WASP Modeling Proves Its Worth

One Bug Fixes Another Bug

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UPPER TRINITY REGIONAL WATER DISTRICT

A Permitting Story

TCEQ's **new model showed** that discharge could not meet **ambient DO standards** even under the **most stringent** effluent limits!

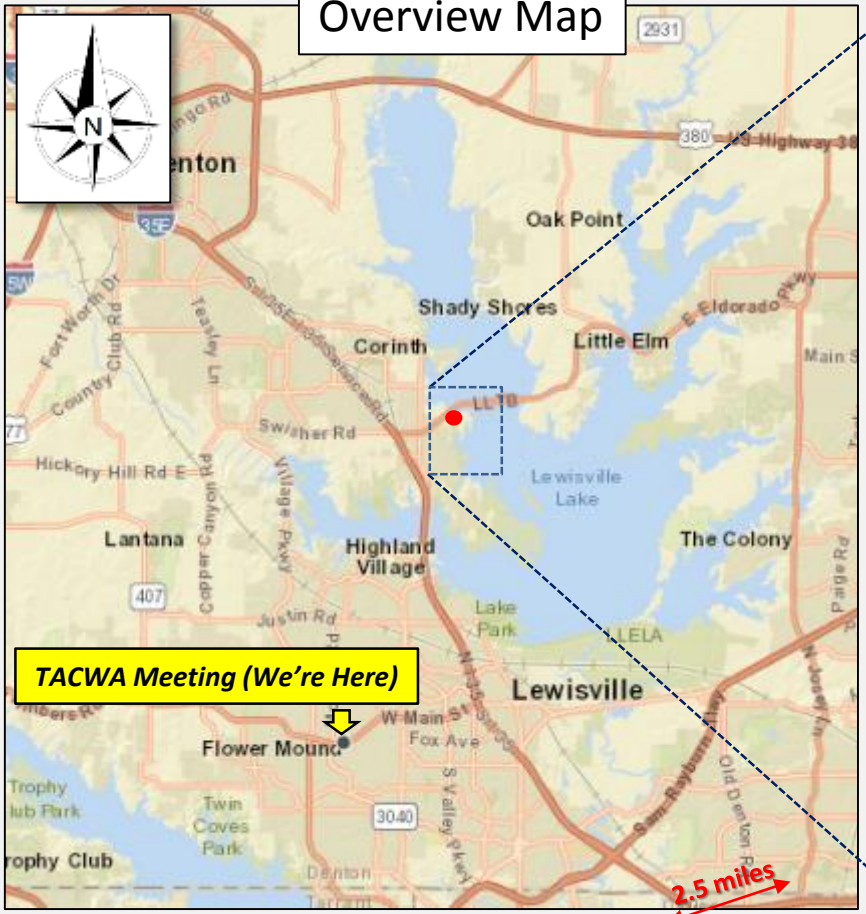
Advanced water quality models were used to provide a **more accurate assessment**.

Reasonable permit limits were **identified** and **approved by TCEQ!**

And they lived happily ever after.

Lakeview Regional Water Reclamation Plant

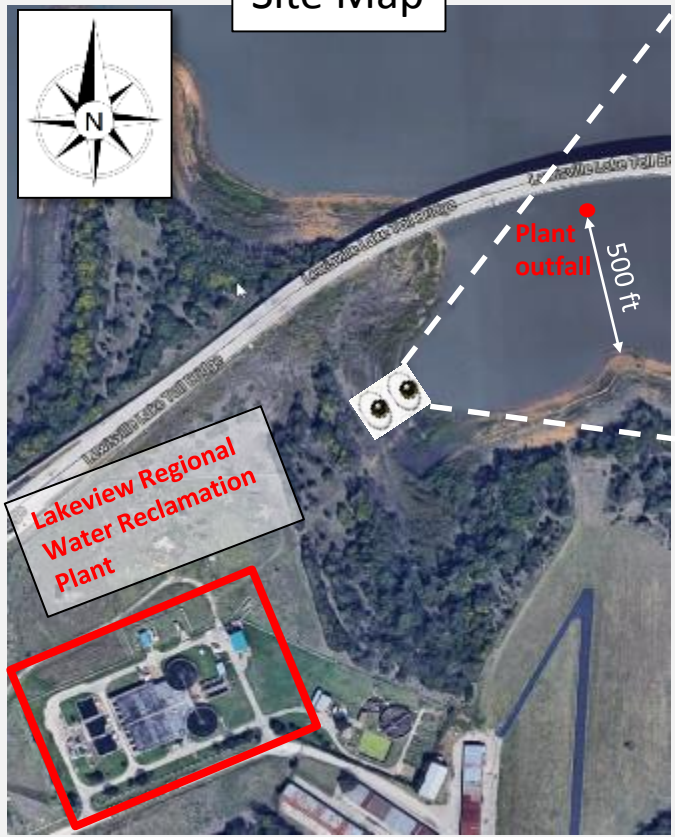
Overview Map



Site Map

Lakeview WRP Outfall Location

Site Map



View from Shore

Characteristics of Outfall

- Located in **open water** just south of Lewisville Lake Toll Bridge
- Under ~**17 ft of water**
- **Distance** to closest **shore ~ 500 ft**

Outfall Location

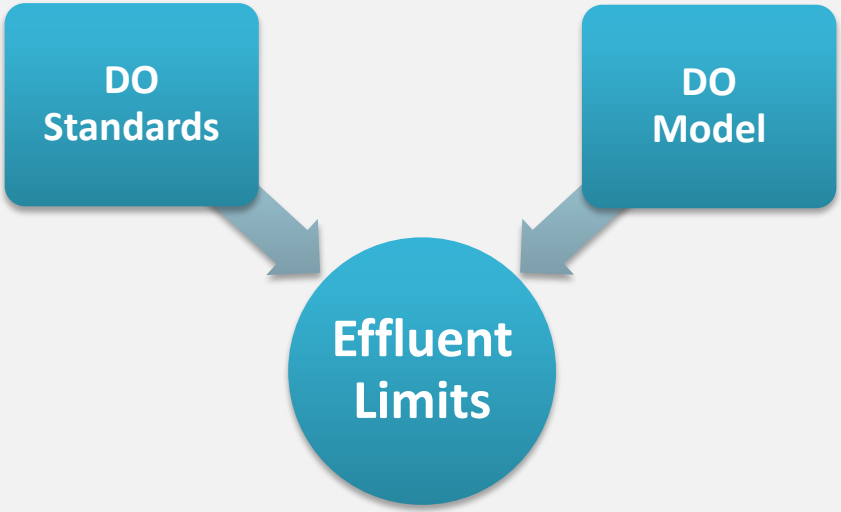
Permitting history

- 2007 and 2011
  - Permit renewed and issued with three phases:

    - **Interim I Phase:** 5.0 MGD @ 10 BOD_5/4 DO
    - **Interim II Phase:** 5.5 MGD @ 10 BOD_5/4 DO
    - **Final Phase:** 7.5 MGD @ 10 BOD_5/4 DO

- 2016
  - Permit renewal application was halted because no reasonable effluent limits could be identified.

