OIL FIELD PRODUCED WATER FOR CROP IRRIGATION

Clay Rodgers
Assistant Executive Officer
Presentation Overview

- Why are we here
- Project Charter
- Background on produced water
- Produced water analytical data
- Crop data
- Regulatory Issues
Why Are We Here?

- To ensure protection of human health
- Heightened attention on oil production activities
- New projects to expand recycling for agriculture
- How do we address food safety concerns
Crop Safety Goals

- Involve our sister agencies responsible for food safety
- Get input from experts
- Confirm use is appropriate
- Should there be conditions
- Not to become an extended research project
Project Charter

- Open to discussion
- Provides some background
- Purpose
- White paper.
Produced Water

- Water produced during oil extraction
- 1.9 billion barrels (240,000+ ac/ft) of produced water in 2013
- 878 million barrels for enhanced oil recovery in 2013
- Approximately 50,000 ac/ft currently used for irrigation
- Remainder is disposed in ponds and injection wells
Oil/Gas Fields

Kings County

Tulare County

Kern River

Kern County

San Luis Obispo County

Bakersfield

I-5

99

Sources: Esri, Delorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community
Chemical Analyses

- General minerals
- Metals
- Volatile and semi-volatile organics
- Radionuclides
Produced Water Quality
Inorganic Compounds

<table>
<thead>
<tr>
<th></th>
<th>TDS mg/L</th>
<th>Chloride mg/L</th>
<th>Boron mg/L</th>
<th>Sodium mg/L</th>
<th>Arsenic ug/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>VWM</td>
<td>570 - 600</td>
<td>80 - 82</td>
<td>1 – 1.1</td>
<td>180 - 210</td>
<td>34 - 41</td>
</tr>
<tr>
<td>Chevron</td>
<td>490 - 500</td>
<td>100 - 110</td>
<td>0.72 - 0.78</td>
<td>120 - 130</td>
<td>11 - 14</td>
</tr>
<tr>
<td>CRC</td>
<td>540 - 620</td>
<td>77 - 90</td>
<td>0.9 - 1.2</td>
<td>155 - 185</td>
<td>68 - 86</td>
</tr>
</tbody>
</table>
## Produced Water Quality
### Organic Compounds

<table>
<thead>
<tr>
<th></th>
<th>Acetone ug/L</th>
<th>Benzene ug/L</th>
<th>Ethyl-benzene ug/L</th>
<th>Toluene ug/L</th>
<th>1,2,4-Trimethyl-benzene ug/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>VWM</td>
<td>ND – 79.4</td>
<td>ND</td>
<td>ND</td>
<td>ND – 7.5</td>
<td>ND</td>
</tr>
<tr>
<td>Chevron</td>
<td>31 - 150</td>
<td>ND - 0.67</td>
<td>0.25 - 1.2</td>
<td>0.39 - 1.3</td>
<td>0.40 – 1.9</td>
</tr>
<tr>
<td>CRC</td>
<td>ND-53.9</td>
<td>1.2</td>
<td>9.1</td>
<td>5.1</td>
<td>ND</td>
</tr>
</tbody>
</table>
## Produced Water Quality

### Organic Compounds

<table>
<thead>
<tr>
<th></th>
<th>2-Butanone</th>
<th>m,p-Xylene</th>
<th>o-Xylene</th>
<th>Xylenes, Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ug/L</td>
<td>ug/L</td>
<td>ug/L</td>
<td>ug/L</td>
</tr>
<tr>
<td>VWM</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Chevron</td>
<td>7.2 - 12</td>
<td>0.75 - 4.3</td>
<td>0.43 - 1.5</td>
<td>1.2 - 3.9</td>
</tr>
<tr>
<td>CRC</td>
<td>ND</td>
<td>14</td>
<td>7</td>
<td>21</td>
</tr>
</tbody>
</table>
Produced Water Mixed with Other Irrigation Water
Produced Water on Cropland
Cropland Data

- 90,000+ Acres
- Crops Grown
  - Almonds (41,000 acres)
  - Grapes (15,000 acres)
  - Pistachios (12,000 acres)
  - Citrus (11,000 acres)
  - Other (apples, stone fruit, pomegranates, tomatoes, potatoes, beans, carrots)
Produced Water Irrigation Issues

- Produced water being used
- Desire to increase use
- Media and stakeholder concern
- Hydraulic fracturing constituents on crops for human consumption
Produced Water Irrigation Issues

- Increased the suite of analyses
- Demonstration of adequacy or prohibition
- Creating a food safety group
Regulatory Issues

- Report of Waste Discharge
- Comply with laws, policies, and regulations
- Waste Discharge Requirements
Questions ?