# Hydrologic and Chemical Connectivity of Surface and Soils in an Urban Accidental Wetland: Implications for Nitrogen Removal

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## Introduction and Background

Wetland ecosystems can be highly effective at removing excess nutrients. Nitrogen, a common surface water pollutant in the form of nitrate ($NO_3^-$), can be transformed by microbial organisms to other forms of the nutrient via denitrification to dinitrogen ($N_2$) or nitrous oxide ($N_2O$) or via dissimilatory nitrate reduction to ammonium ($NH_4^+$; DNRA). Both reduction reactions require low oxygen and high organic carbon availability that are characteristic of wetland soils. However, if $NO_3^-$ enters wetlands through surface water, exchange between the surface and subsurface soil is required to facilitate $NO_3^-$ reduction. In this study, we investigate the hydrochemical connectivity of surface water and subsurface porewater in the stormwater-fed urban accidental wetlands located in the Salt River channel in Phoenix, Arizona to evaluate the potential for $NO_3^-$ reduction (Figure 1).

Denitrification: $NO_3^- \rightarrow NO_2^- \rightarrow NO \rightarrow N_2O \rightarrow N_2$

DNRA: $NO_3^- \rightarrow NO_2^- \rightarrow NH_4^+$

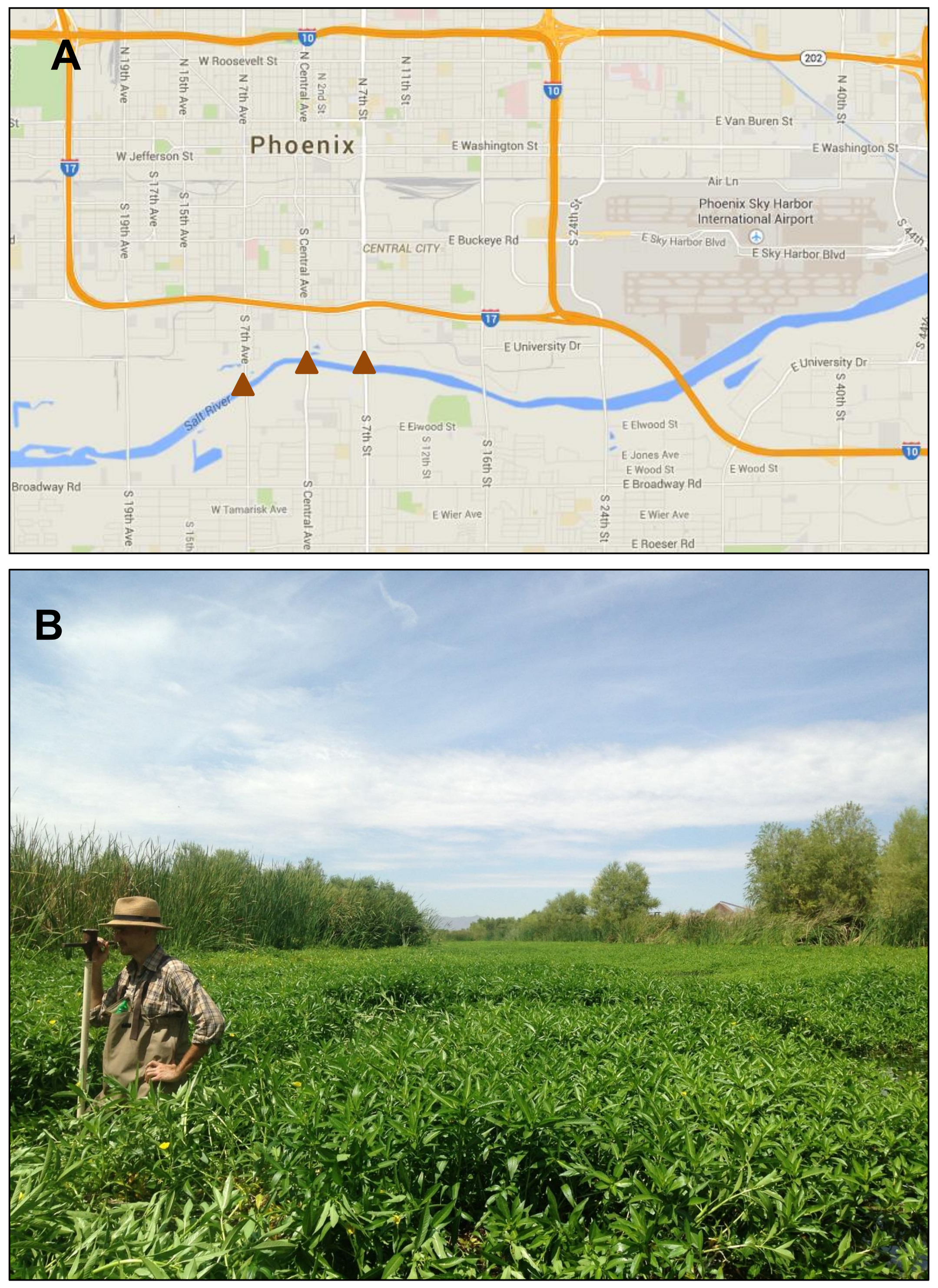

**Figure 1.** A) A map of the Phoenix metropolitan area with the three wetland site locations shown (triangles). B) An image of the urban wetland located at the 7th Avenue site during peak vegetated cover in June, 2014. Image courtesy of A. Suchy.

