

# Tropical Storm Isaac

*Readiness, Response, Recovery*

## Water Conditions Summary and After Action Assessment September 13, 2012

Tommy B. Strowd, P.E., Director  
Operations, Maintenance & Construction Division

# Tropical Storm Isaac

- Overview of regional drainage system
- Overview of District responsibilities
- Tropical Storm Isaac
  - Pre Storm Operations
  - Onslaught
  - Post Storm Operations
  - Operational Summary

# Tropical Storm Isaac

*Readiness, Response, Recovery*

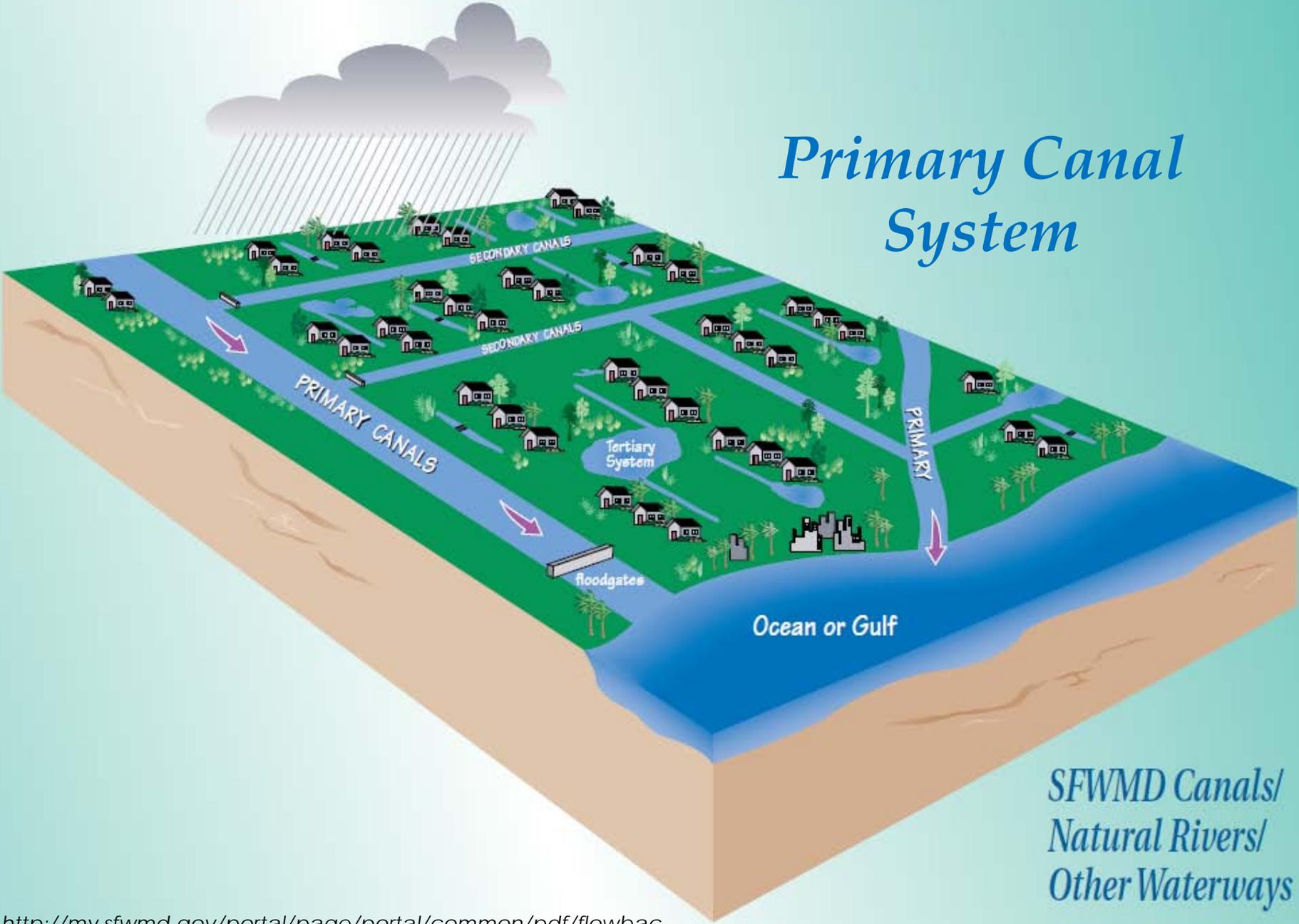
## DRAINAGE SYSTEM OVERVIEW

# Three-Tiered Drainage System

- Primary
  - USACE
  - SFWMD
- Secondary
  - Local Governments
  - Special Districts
- Tertiary
  - Home Owners Associations
  - Private Land Owners

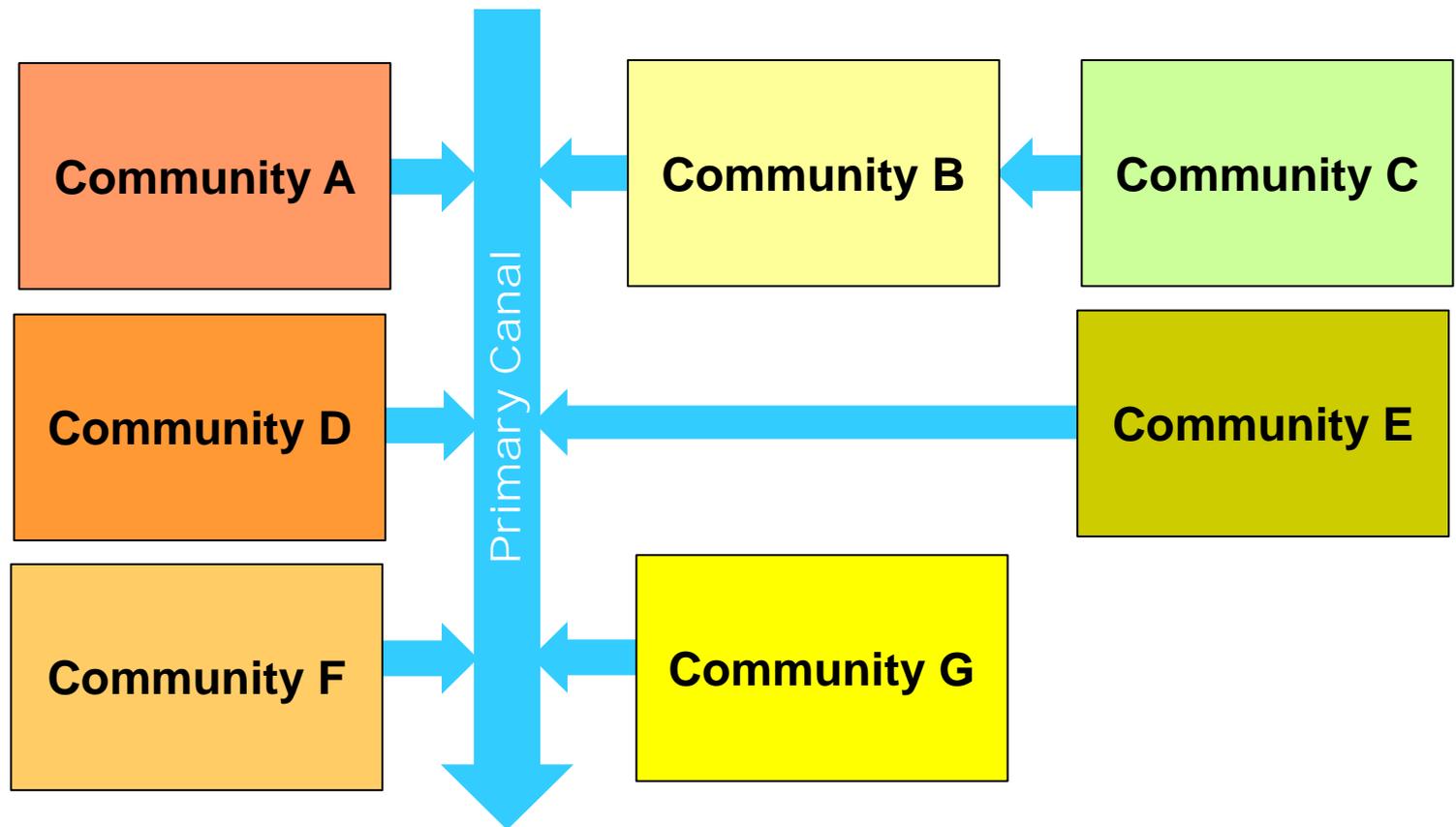


# Primary Canal System



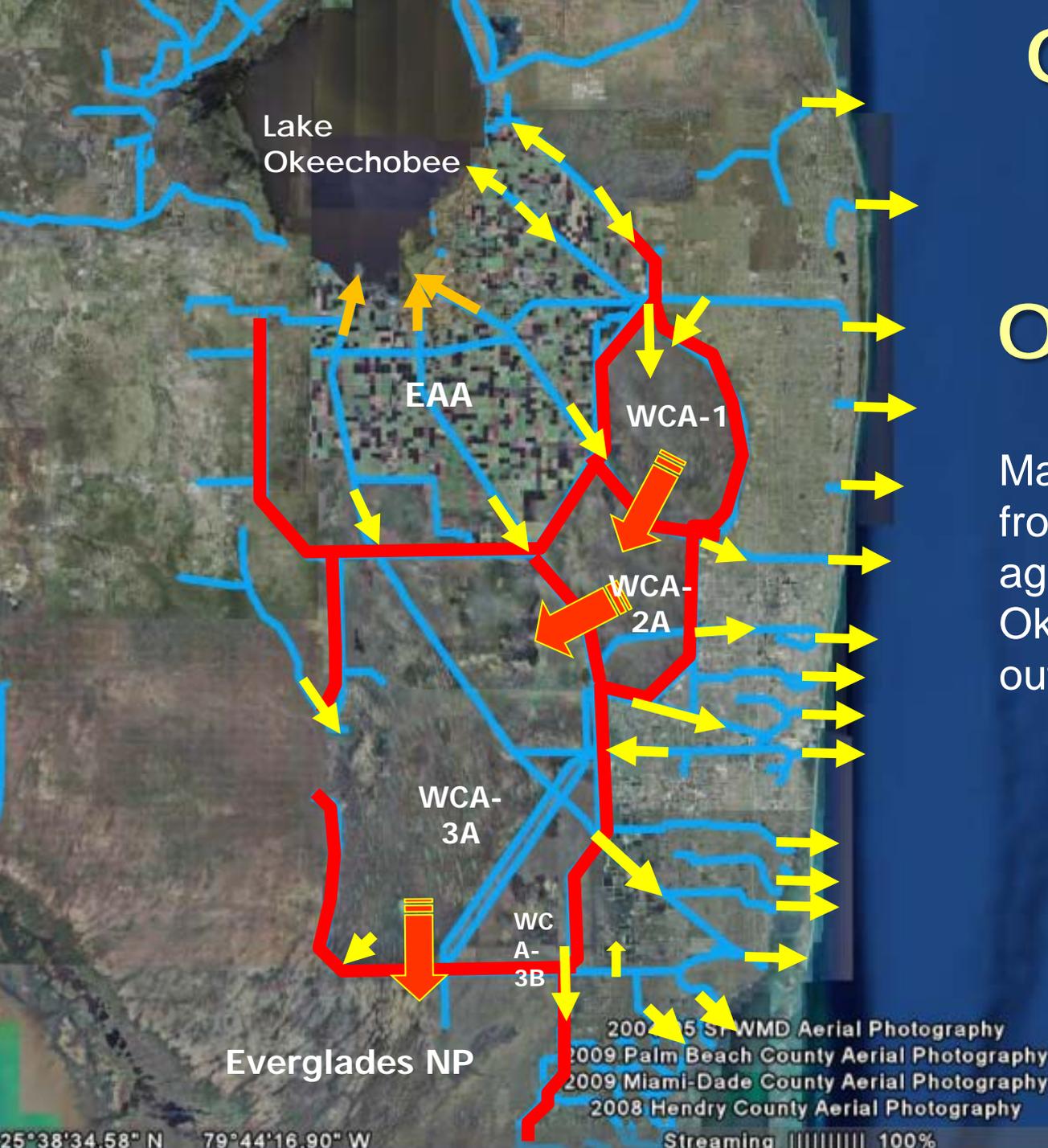
SFWMD Canals/  
Natural Rivers/  
Other Waterways

# Coordination with Secondary Systems



# Overview of Flood Control Operations

Maximizing water away from residential, urban and agricultural areas to Lake Okeechobee, WCAs and out to tide.



# Tropical Storm Isaac

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## DISTRICT RESPONSIBILITIES

# Tropical System Operations

- Constant monitoring of meteorological conditions that could impact the District
  - Coordination with National Hurricane Center
    - Extensive use of NHC products in real-time
  - The District does NOT make hurricane forecasts
    - Utilize NHC products to develop Pre and Post Storm Operational Plans
  - The District prepares forecasts of 'Quantitative Precipitation' on a drainage basin level
    - Accurate to 2 – 4 days in advance

# Tropical System Operations

- Pre-Storm Operations
  - Based on weather forecasts, the District prepares the system to accept and convey rainfall runoff from anticipated storms
  - Facility field inspections
  - Equipment and personnel pre-deployment
  - Lowering of regional canal levels
  - Local government / USACE coordination
  - Emergency Operations Center activation
  - ‘Lock-Down’ key staff in operational positions

# Tropical System Operations

- Storm Onslaught
  - Continually monitor and operate the flood control system
  - Coordinate operations with local governments
  - Monitor changes in storm position and intensity
  - Adjust quantitative precipitation estimates

# Tropical System Operations

- Post-Storm Operations
  - Estimate accumulated rainfall
  - Establish impact to the regional system
  - Deploy post-storm inspection teams
  - Coordinate operations with local governments
  - Implement recovery operations

# Tropical Storm Isaac

*Readiness, Response, Recovery*

## TROPICAL STORM ISAAC

# SFWMD

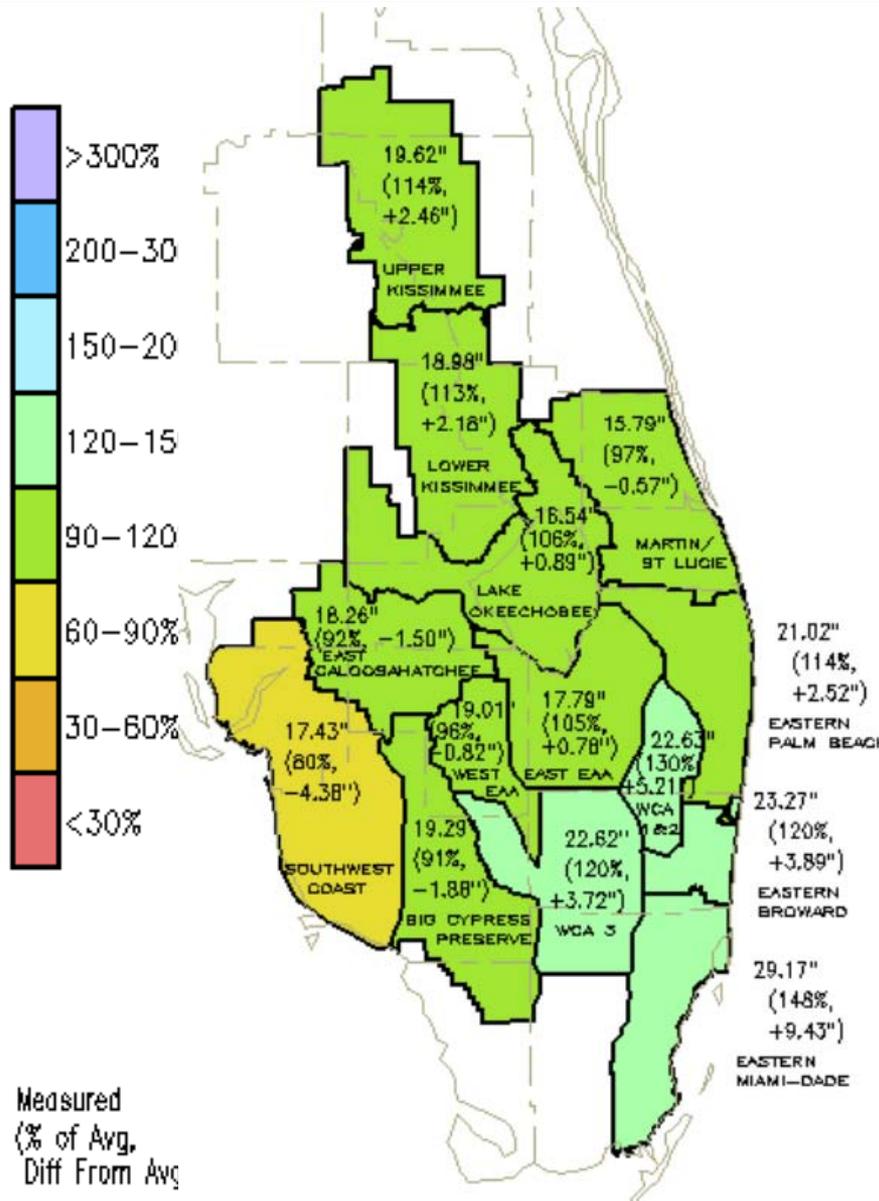
## Wet Season Rainfall

08 May – 01 Aug 2012

**DISTRICT-WIDE: 19.44"  
(106% of Avg, or +1.05")**

**Above normal rainfall :**

- **Miami-Dade + 9.4"**
- **WCA 1 & 2 + 5.2"**
- **WCA 3 / Broward + 3.8"**
- **E. Palm Bch Co. + 2.5**
- **Kissimmee + 2.2"**



