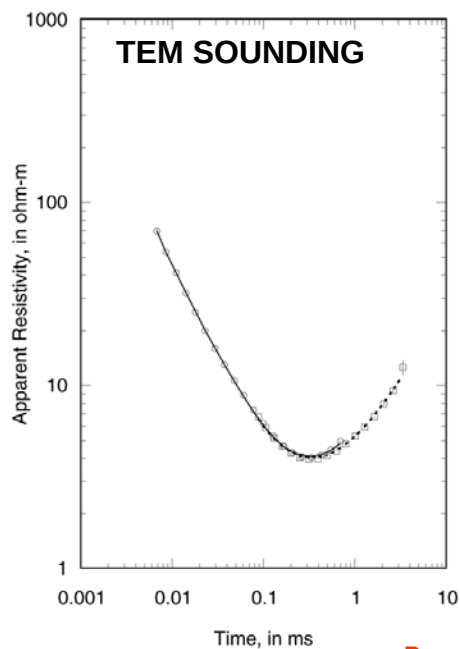
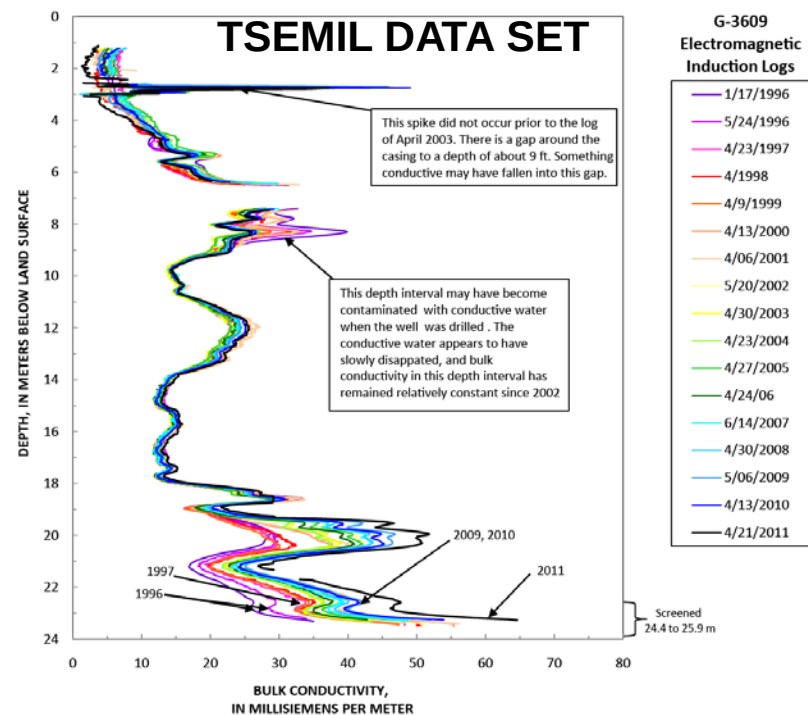
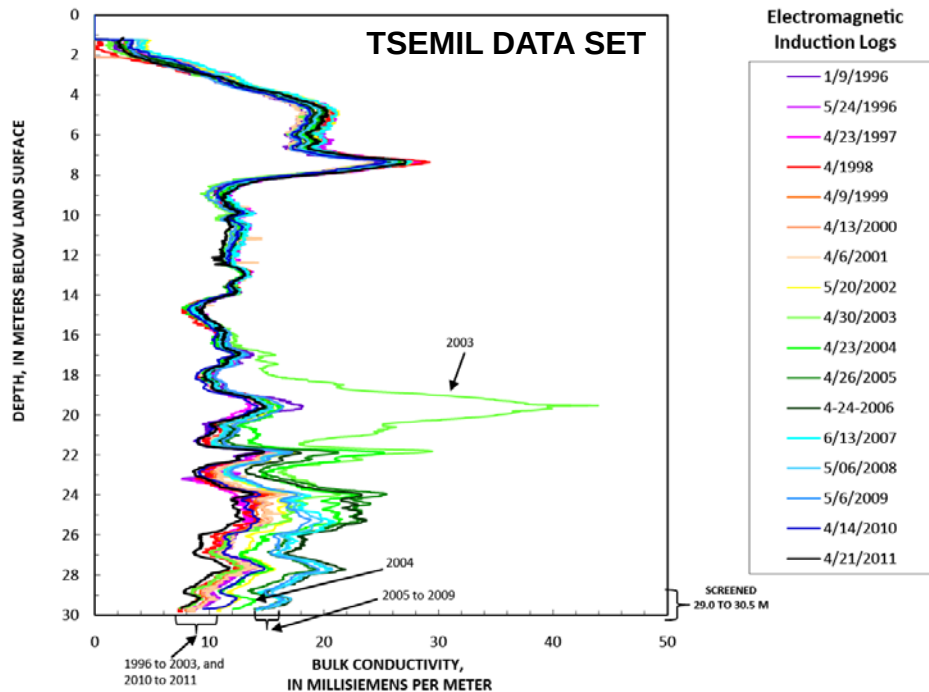
SEISMIC SURVEY