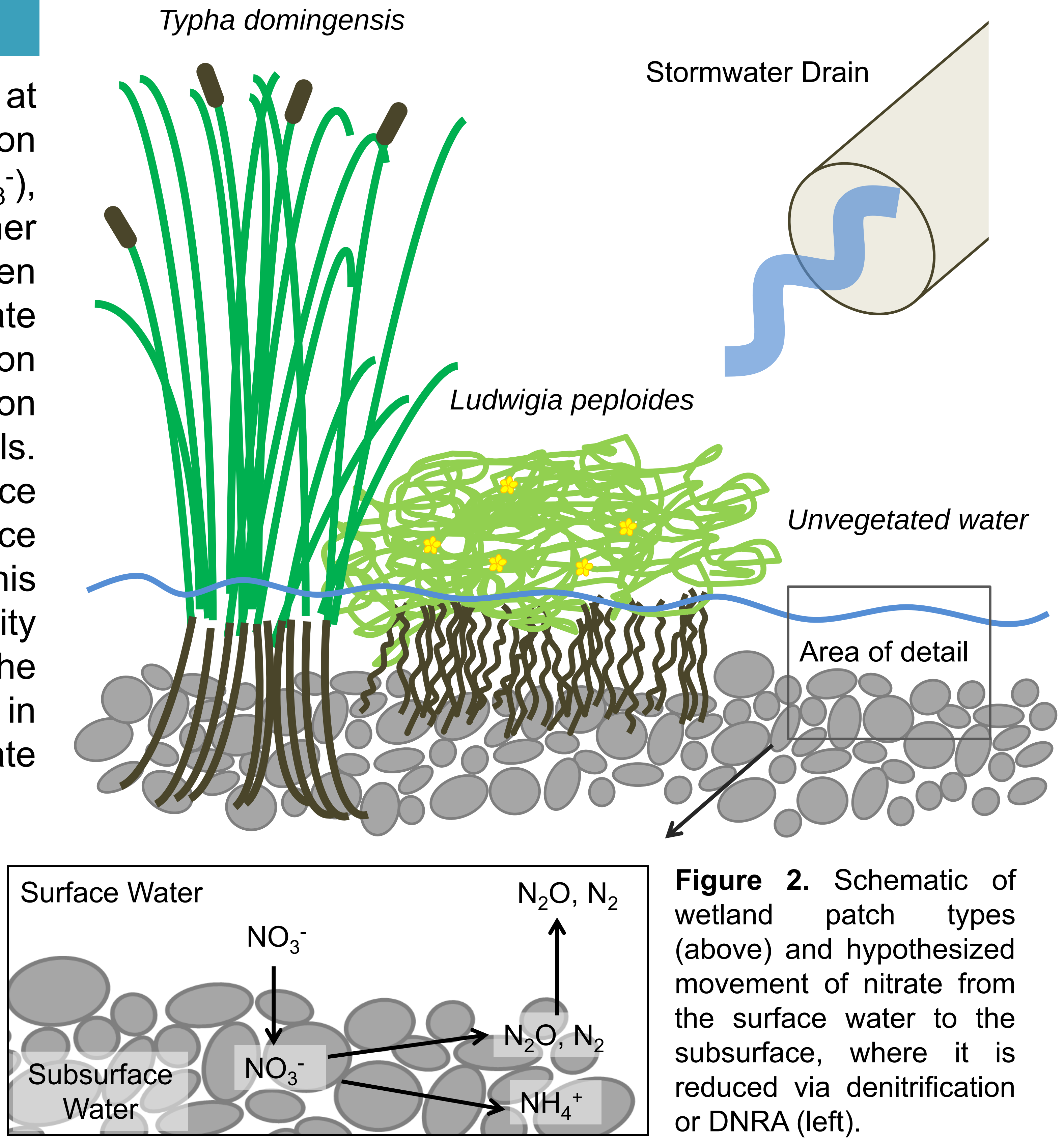

**Figure 2.** Schematic of wetland patch types (above) and hypothesized movement of nitrate from the surface water to the subsurface, where it is reduced via denitrification or DNRA (left).

## Methods

We collected water samples from three patch types across three wetland sites in the Salt River (Figure 2). We installed permanent wells inserted to a depth of 40 cm with perforations and mesh covering the bottom 30 cm of the shaft. We sampled wells for deep subsurface water and used a portable porewater sampler inserted to a depth of 10 cm to sample shallow water (Figure 3). We sampled a total of 31 locations for surface water, shallow water (porewater), and deep subsurface water (well) whenever present. We collected conductivity, dissolved oxygen concentration, and nitrate concentration from each water sample.

