Dioxin Fingerprinting in the HSC

Philip Turner, EPA R6

Linda Broach, TCEQ

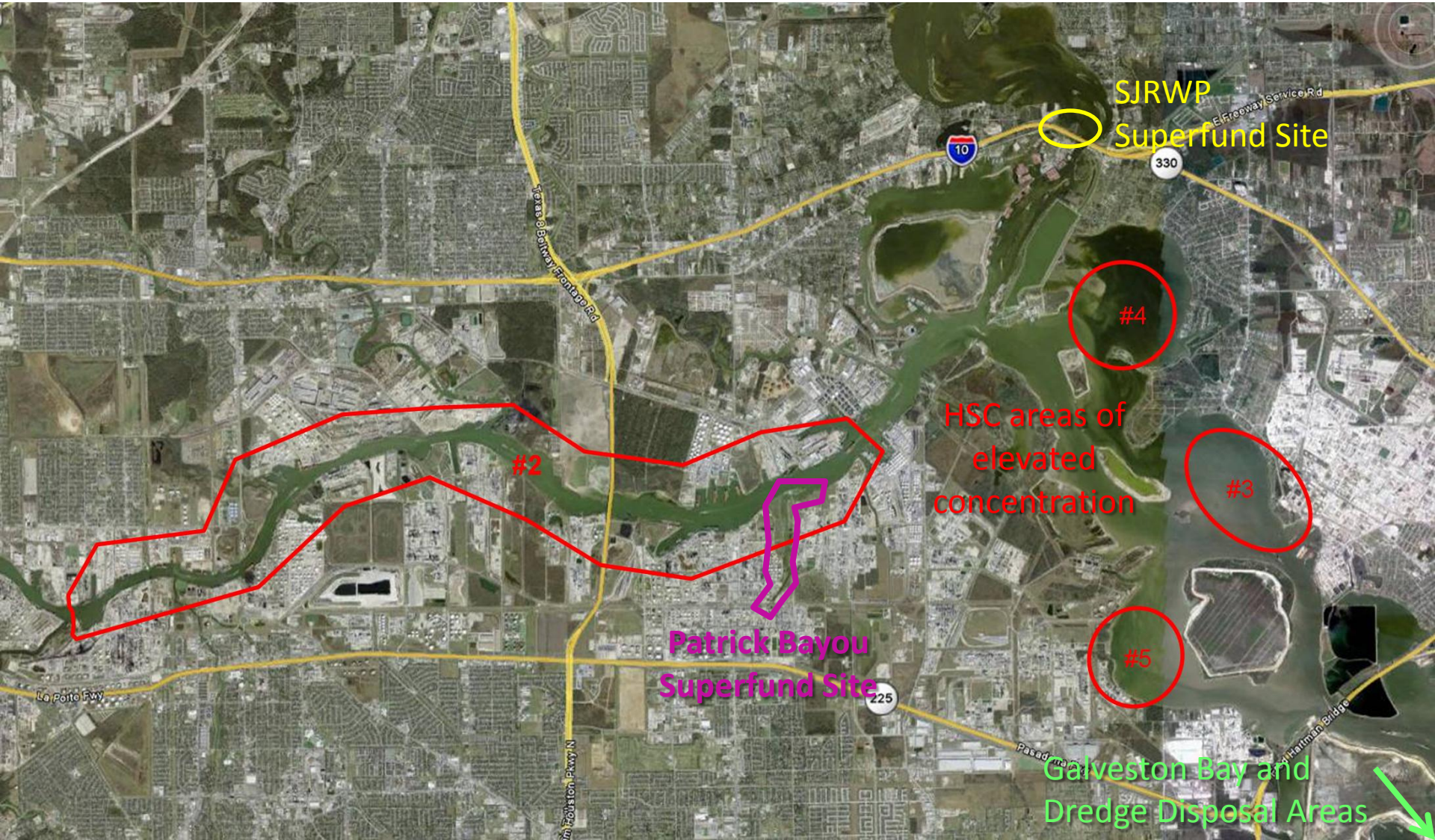
April 2011

9988272

Objectives

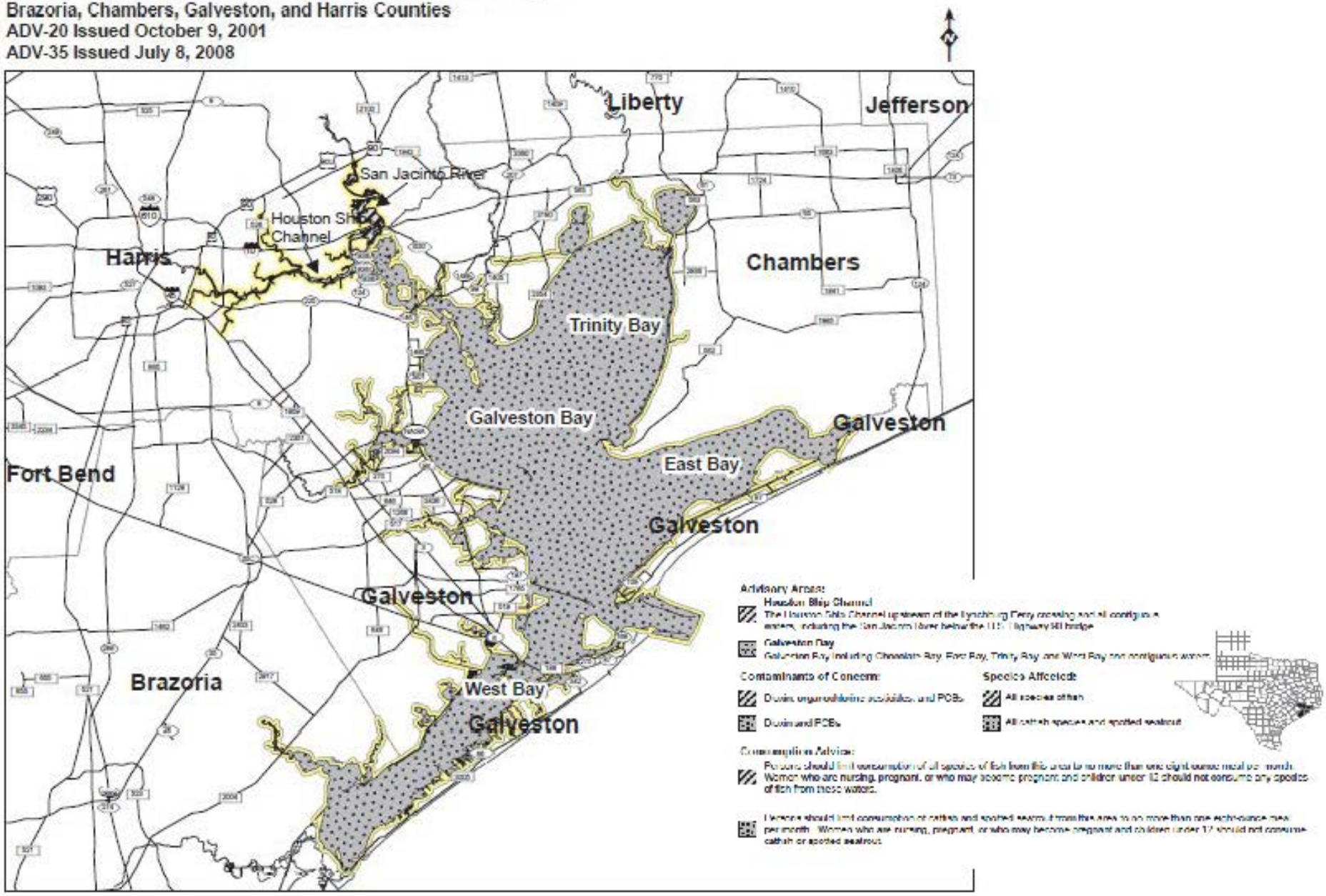
- Compare dioxin fingerprints from several areas of the HSC to the SJRWP superfund site:
  - Patrick Bayou superfund site
  - HSC from Sims Bayou to Tucker Bayou
  - Burnett Bay
  - Scott Bay
  - San Jacinto Bay
  - Galveston Bay along the HSC

Areas of Interest for this project:



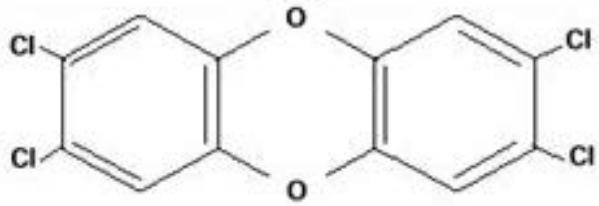
Houston Ship Channel and Galveston Bay

Brazoria, Chambers, Galveston, and Harris Counties
ADV-20 Issued October 9, 2001
ADV-35 Issued July 8, 2008

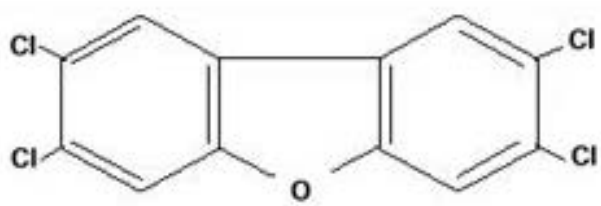


Methods

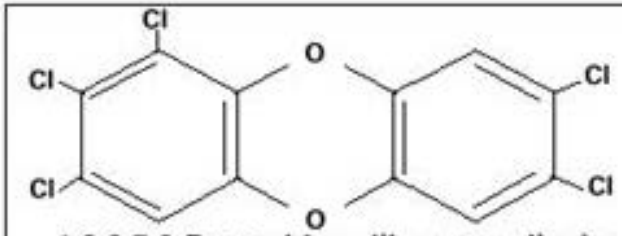
- Used Surface Sediment data from SJRWP site geodatabase, Patrick Bayou site database, and EPA Marine and Coastal Studies report
- Used 2 upstream stations in the SJR as background – 11200 and 16622
- Plotted highest 12 samples from inside SJRWP to describe pit "fingerprint"
- All values given are station averages, if more than one sample was available for a site
- TEQs computed using 2008 WHO TEFs with ND=0
- Fingerprint is computed by dividing each congener by the total for all 2,3,7,8 dioxin and furan congeners except OCDD, which was omitted for clarity



