# Making tabular data spatial

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Galveston District (SWG)

# Background

## How I got here

US Army Corps of Engineers (USACE) has a lot of tabular data that is of a known point on the ground

Still collect data about locations in a tabular format – we are getting better ☺

- Put into a database
  - Manually and Automatically

Someone still puts it on a map (every time) ☹

- Pulled out and put into a shapefile to be added to the map

We still reference historic data

- Shapefiles (sometimes recreated because could not find the old one)

# My Mission

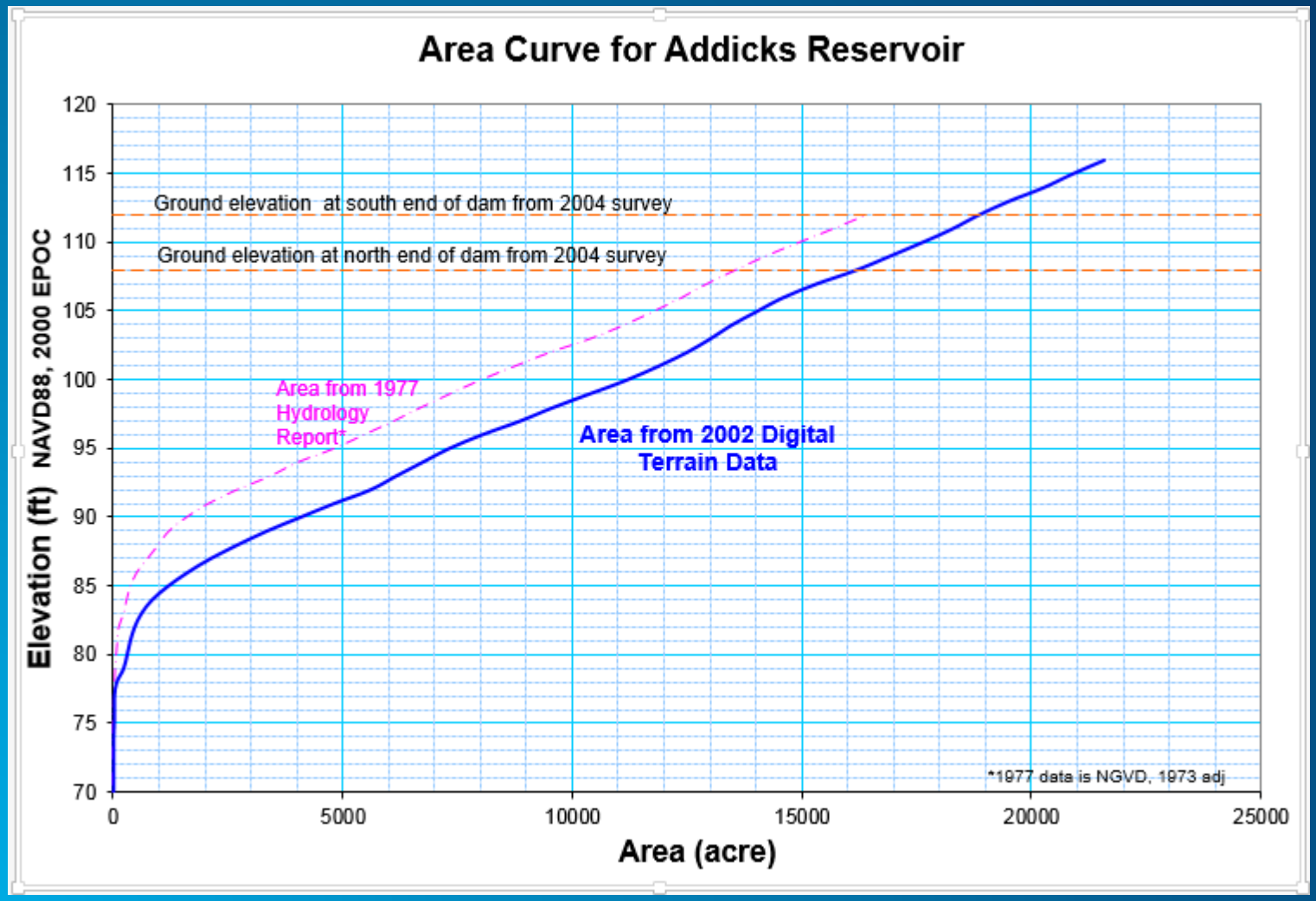
Take automatic stream gage and reservoir gate readings (every 15 minutes)  and add them to a database and map them automatically!

