

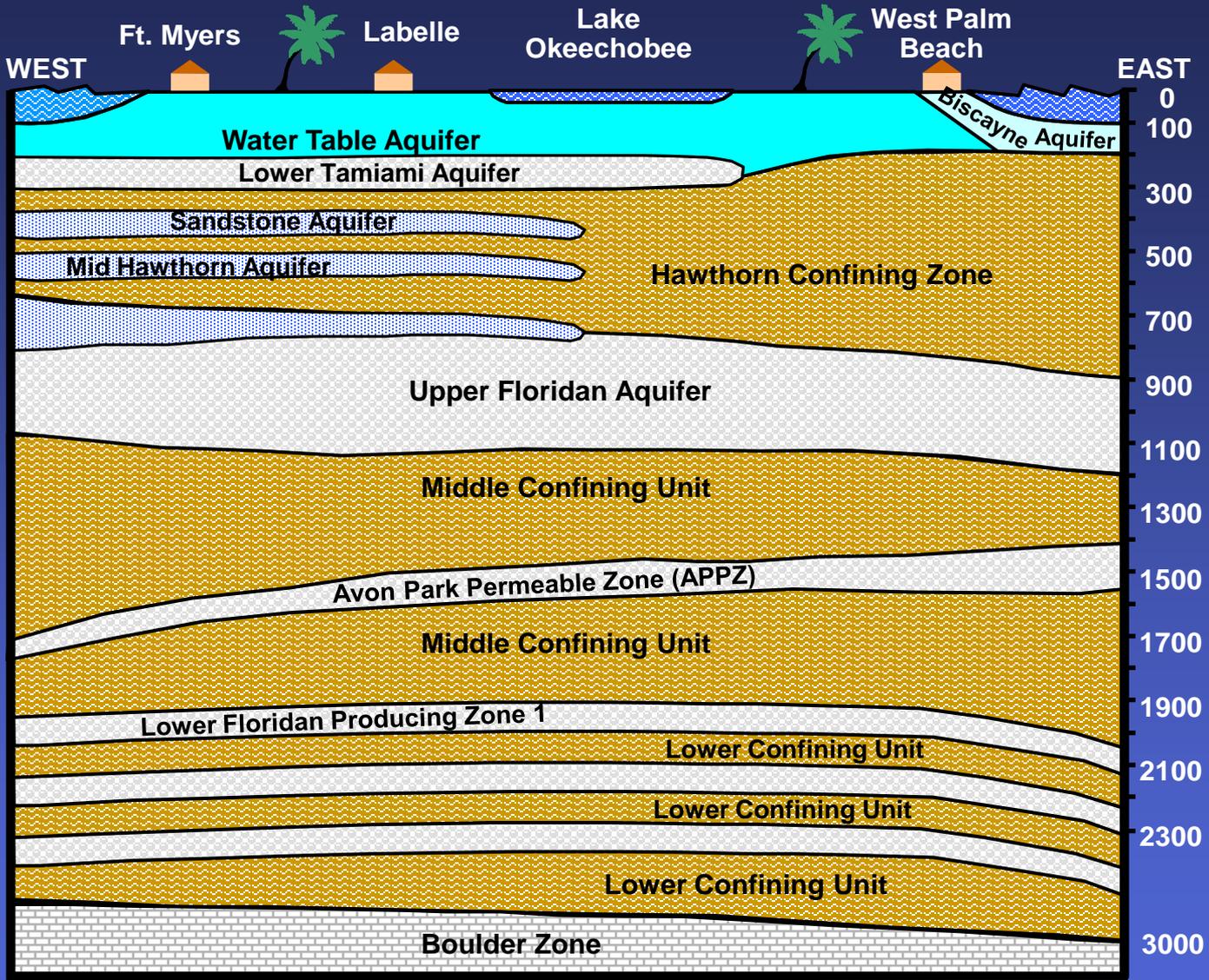
Overview and Current Use of the Floridan Aquifer System in the Lower East Coast

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sfwmd.gov



Generalized Aquifer Systems of South Florida

Major Aquifers, Relative Yields, and Generalized Depths in South Florida

<u>Aquifer</u>	<u>Yield</u>	<u>Depth (ft bls)</u>
Upper Floridan Aquifer	Moderate	800 to 1,200
APPZ	Moderate	1,200 to 1,600
Boulder Zone	Very High	2,800 to 3,500
Biscayne Aquifer	Very High	0 to 200
Surficial Aquifer	Low	0 to 100

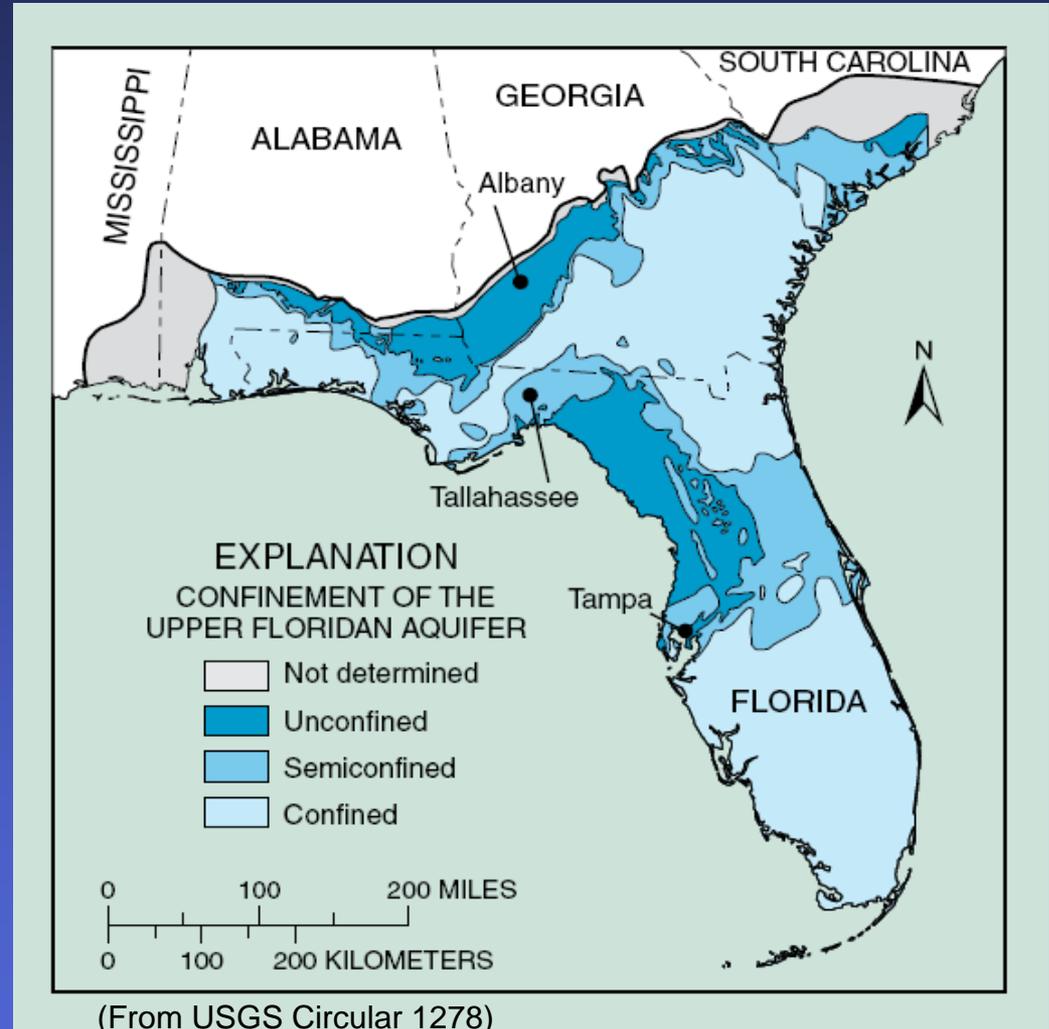
NOTES:

APPZ = Avon Park Permeable Zone

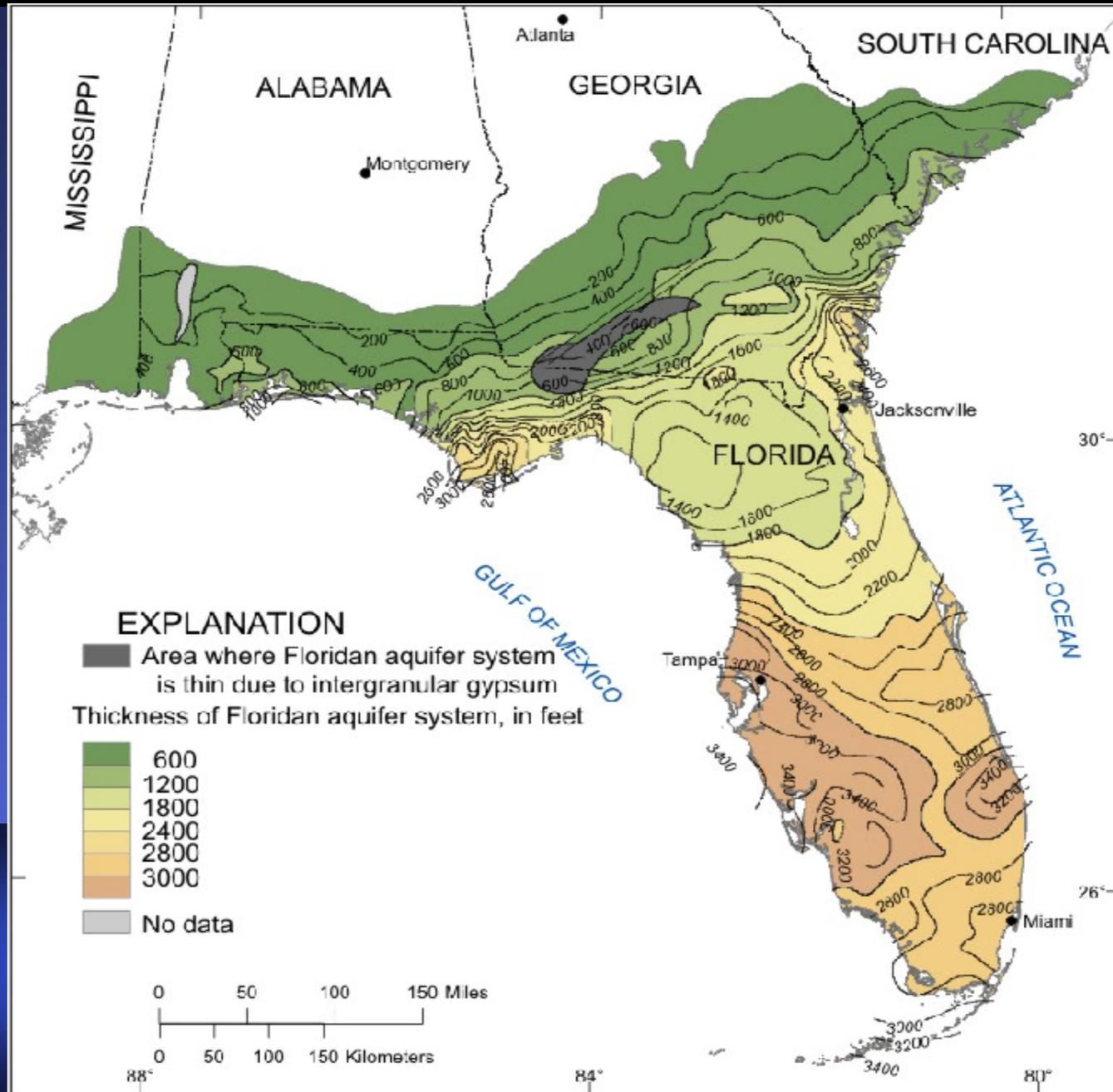
ft bls = feet below land surface

Geographic Differences of the Floridan Aquifer System (FAS)

- Recharge Area in Central Florida (Unconfined)
- Confined Aquifer in South Florida – less water released from storage, greater drawdowns

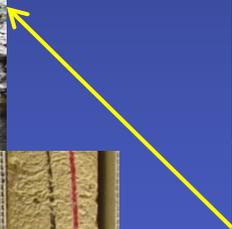


Thickness of the Floridan Aquifer System

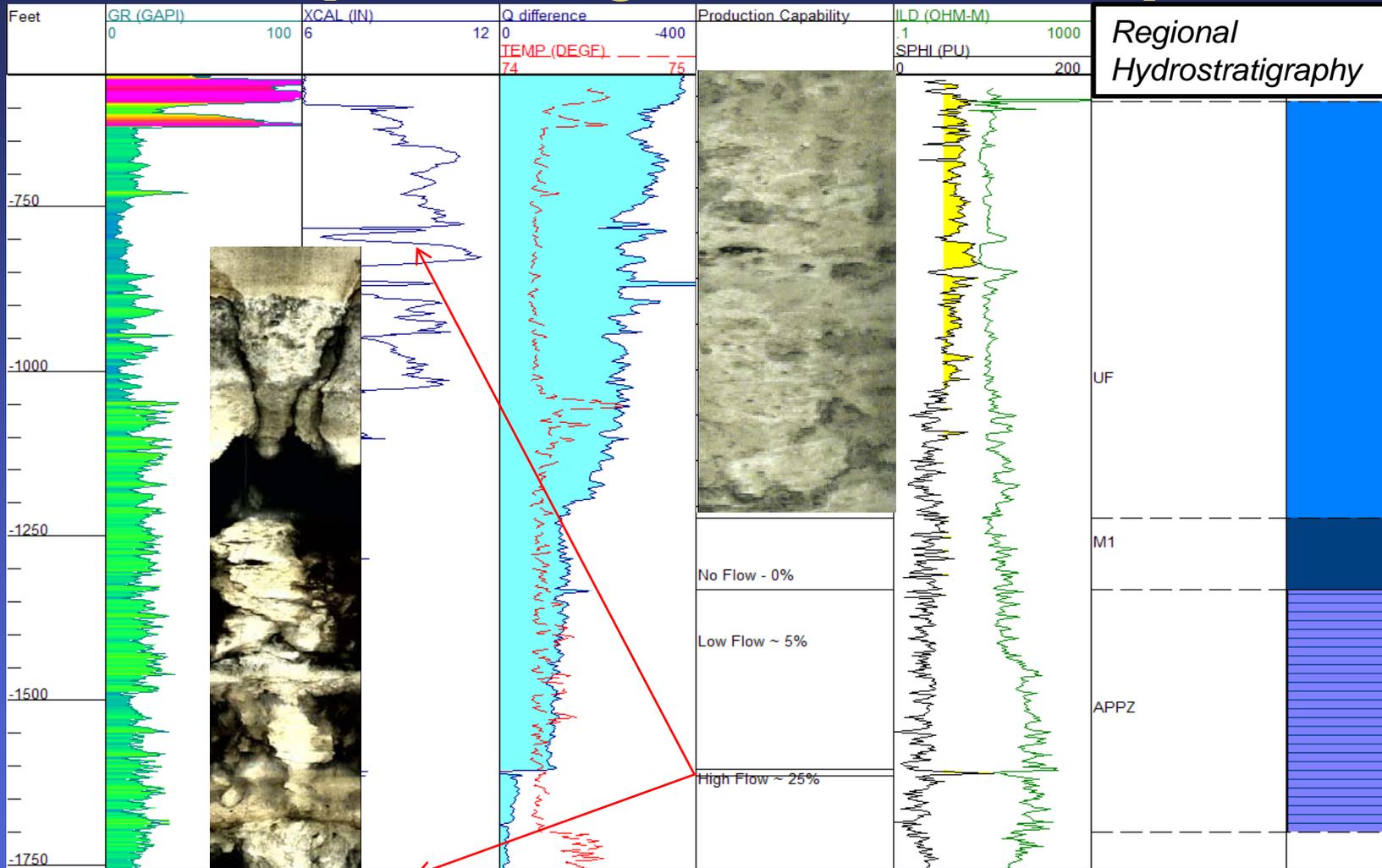


Simplified Hydrostratigraphic Chart

Geologic unit		Lithology	Hydrogeologic unit		Approximate thickness (feet)
Undifferentiated and various Pleistocene-aged formations		Quartz sand; silt; clay; shell; limestone; sandy shelly limestone	SURFICIAL AQUIFER SYSTEM	WATER-TABLE / BISCAYNE AQUIFER	20-400
TAMIAMI FORMATION		Silt; sandy clay; sandy, shelly limestone; calcareous sandstone; and quartz sand		CONFINING BEDS LOWER TAMIAMI AQUIFER	
HAWTHORN GROUP	PEACE RIVER FORMATION	Interbedded sand, silt, gravel, clay, carbonate, and phosphatic sand	INTERMEDIATE AQUIFER SYSTEM OR CONFINING UNIT	CONFINING UNIT SANDSTONE AQUIFER OR PZ1(?)	0-900
	ARCADIA FORMATION	Sandy micritic limestone; marlstone; shell beds; dolomite; phosphatic sand and carbonate; sand; silt; and clay		CONFINING UNIT MID-HAWTHORN AQUIFER OR PZ2	
	BASAL HAWTHORN UNIT			CONFINING UNIT	
SUWANNEE LIMESTONE		Fossiliferous, calcarenitic limestone	SYSTEM	LOWER HAWTHORN PRODUCING ZONE PZ3	0-300
OCALA LIMESTONE		Chalky to fossiliferous, mud-rich to calcarenitic limestone		UPPER FLORIDAN AQUIFER (UF)	100-800
AVON PARK FORMATION		Fine-grained, micritic to fossiliferous limestone; dolomitic limestone; and dolostone. Also contains in the lower part anhydrite/gypsum as bedded deposits, or more commonly as pore filling material. Glauconitic limestone near top of Oldsmar Formation in some areas	AQUIFER	MIDDLE CONFINING UNIT (MC1) APPZ	500-1,500 0-600
? — ? — ? OLDSMAR FORMATION			FLORIDAN	MIDDLE CONFINING UNIT (MC2) L1	0-1,800
CEDAR KEYS FORMATION		Dolomite and dolomitic limestone Massive anhydrite beds		LOWER FLORIDAN AQUIFER BZ	0-700
				SUB-FLORIDAN CONFINING UNIT	1,200?

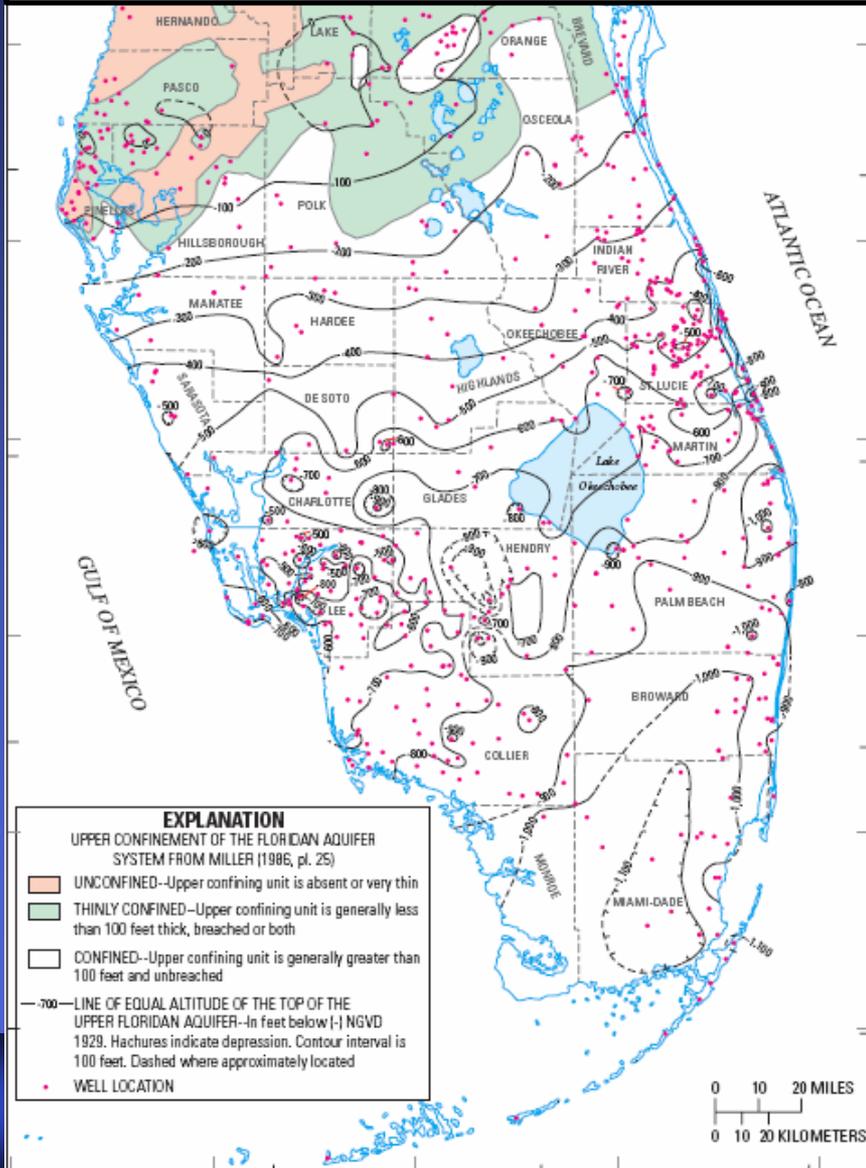


Vertical Differences of Floridan Aquifer System: Example

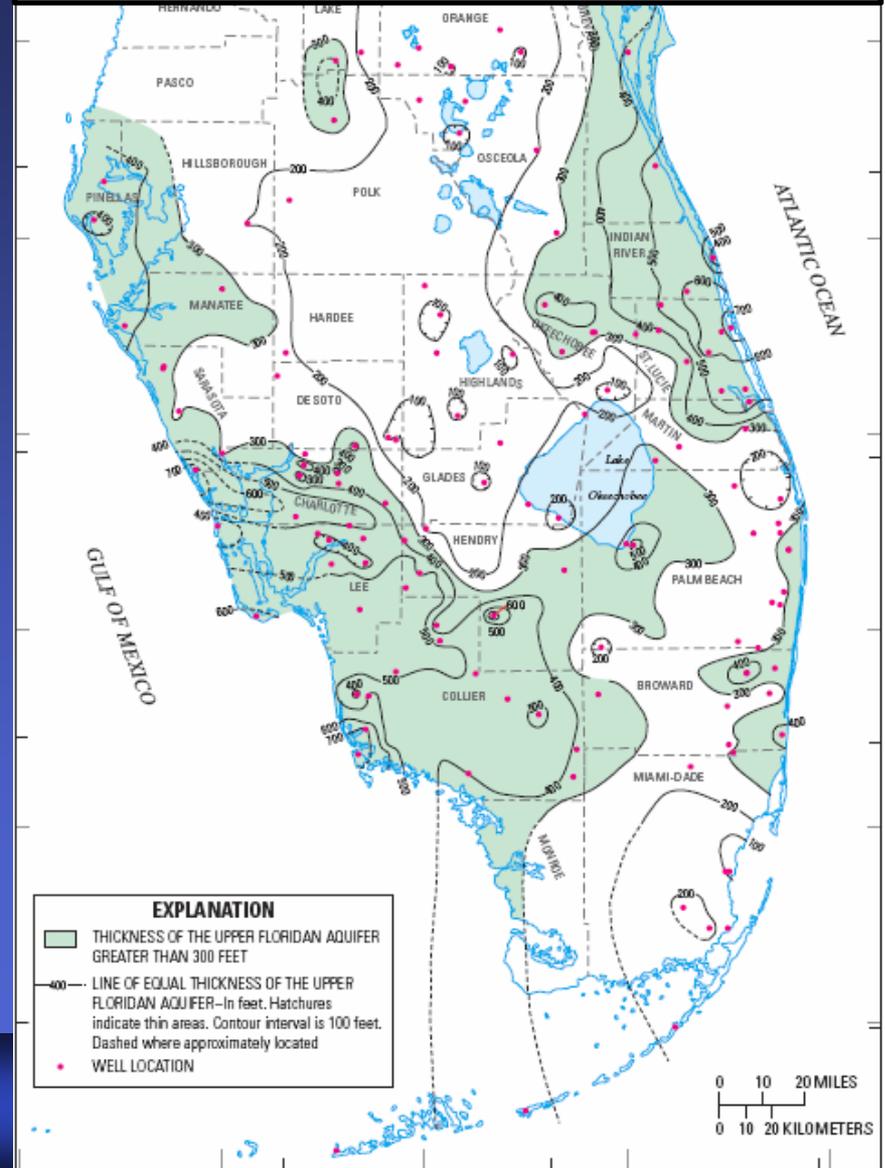


Uppermost Production Zone

Top Elevation [NGVD]

