Highlights of a pilot study to investigate natural attenuation of arsenic in the Little River near Norman, Oklahoma, 2012

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Reasons for pilot study

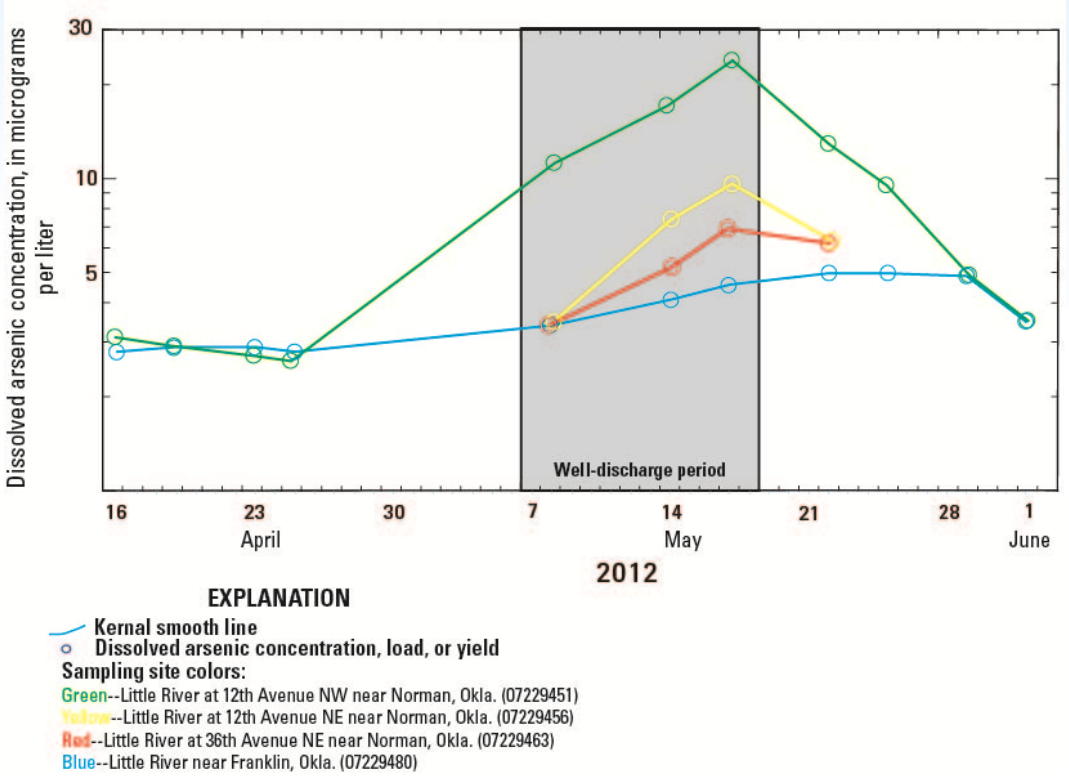
- About 1/3 of the city of Norman's wells have been inactivated because of arsenic concentrations in well water exceeded the drinking water MCL of 10 micrograms per liter.
- Conventional treatments to remove arsenic from water are expensive, requiring continual maintenance.
- The city relies on Lake Thunderbird for about 2/3 of its water supply.
- City population and water demand have been growing and water levels have been decreasing in Lake Thunderbird.
- Natural soils and streambed sediments containing minerals of iron, aluminum, and other metals can sorb arsenic out of water.
- Six city wells were discharged for 12 days into channels leading to the Little River to investigate the potential for using natural attenuation of arsenic in groundwater to augment city water supplies in Lake Thunderbird.

Study area

Figure 2. Study area and sites sampled near Norman, Oklahoma, April through June, 2012.

