Produced water from oil and gas production

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Produced Water

• Any water that is produced to the surface along with oil or gas

• It is the largest waste stream generated by the oil and gas industry
Produced Water Quantity

- On average, about 7 - 10 barrels (bbls), (which is 280 - 400 U.S. gallons) of produced water generated per barrel of crude oil.

- Natural gas wells typically produce much less water than oil wells.
Typically, for conventional oil and gas wells, water production increases over time.

Source: USGS. 1997. USGS Research on Saline Waters Co-Produced with Energy Resources
What’s in produced water?

Major components include:

1. hydrocarbons
2. salts
3. metals
4. radionuclides
5. production chemicals
Hydrocarbons and organic compounds

- Include oil, grease, and dissolved organic compounds such as: benzene, naphthalene, toluene, phenanthrene, and pentachlorophenol.
- Generally, as the weight of organic compounds decreases they are more difficult to remove using oil/water separators.
Salts

• Salts in produced water are primarily chlorides and sulfides of Ca, Mg, and Na. Produced water may contain high levels of chlorides - as much as 10 times more than seawater.
Metals and trace elements

- Lead, chromium and nickel are often among the most abundant. Also, barium, manganese, iron, strontium, zinc, silver, cadmium, lithium, copper, mercury, arsenic, selenium, boron and antimony may also be present in produced water.
Total dissolved solids

The U.S. Geological Survey has a database of produced water constituents from various oil and gas producing regions across the country

- it contains good information on total dissolved solids (TDS)
- it does not contain detailed information on hydrocarbons, radionuclides or metals

http://energy.cr.usgs.gov/prov/prodwat/tds.htm
## Comparison of water quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Drinking water criteria</th>
<th>CBM produced water</th>
<th>Natural gas produced water</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.5 – 8</td>
<td>7 - 8</td>
<td>6.5 – 8</td>
</tr>
<tr>
<td>TDS (mg/L)</td>
<td>500 (taste)</td>
<td>4,000 – 20,000</td>
<td>20,000 – 100,000</td>
</tr>
<tr>
<td>Benzene (ppb)</td>
<td>5</td>
<td>&lt; 100</td>
<td>1,000 – 4,000</td>
</tr>
<tr>
<td>Na⁺ (mg/L)</td>
<td>200</td>
<td>500 – 2,000</td>
<td>6,000 – 35,000</td>
</tr>
<tr>
<td>Barium (mg/L)</td>
<td>-</td>
<td>0.001 – 0.1</td>
<td>0.1 - 40</td>
</tr>
<tr>
<td>Cl⁻ (mg/L)</td>
<td>-</td>
<td>1,000 – 2,000</td>
<td>13,000 – 65,000</td>
</tr>
<tr>
<td>HCO₃⁻</td>
<td>-</td>
<td>150 – 2,000</td>
<td>2,000 – 10,000</td>
</tr>
</tbody>
</table>

Benzene in water after treatment

Produced water contamination

Prior to the institution of Federal regulations in the 1970's, large volumes of these waters were discharged into rivers, streams, and unlined evaporation ponds, contaminating surface and ground waters and soils in energy producing States.

Produced water incidents

• Study by Fisher and Sublette
• Fluid releases in OK between 1993 - 2003
• An average of 790 releases a year
• 50% were less than 40 bbls; 25% were between 40 and 100 bbls; the remaining 25% were > 100 bbls (4,000 U.S. gallons).

Most frequent source of produced water release

- Flowlines
- Wells
- Tanks
- Surface Equ't
- Pits
- Other/Unknown
Most frequent cause of release

- Overflows
- Illegal Activity
- Storms
- Fire
- Accidents
- Corrosion
overflowing tank
tank corrosion
Accidental cause of produced water spill?

One of the causes of releases outlined in the study was livestock or wildlife opening produced water valves.
Impact of releases
Spills

produced water spill
sterilized soil
Produced water disposal today

- Surface or stream disposal
- Evaporation pits/ponds
- Underground injection for waterflooding and maintaining field pressures
- Underground injection for disposal
Pits and ponds

brine pit in SE NM
rips in liner
Injection wells

Diagram credit: NM Oil Conservation Division
Enhanced Recovery Wells
Pathways for contamination

- leaks or cracks in injection well casing
- improperly plugged abandoned oil and gas wells within the radius of influence created by injection wells
- natural or induced fractures, which connect the injection zone with adjacent water zones
GAO Study

• Study found 23 confirmed cases of groundwater contamination from produced water injection wells

• “for most of the 23 confirmed cases, the drinking water sources that were contaminated will remain so for years until natural processes restore water quality.”

GAO. 1989. Safeguards Are Not Preventing Contamination from Oil and Gas Wells.
Natural fracture?

Simon Land and Cattle Injection Well, La Plata County, CO

- 1989 - SL&C injection well installed
- 1993 - increase in injection pressure
- 1996 - sharp decrease in injection pressure
- 1997 - flow and temperature at hot springs increase
- 1999 - (January) injection ceases
- 1999 - (August) hot springs water temperature and flow rate decrease
Conclusion

• Produced water is the largest volume waste produced by the industry
• Produced water contains constituents that are harmful living organisms
• There are risks to human and environmental health involved with every method of disposal