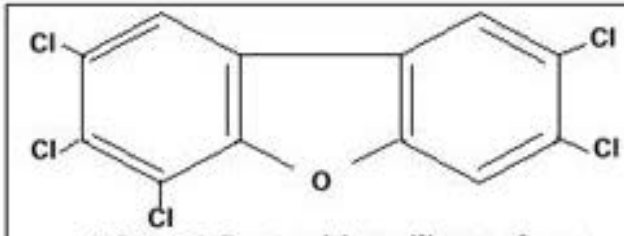
2,3,7,8-Tetrachlorodibenzo-p-dioxin



2,3,7,8-Tetrachlorodibenzofuran



1,2,3,7,8-Pentachlorodibenzo-p-dioxin

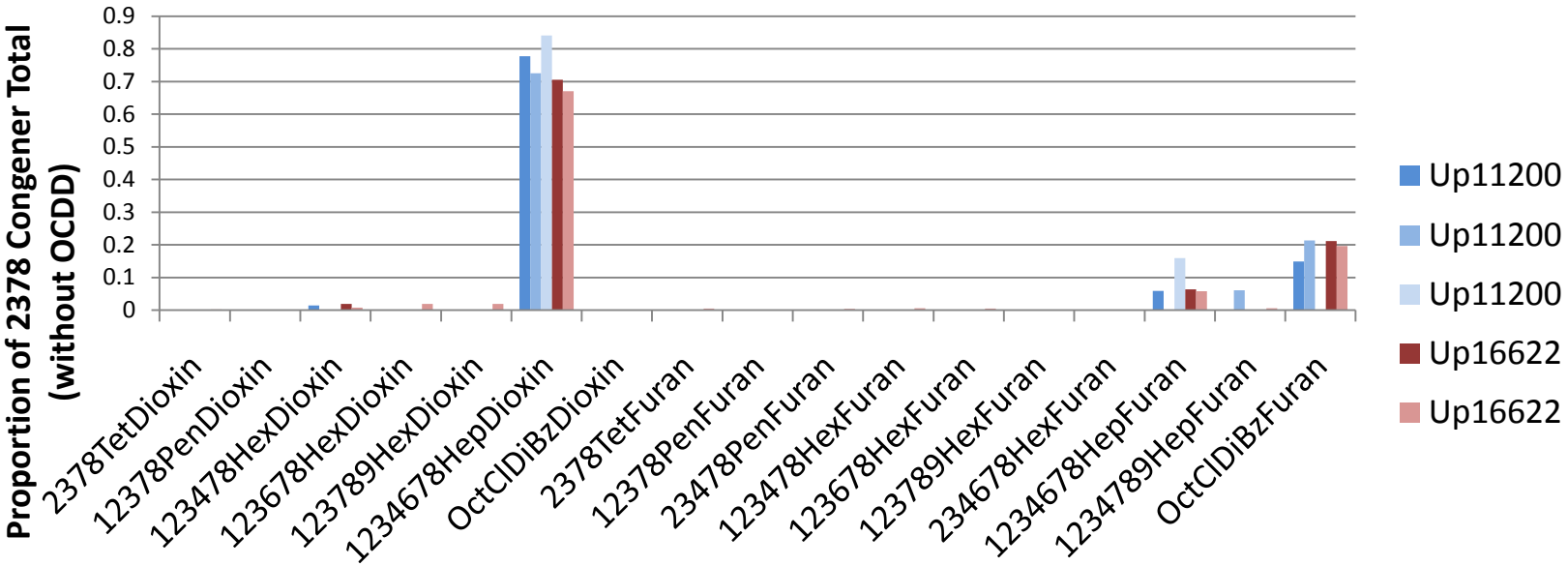


2,3,4,7,8-Pentachlorodibenzofuran

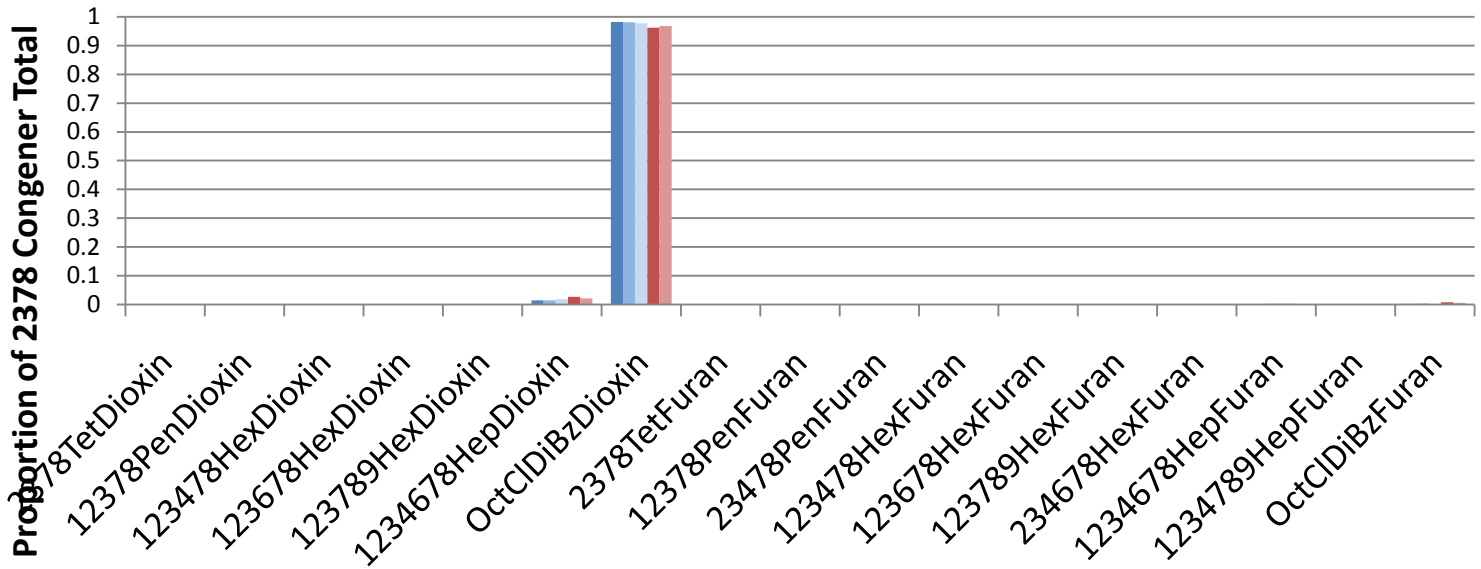
TOXIC EQUIVALENCY FACTORS (TEFs)

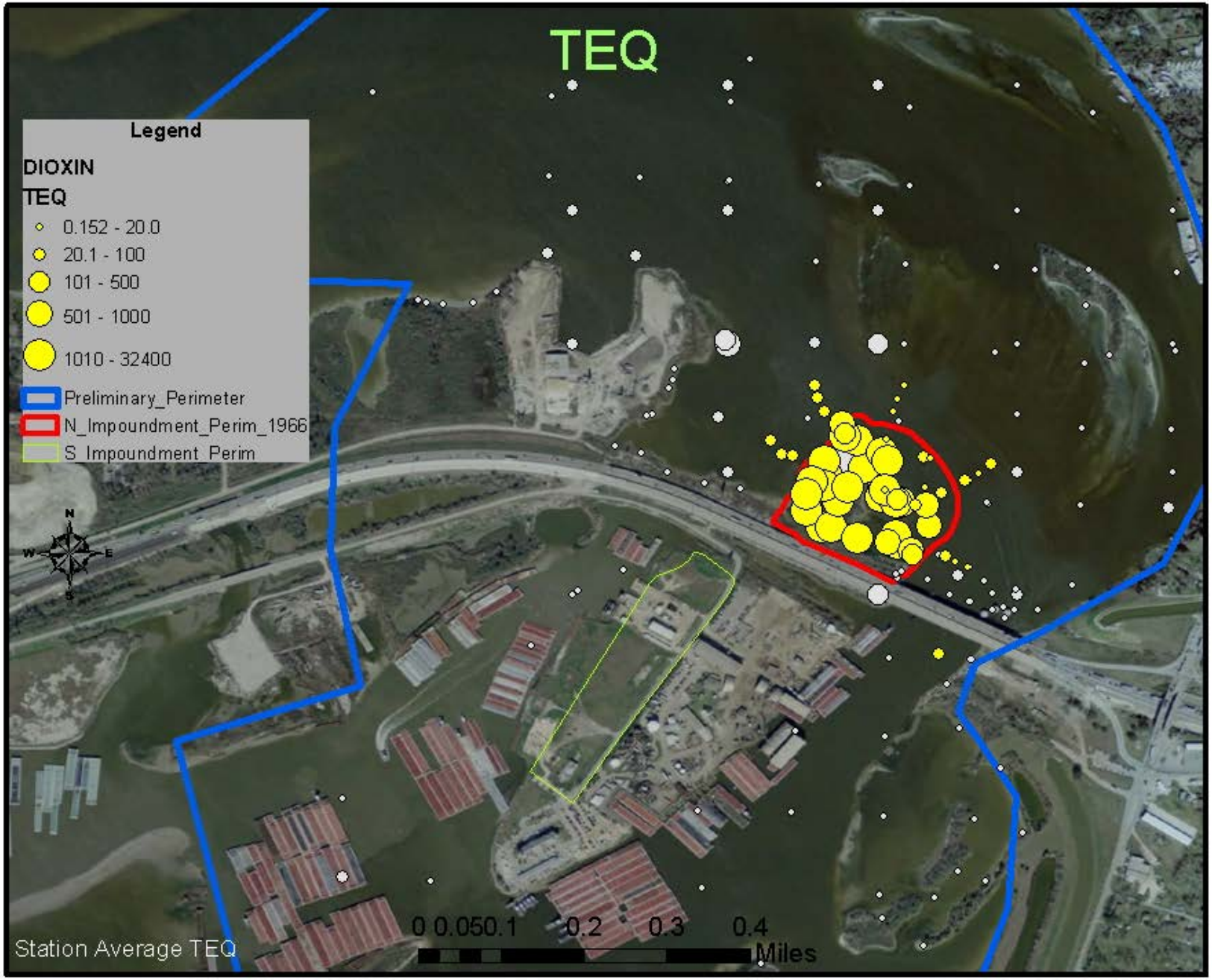
	TEF
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.01
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	0.0003
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.1
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	0.03
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	0.3
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.1
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.1
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.01
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.01
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	0.0003

Upstream SJR samples without OCDD

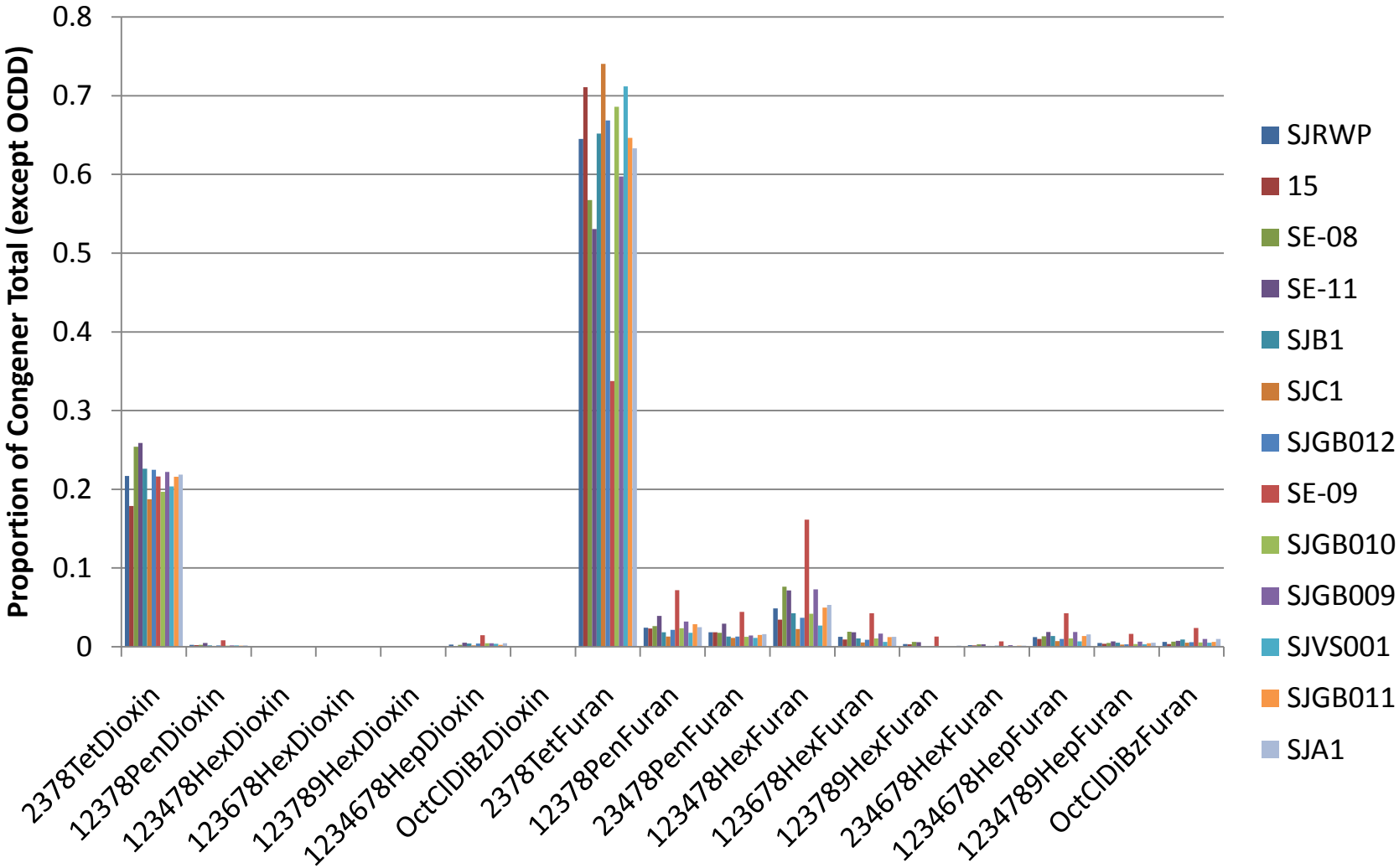


Upstream SJR samples with OCDD




TEQ
Legend
DIOXIN
TEQ
0.152 - 20.0
20.1 - 100
101 - 500
501 - 1000
1010 - 32400
Preliminary_Perimeter
N_Impoundment_Perim_1966
S_Impoundment_Perim
N
W
E
S
0 0.050.1 0.2 0.3 0.4
Miles
Station Average TEQ