## Pre-Storm Actions

- Flood control system was operating at normal levels through the wet season
- Meteorological forecast projected heavy rains associated with TS Isaac
- Initiated pre-storm draw-down of the Lower East Coast canal network and Everglades Agricultural Area well in advance of forecasted landfall
- Staffed all pumping stations on a 24-hr basis in preparation for the storm
- Pre-positioned District equipment and helicopters



N460WM



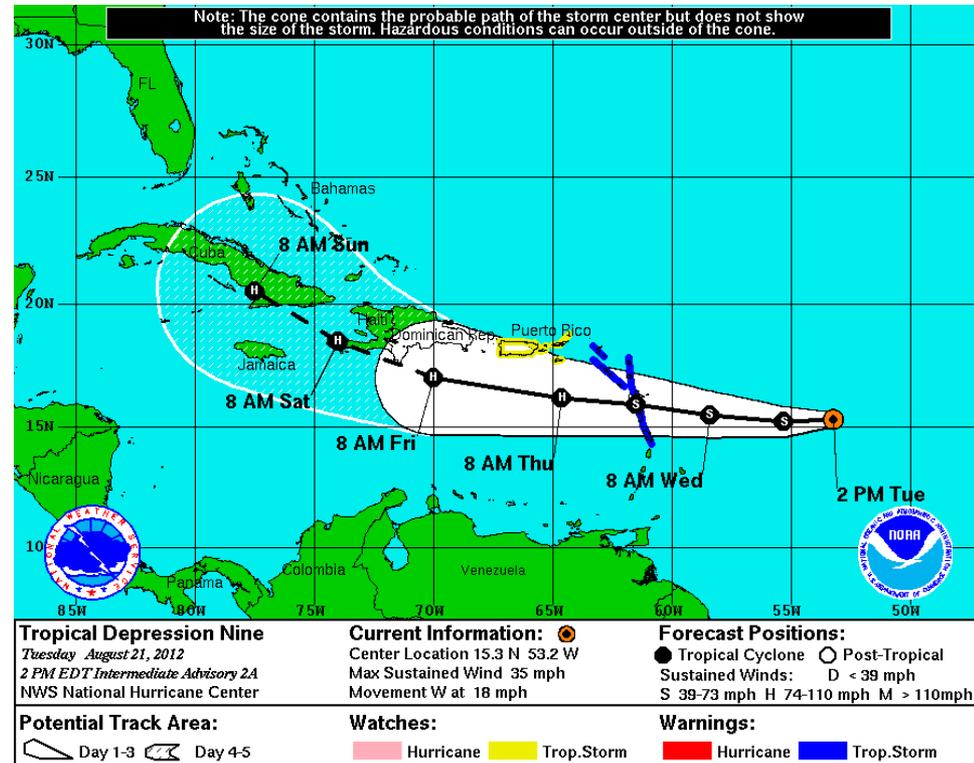
08/24/2012 15:07



08/24/2012 15:35

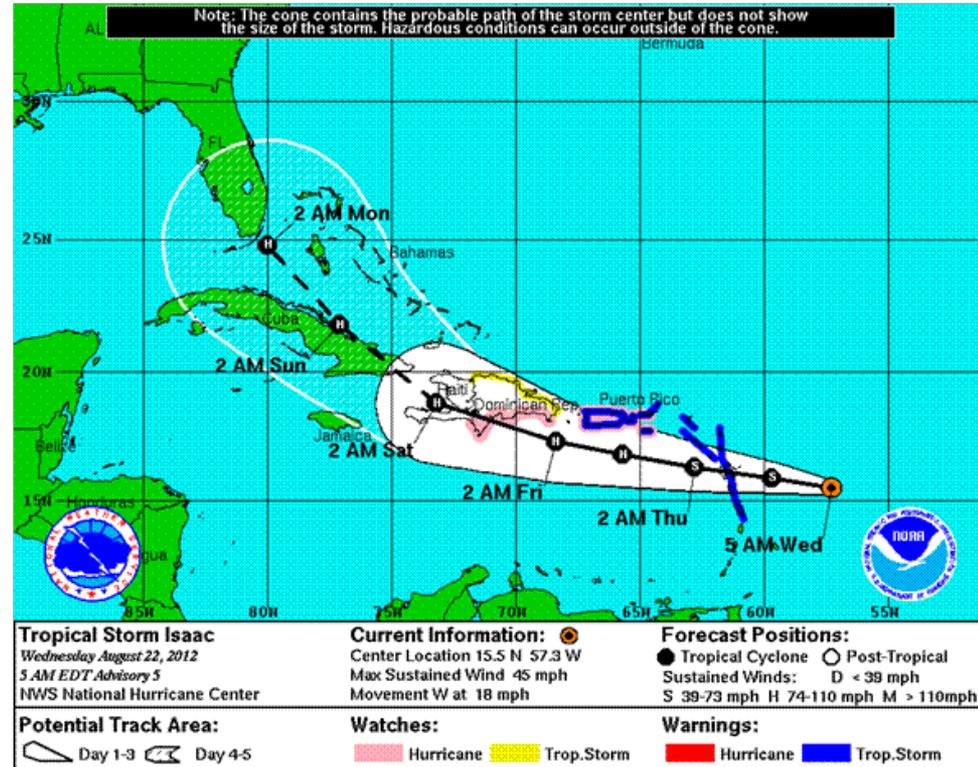
# Tuesday, August 21, 2012

- Monitoring the potential threat of Isaac began
- Meteorologists worked to determine timing of potential impact to District
- Operations initiated to lower the C-4 canal in Miami-Dade County
- Inspected the C-4 Emergency Impoundment



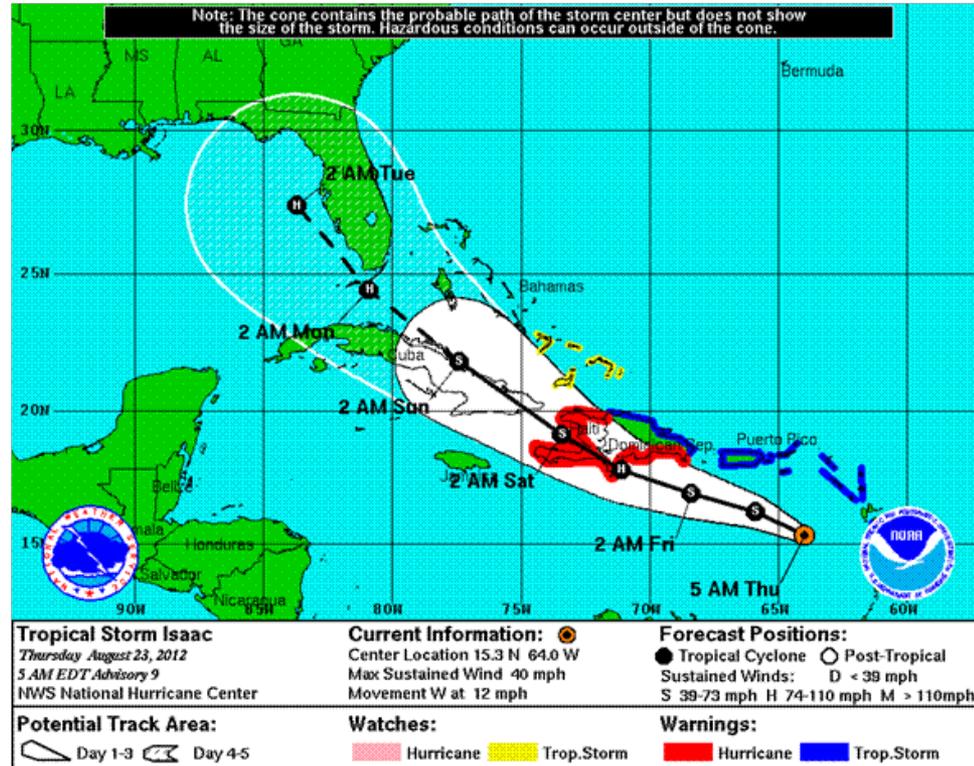
# Wednesday, August 22, 2012

- District placed in "Increased Readiness" for potential threat to District late Sunday
- Request made to the U.S. Army Corps of Engineers to place the L-31 N canal and the C-111 canal in western Miami-Dade County in pre-storm drawdown mode



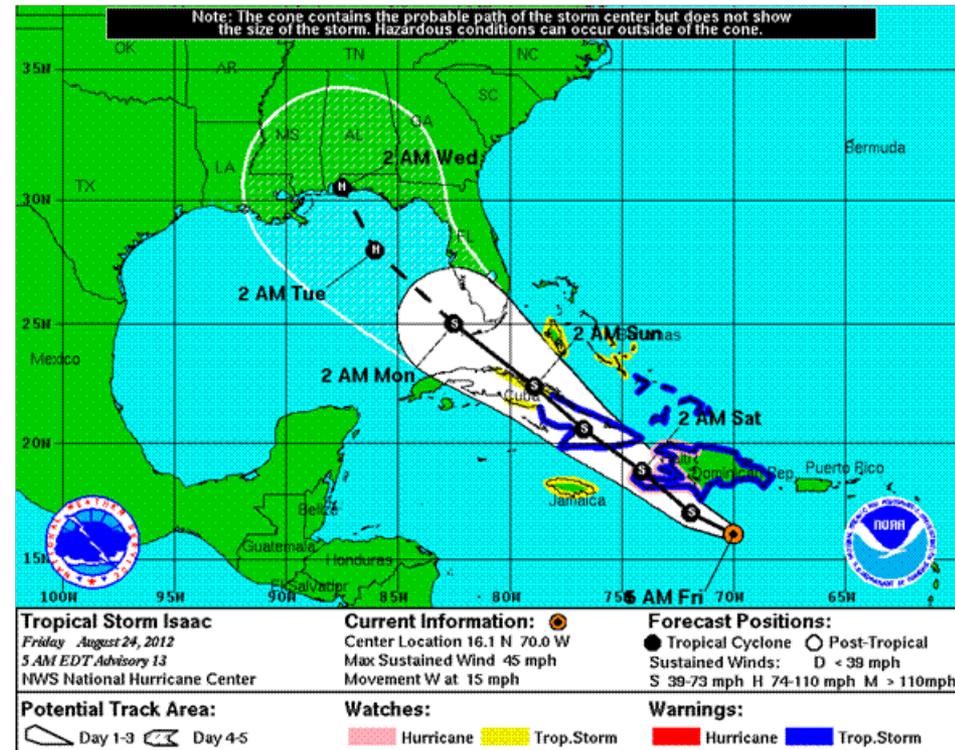
# Thursday, August 23, 2012

- District in Condition 4, "Readiness" – potential threat still expected Sunday
- Pre-storm drawdown continued for coastal canals
- District Intergovernmental Representatives began communications with 298 districts and local governments
- USACE approved request for pre-storm drawdown of South Dade Conveyance System; gate openings and pump operations initiated



# Friday, August 24, 2012

- District still in Condition 4, "Readiness" – potential threat to District by mid-day Sunday
- 9 a.m. - Coordination teleconference held for 298 districts and local public works to share information and coordinate activities relative to potential storm event

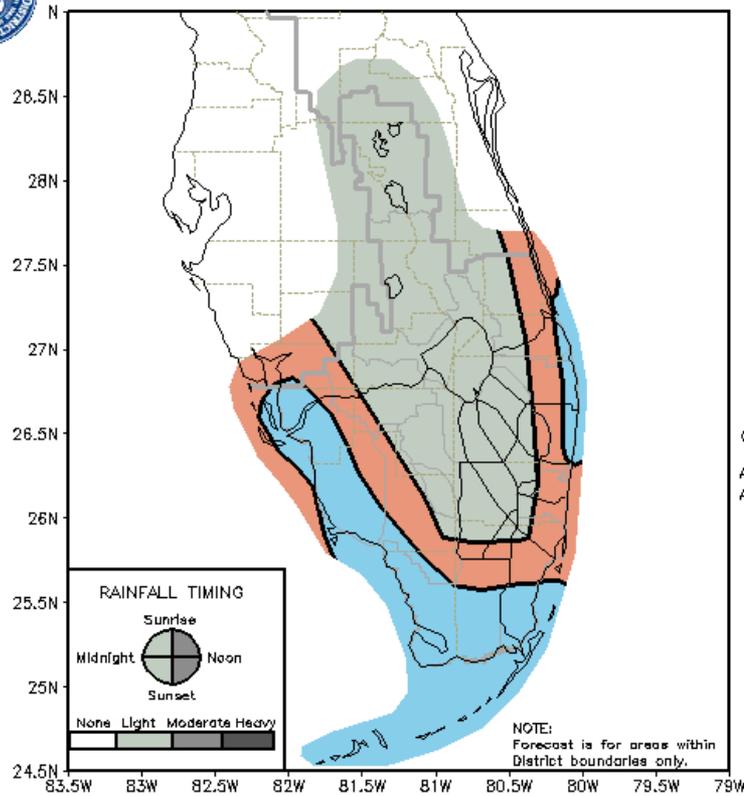


## Forecast – Friday, August 24

## Observed – Friday, August 24

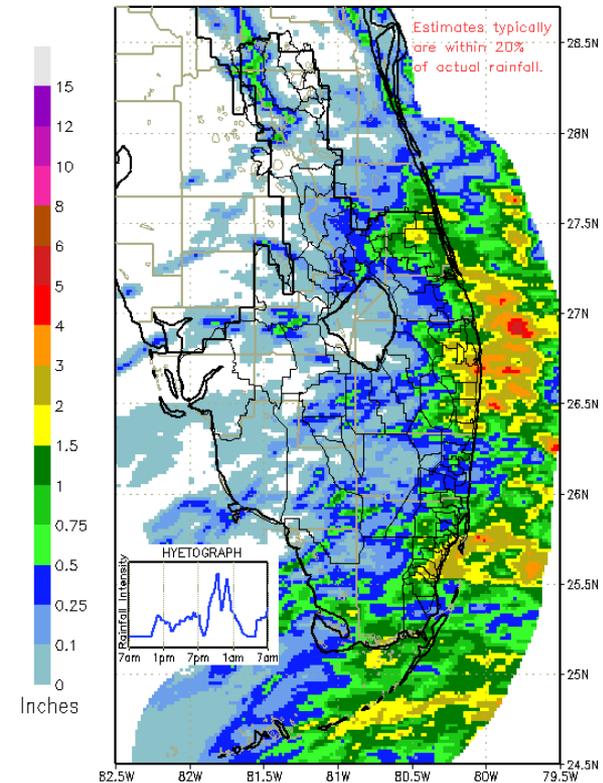


SFWMD QUANTITATIVE PRECIPITATION FORECAST  
Day 1 24-Hour Period Beginning 7am EST FRI



ISSUED: Fri 24-Aug-2012 08:52 EDT

SFWMD RAINFAR EOD DAILY RAINFALL ESTIMATES  
FROM: 0700 EST, 08/24/2012 THROUGH: 0700 EST, 08/25/2012

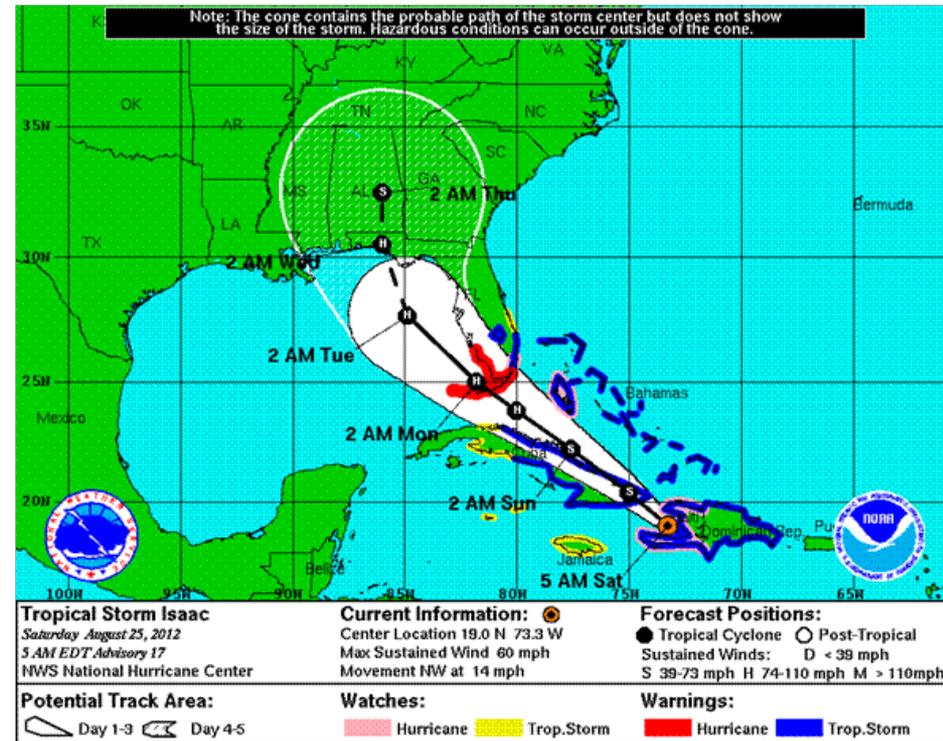


DISTRICT-WIDE RAINFALL ESTIMATE: 0.329"

