Effects of Wastewater Treatment Plants on Water Chemistries and Benthic Invertebrate Populations in the Middle Rio Grande

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Wastewater Treatment Plants (WWTPs)

- Water is diverted from water sources (rivers, wells etc) and used for a variety of needs.
- Waste Water Treatment Plants (WWTP) are responsible for collecting, chemically and physically treating this water after use.
- Waste sludge is disposed of
- "Clean" water effluent is put back into stream systems

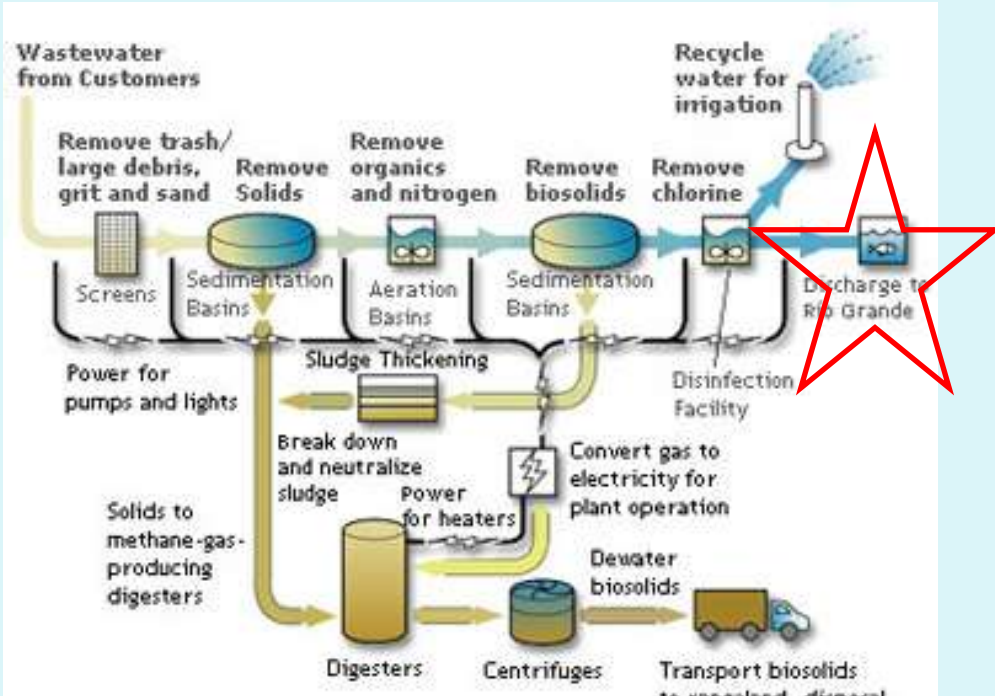


Image courtesy of http://www.abcwua.org

Treatment and Regulation

- Waste water is treated with physical filters and large amounts of chlorine
- Some WWTPs also have implemented terterary treatments with ozone, UV light or reverse osmosis but these treatments are not always used because of cost
- The US Environment Protection Agency (EPA) oversees effluent according to the Clean Water Act
- EPA now requires de-chlorination step
- EPA has set regulations in place for many chemicals

Scientific Inquiry

- How is WWTP effluent affecting water chemistries and overall stream health in arid environments?

- Hypothesis: Water chemistries and overall stream health would be significantly altered and degraded.

The Rio Grande

- 5th largest watershed in the US
- Average annual flow volume (1986-2007) 1,050,000 acre-feet/yr at Otowi Bridge (near Santa Fe)
  - Fluctuates largely, but generally loses volume downstream from this point.
- Average depth ~3 ft in natural channel
  - Highly variable channel depth (ranges from 0-30+ ft) depending on position and season
- ~90% of withdrawal is for crop irrigation.
- ~42% of Albuquerque metro areas drinking water comes from the Rio Grande
  - 167 gal/day/person (2007)

