Shallow Groundwater Quality along the Las Vegas Wash

(Final Project Report)

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Abstract

A total of fourteen erosion control structures have been built along the Las Vegas Wash (Wash) since 1999. The Wash serves as the drainage channel for the Las Vegas valley. These structures are playing a significant role in protecting sediment erosion, restoring ecosystems and wetlands, and improving water quality. During the construction of these erosion control structures, shallow groundwater from dewatering at the construction sites was discharged into the Wash. As part of the Nevada Division of Environmental Protection (NDEP) discharge permit requirements, shallow groundwater, dewatering water, and surface water quality has been monitored and reported on more than a dozen wells at several strategic locations along both sides of the Wash. This report summarizes data collected between 2001 and 2010 at 21 shallow groundwater wells. Field water quality parameters, including temperature, pH, Dissolved Oxygen (DO), and Electrical Conductance (EC), were measured at each sampling location. Water samples were collected and analyzed for major anions and cations, Total Dissolved Solids (TDS), perchlorate, and trace metals.

Introduction

The Las Vegas Wash Coordination Committee (LVWCC) implemented a re-vegetation project along both banks of the Las Vegas Wash (Wash) as part of the master plan for bank erosion protection and wetland system restoration in the Wash. The original plan was to drill a series of shallow groundwater wells at the re-vegetation sites and to pump shallow groundwater to irrigate these newly-planted trees and shrubs. Shallow groundwater wells were developed near the planting sites. In order to ensure the groundwater from these irrigation wells was suitable for the growth of plants, water quality was monitored. Beginning in April 2001, groundwater quality from two irrigation wells located downstream of the Pabco Erosion Control Structure (PECS), Pabco South Well (WMW6.0S) and Pabco North Well (WMW6.0N), have been monitored regularly. Since June 2002, the program was expanded to include four more wells around the PECS, WMW5.58S, WMW5.85S, WMW6.15S and WMW5.7N. It was found that quantity and quality of groundwater pumped from these wells were either limited or unsuitable for the irrigation, based on the hydrogeological and water quality data collected. Since that time, Wash water has been pumped and used for irrigation. Water quality and hydrologic data collection continued and data are available since 2001.

Meanwhile, more than a dozen erosion control structures and miles of bank protection have been built across and along the Wash. Before and during the construction of these erosion control structures, shallow groundwater was pumped from wells and discharged into the Wash. As required by the Nevada Division of Environmental Protection (NDEP) permits, groundwater quality samples and flow data were monitored and collected to evaluate any impacts of the dewatering on water quality in the Wash, Lake Mead, and adjacent shallow groundwater systems. The Southern Nevada Water Authority (SNWA) has been sampling and collecting data from the shallow groundwater wells from 2001 to 2010.

The current program not only collects water quality data from the shallow groundwater wells, but also provides information on pollutant (such as perchlorate and others) loading rates from the shallow groundwater systems into the Wash and Lake Mead and interactions between groundwater and surface water along the Wash. This report summarizes water quality and hydrologic data collected from these shallow groundwater wells.

Sample Collection and Analysis

Groundwater samples were collected from the monitoring wells regularly (monthly or quarterly). All shallow groundwater monitoring wells are shown in Figure 1.