GRADS: COLA/ICES

# Saturday, August 25, 2012

- District placed in Condition 2, "Readiness" – potential threat to District by midday Sunday
- Pre-storm drawdown actions completed
- Wind field area and large, heavy rains anticipated throughout District
- Later in the day, the District moves to Condition 1, "Readiness"
- Onset – Offset wind estimates produced

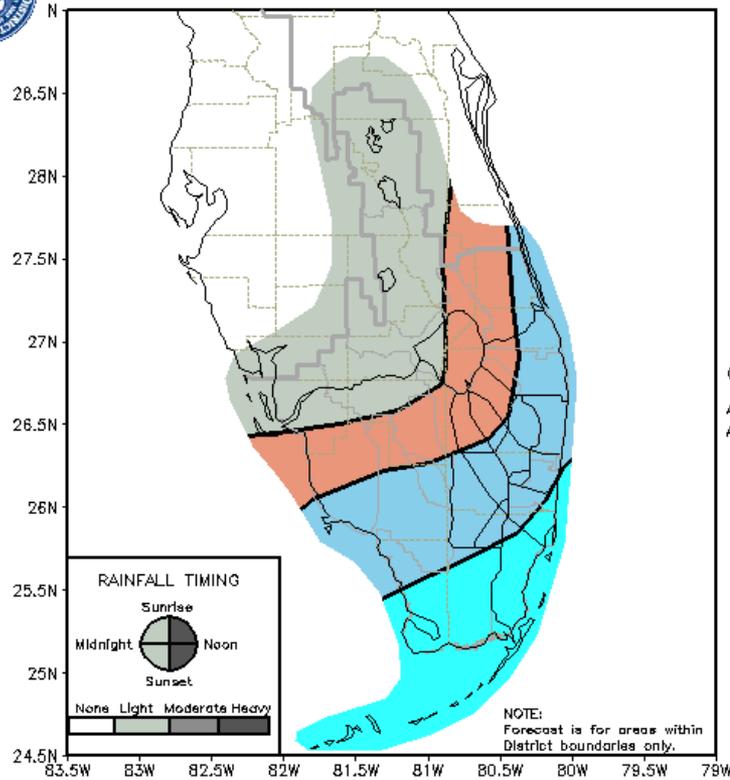


## Forecast – Saturday, August 25

## Observed – Saturday, August 25

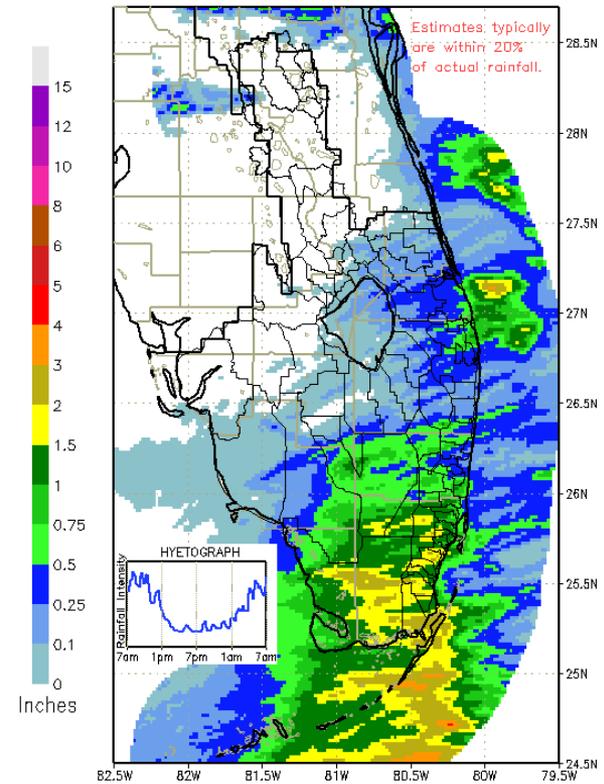


SFWMD QUANTITATIVE PRECIPITATION FORECAST  
Day 1 24-Hour Period Beginning 7am EST SAT



ISSUED: Sat 25-Aug-2012 09:28 EDT

SFWMD RAINDAR EOD DAILY RAINFALL ESTIMATES  
FROM: 0700 EST, 08/25/2012 THROUGH: 0700 EST, 08/26/2012

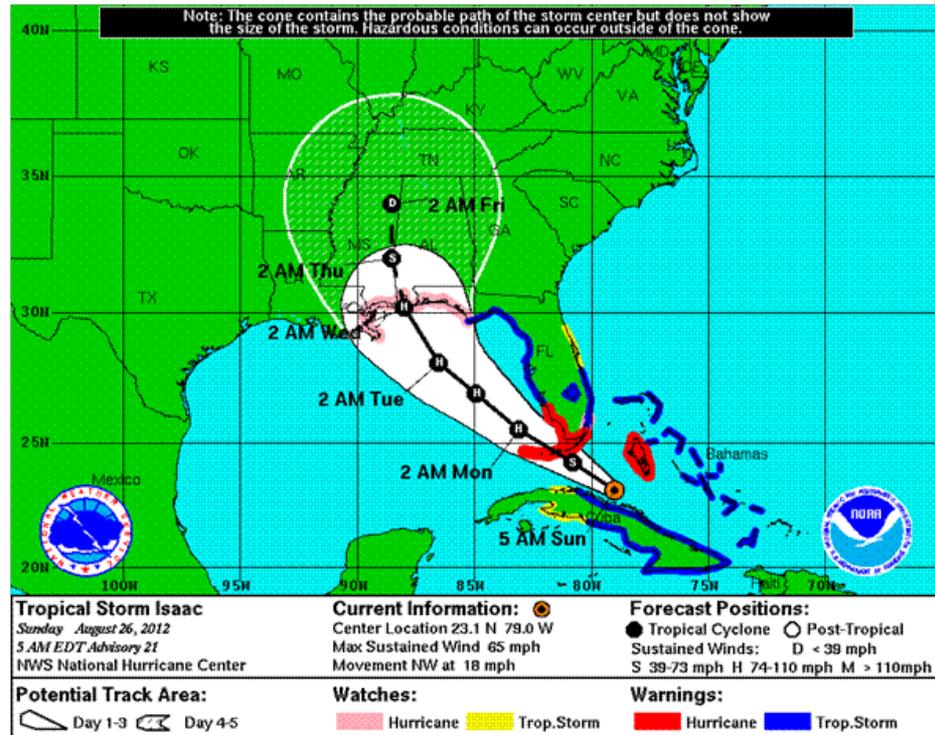


GRADS: COLA/ICES

DISTRICT-WIDE RAINFALL ESTIMATE: 0.266"

# Sunday, August 26, 2012

- EOC activation at noon
- Heavy rains over the previous three days had reduced pre-storm capacity in the Miami-Dade areas
- Forecasted 2 to 4 inch rainfall in Miami-Dade County
- 9 a.m. - Coordination teleconference held for 298 districts and local public works representatives
- Onslaught staff in place and "locked-down" at all manually operated pump stations



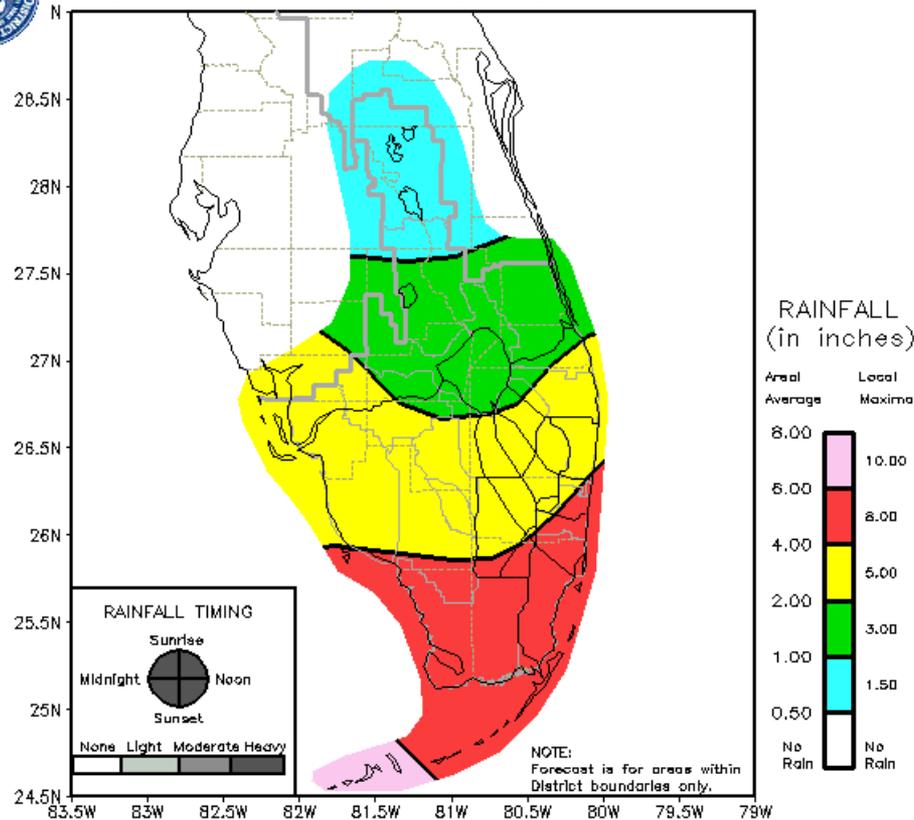
# Onslaught – August 26, 2012

- Coastal water control structures remained configured to make maximum discharges
  - S-197 in south Miami-Dade County was opened pursuant to the USACE criteria
- Pumping stations were operated on a 24 hour basis at maximum practicable discharge
  - S-331 was constrained from pumping due to the potential for downstream flooding near Homestead
- Pump Station S-319 (full capacity) and STA-1E used for residential flood waters

# Rainfall Forecast Sunday, August 26



SFWMD QUANTITATIVE PRECIPITATION FORECAST  
Day 1 24-Hour Period Beginning 7am EST SUN



ISSUED: Sun 26-Aug-2012 09:55 EDT

Sunday, August 26, 2012

Aug 27 02:40UTC

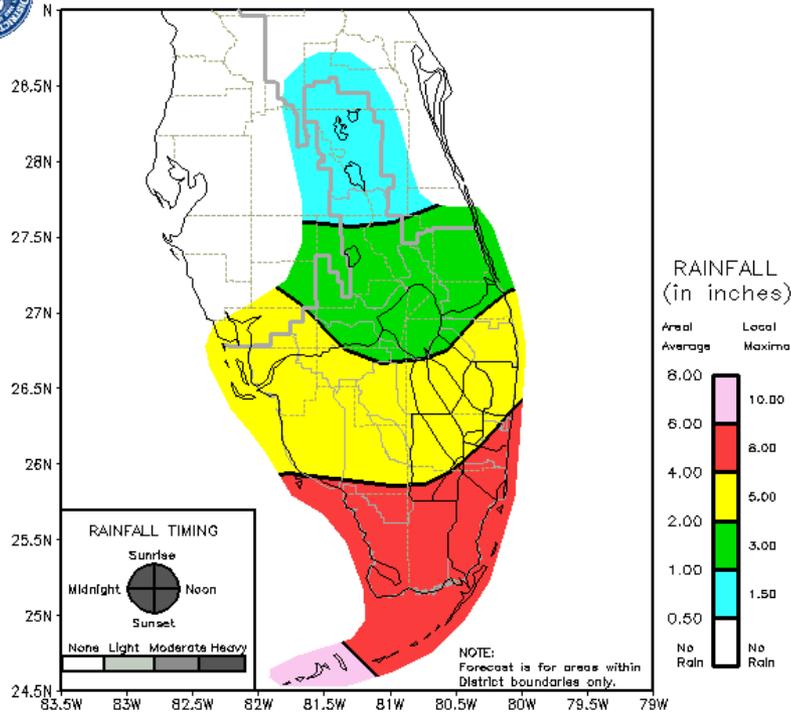


## Forecast – Sunday, August 26

## Observed – Sunday, August 26

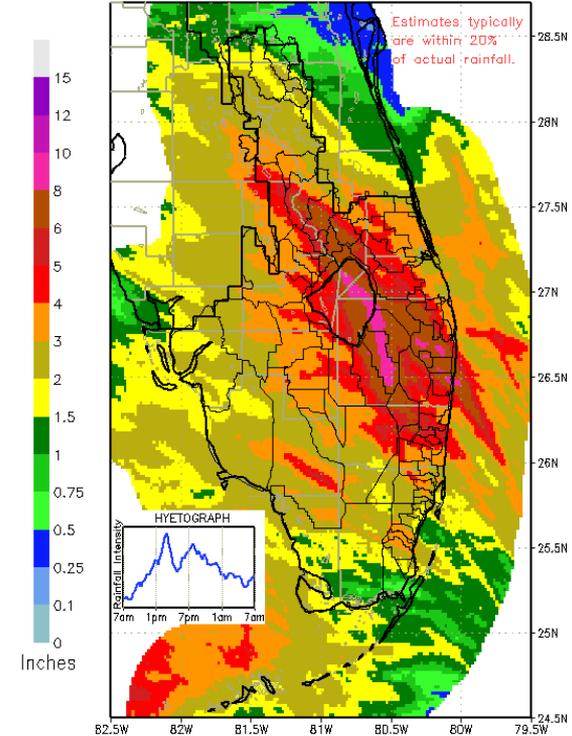


SFWM DISTRICT QUANTITATIVE PRECIPITATION FORECAST  
Day 1 24-Hour Period Beginning 7am EST SUN



ISSUED: Sun 26-Aug-2012 09:55 EDT

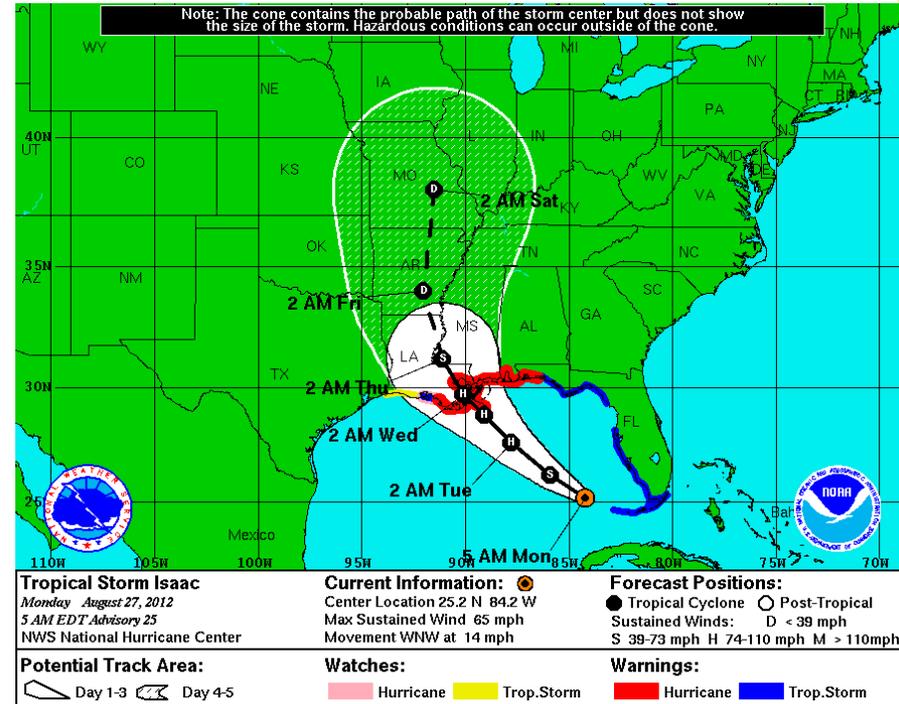
SFWM DISTRICT RAINFALL EOD DAILY RAINFALL ESTIMATES  
FROM: 0700 EST, 08/26/2012 THROUGH: 0700 EST, 08/27/2012



GRIDS: OBU/IGES

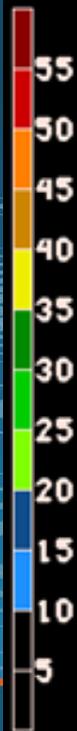
# Monday, August 27, 2012

- Tropical Storm Isaac entered the Gulf of Mexico, bringing heavy rain across the District
- Heaviest rainfall occurred in areas of Broward and Palm Beach County from Aug 26 – 27, 2012
- 9 a.m. - Coordination Teleconference held for Chapter 298 Districts and local public works representatives