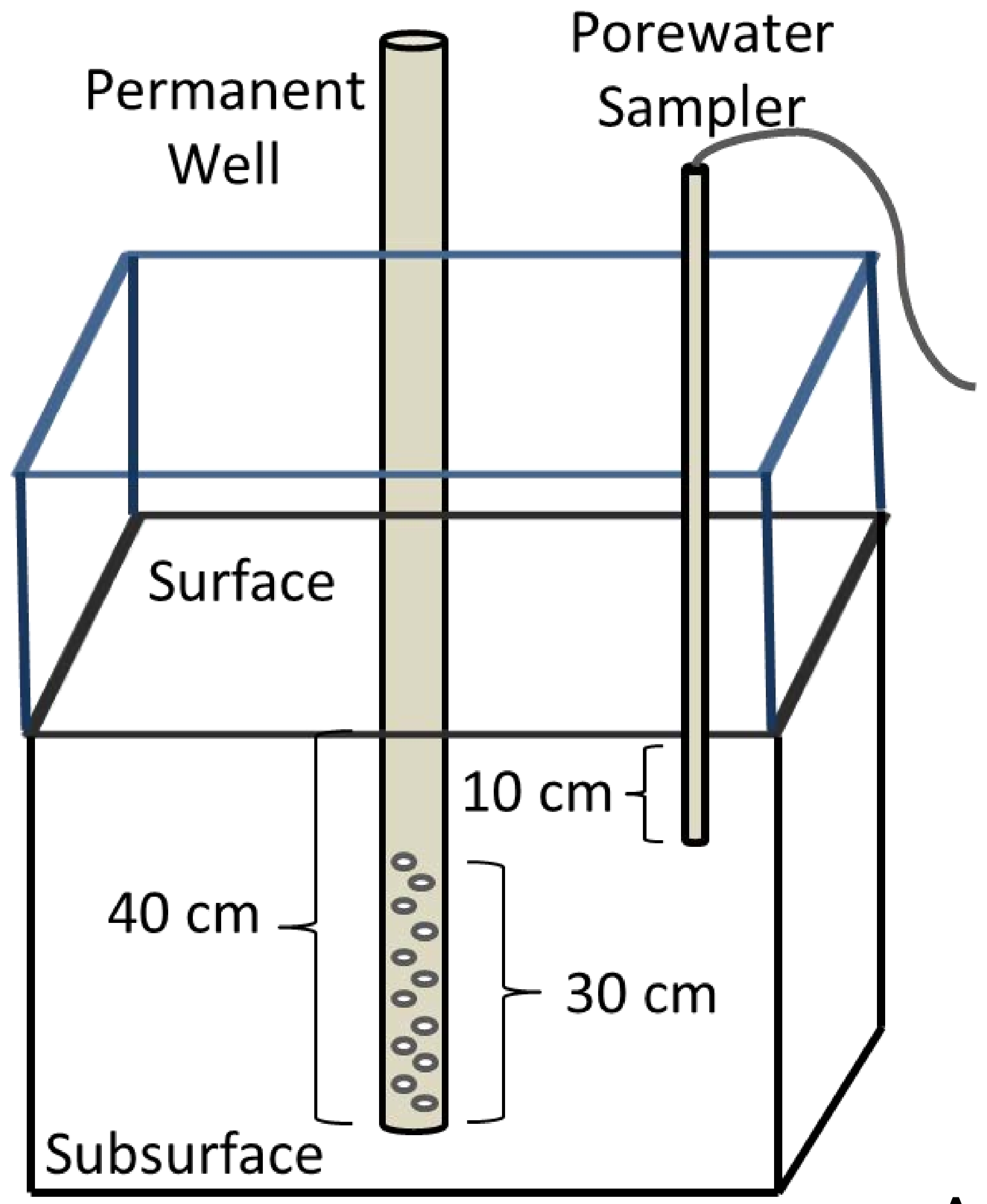

**Figure 3.** A diagram of the water sampling apparatus used for this investigation.

## Results and Discussion

Preliminary results of the investigation are as follows:

Conductivity was similar among the different water compartments and wetland patch types (Figure 3), indicating that different water compartments are hydrochemically connected regardless of the vegetative cover and type.

Dissolved oxygen concentrations were lower on average in the subsurface water compared to the surface water across all wetland patch types ( Figure 3), indicating conditions more conducive to nitrate reduction in the subsurface soils.

Nitrate concentrations were generally higher in the surface water compared to subsurface porewater (Table 1). This suggests the surface water is the source of nitrate that, once in the subsurface, can be either transformed or attenuated.