Typical Permitting Process

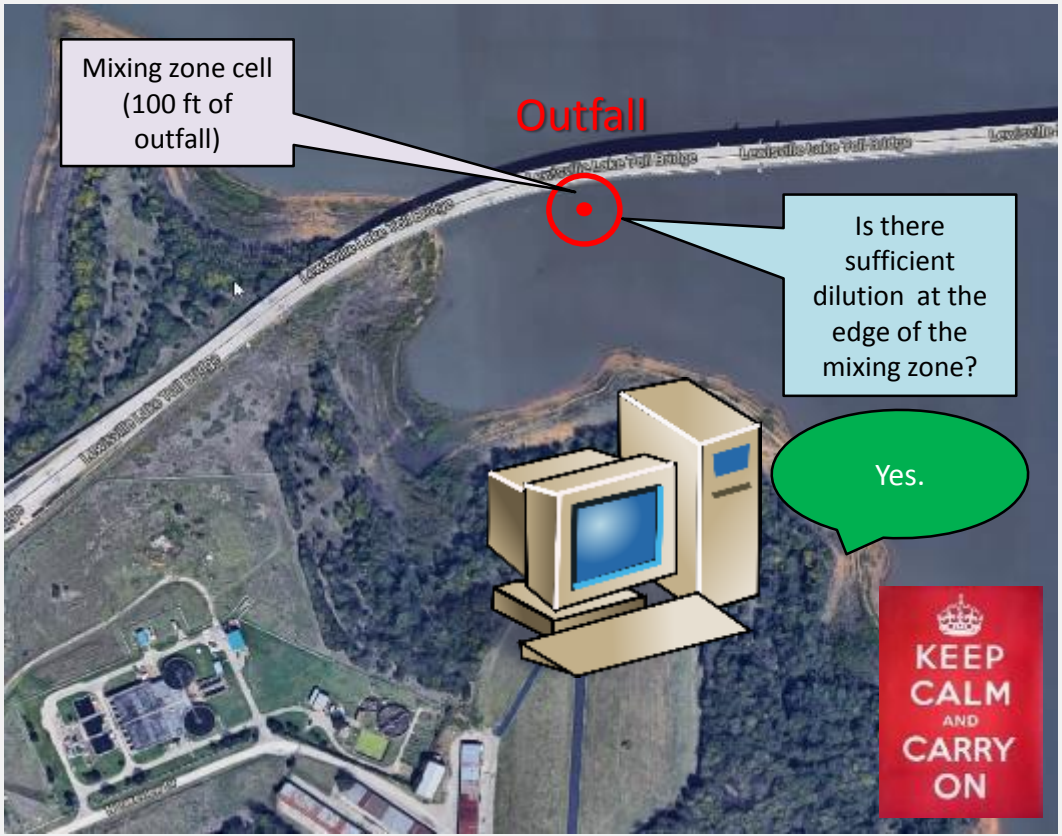


- Texas Commission on Environmental Quality (**TCEQ**) responsible for **issuing** Texas Pollutant Discharge Elimination System (**TPDES**) **permits**.
- Dissolved Oxygen (DO) Model is used to identify **effluent limits** protective of **DO water quality standard.**

What happens when discharging to open water?

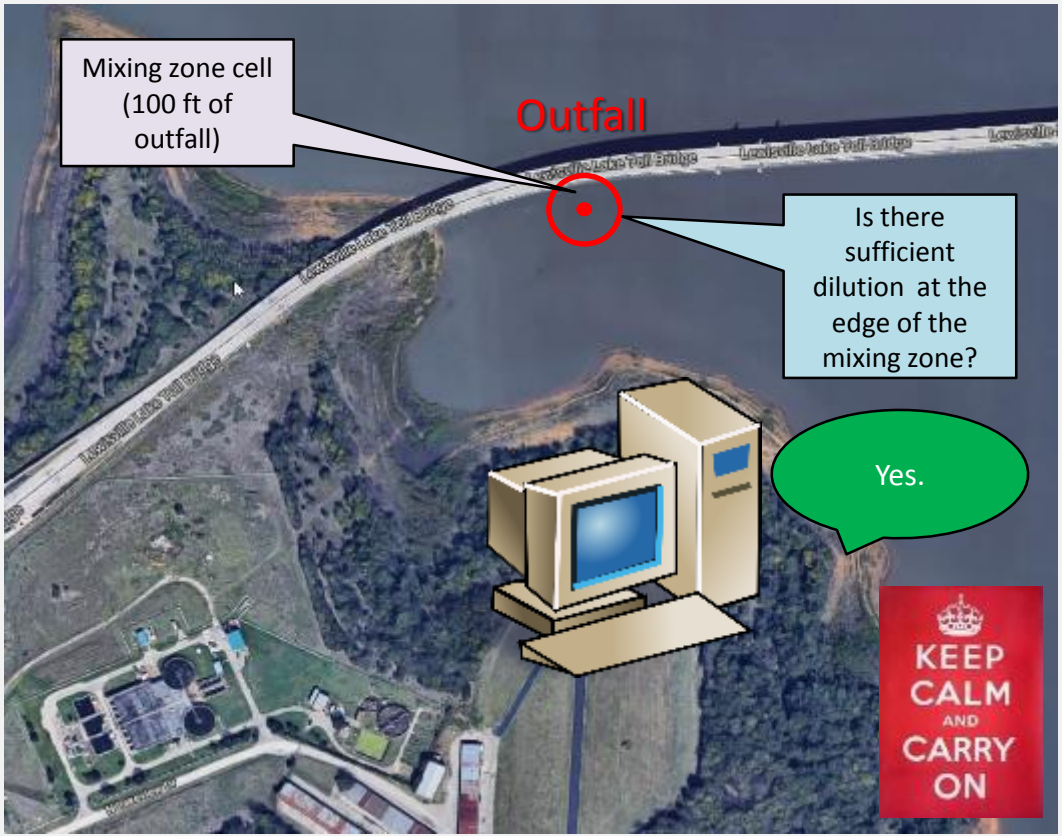
- Large volume of **ambient water** available to mix with **effluent**
- **Mixing** can
  - **Dilute** constituents e.g. **BOD** and **ammonia**
  - **Lessen effluent impacts** on water quality