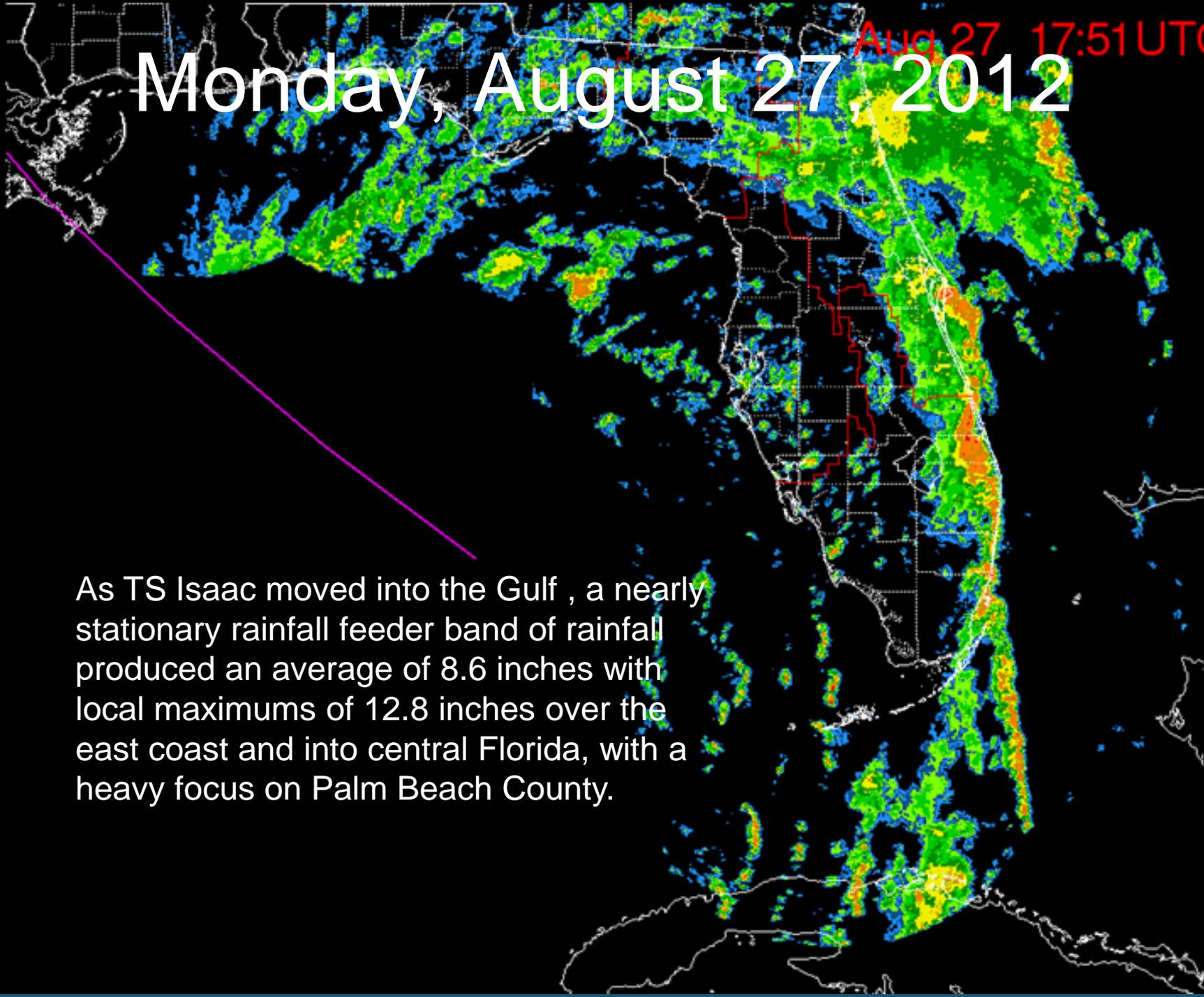


# Monday, August 27, 2012

Aug 27 17:51 UTC



As TS Isaac moved into the Gulf , a nearly stationary rainfall feeder band of rainfall produced an average of 8.6 inches with local maximums of 12.8 inches over the east coast and into central Florida, with a heavy focus on Palm Beach County.



# Tropical Storm Isaac

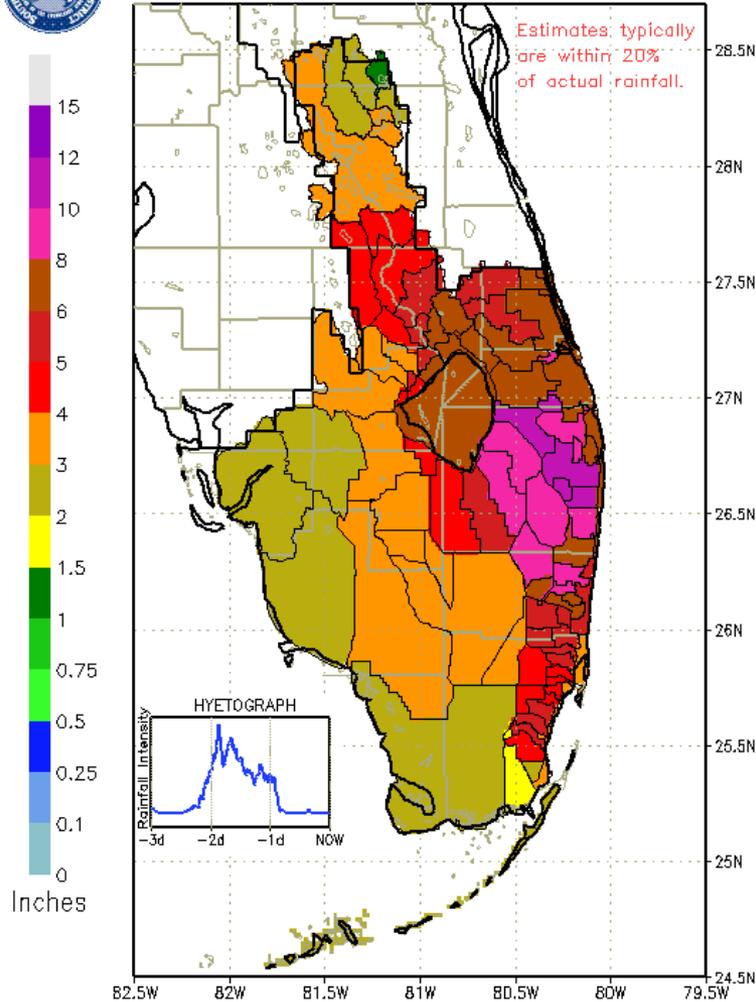
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## RAINFALL SUMMARY

## 3-Day Rainfall Estimate



SFWMD RAINDAR 3-DAY BASIN RAINFALL ESTIMATES  
 FROM: 1200 EST, 08/25/2012 THROUGH: 1200 EST, 08/28/2012

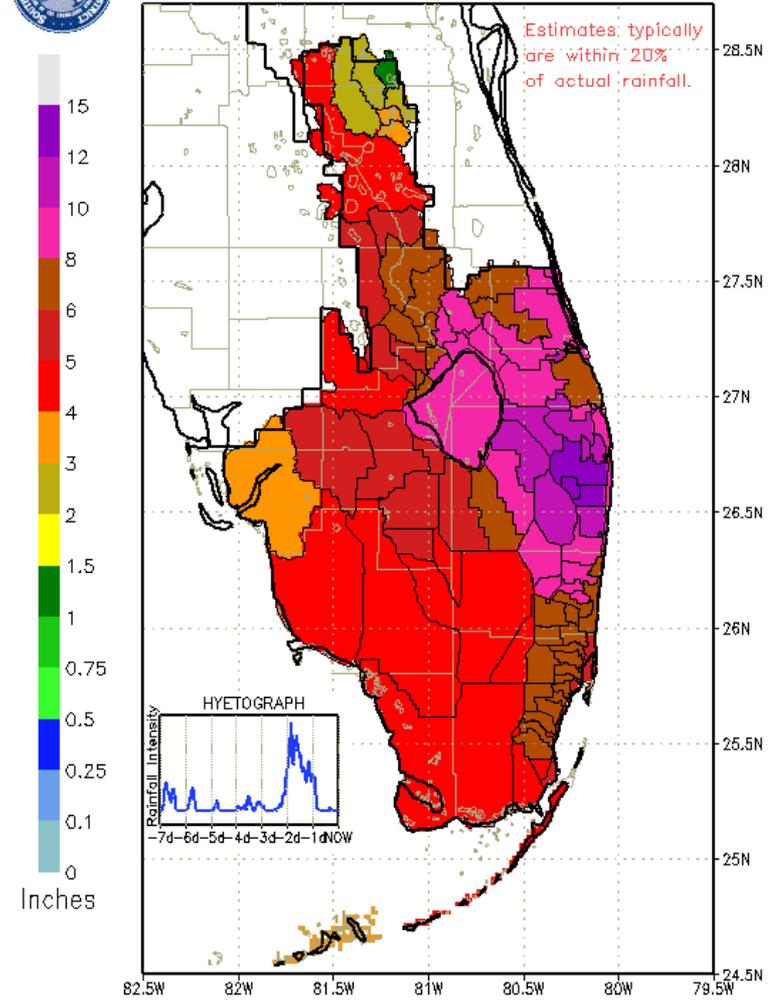


DISTRICT-WIDE RAINFALL ESTIMATE: 4.755"

## 7-Day Rainfall Estimate



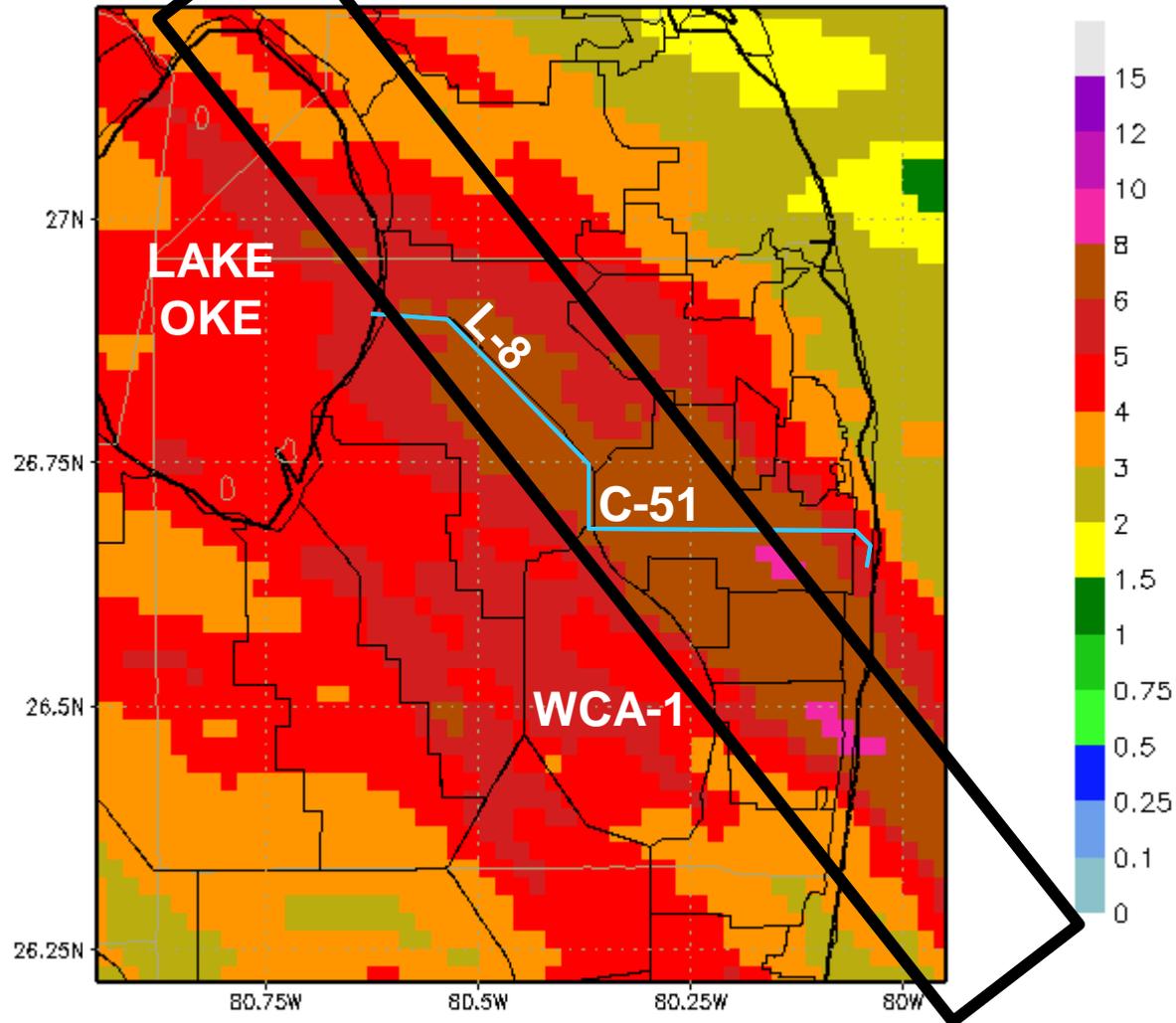
SFWMD RAINDAR 7-DAY BASIN RAINFALL ESTIMATES  
 FROM: 1130 EST, 08/21/2012 THROUGH: 1130 EST, 08/28/2012



DISTRICT-WIDE RAINFALL ESTIMATE: 6.249"

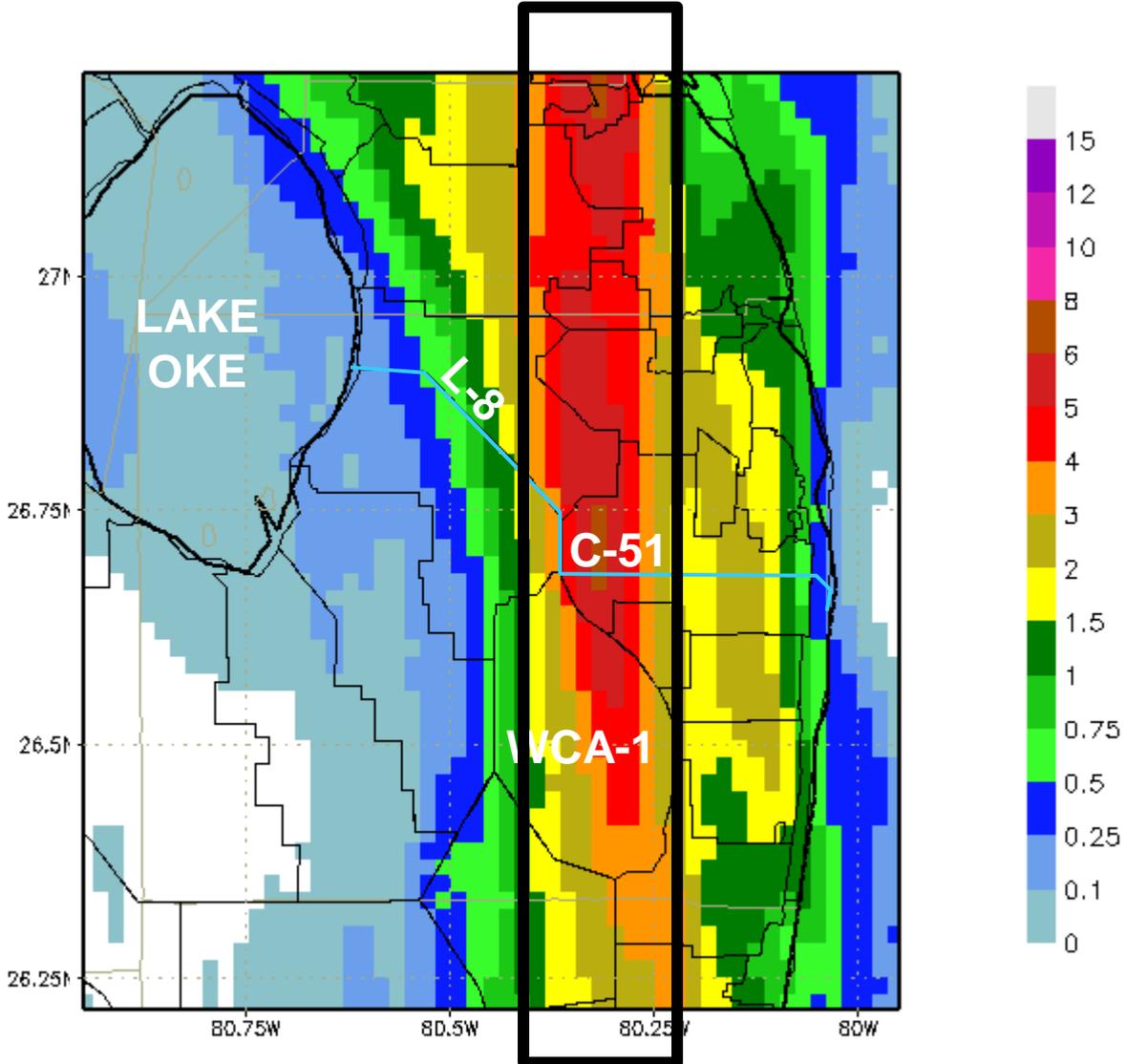
# 18-Hour Rainfall Amounts 8am Sunday - 2am Monday (Aug 26-27)