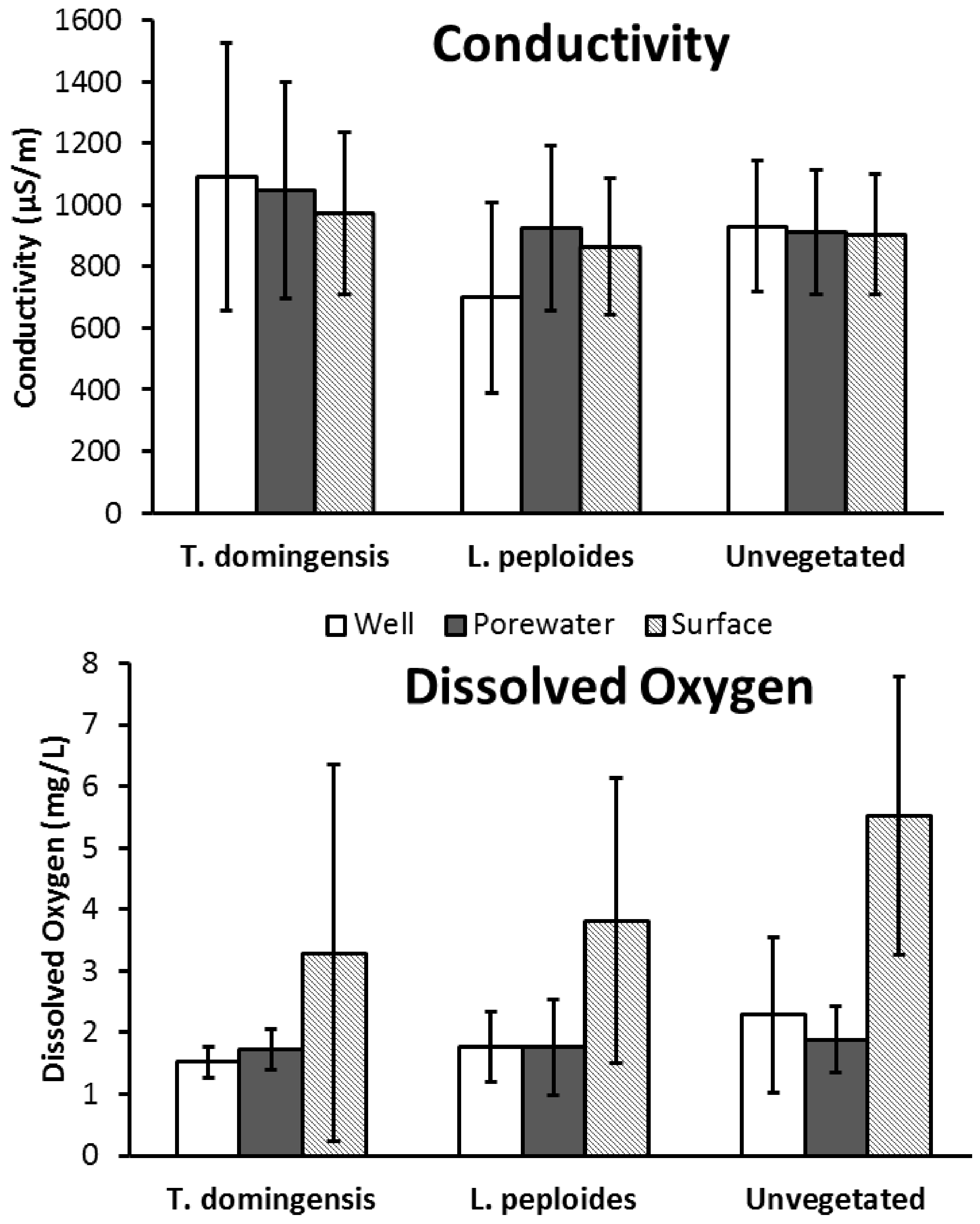

**Figure 4.** Conductivity (upper panel) and dissolved oxygen (lower panel) means and standard deviations for each water compartment within each patch type for water samples collected from all three wetland sites.

**Table 1.** Nitrate concentrations for the 7th Street site grouped as measurements above 0.1 ppm, below 0.1 ppm, and below detection limit (BDL).

| Compartment | > 0.1 ppm | < 0.1 ppm | BDL |
|---|---|---|---|
| Surface | 5 | 4 | 2 |
| Porewater | 0 | 4 | 7 |
| Well | 1 | 4 | 2 |

## Future Directions

In order to achieve a more complete understanding of the wetlands' capacity for microbial nitrate reduction we plan to collect water samples for analysis of conservative tracer ions and ammonium concentrations. We will also conduct experiments to measure denitrification and DNRA rates among different wetland patch types to compare the effect of wetland cover type on the capacity for nitrate transformations and removal.

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