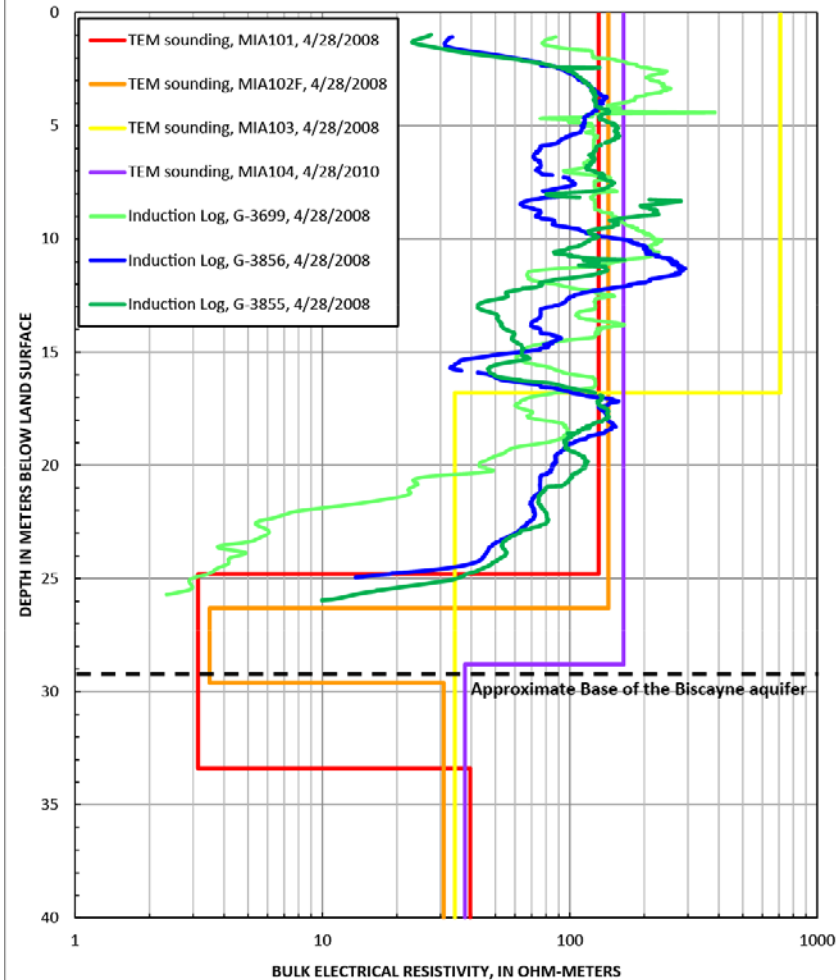