- Oracle database of gages and gates
- Read-Only access
- Not spatial (yet)

Curves in excel

- One for every reservoir
- Reservoir Manual

# Example Area Curve



# Example of Area/Capacity table

**Table 7-01**

**Elevation-Area/Capacity Table - Addicks Reservoir**

| Elevation (ft) NAVD 1988 | Area ($ft^2$) Capacity (Ac-ft) 0 | Area ($ft^2$) Capacity (Ac-ft) 0.01 | Area ($ft^2$) Capacity (Ac-ft) 0.02 | Area ($ft^2$) Capacity (Ac-ft) 0.03 | Area ($ft^2$) Capacity (Ac-ft) 0.04 | Area ($ft^2$) Capacity (Ac-ft) 0.05 | Area ($ft^2$) Capacity (Ac-ft) 0.06 | Area ($ft^2$) Capacity (Ac-ft) 0.07 | Area ($ft^2$) Capacity (Ac-ft) 0.08 | Area ($ft^2$) Capacity (Ac-ft) 0.09 |
|---|---|---|---|---|---|---|---|---|---|---|
| 66 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| | 25 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 |
| 66.1 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 27 | 27 | 27 |
| 66.2 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 |
| 66.3 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| | 27 | 27 | 27 | 27 | 28 | 28 | 28 | 28 | 28 | 28 |
| 66.4 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 |
| 66.5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 |
| 66.6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| | 29 | 29 | 29 | 29 | 29 | 30 | 30 | 30 | 30 | 30 |

# Example Gate Openings and field calculations

| Elv. | Gate Openings G1 | G2 | G3 | G4 | G5 | G1-Flow | G2-Flow | G3-Flow | G4-Flow | G5-Flow | Total Gate Flow | Storage Ac-Ft | Total Inflow cfs | Elev 0730 0800 | 24-hr Ave Q | 24-hr Ave inflow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | | | | | | | | | | | | | | | | |
| 69.32 | 0.00 | 1.00 | 0.00 | 1.00 | 0.00 | 0.00 | 63.16 | 0.00 | 63.16 | 0.00 | 126.32 | 49 | 0 | 69.34 | | |
| 69.32 | 0.00 | 1.00 | 0.00 | 1.00 | 0.00 | 0.00 | 63.16 | 0.00 | 63.16 | 0.00 | 126.32 | 49 | 126 | 69.34 | | |
| 69.23 | 0.00 | 1.00 | 0.00 | 1.00 | 0.00 | 0.00 | 61.58 | 0.00 | 61.58 | 0.00 | 123.15 | 48 | 123 | | | |
| 69.24 | 0.00 | 1.00 | 0.00 | 1.00 | 0.00 | 0.00 | 61.76 | 0.00 | 61.76 | 0.00 | 123.51 | 49 | 123 | | | |
| 69.31 | 0.00 | 1.00 | 0.00 | 1.00 | 0.00 | 0.00 | 62.99 | 0.00 | 62.99 | 0.00 | 125.97 | 49 | 126 | 69.37 | 125 | 125 |
| 69.37 | 0.00 | 1.00 | 0.00 | 1.00 | 0.00 | 0.00 | 64.02 | 0.00 | 64.02 | 0.00 | 128.04 | 50 | 128 | 69.39 | | |

Gate Calculation =IF($C11<$C$1,0,(IF(+F11<=0.1,0,IF(+$C11-($C$1+F11)<=0,2.87*8*(+$C11-$C$1)^1.5,(0.7292311/(F11^0.07988726)*8*F11*((64.4*($C11-$C$1))^0.5)))))) Different for each reservoir

