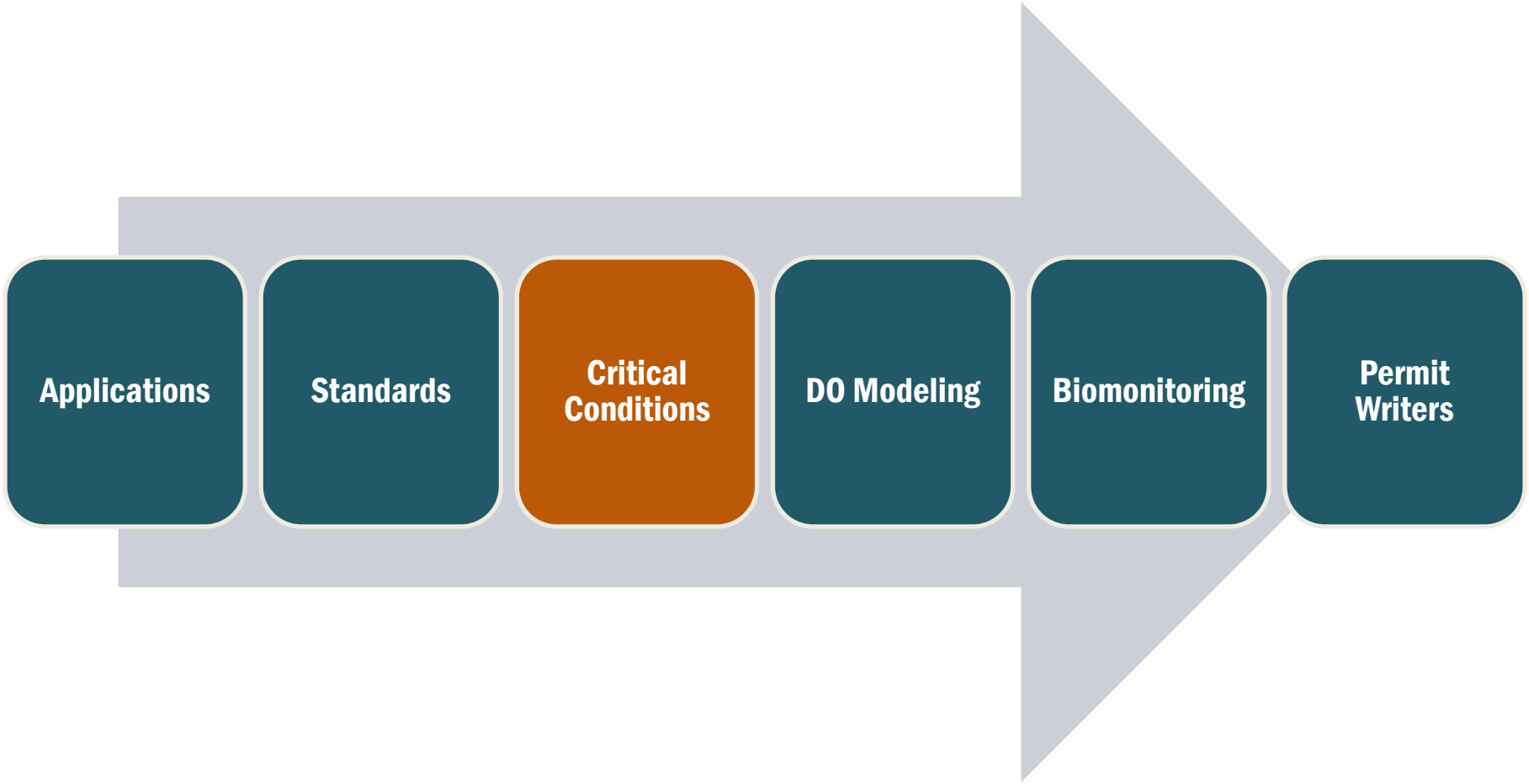
Critical Conditions Review

Jeff Borski | Water Quality Assessment Section

What Do We Do?

- Determine size and shape of mixing zones
- Calculate critical low flows for flowing water bodies
- Calculate effluent percentages
- Determine applicable TEXTOX Menu numbers
- Maintain GIS and paper maps of all TPDES outfalls

Where We Fit in the Permitting Process



Which Applications Do We Review?

- All industrial wastewater permits
- All municipal permits with biomonitoring
- Municipal permits with design flows of ≥1.0 MGD

- We do not review stormwater or general permits

What is a Regulatory Mixing Zone?