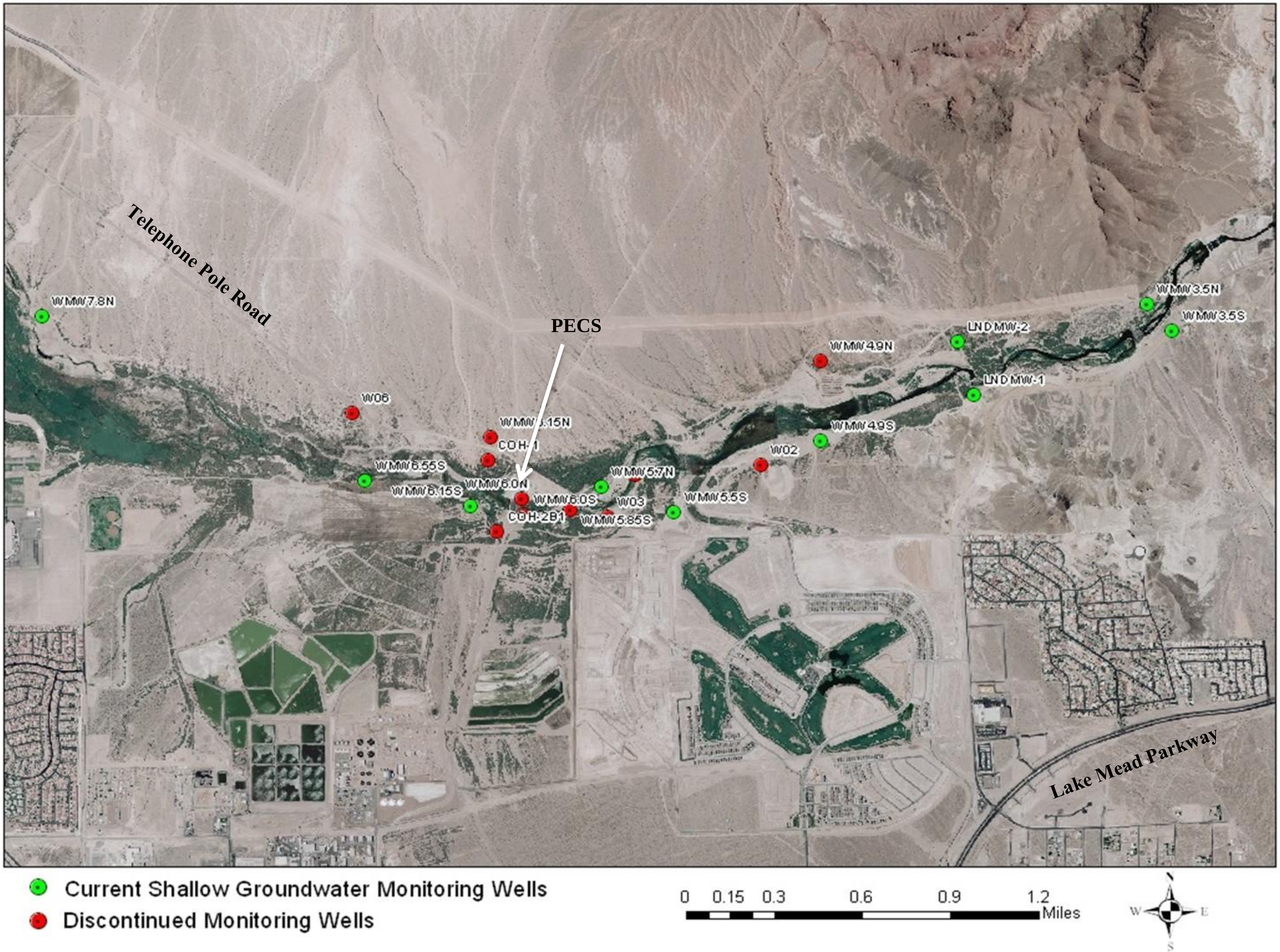

Figure 1. Location map showing current and discontinued monitoring wells along the Las Vegas Wash

A pre-cleaned battery operated pump was used to withdraw samples from each well. Generally, the pump ran approximately 15 minutes and pumped at least 3 well volumes of water before the water sample was collected. This process allows groundwater to flow around the well and guarantees the water samples taken are “fresh” and representative. Water samples were directly collected from a clean tube, which is connected to the pump, to acid-washed bottles. For cation and trace metal analyses, preservations, such as nitric acid, were pre-added to the bottles.

At each monitoring well, field water quality parameters including water temperature, pH, DO, and EC were measured using a Hydrolab. The following water quality parameters were analyzed by contracted labs and the SNWA laboratories: major ions, TDS, silica (SiO_2), boron, perchlorate, and metals.

Results and Discussion

Field Measurements: The monitoring wells were generally shallow in depth. The water table ranged from 3 to 44 feet below ground. The water table becomes shallower from upstream to downstream in the Wash (Figure 2).

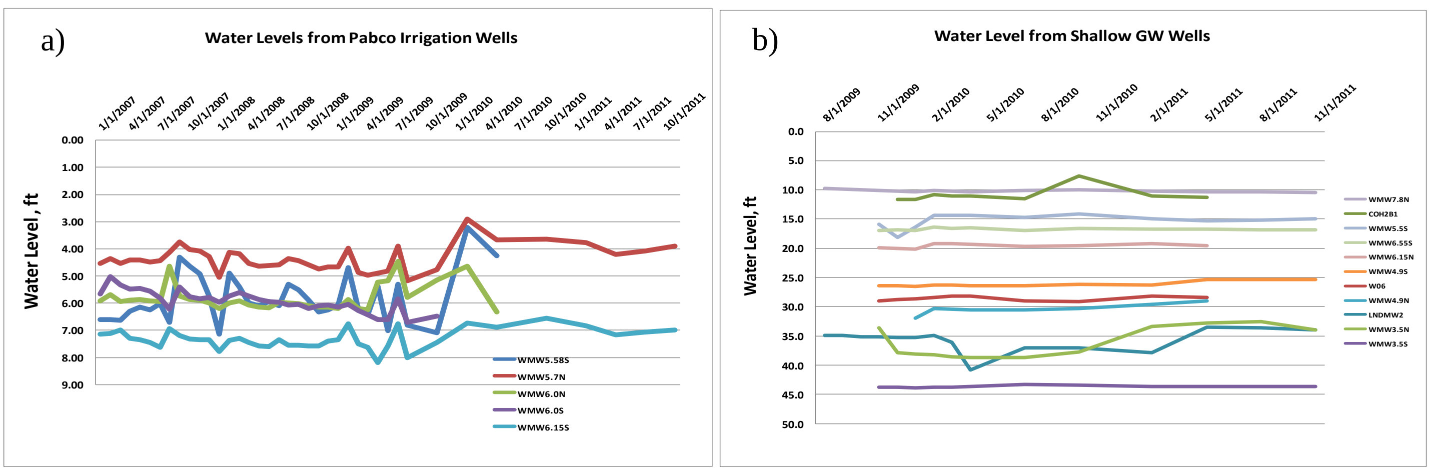

Figure 2. Water levels from shallow groundwater monitoring wells along the Wash. a) Water levels for wells near the PECS originally intended as irrigation wells. b) Water levels for other wells adjacent to the Las Vegas Wash.

As indicated by the conductance values, several wells near the Wash had a significant input of Wash water. The pH values were very consistent, ranging from 6.5 to 7.5. DO concentrations of these waters were generally lower than 5.0 mg/L or unsaturated. The wells around the PECS, such as WMW3.5N, COH-2A, COH2B1, WMW6.55S, WMW6.15S and WMW6.0S, had higher conductance values. The wells with significant inputs from Wash water, such as WMW5.58S, WMW4.9S, WMW7.8N, and WMW5.7N, had lower conductance values. The wells that have both groundwater and Wash water (mixture), such as WMW4.9N and W02, and W06, had intermediate conductance values. Corresponding to conductance, TDS concentrations in these monitoring wells showed similar variations (Figures 3 and 4).