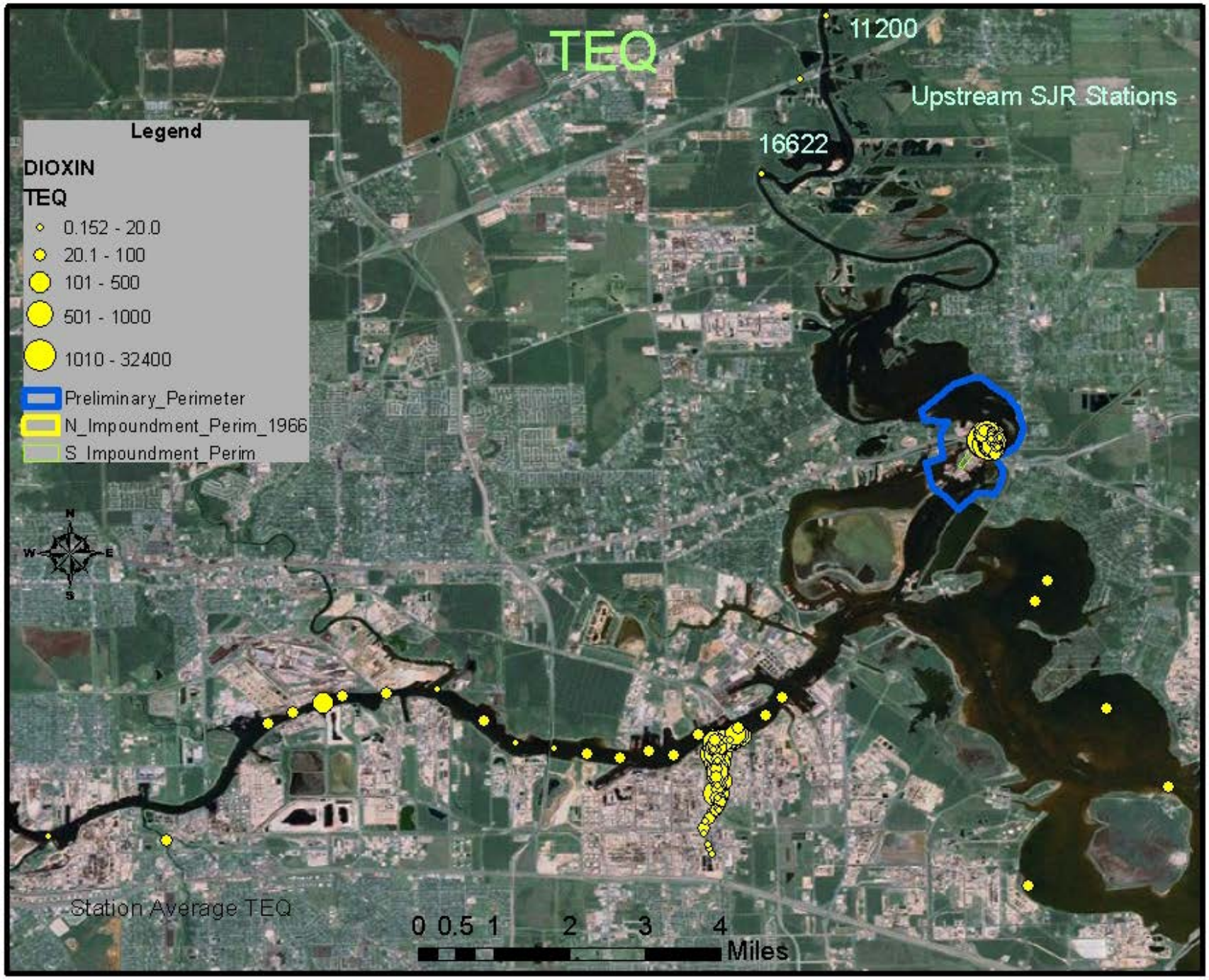
SJRWP Congener Fingerprint



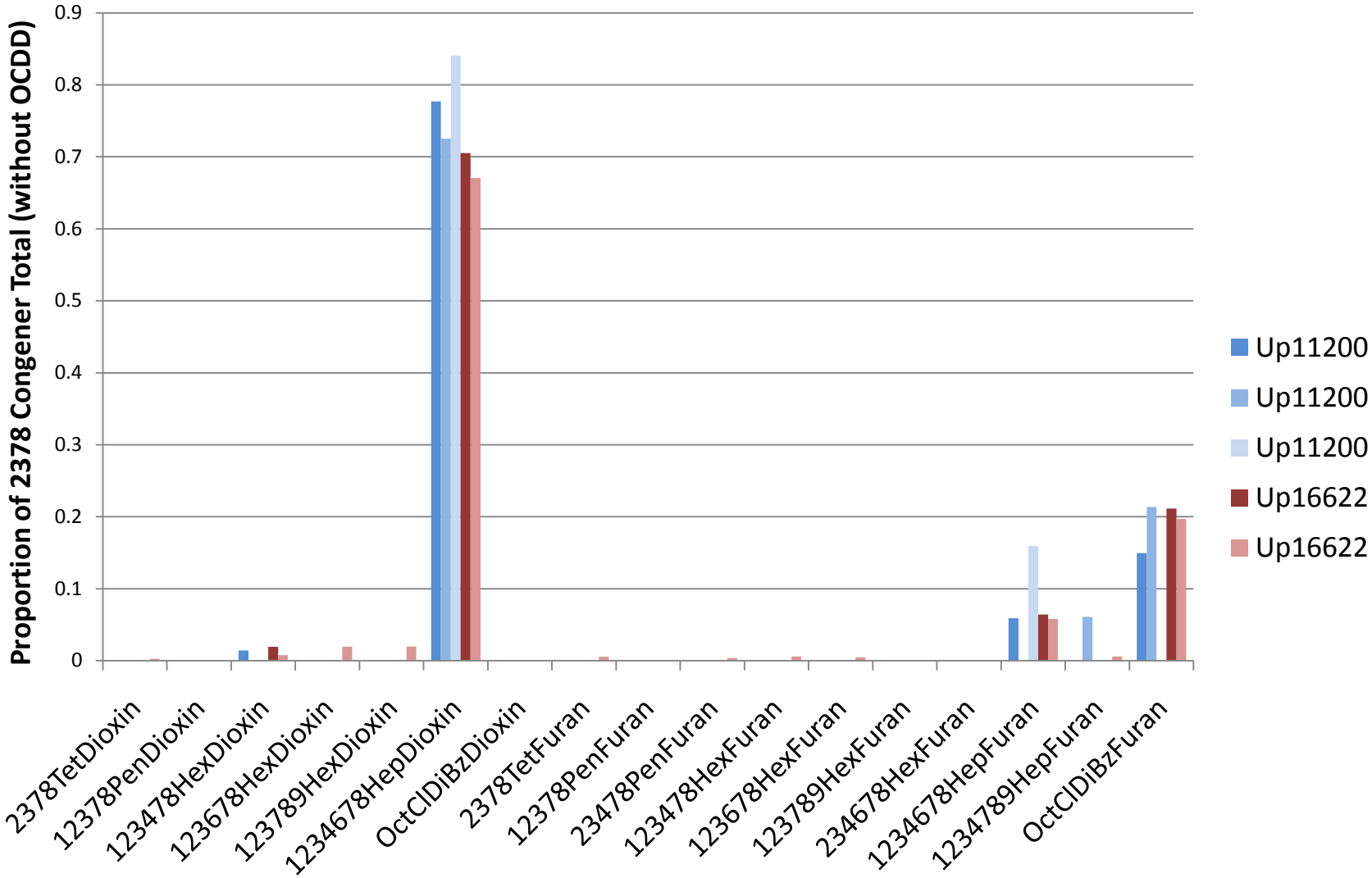
TEQ range = 10,080 to 32,400 ppt

Observations - SJRWP

- SJRW Pits are not homogenous
- Clear evidence of deposition from other sources and “clean” mud
- Congener fingerprint is dominated by
  - **2378 Tetra-furan (TCDF),**
  - **2378 Tetra-dioxin (TCDD)**,
    - smaller amounts of other furans


TEQ
11200
Upstream SJR Stations
16622
Legend
DIOXIN
TEQ
0.152 - 20.0
20.1 - 100
101 - 500
501 - 1000
1010 - 32400
Preliminary_Perimeter
N_Impoundment_Perim_1966
S_Impoundment_Perim
N
W
E
S
Station Average TEQ
0 0.5 1 2 3 4
Miles

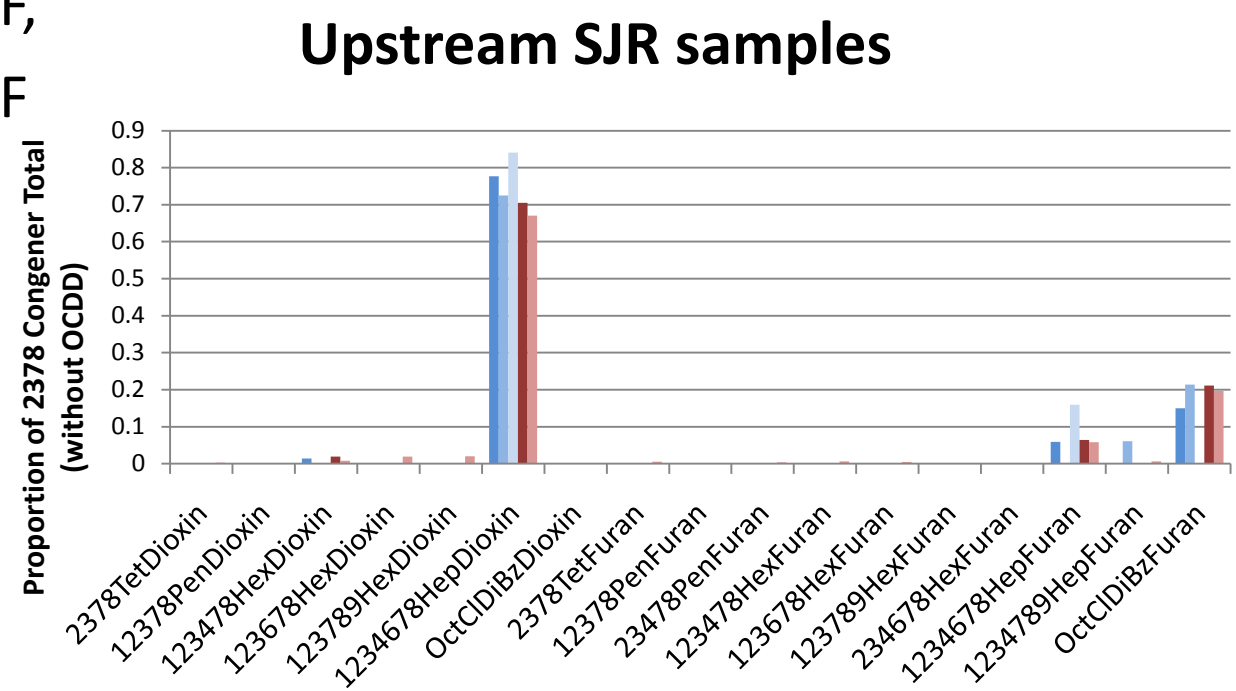
Upstream SJR samples



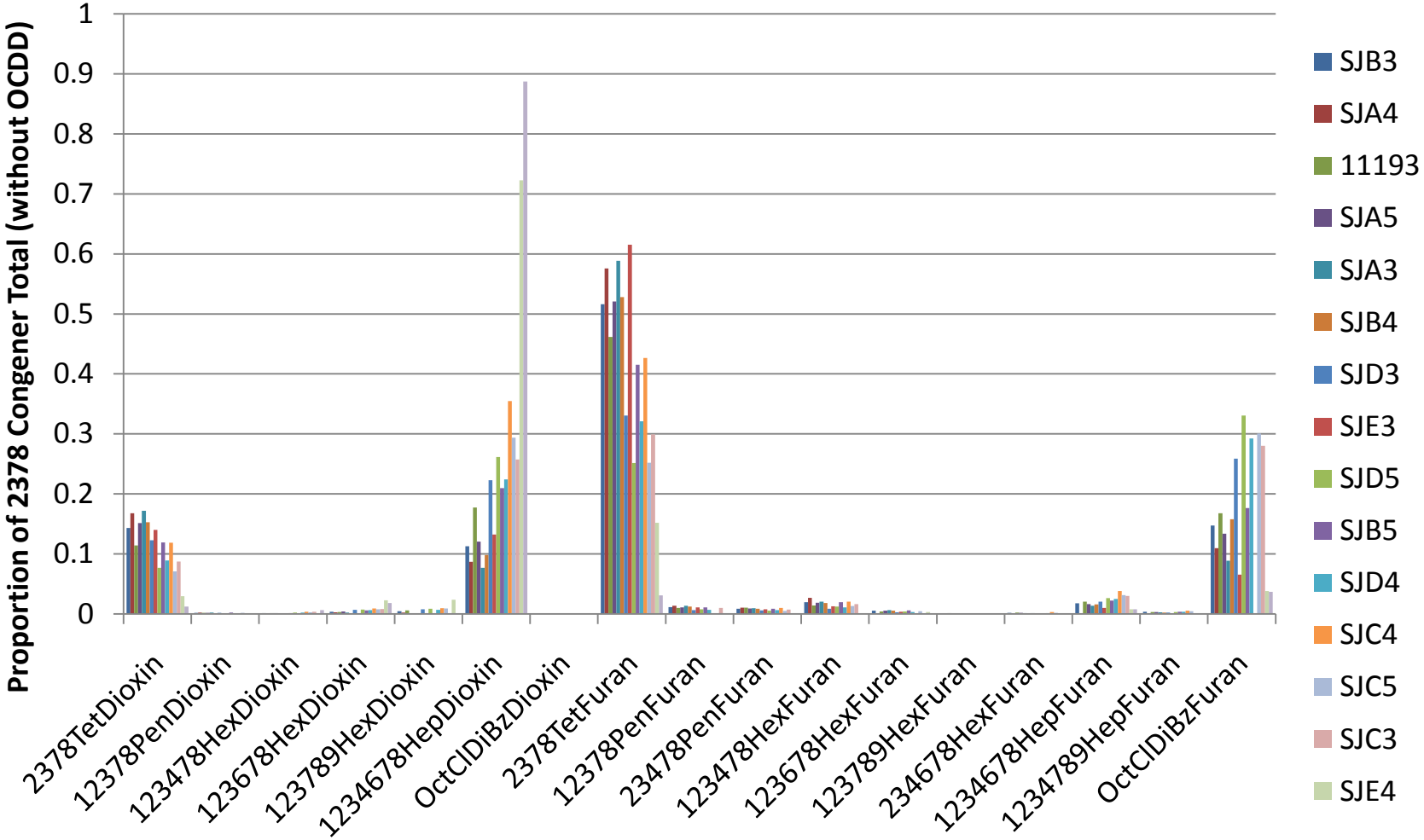
TEQ range = 0.4 to 3.1 ppt

Observations - Upstream SJR

- Upstream (background) fingerprint dominated by
  - 1234678 HpCDD,
  - OCDF,
  - 1234678 HpCDF,
  - 1234789 HpCDF