- An area adjacent to an outfall where initial effluent dilution takes place
- Numerical water quality criteria can be exceeded as long as acutely toxic conditions are prevented
- Dilution is the solution to pollution

What are Critical Mixing Conditions?

- In flowing waters, the stream's low-flow metric (7Q2) is the critical condition for receiving-water flow
- In pooled waters, the width of the water body is the critical condition for receiving-water dilution
- These are used to calculate effluent percentages for each mixing zone

EPA Guidance on Critical Conditions

- "States may, at their discretion, include in their State standards, policies generally affecting their application and implementation, such as mixing zones, low flows and variances. Such policies are subject to EPA review and approval." (40 CFR §131.13)

- Guidance for Texas can be found in the Texas Surface Water Quality Standards – 30 TAC §307.8

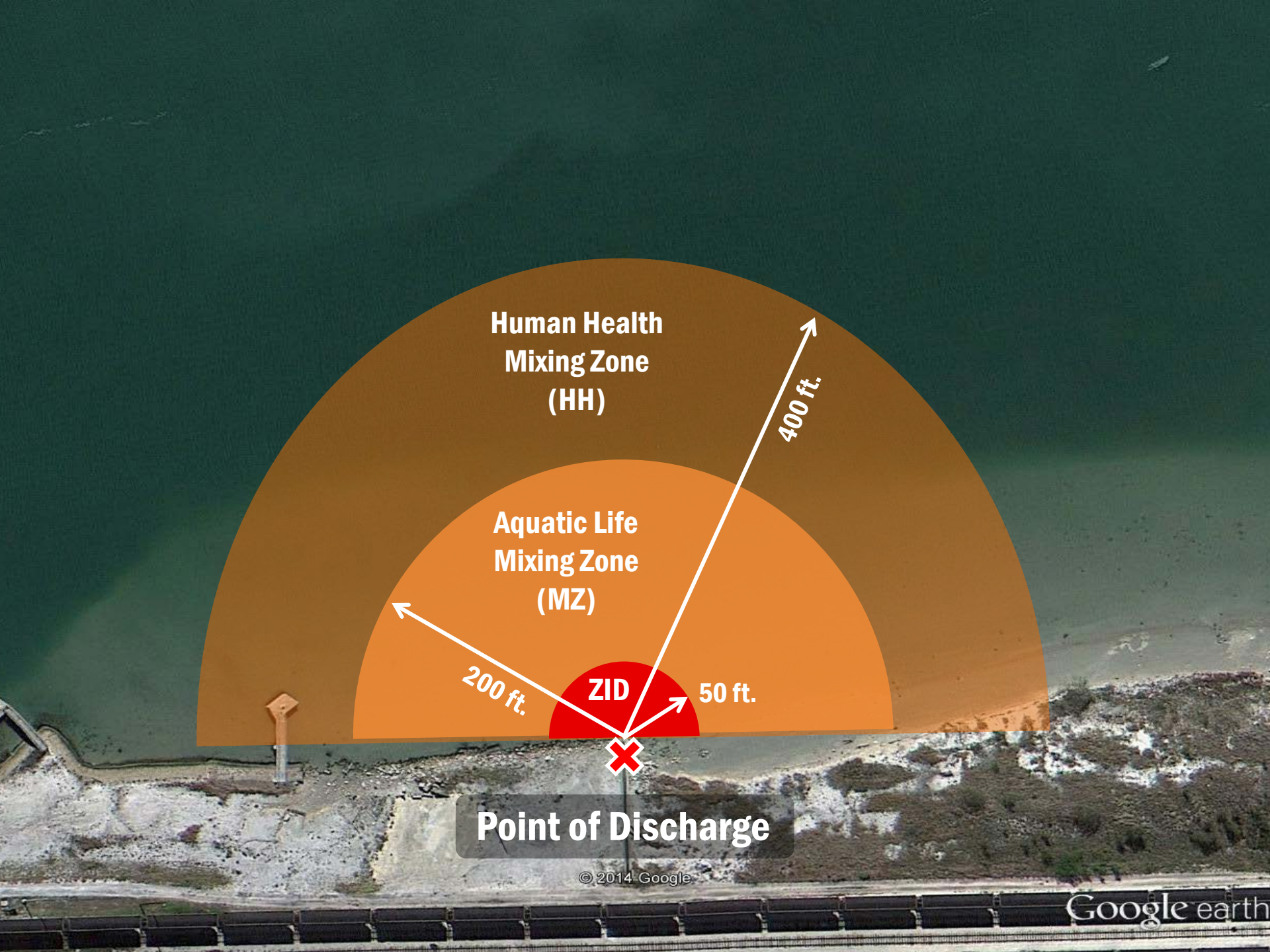
TEXTOX Menu Determination

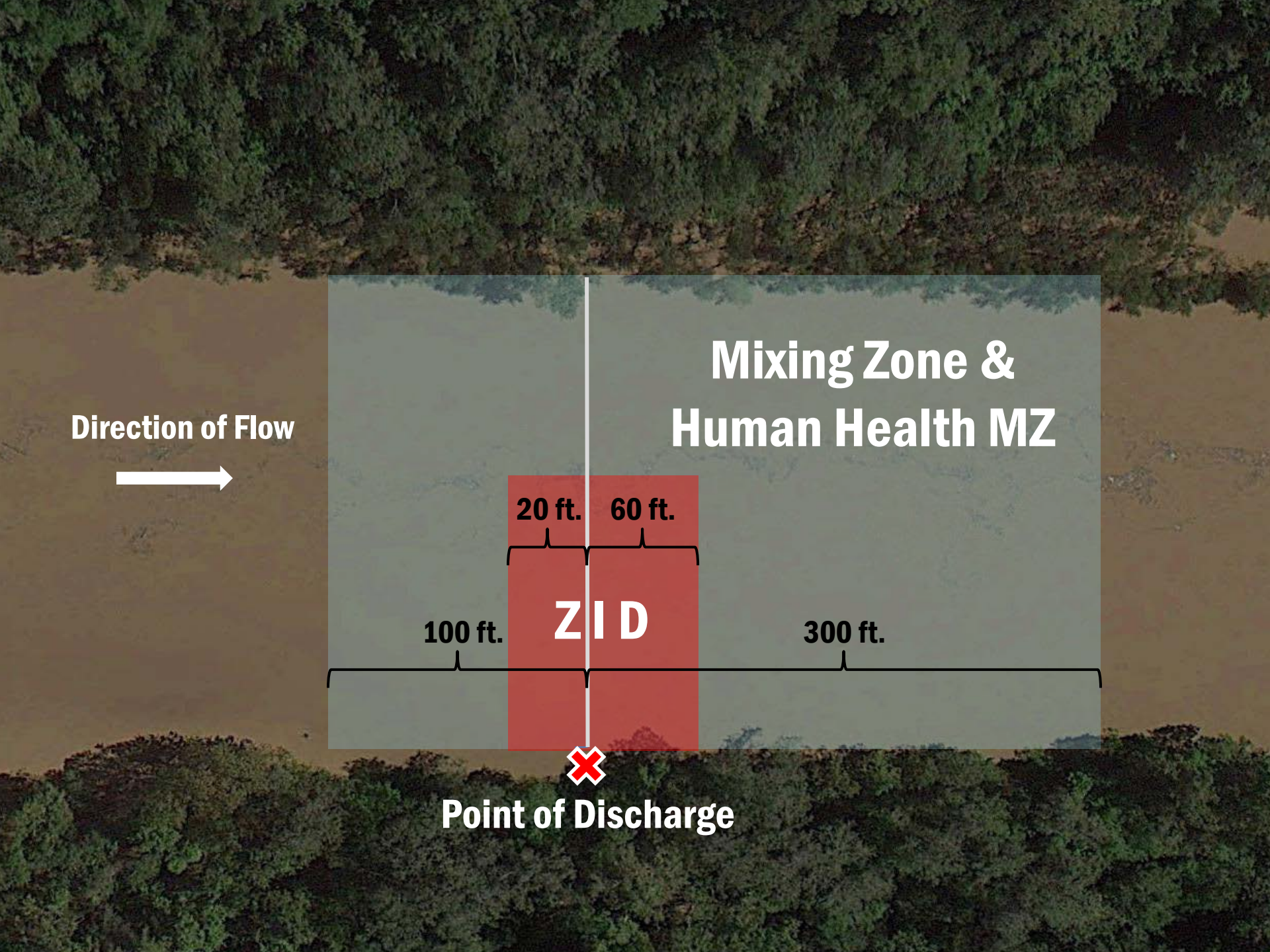
- Assess the characteristics of all receiving water character within 3 miles of the outfall
    - Are the receiving waters intermittent, perennial, tidal, etc?
    - What are the human health criteria for downstream receiving waters?