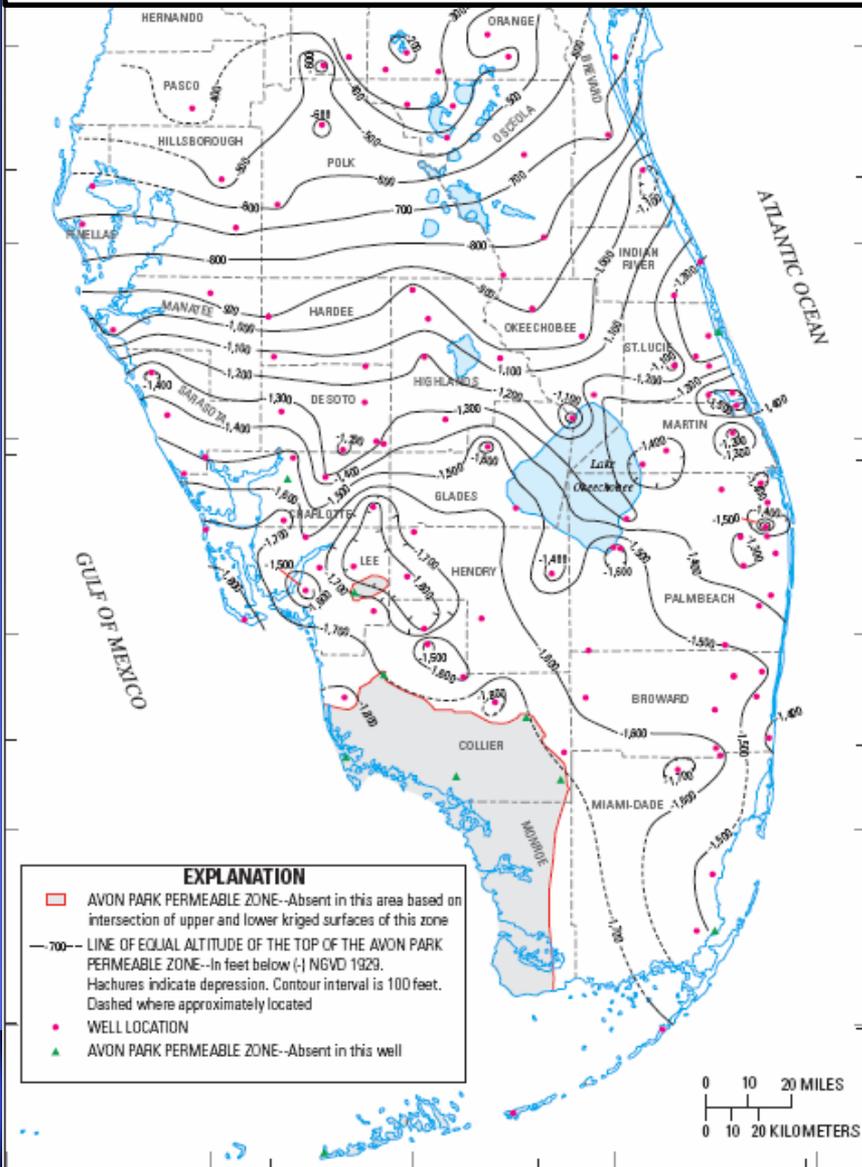


Thickness [ft]

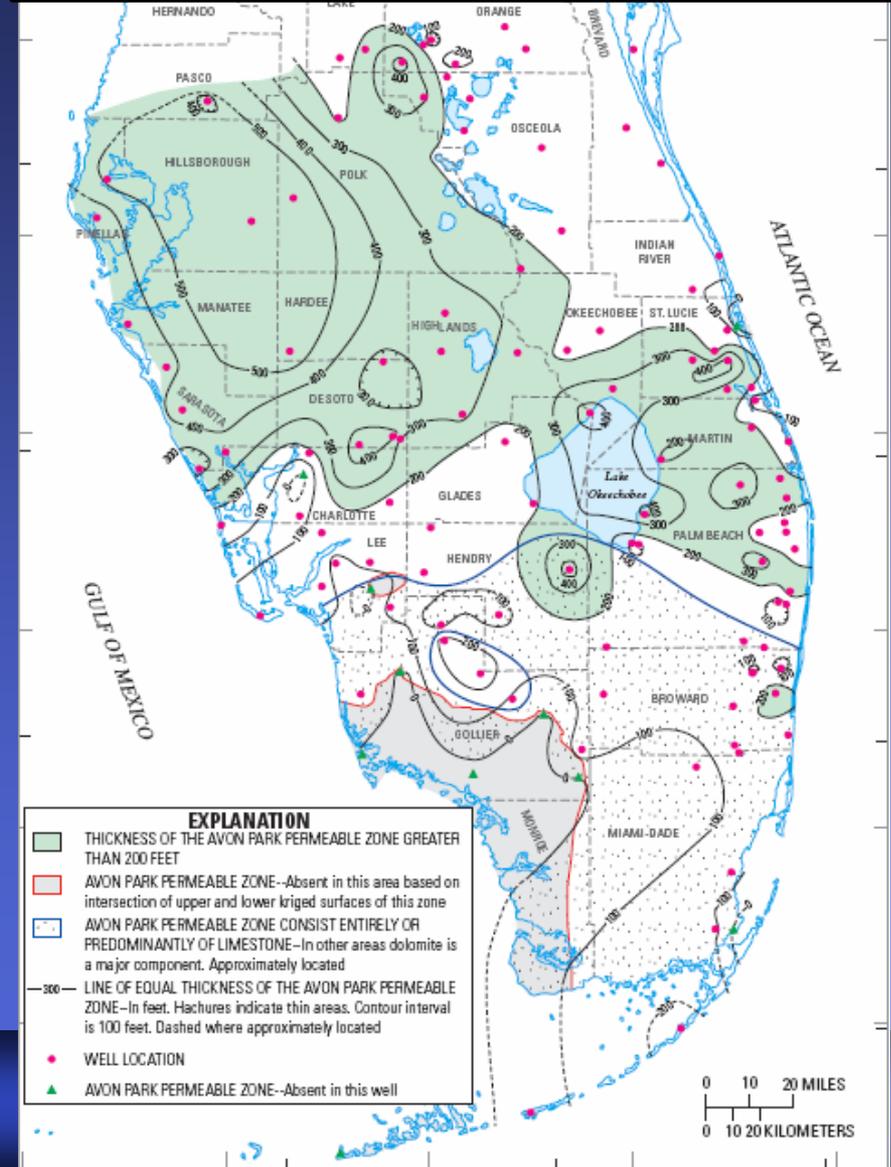


Avon Park Producing Zone

Top Elevation [ft NGVD]

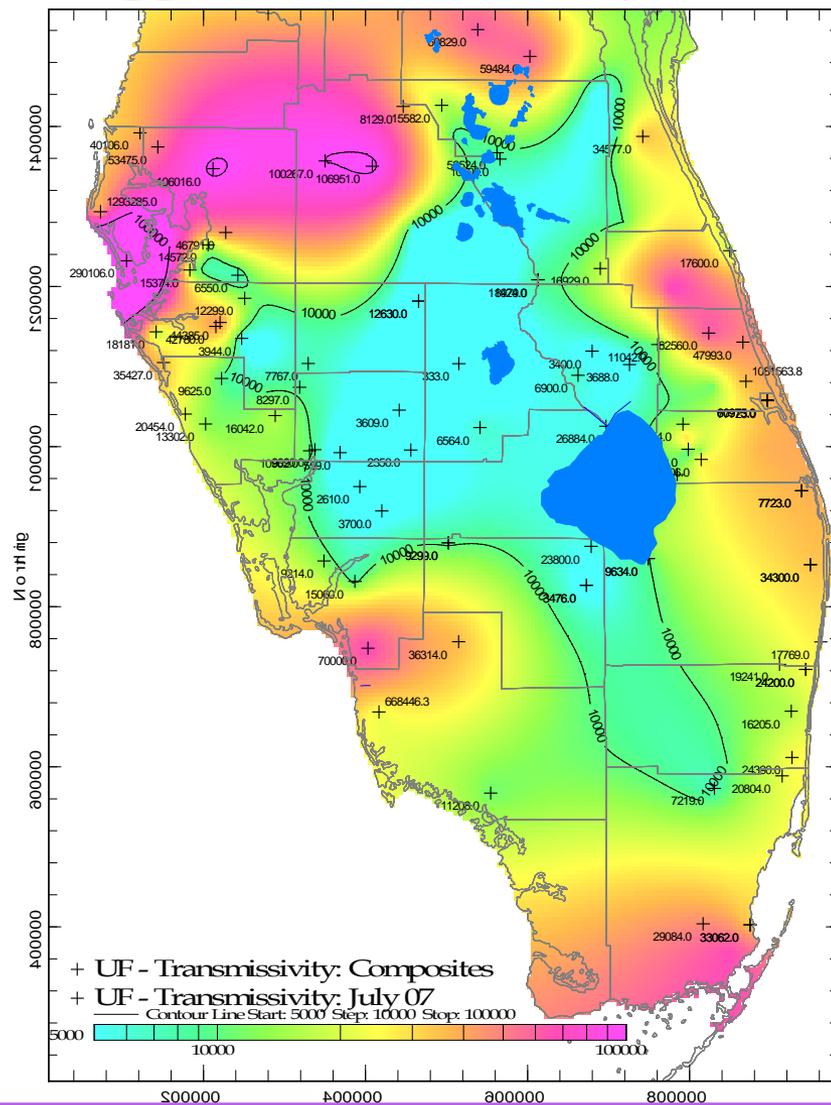


Thickness [ft]