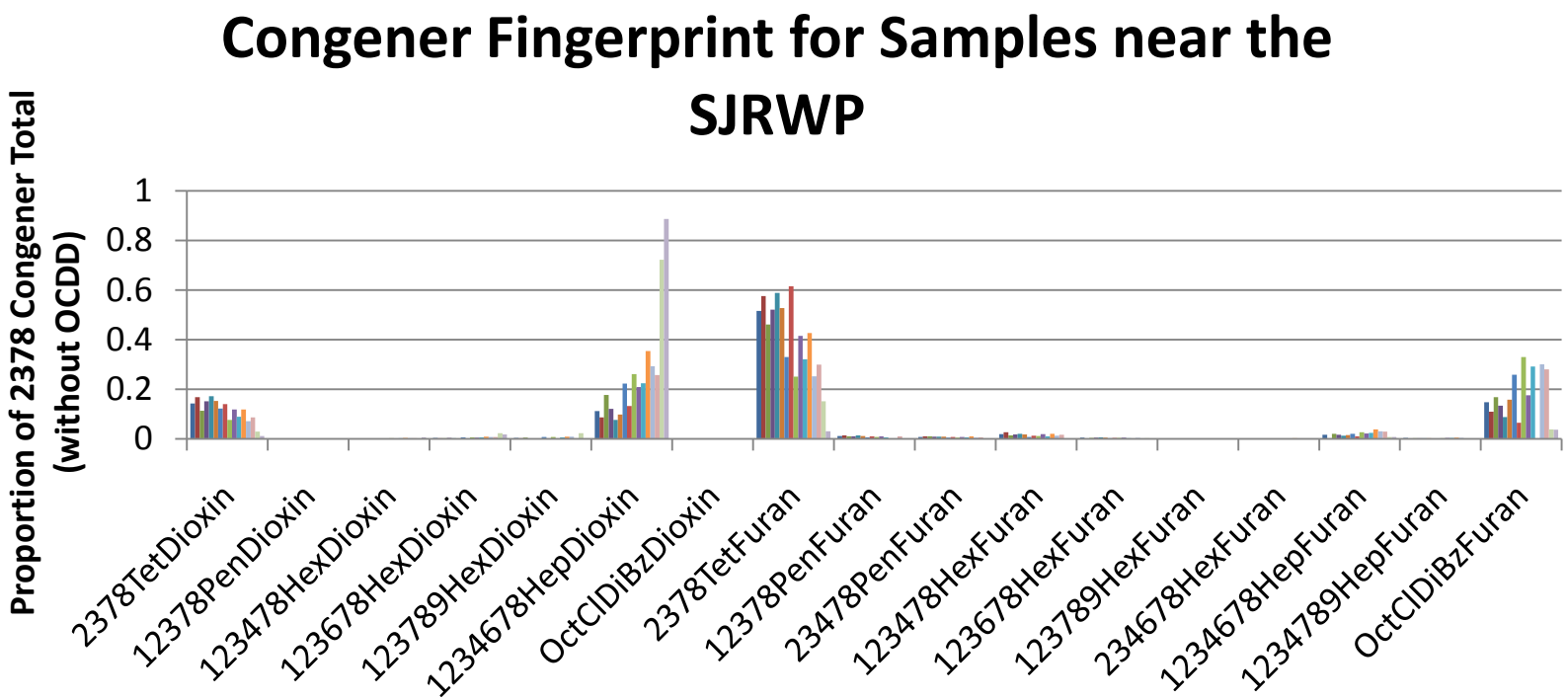
Congener Fingerprint for Samples near the SJRWP



TEQ range for these samples = 2.4 to 93 ppt

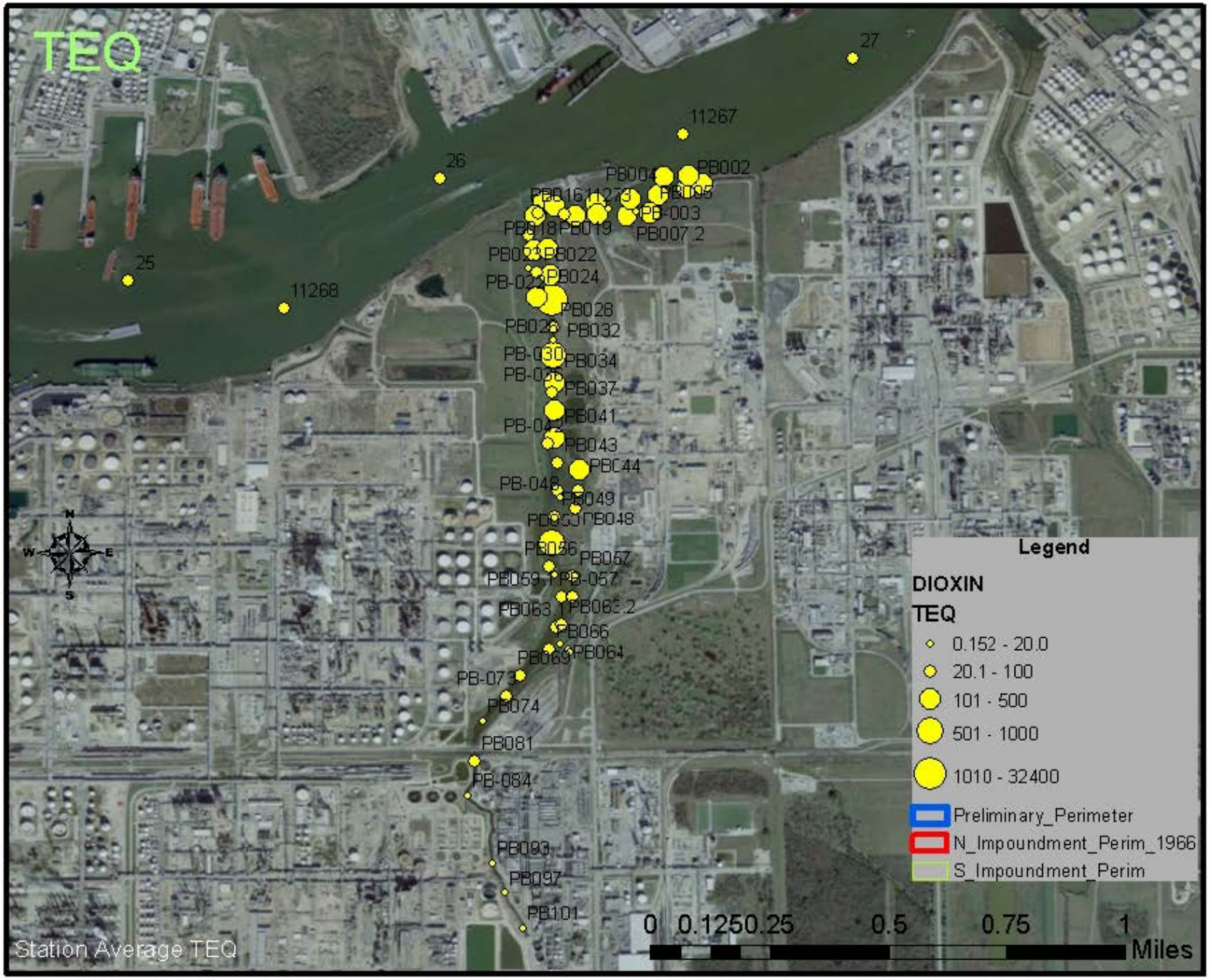
Observations - Near Pit samples

- Near-pit fingerprints are similar to pits,
  - but with lots more HpCDDs and OCDFs
  - and less PeCDFs and HxCDFs
- You can see the decline in %TCDF and %TCDD with the increase in %HpCDD

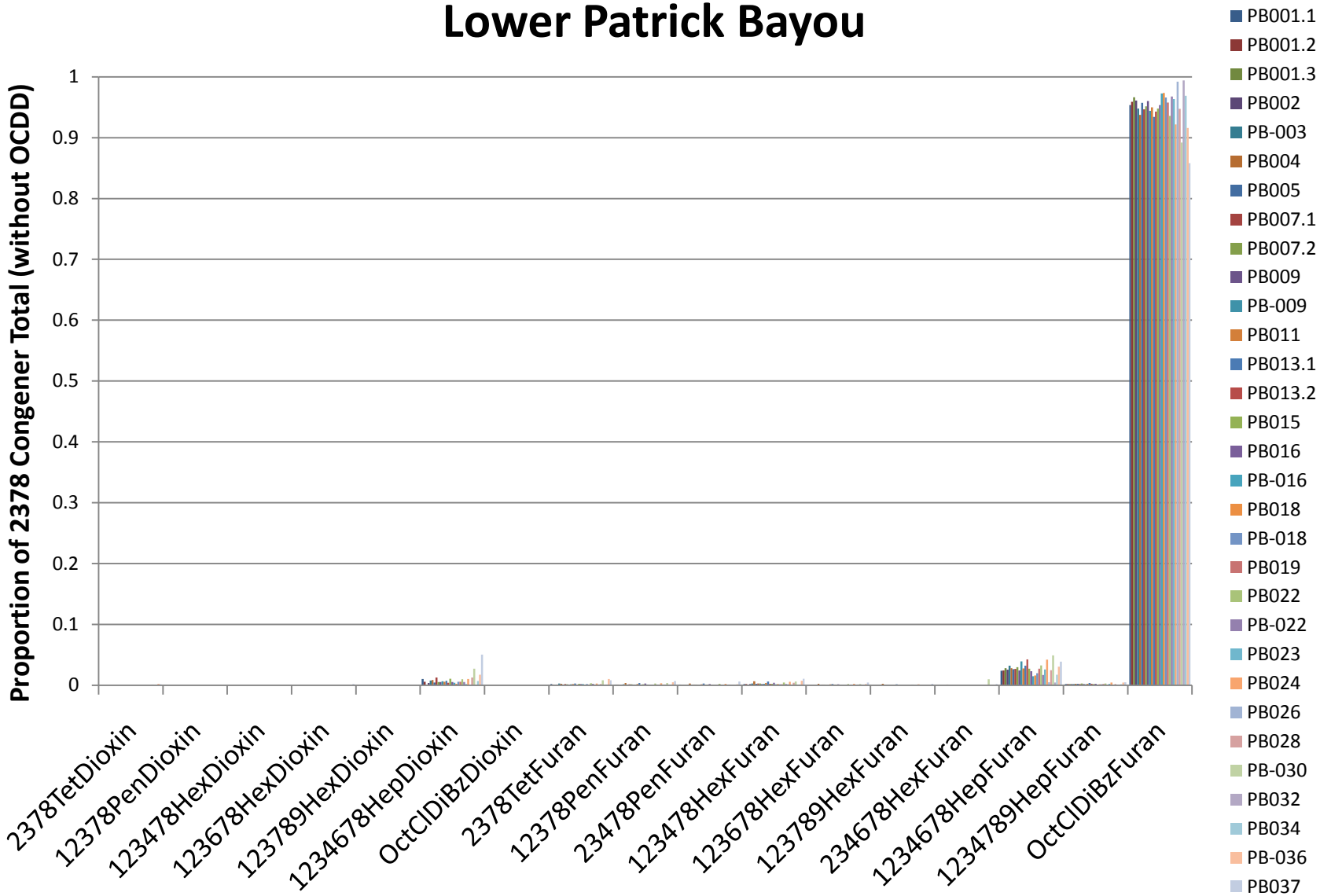


Patrick Bayou

- 60 stations
- TEQ range: 0.2 to 2224 ppt
  - Average TEQ = 133 ppt (Median = 73 ppt)
- High OCDF in lower reach
- Middle and upper reaches have various fingerprints

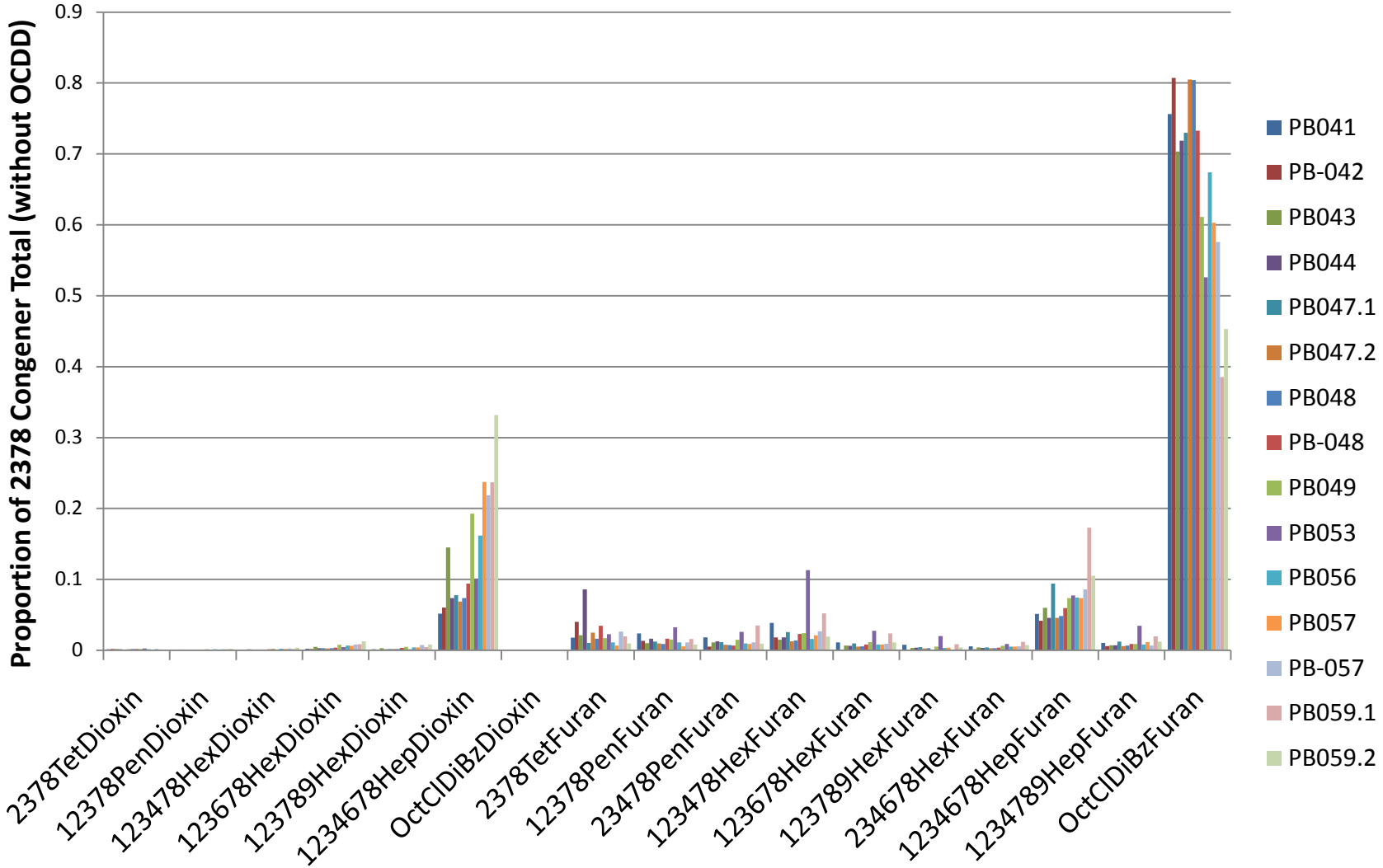

TEQ
27
11267
26
25
11268
PB002
PB003
PB007.2
PB022
PB024
PB028
PB032
PB034
PB037
PB041
PB043
PB044
PB049
PB048
PB057
PB066
PB064
PB074
PB081
PB093
PB097
PB101
N
S
E
W
Legend
DIOXIN
TEQ
0.152 - 20.0
20.1 - 100
101 - 500
501 - 1000
1010 - 32400
Preliminary_Perimeter
N_Impoundment_Perim_1966
S_Impoundment_Perim
0 0.1250.25 0.5 0.75 1
Miles
Station Average TEQ