Menu #	Immediate Receiving Water	Water Body Within 3 Miles
1	Intermittent water body	———
2	Intermittent water body	Perennial ditch, stream, or river
3	Perennial ditch, stream, or river	———
4	Lake or lake-like water body	———
5	Wide tidal water body or narrow tidal with no upstream flow data	———
6	Narrow tidal water body with upstream flow data	———
7	Intermittent stream w/perennial pools	———
8	Intermittent water body	Lake or lake-like water body
9	Intermittent water body	Narrow tidal water body w/ upstream flow
10	Intermittent water body	Wide tidal water body or narrow tidal with no upstream flow data

Types of Mixing Zones

- Zone of Initial Dilution (ZID) – Acute aquatic life criteria applies at the edge of the ZID
- Mixing Zone (MZ) – Chronic aquatic life protection applies at the edge of the MZ
- Human Health Mixing Zone – Chronic human health protection at the edge of the HHMZ


Human Health
Mixing Zone
(HH)
Aquatic Life
Mixing Zone
(MZ)
400 ft.
200 ft.
ZID
50 ft.
Point of Discharge
© 2014 Google
Google earth


Direction of Flow
Mixing Zone &
Human Health MZ
20 ft.
60 ft.
ZID
100 ft.
300 ft.
Point of Discharge

Zone of Initial Dilution

- The small area immediately adjacent to the point of discharge (PoD)
- Numerical acute aquatic life criteria do not apply inside it, but narrative criteria do apply
  - No lethality to aquatic organisms
  - Discharge may not impede migration of aquatic organisms

Mixing Zone

- Acute aquatic life criteria apply within the MZ
- Chronic aquatic life criteria apply at the edge of the MZ

Human Health Mixing Zone

- Chronic aquatic life criteria apply within the HHMZ
- Human health criteria apply at the edge of the HHMZ

Undefined Mixing Zones

- Receiving waters that do not have defined mixing zones
  - Intermittent streams
  - Intermittent streams with perennial pools (ZID and MZ is not defined, but the human health mixing zone is defined)
  - Wetlands, marshes, and tidal mudflats

Diffuser Reviews

- For outfalls with diffusers, the DO modelers determine mixing-zone dimensions and effluent percentages
- It's possible to get effluent percentages that are lower than default levels because of increased mixing efficiency
- Mixing zone shape may also differ from gravity-driven outfalls
  - Round, square, or irregular shape based on diffuser characteristics

What is the 7Q2?

- The lowest 7-day average discharge (Q) with a recurrence interval of 2 years
- Used to calculate effluent limits for aquatic life protection
- Another way to think about the 7Q2
  - There is a 50% chance in any given year that the in-stream flow will be less than the 7Q2
  - For comparison, there is a 10% chance in any given year than the in-stream flow will be less than the 7Q10

How Do We Calculate the 7Q2?

- Calculator for Low Flows (CaLF)
  - Excel-based application that calculates the 7Q2 and HM using 30 years of continuous USGS gaging data (ideally)
- In areas with limited flow data, the 10th percentile of available flow data will be analyzed
- Default value for perennial streams: 0.10 cfs (TSWQS)
- Special rules for springflow-dominated segments

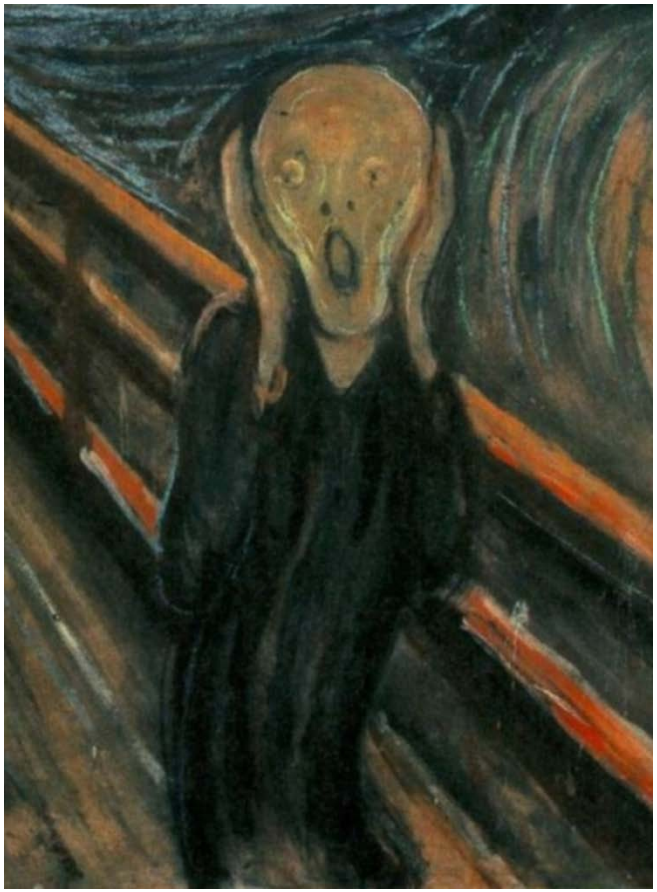
What is the Harmonic Mean?