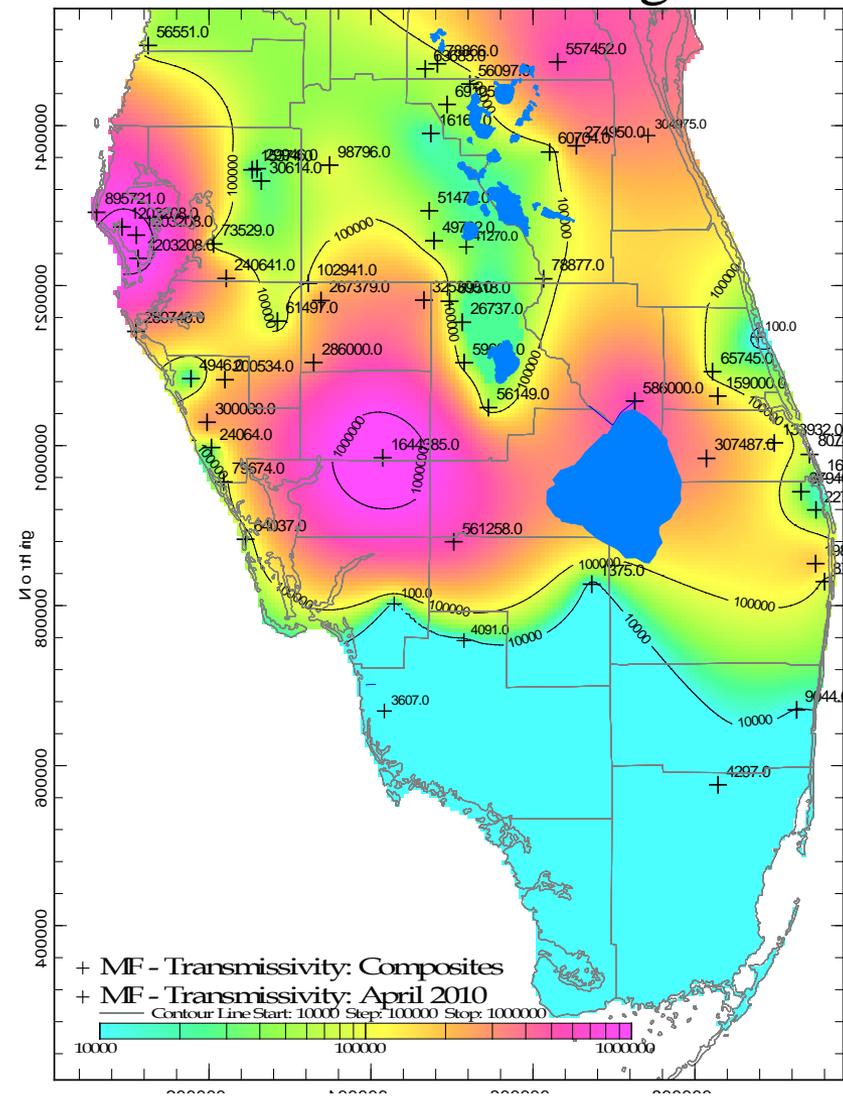


Geographic Differences in Transmissivity within the FAS

Uppermost Producing Zone

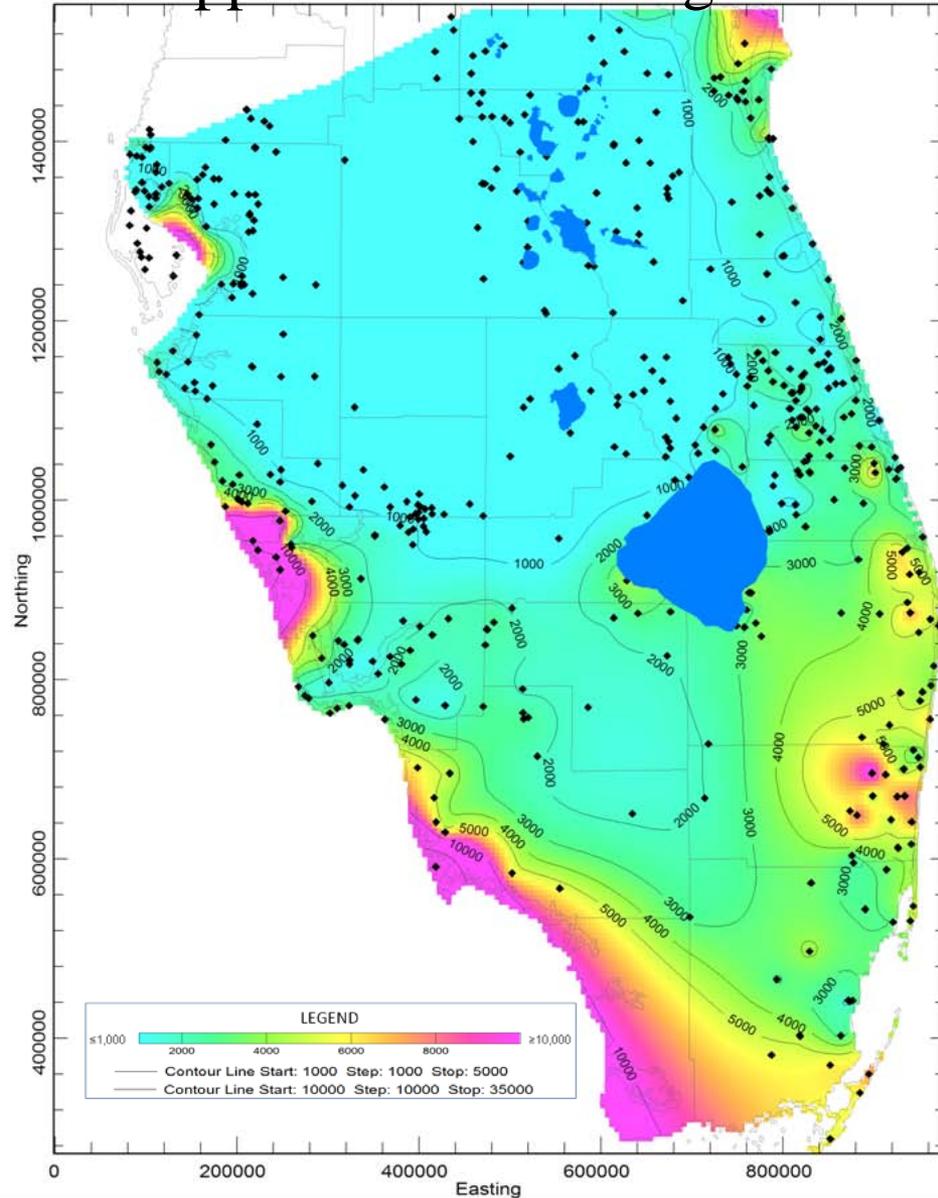


Avon Park Producing Zone

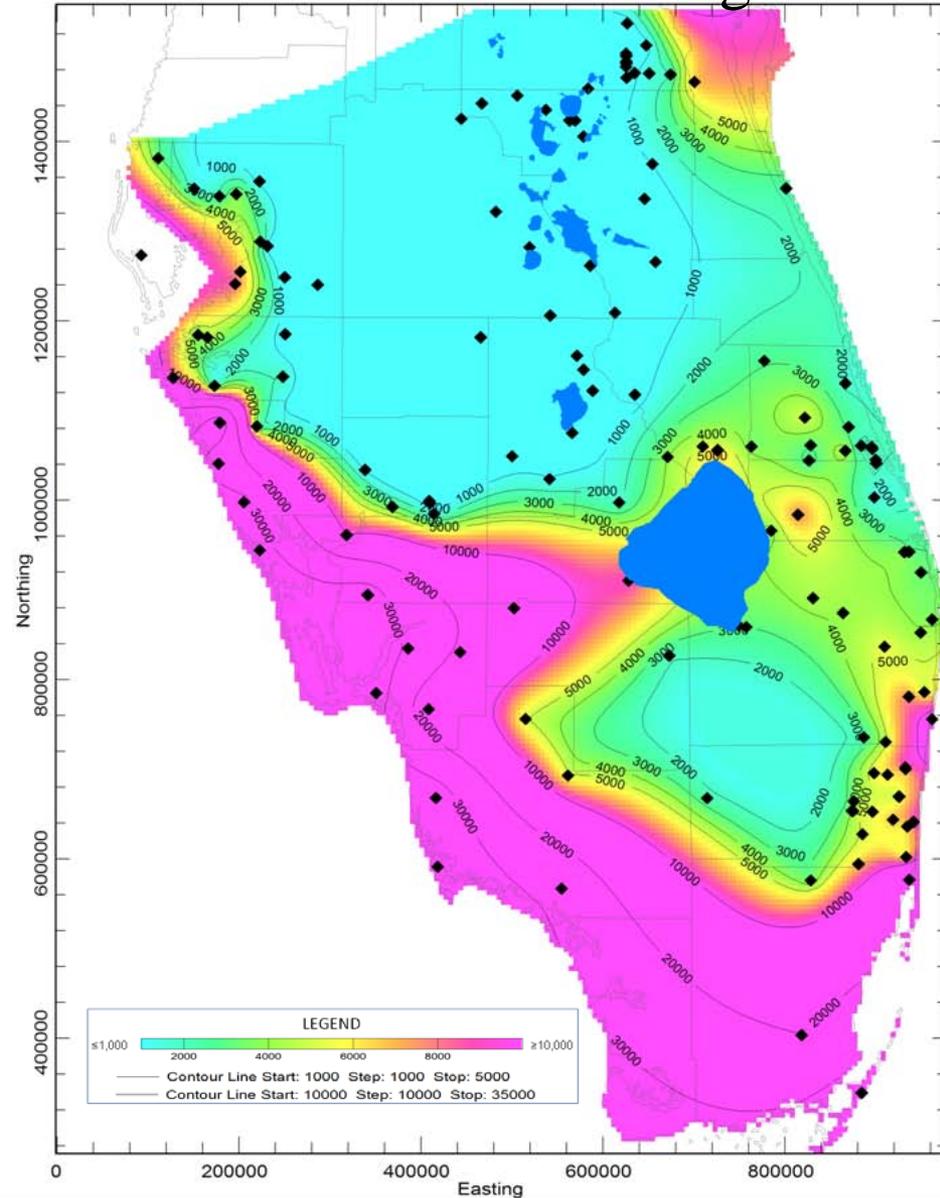


Geographic Differences in Salinity within the FAS

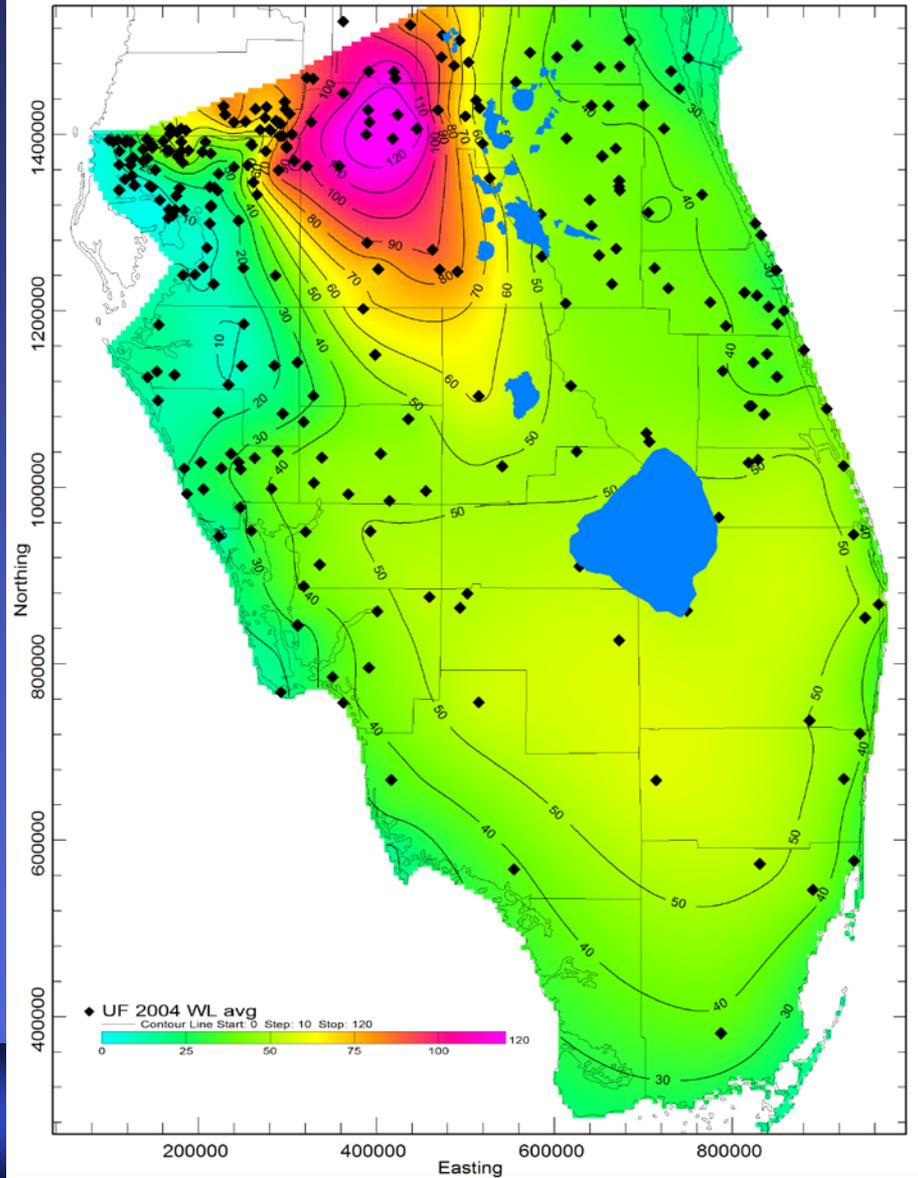
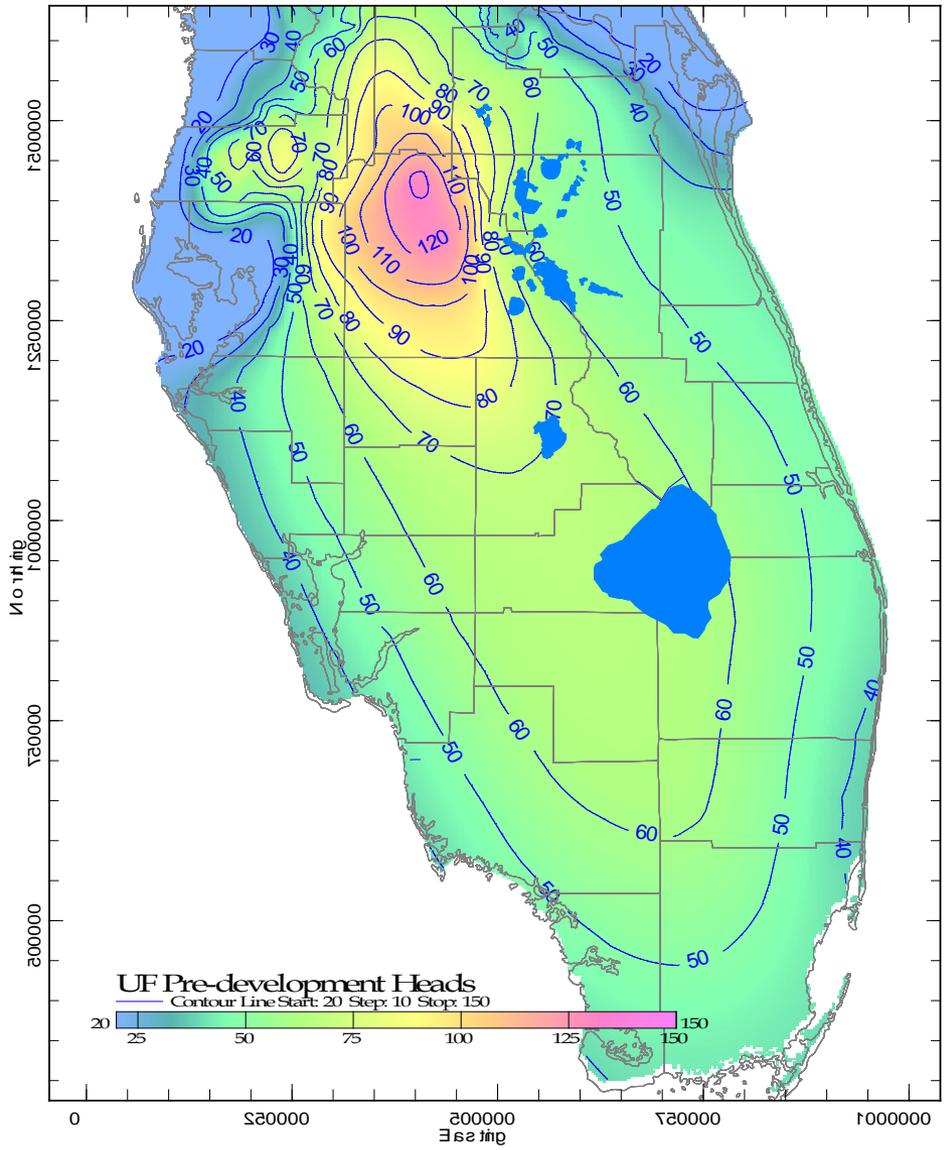
Uppermost Producing Zone



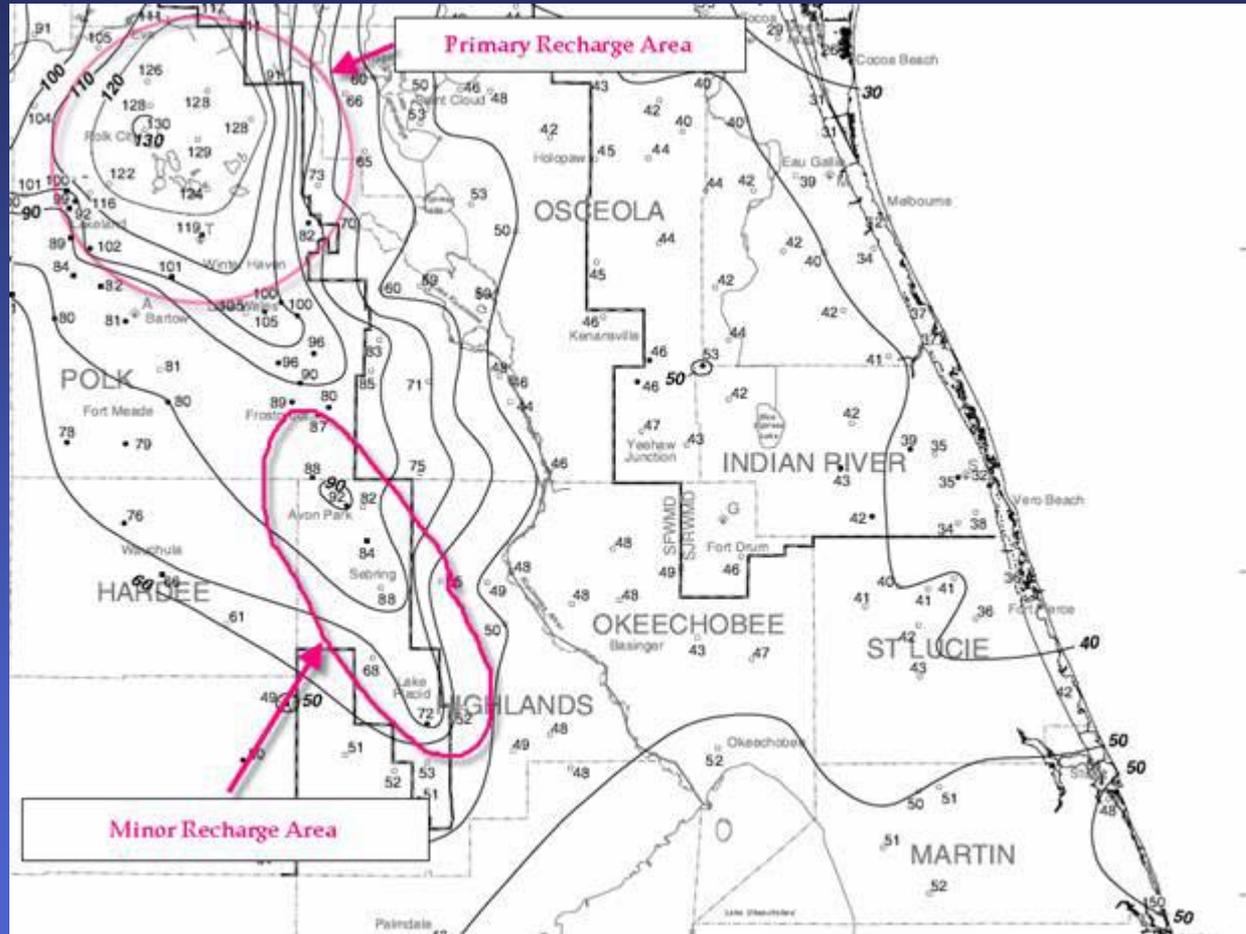
Avon Park Producing Zone



Changing Water-levels due to Long-term Withdrawals



Recharge to FAS Occurs in Polk and Highlands Counties



(From USGS OFR 2004-1288)

General Observations of the Floridan Aquifer System in the LEC

- Confined in South Florida by several hundred feet of relatively impermeable sediments (Hawthorn Group) – isolated from overlying Biscayne aquifer
- Depth to the base of the Underground Source of Drinking Water [USDW; 10,000 mg/L of total dissolved solids (TDS)] ranges from 1,600 to 1,900 feet below land surface
- Lower portion (Boulder Zone) used to dispose of secondary effluent from wastewater treatment plants and concentrate from reverse osmosis facilities
- Upper portions of Floridan aquifer system used for brackish (slightly saline) water supply (e.g., Town of Jupiter) since late 1980s

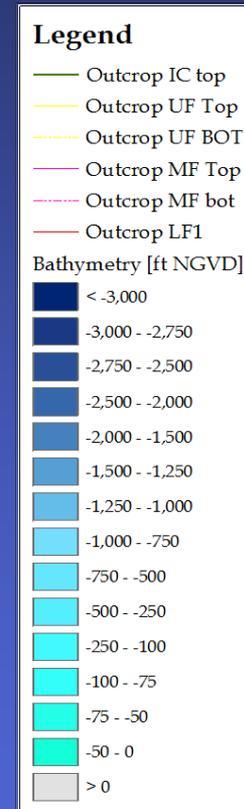
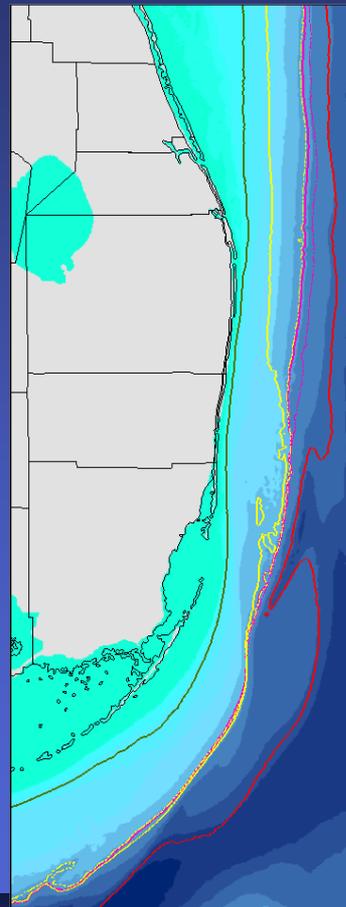
Well Flowing Under Artesian Pressure

- Several FAS zones under artesian pressure in South Florida
- Flow at land surface naturally (no pumping required)
- In general, occurs from Lake Okeechobee southward where Hawthorn Group confinement is extensive
- Boulder Zone (saltwater) does not flow naturally

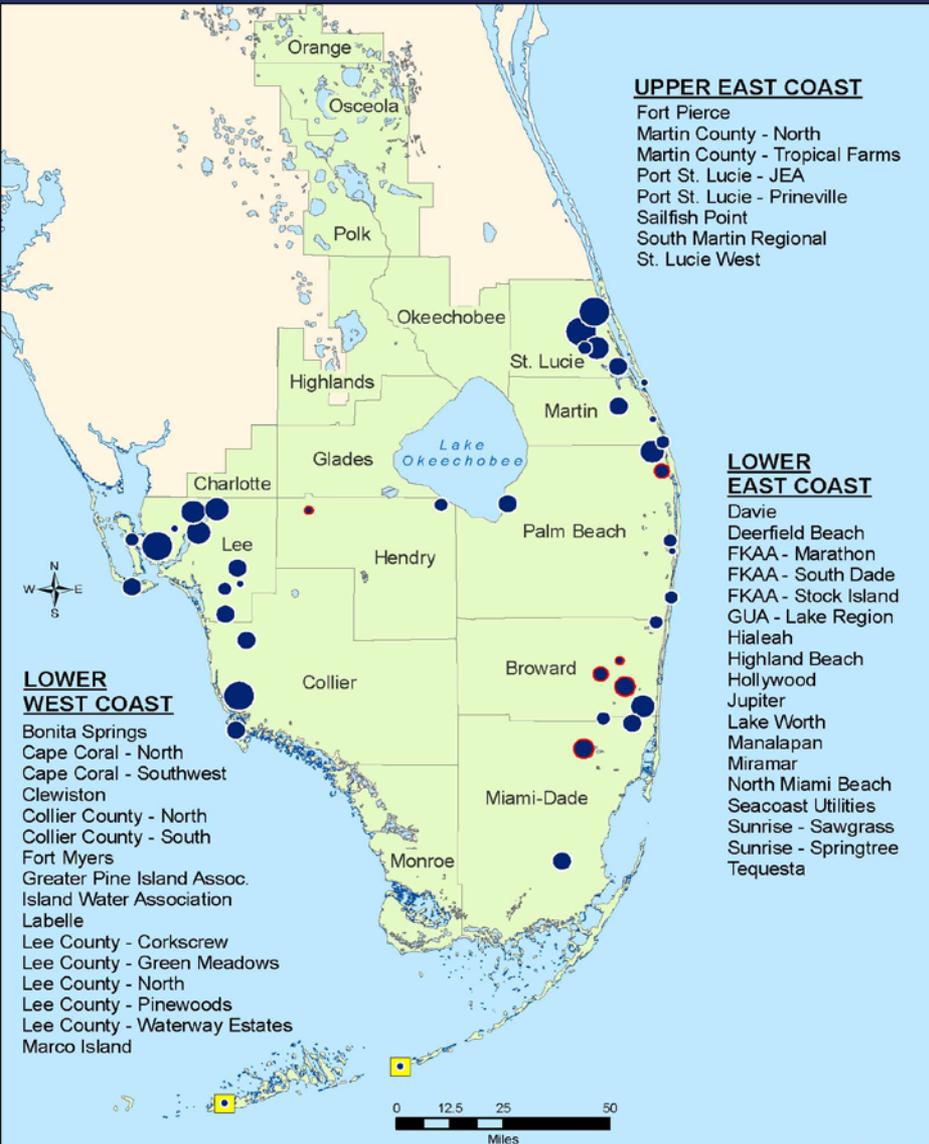


Geologic Formations of the FAS extend offshore at depth

Hydrostratigraphic Outcrops
Based on 2nd Order Trend Analysis



Potable Water Desalination Plants within SFWMD, 2012



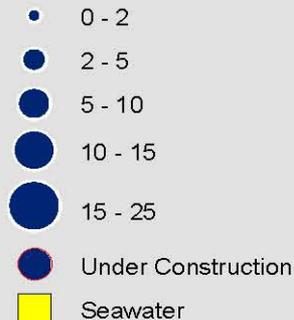
Number of Facilities:

- Operating 35
- Under construction 7

Total Capacity (MGD):

- Operating 245
- Under Construction 35

Desalination Facilities by MGD



General Water Quality Characterization of the Floridan Aquifer System

- **Upper Floridan Aquifer and Avon Park Permeable Zone (APPZ) are potential zones for RO source water or Aquifer Storage and Recovery (ASR)**
- **Brackish quality requires membrane treatment to meet drinking water standards**
- **Relatively stable water quality seasonally, but geographically variable**
- **Some pumping wells become saltier (upconing of more saline water from below or laterally along coast) over time – related to aquifer productivity, well spacing, depth to saline water, etc.**

Biscayne Aquifer

- More data, greater understanding, greater use
- Recharged locally through rainfall, canals, Everglades seepage
- Subject to contamination
- Much more likely to have water shortage restrictions imposed
- Primary use is supply not storage (i.e., ASR)
- Cheaper because of fresh water quality and shallower well depths

Technical Considerations of FAS

■ Greater Drawdowns

- Increased energy costs associated with lifting water via pumps
- Increase well spacing to lessen drawdown effects (i.e., greater pipeline costs)
- Adjacent user effects

■ Potential for decline in water quality over time

- Membrane design and periodic replacement
- Blending with Biscayne water

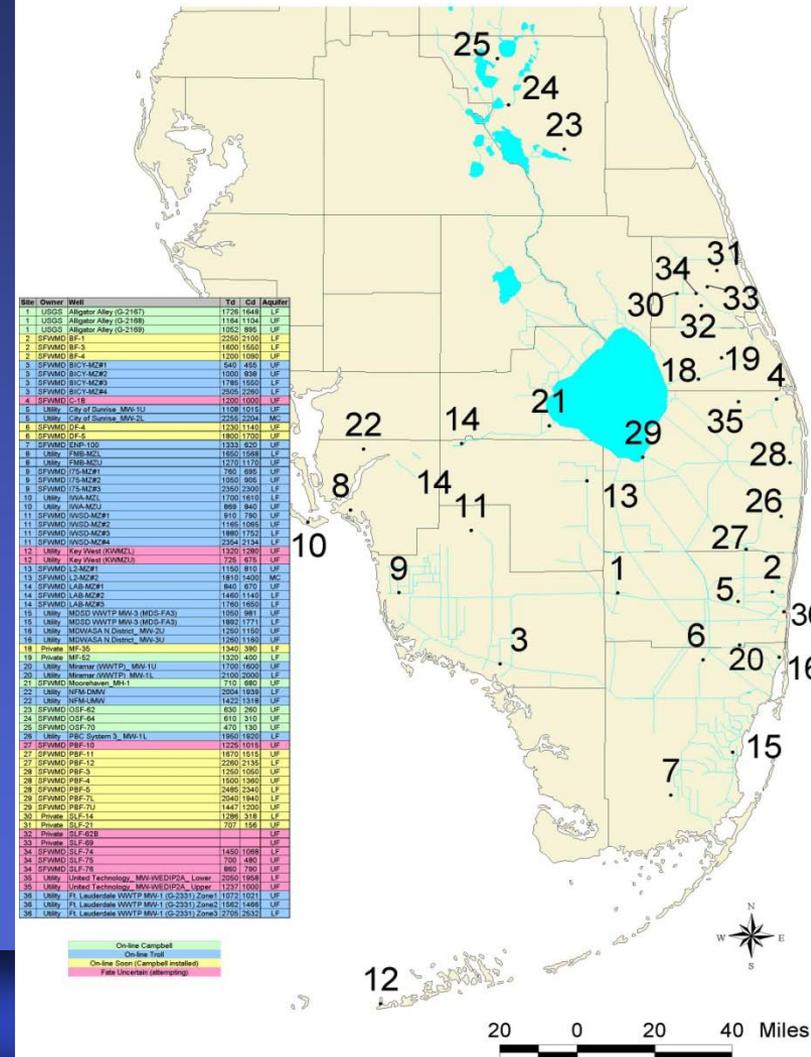
■ Membrane Treatment

- Estimated 115 to 125% of raw water to meet treated water demands
- Concentrate disposal via deep injection wells