TCEQ's Best Professional Judgment Approach



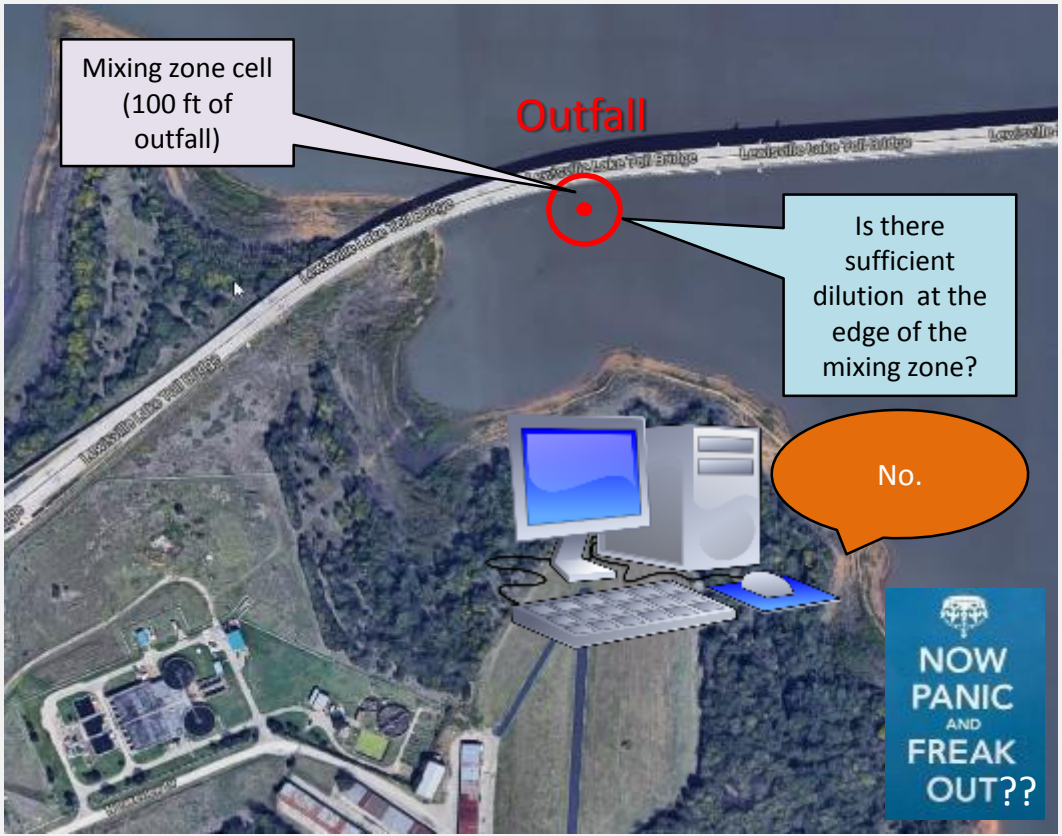
- Because of **presence** of **ambient water**
  - TCEQ developed **indirect** but **simple** method for assessing **WQ impacts** of Lakeview WWTP
- Calculation of **dilution** at **edge of** the **mixing zone**
- If effluent fraction **< 5%** then
  - Assume **no significant WQ impacts** based on best professional judgment **(BPJ)**
  - **No need to perform DO modeling**
  - **Renew permit**

TCEQ Alternative Approach



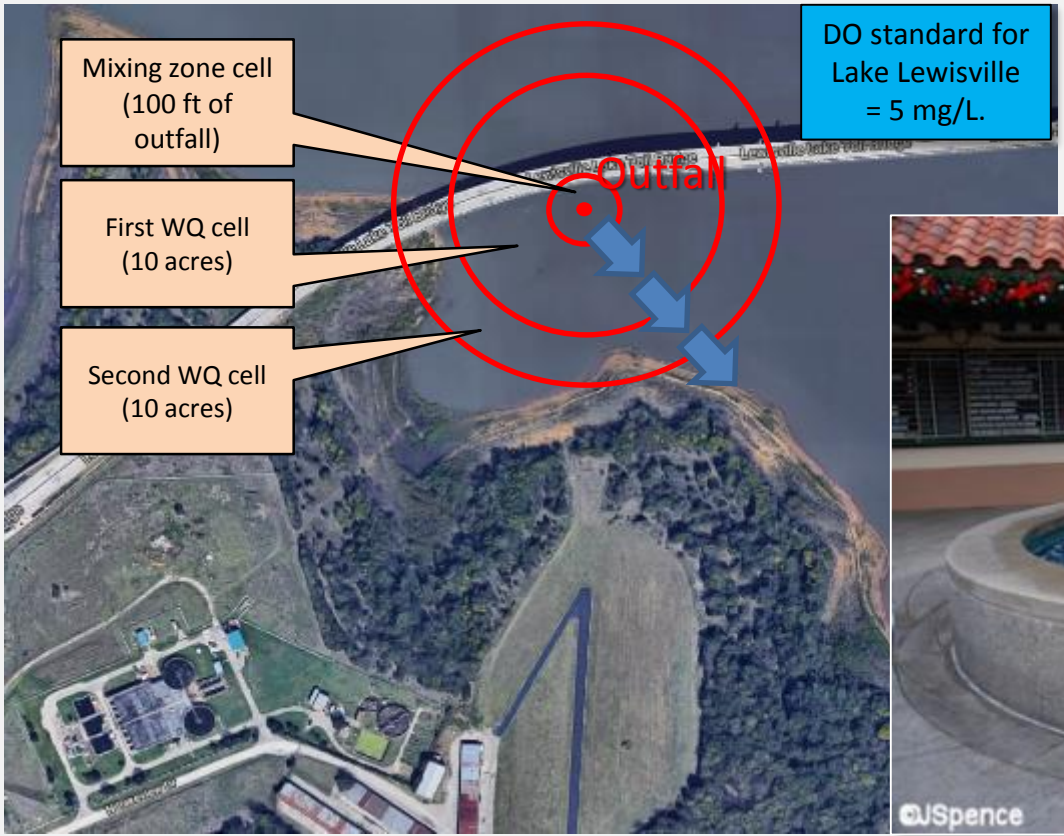
- **Permit** was **renewed over many years** using this method.
- **A commercial software** was used for mixing analysis.