- The reciprocal of the average of the reciprocals
- Yields a truer average for rates, e.g. streamflows
- Also calculated using the CaLF program
- Used to establish human health effluent percentage in flowing water bodies
- Default value – 0.20 cfs

The Challenge of Critical Conditions

- There are 3,700 named streams in Texas
- Countless other unnamed tributaries & ditches
- 191,000 named stream miles

...Yet there are only about 800 USGS usable gages in Texas



Determining the 7Q2 and Harmonic Mean

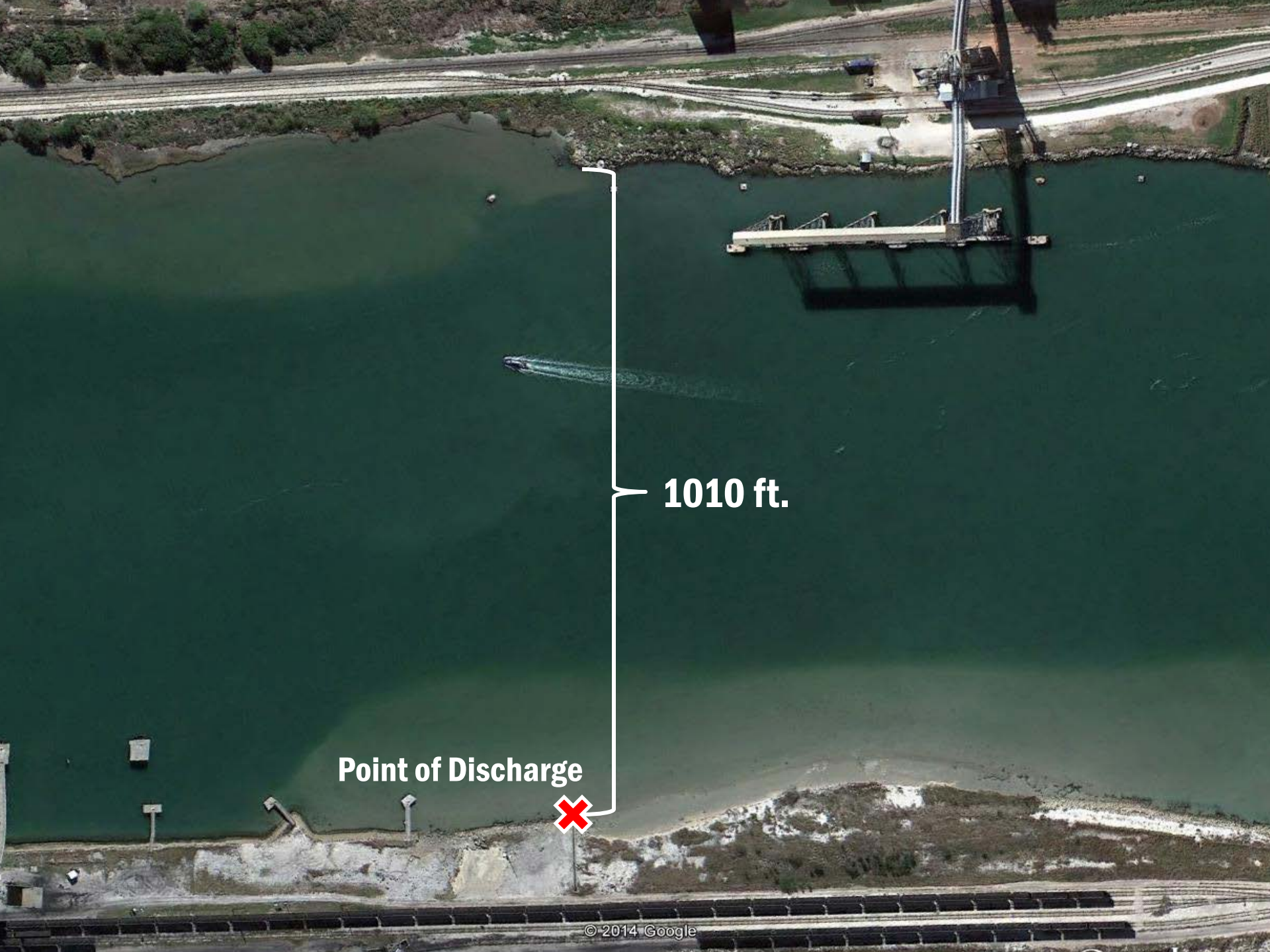
- USGS gage upstream of the point of discharge
- USGS gage downstream of the point of discharge
- Upstream dischargers
- SWQM station (10th percentile)
- Drainage area ratio
- Receiving Water Assessment (RWA)
- Waste Load Evaluation (WLE)
- Other sources of info (e.g. applicant model)