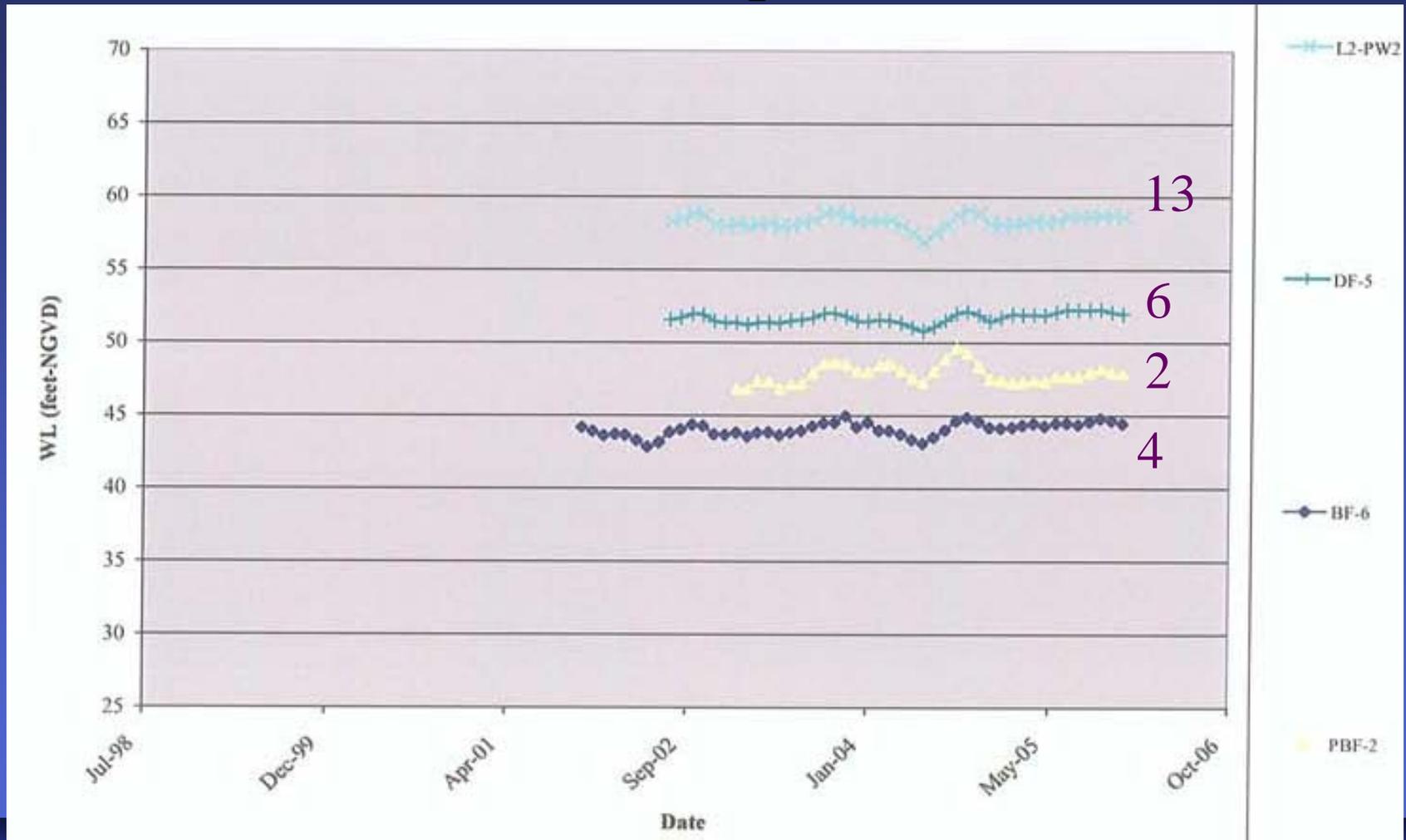
FAS Monitoring Network

- Data Loggers w/Continuous Recorders
- Provides data to support model calibration
- Most stations in Upper Floridan Aquifer
- Few stations in APPZ or deeper zones of FAS, except at deep injection well sites

SWFMD FAS Monitoring Efforts



Water Levels in LEC FAS Relatively Stable

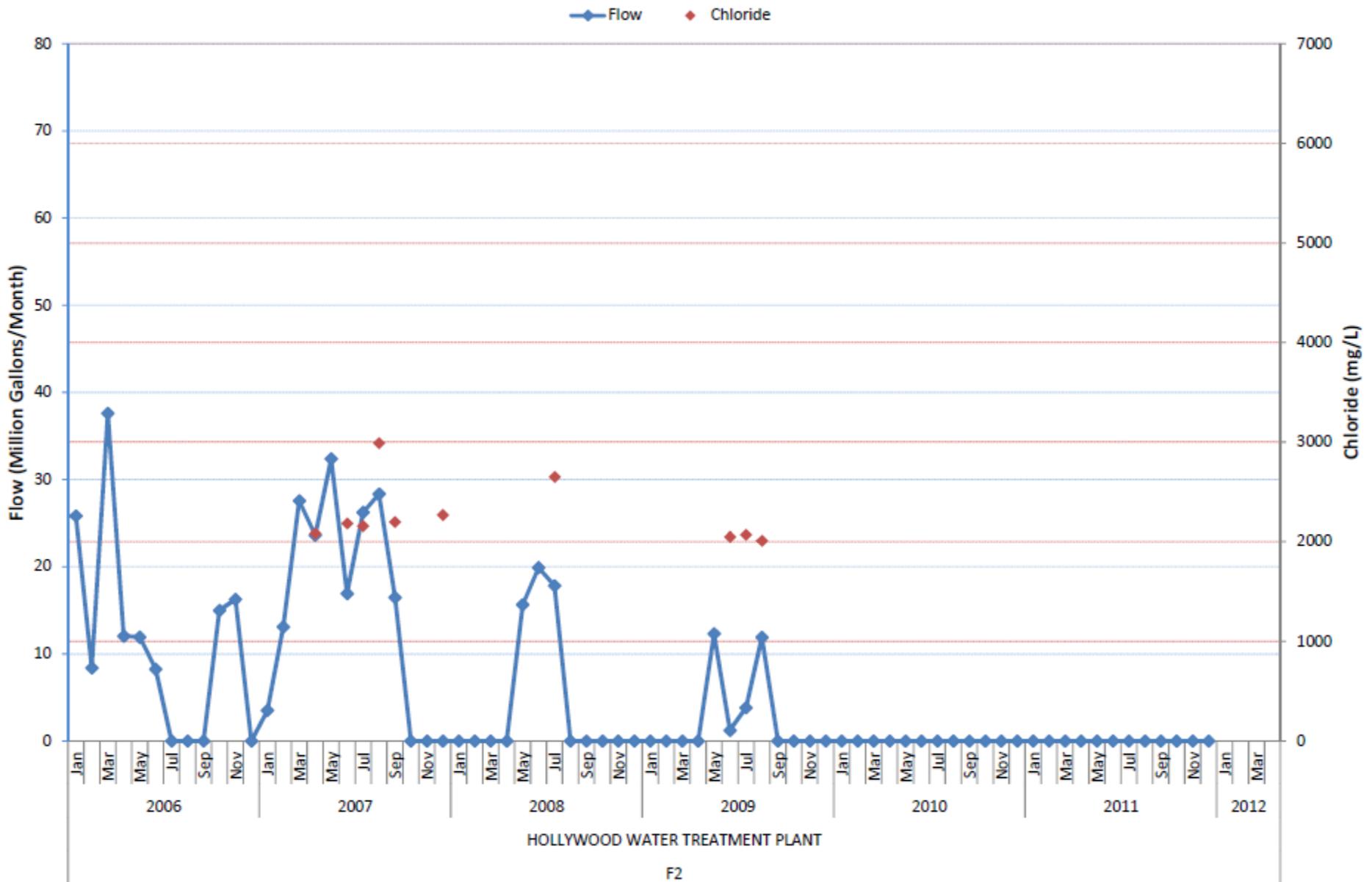


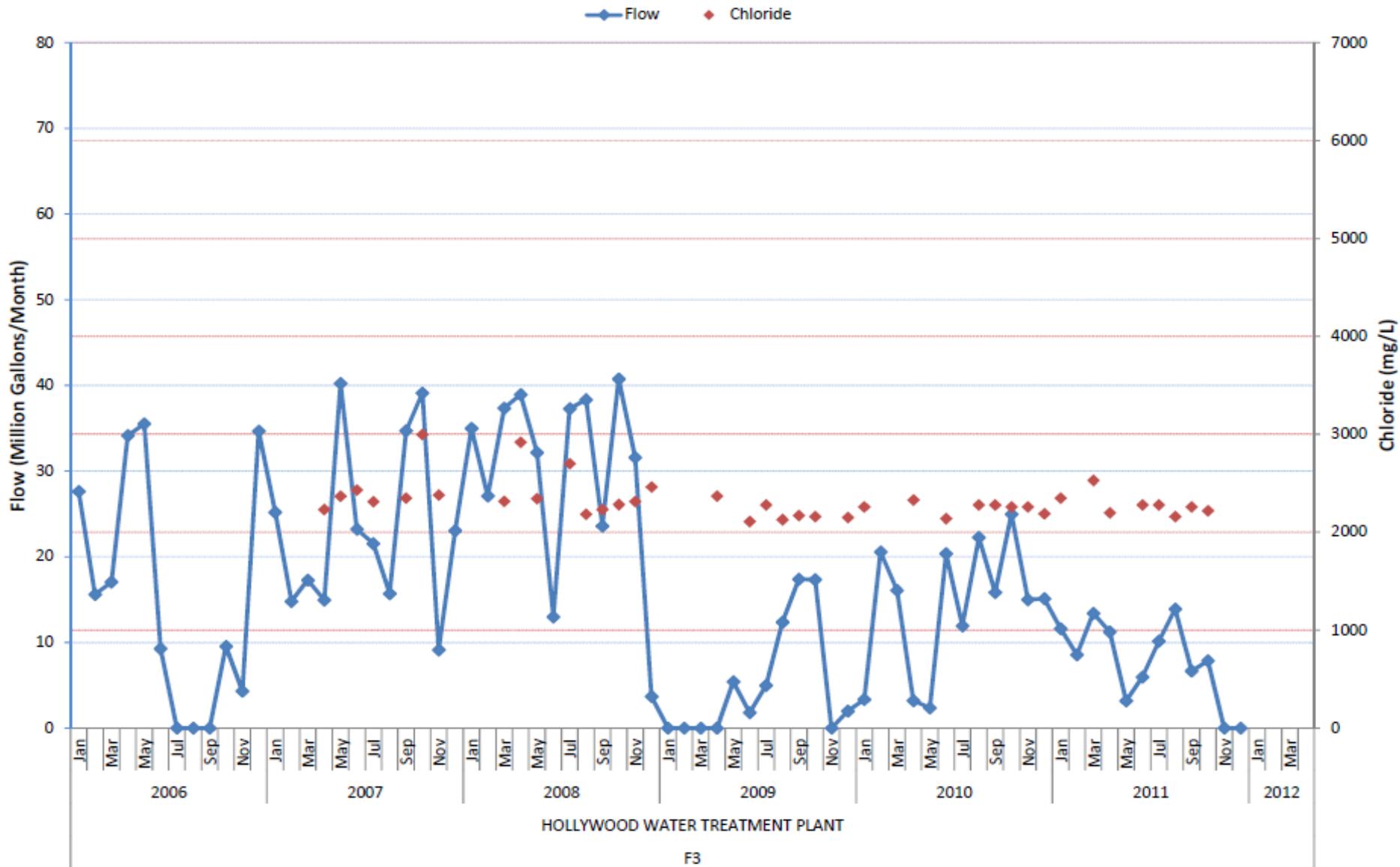
Permitted FAS Users

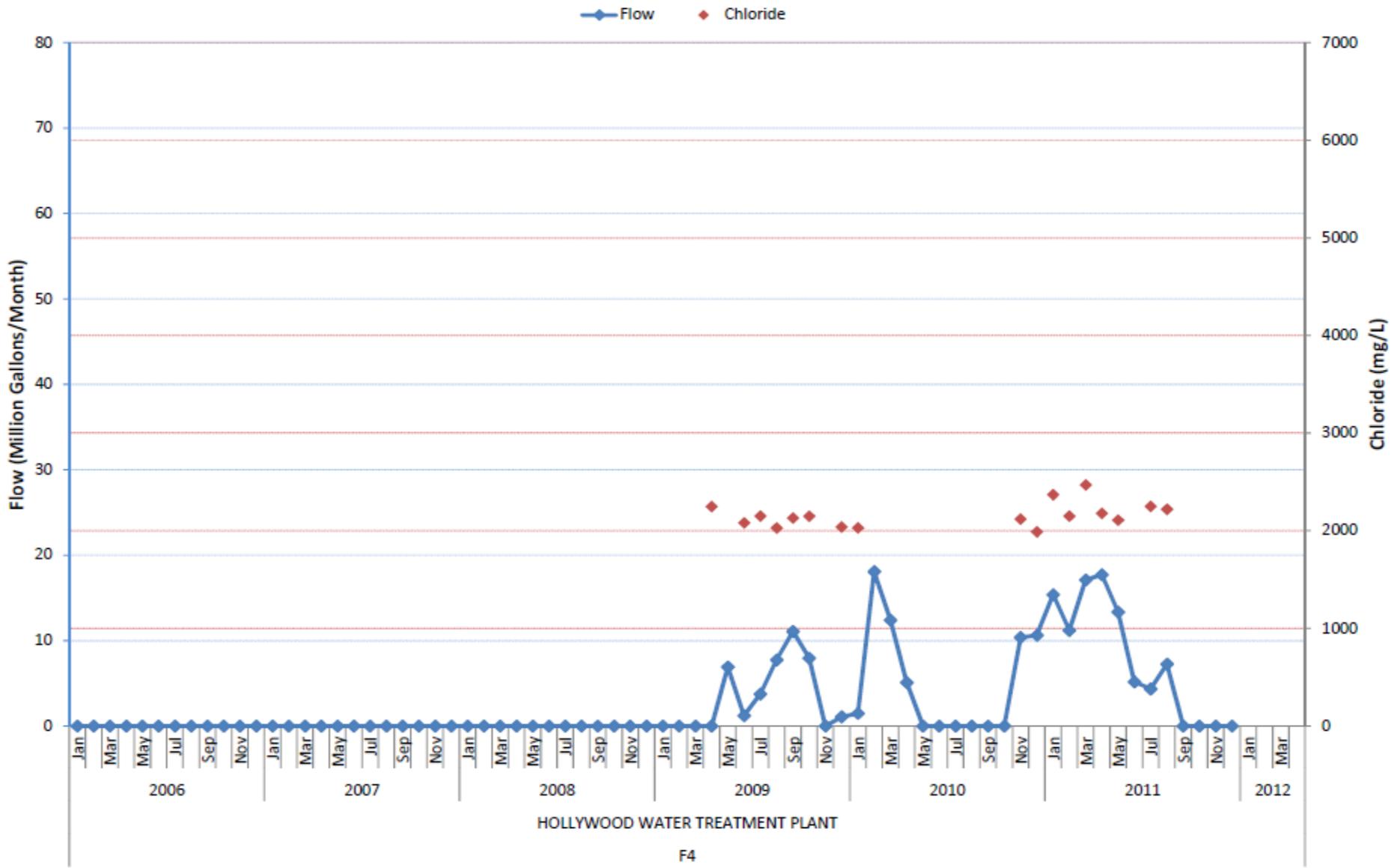
- Graphs of Chlorides (mg/L) and Flow (MGM) vs. time (2006 to present)

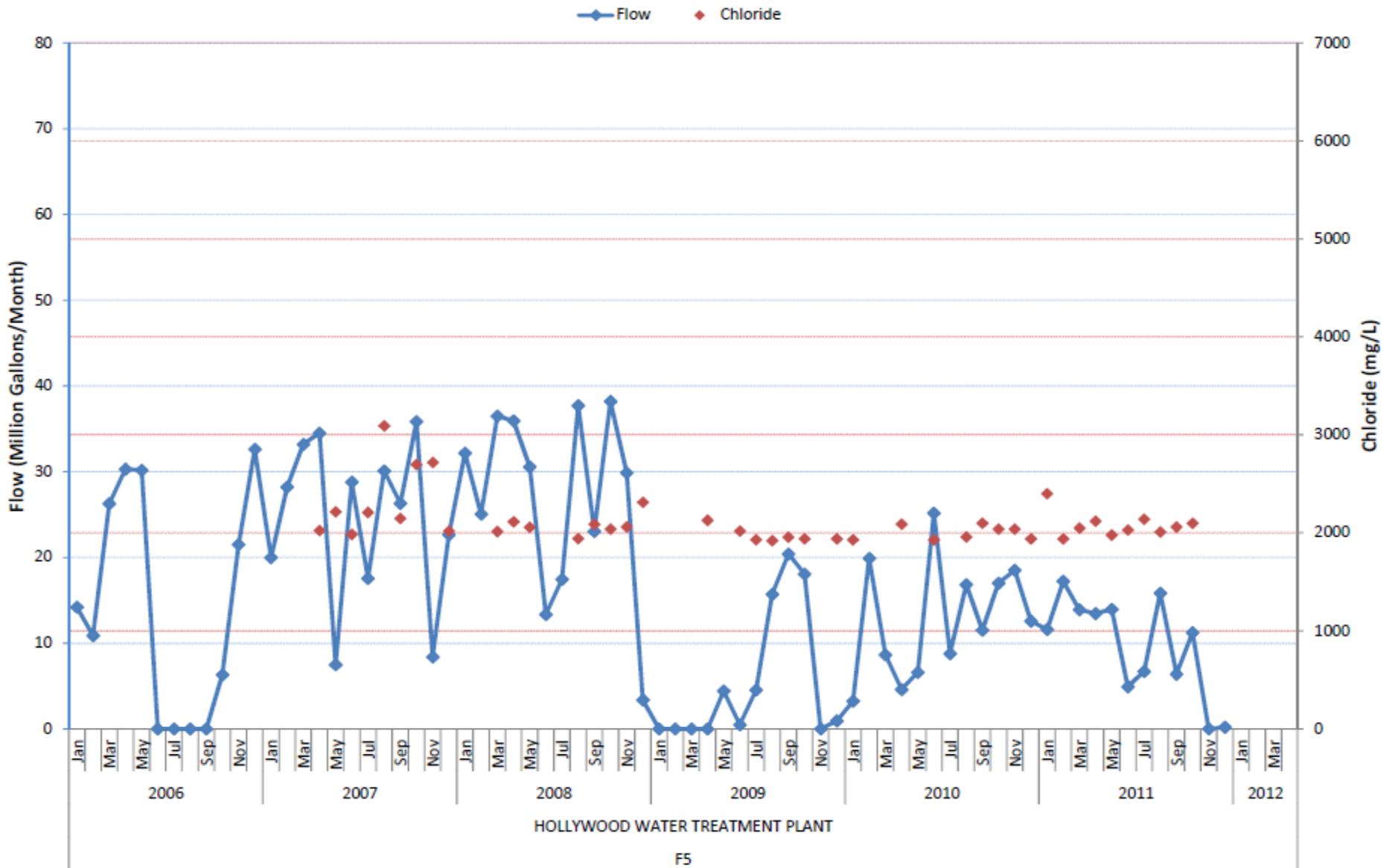
- Hollywood
- Jupiter
- Tequesta
- Sunrise
- Lake Worth
- Highland Beach