Software update



- In the 2016 permit cycle, a **new version** of commercial software was used
  - **fixed bug** in previous version
  - **calculated** a dilution fraction of **39%**
  - **> 5%** threshold!
- **BPJ can no longer be used**
- **DO modeling needs to be performed**

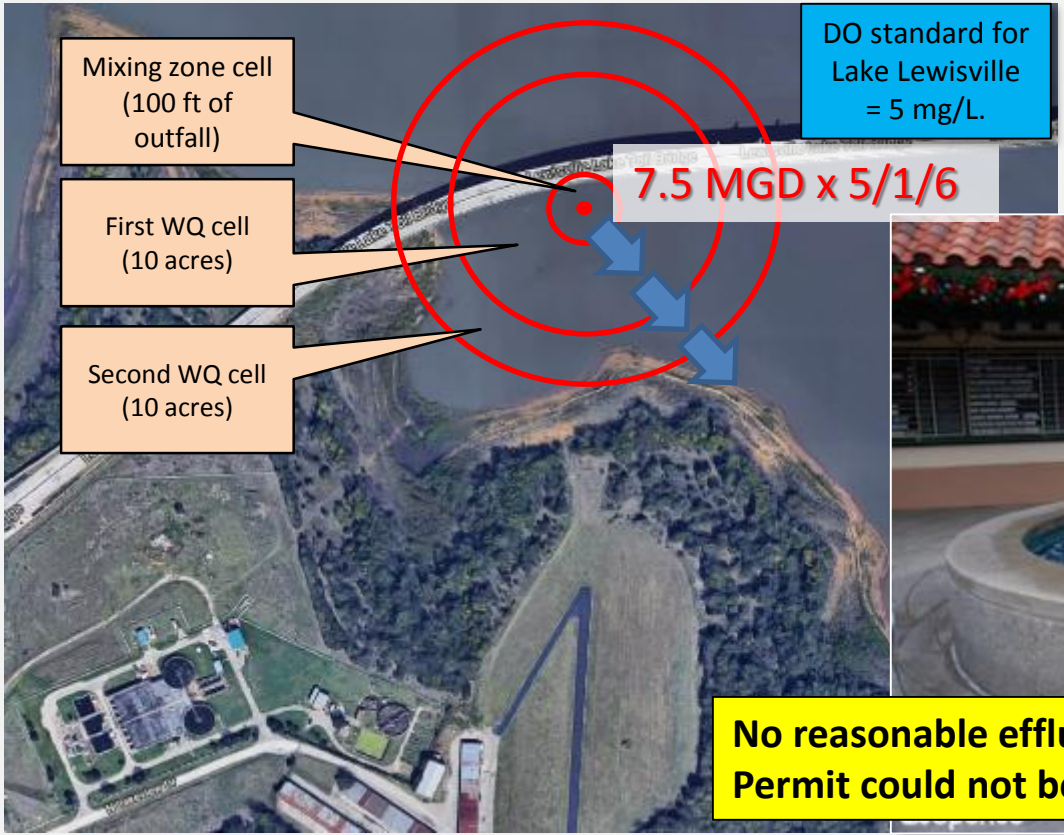
TCEQ Default DO Modeling Approach



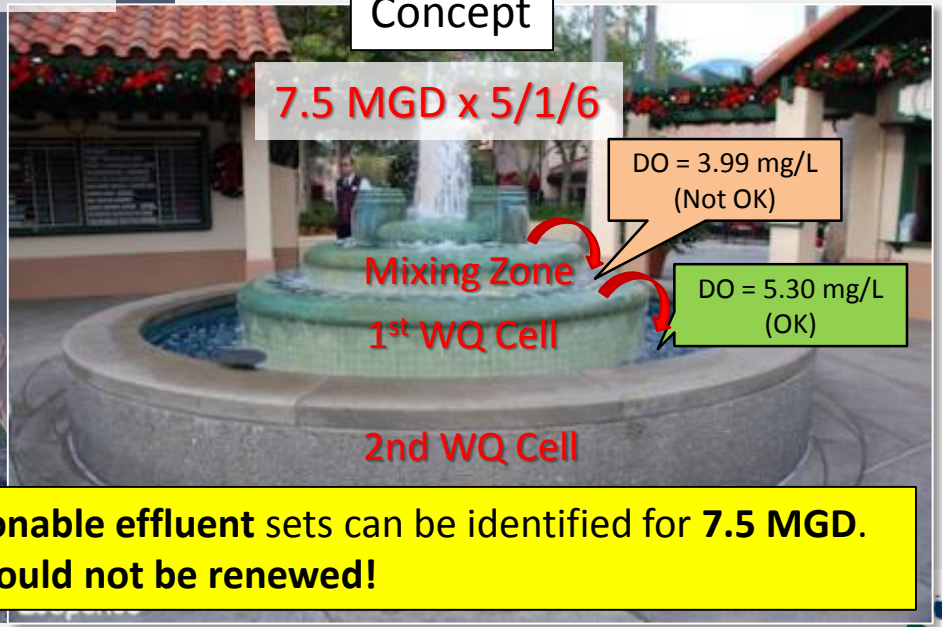
CSTR Models = Completely Stirred Tank Reactors

TCEQ Default DO Modeling Approach

Final Phase Flow = 7.5 MGD
Most Stringent Effluent Set:
BOD_5 = 5 mg/L
NH_3 = 1 mg/L as N
DO = 6 mg/L