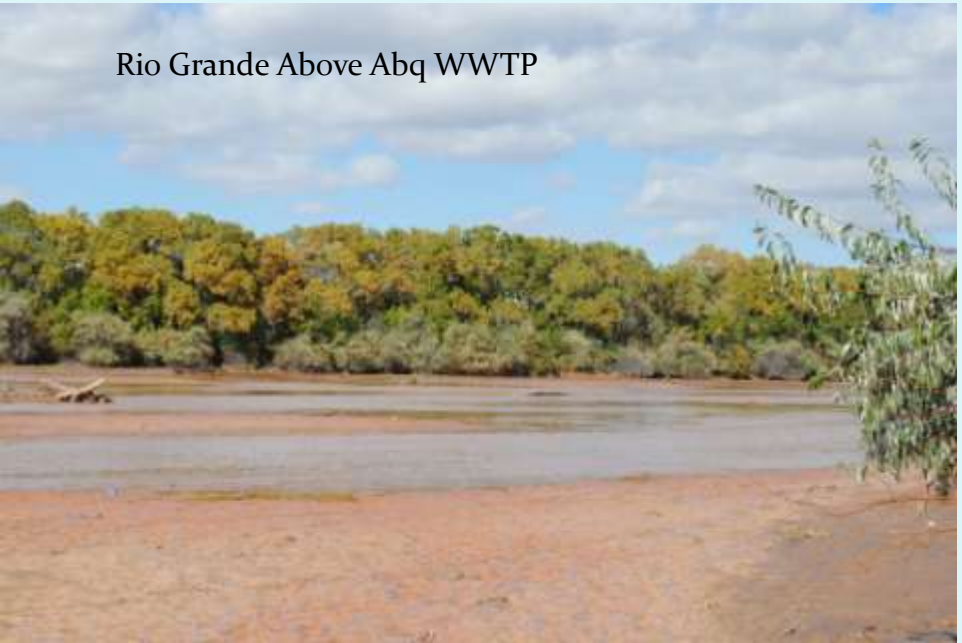
Study Sites

- Buckman, NM – Control Site
- Bernalillo WWTP
- Below Bernalillo WWTP
- Rio Rancho WWTP

- Below Rio Rancho WWTP
- Albuquerque WWTP
- Los Lunas WWTP
- Below Los Lunas WWTP

Magnitude of Effect: The Albuquerque WWTP

- ~56 million gallons per day
- 5th largest tributary to the Rio Grande
- Contributes ~30% of downstream flow