Lower Patrick Bayou



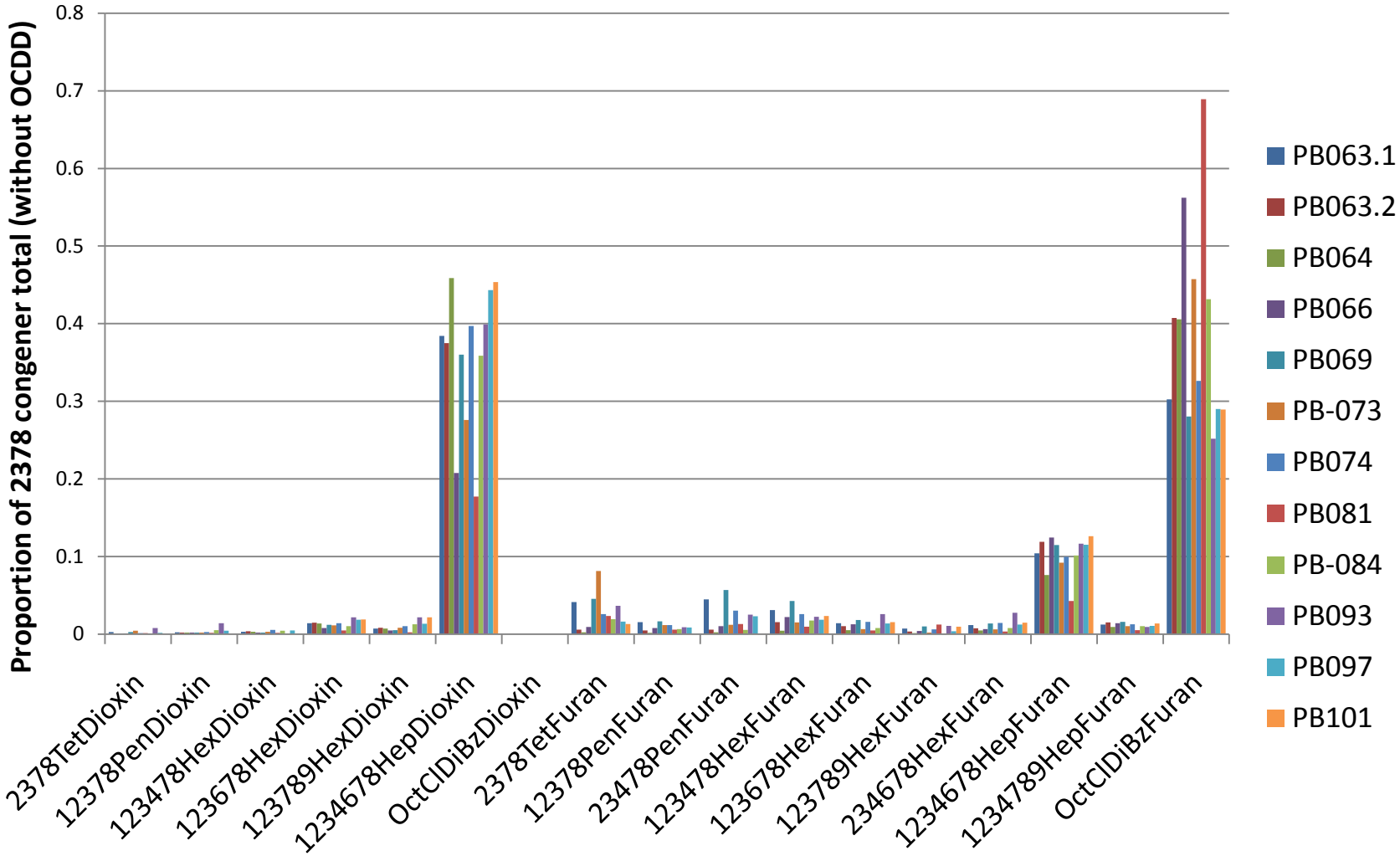
31 sites, average TEQ = 209 ppt, max TEQ = 2224 ppt at PB026

Middle Patrick Bayou



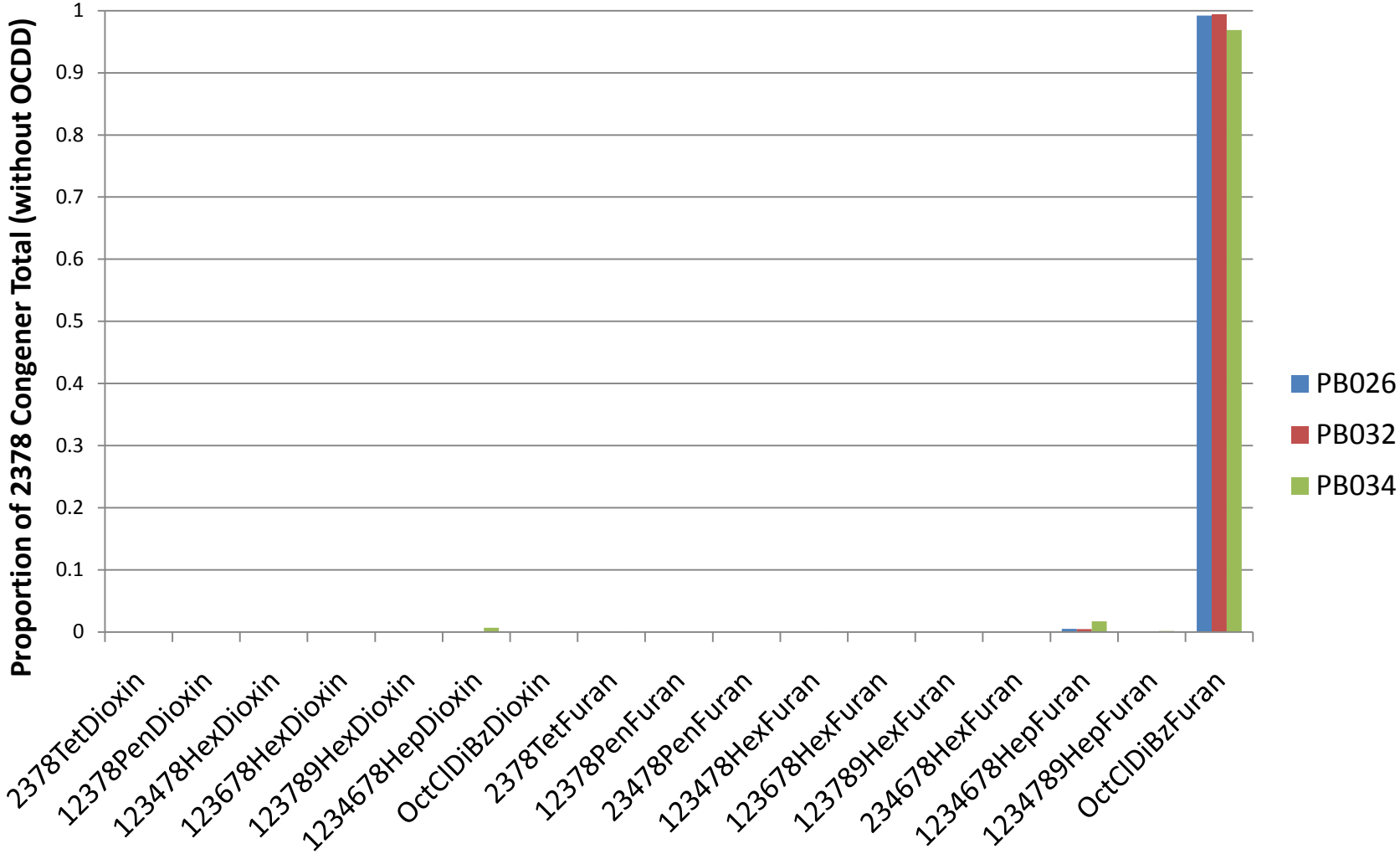
15 sites, average TEQ = 99 ppt, max TEQ = 610 ppt at PB053

Upper Patrick Bayou



12 sites, average TEQ = 26 ppt, max TEQ = 84 ppt at PB069

Patrick Bayou Highest TEQ reach

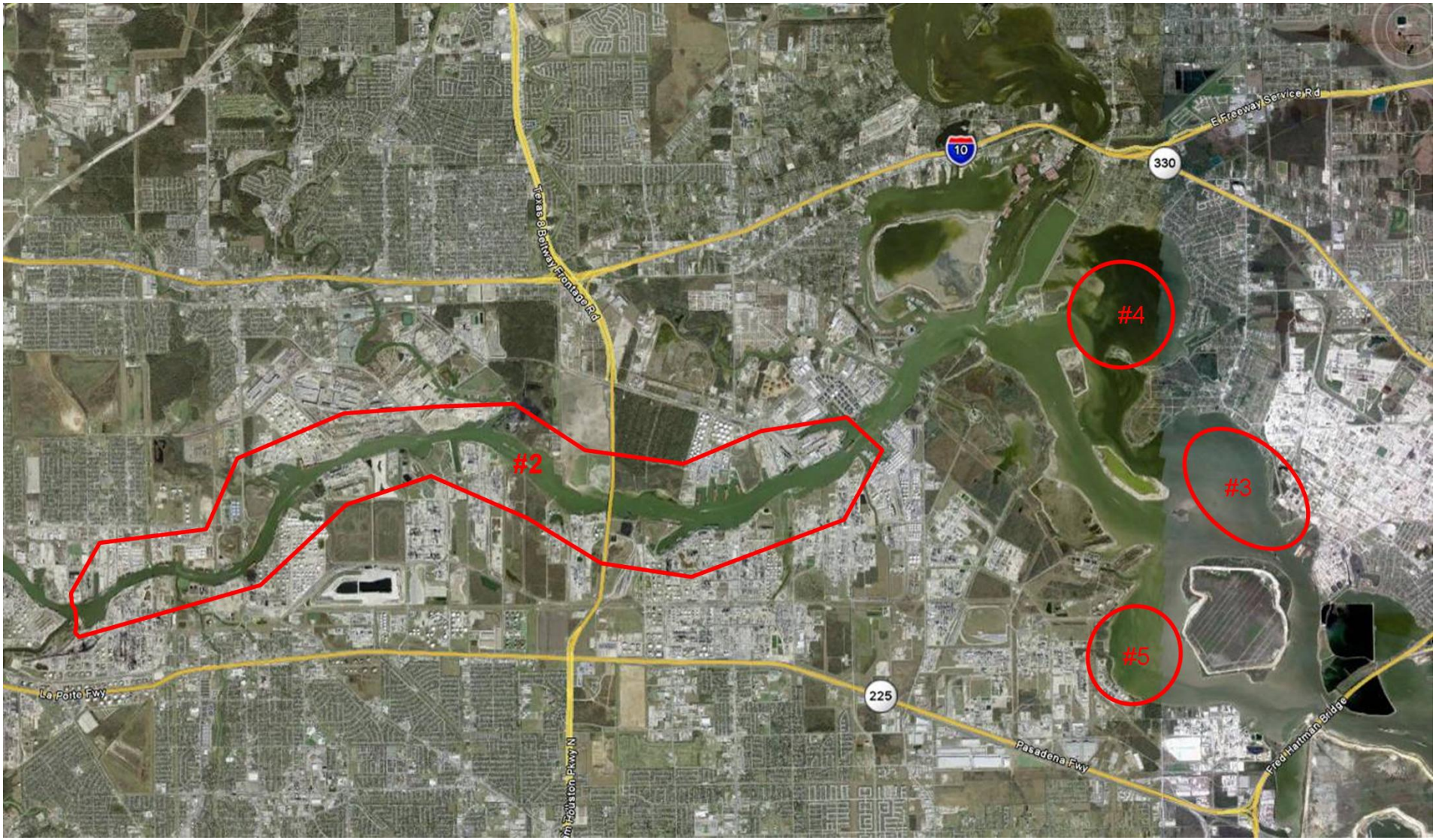


TEQ = 2224, 756, & 356 ppt

Observations – Patrick Bayou

- Patrick Bayou downstream fingerprint dominated by OCDF
- Upstream fingerprint includes HpCDD and one of the HpCDFs, in addition to the OCDF
- Cleaner signal downstream, and as move upstream (away from HSC) more congeners appear
- In HSC, strong decrease in OCDFs away from Patrick Bayou