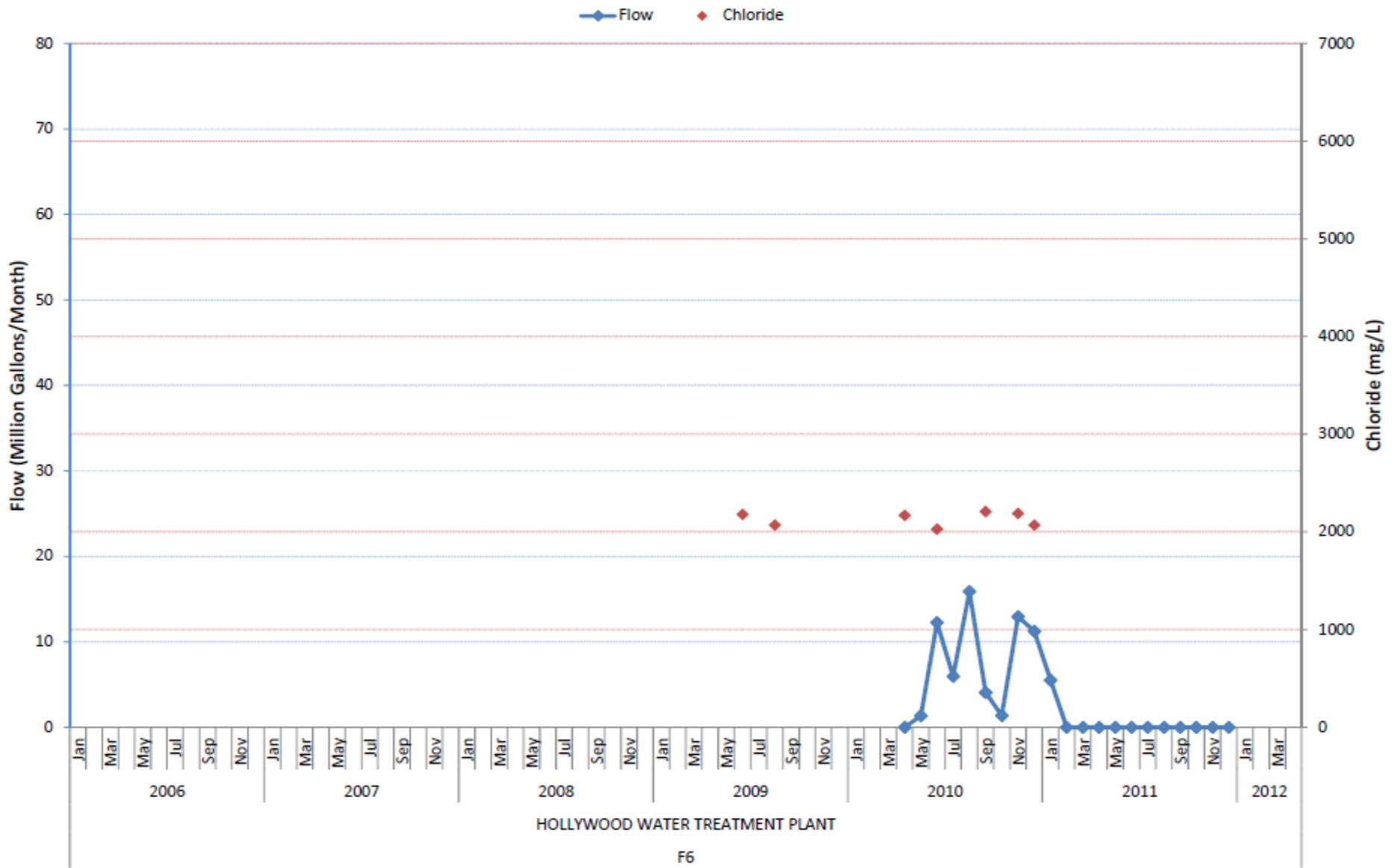


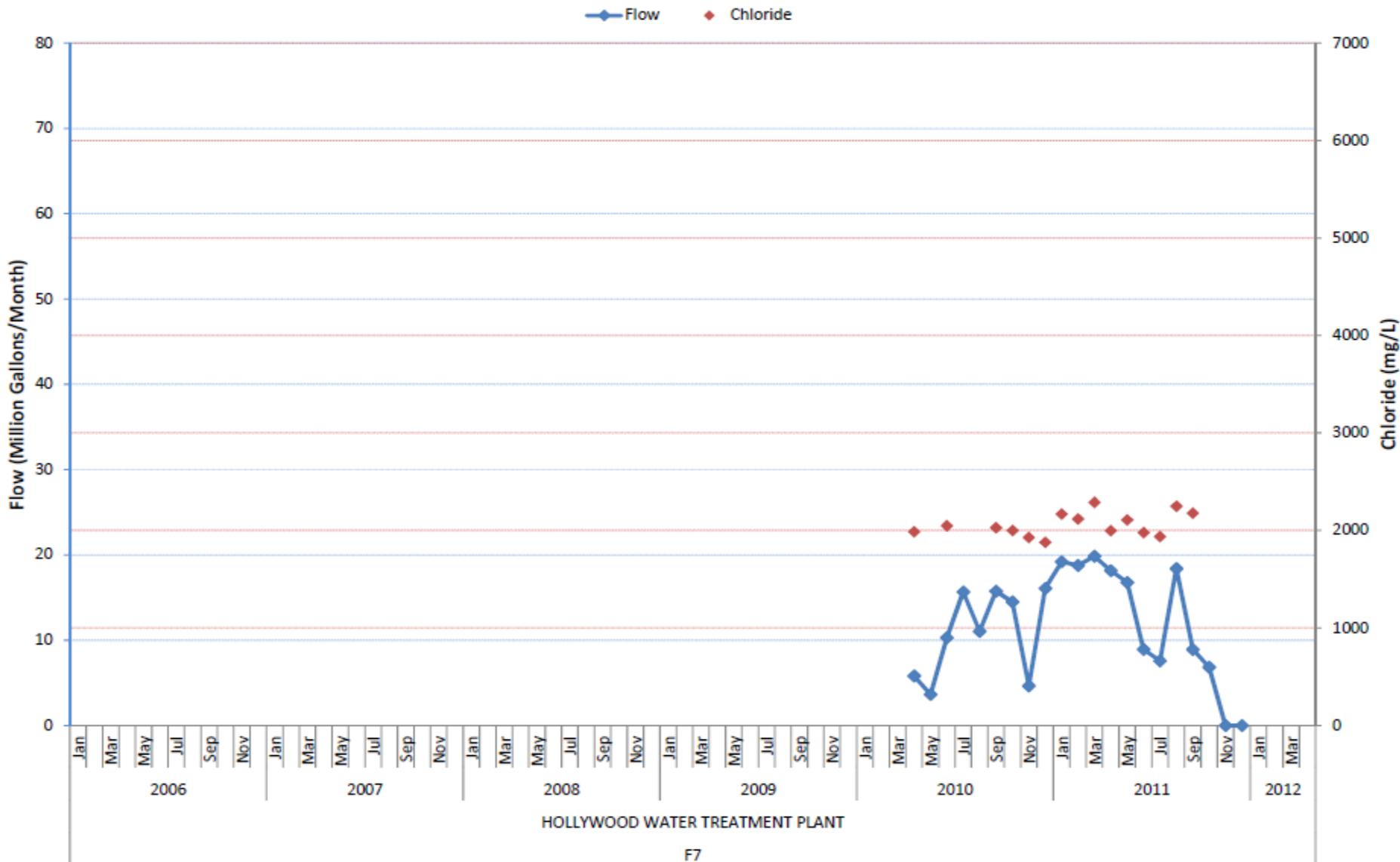




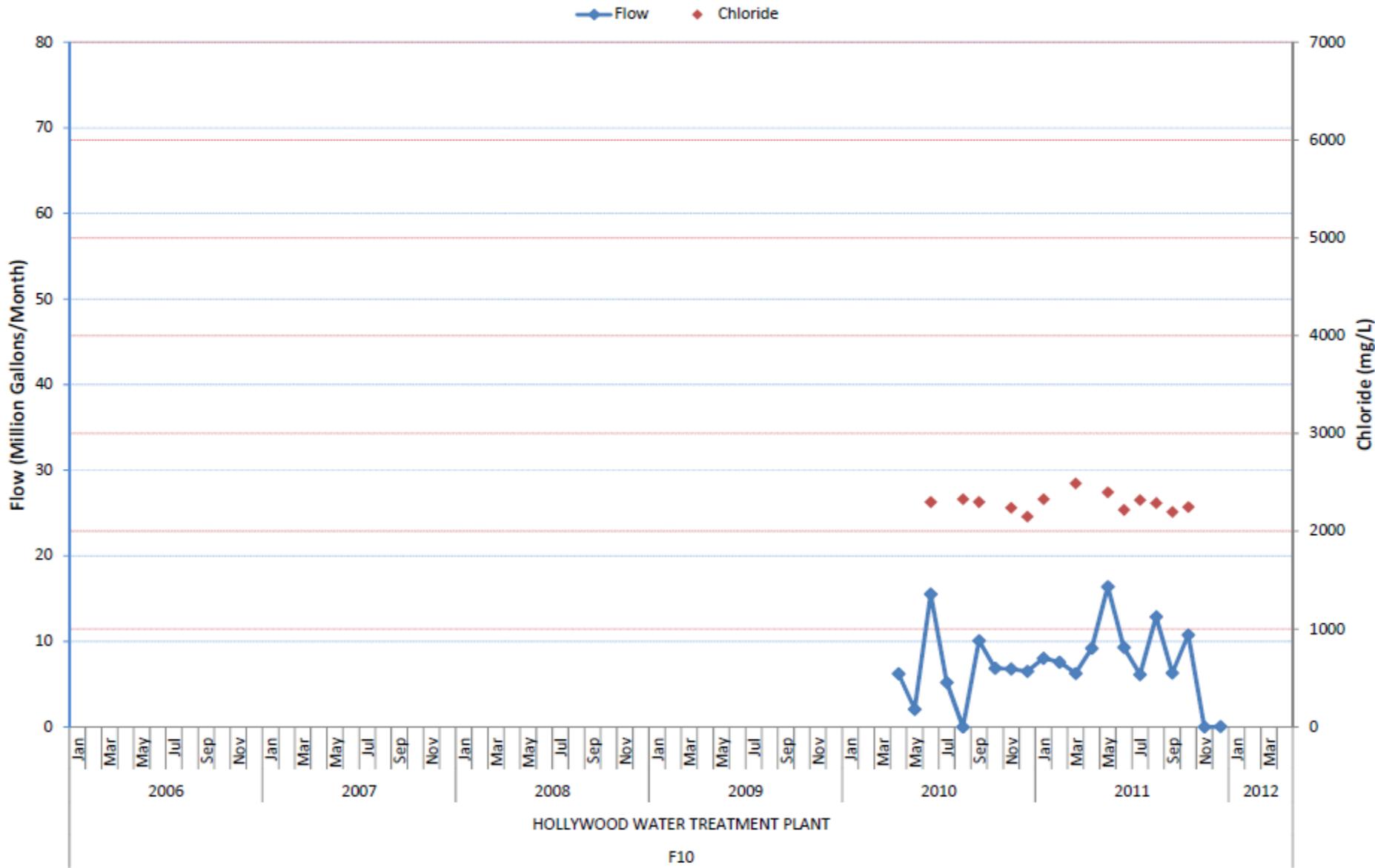


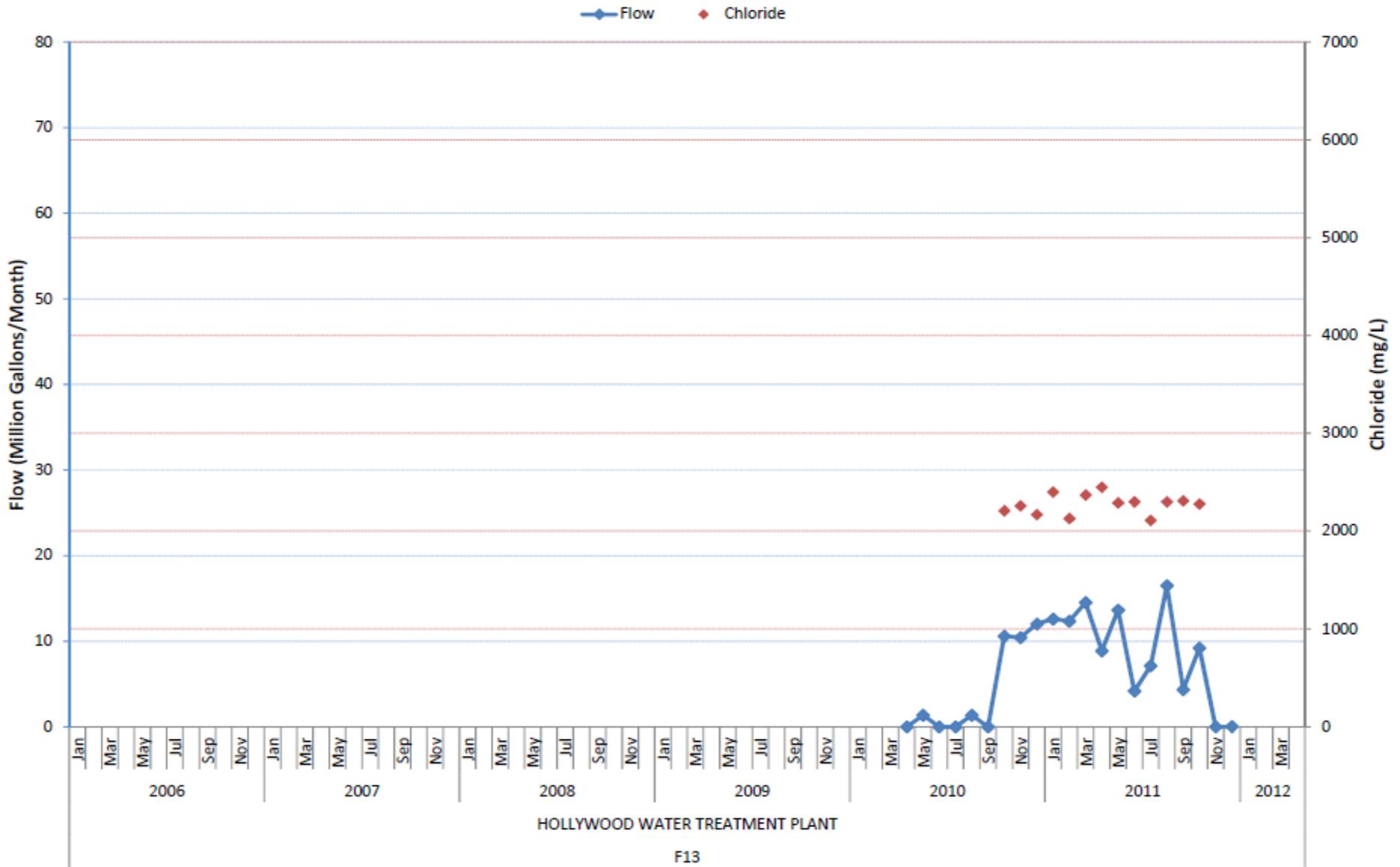


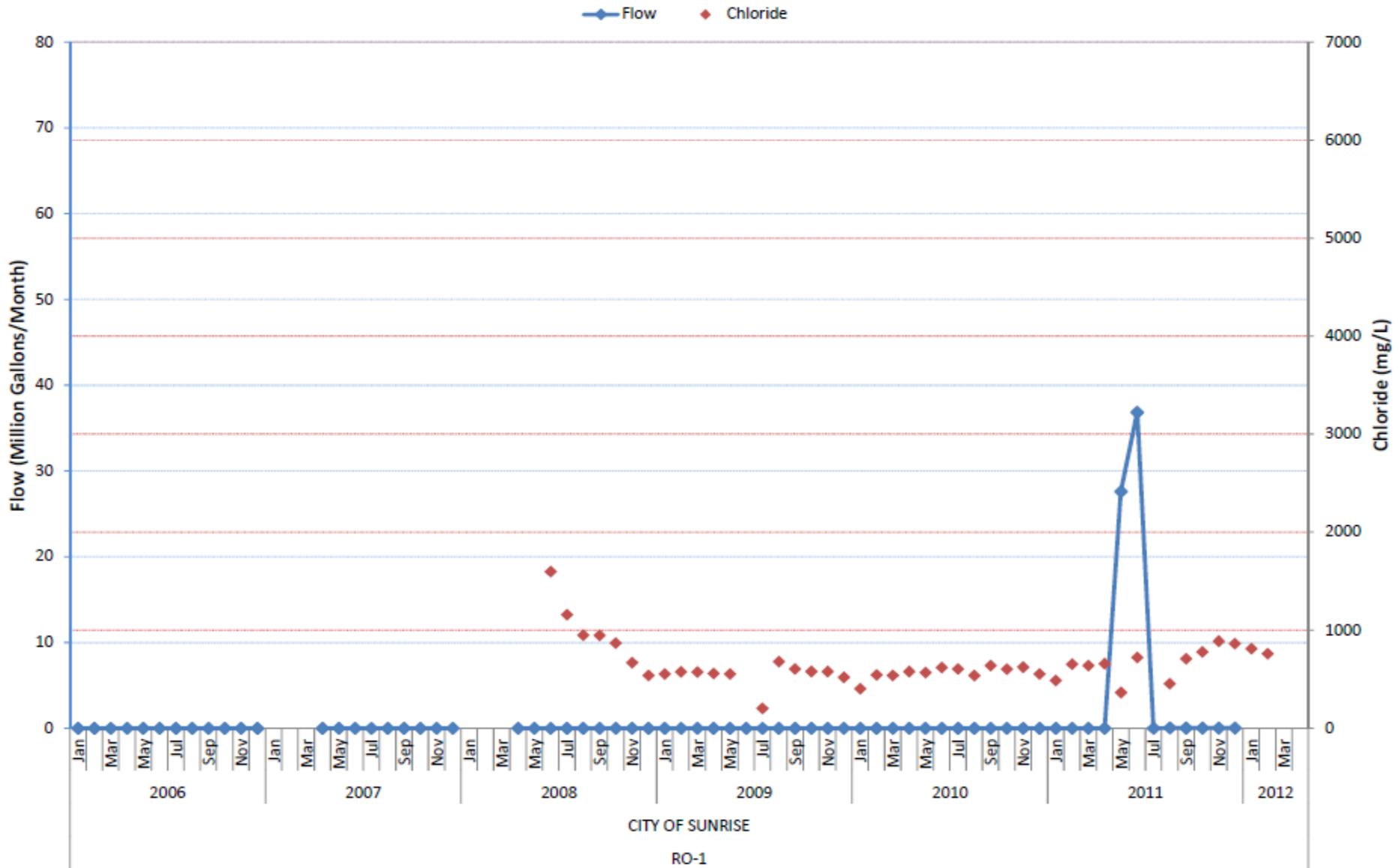


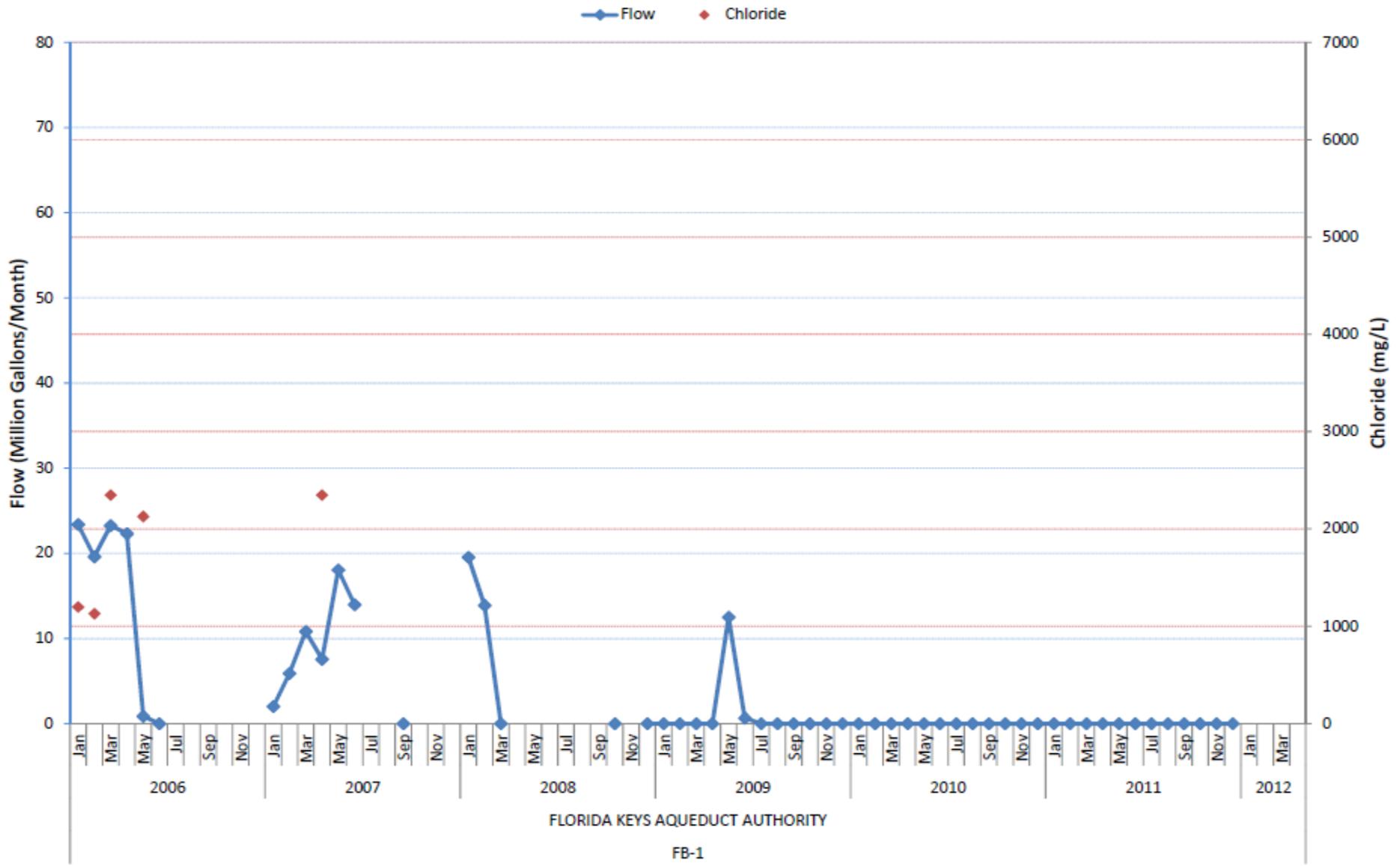


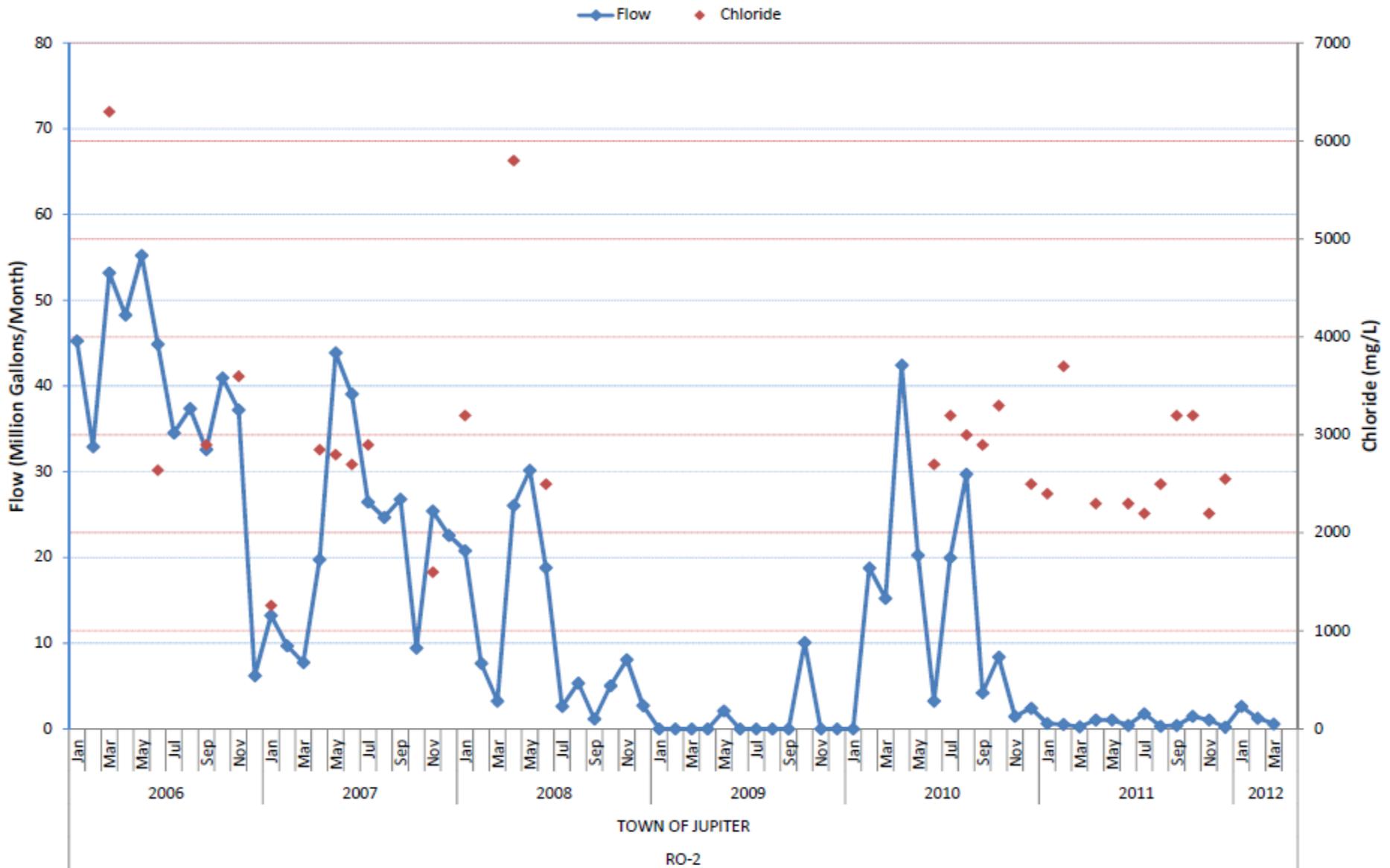
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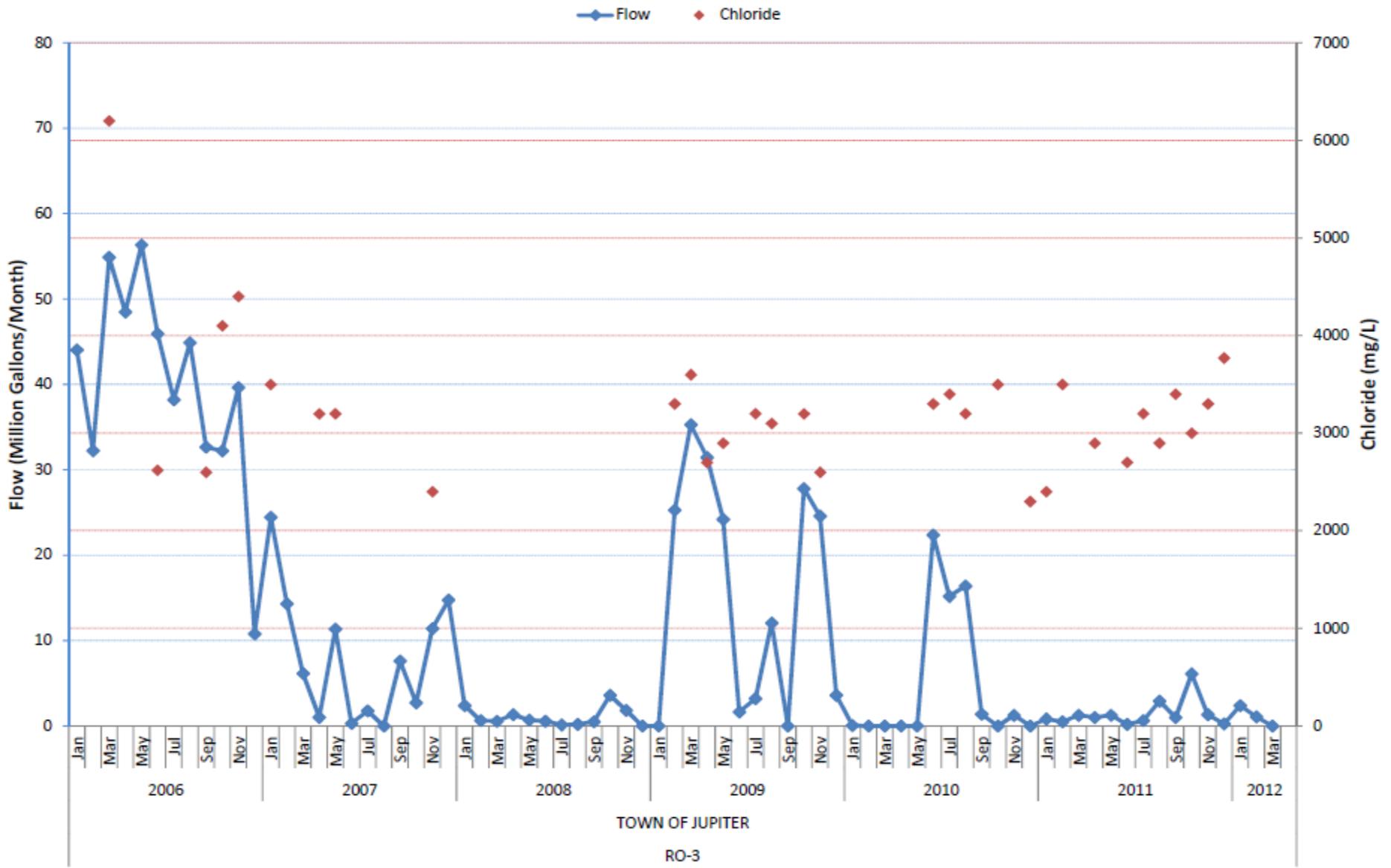