Concept

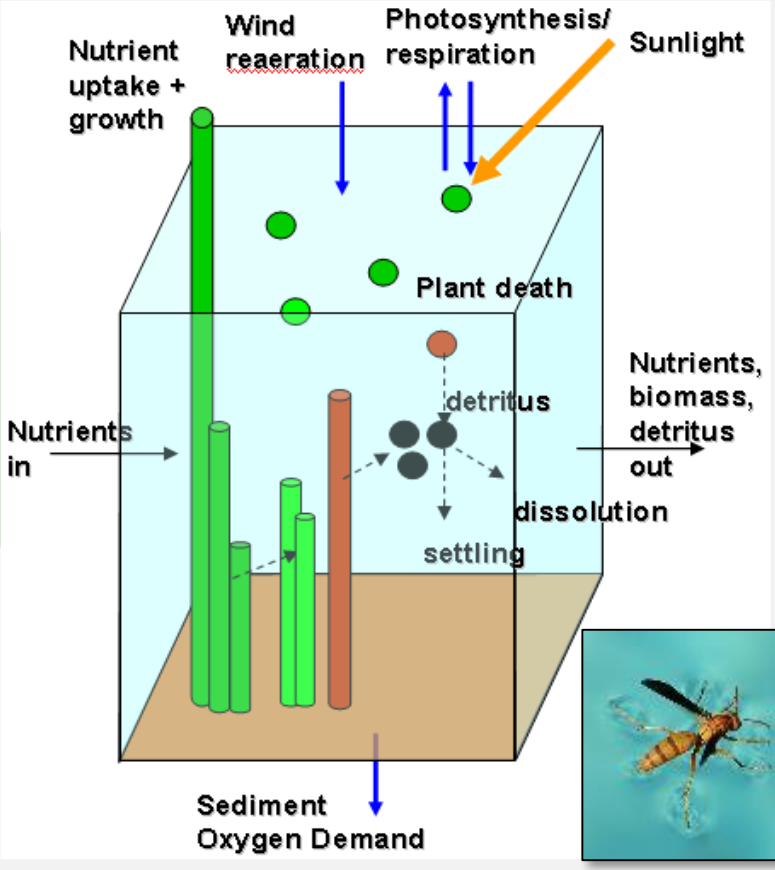


No reasonable effluent sets can be identified for **7.5 MGD**. **Permit could not be renewed!**

New modeling approach is needed

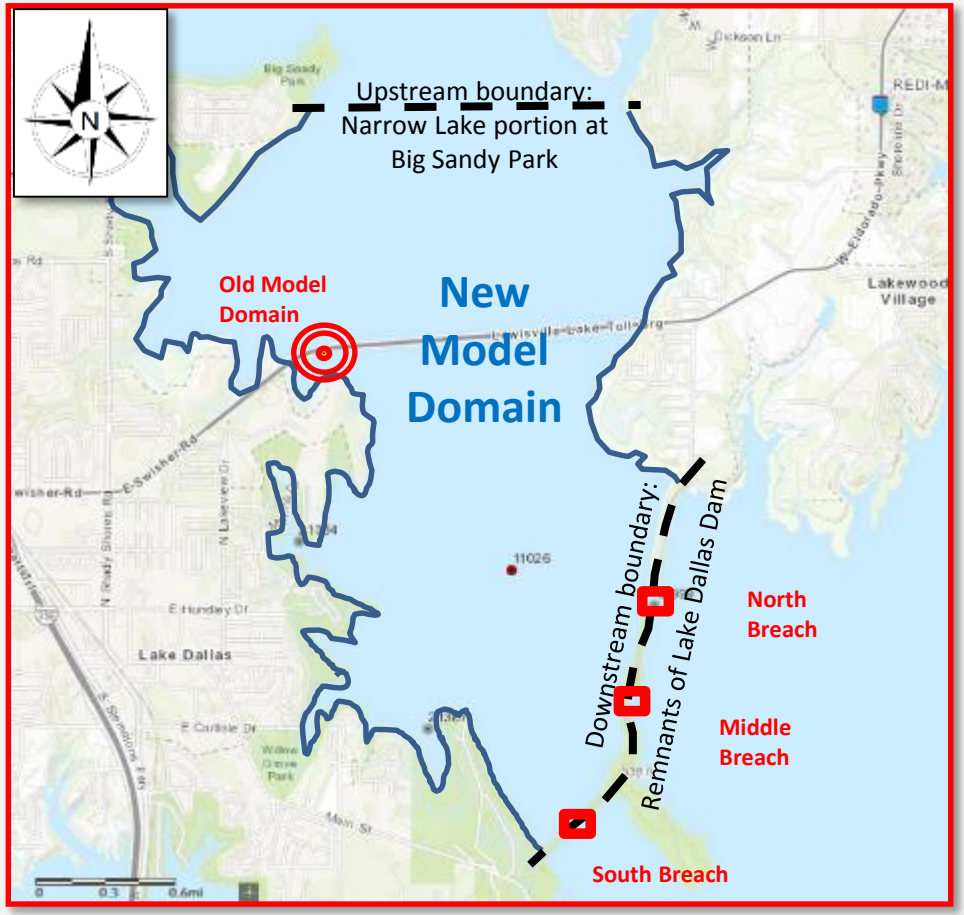
- **Where** is the **ambient water?**
- **Not accounting** for **mixing with ambient water** causes **very conservative results.**
- A **more advanced model** is needed to handle both **mixing with ambient waters** and **DO modeling**
- Solution: Use **USEPA WASP model!**

What is the WASP model?