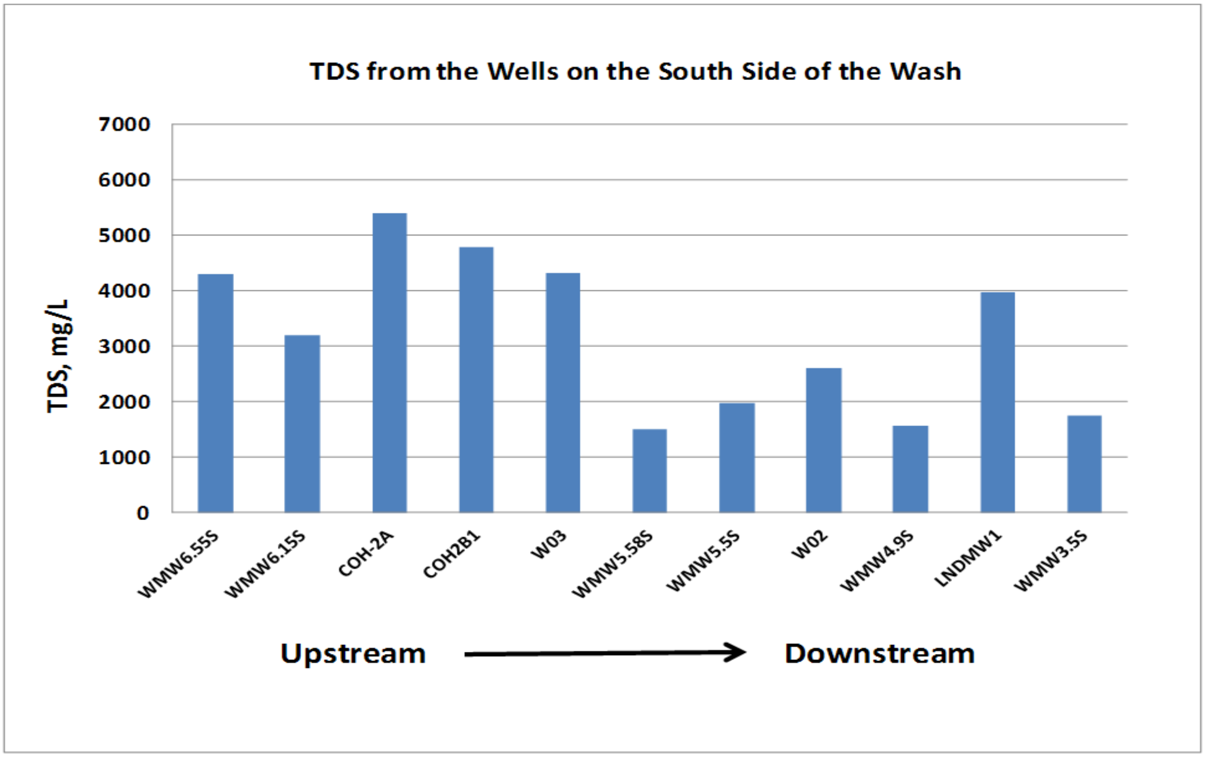

Figure 3. Average TDS from the wells on the south side of the Wash

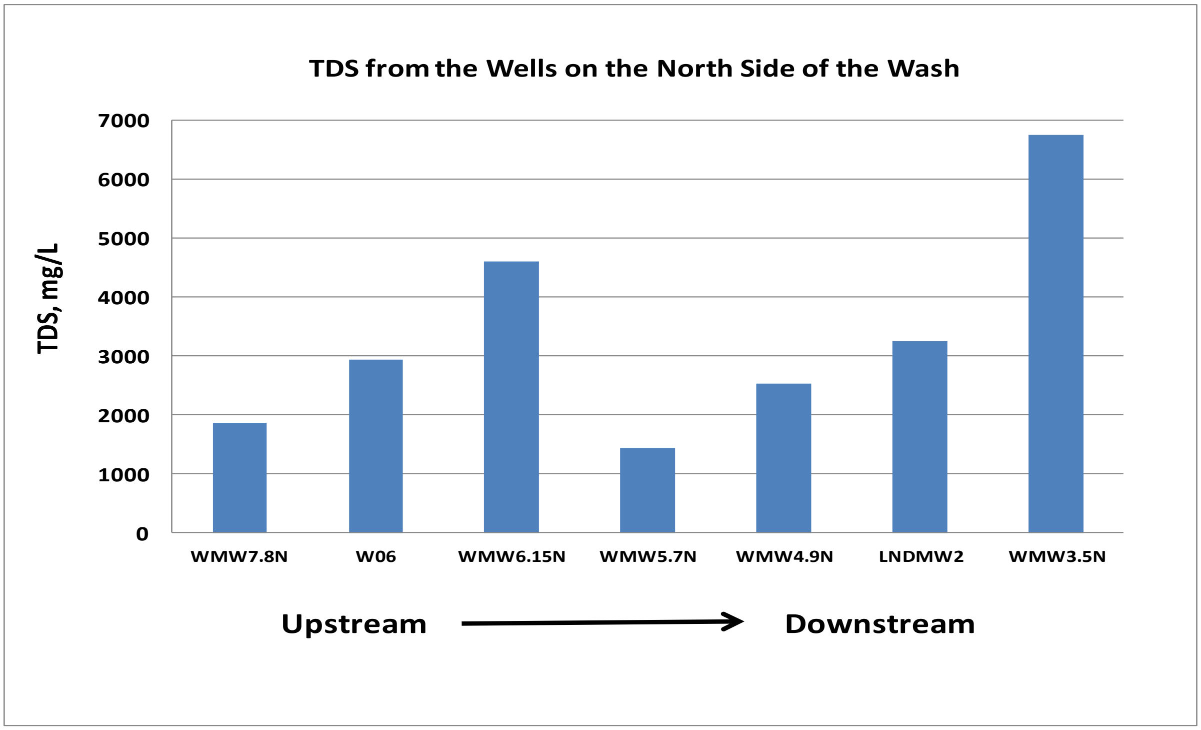

Figure 4. Average TDS from the wells on the north side of the Wash

Major Ion Geochemistry: Cations were dominated by calcium, magnesium, sodium, and potassium. Anions were dominated by chloride, sulfate, and alkalinity (Figures 5 and 6).