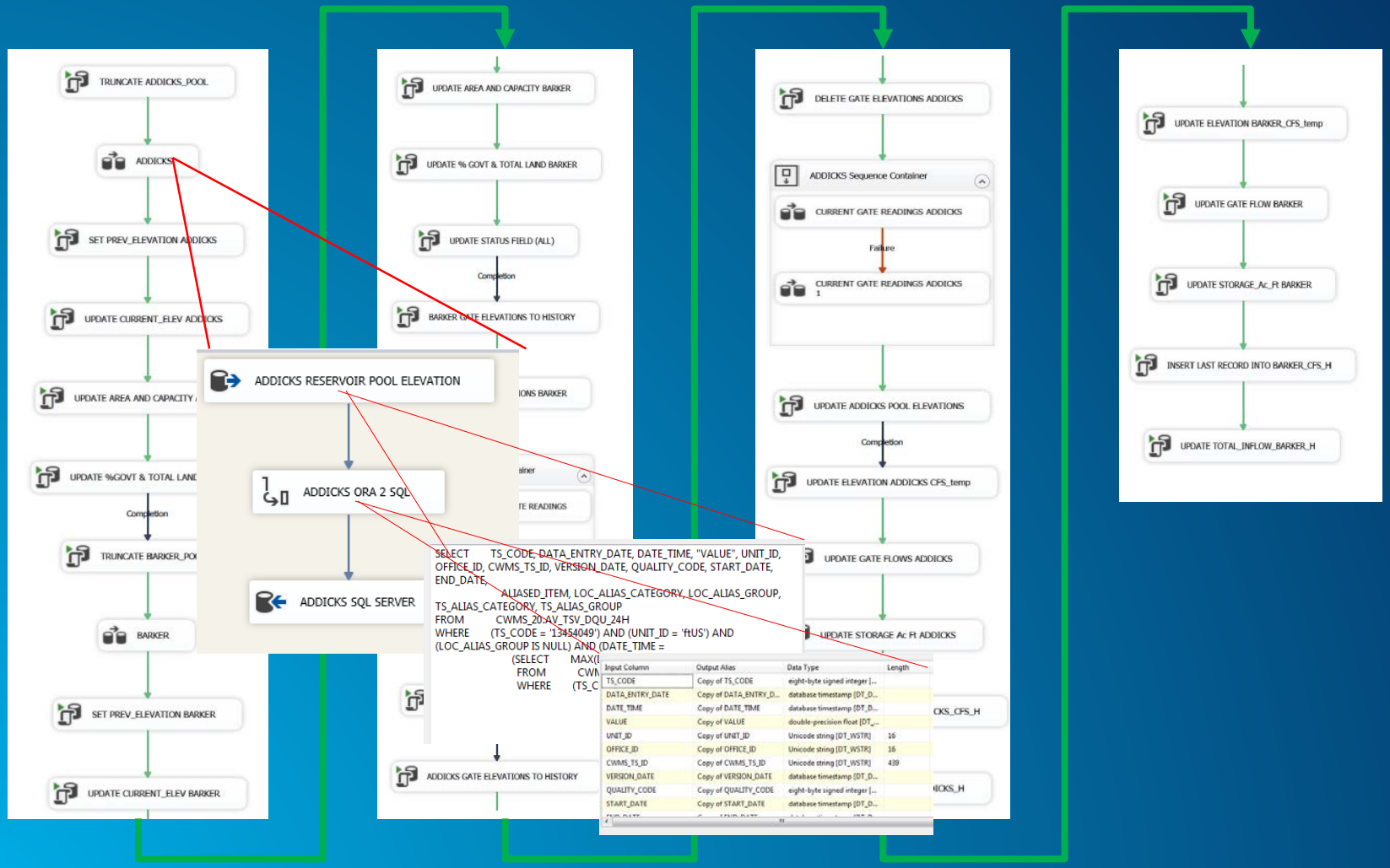
24hr Flow =SUM((R11+R12)/2,(R13+R12)/2,(R14+R13)/2,(R15+R14)/2)/4

Macros run in background too

## Step 1 through …….

- Extract data from Oracle and put into SQL Server we can add calculations and triggers
  - USACE rules prevent me from adding triggers to the water control database
  - Correct data
    - USACE has raw and revised data
- Load data in SQL Server tables
  - Validate data
  - Add date time stamp to incoming record
    - Update previous elevation reading data time stamp
- Perform calculations on data
    - Verify those results