Sunday

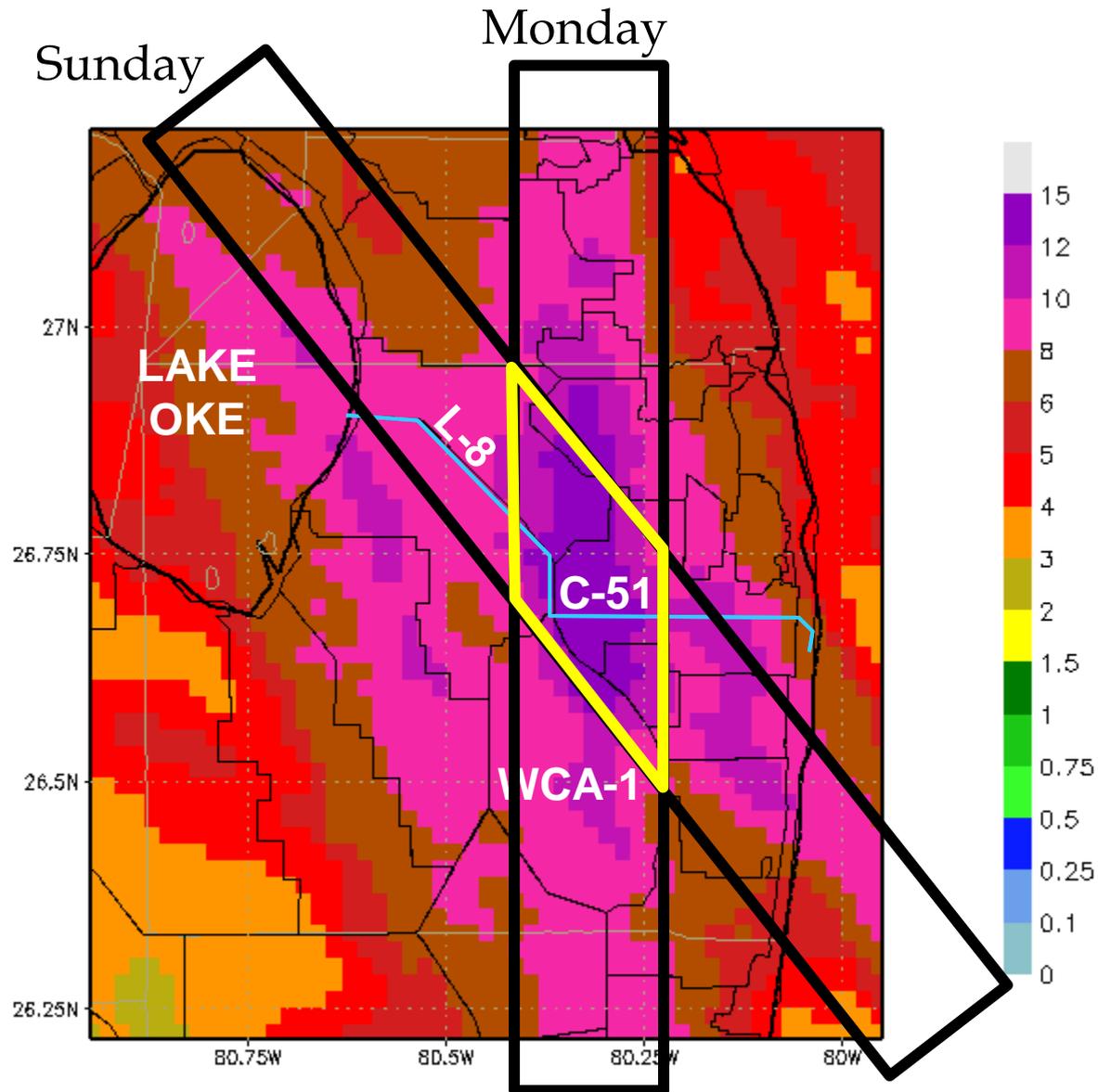


# 6-Hour Rainfall Amounts 9am - 3pm Monday (Aug 27)

Monday

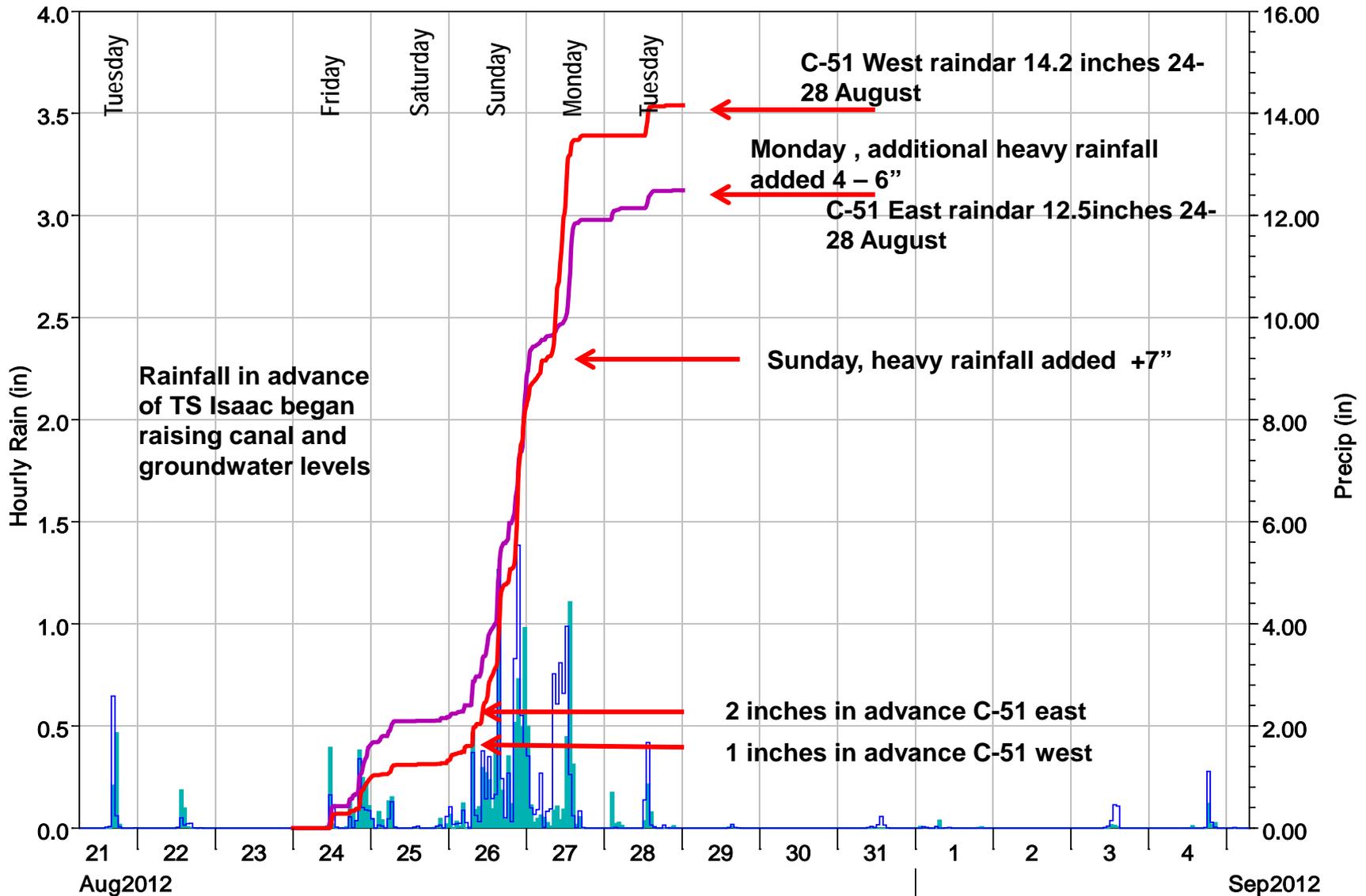


# 48-Hour Isaac Estimated Rainfall Amounts 8pm Saturday - 8pm Monday (Aug 25-27)



# C-51 Basin Rain - Hourly & Accumulated

Raindar = rain gauge adjusted radar rainfall



TS Isaac - AfterAction - 2012

- █ C-51 EAST NEXRAD PRECIP\_CUM\_1HOUR
- █ C-51 WEST NEXRAD PRECIP\_CUM\_1HOUR
- █ C-51 EAST NEXRAD PRECIP\_CUM\_24-28AUG
- █ C-51 WEST NEXRAD PRECIP\_CUM\_24-28AUG

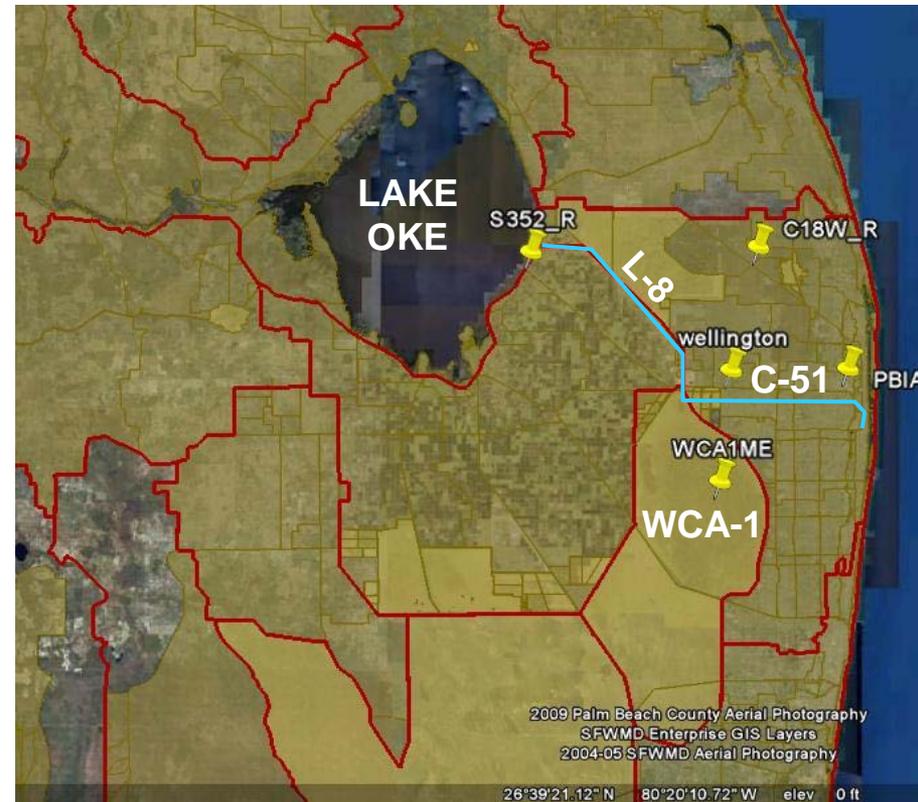
# Tropical Storm Isaac

## Rainfall frequency in years of return period at sites in the C-51 Basin and surrounding area

A return period is a statistical measure of the average number of years between rainfall events of a certain size. For example: The 100 year flood has a one percent chance of being equaled or exceeded during any given year.

**Tropical Storm Isaac rainfall frequency in years of return period at sites in the C-51 Basin and surrounding**

Site or Location	Three-day Rainfall	August 2012 Rainfall
	Inches (return period)	inches (return period)
Pump Station 4 (Wellington)	<b>14.70</b> (100-yr)	<b>20.27</b> (>>>100-YR)
Structure 40 (Wellington)	<b>14.04</b> (100-yr)	<b>19.54</b> (>>>100-YR)
C-51 Basin (raindar* rainfall)	<b>14.70</b> (100-yr)	Not Available
S-352	11.43 (> 50-yr)	14.77 (50-YR)
Structure 42 (Wellington)	10.89 (25-yr)	<b>20.37</b> (100-yr)
C-18W	11.16 (>10-yr)	<b>21.92</b> (100-yr)
PBIA	9.70 (10-yr)	<b>21.43</b> (>>>100-yr)
WCA1ME	11.21 (25-yr)	<b>21.22</b> (100-yr)



\* rain gauge adjusted radar rainfall

# Tropical Storm Isaac

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## POST STORM OPERATIONS

# Areas of Concern



Primary areas of concern were C-51 basin, C-17, C-18, L-8 basins and areas north of Lake Okeechobee; C-13, C-14

Ponded water in the secondary and tertiary systems was slow in reaching the primary system

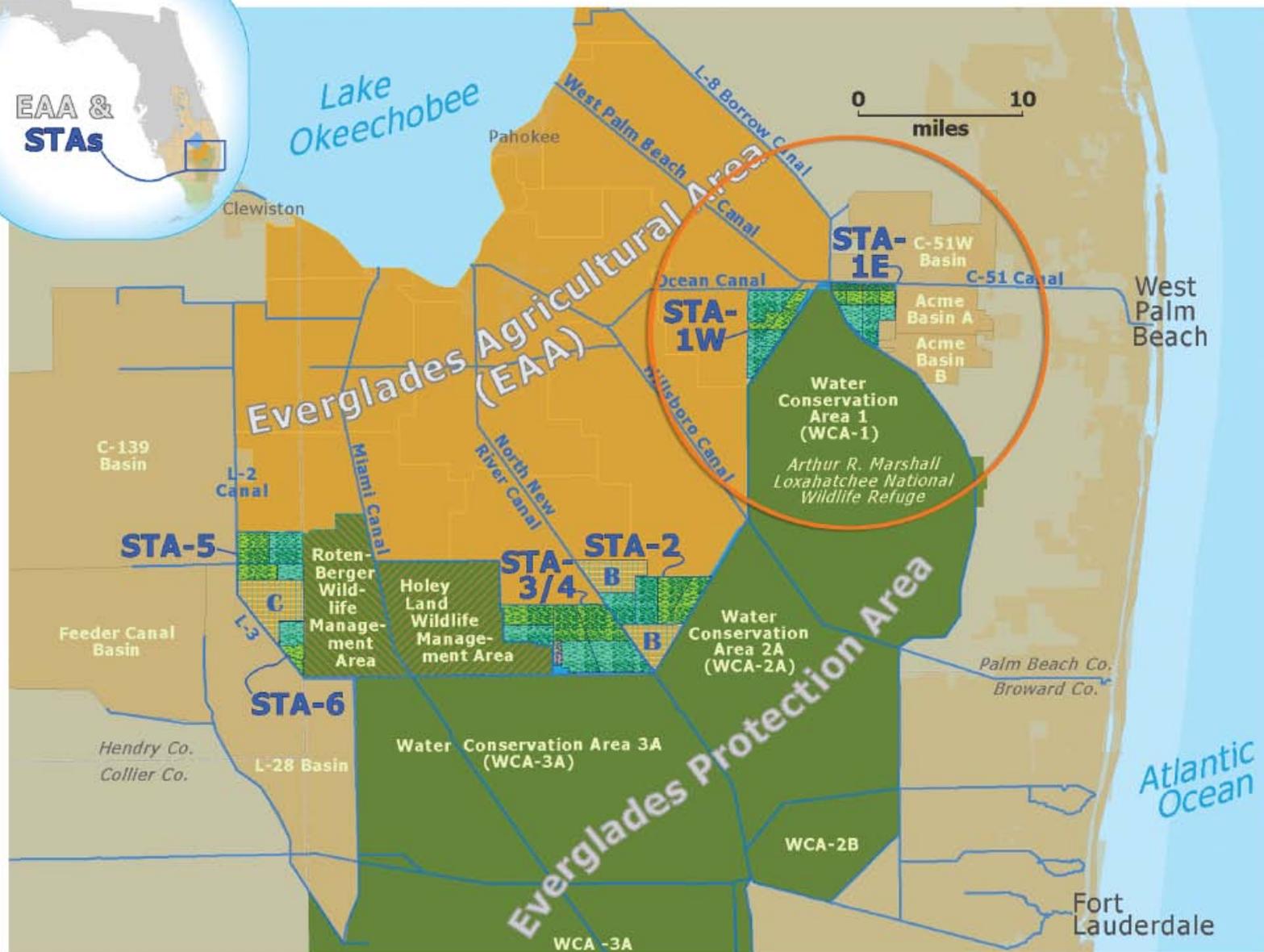
Water levels throughout the system were slowly receding.