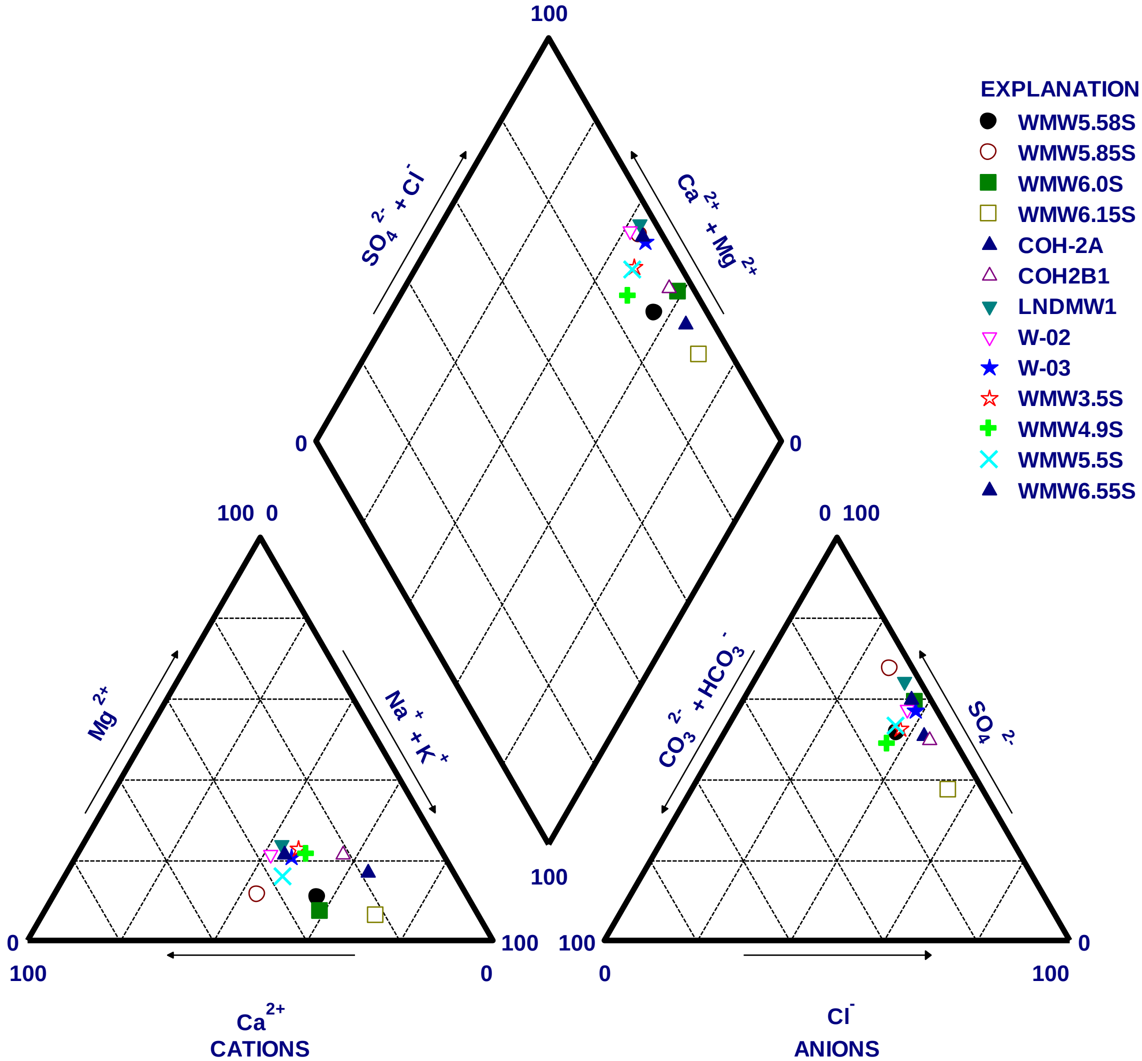

Figure 5. Piper diagrams from the wells on the south side of the Wash

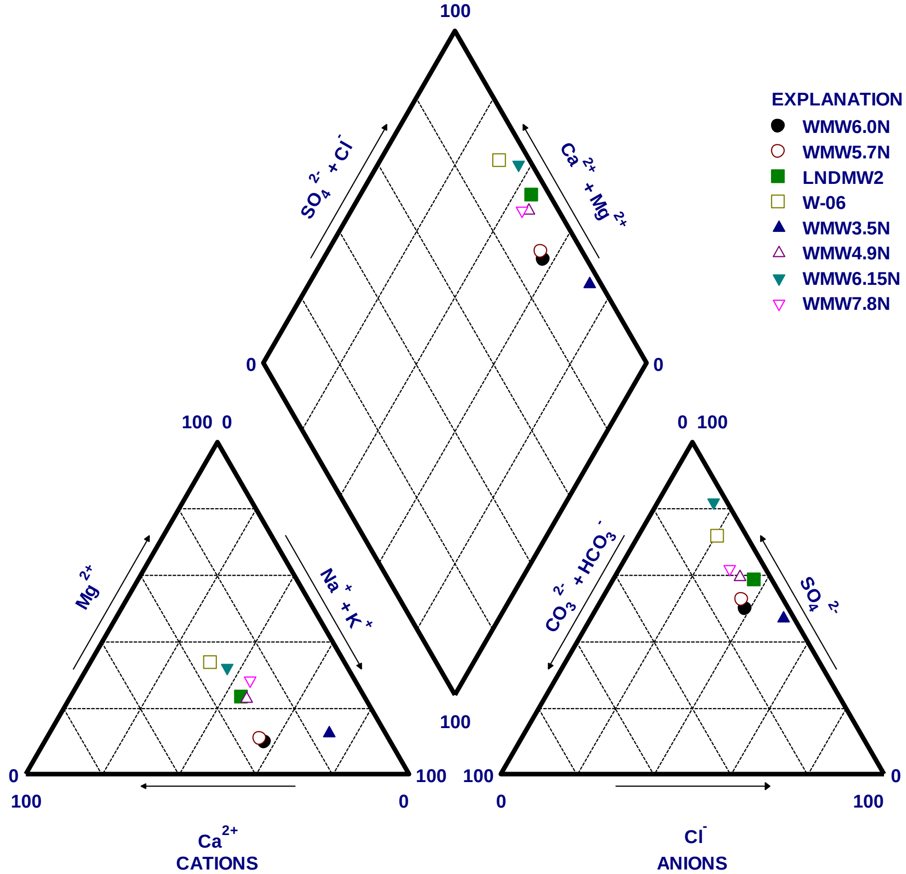

Figure 6. Piper diagrams from the wells on the north side of the Wash

Average nitrate concentrations varied from 0.3 mg/L to 14 mg/L. Groundwater from the wells near the Wash contained a high nitrate concentration due to the infiltration of the Wash water. The wells with no or less influence of the Wash water had lower nitrate concentrations (Figure 7). Orthophosphate as P (OP) concentrations from these wells ranged from 0.01 mg/L