Rio Grande Above Abq WWTP

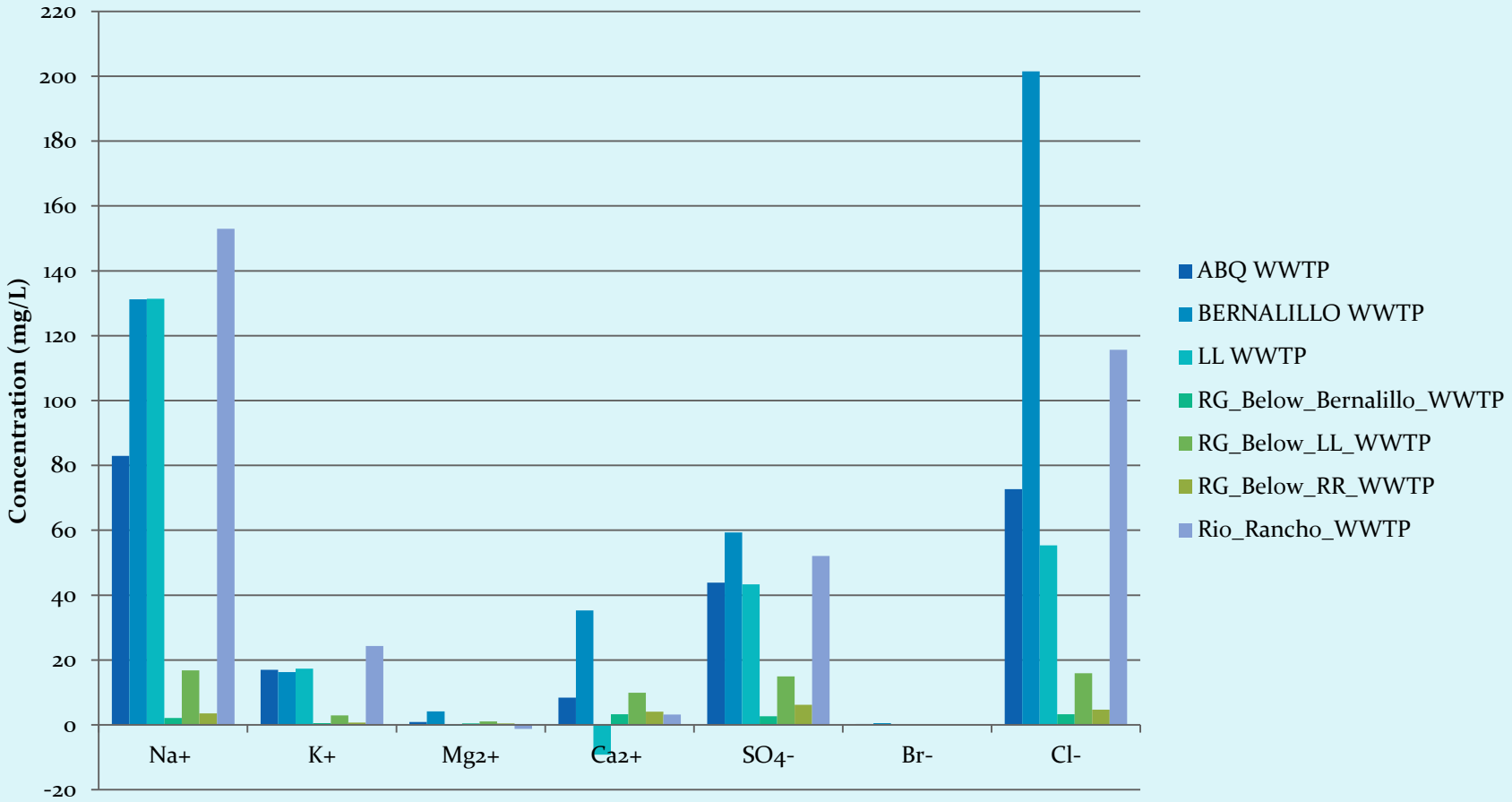

Rio Grande Below Abq WWTP

Experimental Methods

- Water samples taken and analyzed monthly from September 2005-January 2008 by Dr. David Van Horn, UNM Biology and Sevilleta LTER
  - Monthly data provided by Dr. Van Horn was averaged
  - Data from metro area sites were compared to Buckman, NM data
    - Buckman is upstream from all major metro areas
- Benthic invertebrate population survey was conducted October 2010 by Michelle Nuanez, Matt Peralta and Jennifer Kraus
  - Throw traps were set in 6 different pools, 3 upstream and 3 downstream from the Albuquerque WWTP
- T-Tests were performed on individual parameters, ANOVA test was performed on group parameters to determine statistical significance