# SQL Server Business Intelligence – Let the database do the work



# More steps…….

Create historic record of data, calculations and changes

- data, data, data and more data

Join data to spatial feature

- Easiest part of the process

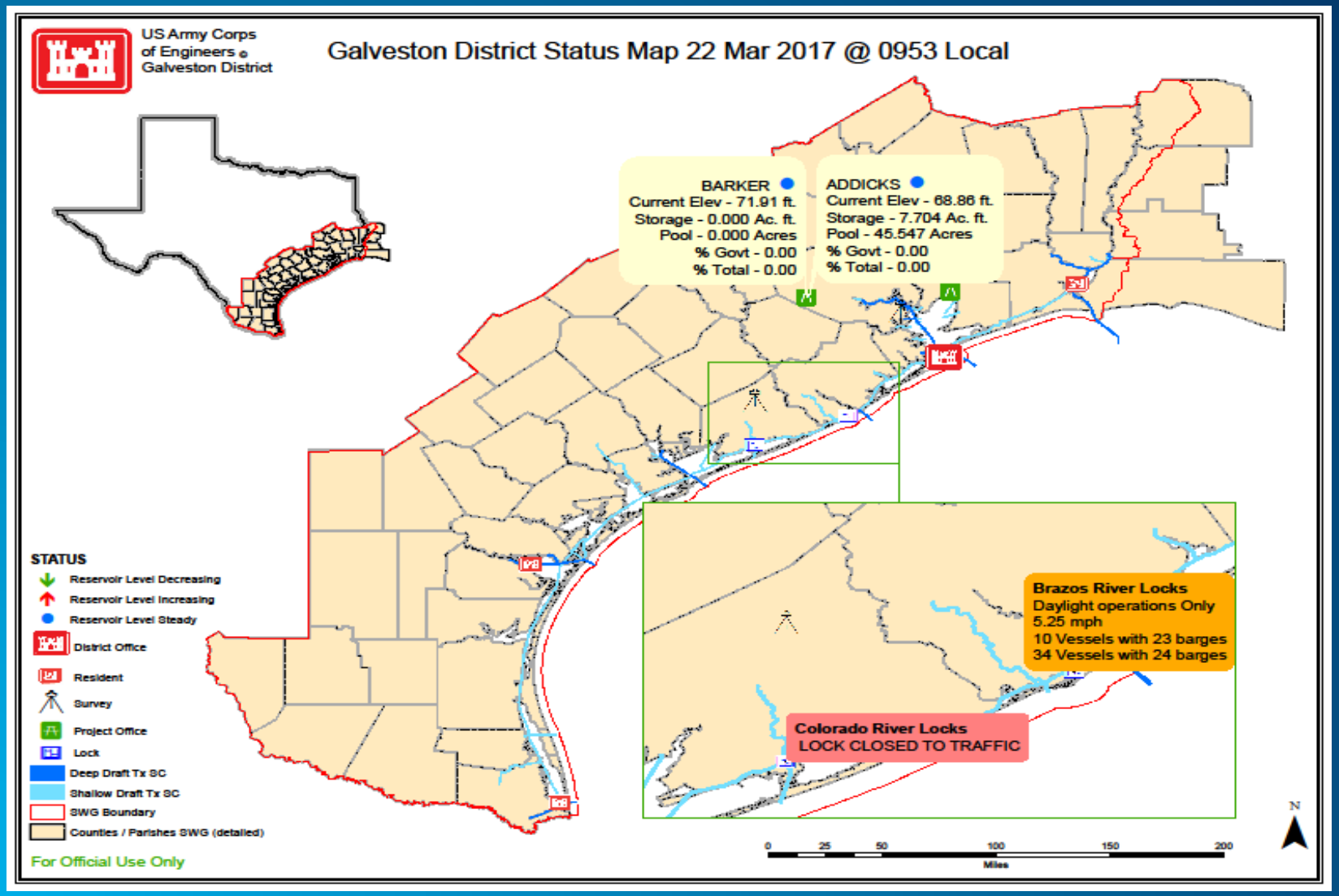
Calculate symbology of action by query (Symbology Classes)