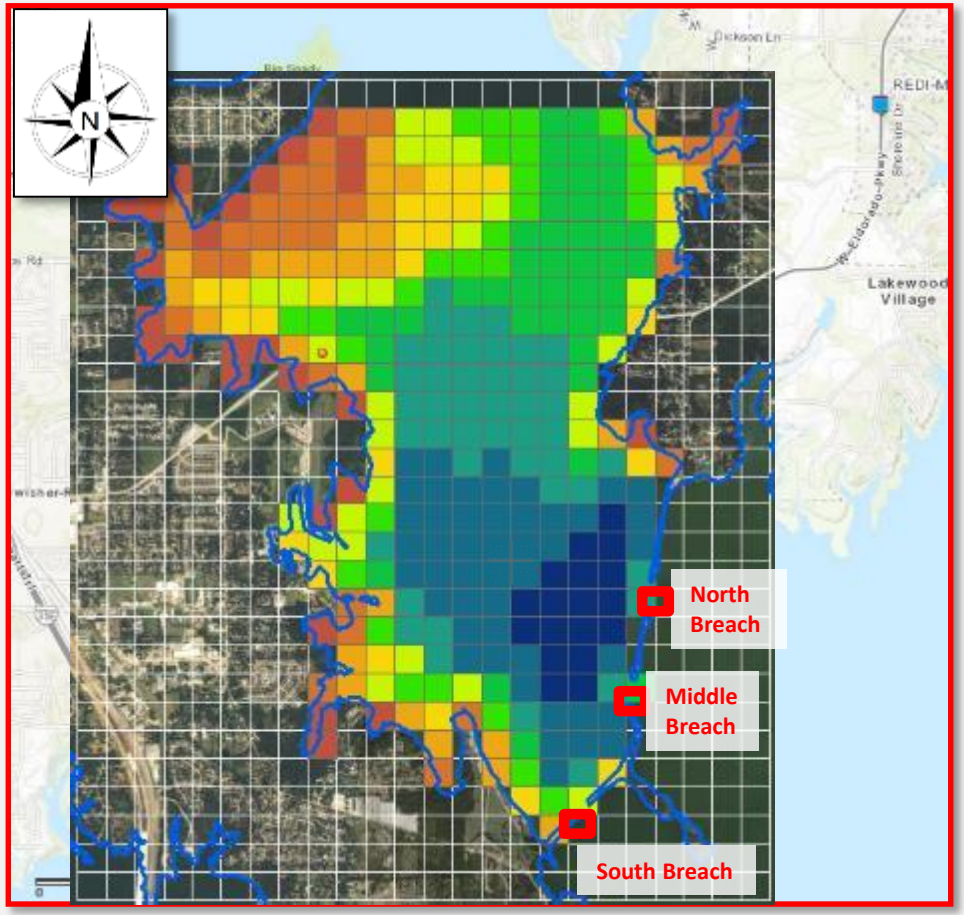
- **WASP = Water Quality Analysis Simulation Program**
- Developed by **USEPA**
- Simulates **DO**-Nutrient Cycle
- Can accommodate more **advanced hydrodynamics**
- Has been used to model **many waterbodies** across the nation
- More **complex** to set up than **CSTR**

WASP Modeling Approach



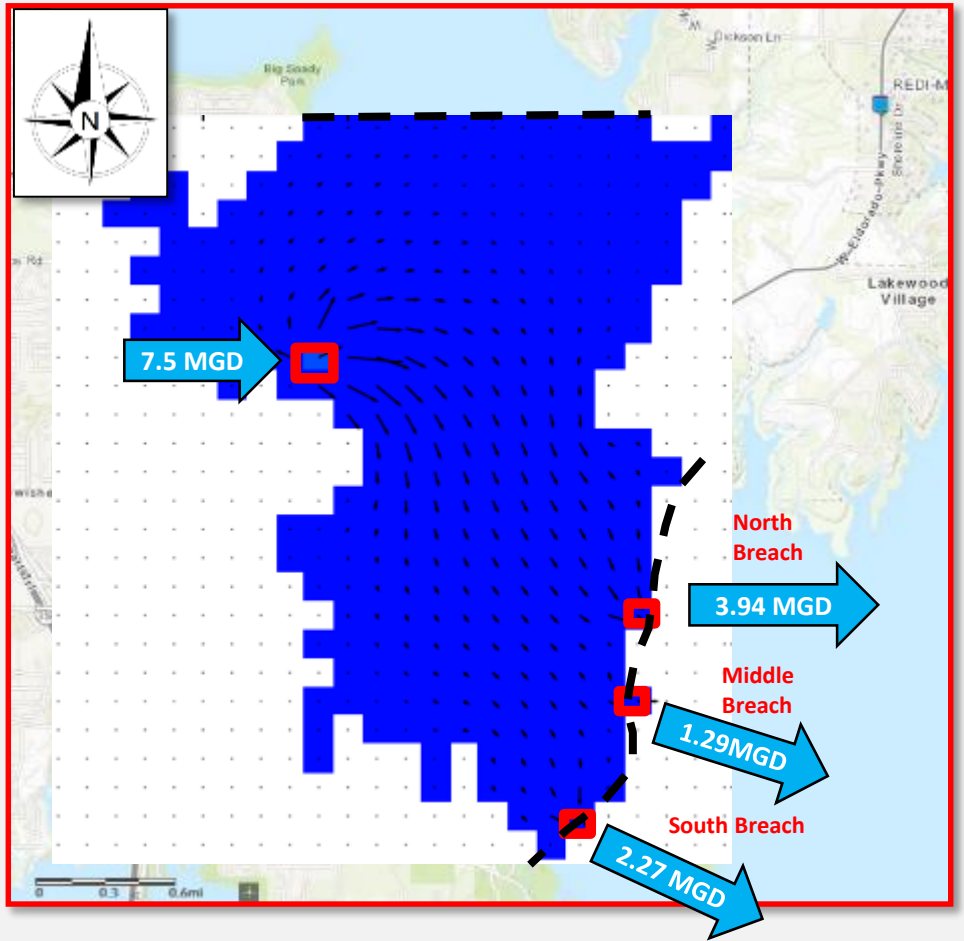
- Model a **larger portion** of Lake Lewisville
  - account for **ambient** effects
  - capture **extent** of effluent water quality impacts

WASP Modeling Approach



- Model a **larger area** of Lake Lewisville
  - account for **ambient** effects
  - capture **extent** of effluent water quality impacts
- **Divide** up model domain into ten-acre square **cells**
- Assign cell depths based on **TWDB hydrography** data

WASP Modeling Approach



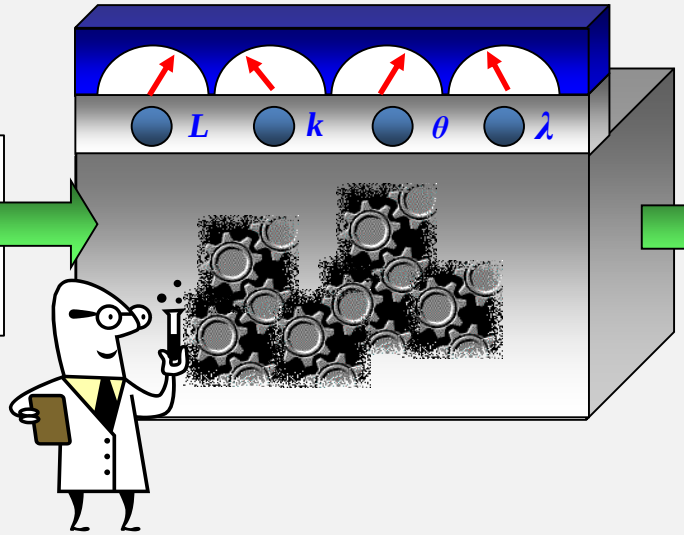
- Compute **cell-to-cell flows**
- Simulate **transport** of water quality constituents, e.g.
  - BOD5
  - NH3
  - DO
- Simulate **physical, chemical and biological processes**, e.g.
  - Decay of organics
  - Sediment Oxygen Demand
  - Reaeration
  - Photosynthesis
- Select model **parameters** based on
  - TCEQ Modeling Standard Operating Procedures (**SOPs**)
  - Consultation with **TCEQ modelers**