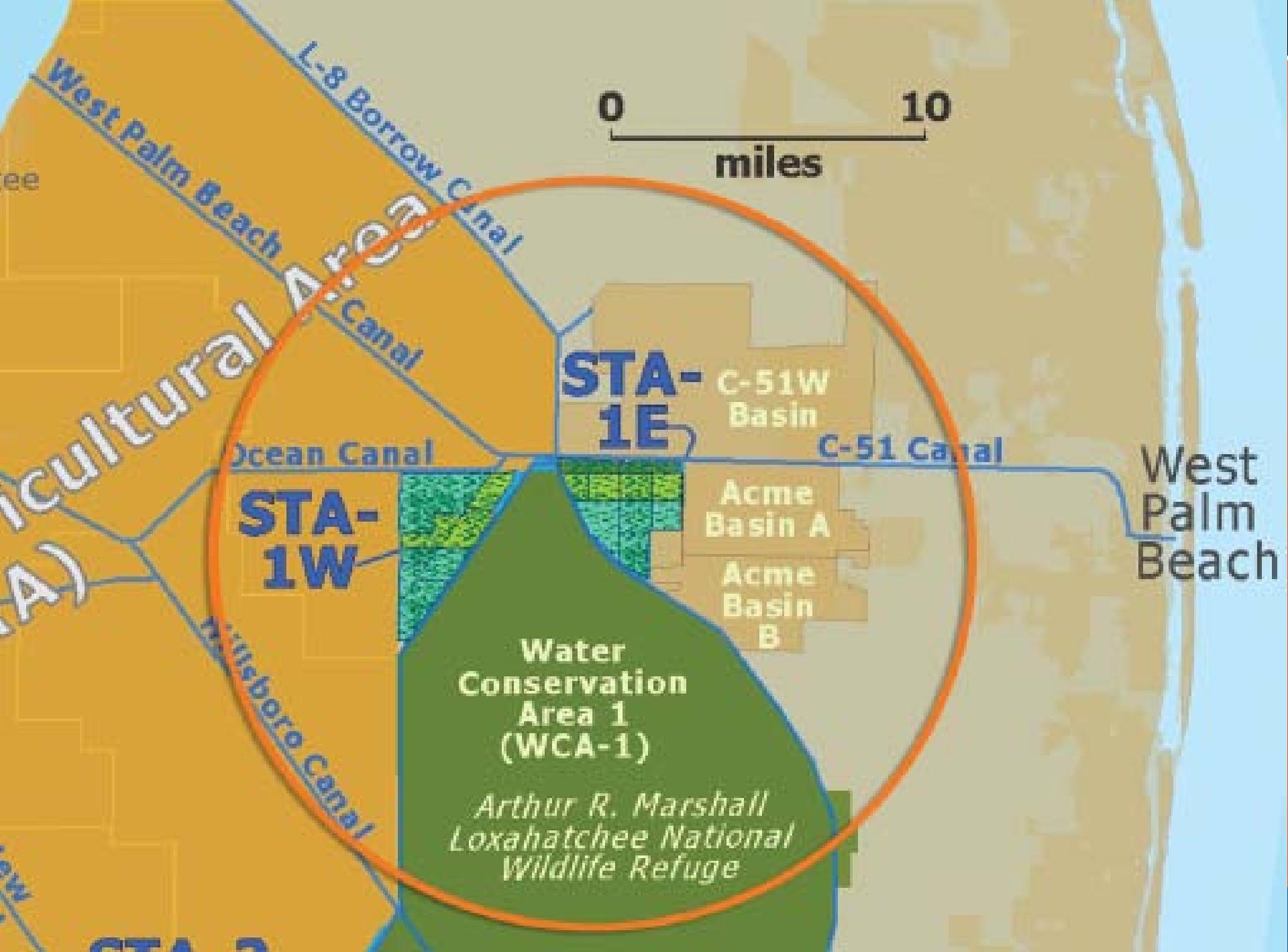
SFWMD

2004-05 SFWMD Aerial Photography  
2007 Palm Beach County Aerial Photography

2005 Miami-Dade County Aerial Photography

# SOUTH FLORIDA WATER MANAGEMENT DISTRICT





0 10  
miles

West Palm Beach Canal  
L-8 Borrow Canal  
Agricultural Area (A)  
Ocean Canal  
Gladesboro Canal

**STA-1E**  
C-51W Basin  
**STA-1W**  
Acme Basin A  
Acme Basin B  
C-51 Canal

West Palm Beach

Water Conservation Area 1 (WCA-1)  
Arthur R. Marshall Loxahatchee National Wildlife Refuge

STA-2



**J.W. Corbett Wildlife Management Area**

**The Acreage**  
*(Indian Trail Improvement District)*

**EAA**

**Village of Royal Palm Beach**

**STA-1E**

**WCA-1**

Palm Beach Gardens

North Palm Beach

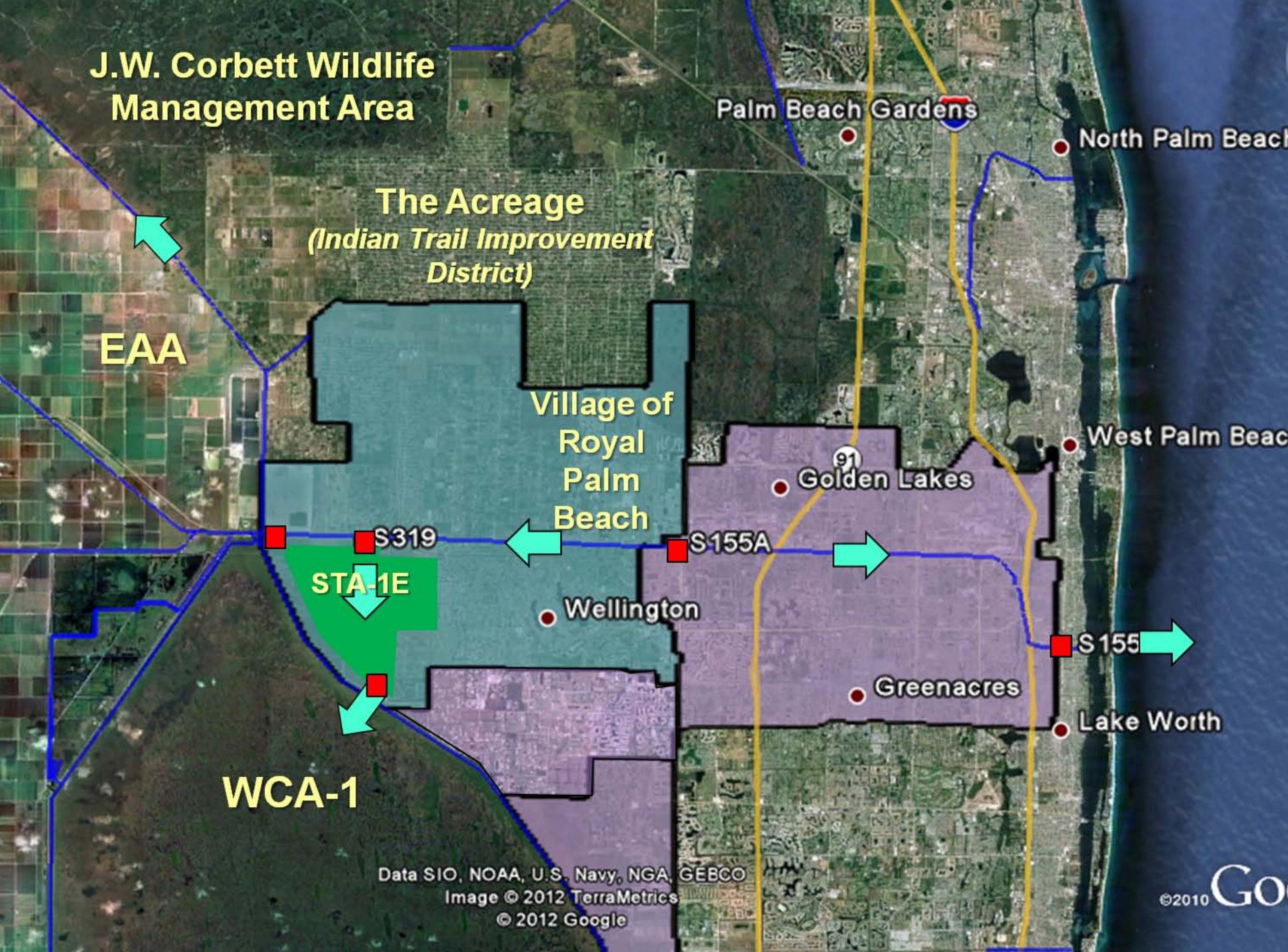
West Palm Beach

Golden Lakes

Wellington

Greenacres

Lake Worth



# Post Storm Operations

- Identified and issued emergency orders
- Regional system operations
  - Western C-51 discharged east and west
  - Utilized L-8 Reservoir
  - Discharged to Lake Okeechobee
  - Discharged to Water Conservation Area and tide
  - Coordinated with 298 Districts, local governments and others



# Post Storm Operations

- Diversions to Water Conservation Area 1 (WCA-1)
  - On Monday, August 27, inflow into Stormwater Treatment Area 1E exceeded its capacity
    - SFWMD made an emergency diversion around STA-1E to WCA-1
    - Maintained flood discharges to protect human health and safety

# Post Storm Operations

- Diversions to Water Conservation Area 1
  - G-300 discharges (21,850 ac-ft) ended completely September 3 at 8:15 p.m.
  - G-301 discharges (6,028 ac-ft) ended September 1 at 2:30 p.m.
  - Total volume = 27,878 ac ft
  - Wellington Pump #2 began discharges Tuesday, August 28, at 4 p.m. due to extensive local flooding
  - Discharges ended on Friday, August 31, at 8 a.m.

## Flood Control Pumping at S-2 & S-3

- S-2
  - Pumped about 8 days (7a.m. 8/27 – 2 p.m. 9/4)
  - Estimated volume = 36,000 acre-feet
- S-3
  - Pumped about 2 days (9:15 p.m. 8/27 – 2:50 p.m. 8/29)
  - Estimated volume = 4,000 acre-feet
- Total volume pumped = 40,000 acre-feet
  - Equivalent to about 0.1 feet of Lake stage increase
  - Less than 4% of the total Lake inflow

# Post Storm Operations

- Chapter 298 District Operations
  - Experienced extensive flooding of streets and swales in residential communities
  - Requested additional discharge capacity
    - ITID (C-51 permitted off-peak discharge)
    - Wellington (emergency discharge to WCA-1)
  - Coordination with affected downstream entities
    - Village of Royal Palm Beach
    - City of West Palm Beach

## Volumes Discharged by County (Aug. 24 to Sep. 5)

County	Volume Discharged (billion gallons)
Palm Beach	88.1
Broward	29.2
Miami-Dade	44.3

## Total inflow into Lake Okeechobee (Aug. 24 to Sep. 5)

Runoff into Lake Okeechobee	150.7 billion gallons
-----------------------------	--------------------------

# Tropical Storm Isaac

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## IMPACTED AREAS







NO  
THRU  
TRUCKS  
3 OR  
MORE AXLES

25

CAUTION  
ROAD  
SUBJECT  
TO  
FLOODING















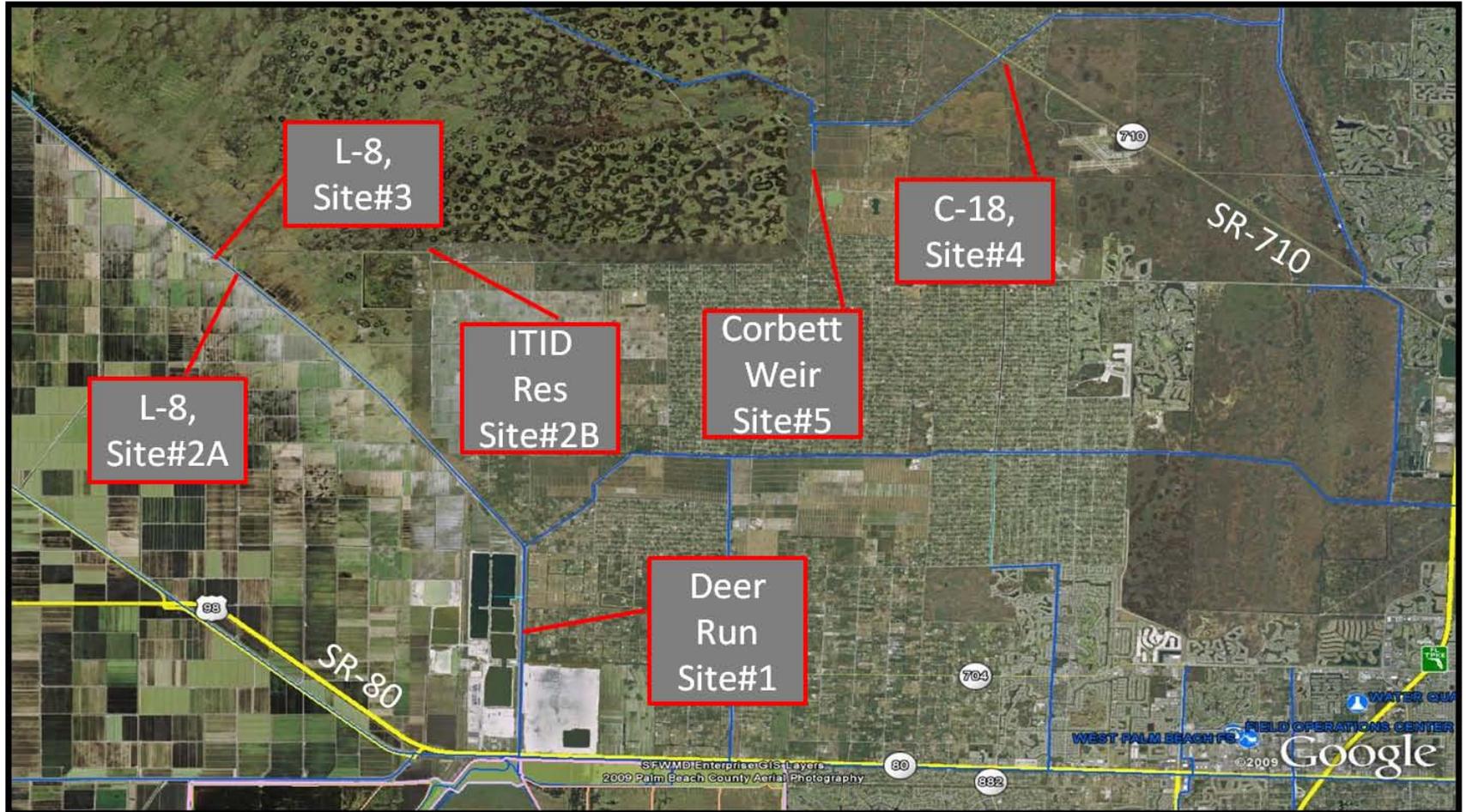


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## SFWMD FIELD RESPONSE

# Emergency Pump Installation Sites



# Deer Run Site #1; 12" & 24" Pumps



# Community of Deer Run

- One of the hardest hit areas with extensive, long-standing flooding
- Deer Run has a 36" (60 cfs ) permanent pump station
- After the event the residents installed a temporary 12" pump (10 cfs) and a 24" pump (40 cfs)
- SFWMD installed two temporary pumps (total 60 cfs)
  - 12" pump and pipe installed 8/30
  - 24" pump installed in the overnight hours of 8/31
- Pumps staffed and began operating 8/30 on a 24-hour basis