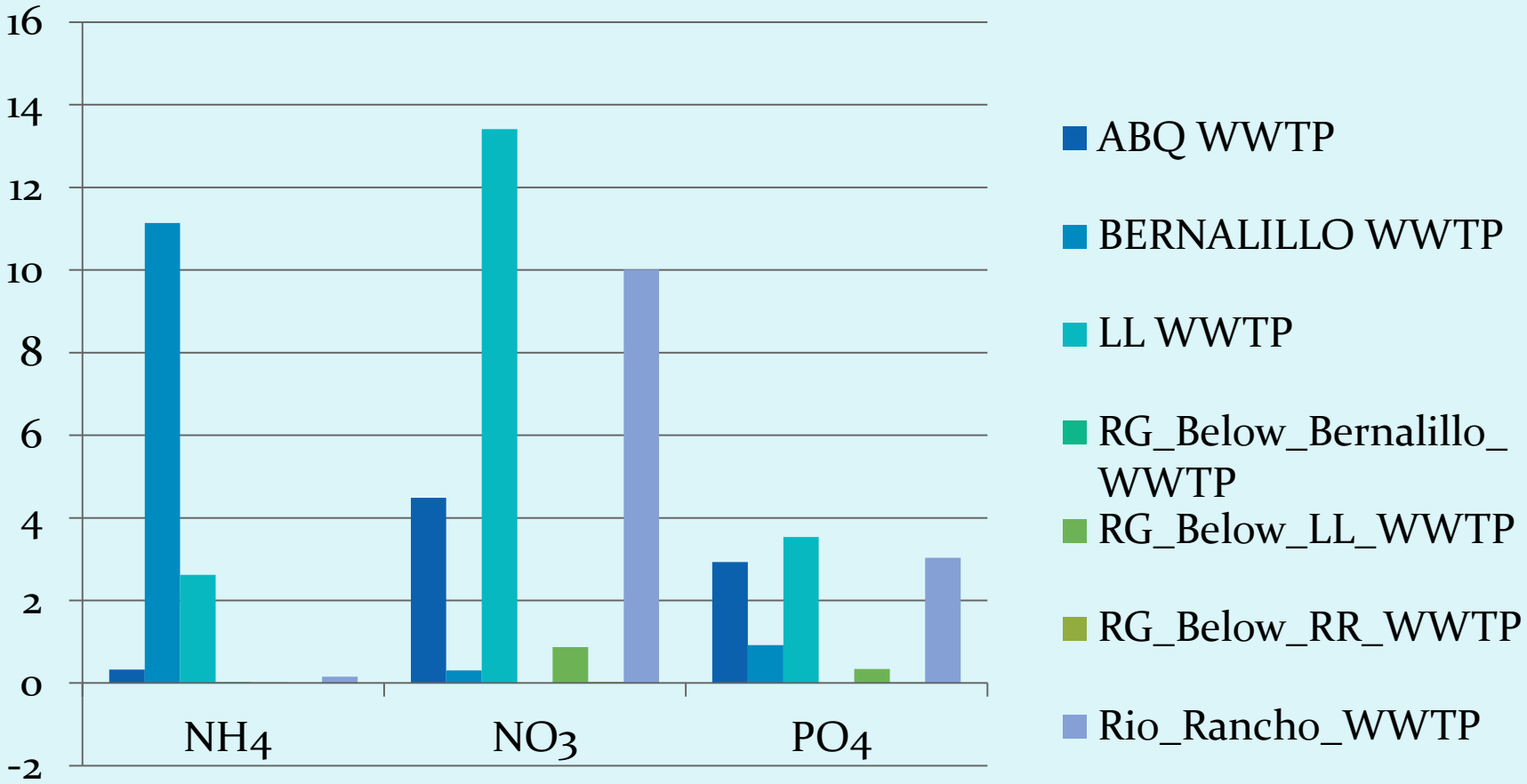
Major Anions and Cations

Graph shows concentration of specific anions and cations compared to Buckman, NM values