Evaluate Permit Effluent Limits

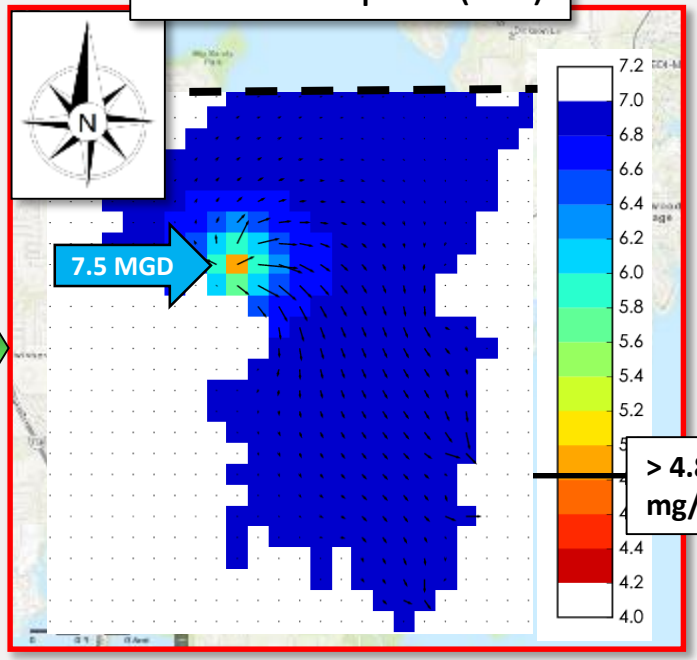
Effluent Limits

Q = 7.5 MGD
BOD_5 = 5-10 mg/L?
NH_3 = 1-4 mg/L as N?
DO = 4-6 mg/L?

Lakeview WASP Model



Model Outputs (DO)

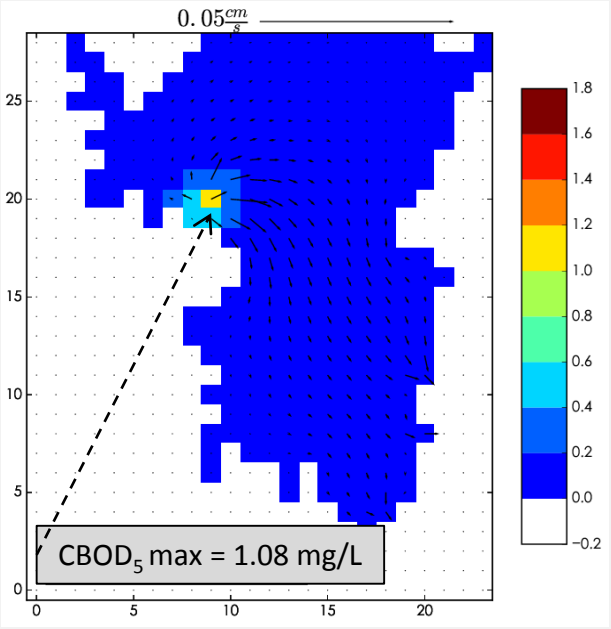


- All cells must meet DO standard for Lake Lewisville of 5 mg/L
  - (0.2 mg/L tolerance allowed, so > 4.8 mg/L)
- Use model to evaluate range of effluent limits

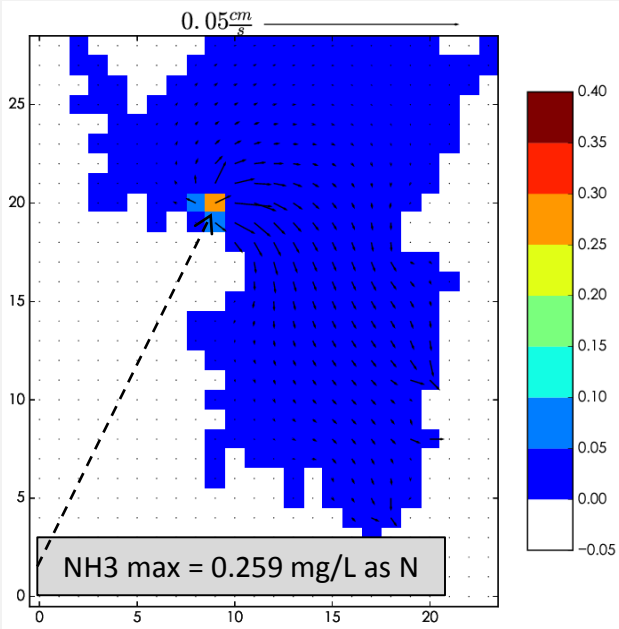
Recommended Effluent Limits for 7.5 MGD (Final Phase)

Results for 7.5 MGD @ 7 $CBOD_5$/ 3 NH_3/ 4 DO

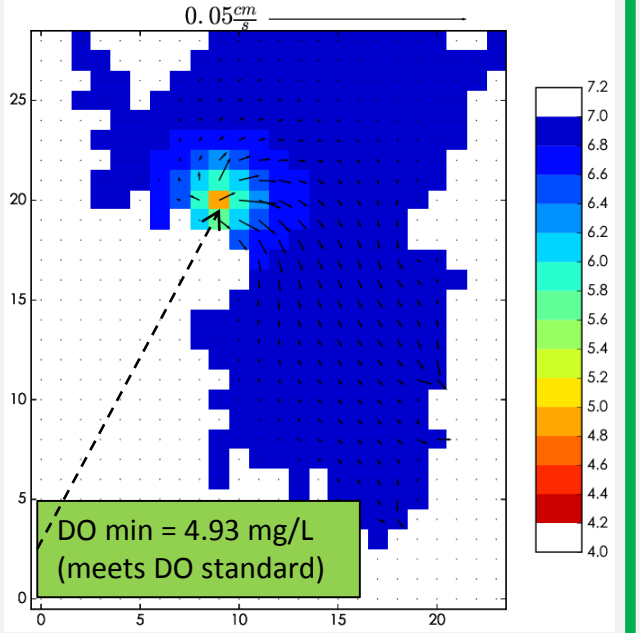
$CBOD_5$ (mg/L)