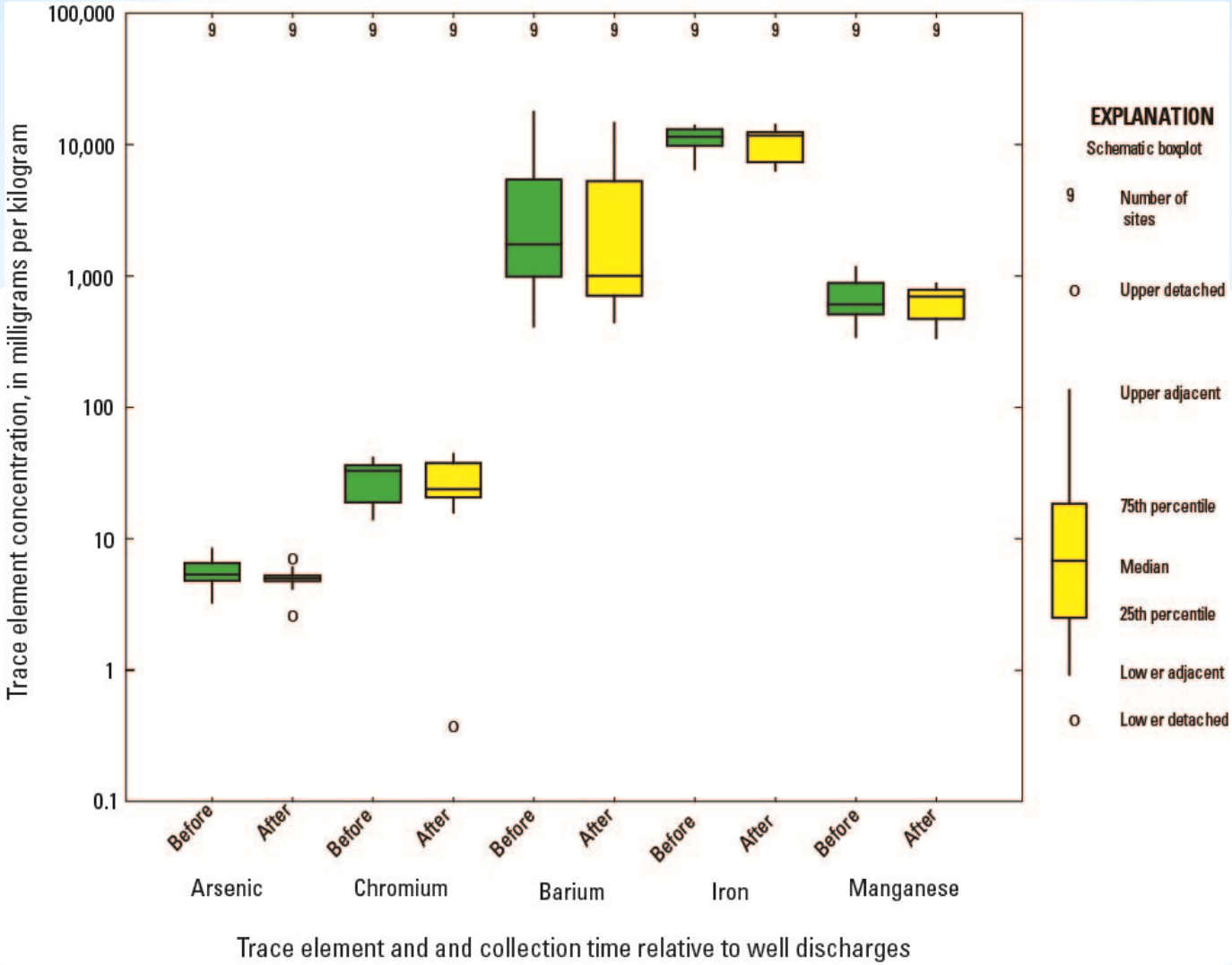
Lake Thunderbird at gage height of 1,031.4 ft on Feb. 13, 2013 (Stan Paxton photo)

Effects of well discharge on arsenic concentration in the Little River



- Pumping of ~1,200 gpm of groundwater gradually increased Little River arsenic concentrations, but they remained far less than fish and wildlife propagation standards of 360 ug/L (CMC) and 190 ug/L (CCC).
- Arsenic concentrations in water reaching the Little River were less than half of wellhead concentrations.
- Arsenic concentrations were attenuated by about another 50 percent downstream, with only a slight increase in dissolved arsenic concentration near the lake.
- If these wells were discharged throughout the year, that discharge would represent 2.75 percent of the storage in the lake.

Trace elements in streambed sediments



Trace-element concentrations did not significantly increase compared to the period before well pumping.

Lingering questions from the pilot study

If groundwater were pumped longer, e.g. for 2-4 months, would:

a) streamwater arsenic concentrations continue to increase?

b) streambed sediments show substantial increases in arsenic concentration that would indicate natural attenuation capacity?

Can increased concentrations of arsenic associated with streambed sediments be documented in the depositional delta where the Little River discharges into the lake? (What is the fate and transport of arsenic associated with streambed sediments?)

Would lake water arsenic concentrations be affected by groundwater discharges, either in the top of the water column or near lakebed sediments on the bottom of the lake?

Nutrients and Lake Thunderbird

- The Little River is on Oklahoma's 303d list for increased turbidity and low dissolved oxygen concentration.
- Lake Thunderbird is on the 303d list for increased turbidity, low dissolved oxygen concentration, and increased chlorophyll-a concentrations.
- Issues with those constituents are typical for freshwater eutrophic streams and lakes, which are commonly phosphorus-limited.