Critical Conditions for Ambient Water Bodies

- Effluent percentages are based on receiving-water width
- Percentages are calculated with the Jet Plume Equation

$$\text{Effluent } \% = \frac{2.8D\sqrt{\pi}}{R} \times 100$$

- All discharges ≥100 MGD are assessed 100% for all MZs


1010 ft.
Point of Discharge
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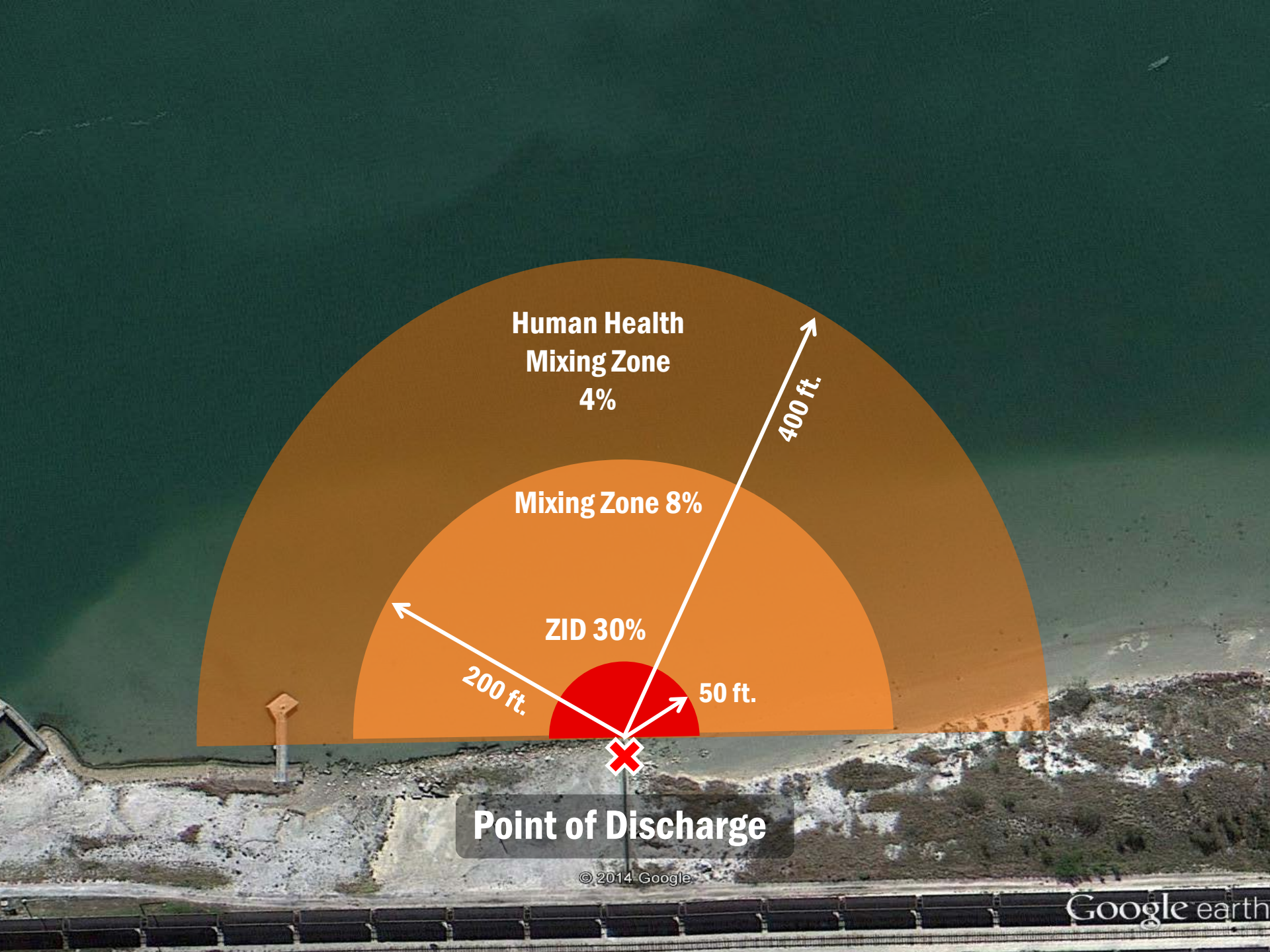
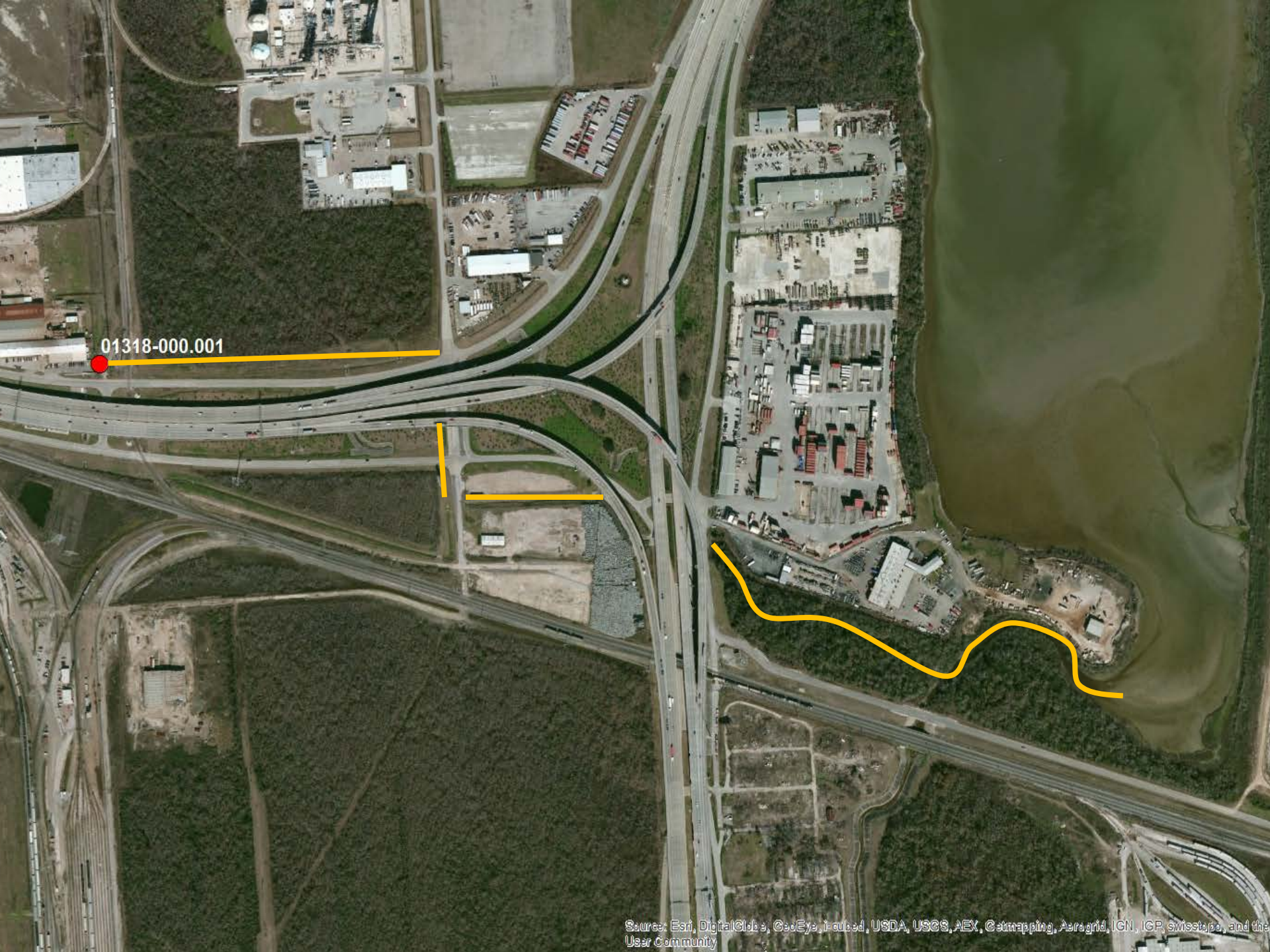
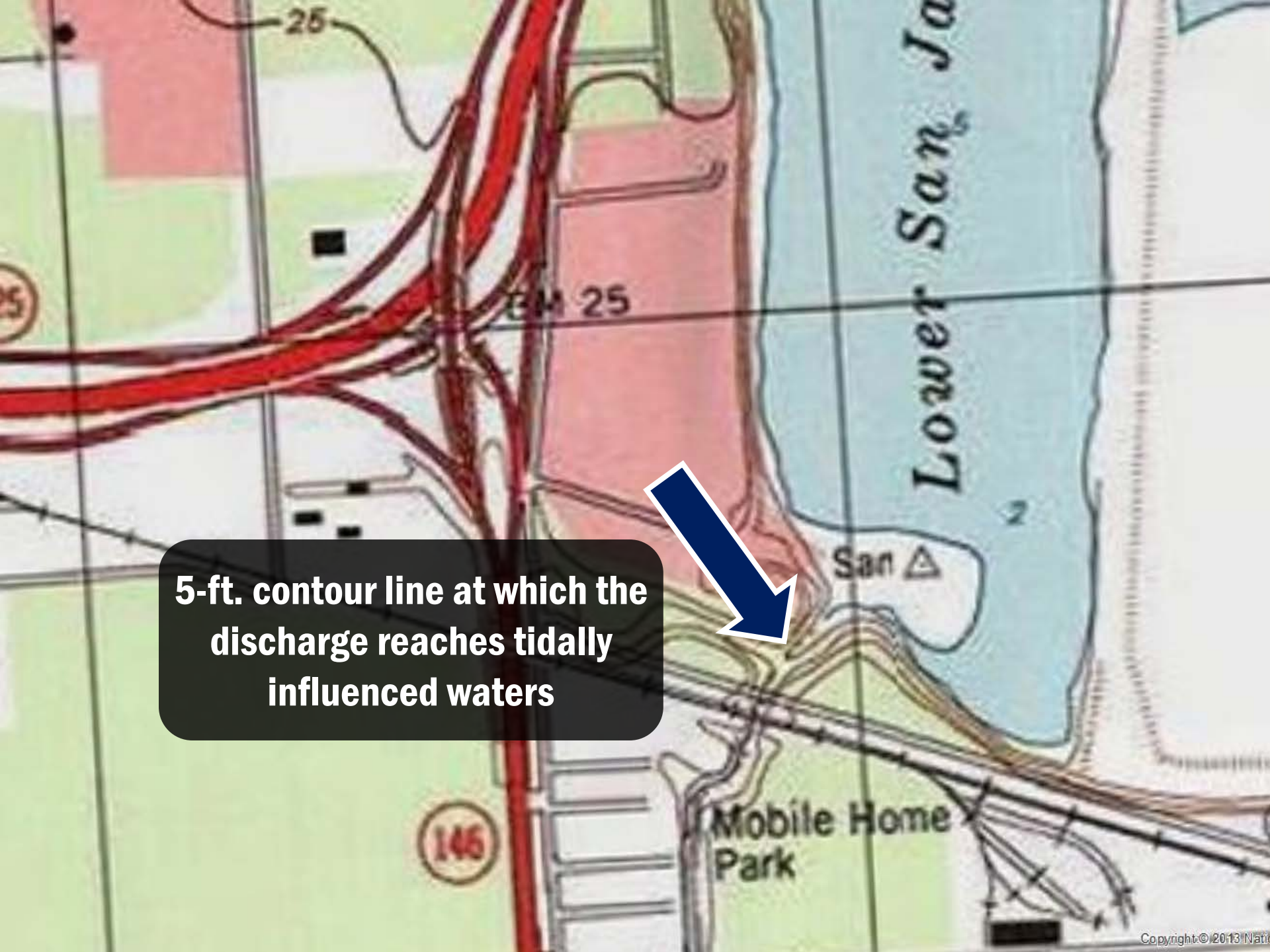

Human Health
Mixing Zone
4%
400 ft.
Mixing Zone 8%
ZID 30%
200 ft.
50 ft.
Point of Discharge
© 2014 Google
Google earth


01318-000.001
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



5-ft. contour line at which the discharge reaches tidally influenced waters

Width of the tidal creek ~40 ft.
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Critical Conditions Contacts

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Questions?