- Increasing Levels
- Decreasing Levels
- Steady Levels

# Map it to USACE requirements for higher ups

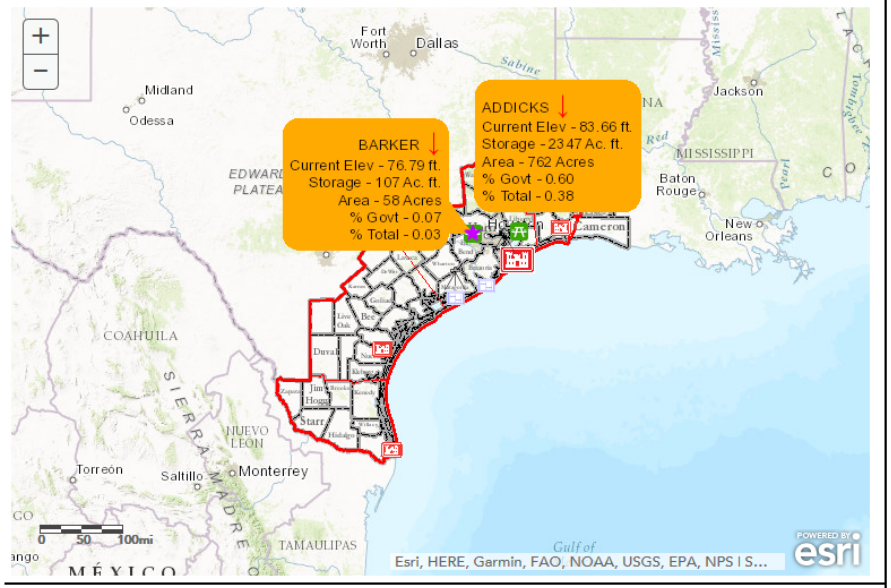
- Everyone has a boss or three
- Data display requirements
  - Multiple formats
- Extend it to other districts

# Sample of print map



# Live online page for viewing reservoir status and situation report

## 2017 Galveston District Situation




Colorado River Locks - OPEN
None
Vessels East:
Vessels West:
Riverspeed:

Brazos River Flood Gates - OPEN
None
Vessels East:
Vessels West:
Riverspeed:

Addicks / Barker Release Schedule:

Current Situation: Record rainfall led to major flooding in southeast Texas. Additional rainfall exceeding 15" in some areas was received the last 48 hours. This precipitation has led to major and/or historic flooding in some rivers. Releases at Addicks and Barker are being adjusted. Flows at the Colorado River Locks (CRL) and Brazos River Floodgates (BRFG) are being monitored for potential closure.
USACE Activities: EOC activated at Level III, partial activation, ensuring safe navigation, monitoring federal projects and river levels, providing support to the State.
District Report

- No known impacts to federal projects
- Provided Ft. Bend County 37,500 sandbags (450K on hand)

State/Local Activities

- Activated to Level III on 27 May 2016

River Report
Colorado River at Wharton @ 33.4' (major occurs @ 43')

- Expected to reach 46.6' on 30 May
- @ 48' US59 impassable and 44 homes flooded
- Historic 51.9' 12/13/1913; Recent 42.7' 05/31/2015

Brazos River at Richmond @ 44.14' (major occurs @ 50')

- Crest expected at 53.5' on 31 May-RECORD
- Historic 50.3' 10/21/1994; Recent 49.9' 06/03/2016
- Voluntary evacuations ongoing

Spring Creek at Spring @ 107.75' MAJOR (occurs @ 102')

- Evacuations ongoing
- Historic 123.8' 10/18/1994; Recent 95.1' 05/28/2015

Trinity River at Romayor@ 38.21' (major occurs @ 43')

- Historic 45.6' 05/09/1942; Recent 34.7' 03/13/1997

W Fork San Jacinto at Humble @ 58.11' MAJOR (occurs @ 52.3')

- Homes flooded
- Historic 67.3' 10/18/1994; Recent 53.65' 05/28/2015

Next 24-72 hours

- Monitor flows at CRL and BRFG
- Continue to provide support to the State
- Adjust releases at Addicks and Barker

Commander's Assessment: SWG's AOR received excessive rainfall in already saturated locations in the past 48 hours. Ongoing flooding across most watersheds in SE Texas. Addicks and Barker releases are being adjusted. Addicks is being monitored 24/7 as it has returned to EW 2, anticipate EW 1 by 31 May. The CRL and BRFG anticipate closure to navigation in the next 24-72 hours. Staff is monitoring all waterways to ensure safe navigation.