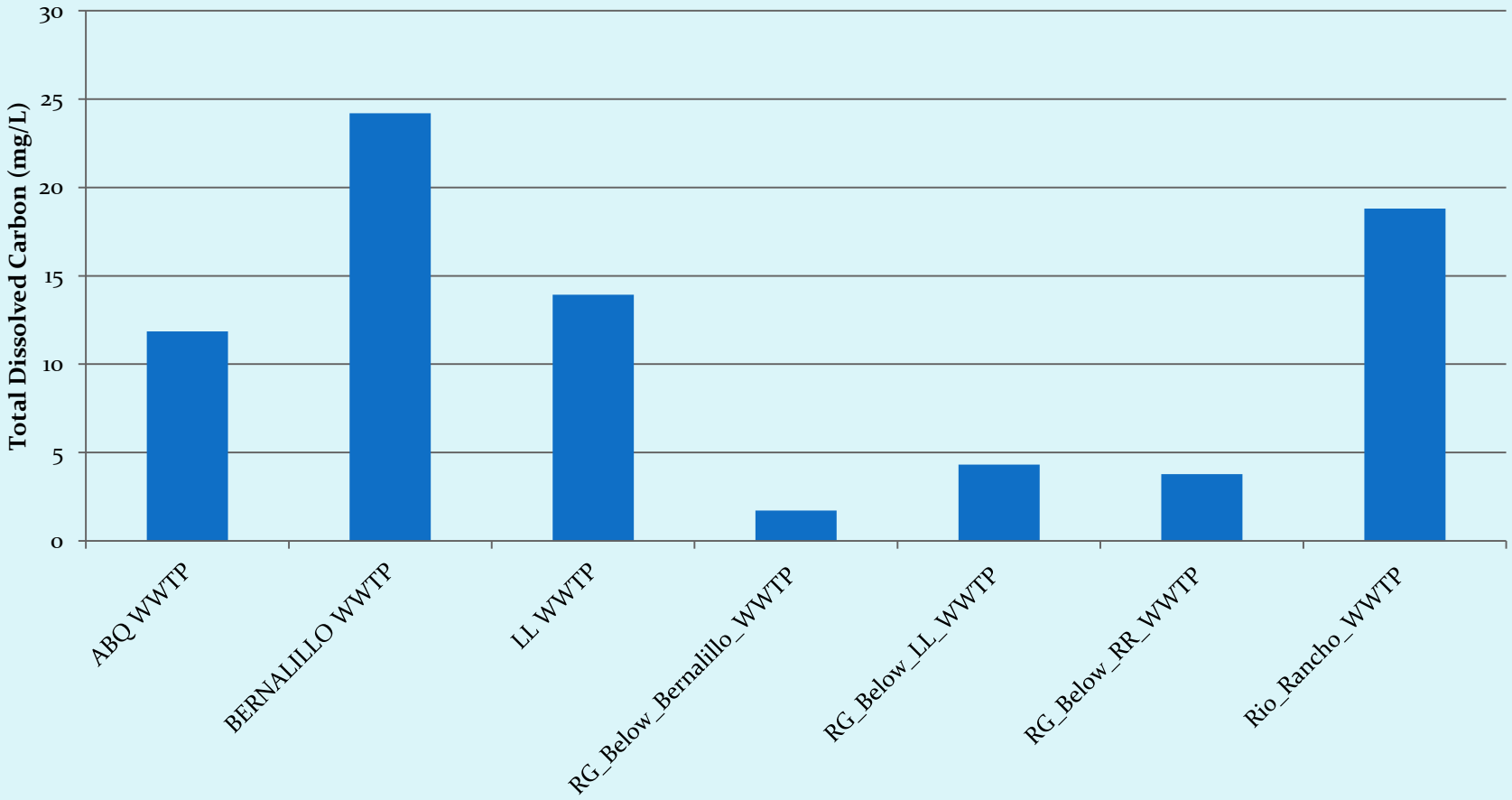


Inorganic Nutrient Concentrations

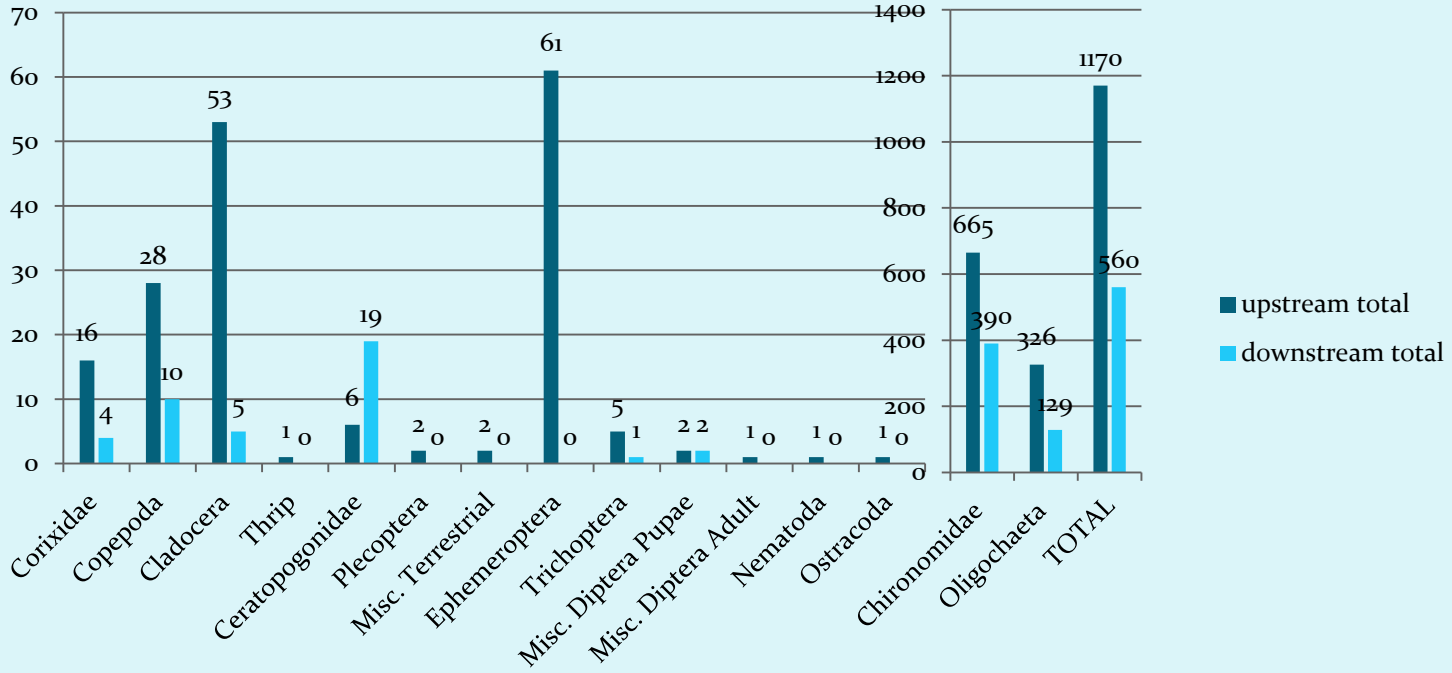
Graph shows inorganic nutrient concentrations compared to Buckman, NM values in mg/L



Dissolved Carbon



Invertebrate Species Count



Statistics of Invertebrate Species Sampled			
	Richness	Shannon	Abundance
Upstream	9	1.599368	75
	11	1.427619	327
	8	0.874374	767
Downstream	8	0.700668	442
	6	1.206709	110
	4	0.556554	59

Statistical Analysis

Perameter	T-Test P value	Significant?
Invert Total	0.081	No
Na+	0.011	Yes
K+	0.009	Very
Mg	0.228	No
Ca	0.151	No
NH4	0.2152	No
NO3	0.0914	No
PO4	0.0228	Yes
SO4	0.0111	Yes
Br	0.042	Yes
Cl	0.0491	Yes
TDC	0.0042	Very

Group water chemistry
ANOVA results =.000
Very significant

Conclusions

- Stream chemistries are significantly altered from upstream
- Benthic invertebrate populations decreased downstream of WWTP
  - Statistical analysis shows non-significant changes
  - Results from this aspect of the research are very preliminary, replication is needed to determine true significance.
  - It has been proposed that altered fish populations, specifically channel catfish which are highly tollerant, may have a notable impact on this

Where to go from here?

- Reduced water use
- Increased regulation by EPA
- Increased pressure on governments to use ozone or other tertiary steps to degrade cleaning chemicals
- Increased use of perforated pavement and storm channels to naturally filter water without ever having to go thru the WWTP

Literature Cited

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