NH_3 (mg/L as N)



DO (mg/L)

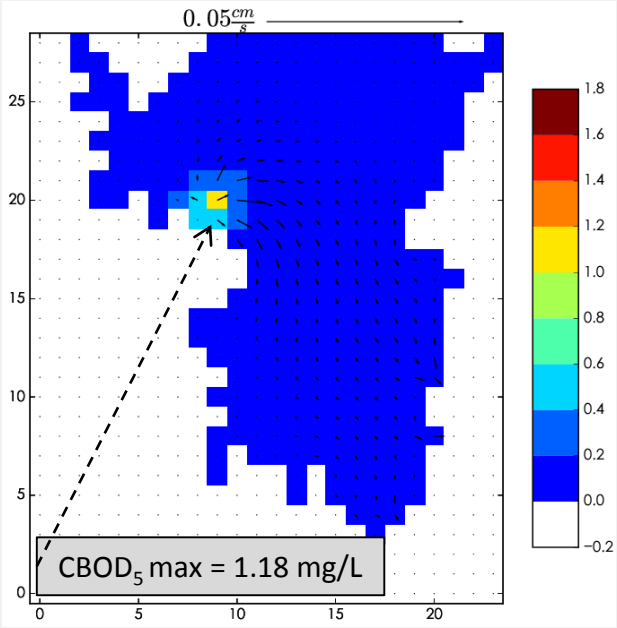


7.5 MGD @ 7 $CBOD_5$/ 3 NH_3/ 4 DO recommended as final phase limits.

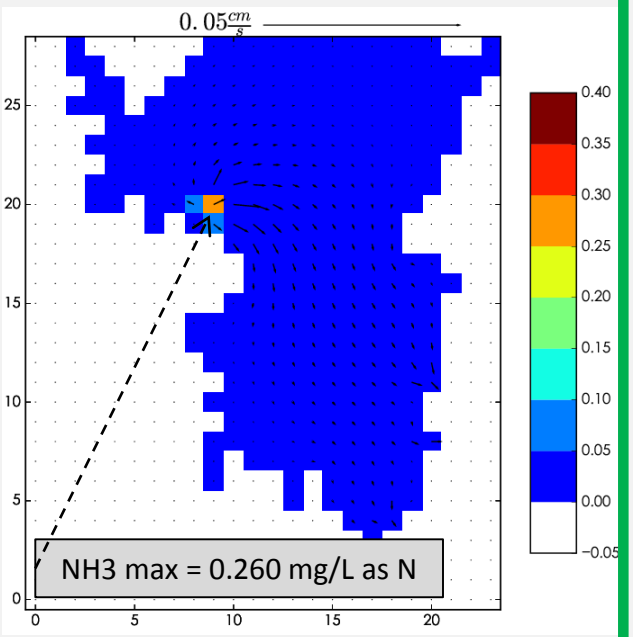
Recommended Effluent Limits for 5.5 MGD (Interim Phase)

Results for 5.5 MGD @ 10 $CBOD_5$/ 4 NH_3/ 4 DO

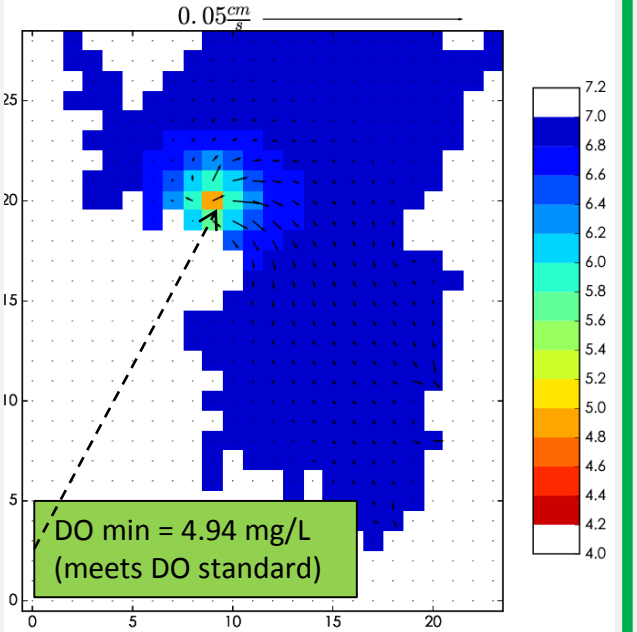
$CBOD_5$ (mg/L)



NH_3 (mg/L as N)



DO (mg/L)



5.5 MGD @ 10 $CBOD_5$/ 4 NH_3/ 4 DO recommended as interim phase limits.

Modeling Conclusions

- **TCEQ Default WQ Models** can incorporate **very conservative** assumptions
  - May in some cases **underestimate assimilative capacity** of a receiving waterbody
- In the case of **direct discharge** into large **open waterbodies**
  - **Advanced WQ models** can be used to
    - account for both **mixing** with ambient waters and **biological/chemical** processes
    - Provide more **reasonable estimates** of **assimilative capacity**
    - But require **more effort** to set up!

Permit Status

- Modeling report was submitted to the TCEQ to recommend the following permit limits:

  - **Interim Phase:**
    - **5.5 MGD @ 10 BOD_5/4 NH3/4 DO**
  - **Final Phase:**
    - **7.5 MGD @ 7 BOD_5/3 NH3/4 DO**

- TCEQ approved recommended permit limits.
- Draft permit with approved limits were provided by TCEQ.
- Awaiting second draft permit and eventual issuance.

Overall Conclusions

If **permit limits** recommended by TCEQ seem **stringent**:

- Worthwhile to **request TCEQ's DO model** for review
- **Evaluate** whether
  - **model assumptions** are too conservative?
  - important **site-specific conditions** have been considered?
  - **modeling methodology** is appropriate for factoring site-specific conditions?
- Then decide whether to **develop revised models** and **recommend new limits**

QUESTIONS?

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THANK YOU!

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