to 0.14 mg/L. Similar to nitrate, OP concentrations were higher in the wells with more input from the Wash water, such as WMW5.7N, WMW6.15S, WMW5.58S, and WMW4.9S (Figure 8). Average silica concentrations from these monitoring wells ranged from 19 mg/L to 162 mg/L. Two wells on the north side of the Wash (WMW5.7N and W06) had higher silica concentrations (> 100 mg/L). Average fluoride concentrations ranged from 0.7 mg/L to 2.5 mg/L.

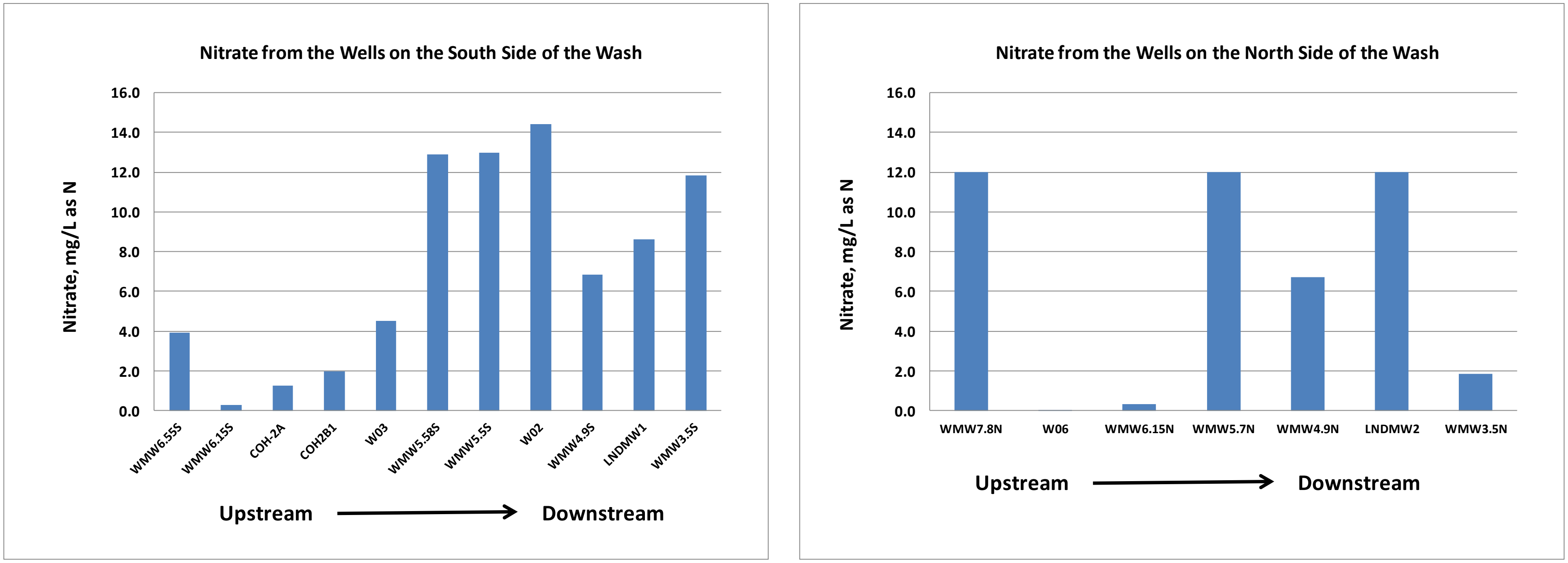

Figure 7. Average nitrate concentrations from the wells on the south (left) and north (right) side of the Wash