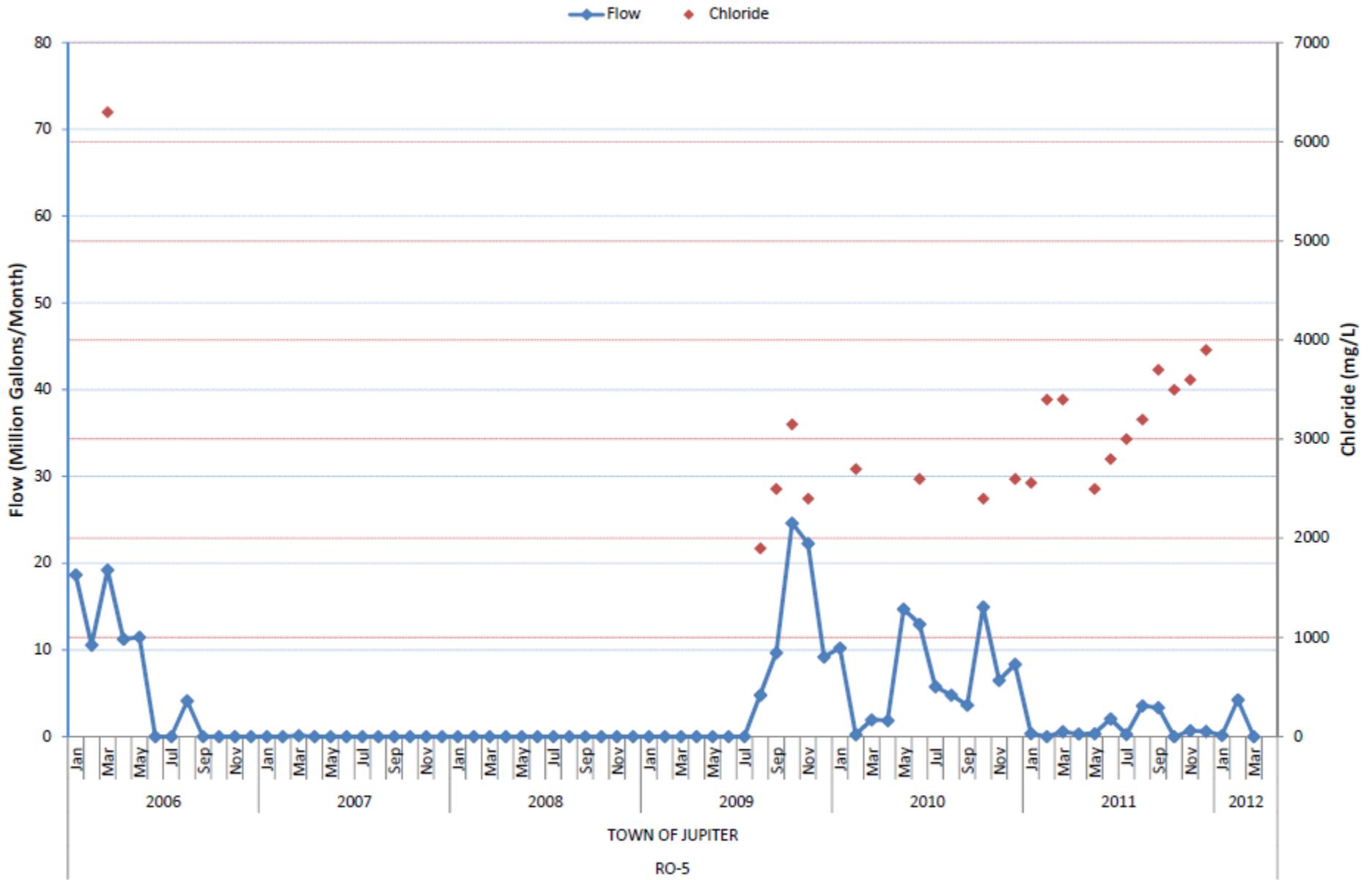


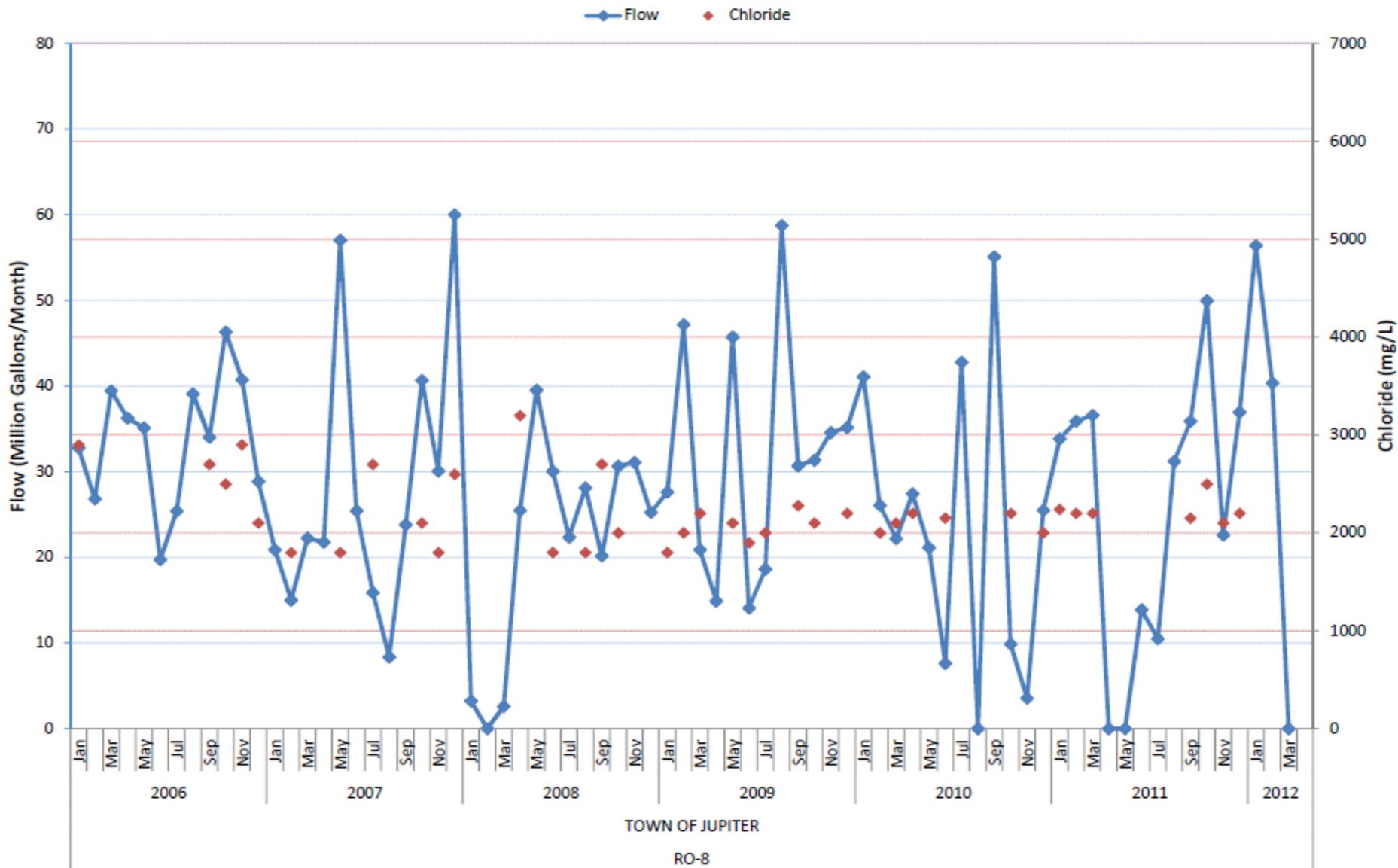


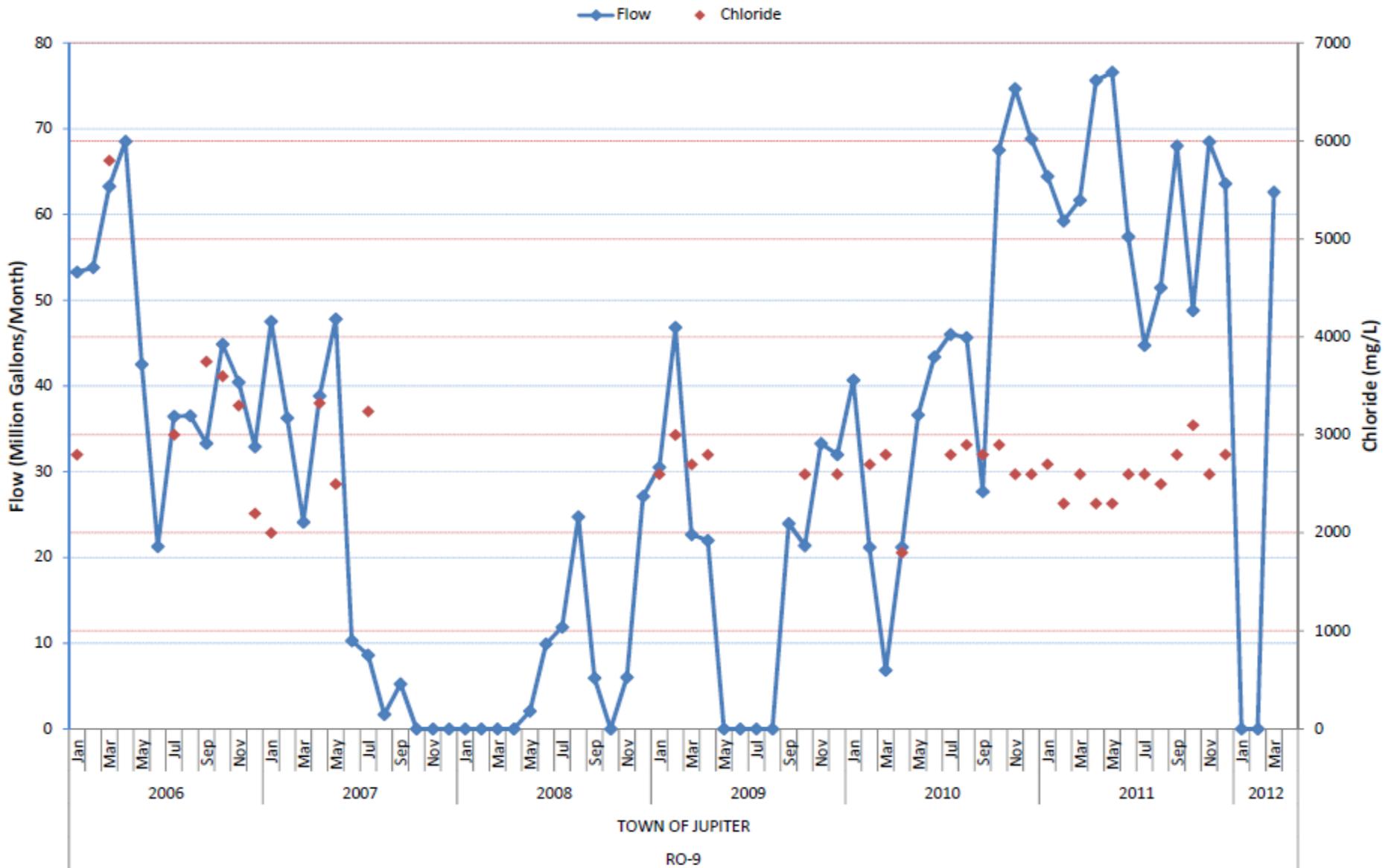


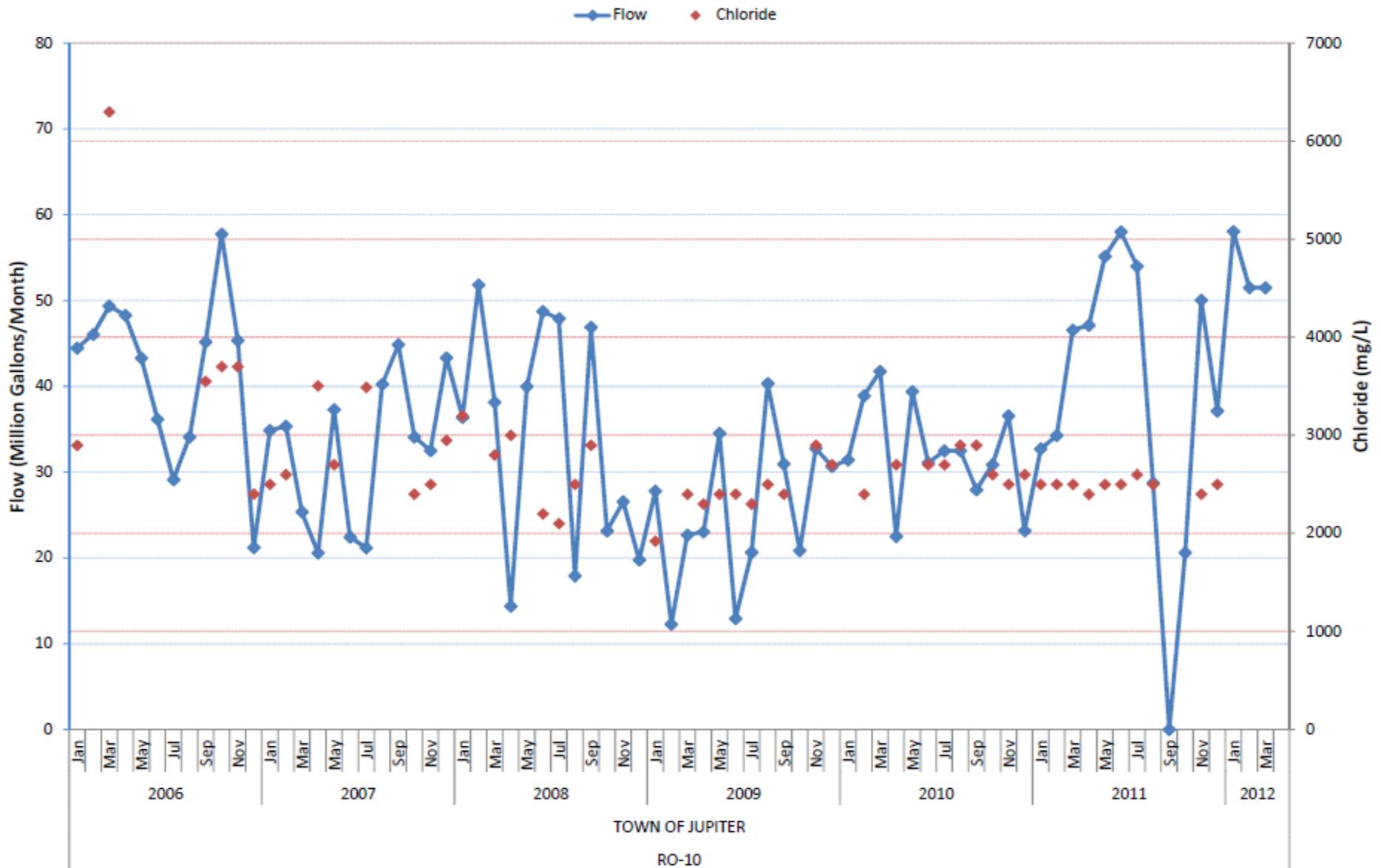


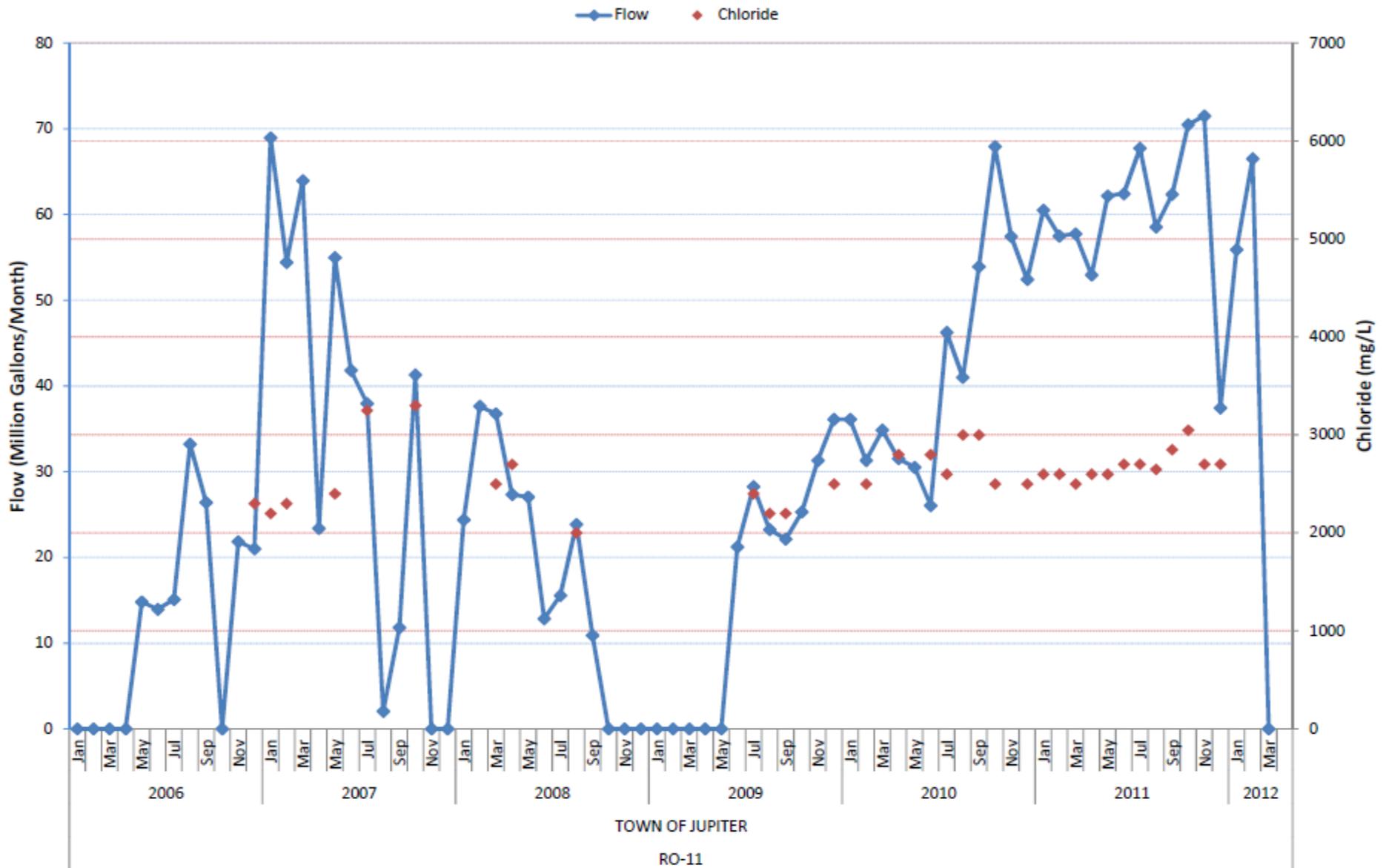




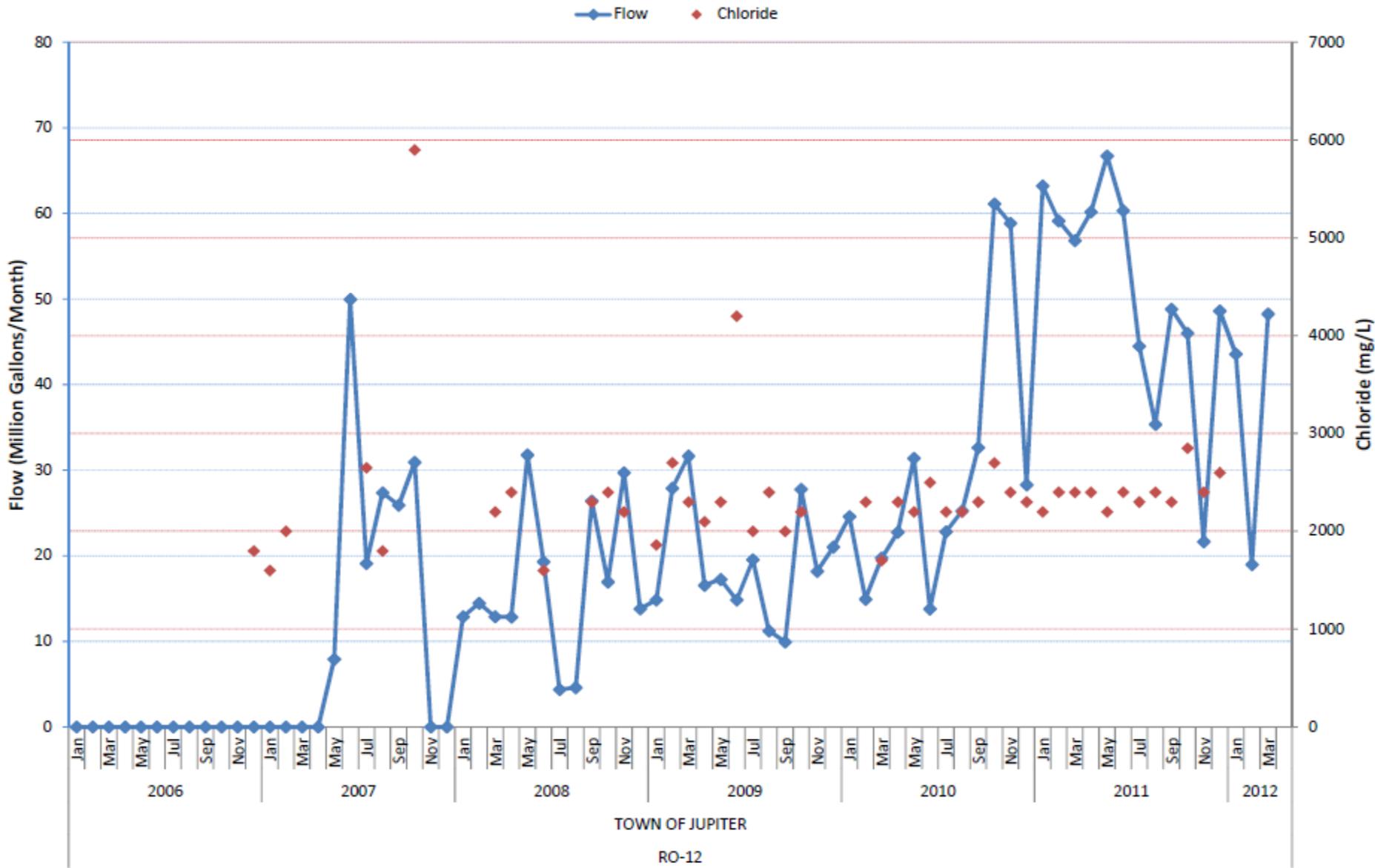


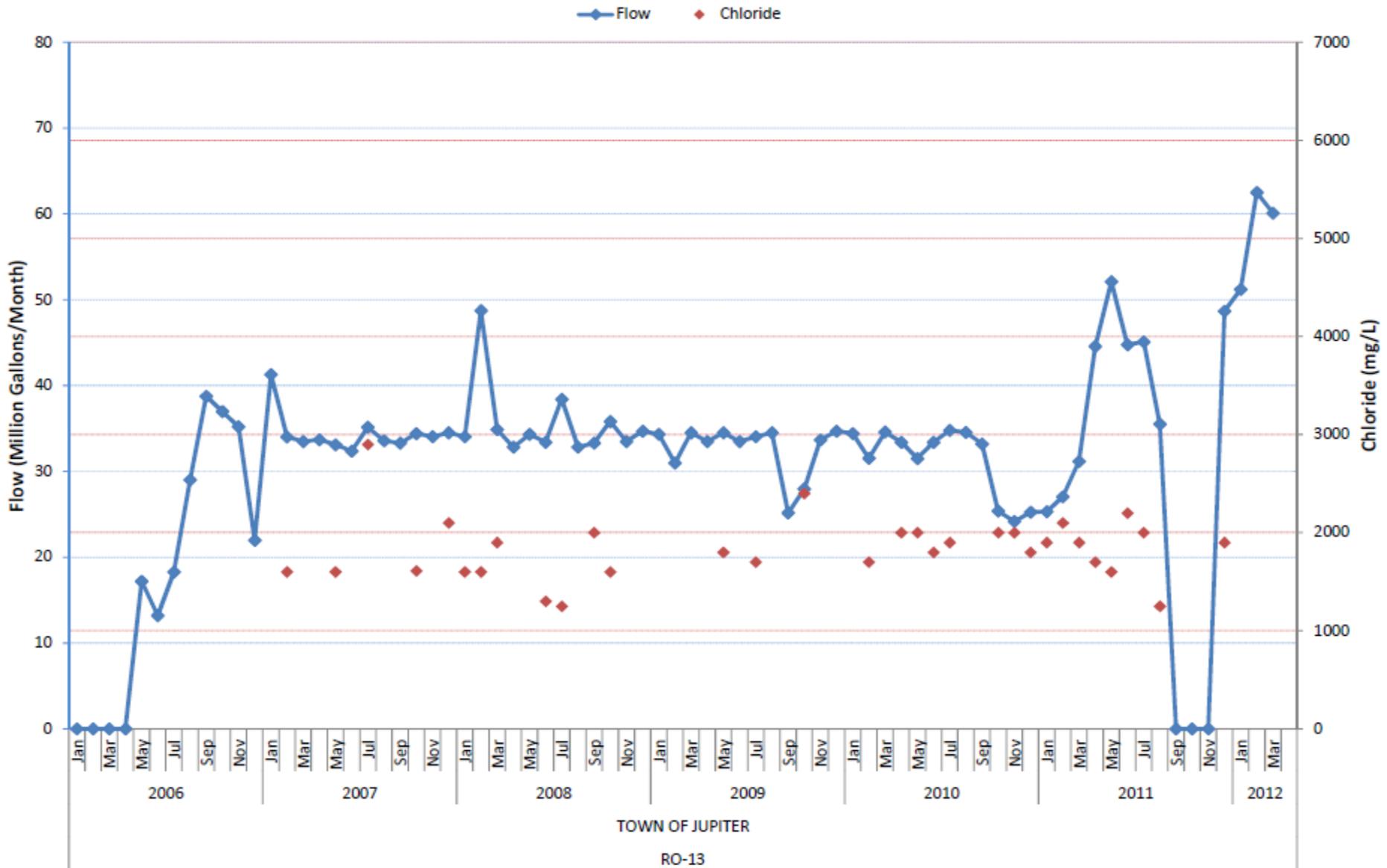