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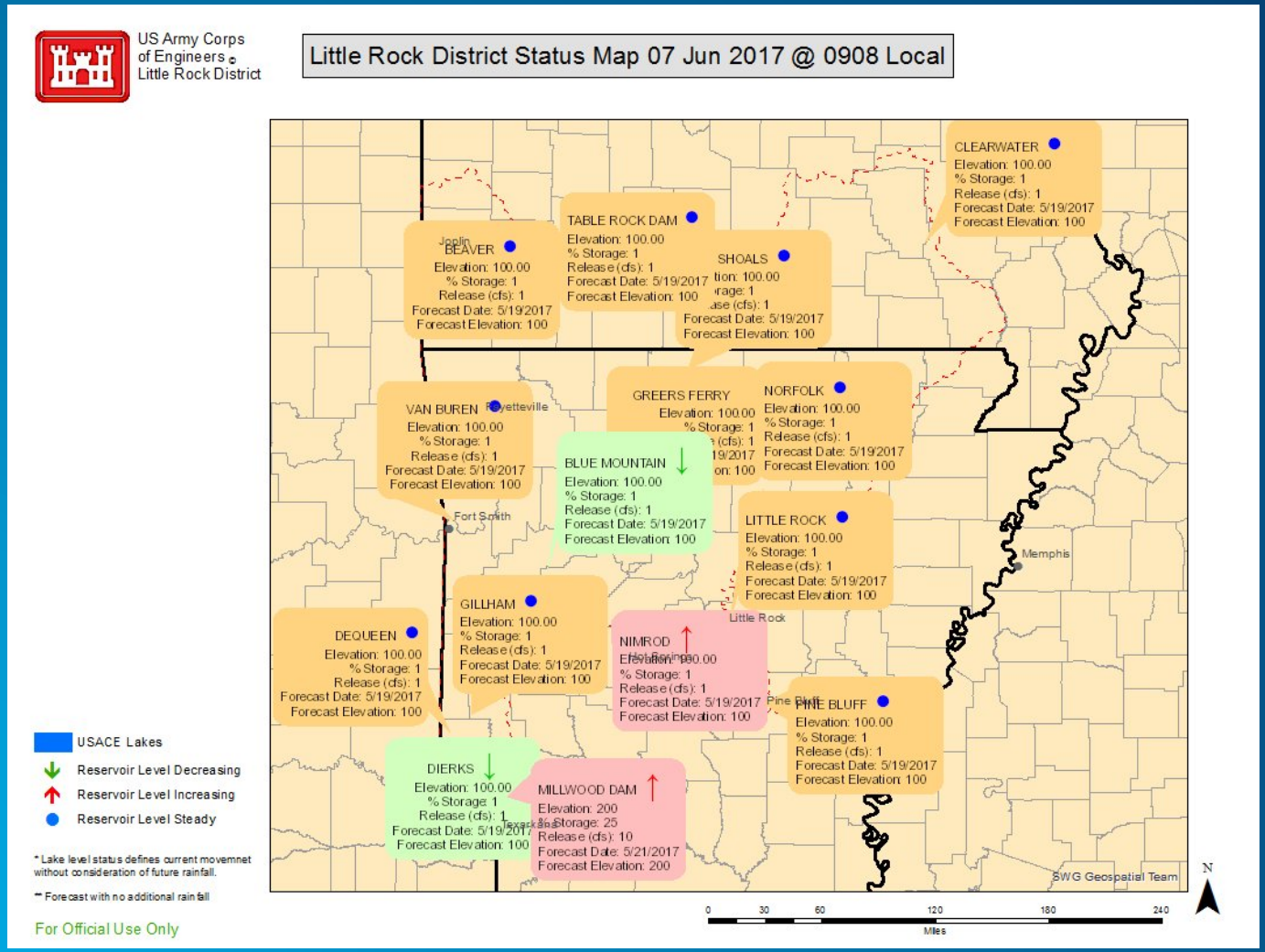