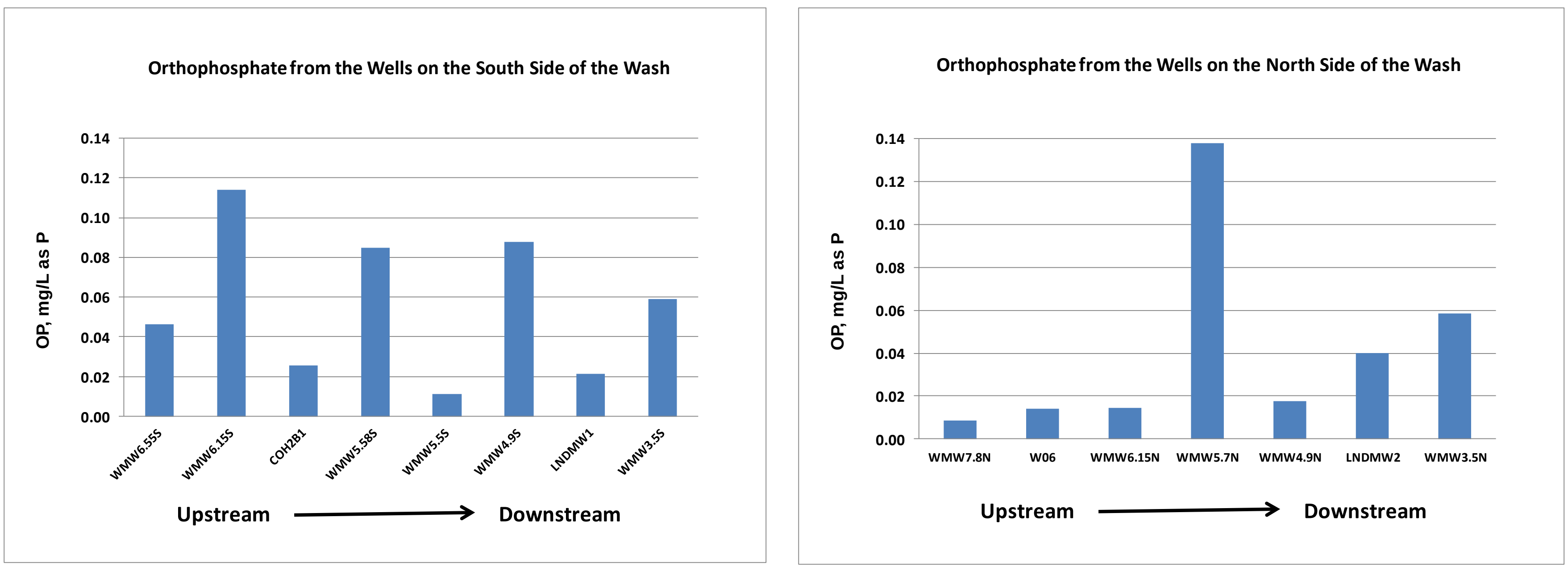

Figure 8. Average orthophosphate concentrations from the wells on the south (left) and north (right) side of the Wash

Perchlorate: Perchlorate concentrations from the monitoring wells around the PECS were normally high due to contribution from the Tronox perchlorate plume. These wells include COH-2A, COH2B1, W03, WMW6.55S, and WMW6.15S (Figure 9). Average perchlorate concentrations from these wells ranged from 1,000 µg/L to 9,000 µg/L. The wells with more Wash water contribution, including WMW5.58S, WMW5.5S, WMW4.9S and WMW3.5S, had much lower perchlorate concentrations (from 44 µg/L and 230 µg/L). Also, perchlorate concentrations from the south-side wells were much higher than those from the north-side wells (Figure 10).

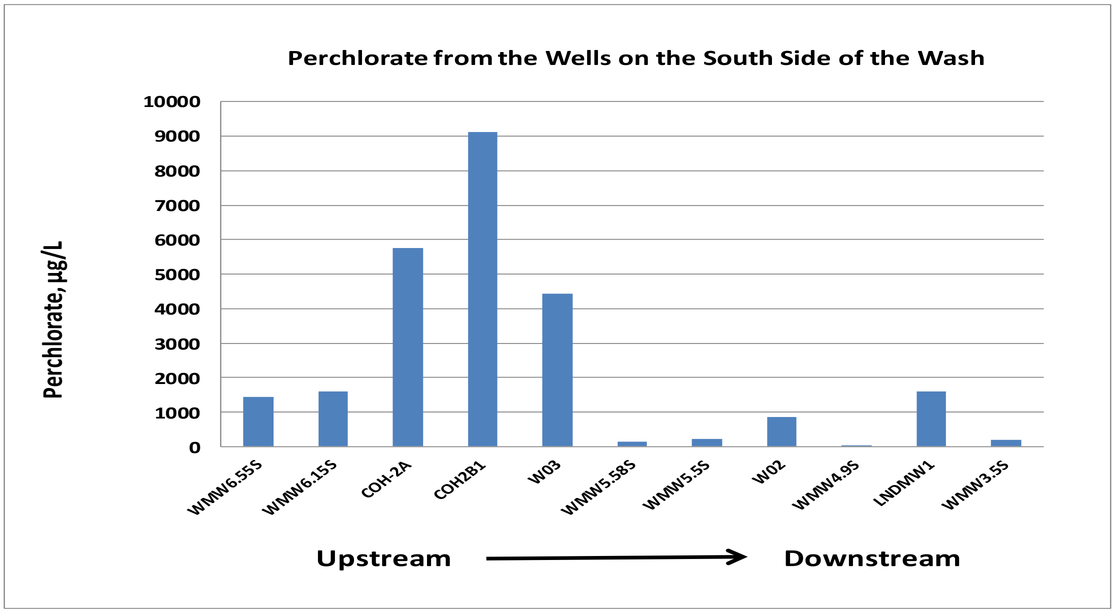

Figure 9. Perchlorate concentrations from the wells on the south side of the Wash