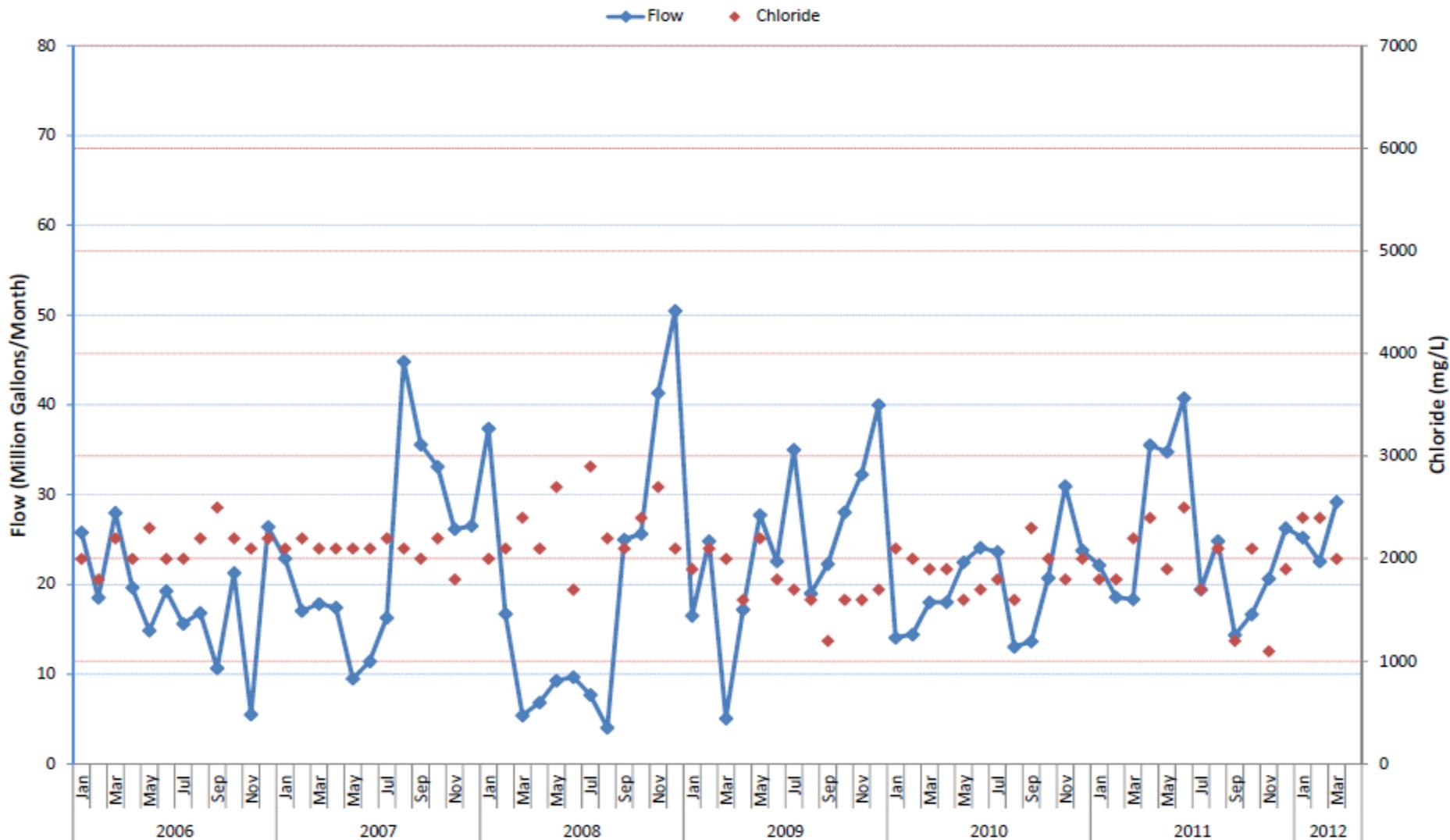
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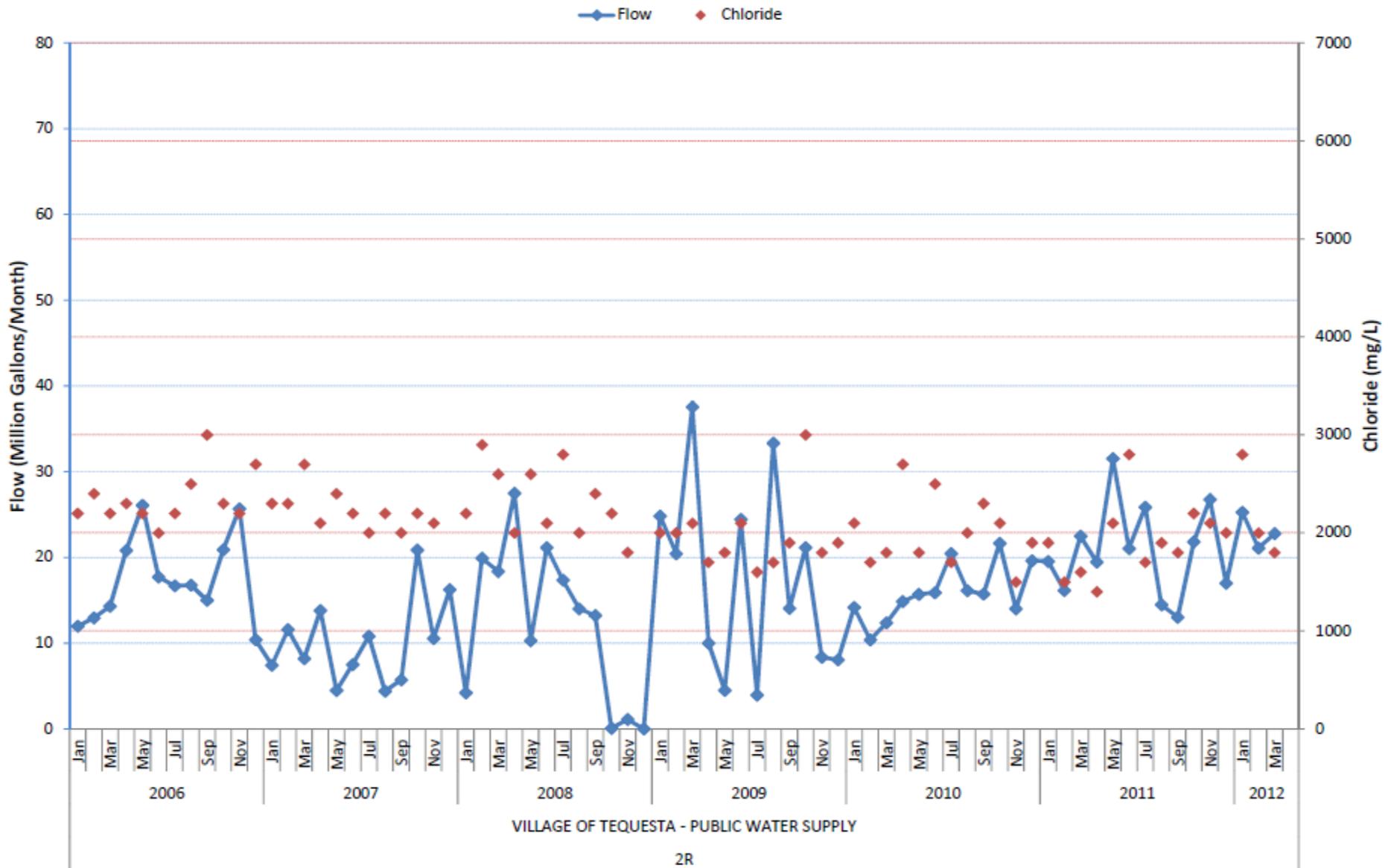
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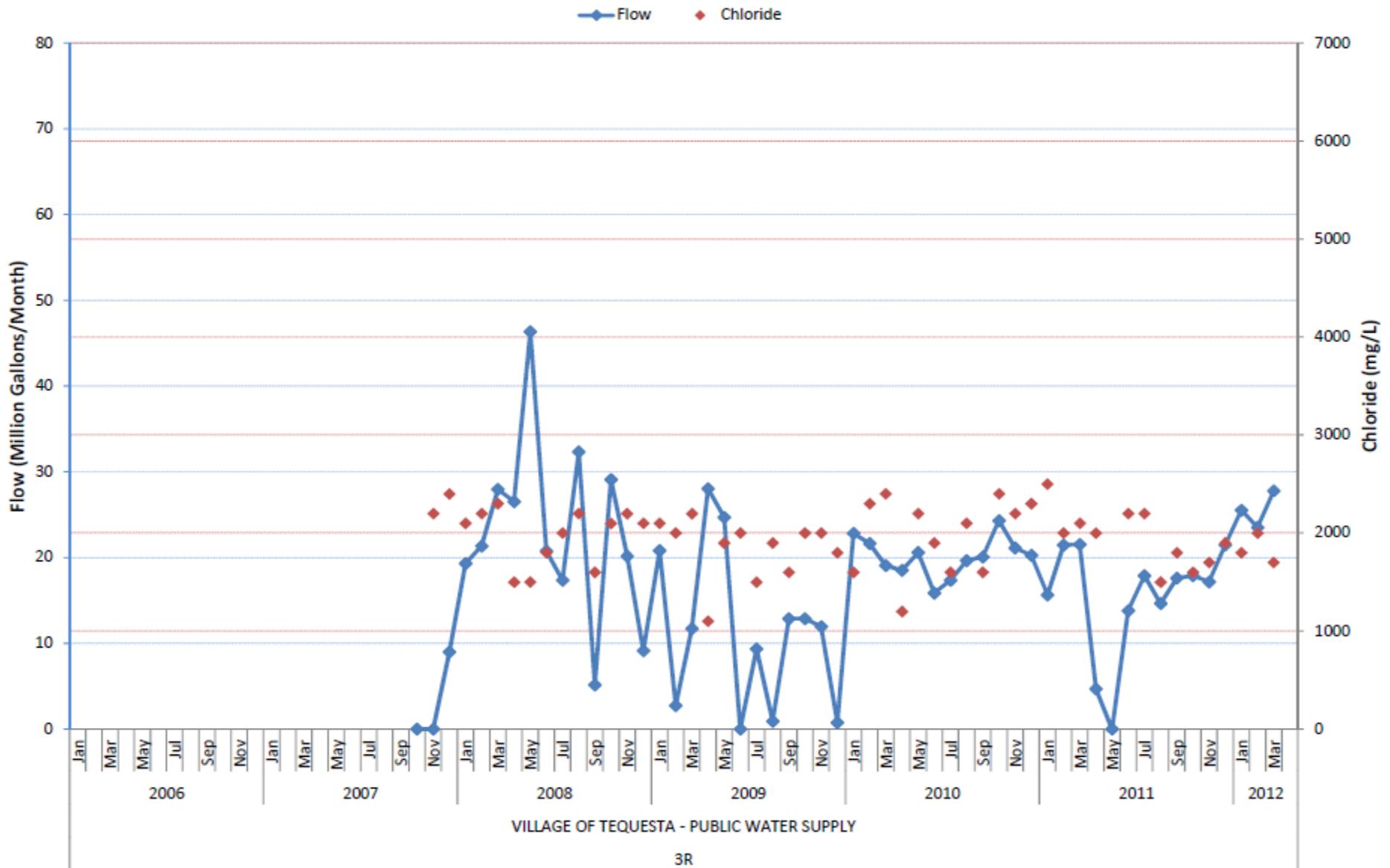
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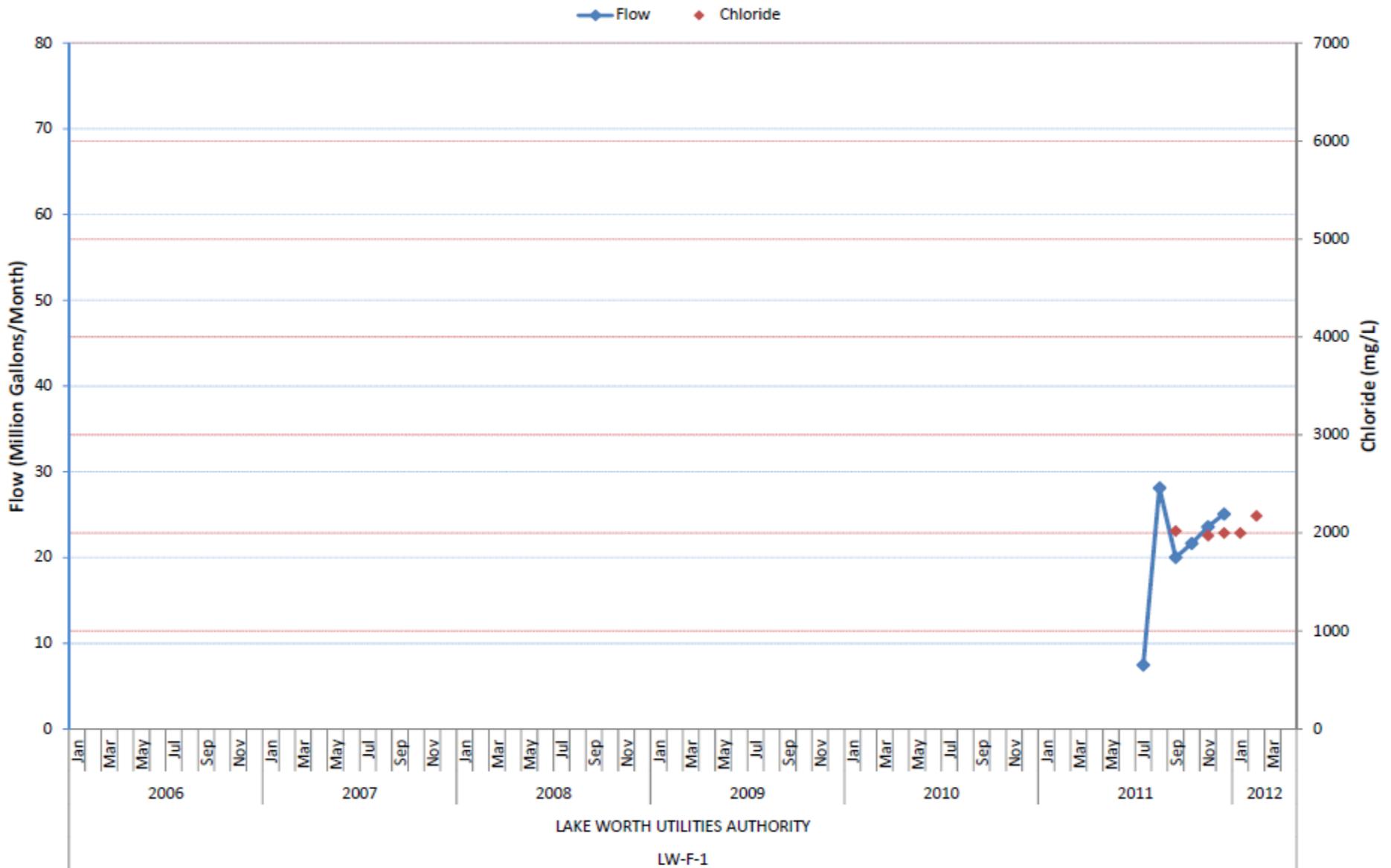