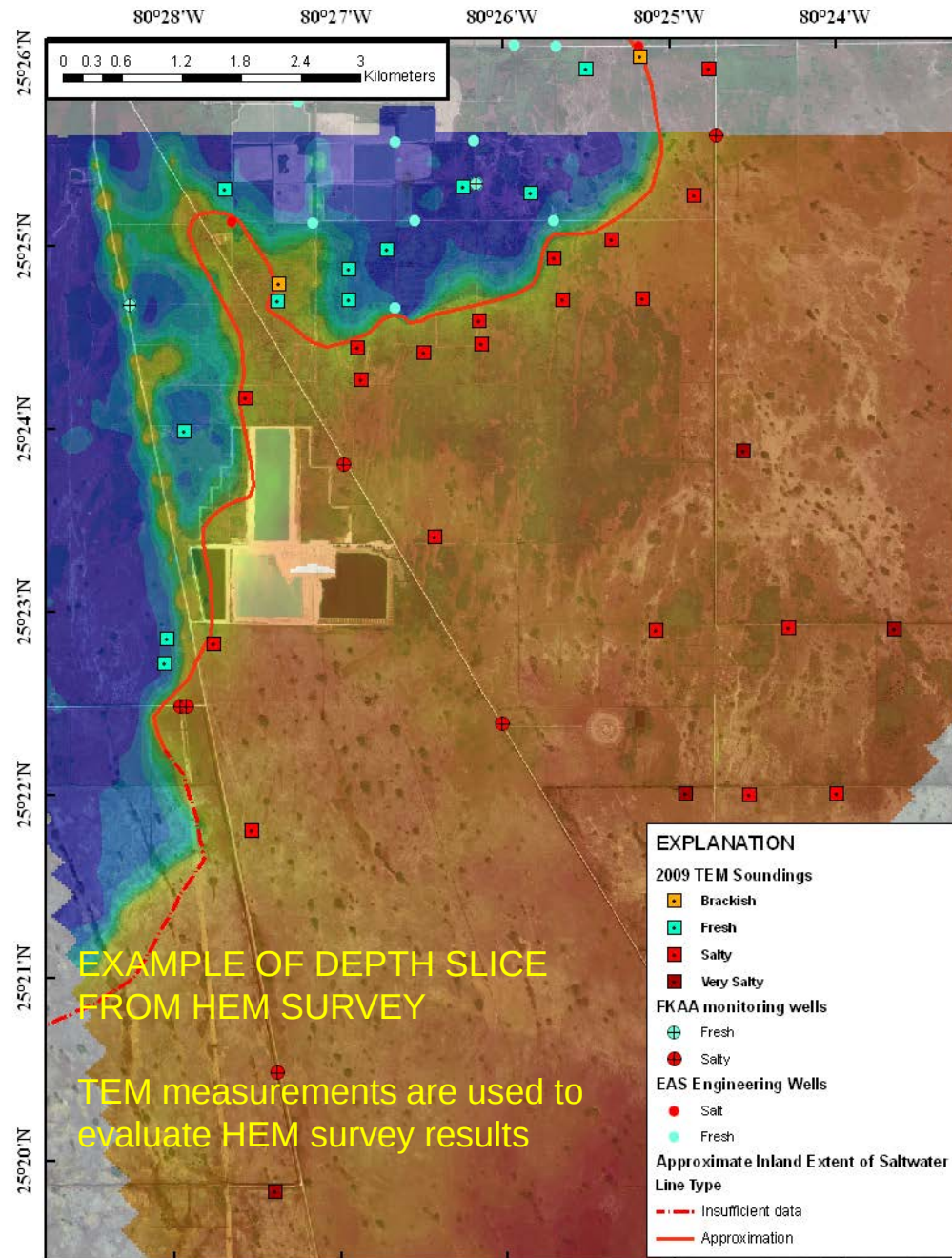


