Development of Statewide Nutrient Standards
Impacts to Wastewater Treatment
EPA Mandate

• 1996 – states must adopt numeric nutrient criteria for surface waters
• Narrative standards do not adequately identify or protect problem waterbodies
• Nutrient pollution causes harmful algal blooms
  – Toxic algal events
  – Depleted dissolved oxygen
• Required a “Nutrient Criteria Development Work Plan”
Work Plan

- **Reservoirs**
  - June 2010 TCEQ adopted criteria for chlorophyll a for 75 reservoirs
  - July 2013 EPA Review
    - Approved 39 reservoirs
    - Disapproved 36 reservoirs

- **Streams – In progress**

- **Triennial Standards Review** will only include revision to nutrient work plan
  - No new nutrient criteria will be proposed

- **Additional criteria may be considered around the 2016-2017 calendar years**
### Area Reservoir Chlorophyll a Criteria

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Chlorophyll a Criteria (µg/L)</th>
<th>FY 2014 Water Quality Assessment Chlorophyll a Median (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stillhouse Hollow</td>
<td>5.00</td>
<td>4.10</td>
</tr>
<tr>
<td>Lake Belton</td>
<td>6.38</td>
<td>7.64</td>
</tr>
</tbody>
</table>
# Nutrient Concerns in Area Streams from 2012 Texas Water Quality Inventory

<table>
<thead>
<tr>
<th>Segment</th>
<th>Stream</th>
<th>Nutrient Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td>1215</td>
<td>Lampasas River Below Stillhouse Hollow</td>
<td>none</td>
</tr>
<tr>
<td>1217</td>
<td>Lampasas River Above Stillhouse Hollow</td>
<td>none</td>
</tr>
<tr>
<td>1218</td>
<td>Nolan Creek/South Nolan Creek</td>
<td>Nitrate, Orthophosphorus, Total Phosphorus</td>
</tr>
<tr>
<td>1219</td>
<td>Leon River Below Belton</td>
<td>Nitrate, Orthophosphorus</td>
</tr>
<tr>
<td>1221</td>
<td>Leon River Above Belton</td>
<td>Chlorophyll a</td>
</tr>
</tbody>
</table>
Implementation Plan

- Defines procedures used by TCEQ to apply water quality standards to TPDES permit
- Procedures based on location of discharge
  - Reservoir
  - Surface water
Nutrient Standard Applicability

- New or expanding domestic discharges
  - All will be evaluated for total phosphorus (TP) and total nitrogen (TN)
  - Will receive effluent limit if warranted

- Industrial Discharges
  - Evaluation depends on operation
  - May be subject to limitations on TP and/or TN
Initial Assessment

• General Guidelines
• Comprehensive, site-specific screening
  – Very detailed
  – Multi-step
Initial Assessment-Reservoirs

- Generally focusing on TP limits
- Main Body or Near Reservoir
  - New/expanding discharges $\geq 1$ MGD
- Shallow or Restricted Coves
  - New/expanding discharges $\geq 0.25$ MGD
- Watershed rules or other specific regulatory requirements (TMDL, 305b)
- Smaller discharges will be evaluated if discharge is into a sensitive area.
Initial Assessment - Streams

- Generally focusing on TP limits
- New/expanding discharges ≥0.25 MG
  - Perennial, shallow, clear streams with rocky bottoms
  - Long, shallow, clear streams with perennial impoundments
- Watershed rules or other specific regulatory requirements (TMDL, 305b)
- Smaller discharges will be evaluated if discharge is into a sensitive area.
## Typical TP Effluent Limits

<table>
<thead>
<tr>
<th>Permitted Flow (MGD)</th>
<th>TP Limit (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>0.5-3.0</td>
<td>1.0 to 0.5</td>
</tr>
<tr>
<td>&gt;3.0</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Determining What it Means to Individual Dischargers

• Impact highly variable
• New versus retrofit
• Download IP Plan and perform evaluation to determining likelihood of receiving a standard in your permit
• Current Level and Type of Treatment
  – Nitrification
  – Denitrification
• Level of Removal Needed
  – Need to determine current TP loading
When Will Nutrient Criteria Impact Permits

- Not sure
- Nutrient limits and/or monitoring requirements in some permits already
- Expect more during this round of permitting
- Do not have indication on how quickly TCEQ expects plants to meet requirements
- Variances – EPA proposed regulation 10 years max
Other Things to Consider

- Plant capacity restraints
- Property restraints
- Energy costs
- Operational Controls
  - Automation
  - More staff time
  - More staff training
Biological Nutrient Removal (BNR)

- Most current facilities remove ammonia
- Some also remove nitrate
- Very few designed to remove phosphorus
- If you can achieve permit limits, BNR seems to be most cost effective
Nitrogen (N) Removal through BNR

- **Nitrification**
  - Removes ammonia
  - Aerobic conditions

- **Denitrification**
  - Removes nitrate
  - Anoxic conditions

- **Solids Separation**
  - Removes particulate organic N

- **No common removal mechanism for soluble organic nitrogen**
**Phosphorus (P) Removal through BNR**

- Removal of TP requires removal of both particulate and soluble P
- Particulate P
  - Solids separation
- Soluble P
  - Phosphate-accumulating organisms
- Must have an anaerobic zone free of dissolved oxygen and nitrate
- May require construction of additional treatment chamber
**P Removal through Chemical Precipitation**

- Aluminum and iron coagulants
- Lime
- Has higher operating costs than BNR
- Produces more sludge with more chemicals = increased disposal costs
Ultra Low Levels of P
(≈0.1 mg/L)