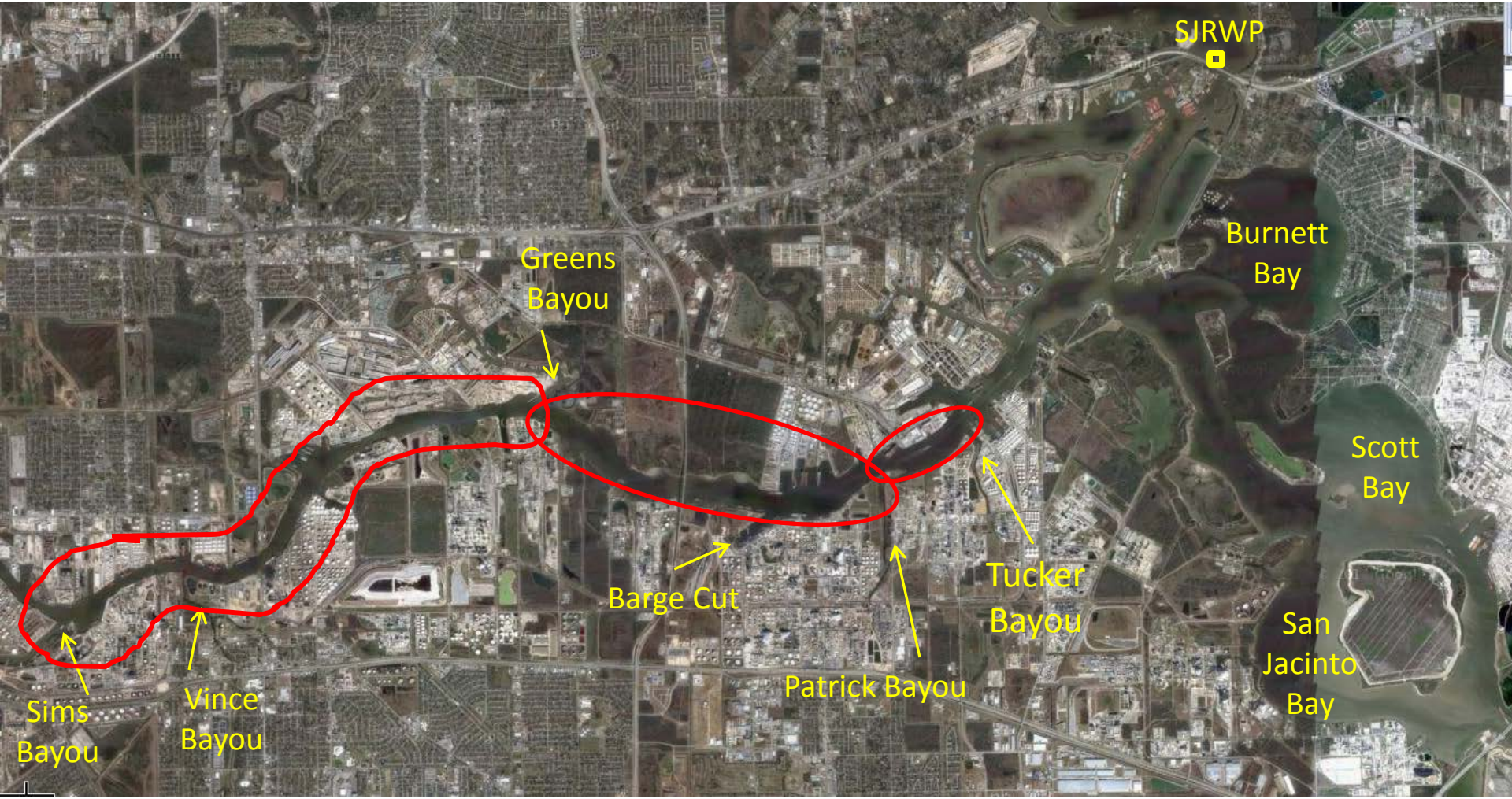
HSC – areas of noted elevated concentrations