RESIDENTS  
ONLY  
NO TRESPASSING  
NO PARKING  
NO MOTOR  
VEHICLES  
NO GUESTS











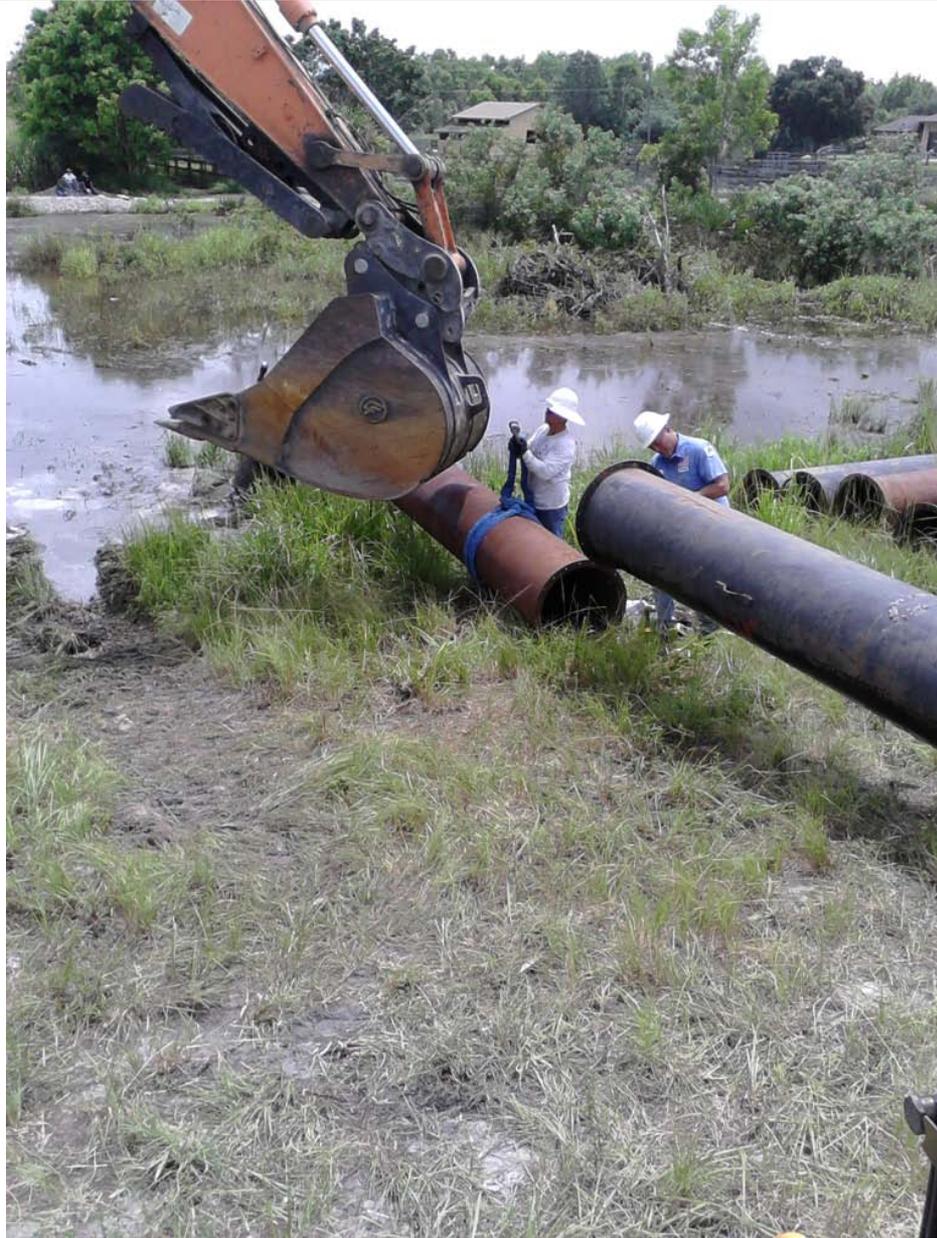
08/31/2012



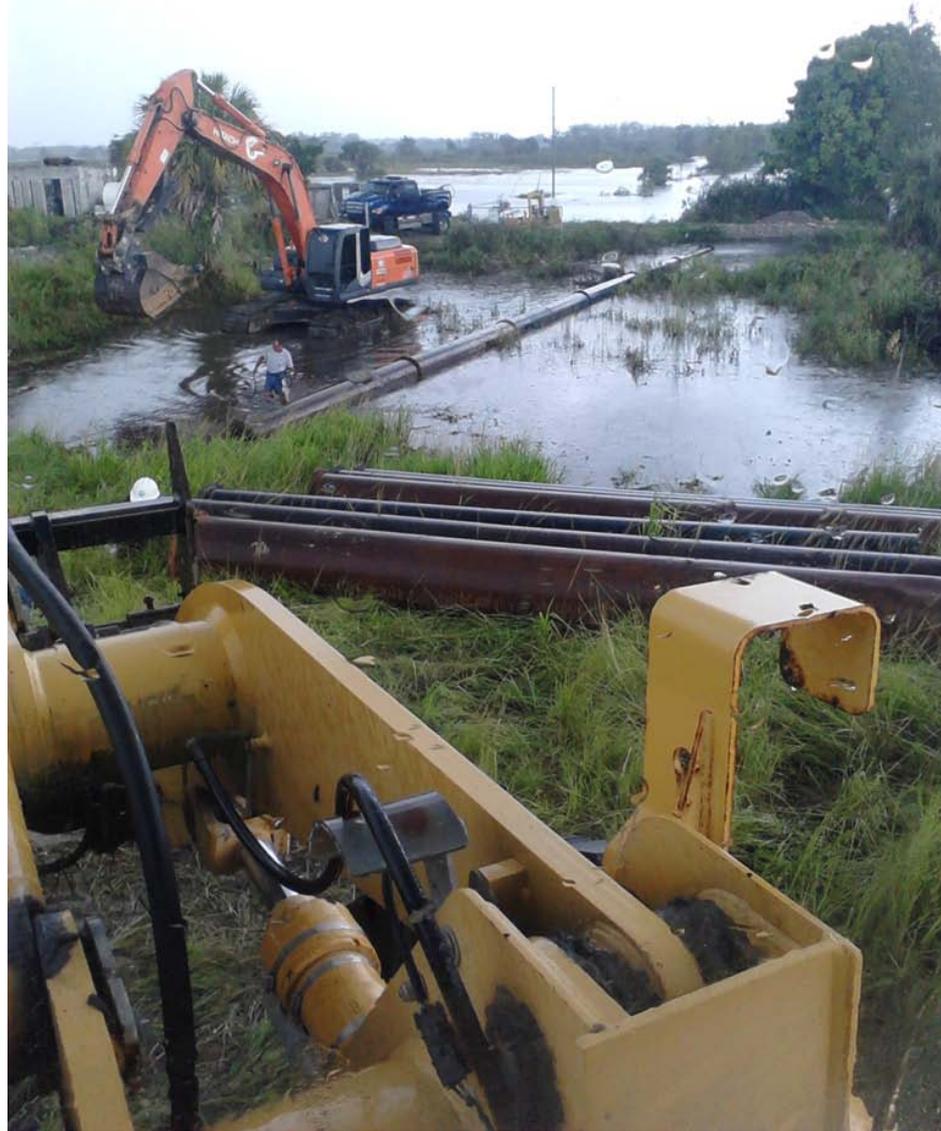














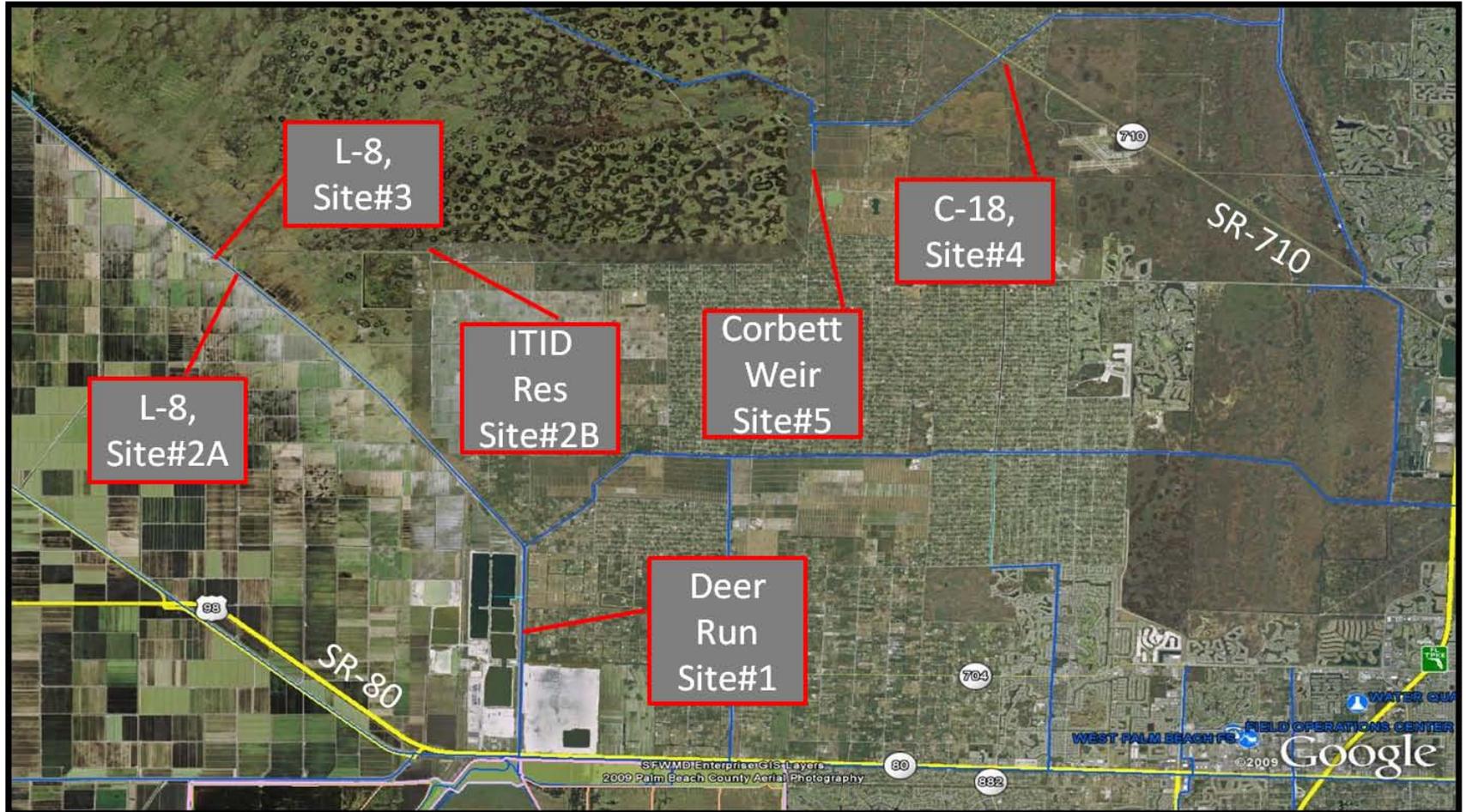
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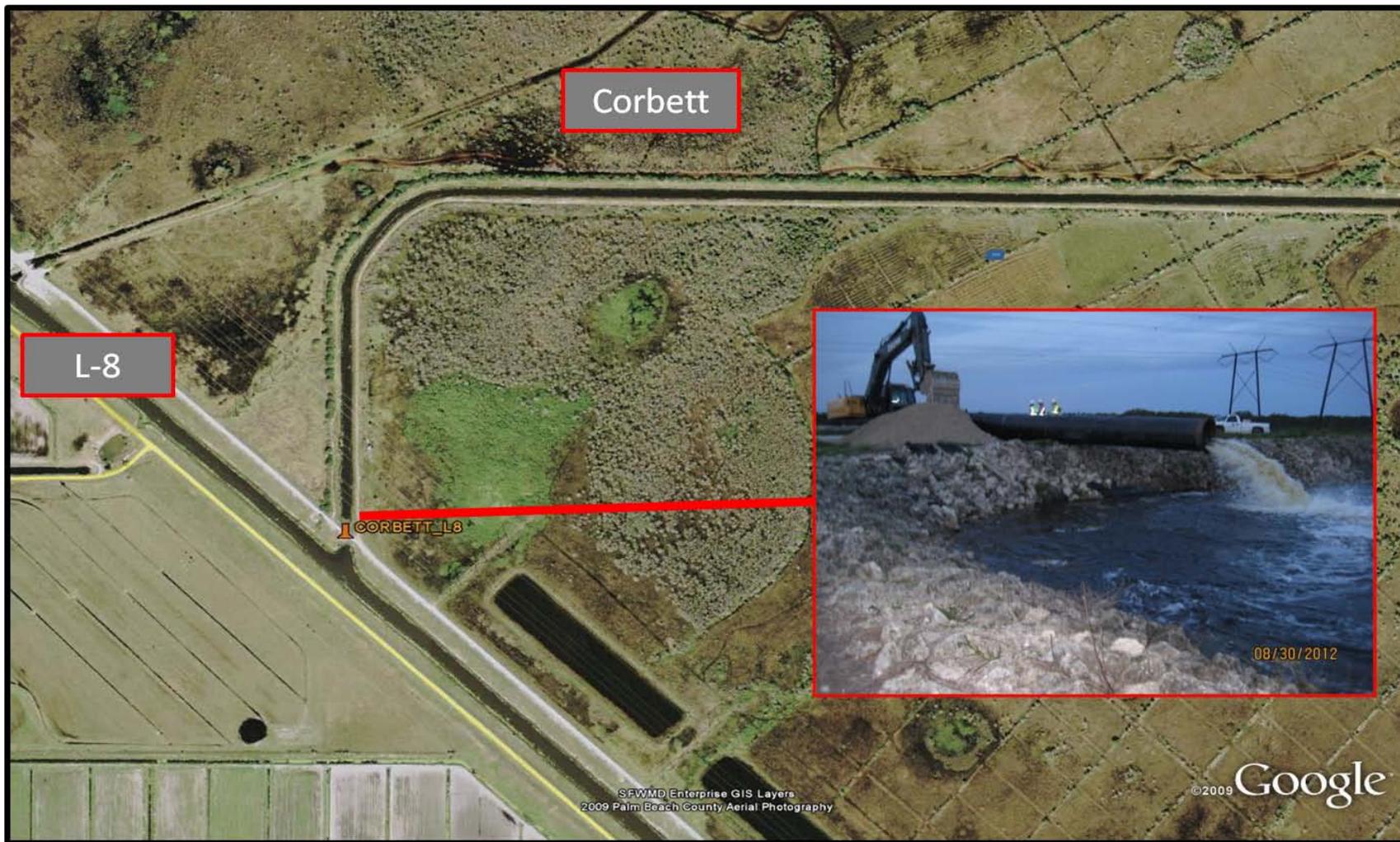
*Readiness, Response, Recovery*

## ASSISTANCE TO INDIAN TRAIL IMPROVEMENT DISTRICT

# Emergency Pump Installation Sites



# L-8 Canal Site #2A; 24" Pump



# Indian Trail Improvement District L-8 Canal Outfall

- High stages in L-8 and the ITID outfall canal hampered discharge from the ITID stormwater reservoir
- Installed a 24" (35 cfs) Gator Pump at the ITID outfall culvert into L8 to provide additional conveyance to help lower the stage in the discharge canal
- Pump staffed and operated on 24- hour basis from 7 p.m. on 8/30 until 6 a.m. on 9/06



2382 WRM







# ITID Reservoir Site #2B; 30" Pump



# Indian Trail Improvement District Reservoir

- Discharge culverts from ITID reservoir overcome from high inflows
- SFWMD installed a 30" (50 cfs) hydraulic pump at the reservoir to increase discharge capacity into discharge canal that leads to L-8 Canal
- Installed on 9/1 and 9/2
- Pump staffed and operated on 24-hours basis from 1 p.m. on 9/2 until 4 p.m. on 9/05



09/01/2012 14:42



DEERE

JOHN DEERE

350D

040819

09/01/2012 13:43



09/01/2012 15:19



09/01/2012 15:39



09/01/2012 16:02



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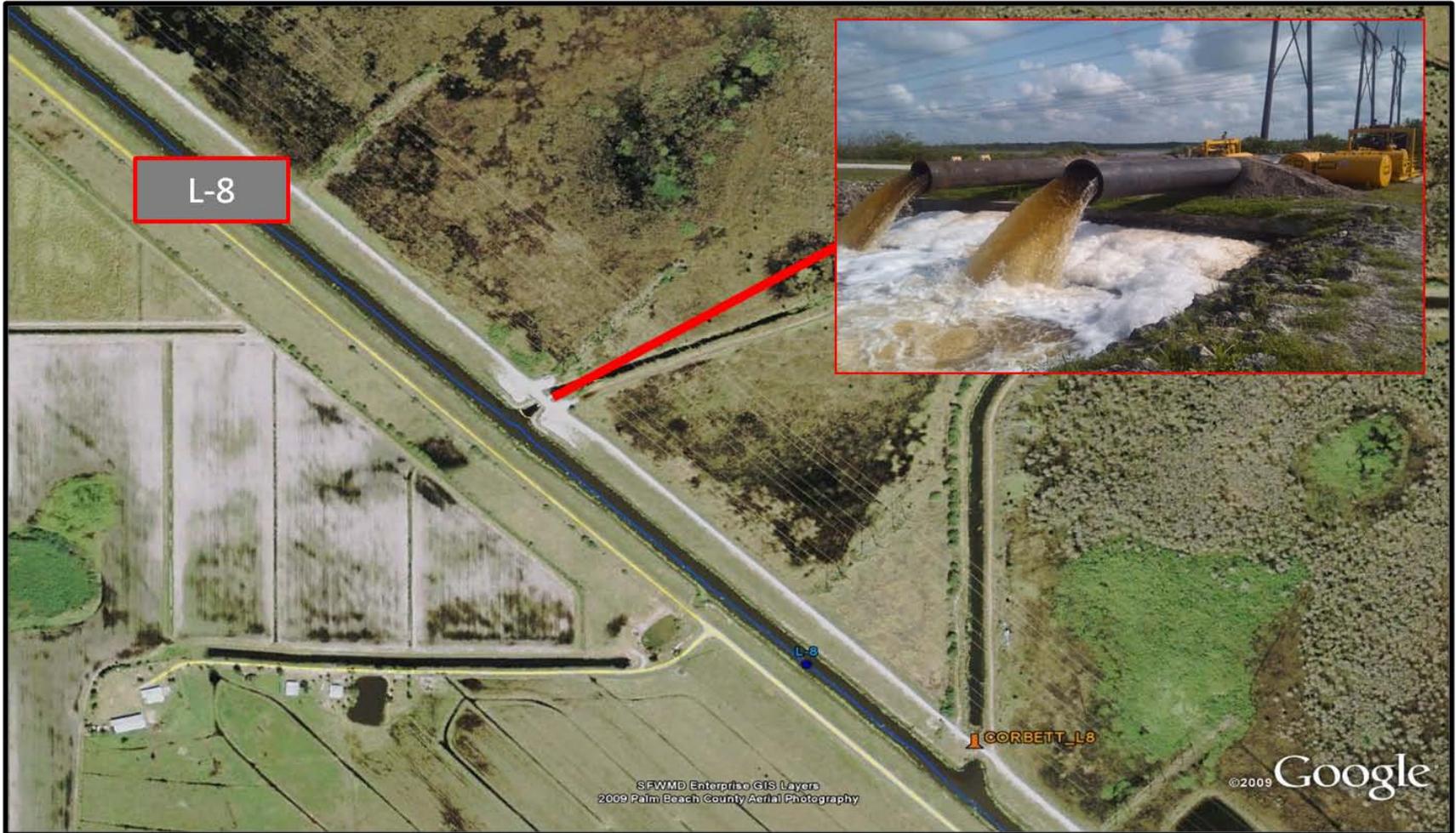


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09/02/2012 12:54

# L-8 Canal Site #3; 2-42" Pumps



## L-8 Canal Site #3

- To remove excess water from the western side of the Corbett Area
- Two 42" pumps
- 200 cfs capacity combined
- Installed 8/28
- Water moved from 6 p.m. on 8/28 to 12 p.m. 8/31 = 302,400,000 gallons

## L-8 / Corbett Area Pumps

- High stages in the J.W. Corbett Wildlife Management Area were placing increased pressure on an old local berm located between ITID and the Corbett Area
- It posed a potential safety risk to the residents of ITID
- SFWMD installed two 42" temporary pumps to help reduce stages in the Corbett Area, thereby reducing pressure on the aging berm
- Pump installation began in overnight hours of 8/28 and finished early 8/29
- Pumps staffed and operated on 24-hour basis from the morning of 8/29 until 6 a.m. on 9/6