- May require a combination of BNR and chemical precipitation
- Sand or other filtration may be necessary to remove additional particulate P
- May require advanced treatment
New Facilities

- More flexibility
- Can be designed to target specified levels of effluent quality
Retrofit

• May be constrained by existing land available and existing treatment units and sludge handling procedures

• Need to Consider
  – Aeration basin size and configuration
  – Clarifier capacity
  – Type of aeration system
  – Sludge processing units
  – Operator skill
Costs

- New plant costs based on estimated influent quality, target effluent quality and available funding
- Retrofit costs are site-specific and vary considerably
- Costs based on discharge size and limit
  - Larger = more cost effective
  - Smaller limit = more expensive
- Cost increase no longer associated with population growth
# Average Unit Capital Costs for BNR Upgrades

**Maryland and Connecticut**

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;0.1 – 1.0</td>
<td>$6,972.000</td>
</tr>
<tr>
<td>&gt;1.0 – 10.0</td>
<td>$1,742.000</td>
</tr>
<tr>
<td>&gt;10.0</td>
<td>$588.00</td>
</tr>
</tbody>
</table>
## Montana

Estimated Costs to Reduce TN to 5.0 mg/L and TP to 0.5 mg/L

<table>
<thead>
<tr>
<th>Cost</th>
<th>0.1 MGD</th>
<th>1.0 MGD</th>
<th>10 MGD</th>
<th>30 MGD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>$241,000</td>
<td>$1,112,00</td>
<td>$4,927,00</td>
<td>$12,383,00</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>$7,046</td>
<td>$29,218</td>
<td>$157,469</td>
<td>$293,938</td>
</tr>
</tbody>
</table>

Estimated Costs to Reduce TN to 3.0 mg/L and TP to 0.1 mg/L

<table>
<thead>
<tr>
<th>Cost</th>
<th>0.1 MGD</th>
<th>1.0 MGD</th>
<th>10 MGD</th>
<th>30 MGD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>$312,000</td>
<td>$1,268,00</td>
<td>$9,620,00</td>
<td>$26,520,00</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>$22,993</td>
<td>$69,925</td>
<td>$311,634</td>
<td>$841,120</td>
</tr>
</tbody>
</table>
Utah

- To remove P to 1.0 mg/L
  - Statewide capital cost to upgrade = $24 million
  - Average monthly bill for residents would increase 7.1% or $1.19/month
  - Costs over 20 years (capital and O&M) = $114 million
Other Strategies to Consider

- Treatment wetlands
  - Tarrant Regional Water District
  - North Texas Municipal Water District
- Watershed strategies/coalitions
- Reuse/No Discharge
  - Lake Travis Water Quality Area
  - Lake Austin Water Quality Area

John Bunker Sands Wetlands – North Texas Municipal Water District
### Estimated Cost of Phosphorus Reduction to 1 mg/L TP at Six WWTPs Discharging to the North Bosque River

<table>
<thead>
<tr>
<th>City</th>
<th>Permitted Discharge (mgd)</th>
<th>Effluent TP (mg/L)</th>
<th>Capital Cost ($)</th>
<th>O&amp;M Cost ($/yr)</th>
<th>Base Residential Bill ($/mo)</th>
<th>Additional Treatment Cost ($/mo)</th>
<th>Revised Residential Bill ($/mo)</th>
<th>% Increase to Monthly Residential Bill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stephenville</td>
<td>3.00</td>
<td>2.69</td>
<td>$786,288</td>
<td>$64,413</td>
<td>$20.69</td>
<td>$1.19</td>
<td>$22.88</td>
<td>11%</td>
</tr>
<tr>
<td>Clifton</td>
<td>0.65</td>
<td>2.40</td>
<td>$979,000</td>
<td>$14,775</td>
<td>$22.00</td>
<td>$3.77</td>
<td>$25.77</td>
<td>17%</td>
</tr>
<tr>
<td>Meridian</td>
<td>0.45</td>
<td>3.36</td>
<td>$2,290,860</td>
<td>$31,191</td>
<td>$18.64</td>
<td>$14.73</td>
<td>$33.37</td>
<td>79%</td>
</tr>
<tr>
<td>Hico</td>
<td>0.20</td>
<td>3.52</td>
<td>$825,000</td>
<td>$9,215</td>
<td>$12.00</td>
<td>$7.77</td>
<td>$19.77</td>
<td>65%</td>
</tr>
<tr>
<td>Valley Mills</td>
<td>0.36</td>
<td>3.14</td>
<td>$957,000</td>
<td>$20,154</td>
<td>$8.00</td>
<td>$12.02</td>
<td>$20.02</td>
<td>150%</td>
</tr>
<tr>
<td>Iredell</td>
<td>0.05</td>
<td>2.96</td>
<td>$792,100</td>
<td>$7,518</td>
<td>$15.14</td>
<td>$25.43</td>
<td>$40.57</td>
<td>168%</td>
</tr>
</tbody>
</table>
References for Cost Data

• USEPA – Biological Nutrient Removal and Costs

• Montana Department of Environmental Quality – Wastewater Treatment Performance and Cost Data to Support an Affordability Analysis for Water Quality
  http://www.deq.mt.gov/wqinfo/Standards/default.mcpx

• Utah Division of Water Quality - Statewide Nutrient Removal Cost Impact Study
  http://www.waterquality.utah.gov/POTWnutrient/

• Keplinger et al. - Cost and Affordability of Phosphorus Removal at Small Wastewater Treatment Facilities