GEOPHYSICAL ANALYSIS

- **DEVELOPMENT OF TIME SERIES ELECTROMAGNETIC INDUCTION LOG (TSEMIL) DATA SETS**
- **COMPARISON OF TSEMIL DATA SETS TO CHLORIDE MEASUREMENTS**
- **MODELING OF TEM, HEM, CRP, AND DC RESISTIVITY SURVEYS**
- **COMPARISON OF (TEM) SOUNDINGS TO INDUCTION LOGS AND AQUIFER DEPTHS**
- **COMPARISON OF (HEM) SURVEYS TO INDUCTION LOGS AND TEM SOUNDINGS**
- **OPTIMUM DESIGN OF WELLS FOR INDUCTION LOGGING**

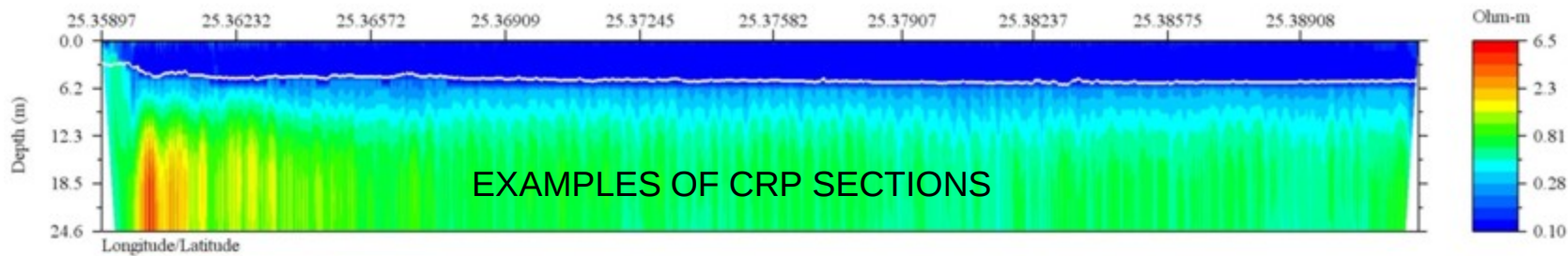






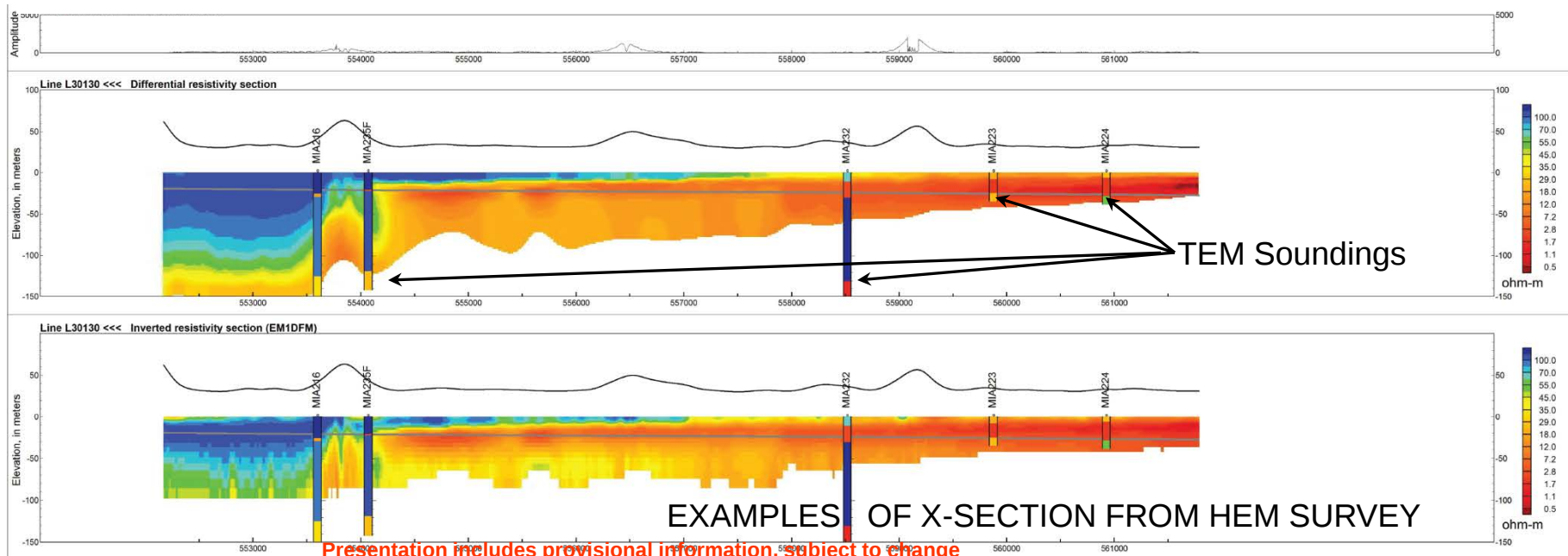
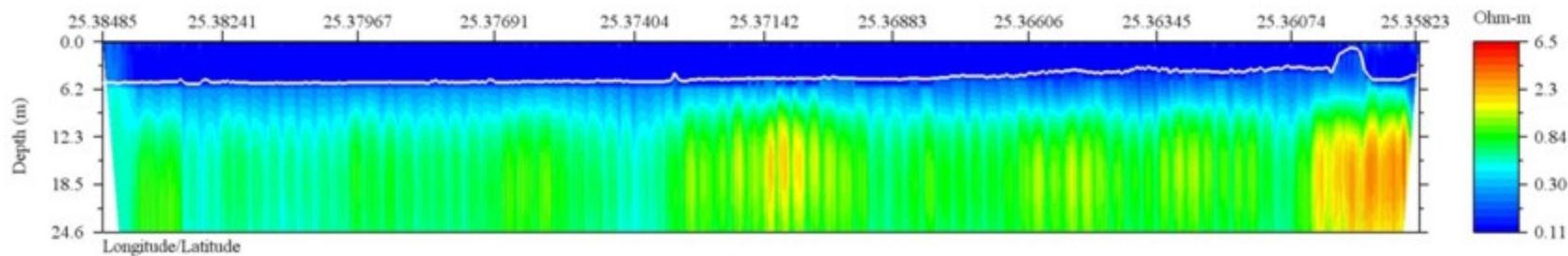
COMPARISON OF MODELED TEM SOUNDINGS TO ELECTROMAGNETIC INDUCTION LOGS AND THE APPROXIMATE DEPTH OF THE BASE OF THE BISCAYNE AQUIFER