# C-18 Canal Site #4; 3-24" & 1-30" Pumps



## C-18 Canal Site #4

- To improve get-away capacity in C-18 and increase gravity flow from Corbett Area
- Three 24" hydraulic pump
- One 30" hydraulic pump
- 150 cfs capacity combined
- Pumps installed on 8/28
- Water moved from 6 p.m. on 8/28 till 12 p.m. on 8/31 = 226,800,000 gallons

## C-18 Weir

- One 30" and three 24" pumps installed at the C-18 weir near the Beeline Highway to provide 120 cfs additional capacity to help lower water levels and increase conveyance from the extreme western reach of the C-8 west leg
- Pumps installed on 8/28
- Pumps staffed and operated on 24-hours basis beginning 8/28



08/28/2012



08/28/2012





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# Tropical Storm Isaac

*Readiness, Response, Recovery*

## CORBETT WILDLIFE MANAGEMENT AREA LEVEE REPAIRS









09/02/2012



08/31/2012



09/01/2012



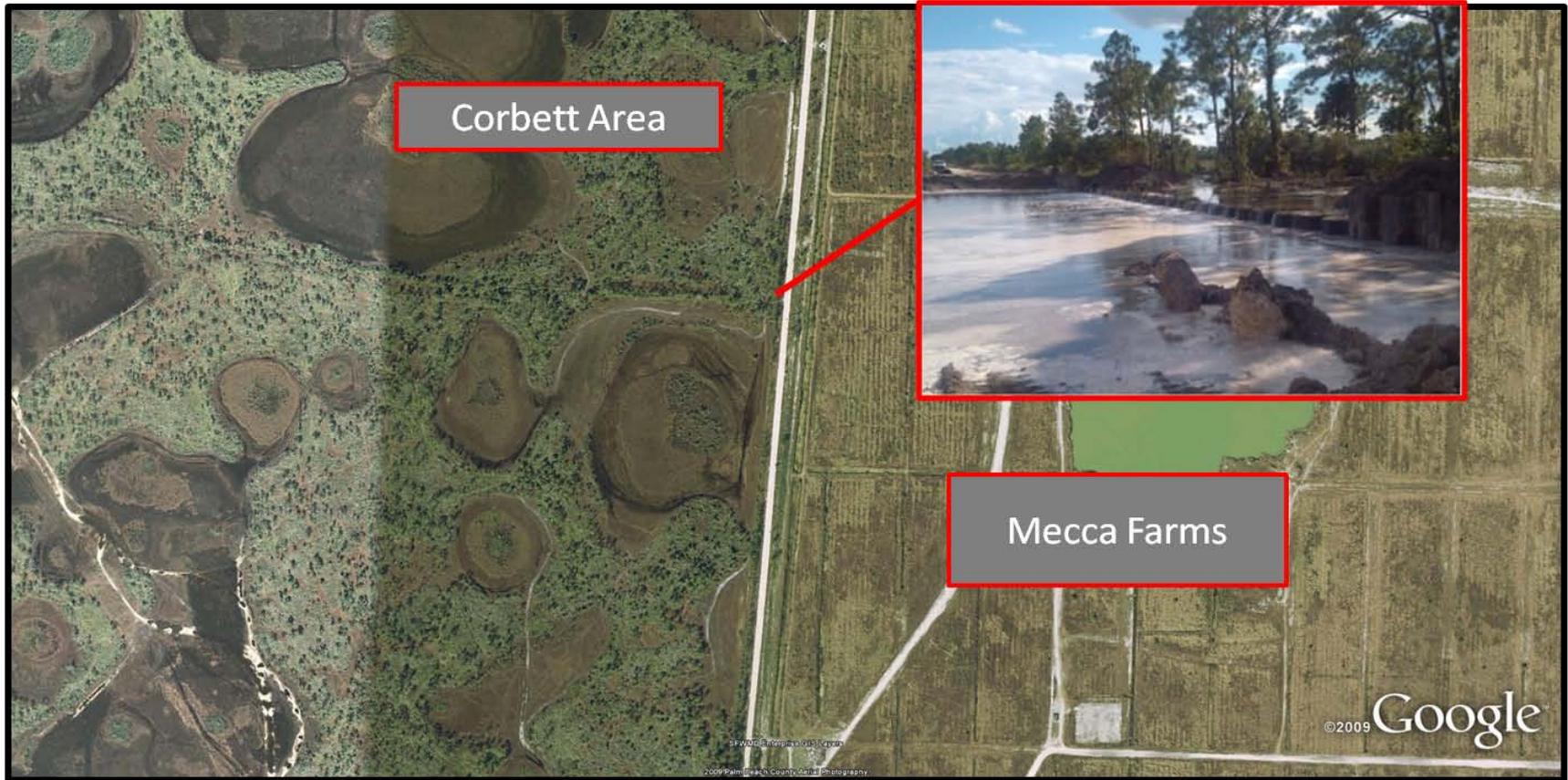
09/02/2012



09/01/2012



# East Corbett Area Emergency Weir to Mecca Property; Site #5



## Corbett Area Site #5

- To drain excess water from the Corbett Area to reduce pressure on the local berm
- 140-foot temporary steel sheet pile weir
- Two 42" temporary pumps to move water from Mecca site to C-18
- Removed C-18 Weir pumps (Site #4)
- Road will be reopened when flooding subsides
- Temporary structure will be removed when the permanent repairs to the berm are complete

**WARNING!**  
THIS AREA IS A DESIGNATED  
**CONSTRUCTION SITE**  
TRESPASSING ON THIS SITE OR THEFT  
FROM THIS SITE IS A  
**FELONY**  
VIOLATORS WILL BE PROSECUTED UNDER  
FLORIDA STATUTES 810.09 AND 812.014

09/05/2012







08/31/2012





09/06/2012





09/06/2012



09/06/2012



09/06/2012



09/06/2012



09/06/2012



09/06/2012



09/06/2012











# Tropical Storm Isaac

*Readiness, Response, Recovery*

## OPERATIONAL SUMMARY

## Post Storm Summary

- Advanced warning from meteorological forecasts allowed adequate time to initiate storm preparations
- Coordination with local communities and drainage districts during the event improved overall response to the event
- The water control system was operated in an effective and responsible manner to deal with the projected rainfall
- Additional pump capacity at S-319 improved overall C-51 performance

# Public Communications

Friday, August 24 – Monday, September 10

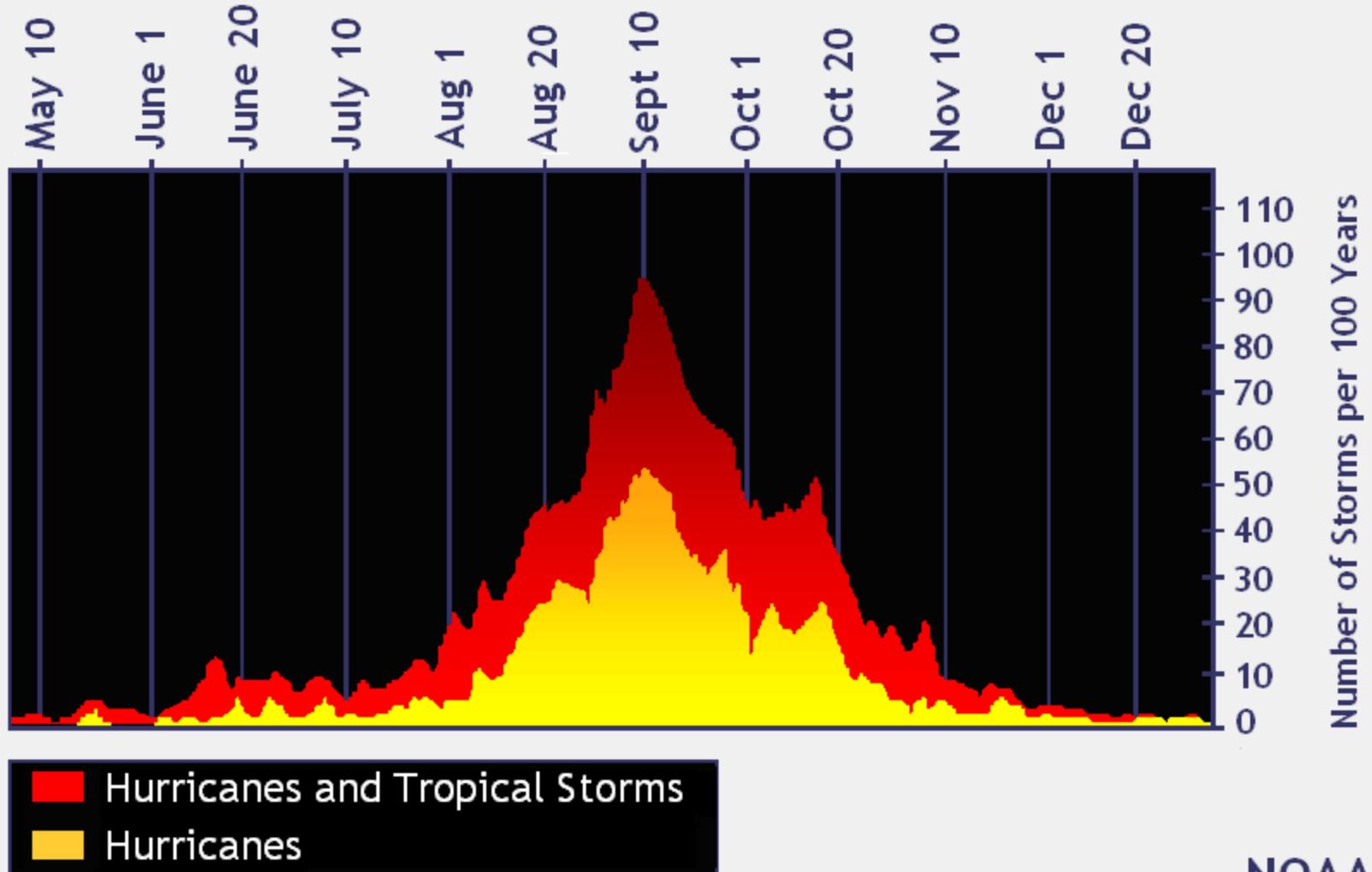
- Citizen Information Line: **1,041** calls fielded
- Public emails: **93** public emails responses
- [www.sfwmd.gov/isaac](http://www.sfwmd.gov/isaac): Continuous updates including news releases, fact sheets, maps and photo gallery
  - Website page views: **25,281**  
(more than triple number in an average week)
- Media Relations:
  - **80** Media Interviews
  - **9** Press Releases
  - **3** Press Conferences
  - **49** Social Media Tweets
  - **26** media outlets covered event



# Tropical Storm Isaac – Obligations

Category	Expense	Encumbrance	Total
Personnel Services Regular	822,096	-	822,096
Personnel Services Overtime	213,565	-	213,565
Fuel	1,508,145	166,408	1,674,553
Equipment Rental	8,000	128,164	136,164
Materials	12,441	228,070	240,511
<b>Total</b>	<b>\$ 2,564,247</b>	<b>\$ 522,642</b>	<b>\$ 3,086,889</b>

## Peak of the Hurricane Season



NOAA

# Isaac's Impacts

Locally heavy rains & strong winds from the Gulf Coast region to the Corn Belt

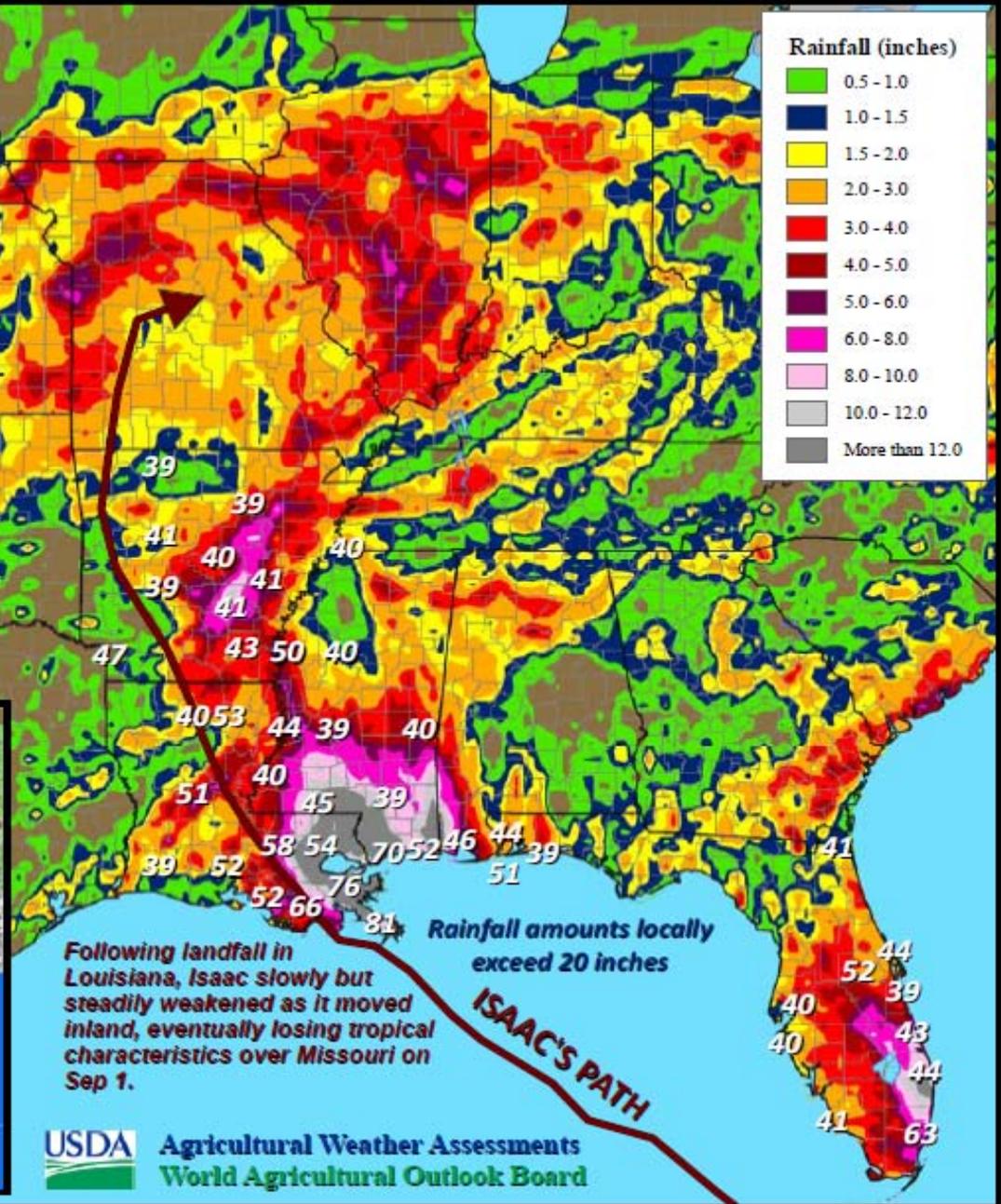
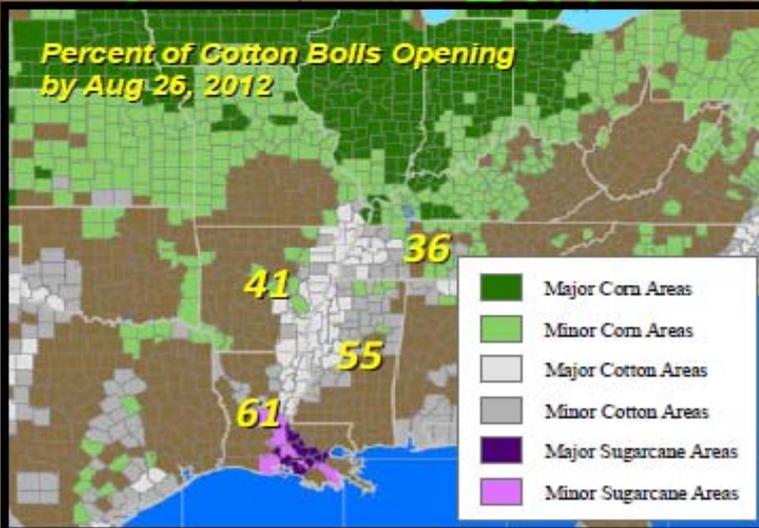
8 AM EDT Aug 25, 2012 - 8 AM EDT Sep 3, 2012

White numbers approximate peak wind speeds at select surface locations based on hourly observations. Stronger winds may have occurred at these sites.

**Data Sources:**

- Rainfall and wind data obtained from the National Weather Service
- Agricultural areas are delineated using NASS county-level crop data

## Percent of Cotton Bolls Opening by Aug 26, 2012



**Rainfall (inches)**

0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 3.0
3.0 - 4.0
4.0 - 5.0
5.0 - 6.0
6.0 - 8.0
8.0 - 10.0
10.0 - 12.0
More than 12.0

Following landfall in Louisiana, Isaac slowly but steadily weakened as it moved inland, eventually losing tropical characteristics over Missouri on Sep 1.

Rainfall amounts locally exceed 20 inches

**ISAAC'S PATH**



Flooding from Hurricane Isaac was severe in Plaquemines Parish, La.

# Tropical Storm Isaac

*Readiness, Response, Recovery*

## DISCUSSION