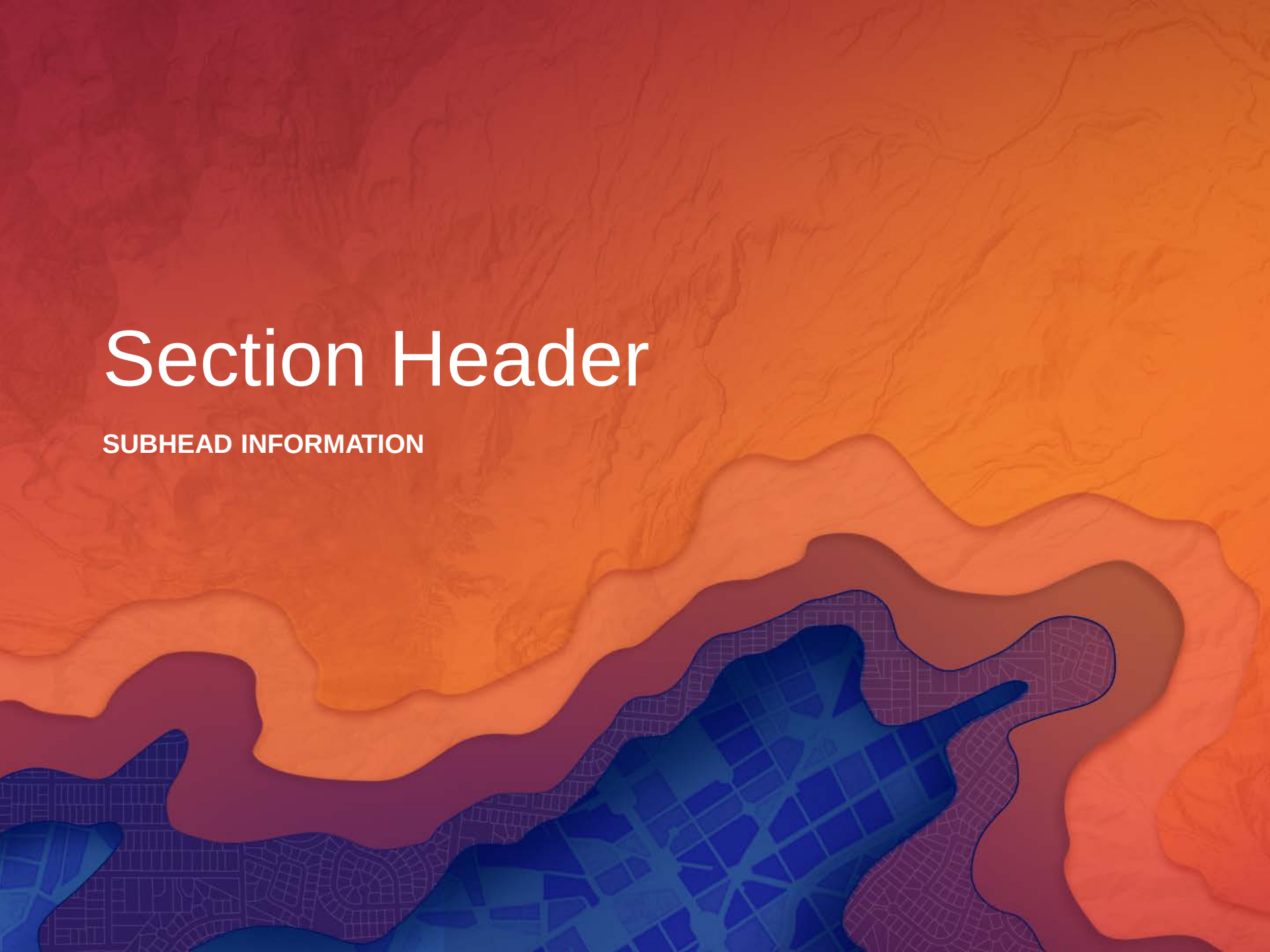
# Little Rock District (SWL) sample map



# Section Header

**SUBHEAD INFORMATION**