VILLAGE OF TEQUESTA - PUBLIC WATER SUPPLY

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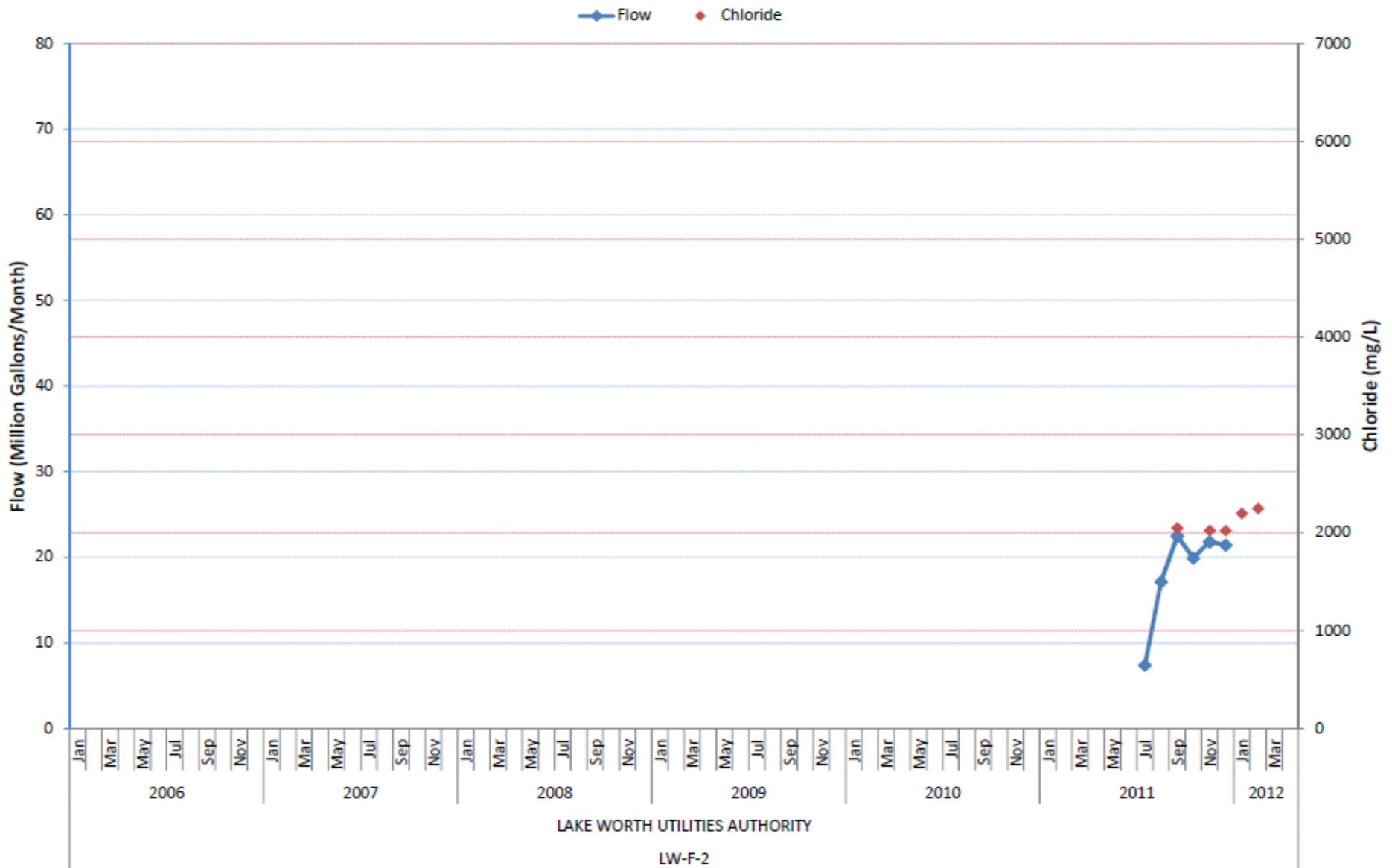






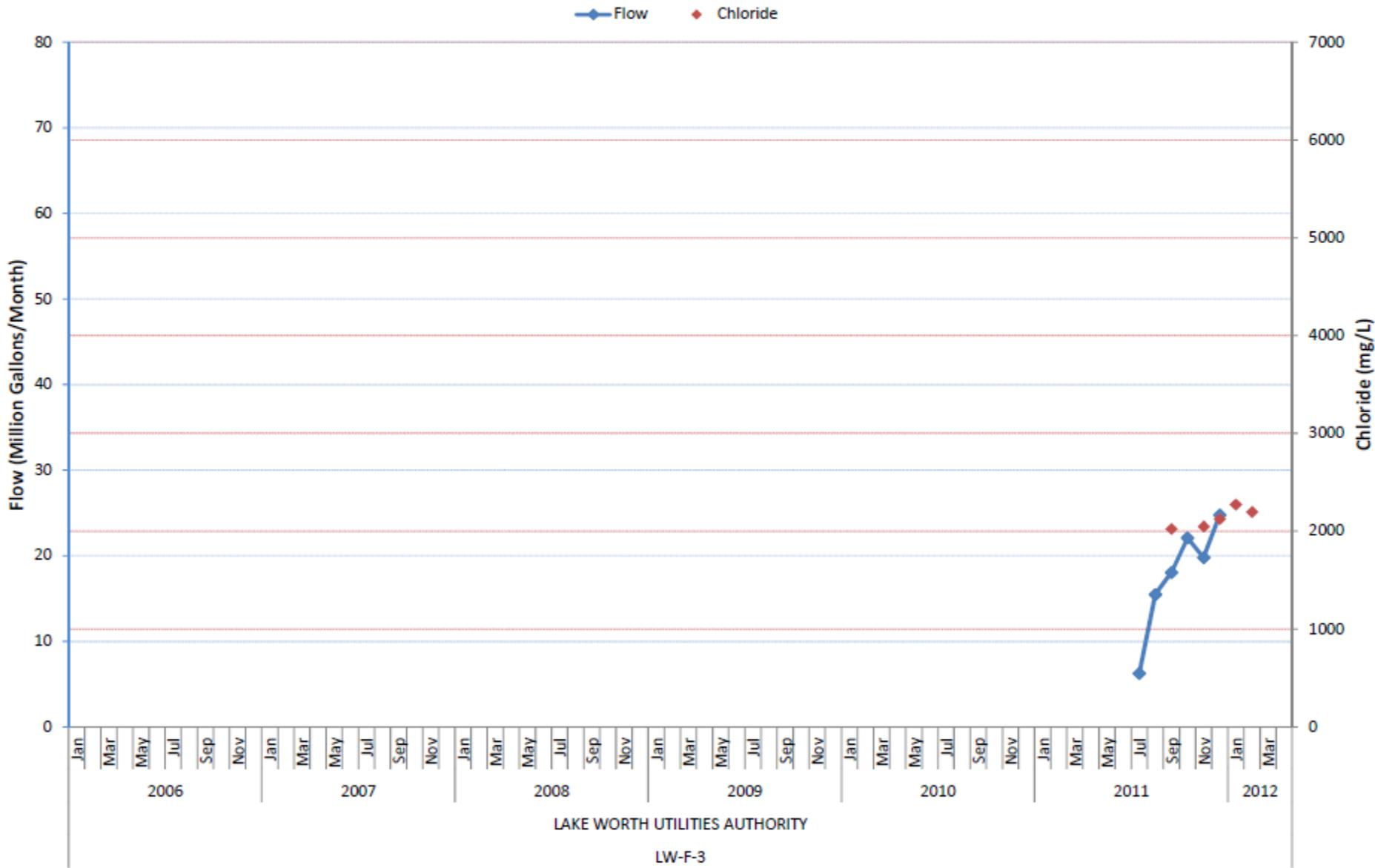
LAKE WORTH UTILITIES AUTHORITY

LW-F-1



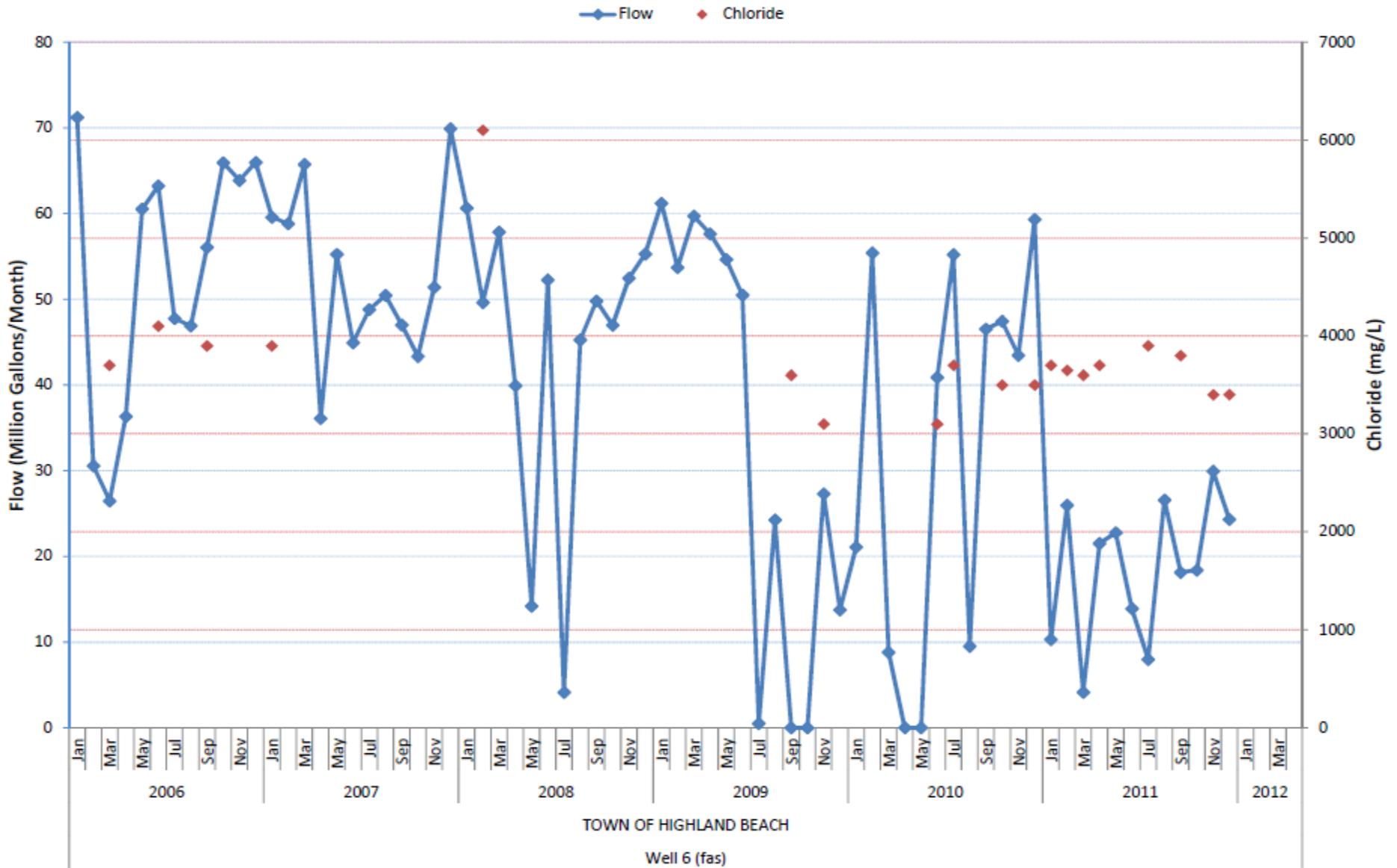
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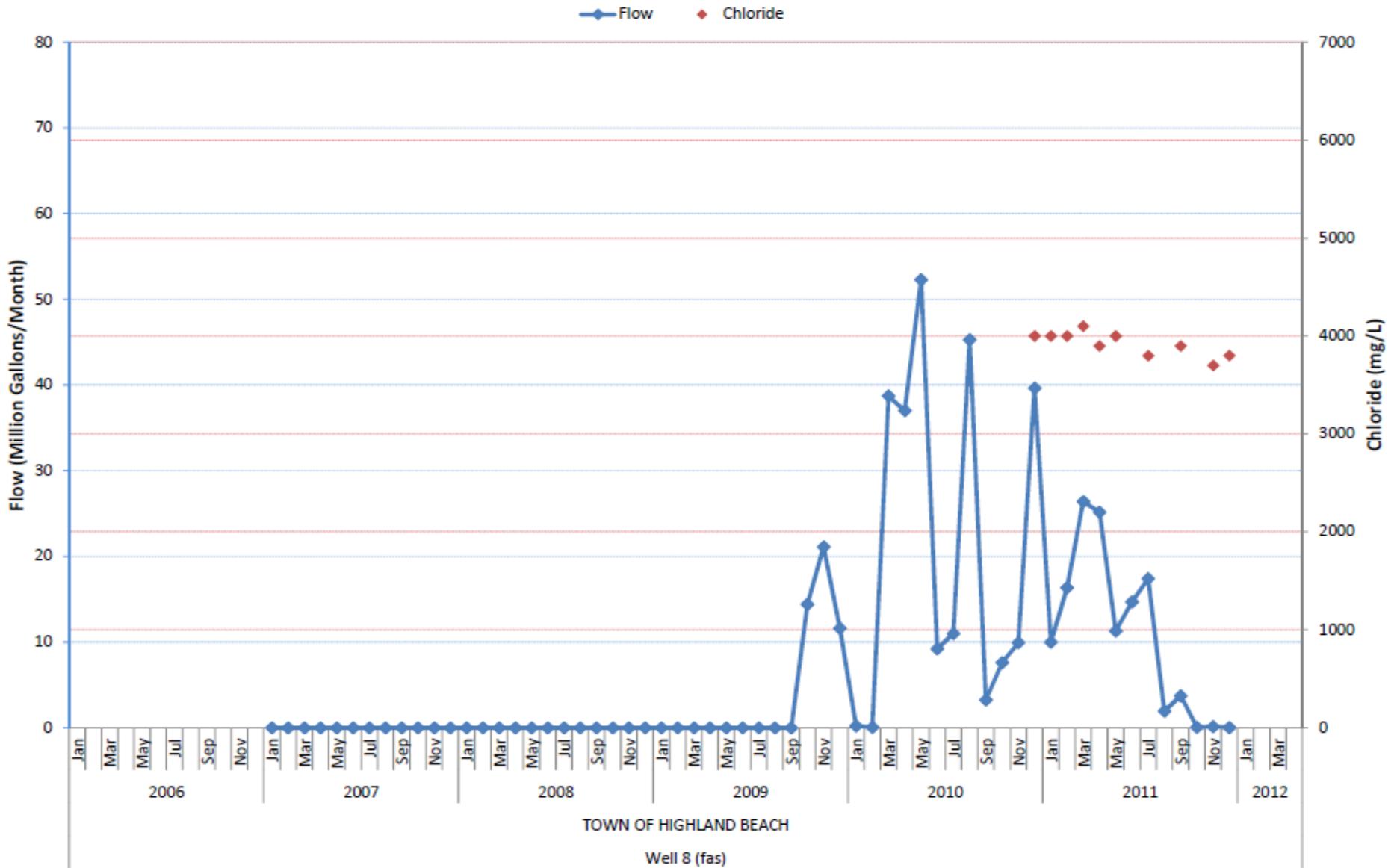
LW-F-2



LAKE WORTH UTILITIES AUTHORITY

LW-F-3





East Coast Floridan Model

- Proposed Tool to Conduct Regional Evaluations of Floridan Aquifer Usage
- Phase 1 (Hydrogeologic, 2006) – Density-Dependent, LEC Only
- Phase 2 (Golder & Associates, 2008) – Added UEC
- Independent Peer Review (June 2011)
- Current Status – Incorporating Peer Review Comments Including New Data (2008 to 2011)
- Current Schedule
 - Complete Model -- Mid 2013

Conclusions

- **Floridan Aquifer is a Viable Alternative Water Supply Source in the LEC**
- **Greater Uncertainty**
 - Aquifer Productivity
 - Changes in water quality over time
 - Careful planning, testing, and conservative well spacing required
- **Costs will be higher than traditional sources**



Questions?