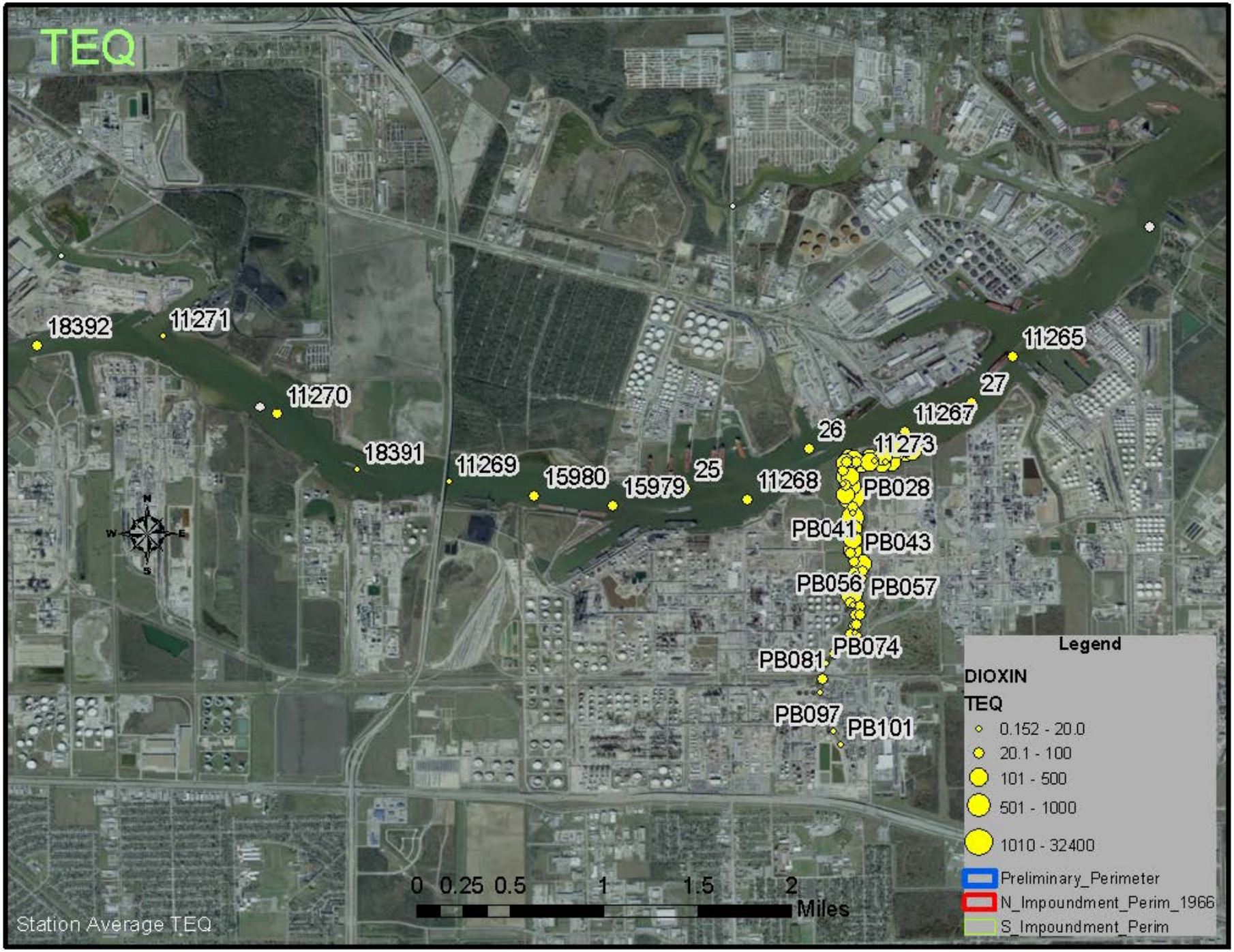


#2 = Buffalo Bayou of HSC; #3 = Scot Bay; #4 = Burnett Bay; #5 = San Jacinto Bay

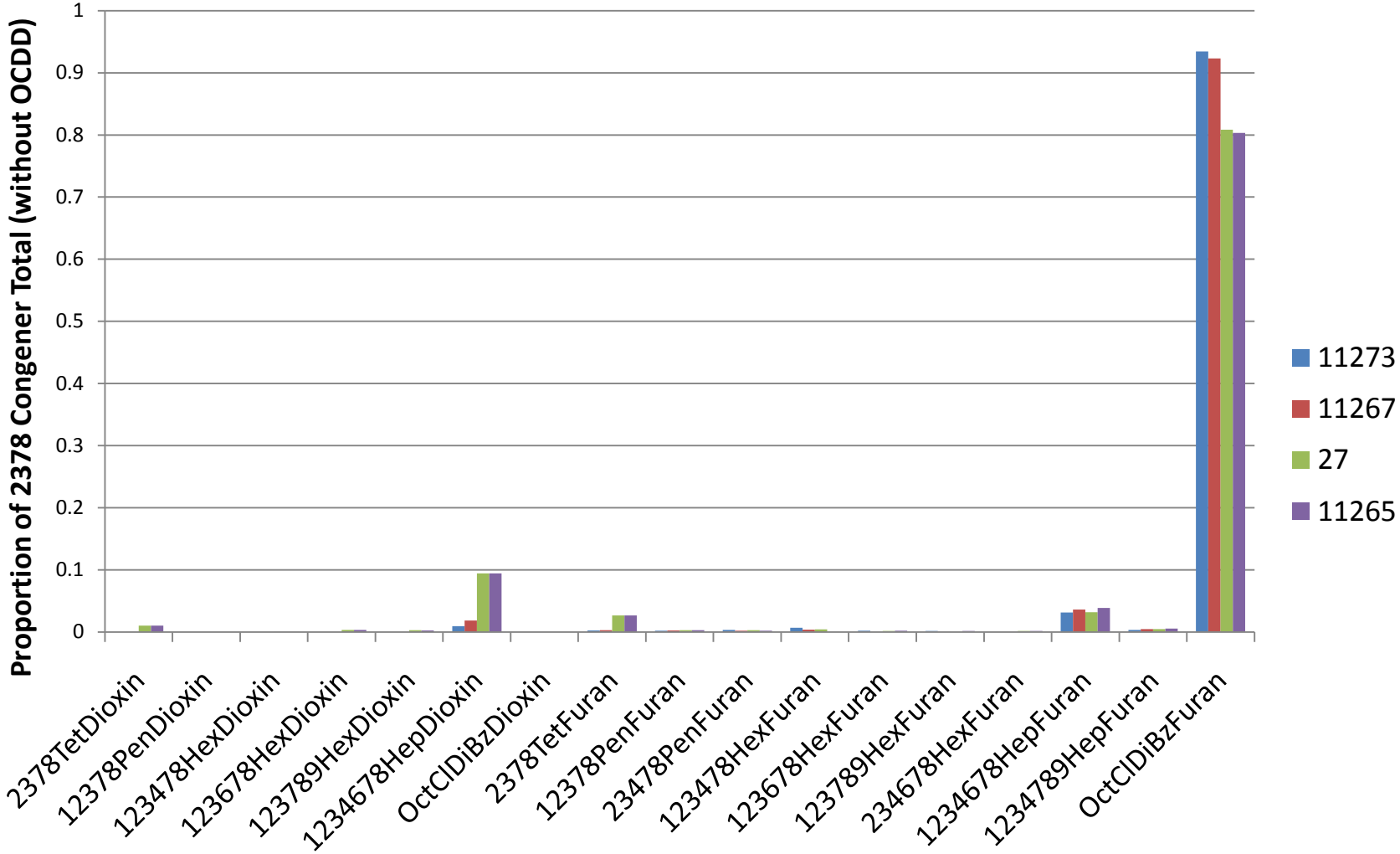
HSC Tributaries and Side Bays

HSC Tributaries and Side Bays



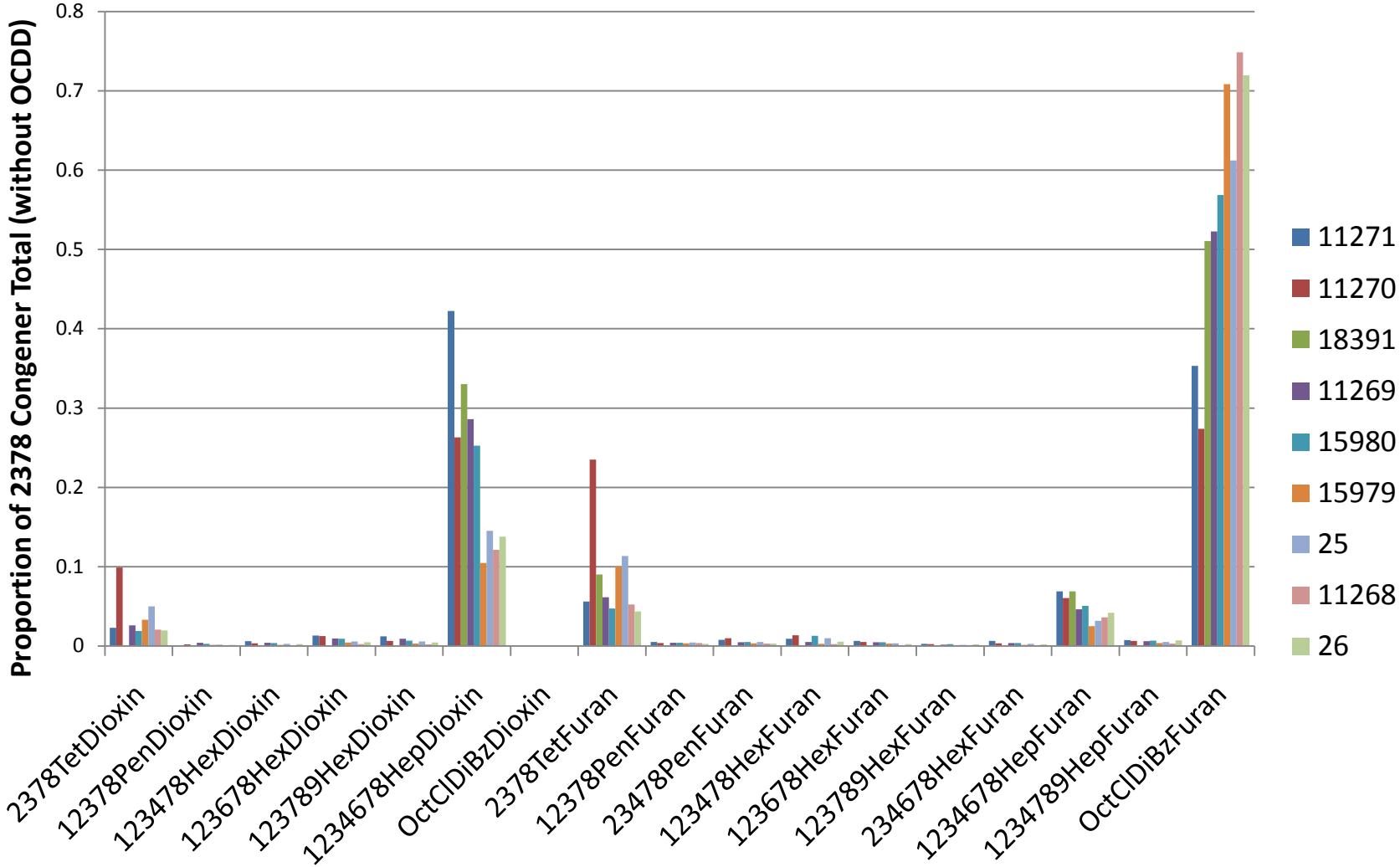

TEQ
18392
11271
11270
18391
11269
15980
15979
25
11268
26
11265
27
11267
11273
PB028
PB041
PB043
PB056
PB057
PB074
PB081
PB097
PB101
N
S
E
W
0 0.25 0.5 1 1.5 2
Miles
Station Average TEQ
Legend
DIOXIN
TEQ
0.152 - 20.0
20.1 - 100
101 - 500
501 - 1000
1010 - 32400
Preliminary_Perimeter
N_Impoundment_Perim_1966
S_Impoundment_Perim

HSC - Patrick Bayou to Tucker Bayou

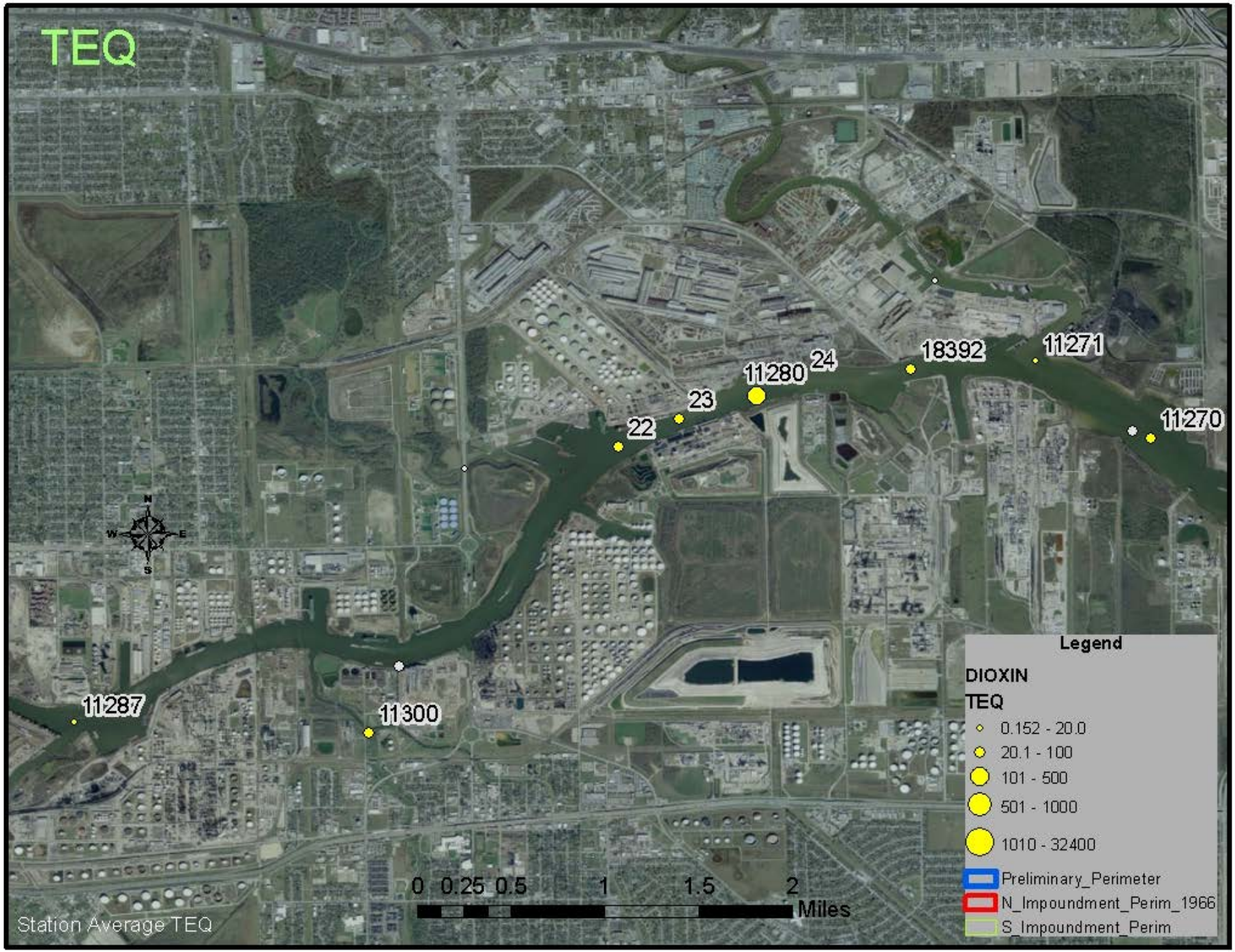


TEQ range = 22 to 159 ppt

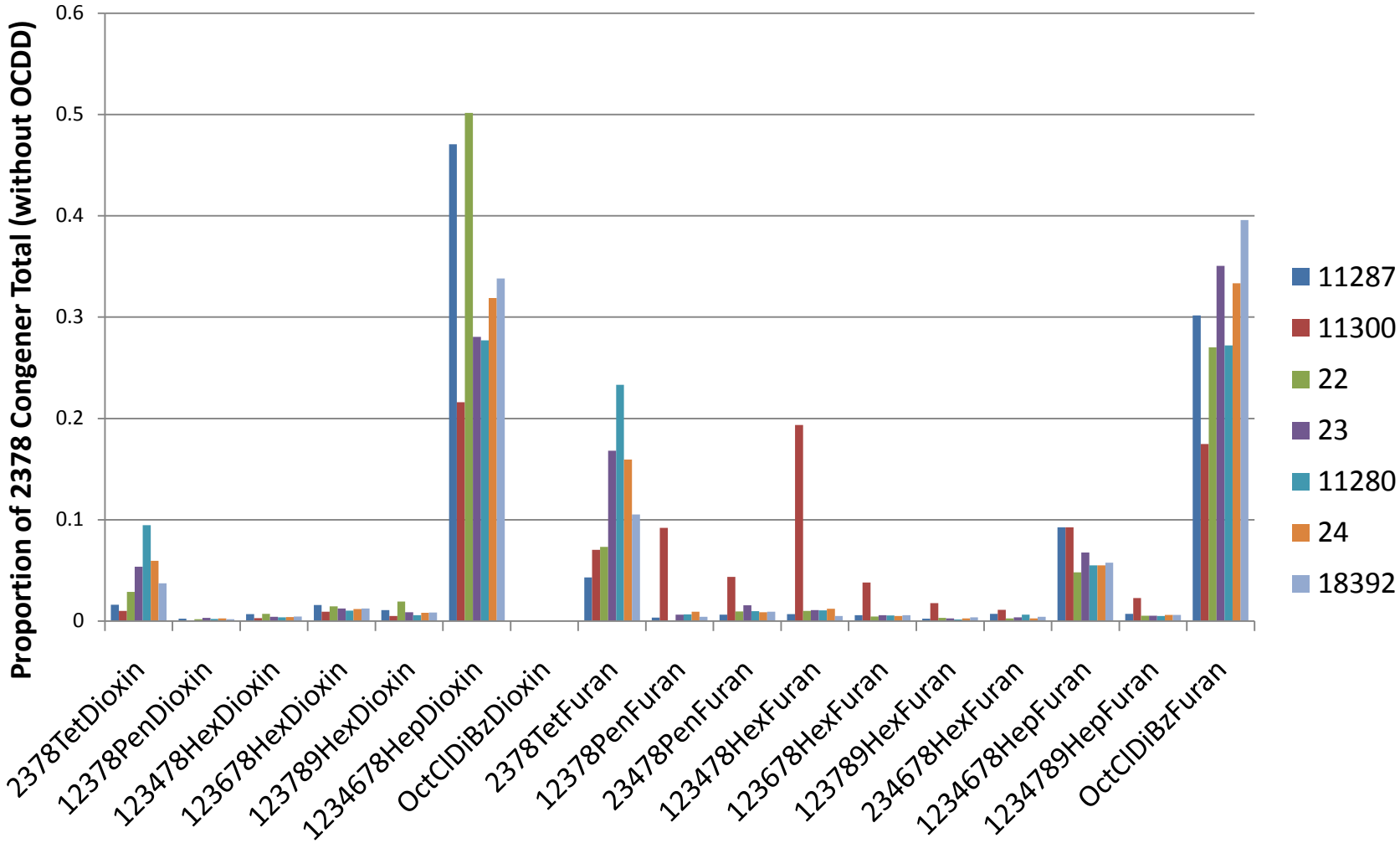
HSC - Greens Bayou to Patrick Bayou



11270 TEQ = 74 ppt, 15979 TEQ = 71 ppt, Others < 44 ppt


TEQ
11271
18392
24
11280
23
22
11270
11287
11300
N
S
E
W
Legend
DIOXIN
TEQ
0.152 - 20.0
20.1 - 100
101 - 500
501 - 1000
1010 - 32400
Preliminary_Perimeter
N_Impoundment_Perim_1966
S_Impoundment_Perim
0 0.25 0.5 1 1.5 2
Miles
Station Average TEQ

HSC - Sims Bayou to Greens Bayou



11287 TEQ = 14 ppt, 11300 TEQ = 84 ppt 11280 TEQ = 194 ppt, others < 63 ppt

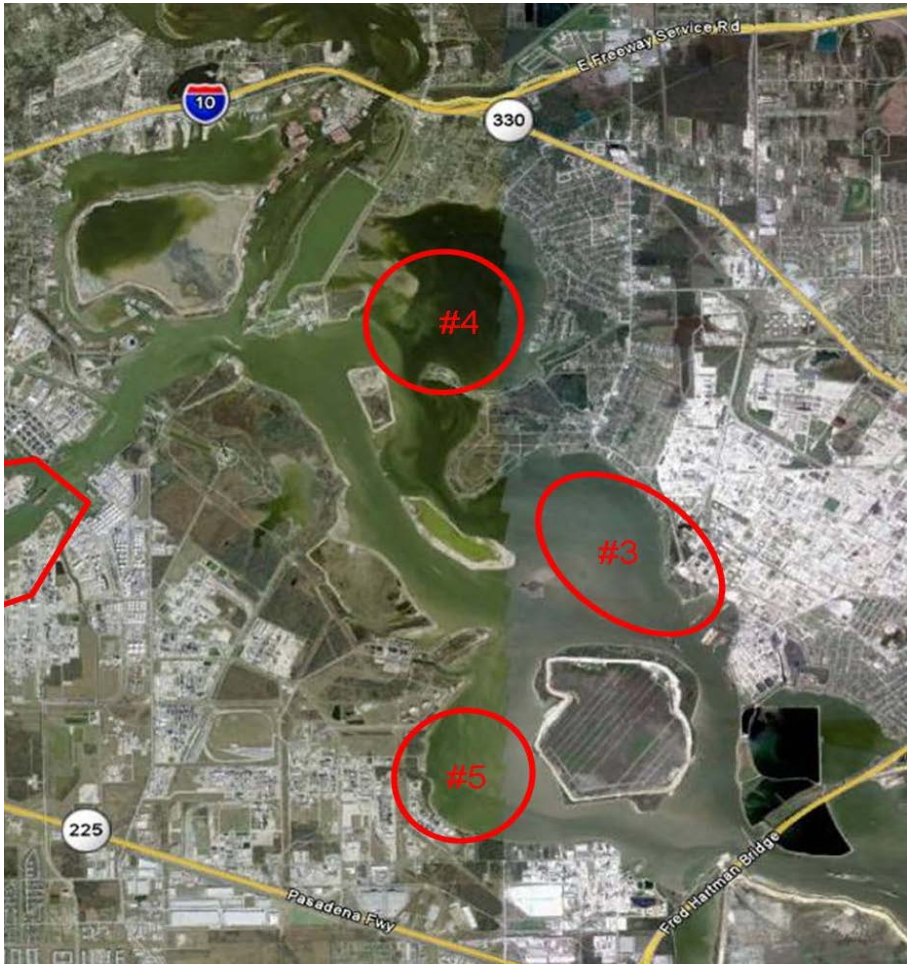
Observations – HSC/Buffalo Bayou

- Patrick Bayou to Tucker Bayou: fingerprint dominated by OCDF
  - some HpCDDs, TCDFs, and HpCDFs
- Greens Bayou to Patrick Bayou: fingerprint dominated by OCDF
  - Some HpCDDs, more TCDFs, and HpCDFs
- Sims Bayou to Greens Bayou: fingerprint dominated by OCDF
  - some HpCDDs, TCDFs, and HpCDFs
  - Small amounts of numerous other congeners