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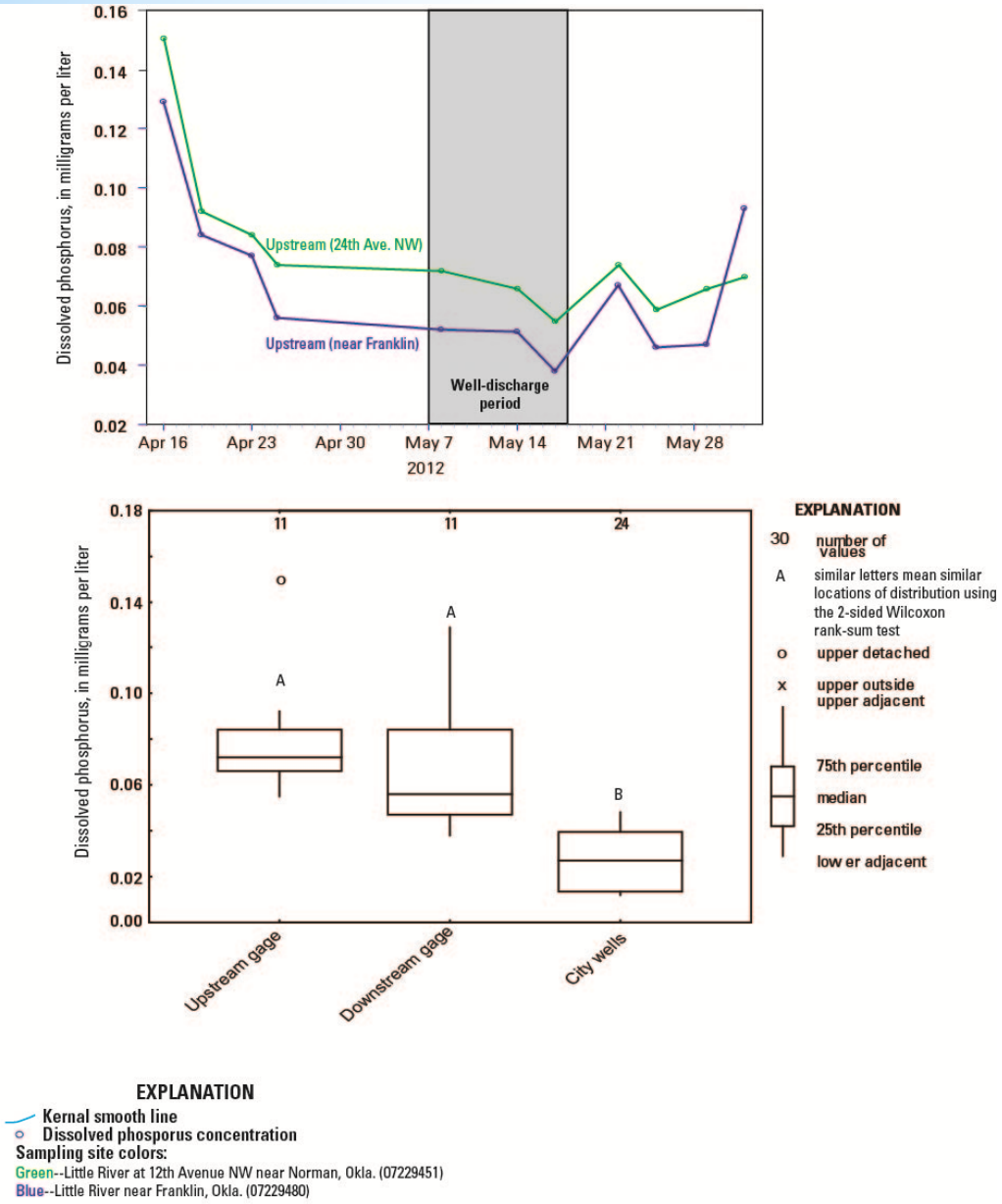
Phosphorus and groundwater pumping



Dissolved phosphorus concentration in groundwater and the Little River in and near Norman, Oklahoma, April through June, 2012.

- Dissolved phosphorus concentrations in groundwater were about ¼ of those in water sampled at the furthest upstream gage prior to well pumping.
- About 50 percent of dissolved phosphorus concentrations in groundwater were less than the 0.037 mg/L Oklahoma Scenic Rivers standard.
- During well pumping, streamwater phosphorus concentrations substantially declined.

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Conclusions

- The City of Norman needs to augment its municipal water supplies in a cost-effective and sustainable manner.
- Results from the pilot study indicated that natural attenuation is an effective way of removing arsenic from well water.
- Discharge from six city wells to the Little River did not appear to increase arsenic concentrations in the river above any relevant water-quality standards.
- Lake Thunderbird is on the 303d list for exceeding water-quality parameters typically associated with eutrophication, which tends to be phosphorus-limited.
- Pumping groundwater to the Little River substantially reduced phosphorus concentrations in the major tributary to Lake Thunderbird and might reduce eutrophication in the lake.
- Natural attenuation may be a cost-effective and sustainable means for reducing arsenic concentrations in water supplies in areas with increased arsenic concentrations in groundwater and is transferable to many other cities and towns in Oklahoma, the southwestern U.S., and other parts of the world.

Waterspout on Lake Thunderbird,
KOCO.com image

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