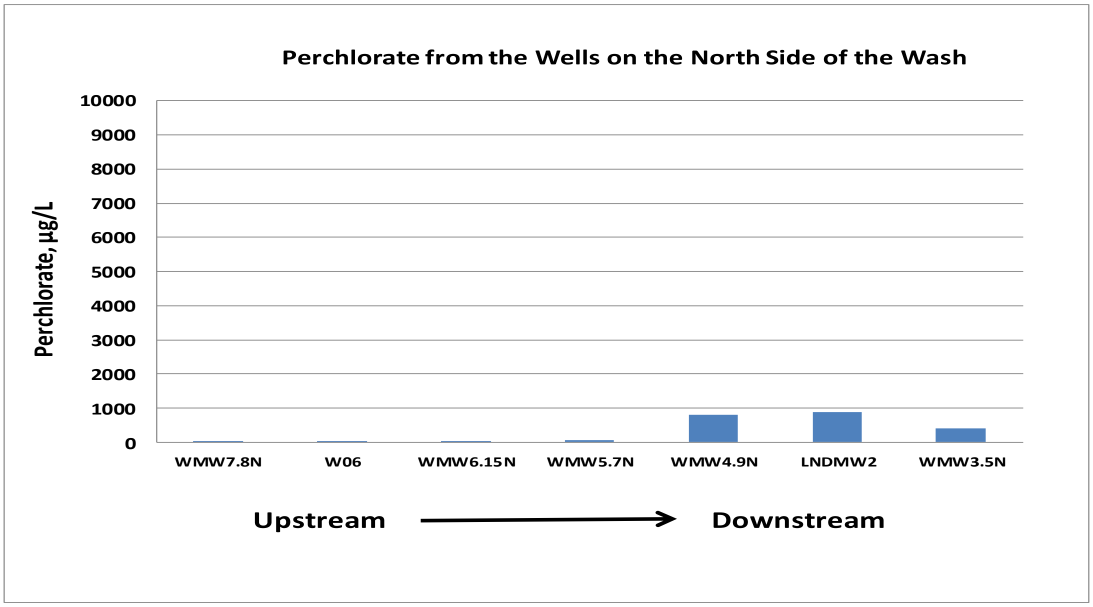

Figure 10. Perchlorate concentrations from the wells on the north side of the Wash

Boron: Boron is an essential trace element for the growth and development of plants (Eisler, 2000). However, when its concentrations in irrigation waters are higher than 2 mg/L, extensive plant toxicity would be expected (Pagenkopf and Connolly, 1982). Boron concentrations from the PECS monitoring wells (WMW5.58S, WMW6.0N, and WMW5.7N) were lower than 1.0 mg/L, whereas boron concentrations from WMW6.15S and WMW6.0S varied between 1.0 mg/L and 3.25 mg/L. However, their boron concentrations have been lowered since 2008 likely due to more Wash water infiltration (Figure 11). Boron concentrations in Wash water were much lower than those in groundwater.

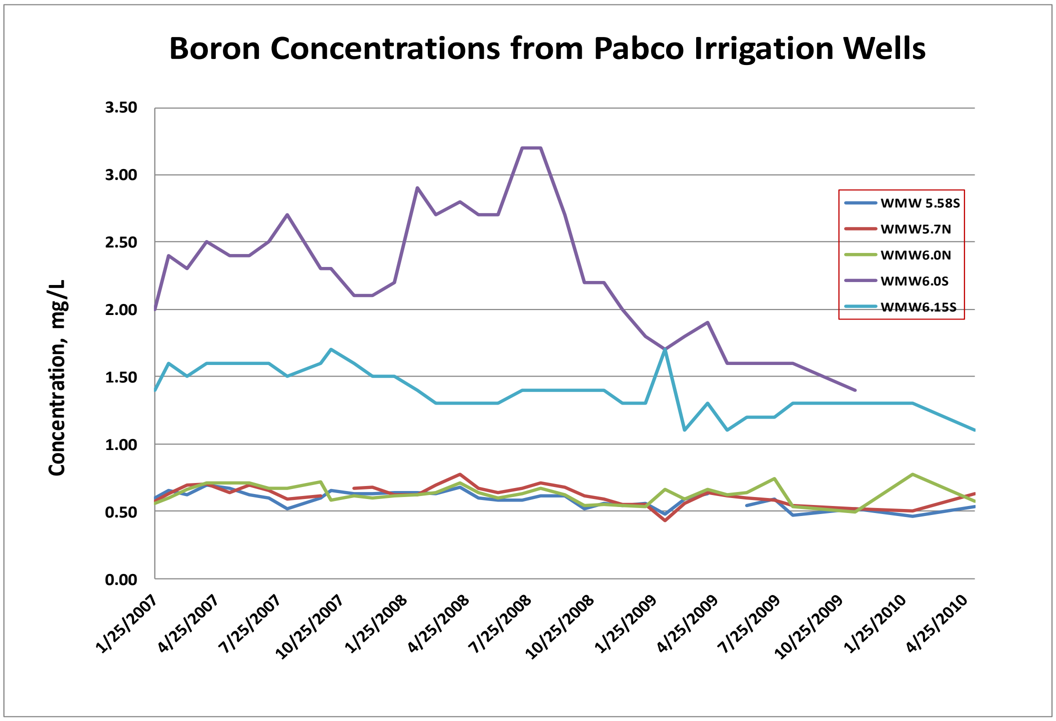

Figure 11. Boron concentrations from PECS irrigation wells

Metals: A total of 19 metals were analyzed for this study. Average concentrations of these metals are plotted and shown in Figure 12. Among these metals, aluminum (Al), iron (Fe), Manganese (Mn) and zinc (Zn) concentrations ranged from 0.01 mg/L to 1.75 mg/L. Concentrations of 15 trace metals were much lower than these minor metal concentrations or not detected. The ranges of concentrations from the wells on the south side of the Wash were 22-140 µg/L for arsenic (As), 10-36 µg/L for barium (Ba), 3-15 µg/L for chromium (Cr), 8-10 µg/L for copper (Cu), 10-270 µg/L for molybdenum (Mo), 8-20 µg/L for nickel (Ni), 3-33 µg/L for selenium (Se), and 10-72 µg/L for vanadium (V). The ranges of concentrations from the wells on the north side of the Wash were 7-64 µg/L for As, 10-51 µg/L for Ba, 3-6 µg/L for Cr, 8-10 µg/L for Cu, 10-80 µg/L for Mo, 8-11 µg/L for Ni, 3-10 µg/L for Se, and 10-34 µg/L for V. Also, it is noted that groundwater from the wells near the PECS had higher concentrations of trace metals, suggesting that these wells have been impacted by the known groundwater plume originating up-gradient.