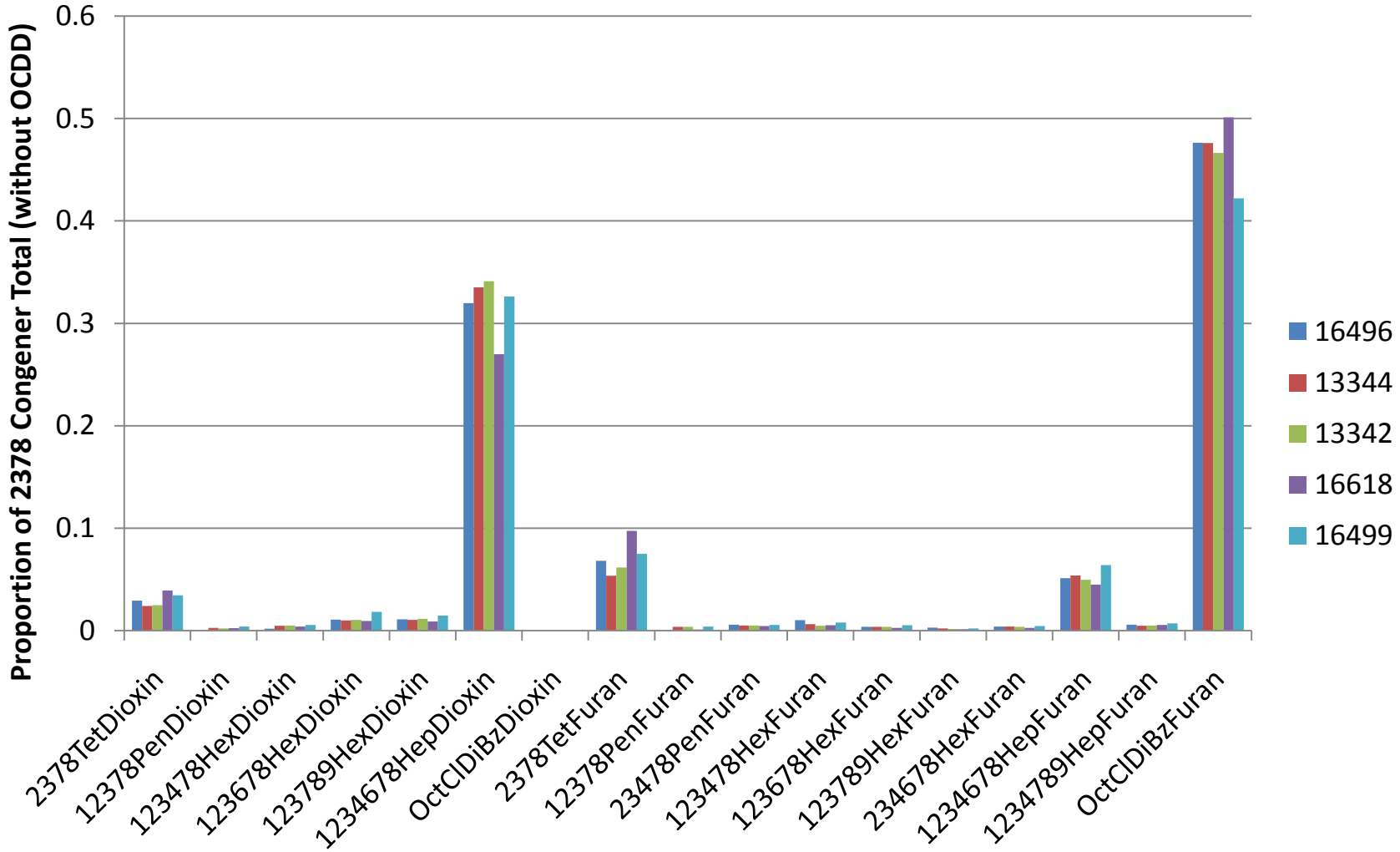
HSC Side Bays

- All have similar fingerprints and TEQ levels

- Burnett Bay
  - 16496, TEQ = 34 ppt
  - 13344, TEQ = 29 ppt
- Scott Bay
  - 13342, TEQ = 29 ppt
  - 16618, TEQ = 24 ppt
- San Jacinto Bay
  - 16499, TEQ = 21.6 ppt



HSC Side Bay Congener Fingerprint



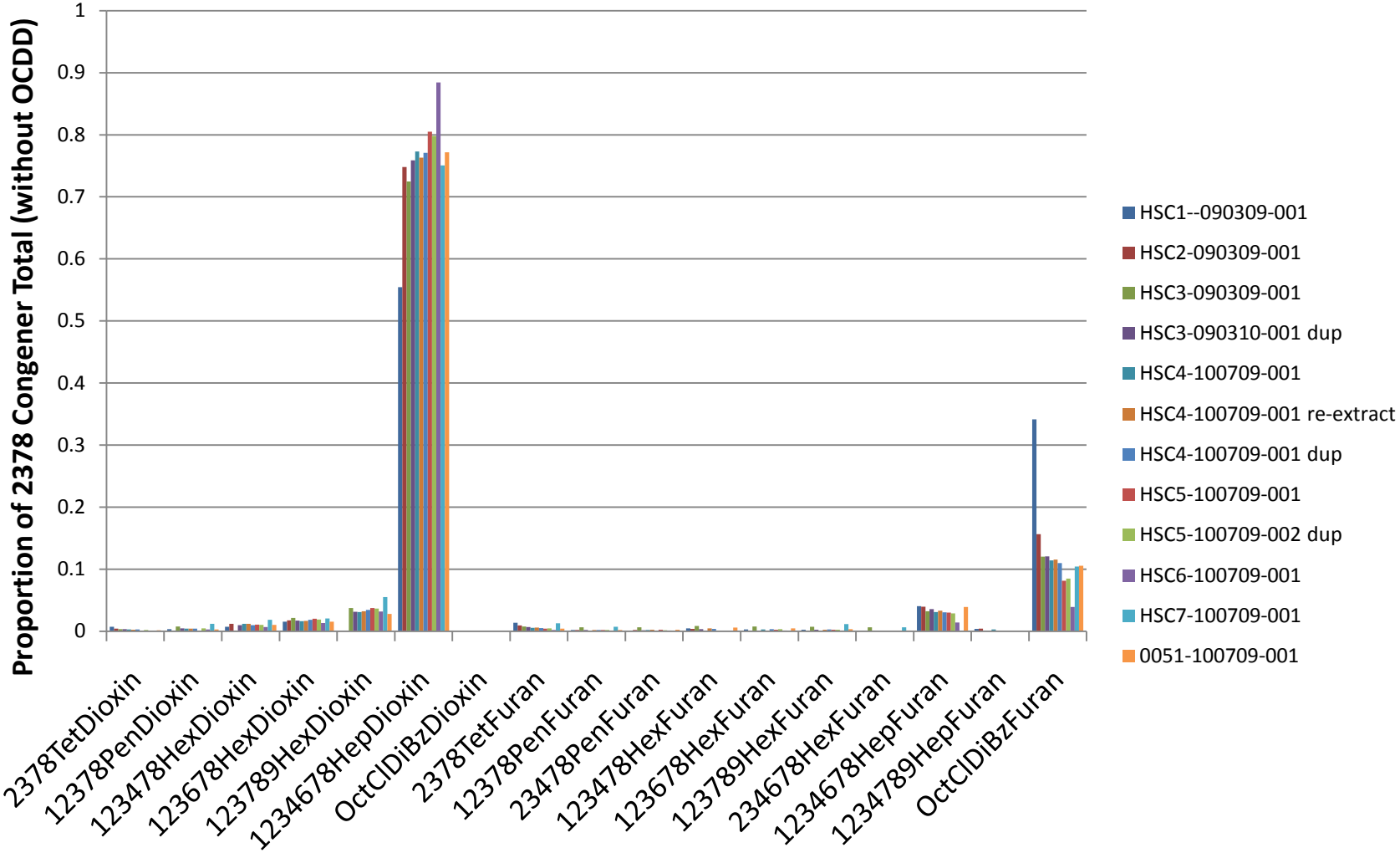
Observations – HSC Side Bays

- All three side bays have very similar fingerprints
  - All three are dominated by OCDF; followed by HpCDDs, TCDFs, HpCDFs and TCDDs.
  - Each also has small amounts of other congeners
  - It is worth noting that this fingerprint appears similar to upstream HSC (OCDF, HpCDDs, HpCDFs) and San Jacinto (TCDDs & TCDFs) though the upstream HSC signal is more prominent

Galveston Bay Samples

- TEQs range from 6.4 ppt to less than 1 ppt
- Fingerprint similar to Upstream SJR background fingerprint
- TEQs on the picture (right) were calculated using WHO 2005 TEFs

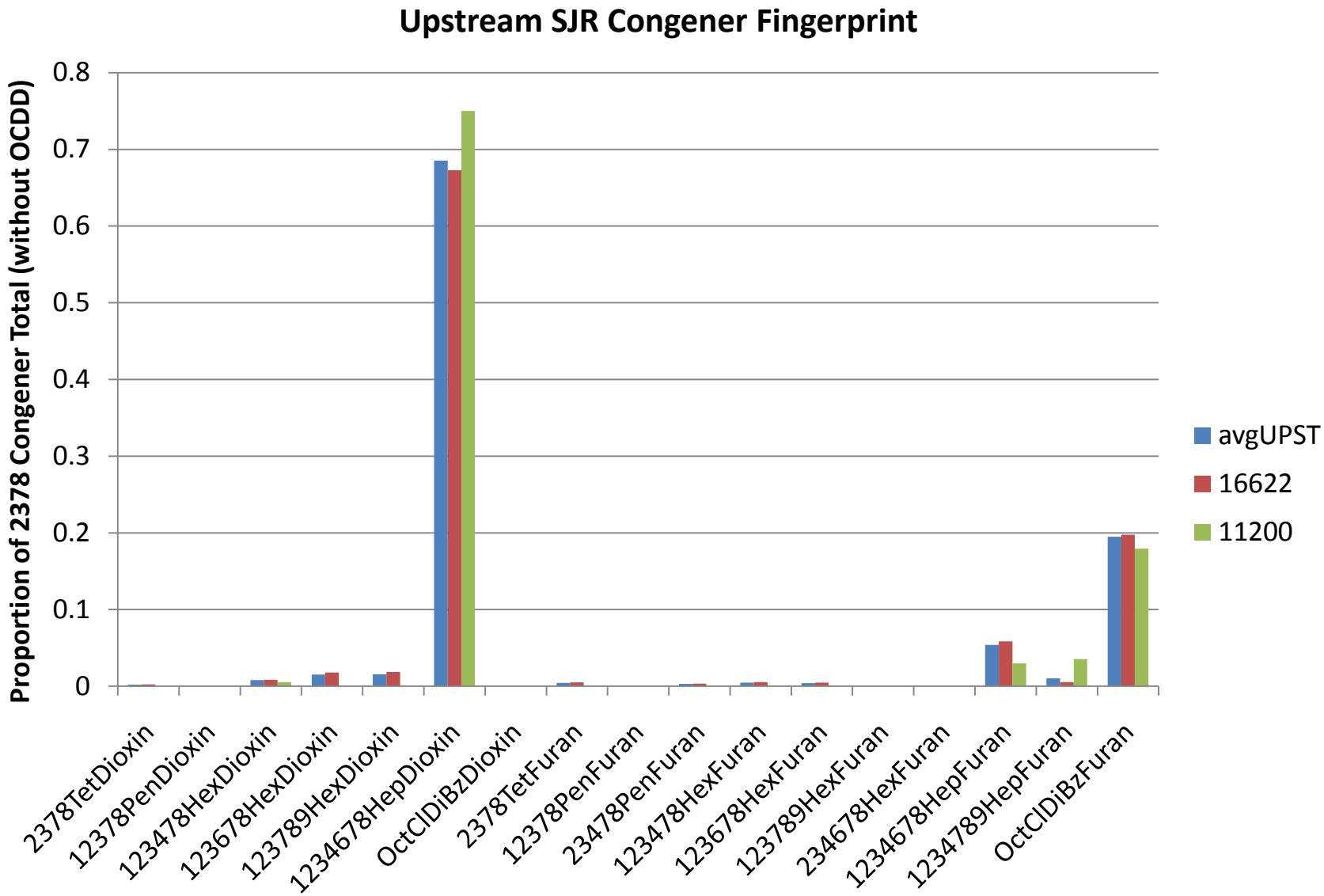
Galveston Bay Samples



TEQ range from 0.2 to 6.4 ppt

Obserevations – HSC/Galveston Bay

- Fingerprint for all stations dominated by HpCDDs; followed by OCDF, HpCDDs and HpCDFs
  - Small amounts of most other congeners
- HSC1 exhibited highest TEQ
- Decreasing TEQ with distance downstream
- Looks much like the upstream SJR samples once you get into Galveston Bay



TEQ range = 0.4 to 3.1 ppt