Complete Inverted Resistivity Section



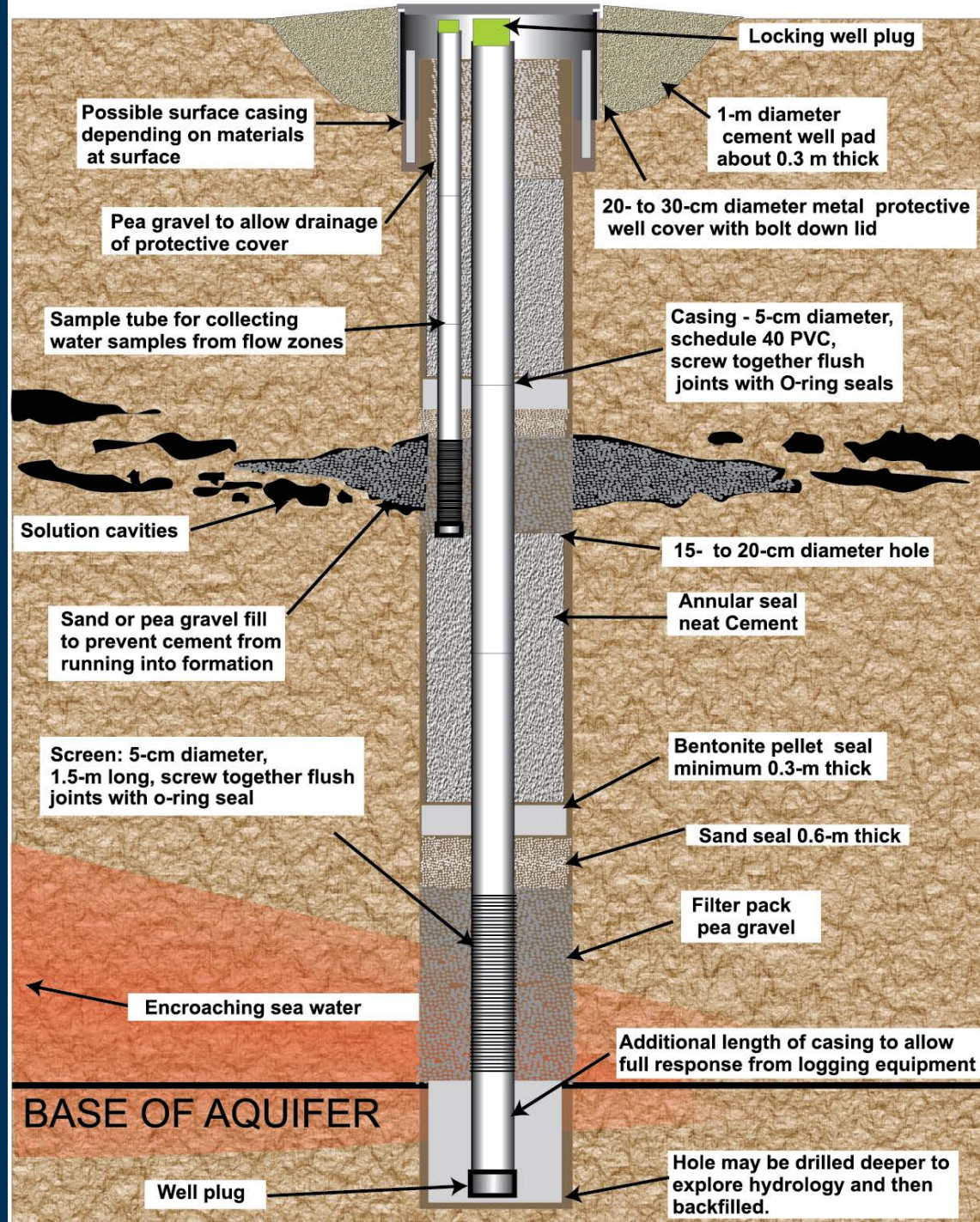
EXAMPLES OF CRP SECTIONS

Complete Inverted Resistivity Section



EXAMPLES OF X-SECTION FROM HEM SURVEY

New well design penetrates beyond the base of the aquifer, and uses sand or pea gravel to fill voids so that logging tool can sense changes occurring in these depth intervals.



REFERENCES

Bear, Jacob, Cheng, A.H.D., Sorek, Shaul, and others, eds., 1999, Seawater intrusion in coastal aquifers – Concepts, methods, and practices: Dordrecht, Netherlands, Kluwer Academic Publishers, 625 p.

WEBSITES

USGS WATER WATCH WEBSITES - <http://waterwatch.usgs.gov/new/>

USGS GROUNDWATER WATCH WEBSITES - <http://groundwaterwatch.usgs.gov/>

USGS CURRENT GROUNDWATER CONDITIONS - http://www.sflorida.er.usgs.gov/ddn_data/index.html

USGS SALINE INTRUSION MONITORING - <http://www.envirobase.usgs.gov/FLIMS/SaltFront/viewer.htm>

USGS REPORTS WEBSITE - <http://pubs.er.usgs.gov/>