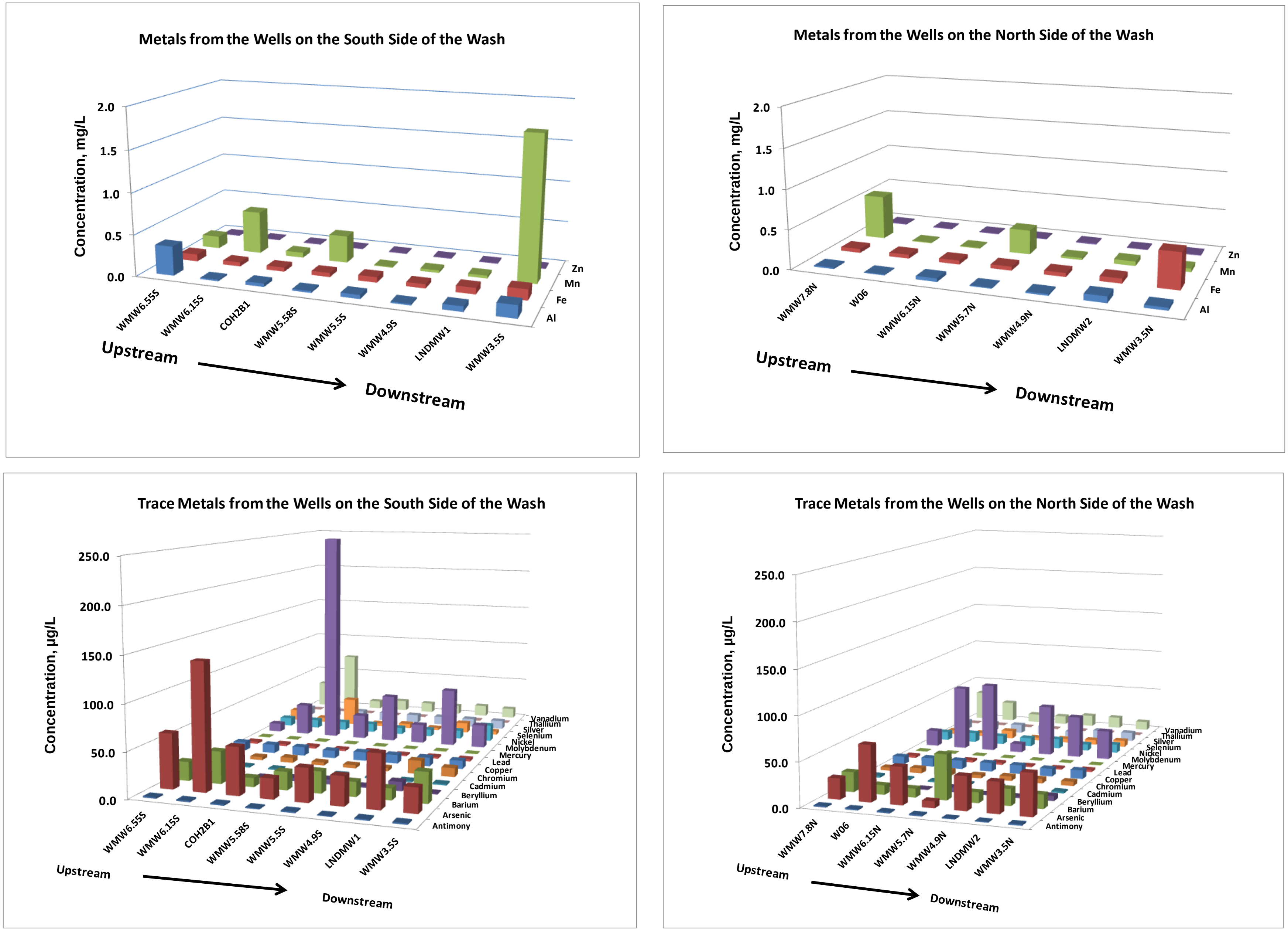

Figure 12. Average metal concentrations from the wells on the south (left) and north (right) side of the Wash

Summary

More than 20 shallow groundwater wells along both sides of the Las Vegas Wash have been monitored and analyzed for water quality. Some wells were located on the floodplain of the Wash (such as WMW 5.58S and WMW 5.7N); the others are located on both banks of the Wash (such as W06, WMW 3.5S, and WMW 4.9N). The water levels of these wells vary based on their locations (Figure 2). The wells closer to the Wash have a shallower water table. Water quality in these shallower wells was strongly influenced by the Wash water quality. For example, TDS, nutrient, and metal concentrations from these shallow wells were fairly similar to their concentrations in the Wash. However, groundwater from the wells located on the banks of the Wash had relatively higher TDS concentrations (> 3000 mg/L). TDS concentrations in these wells also increased from upstream to downstream of the Wash. Perchlorate concentrations from the wells located on the south side of the Wash, especially from the wells near the PECS, were much higher than the wells located on the north side of the Wash. Boron concentrations in two of the PECS irrigation wells were higher than 1.0 mg/L. Out of 19 metals analyzed, some metals were low in concentrations or not detected. The others had a broad range of concentrations (3 µg/L ~ 270 µg/L). Data indicates that a known up-gradient groundwater plume had a strong impact on water quality of the wells near the PECS.

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